Software Defined Networks - Will They be the Next Frontier in Industrial Automation?

Should ODVA create specifications for configuration and operation of integrated automation networks?

General Session and 16th Annual Meeting of Members

www.odva.org
What do a Data Center and Automotive Plant Have in Common?

<table>
<thead>
<tr>
<th>Facility Sq Feet</th>
<th>Physical Ethernet Ports</th>
<th>Compute (PLC vs. Server)</th>
<th>Ethernet Switches</th>
<th>Watts Consumed in operation</th>
<th>Watts Consumed in idle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive Plant</td>
<td>Enterprise Data Center</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
What does an Automotive Plant Have in Common with a Data Center?

<table>
<thead>
<tr>
<th>Facilty Sq Feet</th>
<th>Physical Ethernet Ports</th>
<th>Compute (PLC vs. Server)</th>
<th>Ethernet Switches</th>
<th>Watts Consumed in operation</th>
<th>Watts Consumed in idle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive Plant</td>
<td>Enterprise Data Center</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Answer #1...really big Ethernet networks!
Software Defined Networking

SDN enables automation and virtualization of enterprise data centers. Open standards are starting to take hold.
What does an Automotive Plant Have in Common with a Data Center?
What does an Automotive Plant Have in Common with a Data Center?

Answer #2...they have functions that manage and control the flow of data are somewhat similar!
So what is all this about?

- Software Defined Network controllers focus on controlling the flow of data across a network in a standard and programmatic way.
- PLCs control movement of devices and thus product through a manufacturing system in a standard and programmatic way.
- An SDN Controller is like a PLC.
- A switch or router is like an I/O block.
Functions are Somewhat Similar

A Network Manager is like a PLC.

- PLCs control movement of devices and thus product through a manufacturing system in a standard and programmatic way.

... and a switch or router is like an I/O block.

- Network Controllers focus on controlling the flow of data across a network in a standard and programmatic way.
What does an Automotive Plant Have in Common with a Data Center?

Their Ethernet networks all share the following embedded in all network devices

- **Management Plane**
  - Monitoring
  - Remediation

- **Control Plane**
  - Behavior
  - Characteristics

- **Data Plane**
  - Message transport

Traditionally each network device must be “touched” to configure and manage these planes - with the Control Plane being touched the most – creating complexity
SDN Helps Reduce Complexity by Automating the Configuration of Planes Today and Tomorrow

Switch/Router/?
Management
Control
CPU
Memory
LLC
MAC
PHY

Data Plane

Switch/Router/?
Management
Control
CPU
Memory
LLC
MAC
PHY

Data Plane

SDN Controller
Management
Control
API/Protocol

Touch Many
Configure Many
Touch One
Configure Many
Dynamically

API

Touch Many
Configure Many

Dynamically

Data Plane

SDN Helps Reduce Complexity by Automating the Configuration of Planes Today and Tomorrow

Switch/Router/?
Management
Control
CPU
Memory
LLC
MAC
PHY

Data Plane

Switch/Router/?
Management
Control
CPU
Memory
LLC
MAC
PHY

Data Plane

SDN Controller
Management
Control
API/Protocol

Touch Many
Configure Many

Dynamically

API

Touch Many
Configure Many

Dynamically

Data Plane
The Challenges of Convergence and Expertise

Robotics and Welding Expertise

Conveyor Control Expertise

Error Proofing Expertise

Network Expertise

Robotics and Welding Cell Solution

Conveyor Control Cell Solution

Error Proofing Solution

Bottle Neck
Today - Separate Management of Network Assets

IT Network Management Center
- IT Administrator
- NMS

Enterprise IT LAN
- Manage, Configure, Control

IT Assets
- Routers, Switches, Bridges, Firewalls, Desktops, Laptops, Servers, …

OT Network Management Center
- Floor Operator
- Historian

Control Network LAN
- Manage, Configure, Control

OT Assets
- IEDs, RTUs, PLCs, Drives, Actuators, Sensors, Cameras, Pump Stations, …
Problems and Challenges

Two Sets of Management Systems

No Policy Integration

Insufficient Network Security Practices

Hard to diagnose network problems
So where is the complexity?

- The Control Plane has five Pillars that require specific network expertise.
- Currently each Pillar must be configured separately yet each has an impact on the others.
What Resides in these Pillars?

1. **Scalable High Availability**
   - EIGRP, OSPF, IS-IS, BGP, MP-BGP, Spanning Tree, MC-LAG, Cluster, VSS, VPC, HSRP, VRRP, GLBP, ISSU, PFR, MPLS TE, etc.

2. **Virtual Segmentation**
   - VLAN, VDC, Contexts, 802.1Q, VRF, MPLS VPN, EVN, VXLAN, LISP, SXP, SGT

3. **Mobility (Layer 2 extension and Host Routing)**
   - OTV, VLAN 802.1Q, L2TPv3, MPLS Pseudo Wire, MPLS VPLS, MPLS EVPN, VXLAN, LISP, CAP/WAP

4. **Quality of Service with Service Assurance**
   - Modular QoS, WRR, DWRR, SRR, Strict Priority, MLS QoS, HQoS, WTD, Policing, Shaping, Hierarchical Shaping, Bandwidth Remaining Ratio, RED, WRED, DBL, WFQ, etc.

5. **Single point of configuration and management**
   - CLI, Cisco Prime Infrastructure, DCNM, Cisco Fabric Manager, XML/CLI Scripting, Cisco Configuration Professional, Cisco Prime Analytics, Cisco Prime Network, Cisco Prime Performance Manager, Cisco Prime Central, Cisco Prime Provisioning, Cisco ONE/XNC, Open Daylight, CIAC, Cloupia, Openstack Nebula, Cisco WAN Manager, etc.

*Each is impacted by vendor-specific characteristics requiring expertise to optimize their use.*
The Benefits of Software Defined Networking Can Apply to Industrial Automation

- Lower Cost
- Faster deployment
- More dynamic
- Control the network configuration as an entity
- Eliminate device by device configuration treatment
- Provides for application control of the network
- Facilitates Network Automation for changes
Today manual:
- Determine ports used
- Get/choose VLAN number
- Get/choose IP address
- Create VLAN
- Assign ports to VLAN
- Connect locally and configure via device interface

SDN programmatic:
- SDN server application finds network devices
- SDN server application finds end points connected to network
- Control program requests SDN server to connect devices
- Control Program requests ....
SDN Standards Today

- OpenDaylight: open source controller
- OpenFlow: open source protocol/API
- Both are current communities providing standards for Software Defined Networks
- Both are open and may be used together
- Overlapping vendor support
- Data center focused
- Underlying hardware provides performance differentiation only; throughput etc.

No thought to the industrial space
Can ODVA Bring SDN Concepts to Industrial Automation?

- CIP and EtherNet/IP can be used to create an Industrial Network Controller for the automation network infrastructure.

- This Controller can be used to operate switches and routers as we do I/O today.

- CIP can be extended to communicate with the network infrastructure devices with new attributes.
Controller Architecture Overview

- **SDN Controller**
  - **ENG Applications**
    - Visualizer
    - Asset Disc
    - Manager
    - Compliance
  - **OT Applications**
    - OT
    - Asset Disc
    - DE
    - Security Mgr.
    - IT-OT
    - OT-IT Agent
  - **RESTFUL API**

- **Standard ENG Services**
  - Topology
  - Policy
  - Inventory
  - QoS
  - NIB
  - DAS

- **OT Services**
  - Prot
  - PCE
  - Policy
  - Data Model

- **CIP, Restful API, …**
  - OnePK, OpenFlow, CLI, SNMP, …
  - CIP, Profinet, …

- **OT Network Management Center**
  - HMI
  - Floor Operator
  - Historian

- **OT Assets**

- **IT Assets**

- **IT Assets**

General Session and Annual Meeting of Members
© 2014 ODVA, Inc.
The Call to Action

True Convergence
EtherNet/IP and CIP controlling a multiprotocol automation network based on standard Ethernet.

CIP Messages
Thank You