Power Utilities Energy Automation

Paulo Pereira, IoT Consulting Systems Engineer
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Thank You!

Maik Seewald
Patrick Grossetete
Ruben Lobo
Rik Irons-Mclean

Sean Song Jiang
Motaz Elshafi
Robert Barton
Dave Schmitt
Agenda

- Utilities Digital Transformation
- Utility MPLS WAN
- Digital Substation
- New Distribution Grid
- Big Data and Analytics
- Conclusion
Utilities Digital Transformation
Utilities digital business imperatives
where utilities industry is focusing today

- Retain & acquire customers & employees
- Improve safety, security and regulatory compliance
- Develop new energy sources and consumption models
- Modernize the utility grid
Utilities capabilities delivered by Cisco solutions

- Substation automation
- Utility telecoms
- Distribution automation
- Smart metering

- Cyber & physical security
- Secure ops for automated systems
- Digitalized emergency response system

- Intelligent contact center
- Customer interaction enrichment
- Smart metering
Industry Business Imperative: Utility Grid Modernization

Business Capabilities

- Increase service reliability
- Optimize grid operations
- Reduce risk
- IT/OT convergence
- Interoperability & Flexibility

Cisco OT Solutions

- Utility WAN
  - TDM to IP/MPLS migration
- Digital Substation
  - IEC 61850 SA + Security
Business and IT must work together
to Respond to Digital Disruption
Utility MPLS WAN
MPLS vs. TDM On The Power Grid

• Strengths of TDM are *Reliability*, *Predictable Delay* and *Bandwidth*

• Strength of packet networks is *flexibility* and *scalability*

• **MPLS** is a solution which is all of the above

• **OPEX** promotes Infrastructure convergence for better utilization of network assets
  • MPLS enables this with advanced L2 and L3 **VPN** technologies
  • Legacy TDM, archaic interfaces (Serial RS-232, E&M), and specific interfaces used in energy (C37.94) will persist for many years

• **MPLS** is the only technology that can unify transport systems and still support all current and future Power Grid services in a secure way
## Power Utilities HV Example Use Cases

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitor, Measure, Control, Automation, &amp; Protection</td>
<td>SCADA (DNP3, Modbus, T101) serial tunneling with Raw Sockets</td>
</tr>
<tr>
<td></td>
<td>SCADA (DNP3-IP, Modbus-TCP &amp; T104) IP transport</td>
</tr>
<tr>
<td></td>
<td>Wide Area Measurement Systems (WAMS) with IEC 61850-90-5</td>
</tr>
<tr>
<td></td>
<td>Workforce Enablement. Mobile Workforce. Personal Protective Equipment (PPE)</td>
</tr>
<tr>
<td></td>
<td>Video Surveillance and Analytics. Access Control</td>
</tr>
<tr>
<td></td>
<td>Voice and Video for Remote Expert and Collaboration, Wearables</td>
</tr>
<tr>
<td></td>
<td>Cyber Security. Safety. Regulation</td>
</tr>
<tr>
<td></td>
<td>Teleprotection and Current Differential Protection with legacy interfaces</td>
</tr>
<tr>
<td></td>
<td>IEC 61850 Teleprotection with Ethernet interfaces</td>
</tr>
<tr>
<td></td>
<td>IEC 61850 GOOSE messaging for Feeder Protection over Station Bus</td>
</tr>
<tr>
<td></td>
<td>IEC 61850 SV messaging with Merging Units over Process Bus</td>
</tr>
</tbody>
</table>
A Standard-based WAN Architecture

- **Cisco’s WAN architecture** for tele-protection and other power automation use cases is **based on international standards**, guidelines, and recommendations.

- Architectural recommendations and functional requirements, such as latency, latency symmetry and jitter, are derived from:
  - IEC 61850-90-12: Wide Area Network Engineering Guidelines
  - IEC 61850-90-1: Use of IEC 61850 for the communication between substations
  - IEC 61850-5: Communication requirements for functions and device models
  - IEC 61850-90-5: Use of IEC 61850 to transmit synchro phasor information according to IEEE C37.118
  - IEEE 1588: Precision Time Protocol
  - CIGRE D2.35: SCALABLE COMMUNICATION TRANSPORT SOLUTIONS OVER OPTICAL NETWORKS
Cisco Solution Validated Design and Lab

- **Dedicated solution validation** lab for substation automation
- Designed to support current and future **real-world Power Utilities use cases**
- Lab consists of complete **E2E utility network**: NOC, substations, DMZ, WAN
- **End-to-end validation** with RTU, Relays, IED, PMU etc
- Test validation **results documented** in Design and Implementation Guides
Cisco Utility WAN Solution Overview

Business Needs
- Reliability and Efficiency
- Cost Reduction

Business Outcomes
- Greater Visibility and Control over Grid Operations
- Reduced OPEX

Capabilities
- High performance and resilience for Teleprotection
- SCADA Scalability
- Utility compliant
- Easy provisioning, monitoring, and trouble shooting

Solution Components

Legend
- HV = High Voltage
- LV = Low Voltage
- Sub = Substation
- Ctrl = Control

Hardware
- ASR 920U/902U/903U

Software
- EPN-M

Services
- Advanced Services
- Solution Support
Teleprotection Migration to IP

G.703 Co-Dir
TPR Relay
E1/T1, Serial, E&M, C37.94
Migrate from existing Channel-Bank to ASR-900

E1/T1
Line Timing
Preserving channel-bank
CESoPSN or SAToP Pseudowire
Freq. Sync using SyncE
Future support for E&M, C37.94 etc.

Direct Attachment from legacy relays

E1/T1, Serial, E&M, C37.94
Migrate from existing Channel-Bank to ASR-900

E&M, G.703 Co-Dir, C37.94
TPR Relay
E1/T1
Line Timing

Direct Attachment from IEC 61850 relays

Ethernet
TPR Relay

MPLS/IP Transport
Substation Edge Network
Core Network
Substation Edge Network
Substation
# Interface Support for Relay Communications

<table>
<thead>
<tr>
<th>Interface</th>
<th>Line Protection Scheme</th>
<th>Supported Cisco Platforms Today</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1/E1</td>
<td>Line Current Differential (87L) Distance Schemes</td>
<td>ASR903/902 (RSP2), ASR920</td>
</tr>
<tr>
<td>Ethernet</td>
<td>Line Current Differential (87L) Distance Schemes</td>
<td>ASR903/902 (RSP2), ASR920</td>
</tr>
<tr>
<td>C37.94*</td>
<td>Line Current Differential (87L) Distance Schemes</td>
<td>ASR903/902 (RSP2)</td>
</tr>
<tr>
<td>Async RS-232 / V.24*</td>
<td>Distance Schemes</td>
<td>ASR903/902 (RSP2)</td>
</tr>
<tr>
<td>X.21*</td>
<td>Line Current Differential (87L)</td>
<td>ASR903/902 (RSP2)</td>
</tr>
<tr>
<td>E&amp;M*</td>
<td>Distance Schemes</td>
<td>ASR903/902 (RSP2)</td>
</tr>
<tr>
<td>G.703 Co-Directional</td>
<td>Distance Schemes</td>
<td>Roadmap for Nov 2018</td>
</tr>
<tr>
<td></td>
<td>Line Current Differential (87L)</td>
<td></td>
</tr>
<tr>
<td>110 VDC Dry Contact</td>
<td>Distance Schemes</td>
<td>3rd party box required</td>
</tr>
</tbody>
</table>

*Support for ASR920-12SZ-IM platform in roadmap*
Benefits of Ethernet based Teleprotection
IEC 61850

• Lower latency, from few ms to dozens of us (20x improvement!)
• Lower cost (less interface modules in relays and in routers)
• Less complexity (no need for TDM over MPLS technologies)
• Increased HA, up to 0ms failover, with standards like PRP*
• More resilient solution with multiple distinct precision clock sources

*technology concept to be validated
## ASR 903/902/920 Utility Features

<table>
<thead>
<tr>
<th>HW / SW</th>
<th>Feature</th>
<th>SW Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW</td>
<td>RS232 TCP Raw Socket for RSP2 (Serial IM)</td>
<td>Aug 2015</td>
</tr>
<tr>
<td>SW</td>
<td>RS232 Mirrored bits - Teleprotection</td>
<td>Aug 2015</td>
</tr>
<tr>
<td>HW</td>
<td>ASR 903 / 902 Utility Env. Certification: IEEE 1613 and IEC 61850-3</td>
<td>Nov 2015</td>
</tr>
<tr>
<td>HW/SW</td>
<td>4w E&amp;M IM - CESoPSN Pseudowire</td>
<td>Nov 2015</td>
</tr>
<tr>
<td>SW</td>
<td>X.21 CESoPSN Pseudowire for RSP2 (Serial IM)</td>
<td>Apr 2016</td>
</tr>
<tr>
<td>SW</td>
<td>RS485 TCP Raw Socket for RSP2 (Serial IM)</td>
<td>Nov 2016</td>
</tr>
<tr>
<td>HW/SW</td>
<td>C37.94 IM - CESoPSN Pseudowire</td>
<td>Nov 2016</td>
</tr>
</tbody>
</table>
# ASR 903/902/920

## Latest Utility Features (2017)

<table>
<thead>
<tr>
<th>HW / SW</th>
<th>Feature</th>
<th>Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW</td>
<td>E&amp;M to T1/E1 CESoPSN interworking</td>
<td>Aug 2017</td>
</tr>
<tr>
<td>SW</td>
<td>ASR 920: Raw Socket &amp; IoT IM’s support</td>
<td>Aug 2017</td>
</tr>
<tr>
<td>SW</td>
<td>EPN-M: ASR 902 and ASR 920-12SZ-IM support</td>
<td>Aug 2017</td>
</tr>
<tr>
<td>SW</td>
<td>EPN-M: support for ASR 900 IOT IM’s and features (ex. Raw Socket)</td>
<td>Aug 2017</td>
</tr>
<tr>
<td>HW</td>
<td>ASR 920 Utility Env. Certification: IEEE 1613 and IEC 61850-3</td>
<td>Oct 2017</td>
</tr>
<tr>
<td>HW</td>
<td>G.703+FXS/FXO (G.703 Co-dir<em>4 + FXS</em>3 + FXO*2)</td>
<td>Nov 2018</td>
</tr>
</tbody>
</table>
Evolved Programmable Network Manager

- Life Cycle Device and Service Management
- Evolved Programmable Network (EPN) Manager
- Automated Model Based Point- and - Click Multidomain Provisioning
- 3D Multilayer Packet Flow Visualization
- Model Based Service & Device Views
- Multi Layer End to End Management (Physical & Virtual)

Device IP | Maximum Utilization | Current Utilization
---|---|---
172.23.218.03 | 80% | 72% | 5% | 4% | 3% | 2% | 1% | 0%
10.89.205.140 | 77% | 72% | 5% | 4% | 3% | 2% | 1% | 0%
172.23.218.69 | 61% | 52% | 4% | 3% | 2% | 1% | 0%
10.89.205.33 | 51% | 42% | 3% | 2% | 1% | 0%
10.89.205.45 | 41% | 32% | 2% | 1% | 0% | 0% | 0% | 0%
Digital Substation
IEC 61850 - Communication networks and systems for power utility automation

Scope and Objectives

- **Interoperability** (between devices and systems)
- **Free configuration** (free allocation of functions to devices)
- **Long term stability** (layered, object-model based design)
- **Extensibility** (into new domains or even other IoT verticals)

- Btw, IEC 61850 has left the substation!
IEC 61850: The Protocol Stack

- Network Architecture for the Substation LAN is defined in IEC TR 61850-90-4 (VLANs, RSTP, PTP)
- It contains also PRP/HSR references to IEC 62439-3:2012 for seamless redundancy and recovery including Red Boxes
- Specifies Reference Topologies based on PRP/HSR

Note: Protocol Stack extended by XMPP profile
IEC 61850: Within the Substation
Station and Process Bus

- **The Station Bus** connects entire substation; provides connectivity between central management and individual bays
  - Connects IEDs within a bay, connects bays, bays with the gateway/gateway router
  - Provides only soft real-time quality of service (except for bus bar protection)

- **The Process Bus** connects the primary measurement and control equipment to the IEDs
  - May be limited to a bay
  - Expected to provide hard real-time quality of service

Source: IEC TC57
Substation Automation
Main Design Topics

- High Availability
- Topology
- Timing
- Network Segmentation
- QoS
- Security
- Management

Core Connectivity Design Topics
# Substation Automation HA

Recovery time examples in IEC 61850-5 (Communication Requirements)

=> HA Protocol to be used

<table>
<thead>
<tr>
<th>Use Cases</th>
<th>Locale</th>
<th>Network Recovery Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCADA to IED, client-server</td>
<td>Station bus</td>
<td>400 ms</td>
</tr>
<tr>
<td>IED to IED interlocking</td>
<td>Station bus</td>
<td>4 ms</td>
</tr>
<tr>
<td>IED to IED reverse blocking</td>
<td>Station bus</td>
<td>4 ms</td>
</tr>
<tr>
<td>Bus bar protection</td>
<td>Station bus</td>
<td>0 ms</td>
</tr>
<tr>
<td>Sampled values</td>
<td>Process Bus</td>
<td>0 ms</td>
</tr>
</tbody>
</table>

- REP or RSTP can not meet HA requirements for Station and Process Bus
- HSR is now partially supported by Cisco but…
- PRP is currently the best technical option in most cases!
PRP Overview

- Parallel Redundancy Protocol: IEC 62439-3 Clause 4
- Two versions so far: PRP-0 (2010) and PRP-1 (2012) and they are not compatible
- Two independent LANs must exist (any topology)
- Two copies of each packet are delivered over these LANs

- Main PRP benefits: Zero packet loss when single LAN fail with support for any network topology
- Main PRP limitation: Double of network components and cost
IEC 61850 Station Bus and PRP
Platform Requirements

**Forward** Jumbo (PRP) Frames
- Cisco Catalyst, IE, CGS, etc

**Environment:** IEC 61850-3
- CGS 2520 and all IE switches

**PTP:** 1588v2 Power Profile (and more…)
- IE5k, IE4k, IE 2kU, CGS 2520

**PRP RedBox Support** (Station Level):
- IE5k, IE4k, or …IE2kU
Power Utilities Timing Requirements

…and typical deployment models

- **General Applications (<1msec)**
  - Sequence of Events
  - Digital Fault Recorder (DFR)

- **High Precision Timing (<10usec)**
  - Synchrophasors (C37.118)
  - Sample Values (IEC 61850-9-2)
  - Distributed DFR Events

- **IEC 61850-5-2003 (1usec to 1msec)**
  - Class T1: Events = ±1msec
  - Class T5: Samples Values ±1usec

- **Dedicated IRIG-B Cables:**
  - Distance Limitations,
  - Cost, Flexibility, etc

---

**Distributed Controller**

**RTU**

**DFR**

**IED**

**PMU**

**GPS Antenna**

**Station Bus**

**Process Bus**

**IRIG-B Source**

**Dedicated IRIG-B Cables:**

- Distance Limitations,
- Cost, Flexibility, etc
Why IEEE 1588?

- IEC 61850 Edition 2 makes reference to IEEE 1588v2 Power Profile
- Precision Time Protocol (PTP) IEEE 1588v2 was developed with the following aims:
  - Synchronization accuracy in the sub-microsecond range
  - Minimum requirements of the processor performance and network bandwidth
  - Low administration effort
  - Use via Ethernet networks
  - Specification as an international standard

**Power Profile, as defined in IEEE C37.238:**
- Layer 2 (Ethernet) Multicast
- 1usec over 16 hops
- Peer-To-Peer Delay Measurements
Utility IEEE 1588 PTP Requirements
…and new deployment model

- IEC 61850-90-4
  (Substation Engineering Guidelines)
- IEEE C37.238
  (IEEE 1588 PTP in Power System Applications)
New HA and Timing Features
IE 5000 and/or IE 4000

New Features Shipping:
• NTP (WAN or local server) to 1588v2 PTP GMC (IE 5000 and IE 4000)
• IRIG-B Interface support (IE 5000)
• Horizontal Stacking (10G IE 5000)
• GNSS support (GPS, GLONASS) with PTP GMC (IE 5000)
• 1588 PTP redundancy over PRP - IEC 62439-3, Annex A (IE 5000 and IE 4000)
• HSR basic Redbox - currently no PTP or PRP support (IE 4000 only)

Committed Roadmap Features (early Spring):
• Coupling box between HSR and PRP (IE 4000 only)
• Support for CDP/LLDP on HSR (IE 4000 only)
IoT Industrial Network Director

Industrial operations focused network management
Gain asset visibility and reduce unplanned downtime
Zero Touch Commissioning and Replacement

- Pre-provision configuration and software for automated network commissioning
- Ensure consistent Network design and Security policies
- Swap hardware when switch fails and recover with automated configuration and software image replacement
- Supported on all managed IE switches

1-year term license at no cost with every new IE switch
## Security in Energy Automation

### Regulations and Standards in the Energy World

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Guidelines</th>
<th>Requirements</th>
<th>Implementation &amp; Technical Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NIST 7628</td>
<td>IEC 62443-3-3: System requirements for IACS solution suppliers</td>
<td>IEC 62056-5-3: DLMS/COSEM Security</td>
</tr>
<tr>
<td></td>
<td>EU Mandate M/490 SGIS</td>
<td>DIN SPEC 27009</td>
<td>IEC 62443-4-1: Product development requirements</td>
</tr>
<tr>
<td></td>
<td>Report: Smart Grid Information Security</td>
<td>BDEW Whitepaper (D,A)</td>
<td>IEC 62443-4-2: Technical security requirements IACS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Integrator</th>
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</tr>
</thead>
<tbody>
<tr>
<td>NIST 7628</td>
<td></td>
<td></td>
<td>IEC 15118-2: Vehicle-to-Grid Communication/VF</td>
</tr>
</tbody>
</table>

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NERC CIP v5 (US, CAN)
IEC 62351: Undertake the development of standards for security of the communication protocols defined by the IEC TC 57 and on end-to-end security issues.
Part 3, 4, 5, 6 contain cryptographic definitions to protect protocols end-to-end.

Part 8 defines Role Based Access Control.

Part 9 specifies key and credential management.

Part 11 defines security for XML files (typically CIM data).
IEC 62443 – Security for IAC

Industrial Automation and Control Systems

• **Title: Industrial Automation and Control Systems Security**

• Industrial automation and control (Initially developed in the scope of ISA99) → CENELEC EN 62443 in future

• Includes the SCADA components typically found in process industries

• Especially used by organizations that operate in critical infrastructure industries:
  • Electricity transmission and distribution
  • Gas and water distribution networks
  • Oil and gas production operations
  • Gas and liquid transmission pipelines
IEC 62443 – Security for IAC
Overview

<table>
<thead>
<tr>
<th>General</th>
<th>Policies &amp; Procedures</th>
<th>System</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1 Terminology, concepts and models</td>
<td>2-1 Requirements for an IACS security management system Ed.2.0 Profile of ISO 27001/02</td>
<td>3-1 Security technologies for IACS</td>
<td>4-1 Product development requirements</td>
</tr>
<tr>
<td>IS 2009</td>
<td>CDV 2Q/15</td>
<td>TR 2009</td>
<td>CDV</td>
</tr>
<tr>
<td>1-2 Master glossary of terms and abbreviations</td>
<td>2-2 Implementation Guidance for an IACS Security Management System</td>
<td>3-2 Security risk assessment and system design</td>
<td>C</td>
</tr>
<tr>
<td>In Developm.</td>
<td>Planned</td>
<td>Procedural</td>
<td>Procedural</td>
</tr>
<tr>
<td>1-3 System security compliance metrics</td>
<td>2-3 Patch management in the IACS environment</td>
<td>3-3 System security requirements &amp; security levels</td>
<td>C</td>
</tr>
<tr>
<td>In Developm.</td>
<td>TR</td>
<td>Procedural</td>
<td>Functional</td>
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<tr>
<td>1-4 IACS Security Life Cycle and Use Cases</td>
<td>2-4 Requirements for IACS solution suppliers</td>
<td>Requirements for Systems</td>
<td>Requirements for Systems</td>
</tr>
<tr>
<td>Planned</td>
<td>IS 2015</td>
<td>Requirements for Components</td>
<td>Requirements for Components</td>
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<td>Definitions and Metrics</td>
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<th>Requirements for Organizations</th>
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<td>Definitions and Metrics</td>
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</tbody>
</table>
Applied Security for IAC
IEC 62443-3-3: System security requirements

“It’s more than just a bunch of boxes, it’s solutions that work together”
Segmentation by use case (ZONE)
Deep Packet inspection with IoT Signatures
New Distribution Grid
New Distribution Grid Model

<table>
<thead>
<tr>
<th>Top Use Cases</th>
<th>Use Case Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Distribution Automation (DA) – Grid Reliability / Quality of Service:</td>
</tr>
<tr>
<td></td>
<td>- Supervisory Control and Data Acquisition (SCADA), Grid visibility and control</td>
</tr>
<tr>
<td></td>
<td>- Fault Location, Isolation and Service Restoration (FLISR)</td>
</tr>
<tr>
<td></td>
<td>- Remote Asset Monitoring.</td>
</tr>
<tr>
<td></td>
<td>- Improve SAIFI / SAIDI</td>
</tr>
<tr>
<td>2</td>
<td>Advanced Metering Infrastructure (AMI) – Energy Efficiency:</td>
</tr>
<tr>
<td></td>
<td>- OPEX Reduction: Remote meter reading, Connect/Disconnect - Pre-payment, Demand Response</td>
</tr>
<tr>
<td></td>
<td>- Customer Service: Power Outage / Restoration reporting, customer portals for usage data</td>
</tr>
<tr>
<td>3</td>
<td>Distributed Energy Resources – Grid Efficiency and Stability:</td>
</tr>
<tr>
<td></td>
<td>- Renewable resources integration</td>
</tr>
<tr>
<td></td>
<td>- Anti-islanding; Peak shaving; Inject energy surplus; Energy storage</td>
</tr>
<tr>
<td></td>
<td>- Integrated Volt / Var Control (IVVC)</td>
</tr>
</tbody>
</table>

Key Use Cases Driving Communication Deployments in the MV/LV Distribution Grid

Advanced European Secondary Substation

IP WAN Backhaul:
1. 3G / 4G
2. Fiber; xDSL

DER: Solar and Wind
IEC 61850 (MMS & Goose)
SCADA (IEC 104)

DA - Grid Visibility and Control
SCADA: IEC 104/101; DNP3; Modbus
Other: NTP; HTTP; SNMP
Ethernet or Fiber

AMI – Reduce OPEX; Improve Customer Service
Metering: Web Services/ HTTP
Other: FTP; SSH; SNMP; NTP; LDAP
Ethernet

DER IED; Self Healing
IEC 61850 (MMS & Goose); SCADA (IEC 104)
Other: NTP; HTTP; SNMP, SSH
Ethernet
Mature European Trend: Renewable Energy

Key Opportunities created:
- Power Generation (wind farms, solar farms, etc)
- Machine vendors (wind turbines; etc)
- Distribution System Operators

Why investing in Renewables:
- Reduce energy dependency from other countries
- Create a profitable and growing industry in the country
- Regulation following Japan nuclear incident
- Diversify business, reduce risk
Cisco Multiservice (Secure) Field Area Network

AMI Operations
- Meter Data Collection & Management
- AMI / HAN
- Transformer Monitoring
- Distribution Automation
- EV Charging

FAN Operations
- Public or Private WAN Backhaul (3G, WiMax, Fiber)
- Substation
- CGR 1000
- Ethernet Networks
- Street Lighting
- Gas / Water Meters

DA Operations
- ASR 1000
- IR 800
- IR 809
- Distributed Resources
- SCADA, Protection & Control
- Direct Cellular Connected Assets

NAN Tier
- RF Mesh, PLC or LoRa

FAN Operations
- Work Force Enablement
- NAN

DA Operations
- AMI Operations
- Substation
- Ethernet Networks

CISCO Multiservice (Secure) Field Area Network
Flexible, Enabling Multiple Applications and Devices

Proprietary protocols over Serial

Vendor’s dependent

Standard protocols over Serial

IEC 101, DNP3, Modbus, DLMS/COSEM, etc

IEC 104, DLMS/COSEM, Modbus/TCP, Web Svc, etc

IEC 101, DNP3, Modbus, DLMS/COSEM, etc

IEC 104, DLMS/COSEM, Modbus/TCP, Web Svc, etc

Standards protocols over TCP/IP

Secure & Reliable IP infrastructure

VLAN; 802.1X; VRF; QoS; FlexVPN & DMVPN; FW; IPv4 & IPv6 dual stack; Multicast; EEM; IOX

IP Interfaces

GOOSE/SV

Industrial Ethernet, Fiber and Copper

Traffic tunneled over IP Raw Socket (TCP & UDP)

Protocol Translation GW:
• IEC 101 to IEC 104
• DNP3 to DNP3/IP

Serial PPP/CHAP

L2 over IP WAN (L2TPv3 or EoMPLS)

Ethernet L2 switching

MMS

GOOSE/SV over IP/UDP future IEC 8-1 and 9-2 profiles

Flexible, Enabling Multiple Applications and Devices
Secure and Scalable FAN Solution

Metering & Data

- Meter Data Management
- SIEM

NTP Appliance: acts as precision timing source

Active Directory (AD) & Certificate Authority (CA): for user & device identity management along with CA for certificate management. Supports Cryptography: ECC keys for certificate-based authentication

Firewall + IPS Appliance: primary firewall for securing the head-end infrastructure; optional use of IPS module

Public or Private IP WAN

SCADA

- OMS
- DMS
- GIS

AAA Server: scalable, high-performance policy system for authentication, user access, and administrator access; ECC for meters

IPAM, DHCPv6 and DNS: IPv4/IPv6 address allocation and naming: scale up to +10M endpoints

IPv4 / IPv6
- Adv. Scalable Routing
- FlexVPN, IKEv2
- Application Visibility

CIDR (RF Mesh & PLC)

CG-NMS: Network & Security Management: supports browser based clients, interface with ASR 1K, CGR 1K and End Points

CG-NMS DB (Oracle): Stores all operational state, device configuration, network event alarm, performance metric, etc

Cisco FND

Directory Services
Certificate Authority

AAA Server

IPAM DHCP

ASR 1K

DA devices (Ethernet / Serial)

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Cisco FND

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ASR 1K

DA devices (Ethernet / Serial)
IoT Access Technologies Landscape

**Long Range**
- 2G
- 3G
- 4G
- 5G

**Medium Range**
- Wi-Fi .b, .g, .n
- Wi-Fi .p
- Wi-Fi .a
- Wi-Fi .ac
- Wi-Fi .ah
- 802.15.4 g/e
- 802.15.4
- W-HART
- 1901.2 PLC
- 6Tisch
- ZigBee
- ISA 100.11a

**Short Range**
- B-LE

**Cost**
- Licensed vs. unlicensed
- Private vs. public
- Frequency bands
- Power requirements
- Provisioning

**TX Current**
- Standby Current
- Module Cost

**Power requirements**
- Signal penetration
- GHz vs. sub-GHz

**Device eco-system**
- Bandwidth capacity

**Use cases applicability**
- Indoor vs. Outdoor
- Mobile vs. Fixed

**Broad Use Cases support**
- Utilities, Industrial (process and discrete manufacturing), Smart Cities (parking, environment,…), Agriculture and rural, Transportations, horizontal/consumers, Assets management

- Power consumption very sensitive to endpoint
- Massively scattered deployment in geo
- Low data rate applications
- Open technology – Ecosystem for solution
Cisco Solution for LoRaWAN™
New Business and Operational Models with IoT Connectivity

Cisco IoT Back End – LoRaWAN™ Solution

IoT Infrastructures

Cisco Field Network Director - LoRaWAN™ Gateway MGMT
- Field Network Director
- AAA/CA
- VPN Connectivity

LoRaWAN™ Mgmt. Subsystem
- App Connector
- App Connector
- LoRaWAN™ App Router
- LoRaWAN™ Network Server

IoT Applications

VPN Connectivity

GW ZTD and LRR Initial Provisioning

LoRaWAN™ Network Mgmt. and Application Enablement

IP WAN

Public Network

Private Network

IR8x9 LoRaWAN™

Unlicensed ISM Radio

LoRa Endpoints

IR8x9 LoRaWAN™

Unlicensed ISM Radio

LoRa Endpoints

Cisco live!
New Business and Operational Models
Cisco IoT systems enables Applications to run closer to edge

VERTICAL SOLUTIONS
- Transportation
- Oil and Gas
- Manufacturing
- Service Provider
- City
- Defense
- Utility
- Public Safety

APPLICATIONS
- Application Enablement
- Fog Services
- Management and Automation

ECOSYSTEM
- Emerson
- Rockwell Automation
- BOMBARDIER
- SK
- Honeywell
- SAP
- Itron
- Huawei
- Dell
- Jabe

IoT Connectivity

Security

New Business and Operational Models
Cisco IoT systems enables Applications to run closer to edge
Combine SCADA and ICT

Eximprod ES 200 Virtual RTU

- Standard Communication protocols (Modbus, DNP3, IEC 61850, IEC 60870-5-104) allow interoperability with any new or existing third-party equipment (protection relays, power quality devices, IEDs) and SCADA DMS dispatch;

- Master/Client communication protocols are available on both Ethernet (TCP/IP) and serial (RS232/485).
Fog Application Management
Cisco Fog Director

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Fog Application Management

Provisioning
Change management

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Scalable Control

Management up to 5000 Devices
Application monitoring

---

Easily Adopted and Integrated

Rest APIs
Realizing the full value of IoT data
…with Cisco IoT

Data Sources
- Transport agnostic
- Data Flexible

Cisco IoT
- Extract Data
- Compute Data
- Move Data

Apps on public clouds, private clouds, data centers, and networks

Business Outcomes
- $59

Data brokering
Pre-integrated
Big Data and Analytics Use Cases in Utilities

- Large Scale LV Outage Management
- Cyber Security
- Energy forecast
- Grid and Social Data Correlation
- Dynamic Line Rating
- Load and Generation Disaggregated Forecast
- Environment monitoring
- EV impact on LV
- Modeling Geographical Information
- Asset Monitoring
- Predictive Maintenance
- Smart Metering Analytics
- LV and MV Outage Management
- Data Integration and Interoperability
- Grid and Social Data Correlation
- Proactively Manage Power Quality
- Analytics for Settlement Process

Cisco Live!
Predictive Maintenance Example Use Cases

…according to some European DSO

- Vegetation Analysis and Route Cost
- Weather Effects on overhead lines
- Historical Id of problematic Assets
- Oil Quality and Transformer Usage
- Turbine Monitoring and Anomaly Detection
- Environment Monitoring and Reporting
Data science at high level:

1. Define Business Problem

2. Acquire, Process and Move Data

3. Develop and Deploy Model

4. Monitor Model Performance

- Start with the Business Case!
- Understand your use case requirements and the data and analytics solutions in the market
- Build the complete team:
  - Sensor, Network, Security
  - Advanced Analytics, Data Scientist
  - Industry Subject Matter Experts
  - etc
- Start small, learn and grow fast to design a system architecture
Conclusion
Key Takeaways

• Cisco has mature IP solutions, validated with other Industry leaders, that answer to Power Utilities’ most demanding applications:
  • Current Differential Protection
  • IEC 61850 Substation Automation
  • Distributed Energy Resources at scale

• Cisco continues to innovate with new products and solutions (ex. IOx, Kinetics) in order to increase Cisco value proposition to Power Utilities
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Use Cisco Spark to communicate with the speaker after the session

How
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4. Enter messages/questions in the space

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Thank you