E-PON 기반 데이터 및 TDM 전달을 위한 방안

(Scheme for transmitting Data and TDM based on E-PON)

진걸°, 박천관
Jin Geol°, Chun Kwan Park

<요 약>

본 논문은 E-PON 시스템을 통하여 데이터 및 TDM 신호를 전달하기 위한 방안이다. 저가의 이더넷 기술과 광 인프라를 결합한 E-PON 기술은 차세대 액세스 네트워크의 솔루션으로 등장하였다. E-PON의 전송 속도는 1Gbps이며, 다운스트림과 업스트림인 양방향에 대하여 대칭적이다. 따라서 광 IP 이더넷 네트워크 간단한 네트워크 구조, 효율적인 운용, 그리고 낮은 유지비용을 통하여 비용을 상당히 절약할 수 있다. 이와 같은 E-PON 시스템에 TDMoIP(Time Division Multiplexing over Internet Protocol) 모듈을 첨가하고 QoS 제어 기능을 구현함으로써, 이 시스템은 데이터 및 TDM 서비스를 효율적으로 제공할 수 있다.

<Abstract>

This paper addresses the scheme for transmitting Data and TDM signals based on E-PON. E-PON technology, that combines low-cost Ethernet technology and optical fiber infra-structure, has been appeared as a solution of next generation access network. The transmission speed of E-PON is 1Gbps and symmetric in both direction, such as downstream and upstream. Therefore, it is possible to save the cost through sample network architecture, efficient operation, and low maintenance cost of optical IP Ethernet network. By adding TDMoIP(Time Division Multiplexing over Internet Protocol) module to this E-PON system, and implementing QoS(Quality of Service) control function, this system can provide data and TDM service efficiently.

1. Introduction

The future information communication era will be presented as ubiquitous era exchanging high-speed multimedia services, such as voice and data convergence, communication and broadcasting conference, and home network. In ubiquitous era, the highlighting infrastructure technology to transmit high-speed multimedia data efficiently is FTTH technology. FTTH is technology that can establish optic communication network up to customer premise site ultimately. By providing each home the capacity of 100Mbps ~ a few Gbps, it can provide the united high-quality multimedia services. Especially, as PON provides optical customer network, it can simplify the complicated customer network environment, such as phone line, cable TV, and other cabling networks. Through these, PON can provide triple play service that supports voice, data, and broadcasting in united one.

In 1980s, some companies adapted the network based on TDM. But these networks are migrated into IP network. So, they want to implement TDM over IP/Ethernet ones through E-PON system based on IP/Ethernet technologies.

Therefore, This paper addresses the scheme for transmitting Data and TDM services based on E-PON. E-PON technology, that combines low-cost Ethernet technology and optical fiber infra-structure, has been appeared as a solution of next generation access network. The transmission speed of E-PON is 1Gbps and symmetric in both direction, such as downstream and upstream. Therefore, it is possible to save the cost

through sample network architecture, efficient operation, and low maintenance cost of optical IP Ethernet network. By adding TDMoIP(Time Division Multiplexing over Internet Protocol) module to this E-PON system, and implementing QoS(Quality of Service) control function, this system can provide data and TDM service efficiently.

2. E-PON System Architecture

IEEE802.3 standard defines two basic configurations of Ethernet network. One is the method that be configured on shared medium using CSMA/CD protocol, another is the one that stations can be connected to through switch using full duplex point-to-point link. E-PON is the combination of above two methods shown in figure 1. In downstream, OLU broadcasts a packet to many ONUs, and then the destination ONU extracts the packet based on MAC address. In upstream, because of the direction in splitter, a data frame from any ONU is arrived at OLT and not ONU. Therefore, the operation of E-PON is similar to point-to-point architecture. But contrary to strict point-to-point, the data frames from different ONUs in E-PON can be conflicted. So in upstream, ONUs must have the arbitration mechanism to avert the collision and share the optical channel capacity fairly.

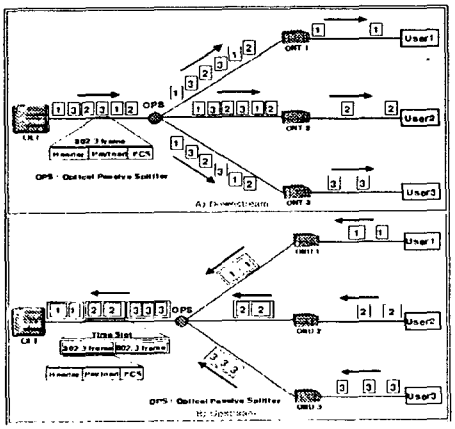

Figure 1. Traffic flow in E-PON

In figure 1-b), all ONU's synchronize the common standard time, and then the time slot is assigned to each ONU. Each time slot can delivery many Ethernet frames. ONU will buffer the frames received from subscribers until its own time slot is arrived at. When its own frame is arrived at, the ONU bursts all frames at full channel speed. When there are no frames in buffer to fill the entire time slots, the ONU transmits 10bits idle characteristics. There are the static assigning method (TDMA) and the dynamic adaptive method based on the instantaneous queue length of all ONUs (statistics multiplexing) in time slot assigning methods.

3. The Architecture for Data and TDM service

To provide data and TDM services through E-PON. TDMoIP Module must be added to the existing E-PON. E-PON module must support E-PON interfaces based on IEEE 802.3ah and gigabit uplink interfaces. TDMoIP module converts T1/E1 TDM traffic to IP packets or reverse. And video overlay module converting CATV and digital broadcasting RF signal to 1550nm wavelength. Figure 2 shows OLT system for supporting data and TDM service. This system has the maximum 8Gbps bandwidth(expandable up to 12Gbps) for data and TDM traffic. Maximum 6Gbps bandwidth can be used for data traffic and up to 2Gbps bandwidth can be used for TDM traffic. And this can support many T1/E1 links for the transparent connection to multiple ONUs and the voice service based on V5.2 interface.

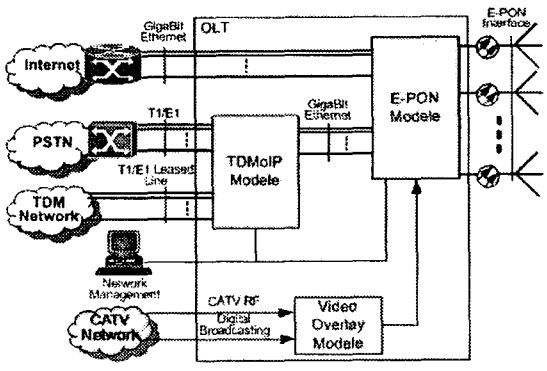

Figure 2. OLT system configuration

Figure 3 shows ONU system for supporting data and TDM service. E-PON ONU module is connected to OLT system through single mode fiber and transmits/receives up to 200Mbps Ethernet between OLT and ONU. TDMoIP module converts T1/E1 TDM traffic to IP packets. Ethernet switch distributes Ethernet traffic to external Ethernet interfaces, such as

xDSL DSLAM and wires LAN APs. E-PON ONU module supports two 100Base-T interfaces(Can allocate up to 200Mbps bandwidth); one for TDMoIP module and one for internet service including external Ethernet, xDSL and wireless LAN. TDMoIP module supports up to 16 T1/E1 links.

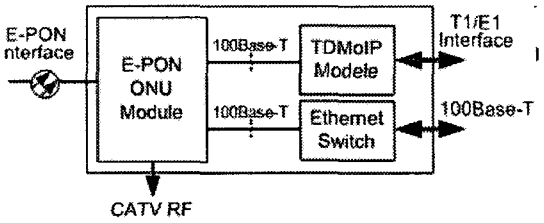

Figure 3. ONU system configuration

4. Design of E-PON system for data and TDM signal

OLT system of E-PON performs OLT operation, and the terminating function for ONU or ONU. Gigabit Ethernet Switching Module performs uplink and control function. It has 1000Base-Tx and 1000Base-Fx interfaces for uplink. And it supports link aggregation function to supply the function for increasing bandwidth. This module includes Gigabit Ethernet switch that supports L2/L3 switching function. It has a few Gigabit Ethernet ports for uplink port, and these ports can be used for 1000Base-Tx.

E-PON line card supports E-PON interfaces, and is connected to Gigabit Ethernet Switching Module using 1000Base-Tx signal in backplane. Processor built-in in E-PON chip of E-PON line card is assigned to the private IP address for the appropriate slot location, and communicates with main processor in UDP message. And processor built-in in E-PON chip is connected to main processor through 100Mbps Ethernet interface for management, and then exchanges the control message with that processor. And E-PON line card supports the control path for control and statue/statistics information monitoring of all ONUs connected to link. Each E-PON chip provides RS-232C interface for parameter setting and status monitoring. And this card supports 100Mbps Ethernet port for local management to test card itself.

TDMoIP line card accommodates many T1/E1 interfaces. This card converts T1/E1 signal into Ethernet frame. and then sends the frames to Gigabit Ethernet Switching Module. In reverse operation, this card receives Ethernet frame from the module, and then converts that frame to T1/E1 signal.

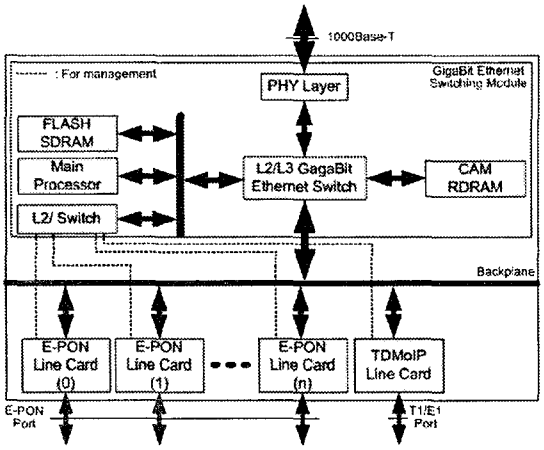

Figure 4. OLT architecture in E-PON

ONU board has all functions defined in IEEE802.3ah standard through E-PON MAC chip and then performs TDMoIP function. This board operates as multi-port bridge between IEEE802.3ah E-PON MAC and two 10/100Base-T MACs. Each 10/100Base-T MAC has unique LLID (Logical Link IDentifier) based on its own MAC address. Each ONU port appears as separate point-to-point link through E-PON emulation layer in E-PON line card(OLT). E-PON MAC chip of the card also supports DBA (Dynamic Bandwidth Allocation), traffic shaping, QoS, VLAN tagging, and encapsulation function. ONU is subscriber equipment of E-PON network (CPE : Customer Premise Device), and ONU converts the incoming optical PON traffics into phone, T1/E1, and 10/100Mbps Ethernet service for end user.

TDMoIP processor receives Ethernet frame from E-PON ONU MAC, and converts it into T1/E1 signal, and then sends it signal to T1/E1 interface. In reverse operation, this processor receives T1/E1 signal from T1/E1 interface, and converts it Ethernet frame, and then sends the frame to OLT.

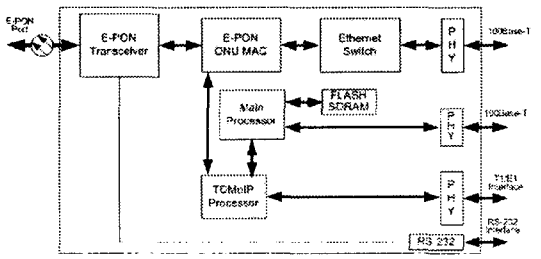

Figure 5. ONU architecture in E-PON

5. conclusion

In this paper, we addresses the scheme to tramsfer both Ethernet frame and T1/E1 TDM signals by adding TDMoIP technology to E-PON. For this, we design the interface board to convert T1/E1 signal to Ethernet frame in OLT and ONU. This system can provide both data service and T1/E1 leased line service based on E-PON, and then can save the cost of network installation. And if the new access network must be installed, it is possible to save the cost and transit it to NGN (Nest Generation Network) based on IP by using E-PON system having TDM transmission function.

In future, we will use QoS control functions to guarantee QoS for all services, and then verify the performance.

[reference]

[1] IEEE P802.3ah task force home page : http://www.ieee802.org/3/efm

[2] IEEE 802.3ah EFM Task Force P2MP (EPON) Baseline Proposals, http://www.ieee802.org/3/efm/baseline/p2mpbaseline.html

[3] Glen Kramer, Ethernet Passive Optical Networks", McGraw-Hill, 2005.

[4] Gerry Pesavento and Mark Kelsey, Gigabit Ethernet Passive Optical Networks, Alloptic White Paper, 2001.

[5] Glen Kramer and Gerry Pesavento, Ethernet Passive Optical Network (EPON): Building a Next-Generation Optical Access Network, IEEE Commun. Magazine, Feb. 2002, pp.66-73.

[6] http://www.iec.org Tutorials : Ethernet Passive Optical Networks WebProForm.

[7] Tang Shan; Ji Yang; Cheng Sheng, EPON upstream multiple access scheme, Info-tech and Info-net, 2001. Proceedings. ICII 2001 - Beijing. 2001 International Conferences on. Volume 2. 29 Oct.-1 Nov. 2001 Page(s):273 - 278 vol.2.

[8] Wong, E.; Chang-Joon Chae, CSMA/CD-based Ethernet over passive optical network for delivery of voice-over-IP traffic, Lasers and Electro-Optics Society, 2003. LEOS 2003. The 16th Annual Meeting of the IEEE, Volume 1,27-28 Oct. 2003 Page(s):447 - 448 vol.1.

[9] EITAN SCHWARTZ, "TDMoIP Vs. VoIP Matching Technology to Requirements", White Paper, RAD DATA COMMUNICATIONS, August, 2003.