When choosing the best technology and the right products to meet their data center connect (DCC) networking requirements, enterprises must fully understand the challenges to be addressed and the applications that must be supported. In particular, a DCC solution must accommodate rapidly increasing volumes of data between data centers, improve the quality of inter-data center disaster recovery and enable OPEX reductions by consolidating networking resources. Optical Wave Division Multiplexing (WDM) is the technology of choice to address the high-bandwidth, low-latency, multi-protocol transport requirements of mission-critical data across enterprise metro and long-haul DCC networks. Satisfying these requirements with versatility and scale, the Alcatel-Lucent 1830 Photonic Service Switch (PSS) allows enterprises to realize lower IT costs, while improving network reliability and performance for DCC.
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1 DATA CENTER NETWORKING CHALLENGES

Today’s enterprises face four key DCC networking challenges, driven primarily by the continuous and unpredictable demand for computing and storage across all data center applications. Each of the following challenges places demands on the underlying DCC infrastructure.

Enterprises must:

• Continue to improve on their critical business continuity-disaster recovery (BCDR) capabilities
• Support growth in the volume and types of mission-critical data
• Consolidate data centers to increase efficiency and decrease CAPEX and OPEX
• Support converged storage resources to accommodate massive scalability demands

1.1 Improving BCDR capabilities

Data centers provide crucial support for enterprise applications and data. Therefore, improving BCDR capabilities that enable resilient, uninterrupted access to services is a top priority for IT decision-makers1, and enterprises continue to upgrade these capabilities each year to meet business uptime requirements.

Primary research shows that “two-thirds of IT decision makers see guaranteed cloud performance as critical for essential operations,”1 and such performance guarantees are not currently available from most cloud offerings. Although enterprises are evaluating future cloud-based infrastructure services, such as Disaster-Recovery as a Service (DRaaS), for non-critical applications and data, they continue to deploy dedicated DCC infrastructures for real-time protection of their mission-critical data. BCDR requirements for bandwidth, latency and resiliency must be met by both intra-data center and inter-data center networking infrastructure.

1.2 Growth of mission-critical data

Enterprises also regard a growing range of applications as being “mission critical.”2 Because of the complex inter-dependencies of enterprise systems, previously non-critical applications, such as e-mail and collaboration software like Sharepoint, are now considered to be mission critical. As a result, the data used by these new applications requires a higher degree of availability to meet enterprise quality requirements.

As enterprise storage requirements grow at 60 percent annually, and the relative percentage of mission-critical data increases, enterprises must provide resilient support for this growth. This includes replicating mission-critical information synchronously in real-time, which puts additional performance pressure on the DCC network infrastructure.

2 “Understanding the market opportunity for carrier cloud services,” Alcatel-Lucent, June, 2012.
1.3 Data center consolidation
Data center consolidation is one of the most effective methods for lowering the overall cost of IT operations. Larger data centers are simply more cost effective on a per-unit basis for computing and storage. Consequently, enterprises are consolidating their existing data centers in new strategic locations, often placing these large data centers outside major cities, where real estate costs are lower. To realize lower overall energy costs, some are built near greener energy sources, such as hydro dams or improved solar or wind locations.

These larger data centers hold greater volumes of storage data and increasing numbers of applications. Therefore, higher performance is required across the DCC infrastructure to enable data- and application-sharing with remote data centers, which may be separated by large distances.

1.4 Convergence of storage
To satisfy the massive storage requirements of an “always-on” business culture, enterprises are turning to federated storage systems. This technology enables virtual clustering of resources over large distances, creating storage networks with virtually unlimited capacity and improved BCDR. Federated storage systems can eliminate disruptive data migrations and allow business applications to share storage over local, metro or global distances.

The DCC networking requirements of federated storage are similar to those of BCDR solutions. They need high bandwidth, low latency and multi-protocol storage support over long distances.

2 DATA CENTER CONNECT TECHNOLOGIES
Various networking technologies are available to address diverse DCC networking challenges, and large enterprises often use multiple technologies to support applications with different performance requirements. To select an appropriate technology, enterprises must analyze the following key requirements:

- The type of applications using the DCC network
- Overall bandwidth requirements across the DCC
- Latency requirements for mission-critical applications
- The types of client interfaces (both computing and storage) which must be aggregated over the network
Table 1 identifies the optimal networking technology to support the requirements of typical DCC applications. The applications are organized into tiers, with Tier 1 applications requiring a DCC solution with the highest performance. The tiers are then mapped onto networking technologies that can meet the underlying requirements of the application.

### Table 1 – Optimal technologies for typical DCC applications

<table>
<thead>
<tr>
<th>DATA CENTER APPLICATION</th>
<th>APPLICATION PERFORMANCE REQUIREMENT</th>
<th>EXAMPLE APPLICATIONS</th>
<th>DCC NETWORKING TECHNOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 1</td>
<td>&lt; 5 msec latency</td>
<td>BCDR (synchronous)</td>
<td>Optical WDM</td>
</tr>
<tr>
<td></td>
<td>&gt; 100 Gb/s bandwidth</td>
<td>Federated storage - data collaboration (metro)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 100 ports of FC, FICON, iB transport</td>
<td>Federated storage - data migration (metro)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Content delivery and video caching synchronization</td>
<td></td>
</tr>
<tr>
<td>Tier 2</td>
<td>&lt; 50 msec latency</td>
<td>BCDR (asynchronous)</td>
<td>Optical WDM</td>
</tr>
<tr>
<td></td>
<td>&gt; 20 and &lt; 100 Gb/s bandwidth</td>
<td>Tape vaulting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 20 ports FC, Ethernet</td>
<td>Bandwidth aggregation (DC consolidation)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Federated storage - data collaboration (regional/national/international)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Federated storage - data migration (regional/national/international)</td>
<td></td>
</tr>
<tr>
<td>Tier 3</td>
<td>&lt; 20 Gb/s bandwidth</td>
<td>Server-based replication</td>
<td>Layer 2 Ethernet</td>
</tr>
<tr>
<td></td>
<td>&lt; 20 GE ports</td>
<td>NAS backup</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remote tape backup</td>
<td></td>
</tr>
<tr>
<td>Tier 4</td>
<td>&lt; 2 Gb/s bandwidth</td>
<td>NAS backup</td>
<td>Layer 2 Ethernet or Layer 3 IP</td>
</tr>
<tr>
<td></td>
<td>&lt; 10 GE ports</td>
<td>Remote tape backup</td>
<td></td>
</tr>
</tbody>
</table>

Layer 3 IP transport, widely available through service provider VPN services, is often deployed in support of data center Tier 4 applications that have unbound latency and lower bandwidth requirements.

With Layer 2 Ethernet services now generally available from service providers, Ethernet transport is typically deployed to address Tier 3 and Tier 4 metro and regional application requirements.

Optical WDM is the technology of choice to address the high-bandwidth, predictable low-latency and multi-protocol requirements of Tier 1 and Tier 2 data center applications. To support DCC transport, enterprises may build their own private optical WDM networks, or they may lease managed wavelengths from service providers, thus satisfying DCC transport requirements inside a metro area or across the long-haul network between data centers.
Ultimately, enterprises will continue to rely on private WDM networks or leased wavelength capacity to support mission-critical Tier 1 and Tier 2 DCC applications. But in addition, they will need service provider networks that interconnect remote enterprise data centers or public data centers to support Tier 3 and Tier 4 applications. Figure 1 shows a network blueprint for such transport.

3 ALCATEL-LUCENT 1830 PHOTONIC SERVICE SWITCH (PSS) FOR ENTERPRISE DCC

The Alcatel-Lucent 1830 PSS supports a variety of optical data center interconnect deployments. The following overview describes its main capabilities, which enable versatile and scalable data center connect.

3.1 Versatility and scalability with the Alcatel-Lucent 1830 PSS

The 1830 PSS is a multi-reach platform that can be used for long-haul to regional and metro DCC transport. It delivers an unparalleled range of client-side data interfaces and network outputs, enabling scalable interconnection of data centers for Tier 1 and Tier 2 applications. It also provides versatility for adapting to the most challenging optical DCC deployments, with support for point-to-point, ring and mesh architectures.
3.1.1 Alcatel-Lucent 1830 PSS systems
The Alcatel-Lucent 1830 PSS is available in three shelf form factors that address small to very large DCC requirements.

The 1830 PSS-4 offers four half-height slots or two full-height slots that support CWDM and DWDM with fixed OADM (FOADM) for point-to-point DCC. AC or DC power options are available for deployment flexibility, and the PSS-4 shelf supports multi-shelf applications for increased low-end scalability and adaptation to future demands.

The 1830 PSS-32 has 32 half-height or 16 full-height slots, and the 1830 PSS-16 has 16 half-height or 8 full-height slots. They support DWDM as fixed, reconfigurable and tunable OADM rings, meshed architectures, or point-to-point DCC architectures.

3.1.2 Scalability
The Alcatel-Lucent 1830 PSS supports a unified portfolio of universal transponder and muxponder line cards that can be deployed in the PSS-4/16/32 shelves. While some solutions require dedicated spare cards for each shelf configuration, the 1830 PSS offers a universal portfolio. It reduces capital costs by allowing fewer shared cards to be purchased for sparing, since they are supported across all shelf configurations.

The Alcatel-Lucent 1830 PSS supports WDM networking options at 2.5 G, 10 G, 40 G and 100 G, with 400 G soon to be available. It supports metro, regional, long-haul and ultra-long-haul network reach, with a variety of optimized modulation schemes. The channel capacity per fiber can grow from a single wavelength per fiber pair to an industry-leading 88 wavelengths (8.8 T total with 100 G waves) per fiber pair.
For additional DCC convergence and flexibility, the Alcatel-Lucent 1830 PSS supports the IBM Geographically Dispersed Parallel Sysplex (GDPS) server clustering application and has been certified to interoperate with the Symmetrix Remote Data Facility (EMC SRDF) synchronous solution for business continuity.

### 3.1.3 High-capacity DCC

Large enterprises that require high-bandwidth interconnect between data centers over their private metro, regional or national footprint deploy the Alcatel-Lucent 1830 PSS to deliver the most advanced 100G technology, with transponders and muxponders optimized for metro, regional or national reach.

In particular, the 1830 PSS high-capacity muxponder (HCM) is a metro-focused line card that supports 112 G of capacity for 100-G data rates, while delivering spectral efficiency more than double that of traditional 10-G line rate solutions. The HCM supports 16-G Fibre Channel (FC), 10 Gigabit Ethernet (GE), 40 GE and SDR/DDR/QDR Infiniband (IB) connectivity.

Even with forward error correction (FEC) enabled, the HCM supports single-digit µsec latency for DCC applications. FEC can also be disabled to achieve optimal performance for metro applications, such as high-frequency trading (HFT), that prioritize lower latency over increased reach.
3.1.4 100-G second generation coherent long-haul application
The Alcatel-Lucent market-leading second generation 100-G coherent technology offers low-latency FEC for 8-G FC, as well as 10-GE, 40-GE and 100-GE transport solutions for DDC with regional and national reach of up to 2000 km.

3.1.5 Secure DCC
The Alcatel-Lucent 1830 PSS implements the National Institute of Standards and Technology (NIST) Advanced Encryption Standard (AES) block encryption/decryption algorithm (cipher) to perform symmetric Layer 1 encryption for multi-protocol data types. Integrated hardware and robust 256-bit AES keys encrypt data flows and deliver securely transported information. Working at a 10-G line rate, the L1 encryption hardware in the 1830 PSS introduces less than 1 µsec latency (equivalent to approximately 200 meters of fiber) to the end-to-end data stream.

The Alcatel-Lucent 1830 PSS encryption module was designed and tested using the Federal Information Processing Standards (FIPS) 1402 standards, including detailed requirements for strong cryptographic algorithms and physical device protection, based on guidelines from NIST.

For more detailed information about secure Alcatel-Lucent solutions for data center interconnect, see “Delivering a Comprehensive Approach to Data Center Connect Security,” a white paper available on the Alcatel-Lucent website.

3.1.6 High availability for DCC
The Alcatel-Lucent 1830 PSS supports high availability by providing 50-msec failover protection switching. Most 1830 PSS transponder/muxponder cards support one or more of the following protection modes: unprotected, optical protection switching (OPS), electrical sub-block network connection protection (E-SNCP) and optical sub-block network connection protection (O-SNCP), also known as 1 + 1 Y cable protection.

3.2 DCC Application coverage with the Alcatel-Lucent 1830 PSS
3.2.1 BCDR applications
Large enterprises construct private cloud networks for BCDR by leveraging dark fiber and building private DWDM networks — or by leasing wavelengths from service providers. For BCDR, mission-critical data is replicated synchronously across a pair of active and backup data centers, often placed within metro distances to meet desired latency requirements. The 1830 PSS supports Fibre Channel over DWDM at 1-G, 2G, 4G, 8G, 10G and 16G FC rates. End-to-end FC transport solutions based on this platform are certified to be interoperable with major storage and FC switch vendors.
Large enterprises typically replicate mission-critical data to a third data center (which could be private or public) located in a different geographical area from the active and backup data centers. This solution minimizes the risk of impacting business continuity if a disaster occurs beyond a metro area. For these remote BCDR applications, the Alcatel-Lucent 1830 PSS supports:

- FC or Ethernet over DWDM
- Native packet GE and 10 GE over Carrier Ethernet or IP VPNs
- 10 GE WAN connectivity

3.2.2 Federated storage applications

Federated storage resources, such as storage array controllers or federated appliances, must be connected by a full mesh of high-speed Fibre Channel links over metro distances — or high-speed Ethernet links beyond the metro area.
The Alcatel-Lucent 1830 PSS provides an optimized transport solution for Fiber Channel and Ethernet communication between federation nodes. The 1830 PSS can be deployed with EMC VPLEX local and metro federated storage solutions using 8G FC. It can also be used with EMC VPLEX Geo solutions using 10 GE for distances beyond metro reach.

3.3 Beyond the box
For an Alcatel-Lucent 1830 PSS network deployment, a comprehensive set of operations, administration and maintenance (OA&M) tools allows enterprises to effectively control the cost of network planning, management, security and maintenance operations.

Figure 11. OA&M tools to support the Alcatel-Lucent 1830 PSS

These tools include:

- Engineering planning tool (EPT) — A simple and effective tool to aid planning, design and deployment of DWDM network solutions
- Fiber source — A collaborative partner tool, enabling enterprises to plan, find and acquire associated dark fiber in metro, regional, national and continental regions
- Commissioning and power balancing tool (CPB) — An easy-to-use tool for the DWDM network. It integrates with the EPT tool for simple, continuous operations.
- Comprehensive network management solutions — Integrated with the Alcatel-Lucent 1830 PSS Wavelength Tracker (WT) technology, this tool provides fast, simple troubleshooting of network problems. The Alcatel-Lucent 5620 Service Aware Manager (SAM) provides integrated IP/optical management of data center connectivity, while the 1354 Photonics Manager (PhM) enables standalone optical data center interconnect solutions.
- Performance expert — A simple service assurance tool, fully integrated with the Alcatel-Lucent 1354 PhM to enable monitoring of network Key Performance Indicators (KPIs) like fault, performance, delay and utilization
- Key Management Tool (KMT) — A secure, scalable application that supports management of the cryptographic life cycle of each encrypted wavelength service. This includes key generation to perform encryption, management of encryption key expiration, rotation and destruction by the end user.
4 SUMMARY

Inter-data center bandwidth continues to increase because it is needed to support improvements in enterprise BCDR, growth in mission-critical data, consolidation of data centers and converging storage.

To support a wide range of applications with specific performance criteria, large enterprises must make effective DCC technology choices. They continue to deploy optical WDM for Tier 1 and Tier 2 applications, because it is the only technology that can deliver the high bandwidth, low latency and multi-protocol support required by mission-critical applications.

The Alcatel-Lucent 1830 PSS is a comprehensive, industry-leading DWDM platform for addressing today’s enterprise DCC needs. It is the most economical carrier-grade DWDM platform available, enabling versatile, scalable and secure solutions that can meet current and future DCC demands.

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.