Industrial Automation and emerging Ethernet

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What is Industrial Automation?

- An Industrial Automation Definition:
  - “Application of technology to transform raw materials into finished goods”
    - Moving materials
    - Manipulating materials

- Some technology evolutions
  - Automation degree: Manual (tools) -> Semi-automatic -> Automatic
  - Power source: Human -> animal -> water -> fuel -> electricity
  - Technology: Mechanics -> fluidics -> relays -> electronics
Interconnection of components

- Industrial Automation components
  - Sensors, Actuators, Controllers, Human Interfaces, Information Interfaces

- Generic components are interconnected into application systems
  - Power connection
  - Control and information connection
    - Hardwired -> Networks

- Some interconnection goals:
  - Reliable, integrated, simple to apply, economical
In their report “Industrial Internet of Things – 2014”, industry market analysis firm IHS Technology forecasts that there will be (2015):

- 50B node installed base at 13% connected (sensors, actuators, controllers, interface modules, operator interfaces, IT infrastructure, instrumentation, servers, etc.)
- 6B new node shipments at 31% connected
- 1.8B new wired nodes with 11.7% CAGR
  - Predominant connectivity via wired networks followed by WLAN then WPAN and WWAN
- Approaching 50% Ethernet in Process Industry (related IHS report)
- Other portions of installed base can tolerate less Ethernet overhead
- Reduced *interconnection* is a significant factor in further penetration
Scope of presentation

- A wide range of IEEE standards apply to Industrial Automation
  - Power and energy
  - Communication
  - Information

- IEEE Scope for this presentation is 1-Pair Ethernet:
  - IEEE P802.3bp 1000BASE-T1 PHY
  - IEEE P802.3bw 100BASE-T1
  - IEEE P802.3bu 1-Pair Power over Data Lines (PoDL)
  - Related CFIs...
Basic Automation Disciplines/Domains

Discrete

Process

Batch/Hybrid

“Factory Automation”

“Process Automation”
Industrial Automation Characteristics

- A large portion of the Discrete Control & Visualization and associated Motor Control Equipment is concentrated in machines and is of relatively short distance (40m) and benefits from high performance (100Mb/s -> 1Gb/s)
- Certain important Process Control and Instrumentation applications require very long distances (1000m) and have relatively low performance requirements

Factory Automation Modules

- Control Cabinets
- Work cells
- Conveyors
In-cabinet cabling relationship to On-machine cabling

In-cabinet
IP20
RJ45 Ethernet

On-machine
IP67
M12 Ethernet

Bulkhead Adapter

Segment

Segment
In-cabinet

- Dense node packing
- Very short segments
- Linear or Ring configuration of dual-port nodes
  - Cable lengths rarely > 15m
**On-machine**

**Work Cells**
- Nodes spread to best physical position
- Somewhat bigger than the product
  - i.e., an Automobile
- Linear or Ring configuration of dual-port nodes
  - Cable lengths rarely > 40m

**Conveyors**
- Nodes distributed along length
- Often modular
  - i.e., 3m sections
- Linear or Ring configuration of dual-port nodes
Process Automation “Skids”

- Many Process Automation skids are reasonably small
- On-machine requirements apply
Large Process Automation Applications

- Nodes spread over large site
- Star topologies
- Legacy cable runs
  - 1000m
  - 4-20mA -> Fieldbus -> Ethernet?
Additional application coverage via hybrid systems

- Selectively extend distance with reduced rate for greater application coverage
- Minimize media converters

Auto-negotiation:

- 802.1bp
- 15m/40m
- ??m
- 802.1bw
- 1000m

CFI?
Power

- Industrial Automation nodes require power

- Various applications will benefit from two strategies
  - 1-pair Ethernet within a “harness” that includes power
    - 24VDC is common
  - 1-pair Ethernet + PoDL
Conclusions

- Major segments within Industrial Automation can benefit from the ongoing 1-pair Ethernet development
  - Factory Automation
    - In-cabinet
    - On-machine
  - Process Automation
    - Skids
- An important portion of Process Automation applications are not met except with much greater length
  - A CFI is likely for an additional 1-pair Ethernet to meet these application needs
- Auto-negotiation extends the benefits of the individual 1-pair standards