

# Verizon's Fiber-To-The-Premises and Lessons Learned

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**Abstract:** This paper covers examples of lessons learned during the five years of Verizon's FiOS and the need to continually be evolving in product and service offering to meet customer's needs.

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## 1. Introduction

Verizon started deploying FiOS in Keller Texas in June 2004 with a POTS and Data based set of services followed the next year with our video offering in September 2005. This presentation looks at the initial network and how over the last five years Verizon has evolved in several key areas of *Cost Reduction, ONT Evolution, Network stability and availability, Increases in consumers' appetite for speed* and how these and other improvements have come together to result in a network that is well positioned to support the continuing and evolving needs of the customer in the coming years.

## 2. Increase in consumers' need for speed

Over the last several years the speeds offered and expected by broadband customers has increased with some estimates suggesting that there is a ten fold increase in speed every six years, as illustrated in Figure 1. This present trend is expected to keep increasing over time. Looking to the future one sees that there is interest in 3DTV offerings, Super and Ultra HD that will increase the expected bandwidth needs per channel. This together with the increased usage of multiple computers, Digital Video Recorders (DVRs) in any given home and the consumer need for instant access to the web to support a multitude of both work and personal needs are expected to fuel this thirst for bandwidth. These are all expected to increase the service requirements to the home to over 100Mbps-200mpbs over the coming years and even further over the longer 2-5 year timeframe.

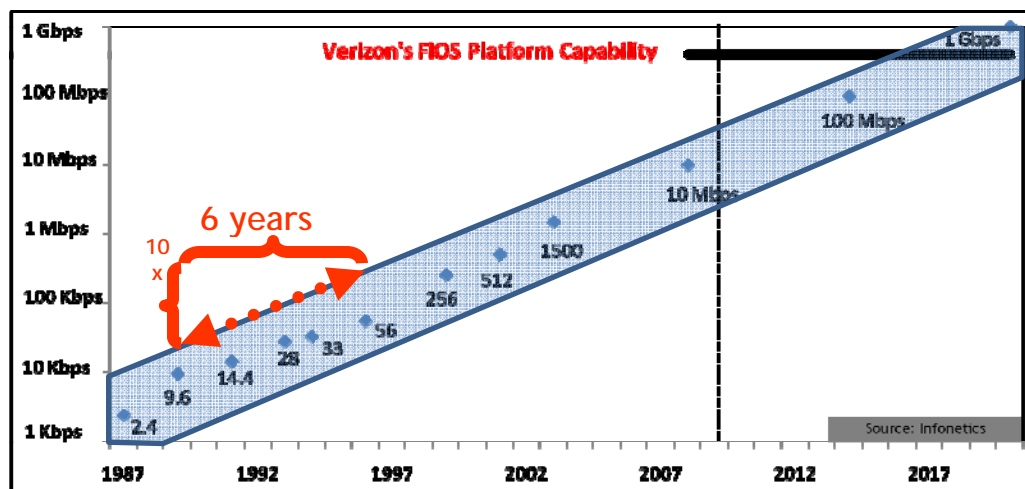


Figure 1 Increase in speed over time: Bandwidth of technology has grown at a rate of 10x every 6 years (...similar to Moore's law).

Verizon has learned through its broadband experience over the last several years that one has to adapt quickly to increasing customer's needs to increase its throughput offering. Verizon's plans are to stay ahead of customers need sand to ensure that the rest of the network beyond the Central Office (CO) is ready for the increase in customer

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service requirements. Indeed our present GPON ONTS can support 200-400mbps and higher, sufficient for many years to come.

### **3. Need for *Network Stability and Availability* to increase perceived Customer Quality**

In order to ensure that the underlying service can be maintained at a high quality there is a need to ensure that the outside plant is maintained at a high reliability level and also that the overall FTTP platform is maintained well and that issues such as *Rogue ONTs*, which can result in a single ONT interfering with other ONTs on the PON is controlled and its effects minimized. This used to be more prevalent in BPON systems but the ONTS have evolved to incorporate such items as watchdog times to ensure that the ONT does not get into an indeterminate state or when in a particular state that it can recover. In addition because issues can occur in manufacturing or during transportation or other times when the ONT may be stressed, for examples during installation, that it is important that the ONT be able to measure the power its transmitting both within and without its approved timeslots. With this information the ONT can self-police itself and determine whether it is behaving correctly in an approved manner during the time slots. This requirement becomes even more critical in GPON systems as the number of potential splits increases to sixty-four or higher and as service providers consider moving more business services onto shared PON networks and as services quality metrics become more than best effort.

On the video side when Verizon started its initial deployment the aim was to offer both analog and digital video transmission and the outside plant was designed to accommodate this and ensure a high level of quality was maintained. Where connectors were used in the plant they were chosen to be SC/APC which have a better optical return loss than flatter connectors, even in the presence of dirt on the connectors. This ensured that the OSP was more robust to reflections that might arise as the plant ages and was impervious to possible failures to terminate the connectors or clean them when re-connectorized. This becomes even more important in Verizon's outside plant where the splitters are deployed as needed.

Verizon has taken its early deployment guidelines and over the last several years has optimized the deployment and associated link budget to take advantage of improvements in connectors and adapting to the service mix.

### **4. FiOS Cost Reduction**

From the very start of Verizon's FiOS deployment, the company has been striving to deploy FTTP in a cost effective manner as possible and ensure that the quality of the network is being maintained. As part of this work Verizon has looked at introducing *Bend Insensitive Fiber* for MDU applications to reduce the cost of deploying single family units (SFU) in the living units of Multiple Dwelling apartment blocks. This ensures that the services are uniform across the FiOS footprint and similar services and throughputs can be offered in single as well as multi-family neighborhoods.

Verizon is continuing to look at means of reducing costs such as *Mechanical splicing* while maintaining angled cleaves, in MDU applications where the environment is more controlled than in the outside plant. Other methods for increasing the speed of deployment such as the use of *Verizon Advanced Terminals* (VATS) which take advantage of the flexibility of using connectorized Fiber Distribution Terminals (FDTs) and the deployment of *multi-drop fibers* in MDU locations are all at different stages of investigation or deployment to help further optimize the cost of FTTP.

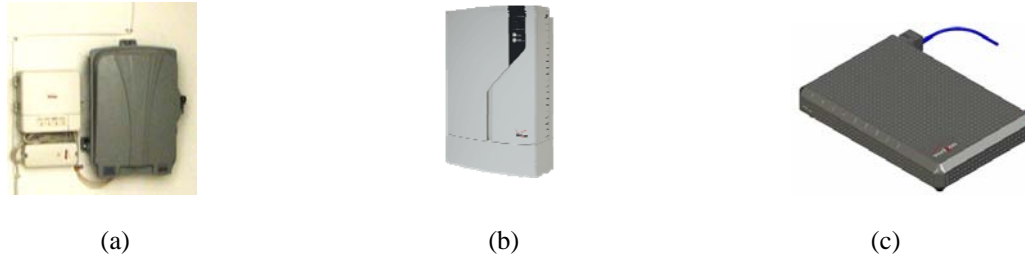
During the course of the FiOS deployment Verizon has learned that there are opportunities on product improvements as well as processes that can together result in lower overall cost of deployment.

### **5. Need for *ONT Evolution* to meet customers' and deployment need**

When Verizon started over 5 years ago in Keller Texas the number of ONTs that were available to Verizon was a single outdoor variant, shortly followed by a unit that could handle multiple customers called an MDU or common ONT. These units provided the functionality necessary to meet our initial customers and operational needs but as we installed these pieces of equipment in volume it became clear that there were operational issues such as, position of

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the coaxial cable, position of the POTS ports as well as their number, having reduced from four for the case of BPON to a requirement of only two several years later to account for what customers were looking for. Those looking for more could be handled by the use of a GPON variant called the Small Office Home Office (SOHO) ONT which had 8 POTS ports. In addition since the first introduction of FiOS the ONT, as shown in Figure 2, has gone from an industrial looking ONT that resides on the outside of someone house to a more aesthetically pleasing ONT that is more acceptable from the customers perspective and increases the options for a technician in his deployment options. Now the units can be placed in more visible living spaces.



**Figure 2 Evolution of Single Living Unit ONT. (photos not to scale)**

This has helped also in our installation times as initially when the ONTs were deployed outside they required long lengths of powering cables which increased the installation process. Over time we developed a *Just Inside ONT* which as the name suggests allowed us to move the ONT indoors and combine functionally the ONT with the Battery Backup unit and the OPSU within a common shroud. This reduced the number of separate units deployed and also took advantage of the availability of ac outlets.

In MDU living rooms where we deployed these earlier versions of ONTs the customer was excited when they were getting FiOS, but their response was somewhat muted when they saw the initial industrial looking ONTs that would be installed, so many times the ONT was relegated to less visible locations like closets. This increased install time due to the need to wire to an available ac outlet, typically outside the closet especially in older MDUs for example in Manhattan, as well as getting access to the POTS and Coax wiring outside the closet. To address this Verizon with its vendors developed the *MDU Indoor ONT* as shown in Figure 2(c) which was smaller in design, allowed the units to be placed in more visible locations and met the customers expectations of modern electronic equipment. By doing this Verizon reduced its installation time significantly.



**Figure 3 Evolution of MDU Common ONT. (pictures not to scale)**

In some cases we cannot deploy fiber all the way to the living units in MDUs. To address this Verizon and the vendors developed a unit specifically to address where we could not deploy fiber and where we would take advantage of the economies of scale from a shared ONT. As Verizon deployed these MDU ONTs it became clear that there were more floor space available than wall space in the common rooms and that the MDU take rate needed to allow us to scale better, so that when it came time for second generation units the units were redesigned to be

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more *scalable, stackable* and floor mounted so that they better met the environment that was readily available. An example is shown in Figure 3. This has allowed Verizon to increase the deployment into MDUs and take advantage of the space available.

**6. Concluding remarks**

During the last five years Verizon has learned a lot about deploying FTTP and what it takes to be successful in this arena. Having made some initial choices, the various teams kept on learning through the process and re-applied lessons learned to its different generation of products and services to meet the customer's requirements and make the platform robust to the evolving deployment scenarios. Verizon continues to develop technologies, redesigns and different ONTS for various deployment scenarios and works with its vendors closely to take steps to ensure that the platform maintains its future proofness and ensure that the FiOS platform is ready and quickly adapts to customer needs.

By being responsive to the customer needs and by developing partnerships with our vendors we have been able to quickly adapt to the market place with new products and services and addressed issues as they have arisen. Verizon sees the future as exciting with increased focus on continued service development and further cost reduction to support the continued evolution of its customers needs.

**References:**

- 1] M. Abrams, P. C. Becker, Y. Fujimoto, V. O'Byrne, and D. Piehler, "FTTP deployments in the United States and Japan- equipment choices and service provider imperatives," IEEE J. Lightwave Technol. **23**, 236-246, (2005)
- 2].Frank Effenberger, Kent McCammon and Vincent O'Byrne," Passive Optical Network Deployments in North America", Journal of Optical Networking, vol. 6, Issue 7, pp.808-818, 2007.
- 3] Joseph Finn, "PON technology in the Verizon Network", IEEE WTC, New Orleans Nov. 20-Dec. 4<sup>th</sup>, 2008.