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PRE-COMPUTATIONAL CYNAMIC BANDWIDTH ALLOCATION ALGORITHM USING TDM/WDM PASSIVE OPTICAL NETWORKS

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Abstract

Passive optical networks are referred to as the main means of communication for high-speed data transmission. Today's passive optical network techniques fail to utilize the available bandwidth efficiently and also unsuccessful to effectively use the idle time. So to overcome these problems, a pre-computational algorithm has been presented in this paper which overcomes the problems stated above. The proposed algorithm is expected to reduce the delay is capable to quickly assign the bandwidth requests by the ONUs.

***Key Words*:**dba,olt,onu,rn.

1 Introduction

The demand for high-speed networks is increasing exponentially and Passive Optical Networks (PON) is considered as the promising solution which can provide great speeds.

Time Division Multiplexing (TDM) has been the best multiplexing technique for quite some amount of time. But due to its bandwidth limitation, it had not survived for much time. A new multiplexing technique Wavelength Division Multiplexing (WDM) has been implemented further by using different wavelengths in same optical fibre which increased the capacity of PON networks [3]. The shortage of wavelengths in WDM was considered as a problem but the implementation of TDM into each wavelength and introducing shared network in one wavelength made up a new multiplexing technique called hybrid TDM/WDM technique.

The Multi-Point Control Protocol (MPCP) is introduced in the PON networks to dynamically allocate the bandwidth to the users. It provides better utilization rate for the DBA algorithm. It consists of two operation modes: 1) Normal Mode and 2) Auto Discovery Mode. In normal mode MPCP consists of two control messages namely REPORT and GATE. A REPORT message is received by the OLT from the ONU, which is passed by the MAC client, responsible for recalculation and allocation of round-trip time to the source ONU [2]. This mode is used in our algorithm as the data transmission protocol.

Ethernet Passive Optical Network (EPON) is a solution for the first mile optical access network [1]. While GPON, or Gigabit PON, is expected to prevail as a leading optical access technology and to eliminate the bandwidth bottleneck in the last mile. But EPON is cost-efficient and more suitable while on other hand GPON has higher bandwidth, faster transmission rate and supporting triple-play services.

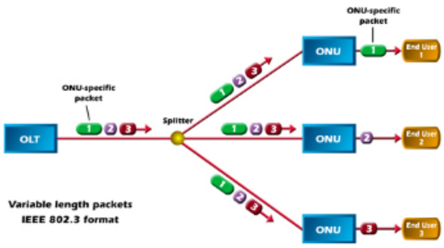


Figure 1 Passive Optical Network

Fig 1 consists of 3 main sections ONU, OLT, Splitter/ Remote Node (RN). The Optical Network Unit (ONU) is the unit present by the customer premises. The main function of this unit is to convert light signal which comes from the optical fiber to the electrical signal and vice versa for the convenience of users. The optical line terminal (OLT) is the central office of the whole network. This is usually a telecom operator and controls the flow of data through the network. All the available bandwidth is stored at the OLT. The remote node (RN) present in the middle of the network is used as a splitter to split and combine the data coming from the OLT and ONU respectively. The following paper has been divided into the sections given below. Section II consists of literature review for the analyzed papers, Section III consists of proposed algorithm and its flowchart, Section IV consists of results, Section V consists of conclusion followed by references.

2 LITERATURE REVIEW

In paper [4] a linear proportional algorithm is proposed which categorizes the data into 3 categories like voice, video, web browsing. The voice data are given the higher priority and other kinds of data are given lower priority which leads to the starvation of services like browsing and email. But the idle time problem still exists.

In paper [5] a partially online DBA algorithm is proposed which idle period problem is reduced to some extent. This is done by the allocation of bandwidth to highly loaded ONU's immediately when they appear. But the problem is that the OLT won't allocate any bandwidth to the heavily loaded ONU if sufficient bandwidth is not at the OLT.

In paper [6] a sort-DBA algorithm is proposed where the idle time is compensated by sorting the requests from all the ONUs are placed in ascending order were the heavily loaded ONU is placed in the last to use the idle time. But the heavily loaded ONU has to starve till the end of the cycle which is undesirable in PON networks.

In paper [7] a predicting and allocating algorithm has been presented which is designed based on next-generation XG-PON. The data is divided into 4 major categories like TCONT-1 for constant bit rate, TCONT-2 for assured bandwidth, TCONT-3 for non-assured bandwidth and TCONT-4 for best effort. The report and grant messages are sent which in the data. There is no special allocation for the report messages. So if no data is processing in the channel then the OLT cannot know the requests of that ONU which is the disadvantage of this paper.

In paper [8] two algorithms namely Status Reporting (SR) and Non-Status Reporting (NSR) are proposed. In SR algorithm the bandwidth requests from all ONU's are collected and sent to the OLT. OLT further categorizes these requests into two types namely highly loaded and lightly loaded. While processing the lightly loaded bandwidth, the excess bandwidth will be collected and stored at the OLT and while processing the heavily loaded the excess bandwidth is given to that ONU. As this algorithm utilizes the excess bandwidth effectively, the idle time of the network is very high which makes it unreliable. The NSR algorithm doesn't send any requests to the OLT. Instead, the OLT itself estimates the amount of bandwidth it requires and allocates it to the ONU. This is a predicting-type algorithm and the algorithm like these will not work effectively in Passive Optical Networks (PON).

In paper [9] three similar algorithms namely DWBA-1, DWBA-2, DWBA-3 has been proposed. Of all these three DWBA-2 is said to be the best method. In DWBA-1 OLT receives bandwidth requests from all the ONUs. If the requested bandwidth is present at the OLT, it will allocate it to the requested ONU's. Whenever the requested bandwidth is not available the excess bandwidth is collected from the lightly loaded ONU's and is allocated to the lightly loaded ONU's. That explains to us that the excess bandwidth will not be collected until there is a requirement. In DWBA-2 the OLT will not wait for all the request messages, instead will allocate immediately once the heavily loaded ONU occurs. In DWBA-3 the OLT will not wait for all the request messages, instead sends the gate message immediately the report message is received.

In paper [10] an Interleaved Polling with Adaptive Cycle Time algorithm is proposed. The report message is sent to the OLT once the gate message is received by the ONU. By this technique, the OLT can know the amount of bandwidth that it has to compensate to the data that is waiting at the ONU so that it can allocate it in the next cycle. The round trip time (RTT) of all ONU's are stored in a table like a format at the OLT to reduce the collision.

In paper [11] a limited sharing with traffic prediction DBA algorithm has been presented where the report message from the OLT to ONU is sent before the request message from the ONU is received. This is done by predicting the bandwidth from the previously requested bandwidth. But bandwidth prediction is not the perfect method to allocate the bandwidth which makes this algorithm inconsistent.

3 PROPOSED DBA ALGORITHM

Our proposed algorithm consists an OLT, an RN (Remote Node) and n ONUs (where n can be any number 8, 16, 32 and 64). The data is transmitted from OLT to ONU and vice versa through RN. The total available bandwidth is fixed at OLT and it cannot allocate bandwidth more than that. Initially, at the ONU, the request messages split into two categories. The first category also called FRAME-1 consist of requests only from highly loaded ONUs, and the second category also known as FRAME-2 consist of requests only from lightly loaded ONUs.

Initially, the bandwidth requests by the users appear at the respective ONU's. All these requests are processed at the ONUs and send to the OLT in the two above mentioned frame formats. The FRAME-1 is sent first and this frame consists of the requests only from the heavily loaded ONU's. These requests arrive at OLT and are processed in first-in-first-out (FIFO) process. If the total requested bandwidth is less than the bandwidth at the OLT, the

ONU requests are allocated as per their requests. If the requested bandwidth is not available at the OLT then the total available bandwidth present at the OLT is divided by the number of heavily loaded ONU's. This bandwidth named as crisis bandwidth as this process will take place only in the crisis situation. The crisis bandwidth is added to the existing bandwidth of each ONU and the gate message is sent by the OLT. Once this gate message sends by the OLT is received by the ONU's, ONU's will update their bandwidths and the FRAME-2 will be processed.

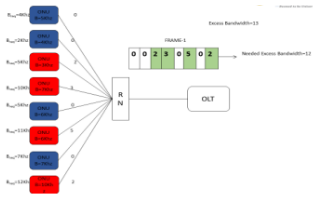


Figure 2 Frame-1 report message

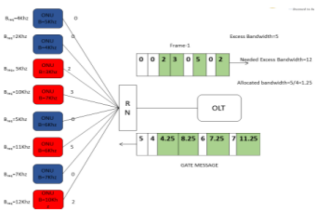


Figure 2 Frame-1 at crisis situation

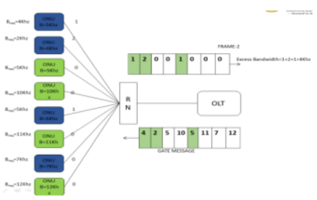


Figure 2 Frame-2 Report and Gate massage

The FRAME-2 consists of the requests from only from the lightly loaded ONUs and the subtraction of the maximum bandwidth to the requested bandwidth will be sent to the OLT. At the OLT all these subtracted values are added up to get the excess bandwidth present in the network and this bandwidth is used for the next cycle of heavily loaded ONUs. Later the FRAME-2 values are subtracted from the existing bandwidths at the OLT and the gate message is sent to all the ONU's and they will be updated.

A. Flow Chart

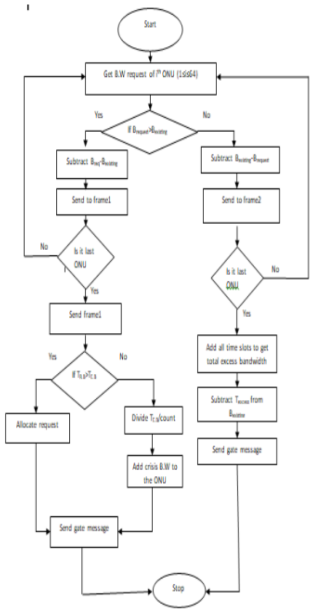
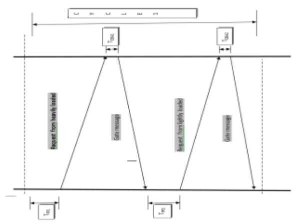


Figure 5 Flow Chart

B. B.Frame Format



4 RESULT

The results for the proposed algorithm have been presented below. The first graphs plot the throughput graph which can effectively work at given loads. The second graph shows the offered load vs bandwidth utilization rate for the proposed algorithm. It is compared with two other algorithms such as SREB and NSREB and it performs better than both the algorithms.

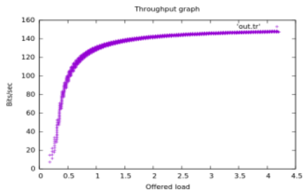


Figure 7 Throughput Graph

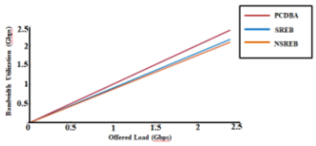


Figure 8 Offered load vs Bandwidth utilization graph

5 CONCLUSION

In this paper we have presented an algorithm which can had better throughput and can efficiently utilize the bandwidth properly. As shown in graphs the proposed algorithm works better than the other compared algorithms.

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