

The Optical Transport Network

Building the future of transport



Background

Optical transport network (OTN) technology continues to gain momentum in transport networks due to the ever-increasing demand for bandwidth, advances in optical technology and the increasing obsolescence of synchronous optical networking (SONET) and synchronous digital hierarchy (SDH) networks. OTN offers a roadmap for scalability beyond 100G and 400G rates with guaranteed service levels for all user.

For many decades, SDH and SONET networks provided extremely reliable and highly deterministic optical networks for long-distance transport. The reliability and determinism came from key capabilities of the technology such as extensive fault detection and isolation, performance monitoring, availability of communications channels at multiple levels and bandwidths, standardized transport of client signals and provisioning for traffic protection and recovery.

With the near ubiquity of Ethernet and IP-based packet communications from networked applications, coupled with the insatiable demand for bandwidth from the increasing numbers of applications and the trend toward a networked world, the legacy SDH and SONET networks and equipment are rapidly becoming obsolete. Many established vendors have announced end-of-life for their SDH and SONET products. Replacement gear, spare parts, technical staff availability and support are all major issues for these aging products.

Wavelength-division multiplexing (WDM) technology, commercialized in the mid-1990s, was the first answer to the bandwidth challenges and the demands of packet-based applications. WDM provided the necessary technology to deliver bandwidth through multiple wavelengths within the same fibers, which meant an enormous reduction in the cost of bandwidth and the possibilities of carrying multiple applications and services over the same physical networks.

However, by itself, raw WDM lacks the reliability, determinism and interoperability of the earlier SDH and SONET technology. The answer came in 2001 with the approval of the G.709 standards by the International Telecommunication Union's Telecommunication Standardization Sector (ITU-T), which defined the OTN. Indeed, OTN combines the reliability and determinism of SDH and SONET networks with the bandwidth expansion and flexibility of WDM. The ITU-T's move made OTN the de facto technology for long-distance transport networking in today's networks and for many years to come.

Another important factor for the success of OTN was ITU-T Recommendation G.709/Y.1331, prepared by ITU-T Study Group 15 (2001-2004) and approved under the WTSA Resolution 1 procedure in 2001. This recommendation forms part of a suite of recommendations covering the full functionality of an OTN and follows the principles defined in ITU-T G.805. The recommendation also defines the requirements for the optical transport module of order n (OTM-n) signals of the OTN, in terms of:

- 01 – Optical transport hierarchy
- 02 – Functionality of the overhead in support of multi-wavelength optical networks
- 03 – Frame structures
- 04 – Bit rates
- 05 – Formats for mapping client signals

As with any technology, the primary challenge for service providers is the ability of OTNs to satisfy the demand for new hardware and management systems. This challenge is more acute today than ever before because of the shrinking window for operators to recover network outlay costs and their need to focus on developing new value-added services, which are core business drivers.

01 The OTN Market

The major driver for OTN is the increasing demand for bandwidth from residential and business customers. Residential internet use is rising for a variety of reasons: growing demand for cloud storage of personal information, online gaming, online shopping, staying connected over long distances, social media, video chatting and more. All of these applications require communications and network service providers to deliver more capacity on their networks.

Service providers face high-capacity demand from their business customers driven by the increase in e-commerce, mobile and internet banking, online government facilities, industrial automation, Internet of Things (IoT), utility networking and so on.

Communications and network operators—and indirectly network equipment providers (NEPs)—must support all this demand by upgrading their networks and offering new value-added services. However, existing SDH and SONET solutions are unable to viably address the challenge of rising bandwidth demand. Therefore, OTN emerges as the solution by using WDM and DWDM (Dense Wavelength Division Multiplexing) to overcome the bandwidth limitations of SDH and SONET, while, at the same time, incorporating key aspects of SDH and SONET to provide determinism and reliability.

The OTN market includes optical switches, transport and packet platforms, as well as network design, optimization, maintenance and support services. Users of the technology include communications service providers and network operators, private enterprises and government. OTN is finding traction across Asia-Pacific (APAC), Europe, the Middle East and Africa, North America and Latin America. The notable players with major market share, include ADVA Optical, ADTRAN, Aliathon, Ciena, Cisco, Fujitsu, Huawei, Infinera, Nokia and ZTE.

The global OTN market is expected to grow at a 15%-plus compound annual rate, from \$11 billion in 2014 to \$23 billion in 2019 and \$33 billion by 2025. APAC is forecast to have the highest growth rate while China will lead the market in terms of total spending. The North American market will lead in regional spend and adoption.

Key benefits of OTN

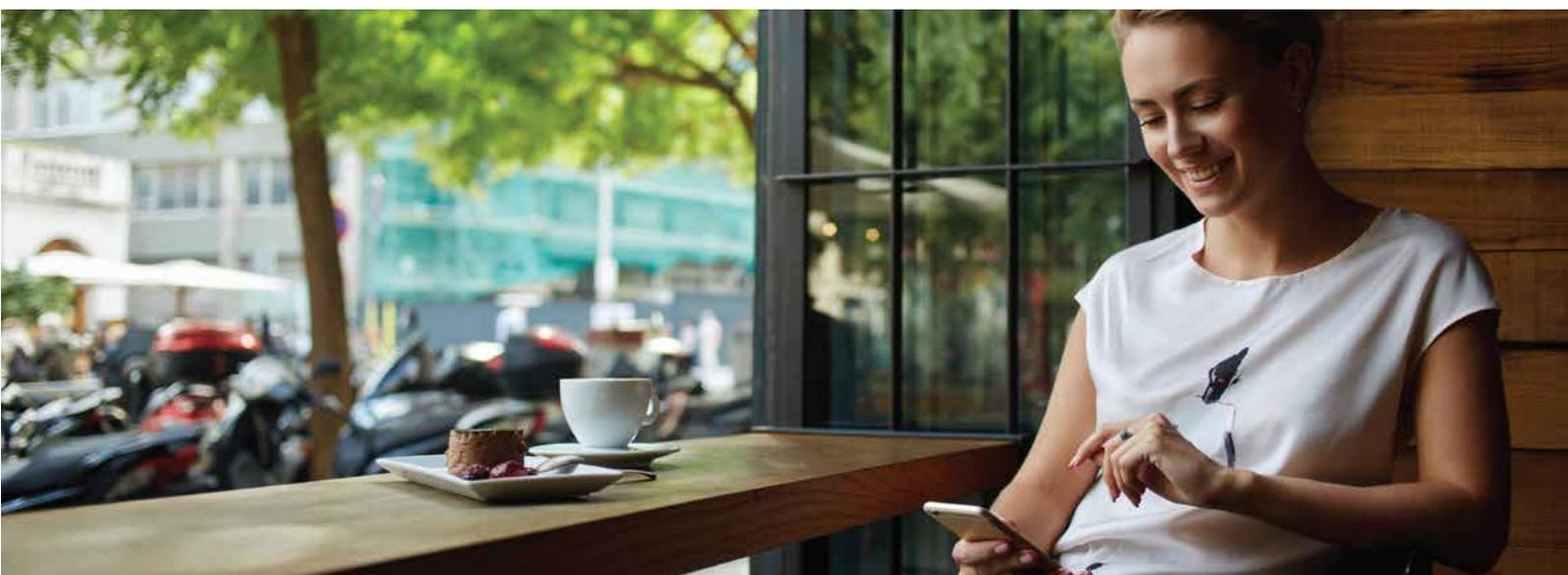
There are eight areas where OTN has a distinct advantage over previous technologies:

- 01 — **Scalability beyond 40G, 100G and 400G:** SDH and SONET are not efficient for Ethernet or IP packet traffic, or high-bandwidth services requiring speeds of 100 Gigabits per second (100G) or higher. Designed for such speeds, OTN efficiently supports high-bandwidth services such as 100G, 400G as well as Terabit payloads. (400G is not yet standardized.)
- 02 — **Reliability:** Connection monitoring capabilities built into the technology enable extensive performance monitoring. Coupled with built-in capabilities for service protection and service availability guarantees, this makes OTN networks extremely reliable.

- 03 – **Flexibility:** OTN technology supports rapid provisioning for adding new services or making changes in existing services, which enables more dynamism and agility in the network. Together with the capability to deliver an enormous increase in bandwidth, this flexibility helps network operators satisfy existing demand, while they introduce new service types and cost models as business requires.
- 04 – **Security:** OTN-channelized links and hard partitioning of traffic onto dedicated circuits ensures a high level of privacy and security, effectively stopping hackers who access one part of the network from intercepting data or gaining access to other parts. OTN also provides the ability to use AES encryption at the OTN layer (Layer 1) which provides a high degree of end-to-end security at line rates. This is especially true in applications like datacenter interconnect, which offers the best combination of security and throughput.
- 05 – **Cost optimization:** By using standardized frame structures to transport multiple clients on a single wavelength—while preserving their specific requirements—OTN reduces the overall cost of transport and ensures efficient bandwidth utilization.
- 06 – **Deterministic:** Dedicated, specific and configurable bandwidth guarantees network capacity and managed performance for each client without contention between concurrent services or users.
- 07 – **Infrastructure agility:** OTN supports network manipulation with a control plane. Higher-layer applications, management applications, OSS applications and cloud operating systems can use the control plane to create an agile and responsive real-time network. This agility and responsiveness allows bandwidth calendaring and on-demand, real-time service management, thus enabling a host of new services that harness the cloud and datacenter infrastructure.
- 08 – **Virtualized network operations:** The capability to provide dedicated virtual circuits to network users enables operators to partition an OTN-switched network into optical virtual private networks (O-VPNs). Each O-VPN can provide dedicated, independent network resources to the user.

02 OTN Basics

To appreciate the benefits of OTN and to make informed choices, it is important to understand the basics of the technology. OTN technology comprises some broad categories with standards addressing each category, as captured in Table 1.



Optical Transport Unit (OTU) Signal	Approximate data rate (Gbits/sec)	Applications
OTU1	2.66	Transports SONET OC-48 or synchronous digital hierarchy (SDH) STM-16 signal
OTU2	10.70	Transports an OC-192, STM-64 or wide area network (WAN) physical layer (PHY) for 10 Gigabit Ethernet (10GBASE-W)
OTU2e	11.09	Transports a 10 Gigabit Ethernet local area network (LAN) PHY coming from IP/Ethernet switches and routers at full line rate (10.3 Gbit/s)
OTU2f	11.32	Transports a 10 Fibre Channel
OTU3	43.01	Transports an OC-768 or STM-256 signal or a 40 Gigabit Ethernet signal
OTU3e2	44.58	Transports up to four OTU2e signals
OTU4	112	Transports a 100 Gigabit Ethernet signal

Table 1: OTN standardized line rates²

OTNs carry any kind of traffic and remove the restriction of the different physical network dependencies for different types of services such as Ethernet, SDH, SONET, FiberChannel and others.

Network architecture

The network comprises four planes that work together to deliver services to clients and enable operators to monitor and control the network.

Network layers

The OTN comprises two switching layers—TDM (Time Division Multiplexing) and WSON (Wavelength Switched Optical Network)—and comprises functions of transport, multiplexing, routing, management, supervision and survivability. The network comprises multiple layers, as shown in Figure 1 on the next page. A frame format is defined by which data packets are encapsulated, in a way that is similar to that of a SONET frame.

- 01 — OPU: Optical Channel Payload Unit. This contains the encapsulated client data and a header describing the type of that data. It is analogous to the “Path” layer in SONET/SDH.
- 02 — ODU: Optical Data Unit. This level adds optical path-level monitoring, alarm indication signals and automatic protection switching. It performs similar functions to the “Line Overhead” in SONET/SDH.
- 03 — OTU: Optical Transport Unit. This represents a physical optical port (such as OTU2, 10Gbps), and adds performance monitoring (for the optical layer) and the forward error correction (FEC). It is similar to the “Section Overhead” in SONET/SDH.
- 04 — OCh: Optical Channel. This represents an end-to-end optical path.
- 05 — OMS: Optical Multiplex Section. This deals with the fixed wavelength Dense Wavelength Division Multiplexing (DWDM) between the Optical Add Drop Multiplexers (OADMs).
- 06 — OTS: Optical Transport Section. This deals with the fixed wavelength DWDM between relays.

The above format creates a transparent, hierarchical network combining TDM and WDM switching functions.

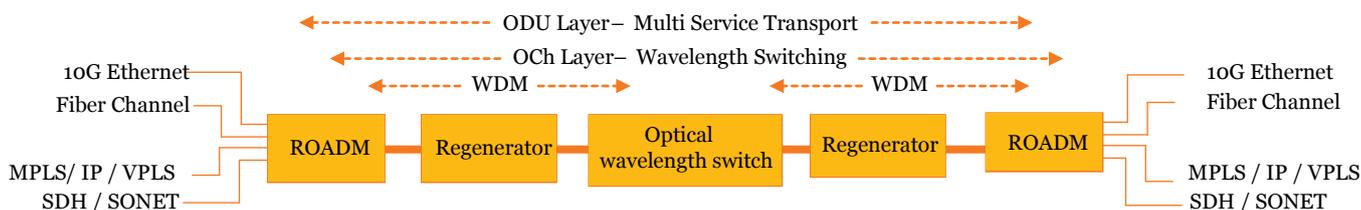


Figure 1: The multiple layers of the OTN network³

Payload structure and mapping of client signals

The mapping of the client (user) payload onto ODUs and the resulting hierarchy of transport is shown in Figure 2.

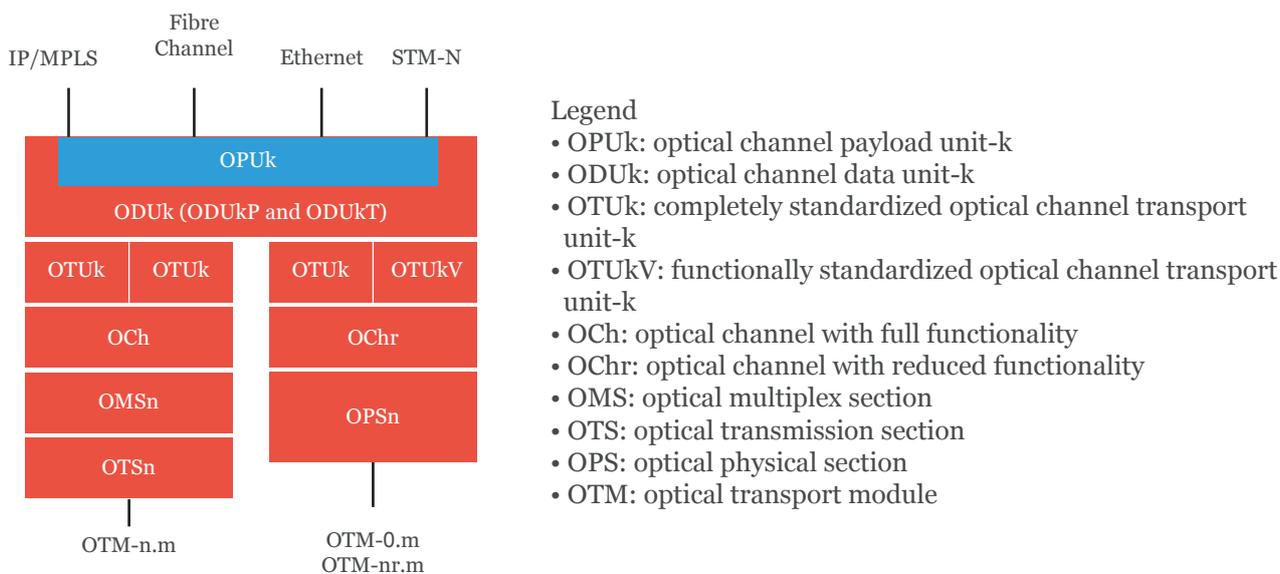
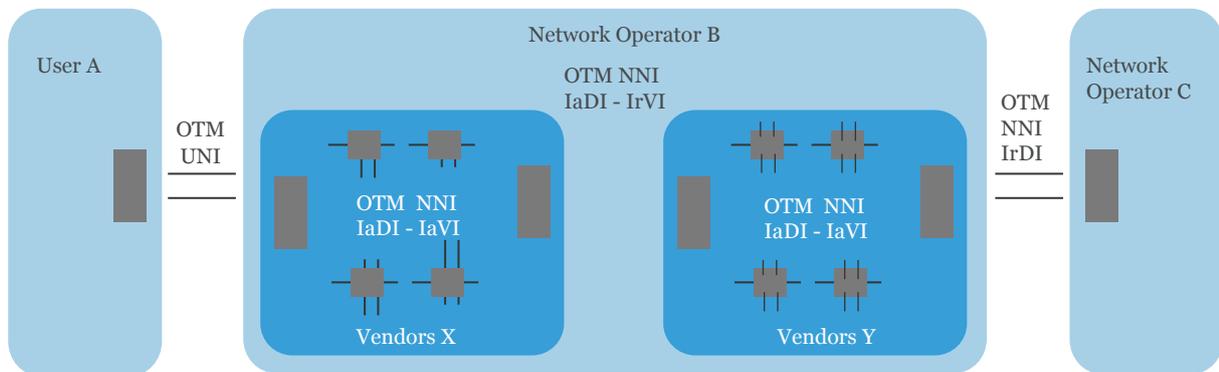


Figure 2: How OTN maps the client payload⁴

OTN ports

The OTN standards define types of interfaces (ports) where users attach to the network and interfaces between elements in the network, and where different domains interconnect. Figure 3 shows the architecture of the interfaces.



Legend:

- User to network interface (UNI)
- Network node interface (NNI)
- Inter-domain interface (IrDI)
- Intra-domain interface (IaDI)
- Between equipment provided by different vendors (IrVI)
- Within subnet of one vendor (IaVI)
- The standardized OTUk is used at the optical transport module (OTM) IrDIs and OTM IaDIs.

Figure 3: The interconnections between users and the OTN network⁵

Equipment functions

The OTN standards define functions for different network elements. This helps standardize the design of vendor equipment and ensures interworking and interoperability, which makes it easier for operators to make informed, optimal choices. The functions include:

- 01 – Supervision
 - Alarm reporting control
 - Defects
 - Consequent actions
 - Defect correlations
 - Performance filters
- 02 – Information flow across reference points
- 03 – Generic processes
 - Scrambling processes
 - Alignment processes
 - Signal quality supervision
 - BIP correction
 - OTUk forward error correction processing

- Trail trace identifier (TTI) processing
 - Payload structure indication (PSI) acceptance processes
 - Status information (STAT) acceptance process
 - Generic AIS generation and detection
 - Generic layer fault processing
 - Optical signal processing
- 03 – Optical transmission
- Connection functions
 - Termination functions
 - Adaptation functions
- 04 – Optical multiplex section (OMS) layer functions
- Connection functions
 - Termination functions
 - Adaptation functions
 - Sub-layer functions
- 05 – Optical physical section (OPS) layer functions
- Connection functions
 - Termination functions
 - OPS0 to OChr adaptation function
- 06 – OCh (layer) functions
- Connection functions
 - Termination functions
 - Adaptation functions
- 07 – Layer functions
- OTU (layer) functions
 - Connection functions
 - Termination functions
 - Adaptation functions
 - Sub-layer functions
- 08 – ODU (layer) functions
- Connection functions
 - Termination functions
 - Adaptation functions
 - COMMS functions
 - Sub-layer functions
 - Virtual concatenation functions

Performance management

The OTN recommendations include performance management, performance monitoring and thresholding functions. The performance management functions evaluate and report on the behavior of telecom equipment and the effectiveness of the network or network element. The functions include gathering and

analyzing statistical data to monitor and correct the behavior and effectiveness of the network, network elements or other equipment and to aid in planning, provisioning, maintenance and quality measurement. Performance monitoring requirements are specified in the G.7710 specification from the ITU-T.

Measurements are recommended at the circuit and packet layers as follows:

01 — Circuit Layer

- Transmitted block count
- Errored block count
- Block delay
- Errored block ratio
- Background block count
- Background block errors
- Block delay variation

02 — Packet Layer

- Transmitted block count
- Lost block count
- Block delay
- Lost block ratio
- Background block count
- Background block error
- Block delay variation

The following quality parameters are also defined:

- Errored second ratio
- Severely errored second ratio
- Background block error ratio
- Severely errored period intensity
- Availability ratio
- Outage intensity

The standardization of performance management functions and the high degree of specification provides the necessary functions to monitor and manage carrier-grade networks.

Protection for service availability

The OTN recommendations define two types of protection:

- 01 — Linear protection
- 02 — Ring protection

Linear protection

Linear protection deals with the protection of an end-to-end optical channel data unit k (ODUk) path through the network. A working path and a protection path are defined for the ODUk. With 1:1 protection, traffic is normally carried on the working path. If the working path fails, the traffic is carried on the

protection path. Both ends of the ODUk must be synchronized so that the receiver is listening on the path that the transmitter is sending the traffic. With 1+1 protection, traffic is carried on both working and protection paths, and the receiver listens and takes the traffic from the working path alone, as shown in Figure 4.

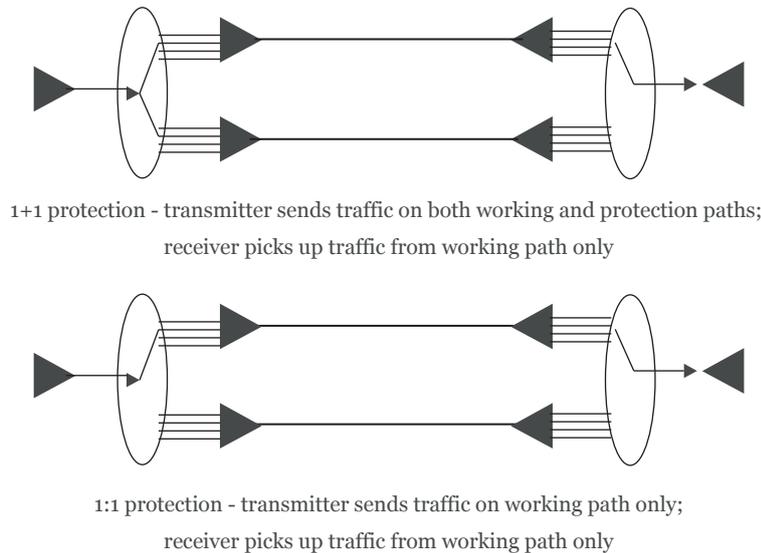


Figure 4: Two options for protecting traffic on an OTN network⁶

For linear protection, the OTN recommendations define the automatic protection switching (APS) protocol and protection switching operation for linear protection schemes for the OTN at the ODUk level. Broadly, four schemes are defined:

- 01 – ODUk subnetwork connection protection with inherent monitoring (1+1, 1:N)
- 02 – ODUk subnetwork connection protection with non-intrusive monitoring (1+1)
- 03 – ODUk subnetwork connection protection with sublayer monitoring (1+1, 1:N)
- 04 – ODUk compound link with subnetwork connection group protection and inherent monitoring (1+1, 1:1)

Irrespective of the scheme, there are two activities involved:

- 01 – Failure detection – failure of a working path is based on detection of defects on the transport entities (working and protection). The detection of defects is addressed in the recommendations for OTN equipment (G.798 and G.806)
- 02 – Switching traffic from a working to a protection path – after a failure is detected, traffic on a failed path must be moved to an alternative path. The actions related to this are addressed in the G.873.1 recommendation.

Detection of defects is based on monitoring of the paths. Three types of monitoring are defined:

- 01 – Inherent – protection switching is triggered based on defects detected at the ODUk link connection
- 02 – Non-intrusive – protection switching is triggered by a non-intrusive monitor of the ODUkP trail or ODUkT sublayer trail at the tail-end of the protection group

- 03 – Sublayer monitoring – protection switching is triggered by defects detected at the ODUkT sublayer trail

Ring protection

The G.873.2 recommendation describes shared ring protection (SRP) for the highest order ODUk between all nodes in a ring. The failure detection mechanism (described in G.798 and G.806) is the same as for linear protection, but the automatic protection switching (APS) is done for a whole group carried on the ring.

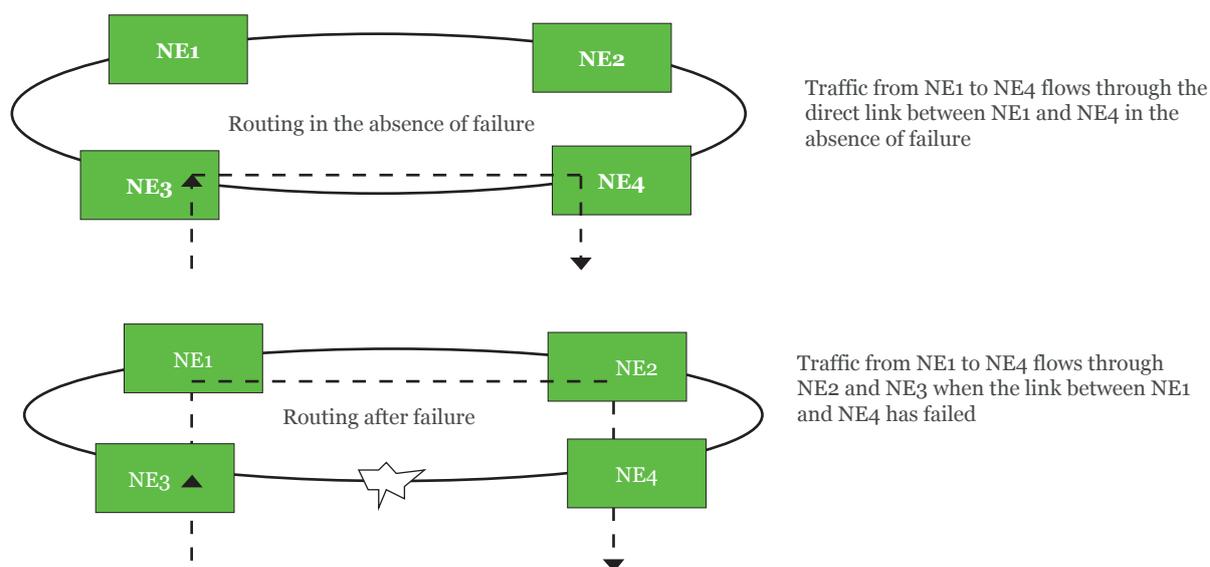


Figure 5: Ring protection – traffic routing before and after failure

Network discovery - GMPLS control plane

The GMPLS Control Plane model relies on three protocols:

- 01 – LMP
- 02 – OSPF-TE
- 03 – ISIS-TE

LMP is used between network elements for resource discovery. LMP provides four basic functions between a pair of nodes.

- 01 – Control channel management
- 02 – Link property correlation
- 03 – Link connectivity verification
- 04 – Fault management

Using the information discovered by LMP, either OSPF-TE or ISIS-TE are then used to form adjacencies between neighboring nodes, build network topology and discover paths based on constraints such as bandwidth availability.

Network discovery - ASON (automatically switched optical network) control plane

The G.7714 recommendation describes generic processes applicable to any layer of a multilayer network. As shown in Figure 6, there are three discovery processes with the following functions.

- 01 – Discovery trigger (DT): The DT process is responsible for triggering the LAD and TCE processes. The DT process is realized through a discovery agent (DA).
- 02 – Layer adjacency discovery (LAD): The LAD process is used for deriving an association between two TCPs/CPs that form a network connection or link connection in a particular layer of the network. The association discovered through layer adjacency discovery is valid if the trail supporting the link connection is valid. Preconditions of the LAD process include knowledge of the termination connection point IDs.
- 03 – Transport entity capability exchange (TCE): The TCE process is used for exchanging information about the capabilities of the transport entities—for example, link connections and trails—to facilitate the negotiation of an agreed set of capabilities. Preconditions of the TCE process include knowledge of the layer adjacency information and the local capabilities information.

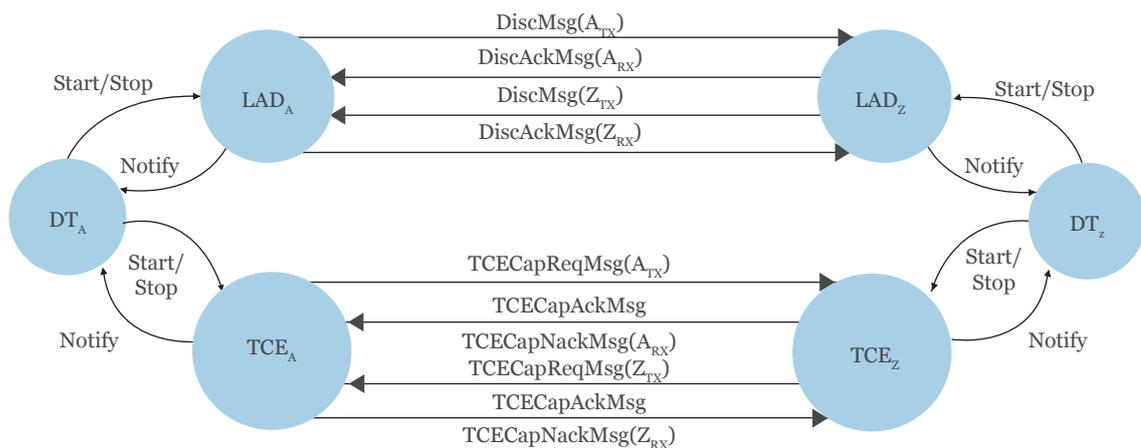


Figure 6: Network discovery by OTN network elements⁷



The G.7714 recommendation elaborates these procedures by specifying requirements and describing discovery messages for the following:

- 01 – Discovery agent
- 02 – Termination connection point
- 03 – Discovery process
- 04 – Discovery of a transport entity
- 05 – Discovery of a unidirectional transport entity
- 06 – Discovery of a bidirectional transport entity
- 07 – Discovery of transport entity capabilities

The G.7714.1 further elaborates the requirements outlined in G.7714 and describes:

- 01 – In-service discovery - termination connection points are discovered by using the server layer overhead
- 02 – Out-of-service discovery - uses test signals and can only be used if the link connection is not carrying any client traffic

The recommendations also specify requirements for resource discovery, service discovery and service capability exchange:

- 01 – Resource discovery allows every node to discover network topology and resources. This kind of discovery determines what resources are available, the capabilities of the various network elements and how the resources are protected.
- 02 – Service discovery is responsible for verifying and exchanging service capabilities of the network such as services supported over a trail or link. Such capabilities may include the class of service (CoS), the grade of service (GoS) supported by different administrative domains, the ability to support flexible adaptation at either end of the connection and the ability to support diverse routing.
- 03 – Service capability exchange reduces the number of in-band events that are required to perform discovery. Discovery of trails at a server level allows for automatic identification of the link connections that are supported by these trails.

Routing – GMPLS control plane

OSPF-TE and ISIS-TE provide the path computation between any source and destination using the discovered network topology and resource requirements.

Based on the computation by OSPF-TE and ISIS-TE, RSVP-TE is used to establish, manage and tear-down connections. Extensions to these IP domain protocols for GMPLS have been standardized by the CCAMP Working Group of the IETF.

Routing – ASON control plane

G.7715 refines the architecture of routing and provides detailed requirements with the following broad framework:



- 01 – Protocol neutrality
- 02 – Provides independence of bearer topology from the routing control topology
- 03 – Enables subdivision of the network into routing areas, where areas can contain smaller areas, which creates routing levels
- 04 – Adjacent routing levels may be implemented by different routing protocols
- 05 – Path computation can encompass step-by-step, source, and hierarchical routing paradigms
- 06 – Influences from IP routing, telephony routing, ATM routing
- 07 – Independence of routing function from established connections

Figure 7 provides a pictorial overview of routing in the OTN, as recommended by the G.7715.

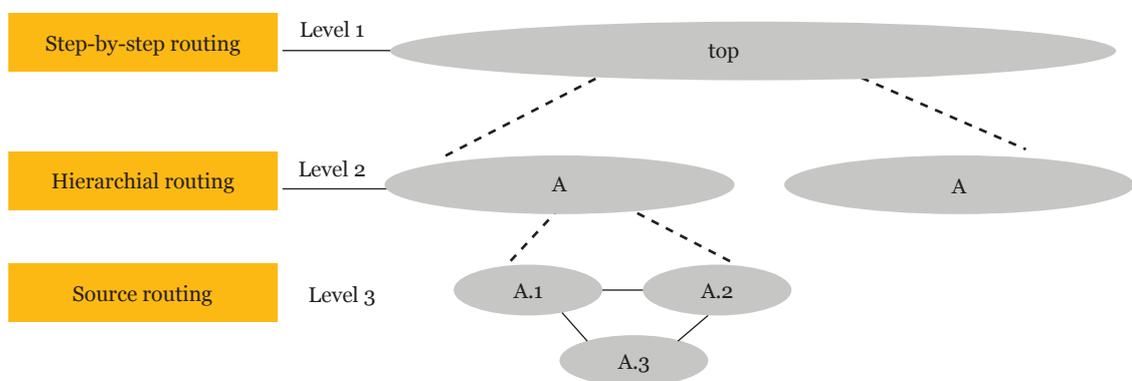


Figure 7: Routing in the OTN

Comparing the ASON and GMPLS Control Planes, the GMPLS Control Plane mechanisms offer the following advantages.

- 01 – Reuse of the same Control Plane protocols in the client IP and MPLS networks and the carrier OTN network
- 02 – Interoperability of the Control Plane protocols through extensive experience in the IP and MPLS domain
- 03 – Stabilization and optimization of the Control Plane protocols through extensive experience in the IP and MPLS domain

03 OTN Technology in Networks

OTN is used extensively and continues to gain traction in the following networks:

01 – Aggregation Networks

- Both the transport and switching capabilities of OTN are used in network elements that perform aggregation. Ethernet and IP/MPLS traffic is aggregated to be transported across the OTN backbone.
- The aggregation nodes also switch between OUT links on the backbone side of the equipment.

02 – Metro and Regional Networks

- Primarily, these networks provide multi-service access for MPLS-TP, Ethernet, smaller OTN services, FiberChannel and SDH.
- OUT 2 & OTU 4 mesh rings are prevalent in these networks.

03 – Backhaul Networks

- These networks use ODUFlex tunnels to provide virtual circuits and VPNs for businesses, cellular networks and service provider regional networks.

04 – Datacenter Interconnects

- Security is a major concern in this deployment.



04 OTN Standards

The OTN standards can be grouped into nine general categories. Within each category, there are one or more standards for specifying detailed requirements. The categories and standards are captured in Table 2 below.

Category	Standard ID Number	Description
Network architecture	G.8080	Architecture for optical transport networks
	G.872	Architecture for the optically switched optical network
Physical layer requirements	G.664	Safety and security requirements
	G.693	Optical interfaces for intra-office systems
	G.959.1	Physical layer ports
Structure and mapping	G.709	Ports on an OTN network
	G.7041	Generic Frame Protocol (GFP)
	G.7042	Link Capacity Adjustment Scheme (LCAS) for virtual concatenation signals
Equipment functions and features	G.798	Features of function blocks of equipment
	G.806	Transport network equipment features; description, methods and general functions
Network protection	G.873.1	Linear protection
	G.873.2	Ring protection
Jitter and performance	G.8201	Jitter and shift control
	G.8251	Bit error performance parameters and specifications on international channels of multiple carriers
Network discovery	G.7714	Generalized automatic discovery for transport entities
	G.7714.1	Protocol for automatic discovery in transport networks
Routing	G.7715	Architecture and requirements for routing in the automatically switched optical networks
	G.7715.1	ASON routing architecture and requirements for link state protocols
	G.7715.2	ASON routing architecture and requirements for remote route query
Equipment management	G.874	Management features of network elements
	G.874.1	Protocol-neutral management information model for the network element

Table 2: Key OTN standards

05 Inside the OTN Switch

Even though OTN equipment can vary in the way it is designed, the basic concepts are similar. Figure 8 shows the four key components in each OTN network element. Components such as the fans and power supplies were deliberately left out since the focus of this paper is on the telecommunications aspect of the OTN.

The components are:

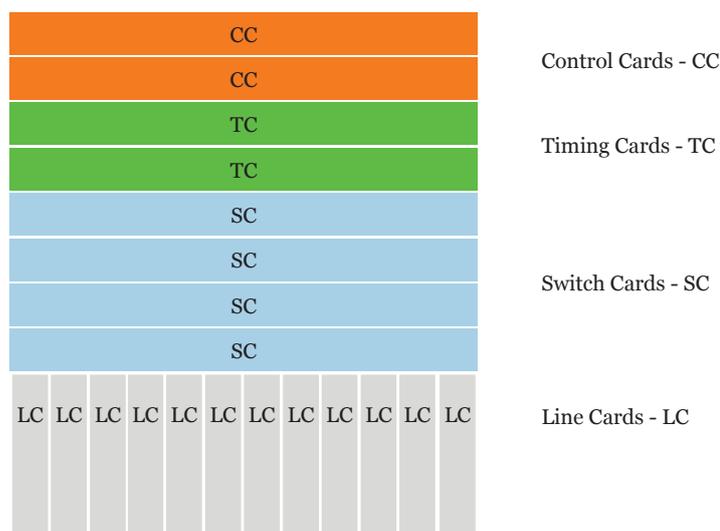


Figure 8: The four key components of an OTN network element

- 01 – Line cards – Typically there are one or more line cards that terminate the ports in the system. Depending on the deployment, the ports may be only OTUk terminations in pure OTN switches or they could be Ethernet, FiberChannel, SDH or SONET ports in ROADMs and aggregation deployments. Small form-factor switches may have just a single line card. As the port density increases, the number of cards also increases. The cards may be configured in 1:1, 1+1 or 1:N redundant configurations.
- 02 – Switch cards – The key component in these cards is the switching fabric that moves traffic between the ports on the line cards, and performs multiplexing and demultiplexing at the ODU levels. Considering that OTN deployment is in the operators' networks, which have stringent high-availability requirements, these cards are usually located in redundant 1:1 or 1+1 configurations.
- 03 – Timing cards – These cards provide timing to the other cards and serve to distribute timing information through the network. Considering that OTN deployment is in operator networks, which have stringent high-availability requirements, these are usually populated in redundant 1:1 or 1+1 configurations.
- 04 – Control cards – These cards host the central processing units (CPUs) for the network element. They contain most of the software for the network element, management and control plane, and for controlling and monitoring the operations of the other cards. Considering that OTN deployment is in operator networks, which have stringent high-availability requirements, these are usually populated in redundant 1:1 or 1+1 configurations.



06 Managing the OTN

Figure 9 shows a simplified view of the management of the OTN. A network may comprise several domains for ease of administration. Each domain is typically managed by a Domain Manager. This could also be a SDN (Software Defined Networking) Controller. The Domain Manager performs functions like topology discovery, topology maintenance, provisioning of network elements in the domain and providing read-access to the data within the network elements. Several applications like Alarm Management, Configuration Management, Fault Management, Performance Management and Service Management are necessary to manage different aspects of the network. These applications can co-exist with the Domain Manager or may execute in separate systems (containers or virtual machines, etc). An overall NMS (Network Management Station) Server aggregates the various other management entities to provide a unified single window for management of the OTN.

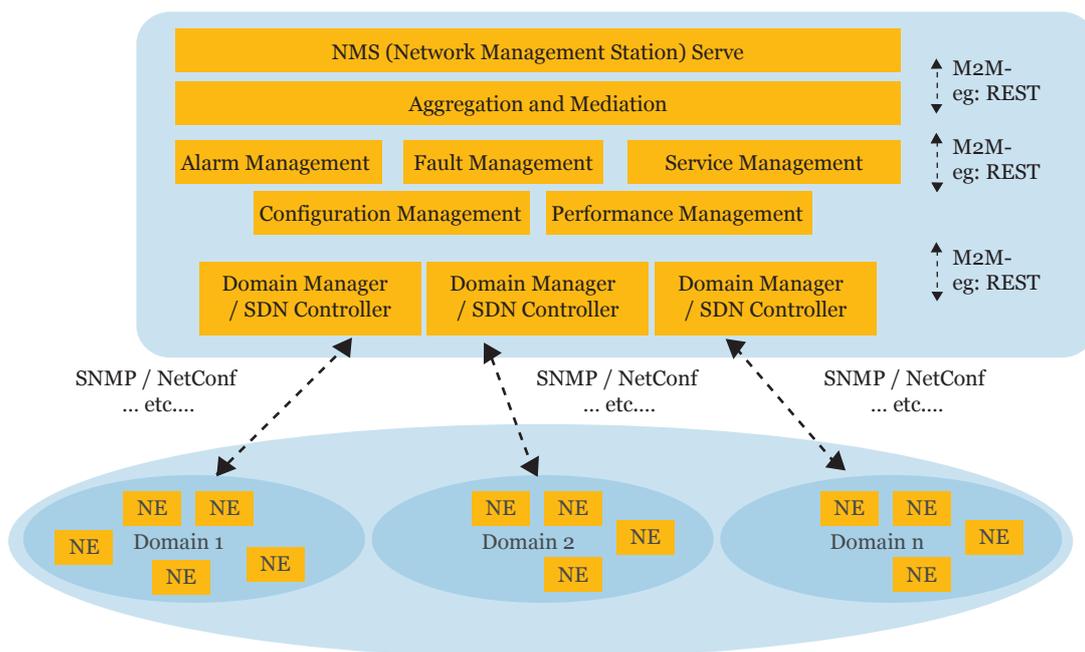


Figure 9: OTN network management

07 The Altran OTN Software Framework

As with any emerging technology, the challenge with OTN is the demand for new hardware and management systems. This challenge is acuter now than in the past because of the ever-shrinking window-of-opportunity for network operators to recover their network outlay costs, and the need to focus on value-added services rather than the core technology. Altran is in the business of addressing these technological challenges by delivering innovative and practical solutions that allow networking OEMs and operators to quickly adopt new technology at low cost, which frees them up to focus on market share acquisition by launching value-added services.

As part of its comprehensive portfolio of networking products, Altran offers a licensable software framework for a variety of OTN network equipment. The Altran framework provides software for both the network element and the network management system (NMS). This enables OEMs to rapidly assemble the core networking aspects of an OTN offering while keeping a sharp focus on customer and market development without depleting resources on already-solved R&D problems.

The software framework for the network element is integrated and referenced on industry-leading hardware solutions, thus saving months or even years of development time and millions of dollars in development and integration costs. The management framework can be integrated into an existing NMS for seamless extension to manage the optical part of the network.

Altran's offering is the first of its kind in the industry and will be a game changer in the transport network market. The high level of integration and the mature software offer compelling advantages of lower cost and faster time-to-market for network equipment manufacturers and network operators worldwide. Altran provides a variety of services, including product definition, design, development, system integration, testing, validation and sustenance to customers around the world, offering unmatched efficiencies and value.

The Altran OTN framework supports:

- 01 — Traffic aggregation
- 02 — Encapsulation and transport
- 03 — End-to-end supervision
- 04 — Protection and restoration
- 05 — OTN and MPLS-TP
- 06 — Enabling OTN encryption in hardware

Time-to-market advantage using the Altran OTN framework

Figure 10 shows the dramatic difference in time-to-market for new OTN products between not using the Altran software framework and using it: a decline from 30 months to 15 months. If all other factors remained the same—such as time to select the right hardware, negotiating hardware issues, building familiarity with third-party hardware and drivers—the time difference could be even larger. The staffing requirements for the Altran solution are expected to be lower because of the amount of existing development and pre-integration experience. Therefore, the cost savings could be even higher.

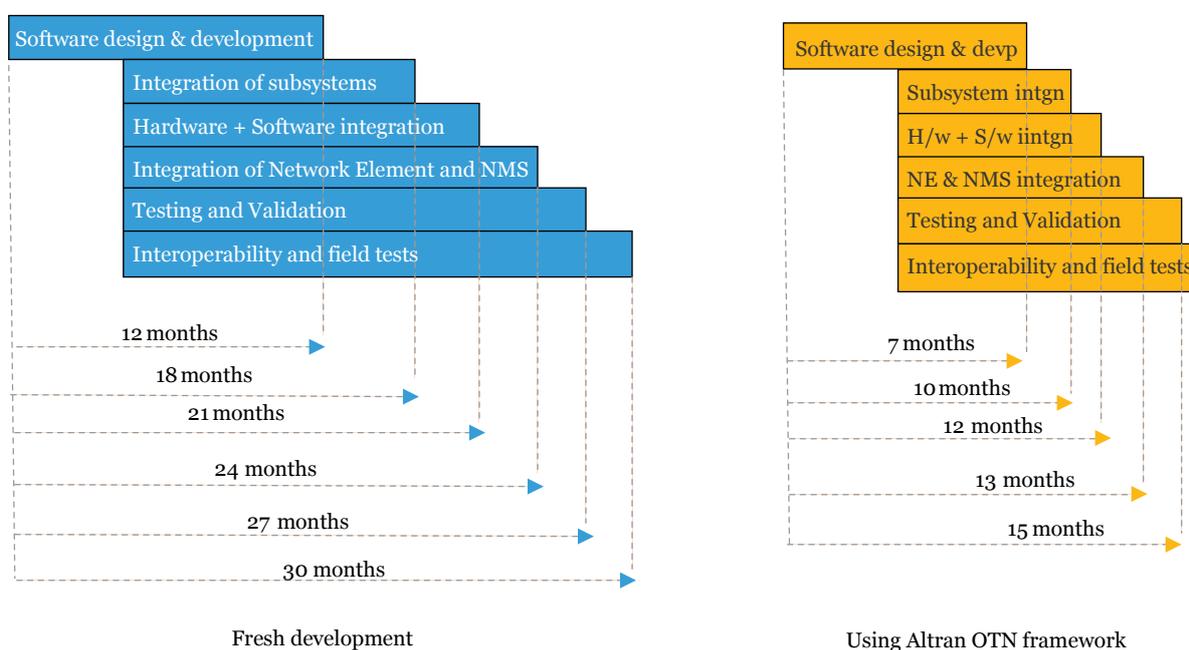


Figure 10: Altran's OTN framework cuts time-to-market in half

References

1. 7 Key benefits of OTN Networks (www.ciena.com/insights/articles/7-Key-Benefits-of-OTN-Networks-prx.html)
2. OTN Wikipedia page (en.wikipedia.org/wiki/Optical_Transport_Network)
3. Metaswitch (www.metaswitch.com/resources/what-is-optical-transport-network-otn)
4. ITU-T OTN Tutorial (<https://www.itu.int/ITU-T/studygroups/com15/otn/OTNtutorial.pdf>)
5. OTN for beginners (www.slideshare.net/sanmap/otn-for-beginners)
6. ITU-T G.873.1, <https://www.itu.int/rec/T-REC-G.873.1>
7. ITU-T G.7714

Author

Rajesh Kumar Sundararajan

Contact

If you wish to schedule a call or meeting with an Altran expert, please email us at marketing@altran.com or visit altran.com

Aricent is now Altran.

About Altran

Altran ranks as the undisputed global leader in Engineering and R&D services (ER&D), following its acquisition of Aricent. The company offers clients an unmatched value proposition to address their transformation and innovation needs. Altran works alongside its clients, from initial concept through industrialization, to invent the products and services of tomorrow.

For over 30 years, the company has provided expertise in aerospace, automotive, defense, energy, finance, life sciences, railway, and telecommunications. The Aricent acquisition extends this leadership to semiconductors, digital experience, and design innovation. Combined, Altran and Aricent generated revenues of €2.9 billion in 2017, with some 45,000 employees in more than 30 countries.

© 2019 Altran. All rights reserved.

All Altran brand and product names are service marks, trademarks, or registered marks of Altran in the United States and other countries.