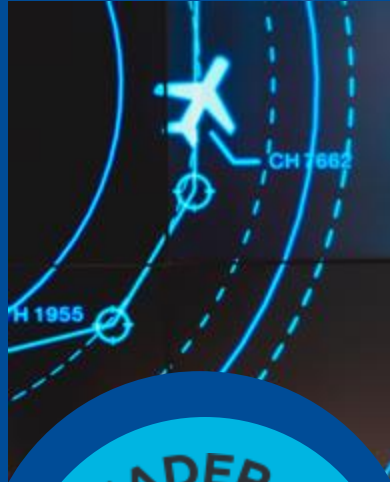




**Zhi Kai Lim**  
Senior Field Application  
Engineer  
RTI

# DDS in Robotic Systems: Advancements in Technologies and Ecosystem Collaboration

30 November 2023



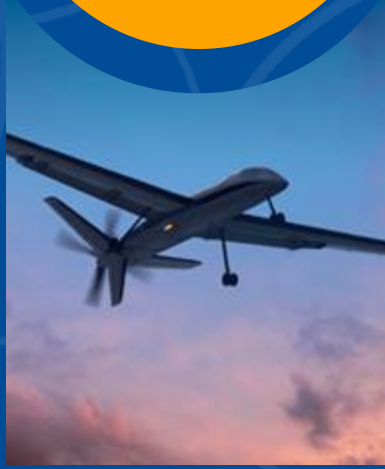
**2000+**  
DESIGNS

LEADER IN  
**20+**  
industry standards

NUMBER  
**ONE**  
SOFTWARE FRAMEWORK  
FOR AUTONOMY

**750+**  
RESEARCH PROGRAMS

250+ EMPLOYEES  
A globe icon with three location pins.  
Silicon Valley • Denver  
Spain • Singapore



# Requirements for Advanced Robotics

## Technical Requirements:

- Low Latency
- Reliability
- Scalability
- Interoperability
- Security
- Quality of Service (QoS)
- Redundancy and Failover
- Standards Compliance



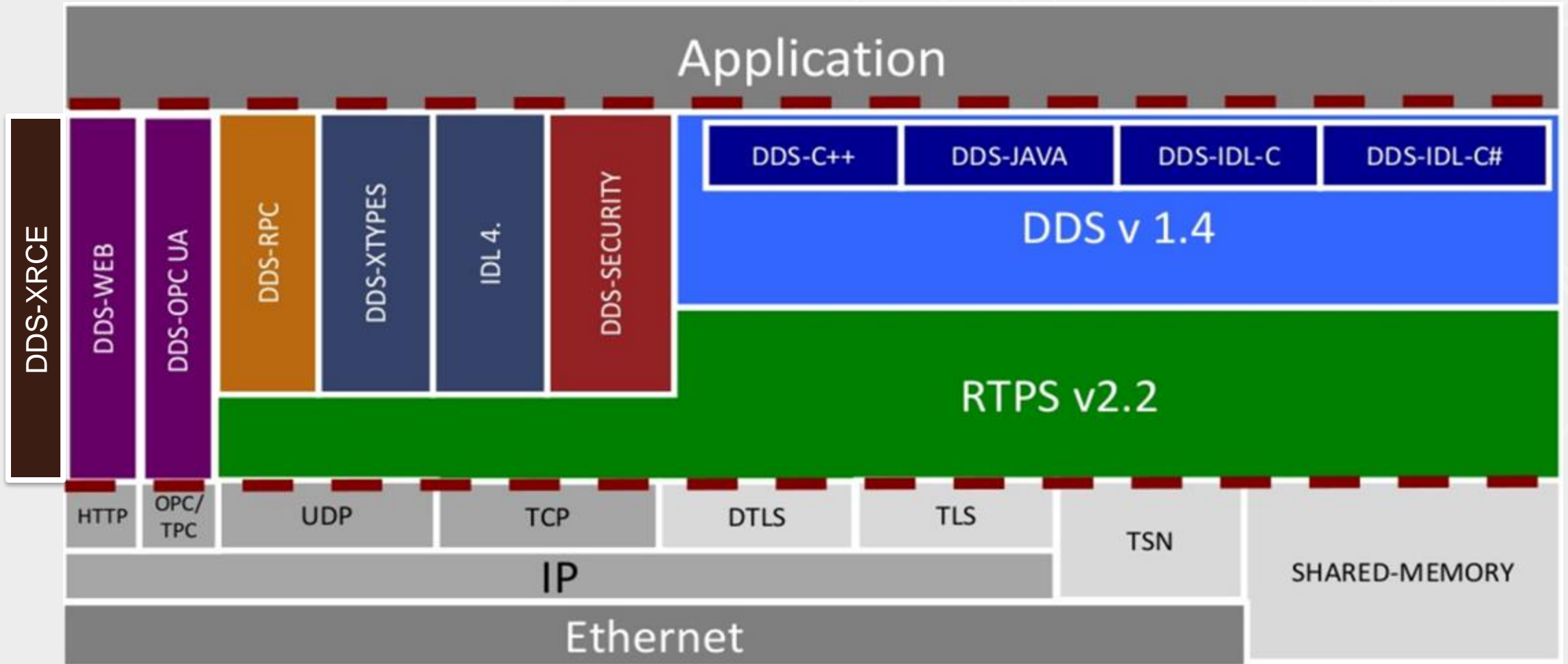
# Robot Operating System (ROS)

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 ROS 2<sup>TM</sup>

- Open-source middleware framework for robotic applications
  - Component-oriented
  - Topic-based pub/sub with typed messages
  - Remote method invocation
  - ROS Client API language bindings: C++, Python, Java
- Version 2 adopted DDS as its default communication layer
  - Abstracted by a "middleware layer" to support alternative communication technologies

# DDS Standard Family - 15 specifications (and growing)



<https://www.omg.org/spec/category/data-distribution-service/>

# Technical Benefits

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- Data-Centric
- Open Standard
- High Performance & Efficient
- Automated Discovery
- Transport-independent
- Secure Protocol
- Type Extensibility
- Redundancy/Failover
- Platform Support (>100)
- Language Support
- Safety-Cert
- Quality of Service (QoS)

# DDS Standard



OMG® DDS - Data Distribution Service (DDS)

- DDS Foundation

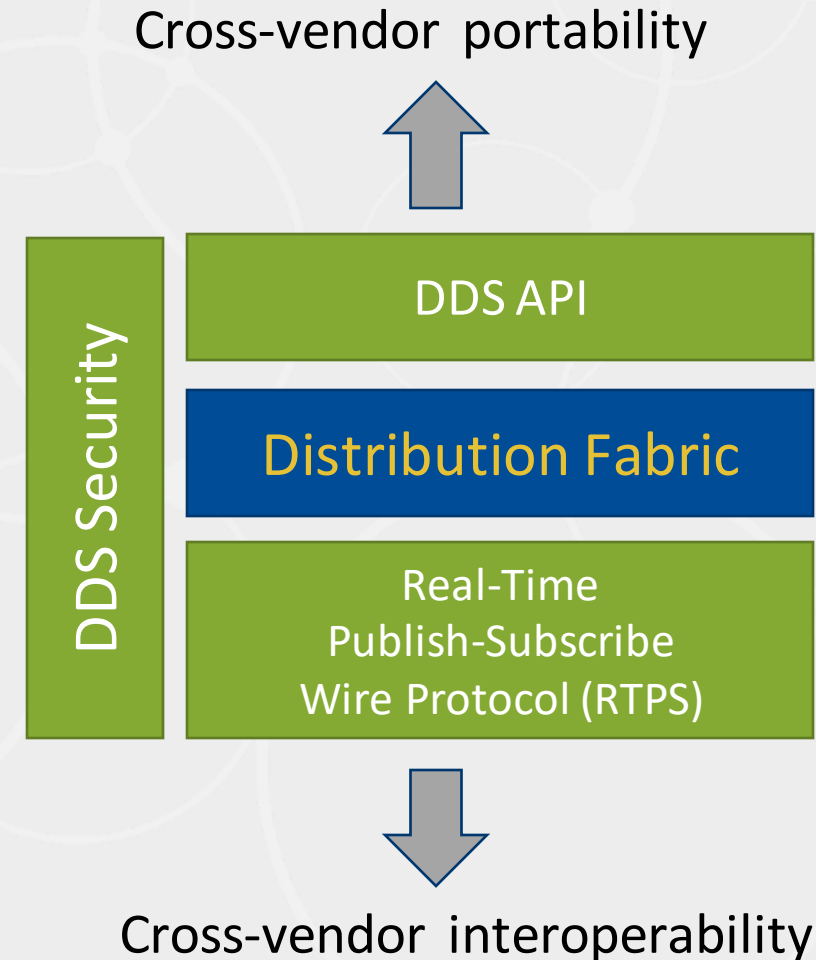
OMG Standard defines

- **Interoperability** – RTPS Wire Protocol
- **Portability** - DDS Language API
- **Security** - Plug-in Security Architecture

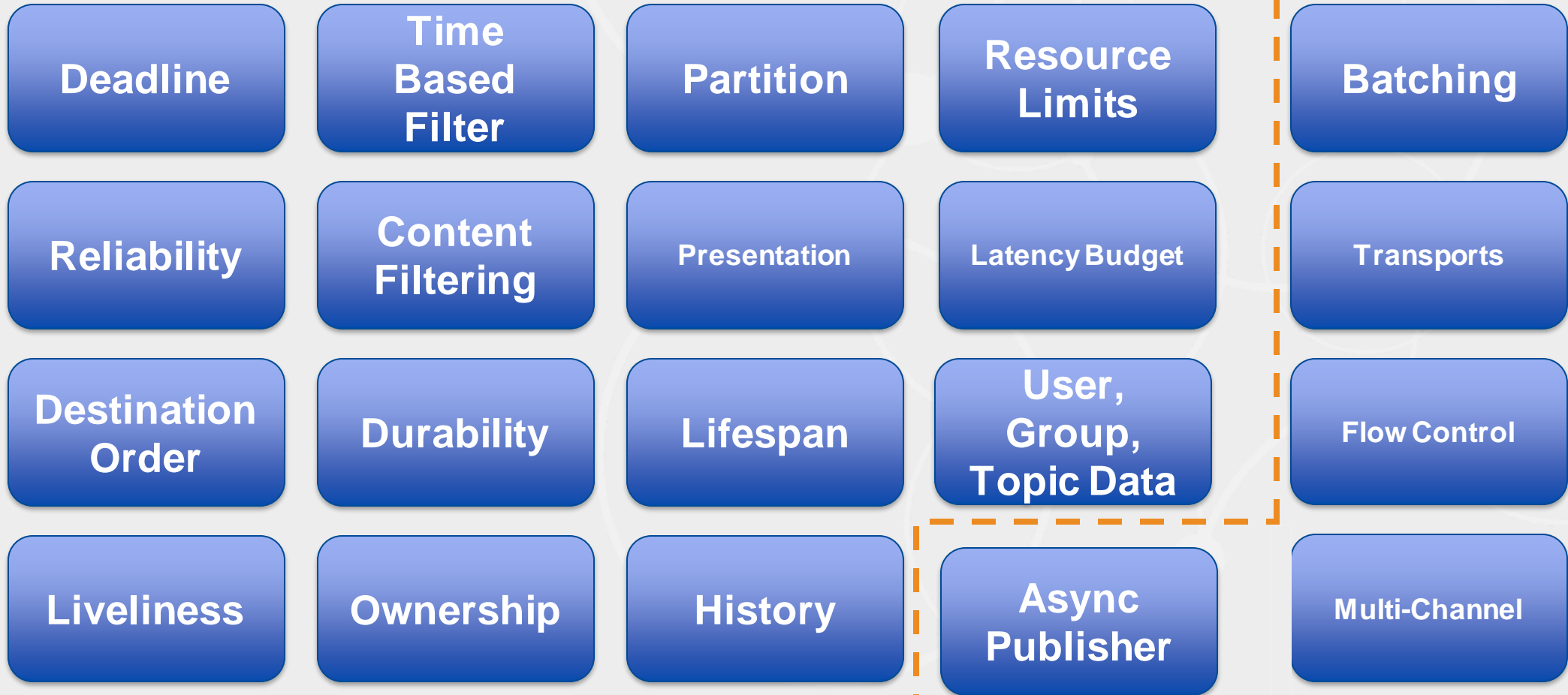
Multi-platform support

- Windows, Linux, RTOS, iOS, Android

**DDS excels at mission critical,  
real-world data communications**



# DDS Quality of Service



Unique to RTI Connex<sup>®</sup>



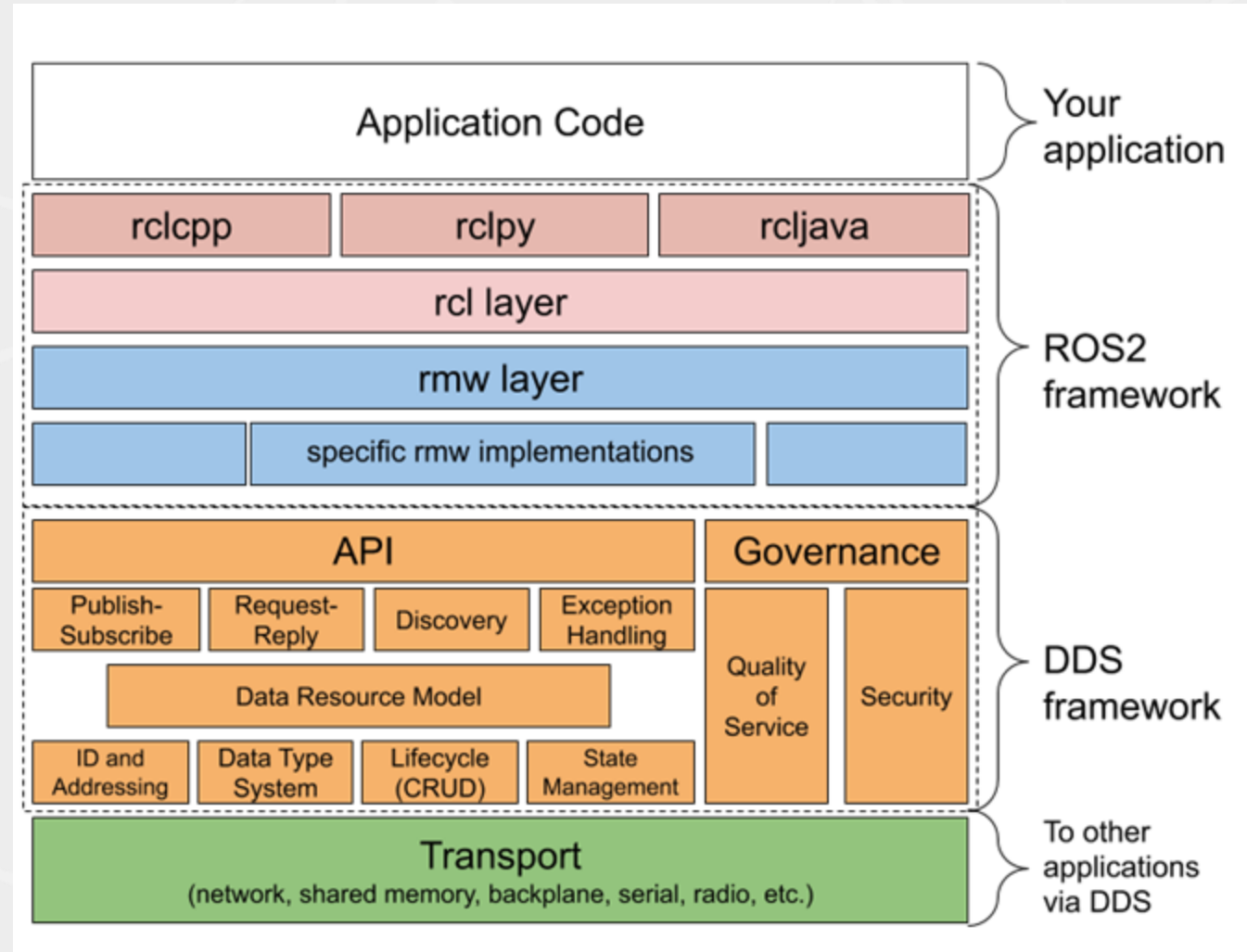


# Leveraging DDS for Robotics

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# DDS is the Connectivity Backbone for ROS 2

- ROS2 is built on the DDS framework
- All ROS2 applications are DDS applications
- DDS applications can freely interoperate with ROS2 applications
- **ROS 2 uses a subset of the DDS standard**

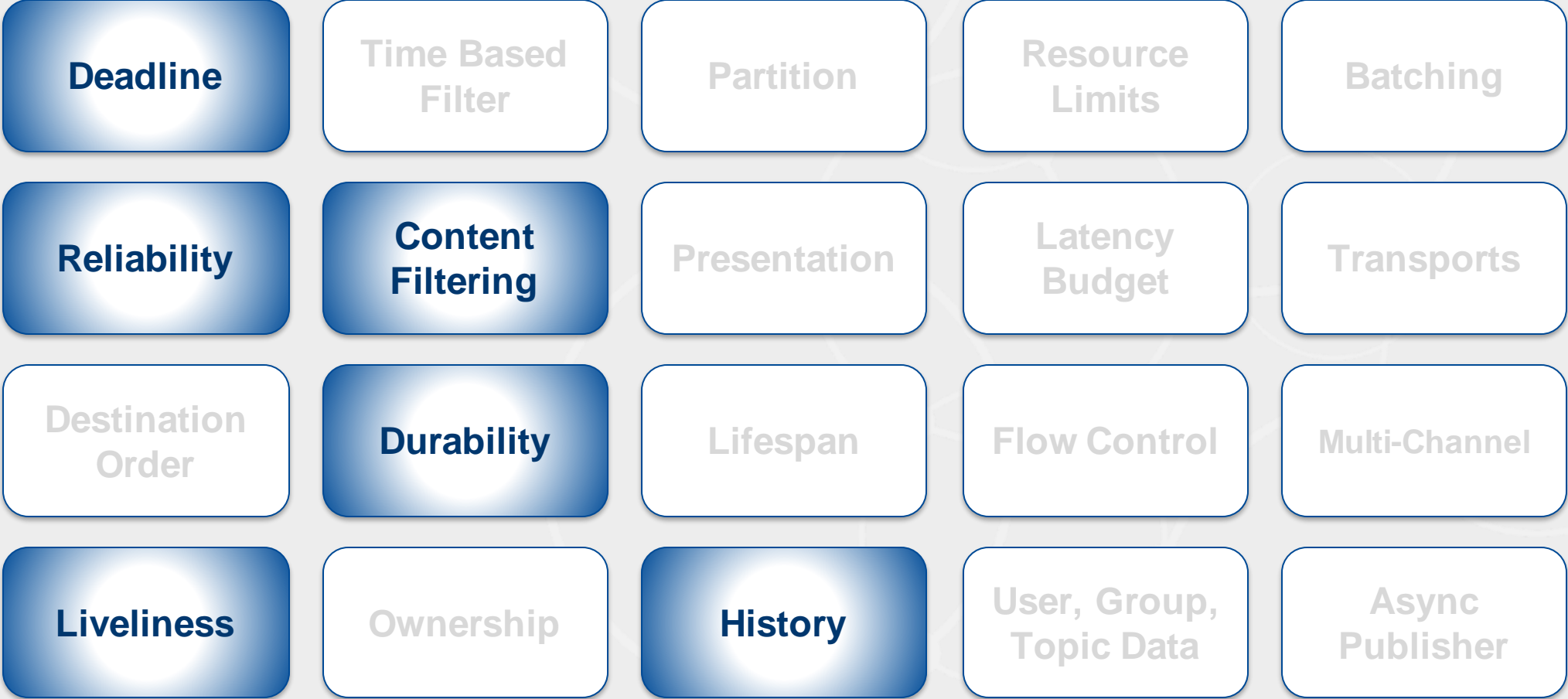


# DDS + ROS 2 Synergies

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- ROS 2 and DDS are data-centric technologies
- ROS 2 is built on the DDS framework
- ROS 2 applications are DDS applications
- ROS 2 is part of the DDS ecosystem
- ROS 2 and DDS offer standards-based interoperability
- **ROS 2 utilizes a subset of OMG DDS**
  - Limits QoS
  - Limits API/Patterns

# ROS2 Quality of Service



# What if ROS 2 relied more on DDS Features?

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## Disadvantages:

- Almost none
- Retains full interoperability with existing DDS/ROS 2 systems
- Slightly more complex API because of additional features and configuration options

## Advantages:

- QoS Capabilities
- Performance
- Scalability
- Design Patterns
- Improved interoperability with (non-ROS) DDS systems

# Using DDS instead of ROS 2 for Component Development

## Disadvantages:

- Loss of some higher-level abstractions provided by ROS 2 (e.g. actions)
- Unfamiliar API for ROS 2 users
- No dependency management and packaging system
- No predefined message types

## Advantages:

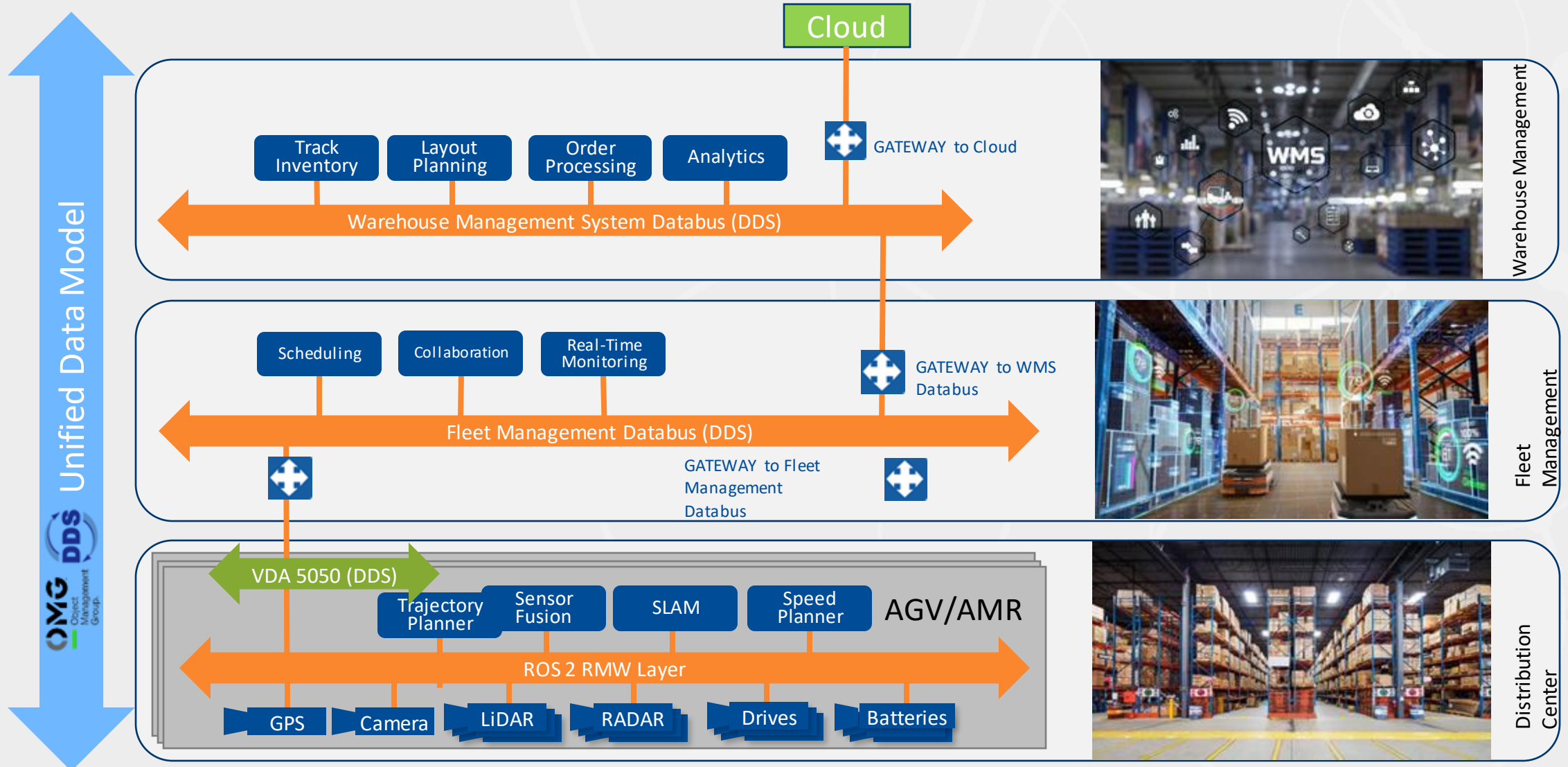
- QoS capabilities
- Performance
- Scalability
- Reduced executable size
- Safety certifiable
- Platform support
- Alternative build systems
- Design patterns
- Full interoperability with any DDS system
- Richer type system
- Deployment-grade architecture

# Use Case: AGVs / AMRs

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# AGV/AMR - Data-Centric Edge-to-Cloud Solution





# RTI Connex RMW

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# RTI Connex support for ROS 2

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- Connex is integrated with ROS 2 via **rmw\_connextdds**
  - New RMW implementation (since ROS 2 Galactic)
  - Created and maintained by RTI, in collaboration with OSRF
- Improved performance and vendor interoperability
- Advanced QoS configuration via XML configuration files
- Easier integration with Connex tools and applications
  - Automatic propagation of topic types
- Support for any version of Connex DDS
  - 5.3.1 or newer

# Connex offers a roadmap for better synergy between DDS and ROS

- Improved use of DDS in the RMW layer
  - Piggyback ROS metadata over DDS built-in discovery topics
- Extended DDS support in the ROS Client API
  - Support *keyed* data types and topic *instances*
  - Direct access to the RMW's underlying DDS middleware
  - Easier configuration of advanced QoS settings
- Simplified integration between DDS and ROS components
  - Automatic "(de)mangling" of topic and type names
  - Automatic mediation between *keyed* and *unkeyed* versions of the same topic
  - DDS/ROS data binding interoperability

# DDS Node API

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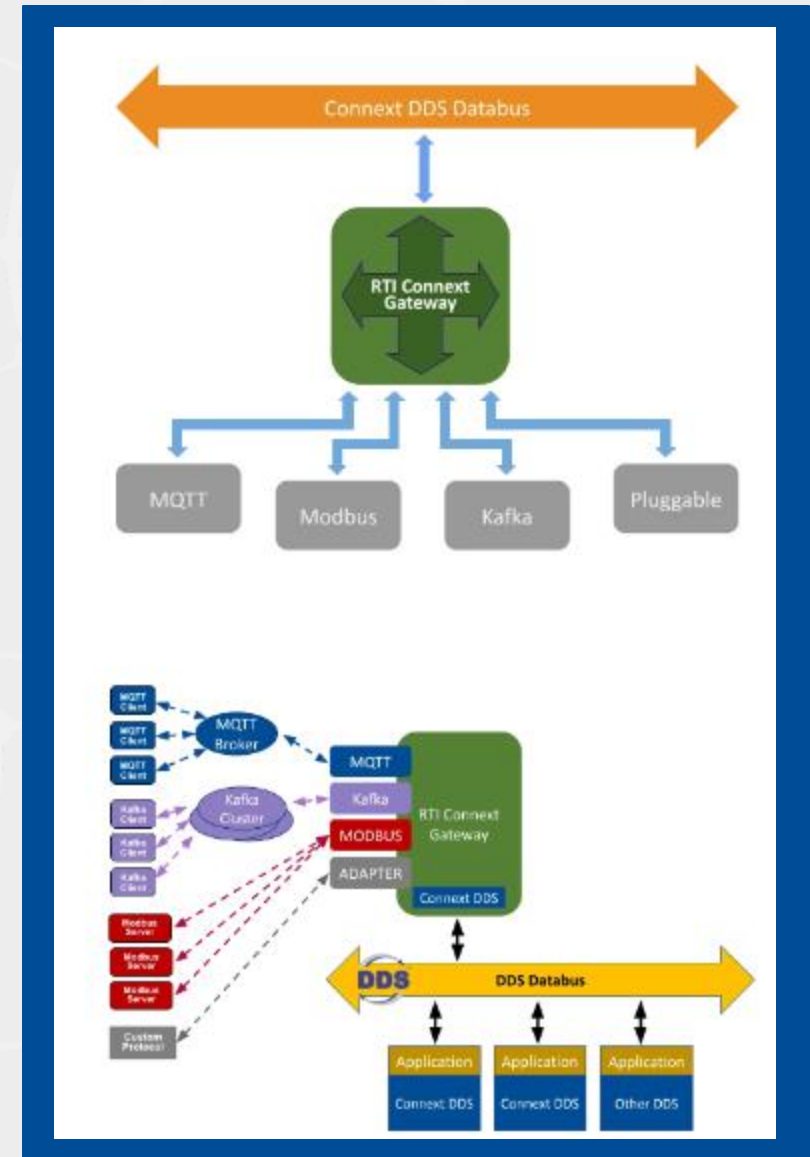
- Extends the ROS Node API to facilitate use of DDS from ROS applications:
  - Access the DDS DomainParticipant created by the RMW layer
  - Create DDS DataWriters and DataReaders with a ROS-like API
- Focused on ease of use by ROS 2 developers:
  - Drop-in replacement superclass (`rclcpp::Node`→`rclcpp_dds::DDSNode`)
  - Automatic creation of other DDS entities (Topic, Publisher, Subscriber)
  - Automatic "mangling" of ROS topic and type names
    - `my_topic`→`rt/my_topic`
    - `my_package::msg::MyType`→`my_package::msg::dds_::MyType_`
  - Callback-based interface to consume incoming data one at a time
- Based on the DDS C++11 API
- Experimental prototype available on [GitHub](#)

# Gateway Adapters

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# Connex Gateway

- Enables users to easily integrate various communication protocols into a DDS databus
- Built-in adaptors for several common protocols, including: MQTT, Apache Kafka, Modbus, OPC UA
- Open framework based on the RTI Routing Service SDK for easy add-on of new adaptors, processors and transformations



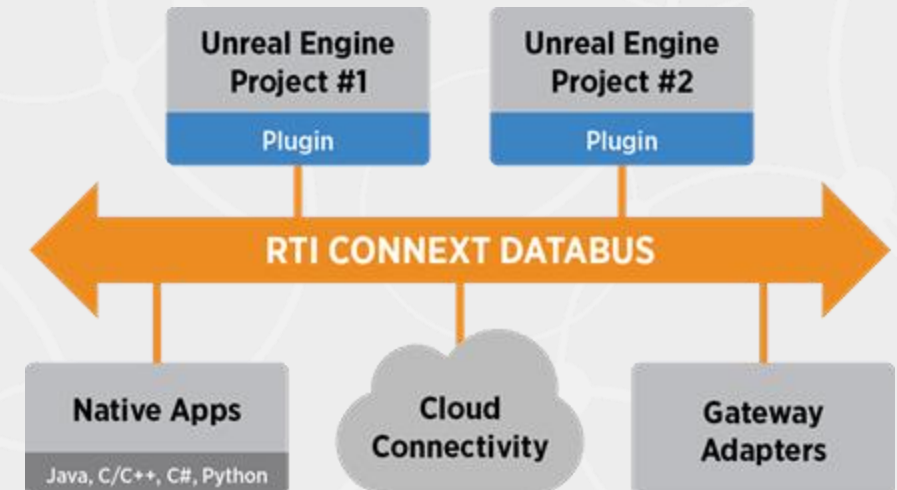
# Unreal Engine Plugin for RTI Connex

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# Simplified Real-Time Data Sharing with Unreal Engine

- Fast, secure and interoperable data communications infrastructure
- Distributes real-time data:
  - Between Unreal Engine projects
  - Between Unreal Engine projects and other applications (C, C++, C#, Java)
- Reliably scales systems to hundreds or even thousands of applications distributed across local and wide area networks



<https://www.rti.com/developers/rti-labs/unreal-engine>



# Download it on the Unreal Engine Marketplace

<https://www.unrealengine.com/marketplace/en-US/product/simplified-real-time-data-sharing>

The screenshot shows the Unreal Engine Marketplace interface. At the top, there's a navigation bar with the Unreal Engine logo, menu items (PRODUCTS, SOLUTIONS, LEARN, MORE), a search icon, a globe icon, a user profile icon labeled 'DRUANA-RTI', and a 'DOWNLOAD' button. Below the navigation bar is a promotional banner for a 'Seller Spotlight Sale' with a 70% discount. The main content area features a 'CONTENT DETAIL' section with a breadcrumb trail: Home > Browse > Industries > Free > On Sale > Seller Spotlight Sale > Vault > Help. A search bar and icons for favorites and cart are also present. The product 'Simplified Real Time Data Sharing' is displayed, including a 5-star rating, a review count, and a description. The description states: 'This plugin provides a fast, secure and interoperable data communications infrastructure for your real-time projects, based on the well-known DDS standard. Powered by RTI Connex.' Below the description is a 'Supported Platforms' section.

**CONTENT DETAIL** Home Browse Industries Free On Sale Seller Spotlight Sale Vault Help Search Products..

**Simplified Real Time Data Sharing**  
Real-Time Innovations (RTI) - Code Plugins - Jun 1, 2023  
★★★★★ 1 1 review written  
This plugin provides a fast, secure and interoperable data communications infrastructure for your real-time projects, based on the well-known DDS standard. Powered by RTI Connex.

Supported Platforms

# Summary

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# Summary

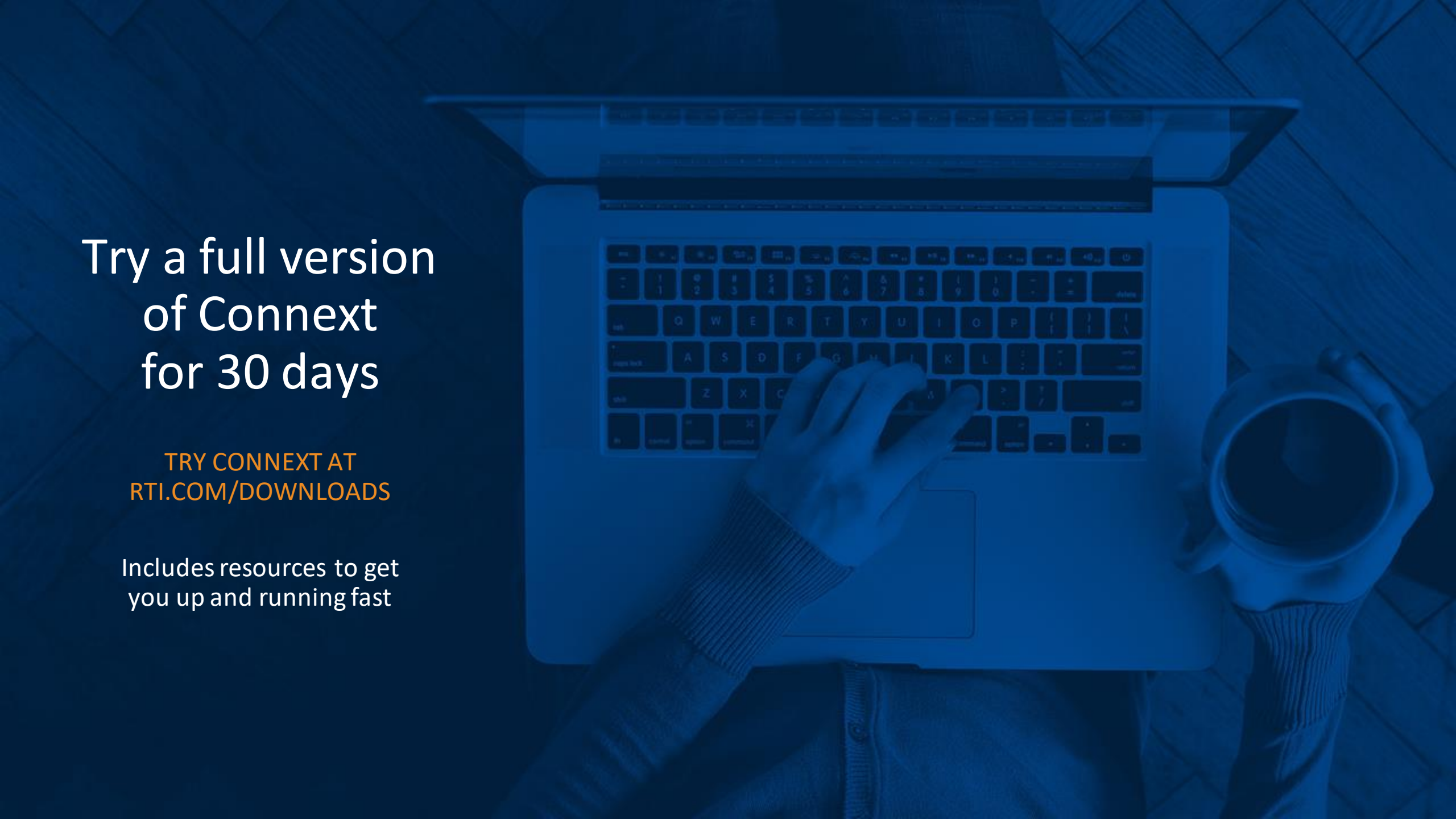
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- DDS and ROS 2 are closely related ecosystems, with mutually beneficial technologies and increasingly overlapping user bases.
  - They must continue to complement and support each other for the ultimate success of their users.
- Full, optimal integration between DDS and ROS 2 is critical.
  - Efficient use of DDS by the RMW layer.
  - Support for all DDS features in the ROS API.
  - Direct access to the DDS databus.
- Feedback is important
  - What does the community want?
  - Let us know! [community.rti.com](https://community.rti.com) or via email at [robotics@rti.com](mailto:robotics@rti.com)

**Questions?**

**Thank you!**





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