2022 ODVA

INDUSTRY CONFERENCE
AND 21ST ANNUAL MEETING

21st Annual Meeting of Members

March 10, 2022

Agenda

- Call to Order
- Activities of the Corporation: 21st Term in Review
- Introduction to Candidates for Election by the Regular Membership
- Election and Break
- It's Not Enough to Be Smart: A User's Perspective on Smart Process Instrumentation and Networks
- Industrial Automation 2030: A Discussion of Industry's Next Steps
- Looking Ahead to the 22nd Term
- Adjourn

21st Term in Review

- Al Beydoun, President & Executive Director, ODVA
- Adrienne Meyer, VP of Operations and Membership, ODVA
- Joakim Wiberg, CTO and Chair of TRB, HMS Networks

21st Term in Review

- Overall Review of Activities
    - Organization and Board update
    - Key accomplishments
    - Key activities in specific regions
- Membership Review
    - Current status
    - Planned updates
- Technology Review

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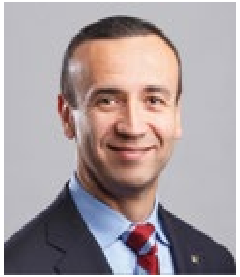
Board and Organization Updates

Board of Directors

Dr. Rolf Birkhofer
Endress+Hauser



Mr. Jon DeSouza
HARTING

Mr. Satoshi Kojima
OMRON

Mr. David Lagerstrom
TURCK

Mr. Samuel Pasquier
Cisco Systems

Mr. Thomas Petersen
Danfoss

Mr. Brian Reynolds
Honeywell

Mr. André Uhl
Schneider Electric

Dr. Juergen Weinhofer
Rockwell Automation

Technical Review Board

- Mr. Raj Bandekar, Honeywell
- Dr. Rudy Belliardi, Schneider Electric
- Mr. Mirko Brcic, Endress+Hauser
- Dr. Vivek Dave, HARTING
- Mr. Paul Didier, Cisco
- Mr. Gregory Majcher, Rockwell Automation
- Mr. Shinji Murayama, Omron
- Ms. Roxana Sudrijan, Molex
- Mr. Joakim Wiberg, HMS Networks

Market Advisory Committee

- ODVA's Market Advisory Committee was established during the last term by the Board of Directors to provide additional member input on the overall direction of industry.
- The MAC's mission is to assess the state and future of ODVA technologies, including their global and regional adoption and utilization. The MAC will provide recommendations and advice to the Board.
- A call for nominations was sent out to the Regular Membership in January 2021, and the Board of Directors appointed the initial slate of representatives in March 2021.
- The MAC has been meeting regularly since May 2021 to review and advise on ODVA technology growth.

Market Advisory Committee

- Mr. Joe Bastone, Honeywell
- Mr. Elango Ganesan, Cisco
- Dr. Vivek Hajarnavis, Rockwell Automation
- Mr. McKenzie Reed, HARTING
- Mr. Ryo Shimizu, Omron
- Mr. Tom Weingartner, Analog Devices
- Ms. Tonya Wyatt, Micro Motion
- Ms. Feiyan Zhao, Schneider Electric

21^{st} Term in Review

- Grew membership to over 365 members and welcomed HARTING as the newest Principal Member of the association
- Continued to enhance and expand ODVA's technologies through 13 active working groups, bringing over 80 specification enhancements in key areas like CIP Security, Ethernet-APL, and in-cabinet and resource-constrained devices
- Formed and launched the Market Advisory Committee to help advise the organization on market trends
- Promoted ODVA's technologies at global virtual events and trade shows
- Continued to grow adoption of ODVA's technologies by offering virtual training during the pandemic
- Focused on growth in China through the standardization and translation of EtherNet/IP to Chinese GB/T Standard

21^{st} Term in Review

- Continued to develop support for EtherNet/IP over TSN within ODVA, with participation in the 60802 TSN Industrial Profile, by collaborating with industry organizations to develop Conformance Specification for TSN Industrial Profiles, and through a committee of the TRB to refine the path forward
- Recertified CIP Safety Volume 5 Edition 2.22 for Compliance with IEC 61784-3 Edition 4 with TÜV Rheinland.
- Collaborated on device integration both with the FieldComm Group in establishing support for EtherNet/IP with FDI Device Package and FDI tools and with the FDT Group in integrating EtherNet/IP with the FITS architecture
- Continued to expand the EtherNet/IP ecosystem to meet the needs of Industry 4.0 and IIOT through joint working groups to develop an OPC-UA companion specification for EtherNet/IP
- On-going progress to develop ODVA's xDS next generation digital device descriptions

Thank you for your service to ODVA!

Congratulating on their retirement key member contributors who have been instrumental to the success of ODVA and its technologies, including:

- Kevin Knake, former chair of Roundtable
- Ray Romito, original contributor to DeviceNet and many other roles
- Steve Zuponcic, former chair of Distributed Motion SIG

We wish all ODVA Community members who retired this past term all the best on their next endeavors!

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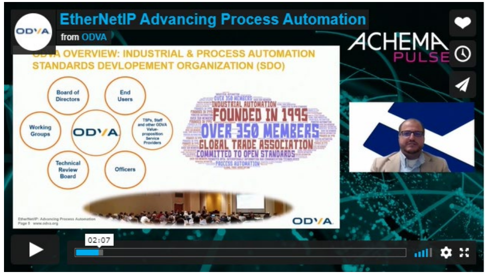
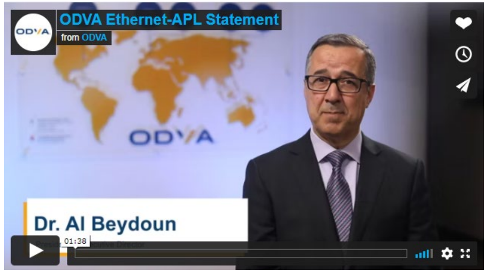
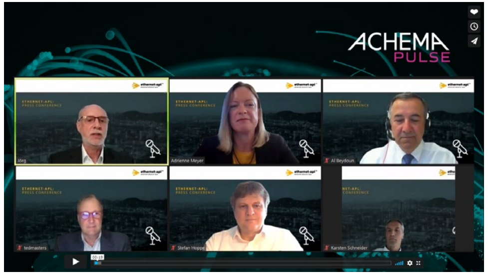
Highlights of Key Activities: Territory Alliance Groups (TAGs) and Global Outreach

Major Trade Shows in Europe – Engaging Virtually

- Hannover Messe Digital 2020 and 2021
- SPS Connect 2020
- ACHEMA Pulse 2021







Education for Members and Vendors

- **EtherNet/IP Quick Start Training**
- **CIP Safety Quick Start Training**
- **Technology Update to the Membership**

Special thanks to ODVA Members who have been on the training team:

- Drew Baryenbruch, Real Time Automation
- Chatrapathi, Utthunga
- Jamie Gallant, Hilscher
- Jim Grosskreuz, Rockwell Automation
- Oliver Haya, Rockwell Automation
- Vivek Hajarnavis, Rockwell Automation
- Andreas Kramer, HMS Networks
- Stefan Kraus, HMS Networks
- Rob Lodesky, HMS Networks
- Michael Schaffner, Rockwell Automation

TAG China

- CEC forum

- September, 2020
- 200+ attendees
- Interview

TAG China

- Automation seminar

Online promotion on www.gongkong.com

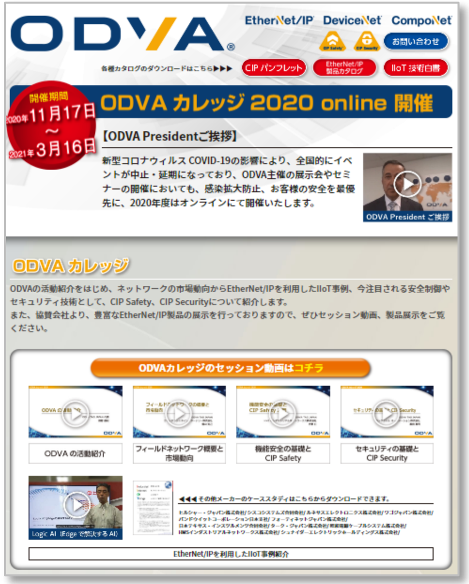
- Technical Blog
- Seminar Video
- Q & A
- Members' interaction

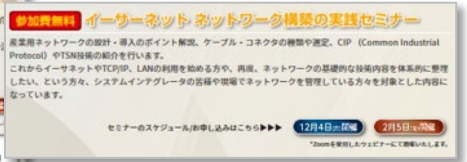
TAG Japan

- ODVA College 2020 Online

Event name	Date / Number of participants	
ODVA College 2020 Online	Nov 17th,2020 - Mar 16th, 2021	185

[WEB page]





Event name	Date / Number of participants	
Implementer Seminar	Dec 10th, 2020	29
Network Seminar	Dec 4th, 2020	32
Implementer Seminar	Feb 4th, 2021	28
Implementer Seminar	Feb 5th, 2021	24

TAG Japan

- IIFES 2022

[Real Exhibition] Booth design that was planned to be exhibited

Event name	Date / Number of page accesses	
IIFES 2022 Real	Jan 26th - 28th, 2022	Cancel
Online	Jan 26th - Feb 25th, 2022	641

[Online Exhibition]

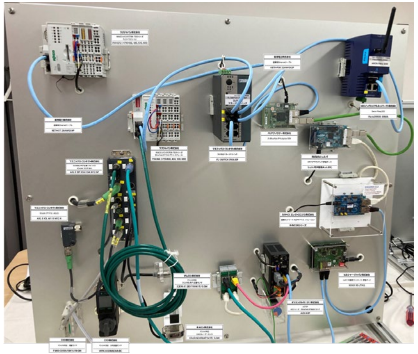
1.ODVA activity introduction

2. EtherNet/IP product introduction

3.CIP Safety/CIP Security

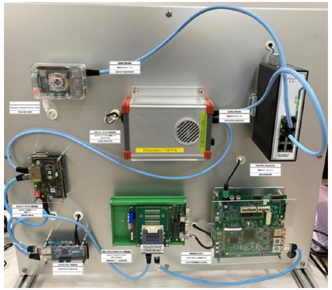
TAG Japan

- Demonstration machine renewal
  - TAG Japan members have newly created "self-supporting mobile demo machines" for each of the five categories.
  - The created demonstration machine will be used in future TAG Japan exhibitions and seminars.



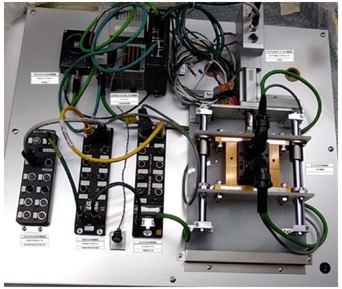
【DLR(Device Level Ring)】
(W900xH800mm)
- Introducing the redundant system configuration by DLR.
- Introducing connectivity with IO-Link and remote maintenance.

【Multi Vendor】
(W700xH600mm)
- Introducing the openness and abundant product lineup of EtherNet/IP.



【Embedded for device development】
(W700xH600mm)
- Introducing embedded devices that develop EtherNet/IP devices.

【CIP Safety】
(W700xH600mm)
- Introducing CIP Safety on EtherNet/IP.



【Quick Connect】
(W700xH600mm)
- Introducing high-speed switching by the Quick Connect function of EtherNet/IP.

TAG Korea

- During the pandemic period (2020-2021), six Korean main magazine companies published ODVA activity status monthly

[1.ELECTRONIC SCIENCE]

[2.MMOACI]

[3.ICN]

[4.CONTROL]

[5.CIT]

[6.AUTOMATION SYSTEMS]

- From January 2020 to December 2021, the total number of technology magazines that printed ODVA's promotional articles was 77 total issues.

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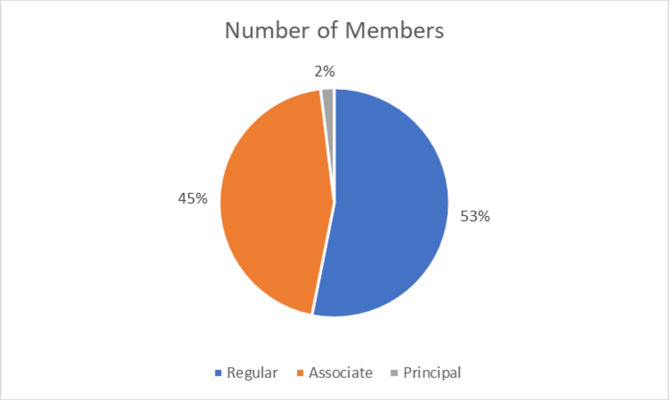
Membership Update

Growth over the 21st Term

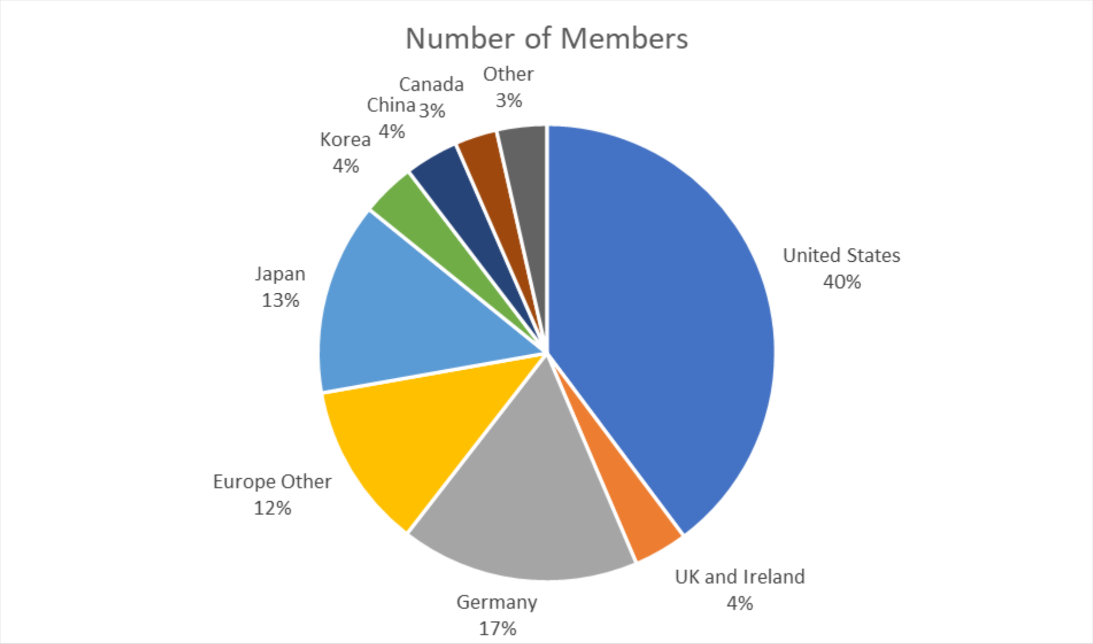
- ODVA made progress in a virtual world
  - Membership grew by over 3.5%, and interest in membership continues to be solid
  - EtherNet/IP adoption increased over 90 new vendor IDs issued



Membership Level on December 31, 2021	Number of Members
Principal	7
Regular	195
Associate	165

Mix of Membership by Membership Class, as of December 31, 2021

Growth over the 21st Term



Country	Number of Members
United States	146
UK and Ireland	14
Germany	62
Europe Other	43
Japan	50
Korea	14
China	14
Canada	11
Other	13

Mix of Membership by Principal Place of Business, as of December 31, 2021

Growth over the 21st Term

- ODVA made progress in a virtual world
  - First ever ODVA Member Survey was launched, and responses from members have helped shape activities, including:
    - Market Advisory Committee was developed, approved, and launched
    - Vendor training events were offered for free and expanded
    - A virtual technology development update was organized to allow the TRB and SIG to keep members informed and engaged
    - Members now receive the ODVA ToolBox for EtherNet/IP integrated learning environment free with membership
    - Members received additional free listings on marketplace.odva.org to promote their products
    - EtherNet/IP and CIP Safety vendor education was expanded, and development of a CIP Security course has begun
    - Test policy issues and solutions under review to ensure clear, consistent, and equitable applications of tests
    - Expanded marketing reach to end users via new videos, advertising, and social media posts

Looking to the Future

Our focus for the 22nd term

- Expand information and education for members
  - Continue work to develop an online knowledgebase for vendors
  - Continue development of additional training and educational tools, including a focus on hands-on training and deep technology dives
  - Expand language access of www.odva.org
- Streamline processes for easier and better access by members
  - Select and integrate new customer management systems to ensure that members receive accurate and prompt information with ease of access
  - Finalize review and create clear actions on test policies and procedures
- Continue to expand ODVA Community opportunities and input
  - Investigate how ODVA can further support product development
  - Expand co-education, marketing, and member participation roles

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Technology Review

SIG Work Summary

- A total of 80 SEs and TDEs
- Two publication cycles in 2020
- Three publication cycles in 2021 – extra to incorporate Ethernet-APL content

- A total of 27 volume revisions
  - Vol 1 – 4
  - Vol 2 – 4
  - Vol 3 – 1
  - Vol 4 – 1
  - Vol 5 – 3
  - Vol 6 – 1
  - Vol 7A – 1
  - Vol 7B – 1
  - Vol 7C – 2
  - Vol 8 – 4
  - Vol 9 – 3

Key Accomplishments since last Annual Meeting

- Constrained EtherNet/IP devices
  - Protocol definitions for EtherNet/IP and CIP Security
  - Drives down the cost for end nodes
  - Foundation for the in-cabinet use case
  - EtherNet/IP down to the smallest devices
    - Profiles for push button and pilot light devices
  - Core technology for IIoT infrastructure
    - With CIP Routers the smallest sensors may be modeled
    - Together with the OPC UA Companion Specification for CIP an ideal vertical data transport

Key Accomplishments since last Annual Meeting

- OPC UA
  - Supporting the OPC Foundation Joint Workgroup for OPC Companion Specification to the Common Industrial Protocol
  - Identity Object Alignment with OPC
    - Adds additional attributes to support additional properties of OPC Part 100: Devices

Key Accomplishments since last Annual Meeting

- EtherNet/IP in Process Automation
  - Ethernet-APL support added to Volume 2, Chapter 8 specification
  - Device Type Revision
    - Provides a common way to report a revision for a Device Type/Profile definition

Key Accomplishments since last Annual Meeting

- Project xDS
  - Requirements analysis and proposals for key components
    - Conformance Information
    - Parameter Dependencies
    - Cybersecurity
    - Artifact Packaging
  - AutomationML Investigation
    - Sample AML models of xDS reference devices created

Key Accomplishments since last Annual Meeting

- CIP Safety
  - Recertification of CIP Safety Volume 5 Edition 2.22 for Compliance with IEC 61784-3 Edition 4 by TÜV was completed

Key Accomplishments since last Annual Meeting

- Time Sensitive Networking
  - High level approach for EtherNet/IP + TSN completed
    - Document major technical aspects and decision points
    - Define work packages for SIGs
  - Early draft for 802.1AS-2020 as an optional Time Profile for CIP Sync Object

Key Accomplishments since last Annual Meeting

- Conformance
  - Developed detailed test plan for originator interoperability
  - Conformance Testware is up-to-date with 2021 PC2 CIP Networks Library

Key Planned Activities for Next Term

- EtherNet/IP
  - Start looking at IPv6 - again
  - General purpose use of SPE
  - Gigabit Ethernet Physical Layer
  - Time Sensitive Networking
    - Synchronize with IEC/IEEE 60802 TSN Profile for Industrial Automation
    - Start developing specification material

Key Planned Activities for Next Term

- Project xDS
  - Begin develop material for the formal specification
  - Continue development of an EZ-xDS prototype

Key Planned Activities for Next Term

- OPC UA
  - Continue assist OPC Foundation JWG developing the OPC Companion Specification for CIP
  - Seamless mapping of CIP data

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It’s Not Enough to be Smart

A User’s Perspective on Smart Process Instrumentation and Networks

Paul R. Maurath
The Procter & Gamble Company

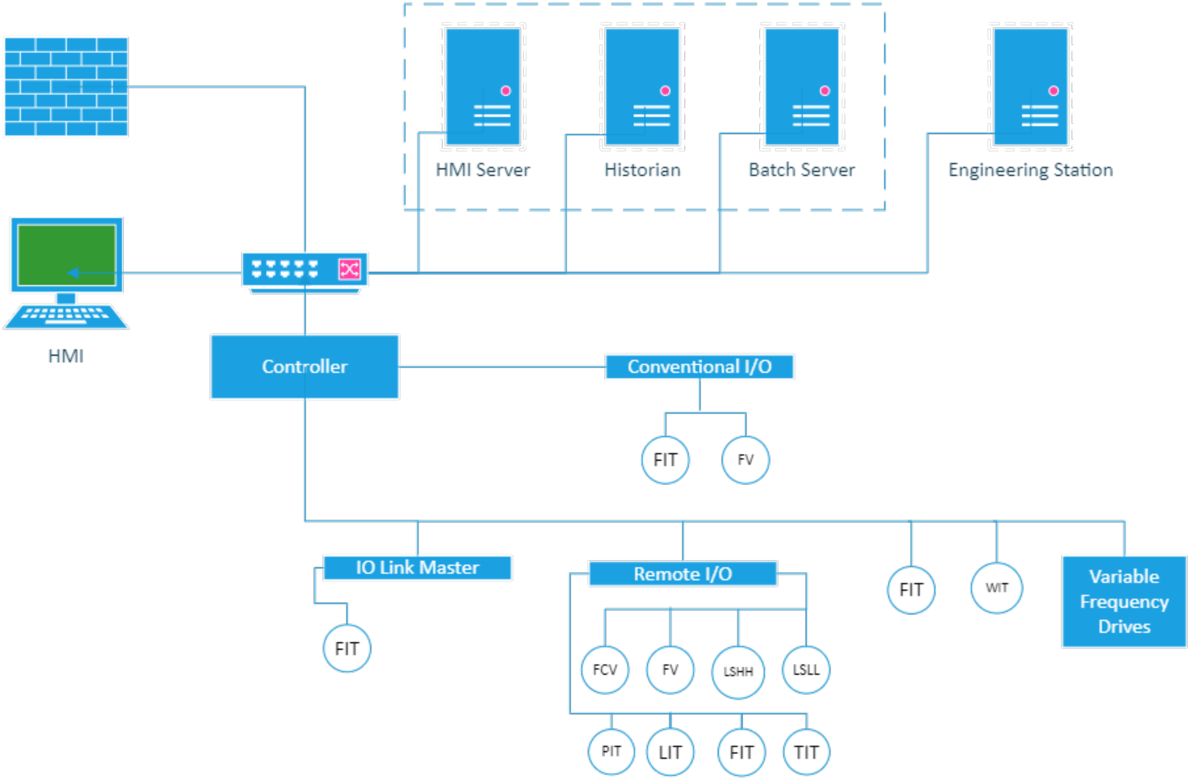
Brief Resume

- B.S. / Ph.D. in Chemical Engineering
- 36 years with Procter & Gamble
- Focus areas
  - Process automation and control
  - Control loop performance and tuning
  - Process instrumentation
  - Community manager of the internal P&G automation and control global community.

Today's Process Instrumentation "Network"

- Conventional I/O dominates
  - Highly distributed
  - Ethernet backbone
- Discrete devices are simple ON/Off
- HART is broadly available for analog devices but not highly leveraged
- Ethernet is becoming more important
  - Backbone of Remote I/O
  - Drives of all kinds
  - Complex / multivariable instruments
    - Coriolis flowmeters
    - pH transmitters
- Typically on an isolated private network (192.168.1.xxx)

PI Network Example



Business and Technical Drivers

- “Smarter” devices with more data to share
- More systems want that data
  - Maintenance
  - Data Analytics
- Continued penetration of Ethernet farther down in the architecture
- Key process industry needs have not been met by mainstream IT Ethernet technologies.
  - Multi-conductor fragile wiring
  - Long distance wiring (not fiber)
  - Loop powered devices
  - Electrically classified areas
- New networking technologies
  - Advanced Physical Layer (APL)
  - IO Link

Advanced Physical Layer (Ethernet-APL)

Emerging Single Pair Ethernet / 2-Wire Intrinsically Safe Ethernet Standard for Process Automation Protocols

Process Industry Requirements for Ethernet field devices

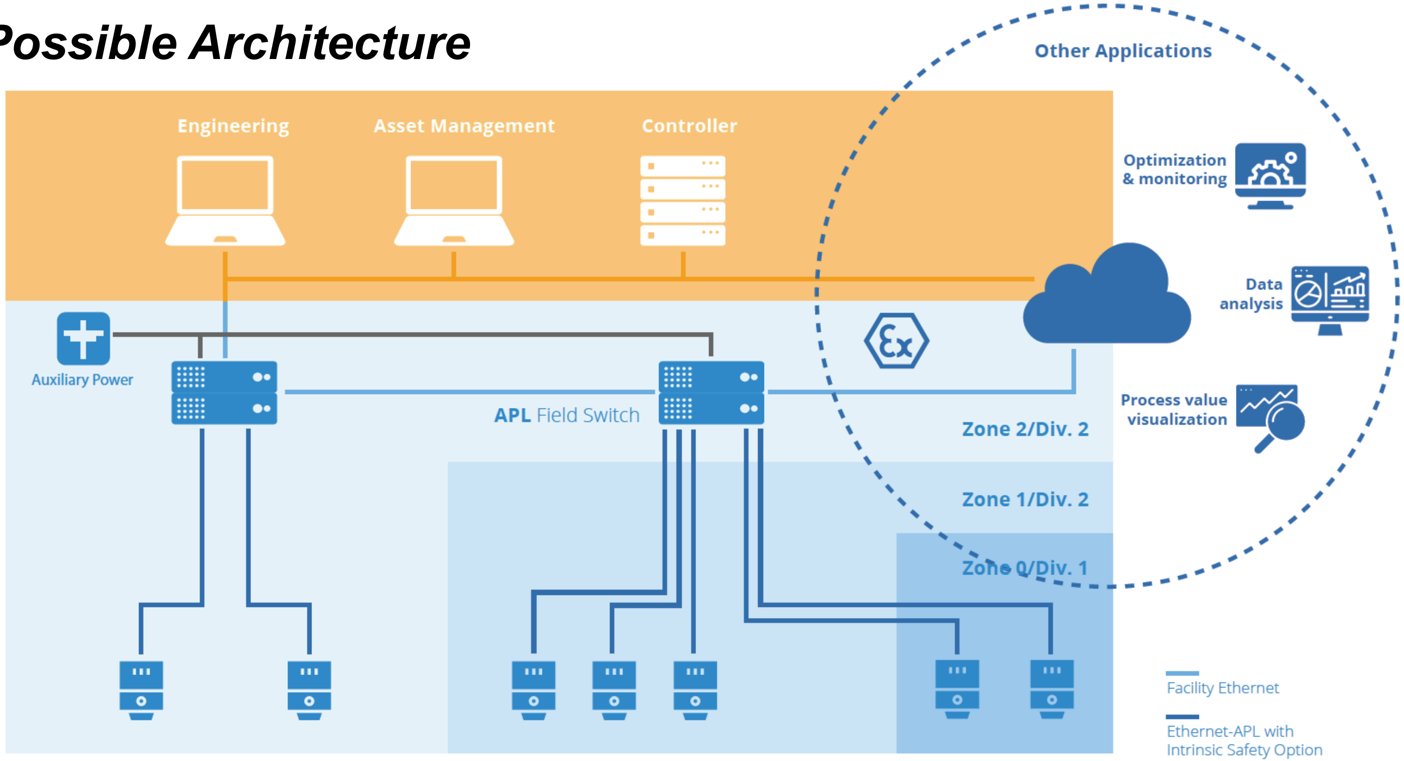
- Twisted pair cabling
- Deployable in electrically classified / hazardous areas
- Reaching long distances
- Easy to handle technology
- Connectors for harsh conditions
- Loop-powered devices

Ethernet-APL is a 2-wire Ethernet (Physical Layer) for **process automation**, based on

- IEEE 802.3cg-2019, 10BASE-T1L
- IEC standards (IEC60079, IEC61158)
- Communication protocol independent

Advanced Physical Layer (Ethernet-APL)

Possible Architecture



P&G APL Demonstration Learning Objectives

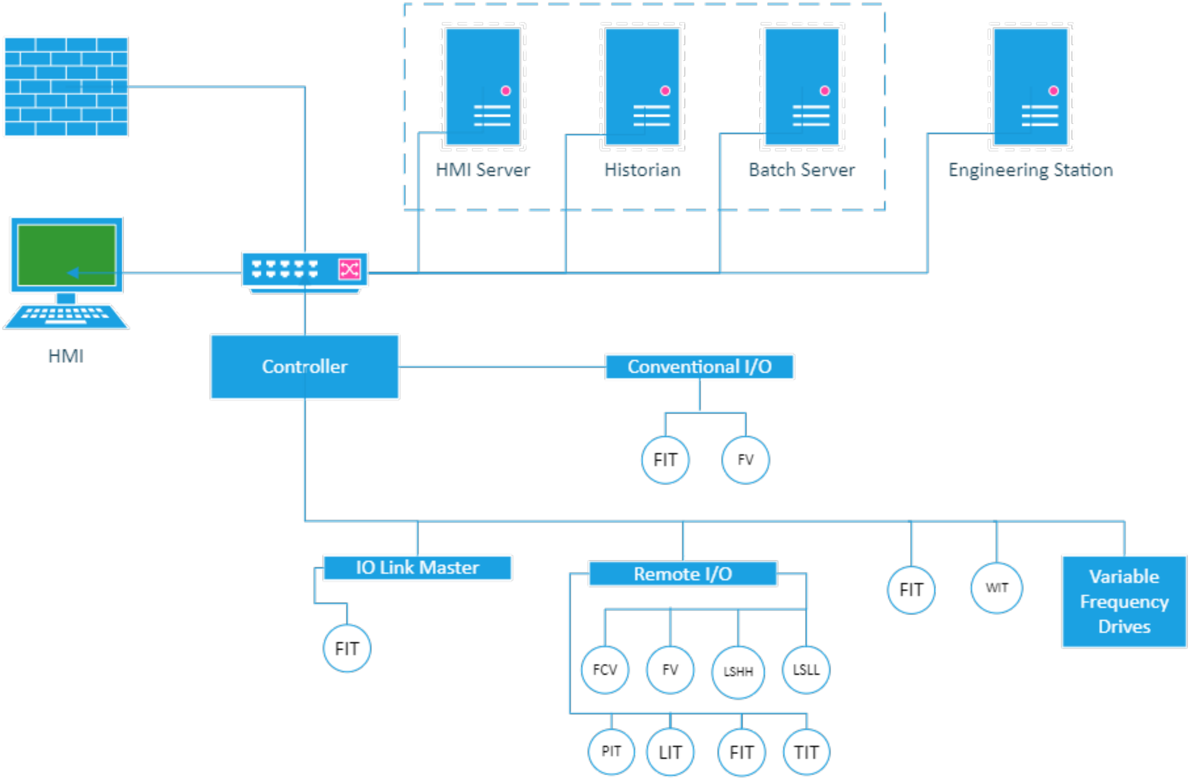
1. ***Gain an understanding of the knowledge and skills required to implement and maintain APL***
2. ***Assess the potential benefits of APL for P&G***

- Basic installation and wiring of switches and instruments.
- Instrument configuration and replacement
- Network and switch configuration and management
- Interoperability between switches and instruments from multiple vendors
- Instrument update rates and impact of faster communications vs. HART
- Access to multiple variables and diagnostic information
- Potential impact of higher power availability – conversion of 4-wire devices to 2-wire
- Functional comparison of APL vs. other communications such as 4-20 mA HART, IO-Link

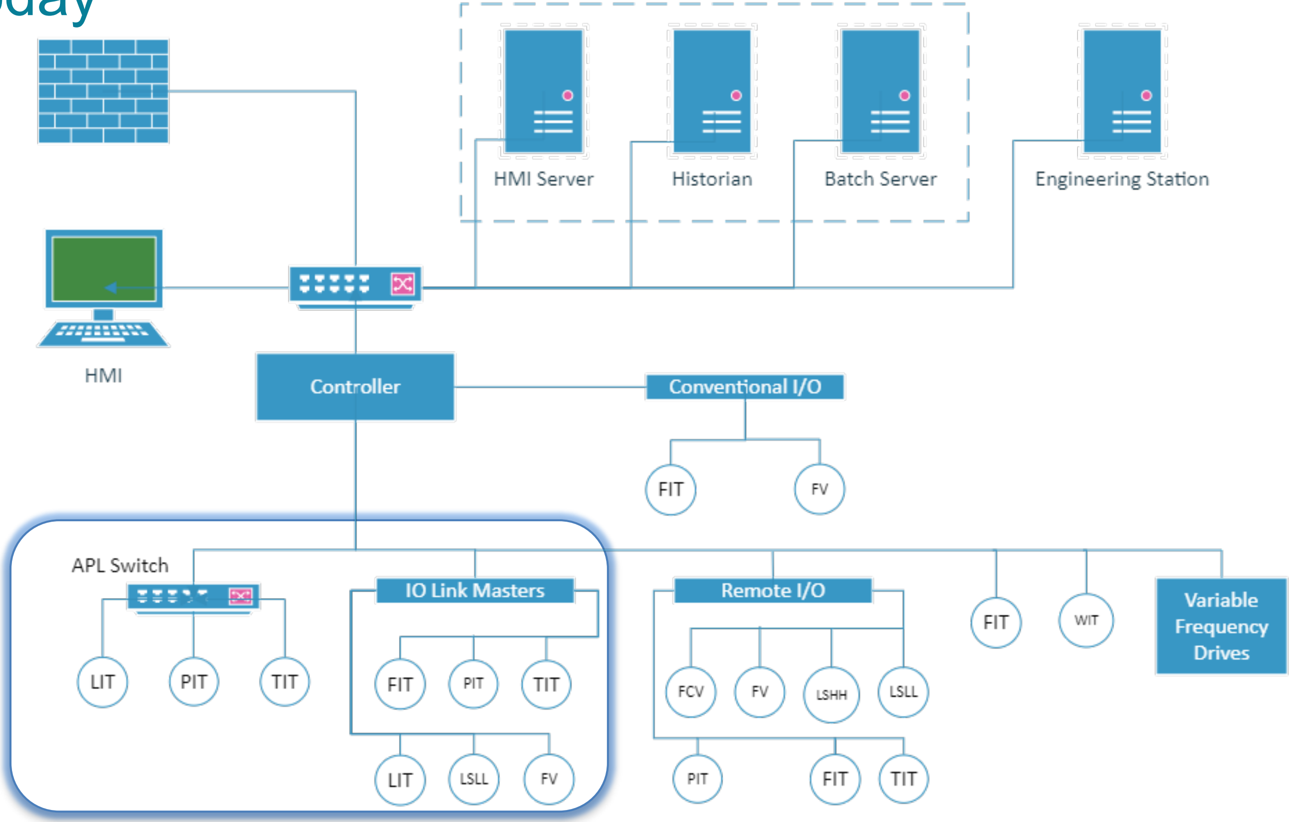
Smart Process Cell – “SPC”

- Located at P&G Corporate Engineering Technology Lab (CETL) in West Chester, OH
- Process Equipment
  - Four tank (500 kg and 375 kg)
  - Six pumps with flowmeters
  - Continuous and batch operations (3 units)
- Process Fluid – water
- Fully self-contained and remotely operated

The SPC Automation Network (December 2019)



The SPC Today



Our APL Results – APL Works!

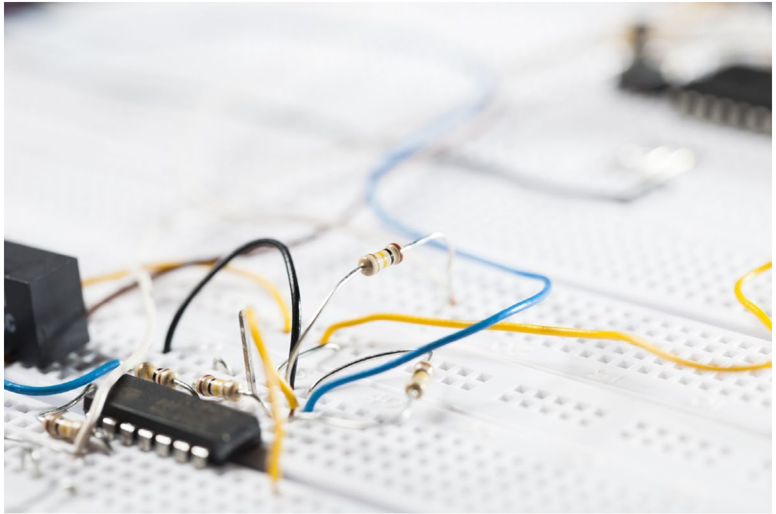
Initial Benchtop Tests

Using EtherNet/IP

Largest barrier was assigning IP addresses

Three devices were “bricked” and had to be returned to their suppliers

Communications established with our controller after importing EDS files



Field Tests on the SPC

Straightforward wiring

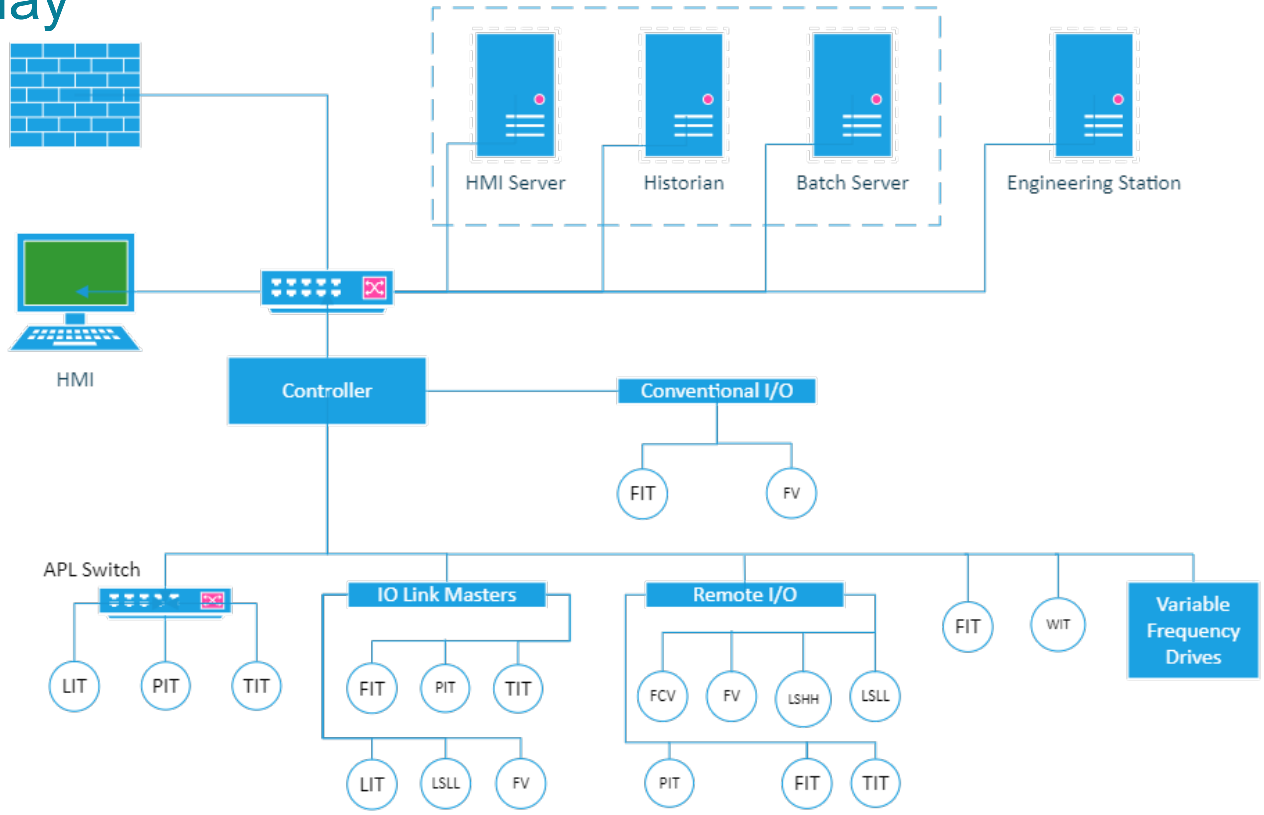
Replaced existing 4-20 mA / HART instruments

APL was completely “invisible” to the controller

Devices looked like any other EtherNet/IP device

Parallel testing of multiple IO Link devices.

The SPC Today



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- Functional comparison of APL vs. other communications such as
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What Do Users Need?

Help Us Manage Complexity

Hand tools

DVM

HART Communicator

BootP

DHCP

IODD

EDS

Profiles

Firmware Rev

Data Model

The World of Logitech Mice for Windows

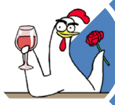
Replacing a Mouse

The user . . .

Removes old mouse

Connects new mouse

Wait



Uses new mouse

Windows . . .

Loses connection to old device

Sees a new "pointing device"

- Finds an appropriate driver, using the network connection if it needs to.

Installs the new driver

Tells you it's done.

Replacing a Mouse

The user . . .

Removes old mouse

Connects new mouse

Wait

Uses new mouse,
but no emojis.

Windows . . .

Loses connection to old device

Sees a new “pointing device”

- Finds an appropriate driver, using the network connection if it needs to.

Installs the new driver

Tells you it’s done.

Replacing a Gaming Mouse

The user . . .

Removes old mouse

Connects new mouse

Wait

Uses new mouse, but
lost 15 button configurations

Windows . . .

Loses connection to old device

Sees a new "pointing device"

- Finds an appropriate driver, using the network connection if it needs to.

Installs the new driver

Tells you it's done.

Replacing a 4-20mA HART Pressure Transmitter

In the field

- PIT — Remove old transmitter
- PIT — Connect new transmitter
-  Configure the range in the new transmitter
- It probably works.

In the application / controller . . .

- Loses connection to old device
- Valid connection to a new device
- Check scaling
- Valid signal

Replacing A Smart Device (EtherNet/IP, IO Link, etc)

In the field

PIT — Remove old transmitter

PIT — Connect new transmitter


Configure communications


Does it work?

In the application / controller . . .

Loses connection to old device

Does the new device communicate?

- New configuration file?
- Do I have to restart/reload the controller?

Is the data structure the same?

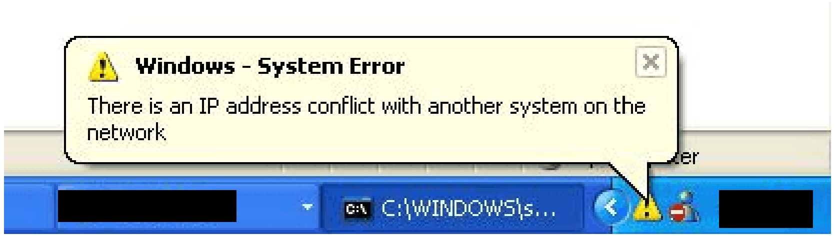
- Do I have to change application code?

How long will it take to get back up?

Where Do Users Need Help With Smart Devices

Communications

- IP Address Assignment
  - DHCP, BootP
  - Local displays
  - Dip switches
  - Selector wheels
- Switch port based DHCP ?
- Watch out for assumptions
  - 192.168.1.x
  - 10.10.x.x
  - ????



Where Do Users Need Help With Smart Devices

Integration and Compatibility

- Configuration Files / Drivers
  - EDS files
  - IODD files
- Easy replacement of “like for like” devices
  - Temperature
  - Pressure
  - Switches

What skills will be needed to troubleshoot and repair our smart systems?

Where Do Users Need Help With Smart Devices

Configuration Confusion

How many ways are there to change the configuration of a smart process transmitter?

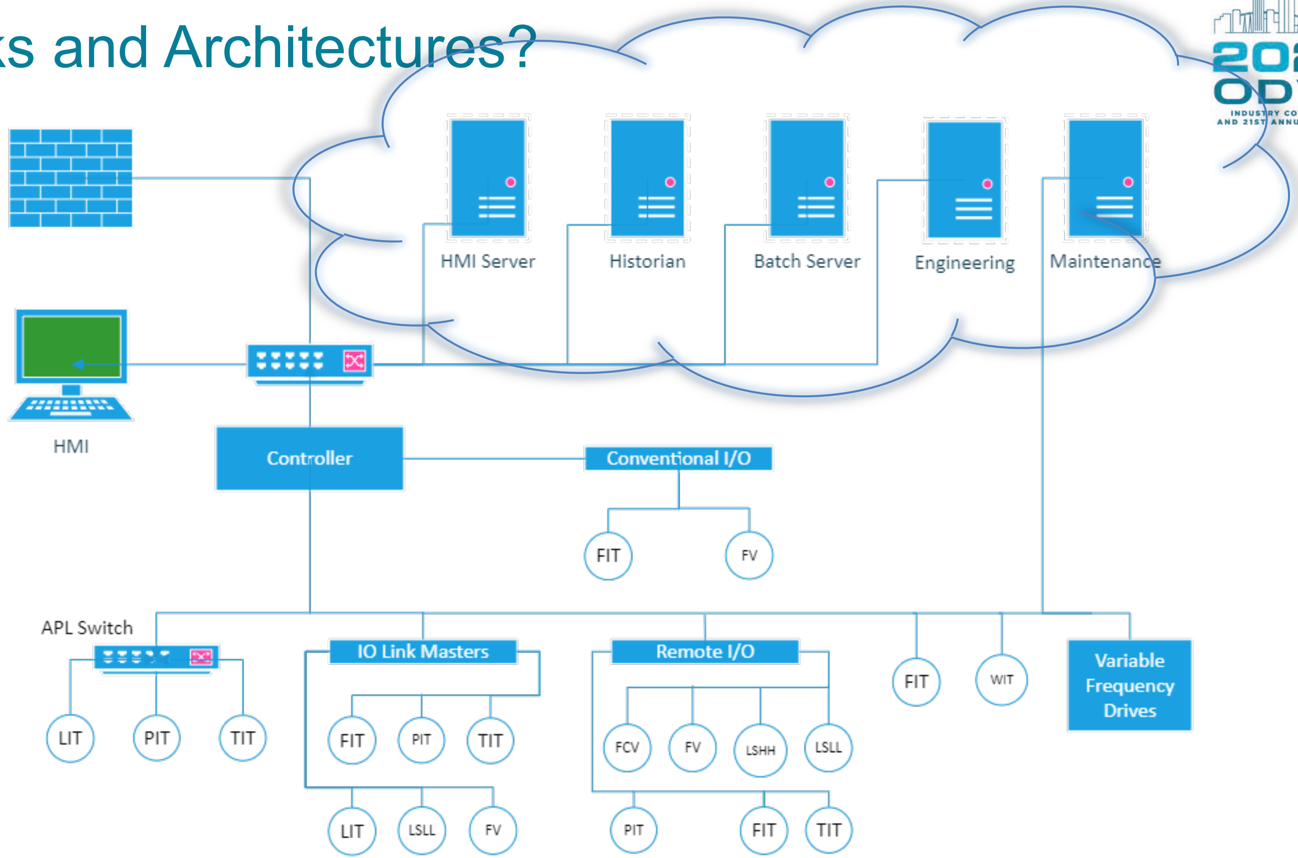
- Local display
- Field communicator
- Controller programming software
- Asset management system
- Web interface

Do they all show the same information?

Who has the "Master Copy"?

Future Networks and Architectures?

- Cloud
- Less controller-centric?
- Different protocols
- Users will need standards



Conclusions

- Standards are great!
- Please put the end users front and center when creating and managing standards.
- New technologies need to deliver functionality and simplicity.

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Thank you for your attention

Industrial Automation 2030

A Discussion of Industry's Next Steps

March 10, 2022

Harry Forbes
Research Director
ARC Advisory Group
HForbes@ARCweb.com

Agenda

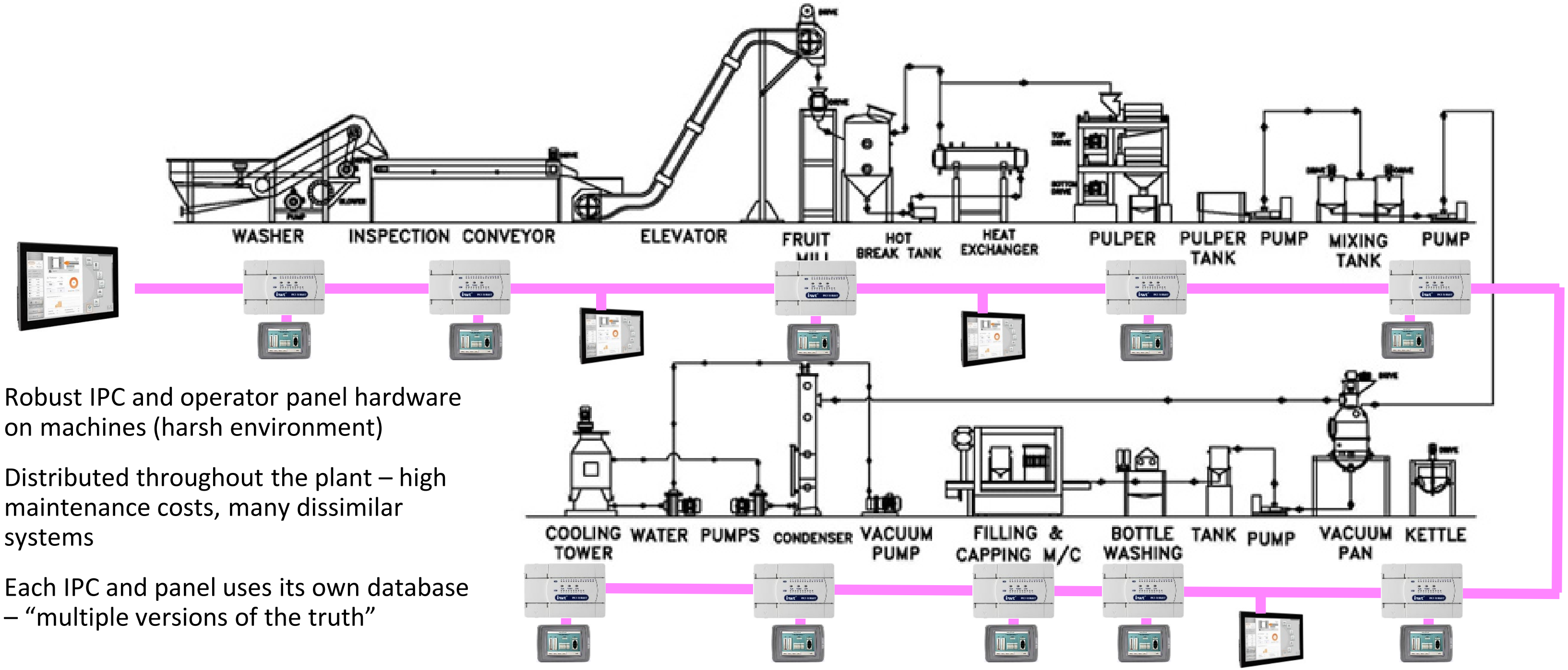
- Why so slow?
- The view of one leading, large (and pesky) manufacturer
- What is it that the automation industry not seeing?
- The shape of (automation) things to come
- “Would you like TSN with that?”

Agenda

- **Why so slow?**
- The view of one leading, large (and pesky) manufacturer
- What is it that the automation industry not seeing?
- The shape of (automation) things to come
- “Would you like TSN with that?”

Innovation Cycles in Automation

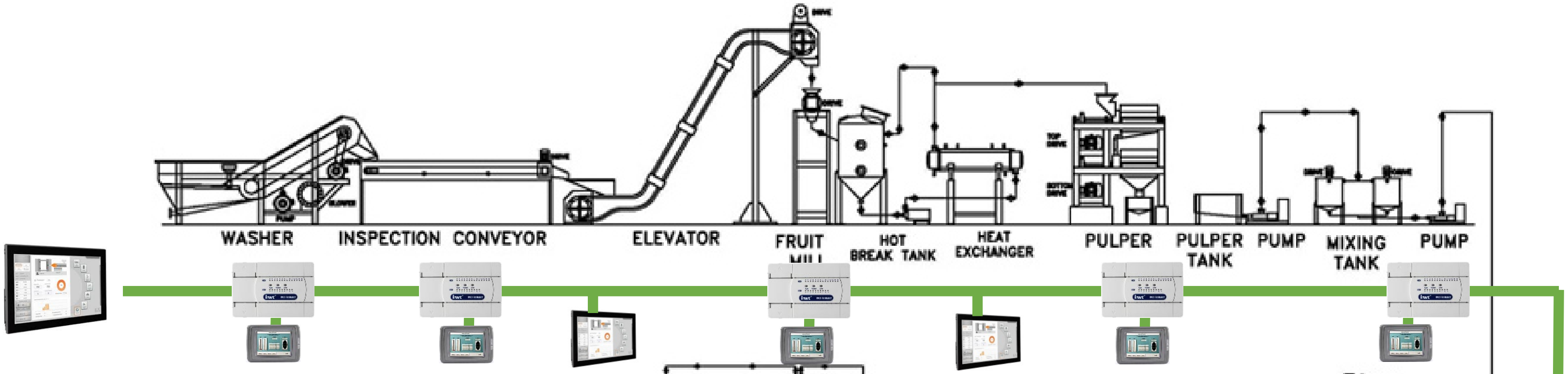
Automation Architecture ca. 1995…



- Robust IPC and operator panel hardware on machines (harsh environment)
- Distributed throughout the plant – high maintenance costs, many dissimilar systems
- Each IPC and panel uses its own database – "multiple versions of the truth"

Innovation Cycles in Automation

Automation architecture today…



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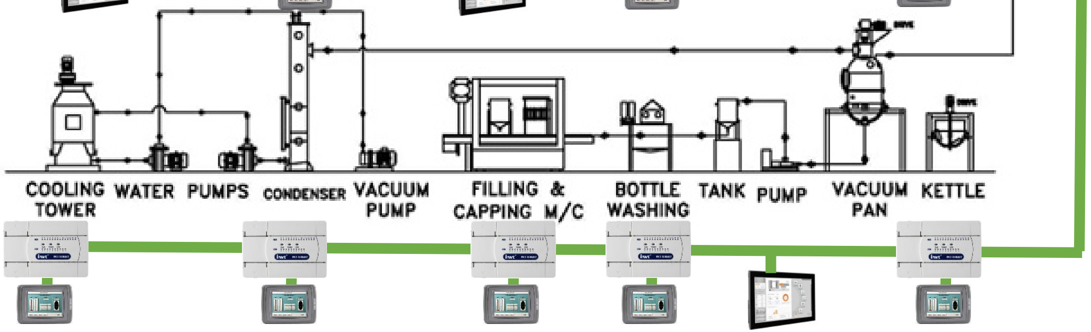


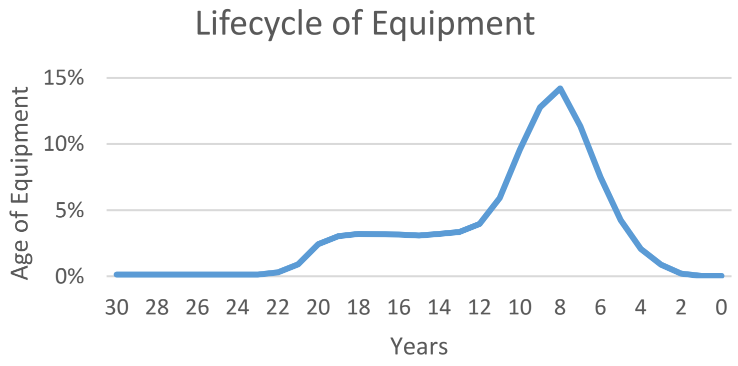
ARC Advisory Group

Speed of Innovation in Industry

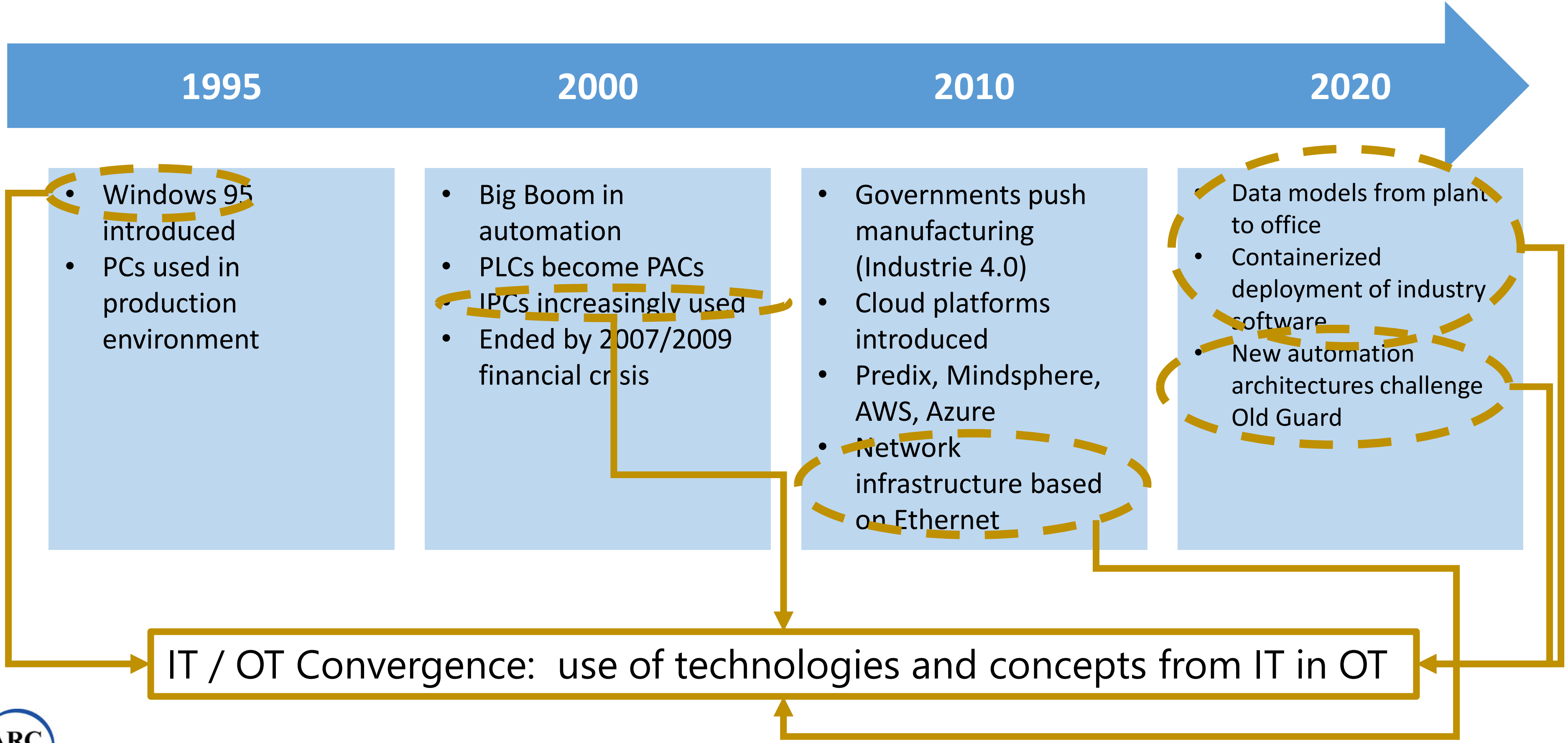
- Why so slow?
  - Cost of downtime and failure are high
  - Reluctant players
  - Long equipment lifecycles
  - Certifications
  - Lack of global standards
  - …

Why so slow?

- Cost of downtime and failures
  - Cost of unplanned downtime can be $millions/hour
  - Equipment failure can harm people, environment and equipment
- Reluctant players
  - Automation companies: protective strategies (“proprietary-open”), need to cater all clients
  - Machine builders: Small R&D teams, typical innovation cycles ~10 years, cost of equipment is critical
  - EPCs: competence and pressure in projects, but little involvement in plant operations
  - End users: care about costs over lifecycle, “need to run”
- Long Equipment Lifecycles
  - Equipment is installed for 2 to 40 years
  - During this period end users need:
    - support/maintenance
    - spare parts
    - compatibility
- Certifications
  - Necessary, but…
  - Barrier to entry/protection of status quo
  - Markets are highly competitive
  - Certification processes are long, specialized, and expensive
- Lack of global standards
  - Promotes “walled garden” product and business strategies
  - Lack of scale and market fragmentation hampers innovation



Innovation Cycles in Automation



Some End User Comments

- “We are afraid that any new technology will just add complexity to our production.”
- “We need to have a clear business case when we want to implement something new, in order to get the approval from management.”
- “We need clear and measurable KPIs for any new technology we introduce.”
- “I buy only proven technology from market leaders, so I do nothing wrong.”
- “We test for years to know how they behave in our industry.”
- “We have the capabilities to just set up our own data center and do everything ourselves; we have the economies of scale.”
- “Once installed, we do everything to keep the system running.”

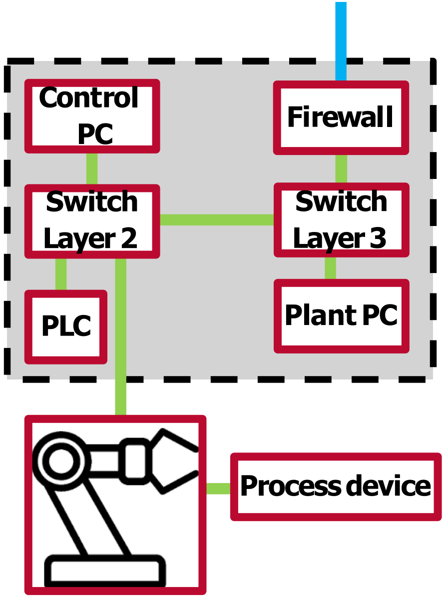
Agenda

- Why so slow?
- **The view of one leading, large (and pesky) manufacturer**
- What is it that the automation industry not seeing?
- The shape of (automation) things to come
- “Would you like TSN with that?”

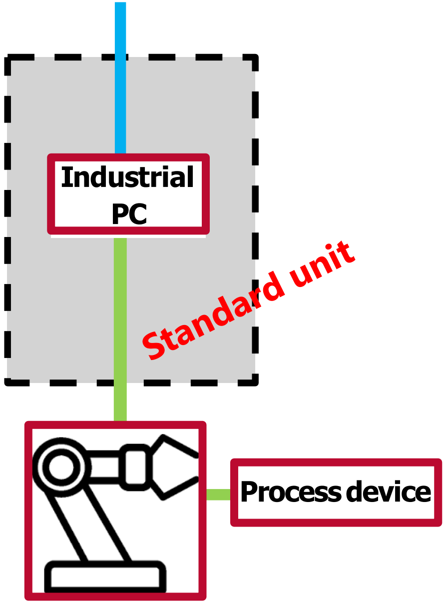
A Different End User Comment

If I need a specific function...

Today:
I buy a box that provides it.



Future:
I buy software that provides it.
(I already have the box because it is a standard part.)



AUDI AG
ARC Industry Forum, 2020

From the same automotive manufacturing executive

"Why do we need a virtualized/containerized software environment?

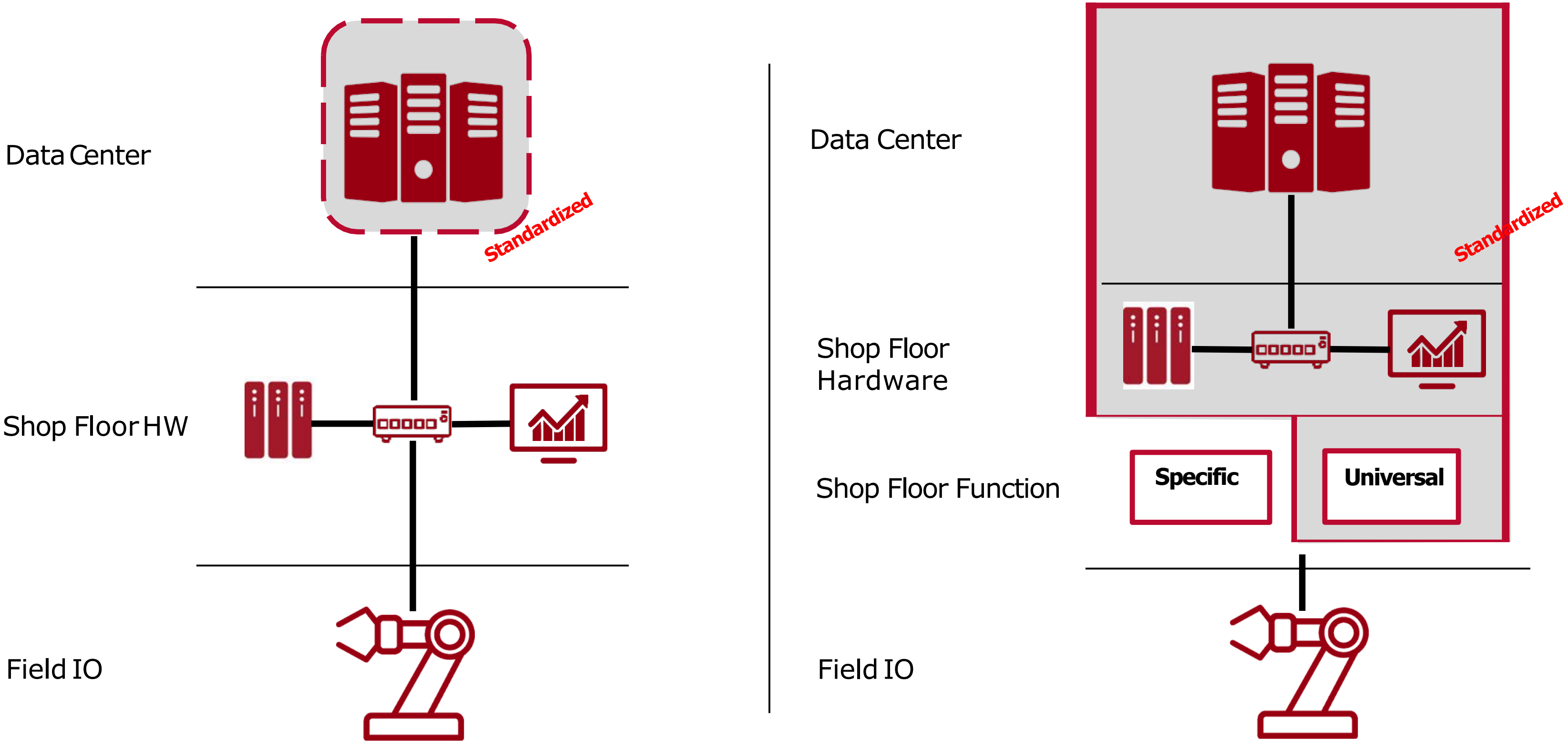
Because of the maintenance costs we have now in our factories.

As I said, [we have] 45,000 IPCs. Now imagine you want to do to an operating system upgrade on 45,000 IPCs, which you cannot do remotely because every single one of them has very specific tasks.

You must walk to each particular IPC. You have to do the upgrade. You have to pray that the drivers still work for that specific task. Then move on to the next IPC.

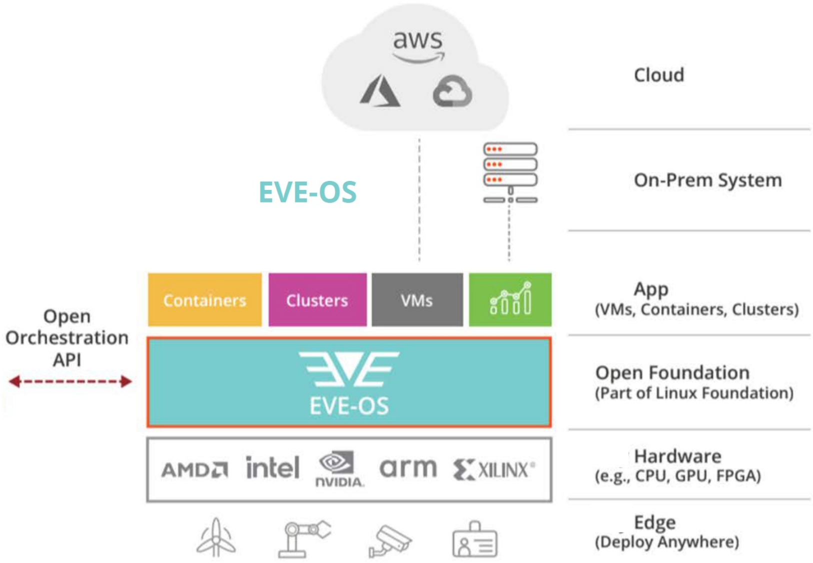
It's an incredible amount of money we're spending on doing this,
and these upgrades won't go away."

Automation Paradigm Shift



Audi AG
ARC Industry Forum, 2020

Here is what Audi envisions (in ARC's opinion)



- Thin, open source orchestration layer
  - Provides for self-updates
  - Provides for virtualization
  - Has a public API for orchestration
- Supports all types of applications
  - Guest RTOS
  - VMs
  - Containerized apps
  - Lightweight Kubernetes implementations

Agenda

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What is missing from this viewpoint? The Linux Foundation

- Software is eating the world, but…
  - Open Source software is eating the software world

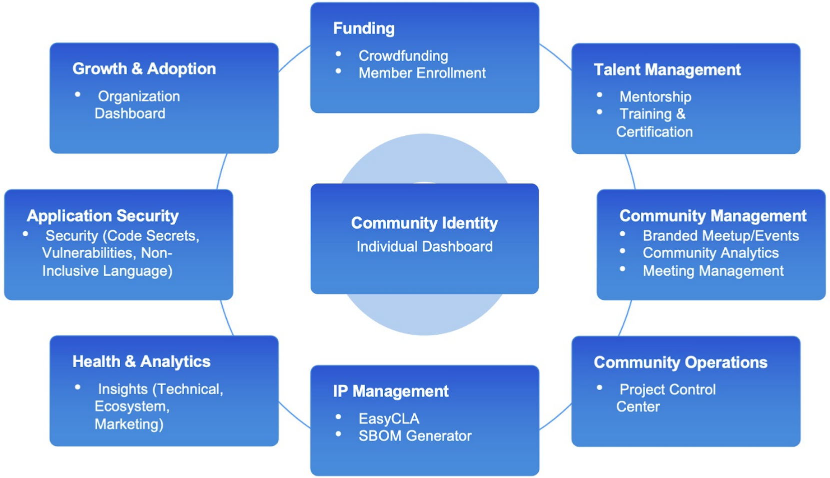
- Today's enterprise IT **products** are built on a foundation of Open Source **projects**
  - **Linux**
  - **Docker (containers are made usable for normal people)**
  - **Kubernetes (delivers containerized, reliable, scalable, distributed systems)**
  - **Yocto, and many, many others…**

- The Good News
  - The Linux Foundation is dominating this landscape
  - The Linux Foundation is delivering huge resources to open source software developers

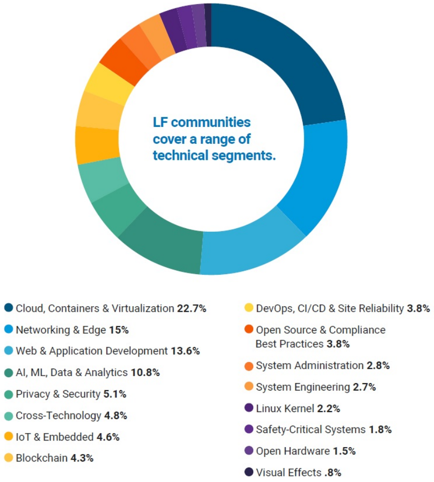
- The Bad News
  - The Linux Foundation has so much influence that they "pick winners and losers"
  - Major IT firms govern the Linux Foundation

The Linux Foundation – The Open Source Software Juggernaut

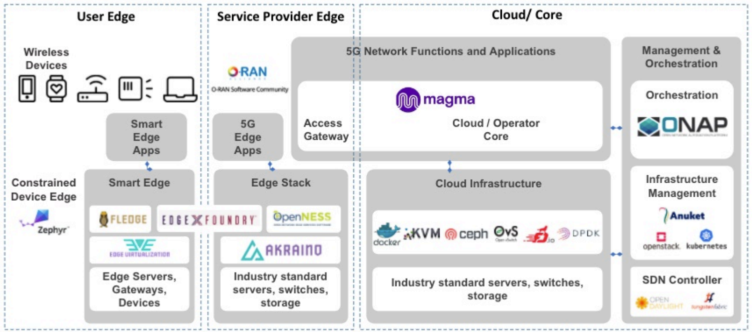
- An Open Source Software "Borg"
- $200 million/year revenue
  - 200 headcount
  - Only 2 developers on salary…
  - Software Development work is done pro bono
- Governance:
  By ALL IT leaders dand Hyperscalers
- Shared expert services for OSS projects… including legal services
- "Up or Out" model for project maturity
- Far more resources/influence than any competition
  - Eclipse Foundation
  - Apache Software Foundation



Where Linux Foundation Operates



LF Open Source Component Projects for 5G



CLOUD NATIVE COMPUTING FOUNDATION

kubernetes docker

OpenSSF OPEN SOURCE SECURITY FOUNDATION

LF EDGE

ELISA ENABLING LINUX IN SAFETY APPLICATIONS

Zephyr®

LF ENERGY

O3DE

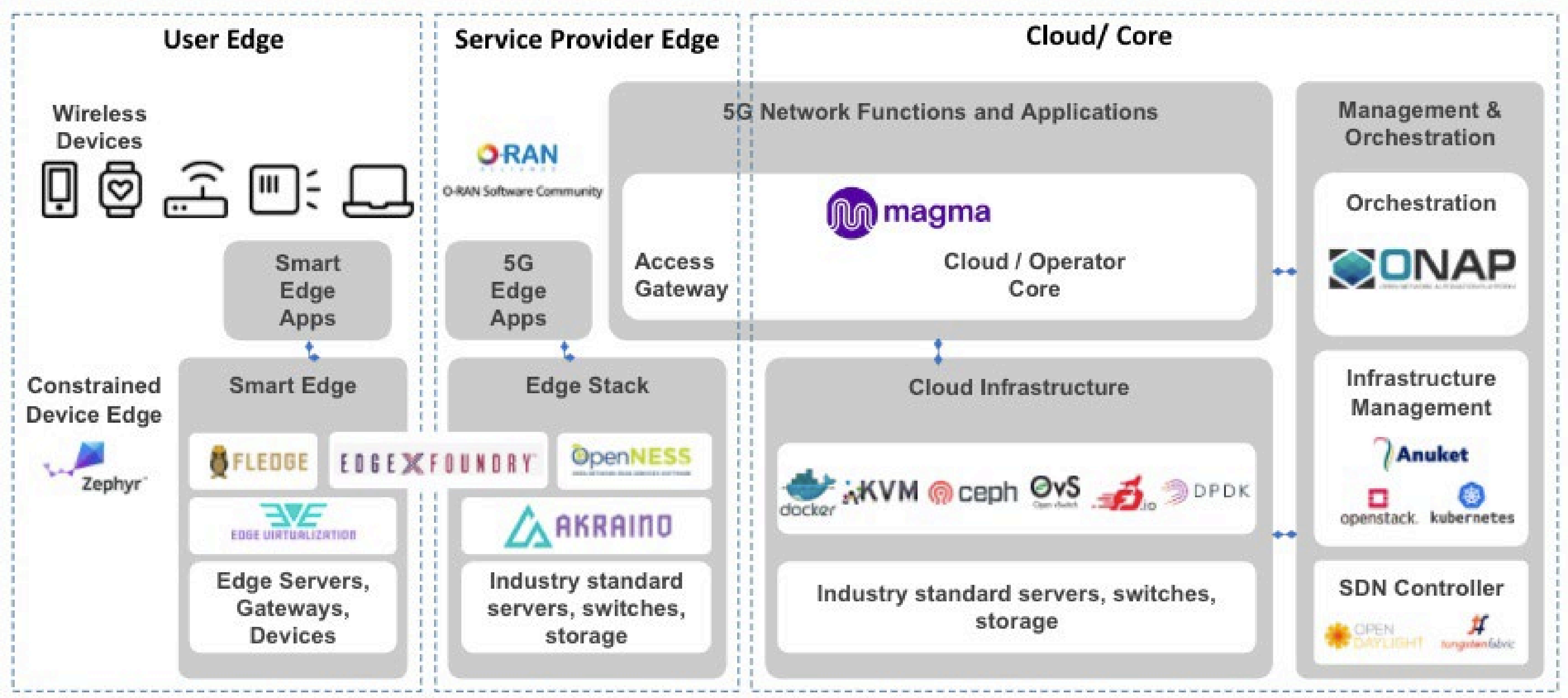
RISC-V®

HYPERLEDGER FOUNDATION

AUTOMOTIVE GRADE LINUX

FINOS Fintech Open Source Foundation

Linux Foundation Component Projects for 5G



Linux Foundation Platinum and Gold Members

ERICSSON
FUJITSU
HITACHI Inspire the Next
HUAWEI
intel
Meta
Microsoft
NEC
ORACLE
QUALCOMM
Red Hat | IBM
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vmware
accenture
Alibaba Cloud
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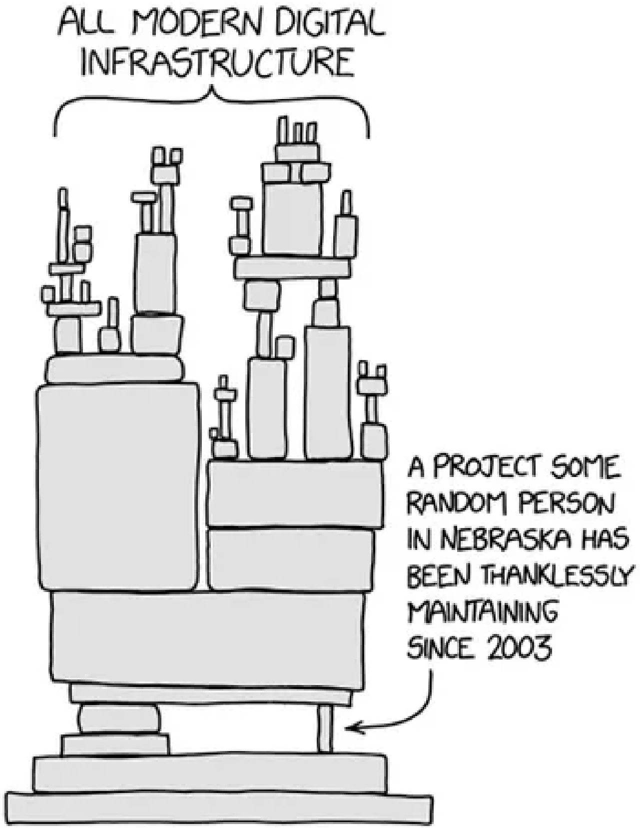
Bai du 百度
BlackRock
cisco
CiTRiX
DELL Technologies
Google
Panasonic
REFINITIV
RENESAS
SONY
TOSHIBA
TOYOTA
Uber
verizon
WeBank 微众银行

Issues with Open Source Software / Linux Foundation



- Maintainer human resources
  - Lack of activity/support for legacy can be a major problem
- Plethora of projects
- Redundancy of projects
  - Difficult to merge or terminate
  - LF is not nearly as ruthless as VCs
- Governance:
  Influence of major IT firms
  - vs. the traditional OSS developer culture
- and...
- Automation firms, IE consortiums <u>simply do not comprehend</u> any OSS business model
  - Is this a legacy of their hardware-oriented or software licensing business model?

Agenda

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The Shape of the Industrial Edge to Come!
Hyper-Converged Infrastructure (HCI)

HCI: software-defined infrastructure that virtualizes all elements of conventional "hardware-defined" systems.

- Virtualized computing
- Software-defined storage
- Virtualized networking (software-defined network)

This would require:

- Virtualize real-time control (soft PLC)
- Virtualize industry software (MES, HMI, historian, analytics)
- Virtualize industrial networks

Benefits

- **Simplicity:** Eliminate complexity of managing different hardware components and infrastructure silos.
- **Cost:** Reduce capital hardware investments, improve cost and storage efficiency, leverage existing in-house technical expertise. Runs on commercial off-the-shelf servers.
- **Agility:** No vendor lock-in, on-demand scalability, support for legacy and modern applications

Product Examples: The Shape of the Industrial Edge to Come!

- Emerson (former GE Intelligent Platforms)
  - Among the first movers
  - Connection to GE Predix platform
  - One Hypervised CPU
- Rockwell
  - PTC investment/alliance
  - Investments in startup firm Zededa
- Siemens
  - Integrated module for S7-1500
  - Sinumerik Edge –extra module
  - Pixeom acquisition
- Phoenix Contact:
  - PLCnext - shift in portfolio strategy
- Bosch Rexroth
  - CtrlX announced @ 2019 SMS
  - New concept, new strategy
  - Deep partnership with Canonical for Ubuntu(s)
- Beckhoff:
  - Partnership with AWS
- TTTech
  - 2021 acquisition of Nebbiolo, "Nerve" platform
- IPC focused suppliers (Advantech, Kontron)
  - Leverage open HW to enable edge control
  - Push CPU power in networks and distributed HW
- Startups, startups, startups
  - Most will be acquired

Edge controllers are either a clean break with or a careful expansion of supplier portfolio.

Agenda

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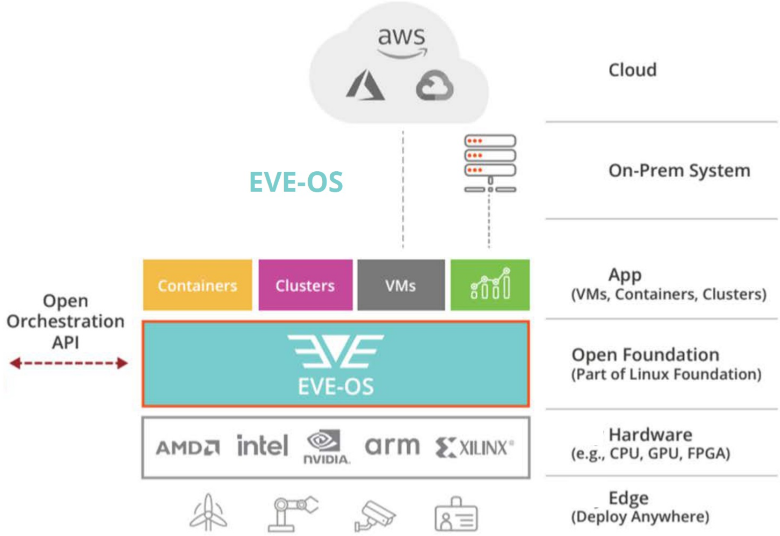
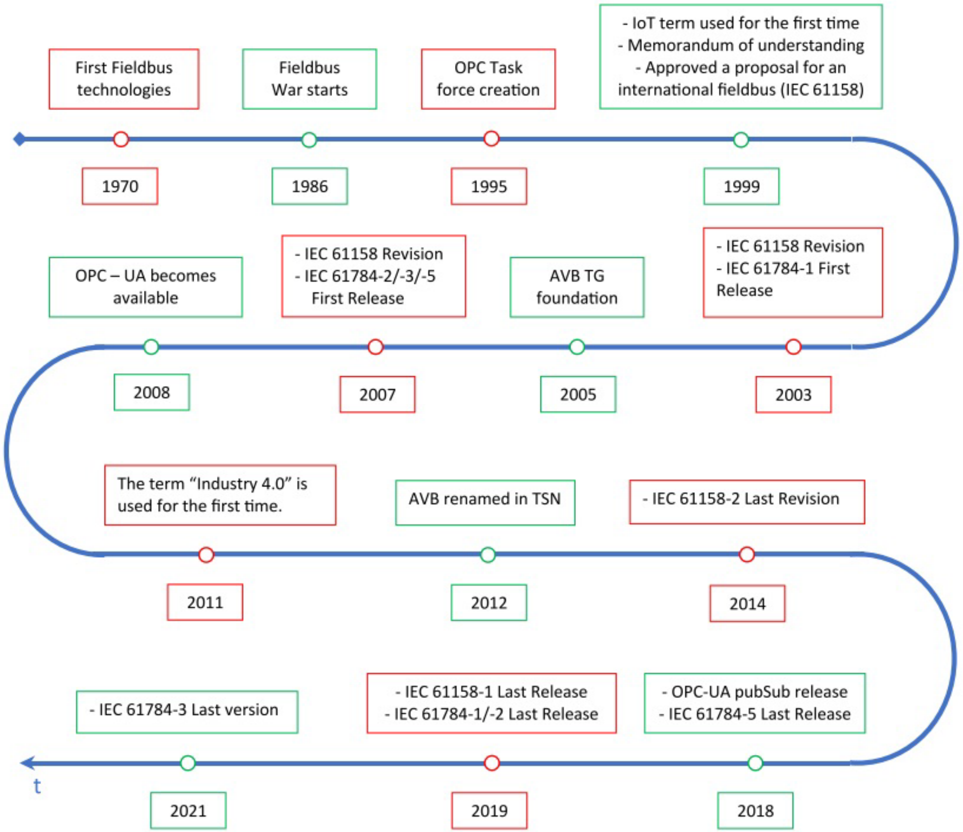
Do we need TSN to do this?

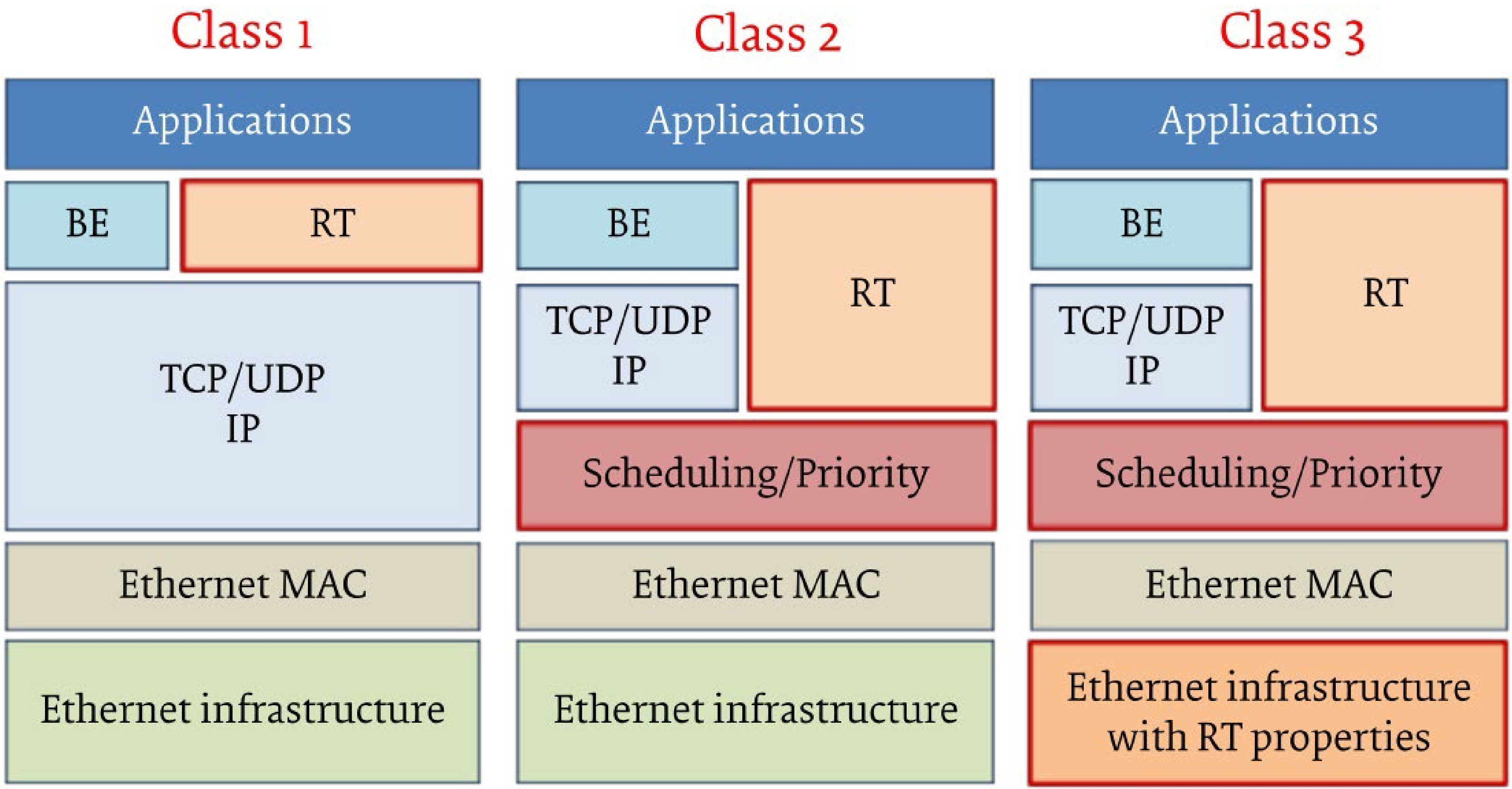


- It depends…
- If the real-time domain is limited to one box and one I/O network, then probably "no"
- Otherwise, probably "yes"

Dates in the Fieldbus Wars



Classification of Real-time Ethernet



List of TSN IEEE 802.x Standardization Projects

Standard	Description
IEEE 802.1AB	Station and Media Access Control Connectivity Discovery
IEEE 802.1AS	Timings & Syncronization
IEEE 802.1AX	Link Aggregation
IEEE 802.1CB	Frame Replication & Elimination
IEEE 802.1CS	Link Local Registration Protocol
Ongoing Projects	
IEEE P802.1CQ	Multicast and Local Address Assignment
IEEE P802.1DC	Quality of Service Provision by Network Systems
IEEE P802f	YANG Data Model for EtherTypes (amending IEEE 802-2014 [62])
IEEE P802.1ABcu	LLDP YANG Data Model (amending IEEE 802.1AB [55])
IEEE P802.1ABdh	Support for Multiframe PDUs (amending IEEE 802.1AB [55])
IEEE P802.1ASdm	Hot Standby (amending IEEE 802.1AS [56])
IEEE P802.1ASdn	YANG Data Model (amending IEEE 802.1AS [56])
IEEE P802.1CBcv	FRER YANG Data Model (amending IEEE 802.1CB [58])
IEEE P802.1CBdb	FRER Extended Stream Identification Funs (amending IEEE 802.1CB [58])
Amendments to the IEEE 802.1Q standard	
Amendment	**Description**
802.1Qat	Stream Reservation Protocol (SRP)
802.1Qav	Credit based Shaper
802.1Qaz	Stream Resv. Pot.
802.1Qbu	Frame Preemption
802.1Qbv	Enhancements for Scheduled Traffic
802.1Qca	Path Control
802.1Qcc	TSN Configuration
802.1Qch	Cyclic Queuing
802.1Qci	Per–stream Filtering
802.1Qcp	Yang Data Model
802.1Qcr	Asynchronous Shaping
802.1Qcx	YANG Data Model for Connectivity Fault Management
Ongoing Projects	
P802.1Qcj	Automatic Attachment to Provider Backbone Bridging (PBB) services
P802.1Qcw	YANG Data Models
P802.1Qcz	Congestion Isolation
P802.1Qdd	Resource Allocation Protocol
P802.1Qdj	Configuration Enhancements for Time-Sensitive Networking
Amendments to the IEEE 802.3 standard	
Amendment	**Description**
802.3br	Interspersing Express Traffic

TSN Profiles and Classes of Industrial Network Traffic

Description	Standard
Audio Video Bridging (AVB) systems	IEEE Std 802.1BA
Time-Sensitive Networking for Fronthaul	IEEE 802.1CM
Ongoing Projects	
Industrial Automation	IEEE/IEC 60802
TSN Profile for Service Provider Networks	IEEE P802.1DF
TSN Profile for Automotive	IEEE P802.1 DG
TSN for Aerospace Onboard Ethernet Communications	IEEE P802.1 DP

Traffic Typology	Periodic	Sporadic	Deadline	Bandwidth	Bounded Latency	Priority
Isochronous cyclic real-time	X		X	X	X	
Cyclic real-time	X		X	X	X	
Network Control		X				X
Audio/Video	X			X	X	
Brownfield	X			X	X	
Alarms/Events		X		X	X	
Configuration/Diagnostic		X		X		
Internal/pass-through		X		X		
Best-Effort		X				

Summary

- Change in automation technology is slow for many reasons
  - Some of them are good reasons
- End users want to move to a standardized and manageable hw/sw platform
  - But…this will need to include Open Source software
- OSS is dominating software and the Linux Foundation is dominating OSS
  - So **watch out!**
- The Automation industry does not have IT-like OSS business models
  - …and denial is not a long-term strategy
- TSN is very difficult
  - Broad applicability across many industries
  - Impact on many existing standards
  - "Things take time"

Reference/Figure Credit

- **TSN Figures:** Fedullo, T.; Morato, A.; Tramarin, F.; Rovati, L.; Vitturi, S. *A Comprehensive Review on Time Sensitive Networks with a Special Focus on Its Applicability to Industrial Smart and Distributed Measurement Systems*. Sensors **2022**, 22, 1638. https://doi.org/10.3390/s22041638

ARC Advisory Group

Thank you!

Harry Forbes

Research Director

ARC Advisory Group

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2022 ODVA
INDUSTRY CONFERENCE
AND 21ST ANNUAL MEETING

Looking Ahead to the 22nd Term

- Al Beydoun, President & Executive Director

Leadership in the 22nd Term

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- Mr. Joakim Wiberg

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- Mr. Elango Ganesan
- Dr. Vivek Hajarnavis
- Mr. Magnus Jansson
- Mr. McKenzie Reed
- Mr. Ryo Shimizu
- Ms. Tonya Wyatt
- Ms. Feiyan Zhao

Looking Ahead to the 22nd Term

- Continue to expand the EtherNet/IP ecosystem and support of Industry 4.0 and IIoT initiatives
- Continue to grow our membership and adoption of CIP technologies through training, tools development, marketing initiatives, and promotions
- Continue to monitor emerging technologies in Industrial Automation working with the Market Advisory Committee for integration into ODVA technologies
- Collaborate with other organizations to expand and address the challenges of tomorrow in areas such as Security, TSN, Energy Management, Ethernet-APL maintenance, and more
- Align our marketing and communication globally working with the TAGs
- Continue adaptation of EtherNet/IP to the Process Industries: Establish conformance certification for Ethernet-APL, and collaborate with industry organizations on Device Information Models and Profiles
- Develop specifications for xDS digital device description
- Complete the translation of EtherNet/IP to GB/T Standard for China market
- Collaborate with industry organizations to develop TSN Industrial Automation Conformance specifications
- And as always, continue to engage with the membership to understand and support their needs

Be a Part of the ODVA Community!

Working Groups are Calling:

- CIP System Architecture – Configuration data, message router fragmentation service
- EtherNet/IP System Architecture – TLS 1.3 support, CIP Authorization Profile, IPv6
- EtherNet/IP Infrastructure – LLDP, TSN, SPE
- EtherNet/IP Physical Layer – Gigabit, TSN, SPE guidance, PoE, PoDL, Wireless
- CIP Safety – safety concurrent connections
- Distributed Motion and Time Synchronization – CIP Sync over DLR
- xDS Digital Device Descriptions – Create specification and prototypes
- Common Industrial Cloud Interface – OPC UA companion specification
- EtherNet/IP In Process Industries – Device profiles for process industries
- Conformance – Continued test improvement

2022 ODVA

INDUSTRY CONFERENCE
AND 21ST ANNUAL MEETING

THANK YOU!