A Bi-Partitional Dynamic Bandwidth Allocation Mechanism for Differentiated Services to Support State Report ONUs in GPON

I-Shyan Hwang, Jhong-Yue Lee, Yung-Shiuan Liang, and Zen-Der Shyu

***Abstract*—With the emerging diversified services, the gigabit-capable PON (GPON) has emerged as one of the most promising broadband access network solutions due to the increasing demand for residential bandwidth. In this paper, a novel bi-partition dynamic bandwidth allocation (B-DBA) mechanism is proposed to enhance the differentiated services over GPON. The proposed B-DBA mechanism divides the transmission cycle time into two groups and adjusts the bandwidth dynamically between the first group for high priorities T-CONT 1, and T-CONT 2 and the second group for low priorities T-CONT 3, and T-CONT 4. Moreover, the T-CONT 2 traffic has prediction mechanism and recycles the remaining unused bandwidth for the low priority T-CONTs. The system performance of B-DBA mechanism is compared with the Jiang's protocol in terms of the throughput, end-to-end delay and jitter for 32 ONUs. Simulation result shows that the proposed B-DBA mechanism can improve the QoS services without sacrificing the low priority traffic except before the system is half-loaded.**

Keywords- GPON, B-DBA mechanism, Differentiated services, System performance, QoS.

I. INTRODUCTION

The access network, also known as the "first mile" or "last mile" network, connects the service provider center offices to businesses and residential subscribers. Residential subscribers demand first mile solutions that have high bandwidth, offer media-rich Internet services, and are comparable in price with existing networks. Similarly, corporate users demand broadband infrastructure through which they can connect their local-area networks to the Internet backbone. Due to the burst number of subscribers and dramatic demand for diversified services, the access network is, therefore, truly the bottleneck for providing broadband triple play services, voice, and video and high speed data. Therefore, the passive optical network (PON) has been introduced at the access network domain to support full-service broadband access networks. The FSAN (Full Service Access Network) group was formed in 1995 by a consortium of major telecom companies worldwide in order to promote the deployment of broadband fiber access networks to the premises. Therefore, the FSAN consortium had defined a common standard for PON equipments which becomes as one of the most scalable and cost-sensitive residential access technology. The GPON (gigabit-capable PON) and EPON (Ethernet PON) have been standardized by ITU-T [1] and IEEE [2], respectively, in response to the increasing requirements of bandwidth and emerging services including strict quality of service (QoS). Both ITU-T and IEEE have standardized solutions for PONs operating at gigabit per second line rates and the transmission of packet-based traffic.

However, the GPON offers multiple services with the required QoS, such as multiple rates, full service and high efficiency advantages. The GPON adapts various transport concepts, for example, the GTC layer carrying ATM cells or GEM frame. The GPON supports symmetrical and asymmetrical line rates over the GTC layer, which can provide full services at high transmission rate in PON architecture. Moreover, the GTC contains five transmission containers (T-CONTs) which are specified by 983.4 [3]. T-CONT 1 is guaranteed fixed bandwidth allocation for time-sensitive applications; T-CONT 2 is guaranteed assured bandwidth allocation for not time-sensitive applications; T-CONT 3 is guaranteed a minimum assured bandwidth and additional non-assured bandwidth; T-CONT 4 is not guaranteed for best effort, dynamically allocates bandwidth. T-CONT 5 includes all kinds of above service categories [4].

Dynamic bandwidth allocation (DBA) mechanism is widely employed in EPON [5, 6, 7], which can dynamically allocate the transmission window among the ONUs and has the ability to solve problems in static bandwidth assignment. Therefore, the GPON not only needs an efficient DBA mechanism to achieve fairness, traffic control and QoS for different T-CONTs [8], but also needs support the GEM operation at MAC layer [9, 10]. When the OLT executes DBA algorithm, the MAC protocol controls the uplink timeslot in each upstream frame of per ONU. A dynamic MAC protocol based on an OLT polling procedure which allows varying successive transmission intervals and bytes among various services has been proposed in [8], but the proposed method does not recycle the unused bandwidth. A new reporting method was proposed in [9], which the ONU reports the length of new arrivals, not the total queue length. And the paper [10] proposed the new ONU reporting process and novel balance transferring mechanism, as well as the underlying bandwidth allocation algorithm, which is that the ONUs reports the information of queue status and the waiting time of new arrival packet. The bandwidth is proportionally distributed among the ONUs depending on the reference value generated by the new ONU reporting process and the balance transferring mechanism. Above research were devoted to discussing the performance of DBA in terms of minimizing the packet delay and improving system performance, but a satisfactory mechanism for jitter and QoS were not proposed.

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For our previous work [11], the Interleaved DBA (*I-DBA*) is to divide the cycle time by partitioning the ONUs into two groups with some timing overlap to execute interleaved bandwidth allocation, which cooperates with limited bandwidth allocation (LBA), excess bandwidth reallocation (EBR) and accurate prediction mechanism in EPONs. The I-DBA mechanism has two advantages; firstly, the idle period problem in the traditional DBA mechanism can be eliminates, secondly, dynamically adjusting the bandwidth within the alternating groups to guarantees QoS services. This will not only support the differentiated services architecture but also offer various QoS levels and excellent jitter performance. In this paper, a novel adaptive DBA algorithms based on bi-partition group (B-DBA) is proposed to improve the system performance in GPON. This scheduling algorithm divides one cycle into two groups, the high priority traffics are transmitted in first group which includes T-CONT 1, and T-CONT 2 and the low priority traffics are transmitted in the second group which includes T-CONT 3 and T-CONT 4 alternatively. The B-DBA mechanism can ensure QoS services by dynamically adjusting the bandwidth between the first and the second group. Moreover, the prediction mechanism is incorporated for T-CONT 2 and recycles the remaining bandwidth in first group for low priority T-CONTs of ONUs in the second group for bandwidth compensation.

The rest of this paper is organized as follows. Section II presents the traditional DBA operation in GPON. Section III presents the proposed B-DBA mechanism in GPON. Simulation results of B-DBA mechanism are compared with Jiang's protocol [10] in Section IV, and followed by conclusions in Section V.

II. Traditional DBA Operation in GPON

Instead of point-to-point (P2P) topology structure, GPON provides bi-directional transmission, that the P2MP in the downstream from the optical line terminal (OLT) to the optical network units (ONUs) and multipoint-to-point (MP2P) in the upstream from the ONUs to OLT. In the upstream direction, the T-CONTs reports queue status by REPORT message, which include PLOu (physical layer overhead upstream), PLOAMu and DBRu (dynamic bandwidth report upstream) by TDMA (time division multiple access) [12] to avoid signal collisions. In the downstream direction, the OLT grants GATE messages, which include PCBd, US BWmap and payload, by broadcasting method to coordinate the transmission window of T-CONTs. As consumer demands of bandwidth are continuously increasing with different services and strict QoS applications, an efficient MAC protocol is employed to supply QoS requirement and manage upstream resource sharing among ONUs more efficient and fairness based on the requests of different T-CONTs.

Concerning the process of allocated bandwidth, which can be divided into non-reporting operation (monitor idle slot and surmise traffic status) and reporting operation (queue reporting); in this paper, the status reporting is employed, which deals with the bandwidth allocation providing more powerful advantages. In general, ONUs reports the backlog data at the T-CONTs to the OLT in the REPORT messages at the front of every T-CONT transmission window frame. In contrast, after OLT receives the REPORT messages, it begins to execute the DBA scheme and sends GATE messages to ONUs for the next cycle frame. Moreover, ONUs receive GATE message including when and which T-CONT transmits traffic data to the OLT. The detail operation is illustrated in the Figure. 1.

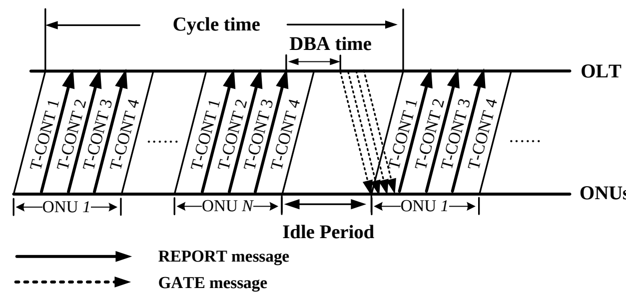

Figure 1. Original DBA operation in GPON.

III. Proposed Bi-Partition DBA Mechanism

The proposed method is motivated by the I-DBA [11] to support different services in GPON, and the different classes of service require differential performance bounds. The proposed scheduling algorithm divides one transmission cycle time into two groups and dynamically adjusts the bandwidth between the first group (high priority traffics T-CONT 1, and T-CONT 2) and the second (low priority traffics T-CONT 3, and T-CONT 4) group. Moreover, the T-CONT 1 traffic is transmitted with guaranteed fixed bandwidth allocation for time-sensitive applications, and the T-CONT 2 traffic is transmitted with prediction mechanism for the guaranteed assured bandwidth allocation and not time-sensitive applications; and, recycling the remaining bandwidth from the first group for the low priorities T-CONT 3 and T-CONT 4 to support T-CONT 3 class minimum guaranteed service as well as the T-CONT 4 to obtain maximum performance.

A. Hybrid cycle scheduling

Conventional, all T-CONTs will report its occupancy of queue and OLT allocates the available bandwidth to T-CONTs except the T-CONT 1 based on the REPORT messages. However, the latency caused by each ONU cannot upload traffic data until all ONUs receives GATE message from the OLT and finish T-CONTs transmission. Take ONU_1 for example, the total numbers of ONUs is N, and from ONU_1 sends REPORT message until ONU_1 receives GATE messages have to wait N-1 transmission time, meaningful, the traffic data still coming into queues of T-CONTs when ONU_1 waits for other ONUs transmission. How to reduce the packet delay and precisely computes packet size into the queues of T-CONTs in the waiting time is one of the important issues.

The proposed B-DBA mechanism is illustrated in Figure. 2, the transmission cycle time is divided by bi-partition

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group. For the first group, this includes T-CONT 1 and T-CONT 2 traffics of ONUs; and the second group, which includes T-CONT 3 and T-CONT 4 traffics of ONUs. At second group DBA time in cycle n, the OLT performs the DBA computation for T-CONT 3 and T-CONT 4 of ONUs in cycle n. At the same time, the OLT has granted the GATE message to T-CONT 1 and T-CONT 2 for ONUs in the previous cycle n-1, so that the T-CONT 1 and T-CONT 2 traffics of ONUs can transmit upstream data. T-CONT 3 and T-CONT 4 traffics for ONUs in cycle n are allowed to transmit upstream data as soon as the T-CONT 1 and T-CONT 2 traffics of ONUs in first group in cycle n finish transmission. Hence, the OLT receives Ethernet frames from ONUs in first group and second group alternately without significant interruptions. Moreover, the B-DBA process executes the QoS-based prediction for T-CONT 2 in the OLT. When the predicted bandwidth has been over-estimated, the unused bandwidth is simply reserved for the next group, and the total transmission time of two successive groups is limited in one maximum cycle time. In general, the total available bandwidth of each ONU will allocate to first group firstly, and then allocates to second group afterwards if the remaining bandwidth is available. However, T-CONT 3 has minimum assured bandwidth or additional non-assured bandwidth characteristic. This algorithm in second group will allocate the minimum assured bandwidth to T-CONT 3, and then distributes the remaining bandwidth to the non-assured T-CONT 3 and the non-guaranteed T-CONT 4 traffics evenly.

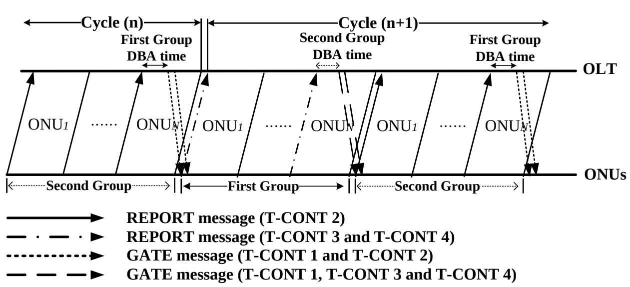

Figure 2. Novel hybrid architecture upstream mechanism.

The proposed B-DBA has two main contributions: one is to ensure QoS services by dynamically adjusting the bandwidth between the first group and the second group, and the other is to enhance the jitter performance for delay sensitive traffic of high priority traffics without scarifying low priority traffic performance, and support differentiated services with various levels of QoS. However, the proposed mechanism will generate the two times of guard time than the original scheme [13], which indicates the minimum guard times in different speed rates have different guard time values, respectively. Suppose that the upstream data rates up to 10 Gbps will have more than 256 bits of guard times, and the authors [14] show that 10 Gbps TDM passive optical network with burst mode configuration can has up to 300 bits of guard time. The total guard time in the proposed mechanism can be up to 300 bits in 10 Gbps passive optical network but the total guard time can be ignored in this paper.

B. Bandwidth allocation in B-DBA

The proposed bi-partition concept is employed in GPON DBA mechanism, called B-DBA. For providing differential QoS, this is necessary to distinguish the transmission data between two groups, treating each of group in a different way according to their individual demand.

Because two groups mechanism produces two times of guard times to transmit traffic data between different ONUs in one cycle, the available bandwidth to upstream in one cycle B^{all} is expressed as (1):

$$B^{all} = S \times (T^{\max} - 2 \times N \times G), \qquad (1)$$

where S is the OLT link capacity, $T^{\max}$ is the maximum cycle time, N is the number of ONU, G is the guard time; and the minimum guaranteed bandwidth for ONUi, $B_i^{\min}$, is expressed as follow:

$$B_i^{\min} = B^{all} \times W_i, \; W_i = \frac{1}{N}, \qquad (2)$$

where W_i is the weight of ONU*i* and each ONU is assumed to have the same weight. Allocating the same minimum bandwidth to each ONU can essentially guarantee the QoS for high priority traffics in first group. The total granted bandwidths to the first group $A_{i,n}^{g1}$ and the second group $A_{i,n}^{g2}$ for ONU*i* in cycle n are expressed as (3).

$$A_{i,n}^{g1} = C_{i,n}^{T1} + C_{i,n}^{T2} \text{ and } A_{i,n}^{g2} = C_{i,n}^{T3} + C_{i,n}^{T4}, \qquad (3)$$

where $C_{i,n}^{T1}$ and $C_{i,n}^{T2}$ are the granted bandwidths to T-CONT 1 and T-CONT 2 of ONU*i* in the second group of cycle n-1, and $C_{i,n}^{T3}$ and $C_{i,n}^{T4}$ are the granted bandwidths to T-CONT 3 and T-CONT 4 of ONU*i* in the first group of cycle n, respectively.

Next, the total granted bandwidths to the first group $A_{i,n+1}^{g1}$ and the second group $A_{i,n+1}^{g2}$ for ONU*i* in cycle n+1 will be addressed in the following. The T-CONT 1 traffic with fixed upstream bandwidth $C_{i,n+1}^{T1}$ has no need to send the REPORT message. The T-CONT 2 is guaranteed bandwidth with the prediction algorithm to calculate upstream bandwidth. The proposed prediction mechanism of T-CONT 2 traffic compares the difference between the requested transmission window at the present cycle and the mean value requested transmission window of historical cycles is defined as (4).

$$P_{i,n}^{index} = R_{i,n}^{T2} - \overline{H_i^{T2}}, \qquad (4)$$

where $P_{i,n}^{index}$ represents the predicted index of T-CONT 2 of ONU*i* in cycle n, $R_{i,n}^{T2}$ is the REPORT message of T-CONT 2 of ONU*i* in cycle n, and $\overline{H_i^{T2}}$ is the average bandwidth requirement of history cycle of T-CONT 2 of

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ONU*i*. If $P_{i,n}^{index}$ >0, the demand of T-CONT 2 of ONU*i* tends to increase gradually and the B-DBA updates the forecast index to obtain the new bandwidth requirements; otherwise, the forecast value has no need to update. Therefore, the granted bandwidth requirement for T-CONT 2 with maximum bandwidth $\left(B_i^{\min} - C_{i,n+1}^{T1}\right)$ in cycle n+1, $C_{i,n+1}^{T2}$, is defined as (5).

$$C_{i,n+1}^{T2} = \begin{cases} R_{i,n}^{T2} & P_{i,n}^{index} < 0 \text{ and } R_{i,n}^{T2} < B_i^{\min} \\ B_i^{\min} & P_{i,n}^{index} < 0 \text{ and } R_{i,n}^{T2} > B_i^{\min} \\ R_{i,n}^{T2} + P_{i,n}^{index} & P_{i,n}^{index} > 0 \text{ and } R_{i,n}^{T2} + P_{i,n}^{index} < B_i^{\min} \\ B_i^{\min} & P_{i,n}^{index} > 0 \text{ and } R_{i,n}^{T2} + P_{i,n}^{index} > B_i^{\min} \end{cases}, \quad (5)$$

If the total granted bandwidth $A_{i,n+1}^{g1}$ of ONU*i* in the first group of cycle n+1 is less than the minimum guaranteed bandwidth, $B_i^{\min}$, the remaining unused bandwidth, $B_{n+1}^{recycle}$, will be recycled and allocated to the second group of cycle n+1 and is given as (6).

$$B_{n+1}^{recycle} = \sum_{i=1}^{N}\left(B_i^{\min} - A_{i,n+1}^{g1}\right), \text{ if } B_i^{\min} > A_{i,n+1}^{g1} \quad (6)$$

For $A_{i,n+1}^{g2}$ of ONU*i* in cycle n+1, if $A_{i,n+1}^{g1} + R_{i,n+1}^{g2} \le B_i^{\min}$, then the total granted bandwidth to the second group for ONU*i* $A_{i,n+1}^{g2}$ is equal to $R_{i,n+1}^{g2}$, where $R_{i,n+1}^{g2}$ is the REPORT message of first group of ONU*i* for T-CONT 3 and T-CONT 4 in cycle n+1; if $A_{i,n+1}^{g1} + R_{i,n+1}^{g2} > B_i^{\min}$, the ONU*i* may have extra bandwidth based on extra demand bandwidth of ONU*i* to the sum of extra demand bandwidth of all ONUs if the $B_{n+1}^{recycle}$ is available. The extra bandwidth allocating to ONU*i* in cycle n+1, $B_{i,n+1}^{ex}$, can be calculated as follows:

$$B_{i,n+1}^{ex} = B_{n+1}^{recycle} \times \frac{B_{i,n+1}^{re}}{B_{n+1}^{re}}, \quad (7)$$

where $B_{i,n+1}^{re}$ is the extra demand bandwidth of ONU*i*, and B_{n+1}^{re} is the sum of extra demand bandwidth of total ONUs in cycle n+1 which is obtained as (8).

$$B_{n+1}^{re} = \sum_{i=1}^{N}\left(A_{i,n+1}^{g1} + R_{i,n+1}^{g2} - B_i^{\min}\right), \text{ if } A_{i,n+1}^{g1} + R_{i,n+1}^{g2} > B_i^{\min} \quad (8)$$

Then, the total granted bandwidth to the second group for ONU*i* $A_{i,n+1}^{g2}$ is equal to $B_{i,n+1}^{ex}$.

Since the T-CONT 3 $C_{i,n+1}^{T3}$ $(= C_{i,n+1}^{T3\_assured} + C_{i,n+1}^{T3\_non\_assured})$ is guaranteed a minimum assured bandwidth $C_{i,n+1}^{T3\_assured}$ and additional non-assured bandwidth $C_{i,n+1}^{T3\_non\_assured}$, the minimum assured bandwidth should be guaranteed first and then assign evenly to non-assured bandwidth and T-CONT 4 $C_{i,n+1}^{T4}$ in cycle n+1, if the remaining bandwidth is available.

If the minimum assured bandwidth of T-CONT 3 $C_{i,n+1}^{T3\_assured}$ of ONU*i* is greater than the granted bandwidth in the second group of cycle n+1 $A_{i,n+1}^{g2}$, then $C_{i,n+1}^{T3\_assured} = A_{i,n+1}^{g2}$; otherwise, the remaining unused bandwidth, $B_{n+1}^{recycle}$, will be recycled and allocated to non-assured bandwidth $C_{i,n+1}^{T3\_non\_assured}$ and T-CONT 4 $C_{i,n+1}^{T4}$ of ONU*i* in the second group of cycle n+1 evenly. Then, the bandwidth of $C_{i,n+1}^{T3\_non\_assured}$ and $C_{i,n+1}^{T4}$ assigned to non-assured bandwidth of T-CONT 3 and T-CONT 4 are limited by $A_{i,n+1}^{g2} > C_{i,n+1}^{T3\_assured}$ which are describe as (9).

$$C_{i,n+1}^{T3\_non\_assured} = C_{i,n+1}^{T4} = \frac{A_{i,n+1}^{g2} - C_{i,n+1}^{T3\_assured}}{2}, \quad (9)$$

IV. Performance Evaluation

In this section, the system performance of B-DBA mechanism is compared with the Jiang's protocol [10] in terms of the throughput, end-to-end delay and jitter for 32 ONUs. The GPON simulation model, set up by the OPNET modeler network simulator, supports the T-CONT 1, T-CONT 2, T-CONT 3 and T-CONT 4 traffics of each ONU. The T-CONT 1 traffic has the deterministic efficacy with limits is anticipated. For the traffic model considered, an extensive study has shown that most network traffic can be characterized by self-similarity and long-range dependence (LRD) [15, 16]. The packet size generated each time for T-CONT 2, T-CONT 3 or T-CONT 4 traffic is 64, 500, 1500 bytes with probability of 60%, 20% and 20%, respectively [17]. The traffics with minimum assured bandwidth and with additional non-assured bandwidth of T-CONT 3 are assumed to distribute evenly. In order to observe the effective of high priority traffic, the proportion of traffic profile is analyzed by simulating the six significant scenarios in (T-CONT 1, T-CONT 2, T-CONT 3, and T-CONT 4) with (10%, 30%, 30%, 30%), (10%, 40%, 30%, 20%), (10%, 60%, 20%, 10%), (40%, 20%, 20%, 20%), (40%, 30%, 20%, 10%) and (40%, 40%, 10%, 10%), respectively. The simulation scenario is summarized in Table I.

TABLE I. Simulation scenario

Number of ONUs in the system	32
Upstream/downstream link capacity	1.24 Gbps
OLT-ONU distance (uniform)	10-20 km
Buffer size	10 MB
Maximum transmission cycle time	1.25*ms*
Guard time	1.8μs
Computation time of DBA	10μs

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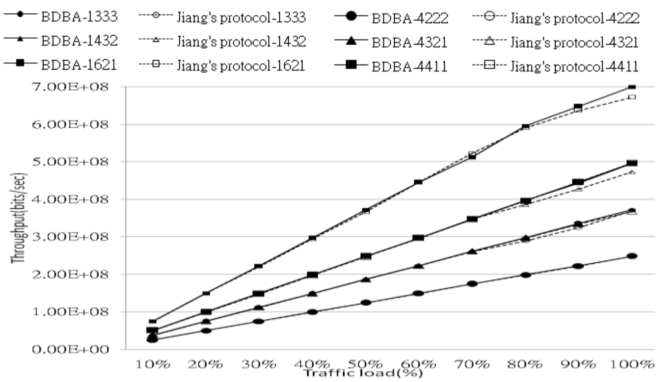
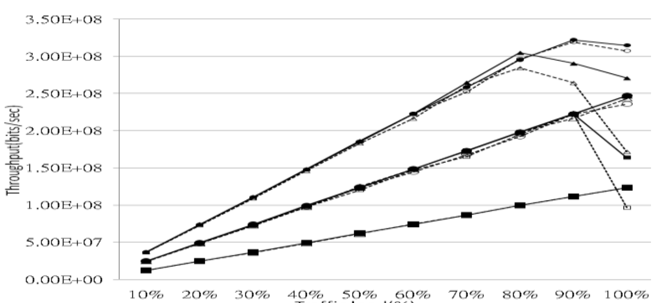
A. *Throughput*

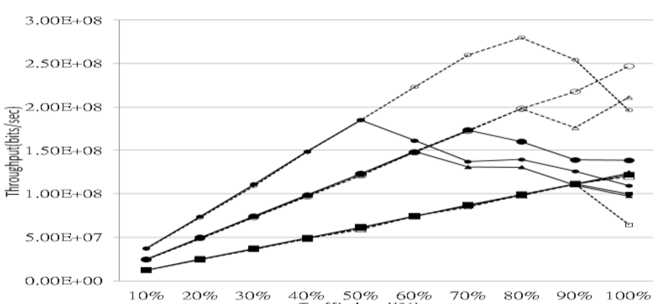
Figure 3 shows the throughput comparisons of T-CONT 2, T-CONT 3 and T-CONT 4 of B-DBA mechanism and Jiang's protocol in 32 ONUs with different proportions of traffic profile for different traffic loads. Figures 3(a) and 3(b) show that the proposed B-DBA mechanism has the same performance as Jiang's protocol until the traffic load exceeds 80% in T-CONT 2 throughput and 70% in T-CONT 3 throughput. However, the TCONT 4 throughput is worse than Jiang's protocol when the traffic load exceeds 50%. The reason is that there is no buffer for T-CONT 3 and T-CONT 4 when the traffic load is heavy, and we priority service the T-CONT 1 and T-CONT 2 follow by T-CONT 3 and T-CONT 4.



(a) T-CONT 2 throughput

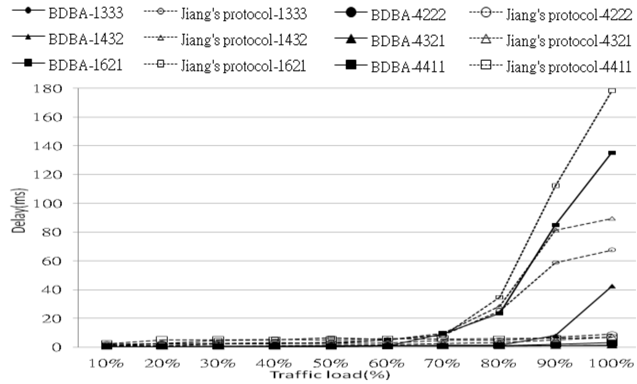


(b) T-CONT 3 throughput

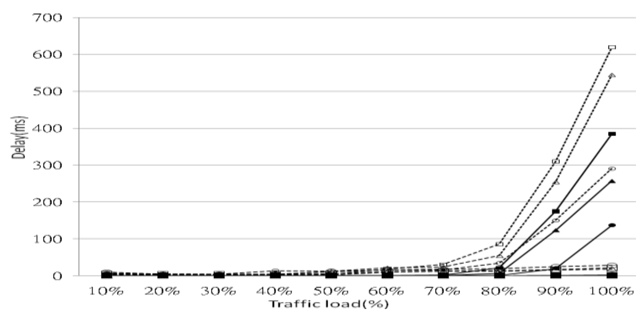


(c) T-CONT 4 throughput

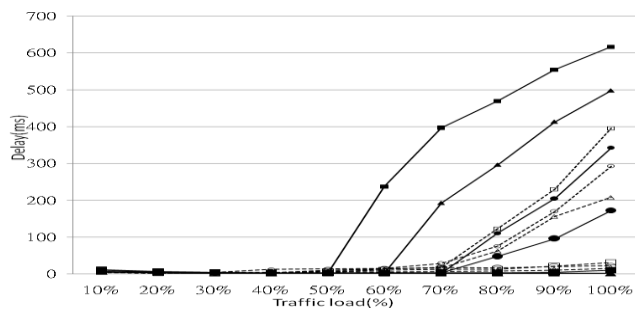
Figure 3. Throughput comparisons with B-DBA mechanism and Jiang's protocol: (a) T-CONT 2, (b) T-CONT 3, (c) T-CONT 4



(a) T-CONT 2 end-to-end delay



(b) T-CONT 3 end-to-end delay



(c) T-CONT 4 end-to-end delay

Figure 4. End-to-end delay comparisons with B-DBA mechanism and Jiang's protocol: (a) T-CONT 2, (b) T-CONT 3, (c) T-CONT 4

B. *End-to-end delay*

Figures 4(a) and (b) shows that the B-DBA mechanism has better performance than Jiang's protocol when the ratio of T-CONT 2 traffic increases. The reason is that the B-DBA mechanism with prediction mechanism satisfies the bandwidth requirement of T-CONT 2 first follow by the requirement of T-CONT 3 and T-CONT 4 traffic. For T-CONT 2, the B-DBA mechanism has the same the end-to-end packet delay as Jiang's protocol until of the traffic load exceeds 70% especially for the scenarios (10%, 40%, 30%, 20%) and (10%, 60%, 20%, 10%). For T-CONT 3, shown in Figure 4(b), the proposed B-DBA mechanism has lower end-to-end packet delay than Jiang's protocol. It can be observed, shown in Figure 4(c), that when the traffic load exceeds 50%, the T-CONT 4 end-to-end delay of B-DBA in scenario (10%,

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60%, 20%, 10%) and (10%, 40%, 30%, 20%) is higher than Jiang's protocol scheme. The reason is that the B-DBA will allocate bandwidth and satisfies to the high priority traffic first, and there is no buffer for T-CONT 3 and T-CONT 4 when the T-CONT 2 traffic load is heavy.

C. Jitter

Figure 5 shows the comparison of the delay variance of T-CONT 2 for B-DBA and Jiang's protocol in 32 ONUs with different proportions of traffic profile for different traffic loads. Simulation results show that the delay variance for T-CONT 2 increases as the traffic load increases, especially in the heavy load for Jiang's protocol in 32 ONUs and for B-DBA. The proposed B-DBA mechanism shows that the T-CONT 2 jitter has better than Jiang's protocol mechanism for every scenario. This is because the transmission order of each T-CONT 2 of B-DBA is sequential and gratifies the T-CONT 2 traffic firstly. However, the T-CONT 2 jitter performance of Jiang's protocol is poor that is due to the Jiang's protocol is to distribute the bandwidth proportionally among the ONUs for each type of traffic, and actually, the obtained T-CONT 2 bandwidth is less than the requirement and causes the delay of T-CONT 2 traffic is higher.

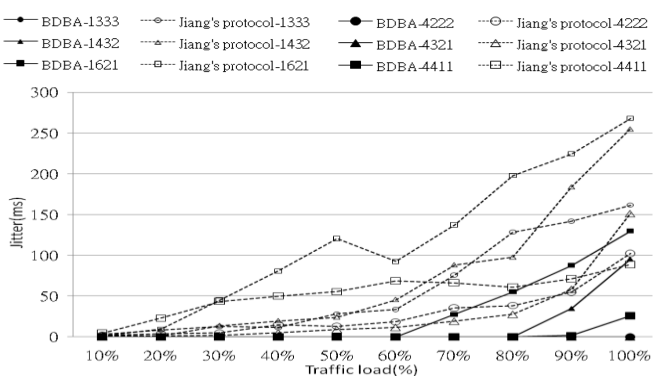

Figure 5. T-CONT 2 jitter comparison with B-DBA mechanism and Jiang's protocol.

V. CONCLUSIONS

This paper proposed the B-DBA mechanism which is to divides dynamically the transmission cycle time into two groups – one for transmitting high priority traffics T-CONT 1, and T-CONT 2 of ONUs and the other for transmitting low priority traffics T-CONT 3, and T-CONT 4 of ONUs and dynamically adjusting the bandwidth within the alternating groups. Moreover, the prediction mechanism is proposed for T-CONT 2 and recycles the remaining unused bandwidth for the low priority T-CONTs. In performance evaluation, for T-CONT 2, the B-DBA mechanism has better performance than the Jiang's protocol in terms of throughput, end-to-end delay and jitter for 32 ONUs. For T-CONT 3, the B-DBA mechanism outperforms the Jiang's protocol in terms of throughput and end-to-end delay for 32 ONUs. However, for T-CONT 4, the performance of B-DBA mechanism has better throughput and end-to-end delay than Jiang's protocol until when the traffic load exceeds 50%.

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