



JUNIPER CONVERGED INDUSTRIAL EDGE FOR UTILITIES

Open, standards-based, multivendor platform for IT-OT Convergence

Challenges

Grid infrastructure modernization creates management and technical complexity. Eliminating leased lines, retiring analog technologies, adopting new traffic engineering controls, establishing stronger cybersecurity, and introducing new applications may lead to siloed systems with limited abilities to share data across systems.

Solution

The Converged Industrial Edge for Utilities architecture—featuring Juniper routing, switching, and security, Dragos Industrial Control System Threat Detection, and SEL software-defined Ethernet switches, flow controllers, and TDM-to-Ethernet multiplexers—combines best-of-breed technology with proven automation tools to scale your transition while eliminating complexity.

Benefits

- Reduce TCO for delivering new services while improving security, situational awareness, and resilience
- Support legacy serial infrastructure on IP networks
- Deploy circuits on demand, without defining flows in any switches and without truck rolls
- Secure critical infrastructure with visibility and active response to cyberattacks in IT-OT domains

Electrical utilities rely on operational technology (OT) networks to support the industrial control systems (ICS) essential to their businesses. Historically, OT/ICS platforms have been managed independent of IT networks; differences in operation modes, the duration of refresh cycles, and physical and cybersecurity considerations are common justifications for keeping IT and OT domains separate. However, as budget pressures mount and business cases for modernizing the grid edge multiply, the benefits of reducing costs and streamlining operations compel utilities to reevaluate their options for converging the communications infrastructure.

Whether from a cybersecurity or interoperations standpoint, OT/ICS personnel are historically suspicious of IT's lack of determinism, precision, and security. Not only does the "best effort" nature of IT-based communications technologies fundamentally conflict with the sub-millisecond demands of grid control and protection applications, it also puts expensive grid assets—and even personal safety—at risk. Packet-based networks represent a cyber attack surface, so even as the economics of OT/ICS modernization delivers the advantages of consolidation, the lack of a common, trusted, secure communications model impedes implementation and delays benefits.

Juniper Networks, SEL Inc., and Dragos Inc. have partnered to build the Converged Industrial Edge for Utilities reference architecture. This architecture directly addresses the trust, data integrity, and mediated access challenges of utilizing a multivendor solution for native support of IT and OT use cases that are secured, controlled, tested, and monitored in a single end-to-end platform. The architecture uses cloud-native technologies that simplify and improve orchestration, control, management, automation, cybersecurity, and predictive analytics in private, autonomous, packet-based networks, reimagining IT-OT convergence as the private operations cloud (OC).

The Challenge

The safe and secure integration of IT and OT is fundamental not only to the successful digitalization of the grid edge, but also to current and future business requirements. While utilities recognize the broader business value of convergence, concerns about cybersecurity, safety, reliability, and the performance of protection and control applications must be addressed.

The Converged Industrial Edge for Utilities architecture delivers a solution that allows you to:

- Achieve deployment readiness for OT-SDN and IEC 61850 Ethernet-based substation modernization
- Enhance cybersecurity, compliance, and situational awareness across IT-OT boundaries
- Arm utility operations staff with predictive analytics and orchestration automation platforms
- Enable the agile deployment of circuits and services without requiring truck rolls
- Support legacy communications of installed relays, intelligent electronic devices (IEDs), and remote terminal units (RTUs)

Converged Industrial Edge for Utilities Architecture

Juniper Networks, a leader in networking and security, SEL Inc., a leader in the protection and control infrastructure for the electrical grid, and Dragos Inc., a leader in ICS threat detection and mitigation, have joined forces to define an architecture that reframes the existing IT-OT grid communications paradigm. The partnership, rooted in a Department of Energy research and development grant to enhance the resilience of the nation's energy infrastructure through cloud-native technologies for operations environments, agreed on a vision to create an open, multivendor network architecture. This architecture is composed of a single packet-based forwarding plane stretching from the data/control center to the electrical substation, a single management control plane for end-to-end provisioning, monitoring, and testing, and a single cybersecurity plane for NERC-CIP compliance and industrial control system threat detection.

Three distinct features distinguish this joint solution from the competition:

- 1. End-to-end, packet-based data plane:** The packet forwarding plane is composed of Juniper Networks routers, switches, and firewalls, architecturally optimized for two use cases: a) a secure, cloud-ready data/control center and b) a WAN transport core, aggregation, and edge. The packet-based forwarding plane is extended into the electrical substation using SEL Inc.'s OT-SDN Ethernet solution. End-to-end circuit provisioning and telemetry aggregation and visualization provide the class of service (CoS), timing, and synch and control plane flexibility to solve for deterministic applications demanding millisecond resolution.

Benefit: End-to-end label-switched paths (LSPs), L2/L3 VPNs, and logical flows can be created, tested, monitored, and torn

down across this infrastructure. End-to-end circuit provisioning and telemetry aggregation and visualization are created using the management and control planes described below.

- 2. Management and control plane:** The management and control plane is composed of discreet software applications like WAN and LAN controllers, telemetry aggregators, collators, and element managers, all safely interoperating on a modern Kubernetes software platform to deploy use cases, services, and applications as workflows. The software components are integrated on physical servers optimized for on-premises, private network deployments.

Benefit: The management and control plane uses a Kubernetes cluster microservices architecture to deploy and control multivendor applications exposed through standard APIs, ensuring interoperability. Event-driven infrastructure provides inter-application communication, while a workflow engine connects operator intent with corporate network security policy and network inventory. Use cases are delivered as automated workflows, triggering provisioning, monitoring, and testing with limited human intervention.

- 3. Cybersecurity plane:** The cybersecurity plane is composed of Juniper Networks® SRX Series Services Gateways within the data/control center and throughout the IT-OT environments, and the Dragos Inc. threat protection and incidence response products and services for OT ICS environments. Juniper and Dragos interoperate via established REST APIs.

Benefit: The industry's first active response to an OT event security feed is digested by the Junos Space® Policy Enforcer engine to actively respond to attacks within the operations domain.

With a private OC, utilities can safely accelerate the deployment of:

- Time-division multiplexing (TDM)-to-IP transport conversions
- OT-SDN and IEC 61850 substation digital secondary system (DSS) modernization
- Data or control center modernization
- Safe and secure introductions of new services like VoIP and video flows with no impact on OT system performance

The Converged Industrial Edge for Utilities architecture delivers use cases as automated workflows. User intent, network security policy, and network inventory are modeled and templated, making user errors and one-off networking requirements outliers. The resulting efficiency gains reduce TCO for delivering new services and improving security, situational awareness, and resilience.

How It Works

The Converged Industrial Edge for Utilities architecture leverages components from each company's respective areas of expertise to provide a complete end-to-end converged solution:

- Juniper Networks MX Series 5G Universal Routing Platforms provide the scalable, resilient, and automation-ready MPLS backbone required to safely transport OT-SDN, IEC 61850, and TDM-to-IP traffic, as well as VoIP, video, and corporate IT applications.
- Juniper Networks QFX Series Switches and EX Series Ethernet Switches provide a modern Layer 3 IP-based underlay, also known as a Clos network, and an Ethernet VPN (EVPN)-Virtual Extensible LAN (VXLAN) overlay for network virtualization.
- Juniper's microservices-based management and orchestration tools establish an automation backplane capable of merging siloed software systems like trouble-ticketing systems, SDN controllers, and element management systems with configurable workflows, creating a new level of business value and cost efficiency.
- Dragos Inc.'s threat protection and incidence response products and services for OT ICS environments provide comprehensive visibility into ICS/OT assets, as well as into the threats that utilities and other critical infrastructure face, with best-practice advice for responding before a significant compromise occurs.
- The substation-hardened SEL 2740S Software-Defined Switch and SEL 5056 Software-Defined Flow Controller provide OT-SDN and IEC 61850 Ethernet fabric for substation modernization.
- SEL Integrated Communications Optical Network (ICON) TDM-to-Ethernet multiplexers support legacy circuit requirements by integrating with the MPLS network while retaining millisecond precision for line-current differential protection and direct transfer trip applications.

By embracing the power of automation, Juniper, SEL, and Dragos can help our joint customers:

- Accelerate the deployment of new policy-based architectures while reducing the risk of human error
- Create a prescriptively engineered network environment where flows are safely instantiated, tested, monitored, and decommissioned

- Bridge the transition from legacy IEDs, RTUs, and relays with a hybrid legacy/modern substation architecture
- Provide unmatched visibility into the ICS/OT environment using protocols, network traffic, data historians, host logs, asset characterizations, and anomalies as data sources

Summary—Grid Modernization Through Sound Engineering

Modernizing grid infrastructure can lead to significant management and technical complexity. What today's utilities need is a healthy dose of engineering simplicity.

For the last 30 years, the IT domain has evolved at a remarkable pace. However, that evolution introduced significant complexity, making IT systems harder to manage and less secure. Wary of the rate of change and level of instability, the OT domain has understandably avoided adopting IT technologies for critical infrastructure.

In the face of these challenges, IT organizations have innovated massively to scale their offerings and capabilities. Cloud-native technologies created the software-defined network functions, orchestration, automation, and new forms of cybersecurity used today by the world's largest companies, supporting their most critical operations.

By applying sound engineering principles, it is possible to deploy Ethernet/IP-based packet technologies in critical infrastructure—just in time to address utilities' needs to support a new generation of distribution edge grid modernization and industrial IoT applications. The introduction of automation can backfill an aging and retiring OT workforce and safely retire or replace electro-mechanical equipment that has reached its end of life.

IT has survived this battle with complexity, emerging with a renewed commitment to engineering simplicity. The Converged Industrial Edge for Utilities architecture takes advantage of these proven innovations by automating complex tasks such as provisioning circuits end-to-end across multiple networking fabrics and operating systems. It adopts the software-defined model of abstracting physical components into a forwarding plane from the control center to the end devices. And it is optimized for on-premises and private network applications, retaining the ability to centrally manage and control security, situational awareness, and network agility.

Next Steps

To learn more about this joint solution, contact your Juniper account representative at Converged-Industrial-Edge-Juniper-Info@juniper.net or visit [Juniper's utility solutions page](#).

About Juniper Networks

Juniper Networks brings simplicity to networking with products, solutions and services that connect the world. Through engineering innovation, we remove the constraints and complexities of networking in the cloud era to solve the toughest challenges our customers and partners face daily. At Juniper Networks, we believe that the network is a resource for sharing knowledge and human advancement that changes the world. We are committed to imagining groundbreaking ways to deliver automated, scalable and secure networks to move at the speed of business.

About Dragos Inc.

Dragos is the Industrial Cybersecurity expert on a relentless mission to safeguard civilization. In a world of rising cybersecurity threats, Dragos protects the most critical infrastructure—those that provide us with the tenets of modern civilization—from increasingly capable adversaries who wish to do it harm. Devoted to codifying and sharing our in-depth industry knowledge of ICS/OT systems, Dragos arms industrial defenders around the world with the knowledge and tools needed to protect their systems as effectively and efficiently as possible. Learn more at www.dragos.com/#Dragos

About SEL Inc.

SEL invents, designs, and builds digital products and systems that protect power grids around the world. This technology prevents blackouts and enables customers to improve power system reliability and safety at a reduced cost. A 100-percent employee-owned company headquartered in Pullman, Washington, SEL has manufactured products in the United States since 1984 and now serves customers worldwide. Our mission is simple: to make electric power safer, more reliable, and more economical. Learn more at www.selinc.com

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