APPLICATION NOTE

NATIVE PACKET OPTICAL 2.0

GO NATIVE WITH NATIVE PACKET OPTICAL 2.0

Ethernet-friendly and Ready for the Future

Introduction

Packet-optical networks have boomed in recent years, driven by the well-documented traffic growth in many sectors of the telecom market and the migration to Ethernet-based services.

There are a number of slightly different approaches taken by vendors in the industry to address this packet-optical evolution, with different technologies being deployed at different places in the network with varying advantages to the network operator. Infinera was an early adopter in the transition, bringing Layer 2 Ethernet functionality directly into metro and regional optical networks. The company's Native Packet Optical architecture is deployed by a wide variety of network operators for a broad range of applications.

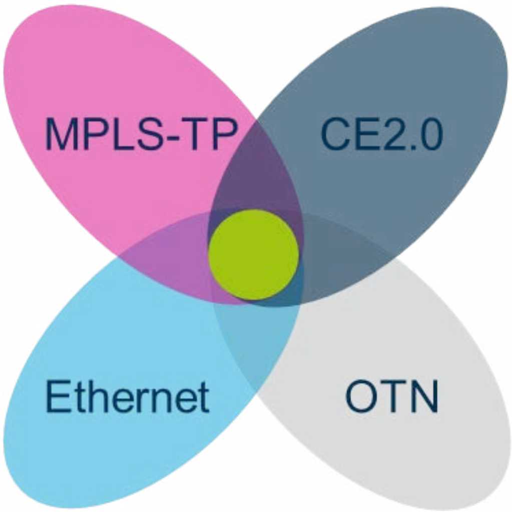
With the belief that standards-based implementations bring the best value, Infinera is committed to continuing development and investment in this architecture. Developments, such as Carrier Ethernet 2.0 (CE2.0) from the Metro Ethernet Forum (MEF), have led to a step change in the level of functionality available from the Native Packet Optical architecture, creating enhanced Native Packet Optical 2.0.

Native Packet Optical 2.0 combines the best of the optical and Ethernet worlds and adds significant capabilities including MEF CE2.0 services, multi-protocol label switching—transport profile (MPLS-TP) and optical transport network (OTN) transport to the already solid and proven architecture.

This application note describes the currently deployed Native Packet Optical architecture, its applications and benefits to the user, and addresses the technology, services and benefits that are included in Native Packet Optical 2.0.

Native Packet Optical

The Infinera Native Packet Optical architecture has many similarities with other packet-optical system architectures in that standard Layer 2 Ethernet functionality and MEF-defined services are integrated into a widely-deployed optical platform optimized for metro and regional networks.



Infinera Native Packet Optical 2.0 Brings the Best of Two Worlds: Optical and Ethernet in a Single Platform.

The Infinera Native Packet Optical architecture offers a range of technology choices and allows the operator to deploy those that make sense in various parts of their networks rather than imposing a one-size-fits-all approach to every part of the network. This approach can have a significant impact on network performance and costs.

The Infinera approach is to use native Ethernet as the standard payload within those domains of the network that need to be either service-aware or that need to undertake Layer 2 traffic aggregation for capacity optimization reasons. Service awareness gives the network the ability to inspect traffic and make decisions on how traffic is handled and routed on a per-service/flow basis. Layer 1 networks conversely can be viewed as a high-availability bit-pipe. What goes in one end comes out at the other, regardless of traffic priority or utilization level.

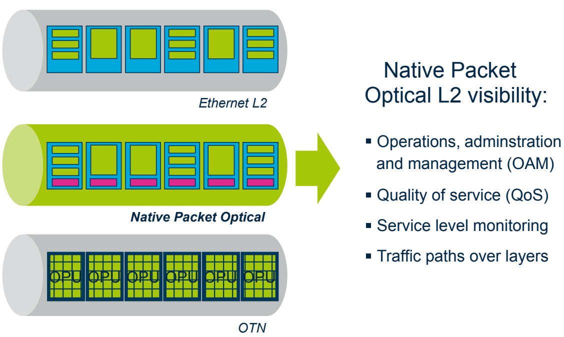


Fig 1. Native Packet Optical Provides Transparent Service Transport and Full Service Visibility.

The use of native Ethernet as the main transport payload of the packet-optical network for all Layer 2 Ethernet traffic is a key differentiator of the Native Packet Optical architecture. Rather than simply building a network of Layer 2 switches interconnected by a simple transport network, the architecture combines the necessary Layer 2 functionality into the transport layer to create a transport-oriented switched Ethernet network.

OTN in Core and Metro Networks

OTN is often successfully used in or near the core of the network. This is typically after the bandwidth is aggregated together so that additional aggregation is unnecessary or the traffic no longer needs to be service-aware as the whole block of aggregated data requires the same handling. Native Packet Optical allows OTN to be implemented where and when it makes sense.

Simplicity is a key factor in the Native Packet Optical approach. Using native Ethernet allows the network to utilize 100 percent of the available bandwidth without introducing network inefficiencies. OTN makes sense once this traffic is aggregated as much as required and is deep enough within the network that visibility of the services is no longer required.

Native Packet Optical 2.0

Native Packet Optical is implemented through a range of packet-optical transport switches (EMXP and PT-Fabric) within the widely deployed XTM Series packet-optical networking platform. These units support a range of gigabit Ethernet (GbE), 10 GbE and 100 GbE interface options with a broad range of Ethernet capabilities. The packet-optical transport switches are complemented by a range of Ethernet demarcation units (EDU) and network interface devices (NID) for service termination at a remote location, such as a customer premise or a cell site.

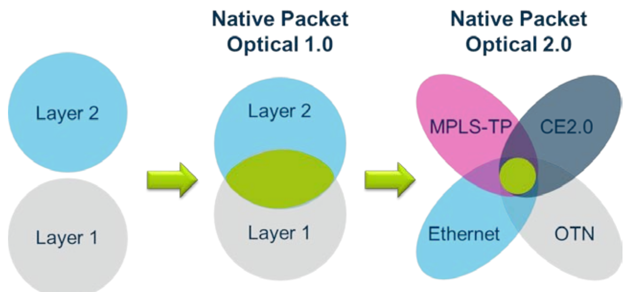


Fig 2. Native Packet Optical 2.0 Is Built on an Integrated Layer 1 and Layer 2 Platform and Supports MPLS-TP, CE2.0 and OTN.

MPLS-TP

While Ethernet technology brings great advantages to the packet transport network, there are some limitations in terms of protection options, traffic engineering and service scalability. These can be addressed by the use of MPLS-TP, which is the transport profile of MPLS, a technology used in the core of the network.

MPLS-TP is available within the Native Packet Optical 2.0 architecture and the EMXP IIe. Any physical port on an EMXP IIe can support both native Ethernet and MPLS-TP, allowing operators to deploy MPLS-TP where and when it makes sense for them. This technology brings a number of advantages to the network operator in terms of network resilience, service scalability and operational procedures.

MPLS-TP in Flexible Optical Networks

Packet-optical networks are often deployed today over a reconfigurable optical add-drop multiplexer (ROADM)-based flexible optical network, which brings a mesh-based structure to wavelength routing and the paths available through the physical network for any services.

One previous drawback with Ethernet was that it wasn't well-suited to protection and restoration over mesh-based networks as the available protection schemes were largely based on point-to-point or ring architectures. MPLS-TP is highly suited to a mesh-based environment and allows network operators to design network resilience strategies that are closely aligned to the physical structure of the network, therefore ensuring the best possible resilience and service uptime.

MPLS-TP – Easy Service Creation

Another advantage of MPLS-TP is that it breaks the service creation into two steps. First, tunnels are created between endpoints within the network for service and protection paths for the MPLS-TP-based services. Then, the network administrator simply creates new services by adding the new services to the tunnel endpoints, safe in the knowledge that all routing aspects of the service have already been handled.

This brings two distinct advantages. First, it makes the solution more scalable as it is simpler to add a large number of services to the network. Second, it brings a very familiar look and feel to service creation to the network, as it is very similar to the processes involved in traditional transport networks. This helps operators migrate from traditional transport networks to packet-optical.

Of course, as the MPLS-TP services are delivered over the same hardware platform as native Ethernet services, they also benefit from the same transport-like performance with extremely low latency and almost zero jitter, and can be combined with synchronization schemes like Synchronous Ethernet (SyncE) when required, e.g. in mobile backhaul networks.

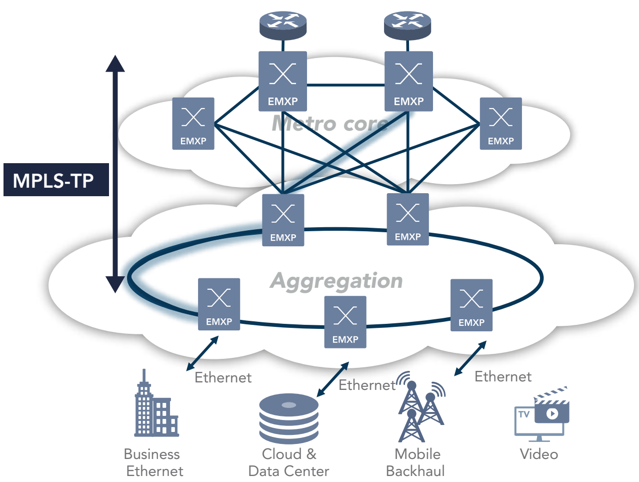


Fig 3. MPLS-TP Is Fully Supported in Native Packet Optical 2.0.

Carrier Ethernet 2.0

Native Packet Optical 2.0 supports the CE2.0 MEF-standardized service definitions. The EMXP family and the range of EDUs are all CE2.0-certified.

CE2.0 brings eight service classes—two each in E-Line, E-LAN, E-Tree, and E-Access—as well as dedicated Ethernet and shared Ethernet Virtual services per type.

Overall, the range of services available from compliant service provider networks will help the uptake of Ethernet services by enterprise customers. The Native Packet Optical 2.0 architecture fully supports these services.

One further advantage of the Infinera implementation of CE2.0 is that XTM Series customers are able to broaden the service range to extend E-Access services from just point-to-point configurations as defined in the standards to point-to-multipoint E-LAN architectures.

CE 2.0 MEF CERTIFIED

OTN Functionality

A key component of the Native Packet Optical 2.0 architecture is the use of OTN transport and interoperability with an OTN core.

When required, the original Native Packet Optical architecture achieved this by passing 10 GbE signals into an OTN network. In some cases, additional optical reach was required to span a particularly long link and operators needed to use forward error correction (FEC) via either an Intelligent WDM® (iWDM®) or OTN transponder. Both options use the G.709 standard FEC defined in the OTN standards to allow a longer span.

Native Packet Optical 2.0 and OTN

Native Packet Optical 2.0 simplifies the interoperability with an OTN core network and supports these long spans directly.

The optional OTN framing on 10G/100G ports allows the native frame to be mapped into an ODU2e/ODU4 ready for transport into the OTN core and large OTN switches. This is most useful once the traffic has been aggregated as much as possible to ensure the best possible utilization of the 10G/100G circuit.

One further advantage of OTN implementation within the Native Packet Optical 2.0 architecture is that it makes the Layer 2 network aware of Layer 1. The network can therefore perform Layer 2 decisions with knowledge of both Layer 1 and 2 information.

Technology-agnostic Core

One advantage of this approach is that a Native Packet Optical 2.0-enabled metro access and metro core network becomes technology-agnostic in the core. The network can seamlessly interoperate with IP-MPLS, MPLS-TP, Infinera or third-party OTN, or switched Ethernet core, or a combination of these. The network then switches between different core networks in protection event scenarios. These core network options and the metro network may all be running over a ROADM-based flexible optical network. In this scenario the Native Packet Optical 2.0 network is also aware of the optical layer and can make switching decisions based on events in any layer of the network.

An Infinera OTN core based on the DTN-X XTC Series can also provide a unified transport layer where core nodes can combine traffic from OTN muxponder-based Layer 1 services with ODU2e/ODU4-framed Ethernet services from the Native Packet Optical 2.0 architecture. End-to-end performance monitoring is achievable even over multiple carrier networks through OTN with tandem connection monitoring and Ethernet's inherent operations, administration and maintenance (OAM) capabilities.

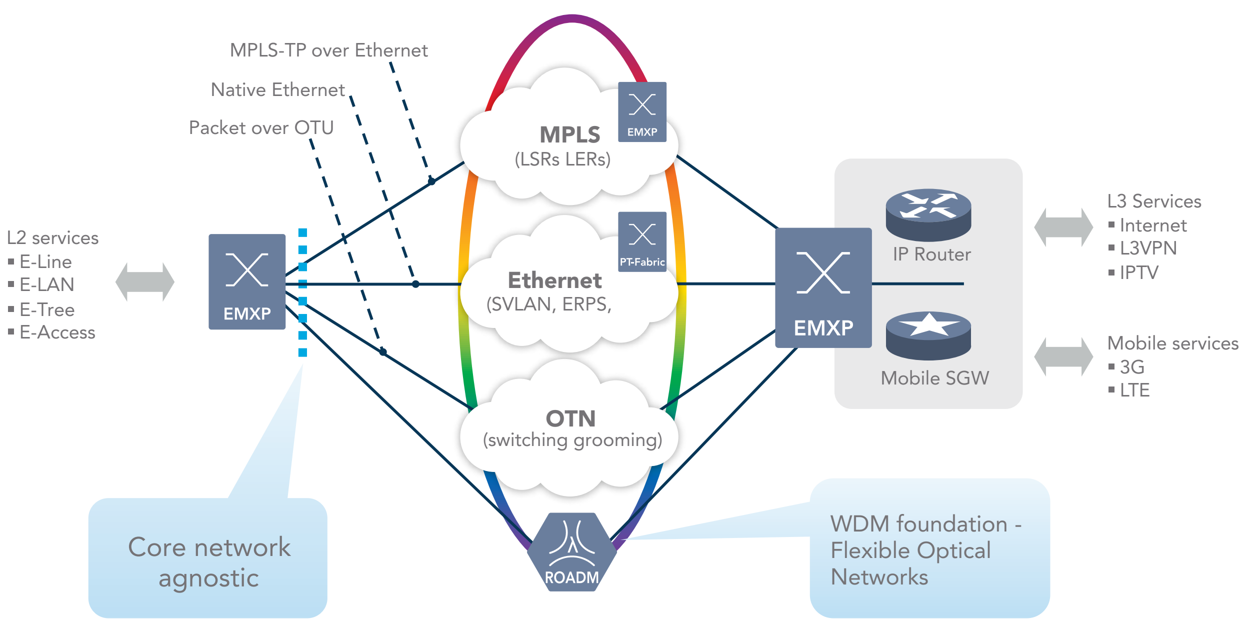


Fig 4. Native Packet Optical 2.0 Provides a Core-agnostic Metro Infrastructure – Ethernet, MPLS or OTN All Running Over ROADM-Based Flexible Optical Networking.

Transport Performance

The Native Packet Optical 2.0 architecture provides best-in-class low-latency performance and almost zero jitter. Therefore, applications such as video distribution and mobile backhaul, which can be very sensitive to latency and jitter issues, can easily migrate to a packet-optical architecture with an improvement in performance compared to legacy and alternative solutions.

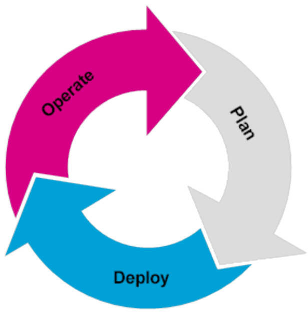
A consideration for mobile backhaul networks is network synchronization. Infinera has been able to achieve outstanding SyncE performance and ensure the best underlying platform for transparent support for other synchronization protocols such as 1588v2.

Key Feature in Video Distribution

Through support for Internet group management protocol version 3 (IGMPv3) and source-specific multicast capabilities, Native Packet Optical 2.0 enables multicast video distribution in transport networks. This removes the need for a large number of expensive routers from the network, which greatly reduces costs. It also greatly improves network performance with much lower latency and jitter than a router-based solution, which is critical for high-definition video distribution.

Enlighten® – Multi-layer Management Suite

The move from simple Layer 1 transport networks to sophisticated packet-optical networks that often also use flexible optical networking capabilities brings considerable additional complexity in terms of network management. Infinera addresses this requirement through the Enlighten multi-layer management suite for XTM Series and XTG Series-based networks.



Enlighten is a lifecycle suite of software tools that supports network and service planning, deployment and operation over Layers 0 (optical wavelengths), 1 (transport), 2 (Ethernet) and 2.5 (MPLS-TP).

Enlighten provides full point-and-click provisioning of services across all layers, enabling swift deployment of services and simplified network operations. The software suite also provides service assurance across all layers and enables root cause analysis of alarms to ensure fast resolution of service-affecting issues.

Network Flexibility – It's All About Services

Infinera has deployed many Native Packet Optical-based packet-optical networks across the globe, and the architecture brings unique capabilities. Deployments cover applications including mobile backhaul, business Ethernet services, cloud and data center interconnection, gigabit passive optical network (GPON) replacement and video distribution. All these applications differ greatly from each other and previously they would have required Layer 1 and Layer 2 networks that were optimized for each of the applications.

One Architecture – Many Applications

The Native Packet Optical 2.0 architecture provides network operators with great flexibility both at the network and the chassis level. It supports a wide range of applications, often providing application-specific capabilities as outlined above. These can be deployed on an as-needed basis over the same architecture and even in the same chassis. An operator can build a network for one application, such as mobile backhaul, and then quickly and simply add new services over the same infrastructure, still using the same chassis.

Due to the modular nature of the Infinera XTM Series, the Native Packet Optical 2.0 architecture can also be deployed parallel to other services such as Layer 1 transport or iWDM-passive optical network (iWDM-PON) access in the same network and chassis. Overall this provides operators with unparalleled flexibility.

Bringing It All together

The Native Packet Optical 2.0 architecture enables the creation of a very powerful and Ethernet-friendly network.

EMXPs and EDU/NIDs provide transport-optimized Layer 2 Ethernet service delivery while OTN or iWDM multi-service muxponders deal with any legacy or non-Ethernet services, such as synchronous digital hierarchy (SDH)/synchronous optical networking (SONET) or Fibre Channel services.

The operator can selectively use native Ethernet, CE2.0, MPLS-TP and OTN where they make sense in the network, creating a flexible metro access and metro core environment that is core network-agnostic. The resulting network architecture is highly scalable and flexible and supports a broad range of services and applications over a common network infrastructure, allowing the operator to rapidly deploy new service types to meet ever-changing demands in the marketplace.

In summary, the Native Packet Optical 2.0 architecture uses:

- Ethernet to provide an extremely packet-friendly metro network
- CE2.0 to add a broad range of service options for operators
- MPLS-TP to add traffic engineering, additional protection schemes and scalability
- OTN to add core network interworking and a core network-agnostic architecture

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