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PROGRAMMABLE POWER




11 December 2018

Leveraging IOT technologies to improve distributed data acquisition for large-scale integrated tests"

Overview

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Test and measurement has learned to leverage emerging technologies from the larger consumer markets to lower testing costs and improve performance. The IOT or Internet of Things world has spawned a number of new technologies necessary to make it work for the everyday consumer. One of these is a data centric middleware or connectivity framework that is now being investigated and promoted to improve capabilities for the Test and Measurement market. DDS or Data Distribution Service looks to be able to provide real world capabilities that will be able to transform test and measurement to make it truly distributed in nature. It brings several features and benefits that can be leveraged and used in both a wired sensor world or wireless sensor future.

Current Status of Large Scale Structural Testing

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- New materials and technologies are driving more channels of data acquisition (sensors)
  - *Channel counts are now in the 1000's of transducers for a single test*
  - *Primary measurements are strain, force/load, pressure, displacement and temperature*
  - *90+ percent of sensors are typically foil strain gages*

Current Status of Large Scale Structural Testing

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- End to end channel verification is time consuming and impacts the critical schedule
- Mass of the cabling can effect the response of the structure
- Transducer cable management is becoming an increasingly difficult problem to manage
- Cost of cabling for large channel count large structures is considerable
  - *Cable use can be extreme. Assuming an average of 100' per channel, 1000 channels of data can use almost 20 miles of cable. Some tests can run as high as almost 10000 channels*

What tools do we use now to help manage this issue?

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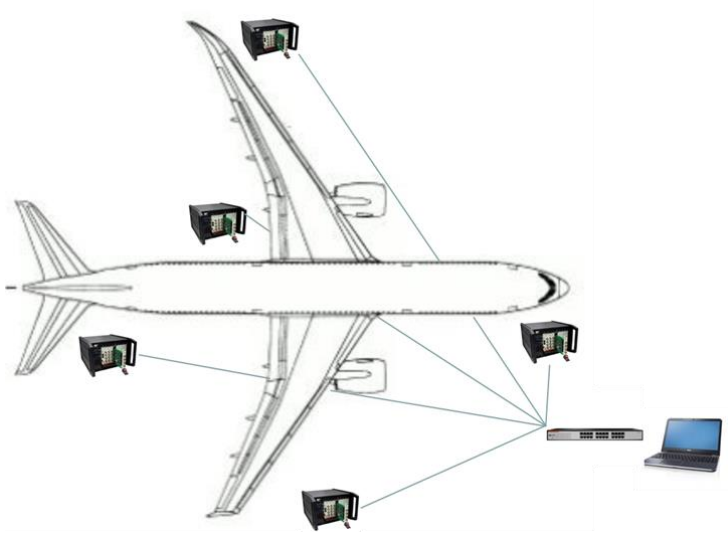
- TED's (Transducer Electronic Data Sheet) or IEEE 1451.4
  - *This helps reduce end to end checkout time and reduces cabling errors*
  - *Ideally its imbedded into the sensor but can also be contained in the cable or connector*
  - *Key sensor info can be stored in the TEDs chip including location*
- Distributed measurements
  - *Rugged or portable instruments can be placed closer to the structure*
  - *Distributing the instruments allows us to reduce cable lengths*
  - *Ethernet is a key technology that allows instruments to be located where needed*

DALLAS SEMICONDUCTOR



What tools do we use now to help manage this issue?

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- LXI improves our standard Ethernet interface by adding layers that improve interoperability and the ability to work in a test and measurement world
- POE- Power over Ethernet further reduces wires making it easier to distribute
- LXI/Ethernet allows us to better distribute the instruments but IEEE 1588 (also known as PTP or Precision Time Protocol) allows us to synchronize measurements from multiple instruments
  - *This gives us a distributed backplane with almost unlimited expansion and flexibility*
  - *Different measurement types can be fully synchronized to allow post data correlation*

LXI™

LAN eXtensions for Instrumentation

IEEE 1588 or
PTP (Precision Time Protocol)

Software and communication evolution

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- Hewlett Packard created HP-IB for instrument communications and a new communication protocol was born- SCPI (Standard Commands for Programmable Instruments)
- VXIplug&play was then created to simplify modular instrument communication
- IVI (Interchangeable Virtual Instruments) was created to solve a primary issue with interoperability between multiple vendors equipment. With so much invested in large test system programming, a need to allow a user to swap an instrument with another from a different vendor without software changes was needed. IVI was created to address that problem.
- Need to maintain these standards but continue to evolve to address future needs

So whats missing?

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- LXI/Ethernet operates over standard TCP-IP but-
  - *Latency of data might not be acceptable for some applications, especially when some level of control is needed*
  - *Determinism- TCP-IP lacks determinism that might be needed for real time data displays*
- Some testing needs require absolute certainty that data is collected. Testing to ultimate requires all data to be recorded and a level of data redundancy is needed

We still have the wires to deal with

What can we do to improve the situation-

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- A desire to improve the functionality without massive architectural changes to the way we do test and measurement
  - *Still leverage technologies like LXI/Ethernet and use standard off the shelf networking hardware*
  - *Continue to expand and leverage TEDs to simplify plug and play sensor use*
  - *Continue to take advantage of distributing the instruments but make improvement in how we distribute our instruments*
- Add the ability to easily provide data redundancy

- Investigation into existing standards and leverage those widely used by consumers and one technology that came to the top was DDS (Distributed Data Services)
  - *OMG DDS already adopted by the US Navy and US Air Force for a number of programs*

IoT Internet of Things

What is DDS?

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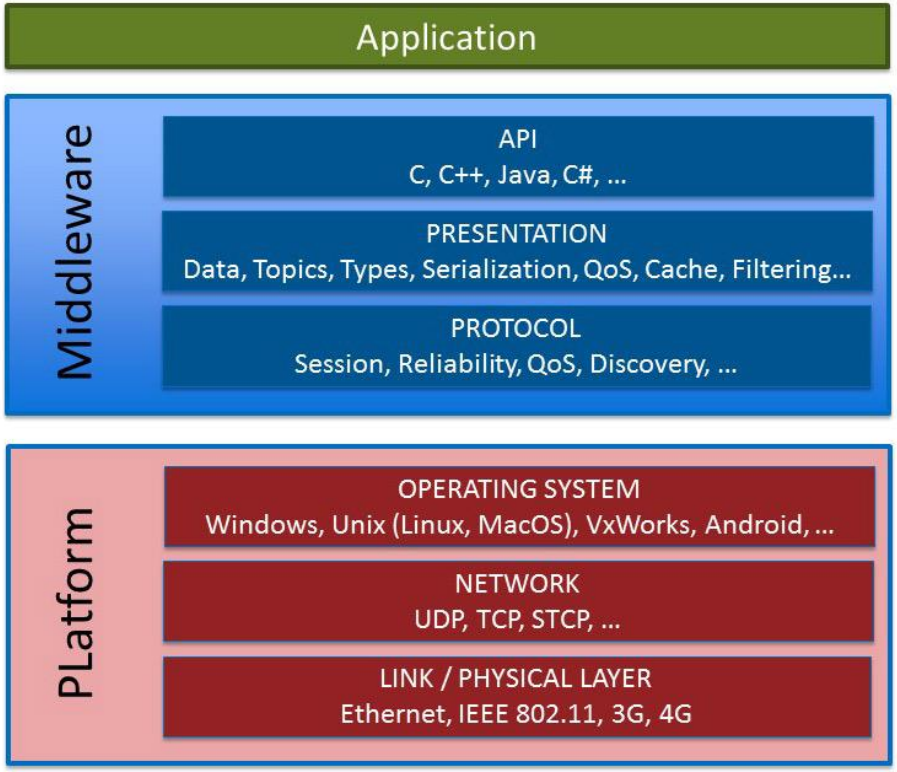
- The Data Distribution Service (DDS™) is a middleware protocol and API standard for data-centric connectivity. It integrates the components of a system together, providing low-latency data connectivity, extreme reliability, and a scalable architecture that business and mission-critical Internet of Things (IoT) applications need.
- In a distributed system, middleware is the software layer that lies between the operating system and applications. It enables the various components of a system to more easily communicate and share data. It simplifies the development of distributed systems by letting software developers focus on the specific purpose of their applications rather than the mechanics of passing information between applications and systems.



http://portals.omg.org/dds/

What is DDS?

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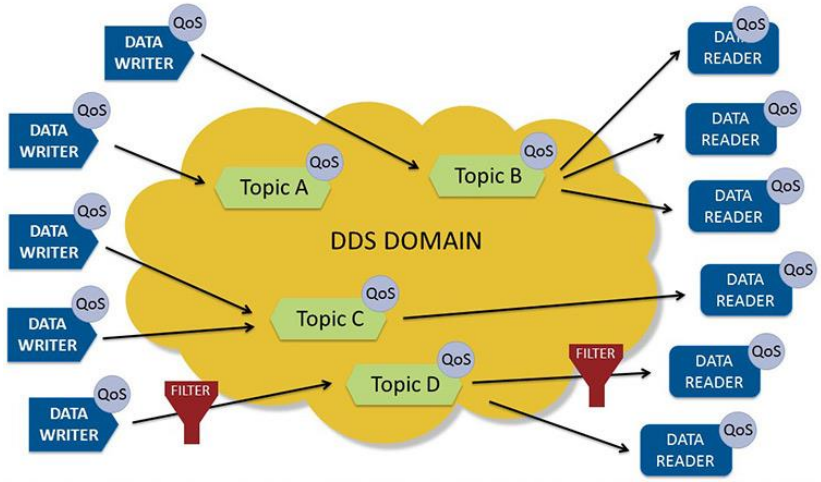
DDS is often described as being composed of Subscribers (data readers or acquisition computers) and Publishers (data writers or test instruments)

DDS is Data Centric

- DDS is uniquely **data centric**, which is ideal for the Internet of Things. Most middleware works by sending information between applications and systems. Data centricity ensures that all messages include the contextual information an application needs to understand the data it receives.
- The essence of data centricity is that DDS knows what data it stores and controls how to share that data. Programmers using traditional message-centric middleware must write code that sends messages. Programmers using data-centric middleware write code that specifies how and when to share data and then directly share data values. Rather than managing all this complexity in the application (your) code, DDS directly implements controlled, managed, secure data sharing for you.

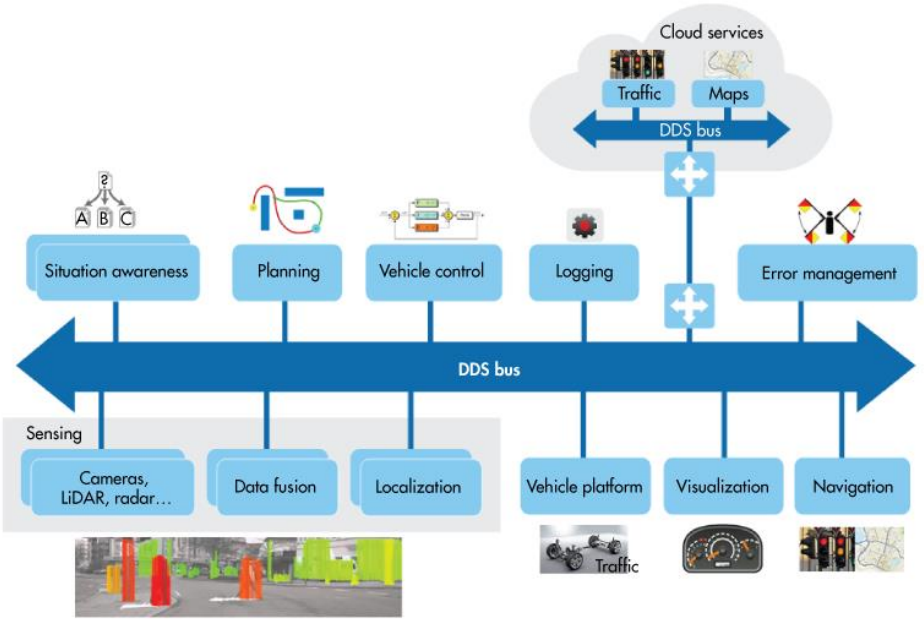


DDS Self driving car example

A wide range of sensors publish data into the Global Data Space (DDS bus)

Data readers or subscribers can then read data as needed and act upon it

- Video and Sensor recording
- Logging or storing the data
- Performing vehicle control
- Situation awareness
- Driver Feedback
- Interacting with Automotive Data



Typical Test and measurement system

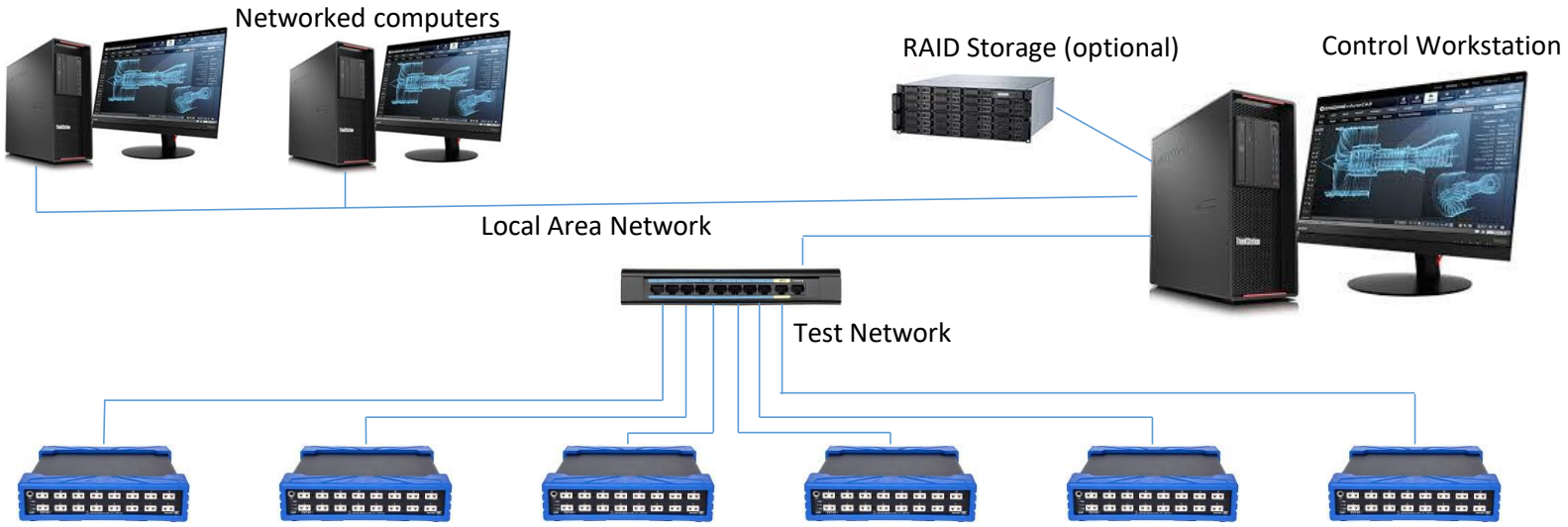
Current Test and Measurement Model with distributed data acquisition

Advantages

- System is expandable and distributed
- Data flows into a central workstation for storage and processing
- Provides for large storage and data can be saved on local storage (can be RAID) or moved to the cloud

Disadvantages

- Central workstation required to do all data storage, processing and any data forwarding
  - Single point of failure
  - May require high end workstation to record, process and forward data



DDS distributed measurement system

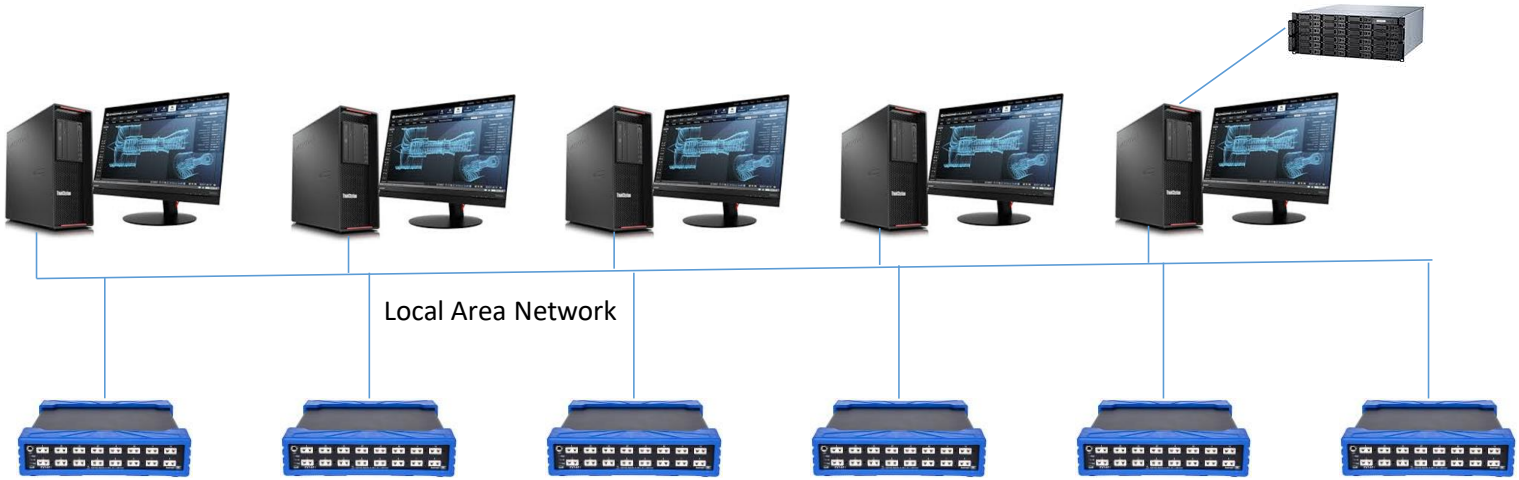
DDS test and measurement configuration

Advantages

- Each instrument can be stand alone but still be synchronized for true distribution
- Data flows into the network and can be recorded or processed by a single or many computers
- One or more work stations can record data (redundancy), others can provide processing, analysis, and real time displays
- Instruments can be added or removed while taking data without effecting the other instruments
- DDS provides a high level of security
- Direction that the larger technical community is going so more future proof

Disadvantages

- Requires the instruments to be smarter so that they can publish or push data onto the network.
- New technology to Test and Measurement



How do we leverage DDS for test and measurement

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- A need for a unified standard to protect investment from both the instrument providers and provide flexibility to the end users
- Instrumentation DDS working group was created
  - *Currently managed by MDS Aero*
  - *Initial definition came from Rolls-Royce*
  - *Goal is to create a standard IDL (Interface Description Language)*
- A number of instrumentation vendors, end users, and application providers are participating in the consortium
  - *Rolls-Royce*
  - *MDS Aero*
  - *VTI Instruments / Ametek*
  - *HGL*
  - *UEI*
  - *Bruel and Kjear*
  - *ATCOM*
  - *-Safran*
  - *-MTU*
  - *-Mueller BBM*
  - *-Scanivalve*
  - *-TE/PSI*
  - *-National Instruments*

http://iddswg.org/forum/

Summary

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- DDS gives us the following benefits:
  - *Low Latency and determinism*
  - *Data redundancy as needed*
  - *Better security to allow instruments to live on a larger network*
  - *Software agnostic (doesn't care what OS we want to use)*
  - *Hardware interoperability- application software can support instruments all using the same IDL file format*
- When?
  - *Currently in development, instruments supporting this will be available in 2019*
  - *Turbo Fan guys will be the early adopters*

Thank you for your time …

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