Combining Real Time and Enterprise Networking on a Single Infrastructure

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Abstract

Passive Optical Networking (PON) technology, when configured well, is uniquely suited to support concurrently on a single infrastructure two styles of network communication that are normally incompatible, i.e. real time communication and enterprise network communication. A PON based infrastructure guarantees the delivery of time critical data and, in parallel, the delivery of enterprise networking services, whilst maintaining strict data segregation between different types of traffic passing through the PON.

A real world application of PON is presented in which the two communication styles have been successfully combined into a single infrastructure.

Network Communication Styles

In general two different styles of network communication can be identified, i.e.:

1. The ***real time communication style*** in which devices send a small amount of data at regular intervals. The timely delivery of this data to its destination is critical for the success of the applications. Examples of applications that require this style of communication are:
    a. Trading platforms as used on many trading floors of financial organisations;
    b. Process control systems as found in the power and water industry as well as any chemical and industrial production facilities;
    c. Building and facility management systems as installed in any modern real estate developments such as office towers and hospitals.

2. The ***enterprise network communication style*** in which at any one time large amounts of data are transferred by only a relatively small number of devices. Bandwidth availability and sustainable throughput are the major issues in an enterprise networking environment. However, because all enterprise networking devices are inherently capable of dealing with time delay, timely delivery is of lesser importance.

Obviously, there are installations that require both styles of communication to be accommodated concurrently. If implemented on the most common networking technology in use today, i.e. standard Ethernet, there is a significant risk that at times the real time traffic will be delayed or even be lost due to high enterprise traffic volumes.

Traditional Approach – Separate Networks for Each Communication Style

IT staff at the world's leading financial organisations, responsible for the technical implementation of the trade floors, have had to deal with the challenge of accommodating the two different communication styles into a single platform for the last two decades. Typically, they decided to segregate the traffic onto two separate Ethernet networks, i.e. one network for the real time market data and one network for enterprise style activities such as printing and access to file shares, software updates, e-mail and the web.

By implementing this segregation the real time data flows unimpeded, regardless of the load on the enterprise side. The Quality of Service, delivered by the real time market data network, is very tightly managed as timely delivery of the most up-to-date market data is essential for any trade floor. If Ethernet is used to satisfy all requirements it is necessary to implement two separate networks. Figure 1 shows a typical trade floor installation.

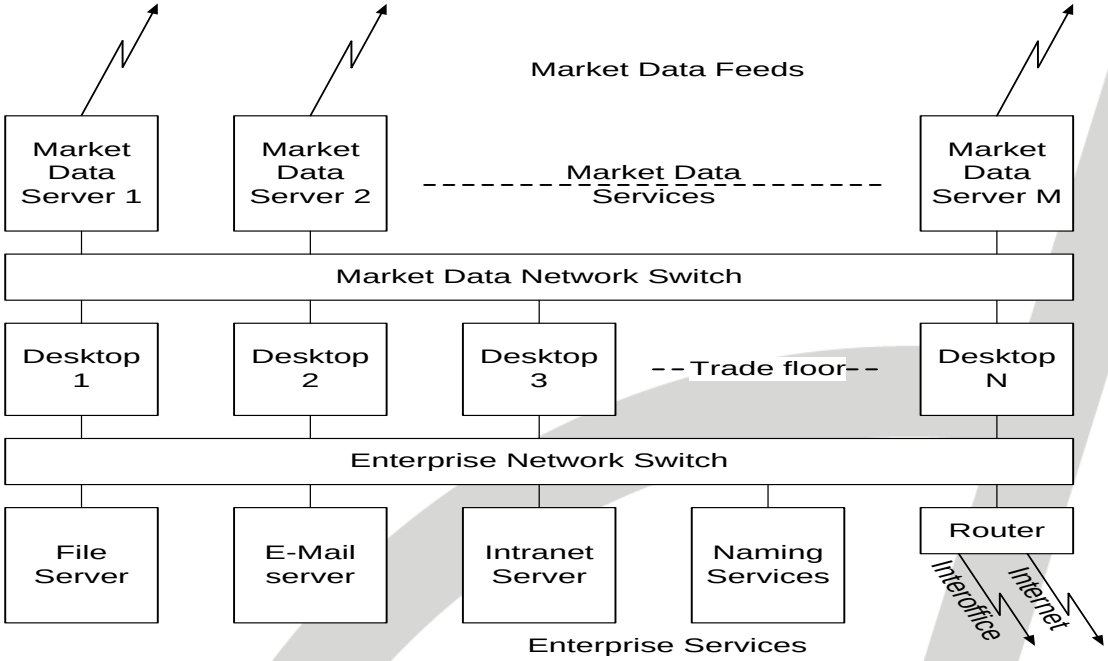

Figure 1

One Network Solution based on Passive Optical Networking

The late 90's saw the development of a new fibre based networking technology, namely Passive Optical Networking (PON). The PON standards have been enshrined in IEEE standard 802.3av-2009. The main characteristic of PON is the use of passive optical splitters to implement point-to-multi-point communications. I.e. a single fibre connected to the PON head end (known as an Optical Line Terminal or OLT) reaches up to 32 different optical end points (known as Optical Network Units or ONUs) by means of the splitters. To implement a parallel send and a return path on the same fibre strand PON uses Wavelength Division Multiplexing (WDM) techniques, the light equivalent of AM radio. However, it is the splitter that gives rise to a very interesting characteristic of PON and the Gigabit Ethernet version of PON in particular, which is the focus of the remainder of this paper.

Because of the splitter and PON's capability to connect to 32 optical endpoints in parallel there are potentially 32 sources of data (the ONUs) that will be trying to send back data to the OLT at the same time. To avoid transmission collisions on the return path, which would lead to loss of data, PON uses Time Division Multiplexing (TDM) techniques. The OLT in a PON allocates periodically certain transmission time slots to certain ONUs, thereby implicitly creating a QoS capability. In practice PON uses TDM on both, the send and return paths, thereby creating a QoS capability that can manage both directions.

To ensure that data in a PON network remains segregated, PON adopted Virtual LAN (VLAN) tagging as defined in IEEE standard 802.1Q. Each port on an ONU is configured by the OLT to be member of a particular VLAN. Within the PON system the packets moved around are tagged with a VLAN id. Before the packet leaves the ONU the VLAN tag is removed and is therefore not visible to the end user device. At the OLT side, either OLT or a VLAN enabled router can perform the necessary action of adding and removing VLAN tags, thus rendering the use of VLANs completely transparent for end user computing devices. Figure 2 shows an example of this configuration.

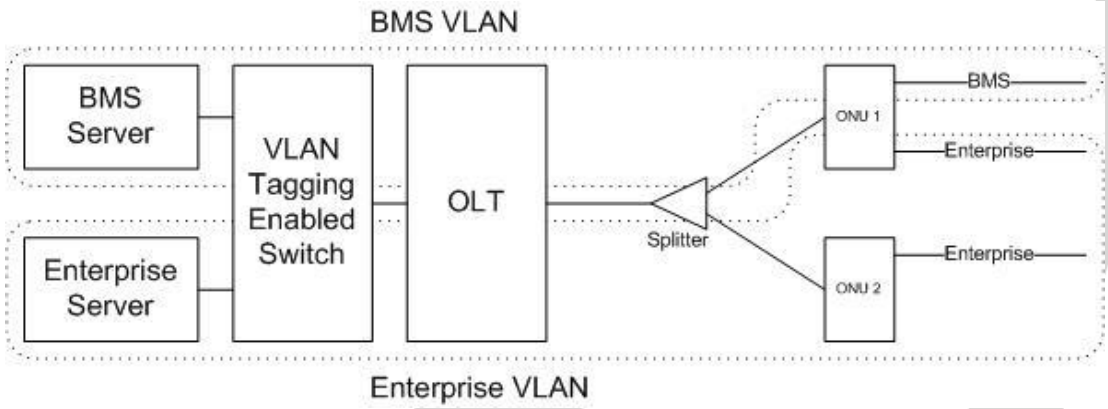

Figure 2

Unified Physical Networks and PON

In conclusion, the two differentiating characteristics of PON, i.e. QoS through TDM and the use of VLANs, enable a PON environment, when configured well, to combine the two styles of communications into a single infrastructure. This infrastructure guarantees data segregation, the delivery of time critical data and the delivery of enterprise networking services.

Further, a PON network supports operations of ONUs that are up to 20 fibre km away from the OLT, giving PON a reach that is hard to match. It is therefore eminently suitable for large infrastructure and real estate developments.

A first realisation of a Unified Physical Networking Infrastructure (UPI) based on PON went live in the Arcapita Headquarters building in Bahrain in late 2010. The network is used concurrently for both real time data required by the various building systems as well as the enterprise data required by the bank for its day-to-day operation.

Implementing a PON network has enabled Arcapita to implement a single cabling system, resulting in significant space and operational expenditure savings. For a full description of Unified Physical Infrastructures in Real Estate and Infrastructure Developments please refer to the related publications listed below. The PON UPI at the Arcapita Headquarters was conceived and the implementation was supervised by staff now working for 2024Sight.

Related Publications

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

A Hofland, “Implementation of an Enterprise Access Network using PON”, 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.