Industrial Automation
Agenda

- Business and Solution Trends
- Turning Vision into Reality
- Physical Network Design Process
- Cabling Infrastructure
- Physical Network Design Considerations
Trends in Industrial Networks

- Migration to switch-centric topologies
- Data explosion stretching the limitations of legacy networks
- Industrial Ethernet is enabling IT based solutions
- Real-time analytics and data mining
- Challenge to connect the factory and enterprise to boost productivity, innovation and business agility

What C-suite executives are saying about the IoT

- 95% Expect their company to be using the IoT in three years’ time
- 63% Believe that companies slow to integrate the IoT will fall behind the competition

The Internet of Things Business Index, The Economist-Intelligence Unit
Business and Solution Trends

Rapid Growth of IoT “things”

- Rapid adoption rate of digital infrastructure
  - 5 x faster than electricity & telephony

- “~6 things online” per person

- World Population
  - 6.307 billion in 2003
  - 6.721 billion in 2008
  - 6.894 billion in 2010
  - 7.347 billion in 2015
  - 7.83 billion in 2020


Panduit
Infrastructure for a connected world
Business and Solution Trends

Internet of Things in Manufacturing

- Monitor production flow
- Manage Equipment Remotely
- Remote OEM Optimize and Repair
- Optimize Third Party Supply Chain
- Condition Based Maintenance
- Aggregate Product Data to Correct Quality Issues
- Manage Operational Costs
- Gain Insight to Re-engineer Products
- Alert Field Service for Predictive Maintenance
Business and Solution Trends

Infrastructure Investment Compared to Longevity

- **Software**
  - 60%
  - 2 to 5 years

- **Networking**
  - 23%
  - 5 Years

- **Operations**
  - 10%
  - 5 Years

- **Cabling**
  - 7%
  - 20+ years (or forever)

80% of network problems are caused by only 7% of invested budget.
Preventable Installation Issues

Poor infrastructure planning puts both performance and security at risk.
Business and Solution Trends

Invest Now or Pay Much More Later

Cost to resolve issues increases exponentially throughout the design cycle

Turning Vision into a Reality

Achieves Benefits

- Ensure performance, uptime and productivity
- Build reliability, reduce troubleshooting time
- Ease integration with a standards based approach that is modular and scalable
- Reduce cost and time to production
The Value of Assessment

Turning Vision into a Reality

Downtime Cost
How Critical is the Network?
Drives Resiliency, Hardening and Recovery

Number of Connections
Today
Next 10 years

Bandwidth Consumers
Data
Video
Control

Walk Through
Cable Distances
Environment
Obstructions

Security
Control Physical and Electronic Access
Assessment: Network Availability Considerations

- The degree of Availability is driven by the downtime cost
  - **Balance** network resiliency costs and downtime costs

- Different types of resilient network topologies impact the physical layer
  - Path and device **separation**

- Different grades of hardening to choose from
  - Cable jacket/outer
  - Device **protection/cooling**

- Connection reliability
  - Tested, i.e. not just green light on
  - Installation **best practices**
Physical Network Design Process
Define the Logical Architecture

- How many nodes are on the network? What types of nodes?
- How critical are these nodes to process and to safety?
- What type of traffic?
- What are the performance requirements? How much data? How fast?
- Availability?
- Who owns what in the infrastructure?
- System environment? Noise concerns? Distance concerns?
- Data flow?
- What are the security policies?
- Are there remote user requirements?
- Integration into existing systems?
Industrial Premises Telecommunications Standards

Developed by the TIA TR-42.9 Industrial Infrastructure Subcommittee and published in May 2012, the Standard provides infrastructure, distance, telecommunications outlet/connector configuration, and topology requirements for cabling deployed in industrial environments.

- Industrial Areas
- Telecommunications Spaces
- Telecommunications Pathways
- Firestopping
- Backbone Cabling
- Horizontal Cabling
- Work Area
- Grounding and Bonding
- Industrial Cabling Performance Requirements
Applicable Industrial Standards

Telecommunications Standards

- ANSI/TIA-1005 is explicitly supported by the 568-C cabling standard
- TIA/EIA-568-C Defines cabling types, distances, connectors, cable system architectures, cable termination standards and performance characteristics, cable installation requirements and methods of testing installed cable
- C.0 defines the overall premises infrastructure for copper and fiber cabling
- C.2 addresses components of the copper cabling system
- C.3 addresses components of fiber optic cable systems
Structured Cabling: A planned cabling system which systematically lays out the wiring and wire management necessary for communications, including voice, data and video.
• Cabling Infrastructure
Structured Cabling Schematic

M.I.C.E diagramming allows the design to balance component costs with mitigation costs in order to build a robust yet cost-effective system.
Cabling Infrastructure

Industrial Architecture

Example of Fiber to the Telecom Enclosure (FTTE)

- Dielectric Conduit-ted Fiber Distribution Cable
- DIN mount enclosure to break out and protect buffered fibers
- Fiber Panel to create testable permanent links on distribution cable
- LC to LC Jumpers to Ethernet Switch uplink
- Copper patch panel and horizontal cable distribution
What’s Happening in Industrial Automation

- IT drives structured cabling
- The control panel industry drives connecting cable to plugs
Structured and Point to Point Cabling

Structured Cabling
- Solid horizontal cable terminated with jacks
- Typically installed and left in place; measured and warrantied performance
- Connected to equipment with flexible patch cords

Point to Point Cabling
- Stranded cable field terminated with plugs;
- Measurements infrequently done
- No standard exists to define the measurement method
- If the green light goes on, then it works
Cabling Infrastructure

Structured Cabling

- Consists of patch cords, jack (patch panel), and horizontal cabling
- Accurately test horizontal cable
- Panduit patch cords 100% tested
- Easier to reliably terminate to a jack compared to a plug
- Can have spare or redundant links
  - Aids in troubleshoot
  - Easier to add connections “on the fly”
  - Can plan for the future
Structured Cabling for EtherNet/IP Example

Control Room
Micro Data Center

Zone Enclosure

Control Panel / Cabinet

Patch Panel
Up to 90 Meters of Horizontal Cable

Patch Cords

Commercial Switch

Industrial Switch

End Devices (e.g. Servers)

End Devices (e.g. PLC, HMI, Drive)
Cabling Infrastructure

Point to Point Cabling

- Single cable terminated to plugs
- Most often stranded conductors for flexibility
  - Solid cable prone to break
  - De-rated length
- Testing can be inaccurate
- Plugs can be hard to terminate reliably for the long term especially for higher bandwidth cable
- Cannot plan for the future
  - Extra cables are not secure
## Cabling Infrastructure

### Where Would You Consider Using Structured or Point to Point Cabling?

<table>
<thead>
<tr>
<th><strong>Primary Considerations</strong></th>
<th><strong>Structured Cabling</strong></th>
<th><strong>Point to Point Cabling</strong></th>
</tr>
</thead>
</table>
| **Meet Design Specifications** | • High cable quantity – many cables from panel to machine  
• Customer verification and testing required from installer  
• Warranty | • Low cable quantity – few cables from panel to machine  
• Ring or linear topology for reach beyond 100M where distance between connection is < 100M |
| **Network Longevity (Future Proof)** | • Designed in spare ports | • Difficult to have spare connectivity |
| **Maintainability (Moves, Adds, Changes)** | • Environments with multiple changes occurring  
• Cable slack is required | • Environments with minimal changes occurring  
• Slack cabling is undesired and precise cable lengths are required |
| **Installation** | • Multiple points of connectivity  
• Horizontal cabling is largely untouched | • Quick and easy installation  
• Where tight bends or moderate flexing is required  
• Areas where it is impractical or impossible to mount a patch panel or other horizontal cable jack interface |
# Cabling Infrastructure

## A Facility Assessment

<table>
<thead>
<tr>
<th>Consideration</th>
<th>Assessment</th>
<th>Design Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Connectivity Count</strong></td>
<td>Number of Devices, Machines, etc.</td>
<td>Cable Runs, Pathway Capacity, Port Count, etc.</td>
</tr>
<tr>
<td><strong>Environment</strong></td>
<td>Mechanical, Ingress, Climatic/Chemical, Electro Magnetic</td>
<td>Protection, Separation, Transmission Media (Cu vs. Fiber)</td>
</tr>
<tr>
<td><strong>Bandwidth</strong></td>
<td>Current Network Utilization and Future Load</td>
<td>Cable Media, Switches, Installation</td>
</tr>
<tr>
<td><strong>Cable Reach</strong></td>
<td>Cable Length</td>
<td>Cable Media, Switches</td>
</tr>
<tr>
<td><strong>Safety</strong></td>
<td>Nearby High Voltage</td>
<td>Device Access, Protection</td>
</tr>
<tr>
<td><strong>Security</strong></td>
<td>Threat Level, Isolation</td>
<td>Port Protection, Access,</td>
</tr>
<tr>
<td><strong>Longevity</strong></td>
<td>Years of Service</td>
<td>Bandwidth, Hardening, Manufacturing Growth</td>
</tr>
</tbody>
</table>
## Cabling Infrastructure

### Availability Considerations

<table>
<thead>
<tr>
<th>Uptime</th>
<th>Cost</th>
<th>Redundancy Separation</th>
<th>Hardening</th>
<th>Connection</th>
<th>Troubleshoot</th>
<th>Mistake Proof</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fair</td>
<td>$</td>
<td>In Same Media</td>
<td>Standard Jacket</td>
<td>Point to Point</td>
<td>Network Layout Doc</td>
<td>Network Layout Doc</td>
</tr>
<tr>
<td>Good</td>
<td>$$</td>
<td>Different Media</td>
<td>Loom Tube</td>
<td>Structured Cabling</td>
<td>Structured Cabling</td>
<td>Labeling and Color Coding</td>
</tr>
<tr>
<td>Better</td>
<td>$$$</td>
<td>Different Media in Adjacent Pathway</td>
<td>Armor</td>
<td>Structured Cabling with Port Lockin &amp; Block-out</td>
<td>Labeling and Color Coding</td>
<td>Structured Cabling w/ Port Lockin &amp; Block-out</td>
</tr>
<tr>
<td>Best</td>
<td>$$$$</td>
<td>Media Running on Opposite Ends of Plant</td>
<td>Conduit</td>
<td>Certified Network</td>
<td>Physical Infrastructure Monitoring</td>
<td>Guided Patching</td>
</tr>
</tbody>
</table>

- **Availability Considerations**
  - **Uptime**: The level of uptime availability.
  - **Cost**: The cost associated with each level of availability.
  - **Redundancy Separation**: The method used to ensure redundancy and separation.
  - **Hardening**: The level of hardening applied.
  - **Connection**: The type of connection used.
  - **Troubleshoot**: The methods used for troubleshooting.
  - **Mistake Proof**: The methods used to ensure no mistakes in implementation.
## Cabling Infrastructure

### Media Selection

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Copper Cable</th>
<th>Multi-mode Fiber</th>
<th>Single-mode Fiber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reach (max)</td>
<td>100m (330ft)</td>
<td>500m (1,750ft)</td>
<td>40km (24 miles)</td>
</tr>
<tr>
<td>Noise Mitigation</td>
<td>Foil shielding</td>
<td>Noise immune</td>
<td>Noise immune</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>1 Gb/s</td>
<td>10 Gb/s</td>
<td>10 Gb/s</td>
</tr>
<tr>
<td>Cable Bundles</td>
<td>Large</td>
<td>Medium</td>
<td>Small</td>
</tr>
<tr>
<td>Power Over Ethernet (PoE) Capable</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
**Choose Connectors Wisely**

Overall channel category determined by the lowest performing component

<table>
<thead>
<tr>
<th>Guaranteed Channel Headroom</th>
<th>Electrical Value</th>
<th>TIA/EIA Cat 6A</th>
<th>ISO Class $E_A$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Insertion Loss</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td>NEXT</td>
<td>3.5 dB</td>
<td>2.5 dB</td>
</tr>
<tr>
<td></td>
<td>PSNEXT</td>
<td>5 dB</td>
<td>4 dB</td>
</tr>
<tr>
<td></td>
<td>PSACR-F</td>
<td>10 dB</td>
<td>10 dB</td>
</tr>
<tr>
<td></td>
<td>Return Loss</td>
<td>3 dB</td>
<td>3 dB</td>
</tr>
<tr>
<td></td>
<td>PSACR-N</td>
<td>6.5 dB</td>
<td>6.5 dB</td>
</tr>
<tr>
<td></td>
<td>PSANEXT</td>
<td>20 dB</td>
<td>20 dB</td>
</tr>
<tr>
<td></td>
<td>PSAACR-F</td>
<td>20 dB</td>
<td>20 dB</td>
</tr>
</tbody>
</table>

Electrical values are above specified standards and consist of worst pair margin per ANSI/TIA/-568-C.2 Category 6A and ISO 11801 Edition 2.1 Class $E_A$ standards. See Panduit Certification PLUS System Warranty Program for additional information.
Other Considerations

- **Cable protection**
  - Bend radius control
  - Bundling

- **Pathways**
  - Ladder, Wyr-Grid® Overhead Cable Tray Routing System, J-Hooks
  - Protect cabling, out of the way

- **Identification/color coding**
  - Labels, bands, colored cables & jacks
  - Facilitates moves, adds, and changes
  - Troubleshoot

- **Grounding and bonding**
  - Critical for communication
  - Not just safety
Physical Network Design Considerations

Physical Network Security in the Panel

- Keyed solutions for copper and fiber
- USB Type A, B Ports
- Lock-in, Blockout products secure connections
Conclusion

Resources

- Industrial Ethernet Physical Infrastructure Reference Architecture Design Guide
- Introduction to a Micro Data Center White Paper
- Scaling the Plant Network White Paper
- Design Tools:
  - Rockwell Automation Proposal Works
  - Rockwell Automation Integrated Architecture Builder (IAB) www.rockwellautomation.com/go/tools