

# GPON vs. EPON Costs Comparison

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## Abstract

*Industry standards for Passive Optical Network (PON) technology have enabled the initial deployment of Fiber to the Premise (FTTP) services. The ITU-T BPON standard has been embraced in North America while the IEEE 802.3ah based EPON (a.k.a. GE-PON) has been chosen as the next step in Japan after close to 2 million BPON subscribers have been deployed. Regardless of any technology merits, the lowest cost solution will be preferred. With this in mind, this paper makes a simple costs comparison between EPON and the emerging ITU-T GPON for a given FTTP network.*

## Technology Comparison

A key factor in determining the cost effect on a FTTP network is to understand the performance characteristics of the PON technology. Critical cost bearing factors are: PON bandwidth, bandwidth efficiency and split ratio. The following table highlights the performance and operational differences between EPON (a.k.a GE-PON) and GPON technology:

	<b>IEEE 802.3ah (EPON)</b>	<b>ITU-T G.984 (GPON)</b>
<b>Downstream</b>	1250 Mbps	2500 or 1250 Mbps
<b>Upstream</b>	1250 Mbps	1250 or 622 Mbps
<b>Split ratio</b>	1:32	1:32, 1:64, (1:128 planned)
<b>Downstream Efficiency</b>	~72% as a result of: 8B/10B encoding (20%) Overhead & Preamble (8%)	~92% as a result of: NRZ scrambling (no encoding) Overhead (8%)
<b>Revenue BW</b>	900 Mbps	2300 Mbps
<b>OAM&amp;P</b>	OAM is optional and minimally supports: failure indication, loop-back and link monitoring to the ONT. Provisioning and services are out of scope.	OMCI is mandatory. Full FCAPS on ONT and services.
<b>Security</b>	None specified. AES used by various vendors.	AES is part of the standard.
<b>Network Protection</b>	None specified.	Optional 50 mS switching time.
<b>TDM transport</b>	Circuit Emulation over Ethernet (ITU-T Y.1413 or MEF or IETF)	Native via GEM or Circuit Emulation over Ethernet (ITU-T Y.1413 or MEF or IETF)
<b>Interoperability</b>	None specified	FSAN and ITU-T

Table 1 Technology Comparison

From Table 1, GPON seems better suited for implementation in carrier networks providing the necessary support for O&M, interoperability and security, all necessary for large network operation. However, these technical merits alone will not result in an industry endorsement for GPON. For the access network, cost is the final determining factor. Thus, the results of a fair cost comparison with EPON will reveal the viability of GPON technology.

### **Cost Comparison Methodology**

For a simple cost comparison between EPON and GPON, only the total equipment costs for a FTTP network of 10,000 subscribers with a 100% take rate of service will be considered. To keep the analysis uncomplicated, only sustained rate Ethernet based services will be considered since this is the type of service for multiple IPTV and HDTV streams into the home. Also, the Outside Plant (OSP) will be treated as equal although the PON split ratio will be different. For a comparison based on the merits of each technology, the following assumptions will be made:

#### Equipment cost technology

EPON OLT = GPON OLT = \$1800 per interface

EPON ONT = GPON ONT = \$100 per subscriber

#### PON revenue bandwidth

	<b>DS Rate (Mbps)</b>	<b>US Rate (Mbps)</b>	<b>DS Efficiency</b>	<b>DS Revenue BW (Mbps)</b>	<b>Split Ratio</b>	<b>Reach (Km)</b>
<b>EPON</b>	1250	1250	72%	900	1 :32	10
<b>GPON</b>	2500	1250	92%	2300	1 :64	10

Given these assumptions, Figures 1 illustrates the total network equipment cost differences while Figure 2 provides the cost per subscriber.

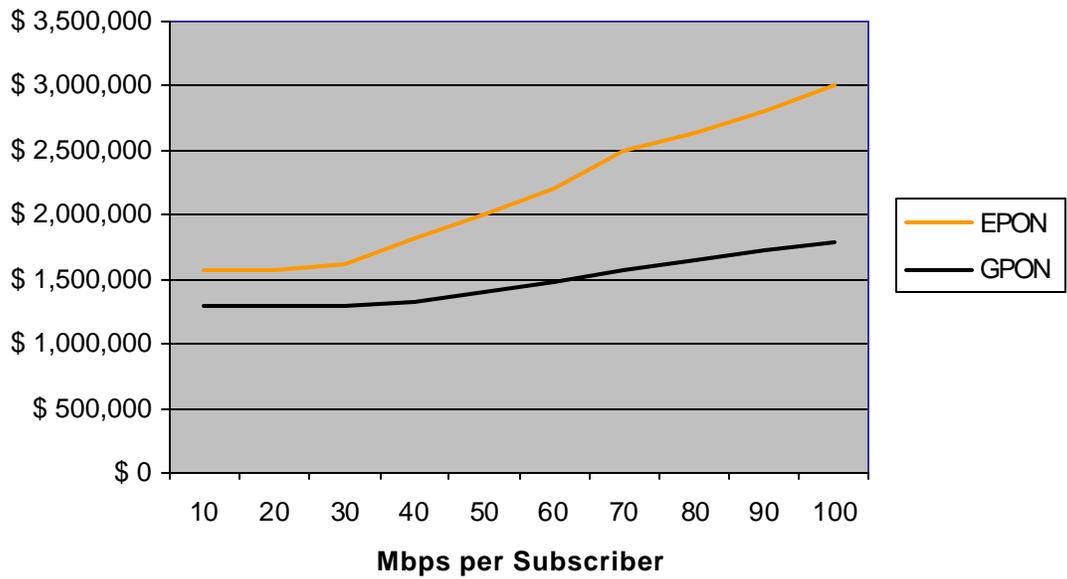


Figure 1 GPON vs. EPON Total Network Equipment Cost

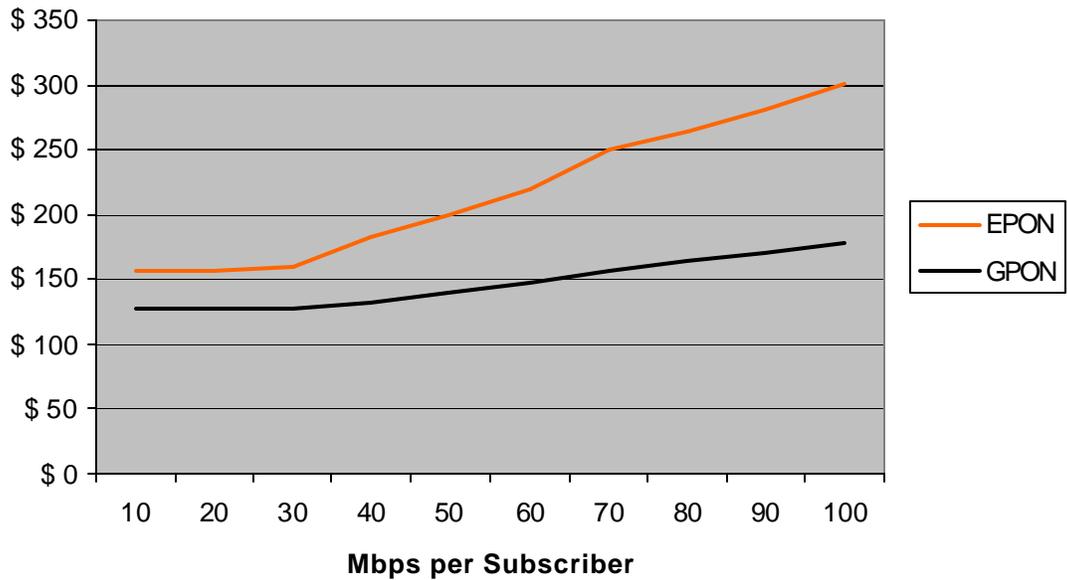


Figure 2 GPON vs. EPON Cost per Subscriber

GPON's significant cost advantage is simply a result of the reduction in the number of OLT's needed. This is because of GPON's higher split ratio, PON bandwidth and bandwidth efficiency. As seen in Table 1 and Figure 1, at 100 Mbps per subscriber, GPON offers up to a 2.6:1 OLT advantage for this network which means a total savings of about \$1.2M.

<b>BW Per Sub (Mbps)</b>	<b>10</b>	<b>20</b>	<b>30</b>	<b>40</b>	<b>50</b>	<b>60</b>	<b>70</b>	<b>80</b>	<b>90</b>	<b>100</b>
<b>Number of EPON OLTs</b>	313	313	334	455	556	667	834	910	1000	1112
<b>Number of GPON OLTs</b>	157	157	157	176	218	264	313	358	400	435
<b>GPON to EPON OLT Ratio 1:</b>	2	2	2.2	2.6	2.6	2.6	2.7	2.6	2.5	2.6

Table 2 GPON & EPON Deployment

Given this OLT cost savings, the cost sensitivity of a GPON OLT can be calculated based on the money saved and then applied against the total number of OLTs in the network. Thus, for a GPON OLT savings of \$1.2M for 100 Mbps subscriber service, \$1.2M can be spent on 10,000 OLTs to obtain an equivalent EPON cost. Thus the GPON OLTs can cost \$220 or 120% more than an EPON OLT in order to have the same total network costs.

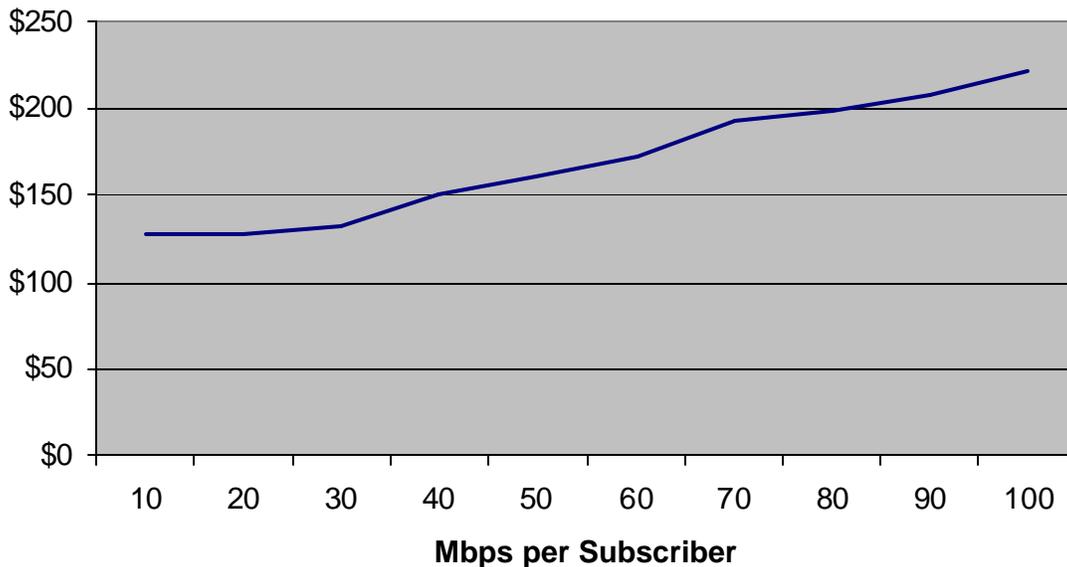


Figure 3 GPON OLT Cost Sensitivity for Breakeven with EPON

Since the total cost savings of FTTP network using GPON is due to the savings in the number of OLTs, the OLT cost sensitivity becomes a factor. The GPON OLT breakeven cost sensitivity can be determined by applying the difference between an EPON and GPON equipment cost to the total number of GPON OLTs with fixed cost OLTs. The GPON to EPON cost breakeven sensitivity for the GPON OLT is shown Figure 4:

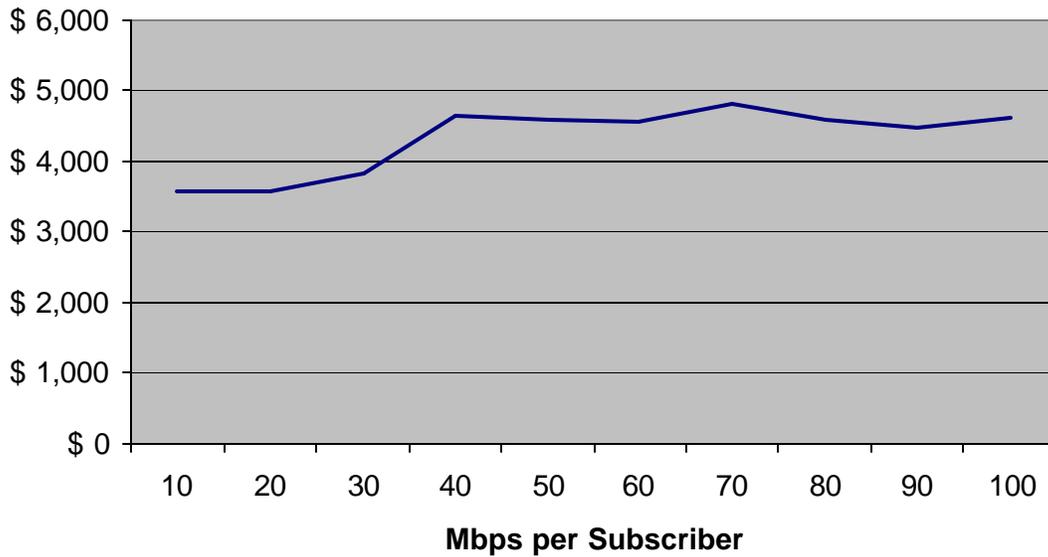


Figure 4 GPON OLT Cost Sensitivity for Breakeven with EPON

A major factor for GPON's cost performance is its split ratio. Thus, cost per subscriber impact in reducing the GPON split ratio to 1:32 needs to be determined. The result is illustrated in Figure 5.

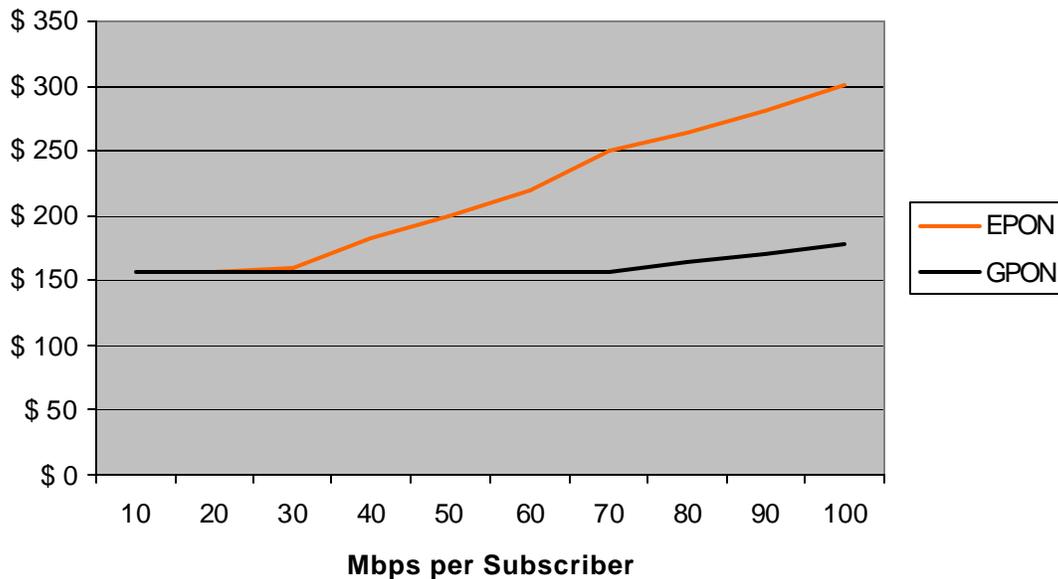


Figure 5 GPON vs. EPON Cost per Subscriber with Equal Split Ratio of 1:32

## Comments

This simple cost analysis for a given FTTP network highlight's GPON's significant cost advantage over EPON. This is due to GPON's higher split ratio, line rate and bandwidth efficiency which results in a reduction in the amount of OLT equipment by more than a factor of 2 over EPON. This also translates into significant space and power reduction at the Central Office as illustrated in Table 2 as well as life cycle cost savings due to the reduction in OLT equipment.

As with ITU-T G.983 BPON, GPON also promises equipment interoperability through Full Service Access Network (FSAN) and ITU initiatives. This enables ubiquitous deployment of PON whereby various vendor's OLTs and ONTs can be mixed and matched across a network as is done with BPON. It also enables the supply of low-cost, high volume PON ONTs from CPE vendors as is done in the DSL industry, thus further enabling low-cost PON deployment.

The currently acceptable price of EPON from vendors has enabled service providers to deploy residential PONs in mass in Asia. The ITU-T G.984 GPON standard provides native carrier class transport of both Ethernet and legacy TDM and thus has the promise of a single cost-effective PON technology for both residential and business service. As consumer bandwidth increases from 10 Mbps for best-effort high-speed internet data up to sustained 100 Mbps for multiple IPTV streams of SDTV and HDTV, GPON offers the best cost advantage over EPON.

### References:

- [1] How Efficient is EPON? Glen Kramer, Teknovus.
- [2] ITU-T G.984 Gigabit capable Passive Optical Network (GPON)