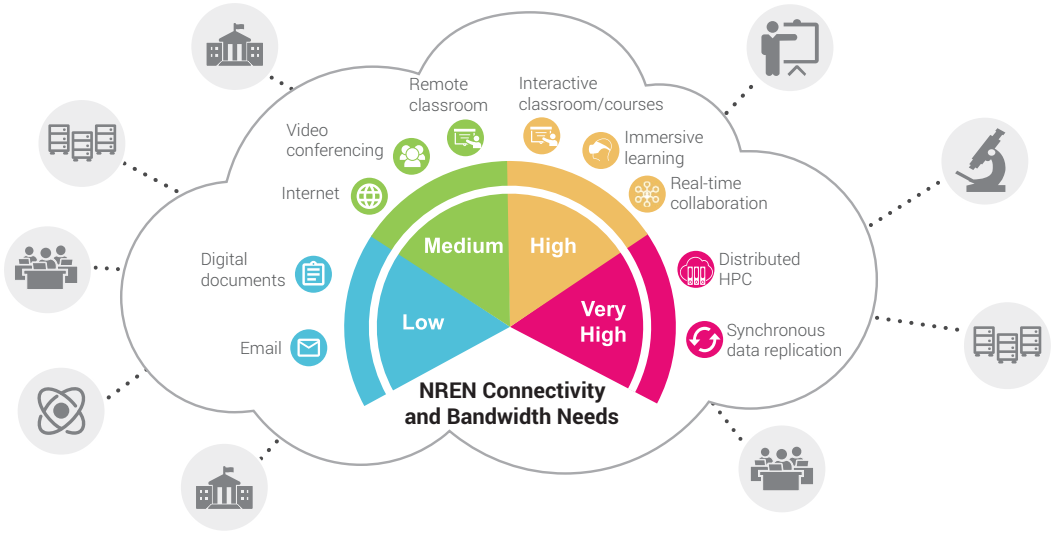
Research and Education Network Solutions

Powering High Performance Computing and Collaboration Applications

Research and education networks (RENs and NRENs) serve higher education and research institutions within a geographic region. They enable the development and deployment of innovative Information and Communication Technology (ICT) applications serving students, educators, and researchers. These include applications like collaborative high performance computing, distance learning, digital health, massive data sharing and backup, high speed Internet access, as well as interworking with other regional and national RENs. RENs are strategic assets that strengthen regional economies and serve as a showcase for technological excellence.



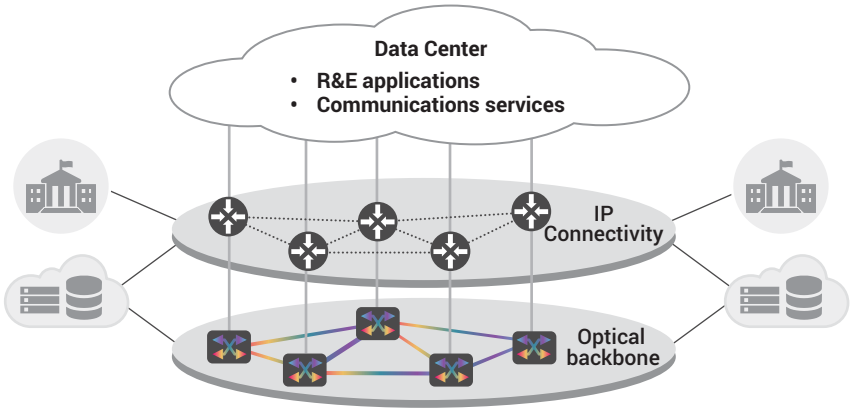
Beyond simple Internet connectivity that was sufficient in the past, modern NRENs must now support high bandwidth and low latency connectivity for a variety of applications, including:

- **Interactive Classroom and Courses.** Elevates remote classrooms and courses to the next level, with remote students interacting with and directing the flow of the educational material.
- **Immersive Learning.** Enhances learning using augmented reality and virtual reality mechanisms that immerse students into a learning experience, overcoming physical access issues and time constraints.
- **Real-time Collaboration.** Multiple students or researchers work together on a project simultaneously, where the real-time aspects are important, so that they are physically together virtually. Examples are interacting with simulations and music creation.
- **Distributed High Performance Computing.** HPC aggregates clusters of computers to apply very high performance to solving large and complex problems in science, engineering, or health. In a distributed scenario, HPC resources communicate with each other in real-time over a wide area.
- **Synchronous Data Replication.** For ultimate data integrity and project continuity, synchronous data replication writes the results of data transactions to two physically separate locations until the transaction is considered complete. This ensures there is no discrepancy in the data mirroring process.

REN Requirements

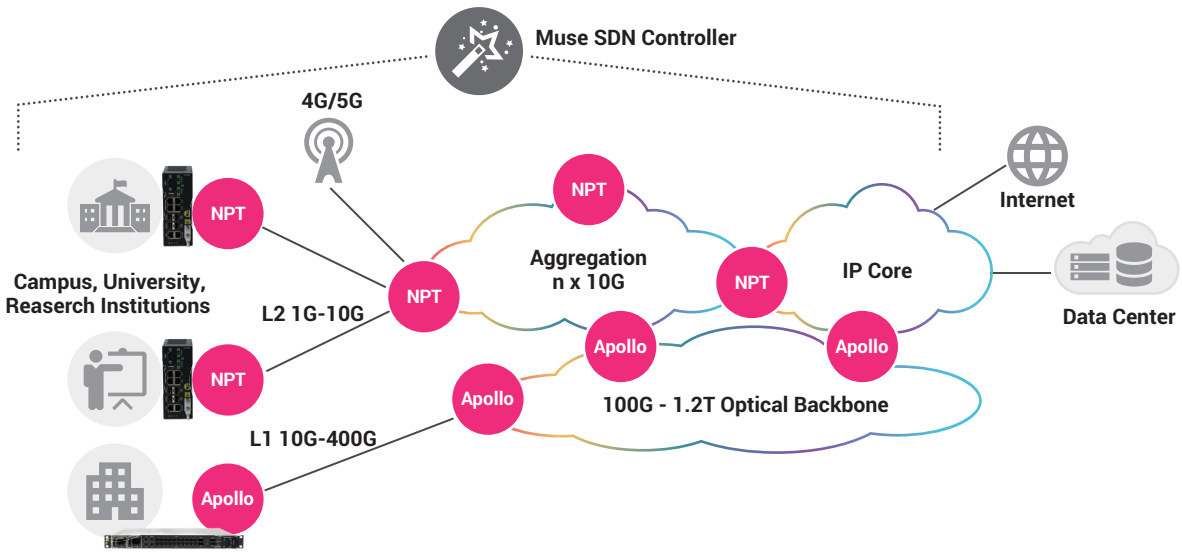
The mission of RENs is to connect and provide transport between routers and switches located at the edge of research and education institutions' internal networks. Major functionality includes:

- Providing connectivity between the edge devices, with different levels of service ranging from best effort QoS to guaranteed SLAs for bandwidth and latency.
- Segmenting and monitoring traffic flows and determining quickly the source of problems when these occur.
- Providing an underlying optical backbone – including in particular an ability to support alien wavelengths – that delivers the bandwidth for the services traffic at the lowest cost per bit.
- Resiliency mechanisms at the service and optical layers to ensure service continuity in the event of failure.
- Value-added voice communications services, with an ability to interoperate with research and education vertical applications like remote learning and collaboration.
- Ease of management with slim operations staff.
- Strong security throughout the solution, to prevent hacking and erroneous operations.



Ribbon REN Solution Framework

Ribbon has a record of accomplishment worldwide implementing RENs, from national to regional RENs, as well as smaller university networks. Ribbon's REN solution encompasses a flexible high bandwidth optical backbone, IP connectivity, management and automation, as well as value-added communications services.



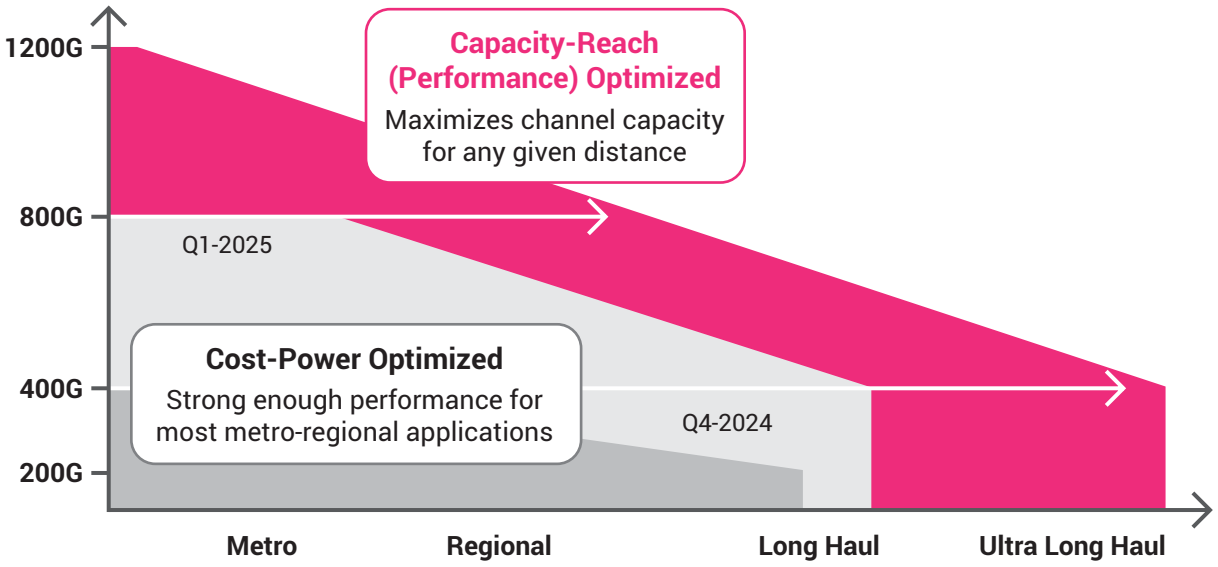
Optical Backbone Network

Optical networks provide the high bandwidth foundation for RENs. Ribbon's versatile and powerful Apollo optical networking system fulfills all REN optical networking needs, from a complete next generation turnkey optical network to an overlay of high-speed optical links running as alien wavelengths on an existing network's line system.

Capacity-Reach or Power-Cost Optimized Wavelengths

Apollo uses a variety of industry-best transmission technology to provide NRENs with a choice of two types of optical transport optimization:

- **Capacity-reach (performance) optimized transport** uses a 5nm-140Gbaud pluggable transceiver that maximizes channel capacity for any given distance, operating right at the edge of the Shannon limit.
- **Cost-power optimized transport** uses 7nm-64Gbaud pluggable transceivers that deliver strong enough performance for most metro-regional applications.

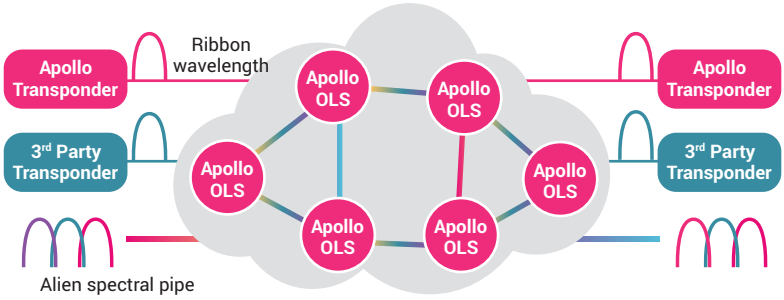


Many RENs rely on older optical line systems where the original supplier no longer supports the most recent transmission technology. There is a need to introduce modern optical transmission solutions to transport client traffic without replacing the existing optical line system infrastructure.

Ribbon enables RENs to overcome this challenge by deploying Apollo optical transport solutions over the existing infrastructure as alien wavelengths, including over brownfield fixed grid 50GHz and 100GHz spacing networks. This enables taking advantage of the many performance and economic benefits Apollo transport brings without a forklift upgrade. Apollo's transport blades cover all application spaces, and are controllable through standard OpenConfig APIs.

Open Optical Line System

Ribbon provides a complete, modern, open optical line system that optimizes the network architecture and performance based on an extensive selection of ROADM and amplifier modules. These are configurable from low to high degree nodes for mesh, star, and ring topologies, using either economical broadcast-and-select or low loss route-and-select architectures, and C/CD/CDC (colorless, directionless, contentionless) add-drop combinations.

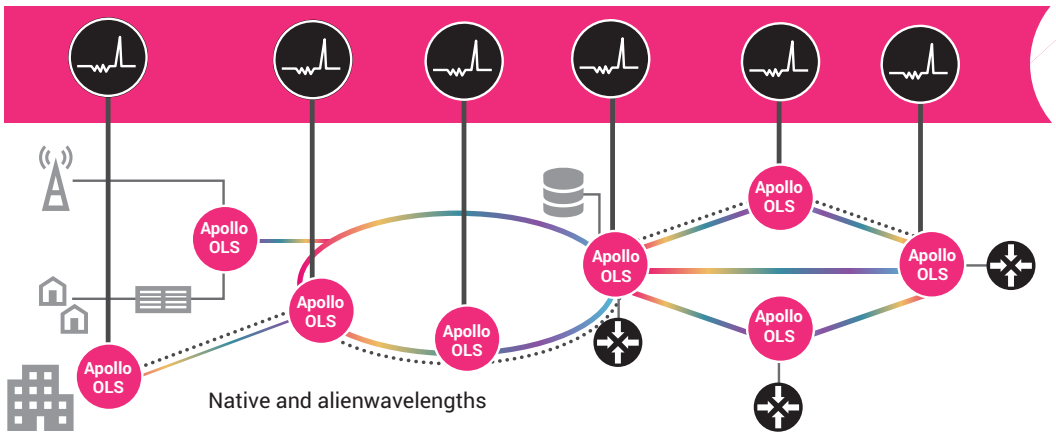


Apollo's open OLS is exceptionally modular with a powerful array of value-added capabilities:

Alien Wavelengths. Apollo provisions and transports wavelengths from 3rd-party transponders and muxponders, as well as its own. This gives REN's the flexibility to migrate existing optical links over time, as well as to take advantage of other supplier's transmission technology for specific applications.

Alien Spectral Pipes. With this unique Apollo capability, a REN assigns an institution it serves, or perhaps a collaborating REN, a point-to-point spectral pipe over which that institution or sister REN can transmit multiple wavelengths based on their particular needs; opening up a completely new level of service offering.

Integrated Performance Monitoring. This applies to both native and alien wavelengths and spectrum, and covers optical power, OSNR and multiple other parameters. It tracks and displays historical trends to quickly identify potential problems before they become service affecting.

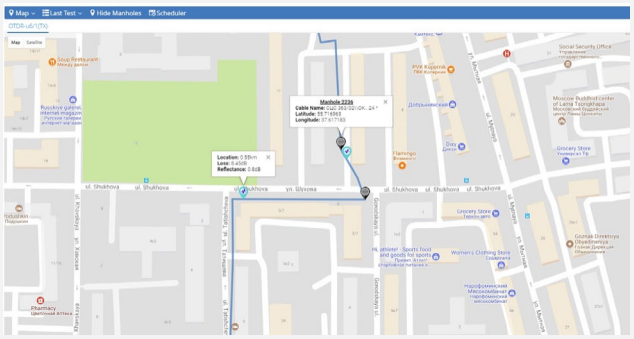


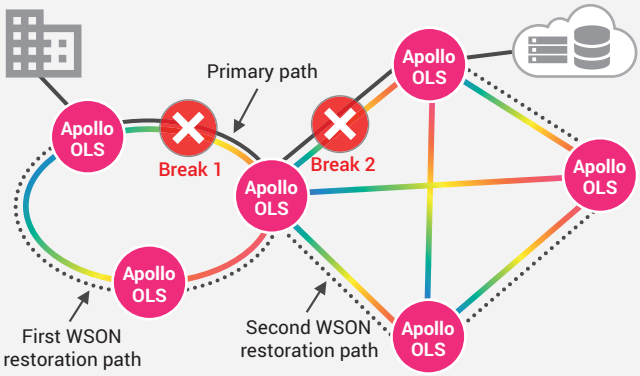
Per channel:

- Power
- OSNR
- Non-linearity
- CD, PMD
- Distance
- Rate
- Q factor
- Q margin

Fiber Health Management

Centralized OTDR (optical time domain reflectometry) monitors the physical health of a REN's underlying dark fiber, including the integrity of all splices along a fiber's path. In the event of a fiber cut, it detects the location of the cut to within a few meters, and can integrate with GPS systems to dispatch repair crews with pinpoint accuracy.





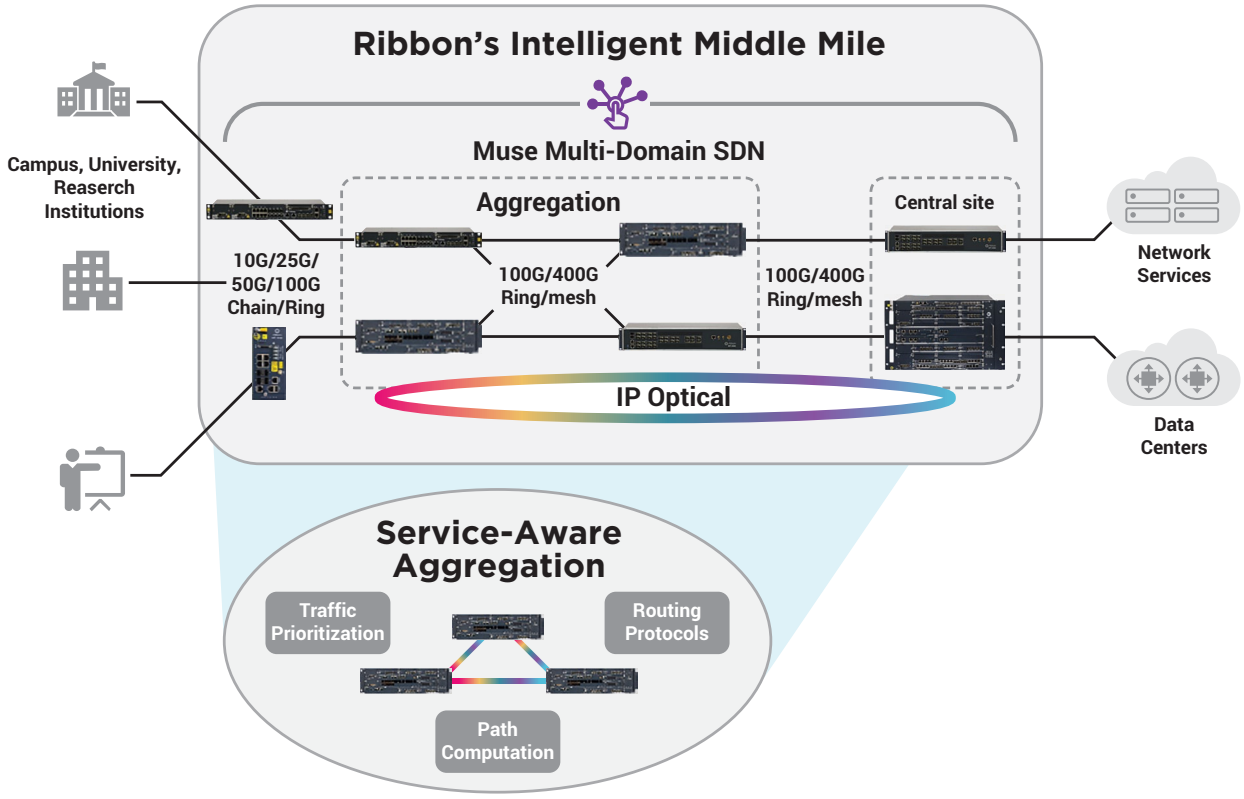
Dynamic Restoration

In the event of a fiber failure, Apollo OLS uses Wavelength Switched Optical Network (WSON) signaling to reroute wavelengths dynamically to restore services.

IP Aggregation

RENs need to support an array of services with a range of performance characteristics. While traditional, IP router-based networks can support many of these services, an increasing number require deterministic performance in terms of bandwidth, latency and availability.

One option is to push everything to the OTN and DWDM transport layers, and while this will meet the performance requirements, it can result in very inefficient use of the optical layer for transporting IP based services. Another option is to over-provision the IP layer, reducing the chance of QoS mechanisms causing unpredictable performance, however, this results in an inefficient IP network.



The solution is Ribbon's intelligent middle mile which uses intent-driven operations to seamlessly integrate service–aware IP aggregation with programmable optical networking. In this approach, high-bandwidth services are handled by the optical layer, while lower bandwidth services use service-aware IP aggregation. This occurs at the edge of the network to guarantee service SLAs on a service-by-service basis, removing over-provisioning without compromising performance.

Ribbon's service aware IP aggregation supports all services on a single routing platform, delivering multiple benefits:

- **No restrictions on traffic mix:** With full support for Carrier Ethernet, MEF services and IP/ MPLS VPN services such Layer 2 and Layer 3 VPNs and E-VPNs
- **Guaranteed Service SLAs:** Service Aware IP routing routes traffic and uses the right transport technology and protocols to guarantee service SLAs
- **Lowest TCO:** Automated IP uses multi-layer automation to make the most efficient use of network resources by treating the IP and optical layers as a single multi-layer entity, and operations are simplified and cost-reduced by managing the entire lifecycle of the network resources
- **Accelerated Service Velocity:** Dynamic IP is used to route traffic to where it is required in the network to support services, for example to commercial web services to private applications hosted in edge data centers or to centralized data centers. Dynamic IP also allows the network to seamlessly grow, allocating network resources smoothly wherever they are required to support new services or customers

With deployment in markets as diverse as mobile backhaul, research and education, defense, critical industries, and enterprises, Ribbon's IP routing portfolio is tailorable to meet specific REN needs. Its outstanding capabilities are:

1

Converged Multiservice Access Aggregation

- Aggregates and transport services from any fixed or mobile access network.
- Supports real-time Layer 2 and 3 services, including Ethernet Private Line (E-LINE) and Private LAN (E-LAN), Virtual Private LAN Service (VPLS), and IP Virtual Private Network (IP-VPN).
- Uses circuit emulation to map legacy TDM interfaces onto the packet transport network.

2

Optimized Service Aggregation

- Routes traffic using the most appropriate transport technology. Engineers different levels of service ranging from best effort QoS to guaranteed SLAs for bandwidth and latency. Notably, it engineers IP transport using MPLS-TP, IP/MPLS and segment routing (SR-TE) to meet the needs of business and mission critical services.
- Applies slicing technologies to keep sensitive data separate from general data for regulatory or compliance reasons.
- Performance monitoring and analysis ensures institutional customers are receiving the service levels they expect.
- MAC encryption secures against hackers.

3

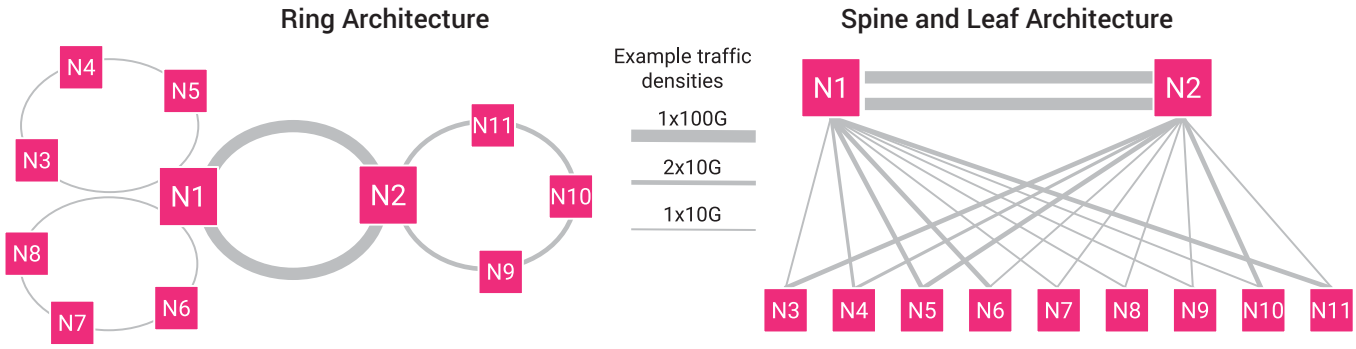
One-Network IP Optical integration

- Provides seamless IP Optical integration allowing the right level of integration to meet service and operational needs. As required, optical can be a distinct layer, or IP over DWDM using coherent optical pluggables.
- Multilayer IP and Optical optimization, with the Muse SDN domain manager supporting multilayer planning, configuration, restoration and service assurance.

4

Flexibility

- Integrates new IP/MPLS networking technologies. While not typically found in RENs, NPT supports state-of-the-art features such as SR-TE, PCE, FlexE, and L3VPNs, if needed.
- NPT high density, high scalability, modular design offers pay-as-you grow.
- NPT supports different architectures depending on the size, geography and resiliency required by the REN. For example, while ring and mesh architectures are more typical, spine and leaf architectures often have advantages for regional RENs, such as low latency paths between all peers.



Muse Control and Solution Security

All Ribbon networking and transport solutions are controllable via the Muse SDN controller. Muse provides complete lifecycle control, covering planning, commissioning, service design, service provisioning, analytics, assurance and maintenance. Control is exercised through modern Web UI human interfaces, as well as machine-to-machine northbound T-API based on ONF standards for integration with higher-level controllers and operations support systems.

Muse can be used as a simple network controller to operate the REN with minimal staff, and also as a basis to build automated processes, to respond to service demands and changing network conditions without direct human intervention.

Automation

- Intent-based network and services lifecycle control and orchestration
- Low code tools to automate any workflow

Multi-domain

- Unified IP and Optical
- Unified access/metro core
- Unified Connectivity and MEC

Cloud-native Open Networking

- Northbound integration
- Southbound integration
- Application integration

Business Model Engine

- Bundled connectivity/cloud app
- Multi-tenant virtual network offerings
- On-demand service offerings

IP Optical networks, like Ribbon's REN solution, are configurable today with a few button clicks. Without proper protection, it can be just as easy to misconfigure or bring them down, whether inadvertently or maliciously. To ensure that this does not occur, Ribbon provides multiple layers of comprehensive security throughout its product portfolio, from the Muse control layer to the networking equipment itself. Role based-access control (RBAC) extends to operations personnel. Transport Layer Security (TLS) secures all inter-system links, and the underlying operating systems are hardened. In addition, the networking products offer advanced security features like encryption at all layers, which the REN operator can use for internal purposes or offer to its institutions as a service.

Value-added Communication Services

Beyond networks, Ribbon also has a long history of bringing value to the research and education sector for real-time communications, focused on the security and interworking of voice and video over IP services. Ribbon's carrier-grade solutions ensure our customers can maintain secure, reliable, and scalable VoIP services as they migrate to modern communications solutions for collaboration and contact center. Ribbon's solutions are deployable on-premises or in the cloud. Ribbon is certified and widely deployed with the leading UC and contact center vendors. In fact, many use Ribbon in their own networks.

Application Server (AS)

The Ribbon Application Server is one of the world's most widely-deployed UC solutions with over 30 million seats sold. This includes multiple enterprise deployments that exceed 50,000 seats. Universities, healthcare providers, financial services and government agencies (including secure Dept. of Defense deployments that require JITC certification) often struggle to find a platform that can replace their legacy Nortel , Siemens, or Avaya solutions. The AS supports a broad variety of industry standard SIP phones and can cost- effectively support tens of thousands of analog devices. Ribbon's Application Server has the scale and carrier-grade redundancy required for large organizations that can't easily transition to the cloud.

Session Border Controller (SBCs)

In today's multi-vendor networks, security and interoperability is required to assure that different networks (and different network elements from a variety of vendors) can securely communicate with one another. Ribbons' carrier-grade SBCs provide robust SIP security and interoperability for diverse communications environments. As large organizations migrate to cloud-based UC like Teams Phone, Zoom Phone, and Webex Calling or cloud-based contact centers such as Five9, Genesys and NICE, they must seamlessly transition users off on-premises solutions. It's not a weekend task, it can take months or years. Ribbon SBCs are tested in the real world, giving REN institutions more options to migrate at a pace that matches their business drivers. They can have a mix of users across multiple solutions, all securely connected to each other and their customers.

Policy and Routing Server

Ribbon's policy and routing solution (PSX) provides a better way to manage the security, complexity and cost of routing calls within an enterprise. PSX is a highly flexible and adaptable centralized routing engine that provides intelligent session control that optimizes both policy management and routing decisions. REN institution can enhance security with real-time assessment of allowable call routing, and optimization of intra and inter-enterprise routing. The PSX's centralized dial plan management and integration with Microsoft Active Directory, enables the PSX to instantly re-route calls when a user migrates from a legacy communications system to Teams Phone.

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.