
DDS Record Replay Documentation

Release ..

eProsima

Jul 07, 2023

INTRODUCTION

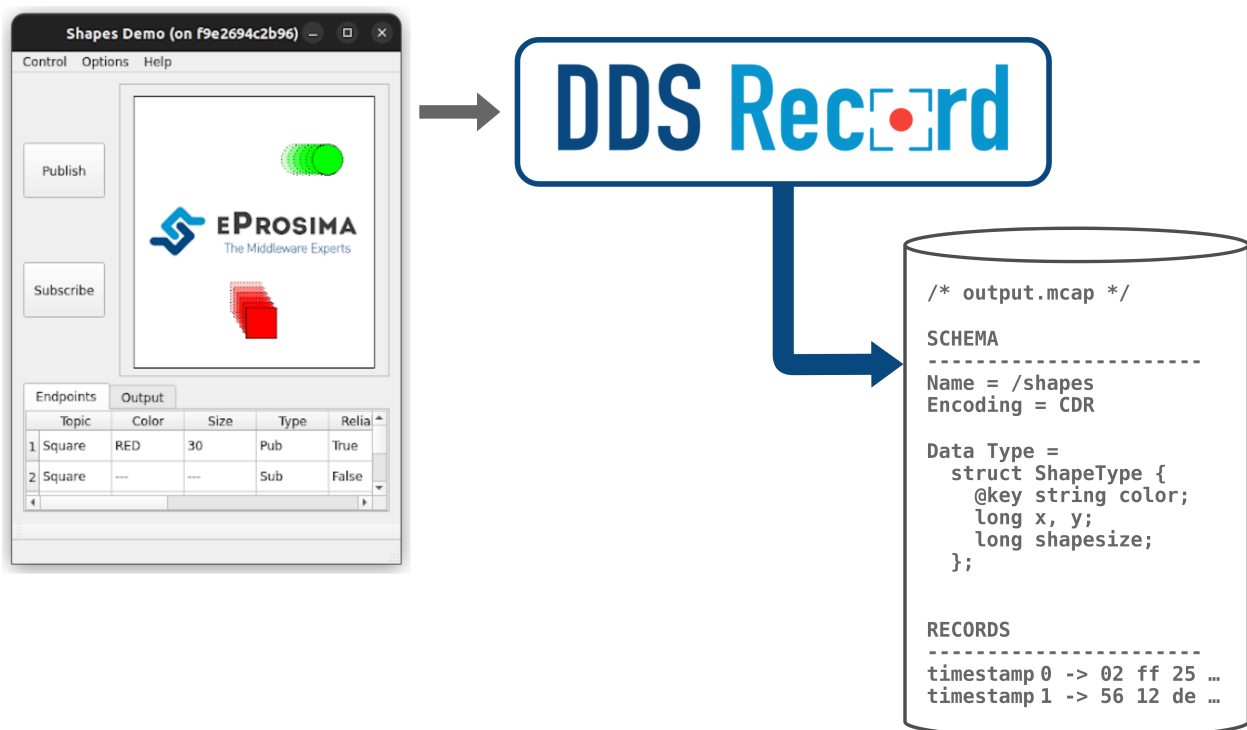
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eProsima DDS Record & Replay is an end-user software application that efficiently saves DDS data published into a DDS environment in a MCAP format database. Thus, the exact playback of the recorded network events is possible as the data is linked to the timestamp at which the original data was published.

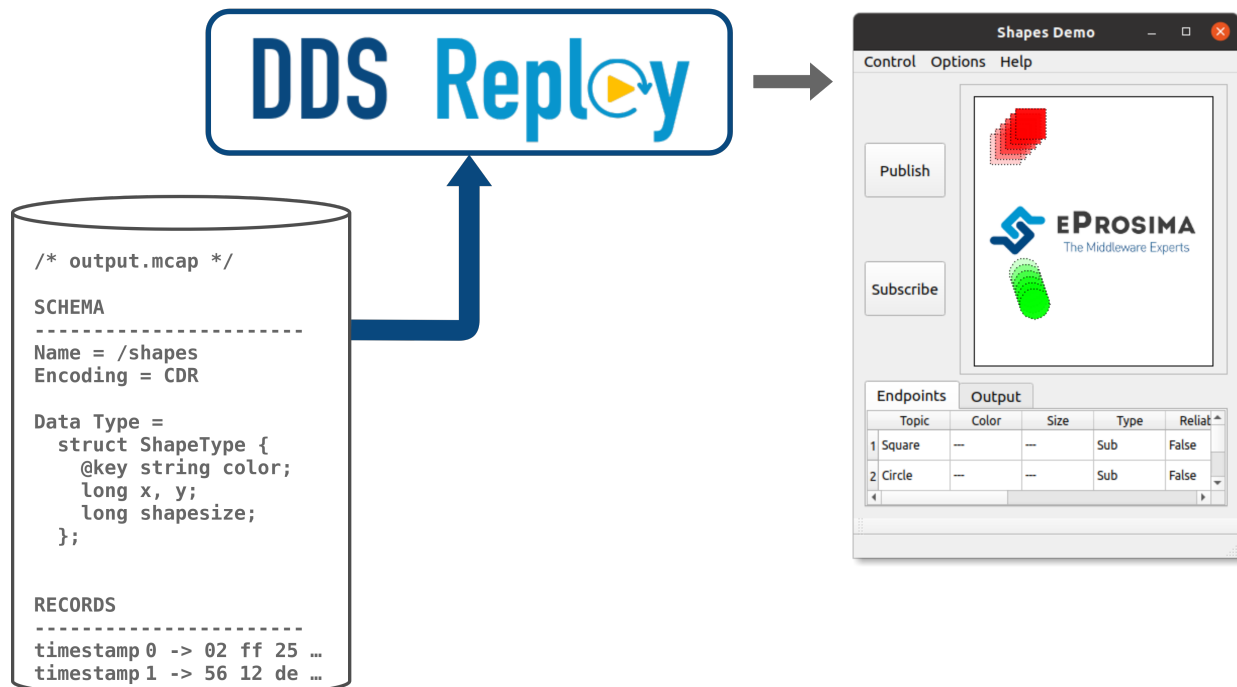
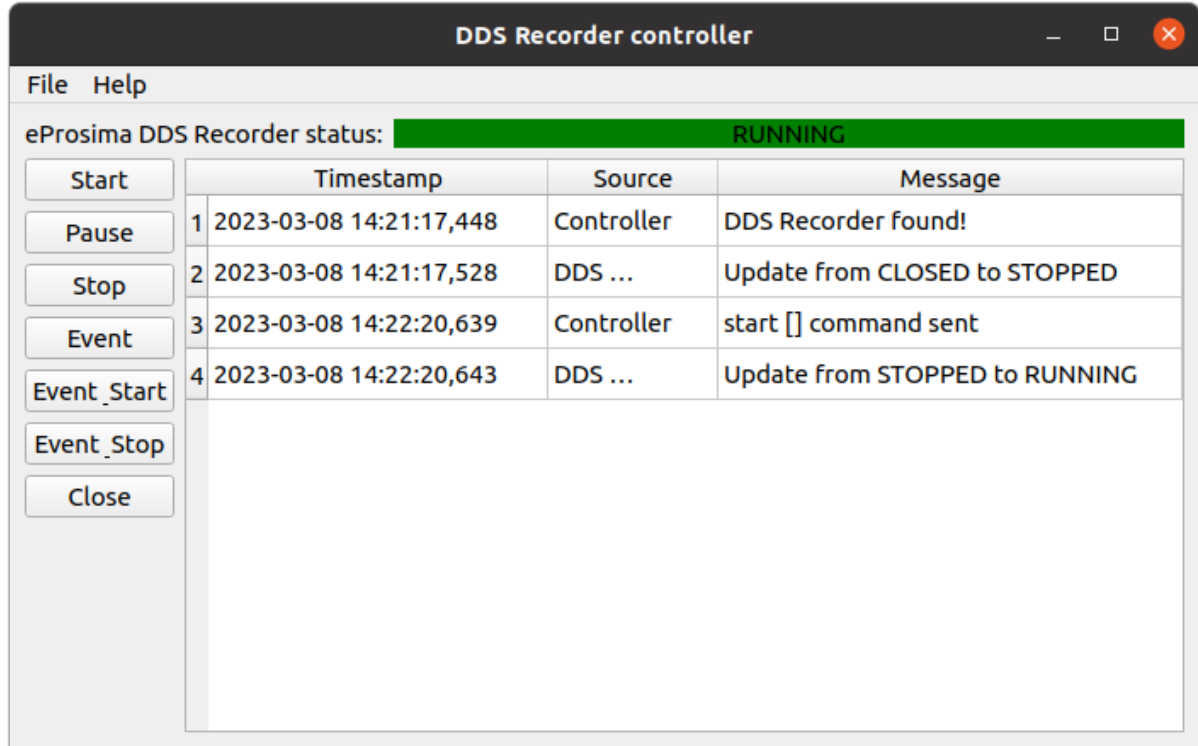
eProsima DDS Record & Replay is easily configurable and installed with a default setup, so that DDS topics, data types and entities are automatically discovered without the need to specify the types of data recorded. This is because the recording tool exploits the DynamicTypes functionality of *eProsima Fast DDS*, the C++ implementation of the *DDS (Data Distribution Service) Specification* defined by the *Object Management Group (OMG)*.

eProsima DDS Record & Replay includes the following tools:

- **DDS Recorder tool.** The main functionality of this tool is to save the data in a *MCAP* database. The database contains the records of the publication timestamp of the data, the serialized data, and the definition of the data serialization type and format. The output MCAP file can be read with any user tool compatible with MCAP file reading since it contains all the necessary information for reading and reproducing the data.



- **DDS Remote Controller tool.** This application allows remote control of the recording tool. Thus, a user can have the recording tool on a device and from another device send commands to start, stop or pause data recording.
- **DDS Replay tool.** This application allows to reproduce DDS traffic recorded with a *DDS Recorder*. A user can specify which messages to replay by either setting a time range (begin/end times) out of which messages will be discarded, or directly by blocking/whitelisting a set of topics of interest. It is also possible to choose a different playback rate, as well as to use topic QoS different to the ones recorded.



CONTACTS AND COMMERCIAL SUPPORT

Find more about us at [eProsimas webpage](#).

Support available at:

- Email: support@eprosima.com
- Phone: +34 91 804 34 48

CONTRIBUTING TO THE DOCUMENTATION

DDS Record & Replay Documentation is an open source project, and as such all contributions, both in the form of feedback and content generation, are most welcomed. To make such contributions, please refer to the [Contribution Guidelines](#) hosted in our GitHub repository.

STRUCTURE OF THE DOCUMENTATION

This documentation is organized into the sections below.

- *Installation Manual*
- *Recording application*
- *Replay application*
- *Tutorials*
- *Developer Manual*
- *Release Notes*

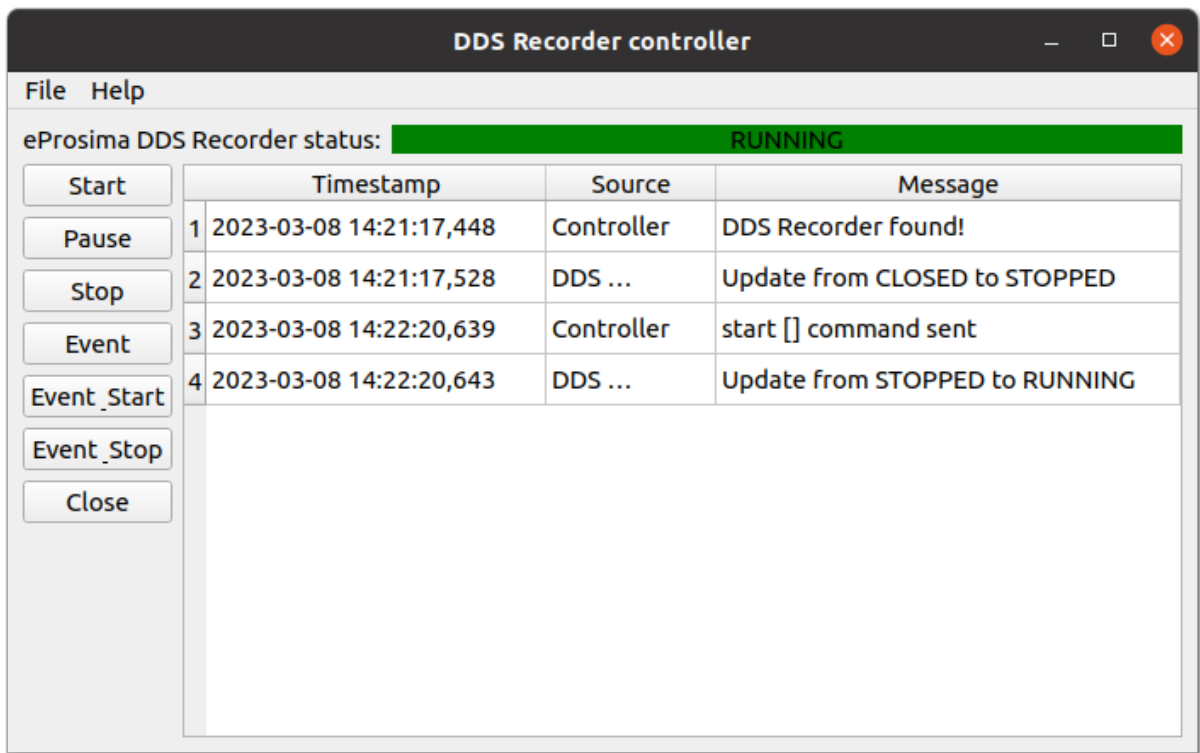
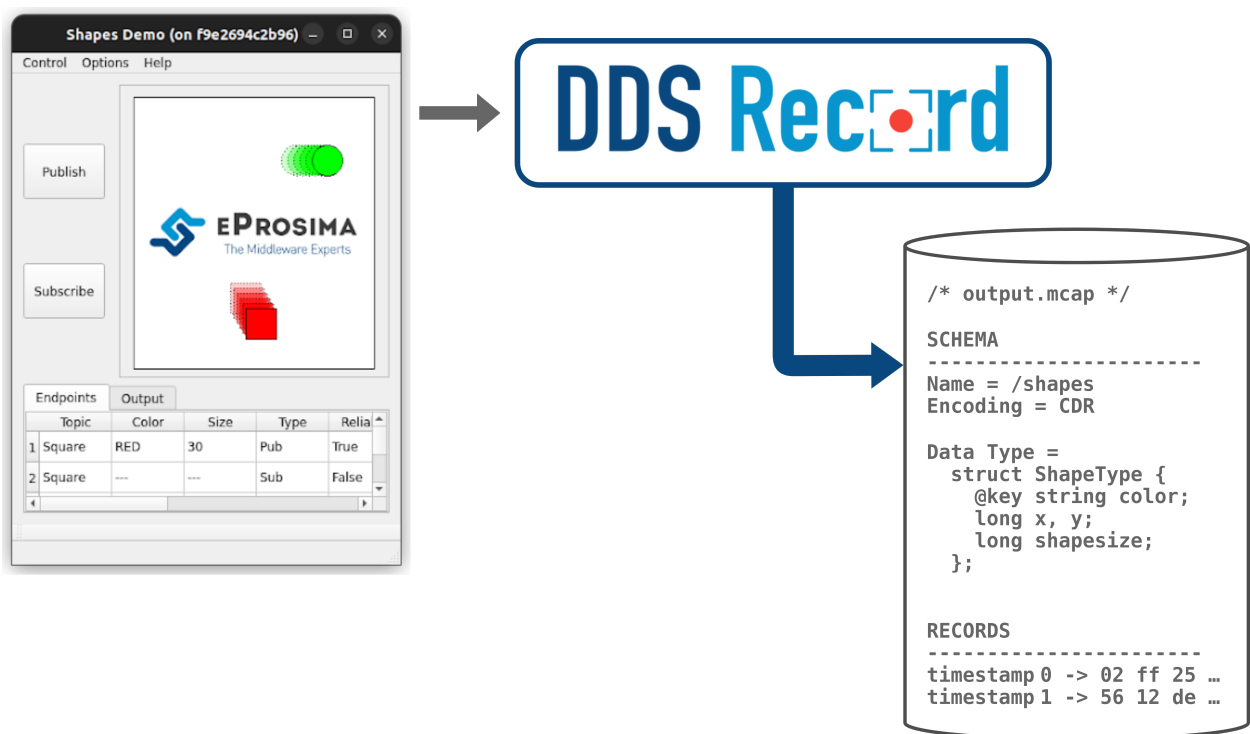
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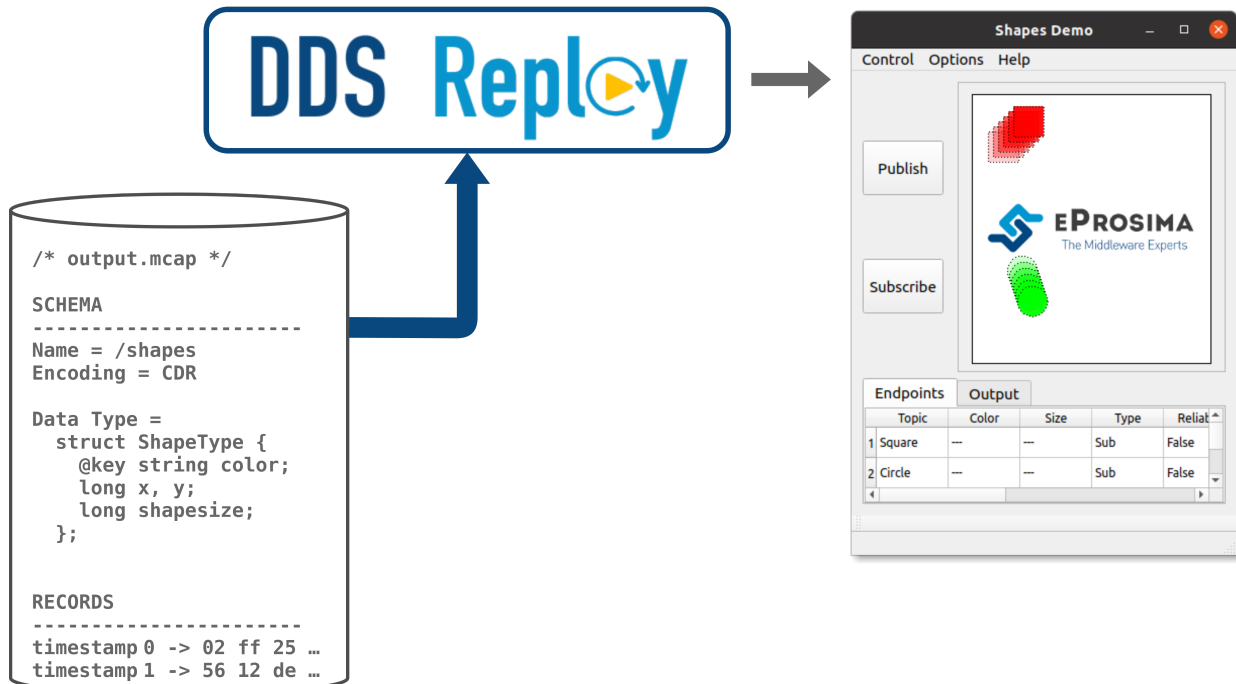
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3.1 Overview

eProsima DDS Record & Replay includes the following tools:

- **DDS Recorder tool.** The main functionality of this tool is to save the data in a *MCAP* database. The database contains the records of the publication timestamp of the data, the serialized data, and the definition of the data serialization type and format. The output MCAP file can be read with any user tool compatible with MCAP file reading since it contains all the necessary information for reading and reproducing the data.
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3.5 DDS Record & Replay on Windows

Warning: The current version of *DDS Record & Replay* does not have installers for Windows platforms. Please refer to the [Windows installation from sources](#) section to learn how to build *DDS Record & Replay* on Windows from sources.

3.6 DDS Record & Replay on Linux

Warning: The current version of *DDS Record & Replay* does not have installers for Linux platforms. Please refer to the [Linux installation from sources](#) section to learn how to build *DDS Record & Replay* on Linux from sources.

3.7 Docker Image (recommended)

Warning: Currently, *DDS Record & Replay* Docker image only contains *DDS Recorder* tool, *DDS Replay tool* application will be added soon.

eProsima distributes a Docker image of *DDS Record & Replay* with Ubuntu 22.04 as base image. This image launches an instance of *DDS Record & Replay* that is configured using a *YAML* configuration file provided by the user and shared with the Docker container. The steps to run *DDS Record & Replay* in a Docker container are explained below.

1. Download the compressed Docker image in `.tar` format from the [eProsima Downloads website](#). It is strongly recommended to download the image corresponding to the latest version of *DDS Record & Replay*.
2. Extract the image by executing the following command:

```
load ubuntu-ddsrecorder:<version>.tar
```

where `version` is the downloaded version of *DDS Record & Replay*.

3. Build a *DDS Record & Replay* configuration *YAML* file on the local machine. This will be the *DDS Record & Replay* configuration file that runs inside the Docker container. To continue this installation manual, let's use the configuration file provided in [this tutorial](#). Open your preferred text editor and copy the configuration example from [here](#) into the `/<dds_recorder_ws>/DDS_RECORDER_CONFIGURATION.yaml` file, where `dds_recorder_ws` is the path of the configuration file. To make this accessible from the Docker container we will create a shared volume containing just this file. This is explained in next point.

4. Run the Docker container executing the following command:

```
docker run -it \
  --net=host \
  --ipc=host \
  --privileged \
```

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```
-v /<dds_recorder_ws>/DDS_RECORDER_CONFIGURATION.yaml:/root/DDS_RECORDER_
↪CONFIGURATION.yaml \
ubuntu-ddsrecorder:v0.3.0
```

It is important to mention that both the path to the configuration file hosted in the local machine and the one created in the Docker container must be absolute paths in order to share just one single file as a shared volume.

After executing the previous command you should be able to see the initialization traces from the *DDS Record & Replay* running in the Docker container. If you want to terminate the application gracefully, just press `Ctrl+C` to stop the execution of *DDS Record & Replay*.

3.8 Getting Started

3.8.1 Project Overview

eProsima DDS Record & Replay is a cross-platform application developed by eProsima and powered by *Fast DDS* that contains a set of tools for debugging DDS networks. Among these tools is a recording application, called *DDS Recorder*, which allows a user to capture data published in a DDS environment for later analysis or playback.

The *DDS Recorder* application automatically discovers all topics in the DDS network and saves the data published in each topic with the publication timestamp of the data. Furthermore, by using the [DynamicTypes](#) feature of *Fast DDS*, it is possible to record the type of the data in the MCAP file. The benefit of this comes from the fact that the data is saved serialized according to the CDR format.

By default, *eProsima DDS Recorder* saves all DDS traffic encountered in the domain of choice, storing samples in the same form they are received (serialized) without the need to have received the (dynamic) type associated to these samples. When recorded samples with no associated type information are played back through a *DDS Replayer*, only DDS applications in possession of this type information will be able to receive and process these messages.

However, some applications might not have this information available out of the box, as it is the case of applications relying on [Dynamic Types](#). Additionally, tools such as [Foxglove Studio](#) require this information to be stored in the resulting MCAP file so messages can be deserialized for visualization. In such scenarios, it is required that type information gets stored along with data samples, which is automatically done by a *DDS Recorder* instance as long as the publisher applications (whose messages are recorded) send this information. This can be easily achieved by applying the configuration described in [this section](#).

Moreover, *DDS Recorder* is designed to ensure that internal communications are handled efficiently, from the reception of the data to its storage in the output database. This is achieved through the internal implementation of a zero-copy communication mechanism implemented in one of the *DDS Recorder* base libraries. It is also possible to configure the number of threads that execute these data reception and saving tasks, as well as the size of the internal buffers to avoid writing to disk with each received data.

Usage Description

DDS Recorder is a terminal (non-graphical) application that creates a recording service as long as it is running. Although most use cases are covered by the default configuration, the *DDS Recorder* can be configured via a YAML file, whose format is very intuitive and human-readable.

- **Run:** Only the command that launches the application (`ddsrecorder`) needs to be executed to run a *DDS Recorder*. Please, read this [section](#) to apply a specific configuration, and this [section](#) to see the supported arguments.
- **Interact:** Once the *DDS Recorder* application is running, the allowlist and blocklist topic lists could be changed in runtime by just changing the YAML configuration file. It is also possible to change the status of the recorder

(RUNNING, PAUSED, STOPPED or CLOSED) by remote control of the application. This remote control is done by sending commands via DDS or by using the graphical remote control application provided with the *eProsima DDS Record & Replay* software tool (see [Remote control](#)).

- **Close:** To close the *DDS Recorder* application just send a *Ctrl+C* signal to terminate the process gracefully (see [Closing Recording Application](#)) or close it remotely using the remote control application (see [Remote control](#)).

Common Use cases

To get started with *DDS Recorder*, please visit section [Example of usage](#). In addition, this documentation provides several tutorials on how to set up a *DDS Recorder*, a comprehensive Fast DDS application using DynamicTypes and how to read the generated MCAP file.

3.8.2 Example of usage

This example will serve as a hands-on tutorial, aimed at introducing some of the key concepts and features that *eProsima DDS Record & Replay* recording application (*DDS Recorder* or *ddsrecorder*) has to offer.

Prerequisites

It is required to have *eProsima DDS Record & Replay* previously installed using one of the following installation methods:

- [DDS Record & Replay on Windows](#)
- [DDS Record & Replay on Linux](#)
- [Docker Image \(recommended\)](#)

Additionally, [ShapesDemo](#) is required to publish and subscribe shapes of different colors and sizes. [ShapesDemo](#) application is already prepared to use Fast DDS DynamicTypes, which is required when using the *DDS Recorder*. Install it by following any of the methods described in the given links:

- [Windows installation from binaries](#)
- [Linux installation from sources](#)
- [Docker Image](#)

Start ShapesDemo

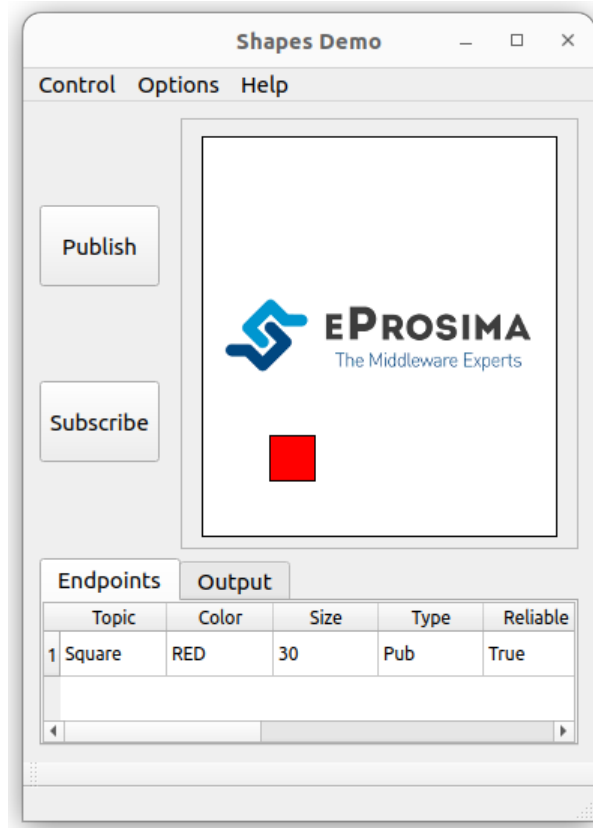
Let us launch a [ShapesDemo](#) instance and start publishing in topics `Square` with default settings.

Recorder configuration

DDS Recorder runs with default configuration settings. This default configuration records all messages of all DDS Topics found in DDS Domain 0 in the `output_YYYY-MM-DD-DD_hh-mm-ss.mcap` file.

Additionally, it is possible to change the default configuration parameters by means of a YAML configuration file.

Note: Please refer to [Configuration](#) for more information on how to configure a *DDS Recorder*.



Recorder execution

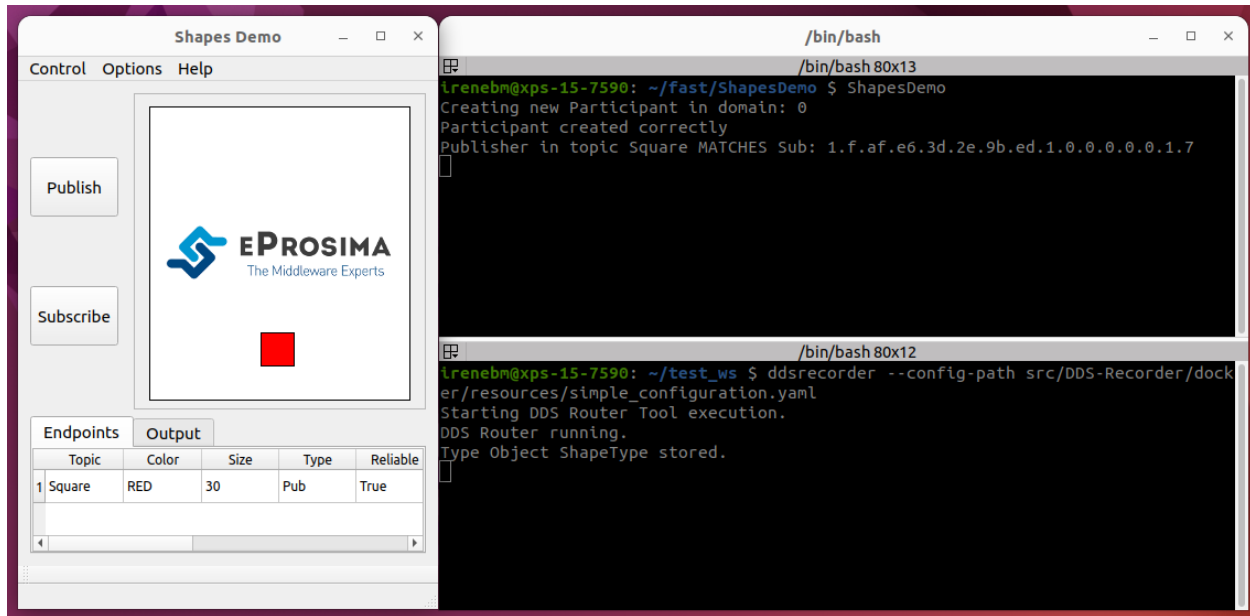
Launching a *DDS Recorder* instance is as easy as executing the following command:

```
ddsrecorder
```

In order to know all the possible arguments supported by this tool, use the command:

```
ddsrecorder --help
```

Stop the recorder with **Ctrl+C** and check that the MCAP file exists.



Next Steps

Explore section [Tutorials](#) for more information on how to configure and set up a recorder, as well as to discover multiple scenarios where *DDS Recorder* may serve as a useful tool. Also, feel free to check out [this](#) example, where a *DDS Replayer* is used to reproduce the traffic recorded following the steps in this tutorial.

3.9 Usage

eProsima DDS Recorder is a user application executed from command line.

- *Starting Recording Application*
- *Closing Recording Application*
- *Recording Service Command-Line Parameters*

3.9.1 Starting Recording Application

Docker Image

The recommended method to run the *DDS Recorder* is to instantiate a Docker container of the *DDS Record & Replay* image. [Here](#) are the instructions to download the compressed *DDS Record & Replay* Docker image and load it locally.

To run the *DDS Recorder* from a Docker container execute the following command:

```
docker run -it \
  --net=host \
  --ipc=host \
  -v /<dds_recorder_ws>/DDS_RECORDER_CONFIGURATION.yaml:/root/DDS_RECORDER_
  CONFIGURATION.yaml \
  ubuntu-ddsrecorder:v<X.X.X> ddsrecorder
```

Installation from sources

eProsima DDS Record & Replay depends on *fastrtps*, *fastcdr* and *ddspipe* libraries. In order to correctly execute the recorder, make sure that *fastrtps*, *fastcdr* and *ddspipe* are properly sourced.

```
source <path-to-fastdds-installation>/install/setup.bash
source <path-to-ddspipe-installation>/install/setup.bash
source <path-to-ddsrecordreplay-installation>/install/setup.bash
```

Note: If Fast DDS, DDS Pipe and DDS Record & Replay have been installed in the system, these libraries would be sourced by default.

To start *eProsima DDS Recorder* with a default configuration, enter:

```
ddsrecorder
```

3.9.2 Closing Recording Application

SIGINT

To close *eProsima DDS Recorder*, press Ctrl+C. *DDS Recorder* will perform a clean shutdown.

SIGTERM

Write command `kill <pid>` in a different terminal, where `<pid>` is the id of the process running the *DDS Recorder*. Use `ps` or `top` programs to check the process ids.

TIMEOUT

Setting a maximum amount of seconds that the application will work using argument `--timeout` will close the application once the time has expired.

3.9.3 Recording Service Command-Line Parameters

The *DDS Recorder* application supports several input arguments:

Com- mand	Description	Option	Pos- sible Values	Default Value
Help	It shows the usage information of the application.	-h --help		
Ver- sion	It shows the current version of the <i>DDS Recorder</i> and the hash of the last commit of the compiled code.	-v --version		
Con- figu- ration File	Configuration file path.	-c --config-path		./ DDS_RECORDER_CONFIGURATION. yaml
Reload Timer	The configuration file will be automatically reloaded according to the specified time period.	-r --reload	Un- signed Integer	0
Time- out	Set a maximum time while the application will be running. 0 means that the application will run forever (until kill via signal).	-t --timeout	Un- signed Integer	0
Debug	Enables the <i>DDS Recorder</i> logs so the execution can be followed by internal debugging information. Sets Log Verbosity to <code>info</code> and Log Filter to <code>DDSRECORDER</code> .	-d --debug		
Log Ver- bosity	Set the verbosity level so only log messages with equal or higher importance level are shown.	--log-verbosity	info warning error	warning
Log Filter	Set a regex string as filter.	--log-filter	String	"DDSRECORDER"

3.10 Configuration

- *DDS Recorder Configuration*
 - *DDS Configuration*
 - *Recorder Configuration*
 - *Remote Controller*
 - *Specs Configuration*
 - *General Example*
- *Fast DDS Configuration*

3.10.1 DDS Recorder Configuration

A *DDS Recorder* is configured by a *.yaml* configuration file. This *.yaml* file contains all the information regarding the DDS interface configuration, recording parameters, and *DDS Recorder* specifications. Thus, this file has four major configuration groups:

- **dds**: configuration related to DDS communication.
- **recorder**: configuration of data writing in the database.
- **remote-controller**: configuration of the remote controller of the *DDS Recorder*.
- **specs**: configuration of the internal operation of the *DDS Recorder*.

DDS Configuration

Configuration related to DDS communication.

Topic Filtering

DDS Recorder includes a mechanism to automatically detect which topics are being used in a DDS network. By automatically detecting these topics, a *DDS Recorder* creates internal DDS *Readers* for each topic in order to record the data published on each discovered topic.

Note: *DDS Recorder* entities are created with the QoS of the first Publisher/Subscriber found in this Topic, unless manually set in the *built-in topics* list.

DDS Recorder allows filtering of DDS *Topics*, that is, it allows to define the DDS Topics' data that is going to be recorded by the application. This way, it is possible to define a set of rules in *DDS Recorder* to filter those data samples the user does not wish to save.

It is not mandatory to define such set of rules in the configuration file. In this case, a *DDS Recorder* will save all the data published under the topics that it automatically discovers within the DDS network to which it connects.

To define these data filtering rules based on the Topics to which they belong, the following lists are available:

- Allowed topics list (**allowlist**)
- Block topics list (**blocklist**)

These lists of topics stated above are defined by a tag in the *YAML* configuration file, which defines a *YAML* vector (`[]`). This vector contains the list of topics for each filtering rule. Each Topic is determined by its entries **name** and **type**, with only the first one being mandatory.

Topic entries	Data type	Default value
name	string	-
type	string	"*"

See *Topic* section for further information about the topic.

Note: Placing quotation marks around values in a *YAML* file is generally optional. However, values containing wildcard characters must be enclosed by single or double quotation marks.

Allow topic list

This is the list of topics that *DDS Recorder* will record, i.e. the data published under the topics matching the expressions in the `allowlist` will be saved by *DDS Recorder*.

Note: If no `allowlist` is provided, data will be recorded for all topics (unless filtered out in `blocklist`).

Block topic list

This is the list of topics that the *DDS Recorder* will block, that is, all data published under the topics matching the filters specified in the `blocklist` will be discarded by the *DDS Recorder* and therefore will not be recorded.

This list takes precedence over the `allowlist`. If a topic matches an expression both in the `allowlist` and in the `blocklist`, the `blocklist` takes precedence, causing the data under this topic to be discarded.

Example of usage - Allowlist and blocklist collision:

In the following example, the `HelloWorldTopic` topic is both in the `allowlist` and (implicitly) in the `blocklist`, so according to the `blocklist` preference rule this topic is blocked. Moreover, only the topics present in the `allowlist` are relayed, regardless of whether more topics are dynamically discovered in the DDS network. In this case the forwarded topics are `AllowedTopic1` with data type `Allowed` and `AllowedTopic2` regardless of its data type.

```
allowlist:
- name: AllowedTopic1
  type: Allowed
- name: AllowedTopic2
  type: "*"
- name: HelloWorldTopic
  type: HelloWorld

blocklist:
- name: "*"
  type: HelloWorld
```

Built-in Topics

Apart from the dynamic DDS topics discovered in the network, the discovery phase can be accelerated by using the builtin topic list (`builtin-topics`). By defining topics in this list, the *DDS Recorder* will create the `DataWriters` and `DataReaders` in recorder initialization.

The builtin-topics list is defined in the same form as the `allowlist` and `blocklist`.

This feature also allows to manually force the QoS of a specific topic, so the entities created in such topic follows the specified QoS and not the one first discovered.

Topic Quality of Service

For every topic contained in this list, both `name` and `type` must be specified and contain no wildcard characters. Apart from these values, the tag `qos` under each topic allows to configure the following values:

Quality of Service	Yaml tag	Data type	Default value	QoS set
Reliability	<code>reliability</code>	<i>bool</i>	<code>false</code>	RELIABLE / BEST_EFFORT
Durability	<code>durability</code>	<i>bool</i>	<code>false</code>	TRANSIENT_LOCAL / VOLATILE
History Depth	<code>depth</code>	<i>integer</i>	<i>default value</i>	<code>.</code>
Partitions	<code>partitions</code>	<i>bool</i>	<code>false</code>	Topic with / without partitions
Ownership	<code>ownership</code>	<i>bool</i>	<code>false</code>	EXCLUSIVE_OWNERSHIP_QOS / SHARED_OWNERSHIP_QOS
Key	<code>keyed</code>	<i>bool</i>	<code>false</code>	Topic with / without key
Downsampling	<code>downsampling</code>	<i>integer</i>	<i>default value</i>	Downsampling factor
Max Reception Rate	<code>max-reception-rate</code>	<i>float</i>	<i>default value</i>	Maximum sample reception rate [Hz]

Example of usage:

```
builtin-topics:
- name: HelloWorldTopic
  type: HelloWorld
  qos:
    reliability: true      # Use QoS RELIABLE
    durability: true      # Use QoS TRANSIENT_LOCAL
    depth: 100            # Use History Depth 100
    partitions: true       # Topic with partitions
    ownership: false       # Use QoS SHARED_OWNERSHIP_QOS
    keyed: true            # Topic with key
    downsampling: 4        # Keep 1 of every 4 samples
    max-reception-rate: 10 # Discard messages if less than 100ms elapsed
↪since the last sample was processed
```

DDS Domain

Tag `domain` configures the *Domain Id*.

```
domain: 101
```

Ignore Participant Flags

A set of discovery traffic filters can be defined in order to add an extra level of isolation. This configuration option can be set through the `ignore-participant-flags` tag:

```
ignore-participant-flags: no_filter           # No filter (default)
# or
ignore-participant-flags: filter_different_host # Discovery traffic from
↳ another host is discarded
# or
ignore-participant-flags: filter_different_process # Discovery traffic from
↳ another process on same host is discarded
# or
ignore-participant-flags: filter_same_process # Discovery traffic from
↳ own process is discarded
# or
ignore-participant-flags: filter_different_and_same_process # Discovery traffic from
↳ own host is discarded
```

See [Ignore Participant Flags](#) for more information.

Custom Transport Descriptors

By default, *DDS Recorder* internal participants are created with enabled [UDP](#) and [Shared Memory](#) transport descriptors. The use of one or the other for communication will depend on the specific scenario, and whenever both are viable candidates, the most efficient one (Shared Memory Transport) is automatically selected. However, a user may desire to force the use of one of the two, which can be accomplished via the `transport` configuration tag.

```
transport: builtin    # UDP & SHM (default)
# or
transport: udp        # UDP only
# or
transport: shm        # SHM only
```

Warning: When configured with `transport: shm`, *DDS Recorder* will only communicate with applications using Shared Memory Transport exclusively (with disabled UDP transport).

Interface Whitelist

Optional tag `whitelist-interfaces` allows to limit the network interfaces used by UDP and TCP transport. This may be useful to only allow communication within the host (note: same can be done with [Ignore Participant Flags](#)). Example:

```
whitelist-interfaces:
- "127.0.0.1"    # Localhost only
```

See [Interface Whitelist](#) for more information.

Warning: When providing an interface whitelist, external participants with which communication is desired must also be configured with interface whitelisting.

Recorder Configuration

Configuration of data writing in the database.

Output File

The recorder output file does support the following configurations:

Parameter	Tag	Description	Data type	Default value
File path	<code>path</code>	Configure the path to save the output file.	string	.
File name	<code>filename</code>	Configure the name of the output file.	string	output

When DDS Recorder application is launched (or when remotely controlled, every time a `start` command is received), a temporary file with `filename` name and `.mcap.tmp~` extension is created in `path`. This file is not readable until the application is terminated (or a `stop` / `close` command is received). On such event, the temporal file is renamed to `filename` with `.mcap` extension in the same location, and is then ready to be processed.

Buffer size

`buffer-size` indicates the number of samples to be stored in the process memory before the dump to disk. This avoids disk access each time a sample is received. By default, its value is set to `100`.

Event Window

DDS Recorder can be configured to continue saving data when it is in paused mode. Thus, when an event is triggered from the remote controller, samples received in the last `event-window` seconds are stored in the database.

In other words, the `event-window` acts as a sliding time window that allows to save the collected samples in this time window only when the remote controller event is received. By default, its value is set to `20` seconds.

Log Publish Time

By default (`log-publish-time: false`) received messages are stored in the MCAP file with `logTime` value equals to the reception timestamp. Additionally, the timestamp corresponding to when messages were initially published (`publishTime`) is also included in the information dumped to MCAP files. In some applications, it may be required to use the `publishTime` as `logTime`, which can be achieved by providing the `log-publish-time: true` configuration option.

Max Reception Rate

Limits the frequency [Hz] at which samples are processed, by discarding messages received before $1/\text{max-reception-rate}$ seconds have elapsed since the last processed message was received. When specified, `max-reception-rate` is set for all topics without distinction, but a different value can also set for a particular topic under the `qos` configuration tag within the builtin-topics list. This parameter only accepts non-negative values, and its default value is 0 (no limit).

Downsampling

Reduces the sampling rate of the received data by keeping 1 out of every n samples received (per topic), where n is the value specified in `downsampling`. If `max-reception-rate` is also set, downsampling applies to messages that already managed to pass this filter. When specified, this downsampling factor is set for all topics without distinction, but a different value can also set for a particular topic under the `qos` configuration tag within the builtin-topics list. This parameter only accepts positive integer values, and its default value is 1 (no downsampling).

Only With Type

By default, all (allowed) received messages are recorded regardless of whether their associated type information has been received. However, a user can enforce that **only** samples whose type is received are recorded by setting `only-with-type: true`.

Remote Controller

Configuration of the DDS remote control system. Please refer to [Remote Control](#) for further information on how to use *DDS Recorder* remotely. The supported configurations are:

Parameter	Tag	Description	Data type	Default value	Possible values
Enable	<code>enable</code>	Enable DDS remote control system topics.	boolean	true	true false
DDS Domain	<code>domain</code>	DDS Domain of the DDS remote control system.	integer	DDS domain being recorded	From 0 to 255
Initial state	<code>initial-state</code>	Initial state of <i>DDS Recorder</i> .	string	RUNNING	RUNNING PAUSED STOPPED
Command Topic Name	<code>command-topic-name</code>	Name of Controller Command DDS Topic.	string	/ddsrecorder/command	
Status Topic Name	<code>status-topic-name</code>	Name of Controller Status DDS Topic.	string	/ddsrecorder/status	

Specs Configuration

The internals of a *DDS Recorder* can be configured using the `specs` optional tag that contains certain options related with the overall configuration of the *DDS Recorder* instance to run. The values available to configure are:

Number of Threads

`specs` supports a `threads` optional value that allows the user to set a maximum number of threads for the internal `ThreadPool`. This `ThreadPool` allows to limit the number of threads spawned by the application. This improves the performance of the internal data communications.

This value should be set by each user depending on each system characteristics. In case this value is not set, the default number of threads used is 12.

Maximum Number of Pending Samples

It is possible that a *DDS Recorder* starts receiving data from a topic that it has not yet registered, i.e. a topic for which it does not know the data type. In this case, messages are kept in an internal circular buffer until their associated type information is received, event on which they are written to disk.

However, the recorder execution might end before this event ever occurs. Depending on configuration (see *Only With Type*), messages kept in the pending samples buffer will be stored or not on closure. Hence, note that memory consumption would continuously grow whenever a sample with unknown type information is received.

To avoid the exhaustion of memory resources in such scenarios, a configuration option is provided which lets the user set a limit on memory usage. The `max-pending-samples` parameter allows to configure the size of the aforementioned circular buffers **for each topic** that is discovered. The default value is equal to 5000 samples, with -1 meaning no limit, and 0 no pending samples.

Depending on the combination of this configuration option and the value of `only-with-type`, the following situations may arise when a message with unknown type is received:

- If `max-pending-samples` is -1, or if it is greater than 0 and the circular buffer is not full, the sample is added to the collection.
- If `max-pending-samples` is greater than 0 and the circular buffer reaches its maximum capacity, the oldest sample with same type as the received one is popped, and either written without type (`only-with-type: false`) or discarded (`only-with-type: true`).
- If `max-pending-samples` is 0, the message is written without type if `only-with-type: false`, and discarded otherwise.

Cleanup Period

As explained in *Event Window*, a *DDS Recorder* in paused mode awaits for an event command to write in disk all samples received in the last `event-window` seconds. To accomplish this, received samples are stored in memory until the aforementioned event is triggered and, in order to limit memory consumption, outdated (received more than `event-window` seconds ago) samples are removed from this buffer every `cleanup-period` seconds. By default, its value is equal to twice the `event-window`.

General Example

A complete example of all the configurations described on this page can be found below.

Warning: This example can be used as a quick reference, but it may not be correct due to incompatibility or exclusive properties. **Do not take it as a working example.**

```
dds:
  domain: 0

  allowlist:
    - name: "topic_name"
      type: "topic_type"

  blocklist:
    - name: "topic_name"
      type: "topic_type"

  builtin-topics:
    - name: "HelloWorldTopic"
      type: "HelloWorld"
      qos:
        reliability: true
        durability: true
        keyed: false
        partitions: true
        ownership: false
        downsampling: 4
        max-reception-rate: 10

  ignore-participant-flags: no_filter
  transport: builtin
  whitelist-interfaces:
    - "127.0.0.1"

recorder:
  output:
    filename: "output"
    path: "."

  buffer-size: 50
  event-window: 60
  log-publish-time: false
  downsampling: 3
  max-reception-rate: 20
  only-with-type: false

remote-controller:
  enable: true
  domain: 10
  initial-state: "PAUSED"
```

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```

command-topic-name: "/ddsrecorder/command"
status-topic-name: "/ddsrecorder/status"

specs:
  threads: 8
  max-pending-samples: 10
  cleanup-period: 90

```

3.10.2 Fast DDS Configuration

As explained in [this section](#), a *DDS Recorder* instance stores (by default) all data regardless of whether their associated data type is received or not. Some applications rely on this information being recorded and written in the resulting MCAP file, which requires that the user application is configured to send the necessary type information. However, *Fast DDS* does not send the data type information by default, it must be configured to do so.

First of all, when generating the topic types using *eProsima Fast DDS Gen*, the option `-typeobject` must be added in order to generate the needed code to fill the `TypeObject` data.

For native types (data types that does not rely in other data types) this is enough, as *Fast DDS* will send the `TypeObject` by default. However, for more complex types, it is required to use `TypeInformation` mechanism. In the *Fast DDS* `DomainParticipant` set the following QoS in order to send this information:

```

DomainParticipantQos pqos;
pqos.wire_protocol().builtin.typelookup_config.use_server = true;

```

Feel free to review [this](#) section, where it is explained in detail how to configure a Fast DDS Publisher/Subscriber leveraging *Dynamic Types*.

3.11 Remote Control

The *DDS Recorder* application from *eProsima DDS Record & Replay* allows remote control and monitoring of the tool via DDS. Thus it is possible both to monitor the execution status of the *DDS Recorder* and to control the execution status of this application.

Moreover, eProsima provides a remote controlling tool that allows to visualize the status of a *DDS Recorder* and to send commands to it to change its current status.

This section explains the different execution states of a *DDS Recorder*, how to create your own tool using the DDS topics that the application defines to control its behavior, and the presentation of the eProsima user application for the remote control of the *DDS Recorder*.

3.11.1 DDS Recorder Statuses

The *DDS Recorder* application may have the following states:

- **CLOSED:** The application is not running. To start running the application it is required to launch it from the terminal by executing `ddsrecorder`. Once the `ddsrecorder` application is executed, it will automatically go into recording mode (RUNNING state), although this can be modified through the `.yaml` configuration file. Please refer to the *DDS Recorder remote controller configuration section* for more options on the initial state of the application.
- **RUNNING:** The application is running and recording data in the database.

- **PAUSED:** The application is running but not recording data in the database. In this state, the application stores the data it has received in a time window prior to the current time. The data will not be saved to the database until an event arrives from the remote controller.
- **STOPPED:** The application is running but not receiving data.

To change from one state to another, commands can be sent to the application through the *Controller Command* DDS topic to be defined later. The commands that the application accepts are as follows:

- **start:** Changes to RUNNING state if it was not in it.
- **pause:** Changes to PAUSED state if it was not in it.
- **stop:** Changes to STOPPED state if it was not in it.
- **event:** Triggers a recording event to save the data of the time window prior to the event. This command can take the next state as an argument, so it is possible to trigger an event and change the state with the same command. This is useful when the recorder is in a paused state, the user wants to record all the data collected in the current time window and then immediately switch to RUNNING state to start recording data. It could also be the case that the user wants to capture the event, save the data and then stop the recorder to inspect the output file. The arguments are sent as a serialized *json* in string format.
- **close:** Closes the *DDS Recorder* application.

The following is the state diagram of the *DDS Recorder* application with all the available commands and the state change effect they cause.

3.11.2 DDS Controller Data Types

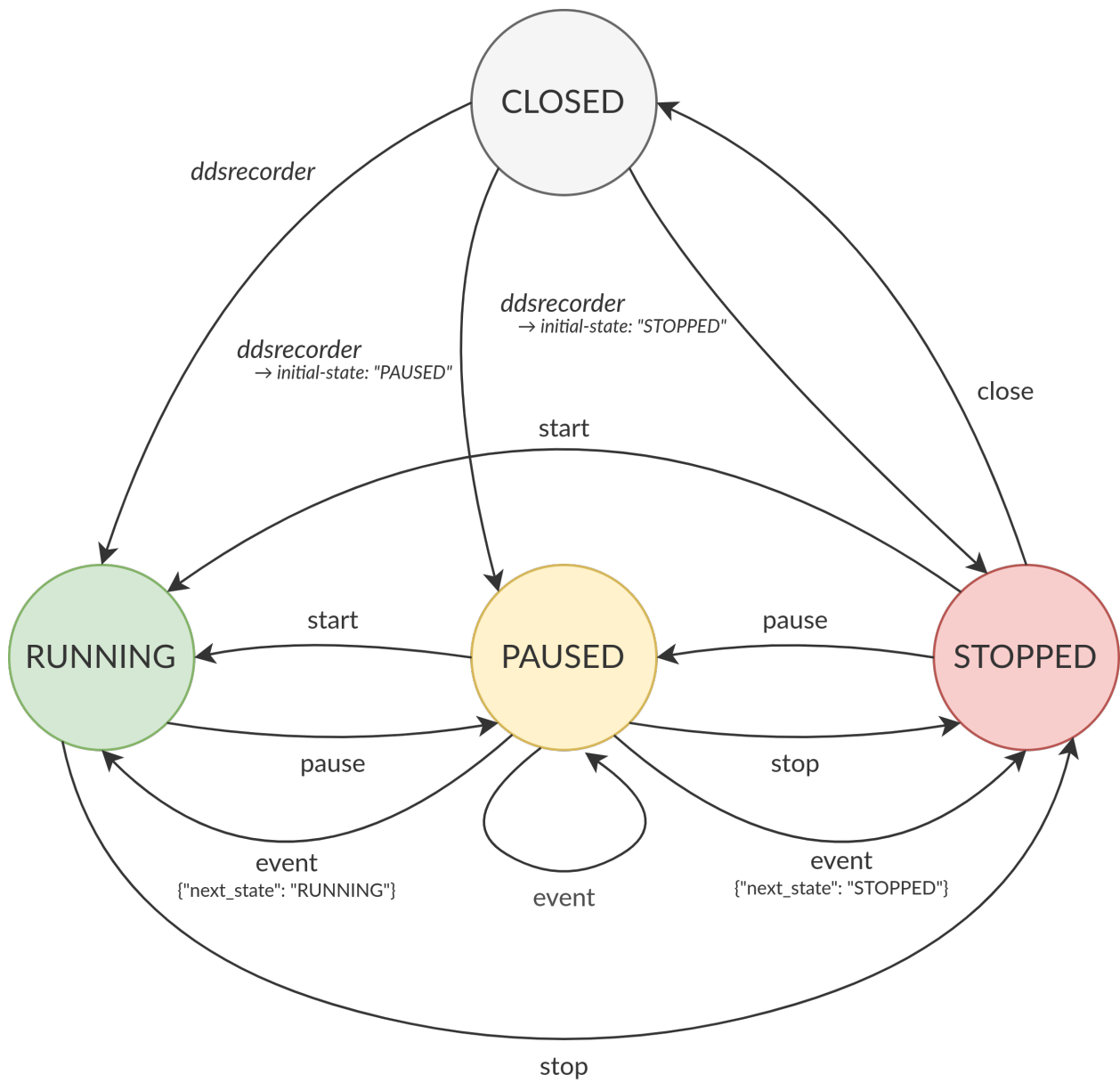
The *DDS Recorder* contains a DDS subscriber in the *Controller Command* topic and a DDS publisher in the *Controller Status* topic. These topics' names are by default `/ddsrecorder/command` and `/ddsrecorder/status`, respectively, but can also be specified by users via the `command-topic-name` and `status-topic-name` configuration tags. Therefore, any user can create his own application to control the *DDS Recorder* remotely by creating a publisher in the *Controller Command* topic, which sends commands to the recorder, and a subscriber in the *Controller Status* topic to monitor its status.

Note: Status and command topics are not blocked by default, i.e. messages on this topics will be recorded if listening on the same domain the controller is launched. If willing to avoid this, include these topics in the *blocklist*:

```
dds:
  blocklist:
    - type: DdsRecorderStatus
    - type: DdsRecorderCommand
```

The following is a description of the aforementioned control topics.

- Command topic:
 - Topic name: Specified in `command-topic-name` configuration parameter (Default: `/ddsrecorder/command`)
 - Topic type name: `DdsRecorderCommand`
 - Type description:
 - * IDL definition



```
struct DdsRecorderCommand
{
    string command;
    string args;
};
```

* DdsRecorderCommand type description:

Argument	Description	Data type	Possible values
command	Command to send.	string	start pause stop event close
args	Arguments of the command. This arguments should contain a JSON serialized string.	string	· event command: {"next_state": "RUNNING"} {"next_state": "STOPPED"}

- Status topic:

- Topic name: Specified in `status-topic-name` configuration parameter (Default: `/ddsrecorder/status`)
- Topic type name: `DdsRecorderStatus`
- Type description:
 - * IDL definition

```
struct DdsRecorderStatus
{
    string previous;
    string current;
    string info;
};
```

* DdsRecorderStatus type description:

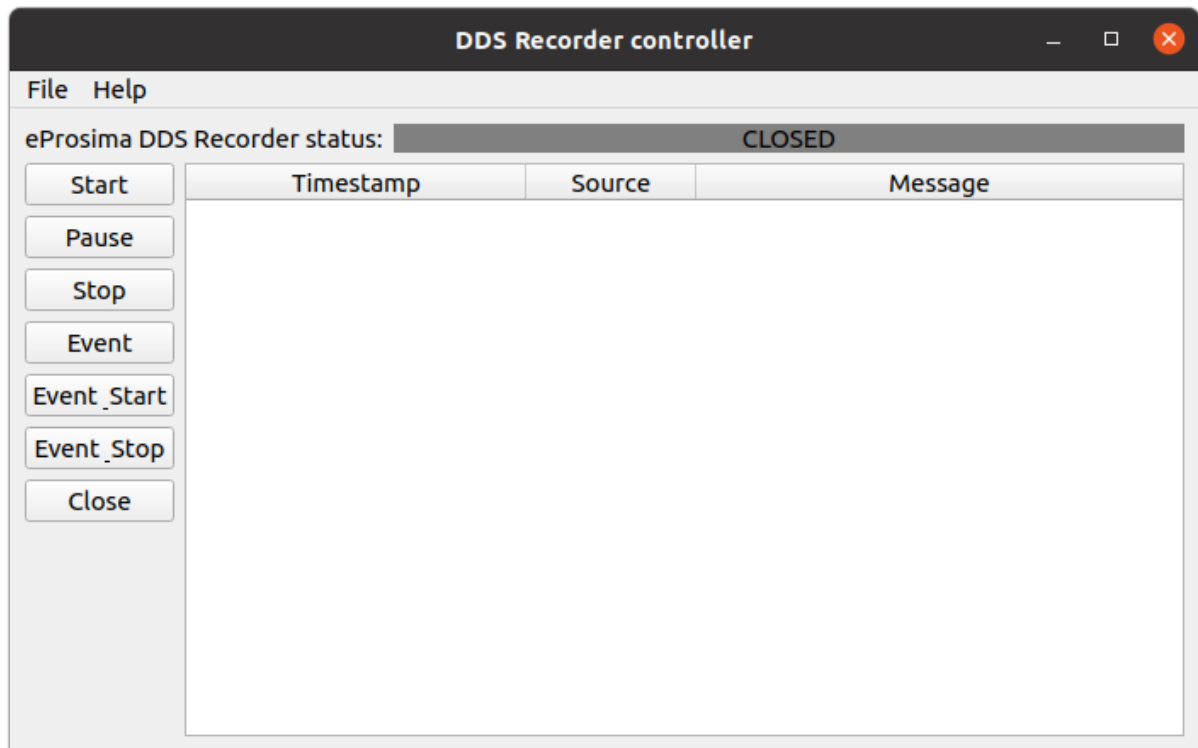
Argument	Description	Data type	Possible values
previous	Previous status of the <i>DDS Recorder</i> .	string	RUNNING PAUSED STOPPED
current	Current status of the <i>DDS Recorder</i> .	string	RUNNING PAUSED STOPPED
info	Additional information related to the state change. (Unused)	string	-

3.11.3 DDS Recorder remote controller application

eProxima DDS Record & Replay provides a graphical user application that implements a remote controller for the *DDS Recorder*. Thus the user can control a *DDS Recorder* instance using this application without having to implement their own.

Note: If installing *eProxima DDS Record & Replay* from sources, compilation flag `-DBUILD_DDSRECORDER_CONTROLLER=ON` is required to build this application.

Its interface is quite simple and intuitive. Once the application is launched, a layout as the following one should be visible:



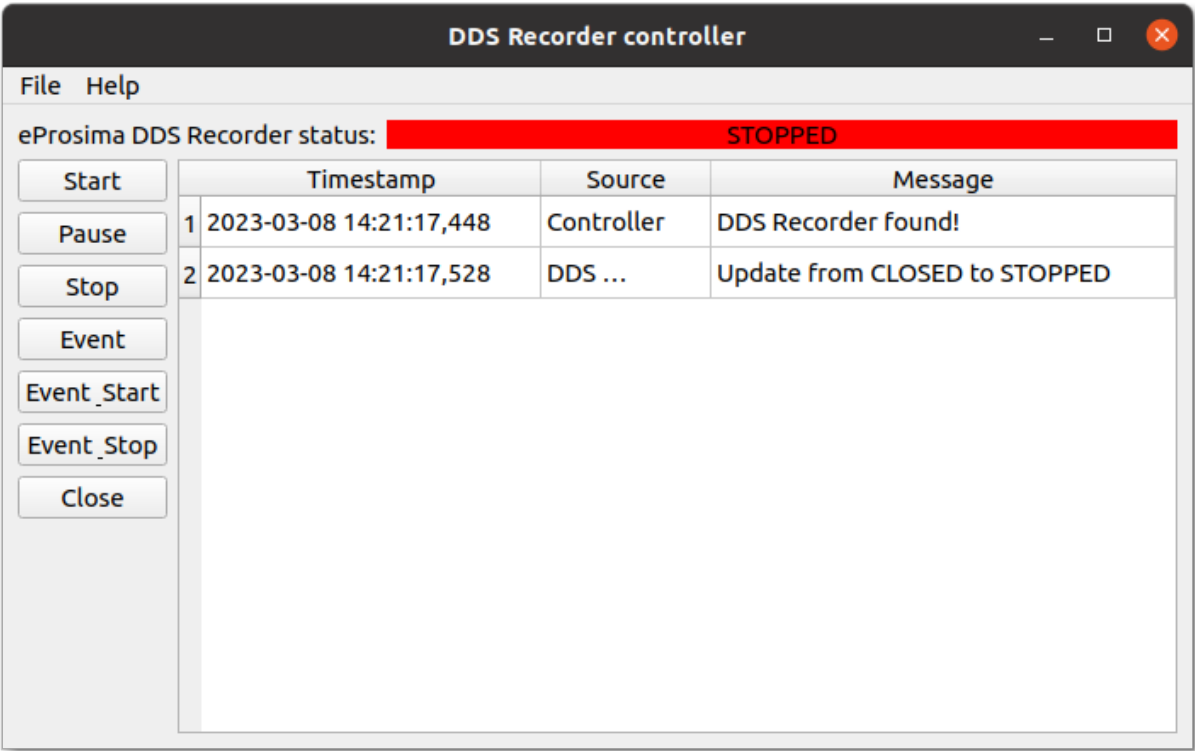
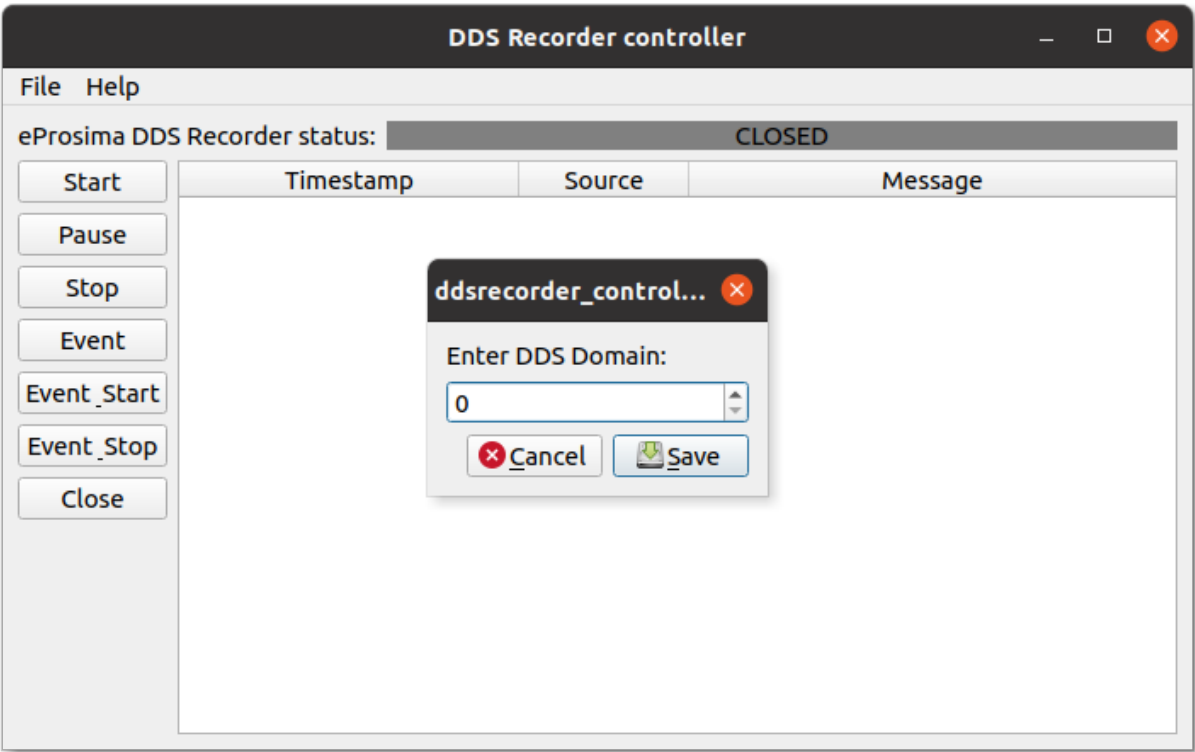
If the controller should function in a domain different than the default one (0), change it by clicking **File->DDS Domain** and introducing the one desired:

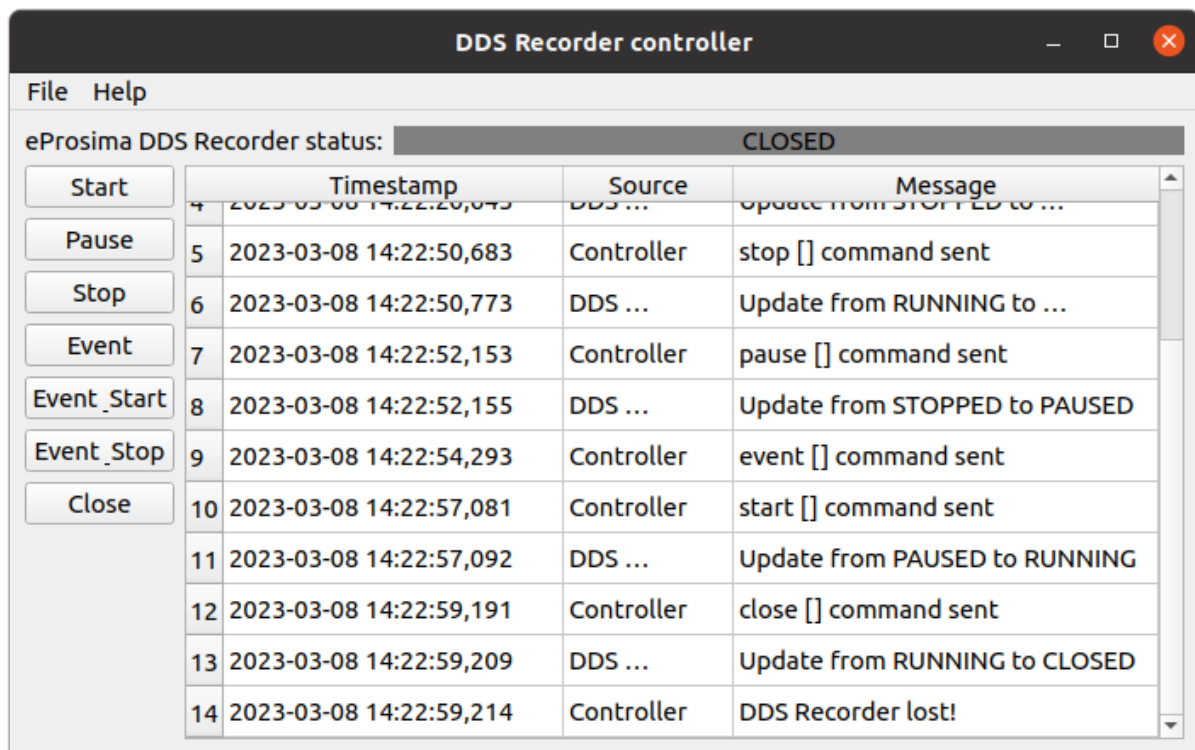
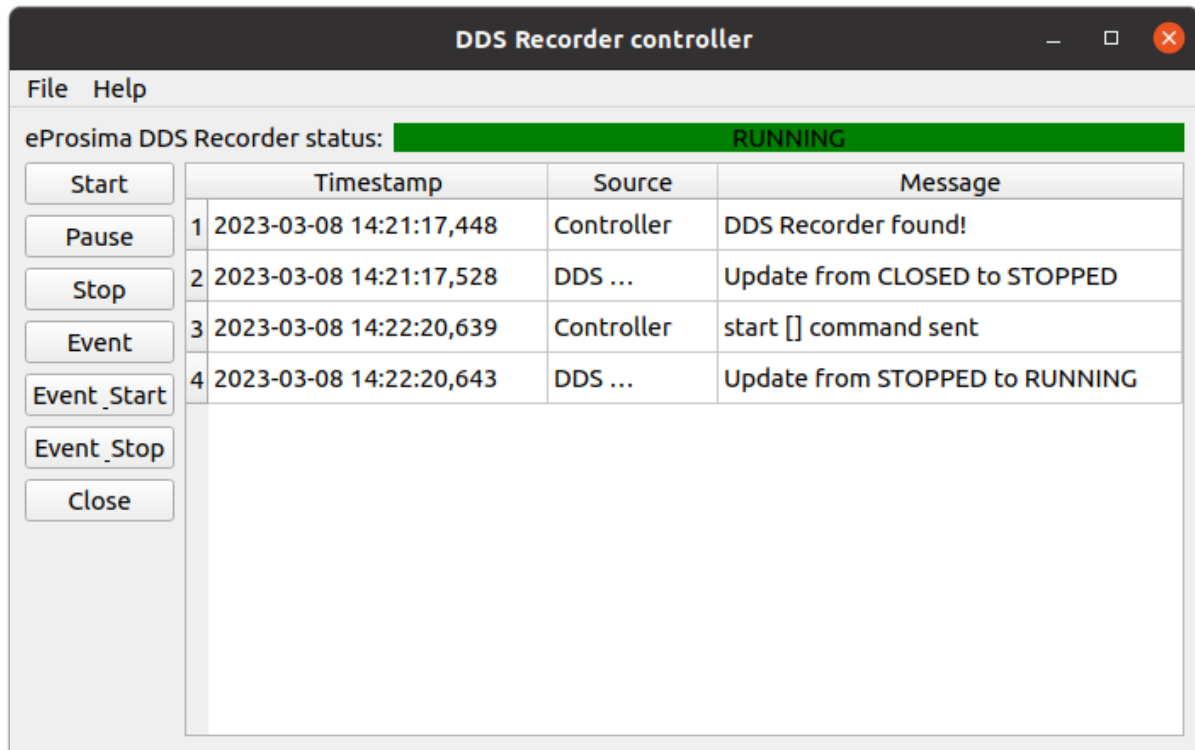
When a *DDS Recorder* instance is found in the domain, a message is displayed in the logging panel:

From this point on, it is possible to interact with the recorder application by pushing any of the buttons appearing on the left. Every command sent is reflected in the logging panel and, additionally, the recorder application publishes its current status with every state transition undergone. This can be observed in the *eProxima DDS Recorder status* placeholder, located in the upper part of the layout:

By clicking on **Stop** button, the recorder application ceases recording, but can be commanded to **Start** / **Pause** whenever wished. Once the user has finished all recording activity, it is possible to **Close** the recorder and free all resources used by the application:

Note that once **CLOSED** state has been reached, commands will no longer have an effect on the recorder application as its process is terminated when a **close** command is received.





3.12 Getting Started

3.12.1 Project Overview

eProsima DDS Replayer is a cross-platform application that allows to play back messages recorded by a *DDS Recorder* instance.

A user can configure a *DDS Replayer* instance differently depending on the scenario and purpose, being able to tune parameters concerning the DDS layer as well as playback settings.

Among its many [configuration](#) options, the user is able to allow/block a set of topics, and/or define specific QoS (other than the recorded ones) to be applied to certain topics. It is also possible to publish samples at a rate different than the original one, filter messages according to its timestamp, or define a publication begin time, among others.

In addition, *eProsima DDS Replayer* is able to automatically send the type information recorded in a MCAP file, which might be required for applications relying on [Dynamic Types](#).

Usage Description

DDS Replayer is a terminal (non-graphical) application that creates a replay service given an input data file. Although most use cases are covered by the default configuration, the *DDS Replayer* can be configured via a YAML file, whose format is very intuitive and human-readable.

- **Run:** Only the command that launches the application (`ddsreplayer`) needs to be executed to run a *DDS Replayer*. Please, read this [section](#) to apply a specific configuration, and this [section](#) to see the supported arguments.
- **Interact:** Once the *DDS Replayer* application is running, the allowlist and blocklist topic lists could be changed in runtime by just changing the YAML configuration file.
- **Close:** To close the *DDS Replayer* application just send a `Ctrl+C` signal to terminate the process gracefully (see [Closing Replay Application](#)).

Common Use cases

To get started with *DDS Replayer*, please visit section [Example of usage](#).

3.12.2 Example of usage

This example will serve as a hands-on tutorial, aimed at introducing some of the key concepts and features that *eProsima DDS Record & Replay* replay application (*DDS Replayer* or `ddsreplayer`) has to offer.

Prerequisites

It is required to have *eProsima DDS Record & Replay* previously installed using one of the following installation methods:

- [DDS Record & Replay on Windows](#)
- [DDS Record & Replay on Linux](#)
- [Docker Image \(recommended\)](#)

Additionally, [ShapesDemo](#) is required to publish and subscribe shapes of different colors and sizes. Install it by following any of the methods described in the given links:

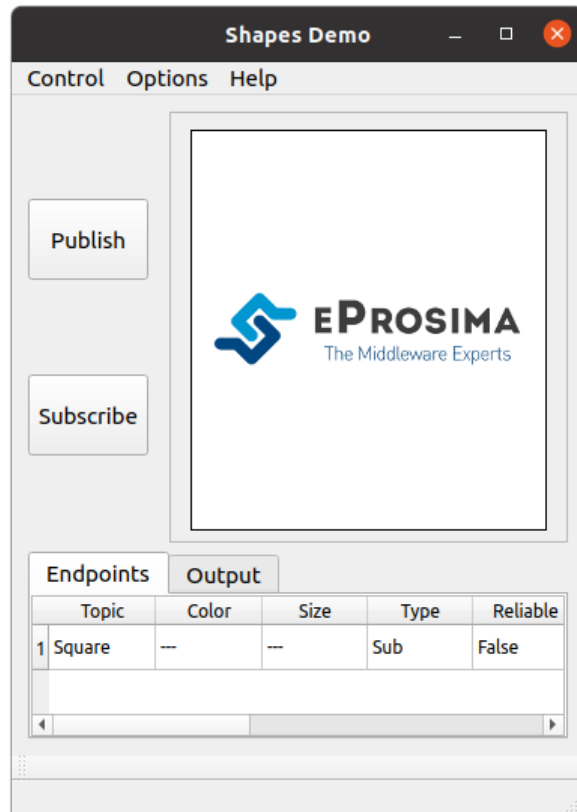
- [Windows installation from binaries](#)

- [Linux installation from sources](#)
- [Docker Image](#)

This is a follow-up tutorial, and assumes that *DDS Recorder* [Example of usage](#) has already been completed.

Start ShapesDemo

Let us launch a ShapesDemo instance and create a subscription in the Square topic with default settings.



Replayer configuration

The only configuration option required by a *DDS Replayer* is the path to an input MCAP file, which can be provided both as a CLI argument or via YAML configuration. By default, all messages stored in the provided input file are played back in DDS Domain 0, starting at the very moment the application is launched.

It is also possible to change the default configuration parameters by means of a YAML configuration file.

Note: Please refer to [Configuration](#) for more information on how to configure a *DDS Replayer*.

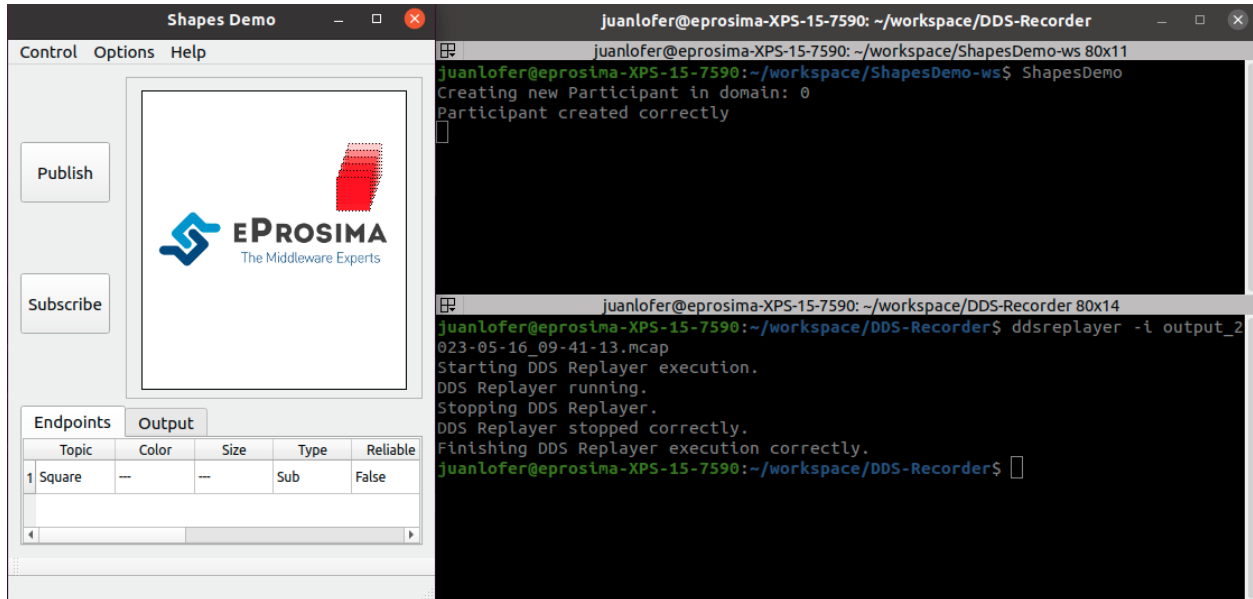
Replayer execution

Launching a *DDS Replayer* instance is as easy as executing the following command:

```
ddsreplayer -i output_YYYY-MM-DD-DD_hh-mm-ss.mcap
```

In order to know all the possible arguments supported by this tool, use the command:

```
ddsreplayer --help
```



Execution will end once every message found in the given input file is played back, although it can also be terminated with `Ctrl+C` at any point.

Next Steps

Feel free to experiment with the many *configuration* options available for a *DDS Replayer* instance. For example, you may try to modify the playback rate, block/allow the Square topic in the middle of execution, or set a different topic QoS configuration via the builtin-topics list.

3.13 Usage

eProsimas DDS Replayer is a user application executed from command line.

- *Starting Replay Application*
- *Closing Replay Application*
- *Replay Service Command-Line Parameters*

3.13.1 Starting Replay Application

Docker Image

Warning: Currently, *DDS Record & Replay* Docker image only contains *DDS Recorder* tool, *DDS Replay tool* application will be added soon.

The recommended method to run the *DDS Replayer* is to instantiate a Docker container of the *DDS Record & Replay* image. [Here](#) are the instructions to download the compressed *DDS Record & Replay* Docker image and load it locally.

To run the *DDS Replayer* from a Docker container execute the following command:

```
docker run -it \
  --net=host \
  --ipc=host \
  -v /<dds_replayer_ws>/DDS_REPLAYER_CONFIGURATION.yaml:/root/DDS_REPLAYER_
  CONFIGURATION.yaml \
  ubuntu-ddsrecorder:v<X.X.X> ddsreplayer
```

Installation from sources

eProsima DDS Record & Replay depends on *fastrtps*, *fastcdr* and *ddspipe* libraries. In order to correctly execute the replayer, make sure that *fastrtps*, *fastcdr* and *ddspipe* are properly sourced.

```
source <path-to-fastdds-installation>/install/setup.bash
source <path-to-ddspipe-installation>/install/setup.bash
source <path-to-ddsrecordreplay-installation>/install/setup.bash
```

Note: If Fast DDS, DDS Pipe and DDS Record & Replay have been installed in the system, these libraries would be sourced by default.

To start *eProsima DDS Replayer* with a default configuration, enter:

```
ddsreplayer -i input_file.mcap
```

3.13.2 Closing Replay Application

SIGINT

To close *eProsima DDS Replayer*, press **Ctrl+C**. *DDS Replayer* will perform a clean shutdown.

SIGTERM

Write command `kill <pid>` in a different terminal, where `<pid>` is the id of the process running the *DDS Replayer*. Use `ps` or `top` programs to check the process ids.

TIMEOUT

Setting a maximum amount of seconds that the application will work using argument `--timeout` will close the application once the time has expired.

3.13.3 Replay Service Command-Line Parameters

The *DDS Replayer* application supports several input arguments:

Com-mand	Description	Option	Pos-sible Values	Default Value
Help	It shows the usage information of the application.	<code>-h</code> <code>--help</code>		
Ver-sion	It shows the current version of the <i>DDS Replayer</i> and the hash of the last commit of the compiled code.	<code>-v</code> <code>--version</code>		
Input File	Input MCAP file path.	<code>-i</code> <code>--input-file</code>		
Con-figu-ration File	Configuration file path.	<code>-c</code> <code>--config-path</code>		<code>./DDS_REPLAYER_CONFIGURATION.yaml</code>
Reload Timer	The configuration file will be automatically reloaded according to the specified time period.	<code>-r</code> <code>--reload-time</code>	Un-signed Integer	<code>0</code>
Time-out	Set a maximum time while the application will be running. <code>0</code> means that the application will run forever (until kill via signal).	<code>-t</code> <code>--timeout</code>	Un-signed Integer	<code>0</code>
Debug	Enables the <i>DDS Replayer</i> logs so the execution can be followed by internal debugging information. Sets <code>Log Verbosity</code> to <code>info</code> and <code>Log Filter</code> to <code>DDSREPLAYER</code> .	<code>-d</code> <code>--debug</code>		
Log Ver-bosity	Set the verbosity level so only log messages with equal or higher importance level are shown.	<code>--log-verbosity</code>	<code>info</code> <code>warning</code> <code>error</code>	<code>warning</code>
Log Filter	Set a regex string as filter.	<code>--log-filter</code>	String	<code>"DDSREPLAYER"</code>

3.14 Configuration

- *DDS Replayer Configuration*
 - *DDS Configuration*
 - *Replay Configuration*
 - *Specs Configuration*
 - *General Example*

3.14.1 DDS Replayer Configuration

A *DDS Replayer* is configured by a *.yaml* configuration file. This *.yaml* file contains all the information regarding the DDS interface configuration, playback parameters, and *DDS Replayer* specifications. Thus, this file has four major configuration groups:

- **dds**: configuration related to DDS communication.
- **replayer**: configuration with data playback parameters.
- **specs**: configuration of the internal operation of the *DDS Replayer*.

DDS Configuration

Configuration related to DDS communication.

Topic Filtering

As seen in *DDS Recorder topic filtering*, a user can define a set of rules to only record DDS *Topics* of interest.

In addition to the filters applied to *DDS Recorder* when recording, *DDS Replayer* also allows filtering of DDS *Topics*. That is, it allows to define the DDS Topics' data that is going to be replayed by the application. This way, it is possible to define a set of rules in *DDS Replayer* to filter those data samples the user does not wish to replay.

It is not mandatory to define such set of rules in the configuration file. In this case, a *DDS Replayer* will publish all data stored in the provided input MCAP file.

To define these data filtering rules based on the Topics to which they belong, the following lists are available:

- Allowed topics list (**allowlist**)
- Block topics list (**blocklist**)

These lists of topics stated above are defined by a tag in the *YAML* configuration file, which defines a *YAML* vector (`[]`). This vector contains the list of topics for each filtering rule. Each Topic is determined by its entries **name** and **type**, with only the first one being mandatory.

Topic entries	Data type	Default value
name	string	-
type	string	"*"

See *Topic* section for further information about the topic.

Note: Placing quotation marks around values in a YAML file is generally optional. However, values containing wildcard characters must be enclosed by single or double quotation marks.

Allow topic list

This is the list of topics that *DDS Replayer* will replay, i.e. only recorded data under the topics matching the expressions in the `allowlist` will be published by *DDS Replayer*.

Note: If no `allowlist` is provided, data will be replayed for all topics (unless filtered out in `blocklist`).

Block topic list

This is the list of topics that the *DDS Replayer* will block, that is, all input data under the topics matching the filters specified in the `blocklist` will be discarded by the *DDS Replayer* and therefore will not be published.

This list takes precedence over the `allowlist`. If a topic matches an expression both in the `allowlist` and in the `blocklist`, the `blocklist` takes precedence, causing the data under this topic to be discarded.

Example of usage - Allowlist and blocklist collision:

In the following example, the `HelloWorldTopic` topic is both in the `allowlist` and (implicitly) in the `blocklist`, so according to the `blocklist` preference rule this topic is blocked. Moreover, only the topics present in the `allowlist` are relayed, regardless of whether more topics are dynamically discovered in the DDS network. In this case the forwarded topics are `AllowedTopic1` with data type `Allowed` and `AllowedTopic2` regardless of its data type.

```
allowlist:
- name: AllowedTopic1
  type: Allowed
- name: AllowedTopic2
  type: "*"
- name: HelloWorldTopic
  type: HelloWorld

blocklist:
- name: "*"
  type: HelloWorld
```

Built-in Topics

As seen in *Topic Filtering*, a *DDS Recorder* uses the QoS of the first Publisher/Subscriber found in every recorded topic, unless manually defined in the *built-in topics* list. This QoS information is stored in the MCAP file along with the user data, and thus a *DDS Replayer* instance is able to publish recorded data preserving the original QoS.

However, the user has the option to manually set the QoS of any topic to be played back through the replayer's builtin-topics list. The builtin-topics list is defined in the same form as the `allowlist` and `blocklist`.

This feature also allows to manually force the QoS of a specific topic, so the entities created in such topic follows the specified QoS and not the one first discovered.

Topic Quality of Service

For every topic contained in this list, both `name` and `type` must be specified and contain no wildcard characters. Apart from these values, the tag `qos` under each topic allows to configure the following values:

Quality of Service	Yaml tag	Data type	Default value	QoS set
Reliability	<code>reliability</code>	<i>bool</i>	false	RELIABLE / BEST_EFFORT
Durability	<code>durability</code>	<i>bool</i>	false	TRANSIENT_LOCAL / VOLATILE
Partitions	<code>partitions</code>	<i>bool</i>	false	Topic with / without partitions
Ownership	<code>ownership</code>	<i>bool</i>	false	EXCLUSIVE_OWNERSHIP_QOS / SHARED_OWNERSHIP_QOS
Key	<code>keyed</code>	<i>bool</i>	false	Topic with / without key

Example of usage:

```
builtin-topics:
- name: HelloWorldTopic
  type: HelloWorld
  qos:
    reliability: true      # Use QoS RELIABLE
    durability: true      # Use QoS TRANSIENT_LOCAL
    partitions: true      # Topic with partitions
    ownership: false      # Use QoS SHARED_OWNERSHIP_QOS
    keyed: true           # Topic with key
```

DDS Domain

Tag `domain` configures the *Domain Id*.

```
domain: 101
```

Ignore Participant Flags

A set of discovery traffic filters can be defined in order to add an extra level of isolation. This configuration option can be set through the `ignore-participant-flags` tag:

```
ignore-participant-flags: no_filter      # No filter (default)
# or
ignore-participant-flags: filter_different_host      # Discovery traffic from
↳ another host is discarded
# or
ignore-participant-flags: filter_different_process   # Discovery traffic from
↳ another process on same host is discarded
# or
ignore-participant-flags: filter_same_process        # Discovery traffic from
↳ own process is discarded
# or
ignore-participant-flags: filter_different_and_same_process # Discovery traffic from
↳ own host is discarded
```

See [Ignore Participant Flags](#) for more information.

Custom Transport Descriptors

By default, *DDS Replayer* internal participants are created with enabled [UDP](#) and [Shared Memory](#) transport descriptors. The use of one or the other for communication will depend on the specific scenario, and whenever both are viable candidates, the most efficient one (Shared Memory Transport) is automatically selected. However, a user may desire to force the use of one of the two, which can be accomplished via the `transport` configuration tag.

```
transport: builtin    # UDP & SHM (default)
# or
transport: udp        # UDP only
# or
transport: shm        # SHM only
```

Warning: When configured with `transport: shm`, *DDS Replayer* will only communicate with applications using Shared Memory Transport exclusively (with disabled UDP transport).

Interface Whitelist

Optional tag `whitelist-interfaces` allows to limit the network interfaces used by UDP and TCP transport. This may be useful to only allow communication within the host (note: same can be done with [Ignore Participant Flags](#)). Example:

```
whitelist-interfaces:
- "127.0.0.1"        # Localhost only
```

See [Interface Whitelist](#) for more information.

Warning: When providing an interface whitelist, external participants with which communication is desired must also be configured with interface whitelisting.

Replay Configuration

Configuration of data playback settings.

Input File

The path to the file, set through the `input-file` configuration tag. When the input file is specified both through CLI argument and YAML configuration file, the former takes precedence.

Begin Time

By default, all data stored in the provided MCAP file is played back. However, a user might be interested in only replaying data relative to a specific time frame. `begin-time` and `end-time` configuration options can be leveraged for this purpose, and their format is as follows:

Parameter	Tag	Description	Data type	Default value
Use local time zone	<code>local</code>	Whether to interpret the provided datetime as local (<code>true</code>) or as a Greenwich Mean Time (GMT/UTC +0) without Daylight Saving Time (DST) considerations (<code>false</code>).	<code>bool</code>	<code>true</code>
Date-time Format	<code>format</code>	Format followed by the provided datetime.	<code>string</code>	<code>"%Y-%m-%d_%H-%M-%S"</code>
Date-time	<code>datetime</code>	Datetime (seconds precision).	<code>string</code>	
Milliseconds	<code>milliseconds</code>	Milliseconds.	<code>integer</code>	<code>0</code>
Microseconds	<code>microseconds</code>	Microseconds.	<code>integer</code>	<code>0</code>
Nanoseconds	<code>nanoseconds</code>	Nanoseconds.	<code>integer</code>	<code>0</code>

Messages recorded/sent (see [Log Publish Time](#)) before `begin-time` will not be played back by a *DDS Replayer* instance.

End Time

As with `begin-time`, a user can discard messages recorded/sent after a specific timepoint set through the `end-time` tag, which follows the format described in [Begin Time](#).

Start Replay Time

This configuration option (`start-replay-time`) allows to start replaying data at a certain timepoint following the format described in [Begin Time](#). If the provided timepoint already expired, the replayer starts publishing messages right away.

Playback Rate

By default, data is replayed at the same rate it was published/received. However, a user might be interested in playing messages back at a rate different than the original one. This can be accomplished through the `playback rate` tag, which accepts positive float values (e.g. `0.5` <-> half speed || `2` <-> double speed).

Replay Types

By default, a *DDS Replayer* instance automatically sends all type information found in the provided MCAP file, which might be required for applications relying on *Dynamic Types*. Nonetheless, a user can choose to avoid this by setting `replay-types: false`, so only data samples are sent while their associated type information is disregarded.

Specs Configuration

The internals of a *DDS Replayer* can be configured using the `specs` optional tag that contains certain options related with the overall configuration of the *DDS Replayer* instance to run. The values available to configure are:

Number of Threads

`specs` supports a `threads` optional value that allows the user to set a maximum number of threads for the internal `ThreadPool`. This `ThreadPool` allows to limit the number of threads spawned by the application. This improves the performance of the internal data communications.

This value should be set by each user depending on each system characteristics. In case this value is not set, the default number of threads used is 12.

Wait-for-acknowledgement Timeout

The execution of a *DDS Replayer* instance ends when the last message contained in the provided input file is published (or the user manually aborts the process, see *Closing Replay Application*). Note that this last message might be lost after publication, and if reliable *Reliability QoS* is being used, a mechanism should be established to avoid this problematic situation. For this purpose, the user can specify the maximum amount of milliseconds (`wait-all-acked-timeout`) to wait on closure until published messages are acknowledged by matched readers. Its value is set to 0 by default (no wait).

General Example

A complete example of all the configurations described on this page can be found below.

Warning: This example can be used as a quick reference, but it may not be correct due to incompatibility or exclusive properties. **Do not take it as a working example.**

```
dds:
  domain: 0

  allowlist:
    - name: "topic_name"
      type: "topic_type"

  blocklist:
    - name: "topic_name"
      type: "topic_type"

  builtin-topics:
```

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```

- name: "HelloWorldTopic"
  type: "HelloWorld"
  qos:
    reliability: true
    durability: true
    keyed: false
    partitions: true
    ownership: false

ignore-participant-flags: no_filter
transport: builtin
whitelist-interfaces:
  - "127.0.0.1"

replayer:
  input-file: my_input.mcap

begin-time:
  local: true
  datetime: 2023-04-10_10-37-50
  milliseconds: 100
  nanoseconds: 50

end-time:
  format: "%H-%M-%S_%Y-%m-%d"
  local: true
  datetime: 10-39-11_2023-04-10
  milliseconds: 200

start-replay-time:
  local: true
  datetime: 2023-04-12_12-00-00
  milliseconds: 500

rate: 1.4
replay-types: true

specs:
  threads: 8
  wait-all-acked-timeout: 10

```

3.15 Configuring Fast DDS DynamicTypes

- *Background*
- *Prerequisites*
- *Generating data types*
- *DDS Publisher*

- *Data types*
- *Examining the code*
- *DDS Subscriber*
 - *Examining the code*
- *Running the application*

3.15.1 Background

As explained in [this section](#), a *DDS Recorder* instance stores (by default) all data regardless of whether their associated data type is received or not. However, some applications require this information to be recorded and written in the resulting MCAP file, and for this to occur the publishing applications must send it via *Dynamic Types*.

This tutorial focuses on how to send the data type information using Fast DDS DynamicTypes and other relevant aspects of DynamicTypes. More specifically, this tutorial implements a DDS Publisher configured to send its data type, a DDS Subscriber that collects the data type and is able to read the incoming data, and a DDS Recorder is launched to save all the data published on the network. For more information about how to create the workspace with a basic DDS Publisher and a basic DDS Subscriber, please refer to [Writing a simple C++ publisher and subscriber application](#).

The source code of this tutorial can be found in the public *eProsima DDS Record & Replay* [GitHub repository](#) with an explanation of how to build and run it.

Warning: This tutorial works with [this](#) branch of Fast DDS.

3.15.2 Prerequisites

Ensure that *eProsima DDS Record & Replay* is installed together with *eProsima* dependencies, i.e. *Fast DDS*, *Fast CDR* and *DDS Pipe*.

If *eProsima DDS Record & Replay* was installed using the [recommended installation](#) the environment is sourced by default, otherwise, just remember to source it in every terminal in this tutorial:

```
source <path-to-fastdds-installation>/install/setup.bash
source <path-to-ddspipe-installation>/install/setup.bash
source <path-to-ddsrecordreplay-installation>/install/setup.bash
```

3.15.3 Generating data types

eProsima Fast DDS-Gen is a Java application that generates *eProsima Fast DDS* source code using the data types defined in an IDL (Interface Definition Language) file. When generating the Types using *eProsima Fast DDS Gen*, the option `-typeobject` must be added in order to generate the needed code to fill the `TypeInformation` data.

The expected argument list of the application is:

```
fastddsgen -typeobject MyType.idl
```


3.15.4 DDS Publisher

The DDS publisher will be configured to act as a server of the data types of the data it publishes.

However, *Fast DDS* does not send the data type information by default, it must be configured to do so.

Data types

At the moment, there are two data types that can be used:

- [HelloWorld.idl](#)

```
struct HelloWorld
{
    unsigned long index;
    string message;
};
```

- [Complete.idl](#)

```
struct Timestamp
{
    long seconds;
    long milliseconds;
};

struct Point
{
    long x;
    long y;
    long z;
};

struct MessageDescriptor
{
    unsigned long id;
    string topic;
    Timestamp time;
};

struct Message
{
    MessageDescriptor descriptor;
    string message;
};

struct CompleteData
{
    unsigned long index;
    Point main_point;
    sequence<Point> internal_data;
    Message messages[2];
};
```

Examining the code

This section explains the C++ source code of the DDS Publisher, which can also be found [here](#).

The private data members of the class defines the DDS Topic, DataTypeKind, DDS Topic type and DynamicType. The DataTypeKind defines the type to be used by the application (HelloWorld or Complete). For simplicity, this tutorial only covers the code related to the HelloWorld type.

```

///! Name of the DDS Topic
std::string topic_name_;
///! The user can choose between HelloWorld and Complete types so this defines the
→chosen type
DataTypeKind data_type_kind_;
///! Name of the DDS Topic type according to the DataTypeKind
std::string data_type_name_;
///! Actual DynamicType generated according to the DataTypeKind
eprosima::fastdds::types::DynamicType_ptr dynamic_type_;

```

The next lines show the constructor of the TypeLookupServicePublisher class that implements the publisher. The publisher is created with the topic and data type to use.

```

TypeLookupServicePublisher::TypeLookupServicePublisher(
    const std::string& topic_name,
    const uint32_t domain,
    DataTypeKind data_type_kind)
: participant_(nullptr)
, publisher_(nullptr)
, topic_(nullptr)
, datawriter_(nullptr)
, topic_name_(topic_name)
, data_type_kind_(data_type_kind)

```

Inside the TypeLookupServicePublisher constructor are defined the DomainParticipantQos. As the publisher act as a server of types, its QoS must be configured to send this information. Set use_client to false and use_server to true.

```

DomainParticipantQos pqos;
pqos.name("TypeLookupService_Participant_Publisher");

pqos.wire_protocol().builtin.typelookup_config.use_client = false;
pqos.wire_protocol().builtin.typelookup_config.use_server = true;

```

Next, we register the type in the participant:

1. Generate the dynamic type through generate_helloworld_type_() explained below.
2. Set the data type.
3. Create the TypeSupport with the dynamic type previously created.
4. Configure the type to fill automatically the TypeInformation and not TypeObject to be compliant with DDS-XTypes 1.2. standard.

```

switch (data_type_kind_)
{
    case DataTypeKind::HELLO_WORLD:

```

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```

        dynamic_type_ = generate_helloworld_type_();
        data_type_name_ = HELLO_WORLD_DATA_TYPE_NAME;
        break;
    case DataTypeKind::COMPLETE:
        dynamic_type_ = generate_complete_type_();
        data_type_name_ = COMPLETE_DATA_TYPE_NAME;
        break;
    default:
        throw std::runtime_error("Not recognized DynamicType kind");
        break;
}

TypeSupport type(new eprosima::fastrtps::types::DynamicPubSubType(dynamic_type_));

// Send type information so the type can be discovered
type->auto_fill_type_information(true);
type->auto_fill_type_object(false);

// Register the type in the Participant
participant->register_type(type);

```

The function `generate_helloworld_type_()` returns the dynamic type generated with the `TypeObject` and `TypeIdentifier` of the type.

```

eprosima::fastrtps::types::DynamicType_ptr
TypeLookupServicePublisher::generate_helloworld_type_() const
{
    // Generate HelloWorld type using methods from Fast DDS Gen autogenerated code
    registerHelloWorldTypes();

    // Get the complete type object and type identifier of the dynamic type
    auto type_object = GetHelloWorldObject(true);
    auto type_id = GetHelloWorldIdentifier(true);

    // Use data type name, type identifier and type object to build the dynamic type
    return eprosima::fastrtps::types::TypeObjectFactory::get_instance()->build_dynamic_
    ↪type(
        HELLO_WORLD_DATA_TYPE_NAME,
        type_id,
        type_object);
}

```

Then we initialized the Publisher, DDS Topic and DDS DataWriter.

To make the publication, the public member function `publish()` is implemented:

1. It creates the variable that will contain the user data, `dynamic_data_`.
2. Fill that variable with the function `fill_helloworld_data_(msg)`, explained below.

```

void TypeLookupServicePublisher::publish(unsigned int msg_index)
{
    // Get the dynamic data depending on the data type
    eprosima::fastrtps::types::DynamicData_ptr dynamic_data_;

```

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```

switch (data_type_kind_)
{
case DataTypeKind::HELLO_WORLD:
    dynamic_data_ = fill_helloworld_data_(msg_index);
    break;
case DataTypeKind::COMPLETE:
    dynamic_data_ = fill_complete_data_(msg_index);
    break;

default:
    throw std::runtime_error("Not recognized DynamicType kind");
    break;
}

// Publish data
datawriter_>write(dynamic_data_.get());

// Print the message published
std::cout << "Message published: " << std::endl;
eprosima::fastrtps::types::DynamicDataHelper::print(dynamic_data_);
std::cout << "-----" << std::endl;
}

```

The function `fill_helloworld_data_()` returns the data to be sent with the information filled in.

First, the `Dynamic_ptr` that will be filled in and returned is created. Using the `DynamicDataFactory` we create the data that corresponds to our data type. Finally, data variables are assigned, in this case, `index` and `message`.

```

eprosima::fastrtps::types::DynamicData_ptr
TypeLookupServicePublisher::fill_helloworld_data_(
    const unsigned int& index)
{
    // Create and initialize new dynamic data
    eprosima::fastrtps::types::DynamicData_ptr new_data;
    new_data = eprosima::fastrtps::types::DynamicDataFactory::get_instance()->create_
    ↪data(dynamic_type_);

    // Set index
    new_data->set_uint32_value(index, 0);
    // Set message
    new_data->set_string_value("Hello World", 1);

    return new_data;
}

```

3.15.5 DDS Subscriber

The DDS Subscriber is acting as a client of types, i.e. the subscriber will not know the types beforehand and it will discovery the data type via the type lookup service implemented on the publisher side.

Examining the code

This section explains the C++ source code of the DDS Subscriber, which can also be found [here](#).

The private data members of the class defines the DDS Topic, DDS Topic type and DynamicType.

```

///! Name of the DDS Topic
std::string topic_name_;
///! Name of the received DDS Topic type
std::string type_name_;
///! DynamicType generated with the received type information
eprosima::fastrtps::types::DynamicType_ptr dynamic_type_;

```

The next lines show the constructor of the TypeLookupServiceSubscriber class that implements the subscriber setting the topic name as the one configured in the publisher side.

```

TypeLookupServiceSubscriber::TypeLookupServiceSubscriber(
    const std::string& topic_name,
    uint32_t domain)
: participant_(nullptr)
, subscriber_(nullptr)
, topic_(nullptr)
, datareader_(nullptr)
, topic_name_(topic_name)
, samples_(0)

```

The DomainParticipantQos are defined inside the TypeLookupServiceSubscriber constructor. As the subscriber act as a client of types, set the QoS in order to receive this information. Set use_client to true and use_server to false.

```

DomainParticipantQos pqos;
pqos.name("TypeLookupService_Participant_Subscriber");

pqos.wire_protocol().builtin.typelookup_config.use_client = true;
pqos.wire_protocol().builtin.typelookup_config.use_server = false;

```

Then, the Subscriber is initialized.

Inside on_data_available() callback function the DynamicData_ptr is created, which will be filled with the actual data received.

As in the subscriber, the DynamicDataFactory is used for the creation of the data that corresponds to our data type.

```

void TypeLookupServiceSubscriber::on_data_available(
    DataReader* reader)
{
    // Create a new DynamicData to read the sample
    eprosima::fastrtps::types::DynamicData_ptr new_dynamic_data;
    new_dynamic_data = eprosima::fastrtps::types::DynamicDataFactory::get_instance()->
    ↪create_data(dynamic_type_);

```

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```

SampleInfo info;

// Take next sample until we've read all samples or the application stopped
while ((reader->take_next_sample(new_dynamic_data.get(), &info) == ReturnCode_
↳t::RETCODE_OK) && !is_stopped())
{
    if (info.instance_state == ALIVE_INSTANCE_STATE)
    {
        samples_++;

        std::cout << "Message " << samples_ << " received:\n" << std::endl;
        eprosima::fastrtps::types::DynamicDataHelper::print(new_dynamic_data);
        std::cout << "-----" <<
↳std::endl;

        // Stop if all expecting messages has been received (max_messages number_
↳reached)
        if (max_messages_ > 0 && (samples_ >= max_messages_))
        {
            stop();
        }
    }
}

```

The function `on_type_information_received()` detects if new topic information has been received in order to proceed to register the topic in case it has the same name as the expected one. To register a remote topic, function `register_remote_type_callback_()` is used. Once the topic has been discovered and registered, it is created a `DataReader` on this topic.

```

void TypeLookupServiceSubscriber::on_type_information_received(
    eprosima::fastdds::dds::DomainParticipant*,
    const eprosima::fastrtps::string_255 topic_name,
    const eprosima::fastrtps::string_255 type_name,
    const eprosima::fastrtps::types::TypeInformation& type_information)
{
    // First check if the topic received is the one we are expecting
    if (topic_name.to_string() != topic_name_)
    {
        std::cout <<
            "Discovered type information from topic < " << topic_name.to_string() <<
            " > while expecting < " << topic_name_ << " >. Skipping..." << std::endl;
        return;
    }

    // Set the topic type as discovered
    bool already_discovered = type_discovered_.exchange(true);
    if (already_discovered)
    {
        return;
    }
}

```

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```

std::cout <<
    "Found type in topic < " << topic_name_ <<
    " > with name < " << type_name.to_string() <<
    " > by lookup service. Registering..." << std::endl;

    // Create the callback to register the remote dynamic type
    std::function<void(const std::string&, const eprosima::fastrtps::types::DynamicType_
    ptr)> callback(
        [this]
        (const std::string& name, const eprosima::fastrtps::types::DynamicType_ptr_
    type)
        {
            this->register_remote_type_callback(name, type);
        });

    // Register the discovered type and create a DataReader on this topic
    participant_->register_remote_type(
        type_information,
        type_name.to_string(),
        callback);
}

```

The function `register_remote_type_callback()`, which is in charge of register the topic received, is explained below. First, it creates a `TypeSupport` with the corresponding type and registers it into the participant. Then, it creates the DDS Topic with the topic name set in the creation of the Subscriber and the topic type previously registered. Finally, it creates the `DataReader` of that topic.

```

void TypeLookupServiceSubscriber::register_remote_type_callback(
    const std::string&,
    const eprosima::fastrtps::types::DynamicType_ptr dynamic_type)
{
    //////////////////////////////////////
    // Register the type
    TypeSupport type(new eprosima::fastrtps::types::DynamicPubSubType(dynamic_type));
    type.register_type(participant_);

    //////////////////////////////////////
    // Create the DDS Topic
    topic_ = participant_->create_topic(
        topic_name_,
        dynamic_type->get_name(),
        TOPIC_QOS_DEFAULT);

    if (topic_ == nullptr)
    {
        return;
    }

    //////////////////////////////////////
    // Create the DataReader
    datareader_ = subscriber_->create_datareader(

```

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```
topic_,  
DATAREADER_QOS_DEFAULT,  
this);
```

3.15.6 Running the application

Open two terminals:

- In the first terminal, run the DDS Publisher:

```
source install/setup.bash  
cd DDS-Record-Replay/build/TypeLookupService  
./TypeLookupService --entity publisher
```

- In the second terminal, run the DDS Subscriber:

```
source install/setup.bash  
cd DDS-Record-Replay/build/TypeLookupService  
./TypeLookupService --entity subscriber
```

At this point, we observe that the data published reach the subscriber and it can access to the content of the sample received.

3.16 Visualize data with Foxglove

- *Background*
- *Prerequisites*
- *Configuring DDS Recorder*
- *Running the application*
 - *Start ShapesDemo*
 - *Recorder execution*
 - *Visualize data with Foxglove Studio*

3.16.1 Background

This tutorial explains how to record data with *DDS Recorder* tool and visualize it with [Foxglove Studio](#).


```

colcon build [1/1 done] [0 ongoing] 114x20
irenebm@xps-15-7590: ~/annapurna/DDS-Recorder/build/TypeLookupService $ ./TypeLookupService --entity publisher
Participant < 01.0f.af.e6.e1.58.1e.40.00.00.00.00|0.0.1.c1> created...
- DDS Domain: 0
- DataWriter: 01.0f.af.e6.e1.58.1e.40.00.00.00.00|0.0.1.3
- Topic name: /dds/topic
- Topic data type: HelloWorld
Publisher running. Please press CTRL+C to stop the Publisher at any time.
Message published:
index: 0
message: Hello World
-----
2023-02-20 16:13:05.525 [RTPS_TRANSPORT_SHM Warning] Buffer is being invalidated, segment_size may be insufficient
-> Function invalidate_if_not_processing
DataWriter matched with DataReader: 1.f.af.e6.eb.58.8f.69.0.0.0.0.0.1.4
Message published:
index: 1
message: Hello World
-----
Message published:
index: 2

/bin/bash 114x20
irenebm@xps-15-7590: ~/annapurna/DDS-Recorder/build/TypeLookupService $ ./TypeLookupService --entity subscriber
Participant < 01.0f.af.e6.eb.58.8f.69.00.00.00.00|0.0.1.c1> created...
- DDS Domain: 0
Subscriber waiting to discover type for topic < /dds/topic >. Press CTRL+C to stop the Subscriber...
2023-02-20 16:13:05.526 [RTPS_TRANSPORT_SHM Warning] Buffer is being invalidated, segment_size may be insufficient
-> Function invalidate_if_not_processing
Found type in topic < /dds/topic > with name < HelloWorld > by lookup service. Registering...
DataReader matched with DataWriter: 1.f.af.e6.e1.58.1e.40.0.0.0.0.0.1.3
Participant < 01.0f.af.e6.eb.58.8f.69.00.00.00.00|0.0.1.c1 > in domain < 0 > created reader < 01.0f.af.e6.eb.58.8f
.69.00.00.00.00|0.0.1.4 > in topic < /dds/topic > with data type < HelloWorld >
Subscriber < 01.0f.af.e6.eb.58.8f.69.00.00.00.00|0.0.1.4 > listening for data in topic < /dds/topic > found data t
ype < HelloWorld >
Press CTRL+C to stop the Subscriber.
Message 1 received:
index: 1
message: Hello World
-----
Message 2 received:

```

3.16.2 Prerequisites

It is required to have *eProsima DDS Record & Replay* previously installed using one of the following installation methods:

- *DDS Record & Replay on Windows*
- *DDS Record & Replay on Linux*
- *Docker Image (recommended)*

Additionally, we will use [ShapesDemo](#) as a DDS Demo application to publish the data that will be recorded. This application is already prepared to use Fast DDS DynamicTypes, which is required when using the *DDS Recorder* tool. Download *eProsima Shapes Demo* from [eProsima website](#) or install it by following any of the methods described in the given links:

- [Windows installation from binaries](#)
- [Linux installation from sources](#)
- [Docker Image](#)

3.16.3 Configuring DDS Recorder

The DDS Recorder runs with default configuration parameters, but can also be configured via a YAML file. In this tutorial we will use a configuration file to change some default parameters and show how this file is loaded. The configuration file to be used is the following:

```
dds:
  domain: 0

recorder:
  output:
    filename: "shapesdemo_data"
    path: "."
```

The previous configuration file configures a recorder in DDS Domain 0 and save the output file as `shapesdemo_data_<YYYY-MM-DD_hh-mm-ss>.mcap`, being `<YYYY-MM-DD_hh-mm-ss>` the timestamp of the time at which the *DDS Recorder* started recording.

Create a new file named `conf.yaml` and copy the above snippet into this file.

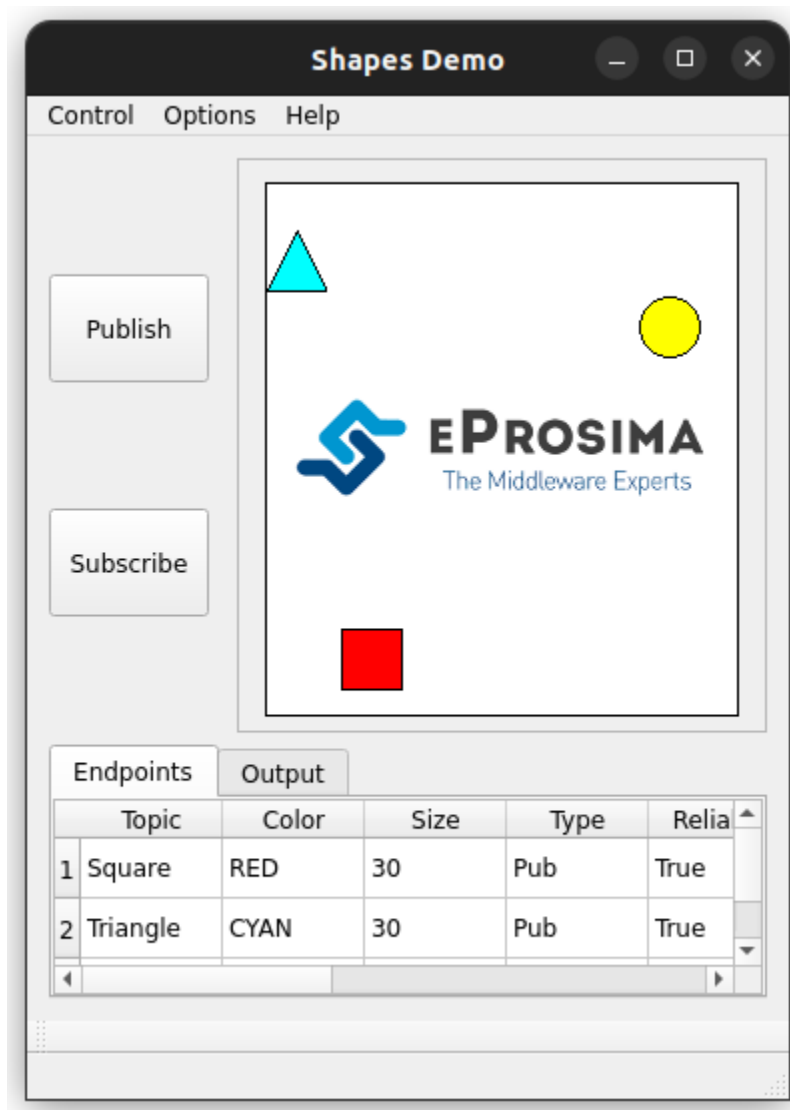
3.16.4 Running the application

Start ShapesDemo

Launch *eProsima Shapes Demo* application running the following command:

```
ShapesDemo
```

Start publishing in topics `Square`, `Triangle`, and `Circle` with default settings:



Recorder execution

Launch the *DDS Recorder* tool passing the configuration file as an argument:

```
ddsrecorder -c <path/to/config/file>/conf.yaml
```

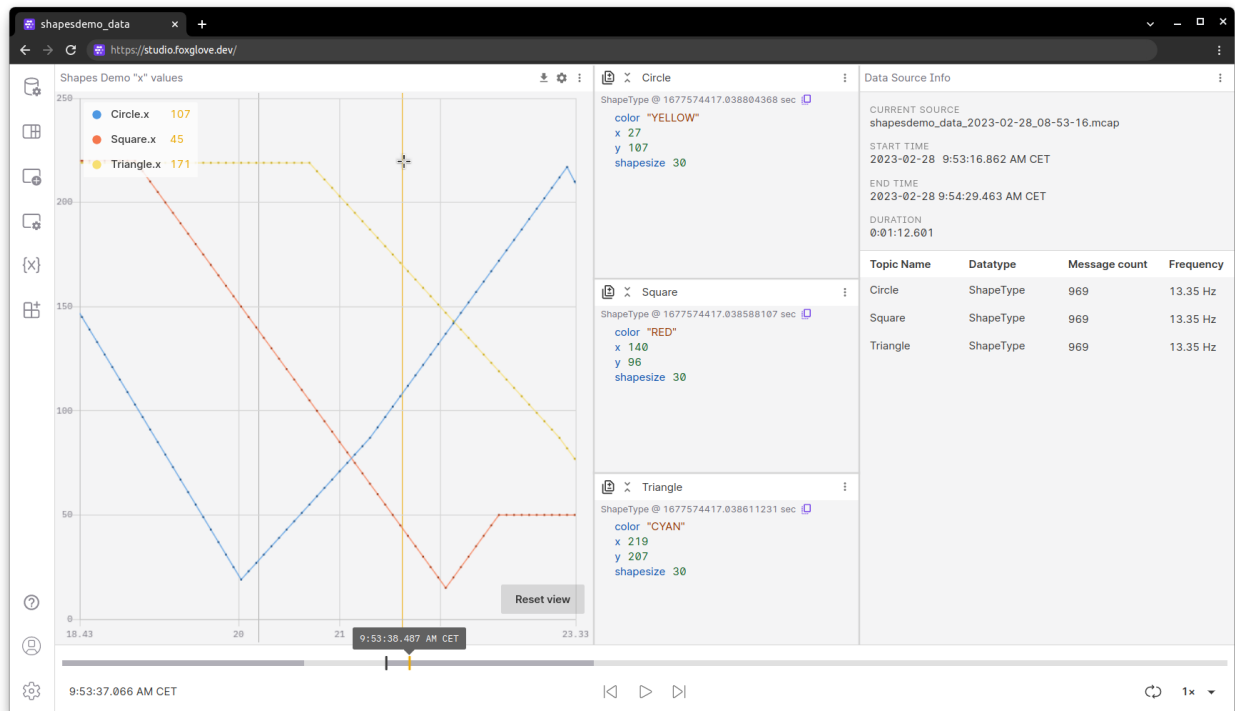
Once you have all the desired data, close the *DDS Recorder* application with **Ctrl+C**.

Important: Please remember to close the *DDS Recorder* application before accessing the output file as the *.mcap* file needs to be properly closed.

Visualize data with Foxglove Studio

Finally, we will show how to load the generated MCAP file into Foxglove Studio in order to display the saved data.

1. Open [Foxglove Studio](#) web application using Google Chrome or download the desktop application from their [Foxglove website](#). We recommend to use the web application as the it is usually up to date with the latest features.
2. Click **Open local file** and load the *.mcap* file previously created: *shapedemo_data.mcap*.
3. Once the *.mcap* file is loaded, create your own layout with custom panels to visualize the recorded data. The image below shows an example of a dashboard with several panels for data introspection.



Feel free to further explore the number of possibilities that *eProsima DDS Recorder* and *Foxglove Studio* together have to offer.

3.17 Linux installation from sources

The instructions for installing the *eProsima DDS Record & Replay* from sources and its required dependencies are provided in this page. It is organized as follows:

- *Dependencies installation*
 - *Requirements*
 - *Dependencies*
- *Colcon installation (recommended)*
- *CMake installation*
 - *Local installation*
 - *Global installation*
- *Run an application*

3.17.1 Dependencies installation

DDS Record & Replay depends on *eProsima Fast DDS* library and certain Debian packages. This section describes the instructions for installing *DDS Record & Replay* dependencies and requirements in a Linux environment from sources. The following packages will be installed:

- `foonathan_memory_vendor`, an STL compatible C++ memory allocation library.
- `fastcdr`, a C++ library that serializes according to the standard CDR serialization mechanism.
- `fastrtps`, the core library of *eProsima Fast DDS* library.
- `cmake_utils`, an *eProsima* utils library for CMake.
- `cpp_utils`, an *eProsima* utils library for C++.
- `ddspipe`, an *eProsima* internal library that enables the communication of DDS interfaces.

First of all, the *Requirements* and *Dependencies* detailed below need to be met. Afterwards, the user can choose whether to follow either the *colcon* or the *CMake* installation instructions.

Requirements

The installation of *eProsima DDS Record & Replay* in a Linux environment from sources requires the following tools to be installed in the system:

- *CMake*, *g++*, *pip*, *wget* and *git*
- *Colcon* [optional]
- *Fast DDS Python* [for remote controller only]
- *Gtest* [for test only]

CMake, g++, pip, wget and git

These packages provide the tools required to install *eProsima DDS Record & Replay* and its dependencies from command line. Install [CMake](#), [g++](#), [pip](#), [wget](#) and [git](#) using the package manager of the appropriate Linux distribution. For example, on Ubuntu use the command:

```
sudo apt install cmake g++ pip wget git
```

Colcon

[colcon](#) is a command line tool based on [CMake](#) aimed at building sets of software packages. Install the ROS 2 development tools ([colcon](#) and [vcstool](#)) by executing the following command:

```
pip3 install -U colcon-common-extensions vcstool
```

Note: If this fails due to an Environment Error, add the `--user` flag to the `pip3` installation command.

Fast DDS Python

eProsima Fast DDS Python is a Python binding for the *eProsima Fast DDS C++* library. It is only required for the *remote controller application*.

Clone the Github repository into the *eProsima DDS Record & Replay* workspace and compile it with [colcon](#) as a dependency package. Use the following command to download the code:

```
git clone https://github.com/eProsima/Fast-DDS-python.git src/Fast-DDS-python
```

Gtest

[Gtest](#) is a unit testing library for C++. By default, *eProsima DDS Record & Replay* does not compile tests. It is possible to activate them with the opportune [CMake options](#) when calling [colcon](#) or [CMake](#). For more details, please refer to the [CMake options](#) section. For a detailed description of the [Gtest](#) installation process, please refer to the [Gtest Installation Guide](#).

It is also possible to clone the [Gtest](#) Github repository into the *eProsima DDS Record & Replay* workspace and compile it with [colcon](#) as a dependency package. Use the following command to download the code:

```
git clone --branch release-1.11.0 https://github.com/google/googletest src/googletest-  
↳distribution
```

Dependencies

eProsima DDS Record & Replay has the following dependencies, when installed from sources in a Linux environment:

- *Asio and TinyXML2 libraries*
- *OpenSSL*
- *yaml-cpp*
- *SWIG* [for remote controller only]
- *PyQt6* [for remote controller only]
- *MCAP dependencies*
- *eProsima dependencies*

Asio and TinyXML2 libraries

Asio is a cross-platform C++ library for network and low-level I/O programming, which provides a consistent asynchronous model. TinyXML2 is a simple, small and efficient C++ XML parser. Install these libraries using the package manager of the appropriate Linux distribution. For example, on Ubuntu use the command:

```
sudo apt install libasio-dev libtinyxml2-dev
```

OpenSSL

OpenSSL is a robust toolkit for the TLS and SSL protocols and a general-purpose cryptography library. Install [OpenSSL](#) using the package manager of the appropriate Linux distribution. For example, on Ubuntu use the command:

```
sudo apt install libssl-dev
```

yaml-cpp

yaml-cpp is a YAML parser and emitter in C++ matching the YAML 1.2 spec, and is used by *DDS Record & Replay* application to parse the provided configuration files. Install yaml-cpp using the package manager of the appropriate Linux distribution. For example, on Ubuntu use the command:

```
sudo apt install libyaml-cpp-dev
```

SWIG

[SWIG](#) is a software development tool that connects programs written in C and C++ with a variety of high-level programming languages. It is leveraged by *Fast DDS Python* to generate a Python wrapper over Fast DDS library. SWIG is only a requirement for the *remote controller application*. It can be installed using the package manager of the appropriate Linux distribution. For example, on Ubuntu use the command:

```
sudo apt install swig libpython3-dev
```

PyQt6

The *eProsima DDS Record & Replay* remote controller is a graphical user interface application implemented in Python using [PyQt6](#). To install PyQt6 simply run:

```
pip3 install PyQt6
```

Note: To install PyQt6 on Ubuntu 20.04, update pip and setuptools packages first.

```
python3 -m pip install pip setuptools --upgrade
```

MCAP dependencies

[MCAP](#) is a modular container format and logging library for pub/sub messages with arbitrary message serialization. It is primarily intended for use in robotics applications, and works well under various workloads, resource constraints, and durability requirements. MCAP C++ library is packed within *DDS Record & Replay* as a header-only, but its dependencies need to be installed using the package manager of the appropriate Linux distribution. For example, on Ubuntu use the command:

```
sudo apt install liblz4-dev libzstd-dev
```

eProsima dependencies

If it already exists in the system an installation of *Fast DDS* and *DDS Pipe* libraries, just source this libraries when building *eProsima DDS Record & Replay* by running the following commands. In other case, just skip this step.

```
source <fastdds-installation-path>/install/setup.bash
source <ddspipe-installation-path>/install/setup.bash
```

3.17.2 Colcon installation (recommended)

1. Create a DDS-Record-Replay directory and download the .repos file that will be used to install *eProsima DDS Record & Replay* and its dependencies:

```
mkdir -p ~/DDS-Record-Replay/src
cd ~/DDS-Record-Replay
wget https://raw.githubusercontent.com/eProsima/DDS-Record-Replay/v0.2.0/
↳ ddsrecordreplay.repos
vcs import src < ddsrecordreplay.repos
```

Note: In case there is already a *Fast DDS* installation in the system it is not required to download and build every dependency in the .repos file. It is just needed to download and build the *eProsima DDS Record & Replay* project having sourced its dependencies. Refer to section [eProsima dependencies](#) in order to check how to source *Fast DDS* library.

2. Build the packages:


```
colcon build
```

Note: To install *DDS Recorder remote controller application*, compilation flag `-DBUILD_DDSREORDER_CONTROLLER=ON` is required.

Note: Being based on [CMake](#), it is possible to pass the CMake configuration options to the `colcon build` command. For more information on the specific syntax, please refer to the [CMake specific arguments](#) page of the `colcon` manual.

3.17.3 CMake installation

This section explains how to compile *eProsima DDS Record & Replay* with [CMake](#), either *locally* or *globally*.

Local installation

1. Create a `DDS-Record-Replay` directory where to download and build *DDS Record & Replay* and its dependencies:

```
mkdir -p ~/DDS-Record-Replay/src
mkdir -p ~/DDS-Record-Replay/build
cd ~/DDS-Record-Replay
wget https://raw.githubusercontent.com/eProsima/DDS-Record-Replay/v0.2.0/
↳ ddsrecordreplay.repos
vcs import src < ddsrecordreplay.repos
```

2. Compile all dependencies using [CMake](#).

- [Foonathan memory](#)

```
cd ~/DDS-Record-Replay
mkdir build/foonathan_memory_vendor
cd build/foonathan_memory_vendor
cmake ~/DDS-Record-Replay/src/foonathan_memory_vendor -DCMAKE_INSTALL_
↳ PREFIX=~/DDS-Record-Replay/install -DBUILD_SHARED_LIBS=ON
cmake --build . --target install
```

- [Fast CDR](#)

```
cd ~/DDS-Record-Replay
mkdir build/fastcdr
cd build/fastcdr
cmake ~/DDS-Record-Replay/src/fastcdr -DCMAKE_INSTALL_PREFIX=~/DDS-
↳ Record-Replay/install
cmake --build . --target install
```

- [Fast DDS](#)

```
cd ~/DDS-Record-Replay
mkdir build/fastdds
cd build/fastdds
```

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```
cmake ~/DDS-Record-Replay/src/fastdds -DCMAKE_INSTALL_PREFIX=~/.DDS-
Record-Replay/install -DCMAKE_PREFIX_PATH=~/.DDS-Record-Replay/install
cmake --build . --target install
```

- Dev Utils

```
# CMake Utils
cd ~/DDS-Record-Replay
mkdir build/cmake_utils
cd build/cmake_utils
cmake ~/DDS-Record-Replay/src/dev-utils/cmake_utils -DCMAKE_INSTALL_
PREFIX=~/.DDS-Record-Replay/install -DCMAKE_PREFIX_PATH=~/.DDS-Record-
Replay/install
cmake --build . --target install

# C++ Utils
cd ~/DDS-Record-Replay
mkdir build/cpp_utils
cd build/cpp_utils
cmake ~/DDS-Record-Replay/src/dev-utils/cpp_utils -DCMAKE_INSTALL_
PREFIX=~/.DDS-Record-Replay/install -DCMAKE_PREFIX_PATH=~/.DDS-Record-
Replay/install
cmake --build . --target install
```

- DDS Pipe

```
# ddspipe_core
cd ~/DDS-Record-Replay
mkdir build/ddspipe_core
cd build/ddspipe_core
cmake ~/DDS-Record-Replay/src/ddspipe/ddspipe_core -DCMAKE_INSTALL_
PREFIX=~/.DDS-Record-Replay/install -DCMAKE_PREFIX_PATH=~/.DDS-Record-
Replay/install
cmake --build . --target install

# ddspipe_participants
cd ~/DDS-Record-Replay
mkdir build/ddspipe_participants
cd build/ddspipe_participants
cmake ~/DDS-Record-Replay/src/ddspipe/ddspipe_participants -DCMAKE_
INSTALL_PREFIX=~/.DDS-Record-Replay/install -DCMAKE_PREFIX_PATH=~/.DDS-
Record-Replay/install
cmake --build . --target install

# ddspipe_yaml
cd ~/DDS-Record-Replay
mkdir build/ddspipe_yaml
cd build/ddspipe_yaml
cmake ~/DDS-Record-Replay/src/ddspipe/ddspipe_yaml -DCMAKE_INSTALL_
PREFIX=~/.DDS-Record-Replay/install -DCMAKE_PREFIX_PATH=~/.DDS-Record-
Replay/install
cmake --build . --target install
```

3. Once all dependencies are installed, install *eProsima DDS Record & Replay*:

```
# ddsrecorder_participants
cd ~/DDS-Record-Replay
mkdir build/ddsrecorder_participants
cd build/ddsrecorder_participants
cmake ~/DDS-Record-Replay/src/ddsrecorder/ddsrecorder_participants -DCMAKE_INSTALL_
↳PREFIX=~/DDS-Record-Replay/install -DCMAKE_PREFIX_PATH=~/DDS-Record-Replay/install
cmake --build . --target install

# ddsrecorder_yaml
cd ~/DDS-Record-Replay
mkdir build/ddsrecorder_yaml
cd build/ddsrecorder_yaml
cmake ~/DDS-Record-Replay/src/ddsrecorder/ddsrecorder_yaml -DCMAKE_INSTALL_PREFIX=~/
↳DDS-Record-Replay/install -DCMAKE_PREFIX_PATH=~/DDS-Record-Replay/install
cmake --build . --target install

# ddsrecorder
cd ~/DDS-Record-Replay
mkdir build/ddsrecorder_tool
cd build/ddsrecorder_tool
cmake ~/DDS-Record-Replay/src/ddsrecorder/ddsrecorder -DCMAKE_INSTALL_PREFIX=~/DDS-
↳Record-Replay/install -DCMAKE_PREFIX_PATH=~/DDS-Record-Replay/install
cmake --build . --target install

# ddsreplayer
cd ~/DDS-Record-Replay
mkdir build/ddsreplayer_tool
cd build/ddsreplayer_tool
cmake ~/DDS-Record-Replay/src/ddsrecorder/ddsreplayer -DCMAKE_INSTALL_PREFIX=~/DDS-
↳Record-Replay/install -DCMAKE_PREFIX_PATH=~/DDS-Record-Replay/install
cmake --build . --target install
```

Note: By default, *eProsima DDS Record & Replay* does not compile tests. However, they can be activated by downloading and installing [Gtest](#) and building with CMake option `-DBUILD_TESTS=ON`.

4. Optionally, install the *remote controller application* along with its dependency *Fast DDS Python*:

```
# Fast DDS Python
cd ~/DDS-Record-Replay
mkdir build/fastdds_python
cd build/fastdds_python
cmake ~/DDS-Record-Replay/src/Fast-DDS-python/fastdds_python -DCMAKE_INSTALL_
↳PREFIX=~/DDS-Record-Replay/install -DCMAKE_PREFIX_PATH=~/DDS-Record-Replay/install
cmake --build . --target install

# Remote Controller Application
cd ~/DDS-Record-Replay
mkdir build/controller_tool
cd build/controller_tool
cmake ~/DDS-Record-Replay/src/ddsrecorder/controller/controller_tool -DCMAKE_
↳INSTALL_PREFIX=~/DDS-Record-Replay/install -DCMAKE_PREFIX_PATH=~/DDS-Record-
↳Replay/install -DBUILD_DDSRECORDER_CONTROLLER=ON
```

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```
cmake --build . --target install
```

Global installation

To install *eProsima DDS Record & Replay* system-wide instead of locally, remove all the flags that appear in the configuration steps of Fast-CDR, Fast-DDS, Dev-Utills, DDS-Pipe, and DDS-Record-Replay, and change the first in the configuration step of *foonathan_memory_vendor* to the following:

```
-DCMAKE_INSTALL_PREFIX=/usr/local/ -DBUILD_SHARED_LIBS=ON
```

3.17.4 Run an application

To run the *DDS Recorder* tool, source the installation path and execute the executable file that has been installed in `<install-path>/ddsrecorder_tool/bin/ddsrecorder`:

```
# If built has been done using colcon, all projects could be sourced as follows
source install/setup.bash
./<install-path>/ddsrecorder_tool/bin/ddsrecorder
```

Likewise, to run the *DDS Replay tool*, source the installation path and execute the executable file that has been installed in `<install-path>/ddsreplayer_tool/bin/ddsreplayer`:

```
# If built has been done using colcon, all projects could be sourced as follows
source install/setup.bash
./<install-path>/ddsreplayer_tool/bin/ddsreplayer
```

Be sure that these executables have execution permissions.

3.18 Windows installation from sources

The instructions for installing the *eProsima DDS Record & Replay* application from sources and its required dependencies are provided in this page. It is organized as follows:

- *Dependencies installation*
 - *Requirements*
 - *Dependencies*
- *Colcon installation (recommended)*
- *CMake installation*
 - *Local installation*
 - *Global installation*
- *Run an application*

3.18.1 Dependencies installation

eProsima DDS Record & Replay depends on *eProsima Fast DDS* library and certain Debian packages. This section describes the instructions for installing *eProsima DDS Record & Replay* dependencies and requirements in a Windows environment from sources. The following packages will be installed:

- `foonathan_memory_vendor`, an STL compatible C++ memory allocation library.
- `fastcdr`, a C++ library that serializes according to the standard CDR serialization mechanism.
- `fastrtps`, the core library of eProsima Fast DDS library.
- `cmake_utils`, an eProsima utils library for CMake.
- `cpp_utils`, an eProsima utils library for C++.
- `ddspipe`, an eProsima internal library that enables the communication of DDS interfaces.

First of all, the [Requirements](#) and [Dependencies](#) detailed below need to be met. Afterwards, the user can choose whether to follow either the [colcon](#) or the [CMake](#) installation instructions.

Requirements

The installation of *eProsima Fast DDS* in a Windows environment from sources requires the following tools to be installed in the system:

- [Visual Studio](#)
- [Chocolatey](#)
- [CMake](#), [pip3](#), [wget](#) and [git](#)
- [Colcon](#) [optional]
- [Fast DDS Python](#) [for remote controller only]
- [Gtest](#) [for test only]

Visual Studio

[Visual Studio](#) is required to have a C++ compiler in the system. For this purpose, make sure to check the `Desktop development with C++` option during the Visual Studio installation process.

If Visual Studio is already installed but the Visual C++ Redistributable packages are not, open Visual Studio and go to `Tools -> Get Tools and Features` and in the `Workloads` tab enable `Desktop development with C++`. Finally, click `Modify` at the bottom right.

Chocolatey

Chocolatey is a Windows package manager. It is needed to install some of *eProsima Fast DDS*'s dependencies. Download and install it directly from the [website](#).

CMake, pip3, wget and git

These packages provide the tools required to install *eProsima Fast DDS* and its dependencies from command line. Download and install [CMake](#), [pip3](#), [wget](#) and [git](#) by following the instructions detailed in the respective websites. Once installed, add the path to the executables to the PATH from the *Edit the system environment variables* control panel.

Colcon

[colcon](#) is a command line tool based on [CMake](#) aimed at building sets of software packages. Install the ROS 2 development tools ([colcon](#) and [vcstool](#)) by executing the following command:

```
pip3 install -U colcon-common-extensions vcstool
```

Note: If this fails due to an Environment Error, add the `--user` flag to the `pip3` installation command.

Fast DDS Python

[eProsima Fast DDS Python](#) is a Python binding for the *eProsima Fast DDS* C++ library. It is only required for the *remote controller application*.

Clone the Github repository into the *eProsima DDS Record & Replay* workspace and compile it with [colcon](#) as a dependency package. Use the following command to download the code:

```
git clone https://github.com/eProsima/Fast-DDS-python.git src/Fast-DDS-python
```

Gtest

Gtest is a unit testing library for C++. By default, *eProsima DDS Record & Replay* does not compile tests. It is possible to activate them with the opportune [CMake options](#) when calling [colcon](#) or [CMake](#). For more details, please refer to the [CMake options](#) section.

Run the following commands on your workspace to install Gtest.

```
git clone https://github.com/google/googletest.git
cmake -DCMAKE_INSTALL_PREFIX='C:\Program Files\gtest' -Dgtest_force_shared_crt=ON -
↳ DBUILD_GMOCK=ON ^
-B build\gtest -A x64 -T host=x64 googletest
cmake --build build\gtest --config Release --target install
```

or refer to the [Gtest Installation Guide](#) for a detailed description of the Gtest installation process.

Dependencies

eProsima DDS Record & Replay has the following dependencies, when installed from sources in a Windows environment:

- *Asio and TinyXML2 libraries*
- *OpenSSL*
- *yaml-cpp*
- *SWIG* [for remote controller only]
- *PyQt6* [for remote controller only]
- *MCAP dependencies*
- *eProsima dependencies*

Asio and TinyXML2 libraries

Asio is a cross-platform C++ library for network and low-level I/O programming, which provides a consistent asynchronous model. TinyXML2 is a simple, small and efficient C++ XML parser. They can be downloaded directly from the links below:

- [Asio](#)
- [TinyXML2](#)

After downloading these packages, open an administrative shell with *PowerShell* and execute the following command:

```
choco install -y -s <PATH_TO_DOWNLOADS> asio tinyxml2
```

where <PATH_TO_DOWNLOADS> is the folder into which the packages have been downloaded.

OpenSSL

OpenSSL is a robust toolkit for the TLS and SSL protocols and a general-purpose cryptography library. Download and install the latest OpenSSL version for Windows at this [link](#). After installing, add the environment variable `OPENSSL_ROOT_DIR` pointing to the installation root directory.

For example:

```
OPENSSL_ROOT_DIR=C:\Program Files\OpenSSL-Win64
```

yaml-cpp

`yaml-cpp` is a YAML parser and emitter in C++ matching the YAML 1.2 spec, and is used by *DDS Record & Replay* application to parse the provided configuration files. From an administrative shell with *PowerShell*, execute the following commands in order to download and install `yaml-cpp` for Windows:

```
git clone --branch yaml-cpp-0.7.0 https://github.com/jbeder/yaml-cpp
cmake -DCMAKE_INSTALL_PREFIX='C:\Program Files\yamlcpp' -B build\yamlcpp yaml-cpp
cmake --build build\yamlcpp --target install # If building in Debug mode, add --
↪ config Debug
```

MCAP dependencies

MCAP is a modular container format and logging library for pub/sub messages with arbitrary message serialization. It is primarily intended for use in robotics applications, and works well under various workloads, resource constraints, and durability requirements. MCAP C++ library is packed within *DDS Record & Replay* as a header-only, but its dependencies need to be installed using the appropriate Windows package manager.

It is recommended to use **vcpkg** dependency manager to install **LZ4** and **zstd** dependencies. Once both dependencies are installed, add the directory where the binaries are located to the PATH. The installed binaries are usually located under `<path>\to\vcpkg>\installed\x64-windows\bin` directory.

SWIG

SWIG is a software development tool that connects programs written in C and C++ with a variety of high-level programming languages. It is leveraged by *Fast DDS Python* to generate a Python wrapper over Fast DDS library. SWIG is only a requirement for the *remote controller application*. Download and install SWIG for Windows, choosing one of the releases available at their [website](#).

PyQt6

The *eProsima DDS Record & Replay* remote controller is a graphical user interface application implemented in Python using **PyQt6**. To install PyQt6 simply run:

```
pip3 install PyQt6
```

eProsima dependencies

If it already exists in the system an installation of *Fast DDS* and *DDS Pipe* libraries, just source this libraries when building the *eProsima DDS Record & Replay* application by using the command:

```
source <fastdds-installation-path>/install/setup.bash
source <ddspipe-installation-path>/install/setup.bash
```

In other case, just skip this step.

3.18.2 Colcon installation (recommended)

Important: Run colcon within a Visual Studio prompt. To do so, launch a *Developer Command Prompt* from the search engine.

1. Create a **DDS-Record-Replay** directory and download the **.repos** file that will be used to install *eProsima DDS Record & Replay* and its dependencies:

```
mkdir <path>\to\user\workspace>\DDS-Record-Replay
cd <path>\to\user\workspace>\DDS-Record-Replay
mkdir src
wget https://raw.githubusercontent.com/eProsima/DDS-Record-Replay/v0.2.0/
↳ ddsrecordreplay.repos ddsrecordreplay.repos
vcs import src < ddsrecordreplay.repos
```

Note: In case there is already a *Fast DDS* installation in the system it is not required to download and build every dependency in the `.repos` file. It is just needed to download and build the *eProsima DDS Record & Replay* project having sourced its dependencies. Refer to section *eProsima dependencies* in order to check how to source *Fast DDS* library.

2. Build the packages:

```
colcon build
```

Note: To install *DDS Recorder remote controller application*, compilation flag `-DBUILD_DDSRECORDER_CONTROLLER=ON` is required.

Note: Being based on *CMake*, it is possible to pass the *CMake* configuration options to the `colcon build` command. For more information on the specific syntax, please refer to the *CMake specific arguments* page of the *colcon* manual.

3.18.3 CMake installation

This section explains how to compile *eProsima DDS Record & Replay* with *CMake*, either *locally* or *globally*.

Local installation

1. Open a command prompt, and create a `DDS-Record-Replay` directory where to download and build *eProsima DDS Record & Replay* and its dependencies:

```
mkdir <path\to\user\workspace>\DDS-Record-Replay
mkdir <path\to\user\workspace>\DDS-Record-Replay\src
mkdir <path\to\user\workspace>\DDS-Record-Replay\build
cd <path\to\user\workspace>\DDS-Record-Replay
wget https://raw.githubusercontent.com/eProsima/DDS-Record-Replay/v0.2.0/
↳ddsrecordreplay.repos ddsrecordreplay.repos
vcs import src ddsrecordreplay.repos
```

2. Compile all dependencies using *CMake*.

- *Foonathan memory*

```
cd <path\to\user\workspace>\DDS-Record-Replay
mkdir build\foonathan_memory_vendor
cd build\foonathan_memory_vendor
cmake <path\to\user\workspace>\DDS-Record-Replay\src\foonathan_memory_
↳vendor -DCMAKE_INSTALL_PREFIX=<path\to\user\workspace>\DDS-Record-
↳Replay\install ^
      -DBUILD_SHARED_LIBS=ON
cmake --build . --config Release --target install
```

- *Fast CDR*

```
cd <path\to\user\workspace>\DDS-Record-Replay
mkdir build\fastcdr
cd build\fastcdr
cmake <path\to\user\workspace>\DDS-Record-Replay\src\fastcdr -DCMAKE_
↳INSTALL_PREFIX=<path\to\user\workspace>\DDS-Record-Replay\install
cmake --build . --config Release --target install
```

- Fast DDS

```
cd <path\to\user\workspace>\DDS-Record-Replay
mkdir build\fastdds
cd build\fastdds
cmake <path\to\user\workspace>\DDS-Record-Replay\src\fastdds -DCMAKE_
↳INSTALL_PREFIX=<path\to\user\workspace>\DDS-Record-Replay\install ^
  -DCMAKE_PREFIX_PATH=<path\to\user\workspace>\DDS-Record-Replay\
↳install
cmake --build . --config Release --target install
```

- Dev Utils

```
# CMake Utils
cd <path\to\user\workspace>\DDS-Record-Replay
mkdir build\cmake_utils
cd build\cmake_utils
cmake <path\to\user\workspace>\DDS-Record-Replay\src\dev-utils\cmake_
↳utils -DCMAKE_INSTALL_PREFIX=<path\to\user\workspace>\DDS-Record-
↳Replay\install ^
  -DCMAKE_PREFIX_PATH=<path\to\user\workspace>\DDS-Record-Replay\
↳install
cmake --build . --config Release --target install

# C++ Utils
cd <path\to\user\workspace>\DDS-Record-Replay
mkdir build\cpp_utils
cd build\cpp_utils
cmake <path\to\user\workspace>\DDS-Record-Replay\src\dev-utils\cpp_utils_
↳-DCMAKE_INSTALL_PREFIX=<path\to\user\workspace>\DDS-Record-Replay\
↳install ^
  -DCMAKE_PREFIX_PATH=<path\to\user\workspace>\DDS-Record-Replay\
↳install
cmake --build . --config Release --target install
```

- DDS Pipe

```
# ddspipe_core
cd <path\to\user\workspace>\DDS-Record-Replay
mkdir build\ddspipe_core
cd build\ddspipe_core
cmake cd <path\to\user\workspace>\DDS-Record-Replay\src\ddspipe\ddspipe_
↳core -DCMAKE_INSTALL_PREFIX=<path\to\user\workspace>\DDS-Record-Replay\
↳install -DCMAKE_PREFIX_PATH=<path\to\user\workspace>\DDS-Record-Replay\
↳install
cmake --build . --target install
```

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```

# ddspipe_yaml
cd <path\to\user\workspace>\DDS-Record-Replay
mkdir build\ddspipe_yaml
cd build\ddspipe_yaml
cmake <path\to\user\workspace>\DDS-Record-Replay\src\ddspipe\ddspipe_
↳yaml -DCMAKE_INSTALL_PREFIX=<path\to\user\workspace>\DDS-Record-Replay\
↳install -DCMAKE_PREFIX_PATH=<path\to\user\workspace>\DDS-Record-Replay\
↳install
cmake --build . --target install

# ddspipe_participants
cd <path\to\user\workspace>\DDS-Record-Replay
mkdir build\ddspipe_participants
cd build\ddspipe_participants
cmake <path\to\user\workspace>\DDS-Record-Replay\src\ddspipe\ddspipe_
↳participants -DCMAKE_INSTALL_PREFIX=<path\to\user\workspace>\DDS-
↳Record-Replay\install -DCMAKE_PREFIX_PATH=<path\to\user\workspace>\DDS-
↳Record-Replay\install
cmake --build . --target install

```

3. Once all dependencies are installed, install *eProsima DDS Record & Replay*:

```

# ddsrecorder_participants
cd <path\to\user\workspace>\DDS-Record-Replay
mkdir build\ddsrecorder_participants
cd build\ddsrecorder_participants
cmake <path\to\user\workspace>\DDS-Record-Replay\src\ddsrecorder\ddsrecorder_
↳participants ^
-DCMAKE_INSTALL_PREFIX=<path\to\user\workspace>\DDS-Record-Replay\install -
↳DCMAKE_PREFIX_PATH=<path\to\user\workspace>\DDS-Record-Replay\install
cmake --build . --config Release --target install

# ddsrecorder_yaml
cd <path\to\user\workspace>\DDS-Record-Replay
mkdir build\ddsrecorder_yaml
cd build\ddsrecorder_yaml
cmake <path\to\user\workspace>\DDS-Record-Replay\src\ddsrecorder\ddsrecorder_yaml -
↳DCMAKE_INSTALL_PREFIX=<path\to\user\workspace>\DDS-Record-Replay\install ^
-DCMAKE_PREFIX_PATH=<path\to\user\workspace>\DDS-Record-Replay\install
cmake --build . --config Release --target install

# ddsrecorder
cd <path\to\user\workspace>\DDS-Record-Replay
mkdir build\ddsrecorder_tool
cd build\ddsrecorder_tool
cmake <path\to\user\workspace>\DDS-Record-Replay\src\ddsrecorder\ddsrecorder -
↳DCMAKE_INSTALL_PREFIX=<path\to\user\workspace>\DDS-Record-Replay\install ^
-DCMAKE_PREFIX_PATH=<path\to\user\workspace>\DDS-Record-Replay\install
cmake --build . --config Release --target install

# ddsreplayer

```

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```
cd <path\to\user\workspace>\DDS-Record-Replay
mkdir build\ddsreplayer_tool
cd build\ddsreplayer_tool
cmake <path\to\user\workspace>\DDS-Record-Replay\src\ddsrecorder\ddsreplayer -
↳DCMAKE_INSTALL_PREFIX=<path\to\user\workspace>\DDS-Record-Replay\install ^
  -DCMAKE_PREFIX_PATH=<path\to\user\workspace>\DDS-Record-Replay\install
cmake --build . --config Release --target install
```

Note: By default, *eProsima DDS Record & Replay* does not compile tests. However, they can be activated by downloading and installing *Gtest* and building with CMake option `-DBUILD_TESTS=ON`.

4. Optionally, install the *remote controller application* along with its dependency *Fast DDS Python*:

```
# Fast DDS Python
cd <path\to\user\workspace>\DDS-Record-Replay
mkdir build\fastdds_python
cd build\fastdds_python
cmake <path\to\user\workspace>\DDS-Record-Replay\src\Fast-DDS-python\fastdds_python.
↳DCMAKE_INSTALL_PREFIX=<path\to\user\workspace>\DDS-Record-Replay\install ^
  -DCMAKE_PREFIX_PATH=<path\to\user\workspace>\DDS-Record-Replay\install
cmake --build . --config Release --target install

# Remote Controller Application
cd <path\to\user\workspace>\DDS-Record-Replay
mkdir build\controller_tool
cd build\controller_tool
cmake <path\to\user\workspace>\DDS-Record-Replay\src\controller\controller_tool -
↳DCMAKE_INSTALL_PREFIX=<path\to\user\workspace>\DDS-Record-Replay\install ^
  -DCMAKE_PREFIX_PATH=<path\to\user\workspace>\DDS-Record-Replay\install -DBUILD_
↳DDSRECORDER_CONTROLLER=ON
cmake --build . --config Release --target install
```

Global installation

To install *eProsima DDS Record & Replay* system-wide instead of locally, remove all the flags that appear in the configuration steps of Fast-CDR, Fast-DDS, Dev-Utils, DDS-Pipe, and DDS-Record-Replay

3.18.4 Run an application

If *eProsima DDS Record & Replay* was compiled using colcon, when running an instance of *DDS Recorder* or *DDS Replayer*, the colcon overlay built in the dedicated DDS-Record-Replay directory must be sourced. There are two possibilities:

- Every time a new shell is opened, prepare the environment locally by typing the command:

```
setup.bat
```

- Add the sourcing of the colcon overlay permanently, by opening the *Edit the system environment variables* control panel, and adding the installation path to the PATH.

However, when running a *DDS Recorder* or *DDS Replayer* compiled using CMake, it must be linked with its dependencies where the packages have been installed. This can be done by opening the *Edit system environment variables* control panel and adding to the PATH *eProsima DDS Record & Replay* installation directory: <path\to\user\workspace>\DDS-Record-Replay\install.

3.19 CMake options

eProsima DDS Record & Replay provides numerous CMake options for changing the behavior and configuration of *eProsima DDS Record & Replay*. These options allow the developer to enable/disable certain *eProsima DDS Record & Replay* settings by defining these options to ON/OFF at the CMake execution, or set the required path to certain dependencies.

Warning: These options are only for developers who installed *eProsima DDS Record & Replay* following the compilation steps described in [Linux installation from sources](#).

Option	Description	Possible values	Default
CMAKE_BUILD_TYPE	CMake optimization build type.	Release Debug	Release
BUILD_DDSRECORDER_CONTROLLER	Build the <i>eProsima DDS Recorder</i> remote controller application.	OFF ON	OFF
BUILD_DOCS	Build the <i>eProsima DDS Record & Replay</i> documentation.	OFF ON	OFF
BUILD_TESTS	Build the <i>eProsima DDS Record & Replay</i> tools and documentation tests.	OFF ON	OFF
LOG_INFO	Activate <i>eProsima DDS Record & Replay</i> logs. It is set to ON if CMAKE_BUILD_TYPE is set to Debug.	OFF ON	ON if Debug OFF otherwise
ASAN_BUILD	Activate address sanitizer build.	OFF ON	OFF
TSAN_BUILD	Activate thread sanitizer build.	OFF ON	OFF

3.20 Version v0.2.0

This release includes *DDS Replay tool*, supporting the following **Replay features**:

- Supports setting *begin* and *end* times (begin-time / end-time).
- Supports setting a replay *start* time (start-replay-time).
- Supports playing stored data at a specific playback *rate* (rate).
- Supports sending dynamic types stored in input MCAP file.

This release includes the following **User Interface features**:

- *Replay Service Command-Line Parameters*.

This release includes the following (*DDS Replay tool*) **Configuration features**:

- Support YAML *configuration file*.
- Support for allow and block topic filters at execution time and in run-time.
- Support configuration related to DDS communication.
- Support configuration of playback settings.

- Support configuration of the internal operation of the DDS Replayer.
- Support enabling/disabling dynamic types dispatch (see *Only With Type*).
- Support *Interface Whitelisting*.
- Support *Custom Transport Descriptors* (UDP or Shared Memory only).
- Support *Ignore Participant Flags*.

This release includes the following **Recording features**:

- Supports recording messages with unknown (dynamic) data type, and to only record data whose type is known (see *Only With Type*).

This release includes the following (*DDS Recorder tool*) **Configuration features**:

- Support record only data whose (dynamic) type is known: `only-with-type: true` (see *Only With Type*).
- Support *Interface Whitelisting*.
- Support *Custom Transport Descriptors* (UDP or Shared Memory only).
- Support *Ignore Participant Flags*.

This release includes the following **Documentation features**:

- Updated documentation with Replay service configuration and usage instructions.

This release includes the following **Dependencies Update**:

	Repository	Old Version	New Version
Foonathan Memory Vendor	eProsima/foonathan_memory_vendor	v1.3.0	v1.3.1
Fast CDR	eProsima/Fast-CDR	v1.0.27	v1.1.0
Fast DDS	eProsima/Fast-DDS	v2.10.1	v2.11.0
Dev Utils	eProsima/dev-utils	v0.3.0	v0.4.0
DDS Pipe	eProsima/DDS-Pipe	v0.1.0	v0.2.0

3.21 Previous Versions

3.21.1 Version v0.1.0

This is the first release of *eProsima DDS Record & Replay*.

This release includes several **features** regarding the recording of DDS data, configuration and user interaction.

This release includes the following **Recording features**:

- Supports DynamicTypes.
- Supports saves the data in a MCAP database.
- Supports for `downsampling` that reduces the sampling rate of the received data.
- Supports for `buffer-size` that indicates the number of samples to be stored in the process memory before the dump to disk.

This release includes the following **User Interface features**:

- *Recording Service Command-Line Parameters*.
- *Remote Control*.

This release includes the following **Configuration features**:

- Support YAML *configuration file*.
- Support for allow and block topic filters at execution time and in run-time.
- Support configuration related to DDS communication.
- Support configuration of data writing in the database.
- Support configuration of the remote controller of the DDS Recorder.
- Support configuration of the internal operation of the DDS Recorder.

This release includes the following **Tutorials**:

- *Configuring Fast DDS DynamicTypes for data recording*.
- *Visualize recorded data with Foxglove*.

This release includes the following **Documentation features**:

- This same documentation.

3.22 Glossary

3.22.1 Networking nomenclature

LAN Local Area Network

3.22.2 DDS Record & Replay nomenclature

MCAP Modular container file format for heterogeneous timestamped data.

3.22.3 DDS nomenclature

DataReader DDS element that subscribes to a specific Topic. It belong to one and only one Participant, and it is uniquely identified by a Guid.

See [Fast DDS documentation](#) for further information.

DataWriter DDS entity that publish data in a specific Topic. It belong to one and only one Participant, and it is uniquely identified by a Guid.

See [Fast DDS documentation](#) for further information.

Domain Id The Domain Id is a virtual partition for DDS networks. Only DomainParticipants with the same Domain Id would be able to communicate to each other. DomainParticipants in different Domains will not even discover each other.

See [Fast DDS documentation](#) for further information.

DomainParticipant A DomainParticipant is the entry point of the application to a DDS Domain. Every DomainParticipant is linked to a single domain from its creation, and cannot change such domain. It also acts as a factory for Publisher, Subscriber and Topic.

See [Fast DDS documentation](#) for further information.

Endpoint DDS element that publish or subscribes in a specific Topic. Endpoint kinds are *DataWriter* or *DataReader*.

Guid Global Unique Identifier. It contains a GuidPrefix and an EntityId. The EntityId uniquely identifies sub-entities inside a Participant. Identifies uniquely a DDS entity (DomainParticipant, DataWriter or DataReader).

GuidPrefix Global Unique Identifier shared by a Participant and all its sub-entities. Identifies uniquely a DDS Participant.

Topic DDS isolation abstraction to encapsulate subscriptions and publications. Each Topic is uniquely identified by a topic name and a topic type name (name of the data type it transmits).

See [Fast DDS documentation](#) for further information.

DynamicTypes The dynamic topic types offer the possibility to work over DDS without the restrictions related to the IDLs. Using them, the users can declare the different types that they need and manage the information directly, avoiding the additional step of updating the IDL file and the generation of C++ classes.

See [Fast DDS documentation](#) for further information.

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