

State of the Art Packet and
Optical Networking



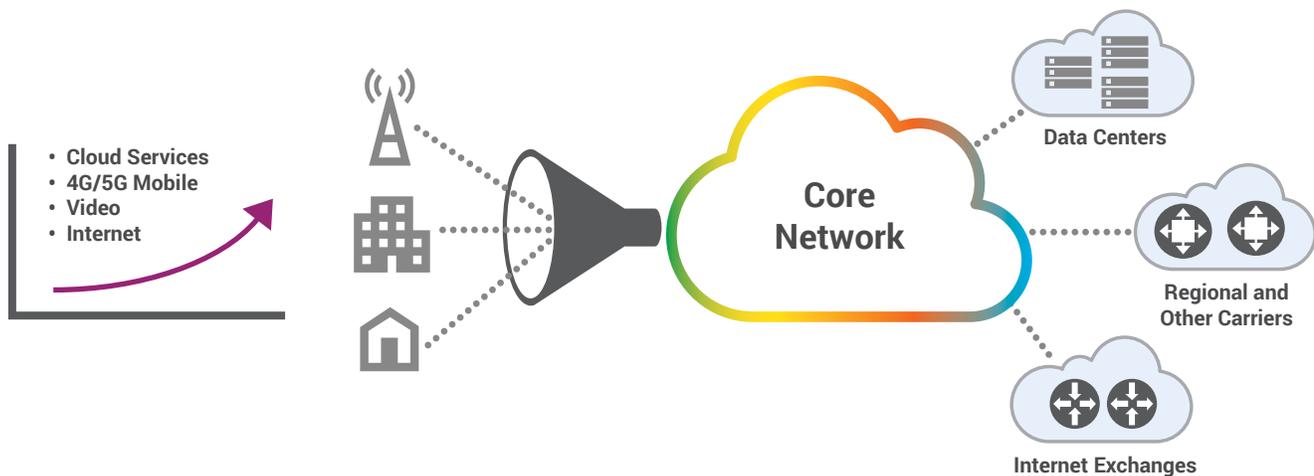
Apollo OPT9900

Reimagining Core Networks

Core Under Pressure

Traffic flows originate from businesses, homes, and mobile base stations. Composed of data, video and voice, these flows aggregate into great rivers of information that enter the core network and criss-cross their way to traffic exchanges and data centers. The core is where the heavy lifting of networking takes place.

As traffic from the edge continues to grow – thanks to cloud services, video streaming, 4G/5G mobile technologies, and the Internet of Things – the pressure at the core network is further multiplied. You want to ensure that the core networking investments that you make today will continue to serve you for many years to come.



Core Networking Challenges

The core network is a strategic asset. In this fluctuating business environment, it must play a greater role than being just a traffic exchange. Core networking deployments must address four key business challenges:



Fast Flexible Provisioning

Creating bandwidth connections flexibly, to respond rapidly to new service requests and changing traffic patterns.



Maximize Bandwidth Capacity

Extracting maximum bandwidth from the infrastructure, particularly in face of impending physical constraints like the Shannon Limit.



Packet Friendliness

Supporting optimized transport for packet services, which constitute most traffic growth, while continuing to support existing services.

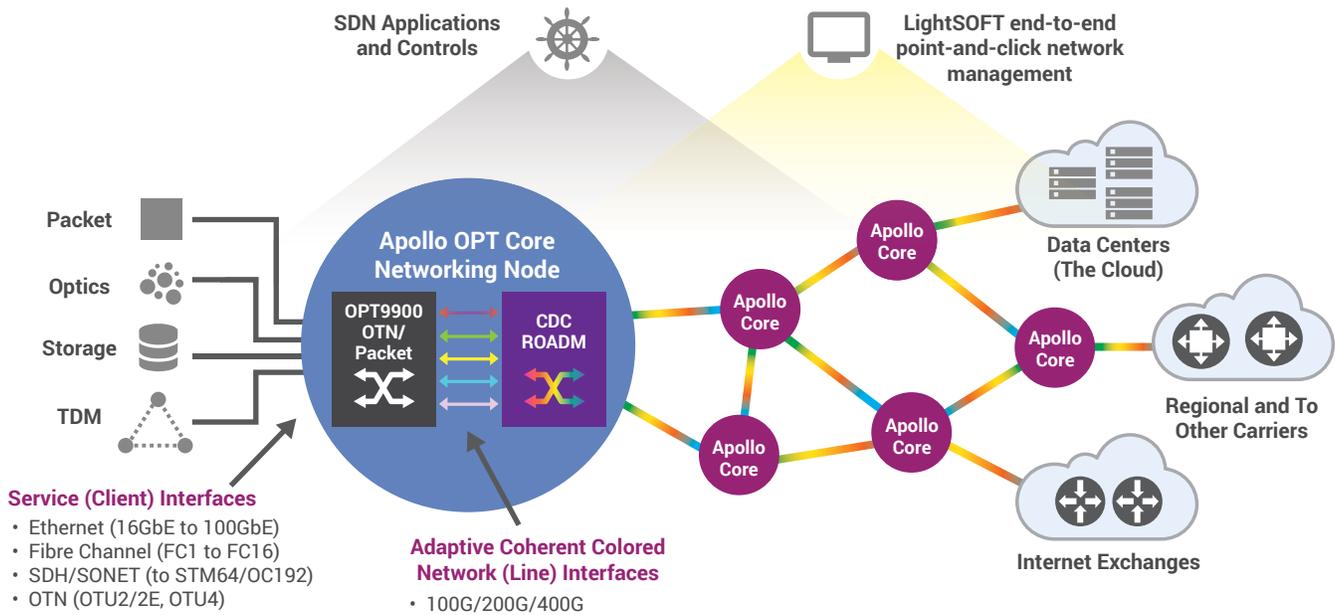


Revenue Generation

Offering innovative new bandwidth services and features that add to revenue streams.

ElastiNET™ Core Networking

Ribbon's ElastiNET core networking solution provides uncompromised power, versatility, and intelligence, to address today's core networking business challenges with confidence, and for years to come. It provides a clean partition for the access and aggregation portions of the network. This allows them to evolve independently, while handling all their traffic with ease and efficiency. CDC ROADMS with up to 20 degrees of connectivity at the optical layer provide flexibility. OTN cross connects at the electrical layer and MPLS switching at the packet layer support high capacity. These are coupled through intelligent SDN control for value-added services and multilayer optimization. The OPT9900 family of high capacity OTN-packet switches are at the heart of the ElastiNET core network.



The Apollo OPT9932 and OPT9914 OTN switching (cross-connect) and grooming platforms provide future-proof capability. They address changing mixes of Layer 1 transport and Layer 2 packet switching traffic, while ensuring a maximum fill of rate-adaptive 100G, 200G, and 400G coherent network interfaces. Featuring 16T and 5.6T switching capacities, respectively, these two switches can be right-sized from very large to mid-scale core networking applications. With centralized SDN or peer GMPLS signaling, they deliver software-controlled value-added bandwidth management services and automated services restoration. OPT9900 are compact single-rack platforms with low-power consumption that address rising space and energy costs.

ElastiNET Benefits

Value-Added
shared bandwidth
services

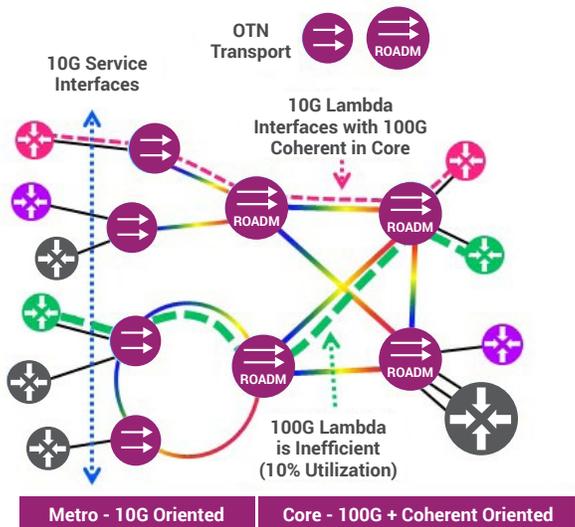
Integrated
L1 and L2 traffic
mixes

**Multilayer Path
Computation**
for optimal resource use

Dynamic Restoration
supplementing protection
switching

Fast Flexible Provisioning Challenge

Core networks must respond quickly and efficiently to new service connection requests and to changes in traffic demand on existing connections. This requires flexible partitioning between the traffic fed to the core network (from aggregation networks, data centers, and carrier exchanges) and the high-capacity traffic switching capabilities of the core network itself. It also requires end-to-end visibility of network resources and smart connectivity algorithms to manage the provisioning processes.



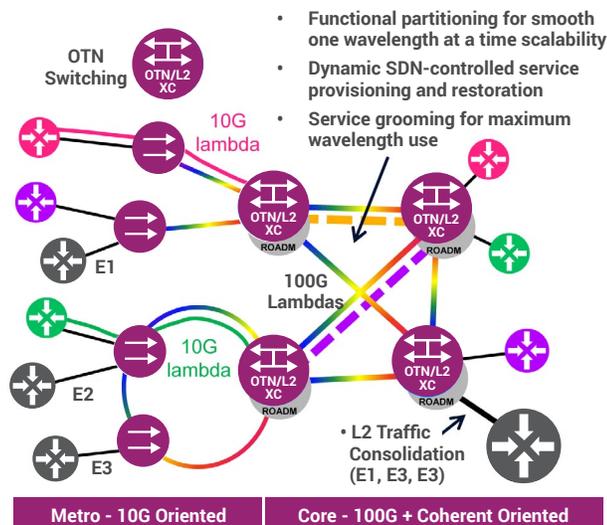
ElastiNET Partitioned Provisioning Solution

Typically, aggregation networks feature 10G services, while core networks are dominated by 100G links and higher. In a pure transport solution, these are implemented “all-optically, end-to-end” using optical add/drop multiplexers. An advantage of this approach is that it eliminates the need for electrical conversions at intermediary nodes. However, it does not allow a clean separation between the core network and its feeders, leading to inefficient use of core network capacity. There are also transmission issues from mixing non-coherent and coherent technologies.

ElastiNET addresses these limitations through the deployment of OPT9900 OTN/packet switches. These provide a flexible partition between the lower speeds (typically feeding the core network) and the higher speeds of the core network itself.

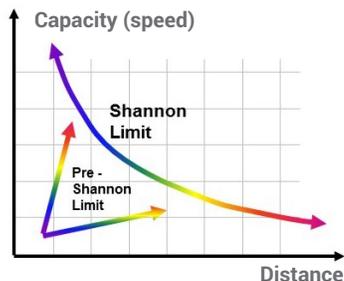
This approach has multiple benefits:

- **Functional separation** – Different parts of the network evolve at their own pace in response to their specific needs. This is particularly helpful for capping TDM networks.
- **Incremental investment** – The network grows smoothly one wavelength at a time, using cost-effective pluggables. This is a huge advantage over competitive approaches that require investments in bundles of wavelengths and use proprietary interfaces.
- **Grooming** – Multiple lower speed links fill up the more expensive coherent links, ensuring no wasted bandwidth.
- **All-optical bypass traffic** – Works seamlessly with ROADMs to route optically the majority of traffic that is not being added or dropped at a node. This reduces the number of interfaces on the OTN cross-connect.
- **Dynamic restoration** – In case of link failures, individual services can be automatically switched to new paths, using ASON or WSON capabilities.
- **SDN services** – When coupled with centralized intelligence provisioning can be turned into revenue-generating services.



DID YOU KNOW?

Ribbon makes it easy to obtain the benefits of SDN applications that leverage ElastiNET connectivity. Start today by building on top of LightSOFT®, Ribbon's best-in-class multiservice multilayer NMS featuring E2E visibility and smart connectivity algorithms. For real-time capabilities, you can port these open interface applications to run on top of Ribbon's Muse™ PaaS.



Maximizing Bandwidth Capacity Challenge

Growing the raw traffic-handling capacity of the core network will always be a top priority. The big question is how to accomplish this most efficiently in the face of hard physical limitations, such as those imposed by the Shannon Limit. Until recently, developments in optical transmission technology allowed increasing both speed and reach simultaneously. But now, we are reaching the point where we can increase either speed or distance, but not both. We need to invest in new approaches to maximize bandwidth capacity.

Elastinet Bandwidth Maximization Solution

ElastiNET uses a multi-prong approach to ensure the abundance of raw bandwidth and maximum utilization efficiency. From the physical layer up, ElastiNET’s bandwidth toolbox includes:

Rate adaptive coherent transmission – Sophisticated encoding and coherent reception techniques adapt to provide the highest possible optical rate for given line conditions. A common line card can transmit 500G for over 800km with just over 100GHz of spectrum, or over 3000km using just under 200GHz.

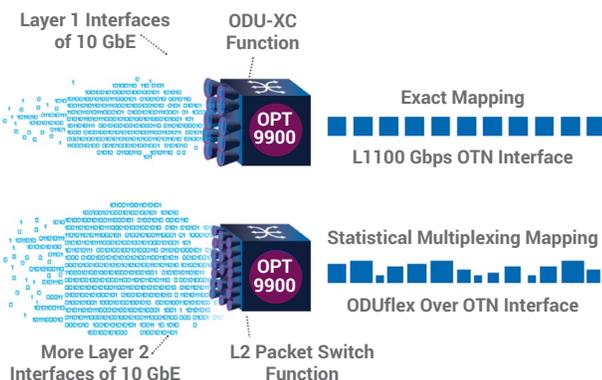


Flexible spectrum – Say goodbye to wasteful fixed spectrum, where an optical signal had to fit a 50GHz or 100GHz slot whether they needed the bandwidth or not. Flexible spectrum in 6.25 GHz increments allocates only the needed spectrum to transmit an optical signal, increasing the number channels and enabling super-channels for up to 1Tbps.

OTN switching and grooming – Multiple streams of optical traffic entering a node are re-organized to provide maximum fill on the optical pipes leaving the node. This ensures that investments in high-speed 100G/200G/400G coherent transmission within the core network are fully utilized, with no wasted capacity.

Layer 2 statistical multiplexing – Taking advantage of statistical multiplexing, L2 traffic from multiple sources is aggregated onto a common wavelength. This oversubscribes the total capacity of a given wavelength without impacting service quality.

Multilayer optimization – ElastiNET leverages centralized intelligence and sophisticated algorithms to optimize connectivity across all technology layers for lowest overall cost. For example, routers may be connected optically directly, bypassing intermediary routers and unnecessary electrical conversions. When selecting alternate paths for backup, multilayer also avoids sharing common facilities with the primary paths.



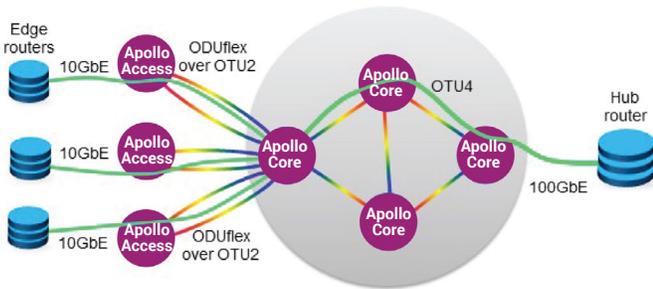
Advanced services using shared resources – Leveraging intelligence even further, ElastiNET opens the gateway to a world where all resources can be shared statistically among multiple users. For example, a user may be guaranteed a fixed amount of bandwidth supplemented by another amount, based on best-effort. This creates greater service variety and the most efficient use of network bandwidth and resources.

Packet-Friendly Challenge

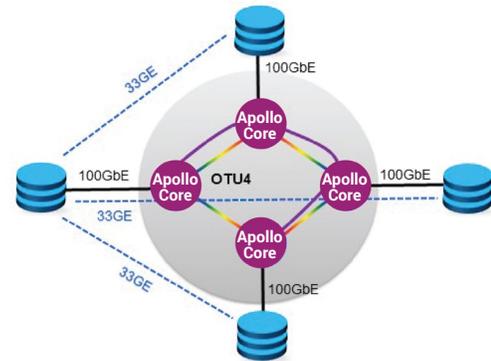
Not too long ago, core networks were optimized for voice-dominated TDM traffic. With the growth of packet-based data services, networks shifted to the service-agnostic OTN standard. This trend has been continuing, so that networks are now becoming dominated by packet traffic. The challenge is how to best accommodate this traffic while still supporting legacy infrastructures and services.

ElastiNET Packet-Friendly Solution

ElastiNET supplements the proven benefits of OTN with integrated Layer 2 capabilities. With L2 statistical multiplexing and packet switching functions, ElastiNET delivers and extends all MEF Carrier Ethernet 2.0 services across the core network, including E-Line, E-Lan, and E-Tree. It also guarantees SLAs across the core by using MPLS-TP to set up congruent bi-directional connection-oriented paths. Other benefits of L2 statistical multiplexing include saving bandwidth by aggregating many lower-speed interfaces into a few high speed ones, and optimizing the utilization of expensive router ports.

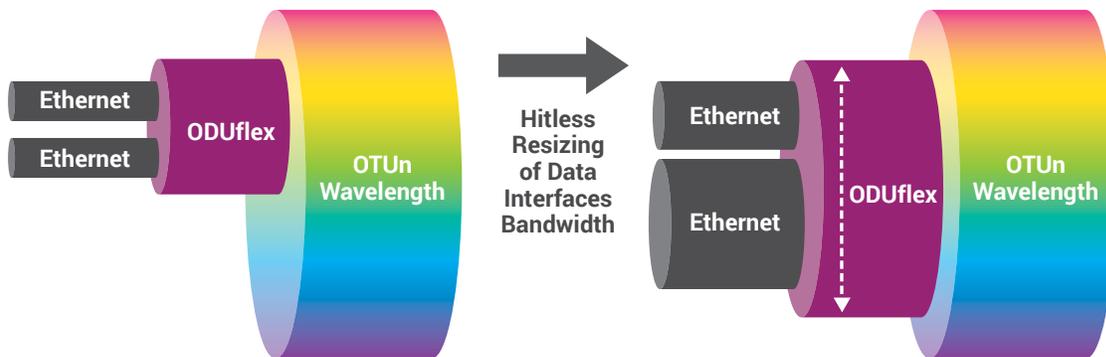


L2 bandwidth aggregation – With statistical multiplexing, ElastiNET can aggregate L2 traffic from many access routers onto a single high-speed channel, terminating on a core router.



High-speed router port optimization – Connected to a router through just one physical port, ElastiNET packet switching can distribute traffic to many other routers

Another way in which ElastiNET is packet-friendly is through the use of ODUflex, which features packet service interfaces for OTN transport in granular 1.25G increments. This allows dialing-up any bandwidth you wish to allocate to L2 signals, for varied customer service offerings, while optimizing network capacity. Moreover, as needs change, you can resize allocated bandwidth in a hitless manner, with no service disruption.



The icing on the cake is that Layer 2 services enjoy the full use and benefits of the OTN infrastructure. Built-in colored OTN Interfaces provide extended transmission reach, based on forward error correction, while L2 services can rely on OTN performance monitoring as a trigger for MPLS-TP restoration.

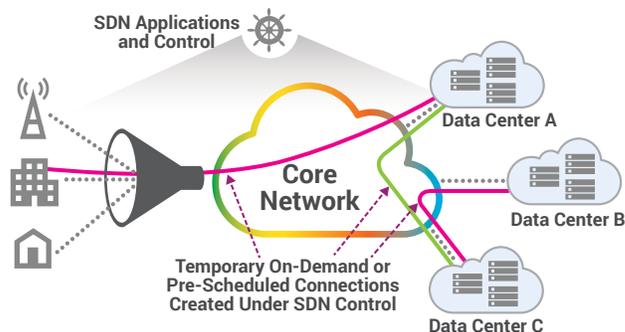
Revenue Generation Challenge

Until recently, the core network has just been a cost center, providing successive generations of thicker pipes to transport and service traffic originating from the network's edge. All emphasis was on lowering the cost per bit. This has been particularly painful for carrying the surge of over the top (OTT) traffic to and from data centers. It just strained core network resources and provided no added-value revenue. The question is how new investments in the core network can be monetized, so that it can also serve as a profit center.

ElastiNET Revenue-Generating Solution

ElastiNET core networking multilayer flexibility, combined with real-time intelligent SDN control, opens the door to core network revenue generation. The important underlying principle is that service bandwidth (and any associated protection bandwidth) no longer needs to be regarded as a fixed resource dedicated to a single customer. ElastiNET looks at the ocean of bandwidth passing through the core as a shared resource, which can be packaged and sold in creative ways.

Bandwidth-on-demand (BWoD) services whereby enterprises and cloud service providers can call up temporary high-speed connectivity, enable a multitude of applications. These include ad-hoc broadband video feeds for events, fast unplanned storage backups, VM migration for distributing processing workloads, or expanding bandwidth for a website that becomes overloaded during a marketing campaign. ElastiNET offers the LightCONNECT BWoD service plus a variant for scheduled bandwidth called LightTIME, both available today.



Another opportunity is to create multi-tiered service level agreements (SLAs). Currently, high-speed bandwidth services have all-or-nothing bandwidth and all-or-nothing protection schemes. ElastiNET opens the gateway to a world where all resources can be shared statistically among multiple users. For example, a user may be guaranteed a fixed amount of bandwidth supplemented by another amount, based on best effort. Also, by taking advantage of dynamic restoration capabilities, it is possible to craft SLAs whereby customers will have part of their bandwidth fully and instantaneously protected via backup facilities. The remainder is protected within statistical constraints through restoration.

These combinations create an unprecedented win-win situation. Customers have greater service variety and service providers can share resources. The result is much more efficient use of network bandwidth and an ability to monetize the core network.

DID YOU KNOW?

Core networks need to be designed, whether they are greenfield or brownfield extensions. LightPLAN™ creates flawless network designs that optimize over all technology layers: WDM, OTN, SDH/SONET, and L2 packet. Using sophisticated “what if” simulations LightPLAN tests how each design handles shifts in traffic patterns or responds to potential link failures. Once you are satisfied with a design, LightPLAN links with Ribbon NMS and EMS ensuring a smooth error-free installation process.

ElastiNET Re-Imagines Core Networks

ElastiNET multilayer core network optimization provides maximum flexibility for accepting aggregated streams of traffic from business, residential and mobile sources, and interconnecting these to data centers, ISPs, and carrier traffic exchanges. Moreover, ElastiNET's centralized SDN intelligence transforms this flexibility into revenue-generating bandwidth and restoration services. ElastiNET's bandwidth and resource optimization, with smooth scalability, protects your core networking investment.

At the heart of ElastiNET core networking is the OPT9900 series of high-capacity OTN-packet switches. OPT9900 offers state-of-the-art adaptive coherent transmission and universal fabric switching technologies, with up to 16T in a single frame. These switches allow you to gracefully evolve mixes of Layer 1 and Layer 2 traffic, based on evolving customer demands.

Contact us to find out how our ELASTIC networks can help you grow at rbbn.com

About Ribbon

Ribbon Communications (Nasdaq: RBBN), which recently merged with ECI Telecom Group, delivers global communications software and network solutions to service providers, enterprises and critical infrastructure sectors. 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 IP solutions, UCaaS/CPaaS cloud offers, leading-edge software security and analytics tools, as well as packet and optical networking leveraging ECI's Elastic Network technology.