J Korea Industr Inf Syst Res Volume 18 Number 6
http://dx.doi.org/10.9723/jksiis.2013.18.6.039

The approach for supporting synchronous Ethernet in 10G EPON†

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Abstract In recent, many countries and research institutes have been studying how to construct the high-speed subscriber access network. Task Force team of IEEE 802.3ah has accomplished the standardization of EPON which is the next generation subscriber access network. EPON doesn't still have the bandwidth enough to support the new service(e.g various multimedia service) which demands the high bandwidth. For these new multimedia services,10G EPON is the next generation subscriber access network which expanded the up-down bandwidth range of 1G EPON 10 times in order to support demanding high bandwidth. We have proposed the model which can accommodate IEEE 802.1 AVB traffics smoothly in 10G EPON and suggesting the Intra-ONU scheduling model which makes this model operate effectively.

Key Words : EPON, FTTH, Subscribe Access Network, Bandwidth Allocation, QoS

1. Introduction

Recently many countries have kept studying on the methods of constructing high speed networks. So high speed network is an important indicator of national power in information society. In this society, real time demand for multimedia service based on internet is consistently increasing. For this reason, many developed countries are ongoing a number of projects for construct high speed networks. There are two types of communication network, local area network and subscriber access network. The local area network (LAN) is a computer network that interconnects computers in a limited area such as a home, school, computer laboratory, or office building using network media. The other is the subscriber access network which connects countries or local area networks with the backbone network. In order to construct a high speed communication network, all the above mentioned Local Area Network, subscriber access network and backbone network should be able to transfer at the high bandwidth.

In many developed countries, the construction of FTTH is still in the early stage due to the expenses for large scale facility investment such as the introduction of the light switch and the paving of the light cable and is approaching in various ways according to the communication environment of each country. These ways include xDSL(Digital Subscriber Line), cable modem, FTTC(Fiber-to-the-Curb/ Cabinet), FTTB(Fiber-To-The-Building) and GE/10GE (Gigabit Ethernet) technologies.

The EPON(Ethernet Passive Optical Network) which is a technology for FTTH, the final destination of this subscriber access network is the next generation subscriber access network[1][2]. The EPON based upon IEEE 802.3 Ethernet that was

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modified to support Point-to-Multipoint (P2MP) connectivity. Ethernet traffic is transported natively and all Ethernet Features are fully supported.

The EPON has been set up in many places in the world as a new alternative for subscriber access network doesn't still have enough bandwidth to support new services in the future such as the HD level IPTV which needs a high bandwidth, the Real-Time VoD(Video On Demand), video conferences, IP Video surveillance systems and online games which demand high interaction. Additionally the demand for Tripe-Play Service(Internet service, broadcast data and voice data) data is so high that the service to secure sure delay and jitter should be guarantee of its satisfaction.

The IEEE 802.03av PON standard was developed to increase the data rate of EPON systems from 1 Gbit/s to 10 Gbit/s, in keeping with the 10 Gbit/s Ethernet interface. Many protocols are shared between 10G EPON with EPON. Because It basically communicates data between OLT(Optical Line Terminator) and ONU(Optical Network Unit) using optical fibers on the physical layer as one type of FTTH, there is no weakness for distances. Moreover it can allow various multimedia services that have their strict characteristics as its MAC layer to adopt the proper bandwidth allocation algorithm.

Therefore in this paper, we propose the effective Bandwidth Allocation Algorithm in order to support IEEE 802.1 AVB in 10G EPON. In the 2nd chapter, we introduce the basic concept of PON, the configuration and bandwidth allocation algorithm of 10G EPON to support IEEE 802.1 AVB traffic explained in 3rd chapter and the experimental results of the scheduling method described in 4th chapter. Finally we will summarize the result of this paper in 5th chapter.

2. EPON and 10G EPON

2.1 EPON

The OLT and the ONU are located at the End Point of a PSS (Passive Star Splitter), each of which is connected by an optical fiber(e.g. assigning more bandwidth to the OLT ports then the uplink ports in the switch connected to the OLT to save CAPEX). The PON is either distributed into several identical optical signals or united into one signal according to the transfer direction of the optical signal. PSSs(Primary Synchronization Signals) are economical as they have low construction, maintenance, and repair costs, plus since a PSS is a passive component, it does not require any extra power supply. Furthermore, because the OLT and the ONU are connected by a Point-to-Multipoint form, the installment cost of the optical fiber is lower than that of a Point-to-Point form. Figure 1 shows the overview of EPON(FTTH, FTTC, FTTB) system structure, as described above.

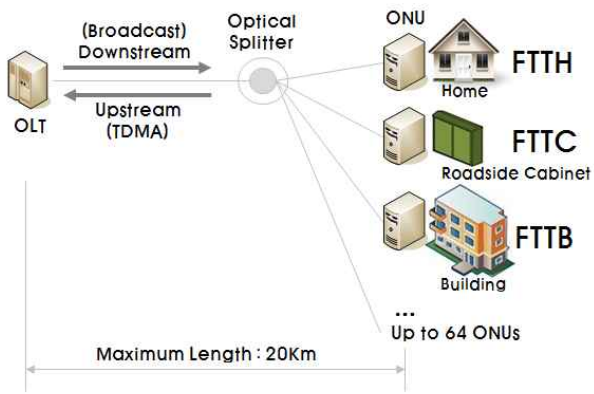

Figure 1. The structure of Ethernet PON.

2.2 10G-EPON

The 10G EPON(10 Gbit/s Ethernet Passive Optical Network) is a next generation subscriber access network with 10 times faster speed in the upstream and downstream than 1G-EPON. So it can transmit easily the next generation multimedia data. That is required a high bandwidth using its improved data transmission rate without shortage of bandwidth as well as it has advantages for setup expenses. And it has adaptability from the aspect of its simple structure and operation than WDM-PON(Wavelength Division Multiplexing PON) which allocates ONU's bandwidth for each wavelength[4].

Even though the physical layer of 10G-EPON is different from the physical layer of 1G-EPON, since both MAC layers have analogous functionalities, 10G-EPON can use the control protocol and MAC protocol of 1G-EPON without modification. But the existing DBA(Dynamic Bandwidth Allocation) algorithms of 1G- EPON seem unsuitable to accommodate 802.1 AVB(Audio Video Bridging) traffic with the strict real-time property. In this paper, we suggest a DBA algorithm that consists of Inter-ONU scheduling and Intra-ONU scheduling to support 802.1 AVB traffic. Inter-ONU scheduling allocates each ONU's bandwidth. And Intra-ONU scheduling is the method to arrange quantity of data by scheduling priority queue. It stores traffics of each class consists of voice, video and data and arrange the priority of transfer within the range of bandwidth allocated to each ONU as you can see in Figure 2. The 10G-EPON adds traffics of the class 5 for IEEE 802.1 AVB traffic and the priority queue for traffics of class 4 while it introduces and utilizes the scheduling structure used in 1G-EPON.

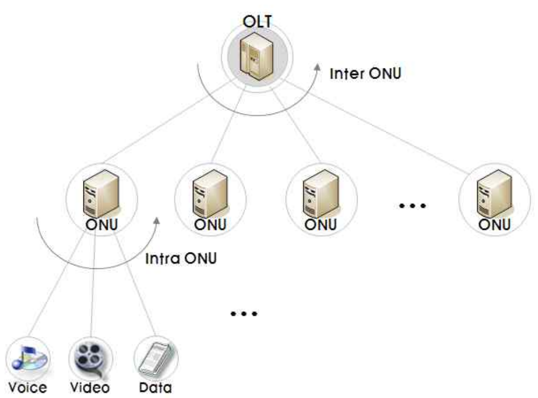

Figure 2. Queue scheduling in EPON.

As for bandwidth allocation methods for 10G-EPON, there are two types. First is the single level model which allocates bandwidth by reporting the scheduling information of each queue to ONU through GATE message. The GATE Message is transmitted from the OLT to the ONU and is used to assign a time slot to the ONU. Second is the hierarchical model in which ONU makes notice to the length of the entire queue to REPORT and arranges the priority through the queue scheduler of its own bandwidth allocated in the DBA of OLT. The single level model provides convenience for maintenance because all the information can be controlled in OLT by reducing the load of the queue scheduling in ONU. However there is the shortcoming that it can't cope with input traffics while each ONU transfers REPORT message and receives GATE message. Whereas the hierarchical model can flexibly deal with input traffics in the queue of ONU between REPORT message and GATE message even though the price of ONU rises due to scheduling function.

2.3 Bandwidth Allocation algorithms in the EPON

We assorted the study of DBA algorithm into statistical multiplexing method and QoS(Quality of Service) assurance and divided again the latter into absolute assurance and relative QoS assurance in reference [5][6]. But the study for acceptance control to handle IEEE 802.1 AVB traffic and the DBA based on resource reservation was not accomplished. In [7], we assorted IPACT(Interleaved Polling with Adaptive Cycle Time) by Kramer with statistical multiplex method. Kramer suggested fixed bandwidth allocation method in reference [8] and polling method based on OLT in order to improve the decrease of availability rate due to fixed bandwidth allocation method in reference [7]. Basically IPACT operates in the way of polling the following ONU before the transfer of prior ONU is completed. The polling method is not adequate to the service delicate to delay and jitter because of variable polling cycle time. Although it enables the statistical multiplex and has excellent capability. The six bandwidth allocation by polling are Fixed, Limited, Gated, Const, Linear and Elastic method. The Fixed method is the static allocation method which allocates the same bandwidth to every ONU. And the Limited method allocates bandwidth which each ONU demands within the range not beyond maximum transmission window. The Gated method allocates all bandwidth ONU demands. And the Const method allocates fixed credit to demanding bandwidth by adding the time slot and Linear method decides the size of credit according to demanding bandwidth. Finally Elastic method is the one which transfers bandwidth of ONU to demanding ONU which requires smaller amount than MTW(Maximum Transmission Window) does beyond the maximum bandwidth.

Ma and Zhu suggested the BGP(Bandwidth Guaranteed Polling) which shares upward traffic based on SLA(Service Level Agreement) between network entrepreneur and subscriber[9]. This algorithm refer to the most advanced service to general subscribers while it guarantees bandwidth to premium subscribers who contracted SLA. This model classifies ONU in network into two types of class. One is ONU which bandwidth guarantee service is secured. The other is ONU which the most advance service is secured. In [10], minimum bandwidth is secured and the bandwidth beyond limitation is distributed fairly. However it takes quite some time to receive GATE message because allocating is possible only treated bandwidth of all ONUs are reported. Moreover, this study decreased the time between receiving of REPORT message and GATE message by dividing them into 2 groups. But it was not solved perfectly yet. So it has limitations to provide QoS(Quality of Service) to traffic arriving during the time between REPORT message and GATE message.

3. The method for supporting synchronous Ethernet

3.1 Resource Booking Procedure

IEEE 802.1 Audio/Video Bridging Task Group resource reservation for the traffic transmission path set before sending the traffic. The host wants to set a group. It is used to set the MAC address and MAC address of the device in the group, including the MRP(Multiple Registration Protocol) PDU broadcast and spanning tree which spread to all ports of the device. This message is sent to each port to determine whether the participants will be registered in this group. After the registration phase is completed, the transmission of traffic messages sends instructions to the nodes which are already declared. They make sure that the excepted group is generated. When the path setup is completed, the node hopped the traffic and sends it to another node. And it is reservation resource based on SRP(Stream Reservation Protocol) defined in the IEEE 802.1 Qat [12]. SRP is sent to the listener from the talker. Figure 3 shows the simplex protocol for SRP PDU. SRP PDU is the Data field of SRP, consists of StreamIdentifier, TSPEC, TalkMAC, ReservationStatus.

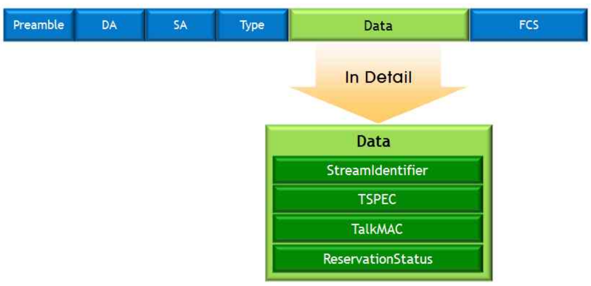

Figure 3. SRP PDU.

When ONU receives SRP PDU(Protocol Data Unit) from network, TSPEC field in the SRP PDU can be scheduled to determine whether the resources are considered. If there is a insufficiency on resource distribution, the predetermined distribution would fail in Reservation Status field, then a REPORT message will send to OLT.

If the reservation resources are sufficient to TSPEC, the temporary reserve and assign value of reservation success in the Reservation Status field, then this is sent in a REPORT message to OLT. OLT receives a REPORT message including the SRP PDU, OLT and SLA in the database test condition of TSPEC and Talker MAC address. Then SLA concludes the contract with the resources necessary for booking a reservation. Likewise, response for reservation is processed at high position protocol. However, in this paper, to reduce processing delays caused by resource reservation, a GATE message with successful Stream Identifier is sent by the resource reservation, then confirms response about SRP. Figure 3 and 4 shows the REPORT message and GATE message including SRP PDU.

3.2 Inter-ONU Scheduling

The Inter-Optical Network Unit(ONU) scheduler in the OLT will allocate a bandwidth(start time and granted transmission time) within one cycle to each ONU based on REPORT messages. Inter-ONU scheduling can be expressed in (1), at (1) RB_i requires bandwidth as input, GB_i is the Granted Bandwidth as output. RB_i consists of Booking information(B_i) for the reservation of IEEE 802.1 AVB traffic and Queuing information(R_i) for non-real-time traffic. Because AVB traffic is constant, once Inter-ONU scheduler permits B_i to ONU_i, it continues until ONU requests to terminate the connection. Therefore, OLT keeps each ONU's B_i summation. But R_i is avariable per cycle, therefore each ONU requests R_i every cycle.

$$GB_i = InterDBA\ (RB_i)$$

$$RB_i \in \{B_i, R_i\},\ GB_i \in \{T_i^{start}, G_i\} \qquad (1)$$

GB_i that is notified to each ONU consists of a start time(T_i^{start}) and transmission duration(G_i). Each ONU initiates to transmit their traffic in queues according to their priority and allocated quantities at T_i^{start} in time next cycle and continues to T_i^{stop} as expressed in (2). $_{max}$ is the maximum transmission rate and is equal to 10Gbps in the 10G EPON model.

$$T_i^{end} = T_i^{start} + G_i / B_{max} \qquad (2)$$

In our work We accommodate two kinds of traffic of class 4 and class 5 as defined in the IEEE 802.1 AVB to support synchronous Ethernet traffic. Each class has constraints of the maximum delay and jitter. Class 4 and Class 5, have 1ms and 125㎲ respectively. So, we chose the lower class which is limited to 125㎲ in upstream. One cycle can be expressed in (3). G_{BAND} is Guard Band in expression (3) that transmits data laser transmitter in ONU_i. This is used to prevent ONU_{i+1} transmitting before the nature signal disappeared after a short period. G_{BAND} uses 512ns which is the same in the existing EPON. M_{report} represents bit unit in length of a REPORT message.

$$T_{cycle} = \sum_{i=1}^{N} (G_i / B_{max} + (G_{BAND} + M_{report} / B_{max})) \qquad (3)$$

As shown in Figure 4, our Inter-ONU scheduler operates in a transmission procedure based on IPACT made by Kramer. IPACT. Each ONU reports its queue information and OLT transmits the GATE message through the DBA to each ONU. This process increases the throughput by reducing the bandwidth of the uplink stream. We chose Limit method within IPACT methods to support synchronous Ethernet traffic.

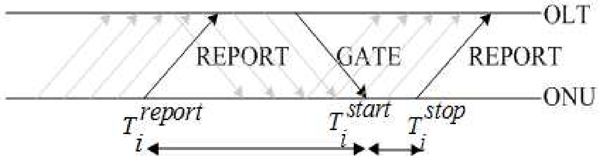

Figure 4. IPACT mechanism

Figure 5 shows REPORT message includes the SRP PDU. Figure 6 shows GATE message include the SRP response.

G_i and T_i^{start} are specified by Inter-ONU scheduler based on equation (4).

$$G_i = \begin{cases} R_i - B_i, & R_i + B_i < W_{max} \\ W_{max} - B_i, & R_i + B_i \geq W_{max} \end{cases}$$
$$W_{max} = (T_{cycle} / N - G_{BAND}) \times B_{max} - M_{report} \tag{4}$$

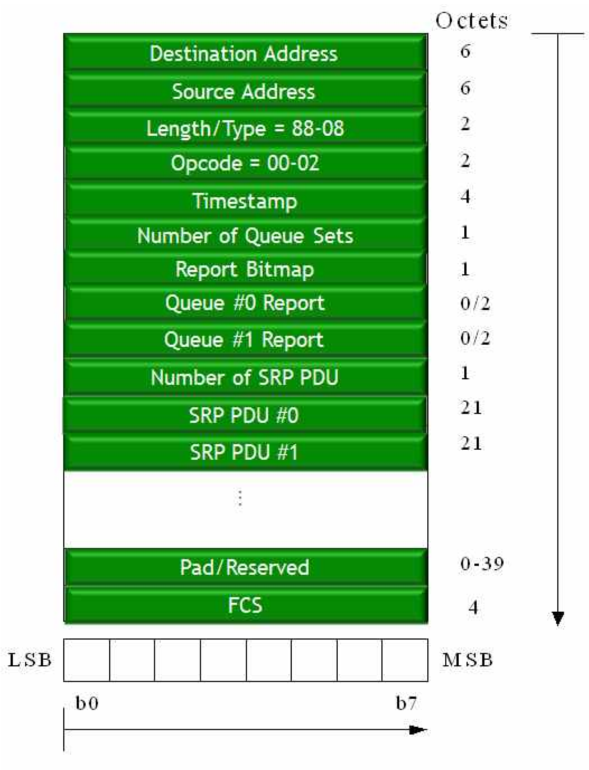

Figure 5. REPORT message includes the SRP PDU

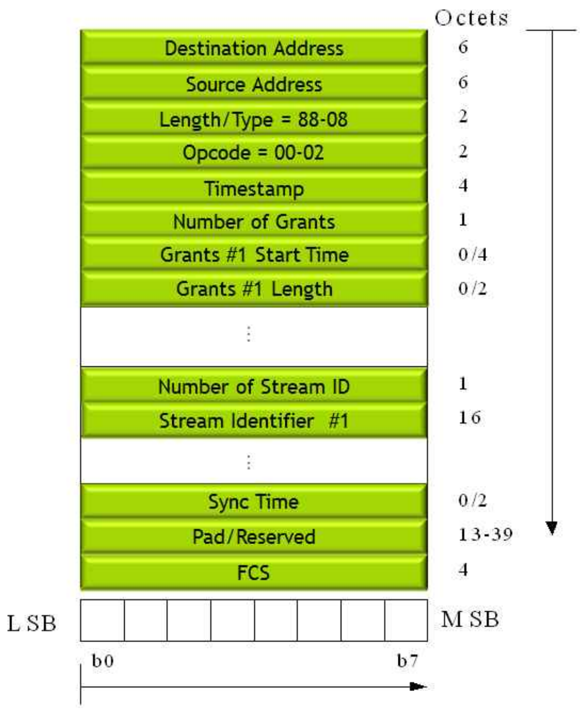

Figure 6. GATE message includes the SRP response

3.3 Intra-ONU Scheduling

Inter-ONU scheduling mechanism allocates transmission starting time(T_i^{start}) and transmission allowance quantity (G_i) based on queue information indicated in the REPORT message from ONU so that the conflict between each ONU may not occur. In other words, Intra-ONU scheduling is carried out for transmission window (W_i) which is the sum of the bandwidth G_i allocated from OLT and reserved bandwidth B_i in each ONU.

$$W_i = B_i + G_i \tag{5}$$

B_i is classified into class 5 and class 4, which are defined in IEEE 802.1AVB like Equation (6) below.

$$B_i = B_i^{T4} + B_i^{T5} \tag{6}$$

The bandwidth G_i allocated from Inter-ONU scheduler indicates the total quantity of 3 classes which are high, medium and low priority like Equation (7).

$$G_i = W_i^H + W_i^M + W_i^L \quad (7)$$

As shown in Figure 7, Intra-ONU scheduling mechanism has the queue which has 5 priorities and its structure. It accomplishes the role of determine the size of the transmission window and the transmission starting time with G_i which is carried out and allocated in ONU and B_i recorded on resource reservation table . In Figure 6, $T_i^{T5,start}$, $T_i^{T4,start}$, $T_i^{H,start}$, $T_i^{M,start}$ and $T_i^{L,start}$ indicates the transmission time while W_i^{T5}, W_i^{T4}, W_i^{H}, W_i^{M}, and W_i^{L} are the size of the transmission window. Figure 8 shows the example of 5 classes of traffic transmission.

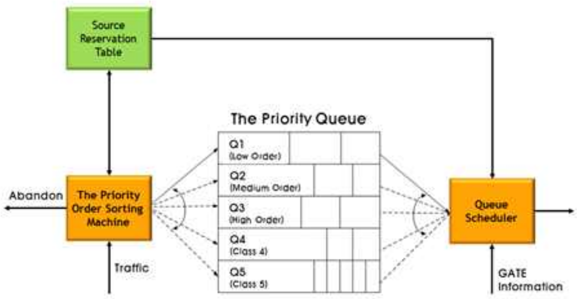

Figure 7. The structure of Intra-ONU scheduler

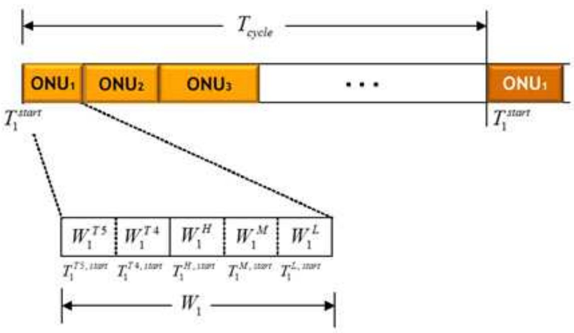

Figure 8. The example of 5 classes of traffic transmission

Intra-ONU scheduler is made up 5 priority queues, priority sorter and queue scheduler. Ethernet frame introduced into Intra-ONU scheduler is sorted according to priority and input in the queue matching priority. Priority sorter assorts Ethernet frame into 5 classes based on PCP (Priority code point) in VLAN(Virtual LAN) tag of input frame.

As mentioned before, IEEE 802.1 AVB frame of class 4 and class 5 operate based on resource reservation, it is considered that the resource for introduced frame is available if there is reservation on resource table. So, it is stored in queue available if there is reservation on resource table and it is abolished regardless of room in queue if not. The transaction time is allocated according to priority from high one to low one after bandwidth of synchronous data and IEEE 802.1 AVB data are allocated.

3.4 The method of Allocating Bandwidth

IEEE 802.1 AVB traffic specifies the resource. It requires on the field of TSPEC(Traffic Specification) in SRP(Stream Reservation Protocol) frame. Although the Resources are specified variably from minimum to maximum number of frame, ONU makes reservation of resource according to the maximum number. This means the waste of bandwidth can occur because actual traffic doesn't arrive, it calculates bandwidth of synchronous and asynchronous traffic both like Equation 8.

For the size(B_i^{T5}) and transmission of bandwidth reserved for class 5 traffic, the minimum value of traffic size (Q_i^{T5}) is designated as the transmission window size in Equation (8). Similarly it is applied to traffic of class 4.

$$\begin{aligned} W_i^{T5} &= MIN(B_i^{T5}) \\ W_i^{T4} &= MIN(B_i^{T4}, Q_i^{T4}) \\ W_i^{NR} &= Gi + (B_i^{T5} - W_i^{T5}) + (B_i^{T4} - W_i^{T4}) \end{aligned} \quad (8)$$

The asynchronous traffic transmits the data of subscriber with SLA contract which doesn't support synchronous traffic. It can be classified into three types. First one is EF(Expedited Forward) which is high priority traffic, Second one is AF (Assured Forward) which is medium priority and Third one is BE(Best Effort) class which is low priority traffic. It is the QoS method which has been studied in 1G-EPON and the service that should be provided for exchangeability with conventional EPON. When ONU_i produces REPORT message, the entire demanding bandwidth of asynchronous traffic can be expressed as follows.

$$R_i = R_i^H + R_i^M + R_i^L \tag{9}$$

After the GATE message is received, the status of queue which stores asynchronous data at the time of starting transmission can be expressed as follows.

$$Q_i^{NR} = Q_i^H + Q_i^M + Q_i^L \tag{10}$$

The reason is it divides Equation 9 and Equation 10 is because the packet which arrived during T_{WT} can be delayed for more than a cycle since only the length of packet which arrived during T_{report} is reported to OLT through REPORT in IPACT method shown as Figure 9.

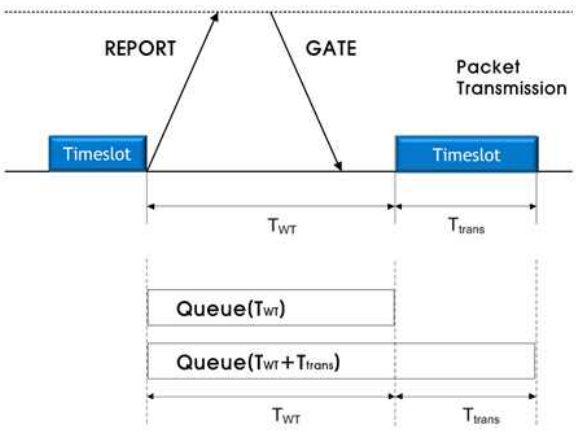

Figure 9. Example of frame delay

The high the load of network is one cause of the long delay. Therefore, quality of high priority traffic which has the lowest delay among asynchronous traffics could be lowered[7].

For the secure QoS of high priority traffic, traffic which arrives during T_{WT} should be transmitted faster than traffic of other class. The most basic scheme is to use SPQ(Strict Priority Queuing). This scheme causes shortage phenomenon for low priority traffic as load is increased. The second scheme is the way additional Credit is allocated as expecting high priority traffic during T_{WT}. This scheme could cause the waste of additional bandwidth because it is hard to estimate Credit. And the increased entire cycle could cause delay of other traffics. As it couldn't accommodate synchronous traffic, high priority traffic was dealt first. Therefore, the paper was focused on minimizing delay of high priority traffic. However, as 10G-EPON can accommodate synchronous traffic, the efficiency of asynchronous traffic like abolition rate of traffic rather than capability of high priority traffic is important. So in this paper, we suggest AGBA(Adaptive Guarantee Bandwidth Allocation) which takes consideration in characteristics of 10G-EPON which supports synchronous Ethernet traffic based on WFQ(Weighted Fair Queue). This method is the way QoS of high priority traffic and it is supported under the condition that the shortage phenomenon does not occur. As AGBA is a WFQ method which sets weight dynamically, weight is an important criteria for capability. To decide weight, we consider maximum delay, maximum jitter and characteristics of traffic quantity stored in queue of each class.

The maximum delay and jitter of high priority traffic(EF : Expedited Forwarding) and medium priority traffic(AF : Assured Forwarding) are defined as 10㎳ and 100㎳ in IEEE 802.1Q. But there is no definition in low priority traffic(BE). However, excessive delay can cause Time out in TCP, in a high protocol layer. The value which decides time-out of timer is RTO (Retransmission Time-Out) and it is calculated based on RTT(Round-Trip Time). So it is decided dynamically for each TCP.

For this reason, in this paper the maximum delay value of BE is designated 1s, 10 times of AF. The ratio for EF, AF and BE becomes 1:10:100 when considering the max delay time of them. As the max value of cycle in 10G-EPON is 125μs, we can conclude that the max delay can be secured only if EF can transmit 80 cycles, AF can do 800 cycles and BE can do 8000 cycles for traffic which arrives within one cycle. So, the quantity for traffic of each class, which arrived within a cycle, can be estimated. The period of a cycle is divided into T_{trans}andT_{WT}.

The following three cases happen if compare the sum of $W_{i,t}^{min}$ of minimum guarantee bandwidth with allowed bandwidth, G_i before additional bandwidth is allocated. Therefore the additional bandwidth is allocated according to three cases.

- $W_{i,t}^{min}=G_{i,t}$: The minimum guarantee bandwidth becomes the size of transmission window.

$$W_{i,t}^{c,add} = 0 \tag{11}$$

The collection of asynchronous traffic classes are as follows.

- $W_{i,t}^{min}>G_{i,t}$: the minimum guarantee bandwidth of all classes is decreased by the ratio of sum of allocated bandwidth and minimum guarantee bandwidth.

$$W_{i,t}^{c,add} = \left(G_{i,t} - W_{i,t}^{min}\right) \times \frac{W_{i,t}^{c}}{W_{i,t}^{min}} \tag{12}$$

The collection of asynchronous traffic classes are as follows.

- $W_{i,t}^{min}>G_{i,t}$:, Like Equation (14), it calculates out and allocates the additional bandwidth. It calculated by multiplying average and the ratio in queue on sum of weight for the excess bandwidth. Shown as Equation 13, subtracts the sum of minimum guarantee bandwidth from allocated bandwidth.

$$W_{i,t}^{c,add} = W_{i,t}^{\alpha} \times \frac{1}{2} \times (Q_{i,t}^{c,ratio} + \omega^{c}) \tag{13}$$

$$Q_{i,t}^{c,ratio} = \frac{Q_{i,t}^{c}}{Q_{i,t}^{NR}}$$

$$W_{i,t}^{\alpha} = W_{i,t}^{NR} - \sum_{\beta \in c} W_{i,t}^{\beta,min} \tag{14}$$

4. Experimental Results

This section has embodied the 10G-EPON model that supports IEEE 802.1 AVB traffic in order to analyze the capability of bandwidth allocating method. In this work, we suggest by use of OPNET, commercial capability analysis tool. And It is analyzing capability of Intra-ONU scheduling method. Intra-ONU scheduling accomplishes the role to allocate bandwidth allocated by Intra-ONU scheduling to each class as mentioned before in section 3.

The Figure 10 and the Figure 11 show the analyzed capability of asynchronous traffic under synchronous traffic allocation for average delay of packets and average queue size. Under asynchronous experiment model, we allocated 30% of whole traffic produced to synchronous traffic and kept the ratio of EF, AF and BE with 1:1:2 and increased 10% each time from 10% to 100%. This experiment compared Par and DBA2[11] of the method this paper suggests with those of SPQ, WFQ and AGBA method. Each experiment model of bandwidth allocation system has 3 10Mbits priority queues.

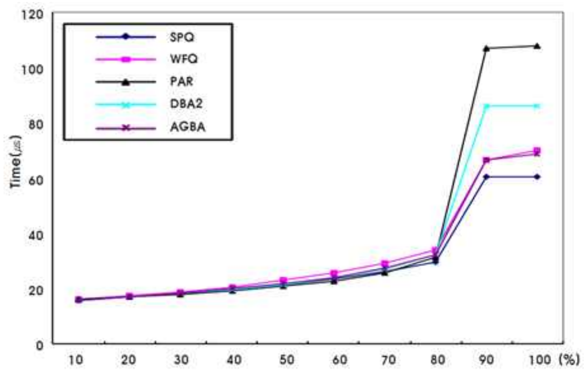

Figure 10. Average packet delay of EF traffic

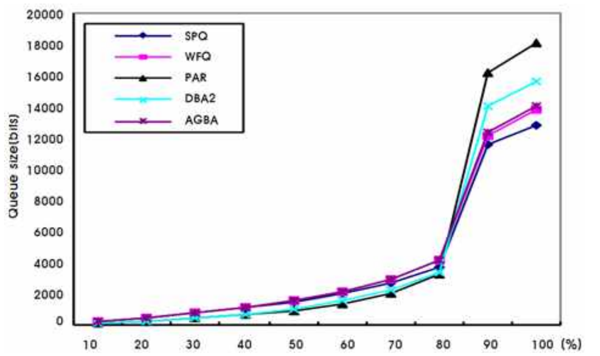

Figure 11. Average queue size of EF traffic in ONUs

The Figure 10 and the Figure 11 show average packet delay and average queue size of EF traffic in each bandwidth which allocation method. Under load below 70%, average packet delay lower in order of Par, the suggested method, DBA2, SPQ and WFQ method. When load goes over 70%, average packet delay of EF traffic changed in order of SPQ, WFQ, the suggested method, DBA2 and Par method. The average queue size showed the same order with average packet delay. However SPQ which showed the lowest packet delay, had no large difference in average packet delay and average queue size while it showed delay low enough to accommodate EF traffic.

5. Conclusion

According to the demand for real-time multimedia service increases, huge research and development investment on bandwidth expansion of network has been accomplished. The backbone network and local area network enabled the transfer of large amount of multimedia data. It developed a lot as a result of a long time research and development investment. However the subscriber access network which connects backbone network to short distance network still remains the area that deteriorates multimedia data transfer to require seamless high bandwidth of backbone network and local area network.

Because of these circumstances, the EPON technology that can provide higher transmission rate than various subscriber access networks appeared. But as its transmission rate is just maximum 1Gbps, its bandwidth is not enough to serve the IPTV that has more than 100 channels, VOD of HD class and online games of large capability in the future. Therefore, at this stage, 10G-EPON is considered to be an alternative. As 10G-EPON not only can support high bandwidth but also traffic of IEEE 802.1 AVB that requires strict delay and jitter. And it can support all services that customers want. So, this paper has designed the model that can accommodate IEEE 802.1 AVB traffic smoothly in those 10G-EPONs and has suggested Intra-ONU scheduling model to make this model work effectively. For high effective Intra-ONU scheduling model, the method is to improve the jitter of traffic of class 5. And also AGBA to accommodate the designed model for QoS of multimedia traffic in 1G-EPON effectively was suggested. The suggested 10G-EPON is not just the issue of bandwidth expansion but will be a solution which can accommodate multimedia service and high quality network service with high capacity in the future.

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논 문 접 수 일 : 2013년 07월 01일
1차수정완료일 : 2013년 07월 15일
2차수정완료일 : 2013년 08월 12일
게 재 확 정 일 : 2013년 08월 26일