DEPLOYING 10 GIGABIT SD-ACCESS NETWORKS

Using Fiber Deep Networks to Build Emerging Remote and Distributed Access Architectures

What is Driving the Need for Next-Generation EPON and Fiber Deep?

Rapidly rising bandwidth usage within a growing residential and business subscriber base combined with the need to deliver new user-driven services have cable service providers around the globe taking stock of their existing networks. They must identify the technologies needed to ensure their competitive position moving forward when facing both existing and new entrants into the markets they serve. Next-Generation Passive Optical Network (PON) technologies deployed closer to the subscriber in distributed architectures will enable service providers to support new, enhanced broadband services while responding to key operational concerns such as headend congestion and fiber exhaust.

Contending with Fiber Exhaust Using Highly Scalable PON

The primary value of next-generation Ethernet Passive Optical Network (EPON) technologies, 10G-EPON, is the ability to serve a mix of residential, business and infrastructure backhaul services over a common fiber network and to expand those services more rapidly than alternative point-to-point (P2P) fiber architectures. If we look at fiber services expansion within the U.S. over the last decade, comparing P2P and point-to-multipoint or Fiber-to-the-Home (FTTH) architectures, we find that over 100 times the penetration has been achieved using FTTH. According to Vertical Systems Group, the penetration of fiber-lit buildings grew approximately 250,000 units in the last decade. During this same period, Verizon Fiber Optic Service (FIOS) rollouts have passed over 20 million homes, and another 5 million homes have been passed by the remaining U.S. FTTH providers. It should be noted that next-generation 10G-EPON technologies have the capacity to double the useful life of an operators' fiber network investment compared to EPON or Gigabit Passive Optical Network (GPON).

Relieving Head End Congestion with the Adoption of Distributed Architectures

MSOs have been successful capturing broadband market share while upgrading to greater broadband service rates. This success has resulted in increased headend congestion to the point where placing new centralized Cable Modem Termination System (CMTS) and Converged Cable Access Platform (CCAP) equipment and making additional node splits has become untenable. Remote or distributed access architectures (DAA) solve this congestion issue by deploying CMTS and CCAP functions out in the access network or virtualized in a data center as opposed to congesting the headend. This new architecture allows for higher modulation supporting higher bandwidth devices that then serve smaller sets of subscribers. This provides a highly scalable network to support future enhanced broadband services such as 4k/8k video and virtual/augmented reality. These distributed architectures such as virtual Converged Cable Access Platform (vCCAP) and Remote Optical Line Terminal (R-OLT) also spurs fiber deep align initiatives and align with future network plans to adopt modern data center principles and emerging software defined access (SD-Access) architectures designed to provide further operational benefits.

Applying Data Center Architectures to Access

As cable operators look to optimize their networks, they are applying lessons learned from data center networks. Therefore, they are looking to build modular, component-based network architectures that are open, programmable and scalable. This approach represents a major shift from closed, monolithic systems controlled by multiple misaligned vendor-specific management systems. These newer SDN-based systems uniquely scale to provide the network management and service orchestration required rapidly deploy and support the thousands of Remote Physical Layer (R-PHY) or Remote Media Access Control/ Physical Layer (R-MAC/PHY) devices forecast.

ADTRAN Mosaic is the industry's most open and complete Software Defined Access (SD-Access) solution natively integrating a complete access portfolio with an open source SDN controller whether Open Network Operating System (ONOS), Open DayLight (ODL) or Open Network Automation Platform (ONAP). The inherent scale and agility of disaggregated and virtualized 10G-EPON architectures offers unprecedented fiber distribution and network flexibility as MSO look to support more subscribers, more bandwidth and more services.

Open Systems, Endless Possibilities

Open interfaces exist for cable and video networks allowing MSOs to select customer premises equipment, middleware, and access platforms based on their specific network topology and service requirements. Early rollouts of FTTH broadband networks, however, have used a closed system. This has historically forced service providers into selecting the same vendor for the fiber aggregation (OLT) and the optical network terminal (ONT) equipment, limiting the available solutions. In a multi-vendor network, this further complicates the ability to offer network-wide services and solutions.

Assuring Consumer Quality of Experience

The expected growth of Gigabit and multi-Gigabit services demand requires providers to architect network access scalability up front. For this reason, ADTRAN has delivered a data center-influenced standalone OLT architecture paired with non-blocking leaf-spine fabric and aggregation switching. A key characteristic of these leaf-spine switching networks is that all leaf switches, also referred to as Top of Rack (ToR) switches, have full meshed connectivity to the spine switches.

Another key value of these programmable network elements is that they scale horizontally, also known as scaling out. In an SD-Access network, as the number of Ethernet aggregation ports grows, spine and ToR switches are added, and the meshed, connectivity stays in place. The leaf and spine switching functions are sized to accommodate this growth and can be easily upgraded as needed.

ADTRAN programmable network elements leverage agile, real-time service configuration, typically found in the data center, and apply it to the service provider's access network. The ADTRAN SDX Series of software-defined network elements can be deployed in concert with a cloud platform, such as ADTRAN Mosaic, enabling service providers to realize data-center economies and agility in their broadband and business services access networks. Aligned closely with ON.Lab's Central Office Reimagined as a Datacenter (CORD) initiative, ADTRAN SDX network solutions portfolio benefits directly from the expanding community of application developers leveraging an open architecture.

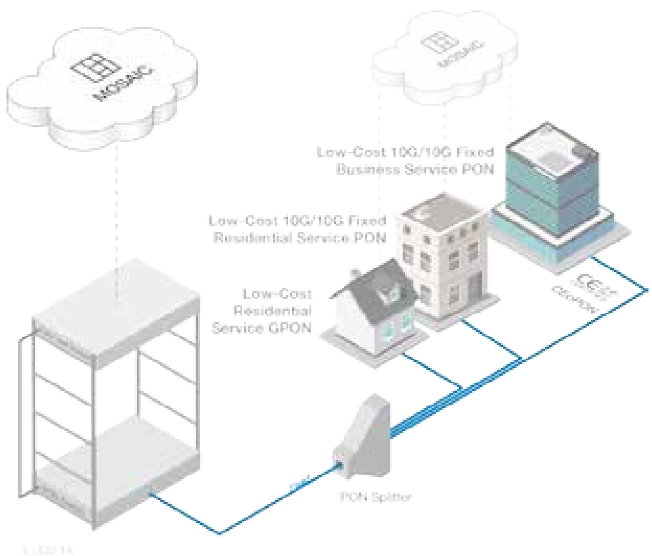


Figure A: *Deploy mass market Gigabit or multi-Gigabit converged broadband services using low-cost fixed 10/10G optics (XGS-PON).*

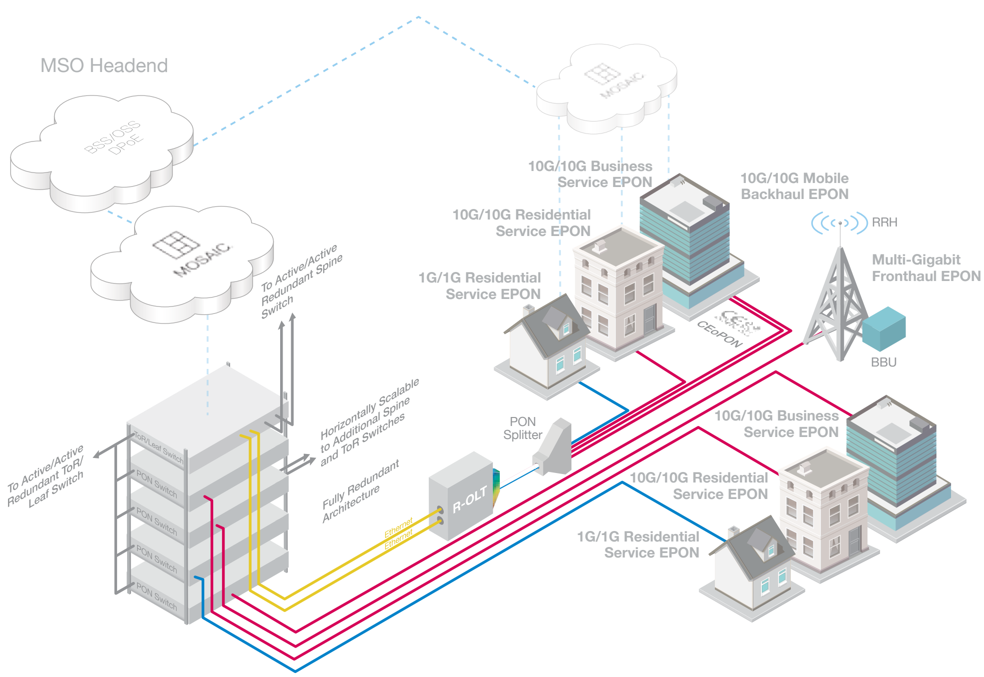
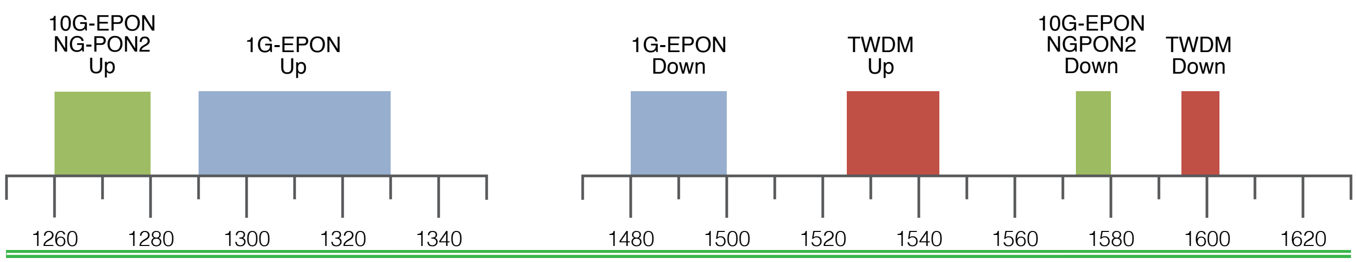


Figure B: *With support for ultra-low latency and network timing synchronization, the same fiber network serving enterprise access services can be used to support x-haul services advancing 5G densification initiatives.*



Technology	Direction	Nominal λ (nm)	Wavelength Range (nm)
10G-EPON	Upstream	1270	1260-1280
1G-EPON	Upstream	1310	1290-1330[1] 1300-1320[2]
1G-EPON	Downstream	1490	1480-1500
Time and Wavelength Division Multiplexing (TWDM)	Upstream	n/a	1524-1544
10G-EPON	Downstream	1577	1574-1580
TWDM	Downstream	n/a	1596-1603

[1] Typical for DFB lasers without temperature control

[2] Typical for DFB lasers with temperature control

Table 1: *Wavelength Allocation Plans*

ADTRAN Products

SDX 6210-4
- Sealed, Weather-hardened Remote OLT
- 4x10G Ethernet Uplinks
- 4x10G-EPON Downstream
- DPoE Support
- Low Power, Energy Efficient
- Mosaic OS Ready

SDX 6310-16
- 1U, 16-port NG-PON2/XGS PON OLT
- 2x100G Uplink Interfaces, Non-blocking 200G Capacity
- Redundant, Hot-Swappable Power Supplies
- Mosaic OS and Class G Optics Ready

SDX 8310-32
- 1U, 32x100G ToR Switch
- Quad SFP (4x28Gbps) (QSFP28) Interfaces Programmable for 10G/40G
- 3.2 Terabits per Second Throughput
- Redundant, Hot-Swappable Power Supplies
- Mosaic OS and Class G Optics Ready

SDX 8210-54
- 1U, 48x10 SFP+, 4x100G QSFP28 Access Switch
- 880 Gbps Bidirectional Downstream Throughput
- Redundant, Hot-Swappable Power Supplies
- Mosaic OS and Class G Optics Ready

SDX CPE 10/10G-EPON ONUs
- Residential and Small Business Units
- Integrated Residential Gateway Options
- Line Rate Throughput on Each ONU
- Optical Network Unit (ONU) will converge to a single Enhanced Small Form-factor Pluggable (SFP+) Uplink Supporting All Optics Types over Time

Acronym	Description
10/10G	10 Gbps Upstream/10 Gbps Downstream Rate
API	Application Programming Interface
CCAP	Converged Cable Access Platform
CMTS	Cable Modem Termination System
CORD	Central Office Reimagined as a Datacenter
DAA	Distributed Access Architecture
EPON	Ethernet Passive Optical Network
FTTH	Fiber to the Home
GPON	Gigabit Passive Optical Network
MAC	Media Access Control
ODL	Open DayLight
OLT	Optical Line Terminal
ONU	Optical Network Unit
ONT	Optical Network Terminal
P2P	Point to Point
PON	Passive Optical Network
PHY	PHYsical Layer
QSFP28	Quad SFP (4x28Gbps)
RF	Radio Frequency
R-PHY	Remote Physical Layer
SDX	ADTRAN Product Model
SFP+	Enhanced Small Form-factor Pluggable
ToR	Top of Rack
TWDM	Time and Wavelength Division Multiplexing

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ISO 14001 ENVIRONMENT

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