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Novel DBA Schemes for Improving Bandwidth Utilization and QoS in EPON System

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Abstract

The paper proposes some advanced DBA schemes for the improvement of QoS in EPON systems, as well as for the improvement of system performance and bandwidth utilization. The proposed DBA schemes enable the feeder fibers to provide a recovery mechanism. It can also share the load of the feeder fiber works, if no failures occurred. When the failures occur on the OLT or feeder fibers, the backup fibers will recover the failed ones. The PFWBA scheme integrates an efficient DBA and EDBA mechanisms of PFEBA for improving the prediction accuracy and system performance. The paper is proposing new algorithms for DBA schemes to improve the P2P VoD services. The proposed DBA schemes also outperform the early proposed DBA schemes.

Keywords: multimedia services, passive optical network, DBA, PFWBA, EPON.

1. Introduction

Network operators have already started the deployment of new multimedia services such as video-on demand (VoD), high-definition television (HDTV), peer-to-peer (P2P) live video streaming and IPTV [1]. Within the last few years the information volumes transferred through network channels increased radically and the continuing growth of broadband technology in the worldwide markets has been driven by the hunger of customers for new multimedia services as well as web content. Generally the most important are the audio and video streaming. Audio and video streaming has become very popular for delivery of rich information to the public for both residential and business.

Nowadays, the main technology of broadband access system moves from metallic systems such as ADSL to optical systems PONs [2]. A PON is a point-to-multipoint (P2MP) optical network architecture in which passive optical splitters are used for enabling a single optical fiber to serve multiple premises. In general, the networks which are founded on a single fiber PON simply require N+1 transceivers and L km of fiber. One of the most important concerns is how the network operators can increase sufficient revenue and profits by providing services to the end users. Thus, video on demand (VoD) services are becoming more and more important. Nowadays, for the network operators one of the toughest challenges is to carry a large data-centric traffic with tighter timing and Quality-of-Services (QoS) requirements for mounting upon the existing network infrastructures [3].

The EPON architecture consists of a centralized optical line terminal (OLT), splitters, and connects a group of associated optical network units (ONUs) over point-to-multipoint topologies to deliver broadband packet and reduce cost relative to maintenance and power. In the upstream direction, all ONUs share the common transmission channel towards the OLT, only a single ONU may transmit data in its time-slots for avoiding data collisions. For this kind of reason, it needs a robust dynamic bandwidth allocation (DBA) mechanism for assigning time-slots and upstream bandwidth for each ONU for transmitting the data. This paper proposes a novel prediction-based fair wavelength and bandwidth allocation (PFWBA) scheme, which contains DBA and EDBA mechanisms of the Prediction-based Fair Excessive Bandwidth Allocation (PFEBA) scheme. The proposed EDBA mechanism improves the packet delay time by early execution of the DBA scheme for reducing the idle period, and also the DBA mechanism chooses the wavelength with at least available time for each ONU to reduce the average delay time.

The rest of the paper is organized as follows. Section II introduces the design of the DBA and dynamic wavelength. In Section III the system performance is evaluated by simulation results and Section IV concludes our paper.

2. The Design of DBA and Dynamic Wavelength

The paper proposes new mechanisms based on IEEE standard 802.3ah to improve the system performance and bandwidth utilization. In the early revisions DWBA scheme was proposed as an extension of EBR in WDM EPON system, which can allocate the bandwidth in two phases [4]. Primarily the system first allocates the guaranteed bandwidth for heavy loaded ONUs, and thereafter the requested bandwidth for light loaded ONUs. At last, after the REPORT messages are received, it reorganizes the available excessive bandwidth to the heavily loaded ONUs founded on the proportion of each request in the next cycle. The upstream is slightly different; the transmission cycle for heavy loaded ONUs raises the number of guard time, which drops the available bandwidth, and surges the packet delay.

The PFEBA is performing the DBA scheme once the *REPORT* messages from the unbalanced traffic ONUs are received at the ONU_{N-1} side, instead of at the end of ONU_N in the normal DBA scheme. The following action can decrease the idle period in the standard DBA scheme, and is able to discover more fresh information of unbalanced traffic ONUs for the improvement of the correctness of the prediction in the next cycle. Besides, the bandwidth is assigned to each ONU in the next cycle according to the unbalanced degree list, which is calculated by using the change of historical traffic and is arranged in reducing order of all ONUs. The DBA scheme of PFEBA eases the traffic change by shortening the waiting time. It is done before data transmission for unbalanced traffic ONUs, which also can improve the prediction correctness.

The DBA can cooperate with the PFWBA scheme for selecting a proper wavelength, and dropping the packet delay time for each ONU. The following services can be categorized into three priorities; so-called traffic classes: AF, EF and BE. Though EF traffic class services need bounded packet delay and jitter specification, AF is intended for services that are not delay-sensitive but need more bandwidth guarantees. As a final point, BE traffic class applications are not delay-sensitive and do not need any jitter specifications. The traffic outline is as follows: 80% is equally distributed between the low and medium priority traffic and the rest 20% of the total generated traffic is considered as high priority traffic [5]. In Table I the description of parameters is given.

Table I. The description of parameters in WDM PONs

N	Number of ONUs in the system
β_V	Set of ONUs with higher traffic variance in unbalanced degree list
N_V	Number of ONUs in the β_V
Tcycle	Maximum cycle time in one cycle
λi	Wavelength i, where i = 1, 2,….*w*
CAT[i]	Channel available time, where i = 1, 2,...,*w*
RTT[i]	Round trip times between the OLT and the i^{th} ONU

Figure 1 shows the wavelength preparation and scheduling procedure.

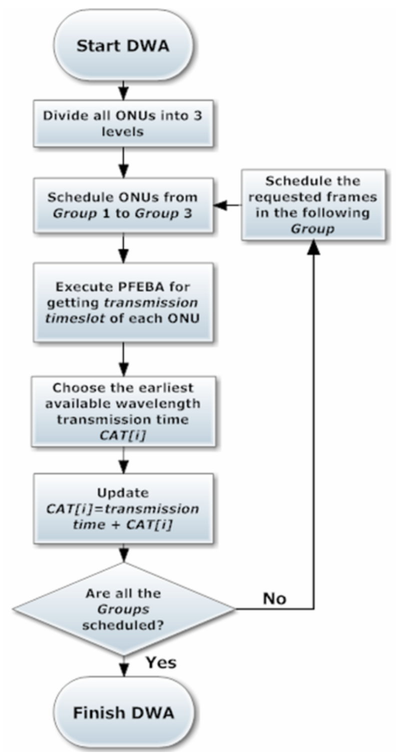


Fig. 1. Flowchart of DWA

3. Performance Valuation

Table II. System Parameters

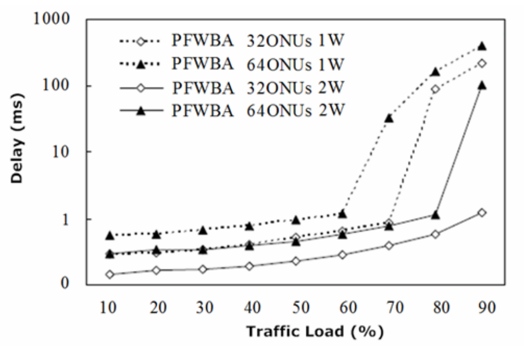
Parameter	**Value**
Number of ONUs	32
Upstream/downstream link capacity	1 Gbps
ONU-OLT distance	10-20 km
Guard time	5 μs
Maximum transmission cycle time	2 *m*s
Computation time of DBA	10 μs
Number of ONUs in β_V	4
Control message length	0.512 μs

The period time of simulation in OPNET is intended as 15 seconds. The package strategy is chosen as a First-in-First-out (FIFO). Extensive studies show that the network traffics can mostly be categorized according to LRD and self-similarity, which are examined in the traffic modeling [6]. The system model is set up in the OPNET simulator with one OLT and 16 or 32 ONUs. Table II is showing the system parameters used in the paper. The distance from OLT to ONU is 10-20 km, the downstream and upstream link capacities are equally 1 Gbps. 2 stages are discussed; first each ONU has 10 MB of buffer size and second each ONU has an infinite buffer size. In the simulation the maximum transmission cycle time is 2 *m*s with 5μs of Guard time.

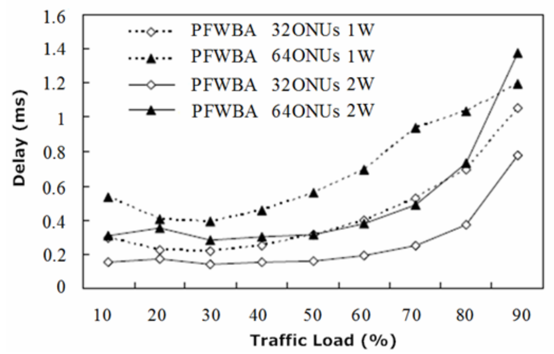
3.1 ONU with 10 MB Buffer State

I. Packet delay

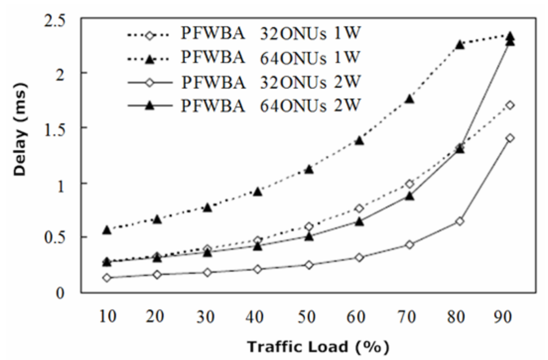
Figure 2 (a, b, c, d) associates the packet delays of PFWBA for EF, AF and BE traffic classes with different numbers of wavelengths and ONUs versus traffic loads in 10M buffer state.



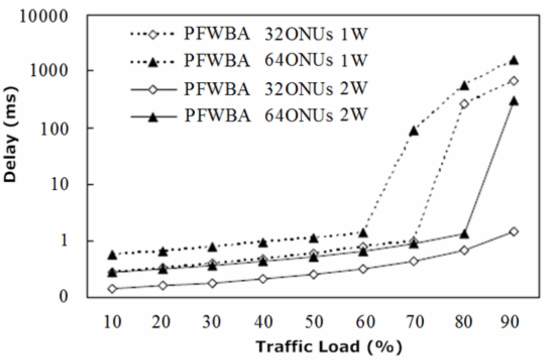
(a) Average packet delay



(b) EF packet delay



(c) AF packet delay



(d) BE packet delay

Fig. 2 (a, b, c, d) Packet delay comparison for PFWBA (10M Buffer)

II. Jitter performance

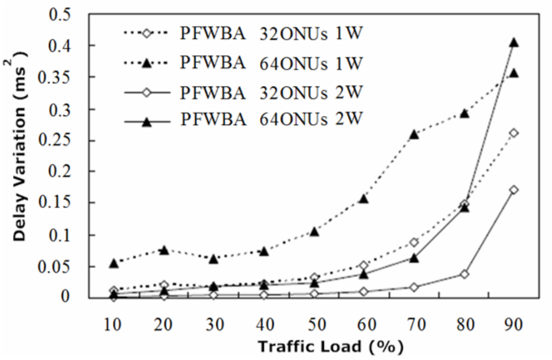


Fig. 2 (a)

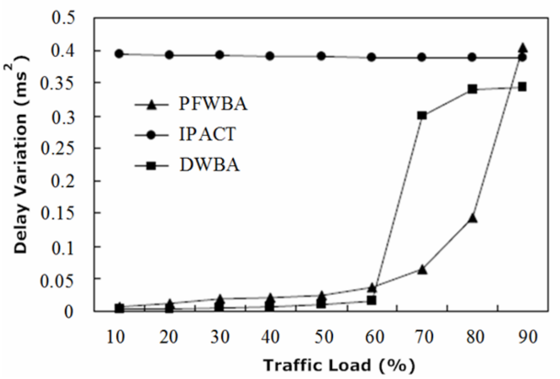


Fig. 2 (b)

Fig. 4.10 (a, b) Delay variation of EF traffic classes (10M Buffer)

Figure 2 (a, b) compares the jitter performance with different number of wavelengths and ONUs versus traffic loads, separately.

III. Packet Loss

Fig. 3 (a, b) shows the comparison of the packet loss ratio with unlike number of wavelengths and ONUs versus traffic loads, respectively for 10 MB buffer size.

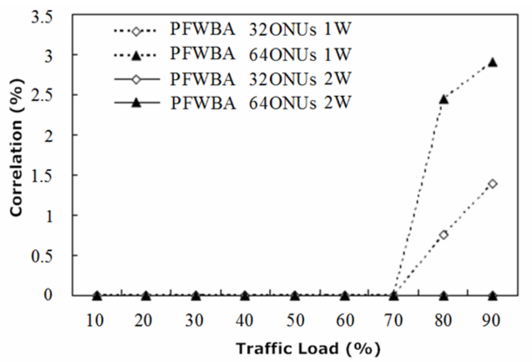


Fig. 3 (a)

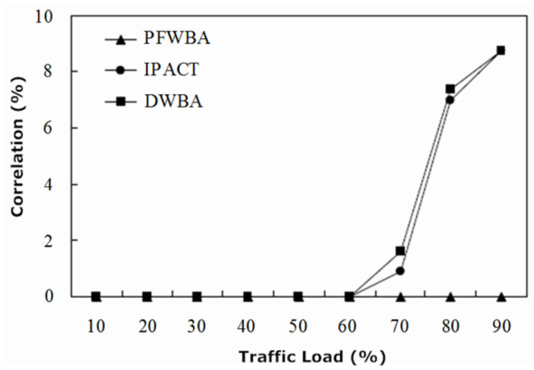
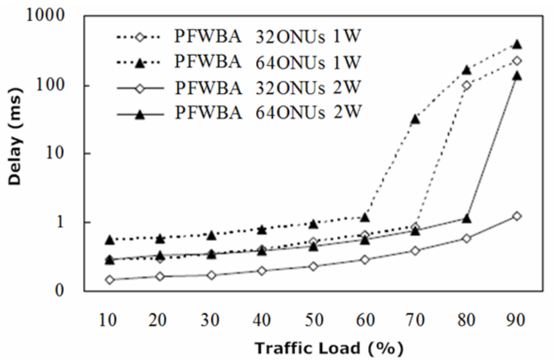


Fig. 3 (b)

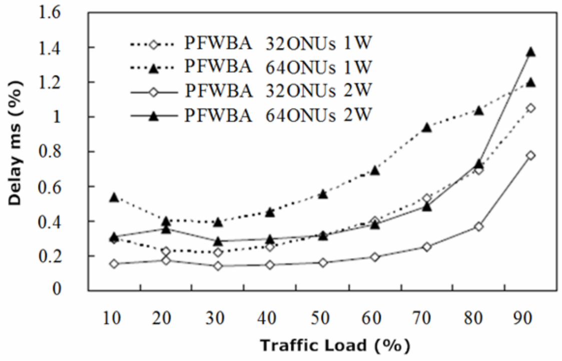
3.2 ONU with an Infinite Buffer State

I. Packet delay

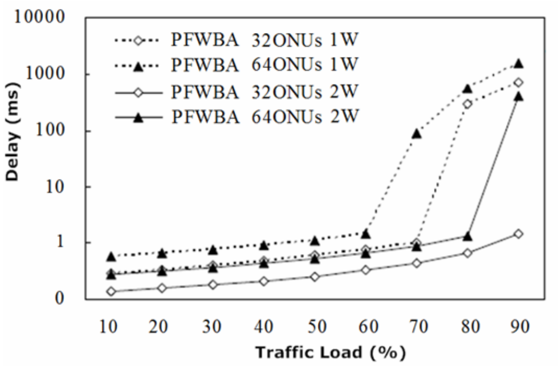
Figure 4 (a, b, c, d) shows the comparison of the packet delay of the PFWBA for EF, AF, BE traffic classes and total traffic classes with an unlike number of wavelengths and ONUs versus traffic loads in an infinite buffer state. Judging from the simulation results we can say that the packet delays for EF, AF and BE traffic classes are being drastically increased when the traffic load is raised.



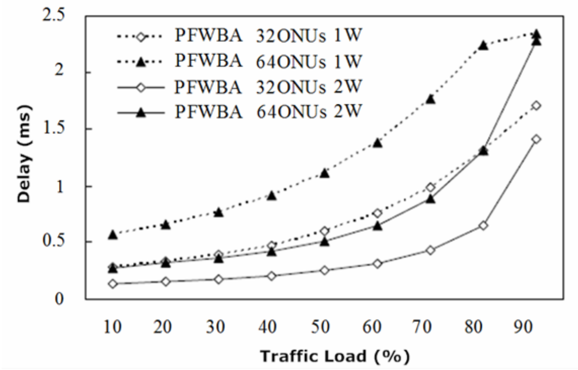
(a) Average packet delay



(b) EF packet delay



(c) AF packet delay



(d) BE packet delay

Fig. 4 (a, b, c, d) Packet delay comparison for PFWBA (Infinite Buffer)

II. Throughput

In Figure 5 is shown the throughput of PFWBA, WDM IPACT and DWBA with two wavelengths and 64 ONUs for numerous traffic loads. When the traffic load is heavy, the PFWBA has the best system throughput. The reason behind this fact is that WDM IPACT has FBA of 15000 bytes for every ONU, resulting in an inefficient bandwidth allocation, while DWBA has a long guard time, since the number of heavy loaded ONUs are amplified when the traffic load is too high.

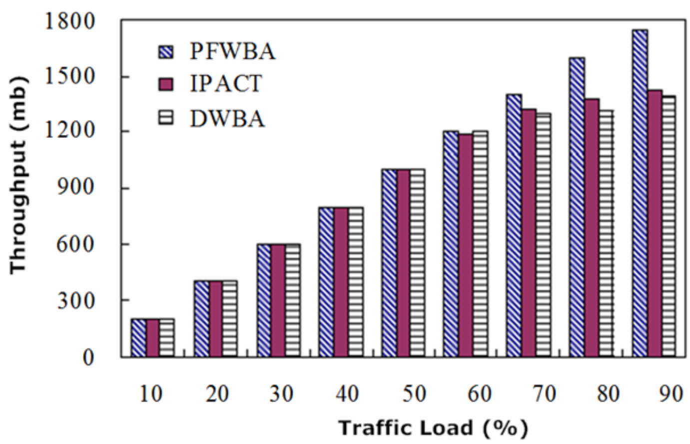


Fig. 5. System throughput

6. Conclusion

The paper proposes a novel DBA schemes for improving the QoS and the bandwidth utilization. In future internet providers can use the proposed schemes for providing their individual services. Moreover, they will be able to deliver high quality video-on-demand, P2P and other on demand services. Our proposed EDBA mechanism improves the packet delay time by early execution of the DBA scheme for reducing the idle period. The DBA mechanism chooses the wavelength with at least available time for each ONU to reduce the average delay time. Furthermore, the DBA can cooperate with the PFWBA scheme for selecting a proper wavelength, and dropping the packet delay time for each ONU.

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Դինամիկ ցանցի թողունակության նոր սխեմաներ EPON համակարգում թողունակության և ազդանշանի բարելավման համար

Դ. Բեյբության

Ամփոփում

Հոդվածում առաջարկվում են դինամիկ թողունակության բաշխման (ԴԹԲ) նոր առաջատար սխեմաներ ԻՊՕՆ համակարգերում ազդանշանի որակի (ԱՈ), համակարգի աշխատանքային կատարողականության և թողունակության օգտագործման բարելավման համար: Առաջարկված ԴԹԲ-ի սխեմաները հնարավոր են դարձնում վերականգնման մեխանիզմի օգտագործումը սնուցող գծերում: Այն թույլ է տալիս նաև խափանումների բացակայության դեպքում վերաբաշխման միջոցով բեռնաթափել սնուցող գծերի աշխատանքային բեռնավորվածությունը: Օպտիկական գծերի տերմինալում (ՕԳՏ) կամ սնուցող գծերում խափանումների առաջացման դեպքում վթարային գծերը կվերականգնեն խափանվածներին: Կանխագուշակման ճշգրտության և համակարգի աշխատանքային կատարողականության բարելավման համար կանխագուշակման վրա հիմնված արդար ալիքի և թողունակության բաշխման (ԿԱԱԹԲ) սխեման արդյունավետ կերպով ինտեգրում է կանխագուշակման վրա հիմնված արդար ավելորդ թողունակության բաշխման (ԿԱԱԹԲ) ԴԹԲ և ՎԴԹԲ մեխանիզմները: P2P VoD ծառայությունների բարելավման համար աշխատանքն առաջարկում է ԴԹԲ սխեմաների նոր ալգորիթմներ: Առաջարկվող ԴԹԲ սխեմաների կատարողականությունը գերազանցում է նախկինում առաջարկված սխեմաների կատարողականությունները:

Новые ДПС схемы для улучшения пропускной способности и качества сигнала в ЕПОС системе

Д. Бейбутян

Аннотация

Работа предлагает усовершенствование DBA схемы для улучшения Качества Сигнала (QoS) в EPON системах, улучшения производительности и пропускной способности системы. Предложенные DBA схемы позволяют оптическим линиям обладать механизмом восстановления. Это также позволяет разделить рабочую нагрузку линий, если в системе отсутствуют отказы. Если возникает отказ на терминале оптических линий или на самих линиях, запасные линии сразу восстановят работоспособность отказавшего участка. Для улучшения точности предсказания и эффективного функционирования системы (PFWBA) схема эффективно объединяет DBA и EDBA схемы PFEBA. Для улучшения P2P VoD услуг работа предлагает новые алгоритмы для DBA схем. Рабочие показатели предложенных DBA схем превосходят показатели ранее предложенных DBA схем.