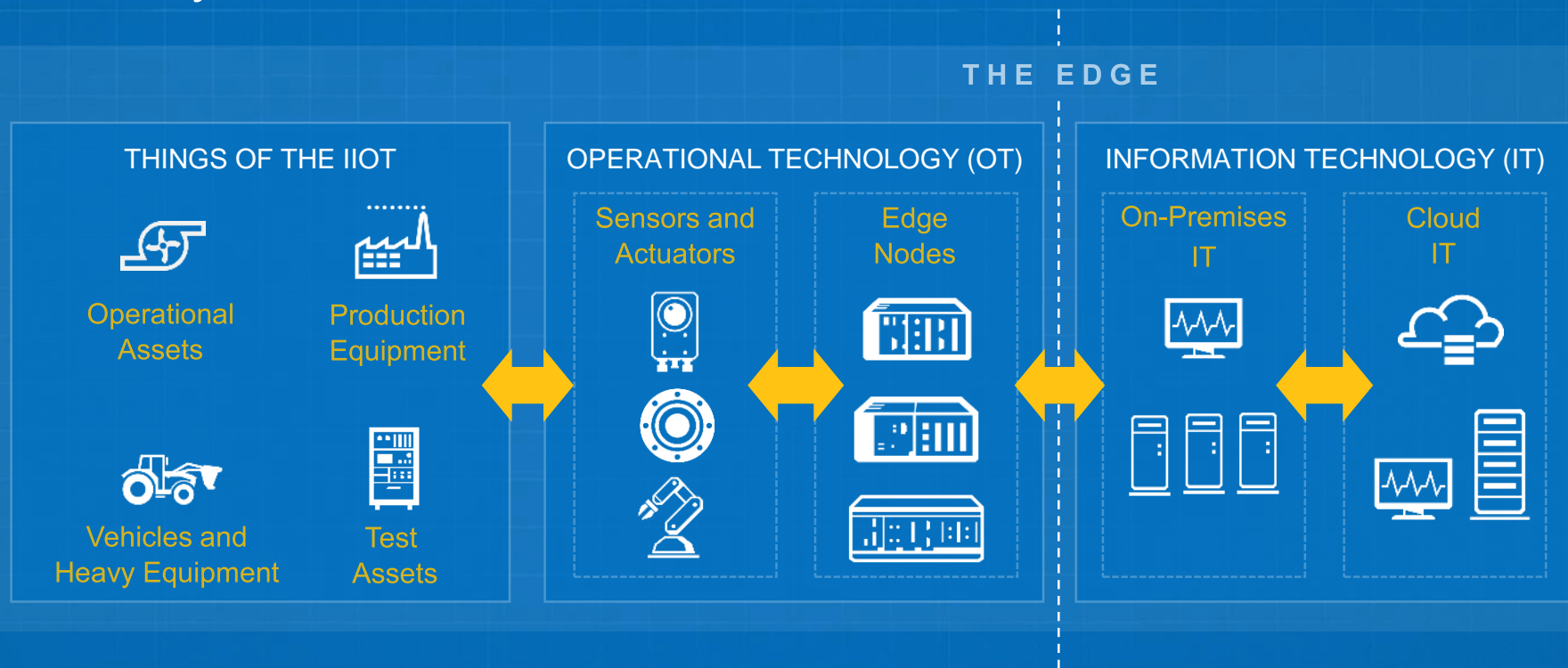


# Practical Considerations for Connecting LabVIEW to the Industrial IoT

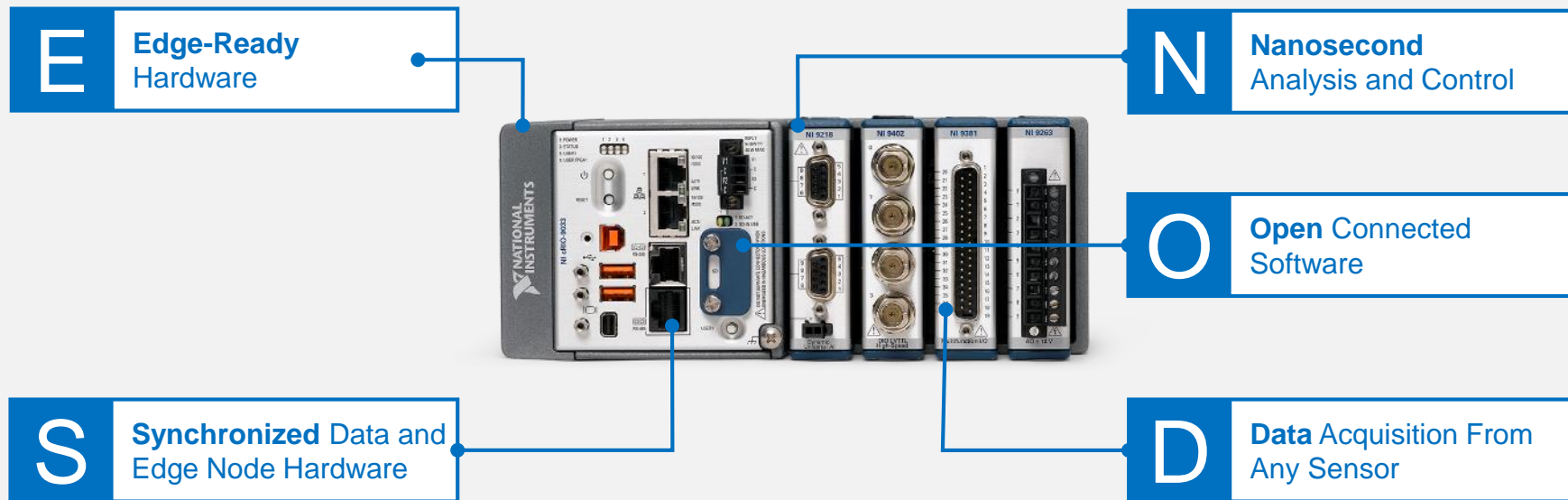
# Today's Agenda

- Introduction to the Industrial IoT and NI Edge Nodes
- Speaking the IIoT “Lingo”
- Trending IIoT Cloud Platforms
- Connecting to IoT Cloud Platforms From LabVIEW

# IIoT System Architecture



# The NI Edge Node Advantage



# The NI Edge Node Advantage

N

## Nanosecond Analysis and Control

Assess and respond to inputs **860X** faster than the average human with FPGA-enabled hardware.

O

## Open, Connected Software

Leverage technology from the anticipated **4 million** IoT software developers by 2020.

D

## Data Acquisition From Any Sensor

Acquire and manage any of the **78 exabytes** of industrial data expected by 2020.

E

## Edge-Ready Hardware

Deploy hardware that's certified to withstand the most demanding environments since **0%** of OT assets are in an environmentally controlled data center.

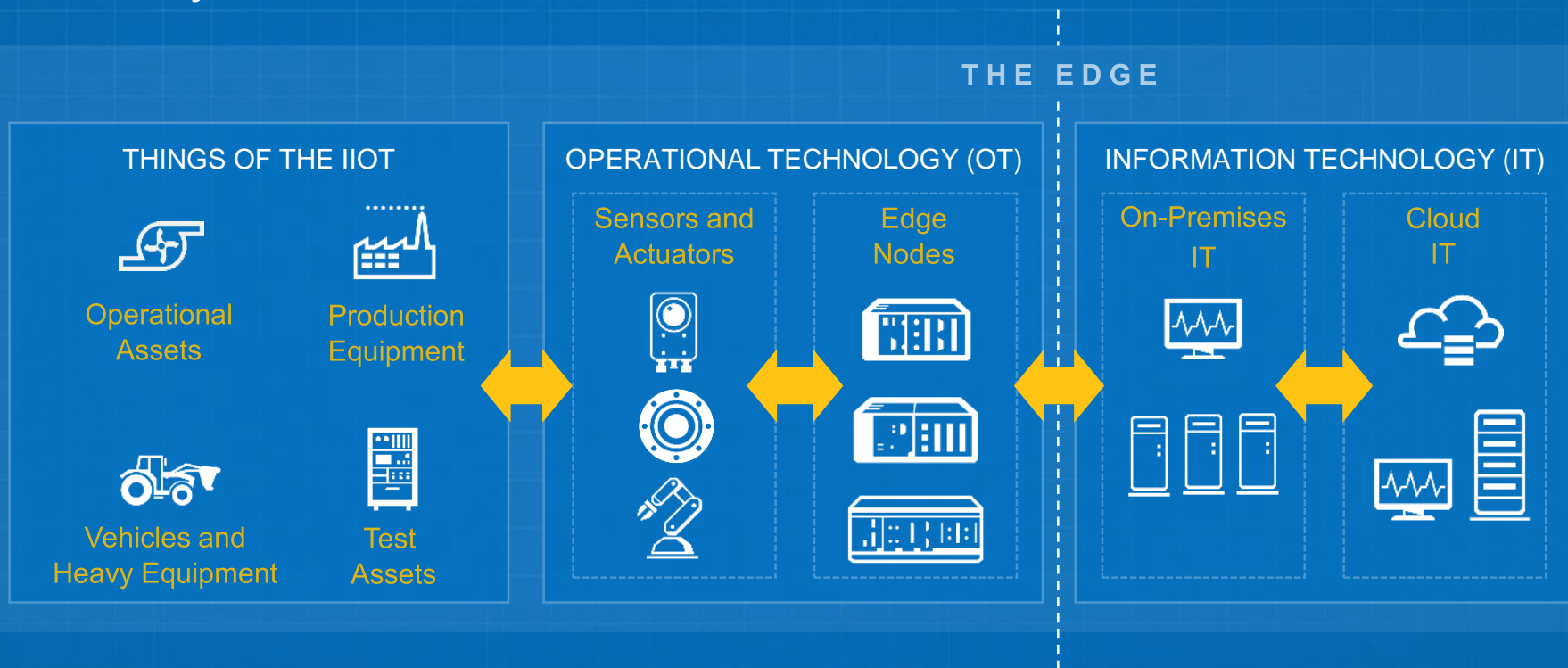
S

## Synchronization

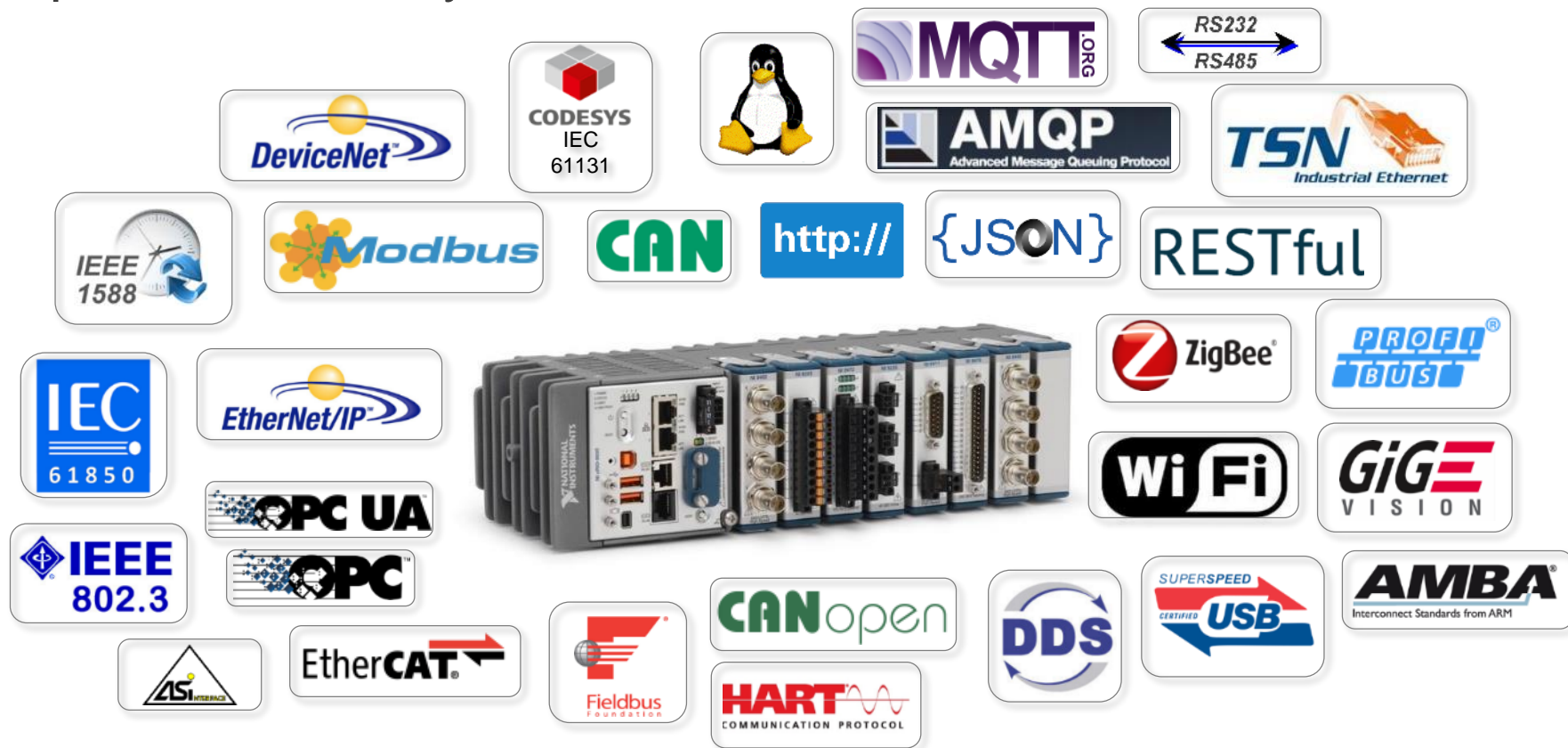
Synchronize edge nodes to within **100 ns** of each other anywhere in the world with Time Sensitive Networking.



# IIoT System Architecture



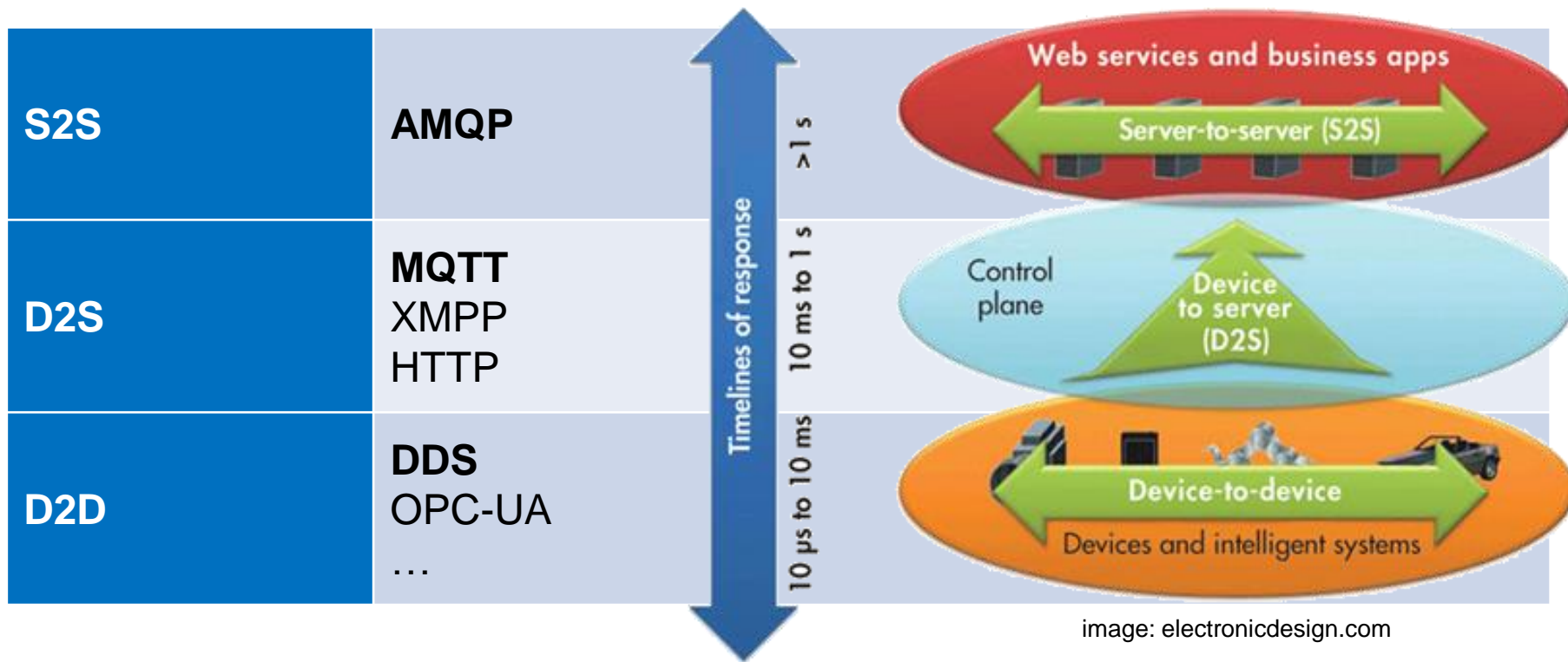
# Open Connectivity to OT *and* IT







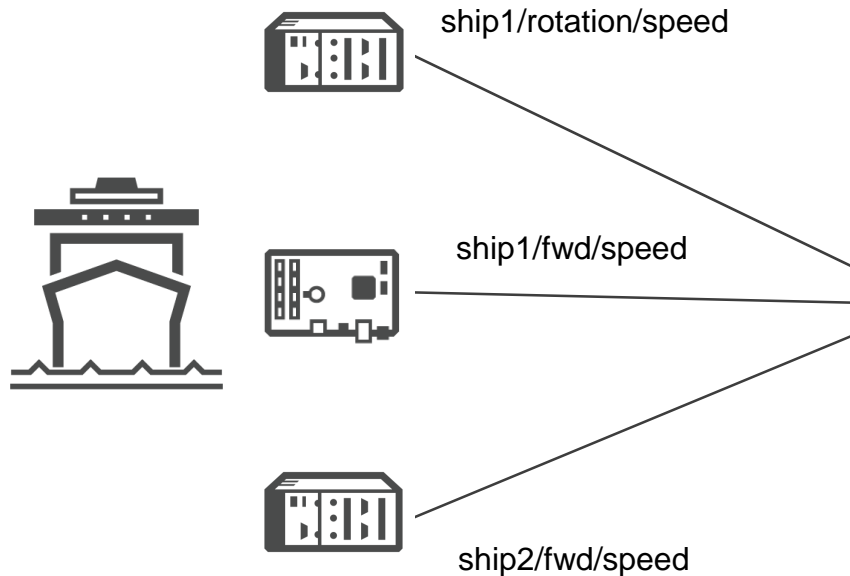
# Common IIoT Protocols



# MQTT—Message Queue Telemetry Transport



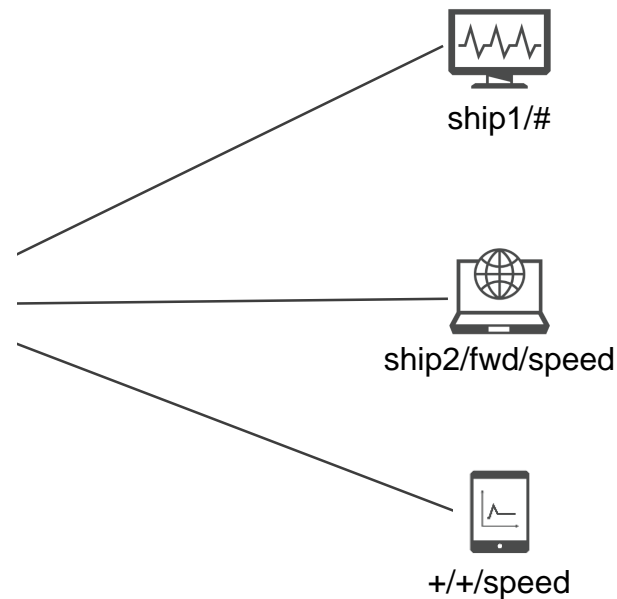
## MQTT publishers



## MQTT broker

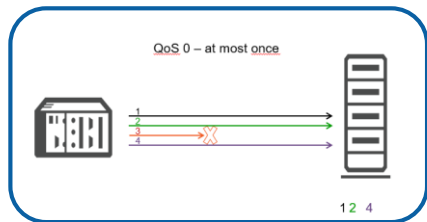


## MQTT subscribers

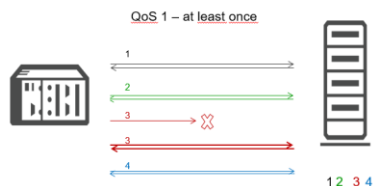


topic = "device/path/topic"

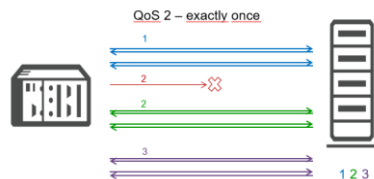
# MQTT—Quality of Service (QoS)



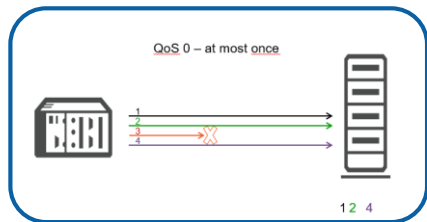
QoS 0—at most once



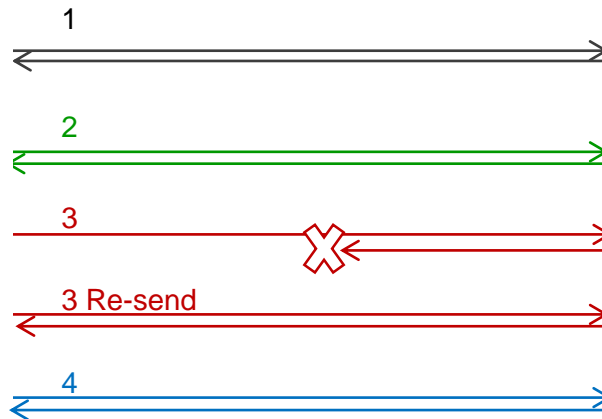
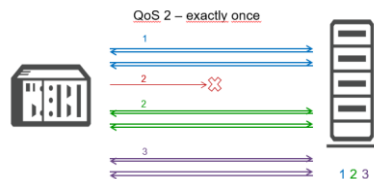
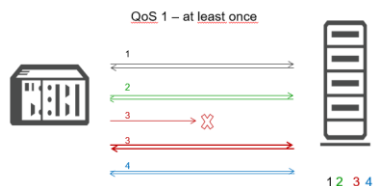
1 2 4



# MQTT—Quality of Service (QoS)

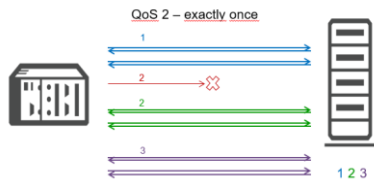
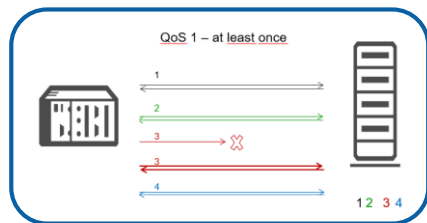
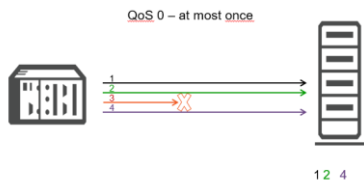


## QoS 1—at least once

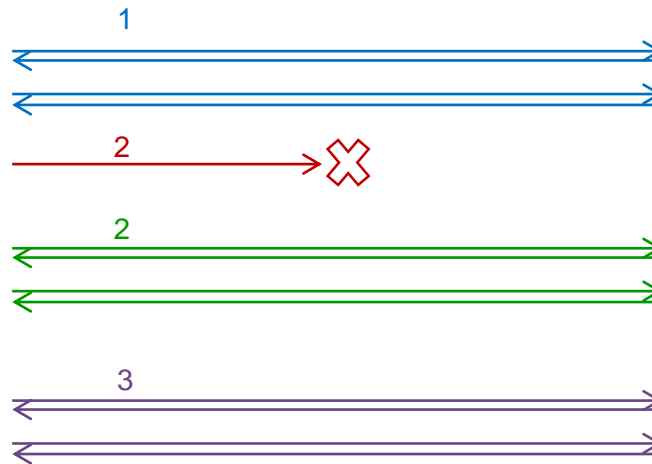


1 2 3 3 4

# MQTT—Quality of Service (QoS)



QoS 2—exactly once

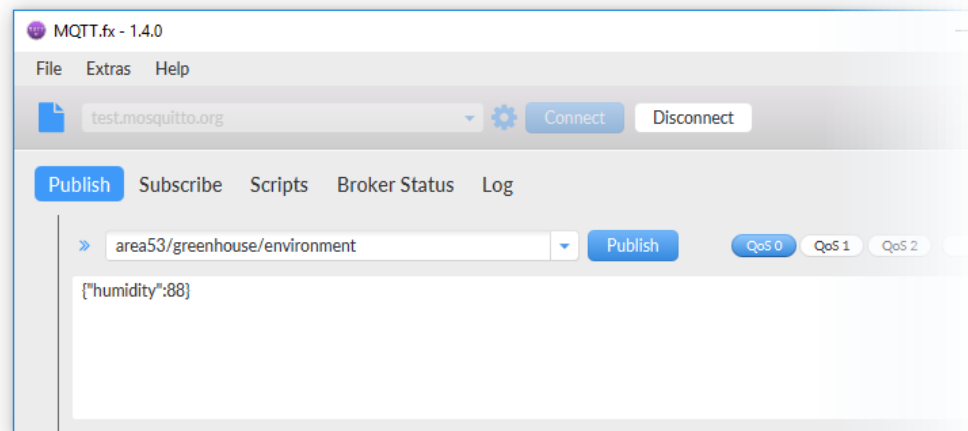


1 2 3

# MQTT—Tips



- MQTT client
  - MQTT.fx
  - Linux, Mac and Windows
  - <http://www.mqttfx.org/>
- MQTT broker
  - test.mosquitto.org
  - Linux, Mac and Windows
  - Install your own MQTT broker
  - <https://mosquitto.org/download/>
- Use port 1883 for open and 8883 for encrypted data transfer (TLS 1.2/SSL).



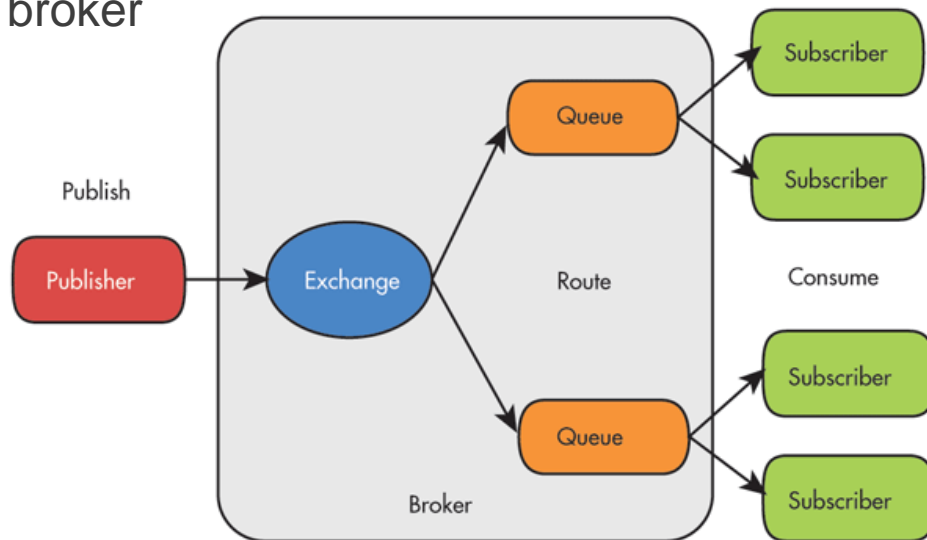
-



# AMQP—Advanced Message Queuing Protocol

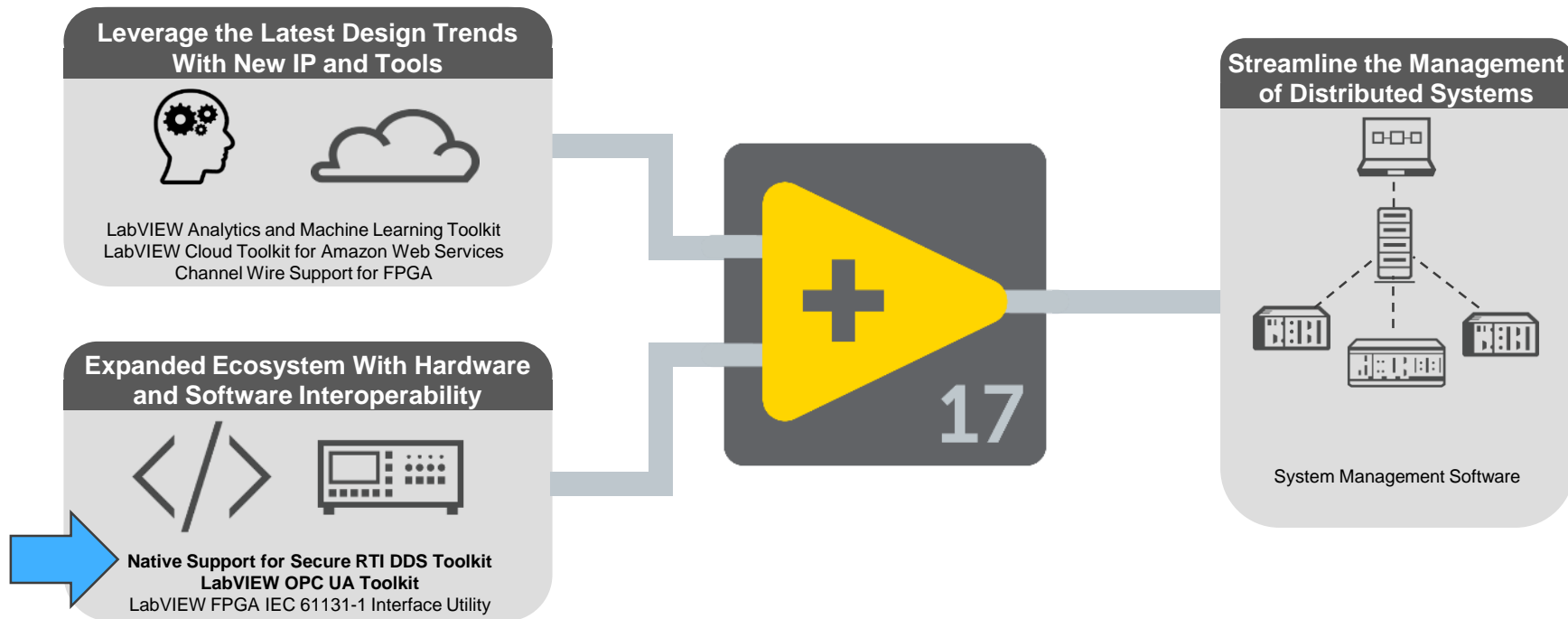


- Sends queues of data between servers
- Endpoints must acknowledge receiving data
- RabbitMQ—open source message broker
- LabVIEW APIs
  - LabbitMQ by Distrio
  - Github AMQP implementation



# LabVIEW 2017

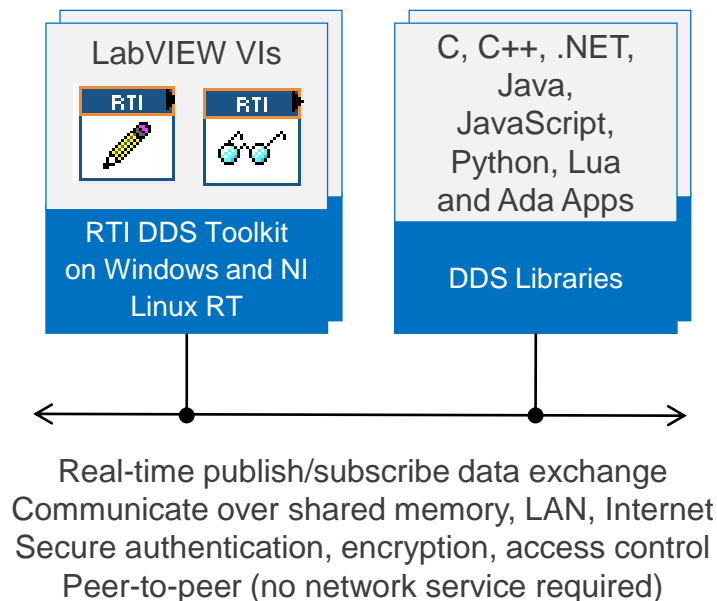
Complex applications. Distributed systems. Streamlined development.



# DDS—Data Distribution Service

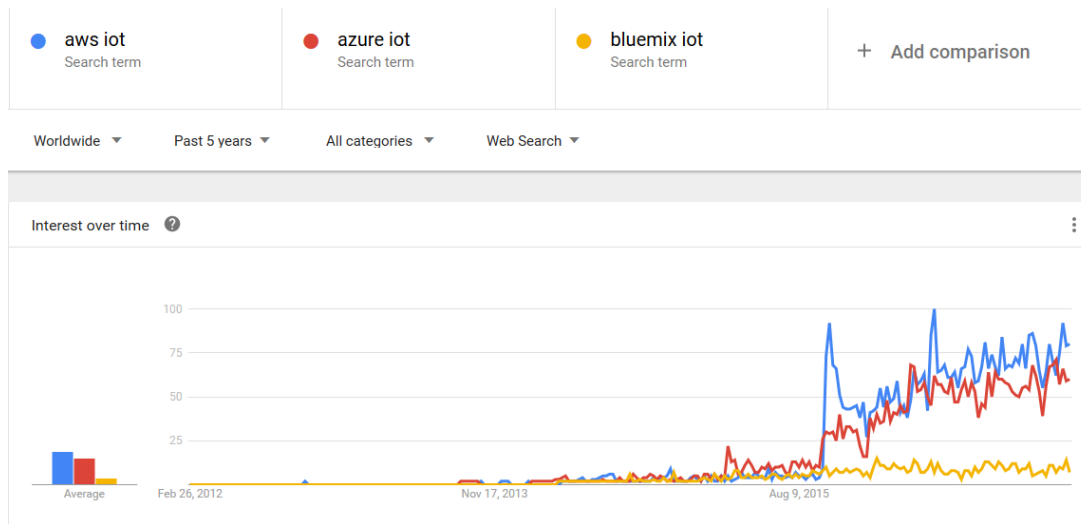


- Publish/subscribe communication model for distributed systems
- Native LabVIEW API that supports Windows and NI Linux Real-Time systems
- DDS compliance—interoperates with C, C++, Java, and C#/.NET applications
- Set quality of service requirements—latency, throughput, and reliability
- Ability to scale to thousands of nodes and millions of data points
- **DDS Security** enables per-topic read/write access control

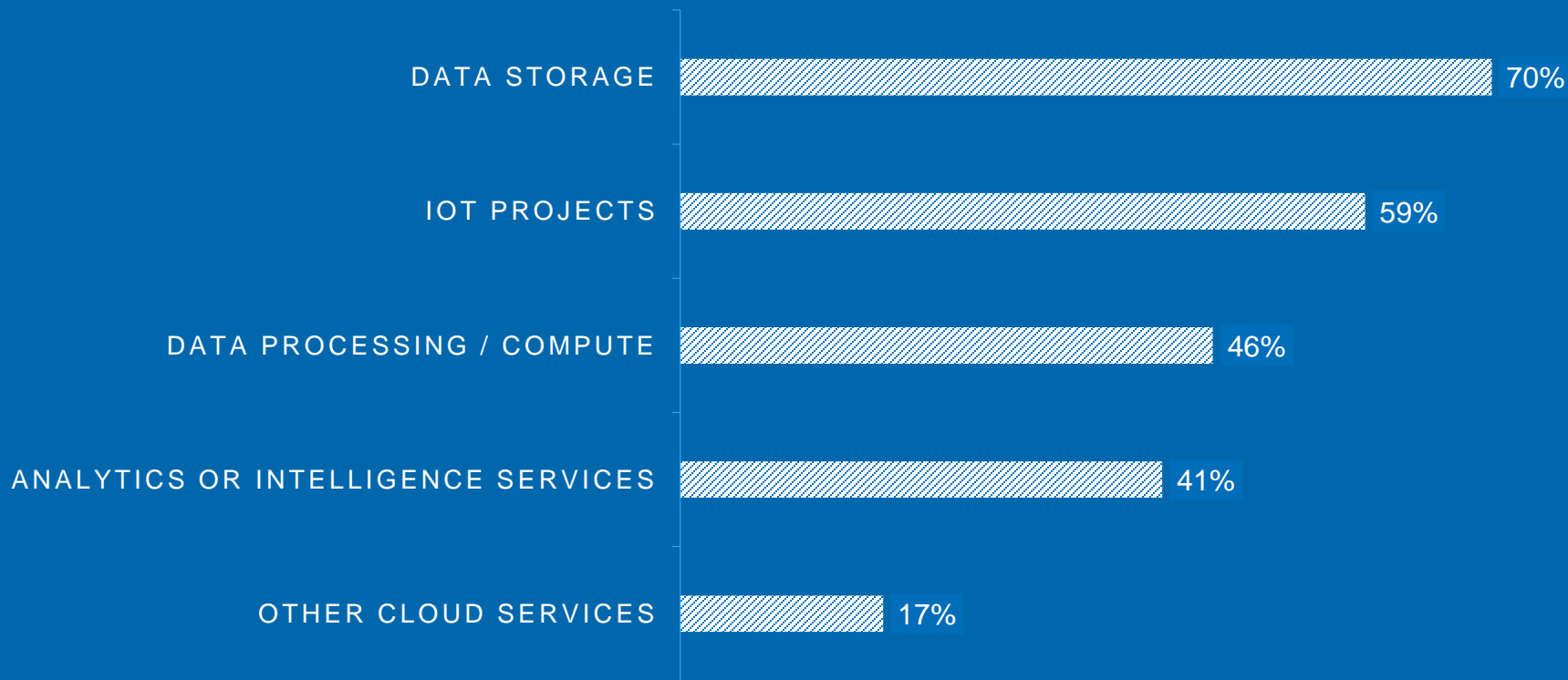


# Popular IIoT Platforms

- Amazon Web Services
- PTC ThingWorx
- IBM Bluemix
- Microsoft Azure
- Google Cloud
- GE Predix
- ...
- Preference depends on
  - Service model (IaaS, PaaS, SaaS)
  - Company IT preference
  - Capabilities
  - Cost model

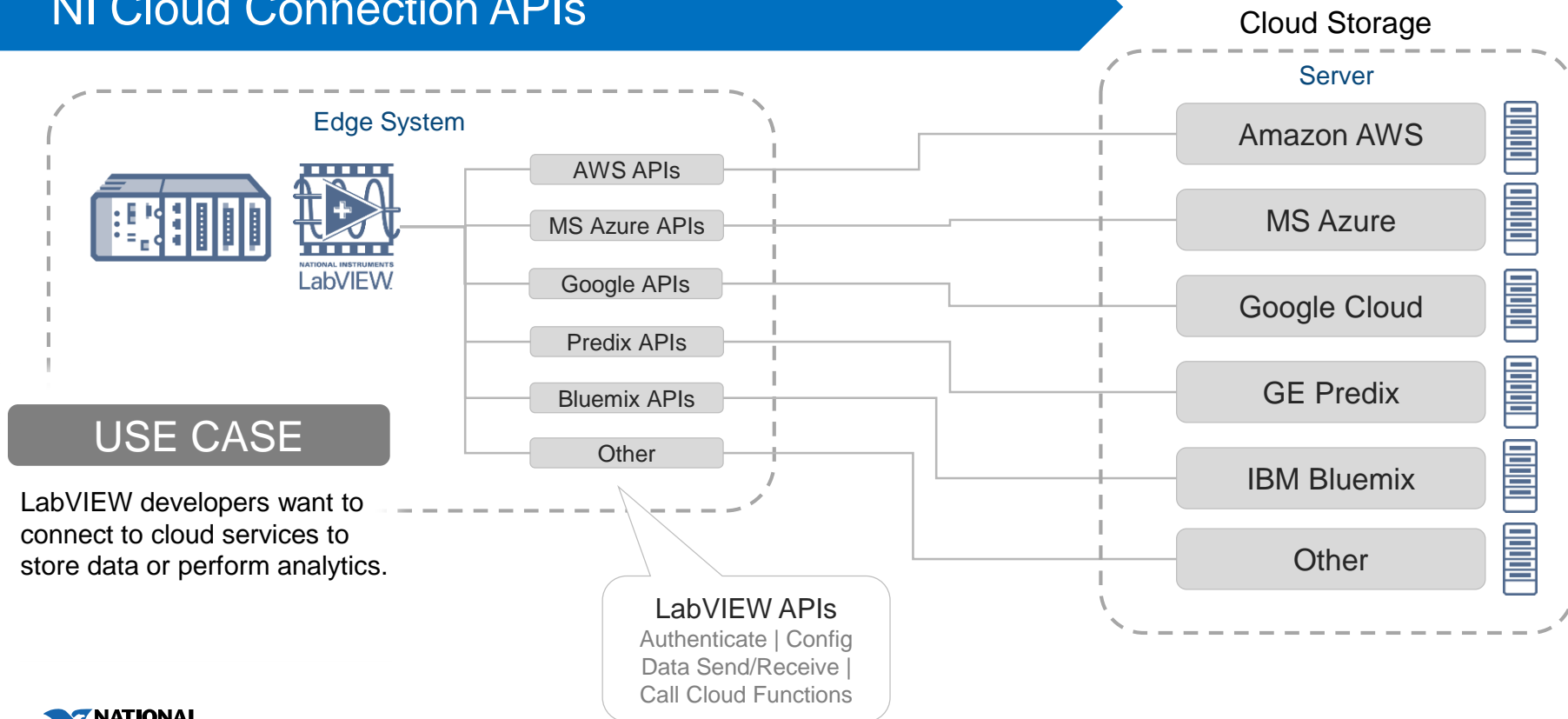


# Which cloud computing services are relevant to your LabVIEW projects?



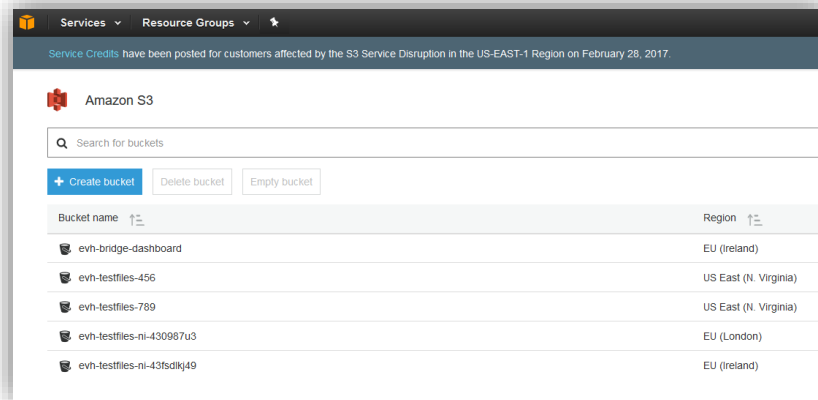
# CLOUD STORAGE OPTIONS

## NI Cloud Connection APIs

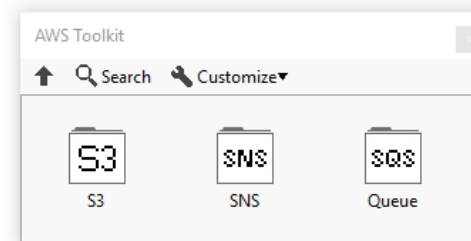


# Amazon S3 Storage

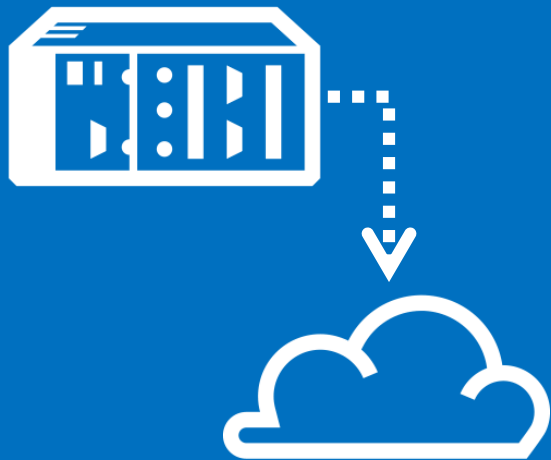
- Simple Storage Service (S3)
- Store and retrieve from anywhere
- Store large files up to 5TB
- S3 Buckets (folders) and objects (files)
- Regions
- <https://aws.amazon.com/s3/>



- LabVIEW Cloud Toolkit for Amazon Web Services
  - HTTP and HTTPS
  - Large data uploads
  - Low-level VIs include source code
  - Run on desktop and real-time OS



# DEMO



## Store Waveform Data Into Cloud

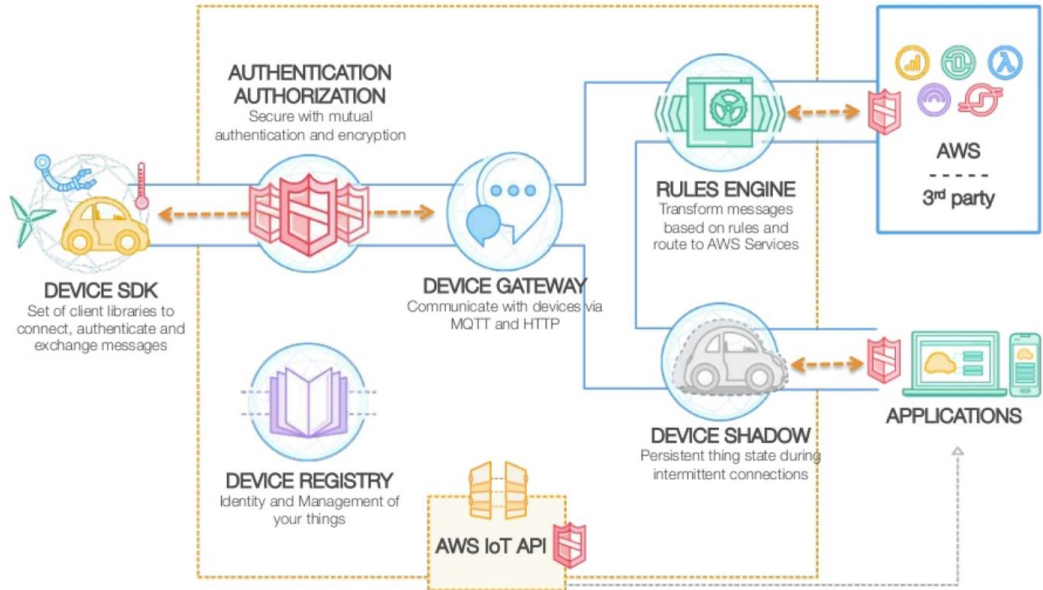
- Features
  - Amazon Web Service S3
  - CompactRIO
- Requirements
  - Network connection
  - Amazon AWS account (free tier)
  - LabVIEW Interface for Amazon S3 package



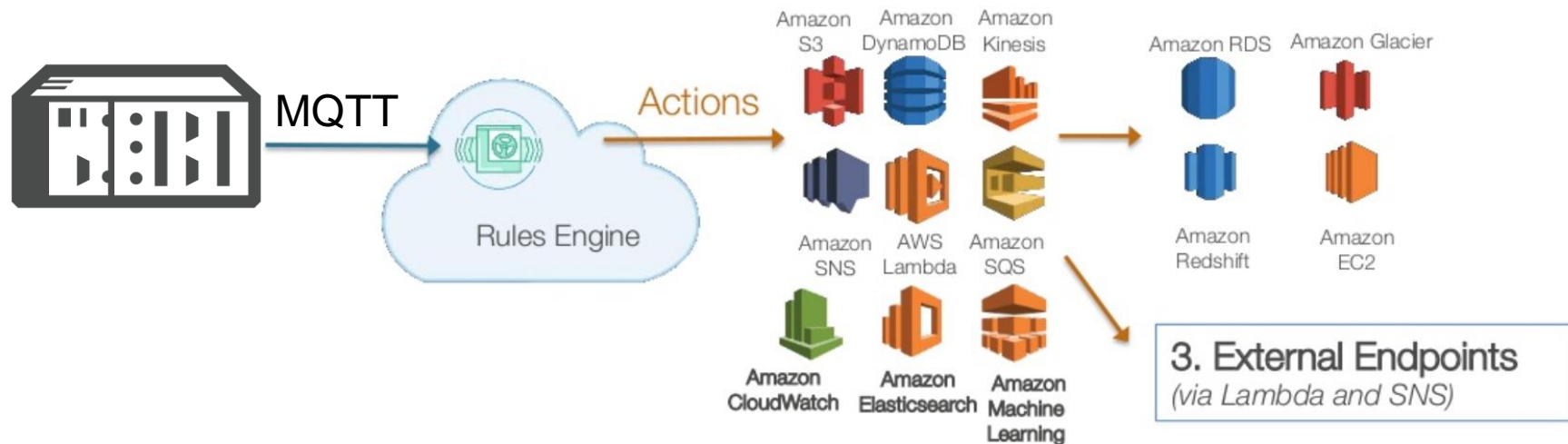
# Monitoring Using Amazon Web Services IoT

# Amazon Web Services (AWS)

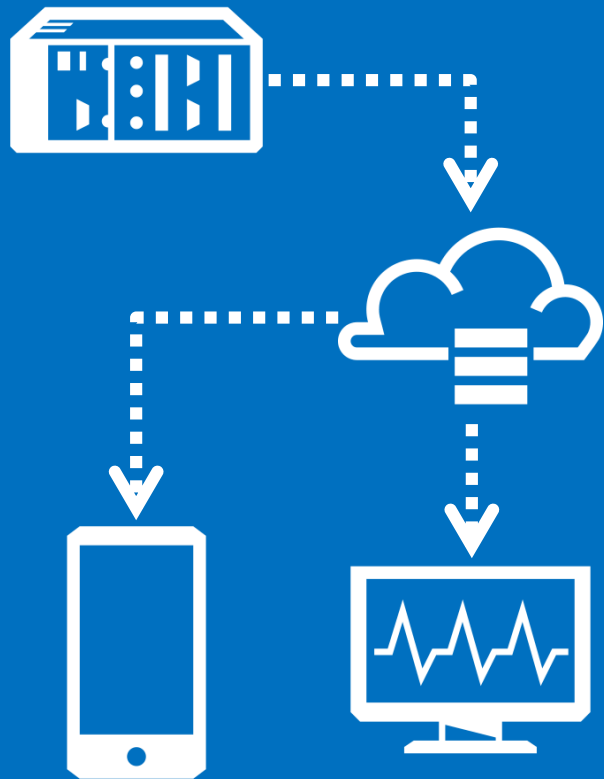
- AWS IoT service
- Devices and SDKs
- Connect over MQTT
- Manage things
- Route messages to other services
- Debug
- AWS CLI
- <https://aws.amazon.com/iot/>



# AWS IoT Rules and Services



## DEMO



## IoT Connections, Rules, and Monitoring

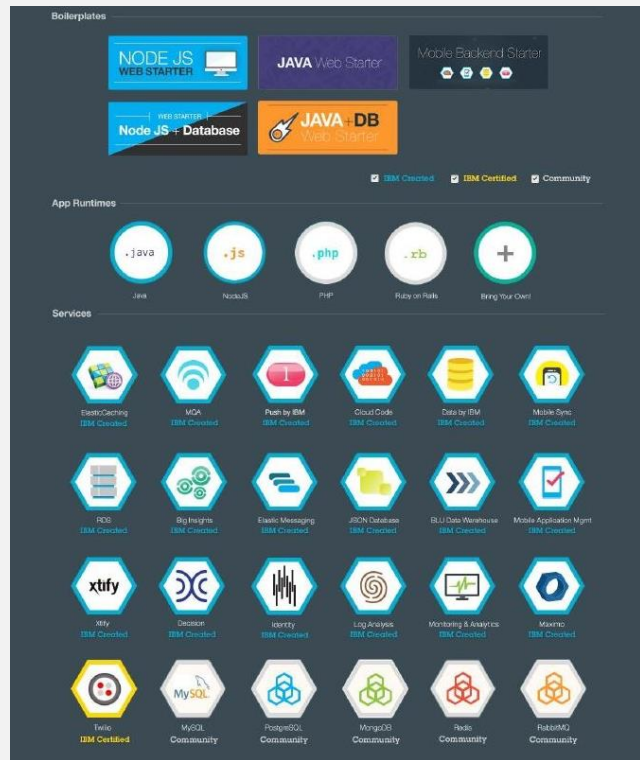
- Features
  - Amazon Web Services—IoT, DynamoDB, S3
  - MQTT
  - CompactRIO
- Requirements
  - Network connection
  - AWS account (free tier)
  - LabVIEW MQTT API

# Data Processing

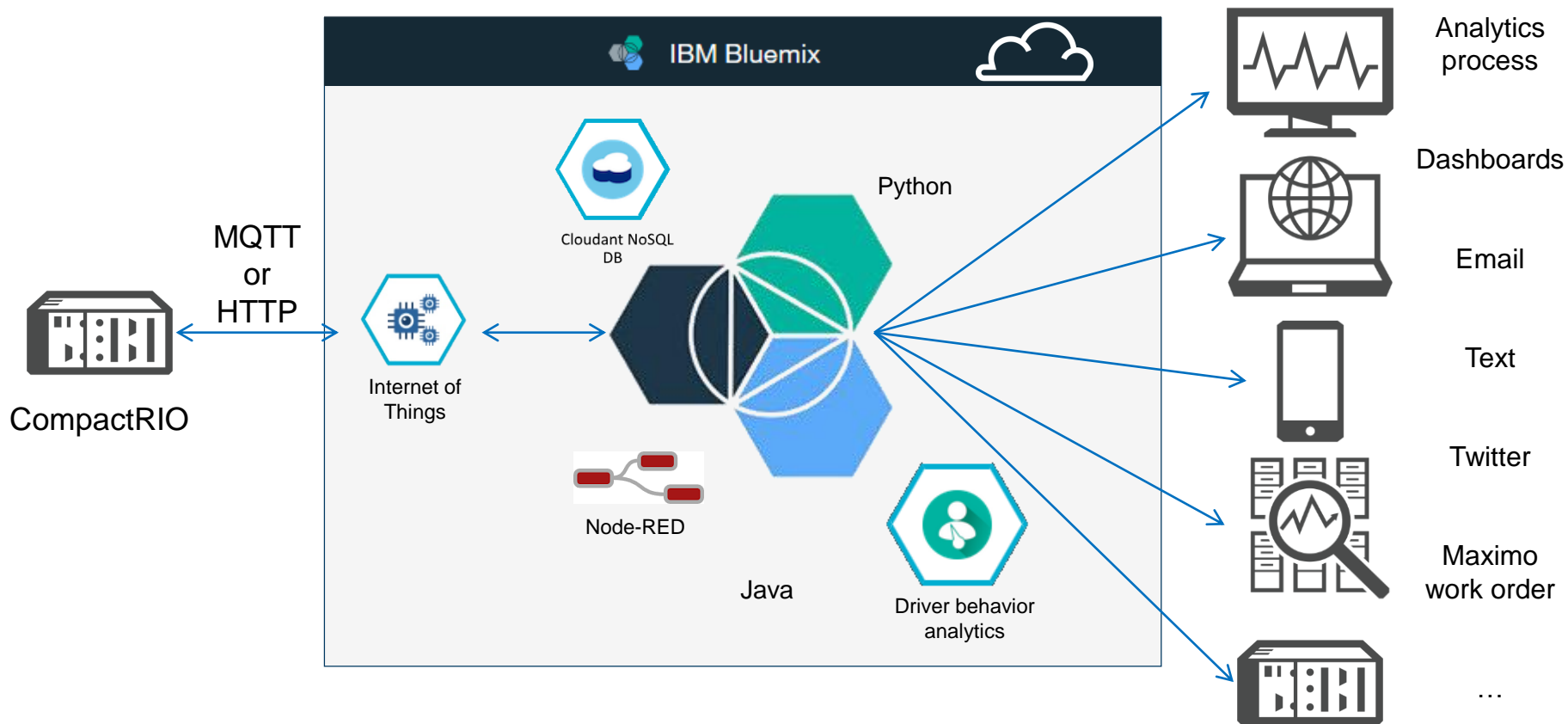
## Using IBM Watson IoT for Bluemix

# IBM Watson IoT for Bluemix

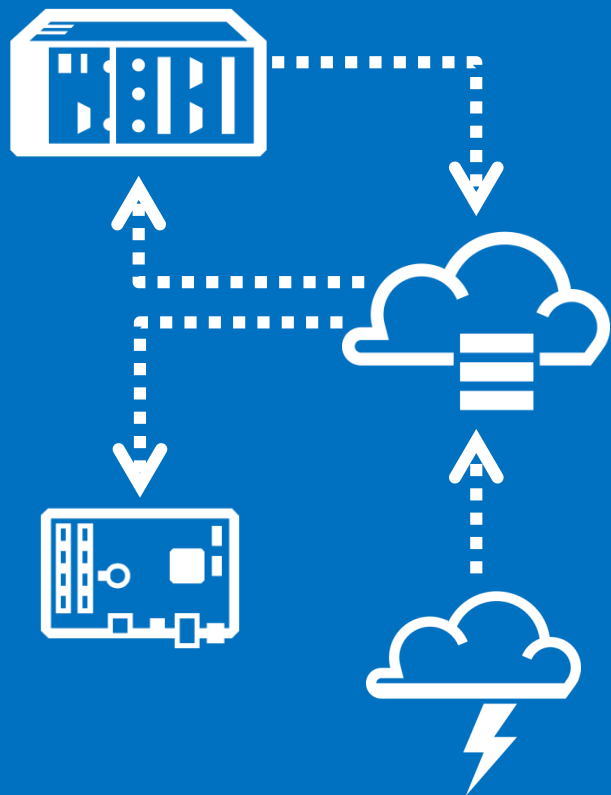
- Open cloud platform
- Build, run, deploy, and manage applications in the cloud
- Support for several programming languages
  - Java, Node.js, Python, PHP, Go, and so on
- Broad catalog of services
  - Data analytics, Watson, IoT, network, storage, and so on
- Communicate with devices via Watson IoT for Bluemix
- MQTT support
- <https://bluemix.net>



# IBM Bluemix Concept



## DEMO



## IoT Control and Analytics

- Features
  - IBM Watson IoT for Bluemix
  - Node-RED
  - External data (web services)
  - CompactRIO
- Requirements
  - Network connection
  - IBM Bluemix account (free or lite tier)
  - LabVIEW MQTT API



# PTC ThingWorx

# PTC ThingWorx IoT platform

- CAD industry
- Model Based Design approach
- Things modelled in detail
- Connectivity:
  - REST API
  - Edge microserver
  - Device SDK
  - Kepware
  - AWS IoT
- LabVIEW Rest API available

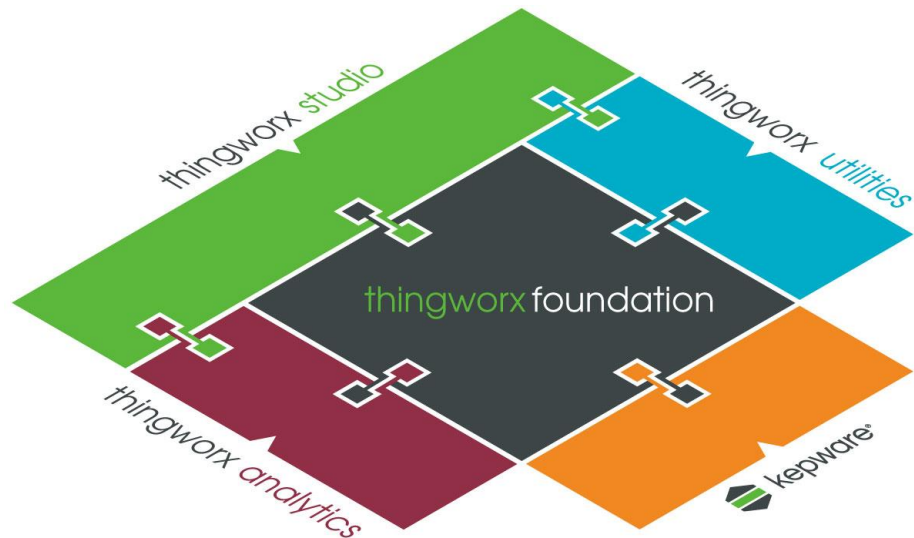
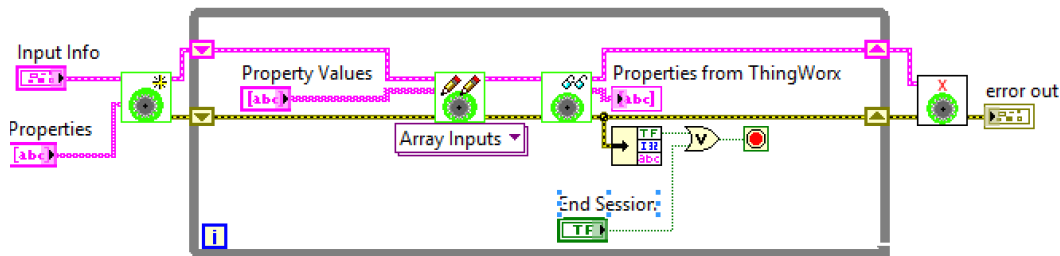


Image source: PTC



# myRIO Mechatronics System for PTC ThingWorx—Beta



## Configure and Customize

- Design labs that emphasize key industrial applications
- Combine myRIO, NI ELVIS RIO Control Module, and high-fidelity plants for a unique learning experience
- Test application-specific course material developed by industry partners



## Apply and Advance

- Join the IoT community when it is launched at NIWeek
- Purchase a beta solution based on myRIO complete with ready-to-run projects
- Grow your knowledge while helping shape future course material

# IoT Cloud Platform Comparison

|            | Amazon AWS IoT  | IBM Watson IoT for Bluemix  | Microsoft Azure IoT Suite   | PTC ThingWorx   |
|------------|---|---|---|---|
| Free Trial | 12-month free trial, 250k msgs/month                                  | 30-day free trial, then Lite version  | Unlimited trial, 8000 msgs/day, 500 devices   | 30-day trial  |
| Pricing    | By # msgs   | By # devices, data, storage, and services   | # of IoT hub units (msgs)   | Subscription  |
| Access     | GUI and CLI   | GUI and CLI   | GUI and CLI   | GUI   |
| Protocols  | HTTP<br>MQTT  | HTTP<br>MQTT  | HTTP<br>MQTT<br>AMQP  | HTTP<br>MQTT<br>RabbitMQ  |
| Home Page  | <a href="https://aws.amazon.com/iot/">https://aws.amazon.com/iot/</a> | <a href="http://www.ibm.com/internet-of-things/iot-solutions/watson-iot-platform/">http://www.ibm.com/internet-of-things/iot-solutions/watson-iot-platform/</a> | <a href="https://www.microsoft.com/en-us/server-cloud/internet-of-things/azure-iot-suite.aspx">https://www.microsoft.com/en-us/server-cloud/internet-of-things/azure-iot-suite.aspx</a> | <a href="http://www.thingworx.com/iot-platform">http://www.thingworx.com/iot-platform</a> |

# IoT Cloud Platform Comparison (continued)

|                       | Amazon AWS IoT   | IBM Watson IoT for Bluemix | Microsoft Azure IoT Suite   | PTC ThingWorx                       |
|-----------------------|------------------|----------------------------|-----------------------------|-------------------------------------|
| Storage/DB            | Yes              | Yes                        | Yes                         | Yes                                 |
| Machine Learning      | Yes              | Yes                        | Yes                         | Yes                                 |
| LabVIEW Compatibility | Yes              | Yes                        | Yes                         | Yes                                 |
| Virtual Devices       | Yes              | No                         | Yes                         | No                                  |
| Rules                 | Yes, rule engine | Yes, i.e. node.js          | Yes, Azure stream analytics | Yes, expressions                    |
| Data visualization    | Quicksight       | Yes, IoT real-time insight | Yes, Azure web apps         | Yes, ThingWorx Studio (AR), mashups |

# SystemLink

Manage distributed systems with software that enables the mass coordination of device configuration, software deployment, and data transfer.

## Web Application

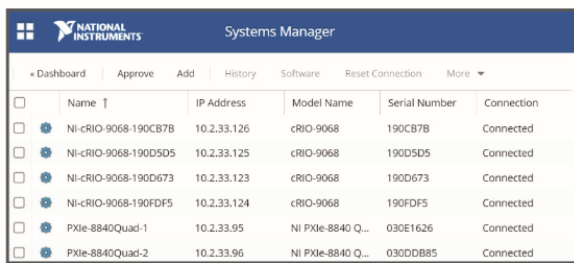
Browser-Based: PC, Mac, Mobile

## Server

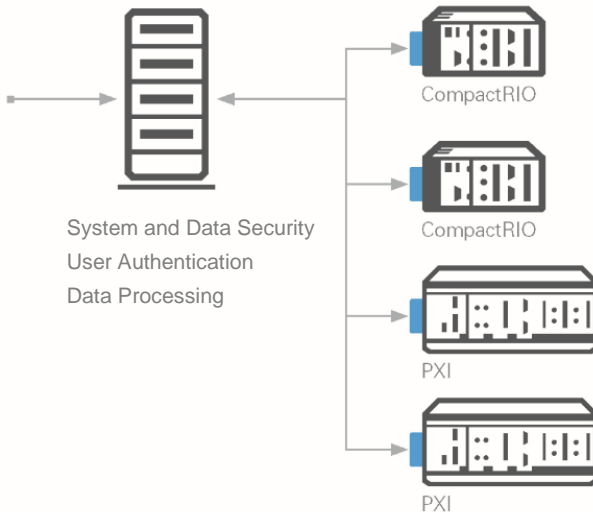
Windows PC or Server

## Managed Systems

Windows and NI Linux Real-Time



|                          | Name ↑               | IP Address  | Model Name        | Serial Number | Connection |
|--------------------------|----------------------|-------------|-------------------|---------------|------------|
| <input type="checkbox"/> | NI-cRIO-9068-190CB78 | 10.2.33.126 | cRIO-9068         | 190CB78       | Connected  |
| <input type="checkbox"/> | NI-cRIO-9068-190D5D5 | 10.2.33.125 | cRIO-9068         | 190D5D5       | Connected  |
| <input type="checkbox"/> | NI-cRIO-9068-190D673 | 10.2.33.123 | cRIO-9068         | 190D673       | Connected  |
| <input type="checkbox"/> | NI-cRIO-9068-190FDF5 | 10.2.33.124 | cRIO-9068         | 190FDF5       | Connected  |
| <input type="checkbox"/> | PXIe-8840Quad-1      | 10.2.33.95  | NI PXIe-8840 Q... | 030E1626      | Connected  |
| <input type="checkbox"/> | PXIe-8840Quad-2      | 10.2.33.96  | NI PXIe-8840 Q... | 030DDB85      | Connected  |



## PRODUCT FEATURES

- Mass deploy software to remote hardware nodes
- Execute diagnostics functions such as restart and self-test
- View and configure device settings; classify systems according to operational context
- Automate data transfer throughout the distributed system using LabVIEW and/or Web APIs

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# Summary

- MQTT—most common IIoT communication protocol for Device to Server
  - MQTT through github or native HTTP calls
  - Feature extraction
- LabVIEW 2017
  - Native AWS S3 and RTI DDS Toolkit
  - Data storage to cloud
- NI's continual investment in IIoT technologies
- Resources
  - White paper
  - Examples

## Other NIWeek Sessions you might be interested in

- AWS Session:
  - Tue, May 23rd, 2:15 PM - 3:15 PM; 19A
  - **Leveraging AWS Cloud Services in LabVIEW**
- Azure Session:
  - Tue, May 23rd, 2:15 PM - 3:15 PM; 16A
  - **IIoT: Connecting LabVIEW, CompactRIO, and Microsoft Azure IoT**
- PTC:
  - Tue, May 23rd, 3:30 PM - 4:30 PM; Tech Theater
  - **ThingWorx Technical Overview: Create Breakthrough Solutions for the Smart Connected World**
  - Wed, May 24th, 1:00 PM - 2:00 PM; 17B
  - **Manufacturing Transformed: IIoT Delivers Unprecedented Speed**



# Industrial Internet Consortium Testbeds

## Microgrid Communication and Control



## Condition Monitoring and Maintenance



## Time Sensitive Network



4G LTE 12:54 PM

Surveys

Title  
Processing at the Edge: Why a Platform-Based Approach Is Ideal for the IIoT

Time  
Tuesday, 1:00 PM - 2:00 PM

Speaker(s)  
Nick Butler

Nick Butler

\*1. Please rate the session content on the following

Overall Quality  
- select one -

Technical Level  
- select one -

Relevance to your job  
- select one -

Relevance to published title and abstract  
- select one -

Nick Butler

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take the survey.

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[youtube.com/nationalinstruments](https://youtube.com/nationalinstruments)

Please provide feedback on this session via the NIWeek Mobile App