GEPON & GPON Comparison

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PON History

- Initial PON (1990s) were based on ATM framing (APON, BPON)
  - ATM-based BPON were inefficient, majority of traffic through the access network was IP traffic.
  - Ethernet based PON (EPON), QOS-aware Gigabit Ethernet (GbE) (VLANs, prioritization, OAM) and integration with other Ethernet equipment.
- Gigabit-capable Passive Optical Network (GPON) proposed by FSAN members (Quantum Bridge et. al) - dual Gigabit speed ATM/Ethernet PON to IEEE 802.3ah – had to continue this work within the ITU.
- EPON and GPON both draw on G.983, the BPON standard
  - (PON operation, ODN framework, wavelength plan, and application)
  - designed to better accommodate variable length IP frames at Gigabit line rates.
EPON & GPON Basics

- Ethernet Passive Optical Network (EPON)
  - Sometimes called GEPON (Gigabit Ethernet Passive Optical Network)
  - IEEE 802.3 standard, ratified as 802.3ah-2004 for 1Gbits/s
  - IEEE 802.3av standard for 10Gbits/s
  - Uses standard 802.3 Ethernet data frames

- Gigabit Passive Optical Network (GPON)
  - ITU Standard G.984
  - Downstream 2.488Gbits/s, Upstream 1.244/2.488Gbits/s
  - ITU Standard G.987 for 10Gbits
  - Downstream 10Gbits/s, Upstream 2.488/10Gbits/s
  - Uses GPON Encapsulation Method (GEM), fragmented packets or ATM (most implementations use GEM as ATM is expensive)
EPON & GPON Link Speed

- **GPON G.984** Provides faster link speed than EPON 802.3ah
  - GPON 2.448 Gbps in the downstream direction and 1.24416 Gbps in the upstream direction, whereas EPON is symmetrical 1.25 Gbps (1.0 Gbps prior to 8B/10B coding)
  - EPON efficiency reaches 97.13% to 98.92% of the efficiency of a point-to-point 1GbE link. While GPON in GEM mode can achieve ~ 95% efficiency of its usable bandwidth
  - EPON can be operated in what is typically termed ‘turbo mode’ - downstream EPON data rate is doubled to 2.5Gbps, thus enabling bandwidth throughput comparable to GPON.

- **EPON OLTs** connect to the provider network using cost-efficient devices, such as Ethernet switches and routers.
  - GPON OLTs connect to the provider network using ATM switches or convert to Ethernet
  - Ethernet switches and routers use 802.3 as their standard as does EPON

- **GPON G.987** and **EPON 802.3av** are the same link speed
  - EPON can scale via 802.3 standards 1Gbits/s, 10Gbits/s, etc.

- **IP not ATM** is the dominant networking technology going forward
  - Standard data services are IP (802.3)
  - Voice is transitioning to VoIP (802.3)
  - Video is transition to IP TV (802.3)
Basic PON Operation

Downstream Broadcast
All data goes to all ONUs, and the ONU address controls the downstream data.

Upstream TDMA Operation
ONUs send information to the OLT in a specific time window.
EPON & GPON Split Ratios

- EPON does not limit the split ratio
  - Standard supports a minimum of 32 but no upper limit
  - Split ratio defined by the services and bandwidth the provider wants to support
  - Typical split ratio is 32 and 64 with FEC
  - EPON can deploy cheaper optics at the ONU as it does not need to reach a split ratio of 128
- GPON defines an upper limit
  - Promises to support 128 (with FEC)
  - Typical split ratio is 64
- 10Gbits/s everything the same
  - Provides the same bandwidth to the same number of subscribers
EPON & GPON Similarities

- Both have an Optical Line Terminal (OLT) at the headend
- Both use passive optical splitters in the Optical Distribution Network (ODN)
- Both have multiple Optical Network Units (ONUs) or Optical Network Terminals (ONTs) at the subscriber
- Both utilize WDM
  - 802.3ah/ITU G.984 Downstream 1490nm, Upstream 1310nm
  - 802.3av/ITU G.987 Downstream 1260-1280nm, Upstream 1575-1580nm
- Standards define different loss budgets but typically use 28dB which corresponds to 32 split at 20km
- Forward Error Correction (FEC) is used to gain more loss budget
- Both provide support for Voice, Video and Data
EPON & GPON Differences

• EPON assumes that data today starts and ends as Ethernet and therefore 802.3 frame format is appropriate. Used widely in the Enterprise and Asian ISP markets.
  • IP data services
  • VoIP
  • IPTV – Supports multicast so uses less bandwidth
• GPON Provides native support for different services. As this is an ITU standard it is aimed at Telco’s
  • Provides ATM for Voice
  • Ethernet for Data
  • Proprietary Encapsulation for other voice services
• GPON equipment requires multiple protocol conversions, segmentation and reassembly (SAR), virtual channel (VC) termination and point-to-point protocol (PPP)
EPON & GPON Layering

- EPON is based upon IEEE 802.3 modified to support Point-to-Multipoint (P2MP) connectivity. Ethernet traffic is transported natively and all Ethernet Features are fully supported.
- GPON on the other hand is fundamentally a transport protocol, wherein Ethernet services are adapted at the OLT and ONT.
EPON & GPON Framing
SFP ONU

- SFP form-factor ONU
- Plugs into any SFP-enabled device
  - Switches, routers, DAS, specialized modems
- EPON manages ONU; In-band management for device
Multi class Services

ODN Network

1G PON

1G PON

Splitter

Splitter

WDM

Subscribers

Residential

Small

Medium

Large

Multi-Tenant

Services

Video

Data

POTS/ VoIP

TDM

Security Automation
EPON & GPON Costs

- EPON deployments driven by Asia (Japan, China & Korea)
  - Approximately 60% of PON subscribers worldwide
  - Scale reducing cost and driving investment
  - North American Cable Operators also moving to EPON
  - Ethernet devices approximately 1/10 the cost of ATM devices
  - Optics less expensive than GPON

- GPON deployments initially driven by Telco’s (SONET)
  - xDSL still widely deployed but moving to PON
  - ATM devices supporting DSL and GPON expensive and being replaced with Ethernet devices
  - North American Telco’s have historically used GPON
  - No native support for Multicast so uses proprietary solution or more bandwidth
  - Timing constraints tighter with GPON so optics more expensive
  - GPON adds a layer of complexity to data networks (including VoIP), as traffic must be converted to IP
EPON & GPON Summary

- Both EPON and GPON recognized the need to evolve PON to being a Gigabit capable solution for transporting Ethernet IP traffic.
- Both utilize a common optical infrastructure, but very different in execution. EPON extended native Ethernet to support the PON P2MP architecture, while GPON wished to extend the life of GFP framed SONET/SDH
- GPON Telco legacy supporting legacy telecom SONET networking
  - GPON link rates match ITU standards like OC3, OC12, etc
  - North American Telco’s SONET/GPON
  - Equipment based on ITU/SONET typically more expensive/complicated
- EPON is designed to support Ethernet and IP
  - EPON link rates match IEEE standards like 1Gbs, 10Gbs, etc
  - North American Cable Operators adopting EPON
  - EPON is widely deployed world-wide
  - Ethernet and IP scale reducing costs and driving investment in EPON systems
RF Video?

PON WDM
- Allows 1550nm wavelength carrying RF video to be muxed onto PON fiber
- Allows RF return signal at 1310nm to be demuxed from the PON fiber

RF Headend Transmitter → 1550nm → PON WDM

PON WDM → 1610nm → RF Headend Receiver

PON WDM → 1310/1490/1550/1610nm → PON Network

PON OLT ← 1490nm/1310nm
DAS Supported

RF Video
- Video Transmitter
- EDFA
- Combiner network
- DAS Donor Antenna
- DAS Fiber Node
- Return Path Receiver
- WDM
- CMTS/STB controller
- Video

ODN
- 1G PON
- Splitter/Optical Tap
- WDM

Subscribers
- Residential
- Business
- In-Building Antennas

CommScope OLT
- Data
- Voice
- Video

Data Splitter
- 1:n

EDFA

DAS Supported
Products

PON

- PON OLTs
- SFP ONUs
- FTTH/B/Desktop ONUs
- FTTMDU ONUs

OSP Passives and Enclosures

- Above Ground Closure
- Below Ground Closure
- Optical Taps & Splitters
- Splitter Cabinet

Enclosures and Power

- NID / ONU Enclosures
- Battery Backup
- Power Inserters & Supplies
Products

Indoor Passives and Enclosures

Wall- and Rack-mount Enclosures

Splitters and Bulkheads

Faceplates

Cables

Patchcords
CommScope Solution

- Provides Support for both EPON and GPON
  - 1Gbits/s symmetric EPON
  - 10Gbits/s symmetric EPON (waiting on Silicon to go to production)
  - 2.5Gbits/s GPON
- Provides a wide range of ONUs
  - SFP ONU to support legacy equipment
  - 1,2,4 Ethernet Ports
  - 4 Ethernet Ports, 2 VoIP ports
  - 4 Ethernet Ports, 2 VoIP ports and Wifi
  - 8,16,24 Ethernet Ports
- Standards based no Proprietary solutions
  - EPON equipment meets IEEE standards for both subscriber and network side
  - GPON equipment meets ITU standards
- Supports Layer 3 features
  - Supports routing protocols, OSPF, BGP, IS-IS.
Product Deployment

- 2.5 Million subscribers
- Largest current customers Korean Telecom (KT) and LG
- Deployments around the world
  - USA
  - Korea
  - India
  - Bulgaria
  - Russia
  - Czech Republic
  - Vietnam
Thank You