OPTIMAL SOLUTIONS FOR DATA CENTER CONNECT (DCC)

STRATEGIC WHITE PAPER

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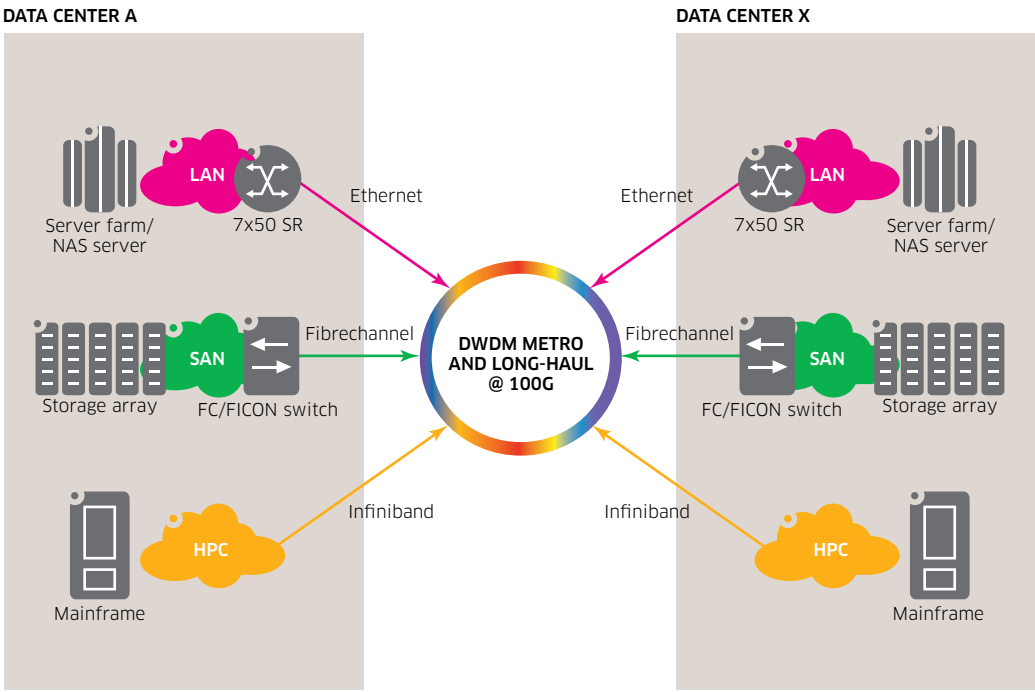
In a Web 2.0 world, enterprise customers expect anywhere, anytime access to storage and computing capabilities from their service provider (SP). Accommodating these demands for large numbers of enterprise customers, each with many sites, spread over a large geographic area, has driven SPs to implement highly scalable storage and computing resources in their data centers. These data center resources can be dedicated to individual customers or applications, or can be virtually "shared" for optimal utilization.

This new generation of virtual computing and storage resources dictate that SPs need more than a pair of (active and backup) data centers — and typically require many data centers to support their enterprise customer base. Low latency transport enables multi-data center architectures, where all data centers are connected together with a scalable and redundant mesh of high-speed links. The data center mesh then delivers processing, storage, and networking to end-user locations for optimal application performance, even though the underlying data may be moving dynamically between data centers attached to the mesh.

Figure 1. Datacenter Connect Architecture



Delivering these services puts increased demands on the metro and long haul Wide Area Networks (WANs) that create the data center mesh. Ultimately, the network is the mechanism that has to deliver a high quality experience to the end users, and this, in turn, drives SPs to demand new technology innovation.

Dense Wave Division Multiplexing (DWDM) transport is the leading technology to meet Data Center Connect (DCC) requirements. DWDM is the only solution that enables full network flexibility and adaptability at speeds of 100G and beyond, quick service turn-up to meet dynamic bandwidth requirements, ultra-low latency connectivity, and transport-grade reliability. Ultimately, DWDM solutions enable the highest throughput for DCC at the lowest total cost of ownership (TCO) for SPs.

Alcatel-Lucent is a worldwide leader in optical transport innovation with a complete portfolio of terrestrial and submarine transport solutions, including the 1830 Photonic Service Switch (PSS), a scalable DWDM platform that supports data center aggregation of Ethernet, Fiber Channel (FC), and Infiniband (IB) data sources. Using internally developed silicon, the 1830 PSS was the first platform to support 100G coherent DWDM in a single wavelength. The 1830 PSS also supports efficient wavelength switching between source and destination using Tunable-Reconfigurable Optical Add-Drop Multiplexing (T-ROADM).

Capabilities of the 1830 PSS are further enhanced with support for efficient L2 Ethernet services over the optical infrastructure, and a Generalized Multiprotocol Label Switching (G-MPLS) control plane that enables automated set-up, provisioning, and restoration of the optical layer, decreasing operating expenses and increasing uptime. Additionally, built-in hardware encryption addresses secure communication for critical applications in DCC.

The Alcatel-Lucent 1830 PSS provides the features, interfaces, reliability, and reach required to optimize DCC across metro and long haul WANs.

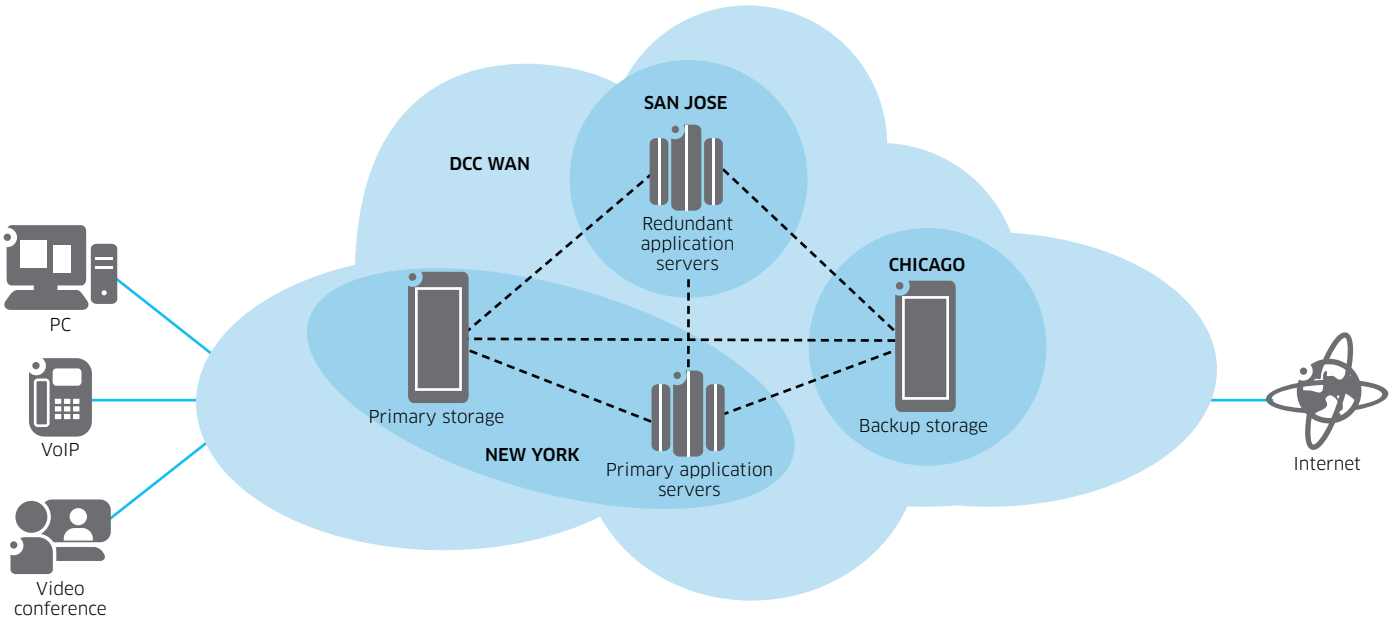
Data center evolution

According to the May 2011 “Annual Data Center Survey” conducted by the Uptime Institute, 36 percent of data center respondents said their facility would run out of power, cooling, or space in 2011 or 2012; and 60 percent claimed they would need to build new data center(s) and/or perform upgrades over the next three years. Respondents also claimed that their primary data center concerns were scalability, flexibility, and overall cost reduction. Addressing these concerns influences decisions inside the data center, and also on the DCC architecture across both metro and long haul networks.

Legacy data center interconnection typically consisted of a primary and a secondary site, connected through a short (20 km to 50 km) optical leased line, inside a single metro area. In this architecture, the primary data center supported compute and storage resources for all end users and the secondary site existed mainly for redundancy and disaster recovery purposes.

Although SPs continue to require support for such legacy point-to-point data center architectures, SPs are now focused on multipoint-to-multipoint meshed architectures in support of data center interconnection, as this is the only solution that can meet capacity and redundancy requirements driven by virtual computing and storage. A key consideration for this meshed architecture is that both applications and content move dynamically between the geographically meshed data centers. The resulting WAN must meet enterprise requirements (bandwidth, service quality, latency) for applications and content regardless of where the end user resides, and regardless of which data center provides the end services.

Figure 2. Multi-point Meshed DCC WAN



What are some of the key concerns for data center evolution?

- Overall economics, including capital expenses, power consumption and space used
- Maximizing utilization on links and minimizing cost per bit transported, including the convergence of Storage Area Network (SAN) and Local Area Network (LAN) traffic
- End-to-end (E2E) management to decrease time spent on frequent operations tasks such as provisioning
- Network capacity to support logarithmic growth in inter-data center high definition video traffic

In support of this evolution, DCC requires compact, power-efficient platforms that can ensure the highest levels of availability, can guarantee application performance, are Ethernet-capable, and can scale to match uncertain traffic projections, ultimately bringing increased value to the data center infrastructure.

What are the requirements for the DCC regardless of the technology deployed?

- Converged aggregation capabilities for Ethernet, FC, and IB
- Scalable transport on network fiber, from 10G to 100G and beyond, on the same fiber pair
- Guaranteed quality of service (QoS) for all traffic
- Low latency to support applications such as disaster recovery and SAN replication
- Lossless transport of business-critical applications
- < 50 ms protection switching for reliability and uptime of the service
- Photonics-level operations, administration, and maintenance (OA&M) in support of fast fault detection, isolation, and resolution
- Dynamic bandwidth-on-demand in support of changing application and service requirements
- Built-in encryption capabilities for application security across the public cloud
- Integrated wavelength identification for E2E wavelength uniqueness across the optical network
- Integrated, remote power management to ensure that the wavelength meets required signal quality levels across the network

Why DWDM transport for DCC?

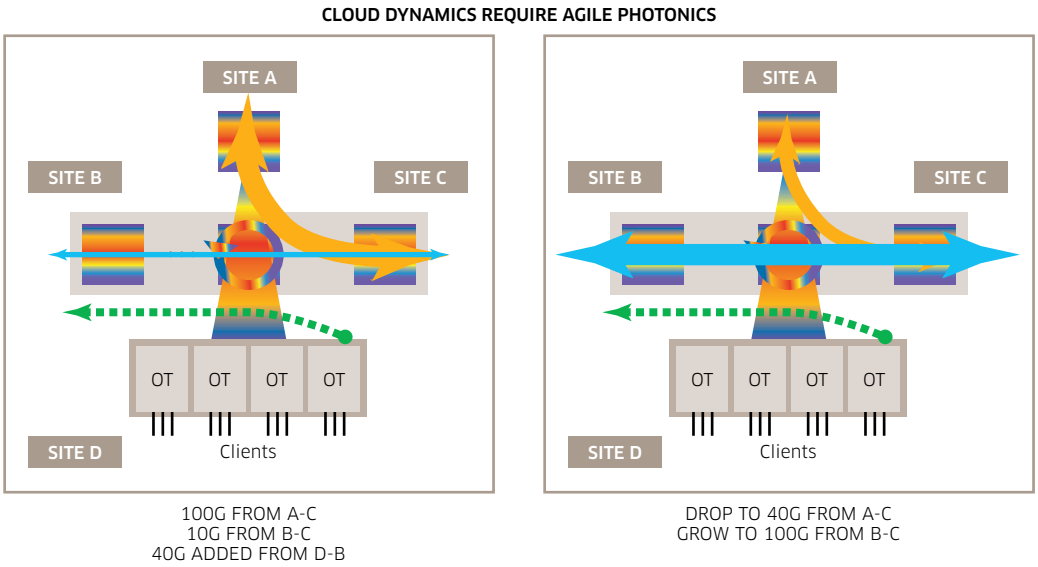
According to Current Analysis in their June 2011 report, "Clouds, Networks, and the Data Center – How Do They Communicate?": "…vendors have been busy launching next-generation data center architectures and solutions, mostly focused on the issues related to 'inside' the data center…. However, the need to communicate effectively over the WAN will become an even more critical factor…".

DCC built on DWDM provides the ultimate solution to address the concerns of data center evolution. DWDM with T-ROADM provides the highest level of scale and flexibility for switching data center traffic, along with metro and long haul reach, high reliability, and OA&M. DWDM delivers low latency across a predictable infrastructure of high-speed optical channels from 10G to 100G and beyond, and provides the lowest overall TCO of any DCC solution.

Starting with a wavelength router, tunable optics and colorless optical transponders support connectivity from and through the DWDM platform. Multi-degree, directionless Reconfigurable Optical Add-Drop Multiplexing (ROADM) adds the flexibility for any wavelength to be connected to/from any direction across the optical infrastructure. G-MPLS controls signaling then addresses the real-time, dynamic nature required of connectivity between optical DWDM sites. This feature list can then be further enhanced by providing full Ethernet aggregation capabilities. Security, another critical element in DCC, must be supported by providing encryption capabilities for mission-critical traffic. Finally, high channel capacity (> 80 wavelengths per fiber) and high speed (10G, 40G, and 100G channels) are required for DCC to meet expanding capacity requirements between data center sites on the mesh.

Per the Figure 3 below, T-ROADM supports rapid set-up and changes to wavelength transport across the entire DWDM network. This is required to support the dynamic nature of application and content traffic generated by enterprises into data centers, and also between data centers. Combining many wavelengths onto a single fiber maximizes the efficiency of each fiber pair, and converging traffic types (Ethernet, FC, and IB) onto a single wavelength further increases the efficiency of each wavelength maximizing overall utilization on the WAN. For fully converged DCC operation, packet aggregation functionality must be integrated into the ROADM, including support for the full set of Ethernet protocols.

Figure 3. Adding and Dropping Wavelengths for DCC



100G FROM A-C
10G FROM B-C
40G ADDED FROM D-B

DROP TO 40G FROM A-C
GROW TO 100G FROM B-C

Dedicated, high-speed channels (wavelengths or sub-wavelengths) on DWDM spans deliver low latency connectivity, and because the optical network does not process the traffic, there is no contention on the DCC channels between sites, resulting in lossless transport.

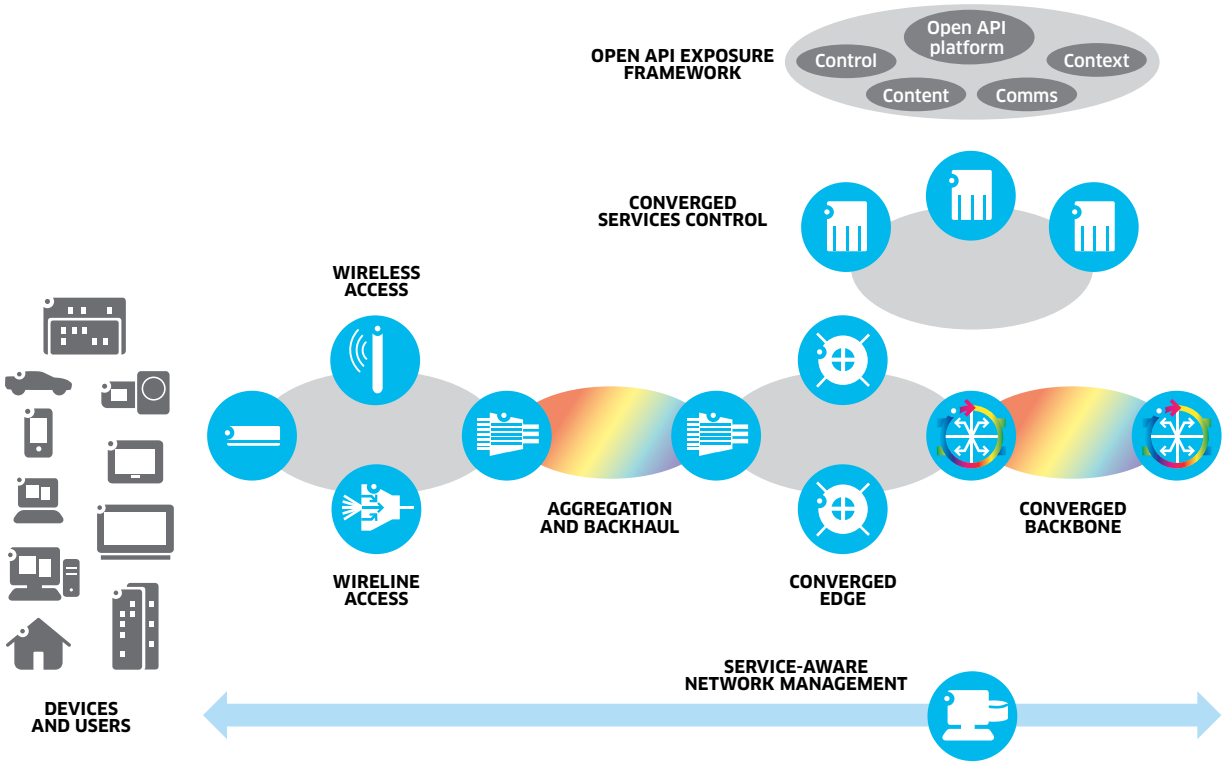
The Yankee Group often quotes overall service availability as the key attribute required from the cloud, and the use of DWDM can provide the highest level of availability and highest level of flexibility for DCC. Finally, DWDM supports the metro and long haul and WAN connectivity for DCC, over spans of > 2000 km.

The Alcatel-Lucent 1830 PSS: The leading DWDM solution for DCC

The Alcatel-Lucent 1830 PSS is a best-in-class DWDM platform, including 100G coherent optics, T-ROADM, photonic OA&M, and metro to long haul reach. Scaling higher than 2 TB in a single chassis, and as low as a single slot version, the 1830 PSS also supports interchangeable line cards. This fourth generation Wave Division Multiplexing (WDM) solution was developed to maximize wavelength utilization levels, while meeting strict service level agreements (SLAs) with ultra-fast restoration and coordinated network management.

Alcatel-Lucent has the largest optics installed base in the world. With more than 70 references for the 1830 PSS alone, the product plays a key role in the Alcatel-Lucent High Leverage Network™ (HLN) architecture, supporting integrated DWDM and optical transport network (OTN) switching as part of the Converged Backbone Transformation solution.

Figure 4. Alcatel-Lucent High Leverage Network (HLN)



The 1830 PSS decreases operating expenses (OPEX) through industry-leading power efficiency < 2 W/Gb/s, and automated provisioning and restoration through a G-MPLS control plane. G-MPLS/Automatically Switched Optical Network (ASON) also supports automated topology and services discovery, and supports optimized path computations to minimize latency across the network.

In implementing Zero Touch Photonics (ZTP), the 1830 PSS transforms traditional WDM into a flexible DCC transport layer with complete end-to-end visibility and traceability of individual wavelengths.

Key DCC features of the Alcatel-Lucent 1830 PSS:

- Support for any mix of client traffic (Ethernet, FC, and IB) onto WDM
- Support for L1 encryption at ultra-low latency (with FIPS 140-2 certification)
- Encryption key management, with hitless key rotation
- Certified interoperability with leading FC switching and storage vendors
- Ethernet aggregation function, including support for Ethernet protocols
- Tunable and reconfigurable Optical Add-Drop Multiplexer (OADM) with single wavelength add-drop granularity
- Colorless and directionless add-drop of wavelengths up to 10 degrees
- Up to 88 wavelengths per fiber pair, using ITU 50 GHz grids, at 100G
- OTH G.709 transport interfaces at ODU1 (2.5G), ODU2 (10G), ODU3 (40G), and ODU4 (100G) rates, including integrated checksums to guarantee the correctness of the data
- Mix of 10G, 40G, and 100G DWDM onto a fiber pair
- 96x10G per rack and 15x100G interfaces per rack
- Optical reach of 1600 km @ 100G for 88 channels = 8.8 Tb/s of traffic per fiber
- Optical reach of 3200 km @ 10G or 40G for 88 channels
- Leading PDM-QPSK coherent 100G optics, and PDM-BPSK 40G coherent optics, without interference to existing 10G channels on a fiber pair
- Alien wavelength management
- Integrated intrusion detection with a 0.5 dB threshold, for immediate detection of potential interference on optical fibers
- Flexible protection/restoration options per wavelength, including diverse routed protection, dedicated and shared protection options, and 1 + 1 protection
- Full OA&M and provisioning using the 1354 Photonic Manager (PHM)
- G-MPLS/ASON cross-layer automation and resilience
- Wavelength Tracker (WT) to automatically monitor and adjust wavelengths and power levels at any point in the network, without requiring manual Optical Spectrum Analyzers (OSA)

Supported DCC interfaces on the Alcatel-Lucent 1830 PSS:

- Fast Ethernet, Gigabit Ethernet, 10GigE (LAN and WAN), and 100GigE
- 4x10GigE Muxponder (40G) and 10x10GigE Muxponder (100G)
- Fiber Channel 1G, 2G, 4G, 8G, and 10G
- FICON 1G, and 2G; and FICON-Express
- Infiniband 5G
- IBM Intersystem Channel ISC-3 peer-mode
- Video: SD-SDI, HD-SDI, DVB-ASI
- Transponderless (direct connection) support of ITU-grid wavelengths from external equipment

Muxponder functionality is a key driver for evolving DCC WANs, and is supported at 10G, 40G and 100G on the 1830 PSS. The ability to take multiple existing 10GigE interfaces and combine these Ethernet clients onto 40G or 100G wavelengths can immediately address bandwidth scaling issues on the WAN while decreasing network complexity and increasing efficiency. Many such Muxponder wavelengths can also be combined onto a single fiber optic pair to quickly and drastically increase overall DCC WAN capacity. Similarly, the ability to take high throughput 8G/10G FC interfaces and transport them between data centers with low latency is a key enabler for mission-critical applications such as High Frequency Trading (HFT), used by financial institutions.

For SPs, optical transport between data centers using the Alcatel-Lucent 1830 PSS represents a premiere, interoperable solution to meet DCC networking require-ments with the world's leading provider of DWDM. Furthermore, SPs with an installed base of the Alcatel-Lucent 1830 PSS can instantly enable additional services on their DWDM transport network, decreasing time to market and multi-service cost of ownership.

First to market with coherent 100G

The Coherent 100G transport is an important solution for DCC transport across a meshed infrastructure. Service providers are deploying 100G today to address immediate bandwidth demands; or deploying 100G coherent-capable DWDM systems to meet future capacity requirements. SPs are also using Muxponders to aggregate 10GigE and high capacity FC interfaces onto more efficient 100G transmission systems, eliminating fiber exhaust and costly fiber build-outs.

Simply put, 100G coherent is the right technology to meet DCC scale and efficiency challenges in meshed data center interconnection; and Alcatel-Lucent is the right vendor to provide this technology — with more than one year of experience in mass production and customer deployments. The 100G is more efficient and more cost effective per bit, and it is the only solution capable of meeting current and future bandwidth demands. Alcatel-Lucent was first to market with 100G coherent optics on the 1830 PSS, and remains the only vendor to deliver a 100G coherent solution that uses a single (wavelength) carrier. A single carrier imple-mentation maximizes the number of wavelengths that can be transported across a single fiber pair.

The use of 100G coherent detection combined with powerful signal processing allows for fully compensating linear transmission impairments, providing the benefit of being able to reach distances over 2000 km. This technology requires ultra-fast Digital Signal Processing (DSP) in a complementary metal oxide semi-conductor (CMOS). With the Alcatel-Lucent internally developed silicon DSP, and Bell Labs algorithms, the Alcatel-Lucent 100G coherent solution eliminates dependencies on third-party vendors for next-generation transport technologies. The solution is also the lowest power available in the industry at < 2 W/Gb/s, providing the additional benefit of OPEX reduction.

SUMMARY

Service providers are already virtualizing and distributing applications and storage across the WAN, driving meshed data center architectures. The support-ing Data Center Connect infrastructure will only be successful when it delivers cost-effective scale and meets user requirements for reliability and latency.

This evolution will be addressed through the DWDM infrastructure, with integrated T-ROADM for flexibility, and metro and long haul 100G transport to meet scale and reach requirements. The infrastructure will deliver fixed, predictable latency without traffic loss, and high reliability. It is also inherently protocol transparent.

Alcatel-Lucent is the leader in optical transport solutions worldwide, and the 1830 PSS — with first to market 100G coherent DWDM — provides the lowest TCO, lowest risk, and most capable solution available. This is the solution of DWDM and T-ROADM at 100G that service providers need today for DCC.

For additional information

- Alcatel-Lucent 1830 PSS: www.alcatel-lucent.com/1830
- Alcatel-Lucent 100G coherent: www.alcatel-lucent.com/100g
- With operations in more than 130 countries and one of the most experienced global services and support organizations in the industry, Alcatel-Lucent is a local partner with global reach. Visit the Alcatel-Lucent Web site at www.alcatel-lucent.com.