

Why utilities must modernize from TDM to secure, intelligent grids

White paper



By Emmanuel Waeghebaert and Christian Proost

Utilities worldwide have long depended on time-division multiplexing (TDM) systems, such as SDH/SONET and PDH (including E1/T1), for transmission of mission-critical data. Although reliable, these networks face end-of-life due to obsolete equipment, increased maintenance costs and workforce attrition that makes it difficult to find expertise to sustain them.

Simultaneously, utilities are adopting IEC 61850-based automation, tighter cybersecurity requirements and the integration of distributed energy resources.

Taking a phased and risk-mitigated approach to achieve modern substation-grade packet networks is essential to reduce disruption and ensure reliability.

By combining deterministic MPLS-TP transport, legacy protocol support, robust cybersecurity, precise synchronization and operational visibility tailored for utility environments, your plant can transition to next-generation networking with minimal risk.

What your new network must deliver

As SDH/SONET and E1/T1 systems become harder to support, utilities are pressed to maintain reliability while accommodating new digital demands.

Existing networks no longer scale efficiently or support advanced applications like smart grids, IoT devices and sensors.

As you transition to a more modern telecom infrastructure, it must:

- Accommodate IEC 61850 protocols and GOOSE/SV traffic for seamless interoperability and efficient automation
- Provide secure, auditable access control down to the device level to meet cybersecurity and compliance requirements
- Ensure precise synchronization across distributed assets to enable accurate event timing and coordination
- Support legacy applications during the transition to avoid service disruption and make the most of your investments
- Facilitate the integration of power IoT sensors and devices for real-time data acquisition

MPLS-TP provides a deterministic backbone with static path routing, traffic engineering and timing support to carry legacy and IP traffic without performance degradation.

Table of contents

[Introduction](#)

[What your new network must deliver](#)

[How to evaluate new network solutions](#)

[How Belden helps utilities transition from TDM to intelligent architecture](#)

[Belden's five pillars of network modernization](#)

[Use cases supported by Belden's complete connection solutions](#)

[Bringing the gap to future-ready utility operations](#)

How to evaluate new network solutions

To serve current and future needs, your new network must reliably transmit protection signals, SCADA data, CCTV data, telemetry and power IoT data over a unified platform. It must also offer reliability, scalability and operational simplicity.

This means you should look for a complete connection solution that offers:

- Standards-based security based on globally recognized standards like IEC 62443, NERC-CIP, etc. to ensure compliance and protect against threats
- Transparent legacy protocol bridging to make sure existing systems remain operational
- End-to-end timing with IEEE 1588v2, GNSS and ePRTC to maintain precise, network-wide synchronization
- Scalable, segmented architecture with traffic visibility to simplify network management
- Failover below 50 ms and symmetrical latency control for uninterrupted operation
- Native integration paths for power IoT endpoints and analytics platforms to support data-driven insights

How Belden helps utilities transition from TDM to intelligent architecture

Belden's MPLS-TP platform is engineered to support mission-critical traffic in the harshest utility environments. Our hardware and software ecosystem, paired with expert support, allows utilities to transition in a phased and secure way.

By integrating network access control (NAC), next-generation firewalls (NGFWs) and passive sensors, the platform enables:

- Deterministic transport for protection, SCADA and automation services
- Native support for legacy devices via circuit emulation
- Role- and zone-based segmentation and access control
- Passive threat detection and asset visibility with integrated sensors
- Grid-wide PTP timing resilience
- Real-time monitoring and SCADA-ready diagnostics
- Integration with power IoT devices and cloud-based applications

Our process includes a detailed migration blueprint, documentation of legacy infrastructure and comprehensive local staff training.



Belden's five pillars of network modernization

To simplify the transition to next-generation grid communications, Belden's approach is built on five technology pillars that define our solution.

Pillar 1: Deterministic packet transport (MPLS-TP)

Substation-grade packet transport with pre-engineered paths, symmetrical delay, jitter control and failover under 50 ms.

Pillar 2: Legacy protocol support

Circuit emulation and protocol conversion for RS-232, G.703, E1/T1 and C37.94 enable seamless coexistence of old and new systems, with hitless switching to maintain service continuity during failover.

Pillar 3: Layered OT security with NAC, NGFWs and sensors

Control who connects, what they access and how threats are detected without disrupting operations. This integrated stack delivers visibility, segmentation and policy enforcement across substations and DERs. Built for compliance with NERC CIP, IEC 62443 and Zero Trust principles.

Pillar 4: Grid-wide time synchronization

IEEE 1588v2 Precision Time Protocol (PTP) with GNSS and ePRTC holdover maintains synchronization across merging units, PMUs and relays, even during GNSS outages.

Pillar 5: Operational visibility and expert support

Industrial HiVision and SCADA integration provide insight into fiber performance, device health and traffic behavior. Belden's engineering team supports planning, rollout and training.

Our five-pillar approach delivers operational and business value through:

- Ongoing support for legacy devices without rewiring
- Automated access control and zone segmentation using NAC and NGFWs
- Real-time protection signaling with <50 ms recovery
- Grid-wide synchronization for accurate sampling and events
- Secure OT/IT/IoT data integration with firewall rules and sensor-based monitoring

These outcomes lead to reduced operational risk, lower cost of ownership, improved compliance and enhanced network resilience.



Use cases supported by Belden's complete connection solutions

Belden's complete connection solutions are designed to meet the evolving and demanding needs of modern utility networks. We enable utilities to confidently support new applications while bridging legacy systems and infrastructure.

Explore the key use cases enabled by our portfolio to address the real-world challenges your utility faces as it works to balance reliability, modernization and future-readiness.

Modernizing substation LANs

Redundant process and station bus networks are enabled using PRP/HSR over MPLS-TP. Network access control secures device access while ensuring deterministic, IEC 61850-compliant performance.

WAN-based protection messaging

MPLS-TP pseudowires deliver teleprotection and GOOSE messages over wide-area links, eliminating leased E1/T1 circuits and enabling low-latency, IP-based protection.

Legacy protocol transport

Circuit emulation bridges legacy serial and electrical interfaces, preserving the function of RTUs, relays and SCADA equipment during network transition.

Grid-wide time synchronization

Distributed PTP with GNSS-fed grandmasters and ePRTC backup ensures that merging units and PMUs remain synchronized for sampled values and event correlation.

Secure maintenance access

Field engineers and contractors connect securely through NAC, with access limited by device, user role, location and time.

Field-to-central data flow

Telemetry, synchrophasors, power IoT sensor data and SCADA signals are transported to control centers or cloud platforms using isolated, performance-optimized channels.

Mixed legacy/IP environments

Coexistence of C37.94-based protection and modern IP applications is enabled through dedicated service paths and protocol emulation.



Converged OT backbone

SCADA, CCTV, VoIP, engineering, power IoT and monitoring applications run over a unified MPLS-TP network, each with its own performance guarantees.

Unified policy enforcement

NAC enforces dynamic security policies across all locations, ensuring role-specific access and visibility into all connected assets.

Securing substations with NAC, firewalls and sensors

Substations are protected by combining three components to avoid disruption, support compliance and improve network visibility:

- Network access control to control who connects
- Next-generation firewalls to separate traffic zones
- Sensors to monitor for unusual activity

Bringing the gap to future-ready utility operations

As utility networks evolve, Belden provides a comprehensive, field-proven approach to modernization. Our complete connection solutions bridge legacy systems and future-ready applications—including the expanding world of Power IoT—while maintaining security, uptime and performance.

With Belden, utilities gain the flexibility to migrate at their own pace, modernizing infrastructure while ensuring continuity of protection, control and operational efficiency.

By integrating cybersecurity at every layer—through network access control, next-generation firewalls and sensors, Belden helps utilities meet today's compliance demands and defend against growing OT threats so they can unlock new possibilities.



Connect to what's possible.

White paper



About Belden

Belden Inc. delivers the infrastructure that makes the digital journey simpler, smarter and secure. We're moving beyond connectivity, from what we make to what we make possible through a performance-driven portfolio, forward-thinking expertise and purpose-built solutions. With a legacy of quality and reliability spanning 120-plus years, we have a strong foundation to continue building the future. We are headquartered in St. Louis, United States, and have manufacturing capabilities in North America, Europe, Asia, and Africa.

Ready to connect to what's possible?

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