Delivering High-performance Business Services over a Dynamic Optical Infrastructure

A Technical Paper prepared for SCTE/ISBE by

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Introduction

Driven by the need for greater productivity and lower costs, enterprises around the globe are moving their applications to the cloud. Today, nine out of 10 enterprises are using at least one cloud application to increase productivity and reduce cost, a fact that is not surprising when 84 percent of chief information officers report that they have cut application costs by moving to the cloud[1]. Compounded by the need for scalable bandwidth driven by the proliferation of large volumes of digital content and applications, enterprises are turning to a new hybrid cloud network model, with applications delivered from an abstracted cloud services layer that bridges private and public cloud infrastructures. This article describes how cable operators can use the latest software and hardware innovation in optical networking to deliver advanced, secure and high-performance business services to the enterprise, such as software defined capacity (SDC), optical private network virtualization, data encryption and many others, to underpin the deployment of cloud enterprise applications. Common challenges and solutions for cable operators as they build and deliver key enterprise applications are also presented, such as business continuity/disaster recovery (BC/DR), data mirroring, off-hours/off site data backup and many others. This paper also describes best practices and emerging operational models to reduce first-in costs as well as recurring operational expenditures.

Content

1. An Industry Undergoing Massive Transformation

Cloud-based applications are impacting multiple aspects of the enterprise business - from the products they manufacture to the services they offer and even to the way their employees interact with each other or with customers and partners.

- **Connected products:** More products than ever are designed and manufactured to be online. 30 billion devices are expected to connect to the Internet in 2020[2]. From connected cars to home appliances to smart sensors on city streets, products are becoming more sophisticated.

- **Connected services:** Services enterprises are also elevating their portfolios by leveraging wireless and wireline connectivity to provide advanced offerings such as remote monitoring and emergency response, intelligent home and business surveillance and many others.

- **Connected employees:** The workforce is more connected than ever before in day-to-day operations, relying on cloud applications for document management and sharing, social media-based employee interaction and video conferencing for meetings and training.

Enterprises need connectivity with the highest levels of performance (high capacity, low latency, high reliability, agility, etc.) across short (local area network, or LAN), medium (wide area network, or WAN) and long distances, putting the transport network at the heart of the enterprise evolution to the cloud and the Internet of Things (IoT).

2. A Transformation That Brings New Challenges

The enterprise's journey through this transformation creates many challenges for cable operators offering enterprise services and applications. Better network performance, on-demand bandwidth consumption models, and the ability to combat cyber-attacks are a few examples of emerging requirements for cable operators. The following paragraphs briefly describe imperatives relating to these concerns and their impact on the cable operator's business and operational health.

- **Scale the network:** It can take 45 to 60 days for a simple bandwidth upgrade, not to mention the additional cost of equipment. This places significant pressure on cable operators' network planning teams, especially for unexpected network events.

- **Decrease the cost of operations:** Enterprise migration to the cloud and the evolution of operational and business models are fueling unprecedented demand for bandwidth. Traditionally, more bandwidth requires more money and more complexity, leading to significant hikes in capital and operational expenditures (CapEx/OpEx).

- **Protect enterprise data:** As more content is being pushed to the cloud, cyber-attacks and data breaches are becoming frequent occurrences. The annual damage to the U.S. economy caused by cyber-attacks is estimated to be up to $100 billion[3]. Cable operators must protect enterprise customer data carried over the network from intruders and hacking tools.

- **Enhance network performance:** Latency, capacity and transactions per second are all key concerns cable operators must address when servicing enterprise customers. Networks must meet or exceed performance requirements dictated by enterprise applications and must be agile to support dynamic demand for bandwidth and any change in network topology, including connectivity to new offices or data centers.

- **Minimize downtime:** Cable operators' network outages can be disastrous to enterprises, resulting in significant loss of revenue, massive disruption to business operations and a major impact on customer loyalty. The average downtime costs vary across industries, from approximately $90,000 per hour in the media sector to about $6.48 million per hour for large online brokerages, according to Information Management magazine[4].

Overcoming the above challenges requires intelligent high-capacity optical networks that offer the flexibility, scale and programmability to meet bandwidth demands and ensure the highest levels of availability and security while lowering operating costs.

3. Technology Enablers for Cable Operators

New advances in software and hardware are allowing cable operators to broaden their addressable enterprise markets by offering new services with the highest level of performance, flexibility and security, as well as advancing to dynamic and on-demand operational and service consumption models. The optical technologies that enable these new services provide the foundation for intelligent high-capacity optical networks and are described below:

- **High capacity through super-channels:** dense wavelength-division multiplexing (DWDM) technology disrupted the telecommunication industry by enabling multiple optical carriers to travel in parallel on a fiber and thus increase capacity and maximizing fiber utilization. However, the current growth in internet traffic and enterprise migration to the cloud are demanding a whole new level of scalability. A new innovation, called super-channels, evolved to take DWDM networks to a new era of high capacity and optical performance – all without increasing operational complexity. A super-channel includes several optical carriers combined to create a composite line side signal of the desired capacity that is provisioned in one operational cycle, as depicted in Figure 1. Super-channels overcome three fundamental challenges:
  - How to scale bandwidth without scaling operational procedures
  - How to optimize DWDM capacity and reach
  - How to support the next generation of high speed services such as 100 Gigabit Ethernet (GbE), 400 GbE, etc.

The use of super-channels is also transparent and seamless from the end user's (client services) perspective, as enterprises can hand over to service providers a mix of low (e.g. 10 GbE), medium (40 GbE and 100 GbE) and high (100 GbE and 400 GbE) bandwidth services without any change in their network infrastructure.

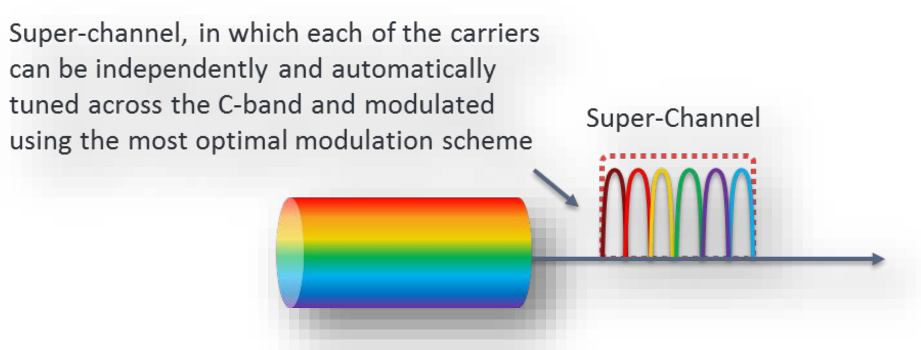

Figure 1 - High Capacity Through Super-channels

- **Data protection through in-flight encryption:** An enterprise's success is heavily dependent on its ability to protect its own and its customers' data. Data breaches can trigger irreparable damage to the company's reputation and its ability to conduct business in the future, even driving enterprises to bankruptcy. Cable operators can protect enterprise data carried over the network using in-flight encryption as depicted in Figure 2, without the need for external boxes or complex setups. Different and flexible encryption schemes are available, such as Layer 1 encryption and Layer 2 Media Access Control Security (MACSec) encryption.

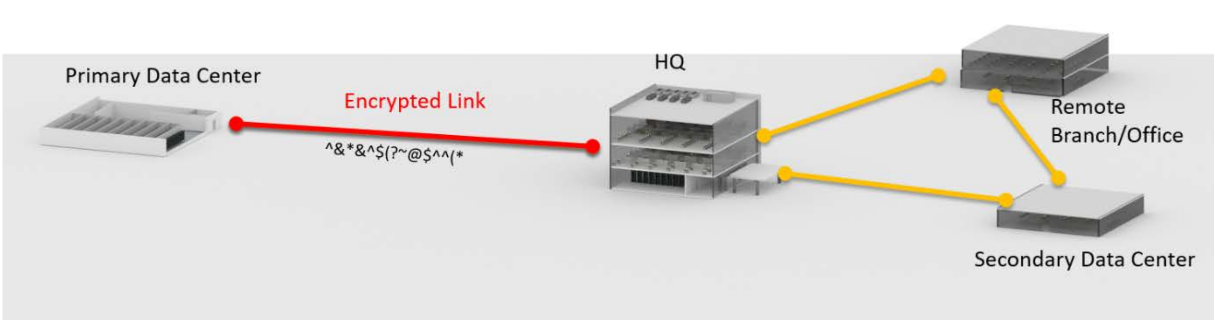

Figure 2 - Data Protection Through In-flight Encryption

- **Purpose-built cloud direct connection platforms:** The enterprise shift to cloud is well underway and accelerating, driving the need for increased bandwidth and performance to connect to data centers and service providers. As more applications and content move to the cloud, including not only web-based customer-facing applications, but also mission-critical business applications, such as customer relationship management (CRM), enterprise resource planning and human resources, enterprises are relying more heavily on the networks that connect their sites to cloud service providers at carrier-neutral facilities across the world (Figure 3). A new breed of optical platforms provides the needed capacity for direct connection to cloud services with high security, low latency and simple scalability. These compact 1 or 2 rack unit (RU) platforms also provide open interfaces such as representational state transfer (REST) application programming interfaces (APIs) that allow seamless integration of these cloud services into the enterprise's existing IT environment and processes and the development of custom applications for traffic setup and monitoring, network optimization, etc.

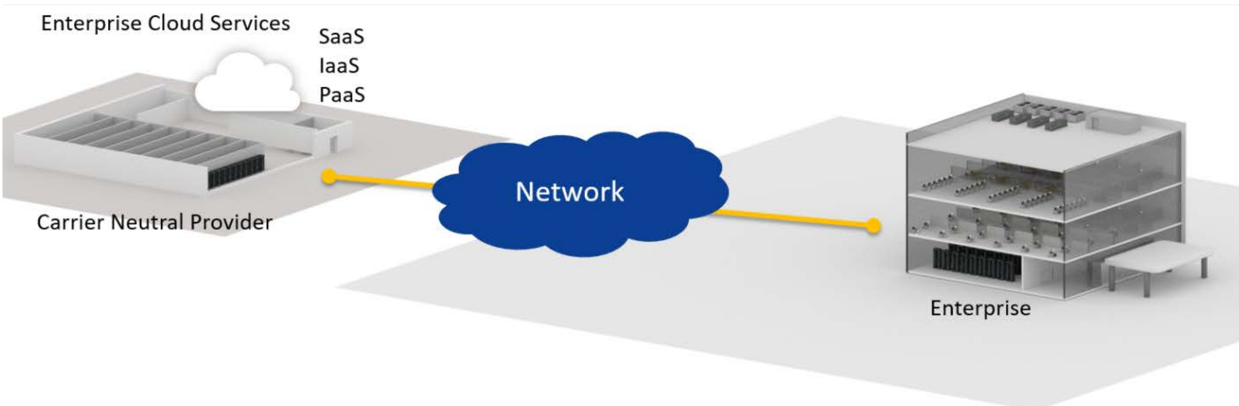

Figure 3 - Cloud Direct Connection

- **Dynamic bandwidth allocation:** New technology innovation in software and hardware allows bandwidth allocation to become dynamic and on-demand. Dynamic bandwidth allocation provides enterprise customers with on-demand provisioning of digital Optical Transport Network (OTN) and Metro Ethernet Forum (MEF)-compliant Ethernet services. Dynamic bandwidth can be deployed for a wide variety of use cases, including customer self-provisioned connectivity services and advanced policy-based services. Through the use of open APIs or the cable operator's graphical user interface, enterprise customers can provision services tailored around their needs, such as an ultra-low latency service that cannot exceed a certain latency threshold for delay-sensitive applications, or time-sensitive or time-of-day-based services for more efficient utilization of network assets.

- **Optical networks virtualization:** New advancements in network abstraction capabilities can create virtualized networks at the packet, digital and optical layers and across metro and core domains. Parts of the cable operator's optical infrastructure can be logically partitioned based on each enterprise customer's needs, as depicted in Figure 4. Enterprise customers can have dedicated logical partitions of the network with complete visibility and control of their logical network and isolation from other enterprise customers, allowing them to customize their connectivity and services around their own applications. Similarly, such virtualization capability allows cable operators to maximize their return on assets and broaden their addressable markets without the additional capital often required to build private physical networks.

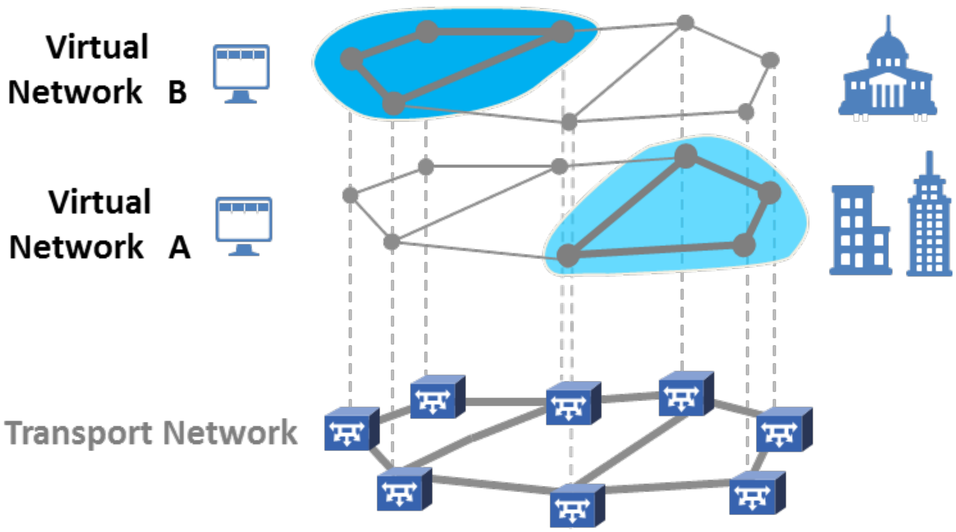

Figure 4 - Optical Network Virtualization

- **Increased network uptime though intelligent software and optical hardware design:** Network downtime can translate into millions of dollars lost for enterprise customers, as well as serious damage to the cable operator's reputation and brand image. A network failure can have a disastrous impact on cloud applications such as data mirroring and backup. Cable operators can use intelligent software tools such as control planes to operate as the brain of the network, reacting to network changes in real time, without human intervention. Network changes may include anything from multiple simultaneous failures to an increase in latency across any one of the network's critical spans. A control plane increases network availability and protects against failures, such as fiber cuts or hardware failures that would otherwise impact connectivity between an enterprise and its data centers. It can make enterprise networks autonomous and self-healing, even in the event of multiple fiber cuts or hardware failures. When coupled with the network virtualization capabilities described above, the control plane can partition an enterprise network by allowing specific links, wavelengths, subwavelengths or even nodes to be dedicated to a specified use, with preset thresholds for latency, bandwidth and resiliency. Some virtual enterprise networks are configured for high capacity, high resiliency and low latency for mission-critical applications (e.g. data mirroring). Other virtual networks are created with less stringent requirements for user access or other applications. Intelligent high-capacity optical networks make the infrastructure highly flexible to accommodate varying customer requirements.

4. Key Enterprise Applications

Most enterprises rely on a few key networking applications that are vital to their existence, all with varying requirements. Optical transport networks are built to accommodate these varying requirements while maximizing performance and cost-efficiency. Some of these enterprise networking applications are listed below:

- **Business continuity/disaster recovery:** BC/DR describes a set of applications built to minimize the impact of downtime on an enterprise's operations in the aftermath of an emergency (natural disasters, terrorist attacks, major disruptions to the company's network, etc.). These applications consist of backup plans to transfer data and control access and offload other activities to one or more enterprise sites, including alternate data centers. Recovery time varies based on numerous factors, ranging from the few seconds needed to automatically transfer control and reroute traffic from primary to secondary sites once a failure or disruption is detected, to several minutes (Figure 5). Intelligent high-capacity optical networks play a vital role in BC/DR applications, providing the required bandwidth and alternative routes that meet stringent latency and capacity requirements in a very short period of time to minimize the impact on business operations. The successful deployment and operations of BC/DC applications are directly related to the performance of the optical network they rely on.

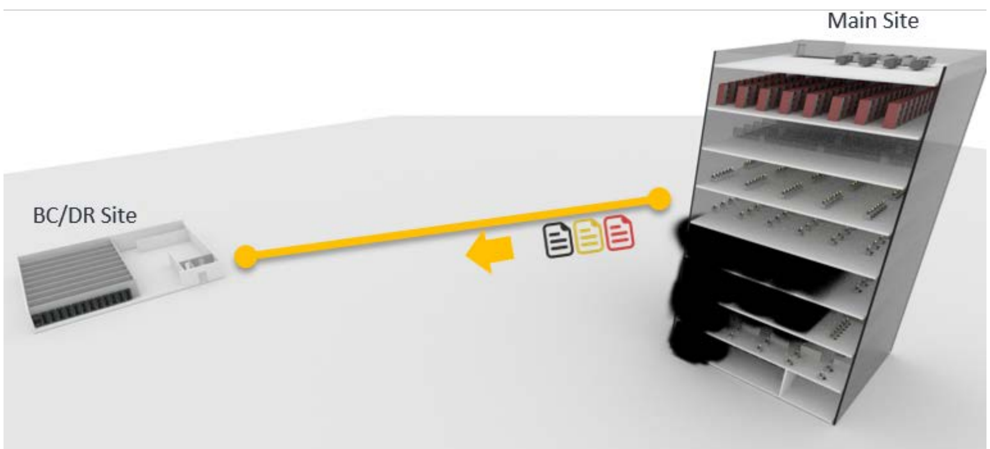

Figure 5 - Business Continuity/Disaster Recovery

- **Offsite/off-hours data backup:** This is a recurring operational procedure aimed to replicate or back up enterprise-critical data every day after hours to a remote data center (Figure 6). Typically, a large amount of data (terabytes) is automatically duplicated at another remote site/data center overnight during a backup window that spans anywhere from 30 minutes to several hours. There are several methods of data backup designed to save and keep an accurate history of data changes, such as full, incremental, differential, hybrid techniques and many others. The high capacity, low latency and task automation enabled by intelligent high-capacity optical networks make a significant positive impact on the time of execution, reducing the backup window from several hours to minutes, and enabling the overall success of this application.

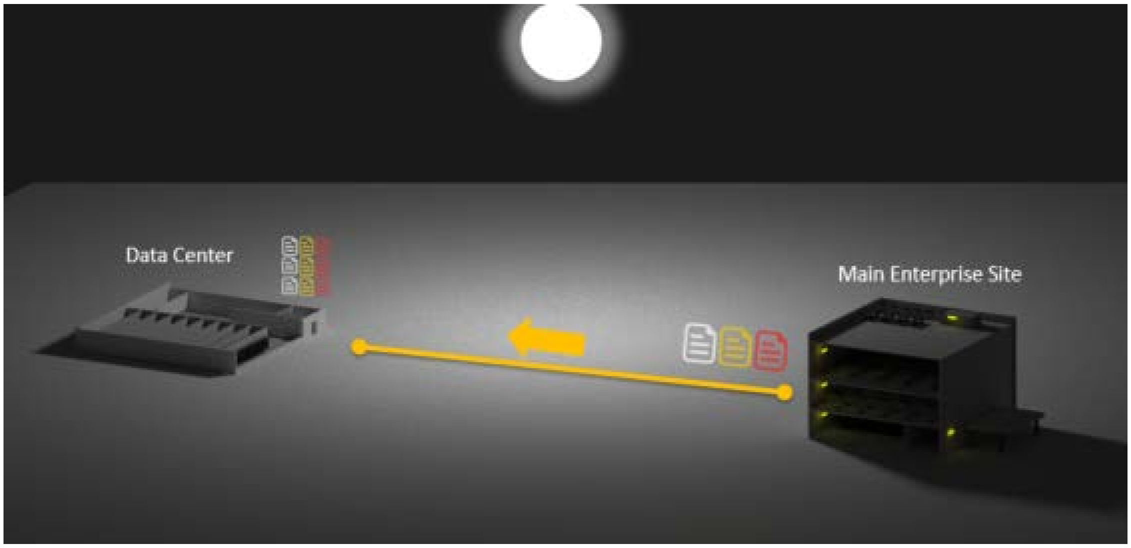

Figure 6 - Offsite/Off-hours Data Backup

- **Data mirroring:** Heavily used by enterprises that process millions of transactions daily (e.g. retail, finance, airlines, etc.), this application is used to instantaneously duplicate the same set of processes and transactions from a primary or master site (mainframe/data center) to a secondary volume or mirroring site (Figure 7). Keeping latency below a certain threshold is often a key factor in properly deploying this application. For example, a data mirroring application in a metro network is typically designed with round trip times (RTT) that range between 2 milliseconds (ms) and 20 ms. When deploying this application in a wide area network, the RTT can be as long as 200 ms[5], hence a high-performance optical transport network with low latency and low jitter (a variation of latency) is a key building block of deploying any data mirroring application.

Figure 7 - Data Mirroring

5. Best Practices and New Operational Models

The landscape of the telecommunication industry is changing with new technologies, new end-customer requirements and new players. The following paragraphs highlight some of the best practices and emerging operational models that can help cable operators enhance customer experience, reduce operating costs, and increase their competitive edge.

- **Software defined capacity – on-demand service turn-up:** One of the main reasons behind customer dissatisfaction is the long time it takes to turn up a service. Slow turnarounds can easily escalate as a major source of conflict between the customer and network operator, and quite often it becomes the motivator for a customer to quit and go to a competitor that offers a faster response. Deploying a high-capacity network with super-channels, as described earlier, enables cable operators to turn up services faster, and often without truck rolls, hence reducing turn-up time and accelerating time to revenue. Pre-deploying high capacity does not require massive CapEx, as next-generation super-channel-based optical transport networks allow cable operators to add, activate and pay for additional bandwidth on existing network hardware in real time by making few clicks in a software application. The SDC model speeds up service activation from weeks to minutes and avoids the need for significant capital investment (e.g. pre-deployed chassis or idle line cards) to meet future growth.

- **Next-generation packet-optical platforms for lower CapEx/OpEx:** Next-generation transport platforms offer a compelling alternative to router-based solutions as they consume significantly less power and provide capacity and cost advantages for Carrier Ethernet services. Features aimed to simplify network implementation, design and operation such as plug-and-play setup and installation, zero-touch provisioning (ZTP), network auto-discovery, intuitive graphical user interfaces and easy, simultaneous network upgrades also contribute to lower OpEx.

- **Differentiated service offerings:** Enterprise customers have various requirements based on the industry they belong to and the applications they run. Cable operators can exploit the latest innovations in optical networking to offer differentiated services based on performance (bitrate), latency, security (e.g. encrypted links for financial institutions or government agencies) and survivability (e.g. protection against numerous simultaneous network failures due to a natural disaster). A broad service offering further widens the addressable market, increases competitive edge and augments revenue streams.

- **Enhanced network security:** Cyber-attacks and data breaches are frequent occurrences today. According to the recent Verizon Data Breach Investigation Report[6], there were 3,141 confirmed data breaches in 2016. Cable operators can exploit the latest innovations in software and hardware to protect their networks and the enterprise customers they serve from intruders and hacking tools with features like in-flight Layer 1 and Layer 2 encryption, stringent access procedures and centralized authentication and authorization, to name just a few examples.

- **Task automation to streamline operations and eliminate human error:** Enterprise migration to the cloud is dictating a whole new level of network agility, making traffic profiles and trends difficult to predict. Moreover, human error is often behind major network outages, hence the need to automate recurring tasks for better efficiency and reliability. Cable operators can use the latest developments in programmability, software tools and open interfaces such as REST APIs, NETCONF/YANG and others to simplify network management and automate recurring tasks. These intelligent software capabilities play a vital role in streamlining operations and evolving cable operators' and their enterprise customers' networks to the cloud by implementing task automation, proactive network monitoring, dynamic bandwidth allocation and much more.

Conclusion

Enterprises are undergoing a major shift in how they conduct business. Cable operators can benefit from enterprise evolution to the cloud by broadening their service portfolios and increasing their addressable markets while undertaking a continuous reduction in costs. The latest innovations in optical technologies provide the scalability, flexibility and programmability for cable operators to build intelligent high-capacity optical networks. These in turn help them to better serve enterprise customers to protect critical information, and provide the scalability required to meet the surging demand for bandwidth driven by cloud while reducing recurring costs.

Abbreviations

API	application programming interface
BC/DR	business continuity/disaster recovery
CapEx	capital expenditures
CRM	customer relationship management
DWDM	dense wavelength-division multiplexing
GbE	Gigabit Ethernet
IT	information technology
LAN	local area network
MACSec	media access control security
MEF	Metro Ethernet Forum
ms	millisecond
NETCONF	network configuration
OpEx	operational expenditures
OTN	optical transport network
REST	representational state transfer
RTT	round trip times
RU	rack unit
SDC	software-defined capacity

WAN	wide area network
YANG	yet another next gen
ZTP	zero-touch provisioning

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