The urgent need for agility in optical networks

The seemingly insatiable demand for mobile, video and cloud-based services pressuring the world's networks shows no sign of slowing down – and bigger pipes and more capacity alone won't relieve the burden.

Exactly how much demand are we talking about? Global IP traffic is expected to increase threefold over the next three years, driven by the rapid expansion of LTE, IPTV and Big Data. Mobile data traffic will see a 13 times increase between 2012 and 2017, and metro traffic will skyrocket by more than 560 percent in that same period – almost doubling the projected growth in backbone network traffic.

Telecom operators that don't rebuild or retool to stay competitive and meet their financial performance expectations risk losing customers. Yet as bandwidth utilization continues unabated, today's high-speed, high-capacity 100G optical networks may not be sufficient just a few years down the road.

So what's next? And more importantly, how do we get there?

Telecom operators need a scalable, versatile and dynamic networking solution that can adapt to the ever-changing needs of users in a cost-effective way. Tomorrow's networks will have to provide the flexibility to drive down costs, the intelligence to easily add new services, and the agility to scale bandwidth where and when it is needed.

At Alcatel-Lucent, we call this Agile Optical Networking.

Agile Optical Networking creates a streamlined optical network that combines packet, electrical and photonic switching technologies, making it easy to connect customers to the services they crave and realize the network's full potential.

The articles in this e-book provide a broader explanation of Agile Optical Networking and look more closely at some of the specific technologies and solutions needed to transform optical networks from 100G to 200G, 400G and beyond.

We hope you find these articles informative. For more on Alcatel-Lucent's vision, strategy and solutions for Agile Optical Networking, please visit **www.alcatel-lucent.com/solutions/agile-optical-networking.**

Sam Bucci

Vice President & General Manager
IP Transport Business Unit

In this video, hear analysts articulate the key capabilities enabled by Agile Optical Networking and your colleagues talk about how those features benefit the evolution of their IP Transport networks.

Retool metro transport networks with packet-optimized WDM

Dave Brown

Listen to the podcast

If you're a sports fan you don't like to hear that your favorite team is going through a rebuilding phase. But even winning franchises inevitably need to address declining performance of a mature team as it battles new on- or off-the-field dynamics – such as a new offensive scheme or free agency. These teams can rebuild over the long-term, or pay dearly for a quick fix addition of one or two high performing players. Some choose a tricky balance of both approaches to keep fans happy.

This scenario is not too different from what service providers face with their metro transport networks. Many are choosing a **cloud-optimized metro** network approach using **integrated packet transport** solutions. Let's see why.

A recent Bell Labs study revealed some major dynamics that today's metro networks must address:

1. Metro traffic will grow more than 560% by 2017 – twice the growth of backbone network traffic.
   - Video and data center/cloud traffic are the biggest drivers of this growth.
2. The proliferation of data centers in the metro means more traffic and more of that traffic terminating within the metro – and not going to the backbone.
   - In 2012, 57% of traffic terminated in the metro.
   - By 2017, 75% will be terminated within the metro.

These changing patterns have huge implications for how service providers deliver on-demand, high bandwidth traffic such as video to end users.

The game is changing! They need to rebuild or retool their metro networks to stay competitive and meet financial performance expectations.

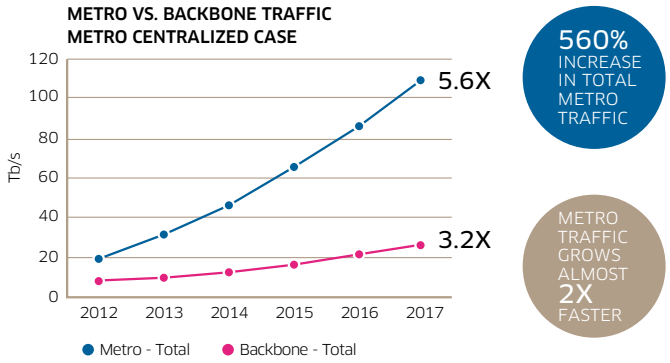
These trends challenge service providers to address network scalability, agility and efficiency while meeting overall total cost of ownership (TCO) and network ROI objectives.

The key difference from the sports team analogy is that service providers must address this in long-term cycles. There's no off-season trading or annual draft. They need to retool the network now to address dynamic and unpredictable long-term needs. They must field a starting team that will produce optimal all-star results for years!

So, what's in the toolkit that can meet this daunting challenge?

Adding higher capacity 100G-capable transport systems is one tool of choice. The rapid and widespread adoption of 100G in core or long-haul networks is now spreading to metro or regional networks.

However, this quick-fix approach to scalability has shortcomings. Service providers are realizing that



current networks are not efficiently filling the 100G pipes with the mix of packet traffic. This issue will only exacerbate in the more complex and dynamic nature of metro networks. Some analysts indicate that 100G market adoption is now only at about 10% of its peak i.e. it's the higher volume metro market that will drive 100G to mass market volumes.

The time is now to retool the metro network with a more holistic approach – a solution that is not only scalable but agile and efficient. We already see service providers making this choice, and moving toward a packet-optimized WDM approach.

To meet this challenge most effectively, look for:

- A packet-optimized WDM platform that is optimized for scalability with metro-tuned, programmable 100G and 200G options and with multilayer, multiservice switching.
- An integrated layer 2 over WDM solution for maximum efficiency and performance.
- A solution that is MEF Carrier Ethernet (CE) 2.0 certified for all MEF service types – E-Line, E-LAN, E-Tree and E-Access.
- A solution that leverages a proven OS across the **optical** and Ethernet/IP/MPLS platforms for the benefits of a common service, operational and management model.

The growth and shifts in metro traffic signal the inflection point for change. Packet-optimized WDM delivers the scale, agility and efficiency to deliver winning results for seasons to come.

Find out more: Read the **Meeting Pervasive Ethernet-based Service Demands with Integrated Packet Transport** Application Note.

Optical networks light up broadband experience

David Stokes

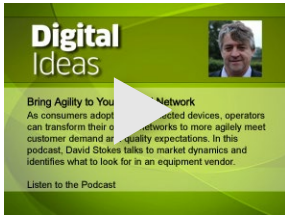
I was fascinated to hear Jim Cramer of TV's Mad Money say: "One word: Optical," on a recent episode. Cramer was referring to the transport networks required to support high performance video. His observation acknowledges the reality known by telecom operators for some time now; consumers are using new devices that offer new services that fuel an exponential need for more bandwidth. Telecom operators need to transform their network to cope with these new demands in a cost effective way. The optical network is at the heart of supporting this transformation by providing high capacity connectivity along with the network flexibility and intelligence required to maximize network utilization.

Telecom operators are embracing the need for a scalable, versatile and dynamic networking solution that can adapt to the ever-changing needs of their users. That's evident with customers like Turkcell Superonline, China Unicom and NORDUnet. They have all made the necessary changes that give them the capacity to support ultra-broadband, as well as the ability to reduce operational costs and increase revenue.

NETWORK CAPACITY: A MAJOR CHALLENGE

Consumers are driving the demand for more bandwidth; they are increasingly using bandwidth hungry applications and services supported on a new era of connected devices such as smartphones, smart TVs and tablets. We are seeing telecom operators in a race to keep their networks up to speed with this consumer demand. Those that fall behind risk losing their high value clients. New services like IP Video are driving capacity growth in fixed networks, where we see traditional broadcast TV companies, satellite TV delivery companies and Pay TV companies all introducing IPTV services to complement their standard delivery mechanisms. In the mobile space we see LTE rollout rapidly driving up mobile data usage, and the backhaul network must support this rapid bandwidth uplift. In the enterprise space we see a move to cloud-based services driving a requirement for high-capacity, low latency, secure connectivity.

We see little slow-down in this growth with research suggesting that global IP traffic will increase threefold over the next three years and that mobile data traffic will increase 13-fold between 2012 and 2017. This growth is being driven by the widespread rollout of LTE, rapid expansion of cloud services and new higher capacity TV formats such as 3DTV and 4K UltraHD.



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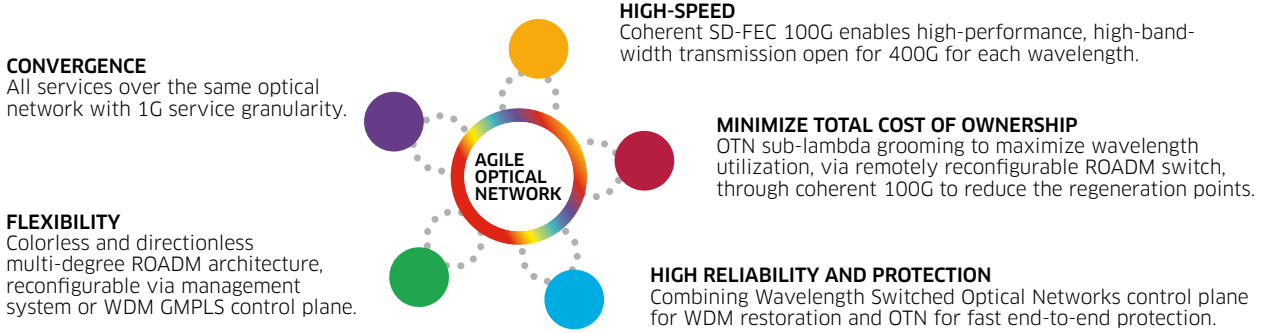
INVESTMENT IN THE TRANSPORT NETWORK: MORE THAN MOVING LIGHT

Telecom operators are seeing the need for a new investment cycle in the transport network to support this huge uplift in capacity. We see them looking to deploy 100G connectivity across their network today, with the potential to seamlessly evolve this to 400G in the future.

We also see that telecom operators are looking for far more than just bigger pipes. They want a scalable, versatile and dynamic networking solution that can adapt to the ever-changing needs of their users, drive down the total cost of ownership and allow them to realize the full potential of their network investment. The network must provide flexibility to support driving down costs, the intelligence to easily add new services and the agility to scale bandwidth where and when it is needed. At Alcatel-Lucent we call this Agile Optical Networking (Figure 1).

Find out more: Read the **Turkcell Superonline**, **China Unicom** and **NORDUnet** case studies.

Figure 1. Alcatel-Lucent Agile Optical Networking summary



100G and beyond for optical networks: From "dreamworks" to reality

Earl Kennedy

Listen to the podcast

This past Christmas an iPhone topped my 11-year-old son's Christmas list. I was surprised to see it, but even more surprised to learn he's a latecomer to the smartphone market. Most of his friends already have one. It's little moments like this, repeated in homes and offices seemingly across the planet, that are forcing big changes in our networks.

It is hard to grasp that just four years ago 100G networks were "dreamworks". But in a short time, **100G optical networks** have become the standard. Now, as bandwidth utilization skyrockets, the question isn't will the market go beyond 100G, but how soon.

Consider that cutting edge services such as **Google Fiber** provide individuals with connection speeds up to 1,000 Mb/s – 100 times faster than today's broadband. Bandwidth like this means applications such as super-sized cloud storage and 4K/Ultra High Definition video are sure to follow. The emergence of enterprise big data and analytics, mobile backhaul, and datacenter interconnect are all driving core network demands beyond 100G sooner rather than later.

REQUIREMENTS FOR 100G AND BEYOND OPTICAL NETWORKS

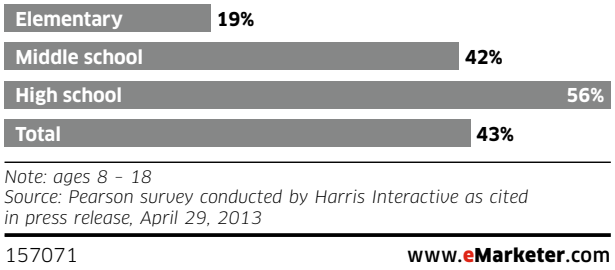
However, going beyond 100G does not come without challenges. This explosive growth in bandwidth utilization will require that optical core networks be scalable, agile, flexible and cost effective.

SCALE TO SUPPORT GROWTH

Current modulation technologies force equipment providers and their customers to choose between transmission speeds. This affects how much data can be transmitted in the shortest amount of time and distance and, thus, how often that data must incur the costly task of being amplified and/or regenerated.

Modulation techniques such as DP-QPSK allow speeds of up to 100G over a single optical carrier at distances of over 3,000 km. Conversely, 16QAM modulation allows speeds of 200G to 400G, but requires a compromise of transmission distance (~800 km). In response, networks have to be scalable, allowing service providers to change modulation techniques on the fly and allow the network to grow as network demands grow.

Figure 1. Large % of Smartphone users under 18 show why service subscriber numbers are exploding



AGILITY TO HANDLE TRAFFIC TYPES

Furthermore, 100G optical networks need to be able to handle multiple data formats. Legacy SONET and SDH traffic have to be able to ride on the same fiber used to transmit newer IP/WDM and OTN traffic. Tomorrow's networks have to be truly agile in supporting and switching all existing and newer traffic types.

FLEXIBILITY TO IMPROVE CAPACITY

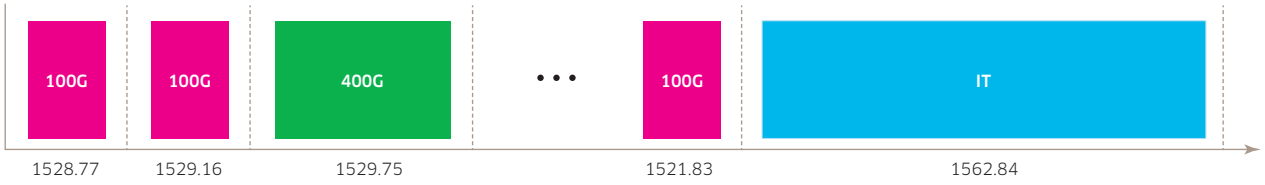
Larger bandwidth demands will require networks to be flexible as well. Recently, a new ITU standard (ITU G694.1) for wavelength spacing in WDM optical networks defined a new flexible grid. For years, WDM systems have adhered to a standard of 50 GHz spacing between each wavelength within the transmit spectrum. The new flexible grid standard allows for 12.5 GHz spacing, which allows much higher spectrum utilization; improving network capacity as much as 30%. Figure 2 illustrates this point.

COST-EFFICIENCY FOR LOW TCO

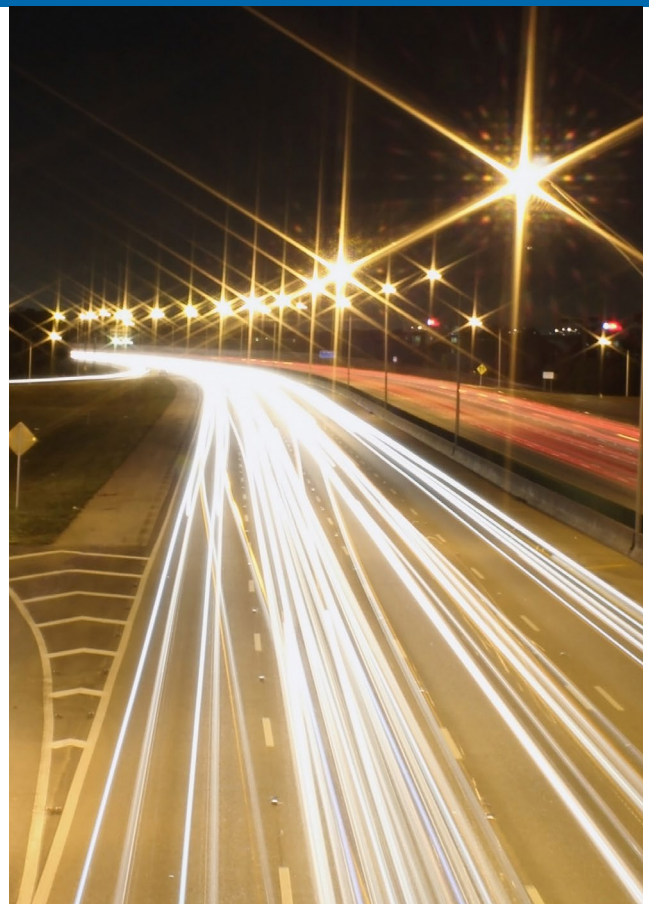
Finally, optical networks that go beyond 100G need to be cost effective. In the past, making network changes that affected capacity, wavelength or ROADM utilization, or transmission reach required costly spare- inventory and onsite manipulation. There is a trend toward Software Defined Networking (SDN), which provides the added benefit of increased automation with lower operational costs.

It is an extremely exciting time for consumers of all ages, businesses, service providers and equipment makers all over the world. Applications and media services for individuals and households that require massive amounts of bandwidth are growing every day, while the cloud era is redefining business models and IT infrastructures. As optical core networks evolve with these changes, future networks will have to be scalable, agile, flexible and cost effective.

Figure 2. Flexible grid* channel plan



* "Evolution to flexible grid WDM", November 26, 2013 Lightwave online.



Find out more: Read the blog **The right optics: Evolving the network to meet demand**.

Optical Transport Networks: Essential for telecom operators deploying 100G

David Stokes

Listen to the podcast

The continued demand for increased bandwidth has forced telecom operators to look for a transport solution that minimizes their total cost of ownership. **Optical Transport Network** (OTN) switching provides telcos with an efficient approach.

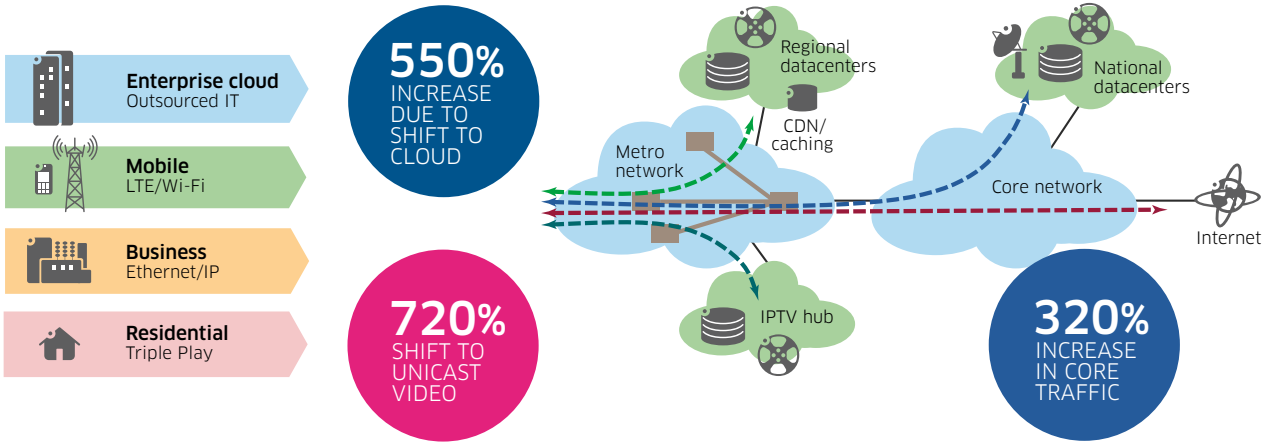
Consumers are driving this demand for more bandwidth and more services. They are increasingly opting for more bandwidth hungry applications and services supported by a new era of connected devices such as smart phones, smart TVs and tablets. Simultaneously, challenges for operators include:

- Capacity growth in fixed residential networks driven by IP video
- Backhaul pressure to support the rapid bandwidth uplift in mobile networks provided by LTE
- Move to cloud based services by both business and residential customers

We see little slow-down in this growth. **Research from Bell Labs** suggests that from 2013 to 2017 we will see a 550% increase in bandwidth demand due to the shift to cloud and a 720% increase in bandwidth to support IP video across fixed and mobile networks. This will result in a 320% increase in the amount of traffic in the core network.

Telecom operators are racing to meet consumer demand, and those that fall behind risk losing their high value clients. Furthermore, telecom operators must offer this increased bandwidth with little incremental revenue, so there is huge pressure to reduce the cost per bit for transport.

Figure 1. Demand for ever increasing bandwidth

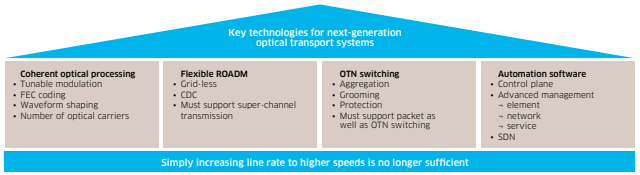


OPTICAL TRANSPORT NETWORK FORECAST

Telecom operators are starting to realize that simply increasing the line rate is no longer sufficient to control the costs associated with increasing bandwidth demands. A recent survey by Infonetics predicted that by 2016, 86% of respondents plan to use OTN switching in the core of their networks[1]. In addition, Ovum forecasts that the growth of OTN will be proportionally linked with the growth of wavelengths that are 100G and beyond[2].

Figure 2. Ovum's technology pillars of next-gen transport systems

Click to enlarge



1. Infonetics Research: OTN, MPLS, and Control Plane Strategies: Global Service Provider Survey May 1, 2013
2. Ovum: 2014 Trends to Watch: Network Infrastructure Nov 1, 2013

WHAT IS OPTICAL TRANSPORT NETWORK?

OTN is a defined in the ITU-Recommendation G.709 and is a set of optical network elements connected by optical fiber links, able to provide functionality of transport, multiplexing, switching, management, supervision and survivability of optical channels carrying client signals. OTN allows the photonic network to inherently support multiple protocols. Transport rates have been defined to maximize network utilization for a photonic network carrying many different service types.

WHAT MAKES OTN SO COMPELLING FOR TELECOM OPERATORS?

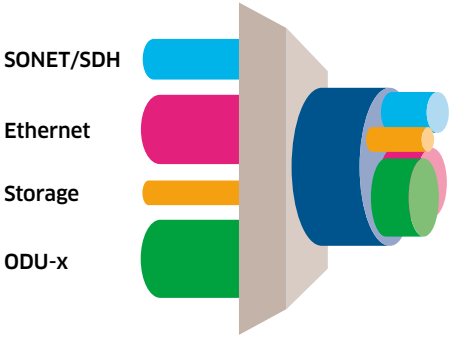
Capacity utilization

Optical Transport Network switching allows better network utilization by eliminating stranded bandwidth and maximizing wavelength utilization.

Network convergence

Using ODUk, Optical Transport Network supports multiple protocols and multiple bit rates, allowing operators to easily support new services on a single transport platform and to cost effectively and efficiently converge their legacy networks and services onto the same platform.

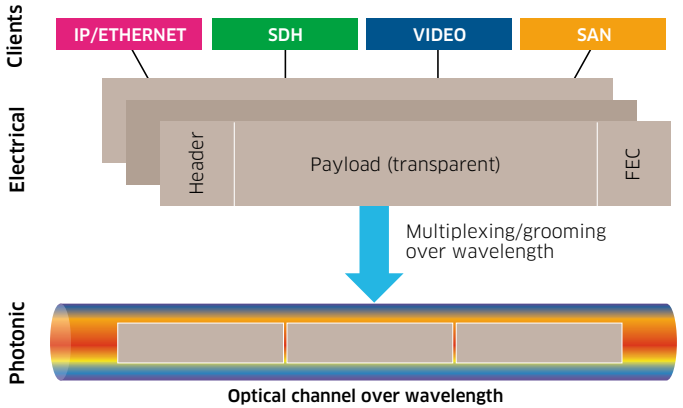
Figure 4. OTN – Multiple Protocols, Multiple Bit Rates



Multiple protocols
- SONET/SDH, Ethernet, storage, ODU, etc.

Multiple bit rates
- Sub-1G, 1G, 2G, 2.5G, 4G, 8G, 10G, etc.

Figure 3. OTN Universal Network Architecture



Multi-service client support of a wide range of protocols

Over high-rate wavelengths

OTU	ODU	"MARKETING" RATE	SIGNAL (OTU)	PAYLOAD (OPU)
	ODU0	1.25G	NA	1.238G/s
1	ODU1	2.5G	2.666G/s	2.488G/s
2	ODU2	10G	10.709G/s	9.953G/s
3	ODU3	40G	43.018G/s	39.813G/s
4	ODU4	100G	111.809G/s	104.794G/s

FEC: Forward Error Correction
ODU: Optical Data Unit
OTN: Optical Transport Network
OTU: Optical Transport Unit
SAN: Storage Area Network
SDH: Synchronous Digital Hierarchy

Network resilience

By using an Optical Transport Network as an overlay it is possible to add resiliency to legacy photonic networks where resiliency was previously not possible.

Service utilization and provisioning

Service requests for minimum or deterministic latency or specific protection schemes are more easily accommodated by an OTN enabled mesh network. OTN switching makes it easier for the telco to make service additions and changes.

CONCLUSION

With optical transport networking, telecom operators can move to a single converged network capable of cost-effectively and efficiently transporting new and legacy services in a way that maximizes network utilization.

Editor's Note: The author would like to thank Kevin Drury for his contribution to this article.

Find out more:
- Read the **Bell Labs: Metro Network Traffic Growth** Architecture Impact Study
- Read the blog **The Right Optics: Evolving the network to meet demand**

The right optics: Evolving the network to meet demand

David Stokes

As one of France's leading telecommunications providers, SFR's announcement that it would upgrade its national access network using ultra-broadband Wave Division Multiplexing, or 'WDM' gear, speaks volumes to what's happening with end user demand. The company's CTO Pierre-Alain Allemand pointed to insatiable customer demand for bandwidth as the primary reason to evolve to an IP/Optical converged infrastructure.

VIRTUAL CYCLE OF DEMAND

It's not only SFR that is facing this scenario. Consumers around the world want their services and content to be available wherever they are located, over fixed and mobile networks, and increasingly from the cloud.

We see little slow-down in this growth with research suggesting that global IP traffic will increase threefold over the next three years and that mobile data traffic will increase 13-fold between 2012 and 2017. This growth is being driven by the widespread rollout of LTE, rapid expansion of cloud services and new higher capacity TV formats such as 3DTV and 4K UltraHD.

Service providers, content providers and application developers are only too happy to provide these extra services. But this in turn puts pressure on the network providers to supply increased capacity to their customers' fixed and mobile devices. When consumers then see they have extra capacity, they use it for new services. And so the cycle continues.

SUPPLY & DEMAND

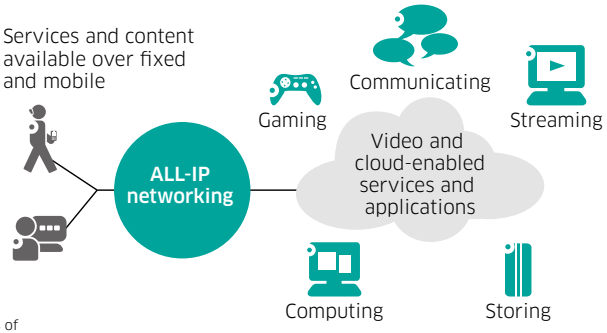
This is not a bad place to be – supplying a product that everyone wants. But to fully benefit, telecoms operators need to transform their network to cope with these new demands in a cost-effective way. The optical network is at the heart of supporting this transformation by providing high-capacity connectivity, along with the network flexibility and intelligence required to maximize network utilization.

NETWORK CAPACITY: A MAJOR CHALLENGE

Telecoms operators are now in a race to keep their networks up to speed with these changes in consumer demand and behaviour. Operators that fall behind risk losing their high value clients. So what exactly needs to be considered when evolving the network for this new era of devices and demands?

PROVIDE UNIVERSAL DEVICE SUPPORT

Increasingly these new services must be agnostic as to whether the consumer device is connected via a fixed or mobile network. And they need to be able to run as a cloud service, or provide cloud storage and backup. For example we see IP video offered by traditional broadcast, satellite TV companies and over the top players. These IP video services are available streamed and cached, real-time and catch-up, on mobile and fixed devices.



EVOLVE THE METRO TRANSPORT NETWORK

The metro transport network must provide the high-capacity, low latency, secure connectivity and provisioning flexibility required to support the new service demands.

In addition this metro transport network must be IP-aware to improve resource utilization and be able to react rapidly to support new services.

We are also seeing an evolution to an integrated metro transport network that is required not only to improve network efficiency but to also offer the network flexibility required to offer services over multiple media delivery mechanisms.

INVEST IN THE METRO TRANSPORT NETWORK

Telecoms operators require an integrated metro transport network that supports Ethernet-based cloud, mobile and video services. This dictates a packet-optimized metro DWDM core with traffic aggregation efficiency and versatility to ensure optimal user experience.

There's no turning back the clock when it comes to exponential bandwidth demand. It has driven one of the most significant shifts ever in operator business models. But by considering these strategies it is possible for network operators to get ahead of the cycle and back to the business of making customers happy.

Find out more about Alcatel-Lucent **Agile Optical Networking** solutions.

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