TRANSFORMING METRO NETWORKS
Extending the scale, flexibility and programmability of the Infinera Intelligent Transport Network with application-specific solutions for network operators
The New Network Model

THE NETWORKING WORLD is undergoing a transformation of its existing infrastructure. Proprietary hardware and software appliances that perform network functions focused on the upper layers of the Open Systems Interconnect (OSI) model are transforming into software instances running on standardized server hardware (x86) servers in cloud datacenters through network functions virtualization (NFV). This transformation to an on-demand delivery model and from specialized, proprietary platforms to open, software-enabled cloud services is referred to as Layer C. The datacenters supporting these cloud services need to be connected to each other as well as to end-users. Today this connectivity is provided by a plethora of proprietary devices operating at the lower layers of the OSI model. This transformation to an on-demand delivery model and from specialized, proprietary platforms to open, software-enabled cloud services is referred to as Layer C. The datacenter supporting these cloud services need to be connected to each other as well as to end users. In order to support Layer C, cloud datacenters and end users need to be interconnected by a highly scalable and flexible transport network, referred to as Layer T. Layer T is the transformation of disparate transport systems into an integrated scalable packet-optical transport layer as shown in Figure 1.

Industry analysts have highlighted the unrelenting growth in bandwidth demand across subsea, long-haul and metro networks, and have identified east-west datacenter to datacenter traffic as a key driver. While long-haul networks have already started transitioning to 100 gigabits per second (100G), 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. Numerous applications are on the cusp of being virtualized, such as cloud radio access networks (C-RAN) in mobile networks and the move toward remote PHY (physical layer) in cable networks. These applications are leading to the creation of mini datacenters closer to the end-user and a shift towards a cloud-based infrastructure across the metro network. As metro network architectures evolve to Layer C and Layer T, the strategic importance of the transport layer has never been higher, and as a consequence it is vital to build Layer T with the right attributes:

- **Layer T** is built on a foundation of scalable optics. It requires best in class, right-sized optics, including photonic integration, offering high-bandwidth with low space and power consumption.
- 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. The rich suite of multi-service applications in operator networks require the appropriate use of the techniques of packet, Optical Transport Network (OTN), optical wavelength division multiplexing (WDM) transmission and switching. The network needs to deliver the highest available efficiency combined with key capabilities such as low latency, superior synchronization performance and multi-service transport.

![Figure 1: Network Transformation](image-url)
Layer T needs to be **open, programmable & agile**, with software defined network (SDN) control and open application programming interfaces (APIs) for rapid service creation and delivery along the lines of the new DevOps model of engineering and development.

## Diverse Requirements

The move to 100G and beyond for long-haul and datacenter interconnection (DCI) applications is well underway. Networks are now seeing pressure for metro data rates to jump to 100G. Metro packet-optical networks are often application-specific, being closer to the service origination points, which are diverse, ranging from end-points like digital subscriber line (DSL) or cable modems, fiber customer premise equipment (CPE) and mobile cell towers. Metro applications include triple-play aggregation, cable broadband aggregation, business Ethernet, mobile front/backhaul, enterprise and DCI. Each of these applications requires specific capabilities—for example mobile backhaul requires very low latency and synchronization. For business Ethernet services, characteristics such as prioritization, service operations, administration and management (OAM) and service level agreements (SLAs) become critical. To meet these requirements, a variety of packet-optical tools customizable for these services are available for network designers and engineers as illustrated in Figure 2.

Infinera’s application-specific metro packet-optical solution is purpose-built, employing the three key attributes of Layer T as outlined in the preceding section. It addresses the unique requirements of the metro and seamlessly connects with the long-haul core to deliver an Intelligent Transport Network that enables a scalable, flexible and programmable Layer T.

### The Infinera End-to-End Intelligent Transport Network Portfolio

Infinera’s unified end-to-end Intelligent Transport Network portfolio expands on two existing platforms that have been at the leading edge of their respective markets for over a decade. In the metro market, Infinera is a pioneer of metro WDM through the TM-Series which today include leading packet-optical metro access, aggregation and core platforms and are complemented by the TG-series passive WDM platforms. These deliver optimized services for applications such as triple play broadband aggregation, cable broadband aggregation, business Ethernet and mobile backhaul and fronthaul.

In the long-haul market the DTN-X Family is the world’s only commercial 500G super-channel system based on large scale photonic integrated circuit (PIC) technology. The DTN-X XTC-4 and XTC-10 Platforms are joined by the new DTN-X XT-500 Platform.

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![Figure 2: Diverse Network Requirements](image-url)
optimized for high bandwidth long-haul interconnect applications and the new DTN-X XTC-2 and XTC-2E Platforms, which extend the DTN-X Family to metro core and regional applications. All platforms in the DTN-X Family are fully interoperable over the common Infinera FlexILS™ line system.

To complement the company’s strengths in metro and long-haul networking, Infinera moved into the metro DCI market with the Cloud Xpress Family, offering hyper-scale density with 500G of super-channel capacity in a 2 rack unit (2RU) rack and stack form factor, low power consumption and simple operations.

The Infinera Intelligent Transport Network portfolio is integrated with the foundation of scalable photonics, granular switching and the simplicity of an open, programmable control and management plane to deliver additional network applications in the future. The portfolio provides a rich set of customizable tools to meet the requirements of specific applications and network locations.

Infinera Metro Solution

The Infinera Intelligent Transport Network portfolio provides an end-to-end solution including long-haul, DCI and metro platforms. Key highlights of the platforms for the metro solution are reviewed below.

**TM-Series**

The TM-Series packet-optical networking platform for carrier-grade transport enables high performance networks. Whether it’s used to push WDM all the way up to the antenna or to the cell site in mobile networks; to connect enterprises together or to the cloud; or to deliver high definition TV (HDTV); the TM-Series delivers a comprehensive set of capabilities to meet provider requirements in a metro network architecture designed to be flexible and highly-scalable. Supporting optical wavelengths up to multi-protocol label switching – transport profile (MPLS-TP), using technologies such as Ethernet, OTN, synchronous digital hierarchy / synchronous optical networking (SDH/ SONET), and
Intelligent WDM (iWDM™), the TM-Series builds on key design philosophies such as low power, high density and a high level of scalability. It offers a multitude of advanced capabilities that make the platform highly suitable for a number of key applications. Examples include:

- Superior sync capabilities that are vital in mobile backhaul, especially as networks evolve to support Long Term Evolution (LTE) Advanced
- Support for the Common Public Radio Interface (CPRI) / Open Base Station Architecture Initiative (OBSAI) enabling WDM in C-RAN architectures and mobile fronthaul
- iWDM-PON, Infinera’s WDM passive optical network (PON) solution, enables scalable access networks that are easy to install and configure, making them ideal for Fiber to the x (FTTx) business access applications
- Intelligent small form-factor pluggables (iSFP) enabling transparent delivery of SDH/SONET services over a packet-optical architecture and eventually a smooth migration of legacy Time Division Multiplexed (TDM) networks to a common TDM/Ethernet network that fulfills strict synchronization and availability requirements
- Forward error correction (FEC), OTN transport, Ethernet, MPLS-TP, and long reach optics all on one packet-optical transport switch module

The PT-Fabric will provide terabit scale packet-optical transport switching that is compatible with the installed base of Infinera TM-Series platforms and will offer up to 960G of non-blocking switching capacity, with a rich set of Metro Ethernet Forum (MEF) Carrier Ethernet (CE) 2.0 and MPLS-TP service options. The feature set is compatible with the existing range of Ethernet Muxponder (EMXP) packet-optical transport switches, and expansion is achieved using an innovative front-plane technology.

**DTN-X XTC-2 and XTC-2E Platforms**

The DTN-X XTC-2 and XTC-2E are purpose-built platforms to extend the DTN-X experience from long-haul into metro core and regional networks in a compact form factor. These platforms deliver a next-generation converged packet, OTN and WDM solution for metro core and regional applications, providing high-capacity 100G WDM transport, and OTN switching with packet-awareness. The WDM line-side modules that plug into the XTC-2 and XTC-2E

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**Extending the value of DTN-X to Lower Bandwidth Sites**

- **Right-sized**
  - 100Gb/x WDM
  - Low space and power
- **Simple**
  - Point-and-click ease of use
  - Converged WDM/OTN Packet
- **Programmable**
  - SDN enabled

**Investment Protection: Common Modules, Software**

Figure 5: The Infinera DTN-X XTC-2 and XTC-2E Platforms
are built with the Infinera FlexCoherent™ Processor and Infinera’s PIC technology, which is optimized for the metro 100G application with the new oPIC-100.

The XTC-2 and XTC-2E support a wide range of client-side interface speeds from 155 megabits per second to 100G and multiple services: traditional SDH/SONET, Ethernet/packet, storage area network (SAN) Fiber Channel, and video.

The TM-Series, DTN-X XTC-2 and XTC-2E are purpose-built metro platforms that feed into a DTN-X core. Service providers often have different architectural approaches and virtually all variations and associated requirements can be met with Infinera’s metro portfolio. The TM-Series provides packet-optical technology with OTN transport and Ethernet switching but no OTN switching. The DTN-X XTC-2 and XTC-2E support integrated WDM and OTN switching. The TM-Series and the XTC are fully complementary and will have line side interoperability and common DNA management as shown in Figure 6.

Cloud Xpress Family

The Infinera Cloud Xpress Family is purpose-built for scale, very low power and simplicity using optimized PIC technology in a rack-and-stack server-like form factor. The Cloud Xpress is very well suited to handle massive traffic flows between metro datacenters over a 500G super-channel supporting 10, 40 or 100 100G.
gigabit Ethernet (GbE) ports, which are the standard interfaces for client-side connectivity. The Cloud Xpress is designed to provide a terabit of input / output (I/O) capacity in just 2RU while using about 1W per Gb/s of traffic.

**TG-Series**

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

**Infinera Unified Metro Portfolio**

Infinera Intelligent Transport Networks provide scalability, flexibility and programmability from subsea to access. As metro networks transform to 100G, Infinera’s portfolio provides a precise set of tools to address specific network location and application requirements. As metro networks transform to the new model of Layer C and Layer T and the deployment of 100G solutions, the Infinera Intelligent Transport Network portfolio provides network operators a precise set of tools to address specific network location and application requirements while scaling bandwidth, accelerating service innovation and simplifying optical network operations.

Figure 8: Infinera Intelligent Transport Network Metro Architecture