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SLICEABLE OPTICS

ELEVATING NETWORK AGILITY TO A WHOLE NEW LEVEL WITH SLICEABLE OPTICS

Introduction

Dense wavelength-division multiplexing (DWDM) technology disrupted the telecommunication industry by enabling multiple optical carriers to travel in parallel on the same fiber, increasing its total capacity. Subsequent innovation in photonic integration and digital signal processing led to the introduction of super-channels to take the network into a new era of capacity and scalability. 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. This increases total fiber capacity and spectral efficiency by eliminating many of the guard bands that used to be reserved at each side of every optical carrier. As migration to the cloud continues to reshape the optical networking landscape with unpredictable traffic patterns and an ever-increasing appetite for capacity, increasing network agility becomes paramount. This application note describes how to increase network agility with a new technology innovation called "sliceable optics," which are designed and built to leverage super-channels to enhance networking flexibility and optimize network assets such as power and real estate.

What Are Sliceable Optics?

The introduction of super-channels revolutionized the optical industry by providing the capacity and efficient fiber utilization dictated by the cloud. Sliceable optics further increase the benefits of super-channels by allowing any super-channel to be sliced, so each 100 gigabits per second (Gb/s) or N x 100 Gb/s wavelength can be tuned across the C-band, modulated and then routed in multiple separate directions to the appropriate destinations over any open optical line system, as shown in Figure 1. The ability to "slice and dice" super-channels significantly reduces total cost of ownership

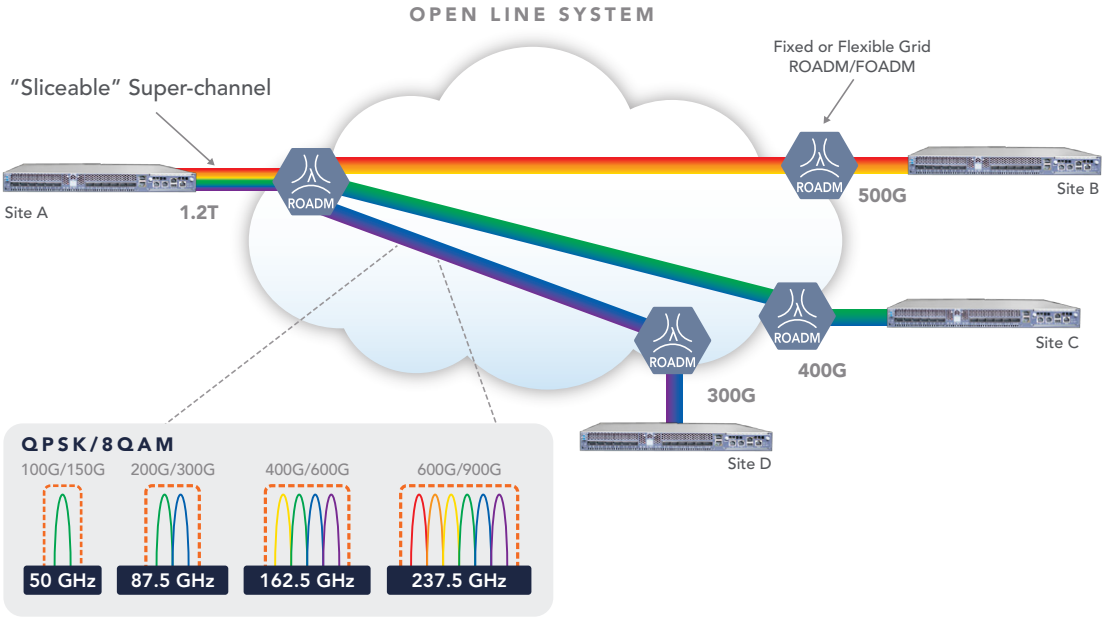

Figure 1: Sliceable Optics

(TCO) in terms of power consumption and footprint, increases network flexibility and streamlines operations through automation and programmability. Conventional optical vendors leverage the use of transponders with a single 200 Gb/s or 400 Gb/s wavelength, which often requires the deployment of multiple circuit packs, higher numbers of fibers, significantly higher power consumption and a larger footprint. Sliceable optics simplify traffic aggregation and accelerate service turn-up by eliminating truck rolls while providing 100 Gb/s economics at multi-terabit scale.

Why Sliceable Optics?

The use of sliceable optics translates into multiple operational benefits for network operators, such as:

- Lower TCO and operational expenditure (OpEx): Conventional ways of networking require the use of transponders and muxponders to deliver the desired capacity to each remote site, which often results in the extensive utilization of chassis and circuit packs. Alternatively, Optical Transport Network (OTN) switching provides networking flexibility, but it often comes with high capital expenditure (CapEx) due to the use of OTN switching fabric and client and line interfaces. Moreover, delivering high capacity (e.g. 300G) to a remote site over an OTN-switched network requires the deployment of a significantly higher-capacity line rate (multiple 100 Gb/s or 200 Gb/s wavelengths), which further increases TCO. Sliceable optics strike the perfect balance between flexibility and low costs (lower TCO, CapEx and OpEx) by providing the required networking flexibility without truck rolls and with significantly lower power consumption and a smaller footprint. As a matter of fact, a case study on a U.S.-based nationwide service provider revealed 50 percent lower TCO, 40 percent lower rack units per client Gb/s and 20 percent lower watts per client Gb/s when compared to the industry's nearest competitor.
- Optimized connectivity: Each "slice" can be set to operate over the optimal modulation scheme (e.g. quadrature phase-shift keying [QPSK], 8 quadrature amplitude modulation [QAM], 16QAM) to provide the best capacity/reach ratio. Moreover, sliceable optics provide the perfect match between traffic requirements and delivered capacity at each site by combining one or multiple carriers. In a nutshell, sliceable optics allow a connection optimized for capacity/reach and bitrate to every remote site, as depicted in Figure 2.
- Increased networking agility: As previously mentioned, the cloud is dictating a new level of network agility in which connections can be created, modified or retired in real time without prior planning or labor-intensive operations. Sliceable optics allow network operators to dynamically increase or decrease capacity to any given site easily, quickly and without truck rolls (Figure 3), thus underpinning cloud applications with a new level of agile and highly flexible network infrastructure.

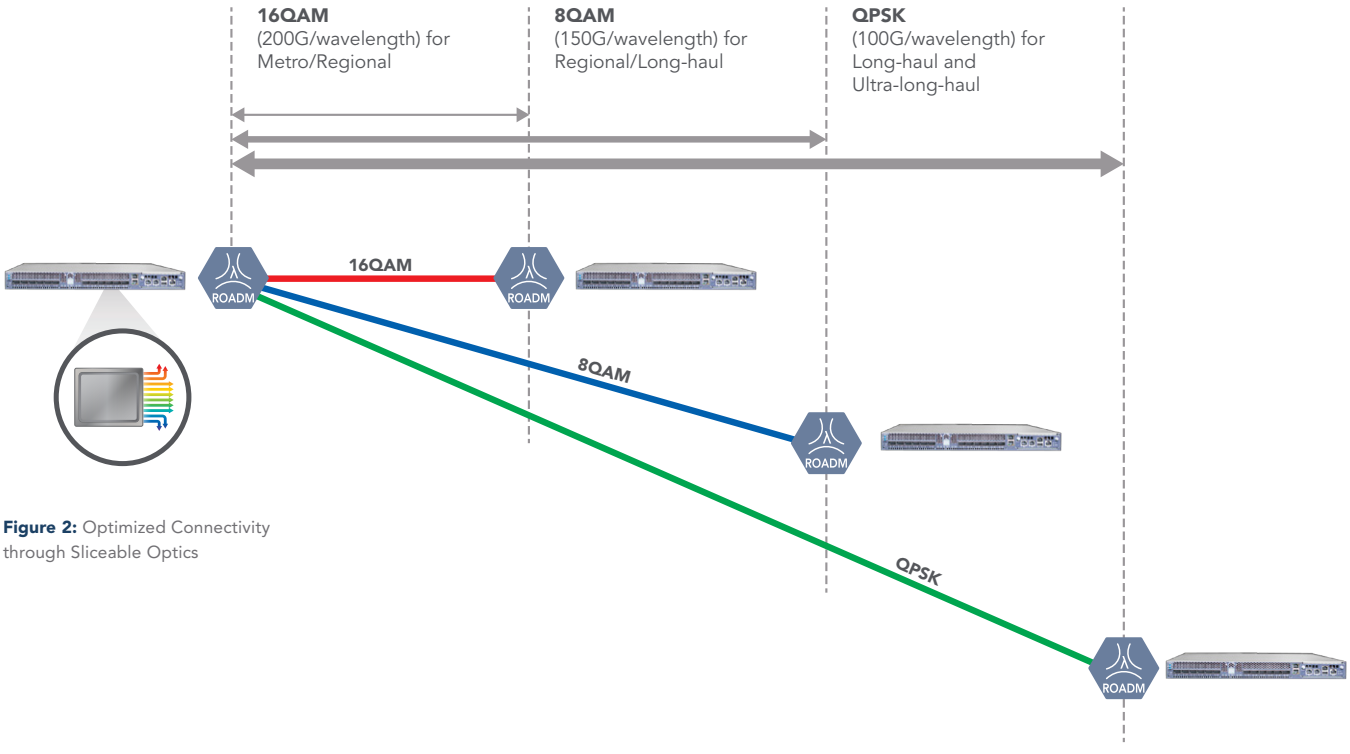

Figure 2: Optimized Connectivity through Sliceable Optics

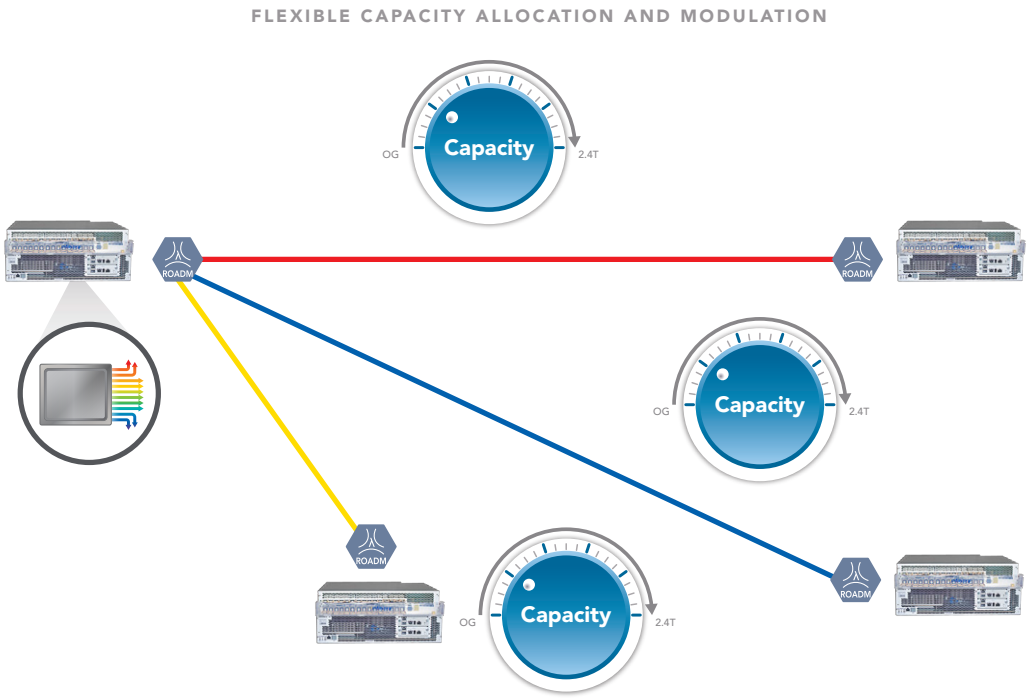

Figure 3: Increasing Network Agility with Sliceable Optics

- Automated operations and enhanced network programmability: Unlike connectivity based on transponders and muxponders, sliceable optics allow network operators to extend back-office software scripts and tools to control service activation and delivery to streamline operations and enhance network programmability. The service-ready capacity (such 1.2 terabits per second [1 Tb/s] or 2.4 Tb/s) can be remotely and quickly activated to meet the immediate demand for bandwidth triggered by upper-layer applications.

What Are the Applications for Sliceable Optics?

The benefits of sliceable optics span a wide scope of applications. The following are just a few of the applications often used by communications service providers (CSPs) and internet content providers.

- Traffic aggregation: This application consists of aggregating traffic in various sizes and across different distances to the network headend before handing the sum of all traffic to the core networks, as depicted in Figure 4. Sliceable optics provide a cost-effective and flexible solution at each remote site in which capacity can remotely scale from 100 Gb/s to multiple Tb/s without forklifting, in a compact footprint and with low power consumption.
- Deploying a dynamic infrastructure for 5G: Next-generation technologies like 5G are expected to disrupt wireless communications with significantly higher bit rates and an unprecedented low level of latency. Therefore, wireless network operators are working tirelessly trying to model and estimate what the real impact on core optical networks will be in terms of capacity and performance. A common network planning practice is to "over-engineer" the network just to be on the safe side when the deployment of 5G

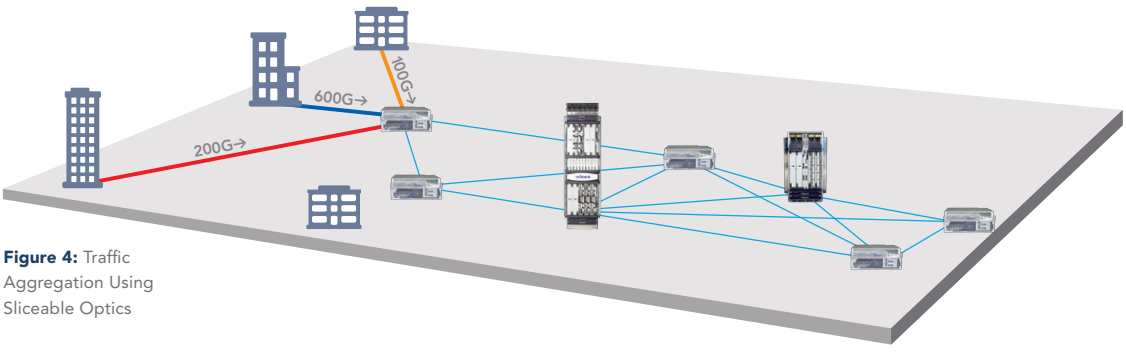

Figure 4: Traffic Aggregation Using Sliceable Optics

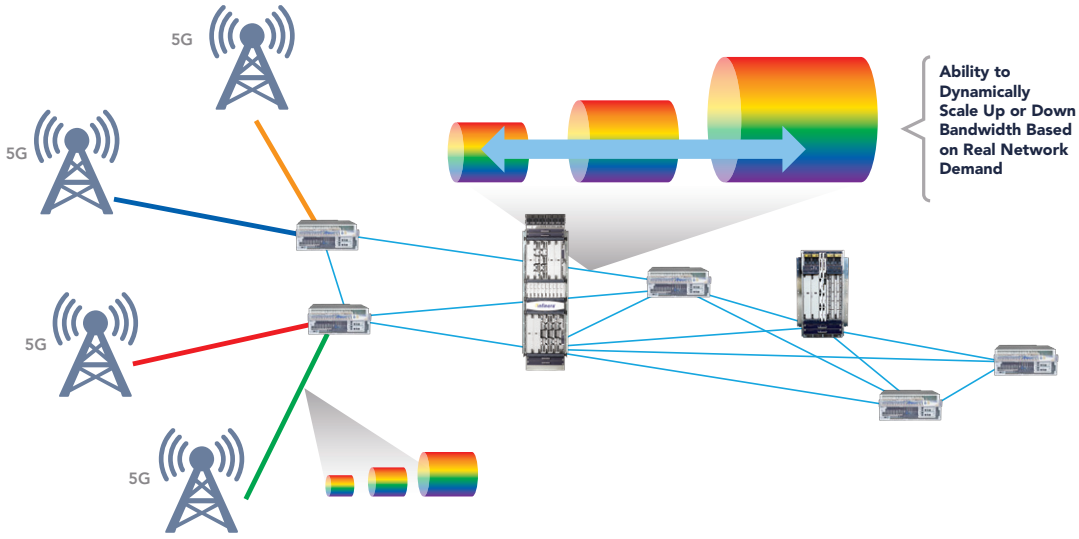

Figure 5: Sliceable Optics as a Dynamic Infrastructure to 5G

triggers massive demand for bandwidth in the core. However, such a practice comes with a very high price tag as network operators have to heavily invest in deploying optical networking gear now and then wait for 5G revenue to materialize, which could take years depending on consumer adoption rate before reaching a level that covers the CapEx. Sliceable optics provide the flexibility needed for any emerging new technology like 5G by allowing network operators to dynamically scale bandwidth up or down based on the real demand triggered by 5G, without truck rolls and without locking in massive CapEx as "standby" infrastructure (Figure 5). Sliceable optics provide a better return on investment and a more flexible and dynamic infrastructure that meets, or even exceeds, the networking requirements of such disruptive emerging technologies.

- Data center interconnect (DCI): Cloud and the Internet of Things (IoT) are fueling the proliferation of data centers in metro and regional networks and across thousands of kilometers. Sliceable optics allow the interconnection of these data centers while providing the high capacity and optical performance that are crucial for the success of such deployments. Sliceable optics also provide the flexibility to evolve network configuration (from point-to-point to mesh) and traffic patterns without network engineering or a massive influx of capital spend, as depicted in Figure 6.
- Extension of network coverage for CSPs: The ability to partition bandwidth and send it in different directions makes sliceable optics a highly flexible and optimized solution for network expansion into new geographical areas. CSPs can now quickly, cost-effectively

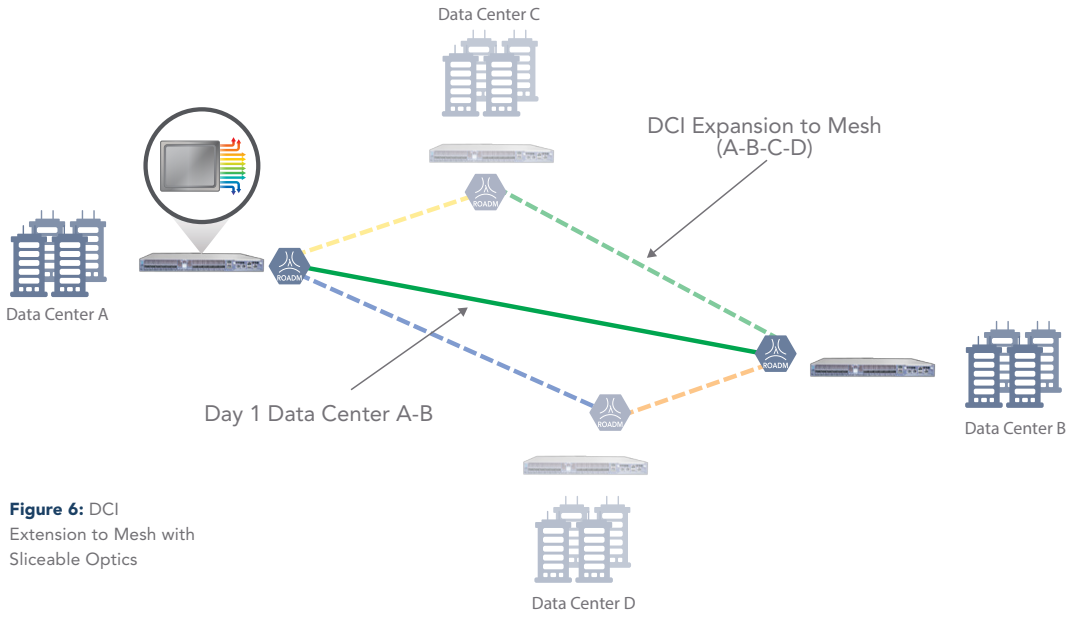

Figure 6: DCI Extension to Mesh with Sliceable Optics

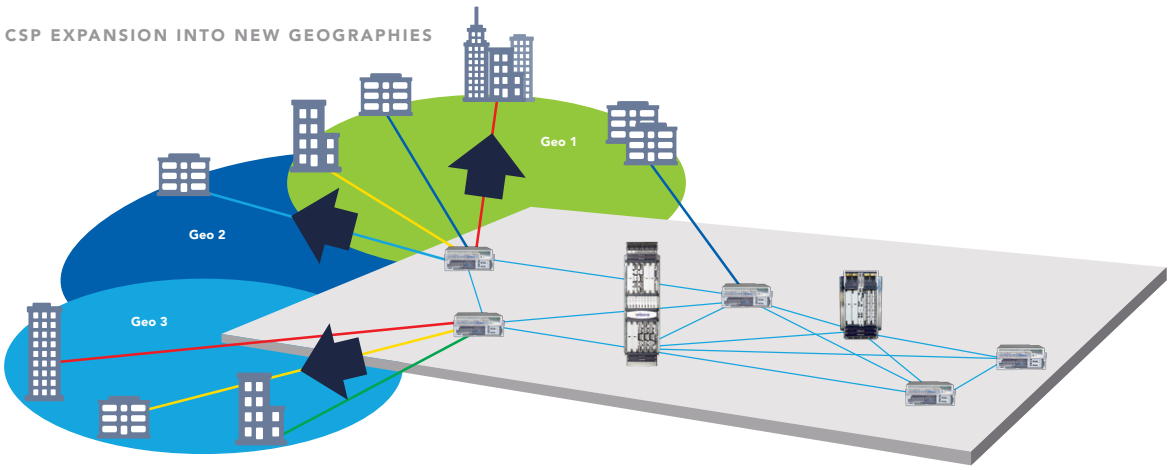

Figure 7: Extension of Network Coverage for CSPs with Sliceable Optics

and efficiently extend their coverage and tap into new markets by deploying Infinera's solution with sliceable optics (Figure 7). The ease of deployment significantly reduces installation time, while fast service activation through Infinera Instant Bandwidth accelerates time to revenue and increases competitive edge.

What Platforms Support Sliceable Optics?

Sliceable optics are one of the key features of Infinera's fourth-generation Infinite Capacity Engine (ICE4). They are supported on the Cloud Xpress 2 and the XT-3300 and XT-3600 meshponders, as well as the XTC Series (Figure 8).

Summary

While super-channels disrupted the optical industry by enabling higher capacity and increased spectral efficiency, sliceable optics elevate networking flexibility to a whole new level. The ability to slice and dice super-channels significantly reduces operating costs in terms of power consumption and footprint and hence decreases TCO, increases network agility and streamlines operations through automation and programmability.

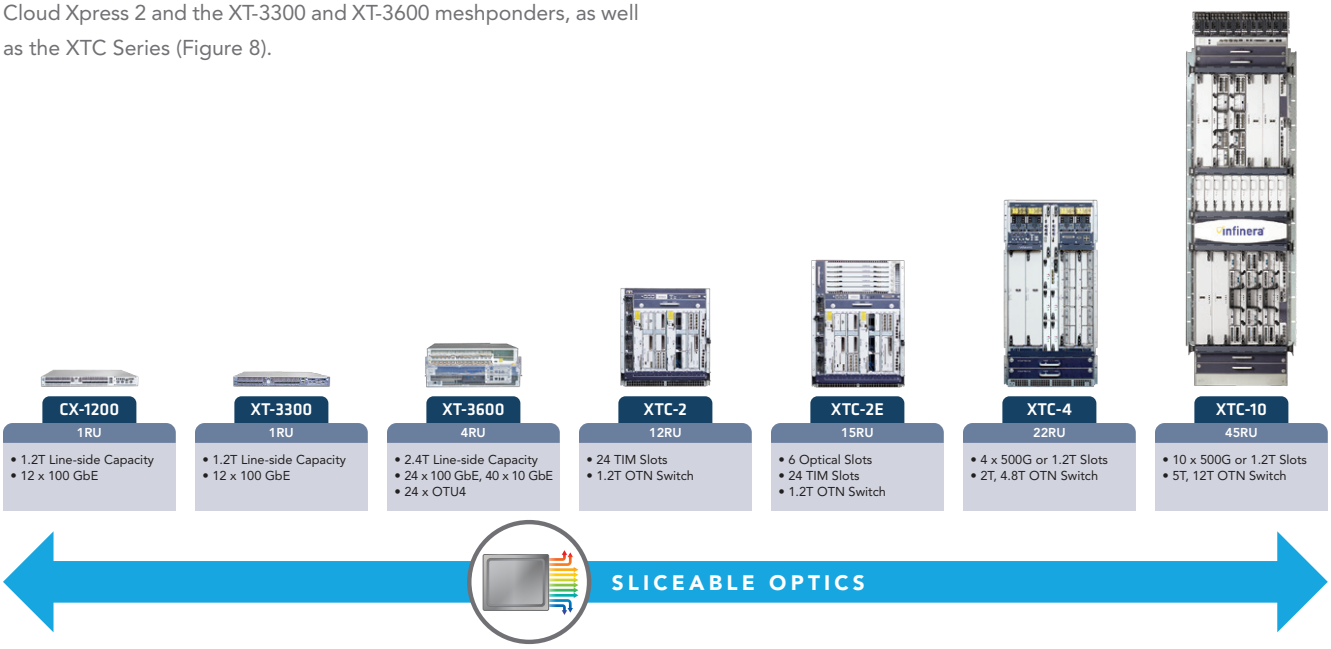

Figure 8: Infinera Platforms Supporting Sliceable Optics

Global Headquarters
140 Caspian Court
Sunnyvale, CA 94089
USA
Tel: 1 408 572 5200
Fax: 1 408 572 5454
www.infinera.com

Asia and Pacific Rim
Infinera Asia Limited
Suite 1611 – 12 City Plaza 1
1111 Kings Road
Tai Koo Shing
Hong Kong
Tel: +852 2521 1215

Europe, Middle East, Africa
Infinera Limited
125 Finsbury Pavement
London EC2A 1NQ,
United Kingdom
Tel: +44 207 065 1340

Customer Service and Technical Support
North America
Tel: 877 INF 5288
Outside North America
Tel: 1 408 572 5288

For more information
Contact Us
infinera.com/contact-us