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QoS-Based DWBA Algorithm for NG-EPON

Ammar Rafiq * and Muhammad Faisal Hayat

Department of Computer Science and Engineering University of Engineering and Technology, Lahore 54000, Pakistan; muhammad.faisal.hayat@uet.edu.pk

* Correspondence: ammar.rafiq@hotmail.com

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Abstract: The next-generation Ethernet passive optical network (NG-EPON) is basically classified into two architectures on the basis of the wavelength sharing by the optical network units (ONUs). The single scheduling domain (SSD) and multi-scheduling domain (MSD) EPON are the two different design architectures for NG-EPON. A vital task in NG-EPON is to design dynamic wavelength bandwidth allocation (DWBA) algorithms that can meet the future demands of the network subscribers. A number of DWBA algorithms have been designed for time and wavelength division multiplex (TWDM) EPON. The existing DWBA algorithms for TWDM-EPON could be used in MSD-EPON by making necessary parametric changes. The design and implementation of new DWBA algorithms for MSD-EPON are still required specifically. In this paper, we have proposed a quality of service (QoS)-based DWBA algorithm for NG-EPON. We have comparatively analyzed our proposed DWBA with the existing algorithms like earlier finished time (EFT), weighted bipartite matching (WBM), and earlier finished time with void filling (EFT-VF). The results show that our proposed DWBA algorithm performs better as compared to EFT, WBM, and EFT-VF on the basis of average packet delay and average completion time for NG-EPON.

Keywords: DWBA algorithms; average packet delay; average completion time; NG-EPON; MSD-EPON; SSD-EPON

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1. Introduction

The requirement for high-speed data services is increasing exponentially, and the current trend shows that the global IP data traffic will reach hundreds of exabytes by 2021 [1]. The increase in bandwidth demand created the space for the deployment of the new passive optical networks (PONs), due to their better data carrying capacity and cost effectiveness [2]. Ethernet PON (EPON) as one of the PON technologies has been reported to be a promising and leading solution for local access networks. One gigabit EPON could not meet the growth in bandwidth demands because of its limited channel capacity. The IEEE 802.3ca Task Force is working on the standardization of NG-EPON; which can meet future access network requirements and expectations [3,4].

NG-EPON is the technology that can manage to provide a huge bandwidth and/or channel capacity distribution, a broader coverage reporting area, and accelerate the data transfer speed [5]. It would also deliver reliable and protected communication as compare to the old legacy EPON system. NG-EPON could offer a communication rate of 100 Gbps in the downstream direction and 10 Gbps/25 Gbps on a single wavelength channel in the upstream direction. NG-EPON would be well suited to the present system by substituting the optical line terminal (OLT) and optical network units (ONUs) in the old legacy EPON system [6]. The architecture of NG-EPON is shown in Figure 1.

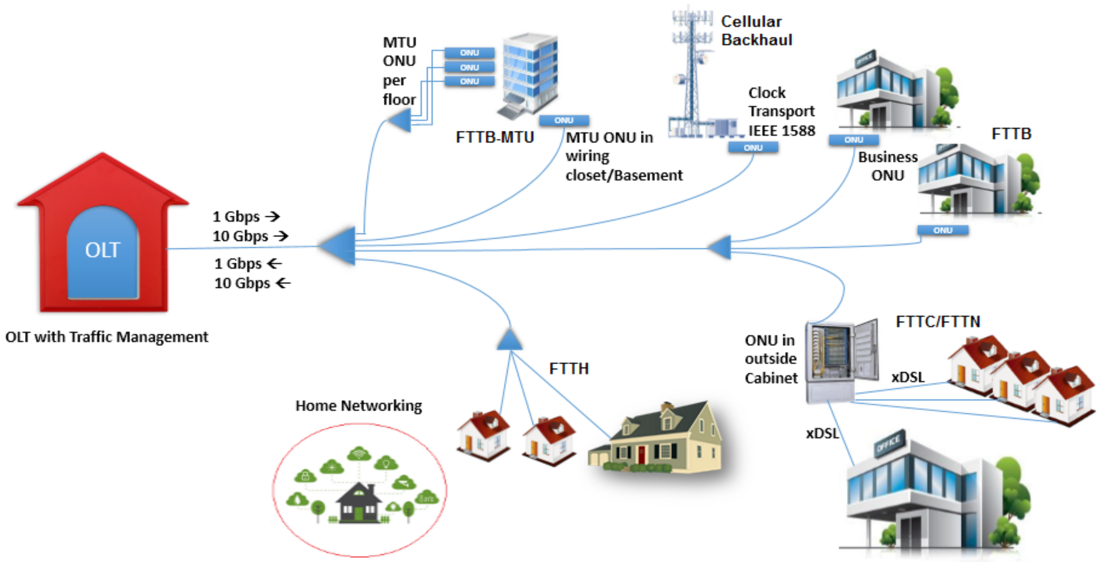

Figure 1. Next-generation EPON. ONU, optical network unit; OLT, optical line terminal.

Generally, the PON architecture is a tree-based topology and involves three main components: the central office equipment named as the optical line terminal (OLT), the subscribers' end equipment named as the optical network unit (ONU), and a passive star coupler (splitter/combiner) that connects OLT to the ONUs. NG-EPON is capable of supporting multiple architectures like time division multiplex (TDM) EPON, wavelength division multiplex (WDM) EPON, and TWDM/hybrid EPON [7]. TDM-EPON offers more bandwidth in a cost effective way by using a single wavelength channel for the downstream direction and a single wavelength channel for the upstream direction. In the downstream, it broadcasts data, and in the upstream, the channel is shared on a time-sharing basis between ONUs [8]. In WDM EPON, each ONU has a dedicated wavelength for its downstream and upstream direction [9]. In hybrid EPON, each ONU does not have a unique/dedicated wavelength; thus, it combines time sharing with a large number of wavelength channels in a single architecture [10]. A set of wavelength channels is shared between the multiple ONUs on the basis of time in hybrid EPON. This increases the network resources' utilization in an efficient manner. TWDM is selected as the multiplexing technology for NG-EPON. By the full service area network (FSAN) group and IEEE working group, this decision has been made based on several factors like modern technology, system performance, and power and cost efficiency. Thus, the hybrid approach combines the great capability of TDM and the flexibility of WDM into a single design architecture via distributing the time slot frames to several subscribers through the number of wavelength channels [11]. In NG-EPON, there are different problems that need to be addressed; key enabling technologies and upgradation of devices, security assurance issues because of the broadcasting nature in the downstream direction, eavesdropping, and an optimized/efficient bandwidth utilization DWBA scheme for upstream traffic [12,13].

Hybrid EPON has been further classified into different design architectures based on how the bandwidth is managed/allocated on multiple wavelengths: SSD-EPON, MSD-EPON, and wavelength agile (WA)-EPON [14]. Dynamic wavelength and bandwidth allocation (DWBA) is a method implemented in the OLT to allocate channel bandwidth dynamically between multiple wavelengths on the basis of time slots for data transmission in the upstream direction. The data could be transmitted by each ONU on its allotted wavelength during the assigned time slot. DWBA helps to avoid any conflict between different ONUs in terms of data transmission. In MSD-EPON, an ONU could transmit its desired traffic on one wavelength channel at one instance, and multiple ONUs can transmit at one time on different wavelength channels. In SSD-EPON, each ONU could transmit its traffic on all the channels simultaneously; hence, only one ONU can transmit its data at one time. Simultaneous transmission of data by multiple ONUs is not possible in SSD-EPON [15,16].

The objective of this paper is to design and implement a new DWBA algorithm for NG-EPON that can provide efficient bandwidth management. The main contribution of this paper is

- We propose an architecture for NG-EPON that provides QoS support to the subscribers.
- We design and implement a dynamic bandwidth allocation algorithm for our proposed NG-EPON architecture by keeping all the needs and parameters of NG-EPON in consideration.
- We evaluate the performance of our proposed DWBA algorithm with the existing solutions on the basis of average packet delay and average completion time.

The rest of the paper is organized as follows. In Section 2, we will discuss related work for DWBA in NG-EPON. In Section 3, we will propose a DWBA technique that can provide better utilization of bandwidth resources in NG-EPON. In Section 4, the performance of our proposed algorithm will be compared with some of the existing DWBA algorithms. Section 5 concludes this work.

2. Related Work

NG-EPON is the technology that could manage to deliver an enormous bandwidth and channel capacity distribution. NG-EPON could provide powerful capabilities that would help different ISPs, cellular networks, and many others to meet unprecedented requirements provided through their networks. NG-EPON would be capable of providing 25/50/100 G EPON architectures to the service providers [17]. The future 5 G cellular networks also require high bandwidth to meet the traffic demand of subscribers. The centralized radio access network (C-RAN), also referred to as cloud-RAN, is a future design for cellular networks. NG-EPON could act as the backbone for the implementation of C-RAN networks [18]. Common public radio interface (CPRI) technology is also introduced in C-RAN. CPRI and Ethernet could be employed together in the access network to optimize the cost of the bandwidth. Multiple network topologies have also been designed for the utilization of optical access networks for the implementation of C-RAN networks. NG-EPON could allow the convergence of multiple service network onto a single optical distribution network (ODN). NG-EPON would help to introduce new and efficient C-RAN architectures that could be adjusted to meet the changing and emerging demands of 5 G mobile networks [19].

In NG-EPON, the downstream wavelength channels are accessed by the OLT for data transmission. To transmit data, OLT does not require any arbitration mechanism. For upstream transmission, OLT grants channel access to different ONUs. OLT permits ONUs to transmit their respective data towards the OLT. On the basis of the OLT's arbitration for wavelength channels access, NG-EPON [20] could be implemented in different design architectures, which are discussed below.

2.1. NG-EPON Design Architectures

MSD-EPON and SSD-EPON are two design architectures for NG-EPON on the basis of DWBA. In MSD-EPON, OLT grants a single wavelength channel to a specific ONU. An ONU transmits queued data on a single channel at one time, so multiple ONUs would be able to transmit their data at the same time on different wavelength channels, as shown in Figure 2. The time slot granted by OLT to a specific ONU depends on the DWBA algorithm implemented by the OLT. MSD-EPON looks similar to TWDM-EPON. The existing efficient DWBA schemes designed for TWDM-EPON could be used for MSD-EPON by making some suitable parametric adjustments of NG-EPON. In SSD-EPON, an ONU is granted access to all of the available upstream wavelength channels by the OLT at one instance of time. Only one ONU is permitted to transmit of its data towards OLT during a single time window. Figure 3 shows the working principle of SSD-EPON. The time slot for which channels are allocated to a specific ONU depends on the DWBA algorithm. SSD-EPON looks similar to TDM-EPON. The existing DBA schemes for TDM-EPON could be used for SSD-EPON by making some suitable parametric adjustments of NG-EPON. A comparison between the two different design architectures of NG-EPON is given in Table 1. DWBA algorithms for NG-EPON along with other DBA algorithms that could be used by different architectures of NG-EPON by making some suitable parametric changes are discussed below.

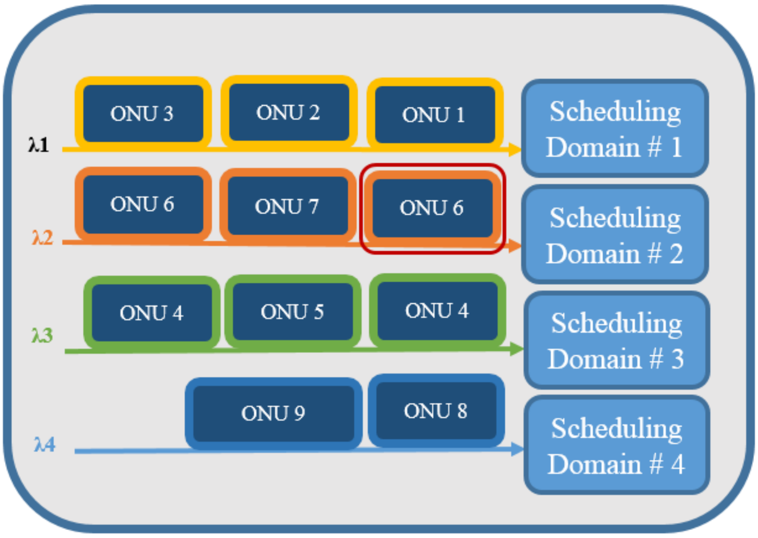

Figure 2. MSD-EPON.

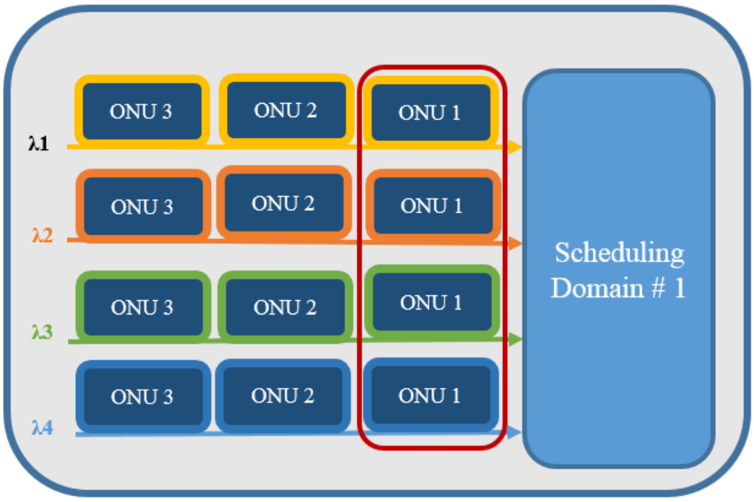

Figure 3. SSD-EPON.

Table 1. Comparison of design architectures.

Parameters	MSD-PON	SSD-PON
Basic principle	1 ONU transmits on different wavelength (1-1) at a time.	1 ONU transmits on all wavelength (1-all) .
Multiplexing technique	Similar to TWDM	Similar to TDM
Status	Existing DBA of TWDM-EPON could be used for MSD-PON by making appropriate parametric adjustments.	Existing DBA of TDM-PON could be used for SSD-PON by making appropriate parametric adjustments.

2.2. Dynamic Bandwidth Allocation in NG-EPON

Dynamic bandwidth allocation in EPON is a decision-making process used for bandwidth allocation and communication. It assigns the optical bandwidth to multiple users in response to their requirements and is usually implemented at OLT (with the possibility of optionally being implemented at the ONU side). The main idea of DBA is to minimize the idle time of upstream channels [21].

As we know, hybrid EPON merges the characteristics of both TDM- and WDM-EPON. In hybrid EPON, the optical distribution center remains the same. The OLT is equipped with arrayed waveguide grating (AWG) to assign a specific wavelength to a splitter in order to transmit TDM frames to multiple ONUs connected to it. For the upstream direction, traffic from different ONUs is received and forwarded by the combiner. From the combiner, the data are forwarded to AWG for delivery to OLT. It combines the time-sharing characteristics of TDM and the flexibility of wavelength channels offered by WDM in single design and is also known as TWDM-EPON [22]. TWDM would be the multiplexing technique for NG-EPON.

A fair DWBA [23] algorithm for NG-EPON has been designed that can reduce the frame sequencing issue and improve the fairness between ONUs. The frame sequencing problem occurs at OLT side when the traffic of an ONU is transmitted on different wavelengths. The frames arrive out of order at the OLT and thus cause frame sequencing problem. Fair DWBA also improves bandwidth utilization by reducing the wastage of resources. The multiple threshold DWBA [24] algorithm is meant for 100 G NG-EPON. The multiple threshold DWBA algorithm utilizes three different thresholds (25 G, 50 G, and 100 G) to ensure the capacity constraints of different types of ONUs. It also maintains fairness by using the weighted min-max technique. Multiple threshold DWBA helps ONUs share bandwidth in a fair manner using their specified weights. Capacity constraints are used by ONUs to share the available bandwidth among themselves flexibly.

Interleave polling with adaptive cycle time (IPACT) [25] is a TDM-based algorithm that could be used for SSD-EPON. IPACT provides a resource management procedure to enable buffer state and bandwidth management. In IPACT, OLT polls ONUs and issues a time slot transmission window in a round robin (RR) manner. The queue status reports the time slot transmission window needed by that ONU, which is allocated by OLT as compared to the request of other ONUs. With IPACT, ONUs having a heavy load could monopolize the wavelength channels for a longer period of time, and the traffic of the other ONUs could face more delays.

The basic working principal of MSD-EPON is the same as TWDM-EPON, and DWBA algorithms designed for TWDM-EPON could be used for MSD-EPON. Some DWBA algorithms for hybrid EPON that could be used for MSD-EPON are discussed here. The static wavelength dynamic time (SWDT) is a DWBA in which wavelength channels are statically assigned to ONUs. The upstream channel is assigned on the basis of the bandwidth request of ONUs. The ONUs are classified into multiple groups depending on the number of wavelengths. A set of wavelengths is predefined and allocated to different groups. The given scheme is simple and could be applied with ease [26]. Dynamic wavelength dynamic time (DWDT) is a DWBA that dynamically allocates wavelength channels and time slots to the ONUs. DWDT maintains information about each and every wavelength channel. It also determines the transmission period assigned to each ONU on a specified wavelength channel, and this procedure is referred to as a DWBA [27]. Three different QoS-based DWBAs for hybrid EPON have also been designed. The structure of DBA-I and DBA-II is the same. DBA-I operates on intra-ONU scheduling for adaptive fairness. QoS-DBA-II operates on both intra and inter ONU scheduling. ONUs support multiple transmitters for low and high priority data traffic. QoS-DBA-III consumes two wavelength channels at a time for both high and low data transmission towards the OLT [28].

The earliest finish time (EFT) is a DWBA meant for scheduling the upstream channels. When consequent REPORT messages arrive at OLT, the scheduling is immediately done to allocate the transmission window. No additional data transmission could be completed on a similar wavelength. The designated data transmission and available wavelength ensure the earliest finishing time among the channels [29]. The earliest finish time with void filling is a modified DWBA that reduces waiting time in contrast to the EFT. A void is the interval between two succeeding communications, once the given wavelength turns out to be free. The void filling part of the DWBA scheme is used to fill these voids by scheduling the transmission of an ONU during time. When the channel becomes free, the scheduled void must be long enough to enable the communication and thus improve network performance by reducing the delay [30].

Weighted bipartite matching (WBM) is a DWBA in which an additive cost is assigned to each wavelength channel. The cost is different for all wavelength channels. It is associated only when the given wavelength becomes free or accessible. The additive cost is signified by the accessibility rate of each wavelength channel for a specific ONU. It is an online DWBA algorithm, which has been proven to be an optimal solution that reduces the total amount of finishing time [31]. The class of service-based DWBA is another scheme, in which data traffic is classified into high and low priority data traffic. The channel distribution scheme is segregated into two parts: one with high priority data and the other with low priority data. The concept of surplus bandwidth is utilized. When extra/vacant bandwidth becomes available, it is gathered from less weighted ONUs, and it is distributed to the more weighted ONUs [32].

The different existing DWBA algorithms for TWDM-EPON discussed above could be used for MSD-EPON by making necessary parametric adjustments. However, still, there is a need to develop new DWBA algorithms for NG-EPON (MSD-EPON) that should be designed by keeping all the needs and parameters of NG-EPON in consideration. In the next section, we will propose a DWBA algorithm for NG-EPON.

3. Methodology

The number of provided upstream wavelength channels in NG-EPON is four. Upstream wavelength channels are shared in TDM fashion by the ONUs. Transmission in the upstream direction is implemented/controlled by the multiple point control protocol (MPCP). A report and grant mechanism is used to control the request and allocation process of wavelength channels for different ONUs based on their demands. DWBA is an important functionality in NG-EPON that closely arbitrates the upstream transmission between different ONUs on the multiple available bandwidth channels. DWBA is responsible for the allocation of the channels and timeslots to different ONUS.

We propose a DWBA algorithm that is designed for the NG-EPON architecture shown in Figure 4. We have designed the DWBA algorithm with QoS support for NG-EPON. In our proposed architecture, we have divided the ONUs' traffic into two categories "high priority (HP) and low priority (LP) traffic". Each ONU has two types of transmitters: one for the HP traffic and the other for LP traffic. HP traffic is comprised of delay-sensitive traffic with a constant bit rate and bandwidth-intensive applications' data traffic with VBR. Business premium data, e-commerce data, business critical mission-oriented data, etc., are also categorized as HP traffic. Non-delay-sensitive data with VBR that need high bandwidth assurances like non-organizational streaming of bulk multimedia data are categorized as LP traffic. The LP and HP traffic would be transmitted on different wavelength channels by each ONU. Separate LP and HP transmitters would be required by ONUs for data transmission on designated LP and HP wavelength channels. At the OLT side, we would have separate scheduling pools for HP and LP traffic. The HP bandwidth demand of ONUs would be gathered in the HP pool, and the LP bandwidth demand of ONUs would be gathered in the LP pool. We have proposed an algorithm for NG-EPON that can meet the future bandwidth demands of the users in an efficient way. Our algorithm would also be capable of handling the heterogeneous property of NG-EPON. It would manage the request of the ONUs situated at variable distances ranging up to 100 km from the OLT. As our DWBA algorithm supports QoS, data traffic would be classified into two separate pools: HP pool and LP pool, as shown in Figure 4. According to our NG-EPON architecture, we need to have separate wavelengths available for HP and LP traffic. For LP traffic, our network architecture supports only one wavelength channel, and for HP traffic, our network supports three wavelength channels. The pseudo-code for our QoS-based DWBA algorithm is given below.

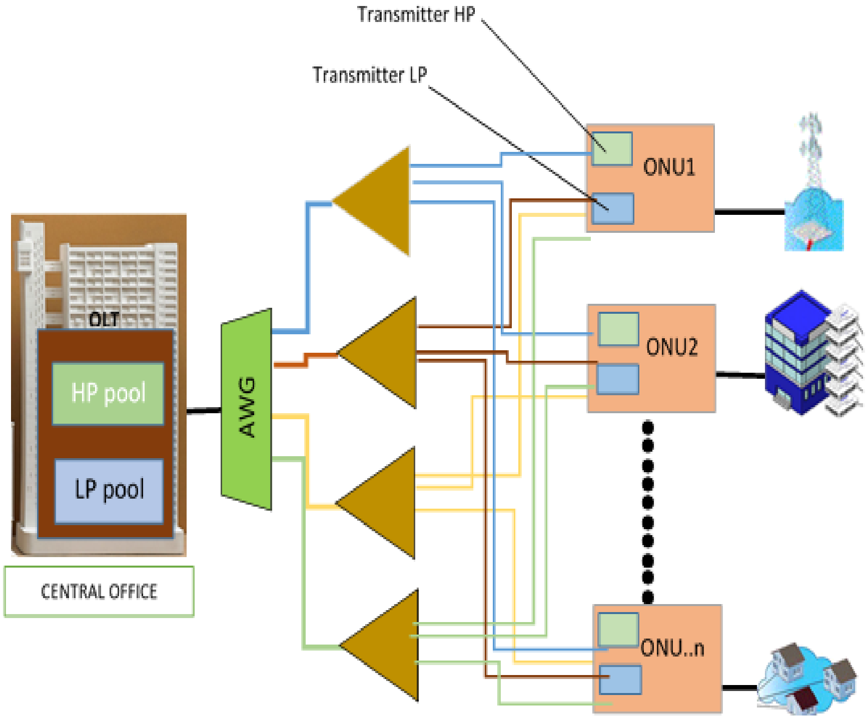

Figure 4. NG-EPON architecture for the proposed DWBA. LP, low priority; HP, high priority.

Proposed DWBA Algorithm
1. Process 1 starts (HP Pool) 2. While (HP request in the pool) 3. //Schedule making starts 4. Arrange ONUs in ascending order on the basis of RTTs; 5. If (RTT of two ONUs is same) then 6. ONUs with SPT would come first in order; 7. end-if // Schedule making ends 8. if (wavelength available for HP), then 9. Assign wavelength slot to ONU at the top; 10. else 11. Wait for the availability of wavelengths; 12. end-if 13. Transmit the data and receive backlogged REQUEST; 14. Complete the scheduling round; 15. end-while 16. Process 1 ends

1. Process 2 starts (LP pool)
2. While (LP reports from all ONU received)
3. If (wavelength available), then
4. Prepare the schedule;
5. else
6. Wait for the availability of wavelength;
7. end-If
8. Arrange ONUs in ascending order;
on the basis of RTTs; //schedule making
9. Assign time slots to the ONUs on the LP wavelength;
10. ONUs' data transmit toward OLT along with RPTs;
11. end-while
12. Process 2 ends

Our DWBA algorithm is composed of two processes: Process 1 and Process 2. In Process 1, we handle HP traffic, and in Process 2, we handle LP traffic. The requests for HP traffic are processed in an online fashion. Our algorithm for Process 1 is comprised of two parts: one is making the schedule, and the other is assignment of wavelengths. In the schedule making phase, we sort ONUs in ascending order on the basis of round trip time (RTT). If two ONUs have the same RTT, then the ONU with the shortest processing time (SPT) would come first in the scheduling order. Once the schedule making phase completes, then we check the availability of the HP wavelength. If the wavelength is available, then we assign available the HP wavelength to ONU at the top of the sorted list. We will allocate wavelength to ONUs available next in the scheduling order in the same manner. After allocation at the OLT side, the gate messages would be transmitted to the ONUs. The ONUs can transmit their data on assigned HP wavelengths in the upstream direction. Similarly, the requests would be received at the OLT, and the wavelength would be assigned to ONUs when a channel becomes free. In Process 2, LP requests are dealt with in an offline manner. Allocation of the channel bandwidth would be done after receiving requests of all ONUs and checking the availability of the wavelength. The schedule can be prepared for the allocation of time slots to ONUs on the LP wavelength. The ONUs are informed about their time slot allocation by the OLT through gate messages. After allocation, the ONUs can transmit their data towards the OLT on their allocated time slots along with report messages for the next bandwidth requests.

The time complexity of the EFT-VF algorithm is O(W + N), where W is the number of upstream wavelengths, given that at any time, there can be at maximum one reservation pending per ONU. This complexity of EFT-VF could be improved to O[log(W + N)]. The time complexity for WBM was computed to be O[N(W + N log N)]. We have computed the time complexity for our proposed DWBA, which is computed to be $O[(W - 1) + N]$. The complexity of our proposed DWBA could also be improved to $O[\log((W - 1) + N))]$. Thus, a simple implementation of this algorithm schedules a single grant in $O[(W - 1) + N]$ amount of time. It can be observed clearly that the computational complexity of our proposed DWBA is better than EFT-VF and WBM.

4. Performance Evaluation

To evaluate the performance of our proposed algorithm with different existing DWBA algorithms, we performed a discrete event C++-based simulation. We have performed a simulation for the NG-EPON model with four wavelength channels for upstream traffic transmission. Our NG-EPON model is composed of a tree-based network arrangement having 64 ONUs. We performed simulations at 1 Gbps and 10 Gbps per wavelength channel capacity. We considered normalized network load, and it varied uniformly at different offered loads. RTTs for different ONUs were uniformly allocated between a range 80 and 120 µs. In between multiple grants, a fixed guard time was set, which was taken as 1 µs. We allocated one wavelength for LP traffic and three wavelengths for HP traffic for our proposed DWBA algorithm. All ONUs had the same constraints for bandwidth allocation.

We compared our proposed DWBA algorithm with some existing algorithms (EFT, WBM, and EFT-VF). We compared DWBA algorithms on the basis of average packet delay and average completion time. As the first step, we performed a simulation for our proposed DWBA and existing algorithms at an offered load of 1 Gbps per wavelength channel. Figure 5 shows a comparison of our proposed algorithm with EFT and WBM on the basis of average packet delay. It shows that there was considerable improvement in terms of average delay between our proposed algorithm and EFT and WBM. In Figure 6, a comparison on the basis of average completion time between our proposed algorithm and EFT and WBM is shown. Figure 6 shows that our proposed algorithm outperformed EFT and WBM by a remarkable amount. The average completion time of the proposed DWBA was lower compared to the EFT and WBM. As the second step, we also performed the simulation for our proposed DWBA and the existing algorithms at an offered load of 10 Gbps per wavelength. Figure 7 shows a comparison of our proposed algorithm with EFT and WBM at a offered channel load of 10 Gbps. Our proposed DWBA shows countable improvement in terms of average delay as compared to EFT and WBM. Figure 8 shows a comparison of algorithms on the basis of average completion time at an offered load of 10 Gbps per wavelength channel. There is also mentionable improvement in the results shown by our DWBA on the basis of average completion time. We have also compared our proposed DWBA with EFT with void filling (EFT-VF) on the basis of average delay and average completion time. Figures 9 and 10 show a comparison of our proposed DWBA with EFT-VF at an offered channel load of 10 Gbps. In Figure 9, a comparison is shown on the basis of average delay, and Figure 10 shows a comparison on the basis of average completion time. Our proposed algorithm also performs better as compared to the EFT-VF in terms of average delay and average completion time.

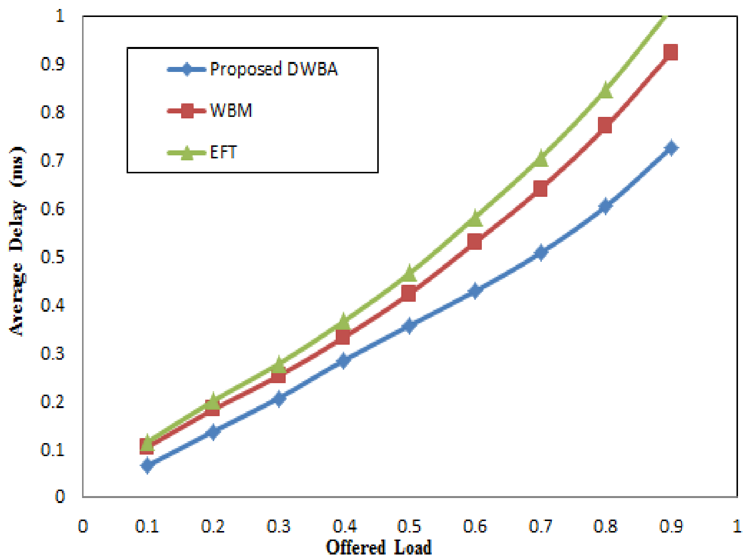

Figure 5. Average packet delay of different DWBA Algorithms with a 1-Gbps data rate for each channel. WBM, weighted bipartite matching; EFT, earlier finished time.

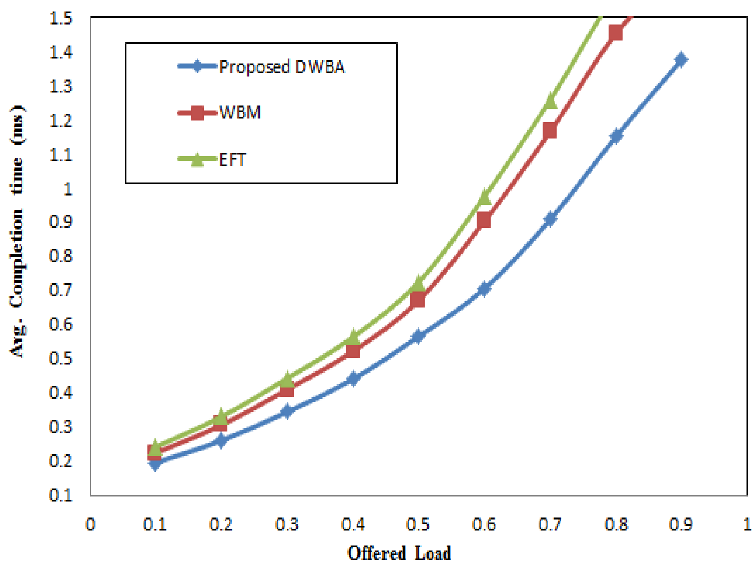

Figure 6. Average completion time of different DWBA algorithms with a 1-Gbps data rate for each channel.

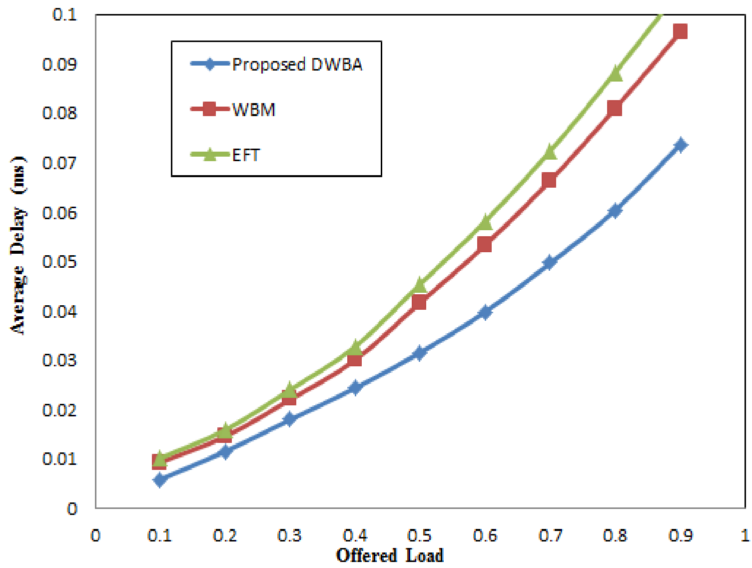

Figure 7. Average packet delay of different DWBA algorithms with a 10-Gbps data rate for each channel.

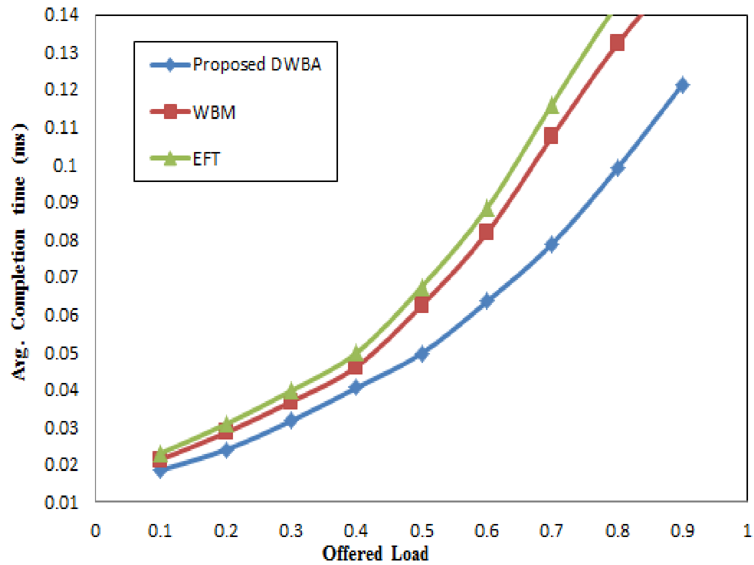

Figure 8. Average completion time of different DWBA algorithms with a 10-Gbps data rate for each channel.

Our proposed DWBA handles two types of traffic simultaneously: HP and LP traffic. HP traffic is handled by our DWBA in an online manner, which helps to reduce the delay experienced by ONUs. HP traffic would be assigned a channel as soon as a wavelength channel becomes free. As we know, HP traffic is delay sensitive and requires a constant bit rate for data transmission. Therefore, we used the online allocation mechanism for HP traffic. LP traffic is the data that do not require a constant bit rate and can also tolerate delay in the transmission of data. Our DWBA handles LP traffic in an offline manner. All the reports are received from ONUs for LP traffic, before the allocation of time slots is done on the wavelength. Our competitive algorithms totally perform the allocation of the channels to the ONUs in an online manner. EFT, WBM, and EFT-VF allocate channels to the ONUs for transmission of all their data on a single channel in an online manner. The online execution of the algorithm each time for the allocation of channels increases the algorithm execution overhead. If we use an online technique for light loads, it would cost much more as compared to the heavy loads because of less bandwidth demand. Secondly, an online DWBA executes each time without having complete knowledge of all ONUs in the system. Therefore, it can be stated that our proposed DWBA is planned in a more innovative manner according to the modern traffic requirements. It uses an adequate technique by deploying the a blend of online-offline according to the traffic types. Our proposed algorithm improves the average delay as compared to EFT, WBM, and EFT-VF. For less network load, the difference between the average delay of our proposed algorithm and existing algorithms is lower. At higher network loads, our proposed algorithm showed more improvement in average packet delay as compared to EFT and WBM. Our proposed algorithm performed better as compared to the WBM and EFT in terms of average completion time. At higher network load, our proposed DWBA showed more improvement in average completion time as compared to EFT and WBM. Our DWBA also performed better as compared to EFT-VF on the basis of average packet delay and average completion time. The simulation results also showed that our DWBA performance was better at a wavelength channel load of 10 Gbps. We executed the simulation 100 times to calculate the results shown in the above-mentioned figures.

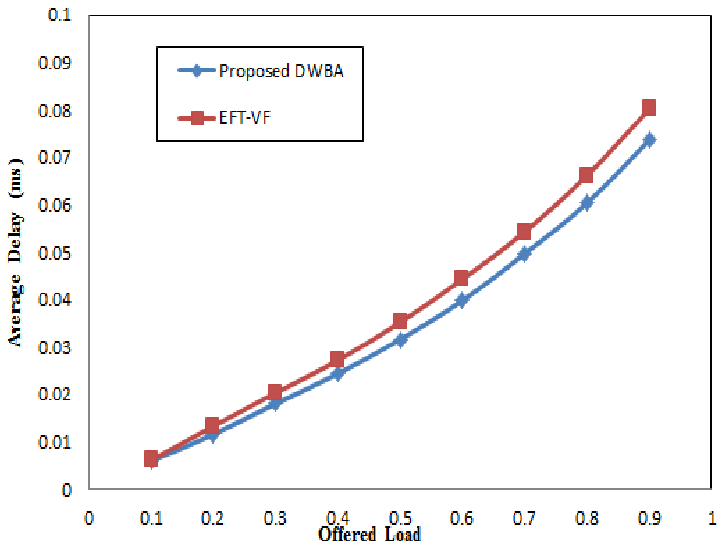

Figure 9. Average packet delay comparison between EFT void filling (VF) and our proposed DWBA at a 10-Gbps data rate per channel.

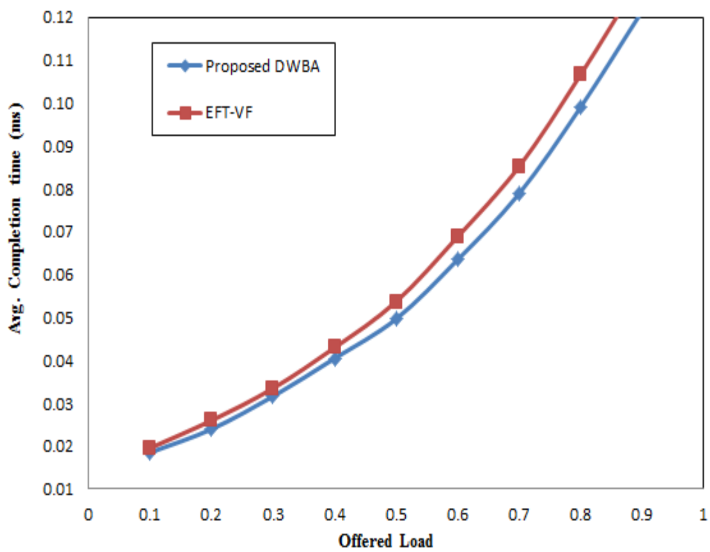

Figure 10. Average completion time comparison between EFT-VF and our proposed DWBA at a 10-Gbps data rate per channel.

5. Conclusions

In this paper, we have discussed NG-EPON as a future network that can meet the bandwidth demands of modern applications and subscribers in the access network. To address the problem of efficient upstream bandwidth management in NG-EPON, different existing DWBA algorithms have been discussed. A QoS-based DWBA for MSD-EPON has been proposed to arbitrate the channel bandwidth efficiently in NG-EPON. We have performed a simulation of our proposed DWBA algorithm and existing algorithms like WBM, EFT, and EFT-VF for the NG-EPON architecture. The simulation results have been analyzed and showed that our proposed DWBA algorithm performed better as compared to EFT, WBM, and EFT-VF on the basis of average delay and average completion time. Our proposed DWBA algorithm provided more improvement in results at higher offered network loads. The future direction of our work is to design and implement new DWBA algorithms that can meet the bandwidth demand of NG-EPON by providing a data rate of up to 100 Gbps to the subscribers. Such DWBA algorithms for NG-EPON should be designed, which can provide quality-oriented service to the subscribers at service-oriented cost.

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