ICON®

Integrated Communications Optical Network

Guarantee fast and dependable operation for power protection and mission-critical applications

- Unmatched communications performance designed for mission-critical applications.
- Minimized network disruptions with restoration of communications traffic within 5 ms.
- Optimized multiplexing of substation circuits through Multiprotocol Label Switching (MPLS) or Carrier Ethernet core networks.
- Flexible time-division multiplexing (TDM) and Ethernet transport options that support multiple network use cases and enable integration with private or public packet-based networks.
- Efficient transport of both mission-critical data and IT services traffic in a single Ethernet network without compromised performance.

Dependable Communications for Critical Infrastructure®

A dependable system requires network resiliency, comprehensive network management, robust security, and the flexibility to support your current and future communications needs. That's why SEL designed the ICON Integrated Communications Optical Network—a wide-area networking multiplexer optimized for industrial and utility applications.

You can configure the ICON to operate as a TDM or Ethernet multiplexer to address the following network use cases:

- Segregated operational technology (OT)—SONET transport
- Segregated OT—Ethernet transport
- Converged IT/OT—MPLS or Carrier Ethernet core network
- Migrating analog leased services

ICON virtual synchronous networking (VSN) preserves the performance characteristics of TDM when converting to Ethernet as a transport protocol. By combining TDM and Ethernet transport options with a comprehensive range of data interfaces, the ICON makes it easy to migrate legacy network technologies to a converged IT/OT packet-based solution. The ICON interoperates with MPLS or Carrier Ethernet core networks to provide a hardened OT edge multiplexer for mission-critical applications.

Whether it's for substation automation, security surveillance, or monitoring and protecting critical equipment, the ICON is designed and built to address demanding communications needs and operate reliably in extreme environments.

icon® INTEGRATED COMMUNICATIONS OPTICAL NETWORK

The ICON comes in two available form-factors: the standard 19-inch rack-mount chassis and the half-width cube chassis.

The Best Transport Option to Solve Your Networking Needs

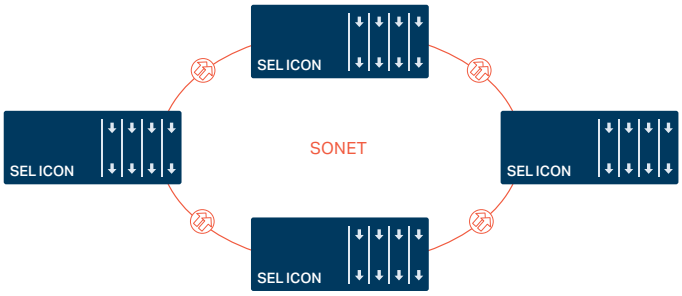
The traditional model for utility communications is to build separate segregated networks for IT and OT. A dedicated network for mission-critical OT applications provides the highest level of control and performance under all network conditions. However, many utilities see efficiency gains by converging IT and OT networks. Whether your network is segregated or converged, the SEL ICON provides the highest level of performance for critical circuits.

Segregated OT Network—SONET Transport

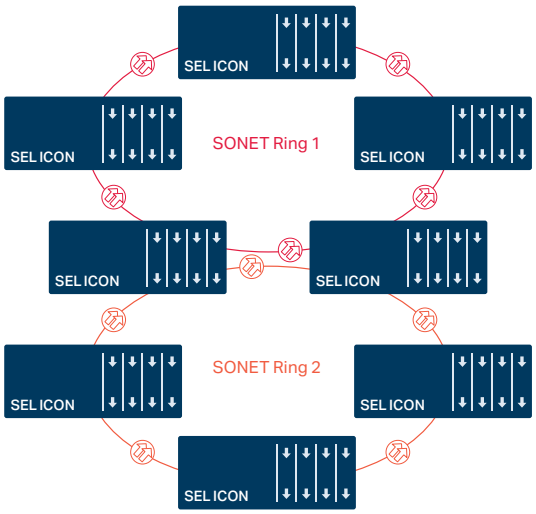
A dedicated network provides the best performance and the highest level of control over network traffic for mission-critical OT applications. Many utilities rely on TDM to provide a dedicated network for their critical protection traffic. TDM provides dedicated bandwidth for each application and uses a synchronous transport structure to achieve deterministic and low-latency communications that are unaffected by traffic on the system. TDM provides the best-performing solution for critical teleprotection applications by offering <1 ms latency, <0.01 ms asymmetry, and <5 ms healing.

Network Topologies and Use Cases

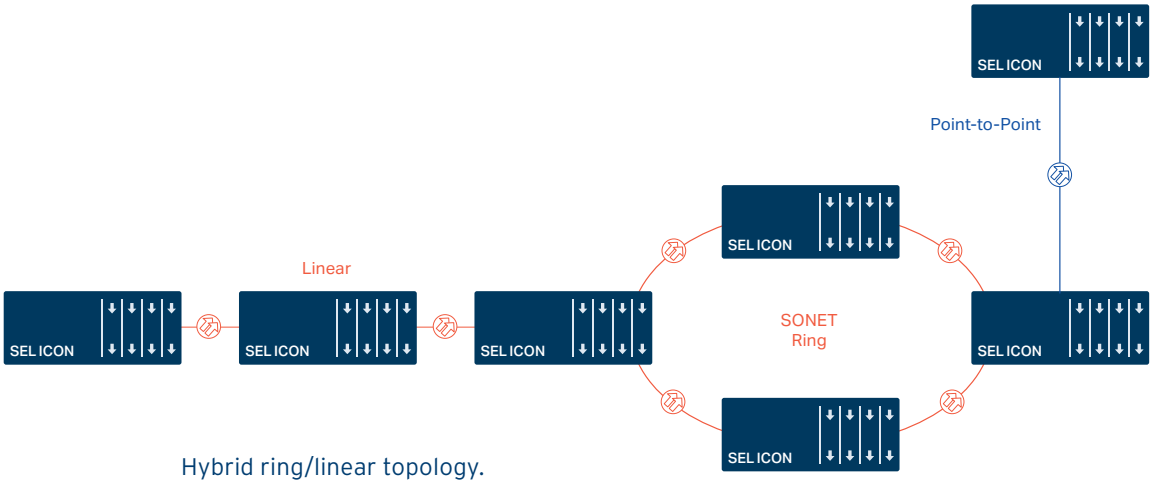
- With the ICON, you will be able to run and maintain your SONET network infrastructure well into the future.
- The ICON supports single-ring, multiple-ring, linear, and hybrid ring/linear topologies.
- Flexible line rate support (OC-3, OC-12, and OC-48) enables the ICON to use TDM radio or microwave links to provide communication to sites that lack fiber connectivity.
- Using TDM synchronous communications architecture, the ICON can distribute time over a WAN with better than 1 µs accuracy, even in the event of a GPS failure.



Single-ring topology.



Dual-ring topology.



Hybrid ring/linear topology.

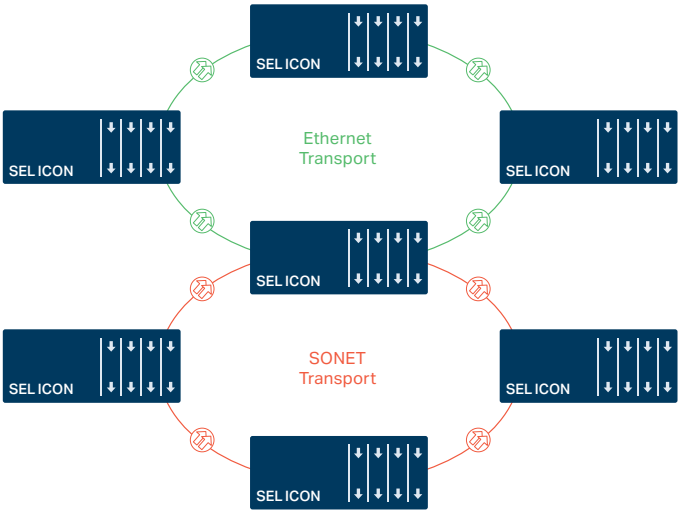
Segregated OT Network—Ethernet Transport

ICON deterministic packet transport is an innovative approach that delivers mission-critical traffic with low latency over an Ethernet transport network. It preserves the performance characteristics of TDM, which is presently available in the ICON platform, with no performance degradation when converting to Ethernet as a transport protocol.

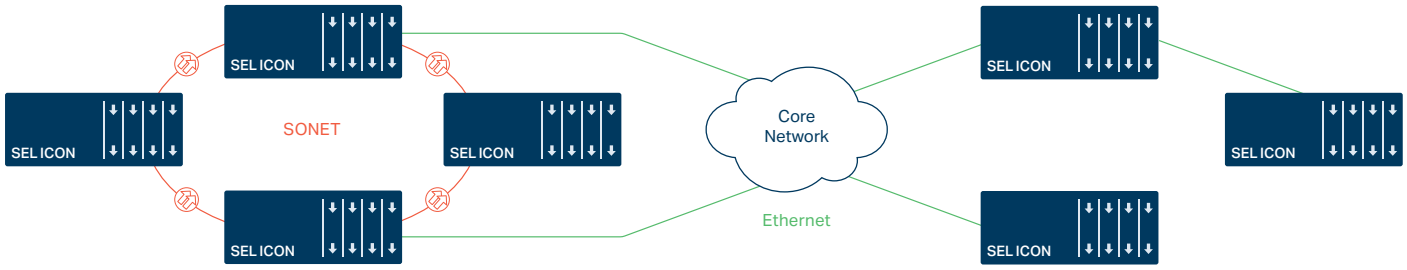
Ethernet transport allows you to migrate your network to a packet-based technology. Packetizing at STS-1 line rates, rather than using DS0/E0 circuit emulation, and transporting a regularly spaced stream of Ethernet packets minimizes the jitter buffer size (13 µs). These attributes let you maintain TDM performance over Ethernet transport.

Network Topologies and Use Cases

- ICON Ethernet transport can operate in single-ring, multiple-ring, linear, and hybrid ring/linear topologies.
- ICON can run with Ethernet-only transport or mixed Ethernet/SONET, providing the ideal migration solution.
- The Ethernet transport mode lets you choose Ethernet radio options for network links that don't have fiber connectivity.



Mixed SONET and Ethernet transport.

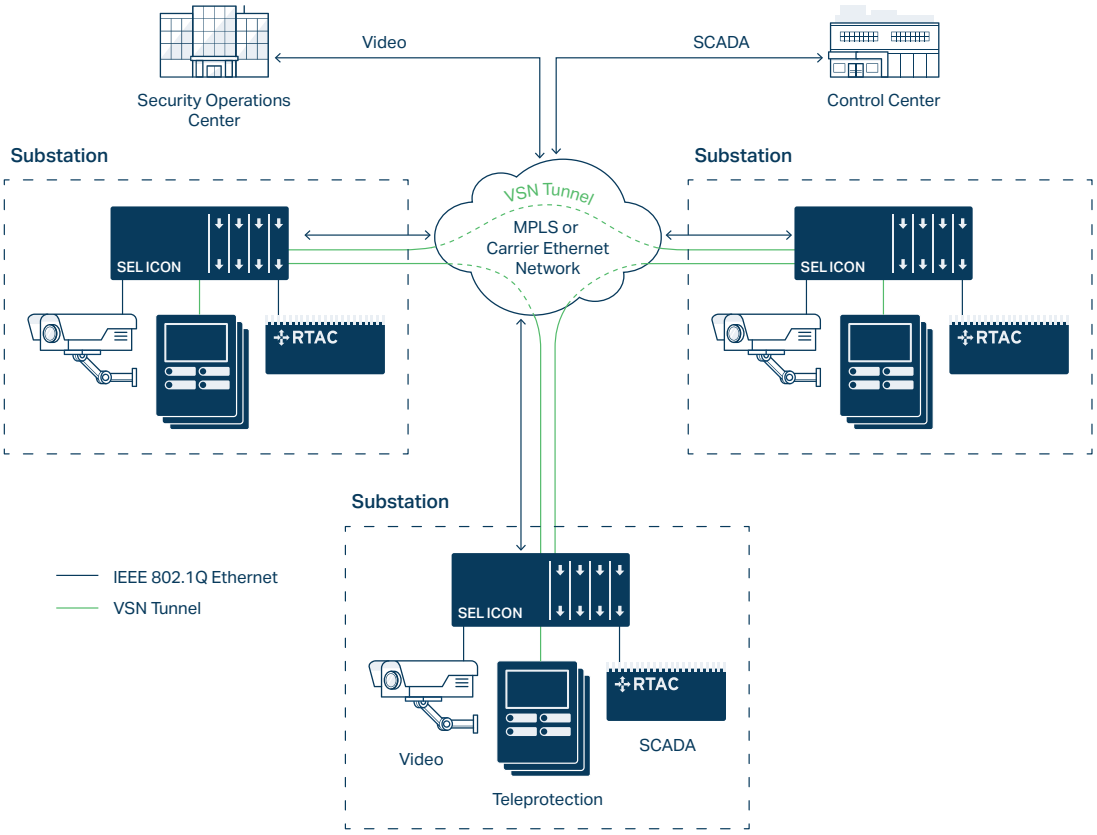


Mixed transport with linear spurs.

Converged IT/OT Network

With the use of high-bandwidth packet-based technologies, such as MPLS and Carrier Ethernet, there is a clear trend within many utilities to move away from using segregated IT and OT networks. Instead, these utilities are choosing an integrated or converged network model that uses a common network to support both IT and OT services. The primary motivation for this move is to increase the efficiency of assets and resources.

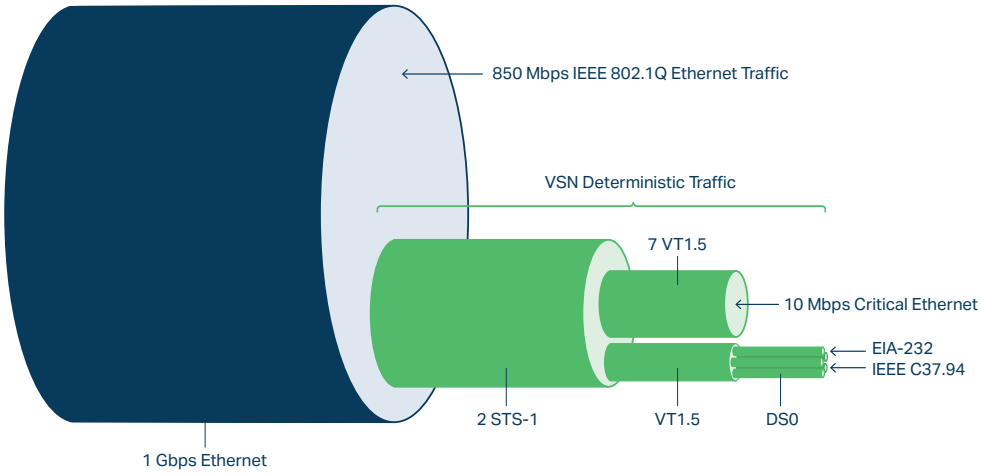
If you have decided on a converged IT/OT network approach, you don't have to compromise on network performance for critical protection circuits. ICON VSN delivers mission-critical traffic with low and deterministic latency over an Ethernet transport network, while utilizing the remaining bandwidth for IT services traffic.



Converged substation IT/OT network.

Converged IT/OT Network Topologies and Use Cases

- In the converged mode of operation, the ICON operates as an edge multiplexer with support for all substation circuits (EIA-232, EIA-422, EIA-485, G.703, 2-wire FXO/FXS, 4-wire voice frequency, direct transfer trip [DTT], IEEE C37.94, DS1, and E1) and delivers a Gigabit Ethernet line interface.
- ICON deterministic transport uses point-to-point links provisioned through MPLS or Carrier Ethernet core networks combined with an innovative, ultra-efficient approach of packetizing TDM data to achieve <1 ms latency, <0.1 ms asymmetry, and <5 ms healing.
- The ICON simplified provisioning model and bandwidth-efficient packetization process ensure the performance of critical circuits is maintained as changes are made on the core network. This process also avoids the need to individually manage each protection circuit.
- Even in a converged network model, the ICON makes it possible to maintain SONET for part of the network and use Ethernet for transport through the packet core network.
- In addition to encapsulating critical services into the VSN payload for deterministic transport, the ICON allocates noncritical services, such as video and SCADA, into standard IEEE 802.1Q Ethernet outside of the VSN container bandwidth. This enables the ICON to efficiently use bandwidth for Ethernet services and provide the flexibility to support the wide-area transport of all substation services.



ICON Ethernet network traffic segmentation.

Migrating Analog Leased Services

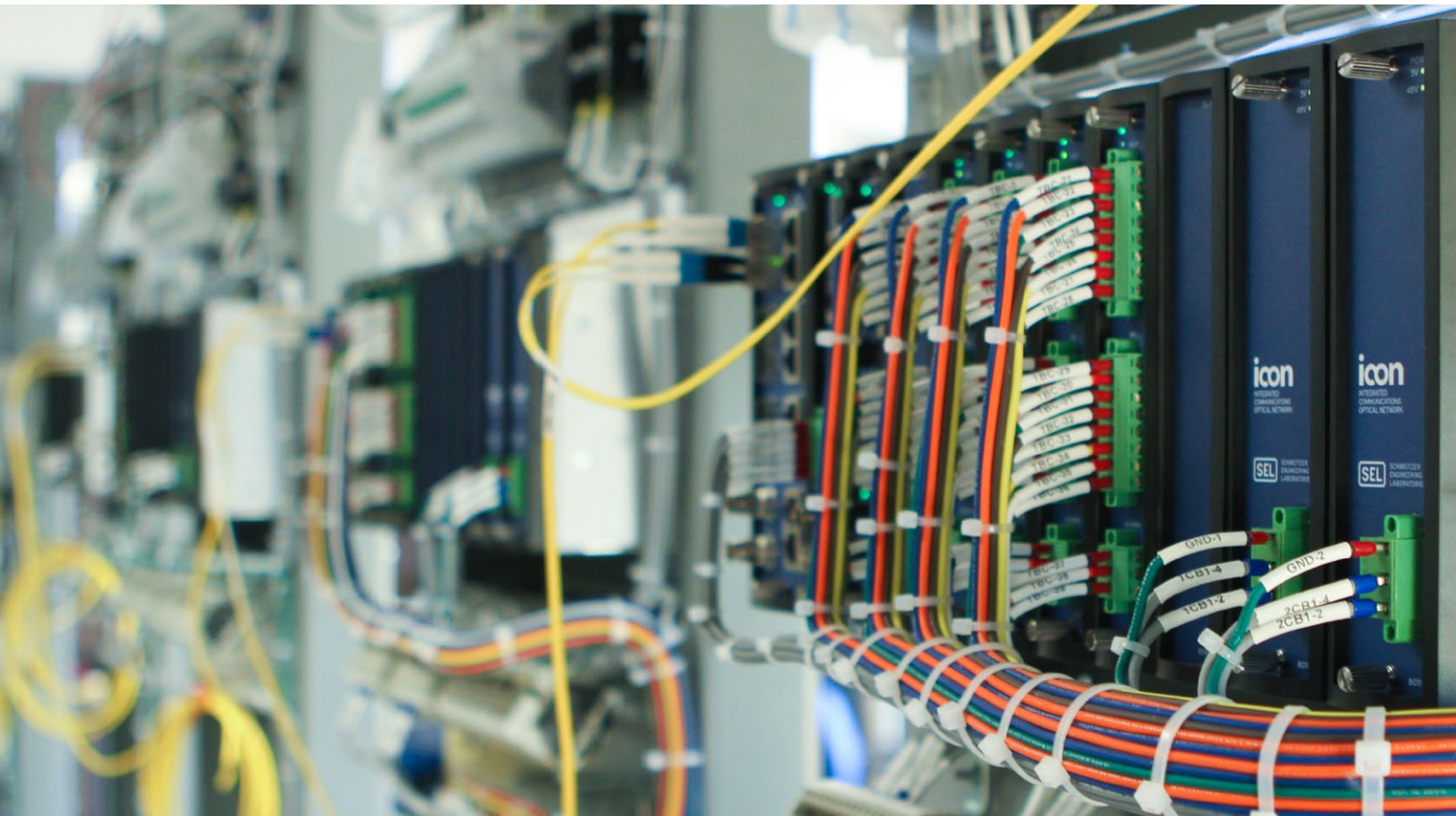
With the major carriers announcing the end of service for leased analog services, many utilities are facing a forced migration to leased Ethernet circuits. This creates the challenge of maintaining adequate latency and asymmetry performance for critical analog circuits.

The ICON provides a solution.

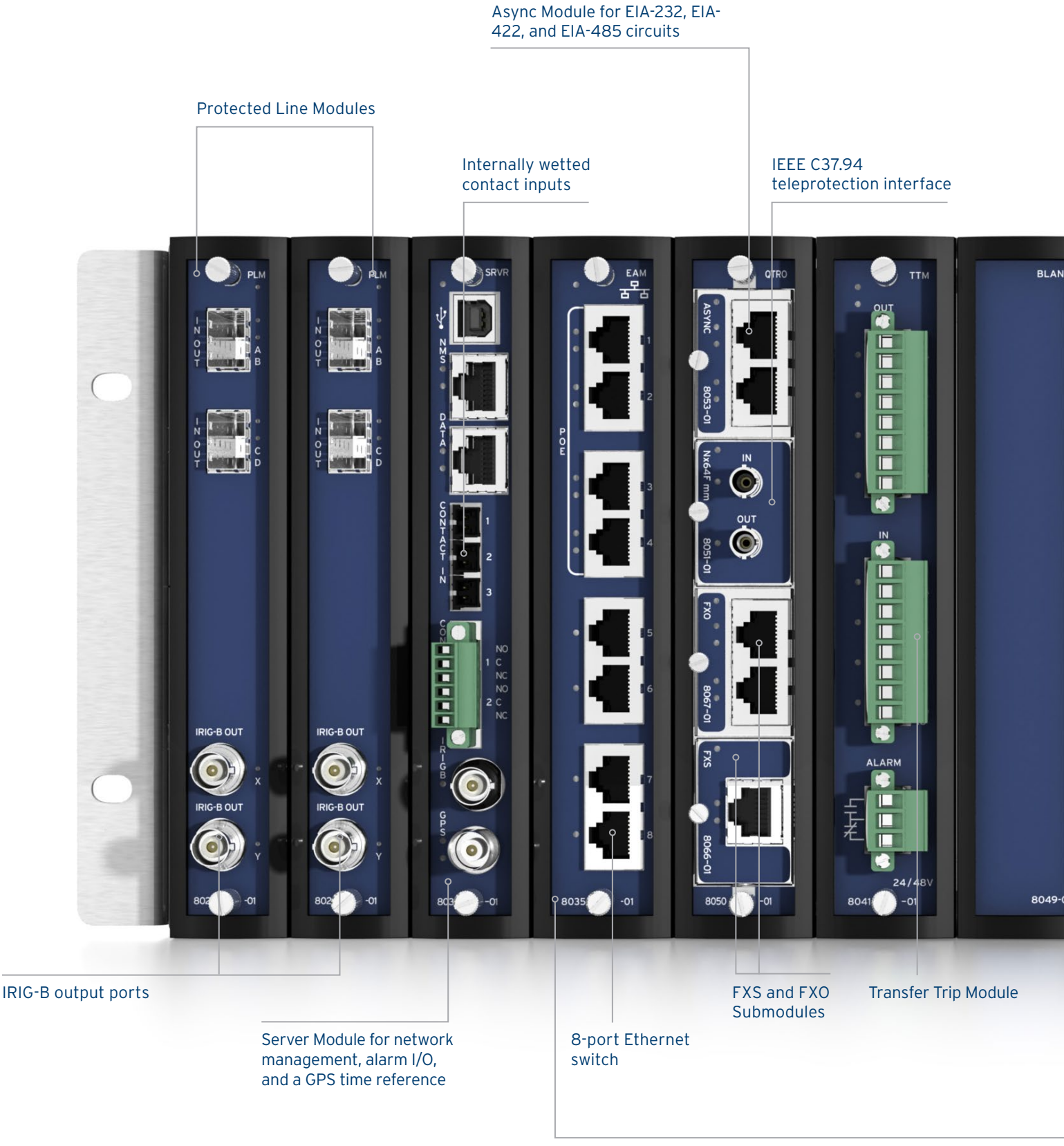
Network Topologies and Use Cases

You can combine ICON VSN with dedicated analog drop interfaces that include 2-wire FXO/FXS, 4-wire analog voice frequency, and DTT. These interfaces allow you to preserve existing analog end equipment and create a low-latency circuit through your leased service provider to maintain end-to-end communications channel performance for critical applications. Using the ICON, you can achieve an end-to-end latency of less than 5 ms for a contact transfer across leased Ethernet service.

Transporting an analog DTT circuit over a leased Ethernet network.



19" Rack-Mount Chassis Product Overview




IEEE 1613-compliant packaging
Dual redundant power supplies
BLANK
BLANK
BLANK
POWER
5V
48V
POWER
5V
48V
icon
INTEGRATED
COMMUNICATIONS
OPTICAL NETWORK
SEL
SCHWEITZER
ENGINEERING
LABORATORIES
GND
−/N
+/H
8049-01
8049-01
8049-01
DC 125/250 V
8011-02
DC 24/48 V
8011-03
Seven slots for access modules

Half-Width Cube Chassis Product Overview

Customize Your System

With multiple module options, the ICON allows direct connectivity to end devices without intermediate equipment.

Access Modules

Ethernet Bridging Access Modules—The 8036-01 module provides four 10/100/1000 Mbps copper ports plus four 100/1000 Mbps small form-factor pluggable (SFP) ports for Ethernet connectivity. The 8036-02 module with the Precision Time Protocol (PTP) provides support for the IEEE 1588 Power Profile (IEEE C37.238-2017) output and Telecom Profile (G.8275.2) input.

Transfer Trip Module—provides four contact inputs and four high-speed hybrid contact outputs for DTT, permissive overreaching transfer trip (POTT), permissive underreaching transfer trip (PUTT), directional comparison blocking (DCB), and directional comparison unblocking (DCUB) schemes.

Quattro Module—provides slots for up to four Quattro Submodules that mount in one full-height ICON slot, saving space and power consumption.

Access Submodules—Data

Nx64F MM—provides an IEEE C37.94 teleprotection interface using multimode fiber.

Nx64F SM—provides an IEEE C37.94 teleprotection interface using single-mode fiber.

Async—provides up to six EIA-232, EIA-422, and EIA-485 circuits.

Async-CB—provides transport of EIA-232/422/485 circuits over a DS1/E1 interface between ICONs using the DS1 Sync or E1 Sync Submodules.

DS1 Async—provides an asynchronous DS1/T1 interface.

DS1 Sync—provides a synchronous DS1/T1 interface.

DS1 Psync—provides a redundant synchronous DS1/T1 interface.

G.703—provides a single codirectional, 64 kbps, G.703-compliant interface.

E1 Async—provides an asynchronous E1 interface.

E1 Sync—provides a synchronous E1 interface.

422 Sync—provides a single full-duplex synchronous 64 kbps interface.

Access Submodules—Voice

4-Wire Voice Frequency (VF)—provides analog modem communications.

2-Wire FXS and FXO—offer analog voice communications for telephone and PBX circuit transport.

Enhanced Protected Line Module (EPLM)

The EPLM provides a redundant SONET and/or Ethernet line interface to ensure communications are maintained in the event of a module failure. Support for time synchronization using the IEEE 1588 PTP Telecom Profile is provided when operating in Ethernet transport mode.

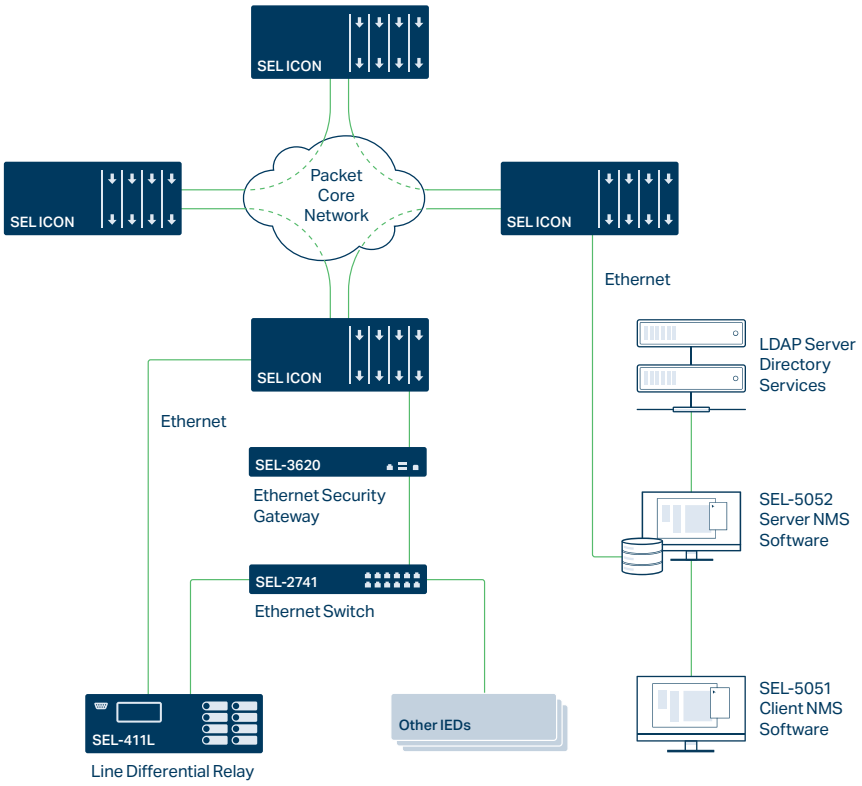
Server Module

The Server Module provides the interface between the ICON and the SEL-5051 Client Network Management System (NMS) Software or third-party Simple Network Management Protocol (SNMP) manager. The Server Module also contains a GPS satellite receiver for network timing and for providing the real-time clock for time distribution to connected IEDs.

Manage Your Network

Whether your network is large or small, keeping it running smoothly can be a challenge. The ICON simplifies this task with SEL-5051 Client and SEL-5052 Server NMS Software—indispensable tools for maintaining a secure, reliable, and efficient communications infrastructure.

In the client server architecture, the SEL-5051 Client Software connects to the SEL-5052 Server Software to provide an efficient solution for managing network access for multiple users. The SEL-5052 Server Software offers centralized user authentication (with Lightweight Directory Access Protocol [LDAP] or Single Sign-On [SSO] integration), security, settings, alarms, and event management. The SEL-5052 Server Software also includes system health checks and circuit tracing, with the ability to remove circuits.



ICON network management.

NMS Software

SEL ICON networks are managed by either standalone SEL-5051 Client Software or a combination of SEL-5051 Client and SEL-5052 Server Software.

SEL-5051 Client NMS Software

SEL-5051 Client Software offers the following features for the configuration and management of your ICON network.

Graphical Network Representation

Provide network discovery and graphical display of a complete ICON network. You can view the status of each ICON node and associated line links.

Configuration Management

Provision Ethernet and TDM circuits. You can manage firmware upgrades remotely and schedule upgrades for specific times and dates.

Alarm Management

View, sort, filter, and archive the time-stamped alarm history for each node on the network.

Event Management

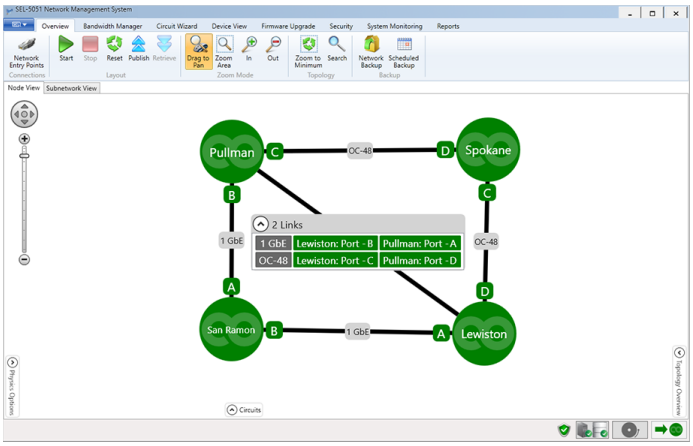
Track administrator and individual user access. You can monitor valid and invalid user logon attempts as well as session settings change logs.

Security Management

Automatically generate security reports for compliance with NERC CIP security logging.

Performance Monitoring

Monitor the performance of TDM and Ethernet communications using comprehensive network statistics.



SEL-5051 Client NMS Software

SEL-5052 Server NMS Software

SEL-5052 Server Software offers centralized user security, settings, alarms, and event management.

User Authentication

Improve the security of the ICON network by having your LDAP or SSO servers authenticate and authorize users on the ICON network. Once set up, the login mode allows LDAP, SSO, or local authentication.

Circuit Removal

Enable authorized users to remove a circuit by completely deprovisioning all settings and releasing bandwidth to be reused for a future circuit.

System Health Check

Analyze the ICON network for common configuration errors to prevent issues with network operation.

SNMP Traps

Securely send ICON network alarm information to third-party network management systems for centralized alarm aggregation and management.

Circuit Trace

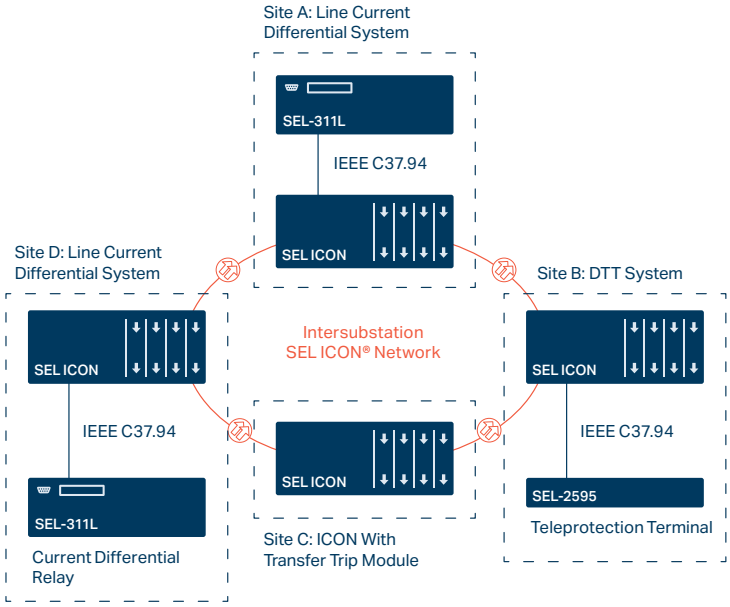
Collect and analyze the settings from a node to identify and show configured circuits and their settings.

Applications

Transmission Line Protection

Implement current differential protection and DTT schemes with SEL relays. The ICON communicates between relays with IEEE C37.94 circuits carried over a fiber-optic link. You can apply the ICON Transfer Trip Module to sense or assert contact closures for pilot protection schemes.

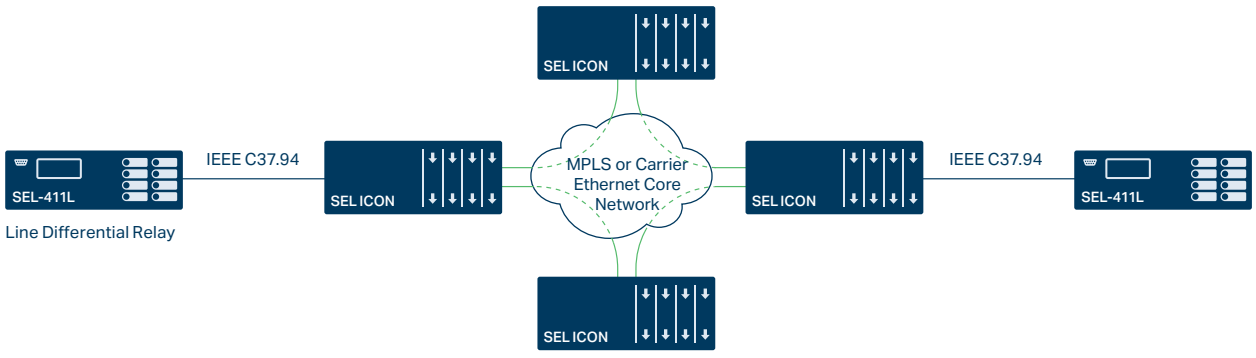
The ICON network monitors and reports channel latency in real time. Selecting the shortest path between terminals as the primary path ensures that the system always reverts back to your primary configuration in the event of a path failure and subsequent restoration. These features, combined with robust IEEE 1613 environmental operating specifications, make the ICON ideal for critical power applications.



Example of teleprotection communication for protecting a transmission system.

Line Current Differential Protection Across MPLS or Carrier Ethernet Core Networks

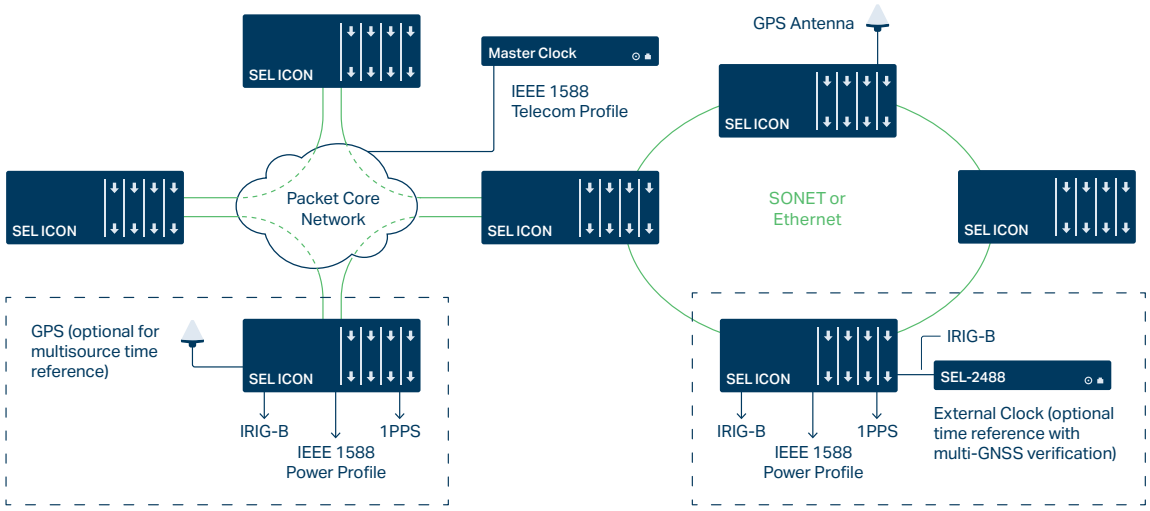
The SEL ICON is designed to provide low-latency services for substation and OT applications. With the ICON, you can provision IEEE C37.94, serial, and DTT teleprotection circuits between substation facilities, while allowing native Ethernet services to transit through core network infrastructure. Using the ICON deterministic Ethernet transport technology, it is possible to achieve TDM performance across an MPLS or Carrier Ethernet packet core network to deliver <1 ms latency, <0.1 ms asymmetry, and 5 ms healing.



Example of protection over Ethernet core network.

Wide-Area, Dependable Time Distribution

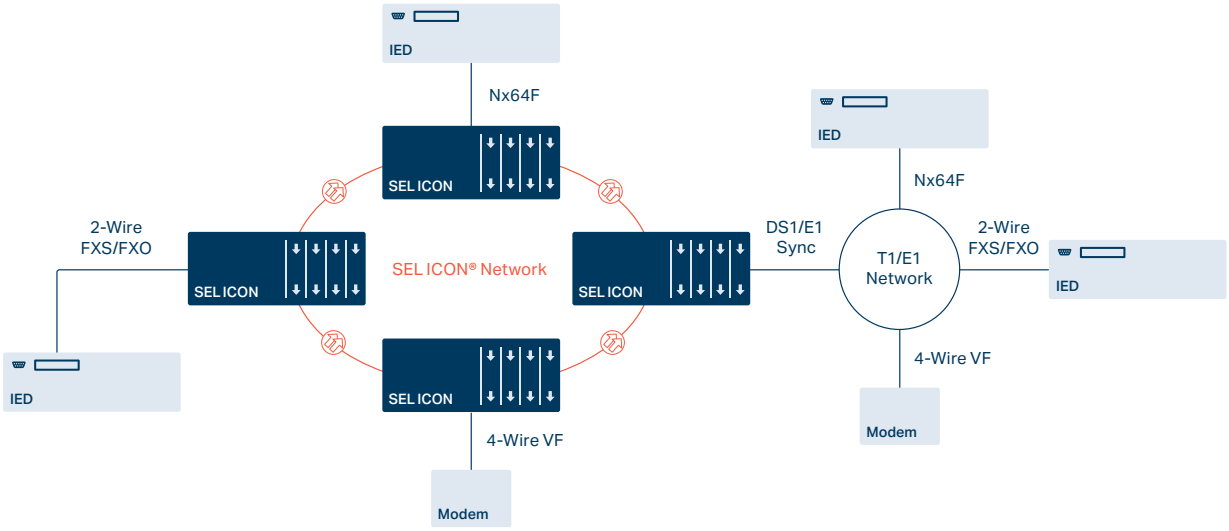
The ICON can distribute time over WANs with an accuracy of 1 µs. The ICON has the ability to obtain time using a built-in GPS receiver or via IRIG-B. In addition, when operating in Ethernet transport (VSN) mode, the ICON can use the IEEE 1588 PTP Telecom Profile from a centralized grandmaster timing reference that is delivered over an Ethernet transport network (MPLS or Carrier Ethernet).



Example network time distribution application. ICON nodes are synchronized across the WAN and generate time references for substation device synchronization.

Legacy Communications Aggregation

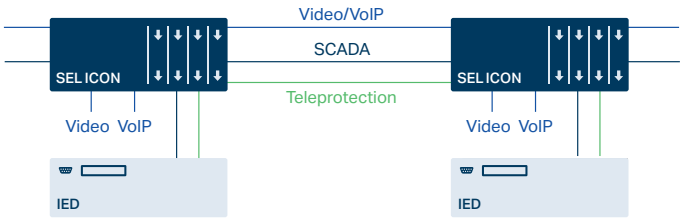
Consolidate legacy DS1/E1 and DS0/E0 circuits between locations onto the ICON WAN to eliminate redundant circuit lease and maintenance costs. You can apply ICON FXS/FXO modules to establish analog telephone, PBX, fax, and modem circuits in every location. The ICON accepts channelized DS1 and E1 circuits from any source. You can groom the individual DS0/E0 circuits to terminate anywhere within the network.



Example of legacy circuit aggregation.

IEC 61850 Network Optimization

Ensure optimal performance of IEC 61850 systems by supporting VLANs and Ethernet Pipes (Epipes). Epipes can contain and isolate Layer 2 broadcast commands, such as IEC 61850 Generic Object-Oriented Substation Event (GOOSE) messages, from all other noncritical traffic on the network, ensuring very low-latency data communications paths between IEDs.



Example of segregating IEC 61850 traffic from other applications.

ICON Specifications

General		
Line Modules	8022-01 Enhanced Protected Line Module	SFP Ports A/B/C/D: 155 Mbps, 622 Mbps, 1 Gbps, or 2.4 Gbps IRIG-B out: 2 BNC
Server Module	8030-01 Server Module	NMS ports: USB, RJ-45 GPS antenna: TNC IRIG-B in: BNC
Chassis and Power Modules	19-Inch Rack Mount Chassis	
	8001-01 Full 19-Inch Chassis	10 available slots
	8011-01 HV AC 120—240 V, IEC C6 Line Cord	Supply voltage: 102—264 Vac, 50/60 Hz
	8011-02 HV AC/DC 120—240 V, Terminal Block	Supply voltage: 102—264 Vac, 50/60 Hz; or 88—300 Vdc
	8011-03 MV DC 24—48 V, Terminal Block	Supply voltage: 19—58 Vdc
	Half-Width Cube Chassis	
	8002-01 Half-Width Chassis	
	8010-01 HV AC 120—240 V, IEC C6 Line Cord	Supply voltage: 102—264 Vac, 50/60 Hz
	8010-02 HV AC/DC 120—240 V, Terminal Block	Supply voltage: 102—264 Vac, 50/60 Hz; or 88—300 Vdc
	8010-13 MV DC 24—48 V, Terminal Block	Supply voltage: 19—60 Vdc
Access Modules	8036-01 Ethernet Bridging Access Module	100/1000 Ethernet ports: 4 SFP 10/100/1000 Ethernet ports: 4 RJ-45
	8036-02 Ethernet Bridging Access Module With PTP	100/1000 Ethernet ports: 4 SFP 10/100/1000 Ethernet ports: 4 RJ-45
	8051-11 Nx64F Multimode Submodule	ST ports: 1 Rx, 1 Tx Standard: IEEE C37.94 multimode
	8051-12 Nx64F Single-Mode Submodule	ST ports: 1 Rx, 1 Tx Standard: IEEE C37.94 single-mode
	8053-11 Data Async Submodule	Ports: 2 RJ-45 Standards: EIA-232, EIA-422, EIA-485
	8053-12 Async-CB Submodule	Ports: 2 RJ-45 Standards: EIA-232, EIA-422, EIA-485
	8055-01 422 Sync Submodule	Port: 1 RJ-45
	8056-01 G.703 Submodule	Port: 1 RJ-48C
	8065-11 4-Wire VF Submodule	Ports: 2 RJ-45
	8065-12 4-Wire VF Bridging Submodule	Ports: 2 RJ-45
	8066-01 2-Wire FXS Submodule	Port: 1 RJ-11
	8067-01 2-Wire FXO Submodule	Ports: 2 RJ-11
	8041-01, -04 Transfer Trip Module	Commands: 4
	8057-11 DS1 Async Submodule	Ports: 4 RJ-48C
	8057-12 DS1 Sync Submodule	Ports: 4 RJ-48C
	8057-03 DS1 Psync Submodule	Ports: 4 RJ-48C
	8057-14 E1 Async Submodule	Ports: 4 RJ-48C
	8057-15 E1 Sync Submodule	Ports: 4 RJ-48C

General, Continued

System Specifications	Network Topologies	Linear and multiple rings with single or dual interconnected nodes, plus linear spur and subtended ring topologies
	Path Switching Time	<5 ms
	Convection-Cooled	No fans
	Operating Temperature	−20° to +65°C (−4° to +149°F)
	Mounting	8", 19", or 23" rack or panel mount

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