SEL Leased Line Alternatives

* Please note that PSEG Long Island does not endorse any product listed on the presentation.

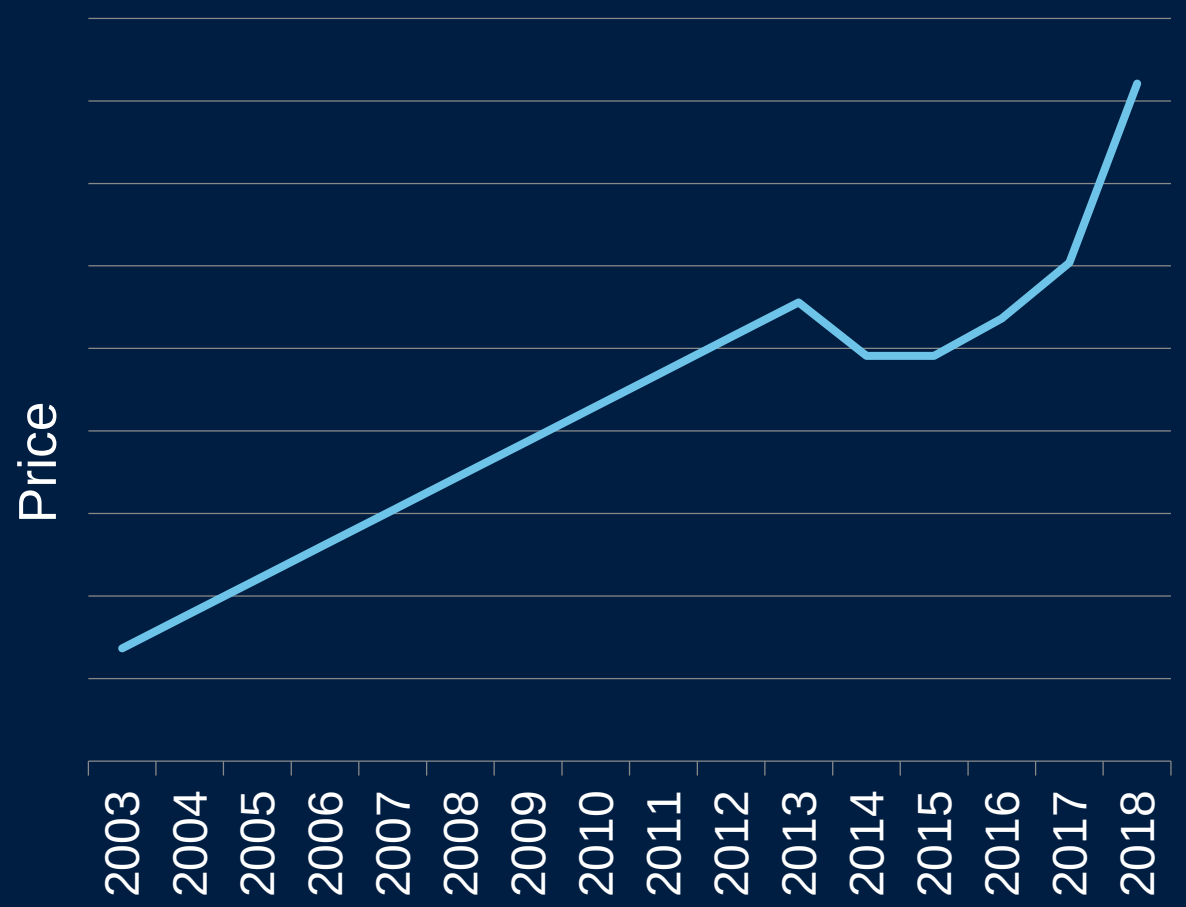
Industry Push to Retire Copper Services

FCC Votes to Hasten Copper Retirement and Notification Process, Hopeful for IP/Fiber Upgrades

11/16/17 at 2:00 PM *by* Joan Engebretson

Help Squad: AT&T receives approval to end copper landline service. What's next for customers?

- Local carrier no longer allows new analog installations
- Maintenance costs are increasing and reliability is decreasing



What Applications Are Run Over Analog Lines?

Direct transfer trip (DTT)

- Is used for DER anti-islanding
- Need DER to come offline rather than risk islanding with load
- Requires service performance objective (SPO) Class A circuit or needs generator to trip within 1 second of detecting channel loss

Alternatives to leased lines for DTT Applications

- Direct Fiber
- Sonet Network
- Leased Ethernet Services
- Serial Radio
- Cellular networks*

SEL DTT Solutions

SEL ICON

SEL 3031 Serial Radio

SEL 3061 Cellular Router*

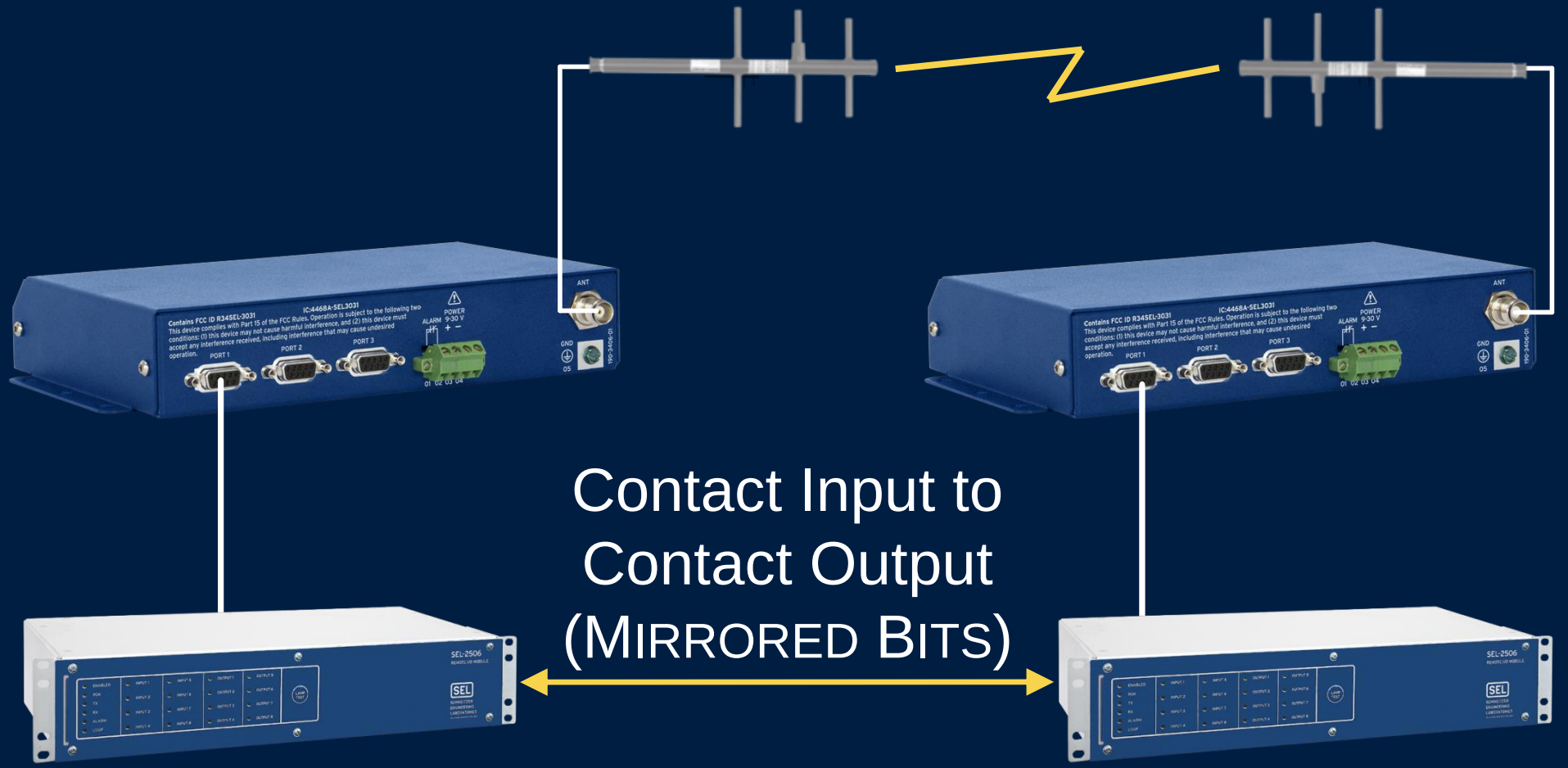
* Not protection speed

SEL 3031 Serial Radio

One Radio – Three Secure Point-to-Point (P2P) Links

- Low latency enables fast control
- Strong security thwarts attackers
- Tough radio operates in extreme conditions
- No licensing reduces delays and expenses

Transfer Contacts Fast



Contact Input to
Contact Output
(Mirrored Bits)

Unencrypted = 8.8 ms
Encrypted = 13.4 ms

SEL-3031 Point-to-Point Applications

- Three serial channels in one radio link
- Synchrophasors
- Revenue metering
- High-speed control

SEL-3031 Latencies Are Less Than Traditional Tone and Carrier!

MIRRORED BITS Communications	No Encryption	With Encryption
9,600 bps	8.9 ms	9.7 ms
19,200 bps	5.6 ms	7.4 ms
38,400 bps	4.8 ms	NA

Improve Security and Safety

- Use strong AES 256-bit encryption
  - Purchase option or upgrade later
  - Meet FIPS 140-2 requirements
- Monitor one or many remote locations

SEL ICON®

Integrated Communications Optical Network

WAN multiplexer for industrial and utility applications

SONET and Ethernet transport technologies

Industry-best performance for protection circuits

Simplified commissioning and network management

Uncompromised Wide-Area Communication

TDM Performance

Deterministic Delivery

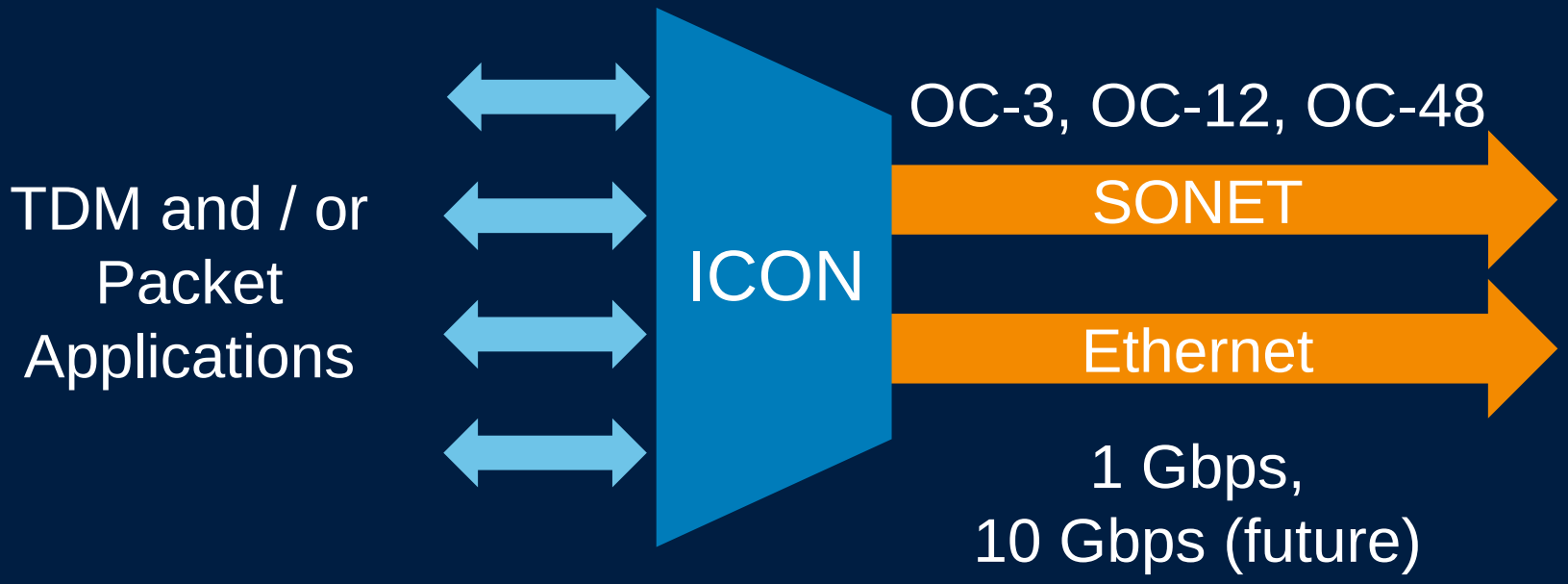
Low Latency

5 ms Healing

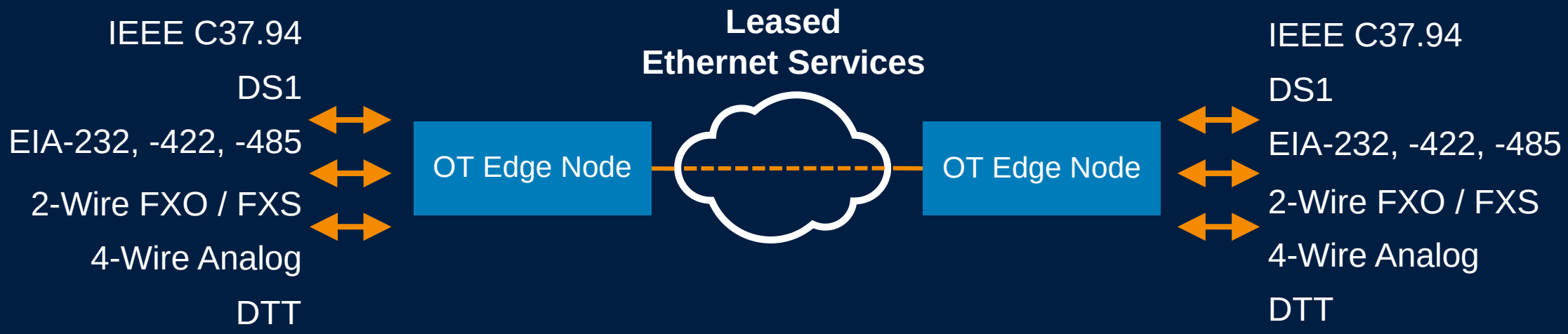
Manufactured in the USA

ICON®
Versatile Communications

- SONET and/or Ethernet multiplexer
- Gigabit / fast Ethernet switch
- Jitter-free TDM over Ethernet

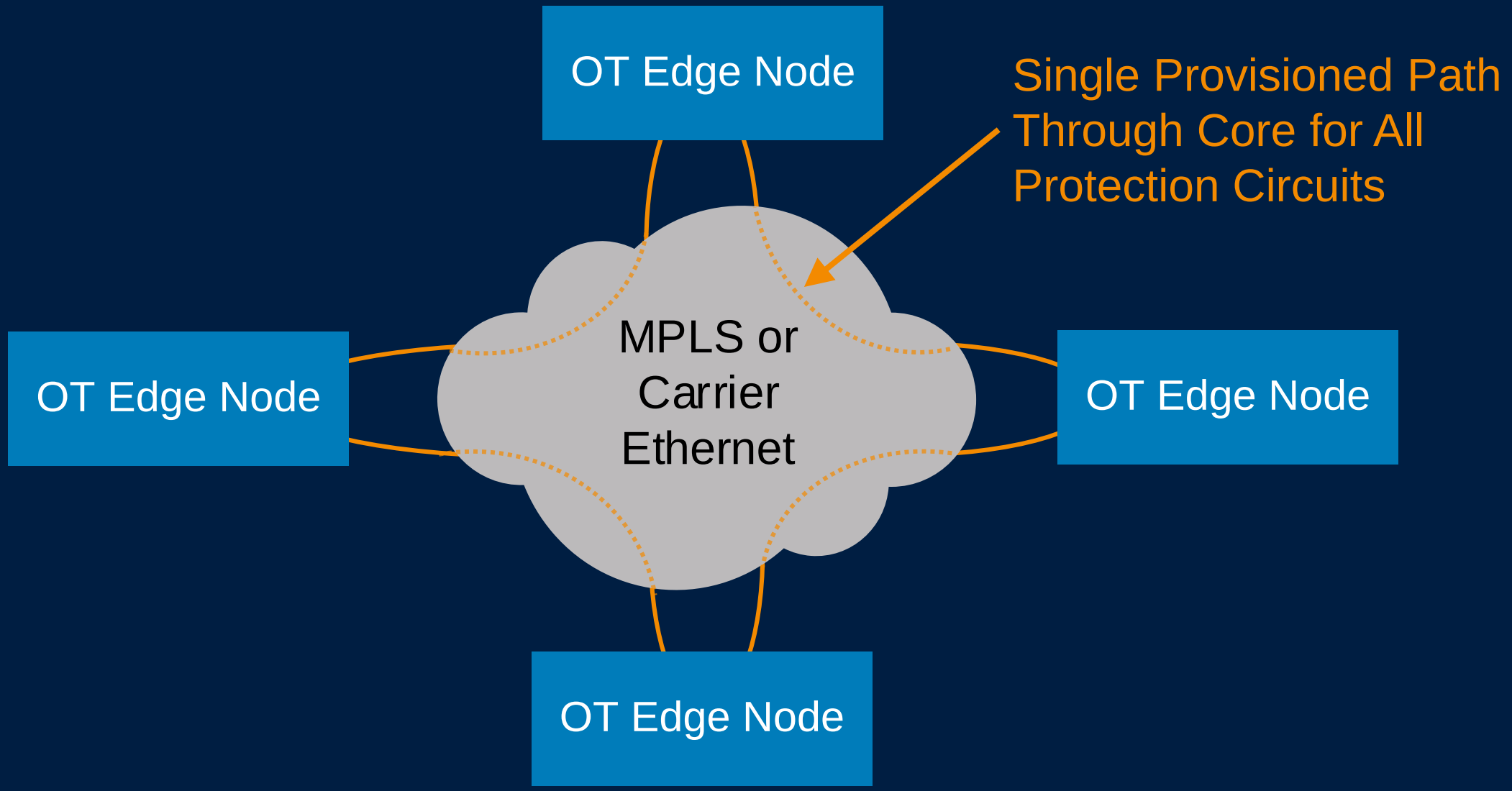


VSN Provides Solution for Leased Analog Replacement



- Improved performance
- Cost savings
- Enhanced reliability

VSN Tunnel Across Core Transport



Fixed Path in Ethernet Packet Core Network

- Simplifies provisioning (add services at edge of network with no impact to core network)
- Minimizes circuit latency and asymmetry controlled by ICON® PDV compensation
- Overlays traditional ring topology on core network for SONET-like performance
- Has less core bandwidth (no backup path required from core)
- Has converged network with demarcation between OT and IT

Delivering TDM Performance Over Ethernet Packet Core Network

- Provision fixed (static) path through core network
- Perform healing using ICON® edge device (less than 5 ms failover)
- Adjust PDV in ICON (compensate for jitter and asymmetry in core network)

DTT over Ethernet Leased Line

The ICON supports protection schemes over packet networks

Is Ethernet Leased Services good enough?

- It offers acceptable performance
  - 5 ms latency
  - 3 ms jitter
  - 99.995% packet delivery rate
  - 99.99% net availability
- Guarantees same level of restoration as emergency and military circuits
- Needs real-time class of service

What we found

- Ethernet is not deterministic enough on its own
- Jitter causes packet queueing delays
- Delays compound until synchronization is lost
- It is necessary to actively keep jitter in check and synchronize data coming in with data going out using known latency

Live Test Results

DTT Over Analog Circuit	DTT Over Ethernet Circuit
13.1 ms	4.5–5 ms

- Channel was monitored over ~4 months
- Only one interval was identified with missing packets
- OT edge node flexibility and reliability instilled confidence to install active DTT or POTT scheme

If operation continues to be problem-free, solution will likely become new teleprotection standard

Overall Conclusions

Leased Ethernet vs. analog and T1

- Reliability of analog Class A circuits have declined
- Analog failure rates and service restoration times are increasing
- Test with CoGen using T1 had multiple outages for hours within given month
- Tests show Ethernet meets cost, reliability, and performance requirements

8-Inch Cube Packaging

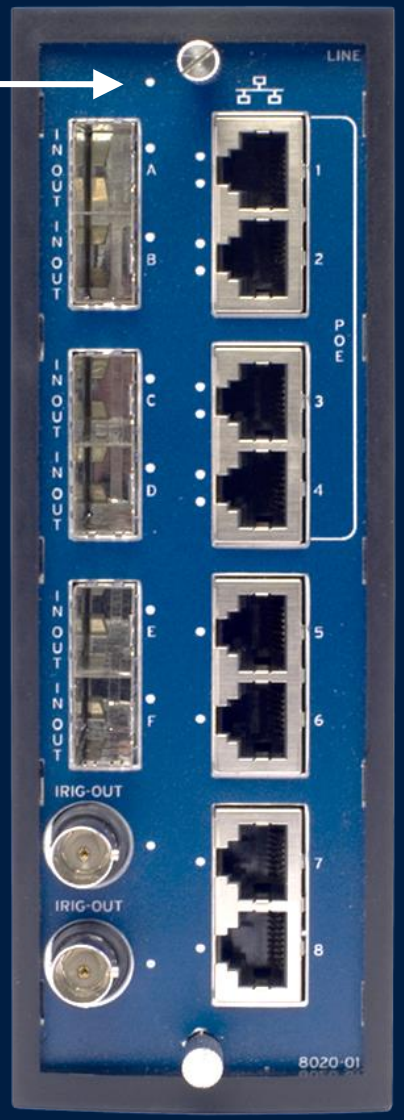
Surface or Panel Mounting

- Line and server modules in fixed positions
- Two access modules
- Redundant power modules

Server Module

- USB NMS local connection
- 10/100 Ethernet NMS local or remote connection
- 3 dry contact inputs (additional alarm points)
- Form C contacts (major and minor alarms)
- GPS antenna and IRIG-B input connections
- Syslog event generation
- Up to 500 unique role-based users

Line Module



Tri-Color Status LEDs

Line Ports (OC-48)

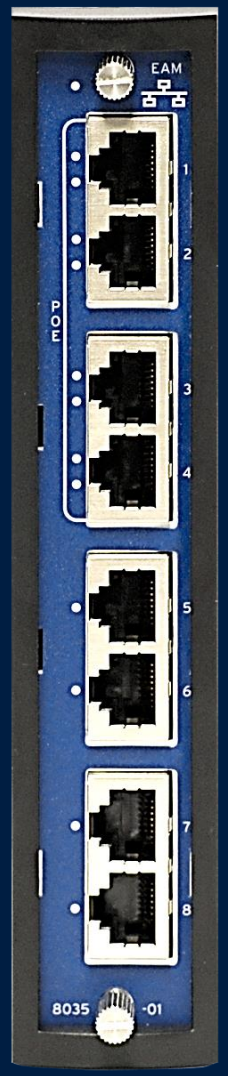
Drop Ports (1 Gbps)

BNC Connectors
(IRIG-B out)

RJ45 Connectors
(10/100 Mbps PoE)

RJ45 Connectors
(10/100 Mbps Ethernet)

Ethernet Access Module (EAM)



- Eight RJ45 ports
- Four ports with PoE
- 10/100 Mbps autonegotiation
- Quality of Service (QoS)
- Differentiated Services Code Points (DSCP)

Transfer Trip Module

- Four high-speed output contacts (30 A “make” rating, 6 A continuous carry at 65°C, and 4 ms total trip time)
- Four input contacts
- 24/48/125/250 Vdc interfaces
- Time-stamped SER records
- Independent alarm contact

SEL-3061 Benefits

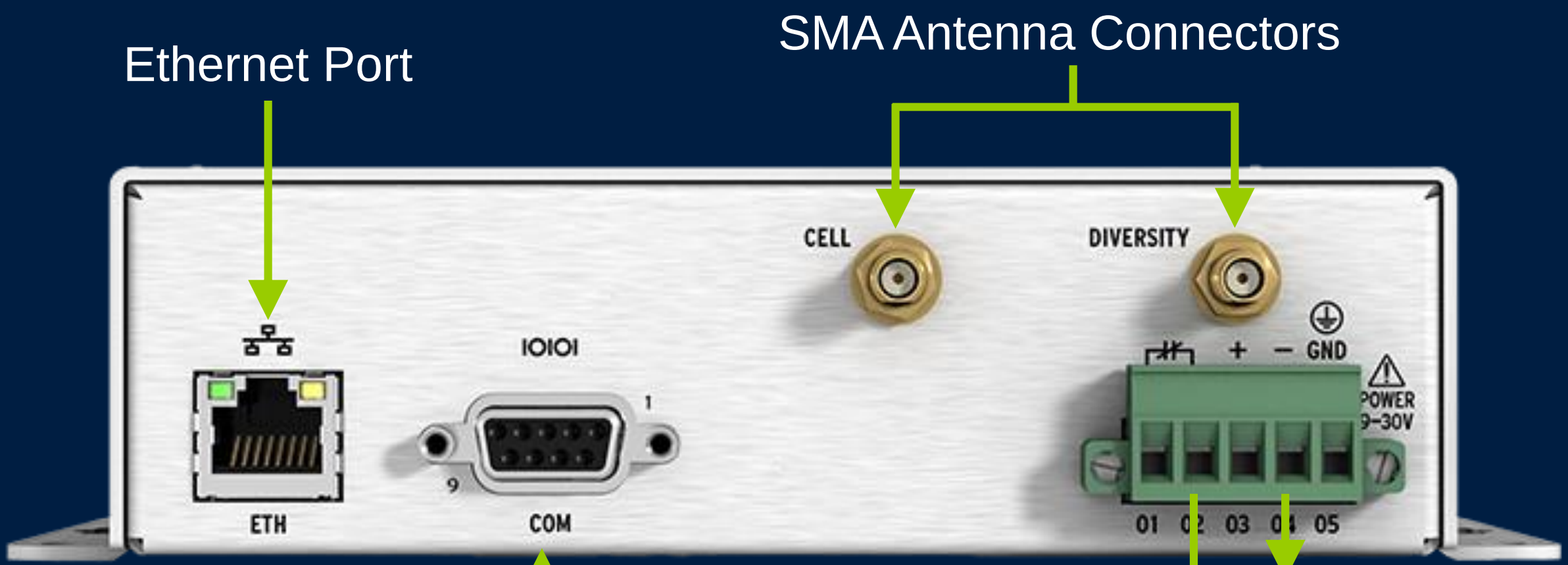
Apply Secure Communications With Confidence

Reliable

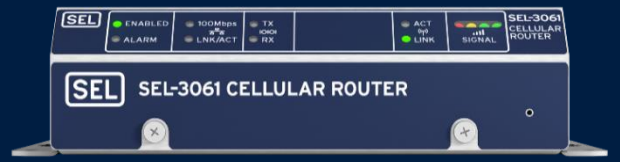
Cyber secure

Easy to use

SEL-3061 Overview

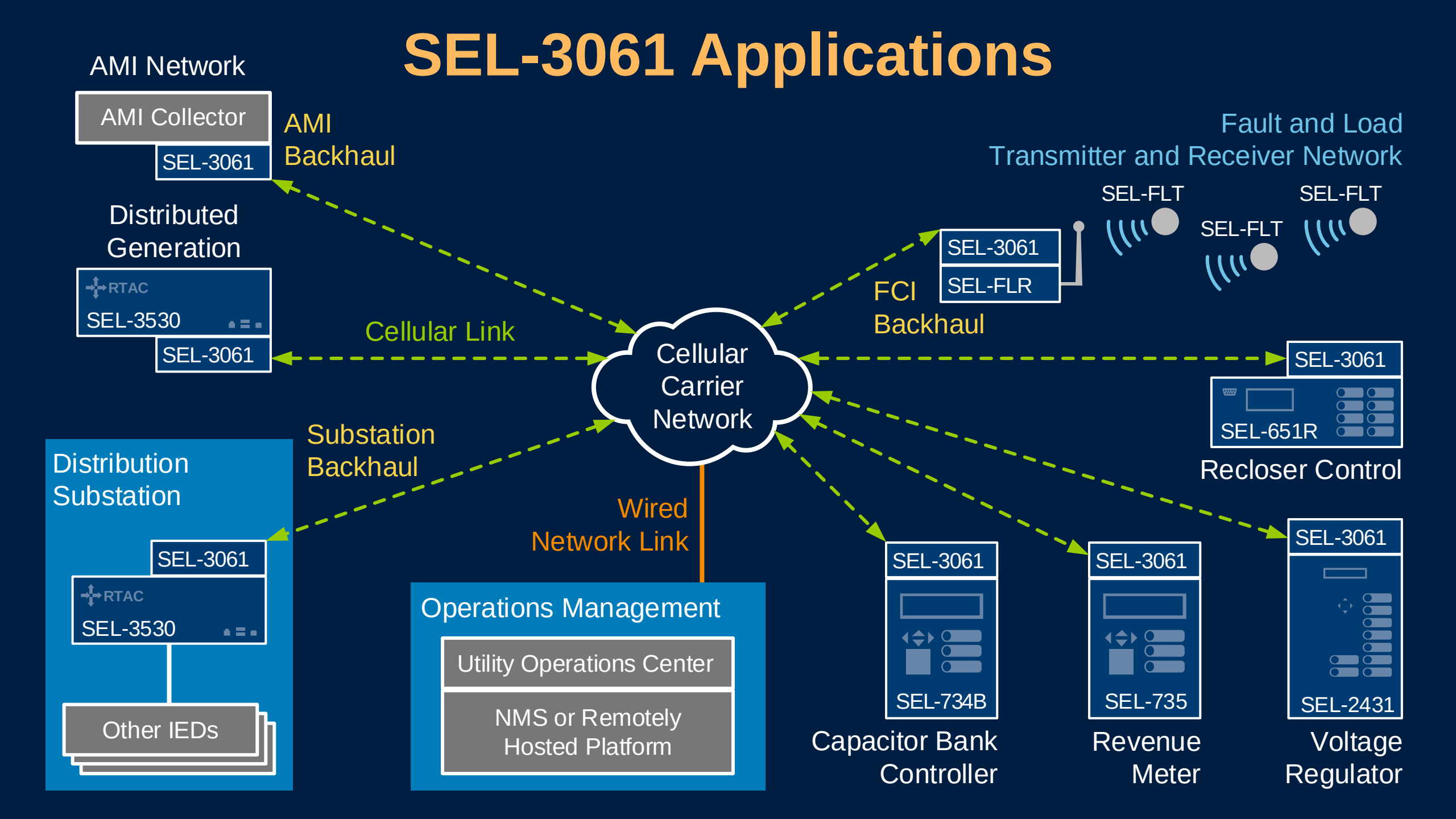


SEL Radio Suite



Capability	SEL-3031	SEL-3060	SEL-3061
Control	Point-to-point, high-speed teleprotection and distributed generation	Point-to-point and point-to-multipoint medium-speed distribution automation, loop schemes, and distributed generation	Cellular low-speed distribution automation and manual remote switching
Engineering access and data collection	Point-to-multipoint data collection (either DNP3 or Modbus)	Point-to-multipoint engineering access and data collection (DNP3, Modbus, and/or IEC 61850)	Cellular engineering access and data collection (DNP3, Modbus, and/or synchrophasors)

SEL-3061 Applications



Device Commissioning

Initial Setup

Step 2 – Create administrator account and select mode of operation

Step 3 – Enter APN (for AT&T and T-Mobile)

Step 4 – Save and restart

Step 5 – Check PPP link status on dashboard page

Step 6 – Ping selinc.com

Access Point Name (APN)

Encryption

Carrier Core Network

Router

Over-the-Air Encryption

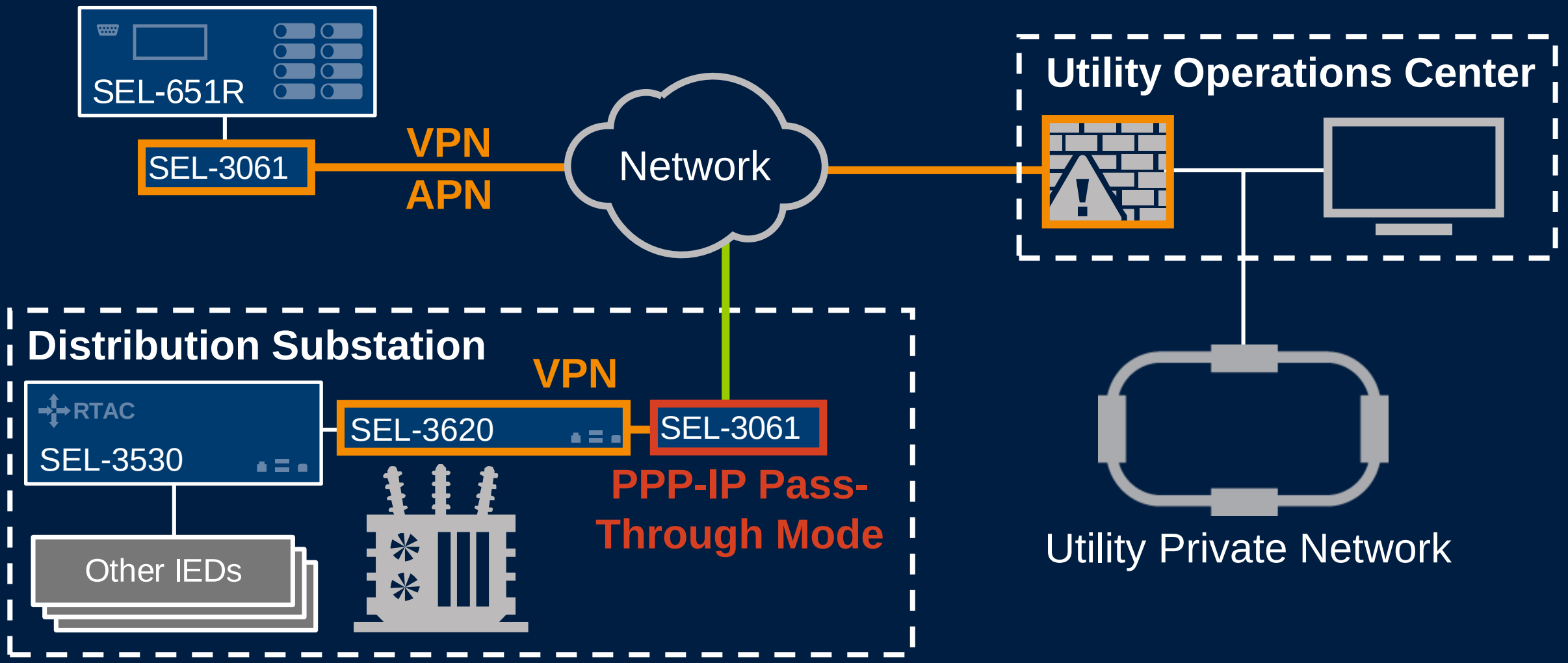
VPN

Utility Private Network

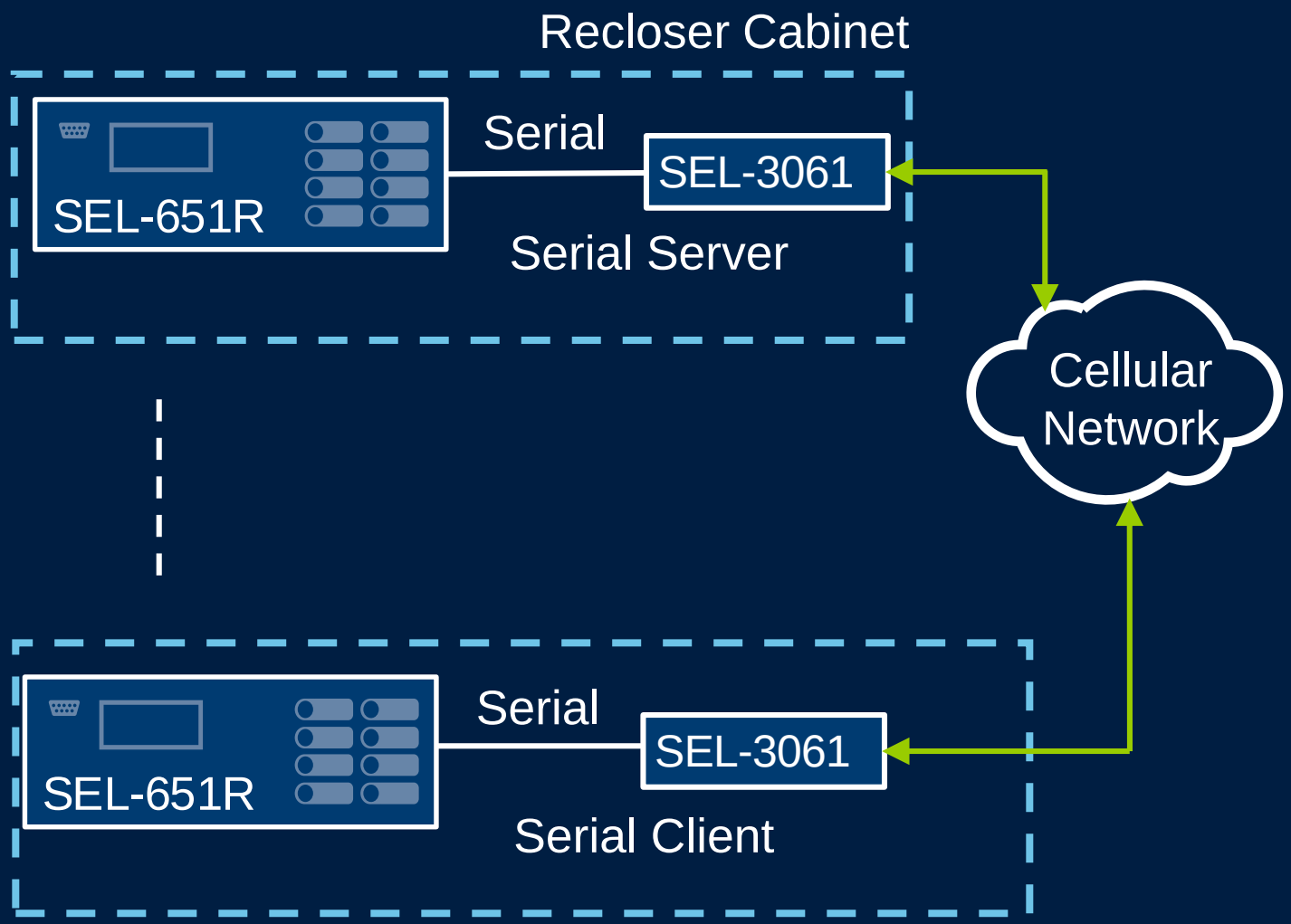
Router

Users may set up APN through carrier; carrier gives dedicated network to end user with encryption (VPN not necessary)

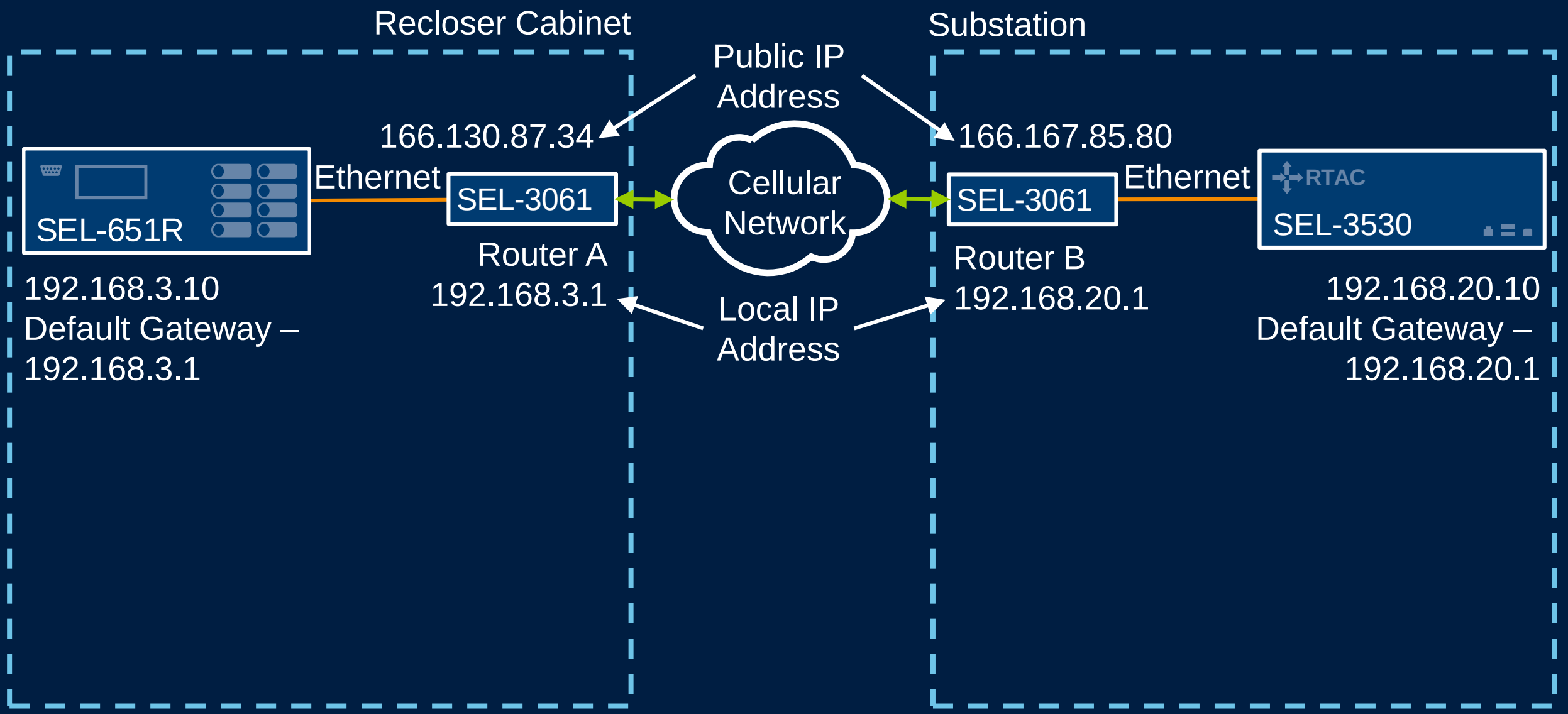
Substation Communications to Utility Operations Center



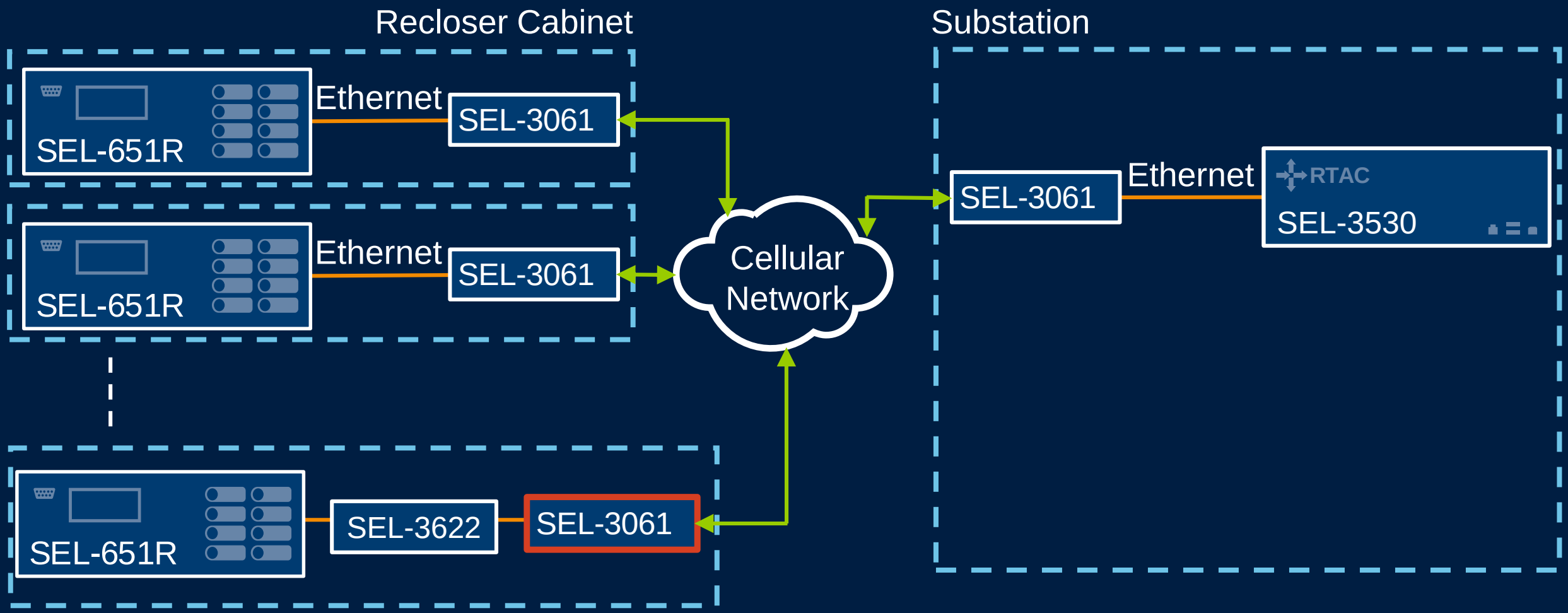
Serial-to-Serial Endpoints (Cable Replacement)



IPsec VPN – 2 SEL-3061 Routers



Ethernet-to-Ethernet Endpoints



SEL-3061 Specifications

Network Types	4G LTE, 3G, and 2G cellular technology
Carriers	AT&T, Verizon, and T-Mobile
Countries	United States
Power Consumption	<5 W
Management	HTTPS web interface for device management, SNMP for network monitoring
Ports	1 copper Ethernet 1 RS-232 serial
Operating Temperature	–40° to +75°C (–40° to +167°F)
Dimensions	5.96 in x 4.08 in x 1.73 in

SEL-3061 Designed as Reliable Utility-Grade Cellular Router

- Tested to relay standards
  - Electromagnetic compatibility
  - Surge immunity
- Has operating temperature of –40° to +75°C (–40° to +167°F)
- Includes 10-year warranty

SEL-3061 Cybersecurity

- IPsec
- Support for up to five VPN connections
- SPI firewall
- MAC address filtering
- User-based accounts with RADIUS support
- X.509 certificates