

OPTIMIZED 100G TRANSPORT

SELECTING A 100G SOLUTION
OPTIMIZED FOR SCALABILITY,
PERFORMANCE AND COST

STRATEGIC WHITE PAPER

Driven by video and application use, Internet traffic across fixed and mobile networks is expected to grow by a factor of five between now and 2013. To keep pace with surging bandwidth demands, service providers must find a way to cost-effectively scale capacity while maintaining reliability and quality of service for end users.

Alcatel-Lucent's market-leading, optimized 100G transport solution provides the best combination of scalability, performance and cost in existing and greenfield network applications. A complete, purpose-built solution based on single-carrier 100G coherent technology, it combines an internally developed electro-optics engine with the Alcatel-Lucent 1830 Photonic Service Switch – a key component of Alcatel-Lucent's Converged Backbone Transformation solution and High Leverage Network™ architecture.

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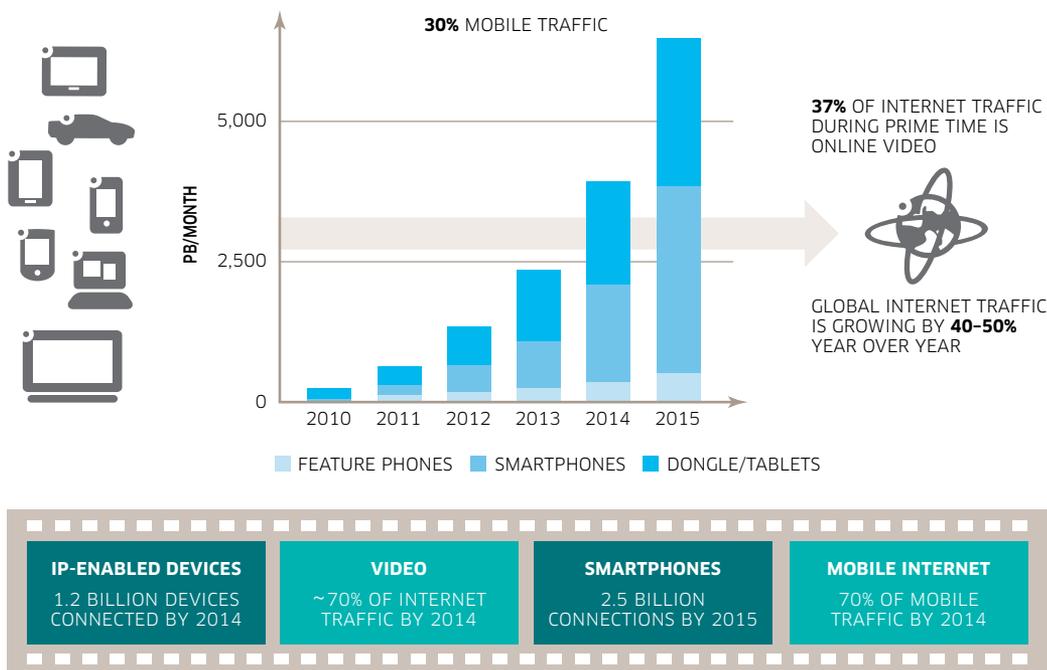
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MARKET DRIVERS FOR 100G TRANSPORT

A number of factors are currently driving service providers' need for 100G transport. First, video and content consumption is booming across fixed and mobile networks. According to studies conducted by Alcatel-Lucent Bell Labs, global Internet traffic is expected to grow by 40–50 percent year over year — and more than two-thirds of consumer traffic already consists of some type of video. At the same time, mobile traffic is expected to double each year for the foreseeable future, with demand for cloud-based service delivery further straining network capacity. Add to this mounting customer expectations of on-demand services that feature a high-quality user experience and it is easy to see why service providers must soon find a reliable, cost-effective way to increase capacity.

Figure 1. 100G market drivers



Source: Alcatel-Lucent Bell Labs analysis

Traffic growth is outpacing the capacity of networks and, specifically, the capacity of dense wavelength-division multiplexing (DWDM) equipment based on 10G and 40G technologies. Although more network capacity is clearly required, service provider revenues do not support the needed network build-out. What’s needed are new network solutions that support higher bandwidth technologies (i.e., in the 100G range) — technologies that are capable of maintaining a high quality of user experience and can be implemented without expensive network upgrades.

CHALLENGES FACED BY TODAY'S SERVICE PROVIDERS

Because of these capacity- and cost-crunch realities, service providers are asking themselves two key questions: What do I need to do to profitably address the traffic explosion? And how do I cost-effectively scale capacity while maintaining reliability and quality of service (QoS)? From the network perspective, the specific challenges faced by service providers are:

- Minimizing cost per transported bit as well as overall network total cost of ownership (TCO)
- Maximizing return on investment (ROI) on existing 10G and 40G or new fiber plant
- Maximizing wavelength utilization and flexibility

Many service providers are turning to 100G to address these issues — but are finding that only a 100G solution optimized for scalability, performance and TCO satisfies all requirements.

OPTIMIZING 100G TRANSPORT

An optimized 100G transport solution is one that can be flawlessly deployed, easily managed, and seamlessly and cost-effectively scaled while maintaining network reliability and QoS.

Table 1. Requirements for an optimized 100G transport solution

OPTIMIZED 100G TRANSPORT SOLUTION CRITERIA
COMMERCIALIZED SOLUTION
Tested and validated in live networks
Fully productized; volume production
Extensive field experience; stable performance
Deployed in diverse network configurations
Delivered in a purpose-built, scalable platform
FUTURE-PROOF PLATFORM
Seamlessly scalable platform
Capable of growth beyond 100G
OPTIMAL NETWORK PERFORMANCE
Flexible and variably priced reach for metro, regional and long-haul application
Advanced managed tolerance to polarization mode dispersion and chromatic dispersion
Patented engineering of improved spectral efficiency
OPTIMAL NETWORK TCO
Compatible with existing 10G and 40G wavelengths
Solid performance on existing (poor) fiber types
Low power consumption
High-density, minimal-footprint platform

A PURPOSE-BUILT 100G TRANSPORT SOLUTION

Alcatel-Lucent's market-leading 100G transport solution provides the best combination of scalability, high performance and low TCO in existing and greenfield network applications. The solution is based on next-generation single-carrier 100G coherent technology, an internally developed electro-optics engine, and the Alcatel-Lucent 1830 Photonic Service Switch (PSS) wavelength-division multiplexing (WDM) platform — a platform purpose-built for 100G and not simply 'bolted' onto legacy technology.

To further control delivery, performance and cost, an advanced electro-optics engine — developed in-house and based on Alcatel-Lucent Bell Labs innovations — provides best-in-class transmission reach, dispersion tolerance, resilience to non-linear effects, compatibility with 10G and 40G channels in existing networks, and the ability to achieve fast reconfigurations. Having shipped 100G coherent single-carrier products since mid-2010, Alcatel-Lucent has been able to continually improve product performance and reduce costs — in fact, Alcatel-Lucent will move to its next generation electro-optics engine before competitors deliver a viable first-generation product.

At a glance: The Alcatel-Lucent 100G transport solution

- First-to-market with a single-carrier 100 Gb/s transmission solution that utilizes an advanced electro-optics engine based on Alcatel-Lucent Bell Labs innovations
- Optimized signal modulation PDM-QPSK (fully compliant with OIF standards requirements) coupled with coherent detection driven by ultra-fast analog-to-digital converters (ADCs) and advanced digital signal processing (DSP) that is monolithically integrated in complementary metal-oxide semiconductor (CMOS) technology, in a compact and power-efficient design
- Outstanding optical transmission performance and TCO
- Deployed in many different network configurations, achieving both regional and long-haul reach over several different fiber types and operating with 10G, 40G and 100G mixed signals
- Includes a new premium card, the 100G eXtended Reach (XR), the first solution on the market capable of substantially extending the range, performance and capacity of 100G optical networks while cutting building and operating costs
- Will leverage future innovations in forward-error correction, modulation, digital signal processing and CMOS integration, in combination with Alcatel-Lucent's extensive production and field experience, to continually improve performance, TCO and investment protection

AT A GLANCE: THE ALCATEL-LUCENT 100G TRANSPORT SOLUTION

First-to-market with a single-carrier 100Gb/s transmission solution that utilizes an advanced electro-optics engine based on Alcatel-Lucent Bell Labs innovations

An optimized transport platform: Alcatel-Lucent 1830 PSS

100G technologies are packaged in the flagship 1830 PSS WDM platform. A highly extensible, reliable and networkable platform, it includes an industry-first switching architecture with 1 Tb/s and 2 Tb/s capacity and a 120 Gb/s per traffic slot in a single chassis, upgradable to 4 Tb/s and 8 Tb/s within the same shelves. The 1830 PSS portfolio supports single-carrier 100G next-generation coherent technology (PSS-16, 32, 36, 64), WDM networking and integrated terabit optical transport network (OTN) switching in a single platform (PSS-36, 64) that services optical networking applications and datacenter interconnects from access to core. Other complementary features include wavelength tracking, generalized multi-protocol label switching (GMPLS) control planes and robust operations, administration and management (OAM) capabilities.

A network-level solution

Alcatel-Lucent is the leader in 100G across optics and IP, delivering the world's first commercial end-to-end 100G solution that combines market-leading IP routing with optical transport technology to enable bandwidth scaling at the metro, edge and core — without performance degradation or the costs associated with complex network re-engineering.

The industry's only 100G IP/optics solution, it serves as a pillar for Alcatel-Lucent's Converged Backbone Transformation (CBT) solution — a key element of the High Leverage Network™ (HLN) architecture. The solution optimizes overall transport network efficiency, maximizing network bandwidth capacity while reducing network complexity for the lowest TCO — ensuring that service providers can profitably meet the demands of continued traffic growth on their networks.

100G DEPLOYMENT SCENARIOS

Typical applications for 100G include:

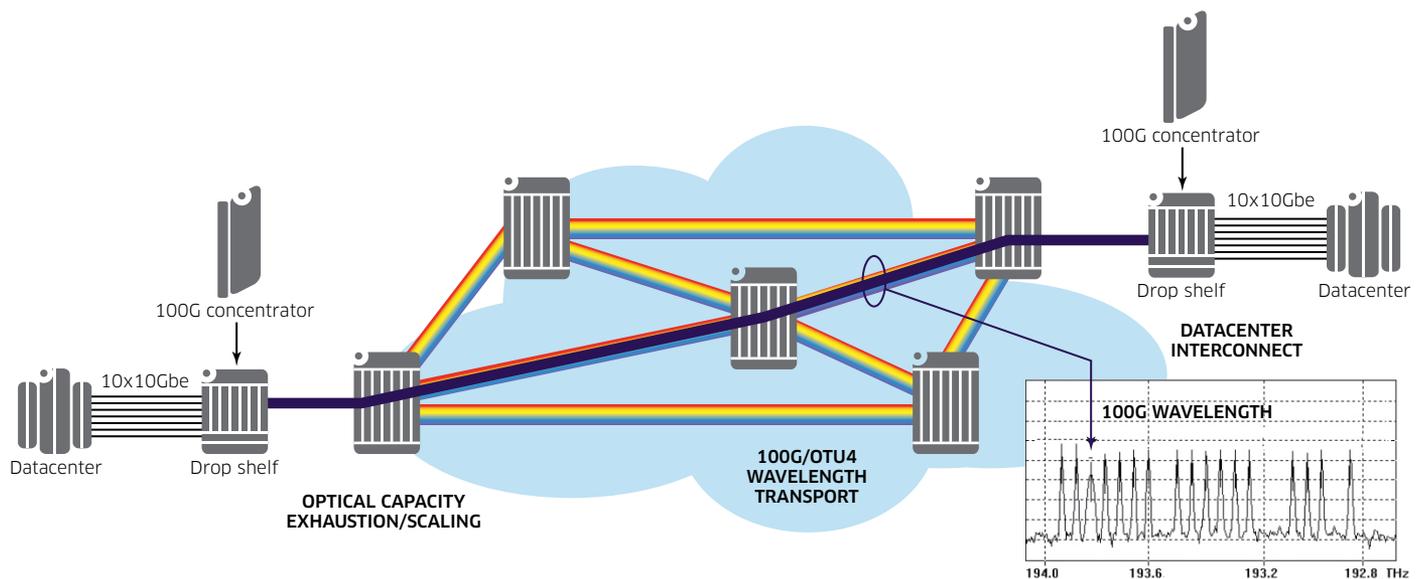
- Expanding capacity in an existing network, especially as an alternative to the expense and/or limitations of laying and lighting new fiber
- Deploying a new greenfield network to scale the overall network capacity and/or relieve network capacity strain/exhaustion
- Creating a converged backbone that utilizes 100G end to end across IP and optical to offload IP transit traffic from datacenters

Existing network

Objective: Expand capacity and datacenter interconnect using 100G concentrators.

- 100G improves cost efficiency (CAPEX/OPEX) compared to 10x10G channels
- Reuses existing DWDM 10G network (dispersion-compensating unit managed with 10G wavelengths, 50 GHz spaced), progressively upgrading individual 10G wavelengths to 100G
- Delivers 100G performance at 10G effort

Figure 2. Deployment scenario A: Existing network

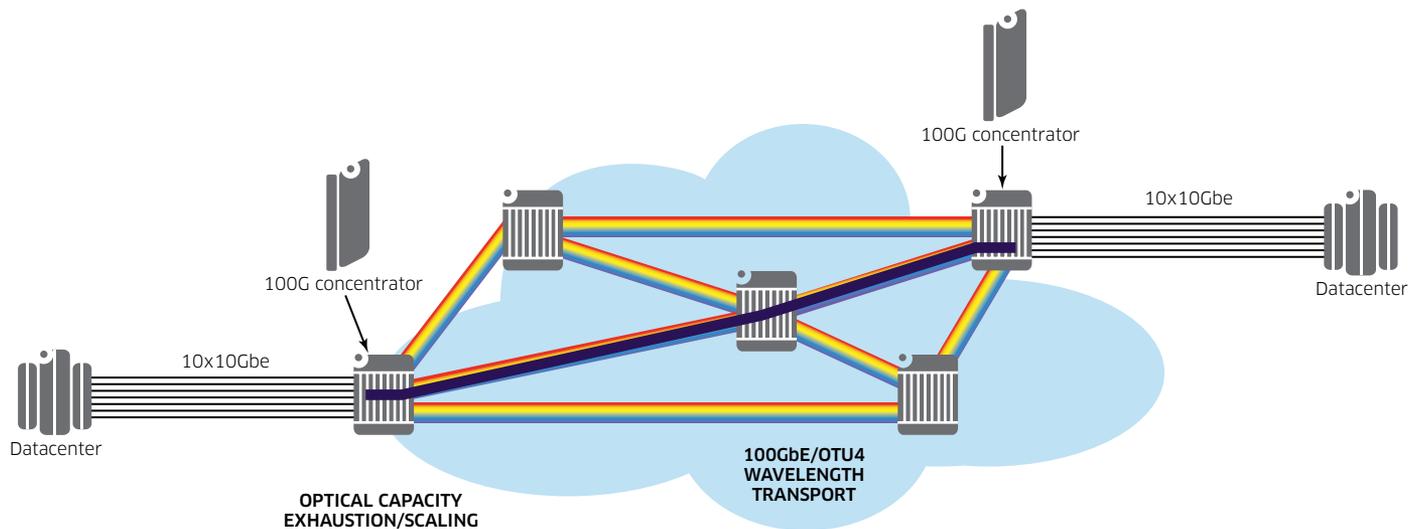


Greenfield network

Objective: Scale and relieve capacity exhaustion.

- Lowers cost, power and footprint requirements while providing higher capacity (8.8 Tb/fiber pair)
- Enables better performance and simpler operations (a single 100G wave is easier to manage than 10x10G channels)
- Allows for fast adaptability to network reconfigurations and faster restoration time
- Improves reach and lowers costs in networks without dispersion-compensating modules and with fewer optical-to-electrical-to-optical conversions
- Delivers optimal performance and TCO

Figure 3. Deployment scenario B: Greenfield network

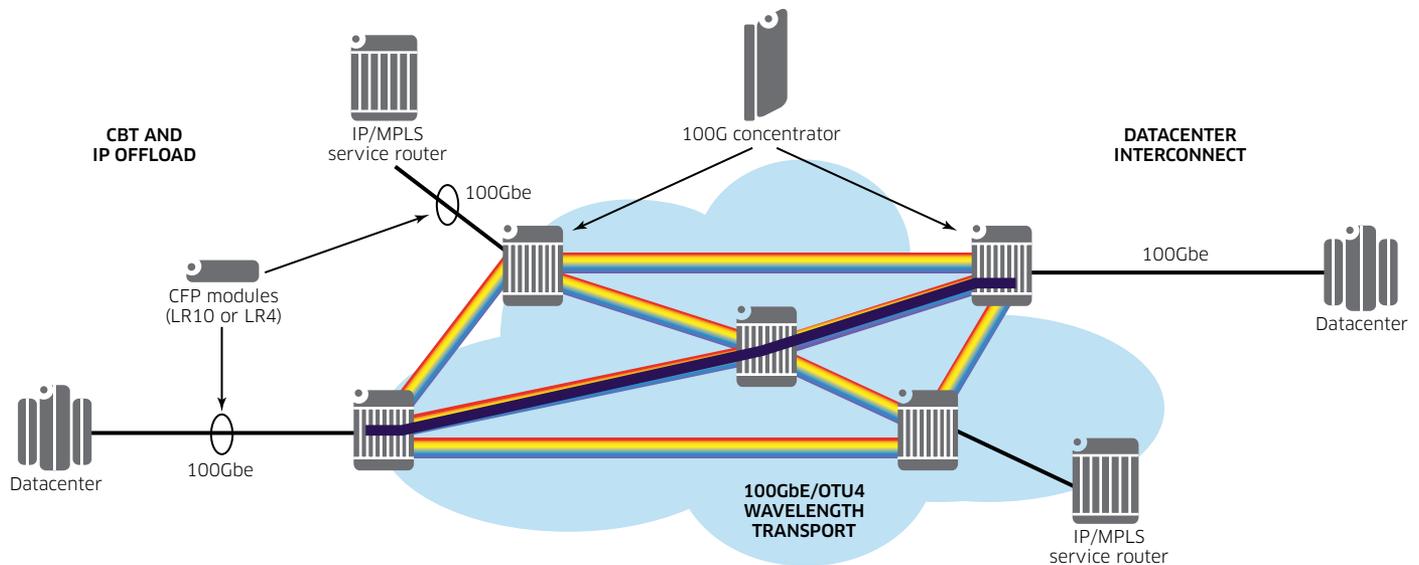


Converged Backbone Transformation and IP offload

Objective: IP offload of datacenter transit traffic and end-to-end integration of optical and IP.

- Reduces number of core routers and transponders by having the OTN/photonic switch handle transit traffic
- Provides better bandwidth filling at router level (100GE solves link aggregation group issues)
- Reduces network CAPEX, lowers OPEX, enables faster and more resilient end-to-end provisioning, and increases scalability

Figure 4. Deployment scenario C: Converged Backbone Transformation and IP offload



BENEFITS OF AN OPTIMIZED 100G TRANSPORT SOLUTION

For service providers, Alcatel-Lucent’s optimized 100G transport solution delivers several benefits associated with scalability, performance and cost:

- Meets increasing consumer and enterprise expectations for high-quality, high-bandwidth services on any device, any time, anywhere
- Provides future-proof scalability with no loss of performance today and inherent lower latency of 100G technology
- Minimizes cost per bit for transport by leveraging 100G and simplifying network planning for lower overall TCO
- Delivers a breadth of new, higher value services enabled by 100G
- Reduces power consumption and OPEX thanks to the ability of internally developed silicon to support more elegant designs, fewer components and decreased complexity
- The 100G eXtended Reach (XR) card substantially extends the range, performance and capacity of 100G optical networks while cutting building and operating costs

ALCATEL-LUCENT: THE LEADER IN 100G SOLUTIONS

Leveraging in-house Bell Labs innovations, Alcatel-Lucent has long invested in 100 Gb/s transmission and next-generation coherent technology research. In November 2007, the company conducted the industry’s first field trial of 100 Gb/s optical transmission over a live, in-service 504-km portion of the Verizon® network between Tampa and Miami, Florida, United States. In November 2009, Alcatel-Lucent carried out the first 100 Gb/s field trial based on the state-of-the-art PDM-QPSK modulation in conjunction with a coherent receiver. In that test, a 112-Gb/s channel with commercial margins was transmitted together with 40 Gb/s and 10 Gb/s channels carrying real traffic on a 1,088-km link in Telefónica’s network between Madrid and Merida via Seville, Spain.

In June 2010, Alcatel-Lucent was the first to market with a single-carrier 100G next-generation coherent solution based on PDM-QPSK modulation, leveraging highly integrated silicon, ultra-fast monolithic DSP, unique algorithms and high-gain FEC techniques. Availability of a 40G PDM-BPSK single-carrier solution followed shortly. In December 2011 the premium 100G XR card was added to the portfolio. It was the first solution on the market capable of substantially extending the range, performance and capacity of 100G optical networks while cutting building and operating costs. The 100G XR enlarges the practical 100G coherent application space by lowering barriers and bringing more 100G network topologies and use cases within range. It simplifies planning and link engineering and expands the number of network scenarios in which 100G can work reliably.

Both the 40G and 100G coherent solutions are the result of in-house developments, including best-in-class algorithms from Alcatel-Lucent Bell Labs and ultra-high speed digital silicon circuits that enable coherent detection and real-time signal processing. These were combined in a circuit pack featuring a very high level of integration — both electronic and photonic—as well as best-in-class density and power consumption.

In addition, Alcatel-Lucent offers technical leadership in the fabrication, testing and deployment of single-carrier coherent solutions. Innovations in FEC, DSP, and CMOS integration will further improve the performance, TCO and investment protection benefits of these solutions.

Network deployments

Alcatel-Lucent has deployed numerous coherent solutions in a full range of applications and operator types, including traditional service providers for wireline and wireless networks, cable operators, datacenters, and national research and educational networks.

Standardization

Alcatel-Lucent has been a leader in the standardization of 100 GigE and 40 GigE in the Institute of Electrical and Electronics Engineers (IEEE). Alcatel-Lucent is also a major player within the International Telecommunication Union, Telecommunication Standardization Sector (ITU-T) and Optical Interworking Forum (OIF) for the consistent transport of 100 GigE and 40 GigE within Optical Transport Unit (OTU) 3/4. Some of the key standardization products for 40G and 100G include:

- *IEEE 802.3ba: IEEE standard for information technology: Telecommunications and information exchange between systems: Local and metropolitan area networks: Specific requirements* (June 2010)
- *ITU-T G.709: Interfaces for the optical transport network (OTN)* (October 2009)
- *OIF-FD-100G-DWDM-01.0: 100G ultra-long-haul DWDM framework document* (June 2009)

SUMMARY: ENABLING A SEAMLESS TRANSITION TO 100G

Service providers considering the move to 100G are encouraged to explore all the critical components of a truly optimized 100G transport solution — not just the transponder costs but also the overall scalability, performance and TCO of the solution. When implemented through a vendor with a high level of technology investment, production and field experience, a purpose-built and networkable 100G solution enables a seamless transition to 100G while delivering substantial benefits that far outweigh mere port-level cost factors.

Alcatel-Lucent's market-leading 100G transport solution provides the best combination of scalability, high performance and low TCO for service providers that need to cost-effectively scale capacity to meet today's exploding bandwidth demands while maintaining reliability and QoS for their end users.

ACRONYMS

ADC	analog-to-digital converter
BPSK	binary phase-shift keying
CAPEX	capital expenditure
CBT	Converged Backbone Transformation
CMOS	complementary metal-oxide semiconductor
DAC	digital-to-analog converter
DSP	digital signal processing
DWDM	dense wavelength-division multiplexing
FEC	forward-error correction
Gb/s	gigabits per second
GMPLS	generalized multi-protocol label switching
HLN	High Leverage Network™
IEEE	Institute of Electrical and Electronics Engineers
ITU-T	International Telecommunication Union, Telecommunication Standardization Sector
LAG	link aggregation group
OAM	operations, administration and management
OEO	optical-to-electrical-to-optical
OIF	Optical Internetworking Forum
OPEX	operational expenditure
OTU	optical transport unit
OTN	optical transport network
PDM	polarization-division multiplexing
PSS	Photonic Service Switch
QoS	quality of service
QPSK	quadrature phase-shift keying
ROI	return on investment
Tb/s	terabits per second
TCO	total cost of ownership
WDM	wavelength-division multiplexing

CONTACTS

For more information about Alcatel-Lucent's advanced coherent technology, 1830 Photonic Service Switch portfolio or the High Leverage Network™ architecture, please visit www.alcatel-lucent.com or contact your Customer Team representative.

REFERENCES

Advanced electro-optics technology: Addressing the challenge of capacity growth in optical networks (Alcatel-Lucent technology white paper)

