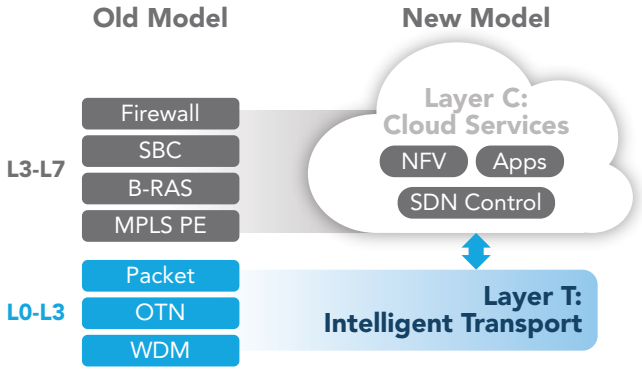
THE INFINERA INTELLIGENT TRANSPORT NETWORK PORTFOLIO

Providing operators with scalability, flexibility and programmability to build open and secure transport networks

infinera®

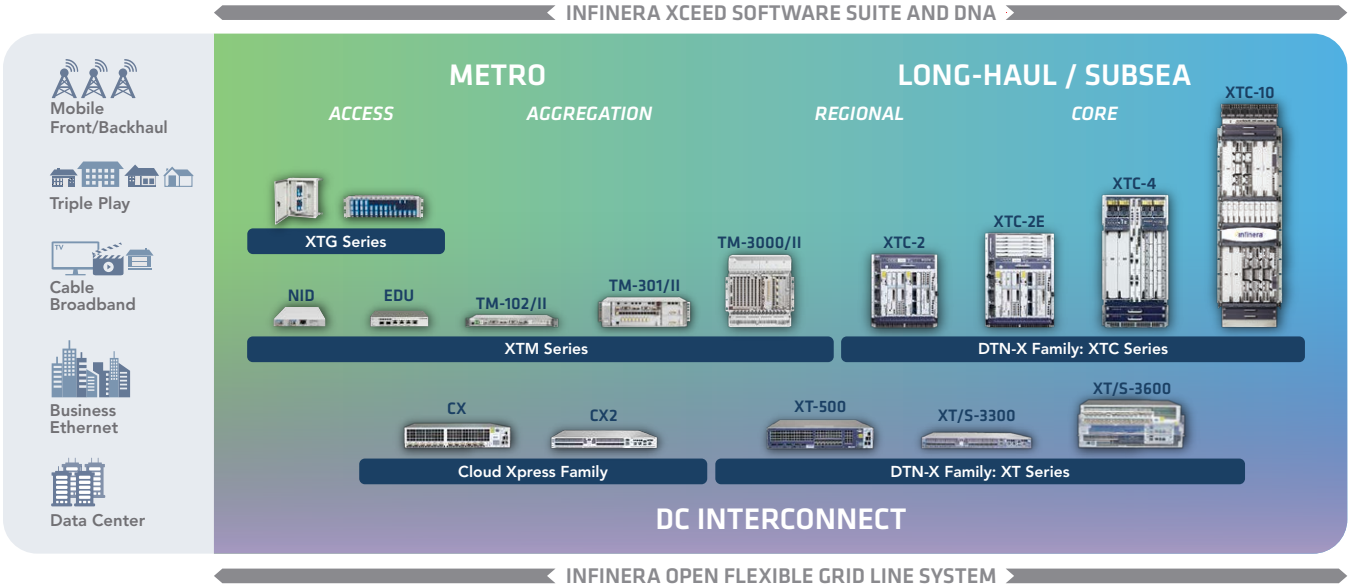
SERVICE PROVIDER AND CLOUD OPERATOR networks are undergoing an extensive transformation to a new network model of Layer C (cloud services) and Layer T (intelligent transport). With Layer C, network operators are taking advantage of the nearly unlimited compute being deployed in cloud data centers around the world and driving vendors to implement network function virtualization (NFV). With NFV the operator goal is to move every network function possible away from dedicated proprietary hardware and into a software implementation that can run in the cloud at lower cost and with better agility and scale. These functions, such as firewalls, are predominantly located in Layers 4–7 of the Open Systems Interconnection (OSI) model, but include lower-speed Layer 3 functions such as virtualized customer premise equipment (vCPE) as well. Service providers are also asking for vendors to move control planes into this new Layer C of the network model, which is often referred to as software-defined networking (SDN), but which can take other forms such as a router control plane in the cloud. These cloud services need to connect to end-users as well as to each other, and thus the physical capability to move packets around the network is required. This connectivity is physical and at Layers 0–3 of the OSI stack, and the most efficient and scalable way to enable this connectivity is packet-optical intelligent transport, referred to as Layer T.

Industry analysts have highlighted the unrelenting growth in bandwidth demand across subsea, long-haul and metro networks, and have identified east-west data center to data center traffic as one of the key drivers for such growth. While long-haul networks are transitioning to 100 gigabits per second (100G) and beyond, the explosive growth in traffic and a shift to cloud-based delivery of applications is now forcing a similar transformation of metro networks from 10G to 100G. Web scale requirements are driving a large number of point-to-point high-capacity interconnects. These large linear channels need to support elephant flows, which often traverse traditional telecom networks; these networks have typically been driven by telco requirements of numerous mice flows and diverse mesh connectivity. Existing network architectures need to evolve to cloud scale, which merges web scale and telco-grade requirements. As networks evolve to cloud scale, the strategic importance of the transport network, Layer T, has never been higher, and therefore it is vital to build Layer T with the following attributes:



Network Transformation

- A **scalable optical layer** is the foundation upon which this Layer T is built. It requires highly scalable optics offering maximum super-channel capacity per optical engine with minimum space and power, and at the same time, the ability to slice the super-channel independently, tuning, modulating and routing each wavelength under SDN control.



Infinera's Intelligent Transport Network Portfolio

- Next-generation services require **flexible and granular control** across the end-to-end packet-optical network to satisfy the unique needs of each service, with application-specific capabilities. This includes steering wavelengths via reconfigurable optical add-drop multiplexers (ROADMs) at the wavelength-division multiplexing (WDM) layer and grooming, multiplexing and switching sub-wavelength traffic flows via Optical Transport Network (OTN) or packet switching. These techniques can be delivered using WDM with integrated switching working in harmony with disaggregated server-like optical-only WDM platforms to build the most cost-effective networks possible. The network needs to deliver the highest available efficiency combined with key capabilities such as low latency, superior synchronization performance and multi-service transport.
- Layer T needs to be **open, programmable, and agile**, with SDN control and open application programming interfaces (APIs) for rapid service creation and delivery. This allows service providers to adopt a DevOps approach to rapidly develop and introduce new services. In addition to being open and programmable it needs to be secure, with in-flight wire-speed encryption capabilities and other critical security features.

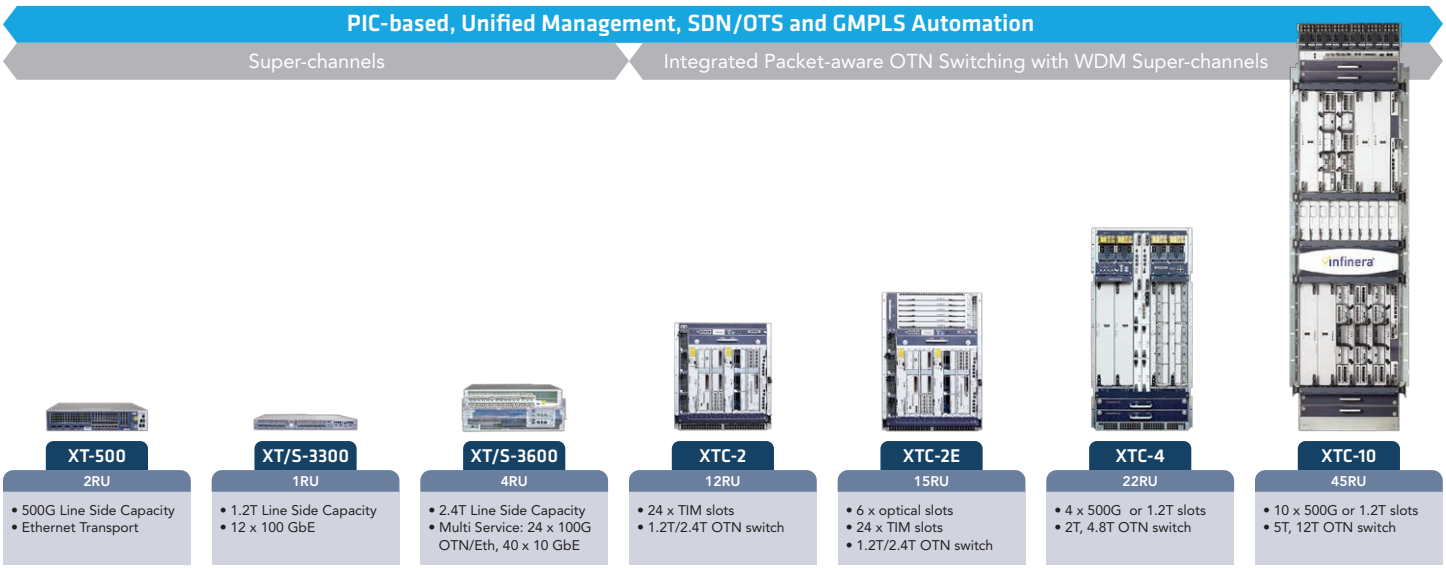
The Infinera Intelligent Transport Network Portfolio

Infinera's end-to-end portfolio has served the long-haul and metro markets for over a decade. This portfolio is powered by optimized photonics and electronics along with robust software for service providers to build highly scalable, flexible and programmable networks.

Infinera is a pioneer of metro WDM through the **XTM Series**, which today includes leading packet-optical metro access, aggregation and metro core platforms and is complemented by the XTG Series passive WDM platforms. These deliver optimized services for applications such as triple play broadband, cable broadband, business Ethernet and mobile transport.

The Infinera **DTN-X Family**, powered by Infinera's Infinite Capacity Engine, is the world's only 2.4 terabit per second (2.4T) commercial super-channel system leveraging large-scale photonic integrated circuit (PIC) technology. The DTN-X Family now includes the industry's first small-form-factor, server-like meshponder WDM platforms, which blend sliceable photonics and muxponder functionality to deliver hyperscalable WDM along with fine-grained granularity. The DTN-X XT Series and the new subsea-optimized XTS Series meshponder platforms seamlessly interoperate with the DTN-X XTC Series chassis-based platforms, which include up to 12T of integrated OTN switching. With a diverse range of form factors and capacities, the DTN-X Family covers subsea, long-haul, metro core and regional applications.

The Infinera **Cloud Xpress Family** is targeted for the metro data center interconnect (DCI) application and offers up to 1.2T of super-channel capacity in form factors as compact as 1 rack unit (1RU), with low power consumption, a simple operational model, and automation support, and is designed to support in-flight



The Infinera DTN-X Family

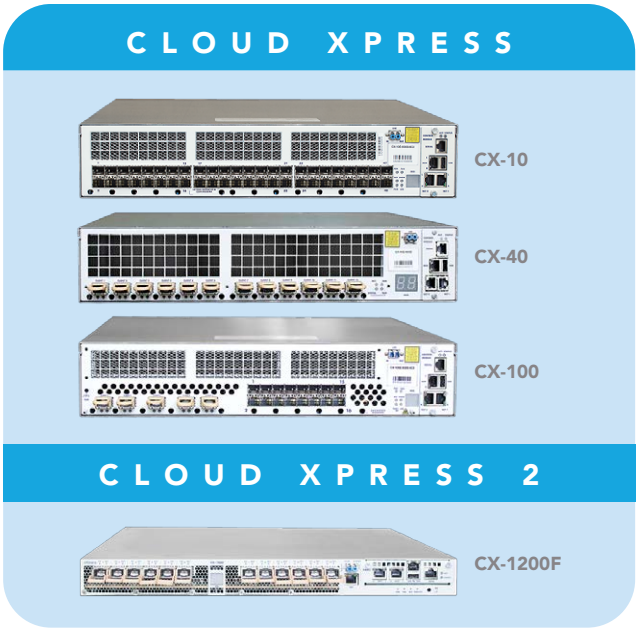
Layer 1 wire-speed encryption (encryption software license required for activation).

The Intelligent Transport Network product portfolio is fully interoperable over the Infinera **FlexILS** flexible grid open line system and is managed in a unified manner using the **Infinera Management Suite** featuring Digital Network Administrator (DNA). Designed for multi-layer networks and unified SDN control across the entire Infinera portfolio, Infinera's **Xceed Software Suite** is powered by open source software and interfaces with third-party solutions via open APIs to provide revenue-ready applications for agile, assured orchestration of new services.

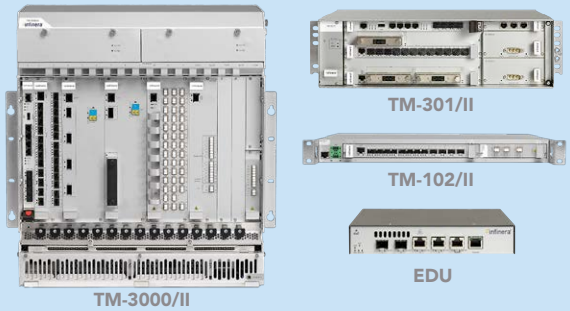
DTN-X Family: Infinera integrates the groundbreaking Infinite Capacity Engine into the DTN-X Family for long-haul terrestrial, subsea, metro and data center interconnect networks. The platforms in the DTN-X Family support Infinera's unique Instant Bandwidth, sliceable super-channels, designed-in support for in-flight wire speed encryption (encryption software license required for activation) and the Advanced Coherent Toolkit (ACT) for better capacity-reach performance. Sized to fit varying application needs, the DTN-X Family is built to scale in multiple dimensions without compromising performance.

The DTN-X XTC-10 and XTC-4 platforms integrate the world's highest density 500G and 1.2T optical engines, and offer up to 12T of non-blocking digital switching capacity with no tradeoffs between client-side tributary capacity and line-side capacity. The XTC-10 and XTC-4 platforms can be upgraded from 500G to 1.2T per slot in a non-disruptive manner. The new 1.2T modules coexist with deployed 500G modules, thereby offering investment protection. The DTN-X XTC-2 and XTC-2E platforms are purpose-built for metro core and regional networks with up to 2.4T of OTN switching capacity, and are smaller form factor variants of the DTN-X XTC-4 and XTC-10 platforms. The DTN-X XTC Series automates many traditional network engineering steps, so operators spend less time engineering the network and more time delivering services and generating revenue. Further, with built-in generalized multi-protocol label switching (GMPLS)-based intelligence, the network is always aware and able to tap into available resources, efficient routing paths and mesh-based network protection that protects customer traffic, as fast as sub-50 milliseconds (ms).

While the DTN-X XTC Series offers integrated WDM, packet-aware OTN switching, grooming and service protection capabilities in the network, the DTN-X XT and XTS Series offer high bandwidth in a compact footprint and include all the benefits of super-channels like provisioning a single unit of capacity in one operational motion. The DTN-X XTS Series is designed to power cloud scale networks for subsea operators. It combines 2.4T super-channels with sliceable photonics and and is designed to support in-flight Layer 1 wire-speed encryption (encryption software license required for activation) in a compact and lower-power form factor. The XTS Series features subsea-optimized modulation formats such as matrix-enhanced phase shift keying (ME-PSK) and 3 quadrature amplitude modulation (QAM), as well as Infinera's Advanced Coherent Toolkit featuring the industry's first commercially-available Nyquist subcarriers to enhance capacity-reach performance. It delivers multi-terabit super-channel bandwidth in a compact form factor and at the same time enables super-channels to be sliced, so each wavelength can be tuned across the C-band, modulated and then routed to the appropriate destination. The DTN-X XTS series includes the XTS-3300 meshponder, delivering up to 1.2T of line-side capacity in 1RU, and the XTS-3600 meshponder, delivering 2.4T of line-side capacity in 4RU, providing enhanced capacity and reach for subsea transport applications in an ultra compact form factor with low power consumption. The XTS Series is designed to support new subsea software tools for open networking, which enhance Infinera's open architecture by allowing subsea operators to partition and monetize valuable fiber spectrum so that it can be safely and securely shared with multiple customer tenants, independent of both cable and submarine line terminal equipment (SLTE) suppliers. Mission-critical subsea link performance data is available in real time on demand via open SDN APIs. This enables subsea operators to monitor transmission health as well as identify opportunities for capacity adjustments. The DTN-X XTS Series seamlessly interoperates with the DTN-X XTC and XT Series, providing a unified end-to-end Intelligent Transport Network portfolio, and when combined with Infinera's Instant Bandwidth it allows for instant end-to-end network re-



XTM SERIES



configuration covering subsea, long-haul, metro and data center interconnect applications.

The DTN-X XT Series is optimized for delivery of cloud scale 100G network services over long-haul, regional and data center interconnect networks spanning hundreds and thousands of kilometers (km). The XT-3300 meshponder platform delivers 1.2T line-side capacity in 1RU. The XT-3300 provides an unmatched reach of 6,000 km in an ultra-compact form factor with low power consumption. The XT-3600 platform delivers 2.4T of line-side capacity in a 4RU form factor. With redundant controller, Network Equipment-Building System (NEBS) compliance, 470 millimeter (mm) rack depth and a mix of OTU4, 100 Gigabit Ethernet (GbE) and 10 GbE client interfaces along with OTN multiplexing, the XT-3600 also supports a reach of 6,000 km. The DTN-X XT-500 delivers 500G super-channel output with 10 GbE or 100 GbE clients in 2RU of rack space. Similar to the XTC Series, the XT Series can be can be seamlessly integrated with the Infinera FlexILS line system and offers support for fixed and flexible grid to maximize spectral efficiency, providing up to 25.6T of fiber capacity. It also helps service providers to take advantage of colorless, directionless and contentionless (CDC) ROADM architectures. This enables super-channel switching at the optical layer, Layer 0, within an optical mesh network, improving overall network switching capability and thus resulting in enhanced network efficiency.

Cloud Xpress Family: The Infinera Cloud Xpress Family delivers simplicity, scalability, efficiency and security while offering choice and flexibility for metro cloud data center interconnect. Purpose-built with a compact form factor and low power consumption for the metro cloud market, the Cloud Xpress Family includes multiple models to match varying requirements.

The second generation, the Cloud Xpress 2, based on the Infinite Capacity Engine, delivers multi-terabit super-channel scale. The Cloud Xpress 2 is optimized for scalable 100 GbE data center interconnect over a 1.2T super-channel output. The 500G Cloud Xpress includes multiple models supporting varying configurations of 10 GbE, 40 GbE and 100 GbE ports for client-side connectivity, and a 500G super-channel output. Combining super-channel output and 130 to 150 km reach without requiring external amplifiers, the Cloud Xpress Family delivers superior plug-and-play reach plus capacity, simplifying deployment and operations.

The Cloud Xpress Family incorporates Infinera's Instant Bandwidth and stackability for simple capacity scaling from 100G up to 27.6T over a single fiber pair. Several Cloud Xpress models are designed to support in-flight wire-speed data encryption (encryption software license required for activation) to ensure the security of all traffic as it travels between data centers, and all Cloud Xpress platforms support rapid provisioning, data center automation and SDN control through open, standard APIs.

XTM II CLOUD SCALE METRO PLATFORM

- High capacity and small footprint for space-constrained environments
- Lowest power per 100G in the industry—ideal in locations where power is limited
- Service-rich platform with Layer 0 to 2/2.5 transport and services
- 200G per wavelength traffic units for Layer 1 and Layer 2 services
- 400G+ per wavelength-ready open line system
- Enhanced chassis options with 1 RU, 3 RU and 11 RU sizes and flexible fuse options
- Instant Bandwidth
- SDN control via Xceed

XTM Series: The XTM Series packet-optical networking platform for carrier-grade transport delivers high-performance networks from metro access to metro core. Whether used to push WDM to the antenna or cell site in mobile backhaul or fronthaul networks, connect enterprises together or to the cloud, deliver high-definition television, or just aggregate different kinds of services for transport onward to the core, the XTM Series delivers a comprehensive set of capabilities to meet the different requirements created by metro network applications. Supporting optical wavelengths and packet switching, using technologies such as Ethernet, OTN, Synchronous Digital Hierarchy/Synchronous Optical Networking (SDH/SONET), multi-protocol label switching—transport profile (MPLS-TP) and Intelligent WDM (iWDM®), the XTM Series builds on key design philosophies such as low power, high density and a high level of scalability.

The XTM II expands the XTM Series into cloud scale metro networks and reduces the power and density per bit even further, while at the same time increasing metro transport capacity. The XTM II is optimized for bandwidth-hungry , latency-sensitive applications and to support fiber-deep access architectures such as Remote PHY, 5G transport and passive optical networking (xPON). Metro WDM aggregation networks are often constrained when it comes to power and space, and are limited to use existing physical infrastructure and facilities that were not designed for high-capacity optical networking. The XTM II is designed for exactly this challenge, taking capacity in metro networks to new heights while keeping power consumption to an absolute minimum, only 20 watts (W) per 100G, footprint small, and latency to a bare minimum.

DTN Platform: The Original Game-Changer: In 2004, the Infinera DTN changed the rules of optical networking. With fully integrated transport and switching, the DTN not only dramatically simplified the service provisioning process, but also shortened time to revenue while eliminating the need for complex optical components. The DTN provides flexibility with integrated WDM transport, OTN switching and GMPLS intelligence in a single platform. The DTN uses the industry's first 100G PIC and supports Bandwidth Virtualization.

FlexILS: Infinera FlexILS is Infinera's open optical line system that enhances the scalability, flexibility and programmability of Intelligent Transport Networks. FlexILS uses the ITU-T flexible grid channel plan with granularity of 12.5 gigahertz (GHz), allowing efficient packing of any combination of optical carriers, modulations, and data rate on the same optical fiber, and enabling over 50T capacity over optical fiber with terabit super-channels. FlexILS includes the MTC-9 and the compact MTC-6 chassis with amplifiers, multiplexers, and four-port, nine-port and 20-port super-channel FlexROADMs. The FlexROADM can support flexible grid super-channels with single-channel granularity with full CDC functionality and utilizes six times fewer fibers than conventional ROADMs. FlexILS is fully open and interoperable with Infinera and third-party terminals. FlexILS, when deployed with the XTC Series, provides the benefits of a multi-layer switching architecture: OTN switching for efficient packing of client services and super-channel-based optical switching for operational simplicity and flexibility of express traffic. FlexILS can also be deployed with the XT Series for long-haul and regional interconnect applications. FlexILS also supports a GMPLS-based, spectrum-switched optical network (SSON)-compliant, unified control plane providing efficient network planning and simpler end-to-end multi-layer service management in the network.

XTG Series: The XTG Series is a family of cost-effective, passive optical WDM products. Designed for access applications, it fits in a wide range of applications and deployment scenarios, from controlled environments in central offices to street cabinets or even in underground enclosures such as manhole environments that require environmentally-hardened products. The XTG Series supports point-to-point, mesh, bus and ring-based network topologies and can be used in numerous network scenarios such as fiber to the curb (FTTC), fiber to the building (FTTB) and high-security access networks. The XTG Series is compatible and interoperable with the XTM Series.

Xceed Software Suite: The Infinera Xceed Software Suite is a portfolio of software solutions that make bandwidth more dynamic and flexible. Xceed combines an open, multi-layer SDN control platform with modular, commercially deployable applications to enable revenue-ready applications while improving network efficiency. Designed for multi-layer networks and unified SDN control across metro, long-haul and subsea networks, Xceed complements Infinera's Digital Network Administrator network management software.

Xceed Applications are commercially-deployable SDN applications designed to help operators rapidly activate revenue-generating services. Built on the APIs of the Xceed Multi-layer SDN Platform, Xceed Applications enable operators and third-party developers to quickly create and deploy additional SDN applications. Xceed Applications span the optical, OTN and packet layers to automate the orchestration of a range of end-user services.

The Xceed Multi-layer SDN Platform comprises a rich abstraction layer, open source-based SDN control functions and custom microservices designed to rapidly optimize and deploy SDN

applications. Based on the OpenDaylight open source platform, the Xceed Multi-layer SDN Platform supports Infinera-developed Xceed Applications and also enables operators and third-party application developers to create and deploy new SDN applications with greater feature velocity, more visibility and greater control of platform functions. Xceed is designed for extensibility and high availability to support the requirements of real-time changes in transport networks.

Infinera Management Suite: Unified network management that maximizes the value of the network elements as well as the network as a whole is critical to achieving scale and service simplicity. The Infinera Management Suite is a feature-rich suite of tools, including Infinera Digital Network Administrator to provision and operate the Intelligent Transport Network product portfolio. The Infinera Management Suite brings together GMPLS-based network intelligence, plug-and-play network elements and point-and-click service provisioning in a single package that uses all the enhanced operations, administration and management (OAM) functions for an Intelligent Transport Network. The suite also features an easy-to-use graphical user interface that can view the entire network down to an individual service element and its performance, in an environment that is secure and customizable.

Infinera Intelligent Transport Networks provide scalability, flexibility and programmability from subsea to access with a precise set of tools to address specific network location and application requirements. As network infrastructures transform to the new model of Layer C and Layer T, Infinera's comprehensive Intelligent Transport Network portfolio offers a foundation for what the network will be.

Infinera Instant Network: Infinera Instant Network is the next generation of software defined capacity (SDC) for cloud scale networks and a necessary foundation for cognitive networking. With Instant Network, service providers activate SDC when revenue-generating services demand it, reducing capital expenditures by diminishing idle optical network capacity and lowering business risk by shrinking the time between paying for capacity and activating revenue-generating services. Instant Network also enables service providers to accelerate service delivery and lower operational expenditures by automating optical capacity engineering and reducing truck rolls to install additional hardware.

Infinera Instant Network capabilities are implemented across Infinera's DNA software and Xceed SDN Software Suite. It amplifies the power of Instant Bandwidth by adding Bandwidth License Pools, Moveable Licenses and Automated Capacity Engineering (ACE), and by extending SDC to new Infinera platforms. These new platforms support flexible grid and sliceable 2.4 terabit super-channels powered by the Infinera Infinite Capacity Engine.

The future of the Intelligent Transport Network is cognitive networking, which includes advanced analytics, machine learning from streams of network telemetry data, autonomous operation of routine tasks, predictive analysis of network problems before they occur and proactive recommendations for network optimization to further reduce operational expense and improve service reliability. Instant Network builds a critical foundation for cognitive networking, including implementing and advancing the industry's only software defined capacity offering.

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