SDN and NFV gaining traction: is your infrastructure ready?

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Executive summary

Around the globe, subscribers' insatiable appetite for wireless content and mobile data is pushing communication service provider (CSP) networks to the breaking point. Mobile data traffic has grown 4,000-fold over the past 10 years and almost 400-million-fold over the past 15 years[1]. At the same time, the gap between wireless bandwidth demand and revenues continues to grow, as does competition from over-the-top (OTT) services and new competitors. To overcome these challenges, CSPs are re-thinking everything—beginning with the design and dimensioning of their network infrastructure.

According to a recent IHS Markit report, 100 percent of service providers say they will deploy network functions virtualization (NFV) at some point, with 81 percent expecting to do so by 2017[2]. For an increasing number of CSPs, NFV and software-defined networking (SDN) are keys to a new network architecture—technologies that can deliver higher levels of automation, faster and more agile deployment of services, new revenue streams and greater efficiencies in terms of management, operations and cost.

More than lip service, many carriers have already committed significant resources to virtualizing their networks. That interest has cascaded—incentivizing vendors, standards bodies and integrators. But success will ultimately hinge on CSPs' abilities to retool their existing facilities to accommodate these new technologies.

This involves shifting data flows from a traditional three-tiered orientation to a high-density leaf-spine network with an east-west flow, all deployed on the network edge. This pod module can take advantage of the cost savings from lower-cost multimode optics. In this fast-moving environment, the migration to higher speeds is common and, in some cases, frequent. Careful planning at the outset can result in a cabling infrastructure that is able to support multiple migrations.

To realize the savings, a number of factors must be considered, including how the pod infrastructure will scale and the anticipated applications the network must support. The CSPs' migration plans must also be aligned with the evolving Ethernet road map to ensure application support and equipment compatibility.

In developing a sound strategy, the CSP engineering team must answer three critical questions:

1. Which specific type of optical fibers should be used?
2. What is the optimal fiber count for the MPO trunk cables to ensure the best fiber usage for anticipated applications?
3. How to maximize fiber and equipment port density while keeping the network manageable?

By focusing on the key issues, CSP engineering teams will be better able to migrate their larger, discrete central office (CO) and data center environment to one that is highly flexible, adaptive and cost efficient.

Carriers' interest generates industry-wide response

The potential for SDN and NFV to radically transform network capability, customer service and organizational profitability has caught the attention of communications service providers, OEMs, system integrators, third-party software developers, standards bodies and open-source initiatives.

AT&T, for example, is ahead of schedule to virtualize 75 percent of its network functions by 2020[3], and has introduced its Open Network Automation Platform (ONAP) software platform. Deutsche Telekom is migrating many of its legacy networks to an all-IP environment, targeting full completion by the end of 2018. In July 2016, Google joined the Central Office Re-architected as a Datacenter (CORD) project. Other CORD partners include AT&T, Cisco, Comcast, Fujitsu, Ciena, China Unicom, Intel, NEC, Nokia, NTT, Radisys, Samsung, SK Telecom, and Verizon.

"A growing group of tier-one operators is leading the charge in implementing NFV and SDN. This group is driving a significant amount of development in the NFV and SDN ecosystem and is pushing the vendor community to rapidly adapt to this new architectural approach to networks."

Chris Antlitz

TBR telecom senior analyst

The interest shown by major carriers has served as a catalyst, prompting a concerted effort from standards bodies and vendors to develop a more robust and deeper SDN/NFV ecosystem capable of supporting larger and more ambitious deployments.

While industry initiatives and announcements regarding carriers' plans to adopt more SDN/NFV receive most of the attention, a more practical—and perhaps more important—challenge is developing the physical-layer architecture that enables carriers to maximize the benefits of SDN/NFV.

Central office evolves to support SDN/NFV implementations

To support the low-latency, high-speed requirements of a highly virtualized cloud/compute environment, CSPs are beginning to shift to a two-tier spine/leaf network architecture deployed in dedicated "pods" close to the edge. Such deployments are often referred to as a Central Office Re-designed as a Datacenter (CORD). But, whether deployed as part of a mobile telephone switching office (MTSO), centralized radio access network (CRAN) hub, or regional data center, these pods are actually part of a central office.

Figure 1 shows a conceptual example of an SDN/NFV pod build with a two-tier spine/leaf architecture.

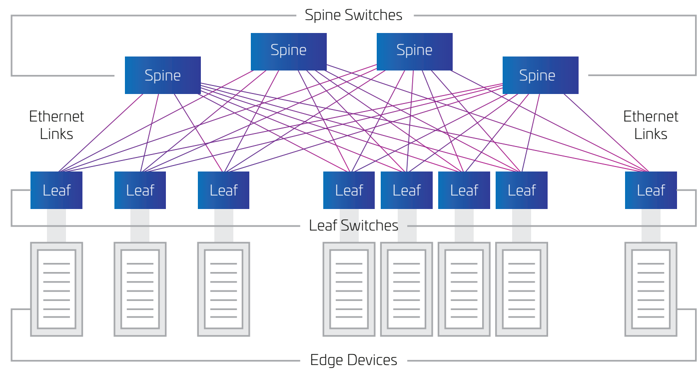


Figure 1: Spine/leaf architecture

The SDN/NFV pod can be deployed in a dedicated area and connected via fiber to the other parts of the central office. Figure 2 illustrates an "evolved" central office.

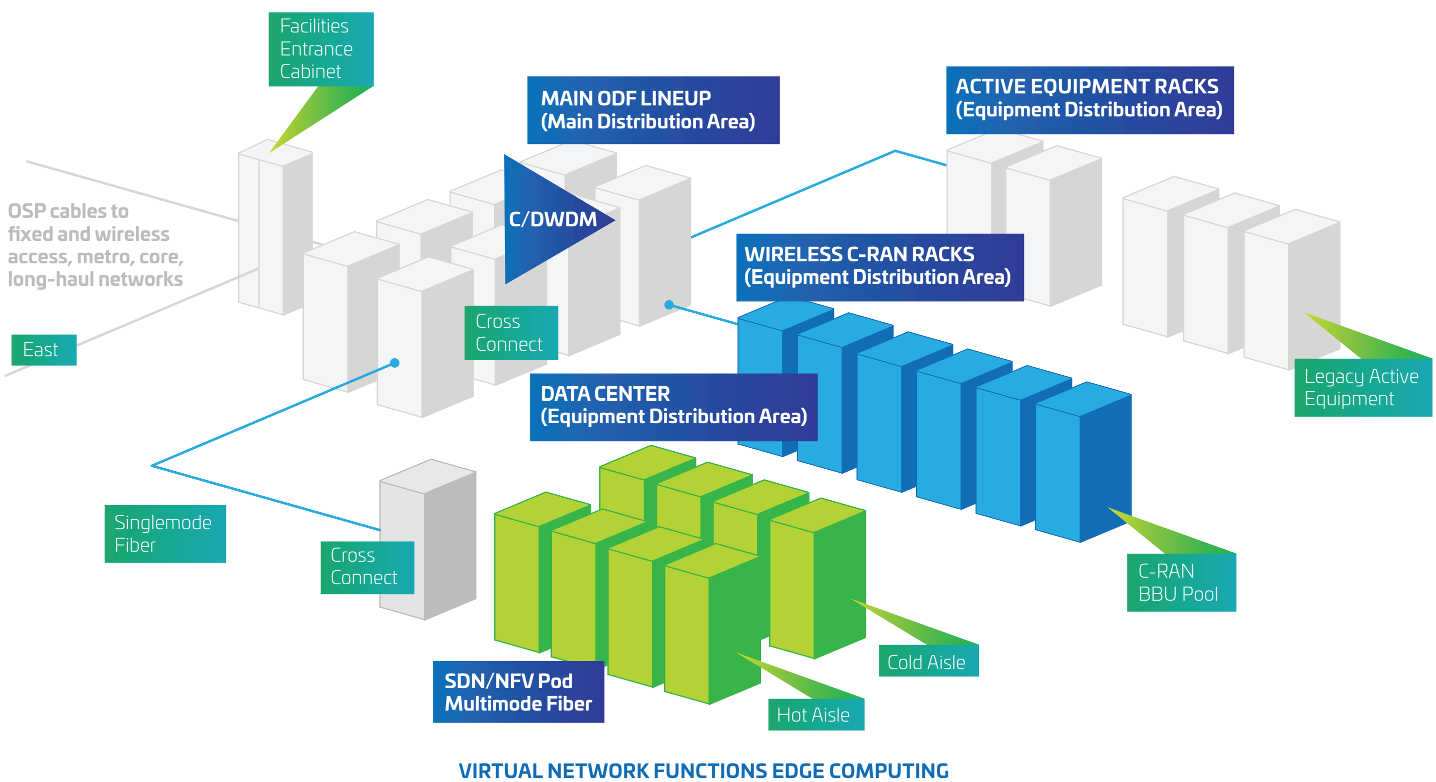


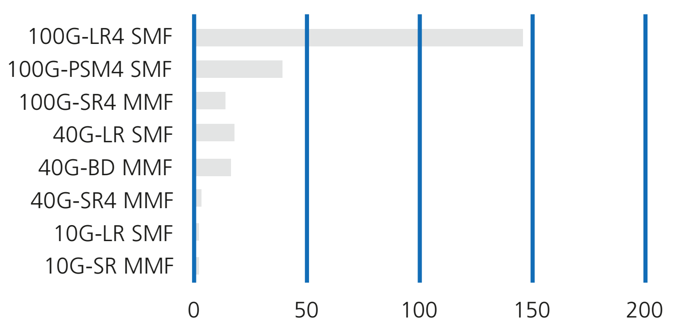
Figure 2: SDN/NFV pod inside central office

Smaller pods enable lower-cost multimode fiber

The spine/leaf architecture is optimized for east-west traffic in an NFV pod, but it also requires CSP engineering teams to rethink the topology of their fiber infrastructure. While the traditional central office infrastructure features singlemode fiber (SMF), the smaller SDN/NFV pods have shorter link distances, making them better suited for lower-cost MMF optic transceivers that use the short wavelength transmission technology. Operating around 850 nm, these transceivers are built for cabling channel lengths up to 150 meters for Ethernet applications above 10 Gbps. They are designed around vertical cavity surface-emitting laser (VCSEL) technology that is far less costly than the lasers used for singlemode transceivers.

The relative cost difference between multimode and singlemode technology is illustrated in Chart 1. As the following graphic shows, the deployment of pod networks using multimode-based transmission technology results in much lower cost compared to a pure singlemode network, a huge CapEx advantage—especially in high-density 100G configurations consisting of a lot of servers and switches inside the pod.

Relative Cost



1 Cisco VNI Mobile Forecast (2015–2020); Cisco Systems Inc.; February 3, 2016

2 Most Service Providers Will Deploy NFV by 2017; IHS Markit, research report; August 23, 2016

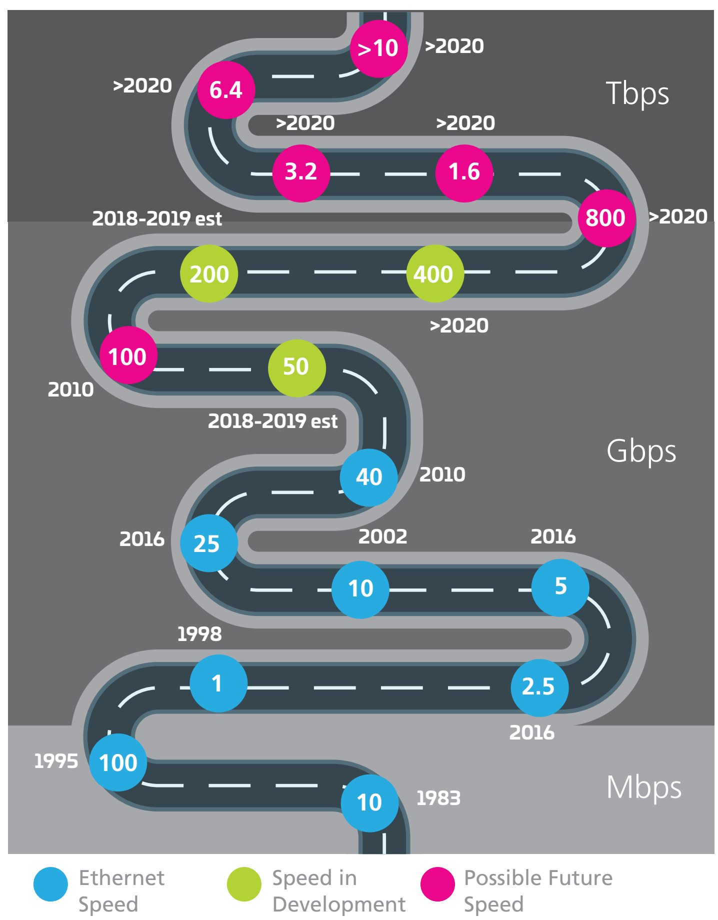
3 AT&T Outlines 5G Goals, Surpasses 2016 Virtualization Goal; SDX Central; January 4, 2017

Aligning infrastructure solutions with the industry road map

A key during the planning phase is understanding the projected trajectory and timeline of the industry's Ethernet road map, then mapping that against the anticipated needs and requirements of the pod's infrastructure. It means knowing how the infrastructure will need to scale. Will capacity grow by adding more racks (rack-scale) or by adding new pods (pod-scale)? The CSP engineering team must consider the high-speed migration path for the enterprise. What future speeds and optics may be required? The current requirements may dictate 10G, 40G and 100G links, while the next upgrade might require 25G, 50G, 200G and 400G links.

It is also essential to have a solid grasp of the industry's Ethernet road map for multimode optics. How are the standards for cabling, channel speeds and connectors evolving and how will that affect the bandwidths and fiber counts available to support your pod infrastructure in the future? Figure 3 provides a snapshot of the most current Ethernet road map, developed by the Ethernet Alliance to try to keep ahead of the bandwidth explosion. The actual standards are developed in the IEEE 802.3 committees. As shown, work is underway on 50, 200 and 400G.

It's anticipated that work will continue out into the terabit range.



Increasing channel speeds are also driving the evolution in fiber counts. Historically, duplex transmission, in which one fiber is used to transmit and one to receive, has been used to send data via fiber. In 2010, the introduction of parallel optics enabled the transmission—send and receive—over multiple fibers. The first parallel optic applications supported 40G and 100G. For the 100G application the signal was split into four 25G signals, also known as quad speed, transmitted on four different fibers, then recombined to create a 100G signal at the far end of the link. This technique is now used to enable higher speeds on multimode fiber, which has become the predominant fiber type deployed in data centers. Figure 4 shows the evolution of Ethernet applications using different fiber counts.

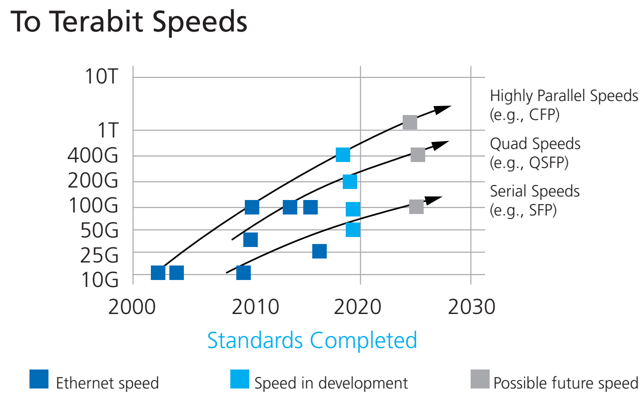


Figure 4: The evolution of Ethernet applications (source, Ethernet Alliance)

Another recent development, short wavelength division multiplexing (SWDM), further enhanced the ability to transmit higher speeds over multimode fiber. As shown in Figure 5, SWDM enables simultaneous transmission of multiple wavelengths over the same fiber to greatly reduce the number of fibers required to support high-speed applications. 100G-SWDM4, for example, can transmit four individual wavelengths of 25GB Ethernet, using only two fibers—one to send and one to receive—instead of the eight fibers required for traditional parallel optics. In 2015, the SWDM Alliance was formed to support the development of cost-effective, high-speed multimode optics.

It's composed of manufacturers of optical transceivers, network electronics, and cabling—manufacturers whose efforts are based on proven wavelength division multiplexing (WDM) technologies such as those found in short-reach data center applications.

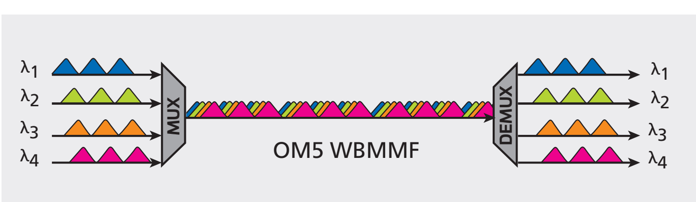


Figure 5: SWDM technology using four wavelengths

Three steps to a high speed migration cabling strategy for the SDN/NFV pod

Because of the highly dynamic nature of the applications and requirements within the CSP pod, the best infrastructure cabling solution is the one that can support the various applications, 10 GbE through 400 GbE, and technologies including two fibers, parallel fibers and SWDM. This suggests an open, standards-based architecture that supports the greatest number of options of fiber configurations and multimode optics.

Today's infrastructure must also be fast and efficient to deploy in order to accelerate turn-up time. This requires the use of modular preterminated cabling systems and MPO multifiber connectors wherever possible. Such solutions have been proven over time to shorten deployment time, reduce costs and improve the life of legacy MMF systems in data centers. To develop the best strategy for longterm migration in the SDN/NFV pod, CSP infrastructure designers must make several important decisions. These regard fiber type, MPO connector fiber count and solutions for developing fiber density and management.

Step 1: Fiber type

As discussed earlier, SWDM technology offers a significant opportunity to increase data speeds while reducing the overall fiber count. To take advantage of this capability, however, transmissions must begin at 850 nm and increase with 30 nm spacing between wavelengths. For SWDM4, this translates to wavelengths of 850/880/910/940 nm. As shown in Figure 6, neither OM3 nor OM4 fiber is specified for transmission on a maximum wavelength of 850 nm. To accommodate the larger wavelengths, a new fiber type— OM5 wideband multimode fiber—has been developed to support transmission of 880, 910 and 940 nm. In 2016, ANSI and TIA adopted the ANSI/TIA-492AAAE standard for OM5. The standard supports 28 Gigabits per wavelength and at least 100

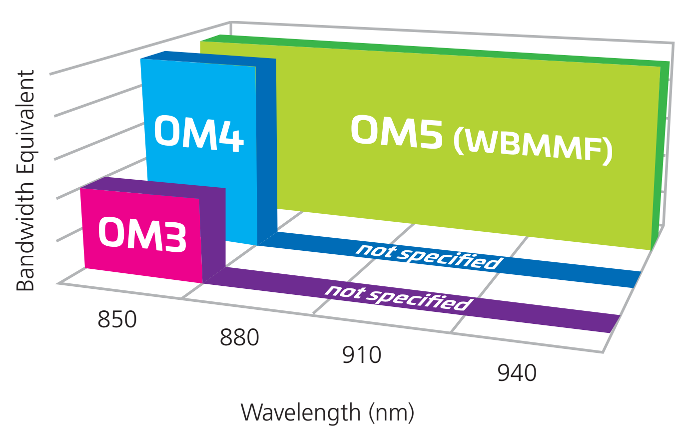


Figure 6: Conceptual Bandwidth Comparison MMF

Gigabits per fiber over 100 meters. It also specifies OM5 multimode fiber as the standard medium for wideband multimode technology. OM5 multimode fiber is fully backward compatible with OM4 and supports legacy highspeed technologies, as well as SWDM-based applications. Based on current standards, OM5 supports fiber applications from 10G to 100G today, and is poised to support much more as optical technologies continue to evolve, making it the best choice for a future-proof cabling infrastructure in a SDN/NFV pod.

Step 2: MPO connector fiber count

Figure 7 shows the three common fiber counts used with MPO connectors today. For CSP deployments of SDN/NFV and cloud/compute environments, trunk cables using MPO-24 connectivity deliver the best duplex and parallel fiber value and migration flexibility.

For the lowest first-cost duplex design, ultra-low-loss (ULL) MPO-24 provides one MPO to clean, test, and manage versus two for MPO-12, or three for MPO-8. For CSPs that plan to migrate to higher data rates but are undecided when it comes to parallel versus duplex, MPO-24 provides multiple parallel—MPO-8, MPO-12 or MPO-24—and/or duplex ports via a single MPO-24 trunk.

Figure 7: MPO-24, MPO-12 and MPO-8 connectors

Step 3: Fiber density and management

Beyond the ability to terminate high fiber counts per rack into a patch panel, there are several additional technical aspects to be considered when it comes to planning for high density. Currently, a fiber count of 144 fibers per rack unit is the de facto standard in data center cabling.

The challenge is ensuring the tightly packed fibers remain accessible, well managed and protected in order to maximize:

- Ease of access to each individual connector
- Proper patch cord routing toward the sides of the cabinet
- Simplified management of the patch cord bundle size

High- or ultra-high-density patch panels with well-designed front side patch cord management will provide the unobstructed access needed for faster turn-ups while reducing mean time to resolution (MTTR). Check for fiber security within the cassette as it will ensure that service from existing fiber connections will not be compromised during maintenance or upgrades. Check the fiber guidance system to ensure unimpeded routing through the sides of the panel and that the bend radius is well within application specifications. An example of a well designed fiber panel, supporting both ultra-high density connectivity and ease of use, is shown in figure 10.

Long term, the demands on the CSP network will continue to grow while customer expectations regarding faster, more personalized and ubiquitous access to content and services increase as well.

NFV and SDN give carriers the flexibility, speed and management capabilities to keep up. To realize the benefits, however, CSP engineering teams must rethink their traditional central office design and architecture. This is already happening as they move their virtualization and cloud/compute resources to the edge and into compact pods designed to take advantage of the increased throughput and reduced latency of spine/leaf networks.

In this newly redesigned environment, the physical layer infrastructure within the pod is critical. The accelerating advances in standards, fiber use and optical technology are converging to create a significant opportunity for CSPs to improve their data throughput, latency performance and cost efficiencies.

Specifically, the greatest number of options appears to be in the design and deployment of 40G to 200/400G links. It is important that CSP teams carefully consider all the options before settling on a migration strategy and link designs. But the results are well worth the effort. SDN/NFV equipment inside the pods may need to be upgraded every two or three years. But, with careful planning, the physical-layer infrastructure can support multiple upgrades—saving the time and costs of replacing the cable plant with each upgrade.

Ultimately, this will result in a more responsive, robust and efficient infrastructure capable of supporting the increasing demands for more data, content and availability.

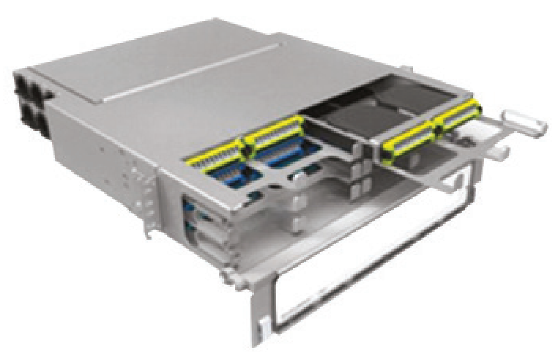


Figure 8: Example of a well-designed, ultra-density fiber rack panel

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