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Modified Dynamic Bandwidth Allocation Algorithm for Upstream Access in WDM/TDM PON to Reduce Energy Consumption

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Abstract: Dynamic bandwidth allocation for upstream access in Wavelength division Multiplexing (WDM) / Time Division Multiplexing (TDM) is proposed. In this proposed work, we have enhanced throughput and minimize packet delay to reduce energy consumption of the system. Therefore, proposed work involves less calculation while providing strong throughput. From the simulation result it can be concluded that modified dynamic algorithm provides more throughput and less packet delay as compared to randomly bandwidth allocation. We conduct detailed simulation experiments to study the performance and validate the effectiveness of the proposed protocols.
Keywords: WDM/ TDM, Buffer, Queuing, Throughput and Packet delay.

I. Introduction

WDM/ TDM**[1]**have many advantages like allocating the resources in the time slot according to the demand of user. Due to such advantage, efficiency is increased and average packet delay is reduced.

To allocate bandwidth to different ONUs, different algorithms are proposed from time to time like fixed bandwidth allocation, two layer bandwidth allocation **[2].** The advantage of fixed algorithm is that there is no overlapping among different users from different ONU's. But it leads to wastage of channel when transmitter does not send any data during its time interval. Due to above mentioned disadvantage, dynamic bandwidth allocation algorithm came into existence. Dynamic bandwidth**[3]** allocation depends upon data length of each ONU and time of arrival of each packet. In the proposed work, average packet delay as well as throughput is increased by increasing the size of buffer and introducing the queuing. Using queuing the data coming from different ONUs are kept in a queue and are processed according to the demand and suggestion of OLT. The Ethernet PON (EPON) has various positive aspects which includes compatibility with traditional Ethernet, flexibility, reliable, and offer various services and more.

The solutions of the problems lie in this advantages only for better outcomes. However, EPON is a single-channel system in which the potential of the system fully utilized. The introduction of this technology helps to carry your system to the next level [13].

1.1EPON

PON is something that carries Ethernet Traffic. Thus, EPON is a combination of Ethernet and time division multiplexing (TDM). Ethernet is accepted in EPON technology perfectly from OTL broadband to proper ONUs with the help of media access control address which is associated in the Ethernet packets in downstream transmission. In the upstream direction, the TDM technology is used [14].The GATE message transfers to proper ONU with the help of starting transmission time and length after receiving the data request.

The paper is organized in the following section: Section 2 deals with proposed work and its algorithm whereas section 3 focuses on Result and discussions.

II. Proposed Work

In the proposed work, we have developed a new algorithm to improve network performance. Steps of algorithm are as follow:

SIDBA (n, G, $\alpha, \Delta t, Q[]$) , Where IDBA is the improved version

//n is the number of ONU;

// $\Delta t = RT$

// α is the traffic load; $Q[]$ stores the data length in information of each ONU.

****Initialization****

While Q_ ~=0

For I ←1 to n

A[i] ← 0//Store bandwidth allocation results of ONU i

P[i] ← 0//Store n randomized variable

****Bandwidth Allocation****

For I ←1 to n

P[i] ← (Q[i]+ αG $\Delta t/n)(\alpha G\Delta t + \Sigma Q[i])$

A[i] ← $GP[i]$

Q_ =update [Q_]

End:: For loop 1

End:: For loop 2

End:: While

For optimized bandwidth utilization

No of ONUs = 32;

Type of system = OFDMA-PONs;

Data rate = 10Gbit/s;

Buffer size =Dynamic Memory allocated towards each ONU;

Queue Size = Dynamic;

Packet seize = 4000;

Traffic type distribution=Pareto;

The heavy traffic arrives to ONU, it dynamically adjust their bandwidth and used the bandwidth of low occupied ONU. This impact also increases the size of the queue and it sequentially process each input with the weightage of their size. If, the input data is of large size and its priority is high also due to its large processing time, it will affect the performance of ONU network. Consequently its high priority and process as compared to the other data. Also the allocated bandwidth for this process increases, secondly the process continues as long as queue is empty. As a result of this algorithm total network performance increases in terms of throughput, packet delivery ratio, packet delay as shown in the graphs of the next section.

When compared to the existing randomly dynamic bandwidth allocation, our algorithm performs better because to store the entire request coming from different ONUs queue and buffer are used to store and process the request. This further helps to remove the overlapping of different requests since requested are implemented according to demands. Queuing helps to store all the contents temporarily. Increasing the buffer size will further leads to decrease the overlapping. This enhances high throughput and less packet delay.

III. PREVIOUS WORK

RDBA (n, G, α, Δt, μ[]) //pseudo code
--n is the number of ONU
--$\Delta t$is the time delay.
--, α is the traffic load
-- μ[] stores the data length information of each ONU
Perform the initialization***
For I ⟵ 1 to n
A[i] ⟵0 // store the bandwidth result of ONU i
P[i] 0⟵store N random variables
Bandwidth allocation
For I ⟵ 1 to n
P[i] ⟵ $(\mu[i] + \alpha G \Delta t/n)/(\alpha G \Delta t/n + \sum \mu[i]$
A[i]

IV. Difference between previous work and proposed work

Key difference between existing approach and new approach is introduction of the concept of queuing. In the previous work data is stored in the variable named as $\mu[i]$, But the disadvantage is that when data becomes very high or demand increases a lot there is no temporary queue to store the data temporary. Thus average delay time increases and throughput decreases. But this is not with our case where we have large buffers to store the data hence through put increases. Further, data is processed in parallel in proposed algorithm as buffer sizes are very high. This in turns decreases overlapping of different demands of ONU and makes the system efficient.

V. Results and Discussions

This section investigates the throughput and average packet delay versus traffic load of random and our modified dynamic bandwidth algorithm. From the throughput graph attached below in fig.5.1states that when the traffic load is less than 0.5 both existing as well as proposed algorithms shows similar behavior. Increasing traffic load above 0.5 proves the strength of our proposed algorithm. Further From the fig.5.2 of average packet delay graph can state that when traffic load is less than 0.5 both the algorithms shows similar behavior but on increasing traffic load our algorithm proves better since we have high buffer size as well as intelligent queuing. From the above discussion we can state that the proposed algorithm improved throughput and decreased average packet delay.

Table 1: Parameters and its attributes

Parameters	Values
Simulation	MATLAB
Number of ONUs	32
Type of System	OFDM-PONs
Data rate	10 Gbit/s
Buffer Size	Dynamic
Queue Size	Dynamic
Packet size	40000
Traffic Type Distribution	Pareto

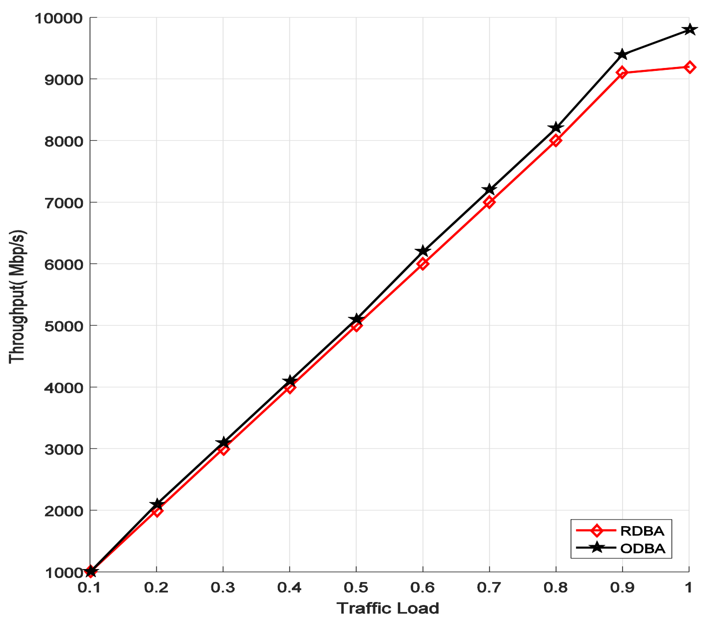

Fig. 5.1 Throughput

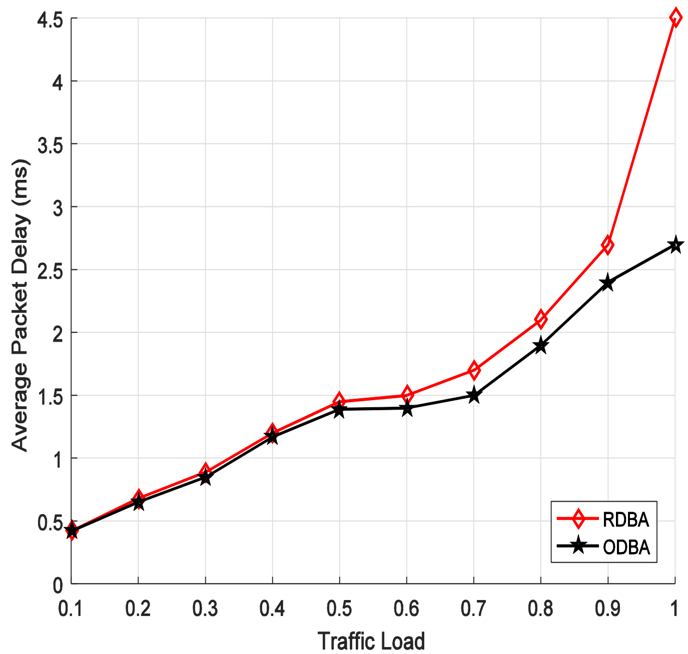

Fig.5.2 Average Packet Delay

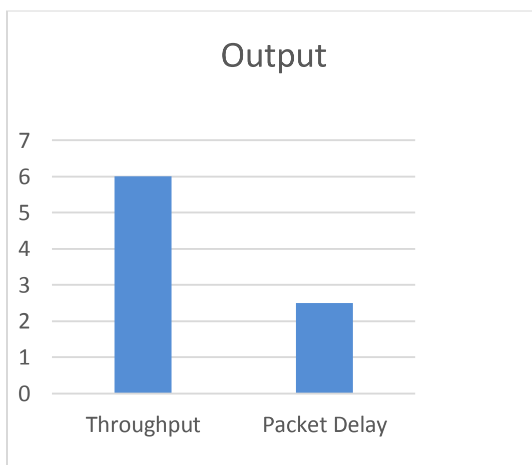

Fig 5.3: Final Outcomes

VI. Conclusion

This paper proposes a novel modified dynamic bandwidth allocation algorithm for upstream access in WDM/TDM PON System. Introducing the concept of Queuing and buffer size, proposed algorithm performs better in the form of throughput and average packet delay. D_{max} = maximum demand of the ONUs for the time slot. If value of Dmax increases discrepancies increases and this will test the robustness of any algorithm. More demand may lead to overlapping of different user data. Keeping this in mind we have introduced the concept of buffers and queuing. This helps to store all the information temporary in virtual slot and make sure that increasing demand discrepancies does not results in data overlapping. Many algorithms fail when demand discrepancies increases but LOWS1 and BOHSA do not fail at high demands. New Graphs comes when we decrease the buffer size throughput decreases and average delay increases. This is because as buffer size decreases less demands are kept there hence efficiency decreases. This in turn decreases parallel processing.

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