CONEXANT

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GPON: The Gateway PON
White Paper

Introduction

Fiber To The Home (FTTH) deployments continue to enjoy accelerated growth worldwide, with major deployments underway in Japan (Nippon Telegraph and Telephone Corporation [NTT]), Korea (Korea Telecom) and the United States (Verizon). Passive Optical Networking (PON) deployments are currently segmented in two flavors: Ethernet PON (EPON) in Japan and Korea, Broadband PON (BPON) in the United States (e.g., Verizon FIOS). The BPON deployments in the United States are expected to transition to Gigabit PON (GPON) in 2008.

In Europe and North America, Competitive Local Exchange Carriers (CLECs) are trialing and deploying PON very aggressively to provide services that differentiate them from the Incumbent Local Exchange Carriers (ILECs). Meanwhile, many local municipalities have started stringing their own fiber in their neighborhoods and inviting system vendors to enable end-to-end solutions. Because of the diverse and fragmented customer base, the deployment models are also very different. The U.S. deployment model is an outdoor Network Interface Device (NID), which is typically installed outside the house, while the Optical Network Unit (ONU) is typically installed inside the house in Japan, Korea, and Europe. The deployment models are driven by local access requirements in each region, as well as the applications that will run over these networks.

This paper looks at current deployments, the applications driving them, and the factors that will determine the deployment toward a certain model. It also looks at the trends in the rest of the access market (e.g., Cable, ADSL, VDSL) for clues about what may be in store for future FTTH deployments.

FTTH Deployment Models

Figure 1 illustrates the FTTH deployment models worldwide.

Figure 1. Deployment Models for FTTH

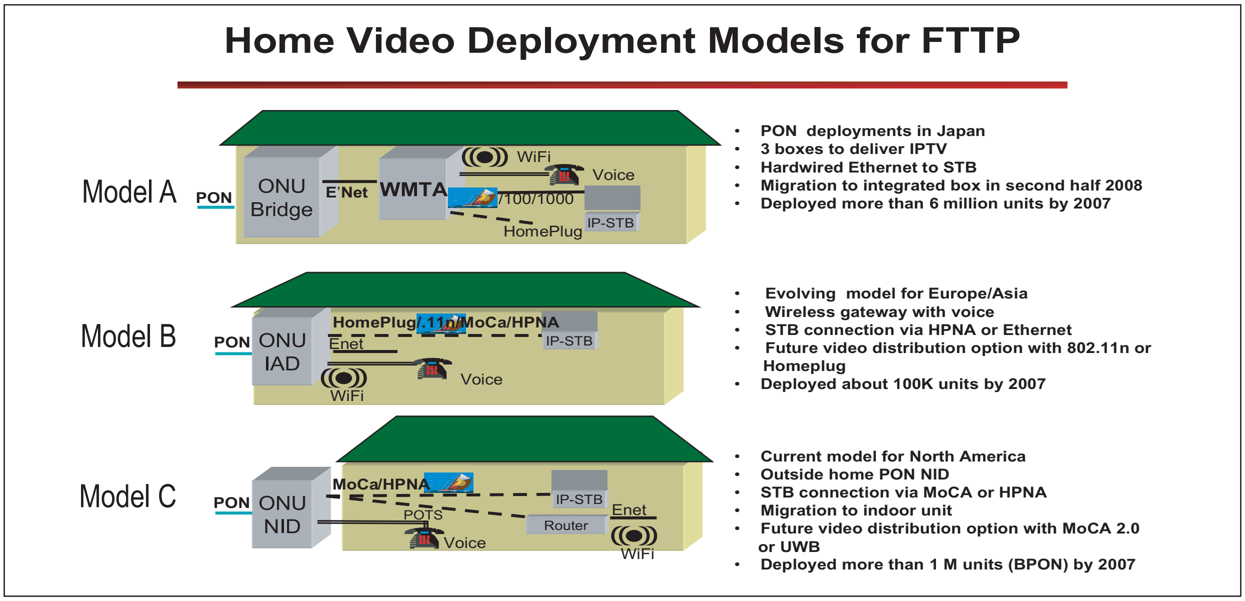


Figure 1 shows that the primary FTTH deployment model features a standalone NID (e.g., Japan, Korea, and the United States), where the PON is terminated at the NID with an Ethernet-based data only service in Japan and data plus voice service in North America. The two major U.S. operators, AT&T and Verizon, have taken a very different approach to their fiber deployments. Providing broadcast TV is the primary driver for both the operators, but Verizon has chosen a more pragmatic analog overlay service for providing broadcast TV services to compete with the cable companies, with digital video services as a follow-on offering. AT&T has opted for providing digital in-band IPTV services for its U-verse℠ offering. The analog overlay approach has clearly driven Verizon to a home distribution network based on Multimedia over Coax Alliance (MoCA™) architecture, while AT&T has opted for the Home Networking over Phone and Coax Line Alliance (HomePNA™) approach.

European operators are targeting an indoor deployment model. Initial deployments are expected to be based on a NID that provides one or two channels of voice and a separate router that enables wireless and home networking technologies inside the home. Service providers are expected to migrate to an integrated gateway that combines the NID and router boxes to reduce deployment costs and provide more robust quality of service for video distribution within the home. Note that Model B in Figure 1 reduces the deployment from three boxes to two, thereby reducing the deployment's overall cost. Clearly, the next generation deployments will either move to an indoor integrated gateway solution (Model B) or an external NID with voice (Model C). The next section looks at the factors that will drive these two deployment models.

Indoor Versus Outdoor Deployment Models

There are various factors to consider when deciding between an outdoor installation versus an indoor installation.

Advantages of an Outdoor Installation

In the United States, the PON NID was a natural replacement to the terminator box outside every home that was just a passive device with a bundle of twisted pairs going to the home. Listed below are some of the advantages of an outdoor installation:

1. It obviated the need to run fiber into the house and also made it easier to install because the fiber termination could be done with the precision needed for the state of the technology available.
2. The Federal Communications Commission (FCC) requires that voice be terminated in this box. This approach also enables the carriers to remove the copper once the fiber is installed for their basic telephony service.
3. It makes a very clear demarcation of ownership. The NID is owned and controlled solely by the carrier. The NID is a secure device with no access for the user.
4. Troubleshooting is easier because the technician does not need to get into the house in order to check the NID. However, this approach may not help some of the more advanced applications, such as IPTV, which would need the ability to troubleshoot at the application layer and are better served by having all the QoS-centric application and diagnostic software in the same box.
5. The NID stays with the house rather than with the owner, so carriers can reuse the same box for new customers. Also, once installed, it will have a fairly long life. The replacement market will be different for these types of installations.

Disadvantages of Outdoor Installation

1. Higher Costs: Replacing a passive, twisted-pair box with an active network terminating box involves initial costs. The NID needs to be in a hermetically-sealed box and capable of operating at industrial temperatures. Typical installations need a custom enclosure, which adds to the cost. This deployment also precludes a self-install, adding to the installation costs, and precludes silicon integration to minimize the number of boxes needed.
2. Limited Diagnostic Options: The three-box solution has led to a diagnostic nightmare. It is hard to diagnose problems between the NID outside the house and the broadband router and IP Set-Top Box (STB) inside the house. This is because carriers are terminating a lot of higher level applications such as IPTV—including Video on Demand (VoD)—voice and multimedia applications. The diagnostic problem is further compounded when these applications are delivered over MoCA and HomePNA, which were not originally designed for these applications. The self-install that is being done in the Digital Subscriber Line (DSL) deployments would be a very attractive cost proposition for an indoor ONU.
3. Fewer Up-sell Opportunities: Carriers want to up-sell customers on advanced features in order to increase Average Revenue Per User (ARPU). Outdoor installation severely limits their ability to do so because it precludes integration. More and more of the value-added services such as VoD, interactive gaming, etc., will have to be put in the indoor boxes, and carriers often do not have complete control of those devices.

Advantages of Indoor Installation

1. Lower Installation Costs: Indoor installation promotes a self-install. However, unlike in the case of DSL over twisted pair or cable over coax, the fiber-based installations need a lot of careful handling. In a typical installation, a fair amount of time is required to get the alignment and the attenuation done correctly, which requires a technician for each installation. However, NTT, the biggest current PON deployment, feels confident that the technology should be self-installable by the end of 2008. NTT has also made a lot of progress in getting the fiber to work like a piece of copper via its research on coiled fiber (www.ntt.co.jp/tr/0505/files/ntr200505057.pdf). This narrow-bending radius fiber technology promises to revolutionize FTTH deployments worldwide. Recently, Verizon indicated that they would look at indoor ONTs for Multi Dwelling Units (MDU) also citing advances in narrow bending radius fiber enabling FTTH deployments into apartment buildings (http://telephonyonline.com/fttp/news/fttp-aid-verizon-0326/).
2. Integration Savings: Indoor installation enables the integration of the NID and the broadband router into one box, thus reducing deployment costs. This approach is also driving System on Chip (SoC) integration in the GPON semiconductor industry.
3. Reduced Software Costs: Indoor installation allows the systems vendors and carriers to leverage their existing software base from their DSL deployments. It also enables one seamless software upgrade for all of their access services.
4. Lower Management Costs: Indoor installation enables a common management process and a platform for all of the carrier's access products. DSLHome™, the DSL Forum's initiative to standardize and simplify the provisioning and configuration of the DSL gateway, coupled with OMCI (ONT Management Control Interface) will be the preferred management protocol for the carriers.
5. AC-powered indoor operation with battery backup.
6. Cheaper enclosure and temperature requirements on the gateway/router.

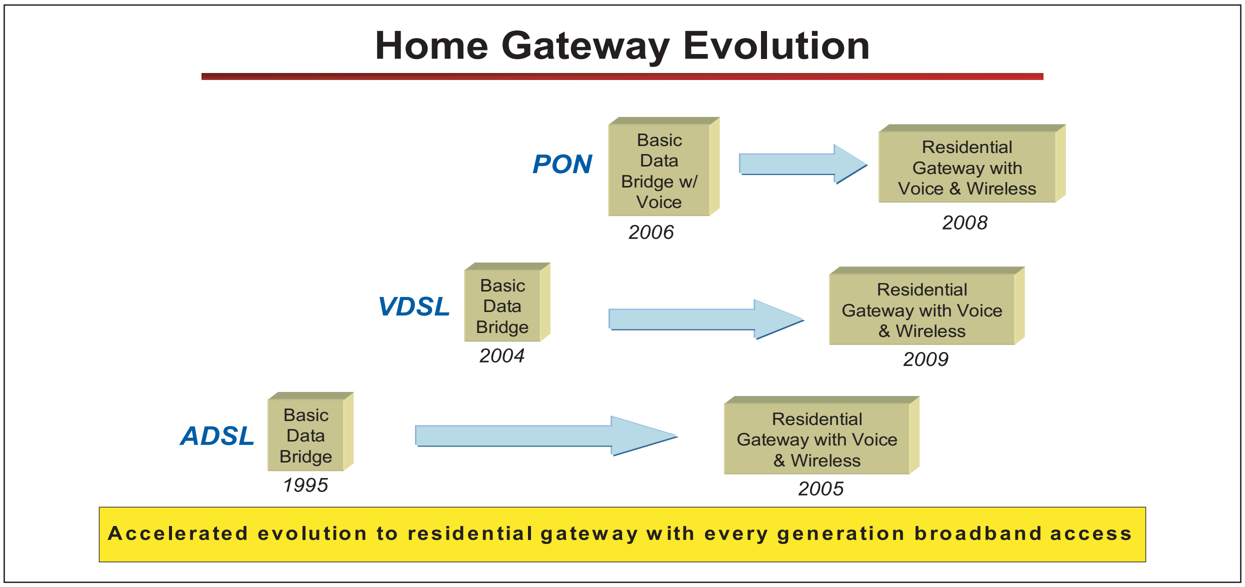
Roadblocks to Indoor Installations

1. Running Fiber into the House: Some carriers see this requirement as a fundamental bottleneck to indoor installations. However, Asian deployments have shown that this is not a big problem since most of the deployments are in multi-family buildings rather than single family dwellings.
2. Terminating Voice Outside of the House: In the United States, this requirement is seen as a major hurdle to indoor installations. Current FCC regulations entail terminating the voice inside the house and then running it back outside of the house for the basic telephony access (www.fcc.gov/oet/info/rules/). This will also impact access for Metallic Loop Testing (MLT).
3. Software Security: Since the integrated gateway will have carrier owned software sitting alongside software that the user may have installed, there are some concerns about the software security of this box. But, this issue is true for all DSL deployments. Carriers are tackling this problem with DSLHome and Universal Plug and Play (UPnP™) standards.
4. Network Management Migration: In the current deployment model, the outdoor NID is managed by the Optical Line Terminator (OLT) using OMCI. The indoor gateway/router is managed by an Asynchronous Communications Server (ACS) in the central office. Thus, the PON network management is separate from the applications network management. Once the NID and the Gateway (GW) are integrated, the carriers will need to merge these two different management entities inside the central office. However, as previously mentioned, this has already been done in the case of the DSL network.

Trends in the Access Market

The overwhelming direction in access markets like cable, Asymmetric Digital Subscriber Line (ADSL) and Very High Speed Digital Subscriber Line (VDSL), is to integrate more functionality. The U.S. cable industry started with outdoor installation before moving the box inside the house. With indoor installation, upgraded modems could be shipped directly to the customer instead of sending expensive technicians to handle that task. So far, the cable industry has stayed away from integrating the gateway functionalities into the cable modems, but there is work ongoing in that direction. The DSL sector, on the other hand, has clearly embraced the self-installation approach, and the data only initial deployments have been replaced by the integrated DSL gateways in the ADSL mass deployments to offer voice services and integrate wireless functionality in a single box. Cost and minimizing technician deployments are the clear drivers for this trend. Wireless and voice integration are now mainstream for both ADSL and VDSL deployments. Once a gateway has been installed in a house, it is difficult for carriers to step back to a data-only bridge that enables only internet access. The customer expects more. This evolution from a basic bridge to an integrated in home gateway has accelerated as the industry has moved from one access technology to the next, as shown in Figure 2.

Figure 2. Broadband Access Home Deployment Evolution



GPON: The "Gateway" PON

Even though the deployment models are currently fragmented and diverse, the overwhelming cost benefits of moving the FTTH deployments to indoor deployments will lead to a migration from data only ONU boxes to a fully integrated gateway, which is similar to what has happened in the ADSL and VDSL markets. Europe and the rest of the world will lead this integration, followed by North America. Fiber technology will continue to develop, and PON self-installation will soon be a reality. Carriers and Original Equipment Manufacturers (OEMs) will be able to leverage their existing gateway software stacks on their new, fiber based deployments, and semiconductor companies will continue to integrate more and more features into the SoC, which will be required for the digital home.

As the PON market moves to an indoor Gateway ONU, GPON as a technology is very well suited to enable this transition. GPON was developed in the ITU standards process with significant input from contributions worldwide from Service Providers, Systems Vendors, and Silicon Providers. The Full Service Access Network (FSAN) community has worked hard on a worldwide Interoperable standard and regularly conducts interop and test events. These events accelerate the deployment of a truly interoperable standard, which enables carriers to choose vendors based on cost and performance. This is one reason why the number of carriers trialing this technology continues to grow. Some of the advantages of the GPON technology to enable the transition to ubiquitous GPON gateway deployments are as follows:

1. Worldwide Interoperable ITU specification (G.984), which is available to everyone with a well published and well understood test specification that allows systems and semiconductor vendors to test their solution.
2. QoS-centric performance requirements: The Carrier-members of FSAN have put together a set of requirements which are clearly aimed at higher bandwidth, QoS-intensive applications such an IPTV and Multimedia-On-Demand, and it has led to GPON SoC designs that clearly focus on the increased QoS requirements of the application.
3. Higher Quality Optical Network: The GPON ODN (Class B+) was designed for longer distance (20 km), higher split ratio (64 going to 128), and higher bandwidth (2.4 Gb/s down, 1.2 Gb/s up). It has an increased loss budget to enable higher split ratios and longer distances to enable cost effective FTTH deployments from the CO.
4. Next Generation PON: The GPON standard recognizes that this is just the beginning for fiber-based deployment, and the band plan is designed to allow for adding even more QoS intensive applications by adding wavelengths to the basic GPON solution. The FSAN is currently very active in defining a scalable next generation PON (NG-PON) solution that can be added as an overlay solution to the current 1310/1490 GPON standard using WDM techniques.
5. Lower power dissipation: GPON's ability to support higher split ratios enables a greener (lower power) solution for next generation access networks compared to EPON and other DSL and Ethernet technologies

In anticipation of this next generation of GPON ONUs being deployed, Conexant has announced the first integrated voice gateway chip in the GPON market, as well as the highest performing GPON NID with integrated voice. The CX95202-11Z (Xenon-IIIG) GPON gateway chip provides the following benefits to key system OEMs and carriers looking to deploy GPON ONU gateways:

1. Full line rate (2.4 Gb/s down and 1.25 Gb/s up) bridging and IP multicasting capabilities to enable IP video applications.
2. Up to four channels of integrated VoIP, including support for G.711, G.726, G.729 A/B and T.38 fax demodulator.
3. Layer 3 routing capabilities such as Network Address Port Translation (NAPT), firewall and Dynamic Host Configuration Protocol (DHCP), with an integrated hardware accelerator engine for Layer 3 functions to enhance Layer 3 gateway performance.
4. Deep classification and filtering capabilities at full line rate (2.4 Gb/s) for 64 byte packets.
5. Shared software architecture with ADSL and VDSL gateway chipsets, which enables fastest time to market for FTTH based GPON gateway deployments.

Ubiquitous deployment of FTTH services will require a very cost effective GPON ONT device that is highly integrated and provides all the services needed for deployment of triple-play services to the home. This will drive the deployment model to indoor ONTs to begin with and the integrated GPON gateway ONTs to follow. Conexant is well-positioned to meet this need with its Xenon-based family of PON products.