

# Connex Conference 2017





# A Guide to the Industrial IoT & RTI's Role

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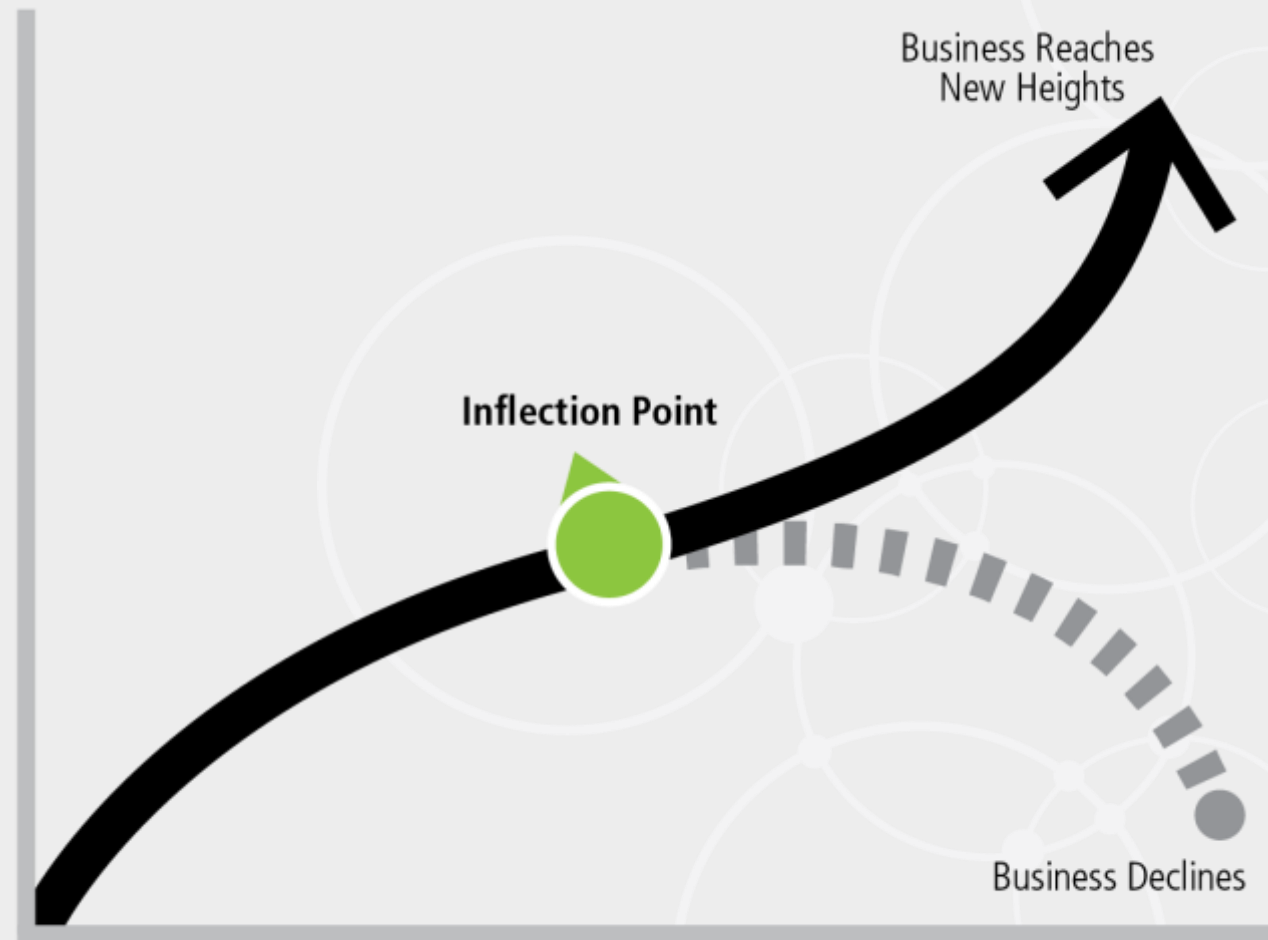
Stan Schneider, PhD. RTI CEO



# Momentum

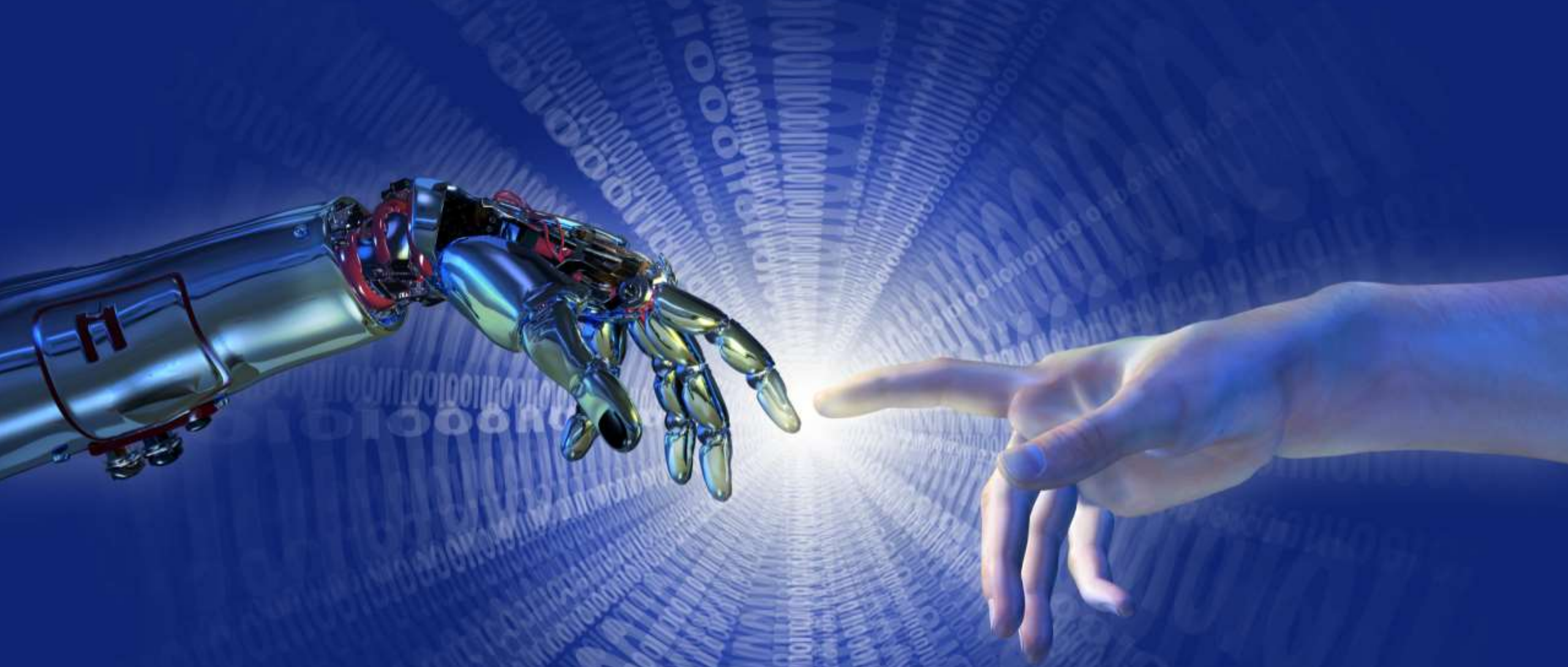


# Inflection



– Only the Paranoid Survive by Andrew Grove





*The smart machine era will be the most disruptive in the history of IT*  
-- Gartner

# The *Industrial* IoT Disruption



The real value is a **common** architecture that connects sensor to cloud, interoperates between vendors, and spans industries



# Why Is RTI?

To enable and realize the potential of smart machines to serve mankind





And It Will Change *Everything*







Artificial Intelligence

Pervasive Networking

RTI lives at the  
intersection of functional  
artificial intelligence and  
pervasive networking<sup>SM</sup>

# The Industrial IoT

- The Industrial IoT will transform nearly every industry
- DDS runs 1000s of designs across industries and consortia







# What's the Disruption?

Change Drivers Across Industries

# Problem: Mistakes Kill

“... the anesthesiologist forgot to resume ventilation after separation from cardiopulmonary bypass...”

*Every surgical team surveyed has experienced this error!*

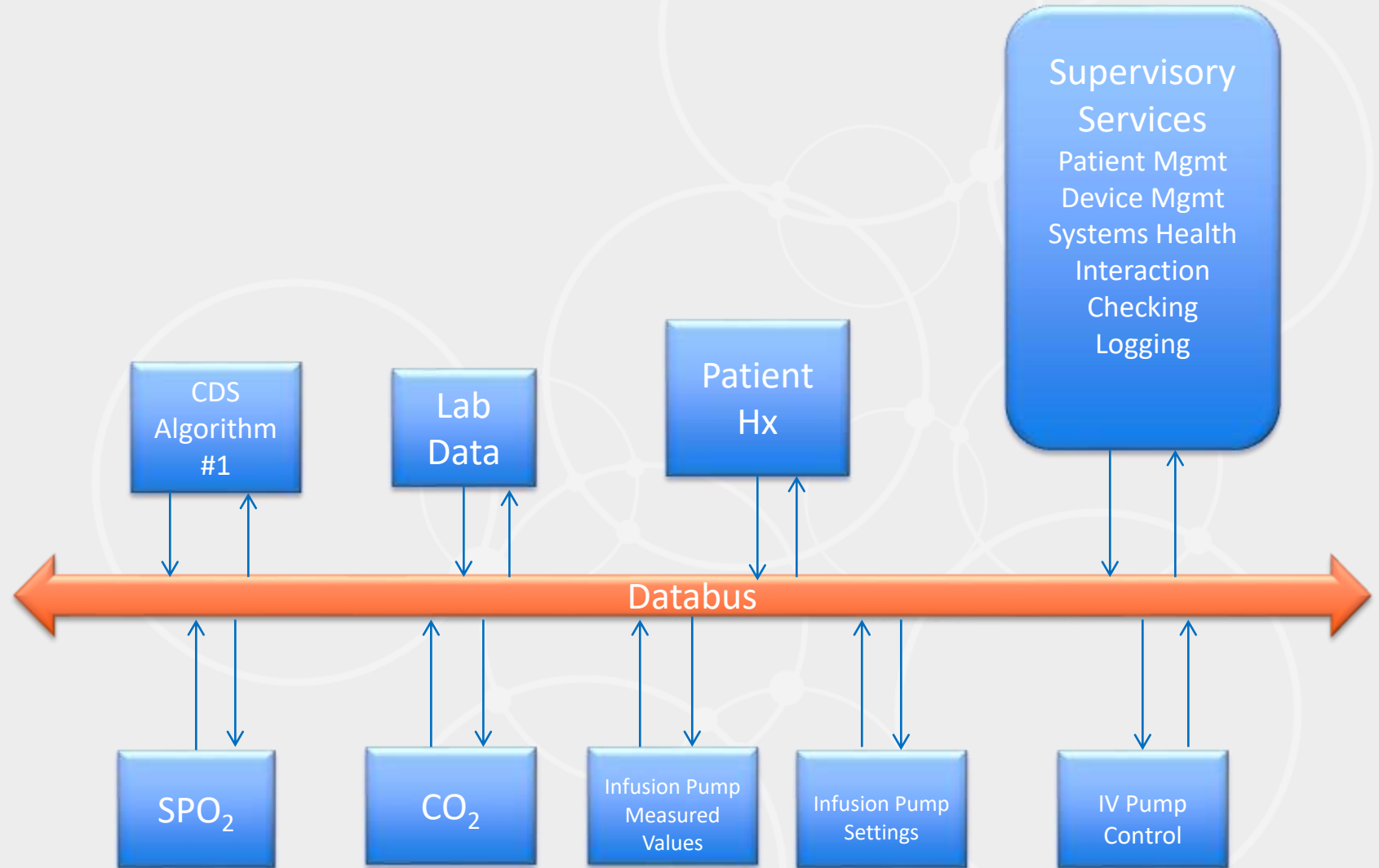
Hospital error is the 3<sup>rd</sup> leading cause of death in the US



# Solution: Smart Connected Patient Care



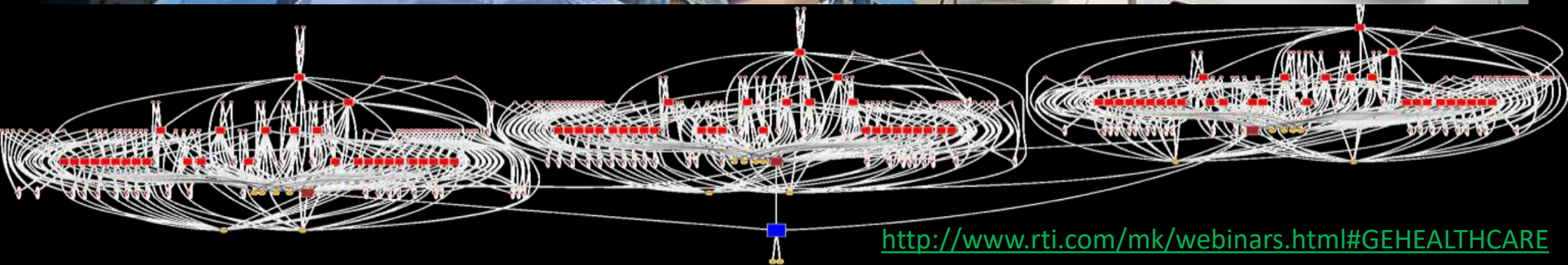
**MD PnP**  
Getting Connected for Patient Safety™



# Smart Machines Join the Care Team

## *The Medical Industry Now Competes on Networking*

GE Healthcare's smart distributed architecture will connect 300 types of devices with RTI software.



<http://www.rti.com/mk/webinars.html#GEHEALTHCARE>



# Problem: Central Generation





# Solution: Make Renewables Reliable



RTI runs the largest hydropower plants in North America, soon expanding to 75 dams.



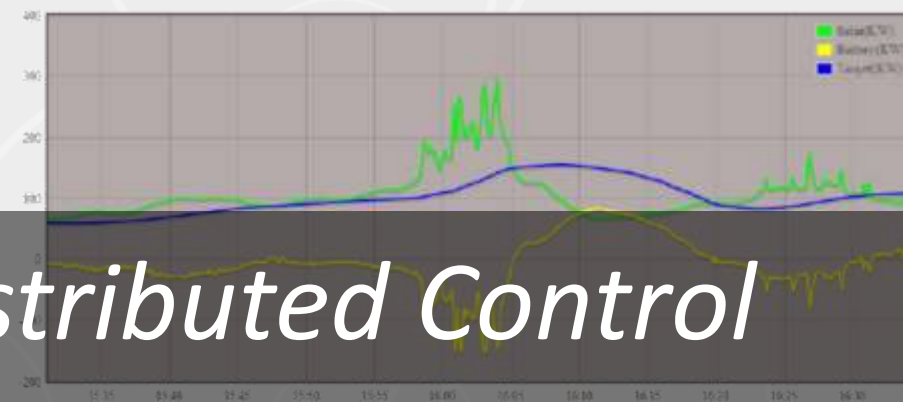
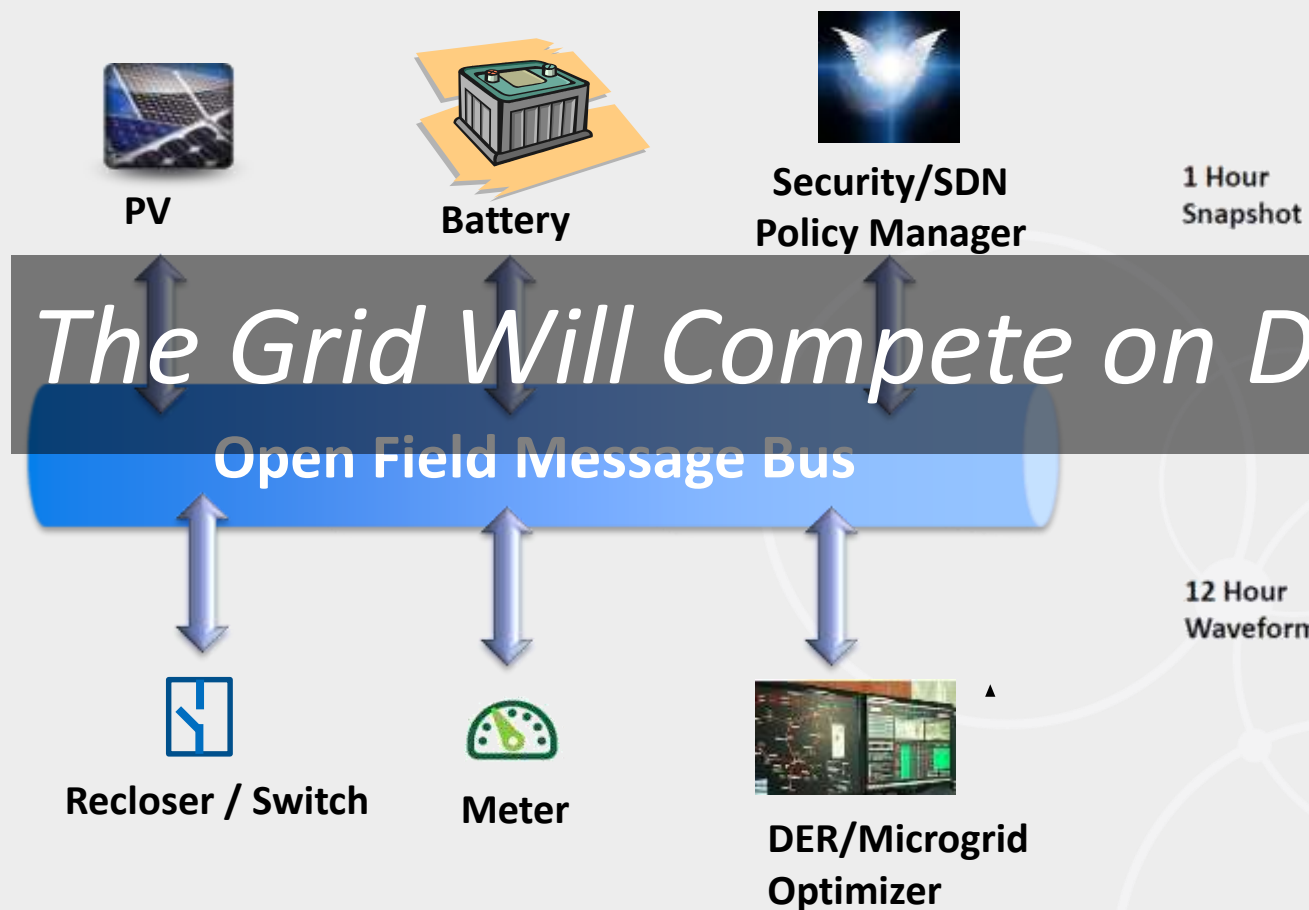
RTI is a principal in the leading new grid standard for solar and battery integration.



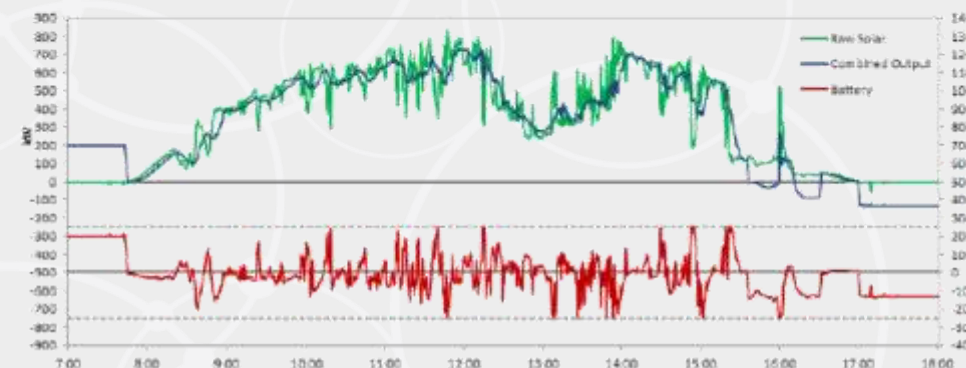
RTI controls Siemens Wind Power's most advanced wind turbines, thousands deployed worldwide.



# OpenFMB™: Enable Efficient DER



**12 Hour Waveform**





# Problem: Getting There is Dangerous and Slow





# Solution: Why Drive?

- Smart transit infrastructure
  - Safer, faster, easier
- Autonomous cars (“carbotts”)
  - Change everything
- Fast, autonomous mass transit
- Autonomous flight



# RTI's Deep Expertise in Autonomy

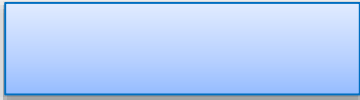

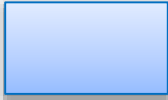

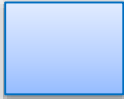







Founded from  
Stanford Aerospace  
Robotics Lab



- Connex DDS enables autonomy
  - Ensure reliable data availability
  - Guarantee real-time response
  - Manage complex data flow and state
  - Ease system integration
  - Allow any network
  - Build in security from the start
  - Make deployment flexible
  - Ease safety certification
  - Adapt Intelligence
  - Connect Vehicle/Cloud Systems



# Carbot Dataflow Challenge

Data Source	Data Type	Data Volume	Data Frequency
Cameras	Video Stream		
Lidar	Data List		
Radar	Point cloud		
GPS	Bin data struct		
Control Cmd	Bin data struct		
Error	Text String		

- Carbots need many different dataflows
  - Volume
  - Frequency
  - Latency
  - Reliability
  - Destination
- A single databus that can handle all greatly simplifies the system

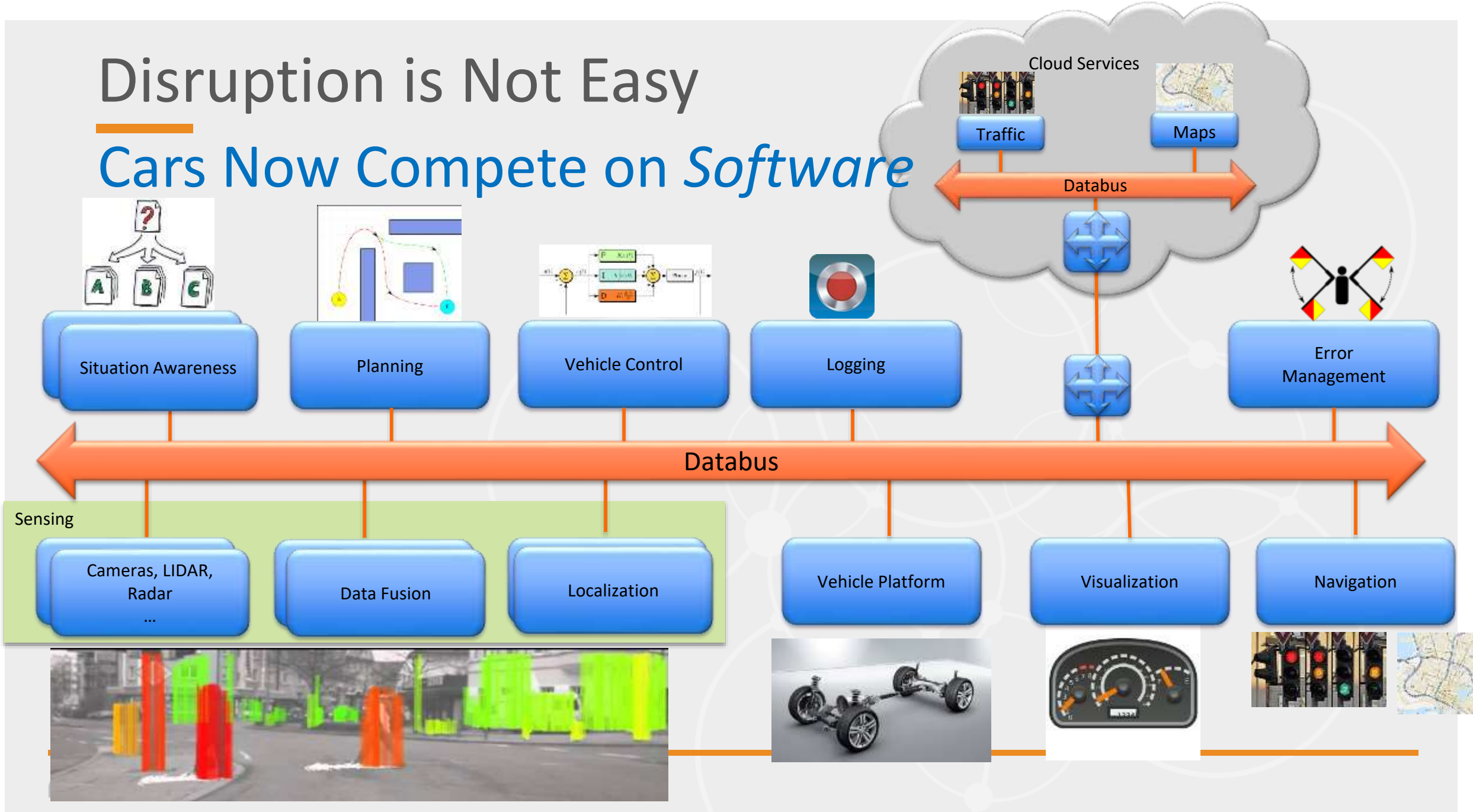


# A Big Difference



# Disruption is Not Easy

## Cars Now Compete on *Software*



# What's the Disruption?



Software is eating the world

-- Andreessen Horowitz  
Silicon Valley VC



# The Real Disruption: Culture

“If you went to bed last night as an industrial company, you’re going to wake up this morning as a software and analytics company”

-- Jeff Immelt  
GE CEO



# The Future of Secure, Distributed Software

“If you went to bed last night as a *software and analytics* company, you’re going to wake up this morning as a *networking and security* company”

-- Stan Schneider



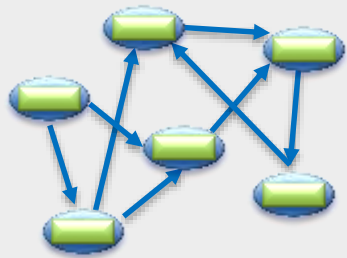




# Why DDS?

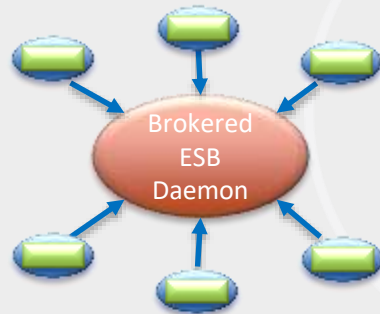
# DDS is Different!

Point-to-Point



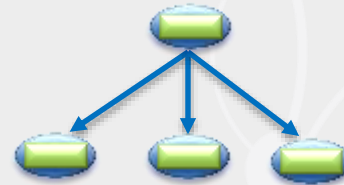
TCP  
Sockets

Client/Server



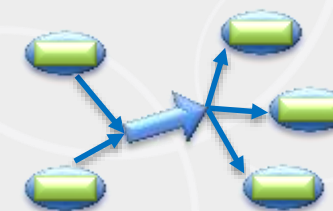
MQTT  
XMPP  
OPC  
CORBA

Publish/Subscribe



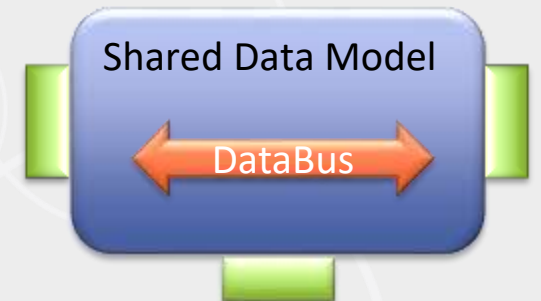
Fieldbus  
CANbus  
ZeroMQ  
JMS

Queuing



AMQP  
Active MQ

Data-Centric

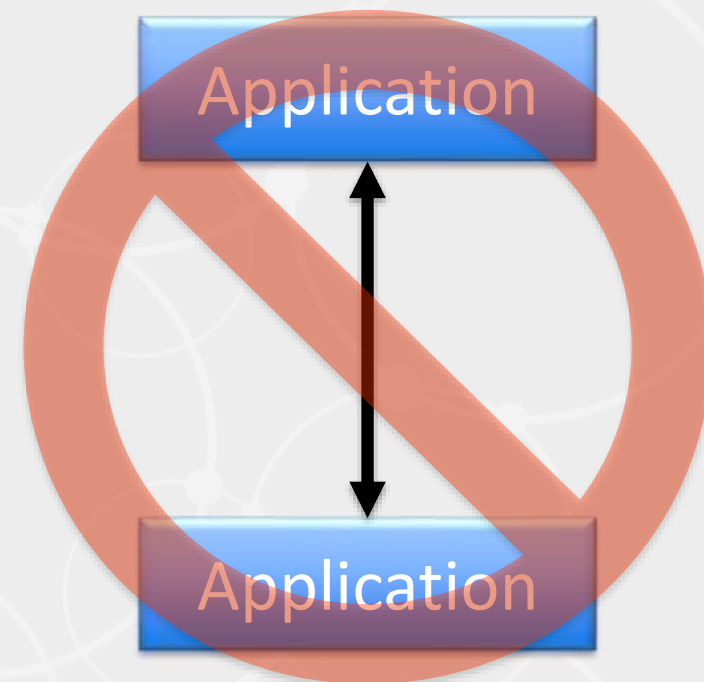
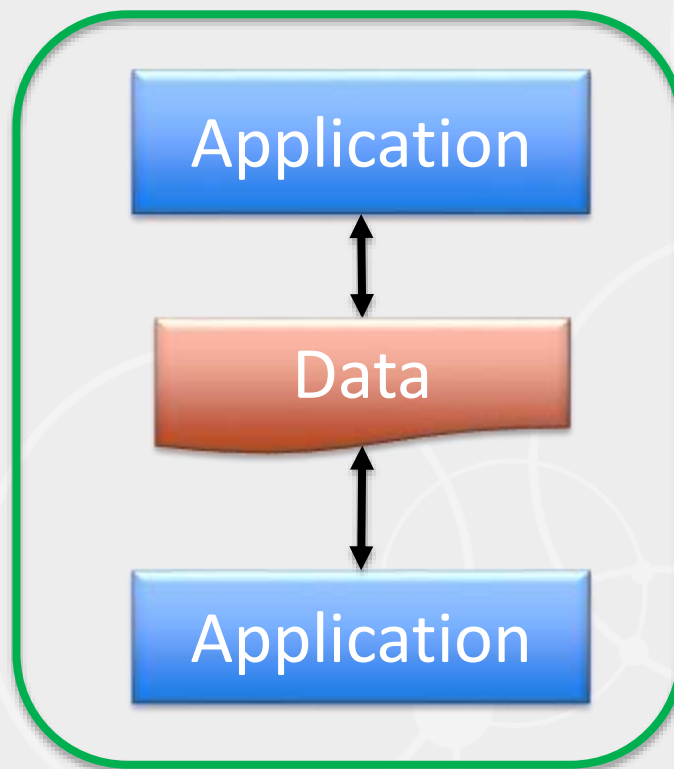


DDS



# The Databus

Data Centric  
technology  
connects  
applications to  
the data, not  
to each other



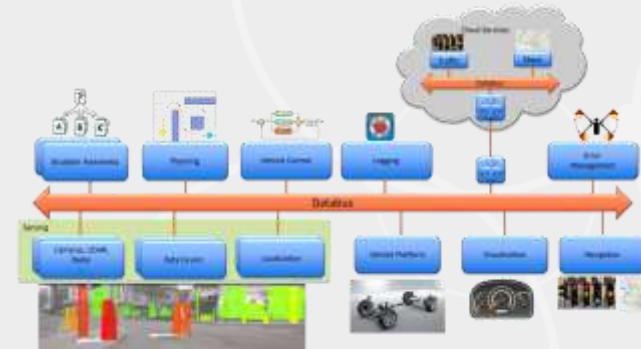
Message centric  
Client/Server  
Remote Objects  
SOA

# Database and Databus: *Data Science* Approaches



Database

Data centric storage and  
search of old data



Databus



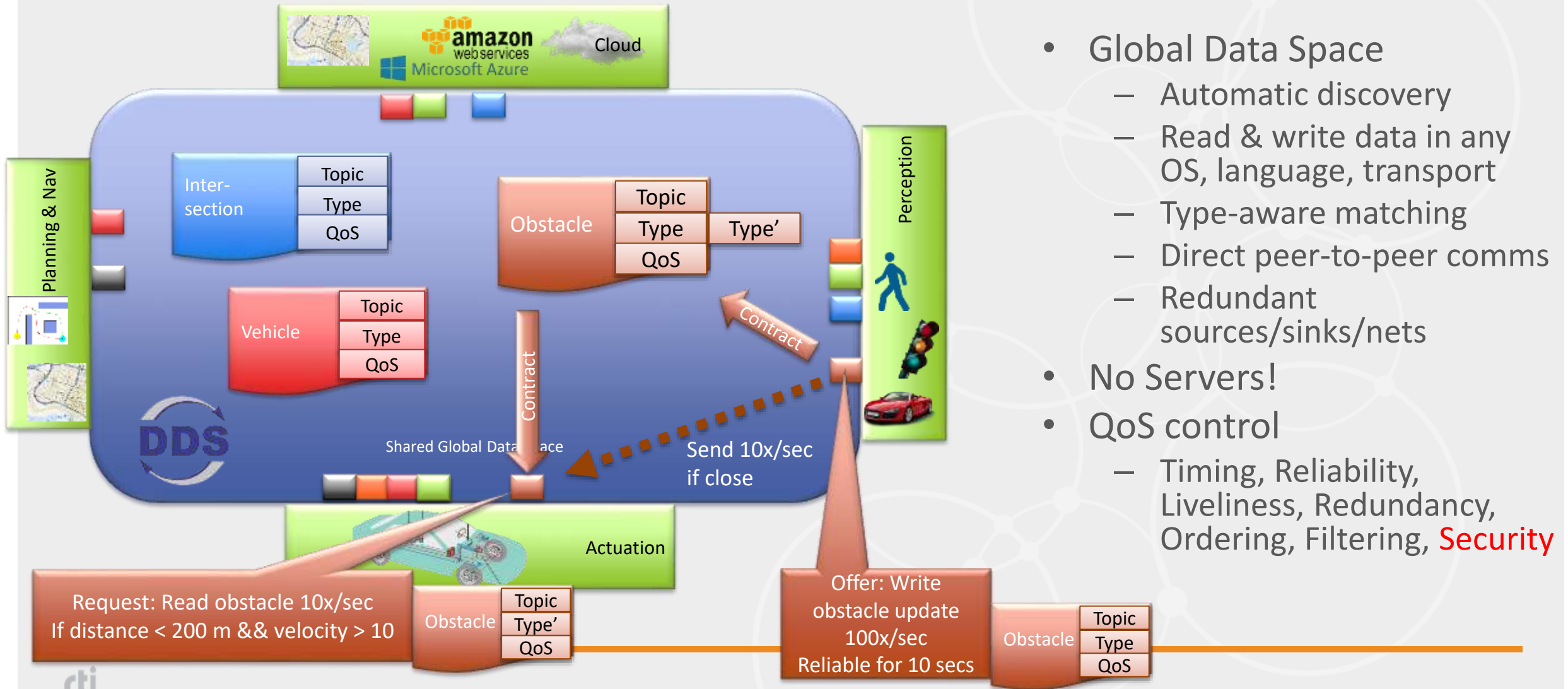
Data centric sharing and  
filtering of future data

## Why Data Centricity?

- Common “truth” for integration
- Extreme reliability & scalability
- Right data, right time, right place
- Complexity in infrastructure, not code
- No startup dependencies
- Generic tools and analyzers



# Data Centric Software Integration



- **Global Data Space**
  - Automatic discovery
  - Read & write data in any OS, language, transport
  - Type-aware matching
  - Direct peer-to-peer comms
  - Redundant sources/sinks/nets
- **No Servers!**
- **QoS control**
  - Timing, Reliability, Liveliness, Redundancy, Ordering, Filtering, **Security**

# Take it to Massive Scale

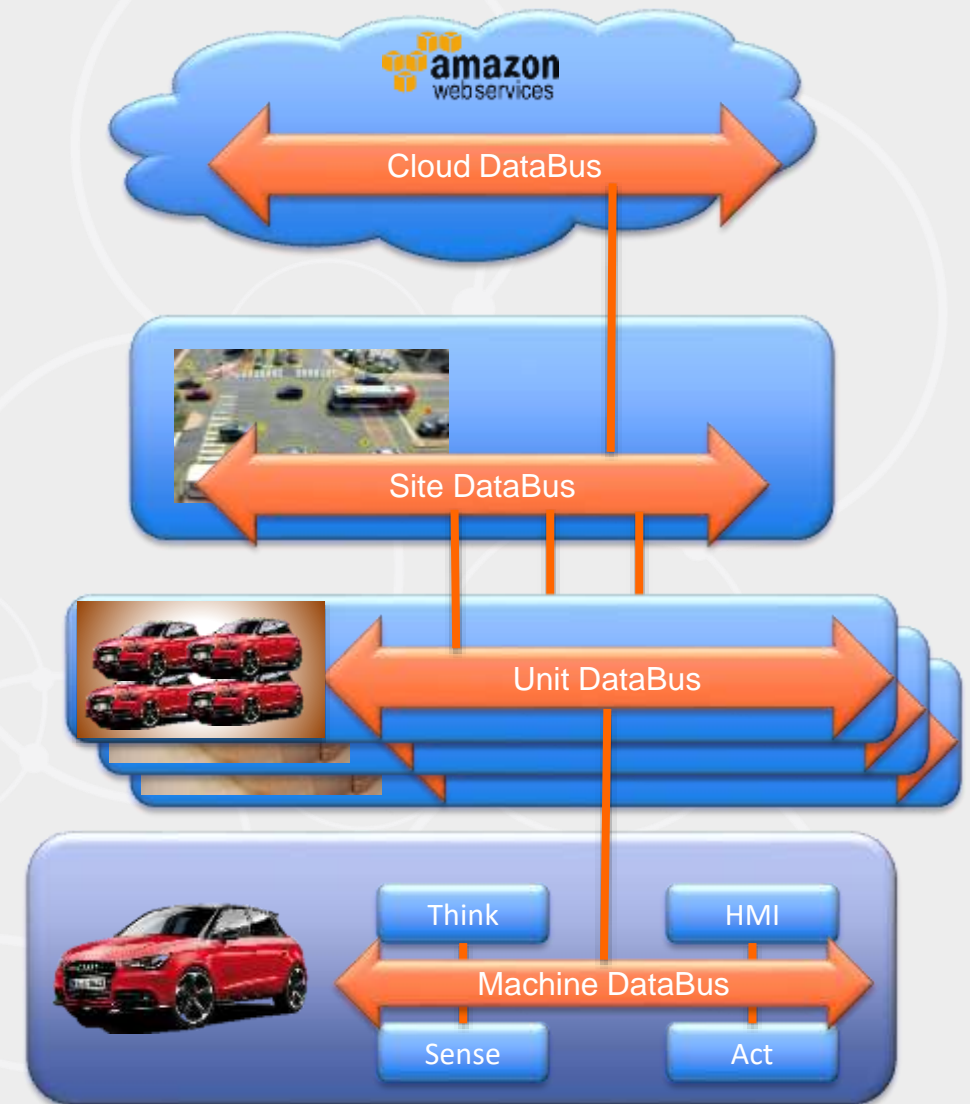
- Each level of the hierarchy has
  - Data model
  - Discovery
  - Security domain
- System-of-systems require
  - Subsystem export control
  - Data model translation
  - Discovery control

Intelligent  
Industrial  
Internet

Intelligent  
System of  
Systems

Intelligent  
Systems

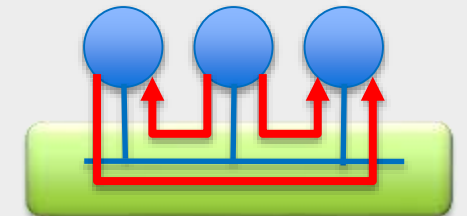
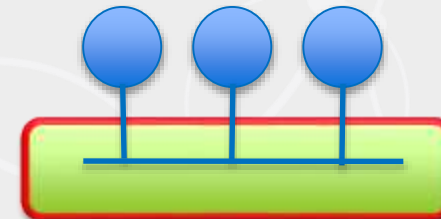
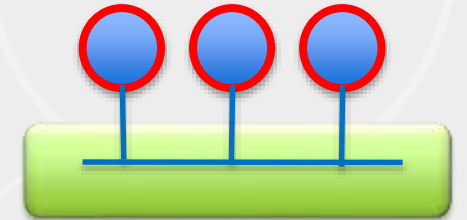
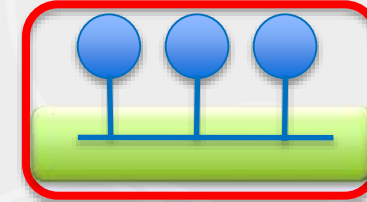
Intelligent  
Machines





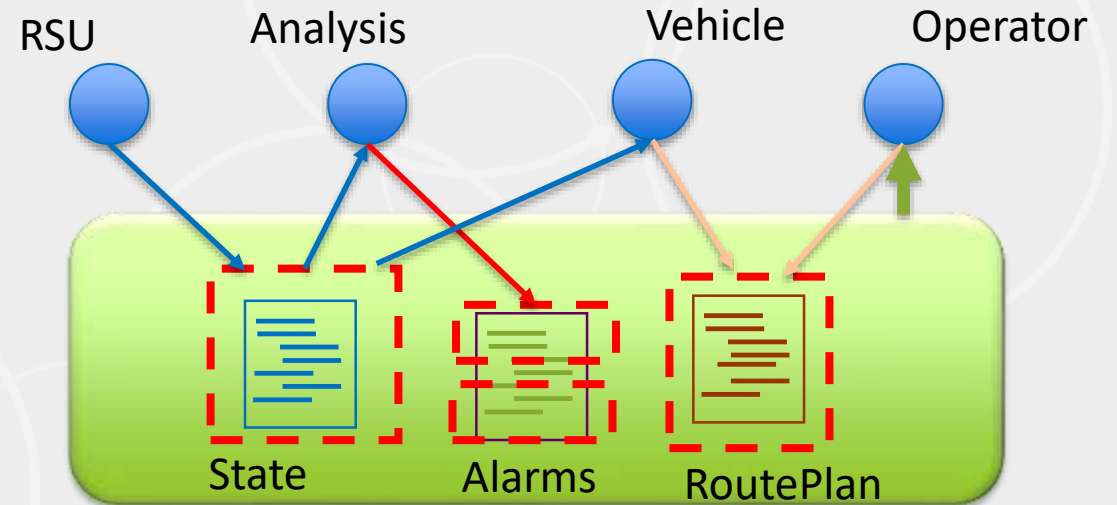
# Security Must Protect Dataflow, Too

- System edge
- Host
  - Machine/OS/Applications/Files
- Network transport
  - Media access (layer 2)
  - Network (layer 3)
  - Session/Endpoint (layer 4/5)
- Dataflow
  - Control *application interaction*



# Integrated *Dataflow* Security

- Dataflow-Level Security
  - Control r,w access to each data item for each function
- Complete Protection
  - Discovery authentication
  - Data-centric access control
  - Cryptography
  - Tagging & logging
  - Non-repudiation
  - Secure multicast
- **No code changes!**
- Plugin architecture for advanced users



Topic Security model:

- RSU: State(w)
- Analysis: State(r); Alarms(w)
- Vehicle: State(r), RoutePlan(w)
- Operator: \*(r), RoutePlan(w)



# Safety-Critical Components

- Connex DDS Micro Cert
  - Stringent SWaP requirements
  - Complete certification evidence
  - Full interoperability with DDS product line

Available

## DO-178C Level A

- Flight management systems

Soon

## ISO 26262

- Road vehicle functional safety

Soon

## IEC 60601 class 3

- Medical devices



# Why a Databus?

- No Servers
  - Easy redundancy, reliable availability, scale
- Reliable secure multicast
  - Fast ms or  $\mu$ s response even under load to many applications
- Source selectivity
  - Finds and delivers exactly the right data to right place at the right time
- Explicit interface management
  - Combine many software modules and coordinate teams
  - Match versions
- Dataflow QoS
  - Adapt to any network & data demands

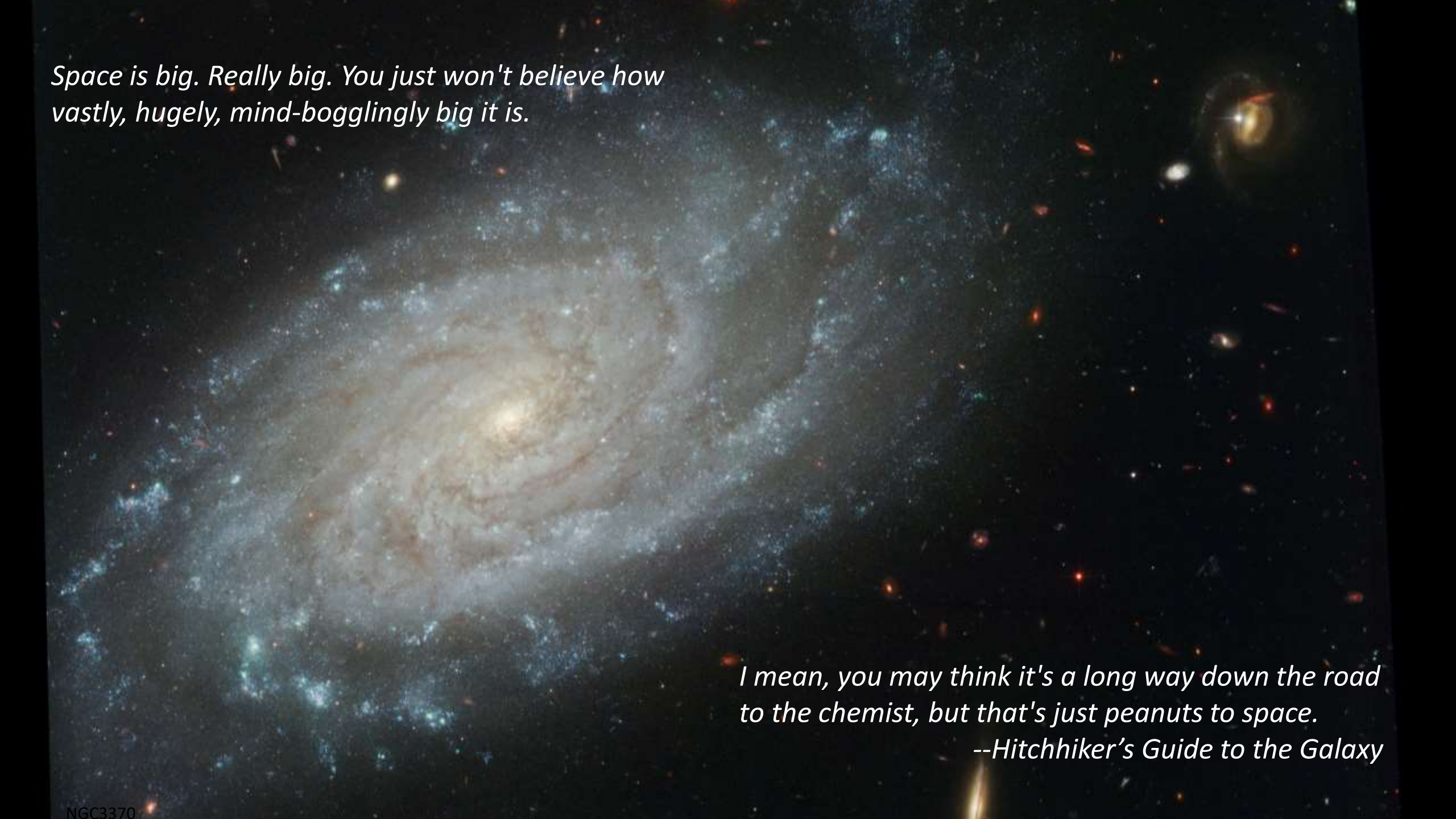






# Positioning

DDS in the IoT Space



*Space is big. Really big. You just won't believe how vastly, hugely, mind-bogglingly big it is.*

*I mean, you may think it's a long way down the road to the chemist, but that's just peanuts to space.*

*--Hitchhiker's Guide to the Galaxy*



[illegible]

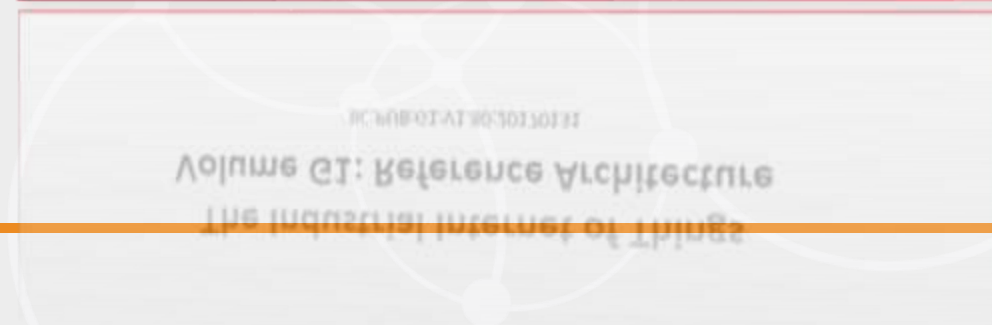
# Industrial Internet Consortium: 270+ Companies, 30+ Countries

## IIC Founding and Contributing Members



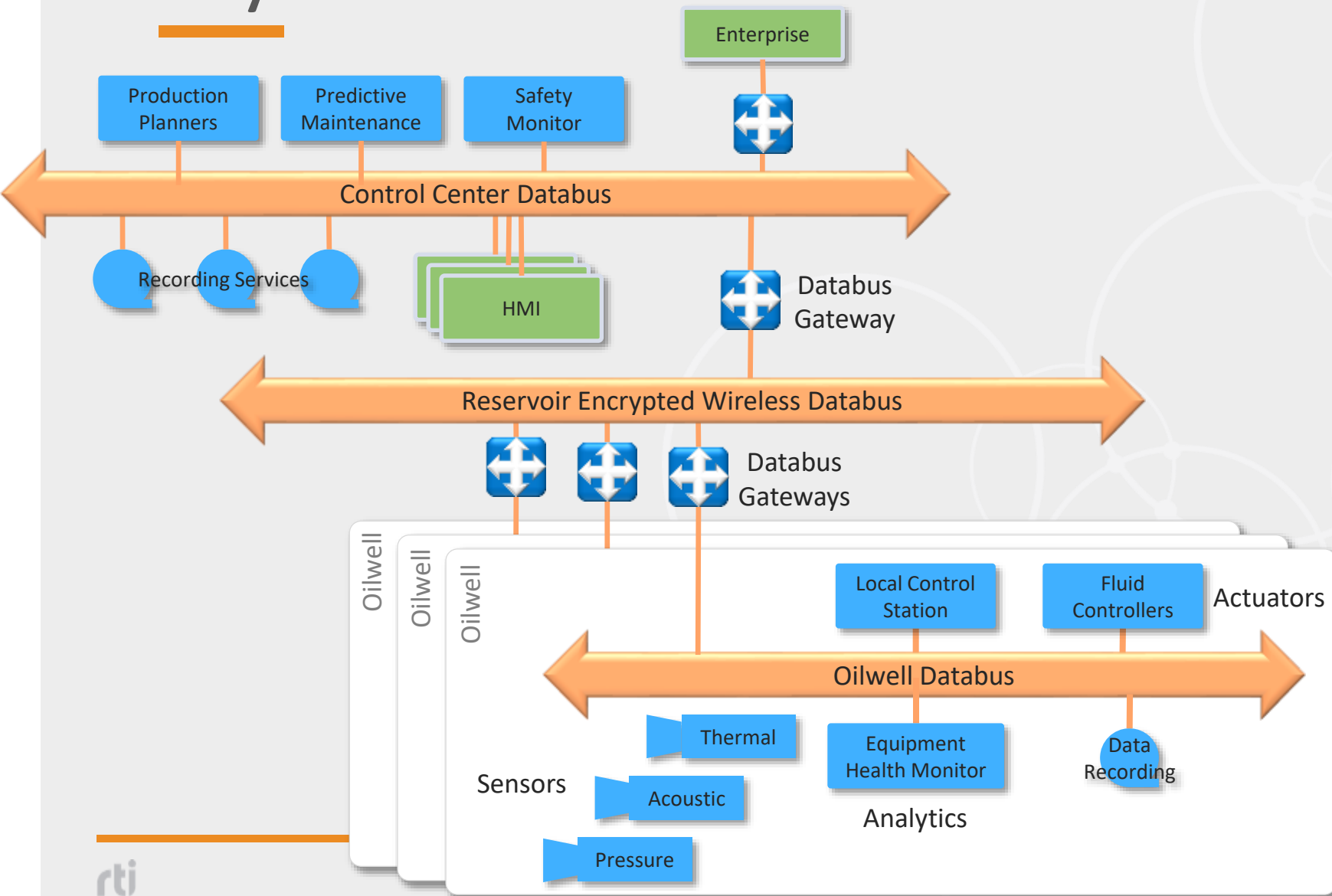
# The IIRA

- Major new release of Industrial Internet Reference Architecture
- Key new content: The Layered *Databus* Architectural Pattern
- Lead author: RTI's Rajive Joshi





# Layered Databus Architectural Pattern



- Common to all above examples
- Fits most industrial control applications
- Fast, reliable, scalable
- From IIC Industrial Internet Reference Architecture (IIRA) v1.8



# The IISF

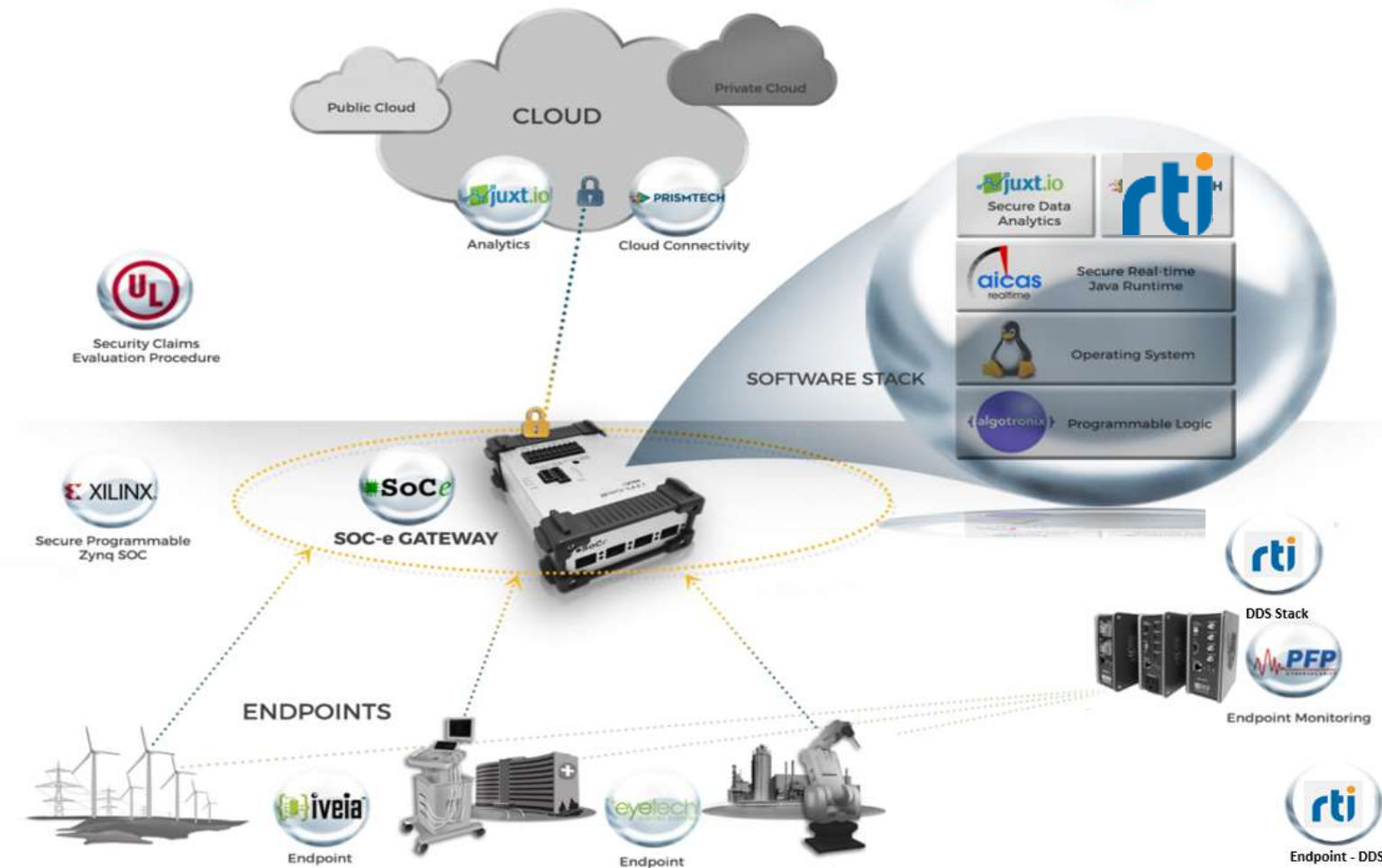
- Major contribution
- Only wide voice on security for IIoT
- Co-lead and primary author: RTI's Hamed Soroush





# Security Claims Evaluation Testbed

## SECURITY CLAIMS EVALUATION TESTBED



- IIC Sponsor Companies
  - Xilinx
  - Underwriters Laboratories (UL)
  - Aicas
- Collaborating Companies
  - Algotronix, EYETech, iVeia, JUXT, PFP Cybersecurity, RTI, SOC-e



# IIC Testbeds!



Asset Efficiency Testbed



Condition Monitoring Testbed



Connected Care Testbed



Edge Intelligence Testbed



FA PaaS Testbed



FOVI Testbed



High-Speed Network Testbed



Industrial Digital Thread Testbed



INFINITE Testbed



Intelligent Urban Water Supply



Microgrid Testbed



Precision Crop Management Testbed



Security Claims Evaluation Testbed



Smart Airline Baggage Management



Smart Energy Management Testbed



Time-Sensitive Networks Testbed



Track and Trace Testbed



Smart Water Management Testbed

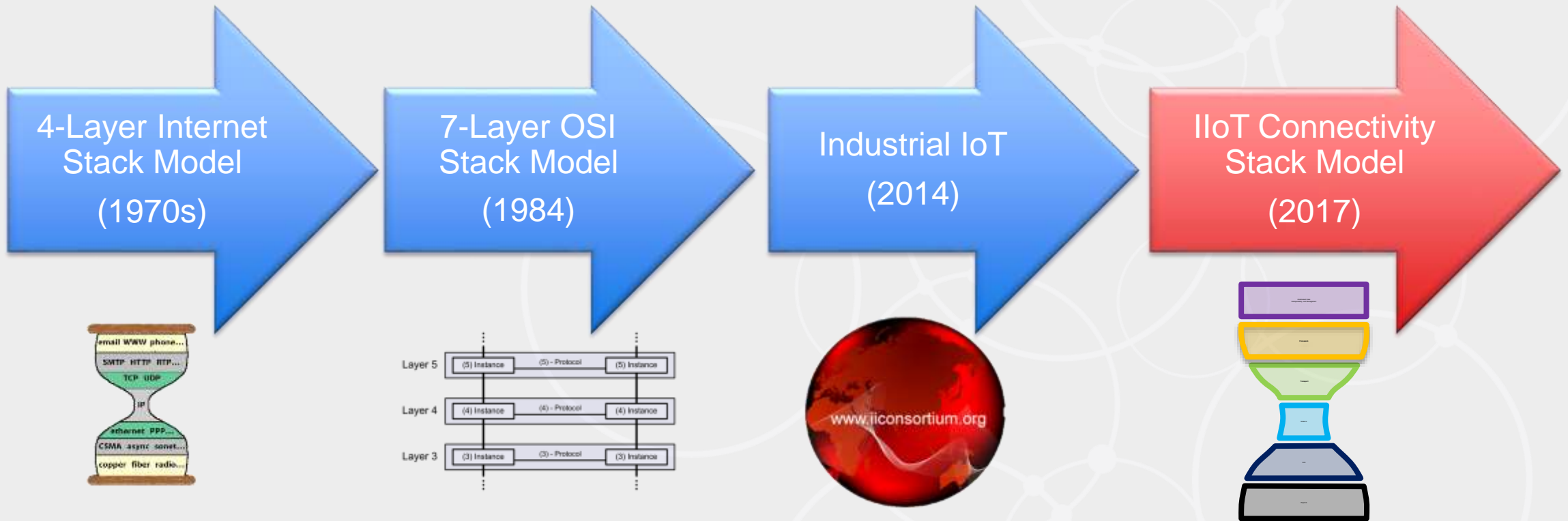
- IIC has by far the industry's most comprehensive testbed program
- Key goals
  - Ensure practical guidance
  - Make impact
  - Span the industry

# The IIC Industrial Internet Connectivity Framework

- The industry's only detailed analysis of IIoT Connectivity Technologies
- Architecture
- Assessment
- Standards
  - DDS
  - OPC UA
  - OneM2M
  - HTTP
  - MQTT
  - CoAP
- Examples & selection guidance
- Years of work by many architects across industries, standards, & technologies

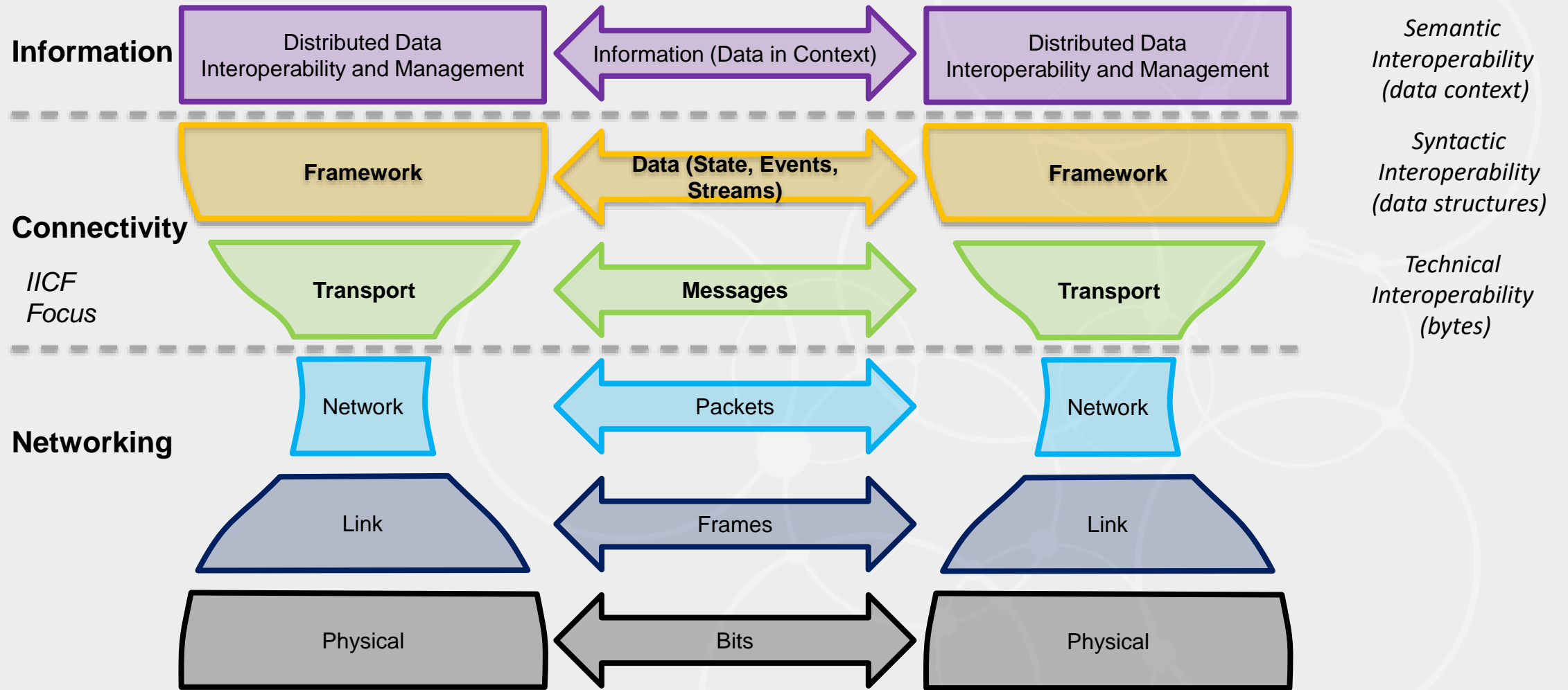


# Evolution of the IIoT Connectivity Stack

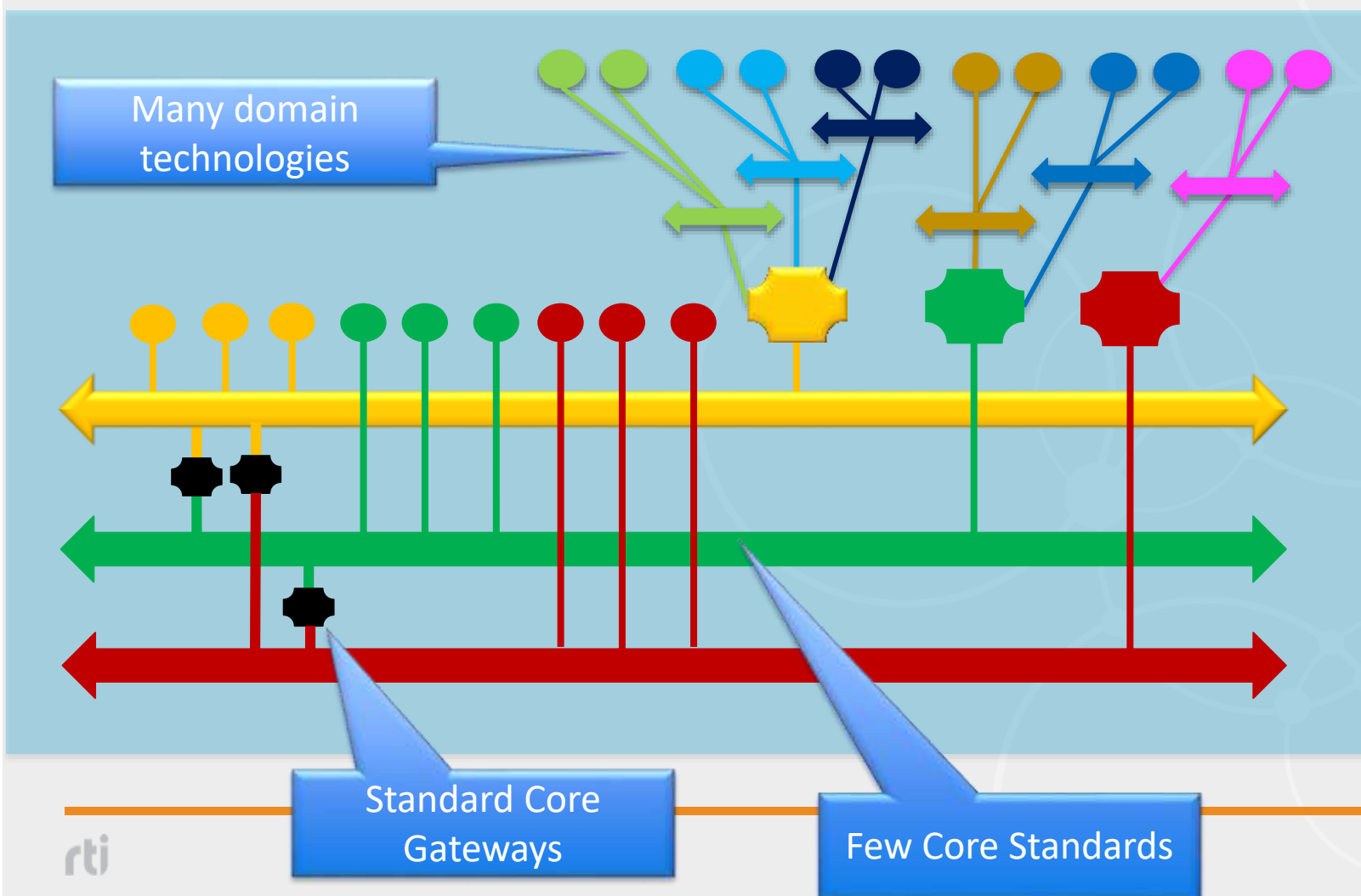




# IIoT Connectivity Stack Model

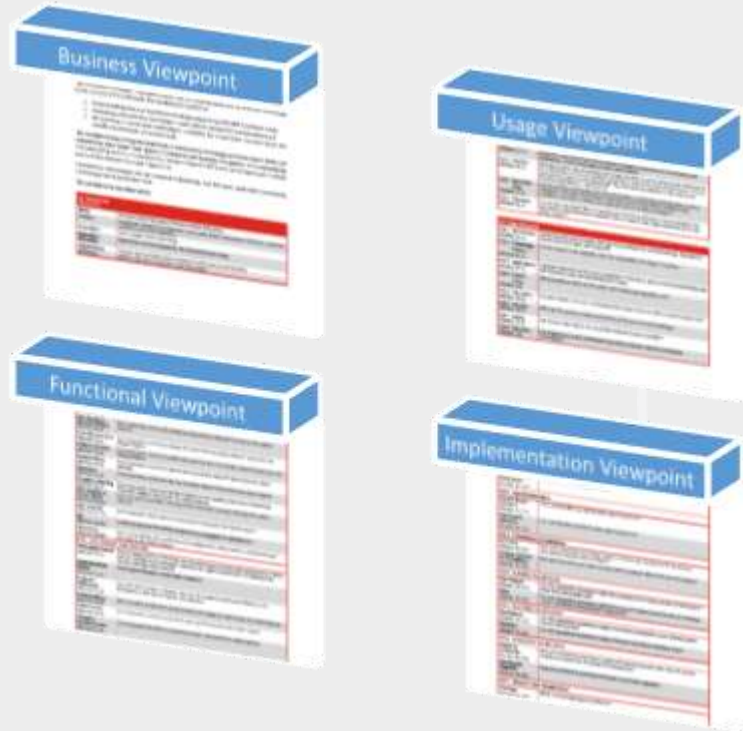


# Connectivity Core Standards Architecture



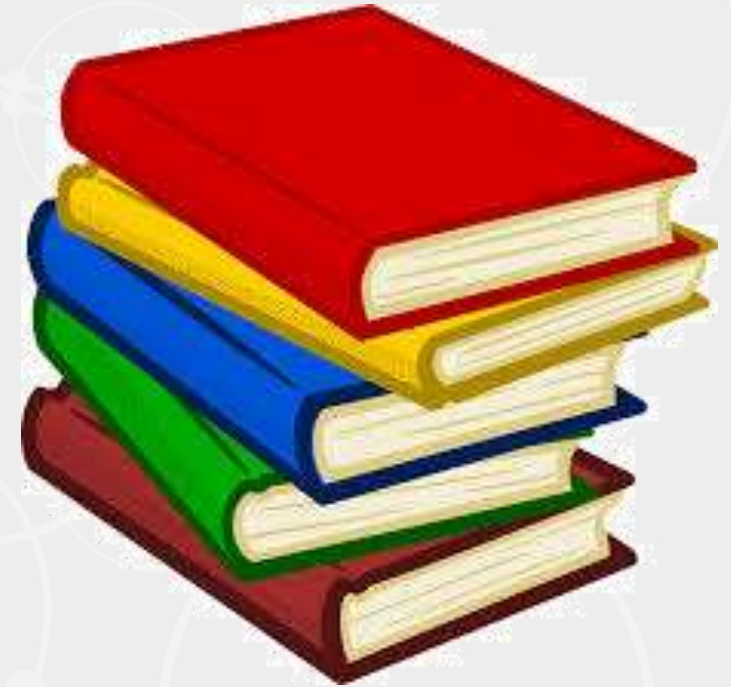
- Connectivity Core Standards
  - Provide syntactic interoperability
  - Stable, deployed, open standard
  - Standard *Core Gateways* to all other CCS
- Domain-Specific Connectivity Technologies
  - Connect via non-standard gateway to any connectivity core standard

# IICF Catalog of Connectivity Standards!



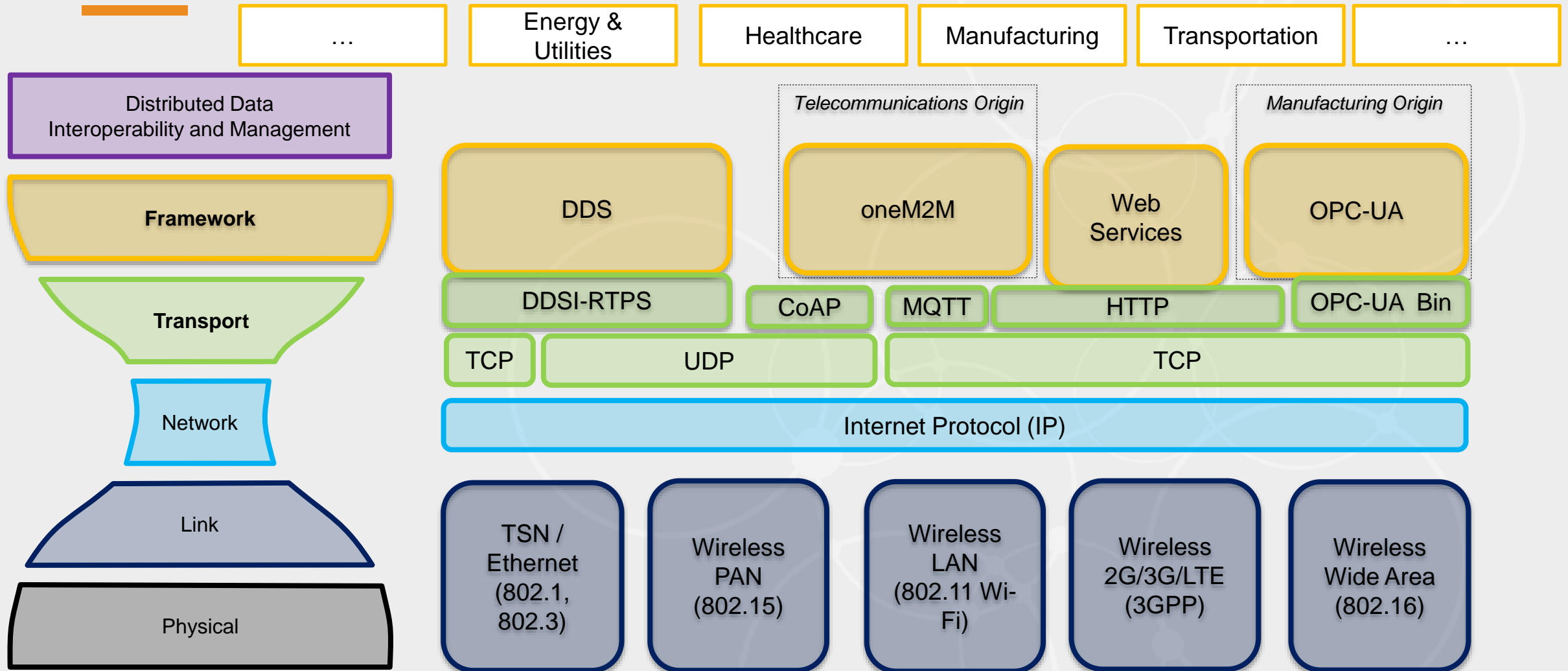
*Assessment Template Worksheets*

- **Frameworks**
- DDS
- OPC-UA
- oneM2M
- **Transports**
- HTTP
- MQTT
- CoAP

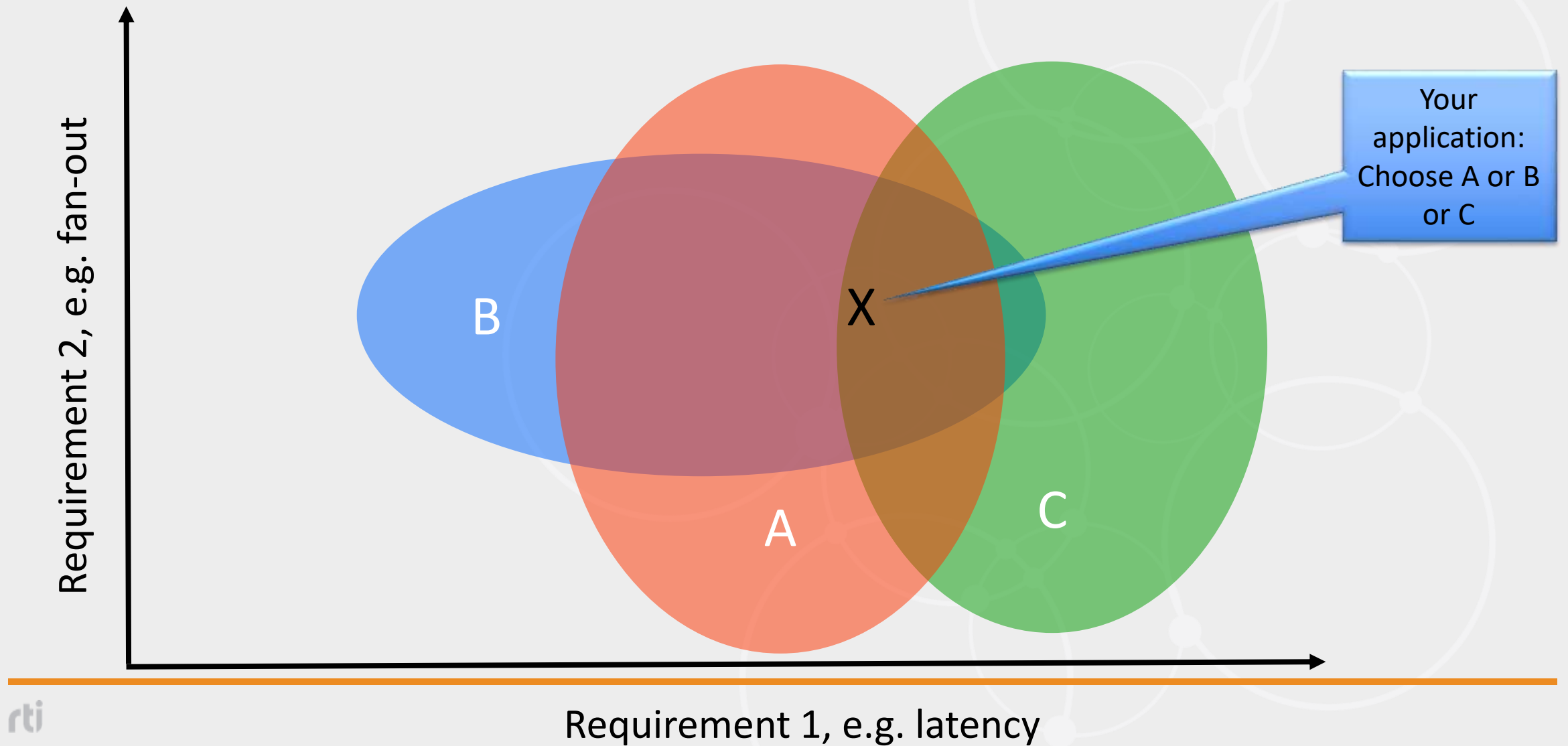




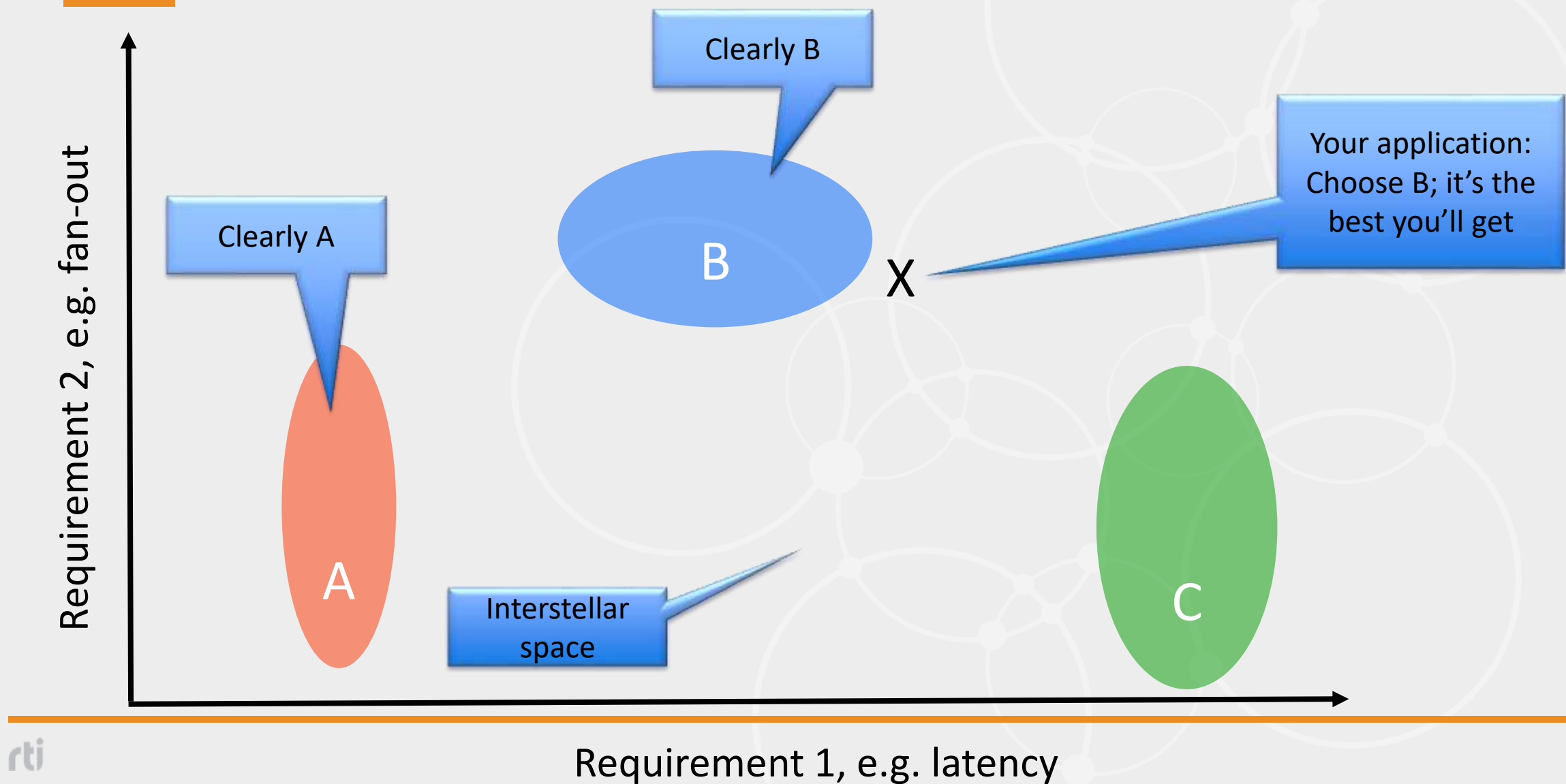
# Connectivity Standards



# IIoT Connectivity Perception



# IloT Connectivity Reality





# How to Choose?

System Aspect	Example User	Approach	Standard
Software Integration & Autonomy	Software Architect integrating components	Data-centric	DDS
Device interchangeability	Device manufacturer selling devices to technicians	Device-centric	OPC-UA
Web & Mobile User I/F	App builder supporting back-end services	RESTful	Web services/HTTP
ICT integration	Wide-area wireless telecom integrator	Common services layer	oneM2M

# Choose DDS?

- Are there severe consequences if offline for a few mins/secs/msecs?
- Have you said “millisecond” or “microsecond” in the last 2 weeks?
- Do you have more than 10 programmers?
- Does your data have many destinations?
- Are you building a next-generation IIoT design?

3+ Yes?



# Choose OPC UA?

---

- Are you in discrete manufacturing?
- Are you building a device that will be integrated by industrial engineers or technicians, rather than software engineers?
- Will your product be used in different applications in different systems, as opposed to a single (type of) system where you control the architecture?
- Have you said the word “workcell” in the last two weeks?



3+ Yes?





# Choose OneM2M?

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- Do you know what “ICT” stands for, and is that you?
- Is the cellular network your primary connection technology?
- Are your target applications largely composed of moving parts?
- Can the components of your system tolerate intermittent connections and loosely-controlled latencies?
- Will your system leverage services provided by a communications provider such as a telco?



3+ Yes?



**one**  
**M2M**

# Choose MQTT?

- Do you think of your application as data collection?
- Is there little device-device communications?
- Is interoperability not a consideration?
- Do you have many small devices?
- Is software a minor challenge?



3+ Yes?



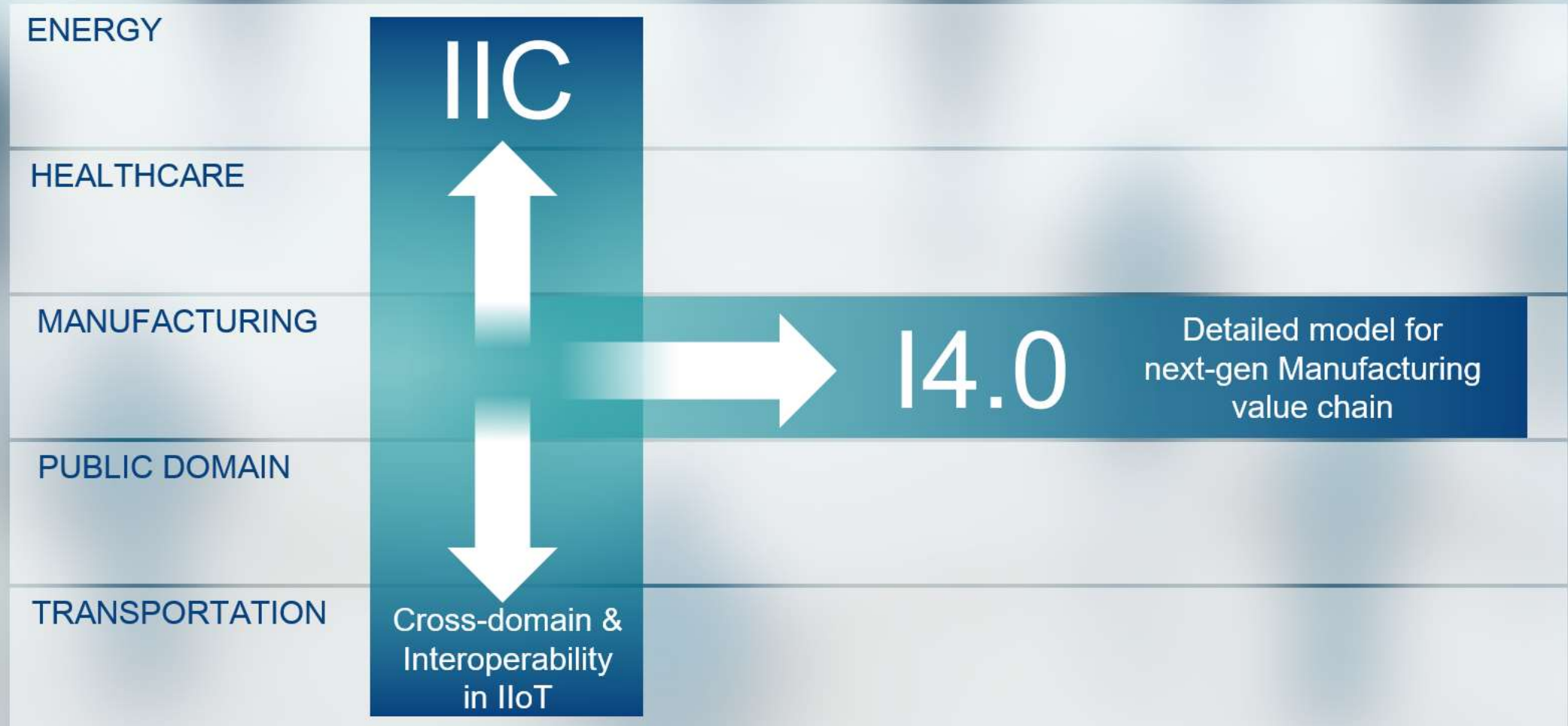


# What if None Fit?



1

## DOMAIN FOCUS AREAS ARE COMPLEMENTARY



# Example Users: Very Different!



You are a software architect. You:

- Manage & integrate software development teams
- Design & control architecture & data model
- Face challenges in defining software module interfaces, implementing redundancy, complex data flow

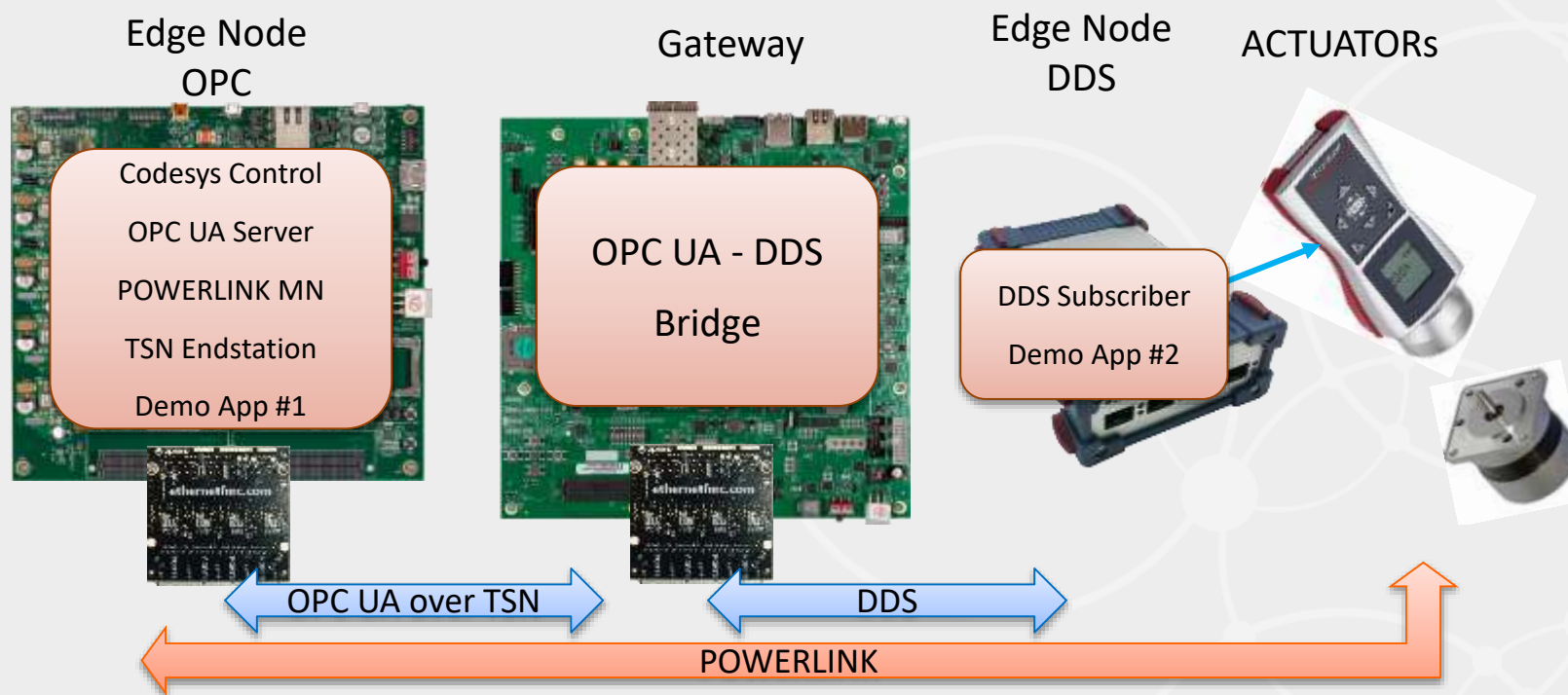


You are a device manufacturer. You:

- Build a device for many applications
- Do not control the installation data architecture
- Face challenges of device vendor interoperability, users who are not software experts



# OPC UA & DDS Integration Testbed





**AL EDGE NODE**

desys Control  
PC UA Server  
Industrial End Station  
OWERLINK MN

**XILINX**




**INDUSTRIAL GATEWAY**

OPC-to-DDS Gateway  
TSN Industrial End Station

**XILINX**

on **ZYNQ**



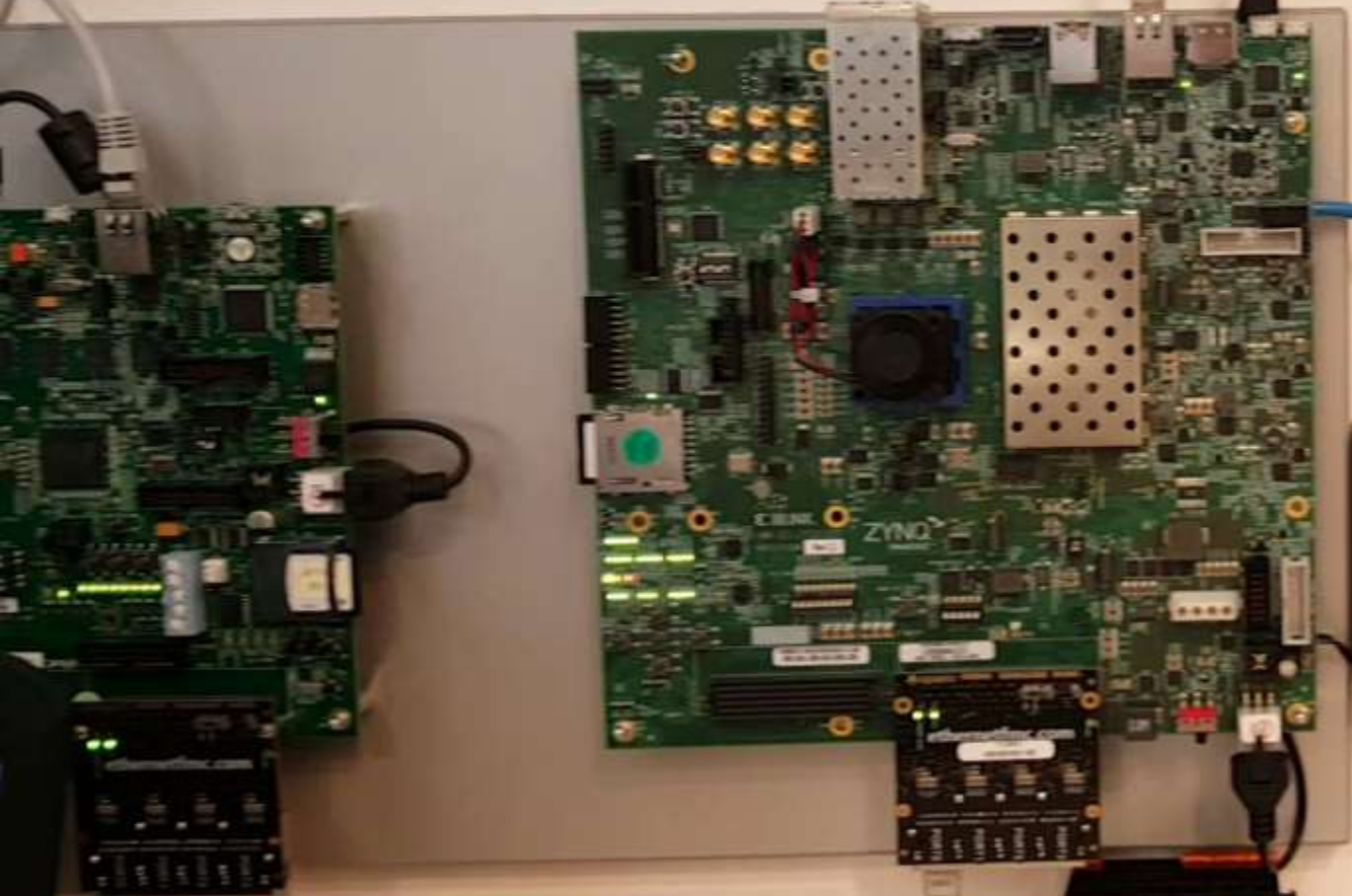
**Connnext DDS**

**INDUSTRIAL EDGE NODE**

DDS Subscriber  
Industrial Actuator Control

**XILINX**

on **ZYNQ**

**OPC UA over TSN**







# IIC's Highest Honor







IIC's Highest Honor...Rajive!



# Progress

How are RTI and DDS Doing?



# Audi – Functional Engineering Platform (FEP-SDK)

- HiL Simulation for development and test across the Volkswagen Group



Audi





# Operational Traffic Control



DDS is in operation at Shanghai PVG ground control since 2015.  
Rolling out to entire South East China region.  
Expanding to air operations and between PuDong and Hongqiao.

# Run 24x7 Across Continents

*We selected Object Management Group (OMG) DDS standard for its high **security** rating; its wide support of tools and programming languages, and its reputation for **performance, scalability, and 24/7 reliability***

Sid Koslow, Chief Technology Officer,  
NAV CANADA



Air Traffic Control for Canada  
2<sup>nd</sup> largest ANSP in the world  
7 major centers



# GE Transportation

GE Transportation freight and passenger locomotives require safe and reliable control, signaling, and communications

The databus will leverage Time Sensitive Networking (TSN) real-time networking physical layer





# Bosch Connected World



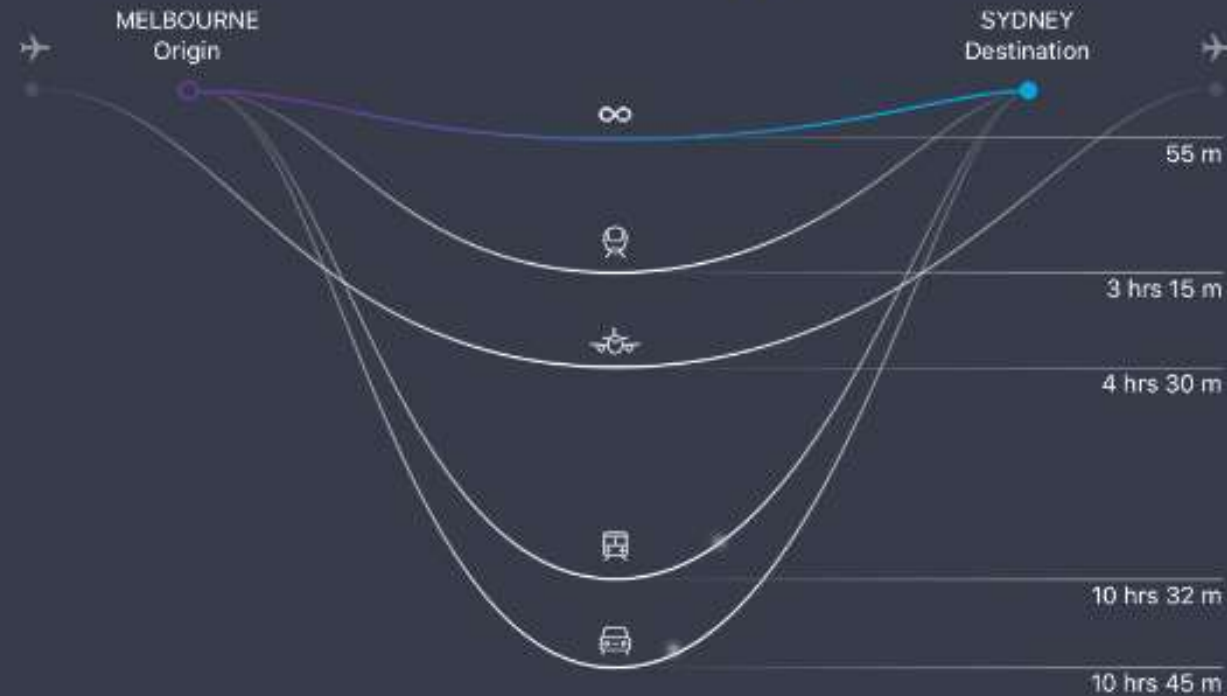


# DDS On Board

- Adaptive AUTOSAR insufficient for carbots
- Many OEMs, Tier-1s, & tool vendors support DDS
- RTI carbot designs include major-brand passenger cars, trucks, mining vehicles, EV startups, campus shuttles, hyperloop and flying cars
- >10 of these *production track*

The RTI databus connects Hyperloop One, the world's first hyperloop.

# We're not selling transportation, we're selling time



HYPERLOOP







# What do These Have in Common?



<sup>TM</sup>  THE OPEN GROUP  
OPEN PROCESS  
AUTOMATION<sup>TM</sup> FORUM





# Microgrid Solution

- Reliably operate microgrids
- Integrate Distributed Energy Resources (DER)
- Enable new business models: arbitrage, fuel offset, VPP
- Flexible, scalable, adaptable software architecture
- Supports islanding, resynchronization, import/export, spinning reserves mgmt



INDU



# Grand Coulee Success!



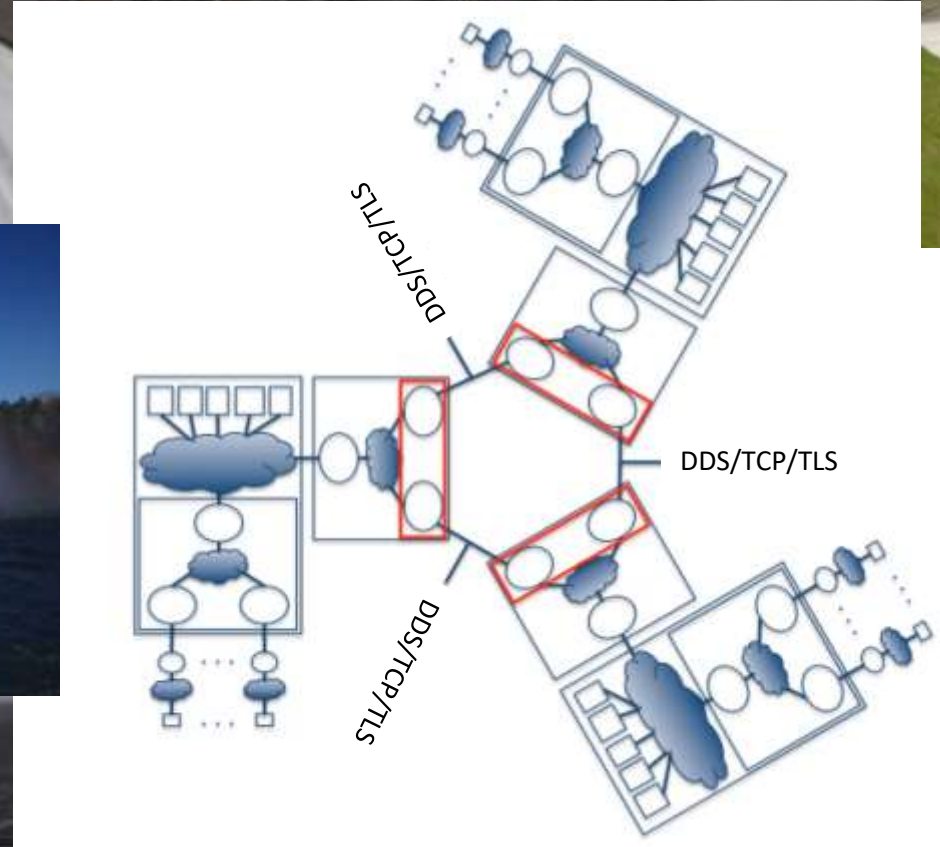
- DDS controls the 6.8 GW GC Dam
  - Largest power plant in North America
  - Fastest-responding major power source on the Western Grid
- RTI system live since Jan 2014



**U.S. Army Corps  
of Engineers®**



# GDACS Connected Plants





# Hydropower Nationwide



- USACE's 75 dams generate 20.5 GW, or 100 billion kilowatt-hours a year
- 20 more dams installing in 2017
  - Chief Joseph, #2 in NA
  - The entire Willamette basin, OR
  - Savannah River, GA





# USACE Tactical Microgrids





# Hundreds of A&D Programs





# NASA KSC Site License

RTI controls NASA's  
Premier Launch Control  
System for Orion – the  
largest SCADA system in  
world



# GE Healthcare

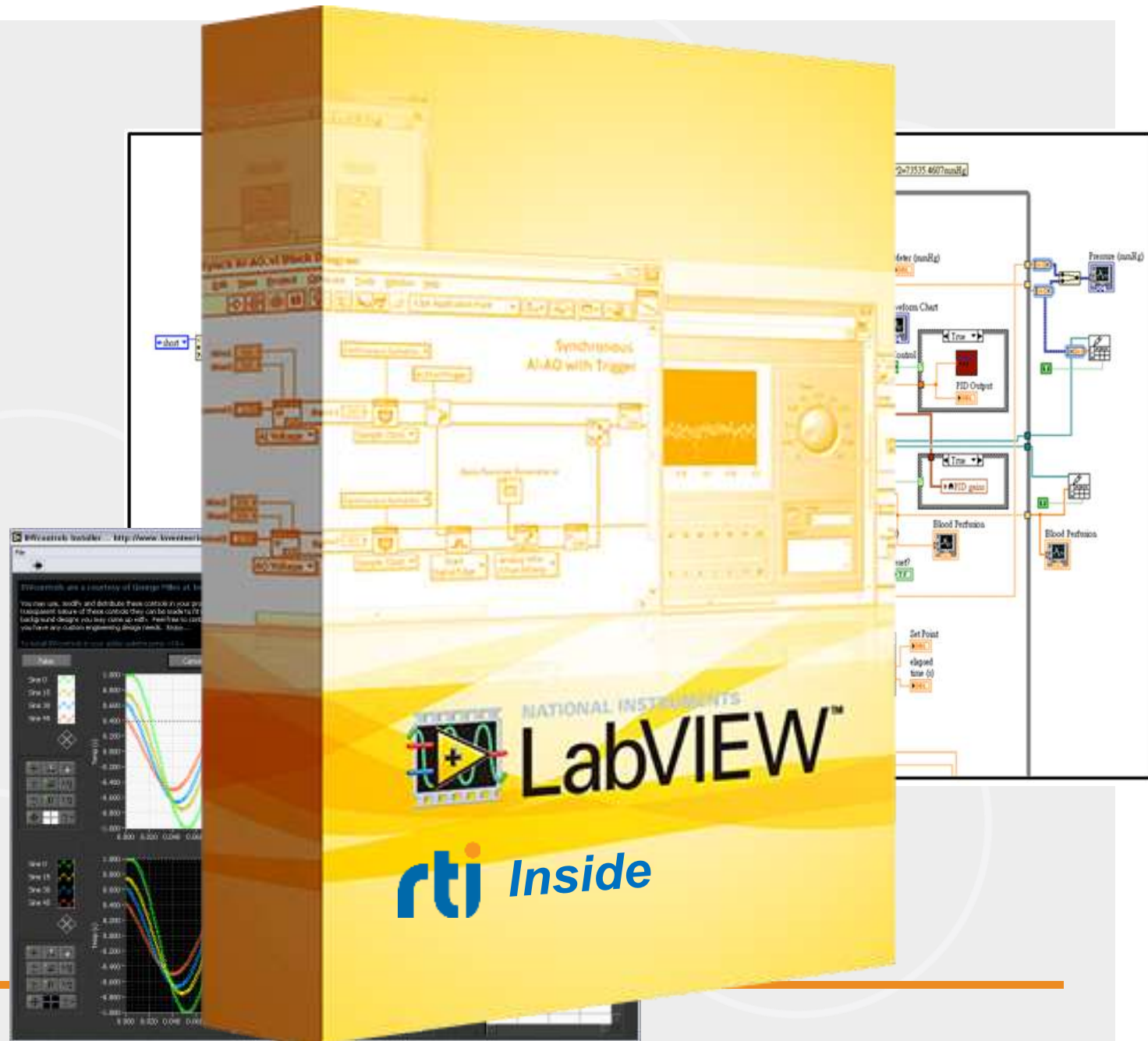
- RTI's largest single project
- Will bring smart systems technology to hospitals worldwide





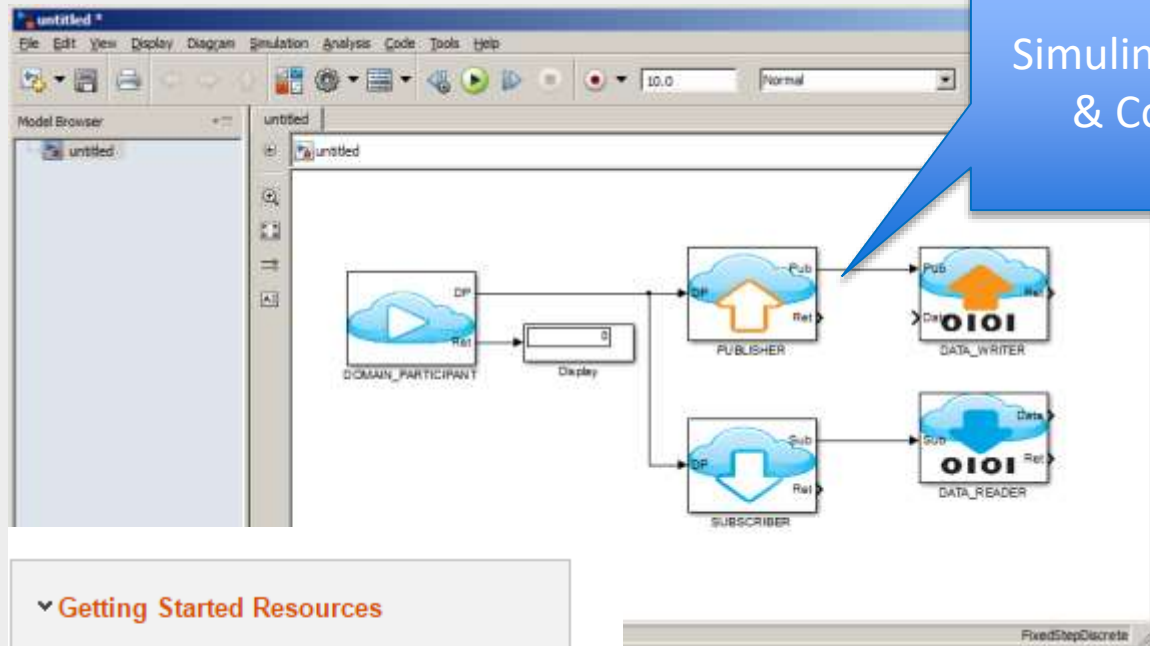


- DDS toolkit for LabVIEW integration inside LV Suite
- Joint sales & marketing efforts





# The Mathworks



Simulink Block Set  
& Code Gen

Direct Matlab  
Ingest, real-time  
plotting and data  
acquisition

## ▼ Getting Started Resources

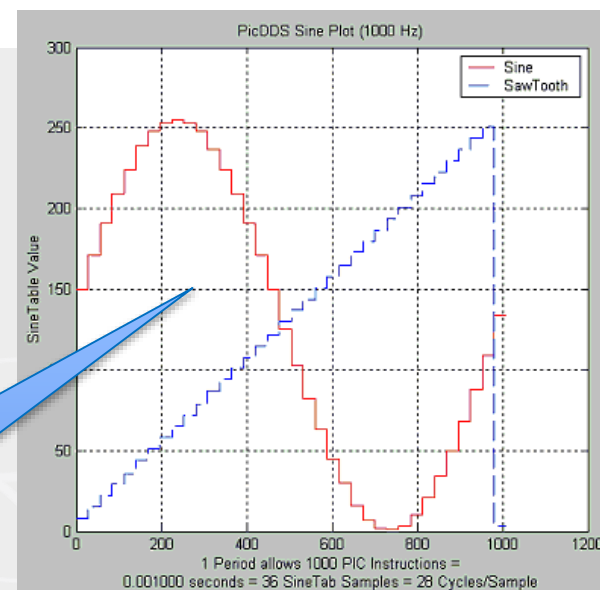
### ▼ Videos

- Installing the DDS Support Package 9:00
- MATLAB and the DDS Support Package 13:08
- Simulink and the DDS Support Package 10:09
- Getting Started with MATLAB 7:00
- Programming and Developing Algorithms with MATLAB 4:32

### ► Documentation

Detailed Video  
Tutorials

70-Page User Guide  
Including  
Code gen, running  
on Raspberry Pi



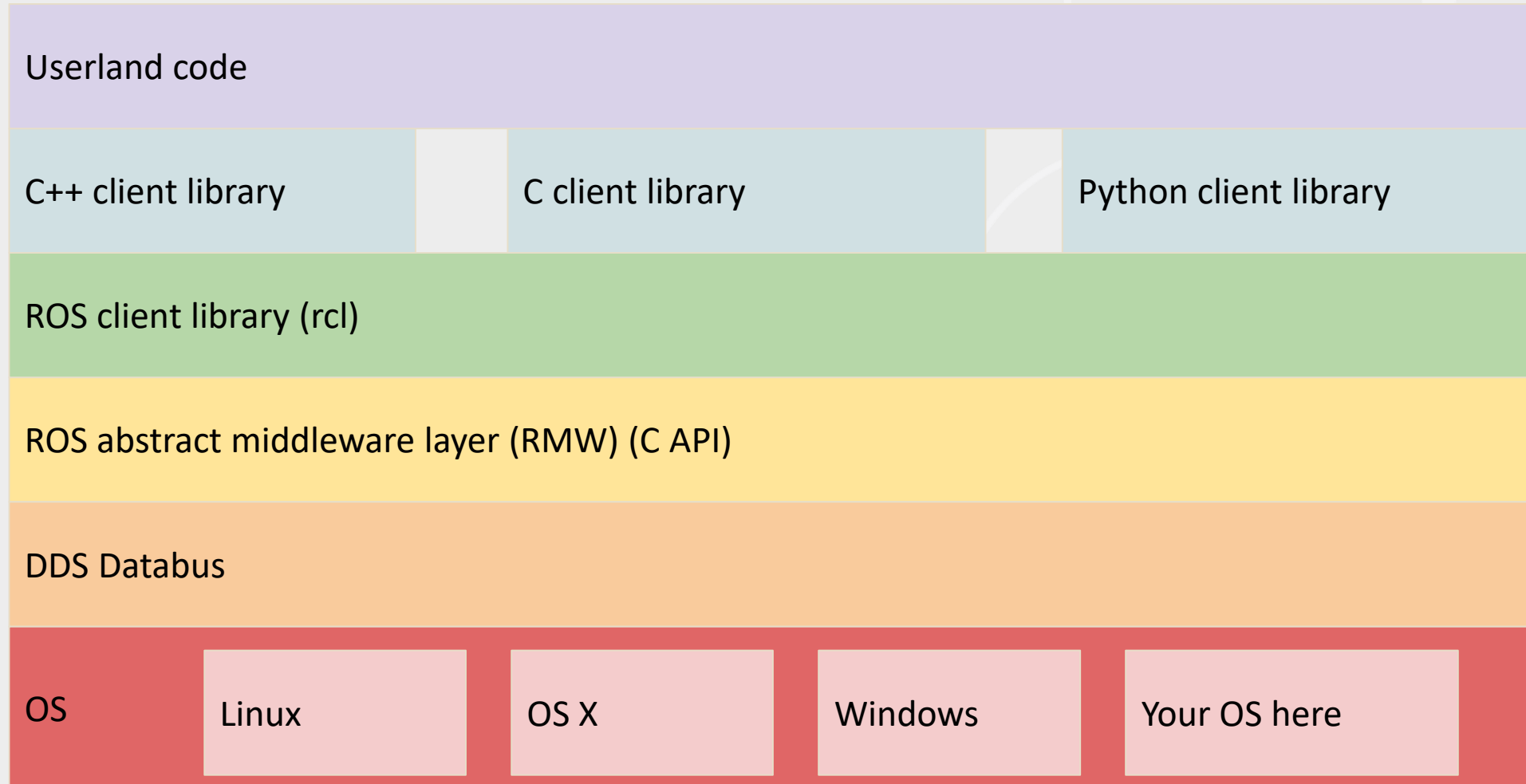
## DDS Blockset Pilot Support Package (PSP) User Guide

Version 2.9.0

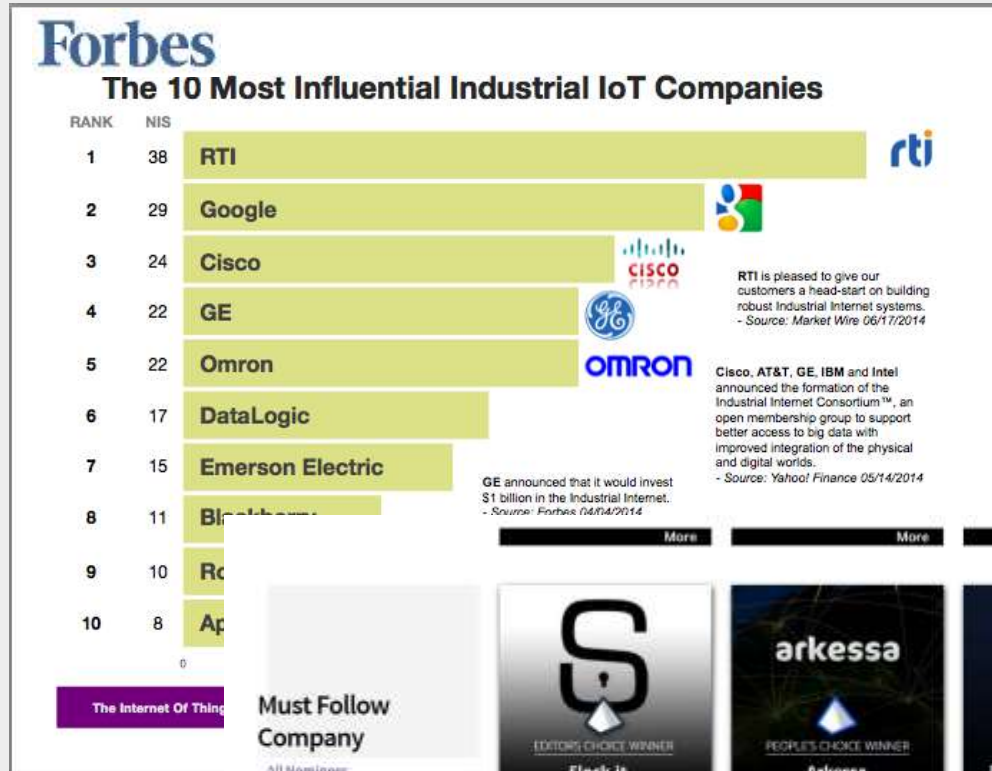
ISSUE DATE: 16 August 2016



# ROS2 Software Stack



# RTI IIoT Influence



RTI: 2016 IoT Emerging  
Company of the Year for the  
Enterprise Market  
Compass Intelligence



Top 25 IoT Companies 2017



Top 10 Companies  
Industrial IoT

IBM  
AT&T  
Cisco  
GE  
RTI

Consumer IoT

Amazon  
Google  
Samsung  
Apple  
Microsoft





# 2017 Plan

# 2017 Goals

## Lead

- Build & solidify leadership position in IIoT

## Grow

- Sustain 35+% sales and cash flow growth

## Deliver

- Build execution ability to match market demand



# Opportunities Abound!

- Transportation
  - Carbots
  - Rail & mass transit
  - Intelligent Traffic Systems (ITS)
  - Drones and personal aviation
- Energy
  - Renewable integration (Substation automation, DER Pilots, microgrids)
  - Automated drilling & production
- Medical
  - Intelligent connected medical devices
  - Surgical robotics
  - Imaging & treatment systems
- Defense
  - Avionics & UAS
  - Naval systems
  - Radar/antimissile/air defense
  - Ground vehicles
  - Asset tracking/C2







DEVELOPER RESOURCES

# GETTING STARTED WITH CONNEXT DDS

From download to hello world, we've got you covered. Find all of the tutorials, documentation, inspiration, and other materials you need to get started using Connex DDS today.



VIDEO TUTORIAL

## Learn DDS Basics without Coding

Play with Shapes, the game-like application that teaches you fundamentals of DDS by demonstrating its capabilities without the need for coding.



VIDEO TUTORIAL

## Connex DDS Installation (Linux)

Follow the simple steps in this video tutorial to install Connex DDS on Linux.



VIDEO TUTORIAL

## Connex DDS Installation (Windows)

Follow the simple steps in this video tutorial to install Connex DDS on Windows.



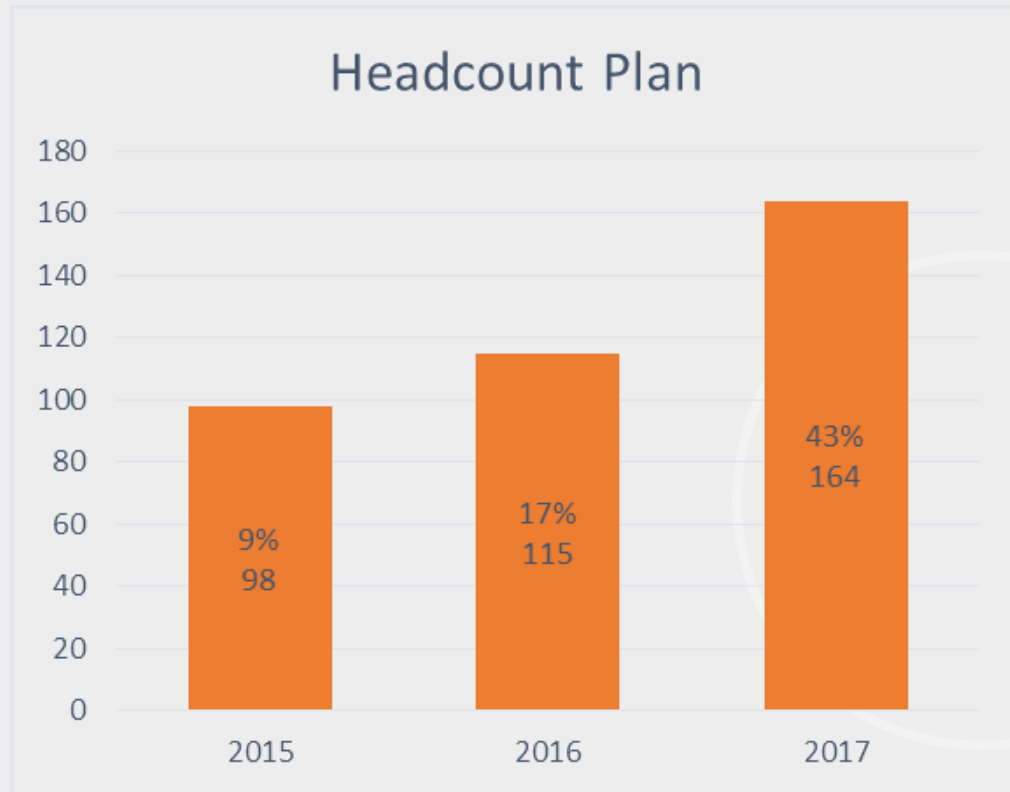
# Some Numbers...

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- ~2x revenue in 2 years
  - 2015 31% + 2016 42%
- 140% cash retention (!)
- 140 new projects in 2016
- 1000+ design wins

“RTI has seen unprecedented growth in projects, customers and revenues. Even more exciting, the market is still young with only a few IIoT projects in production today. As more deploy, the market will expand tremendously. We live on the brink of an innovative new world of intelligent, connected systems.”

# 2017 Headcount Plan



43%



Expanding in Europe...



Scott McNealy

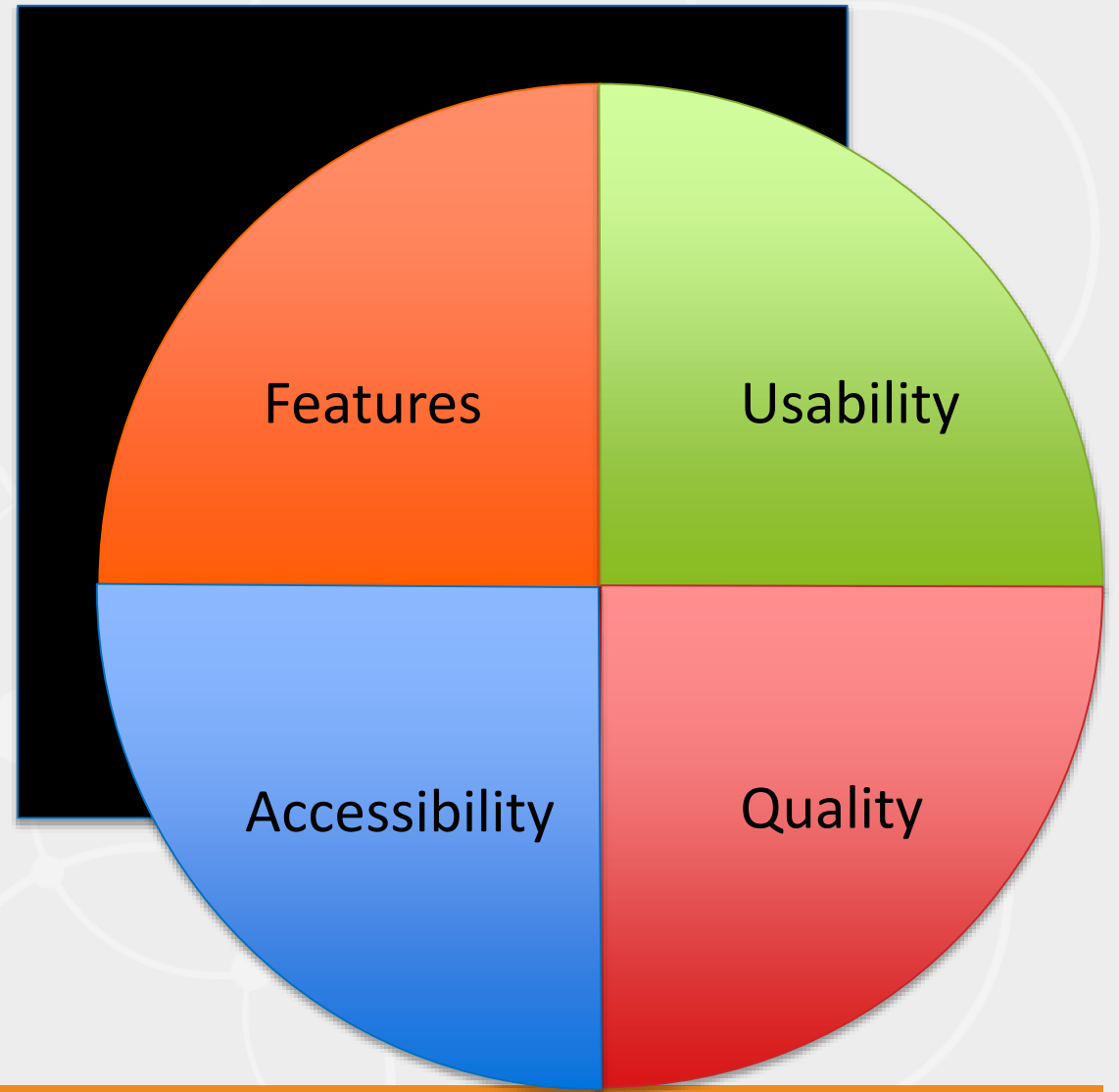


Welcome to RTI's Advisory Board!



# Balanced Delivery

- Consistent progress in all key areas
- User input welcome!





# Faro

- Major new release
- Top new functionality
  - Go anywhere
  - Ask for data anywhere
  - Keep data secure
  - Much more



# Building Momentum

# The *Industrial* IoT Disruption



*RTI lives at the intersection of functional artificial intelligence and pervasive networking*



**This is Profound!!**



The real value is a **common** architecture that connects sensor to cloud, interoperates between vendors, and spans industries



# Why RTI? Why Do We Have Momentum?

Truly profound technologies become part of everyday life. Motors, plastics, computers, and now networking have made this transition in the last 100 years.

2006

Another step is emerging in this progression: pervasive, real-time data. This differs from the Internet in that this pervasive information infrastructure will connect devices, not people.

# This is Why We Have Momentum

- Vision
- Product
- People
- Influence



# We Are Building The Future with You

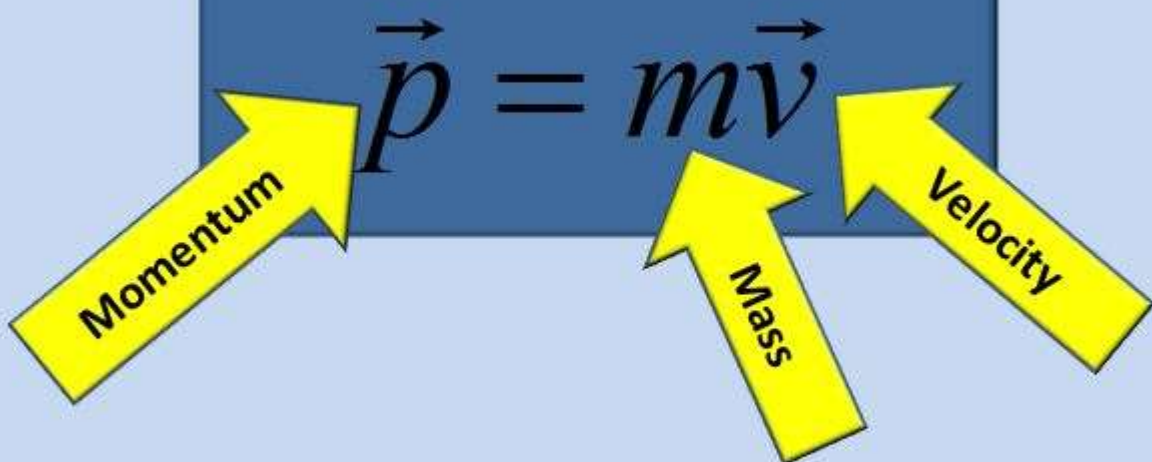




# Momentum Physics

- Increase it?
  - More of us
  - Moving faster together

Momentum = (mass) x (velocity)

$$\vec{p} = m\vec{v}$$


The diagram shows the equation  $\vec{p} = m\vec{v}$  with three yellow arrows pointing to its components: 'Momentum' points to  $\vec{p}$ , 'Mass' points to  $m$ , and 'Velocity' points to  $\vec{v}$ .

What Do These Promise?

Artificial Intelligence

Pervasive Networking

---

# Prom·ise

'präməs (Proper noun)

RTI's primary competitive advantage

“If your career, fortune, or life is on the line, rely on  
RTI's *Promise*”





# RTI's Promise

- We realize potential
- We provide extraordinary value
- We believe in absolute honesty
- We work as a team
- We actively pursue excellence
- We make the world better

DWYSYWD. It really is that simple.

# RTI Staff Here



Gerardo Pardo  
CTO



Nicola Masters  
UK/Scandinavia Sales



Fernando Crespo  
Principal Architect



Sebas Aguilar  
FAE



Juan Jose Martin  
Application Engineer



Reiner Duwe  
EMEA Manager



Cameron Smead  
Public Relations



Sara Granados  
FAE



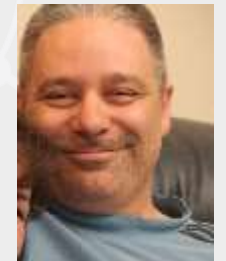
Ulrike Bernges  
Central EU Sales



Vanessa Todd  
Marketing



Stan Schneider  
CEO



Ken Brophy  
Tools Manager



# Makes the World Run Better