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Premium OTN, the Next-Generation Private Line, a Revenue Opportunity

The winning holy trinity: high bandwidth, value-based $/Gbps, and guaranteed low latency

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Summary

In brief

The digital economy is underpinned by an always-on, ultra-fast network. Discerning enterprise and government customers want high availability and guaranteed low latency. Carriers that update their network and operations infrastructure to deliver a premium optical transport network (OTN) have a monetizable differentiator. Carriers can command a premium for a superior service.

Ovum view

The digital economy and governments require a next-generation private-line service. Legacy services no longer scale or have up-to-date "service wrapper" capabilities. Shared services are viewed as vulnerable to security threats and short on adhering to stringent latency performance requirements. The next-generation premium private line based on OTN technology can deliver high availability, low latency, security, and bandwidth flexibility. In addition, next-generation operations and maintenance can be delivered by advanced client and carrier portal capabilities.

The target architecture for premium private line is clear. The challenge is the most effective roadmap for carriers to follow. Carriers will have differing interpretations for their end-game service suite and different network and operations starting points. Carriers do need to match new revenue generation with efficient capital and operations plans. For some carriers, the market need is so great that a greenfield overlay with the latest optical technologies is the most expedient way forward. For other carriers, a series of incremental improvements can be added over time to strengthen their premium private-line portfolios.

Key messages

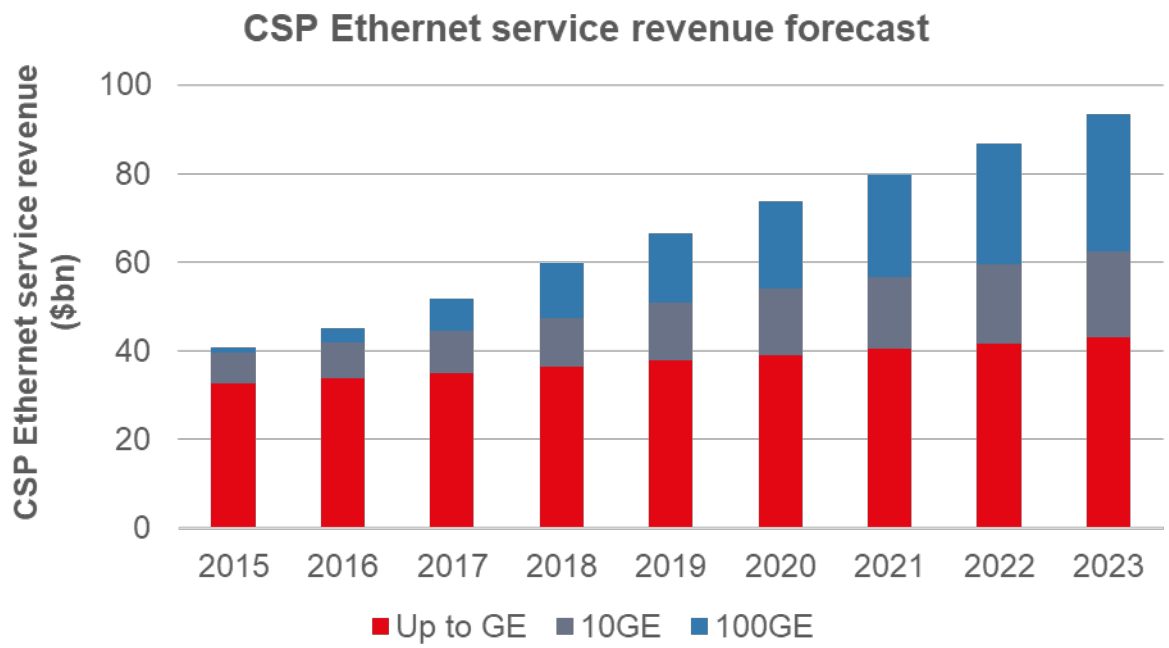
- **High availability.** Government and the financial community, demanding customer segments, desire the highest-availability network performance. Network architectures need to be designed from day one for high availability. It has a cost but delivers a premium, differentiating value.
- **Low latency.** After availability and price, latency performance is the next key differentiator in the high-bandwidth service market. The market has moved beyond estimates and calculations. Real-time measurements enable differentiating guarantees backed by service level agreements (SLAs).
- **Security.** This is no longer an add-on, but a designed-in capability. Demanding and security-conscious clients want networks featuring dedicated resources with no comingled traffic.
- **Bandwidth flexibility.** Traffic planning is notoriously difficult. This challenge is amplified in the cloud era. A value-added service for clients is the ability to accommodate unexpected traffic bursts.
- **Portal enabled.** Businesses and consumers have modern expectations of rapid portal-enabled interaction. Portal functions cover all aspects of the service lifecycle including quoting and ordering, real-time KPI monitoring by the client-tenant, and advanced predictive, AI-driven operations and maintenance for fast, efficient, cost-effective carrier operations.

Business services: market trends and challenges

Cloud-service adoption and IT-asset rationalization

Blue chip enterprises are rapidly shifting to hybrid cloud strategies to take advantage of cloud economics. Governments are also evaluating IT modernization possibilities. Both enterprise and government initiatives have a common thread, transition from an on-site focus to a hybrid on-premises and cloud environment requiring a high-performance and highly secure underpinning network. Cloud adoption and IT-asset rationalization are driving data-service volume growth and a transition to higher speeds (see Figure 1).

Figure 1: Global CSP Ethernet service revenue forecast



Source: Ovum

With increased dependency on and criticality of the network, enterprises are transitioning from best effort-contended services to premium private-line services. The private-line services deliver zero packet loss and high security with predictable latency, ensuring the best possible and most secure enterprise network performance.

Legacy services are due for an update to today's standards

Network availability: classic networks lacked predictive functionality

In the future cloud-centric environment, the network is critical, and high availability is paramount. Networks that were constructed with the goal of minimizing capex need to be reevaluated in the light of heightened performance expectations. Networks have always been designed with robustness and survivability in mind. But networks do have the possibility of an "Achilles' heel," typically exposed during network outage and downtime situations. Older-generation networks were completely reactive with minimal predictive maintenance functionality.

Latency was too uncertain to tie to SLA guarantees

Classic networks were not optimally designed to minimize latency. Services traversed higher layers. The optical core lacked today's advanced wavelength-switching capability. Operational practices did not optimize around latency. Latency was estimated and calculated, but the actual latency performance on production networks and over time was uncertain. Latency SLAs did not exist.

Legacy service-delivery paradigms are due for a refresh

Legacy service environments did not feature today's advanced portal facilities. The presale process was more manual, requiring human involvement. Clients had no visibility on the performance of their service. Carriers operations were limited and reactive.

Classic hard-pipe services had little bandwidth-flexing ability

In the legacy environments, a classic hard pipe enabled a fixed amount of bandwidth with little room for change. A change in service necessitated a change in hardware.

Increasing vigilance and focus on security

Security threats to enterprises and governments are constant. Comprehensive security solutions require a holistic approach to threat management and mitigation. For the optical transport layer, threat-prevention initiatives center on utilizing dedicated rather than shared resources and optical layer encryption. Communications on a dedicated fiber path is the security ideal. At the other end of the spectrum, internet services are over a shared medium that many actors have access to. Today's optical services can be encrypted at the optical transmission level. In the highly unlikely event that an unauthorized party managed to intercept a light path, that signal would be encrypted as well.

Industry forums working to facilitate private-line adoption

MEF private-line initiatives

The MEF has been fostering the development of Ethernet services for over a decade and now has an initiative on optical wavelength private-line services. The MEF service definitions are intended to enable faster service turn-up, for quicker time to revenue at a lower operational cost. The optical L1 services differ from the switched Layer-2 Ethernet services in offering

- improved latency performance without L2 switching latency
- zero packet loss; there is no statistical multiplexing
- lower cost per bit for high-capacity services.

NGOF private-line initiatives

The Next Generation Optical Transport Network Forum (NGOF), founded in 2017, has been focusing on the formulation of unified criteria for premium private lines and has a cloud and private-line working group. NGOF is a partnership of carriers, research institutes, and equipment, component, and chip vendors. The NGOF sees premium private line as a growth engine for the digital economy. In NGOF's view the key tenets of private line are guaranteed high bandwidth, ultra-low latency, high availability, rapid service provisioning, and self-management via online portals.

Key attributes of OTN premium private-line solution

High availability: an essential for the digital economy

Premium services need to be highly available. Service availability is like oxygen: we may not give it a lot of thought until we are a little short of it. Availability is essential to the digital economy and government operations: in the digital economy, availability is revenue. Downtime is customers, revenue, and reputation lost. Government operations need to be highly available. Public safety is highly dependent on communications networks being up.

Most networks are designed to be robust with survivability a key design tenet. Networks can be vulnerable to real-world conditions. An east route and a west route may have to use the same physical conduit over a bridge. Multiple diverse entries into one property may not be economically feasible.

Availability is a function of cost. One fiber route is better than none, but a diversely routed second fiber greatly adds to the service robustness. Many carriers and data center operators prefer a minimum of three distinct fiber routes into important properties.

Next-generation operational practices can also aid network uptime. With more sensors and probes in the networks, network health can be monitored continuously from many perspectives. With AI-powered, predictive network performance analytics, more network performance data can be collected and then analyzed over time. Degradation patterns can be identified and corrective action can be taken before a service-affecting fault occurs, enhancing the overall network availability. Passive operations and maintenance (O&M) can be upgraded to predictive O&M, enabling action before user-impacting failures occur.

Latency, a performance fundamental, can be commercialized and monetized

Latency is a critical network performance metric. A multitude of factors impact a service's latency. Latency is dependent on

- the overall optical network architecture: hierarchical with express vs. completely collector
- optical to customer premises, or aggregation CO
- optical or electrical switching utilized or routed
- the length of the fiber path
- the amount of OEO in a path versus "one-hop"
- carrier operational practices such as fiber slack management
- optical technologies utilized: coherent, Raman, FEC.

Customers have heightened latency requirements, and discerning customers want to know latency performance for both primary and failover routes. To absolutely maximize latency performance requires a greenfield network design backed by a formidable capital plan.

Optical time-domain reflectometers (OTDRs) have been miniaturized and reduced in cost, enabling widespread embedded deployments in carrier networks. With enhanced measurement and reporting capabilities, the actual, not calculated or estimated, latency figures can be measured. With the enhanced certainty, carriers can in turn commercialize and monetize this sophisticated network knowledge. Services can now be offered with a latency SLA for both primary and predetermined failover routes. A premium, differentiating service can command a premium price.

Physical isolation to guarantee security

The financial industry has long had a preference for "hard-pipe" private line. Given the choice between lower-cost shared network resources and dedicated resources, the financial industry has chosen the premium service. The financial industry has utilized dedicated dark-fiber links and Sonet/SDH. Security is enhanced with a dedicated hard pipe versus a shared network resource.

Earlier implementations of premium private line were delivered for dedicated Sonet/SDH or wavelength-division multiplexing (WDM) networks. An OTN network delivers the "hard-pipe" experience over a common infrastructure. More A–Z services can be delivered while maintaining physical isolation.

All-online to speed up business

Consumers and enterprises have become well accustomed to consuming services via portals. In the premium private context, there are suites of functions for sales and quoting, carrier operations and maintenance, and the service KPIs. The sales portal can display the major service attributes including bandwidth, service-availability promise, latency guarantee, and level bandwidth flexibility. Carrier clients can select the desired service and receive service resource confirmation.

The "tenant" portal provides the premium private-line client with a real-time KPI feed. The client can track service performance relative to SLAs. Multiple thresholds can be set to provide indication of potential service-affecting conditions.

From the carrier's O&M perspective, network performance data is collected at scale. An analytics engine, leveraging AI, predicts and highlights precursor degradation conditions and recommends action. The O&M portal is the carrier tool for managing the premium private-line network of the future.

All portals are built upon a foundation of advanced telemetry data. Probes throughout the network send a constant stream of essential network data.

Agility: enable bandwidth flexibility

Clients can have unpredicted bandwidth needs. Incremental bandwidth needs can arise at inopportune times. Carriers that can accommodate the burstable bandwidth needs will be seen as invaluable client partners. Today, real-time network resources can be portrayed visually. Service templates can be prepared in advance with the key set of service parameters. Bandwidth can be adjusted with no packet loss, hitless.

Intercarrier interconnectivity

OTN premium private-line solutions, as with all preceding connectivity solutions, will require intercarrier interconnectivity to scale globally. OTN premium private line will need to adhere to the

major industry standards to foster intercarrier interconnection. Standardized services will enable rapid time to revenue with a lower operational cost. Open APIs open the door to automated service ordering and configuration, speeding up the delivery of global premium OTN connectivity. The MEF has a multiyear track record of industry leadership on intercarrier interconnection for Ethernet services. The MEF is now extending the intercarrier interconnection focus to include premium private line, also known as L1 services.

MEF defines LAN extension and cloud connect use cases

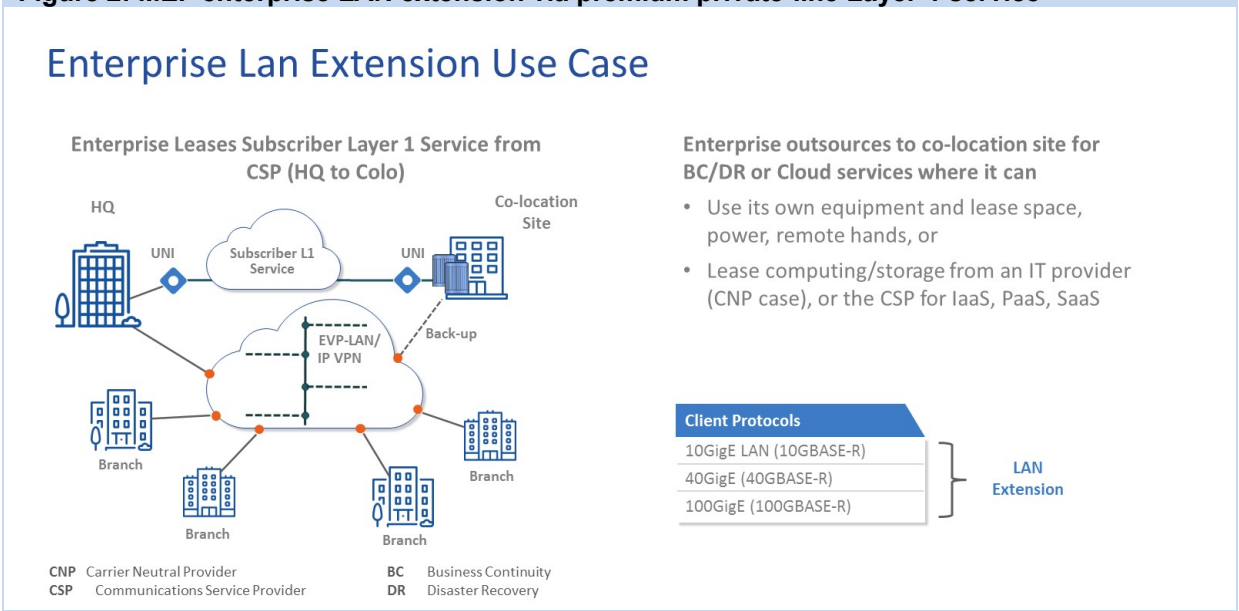
MEF initiative on intercarrier interconnection for premium private line

A number of use cases have arisen that are applicable across many verticals, including LAN extension and cloud connect. For international private-line services, rapid interconnection speeds time to revenue by reducing operational complexity and removing uncertainty involved with attempting to interconnect proprietary implementations.

LAN extension

As enterprises and governments grow and optimize IT services, their LAN requirements grow. Branch offices require connectivity to headquarters and to physically separated backup facilities. For the high-performance, high-Gbps case, premium OTN is a performance-based economical alternative to a contended Layer-2 or Layer-3 service.

Figure 2: MEF enterprise LAN extension via premium private-line Layer-1 service

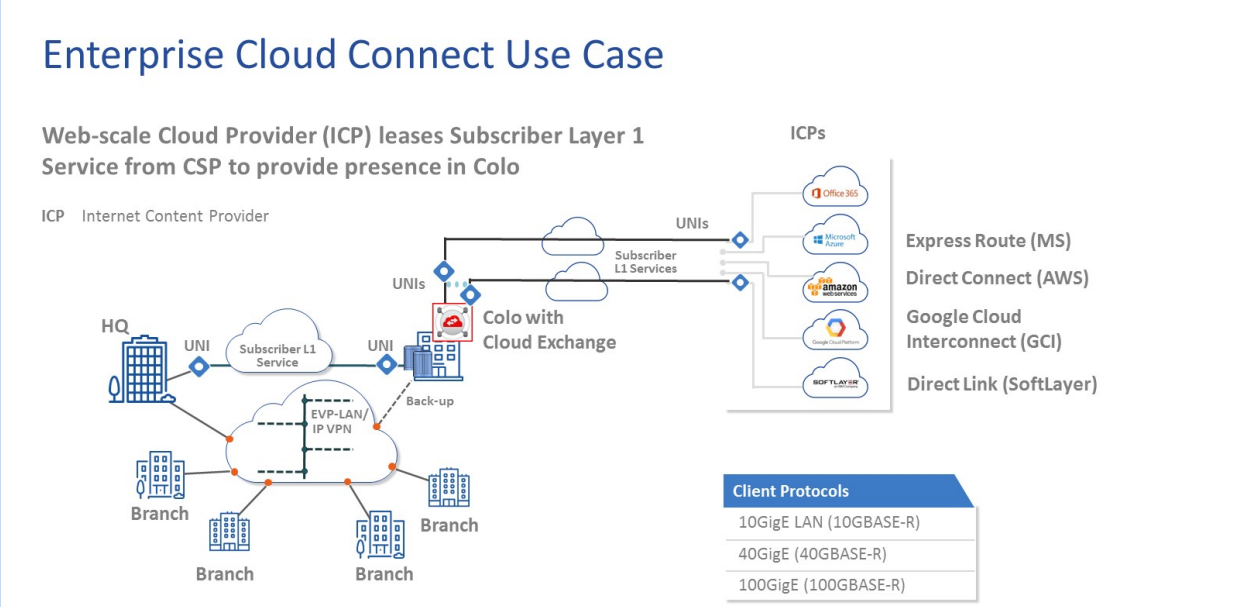


Source: MEF

Cloud connect

Cloud connect enables enterprise and government connectivity to the public cloud service providers. Enterprise traffic may be aggregated up to the OTN private-line service level, then connected to the cloud. And again, a common industry framework accelerates rapid deployments.

Figure 3: MEF enterprise cloud connect via premium private-line Layer-1 service



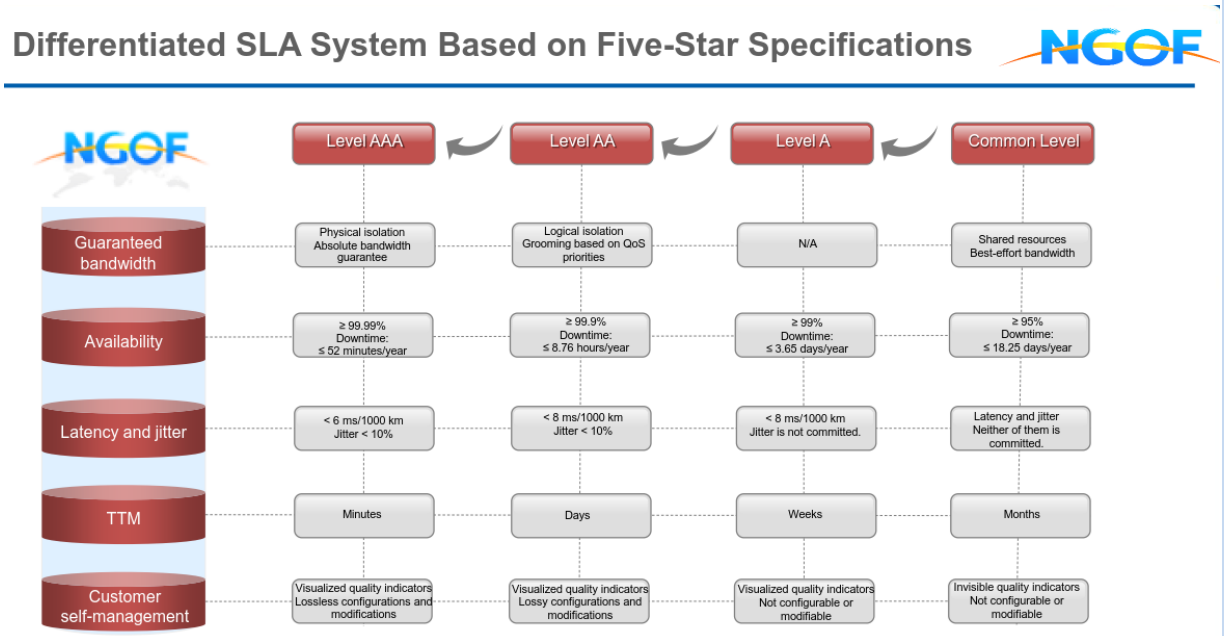
Source: MEF

NGOF defines "five-star" standard for premium private line

Differentiated SLA system based on five-star specifications

NGOF has defined a series of service level agreements for the key premium private-line attributes. The top level, Level AAA, ensures the highest level of performance for mission-critical applications, see Figure 4.

Figure 4: Differentiated SLA system based on five-star specifications



Source: NGOF

The NGOF has also identified the key requirements for governments, enterprise verticals, and enterprise size (see Figure 5).

Figure 5: Diverse requirements for private-line bearer networks

Customer	Industry	Features	Requirement
Government agencies	Government	Mission-critical applications that underpin national economy and people's livelihood, video conferences, life-saving applications such as firefighting systems, and information sharing between organizations	**High security and reliability**
Financial institutions	Finance	99.999% reliability, ultra-high download and upload rate, 24/7 uptime, exclusive link for ultimate security and ultra-low latency	**Low latency, high security and reliability**
Large enterprises	OTT	Numerous services moved to the cloud (access to DCs), rapid and abrupt bandwidth growth, and low latency needed by online services	**Ultra-high bandwidth, BOD, and low latency**
	Enterprise	▪ Real-time video conferences and conference calls require a low packet loss rate and low latency. ▪ Production data requires high security or even encryption. ▪ Common mail services require low costs.	**Low latency, high security, and flexible grooming**
	Healthcare	▪ Considerable data transmission and elastic bandwidth adjustment ▪ Used for cloud desktops, telepresence conferences, and surgery live streaming ▪ Real-time information synchronization between regulators and grassroots institutions	**Low latency, BOD, and high bandwidth**
SMEs	SME	Price sensitivity, fast provisioning, and ICT package service	**High cost effectiveness, fast provisioning, one-stop service**
	Retail	100M: suitable for e-finance Above 100M: suitable for stock, exchange, and lottery	**Fast provisioning, high cost effectiveness, and high bandwidth**

Source: NGOF

Carrier initiatives fostering premium private line

Major European carrier will utilize premium private line to support low-latency 5G

A major European carrier is well into advanced planning for future 5G RAN rollouts. The carrier sees premium private line as an essential wholesale service for 5G mobile fronthaul, midhaul, and backhaul services. New service attributes and capabilities are

- ultra-low latency to support new 5G applications
- burst-ability, bandwidth on demand to handle event driven traffic spikes.

The carrier will offer a complete service suite including

- transparent Gbe/10Gbe/100Gbe
- ODU-k as a service.

To deliver the new service suite with the enhanced and more stringent latency requirements, a network core upgrade is underway. In addition, the preexisting network is multivendor and multitechnology; a graceful migration from the brownfield situation is needed. The new architecture will

- include 100G/200G DCM-free-coherent transmission
- include CDC-F ROADMs equipped with OTDR capability
- be architected for one-hop, maximizing optical bypass, minimizing OEO-induced latency
- employ a universal matrix to support packet, VC-n and ODUk.

In addition to the core network upgrade, the enhanced network will feature value-added capabilities:

- Latency planning will be centralized and visualized with a latency-aware portal.
- Latency mapping will enable latency-based routing and integration with OSS-BSS systems.

The carrier will also expand its international geographic scope to deliver premium private line to a wider community of partners.

Upon completion, the carrier will "tick all the boxes" in preparing for a superior low-latency performance. The carrier will leverage automatically switched optical network (ASON) to ensure secure and highly reliable service delivery. The latency-aware portal and enhanced bandwidth delivery will enhance customer stickiness.

A European Mobile Operator has an OTN target architecture for a 5G and IoT future

The European CSP (communications service provider) is a leading mobile operator preparing for the transition to a 5G future. The CSP's transport network has grown in support of 3G and 4G and has endured many of the typical growing pains along the way. Video and gaming have grown significantly on its network over time. The CSP's customers' consumption of video is shifting from a multicast to a video-on-demand unicast model. Video consumption is also shifting from a static to a highly mobile location model. Traffic patterns have become larger, more fluid, dynamic, and more challenging to predict. Transport network congestion cases have arisen. The transport network, with many

technologies deployed over time, has limited agility and has been difficult to rapidly scale to large capacities in response to rapidly growing customer demands.

The CSP sees many new application and revenue opportunities in the coming Industrial Internet of Things (IIoT) and 5G eras. Significant opportunities exist across many industry verticals, including fleet tracking, closed-loop and flexible manufacturing, large-scale agriculture, medicine, tourism, and resource development. For the CSP's enterprise customer base, the transition to cloud services is ramping. In addition to scale capacity, the enterprise customer base is highly sensitive to latency. A low-latency network is an essential in the highly competitive market for "winning the business."

The combination of all the experiential learnings and new 5G, IIoT, and cloud opportunities has led the CSP to a set of new architectural tenets for the next-generation transport network. The CSP's next-generation transport network will include fixed mobile convergence for a single transport network and other attributes and capabilities:

- The CSP wants a next-generation telemetry, network analytics, and predictive control capability. The CSP desires a real-time network view with advanced analytics to enhance its ability to predict future traffic events and take proactive measures to manage the network.
- Network slicing will be required for control of an advanced multiservice 5G network.
- An optical, one-hop network will deliver a strong low-latency capability.
- There will be greater capacity to the network-edge base stations from 10G to 50G and to 100G. The CSP does want to match edge capex outlay to revenue and application growth but does not want a legacy operational model requiring repeated site visits. The CSP wants a next-generation operational model to support a graceful scaling up of the network.
- OTN will be utilized for 100G grooming, restoration, and disaster recovery, taking over from SDH.
- The 100G access ring network will grow in support of customer growth.
- Massive scale in the network core will support 100G and 400G wavelengths.

A Global CSP: targeting financial sector with low-latency SLA

SDH plant is aging out and a replacement technology is required

The CSP's installed base of SDH equipment is hitting the wall. Its SDH plant is physically aging out. The CSP predicts more equipment failures leading to rising O&M costs. SDH was never designed for greater than 10G environments, and the SDH equipment is running at nearly full capacity

Private-line market: higher performance required to differentiate

The CSP sees more opportunity and also more intensifying competition. It has identified three primary opportunities: enterprise LAN extension, enterprise cloud connect, and guaranteed low latency. The CSP's LAN extension and cloud connect services align with the MEF use cases. The CSP's guaranteed low-latency use case takes the industry discussion one step further. For the CSP, government and the financial sector both have high expectations for availability and security. The financial sector has an additional very stringent low-latency requirement.

The CSP's network failure analysis concludes that

- 95% availability uses a single route

- 99.99% availability requires three diverse routes
- 99.999% availability on the network, based on the CSP's analysis, is not yet feasible with today's technology and economics.

Table 1 highlights the key strengths and shortcomings of the historic SDH private line, the shared resource L2 VPNs, and today's Layer-1 premium private line.

Table 1: The CSP's analysis of technology options

	SDH	L2 VPN	L1 (OTN)
Bandwidth	Up to 10G	GE	1G to 100G (400G coming)
Availability	High	Low	High
Security	Hard pipe	Shared	Hard pipe
Latency	Guaranteed	Best effort	Guaranteed
Jitter	Load independent	Affected by load	Load independent

Source: The CSP

Premium OTN, Layer-1 service, is the high-performance successor to SDH (and Sonet). Premium OTN shares the same high-performance attributes of SDH with a roadmap beyond 100G.

Introducing measured low latency into the network

The CSP plans to introduce latency-committed services initially targeted at the financial community. Latency commitments will be based on measured network latency. Major enterprise locations have been identified, along with measured microsecond latency circles enabling highly compelling SLAs.

High availability, high security are central tenets for success

The CSP is preparing for a high-availability and high-security future. It will ensure high availability by deploying an optical mesh in the core with dual-homed optical edge nodes. The CSP will use OTN hard pipes to enhance security.

Self-service portals and bandwidth flexibility create a next-generation network

The CSP will enable a fast-provisioning bandwidth-scheduling and bandwidth-on-demand capability. It will provide enhanced self-management capabilities via a portal capable of flexing bandwidth and SLA visualization.

Global Mobile CSP deployed a dedicated OTN service overlay

The CSP operates in highly competitive market conditions and sees a great opportunity in premium OTN. With access to substantial capital and available fiber, the CSP was in a position to execute a bold vision. It chose a complete overbuild and constructed a dedicated OTN service network. The premium private-line network overbuild included a 200G flexible mesh backbone network. The national network included 150 central nodes with optical cross connect and OTN switching clusters. OTN was deployed out to large enterprises and aggregation central offices. Low latency was enabled by optical pass-through "one-hop connections." OEOs from legacy SDH ring handoffs were eliminated.

Centralized network management controlled 300,000 network elements including customer premises equipment. Telemetry measurement intervals were set up at minute levels, enabling a "fine-grained" network monitoring. Online portals were deployed including a sales-quote portal and a tenant portal.

Conclusions and recommendations for carriers

Transitioning to premium private-line capability in a capital-efficient manner

Every carrier has a set of target customers and a target suite of applications. Carriers also have different network starting points. While defining a target architecture end state is one thing, plotting a detailed path that delivers revenue on pace with cost is another. Few carriers are in a big and bold position to build a greenfield overlay to pursue the new opportunity.

Carriers need to identify the rich hunting grounds and judiciously upgrade the network to meet the initial needs. Carriers need to lead the industry push for standard Layer-1 service definitions to facilitate rapid and cost-effective interconnect. Carriers can identify network extensions to access high-value customers and build the network mesh. With anchor clients and initial applications in place, carriers can broaden their coverage areas and application spaces and ultimately strive for ubiquity. The next-generation private-line service will include all of low latency, high reliability, high security, bandwidth flexibility, and portal enhanced visibility.

Appendix

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Ovum Consulting

We hope that this analysis will help you make informed and imaginative business decisions. If you have further requirements, Ovum's consulting team may be able to help you. For more information about Ovum's consulting capabilities, please contact us directly at consulting@ovum.com.

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