Manufacturing and the Internet of Everything

Johan Arens, CISCO  (joarens@cisco.com)
- Business relevance of the Internet of everything
- Manufacturing trends
- Business imperatives and outcomes
- A vision of the connected factory

Stephen Crockett, RCDD  (stephen_crockett@hotmail.com)
- The risks
- The impact on the physical network infrastructure
What Is the Internet of Things?

“The Internet of Things is the intelligent connectivity of physical devices driving massive gains in efficiency, business growth, and quality of life.”
Converging Digital Disruptions

The Nexus of Forces

IoT = $1.9 Trillion in 2020

Gartner

The 3rd Platform

$462 Billion in 2013 (22% of total ICT spending)

IDC

The Industrial Internet

$10 Trillion to $15 Trillion Over Next 20 Years

GE

Conference & Exhibition
Ottawa, Ontario, Canada
Converging Digital Disruptions

The Nexus of Forces

The 3rd Platform

The Industrial Internet

Create a Unique Inflection Point
The Internet of Everything (IoE)

People
Connecting People in More Relevant, Valuable Ways

Process
Delivering the Right Information to the Right Person (or Machine) at the Right Time

Data
Leveraging Data into More Useful Information for Decision Making

Things
Physical Devices and Objects Connected to the Internet and Each Other for Intelligent Decision Making
The Internet of Everything (IoE)

People
Connecting People in More Relevant, Valuable Ways

Process
Delivering the Right Information to the Right Person (or Machine) at the Right Time

Data
Leveraging Data into More Useful Information for Decision Making

Things
Physical Devices and Objects Connected to the Internet and Each Other for Intelligent Decision Making

Networked Connection of People, Process, Data, Things
IoT Is Here Now – and Growing!

50 Billion
“Smart Objects”

Rapid Adoption Rate of Digital Infrastructure:
5X Faster Than Electricity and Telephony

Source: Cisco IBSG, 2011
IoT Is Here Now – and Growing!

The New Essential Infrastructure

50 Billion "Smart Objects"

5X Faster than Electricity and Telephony

World Population

Source: Cisco IBSG, 2011

2015 BICSI Canadian Conference & Exhibition
Ottawa, Ontario, Canada
The World Generates More Than 2 Exabytes of Data Every Day

Connected Objects Generate Big

- 46 million smart meters in the U.S alone
  1.1 billion data points (.5TB) per day

- A single consumer packaged good manufacturing machine generates
  13B data samples per day

- A large offshore field produces 0.75TB of data weekly
  A large refinery generates 1TB of raw data per day

- 10TB of data for every 30 minutes of flight
  With >25,000 flights per day, petabytes daily
Enablers/Drivers of IoT

More Innovation and Change than at Any Other Point in Our Lifetime

Technology Transitions

Network as the Platform

Business Transitions

BYOD
CLOUD
NEW BREED OF APPS
SENSORS & DEVICES
BIG DATA ANALYTICS

GROWTH & INNOVATION
NEW BUSINESS MODELS
EXPERIENCE EXPECTATIONS
GLOBALIZATION
SECURITY & PRIVACY

More Innovation and Change than at Any Other Point in Our Lifetime
Connected Public Safety Vehicles

- Video Cameras
- Laptop or MDT
- DVR
- Printer
- GPS
- License Plate Recognition
- 3G / 4G Backhaul
- 4.9, 5.8, 2.4 GHz Uplink to Mesh or WLAN Infrastructure
- 900 Mhz/5.9 Ghz TSP
- Wireless VoIP Handset
- OCR
Connected Forklift?

- Video Cameras
- Laptop or MDT
- Printer
- GPS
- PDA
- Sensors
- Roll ID scanner
- 3G / 4G Backhaul
- 5.0, 2.4 GHz Uplink to Mesh or WLAN Infrastructure
- Wireless VoIP Handset

Conference & Exhibition
Ottawa, Ontario, Canada
Connected Forklift?

- Video Cameras
- Laptop or MDT
- Printer
- GPS
- Roll ID scanner
- 3G/4G Backhaul
- 5.0, 2.4 GHz Uplink to Mesh or WLAN Infrastructure
- Wireless VoIP Handset
- Sensors
Another Example
Big Data becomes Open Data for Customers, Consumers to Use

IoT Transforms Data into Wisdom

Wisdom (Scenario Planning)

Knowledge

Information

Data
... But It Also Adds Complexity

Partner Ecosystem

Applications

Application Interfaces

Unified Platform

Infrastructure Interfaces

Infrastructure
... But It Also Adds Complexity

- Application Interfaces
- Infrastructure Interfaces
- Partner Ecosystem
- Applications
- Unified Platform
- IoT Connectivity Platform
- IoT Specific Network Elements
- Device and Sensor Innovation
- Security

Services

Big Data
Analytics
Control Systems
Application Integration

APPLICATION AND BUSINESS INNOVATION

Data Integration

Bicsi

Conference & Exhibition
Ottawa, Ontario, Canada
... But It Also Adds Complexity

APPLICATION AND BUSINESS INNOVATION

Data Integration | Big Data | Analytics | Control Systems | Application Integration

Application Interfaces

Scalable, Robust, Secure and Future-Ready
Impact on the Physical Network Infrastructure

- Physical layer design considerations
- Industry Standards
- Recommendations developed for component and cable selection
From the Office to the Factory Floor: A Single Integrated Site-Wide Network Topology Using IP
The Plant is Going Industrial IP

- Internet Protocol (IP) for Industrial Applications
- The trend is to extend the office IP network to the factory floor to have one homogeneous network and to gain access to the new IP-enabled devices for manufacturing
- One stop resource: www.industrial-ip.org
Physical Infrastructure Design
3 Steps to Success

**Vision:** Clear understanding of importance of physical infrastructure

**Strategy:** Understand best practices and pitfalls to avoid

**Execution:** Implement robust solutions for each level of the architecture
**Vision: Address Operational Challenges on the Factory Floor**

- Maximize uptime
- Failure prediction
- Real-time data
- Lower Costs
- Human error reduction
- Safety and security

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

*Sage Research*

“76% of companies are seeing convergence between IT and controls systems.”

*Rockwell Automation*
Strategy: Industrial Network Design Methodology

- **Understand application and functional requirements**
  - Devices to be connected – industrial and non-industrial
  - Data requirements for availability, integrity and confidentiality
  - Communication patterns, topology and resiliency requirements
  - Types of traffic – information, control, safety, time synchronization, drive control, voice, video

- **Develop a logical topology**
  - Define zones and segmentation, place applications and devices in the logical framework based on requirements

- **Develop a hardened physical topology to support the logical framework**

- **Deploy a very robust security and safety model**

- **Reduce risk, simplify design, and speed deployment:**
  - Use information technology (IT) standards
  - Follow industrial automation technology (IAT) standards
  - Utilize reference models and reference architectures
Execution: Design & Implement a Robust Physical Layer

- **Environment Classification (MICE) for:**
  - Connectors and Cables
  - Cable Management, Fasteners, and Pathways
  - Enclosures
  - Grounding, Bonding and Shielding (noise mitigation)

- **Industry Standard Physical Media**
  - Wireless
  - UTP Copper (shielded or unshielded)
  - Fiber (Singlemode or Multimode)

- **Physical Layout**
### M.I.C.E. Rating for Physical Infrastructure

A measure of product robustness

Specified in
- ISO/IEC 24702
- TIA-1005
- ANSI/TIA-568-C.0

Product environmental classes for each plant cell, area or zone.

<table>
<thead>
<tr>
<th>Mechanical Shock Vibration</th>
<th>M₁</th>
<th>M₂</th>
<th>M₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingress Water Dust</td>
<td>I₁</td>
<td>I₂</td>
<td>I₃</td>
</tr>
<tr>
<td>Climatic</td>
<td>C₁</td>
<td>C₂</td>
<td>C₃</td>
</tr>
<tr>
<td>Electro magnetic</td>
<td>E₁</td>
<td>E₂</td>
<td>E₃</td>
</tr>
</tbody>
</table>

**Environmental Severity**

- Office
- Industrial
## Select best media for your needs

<table>
<thead>
<tr>
<th>Comparison</th>
<th>UTP (unshielded twisted pair)</th>
<th>STP (shielded twisted pair)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UTP versus STP</strong></td>
<td>Costs less</td>
<td>Excellent immunity from EMI and RFI noise</td>
</tr>
<tr>
<td></td>
<td>Installs faster</td>
<td>Can locate cable close to source of noise</td>
</tr>
<tr>
<td></td>
<td>Smaller diameter, more flexible</td>
<td>Well suited for more rigorous environments</td>
</tr>
<tr>
<td><strong>CAT5e versus CAT6</strong></td>
<td><strong>CAT5e</strong></td>
<td><strong>CAT6</strong></td>
</tr>
<tr>
<td></td>
<td>Costs Less</td>
<td>Higher signal to noise ratio; performance margins</td>
</tr>
<tr>
<td></td>
<td>Suitable for speeds of less a gigabit</td>
<td>Designed to deliver gigabit performance</td>
</tr>
<tr>
<td><strong>Copper versus Fiber Cabling</strong></td>
<td><strong>Copper</strong></td>
<td><strong>Fiber</strong></td>
</tr>
<tr>
<td></td>
<td>Termination and installation is faster</td>
<td>Cost of fiber transceivers is higher</td>
</tr>
<tr>
<td></td>
<td>Less fragile</td>
<td>Use when excessive EMI noise is present</td>
</tr>
<tr>
<td></td>
<td>Distances of less than 100m</td>
<td>Use when distance is a factor (over 100m)</td>
</tr>
<tr>
<td><strong>Singlemode versus Multimode Fiber</strong></td>
<td>For distances of up to 550m @ 1G &amp; 2km @ 100M</td>
<td>Longer Distance (up to 40km)</td>
</tr>
<tr>
<td></td>
<td>Lower cost transceivers, connectors and installation</td>
<td>Higher bandwidth capabilities</td>
</tr>
<tr>
<td></td>
<td>Higher Fiber cost, but lower total system cost</td>
<td>Lower Fiber cost, but higher total system cost</td>
</tr>
</tbody>
</table>
Select Best Connectivity for Environment

M12 D Code Connectivity – Bulletin 1585D
- Overmolded IP67 connector resistant to vibration, shock, and chemicals
- On-Machine and robotic applications
- High Flex to 10 million cycles
- Variety of connector options
- Suitable for MultiCats
- Cat 5e

Variant 1 Connectivity – Bulletin 1585B
- RJ45 connector with protective Thermoplastic or Die Cast Zinc housing providing an IP67 solution
- On-Machine and robotic applications
- High Flex to 10 million cycles
- Variety of connector options
- Overmolded patchcords and field attachable connectors
- Suitable for MultiCats
- Cat 5e

LC Fiber Optic Bulkhead Adapter

Copper Bulkhead Connector - Shielded or Unshielded

2015 BICSI Canadian Conference & Exhibition Ottawa, Ontario, Canada
Power over Ethernet

- Useful for powering devices without additional wiring (e.g.) IP telephones, WAPs, cameras
- One throat to choke
- Non-unionized IT staff vs. unionized electricians
Wireless Applications

- Eliminating Wires and Cables
- Enabling Portability and Mobility
- Tracking Assets / RFID
- Remote Device Monitoring / Maintenance
- Video Surveillance
Select System Enclosures based on MICE

Level 3
Site Operations
Data Center & DMZ

Level 2
Cell/Area Zone
Zone Enclosure

Level 1
Cell/Area Zone
Control Panel

Level 0
Cell/Area Zone
On-Machine
DIN Rail Mounting

- Copper and fiber distribution
- **Use DIN Patch box to patch** to devices in panel
- Validate performance with standards based tests and equipment
What do Physical Layer Reference Architecture based best practices look like?
Critical Industrial Assets are at Risk!

- Downtime
- Security lapses
- Performance degradation
Best Practices: Micro Data Center

**Enterprise/Office**
Patchfield used to uplink switch to Levels 4 & 5 Enterprise

**Server Patching**
Cross connect between production servers and switch

**Firewall and IDMZ**
Logical buffer zone between the Enterprise and Industrial Zones

**Industrial Zone**
Patchfield used to connect Layer 3 distribution switch to Layer 2 access switches used within Cell/Area Zone
**Best Practices: Zone Architecture**

**Previous: Centralized Cabling**
- Home runs from each node back to the network room

**Recommended: Zone Cabling**
- Provides for reduced home-run wiring, easy moves / adds / changes and reduced size of network room
Best Practices: Physical Port Security

- Keyed solutions for copper and fiber
- Lock-in, Blockout products secure connections
- Data Access Port (keyed cable and jack)
Best Practices: Grounding/Bonding

For the Data Center

For Control Panels

Reduce risks of noise coupling at every level with robust, structured grounding/bonding
Best Practices: Wire & Equip Segregation - Noise Zones

- Begin by segregating the equipment and bonding the ground plane.
- Add duct in such a way that you can maintain wire segregation between “clean”, “dirty” and “very-dirty”.
- Add shielding in appropriate places where segregation cannot be achieved by distance.
Best Practices: Machine or Process Areas

- High MICE levels
  - Vibration
  - Chemical
  - Temperature
  - Wash down

- Proper:
  - Wire management
  - Identification
  - Grounding/Bonding
Conclusion

- Planning and installing physical infrastructure based on standards and best practices will result in higher availability, integrity and performance.

Scalable, robust, secure & future-ready