Implementation of an Enterprise Access Network using PON

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Abstract

Enterprise networking is changing in response to technology developments and increasingly demanding environmental constraints. This paper describes how Passive Optical Networking technology, now commonly used in the telecommunications industry, can be adapted to enterprise environments. This technology can achieve significant energy and space savings, while improving manageability of an enterprise network and reducing the operational expenditure.

Introduction to Passive Optical Networking

Passive Optical Networking (PON) is a fibre-based networking technology that has been under development since the late nineties. The unique feature of this technology is the use of so-called passive optical splitters to connect concurrently a single fibre strand, originating from a head end (Optical Line Terminal or OLT), to a maximum of 32 optical endpoint devices (Optical Network Unit or ONU). PON derived its name from the passive optical splitter component. Ethernet based and Gigabit Ethernet PON has been ratified as standard IEEE standard 802.3av-2009.

Using Wavelength Division Multiplexing (WDM) techniques a PON network is capable of carrying data to and from optical endpoint devices simultaneously using a single fibre strand. The best way to think of WDM is as the light equivalent of AM radio. With AM radio you can listen to different stations by tuning your radio to a different radio frequency. Obviously, as long as the stations transmit on different frequencies they do not interfere with one another. WDM does the same using different light frequencies.

Figure 1 shows an example PON configuration, where different services are delivered to the OLT. The OLT multiplexes these services onto the single fibre strand, which connects the OLT to the splitter and the four ONUs. The user's devices are connected to the ONUs and get the various services delivered, as if they were connected directly.

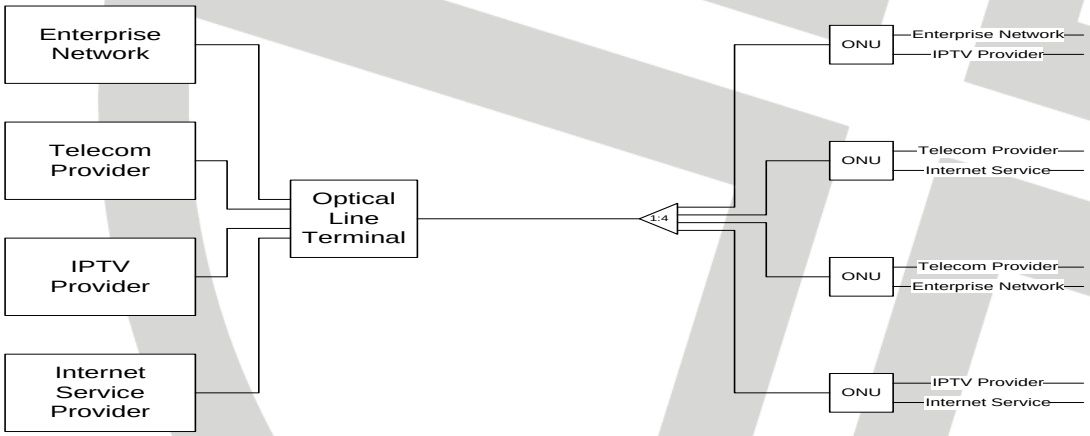

Figure 1

Similar to early Ethernet, all ONUs receive the data transmitted by the OLT. Having been configured by the OLT for certain VLANs and using Ethernet bridging techniques each ONU

only passes through data that is destined for locally connected devices. All other data is dropped avoiding security and load issues.

To send data to the ONUs and to retrieve data from the ONUs the OLT uses Time Division Multiplexing (TDM) techniques, i.e. it sends data to the ONUs and queries the ONUs for data to be retrieved on a round-robin basis. The frequency with which data is sent to an ONU and the frequency with which an ONU is queried is a function of the bandwidth configured to be available to an ONU. Therefore, Quality of Service management (QoS) is inherent to PON.

Introduction to Enterprise Access Networks

Large enterprises implement data networks that are based on a hierarchy of switches. Figure 2 shows a simplified example of an enterprise network.

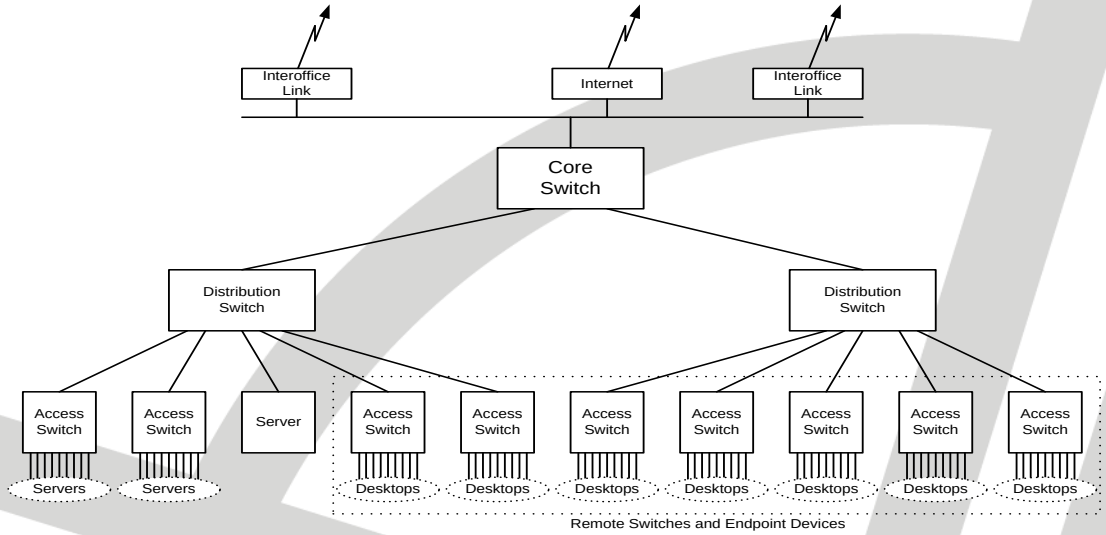

Figure 2

In a traditional enterprise network there are typically core switches and distribution switches, which are normally located in a data centre. These switches provide connectivity between access switches and servers in the data centre as well as connectivity from the data centre to the remote access switches. The remote access switches in turn provide connectivity to end user devices and are typically located in data risers throughout the building, in close proximity to the end user as cable lengths are limited. Consequently, the number of remote access switches is determined not only by the total number of data ports required, but also by floor layouts and distance to the work spaces.

Replacing the Distributed Access Switches with a PON infrastructure

When analysing the way in which networks are being used by end user computing devices in an enterprise environment, one observes that there is rarely an end user computing device which sustains a network load of 1Gb/s or even 100 Mb/s. Installing networks that can sustain these high speeds thus seems costly and unnecessary.

PON allows for the installation of a more cost-effective network that offers a sustained QoS guaranteed throughput. In most cases a throughput of 50Mb/s is more than adequate, while network bandwidth can be increased on demand for those applications that require it. Figure 3 shows how a PON based network could be integrated within an enterprise network environment, replacing all remote access switches by a combination of splitters and ONUs.

Advantages of a PON Network in the Access Layer

There are significant advantages to using PON technology in enterprise network environments:

1. All remote access switches can be replaced with passive infrastructure and ONUs, thereby reducing significantly capital and operational expenditure.
2. There are no practical length limitations. PON fibre can be installed over distances of at least 20 km making it eminently suitable for campus environments and high rise buildings.

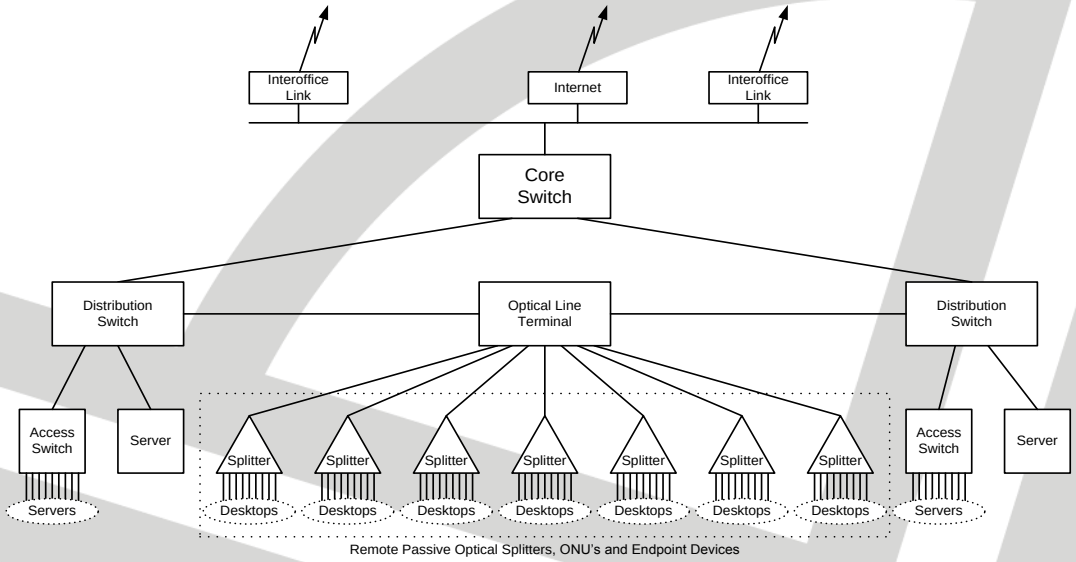

Figure 3

3. Data riser requirements are significantly reduced and data risers may be omitted entirely in some cases.
4. Any copper runs between ONUs and end user devices are short as ONUs can be installed close to or in the user's workspace.
5. ONUs can be installed when required, only giving rise to capital and operational expenditure once a work space is occupied.
6. OLTs and ONUs are centrally managed and monitored, giving the network team centralised fine grained control over the use of the access network while requiring very low staffing levels.
7. The minimum bandwidth to the distribution switch is guaranteed, thus making it impossible for a user to be adversely impacted by any type of network saturation.

2024Sight and PON at the Arcapita Bank Headquarters

Careful planning of a PON network installation is a pre-condition for a successful implementation. 2024Sight has experience with the design and implementation of PON networks in an enterprise environment. Late 2010, planned by 2024Sight staff, the first PON based access network in an enterprise network has become operational. The installation at the Arcapita Bank headquarters in Bahrain supports all data access from workspaces to shared server and data resources in the data centre, while also backhauling the WiFi networks and all data required to manage and control the building itself.

Related Publications

A. Hofland, “Unified Physical Networking in Real Estate and Infrastructure Developments”, 2024Sight White Paper, January 2011

A. Hofland, “Combining Real Time and Enterprise Networking on a Single Infrastructure”, 2024Sight White Paper, January 2011

About 2024Sight

2024Sight is a Vienna-based consultancy that focusses on specifying solutions to IT and IT-related problems that at first glance do not seem to have any obvious or elegant solution. In the recent past 2024Sight has designed and managed the implementation of a PON-based, converged building and enterprise access network for Arcapita Bank B.S.C. and the Riffa Views International School. 2024Sight also specified a high-density data centre using several innovative techniques, such as oxygen reduction to prevent fire and rack-based cooling. Subsequently, it managed and supervised the data centre’s construction, testing and commissioning. Further, 2024Sight managed the deployment of a long-haul telecommunications fibre network connecting the United Arab Emirates, Saudi Arabia and Bahrain.

About the Author

Anton Hofland has more than 20 years’ experience in IT, IT infrastructure and enterprise networking, gained mostly in the financial industry. Before establishing 2024Sight he was the Head of IT for Arcapita Bank in Bahrain. Previously he has worked for several major financial institutions in the City of London. He has also worked in the area of telecommunications regulation and has experience in the telecommunications industry. Anton holds a M.Sc. in mathematics and computer science from Delft University, Netherlands.