

RTI Connex DDS Micro

User's Manual

Version 3.0.2



Your systems.
Working as one.

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RTI® Connex® DDS Micro provides a small-footprint, modular messaging solution for resource-limited devices that have limited memory and CPU power, and may not even be running an operating system. It provides the communications services that developers need to distribute time-critical data. Additionally, *Connex DDS Micro* is designed as a certifiable component in high-assurance systems.

Key benefits of *Connex DDS Micro* include:

- Accommodations for resource-constrained environments.
- Modular and user extensible architecture.
- Designed to be a certifiable component for safety-critical systems.
- Seamless interoperability with *RTI Connex DDS Professional*.

Chapter 1

Introduction

1.1 What is RTI Connex DDS Micro?

RTI Connex DDS Micro is network middleware for distributed real-time applications. It provides the communications service programmers need to distribute time-critical data between embedded and/or enterprise devices or nodes. *Connex DDS Micro* uses the publish-subscribe communications model to make data distribution efficient and robust. *Connex DDS Micro* simplifies application development, deployment and maintenance and provides fast, predictable distribution of time-critical data over a variety of transport networks. With *Connex DDS Micro*, you can:

- Perform complex one-to-many and many-to-many network communications.
- Customize application operation to meet various real-time, reliability, and quality-of-service goals.
- Provide application-transparent fault tolerance and application robustness.
- Use a variety of transports.

Connex DDS Micro implements the Data-Centric Publish-Subscribe (DCPS) API within the OMG's Data Distribution Service (DDS) for Real-Time Systems. DDS is the first standard developed for the needs of real-time systems. DCPS provides an efficient way to transfer data in a distributed system.

With *Connex DDS Micro*, systems designers and programmers start with a fault-tolerant and flexible communications infrastructure that will work over a wide variety of computer hardware, operating systems, languages, and networking transport protocols. *Connex DDS Micro* is highly configurable so programmers can adapt it to meet the application's specific communication requirements.

1.1.1 RTI Connex DDS Cert versus RTI Connex DDS Micro

RTI Connex DDS Micro and *RTI Connex DDS Cert* originate from the same source base, but as of *Connex DDS Micro* 2.4.6 the two are maintained as two independent releases. The latest release with certification evidence is *Connex DDS Cert* 2.4.5. However, features that exist in *Connex DDS Micro* and *Connex DDS Cert* behave identically and the source code is written following identical guidelines. *Connex DDS Cert* only supports a subset of the features found in *Connex*

DDS Micro. In the API reference manuals, APIs that are supported by *Connex DDS Cert* are clearly marked.

1.1.2 Optional Certification Package

An optional Certification Package is available for systems that require certification to DO-178C or other safety standards. This package includes the artifacts required by a certification authority. The Certification Package is licensed separately from Connex DDS Cert.

To use an existing Certification Package, an application must be linked against the same libraries included in the Certification Package. Contact RTI Support, support@rti.com, for details.

1.1.3 Publish-Subscribe Middleware

Connex DDS Micro is based on a publish-subscribe communications model. Publish-subscribe (PS) middleware provides a simple and intuitive way to distribute data. It decouples the software that creates and sends data—the data publishers—from the software that receives and uses the data—the data subscribers. Publishers simply declare their intent to send and then publish the data. Subscribers declare their intent to receive, then the data is automatically delivered by the middleware. Despite the simplicity of the model, PS middleware can handle complex patterns of information flow. The use of PS middleware results in simpler, more modular distributed applications. Perhaps most importantly, PS middleware can automatically handle all network chores, including connections, failures, and network changes, eliminating the need for user applications to program of all those special cases. What experienced network middleware developers know is that handling special cases accounts for over 80% of the effort and code.

1.2 Supported DDS Features

Connex DDS Micro supports a subset of the DDS DCPS standard. A brief overview of the supported features are listed here. For a detailed list, please refer to the [C API Reference](#) and [C++ API Reference](#).

1.2.1 DDS Entity Support

Connex DDS Micro supports the following DDS entities. Please refer to the documentation for details.

- [DomainParticipantFactory](#)
- [DomainParticipant](#)
- [Topic](#)
- [Publisher](#)
- [Subscriber](#)
- [DataWriter](#)
- [DataReader](#)

1.2.2 DDS QoS Policy Support

Connex DDS Micro supports the following DDS QoS Policies. Please refer to the documentation for details.

- [DDS_DataReaderProtocolQosPolicy](#)
- [DDS_DataReaderResourceLimitsQosPolicy](#)
- [DDS_DataWriterProtocolQosPolicy](#)
- [DDS_DataWriterResourceLimitsQosPolicy](#)
- [DDS_DeadlineQosPolicy](#)
- [DDS_DiscoveryQosPolicy](#)
- [DDS_DomainParticipantResourceLimitsQosPolicy](#)
- [DDS_DurabilityQosPolicy](#)
- [DDS_DestinationOrderQosPolicy](#)
- [DDS_EntityFactoryQosPolicy](#)
- [DDS_HistoryQosPolicy](#)
- [DDS_LivelinessQosPolicy](#)
- [DDS_OwnershipQosPolicy](#)
- [DDS_OwnershipStrengthQosPolicy](#)
- [DDS_ReliabilityQosPolicy](#)
- [DDS_ResourceLimitsQosPolicy](#)
- [DDS_RtpsReliableWriterProtocol_t](#)
- [DDS_SystemResourceLimitsQosPolicy](#)
- [DDS_TransportQosPolicy](#)
- [DDS_UserTrafficQosPolicy](#)
- [DDS_WireProtocolQosPolicy](#)

1.3 RTI Connex DDS Documentation

Throughout this document, we may suggest reading sections in other *RTI Connex DDS* documents. These documents are in your *RTI Connex DDS* installation directory under **r_{ti}-connex-dds-
<version>/doc/manuals**. A quick way to find them is from *RTI Launcher*'s Help panel, select "Browse Connex Documentation".

Since installation directories vary per user, links are not provided to these documents on your local machine. However, we do provide links to documents on the [RTI Documentation](#) site for users with Internet access.

New users can start by reading Parts 1 (Introduction) and 2 (Core Concepts) in the *RTI Connex DDS Core Libraries User's Manual*. These sections teach basic DDS concepts applicable to all RTI middleware, including *RTI Connex DDS Professional* and *RTI Connex DDS Micro*. You can open the *RTI Connex DDS Core Libraries User's Manual* from *RTI Launcher's* Help panel.

The [RTI Community](#) provides many resources for users of DDS and the RTI Connex family of products.

1.4 OMG DDS Specification

For the original DDS reference, the OMG DDS specification can be found in the [OMG Specifications](#) under “Data Distribution Service”.

1.5 Other Products

RTI Connex DDS Micro is one of several products in the *RTI Connex* family of products:

RTI Connex DDS Cert is a subset of *RTI Connex DDS Micro*. *Connex DDS Cert* does not include the following features because Certification Evidence is not yet available for them. If you require Certification Evidence for any of these features, please contact RTI.

- C++ language API.
- Multi-platform support.
- Dynamic endpoint discovery.
- delete() APIs (e.g. delete_datareader())

RTI Connex DDS Professional addresses the sophisticated databus requirements in complex systems including an API compliant with the Object Management Group (OMG) Data Distribution Service (DDS) specification. DDS is the leading data-centric publish/subscribe (DCPS) messaging standard for integrating distributed real-time applications. *Connex DDS Professional* is the dominant industry implementation with benefits including:

- OMG-compliant DDS API
- Advanced features to address complex systems
- Advanced Quality of Service (QoS) support
- Comprehensive platform and network transport support
- Seamless interoperability with rtime

RTI Connex DDS Professional includes rich integration capabilities:

- Data transformation
- Integration support for standards including JMS, SQL databases, file, socket, Excel, OPC, STANAG, LabVIEW, Web Services and more
- Ability for users to create custom integration adapters
- Optional integration with Oracle, MySQL and other relational databases

- Tools for visualizing, debugging and managing all systems in real-time

RTI Connex DDS Professional also includes a rich set of tools to accelerate debugging and testing while easing management of deployed systems. These components include:

- Administration Console
- Distributed Logger
- Monitor
- Monitoring Library
- Recording Service

Chapter 2

Installation

2.1 Installing the RTI Connex DDS Micro Package

RTI Connex DDS Micro is provided in one of 4 RTI target packages:

- `rti_connex_dds_micro-3.0.2-Unix.rtipkg`
- `rti_connex_dds_micro-3.0.2-Windows.rtipkg`
- `rti_connex_dds_micro_security_sdk-3.0.2-Unix.rtipkg`
- `rti_connex_dds_micro_security_sdk-3.0.2-Windows.rtipkg`

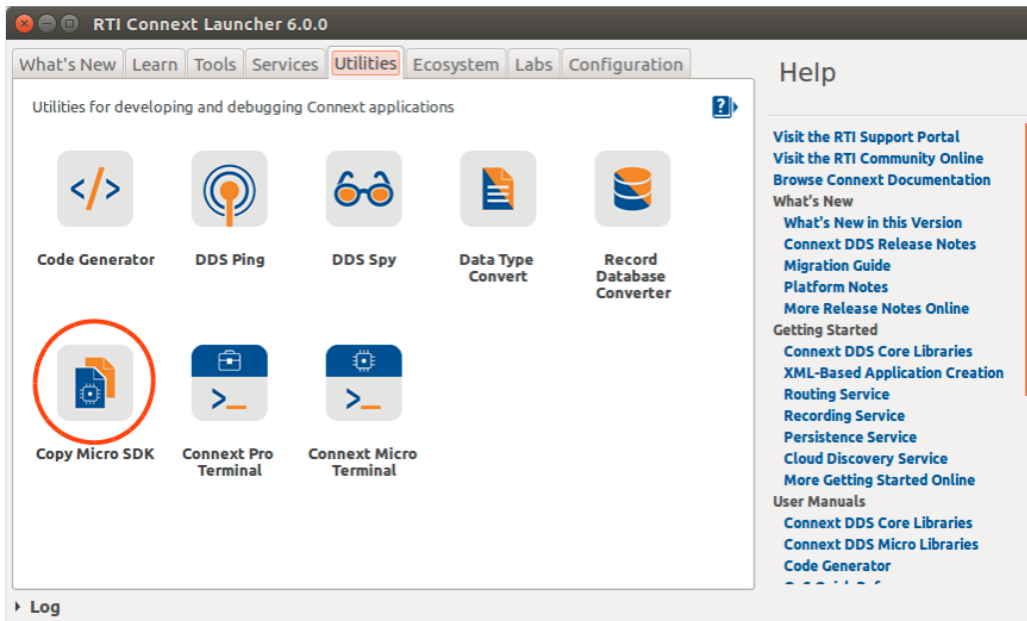
Note: You must first install *RTI Connex DDS Professional* and either `rti_connex_dds_micro-3.0.2-Unix.rtipkg` or `rti_connex_dds_micro-3.0.2-Windows.rtipkg` before the corresponding security SDK packages can be installed.

Once installed, you will see a directory `rti_connex_dds_micro-3.0.2` in the *RTI Connex DDS Professional* installation directory. This installation directory contains this documentation, the `rtiddsgen` code generation tool, and example source code. Note that a JRE is needed to execute `rtiddsgen`.

It is strongly recommended that you copy the *RTI Connex DDS Micro* installation directory outside of the *RTI Connex DDS Professional* installation. This is because it may not be desirable to build the *RTI Connex DDS Micro* libraries in the *RTI Connex DDS Professional* installation directory. To copy *RTI Connex DDS Micro* to another location, open *RTI Launcher*, navigate to the **Utilities** tab, click on **Copy Micro SDK** and follow the instructions. See the image below for a visual aid.

2.2 Setting Up Your Environment

The `RTIMEHOME` environment variable must be set to the installation directory path for *RTI Connex DDS Micro*. If you installed *RTI Connex DDS* with default settings, *RTI Connex DDS Micro* will be here: `<path_to_connex_dds_installation>/rti_connex_dds-6.0.1/rti_connex_micro-3.0.2`. If you copied *RTI Connex DDS Micro* to another place, set `RTIMEHOME` to point to that location.



2.3 Building Connex DDS Micro

This section is for users who are already familiar with [CMake](#) and may have built earlier versions of *Connex DDS Micro*. The sections following describe the process in detail and are recommended for everyone building *Connex DDS Micro*.

This section assumes that the *Connex DDS Micro* source-bundle has been downloaded and installed and that [CMake](#) is available.

1. Make sure [CMake](#) is in the path.
2. Run `rtime-make`.

On UNIX® systems:

```
cd <rtime install directory>
# you should see directories like doc/ lib/ rtiddsgen/ src/
# and CMakeLists.txt

resource/scripts/rtime-make --target self --name i86Linux4gcc7.3.0 \
    -G "Unix Makefiles" --build
```

On Windows® systems:

```
cd <rtime install directory>
# you should see directories like doc/ lib/ rtiddsgen/ src/
# and CMakeLists.txt

resource\scripts\rtime-make --target self --name i86Win32VS2015 \
    -G "NMake Makefiles" --build
```

3. You will find the *Connex DDS Micro* libraries here:

On UNIX-based systems:

```
# <rti_me install directory>/lib/i86Linux4gcc7.3.0
```

On Windows systems:

```
# <rti_me install directory>/lib/i86Win32VS2015
```

NOTE: `rtime-make` uses the platform specified with `--name` to determine a few settings needed by *Connex DDS Micro*. Please refer to *Preparing for a Build* for details.

2.3.1 OpenSSL

The *Connex DDS Micro* builtin security plugin requires OpenSSL® 1.1.1d or a later 1.1.x version. The CMake build files will try to locate a suitable version and use a locally installed library if available. If a compatible library is not available, please check the RTI Download portal for a compatible version of OpenSSL. After installing OpenSSL, set `OPENSSLHOME` to its location when building.

```
rtime-make -DOPENSSLHOME=<path>/release
```

Excluding the Security Plugin from the Build

It is possible to exclude the builtin security plugin in *Connex DDS Micro* (the `rti_me_seccore` library). Set `RTIME_TRUST_INCLUDE_BUILTIN` to `false` to disable it.

```
rtime-make -DRTIME_TRUST_INCLUDE_BUILTIN=false
```

For help, enter:

```
resource\scripts\rtime-make --help
```

To list available targets, enter:

```
resource\scripts\rtime-make --list
```

For help for a specific target, except self, enter:

```
resource\scripts\rtime-make --target <target> --help
```

Chapter 3

Getting Started

3.1 Define a Data Type

To distribute data using *Connexst DDS Micro*, you must first define a data type, then run the *rtiddsgen* utility. This utility will generate the type-specific support code that *Connexst DDS Micro* needs and the code that makes calls to publish and subscribe to that data type.

Connexst DDS Micro accepts types definitions in Interface Definition Language (IDL) format.

For instance, the HelloWorld examples provided with *Connexst DDS Micro* use this simple type, which contains a string “msg” with a maximum length of 128 chars:

```
struct HelloWorld {  
    string<128> msg;  
};
```

For more details, see *Data Types* in the *User’s Manual*.

3.2 Generate Type Support Code with rtiddsgen

You will provide your IDL as an input to *rtiddsgen*. *rtiddsgen* supports code generation for the following standard types:

- octet, char, wchar
- short, unsigned short
- long, unsigned long
- long long, unsigned long long float
- double, long double
- boolean
- string
- struct
- array

- enum
- wstring
- sequence
- union
- typedef
- value type

The script to run `rtiddsgen` is in `<your_top_level_dir>/rti_connex_dds-6.0.0/rti_connex_micro-3.0.0/rtiddsgen/scripts`.

To generate support code for data types in a file called `HelloWorld.idl`:

```
rtiddsgen -micro -language C -replace HelloWorld.idl
```

Run `rtiddsgen -help` to see all available options. For the options used here:

- The `-micro` option is necessary to generate support code specific to *Connex DDS Micro*, as `rtiddsgen` is also capable of generating support code for *Connex DDS*, and the generated code for the two are different.
- The `-language` option specifies the language of the generated code. *Connex DDS Micro* supports C and C++ (with `-language C++`).
- The `-replace` option specifies that the new generated code will replace, or overwrite, any existing files with the same name.

`rtiddsgen` generates the following files for an input file `HelloWorld.idl`:

- **HelloWorld.h and HelloWorld.c.** Operations to manage a sample of the type, and a DDS sequence of the type.
- **HelloWorldPlugin.h and HelloWorldPlugin.c.** Implements the type-plugin interface defined by *Connex DDS Micro*. Includes operations to serialize and deserialize a sample of the type and its DDS instance keys.
- **HelloWorldSupport.h and HelloWorldSupport.c.** Support operations to generate a type-specific *DataWriter* and *DataReader*, and to register the type with a DDS *DomainParticipant*.

This release of *Connex DDS Micro* supports a new way to generate support code for IDL Types that will generate a `TypeCode` object containing information used by an interpreter to serialize and deserialize samples. Prior to this release, the code for serialization and deserialization was generated for each type. To disable generating code to be used by the interpreter, use the `-interpreted 0` command-line option to generate code. This option generates code in the same way as was done in previous releases.

For more details, see *Generating Type Support with rtiddsgen* in the *User's Manual*.

3.3 Create an Application

The rest of this guide will walk you through the steps to create an application and will provide example code snippets. It assumes that you have defined your types (see *Define a Data Type*) and have used *rtiddsgen* to generate their support code (see *Generate Type Support Code with rtiddsgen*).

3.3.1 Registry Configuration

The [DomainParticipantFactory](#), in addition to its standard role of creating and deleting *DomainParticipants*, contains the RT Registry that a new application registers with some necessary components.

The *Connex DDS Micro* architecture defines a run-time (RT) component interface that provides a generic framework for organizing and extending functionality of an application. An RT component is created and deleted with an RT component factory. Each RT component factory must be registered within an RT registry in order for its components to be usable by an application.

Connex DDS Micro automatically registers components that provide necessary functionality. These include components for DDS *Writers* and *Readers*, the RTPS protocol, and the UDP transport.

In addition, every DDS application must register three components:

- **Writer History.** Queue of written samples of a *DataWriter*. Must be registered with the name “wh”.
- **Reader History.** Queue of received samples of a *DataReader*. Must be registered with the name “rh”.
- **Discovery (DPDE or DPSE).** Discovery component. Choose either dynamic (DPDE) or static (DPSE) endpoint discovery.

Example source:

- Get the RT Registry from the [DomainParticipantFactory](#) singleton:

```
DDS_DomainParticipantFactory *factory = NULL;
RT_Registry_T *registry = NULL;

factory = DDS_DomainParticipantFactory_get_instance();
registry = DDS_DomainParticipantFactory_get_registry(factory);
```

- Register the Writer History and Reader History components with the registry:

```
/* Register Writer History */
if (!RT_Registry_register(registry, "wh",
                        WHSM_HistoryFactory_get_interface(), NULL, NULL))
{
    /* failure */
}

/* Register Reader History */
if (!RT_Registry_register(registry, "rh",
```

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```

                                RHSM_HistoryFactory_get_interface(), NULL, NULL))
{
    /* failure */
}

```

Only one discovery component can be registered, either DPDE or DPSE. Each has its own properties that can be configured upon registration.

- Register [DPDE](#) for dynamic participant, dynamic endpoint discovery:

```

struct DPDE_DiscoveryPluginProperty discovery_plugin_properties =
    DPDE_DiscoveryPluginProperty_INITIALIZER;

/* Configure properties */
discovery_plugin_properties.participant_liveliness_assert_period.sec = 5;
discovery_plugin_properties.participant_liveliness_assert_period.nanosec = 0;
discovery_plugin_properties.participant_liveliness_lease_duration.sec = 30;
discovery_plugin_properties.participant_liveliness_lease_duration.nanosec = 0;

/* Register DPDE with updated properties */
if (!RT_Registry_register(registry,
                          "dpde",
                          DPDE_DiscoveryFactory_get_interface(),
                          &discovery_plugin_properties._parent,
                          NULL))
{
    /* failure */
}

```

- Register [DPSE](#) for dynamic participant, static endpoint discovery:

```

struct DPSE_DiscoveryPluginProperty discovery_plugin_properties =
    DPSE_DiscoveryPluginProperty_INITIALIZER;

/* Configure properties */
discovery_plugin_properties.participant_liveliness_assert_period.sec = 5;
discovery_plugin_properties.participant_liveliness_assert_period.nanosec = 0;
discovery_plugin_properties.participant_liveliness_lease_duration.sec = 30;
discovery_plugin_properties.participant_liveliness_lease_duration.nanosec = 0;

/* Register DPSE with updated properties */
if (!RT_Registry_register(registry,
                          "dpse",
                          DPSE_DiscoveryFactory_get_interface(),
                          &discovery_plugin_properties._parent,
                          NULL))
{
    printf("failed to register dpse\n");
    goto done;
}

```

For more information, see the *Application Generation* section in the User's Manual.

3.4 Configure UDP Transport

You may need to configure the UDP transport component that is pre-registered by *RTI Connex DDS Micro*. To change the properties of the UDP transport, first the UDP component has to be unregistered, then the properties have to be updated, and finally the component must be re-registered with the updated properties.

Example code:

- Unregister the pre-registered UDP component:

```

/* Unregister the pre-registered UDP component */
if (!RT_Registry_unregister(registry, "_udp", NULL, NULL))
{
    /* failure */
}

```

- Configure UDP transport properties:

```

struct UDP_InterfaceFactoryProperty *udp_property = NULL;

udp_property = (struct UDP_InterfaceFactoryProperty *)
    malloc(sizeof(struct UDP_InterfaceFactoryProperty));
if (udp_property != NULL)
{
    *udp_property = UDP_INTERFACE_FACTORY_PROPERTY_DEFAULT;

    /* allow_interface: Names of network interfaces allowed to send/receive.
     * Allow one loopback (lo) and one NIC (eth0).
     */
    REDA_StringSeq_set_maximum(&udp_property->allow_interface,2);
    REDA_StringSeq_set_length(&udp_property->allow_interface,2);

    *REDA_StringSeq_get_reference(&udp_property->allow_interface,0) = DDS_String_
    ↪dup("lo");
    *REDA_StringSeq_get_reference(&udp_property->allow_interface,1) = DDS_String_
    ↪dup("eth0");
}
else
{
    /* failure */
}

```

- Re-register UDP component with updated properties:

```

if (!RT_Registry_register(registry, "_udp",
    UDP_InterfaceFactory_get_interface(),
    (struct RT_ComponentFactoryProperty*)udp_property, NULL))
{
    /* failure */
}

```

For more details, see the *Transports* section in the User's Manual.

3.5 Create DomainParticipant, Topic, and Type

A [DomainParticipantFactory](#) creates *DomainParticipants*, and a *DomainParticipant* itself is the factory for creating *Publishers*, *Subscribers*, and *Topics*.

When creating a *DomainParticipant*, you may need to customize [DomainParticipantQos](#), notably for:

- **Resource limits.** Default resource limits are set at minimum values.
- **Initial peers.**
- **Discovery.** The name of the registered discovery component (“dpde” or “dpse”) must be assigned to [DiscoveryQosPolicy](#)’s name.
- **Participant Name.** Every *DomainParticipant* is given the same default name. Must be unique when using DPSE discovery.

Example code:

- Create a *DomainParticipant* with configured [DomainParticipantQos](#):

```

DDS_DomainParticipant *participant = NULL;
struct DDS_DomainParticipantQos dp_qos =
    DDS_DomainParticipantQos_INITIALIZER;

/* DDS domain of DomainParticipant */
DDS_Long domain_id = 0;

/* Name of your registered Discovery component */
if (!RT_ComponentFactoryId_set_name(&dp_qos.discovery.discovery.name, "dpde"))
{
    /* failure */
}

/* Initial peers: use only default multicast peer */
DDS_StringSeq_set_maximum(&dp_qos.discovery.initial_peers,1);
DDS_StringSeq_set_length(&dp_qos.discovery.initial_peers,1);
*DDS_StringSeq_get_reference(&dp_qos.discovery.initial_peers,0) =
    DDS_String_dup("239.255.0.1");

/* Resource limits */
dp_qos.resource_limits.max_destination_ports = 32;
dp_qos.resource_limits.max_receive_ports = 32;
dp_qos.resource_limits.local_topic_allocation = 1;
dp_qos.resource_limits.local_type_allocation = 1;
dp_qos.resource_limits.local_reader_allocation = 1;
dp_qos.resource_limits.local_writer_allocation = 1;
dp_qos.resource_limits.remote_participant_allocation = 8;
dp_qos.resource_limits.remote_reader_allocation = 8;
dp_qos.resource_limits.remote_writer_allocation = 8;

/* Participant name */
strcpy(dp_qos.participant_name.name, "Participant_1");

```

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```

participant =
    DDS_DomainParticipantFactory_create_participant(factory,
                                                    domain_id,
                                                    &dp_qos,
                                                    NULL,
                                                    DDS_STATUS_MASK_NONE);

if (participant == NULL)
{
    /* failure */
}

```

3.5.1 Register Type

Your data types that have been generated from IDL need to be registered with the *DomainParticipants* that will be using them. Each registered type must have a unique name, preferably the same as its IDL defined name.

```

DDS_ReturnCode_t retcode;

retcode = DDS_DomainParticipant_register_type(participant,
                                              "HelloWorld",
                                              HelloWorldTypePlugin_get());

if (retcode != DDS_RETCODE_OK)
{
    /* failure */
}

```

3.5.2 Create Topic of Registered Type

DDS *Topics* encapsulate the types being communicated, and you can create *Topics* for your type once your type is registered.

A topic is given a name at creation (e.g. “Example HelloWorld”). The type associated with the *Topic* is specified with its registered name.

```

DDS_Topic *topic = NULL;

topic = DDS_DomainParticipant_create_topic(participant,
                                           "Example HelloWorld",
                                           "HelloWorld",
                                           &DDS_TOPIC_QOS_DEFAULT,
                                           NULL,
                                           DDS_STATUS_MASK_NONE);

if (topic == NULL)
{
    /* failure */
}

```

3.5.3 DPSE Discovery: Assert Remote Participant

DPSE Discovery relies on the application to specify the other, or remote, *DomainParticipants* that its local *DomainParticipants* are allowed to discover. Your application must call a [DPSE](#) API for each remote participant to be discovered. The API takes as input the name of the remote participant.

```
/* Enable discovery of remote participant with name Participant_2 */
retcode = DPSE_RemoteParticipant_assert(participant, "Participant_2");
if (retcode != DDS_RETCODE_OK)
{
    /* failure */
}
```

For more information, see the *DDS Domains* section in the User's Manual.

3.6 Create Publisher

A publishing application needs to create a DDS *Publisher* and then a *DataWriter* for each *Topic* it wants to publish.

In *Connex DDS Micro*, [PublisherQos](#) in general contains no policies that need to be customized, while [DataWriterQos](#) does contain several customizable policies.

- Create *Publisher*:

```
DDS_Publisher *publisher = NULL;
publisher = DDS_DomainParticipant_create_publisher(participant,
                                                    &DDS_PUBLISHER_QOS_DEFAULT,
                                                    NULL,
                                                    DDS_STATUS_MASK_NONE);

if (publisher == NULL)
{
    /* failure */
}
```

For more information, see the *Sending Data* section in the User's Manual.

3.7 Create DataWriter

```
DDS_DataWriter *datawriter = NULL;
struct DDS_DataWriterQos dw_qos = DDS_DataWriterQos_INITIALIZER;
struct DDS_DataWriterListener dw_listener = DDS_DataWriterListener_INITIALIZER;

/* Configure writer Qos */
dw_qos.protocol.rtps_object_id = 100;
dw_qos.reliability.kind = DDS_RELIABLE_RELIABILITY_QOS;
dw_qos.resource_limits.max_samples_per_instance = 2;
dw_qos.resource_limits.max_instances = 2;
dw_qos.resource_limits.max_samples =
    dw_qos.resource_limits.max_samples_per_instance * dw_qos.resource_limits.max_
instances;
```

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```

dw_qos.history.depth = 1;
dw_qos.durability.kind = DDS_VOLATILE_DURABILITY_QOS;
dw_qos.protocol.rtps_reliable_writer.heartbeat_period.sec = 0;
dw_qos.protocol.rtps_reliable_writer.heartbeat_period.nanosec = 250000000;

/* Set enabled listener callbacks */
dw_listener.on_publication_matched = HelloWorldPublisher_on_publication_matched;

datawriter =
    DDS_Publisher_create_datawriter(publisher,
                                    topic,
                                    &dw_qos,
                                    &dw_listener,
                                    DDS_PUBLICATION_MATCHED_STATUS);

if (datawriter == NULL)
{
    /* failure */
}

```

The [DataWriterListener](#) has its callbacks selectively enabled by the DDS status mask. In the example, the mask has set the `on_publication_matched` status, and accordingly the [DataWriterListener](#) has its `on_publication_matched` assigned to a callback function.

```

void HelloWorldPublisher_on_publication_matched(void *listener_data,
                                              DDS_DataWriter * writer,
                                              const struct DDS_
↵PublicationMatchedStatus *status)
{
    /* Print on match/unmatch */
    if (status->current_count_change > 0)
    {
        printf("Matched a subscriber\n");
    }
    else
    {
        printf("Unmatched a subscriber\n");
    }
}

```

3.7.1 DPSE Discovery: Assert Remote Subscription

A publishing application using [DPSE](#) discovery must specify the other *DataReaders* that its *DataWriters* are allowed to discover. Like the API for asserting a remote participant, the [DPSE](#) API for asserting a remote subscription must be called for each remote *DataReader* that a *DataWriter* may discover.

Whereas asserting a remote participant requires only the remote *Participant's* name, asserting a remote subscription requires more configuration, as all QoS policies of the subscription necessary to determine matching must be known and thus specified.

```

struct DDS_SubscriptionBuiltinTopicData rem_subscription_data =
    DDS_SubscriptionBuiltinTopicData_INITIALIZER;

/* Set Reader's protocol.rtps_object_id */
rem_subscription_data.key.value[DDS_BUILTIN_TOPIC_KEY_OBJECT_ID] = 200;

rem_subscription_data.topic_name = DDS_String_dup("Example HelloWorld");
rem_subscription_data.type_name = DDS_String_dup("HelloWorld");

rem_subscription_data.reliability.kind = DDS_RELIABLE_RELIABILITY_QOS;

retcode = DPSE_RemoteSubscription_assert(participant,
                                        "Participant_2",
                                        &rem_subscription_data,
                                        HelloWorld_get_key_kind(HelloWorldTypePlugin_
↳get(),
                                        NULL));

if (retcode != DDS_RETCODE_OK)
{
    /* failure */
}

```

3.7.2 Writing Samples

Within the generated type support code are declarations of the type-specific *DataWriter*. For the HelloWorld type, this is the HelloWorldDataWriter.

Writing a HelloWorld sample is done by calling the write API of the HelloWorldDataWriter.

```

HelloWorldDataWriter *hw_datawriter;
DDS_ReturnCode_t retcode;
HelloWorld *sample = NULL;

/* Create and set sample */
sample = HelloWorld_create();
if (sample == NULL)
{
    /* failure */
}
sprintf(sample->msg, "Hello World!");

/* Write sample */
hw_datawriter = HelloWorldDataWriter_narrow(datawriter);

retcode = HelloWorldDataWriter_write(hw_datawriter, sample, &DDS_HANDLE_NIL);
if (retcode != DDS_RETCODE_OK)
{
    /* failure */
}

```

For more information, see the *Sending Data* section in the User's Manual.

3.8 Create Subscriber

A subscribing application needs to create a DDS *Subscriber* and then a *DataReader* for each *Topic* to which it wants to subscribe.

In *Connex DDS Micro*, [SubscriberQos](#) in general contains no policies that need to be customized, while [DataReaderQos](#) does contain several customizable policies.

```
DDS_Subscriber *subscriber = NULL;
subscriber = DDS_DomainParticipant_create_subscriber(participant,
                                                    &DDS_SUBSCRIBER_QOS_DEFAULT,
                                                    NULL,
                                                    DDS_STATUS_MASK_NONE);

if (subscriber == NULL)
{
    /* failure */
}
```

For more information, see the *Receiving Data* section in the User's Manual.

3.9 Create DataReader

```
DDS_DataReader *datareader = NULL;
struct DDS_DataReaderQos dr_qos = DDS_DataReaderQos_INITIALIZER;
struct DDS_DataReaderListener dr_listener = DDS_DataReaderListener_INITIALIZER;

/* Configure Reader Qos */
dr_qos.protocol.rtps_object_id = 200;
dr_qos.resource_limits.max_instances = 2;
dr_qos.resource_limits.max_samples_per_instance = 2;
dr_qos.resource_limits.max_samples =
    dr_qos.resource_limits.max_samples_per_instance * dr_qos.resource_limits.max_
↪instances;
dr_qos.reader_resource_limits.max_remote_writers = 10;
dr_qos.reader_resource_limits.max_remote_writers_per_instance = 10;
dr_qos.history.depth = 1;
dr_qos.durability.kind = DDS_VOLATILE_DURABILITY_QOS;
dr_qos.reliability.kind = DDS_RELIABLE_RELIABILITY_QOS;

/* Set listener callbacks */
dr_listener.on_data_available = HelloWorldSubscriber_on_data_available;
dr_listener.on_subscription_matched = HelloWorldSubscriber_on_subscription_matched;

datareader = DDS_Subscriber_create_datareader(subscriber,
                                              DDS_Topic_as_topicdescription(topic),
                                              &dr_qos,
                                              &dr_listener,
                                              DDS_DATA_AVAILABLE_STATUS | DDS_
↪SUBSCRIPTION_MATCHED_STATUS);
if (datareader == NULL)
{
```

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```

    /* failure */
}

```

The `DataReaderListener` has its callbacks selectively enabled by the DDS status mask. In the example, the mask has set the `DDS_SUBSCRIPTION_MATCHED_STATUS` and `DDS_DATA_AVAILABLE_STATUS` statuses, and accordingly the `DataReaderListener` has its `on_subscription_matched` and `on_data_available` assigned to callback functions.

```

void HelloWorldSubscriber_on_subscription_matched(void *listener_data,
                                                DDS_DataReader * reader,
                                                const struct DDS_
↳SubscriptionMatchedStatus *status)
{
    if (status->current_count_change > 0)
    {
        printf("Matched a publisher\n");
    }
    else
    {
        printf("Unmatched a publisher\n");
    }
}

```

```

void HelloWorldSubscriber_on_data_available(void* listener_data,
                                           DDS_DataReader* reader)
{
    HelloWorldDataReader *hw_reader = HelloWorldDataReader_narrow(reader);
    DDS_ReturnCode_t retcode;
    struct DDS_SampleInfo *sample_info = NULL;
    HelloWorld *sample = NULL;

    struct DDS_SampleInfoSeq info_seq =
        DDS_SEQUENCE_INITIALIZER(struct DDS_SampleInfo);
    struct HelloWorldSeq sample_seq =
        DDS_SEQUENCE_INITIALIZER(HelloWorld);

    const DDS_Long TAKE_MAX_SAMPLES = 32;
    DDS_Long i;

    retcode = HelloWorldDataReader_take(hw_reader,
        &sample_seq, &info_seq, TAKE_MAX_SAMPLES,
        DDS_ANY_SAMPLE_STATE, DDS_ANY_VIEW_STATE, DDS_ANY_INSTANCE_STATE);

    if (retcode != DDS_RETCODE_OK)
    {
        printf("failed to take data: %d\n", retcode);
        goto done;
    }

    /* Print each valid sample taken */
    for (i = 0; i < HelloWorldSeq_get_length(&sample_seq); ++i)

```

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```

{
    sample_info = DDS_SampleInfoSeq_get_reference(&info_seq, i);

    if (sample_info->valid_data)
    {
        sample = HelloWorldSeq_get_reference(&sample_seq, i);
        printf("\nSample received\n\tmsg: %s\n", sample->msg);
    }
    else
    {
        printf("not valid data\n");
    }
}

HelloWorldDataReader_return_loan(hw_reader, &sample_seq, &info_seq);

done:
HelloWorldSeq_finalize(&sample_seq);
DDS_SampleInfoSeq_finalize(&info_seq);
}

```

3.9.1 DPSE Discovery: Assert Remote Publication

A subscribing application using [DPSE](#) discovery must specify the other *DataWriters* that its *DataReaders* are allowed to discover. Like the API for asserting a remote participant, the [DPSE](#) API for asserting a remote publication must be called for each remote *DataWriter* that a *DataReader* may discover.

```

struct DDS_PublicationBuiltinTopicData rem_publication_data =
    DDS_PublicationBuiltinTopicData_INITIALIZER;

/* Set Writer's protocol.rtps_object_id */
rem_publication_data.key.value[DDS_BUILTIN_TOPIC_KEY_OBJECT_ID] = 100;

rem_publication_data.topic_name = DDS_String_dup("Example HelloWorld");
rem_publication_data.type_name = DDS_String_dup("HelloWorld");

rem_publication_data.reliability.kind = DDS_RELIABLE_RELIABILITY_QOS;

retcode = DPSE_RemotePublication_assert(participant,
                                        "Participant_1",
                                        &rem_publication_data,
                                        HelloWorld_get_key_kind(HelloWorldTypePlugin_
↳get(),
                                        NULL));
if (retcode != DDS_RETCODE_OK)
{
    /* failure */
}

```

Asserting a remote publication requires configuration of all QoS policies necessary to determine

matching.

3.9.2 Receiving Samples

Accessing received samples can be done in a few ways:

- **Polling.** Do read or take within a periodic polling loop.
- **Listener.** When a new sample is received, the `DataReaderListener`'s `on_data_available` is called. Processing is done in the context of the middleware's receive thread. See the above `HelloWorldSubscriber_on_data_available` callback for example code.
- **Waitset.** Create a waitset, attach it to a status condition with the `data_available` status enabled, and wait for a received sample to trigger the waitset. Processing is done in the context of the user's application thread. (Note: the code snippet below is taken from the shipped `HelloWorld_dpde_waitset` example).

```

DDS_WaitSet *waitset = NULL;
struct DDS_Duration_t wait_timeout = { 10, 0 }; /* 10 seconds */
DDS_StatusCondition *dr_condition = NULL;
struct DDS_ConditionSeq active_conditions =
    DDS_SEQUENCE_INITIALIZER(struct DDS_ConditionSeq);

if (!DDS_ConditionSeq_initialize(&active_conditions))
{
    /* failure */
}

if (!DDS_ConditionSeq_set_maximum(&active_conditions, 1))
{
    /* failure */
}

waitset = DDS_WaitSet_new();
if (waitset == NULL )
{
    /* failure */
}

dr_condition = DDS_Entity_get_statuscondition(DDS_DataReader_as_entity(datareader));

retcode = DDS_StatusCondition_set_enabled_statuses(dr_condition,
                                                    DDS_DATA_AVAILABLE_STATUS);

if (retcode != DDS_RETCODE_OK)
{
    /* failure */
}

retcode = DDS_WaitSet_attach_condition(waitset,
                                       DDS_StatusCondition_as_condition(dr_condition));
if (retcode != DDS_RETCODE_OK)
{
    /* failure */
}

```

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```

}

retcode = DDS_WaitSet_wait(waitset, active_conditions, &wait_timeout);

switch (retcode) {
  case DDS_RETCODE_OK:
  {
    /* This WaitSet only has a single condition attached to it
     * so we can implicitly assume the DataReader's status condition
     * to be active (with the enabled DATA_AVAILABLE status) upon
     * successful return of wait().
     * If more than one conditions were attached to the WaitSet,
     * the returned sequence must be examined using the
     * commented out code instead of the following.
     */

    HelloWorldSubscriber_take_data(HelloWorldDataReader_narrow(datareader));

    /*
    DDS_Long active_len = DDS_ConditionSeq_get_length(&active_conditions);
    for (i = active_len - 1; i >= 0; --i)
    {
      DDS_Condition *active_condition =
        *DDS_ConditionSeq_get_reference(&active_conditions, i);

      if (active_condition ==
          DDS_StatusCondition_as_condition(dr_condition))
      {
        total_samples += HelloWorldSubscriber_take_data(
          HelloWorldDataReader_narrow(datareader));
      }
      else if (active_condition == some_other_condition)
      {
        do_something_else();
      }
    }
    */
    break;
  }
  case DDS_RETCODE_TIMEOUT:
  {
    printf("WaitSet_wait timed out\n");
    break;
  }
  default:
  {
    printf("ERROR in WaitSet_wait: retcode=%d\n", retcode);
    break;
  }
}
}

```

3.9.3 Filtering Samples

In lieu of supporting Content-Filtered Topics, a [DataReaderListener](#) in *Connex DDS Micro* provides callbacks to do application-level filtering per sample.

- **on_before_sample_deserialize.** Through this callback, a received sample is presented to the application before it has been deserialized or stored in the *DataReader's* queue.
- **on_before_sample_commit.** Through this callback, a received sample is presented to the application after it has been deserialized but before it has been stored in the *DataReader's* queue.

You control the callbacks' `sample_dropped` parameter; upon exiting either callback, the *DataReader* will drop the sample if `sample_dropped` is true. Consequently, dropped samples are not stored in the *DataReader's* queue and are not available to be read or taken.

Neither callback is associated with a DDS Status. Rather, each is enabled when assigned, to a non-NULL callback.

NOTE: Because it is called after the sample has been deserialized, `on_before_sample_commit` provides an additional `sample_info` parameter, containing some of the usual sample information that would be available when the sample is read or taken.

The `HelloWorld_dpde` example's subscriber has this `on_before_sample_commit` callback:

```
DDS_Boolean HelloWorldSubscriber_on_before_sample_commit(
    void *listener_data,
    DDS_DataReader *reader,
    const void *const sample,
    const struct DDS_SampleInfo *const sample_info,
    DDS_Boolean *dropped)
{
    HelloWorld *hw_sample = (HelloWorld *)sample;

    /* Drop samples with even-numbered count in msg */
    HelloWorldSubscriber_filter_sample(hw_sample, dropped);

    if (*dropped)
    {
        printf("\nSample filtered, before commit\n\tDROPPED - msg: %s\n",
            hw_sample->msg);
    }

    return DDS_BOOLEAN_TRUE;
}

...

dr_listener.on_before_sample_commit =
    HelloWorldSubscriber_on_before_sample_commit;
```

For more information, see the *Receiving Data* section in the User's Manual.

3.10 Examples

Connex DDS Micro provides buildable example applications, in the **example/** directory of its host bundle. They include a basic HelloWorld application presented in a few different flavors, an RTPS-only emitter, and latency and throughput benchmarking applications.

Each example comes with instructions on how to build and run an application.

All examples are available in C, while the HelloWorld_dpde and HelloWorld_dpde_waitset examples are available in C++.

Note that by the default all the examples link against release libraries. To build release libraries:

```
./resource/scripts/rtime-make --name x64Darwin17clang9.0 --target self --build --config_
↪Release
```

To build the examples against the debug libraries, specify the the DEBUG option:

```
make DEBUG=Y
```

- **HelloWorld_dpse.** Shows how to use rttiddsgen to generate type-support code from a simple HelloWorld IDL-defined type. This example creates a publisher and subscriber, and uses dynamic participant, static endpoint discovery to establish communication.
- **HelloWorld_dpde.** Same as the **HelloWorld_dpse** example, except it uses dynamic participant, dynamic endpoint discovery. This example is available in both C and C++.
- **HelloWorld_dpde_waitset.** Same as the HelloWorld_dpde example, except it uses waitsets instead of listener callbacks to access received data.
- **HelloWorld_dpde_secure** Same as the HelloWorld_dpde example, except that the *RTI Security Plugins* are installed and enabled on each DomainParticipant to perform mutual authentication, enforce access control rules, and encrypt data exchanged by applications.
- **HelloWorld_android.** Example application using Android™ NDK.
- **HelloWorld_static_udp.** Same as HelloWorld_dpde, except it uses static configuration of network interfaces.
- **HelloWorld_appgen.** Example application using Application Generation API.
- **HelloWorld_transformations.** Same as HelloWorld_dpde, except it uses UDP transformations to send encrypted packets using OpenSSL.
- **RTPS.** Example of an RTPS emitter that bypasses the DDS module and APIs to send RTPS discovery and user data.
- **Latency.** Measures the end-to-end latency of *Connex DDS Micro*.
- **Throughput.** Measures the end-to-end throughput of *Connex DDS Micro*.

Chapter 4

User's Manual

4.1 Data Types

How data is stored or laid out in memory can vary from language to language, compiler to compiler, operating system to operating system, and processor to processor. This combination of language/compiler/operating system/processor is called a *platform*. Any modern middleware must be able to take data from one specific platform (for example, C/gcc.7.3.0/Linux®/PPC) and transparently deliver it to another (for example, C/gcc.7.3.0/Linux/Arm® v8). This process is commonly called *serialization/deserialization*, or *marshalling/demarshalling*.

Connext DDS Micro data samples sent on the same *Connext DDS Micro* topic share a data type. This type defines the fields that exist in the DDS data samples and what their constituent types are. The middleware stores and propagates this meta-information separately from the individual DDS data samples, allowing it to propagate DDS samples efficiently while handling byte ordering and alignment issues for you.

To publish and/or subscribe to data with *Connext DDS Micro*, you will carry out the following steps:

1. Select a type to describe your data and use the *RTI Code Generator* to define a type at compile-time using a language-independent description language.

The *RTI Code Generator* accepts input in the following formats:

- **OMG IDL.** This format is a standardized component of the DDS specification. It describes data types with a C++-like syntax. A link to the latest specification can be found here: <https://www.omg.org/spec/IDL>.
- **XML in a DDS-specific format.** This XML format is terser, and therefore easier to read and write by hand, than an XSD file. It offers the general benefits of XML-extensibility and ease of integration, while fully supporting DDS-specific data types and concepts. A link to the latest specification, including a description of the XML format, can be found here: <https://www.omg.org/spec/DDS-XTypes/>.
- **XSD format.** You can describe data types with XML schemas (XSD). A link to the latest specification, including a description of the XSD format, can be found here: <https://www.omg.org/spec/DDS-XTypes/>.

Define a type programmatically at run time.

This method may be appropriate for applications with dynamic data description needs: applications for which types change frequently or cannot be known ahead of time.

2. Register your type with a logical name.
3. Create a *Topic* using the type name you previously registered.

If you've chosen to use a built-in type instead of defining your own, you will use the API constant corresponding to that type's name.

4. Create one or more *DataWriters* to publish your data and one or more *DataReaders* to subscribe to it.

The concrete types of these objects depend on the concrete data type you've selected, in order to provide you with a measure of type safety.

Whether publishing or subscribing to data, you will need to know how to create and delete DDS data samples and how to get and set their fields. These tasks are described in the section on Working with DDS Data Samples in the *RTI Connex DDS Core Libraries User's Manual* (available [here](#) if you have Internet access).

4.1.1 Introduction to the Type System

A *user data type* is any custom type that your application defines for use with *RTI Connex DDS Micro*. It may be a structure, a union, a value type, an enumeration, or a typedef (or language equivalents).

Your application can have any number of user data types. They can be composed of any of the primitive data types listed below or of other user data types.

Only structures, unions, and value types may be read and written directly by *Connex DDS Micro*; enums, typedefs, and primitive types must be contained within a structure, union, or value type. In order for a *DataReader* and *DataWriter* to communicate with each other, the data types associated with their respective *Topic* definitions must be identical.

- octet, char, wchar
- short, unsigned short
- long, unsigned long
- long long, unsigned long long
- float
- double, long double
- boolean
- enum (with or without explicit values)
- bounded string and wstring

The following type-building constructs are also supported:

- module (also called a package or namespace)

- pointer
- array of primitive or user type elements
- bounded sequence of elements—a sequence is a variable-length ordered collection, such as a vector or list
- typedef
- union
- struct
- value type, a complex type that supports inheritance and other object-oriented features

To use a data type with *Connex DDS Micro*, you must define that type in a way the middleware understands and then register the type with the middleware. These steps allow *Connex DDS Micro* to serialize, deserialize, and otherwise operate on specific types. They will be described in detail in the following sections.

Sequences

A sequence contains an ordered collection of elements that are all of the same type. The operations supported in the sequence are documented in the [C API Reference](#) and [C++ API Reference](#) HTML documentation.

Elements in a sequence are accessed with their index, just like elements in an array. Indices start at zero in all APIs. Unlike arrays, however, sequences can grow in size. A sequence has two sizes associated with it: a physical size (the “maximum”) and a logical size (the “length”). The physical size indicates how many elements are currently allocated by the sequence to hold; the logical size indicates how many valid elements the sequence actually holds. The length can vary from zero up to the maximum. Elements cannot be accessed at indices beyond the current length.

A sequence must be declared as bounded. A sequence’s “bound” is the maximum number of elements that the sequence can contain at any one time. A finite bound is very important because it allows *RTI Connex DDS Micro* to preallocate buffers to hold serialized and deserialized samples of your types; these buffers are used when communicating with other nodes in your distributed system.

By default, any unbounded sequences found in an IDL file will be given a default bound of 100 elements. This default value can be overwritten using *RTI Code Generator’s* **-sequenceSize** command-line argument (see the Command-Line Arguments chapter in the *RTI Code Generator User’s Manual*, available [here](#) if you have Internet access).

Strings and Wide Strings

Connex DDS Micro supports both strings consisting of single-byte characters (the IDL string type) and strings consisting of wide characters (IDL wstring). The wide characters supported by *Connex DDS Micro* are large enough to store two-byte Unicode/UTF16 characters.

Like sequences, strings must be bounded. A string’s “bound” is its maximum length (not counting the trailing NULL character in C and C++).

In C and Traditional C++, strings are mapped to `char*`. Optionally, the mapping in Traditional C++ can be changed to `std::string` by generating code with the option `-useStdString`.

By default, any unbounded string found in an IDL file will be given a default bound of 255 elements. This default value can be overwritten using *RTI Code Generator's* `-stringSize` command-line argument (see the Command-Line Arguments chapter in the *RTI Code Generator User's Manual*, available [here](#) if you have Internet access).

IDL String Encoding

The “Extensible and Dynamic Topic Types for DDS specification” (<https://www.omg.org/spec/DDS-XTypes/>) standardizes the default encoding for strings to UTF-8. This encoding shall be used as the wire format. Language bindings may use the representation that is most natural in that particular language. If this representation is different from UTF-8, the language binding shall manage the transformation to/from the UTF-8 wire representation.

As an extension, *Connex DDS Micro* offers `ISO_8859_1` as an alternative string wire encoding.

This section describes the encoding for IDL strings across different languages in *Connex DDS Micro* and how to configure that encoding.

- C, Traditional C++

IDL strings are mapped to a NULL-terminated array of `DDS_Char` (`char*`). Users are responsible for using the right character encoding (UTF-8 or `ISO_8859_1`) when populating the string values. This applies to all generated code, `DynamicData`, and Built-in data types. The middleware does not transform from the language binding encoding to the wire encoding.

IDL Wide Strings Encoding

The “Extensible and Dynamic Topic Types for DDS specification” (<https://www.omg.org/spec/DDS-XTypes/>) standardizes the default encoding for wide strings to UTF-16. This encoding shall be used as the wire format.

When the data representation is Extended CDR version 1, wide-string characters have a size of 4 bytes on the wire with UTF-16 encoding. When the data representation is Extended CDR version 2, wide-string characters have a size of 2 bytes on the wire with UTF-16 encoding.

Language bindings may use the representation that is most natural in that particular language. If this representation is different from UTF-16, the language binding shall manage the transformation to/from the UTF-16 wire representation.

- C, Traditional C++

IDL wide strings are mapped to a NULL-terminated array of `DDS_Wchar` (`DDS_Wchar*`). `DDS_WChar` is an unsigned 2-byte integer. Users are responsible for using the right character encoding (UTF-16) when populating the wide-string values. This applies to all generated code, `DynamicData`, and Built-in data types. *Connex DDS Micro* does not transform from the language binding encoding to the wire encoding.

Sending Type Information on the Network

Connex DDS Micro can send type information the network using a concept called type objects. A type objects is a description of a type suitable to network transmission, and is commonly used by for example tools to visualize data from any application.

However, please note that *Connex DDS Micro* does not support sending type information on the network. Instead, tools can load type information from XML files generated from IDL using *rtiddsgen*. Please refer to the *RTI Code Generator's User's Manual* for more information (available [here](#) if you have Internet access).

4.1.2 Creating User Data Types with IDL

You can create user data types in a text file using IDL (Interface Description Language). IDL is programming-language independent, so the same file can be used to generate code in C and Traditional C++. *RTI Code Generator* parses the IDL file and automatically generates all the necessary routines and wrapper functions to bind the types for use by *Connex DDS Micro* at run time. You will end up with a set of required routines and structures that your application and *Connex DDS Micro* will use to manipulate the data.

Please refer to the section on Creating User Data Types with IDL in the *RTI Connex DDS Core Libraries User's Manual* for more information (available [here](#) if you have Internet access).

Note: Not all features in *RTI Code Generator* are supported when generating code for *Connex DDS Micro*, see *Unsupported Features of rtiddsgen with Connex DDS Micro*.

4.1.3 Working with DDS Data Samples

You should now understand how to define and work with data types. Now that you have chosen one or more data types to work with, this section will help you understand how to create and manipulate objects of those types.

In C:

You create and delete your own objects from factories, just as you create *Connex DDS Micro* objects from factories. In the case of user data types, the factory is a singleton object called the type support. Objects allocated from these factories are deeply allocated and fully initialized.

```
/* In the generated header file: */
struct MyData {
    char* myString;
};
/* In your code: */
MyData* sample = MyDataTypeSupport_create_data();
char* str = sample->myString; /*empty, non-NULL string*/
/* ... */
MyDataTypeSupport_delete_data(sample);
```

In Traditional C++:

Without the **-constructor option**, you create and delete objects using the TypeSupport factories.


```
MyData* sample = MyDataTypeSupport::create_data();
char* str = sample->myString; // empty, non-NULL string
// ...
MyDataTypeSupport::delete_data(sample);
```

Please refer to the section on Working with DDS Data Samples in the *RTI Connext DDS Core Libraries User's Manual* for more information (available [here](#) if you have Internet access).

4.2 DDS Entities

The main classes extend an abstract base class called a DDS *Entity*. Every DDS *Entity* has a set of associated events known as statuses and a set of associated Quality of Service Policies (QoS Policies). In addition, a *Listener* may be registered with the *Entity* to be called when status changes occur. DDS *Entities* may also have attached DDS *Conditions*, which provide a way to wait for status changes. *Figure 4.1: Overview of DDS Entities* presents an overview in a UML diagram.

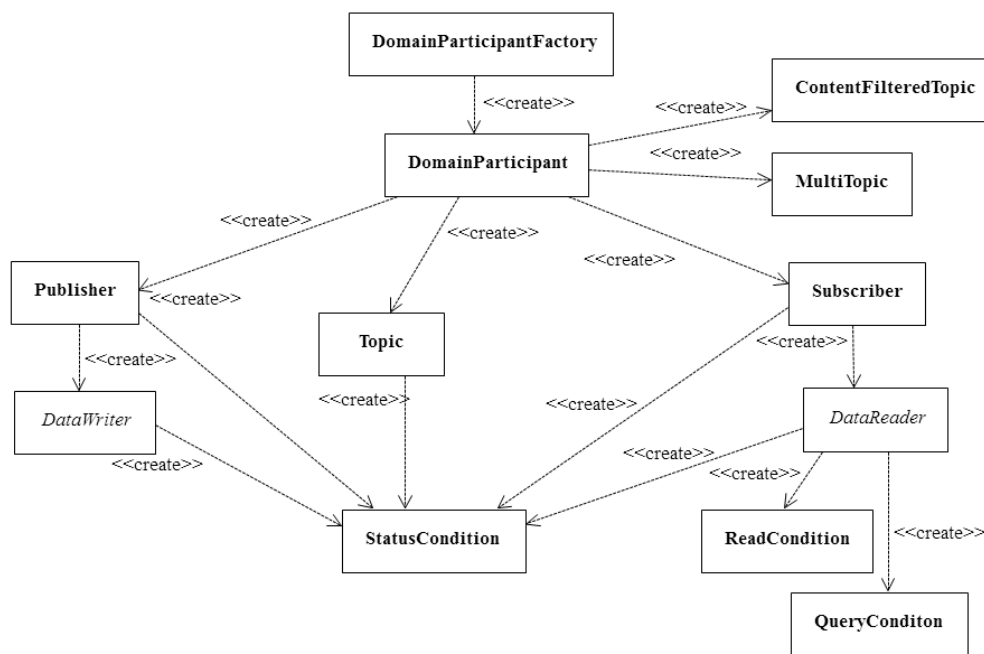


Figure 4.1: Overview of DDS Entities

Please note that *RTI Connext DDS Micro* does not support the following:

- **MultiTopic**
- **ContentFilteredTopic**
- **ReadCondition**
- **QueryConditions**

For a general description of DDS *Entities* and their operations, please refer to the DDS Entities chapter in the *RTI Connext DDS Core Libraries User's Manual* (available [here](#) if you have Internet

access). Note that *RTI Connext DDS Micro* does not support all APIs and QosPolicies; please refer to the [C API Reference](#) and [C++ API Reference](#) documentation for more information.

4.3 Sending Data

This section discusses how to create, configure, and use *Publishers* and *DataWriters* to send data. It describes how these *Entities* interact, as well as the types of operations that are available for them.

The goal of this section is to help you become familiar with the *Entities* you need for sending data. For up-to-date details such as formal parameters and return codes on any mentioned operations, please see the [C API Reference](#) and [C++ API Reference](#) documentation.

4.3.1 Preview: Steps to Sending Data

To send DDS samples of a data instance:

1. Create and configure the required *Entities*:
 - (a) Create a *DomainParticipant*.
 - (b) Register user data types with the *DomainParticipant*. For example, the **'FooDataType'**.
 - (c) Use the *DomainParticipant* to create a *Topic* with the registered data type.
 - (d) Use the *DomainParticipant* to create a *Publisher*.
 - (e) Use the *Publisher* or *DomainParticipant* to create a *DataWriter* for the *Topic*.
 - (f) Use a type-safe method to cast the generic *DataWriter* created by the *Publisher* to a type-specific *DataWriter*. For example, **'FooDataWriter'**. Optionally, register data instances with the *DataWriter*. If the *Topic*'s user data type contain key fields, then registering a data instance (data with a specific key value) will improve performance when repeatedly sending data with the same key. You may register many different data instances; each registration will return an instance handle corresponding to the specific key value. For non-keyed data types, instance registration has no effect.
2. Every time there is changed data to be published:
 - (a) Store the data in a variable of the correct data type (for instance, variable **'Foo'** of the type **'FooDataType'**).
 - (b) Call the **FooDataWriter**'s **write()** operation, passing it a reference to the variable **'Foo'**.
 - For non-keyed data types or for non-registered instances, also pass in **DDS_HANDLE_NIL**.
 - For keyed data types, pass in the instance handle corresponding to the instance stored in **'Foo'**, if you have registered the instance previously. This means that the data stored in **'Foo'** has the same key value that was used to create instance handle.
 - (c) The **write()** function will take a snapshot of the contents of **'Foo'** and store it in *Connext DDS* internal buffers from where the DDS data sample is sent under the criteria set by

the *Publisher's* and *DataWriter's* QosPolicies. If there are matched *DataReaders*, then the DDS data sample will have been passed to the physical transport plug-in/device driver by the time that `write()` returns.

4.3.2 Publishers

An application that intends to publish information needs the following *Entities*: *DomainParticipant*, *Topic*, *Publisher*, and *DataWriter*. All *Entities* have a corresponding specialized *Listener* and a set of QosPolicies. A *Listener* is how *Connex DDS* notifies your application of status changes relevant to the *Entity*. The QosPolicies allow your application to configure the behavior and resources of the *Entity*.

- A *DomainParticipant* defines the DDS domain in which the information will be made available.
- A *Topic* defines the name under which the data will be published, as well as the type (format) of the data itself.
- An application writes data using a *DataWriter*. The *DataWriter* is bound at creation time to a *Topic*, thus specifying the name under which the *DataWriter* will publish the data and the type associated with the data. The application uses the *DataWriter's* `write()` operation to indicate that a new value of the data is available for dissemination.
- A *Publisher* manages the activities of several *DataWriters*. The *Publisher* determines when the data is actually sent to other applications. Depending on the settings of various QosPolicies of the *Publisher* and *DataWriter*, data may be buffered to be sent with the data of other *DataWriters* or not sent at all. By default, the data is sent as soon as the *DataWriter's* `write()` function is called.

You may have multiple *Publishers*, each managing a different set of *DataWriters*, or you may choose to use one *Publisher* for all your *DataWriters*.

4.3.3 DataWriters

To create a *DataWriter*, you need a *DomainParticipant*, *Publisher*, and a *Topic*.

You need a *DataWriter* for each *Topic* that you want to publish. For more details on all operations, see the [C API Reference](#) and [C++ API Reference](#) documentation.

For more details on creating, deleting, and setting up *DataWriters*, see the *DataWriters* section in the *RTI Connex DDS Core Libraries User's Manual* (available [here](#) if you have Internet access).

4.3.4 Publisher/Subscriber QosPolicies

Please refer to the [C API Reference](#) and [C++ API Reference](#) for details on supported QosPolicies.

4.3.5 DataWriter QosPolicies

Please refer to the [C API Reference](#) and [C++ API Reference](#) for details on supported QosPolicies.

4.4 Receiving Data

This section discusses how to create, configure, and use *Subscribers* and *DataReaders* to receive data. It describes how these objects interact, as well as the types of operations that are available for them.

The goal of this section is to help you become familiar with the *Entities* you need for receiving data. For up-to-date details such as formal parameters and return codes on any mentioned operations, please see the [C API Reference](#) and [C++ API Reference](#) documentation.

4.4.1 Preview: Steps to Receiving Data

There are three ways to receive data:

- Your application can explicitly check for new data by calling a *DataReader's* **read()** or **take()** operation. This method is also known as *polling for data*.
- Your application can be notified asynchronously whenever new DDS data samples arrive—this is done with a *Listener* on either the *Subscriber* or the *DataReader*. *RTI Connex DDS Micro* will invoke the *Listener's* callback routine when there is new data. Within the callback routine, user code can access the data by calling **read()** or **take()** on the *DataReader*. This method is the way for your application to receive data with the least amount of latency.
- Your application can wait for new data by using *Conditions* and a *WaitSet*, then calling **wait()**. *Connex DDS Micro* will block your application's thread until the criteria (such as the arrival of DDS samples, or a specific status) set in the *Condition* becomes true. Then your application resumes and can access the data with **read()** or **take()**.

The *DataReader's* **read()** operation gives your application a copy of the data and leaves the data in the *DataReader's* receive queue. The *DataReader's* **take()** operation removes data from the receive queue before giving it to your application.

To prepare to receive data, create and configure the required Entities:

1. Create a *DomainParticipant*.
2. Register user data types with the *DomainParticipant*. For example, the '**FooDataType**'.
3. Use the *DomainParticipant* to create a *Topic* with the registered data type.
4. Use the *DomainParticipant* to create a *Subscriber*.
5. Use the *Subscriber* or *DomainParticipant* to create a *DataReader* for the *Topic*.
6. Use a type-safe method to cast the generic *DataReader* created by the *Subscriber* to a type-specific *DataReader*. For example, '**FooDataReader**'.

Then use one of the following mechanisms to receive data.

- To receive DDS data samples by polling for new data:
 - Using a **FooDataReader**, use the **read()** or **take()** operations to access the DDS data samples that have been received and stored for the *DataReader*. These operations can be invoked at any time, even if the receive queue is empty.
- To receive DDS data samples asynchronously:

- Install a *Listener* on the *DataReader* or *Subscriber* that will be called back by an internal *Connex DDS Micro* thread when new DDS data samples arrive for the *DataReader*.

1. Create a *DDSDataReaderListener* for the *FooDataReader* or a *DDSSubscriberListener* for *Subscriber*. In C++ you must derive your own *Listener* class from those base classes. In C, you must create the individual functions and store them in a structure.

If you created a *DDSDataReaderListener* with the `on_data_available()` callback enabled: `on_data_available()` will be called when new data arrives for that **DataReader**.

If you created a *DDSSubscriberListener* with the `on_data_on_readers()` callback enabled: `on_data_on_readers()` will be called when data arrives for any *DataReader* created by the *Subscriber*.

2. Install the *Listener* on either the *FooDataReader* or *Subscriber*.

For the *DataReader*, the *Listener* should be installed to handle changes in the **DATA_AVAILABLE** status.

For the *Subscriber*, the *Listener* should be installed to handle changes in the **DATA_ON_READERS** status.

3. Only 1 *Listener* will be called back when new data arrives for a *DataReader*.

Connex DDS Micro will call the *Subscriber's Listener* if it is installed. Otherwise, the *DataReader's Listener* is called if it is installed. That is, the `on_data_on_readers()` operation takes precedence over the `on_data_available()` operation.

If neither *Listeners* are installed or neither *Listeners* are enabled to handle their respective statuses, then *Connex DDS Micro* will not call any user functions when new data arrives for the *DataReader*.

4. In the `on_data_available()` method of the *DDSDataReaderListener*, invoke `read()` or `take()` on the *FooDataReader* to access the data.

If the `on_data_on_readers()` method of the *DDSSubscriberListener* is called, the code can invoke `read()` or `take()` directly on the *Subscriber's DataReaders* that have received new data. Alternatively, the code can invoke the *Subscriber's notify_datareaders()* operation. This will in turn call the `on_data_available()` methods of the *DataReaderListeners* (if installed and enabled) for each of the *DataReaders* that have received new DDS data samples.

To wait (block) until DDS data samples arrive:

1. Use the *DataReader* to create a *StatusCondition* that describes the DDS samples for which you want to wait. For example, you can specify that you want to wait for never-before-seen DDS samples from *DataReaders* that are still considered to be 'alive.'
2. Create a *WaitSet*.
3. Attach the *StatusCondition* to the *WaitSet*.
4. Call the *WaitSet's wait()* operation, specifying how long you are willing to wait for the desired DDS samples. When `wait()` returns, it will indicate that it timed out, or that the attached Condition become true (and therefore the desired DDS samples are available).

- Using a **FooDataReader**, use the `read()` or `take()` operations to access the DDS data samples that have been received and stored for the *DataReader*.

4.4.2 Subscribers

An application that intends to subscribe to information needs the following *Entities*: *DomainParticipant*, *Topic*, *Subscriber*, and *DataReader*. All *Entities* have a corresponding specialized *Listener* and a set of *QosPolicies*. The *Listener* is how *RTI Connex DDS Micro* notifies your application of status changes relevant to the *Entity*. The *QosPolicies* allow your application to configure the behavior and resources of the *Entity*.

- The *DomainParticipant* defines the DDS domain on which the information will be available.
- The *Topic* defines the name of the data to be subscribed, as well as the type (format) of the data itself.
- The *DataReader* is the *Entity* used by the application to subscribe to updated values of the data. The *DataReader* is bound at creation time to a *Topic*, thus specifying the named and typed data stream to which it is subscribed. The application uses the *DataWriter's* `read()` or `take()` operation to access DDS data samples received for the *Topic*.
- The *Subscriber* manages the activities of several *DataReader* entities. The application receives data using a *DataReader* that belongs to a *Subscriber*. However, the *Subscriber* will determine when the data received from applications is actually available for access through the *DataReader*. Depending on the settings of various *QosPolicies* of the *Subscriber* and *DataReader*, data may be buffered until DDS data samples for associated *DataReaders* are also received. By default, the data is available to the application as soon as it is received.

For more information on creating and deleting *Subscribers*, as well as setting *QosPolicies*, see the Subscribers section in the *RTI Connex DDS Core Libraries User's Manual* (available [here](#) if you have Internet access).

4.4.3 DataReaders

To create a *DataReader*, you need a *DomainParticipant*, a *Topic*, and a *Subscriber*. You need at least one *DataReader* for each *Topic* whose DDS data samples you want to receive.

For more details on all operations, see the [C API Reference](#) and [C++ API Reference](#) HTML documentation.

4.4.4 Using DataReaders to Access Data (Read & Take)

For user applications to access the data received for a *DataReader*, they must use the type-specific derived class or set of functions in the [C API Reference](#). Thus for a user data type 'Foo', you must use methods of the **FooDataReader** class. The type-specific class or functions are automatically generated if you use *RTI Code Generator*.

4.4.5 Subscriber QosPolicies

Please refer to the [C API Reference](#) and [C++ API Reference](#) for details on supported *QosPolicies*.

4.4.6 DataReader QosPolicies

Please refer to the [C API Reference](#) and [C++ API Reference](#) for details on supported QosPolicies.

4.5 DDS Domains

This section discusses how to use *DomainParticipants*. It describes the types of operations that are available for them and their QosPolicies.

The goal of this section is to help you become familiar with the objects you need for setting up your *RTI Connex DDS Micro* application. For specific details on any mentioned operations, see the [C API Reference](#) and [C++ API Reference](#) documentation.

4.5.1 Fundamentals of DDS Domains and DomainParticipants

DomainParticipants are the focal point for creating, destroying, and managing other *RTI Connex DDS Micro* objects. A DDS *domain* is a logical network of applications: only applications that belong to the same DDS *domain* may communicate using *Connex DDS Micro*. A DDS *domain* is identified by a unique integer value known as a domain ID. An application participates in a DDS domain by creating a *DomainParticipant* for that domain ID.

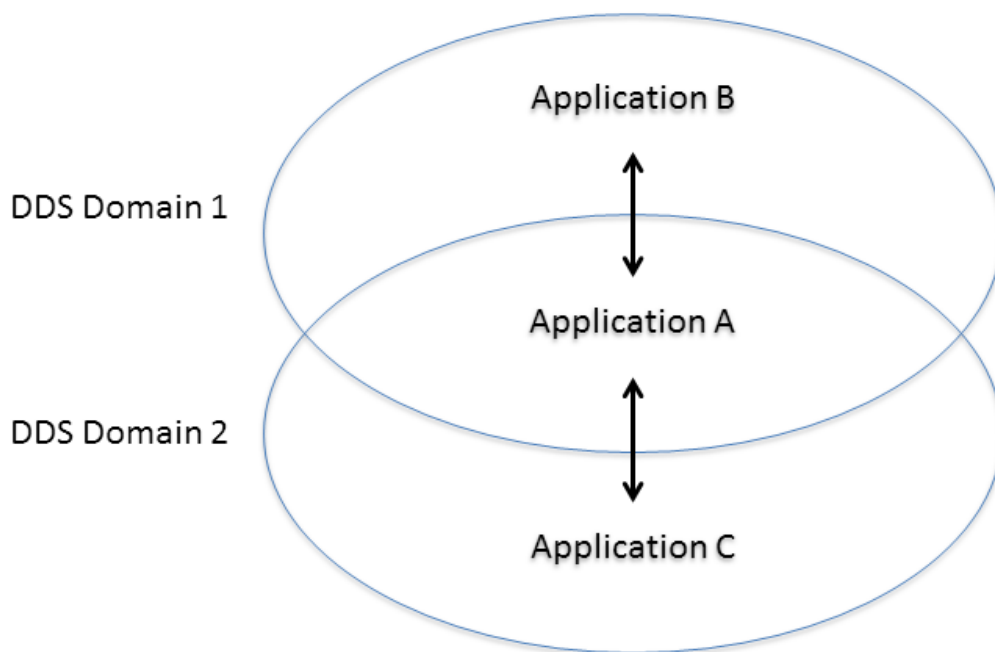


Figure 4.2: Relationship between Applications and DDS Domains

Applications can belong to multiple DDS domains—*A* belongs to DDS domains 1 and 2. Applications in the same DDS domain can communicate with each other, such as *A* and *B*, or *A* and *C*. Applications in different DDS domains, such as *B* and *C*, are not even aware of each other and will not exchange messages.

As seen in *Figure 4.2: Relationship between Applications and DDS Domains*, a single application can participate in multiple DDS domains by creating multiple *DomainParticipants* with different domain IDs. *DomainParticipants* in the same DDS domain form a logical network; they are isolated

discovery messages shall be sent. A maximum of four locators of this type can be specified.

- A **unicast user-traffic locator**. This locator type is used to identify where unicast user-traffic messages shall be sent. A maximum of four locators of this type can be specified.
- A **multicast user-traffic locator**. This locator type is used to identify where multicast user-traffic messages shall be sent. A maximum of four locators of this type can be specified.

It is important to note that a maximum of *four* locators of *each* kind can be sent in a *DomainParticipant* discovery message.

The locators in a *DomainParticipant*'s discovery announcement is used for two purposes:

- It informs other *DomainParticipants* where to send their discovery announcements to this *DomainParticipants*.
- It informs the *DataReaders* and *DataWriters* in other *DomainParticipants* where to send data to the *DataReaders* and *DataWriters* in this *DomainParticipant* unless a *DataReader* or *DataWriter* specifies its own locators.

If a *DataReader* or *DataWriter* specifies their own locators, only user-traffic locators can be specified, then the exact same rules apply as for the *DomainParticipant*.

This document uses *address* and *locator* interchangeably. An address corresponds to the port and address part of a locator. The same address may exist as different kinds, in which case they are unique.

For more details about the discovery process, see the *Discovery* section.

4.6 Application Generation

4.6.1 Introduction

RTI Connext DDS Micro's Application Generation feature simplifies and accelerates application development by enabling the creation of DDS *Entities* by compiling an XML configuration file, linking the result to an application, and calling a single API. Once created, all *Entities* can be retrieved from the application code using standard “lookup_by_name” operations so that they can be used to read and write data. C or C++ source code is generated from the XML configuration and compiled with the application.

This user-guide explains how to use this feature in an application and is organized as follows:

- *Overview*
- *Names Assigned to Entities*
- *Create a Domain Participant*
- *Retrieving Entities*
- *Interoperability*
- *Example Code*
- *Example Configuration*

4.6.2 Overview

The *Connex DDS Micro* Application Generation feature enables the creation of all DDS *Entities* needed in an application and the registration of the factories used in the application. Once created, all *Entities* can be retrieved from application code using standard “lookup_by_name” operations so that they can be used to read and write data. UDP transport, DPDE (Dynamic Participant Dynamic Endpoint) and DPSE (Dynamic Participant Static Endpoint) discovery configuration can also be configured as needed.

C source code is generated from the XML configuration and has to be compiled with the application. This is needed because *Connex DDS Micro* does not include an XML parser (this would significantly increase code size and amount of memory needed). The generated C source code contains the same information as the XML configuration file. The generated C source code can be used from both the C API Reference and C++ API Reference.

The *Connex DDS Micro* Application Generation is enabled by default in this release when compiling with `rttime-make`. However, future releases may disable the feature by default. Thus, it is advised to always compile with the *Connex DDS Micro* Application Generation feature enabled (`-DRTIME_DDS_ENABLE_APPGEN=1` to CMake).

Important Points

Applications can create a *RTI Connex DDS Micro Entity* from a *DomainParticipant* configuration described in the XML Configuration file. All the *Entities* defined by such *DomainParticipant* configuration are created automatically as part of the creation. In addition, multiple *DomainParticipant* configurations may be defined within a single XML configuration file.

All the *Entities* created from a *DomainParticipant* configuration are automatically assigned an entity name. *Entities* can be retrieved via “lookup_by_name” operations specifying their name. Each *Entity* stores its own name in the QoS policies of the *Entity* so that they can be retrieved locally (via a lookup) and communicated via discovery.

A configuration file is not tied to the application that uses it. Different applications may run using the same configuration file. A single file may define multiple *DomainParticipant* configurations. Normally, a single application will instantiate only one *Connex DDS Micro*, but a *Connex DDS Micro* application can instantiate as many as needed.

Changes in the XML configuration file require to generate C/C++ source code again and recompile the application.

4.6.3 Names Assigned to Entities

Each *Entity* configured in the configuration is given a name. This name is used to retrieve them at run-time using the *RTI Connex DDS Micro* API.

In the context of the configuration we should distinguish between two names:

- Configuration name: The name of a specific *Entity*'s configuration. It is given by the name attribute of the corresponding element.
- Entity name in the *Entity*'s QoS: The Entity name in the *Entity*'s QoS.

At runtime, the *Entity* will be created using the Entity name in the *Entity*'s QoS; the configuration name will be used if this is an empty string.

The attribute multiplicity indicates that a set of *Entities* should be created from the same configuration. As each *Entity* must have a unique name, the system will automatically append a number to the Entity name in the *Entity*'s QoS (or, if it is an empty string, the configuration name) to obtain the Entity name. For example, if we specified a multiplicity of “N”, then for each index “i” between 0 and N-1, the system will assign Entity names according to the table below:

Entity Name	Index: i
“configuration_name”	0
“configuration_name#i”	[1,N-1]

That is, the *Entity* name followed by the token “#” and an index.

4.6.4 Create a Domain Participant

To create a *DomainParticipant* from a configuration profile, use API [create_participant_from_config\(\)](#), which receives the configuration name and creates all the *Entities* defined by that configuration. This API is available in *RTI Connex DDS Micro* for compatibility with *RTI Connex DDS Professional*.

4.6.5 Retrieving Entities

After creation, you can retrieve the defined *Entities* by using the [lookup_by_name\(\)](#) operations available in the [C API Reference](#) and [C++ API Reference](#).

4.6.6 Interoperability

Applications created using this feature can inter-operate with other *RTI Connex DDS Micro* applications which are not created using this feature and with *RTI Connex DDS Professional* applications.

4.6.7 Example Code

This section contains an example to instantiate an application using *Connex DDS Micro* Application Generation.

Create the application

Create an application using *Connex DDS Micro* Application Generation. Note that only the *Connex DDS Micro* Application Generation factory needs to be registered; all other factories, such as UDP transport, DPDE, and DPSE discovery can be defined in the *Connex DDS Micro* Application Generation configuration, and are automatically registered by *Connex DDS Micro* Application Generation.

```
DDS_ReturnCode_t retcode;
DDS_DomainParticipantFactory *factory = NULL;
RT_Registry_T *registry = NULL;
```

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```

struct APPGEN_FactoryProperty model_xml = APPGEN_FactoryProperty_INITIALIZER;
DDS_DomainParticipant *participant;
DDS_DataWriter *datawriter;
struct DDS_DataWriterListener dw_listener =
    DDS_DataWriterListener_INITIALIZER;
factory = DDS_DomainParticipantFactory_get_instance();
registry = DDS_DomainParticipantFactory_get_registry(factory);
/* This pointer must be valid as long as the Micro
   Application Generation plugin is registered
  */
model_xml._model = APPGEN_get_library_seq();
/* Register factory used to create participants from config */
if (!APPGEN_Factory_register(registry, &model_xml))
{
    printf("failed to register Application Generation\n");
    goto error;
}
/* create participant from config */
participant = DDS_DomainParticipantFactory_create_participant_from_config(
    factory, "UnitTestAppLibrary::UnitTestPublisherApp");
if (participant == NULL)
{
    printf("failed to create participant\n");
    goto error;
}
datawriter = DDS_DomainParticipant_lookup_datawriter_by_name(
    participant, "TestPublisher1::Test1DW");
if (datawriter == NULL)
{
    printf("failed to lookup datawriter\n");
    goto error;
}
dw_listener.on_publication_matched = HelloWorldPublisher_on_publication_matched;
retcode = DDS_DataWriter_set_listener(datawriter, &dw_listener,
    DDS_PUBLICATION_MATCHED_STATUS);
if (retcode != DDS_RETCODE_OK)
{
    printf("failed to set writer listener\n");
    goto done;
}
retcode = DDS_Entity_enable(DDS_DomainParticipant_as_entity(participant));
if (retcode != DDS_RETCODE_OK)
{
    printf("failed to enable entity\n");
}
hw_datawriter = HelloWorldDataWriter_narrow(datawriter);
/* Using variable hw_datawriter call HelloWorldDataWriter_write()
   to write samples.
  */

```

Delete the application

Connex DDS Micro Application Generation does not include any new API that can be used to delete an application. Instead, the already existing APIs can be used.

```

DDS_ReturnCode_t retcode;
RT_Registry_T *registry = NULL;
DDS_DomainParticipantFactory *factory = NULL;
factory = DDS_DomainParticipantFactory_get_instance();
registry = DDS_DomainParticipantFactory_get_registry(factory);
retcode = DDS_DomainParticipant_delete_contained_entities(participant);
if (retcode != DDS_RETCODE_OK)
{
    printf("failed to delete contained entities: %d\n", retcode);
    return;
}
retcode = DDS_DomainParticipantFactory_delete_participant(participant);
if (retcode != DDS_RETCODE_OK)
{
    printf("failed to delete participant: %d\n", retcode);
    return;
}
if (!APPGEN_Factory_unregister(registry, NULL))
{
    printf("failed to unregister Application Generation\n");
}
retcode = DDS_DomainParticipantFactory_finalize_instance();
if (retcode != DDS_RETCODE_OK)
{
    printf("failed to finalize domain participant factory: %d\n", retcode);
    return;
}

```

4.6.8 Example Configuration

This section contains an example configuration. The example code configuration has been generated from the example XML configuration files.

The example configuration defines one library named “HelloWorldAppLibrary”. This library defines four *RTI Connex DDS Micro* applications: one with a publisher and one with a subscriber, both using DPDE discovery, and one with a publisher and one with a subscriber, both using DPSE discovery. Applications using DPDE discovery are compatible and are able to communicate. Applications using DPSE discovery are compatible and are able to communicate.

Domain Participant “HelloWorldDPDEPubDP”

This application defines a publisher which uses DPDE discovery.

The application has one named “HelloWorldDPDEPubDP”, one named “HelloWorldDPDEPub”, and one named “HelloWorldDPDEDW” which uses topic name “Example HelloWorld”. The application registers one type with name “HelloWorld” and defines one with name “Example HelloWorld” which uses the type “HelloWorld”.

Domain Participant “HelloWorldDPDESubDP”

This application defines a subscriber which uses DPDE discovery.

The application has one named “HelloWorldDPDESubDP”, one named “HelloWorldDPDESub”, and one named “HelloWorldDPDEDR” which uses topic name “Example HelloWorld”. The application registers one type with name “HelloWorld” and defines one with name “Example HelloWorld” which uses the type “HelloWorld”.

Domain Participant “HelloWorldDPSEPubDP”

This application defines a publisher which uses DPSE discovery.

The application has one named “HelloWorldDPSEPubDP”, one named “HelloWorldDPSEPub”, and one named “HelloWorldDPSEDR” which uses topic name “Example HelloWorld” and has RTPS id 100. The application registers one type with name “HelloWorld” and defines one with name “Example HelloWorld” which uses type “HelloWorld”.

The application asserts one remote participant named “HelloWorldDPSESubDP” and one remote subscription with ID 200, type name “HelloWorld”, and topic name “Example HelloWorld”.

Domain Participant “HelloWorldDPSESubDP”

This application defines a subscriber which uses DPSE discovery.

The application has one named “HelloWorldDPSESubDP”, one named “HelloWorldDPSESub”, and one named “HelloWorldDPSEDR” which uses topic name “Example HelloWorld” and has RTPS id 200. The application registers one type with name “HelloWorld” and defines one with name “Example HelloWorld” which uses the type “HelloWorld”.

The application asserts one remote participant named “HelloWorldDPSEPubDP” and one remote subscription with ID 100, type name “HelloWorld”, and topic name “Example HelloWorld”.

Configuration Files

Example *Connex DDS Micro* Application Generation configuration file HelloWorld.xml:

```

<?xml version="1.0"?>
<dds xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:noNamespaceSchemaLocation="http://community.rti.com/schema/6.0.0/rti_dds_
    ↪profiles.xsd">
    <!-- Type Definition -->
    <types>
        <const name="MAX_NAME_LEN" type="long" value="64"/>
        <const name="MAX_MSG_LEN" type="long" value="128"/>
        <struct name="HelloWorld">
            <member name="sender" type="string" stringMaxLength="MAX_NAME_LEN" key=
            ↪"true"/>
            <member name="message" type="string" stringMaxLength="MAX_MSG_LEN"/>
            <member name="count" type="long"/>
        </struct>
    </types>
    <!-- Domain Library -->

```

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```

<domain_library name="HelloWorldLibrary">
  <domain name="HelloWorldDomain" domain_id="0">
    <register_type name="HelloWorldType" type_ref="HelloWorld">
      </register_type>
    <topic name="HelloWorldTopic" register_type_ref="HelloWorldType">
      <registered_name>HelloWorldTopic</registered_name>
    </topic>
  </domain>
</domain_library>
<!-- Participant Library -->
<domain_participant_library name="HelloWorldAppLibrary">
  <domain_participant name="HelloWorldDPDEPubDP"
    domain_ref="HelloWorldLibrary::HelloWorldDomain">
    <publisher name="HelloWorldDPDEPub">
      <data_writer topic_ref="HelloWorldTopic" name="HelloWorldDPDEDW">
        <datawriter_qos base_name="QosLibrary::DPDEProfile"/>
      </data_writer>
    </publisher>
    <participant_qos base_name="QosLibrary::DPDEProfile"/>
  </domain_participant>
  <domain_participant name="HelloWorldDPDESubDP"
    domain_ref="HelloWorldLibrary::HelloWorldDomain">
    <subscriber name="HelloWorldDPDESub">
      <data_reader topic_ref="HelloWorldTopic" name="HelloWorldDPDEDR">
        <datareader_qos base_name="QosLibrary::DPDEProfile"/>
      </data_reader>
    </subscriber>
    <participant_qos base_name="QosLibrary::DPDEProfile"/>
  </domain_participant>
  <domain_participant name="HelloWorldDPSEPubDP"
    domain_ref="HelloWorldLibrary::HelloWorldDomain">
    <publisher name="HelloWorldDPSEPub">
      <data_writer topic_ref="HelloWorldTopic" name="HelloWorldDPSEDW">
        <datawriter_qos base_name="QosLibrary::DPSEProfile"/>
      </data_writer>
    </publisher>
    <participant_qos base_name="QosLibrary::DPSEProfile"/>
  </domain_participant>
  <domain_participant name="HelloWorldDPSESubDP"
    domain_ref="HelloWorldLibrary::HelloWorldDomain">
    <subscriber name="HelloWorldDPSESub">
      <data_reader topic_ref="HelloWorldTopic" name="HelloWorldDPSEDR">
        <datareader_qos base_name="QosLibrary::DPSEProfile"/>
      </data_reader>
    </subscriber>
    <participant_qos base_name="QosLibrary::DPSEProfile"/>
  </domain_participant>
</domain_participant_library>
</dds>

```

Example QoS configuration file HelloWorldQos.xml:

```

<?xml version="1.0"?>
<dds xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
     xsi:noNamespaceSchemaLocation="http://community.rti.com/schema/6.0.0/rti_dds_
     ↪profiles.xsd">
  <qos_library name="QosLibrary">
    <qos_profile name="DefaultProfile" is_default_participant_factory_profile="true">
      <!-- Participant Factory Qos -->
      <participant_factory_qos>
        <entity_factory>
          <autoenable_created_entities>>false</autoenable_created_entities>
        </entity_factory>
      </participant_factory_qos>
      <!-- Participant Qos -->
      <participant_qos>
        <discovery>
          <accept_unknown_peers>>false</accept_unknown_peers>
          <initial_peers>
            <element>127.0.0.1</element>
            <element>239.255.0.1</element>
          </initial_peers>
          <enabled_transports>
            <element>udpv4</element>
          </enabled_transports>
          <multicast_receive_addresses>
            <element>udpv4://127.0.0.1</element>
            <element>udpv4://239.255.0.1</element>
          </multicast_receive_addresses>
        </discovery>
        <default_unicast>
          <value>
            <element>
              <transports>
                <element>udpv4</element>
              </transports>
            </element>
          </value>
        </default_unicast>
        <transport_builtin>
          <mask>UDPv4</mask>
        </transport_builtin>
        <resource_limits>
          <local_writer_allocation>
            <max_count>1</max_count>
          </local_writer_allocation>
          <local_reader_allocation>
            <max_count>1</max_count>
          </local_reader_allocation>
          <local_publisher_allocation>
            <max_count>1</max_count>
          </local_publisher_allocation>
          <local_subscriber_allocation>
            <max_count>1</max_count>
          </local_subscriber_allocation>
        </resource_limits>
      </participant_qos>
    </qos_profile>
  </qos_library>

```

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```

        </local_subscriber_allocation>
    <local_topic_allocation>
        <max_count>1</max_count>
    </local_topic_allocation>
    <local_type_allocation>
        <max_count>1</max_count>
    </local_type_allocation>
    <remote_participant_allocation>
        <max_count>8</max_count>
    </remote_participant_allocation>
    <remote_writer_allocation>
        <max_count>8</max_count>
    </remote_writer_allocation>
    <remote_reader_allocation>
        <max_count>8</max_count>
    </remote_reader_allocation>
    <max_receive_ports>32</max_receive_ports>
    <max_destination_ports>32</max_destination_ports>
</resource_limits>
</participant_qos>
<!-- DataWriter Qos -->
<datawriter_qos>
    <history>
        <depth>32</depth>
    </history>
    <resource_limits>
        <max_instances>2</max_instances>
        <max_samples>64</max_samples>
        <max_samples_per_instance>32</max_samples_per_instance>
    </resource_limits>
    <reliability>
        <kind>RELIABLE_RELIABILITY_QOS</kind>
    </reliability>
    <protocol>
        <rtps_reliable_writer>
            <heartbeat_period>
                <nanosec>250000000</nanosec>
                <sec>0</sec>
            </heartbeat_period>
        </rtps_reliable_writer>
    </protocol>
    <!-- transports -->
    <unicast>
        <value>
            <element>
                <transports>
                    <element>udpv4</element>
                </transports>
            </element>
        </value>
    </unicast>

```

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```

</datawriter_qos>
<!-- DataReader Qos -->
<datareader_qos>
  <history>
    <depth>32</depth>
  </history>
  <resource_limits>
    <max_instances>2</max_instances>
    <max_samples>64</max_samples>
    <max_samples_per_instance>32</max_samples_per_instance>
  </resource_limits>
  <reliability>
    <kind>RELIABLE_RELIABILITY_QOS</kind>
  </reliability>
  <reader_resource_limits>
    <max_remote_writers>10</max_remote_writers>
    <max_remote_writers_per_instance>10</max_remote_writers_per_instance>
  </reader_resource_limits>
  <!-- transports -->
  <unicast>
    <value>
      <element>
        <transports>
          <element>udpv4</element>
        </transports>
      </element>
    </value>
  </unicast>
  <multicast>
    <value>
      <element>
        <receive_address>127.0.0.1</receive_address>
        <transports>
          <element>udpv4</element>
        </transports>
      </element>
    </value>
  </multicast>
</datareader_qos>
</qos_profile>
<qos_profile name="DPDEProfile" base_name="DefaultProfile">
  <participant_qos>
    <discovery_config>
      <builtin_discovery_plugins>SDP</builtin_discovery_plugins>
    </discovery_config>
  </participant_qos>
</qos_profile>
<qos_profile name="DPSEProfile" base_name="DefaultProfile">
  <participant_qos>
    <discovery_config>
      <builtin_discovery_plugins>DPSE</builtin_discovery_plugins>
    </discovery_config>
  </participant_qos>
</qos_profile>

```

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```

        </discovery_config>
    </participant_qos>
</qos_profile>
</qos_library>
</dds>

```

Generated source files

Example generated header configuration HelloWorldAppgen.h:

```

/*
WARNING: THIS FILE IS AUTO-GENERATED. DO NOT MODIFY.
This file was generated from HelloWorld.xml using "rtiddsmag."
The rtiddsmag tool is part of the RTI Connex distribution.
For more information, type 'rtiddsmag -help' at a command shell
or consult the RTI Connex manual.
*/
#include "HelloWorldPlugin.h"
#include "app_gen/app_gen.h"
#include "netio/netio_udp.h"
#include "disc_dpde/disc_dpde_discovery_plugin.h"
#include "disc_dpse/disc_dpse_dpse_discovery.h"
#define RTI_APP_GEN___udpv4__HelloWorldAppLibrary_HelloWorldDPDEPubDP_udp1 \
{ \
    NETIO_InterfaceFactoryProperty_INITIALIZER, \
    REDA_StringSeq_INITIALIZER, /* allow_interface */ \
    REDA_StringSeq_INITIALIZER, /* deny_interface */ \
    262144, /* max_send_buffer_size */ \
    262144, /* max_receive_buffer_size */ \
    8192, /* max_message_size */ \
    -1, /* max_send_message_size */ \
    1, /* multicast_ttl */ \
    UDP_NAT_INITIALIZER \
    UDP_InterfaceTableEntrySeq_INITIALIZER, /* if_table */ \
    NULL, /* multicast_interface */ \
    DDS_BOOLEAN_TRUE, /* is_default_interface */ \
    DDS_BOOLEAN_FALSE, /* disable_auto_interface_config */ \
    { /* rcv_thread */ \
        OSAPI_THREAD_USE_OSDEFAULT_STACKSIZE, /* stack_size */ \
        OSAPI_THREAD_PRIORITY_NORMAL, /* priority */ \
        OSAPI_THREAD_DEFAULT_OPTIONS /* options */ \
    }, \
    RTI_FALSE /* transform_locator_kind */ \
    UDP_TRANSFORMS_INITIALIZER \
}
/* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorldQos.xml, lineNumber=145, columnNumber=35 */
↪
#define RTI_APP_GEN___dpde__HelloWorldAppLibrary_HelloWorldDPDEPubDP_dpde1 \
{ \
    RT_ComponentFactoryProperty_INITIALIZER, /* _parent */ \

```

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```

{ /*participant_liveliness_assert_period */ \
  30L, /* sec */ \
  0L /* nanosec */ \
}, \
{ /*participant_liveliness_lease_duration */ \
  100L, /* sec */ \
  0L /* nanosec */ \
}, \
5, /* initial_participant_announcements */ \
{ /*initial_participant_announcement_period */ \
  1L, /* sec */ \
  0L /* nanosec */ \
}, \
DDS_BOOLEAN_FALSE, /* cache_serialized_samples */ \
DDS_LENGTH_AUTO, /* max_participant_locators */ \
4, /* max_locators_per_discovered_participant */ \
8, /* max_samples_per_builtin_endpoint_reader */ \
DDS_LENGTH_UNLIMITED, /* builtin_writer_max_heartbeat_retries */ \
{ /*builtin_writer_heartbeat_period */ \
  0L, /* sec */ \
  100000000L /* nanosec */ \
}, \
1L /* builtin_writer_heartbeats_per_max_samples */ \
DDS_PARTICIPANT_MESSAGE_READER_RELIABILITY_KIND_INITIALIZER \
}
/* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorldQos.xml, lineNumber=152, columnNumber=35 */
↪
#define RTI_APP_GEN___dpse__HelloWorldAppLibrary_HelloWorldDPSEPubDP_dpse1 \
{ \
  RT_ComponentFactoryProperty_INITIALIZER, /* _parent */ \
  { /*participant_liveliness_assert_period */ \
    30L, /* sec */ \
    0L /* nanosec */ \
  }, \
  { /*participant_liveliness_lease_duration */ \
    100L, /* sec */ \
    0L /* nanosec */ \
  }, \
  5, /* initial_participant_announcements */ \
  { /*initial_participant_announcement_period */ \
    1L, /* sec */ \
    0L /* nanosec */ \
  }, \
  DDS_LENGTH_AUTO, /* max_participant_locators */ \
  4 /* max_locators_per_discovered_participant */ \
  DDS_PARTICIPANT_MESSAGE_READER_RELIABILITY_KIND_INITIALIZER \
}
/* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorldQos.xml, lineNumber=7, columnNumber=38 */
#define RTI_APP_GEN___DPF_QOS_QosLibrary_DefaultProfile \

```

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{ \
  { /* entity_factory */ \
    DDS_BOOLEAN_FALSE /* autoenable_created_entities */ \
  }, \
  DDS_SYSTEM_RESOURCE_LIMITS_QOS_POLICY_DEFAULT \
}
/* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=38, columnNumber=67 */
extern const char *const HelloWorldAppLibrary_HelloWorldDPDEPubDP_initial_peers[2];
extern const char *const HelloWorldAppLibrary_HelloWorldDPDEPubDP_discovery_enabled_
↪transports[3];
extern const char *const HelloWorldAppLibrary_HelloWorldDPDEPubDP_transport_enabled_
↪transports[1];
extern const char *const HelloWorldAppLibrary_HelloWorldDPDEPubDP_user_traffic_enabled_
↪transports[1];
#define RTI_APP_GEN___DP_QOS_HelloWorldAppLibrary_HelloWorldDPDEPubDP \
{ \
  DDS_ENTITY_FACTORY_QOS_POLICY_DEFAULT, \
  { /* discovery */ \
    REDA_StringSeq_INITIALIZER_W_LOAN(HelloWorldAppLibrary_HelloWorldDPDEPubDP_
↪initial_peers, 2, 2), /* initial_peers */ \
    REDA_StringSeq_INITIALIZER_W_LOAN(HelloWorldAppLibrary_HelloWorldDPDEPubDP_
↪discovery_enabled_transports, 3, 3), /* enabled_transports */ \
    { \
      { { "dpde1" } }, /* RT_ComponentFactoryId_INITIALIZER */ \
      NDDS_Discovery_Property_INITIALIZER \
    }, /* discovery_component */ \
    DDS_BOOLEAN_FALSE /* accept_unknown_peers */ \
  }, \
  { /* resource_limits */ \
    1L, /* local_writer_allocation */ \
    1L, /* local_reader_allocation */ \
    1L, /* local_publisher_allocation */ \
    1L, /* local_subscriber_allocation */ \
    1L, /* local_topic_allocation */ \
    1L, /* local_type_allocation */ \
    8L, /* remote_participant_allocation */ \
    8L, /* remote_writer_allocation */ \
    8L, /* remote_reader_allocation */ \
    32L, /* matching_writer_reader_pair_allocation */ \
    32L, /* matching_reader_writer_pair_allocation */ \
    32L, /* max_receive_ports */ \
    32L, /* max_destination_ports */ \
    65536, /* unbound_data_buffer_size */ \
    500UL /* shm_ref_transfer_mode_max_segments */ \
  }, \
  DDS_ENTITY_NAME_QOS_POLICY_DEFAULT, \
  DDS_WIRE_PROTOCOL_QOS_POLICY_DEFAULT, \
  { /* transports */ \
    REDA_StringSeq_INITIALIZER_W_LOAN(HelloWorldAppLibrary_HelloWorldDPDEPubDP_
↪transport_enabled_transports, 1, 1) /* enabled_transports */ \

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    }, \
    { /* user_traffic */ \
        REDA_StringSeq_INITIALIZER_W_LOAN>HelloWorldAppLibrary>HelloWorldDPDEPubDP_user_
↪traffic_enabled_transports, 1, 1) /* enabled_transports */ \
    }, \
    DDS_TRUST_QOS_POLICY_DEFAULT, \
    DDS_PROPERTY_QOS_POLICY_DEFAULT \
}
/* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C>HelloWorld_appgen>HelloWorld.xml, lineNumber=35, columnNumber=74 */
extern const char *const>HelloWorldAppLibrary>HelloWorldDPDEPubDP>HelloWorldDPDEPub_
↪HelloWorldDPDEDW_transport_enabled_transports[1];
#define RTI_APP_GEN___DW_QOS>HelloWorldAppLibrary>HelloWorldDPDEPubDP>HelloWorldDPDEPub_
↪HelloWorldDPDEDW \
{ \
    DDS_DEADLINE_QOS_POLICY_DEFAULT, \
    DDS_LIVELINESS_QOS_POLICY_DEFAULT, \
    { /* history */ \
        DDS_KEEP_LAST_HISTORY_QOS, /* kind */ \
        32L /* depth */ \
    }, \
    { /* resource_limits */ \
        64L, /* max_samples */ \
        2L, /* max_instances */ \
        32L /* max_samples_per_instance */ \
    }, \
    DDS_OWNERSHIP_QOS_POLICY_DEFAULT, \
    DDS_OWNERSHIP_STRENGTH_QOS_POLICY_DEFAULT, \
    DDS_LATENCY_BUDGET_QOS_POLICY_DEFAULT, \
    { /* reliability */ \
        DDS_RELIABLE_RELIABILITY_QOS, /* kind */ \
        { /* max_blocking_time */ \
            0L, /* sec */ \
            100000000L /* nanosec */ \
        } \
    }, \
    DDS_DURABILITY_QOS_POLICY_DEFAULT, \
    DDS_DESTINATION_ORDER_QOS_POLICY_DEFAULT, \
    DDS_TRANSPORT_ENCAPSULATION_QOS_POLICY_DEFAULT, \
    DDS_DATA_REPRESENTATION_QOS_POLICY_DEFAULT, \
    { /* protocol */ \
        DDS RTPS_AUTO_ID, /* rtps_object_id */ \
        { /* rtps_reliable_writer */ \
            { /* heartbeat_period */ \
                0L, /* sec */ \
                250000000L /* nanosec */ \
            }, \
            1L, /* heartbeats_per_max_samples */ \
            DDS_LENGTH_UNLIMITED, /* max_send_window */ \
            DDS_LENGTH_UNLIMITED, /* max_heartbeat_retries */ \
            { /* first_write_sequence_number */ \

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        0, /* high */ \
        1 /* low */ \
    } \
}, \
    DDS_BOOLEAN_TRUE /* serialize_on_write */ \
}, \
    DDS_TYPESUPPORT_QOS_POLICY_DEFAULT, \
    { /* transports */ \
        REDA_StringSeq_INITIALIZER_W_LOAN(HelloWorldAppLibrary_HelloWorldDPDEPubDP_
↪HelloWorldDPDEPub_HelloWorldDPDEDW_transport_enabled_transports, 1, 1) /* enabled_
↪transports */ \
    }, \
    RTI_MANAGEMENT_QOS_POLICY_DEFAULT, \
    DDS_DATAWRITERRESOURCE_LIMITS_QOS_POLICY_DEFAULT, \
    DDS_PUBLISH_MODE_QOS_POLICY_DEFAULT, \
    DDS_DATAWRITERQOS_TRUST_INITIALIZER \
    DDS_DATAWRITERQOS_APPGEN_INITIALIZER \
    NULL, \
    DDS_DataWriterTransferModeQosPolicy_INITIALIZER \
}
/* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=48, columnNumber=67 */
extern const char *const HelloWorldAppLibrary_HelloWorldDPDESubDP_initial_peers[2];
extern const char *const HelloWorldAppLibrary_HelloWorldDPDESubDP_discovery_enabled_
↪transports[3];
extern const char *const HelloWorldAppLibrary_HelloWorldDPDESubDP_transport_enabled_
↪transports[1];
extern const char *const HelloWorldAppLibrary_HelloWorldDPDESubDP_user_traffic_enabled_
↪transports[1];
#define RTI_APP_GEN___DP_QOS_HelloWorldAppLibrary_HelloWorldDPDESubDP \
{ \
    DDS_ENTITY_FACTORY_QOS_POLICY_DEFAULT, \
    { /* discovery */ \
        REDA_StringSeq_INITIALIZER_W_LOAN(HelloWorldAppLibrary_HelloWorldDPDESubDP_
↪initial_peers, 2, 2), /* initial_peers */ \
        REDA_StringSeq_INITIALIZER_W_LOAN(HelloWorldAppLibrary_HelloWorldDPDESubDP_
↪discovery_enabled_transports, 3, 3), /* enabled_transports */ \
        { \
            { { "dpde1" } }, /* RT_ComponentFactoryId_INITIALIZER */ \
            NDDS_Discovery_Property_INITIALIZER \
        }, /* discovery_component */ \
        DDS_BOOLEAN_FALSE /* accept_unknown_peers */ \
    }, \
    { /* resource_limits */ \
        1L, /* local_writer_allocation */ \
        1L, /* local_reader_allocation */ \
        1L, /* local_publisher_allocation */ \
        1L, /* local_subscriber_allocation */ \
        1L, /* local_topic_allocation */ \
        1L, /* local_type_allocation */ \
        8L, /* remote_participant_allocation */ \
    } \
}

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    8L, /* remote_writer_allocation */ \
    8L, /* remote_reader_allocation */ \
    32L, /* matching_writer_reader_pair_allocation */ \
    32L, /* matching_reader_writer_pair_allocation */ \
    32L, /* max_receive_ports */ \
    32L, /* max_destination_ports */ \
    65536, /* unbound_data_buffer_size */ \
    500UL /* shm_ref_transfer_mode_max_segments */ \
}, \
DDS_ENTITY_NAME_QOS_POLICY_DEFAULT, \
DDS_WIRE_PROTOCOL_QOS_POLICY_DEFAULT, \
{ /* transports */ \
    REDA_StringSeq_INITIALIZER_W_LOAN>HelloWorldAppLibrary>HelloWorldDPDESubDP_
↪transport_enabled_transports, 1, 1) /* enabled_transports */ \
}, \
{ /* user_traffic */ \
    REDA_StringSeq_INITIALIZER_W_LOAN>HelloWorldAppLibrary>HelloWorldDPDESubDP_user_
↪traffic_enabled_transports, 1, 1) /* enabled_transports */ \
}, \
DDS_TRUST_QOS_POLICY_DEFAULT, \
DDS_PROPERTY_QOS_POLICY_DEFAULT \
}
/* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C>HelloWorld_appgen>HelloWorld.xml, lineNumber=45, columnNumber=74 */
extern const char *const>HelloWorldAppLibrary>HelloWorldDPDESubDP>HelloWorldDPDESub_
↪HelloWorldDPDEDR_transport_enabled_transports[2];
#define RTI_APP_GEN___DR_QOS>HelloWorldAppLibrary>HelloWorldDPDESubDP>HelloWorldDPDESub_
↪HelloWorldDPDEDR \
{ \
    DDS_DEADLINE_QOS_POLICY_DEFAULT, \
    DDS_LIVELINESS_QOS_POLICY_DEFAULT, \
    { /* history */ \
        DDS_KEEP_LAST_HISTORY_QOS, /* kind */ \
        32L /* depth */ \
    }, \
    { /* resource_limits */ \
        64L, /* max_samples */ \
        2L, /* max_instances */ \
        32L /* max_samples_per_instance */ \
    }, \
    DDS_OWNERSHIP_QOS_POLICY_DEFAULT, \
    DDS_LATENCY_BUDGET_QOS_POLICY_DEFAULT, \
    { /* reliability */ \
        DDS_RELIABLE_RELIABILITY_QOS, /* kind */ \
        { /* max_blocking_time */ \
            0L, /* sec */ \
            0L /* nanosec */ \
        } \
    }, \
    DDS_DURABILITY_QOS_POLICY_DEFAULT, \
    DDS_DESTINATION_ORDER_QOS_POLICY_DEFAULT, \

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DDS_TRANSPORT_ENCAPSULATION_QOS_POLICY_DEFAULT, \
DDS_DATA_REPRESENTATION_QOS_POLICY_DEFAULT, \
DDS_TYPESUPPORT_QOS_POLICY_DEFAULT, \
DDS_DATA_READER_PROTOCOL_QOS_POLICY_DEFAULT, \
{ /* transports */ \
  REDA_StringSeq_INITIALIZER_W_LOAN>HelloWorldAppLibrary>HelloWorldDPDESubDP_
↪HelloWorldDPDESub>HelloWorldDPEDR_transport_enabled_transports, 2, 2) /* enabled_
↪transports */ \
}, \
{ /* reader_resource_limits */ \
  10L, /* max_remote_writers */ \
  10L, /* max_remote_writers_per_instance */ \
  1L, /* max_samples_per_remote_writer */ \
  1L, /* max_outstanding_reads */ \
  DDS_NO_INSTANCE_REPLACEMENT_QOS, /* instance_replacement */ \
  4L, /* max_routes_per_writer */ \
  DDS_MAX_AUTO, /* max_fragmented_samples */ \
  DDS_MAX_AUTO, /* max_fragmented_samples_per_remote_writer */ \
  DDS_SIZE_AUTO /* shmem_ref_transfer_mode_attached_segment_allocation */ \
}, \
RTI_MANAGEMENT_QOS_POLICY_DEFAULT, \
DDS_DATAREADERQOS_TRUST_INITIALIZER \
DDS_DATAREADERQOS_APPGEN_INITIALIZER \
NULL \
}
}
/* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C>HelloWorld_appgen>HelloWorld.xml, lineNumber=58, columnNumber=67 */
extern const char *const>HelloWorldAppLibrary>HelloWorldDPSEPubDP_initial_peers[2];
extern const char *const>HelloWorldAppLibrary>HelloWorldDPSEPubDP_discovery_enabled_
↪transports[3];
extern const char *const>HelloWorldAppLibrary>HelloWorldDPSEPubDP_transport_enabled_
↪transports[1];
extern const char *const>HelloWorldAppLibrary>HelloWorldDPSEPubDP_user_traffic_enabled_
↪transports[1];
#define RTI_APP_GEN___DP_QOS>HelloWorldAppLibrary>HelloWorldDPSEPubDP \
{ \
  DDS_ENTITY_FACTORY_QOS_POLICY_DEFAULT, \
  { /* discovery */ \
    REDA_StringSeq_INITIALIZER_W_LOAN>HelloWorldAppLibrary>HelloWorldDPSEPubDP_
↪initial_peers, 2, 2), /* initial_peers */ \
    REDA_StringSeq_INITIALIZER_W_LOAN>HelloWorldAppLibrary>HelloWorldDPSEPubDP_
↪discovery_enabled_transports, 3, 3), /* enabled_transports */ \
    { \
      { { "dpse1" } }, /* RT_ComponentFactoryId_INITIALIZER */ \
      NDDS_Discovery_Property_INITIALIZER \
    }, /* discovery_component */ \
    DDS_BOOLEAN_FALSE /* accept_unknown_peers */ \
  }, \
  { /* resource_limits */ \
    1L, /* local_writer_allocation */ \
    1L, /* local_reader_allocation */ \
  }

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1L, /* local_publisher_allocation */ \
1L, /* local_subscriber_allocation */ \
1L, /* local_topic_allocation */ \
1L, /* local_type_allocation */ \
8L, /* remote_participant_allocation */ \
8L, /* remote_writer_allocation */ \
8L, /* remote_reader_allocation */ \
32L, /* matching_writer_reader_pair_allocation */ \
32L, /* matching_reader_writer_pair_allocation */ \
32L, /* max_receive_ports */ \
32L, /* max_destination_ports */ \
65536, /* unbound_data_buffer_size */ \
500UL /* shmем_ref_transfer_mode_max_segments */ \
}, \
DDS_ENTITY_NAME_QOS_POLICY_DEFAULT, \
DDS_WIRE_PROTOCOL_QOS_POLICY_DEFAULT, \
{ /* transports */ \
  REDA_StringSeq_INITIALIZER_W_LOAN>HelloWorldAppLibrary>HelloWorldDPSEPubDP_
↪transport_enabled_transports, 1, 1) /* enabled_transports */ \
}, \
{ /* user_traffic */ \
  REDA_StringSeq_INITIALIZER_W_LOAN>HelloWorldAppLibrary>HelloWorldDPSEPubDP_user_
↪traffic_enabled_transports, 1, 1) /* enabled_transports */ \
}, \
DDS_TRUST_QOS_POLICY_DEFAULT, \
DDS_PROPERTY_QOS_POLICY_DEFAULT \
}
/* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C>HelloWorld_appgen>HelloWorld.xml, lineNumber=55, columnNumber=74 */
extern const char *const>HelloWorldAppLibrary>HelloWorldDPSEPubDP>HelloWorldDPSEPub_
↪HelloWorldDPSEDW_transport_enabled_transports[1];
#define RTI_APP_GEN__DW_QOS>HelloWorldAppLibrary>HelloWorldDPSEPubDP>HelloWorldDPSEPub_
↪HelloWorldDPSEDW \
{ \
  DDS_DEADLINE_QOS_POLICY_DEFAULT, \
  DDS_LIVELINESS_QOS_POLICY_DEFAULT, \
  { /* history */ \
    DDS_KEEP_LAST_HISTORY_QOS, /* kind */ \
    32L /* depth */ \
  }, \
  { /* resource_limits */ \
    64L, /* max_samples */ \
    2L, /* max_instances */ \
    32L /* max_samples_per_instance */ \
  }, \
  DDS_OWNERSHIP_QOS_POLICY_DEFAULT, \
  DDS_OWNERSHIP_STRENGTH_QOS_POLICY_DEFAULT, \
  DDS_LATENCY_BUDGET_QOS_POLICY_DEFAULT, \
  { /* reliability */ \
    DDS_RELIABLE_RELIABILITY_QOS, /* kind */ \
    { /* max_blocking_time */ \

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        0L, /* sec */ \
        100000000L /* nanosec */ \
    } \
}, \
DDS_DURABILITY_QOS_POLICY_DEFAULT, \
DDS_DESTINATION_ORDER_QOS_POLICY_DEFAULT, \
DDS_TRANSPORT_ENCAPSULATION_QOS_POLICY_DEFAULT, \
DDS_DATA_REPRESENTATION_QOS_POLICY_DEFAULT, \
{ /* protocol */ \
    1UL, /* rtps_object_id */ \
    { /* rtps_reliable_writer */ \
        { /* heartbeat_period */ \
            0L, /* sec */ \
            250000000L /* nanosec */ \
        }, \
        1L, /* heartbeats_per_max_samples */ \
        DDS_LENGTH_UNLIMITED, /* max_send_window */ \
        DDS_LENGTH_UNLIMITED, /* max_heartbeat_retries */ \
        { /* first_write_sequence_number */ \
            0, /* high */ \
            1 /* low */ \
        } \
    }, \
    DDS_BOOLEAN_TRUE /* serialize_on_write */ \
}, \
DDS_TYPESUPPORT_QOS_POLICY_DEFAULT, \
{ /* transports */ \
    REDA_StringSeq_INITIALIZER_W_LOAN>HelloWorldAppLibrary>HelloWorldDPSEPubDP_
↪HelloWorldDPSEPub>HelloWorldDPSEDW_transport_enabled_transports, 1, 1) /* enabled_
↪transports */ \
}, \
RTI_MANAGEMENT_QOS_POLICY_DEFAULT, \
DDS_DATAWRITERRESOURCE_LIMITS_QOS_POLICY_DEFAULT, \
DDS_PUBLISH_MODE_QOS_POLICY_DEFAULT, \
DDS_DATAWRITERQOS_TRUST_INITIALIZER \
DDS_DATAWRITERQOS_APPGEN_INITIALIZER \
NULL, \
DDS_DataWriterTransferModeQosPolicy_INITIALIZER \
}
/* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C>HelloWorld_appgen>HelloWorld.xml, lineNumber=68, columnNumber=67 */
extern const char *const>HelloWorldAppLibrary>HelloWorldDPSESubDP_initial_peers[2];
extern const char *const>HelloWorldAppLibrary>HelloWorldDPSESubDP_discovery_enabled_
↪transports[3];
extern const char *const>HelloWorldAppLibrary>HelloWorldDPSESubDP_transport_enabled_
↪transports[1];
extern const char *const>HelloWorldAppLibrary>HelloWorldDPSESubDP_user_traffic_enabled_
↪transports[1];
#define RTI_APP_GEN___DP_QOS>HelloWorldAppLibrary>HelloWorldDPSESubDP \
{ \
    DDS_ENTITY_FACTORY_QOS_POLICY_DEFAULT, \

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{ /* discovery */ \
  REDA_StringSeq_INITIALIZER_W_LOAN>HelloWorldAppLibrary>HelloWorldDPSESubDP_
↪initial_peers, 2, 2), /* initial_peers */ \
  REDA_StringSeq_INITIALIZER_W_LOAN>HelloWorldAppLibrary>HelloWorldDPSESubDP_
↪discovery_enabled_transports, 3, 3), /* enabled_transports */ \
  { \
    { { "dpse1" } }, /* RT_ComponentFactoryId_INITIALIZER */ \
    NDDS_Discovery_Property_INITIALIZER \
  }, /* discovery_component */ \
  DDS_BOOLEAN_FALSE /* accept_unknown_peers */ \
}, \
{ /* resource_limits */ \
  1L, /* local_writer_allocation */ \
  1L, /* local_reader_allocation */ \
  1L, /* local_publisher_allocation */ \
  1L, /* local_subscriber_allocation */ \
  1L, /* local_topic_allocation */ \
  1L, /* local_type_allocation */ \
  8L, /* remote_participant_allocation */ \
  8L, /* remote_writer_allocation */ \
  8L, /* remote_reader_allocation */ \
  32L, /* matching_writer_reader_pair_allocation */ \
  32L, /* matching_reader_writer_pair_allocation */ \
  32L, /* max_receive_ports */ \
  32L, /* max_destination_ports */ \
  65536, /* unbound_data_buffer_size */ \
  500UL /* shm_ref_transfer_mode_max_segments */ \
}, \
  DDS_ENTITY_NAME_QOS_POLICY_DEFAULT, \
  DDS_WIRE_PROTOCOL_QOS_POLICY_DEFAULT, \
  { /* transports */ \
    REDA_StringSeq_INITIALIZER_W_LOAN>HelloWorldAppLibrary>HelloWorldDPSESubDP_
↪transport_enabled_transports, 1, 1) /* enabled_transports */ \
  }, \
  { /* user_traffic */ \
    REDA_StringSeq_INITIALIZER_W_LOAN>HelloWorldAppLibrary>HelloWorldDPSESubDP_user_
↪traffic_enabled_transports, 1, 1) /* enabled_transports */ \
  }, \
  DDS_TRUST_QOS_POLICY_DEFAULT, \
  DDS_PROPERTY_QOS_POLICY_DEFAULT \
}
/* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C>HelloWorld_appgen>HelloWorld.xml, lineNumber=65, columnNumber=74 */
extern const char *const>HelloWorldAppLibrary>HelloWorldDPSESubDP>HelloWorldDPSESub_
↪HelloWorldDPSEDR_transport_enabled_transports[2];
#define RTI_APP_GEN___DR_QOS>HelloWorldAppLibrary>HelloWorldDPSESubDP>HelloWorldDPSESub_
↪HelloWorldDPSEDR \
{ \
  DDS_DEADLINE_QOS_POLICY_DEFAULT, \
  DDS_LIVELINESS_QOS_POLICY_DEFAULT, \
  { /* history */ \

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        DDS_KEEP_LAST_HISTORY_QOS, /* kind */ \
        32L /* depth */ \
    }, \
    { /* resource_limits */ \
        64L, /* max_samples */ \
        2L, /* max_instances */ \
        32L /* max_samples_per_instance */ \
    }, \
    DDS_OWNERSHIP_QOS_POLICY_DEFAULT, \
    DDS_LATENCY_BUDGET_QOS_POLICY_DEFAULT, \
    { /* reliability */ \
        DDS_RELIABLE_RELIABILITY_QOS, /* kind */ \
        { /* max_blocking_time */ \
            0L, /* sec */ \
            0L /* nanosec */ \
        } \
    }, \
    DDS_DURABILITY_QOS_POLICY_DEFAULT, \
    DDS_DESTINATION_ORDER_QOS_POLICY_DEFAULT, \
    DDS_TRANSPORT_ENCAPSULATION_QOS_POLICY_DEFAULT, \
    DDS_DATA_REPRESENTATION_QOS_POLICY_DEFAULT, \
    DDS_TYPESUPPORT_QOS_POLICY_DEFAULT, \
    { /* protocol */ \
        2UL /* rtps_object_id */ \
    }, \
    { /* transports */ \
        REDA_StringSeq_INITIALIZER_W_LOAN>HelloWorldAppLibrary>HelloWorldDPSESubDP_
↪HelloWorldDPSESub>HelloWorldDPSEDR_transport_enabled_transports, 2, 2) /* enabled_
↪transports */ \
    }, \
    { /* reader_resource_limits */ \
        10L, /* max_remote_writers */ \
        10L, /* max_remote_writers_per_instance */ \
        1L, /* max_samples_per_remote_writer */ \
        1L, /* max_outstanding_reads */ \
        DDS_NO_INSTANCE_REPLACEMENT_QOS, /* instance_replacement */ \
        4L, /* max_routes_per_writer */ \
        DDS_MAX_AUTO, /* max_fragmented_samples */ \
        DDS_MAX_AUTO, /* max_fragmented_samples_per_remote_writer */ \
        DDS_SIZE_AUTO /* shmem_ref_transfer_mode_attached_segment_allocation */ \
    }, \
    RTI_MANAGEMENT_QOS_POLICY_DEFAULT, \
    DDS_DATAREADERQOS_TRUST_INITIALIZER \
    DDS_DATAREADERQOS_APPGEN_INITIALIZER \
    NULL \
}
extern struct DPDE_DiscoveryPluginProperty>HelloWorldAppLibrary>HelloWorldDPDEPubDP_
↪dpde[1];
extern struct UDP_InterfaceFactoryProperty>HelloWorldAppLibrary>HelloWorldDPDEPubDP_
↪udp4[1];
extern const struct ComponentFactoryUnregisterModel>HelloWorldAppLibrary_
↪HelloWorldDPDEPubDP_unregister_components[2];

```

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```

extern const struct ComponentFactoryRegisterModel HelloWorldAppLibrary_
↳HelloWorldDPDEPubDP_register_components[2];
#define RTI_APP_GEN__DPF_HelloWorldAppLibrary_HelloWorldDPDEPubDP \
{ \
    2UL, /* unregister_count */ \
    HelloWorldAppLibrary_HelloWorldDPDEPubDP_unregister_components, /* unregister_
↳components */ \
    2UL, /* register_count */ \
    HelloWorldAppLibrary_HelloWorldDPDEPubDP_register_components, /* register_components_
↳*/ \
    RTI_APP_GEN__DPF_QOS_QosLibrary_DefaultProfile /* factory_qos */ \
}
/* XML Source Location: file=c:\shared\connextmicro\rti\ndds_lite\rti_me.2.
↳0\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=32, columnNumber=62 */
extern const struct APPGEN_TypeRegistrationModel HelloWorldAppLibrary_
↳HelloWorldDPDEPubDP_type_registrations[1];
extern const struct APPGEN_TopicModel HelloWorldAppLibrary_HelloWorldDPDEPubDP_topics[1];
extern const struct APPGEN_PublisherModel HelloWorldAppLibrary_HelloWorldDPDEPubDP_
↳publishers[1];
#define RTI_APP_GEN__DP_HelloWorldAppLibrary_HelloWorldDPDEPubDP \
{ \
    "HelloWorldDPDEPubDP", /* name */ \
    RTI_APP_GEN__DPF_HelloWorldAppLibrary_HelloWorldDPDEPubDP, /* domain_participant_
↳factory */ \
    RTI_APP_GEN__DP_QOS_HelloWorldAppLibrary_HelloWorldDPDEPubDP, /* participant_qos */
↳
↳\
    0L, /* domain_id */ \
    1UL, /* type_registration_count */ \
    HelloWorldAppLibrary_HelloWorldDPDEPubDP_type_registrations, /* type_registrations */
↳\
    1UL, /* topic_count */ \
    HelloWorldAppLibrary_HelloWorldDPDEPubDP_topics, /* topics */ \
    1UL, /* publisher_count */ \
    HelloWorldAppLibrary_HelloWorldDPDEPubDP_publishers, /* publishers */ \
    0UL, /* subscriber_count */ \
    NULL, /* subscribers */ \
    0UL, /* remote_participant_count */ \
    NULL, /* remote_participants */ \
    0UL, /* flow_controller_count */ \
    NULL, /* flow_controllers */ \
}
extern struct DPDE_DiscoveryPluginProperty HelloWorldAppLibrary_HelloWorldDPDESubDP_
↳dpde[1];
extern struct UDP_InterfaceFactoryProperty HelloWorldAppLibrary_HelloWorldDPDESubDP_
↳udp4[1];
extern const struct ComponentFactoryUnregisterModel HelloWorldAppLibrary_
↳HelloWorldDPDESubDP_unregister_components[2];
extern const struct ComponentFactoryRegisterModel HelloWorldAppLibrary_
↳HelloWorldDPDESubDP_register_components[2];
#define RTI_APP_GEN__DPF_HelloWorldAppLibrary_HelloWorldDPDESubDP \
{ \

```

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```

    2UL, /* unregister_count */ \
    HelloWorldAppLibrary_HelloWorldDPDESubDP_unregister_components, /* unregister_
↪components */ \
    2UL, /* register_count */ \
    HelloWorldAppLibrary_HelloWorldDPDESubDP_register_components, /* register_components_
↪*/ \
    RTI_APP_GEN__DPF_QOS_QosLibrary_DefaultProfile /* factory_qos */ \
}
/* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=42, columnNumber=62 */
extern const struct APPGEN_TypeRegistrationModel HelloWorldAppLibrary_
↪HelloWorldDPDESubDP_type_registrations[1];
extern const struct APPGEN_TopicModel HelloWorldAppLibrary_HelloWorldDPDESubDP_topics[1];
extern const struct APPGEN_SubscriberModel HelloWorldAppLibrary_HelloWorldDPDESubDP_
↪subscribers[1];
#define RTI_APP_GEN__DP_HelloWorldAppLibrary_HelloWorldDPDESubDP \
{ \
    "HelloWorldDPDESubDP", /* name */ \
    RTI_APP_GEN__DPF_HelloWorldAppLibrary_HelloWorldDPDESubDP, /* domain_participant_
↪factory */ \
    RTI_APP_GEN__DP_QOS_HelloWorldAppLibrary_HelloWorldDPDESubDP, /* participant_qos */
↪\
    0L, /* domain_id */ \
    1UL, /* type_registration_count */ \
    HelloWorldAppLibrary_HelloWorldDPDESubDP_type_registrations, /* type_registrations */
↪\
    1UL, /* topic_count */ \
    HelloWorldAppLibrary_HelloWorldDPDESubDP_topics, /* topics */ \
    0UL, /* publisher_count */ \
    NULL, /* publishers */ \
    1UL, /* subscriber_count */ \
    HelloWorldAppLibrary_HelloWorldDPDESubDP_subscribers, /* subscribers */ \
    0UL, /* remote_participant_count */ \
    NULL, /* remote_participants */ \
    0UL, /* flow_controller_count */ \
    NULL, /* flow_controllers */ \
}
/* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=64, columnNumber=82 */
#define RTI_APP_GEN__RSD_HelloWorldAppLibrary_HelloWorldDPSEPubDP_HelloWorldAppLibrary_
↪HelloWorldDPSESubDP_HelloWorldDPSESub_HelloWorldDPSEDR \
{ \
    { /* subscription_data */ \
        { \
            { 0, 0, 0, 2 } /* key */ \
        }, \
        { \
            { 0, 0, 0, 0 } /* participant_key */ \
        }, \
        "HelloWorldTopic", /* topic_name */ \
        "HelloWorldType", /* type_name */ \
    }

```

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```

    DDS_DEADLINE_QOS_POLICY_DEFAULT, \
    DDS_OWNERSHIP_QOS_POLICY_DEFAULT, \
    DDS_LATENCY_BUDGET_QOS_POLICY_DEFAULT, \
    { /* reliability */ \
        DDS_RELIABLE_RELIABILITY_QOS, /* kind */ \
        { /* max_blocking_time */ \
            0L, /* sec */ \
            0L /* nanosec */ \
        } \
    }, \
    DDS_LIVELINESS_QOS_POLICY_DEFAULT, \
    DDS_DURABILITY_QOS_POLICY_DEFAULT, \
    DDS_DESTINATION_ORDER_QOS_POLICY_DEFAULT, \
    DDS_SEQUENCE_INITIALIZER, \
    DDS_SEQUENCE_INITIALIZER, \
    DDS_DATA_REPRESENTATION_QOS_POLICY_DEFAULT \
    DDS_TRUST_SUBSCRIPTION_DATA_INITIALIZER \
}, \
    HelloWorldTypePlugin_get /* get_type_plugin */ \
}
extern struct DPSE_DiscoveryPluginProperty HelloWorldAppLibrary_HelloWorldDPSEPubDP_
↪dpse[1];
extern struct UDP_InterfaceFactoryProperty HelloWorldAppLibrary_HelloWorldDPSEPubDP_
↪udpv4[1];
extern const struct ComponentFactoryUnregisterModel HelloWorldAppLibrary_
↪HelloWorldDPSEPubDP_unregister_components[2];
extern const struct ComponentFactoryRegisterModel HelloWorldAppLibrary_
↪HelloWorldDPSEPubDP_register_components[2];
#define RTI_APP_GEN__DPF_HelloWorldAppLibrary_HelloWorldDPSEPubDP \
{ \
    2UL, /* unregister_count */ \
    HelloWorldAppLibrary_HelloWorldDPSEPubDP_unregister_components, /* unregister_
↪components */ \
    2UL, /* register_count */ \
    HelloWorldAppLibrary_HelloWorldDPSEPubDP_register_components, /* register_components_
↪*/ \
    RTI_APP_GEN__DPF_QOS_QosLibrary_DefaultProfile /* factory_qos */ \
}
/* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=52, columnNumber=62 */
extern const struct APPGEN_TypeRegistrationModel HelloWorldAppLibrary_
↪HelloWorldDPSEPubDP_type_registrations[1];
extern const struct APPGEN_TopicModel HelloWorldAppLibrary_HelloWorldDPSEPubDP_topics[1];
extern const struct APPGEN_PublisherModel HelloWorldAppLibrary_HelloWorldDPSEPubDP_
↪publishers[1];
extern const struct APPGEN_RemoteSubscriptionModel HelloWorldAppLibrary_
↪HelloWorldDPSEPubDP_remote_subscribers[1];
extern const struct APPGEN_RemoteParticipantModel HelloWorldAppLibrary_
↪HelloWorldDPSEPubDP_remote_participants[1];
#define RTI_APP_GEN__DP_HelloWorldAppLibrary_HelloWorldDPSEPubDP \
{ \

```

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```

"HelloWorldDPSEPubDP", /* name */ \
RTI_APP_GEN__DPF>HelloWorldAppLibrary>HelloWorldDPSEPubDP, /* domain_participant_
↪factory */ \
RTI_APP_GEN__DP_QOS>HelloWorldAppLibrary>HelloWorldDPSEPubDP, /* participant_qos */\
↪\
OL, /* domain_id */ \
1UL, /* type_registration_count */ \
HelloWorldAppLibrary>HelloWorldDPSEPubDP_type_registrations, /* type_registrations */
↪\
1UL, /* topic_count */ \
HelloWorldAppLibrary>HelloWorldDPSEPubDP_topics, /* topics */ \
1UL, /* publisher_count */ \
HelloWorldAppLibrary>HelloWorldDPSEPubDP_publishers, /* publishers */ \
OUL, /* subscriber_count */ \
NULL, /* subscribers */ \
1UL, /* remote_participant_count */ \
HelloWorldAppLibrary>HelloWorldDPSEPubDP_remote_participants, /* remote_participants\
↪*/ \
OUL, /* flow_controller_count */ \
NULL, /* flow_controllers */ \
}
/* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C>HelloWorld_appgen>HelloWorld.xml, lineNumber=54, columnNumber=82 */
#define RTI_APP_GEN__RPD>HelloWorldAppLibrary>HelloWorldDPSESubDP>HelloWorldAppLibrary_
↪HelloWorldDPSEPubDP>HelloWorldDPSEPub>HelloWorldDPSEDW \
{ \
  { /* publication_data */ \
    { \
      { 0, 0, 0, 1 } /* key */ \
    }, \
    { \
      { 0, 0, 0, 0 } /* participant_key */ \
    }, \
    "HelloWorldTopic", /* topic_name */ \
    "HelloWorldType", /* type_name */ \
    DDS_DEADLINE_QOS_POLICY_DEFAULT, \
    DDS_OWNERSHIP_QOS_POLICY_DEFAULT, \
    DDS_OWNERSHIP_STRENGTH_QOS_POLICY_DEFAULT, \
    DDS_LATENCY_BUDGET_QOS_POLICY_DEFAULT, \
    { /* reliability */ \
      DDS_RELIABLE_RELIABILITY_QOS, /* kind */ \
      { /* max_blocking_time */ \
        OL, /* sec */ \
        100000000L /* nanosec */ \
      } \
    }, \
    DDS_LIVELINESS_QOS_POLICY_DEFAULT, \
    DDS_DURABILITY_QOS_POLICY_DEFAULT, \
    DDS_DESTINATION_ORDER_QOS_POLICY_DEFAULT, \
    DDS_SEQUENCE_INITIALIZER, \
    DDS_DATA_REPRESENTATION_QOS_POLICY_DEFAULT \
  } \
}

```

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```

        DDS_TRUST_PUBLICATION_DATA_INITIALIZER \
    }, \
    HelloWorldTypePlugin_get /* get_type_plugin */ \
}
extern struct DPSE_DiscoveryPluginProperty HelloWorldAppLibrary_HelloWorldDPSESubDP_
↪dpse[1];
extern struct UDP_InterfaceFactoryProperty HelloWorldAppLibrary_HelloWorldDPSESubDP_
↪udpv4[1];
extern const struct ComponentFactoryUnregisterModel HelloWorldAppLibrary_
↪HelloWorldDPSESubDP_unregister_components[2];
extern const struct ComponentFactoryRegisterModel HelloWorldAppLibrary_
↪HelloWorldDPSESubDP_register_components[2];
#define RTI_APP_GEN__DPF_HelloWorldAppLibrary_HelloWorldDPSESubDP \
{ \
    2UL, /* unregister_count */ \
    HelloWorldAppLibrary_HelloWorldDPSESubDP_unregister_components, /* unregister_
↪components */ \
    2UL, /* register_count */ \
    HelloWorldAppLibrary_HelloWorldDPSESubDP_register_components, /* register_components_
↪*/ \
    RTI_APP_GEN__DPF_QOS_QosLibrary_DefaultProfile /* factory_qos */ \
}
/* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=62, columnNumber=62 */
extern const struct APPGEN_TypeRegistrationModel HelloWorldAppLibrary_
↪HelloWorldDPSESubDP_type_registrations[1];
extern const struct APPGEN_TopicModel HelloWorldAppLibrary_HelloWorldDPSESubDP_topics[1];
extern const struct APPGEN_SubscriberModel HelloWorldAppLibrary_HelloWorldDPSESubDP_
↪subscribers[1];
extern const struct APPGEN_RemotePublicationModel HelloWorldAppLibrary_
↪HelloWorldDPSESubDP_remote_publishers[1];
extern const struct APPGEN_RemoteParticipantModel HelloWorldAppLibrary_
↪HelloWorldDPSESubDP_remote_participants[1];
#define RTI_APP_GEN__DP_HelloWorldAppLibrary_HelloWorldDPSESubDP \
{ \
    "HelloWorldDPSESubDP", /* name */ \
    RTI_APP_GEN__DPF_HelloWorldAppLibrary_HelloWorldDPSESubDP, /* domain_participant_
↪factory */ \
    RTI_APP_GEN__DP_QOS_HelloWorldAppLibrary_HelloWorldDPSESubDP, /* participant_qos */_
↪
↪
    0L, /* domain_id */ \
    1UL, /* type_registration_count */ \
    HelloWorldAppLibrary_HelloWorldDPSESubDP_type_registrations, /* type_registrations */
↪
↪
    1UL, /* topic_count */ \
    HelloWorldAppLibrary_HelloWorldDPSESubDP_topics, /* topics */ \
    0UL, /* publisher_count */ \
    NULL, /* publishers */ \
    1UL, /* subscriber_count */ \
    HelloWorldAppLibrary_HelloWorldDPSESubDP_subscribers, /* subscribers */ \
    1UL, /* remote_participant_count */ \

```

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```

HelloWorldAppLibrary>HelloWorldDPSESubDP_remote_participants, /* remote_participants
↪*/ \
    OUL, /* flow_controller_count */ \
    NULL, /* flow_controllers */ \
}
extern const struct APPGEN_DomainParticipantModel HelloWorldAppLibrary_participants[4];
#define RTI_APP_GEN_LIB>HelloWorldAppLibrary \
{ \
    "HelloWorldAppLibrary", /* library_name */ \
    4UL, /* participant_count */ \
    HelloWorldAppLibrary_participants /* participants */ \
}
extern const struct APPGEN_LibraryModel HelloWorld_libraries[1];

```

Example generated source configuration file HelloWorldAppgen.c:

```

/*
WARNING: THIS FILE IS AUTO-GENERATED. DO NOT MODIFY.
This file was generated from HelloWorld.xml using "rtiddsmag."
The rtiddsmag tool is part of the RTI Connex distribution.
For more information, type 'rtiddsmag -help' at a command shell
or consult the RTI Connex manual.
*/
#include "HelloWorldAppgen.h"
const char *const HelloWorldAppLibrary>HelloWorldDPDEPubDP_initial_peers[2] =
{
    "127.0.0.1",
    "239.255.0.1"
};
const char *const HelloWorldAppLibrary>HelloWorldDPDEPubDP_discovery_enabled_
↪transports[3] =
{
    "udp1://",
    "udp1://127.0.0.1",
    "udp1://239.255.0.1"
};
const char *const HelloWorldAppLibrary>HelloWorldDPDEPubDP_transport_enabled_
↪transports[1] =
{
    "udp1"
};
const char *const HelloWorldAppLibrary>HelloWorldDPDEPubDP_user_traffic_enabled_
↪transports[1] =
{
    "udp1://"
};
const char *const HelloWorldAppLibrary>HelloWorldDPDEPubDP>HelloWorldDPDEPub_
↪HelloWorldDPDEDW_transport_enabled_transports[1] =
{
    "udp1://"
};

```

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```

const char *const HelloWorldAppLibrary_HelloWorldDPDESubDP_initial_peers[2] =
{
    "127.0.0.1",
    "239.255.0.1"
};
const char *const HelloWorldAppLibrary_HelloWorldDPDESubDP_discovery_enabled_
↪transports[3] =
{
    "udp1://",
    "udp1://127.0.0.1",
    "udp1://239.255.0.1"
};
const char *const HelloWorldAppLibrary_HelloWorldDPDESubDP_transport_enabled_
↪transports[1] =
{
    "udp1"
};
const char *const HelloWorldAppLibrary_HelloWorldDPDESubDP_user_traffic_enabled_
↪transports[1] =
{
    "udp1://"
};
const char *const HelloWorldAppLibrary_HelloWorldDPDESubDP_HelloWorldDPDESub_
↪HelloWorldDPDEDR_transport_enabled_transports[2] =
{
    "udp1://",
    "udp1://127.0.0.1"
};
const char *const HelloWorldAppLibrary_HelloWorldDPSEPubDP_initial_peers[2] =
{
    "127.0.0.1",
    "239.255.0.1"
};
const char *const HelloWorldAppLibrary_HelloWorldDPSEPubDP_discovery_enabled_
↪transports[3] =
{
    "udp1://",
    "udp1://127.0.0.1",
    "udp1://239.255.0.1"
};
const char *const HelloWorldAppLibrary_HelloWorldDPSEPubDP_transport_enabled_
↪transports[1] =
{
    "udp1"
};
const char *const HelloWorldAppLibrary_HelloWorldDPSEPubDP_user_traffic_enabled_
↪transports[1] =
{
    "udp1://"
};
const char *const HelloWorldAppLibrary_HelloWorldDPSEPubDP_HelloWorldDPSEPub_
↪HelloWorldDPSEDW_transport_enabled_transports[1] =

```

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```

{
    "udp1://"
};
const char *const HelloWorldAppLibrary_HelloWorldDPSESubDP_initial_peers[2] =
{
    "127.0.0.1",
    "239.255.0.1"
};
const char *const HelloWorldAppLibrary_HelloWorldDPSESubDP_discovery_enabled_
↳ transports[3] =
{
    "udp1://",
    "udp1://127.0.0.1",
    "udp1://239.255.0.1"
};
const char *const HelloWorldAppLibrary_HelloWorldDPSESubDP_transport_enabled_
↳ transports[1] =
{
    "udp1"
};
const char *const HelloWorldAppLibrary_HelloWorldDPSESubDP_user_traffic_enabled_
↳ transports[1] =
{
    "udp1://"
};
const char *const HelloWorldAppLibrary_HelloWorldDPSESubDP_HelloWorldDPSESub_
↳ HelloWorldDPSEDR_transport_enabled_transports[2] =
{
    "udp1://",
    "udp1://127.0.0.1"
};
const struct ComponentFactoryUnregisterModel HelloWorldAppLibrary_HelloWorldDPDEPubDP_
↳ unregister_components[2] =
{
    {
        "_udp", /* NETIO_DEFAULT_UDP_NAME */
        NULL, /* udp struct RT_ComponentFactoryProperty** */
        NULL /* udp struct RT_ComponentFactoryListener** */
    },
    {
        "_intra", /* NETIO_DEFAULT_INTRA_NAME */
        NULL, /* _intra struct RT_ComponentFactoryProperty** */
        NULL /* _intra struct RT_ComponentFactoryListener** */
    }
};
struct DPDE_DiscoveryPluginProperty HelloWorldAppLibrary_HelloWorldDPDEPubDP_dpde[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↳ 0\example\C\HelloWorld_appgen\HelloWorldQos.xml, lineNumber=145, columnNumber=35 */
↳
    RTI_APP_GEN___dpde__HelloWorldAppLibrary_HelloWorldDPDEPubDP_dpde1
}

```

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```

};
struct UDP_InterfaceFactoryProperty HelloWorldAppLibrary_HelloWorldDPDEPubDP_udp4[1] =
{
    RTI_APP_GEN__udpv4_HelloWorldAppLibrary_HelloWorldDPDEPubDP_udp1
};
const struct ComponentFactoryRegisterModel HelloWorldAppLibrary_HelloWorldDPDEPubDP_
↪register_components[2] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorldQos.xml, lineNumber=145, columnNumber=35 */
↪
    {
        "dpde1", /* register_name */
        DPDE_DiscoveryFactory_get_interface, /* register_intf */
        &HelloWorldAppLibrary_HelloWorldDPDEPubDP_dpde[0]._parent, /* register_property_
↪*/
        NULL /* register_listener */
    },
    {
        "udp1", /* register_name */
        UDP_InterfaceFactory_get_interface, /* register_intf */
        &HelloWorldAppLibrary_HelloWorldDPDEPubDP_udp4[0]._parent._parent, /* register_
↪property */
        NULL /* register_listener */
    }
};
const struct APPGEN_TypeRegistrationModel HelloWorldAppLibrary_HelloWorldDPDEPubDP_type_
↪registrations[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=20, columnNumber=72 */
    {
        "HelloWorldType", /* registered_type_name */
        HelloWorldTypePlugin_get /* get_type_plugin */
    }
};
const struct APPGEN_TopicModel HelloWorldAppLibrary_HelloWorldDPDEPubDP_topics[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=23, columnNumber=78 */
    {
        "HelloWorldTopic", /* topic_name */
        "HelloWorldType", /* type_name */
        DDS_TopicQos_INITIALIZER /* topic_qos*/
    }
};
const struct APPGEN_DataWriterModel HelloWorldAppLibrary_HelloWorldDPDEPubDP_publisher_
↪HelloWorldDPDEPub_data_writers[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=34, columnNumber=82 */

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```

    {
        "HelloWorldDPDEDW", /* name */
        1UL, /* multiplicity */
        "HelloWorldTopic", /* topic_name */
        RTI_APP_GEN___DW_QOS>HelloWorldAppLibrary>HelloWorldDPDEPubDP>HelloWorldDPDEPub_
↪HelloWorldDPDEDW /* writer_qos */
    }
};
const struct APPGEN_PublisherModel>HelloWorldAppLibrary>HelloWorldDPDEPubDP_
↪publishers[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C>HelloWorld_appgen>HelloWorld.xml, lineNumber=33, columnNumber=49 */
    {
        "HelloWorldDPDEPub", /* name */
        1UL, /* multiplicity */
        DDS_PublisherQos_INITIALIZER, /* publisher_qos */
        1UL, /* writer_count */
       >HelloWorldAppLibrary>HelloWorldDPDEPubDP_publisher>HelloWorldDPDEPub_data_
↪writers /* data_writers */
    }
};
const struct ComponentFactoryUnregisterModel>HelloWorldAppLibrary>HelloWorldDPDESubDP_
↪unregister_components[2] =
{
    {
        "_udp", /* NETIO_DEFAULT_UDP_NAME */
        NULL, /* udp struct RT_ComponentFactoryProperty** */
        NULL /* udp struct RT_ComponentFactoryListener** */
    },
    {
        "_intra", /* NETIO_DEFAULT_INTRA_NAME */
        NULL, /* _intra struct RT_ComponentFactoryProperty** */
        NULL /* _intra struct RT_ComponentFactoryListener** */
    }
};
struct DPDE_DiscoveryPluginProperty>HelloWorldAppLibrary>HelloWorldDPDESubDP_dpde[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C>HelloWorld_appgen>HelloWorldQos.xml, lineNumber=145, columnNumber=35 */
↪
    RTI_APP_GEN___dpde_>HelloWorldAppLibrary>HelloWorldDPDEPubDP_dpde1
};
struct UDP_InterfaceFactoryProperty>HelloWorldAppLibrary>HelloWorldDPDESubDP_udp4[1] =
{
    RTI_APP_GEN___udp4_>HelloWorldAppLibrary>HelloWorldDPDEPubDP_udp1
};
const struct ComponentFactoryRegisterModel>HelloWorldAppLibrary>HelloWorldDPDESubDP_
↪register_components[2] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C>HelloWorld_appgen>HelloWorldQos.xml, lineNumber=145, columnNumber=35 */
↪

```

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```

{
    "dpde1", /* register_name */
    DPDE_DiscoveryFactory_get_interface, /* register_intf */
    &HelloWorldAppLibrary_HelloWorldDPDESubDP_dpde[0]._parent, /* register_property_
↪*/
    NULL /* register_listener */
},
{
    "udp1", /* register_name */
    UDP_InterfaceFactory_get_interface, /* register_intf */
    &HelloWorldAppLibrary_HelloWorldDPDESubDP_udp4[0]._parent._parent, /* register_
↪property */
    NULL /* register_listener */
}
};
const struct APPGEN_TypeRegistrationModel HelloWorldAppLibrary_HelloWorldDPDESubDP_type_
↪registrations[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=20, columnNumber=72 */
    {
        "HelloWorldType", /* registered_type_name */
        HelloWorldTypePlugin_get /* get_type_plugin */
    }
};
const struct APPGEN_TopicModel HelloWorldAppLibrary_HelloWorldDPDESubDP_topics[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=23, columnNumber=78 */
    {
        "HelloWorldTopic", /* topic_name */
        "HelloWorldType", /* type_name */
        DDS_TopicQos_INITIALIZER /* topic_qos*/
    }
};
const struct APPGEN_DataReaderModel HelloWorldAppLibrary_HelloWorldDPDESubDP_subscriber_
↪HelloWorldDPDESub_data_readers[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=44, columnNumber=82 */
    {
        "HelloWorldDPDEDR", /* name */
        1UL, /* multiplicity */
        "HelloWorldTopic", /* topic_name */
        RTI_APP_GEN___DR_QOS_HelloWorldAppLibrary_HelloWorldDPDESubDP_HelloWorldDPDESub_
↪HelloWorldDPDEDR /* reader_qos */
    }
};
const struct APPGEN_SubscriberModel HelloWorldAppLibrary_HelloWorldDPDESubDP_
↪subscribers[1] =
{

```

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```

/* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=43, columnNumber=50 */
{
    "HelloWorldDPDESub", /* name */
    1UL, /* multiplicity */
    DDS_SubscriberQos_INITIALIZER, /* subscriber_qos */
    1UL, /* reader_count */
    HelloWorldAppLibrary_HelloWorldDPDESubDP_subscriber_HelloWorldDPDESub_data_
↪readers /* data_readers */
}
};
const struct ComponentFactoryUnregisterModel HelloWorldAppLibrary_HelloWorldDPSEPubDP_
↪unregister_components[2] =
{
    {
        "_udp", /* NETIO_DEFAULT_UDP_NAME */
        NULL, /* udp struct RT_ComponentFactoryProperty** */
        NULL /* udp struct RT_ComponentFactoryListener** */
    },
    {
        "_intra", /* NETIO_DEFAULT_INTRA_NAME */
        NULL, /* _intra struct RT_ComponentFactoryProperty** */
        NULL /* _intra struct RT_ComponentFactoryListener** */
    }
};
struct DPSE_DiscoveryPluginProperty HelloWorldAppLibrary_HelloWorldDPSEPubDP_dpse[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorldQos.xml, lineNumber=152, columnNumber=35 */
↪
    RTI_APP_GEN___dpse__HelloWorldAppLibrary_HelloWorldDPSEPubDP_dpse1
};
struct UDP_InterfaceFactoryProperty HelloWorldAppLibrary_HelloWorldDPSEPubDP_udp4[1] =
{
    RTI_APP_GEN___udp4__HelloWorldAppLibrary_HelloWorldDPSEPubDP_udp1
};
const struct ComponentFactoryRegisterModel HelloWorldAppLibrary_HelloWorldDPSEPubDP_
↪register_components[2] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorldQos.xml, lineNumber=152, columnNumber=35 */
↪
    {
        "dpse1", /* register_name */
        DPSE_DiscoveryFactory_get_interface, /* register_intf */
        &HelloWorldAppLibrary_HelloWorldDPSEPubDP_dpse[0]._parent, /* register_property_
↪*/
        NULL /* register_listener */
    },
    {
        "udp1", /* register_name */

```

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```

        UDP_InterfaceFactory_get_interface, /* register_intf */
        &HelloWorldAppLibrary>HelloWorldDPSEPubDP_udp4[0]._parent._parent, /* register_
↪property */
        NULL /* register_listener */
    }
};
const struct APPGEN_TypeRegistrationModel HelloWorldAppLibrary>HelloWorldDPSEPubDP_type_
↪registrations[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C>HelloWorld_appgen>HelloWorld.xml, lineNumber=20, columnNumber=72 */
    {
        "HelloWorldType", /* registered_type_name */
        HelloWorldTypePlugin_get /* get_type_plugin */
    }
};
const struct APPGEN_TopicModel HelloWorldAppLibrary>HelloWorldDPSEPubDP_topics[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C>HelloWorld_appgen>HelloWorld.xml, lineNumber=23, columnNumber=78 */
    {
        "HelloWorldTopic", /* topic_name */
        "HelloWorldType", /* type_name */
        DDS_TopicQos_INITIALIZER /* topic_qos*/
    }
};
const struct APPGEN_DataWriterModel HelloWorldAppLibrary>HelloWorldDPSEPubDP_publisher_
↪HelloWorldDPSEPub_data_writers[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C>HelloWorld_appgen>HelloWorld.xml, lineNumber=54, columnNumber=82 */
    {
        "HelloWorldDPSEDW", /* name */
        1UL, /* multiplicity */
        "HelloWorldTopic", /* topic_name */
        RTI_APP_GEN__DW_QOS>HelloWorldAppLibrary>HelloWorldDPSEPubDP>HelloWorldDPSEPub_
↪HelloWorldDPSEDW /* writer_qos */
    }
};
const struct APPGEN_PublisherModel HelloWorldAppLibrary>HelloWorldDPSEPubDP_
↪publishers[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C>HelloWorld_appgen>HelloWorld.xml, lineNumber=53, columnNumber=49 */
    {
        "HelloWorldDPSEPub", /* name */
        1UL, /* multiplicity */
        DDS_PublisherQos_INITIALIZER, /* publisher_qos */
        1UL, /* writer_count */
        HelloWorldAppLibrary>HelloWorldDPSEPubDP_publisher>HelloWorldDPSEPub_data_
↪writers /* data_writers */
    }
};

```

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```

    }
};
const struct APPGEN_RemoteSubscriptionModel HelloWorldAppLibrary_HelloWorldDPSEPubDP_
↳remote_subscribers[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↳0\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=64, columnNumber=82 */
    RTI_APP_GEN_RSD_HelloWorldAppLibrary_HelloWorldDPSEPubDP_HelloWorldAppLibrary_
↳HelloWorldDPSESubDP_HelloWorldDPSESub_HelloWorldDPSEDR
};
const struct APPGEN_RemoteParticipantModel HelloWorldAppLibrary_HelloWorldDPSEPubDP_
↳remote_participants[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↳0\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=62, columnNumber=62 */
    {
        "HelloWorldDPSESubDP", /* name */
        0UL, /* remote_publisher_count */
        NULL, /* remote_publishers */
        1UL, /* remote_subscriber_count */
        HelloWorldAppLibrary_HelloWorldDPSEPubDP_remote_subscribers /* remote_
↳subscribers */
    }
};
const struct ComponentFactoryUnregisterModel HelloWorldAppLibrary_HelloWorldDPSESubDP_
↳unregister_components[2] =
{
    {
        "_udp", /* NETIO_DEFAULT_UDP_NAME */
        NULL, /* udp struct RT_ComponentFactoryProperty** */
        NULL /* udp struct RT_ComponentFactoryListener** */
    },
    {
        "_intra", /* NETIO_DEFAULT_INTRA_NAME */
        NULL, /* _intra struct RT_ComponentFactoryProperty** */
        NULL /* _intra struct RT_ComponentFactoryListener** */
    }
};
struct DPSE_DiscoveryPluginProperty HelloWorldAppLibrary_HelloWorldDPSESubDP_dpse[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↳0\example\C\HelloWorld_appgen\HelloWorldQos.xml, lineNumber=152, columnNumber=35 */
    ↳
    RTI_APP_GEN___dpse__HelloWorldAppLibrary_HelloWorldDPSEPubDP_dpse1
};
struct UDP_InterfaceFactoryProperty HelloWorldAppLibrary_HelloWorldDPSESubDP_udp4[1] =
{
    RTI_APP_GEN___udp4__HelloWorldAppLibrary_HelloWorldDPDEPubDP_udp1
};
const struct ComponentFactoryRegisterModel HelloWorldAppLibrary_HelloWorldDPSESubDP_
↳register_components[2] =

```

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```

{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorldQos.xml, lineNumber=152, columnNumber=35 */
    ↪
    {
        "dpse1", /* register_name */
        DPSE_DiscoveryFactory_get_interface, /* register_intf */
        &HelloWorldAppLibrary_HelloWorldDPSESubDP_dpse[0]._parent, /* register_property_
↪*/
        NULL /* register_listener */
    },
    {
        "udp1", /* register_name */
        UDP_InterfaceFactory_get_interface, /* register_intf */
        &HelloWorldAppLibrary_HelloWorldDPSESubDP_udp4[0]._parent._parent, /* register_
↪property */
        NULL /* register_listener */
    }
};
const struct APPGEN_TypeRegistrationModel HelloWorldAppLibrary_HelloWorldDPSESubDP_type_
↪registrations[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=20, columnNumber=72 */
    {
        "HelloWorldType", /* registered_type_name */
        HelloWorldTypePlugin_get /* get_type_plugin */
    }
};
const struct APPGEN_TopicModel HelloWorldAppLibrary_HelloWorldDPSESubDP_topics[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=23, columnNumber=78 */
    {
        "HelloWorldTopic", /* topic_name */
        "HelloWorldType", /* type_name */
        DDS_TopicQos_INITIALIZER /* topic_qos*/
    }
};
const struct APPGEN_DataReaderModel HelloWorldAppLibrary_HelloWorldDPSESubDP_subscriber_
↪HelloWorldDPSESub_data_readers[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=64, columnNumber=82 */
    {
        "HelloWorldDPSEDR", /* name */
        1UL, /* multiplicity */
        "HelloWorldTopic", /* topic_name */
        RTI_APP_GEN___DR_QOS_HelloWorldAppLibrary_HelloWorldDPSESubDP_HelloWorldDPSESub_
↪HelloWorldDPSEDR /* reader_qos */
    }
}

```

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```

};
const struct APPGEN_SubscriberModel HelloWorldAppLibrary_HelloWorldDPSESubDP_
↳subscribers[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
    ↳\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=63, columnNumber=50 */
    {
        "HelloWorldDPSESub", /* name */
        1UL, /* multiplicity */
        DDS_SubscriberQos_INITIALIZER, /* subscriber_qos */
        1UL, /* reader_count */
        HelloWorldAppLibrary_HelloWorldDPSESubDP_subscriber_HelloWorldDPSESub_data_
↳readers /* data_readers */
    }
};
const struct APPGEN_RemotePublicationModel HelloWorldAppLibrary_HelloWorldDPSESubDP_
↳remote_publishers[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
    ↳\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=54, columnNumber=82 */
    RTI_APP_GEN__RPD_HelloWorldAppLibrary_HelloWorldDPSESubDP_HelloWorldAppLibrary_
↳HelloWorldDPSEPubDP_HelloWorldDPSEPub_HelloWorldDPSEDW
};
const struct APPGEN_RemoteParticipantModel HelloWorldAppLibrary_HelloWorldDPSESubDP_
↳remote_participants[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
    ↳\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=52, columnNumber=62 */
    {
        "HelloWorldDPSEPubDP", /* name */
        1UL, /* remote_publisher_count */
        HelloWorldAppLibrary_HelloWorldDPSESubDP_remote_publishers, /* remote_publishers_
↳*/
        0UL, /* remote_subscriber_count */
        NULL /* remote_subscribers */
    }
};
const struct APPGEN_DomainParticipantModel HelloWorldAppLibrary_participants[4] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
    ↳\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=32, columnNumber=62 */
    RTI_APP_GEN__DP_HelloWorldAppLibrary_HelloWorldDPDEPubDP,
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
    ↳\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=42, columnNumber=62 */
    RTI_APP_GEN__DP_HelloWorldAppLibrary_HelloWorldDPDESubDP,
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
    ↳\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=52, columnNumber=62 */
    RTI_APP_GEN__DP_HelloWorldAppLibrary_HelloWorldDPSEPubDP,
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
    ↳\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=62, columnNumber=62 */
    RTI_APP_GEN__DP_HelloWorldAppLibrary_HelloWorldDPSESubDP
};

```

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```

};
const struct APPGEN_LibraryModel HelloWorld_libraries[1] =
{
    /* XML Source Location: file=c:\shared\connexmicro\rti\ndds_lite\rti_me.2.
↪0\example\C\HelloWorld_appgen\HelloWorld.xml, lineNumber=30, columnNumber=61 */
    RTI_APP_GEN_LIB>HelloWorldAppLibrary
};
const struct APPGEN_LibraryModelSeq HelloWorld_libraries_sequence =
    REDA_DEFINE_SEQUENCE_INITIALIZER_W_LOAN(
        HelloWorld_libraries,
        1,
        1,
        struct APPGEN_LibraryModel);
APPGENDllExport const struct APPGEN_LibraryModelSeq*
    APPGEN_get_library_seq(void)
{
    return &HelloWorld_libraries_sequence;
}

```

4.7 Transports

4.7.1 Introduction

RTI Connex DDS Micro has a pluggable-transports architecture. The core of *Connex DDS Micro* is transport agnostic—it does not make any assumptions about the actual transports used to send and receive messages. Instead, *Connex DDS Micro* uses an abstract “transport API” to interact with the transport plugins that implement that API. A transport plugin implements the abstract transport API, and performs the actual work of sending and receiving messages over a physical transport.

In *Connex DDS Micro* a Network Input/Output (NETIO) interface is a software layer that may send and/or receive data from a higher and/or lower level locally, as well as communicate with a peer. A transport is a NETIO interface that is at the lowest level of the protocol stack. For example, the UDP NETIO interface is a transport.

A transport can send and receive on addresses as defined by the concrete transport. For example, the *Connex DDS Micro* UDP transport can listen to and send to UDPv4 ports and addresses. In order to establish communication between two transports, the addresses that the transport can listen to must be determined and announced to other *DomainParticipants* that want to communicate with it. This document describes how the addresses are reserved and how these addresses are used by the DDS layer in *Connex DDS Micro*.

While the NETIO interface is not limited to DDS, the rest of this document is written in the context of how *Connex DDS Micro* uses the NETIO interfaces as part of the DDS implementation.

4.7.2 Transport Registration

RTI Connex DDS Micro supports different transports and transports must be registered with *RTI Connex DDS Micro* before they can be used. A transport must be given a name when it

is registered and this name is later used when configuring discovery and user-traffic. A transport name cannot exceed 7 UTF-8 characters.

The following example registers the UDP transport with *RTI Connex DDS Micro* and makes it available to all DDS applications within the same memory space. Please note that each DDS applications creates its *own* instance of a transport. Resources are *not* shared between instances of a transport unless stated.

For example, to register two UDP transports with the names `myudp1` and `myudp2`, the following code is required:

```
DDS_DomainParticipantFactory *factory;
RT_Registry_T *registry;
struct UDP_InterfaceFactoryProperty udp_property;

factory = DDS_DomainParticipantFactory_get_instance();
registry = DDS_DomainParticipantFactory_get_registry(factory);

/* Set UDP properties */
if (!RT_Registry_register(registry,"myudp1",
                        UDP_InterfaceFactory_get_interface(),
                        &udp_property._parent._parent,NULL))
{
    return error;
}

/* Set UDP properties */
if (!RT_Registry_register(registry,"myudp2",
                        UDP_InterfaceFactory_get_interface(),
                        &udp_property._parent._parent,NULL))
{
    return error;
}
```

Before a DomainParticipant can make use of a registered transport, it must enable it for use within the DomainParticipant. This is done by setting the [TransportQoS](#). For example, to enable only `myudp1`, the following code is required (error checking is not shown for clarity):

```
DDS_StringSeq_set_maximum(&dp_qos.transports.enabled_transports,1);
DDS_StringSeq_set_length(&dp_qos.transports.enabled_transports,1);
*DDS_StringSeq_get_reference(&dp_qos.transports.enabled_transports,0) =
    REDA_String_dup("myudp1");
```

To enable both transports:

```
DDS_StringSeq_set_maximum(&dp_qos.transports.enabled_transports,2);
DDS_StringSeq_set_length(&dp_qos.transports.enabled_transports,2);
*DDS_StringSeq_get_reference(&dp_qos.transports.enabled_transports,0) =
    REDA_String_dup("myudp1");
*DDS_StringSeq_get_reference(&dp_qos.transports.enabled_transports,1) =
    REDA_String_dup("myudp2");
```

Before enabled transports may be used for communication in *Connex DDS Micro*, they must be

registered and added to the [DiscoveryQos](#) and [UserTrafficQos](#) policies. Please see the section on *Discovery* for details.

4.7.3 Transport Addresses

Address reservation is the process to determine which locators should be used in the discovery announcement. Which transports and addresses to be used is determined as described in *Discovery*.

When a *DomainParticipant* is created, it calculates a port number and tries to reserve this port on all addresses available in *all* the transports based on the registration properties. If the port cannot be reserved on all transports, then it release the port on *all* transports and tries again. If no free port can be found the process fails and the *DomainParticipant* cannot be created.

The number of locators which can be announced is limited to *only* the first *four* for each type across *all* transports available for each policy. If more than four are available of any kind, these are *ignored*. This is by design, although it may be changed in the future. The order in which the locators are read is also not known, thus the four locators which will be used are not deterministic.

To ensure that *all* the desired addresses and *only* the desired address are used in a transport, follow these rules:

- Make sure that no more than four unicast addresses and four multicast addresses can be returned across *all* transports for discovery traffic.
- Make sure that no more than four unicast addresses and four multicast addresses can be returned across *all* transports for user traffic.
- Make sure that no more than four unicast addresses and four multicast addresses can be returned across *all* transports for user-traffic, for *DataReader* and *DataWriter* specific locators, and that they do *not* duplicate any of the *DomainParticipant*'s locators.

4.7.4 Transport Port Number

The port number of a locator is not directly configurable. Rather, it is configured indirectly by the [DDS_WireProtocolQosPolicy](#) ([rtps_well_known_ports](#)) of the *DomainParticipant*'s QoS, where a well-known, interoperable RTPS port number is assigned.

4.7.5 INTRA Transport

The builtin intra participant transport (INTRA) is a transport that bypasses RTPS and reduces the number of data-copies from three to one for data published by a *DataWriter* to a *DataReader* within the same participant. When a sample is published, it is copied directly to the data reader's cache (if there is space). This transport is used for communication between *DataReaders* and *DataWriters* created within the same participant by default.

Please refer to *Threading Model* for important details regarding application constraints when using this transport.

Registering the INTRA Transport

The builtin INTRA transport is a *RTI Connex DDS Micro* component that is automatically registered when the [DDS_DomainParticipantFactory_get_instance\(\)](#) method is called. By default,

data published by a *DataWriter* is sent to all *DataReaders* within the same participant using the INTRA transport.

In order to prevent the INTRA transport from being used it is necessary to remove it as a transport and a user-data transport. The following code shows how to only use the builtin UDP transport for user-data.

```

struct DDS_DomainParticipantQos dp_qos =
    DDS_DomainParticipantQos_INITIALIZER;

REDA_StringSeq_set_maximum(&dp_qos.transports.enabled_transports,1);
REDA_StringSeq_set_length(&dp_qos.transports.enabled_transports,1);
*REDA_StringSeq_get_reference(&dp_qos.transports.enabled_transports,0) =
    REDA_String_dup(NETIO_DEFAULT_UDP_NAME);

/* Use only unicast for user-data traffic. */
REDA_StringSeq_set_maximum(&dp_qos.user_traffic.enabled_transports,1);
REDA_StringSeq_set_length(&dp_qos.user_traffic.enabled_transports,1);
*REDA_StringSeq_get_reference(&dp_qos.user_traffic.enabled_transports,0) =
    REDA_String_dup("_udp://");

```

Note that the INTRA transport is never used for discovery traffic internally. It is not possible to disable matching of *DataReaders* and *DataWriters* within the same participant.

Reliability and Durability

Because a sample sent over INTRA bypasses the RTPS reliability and DDS durability queue, the [Reliability](#) and [Durability](#) Qos policies are *not* supported by the INTRA transport. However, by creating all the *DataReaders* before the *DataWriters* durability is not required.

Threading Model

The INTRA transport does not create any threads. Instead, a *DataReader* receives data over the INTRA transport in the context of the *DataWriter*'s *send thread*.

This model has two *important limitations*:

- Because a *DataReader*'s `on_data_available()` listener is called in the context of the *DataWriter*'s send thread, a *DataReader* may potentially process data at a different priority than intended (the *DataWriter*'s). While it is generally not recommended to process data in a *DataReader*'s `on_data_available()` listener, it is particularly important *to not do so* when using the INTRA transport. Instead, use a DDS WaitSet or a similar construct to wake up a separate thread to process data.
- Because a *DataReader*'s `on_data_available()` listener is called in the context of the *DataWriter*'s send thread, any method called in the `on_data_available()` listener is done in the context of the *DataWriter*'s stack. Calling a *DataWriter* `write()` in the callback could result in an infinite call stack. Thus, it is recommended *not* to call in this listener any *Connex DDS Micro* APIs that write data.

4.7.6 Shared Memory Transport (SHMEM)

This section describes the optional builtin *RTI Connex DDS Micro* SHMEM transport and how to configure it.

Shared Memory Transport (SHMEM) is an optional transport that can be used in *Connex DDS Micro*. It is part of a standalone library that can be optionally linked in.

Currently, *Connex DDS Micro* supports the following functionality:

- Unicast
- Configuration of the shared memory receive queues

Registering the SHMEM Transport

The builtin SHMEM transport is a *Connex DDS Micro* component that needs to be registered before a *DomainParticipant* can be created with the ability to send data across shared memory. Unlike the UDP Transport, this transport is not automatically registered. Register the transport using the code snippet below:

```
#include "netio_shmem/netio_shmem.h"

...

{
    DDS_DomainParticipantFactory *factory = NULL;
    RT_Registry_T *registry = NULL;
    struct NETIO_SHMEMInterfaceFactoryProperty shmem_property = NETIO_
↪SHMEMInterfaceFactoryProperty_INITIALIZER;
    struct DDS_DomainParticipantQos dp_qos = DDS_DomainParticipantQos_INITIALIZER;

    /* Optionally configure the transport settings */
    shmem_property.received_message_count_max = ...
    shmem_property.receive_buffer_size = ...
    shmem_property.message_size_max = ...

    factory = DDS_DomainParticipantFactory_get_instance();

    registry = DDS_DomainParticipantFactory_get_registry(factory);
    if (!RT_Registry_register(
        registry,
        "_shmem",
        NETIO_SHMEMInterfaceFactory_get_interface(),
        (struct RT_ComponentFactoryProperty*)&shmem_property,
        NULL))
    {
        /* ERROR */
    }

    /* Enable the transport on a Domain Participant */
    DDS_StringSeq_set_maximum(&dp_qos.transports.enabled_transports,1);
    DDS_StringSeq_set_length(&dp_qos.transports.enabled_transports,1);
    *DDS_StringSeq_get_reference(&dp_qos.transports.enabled_transports,0) = DDS_String_
↪dup("_shmem");
```

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```

    DDS_StringSeq_set_maximum(&dp_qos.discovery.enabled_transports,1);
    DDS_StringSeq_set_length(&dp_qos.discovery.enabled_transports,1);
    *DDS_StringSeq_get_reference(&dp_qos.discovery.enabled_transports,0) = DDS_String_
↪dup("_shmem://");

    DDS_StringSeq_set_maximum(&dp_qos.user_traffic.enabled_transports,1);
    DDS_StringSeq_set_length(&dp_qos.user_traffic.enabled_transports,1);
    *DDS_StringSeq_get_reference(&dp_qos.user_traffic.enabled_transports,0) = DDS_String_
↪dup("_shmem://");

    DDS_StringSeq_set_maximum(&dp_qos.discovery.initial_peers,1);
    DDS_StringSeq_set_length(&dp_qos.discovery.initial_peers,1);
    *DDS_StringSeq_get_reference(&dp_qos.discovery.initial_peers,0) = DDS_String_dup("_
↪shmem://");

    ...

    /* Explicitly unregister the shared memory transport before clean up */
    if (!RT_Registry_unregister(
        registry,
        "_shmem",
        NULL,
        NULL)
    {
        /* ERROR */
    }
}

```

The above snippet will register a transport with the default settings. To configure it, change the individual configurations as described in *SHMEM Configuration*.

When a component is registered, the registration takes the properties and a listener as the 3rd and 4th parameters. The registration of the shared memory component will make a copy of the properties configurable within a shared memory transport. There is currently no support for passing in a listener as the 4th parameter.

It should be noted that the SHMEM transport can be registered with any name, but all transport QoS policies and initial peers must refer to this name. If a transport is referred to and it does not exist, an error message is logged.

While it is possible to register multiple SHMEM transports, it is not possible to use multiple SHMEM transports within the same participant. The reason is that SHMEM port allocation is not synchronized between transports.

Threading Model

The SHMEM transport creates one receive thread for each unique SHMEM receive address and port. Thus, by default two SHMEM threads are created:

- A unicast receive thread for discovery data

- A unicast receive thread for user data

Each receive thread will create a shared memory segment that will act as a message queue. Other *DomainParticipants* will send RTPS message to this message queue.

This message queue has a fixed size and can accommodate a fixed number of messages (*received_message_count_max*) each with a maximum payload size of (*message_size_max*). The total size of the queue is configurable with (*receive_buffer_size*).

Configuring SHMEM Receive Threads

All threads in the SHMEM transport share the same thread settings. It is important to note that all the SHMEM properties must be set before the SHMEM transport is registered. *Connex DDS Micro* preregisters the SHMEM transport with default settings when the [DomainParticipantFactory](#) is initialized. To change the SHMEM thread settings, use the following code.

```

struct SHMEM_InterfaceFactoryProperty shmem_property = NETIO_SHMEMInterfaceFactoryProperty_
↳INITIALIZER

shmem_property.recv_thread_property.options = ...;

/* The stack-size is platform dependent, it is passed directly to the OS */
shmem_property.recv_thread_property.stack_size = ...;

/* The priority is platform dependent, it is passed directly to the OS */
shmem_property.recv_thread_property.priority = ...;

if (!RT_Registry_register(registry, "_shmem",
                        SHMEM_InterfaceFactory_get_interface(),
                        (struct RT_ComponentFactoryProperty*)&shmem_property,
                        NULL))
{
    /* ERROR */
}

```

SHMEM Configuration

All the configuration of the SHMEM transport is done via the struct `SHMEM_InterfaceFactoryProperty` structure:

```

struct NETIO_SHMEMInterfaceFactoryProperty
{
    struct NETIO_InterfaceFactoryProperty _parent;
    /* Max number of received message sizes that can be residing
       inside the shared memory transport concurrent queue
       */
    RTI_INT32 received_message_count_max;
    /* The size of the receive socket buffer */
    RTI_INT32 receive_buffer_size;
    /* The maximum size of the message which can be received */
    RTI_INT32 message_size_max;
    /* Thread properties for each receive thread created by this

```

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```
    NETIO interface.
    */
    struct OSAPI_ThreadProperty recv_thread_property;
};
```

received_message_count_max

The number of maximum RTPS messages that can be inside a receive thread's receive buffer. By default this is 64.

receive_buffer_size

The size of the message queue residing inside a shared memory region accessible from different processes. The default size is $((received_message_count_max * message_size_max) / 4)$.

message_size_max

The size of an RTPS message that can be sent across the shared memory transport. By default this number is 65536.

recv_thread_property

The `recv_thread` field is used to configure all the receive threads. Please refer to *Threading Model* for details.

Caveats

Leftover shared memory resources

Connex DDS Micro implements the shared memory transport and utilizes shared memory semaphores that can be used concurrently by processes. *Connex DDS Micro* implements a shared memory mutex from a shared memory semaphore. If an application exits ungracefully, then the shared memory mutex may be left in a state that prevents it from being used. This can occur because the *Connex DDS Micro* Shared Memory Transport tries to re-use and clean up and leftover segments as a result of an application's ungraceful termination. If ungraceful termination occurs, the leftover shared memory mutexes need to be cleaned up either manually or by restarting the system.

The same applies to shared memory semaphores. If an application exists ungracefully, there can be leftover shared memory segments.

Darwin and Linux systems

In the case of Darwin and Linux systems which use SysV semaphores, you can view any leftover shared memory segments using `ipcs -a`. They can be removed using the `ipcrm` command. Shared memory keys used by *Connex DDS Micro* are in the range of 0x00400000. For example:

- `ipcs -m | grep 0x004`

The shared semaphore keys used by *Connex DDS Micro* are in the range of 0x800000; the shared memory mutex keys are in the range of 0xb00000. For example:

- `ipcs -m | grep 0x008`
- `ipcs -m | grep 0x00b`

QNX systems

QNX® systems use POSIX® APIs to create shared memory segments or semaphores. The shared memory segment resources are located in `/dev/shmem` and the shared memory mutex and semaphores are located in `/dev/sem`.

To view any leftover shared memory segments when no *Connex DDS Micro* applications are running:

- `ls /dev/shmem/RTIOsapi*`
- `ls /dev/sem/RTIOsapi*`

To clean up the shared memory resources, remove the files listed.

Windows and VxWorks systems

On Windows and VxWorks® systems, once all the processes that are attached to a shared memory segment, shared memory mutex, or shared memory semaphores are terminated (either gracefully or ungracefully), the shared memory resources will be automatically cleaned up by the operating system.

4.7.7 UDP Transport

This section describes the builtin *RTI Connex DDS Micro* UDP transport and how to configure it.

The builtin UDP transport (UDP) is a fairly generic UDPv4 transport. *Connex DDS Micro* supports the following functionality:

- Unicast
- Multicast
- Automatic detection of available network interfaces
- Manual configuration of network interfaces
- Allow/Deny lists to select which network interfaces can be used
- Simple NAT configuration
- Configuration of receive threads

Registering the UDP Transport

The builtin UDP transport is a *Connex DDS Micro* component that is automatically registered when the `DDS_DomainParticipantFactory_get_instance()` method is called. To change the UDP configuration, it is necessary to first unregister the transport as shown below:

```

DDS_DomainParticipantFactory *factory = NULL;
RT_Registry_T *registry = NULL;

factory = DDS_DomainParticipantFactory_get_instance();
registry = DDS_DomainParticipantFactory_get_registry(factory);

/* The builtin transport does not return any properties (3rd param) or
 * listener (4th param)
 */
if (!RT_Registry_unregister(registry, "_udp", NULL, NULL))
{
    /* ERROR */
}

```

When a component is registered, the registration takes the properties and a listener as the 3rd and 4th parameters. In general, it is up to the caller to manage the memory for the properties and the listeners. There is no guarantee that a component makes a copy.

The following code-snippet shows how to register the UDP transport with new parameters.

```

struct UDP_InterfaceFactoryProperty *udp_property = NULL;

/* Allocate a property structure for the heap, it must be valid as long
 * as the component is registered
 */
udp_property = (struct UDP_InterfaceFactoryProperty *)
                malloc(sizeof(struct UDP_InterfaceFactoryProperty));
if (udp_property != NULL)
{
    *udp_property = UDP_INTERFACE_FACTORY_PROPERTY_DEFAULT;

    /* Only allow network interface "eth0" to be used;
    */
    REDA_StringSeq_set_maximum(&udp_property->allow_interface, 1);
    REDA_StringSeq_set_length(&udp_property->allow_interface, 1);

    *REDA_StringSeq_get_reference(&udp_property->allow_interface, 0) =
        REDA_String_dup("eth0");

    /* Register the transport again, using the builtin name
    */
    if (!RT_Registry_register(registry, "_udp",
                              UDP_InterfaceFactory_get_interface(),
                              (struct RT_ComponentFactoryProperty*)udp_property,
                              NULL))
    {
        /* ERROR */
    }
}
else
{
    /* ERROR */
}

```

It should be noted that the UDP transport can be registered with any name, but all transport QoS policies and initial peers must refer to this name. If a transport is referred to and it does not exist, an error message is logged.

It is possible to register multiple UDP transports with a [DomainParticipantFactory](#). It is also possible to use different UDP transports within the same *DomainParticipant* when multiple network interfaces are available (either physical or virtual).

When UDP transformations are enabled, this feature is always enabled and determined by the [allow_interface](#) and [deny_interface](#) lists. If any of the lists are non-empty the UDP transports will bind each receive socket to the specific interfaces.

When UDP transformations are not enabled, this feature is determined by the value of the [enable_interface_bind](#). If this value is set to **RTI_TRUE** and the [allow_interface](#) and/or [deny_interface](#) properties are non-empty, the receive sockets are bound to specific interfaces.

Threading Model

The UDP transport creates one receive thread for each unique UDP receive address and port. Thus, by default, three UDP threads are created:

- A multicast receive thread for discovery data (assuming multicast is available and enabled)
- A unicast receive thread for discovery data
- A unicast receive thread for user data

Additional threads may be created depending on the transport configuration for a *DomainParticipant*, *DataReader*, and *DataWriter*. The UDP transport creates threads based on the following criteria:

- Each unique unicast port creates a new thread
- Each unique multicast address *and* port creates a new thread

For example, if a *DataReader* specifies its own multicast receive address, a new receive thread will be created.

Configuring UDP Receive Threads

All threads in the UDP transport share the same thread settings. It is important to note that all the UDP properties must be set before the UDP transport is registered. *Connex DDS Micro* preregisters the UDP transport with default settings when the [DomainParticipantFactory](#) is initialized. To change the UDP thread settings, use the following code.

```

struct UDP_InterfaceFactoryProperty *udp_property = NULL;
struct UDP_InterfaceFactoryProperty udp_property =
    UDP_INTERFACE_FACTORY_PROPERTY_DEFAULT;

/* Allocate a property structure for the heap, it must be valid as long
 * as the component is registered
 */
udp_property = (struct UDP_InterfaceFactoryProperty *)

```

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```

        malloc(sizeof(struct UDP_InterfaceFactoryProperty));
*udp_property = UDP_INTERFACE_FACTORY_PROPERTY_DEFAULT;

/* Please refer to OSAPI_ThreadOptions for possible options */
udp_property->recv_thread.options = ...;

/* The stack-size is platform dependent, it is passed directly to the OS */
udp_property->recv_thread.stack_size = ....

/* The priority is platform dependent, it is passed directly to the OS */
udp_property->recv_thread.priority = ....

if (!RT_Registry_register(registry, "_udp",
                        UDP_InterfaceFactory_get_interface(),
                        (struct RT_ComponentFactoryProperty*)udp_property,
                        NULL))
{
    /* ERROR */
}

```

UDP Configuration

All the configuration of the UDP transport is done via the [UDP_InterfaceFactoryProperty](#).

```

struct UDP_InterfaceFactoryProperty
{
    /* Inherited from */
    struct NETIO_InterfaceFactoryProperty _parent;

    /* Sequence of allowed interface names */
    struct REDA_StringSeq allow_interface;

    /* Sequence of denied interface names */
    struct REDA_StringSeq deny_interface;

    /* The size of the send socket buffer */
    RTI_INT32 max_send_buffer_size;

    /* The size of the receive socket buffer */
    RTI_INT32 max_receive_buffer_size;

    /* The maximum size of the message which can be received */
    RTI_INT32 max_message_size;

    /* The maximum TTL */
    RTI_INT32 multicast_ttl;

#ifdef RTI_CERT
    struct UDP_NatEntrySeq nat;
#endif
}

```

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```

/* The interface table if interfaces are added manually */
struct UDP_InterfaceTableEntrySeq if_table;

/* The network interface to use to send to multicast */
REDA_String_T multicast_interface;

/* If this should be considered the default UDP interfaces if
 * no other UDP interface is found to handle a route
 */
RTI_BOOL is_default_interface;

/* Disable reading of available network interfaces using system
 * information and instead rely on the manually configured
 * interface table
 */
RTI_BOOL disable_auto_interface_config;

/* Thread properties for each receive thread created by this
 * NETIO interface.
 */
struct OSAPI_ThreadProperty recv_thread;

/* Bind to specific interfaces
 */
RTI_BOOL enable_interface_bind;

struct UDP_TransformRuleSeq source_rules;

/* Rules for how to transform sent UDP payloads based on the
 * destination address.
 */
struct UDP_TransformRuleSeq destination_rules;

/* Determines how regular UDP is supported when transformations
 * are supported.
 */
UDP_TransformUdpMode_T transform_udp_mode;

/* The locator to use for locators that have transformations.
 */
RTI_INT32 transform_locator_kind;
};

```

allow_interface

The [allow_interface](#) string sequence determines which interfaces are allowed to be used for communication. Each string element is the name of a network interface, such as “en0” or “eth1”.

If this sequence is empty, all interface names pass the allow test. The default value is empty. Thus, all interfaces are allowed.

deny_interface

The `deny_interface` string sequence determines which interfaces are not allowed to be used for communication. Each string element is the name of a network interface, such as “en0” or “eth1”.

If this sequence is empty, the test is false. That is, the interface is allowed. Note that the deny list is checked *after* the allow list. Thus, if an interface appears in both, it is denied. The default value is empty, thus no interfaces are denied.

max_send_buffer_size

The `max_send_buffer_size` is the maximum size of the send socket buffer and it *must* be at least as big as the largest sample. Typically, this buffer should be a multiple of the maximum number of samples that can be sent at any given time. The default value is 256KB.

max_receive_buffer_size

The `max_receive_buffer_size` is the maximum size of the receive socket buffer and it *must* be at least as big as the largest sample. Typically, this buffer should be a multiple of the maximum number of samples that can be received at any given time. The default value is 256KB.

max_message_size

The `max_message_size` is the maximum size of the message which can be received, including any packet overhead. The default value is 65507 bytes.

multicast_ttl

The `multicast_ttl` is the Multicast Time-To-Live (TTL). This value is only used for multicast. It limits the number of hops a packet can pass through before it is dropped by a router. The default value is 1.

nat

Connex DDS Micro supports firewalls with NAT. However, this feature has limited use and only supports translation between a private and public IP address. UDP ports are not translated. Furthermore, because *Connex DDS Micro* does not support any hole punching technique or WAN server, this feature is only useful when the private and public address mapping is static and known in advance. For example, to test between an Android emulator and the host, the following configuration can be used:

```
UDP_NatEntrySeq_set_maximum(&udp_property->nat,2);
UDP_NatEntrySeq_set_length(&udp_property->nat,2);

/* Translate the local emulator eth0 address 10.10.2.f:7410 to
 * 127.0.0.1:7410. This ensures that the address advertised by the
 * emulator to the host machine is the host's loopback interface, not
 * the emulator's host interface
 */
```

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```

UDP_NatEntrySeq_get_reference(&udp_property->nat,0)->
    local_address.kind = NETIO_ADDRESS_KIND_UDPv4;
UDP_NatEntrySeq_get_reference(&udp_property->nat,0)->
    local_address.port = 7410;
UDP_NatEntrySeq_get_reference(&udp_property->nat,0)->
    local_address.value.ipv4.address = 0x0a00020f;

UDP_NatEntrySeq_get_reference(&udp_property->nat,0)->
    public_address.kind = NETIO_ADDRESS_KIND_UDPv4;
UDP_NatEntrySeq_get_reference(&udp_property->nat,0)->
    public_address.port = 7410;
UDP_NatEntrySeq_get_reference(&udp_property->nat,0)->
    public_address.value.ipv4.address = 0x7f000001;

/* Translate the local emulator eth0 address 10.10.2.f:7411 to
 * 127.0.0.1:7411. This ensures that the address advertised by the
 * emulator to the host machine is the host's loopback interface
 */
UDP_NatEntrySeq_get_reference(&udp_property->nat,1)->
    local_address.kind = NETIO_ADDRESS_KIND_UDPv4;
UDP_NatEntrySeq_get_reference(&udp_property->nat,1)->
    local_address.port = 7411;
UDP_NatEntrySeq_get_reference(&udp_property->nat,1)->
    local_address.value.ipv4.address = 0x0a00020f;

UDP_NatEntrySeq_get_reference(&udp_property->nat,1)->
    public_address.kind = NETIO_ADDRESS_KIND_UDPv4;
UDP_NatEntrySeq_get_reference(&udp_property->nat,1)->
    public_address.port = 7411;
UDP_NatEntrySeq_get_reference(&udp_property->nat,1)->
    public_address.value.ipv4.address = 0x7f000001;

```

if_table

The `if_table` provides a method to manually configure which interfaces are available for use; for example, when using IP stacks that do not support reading interface lists. The following example shows how to manually configure the interfaces.

```

/* The arguments to the UDP_InterfaceTable_add_entry functions are:
 * The if_table itself
 * The network address of the interface
 * The netmask of the interface
 * The name of the interface
 * Interface flags. Valid flags are:
 *   UDP_INTERFACE_INTERFACE_UP_FLAG - The interface is UP
 *   UDP_INTERFACE_INTERFACE_MULTICAST_FLAG - The interface supports multicast
 */
if (!UDP_InterfaceTable_add_entry(&udp_property->if_table,
                                0x7f000001,0xff000000,"loopback",
                                UDP_INTERFACE_INTERFACE_UP_FLAG |

```

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```

UDP_INTERFACE_INTERFACE_MULTICAST_FLAG))
{
    /* Error */
}

```

multicast_interface

The [multicast_interface](#) may be used to select a particular network interface to be used to send multicast packets. The default value is any interface (that is, the OS selects the interface).

is_default_interface

The [is_default_interface](#) flag is used to indicate that this *Connex DDS Micro* network transport shall be used if no other transport is found. The default value is **RTI_TRUE**.

disable_auto_interface_config

Normally, the UDP transport will try to read out the interface list (on platforms that support it). Setting [disable_auto_interface_config](#) to **RTI_TRUE** will prevent the UDP transport from reading the interface list.

recv_thread

The [recv_thread](#) field is used to configure all the receive threads. Please refer to *Threading Model* for details.

enable_interface_bind

When this is set to **TRUE** the UDP transport binds each receive port to a specific interface when the [allow_interface/deny_interface](#) lists are non-empty. This allows multiple UDP transports to be used by a single *DomainParticipant* at the expense of an increased number of threads. This property is ignored when transformations are enabled and the [allow_interface/deny_interface](#) lists are non-empty.

source_rules

Rules for how to transform received UDP payloads based on the source address.

destination_rules

Rules for how to transform sent UDP payloads based on the destination address.

transform_udp_mode

Determines how regular UDP is supported when transformations are supported. When transformations are enabled the default value is **UDP_TRANSFORM_UDP_MODE_DISABLED**.

transform_locator_kind

The locator to use for locators that have transformations. When transformation rules have been enabled, they are announced as a vendor specific locator. This property overrides this value.

NOTE: Changing this value may prevent communication.

UDP Transformations

The UDP transform feature enables custom transformation of incoming and outgoing UDP payloads based on transformation rules between a pair of source and destination IP addresses. Some examples of transformations are encrypted data or logging.

This section explains how to implement and use transformations in an application and is organized as follows:

- *Overview*
- *Creating a Transformation Library*
- *Creating Transformation Rules*
- *Interoperability*
- *Error Handling*
- *Example Code*
- *Examples*
- *OS Configuration*

Overview

The UDP transformation feature enables custom transformation of incoming and outgoing UDP payloads. For the purpose of this section, a UDP payload is defined as a sequence of octets sent or received as a single UDP datagram excluding UDP headers – typically UDP port numbers – and trailers, such as the optional used checksum.

An outgoing payload is the UDP payload passed to the network stack. The transformation feature allows a custom transformation of this payload just before it is sent. The UDP transport receives payloads to send from an upstream layer. In *Connex DDS Micro* this layer is typically RTPS, which creates payloads containing one or more RTPS messages. The transformation feature enables transformation of the entire RTPS payload before it is passed to the network stack.

The same RTPS payload may be sent to one or more locators. A locator identifies a destination address, such as an IPv4 address, a port, such as a UDP port, and a transport kind. The address and port are used by the UDP transport to reach a destination. However, only the destination address is used to determine which transformation to apply.

An incoming payload is the UDP payload received from the network stack. The transformation feature enables transformation of the UDP payload received from the network stack *before* it is passed to the upstream interface, typically RTPS. The UDP transport only receives payloads destined for one of its network interface addresses, but may receive UDP payloads destined for many different

ports. The transformation does not take a port into account, only the source address. In *Connext DDS Micro* the payload is typically a RTPS payload containing one or more RTPS messages.

UDP transformations are registered with *Connext DDS Micro* and used by the UDP transport to determine how to transform payloads based on a source or destination address. Please refer to *Creating a Transformation Library* for details on how to implement transformations and *Creating Transformation Rules* for how to add rules.

Transformations are local resources. There is no exchange between different UDP transports regarding what a transformation does to a payload. This is considered a-priori knowledge and depends on the implementation of the transformation. Any negotiation of e.g. keys must be handled before the UDP transport is registered. Thus, if a sender and receiver do not apply consistent rules, they may not be able to communicate, or incorrect data may result. Note that while information is typically in the direction from a *DataWriter* to a *DataReader*, a reliable *DataReader* also send protocol data to a *DataWriter*. These messages are also transformed.

Network Interface Selection

When a *DomainParticipant* is created, it first creates an instance of each transport configured in the `DomainParticipantQos::transports` QoS policy. Thus, each UDP transport registered with *Connext DDS Micro* must have a unique name (up to 7 characters). Each registered transport can be configured to use all or some of the available interfaces using the `allow_interface` and `deny_interface` properties. The registered transports may now be used for either discovery data (specified in `DomainParticipantQos::discovery`), `user_traffic` (specified in `DomainParticipantQos::user_traffic`) or both. The *DomainParticipant* also queries the transport for which addresses it is capable of sending to.

When a participant creates multiple instances of the UDP transport, it is important that instances use non-overlapping networking interface resources.

Data Reception

Which transport to use for discovery data is determined by the `DomainParticipantQos::discovery` QoS policy. For each transport listed, the *DomainParticipant* reserves a network address to listen to. This network address is sent as part of the discovery data and is used by other *DomainParticipants* as the address to send discovery data for this *DomainParticipant*. Because a UDP transformation only looks at source and destination addresses, if different transformations are needed for discovery and user-data, different UDP transport registrations must be used and hence different network interfaces.

Data Transmission

Which address to send data to is based on the locators received as part of discovery and the peer list.

Received locators are analyzed and a transport locally registered with a *DomainParticipant* is selected based on the locator kind, address and mask. The first matching transport is selected. If a matching transport is not found, the locator is discarded.

NOTE: A transport is not a matching criteria at the same level as a QoS policy. If a discovered entity requests user data on a transport that doesn't exist, it is not unmatched.

The peer list, as specified by the application, is a list of locators to send participant discovery announcements to. If the transport to use is not specified, e.g. "udp1@192.168.1.1", but instead "192.168.1.1", then all transports that understand this address will send to it. Thus, in this case the latter is used, and two different UDP transports are registered; they will both send to the same address. However, one transport may send transformed data and the other may not depending on the destination address.

Creating a Transformation Library

The transformation library is responsible for creating and performing transformations. Note that a library is a logical concept and does not refer to an actual library in, for example, UNIX. A library in this context is a collection of routines that together creates, manages, and performs transformations. How these routines are compiled and linked with an application using *Connex DDS Micro* is out of scope of this section.

The transformation library must be registered with *Connex DDS Micro*'s run-time and must implement the required interfaces. This ensures proper life-cycle management of transformation resources as well as clear guidelines regarding concurrency and memory management.

From *Connex DDS Micro*'s run-time point of view, the transformation library must implement methods so that:

- A library can be initialized.
- A library can be instantiated.
- An instance of the library performs and manages transformations.

The first two tasks are handled by *Connex DDS Micro*'s run-time factory interface which is common for all libraries managed by *Connex DDS Micro*. The third task is handled by the transformation interface, which is specific to UDP transformations.

The following describes the relationship between the different interfaces:

- A library is initialized once when it is registered with *Connex DDS Micro*.
- A library is finalized once when it is unregistered from *Connex DDS Micro*.
- Multiple library instances can be created. If a library is used twice, for example registered with two different transports, two different library contexts are created using the factory interface. *Connex DDS Micro* assumes that concurrent access to two different instances is allowed.
- Different instances of the library can be deleted independently. An instance is deleted using the factory interface.
- A library instance creates specific source or destination transformations. Each transformation is expected to transform a payload to exactly one destination or from one source.

The following relationship is true between the UDP transport and a UDP transformation library:

- Each registered UDP transport may make use of one or more UDP transformation libraries.

- A DDS *DomainParticipant* creates one instance of each registered UDP transport.
- Each instance of the UDP transport creates one instance of each enabled transformation library registered with the UDP transport.
- Each Transformation rule created by the UDP transport creates one send or one receive transformation.

Creating Transformation Rules

Transformation rules decide how a payload should be transformed based on either a source or destination address. Before a UDP transport is registered, it must be configured with the transformation libraries to use, as well as which library to use for each source and destination address. For each UDP payload sent or received, an instance of the UDP transport searches for a matching source or destination rule to determine which transformation to apply.

The transformation rules are added to the [UDP_InterfaceFactoryProperty](#) before registration takes place.

If no transformation rules have been configured, all payloads are treated as regular UDP packets.

If no send rules have been asserted, the payload is sent as is. If all outgoing messages are to be transformed, a single entry is sufficient (address = 0, mask = 0).

If no receive rules have been asserted, it is passed upstream as is. If all incoming messages are to be transformed, a single entry is sufficient (address = 0, mask = 0).

If no matching rule is found, the packet is dropped and an error is logged.

NOTE: [UDP_InterfaceFactoryProperty](#) is immutable after the UDP transport has been registered.

Interoperability

When the UDP transformations has enabled at least one transformation, it will only inter-operate with another UDP transport which also has at least one transformation.

UDP transformations does not interoperate with *RTI Connex DDS Professional*.

Error Handling

The transformation rules are applied on a local basis and correctness is based on configuration. It is not possible to detect that a peer participant is configured for different behavior and errors cannot be detected by the UDP transport itself. However, the transformation interface can return errors which are logged.

Example Code

Example Header file MyUdpTransform.h:

```
#ifndef MyUdpTransform_h
#define MyUdpTransform_h
```

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```

#include "rti_me_c.h"
#include "netio/netio_udp.h"
#include "netio/netio_interface.h"

struct MyUdpTransformFactoryProperty
{
    struct RT_ComponentFactoryProperty _parent;
};

extern struct RT_ComponentFactoryI*
MyUdpTransformFactory_get_interface(void);

extern RTI_BOOL
MyUdpTransformFactory_register(RT_Registry_T *registry,
                               const char *const name,
                               struct MyUdpTransformFactoryProperty *property);

extern RTI_BOOL
MyUdpTransformFactory_unregister(RT_Registry_T *registry,
                                  const char *const name,
                                  struct MyUdpTransformFactoryProperty **);

#endif

```

Example Source file MyUdpTransform.c:

```

/*ce
 * \file
 * \defgroup UDPTransformExampleModule MyUdpTransform
 * \ingroup UserManuals_UDPTransform
 * \brief UDP Transform Example
 *
 * \details
 *
 * The UDP interface is implemented as a NETIO interface and NETIO interface
 * factory.
 */

/*ce \addtogroup UDPTransformExampleModule
 * @{
 */
#include <stdio.h>

#include "MyUdpTransform.h"

/*ce
 * \brief The UDP Transformation factory class
 *
 * \details
 * All Transformation components must have a factory. A factory creates one

```

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```

* instance of the component as needed. In the case of UDP transformations,
* \rttime creates one instance per UDP transport instance.
*/
struct MyUdpTransformFactory
{
    /*ce
    * \brief Base-class. All \rttime Factories must inherit from RT_ComponentFactory.
    */
    struct RT_ComponentFactory _parent;

    /*ce
    * \brief A pointer to the properties of the factory.
    *
    * \details
    *
    * When a factory is registered with \rttime it can be registered with
    * properties specific to the component. However \rttime does not
    * make a copy ( that would require additional methods). Furthermore, it
    * may not be desirable to make a copy. Instead, this decision is
    * left to the implementer of the component. \rttime does not access
    * any custom properties.
    */
    struct MyUdpTransformFactoryProperty *property;
};

/*ce
* \brief The custom UDP transformation class.
*
* \details
* The MyUdpTransformFactory creates one instance of this class for each
* UDP interface created. In this example one packet buffer (NETIO_Packet_T),
* is allocated and a buffer to hold the transformed data (\ref buffer)
*
* Only one transformation can be done at a time and it is synchronous. Thus,
* it is sufficient with one buffer to transform input and output per
* instance of the MyUdpTransform.
*/
struct MyUdpTransform
{
    /*ce
    * \brief Base-class. All UDP transforms must inherit from UDP_Transform
    */
    struct UDP_Transform _parent;

    /*ce \brief A reference to its own factory, if properties must be accessed
    */
    struct MyUdpTransformFactory *factory;

    /*ce \brief NETIO_Packet to hold a transformed payload.
    *
    * \details

```

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```

*
* \rttime uses a NETIO_Packet_T to abstract data payload and this is
* what is being passed between the UDP transport and the transformation.
* The transformation must convert a payload into a NETIO_Packet. This
* is done with NETIO_Packet_initialize_from. This function saves all
* state except the payload buffer.
*/
NETIO_Packet_T packet;

/*ce \brief The payload to assign to NETIO_Packet_T
*
* \details
*
* A transformation cannot do in-place transformations because the input
* buffer may be sent multiple times (for example due to reliability).
* A transformation instance can only transform one buffer at a time
* (send or receive). The buffer must be large enough to hold a transformed
* payload. When the the transformation is created it receives a
* \ref UDP_TransformProperty. This property has the max send and
* receive buffers for transport and can be used to size the buffer.
* Please refer to \ref UDP_InterfaceFactoryProperty::max_send_message_size
* and \ref UDP_InterfaceFactoryProperty::max_message_size.
*/
char *buffer;

/*ce \brief The maximum length of the buffer. NOTE: The buffer must
* be 1 byte larger than the largest buffer.
*/
RTI_SIZE_T max_buffer_length;
};

/*ce \brief Forward declaration of the interface implementation
*/
static struct UDP_TransformI MyUdpTransform_fv_Intf;

/*ce \brief Forward declaration of the interface factory implementation
*/
static struct RT_ComponentFactoryI MyUdpTransformFactory_fv_Intf;

/*ce \brief Method to create an instance of MyUdpTransform
*
* \param[in] factory The factory creating this instance
* \param[in] property Generic UDP_Transform properties
*
* \return A pointer to MyUdpTransform on sucess, NULL on failure.
*/
RTI_PRIVATE struct MyUdpTransform*
MyUdpTransform_create(struct MyUdpTransformFactory *factory,
                     const struct UDP_TransformProperty *const property)
{
    struct MyUdpTransform *t;

```

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```

OSAPI_Heap_allocate_struct(&t, struct MyUdpTransform);
if (t == NULL)
{
    return NULL;
}

/* All component instances must initialize the parent using this
 * call.
 */
RTI_Component_initialize(&t->_parent._parent,
                        &MyUdpTransform_fv_Intf._parent,
                        0,
                        (property ? &property->_parent : NULL),
                        NULL);

t->factory = factory;

/* Allocate a buffer that is the larger of the send and receive
 * size.
 */
t->max_buffer_length = property->max_receive_message_size;
if (property->max_send_message_size > t->max_buffer_length )
{
    t->max_buffer_length = property->max_send_message_size;
}

/* Allocate 1 extra byte */
OSAPI_Heap_allocate_buffer(&t->buffer, t->max_buffer_length+1,
                           OSAPI_ALIGNMENT_DEFAULT);

if (t->buffer == NULL)
{
    OSAPI_Heap_free_struct(t);
    t = NULL;
}

return t;
}

/*ce \brief Method to delete an instance of MyUdpTransform
 *
 * \param[in] t Transformation instance to delete
 */
RTI_PRIVATE void
MyUdpTransform_delete(struct MyUdpTransform *t)
{
    OSAPI_Heap_free_buffer(t->buffer);
    OSAPI_Heap_free_struct(t);
}

```

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```

/*ce \brief Method to create a transformation for an destination address
*
* \details
*
* For each asserted destination rule a transform is created by the transformation
* instance. This method determines how a UDP payload is transformed before
* it is sent to an address that matches destination & netmask.
*
* \param[in] udptf      UDP Transform instance that creates the transformation
* \param[out] context   Pointer to a transformation context
* \param[in] destination Destination address for the transformation
* \param[in] netmask    The netmask to apply to this destination.
* \param[in] user_data  The user_data the rule was asserted with
* \param[in] property   UDP transform specific properties
* \param[out] ec        User defined error code
*
* \return RTI_TRUE on success, RTI_FALSE on failure
*/
RTI_PRIVATE RTI_BOOL
MyUdpTransform_create_destination_transform(
    UDP_Transform_T *const udptf,
    void **const context,
    const struct NETIO_Address *const destination,
    const struct NETIO_Netmask *const netmask,
    void *user_data,
    const struct UDP_TransformProperty *const property,
    RTI_INT32 *const ec)
{
    struct MyUdpTransform *self = (struct MyUdpTransform*)udptf;
    UNUSED_ARG(self);
    UNUSED_ARG(destination);
    UNUSED_ARG(user_data);
    UNUSED_ARG(property);
    UNUSED_ARG(ec);
    UNUSED_ARG(netmask);

    /* Save the user-data to determine which transform to apply later */
    *context = (void*)user_data;

    return RTI_TRUE;
}

/*ce \brief Method to delete a transformation for an destination address
*
*
* \param[in] udptf      UDP Transform instance that created the transformation
* \param[out] context   Pointer to a transformation context
* \param[in] destination Destination address for the transformation
* \param[in] netmask    The netmask to apply to this destination.
* \param[out] ec        User defined error code
*
*

```

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```

* \return RTI_TRUE on success, RTI_FALSE on failure
*/
RTI_PRIVATE RTI_BOOL
MyUdpTransform_delete_destination_transform(UDP_Transform_T *const udptf,
                                           void *context,
                                           const struct NETIO_Address *const destination,
                                           const struct NETIO_Netmask *const netmask,
                                           RTI_INT32 *const ec)
{
    UNUSED_ARG(udptf);
    UNUSED_ARG(context);
    UNUSED_ARG(destination);
    UNUSED_ARG(ec);
    UNUSED_ARG(netmask);

    return RTI_TRUE;
}

/*ce \brief Method to create a transformation for an source address
*
* \details
*
* For each asserted source rule a transform is created by the transformation
* instance. This method determines how a UDP payload is transformed when
* it is received from an address that matches source & netmask.
*
* \param[in] udptf      UDP Transform instance that creates the transformation
* \param[out] context  Pointer to a transformation context
* \param[in] source    Destination address for the transformation
  \param[in] netmask   The netmask to apply to this destination.
* \param[in] user_data The user_data the rule was asserted with
* \param[in] property  UDP transform specific properties
* \param[out] ec       User defined error code
*
* \return RTI_TRUE on success, RTI_FALSE on failure
*/
RTI_PRIVATE RTI_BOOL
MyUdpTransform_create_source_transform(UDP_Transform_T *const udptf,
                                       void **const context,
                                       const struct NETIO_Address *const source,
                                       const struct NETIO_Netmask *const netmask,
                                       void *user_data,
                                       const struct UDP_TransformProperty *const property,
                                       RTI_INT32 *const ec)
{
    struct MyUdpTransform *self = (struct MyUdpTransform*)udptf;
    UNUSED_ARG(self);
    UNUSED_ARG(source);
    UNUSED_ARG(user_data);
    UNUSED_ARG(property);
    UNUSED_ARG(ec);
}

```

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```

UNUSED_ARG(netmask);

*context = (void*)user_data;

return RTI_TRUE;
}

/*ce \brief Method to delete a transformation for an source address
*
*
* \param[in] udptf      UDP Transform instance that created the transformation
* \param[out] context   Pointer to a transformation context
* \param[in] source     Source address for the transformation
* \param[in] netmask    The netmask to apply to this destination.
* \param[out] ec        User defined error code
*
* \return RTI_TRUE on success, RTI_FALSE on failure
*/
RTI_PRIVATE RTI_BOOL
MyUdpTransform_delete_source_transform(UDP_Transform_T *const udptf,
                                       void *context,
                                       const struct NETIO_Address *const source,
                                       const struct NETIO_Netmask *const netmask,
                                       RTI_INT32 *const ec)
{
    UNUSED_ARG(udptf);
    UNUSED_ARG(context);
    UNUSED_ARG(source);
    UNUSED_ARG(ec);
    UNUSED_ARG(netmask);

    return RTI_TRUE;
}

/*ce \brief Method to transform data based on a source address
*
* \param[in] udptf      UDP_Transform_T that performs the transformation
* \param[in] context    Reference to context created by \ref MyUdpTransform_create_
↪source_transform
* \param[in] source     Source address for the transformation
* \param[in] in_packet  The NETIO packet to transform
* \param[out] out_packet The transformed NETIO packet
* \param[out] ec        User defined error code
*
* \return RTI_TRUE on success, RTI_FALSE on failure
*/
RTI_PRIVATE RTI_BOOL
MyUdpTransform_transform_source(UDP_Transform_T *const udptf,
                               void *context,
                               const struct NETIO_Address *const source,
                               const NETIO_Packet_T *const in_packet,

```

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```

        NETIO_Packet_T **out_packet,
        RTI_INT32 *const ec)
{
    struct MyUdpTransform *self = (struct MyUdpTransform*)udptf;
    char *buf_ptr,*buf_end;
    char *from_buf_ptr,*from_buf_end;
    UNUSED_ARG(context);
    UNUSED_ARG(source);

    *ec = 0;

    /* Assigned the transform buffer to the outgoing packet
     * saving state from the incoming packet. In this case the
     * outgoing length is the same as the incoming. How to buffer
     * is filled in is of no interest to \rtime. All it cares about is
     * where it starts and where it ends.
     */
    if (!NETIO_Packet_initialize_from(
        &self->packet,in_packet,
        self->buffer,self->max_buffer_length,
        0,NETIO_Packet_get_payload_length(in_packet)))
    {
        return RTI_FALSE;
    }

    *out_packet = &self->packet;

    buf_ptr = NETIO_Packet_get_head(&self->packet);
    buf_end = NETIO_Packet_get_tail(&self->packet);
    from_buf_ptr = NETIO_Packet_get_head(in_packet);
    from_buf_end = NETIO_Packet_get_tail(in_packet);

    /* Perform a transformation based on the user-data */
    while (from_buf_ptr < from_buf_end)
    {
        if (context == (void*)1)
        {
            *buf_ptr = ~(*from_buf_ptr);
        }
        else if (context == (void*)2)
        {
            *buf_ptr = (*from_buf_ptr)+1;
        }

        ++buf_ptr;
        ++from_buf_ptr;
    }

    return RTI_TRUE;
}

```

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```

/*ce \brief Method to transform data based on a destination address
 *
 * \param[in] udptf      UDP_Transform_T that performs the transformation
 * \param[in] context   Reference to context created by \ref MyUdpTransform_create_
↪destination_transform
 * \param[in] destination Source address for the transformation
 * \param[in] in_packet  The NETIO packet to transform
 * \param[out] packet_out The transformed NETIO packet
 * \param[out] ec       User defined error code
 *
 * \return RTI_TRUE on success, RTI_FALSE on failure
 */
RTI_PRIVATE RTI_BOOL
MyUdpTransform_transform_destination(UDP_Transform_T *const udptf,
                                   void *context,
                                   const struct NETIO_Address *const destination,
                                   const NETIO_Packet_T *const in_packet,
                                   NETIO_Packet_T **packet_out,
                                   RTI_INT32 *const ec)
{
    struct MyUdpTransform *self = (struct MyUdpTransform*)udptf;
    char *buf_ptr,*buf_end;
    char *from_buf_ptr,*from_buf_end;
    UNUSED_ARG(context);
    UNUSED_ARG(destination);

    *ec = 0;

    if (!NETIO_Packet_initialize_from(
        &self->packet,in_packet,
        self->buffer,8192,
        0,NETIO_Packet_get_payload_length(in_packet)))
    {
        return RTI_FALSE;
    }

    *out_packet = &self->packet;

    buf_ptr = NETIO_Packet_get_head(&self->packet);
    buf_end = NETIO_Packet_get_tail(&self->packet);
    from_buf_ptr = NETIO_Packet_get_head(in_packet);
    from_buf_end = NETIO_Packet_get_tail(in_packet);

    while (from_buf_ptr < from_buf_end)
    {
        if (context == (void*)1)
        {
            *buf_ptr = ~(*from_buf_ptr);
        }
        else if (context == (void*)2)
        {

```

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```

        *buf_ptr = (*from_buf_ptr)-1;
    }

    ++buf_ptr;
    ++from_buf_ptr;
}

return RTI_TRUE;
}

/*ce \brief Definition of the transformation interface
*/
RTI_PRIVATE struct UDP_TransformI MyUdpTransform_fv_Intf =
{
    RT_COMPONENTI_BASE,
    MyUdpTransform_create_destination_transform,
    MyUdpTransform_create_source_transform,
    MyUdpTransform_transform_source,
    MyUdpTransform_transform_destination,
    MyUdpTransform_delete_destination_transform,
    MyUdpTransform_delete_source_transform
};

/*ce \brief Method called by \runtime to create an instance of transformation
*/
MUST_CHECK_RETURN RTI_PRIVATE RT_Component_T*
MyUdpTransformFactory_create_component(struct RT_ComponentFactory *factory,
                                     struct RT_ComponentProperty *property,
                                     struct RT_ComponentListener *listener)
{
    struct MyUdpTransform *t;
    UNUSED_ARG(listener);

    t = MyUdpTransform_create(
        (struct MyUdpTransformFactory*)factory,
        (struct UDP_TransformProperty*)property);

    return &t->_parent._parent;
}

/*ce \brief Method called by \runtime to delete an instance of transformation
*/
RTI_PRIVATE void
MyUdpTransformFactory_delete_component(
                                     struct RT_ComponentFactory *factory,
                                     RT_Component_T *component)
{
    UNUSED_ARG(factory);

    MyUdpTransform_delete((struct MyUdpTransform*)component);
}

```

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```

/*ce \brief Method called by \runtime when a factory is registered
*/
MUST_CHECK_RETURN RTI_PRIVATE struct RT_ComponentFactory*
MyUdpTransformFactory_initialize(struct RT_ComponentFactoryProperty* property,
                               struct RT_ComponentFactoryListener *listener)
{
    struct MyUdpTransformFactory *fac;
    UNUSED_ARG(property);
    UNUSED_ARG(listener);

    OSAPI_Heap_allocate_struct(&fac, struct MyUdpTransformFactory);

    fac->_parent._factory = &fac->_parent;
    fac->_parent.intf = &MyUdpTransformFactory_fv_Intf;
    fac->property = (struct MyUdpTransformFactoryProperty*)property;

    return &fac->_parent;
}

/*ce \brief Method called by \runtime when a factory is unregistered
*/
RTI_PRIVATE void
MyUdpTransformFactory_finalize(struct RT_ComponentFactory *factory,
                              struct RT_ComponentFactoryProperty **property,
                              struct RT_ComponentFactoryListener **listener)
{
    struct MyUdpTransformFactory *fac =
        (struct MyUdpTransformFactory*)factory;

    UNUSED_ARG(property);
    UNUSED_ARG(listener);

    if (listener != NULL)
    {
        *listener = NULL;
    }

    if (property != NULL)
    {
        *property = (struct RT_ComponentFactoryProperty*)fac->property;
    }

    OSAPI_Heap_free_struct(factory);

    return;
}

/*ce \brief Definition of the factory interface
*/
RTI_PRIVATE struct RT_ComponentFactoryI MyUdpTransformFactory_fv_Intf =

```

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```

{
    UDP_INTERFACE_INTERFACE_ID,
    MyUdpTransformFactory_initialize,
    MyUdpTransformFactory_finalize,
    MyUdpTransformFactory_create_component,
    MyUdpTransformFactory_delete_component,
    NULL
};

struct RT_ComponentFactoryI*
MyUdpTransformFactory_get_interface(void)
{
    return &MyUdpTransformFactory_fv_Intf;
}

/*ce \brief Method to register this transformation in a registry
*/
RTI_BOOL
MyUdpTransformFactory_register(RT_Registry_T *registry,
                               const char *const name,
                               struct MyUdpTransformFactoryProperty *property)
{
    return RT_Registry_register(registry, name,
                                MyUdpTransformFactory_get_interface(),
                                &property->_parent, NULL);
}

/*ce \brief Method to unregister this transformation from a registry
*/
RTI_BOOL
MyUdpTransformFactory_unregister(RT_Registry_T *registry,
                                  const char *const name,
                                  struct MyUdpTransformFactoryProperty **property)
{
    return RT_Registry_unregister(registry, name,
                                   (struct RT_ComponentFactoryProperty**)property,
                                   NULL);
}

/*! @} */

```

Example configuration of rules:

```

#include <stdio.h>
#include <stdlib.h>
#include <string.h>

#include "common.h"

void

```

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```

MyAppApplication_help(char *appname)
{
    printf("%s [options]\n", appname);
    printf("options:\n");
    printf("-h                - This text\n");
    printf("-domain <id>       - DomainId (default: 0)\n");
    printf("-udp_intf <intf>   - udp interface (no default)\n");
    printf("-peer <address>    - peer address (no default)\n");
    printf("-count <count>    - count (default -1)\n");
    printf("-sleep <ms>       - sleep between sends (default 1s)\n");
    printf("\n");
}

struct MyAppApplication*
MyAppApplication_create(const char *local_participant_name,
                       const char *remote_participant_name,
                       DDS_Long domain_id, char *udp_intf, char *peer,
                       DDS_Long sleep_time, DDS_Long count)
{
    DDS_ReturnCode_t retcode;
    DDS_DomainParticipantFactory *factory = NULL;
    struct DDS_DomainParticipantFactoryQos dpf_qos =
        DDS_DomainParticipantFactoryQos_INITIALIZER;
    struct DDS_DomainParticipantQos dp_qos =
        DDS_DomainParticipantQos_INITIALIZER;
    DDS_Boolean success = DDS_BOOLEAN_FALSE;
    struct MyAppApplication *application = NULL;
    RT_Registry_T *registry = NULL;
    struct UDP_InterfaceFactoryProperty *udp_property = NULL;
    struct DPDE_DiscoveryPluginProperty discovery_plugin_properties =
        DPDE_DiscoveryPluginProperty_INITIALIZER;
    UNUSED_ARG(local_participant_name);
    UNUSED_ARG(remote_participant_name);

    /* Uncomment to increase verbosity level:
       OSAPILog_set_verbosity(OSAPI_LOG_VERBOSITY_WARNING);
    */
    application = (struct MyAppApplication *)malloc(sizeof(struct MyAppApplication));

    if (application == NULL)
    {
        printf("failed to allocate application\n");
        goto done;
    }

    application->sleep_time = sleep_time;
    application->count = count;

    factory = DDS_DomainParticipantFactory_get_instance();

    if (DDS_DomainParticipantFactory_get_qos(factory, &dpf_qos) != DDS_RETCODE_OK)

```

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```

{
    printf("failed to get number of components\n");
    goto done;
}

dpf_qos.resource_limits.max_components = 128;

if (DDS_DomainParticipantFactory_set_qos(factory,&dpf_qos) != DDS_RETCODE_OK)
{
    printf("failed to increase number of components\n");
    goto done;
}

registry = DDS_DomainParticipantFactory_get_registry(
            DDS_DomainParticipantFactory_get_instance());

if (!RT_Registry_register(registry, DDSHST_WRITER_DEFAULT_HISTORY_NAME,
                        WHSM_HistoryFactory_get_interface(), NULL, NULL))
{
    printf("failed to register wh\n");
    goto done;
}

if (!RT_Registry_register(registry, DDSHST_READER_DEFAULT_HISTORY_NAME,
                        RHSM_HistoryFactory_get_interface(), NULL, NULL))
{
    printf("failed to register rh\n");
    goto done;
}

if (!MyUdpTransformFactory_register(registry, "T0",NULL))
{
    printf("failed to register T0\n");
    goto done;
}

if (!MyUdpTransformFactory_register(registry, "T1",NULL))
{
    printf("failed to register T0\n");
    goto done;
}

/* Configure UDP transport's allowed interfaces */
if (!RT_Registry_unregister(registry, NETIO_DEFAULT_UDP_NAME, NULL, NULL))
{
    printf("failed to unregister udp\n");
    goto done;
}

udp_property = (struct UDP_InterfaceFactoryProperty *)
                malloc(sizeof(struct UDP_InterfaceFactoryProperty));

```

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if (udp_property == NULL)
{
    printf("failed to allocate udp properties\n");
    goto done;
}
*udp_property = UDP_INTERFACE_FACTORY_PROPERTY_DEFAULT;

/* For additional allowed interface(s), increase maximum and length, and
   set interface below:
*/
udp_property->max_send_message_size = 16384;
udp_property->max_message_size = 32768;

if (udp_intf != NULL)
{
    REDA_StringSeq_set_maximum(&udp_property->allow_interface,1);
    REDA_StringSeq_set_length(&udp_property->allow_interface,1);
    *REDA_StringSeq_get_reference(&udp_property->allow_interface,0) =
        DDS_String_dup(udp_intf);
}

/* A rule that says: For payloads received from 192.168.10.* (netmask is
   * 0xffffffff), apply transformation T0.
*/
if (!UDP_TransformRules_assert_source_rule(
    &udp_property->source_rules,
    0xc0a80ae8,0xffffffff,"T0",(void*)2))
{
    printf("Failed to assert source rule\n");
    goto done;
}

/* A rule that says: For payloads sent to 192.168.10.* (netmask is
   * 0xffffffff), apply transformation T0.
*/
if (!UDP_TransformRules_assert_destination_rule(
    &udp_property->destination_rules,
    0xc0a80ae8,0xffffffff,"T0",(void*)2))
{
    printf("Failed to assert source rule\n");
    goto done;
}

/* A rule that says: For payloads received from 192.168.20.* (netmask is
   * 0xffffffff), apply transformation T1.
*/
if (!UDP_TransformRules_assert_source_rule(
    &udp_property->source_rules,
    0xc0a81465,0xffffffff,"T1",(void*)1))
{

```

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```

    printf("Failed to assert source rule\n");
    goto done;
}

/* A rule that says: For payloads received from 192.168.20.* (netmask is
 * 0xffffffff00), apply transformation T1.
 */
if (!UDP_TransformRules_assert_destination_rule(
    &udp_property->destination_rules,
    0xc0a81465,0xffffffff00,"T1",(void*)1))
{
    printf("Failed to assert source rule\n");
    goto done;
}

if (!RT_Registry_register(registry, NETIO_DEFAULT_UDP_NAME,
    UDP_InterfaceFactory_get_interface(),
    (struct RT_ComponentFactoryProperty*)udp_property, NULL))
{
    printf("failed to register udp\n");
    goto done;
}

DDS_DomainParticipantFactory_get_qos(factory, &dpf_qos);
dpf_qos.entity_factory.autoenable_created_entities = DDS_BOOLEAN_FALSE;
DDS_DomainParticipantFactory_set_qos(factory, &dpf_qos);

if (peer == NULL)
{
    peer = "127.0.0.1"; /* default to loopback */
}

if (!RT_Registry_register(registry,
    "dpde",
    DPDE_DiscoveryFactory_get_interface(),
    &discovery_plugin_properties._parent,
    NULL))
{
    printf("failed to register dpde\n");
    goto done;
}

if (!RT_ComponentFactoryId_set_name(&dp_qos.discovery.discovery.name, "dpde"))
{
    printf("failed to set discovery plugin name\n");
    goto done;
}

DDS_StringSeq_set_maximum(&dp_qos.discovery.initial_peers,1);
DDS_StringSeq_set_length(&dp_qos.discovery.initial_peers,1);
*DDS_StringSeq_get_reference(&dp_qos.discovery.initial_peers,0) = DDS_String_
↪dup(peer);

```

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DDS_StringSeq_set_maximum(&dp_qos.discovery.enabled_transports,1);
DDS_StringSeq_set_length(&dp_qos.discovery.enabled_transports,1);

/* Use network interface 192.168.10.232 for discovery. T0 is used for
 * discovery
 */
*DDS_StringSeq_get_reference(&dp_qos.discovery.enabled_transports,0) = DDS_String_
↪dup("_udp://192.168.10.232");

DDS_StringSeq_set_maximum(&dp_qos.user_traffic.enabled_transports,1);
DDS_StringSeq_set_length(&dp_qos.user_traffic.enabled_transports,1);

/* Use network interface 192.168.20.101 for user-data. T1 is used for
 * this interface.
 */
*DDS_StringSeq_get_reference(&dp_qos.user_traffic.enabled_transports,0) = DDS_String_
↪dup("_udp://192.168.20.101");

/* if there are more remote or local endpoints, you need to increase these limits */
dp_qos.resource_limits.max_destination_ports = 32;
dp_qos.resource_limits.max_receive_ports = 32;
dp_qos.resource_limits.local_topic_allocation = 1;
dp_qos.resource_limits.local_type_allocation = 1;
dp_qos.resource_limits.local_reader_allocation = 1;
dp_qos.resource_limits.local_writer_allocation = 1;
dp_qos.resource_limits.remote_participant_allocation = 8;
dp_qos.resource_limits.remote_reader_allocation = 8;
dp_qos.resource_limits.remote_writer_allocation = 8;

application->participant =
    DDS_DomainParticipantFactory_create_participant(factory, domain_id,
                                                    &dp_qos, NULL,
                                                    DDS_STATUS_MASK_NONE);

if (application->participant == NULL)
{
    printf("failed to create participant\n");
    goto done;
}

sprintf(application->type_name, "HelloWorld");
retcode = DDS_DomainParticipant_register_type(application->participant,
                                              application->type_name,
                                              HelloWorldTypePlugin_get());

if (retcode != DDS_RETCODE_OK)
{
    printf("failed to register type: %s\n", "test_type");
    goto done;
}

```

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```

sprintf(application->topic_name, "HelloWorld");
application->topic =
    DDS_DomainParticipant_create_topic(application->participant,
                                       application->topic_name,
                                       application->type_name,
                                       &DDS_TOPIC_QOS_DEFAULT, NULL,
                                       DDS_STATUS_MASK_NONE);

if (application->topic == NULL)
{
    printf("topic == NULL\n");
    goto done;
}

success = DDS_BOOLEAN_TRUE;

done:

if (!success)
{
    if (udp_property != NULL)
    {
        free(udp_property);
    }
    free(application);
    application = NULL;
}

return application;
}

DDS_ReturnCode_t
MyAppApplication_enable(struct MyAppApplication * application)
{
    DDS_Entity *entity;
    DDS_ReturnCode_t retcode;

    entity = DDS_DomainParticipant_as_entity(application->participant);

    retcode = DDS_Entity_enable(entity);
    if (retcode != DDS_RETCODE_OK)
    {
        printf("failed to enable entity\n");
    }

    return retcode;
}

void
MyAppApplication_delete(struct MyAppApplication *application)
{

```

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```

DDS_ReturnCode_t retcode;
RT_Registry_T *registry = NULL;

retcode = DDS_DomainParticipant_delete_contained_entities(application->participant);
if (retcode != DDS_RETCODE_OK)
{
    printf("failed to delete contained entities (retcode=%d)\n",retcode);
}

if (DDS_DomainParticipant_unregister_type(application->participant,
    application->type_name) != HelloWorldTypePlugin_get())
{
    printf("failed to unregister type: %s\n", application->type_name);
    return;
}

retcode = DDS_DomainParticipantFactory_delete_participant(
    DDS_DomainParticipantFactory_get_instance(),
    application->participant);

if (retcode != DDS_RETCODE_OK)
{
    printf("failed to delete participant: %d\n", retcode);
    return;
}

registry = DDS_DomainParticipantFactory_get_registry(
    DDS_DomainParticipantFactory_get_instance());

if (!RT_Registry_unregister(registry, "dpde", NULL, NULL))
{
    printf("failed to unregister dpde\n");
    return;
}
if (!RT_Registry_unregister(registry, DDSHST_READER_DEFAULT_HISTORY_NAME, NULL,
↪NULL))
{
    printf("failed to unregister rh\n");
    return;
}
if (!RT_Registry_unregister(registry, DDSHST_WRITER_DEFAULT_HISTORY_NAME, NULL,
↪NULL))
{
    printf("failed to unregister wh\n");
    return;
}

free(application);

DDS_DomainParticipantFactory_finalize_instance();
}

```

Examples

The following examples illustrate how this feature can be used in a system with a mixture of different types of UDP transport configurations.

For the purpose of the examples, the following terminology is used:

- Plain communication – No transformations have been applied.
- Transformed User Data – Only the user-data is transformed, discovery is plain.
- Transformed Discovery – Only the discovery data is transformed, user-data is plain.
- Transformed Data – Both discovery and user-data are transformed. Unless stated otherwise the transformations are different.

A transformation T_n is a transformation such that an outgoing payload transformed with T_n can be transformed back to its original state by applying T_n to the incoming data.

A network interface can be either physical or virtual.

Plain Communication Between 2 Nodes

In this system two Nodes, A and B, are communicating with plain communication. Node A has one interface, a0, and Node B has one interface, b0.

Node A:

- Register the UDP transport U_a with `allow_interface = a0`.
- `DomainParticipantQos.transports.enabled_transports = "Ua"`
- `DomainParticipantQos.discovery.enabled_transports = "Ua://"`
- `DomainParticipantQos.user_data.enabled_transports = "Ua://"`

Node B:

- Register the UDP transport U_b with `allow_interface = b0`.
- `DomainParticipantQos.transports.enabled_transports = "Ub"`
- `DomainParticipantQos.discovery.enabled_transports = "Ub://"`
- `DomainParticipantQos.user_data.enabled_transports = "Ub://"`

Transformed User Data Between 2 Nodes

In this system two Nodes, A and B, are communicating with transformed user data. Node A has two interfaces, a0 and a1, and Node B has two interfaces, b0 and b1. Since each node has only one peer, a single transformation is sufficient.

Node A:

- Add a destination transformation T_0 to U_{a0} , indicating that all sent data is transformed with T_0 .

- Add a source transformation T1 to Ua0, indicating that all received data is transformed with T1.
- Register the UDP transport Ua0 with `allow_interface = a0`.
- Register the UDP transport Ua1 with `allow_interface = a1`.
- No transformations are registered with Ua1.
- `DomainParticipantQos.transports.enabled_transports = "Ua0","Ua1"`
- `DomainParticipantQos.discovery.enabled_transports = "Ua1://"`
- `DomainParticipantQos.user_traffic.enabled_transports = "Ua0://"`

Node B:

- Add a destination transformation T1 to Ub0, indicating that all sent data is transformed with T1.
- Add a source transformation T0 to Ub0, indicating that all received data is transformed with T0.
- Register the UDP transport Ub0 with `allow_interface = b0`.
- Register the UDP transport Ub1 with `allow_interface = b1`.
- No transformations are registered with Ub1.
- `DomainParticipantQos.transports.enabled_transports = "Ub0","Ub1"`
- `DomainParticipantQos.discovery.enabled_transports = "Ub1://"`
- `DomainParticipantQos.user_traffic.enabled_transports = "Ub0://"`

Ua0 and Ub0 perform transformations and are used for user-data. Ua1 and Ub1 are used for discovery and no transformations takes place.

Transformed Discovery Data Between 2 Nodes

In this system two Nodes, A and B, are communicating with transformed user data. Node A has two interfaces, a0 and a1, and Node B has two interfaces, b0 and b1. Since each node has only one peer, a single transformation is sufficient.

Node A:

- Add a destination transformation T0 to Ua0, indicating that all sent data is transformed with T0.
- Add a source transformation T1 to Ua0, indicating that all received data is transformed with T1.
- Register the UDP transport Ua0 with `allow_interface = a0`.
- Register the UDP transport Ua1 with `allow_interface = a1`.
- No transformations are registered with Ua1.
- `DomainParticipantQos.transports.enabled_transports = "Ua0","Ua1"`

- DomainParticipantQos.discovery.enabled_transports = "Ua0://"
- DomainParticipantQos.user_data.enabled_transports = "Ua1://"

Node B:

- Add a destination transformation T1 to Ub0, indicating that all sent data is transformed with T1.
- Add a source transformation T0 to Ub0, indicating that all received data is transformed with T0.
- Register the UDP transport Ub0 with allow_interface = b0.
- Register the UDP transport Ub1 with allow_interface = b1.
- No transformations are registered with Ub1.
- DomainParticipantQos.transports.enabled_transports = "Ub0","Ub1"
- DomainParticipantQos.discovery.enabled_transports = "Ub0://"
- DomainParticipantQos.user_data.enabled_transports = "Ub1://"

Ua0 and Ub0 perform transformations and are used for discovery. Ua1 and Ub1 are used for user-data and no transformation takes place.

Transformed Data Between 2 Nodes (same transformation)

In this system two Nodes, A and B, are communicating with transformed data using the same transformation for user and discovery data. Node A has one interface, a0, and Node B has one interface, b0.

Node A:

- Add a destination transformation T0 to Ua0, indicating that all sent data is transformed with T0.
- Add a source transformation T1 to Ua0, indicating that all received data is transformed with T1.
- Register the UDP transport Ua0 with allow_interface = a0.
- DomainParticipantQos.transports.enabled_transports = "Ua0"
- DomainParticipantQos.discovery.enabled_transports = "Ua0://"
- DomainParticipantQos.user_data.enabled_transports = "Ua0://"

Node B:

- Add a destination transformation T1 to Ub0, indicating that all sent data is transformed with T1.
- Add a source transformation T0 to Ub0, indicating that all received data is transformed with T0.
- Register the UDP transport Ub0 with allow_interface = b0.

- `DomainParticipantQos.transports.enabled_transports = "Ub0"`
- `DomainParticipantQos.discovery.enabled_transports = "Ub0://"`
- `DomainParticipantQos.user_data.enabled_transports = "Ub0://"`

Ua0 and Ub0 performs transformations and are used for discovery and for user-data.

Transformed Data Between 2 Nodes (different transformations)

In this system two Nodes, A and B, are communicating with transformed data using different transformations for user and discovery data. Node A has two interfaces, a0 and a1, and Node B has two interfaces, b0 and b1.

Node A:

- Add a destination transformation T0 to Ua0, indicating that all sent data is transformed with T0.
- Add a source transformation T1 to Ua0, indicating that all received data is transformed with T1.
- Add a destination transformation T2 to Ua1, indicating that all sent data is transformed with T2.
- Add a source transformation T3 to Ua1, indicating that all received data is transformed with T3.
- Register the UDP transport Ua0 with `allow_interface = a0`.
- Register the UDP transport Ua1 with `allow_interface = a1`.
- `DomainParticipantQos.transports.enabled_transports = "Ua0","Ua1"`
- `DomainParticipantQos.discovery.enabled_transports = "Ua0://"`
- `DomainParticipantQos.user_data.enabled_transports = "Ua1://"`

Node B:

- Add a destination transformation T1 to Ub0, indicating that all sent data is transformed with T1.
- Add a source transformation T0 to Ub0, indicating that all received data is transformed with T0.
- Add a destination transformation T3 to Ub1, indicating that all sent data is transformed with T3.
- Add a source transformation T2 to Ub1, indicating that all received data is transformed with T2.
- Register the UDP transport Ub0 with `allow_interface = b0`.
- Register the UDP transport Ub1 with `allow_interface = b1`.
- `DomainParticipantQos.transports.enabled_transports = "Ub0","Ub1"`
- `DomainParticipantQos.discovery.enabled_transports = "Ub0://"`

- `DomainParticipantQos.user_data.enabled_transports = "Ub1://"`

Ua0 and Ub0 perform transformations and are used for discovery. Ua1 and Ub1 perform transformations and are used for user-data.

OS Configuration

In systems with several network interfaces, *Connex DDS Micro* cannot ensure which network interface should be used to send a packet. Depending on the UDP transformations configured, this might be a problem.

To illustrate this problem, let's assume a system with two nodes, A and B. Node A has two network interfaces, a0 and a1, and Node B has two network interfaces, b0 and b1. In this system, Node A is communicating with Node B using a transformation for discovery and a different transformation for user data.

Node A:

- Add a destination transformation T0 to Ua0, indicating that sent data to b0 is transformed with T0.
- Add a source transformation T1 to Ua0, indicating that received data from b0 is transformed with T1.
- Add a destination transformation T2 to Ua1, indicating that sent data to b1 is transformed with T2.
- Add a source transformation T3 to Ua1, indicating that received data from b1 is transformed with T3.
- Register the UDP transport Ua0 with `allow_interface = a0`.
- Register the UDP transport Ua1 with `allow_interface = a1`.
- `DomainParticipantQos.transports.enabled_transports = "Ua0","Ua1"`
- `DomainParticipantQos.discovery.enabled_transports = "Ua0://"`
- `DomainParticipantQos.user_data.enabled_transports = "Ua1://"`

Node B:

- Add a destination transformation T1 to Ub0, indicating that sent data to a0 is transformed with T1.
- Add a source transformation T0 to Ub0, indicating that received data from a0 transformed with T0.
- Add a destination transformation T3 to Ub1, indicating that sent data to a1 is transformed with T3.
- Add a source transformation T2 to Ub1, indicating that received data from a1 transformed with T2.
- Register the UDP transport Ub0 with `allow_interface = b0`.
- Register the UDP transport Ub1 with `allow_interface = b1`.

- `DomainParticipantQos.transports.enabled_transports = "Ub0","Ub1"`
- `DomainParticipantQos.discovery.enabled_transports = "Ub0://"`
- `DomainParticipantQos.user_data.enabled_transports = "Ub1://"`

Node A sends a discovery packet to Node B to interface b0. This packet will be transformed using T0 as specified by Node A's configuration. When this packet is received in Node B, it will be transformed using either T0 or T2 depending on the source address. Node's A OS will use a0 or a1 to send this packet but *Connex DDS Micro* cannot ensure which one will be used. In case the OS sends the packet using a1, the wrong transformation will be applied in Node B.

Some systems have the possibility to configure the source address that should be used when a packet is sent. In POSIX systems, the command `ip route add <string> dev <interface>` can be used.

By typing the command `ip route add < b0 ip >/32 dev a0` in Node A, the OS will send all packets to Node B's b0 IP address using interface a0. This would ensure that the correct transformation is applied in Node B. The same should be done to ensure that user data is sent with the right address `ip route add < b1 ip >/32 dev a1`. Of course, similar configuration is needed in Node B.

4.8 Discovery

This section discusses the implementation of discovery plugins in *RTI Connex DDS Micro*. For a general overview of discovery in *RTI Connex DDS Micro*, see *What is Discovery?*.

Connex DDS Micro discovery traffic is conducted through transports. Please see the *Transports* section for more information about registering and configuring transports.

4.8.1 What is Discovery?

Discovery is the behind-the-scenes way in which *RTI Connex DDS Micro* objects (*DomainParticipants*, *DataWriters*, and *DataReaders*) on different nodes find out about each other. Each *DomainParticipant* maintains a database of information about all the active *DataReaders* and *DataWriters* that are in the same DDS domain. This database is what makes it possible for *DataWriters* and *DataReaders* to communicate. To create and refresh the database, each application follows a common discovery process.

This section describes the default discovery mechanism known as the Simple Discovery Protocol, which includes two phases: *Simple Participant Discovery* and *Simple Endpoint Discovery*.

The goal of these two phases is to build, for each *DomainParticipant*, a complete picture of all the entities that belong to the remote participants that are in its peers list. The peers list is the list of nodes with which a participant may communicate. It starts out the same as the *initial_peers* list that you configure in the **DISCOVERY** QosPolicy. If the `accept_unknown_peers` flag in that same QosPolicy is TRUE, then other nodes may also be added as they are discovered; if it is FALSE, then the peers list will match the *initial_peers* list, plus any peers added using the *DomainParticipant's* `add_peer()` operation.

The following section discusses how *Connex DDS Micro* objects on different nodes find out about each other using the default Simple Discovery Protocol (SDP). It describes the sequence of messages

that are passed between *Connex DDS Micro* on the sending and receiving sides.

The discovery process occurs automatically, so you do not have to implement any special code. For more information about advanced topics related to Discovery, please refer to the Discovery chapter in the *RTI Connex DDS Core Libraries User's Manual* (available [here](#) if you have Internet access).

Simple Participant Discovery

This phase of the Simple Discovery Protocol is performed by the Simple Participant Discovery Protocol (SPDP).

During the Participant Discovery phase, *DomainParticipants* learn about each other. The *DomainParticipant's* details are communicated to all other *DomainParticipants* in the same DDS domain by sending participant declaration messages, also known as participant *DATA* submessages. The details include the *DomainParticipant's* unique identifying key (GUID or Globally Unique ID described below), transport locators (addresses and port numbers), and QoS. These messages are sent on a periodic basis using best-effort communication.

Participant DATAs are sent periodically to maintain the liveliness of the *DomainParticipant*. They are also used to communicate changes in the *DomainParticipant's* QoS. Only changes to QoS Policies that are part of the *DomainParticipant's* built-in data need to be propagated.

When receiving remote participant discovery information, *RTI Connex DDS Micro* determines if the local participant matches the remote one. A 'match' between the local and remote participant occurs only if the local and remote participant have the same Domain ID and Domain Tag. This matching process occurs as soon as the local participant receives discovery information from the remote one. If there is no match, the discovery *DATA* is ignored, resulting in the remote participant (and all its associated entities) not being discovered.

When a *DomainParticipant* is deleted, a participant *DATA (delete)* submessage with the *DomainParticipant's* identifying GUID is sent.

The GUID is a unique reference to an entity. It is composed of a GUID prefix and an Entity ID. By default, the GUID prefix is calculated from the IP address and the process ID. The entityID is set by *Connex DDS Micro* (you may be able to change it in a future version).

Once a pair of remote participants have discovered each other, they can move on to the Endpoint Discovery phase, which is how *DataWriters* and *DataReaders* find each other.

Simple Endpoint Discovery

This phase of the Simple Discovery Protocol is performed by the Simple Endpoint Discovery Protocol (SEDP).

During the Endpoint Discovery phase, *RTI Connex DDS Micro* matches *DataWriters* and *DataReaders*. Information (GUID, QoS, etc.) about your application's *DataReaders* and *DataWriters* is exchanged by sending publication/subscription declarations in *DATA* messages that we will refer to as *publication DATAs* and *subscription DATAs*. The Endpoint Discovery phase uses reliable communication.

These declaration or *DATA* messages are exchanged until each *DomainParticipant* has a complete database of information about the participants in its peers list and their entities. Then the discovery process is complete and the system switches to a steady state. During steady state, *participant*

DATAs are still sent periodically to maintain the liveness status of participants. They may also be sent to communicate QoS changes or the deletion of a *DomainParticipant*.

When a remote *DataWriter/DataReader* is discovered, *Connex DDS Micro* determines if the local application has a matching *DataReader/DataWriter*. A ‘match’ between the local and remote entities occurs only if the *DataReader* and *DataWriter* have the same *Topic*, same data type, and compatible QoS Policies. Furthermore, if the *DomainParticipant* has been set up to ignore certain *DataWriters/DataReaders*, those entities will not be considered during the matching process.

This ‘matching’ process occurs as soon as a remote entity is discovered, even if the entire database is not yet complete: that is, the application may still be discovering other remote entities.

A *DataReader* and *DataWriter* can only communicate with each other if each one’s application has hooked up its local entity with the matching remote entity. That is, both sides must agree to the connection.

Please refer to the section on Discovery Implementation in the *RTI Connex DDS Core Libraries User’s Manual* for more details about the discovery process (available [here](#) if you have Internet access).

4.8.2 Configuring Participant Discovery Peers

An *RTI Connex DDS Micro DomainParticipant* must be able to send participant discovery announcement messages for other *DomainParticipants* to discover itself, and it must receive announcements from other *DomainParticipants* to discover them.

To do so, each *DomainParticipant* will send its discovery announcements to a set of locators known as its peer list, where a peer is the transport locator of one or more potential other *DomainParticipants* to discover.

peer_desc_string

A peer descriptor string of the [initial_peers](#) string sequence conveys the interface and address of the locator to which to send, as well as the indices of participants to which to send. For example:

```
DDS_StringSeq_set_maximum(&dp_qos.discovery.initial_peers, 3);
DDS_StringSeq_set_length(&dp_qos.discovery.initial_peers, 3);

*DDS_StringSeq_get_reference(&dp_qos.discovery.initial_peers, 0) =
    DDS_String_dup("_udp://239.255.0.1");

*DDS_StringSeq_get_reference(&dp_qos.discovery.initial_peers, 1) =
    DDS_String_dup("[1-4]@_udp://10.10.30.101");

*DDS_StringSeq_get_reference(&dp_qos.discovery.initial_peers, 2) =
    DDS_String_dup("[2]@_udp://10.10.30.102");
```

The peer descriptor format is:

```
[index@][interface://]address
```

Remember that every *DomainParticipant* has a participant index that is unique within a DDS domain. The participant index (also referred to as the participant ID), together with the DDS

domain ID, is used to calculate the network port on which *DataReaders* of that participant will receive messages. Thus, by specifying the participant index, or a range of indices, for a peer locator, that locator becomes a port to which messages will be sent only if addressed to the entities of a particular *DomainParticipant*. Specifying indices restricts the number of participant announcements sent to a locator where other *DomainParticipants* exist and, thus, should be considered to minimize network bandwidth usage.

In the above example, the first peer, “_udp://239.255.0.1,” has the default UDPv4 multicast peer locator. Note that there is no [index@] associated with a multicast locator.

The second peer, “[1-4]@_udp://10.10.30.101,” has a unicast address. It also has indices in brackets, [1-4]. These represent a range of participant indices, 1 through 4, to which participant discovery messages will be sent.

Lastly, the third peer, “[2]@_udp://10.10.30.102,” is a unicast locator to a single participant with index 2.

4.8.3 Configuring Initial Peers and Adding Peers

[DiscoveryQosPolicy_initial_peers](#) is the list of peers a *DomainParticipant* sends its participant announcement messages, when it is enabled, as part of the discovery process.

[DiscoveryQosPolicy_initial_peers](#) is an empty sequence by default, so while [DiscoveryQosPolicy_enabled_transports](#) by default includes the DDS default loopback and multicast (239.255.0.1) addresses, [initial_peers](#) must be configured to include them.

Peers can also be added to the list, before and after a *DomainParticipant* has been enabled, by using [DomainParticipant_add_peer](#).

The *DomainParticipant* will start sending participant announcement messages to the new peer as soon as it is enabled.

4.8.4 Discovery Plugins

When a *DomainParticipant* receives a participant discovery message from another *DomainParticipant*, it will engage in the process of exchanging information of user-created *DataWriter* and *DataReader* endpoints.

RTI Connext DDS Micro provides two ways of determining endpoint information of other *DomainParticipants*: *Dynamic Discovery Plugin* and *Static Discovery Plugin*.

Dynamic Discovery Plugin

Dynamic endpoint discovery uses builtin discovery *DataWriters* and *DataReader* to exchange messages about user created *DataWriter* and *DataReaders*. A *DomainParticipant* using dynamic participant, dynamic endpoint (DPDE) discovery will have a pair of builtin *DataWriters* for sending messages about its own user created *DataWriters* and *DataReaders*, and a pair of builtin *DataReaders* for receiving messages from other *DomainParticipants* about their user created *DataWriters* and *DataReaders*.

Given a *DomainParticipant* with a user *DataWriter*, receiving an endpoint discovery message for a user *DataReader* allows the *DomainParticipant* to get the type, topic, and QoS of the *DataReader* that determine whether the *DataReader* is a match. When a matching *DataReader* is discovered,

the *DataWriter* will include that *DataReader* and its locators as destinations for its subsequent writes.

Static Discovery Plugin

Static endpoint discovery uses function calls to statically assert information about remote endpoints belonging to remote *DomainParticipants*. An application with a *DomainParticipant* using dynamic participant, static endpoint (DPSE) discovery has control over which endpoints belonging to particular remote *DomainParticipants* are discoverable.

Whereas dynamic endpoint-discovery can establish matches for all endpoint-discovery messages it receives, static endpoint-discovery establishes matches only for the endpoint that have been asserted programmatically.

With DPSE, a user needs to know *a priori* the configuration of the entities that will need to be discovered by its application. The user must know the names of all *DomainParticipants* within the DDS domain and the exact QoS of the remote *DataWriters* and *DataReaders*.

Please refer to the [C API Reference](#) and [C++ API Reference](#) for the following remote entity assertion APIs:

- [DPSE_RemoteParticipant_assert](#)
- [DPSE_RemotePublication_assert](#)
- [DPSE_RemoteSubscription_assert](#)

Remote Participant Assertion

Given a local *DomainParticipant*, static discovery requires first the names of remote *DomainParticipants* to be asserted, in order for endpoints on them to match. This is done by calling [DPSE_RemoteParticipant_assert](#) with the name of a remote *DomainParticipant*. The name must match the name contained in the participant discovery announcement produced by that *DomainParticipant*. This has to be done reciprocally between two *DomainParticipants* so that they may discover one another.

For example, a *DomainParticipant* has entity name “participant_1”, while another *DomainParticipant* has name “participant_2.” participant_1 should call [DPSE_RemoteParticipant_assert](#)(“participant_2”) in order to discover participant_2. Similarly, participant_2 must also assert participant_1 for discovery between the two to succeed.

```

/* participant_1 is asserting (remote) participant_2 */
retcode = DPSE_RemoteParticipant_assert(participant_1,
                                       "participant_2");
if (retcode != DDS_RETCODE_OK) {
    printf("participant_1 failed to assert participant_2\n");
    goto done;
}

```

Remote Publication and Subscription Assertion

Next, a *DomainParticipant* needs to assert the remote endpoints it wants to match that belong to an already asserted remote *DomainParticipant*. The endpoint assertion function is used, specifying an argument which contains all the QoS and configuration of the remote endpoint. Where *DPDE* gets remote endpoint QoS information from received endpoint-discovery messages, in *DPSE*, the remote endpoint's QoS must be configured locally. With remote endpoints asserted, the *DomainParticipant* then waits until it receives a participant discovery announcement from an asserted remote *DomainParticipant*. Once received that, all endpoints that have been asserted for that remote *DomainParticipant* are considered discovered and ready to be matched with local endpoints.

Assume *participant_1* contains a *DataWriter*, and *participant_2* has a *DataReader*, both communicating on topic *HelloWorld*. *participant_1* needs to assert the *DataReader* in *participant_2* as a remote subscription. The remote subscription data passed to the operation must match exactly the QoS actually used by the remote *DataReader*:

```
/* Set participant_2's reader's QoS in remote subscription data */
rem_subscription_data.key.value[DDS_BUILTIN_TOPIC_KEY_OBJECT_ID] = 200;
rem_subscription_data.topic_name = DDS_String_dup("Example HelloWorld");
rem_subscription_data.type_name = DDS_String_dup("HelloWorld");
rem_subscription_data.reliability.kind = DDS_RELIABLE_RELIABILITY_QOS;

/* Assert reader as a remote subscription belonging to (remote) participant_2 */
retcode = DPSE_RemoteSubscription_assert(participant_1,
                                         "participant_2",
                                         &rem_subscription_data,
                                         HelloWorld_get_key_kind(HelloWorldTypePlugin_
↳get(), NULL));
if (retcode != DDS_RETCODE_OK)
{
    printf("failed to assert remote subscription\n");
    goto done;
}
```

Reciprocally, *participant_2* must assert *participant_1*'s *DataWriter* as a remote publication, also specifying matching QoS parameters:

```
/* Set participant_1's writer's QoS in remote publication data */
rem_publication_data.key.value[DDS_BUILTIN_TOPIC_KEY_OBJECT_ID] = 100;
rem_publication_data.key.value.topic_name = DDS_String_dup("Example HelloWorld");
rem_publication_data.key.value.type_name = DDS_String_dup("HelloWorld");
rem_publication_data.key.value.reliability.kind = DDS_RELIABLE_RELIABILITY_QOS;

/* Assert writer as a remote publication belonging to (remote) participant_1 */
retcode = DPSE_RemotePublication_assert(participant_2,
                                         "participant_1",
                                         &rem_publication_data,
                                         HelloWorld_get_key_kind(HelloWorldTypePlugin_
↳get(), NULL));
if (retcode != DDS_RETCODE_OK)
{
    printf("failed to assert remote publication\n");
}
```

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```
    goto done;
}
```

When participant_1 receives a participant discovery message from participant_2, it is aware of participant_2, based on its previous assertion, and it knows participant_2 has a matching *DataReader*, also based on the previous assertion of the remote endpoint. It therefore establishes a match between its *DataWriter* and participant_2's *DataReader*. Likewise, participant_2 will match participant_1's *DataWriter* with its local *DataReader*, upon receiving one of participant_1's participant discovery messages.

Note, with [DPSE](#), there is no runtime check of QoS consistency between *DataWriters* and *DataReaders*, because no endpoint discovery messages are exchanged. This makes it extremely important that users of [DPSE](#) ensure that the QoS set for a local *DataWriter* and *DataReader* is the same QoS being used by another *DomainParticipant* to assert it as a remote *DataWriter* or *DataReader*.

4.9 Generating Type Support with rtiddsgen

4.9.1 Why Use rtiddsgen?

For *Connex DDS Micro* to publish and subscribe to topics of user-defined types, the types have to be defined and programmatically registered with *Connex DDS Micro*. A registered type is then serialized and deserialized by *Connex DDS Micro* through a pluggable type interface that each type must implement.

Rather than have users manually implement each new type, *Connex DDS Micro* provides the *rtiddsgen* utility for automatically generating type support code.

4.9.2 IDL Type Definition

rtiddsgen for *Connex DDS Micro* accepts types defined in IDL. The HelloWorld examples included with *Connex DDS Micro* use the following HelloWorld.idl:

```
struct HelloWorld {
    string<128> msg;
};
```

For further reference, see the section on Creating User Data Types with IDL in the *RTI Connex DDS Core Libraries User's Manual* (available [here](#) if you have Internet access).

4.9.3 Generating Type Support

Before running *rtiddsgen*, some environment variables must be set:

- `RTIMEHOME` sets the path of the *Connex DDS Micro* installation directory
- `RTIMEARCH` sets the platform architecture (e.g. `i86Linux2.6gcc4.4.5` or `i86Win32VS2010`)
- `JREHOME` sets the path for a Java JRE

Note that a JRE is shipped with *Connex DDS Micro* on platforms supported for the execution of *rtiddsgen* (Linux, Windows, and Mac® OS X®). It is not necessary to set `JREHOME` on these platforms, unless a specific JRE is preferred.

C

Run *rtiddsgen* from the command line to generate C language type-support for a `UserType.idl` (and replace any existing generated files):

```
> cd $rti_connex_micro_root/rtiddsgen/scripts
> rtiddsgen -micro -language C -replace UserType.idl
```

C++

Run *rtiddsgen* from the command line to generate C++ language type-support for a `UserType.idl` (and replace any existing generated files):

```
> cd $rti_connex_micro_root/rtiddsgen/scripts
> rtiddsgen -micro -language C++ -replace UserType.idl
```

Notes on Command-Line Options

In order to target *Connex DDS Micro* when generating code with *rtiddsgen*, the `-micro` option must be specified on the command line.

To list all command-line options specifically supported by *rtiddsgen* for *Connex DDS Micro*, enter:

```
> cd $rti_connex_micro_root/rtiddsgen/scripts
> rtiddsgen -micro -help
```

Existing users might notice that that previously available options, `-language microC` and `-language microC++`, have been replaced by `-micro -language C` and `-micro -language C++`, respectively. It is still possible to specify `microC` and `microC++` for backwards compatibility, but users are advised to switch to using the `-micro` command-line option along with other arguments.

Generated Type Support Files

rtiddsgen will produce the following header and source files for each IDL file passed to it:

- `UserType.h` and `UserType.c(xx)` implement creation/initialization and deletion of a single sample and a sequence of samples of the type (or types) defined in the IDL description.
- `UserTypePlugin.h` and `UserTypePlugin.c(xx)` implement the pluggable type interface that *Connex DDS Micro* uses to serialize and deserialize the type.
- `UserTypeSupport.h` and `UserTypeSupport.c(xx)` define type-specific *DataWriters* and *DataReaders* for user-defined types.

4.9.4 Using custom data-types in Connex DDS Micro Applications

A *Connex DDS Micro* application must first of all include the generated headers. Then it must register the type with the *DomainParticipant* before a topic of that type can be defined. For

an example HelloWorld type, the following code registers the type with the participant and then creates a topic of that type:

```
#include "HelloWorldPlugin.h"

/* ... */

retcode = DDS_DomainParticipant_register_type(application->participant,
                                             "HelloWorld",
                                             HelloWorldTypePlugin_get());

if (retcode != DDS_RETCODE_OK)
{
    /* Log an error */
    goto done;
}

application->topic =
    DDS_DomainParticipant_create_topic(application->participant,
                                       "Example HelloWorld",
                                       "HelloWorld",
                                       &DDS_TOPIC_QOS_DEFAULT, NULL,
                                       DDS_STATUS_MASK_NONE);

if (application->topic == NULL)
{
    /* Log an error */
    goto done;
}
```

See the full HelloWorld examples for further reference.

4.9.5 Customizing generated code

rtiddsgen allows *Connex DDS Micro* users to select whether they want to generate code to subscribe to and/or publish a custom data-type. When generating code for subscriptions, only those parts of code dealing with deserialization of data and the implementation of a typed *DataReader* endpoint are generated. Conversely, only those parts of code addressing serialization and the implementation of a *DataWriter* are considered when generating publishing code.

Control over these options is provide by two command-line arguments:

- **-reader** generates code for deserializing custom data-types and creating *DataReaders* from them.
- **-writer** generates code for serializing custom data-types and creating *DataWriters* from them.

If neither of these two options are supplied to *rtiddsgen*, they will both be considered active and code for both *DataReaders* and *DataWriters* will be generated. If only one of the two options is supplied to *rtiddsgen*, only that one is enabled. If both options are supplied, both are enabled.

4.9.6 Unsupported Features of rtiddsgen with Connex DDS Micro

Connex DDS Micro supports a subset of the features and options in *rtiddsgen*. Use `rtiddsgen -micro -help` to see the list of features supported by *rtiddsgen* for *Connex DDS Micro*.

4.10 Threading Model

4.10.1 Introduction

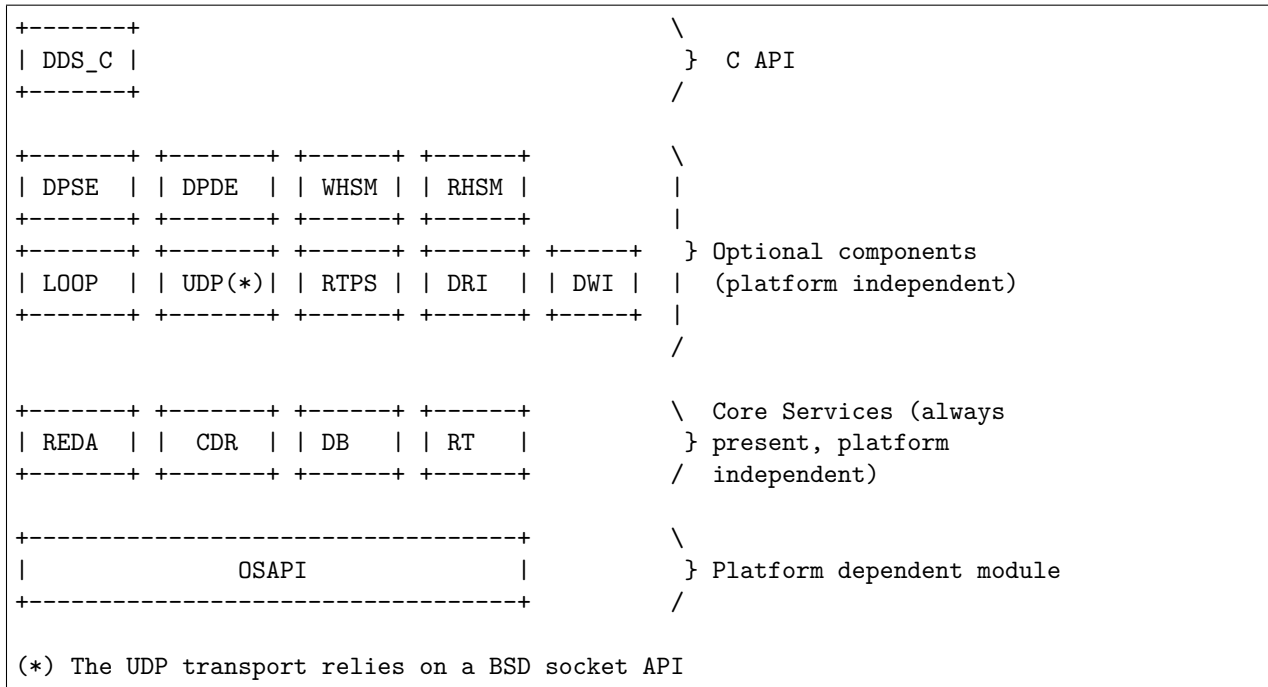
This section describes the threading model, the use of critical sections, and how to configure thread parameters in *RTI Connex DDS Micro*. Please note that the information contained in this document applies to application development using *Connex DDS Micro*. For information regarding *porting* the *Connex DDS Micro* thread API to a new OS, please refer to *Porting RTI Connex DDS Micro*.

This section includes:

- *Architectural Overview*
- *Threading Model*
- *UDP Transport Threads*

4.10.2 Architectural Overview

RTI Connex DDS Micro consists of a core library and a number of components. The core library provides a porting layer, frequently used data-structures and abstractions, and the DDS API. Components provide additional functionality such as UDP communication, DDS discovery plugins, DDS history caches, etc.



4.10.3 Threading Model

RTI Connex DDS Micro is architected in a way that makes it possible to create a port of *Connex DDS Micro* that uses no threads, for example on platforms with no operating system. Thus, the following discussion can only be guaranteed to be true for *Connex DDS Micro* libraries from RTI.

OSAPI Threads

The *Connex DDS Micro* OSAPI layer creates one thread per OS process. This thread manages all the *Connex DDS Micro* timers, such as deadline and liveliness timers. This thread is created by the *Connex DDS Micro* OSAPI System when the `OSAPI_System_initialize()` function is called. When the *Connex DDS Micro* DDS API is used `DomainParticipantFactory_get_instance()` calls this function once.

Configuring OSAPI Threads

The timer thread is configured through the `OSAPI_SystemProperty` structure and any changes must be made before `OSAPI_System_initialize()` is called. In *Connex DDS Micro*, `DomainParticipantFactory_get_instance()` calls `OSAPI_System_initialize()`. Thus, if it is necessary to change the system timer thread settings, it must be done before `DomainParticipantFactory_get_instance()` is called the first time.

Please refer to `OSAPI_Thread` for supported thread options. Note that not all options are supported by all platforms.

```

struct OSAPI_SystemProperty sys_property = OSAPI_SystemProperty_INITIALIZER;

if (!OSAPI_System_get_property(&sys_property))
{
    /* ERROR */
}

/* Please refer to OSAPI_ThreadOptions for possible options */
sys_property.timer_property.thread.options = ....;

/* The stack-size is platform dependent, it is passed directly to the OS */
sys_property.timer_property.thread.stack_size = ....

/* The priority is platform dependent, it is passed directly to the OS */
sys_property.timer_property.thread.priority = ....

if (!OSAPI_System_set_property(&sys_property))
{
    /* ERROR */
}

```

UDP Transport Threads

Of the components that RTI provides, only the UDP component creates threads. The UDP transport creates one receive thread for each unique UDP receive address and port. Thus, three UDP threads are created by default:

- A multicast receive thread for discovery data (assuming multicast is available and enabled)
- A unicast receive thread for discovery data
- A unicast receive thread for user-data

Additional threads may be created depending on the transport configuration for a *DomainParticipant*, *DataReader* and *DataWriter*. The UDP transport creates threads based on the following criteria:

- Each unique unicast port creates a new thread
- Each unique multicast address *and* port creates a new thread

For example, if a *DataReader* specifies its own multicast receive address a new receive thread will be created.

Configuring UDP Receive Threads

All threads in the UDP transport share the same thread settings. It is important to note that all the UDP properties must be set before the UDP transport is registered. *Connex DDS Micro* pre-registers the UDP transport with default settings when the [DomainParticipantFactory](#) is initialized. To change the UDP thread settings, use the following code.

```
RT_Registry_T *registry = NULL;
DDS_DomainParticipantFactory *factory = NULL;
struct UDP_InterfaceFactoryProperty *udp_property = NULL;

factory = DDS_DomainParticipantFactory_get_instance();

udp_property = (struct UDP_InterfaceFactoryProperty *)
    malloc(sizeof(struct UDP_InterfaceFactoryProperty));
*udp_property = UDP_INTERFACE_FACTORY_PROPERTY_DEFAULT;

registry = DDS_DomainParticipantFactory_get_registry(factory);

if (!RT_Registry_unregister(registry, "_udp", NULL, NULL))
{
    /* ERROR */
}

/* Please refer to OSAPI_ThreadOptions for possible options */
udp_property->recv_thread.options = ...;

/* The stack-size is platform dependent, it is passed directly to the OS */
udp_property->recv_thread.stack_size = ....

/* The priority is platform dependent, it is passed directly to the OS */
udp_property->recv_thread.priority = ....

if (!RT_Registry_register(registry, "_udp",
    UDP_InterfaceFactory_get_interface(),
    (struct RT_ComponentFactoryProperty*)udp_property,
    NULL))
```

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```
{  
    /* ERROR */  
}
```

General Thread Configuration

The *Connex DDS Micro* architecture consists of a number of components and layers, and each layer and component has its own properties. It is important to remember that the layers and components are configured independently of each other, as opposed to configuring everything through DDS. This design makes it possible to relatively easily swap out one part of the library for another.

All threads created based on *Connex DDS Micro* OSAPI APIs use the same [OSAPI_ThreadProperty](#) structure.

4.10.4 Critical Sections

RTI Connex DDS Micro may create multiple threads, but from an application point of view there is only a single critical section protecting all DDS resources. Note that although *Connex DDS Micro* may create multiple mutexes, these are used to protect resources in the OSAPI layer and are thus not relevant when using the public DDS APIs.

Calling DDS APIs from listeners

When DDS is executing in a listener, it holds a critical section. Thus it is important to return as quickly as possible to avoid stalling network I/O.

There are no deadlock scenarios when calling *Connex DDS Micro* DDS APIs from a listener. However, there are no checks on whether or not an API call will cause problems, such as deleting a participant when processing data in [on_data_available](#) from a reader within the same participant.

4.11 Batching

This section is organized as follows:

- *Overview*
- *Interoperability*
- *Performance*
- *Example Configuration*

4.11.1 Overview

Batching refers to a mechanism that allows *RTI Connex DDS Micro* to collect multiple user data DDS samples to be sent in a single network packet, to take advantage of the efficiency of sending larger packets and thus increase effective throughput.

Connex DDS Micro supports receiving batches of user data DDS samples, but does not support any mechanism to collect and send batches of user data.

Receiving batches of user samples is transparent to the application, which receives the samples as if the samples had been received one at a time. Note though that the reception sequence number refers to the sample sequence number, not the RTPS sequence number used to send RTPS messages. The RTPS sequence number is the batch sequence number for the entire batch.

A *Connex DDS Micro DataReader* can receive both batched and non-batched samples.

For a more detailed explanation, please refer to the BATCH QoS Policy section in the *RTI Connex DDS Core Libraries User's Manual* (available [here](#) if you have Internet access).

4.11.2 Interoperability

RTI Connex DDS Professional supports both sending and receiving batches, whereas *RTI Connex DDS Micro* supports only receiving batches. Thus, this feature primarily exists in *Connex DDS Micro* to interoperate with *RTI Connex DDS* applications that have enabled batching. An *Connex DDS Micro DataReader* can receive both batched and non-batched samples.

4.11.3 Performance

The purpose of batching is to increase throughput when writing small DDS samples at a high rate. In such cases, throughput can be increased several-fold, approaching much more closely the physical limitations of the underlying network transport.

However, collecting DDS samples into a batch implies that they are not sent on the network immediately when the application writes them; this can potentially increase latency. But, if the application sends data faster than the network can support, an increased proportion of the network's available bandwidth will be spent on acknowledgements and DDS sample resends. In this case, reducing that overhead by turning on batching could decrease latency while increasing throughput.

4.11.4 Example Configuration

This section includes several examples that explain how to enable batching in *RTI Connex DDS Professional*. For more detailed and advanced configuration, please refer to the *RTI Connex DDS Core Libraries User's Manual*.

- This configuration ensures that a batch will be sent with a maximum of 10 samples:

```
<datawriter_qos>
  <publication_name>
    <name>HelloWorldDataWriter</name>
  </publication_name>
  <batch>
    <enable>true</enable>
    <max_samples>10</max_samples>
  </batch>
</datawriter_qos>
```

- This configuration ensures that a batch is automatically flushed after the delay specified by `max_flush_delay`. The delay is measured from the time the first sample in the batch is written by the application:

```

<datawriter_qos>
  <publication_name>
    <name>HelloWorldDataWriter</name>
  </publication_name>
  <batch>
    <enable>true</enable>
    <max_flush_delay>
      <sec>1</sec>
      <nanosec>0</nanosec>
    </max_flush_delay>
  </batch>
</datawriter_qos>

```

- The following configuration ensures that a batch is flushed automatically when `max_data_bytes` is reached (in this example 8192).

```

<datawriter_qos>
  <publication_name>
    <name>HelloWorldDataWriter</name>
  </publication_name>
  <batch>
    <enable>true</enable>
    <max_data_bytes>8192</max_data_bytes>
  </batch>
</datawriter_qos>

```

Note that `max_data_bytes` does not include the metadata associated with the batch samples.

Batches must contain whole samples. If a new batch is started and its initial sample causes the serialized size to exceed `max_data_bytes`, *RTI Connex DDS Professional* will send the sample in a single batch.

4.12 Sending Large Data

Connex DDS Micro supports transmission and reception of data types that exceed the maximum message size of a transport. This section describes the behavior and the configuration options.

This section includes:

- *Overview*
- *Configuration of Large Data*
- *Limitations*

4.12.1 Overview

Connex DDS Micro supports transmission and reception of data samples that exceed the maximum message size of a transport. For example, UDP supports a maximum user payload of 65507 bytes. In order to send samples larger than 65507 bytes, *Connex DDS Micro* must split the sample into multiple UDP payloads.

When a sample larger than the transport size is sent, *Connex DDS Micro* splits the sample into fragments and starts sending fragments based on a flow-control algorithm. A bandwidth allocation parameters on the *DataWriter* and the scheduling rate determined how frequent and how much data can be sent each period.

When a sample is received in multiple fragments, the receiver reassembles the each fragment into a complete serialized sample. The serialized data is then de-serialized and made available to the user as regular data.

When working with large data, it is important to keep the following in mind:

- Fragmentation is always enabled.
- Fragmentation is per *DataWriter*.
- Flow-control is per *DataWriter*. *It is important to keep this in mind since in `|rti_core_prof|` the flow-controller works accross all `*DataWriters` in the same publisher.*
- Fragmentation is on a per sample basis. That is, two samples of the same type may lead to fragmentation of one sample, but not the other. The application is never exposed to fragments.
- It is the *DataWriters* that determines the fragmentation size, and different *DataWriters* can use different fragmentation sizes for the same type.
- All fragments must be received before a sample can be re-constructed. When using best-effort, if a fragment is lost, the entire sample is lost. When using reliability, a fragment that is not received may be resent. If a fragment is no longer available, the entire sample is dropped.
- If one of the DDS `write()` APIs are called too fast when writing large samples, *Connex DDS Micro* may run out of resources. This is because sample may take a long time to send, and resources are not freed until the complete sample has been sent.

It is important to distinguish between the following concepts:

- Fragmentation by *Connex DDS Micro*
- Fragmentation by an underlying transport, e.g. IP fragmentation when UDP datagrams exceeds about 1488 bytes.
- The maximum transmit message size of the sender. This is the maximum size of any payload going over the transport.
- The maximum transport transmit buffer size of the sender. This is the maximum number of bytes that can be stored by the transport.
- The maximum receive message size of a receiver. This is the maximum size of a single payload on a transport.
- The maximum receive buffer size of a receiver. This is the maximum number of bytes which can be received.

4.12.2 Configuration of Large Data

For a general overview of writing large data, please refer to these sections in the *RTI Connex DDS Core Libraries User's Manual*:

- the ASYNCHRONOUS_PUBLISHER QoS Policy section (available [here](#) if you have Internet access)
- the FlowControllers section (available [here](#) if you have Internet access)

NOTE: *Connex DDS Micro* only supports the default FlowController.

Asynchronous publishing is handled by a separate thread that runs at a fixed rate. The rate and properties of this thread can be adjusted in the OSAPI_SystemProperty and the following fields before `DomainParticipantFactory_get_instance()` is called.

```

struct OSAPI_SystemProperty sys_property = OSAPI_SystemProperty_INITIALIZER;
DDS_DomainParticipantFactory *factory = NULL;

if (!OSAPI_System_get_property(&sys_property))
{
    /* error */
}

sys_property.task_scheduler.thread.stack_size = ....
sys_property.task_scheduler.thread.options = ....
sys_property.task_scheduler.thread.priority = ....
sys_property.task_scheduler.rate = rate in nanosec;

if (!OSAPI_System_set_property(&sys_property))
{
    /* error */
}

factory = DDS_DomainParticipantFactory_get_instance();

....

```

4.12.3 Limitations

The following are known limitations and issues with Large Data support:

- It is not possible to disable fragmentation support.
- The scheduler thread accuracy is based on the operating system.

4.13 Zero Copy Transfer Over Shared Memory

This section is organized as follows:

- *Overview*
- *Getting Started*
- *Synchronization of Zero Copy Samples*
- *Caveats*
- *Further Information*

4.13.1 Overview

Zero Copy transfer over shared memory allows large samples to be transmitted with a minimum number of copies. These samples reside in a shared memory region accessible from multiple processes. When creating a [FooDataWriter](#) that supports Zero Copy Transfer of user samples, a sample must be created with a new non-DDS API (`FooDataWriter__get_loan(...)`). This will return a pointer A^* to a sample **Foo** that lies inside a shared memory segment. A reference to this sample will be sent to a receiving [FooDataReader](#) across the shared memory. This [FooDataReader](#) will attach to a shared memory segment and a pointer B^* to sample **Foo** will be presented to the user. Because the two processes shared different memory spaces, A^* and B^* will be different but they will point to the same place in RAM.

This feature requires the usage of new RTI DDS Extension APIs:

- `FooDataWriter__get_loan()`
- `FooDataWriter__discard_loan()`
- `FooDataReader__is_data_consistent()`

For detailed information, see the [C API Reference](#) and [C++ API Reference](#).

4.13.2 Getting Started

To enable Zero Copy transfer over shared memory, follow these steps:

1. Annotate your type with the `@transfer_mode(SHMEM_REF)` annotation. Currently, variable-length types (strings and sequences) are not supported for types using this transfer mode when the language binding is INBAND.

```
@transfer_mode(SHMEM_REF)
struct HelloWorld {
    long id;
    char raw_image_data[1024 * 1024]; // 1 MB
};
```

2. Register the Shared Memory Transport (see *Registering the SHMEM Transport*). References will be sent across the shared memory transport.
3. Create a [FooDataWriter](#) for the above type.
4. Get a loan on a sample using `FooDataWriter__get_loan()`.
5. Write a sample using `FooDataWriter__write()`.

For more information, see the example `HelloWorld_zero_copy`, or generate an example for a type annotated with `@transfer_mode(SHMEM_REF)`:

```
rtiddsgen -example -micro -language C HelloWorld.idl
```

Writer Side

Best practice for writing samples annotated with `@transfer_mode(SHMEM_REF)`:

```

for (int i = 0; i < 10; i++)
{
    Foo* sample;
    DDS_ReturnCode_t dds_rc;
    /* NEW API
       IMPORTANT - call get_loan each time when writing a NEW sample
    */
    dds_rc = FooDataWriter_get_loan(hw_datawriter, &sample);

    if (dds_rc != DDS_RETCODE_OK)
    {
        printf("Failed to get a loan\n");
        return -1;
    }

    /* After this function returns with DDS_RETCODE_OK,
       * the middleware owns the sample
    */
    dds_rc = FooDataWriter_write(hw_datawriter, sample, &DDS_HANDLE_NIL);
}

```

Reader Side

```

DDS_ReturnCode_t dds_rc;
dds_rc = FooDataReader_take(...)

/* process sample here */

dds_rc = FooDataReader_is_data_consistent(hw_reader,
                                         &is_data_consistent,
                                         sample, sample_info);

if (dds_rc == DDS_RETCODE_OK)
{
    if (is_data_consistent)
    {
        /* Sample is consistent. Processing of sample is valid */
    }
    else
    {
        /* Sample is NOT consistent. Any processing of the sample should
           * be discarded and considered invalid.
        */
    }
}
}

```

4.13.3 Synchronization of Zero Copy Samples

There is **NO** synchronization of a zero copy sample between a sender (*DataWriter*) and receiver (*DataReader*) application. It is possible for a sample's content to be invalidated before the receiver application actually has had a chance to read it.

To illustrate this scenario, consider creating the case of creating a *Best-effort DataWriter* with `max_samples` of $X=1$. When the *DataWriter* is created the middleware will pre-allocate a pool of $X+1$ (2) samples residing in a shared memory region. This pool will be used to loan samples when calling `FooDataWriter_get_loan(...)`,

```

DDS_ReturnCode_t ddsrc;
Foo* sample;

ddsrc = FooDataWriter_get_loan(dw, &sample); /* returns pointer to sample 1 */
sample->value = 10000;
ddsrc = FooDataWriter_write(datawriter, sample, &DDS_HANDLE_NIL);
/*
 * Because the datawriter is using best effort, the middleware immediately
 * makes this sample available to be returned by another FooDataWriter_get_loan(...)
 */

ddsrc = FooDataWriter_get_loan(dw, &sample); /* returns pointer to sample 2 */
sample->value = 20000;
ddsrc = FooDataWriter_write(datawriter, sample, &DDS_HANDLE_NIL);
/*
 * Because the datawriter is using best effort, the middleware immediately
 * makes this sample available to be returned by another FooDataWriter_get_loan(...)
 */

/*
 * At this point, it is possible the sample has been received by the receiving
↪ application
 * but has not been presented yet to the user.
 */

ddsrc = FooDataWriter_get_loan(dw, &sample); /* returns pointer to sample 1 */
/* sample->value will contain the integer 10000 because we are re-using samples
 * from a list that contains only 2 buffers.
 *
 * Also, at this point in time a referemce to sample 1 and 2 may have already been
↪ received
 * by the middleware on the DataReader side and are lying inside a DataReader's internal
↪ cache.
 * However, the sample may not have been received by the
 * application. If at this point the sample's value (sample->value) was changed to 999,
 * the sample returned from the Subscribers
 * read(...) or take(...) would contain unexpected values (999 instead of 10000). This
↪ is because
 * both the Publisher and the Subscriber process have mapped into their virtual
 * address space the same shared memory region where the sample lies.
 *
 * Use **FooDataReader_is_data_consistent** to verify the consistency, to prevent this
 * scenario.
 *
 * Note, a sample is actually invalidated right after the completion
 * of FooDataWriter_get_loan(dw, &sample). If the address of the newly created sample
↪ has been
 * previously written and its contents has not been read by the receiver application,

```

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```
* then the previously written sample has been invalidated.  
*/  
  
ddsrc = FooDataWriter_write(datawriter, sample, &DDS_HANDLE_NIL);
```

4.13.4 Caveats

- After you call `FooDataWriter_write()`, the middleware takes ownership of the sample. It is no longer safe to make any changes to the sample that was written. If, for whatever reason, you call `FooDataWriter_get_loan()` but never write the sample, you must call `FooDataWriter_discard_loan()` to return the sample back to `FooDataWriter`. Otherwise, subsequent `FooDataWriter_get_loan` may fail, because the `FooDataWriter` has no samples to loan.
- The current maximum supported sample size is a little under the maximum value of a signed 32-bit integer. For that reason, do not use any samples greater than 2000000000 bytes.

4.13.5 Further Information

For more information, see the section on Zero Copy Transfer Over Shared Memory in the *RTI Connex DDS Core Libraries User's Manual* (available [here](#) if you have Internet access).

4.14 FlatData Language Binding

This section is organized as follows:

- *Overview*
- *Getting Started*
- *Further Information*

4.14.1 Overview

RTI Connex DDS Micro supports the FlatData™ language binding in the same manner as *RTI Connex DDS*. However, *Connex DDS Micro* only supports the FlatData language binding for traditional C++ APIs, whereas *RTI Connex DDS* also supports it for the Modern C++ API. The FlatData language binding is not supported for the C language binding.

4.14.2 Getting Started

The best way to start is to generate an example by creating an example IDL file `HelloWorld.idl` containing the following IDL type:

```
@final  
@language_binding(FLAT_DATA)  
struct HelloWorld  
{  
    long a;  
}
```

Next, run:

```
rtiddsgen -example -micro -language C++ HelloWorld.idl
```

4.14.3 Further Information

For more details about this feature, please see the FlatData Language Binding section in the *RTI Connex DDS Core Libraries User's Manual* (available [here](#) if you have Internet access).

For details on how to build and read a FlatData sample, see [FlatData](#).

4.15 Security SDK

4.15.1 Introduction

RTI Security Plugins introduce 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-grained control over the level of security applied to each data flow, such as whether encryption or just data integrity is required.

The *RTI Connex DDS Micro Security SDK* includes a set of builtin plugins that implement the Service Plugin Interface defined by the DDS Security specification.

RTI Security Plugins is a separate package, available from the RTI Support Portal, <https://support.rti.com/>.

It is also possible to implement new custom plugins by using the *Security Plugins SDK* bundle (for more information, please contact support@rti.com). See the *RTI Security Plugins Release Notes* and *RTI Security Plugins Getting Started Guide* on the [RTI Documentation](#) page.

4.15.2 Installation

Please refer to the main *Installation* section for how to install the *RTI Connex DDS Micro Security SDK*.

4.15.3 Examples

For descriptions and examples of the security configuration in this release, please consult the `HelloWorld_dpde_secure` examples under the `example/[unix, windows]/[C, CPP]` directory. *RTI Connex DDS Micro Security SDK* supports both the C and C++ programming languages.

To use the *RTI Connex DDS Micro Security SDK*, 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.

4.15.4 Enabling RTI Security Plugins

To enable the *RTI Security Plugins*, the name of a “plugin suite” (i.e. the collection of security plugins defined by DDS Security) must be specified in a DomainParticipant's QoS. Plugin factories for this suite must also be registered with the `RT_Registry` before the DomainParticipant is created.

When using *RTI Connex DDS Micro's* C API, this can be achieved with the following code:

```

RTI_BOOL result = RTI_FALSE;
struct DDS_DomainParticipantQos dp_qos = DDS_DomainParticipantQos_INITIALIZER;
struct SECCORE_SecurePluginFactoryProperty sec_plugin_prop = SECCORE_
↪SecurePluginFactoryProperty_INITIALIZER;
DDS_DomainParticipantFactory *factory = DDS_DomainParticipantFactory_get_instance();
RT_Registry_T *registry = DDS_DomainParticipantFactory_get_registry(factory);

/* Register factories for built-in security plugins, using default
 * properties and default name */
if (!SECCORE_SecurePluginFactory_register(
    registry, SECCORE_DEFAULT_SUITE_NAME, &sec_plugin_prop))
{
    printf("failed to register security plugins\n");
    goto done;
}

/* In order to enable security, the name used to register the suite of
 * plugins must be set in DomainParticipantQos */
if (!RT_ComponentFactoryId_set_name(
    &dp_qos->trust.suite, SECCORE_DEFAULT_SUITE_NAME))
{
    printf("failed to set component id\n");
    goto done;
}

result = RTI_TRUE;

done:

return result;

```

For users of *RTI Connex DDS Micro's* C++ API, the suite can be registered using the following code:

```

RTI_BOOL result = RTI_FALSE;
DDS_DomainParticipantQos dp_qos;
SECCORE_SecurePluginFactoryProperty sec_plugin_prop;
DDS_DomainParticipantFactory *factory = DDS_DomainParticipantFactory::get_instance();
RT_Registry_T *registry = factory->get_registry();

/* Register factories for built-in security plugins, using default
 * properties and default name */
if (!SECCORE_SecurePluginFactory::register_suite(
    registry, SECCORE_DEFAULT_SUITE_NAME, sec_plugin_prop))
{
    printf("failed to register security plugins\n");
    goto done;
}

/* In order to enable security, the name used to register the suite of
 * plugins must be set in DomainParticipantQos */
if (!dp_qos.trust.suite.set_name(SECCORE_DEFAULT_SUITE_NAME))

```

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```

{
    printf("failed to set component id\n");
    goto done;
}

result = RTI_TRUE;

done:

return result;

```

Additional properties can be controlled using (key,value) pairs in a DomainParticipant's DDS_PropertyQosPolicy.

The configuration keys (and their corresponding valid values) supported by each security plugin are listed in the tables below:

- Table 4.1, *DDS Security Prefix Property*
- Table 4.2, *DDS Security Properties for Configuring Authentication*
- Table 4.3, *DDS Security Properties for Configuring Access Control*
- Table 4.4, *RTI Properties for Configuring Cryptography*
- Table 4.5, *RTI Properties for Configuring Logging*

In *RTI Connex DDS Micro*, you must set the security-related participant properties before you create a participant. 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.

Table 4.1: DDS Security Prefix Property

Property Name	Property Value Description
DDS_PARTICIPANT_TRUST_PREFIX_PROPERTY	Optional. The prefix string for security properties. For example: <code>com.rti.serv.secure</code> . If set, you will use this string as the prefix, followed by a “dot”, to some of the property names. Note: This is different than the <i>Connex DDS Pro</i> prefix property which also allows you to load the plugin. This property only allows you to use the prefix string. Default : NULL

Table 4.2: DDS Security Properties for Configuring Authentication

Property Name	Property Value Description
DDS_SECURITY_IDENTITY_CA_PROPERTY	Required. The Identity Certificate Authority for signing authentication certificate files. See Section 4.15.4.
DDS_SECURITY_PRIVATE_KEY_PROPERTY	Required. The private key associated with the first certificate that appears in the <code>identity_certificate</code> . See Section 4.15.4.
DDS_SECURITY_IDENTITY_CERTIFICATE_PROPERTY	Required. An Identity Certificate, required for secure communication. See Section 4.15.4.
DDS_SECURITY_PASSWORD_PROPERTY	Only required if <code>private_key</code> is encrypted. The password used to decrypt the <code>private_key</code> . See Section 4.15.4.
RTI_SECURITY_SHARED_SECRET_ALGORITHM_PROPERTY NOTE: Prefix with value of <code>DDS_PARTICIPANT_TRUST_PREFIX_PROPERTY</code> if set.	Optional. The algorithm used to establish a shared secret during authentication. See Section 4.15.4.
RTI_SECURITY_CRL_FILE_PROPERTY NOTE: Prefix with value of <code>DDS_PARTICIPANT_TRUST_PREFIX_PROPERTY</code> if set.	Optional. The Certificate Revocation List (CRL) that keeps track of untrusted X.509 certificates. See Section 4.15.4.

Table 4.3: DDS Security Properties for Configuring Access Control

Property Name	Property Value Description
DDS_SECURITY_PERMISSIONS_CA_PROPERTY	Required. Permissions Certificate Authority for signing access control governance and permissions XML files, and verifying the signatures of those files. See Section 4.15.4.
DDS_SECURITY_GOVERNANCE_PROPERTY	Required. Signed document that specifies the level of security required per domain and per topic. See Section 4.15.4.

Table 4.4: RTI Properties for Configuring Cryptography

Property Name	Property Value Description
RTI_SECURITY_ENCRYPTION_ALGORITHM_PROPERTY NOTE: Prefix with value of DDS_PARTICIPANT_TRUST_PREFIX_PROPERTY if set.	Optional. The algorithm used for encrypting and decrypting data and metadata. The options are <code>aes-128-gcm</code> , <code>aes-192-gcm</code> , and <code>aes-256-gcm</code> . (“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: <code>aes-128-gcm</code>
RTI_SECURITY_MAX_RECEIVER_SPECIFIC_MACS_PROPERTY NOTE: Prefix with value of DDS_PARTICIPANT_TRUST_PREFIX_PROPERTY if set.	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 <code>encode_datawriter_submessage</code> , and there could be another 32 receiver-specific MACs in the result of <code>encode_rtps_message</code> . 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 <code>encode_datawriter_submessage</code> , 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
RTI_SECURITY_MAX_BLOCKS_PER_SESSION_PROPERTY NOTE: Prefix with value of DDS_PARTICIPANT_TRUST_PREFIX_PROPERTY if set.	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 hexadecimal. This value is an unsigned 64-bit integer. Default: <code>0xffffffffffff</code>

Table 4.5: RTI Properties for Configuring Logging

Property Name	Property Value Description
DDS_PARTICIPANT_TRUST_PLUGINS_LOGGING_DISTRIBUTE_PROPERTY_NAME NOTE: Prefix with value of DDS_PARTICIPANT_TRUST_PREFIX_PROPERTY if set.	Optional. This boolean value controls whether security-related log messages should be distributed over a DDS DataWriter. If 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 <i>rtiddsgen</i> on <code>resource/idl/builtin_logging_type.idl</code> . Create a DataReader of type <code>DDSSecurity::BuiltinLoggingType</code> and topic <code>DDS:Security:LogTopic</code> . The DataReader must be allowed to subscribe to this topic according to its DomainParticipant's permissions file. Default: FALSE
DDS_PARTICIPANT_TRUST_PLUGINS_LOGGING_LOG_LEVEL_PROPERTY_NAME NOTE: Prefix with value of DDS_PARTICIPANT_TRUST_PREFIX_PROPERTY if set.	Optional. The logging verbosity level. All log messages at and below the <code>log_level</code> setting will be logged. Possible values: <ul style="list-style-type: none"> • 0: emergency • 1: alert • 2: critical • 3: error (default) • 4: warning • 5: notice • 6: informational • 7: debug
DDS_PARTICIPANT_TRUST_PLUGINS_LOGGING_LOG_FILE_PROPERTY_NAME NOTE: Prefix with value of DDS_PARTICIPANT_TRUST_PREFIX_PROPERTY if set.	Optional. The file that log messages are printed to. Default: NULL

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Property Name	Property Value Description
DDS_TRUST_PLUGINS_LOGGING_MAX_REMOTE_READERS_PROPERTY_NAME NOTE: Prefix with value of DDS_PARTICIPANT_TRUST_PREFIX_PROPERTY if set.	Optional. Maximum remote readers the logging writer can write to. Default: 16
DDS_TRUST_PLUGINS_LOGGING_MAX_ROUTES_PER_READER_PROPERTY_NAME NOTE: Prefix with value of DDS_PARTICIPANT_TRUST_PREFIX_PROPERTY if set.	Optional. Logging writer resource-limit, which limits the number of routes per Reader. Default: 4
DDS_TRUST_PLUGINS_LOGGING_WRITER_DEPTH_PROPERTY_NAME NOTE: Prefix with value of DDS_PARTICIPANT_TRUST_PREFIX_PROPERTY if set.	Optional. History depth (in samples) of the logging DataWriter. Default: 64

DDS_SECURITY_IDENTITY_CA_PROPERTY

DDS_SECURITY_IDENTITY_CA_PROPERTY is a **required** property. It appears in Table 4.2, *DDS Security Properties for Configuring Authentication*.

This property's value specifies an Identity Certificate Authority document that will be used for signing authentication certificate files. Participants that want to securely communicate with each other must use the same Identity Certificate Authority.

You will use OpenSSL and an `openssl.cnf` file to create a file in PEM format named `cacert*.pem`.

An example `openssl.cnf` file is here: `rti_workspace/version/examples/dds_security/cert`. You will need to modify this file to match your certificate folder structure and Identity Certificate Authority desired configuration.

Example OpenSSL commands are shown below.

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 ecpkcs8 -name prime256v1 > ecdsaparam
% openssl req -nodes -x509 -days 3650 -newkey ec:ecdsaparam \
-keyout cakeyECdsa.pem -out cacertECdsa.pem -config opensslECdsa.cnf
```

Note: When running the above commands for ECDSA, you may run into these OpenSSL warnings:

```
WARNING: can't open config file: [default openssl
built-inpath]/openssl.cnf

unable to write 'random state'
```

To resolve the first warning, set the environmental variable `OPENSSL_CONF` with the path to the `openssl.cnf` file you are using. To resolve the second warning, set the environmental variable `RANDFILE` with the path to a writable file.

You may specify the value as either a file name or the document contents. The document should be in PEM format.

- If setting the property value to a 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 `cacert*.pem` file that appears after the `-out` parameter in the above commands.
- If setting the property value to 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.

DDS_SECURITY_PRIVATE_KEY_PROPERTY

DDS_SECURITY_PRIVATE_KEY_PROPERTY is a **required** property. It appears in Table 4.2, *DDS Security Properties for Configuring Authentication*.

Its value is a private key associated with the first certificate that appears in the identity_certificate. The default value is NULL.

After generating the ca_file, cacert*.pem (described in Section 4.15.4), use OpenSSL to generate a peer1key*.pem 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
```

Notice that for ECDSA, OpenSSL also generates peer1reqECdsa.pem. That file will be used later to generate the certificate file for DDS_SECURITY_IDENTITY_CERTIFICATE_PROPERTY.

The document should be in PEM format. You may specify either the file name or the document contents.

- If setting the property value to a 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 `peer1key*.pem` that appears after the `-out` parameters in the above commands.
- If setting the property value to 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.

DDS_SECURITY_IDENTITY_CERTIFICATE_PROPERTY

DDS_SECURITY_IDENTITY_CERTIFICATE_PROPERTY is a **required** property. It appears in Table 4.2, *DDS Security Properties for Configuring Authentication*.

Its value is an Identity Certificate, required for secure communication.

Before generating the certificate file for this property, first generate the ca_file (see Section 4.15.4) and the private_key_file (see Section 4.15.4).

Next, 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 those seen below.

Example `.cnf` files are here: `rti_workspace/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 dsouser.csr
% openssl ca -config openssldsa.cnf -days 365 \
  -in dsouser.csr -out peer1dsa.pem
```

ECDSA:

Generate `peer1reqECdsa.pem` using the instructions for `private_key_file` (see Section 4.15.4).

```
% openssl ca -batch -create_serial -config opensslECdsa.cnf \
  -days 365 -in peer1reqECdsa.pem -out peer1ECdsa.pem
```

Notes:

- `openssl((EC)dsa).cnf` must have the same `countryName`, `stateOrProvinceName`, and `localityName` as the example `.cnf` files.
- Example `.cnf` files for 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 setting the property value to a 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 `peer1*.pem` that appears after the `-out` parameters in the above commands.
- If setting the property value to 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 concatenated result as a single file or string. See Section 4.1, Identity Certificate Chaining, in the *Security Plugins User's Manual* for 6.0.1 (available [here](#) if you have Internet access).

Default: NULL

DDS_SECURITY_PASSWORD_PROPERTY

This property is only required if `private_key` is encrypted.

Its value specifies the password used to decrypt the `private_key` (see Section 4.15.4).

This property appears in Table 4.2, *DDS Security Properties for Configuring Authentication*.

The value is interpreted as the Base64 encoding of the symmetric key that will be used to decrypt the `private_key`.

For example, suppose 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
```

Then you can obtain the Base64 encoding of `MyPassword` with commands such as:

```
% echo MyPassword > foo
% openssl base64 -e -in foo
TXlQYXNzd29yZAo=
```

For the above example, the value of the password property should be “TXlQYXNzd29yZAo=”. If the `private_key` was not encrypted, the password must be NULL.

Default: NULL

RTI_SECURITY_SHARED_SECRET_ALGORITHM_PROPERTY

This is an optional property.

Its value sets the algorithm used to establish a shared secret during authentication. The options are `dh` and `ecdh` for (Elliptic Curve) Diffie-Hellman.

This property appears in Table 4.2, *DDS Security Properties for Configuring Authentication*.

If two participants discover each other and they specify different values for this algorithm, the algorithm that will be 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`

RTI_SECURITY_CRL_FILE_PROPERTY

This is an optional property.

This Certificate Revocation List (CRL) keeps track of untrusted X.509 certificates.

This property appears in Table 4.2, *DDS Security Properties for Configuring Authentication*.

Use OpenSSL to generate this file using commands such as those seen below.

An example `opensslECdsa.cnf` file is here: `rti_workspace/version/examples/dds_security/cert`.

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, 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

DDS_SECURITY_PERMISSIONS_CA_PROPERTY

DDS_SECURITY_PERMISSIONS_CA_PROPERTY is a **required** property. It appears in Table 4.3, *DDS Security Properties for Configuring Access Control*.

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 Section 4.15.4 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_SECURITY_GOVERNANCE_PROPERTY

DDS_SECURITY_GOVERNANCE_PROPERTY is a **required** property. It appears in Table 4.3, *DDS Security Properties for Configuring Access Control*.

The Governance property configures 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’s 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 with 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

DDS_SECURITY_PERMISSIONS_PROPERTY

DDS_SECURITY_PERMISSIONS_PROPERTY is a **required** property. It appears in Table 4.3, *DDS Security Properties for Configuring Access Control*.

This property configures 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, *Connex 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 with 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

4.16 Building Against FACE Conformance Libraries

This section describes how to build *Connex DDS Micro* using the FACE™ conformance test tools.

4.16.1 Requirements

Connex DDS Micro Source Code

The *Connex DDS Micro* source code is available from [RTI’s Support portal](#).

FACE Conformance Tools

RTI does not distribute the FACE conformance tools.

CMake

The *Connex DDS Micro* source is distributed with a **CMakeList.txt** project file. CMake is an easy to use tool that generates makefiles or project files for various build-tools, such as UNIX makefiles, Microsoft® Visual Studio® project files, and Xcode.

CMake can be downloaded from <https://www.cmake.org>.

4.16.2 FACE Golden Libraries

The FACE conformance tools use a set of golden libraries. There are different golden libraries for different FACE services, languages and profiles. *Connex DDS Micro only* conforms to the safetyExt and safety profile of OSS using the C language.

Building the FACE Golden Libraries

The FACE conformance tools ship with their own set of tools to build the golden libraries. Please follow the instructions provided by FACE. In order to build the FACE golden libraries, it is necessary to port to the required platform. RTI has only tested *Connex DDS Micro* on Linux 2.6 systems with GCC 4.4.5. The complete list of files modified by RTI are included below in source form.

4.16.3 Building the Connex DDS Micro Source

The following instructions show how to build the *Connex DDS Micro* source:

- Extract the source-code. Please note that the remaining instructions assume that only a single platform is built from the source.
- In the top-level source directory, enter the following:

```
shell> cmake-gui .
```

This will start the CMake GUI where all build configuration takes place.

- Click the “Configure” button.
- Select UNIX Makefiles from the drop-down list.
- Select “Use default compilers” or “Specify native compilers” as required. Press “Done.”
- Click “Configure” again. There should not be any red lines. If there are, click “Configure” again.

NOTE: A red line means that a variable has not been configured. Some options could add new variables. Thus, if you change an option a new red lines may appear. In this case configure the variable and press “Configure.”

- Expand the CMAKE and RTIMICRO options and configure how to build *Connex DDS Micro*:

```

CMAKE_BUILD_TYPE: Debug or blank. If Debug is used, the |me| debug
                    libraries are built.

RTIMICRO_BUILD_API: C or C++
  C   - Include the C API. For FACE, only C is supported.
  C++ - Include the C++ API.

RTIMICRO_BUILD_DISCOVERY_MODULE: Dynamic | Static | Both
  Dynamic - Include the dynamic discovery module.
  Static   - Include the static discovery module.
  Both     - Include both discovery modules.

RTIMICRO_BUILD_LIBRARY_BUILD:
  Single   - Build a single library.
  RTI style - Build the same libraries RTI normally ships. This is useful
              if RTI libraries are already being used and you want to use
              the libraries built from source.

RTIMICRO_BUILD_LIBRARY_TYPE:
  Static - Build static libraries.
  Shared - Build shared libraries.

RTIMICRO_BUILD_LIBRARY_PLATFORM_MODULE: POSIX

RTIMICRO_BUILD_LIBRARY_TARGET_NAME: <target name>
  Enter a string as the name of the target. This is also used as the
  name of the directory where the built libraries are placed.
  If you are building libraries to replace the libraries shipped by RTI,
  you can use the RTI target name here. It is then possible to set
  RTIMEHOME to the source tree (if RTI style is selected for
  RTIMICRO_BUILD_LIBRARY_BUILD).

RTIMICRO_BUILD_ENABLE_FACE_COMPLIANCE: Select level of FACE compliance
  None           - No compliance required
  General        - Build for compliance with the FACE general profile
  Safety Extended - Build for compliance with the FACE safety extended profile
  Safety         - Build for compliance with the FACE safety profile

RTIMICRO_BUILD_LINK_FACE_GOLDEBLIBS:
  Check if linking against the static FACE conformance test libraries.
  NOTE: This check-box is only available if FACE compliance is different
  from "None".

RTIMICRO_BUILD_LINK_FACE_GOLDEBLIBS:
  If the RTIMICRO_BUILD_LINK_FACE_GOLDEBLIBS is checked the path to the
  top-level FACE root must be specified here.

```

- Click “Configure”.
- Click “Generate”.
- Build the generated project.
- Libraries are placed in `lib/<RTIMICRO_BUILD_LIBRARY_TAR-`

GET_NAME>.

4.17 Working With Sequences

4.17.1 Introduction

RTI Connex DDS Micro uses IDL as the language to define data-types. One of the constructs in IDL is the *sequence*: a variable-length vector where each element is of the same type. This section describes how to work with sequences; in particular, the string sequence since it has special properties.

4.17.2 Working with Sequences

Overview

Logically a sequence can be viewed as a variable-length vector with N elements, as illustrated below. Note that sequences indices are 0 based.

```

+----+
0 | T |
+----+
1 | T |
+----+
2 | T |
+----+
  |
  |
+----+
N-1 | T |
+----+

```

There are three types of sequences in *Connex DDS Micro*:

- Builtin sequences of primitive IDL types.
- Sequences defined in IDL using the sequence keyword.
- Sequences defined by the application.

The following builtin sequences exist (please refer to [C API Reference](#) and [C++ API Reference](#) for the complete API).

IDL Type	Connex DDS Micro Type	Connex DDS Micro Sequence
octet	DDS_Octet	DDS_OctetSeq
char	DDS_Char	DDS_CharSeq
boolean	DDS_Boolean	DDS_BooleanSeq
short	DDS_Short	DDS_ShortSeq
unsigned short	DDS_UnsignedShort	DDS_UnsignedShortSeq
long	DDS_Long	DDS_LongSeq
unsigned long	DDS_UnsignedLong	DDS_UnsignedLongSeq
enum	DDS_Enum	DDS_EnumSeq
wchar	DDS_Wchar	DDS_WcharSeq
long long	DDS_LongLong	DDS_LongLongSeq
unsigned long long	DDS_UnsignedLongLong	DDS_UnsignedLongLongSeq
float	DDS_Float	DDS_FloatSeq
double	DDS_Double	DDS_DoubleSeq
long double	DDS_LongDouble	DDS_LongDoubleSeq
string	DDS_String	DDS_StringSeq
wstring	DDS_Wstring	DDS_WstringSeq

The following are important properties of sequences to remember:

- All sequences in *Connex DDS Micro* must be finite.
- All sequences defined in IDL are sized based on IDL properties and *must* not be resized. That is, *never* call `set_maximum()` on a sequence defined in IDL. This is particularly important for string sequences.
- Application defined sequences can be resized using `set_maximum()` or `ensure_length()`.
- There are two ways to use a `DDS_StringSeq` (they are type-compatible):
 - A `DDS_StringSeq` originating from IDL. This sequence is sized based on maximum sequence length *and* maximum string length.
 - A `DDS_StringSeq` originating from an application. In this case the sequence element memory is unmanaged.
- All sequences have an initial length of 0.

Working with IDL Sequences

Sequences that originate from IDL are created when the IDL type they belong to is created. IDL sequences are always initialized with the maximum size specified in the IDL file. The maximum size of a type, and hence the sequence size, is used to calculate memory needs for serialization and deserialization buffers. Thus, changing the size of an IDL sequence can lead to hard to find memory corruption.

The string and wstring sequences are special in that not only is the maximum sequence size allocated, but because strings are also always of a finite maximum length, the maximum space needed for each string element is also allocated. This ensure that *Connex DDS Micro* can prevent memory overruns and validate input.

Some typical scenarios with a long sequence and a string sequence defined in IDL is shown below:

```

/* In IDL */
struct SomeIdlType
{
    // A sequence of 20 longs
    sequence<long,20> long_seq;

    // A sequence of 10 strings, each string has a maximum length of 255 bytes
    // (excluding NUL)
    sequence<string<255>,10> string_seq;
}

/* In C source */
SomeIdlType *my_sample = SomeIdlTypeTypeSupport_create_data()

DDS_LongSet_set_length(&my_sample->long_seq,5);
DDS_StringSeq_set_length(&my_sample->string_seq,5);

/* Assign the first 5 longs in long_seq */
for (i = 0; i < 5; ++i)
{
    *DDS_LongSeq_get_reference(&my_sample->long_seq,i) = i;
    snprintf(*DDS_StringSeq_get_reference(&my_sample->string_seq,0),255,"SomeString %d",
↵i);
}

SomeIdlTypeTypeSupport_delete_data(my_sample);

/* In C++ source */
SomeIdlType *my_sample = SomeIdlTypeTypeSupport::create_data()

/* Assign the first 5 longs in long_seq */

my_sample->long_seq.length(5);
my_sample->string_seq.length(5);

for (i = 0; i < 5; ++i)
{
    /* use method */
    *DDSLongSeq_get_reference(&my_sample->long_seq,i) = i;
    snprintf(*DDSStringSeq_get_reference(&my_sample->string_seq,i),255,"SomeString %d",
↵i);

    /* or assignment */
    my_sample->long_seq[i] = i;
    snprintf(my_sample->string_seq[i],255,"SomeString %d",i);
}

SomeIdlTypeTypeSupport::delete_data(my_sample);

```

Note that in the example above the sequence length is set. The maximum size for each sequence is set when `my_sample` is allocated.

A special case is to copy a string sequence from a sample to a string sequence defined outside of the sample. This is possible, but care *must* be taken to ensure that the memory is allocated properly:

Consider the IDL type from the previous example. A string sequence of equal size can be allocated as follows:

```
struct DDS_StringSeq app_seq = DDS_SEQUENCE_INITIALIZER;

/* This ensures that memory for the strings are allocated upfront */
DDS_StringSeq_set_maximum_w_max(&app_seq,10,255);

DDS_StringSeq_copy(&app_seq,&my_sample->string_seq);
```

If instead the following code was used, memory for the string in **app_seq** would be allocated as needed.

```
struct DDS_StringSeq app_seq = DDS_SEQUENCE_INITIALIZER;

/* This ensures that memory for the strings are allocated upfront */
DDS_StringSeq_set_maximum(&app_seq,10);

DDS_StringSeq_copy(&app_seq,&my_sample->string_seq);
```

Working with Application Defined Sequences

Application defined sequences work in the same way as sequences defined in IDL with two exceptions:

- The maximum size is 0 by default. It is necessary to call **set_maximum** or **ensure_length** to allocate space.
- **DDS_StringSet_set_maximum** does not allocate space for the string pointers. The memory must be allocated on a per needed basis and calls to **__copy** may reallocate memory as needed. Use **DDS_StringSeq_set_maximum_w_max** or **DDS_StringSeq_ensure_length_w_max** to also allocate pointers. In this case **__copy** will *not* reallocate memory.

Note that it is not allowed to mix the use of calls that pass the max (ends in **__w_max**) and calls that do not. Doing so may cause memory leaks and/or memory corruption.

```
struct DDS_StringSeq my_seq = DDS_SEQUENCE_INITIALIZER;

DDS_StringSeq_ensure_length(&my_seq,10,20);

for (i = 0; i < 10; i++)
{
    *DDS_StringSeq_get_reference(&my_seq,i) = DDS_String_dup("test");
}

DDS_StringSeq_finalize(&my_seq);
```

DDS_StringSeq_finalize automatically frees memory pointed to by each element using **DDS_String_free**. All memory allocated to a string element should be allocated using a

`DDS_String` function.

It is possible to assign any memory to a string sequence element if all elements are released manually first:

```

struct DDS_StringSeq my_seq = DDS_SEQUENCE_INITIALIZER;

DDS_StringSeq_ensure_length(&my_seq,10,20);

for (i = 0; i < 10; i++)
{
    *DDS_StringSeq_get_reference(&my_seq,i) = static_string[i];
}

/* Work with the sequence */

for (i = 0; i < 10; i++)
{
    *DDS_StringSeq_get_reference(&my_seq,i) = NULL;
}

DDS_StringSeq_finalize(&my_seq);

```

4.18 Debugging

4.18.1 Overview

Connex DDS Micro maintains a log of events occurring in a *Connex DDS Micro* application. Information on each event is formatted into a log entry. Each entry can be stored in a buffer, stringified into a displayable log message, and/or redirected to a user-defined log handler.

For a list of error codes, please refer to Logging Reference.

4.18.2 Configuring Logging

By default, *Connex DDS Micro* sets the log verbosity to *Error*. It can be changed at any time by calling `OSAPI_Log_set_verbosity()` using the desired verbosity as a parameter.

Note that when compiling with `RTI_CERT` defined, logging is completely removed.

The *Connex DDS Micro* log stores new log entries in a log buffer.

The default buffer size is different for Debug and Release libraries. The Debug libraries are configured to use a much larger buffer than the Release ones. A custom buffer size can be configured using the `OSAPI_Log_set_property()` function. For example, to set a buffer size of 128 bytes:

```

struct OSAPI_LogProperty prop = OSAPI_LogProperty_INITIALIZER;

OSAPI_Log_get_property(&prop);
prop.max_buffer_size = 128;
OSAPI_Log_set_property(&prop);

```

Note that if the buffer size is too small, log entries will be truncated in order to fit in the available buffer.

The function used to write the logs can be set during compilation by defining the macro `OSAPI_LOG_WRITE_BUFFER`. This macro shall have the same parameters as the function prototype `OSAPI_Log_write_buffer_T`.

It is also possible to set this function during runtime by using the function `OSAPI_Log_set_property()`:

```
struct OSAPI_LogProperty prop = OSAPI_LogProperty_INIIALIZER;

OSAPI_Log_get_property(&prop);
prop.write_buffer = <pointer to user defined write function>;
OSAPI_Log_set_property(&prop);
```

A user can install a log handler function to process each new log entry. The handler must conform to the definition `OSAPI_LogHandler_T`, and it is set by `OSAPI_Log_set_log_handler()`.

When called, the handler has parameters containing the raw log entry and detailed log information (e.g., error code, module, file and function names, line number).

The log handler is called for every new log entry, even when the log buffer is full. An expected use case is redirecting log entries to another logger, such as one native to a particular platform.

4.18.3 Log Message Kinds

Each log entry is classified as one of the following kinds:

- *Error*. An unexpected event with negative functional impact.
- *Warning*. An event that may not have negative functional impact but could indicate an unexpected situation.
- *Information*. An event logged for informative purposes.

By default, the log verbosity is set to *Error*, so only error logs will be visible. To change the log verbosity, simply call the function `OSAPI_Log_set_verbosity()` with the desired verbosity level.

4.18.4 Interpreting Log Messages and Error Codes

A log entry in *Connex DDS Micro* has a defined format.

Each entry contains a header with the following information:

- *Length*. The length of the log message, in bytes.
- *Module ID*. A numerical ID of the module from which the message was logged.
- *Error Code*. A numerical ID for the log message. It is unique within a module.

Though referred to as an “error” code, it exists for all log kinds (error, warning, info).

The module ID and error code together uniquely identify a log message within *Connex DDS Micro*.

Connex DDS Micro can be configured to provide additional details per log message:

- *Line Number*. The line number of the source file from which the message is logged.
- *Module Name*. The name of the module from which the message is logged.
- *Function Name*. The name of the function from which the message is logged.

When an event is logged, by default it is printed as a message to standard output. An example error entry looks like this:

```
[943921909.645099999]ERROR: ModuleID=7 Errcode=200 X=1 E=0 T=1  
dds_c/DomainFactory.c:163/DDS_DomainParticipantFactory_get_instance: kind=19
```

- *X* Extended debug information is present, such as file and line number.
- *E* Exception, the log message has been truncated.
- *T* The log message has a valid timestamp (successful call to `OSAPI_System_get_time()`).

A log message will need to be interpreted by the user when an error or warning has occurred and its cause needs to be determined, or the user has set a log handler and is processing each log message based on its contents.

A description of an error code printed in a log message can be determined by following these steps:

- Navigate to the module that corresponds to the Module ID, or the printed module name in the second line. In the above example, “ModuleID=7” corresponds to DDS.
- Search for the error code to find it in the list of the module’s error codes. In the example above, with “Errcode=200,” search for “200” to find the log message that has the value “(DDSC_LOG_BASE + 200)”.

Chapter 5

Building and Porting

5.1 Connex DDS Micro Supported Platforms

RTI Connex DDS Micro is a source product and all platforms supported by RTI are supported. However, RTI does not test and validate the libraries on all permutations of CPU types, compiler version and OS version.

5.1.1 Reference Platforms

The following are reference platforms for which the platform-dependent layers provided with the *RTI Connex DDS Micro* product are tested as part of standard product release:

- Windows®
- Linux®
- Unix™ (POSIX Compliant)
- Wind River® VxWorks®
- Express Logic® ThreadX®
- FreeRTOS™
- macOS® X (Darwin)
- QNX® 6.6, 7

5.1.2 Known Customer Platforms

RTI Connex DDS Micro has been ported to a number of platforms by our customers, such as:

- uC/OS™
- uLinux
- Win32
- Android™
- iOS®

- TI's Stellaris® Arm® Cortex®-M3 and -M4 with only TI device drivers, no OS
- Baremetal - Arm Cortex-M4
- INTEGRITY®-178
- VxWorks 653 2.x, 3.x
- DDC-I Deos™
- LynxOS®-178
- VOS™

RTI Connex DDS Micro is known to run with the following network stacks: - BSD® socket-based stack - Windows Socket library - VxWorks Network stack - ThreadX Network stack - RTNet® - lwIP (event and blocking mode) - QNX Network stack - GHS IPFlite and general purpose stack

5.2 Building the Connex DDS Micro Source

5.2.1 Introduction

RTI Connex DDS Micro has been engineered for reasonable portability to common platforms and environments, such as Darwin, iOS, Linux, and Windows. This document explains how to build the *Connex DDS Micro* source-code. The focus of this document is building *Connex DDS Micro* for an architecture supported by RTI (please refer to *Connex DDS Micro Supported Platforms* for more information). Please refer to *Porting RTI Connex DDS Micro* for documentation on how to port *Connex DDS Micro* to an *unsupported* architecture.

This manual is written for developers and engineers with a background in software development. It is recommended to read the document in order, as one section may refer to or assume knowledge about concepts described in a preceding section.

5.2.2 The Host and Target Environment

The following terminology is used to refer to the environment in which *Connex DDS Micro* is built and run:

- The *host* is the machine that runs the software to compile and link *Connex DDS Micro*.
- The *target* is the machine that runs *Connex DDS Micro*.
- In many cases *Connex DDS Micro* is built *and* run on the same machine. This is referred to as a *self-hosted environment*.

The *environment* is the collection of tools, OS, compiler, linker, hardware etc. needed to build and run applications.

The word *must* describes a requirement that must be met. Failure to meet a *must* requirement may result in failure to compile, use or run *Connex DDS Micro*.

The word *should* describes a requirement that is strongly recommended to be met. A failure to meet a *should* recommendation may require modification to how *Connex DDS Micro* is built, used, or run.

The word *may* is used to describe an optional feature.

The Host Environment

RTI Connex DDS Micro has been designed to be easy to build and to require few tools on the host.

The host machine **must**:

- support long filenames (8.3 will not work). *Connex DDS Micro* does not require a case sensitive file-system.
- have the necessary compiler, linkers, and build-tools installed.

The host machine **should**:

- have [CMake](http://www.cmake.org) (www.cmake.org) installed. Note that it is not required to use [CMake](http://www.cmake.org) to build *Connex DDS Micro*, and in some cases it may also not be recommended. As a rule of thumb, if *RTI Connex DDS Micro* can be built from the command-line, [CMake](http://www.cmake.org) is recommended.
- be able to run bash shell scripts (Unix type systems) or BAT scripts (Windows machines).

Typical examples of host machines are:

- a Linux PC with the GNU tools installed (make, gcc, g++, etc).
- a Mac computer with Xcode and the command-line tools installed.
- a Windows computer with Microsoft Visual Studio Express edition.
- a Linux, Mac or Windows computer with an embedded development tool-suite.

The Target Environment

Connex DDS Micro has been designed to run on a wide variety of targets. For example, *Connex DDS Micro* can be ported to run with no OS, an RTOS, GNU libc or a non-standard C library etc. This section only lists the minimum requirements. Please refer to *Porting RTI Connex DDS Micro* for how to port *Connex DDS Micro*.

The target machine must:

- support 8, 16, and 32-bit signed and unsigned integer. Note that a 16 bit CPU (or even 8 bit) is supported as long as the listed types are supported.

Connex DDS Micro supports 64 bit CPUs, and it does not use any native 64 bit quantities internally.

The target compiler should:

- have a C compiler that is C99 compliant. Note that many non-standard compilers work, but may require additional configuration.
- have a C++ compiler that is C++98 compliant.

The remainder of this manual assumes that the target environment is one supported by RTI:

- POSIX (Linux, Darwin, QNX®, VOS, iOS, Android).

- VxWorks 6.9 or later.
- Windows.
- QNX.

5.2.3 Overview of the Connex DDS Micro Source Bundle

The *Connex DDS Micro* source is available from the [RTI support portal](#). If you do not have access, please contact [RTI Support](#). The source-code is exactly the same as developed and tested by RTI. No filtering or modifications are performed, except for line-ending conversion for the Windows source bundle.

The source-bundle is in a directory called `src/` under your *Connex DDS Micro* installation.

```

RTIMEHOME--+++ CmakeLists.txt
|
|   +-- build -- cmake ---+-- Debug ---+-- <ARCH> -- <project-files>
|   |
|   |   +-- Release ---+-- <ARCH> -- <project-files>
|   +-- doc --
|
|   +-- example
|
|   +-- include
|
|   +-- lib +-- <ARCH> -- <libraries>
|
|   +-- resource ---+-- cmake
|   |
|   |   +-- scripts
|   |
|   +-- rtiddsgen
|
|   +-- rtiddsmag
|
|   +-- src

```

In this document, `RTIMEHOME` refers to the root directory where RTI archives are extracted and installed. The only difference between the UNIX and Windows source bundles is the line endings.

Directory Structure

The recommended directory structure is described below and *should* be used (1) because:

- the source bundle includes a helper script to run [CMake](#) that expects this directory structure.
- this directory structure supports multiple architectures.
- this directory structure mirrors the structure shipped by RTI. (2).

NOTE 1: This applies to builds using [CMake](#). To build in a custom environment, please refer to *Custom Build Environments*.

NOTE 2: The path to an installation of *rtiddsgen*, likely from a bundle shipped by RTI, will also have to be specified separately.

CMakeLists.txt is the main input file to [CMake](#) and is used to generate build files.

The *RTIMEHOME/include* directory contains the public header files. By default it is identical to *RTIMEHOME/include*. However, custom ports will typically add files to this directory.

The *RTIMEHOME/src* directory contains the *Connex DDS Micro* source files. RTI does not support modifications to these files unless explicitly stated in the porting guide. A custom port will typically add specific files to this directory.

The *RTIMEHOME/build* directory is empty by default. [CMake](#) generates one set of build-files for each configuration. A build configuration can be an architecture, *Connex DDS Micro* options, language selection, etc. This directory will contain [CMake](#) generated build-files per architecture per configuration. By convention the *Debug* directory is used to generate build-files for debug libraries and the *Release* directory is used for release libraries.

The *RTIMEHOME/lib* directory is empty by default. All libraries successfully built with the [CMake](#) generated build-files, regardless of which generator was used, will be copied to the *RTIMEHOME/lib* directory.

The following naming conventions are used regardless of the build-tool:

- Static libraries have a *z* suffix.
- Shared libraries do *not* have an additional suffix.
- Debug libraries have a *d* suffix.
- Release libraries do *not* have an additional suffix.

The following libraries are built:

- *rti_me* - the core library, including the DDS C API
- *rti_me_discdpde* - the Dynamic Participant Dynamic Endpoint plugin
- *rti_me_discdpse* - the Dynamic Participant Static Endpoint plugin
- *rti_me_rhsm* - the Reader History plugin
- *rti_me_whsm* - the Writer History plugin
- *rti_me_netioshmem* - the Shared Memory Transport
- *rti_me_netiosdm* - the Zero Copy over shared memory transport library
- *rti_me_cpp* - the C++ API

Note: The names above are the RTI library names. Depending on the target architecture, the library name is prefixed with *lib* and the library suffix also varies between target architectures, such as *.so*, *.dylib*, etc.

For example:

- *rti_mezd* indicates a static debug library
- *rti_me* indicates a dynamically linked release library

5.2.4 Compiling Connex DDS Micro

This section describes in detail how to compile *Connex DDS Micro* using [CMake](#). It starts with an example that uses the included scripts followed by a section showing how to build manually.

[CMake](#), available from www.cmake.org, is the preferred tool to build *Connex DDS Micro* because it simplifies configuring the *Connex DDS Micro* build options and generates build files for a variety of environments. Note that [CMake](#) itself does not compile anything. [CMake](#) is used to *generate* build files for a number of environments, such as make, Eclipse® CDT, Xcode® and Visual Studio. Once the build-files have been generated, any of the tools mentioned can be used to build *Connex DDS Micro*. This system makes it easier to support building *Connex DDS Micro* in different build environments. [CMake](#) is easy to install with pre-built binaries for common environments and has no dependencies on external tools.

NOTE: It is not required to use [CMake](#). Please refer to *Custom Build Environments* for other ways to build *Connex DDS Micro*.

Building Connex DDS Micro with rtime-make

The *Connex DDS Micro* source bundle includes a bash (UNIX) and BAT (Windows) script to simplify the invocation of [CMake](#). These scripts are a convenient way to invoke [CMake](#) with the correct options.

On UNIX-based systems:

```
RTIMEHOME/resource/script/rtime-make --config Debug --target self \
    --name i86Linux2.6gcc4.4.5 -G "Unix Makefiles" --build
```

On Windows systems:

```
RTIMEHOME\resource\scripts\rtime-make --config Debug --target self \
    --name i86Win32VS2010 -G "Visual Studio 10 2010" --build
```

Explanation of arguments:

- `--config Debug` : Create Debug build.
- `--target <target>` : The target for the sources to be built. “self” indicates that the host machine is the target and *Connex DDS Micro* will be built with the options that [CMake](#) automatically determines for the local compiler. Please refer to *Cross-Compiling Connex DDS Micro* for information on specifying the target architecture to build for.
- `--name <name>` : The name of the build, shall be a descriptive name following the recommendation on naming described in section *Preparing for a Build*. If `--name` is not specified, the value for `--target` will be used as the name.
- `--build Build`: The generated project files.

On UNIX-based systems:

- If gcc is part of the name, GCC is assumed.
- If clang is part of the name, clang is assumed.

On Windows systems:

- If Win32 is part of the name, a 32 bit Windows build is assumed.
- If Win64 is part of the name, a 64 bit Windows build is assumed.

To get a list of all the options:

```
rttime-make -h
```

To get help for a specific target:

```
rttime-make --target <target> --help
```

Manually Building with CMake

Preparing for a Build

As mentioned, it is recommended to create a unique directory for each build configuration. A build configuration can be created to address specific architectures, compiler settings, or different *Connex DDS Micro* build options.

RTI recommends assigning a descriptive *name* to each build configuration, using a common format. While there are no requirements to the format for functional correctness, the tool-chain files in *Cross-Compiling Connex DDS Micro* uses the `RTIME_TARGET_NAME` variable to determine various compiler options and selections.

RTI uses the following name format:

```
{cpu}{OS}{compiler}_{config}
```

In order to avoid a naming conflict with RTI, the following name format is recommended:

```
{prefix}_{cpu}{OS}{compiler}_{config}
```

Some examples:

- `acme_ppc604FreeRTOSgcc4.6.1` - *Connex DDS Micro* for a PPC 604 CPU running FreeRTOS compiled with gcc 4.6.1, compiled by acme.
- `acme_i86Win32VS2015` - *Connex DDS Micro* for an i386 CPU running Windows XP or higher compiled with Visual Studio 2015, compiled by acme.
- `acme_i86Linux4gcc4.4.5_test` - a test configuration build of *Connex DDS Micro* for an i386 CPU running Linux 3 or higher compiled with gcc 4.4.5, compiled by acme.

Files built by each build configuration will be stored under `RTIMEHOME/build/[Debug | Release]/<name>`. These directories are referred to as build directories or `RTIMEBUILD`. The structure of the `RTIMEBUILD` depends on the generated build files and should be regarded as an intermediate directory.

Creating Build Files for Connex DDS Micro Using the CMake GUI

Start the [CMake](#) GUI, either from a terminal window or a menu.

Please note that the Cmake GUI does *not* set the **CMAKE_BUILD_TYPE** variable. This variable is used to determine the names of the *Connex DDS Micro* libraries. Thus, it is necessary to add **CMAKE_BUILD_TYPE** manually and specify either Debug or Release. To add this variable manually, click the ‘Add Entry’ button, specify the name as a string type.

As an alternative, `rtime-make`’s `--gui` option can be used. This option starts the **CMake** and also adds the **CMAKE_BUILD_TYPE** option when the **CMake** GUI exits.

Please note that when using Visual Studio or Xcode, it is important to build the same configuration as was specified with `rtime-make`’s `--config` option. While it is possible to build a different configuration from the IDE, selecting a different configuration does *not* update the build configuration generated for *Connex DDS Micro*.

The GUI should be started from the `RTIMEHOME` directory. If this is not the case, check that:

- The source directory is the location of `RTIMEHOME`.
- The binary directory is the location of `RTIMEBUILD`.

With the **CMake** GUI running:

- Press ‘Configure’.
- Select a generator. You must have a compatible tool installed to process the generated files.
- Select ‘Use default native compilers’.
- Press ‘Done’.
- Press ‘Configure’.
- Check ‘Grouped’.
- Expand `RTIME` and select your build options. All available build options for *Connex DDS Micro* are listed here.
- Type a target name for **RTIME_TARGET_NAME**. This should be the same as the `<name>` used to create the `RTIMEBUILD` directory, that is the `RTIMEBUILD` should be on the form `<path>/<RTIME_TARGET_NAME>`.
- Press ‘Configure’. All red lines should disappear. Due to how **CMake** works, it is strongly recommended to always press ‘Configure’ whenever a value is changed for a variable. Other variables may depend on the modified variable and pressing ‘Configure’ will mark those with a red line. No red lines means everything has been configured.
- Press ‘Generate’. This creates the build-files in the `RTIMEBUILD` directory. Whenever an option is changed and Configure is re-run, press Generate again.
- Exit the GUI.

Depending on the generator, do one of the following:

- For IDE generators (such as Eclipse, Visual Studio, Xcode) open the generated solution/project files and build the project/solution.
- For command-line tools (such as `make`, `nmake`, `ninja`) change to the `RTIMEBUILD` directory and run the build-tool.

After a successful build, the output is placed in `RTIMEHOME/lib/<name>`.

The generated build-files may contain different sub-projects that are specific to the tool. For example, when using Xcode or Visual Studio, the following targets are available:

- `ALL_BUILD` - Builds all the projects.
- `rti_me_<name>` - Builds only the specific library. Note that that dependent libraries are built first.
- `ZERO_CHECK` - Runs [CMake](#) to regenerate project files in case something changed in the build input. This target does not need to be built manually.

For command-line tools, try `<tool> help` for a list of available targets to build. For example, if UNIX makefiles were generated:

```
make help
```

Creating Build Files for Connex DDS Micro Using CMake from the Command Line

Open a terminal window in the `RTIMEHOME` directory and create the `RTIMEBUILD` directory. Change to the `RTIMEBUILD` directory and invoke `cmake` using the following arguments:

```
cmake -G <generator> -DCMAKE_BUILD_TYPE=<Debug | Release> \  
      -DCMAKE_TOOLCHAIN_FILE=<toolchain file> \  
      -DRTIME_TARGET_NAME=<target-name>
```

Depending on the generator, do one of the following:

- For IDE generators (such as Eclipse, Visual Studio, Xcode) open the generated solution/project files and build the project/solution.
- For command-line tools (such as `make`, `nmake`, `ninja`) run the build-tool.

After a successful build, the output is placed in `RTIMEHOME/lib/<name>`.

The generated build-files may contain different sub-projects that are specific to the tool. For example, in Xcode and Visual Studio the following targets are available:

- `ALL_BUILD` - Builds all the projects.
- `rti_me_<name>` - Builds only the specific library. Note that that dependent libraries are built first.
- `ZERO_CHECK` - Runs [CMake](#) to regenerate project-files in case something changed in the build input. This target does not need to be built manually.

For command-line tools, try `<tool> help` for a list of available targets to build. For example, if UNIX makefiles were generated:

```
make help
```

CMake Flags used by Connex DDS Micro

The following CMake flags (-D) are understood by *Connex DDS Micro* and may be useful when building outside of the source bundle installed by RTI. An example would be incorporating the *Connex DDS Micro* source in a project tree and invoking cmake directly on the CMakeLists.txt provided by *Connex DDS Micro*.

- `-DRTIME_TARGET_NAME=\<name\>` - The name of the target (equivalent to `--name` to `rtime-make`). The default value is the name of the source directory.
- `-DRTIME_CMAKE_ROOT=\<path\>` - Where to place the CMake build files. The default value is `<source>/build/cmake`.
- `-DRTIME_BUILD_ROOT=\<path\>` - Where to place the intermediate build files. The default value is `<source>/build`.
- `-DRTIME_SYSTEM_FILE=\<file\>` or an empty string - This file can be used to set the `PLATFORM_LIBS` variable used by *Connex DDS Micro* to link with. If an empty string is specified no system file is loaded. This option may be useful when cmake can detect all that is needed. The default value is not defined, which means try to detect the system to build for.
- `-DRTI_NO_SHARED_LIB=true` - Do not build shared libraries. The default is undefined, which means shared libraries are built. NOTE: This flag must be undefined to build shared libraries. Setting the value to false is not supported.
- `-DRTI_MANUAL_BUILDID=true` - Do not automatically generate a build ID. The default value is undefined, which means generate a new build each time the libraries are built. Setting the value to false is not supported. The build ID is in its own source and only forces a recompile of a few files. Note that it is necessary to generate a build ID at least once (this is done automatically). Also, a build ID is not supported for cmake versions less than 2.8.11 because the `TIMESTAMP` function does not exist.
- `-DOPENSSLHOME=<path>` - Specifies the path to OpenSSL 1.0.1.
- `-DRTIME_TRUST_INCLUDE_BUILTIN=false` Excludes the builtin security plugin from the build.
- `-DRTIME_DDS_DISABLE_PARTICIPANT_MESSAGE_DATA=false` Disables P2P Message Data inter-participant channel. This channel is needed to use `DDS_AUTOMATIC_LIVENESS_QOS` and `DDS_MANUAL_BY_PARTICIPANT_LIVENESS_QOS` with a finite lease duration.

5.2.5 Connex DDS Micro Compile Options

The *Connex DDS Micro* source supports compile-time options. These options are in general used to control:

- Enabling/Disabling features.
- Inclusion/Exclusion of debug information.
- Inclusion/Exclusion of APIs.
- Target platform definitions.

- Target compiler definitions.

NOTE: It is no longer possible to build a single library using [CMake](#). Please refer to *Custom Build Environments* for information on customized builds.

Connex DDS Micro Debug Information

Please note that *Connex DDS Micro* debug information is independent of a debug build as defined by a compiler. In the context of *Connex DDS Micro*, debug information refers to inclusion of:

- Logging of error-codes.
- Tracing of events.
- Precondition checks (argument checking for API functions).

Unless explicitly included/excluded, the following rule is used:

- For `CMAKE_BUILD_TYPE = Release`, the `NDEBUG` preprocessor directive is defined. Defining `NDEBUG` includes logging, but excludes tracing and precondition checks.
- For `CMAKE_BUILD_TYPE = Debug`, the `NDEBUG` preprocessor directive is undefined. With `NDEBUG` undefined, logging, tracing and precondition checks are included.

To manually determine the level of debug information, the following options are available:

- **`OSAPI_ENABLE_LOG`** (Include/Exclude/Default)
 - Include - Include logging.
 - Exclude - Exclude logging.
 - Default - Include logging based on the default rule.
- **`OSAPI_ENABLE_TRACE`** (Include/Exclude/Default)
 - Include - Include tracing.
 - Exclude - Exclude tracing.
 - Default - Include tracing based on the default rule.
- **`OSAPI_ENABLE_PRECONDITION`** (Include/Exclude/Default)
 - Include - Include tracing.
 - Exclude - Exclude tracing.
 - Default - Include precondition checks based on the default rule.

Connex DDS Micro Platform Selection

The *Connex DDS Micro* build system looks for target platform files in `RTIMEHOME/include/os-api`. All files that match `*osapi_os_*.h` are listed under `RTIME_OSAPI_PLATFORM`. Thus, if a new port is added it will automatically be listed and available for selection.

The default behavior, `<auto detect>`, is to try to determine the target platform based on header-files. The following target platforms are known to work:

- Linux (posix)
- VOS (posix)
- QNX (posix)
- Darwin (posix)
- iOS (posix)
- Android (posix)
- Win32 (windows)
- VxWorks 6.9 and later (vxworks)

However, for custom ports this may not work. Instead the appropriate platform definition file can be selected here.

Connex DDS Micro Compiler Selection

The *Connex DDS Micro* build system looks for target compiler files in *RTIMEHOME/include/os-api*. All files that match **osapi_cc_*.h* are listed under **RTIME_OSAPI_COMPILER**. Thus, if a new compiler definition file is added it will automatically be listed and available for selection.

The default behavior, <auto detect>, is to try to determine the target compiler based on header-files. The following target compilers are known to work:

- GCC (stdc)
- clang (stdc)
- MSVC (stdc)

However, for others compilers this this may not work. Instead the appropriate compiler definition file can be selected here.

Connex DDS Micro UDP Options

Checking the **RTIME_UDP_ENABLE_IPALIASES** disables filtering out IP aliases. Note that this currently only works on platforms where each IP alias has its own interface name, such as eth0:1, eth1:2, etc.

Checking the **RTIME_UDP_ENABLE_TRANSFORMS_DOC** enables UDP transformations in the UDP transport.

Checking the **RTIME_UDP_EXCLUDE_BUILTIN** excludes the UDP transport from being built.

5.2.6 Cross-Compiling Connex DDS Micro

Cross-compiling the *Connex DDS Micro* source-code uses the exact same process described in *Compiling Connex DDS Micro*, but requires a additional *tool-chain file*. A tool-chain file is a [CMake](#) file that describes the compiler, linker, etc. needed to build the source for the target.

The *Connex DDS Micro* source bundle includes a few basic, generic tool-chain files for cross-compilation. In general it is expected that users will provide their own cross-compilation tool-chain files.

To see a list of available targets, use `--list` :

```
rttime-make --list
```

By convention, RTI only provides generic tool-chain files that can be used to build for a broad range of targets. For example, the Linux target can be used to build for any Linux architecture as long as it is a self-hosted build. The same is true for Windows and Darwin systems. The VxWorks tool-chain file uses the Wind River environment variables to select the compiler.

For example, to build on a Linux machine with Kernel 2.6 and gcc 4.7.3:

```
rttime-make --target Linux --name i86Linux2.6gcc4.7.3 --config Debug --build
```

By convention, a specific name such as `i86Linux2.6gcc4.4.5` is expected to only build for a specific target architecture. Note however that this cannot be enforced by the script provided by RTI. To create a target specific tool-chain file, copy the closest matching file and add it to the `RTIMEHOME/source/Unix/resource/CMake/architectures` or `RTIMEHOME/source/windows/resource/CMake/architectures` directory.

Once a tool-chain file has been created, or a suitable file has been found, edit it as needed. Then invoke `rttime-make`, specifying the new tool-chain file as the target architecture. For example:

```
rttime-make --target i86Linux2.6gcc4.4.5 --config Debug --build
```

5.2.7 Custom Build Environments

The preferred method to build *Connex DDS Micro* is to use [CMake](#). However, in some cases it may be more convenient, or even necessary, to use a custom build environment. For example:

- Embedded systems often have numerous compiler, linker and board specific options that are easier to manage in a managed build.
- The compiler cannot be invoked outside of the build environment, it may be an integral part of the development environment.
- Sometimes better optimization may be achieved if all the components of a project are built together.
- It is easier to port *Connex DDS Micro*.

Importing the Connex DDS Micro Code

The process for importing the *Connex DDS Micro* Source Code into a project varies depending on the development environment. However, in general the following steps are needed:

- Create a new project or open an existing project.
- Import the entire *Connex DDS Micro* source tree from the file-system. Note that some environments let you choose whether to make a copy only link to the original files.

- Add the following include paths:
 - <root>/include
 - <root>/src/dds_c/domain
 - <root>/src/dds_c/infrastructure
 - <root>/src/dds_c/publication
 - <root>/src/dds_c/subscription
 - <root>/src/dds_c/topic
 - <root>/src/dds_c/type
- Add a compile-time definition `-DTARGET="target name"` (note that the " must be included).
- Add a compile-time definition `-DNDEBUG` for a release build.
- Add a compile-time definition of either `-DRTI_ENDIAN_LITTLE` for a little-endian platform or `-DRTI_ENDIAN_BIG` for a big-endian platform.
- If custom OSAPI definitions are used, add a compile-time definition `-DOSAPI_OS_DEF_H="my_os_file"`.
- If custom compiler definitions are used, add a compile-time definition `-DOSAPI_CC_DEF_H="my_cc_file.h"`.

5.3 Porting RTI Connex DDS Micro

RTI Connex DDS Micro has been engineered for reasonable portability to platforms and environments which RTI does not have access to. This porting guide describes the features required by *Connex DDS Micro* to run. The target audience is developers familiar with general OS concepts, the standard C library, and embedded systems.

Connex DDS Micro uses an abstraction layer to support running on a number of platforms. The abstraction layer, OSAPI, is an abstraction of functionality typically found in one or more of the following libraries and services:

- Operating System calls
- Device drivers
- Standard C library

The OSAPI module is designed to be relatively easy to move to a new platform. All functionality, with the exception of the UDP transport which must be ported, is contained within this single module. It should be noted that although some functions may not seem relevant on a particular platform, they must still be implemented as they are used by other modules. For example, the port running on Stellaris with no OS support still needs to implement a threading model.

Please note that the OSAPI module is not designed to be a general purpose abstraction layer; its sole purpose is to support the execution of *Connex DDS Micro*.

5.3.1 Updating from Connex DDS Micro 2.4.8 and earlier

In *RTI Connex DDS Micro 2.4.9*, a few changes were made to simplify incorporating new ports. To upgrade an existing port to work with 2.4.9, follow these rules:

- Any changes to `osapi_config.h` should be placed in its own file (see *Directory Structure*).
- Define the `OSAPI_OS_DEF_H` preprocessor directive to include the file (refer to *OS and CC Definition Files*).
- For compiler-specific definitions, please refer to *OS and CC Definition Files*.
- Please refer to *Heap Porting Guide* for changes to the Heap routines that need to be ported.

5.3.2 Directory Structure

The source shipped with *Connex DDS Micro* is identical to the source developed and tested by RTI (with the exception of the the line-endings difference between the Unix and Windows source-bundles).

The source-bundle directory structure is as follows:

```

RTIMEHOME--+- CmakeLists.txt
|
+-- build -- cmake ---+-- Debug ---+-- <ARCH> -- <project-files>
|
|                               |
|                               +-- Release ---+-- <ARCH> -- <project-files>
+-- doc --
|
+-- example
|
+-- include
|
+-- lib +-+ <ARCH> -- <libraries>
|
+-- resource ---+-- cmake
|
|                               +-- scripts
|
+-- rtiddsgen
|
+-- rtiddsmag
|
+-- src

```

The include directory contains the external interfaces, those that are available to other modules. The src directory contains the implementation files. Please refer to *Building the Connex DDS Micro Source* for how to build the source code.

The remainder of this document focuses on the files that are needed to add a new port. The following directory structure is expected:

```

---+-- include ---+-- osapi ---+-- osapi_os_\

```

The `osapi_os_<port>.h` file contains OS specific definitions for various data-types. The `<port>` name should be short and in lower case, for example `myos`.

The `osapi_cc_<compiler>.h` file contains compiler specific definitions. The `<compiler>` name should be short and in lower case, for example `mycc`. The `osapi_cc_std.h` file properly detects GCC and MSVC and it is not necessary to provide a new file if one of these compilers is used.

The `<port>Heap.c`, `<port>Mutex.c`, `<port>Process.c`, `<port>Semaphore.c`, `<port>String.c` and `<port>System.c` files shall contain the implementation of the required APIs.

NOTE: It is *not* recommended to modify source files shipped with *Connex DDS Micro*. Instead if it is desired to start with code supplied by RTI it is recommended to *copy* the corresponding sub-directory, for example `posix`, and rename it. This way it is easier to upgrade *Connex DDS Micro* while keeping existing ports.

5.3.3 OS and CC Definition Files

The `include/osapi/osapi_os_<port>.h` file contains OS and platform specific definitions used by OSAPI and other modules. To include the platform specific file, define `OSAPI_OS_DEF_H` as a preprocessor directive.

```
-DOSAPI_OS_DEF_H=\"osapi_os_<port>.h\"
```

It should be noted that *Connex DDS Micro* does not use auto-detection programs to detect the host and target build environment and only relies on predefined macros to determine the target environment. If *Connex DDS Micro* cannot determine the target environment, it is necessary to manually configure the correct OS definition file by defining `OSAPI_OS_DEF_H` (see above).

The `include/osapi/osapi_cc_<compiler>.h` file contains compiler specific definitions used by OS-API and other modules. To include the platform specific file, define `OSAPI_CC_DEF_H` as a preprocessor directive.

```
-DOSAPI_CC_DEF_H=\"osapi_cc_<compiler>.h\"
```

Endianness of some platforms is determined automatically via the platform specific file, but for others either `RTI_ENDIAN_LITTLE` or `RTI_ENDIAN_BIG` must be defined manually for little-endian or big-endian, respectively.

5.3.4 Heap Porting Guide

Connex DDS Micro uses the heap to allocate memory for internal data-structures. With a few exceptions, *Connex DDS Micro* does *not* return memory to the heap. Instead, *Connex DDS Micro* uses internal pools to quickly allocate and free memory for specific types. Only the initial memory is allocated directly from the heap. The following functions must be ported:

- [OSAPI_Heap_allocate_buffer](#)
- [OSAPI_Heap_free_buffer](#)

However, if the OS and C library supports the standard malloc and free APIs define the following in the `osapi_os_<port>.h` file:

```
#define OSAPI_ENABLE_STDC_ALLOC (1)
#define OSAPI_ENABLE_STDC_REALLOC (1)
#define OSAPI_ENABLE_STDC_FREE (1)
```

Please refer to the [OSAPI_Heap](#) API for definition of the behavior. The available source code contains implementation in the file `osapi/<port>/<port>Heap.c`.

5.3.5 Mutex Porting Guide

Connex DDS Micro relies on mutex support to protect internal data-structures from corruption when accessed from multiple threads.

The following functions must be ported:

- [OSAPI_Mutex_new](#)
- [OSAPI_Mutex_delete](#)
- [OSAPI_Mutex_take_os](#)
- [OSAPI_Mutex_give_os](#)

Please refer to the [OSAPI_Mutex](#) API for definition of the behavior. The available source code contains implementation in the file `osapi/<port>/<port>Mutex.c`

5.3.6 Semaphore Porting Guide

Connex DDS Micro relies on semaphore support for thread control. If *Connex DDS Micro* is running on a non pre-emptive operating system with no support for IPC and thread synchronization,

it is possible to implement these functions as no-ops. Please refer to *Thread Porting Guide* for details regarding threading.

The following functions must be ported:

- [OSAPI_Semaphore_new](#)
- [OSAPI_Semaphore_delete](#)
- [OSAPI_Semaphore_take](#)
- [OSAPI_Semaphore_give](#)

Please refer to the [OSAPI_Semaphore](#) API for definition of the behavior. The available source code contains implementation in the file *osapi/<port>/<port>Semaphore.c*.

5.3.7 Process Porting Guide

Connex DDS Micro only uses the process API to retrieve a unique ID for the applications.

The following functions must be ported:

- [OSAPI_Process_getpid](#)

Please refer to the [OSAPI_Process_getpid](#) API for definition of the behavior. The available source code contains implementation in the file *osapi/<port>/<port>Process.c*.

5.3.8 System Porting Guide

The system API consists of functions which are more related to the hardware on which *Connex DDS Micro* is running than on the operating system. As of *Connex DDS Micro 2.3.1*, the system API is implemented as an interface as opposed to the previous pure function implementation. This change makes it easier to adapt *Connex DDS Micro* to different hardware platforms without having to write a new port.

The system interface is defined in [OSAPI_SystemI](#), and a port must implement all the methods in this structure. In addition, the function [OSAPI_System_get_native_interface](#) must be implemented. This function must return the system interface for the port (called the native system interface).

The semantics for the methods in the interface are exactly as defined by the corresponding system function. For example, the method [OSAPI_SystemI::get_time](#) must behave exactly as that described by [OSAPI_System_get_time](#).

The following system interface methods must be implemented in the [OSAPI_SystemI](#) structure:

- [OSAPI_SystemI::get_timer_resolution](#)
- [OSAPI_SystemI::get_time](#)
- [OSAPI_SystemI::start_timer](#)
- [OSAPI_SystemI::stop_timer](#)
- [OSAPI_SystemI::generate_uuid](#)
- [OSAPI_SystemI::get_hostname](#)

- [OSAPI_SystemI::initialize](#)
- [OSAPI_SystemI::finalize](#)

Please refer to the [OSAPI_System](#) API for definition of the behavior. The available source code contains implementation in the file: *osapi/<port>/<port>System.c*.

Migrating a 2.2.x port to 2.3.x

In *Connex DDS Micro 2.3.x*, changes were made to how the system API is implemented. Because of these changes, existing ports must be updated, and this section describes how to make a *Connex DDS Micro 2.2.x* port compatible with *Connex DDS Micro 2.3.x*.

If you have ported *Connex DDS Micro 2.2.x* the following steps will make it compatible with version 2.3.x:

- Rename the following functions and make them private to your source code. For example, rename `OSAPI_System_get_time` to `OSAPI_MyPortSystem_get_time` etc.
 - [OSAPI_System_get_time](#)
 - [OSAPI_System_get_timer_resolution](#)
 - [OSAPI_System_start_timer](#)
 - [OSAPI_System_stop_timer](#)
 - [OSAPI_System_generate_uuid](#)
- Implement the following new methods.
 - [OSAPI_SystemI::get_hostname](#)
 - [OSAPI_SystemI::initialize](#)
 - [OSAPI_SystemI::finalize](#)
- Create a system structure for your port using the following template:

```

struct OSAPI_MyPortSystem
{
    struct OSAPI_System _parent;

    Your system variable
};

static struct OSAPI_MyPortSystem OSAPI_System_g;

/* OSAPI_System_gv_system is a global system variable used by the
 * generic system API. Thus, the name must be exactly as
 * shown here.
 */
struct OSAPI_System * OSAPI_System_gv_system = &OSAPI_System_g._parent;

```

- Implement [OSAPI_System_get_native_interface](#) method and fill the [OSAPI_SystemI](#) structure with all the system methods.

5.3.9 Thread Porting Guide

The thread API is used by *Connex DDS Micro* to create threads. Currently only the UDP transport uses threads and it is a goal to keep the generic *Connex DDS Micro* core library free of threads. Thus, if *Connex DDS Micro* is ported to an environment with no thread support, the thread API can be stubbed out. However, note that the UDP transport must be ported accordingly in this case; that is, all thread code must be removed and replaced with code appropriate for the environment.

The following functions must be ported:

- [OSAPI_Thread_create](#)
- [OSAPI_Thread_sleep](#)

Please refer to the [OSAPI_Thread](#) API for definition of the behavior. The available source code contains implementation in the file *srcC/osapi/<platform>/Thread.c*.

Chapter 6

Working with RTI Connex DDS Micro and RTI Connex DDS

In some cases, it may be necessary to write an application that is compiled against both *RTI Connex DDS Micro* and *RTI Connex DDS*. In general this is not easy to do because *RTI Connex DDS Micro* supports a very limited set of features compared to *RTI Connex DDS*.

However, due to the nature of the DDS API and the philosophy of declaring behavior through QoS profiles instead of using different APIs, it may be possible to share common code. In particular, *RTI Connex DDS* supports configuration through QoS profile files, which eases the job of writing portable code.

Please refer to *Introduction* for an overview of features and what is supported by *RTI Connex DDS Micro*. Note that *RTI Connex DDS* supports many extended APIs that are not covered by the DDS specification, for example APIs that create DDS entities based on QoS profiles.

6.1 Development Environment

There are no conflicts between *RTI Connex DDS Micro* and *RTI Connex DDS* with respect to library names, header files, etc. It is advisable to keep the two installations separate, which is the normal case.

RTI Connex DDS Micro uses the environment variable `RTIMEHOME` to locate the root of the *RTI Connex DDS Micro* installation.

RTI Connex DDS uses the environment variable `NDDSHOME` to locate the root of the *RTI Connex DDS* installation.

6.2 Non-standard APIs

The DDS specification omits many APIs and policies necessary to configure a DDS application, such as transport, discovery, memory, logging, etc. In general, *RTI Connex DDS Micro* and *RTI Connex DDS* do not share APIs for these functions.

It is recommended to configure *RTI Connex DDS* using QoS profiles as much as possible.

6.3 QoS Policies

QoS policies defined by the DDS standard behave the same between *RTI Connex DDS Micro* and *RTI Connex DDS*. However, note that *RTI Connex DDS Micro* does not always support all the values for a policy and in particular unlimited resources are not supported.

Unsupported QoS policies are the most likely reason for not being able to switch between *RTI Connex DDS Micro* and *RTI Connex DDS*.

6.4 Standard APIs

APIs that are defined by the standard behave the same between *RTI Connex DDS Micro* and *RTI Connex DDS*.

6.5 IDL Files

RTI Connex DDS Micro and *RTI Connex DDS* use the same IDL compiler (rtiddsgen) and *RTI Connex DDS Micro* typically ships with the latest version. However, *RTI Connex DDS Micro* and *RTI Connex DDS* use different templates to generate code and it is not possible to share the generated code. Thus, while the same IDL can be used, the generated output must be saved in different locations.

@section microcore_interop Interoperability

In general, *RTI Connex DDS Micro* and *RTI Connex DDS* are wire interoperable, unless noted otherwise.

All RTI products, aside from *RTI Connex DDS Micro*, are based on *RTI Connex DDS*. Thus, in general *RTI Connex DDS Micro* is compatible with RTI tools and other products. The following sections provide additional information for each product.

When trying to establish communication between an *RTI Connex DDS Micro* application that uses the Dynamic Participant / Static Endpoint (DPSE) discovery module and an RTI product based on *RTI Connex DDS*, every participant in the DDS system must be configured with a unique participant name. While the static discovery functionality provided by *RTI Connex DDS* allows participants on different hosts to share the same name, *RTI Connex DDS Micro* requires every participant to have a different name to help keep the complexity of its implementation suitable for smaller targets.

6.6 Admin Console

Admin Console can discover and display *RTI Connex DDS Micro* applications that use full dynamic discovery (DPDE). When using static discovery (DPSE), it is required to use the Limited Bandwidth Endpoint Discovery (LBED) that is available as a separate product for *RTI Connex DDS*. With the library a configuration file with the discovery configuration must be provided (just as in the case for products such as Routing Service, etc.). This is provided through the QoS XML file.

Data can be visualized from *RTI Connex DDS Micro* DataWriters. Keep in mind that *RTI Connex DDS Micro* does not currently distribute type information and the type information has to be provided through an XML file using the “Create Subscription” dialog. Unlike some other

products, this information cannot be provided through the QoS XML file. To provide the data types to Admin Console, first run the code generator with the `-convertToXml` option:

```
rtiddsgen -convertToXml <file>
```

Then click on the “Load Data Types from XML file” hyperlink in the “Create Subscription” dialog and add the generated IDL file.

Other Features Supported:

- Match analysis is supported.
- Discovery-based QoS are shown.

The following resource-limits in *RTI Connex DDS Micro* must be incremented as follows when using Admin Console:

- Add 24 to `DDS_DomainParticipantResourceLimitsQosPolicy::remote_reader_allocation`
- Add 24 to `DDS_DomainParticipantResourceLimitsQosPolicy::remote_writer_allocation`
- Add 1 to `DDS_DomainParticipantResourceLimitsQosPolicy::remote_participant_allocation`
- Add 1 to `DDS_DomainParticipantResourceLimitsQosPolicy::remote_participant_allocation` if data-visualization is used

RTI Connex DDS Micro does not currently support any administration capabilities or services, and does not match with the Admin Console DataReaders and DataWriters. However, if matching DataReaders and DataWriters are created, e.g., by the application, the following resource must be updated:

- Add 48 to `DDS_DomainParticipantResourceLimitsQosPolicy::matching_writer_reader_pair_allocation`

6.7 Distributed Logger

This product is not supported by *RTI Connex DDS Micro*.

6.8 LabVIEW

The LabVIEW toolkit uses *RTI Connex DDS*, and it must be configured as any other *RTI Connex DDS* application. A possible option is to use the builtin *RTI Connex DDS* profile: `Builtin-QoSLib::Generic.ConnexMicroCompatibility`.

6.9 Monitor

This product is not supported by *RTI Connex DDS Micro*.

6.10 Recording Service

6.10.1 RTI Recorder

RTI Recorder is compatible with *RTI Connex DDS Micro* in the following ways:

- If static endpoint discovery is used, Recorder is compatible starting with version 5.1.0.3 and onwards.
- If dynamic endpoint discovery is used, Recorder is compatible with *RTI Connex DDS Micro* the same way it is with any other DDS application.
- In both cases, type information has to be provided via XML. Read [Recording Data with RTI Connex DDS Micro](#) for more information.

6.10.2 RTI Replay

RTI Replay is compatible with *RTI Connex DDS Micro* in the following ways:

- If static endpoint discovery is used, Replay is compatible starting with version 5.1.0.3 and onwards.
- If dynamic endpoint discovery is used, Replay is compatible with *RTI Connex DDS Micro* the same way it is with any other DDS application.
- In both cases, type information has to be provided via XML. Read [Recording Data with RTI Connex DDS Micro](#) for more information on how to convert from IDL to XML.

6.10.3 RTI Converter

Databases recorded with *RTI Connex DDS Micro* contains no type information in the DCPSPublication table, but the type information can be provided via XML. Read [Recording Data with RTI Connex DDS Micro](#) for more information on how to convert from IDL to XML.

6.11 Spreadsheet Addin

RTI Connex DDS Micro can be used with Spreadsheet Add-in starting with version 5.2.0. The type information must be loaded from XML files.

6.12 Wireshark

Wireshark fully supports *RTI Connex DDS Micro*.

6.13 Persistence Service

RTI Connex DDS Micro only supports VOLATILE and TRANSIENT_LOCAL durability and does not support the use of Persistence Service.

Chapter 7

API Reference

RTI Connex DDS Micro features API support for C and C++. Select the appropriate language below in order to access the corresponding API Reference HTML documentation.

- [C API Reference](#)
- [C++ API Reference](#)

Chapter 8

Release Notes

8.1 Supported Platforms and Programming Languages

Connex DDS Micro supports the C and traditional C++ language bindings.

Note that RTI only tests on a subset of the possible combinations of OSs and CPUs. Please refer to the following table for a list of specific platforms and the specific configurations that are tested by RTI.

OS	CPU	Com- piler	RTI Architecture Abbreviation
Red Hat® Enterprise Linux® 6.0, 6.1 (Kernel version 2.6)	x86	gcc 4.4.5	i86Linux2.6gcc4.4.5
Ubuntu® 18.04 (Kernel version 4)	x64	gcc 7.3.0	x64Linux4gcc7.3.0
Ubuntu 16.04 (Kernel version 3)	x86	gcc 5.4.0	i86Linux3gcc5.4.0
PPC Linux (Kernel version 2.6)	ppc7400	gcc 3.3.3	ppc7400Linux2.6gcc3.3.3
macOS® 10.16	x64	clang 8.0	x64Darwin16clang8.0
QNX® 7.0	armv8	qcc 5.4.0	armv8QNX7.0.0qcc_gpp5.4.0
QNX 6.6	armv7a	qcc 4.7.3	armv7aQNX6.6.0qcc_cpp4.7.3
QNX 6.6	i86	qcc 4.7.3	i86QNX6.6qcc_cpp4.7.3
Windows® 7	x86	Visual Studio® 2010	i86Win32VS2010
Windows® 7	x64	Visual Studio® 2015	x64Win64VS2015

8.2 Compatibility

For backward compatibility information between 3.0.2 and previous releases, see the *Migration Guide* on the RTI Community Portal (<https://community.rti.com/documentation>).

8.3 What's New in 3.0.2

8.3.1 Micro Application Generation examples now use `ignore_loopback_interface`

Micro Application Generation (MAG) examples now use `ignore_loopback_interface = 0` to tell MAG that the loopback interface should be used. Using this setting is preferred over using a unicast address in `multicast_receive_addresses`.

8.3.2 Support for custom prefix properties when configuring the security plugin

Connex DDS Micro now supports custom prefixes for the RTI specific properties in the security plugin. This property is optional and properties can still be used without the prefixes.

8.3.3 Updated OpenSSL version

The *Connex DDS Micro* security plugin now requires OpenSSL version 1.1.1d or higher. Note that OpenSSL 1.1.x is NOT backward compatible with 1.0.x.

8.3.4 Support for payload encryption between local endpoints

Connex DDS Micro now supports payload encryption for endpoints between endpoints in the same DomainParticipant. Note that payload encryption is not performed for communication over the INTRA transport.

8.3.5 Performance optimization on serialization/deserialization for sequences with complex elements

This release improves the serialization/deserialization performance for sequences containing complex elements when the element type has the following properties:

- It is marked as `@final`.
- It only contains primitive members, or complex members with only primitive members.

For example:

```
@final
struct Point {
    long x;
    long y;
};

@final
struct MyType {
    sequence<Point, 1000> points;
};
```

The optimization is applied to the code generation only when the optimization level (`-optimization`) is set to 2 (default value). The optimization always applies to `DynamicData`.

8.3.6 Protocol improvements for fragmented samples

This release includes minor improvements to the reliability protocol to prevent excessive retransmission of fragments when the subscriber's network stack is unable to buffer at least one sample.

8.4 What's Fixed in 3.0.2

8.4.1 Sample filtering methods are always added to the subscriber code for C

The generated subscriber example code always included code to filter samples-based fields in the IDL type. However, if the generated IDL file was modified to exclude these fields, the code would fail to compile. The generated code now includes instructions for how to filter instead.

[RTI Issue ID MICRO-1980]

8.4.2 Incorrect text in error message when specifying security properties programmatically

When specifying security plugin properties via code, one must prefix the property with `data:.`. However, the error message stated to prefix with `data:` instead of `data:.`. This issue has been fixed.

[RTI Issue ID MICRO-2127]

8.4.3 Invalid serialization of samples with types containing primitive members that require padding

The serialization of samples with a type containing a nested complex type with primitive members that require padding may have failed. This means that a `DataReader` may have received an invalid value for a sample.

```
@nested struct Struct_3 {
    float m1;
    long long m2;
    short m3;
};

@nested struct Struct_2 {
    Struct_3 m1;
};

struct Struct_1 {
    Struct_2 m1;
};
```

In the above example, `Struct_3` is nested, and there is padding between `m1` (4-byte aligned) and `m2` (8-byte aligned) of 4 bytes.

This problem affected `DynamicData` and the generated code for the following languages: C and C++.

For generated code, a potential workaround to this problem was to generate code with a value of 1 for the `-optimization`, but this may have had performance implications.

This problem has been resolved.

[RTI Issue ID MICRO-2133]

8.4.4 Compiler warning in FreeRTOS port

When compiling the FreeRTOS port, the following warning may have been given by the compiler:

```
passing argument 1 of 'xTaskCreate' from incompatible pointer type freertosThread.c
```

This issue has been fixed.

[RTI Issue ID MICRO-2153]

8.4.5 HelloWorld_dpde_waitset C++ example uses wrong loop variable for printing data

When multiple samples are loaned by calling `take()`, the HelloWorld_dpde_waitset C++ example uses the wrong loop variable, `i`, with `data_seq`, instead of the correct index `j`. This issue has been fixed.

[RTI Issue ID MICRO-2158]

8.4.6 Warning DDSC_LOG_DESERIALIZE_UNKNOWN_PID_EC is logged when security is disabled

The following INFO message was always logged when security was not compiled:

```
[1572432716.821711998]INFO: ModuleID=7 Errcode=1209 X=1 E=0 T=1
dds_c/ParticipantBuiltinTopicDataPlugin.c:443/DPDE_ParticipantBuiltinTopicData_
↔deserialize_pv: pid=89 length=176
```

This issue has been fixed.

[RTI Issue ID MICRO-2162]

8.4.7 High memory usage with security enabled

Enabling security may have caused very high application memory usage. This release reduces the amount of memory allocated.

[RTI Issue ID MICRO-2164]

8.4.8 FlatData: possible compilation error building data for a type with a sequence with Traditional C++

Applications using the member function `FinalSequenceBuilder::add_n(count)` failed to compile when the FlatData™ language binding was used with the Traditional C++ API. The member function `add_next()` could be used instead, but `add_n` may achieve better performance. This problem affected types containing sequences of final structs. This problem has been resolved.

[RTI Issue ID MICRO-2187]

8.4.9 FlatData: Conversion warning on some platforms

Applications using FlatData types may have seen a warning such as the following:

```
warning: conversion to 'unsigned int' from 'long unsigned int' may alter its value [-
↔Wconversion]
enum { value = primitive_lc_code_helper<sizeof(T)>::single };
```

This issue has been fixed.

[RTI Issue ID MICRO-2189]

8.4.10 FlatData: Bad performance of PrimitiveSequenceBuilder:add_n

The function `PrimitiveSequenceBuilder::add_n(int count)`, which adds a number of elements to a primitive sequence in a `FlatData` sample, initialized the new elements to zero. This initialization added unnecessary latency to the sample-building process.

This problem has been resolved by avoiding the initialization in that function, and by adding a separate overload (`PrimitiveSequenceBuilder::add_n(int count, T value)`) that initializes the elements.

[RTI Issue ID MICRO-2190]

8.4.11 Large timeout values, e.g liveliness and deadline, may cause segmentation fault

Large timeout values, larger than 2000s, may have caused a segmentation fault during creation of DDS entities. This issue has been fixed.

[RTI Issue ID MICRO-2192]

8.4.12 Generated public APIs to serialize/deserialize samples do not work within an IDL module when the -namespace option is used with rtdidsgen

The code generated with the `-namespace` option to `rtdidsgen` would fail to compile if the IDL file contained more than one IDL module. This issue has been fixed.

[RTI Issue ID MICRO-2194]

8.4.13 Configuring the DPDE Discovery Plugin with max_samples_per_remote_builtin_writer > 1 may result in discovery samples not being processed

If the Dynamic Participant Dynamic Endpoint (DPDE) discovery plugin was configured with a `max_samples_per_remote_builtin_writer > 1`, discovery samples may have been received but not processed. This would typically happen when more than 1 discovery sample was being processed at a time. This issue has been resolved.

[RTI Issue ID MICRO-2195]

8.4.14 Read/take APIs returned more than depth samples if an instance returned to alive without application reading NOT_ALIVE sample

If an instance transitioned from `NOT_ALIVE_NO_WRITERS` or `NOT_ALIVE_DISPOSED` to `ALIVE` and the application did not read/take the sample indicating `NOT_ALIVE_NO_WRITERS` or `NOT_ALIVE_DISPOSED`, the number of samples returned would exceed the depth set by the History QoS policy. This issue has been fixed.

[RTI Issue ID MICRO-2196]

8.4.15 An application may have terminated with a segmentation fault if OS-API_Semaphore_give() was called from one thread while another called OS-API_Semaphore_delete()

An application may have terminated with a segmentation fault if `OSAPI_Semaphore_give()` was called from one thread while another called `OSAPI_Semaphore_delete()` on Unix-like systems.

This issue has been resolved.

[RTI Issue ID MICRO-2209]

8.4.16 PUBLICATION_MATCHED_STATUS and SUBSCRIPTION_MATCHED_STATUS may never trigger a WaitSet if the status is enabled after the DomainParticipant is enabled

A StatusCondition with a PUBLICATION_MATCHED_STATUS or SUBSCRIPTION_MATCHED_STATUS enabled may have never triggered a WaitSet if the status was enabled after the DomainParticipant was enabled. This issue has been resolved.

[RTI Issue ID MICRO-2219]

8.5 Previous Releases

8.5.1 What's New in 3.0.1

Support for FreeRTOS and ThreadX

This release includes support for the FreeRTOS™ and ThreadX® operating systems.

New QoS parameter to adjust preemptive ACKNACK period

A new QoS parameter has been introduced to expose the preemptive ACKNACK period on DataReaders. The new parameter is configured with:

- `DDS_DataReaderQos.protocol.rtps_reliable_reader.nack_period` for user DataReaders
- `builtin_endpoint_reader_nack_period` for the builtin discovery endpoints in the Dynamic discovery plugin.

Please see the reference API for details.

Deserialization of Presentation QoS policy

This release provides better support for the Presentation QoS policy. Previously this QoS policy was not supported by the DataWriter; the default value was assumed for a discovered DataReader, which caused an “Unknown QoS” warning when the it was received. In this release, DataWriters will deserialize the Presentation QoS policy and check for compatibility.

Dynamic memory allocations removed from Dynamic Discovery Plugin

The dynamic discovery plugin in *Connex DDS Micro* allocated memory dynamically after the DomainParticipant was enabled to store discovered type and topic names. This release includes improvements which make it possible to avoid all memory allocations.

Dynamic memory allocations are avoided by creating the DomainParticipant in a disabled state and creating all local endpoints before the DomainParticipant is enabled.

A DomainParticipant is created in a disabled state by setting `DomainParticipantFactoryQos.entity_factory.autoenable_created_entities = DDS_BOOLEAN_TRUE` before calling

`create_participant()`. When all entities have been created, call `enable()` on the `DomainParticipantFactory` to enable all entities.

New APIs to serialize and deserialize samples

Two new APIs are available to applications to serialize and deserialize samples, for example for record and replay type applications. Please see the C and C++ API reference manuals under “DDS API->Topic->User Data Type Support” for a details.

New QoS parameter to set max outstanding samples allowed for remote DataWriter

A new QoS parameter has been exposed for the endpoint discovery endpoints in the dynamic endpoint discovery plugin (DPDE). You can set the new field, `max_samples_per_remote_builtin_endpoint_writer` in `DPDE_DiscoveryPluginProperty`, to increase the number of samples a remote writer may have per builtin endpoint reader and thus decrease network traffic. Please refer to the DPDE reference manual for a description of this new parameter.

DomainParticipants no longer allocate dynamic memory during deletion

`DomainParticipants` will no longer allocate dynamic memory during deletion.

8.5.2 What's Fixed in 3.0.1

DomainParticipant creation failed if active interface had invalid IP

An active interface without a valid IP address assigned may have caused `DomainParticipant` creation to fail. This problem has been resolved. Now if an interface with an invalid IP address is used, it will be ignored and the `DomainParticipant` will still be created.

[RTI Issue ID MICRO-1602]

Incorrect C++ example publisher generated for certain annotations

Generating a C++ example for a type annotated with `@transfer_mode(SHMEM_REF)` and `@language_binding(FLAT_DATA)` caused the publisher to run out of available loanable samples to publish. This problem has been resolved.

[RTI Issue ID MICRO-1998]

Liveliness lease duration matching did not follow OMG specification

Connex DDS Micro allowed a `Writer` to match with a remote `Reader` if the requested `Liveliness` lease duration was `INFINITE`, ignoring the `Liveliness` kind. This behavior did not follow the OMG specification. Now matching will only occur if both these conditions are true:

- Requested `Liveliness` lease duration is \geq the Offered lease duration.
- Requested `Liveliness` kind is \leq the Offered `Liveliness` kind, where `AUTOMATIC_LIVELINESS_KIND < MANUAL_BY_PARTICIPANT_LIVELINESS_KIND < MANUAL_BY_TOPIC_LIVELINESS_KIND`.

[RTI Issue ID MICRO-2007]

rttime-make did not work when started from different shell than Bash

`rttime-make` requires Bash on UNIX systems. However it did not explicitly launch Bash and would fail if started from a Bash-incompatible shell. The script now always launches `/bin/bash` as the shell.

[RTI Issue ID MICRO-2013]

UDP interface warning using valid interfaces

Connex DDS Micro logged a warning if no new interfaces were added for each address listed in the `enabled_transports`.

This applied to the `enabled_transports` field in the `DiscoveryQosPolicy` and `UserTrafficQosPolicy` in the `DomainParticipantQos`, and the `DDS_TransportQosPolicy` in the `DataReaderQos` and `DataWriterQos`.

This problem has been resolved. Now *Connex DDS Micro* will only log a warning if no new interfaces are added per enabled transport.

[RTI Issue ID MICRO-2018]

Payload encryption did not work when using extensible types

Due to a miscalculation of resources, payload encryption failed when using extensible types. This problem has been resolved.

[RTI Issue ID MICRO-2020]

Duplicate DATA messages sent to multicast in some cases

Duplicate DATA messages were sent to multicast when multiple DataReaders were configured with multicast and unicast receive addresses. This problem has been resolved.

[RTI Issue ID MICRO-2043]

Could not build source with `OSAPI_ENABLE_LOG=0`

The *Connex DDS Micro* source was compiled with the `-DOSAPI_ENABLE_LOG=0`. This problem has been resolved.

[RTI Issue IDs MICRO-2049, MICRO-2048]

Compilation error when inter-participant channel disabled

When disabling the inter-participant channel at compile time, the compiler reported an error. This problem has been resolved.

[RTI Issue ID MICRO-2051]

Seq_copy on a loaned or discontinuous sequence caused incorrect behavior

Calling `Fooseq_copy()` on a loaned or discontinuous sequence did not work correctly. This problem has been resolved.

[RTI Issue ID MICRO-2053]

Compiler warning with const IDL strings or strings

When declaring a const string or string in IDL, the compiler may have reported a warning. This problem has been resolved.

[RTI Issue ID MICRO-2054]

Warnings in header file due to conversion between RTI_BOOL C type and bool C++ type

When compiling the security source, the compiler may have reported a warning: “Warnings in header file due to conversion between RTI_BOOL C type and bool C++ type. ” This problem has been resolved.

[RTI Issue ID MICRO-2056]

DDS_Subscriber_create_datareader() affected by local_writer_allocation limit

The maximum number of DataReaders that could be created was determined by the `DomainParticipant.resource_limits.local_writer_allocation` resource limit. This problem has been resolved.

[RTI Issue ID MICRO-2065]

Restarting remote participant when using DPSE caused DDSC_LOG_PARTICIPANT_LOOKUP error

When a remote participant was restarted twice or more when using the static discovery plugin (DPSE), the error message `DDSC_LOG_PARTICIPANT_LOOKUP` was logged. This problem has been resolved.

[RTI Issue ID MICRO-2088]

‘Failure to give mutex’ error

In *Connex DDS Micro* 3.0.0, a subtle race condition may have occurred on multi-core machines. When this happened, an error message about failing to give a mutex would be printed: error code (EC) 44 in module 1 (OSAPI). This problem has been resolved.

[RTI Issue ID MICRO-2095]

DDS_LOG_DR_DESERIALIZE_KEYHASH error

A `DDS_LOG_DR_DESERIALIZE_KEYHASH` error may have been logged, in particular on Linux systems. This issue has been partially fixed in this release.

However, this error may still be logged if the first sample received for an instance is the dispose sample and the dispose sample does not contain the key fields. This is always the case with *Connex DDS Micro* and may be the case with *Connex DDS Professional*, if sending the key fields has been disabled. The error is benign and does not cause any communication failure.

[RTI Issue ID MICRO-2097]

Entity ID generation was not thread-safe

Entity ID generation for DataReaders and DataWriters was not thread-safe and may have lead to duplicate entity IDs. This problem has been resolved.

[RTI Issue ID MICRO-2104]

Fully dropped fragmented sample caused communication to stop with KEEP_ALL on DataWriter

The combination of a HistoryQosPolicy kind of KEEP_ALL and having fragmented samples may have caused communication to stop between a writer and reader if all fragments for a sample were lost. This problem has been resolved.

[RTI Issue ID MICRO-2114]

DDS_WaitSet_wait() returned DDS_RETCODE_ERROR if unblocked with no active conditions

An application that used a combination of polling a DataReader and blocking on a DDS_WaitSet may have caused DDS_WaitSet_wait() to return DDS_RETCODE_ERROR. This happened if the DDS_WaitSet was unblocked by an attached condition, but there were no active conditions. This problem has been resolved.

[RTI Issue ID MICRO-2115]

ALREADY_EXISTS error printed in high-load scenarios

The error code (EC) 23, module 2 (DB) may have been printed if a system was under heavy load and participant lease durations expired. This problem has been resolved.

[RTI Issue ID MICRO-2116]

Publication handle not set in SampleInfo structure when on_before_sample_commit() called

The publication_handle member of the DDS_SampleInfo structure passed to a DataReader's on_before_sample_commit() function was not set. This problem has been resolved.

[RTI Issue ID MICRO-2121]

Using serialize_data_to_cdr_buffer() with statically allocated buffer gave wrong results

Using serialize_data_to_cdr_buffer with a statically allocated buffer may have caused incorrect results if a re-alignment of the buffer size was required.

Foo_serialize_data_to_cdr_buffer() did not support a buffer that was not aligned to 4. This issue has been resolved.

Note that it is still a requirement that the buffer is aligned to at least 4.

[RTI Issue ID MICRO-2130]

Instance resources exhausted even with DDS_REPLACE_OLDEST_INSTANCE_REPLACEMENT_QOS

Instance resources may have been exhausted on the DataReader even when `DDS_REPLACE_OLDEST_INSTANCE_REPLACEMENT_QOS` was specified as the instance-replacement policy and the DataReader was configured to support both XCDRv1 and XCDRv2. This problem has been resolved.

[RTI Issue ID MICRO-2140]

UDP Transformation feature did not work in version 3.0.0

The UDP Transformation feature was not updated from *Connex DDS Micro 2* to work with *Connex DDS Micro 3*. This problem has been resolved. Please refer to the HelloWorld_transformations example, as *Connex DDS Micro 3* uses a different packet structure than *Connex DDS Micro 2*.

[RTI Issue ID MICRO-2144]

Flow-controller with insufficient bandwidth may have caused communication failure

A flow-controller configured with less bandwidth than required based on the publication rate may have caused a communication failure when a data writer was configured with `KEEP_LAST`. This problem has been resolved.

[RTI Issue ID MICRO-2155]

8.5.3 What's New in 3.0.0.1

New APIs to Serialize and Deserialize Samples

Two new APIs are available to applications to serialize and deserialize samples, for example for record and replay type applications. Please refer to the C and C++ API reference manuals under “DDS API->Topic->User Data Type Support” for a details.

Dynamic Memory allocations removed from the Dynamic Discovery Plugin

In previous versions of *Connex DDS Micro* the dynamic discovery plugin (DPDE) allocates memory after the DomainParticipant is enabled to store discovered Topic and Type names. This release includes improvements which make it possible to avoid all memory allocations after the DomainParticipant is enabled.

When a DomainParticipant discovers a Topic that exists locally no memory is allocated. However, if a Topic is discovered that does not exist locally memory is allocated to store the Topic and Type names.

In order to avoid all dynamic memory allocations during discovery the following rules must be followed:

- Create the DomainParticipant disabled by setting `DomainParticipantFactoryQos.entity_factory.autoenable_created_entities = DDS_BOOLEAN_FALSE` before calling `create_participant()`.

- Create all local DataReaders and DataWriters for all Topics that will be discovered.
- If it is possible to discover DomainParticipants that will not match with local DataReaders and DataWriters, set *DomainParticipantFactoryQos.discovery.accept_unknown_peers = DDS_BOOLEAN_FALSE* and list all DomainParticipants that should be discovered in *DomainParticipantFactoryQos.discovery.initial_peers*.
- Call *enable()* on the DomainParticipant to enable all entities.

A known limitation is that it is not possible ignore specific Topics.

8.5.4 What's Fixed in 3.0.0.1

Cannot build source with `OSAPI_ENABLE_LOG=0`

The *Connex DDS Micro* source did not compile when logging was disabled with the preprocessor definition `-DOSAPI_ENABLE_LOG=0`. This has been fixed.

[RTI Issue ID MICRO-2049], [RTI Issue ID MICRO-2048]

`DDS_Subscriber_create_datareader()` was affected by the `local_writer_allocation` limit

The maximum number of DataReaders that could be created was determined by the *DomainParticipant.resource_limits.local_writer_allocation* resource limit. This issue has been fixed.

[RTI Issue ID MICRO-2065]

8.5.5 What's New in 3.0.0

Support for XCDR encoding version 2

This release adds support for the standard XCDR encoding version 2 data representation described in the “Extensible and Dynamic Topic Types for DDS” specification. This encoding version is more efficient in terms of bandwidth than XCDR encoding version 1, which is supported in previous *Connex DDS* releases (and still supported in this release).

To select between XCDR and XCDR2 data representations, you can use the *DataRepresentationQosPolicy* for DataReaders and DataWriters. *Connex DDS Micro* now supports this policy. You may specify XCDR, XCDR2, or AUTO to indicate which versions of the Extended Common Data Representation (CDR) are offered and requested. The default is AUTO.

A DataWriter offers a single representation, which indicates the CDR version the DataWriter uses to serialize its data. A DataReader requests one or more representations, which indicate the CDR versions the DataReader accepts. If a DataWriter's offered representation is contained within a reader's sequence of requested representations, then the offer satisfies the request, and the policies are compatible. Otherwise, they are incompatible. In support of this feature, a new QoS, `DATA_REPRESENTATION`, has been added for the DataWriter and DataReader. There is also a new annotation, `@allowed_data_representation`, that can be used to select the supported data representations for a type.

For more information, see:

- the “Extensible and Dynamic Topic Types for DDS” specification from the Object Management Group (OMG): <https://www.omg.org/spec/DDS-XTypes/>.

- the section on the DATA_REPRESENTATION QoS Policy, in the *RTI Connex DDS Core Libraries User's Manual* (available [here](#) if you have Internet access).
- the Data Representation chapter, in the *RTI Connex DDS Core Libraries Getting Started Guide Addendum for Extensible Types* (available [here](#) if you have Internet access).

Large data streaming using RTI FlatData™ language binding and Zero Copy transfer over shared memory

To meet strict latency requirements, you can reduce the default number of copies made by the middleware when publishing and receiving large samples (on the order of MBs) by using two new features: FlatData language binding and Zero Copy transfer over shared memory.

These features can be used standalone or in combination.

By using the FlatData language binding, you can reduce the number of copies from the default of four copies to two copies, for both UDP and shared memory communications. FlatData is a language binding in which the in-memory representation of a sample matches the wire representation, reducing the cost of serialization/deserialization to zero. You can directly access the serialized data without deserializing it first. To select FlatData as the language binding of a type, annotate it with the new @language_binding(FLAT_DATA) annotation.

Zero Copy transfer over shared memory allows you to reduce the number of copies to zero for communications within the same host. This feature accomplishes zero copies by using the shared memory builtin transport to send references to samples within a shared memory segment owned by the DataWriter, instead of using the shared memory builtin transport to send the serialized sample content by making a copy. With Zero Copy transfer over shared memory, there is no need for the DataWriter to serialize a sample, and there is no need for the DataReader to deserialize an incoming sample since the sample is accessed directly on the shared memory segment created by the DataWriter. The new TransferModeQosPolicy specifies the properties of a Zero Copy DataWriter.

For more information on setting up and using one or both of these features, see the chapter on Sending Large Data, in the *RTI Connex DDS Core Libraries User's Manual* (available [here](#) if you have Internet access).

Support for RTI Security Plugins

RTI Security Plugins introduce 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-grained control over the level of security applied to each data flow, such as whether encryption or just data integrity is required.

Security Plugins are available in a separate package from the RTI Support Portal, <https://support.rti.com/>.

See the *RTI Security Plugins Release Notes* and *RTI Security Plugins Getting Started Guide* (available [here](#) and [here](#) if you have Internet access).

Large Data Types

This release adds support for user-defined data types that exceed the maximum message size supported by the underlying transports, such as 64K in the case of UDP. Its use is fully transparent: samples are automatically fragmented by the DataWriter and reassembled by the DataReader. Once re-assembled, the samples are treated as regular samples and subject to all applicable QoS policies.

Asynchronous DataWriters

This release adds support for publishing data asynchronously. An asynchronous DataWriter offloads the user thread and makes it possible to coalesce samples across multiple write() calls into a single network packet.

Samples written by an asynchronous DataWriter are not sent in the context of the user thread as part of the write() call. Instead, samples are queued and sent in the context of a separate, dedicated thread. An optional flow control mechanism is provided to throttle the rate at which samples are coalesced and sent by the dedicated thread.

To implement this feature, there are two new QoS Policies, ASYNCHRONOUS_PUBLISHER and PUBLISH_MODE. The ASYNCHRONOUS_PUBLISHER QoS Policy enables/disables asynchronous publishing for the Publisher. If enabled, the Publisher will spawn a separate asynchronous publishing thread, which will be shared by all of the Publisher's DataWriters that have their new PUBLISH_MODE QoS Policy set to ASYNCHRONOUS. When data is written asynchronously, a new 'FlowController' object can be used to shape the network traffic. The FlowController's properties determine when the asynchronous publishing thread is allowed to send data and how much.

Support for KEEP_ALL History

This release supports setting the History QoS policy **kind** to KEEP_ALL.

Support for AUTOMATIC and MANUAL_BY_PARTICIPANT Liveliness

Now you can set the Liveliness QoS policy **kind** to AUTOMATIC or MANUAL_BY_PARTICIPANT.

- AUTOMATIC: *Connex DDS Micro* will automatically assert liveliness for the DataWriter at least as often as the lease_duration.
- MANUAL_BY_PARTICIPANT: The DataWriter is assumed to be alive if any Entity within the same DomainParticipant has asserted its liveliness.

Micro Application Generation

This release includes Micro Application Generation, which enables you to create a *Connex DDS Micro* application, including registration of factories and creation of DDS entities, from an XML configuration file. Please see [Application Generation](#) in this documentation, as well as the chapter on Generating Applications for Connex DDS Micro, in the *RTI Connex DDS Core Libraries XML-Based Application Creation Getting Started Guide* (available [here](#) if you have Internet access).

Micro Application Generation is enabled by default in this release when compiling with rtime-make. However, future releases may disable the feature by default. Thus, it is advised to always compile with the Micro Application Generation feature enabled (`-DRTIME_DDS_ENABLE_APPGEN=1` to `cmake`).

Ability to use only one UDP port per DomainParticipant

This release provides a way to use just one UDP port per DomainParticipant. The advantage of this is that by only using one UDP port, *Connex DDS Micro* will only create a receive thread, so fewer resources are used, mainly stack memory.

The disadvantage is that the port mappings used are not compliant with the OMG's DDS Interoperability Wire Protocol and communication with other DDS implementations might not be possible.

You can only use this feature if multicast OR unicast is used for both discovery and user traffic. If both unicast AND multicast are configured, you cannot use this feature.

To enable this feature, assign the same value to both the builtin and user port offsets in `RtpsWellKnownPorts_t`.

New C++ DPSE example

This release includes a new C++ example that uses DPSE (dynamic participant - static endpoint) discovery.

8.5.6 What's Fixed in 3.0.0

Linker error when using shared libraries on VxWorks systems

There was a linker error when compiling examples for architecture `ppc604Vx6.9gcc4.3.3` using shared libraries. The compiler reported that the libraries could not be found. This issue has been fixed.

[RTI Issue ID MICRO-1841]

Failure to link VxWorks RTP mode using shared libraries compiled with CMake

Wrong compiler options were used when compiling for VxWorks RTP mode using CMake. This problem caused a linker error when trying to link an application using shared libraries. This issue has been fixed.

[RTI Issue ID MICRO-1909]

CPU endianness detection method improved

The CPU endianness detection method has been improved. Now the CMake endian test is used. If CMake is not used to compile, the compiler preprocessor macros are used to infer CPU endianness.

[RTI Issue ID MICRO-1919]

Examples used untyped register_type APIs instead of typed APIs

The provided examples have been updated to use FooTypeSupport_register_type() instead of DDS_DomainParticipant_register_type(). Using the typed API to register types is preferred over using the untyped API.

[RTI Issue ID MICRO-1922]

Wait_set generic error when returned condition sequence exceeded capacity

If the number of returned conditions exceeded the maximum size of the returned condition sequence, a generic error, DDS_RETCODE_ERROR, was returned instead of the expected error, DDS_RETCODE_OUT_OF_RESOURCES. This problem has been resolved.

[RTI Issue ID MICRO-1933]

WaitSet waited less than specified time period

A WaitSet may have waited less than the specified time period. This problem has been resolved.

[RTI Issue ID MICRO-1950]

Samples with deserialization errors were accepted

In previous versions, samples that could not be deserialized was rejected, causing samples to be resent when reliability was enabled. This behavior has been changed; now samples with deserialization errors are accepted and discarded.

[RTI Issue ID MICRO-1954]

Potential wrong API used when using host name as peer

The getaddrinfo() API was incorrectly used when a host name was used as a peer. That error might have caused a run-time error. This problem occurred only if compilation was done for Windows or if FACE compliance was enabled. This issue has been fixed.

[RTI Issue ID MICRO-1957]

8.6 Known Issues

8.6.1 Flow Controllers require RTOS

Flow controllers require an RTOS.

8.6.2 Using OpenSSL 1.0.x and using OpenSSL APIs outside of the RTI Connex DDS Micro libraries may lead to a crash

In 3.0.0, the destruction of all the DomainParticipants loading the Security Plugin results in the plugin calling OpenSSL's EVP_cleanup and ERR_free_strings APIs to clean up OpenSSL state. As a result, if an application running Connex DDS invoked OpenSSL APIs after this cleanup has taken place without re-initializing OpenSSL, the application may have run into unexpected OpenSSL behavior.

OpenSSL 1.1.x has deprecated both `EVP_cleanup` and `ERR_free_strings`. For *RTI Connex DDS Micro* 3.0.2 and later, it is recommended to use OpenSSL 1.1.1d or higher, to avoid this problem.

8.6.3 LatencyBudget is not part of the DataReaderQos or DataWriterQos policy

The `LatencyBudgetQos` policy is not supported and does not appear as part of the `DataReader` and `DataWriter Qos` policy documentation. The default value is 0. When creating earliest deadline first (EDF) flow-controllers, the effective scheduling is round-robin.

8.6.4 Porting Guide does not include information about shared memory support

The *RTI Connex DDS Micro* porting guide does not include information about porting the shared memory support. If the target does not support the POSIX shared memory API, it is necessary to compile *RTI Connex DDS Micro* with `-DOSAPI_ENABLE_SHMEM=0`.

Chapter 9

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Chapter 10

Contact Support

We welcome your input on how to improve *RTI Connex DDS Micro* to suit your needs. If you have questions or comments about this release, please visit the RTI Customer Portal, <https://support.rti.com>. The RTI Customer Portal provides access to RTI software, documentation, and support. It also allows you to log support cases.

To access the software, documentation or log support cases, the RTI Customer Portal requires a username and password. You will receive this in the email confirming your purchase. If you do not have this email, please contact license@rti.com. Resetting your login password can be done directly at the RTI Customer Portal.

Chapter 11

Join the Community

[RTI Community](#) provides a free public knowledge base containing how-to guides, detailed solutions, and example source code for many use cases. Search it whenever you need help using and developing with RTI products.

[RTI Community](#) also provides forums for all RTI users to connect and interact.