Broadband residential services over fiber: technologies, services and status - AT&T U-Verse

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ABSTRACT

Today the highest rate connection to the Internet is available through the fiber technologies. This paper aims to introduce the fiber through its technologies, standards, services and status. At first it presents the fiber technology in general then it focuses on its use on telecommunications and networking. The first part of the main body would introduce technologies and standards of broadband access over fiber. It would include the PON types and standards and components. The second part of the main body would discuss services provided by the American telecommunication corporation AT&T, also known at U-Verse. U-verse status and deployment in the US would be shown.

INTRODUCTION

Optical fiber is a pure glass fiber, which is used as a waveguide. In communication the primary function of the fiber is to transmit light between the two ends of the fiber over longer distance and higher bandwidth than others communication systems. By using technologies such as Wavelength Division multiplexing a single fiber is able to carry many different channels transmitted through different wavelength. A record has been established in France, on a single 7000km fiber 155 channels have been carried, each channel was transmitting 100Gbit/s.

Due to its performance the fiber has been deployed widely. In the USA, AT&T started deploying the fiber in the beginning of 2001. Nowadays AT&T has established an important optic network offering a wide range of services under the name of AT&T U-Verse. Today the Internet access is featured by high bit rates, high quality internet and cable services.
1. Broadband Access over fiber technologies and standards

A. PON architecture

A Passive Optical Network (PON) is a point to multipoint fiber to the premises network architecture using optical splitters to permit a single optical fiber to provide broadband access to multiple premises. A PON architecture include several components: OLT, ODN, ONU.

The Optical Line Termination (OLT) situated in the central office performs two functions: the conversion between electrical signals and the optical fiber and the multiplexing coordination. The Optical Distribution Network includes the fibers and splitters; it is situated between the OLT and the ONUs. The Optical Network Unit is situated at the customer's premise and it performs the conversion of optical signals toward electrical signals. At the end ONUs are bridged to dwellers promise device using technologies such as Ethernet over twisted pair or DSL. At the beginning OLT provides the interface between PON and services providers, it includes IP traffic, SONET, SDH, ATM UNI.

Thanks to wavelength division multiplexing PONs use one wavelength for downstream traffic (1490 nm) and another for upstream traffic (1310nm). While upstream signals are multiplexed using Time Division Multiple Access downstream signals are broadcasted to the end users promises by sharing the fiber.

Figure 1- Architecture of passive optical networks

Depending on the Passive Optical Network there are different existing architectures. In fact architecture differs to another with the distance between the end of the fiber and the end user's premise. The most common architectures are the following:

- Fiber To The Node
- Fiber To The Curb
- Fiber To The Building
- Fiber To The Home

Figure 2- Fiber to the x
FTTN
This architecture is also called fiber to the cabinet because the fiber stops at a cabinet, which provides broadband access to a neighborhood. The cabinet is between 300m and 1,500m close to the area served. The cabinet connect to the network trough twisted pair or coaxial cable. This architecture provides cable broadband access or DSL access. In fact the main advantage of the FTTN is previous twisted pair or cable are still used to connect users to the cabinet. However the debit rate is low in comparison with other fiber architecture, it depends on how far is the customer to the cabinet.

Today AT&T uses FTTN architecture trough it U-Verse service to offer to consumers triple play services.

FTTC
Fiber to the curb is fairly similar to FTTN; the only difference is the cabinet is closer to the customer with the FTTC architecture. AT&T carries the largest deployment of FTTC in the USA.

FTTP
Fiber to the premise can gather the FTTB and FFTH, it is the most efficient and expensive architecture. There is a huge deployment of this architecture in Asia, especially in Japan and South Korea. These countries have decided to promote this technology as a part of their national strategy. Although AT&T offers FFTH through its U-Verse service Verizon remains the major proponent of FFTH in the USA.

U-Verse uses both FTTH and FTTN technology, depending on the area. The FTTN model is faster and cheaper to deploy than FTTH, but the copper connections to the homes sacrifices speed compared to FTTH.

Figure 3: Penetration of the FTTP in the world

B. Standards and types

1. EPON
EPON is the Ethernet Passive Optical Network; IEEE 802.3 standard defines it. Based on Ethernet technology it shows a lot of advantages: easy-to-manage connectivity to Ethernet-based, IP equipment, both at the customer premises and at the central office. Plus EPON employs a single Layer 2 network that uses IP to carry data, voice, and video.

Today it supports two configurations: symmetrical, offering 1 Gb/s in both directions and asymmetrical, offering 10Gb/s in the downstream direction and 1Gb/s in the upstream direction.
Ethernet Passive Optical Networks represents the convergence of low-cost Ethernet equipment and low-cost fiber infrastructure, it is the most widespread PON technology.

2. APON, BPON and GPON

The standard ITU-T Recommendation G983 defines both BPON and APON. APON was the first Passive Optical Network, it was primarily used on business purposes. Based on ATM it can provide different high-speed services such as Internet, voice over ATM, voice over IP and video services. APON can be symmetrical with a 155.52 Mbps in both direction or asymmetrical with a 155.52 Mbps bit rate in upstream direction and a 622.08 Mbps bit rate in downstream direction.

BPON is very similar to APON. However it proposes more services including video distribution and Ethernet access.

ITU-T Recommendation G983 defines the Gigabit-capable PON, which is an advanced version of BPON. Indeed the Gigabit Passive Optical Network standard differs from BPON and APON standards in that it achieves higher bandwidth and higher efficiency. GPON offers efficient packaging of user traffic, with frame segmentation allowing a high quality of service (QoS) for delay-sensitive voice and video communications traffic. GPON provides three Layer 2 networks: ATM for voice, Ethernet for data, and proprietary encapsulation for voice.

3. EPON versus GPON

Today GPON and EPON are in active deployment, however they present several differences which worth to be studied. In spite of the fact BPON and EPON use several different technologies both of these types present advantages and drawbacks.

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<th>Advantages</th>
<th>Drawbacks</th>
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<td>GPON</td>
<td>-Higher theoretical bandwidth</td>
<td>-Expensive</td>
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<td></td>
<td>-Encryption of the full payload</td>
<td>-Low upstream debit rate</td>
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<td></td>
<td>-Better chance of interoperability with other standards</td>
<td>-Complex</td>
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<tr>
<td>EPON</td>
<td>-Simple</td>
<td>-Difficult interoperability</td>
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<td></td>
<td>-Low cost</td>
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<td>-Benefit from the Ethernet switching</td>
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EPON is more appropriate for IP/Ethernet switching. Today more and more importance is accorded to the Internet Protocols. EPON seems to be the future main standard. AT&T uses the EPON architecture to run U-Verse.

2. AT&T Universe

A. Definition

AT&T U-Verse is a bundled service providing Internet access, television and phone services to its suscribers in various parts of the USA. U-verse use both FTTN and FTTP architectures. An optic-fiber communication is used from the network to either the premise or the neighborhood. When the fiber ends before the premise ADSL2+ or VDSL are used trough the remaining copper network to the customer's premise. The VRAD (Video Ready Access Device) is employed to provide DSL access and HD TV programming to U-Verse consumers.
B. Technologies

The most common setup for the U-Verse triple play is the FTTN architecture. From the node to the central office, the cabinet or the VRAD a full optical communication is settled. Then by using the existing copper phone lines triple play is provided to the premise. On the copper network, mostly VDSL is employed to guarantee high bit rate: 19 to 32 Mbps in the downstream direction and 2 to 5 Mbps in the upload direction. A better bit rate is available when the premise is closer to the node. The bandwidth is shared between the different services. Up to 24 Mbps are reserved for the Internet access and the VOIP (phone) and up to 7Mbps for Cable Television.

C. Services (TV, Web, Voice)

1. TV

U-Verse TV is delivered through the IPTV technology, using MPEG-4 AVC encoding the video is better compressed than with a MPEG-2 compressing system. Channels broadcasting employs the IP multicast method to provide channels to each consumer through a single stream. Oppositely we get a unicast IP method to provide video on demand to a single premise at a particular moment. The U-verse TV doesn't carry all subscribed channels at the same time, up to 4 streams can be supported by U-Verse TV at the same time. U-Verse TV contract include a HD ready TV receiver which enable several features:

- 720p High Definition or 1080i High Definition
- Interactive program guide enabling channels search and rating
- Pause, play, replay or record live TV
- VOD
- 390 channels available including 155 HD channels

Two different accesses can be settled for the TV access. Firstly if U-Verse is delivered through the phone line or broadband port then TV is delivered from the residential gateway to the set-top-box (HD ready TV receiver) through the coax cable. Secondly if U-Verse is directly delivered to the premise through a coax cable then this latter is split between the set-top-box (for the TV access) and the gateway.
2. Web

Internet services are provided to devices connected to the residential gateway, the DSL modem or the on-promises Ethernet cabling. The communication company offers different rates:

![Figure-7- Rates of Internet provided by AT&T U-Verse](image)

The residential gateway includes 4 Ethernet ports for wired Internet access, however a unlimited number of devices (camera, phone, computer, TV, computers...) can be connected wirelessly to the residential gateway. Besides the AT&T HomePNA device (residential gateway) offer a large number of features:

- Internet security suite powered by McAfee including a firewall, spyware and anti virus protection. A anti-spam features permit to separate junk mail to genuine messages
- A site advisor is also included to prevent and warn consumers to online danger (fraud, identity steals...)
- DEA e-mail addressing management. Disposable E-mail Addressing aims to set up a new, unique e-mail address for every contact, then you can selectively disable a disposable address as soon as you get spam through it, but continue using all other aliases
- Pop-up catcher is used to prevent annoying pop-up ads
- Parental Control

3. Voice

AT&T U-Verse voice is Voice Over IP service offered by AT&T. U-Verse offers several interesting features:

- Customers subscribing to both AT&T U-verse TV and Voice are provided features such as call history and Click to Call, which displays missed and answered calls on the customer's TV.
- Call Forwarding, Busy Call Forwarding, Call History, Call Screening, Call Transfer, Caller ID Blocking, Click to Call, International Call Blocking, Locate Me...

D. Status

AT&T is currently the largest fixed telephony provider in the USA. Its service mark, U-Verse, has encouraging current status. For the fifth consecutive quarter U-verse has driven the growth in wireline consumer revenues. The last quarter (ended 10/15/2011) recorded a 176,000 gain of consumers to reach 3.6million U-Verse consumers. During this same quarter AT&T noticed the average revenue per user for U-Verse triple play increased up to 5.7 percent to reach $170.

The deployment of the U-Verse's offer has reached almost 30 million living units. Combining bundled satellite and U-Verse's customers AT&T deliver services to 5.4 million people. AT&T has matched 22.6% of accessible living units.

The number of U-Verse Internet consumers still growing. The company delivers a high-speed Internet access to 4.6 millions subscribers.
The fiber has been able to offer awesome features and improvements into the Internet world. Today the optical fiber is mastered and used to offer the best Internet access, which have never been provided before. Plus the triple package has also been a revolution in the telecommunications and network field. Today thousand of consumers received a broadband access furnishing TV, phone and high speed Internet. Today several companies compete with AT&T such as Verizon. Verizon offer better and more expensive services than the U-Verse bundle.

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