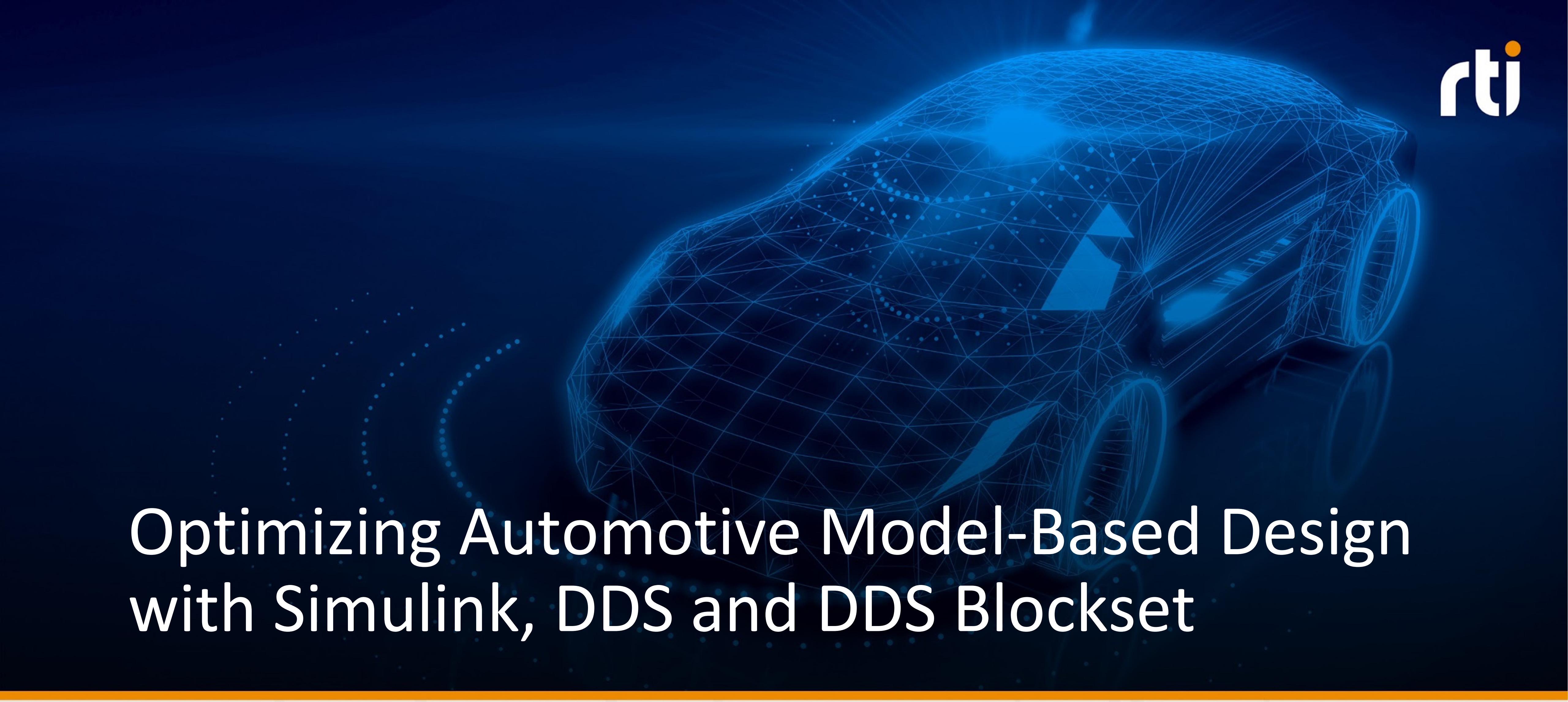

Optimizing Automotive Model-Based Design with Simulink, DDS and DDS Blockset

Angel Martinez Bernal

Senior Software Engineer, RTI
angel@rticom

Agenda

- Speaker / company Introduction
- Challenges in automotive design
- Introduction to DDS
- How DDS works with Simulink / DDS Blockset
- Demo
- Q&A

MathWorks

Partner

1800+

DESIGNS

CH 7662
H 1955
LIFEPAK 15
89

LEADER IN

20+

industry standards

NUMBER ONE

SOFTWARE FRAMEWORK FOR AUTONOMY

750+

RESEARCH PROGRAMS

250+ EMPLOYEES

Silicon Valley • Denver
Spain • Singapore

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RTI in Automotive

- RTI is working with **more than half of the top 10** funded vehicles newcomers.
- RTI Connext® Drive **is running in multiple production vehicles** around the world.
  - Certified to ISO 26262 ASIL D.
  - Complete ECU to Cloud Framework.
  - Integrated with DDS Blockset.

APTIV

XPENG

Baidu 百度

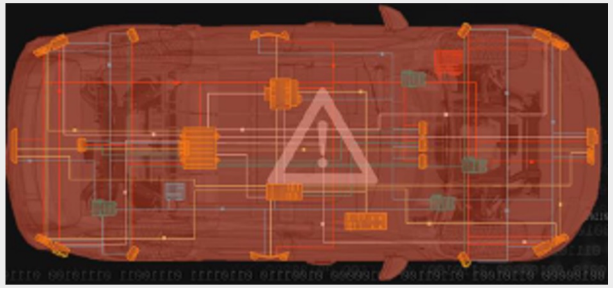
voyage

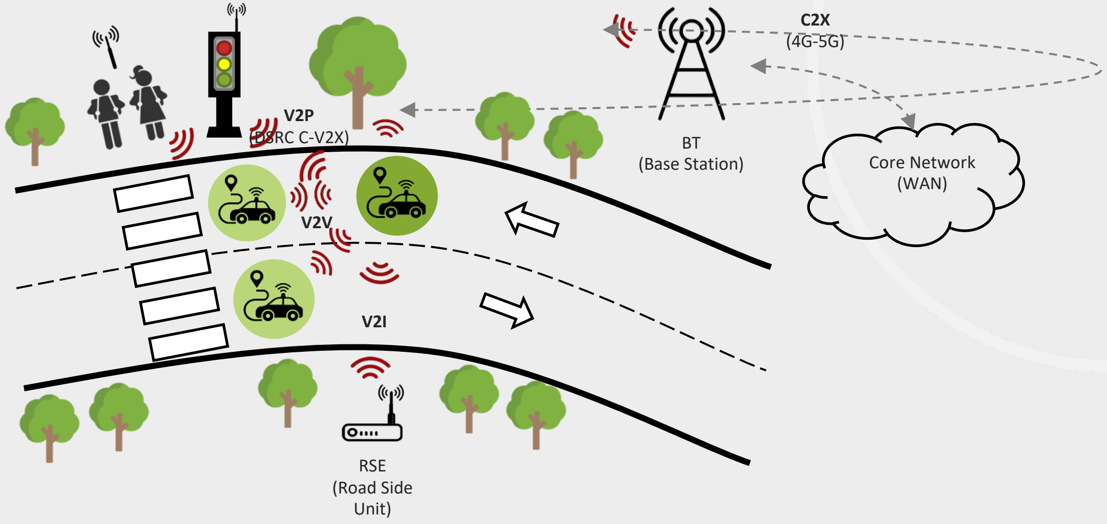
MooVita

Challenges in future automotive architecture design

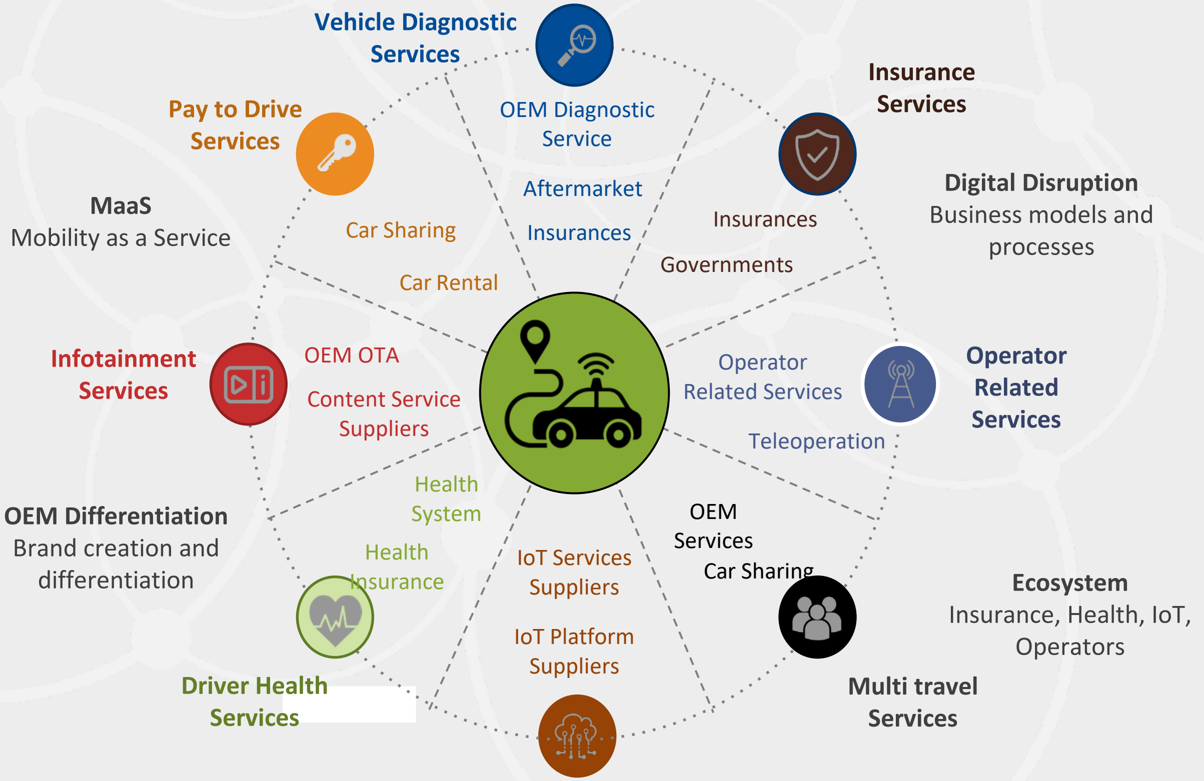
Paradigm Shift Impact is Two Fold

Technology / System Architecture





Commercial/Financial



Vehicle Diagnostic Services

OEM Diagnostic Service

Aftermarket

Insurances

Insurance Services

Insurances

Governments

Operator Related Services

Operator Related Services

Teleoperation

Multi travel Services

OEM Services

Car Sharing

IoT Services Suppliers

IoT Platform Suppliers

Driver Health Services

Health System

Health Insurance

Infotainment Services

OEM OTA

Content Service Suppliers

Pay to Drive Services

Car Sharing

Car Rental

MaaS
Mobility as a Service

OEM Differentiation
Brand creation and differentiation

Digital Disruption
Business models and processes

Ecosystem
Insurance, Health, IoT, Operators

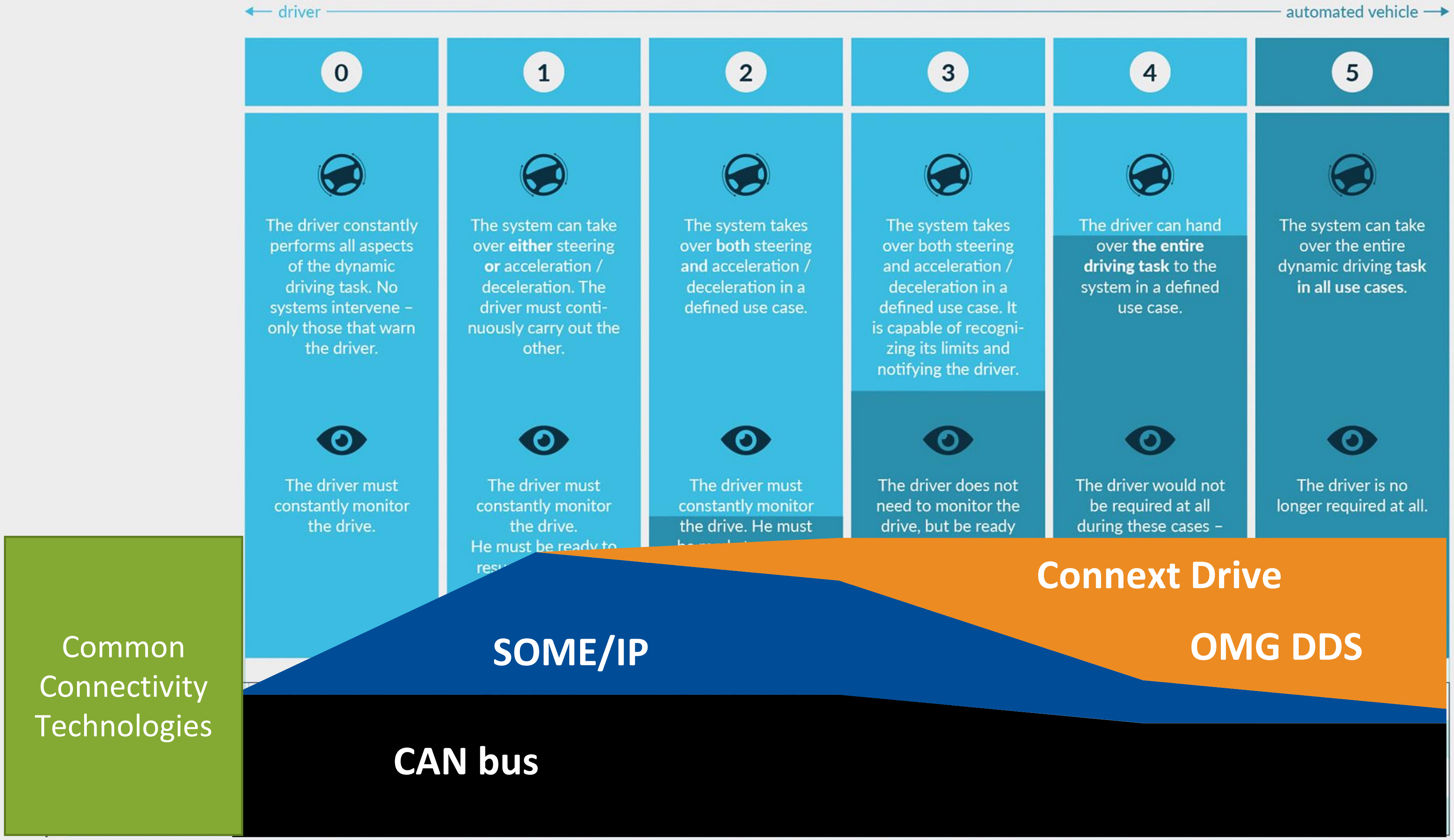
Future Proof

Uncertainty is the main risk

- Heterogenous changing platforms
- Mixed ecosystems (AUTOSAR, ROS, …)
- Evolving physical and logical architecture
- Building L2 and L3 with L4 and L5 in mind
- Unknown risks and challenges in 5-10 years time

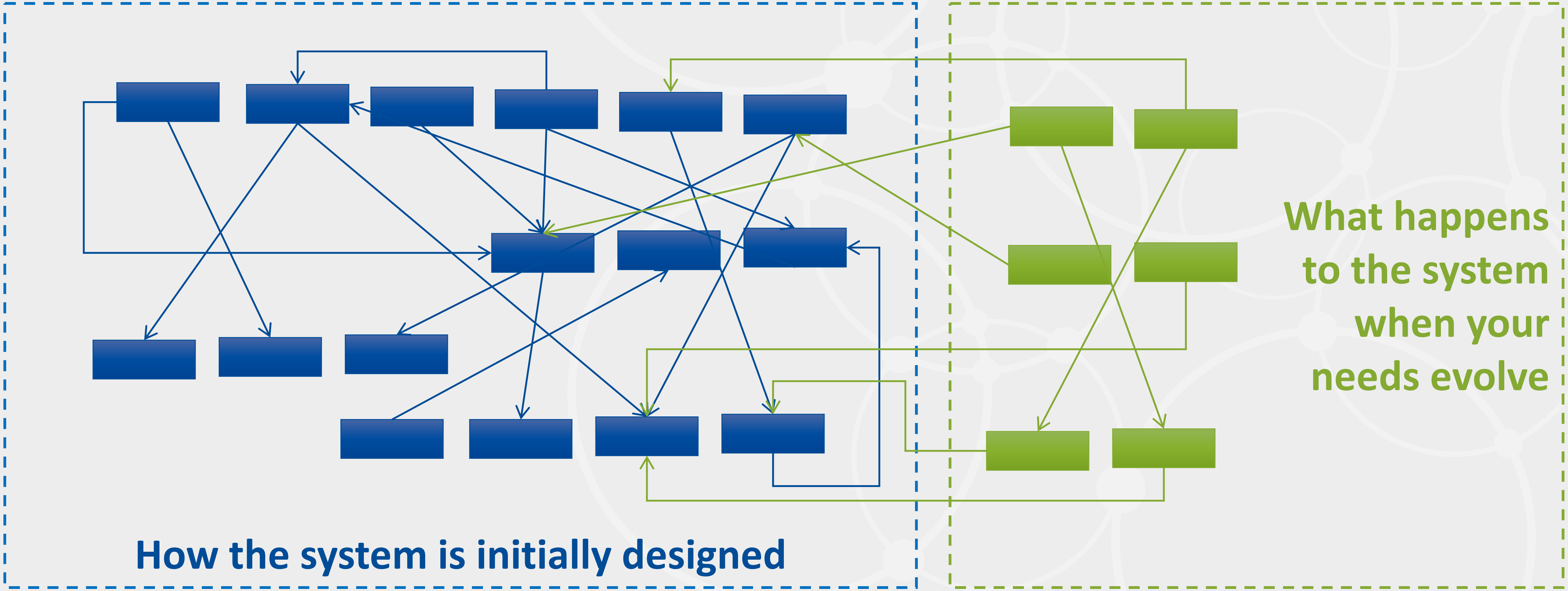
Solution: Design for integration, adaptability and scalability

More Autonomy Requires More Advanced Connectivity



0	1	2	3	4	5
The driver constantly performs all aspects of the dynamic driving task. No systems intervene – only those that warn the driver.	The system can take over **either** steering **or** acceleration / deceleration. The driver must continuously carry out the other.	The system takes over **both** steering **and acceleration** / deceleration in a defined use case.	The system takes over both steering and acceleration / deceleration in a defined use case. It is capable of recognizing its limits and notifying the driver.	The driver can hand over **the entire driving task** to the system in a defined use case.	The system can take over the entire dynamic **driving task in all use cases.**
The driver must constantly monitor the drive.	The driver must constantly monitor the drive. He must be ready to	The driver must constantly monitor the drive. He must	The driver does not need to monitor the drive, but be ready	The driver would not be required at all during these cases –	The driver is no longer required at all.

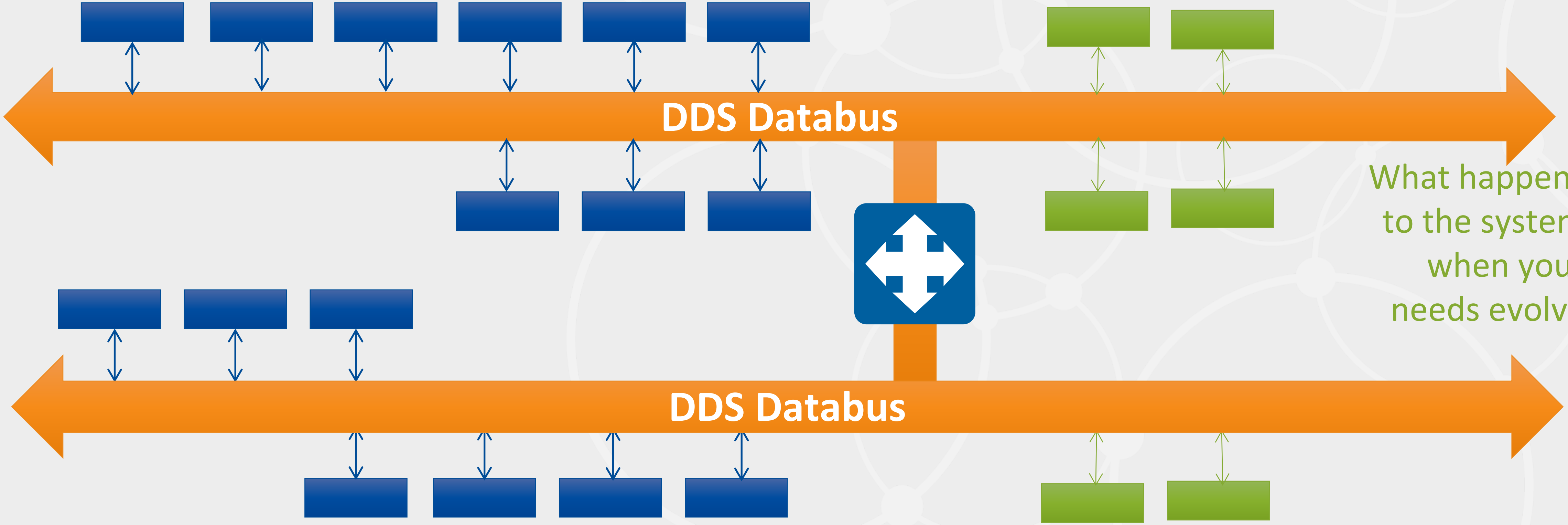
Challenges in traditional message-centric architectures



How the system is initially designed

What happens to the system when your needs evolve

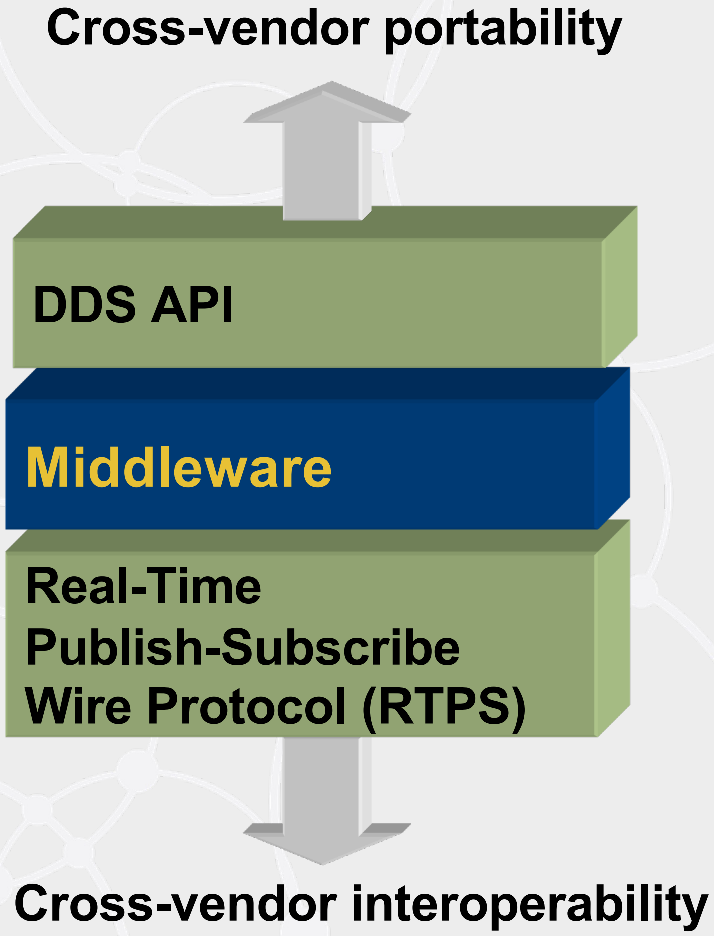
DDS enables the flexibility needed for future-forward design.


DDS Databus
DDS Databus

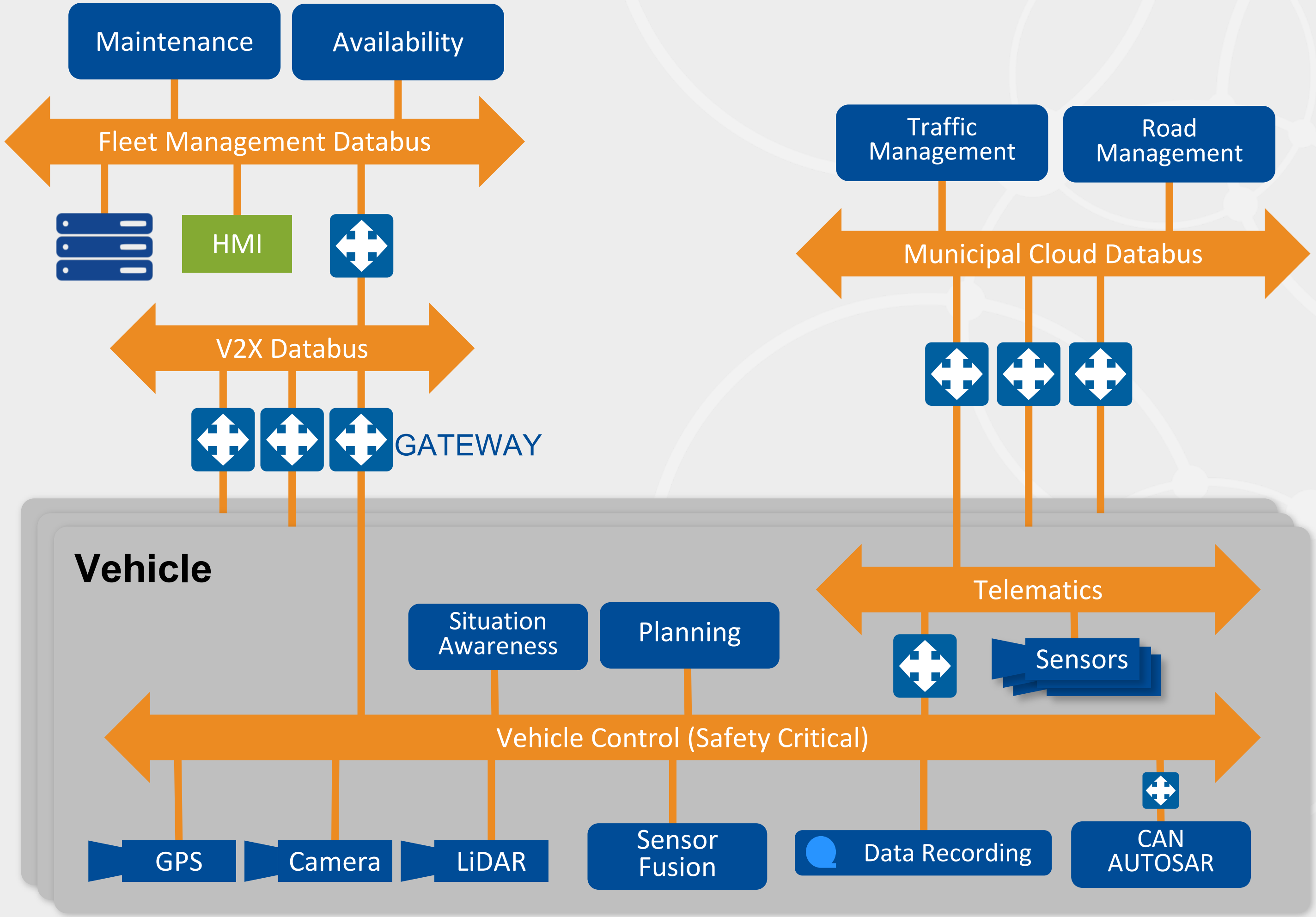
What happens to the system when your needs evolve

Data Distribution Service® (DDS™)

- OMG® Standard
  - APIs for portability
  - Wire Protocol for interoperability
- Automatic Discovery
- Peer to peer (no broker)
- Data-Centric Publish-Subscribe
- Quality of Service Configuration


Cross-vendor portability
DDS API
Middleware
Real-Time Publish-Subscribe Wire Protocol (RTPS)
Cross-vendor interoperability

Autonomous Vehicles



Maintenance
Availability
Fleet Management Databus
HMI
V2X Databus
GATEWAY
Traffic Management
Road Management
Municipal Cloud Databus

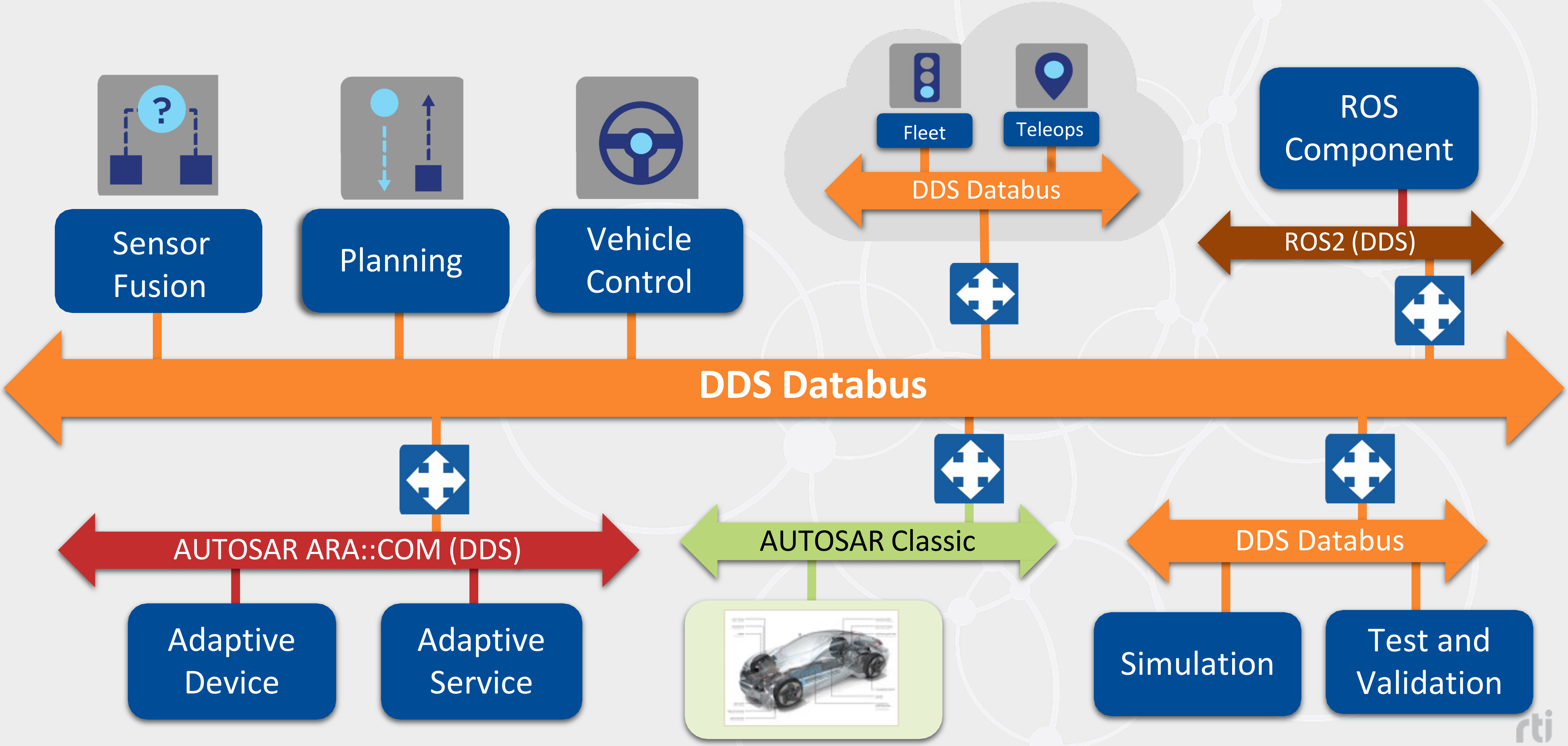
Vehicle

Telematics
Situation Awareness
Planning
Sensors
Vehicle Control (Safety Critical)
GPS
Camera
LiDAR
Sensor Fusion
Data Recording
CAN AUTOSAR

National Operations Center of Excellence

Fleet Management Weekly

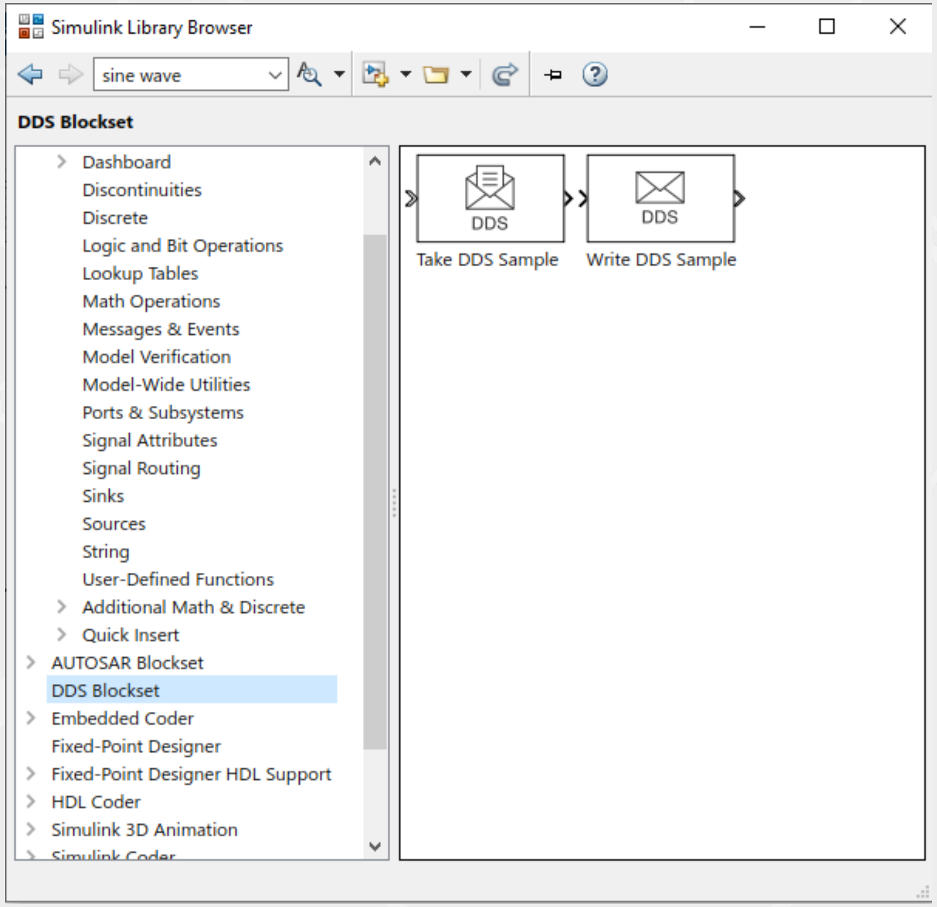
How DDS works in Automotive Design


Fleet
Teleops
DDS Databus
ROS Component
ROS2 (DDS)
Sensor Fusion
Planning
Vehicle Control
DDS Databus
AUTOSAR ARA::COM (DDS)
AUTOSAR Classic
DDS Databus
Adaptive Device
Adaptive Service
Simulation
Test and Validation

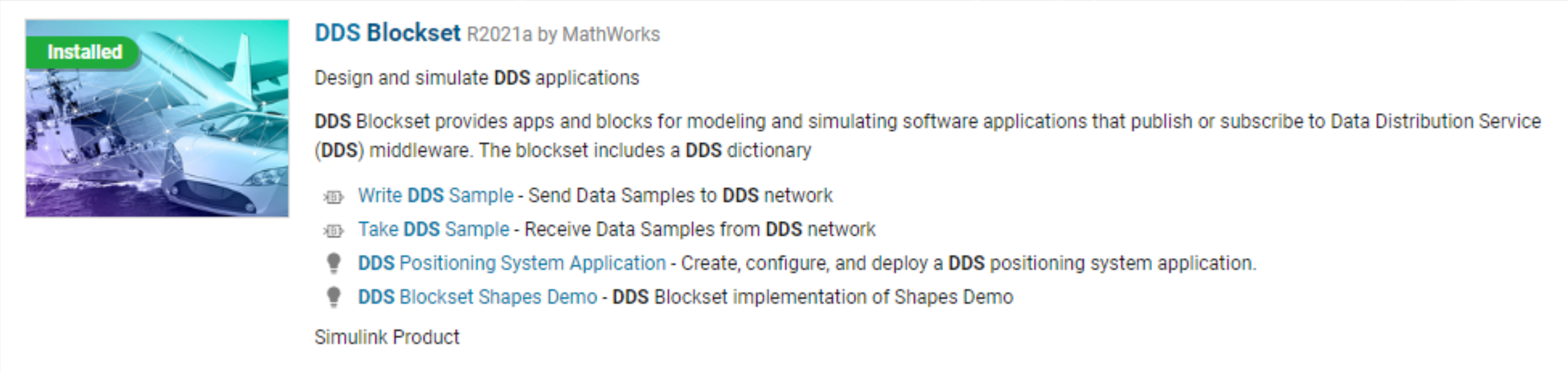
Optimizing Design with DDS Blockset

DDS Blockset

- Allows users to leverage DDS capabilities in Simulink
  - Generate code using DDS
- DDS-XML based
- Easy Simulink Integration
  - Take sample
  - Write sample
- Support
  - RTI Connext DDS
  - RTI Connext Micro 2
  - Open Source


Simulink Library Browser
sine wave
DDS Blockset
Dashboard
Discontinuities
Discrete
Logic and Bit Operations
Lookup Tables
Math Operations
Messages & Events
Model Verification
Model-Wide Utilities
Ports & Subsystems
Signal Attributes
Signal Routing
Sinks
Sources
String
User-Defined Functions
Additional Math & Discrete
Quick Insert
AUTOSAR Blockset
DDS Blockset
Embedded Coder
Fixed-Point Designer
Fixed-Point Designer HDL Support
HDL Coder
Simulink 3D Animation
Simulink Coder
DDS
Take DDS Sample
DDS
Write DDS Sample

DDS Blockset



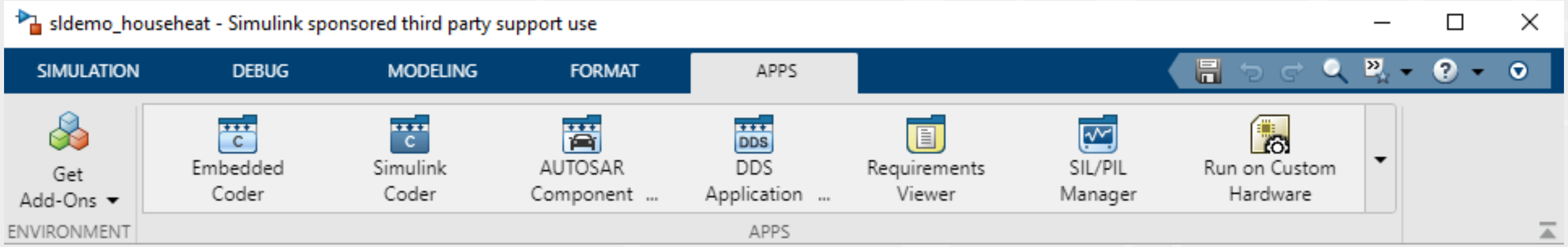
DDS Blockset R2021a by MathWorks

Design and simulate **DDS** applications

DDS Blockset provides apps and blocks for modeling and simulating software applications that publish or subscribe to Data Distribution Service (**DDS**) middleware. The blockset includes a **DDS** dictionary

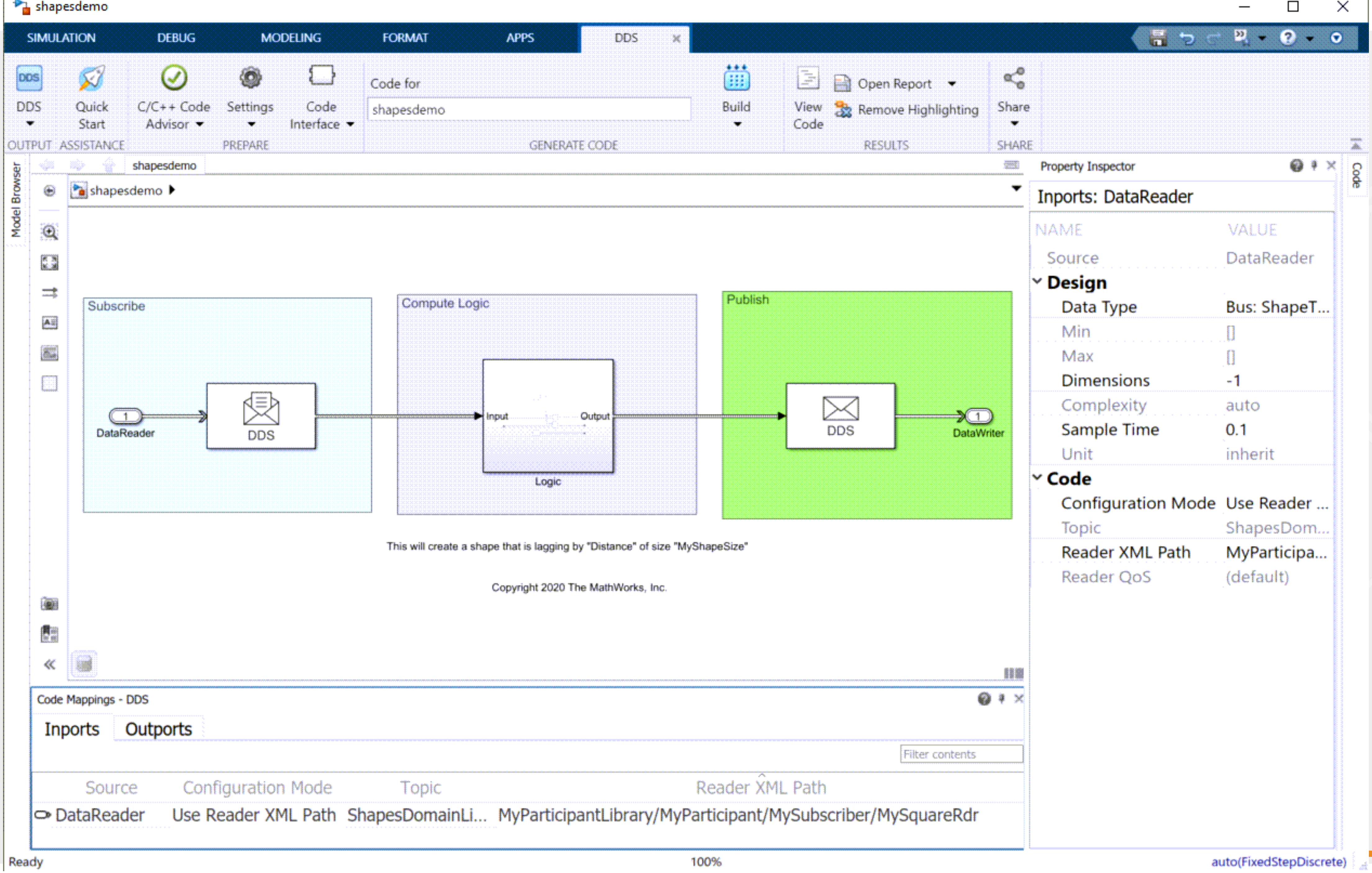
- Write **DDS** Sample - Send Data Samples to **DDS** network
- Take **DDS** Sample - Receive Data Samples from **DDS** network
- **DDS** Positioning System Application - Create, configure, and deploy a **DDS** positioning system application.
- **DDS** Blockset Shapes Demo - **DDS** Blockset implementation of Shapes Demo

Simulink Product



sldemo_househeat - Simulink sponsored third party support use

SIMULATION
DEBUG
MODELING
FORMAT
APPS
Get Add-Ons
ENVIRONMENT
Embedded Coder
Simulink Coder
AUTOSAR Component ...
DDS Application ...
Requirements Viewer
SIL/PIL Manager
Run on Custom Hardware
APPS


shapesdemo
SIMULATION
DEBUG
MODELING
FORMAT
APPS
DDS
DDS
Quick Start
C/C++ Code Advisor
Settings
Code Interface
Build
View Code
Open Report
Remove Highlighting
Share
OUTPUT
ASSISTANCE
PREPARE
GENERATE CODE
RESULTS
SHARE
Model Browser
Code
Subscribe
Compute Logic
Publish
1
DataReader
DDS
Input
Output
Logic
DDS
1
DataWriter

Code for: shapesdemo

This will create a shape that is lagging by "Distance" of size "MyShapeSize"

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Property Inspector

Inports: DataReader

NAME	VALUE
Source	DataReader
Design	
Data Type	Bus: ShapeT...
Min	[]
Max	[]
Dimensions	-1
Complexity	auto
Sample Time	0.1
Unit	inherit
Code	
Configuration Mode	Use Reader ...
Topic	ShapesDom...
Reader XML Path	MyParticipa...
Reader QoS	(default)

Code Mappings - DDS

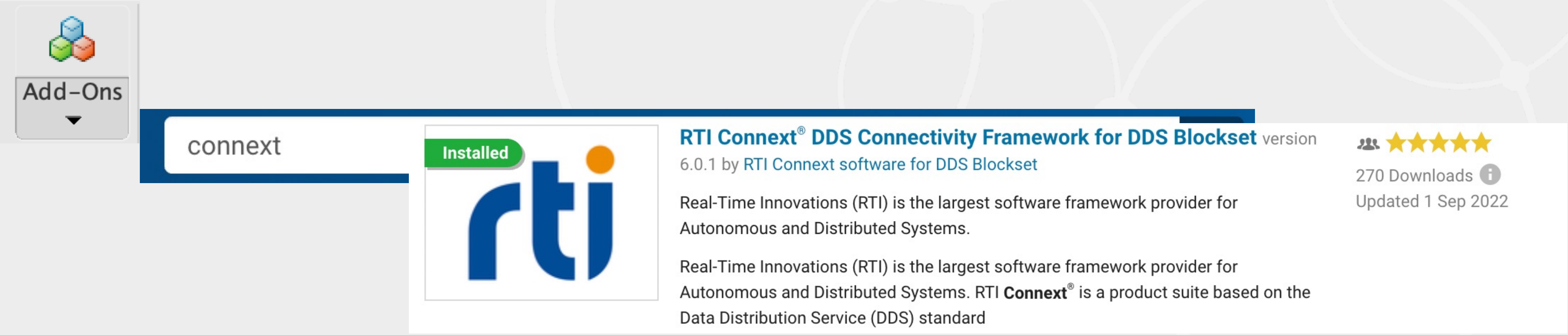
Inports | Outputs

Source	Configuration Mode	Topic	Reader XML Path
DataReader	Use Reader XML Path	ShapesDomainLi...	MyParticipantLibrary/MyParticipant/MySubscriber/MySquareRdr

Ready 100% auto(FixedStepDiscrete)

Getting Started with the DDS Blockset

- RTI Connext for DDS Blockset toolbox
  - Installs an eval version with a 2-month license
    - Request a long-term license
      - https://www.rti.com/connext-for-mathworks-users
  - Configures Simulink DDS Blockset to use Connext
  - Installs and runs RTI Tools from MATLAB



connext

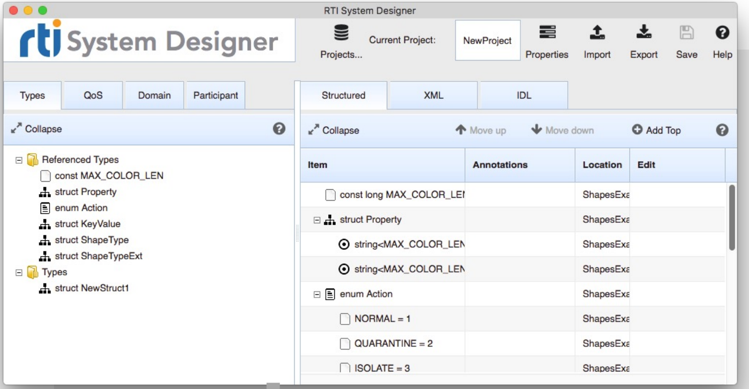
RTI Connext® DDS Connectivity Framework for DDS Blockset version 6.0.1 by RTI Connext software for DDS Blockset

270 Downloads

Updated 1 Sep 2022

Real-Time Innovations (RTI) is the largest software framework provider for Autonomous and Distributed Systems.

Real-Time Innovations (RTI) is the largest software framework provider for Autonomous and Distributed Systems. RTI **Connext**® is a product suite based on the Data Distribution Service (DDS) standard


RTI System Designer
rti System Designer
Projects...
Current Project:
NewProject
Properties
Import
Export
Save
Help
Types
QoS
Domain
Participant
Structured
XML
IDL
Collapse
Collapse
Move up
Move down
Add Top

- Referenced Types
  - const MAX_COLOR_LEN
  - struct Property
  - enum Action
  - struct KeyValue
  - struct ShapeType
  - struct ShapeTypeExt
- Types
  - struct NewStruct1

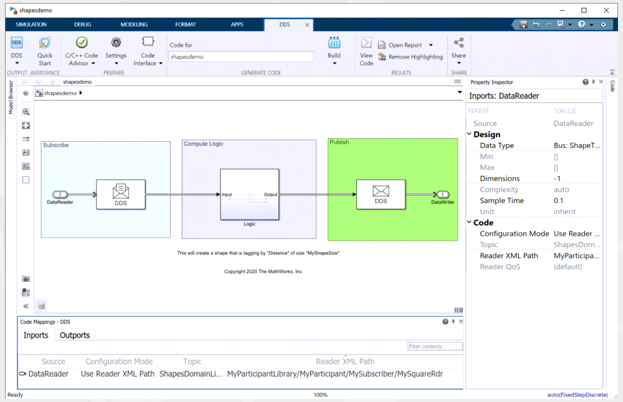
Item	Annotations	Location	Edit
const long MAX_COLOR_LE		ShapesExa	
struct Property		ShapesExa	
string<MAX_COLOR_LEN		ShapesExa	
string<MAX_COLOR_LEN		ShapesExa	
enum Action		ShapesExa	
NORMAL = 1		ShapesExa	
QUARANTINE = 2		ShapesExa	
ISOLATE = 3		ShapesExa	

System Model (DDS-XML file)

Creates

Simulink Data Dictionary

Used by


shapesdemo
SIMULATION
DEBUG
MODELING
FORMAT
APPS
DDS
Subscribe
Compute Logic
Publish
DataReader
DDS
Logic
DDS
DataWriter
Share
SHARE
Property Inspector
Code

This will create a shape that is lagging by "Distance" of size "MyShapeSize"

Copyright 2020 The MathWorks, Inc.

Inports: DataReader

NAME	VALUE
Source	DataReader
Design	
Data Type	Bus: ShapeT...
Min	[]
Max	[]
Dimensions	-1
Complexity	auto
Sample Time	0.1
Unit	inherit
Code	
Configuration Mode	Use Reader ...
Topic	ShapesDom...
Reader XML Path	MyParticipa...
Reader QoS	(default)

Code Mappings - DDS

Inports | Outports

Source	Configuration Mode	Topic	Reader XML Path
DataReader	Use Reader XML Path	ShapesDomainLi...	MyParticipantLibrary/MyParticipant/MySubscriber/MySquareRdr

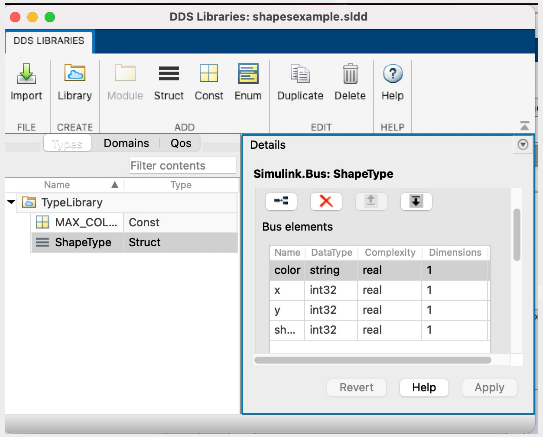
Ready 100% auto(FixedStepDiscrete)

Generates

C/C++

Deploy

Exec + XML files

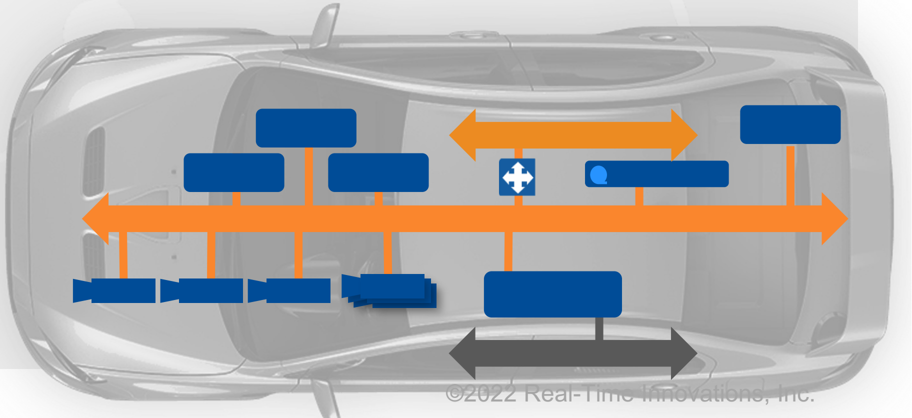

DDS Libraries: shapesexample.sldd
DDS LIBRARIES
Import
Library
Module
Struct
Const
Enum
Duplicate
Delete
Help
FILE
CREATE
ADD
EDIT
HELP
Types
Domains
Qos
Filter contents
Details
Revert
Help
Apply

Name	Type
TypeLibrary	
MAX_COL...	Const
ShapeType	Struct

Simulink.Bus: ShapeType

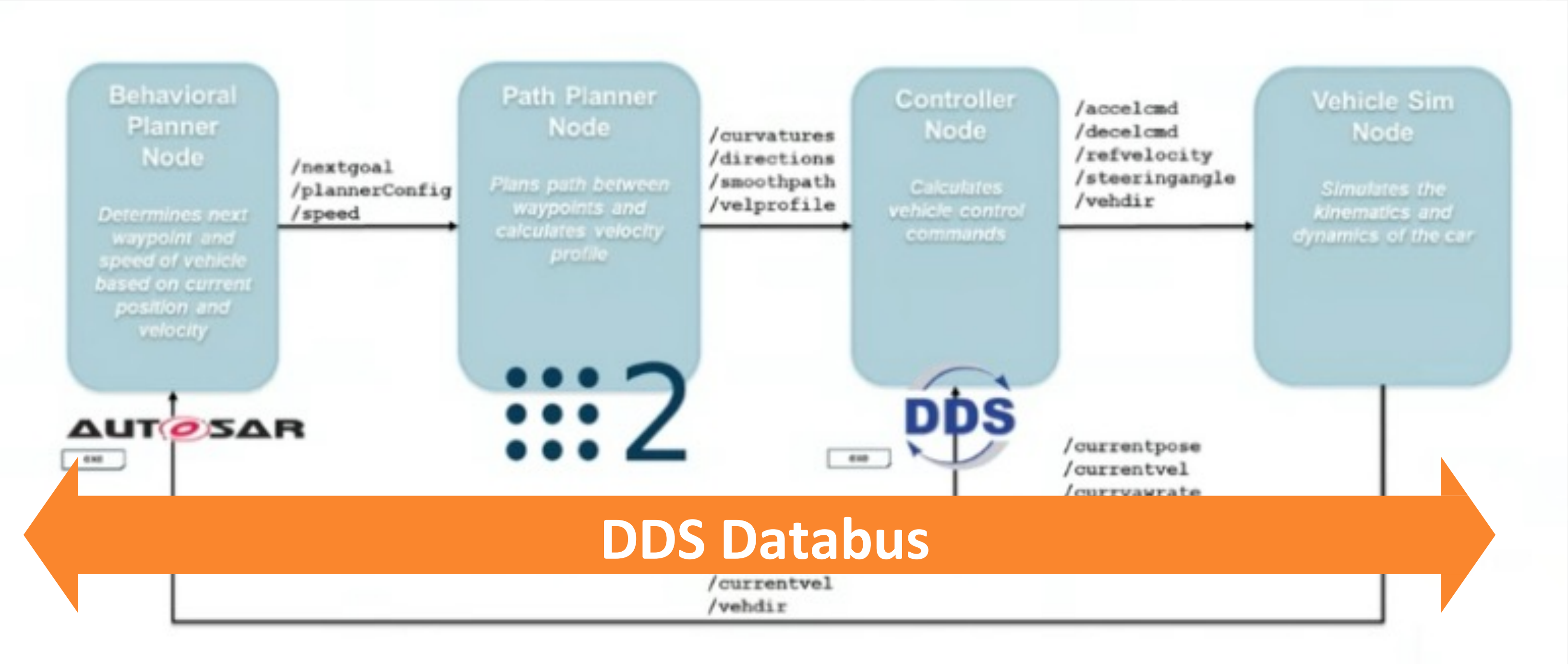
Bus elements

Name	DataType	Complexity	Dimensions
color	string	real	1
x	int32	real	1
y	int32	real	1
sh...	int32	real	1



Valet driving Demo video

Interoperability between AUTOSAR Adaptive, DDS and ROS2 over DDS network


Behavioral Planner Node
Determines next waypoint and speed of vehicle based on current position and velocity
/nextgoal
/plannerConfig
/speed
Path Planner Node
Plans path between waypoints and calculates velocity profile
/curvatures
/directions
/smoothpath
/velprofile
Controller Node
Calculates vehicle control commands
/accelcmd
/decelcmd
/refvelocity
/steeringangle
/vehdir
Vehicle Sim Node
Simulates the kinematics and dynamics of the car
AUTOSAR
2
DDS
/currentpose
/currentvel
/curryawrate
DDS Databus
/currentvel
/vehdir

DDS Blockset

For:	System and algorithm engineers
Who:	Develop software for DDS (Data Distribution Service) based embedded systems
Provides:	• Apps and blocks to model, simulate DDS software applications and communicate the data from a Simulink® Real-Time™ model using a DDS communication • DDS dictionary to manage DDS definitions • API to Import and Export DDS definitions as IDL/XML files • Support for modeling and code generation for event-driven communication • Ability to manage and edit Quality of Services (QoS) profiles • C++ production code generation with DDS APIs (with Embedded Coder)

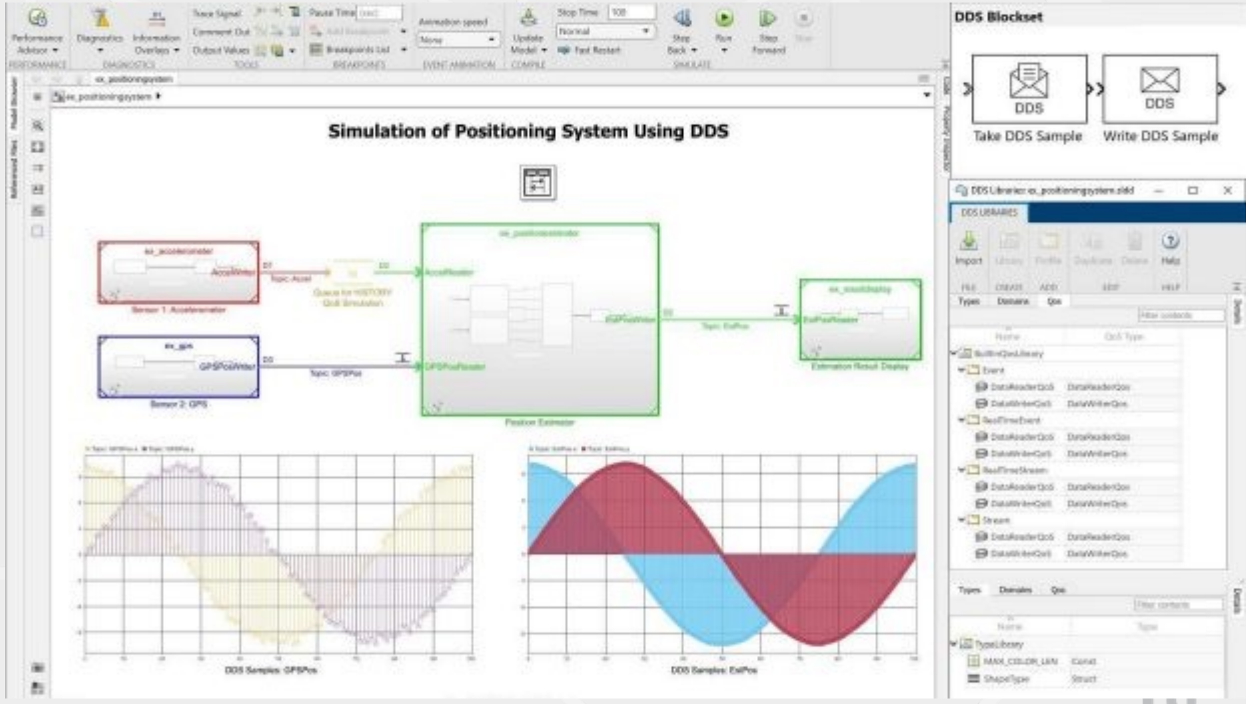
DDS Blockset fully integrates with third-party DDS stacks including
RTI Connext Pro 6.0
RTI Connext Micro 2.4
*RTI TSS Connext 3.1

DDS Blockset is supported for all platforms - Mac, Windows and Linux

DDS Blockset

Design and simulate DDS applications

Request a trial



Simulation of Positioning System Using DDS

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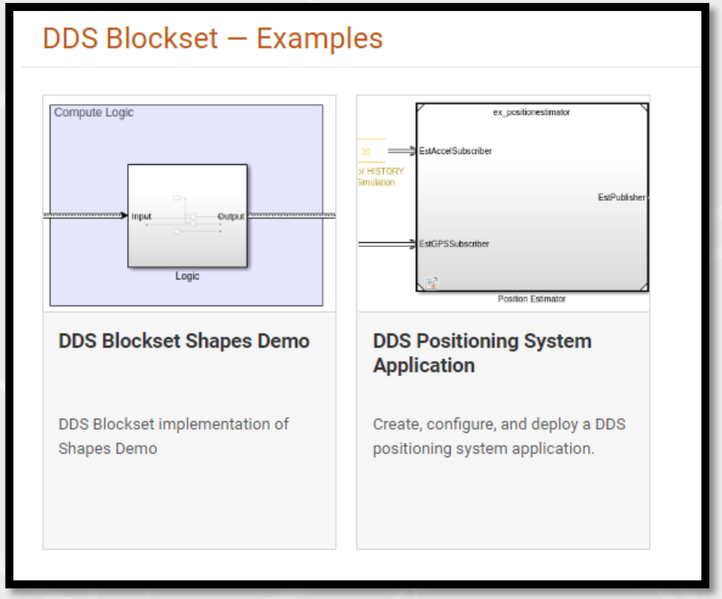
* Beta. FACE TSS. Contact Mark McBroom for details (mmcbroom@mathworks.com)

RTI Connext and DDS Blockset

- DDS Blockset is compatible with Connext 6.0 and Connext Micro 2
- Engineers can design to full embedded design and ECU code generation up to ISO 26262 ASIL-D
- RTI also offers a companion Integration Toolkit for AUTOSAR Classic.

DDS Blockset Resources

- Documentation and Examples
- Videos
  - DDS Blockset with RTI Shapes Demo
  - DDS Blockset with ROS and AUTOSAR for Automotive Applications



DDS Blockset — Examples

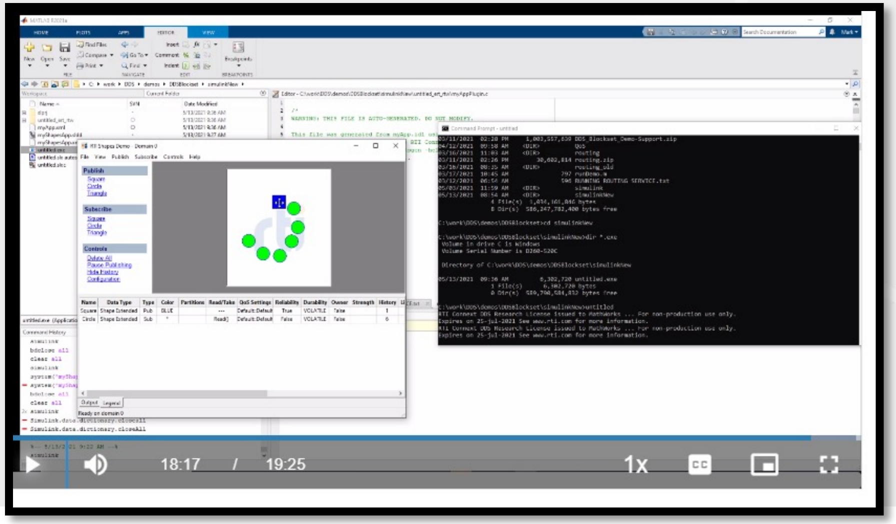
DDS Blockset Shapes Demo

DDS Blockset implementation of Shapes Demo

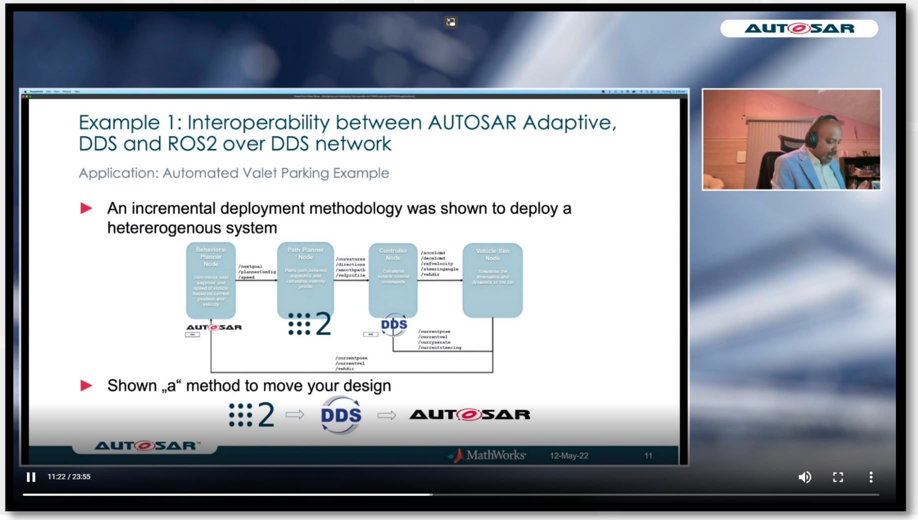
DDS Positioning System Application

Create, configure, and deploy a DDS positioning system application.

Compute Logic
Input
Output
Logic
ex_positionestimator
EstAccelSubscriber
EstPublisher
EstGPSSubscriber
Position Estimator



18:17 / 19:25
1x



Example 1: Interoperability between AUTOSAR Adaptive, DDS and ROS2 over DDS network

Application: Automated Valet Parking Example

- An incremental deployment methodology was shown to deploy a heterergenous system
- Shown „a“ method to move your design

AUTOSAR
DDS
MathWorks
12-May-22
11:22 / 23:55

Questions?

Resources

www.mathworks.com/products/dds

www.rti.com/third-party-integrations/connext-for-mathworks-users

www.rti.com/drive

Angel Martinez Bernal

Senior Software Engineer, RTI
angel@rticom

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Includes resources to get you up and running fast

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