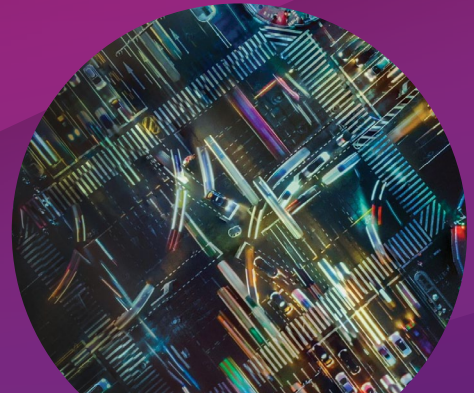# Elastic MPLS

## Rationale and Benefits for Mission Critical Networks

Combining Static and Dynamic MPLS on Critical Infrastructure Applications

In the Critical Infrastructure (CI) market, Information Technology (IT) and Operational Technology (OT) applications have different transport requirements. The IT network runs non-mission-critical, IP-based applications that are optimized to run on IP/MPLS. However, the OT network requires static and deterministic behavior from the IP network to transport its mission-critical applications. MPLS-TP has been designed to provide these capabilities. When operators are forced to use a single technology across the entire network, they must make compromises in terms of features, protection requirements, and performance.

Elastic MPLS design allows operators to use the technology that best fits their operational needs on a per-application basis. This is achieved by providing MPLS-TP and IP/MPLS on the same network element with gateway functionality between the two.

This paper discusses the differences between IP/MPLS and MPLS-TP and demonstrates the benefits and rationale of using both protocols on the same network element, while maintaining separate network domains, for greater security.

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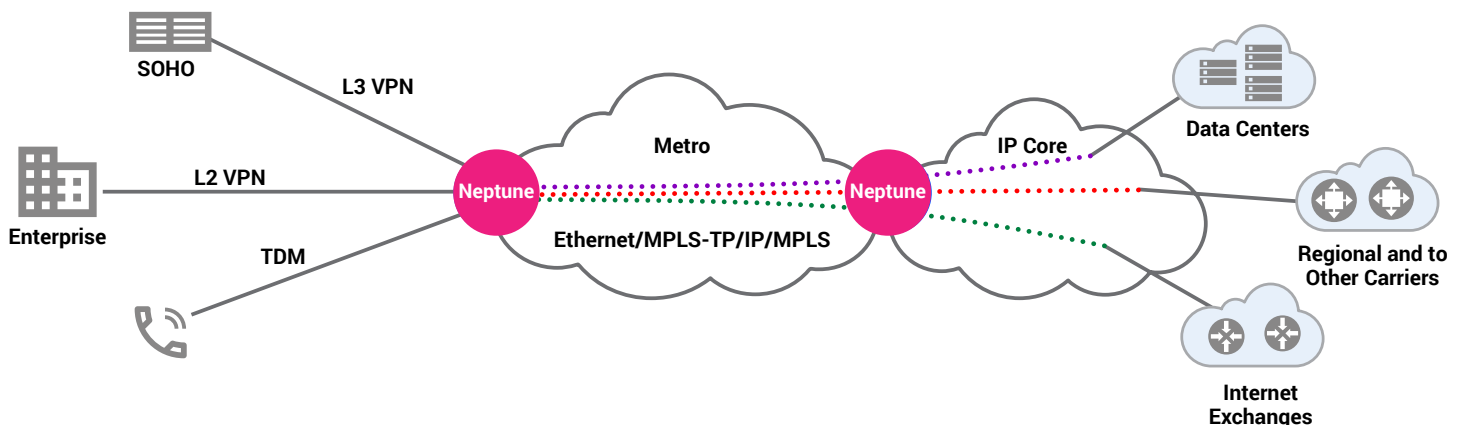
IP/MPLS for Dynamic IP Networks

Standardized by the IETF, IP/MPLS (Multi Protocol Label Switching) is a scalable, protocol-agnostic mechanism designed to carry circuit and packet traffic over virtual circuits, known as Label Switched Paths (LSPs). Functioning between the traditional OSI Layers 2 and 3, IP/MPLS makes packet forwarding decisions based on the contents of the label, without examining the packet itself.

IP/MPLS was originally developed to facilitate packet forwarding via label switching. Its attributes, like connection establishment, improved network resiliency, and OAM functions, help overcome native Ethernet transport gaps to achieve carrier-class Ethernet.
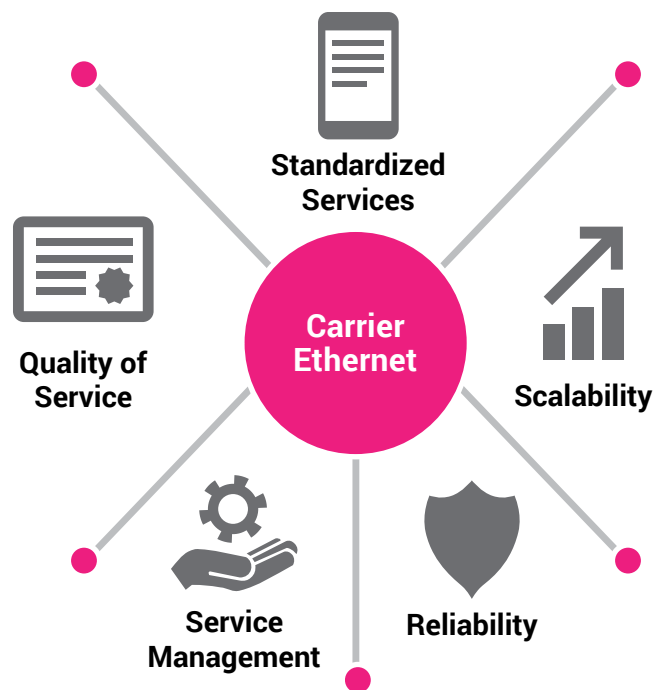
Standardized Services

IP/MPLS enables a full range of high-performance MEF-defined point-to-point (E-LINE), point-to-multipoint (E-TREE), and multipoint-to-multipoint (E-LAN) connectivity services. Legacy services, including SCADA and telemetry, are also supported through TDM pseudowires, providing circuit emulation in the MPLS network. The abundance of MPLS ensures interoperability in a multi-vendor network environment. The addition of multicast capabilities, combined with pseudowire support, provides an efficient IP CCTV connectivity solution. It also enables IP/MPLS deployment within the CI network core or backbone, while deploying MPLS-TP on the aggregation or distribution layer using the same platform.

Quality of Service (QoS)

IP/MPLS can transport all types of traffic with guaranteed QoS, per application, regardless of the encapsulated data protocol. LSPs facilitate the engineering of network traffic patterns without the need for routing tables. They also steer traffic flows from congested links to alternate links and control-specific traffic flow paths to guarantee fast resiliency. IP/MPLS also supports QoS parameters, such as frame delay, jitter, and packet loss. MPLS enables reservation of bandwidth for selected traffic and admission control.

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Reliability

P/MPLS has a variety of local- and path-protection mechanisms to help minimize LSP packet loss and ensure high-service reliability. IP/MPLS can distribute traffic across LSPs to provide superior load balancing. This reduces congestion and improves network predictability. MPLS Fast Reroute (FRR) enables service restoration with SONET/SDH-like protection times of less than 50ms, although it cannot be guaranteed in all network topologies and conditions.

Scalability

IP/MPLS supports a high number of service instances by layering multiple services onto each MPLS LSP. Bandwidth provisioning for each service is tailored to the particular needs of the customer at each site. MPLS-enabled services scale geographically because they can be provisioned over multiple MPLS-based carrier networks. New options, such as pseudowire switching, help scale Ethernet services over several networks.

Service Management

Service management is key in allowing critical infrastructure network operators to roll out, maintain, and troubleshoot their services in a cost-effective and timely manner. MPLS OAM tools complement the Ethernet link OAM (IEEE 802.3ah) and service management OAM (EEE 802.1ag and ITU-T Y.1731) tools to create a multilayer OAM solution. This is necessary to support network and application assurance. CI operators who are willing to deploy business services in order to evolve and become Utelcos (Utility Telecommunications Service Providers) will benefit from the service-awareness features and scalability available with IP/MPLS.

IP/MPLS as a Choice for Core and IT Networks

IP/MPLS streamlines L2 and L3 VPN service provisioning and provides QoS and OAM across core and IT networks. It optimizes services for different performance and user profiles and provides visibility and control of these services for large networks. These capabilities allow Core/IT network expansion across multiple network topologies like mesh, ring, hub, and star. CI operators will be able to virtualize services, converging the different services in the network, such as corporate voice and data, operational voice and video, SCADA and telemetry, and others - under a unified platform.

MPLS-TP for Critical-Mission Application

IP/MPLS enables Ethernet to be used for carrier-class transport of IP services. Similarly, MPLS Transport Profile (MPLS-TP) enables MPLS to be used to transport services for CI networks.

MPLS-TP is based on IP/MPLS, but is optimized for transport networks, providing both a subset and an extension of IP/MPLS. Some of the complex IP/MPLS functionalities that are not relevant for transport networks are disabled, while other transport-specific features have been added.

The aim of MPLS-TP is to support the transport of packet-based services with a degree of predictability, which is similar to that of existing deterministic transport networks. To meet these objectives, MPLS-TP is strictly connection oriented and does not rely on IP forwarding or routing.

Key benefits offered by MPLS-TP include:

Deterministic Transport

MPLS-TP and IP/MPLS use the same data-plane mechanism. However, MPLS-TP uses bidirectional PseudoWires (PW) and Label Switching Paths (LSP), while IP/MPLS uses unidirectional PWs and LSPs. Having bidirectional traffic following exactly the same path ensures predictable, deterministic transport and allows accurate, reliable packet synchronization.

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Full Control

A centralized NMS maintains a static configuration for mission-critical services. This ensures that these services are always functioning, even if there is a failure in the network control plane. The centralized NMS also enables the use of intelligent planning and prediction tools to increase service awareness and enforce strict Service Level Agreements (SLAs). The separation between the data plane and the control plane via MPLS-TP further increases network resilience and security.

Transport-Class OAM

MPLS-TP supports extensive Operation, Administration, and Maintenance (OAM) functions, similar to those available in traditional optical transport networks (like SONET/SDH). These include enhanced Fault Management, Performance Monitoring, and in-band PW/LSP/Section OAM levels. The OAM functions are an integral part of the MPLS-TP data plane and are independent of the control plane.

Improved Resiliency

Predetermined alternative paths ensure sub-50ms protection switching for all network topologies, regardless of the network status. For mission-critical applications such as SCADA and teleprotection, it is mandatory that the protecting paths guarantee the same low latency, jitter, and round-trip delay as the working path.

Lower Total Cost of Ownership (TCO)

The combination of IP/MPLS and MPLS-TP on the same platform reduces TCO by enabling an efficient convergence of IT and OT services, using a unified platform, with end-to-end visibility and control.
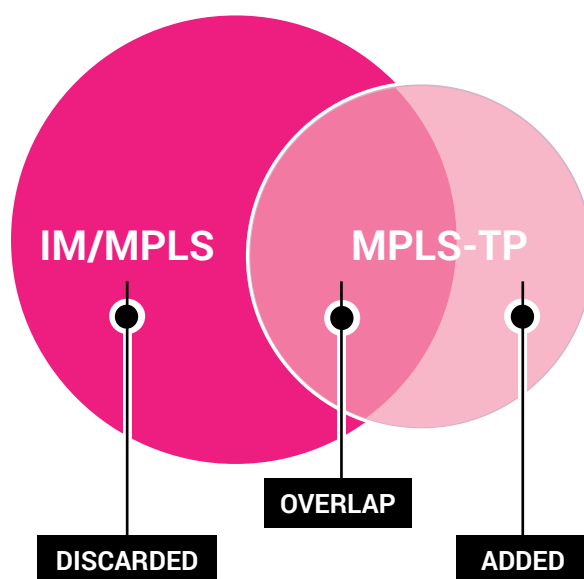
Elastic MPLS – the Best Of Both Worlds

Ribbon considers MPLS technology a key building block for realizing the full efficiency provided by packet-based transport, while still maintaining transport-grade resiliency and manageability. Our view is that MPLS-TP is a better fit for mission-critical services that require deterministic behavior, while IP/MPLS is a better fit for core or backbone IT networks. We believe that supporting both IP/MPLS and MPLS-TP facilitates the convergence and migration of aging, deterministic, critical infrastructure networks into future-proof packet networks.

Elastic (Dual Stack) MPLS enables seamless interworking between IP/MPLS and MPLS-TP domains. This eliminates the need to choose one standard over another and makes it easy and risk-free to extend MPLS from the backbone to the access. Elastic MPLS provides the flexibility to set the extent of the IP/MPLS reach and to switch to either static MPLS (MPLS-TP) or Ethernet.
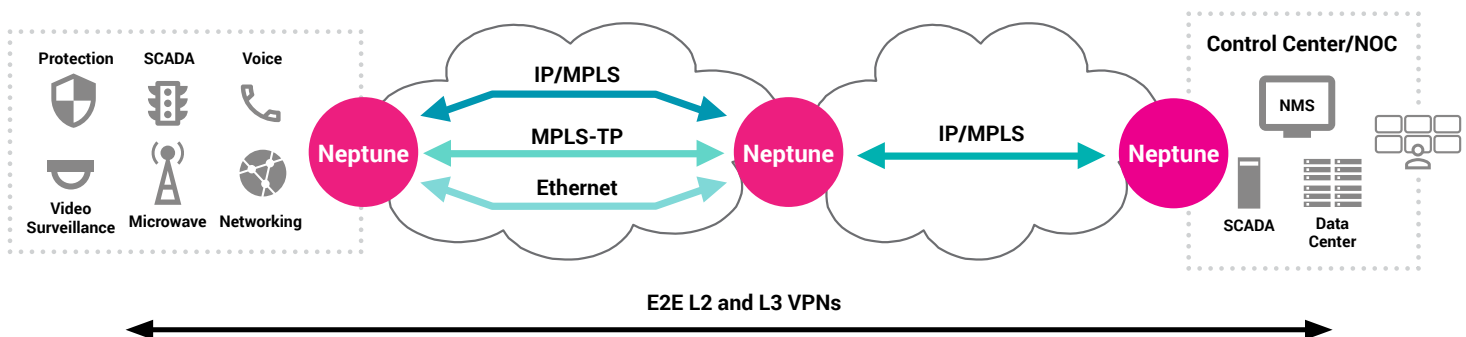

In addition to standard L3 VPNs (using E2E IP/MPLS) and L2 VPNs (either using static MPLS-TP or dynamic IP/MPLS), Elastic MPLS offers additional advantages, including:

Layer 3 VPN for Corporate LAN and Mobile Services

Elastic MPLS provides a unified management plane for end-to-end Layer 3 VPN services as they pass through the IP/MPLS and MPLS-TP domains. Layer 3 VPN services, such as corporate LAN and mobile backhaul, can be supported with the benefits of both MPLS-TP and IP/MPLS. The MPLS-TP domain provides proactive OAM and deterministic 1+1 resiliency. The IP/MPLS domain provides the benefits of dynamic forwarding in the backbone or core of the critical infrastructure network.

### Streamlined Layer 2 Service Interworking

Elastic MPLS supports end-to-end Layer 2 VPN services and provides a unified management plane for service provisioning, visibility, and fault correlation, including OAM across the various network domains. Without Elastic MPLS capabilities, CI operators would be forced deliver services across multiple technology domains, with each technology domain requiring different network platforms.
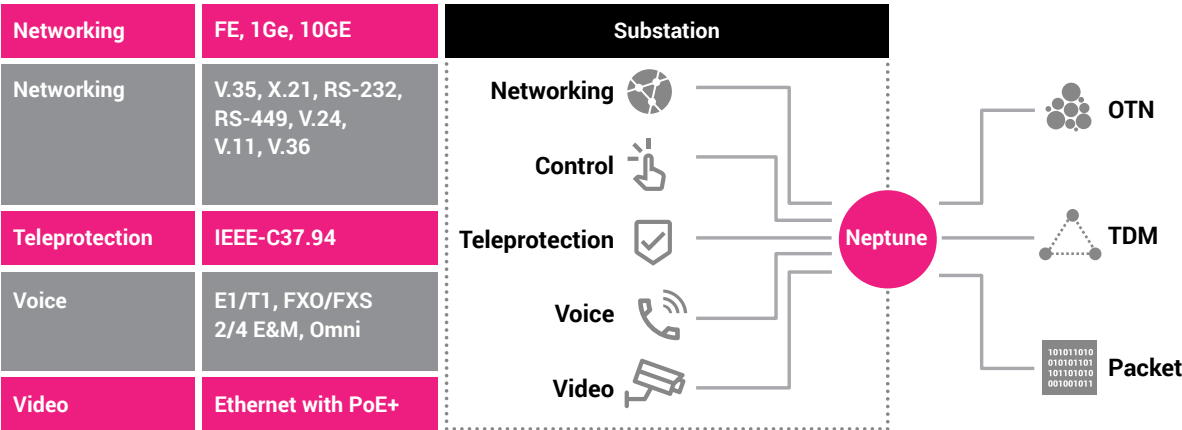
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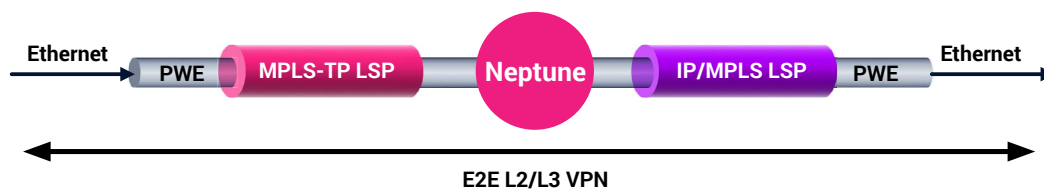
Easier Control

Elastic MPLS allows CI networks to be divided into segments (multi-segment pseudowire). This allows large-scale control while maintaining an end-to-end service experience. Mission-critical services and best-effort services are segmented and each is monitored with a different set of tools and settings.

End-to-end management and future-proof SDN tools provide the operator of the CI network with enhanced visibility of all services, interfaces, and resources in real time. Intuitive service assurance capabilities provide quick and precise failure identification and fault isolation. The combination of all these features provides a network solution with outstanding service awareness.
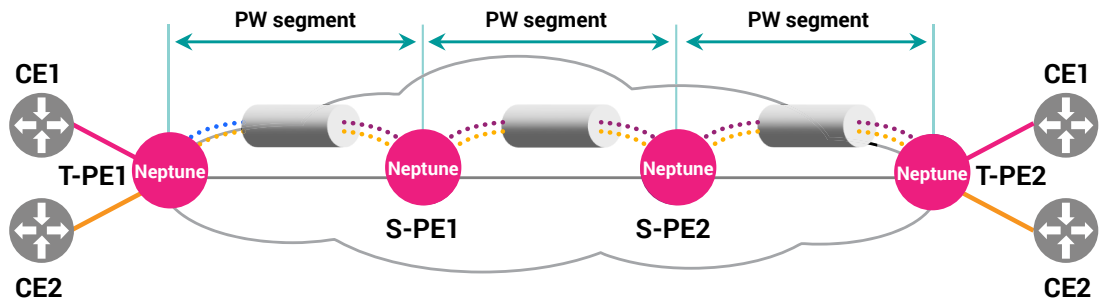
True Convergence

One of the key goals for next-generation transport is to run all services on a unified networking layer. This convergence includes both packet-based next-generation services and TDM-based legacy services. Convergence applies across a wide range of applications that prefer different control planes (e.g. corporate data and voice, operational voice backhaul, IP CCTV, SCADA, telemetry, and others). An elastic MPLS implementation makes migration to a unified packet transport network a practical goal. Moreover, a single network management system can handle both IP/MPLS and MPLS-TP with full operational convergence.

Networking	FE, 1Ge, 10GE
Networking	V.35, X.21, RS-232, RS-449, V.24, V.11, V.36
Teleprotection	IEEE-C37.94
Voice	E1/T1, FXO/FXS 2/4 E&M, Omni
Video	Ethernet with PoE+

Risk-Free Support of MPLS-TP and IP/MPLS

Elastic MPLS provides a dual stack implementation that allows CI operators to reap the benefits offered by both MPLS-TP and IP/MPLS. It achieves this by allowing both technologies to operate in the same network and even within the same network region. In addition, elastic MPLS provides simple, risk-free transition and interconnectivity between MPLS-TP and IP/MPLS without the need for product replacement, hardware upgrades, or extra training.

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Optimized Service Mapping

Elastic MPLS gives the CI network operator the option to select IP/MPLS or MPLS-TP on a per-LSP basis. This allows network operators to choose the technology that best fits each of their applications or regions. For example, legacy and mission-critical services are typically mapped to MPLS-TP, whereas corporate voice and data L3 VPN services are typically mapped to IP/MPLS.

Such flexibility lowers the total cost, simplifies network management, and provides operators with the required quality of service for each specific application.

Summary

Ribbon's Neptune product portfolio provides the following comprehensive set of MPLS implementations, with the flexibility to move between them entirely seamlessly:

- IP/MPLS
- MPLS-TP
- MPLS-TP and native TDM/SDH
- Elastic MPLS (MPLS-TP and IP/MPLS) with a gateway between them

Elastic MPLS allows legacy services to co-exist with IP/Ethernet services on the same transport infrastructure. CI operators with massive low-rate TDM deployments, who wish to remove or reduce their investment in SONET/SDH, can use MPLS-based Circuit Emulation Services (CES) to run theses services over an MPLS network. Alternatively, they can keep the native TDM/SDH infrastructure running in parallel with next-generation IP infrastructure.

IP/MPLS and MPLS-TP are complementary technologies, each with unique characteristics. MPLS-TP is optimized for packet-based mission-critical OT operational networks. It combines packet efficiency with mission-critical performance. IP/MPLS is optimized for IT applications and the core of the network. It is the ideal platform for deploying business and Carrier-of-Carrier services, which will become key for operators moving towards Utelco (utility telecommunications services provider) status. The gateway functionality provided by Elastic MPLS allows easy operation of both technologies and provides CI operators with a simple evolution path between them.
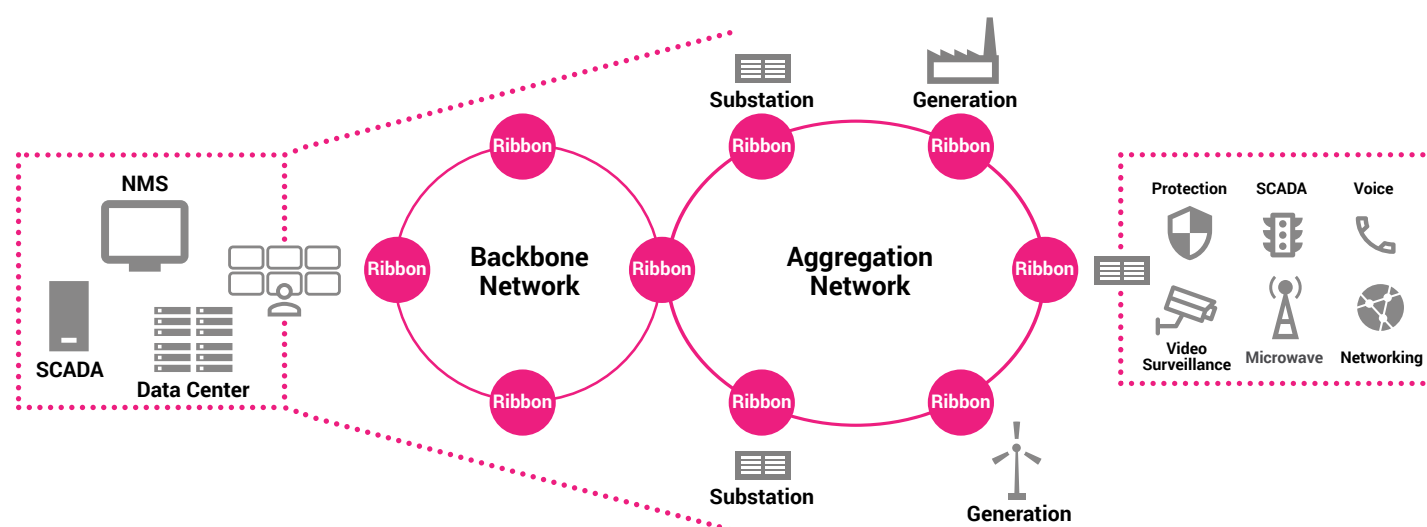
About Ribbon

Ribbon Communications (Nasdaq: RBBN) delivers communications software, IP and optical networking solutions to service providers, enterprises and critical infrastructure sectors globally. We engage deeply with our customers, helping them modernize their networks for improved competitive positioning and business outcomes in today's smart, always-on and data-hungry world. Our innovative, end-to-end solutions portfolio delivers unparalleled scale, performance, and agility, including core to edge software-centric solutions, cloud-native offers, leading-edge security and analytics tools, along with IP and optical networking solutions for 5G. We maintain a keen focus on our commitments to Environmental, Social and Governance (ESG) matters, offering an annual Sustainability Report to our stakeholders. To learn more about Ribbon visit rbbn.com.

Contact Us   Contact us to learn more about Ribbon solutions.