Development And Performance Analysis Of A BR-DBA Algorithm For Improve Network Performance

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Abstract. PON(Passive Optical Network) is the most promising technology applicable to TPS(Triple Play Service). To improve network efficiency, MAC(Multiple Access Control) is the most important technology in the PON. This study develop BR(Borrow-Refund)-DBA for improve network efficiency and prompt process. For performance evaluation, simulated about throughput, fairness and queue delay in SR-DBA and NSR-DBA environment.

Keywords: PON, GPON, DBA, IPTV, MAC

1 Introduction

As various multimedia services gets popular and number of users of the service increases, methods to establish communication networks of the next generation that can provide broader bandwidth and faster transmission are currently being studied. Through such methods, service exceeding 320 Gbps - within the core network using DWDM (Dense Wavelength Division Multiplexing) - and 10 Gbps - by ethernet method for LAN (Local Area Network) - are possible. However, networks of subscribers are still using xDSL(Digital Subscriber Line) and HFC(Hybrid Fiber Coaxial) technologies and they are causing bottleneck phenomenon and diminishing capability of the entire networks. So, PON (Passive Optical Network) technology can be applied.

PON is classified into APON(ATM PON), EOPN(Ethernet PON) and GPON(Gigabit Capable PON) on the basis of protocol method. APON provides transmission at 622Mbps for both up and download using ATM(Asynchronous Transfer Mode) protocol. Later, APON has been renamed as BPON(Broadband PON) since it is misunderstood that APON provides only ATM service. The demerits of BPON technology is that it is not appropriate for service based on IP(Internet Protocol). EPON technology was efficiently provides IP service using variable length of ethernet frame at 1Gbps for both up and download. However, it has the problem that it requires separate equipments to provide audio service. Nonetheless, GPON technology can transmit variable IP, TDM service and ATM protocol without overhead using the newly defined GEM(GPON Encapsulation Method) frame structure.

Most equipment manufacturers and communication companies over the world are now adopting the GPON technology, GPON will take the mainstream position among PON technologies and have 6 million subscribers worldwide in 2009. [6][7]

2 Related Studies

2.1 GPON Standard and Structure

ITU-T SG15 is taking charge of standardization of GPON and the document on the standard in defined in G 984.1,2,3,4. [1] [2] [3] [4] [5]
Basically, GPON has the one-to-multiple structure shown in Figure 1. [4]

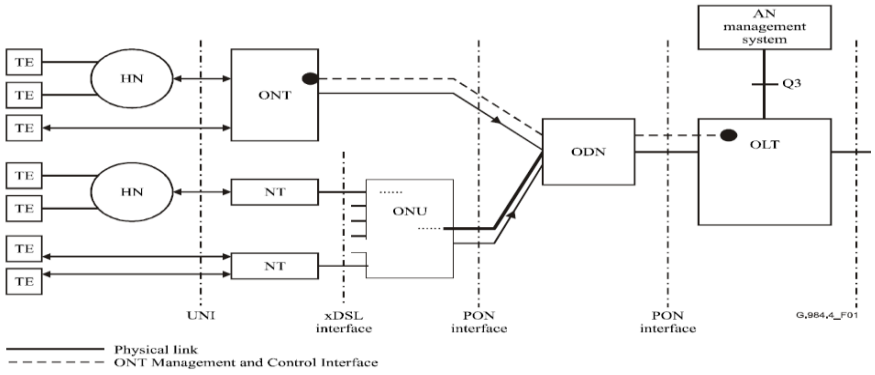

Fig 1. Reference model for GPON

2.2 DBA (Dynamic Bandwidth Assignment)

DBA is the critical element that determines efficiency and QoS(Quality of Service) of PON network. Functions of DBA can be broadly classified as follow.

1) Detection of status of disturbances by ONU and OLT
2) Report of status of disturbances to OLT
3) Assignment of bandwidth in OLT according to predetermined factors
4) Acquiring bandwidth according to the type of T-CONT and assignment of bandwidth
5) Overall management of DBA

DBA algorithm is classified into SR(Status-report) DBA and NSR(Non Status-Report) DBA on a basis of the working method and the characteristics. SR DBA sends calculation outputs on sizes of block and cell of T-CONT buffer to OLT at the time of uploading transmission through ONU. NSR-DBA uses the method in which OLT monitors amount of traffic coming into OLT in order to find out status of each buffer. Since this method uses the past information on inflow of traffic, it is inefficient in assigning bandwidth appropriate for the specific circumstances.[3]

2.3 BPON DBA

Even though the standardization of GPON has been completed in June 2004, the standardization on DBA is not sufficient so far. Data of the buffer are classified into 4 types of service as shown in **Table 1.**[5]

Table 1. Priority bandwidth and allocation

Service classifier	Algorithm of time slot assignment
Fixed BW	Assign time slot in periodically same size
Assured BW	Assign time slot by a demand of ONU. But doesn't make time slot increase , if average-value exceed the guaranteed bandwidth
Non-assured BW	WRR(Weight Round Robin)
Best effort BW	Assign time slot to T-CONTs type 1, 2, 3. And allocate time slot is left in RR(Round Robin)

Such assigning methods cause problems as follow.

1) WRR(Weighted Round Robin) method of the type 3 assigns unevenly inclined to buffers requesting more bandwidth since the method assigns proportionate to requested bandwidth.

2) RR method of the type 4 is the method in which bandwidth is evenly assigned regardless of requested amount. Therefore, buffers requesting either none or large amount cannot be assigned appropriately.

Consequently, it is necessary to improve fairness and efficiency.

3. BR (Borrow-Refund) DBA

The basic concept of BR-DBA has the algorithm in which the same amount of bandwidth is assigned for every buffer and it is allowed to borrow bandwidth among buffers to efficiently maintain bandwidth. The working process of algorithm is explained in Table 2. with an example.

Table 2. Example of time slot allocation

		Buffer 1	Buffer 2	Buffer 3
1st transmission	Possible bandwidth(15)	15/3=5	5	5
	Requested bandwidth	4	5	6
	Quoted bandwidth	4	5	6
2nd transmission	Possible bandwidth(15)	12/3=4	4	4
	Requested bandwidth	5	5	5
	Quoted bandwidth	5	4	3

In the first transmission, each buffer shares the equal bandwidth of 5. However, buffer 3 requests bandwidth more than 5 and buffer 1 requests bandwidth less than 5. Therefore, buffer 1 lends bandwidth to buffer 3. Then all the buffers can transmit necessary information.

In the second transmission, each buffer shares the equal bandwidth of 4. Required bandwidth for all the buffers is 5. Since buffer 1 has lent bandwidth in the first transmission, it get back bandwidth from buffer 3 and transmit necessary information. And buffer 2 transmit bandwidth as much as it is assigned. Finally buffer 3 transmit bandwidth of 3 after lending bandwidth.

4. Functional Evaluation

The network simulator NS-2 was used to evaluate the function of BR-DBA and the evaluating conditions were set up as shown in Table 3.

Table 3. Evaluating Condition

Evaluation condition		
ONU		32
T-CONT Type		Type 1,2,3,4
Packet Size	Fixed BW	1,500 bytes
	Assured BW	4,096 bytes
	Non-assured BW	4,096 bytes
	Best effort BW	4,096 bytes
Bandwidth	Upstream	1.24416 Gbit/s
	Downstream	2.48832 Gbit/s

4.1 Functioanl Evaluation

1) Throughput

To have basic evaluation, the existing BPON-DBA, SR-DBA and NSR-DBA was evaluated, resulting in the outcome shown in Figure 2..

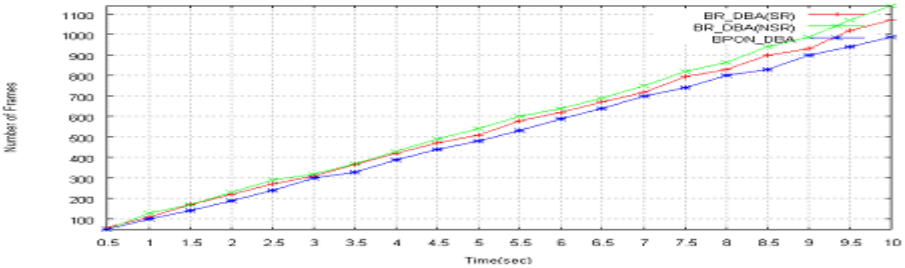

Fig 2. Accumulated packet throughput

BPON DBA shows loss of bandwidth since it assigns bandwidth in the method explained in Table 1. but BR-DBA algorithm increased amount of frame processed

since it makes up the problem of BPON DBA. Comparing SR-DBA and NSR-DBA, NSR-DBA showed better performance. The reason stems from the fact that SR-DBA sends information to check current status of buffer and NSR-DBA does not assign bandwidth to check status of circumstances, and SR-DBA results in loss of bandwidth since information cannot be actually applied in simulation.

2) Fairness

To verify BR(Borrow, Refund) of BR-DBA which makes up the problem of WRR and RR method of BPON DBA, scenario such as following is constructed.
IDs from 1 to 32 were assigned for 32 T-CONT which requires non-assured service and Time Slots as much as each ID number were required. The total Time Slots were limited to be 300 - short of 528 that are the number of Time Slots that the total of 32 buffers required.

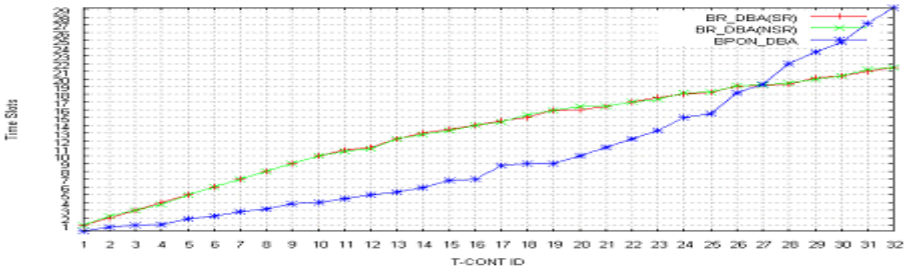

Fig 3. Assigned time slot

In non-assured BW of BPON DBA, the assigned Time Slots get larger as the ID of the buffer increases since WRR is used and more slots are required for buffer that requires more and the tendency shows rapid growth rate. However, since the same bandwidth is assigned in BR-DBA, buffers requesting bandwidth up to the average level (bandwidth=10) are assigned the same bandwidth. Nonetheless, BR-DBA neither shows even bandwidth, but comparing the slopes between the two methods, it can be found out that it is superior method to BPON DBA in the aspect of fairness.

3) Queue Delay

To have a functional evaluation of Queue delay for BR-DBA, BR-DBA was evaluated on a basis of how many times Borrow-Refund is memorized before it is applied.

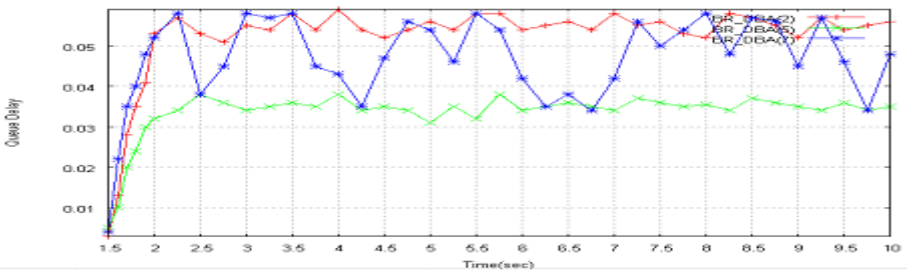

Fig 4. Average delay time of queue

The result as in Figure 4. is represented depending on how many times Borrow-Refund is remembered. Queue delay of 0.05~0.06ms were found if BR information is remembered 5 time and queue delay of 0.03~0.04ms were found. However, if the maximum delay is designated 7 time, irregular delay of 0.03~0.06ms was found. Considering that the average queue delay of BPON DBA was 0.06~0.07ms in the past study, it is evaluated that BR-DBA algorithm can reduce queue delay by 0.03ms on the average.

5. Conclusion

There is DBA algorithm which is the technology to efficiently manage system in GPON. This study carried out functional evaluation of SR-DBA and NSR-DBA for BR-DBA to improve problems of BPON DBA which is the algorithm of DBA of the existing GPON. To improve the algorithm of the existing DBA, BR-DBA fairly assigns bandwidth and borrow and refund if there happens to be differences in bandwidth. To check if the algorithm of BR-DBA is improved, the entire amount processed, amount assigned to Time Slots and the function of the entire system for queue delay was evaluated using NS-2. As a result of the functional evaluation, BR-DBA algorithm, suggested by this study, showed superior results to the existing GPON DBA algorithm in the aspect of the amount processed, fairness and system queue delay.

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