



IP Wave

For Service Provider Networks



State of the Art IP and
Optical Networking

Shift to a Services Driven Network



IP Wave Portfolio for Service Provider Networks

Multiple factors are driving the telecommunications industry to an inflection point.

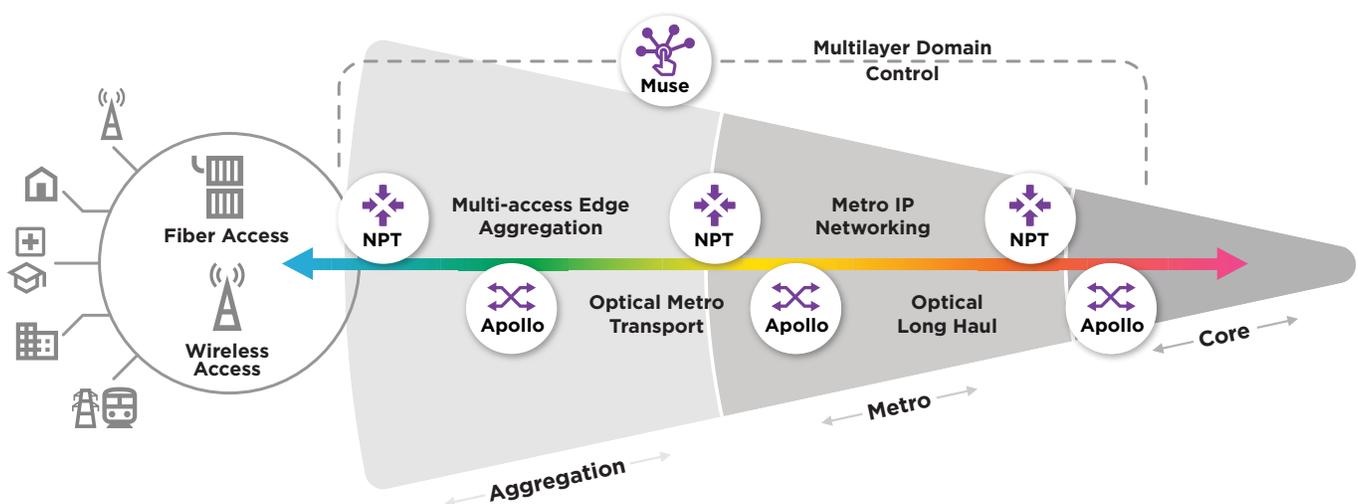
- 5G and fiber-to-the-premise buildouts are fueling massive increases in access and transport bandwidth.
- Users require increasingly sophisticated services with defined performance characteristics for cloud gaming, telemedicine, symmetrical home working, and the social shift to an AR/VR metaverse.
- Cloud networking is moving from centralized data centers to compute and storage distributed across the network, creating more complex high-bandwidth traffic patterns
- Competition is rising from new directions creating an urgency for services differentiation and agility. Webscale content providers have begun competing for Internet and cloud connectivity services to businesses, independent network operators are eroding the residential broadband customer base, and Utelcos are leveraging their fiber plant for incremental revenues.

These changes are forcing service providers to rethink their approach to network architectures, moving from a transport-optimized to a services-driven approach.

Today's networks focus on aggregating and backhauling traffic to a central core, with services mapped onto the traffic flows using simple QoS parameters. While this approach manages costs, it takes an overly simplistic view of services. It does not equip service providers with an ability to respond to an increasingly complex services and competitive environment. Worse, many complex services are engineered as an overlay using dedicated equipment, incurring even more expense.

Under a services-driven approach, the network is optimized for profitability, based on its ability to meet the performance requirements of the services mix. This extends from service planning through the service control and dynamic restoration processes, and the underlying resources these processes require. Services dictate which network resources are used, how they connect and the performance required from these connections. The network instantiates resources and adapts connectivity dynamically to meet these needs. This enables service providers to adapt rapidly to changing business strategies, customer mix, and service mix, without over-engineering their solutions.

Ribbon's IP Wave enables service providers to move to this new dynamic services-driven approach, providing the services agility required to lead the market, and the dynamic optimization required to increase profitability as services are deployed.

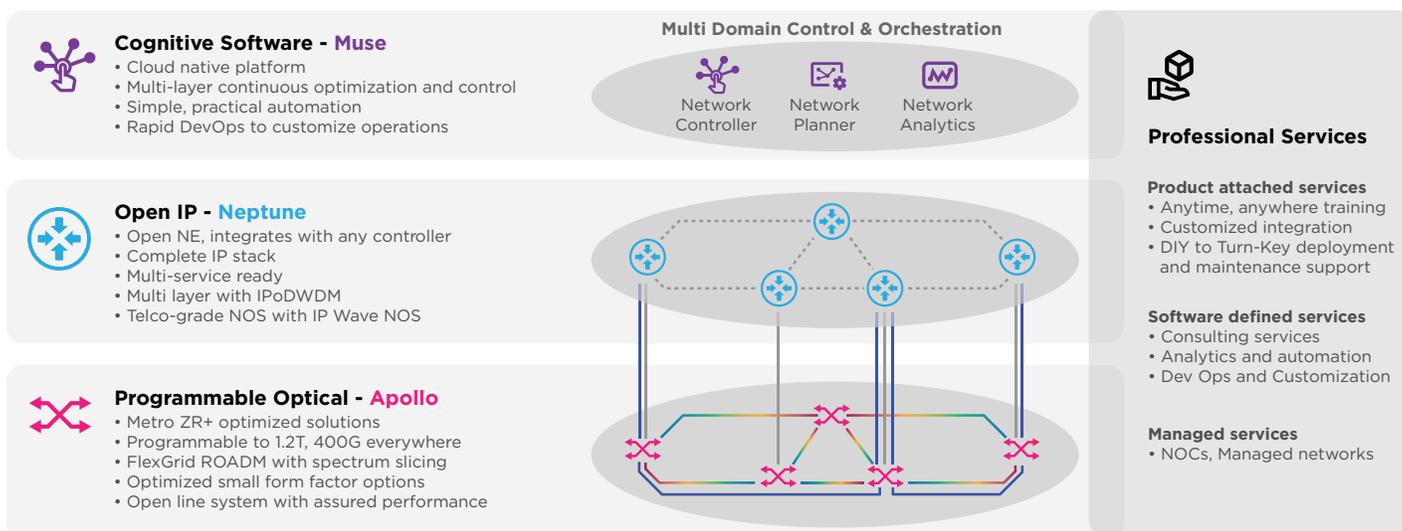


IP WAVE Services Driven Network: Optimized, Automated, Open

IP Wave Service-Driven Networks

IP Wave creates better overall economics for delivering innovative services rapidly over an IP Optical transport (edge-metro-regional) network, by:

- Dynamically creating the network required to transport the services mix, while meeting performance requirements and without costly over-engineering.
- Scaling efficiently to match continuing traffic growth, focusing on a super-converged multi-access edge and on dynamically connecting to the distributed cloud.
- Minimizing CapEx by using a holistic multilayer approach to maximize resource utilization, in real-time.
- Reducing operations costs through continuous automation across the whole lifecycle, at a pace suitable to business needs.
- Facilitating adoption of new technologies through a “no lock-in” guarantee.
- Integrating smoothly into operational frameworks.
- Enabling service providers to create customized operations applications.



IP Wave Portfolio

IP Wave leverages its products and services portfolio to implement service-driven solutions, based on four pillars.

- Optimized IP Optical** – Right technology and feature sets, single or multilayer optimized, not over-engineered.
- Continuous Automation** – Services focused, with implementation across the entire operations lifecycle at the customer’s pace.
- Openness and Disaggregation** – No vendor lock-in, enabling assembly of best-of-breed solutions.
- Collaborative Business Models** – Working together on economics, integration, and customization, to make the solution experience complete.

Optimized IP Optical

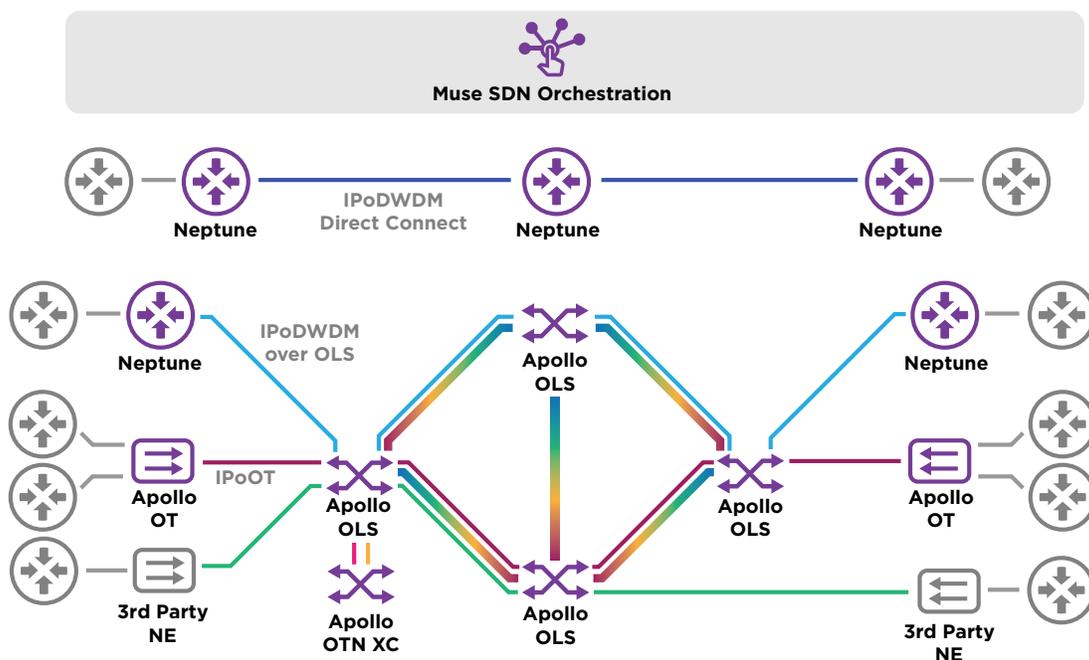
IP Wave solutions provides connectivity engineered to meet service performance requirements, using a complete IP Optical product line that leverages best-of-breed merchant technology and focuses on delivering the right feature sets, without over-engineering or overbuild.

IP Wave uses the Neptune IP routing portfolio to support increasingly complex services, an evolving service mix, and the dynamic edge cloud environment. Advanced IP routing capabilities provide the dynamic, service oriented, metro connectivity required in the distributed cloud era; and a super-converged multi-access edge allows multiple services to be supported from a single, common, IP routing platform. With 400G ZR+ pluggables, Neptune can operate in a single layer IP network using hop-by-hop provisioning, and in a multilayer IP Optical networks by using multilayer optimization to integrate with an optical underlay. Neptune's IP routing capabilities are built around a proven telco-grade NOS allowing various hardware/software disaggregation options to be utilized.



IP Wave uses the Apollo IP optical networking portfolio to provide OTN transport and OTN switching solutions that scale across access, metro and long haul applications. Apollo is programmable to 1.2T per channel, with an ability to transport 400G over the ultra-long haul; leveraging both capacity optimized transceivers and power-cost optimized 400GZR+ pluggable. Its open line system supports Ribbon and alien wavelengths on an equal basis, and enables service providers to offer cutting edge shared spectrum services.

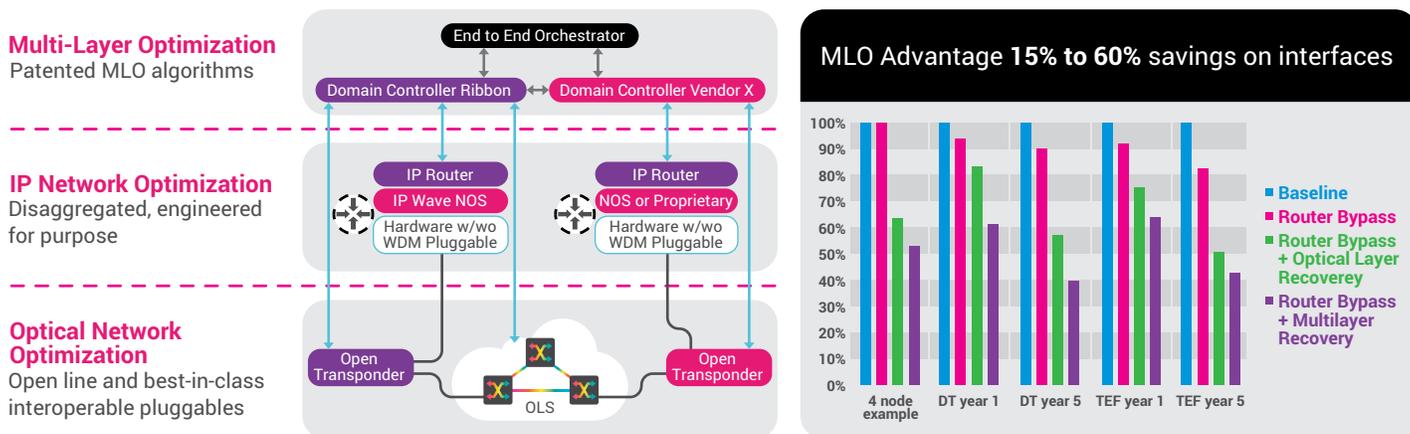
Using these elements, a critical question that IP Wave resolves is the debate between IPoDWDM versus IPoOTN. We have concluded that it is both. IP Wave leverages SDN, IP routing, optical networking and control plane technologies for both IP and Optical, to create a truly integrated IP Optical Network. This network can be optimized to meet specific customer and service needs on a case-by-case basis. Sometimes this means integrating DWDM transmission technologies directly into IP routers, and in others it means using an Optical Transport Network (OTN) layer to transport IP services. Most large networks will incorporate both approaches.



IP Wave Portfolio for Service Provider Networks

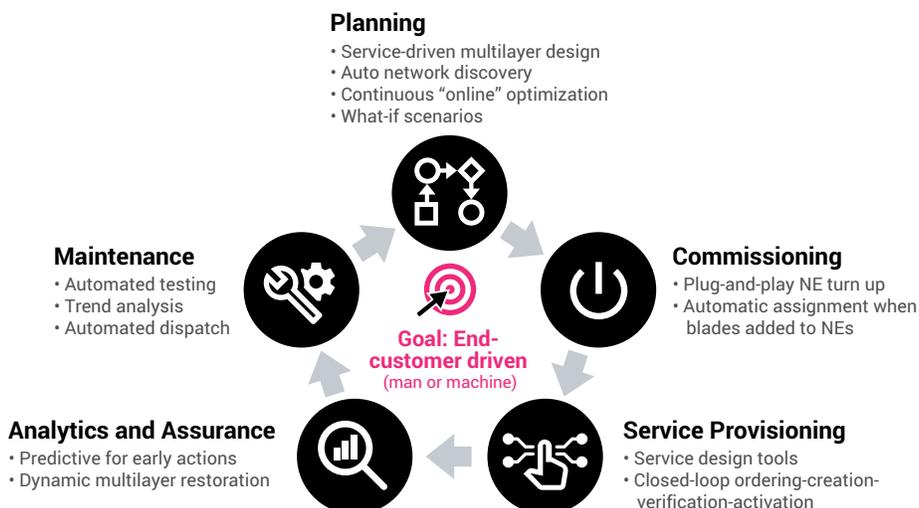
Another area that IP Wave excels at is creating super-converged edge for consolidating mobile, residential and business broadband traffic. Our approach provides investment protection with the flexibility to support any access technology and service, old, current, and new. Independent models show that IP Wave provides CapEx savings of 33%, OpEx savings of 60%, and TCO savings of 46%, over five years compared to running separate edge networks. IP Wave also excels at dynamically connecting the clouds, allowing network-as-a-service offerings as the webscale content and cloud-networking environment evolves.

IP Wave networks are optimizable for each layer individually, but provide maximum advantage when used in multilayer optimized configurations. Advanced planning algorithms design multilayer, any vendor, IP Optical networks that maximize traffic handling with failure resiliency by looking holistically at all network layers, providing the best return on Capex.



Continuous Automation

Optimizing networks for delivering services cost effectively is the starting point. Muse orchestrator extracts maximum value from the network with continuous automation, which covers the complete operations lifecycle: design, plan, build, provision, assure, maintain. Muse allows service providers to migrate to continuous automation in stages, at a pace suited to their own operational needs.

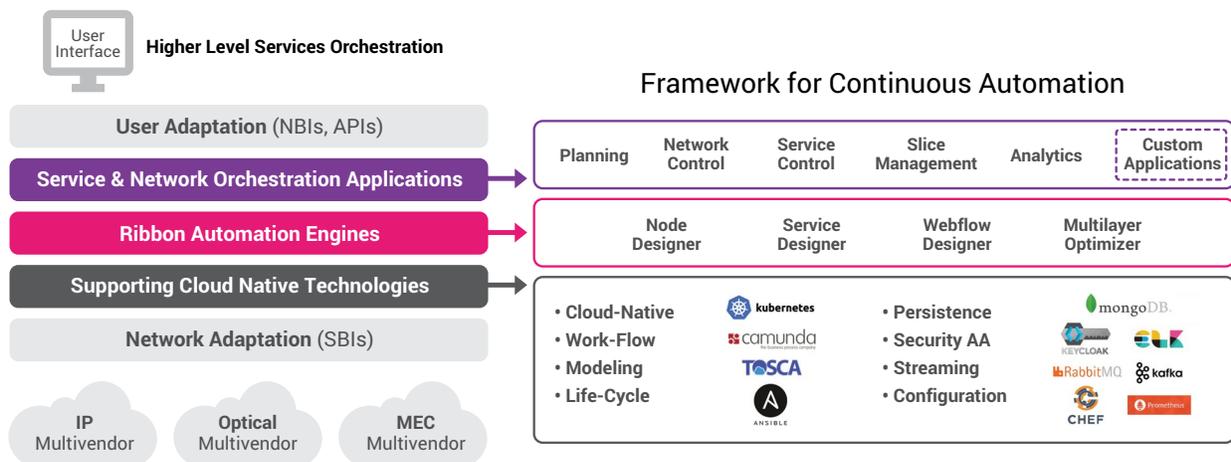


IP Wave Portfolio for Service Provider Networks

Muse allows Service Providers to launch new services and drive new revenue streams quickly, leveraging new technologies. A suite of advanced service and network control applications empower service providers to do more, through simple service creation and lifecycle management, proactive network assurance, network optimization, and automation.

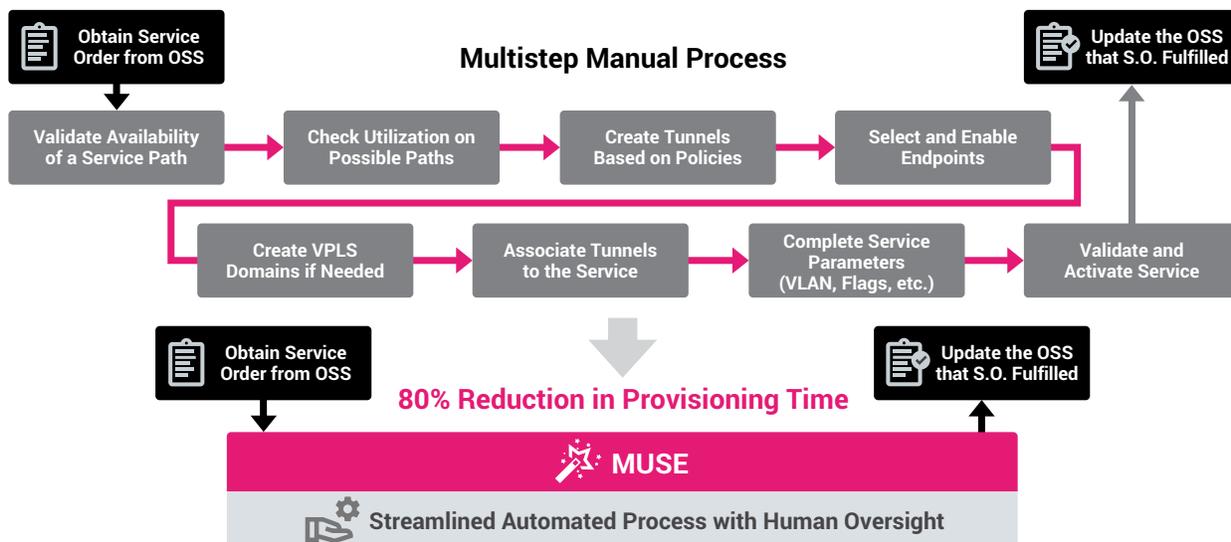
Powered by a carrier-grade cloud native PaaS, Muse uses cognitive service-centric software to deliver real-time control over a programmable IP Optical I network infrastructure. It guarantees the right tools are provided to monetize services effectively through intuitive GUIs or industry-standard APIs.

Continuous integration and continuous delivery (CI/CD) engines enable rapid development of customized applications, whether by Ribbon or the service provider themselves. Engines cover service design, workflow management, and support of any vendor IP and Optical network resources.



Muse Framework for Cloud-native based Continuous Automation

As an example of Muse automation, Ribbon streamlined the MPLS service provisioning process for a tier 1 service provider who was configuring several hundred links per day. This resulted in faster fulfillment, dramatically reduced numbers of data errors and associated “do overs”, and increased the productivity, estimated by the customer to produce up to 80% savings.



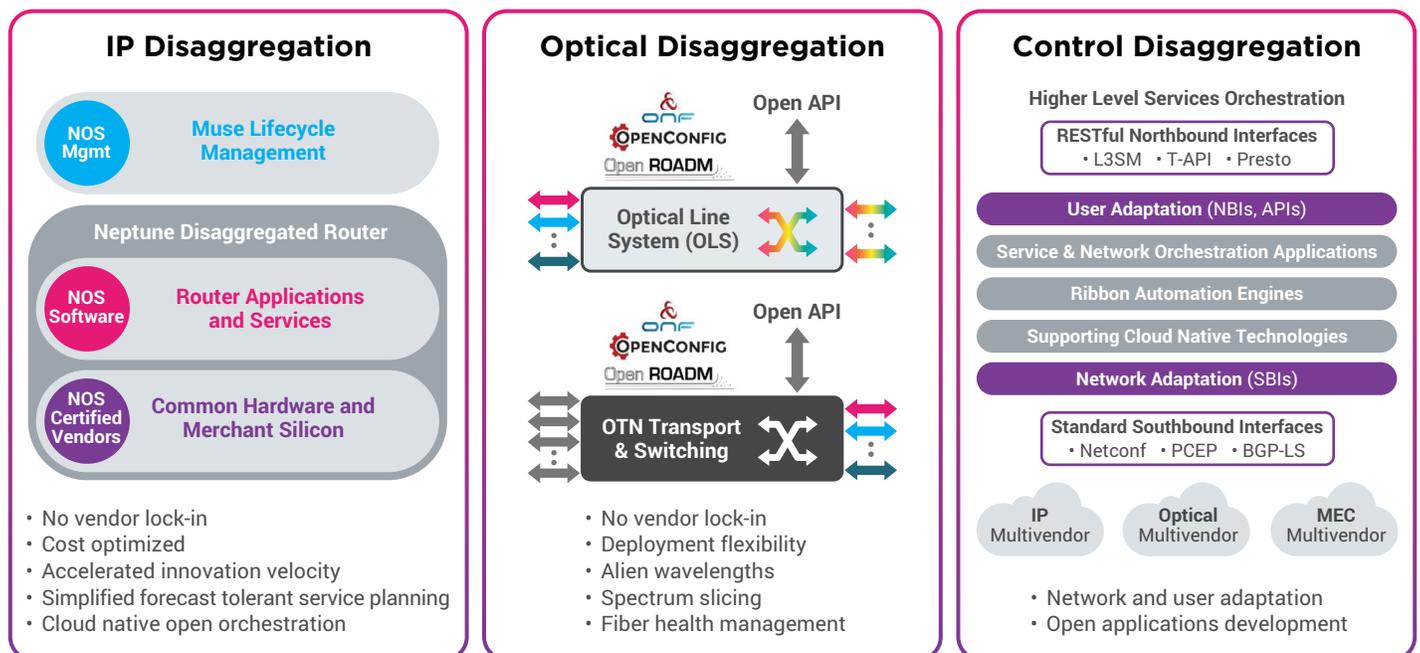
Open and Disaggregated

Freedom of choice, and no vendor lock-in, is a central pillar of IP Wave. At Ribbon, we believe network operators should be able to assemble best of breed solutions, and take advantage of new technologies as they become available. IP Wave fully subscribes to this philosophy, providing future-proof protection.

IP Routing. A Telco grade NOS solution based on a widely deployed NOS provides IP routing features and capabilities tailorable to meet all customer needs and network types. The NOS hardware approach supports multiple deployment models – whitebox/greybox, pre-integrated, integration on request, and software only – and uses merchant chip-set silicon to drive cost-effectiveness, simplicity and increase innovation deployment velocity. Open northbound interfaces provide integration into any network controller including our Muse domain controller that provides a complete set of NOS control capabilities.

Optical Networks. All optical networking NEs, covering optical transport, OTN switching, and ROADMs for wavelength routing, are controllable independently through standards-defined OpenConfig and OpenROADM interfaces. Optical transmission based on OpenROADM O-FEC can interwork with other vendors' optical transport product. Domain control for an open optical line system, which supports both alien wavelengths and shared spectrum, can be exercised via a standard T-API interface.

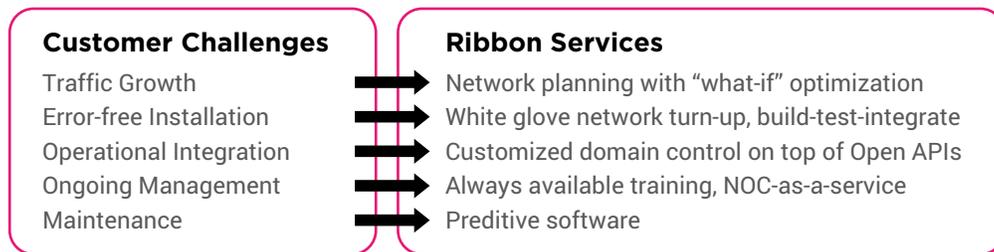
Orchestration and Control: a cloud native open framework with open northbound APIs and southbound NE adapters, enables a multivendor, multilayer ecosystem, providing end-to-end services across the network. Service providers are faster to revenues (fast provisioning), have improved quality of operations (automation), and avoid outages due to analytics and preventative maintenance features.



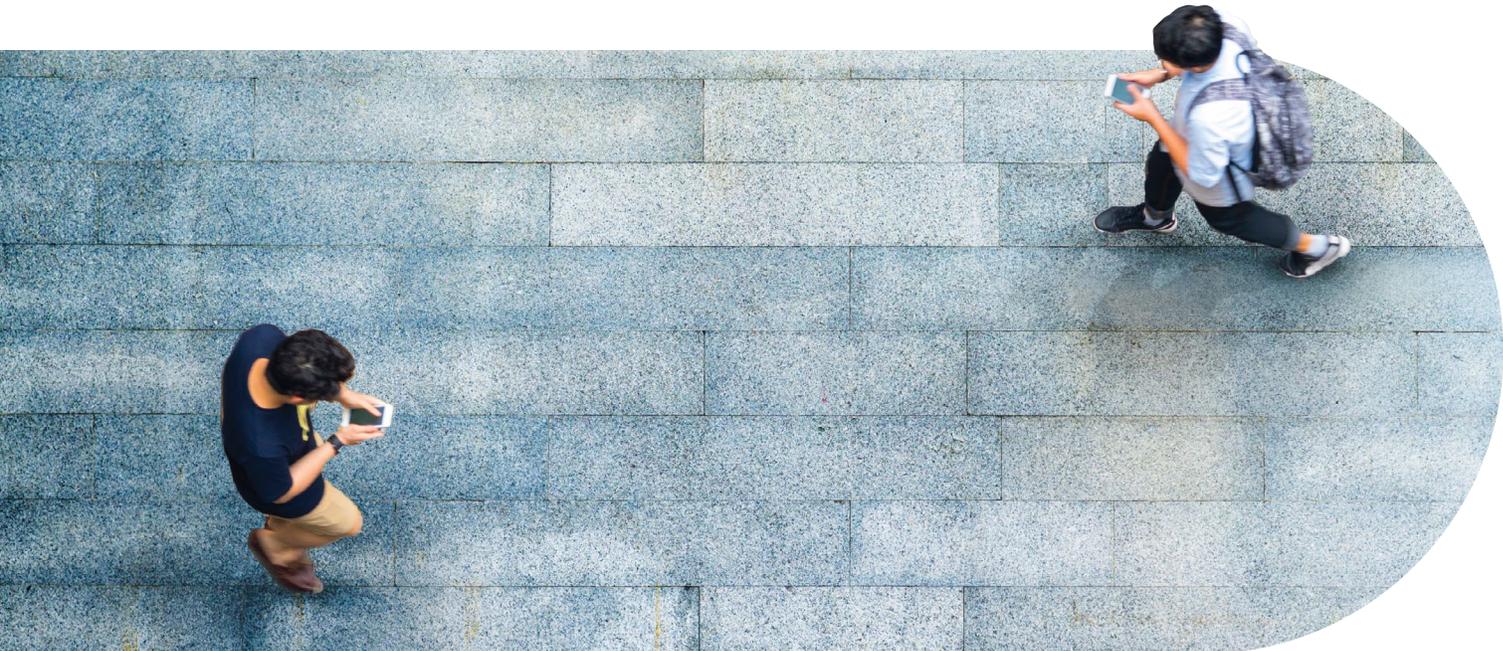
Collaborative Business Models

Beyond hardware and software, Ribbon professional services makes the network experience complete. A global organization supports the complete solution lifecycle from planning to installation, operational integration, and ongoing operations, as needed. Specialists are available to customize Muse software for meet your operating environment and goals.

Indeed, customization of these solutions has started to make service providers adopt true software development models. Breaking down the silos to bridge organizational boundaries, IT and network teams collaborate to define in a continuous development model. Ribbon professional services takes inputs from all stakeholders from network product management, operations, R&D and implements a complete lifecycle plan. We provide joint development to integrate network technologies and operational tools into a customized ecosystem.



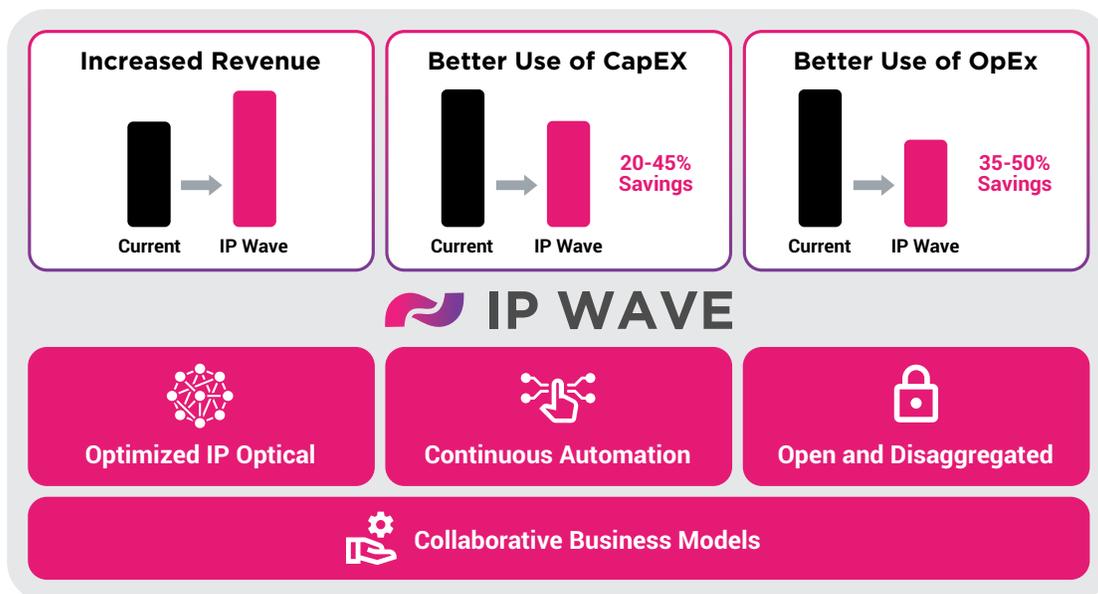
A broad menu of services to make IP Wave solutions “complete”



Summary

IP Wave network solutions creates better overall economics for delivering innovative services rapidly. IP Wave enables service providers to deal with the multiple challenges they face in terms of, demand for increasingly complex high bandwidth services, increasing competition, and pressure on profitability. Based on the four pillars of optimized IP Optical networks, continuous automation, openness and disaggregation, and collaborative business partnering, IP Wave delivers better economics, better technology, and better partnering for creating service-driven networks.

Better Technology	Better Agility	Better Partner
<ul style="list-style-type: none"> • 400G everywhere, performance and power-cost optimized • Patented multilayer planning algorithms • Carrier grade NOS • Carrier grade cloud native platform • In-field expandability 	<ul style="list-style-type: none"> • Lower CAPEX 25-45% → Best fit for purpose, scalable, open, pay as you grow • Lower OPEX 20-55% → SDN-based practical intent driven automation and optimization • Faster time to revenue → Converged multi-service from spectrum to VPNs with intent-driven automated service turn-up • Evolutionary → Maximizes resource use throughout the evolution of the network • No vendor lock-in → Rapidly integrates into multivendor ecosystems, accelerates innovation 	<ul style="list-style-type: none"> • Tailored solutions • Integration into existing operations • Proven dependability, delivering value over the long term to service providers worldwide



Contact Us Contact us to learn more about Ribbon solutions.

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 [ribbon.com](https://www.ribbon.com).