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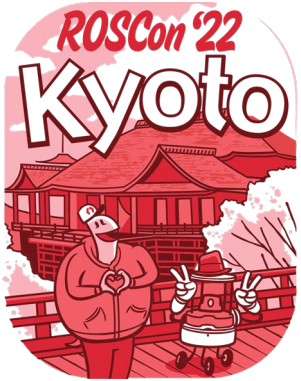
The Middleware Experts



Content Filtering in ROS 2

ROSCon 2022

SONY

Speaker:

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Agenda

01 Motivation

- What is the problem we are trying to solve
- How is now tackled

02 Content Filtering

- Reader & Writer side
- Fast DDS optimizations
- Implementation in ROS 2 when middleware does not offer support

03 Usage in ROS 2

- Available APIs and how to use them
- Writer side filtering in ROS 2 with Fast DDS

04 Bandwidth savings

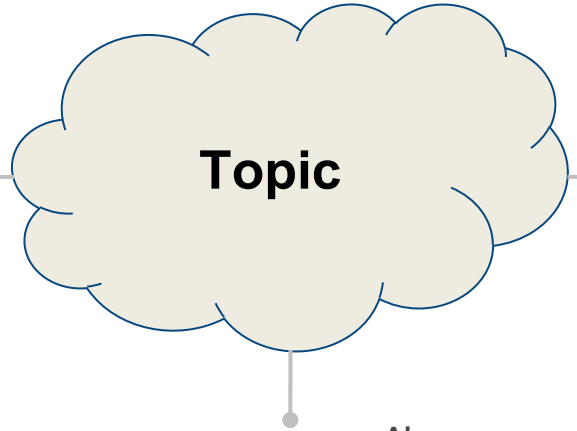
- Benchmark results
- Comparison with current “solutions”

Motivation

Subscribe to a subset of the topic data

Filter by data source

With tagged data, a subscriber may only want data from specific sources



Load balancing

If computation is expensive on the receiver side, several subscribers may be set to process data in turns

Alarms

A monitoring application may fire an alarm y a certain field within a topic samples goes above/below a threshold

Motivation

Current solutions

Application level filtering

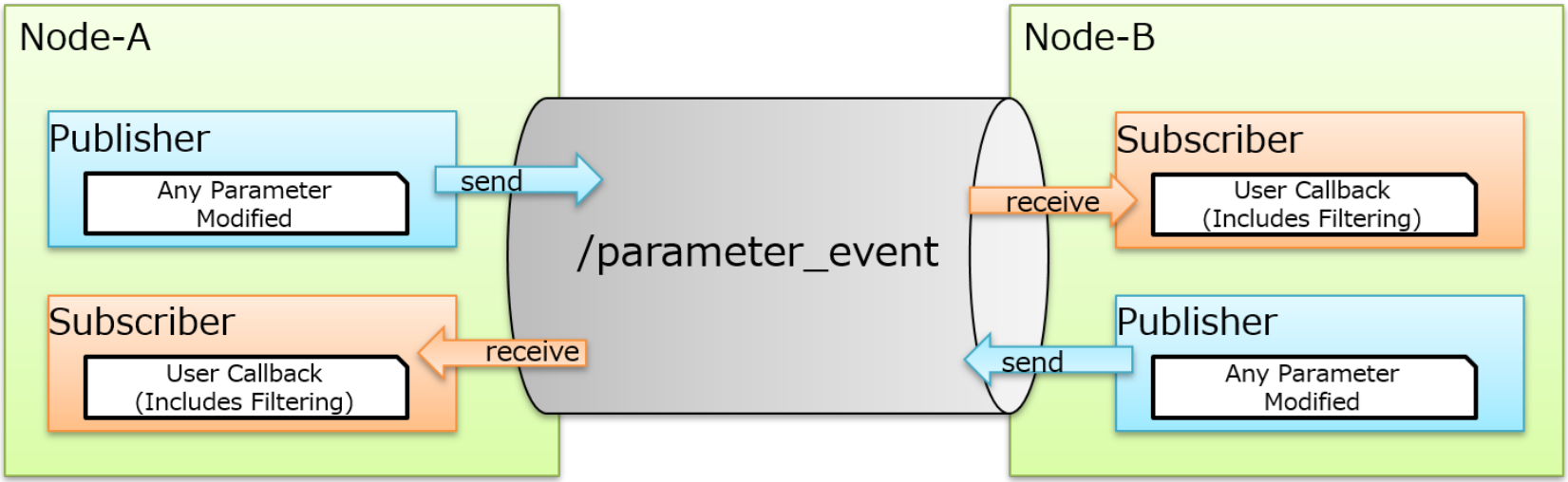
1. Bandwidth utilization
2. Subscriber-side computation
3. Memory and latency overhead
4. CPU usage
5. Maintainability

Splitting the topic

1. Resource utilization
2. Logic management
3. Possible duplicities
4. Subscriber side business logic in the publisher
5. Maintainability

Motivation

Real ROS 2 problem



* *Borrowed from [ROS 2 CFT design] by Mr. Tomoya Fujita*

Content Filtered Topics

A Topic extension to let ROS 2 filter messages based on an SQL-like expression

Main features

Content Filtered Topic main features

Configured at subscriber side

SQL-like syntax for expression with parameters

- Expresion: ‘node = %0’
- Parameters: [‘my_node’]

Each subscriber may set a different filter

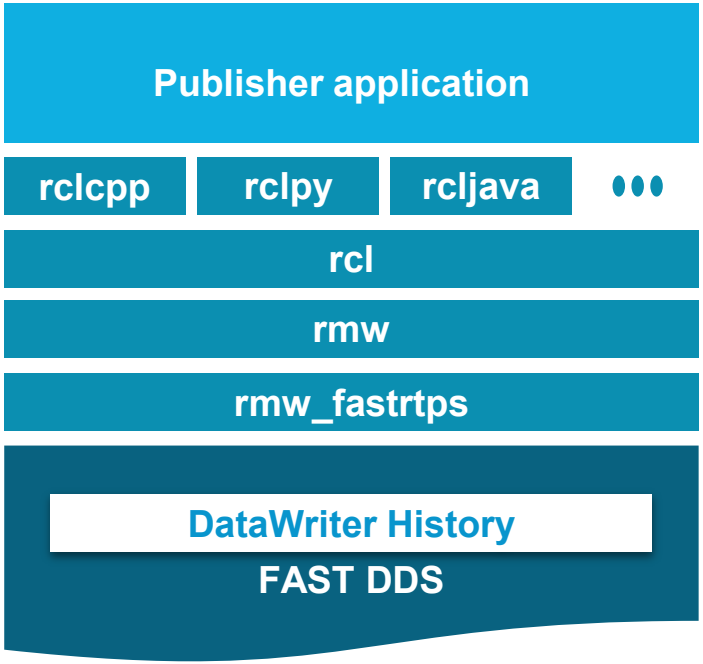
Possibility of filter on the publication side

Dynamically configurable

DDS native support

ROS 2 filtering with Fast DDS

How does CFT work



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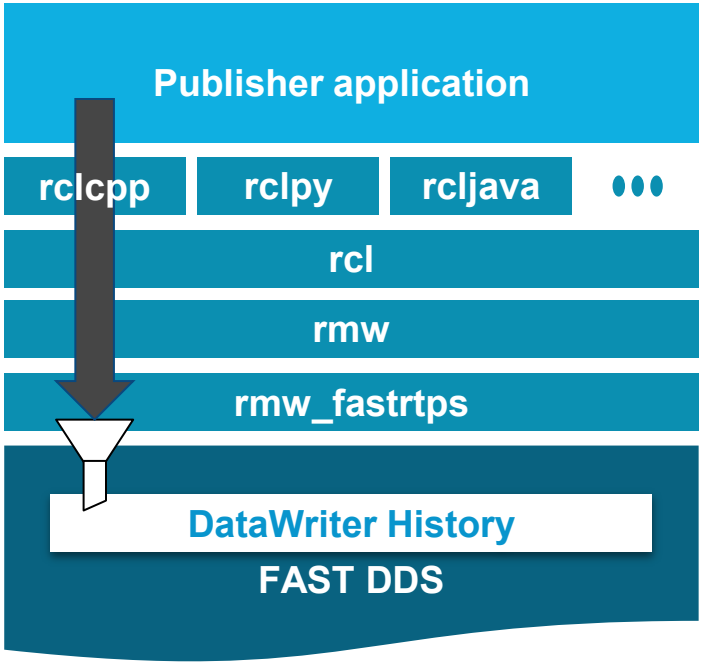

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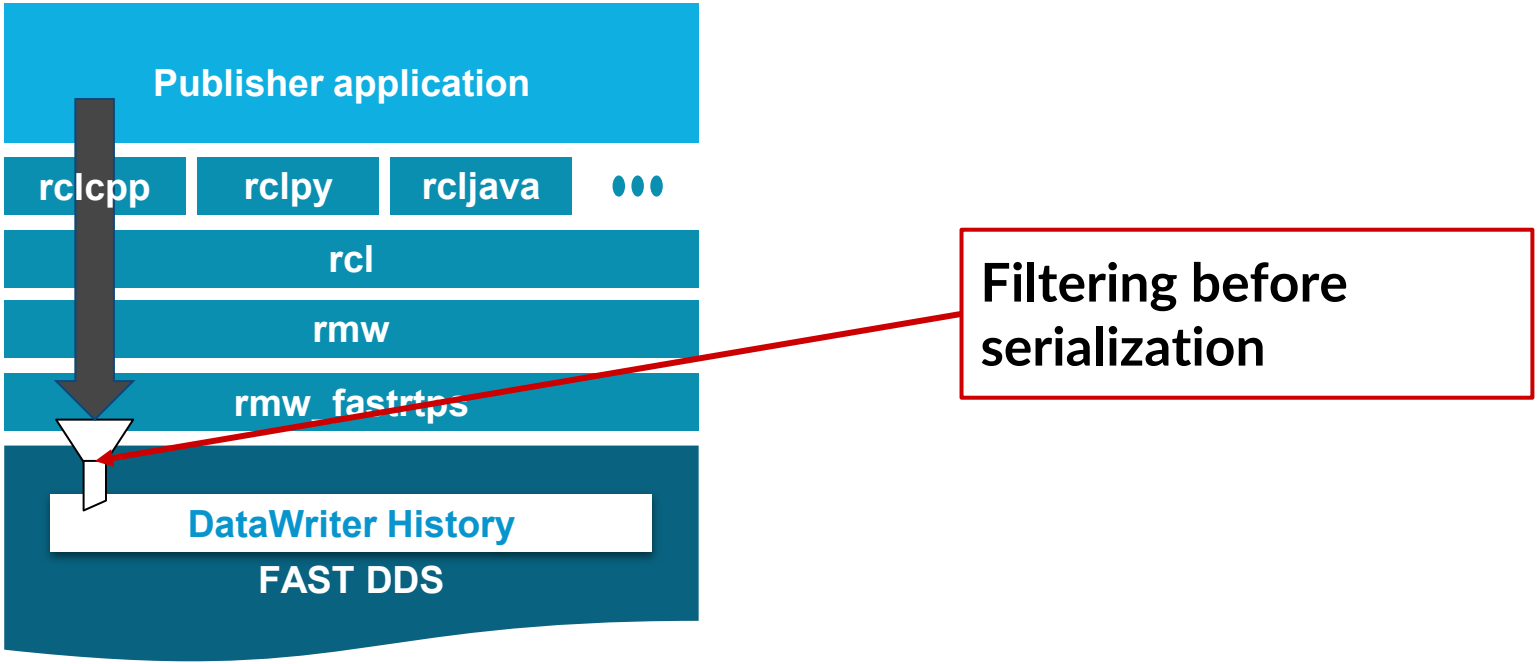

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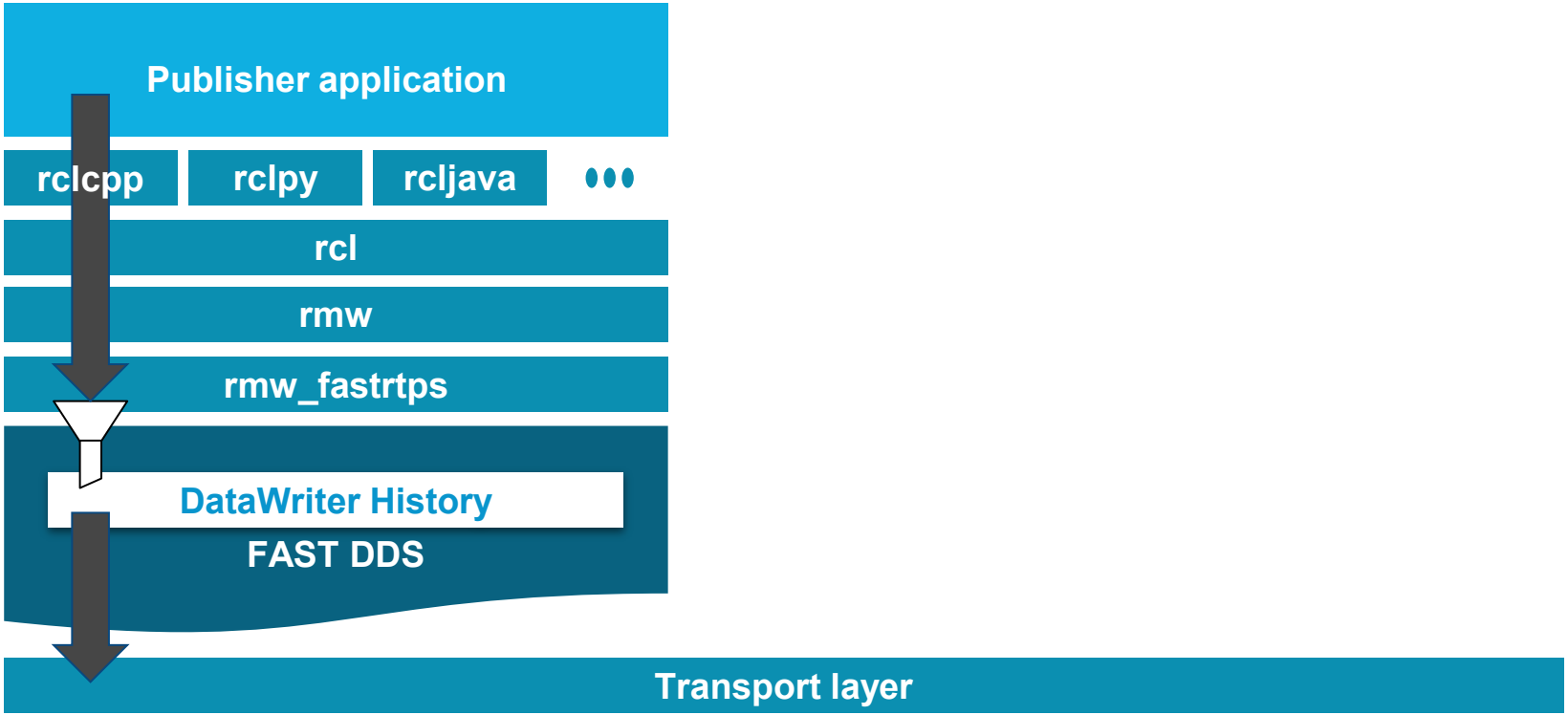

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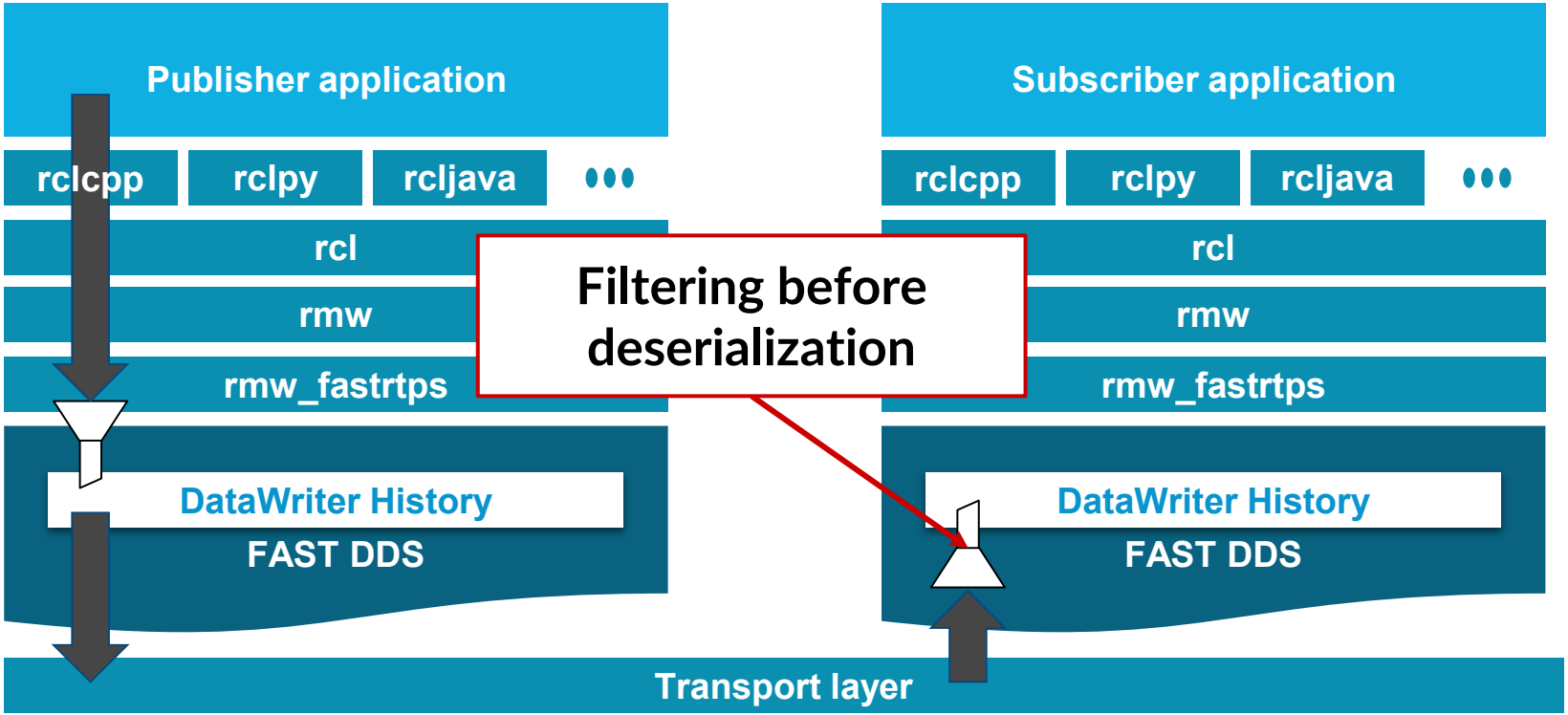

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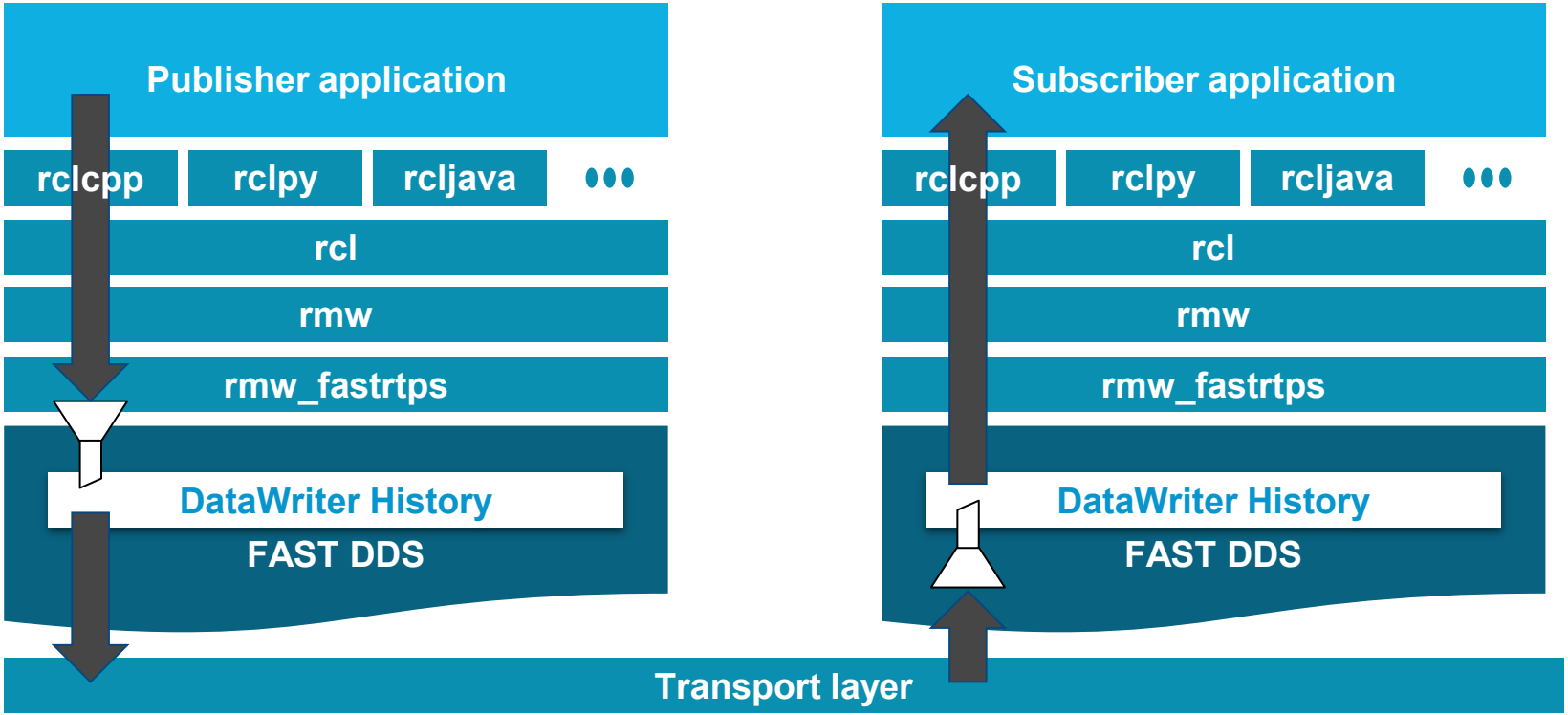
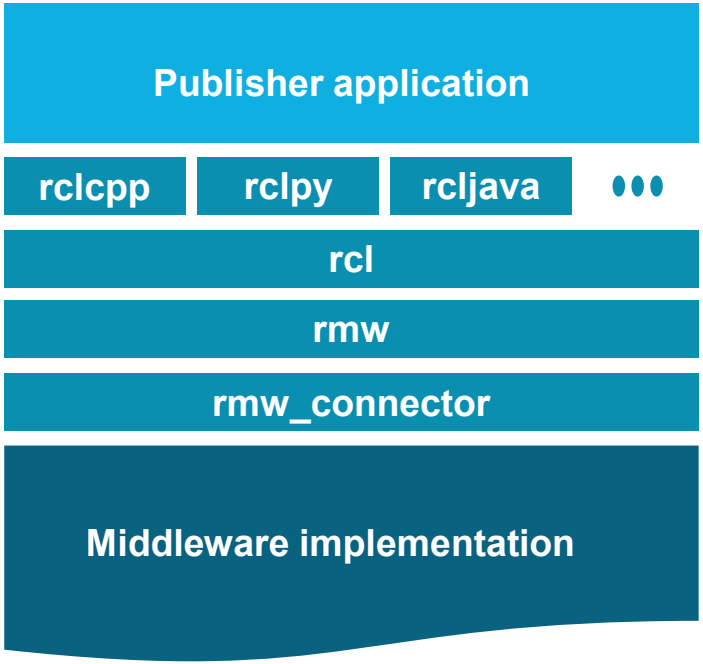


ROS 2 filtering without middleware support

How does CFT work



ROS 2 filtering without middleware support

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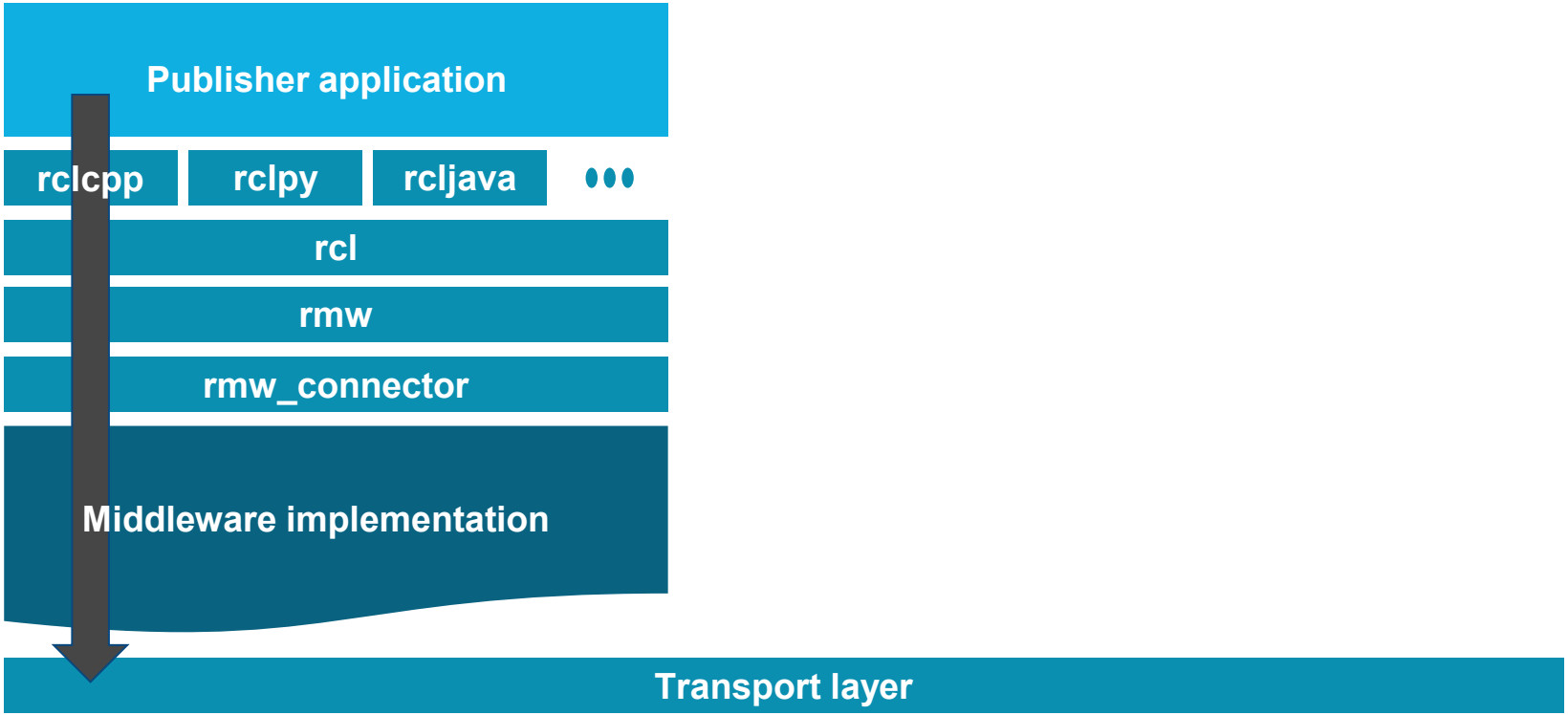

ROS 2 filtering without middleware support

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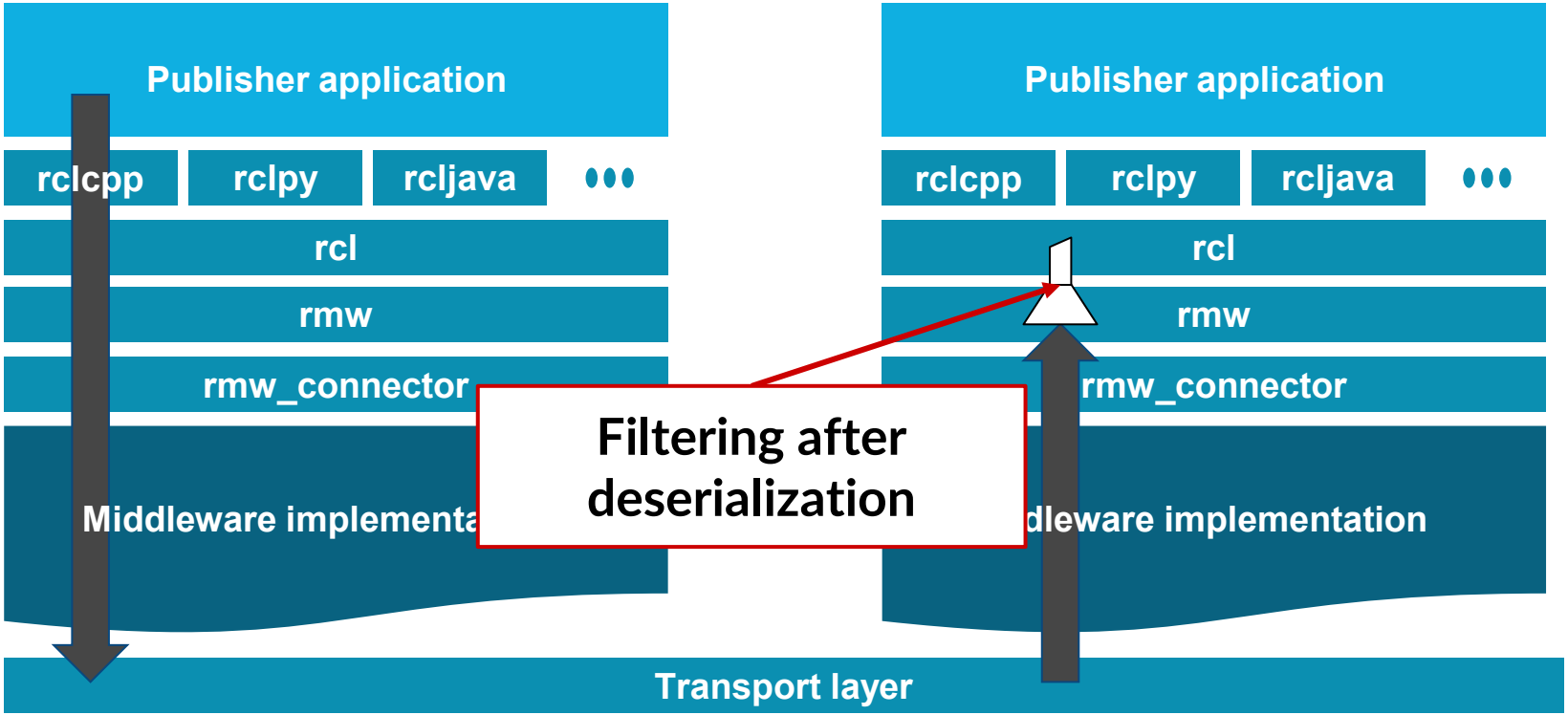

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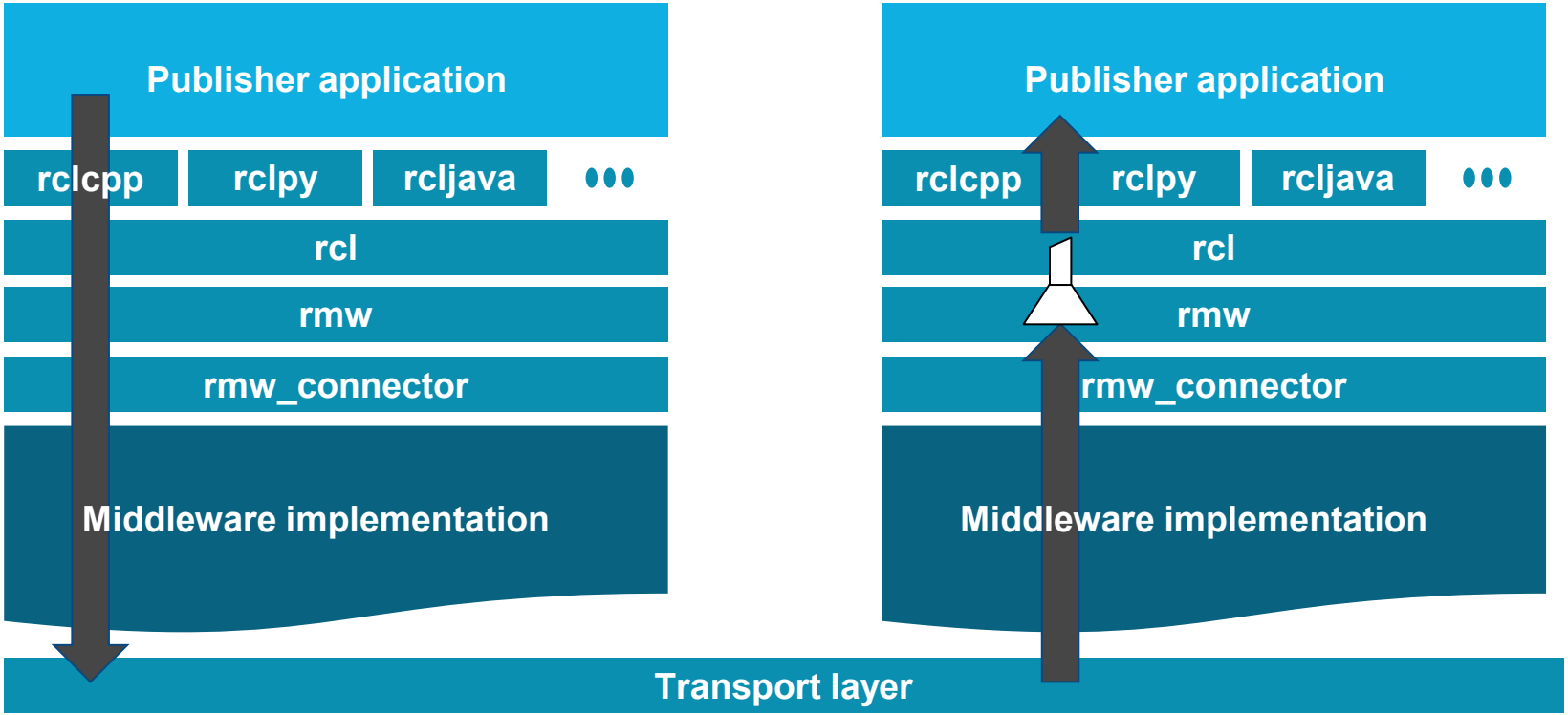


Usage in ROS 2

How to configure content filtering in ROS 2

ROS 2 APIs for Content filtering

Code snippet within the context of a constructor of a class inheriting from Node

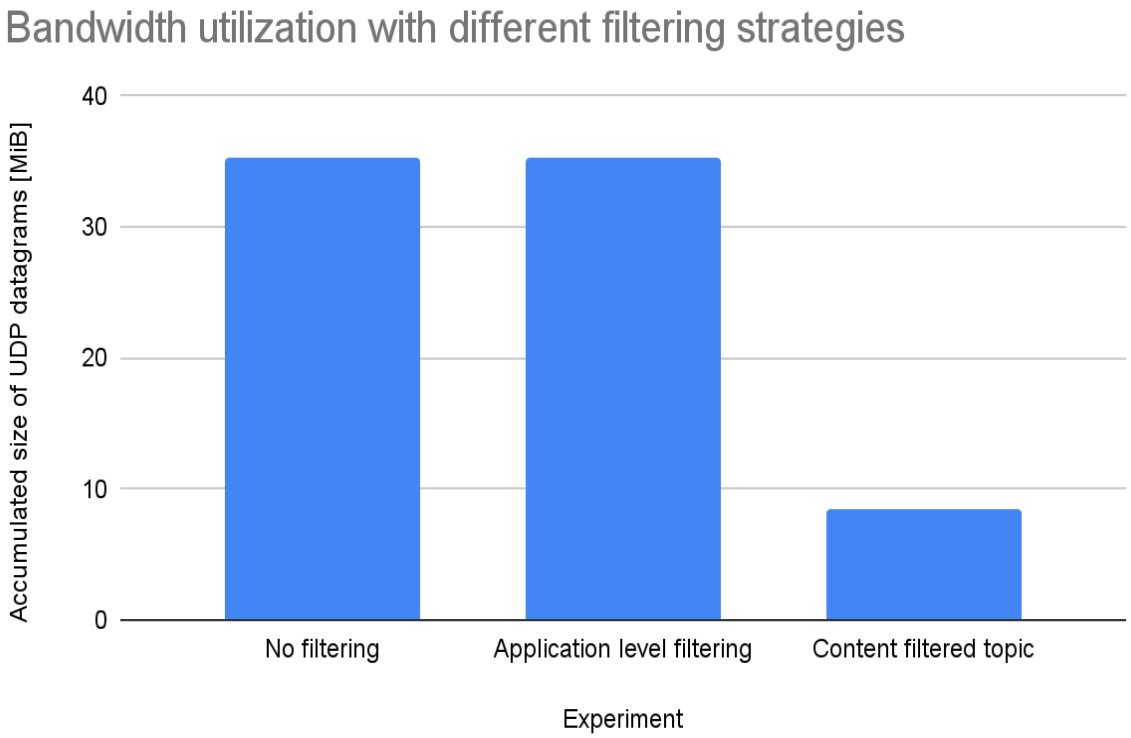
```
rclcpp::QoS qos(10);
rmw_time_t lease_duration({0, 0});
qos.liveliness(RMW_QOS_POLICY_LIVELINESS_AUTOMATIC);
qos.liveliness_lease_duration(lease_duration);

rclcpp::SubscriptionOptions sub_options;
sub_options.content_filter_options.filter_expression = "data = %0";
sub_options.content_filter_options.expression_parameters = {"'Hello!'"};

subscription_ = this->create_subscription<std_msgs::msg::String>(
   "topic",
   qos,
   std::bind(&MinimalContentFilteringSubscriber::topic_callback, this, _1),
   sub_options);

if (!subscription_->is_cft_enabled()) {
   RCLCPP_WARN(this->get_logger(), "Content filter is not enabled since it's not supported");
} else {
   RCLCPP_INFO(this->get_logger(), "Subscribed to topic with content filtering");
}
```

Bandwidth savings

Only sending what you need

Benchmark of different filtering strategies

Writer-side filtering savings using Fast DDS



- 1 Reliable pub
- 10 Reliable subs each filtering 9 out of every 10 samples.
- ~60 KiB data samples
- Pub rate: 1 Hz
- Duration: 60 s

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