FTTH
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Dominic Ruggiero

New Developments in FTTH

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New Developments in FTTH

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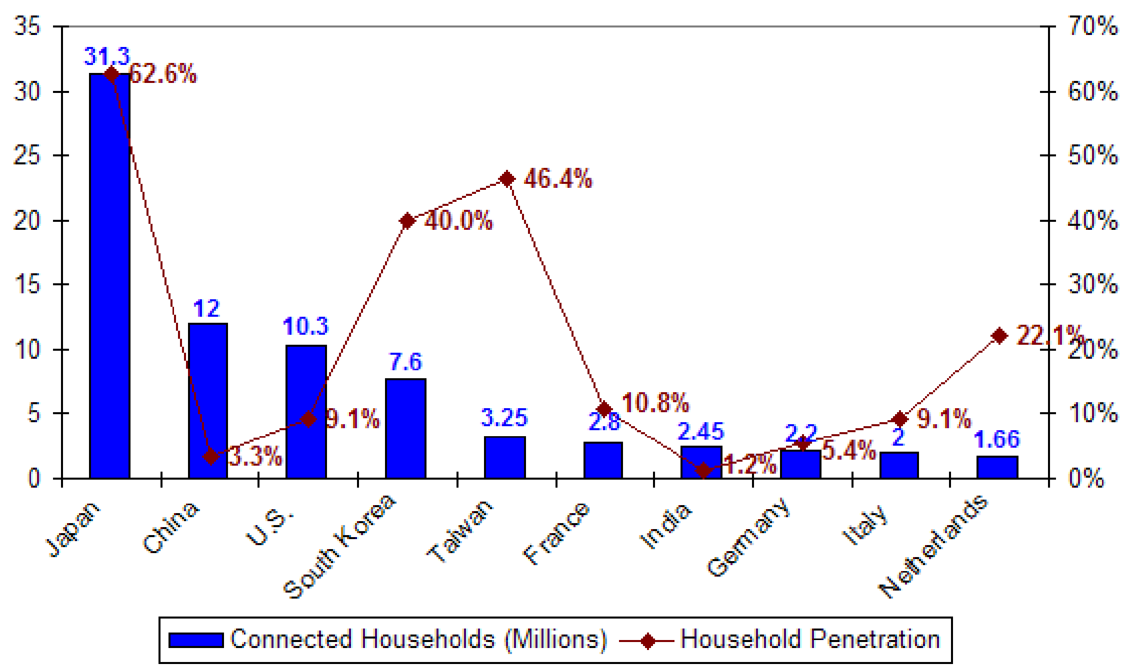
Introduction

It's been almost three decades in the making, but fiber to the home (FTTH) is finally emerging into the mainstream and is set to transform the telecom environment worldwide over the next decade. FTTH represents the first major upgrade to the access network since the deployment of cellular infrastructure in the 80s and 90s, and like cellular, it is likely to have a deep impact on the entire supply chain, including technology vendors and network operators.

Over the next 15 to 20 years, copper access networks worldwide will be largely replaced by a fiber access network, creating massive opportunities for vendors, network builders, and service providers. The most important catalyst for this change is a growing perception that copper access networks will soon no longer be able to meet the ever-growing consumer demand for bandwidth, driven mainly by the Internet, IP, and the many services running over it. At the same time, competition to move customers onto complex service packages that include video is leading some to conclude that they must be first to deploy fiber, pre-empting or frustrating future competition.

This environment has led to the beginnings of a mass migration to fiber in several countries, notably Japan, Sweden, and the U.S. They will be joined in the next year or two by China, France, South Korea, and the Netherlands, among others, and ultimately every city in which consumers are ready to pay for higher performance and richer services.



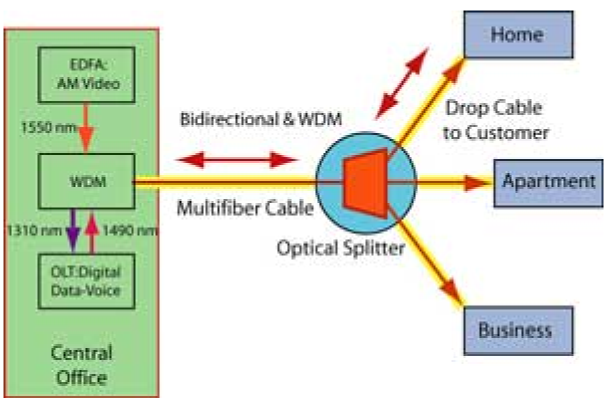
Source-Heavy Reading

Triple Play Systems

Most FTTH systems are so-called "triple play" systems offering voice (telephone), video (TV) and data (Internet access.) To provide all three services over one fiber, signals are sent bi-directionally over a single fiber using several wavelengths of light.

BPON, or broadband PON, was the most popular current PON application in the beginning. BPON uses ATM as the protocol. ATM is widely used for telephone networks and the methods of transporting all data types (voice, Internet, video, etc.) are well known. BPON digital signals operate at ATM rates of 155, 622 and 1244 Mb/s.

Downstream digital signals from the CO through the splitter to the home are sent at 1490 nm. This signal carries both voice and data to the home. Video on the first systems used the same technology as CATV, an analog modulated signal, broadcast separately using a 1550 nm laser which may require a fiber amplifier to provide enough signal strength to overcome the loss of the optical splitter. Video could be upgraded to digital using IPTV, negating the need for the separate wavelength for video. Upstream digital signals for voice and data are sent back to the CO from the home using an inexpensive 1310 nm laser. WDM couplers separate the signals at both the home and the CO.



GPON architecture with analog TV

GPON, or gigabit-capable PON, uses an IP-based protocol and either ATM or GEM (GPON encapsulation method) encoding. Data rates of up to 2.5 Gb/s are specified and it is very flexible in what types of traffic it carries. GPON enables “triple play” (voice-data-video) and is the basis of most planned FTTP applications in the near future. In the diagram above, one merely drops the AM Video at the CO and carries digital video over the downstream digital link. GPON architecture also allows for a maximum of a 64 way split as compared to the 32 way split of BPON & EPON network specifications.

EPON or Ethernet PON is based on the IEEE standard for Ethernet in the First Mile. It uses packet-based transmission at 1 Gb/s with 10 Gb/s under discussion. EPON is widely deployed in Asia. The system architecture is the same as GPON but data protocols are different.

PON System Specification Summary

	BPON	**GPON**	**EPON**
Standard	ITU-T G.983	ITU-T G.984	IEEE 802.3ah (1 Gb/s) IEEE 802.3av (10Gb/s)
Downstream Bitrates	155, 622 Mb/s, 1.2 Gb/s	155, 622 Mb/s, 1.2, 2.5 Gb/s	1.25 Gb/s
Upstream Bitrates	155, 622 Mb/s	155, 622 Mb/s, 1.2, 2.5 Gb/s	1.25 Gb/s, 1
Downstream Wavelength	1490, 1550	1490	1490, 1550
Upstream Wavelength	1310	1310	1310
Protocol	ATM	Ethernet over ATM/IP or TDM	Ethernet
Video	RF at 1550 or IP at 1490	RF at 1550 or IP at 1490	IP Video
Max PON Splits	32	64	16
Coverage	<20 km	<60 km	<20 km

PON consists of the following
OLT ~ Optical Line Terminal is the networks control card. This card resides in the local CO (Central Office) cross connected to the video and data networks that will be delivered to your home, it consists of a special DFB (Distributed Feedback) calibrated laser that is always on. This control card acts as a traffic signal to the remote ONT's for complete data / video throughput upstream and downstream.

ODN ~ Optical Distribution Network, is part of the OSP architecture components. The actual fiber-optic cabling, passive splitters, FDH, attenuators and couplers.

FDH ~ Fiber Distribution Hub, is the cross point for the Fiber CO Trunk and Distribution Fiber to the individual homes. This hub can come in various configurations but the RBOC's configuration will generally be the 144 / 216 user format and designed to be a plug and play cross connect panel for the home connections.

ONT ~ Optical Network Terminal, this is the CPE (Customer Premise Equipment) endpoint of the ODN. The ONT is an Optical to Electrical to Optical device, that delivers your triple play services. It will replace the existing copper NID (Network Interface Device) and the existing coax, POTS services will be cross connected to it. Since PON is completely passive, the endpoint must obtain an AC voltage.

Next Gen Networks

10G-PON (also known as XG-PON) is a 2010 computer networking standard for data links, capable of delivering shared Internet access rates up to 10 Gb/s over existing passive optics.

This is the ITU-T's next generation standard following on from GPON or Gigabit-capable PON. The 10 Gbit/s capacity is shared by all users connected to the same PON, and different multiplexing techniques prevent data frames from interfering with each other. Users have a network device that converts optical signals to the signals used in building wiring, such as Ethernet and wired analog plain old telephone. 10G-PON connections may also find uses in combining multiple fiber nodes within multi-tenant units and apartment buildings.

The number of splits still matches the 1x32 or 1x64 for GPON, however there is a possibility of extending this to 1x128 or 1x256 in the future to improve the overall economics compared to GPON. There is also the option of expanding the fiber distance from 20km to 60km with the use of a mid span optical amplifier.

WDM PON

Wavelength Division Multiplexing Passive Optical Network (WDM PON) is the next generation in development of access networks and offer highest bandwidth. Though it will be some time before they are affordable WDM PONs some vendors are introducing products that can put more wavelengths onto a PON. Wavelength Division Multiplexing (WDM) is either a Coarse (CWDM) or Dense (DWDM) depending on the number of wavelengths multiplexed onto the same fiber. Vendors are of the opinion that a CWDM PON can support 3 to 5 wavelengths, while supporting more than 5 wavelengths requires a DWDM overlay. In WDM PON architecture ONTs operate on different wavelengths and hence higher transmission rates can be achieved. Much research was focused on enhancing WDM PONs ability to serve larger numbers of customers in an attempt to increase revenue from invested resources. As a result, some hybrid structures have been proposed where both WDMA and TDMA models are used to increase the number of potential users. For DWDM, the ONTs require expensive, frequency-stable, temperature controlled lasers. The OLT puts all the wavelengths onto the shared feeder fiber and the splitters replicate the wavelengths to each home.

User Applications

Triple play services over IP of video, data and voice are often cited as driving user demand for heavier usage of broadband that justifies PON investment. While RF overlay has been popular in some countries and minimizes congestion caused by usage of video services, the convergence of HDTV and IPTV could create demand for bandwidth that exceeds the capacity of gigabit services in future. Remote office and video conferencing are other applications sometimes demanding such triple play capabilities.

Other bandwidth-intensive applications include video-conferencing, interactive video, online interactive gaming, peer-to-peer networking, karaoke-on-demand, IP video surveillance, and cloud applications where remote storage and computing resources provide online service on demand to users with thin-client local systems. Cloud applications could take advantage of local content hosting but 10GPON may encourage explosive development of innovative services that become feasible as users connect at faster speeds.

Business continuity systems may also take advantage of 10GPON to enable cost effective real-time backup/replication of critical business systems, which may themselves be centralized services that support multiple sites. Other businesses may just need to connect several sites as a virtual private network, effectively a virtual office, or may have e-commerce services that require business partners to have sufficient connectivity for constant database access.

Many of these applications are already growing in both popularity and demand for bandwidth.

Table 1 shows some potential future residential applications and their bandwidth requirements.

Table 1

Application	Bandwidth (Mbps)
1 High Definition Video Session	20
2 Standard IP Video Session	7
1 Web Surfing Session	1
Internet Appliances	1
1 Internet Gaming Session	2
2 Video Conferencing Sessions	2
4 High Quality Audio Sessions	0.5

Total 33.5

Conclusion

One of the major hurdles for the mass deployment of FTTH is the relatively high cost of CPE/ONT. The increased competition between equipment vendors combined with increased deployment of FTTH systems worldwide will result in a decreased overall system cost and continue to progressively produce improvements in FTTH technology.

There is no right or wrong FTTH technology, rather the technology choice primarily depends on the existing network operator infrastructure and the requirements of the clients utilizing the FTTH network.

Though ultimately, the choice of network architecture is typically driven by the demand for that which offers the greatest service capabilities at the lowest costs.