Modernizing Communications for Highways Agencies

with Ribbon's Optimized Packet and Optical Transport Solution

Risk-Free Transition To A Secure Packet Network

Highway agencies and departments of transportation expect a highly reliable communications network to deliver the voice, video, and data that they require to operate and maintain road infrastructures. However, with traffic volumes constantly increasing, there is a need to introduce Intelligent Transport Systems to manage congestion, reduce pollution, and improve road safety. These systems use thousands of IP devices along the roadside to support real-time video from closed-circuit TV cameras (CCTV), voice from emergency telephones, data from sensors, weather stations, and information for highway message signs. With IoT, this trend will continue with information sharing with vehicles using the highway. For risk-free evolution of traffic management, the network must have a future-proof, IP-based infrastructure, supporting both traditional and new IP devices.

Risk-Free Transition with tailor made evolution for legacy services

Secure Packet guarantees mission critical services

High Availability provided by advanced operations software

Multiservice to enable the Intelligent Transport System

Drivers Of Modernization

Aging Networks vs Evolution to Intelligent Transport Systems (ITS)

TDM networks used by highways are end-of-life and Intelligent Transport Systems are needed to improve traveler satisfaction, meet safety requirements, and reduce congestion and pollution. Network refresh is required to introduce these systems.

Increased Regulation

Highways are critical national infrastructures. We see ever-increasing regulation to reduce carbon emission, improve traffic punctuality, and provide video surveillance.

Security and Safety

Paramount for highways, with signaling and control needing to be "always-up". Networks must be highly secure to reduce cyber attacks.

Improve User Experience of the Highways

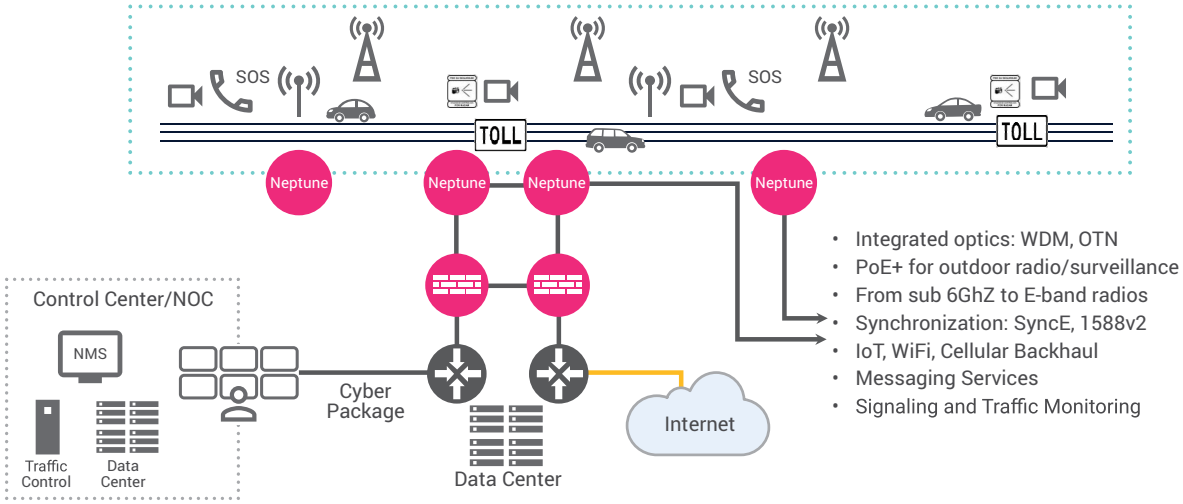
Intelligent transport systems use vast amounts of data from thousands of sensors to greatly improve the highway experience. With IoT, we see information being shared directly between vehicles and the traffic management systems.

Cost-Effective and Risk-Free Transition to Packet

Legacy services and low-rate mission-critical services like SCADA, monitoring and traffic control are migrated to the packet layer, when it makes sense for the network operator . Our Elastic MPLS, dual stack, packet technology has been designed with mission critical networks in mind. It provides IP/MPLS to support IT networks and MPLS-TP (deterministic MPLS) to support the mission critical OT services which require low latency, high reliability, deterministic performance and extensive OAM. With Circuit emulation (CES) capabilities the correct packet transport technology can be selected to meet the service needs on a service by service basis. The solution provides a pay-as-you grow architecture, making the transition to packet extremely cost-effective:

- **Capacity is added when needed** with unique in-service expansion units and in-service upgradeable packet fabrics (e.g. 10G to 60G, 100G to 200/320G, 1T to 2T).
- **Technology is introduced when required** with in-service expansion units to introduce (Eth, Optical, PCM, CES) and integrated WDM, OTN, and bidirectional SFPs.

Ribbon has extensive experience in transitioning networks and has developed field-hardened, proven processes for this migration.



Holistic Security Suite

Critical industries are a prime target for cyber-attacks. Data security is a particularly complex matter. It must protect both IT and OT assets and be able to identify tangible threats from amongst the multitude of reported events.

Our solution provides physical layer security, encryption, firewalls, and intrusion detection. It provides the capabilities to identify and tackle potential attacks in several ways:

- **Preventing attacks where they occur** with distributed attack mitigation.
- **Guarding the integrity of the SCADA and OT network.** The system maintains a complete OT network map and continuously monitors all transactions for abnormal behavior, providing early warnings of any tampering.
- **Identifying real threats** with advanced correlation and analysis for a clear view of tangible threats.

Advanced Operations Software

The solution provides software to simplify network operations with Muse providing an intuitive GUI that simplifies operations with rapid right first time network provisioning and rapid fault isolation.

Advanced operations software provided by Muse™ is able to analyze the network data to ensure the network is operatingat maximum availability, utilization, and efficiency. This functionality can be further extended to non-Ribbon transport devices by using Ribbon's 3rd party integration solution.

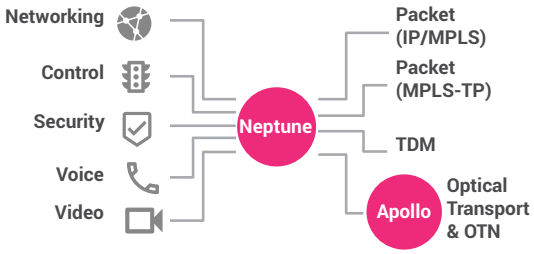
Optimized for High Availabilty

Highways require communications networks that provide 'five-9s availability' or better, Ribbons solution for highways provides this with:

- **Fully-redundant hardened design of the Network Elements** with 1+1 and 1:1 protection of key units and an extended
  temperature range for use in energy applications (-25°C to +70°C)
- **Fast protection against single and multiple network failures:** MPLS-TP supports sub-50ms protection switching for single failures, used in conjunction with pseudowire redundancy, protection is provided for multiple failures
- **Remote disaster recovery** allowing network and management restoration from geographically dispersed sites in the event of catastrophic failure
- **Potential network failure protection:** Muse provides advanced operations software to monitor network performance in real time and help identify trends over time.

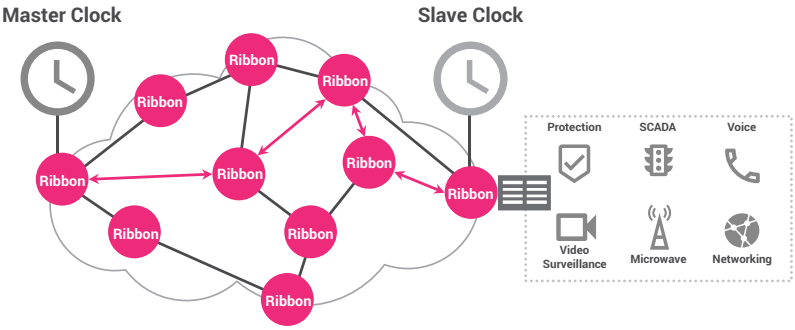
Multiservice Platform

Mission-critical control and security Operational Technology (OT) requires the static, deterministic behavior that TDM and MPLS-TP provides. Whereas, IP/MPLS provides optimized support for Information Technology (IT) services like voice, video, and non-mission-critical networking. With Ribbon's packet and optical portfolio you have a complete multiservice platform for supporting the (OT) and (IT) services over the most appropriate transport technology. It seamlessly integrates the packet and optical layers to enable cost-efficient transport of the high-capacity data generated by video and other (IT) applications. Video technology adds specific challenges; thousands of roadside cameras generate vast quantities of HD video and need it backhauled to a few control locations for real-time analysis of traffic flow, number plate recognition, and hazard identification. The solution provides a multicast architecture with end-to-end QoS monitoring to ensure the quality of the video network, cost effective bulk transport of the video traffic is provided by optical transport and Power over Ethernet (PoE) interfaces are available to power the roadside cameras and other outdoor monitoring devices.



Networking	FE, 1GE, 10GE
Control	V.35, X21,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+

Traditionally, TDM provides the tools to derive and distribute the accurate timing that is fundamental to the operation of highways services. As networks evolve to packet, the timing architecture must remain robust. The solution allows an approach similar to that used in TDM. A built-in GPS receiver or an external timing source provides the master clock. 1588v2 precision timing protocol (PTP) distributes timing across the network and MPLS-TP reduces packet delay variation by using deterministic, bidirectional, traffic paths.



For highways agencies wishing to use their unique geographical footprint to generate extra revenues as a Utelco, the multiservice capabilities of the solution provide the managed L2 and L3 VPNs required for business services, residential services, mobile backhaul, and future IoT applications.

Risk-Free Transition to Packet

Your Challenges	Our Solutions
Risk-free Evolution to Intelligent Transport System	Ribbon's solution for Highways Agencies provides the scalable, elastic multiservice platform required for an Intelligent Transport System. Legacy services are supported on this platform by using circuit emulation (CES). This ensures seamless, risk-free transition from the legacy network to the Intelligent Transport System
Transition Mission Critical Services	Optimized to support transition of mission-critical applications: • IMPLS-TP provides the deterministic transport and advanced OAM required for mission-critical applications • Mission-critical service assurance is guaranteed with advanced operations software provided by Muse® • The solution provides ultra-high availability with hardened design and advanced operations software, monitoring network performance and trends in real time
Enhanced Security	Tailored, holistic security suite provides comprehensive protection for the communications infrastructure: • Integrated SCADA protection, secured connectivity, and secured services • L1 to L3 encryption with L1 optical intrusion detection

Intelligent Multiservice

Your Challenges	Our Solutions
Need highly available telecoms network for mission-critical services	Provides the intelligent, highly-available network required for mission-critical services with: • Hardened network elements and optimized architectures provided by Neptune and Apollo • Intuitive operations and rapid fault isolation provided by Muse • Advanced software provided by Muse ensures the network is operating at maximum availability, utilization, and efficiency • Third-party device management integrated into Ribbbon's end-to-end management
Need a multiservice network to support all the services associated with digitizing the network	Extensive multi-service capabilities provide support of OT services, IT services, and advanced consumer services from a single platform: • Mission critical services like SCADA, sensors, video surveillance and control devices are supported by MPLS-TP. • IP/MPLS is used to support dynamic L2 and L3 services. • Pay-as-you-grow design, with unique in-service expansion units, scalable cross-connects and inservice upgradable packet fabrics. • Easy extension of the services with intuitive, right-first-time introduction of new resources enabled by Muse. • Proven SDN capabilities can be introduced as they are required by the network operators. • Supports business services, residential services, mobile backhaul and future IoT applications, allowing energy operators to evolve as a Utelco.

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.