

The background is a vibrant, abstract graphic. It features a central bright white light source from which numerous colorful rays emanate, creating a sunburst or starburst effect. The rays transition through a spectrum of colors including yellow, orange, red, purple, and blue. Overlaid on this are large, flowing, wavy bands of color in shades of blue, green, yellow, and orange, giving the impression of liquid or smoke. The overall composition is dynamic and energetic.

CISCO *Live!*

Let's go



The bridge to possible

The New Digital Substation

More efficient, more secure and ready for demanding modern Grid applications

Edward Agostinho, IoT Solutions Engineering Leader

Marcus Smith, IoT Utilities Solution Manager

Agenda

- Utility & Substation Operations Challenges
- Digital Substation Automation Solution
- Securing the Substation
- Automated deployment and management
- More capability, smaller footprint
- Substation Wide Area Networking
- Conclusion

Substations face unique challenges

The need for agility is accelerating their digitization



Integrate new energy sources



Grid resiliency



Meet security and compliance regulations



Improve grid efficiency and safety



New demands on the network

Substations becoming more digitized and automated



Physical and cyber security threats



Increased bandwidth requirements



Need future proof technologies to keep up with evolving requirements



High degree of timing synchronization required



Need for simplicity and efficiency (smaller footprint)

But digitization isn't easy

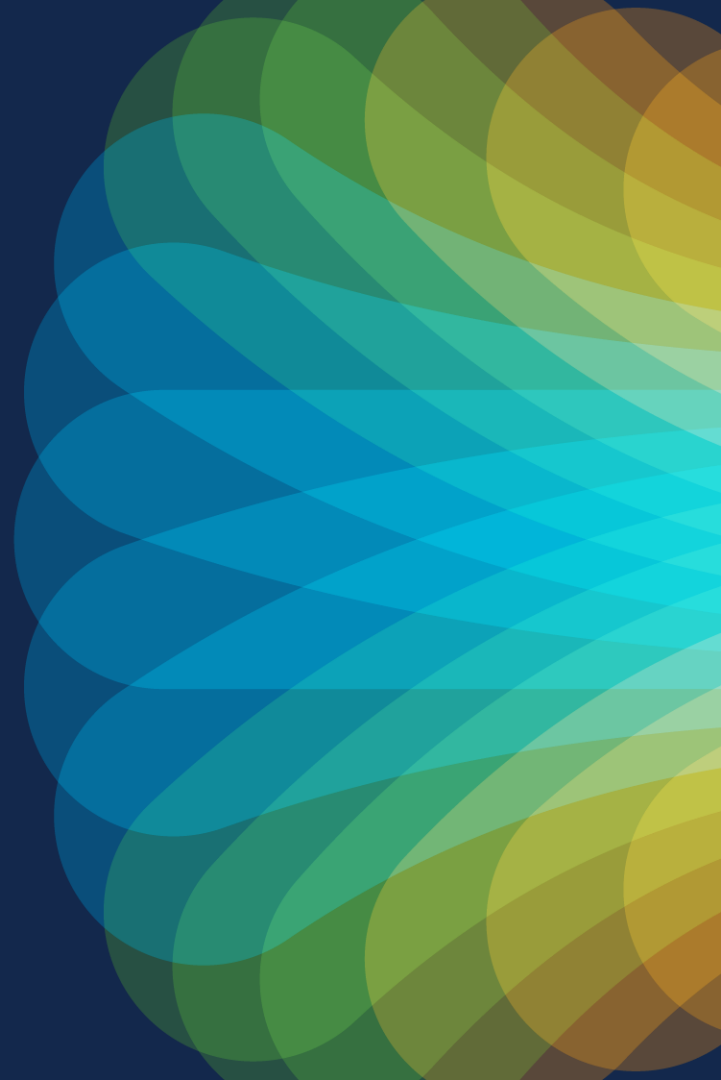
IEC61850 defines Digital Substations



- The IEC 61850 standard has paved the way digital substations to achieve grid modernization
- Protection and control systems based on IEC 61850 can be built faster, more efficiently, and more repeatably with digital communications
- This places stringent requirements on the substation LAN network

The New Digital Substation

Substation Automation Cisco Validated Design



Cisco Validated Design: Substation Automation

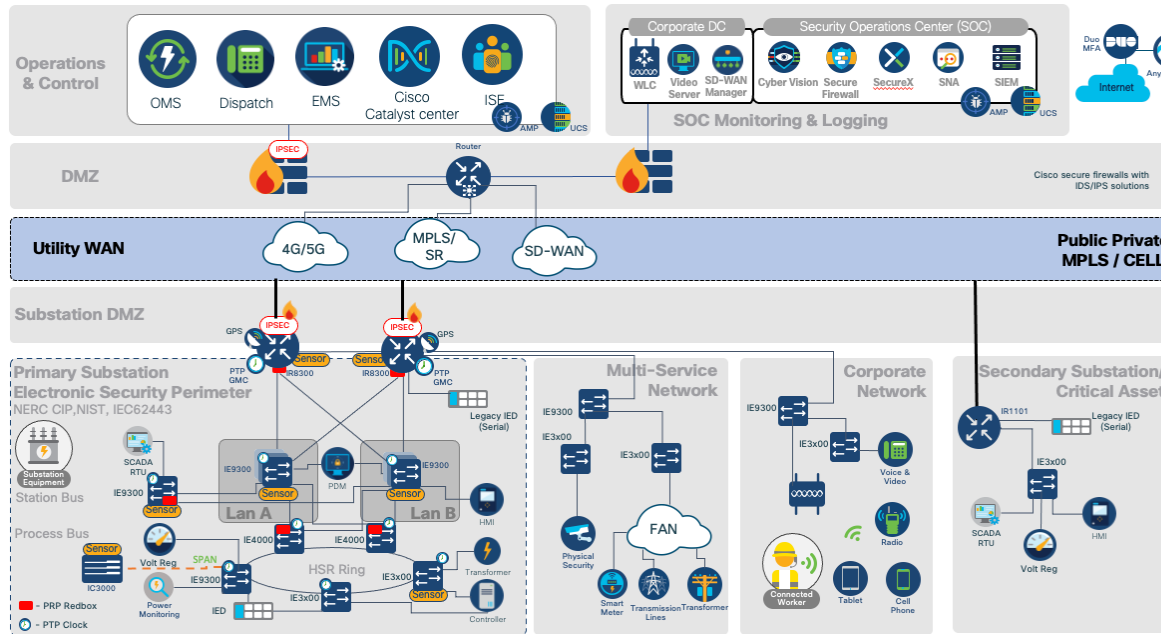
Modernize Grid operations



Foundation for advanced protection and control, remote diagnostics and predictive maintenance capabilities.

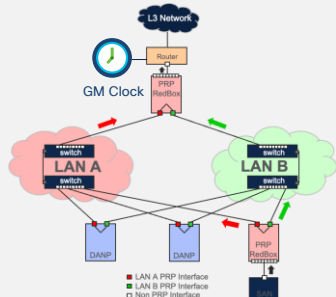
Features/Functions:

- Support **SCADA Services**
 - Serial/TDM to IP transition
 - Station & Process bus architectures – (IEC 61850 MMS, GOOSE & SV)
 - Support IEC104/DNP3 Architectures
- Support for **power management devices** (e.g. Syncho Phasor/PMU, Volt/Var) applications
- **Cybersecurity**
 - NERC CIP compliance
 - IEC62443 (Zones & Conduits)
- Visibility of connected substation devices and communications (**Asset Visibility**)
- Support lossless **Network resiliency and Precise timing**
 - HSR and PRP
 - IEEE1588 PTP Power profile
- **Management and Automation** to proactively identify WAN/LAN network issues and receive remediation suggestions and consistently configure and maintain network infrastructure
- **WAN Connectivity** – SD-WAN, IP/MPLS, Segment Routing, LTE, 5G and 450Mhz



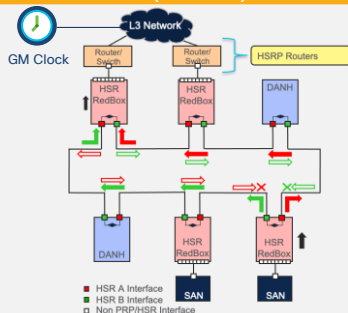
Support for IEC61850 Architectures

Parallel Redundancy Protocol (PRP)



- Loss-less resiliency protocols and no single-point-of-failure topologies for maximum up-time (PRP & HSR)
- Station bus & Process bus topologies
- Substation Synchronization with support for
 - Power-Profile Precision Time protocol (Grandmaster, Transparent Clocks) C37.238/IEC61850-9-3
 - Wide-range of timing inputs and conversions (IRIG B)
- Low-latency communications with Quality-of-Service settings to prioritize IEC61850 critical traffic (GOOSE,SV)
- IEC 61850-3 certifications for substation hardware
- Validated Design topologies and product choices
- IEC62351 (inc MACSEC) security profiles

High-Speed Resiliency (HSR)



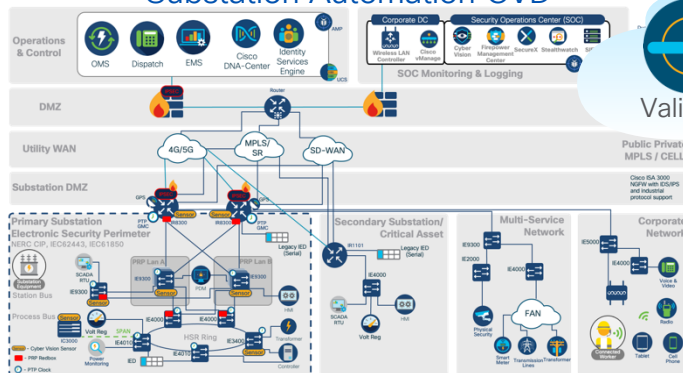
Key Platforms in the SA Validated Design

NEW



Cisco Catalyst Center & ISE

Substation Automation CVD



NEW

Cisco SD-WAN

Manager



Validator



Controllers



Analytics



NEW

Catalyst IE9300 Rugged Series Switch



NEW

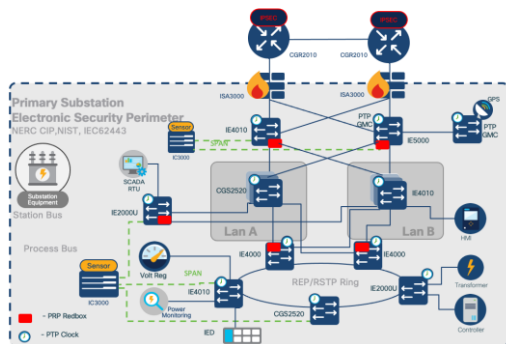
Catalyst IR8300 Rugged Series Router

Blogs :

<https://blogs.cisco.com/internet-of-things/four-must-haves-in-the-new-digital-substation>

Digital Substation Architecture enables new capabilities, while being simpler to manage, more redundant and secure

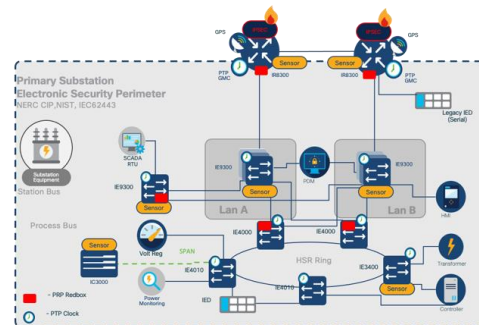
Before



- Complex Redundant WAN design
- Separate boxes for:
 - WAN connections
 - Redbox Layer for PRP to WAN
 - PTP Grandmaster (IE5K or 3rd Party)
 - Firewalls
- Limited BW/Thruput:
 - Very limited WAN throughput (<50Mbps)
 - Limited MPLS support – CE only recommended
 - Limited WAN connections WAN Port count limited
 - Lack of Fiber SFP ports
 - No stacking possible (port count)
 - FE Downlink ports (e.g. CGS)
- No network consolidated network management
- Standalone CV sensors with SPAN ports
- Challenging to deploy TrustSec



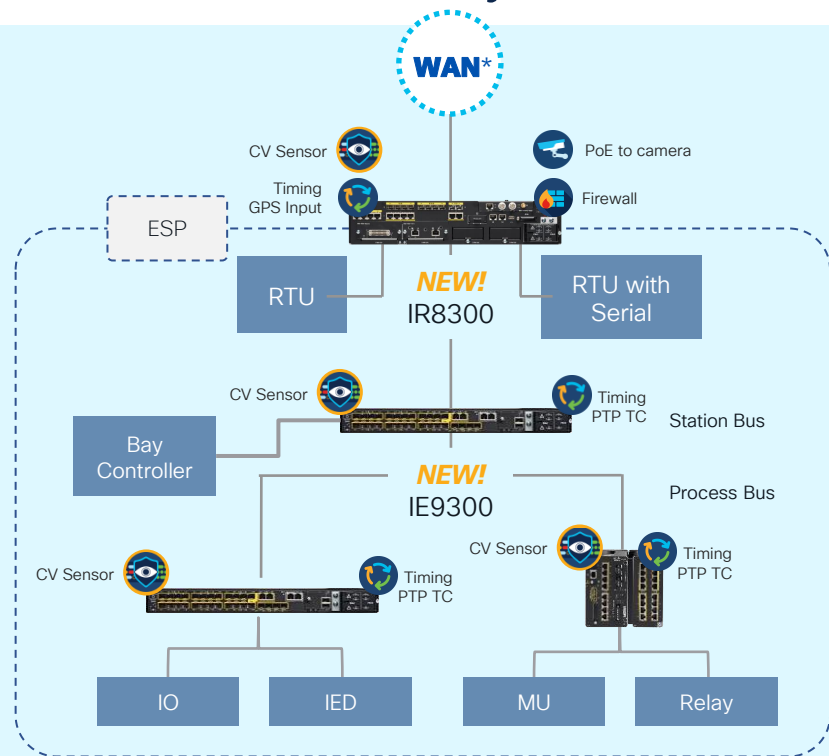
After



- Simple redundant WAN design
- 4 box consolidation: WAN, PRP/HSR SAN Redbox, PTP GM and ZBFW Firewall (IDS/IPS with UTD), Reduced footprint/power/heat
- Dramatically higher BW/Thruput:
 - Higher WAN (950 Mbps LAN-WAN L3 IMIX) & switch throughput (950 Mbps LAN-LAN L2 IMIX)
 - MPLS CE and P/PE with TE, L3VPN
 - High bandwidth and fiber-density SFP and stacking to increase port count
- Common Network management with Catalyst Center and SD-WAN Manager for Automation
- Integrated CV sensors
- More secure infrastructure (TrustSec, Trust Features, MACsec)

Blog: <https://blogs.cisco.com/internet-of-things/deliver-next-generation-substation-automation-with-the-cisco-catalyst-ir8340-rugged-router>

Secure turnkey communications for Digital Substations



- High performance substation 5G router
- Integrated switching, routing, and security
- PTP Grandmaster with GPS Input
- Zone-based firewall for Electronic Security Perimeter
- Cyber Vision sensor for endpoint visibility & security posture
- Secure VPN transport from substation to control center
- IOx edge compute to run applications at the edge

- High performance substation LAN switch
- 8x switch stacking for high port density and reliability
- High precision PTP with 50ns accuracy
- MACsec 256 for point-to-point Ethernet link encryption
- Cyber Vision sensor for endpoint visibility & security posture
- HSR, PRP redundancy for lossless convergence
- IOx edge compute to run applications at the edge



Cisco UADP ASIC

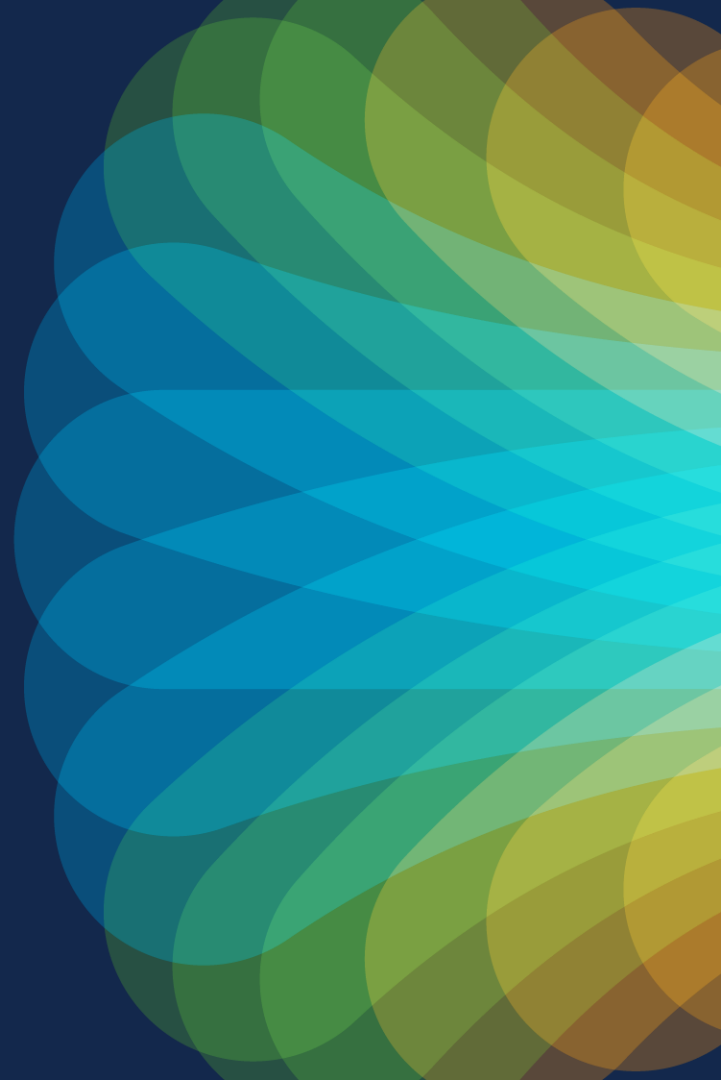


Cisco IOS-XE OS

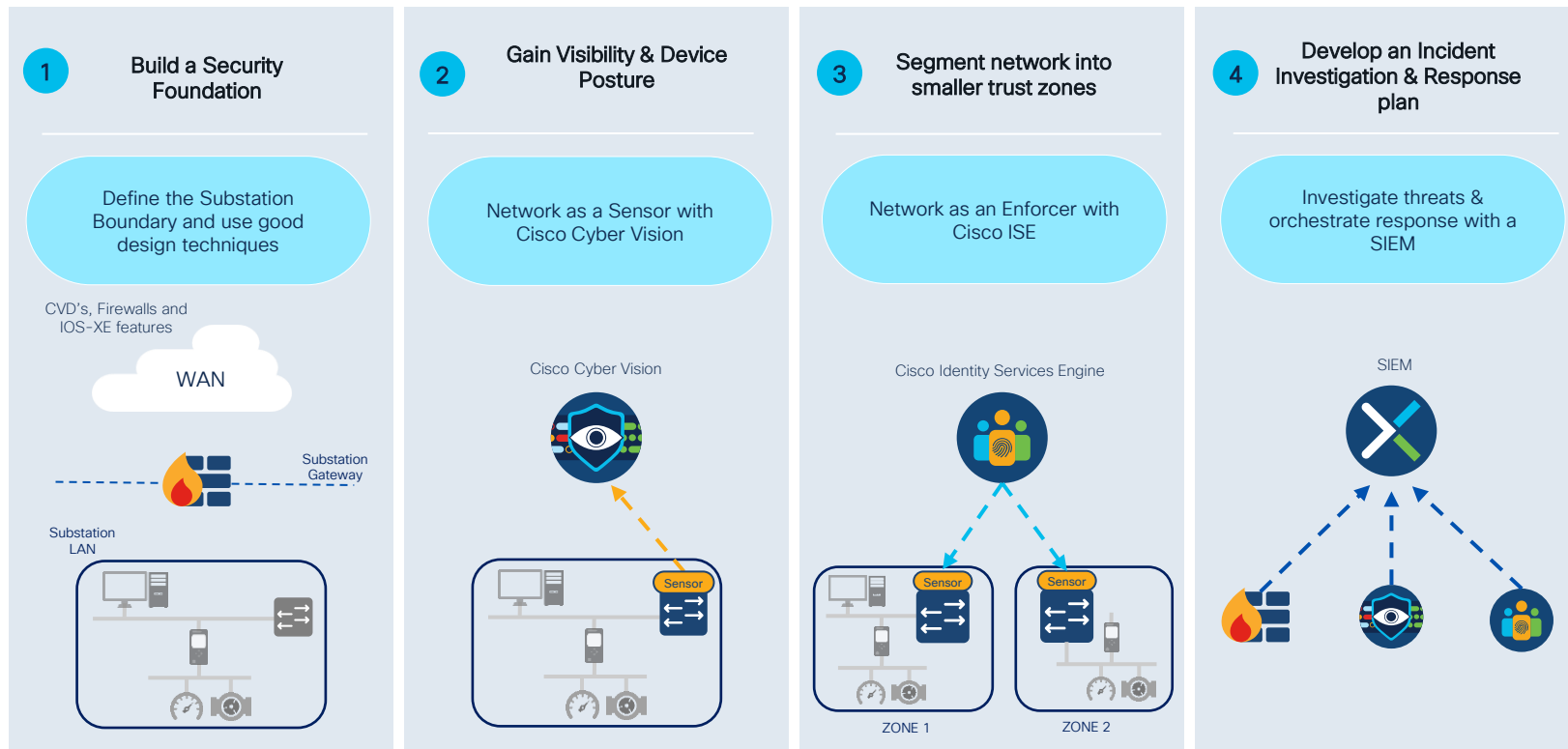


Cisco Catalyst Center/SD-WAN Manager

Protecting the Substation operations



Cisco OT Security Guidelines





Visibility

Asset inventory
Communication patterns



Security Posture

Device vulnerabilities
Risk scoring

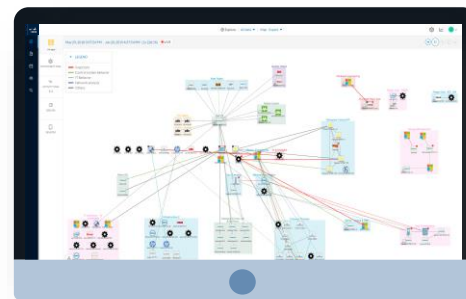


Operational Insights

Track process/device modifications
Record control system events

Cisco substation LAN switches and WAN routers **see everything** that attaches to them so you can gain **visibility at scale**

Cyber Vision Center

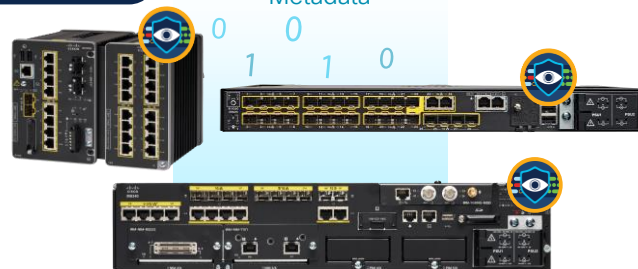


1 0 0 1
0 0 1

Application Flow
Metadata

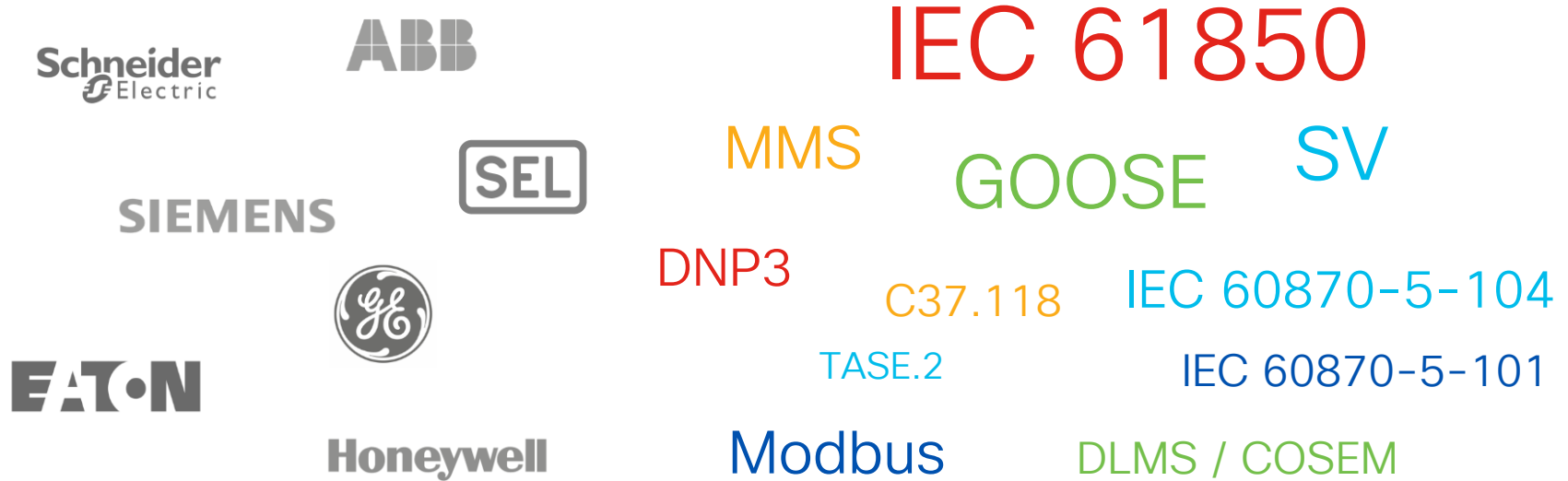
0 0
1 1 0

Cyber Vision
Sensor



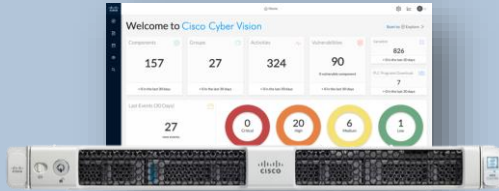
Deep Packet Inspection & Active Discovery
built into your network infrastructure

Cyber Vision understands GRID protocols you use

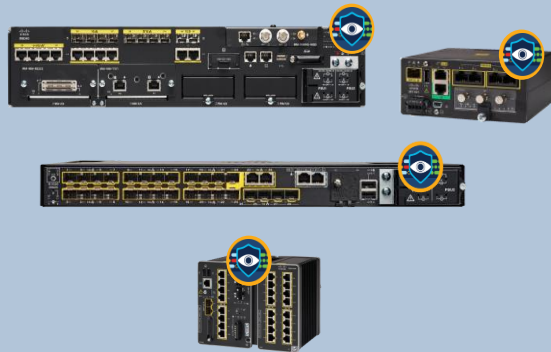


Cisco's Deep Packet Inspection understands process information
even when using proprietary protocols

Cyber Vision Center (Centralized analytics)

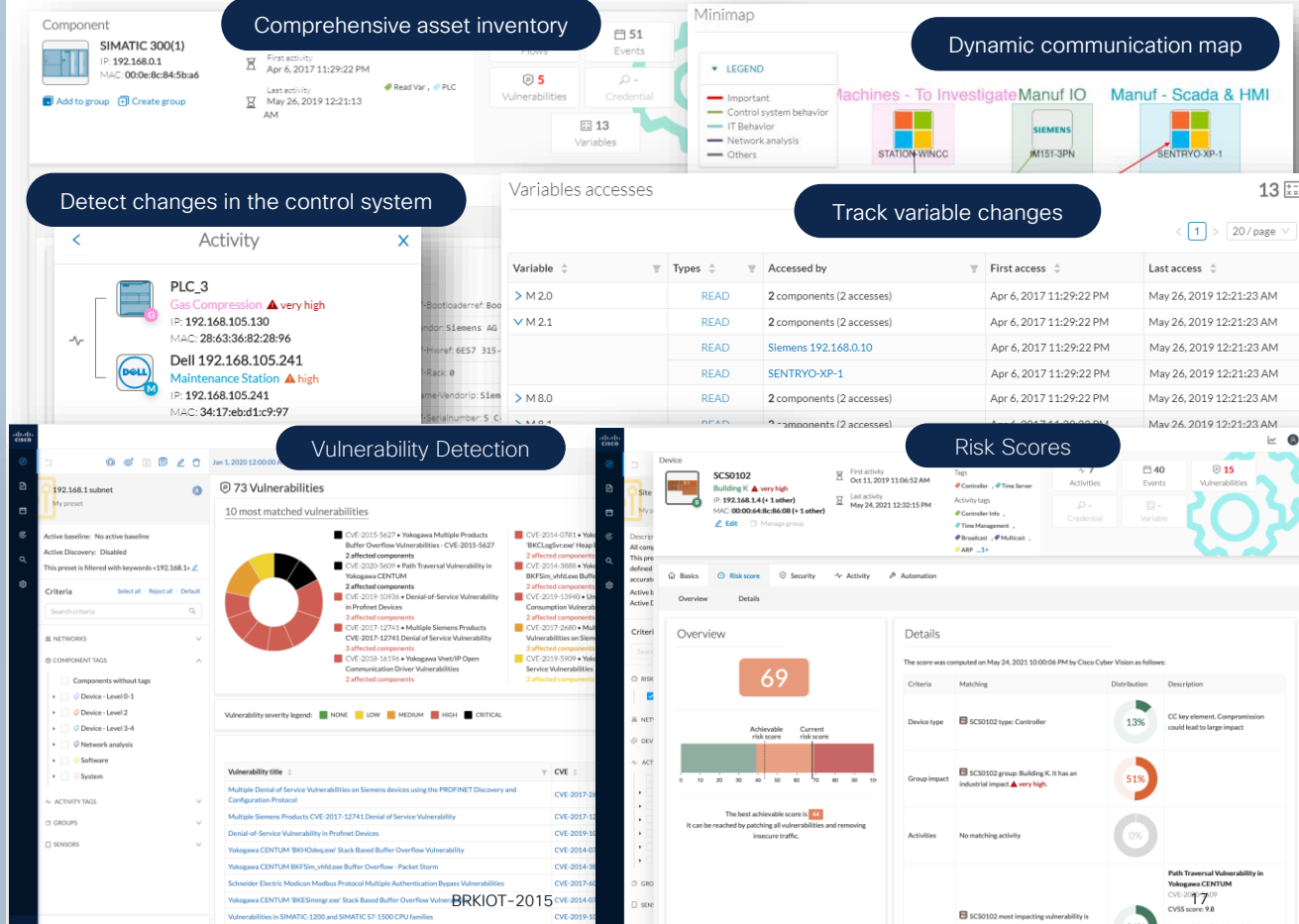


Application
Flow



Network-Sensors
(Built in Deep Packet Inspection)

Gain Operational Insights



Utility Edge Active Discovery and Flow Visibility

Features



Enabled by user, fully passive by default



Closed loop control – Passive collection informs active discovery



No interaction with utility IED/RTU



Embedded sensor behind firewall and NAT boundaries



Active discovery using DPI of flow messages



Benefits



No risk of disrupting industrial assets



Assets are not flooded with ARP requests. Cyber Vision does not scan networks.



Discover devices passively. 100% visibility



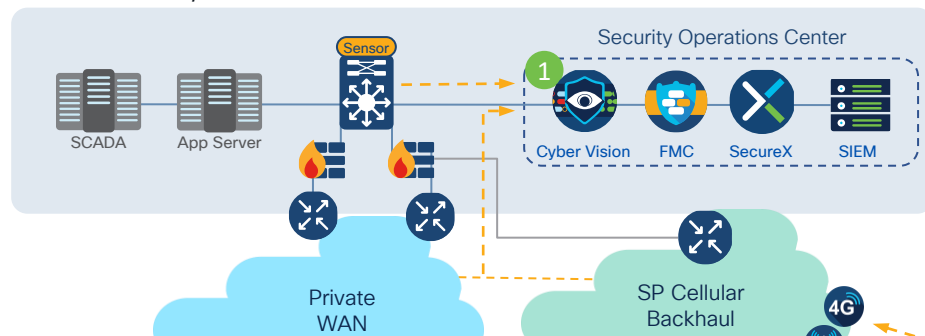
Passes firewalls and NAT boundaries. 100% visibility



Inspection of traffic populates summary information

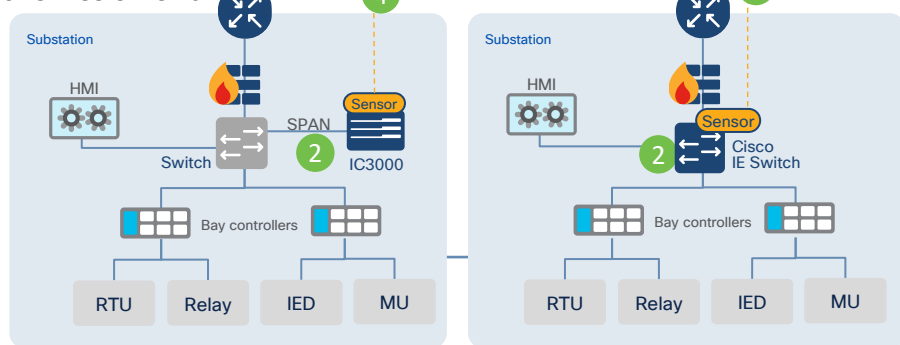
Cisco Cyber Vision in Electric Utilities

Data Center / Control Center

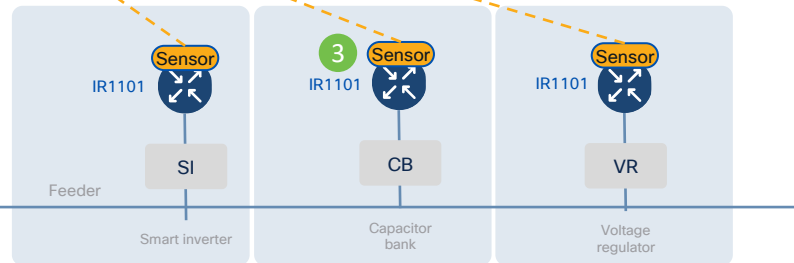


- 1 Cyber Vision Center deployed at Control center
- 2 Cyber Vision Sensor embedded in IE3400 switches or deployed via one-hop SPAN on IC3000 in transmission substations
- 3 Cyber Vision Sensor embedded in IR1101 gateways in the distribution grid
- 4 Application-flow streamed from sensors to center over utility private WAN connecting transmission substations and over cellular backhaul from the distribution grid

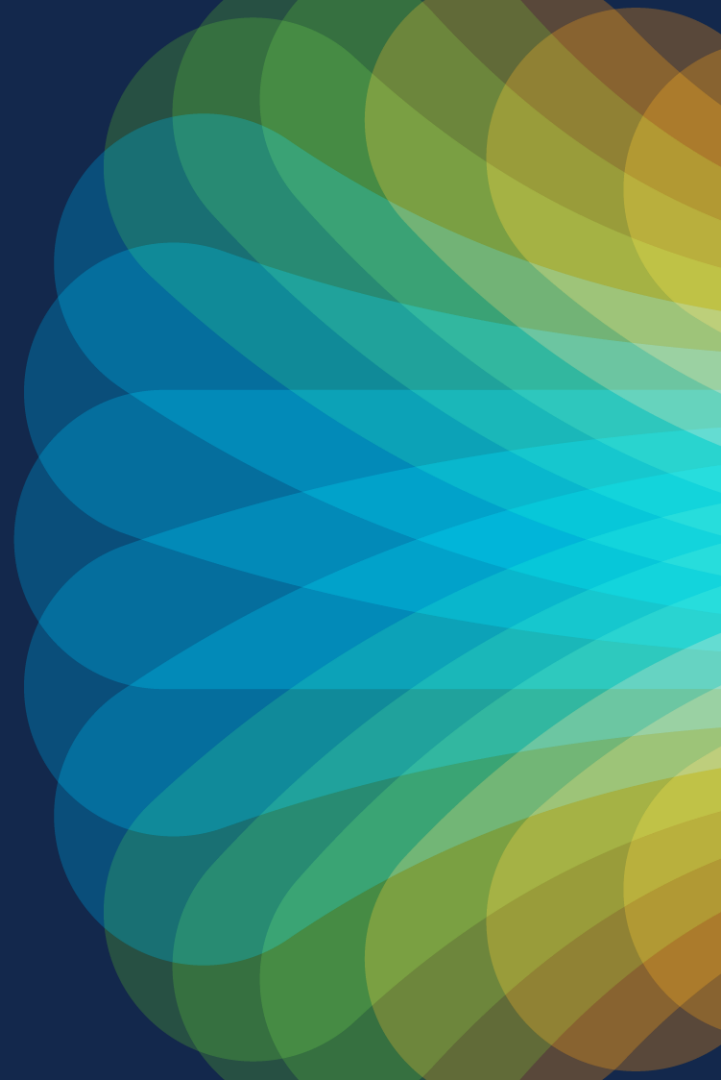
Transmission Grid



Distribution Grid



Automated deployment and management



SW-Defined Network for The Digital Substation

Cisco Catalyst Center

Cisco Catalyst Center



Reduce
Downtime

Improve network visibility and performance with AI/ML and machine reasoning



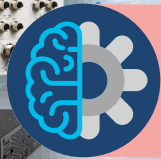
Increase
Efficiency

Automation and workflows simplify, empower, and streamline network management



Stay
Compliant

Track updates, ensure SW images comply, and remain aware of security updates



Redefine the
experience

Platform built on intent-based networking principles and driven by advanced AI, insights and security

Spend less time managing your operational network

Predictive Maintenance for your industrial network – proactively identify and mitigate connectivity issues

Before



After

Hours spent fixing
network faults

Resolve issues
with a single
module click

Automatically detect and prioritize issues

AI/ML-driven remediation for quick resolution

Improve network performance

Cisco Catalyst Center **Assurance**



Constant monitor of network and devices for up-to-date visibility



AI/ML and machine reasoning for root cause analysis, to find anomalies instantly



Correlated insights, with telemetry data to accurately pinpoint root cause



Guided remediation allows for single-click resolution, allowing machine reasoning automation to close the loop

Cisco Catalyst Center Network Automation to drive operational efficiency and streamline maintenance

Base
Automation

Before → After

Manual device
configuration

Simple automated
workflows

Workflows to do in seconds what used to take hours / days

Lower cost of network operations

Bridge the IT skill gap and save time

Cisco Catalyst Center Base
Automation



Zero-touch provisioning speeds and simplifies adding new devices (PNP, RMA)



Software image management (SWIM) provides consistency for better network performance



Machine reasoning (MR/ML) workflows automate complex tasks into the simple push of a button

Compliance Checks to ensure changes made to the network are consistent with your standards

Network
Compliance

Before → After

Discrepancy
between As-Built
vs As-Is network

Insights on
deviations to
ensure compliance

Continuous monitoring for network changes

Audit logging to track who (and what/when) made changes

Cisco Product Security Incident Response Team Alerts

Cisco Catalyst Center **Compliance**

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Configuration Drifts

Compliance Summary > Startup vs Running Configuration

Change History



Startup Config (375 Lines) - July 27, 2021 01:24 PM

Running Config (374 Lines) - July 27, 2021 01:24 PM

16	aaa authorization network cts-list group ISE	16	aaa authorization network cts-list group ISE
17	aaa authorization auth-proxy default group ISE	17	aaa authorization auth-proxy default group ISE
18	aaa server radius dynamic-author	18	aaa server radius dynamic-author
19	client 10.13.48.184	19	server-key ***** 070C705F4D06485744
20	server-key ***** 070C705F4D06485744	20	aaa session-id common
21	aaa session-id common	21	clock timezone EST -5 0
22	clock timezone EST -5 0		

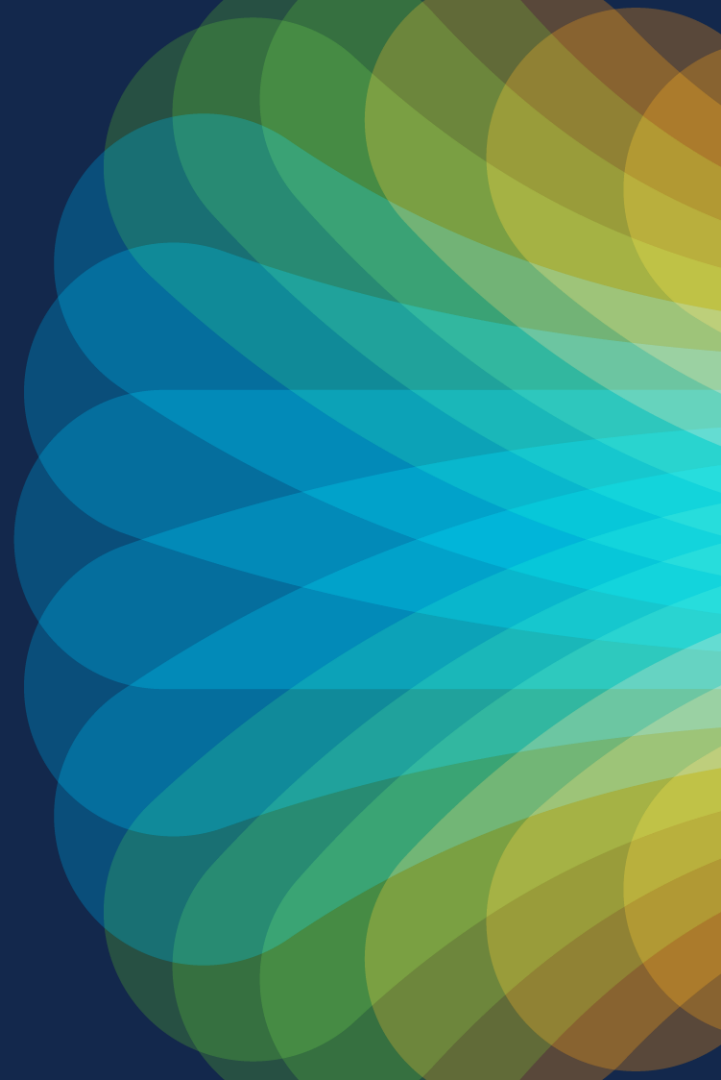


“Golden Image” confirmation for all network devices



Critical Security Advisories – “Psirts”

More Capability, Smaller Footprint



Cisco Catalyst IR8340 Router

Unleashing enterprise features at the industrial edge



IR8340

4 copper • 4 combo • 4 SFP • 2 combo WAN ports
4 expansion slots
5G • SD-WAN
Redundant power supplies
20x increased encryption
GPS Timing module (Stratum 3e)



Unrivaled
performance at scale



Unprecedented
visibility of assets



Industry leading
cyber security

- Single integrated platform for routing, switching, timing and security
- Easier to manage: One control plane for Layer 2 and Layer 3
- Full MPLS Layer 3 support
- Catalyst Center and SD-WAN
- 8 core processor for dispersed workloads
- PoE, PoE+ and UPoE
- Backwards compatible with Serial
- Only Cisco router that converts GNSS time to NTP, PTP, SyncE
- Security and visibility with Cyber Vision
- Hardware based MACSec LAN and WAN
- IPSEC - DMVPN, FlexVPN, IKEv1, IKEv2
- URL filtering, Cisco AMP, IPS/IDS
- Group based policy (TrustSec)
- Zone based firewall

Catalyst IR8340

IR8340 Timing Module



- GNSS
- IRIG-B
- TOD



Constellation Support

- GPS
- GLONASS
- BEIDOU
- GALILEO



Time Pulse Accuracy

- Clear sky – 20ns
- Indoor – 500 ns



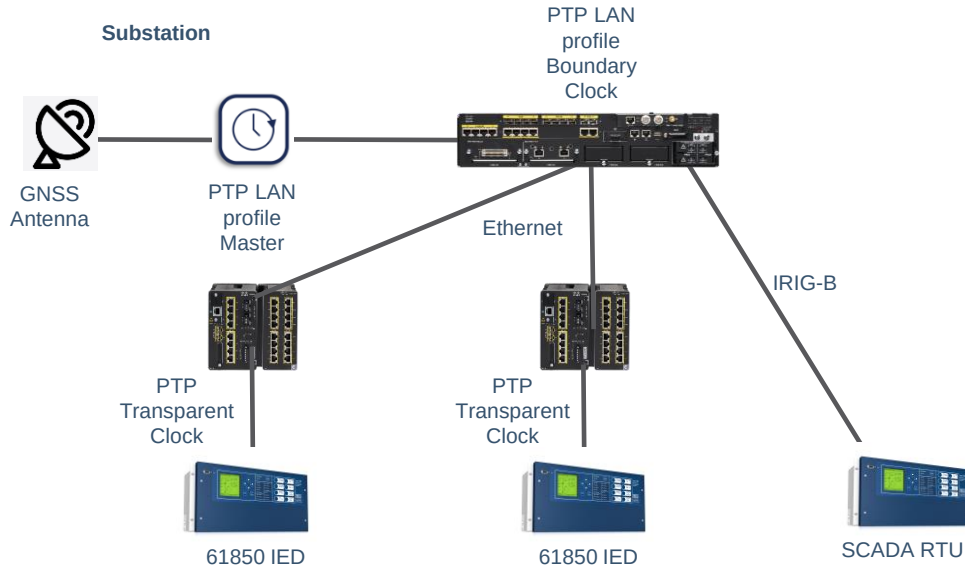
Built-in Oscillator

- Stratum 3e
- More accurate hold-over in case of GNSS loss

Enabling Precision Timing for IEC61850 substation based Applications

Evolution of PTP Timing in Substations

Typical substation timing today with local GNSS

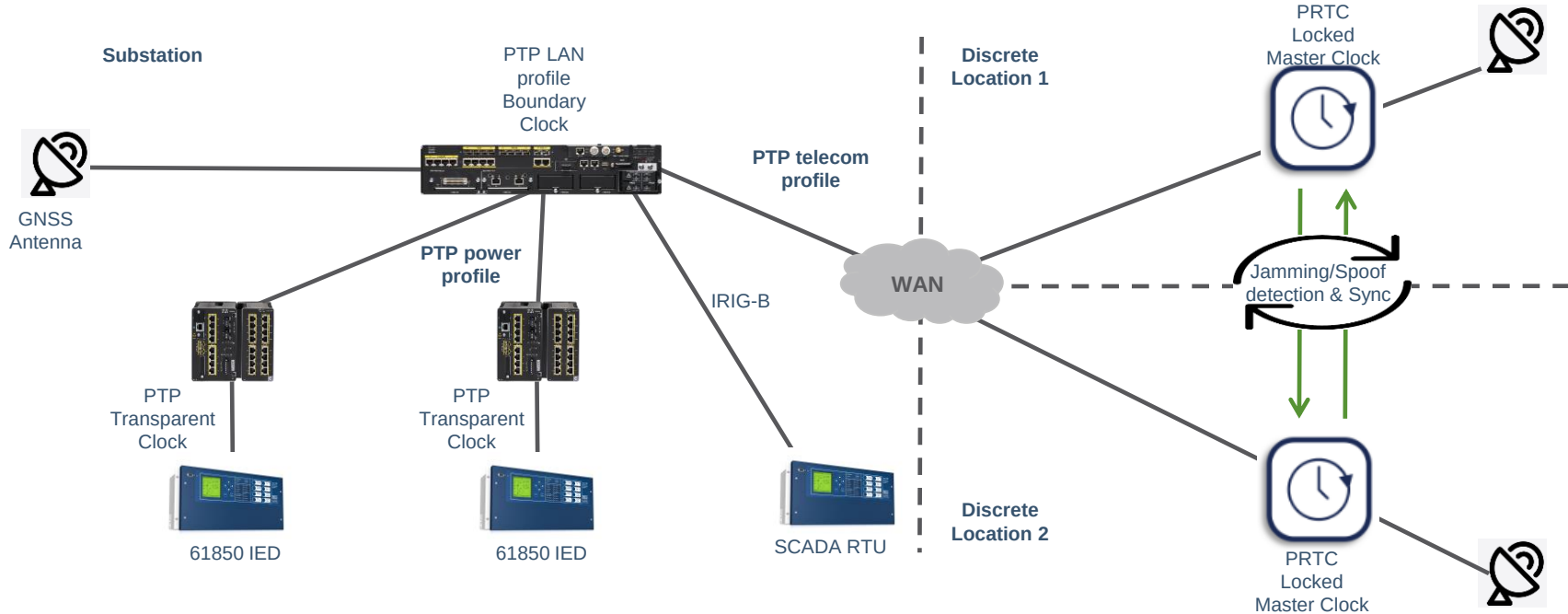


• Architecture Disadvantages:

- Additional management domain for external PTP master at each substation.
- Primary reference clock needed at each substation
- Clock holdover not as good as higher quality master clocks. Quality vs quantity doesn't scale well over many substations. Higher quality clocks more sensitive to industrial temperature ranges, not suitable for substation deployment.
- Failure domains at each substation. Equipment failure, jamming, spoofing. During failure, each substation will drift independently.
- Weather or other environmental factors may impact reception each substation independently.
- Little or no redundancy outside of substation.

Evolution of PTP Timing in Substations

Terrestrial based timing solution



The new Catalyst IE9300 Rugged Series portfolio

All-fiber and all-copper, high performance, ruggedized industrial rackmount switches

Shipping



IE-9310-26S2C

26x 1GE SFP ports
2x 1GE combo ports



IE-9320-26S2C

26x 1GE SFP ports
2x 1GE combo ports
Stackable

5 New Models



IE-9320-24T4X

24x 1GE ports
4x 10G SFP ports
Stackable



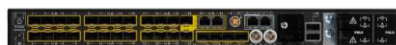
IE-9320-24P4S

24x 1GE with PoE/PoE+
Up to 385W PoE budget
4x 1GE SFP ports
Stackable



IE-9320-24P4X

24x 1GE with PoE/PoE+
4x 10G SFP ports
Up to 720W PoE budget
Stackable



IE-9320-22S2C4X

22x 1GE SFP, 4x 10G SFP
2x 1GE combo ports
Timing input
Conformal coating
Stackable



IE-9320-16P8U4X

8x mGig with 90W 4-pair PoE
16x 1GE with PoE/PoE+ ports
Up to 720W PoE budget
4x 10G SFP ports
Stackable



PWR-RGD-AC-DC-400

720W of PoE power with 2 PSUs

The most comprehensive industrial rackmount portfolio in the market

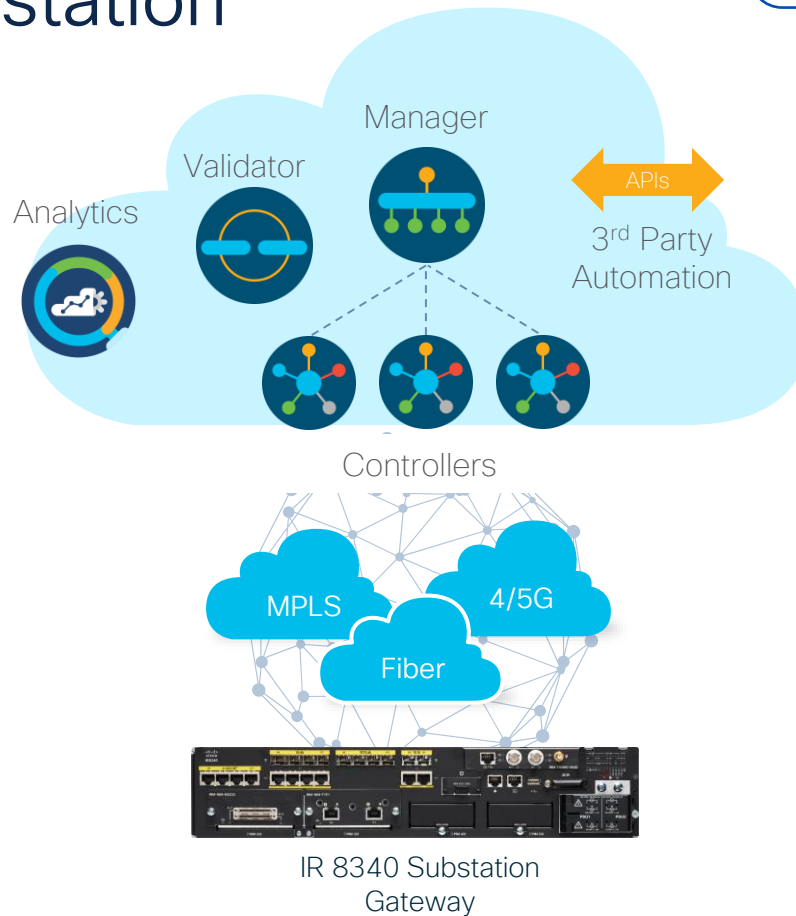
IE9320 Stacking

- Single virtual switch (Single Management and Control Plane)
- Hardware Capable 8 x IE9320 per stack, 3 members supported since 17.8.1a
- Stacking will be supported by Cisco Catalyst Center release (2.3.6)
- Stack members must be homogenous (same license and IOS-XE)
- StackWise-80 - 80Gbps (40Gbps full duplex per port)
- Mixed is supported with IE9320 members
- Some features not supported over stacking:
 - Check datasheet



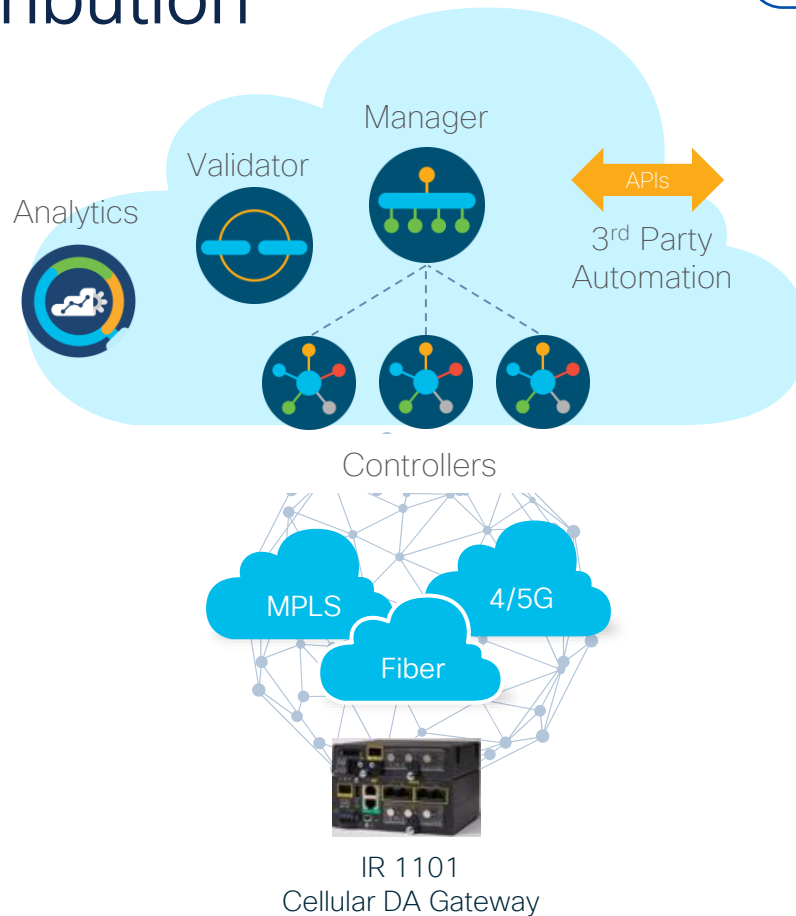
CVD - SD-WAN for Substation Automation

- Centralized provisioning & monitoring
- Implement centralized security policies
 - ZBFW, IDS/IPS, URL Filtering, Cisco Umbrella DNS
- Configuration templates
- Troubleshooting and monitoring
- Software upgrades
- IOS XE application
- Validated for Substation use cases
 - Ethernet and Serial use cases



CVD - SD-WAN for Distribution Automation

- Centralized provisioning & monitoring
- Implement centralized security policies
 - ZBFW
- Configuration templates
- Troubleshooting and monitoring
- Managing multiple backhaul interfaces
- Software upgrades
- IOS XE application
- Validated for field use cases
- Support for multiple cellular modules
 - 5G, 4G and 450Mhz
- Ethernet & Serial end device use cases validated
- Support for NAT per Service VPN

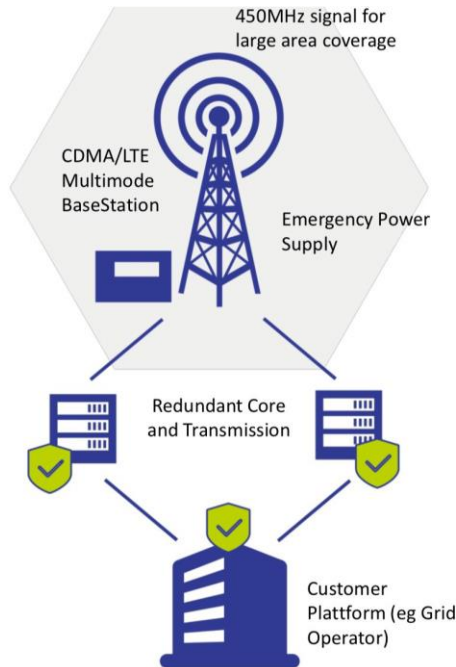


Why 450MHz LTE in Europe?

Both **CDMA450** and **LTE450** can be applied, optimised for **M2M** communications

Standardised and proven mobile communications technologies to achieve high **performance** (capacity, latency, priority handling, scalability)

Customer control on lifecycle management by long term commitment on technology standards



Large **coverage** area and deep **indoor penetration**

Power supply backed up using batteries and generators to continue services during (major) power outages

Stand alone network without public mass market services, allowing for **resilience** and **security**



Catalyst IR1101 Rugged Router With 450Mhz LTE PIM



Catalyst IR1101 Rugged Router With 450Mhz LTE PIM & 4/5G PIM

450connect

UTILITYCONNECT

Net1

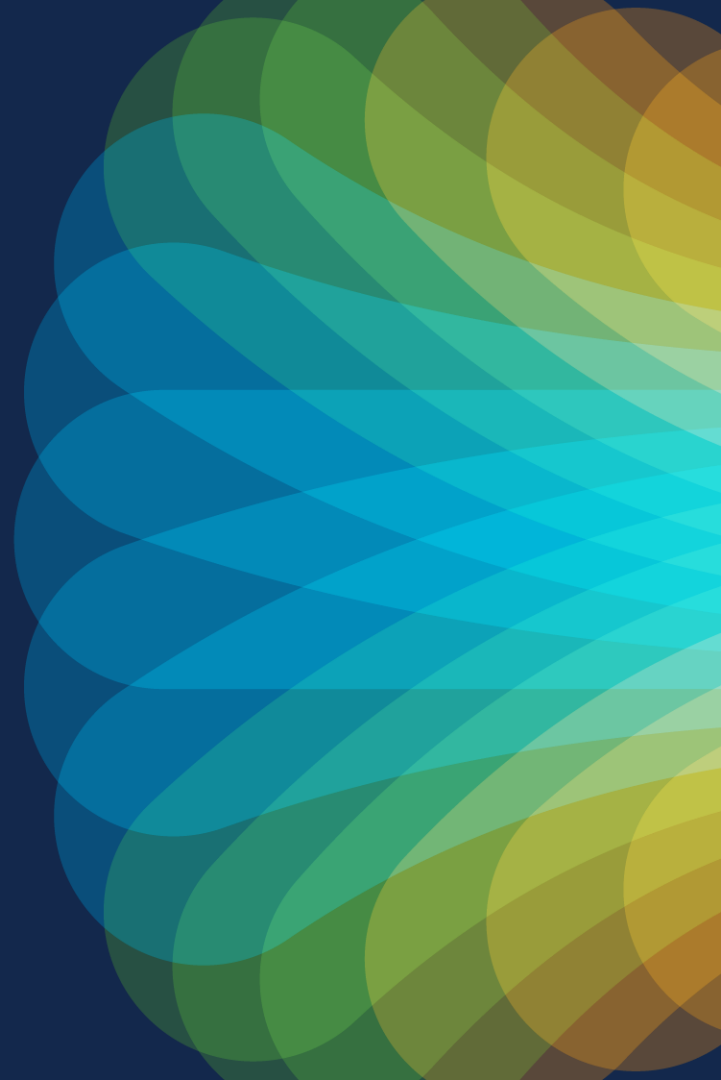
TERACOM

Picture source:



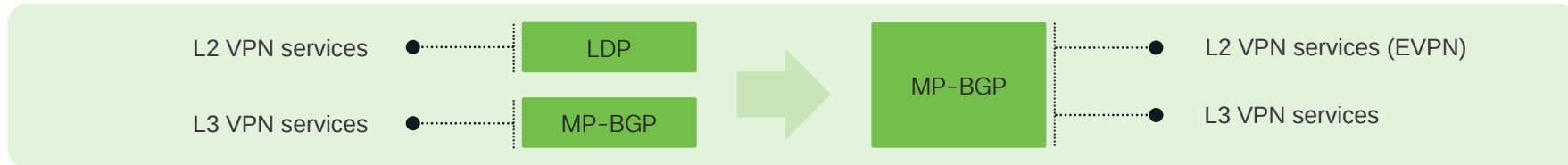
CISCO Live!

Substation Wide Area Networking

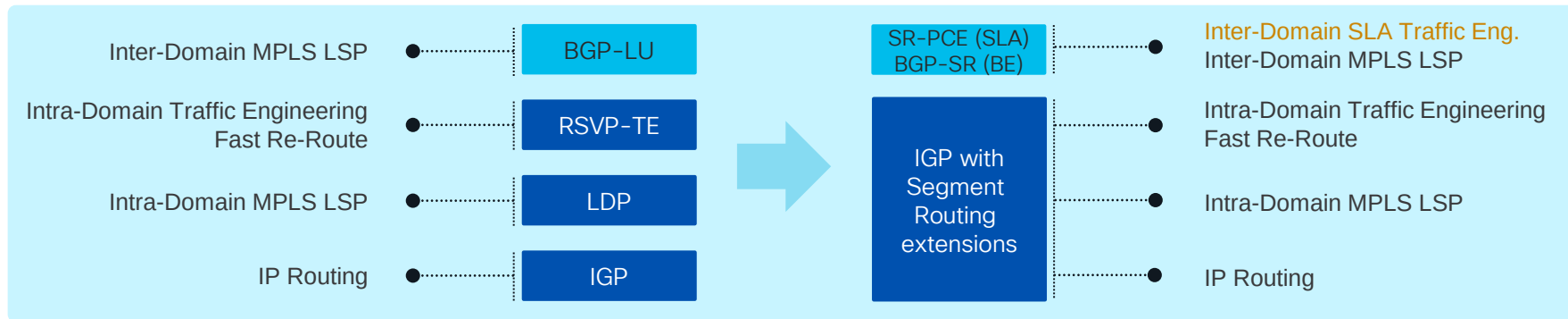


Utility WAN – MPLS Network Evolution

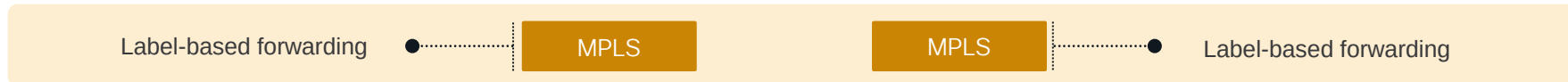
Service Protocols



Transport Protocols



Data-Plane



LDP: Label Distribution Protocol, MP-BGP: Multi-protocol BGP, BGP-LU: BGP Labeled-Unicast, PCE: Path Computation Element, RSVP-TE: Reservation Protocol Traffic Engineering, BE: Best-Effort



- High performance substation LAN switch
- Switch stacking for high port density and reliability
- High precision PTP (e.g. Power profile)
- MACsec 256 for point-to-point Ethernet link encryption
- Cyber Vision sensor for endpoint visibility & security posture
- HSR, PRP redundancy for lossless convergence
- IOx edge compute to run applications at the edge

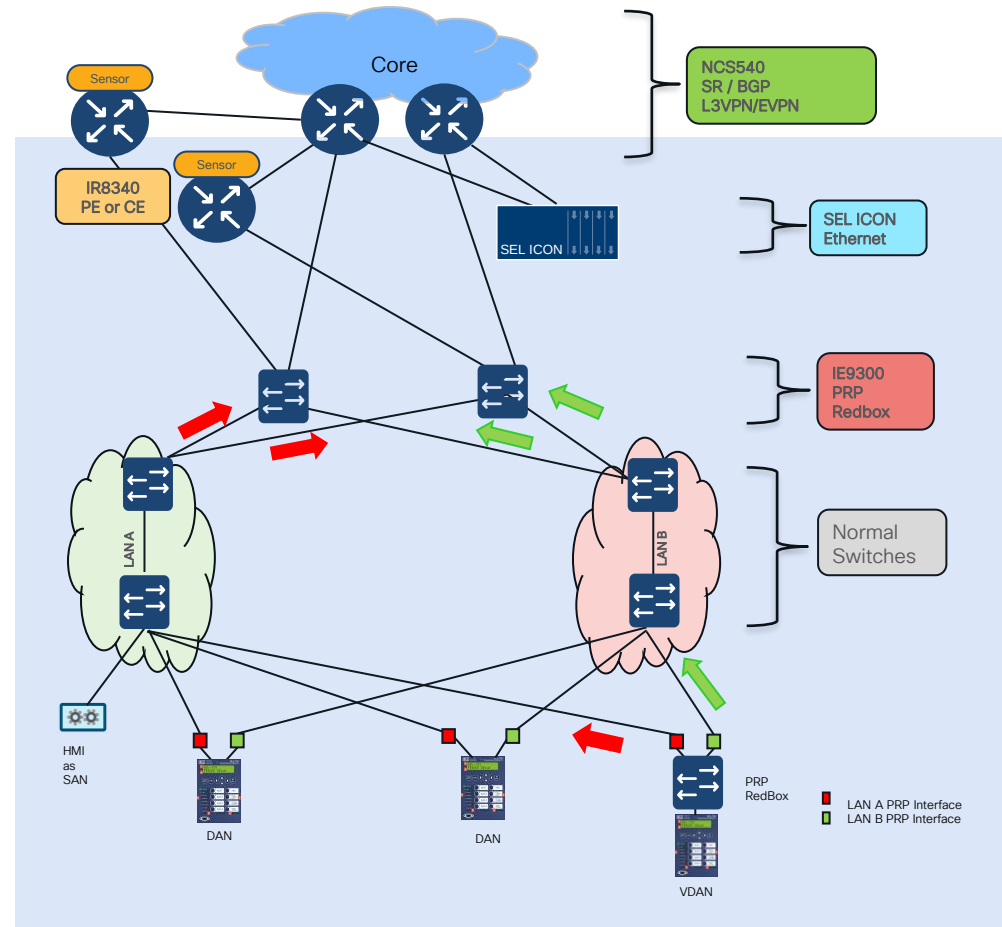
Substation L2 and L3 Architecture

Use Cases

Layer 3 WAN - Substation to Datacenter

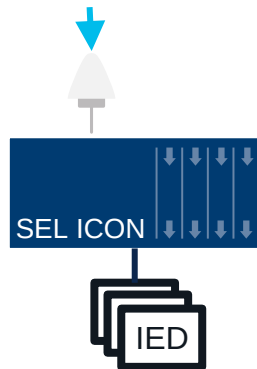
Layer 2 WAN - Substation to Substation for Teleprotection (Ethernet based)

Layer 2 WAN - Substation to Substation for Teleprotection (non-Ethernet based)

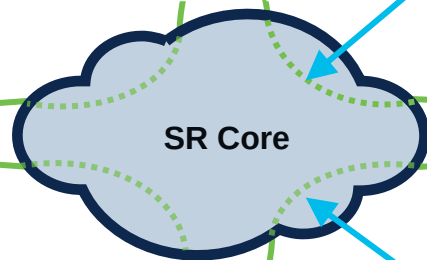


SEL ICON Overlay Architecture for Teleprotection

Time-synchronized edge nodes maintain synchronous data transport



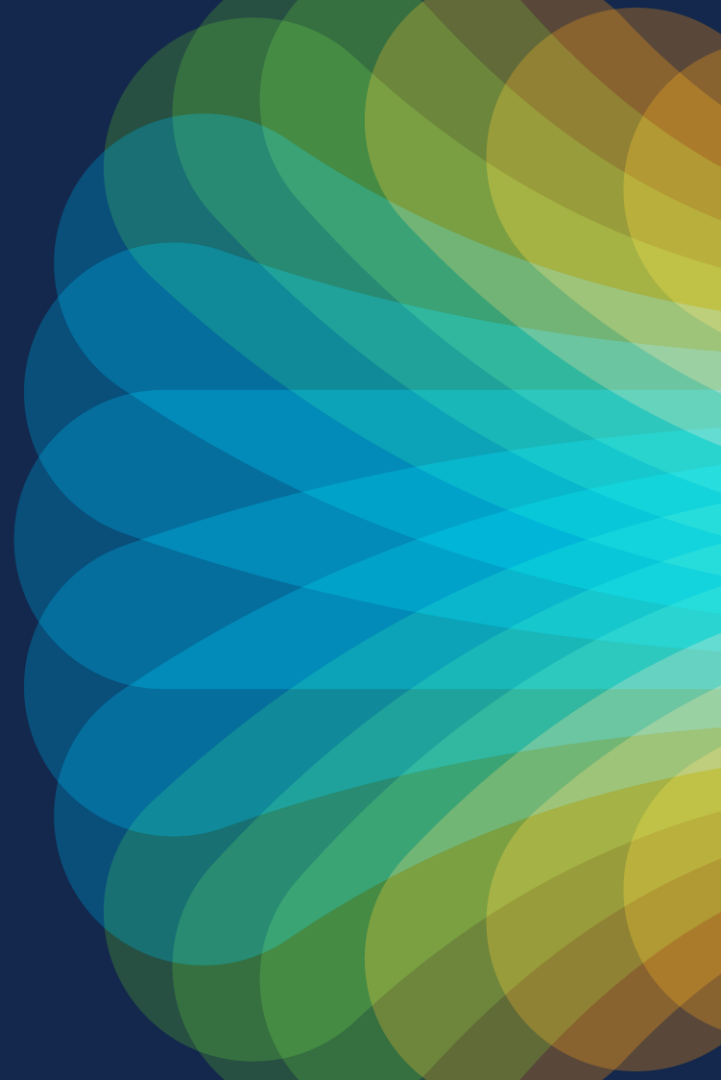
ICON Jitter Buffer Size <100us



Dedicated L2 point-to-point paths carry all critical OT traffic

Ring network topology provides fast healing (<5 ms)

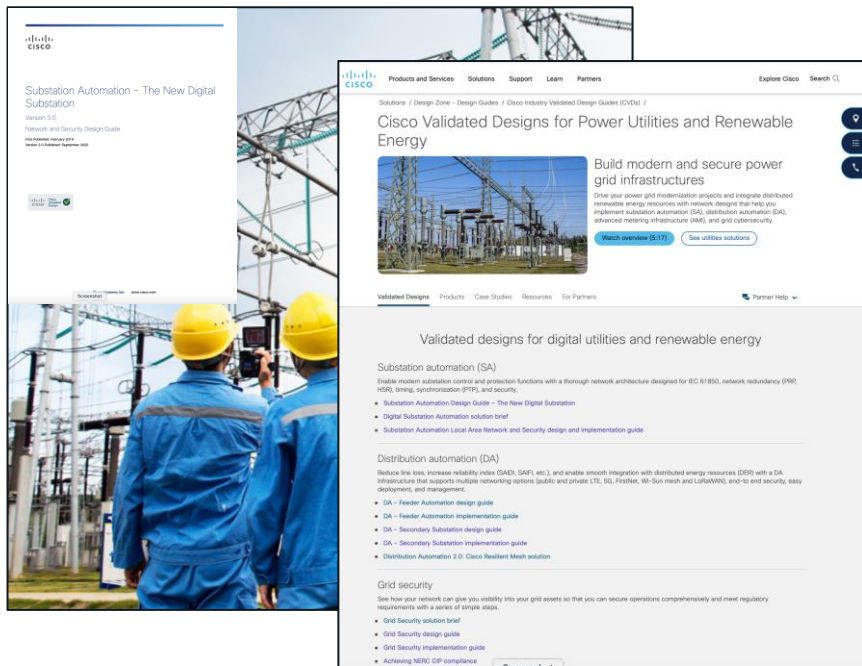
Conclusion



Key Take Aways

- Cisco Validated Designs provide best practice design and implementation guidance
- The New Digital Substation products offer enhanced capabilities to help utilities migrate to IEC61850 based architectures
- The New Digital Substation is more efficient, more secure and ready for more demanding grid applications
- Choosing the best suited Management is based on the persona, use case and capabilities required
- Gaining asset visibility is key to securing your grid applications
- Innovation is only possible through digitising your grid infrastructure

Also Investing in Utilities IoT CVD Solutions



- Distribution Automation **Updates Coming!**
Feeder & Secondary Substations
- Renewable Energy **New Updates!**
Offshore Wind Farms
- SDWAN for Industrial Routers **New!**
SDWAN for DA Use Cases
- Substation Automation (inc WAN) **Updated!**
- Grid Security **Updates Coming!**

www.cisco.com/go/iotcvd

Complimentary Cisco Live sessions applicable to this session

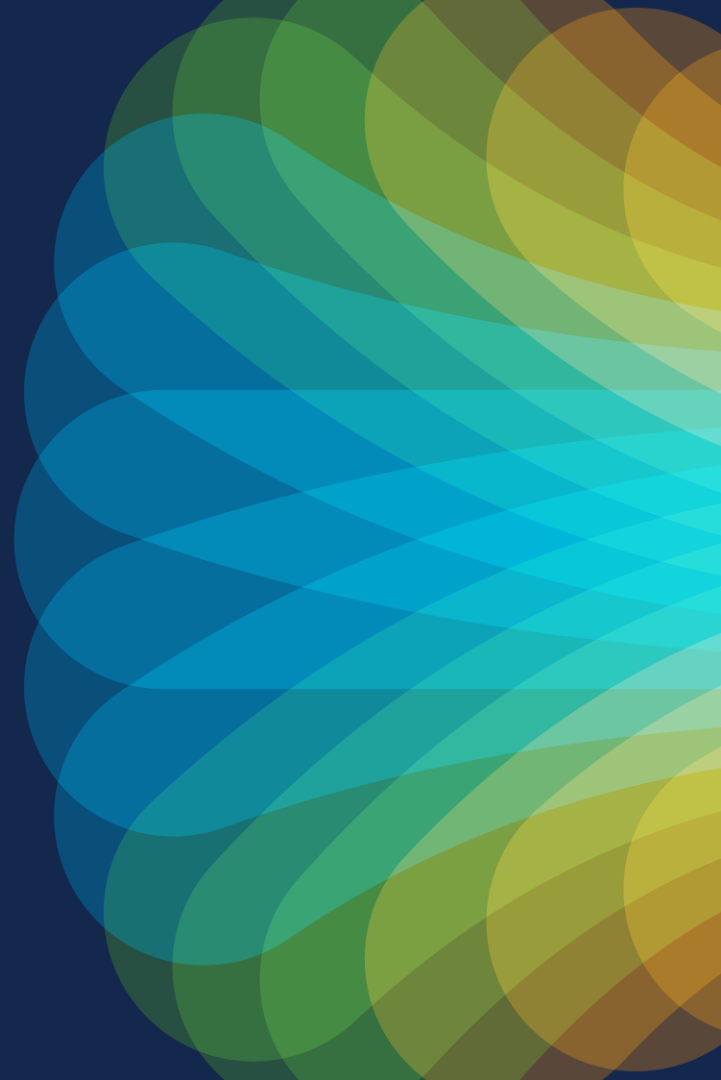
Session ID	Title
BRKIOT-1203	Connecting and Securing Renewable Energy - Enabling Green Technologies with Cisco IoT
BRKIOT-1527	Securing Industrial IoT Networks - A look at ISA/IEC-62443 and how Cisco can help secure the IIoT network
BRKIOT-2882	Implementing Segmentation in Industrial Networks
BRKIOT-2015	The New Digital Substation - more efficient, more secure and ready for demanding modern Grid applications
BRKIOT-2910	Securing Industrial networks - Where to start - using Cyber Vision for OT Asset Visibility
BRKSP-2776	Modernizing mission-critical Utility & Transportation WAN Transport with Segment Routing & EVPN



The bridge to possible

Thank you

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The background features a vibrant, multi-colored abstract design. On the left, there are overlapping, wavy shapes in shades of red, orange, and yellow. On the right, a bright white light source emits a series of colorful rays in shades of blue, green, and yellow, creating a sunburst effect. The overall composition is dynamic and energetic.

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Let's go