RTI Connext

Core Libraries

Getting Started Guide

Addendum for Android Systems

Version 7.7.0

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Chapter 1 Android Systems

> Android™ systems are not supported in every *RTI® Connext®* release. Please refer to the Supported Platforms section of the RTI Connext Core Libraries Release Notes to see which platforms are supported in *Connext* 7.7.0.

This document provides instructions to install and configure *Connext* for Android development and run *Connext* applications on Android systems. Please refer to the documentation provided by Google® for more information on the Android operating system and Android platform: https://developer.android.com/develop/index.html.

This document will guide you through the process of generating, compiling, and running a Hello World application on an Android system, as well as using *Connext* utilities.

Installing Connext for Android Development (Chapter 2 on page 2) describes how to install and configure *Connext* for Android development.

If you want to use the *Connext* Ping or Spy utilities, please read Using DDS Spy and Ping on Android Platforms (Chapter 3 on page 3).

These sections will guide you through the steps to generate, modify, build, and run an example HelloWorld application on an Android target:

- Generating Example Code and a Makefile from IDL (Chapter 4 on page 7)
- Building and Running a Hello World Example with C/C++ or Java (Chapter 5 on page 11)

The last section describes some additional considerations for Android development:

- Additional Considerations (Chapter 6 on page 18)

Chapter 2 Installing Connext for Android Development

You will need to install a host archive and a target archive. The host archive contains documentation, header files, and other files you need for development; the target archive contains the libraries and other files you need for deployment. Unpack them as described in the instructions for Linux systems in the RTI Connext Installation Guide.

Chapter 3 Using DDS Spy and Ping on Android Platforms

You can use the *rtiddsspy* and *rtiddsping* utilities either as Android Apps or as command-line programs. When running as Android Apps on a real Android device, there is no command prompt for entering parameters and no shell for outputting data. So to facilitate their use, the utilities come with a simple GUI.

To use *rtiddsspy* and *rtiddsping* from the command-line, you do not need to install an **.apk** file.

Instead:

1. Copy the *rtiddsspy* and *rtiddsping* executables and the libraries **libnddscore.so**, **libnddsc.so**, and **libnddscpp.so** to a directory on the Android device.

   The executables are in **NDDSHOME/resource/app/bin/<architecture>**.

   The libraries are in **NDDSHOME/lib/<architecture>**.

   You also need to copy the file **libc++_shared.so** for your architecture, available in your Android toolchain. For example, for aarch64 architectures, the file would be in **<ANDROID_NDK_ROOT>/toolchains/llvm/prebuilt/linux-x86_64/sysroot/usr/lib/aarch64-linux-android/libc++_shared.so**.

2. Set **LD_LIBRARY_PATH** to the directory where you copied the libraries.
3. Now you can run the executables from the shell.

For further information such as command-line arguments, see the Connext API Reference HTML documentation (under Modules, select Programming Tools).

Before installing these utilities: the **adb install** command requires that you connect the device to a host machine and enable USB debugging on the device. For details on how to do this, see these instructions (http://developer.android.com/tools/device.html#setting-up).

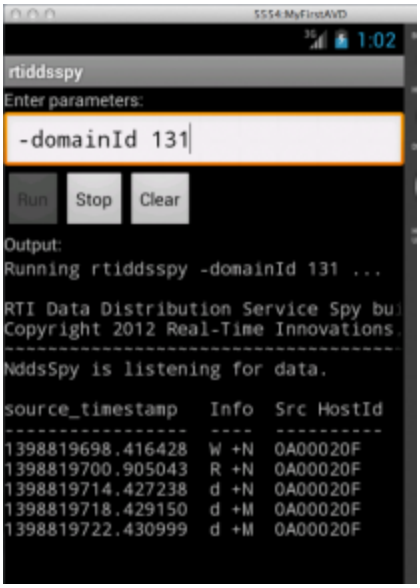
3.1 RTI DDS Spy App

To install and use *rtiddsspy* on an Android device:

1. Install *rtiddsspy* with this command (replace <*arch*> with your architecture name):

```
adb install $NDDSHOME/resource/app/bin/<arch>/rtiddsspy.apk
```

2. Touch or click the *rtiddsspy* icon.
3. On the displayed screen, enter parameters exactly as they would be entered on the command line when using *rtiddsspy* on other platforms.



4. Click or touch **Run**. Data is displayed in the output panel.

   You may need to scroll the panel to the right to see the full output.

   Note that when running *rtiddsspy* as an App on Android, the **-printSample** option is *not* supported.
5. Note that the **Run** button will be disabled until the Spy process is finished (i.e., if you have specified a **-timeout** value in the parameters). To stop a running Spy process gracefully, click or touch the **Stop** button. Once the Spy process is finished, the **Run** button will be enabled again.
6. (Optional) Click or touch the **Clear** button to clear the current output.

To uninstall *rtiddspy* from the Android device through the **adb** shell, use this command:

```
adb uninstall com.rti.dds.rtiddsspy
```

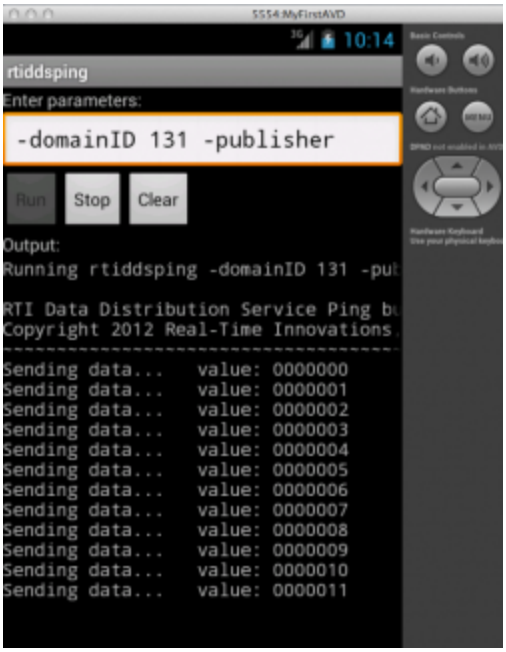
3.2 RTI DDS Ping App

To install and use *rtiddsping* on an Android device:

1. Install *rtiddsping* with this command (replace <*arch*> with your architecture name)

   ```
   adb install $NDDSHOME/resource/app/bin/<arch>/rtiddsping.apk
   ```

2. Touch or click the *rtiddsping* icon.
3. On the displayed screen, enter parameters exactly as they would be entered on the command line when using *rtiddsping* on other platforms.



4. Note that the **Run** button will be disabled until the Ping process is finished (i.e., if you have specified (in the parameters) a **-numSamples** value with the publisher, or a **-timeout** value with the subscriber). To stop a running Ping process gracefully, click or touch the **Stop** button. Once the ping process is finished, the **Run** button will be enabled again.
5. (Optional) Click or touch the **Clear** button to clear the current output.

To uninstall *rtiddsping* from the Android device through the **adb** shell, use this command:

```
adb uninstall com.rti.dds.rtiddsping
```

Chapter 4 Generating Example Code and a Makefile from IDL

This section describes how to generate example code and a makefile from IDL using *RTI Code Generator* (*rtiddsgen*). The generated code will run without modification. The generated makefiles contain recipes for performing various Android SDK and NDK tasks to simplify the process of building and running a HelloWorld example. They also contain default settings for certain variables. These defaults are chosen to get the Hello World examples to run out of the box for as wide a range of SDK and NDK configurations as possible. However for real development, these default values should be reviewed.

To create the example applications:

1. Set up the environment on your development machine:
    - Set the NDDSHOME environment variable and update your PATH as described in Set Up Environment Variables (rtisetenv), in "Hands-On 1" of *Introduction to Publish/Subscribe*, in the RTI Connext Getting Started Guide.
    - The PATH environment variable should also include the SDK's tools, build-tools, and platform-tools directories. Set the ANDROID_SDK_ROOT (for Android 12 systems) and add it to the PATH.
      For example:

      ```
      export ANDROID_SDK_ROOT=<path where Android SDK is installed>
      ```

      ```
      export PATH=$(ANDROID_SDK_ROOT)/tools:$(ANDROID_ROOT_HOME)/build-tools/<build tool version>:$(PATH)
      ```

      (Replace <build tool version> to match the one in your installation.)

- For Android 12 systems: When building Android Apps (***.apk**), set the GRADLE_HOME environment variable to your Gradle® installation directory. *RTI Code Generator* (*rtiddsgen*) will leverage Gradle to create the necessary resources and directory structure to build and create APKs.

```
export GRADLE_HOME=<path where Gradle is installed>
```

- When building Java examples or Android Apps, the PATH should include Eclipse Temurin OpenJDK 21.0.7. For example:

```
export JAVA_HOME=<path where Java is installed>
```

```
export PATH=$(JAVA_HOME)/bin:$(PATH)
```

- When building C and C++ examples, both as executables and as Android Apps, the PATH should include the Android NDK (ANDROID_NDK_ROOT for Android 12 systems). For example:

```
export ANDROID_NDK_ROOT=<path where Android NDK is installed>
```

```
export ANDROID_NDK_TOOLCHAIN_PATH=<path where Android NDK toolchain is
installed>
```

```
export PATH=$(ANDROID_NDK_TOOLCHAIN_PATH)/bin:${PATH}
```

1. Create a directory to work in. In this example, we use a directory called **myhello**.
2. In the **myhello** directory, create a file called **HelloWorld.idl** that contains a user-defined data type. For example:

```
// Temperature data type
struct Temperature {
    // ID of the sensor sending the temperature
    string<256> sensor_id;
    // Degrees in Celsius
    int32 degrees;
};
```

3. Use *Code Generator (rtiddsggen)* to generate sample code and a makefile. Choose Java, C, or C++.

   Examples for each language:

   ```
   $(NDDSHOME)/bin/rtiddsgen -language C -example <arch> HelloWorld.idl
   ```

   ```
   $(NDDSHOME)/bin/rtiddsgen -language C++ -example <arch> HelloWorld.idl
   ```

   ```
   $(NDDSHOME)/bin/rtiddsgen -language Java -example <arch> -package
       com.rti.hello.idl HelloWorld.idl
   ```

   Replace <arch> (following **-example**) with a supported Android architecture name. For example, <arch> may be arm64Android12clang12.0.8ndkr23b. See the *RTI Connext Core Libraries Platform Notes* for the supported Android architectures for each language.

   Android Apps (***.apk**) require the Java code generated by *rtiddsgen* to be in a package. You can achieve this by using either the **modules** keyword in IDL or the **-package** command-line option with *rtiddsgen*. The IDL used here does not have modules, so the **-package** option is used instead.

4. See if you need to change any of the default settings in the generated makefile:
   - DEVICE

     The generated makefile assumes that the computer on which you are building and running these examples only has a single Android device or emulator attached. If this is not the case, you will need to set the DEVICE variable in the makefile. By default, this variable is not set. To see what devices are attached and what value to set DEVICE to, run this command:

     ```
     adb devices
     ```

   - ANDROID_PACKAGE_PREFIX

     If you are building an Android App (***.apk**), the application needs an Android package name prefix. The default prefix is **com.rti.example<language>.<IDL filename>**.

     The prefix will eventually be used to generate two Android applications with these package names:
     - **com.rti.<IDL filename>example.publisher**
     - **com.rti.<IDL filename>example.subscriber**

(where <language> is Java, C, or C++; <IDL filename> is the name of the IDL file that you used for your example).

The ANDROID_PACKAGE_PREFIX is also used in the generated makefile for uninstalling APKs. If you change the ANDROID_PACKAGE_PREFIX value, you will need to update the package name in these generated files:

- **objs/<arch>/publisher/src/main/java/com/rti/example<language>/<IDL filename>/publisher/<IDL filename>PublisherActivity.java**
- **objs/<arch>/subscriber/src/main/java/com/rti/example<language>/<IDL filename>/subscriber/<IDL filename>SubscriberActivity.java**
- **objs/<arch>/publisher/src/main/AndroidManifest.xml**
- **objs/<arch>/subscriber/src/main/AndroidManifest.xml**

- ANDROID_PUSH_DEST

  If you want to run the example directly on an emulator or in a device shell, ANDROID_PUSH_DEST should be set to the location where files are copied to. The default value is **/data/data/com.rti.example<language>.<IDL filename>**, where <IDL filename> is the name of the IDL file that you are using.

5. If you modify the publisher or subscriber code, the makefile, or QoS file, be careful if you re-run *rtiddsgen*: do not use **–replace** in conjunction with **–example**, as that would overwrite those modifications.

Chapter 5 Building and Running a Hello World Example with C/C++ or Java

This section will guide you through the steps required to successfully run an *rtiddsgen*-generated example application written in C/C++ or Java on an Android target, as an Android App (***.apk**).

Note that the C and C++ Android App examples use a Java wrapper class with JNI. It is also possible to write pure C and C++ native code to build Android Apps; see the Android documentation for details (https://developer.android.com/tools/sdk/ndk/index.html).

1. Compile the generated C/C++ or Java code. The auto-generated makefile will create the executables **HelloWorld_publisher** and **HelloWorld_subscriber** in the **objs/<arch>/** directory for C/C++, or it will generate Java code and archive it into **HelloWorld.jar**. You should link with **libc++_shared.so**.
2. See Chapter 4 Generating Example Code and a Makefile from IDL on page 7 regarding the ANDROID_ PACKAGE_PREFIX variable; if you want to change this variable in the makefile, do so now.
3. When using a different SDK version (Android API Level) than what is listed in the "Third-Party Software Versions used for Android 12 Development and Testing" table in the RTI Connext Core Libraries Platform Notes, you can optionally set the environment variables ANDROID_API, ANDROID_BUILD_TOOLS_VERSION, and ANDROID_PATH_TO_CPP_SHARED_SO to compile the generated C/C++ and Java example with the updated SDK.

   Here are the settings used for the Android 14 validation:

   ```
   export ANDROID_API=34
   export ANDROID_BUILD_TOOLS_VERSION=34.0.0
   ```

```
export ANDROID_PATH_TO_CPP_SHARED_SO=${ANDROID_NDK_
ROOT}/toolchains/llvm/prebuilt/linux-x86_64/sysroot/usr/lib/aarch64-linux-android
```

Note: ANDROID_PATH_TO_CPP_SHARED_SO is set to the folder under the NDK, which contains **libc++_shared.so**.

4. Create shared libraries (***.so**) and build the Android projects with the resulting shared libraries. For example (all on one line):

```
make -f makefile_HelloWorld_arm64Android12clang12.0.8ndkr23b
    HelloWorld.so
```

The above command will do the following:

- Generate separate shared libraries for the publisher and subscriber examples.
- Generate separate JNI source code files for both the publisher and subscriber.
- Compile and link the JNI code into separate JNI shared libraries, one for the publisher and one for the subscriber.

5. Create the **.apk** files that will contain the applications. By running the following command, you will build an APK for the publisher and an APK for the subscriber. These APKs will be used later to deploy the Apps:

```
make -f makefile_HelloWorld_arm64Android12clang12.0.8ndkr23b HelloWorld.apks
```

6. Install (via **adb**) the two Apps, and the generated USER_QOS_PROFILES.xml file, on a connected consumer device or an emulator. By default, the Apps will look for the generated USER_QOS_PROFILES.xml file in **/data/local/tmp/rti_examples/<idl_file_name>/USER_QOS_PROFILES.xml** on the Android device.

   To deploy the Apps, you can use the generated makefile's "installapks" rule, which will install the **.apk** files and push the USER_QOS_PROFILES.xml file into the right directory on the device.

   For example (all on one line):

```
make -f makefile_HelloWorld_arm64Android12clang12.0.8ndkr23b
  HelloWorld.installapks
```

7. Run the example on an emulator with a GUI (i.e., not started with the **–no-window** flag) or on a consumer device:
   a. Navigate to the Apps screen displaying icons, it should show **HelloWorld_publisher** and **HelloWorld_subscriber**.

b. Touch (on a device) or click (on an emulator) the **HelloWorld_subscriber** icon.

c. Optionally, enter a single number for the DDS Domain ID as a parameter.

d. Touch or click **Run**. (If the application finishes immediately after being Run, check logcat for errors. Ensure that the **USER_QOS_PROFILES.xml** is deployed at the expected location on the device, as explained in a previous step.)

e. Navigate to the Apps icons (via the **Home** button) and launch **HelloWorld_publisher**.

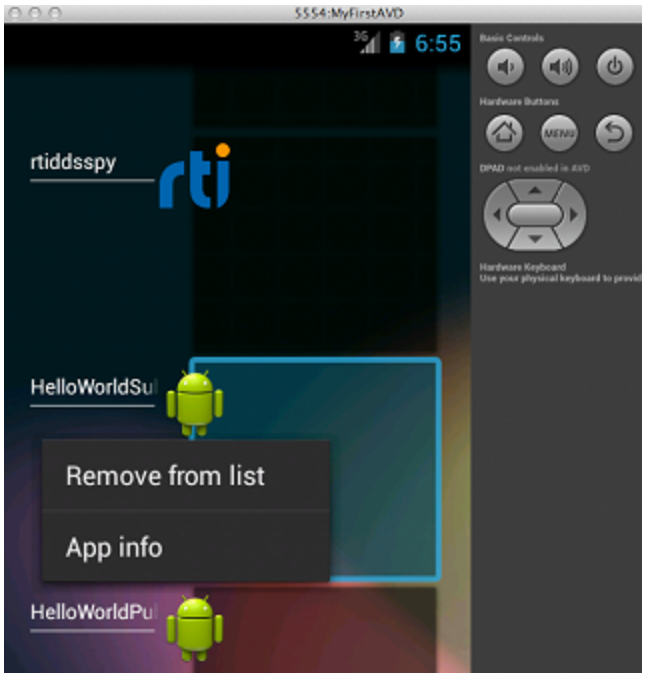
f. Optionally, for parameters, enter the DDS Domain ID (use the same ID you entered for the subscriber) as the first number. Optionally, you can enter the number of samples to be published as the second parameter.

g. Touch or click **Run**. (If the application finishes immediately after being Run, check logcat for errors. Ensure that the **USER_QOS_PROFILES.xml** is deployed at the expected location on the device, as explained in a previous step.)

h. Navigate to the Apps icons and return to **HelloWorld_subscriber**. Note the samples received.

8. An Android App will continue to run in the background when the focus is given to another App. How to stop a running Android App without uninstalling it depends on the device or the virtual device within the emulator. For example, on the emulator hold the **Home** button until a list of applications is shown. Stop an App by swiping it left or right. For example, on a Nexus 7 tablet, touch the **Recent Apps** button (a soft key with an overlapping rectangle) and swipe the App you want to stop. Alternatively, open **Settings**, choose **Apps**, in the subheadings swipe to **Running**, select **Show cached processes**, and lastly touch and **Stop** the App.

On an emulator, press the Home button to see a list of running Apps.



Touch the desired App, then select 'Remove from list'.

9. If you want to see DDS log messages or values of the samples being printed on the subscriber, run **adb logcat** with a filter from a host machine shell. For example:

```
adb logcat -v tag RTIConnextLog:I *:S
```

10. Uninstall (via **adb**) the two Apps on the connected consumer device or emulator.

    To uninstall the Apps, you can use the generated makefile's "uninstallapks" rule, which will remove the Apps from the device as well as the USER_QOS_PROFILES.xml file that was pushed to the device in the installation step, along with the directory **/data/local/tmp/rti_examples/<idl_file_name>/** that was created in that step.

    For example (all on one line):

```
make -f makefile_HelloWorld_arm64Android12clang12.0.8ndkr23b
   HelloWorld.uninstallapks
```

Chapter 6 Additional Considerations

6.1 Output when Running Connext Applications on Android Devices and Emulators

6.1.1 DDS Log Messages from Core Libraries

All DDS log messages from the provided core C and C++ libraries are printed using the Android logging system as "information" using the **RTIConnextLog** tag. Log messages from the *Connext* Java files are printed to **System.out** and **System.err**. The **adb logcat** command without the **-v** option will print all logged messages. To view any of the DDS log messages in real time, use the Android **logcat** tool with the appropriate filter through **adb**. For example:

```
adb logcat -v tag RTIConnextLog:I System.out:I System.err:I *:S
```

Note that if you are calling the **TypeSupport_print_data()** method of any of the *rtiddsgen*-generated data types in C or C++, the value of the samples will also be logged using the Android logging system as stated above.

Refer to the Android documentation for details:

- http://developer.android.com/tools/debugging/debugging-log.html

6.1.2 Output from rtiddsgen-Generated Examples or User Applications

For the *rtiddsgen*-generated Java publisher/subscriber examples, **System.out.println()** is used for printing output.

For the *rtiddsgen*-generated C/C++ examples, **printf()** is used for printing output.

By default, Android systems send stdout and stderr output to **/dev/null**. If you are running the generated publisher/subscriber with the **adb** shell (typically on a device on which you have root access), you should be able to see the example output directly in the shell.

If you are using the Android project files generated by the *rtiddsgen*-generated makefile to compile the publisher and subscriber examples as Android Apps, the generated source code for the application is doing something special to redirect the output to allow them to show up in the Android App.

For the Java example scenario, all the **System.out** output is redirected to the TextView in the GUI of the Android App. Refer to the generated Java Activity class source code under the project **src** directory for details on how this is done.

For the C/C++ example scenario, a special **RTIAndroid_registerOnPrintf()** method can be found in the generated publisher and subscriber example source code to redirect all **printf()** calls to a function callback. The **RTIAndroid_registerOnPrintf()** method is called when the example is run for the first time. Each time **printf()** is called from the generated publisher and subscriber example source code, the registered function callback, implemented in JNI, will be called. In the JNI method, we first attach the current thread to the Android Runtime (ART) if it has not been done, then we call a method in the Java Activity class to display the message in the TextView UI. The native thread will be detached from the Android Runtime (ART), if necessary, before we return to the native publisher/subscriber example code. Refer to the generated Java Activity class source code under the project **src** directory, JNI code, and publisher/subscriber C/C++ code in the example's main directory for details on how this is done.

Note that when running the *rtiddsgen*-generated examples as an Android App, DDS logging messages and the printing of the Samples in the C or C++ subscriber will still need to be viewed using **logcat**—they will not show up in the GUI of the Android App.

Alternatively, you can change the generated example code to cause all the output to go to **logcat**. For C and C++, replace all calls to **printf()** with **__android_log_print()** with your desired priority and tag. For Java, use methods in the **android.util.Log** class instead of the **System.out** class.

Refer to Android SDK documentation for details:

- http://developer.android.com/tools/debugging/debugging-log.html

6.1.3 Output from Connext Utilities

The *Connext rtiddsspy* and*rtiddsping* utilities are implemented with *Connext* core libraries. As a result, DDS log messages must be viewed with **logcat**.

If you run *rtiddsping* and *rtiddsspy* in a shell, all the output from the utility will show up in the shell (even though DDS log messages still need to be viewed with **logcat**).

If you run *rtiddsping* and *rtiddsspy* as Android Apps, most of the utility output will show up on the App UI, with the following exceptions. When running *rtiddsspy* with the **-printSample** option as an Android App, the value of the received sample is printed to stdout and therefore will not show up in either the UI or in **logcat**. The rest of the output from the utility itself will show up in the App UI as expected. DDS log messages still need to be viewed with **logcat**.

6.2 Communication between Connext Applications on Emulator and Host

The emulator has its own virtual LAN: 10.0.2.*. In particular, 10.0.2.15 is the emulator's address for the host's NIC and 10.0.2.2 is the emulator's address for the host's loopback interface (localhost). To reach addresses outside of its virtual LAN, the emulator will route packets through its virtual network interface, 10.0.2.15 (the host's NIC). For communication from host to emulator, packets must be sent to the host's loopback interface, 127.0.0.1. The emulator can be directed to open ports on the host 127.0.0.1.

The emulator does not (for the version used at time of writing) support multicast. Therefore, discovery will be over unicast UDP. The number of participants within the host + emulator is limited due to the need to allocate ports for each participant. By default, that limit is five participants. In normal *Connext* usage, the participants would acquire ports automatically. (The assignment would be implicitly based on the order of start up). The emulator that encapsulates one or more participants needs to explicitly acquire the ports that its contained participants will use. Therefore, it is necessary to explicitly manage the ports used.

Connext determines ports for unicast communication based on Domain and Participant IDs. (For the algorithm used to calculate port numbers, see Ports Used for Communication, in the *Getting Applications to Discover Each Other* chapter of the RTI Connext Core Libraries User's Manual.

Consider the following example: A **Hello_simple** subscriber on the host is communicating with a **Hello_simple** publisher (Android) on an emulator.

Assuming Domain ID 0, the subscriber is given a Participant ID of 3. As there will be no contention, the publisher can assume the Participant ID is 0. The publisher will use ports 7410 for meta-traffic and 7411 for user-traffic. The subscriber will use ports 7416 for meta-traffic and 7417 for user-traffic.

To cause the emulator to open ports 7410 and 7411 on behalf of the publisher, it is necessary to set up some redirections. Use the "**adb devices**" command on the host to get the name of the emulator (e.g., "emulator-5554") and determine its control port (5554).

If the control port is 5554, enter this at the host to determine that no redirections are currently in place:

```
telnet localhost 5554
redir list
```

Then enter the following to set up redirections:

```
redir add udp:7410:7410
redir add udp:7411:7411
```

These redirections apply for 127.0.0.1 on the host, redirected to 10.0.2.2 in the emulator. The **redir** command causes the emulator to open the host port (the first of the two ports specified in the command) on the 127.0.0.1 interface. If another process already has that port, **redir** will report an error.

The publisher, running in the emulator, requires the following settings, shown below in a snippet of a QoS file's **domain_participant_qos** section:

```
<discovery>
   <initial_peers>
       <element>builtin.udpv4://10.0.2.2</element>
   </initial_peers>
</discovery>
<property>
   <value>
       <element>
           <name>dds.transport.UDPv4.builtin.public_address</name>
           <value>127.0.0.1</value>
       </element>
   </value>
</property>
```

The above sets the locators provided by the publisher; these locators instruct the subscriber to direct traffic to the host's loopback interface. The virtual LAN address that would otherwise be used is not accessible to the subscriber running on the host.

Set the environment for the publisher (on the emulator) so that NDDS_QOS_PROFILES points to the QoS file. Note that the **initial_peers** can alternatively be set via the NDDS_DISCOVERY_PEERS environment variable.

Note that for an Android App (***.apk**), these settings can be made programmatically.

The subscriber, running on the host, requires the following settings, shown below in a snippet of a QoS file's **domain_participant_qos** section:

```
<discovery>
   <initial_peers>
       <element>builtin.udpv4://127.0.0.1</element>
   </initial_peers>
</discovery>
<transport_builtin>
   <mask>UDPv4</mask>
</transport_builtin>
<wire_protocol>
   <participant_id>3</participant_id>
</wire_protocol>
```

Explicitly attempting to communicate the participant ID prevents the subscriber from implicitly using participant ID 0 (which would cause a later attempt to set redirections for the emulator to fail).

Explicitly setting the builtin transport to be UDPv4 only will prevent the host from communicating with the emulator via shared memory.

Set the environment for the subscriber (on the host) so that NDDS_QOS_PROFILES points to the QoS file. Note that you can also set **initial_peers** via the NDDS_DISCOVERY_PEERS environment variable. All these settings can also be made programmatically.

Finally, if you need to run *rtiddsspy* on the host to communicate with DDS applications running on the emulator, be careful when specifying its transports, discovery addresses, and participant ID. For example:

```
$(NDDSHOME)/bin/rtiddsspy -peer 127.0.0.1 -transport 1 -index 1
```

There are many variation on this theme to achieve communication between host and emulator. This example illustrates the issues that need to be addressed.

6.3 Loading XML-Specified QoS Settings

If you have root access to the device or you are running on an emulator, you can run your *Connext* application in the Android shell and set up environment variables in the shell, just as you would for any other Linux system. In this scenario, XML QoS profiles can be loaded in the usual ways.

If you want to run *Connext* through an Android App, there is no support for environment variables, which limits the ways that can be used to load XML-specified QoS settings. However, it can still be done by specifying one of the following fields in the ProfileQosPolicy in the DomainParticipantFactoryQos:

- **url_profile**
- **string_profile**

See the PROFILE QosPolicy in the *RTI Connext Core Libraries User's Manual*.

When running an Android App on a non-rooted consumer device, if you want to use **url_profile** to specify the location of the file that contains the XML-specified QoS settings, it will work only if the file is in Android external storage (for example, under **/sdcard**). You will also need to make sure the project's **AndroidManifest.xml** has specified the correct permission to allow reading from external storage.

For example, use the following command to put the file in external storage:

```
adb push <host-qos-file> /sdcard/<target-qos-file>
```

In the source code generated for your application, specify the location of the file in the external storage in the **url_profile** field of the ProfileQosPolicy in DomainParticipantFactoryQos. For example, in Java, you can do the following before creating DDS entities:

```
DomainParticipantFactoryQos factoryQos = new DomainParticipantFactoryQos();
DomainParticipantFactory factory = DomainParticipantFactory.get_instance();
factory.get_qos(factoryQos);
factoryQos.profile.url_profile.add("file:///sdcard/USER_QOS_PROFILES.xml");
factory.set_qos(factoryQos);
```

In the project's **AndroidManifest.xml**, add the following permission:

```
<uses-permission android:name="android.permission.MANAGE_EXTERNAL_STORAGE" />
```

Note that this may not be enough, and you might still be prompted with a security confirmation in your device or emulator to confirm this permission at runtime. Starting with Android 11, apps now require running permissions to be granted by the user, including reading a file from the /sdcard. For this to happen, the app's manifest must have a new permission enabled named MANAGE_EXTERNAL_ STORAGE, and the user must be prompted to grant this permission. However, for development purposes, you can pre-grant this permission for testing. To do so, run this command after the app is installed (all on one line):

```
adb -s <device_id> shell appops set --uid <package_name> MANAGE_EXTERNAL_STORAGE allow
```

For more up to date documentation, please refer to the official Android online documentation.

6.4 Using DDS C++ Libraries for Android Applications

The *Connext* C++ libraries are built and linked against the *C++ runtime*. The *Connext* libraries for Android 9 systems require the shared version of the *C++ runtime*. This is due to the way *Connext* libraries are built.

The *rtiddsgen*-generated makefile for C++ examples builds a shared library (**.so**) that is used by the Android App. When building this shared library, we are also linking against the *C++ runtime*. The *C++ runtime* is not included as part of the *Connext* bundles. You can obtain these libraries as part of the Android NDK.

The static *C++ runtime* can be used only if it is linked into a single binary. If your project contains multiple shared libraries that are linked with the *C++ runtime*, you should use the shared version of the *C++ runtime*. Note that if you use the shared version of the *C++ runtime* in the project for your Android App, you will not be able to write pure native code by just using the Android Native Activity class in your App's manifest file. Instead, you will need to write Java code and call **System.loadLibrary()** to explicitly load the *C++ runtime* first, before loading the shared library of your project. For example, for Android 9:

```
static {
System.loadLibrary("c++_shared");
System.loadLibrary("HelloWorld_publisher");
}
```

Please, also pay attention to the license for LLVM libc++ libraries before using that in your project. Refer to the Android NDK documentation under "C++ Library Support" for more details: https://developer.android.com/ndk/guides/cpp-support.

6.5 Android Threads

When an Android application is launched, the system creates a thread of execution for the application, called "main." This main thread is also sometimes called the UI thread. Due to Android's single thread model, one should never block the UI thread and one should not access the Android UI toolkit from outside the UI thread.

The project files generated by the *rtiddsgen*-generated makefile has taken care of this for you. If you click the **Run** button to run the publisher/subscriber example, a new thread is created to handle the execution of the example, so that the UI thread will not be blocked. Similarly, if the Android UI needs to be updated (for example, to display output of the publisher/subscriber example in the TextView UI), **runOnUiThread()** is called to make sure the display is always updated in the UI thread. See the generated Java Activity class source code under the project **src** directory for details.

6.6 Setting Permission in the App Manifest

When using *Connext* on an Android platform as an App, you need to grant the proper permissions for networking in your project's **AndroidManifest.xml**:

```
<uses-permission android:name="android.permission.INTERNET" />
<uses-permission android:name="android.permission.CHANGE_WIFI_MULTICAST_STATE" />
<uses-permission android:name="android.permission.CHANGE_WIFI_STATE" />
```

If you want to use Android external storage to load XML-specified QoS settings for your *Connext*-based Android App, you also need to grant the proper permissions to read the external storage:

- For Android 12 systems:

  ```
  <uses-permission android:name="android.permission.MANAGE_EXTERNAL_STORAGE" />
  ```

  Note that this may not be enough, and you might still be prompted with a security confirmation on your device or emulator to confirm this permission at runtime. Starting with Android 11, Apps now require running permissions to be granted by the user, including reading a file from the SD card. For this to happen, the App's manifest must have a new permission enabled, named MANAGE_EXTERNAL_STORAGE, and the user must be prompted to grant this permission. However, for development purposes, you can pre-grant this permission for testing. To do so, run this command (all on one line) after the App is installed:

```
adb -s <device_id> shell appops set --uid <package_name>
   MANAGE_EXTERNAL_STORAGE allow
```

Refer to Android documentation for more details:
http://developer.android.com/reference/android/Manifest.permission.html

Chapter 7 Third-Party Licenses

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