Enablence

NO LIMITS:

THE NEXT-GENERATION ROADM NETWORK

AN ENABLENCE WHITEPAPER

EXECUTIVE SUMMARY

Responding to the Traffic Explosion

Global Internet traffic patterns have grown volatile and unpredictable with the proliferation of advanced video and other interactive services that demand high symmetrical bandwidth connectivity. User expectations for high service quality, instantaneous data access, mobility and portability, low latency and massive remote storage is adding to the traffic management challenges being created by these new bandwidth-hungry applications.

According to Cisco's June 2010 Visual Networking Index, global IP traffic grew by 45 percent in 2009 alone, to reach an annual run rate of 176 exabytes. Cisco forecasts that global IP traffic will reach 767 exabytes per year in 2014, a compound annual growth rate (CAGR) of 34 percent.

Gradual cost reduction and capacity increases are not enough to keep up. Metro and long-haul operators need a dramatic shift to a new cost structure that will reduce OPEX and transport costs per bit quickly, while increasing overall network capacity and improving traffic management. They must evolve their networks from 40 channels on a single fiber to 96 channels, and from 10 Gbps per channel to 40-100 Gbps per channel.

They must also deploy new standardized modulation techniques such as DP-QPSK, which provide the high tolerance against signal distortions, superior bandwidth efficiency and increased transmission capacity necessary to transmit 40G and 100G traffic over a fiber that was only designed for 10G.

In addition, metro operators must evolve their networks from the common ring topology, in which each node on the network connects to only two other nodes, to a mesh topology, in which all the nodes are connected to each other, allowing for traffic to be rerouted as needed to prevent "traffic jams" and to maintain service levels despite surges in traffic or network failures.

The Role of the Next-Generation ROADM

All of this functionality is enabled by a next-generation ROADM that allows for traffic to be remotely switched at the wavelength level thanks to advanced optical structures and robust control plane software.

The physical characteristics of the next-generation ROADM at the heart of this agile network are defined as "Colorless, Directionless and Contentionless," or CD&C. Another aspect which we will also define in this paper is "Gridless."

Achieving true network agility with Enablence

Advanced *integrated* optical solutions based on Planar Lightwave Circuitry (PLC) lie at the heart of the truly agile next-generation ROADM network.

Enablence's leadership in PLC ROADM design and fabrication puts it at the forefront of developing the next-generation ROADM solutions. Our advanced tunable optical filter array and multicast switch product lines provide operators and network designers with the contentionless and cost-effective add/drop components they need to build truly agile optical networks with the highest reliability.

Enablence’s portfolio of tunable bypass filters helps system designers achieve 4- to 8-degree directionless, colorless and contentionless ROADM nodes when combined with our state-of-the-art multicast switch product line.

With Enablence, network operators have the advanced solutions they need to build a next-generation ROADM network that is agile, flexible, economical to operate and, most importantly, profitable.

INTRODUCTION:
THE DRIVE TO CUT TRANSPORT COSTS PER BIT

“The ability to deploy an all-ROADM mesh network and remotely control it, to build what we need as we need it, and reconfigure it when needed, is a tremendously powerful vision,” Jim King, executive director of new technology product development and engineering at AT&T Labs, said in a July article published by *Total Telecom Plus*.

Poweful indeed, considering the traffic explosion that is driving metro and long-haul operators the world over to embrace the benefits of evolving their 10G networks to 40 and 100G.

Daryl Inniss, VP Components at market research and analysis firm Ovum, warned in an October 2010 interview with Reuters of the traffic bottlenecks that operators face.

"Overall, the bandwidth in networks is growing,” Inniss said. “The number you hear from telcos is 40-50 percent year-on-year growth in traffic on their network. This type of growth suffocates, and means they have to put in new equipment to support this kind of traffic.”

Traffic patterns have grown volatile and unpredictable with the proliferation of advanced video and other interactive services that demand high symmetrical bandwidth connectivity. According to Cisco’s June 2010 Visual Networking Index, global IP traffic grew by 45 percent in 2009 alone, to reach an annual run rate of 176 exabytes. Cisco forecasts that global IP traffic will reach 767 exabytes per year in 2014, a compound annual growth rate (CAGR) of 34 percent.

This traffic explosion of course begins with the subscriber, be they a teenager at home engaged in Peer2Peer file sharing, or a growing business that is video-conferencing with an offshore supplier in Asia. New real-time, interactive applications demand high symmetrical connectivity. User expectations for high service quality, instantaneous data access, mobility and portability, low latency and massive remote storage is adding to the traffic management challenges being created by these new bandwidth-hungry applications.

Faced with such explosive traffic growth, gradual cost reduction and capacity increases are not enough for metro and long-haul network operators. As bandwidth demands grow, more truck rolls are required for technicians to re-assign optical paths and launch new wavelengths. New equipment must be installed to grow capacity and maintain service levels. As a result, both CAPEX and OPEX rise even as revenues fall due to the commoditization of services.

Operators need a dramatic shift to a new cost structure that will reduce OPEX and transport costs per bit quickly, while increasing overall network capacity and improving traffic management. They need a truly agile network architecture that provides them with the utmost flexibility and control over how traffic is managed and switched through each node without dispatching a technician into the field. In other words, they need a network that is advanced and intelligent enough to reconfigure itself.

This truly agile network is only possible with the next-generation of Reconfigurable Optical Add/Drop Multiplexer, or ROADM. A ROADM is an all-optical system that enables remote configuration of wavelengths at any node in the network. While these devices are not new, their evolution into a next-generation solution that offers true network agility has put them at the forefront of the race to stay ahead of the traffic explosion. It is for this reason we will refer to 40G/100G metro and long-haul networks in this paper as “next-generation ROADM networks” since the next iteration of ROADM technology is fundamental to their operation.

On a next-generation ROADM network, traffic switching is pushed deep into the optical layer from the electrical layer. Switching at the optical layer is less costly and is a prerequisite for operators to roll out more advanced, and profitable, services. With a robust control plane software that offers point-and-click provisioning and remote configuration, the need for manual intervention, and costly truck rolls, is minimized. Wavelengths travelling over this network can be switched, added or dropped seamlessly, from any direction. This is key to eliminating traffic bottlenecks, achieving zero latency, and reducing costs for increased profitability.

In this paper, we explore the market drivers powering the evolution to the next-generation ROADM network, the requirements of this network and the advantages it provides to both metro and long-haul operators. We will also define the next-generation of ROADM (defined as 8-degree or higher) these networks require and what it means to be “directionless, colorless, contentionless and gridless.” Lastly, we will explore the advantages of Enablence’s integrated optical components, based on its proprietary PLC platform, for this application.

PART I: TRAFFIC IS DRIVING THE NEED FOR NEXT-GENERATION ROADM NETWORKS

According to Cisco's June 2010 Visual Networking Index, global IP traffic grew by 45 percent in 2009 alone, to reach an annual run rate of 176 exabytes. Cisco forecasts that global IP traffic will reach 767 exabytes per year in 2014, a compound annual growth rate (CAGR) of 34 percent. The average monthly traffic in 2014 would be equivalent to 32 million people streaming Avatar in 3D continuously for an entire month.

While video is not the only bandwidth hog that is redefining "high-speed" and threatening to choke access, metro and long-haul networks alike, it is obviously the 800-pound gorilla.

According to Cisco, Internet video now accounts for over one-third of all consumer Internet traffic, and will approach 40 percent by the end of 2010, not including video exchanged through P2P file sharing. The sum of all forms of video (TV, video on demand, Internet, and P2P) will continue to exceed 91 percent of global consumer traffic by 2014. Advanced Internet video (HD and 3D) will increase 23-fold between 2009 and 2014 and by 2014, will comprise 46 per cent of all consumer Internet video traffic.

The adoption of advanced video communications is also driving traffic growth for business and enterprise users. Cisco expects business IP traffic will grow at a CAGR of 21 percent from 2009 to 2014.

Lastly, mobile data traffic is on an explosive growth curve from both business and consumer applications. Cisco forecasts that global mobile data traffic will increase 39 times between 2009 and 2014, with a CAGR of 108 percent.

What are the key subscriber trends and technology advances behind this traffic explosion?

It begins with entertainment, entertainment and more entertainment. This is what subscribers want. This is what network operators must be able to deliver. An HD program consumes five times the bandwidth of its standard definition equivalent. Unlimited HD in which multiple channels are streamed simultaneously to different devices throughout the home, VoD, the arrival of 3DTV and its logical evolution into large screen projection 3D-HD formats, as well as low-latency services such as HD gaming, is redefining what constitutes a "high-speed" connection.

New media channels such as Youtube, which require ultra-fast s*ymmetrical* bandwidth connectivity on the access network, has empowered viewers to also be creators of HD content. In fact, Youtube itself reports that more than two billion videos are viewed per day on its service, nearly double the combined prime-time audience for all three major U.S. television networks.

Beyond entertainment, traffic volumes are also expected to grow due to the proliferation of video-conferencing and collaboration for business communication, research and remote healthcare, as well as mobile video and video telephony for residential use.

Migrating from rings to meshes

For metro operators, the growing pains of these explosive traffic patterns are particularly acute. Many metro networks are built with a "ring" topology, in which each node connects to only two other nodes, forming a single continuous pathway for signals through each node. Because a ring topology provides only one pathway between any two nodes, ring networks may be

disrupted by the failure of a single link as well as be prone to “traffic jams” when there are high volumes of data in transit.

Mesh networking overcomes these handicaps and makes it easier to manage and direct higher volumes of traffic. In a mesh configuration (see Fig. 1), the high traffic network nodes are connected directly and a network may act as an independent router to find the shortest and least congested route to the destination. It allows for continuous reconfiguration around blocked paths or by allocating more bandwidth on a fiber as required.

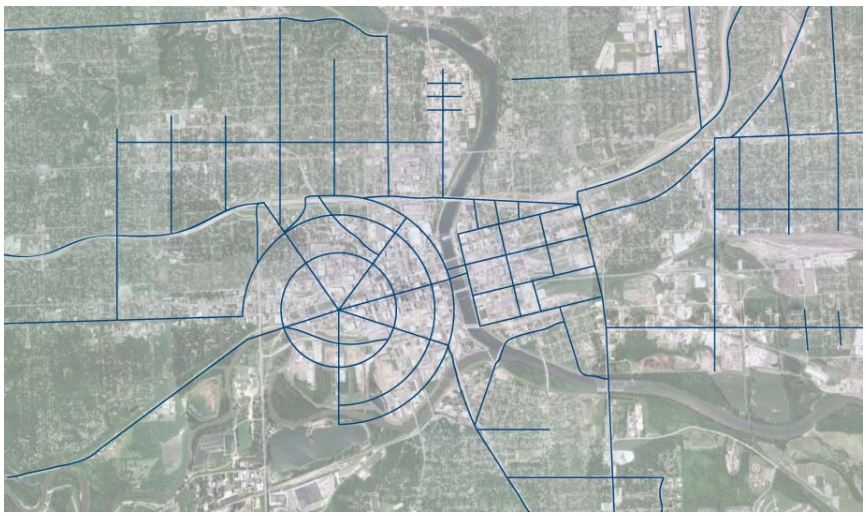

Fig. 1: A metro mesh network configuration can take any form as dictated by local urban planning and established rights of way that impact where fiber nodes can be deployed. However, all mesh networks bear one thing in common – they eliminate the traffic bottlenecks and service disruptions typical of ring networks.

The next-generation ROADM is crucial to a mesh network. As AT&T’s Jim King was quoted in our introduction, the all-ROADM mesh network is the gold standard for the future of IP traffic management. The next-generation ROADM is not a cheap solution, but over the long-term, it is the most reliable, robust and cost effective option to reduce operating and transport costs, increase network reliability and manage more traffic.

Operators today are faced with a simple choice between the upfront deployment costs of a next-generation ROADM solution vs. the cost of ownership advantages it provides over the long term. In today’s dynamic marketplace, network operators must focus on what they will need tomorrow to grow a viable business with a healthy bottom line. As Cisco and other industry players can attest, “tomorrow” is already here.

PART II: THE PRESSURES FACING METRO AND LONG HAUL

In its first biannual ROADM Components report released in March 2010, Infonetics Research reported that WDM ROADM-based optical equipment revenue increased at a compound annual growth rate (CAGR) of 46 percent between 2005 and 2009. By comparison, overall optical equipment revenue has grown at a CAGR of only eight percent since 2002.

"The WDM ROADM optical equipment market will remain the fastest growing segment of the optical equipment business, and the key component fueling growth is the wavelength selective switch (WSS), which allows wavelength route provisioning to become dynamic and protection switching to take place at the optical layer rather than the electrical layer," Infonetics said.

"Telecom service providers are looking for tighter channel spacing to increase fiber capacity and ensure compatibility with cutting-edge WDM solutions, and want larger degree counts to provide greater flexibility as they design their networks."

In May 2010, another Infonetics report illustrated the capacity race by network operators the world over to stay ahead of the traffic explosion. The report found that operators are already "gobbling up 10G, 40G, 100G ports to handle exploding traffic." All of the respondents to the Infonetics survey said they plan to use 40G/100G interfaces in the core networks, and some plan to use these speeds in the metro as well.

Clearly, service providers see the need to invest in higher-speed options for their next-generation networks to handle skyrocketing traffic, regardless of recent economic challenges. They need advanced *integrated* optical solutions based on Planar Lightwave Circuitry (PLC) that will allow them to move from 40 channels on a single fiber to 96 channels, and from 10 Gbps per channel to 40-100 Gbps per channel.

Integrated optical solutions are fundamental to deploying new standardized modulation techniques such as DP-QPSK, which provide the high tolerance against signal distortions, superior bandwidth efficiency and increased transmission capacity necessary to transmit 40G and 100g traffic over a fiber that was only designed for 10G, thereby protecting the existing investment.

As Zeljko Bulut, director of product management at Nokia Semens Networks, confirmed in a September 2010 webinar by *Light Reading*, the market is already experiencing the ramp up of 100G in hand with the mass market adoption of 40G. Size, power dissipation and cost goals will drive continued investment in integration at the component and module level to keep up with the traffic explosion.

But these 40G and 100G solutions must do more than simply accommodate more traffic. They must put network operators on a new cost curve that will also cut transport costs per bit, drive profitability quickly and lower overall cost of ownership to maintain strong margins over the long term. The key criteria to achieve these goals were defined by Bulut as:

Low power consumption

Greener interconnects are required as every megawatt counts. This can only be achieved through higher level integration of components and subsystems with more advanced integrated circuit (IC) and CMOS photonics designs.

Vertical integration

Again, in the bid to lower costs per bit transported, more advanced photonic and IC integration is required to increase reliability and achieve the lowest possible form factor — for example, to reduce a shelf to a module and a module to a chip.

Interoperability

Any solution must have interoperability with any 40G/100G interfaces that have already been deployed. This of course extends to software configurable support for various client mappings and formats, for existing fiber infrastructure, and for transmission over already-deployed ROADMs and line systems.

Standardization

And lastly, there must be compatibility with established industry-standard interfaces. Proprietary interfaces ultimately make life more complicated for the network operator and increase costs. However, the challenge today is that standardization efforts by international bodies such as the OIF, IEEE and ITU are lagging the implementation of 40G and 100G solutions.

Where the next-gen ROADM fits in

These considerations are all key to maximizing the capacity and profitability of the fiber that is already in the ground. The most economical way to do this is by upgrading the node equipment at each end of the fiber. Addressing traffic bottlenecks where they occur in the node is far less costly than laying new fiber. It is here that the next-generation ROADM can increase bandwidth capacity and optimize traffic without changing the basic network structure.

As noted by Infonetics in its ROADM Components report, operators want, and need, the tighter channel spacing, higher degree counts and optical layer switching that only the next-generation of ROADM can provide. It expects worldwide revenue from WSS components with 50GHz of channel spacing and larger degree counts to nearly double between 2009 and 2010.

PART III:
CHARACTERISTICS OF THE NEXT-GEN ROADM NETWORK

The ROADM's evolution

ROADMs are typically defined by the number of degrees, or directions, of switching they can perform. The first generation of ROADMs could only switch wavelengths in two degrees, typically called East and West. The second generation of ROADMs could switch in four degrees – North, South, East and West (see Fig. 2).

However, with these first two generations of ROADM, typically based on wavelength selective switching (WSS), automated switching in the optical layer can only take place at the intermediate nodes across a network link. The add/drop points at the endpoints of the network must still be physically assigned or reassigned by technicians. Manual touch is also required to provision new wavelengths and restore the network after it had gone down.

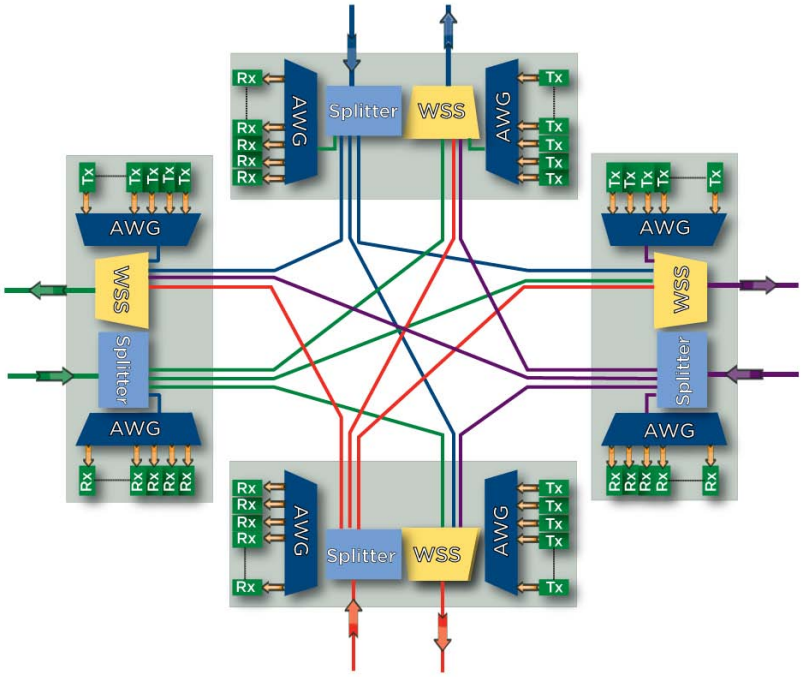

Fig. 2: The typical architecture of a four-degree ROADM. With this design, the add/drop points at the endpoints of the network must still be physically assigned or reassigned by technicians.

Despite these limitations, the first two generations of ROADM do provide benefits to network operators. Since wavelengths remain in the optical layer while passing through intermediate nodes on the network, operators do not have to deploy transponders or convert between optical and electrical signals. These ROADMs are also more elegant than previous architectures, which used fixed optical add/drop multiplexers with external optical patch panels and cabling.

Nonetheless, the inherent limitations of two and four-degree ROADMs still means that switching at the electrical layer with a web interface, while more costly, still has a number of advantages to manage and optimize traffic flow.

The agile next-generation ROADM network, however, delivers on the promise of remote and reconfigurable wavelength provisioning in the optical layer across the ***entire*** network link, which drives down transport costs per bit and operating costs while improving network reliability and service quality.

What defines 'truly agile?'

As we have already discussed, to handle the increased traffic coming from the access network and maintain quality of service, metro operators must evolve from a ring to a mesh topology, which requires a next-generation ROADM network architecture. And while transport operators are not subject to the same traffic demands as metro, they too must evolve their networks to manage and switch greater volumes of traffic without a costly rip and replace of the fiber that is already in the ground.

All of this functionality is enabled by a next-generation ROADM that allows for traffic to be remotely switched at the wavelength level thanks to advanced optical structures and robust control plane software. The physical characteristics of this ROADM are defined as "Colorless, Directionless and Contentionless," or CD&C (see Fig. 3).

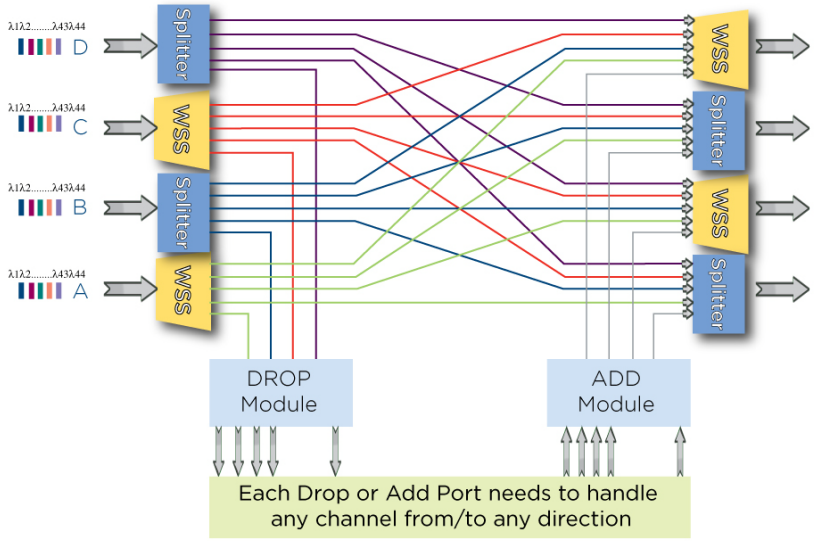

Fig. 3: A truly agile ROADM architecture that is "Colorless, Directionless and Contentionless" allows for full optical layer automation that results in direct operational cost savings and reduces the time required to provision bandwidth.

Colorless

With first and second-generation ROADMs, when a wavelength is selected, a technician must connect the transceiver to the appropriate mux/demux port at the add/drop site. Any change will always require this manual intervention. However, in a next-generation ROADM network, this wavelength assignment is automated in the optical layer and carried out remotely with the control plane software. In this "colorless" architecture, different multiplexers and demultiplexers are replaced by additional wavelength selective switches (WSSs) or 3D micro-electro-mechanical systems (MEMs).

Directionless

As noted above, with first- and second-generation ROADMs, the add-drop port pairs and the transponders connected to them can only pass a wavelength in a fixed outbound direction, such as North only or South only. Again, changing this requires manual intervention by a technician. In a next-generation ROADM network, however, the control plane software can route a wavelength in any direction remotely in the optical layer.

Contentionless

Even with networks that have colorless and directionless functionality, "wavelength blocking" can occur when two wavelengths of the same color hit a WSS structure at the same time. To avoid this "contention" and the resulting truck roll for a technician to resolve the problem, operators can partition add/drop structures so that different wavelengths are associated with

different structures. The trade off is some loss of flexibility that may require the investment in additional add-drop structures. But a “contentionless” architecture allows multiple copies of the same wavelength to transit through a single add/drop structure without any partitioning restrictions.

Gridless

In addition to CD&C is the concept of “gridless,” which means that full flexibility and agility in the network is realized regardless of the age and original capacity of the fiber that is already in the ground. With advanced optical solutions and new modulation techniques, a 10-year old fiber designed for 10G traffic can now handle 40G and 100G through a more granular use of available spectrum thanks to the remote configuration and easy provisioning that is possible through the control plane software.

The benefits this provides to the network operator

As noted by *Heavy Reading* senior analyst Sterling Perrin in his September 2010 paper, “The Need for Next-Generation ROADMS”, network operators reap a number of benefits from this truly agile ROADM architecture.

Greater Automation at the Optical Layer

As already noted, the next-generation ROADM network provides operators with full optical layer automation, including the end points of a link. This results in direct operational cost savings, decreases the time required to provision bandwidth (which can be a competitive differentiator) and reduces the potential for human error. Operators also benefit from greater network reliability, since they can quickly reroute traffic away from a failed fiber, node or even an entire domain in the event of a network failure and route traffic back to its original link when service is restored.

Reducing OPEX/CAPEX

Additional cost savings are also realized by the simple fact that transport costs per bit are reduced when more network functionality is driven into the optical layer. Switching traffic at the electrical layer is more expensive.

New applications

The new functionality of the next-generation ROADM network also creates the opportunity for new applications. Perrin’s paper makes particular reference to “network defragmentation” which is comparable to the defragmentation operation on a PC. As networks grow and evolve, what was once the most efficient path for a connection may become very inefficient after months or years. Network defrag allows operators to employ an automated “reset” of the network that reroutes traffic to the most efficient available path and free up stranded bandwidth throughout the network.

Tighter integration between optical and electrical layers

It should be noted that having more automated switching functionality in the optical layer does not eliminate the need for switching in the electrical layer. In fact, as the next-generation ROADM network evolves, Perrin sees at the systems level increased integration between electrical and optical layer switching in a single network element through a multi-layer control plane.

PART IV: BUILDING BLOCKS OF THE NEXT GEN ROADM

Advanced *integrated* optical solutions based on Planar Lightwave Circuitry (PLC) lie at the heart of the truly agile next-generation ROADM network.

A PLC platform is highly flexible, allowing for precise phase control and the ability to integrate a myriad of active components on the optical chip. Since the waveguides that route light inside an optical chip are lithographically defined, the physical path lengths on the PLC itself can be controlled with nanometer precision. PLCs can also be hybridized with lasers and photodetectors that are mounted directly to the PLC itself, with micron or even sub-micron accuracy.

This allows systems developers to increase integration of various components and modules into subsystems to boost speed and functionality in a smaller footprint. They can migrate from a shelf to a module or from modules to chips. For complex components, such integration also results in reduced costs through improved manufacturability.

Network operators have the horsepower to handle bandwidth-heavy services such as data, video, and storage. At the same time, they enjoy a dramatic reduction in operating costs with easy maintenance, energy-efficiency, and space-saving features that make the most of premium rack space.

Enablence is the global leader in advanced Planar Lightwave Circuitry (PLC). Our Components and Subsystems Division supplies the 12 largest systems developers who command more than 90 per cent of the global market. These include Ericson, Nokia, Siemens, Alcatel-Lucent, Ciena, Tellabs and Motorola.

Achieving true network agility with Enablence

This leadership in PLC design and fabrication puts Enablence is at the forefront of developing the next-generation ROADM network nodes. Our advanced tunable optical filter array and multicast switch product lines provide operators and network designers with the contentionless and cost-effective add/drop components they need to build truly agile optical networks with the highest reliability.

Enablence's portfolio of tunable bypass filters helps system designers achieve 4- to 8-degree directionless, colorless and contentionless ROADM nodes when combined with our state-of-the-art multicast switch product line.

Enablence's iMS NxM and 8x8 multicast switches

An industry-leading solution in Enablence's multicast switch product line is its iMS NxM (typical 4x8) switch module. This PLC module is unique in the marketplace. Channels in any of N input ports can be routed to any of M output ports. This product is not only the most cost-effective routing approach with colorless and directionless features, but also provides a unique and simple solution for contentionless wavelength management.

Enablence has also recently introduced a new 8x8 multicast switch that is designed for ROADMs with up to eight degrees. The signal to any of the input ports can be directed to any one or any combination of output ports to achieve colorless and directionless routing. The 8x8 is available with either dual or single switch packages.

Both switches offer compact size and an easily expandable design, low power consumption and a solid state switch with no moving parts.

Enablence's MSAD solution

Network operators and system designers can either deploy specific optical filter and multicast switch products to upgrade their network in phases, or have tailored to their needs a complete CD&C solution that combines our tunable filters and 8x8 multicast switches. This integrated solution is called the 8x8 Multicast Switch Add/Drop (MSAD) Module. Our veteran engineering team also provides flexible custom design services to meet different port and degree requirements.

These options provide the flexibility and economy to for network operators to "pay as you grow." As traffic increases on the network one can expect the number of drop ports to rise. However, deploying too many drop ports at an early stage results in unnecessary equipment investment and some power loss. The expandable design of Enablence's multicast switch resolves this issue and provides operators with a cost-effective means to scale their network as needed.

With Enablence, network operators have the advanced solutions they need to build a next-generation ROADM network that is agile, flexible, economical to operate and, most importantly, profitable.

CONCLUSION

Metro and long-haul operators are faced with explosive growth driven by the proliferation of advanced video and other interactive services that demand high symmetrical bandwidth connectivity. User expectations for high service quality, instantaneous data access, mobility and portability, low latency and massive remote storage is adding to the traffic management challenges being created by these new bandwidth-hungry applications.

Gradual cost reduction and capacity increases are not enough to keep up with the traffic explosion. Operators need a dramatic shift to a new cost structure that will reduce OPEX and transport costs per bit quickly, while increasing overall network capacity and improving traffic management. They need a network that is advanced and intelligent enough to reconfigure itself.

This requires a next-generation ROADM network architecture that allows traffic to be remotely switched at the wavelength level thanks to advanced optical structures and robust control plane software. The next-generation ROADM network that is “Colorless, Directionless and Contentionless” provides operators with full optical layer automation that results in operational cost savings, lower transport costs per bit, less time to provision bandwidth, greater network reliability and reduced potential for human error.

To build this truly agile network, operators need advanced *integrated* optical solutions based on Planar Lightwave Circuitry (PLC), such as Enablence’s tunable optical filter arrays and 8x8 multicast switches, that allow them to evolve their network in phases and “pay as you grow.”

Enablence can help: Contact us to learn how

Enablence has years of proven technical expertise and industry leadership in advanced integrated optical components and sub-systems. Its proprietary PLC technology provides network operators with the tools they need to respond to the traffic explosion by evolving their networks into next-generation ROADM networks.

We have always thought that any innovation must come with an added element of practicality to offer more than just a standard solution. Our products reflect that through their compliance with multiple standards, ease of use and wide ranging compatibility to maximize the return on your network investments.

We work closely with our customers to tailor a solution that best serves current and future needs. It is an approach characterized by openness and transparency and a proven program of technical and business support that extends far beyond the planning and implementation phases of the network.

Enablence is committed to becoming a long-term, strategic partner to deliver a future-proof Next-Generation Network solution that will provide you with a strong return on the investment for years to come.

Contact us to learn more about how we can help. For more information, please visit www.Enablence.com.

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