Simplifying Robust Industrial Network and IoT Deployment
“The Connected Enterprise”

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The Connected Enterprise Means Different Things to Different Stakeholders

- Voice
- Enterprise Data
- Video
- Manufacturing Data
- Access Control
- Security
- Environmental Management
- Distributed Audio/Paging
- Facility Management
How Dependent Are You On YOUR Network?

If the network is down, can they...
- Run machines or process
- Perform Quality Checks
- Ship or Receive
- Print Labels or package
- Issue material
- Record regulatory data
- Manage resources
- Operate safely and securely
- Communicate with IOT sensors, gateways, devices

If you Answered NO to any, then hardening, resiliency, and redundancy may be required
CPwE’s Ultimate Goal: To Mitigate Risk and Reduce Downtime Costs

Reference Points of Industry Downtime Direct Costs ($ per minute)

Injection... Power Plant Food and... Pulp & Paper Oil & Gas Data Center Automotive...

$120 $180 $275 $550 $3,500 $5,000 $22,000

Industrial Network, Downtime Survey 2001; Emerson Network, Data Center Outages Can Be Painful; ATS/Nielsen Research Automotive Manufacturers Survey, 2007; Plant Engineering; Maintenance Technology.
Panduit’s Place in the Connected Enterprise

The OSI Model (Open Systems Interconnection)

- **APPLICATION** (Layer 7): Provides services/protocols to applications
- **PRESENTATION** (Layer 6): Data formatting, i.e., ANSI, Compression/Decompression
- **SESSION** (Layer 5): Controls conversations/Sessions (Dialog, Control), Integrity and Reliability, Descriptive naming
- **TRANSPORT** (Layer 4): Fragmentation/Sequencing of data, Reliable delivery, Error recovery, Flow Control, Multiplexing (PORTS)
- **NETWORK** (Layer 3): End to end delivery, Logical addressing, Fragmentation/Sequencing for MTU Routing
- **DATA-LINK** (Layer 2): Physical addressing, Error detection (FCS/CRC), Acknowledgements, Packet/Frame header and trailer bridging
- **PHYSICAL** (Layer 1): Media Interface, Transmission method, Signal strength, Topology

TCP/IP Model

- **TCP/IP Model**: Application
  - **Host to Host**: TCP, UDP
  - **Internetwork**: IP, ARP & ICMP
  - **Network Access**: Bridges or switches, NIC Drivers
  - **Network Interface**: Hubs, Network Cards

ENCAPSULATION

- **DATA**: Segment
- **PACKET or DATAGRAM**: Frame
- **Bit or Data-Stream**: Encapsulation
Corporations require upgrades in physical infrastructure technology to meet their customer’s demands and maintain competitive advantage.
THIS is Our Typical Customer’s Plant Network Deployment and Infrastructure Strategy!
Typical Control Panel Deployment of an IA Switch
The Typical Enterprise Data Center
The Reality for Most of Our End Users is that **THIS** is their Industrial Network……
The Reality for Most of Our End Users is that THIS is their Industrial Network……
Our goal is that your Connected Enterprise will support your needs today and tomorrow!
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
- Fire Stopping
- Backbone Cabling
- Horizontal Cabling
- Work Area
- Grounding and Bonding
- Industrial Cabling Performance Requirements
Network Architecture Options: Flat vs Zone

Traditional Cable Deployment
- Node to network room “home runs”

Zone Architecture
- Reduced installation time
- Simplified diagnostics
“Blinky Lights” Don’t Guarantee Performance!
Zone Architecture Promotes A Testable Permanent Link
Converged Plant-wide Ethernet Architecture and the Panduit 5 In’s

Enterprise Zone
Levels 4 and 5

Industrial
Demilitarized Zone (IDMZ)

Industrial Zone
Levels 0–3
(Plant-wide Network)
Level 3 – Site Operations
(Control Room)

Cell/Area Zone
- Levels 0–2
Redundant Star Topology - Flex Links Resiliency Unified Wireless LAN
(Lines, Machines, Skids, Equipment)

Cell/Area Zone
- Levels 0–2
Ring Topology - Resilient Ethernet Protocol (REP) Unified Wireless LAN
(Lines, Machines, Skids, Equipment)

Cell/Area Zone
- Levels 0–2
Linear/Bus/Star Topology Autonomous Wireless LAN
(Lines, Machines, Skids, Equipment)

Enterprise Cabinet Solutions

Micro Data Center

Industrial Distribution Frame

Zone Network System

Control Panel Best Practices
Available CPwE Documentation

- CPwE Main Document
  - Design Implementation Guide
  - White Papers
- Cisco Validated Designs (CVD)
  - Design Implementation Guide
  - Most recent release is *Resiliency for CPwE*
  - Panduit Appendix in this CVD
- Panduit White Paper
  - *Physical Infrastructure for a Resilient Converged Plantwide Ethernet Architecture*

Cell/Area Zone

The Cell/Area Zone represents the outer reaches of the network and provides the network connections to the machines, skids and equipment to be monitored, managed, and controlled. Figure 4 details the physical connectivity of an example switch-level ring topology.
IoT Enablement Throughout Plant Floor
The Panduit 5 In’s

“A significant portion of network downtime, approx. 80%, is attributed to Physical Layer Connections.”
- Sage Research

IN-ROOM™
IN-ROUTE™
IN-PANEL™
IN-FIELD™
IN FRASTRUCTURE
The Industrial DMZ
The Physical Separation Between IT & OT
Connecting Enterprise and the Plant Floor

IN-ROOM™
- Optimize industrial communication and linkage
- Provide a secure, protected environment
- Identify and report critical information – proactively

IN-ROUTE™

IN-PANEL™

IN-FIELD™

IN-FRASSTRUCTURE™

INDUSTRIAL DATA CENTERS
IDMZ Layout / Building Blocks
The Panduit Micro Data Center

• A complete compute, network and storage solution
  – Dedicated to manufacturing
  – Usually a firewall between MDC and Enterprise
  – Virtualization a growing trend
  – Typical applications running on an MDC are Historian, Production Monitoring (OEE), Recipe/Batch, Work Flow, Inspection, Asset Tracking, WIP Tracking, etc.
Panduit’s Pre-Configured Industrial Distribution Frame

• The Pre-Configured Zone Distribution Frame is used to protect 19” rack mount switches on the factory floor in a Zone Architecture Network.

• Consistent deployment and equipment placement while minimizing engineering and deployment time.

• Best in class thermal solution.

• Designed around the use of popular fiber based Cisco 3750X and copper based Cisco 2960S switch deployments.

• Maximum Configuration:
  – (2) Cisco 3750X Switches
  – (3) Cisco 2960S Switches
  – (1) 2U UPS
## IDF Offering

<table>
<thead>
<tr>
<th>26U IDF</th>
<th>IDF</th>
<th>12U IDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>48&quot;H x 24&quot;W x 31&quot;D</td>
<td>Dimensions</td>
<td>24&quot;H x 24&quot;W x 31&quot;D</td>
</tr>
<tr>
<td>26U</td>
<td>Rack Units</td>
<td>12U</td>
</tr>
<tr>
<td>Up to 3</td>
<td>Copper based Switches</td>
<td>Up to 2</td>
</tr>
<tr>
<td>Up to 2</td>
<td>Fiber based Switches</td>
<td>Up to 2</td>
</tr>
<tr>
<td>5</td>
<td>Max Switches</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>UPS or PDU</td>
<td>1</td>
</tr>
</tbody>
</table>
Distributing Ethernet Throughout the Plant Floor

- Distribute Ethernet beyond “IN-ROOM” throughout the plant floor
- Assess, Design, Deploy and Manage an architecture for a high performing, appropriately segmented network
- Localize network traffic, and reducing traffic overloads
Three different ways to obtain a Panduit Industrial Zone Enclosure

- Panduit Pre-Configured Zone Enclosures

  - IAZ1214C
    12" x 14" zone enclosure with pre-configured backplane for one Stratix 5700 industrial switch and cabling

  - IAZ2424C
    24" x 24" enclosure with pre-configured backplane for one Stratix 5700 or Cisco IE2000 series industrial switches with UPS and power supplies.

  - IAZ2436C
    24" x 36" enclosure with pre-configured backplane for up to two Stratix 8000 or Cisco IE3000 series industrial switches with expansion modules, UPS, and power supplies.
Panduit “Switch Ready” Network Zone Systems
Available Now!

- **Z23R-S15**
  - 24” x 36” x 12” Enclosure
  - Wiring ready for switch
  - Redundant power supplies
  - No battery, maintenance-free UPS
  - Connectivity for 16 copper downlinks
  - Connectivity for 2 MM LC fiber uplinks

- **Z22R-S15**
  - 24” x 24” x 12” Enclosure
  - Wiring ready for switch
  - Redundant power supplies
  - No battery, maintenance-free UPS
  - Connectivity for 8 copper downlinks
  - Connectivity for 2 MM LC fiber uplinks

High voltage barrier not shown
Panduit Integrated Zone Enclosure (Large)
Z23N-SBABD1

- 24” x 36” x 12” (610 x 916 x 305mm) NEMA 4/12 enclosure
- Stratix 8000 10-port switch
  (second switch/expansion not included)
- 1Gb uplink capability
- 8-port Copper Expansion module
- UPS battery-backup system completely wired with battery, power supply, circuit protection and grounding configured behind touch-safe cover
- 48-port patch panel for structured cabling; patch cords and jacks included for downlink cabling
- Fiber optic surface mount box for uplink cabling
- IP66 Rated Ingress Protection
- Thermally Validated to 40°C
- Class 1, Division 2 Components

Fully Assembled, UL and CE Approved
Connecting Machine to Plant Floor Architecture

- Utilize best practices and guidelines
- Achieve greater performance
- Enhance network security
- Key elements:
  - Space Optimization
  - Noise Mitigation
  - Security
  - Environmental Protection
  - Safety
  - Planning for Ethernet
Legacy MCC Example w/Modicon Control System
Internal Pathways w/existing control wiring
New: Proposed Retrofit Switch Connectivity

Network Zone System (NZS)

Industrial Distribution Frame (IDF)

Micro Data Center (MDC)

Pre-bundled Pre-Terminated 4-cable IndustrialNet cabling to Stratix/Cisco Switches out of CDPP8RG

Panduit CAT6A STP Horizontal Copper Cabling with Pre-Terminated STP Jacks
Panduit In Panel Solutions

• **Cable Protection**
  – Bend radius control
  – Bundling

• **Identification/Color Coding**
  – Labels, bands, colored cables & jacks
  – Facilitates moves, adds, and changes
  – Troubleshoot

• **Don’t forget grounding and bonding!**
  – Critical for communication
  – Not just safety
Deploying Ethernet to Machine

- Maximize plant uptime and ensure long time reliability
- Maximize facility uptime while reducing operating costs
- Prevent unauthorized disruption of service
- Proactively troubleshoot network connections
## Panduit Industrial Ethernet Cable Addressing the Environmentals!

<table>
<thead>
<tr>
<th>Cable Type</th>
<th>Jacket Type</th>
<th>Jacket Rating</th>
<th>Shielding Type</th>
<th>Flex Rating</th>
<th>Relative Cost, $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat 5e, Cat 6 Unshielded (4pr)</td>
<td>PVC</td>
<td>CM</td>
<td>U/UTP</td>
<td>Standard</td>
<td>$</td>
</tr>
<tr>
<td>Cat 5e, Cat 6 Shielded (4pr)</td>
<td>PVC</td>
<td>CM</td>
<td>F/UTP</td>
<td>Standard</td>
<td>$</td>
</tr>
<tr>
<td>600V High Flex Cat 5e Shielded (2pr) (4pr)</td>
<td>TPE</td>
<td>CM/CMX</td>
<td>SF/UTP</td>
<td>High Flex 1M and 10M cycles</td>
<td>$$</td>
</tr>
<tr>
<td>Zero Halogen Cat 5e (2pr) Cat 6 (4pr)</td>
<td>PUR</td>
<td>IEC 60332-1 IEC 60754</td>
<td>SF/UTP (2pr) S/FTP (4pr)</td>
<td>Medium 10k cycles</td>
<td>$$</td>
</tr>
</tbody>
</table>
Panduit Fiber Optic Cabling: We’ve got you covered!

- 62.5uM, 50uM, and 9uM SM
- Indoor & Outdoor
- Variety of Jackets and Constructions for Mission Critical Applications.
- Opticam Termination Tools and Training!
BackBone Cabling: Panduit Dielectric Armored Cables

Crush-Resistant Dielectric Armor

Distribution-style Cable Core

All-Dielectric Armored Cable

- Lightweight & crush resistant
- Smaller bend radius than metallic interlock armor
- Can be deployed without conduit (J-hooks, undefined pathway)
- No grounding/bonding required
- Available in fiber counts & types supporting switch requirements
- Super alternative to running conduit!
Panduit Industrial Field Terminable Connectivity

- Panduit Industrial Field Terminable RJ45 Plug
- M12 X & D Code Male Connector
- Female M12 to Female RJ45 Adapter
Panduit Modular Patch Panels

- Modular panels use individual jacks (not datapatch)
- Complete line of modular panels available
- 24- and 48-port straight and angled (patented)
- Flush mount, standard mount, with/without labels
- Strain relief bars support cable behind the panels
Copper Cable Patching Solution
Part Number CDPP8RG & CADIN1xx
Supports 8 single width Mini-COM® copper modules
Patch fields that match connector configuration from Stratix switch – same look and feel as the switch
Horizontal cable can be installed directed upwards or downwards
DIN rail or panel mount
Features label pockets/labels
Panduit 600V Rated Industrial Patch Cords

Patch cords needed in UL type control panels containing **high voltages** (up to 600 volts)

- Offered for four pair cable only; RJ45 connectivity
- 600 Volt rated suitable for use with control panels conforming to UL 508A safety standard
- Category 5e component performance
- Stranded conductors for high flexibility
- Shielded TPE cable construction “foil over braid”
- Offered in metric units for global offering
- Colors: teal (TL) standard; YL, RD and BL as options with factory MOQs
- Features Panduit patented plug with tangle-free latch
- Standard lengths 0.3, 0.6, 1, 2, 3, 5, 10, 15 and 20 meters
PanNet® Cat 5e and Cat 6 Small Diameter Patch Cords

• 100% tested to patch cord limits
• Only .150 in (3.8 mm) diameter
• Flexible, tight bend radius
• Occupy < ½ the space
• Dual-rated CM/LSZH jacket
• PoE and PoE+ in bundles up to 48 cables
• 96 meter channels
Strengthening the Network From the Ground Up

- Protect against hazards
- Reduce Intermittent failures
- Maintain a safe working environment
- Reduce risks
Industrial Network Infrastructure Services

**Assess**
- Physical Infrastructure Evaluation
- Grounding & Bonding Assessment
- In-depth Infrastructure Assessment
- Network Visualization

**Design**
- Industrial Networking Physical Infrastructure Design

**Deploy**
- On-site Project Management
- Installation Specification
- Deployment Oversight and Validation
Panduit & Rockwell Advisory & Assessment Services
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
How do we insure the Connected Enterprise is deployed properly??

Hire a Panduit One Partner*

IT Enterprise Data Center

OT Micro Data Center
Panduit Partner One Partner Architecture

Enterprise Structured Cabling Solution
- Includes:
  - Fiber
  - Copper

Data Center Infrastructure Solution
- Physical Infrastructure
  - Includes:
    - Cabinets
    - Pathways
    - Thermal Management
    - Hot/Cold Aisle Containment

- DCIM
  - Includes:
    - PDUs
    - SmartZone™ Software

Industrial Automation Infrastructure Solution
- Includes:
  - Fiber
  - Copper
  - Converged Zone Enclosures

Distributors Panduit Industrial Network Program

Partner Enabled Services
Do you know what is connected to Your Network?

Programmable Controllers
Operator Interfaces
Access Points Wireless devices
Motor Drives
Bar Code Scanner
Terminal servers
Weighing & Inspection
Industrial Ethernet PLC Input / Output modules
OEM Systems
Switchgear
Building / Energy Management
Panduit IntraVue:
Easy to Use & Powerful Graphical Visualization Software

View a live picture of your communications to all the automation devices!

Automatically Maps your Network

Schedule a DEMO Today!
Emerging IoT Technologies…
SynapSense® Wireless Monitoring System

- 2.4 Ghz and 900 MHz
- Fast, low-cost, reliable deployment
- Real-time notification of “out of state” conditions
- Single pane-of-glass monitoring and management
- Operational cost reduction

Connected Asset Manager for IoT Intelligence
# Panduit - SynapSense Wireless Signal

<table>
<thead>
<tr>
<th>2.4 Ghz Mesh 802.15.4</th>
<th>900 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesh Network</td>
<td>Point to Point</td>
</tr>
<tr>
<td>Multiple Communication Paths</td>
<td>Regional frequencies</td>
</tr>
<tr>
<td>Node to Node</td>
<td>920 Mhz Japan</td>
</tr>
<tr>
<td>Node to Gateway</td>
<td>868 Mhz EU</td>
</tr>
<tr>
<td>One model worldwide</td>
<td>900 Mhz Americas</td>
</tr>
<tr>
<td>Frequency Hopping</td>
<td>433 Mhz China, AsiaPac</td>
</tr>
<tr>
<td>Narrow Band</td>
<td>Greater signal propagation</td>
</tr>
<tr>
<td>Clear Channel Detection</td>
<td>Increased distance</td>
</tr>
<tr>
<td></td>
<td>Increased penetration</td>
</tr>
</tbody>
</table>

- Frequency Hopping
- Narrow Band
- Clear Channel Detection

- Greater signal propagation
- Increased distance
- Increased penetration
# Monitoring System

<table>
<thead>
<tr>
<th>Description</th>
<th>900Mhz</th>
<th>2.4Ghz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration Meter 0-250Hz</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Temperature sensor, from -40°F/-40°C to +257°F/+125°C</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Temperature sensor, from -40°F/-40°C to +257°F/+125°C with Probe (3 foot std.)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>AC Current Meter - 20 Amp</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Voltage Meter - 0-5 VDC</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Pressure Meter - 300 PSIG (900Mhz) DP (2.4Ghz)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Open/Closed Sensor</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Pulse Counter (1 and 4-Input)</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
Panduit, Cisco & RA Resources to Assist You!

• Industrial Ethernet Physical Infrastructure Reference Architecture Design Guide
• Converged Plantwide Ethernet (CPwE) – http://www.rockwellautomation.com/rockwellautomation/products-technologies/network-technology/architectures.page?
• Introduction to a Micro Data Center White Paper
• Control Panel Optimization White Paper http://www.hoffman-panduit.com
• Scaling the Plant Network White Paper
• Design Tools:
  – Rockwell Automation Proposal Works

• Panduit Technology Brief: Structured and Point to Point Network Cabling

• Why IP? Visit the Industrial IP Advantage website for FREE TRAINING!
Thank You!