IPWave: State of the Art IP
and Optical Networking
for Rail Networks

Working the Line

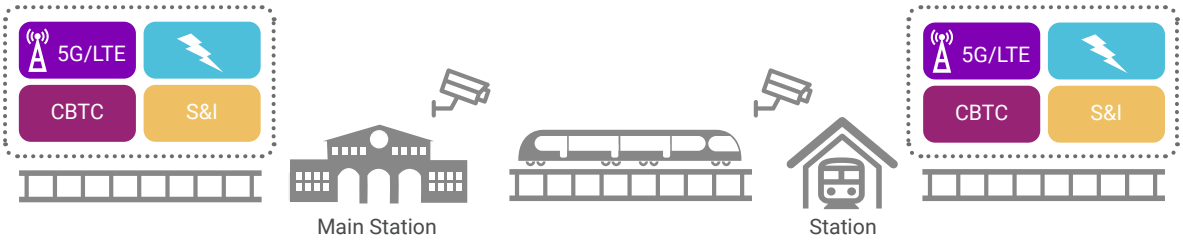
Next-Generation Telecoms for Rail Networks

White Paper

It's A Complex World, All right

These days, rail operators rely on their communications network to support an increasingly varied and numerous set of legacy and modernized systems. There is access control, ticketing, information kiosks and display screens. There is video surveillance to monitor footfall, support facial recognition, assist in weapons detection, and provide information for crowd control. There is wifi and mobile connectivity in stations and on trains. And of course there are the general alarm and warning systems, signaling and control systems, telemetry systems, dispatch systems based on TETRA / Push-To-Talk technology and not least, Communications Base Train Control (CBTC), and supervision and monitoring systems.

These myriad systems help increase the frequency, automation, efficiency, and control of train operations, and all require telecoms networks to operate reliably and consistently.



The Future's Electrifying

In and of themselves, these systems represent a lot of complexity, but they're only part of the story. Another trend in the rail networks is electrification. In other words, replacing all those polluting diesel locomotives with a new generation of electric trains, capable of reaching 200 kilometers per hour.

The electrification process is huge and complex. It not only involves installing electrical substations along the lines, but also control and supervision systems, SCADA, and teleprotection systems to avoid overloads, short circuits and other electrical phenomena. Overall, the rail telecoms network requires very fast response times, measured in milliseconds – much the same as the OT/IT platforms electricity companies currently use.

Most of the systems mentioned are mission-critical, requiring 24/7 redundancy and protection systems to support their availability. They have to be extremely robust, safe and secure, and able to accommodate the vertical and horizontal growth in modern railway and subway companies.

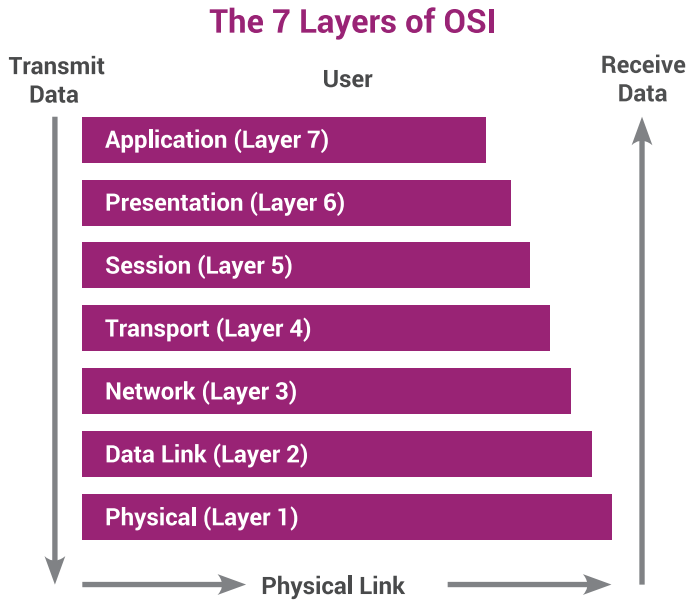
But Modernization Isn't All a Bed of Roses

One of the downsides of modernization is the increased possibility of cyber-attacks. Individual hackers, governments, and private organizations are investing many resources in targeting, paralyzing, and obstructing critical infrastructure.

Utility companies, rail and air systems, energy producers and transporters, and even governments are all in the crosshairs. North America, Poland, Ukraine, and the UK have all suffered attacks recently, and no doubt others are being planned as I write this article now.

So any telecoms infrastructure modernization has to be supported by a risk and vulnerability analysis, before implementing systems to detect and prevent cyber-attacks. This requires a comprehensive multi-layered approach, vision, and strategy. For example, state-of-the-art UTMs (Unified Threat Management), firewalls, encryption systems, layer one segmentation (layer1), layers 3 to 7, and SCADA-focused network anomaly detection systems for zero-day attack prevention and detection. In other words, protection from attacks using malware to penetrate firewalls and anti-virus systems, among others.

The rail market is extremely regulated, so it is vital to comply with the latest recommendations and standards. These include the EN 50126 specifications family that controls RAMS (Reliability, Availability, Maintainability, and Safety), plus standards related to Robustness, Maintenance, Security and Availability of Hardware and Software systems.



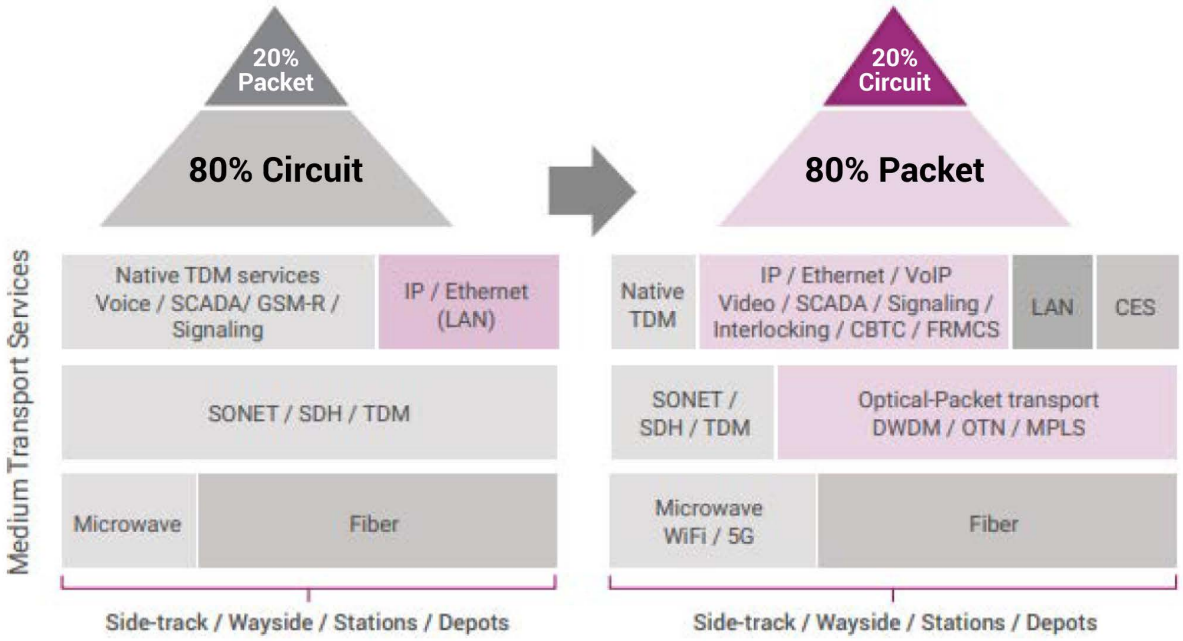
The Challenge of ROI

The challenges are big, because the return on investment will be measured in various ways:

- **Improved Safety** – in both operations and maintenance activities, with a target of zero accidents
- **High Availability** – minimizing system downtime
- **Cyber Security** – to harden the communications network from cyber-attacks, secure the safety of rail users, and protect active and passive meters
- **Better service and increased passengers and freight** – the rail network is being used by more trains and transporting more freight and passengers. A modernized network must allow the rail infrastructure to be used with increased efficiency
- **Customer satisfaction –** access to high-quality, secure mobile broadband allowing users to purchase tickets quickly and safely, monitor schedules and timetables in real time, and access work and entertainment applications from their mobile devices.

Progress Marches On

The need to modernize the telecoms infrastructure is largely due to the simple fact that today's networks are based on TDM and SDH/SONET technologies. These old but proven, robust and standardized technologies will reach end of life within a decade and therefore have limited support. Railway traditional dispatching systems, based on Tetra, P25 and GSM-R are also reaching End-of-Life, and will be replaced within the next decade by the FRMCS-Future Railway Mobile Communications System, which is fully aligned with mobile 5G technology and networks, placing more strict requirements on the railway telecommunications infrastructure. Thus, the simple maintenance and operation of TDM and SDH/SONET networks will become increasingly expensive and difficult. At the same time, almost all new services and applications are being developed over IP technology. These include CBTC systems, telemetry and signaling, which makes modernizing to new packet transport technologies such as MPLS or Carrier Ethernet, extremely efficient at transporting, securing and segmenting these new services.



Don't Look A Gift Horse In The Mouth

An as we have explained, an upgraded communications network is key to providing rail operators with more control over their mission-critical OT and IT and to providing their staff with better more efficient services to manage the network. However an improved communications network is also an opportunity to improve existing customer or passenger services and introduce new revenue-generating services, such as Wi-Fi and on-board advertising. The revenue generated from these paid-for services reduces the investment payback period and increase the return on investment. Rail operators can also lease their fiber networks to other telecoms service providers – again generating additional revenue. The path to support FRMCS will lead to deployment of 5G-ready telecom infrastructure, with advanced network slicing and accurate timing and synchronization mechanisms, further enhancing rail operators position to deliver advanced telecom services for external customers without compromising its own network needs.

The truth is that modernizing and migrating to telecoms systems based on up-to-date technologies such as IP/MPLS, MPLS-TP, Segment Routing, Flex-Ethernet, Carrier Ethernet and DWDM (optical transport) is inevitable. The big challenge for railway operators is choosing the best technologies and partnerships to make this process happen.

The telecoms challenges to support these advances are just as large and include:

Risk-free Technology Migration – no matter which technology you choose to modernize the legacy TDM and SDH/SONET-based communications infrastructure, it is essential that migration can be phased to minimize the impact on the operation of critical applications during the migration process.

Support for Mass Video Surveillance – is required for multiple applications, these include, huge CCTV installations, CCTV for use by analytical software for facial recognition, access control, and passenger counting at stations and onboard trains. Real-time CCTV information also enables real-time proactive maintenance, real-time detection of structural failures, and supports advanced capabilities for operational and functional safety.

Always Connected Networking – provides rail users with in-station and on-the-train access to scheduling information, entertainment systems, work-related applications, mobile broadband, and advertising content, by supporting 3rd, 4th, and 5th generation wireless and Wi-Fi networks.

Mission-critical Systems Support – must provide the same or better availability, connectivity, operational resilience, and performance characteristics (latency, jitter, errors, bandwidth, etc.) for signaling, interlocking, level-crossing systems, telemetry, control, and supervision (SCADA) systems.

Service Elasticity – supporting current and future interfaces and services in the rail network, converging IT services with OT systems, and improving the connectivity of customer services.

Centralized end-to-end control – with increasingly complex telecoms and rail networks, automated provisioning systems are required to enable fast and secure network operation and reduce the risk of human errors being introduced by manual provisioning.

Real-time asset tracking – management systems and software require real-time data to allow network assets to be tracked accurately

Future-proofing – the communications solution a rail operator chooses must last for at least 20 years. To achieve this it must be able to scale capacity and reach as the network grows. To achieve this it must seamlessly introduce the latest technologies and management systems whilst continuing to support automation and network technologies from previous generations.

Cyber security – a holistic strategy based on risk and vulnerability analysis. One that complies with federal regulations and recommendations (see NERC-CIP in the US or ENISA in Europe).

Working the Lines – Our Solutions in Action

Just like a smooth-running rail system, Ribbon has a strong track record of delivering projects on time and without delays. Here are a few examples:

Europe

One of the largest railway operators in Europe with multiple 1000s km of track. In this project, we evolved their optical backbone network to support a fully digitized network, improve consumer connectivity and provide the network resources to enable them to wholesale capacity and connectivity to other operators. We achieved this by providing a highly resilient optical network with advanced monitoring capabilities combining OTN switching with CDC-F ROADM wavelength routing, key elements of the solution included:

- Coherent 100G+ wavelengths
- OTN switches at four main sites
- 4/9/20 degree colorless-directionless flexGrid ROADMs with WSON automation, providing a resilient DWDM layer that recovers from a fiber break in just a few seconds.
- Fiber health monitoring with an integrated OTDR providing live fiber monitoring to detect degradations before they become a problem and accurate real-time identification of precise fault location to speed up repair time when fiber failures occur
- Layer 1 optical encryption selectively to any end-user service
- GUI-based network management for rapid, right first-time fault management and fast provisioning of services, wavelengths

Europe

European railways Infrastructure Company offering transport services to government, the public and private organizations. They wanted a way to manage temporary connections for media and sports events, as well as an efficient way to manage inventory and SLAs. We helped them to:

- Use their network resources to offer customers new services
- Create operational tools for efficient inventory control with customized managers reports and dashboards
- Avoid over-allocating bandwidth for more efficient use of resources
- Integrate the solution within a few weeks.

South America

A metro provider operating 100s of km of track on multiple different lines with 90 stations, handling 2 million passengers a day. We upgraded the telecoms network on one of their lines:

- Designing, implementing, and installing a new generation MPLS-TP and Ethernet technology network
- Integrating new signaling, telephony, voice, data, and image transmission services
- Enabling dynamic interaction between various systems
- Ensuring compliance with railway regulations.

East Europe

This national railway company operates about 1,000km of lines across the country – a third of which is electrified. They wanted to centralize control of their dispersed SCADA, LAN, VoIP, and CCTV systems. We provided:

- SDH, TDM, PCM (64kbps), and data (MPLS-enabled) technologies
- End-to-end network management solution
- Future-proofing to allow new data services and modernization later on
- Mission-critical applications assurance.

Asia

Operator of large metro subway system wanted to move from old PDH systems to packet. This involved a gradual transition that allowed for SDH technology for the current lines to continue to exist alongside MPLS-TP for new ones. We provided:

- Carrier-class MPLS-TP expertise
- Single network management, both for MPLS and SDH networks
- Fully redundant, small footprint solution for low TCO
- Future packet scalability to support emerging services.

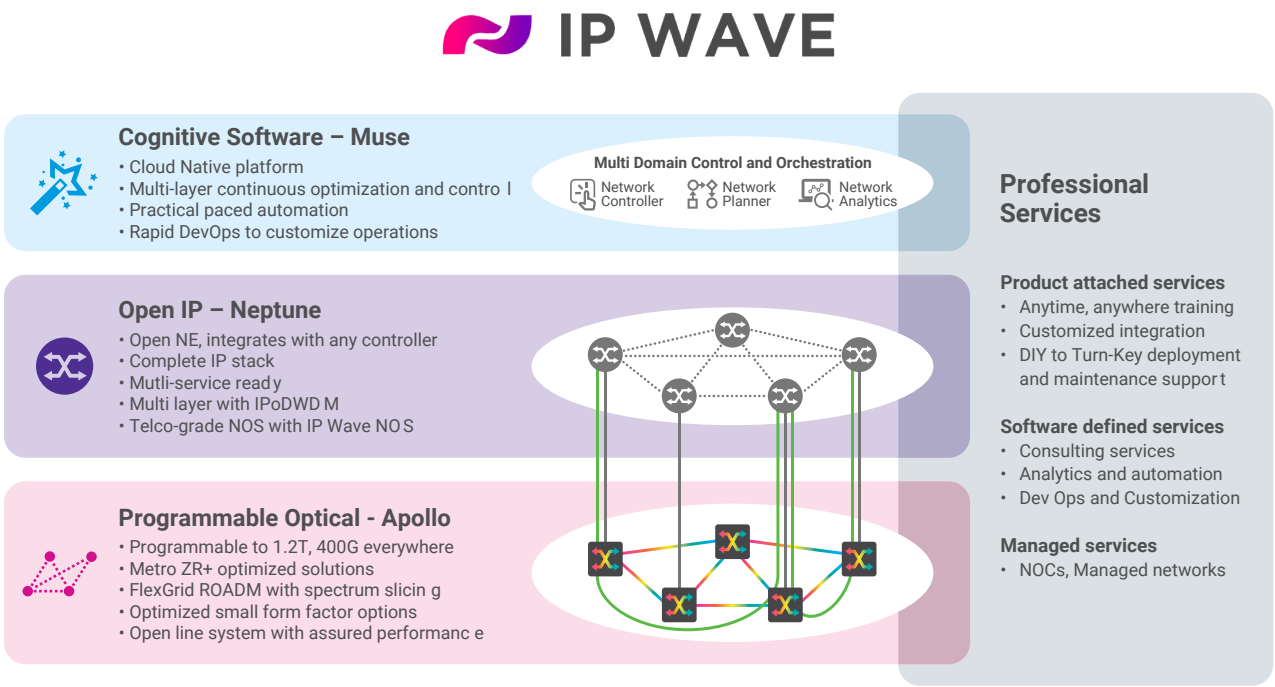
Asia

This company plans, deploys, and operates the land transport infrastructure and systems across 200km of rail network, integrating light train and bus systems. They were expanding one line and deploying a new one. Our solution offered:

- A low TCO and OPEX solution across 53 new stations
- Optional legacy (SDH/TDM) integration
- Future-proof solution with lots of expansion options, excellent local partner with a proven track record of expertise.

About Ribbon Solutions for the Rail

Ribbon's IP Wave is a comprehensive IP Optical portfolio ideal for next-generation rail networks. The portfolio meets stringent network capacity, performance, and resiliency demands while minimizing operations expense and complexity. Ribbon's IP Wave includes Optical networking (Apollo), IP routing and packet transport (Neptune), domain orchestration (Muse) and professional services optimized to the needs of rail operators.



Ribbon's IP Wave solutions can be tailored to provide rail and subway operators with a solution optimized for their specific needs:

Risk-Free Migration and Network Modernization:

With over 50 years of experience helping hundreds of critical infrastructure customers, Ribbon provides proven, field-tested transition processes We provide rail communication network experts who partner with our customers from early project development and definition stages, all the way through final implementation.

Optimal Technology:

Ribbon's service-aware Elastic MPLS ensures that each service receives the right technology; MPLS-TP for the deterministic packet transport and advanced OAM, required for mission-critical (OT) services; IP/MPLS for dynamic non-mission-critical and IT services. This multi-stack approach is the perfect fit for IT/OT convergence and mission-critical assurance.

Optimized Hardware:

The equipment interfaces, cost, size, and footprint are optimized for railways. High scalability is achieved with in-service expansion options.

Optimized for high availability:

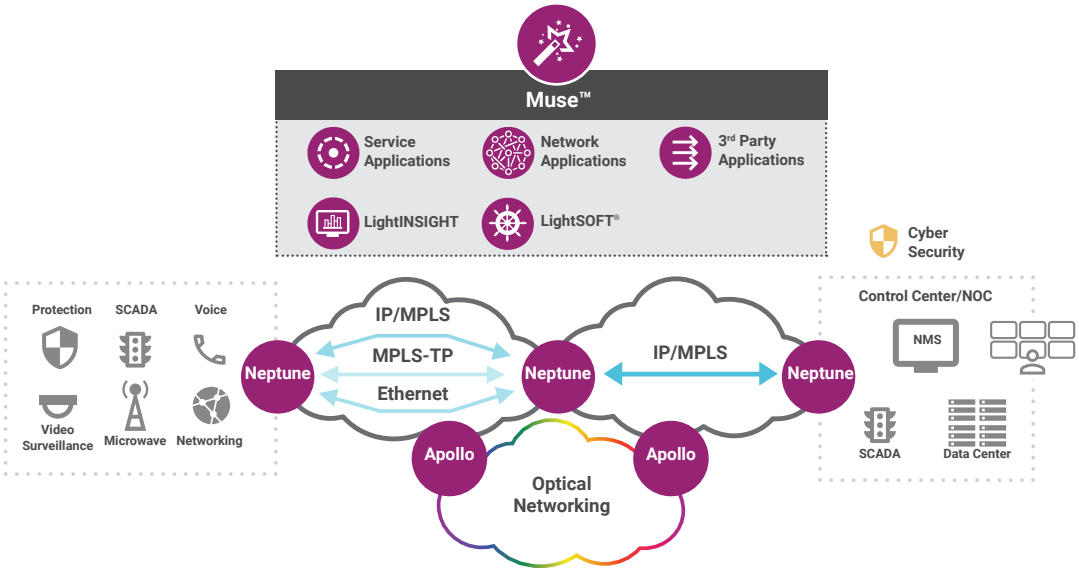
We support hardware and network architectures to provide the high-availability required from the rail communication network

- Fully redundant, hardened design
- Fast protection against single and multiple failures
- Remote disaster recovery
- Prediction of potential failures

Holistic Security Suite:

With the growing number of cyber-attacks on critical infrastructures, it is becoming increasingly important to protect both the IT and the OT systems from attack. Ribbon's Cybersecurity offering, provides capabilities to:

- Prevent attacks where they occur
- Guard the integrity of SCADA and OT networks
- Identify the real threats from the myriad of alerts



One-Stop-Shop:

With years of expertise in driving transformation projects in rail, Ribbon provides turn-key solutions, processes and expertise to its customer. This experience has enabled us be a one-stop-shop for providing performance/cost optimized solutions, operational and future proof agility and the partner expertise you need to meet all of your needs.

IP Wave for Rail | **Wireless Connectivity** | **Unified Communications** | **Cybersecurity**

Summary

IP Wave solutions create better overall economics for delivering secure future-proof telecoms networks optimized to meet the needs of the rail industry.

IP Wave enables the rail operators to deal with the multiple challenges they face in running their OT and IT networks today and into the future, and has the agility to provide a platform for launching new telecoms services to their customers. Moreover, with the service agility and exceptional economic value IP Wave provides, it is ideal to be used by the rail operators to generate extra revenue by leasing services to other telecoms service providers. But it is not just the product portfolio that makes IP Wave a perfect fit for rail operators. When partnering with Ribbon, we bring the expertise and processes we have built up over many decades of providing telecoms solutions for some of the biggest rail networks in the world.

Contact us for more information about how Ribbon can help you apply next-generation telecoms technologies to your rail network at rbbn.com

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. To learn more about Ribbon visit rbbn.com.