Uninterrupted Power: 10 Ways MPLS-TP Technology Reinforces Utility Networks

WHITE PAPER

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Uptime is important in many industries. But, when it comes to demand and reliability, power transmission and distribution companies like yours are in a category all their own.

Because power is vital to the way we live and work, power plants and facilities are the very definition of "mission-critical." The world's infrastructure requires reliable power to run businesses and data centers, financial institutions, public transportation, manufacturing plants, military operations, schools, hospitals and homes. In other words, the stakes are high. **Disruption—even for a few seconds—can cause entire operations to fail and create the opportunity for security breaches. Losing network communication is never an option.**

Making uptime even more complex is the fact that the industry runs on systems and technologies that are unique to power transmission and distribution, such as substations and control centers. What works to keep conventional companies running doesn't provide the same results for a mission-critical utility network.

The Importance of Backbone Infrastructure

To remain viable, you must be able to provide reliable power to consumers at a reasonable cost. But many obstacles—from equipment failures to cyberattacks—stand in the way of meeting this goal.

Offering uninterrupted availability of electricity means preventing disruption and downtime and being able to recover quickly when uptime is threatened. Therefore, a resilient backbone network and the ability to prevent a single point of failure for mission-critical networks are key. This can only be achieved with network equipment designed to minimize downtime and withstand service interruptions.

Many factors can influence these capabilities, and only some of them are within your control. Consider the technology and infrastructure behind your utility network, for instance. They have a major impact on everything from operational expenses to your employees' ability to provide service. And, unlike factors like severe weather, vandalism and demand, this is one area that you can successfully manage. Operators must be in control of the networks whenever possible.

As plants and facilities become more intelligent and automated, the communications protocols used by modern smart grids and digital substations can't be carried efficiently over a TDM-based (time-division multiplexing) network—which is what many utilities have relied on for their backbone technology.

Today, packet-based technology provides a much more efficient use of fiber bandwidth capacity, especially for new Ethernet-based applications.

As TDM-based networks reach end of life, it's becoming more difficult to find the components necessary to keep TDM systems running. For this reason, migration from TDM to packet-based network technology is inevitable for utilities.

MPLS-TP vs. IP/MPLS: How Are They Different?

There are two packet-based technologies that many utilities consider: MPLS-TP and IP/MPLS. It's important to understand the differences so you can select the right packet-based network for your utility network.

Both technologies are based on MPLS (multi-protocol label switching), which is a connection-oriented communication protocol defined by IETF (Internet Engineering Task Force) in RFC 3031 to improve the performance of packet-based networks.

What Is IP/MPLS?

IP/MPLS is an established technology that was developed to address certain limitations in IP-routed networks. IP/MPLS combines the capabilities of IP routing and MPLS and is standardized by IETF.

When IT decision-makers are involved in the selection process, they often lean toward IP/MPLS because of its dynamic behavior. IP/MPLS is a good fit for core networks and large backbone networks, such as ISPs, where large amounts of data must be switched, and the flexibility of any-to any connections is required.

When it comes to transport networks, like the backbone in utility networks, however, IP/MPLS doesn't scale as well. These OT networks are relatively small static networks that require being in control. In transport networks, performance is key. The processing overhead introduced by this dynamic behavior is a costly burden. It leads to more complexity when it comes to configuration and management of critical services.

Furthermore, IP/MPLS technology lacks the presence of an NMS (network management system), which leads to a very-labor intensive process to configure individual nodes. This creates significant network maintenance and troubleshooting issues that, based on in-house knowledge levels, must often involve third parties.

What Is MPLS-TP?

Similar to IP/MPLS, MPLS-TP, defined in RFC 5317, is based on MPLS technology and optimized for mission-critical networks. It enables packet transport services with the predictability and reliability found in existing transport networks. It's defined by ITU-T and IETF to specifically address the needs of OT networks that IP/MPLS can't manage.

Instead of running unwanted dynamic protocols, MPLS-TP incorporates the key requirements of an OT network: in-band OAM (operations, administration and maintenance), static configuration and bidirectional forwarding. For these reasons, MPLS-TP is the most deployed packet-based technology in utility networks today.

Why MPLS-TP Is Better for Mission-Critical Utility Networks

MPLS-TP offers many benefits over IP/MPLS as a complete backbone network solution that addresses the needs and requirements of utility networks.

It provides a robust and reliable framework for utility network solutions and aligns with the strict operational, efficiency and reliability requirements that utility companies demand. Here are 10 ways that MPLS-TP supports utility networks.

1. **Maintains System Stability, Reliability and Control**

   In a utility network, where real-time data transmission is crucial for smart grid management and distribution, deterministic performance is essential for system stability and reliability.

   Because it utilizes deterministic technology, MPLS-TP makes sure a path is established before data is transmitted. Think of it as a way to guarantee certain levels of latency and delay.

   This ensures consistent low latency and low jitter for your mission-critical utility applications, ensuring predictable behavior for network traffic.

2. **Permits Network Scalability to Accommodate Future Growth**

   Utility networks must be able to scale quickly to manage extreme growth and increasing numbers of connected devices.

   MPLS-TP supports high levels of scalability for networks of any size, which means it can support your utility's network as it grows to accommodate the demands of increasing network traffic and more connected devices and endpoints. Accelerated levels of traffic can be managed without compromising performance; services will never suffer because of the network being overloaded.

3. Runs IP and Legacy Applications on the Same Network

As the shift to IP-based applications takes place, many utilities find themselves having to deploy both legacy TDM-based services and modern packet-based services.

MPLS-TP can carry many types of traffic, including TDM and Ethernet, over the same network. This reduces costs and makes it possible to migrate to packet-based technology at a pace that works for your budget and timeline.

Moreover, MPLS-TP is specifically defined for operational telecom. This includes the stringent requirements for delay-sensitive applications. Co-routed bidirectional paths as defined in MPLS-TP RFC 5654 guarantee an equal single path delay in both directions, as the standard requires to follow the same path for both TX and RX traffic. This is yet another main requirement for a utility network addressed by MPLS-TP that is not present in IP/MPLS.

4. Guarantees All Services on the Network

A utility network must be able to handle different types of traffic, including legacy services (IEEE C37.94, E1/T1 and G.703 64K analog voice; and serial and Transparent SDH) and Ethernet traffic (IEC 61850, CCTV and LAN data). To make sure critical data receives the necessary resources and QoS (Quality of Service) levels it requires to maintain precedence, all this data must be prioritized and managed.

Because MPLS-TP supports efficient traffic engineering and path optimization, it's able to ensure that critical services are always guaranteed. Mission-critical applications receive the necessary bandwidth and strict priority they need to always maintain uptime.

5. Facilitates Proactive Network Monitoring, Diagnosis and Troubleshooting

Because network performance is critical to utilities, operators must be able to proactively monitor, diagnose and troubleshoot network issues. This allows them to maintain control over network health and minimize the serious consequences of network disruptions and downtime when potential problems arise.

MPLS-TP provides robust, advanced OAM (operations, administration and maintenance) capabilities like in-band OAM, including BFD (bidirectional forwarding detection), Ethernet OAM IEEE Y.1731 and IEEE 802.3ah for Ethernet in the first mile, which provide connectivity checks, reduce operational complexity and allow operators to maintain the control they need—without lots of training or complex onboarding required before they can operate the network.

6. Enables Intuitive, Streamlined Operations

Because an MPLS-TP network is managed from a centralized control center, nodes can be centrally managed, configured and monitored. This also leads to significant cost savings.

MPLS-TP makes network management simple and predictable by relying on an NMS. Traffic delays and jitter are managed upfront by the NMS, which means that small, in-house teams can manage the entire OT network—sometimes even including design and commissioning—to reduce expenses and optimize staff resources.

7. Creates Fast Traffic Rerouting and Protection

To enhance network reliability and ensure continuous operations, MPLS-TP supports various protection and resiliency mechanisms, such as MPLS-TP Linear Protection, Ring Protection and 1+1 hitless switching for legacy services.

When link or node failures occur within the network—whether due to a hardware or software crash, a cable being unplugged or a configuration change—these protection mechanisms provide rapid and simple protection switching to ensure that traffic is rerouted quickly to avoid downtime and keep power flowing.

When downtime does occur, MPLS-TP reduces the amount of time it takes for a utility to restore services to customers by facilitating faster network convergence and recovery. This minimizes the amount of time that customers must spend without power when failure occurs.

With Ring and Linear protection, downtime is minimized to less than 50 ms. With hitless switching, there is no downtime at all (0 ms).

8. Protects Against Network Attacks

In every MPLS network, the data and control planes are separated, as described in IEEE RFC 5920, the MPLS security framework. MPLS-TP differs because it doesn't have a dynamic control plane. The configuration is done directly from the management plane, which means it isn't vulnerable to attacks on the dynamic control plane. This is one less attack vector to worry about when compared to IP/MPLS.

The lack of a dynamic control plane also optimizes power consumption to reduce costs.

Other built-in security features, such as label-based forwarding and pseudowire emulation edge-to-edge, are also inherent to MPLS-TP, providing yet another layer of defense through secure service segregation on the network. This helps operators protect networks from attacks and prevent unauthorized access to safeguard infrastructure.

9. Enables Smooth Migration Paths

MPLS-TP enables smooth integration and migration paths—without extensive overhauls—for utility companies through an SDH-like operation. It's deterministic and fully controlled by an NMS.

10. Supports Commitments to Performance and Uptime

To maintain required levels of service, service-level agreements (SLAs) that offer contractual assurance are critical for utility network operators.

MPLS-TP technology enables utility companies to take advantage of SLAs offered by systems integrators, which guarantee commitments to certain performance parameters and levels of uptime.

Where to Start with MPLS-TP for Your Utility Network

Because Belden's experts have worked in the utilities industry, we've experienced your challenges first-hand and understand the intricacies of the market.

To make sure you get the right solution in place, we begin our work by assessing your unique situation. After analyzing your current operations and data availability, as well as your network's strengths and deficiencies, we explain our findings and present you with:

- A workflow assessment and digital maturity report that outlines the best opportunities to increase your utility network's performance and value.
- A solution that establishes a robust, futureproof network infrastructure to enable automation, security and reliability.
- A holistic view of implementation costs and what you can expect in terms of ROI.

To help power transmission and distribution companies improve the way they operate, we're always developing solutions that support unrivalled network resilience.

For example, OTN Systems, a Belden Brand, developed XTran, which is a flexible product built on MPLS-TP technology to allow you to go full packet.

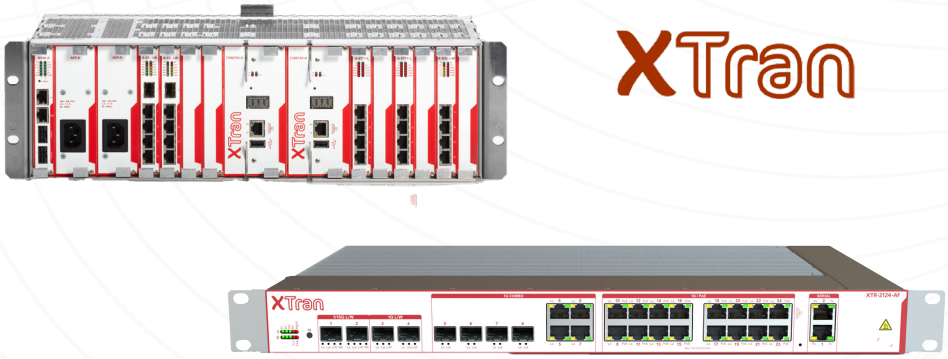
It combines the ruggedness of industrial network devices with the scalability and future-readiness of MPLS so that protection can be guaranteed down to the lowest level in every way in your utility's network.

XTran's features are built for mission-critical applications like yours:

- Hitless switching with zero packet loss and a switchover time of 0 ms.
- Clock drift prevention that prevents asymmetric delay when the clock is lost in one direction.
- Buffer equalization to avoid asymmetric delays related to associated buffers.
- Synchronization through adaptive clocking, SyncE and IEEE 1588v2 Transparent Clocking.

These features mean that XTran is equipped to offer these benefits to utility networks:

- Support for multiple link failures, thanks to ERPSv2 (G.8032 Ethernet Ring Protection Switching). It allows a ladder topology with rings and sub-rings with a sub50 ms switchover time.
- High scalability and easy physical topology changes. Adding nodes can be done through a simple node insert wizard in the GUI, which reconfigures all tunnels and services automatically.
- Layer 3 support on top of MPLS-TP to provide greater flexibility when it comes to network design. Your entire network can act as a router, connecting one site to another site virtually.
- Multicast support for PIM and IGMP.
- Preparation for SDN/SDWAN integration, thanks to the northbound REST API.



XTran

Furthermore, XTran provides wirespeed link encryption via MACSEC to protect ALL traffic on the WAN link. The full link encryption guarantees secure transport of both data and management traffic. How far along are you in transitioning from TDM-based to packet-based protocols? Our team is here to help so that you don't have to take on the task alone. You can get back to leading your plant while we work behind the scenes to make sure your network and infrastructure are ready for the future.

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 and have manufacturing capabilities in North America, Europe, Asia, and Africa. For more information, visit us at www.belden.com; follow us on Facebook, LinkedIn and Twitter.

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