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Fixed Advance Priority based Bandwidth Utilization in TDM EPON

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Abstract

PON technology can be used to avoid the placement of electronics in the field by using passive optical filters (splitters) to distribute optical circuits to individual customers. They reduced the amount of fiber and local exchange and field equipment. With the development of services offered by the Internet, the "last mile" bottleneck problems persist to increase step by step.

Many algorithms were developed for making TDM EPON efficient similar to Scheduling, Priority swapping etc. These all algorithms have problems like starvation, QoS, latency and channel under-utilization. We focused the efficient bandwidth utilization in TDM EPON by managing time slots within ONUs and reducing latency and increasing quality of service.

Our Fixed Advance Priority based Bandwidth Algorithm is an intra-ONU bandwidth allocation algorithm, which is used to enhance the network performance by evaluating the parameters like channel underutilization, delay and Quality of Service. The issues which are lacking in the already made algorithms are being resolved with our proposed solution. The main problem time slots management issue solved in FAPB algorithm.

Keywords: Last Mile Solution, QoS (Quality of Services), FAPB (Fixed Advance Priority based Bandwidth) Algorithm, Delay, Rahul Tiger

1. Introduction

Passive Optical Networks (PON's) are point-to-multipoint optical networks. There are no active elements (such as amplifiers) in the signals path from source to destination. The elements used in such networks are passive combiners, couplers, and splitters.

PON technology is receiving more and more interest by the telecommunication industry as the "last Mile" solution. The "Last Mile" solution is also called "First Mile" solution. Last Mile solution means provides the leg connectivity from communication provider to customer sites.

EPON are emerging access technology that provides the low cost method to deploying the optical access line between Central Office and Customer Site's.

1.1 EPON Features
1.2

1. EPON is inexpensive, flexible, and efficient.
2. 802.3ah draft standard does not mandate a scheduling algorithm. [8]

1.2 PON Components

There are two types of PON components.

1. Active Network Elements
2. Passive Network Elements

1.2.1 Active Network Elements

Vendors of the Network elements mainly focus on active network elements for instance CO chassis and ONU, because these elements can reduce the cost of laying network. The CO chassis is located at service provider's CO, head end. [1]

Optical Line Terminal (OLT):

This network element is placed in CO (Central Office). Its functional units are dependent upon which type of multiplexing used TDM, WDM or hybrid, but main functional unit is transponder. [1]

Optical Network Unit (ONU):

The ONU provides interface between the customer's data, video and telephony networks and the PON. Its primary function is to receive traffic in optical format and then convert it to the user desired format (Ethernet, IP multicast etc.). [1]

Optical Splitter:

Optical Splitter is that with only one input referred to as splitter.

Combiner:
A coupler with only one output referred to as combiner.

1.2.2 Passive Network Element

These elements are placed between OLT and ONUs.
1. Optical Coupler/Splitter.

Optical Coupler:
An optical coupler consists of two fiber fused together. Simply, combine optical signals from multiple fibers into one.

1.3 PON Topologies:

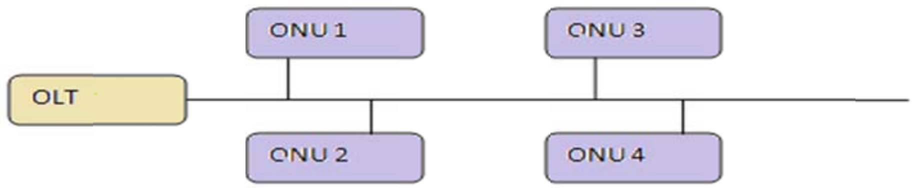


Fig. 1 Bus Topology [[1]

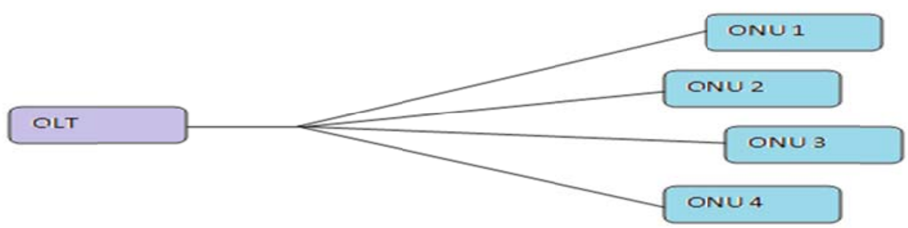


Fig. 2 Tree Topology [1]

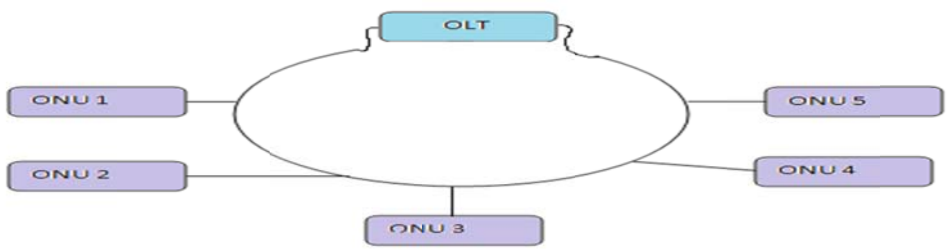


Fig. 3 Ring Topology [1]

PON Topologies

Ring Topology is better than others but mostly Tree

Topology used.

1.4 Transmission in EPON:-

There are two types of transmission in EPON are used:-

1. Downstream(Broadcast from OLT to ONU's)
2. Upstream (Joint from ONU's to OLT)

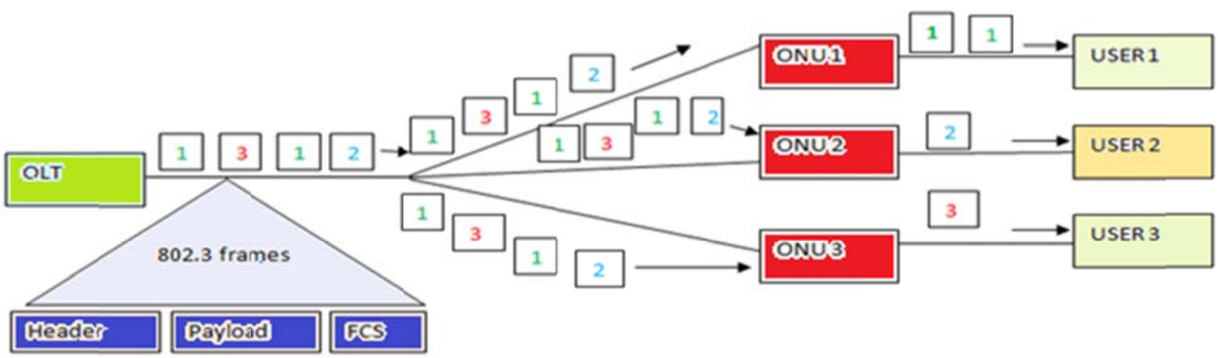


Fig. 4 Downstream Traffic in EPON [4]

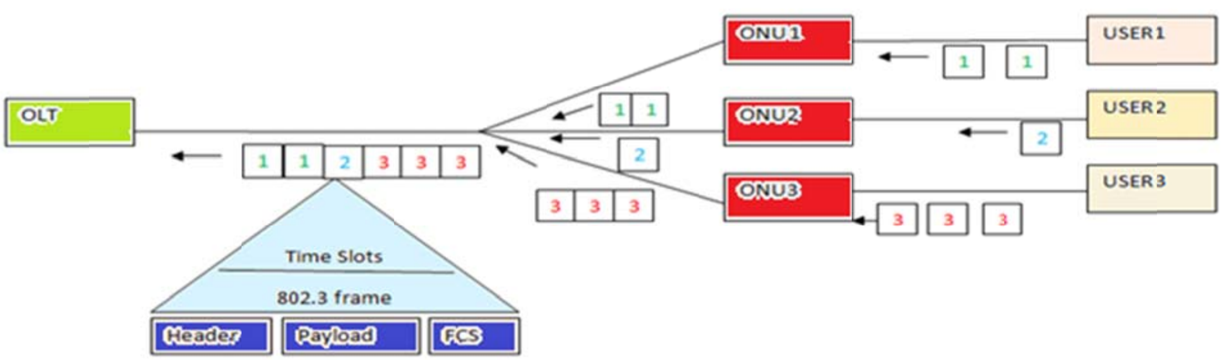


Fig. 5 Upstream Traffic in EPON [4]

2. Accessible Solutions:-

In Scheduling algorithm (No class) except delays there is also one another part for the load management and bandwidth utilization by the ONUs, as we have to broadcast the packets on the basis of the timeslot, if the size of the packet is greater than the timeslot being offered by the OLT, for transmission then that trace has to wait for the next time slot, this may cause channel underutilization, we can avoid it by implementing scheduling, at the ONUs. [7]

In Scheduling algorithm (With Class) We will implement the scheduling in the way that assume there are five packets in the buffer, if the size of the first three and fifth one is up to that is offered by the timeslot, then we will not wait for the fourth packet that is not fitting in the timeslot, we will allow fifth one to move first in the timeslot, by doing so channel will not be underutilized, and less timeslots will be required for packet transmission. [7]

In scheduling algorithm used. We can use different algorithms to fit packets in buffer queue such as first fit, best fit, prediction etc. [7]

In Priority Swapping if the number of bytes 50% or $\alpha >= 0.5$ then assign to P1 is EF and p2 is assign to AF and p3 is assign to BE. If the number of bytes 30% or $\beta >= 0.3$ then 5 then assign to P1 is AF and p2 is assign to EF and p3 is assign to BE. I the number of bytes is 20% or $\gamma >= 0.2$ then 5 then assign to P1 is BE and p2 is assign to EF and p3 is assign to AF. [5]

Three Major Problems in existing Solutions are:-

- Quality of Service
- Delays

3. Material and Methods

Our FAPB (Fixed Advance Priority based Bandwidth) Algorithm is an intra-ONU bandwidth allocation algorithm focusing to handle in better way parameters, like channel underutilization, starvation, delay and Quality of Service.
We have compared our solution with “priority swapping” and simple “scheduling” algorithm in which no classes were implanted for the purpose of quality of service.
As priority swapping contains three classes EF, AF and BE.
EF, AF and BE are IEEE classes. In our FAPB algorithm EF class bandwidth is fixed. EF bandwidth fixed as 60 %. Simply, it means 0nly 60 % data can be sent at a time in EF class (In T1). If the data is more than 60 % than second time slot T2 sent. Every time slot starts with EF data if exits. AF and BE bandwidth is not fixed but priory phenomenon used. Simply if the AF < BE then AF assign the priority p2 and BE act as p3 and if BE < AF then BE assign the priority p2 and AF act as p3.

Network Traffic Schemes

Scheme	Class EF	Class AF	Class BE
	400 / 40%	200 / 20%	500 / 50%
	200 / 20%	600 / 60%	300 / 30%
	100 / 10%	400 / 40%	500 / 50%

Table 1

3.1 Relative Analysis through Gantt Charts

Network Traffic Schemes for scheduling (no class) Priority Swapping and FAPB:-

Delays experienced by the priority queues are on the basis of their turn, when any class has 2nd or 3rd priority it has to wait for the previous class to end transmission.
In no class solution no queue is implemented so bits have to move on the basis of their arrival, while in priority swapping data of that queue has to move that is given highest priority, in FAPB algorithm always EF **1**st and AF and BE base own priority which is move 2nd.
In FAPB delays are less than others.
In No class solution, I entered the sequence No. for arrival of data in such a way:-
Sequence No. 1 AF > EF > BE
Sequence No. 2 AF > BE > EF
Sequence No. 3 EF > AF > BE

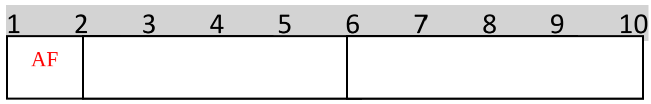
Sequence No. 4 EF > BE > AF

Sequence No. 5 BE > AF > EF

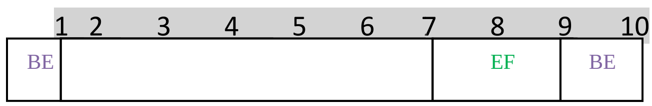
Sequence No. 6 BE > EF > AF

For No Class Solution

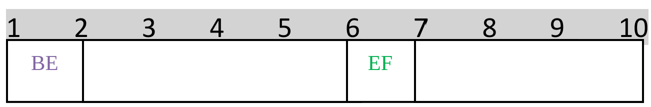
Sequence No. 1 enter



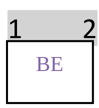
T1



T2



T3



T4

EF Delays = 15 µs

AF Delays = 3 µs

BE Delays = 21 µs

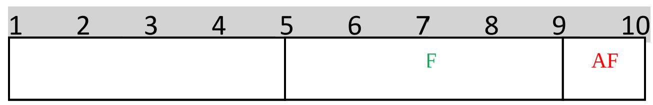
Flow Chart 1

Summary of Delays

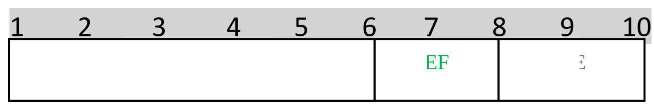
Instances	EF (µs)	AF (µs)	BE (µs)
1st	2	0	6
2nd	7	1	9
3rd	6	2	6

Table 2

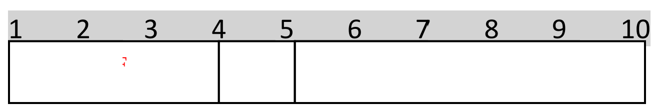
For Priority Swapping



T1



T2



T3

EF Delays = 16 µs

AF Delays = 9 µs

BE Delays = 14 µs

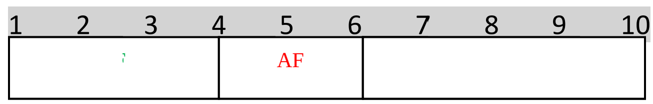
Flow Chart 2

Summary of Delays

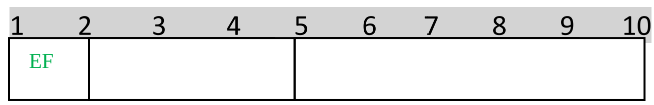
Instances	EF (µs)	AF (µs)	BE (µs)
1st	5	9	0
2nd	7	0	9
3rd	4	0	5

Table 3

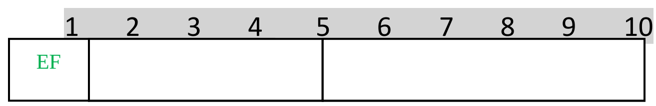
For FAPB Algorithm



T1



T2



T3

EF Delays = 0 µs

AF Delays = 10 µs

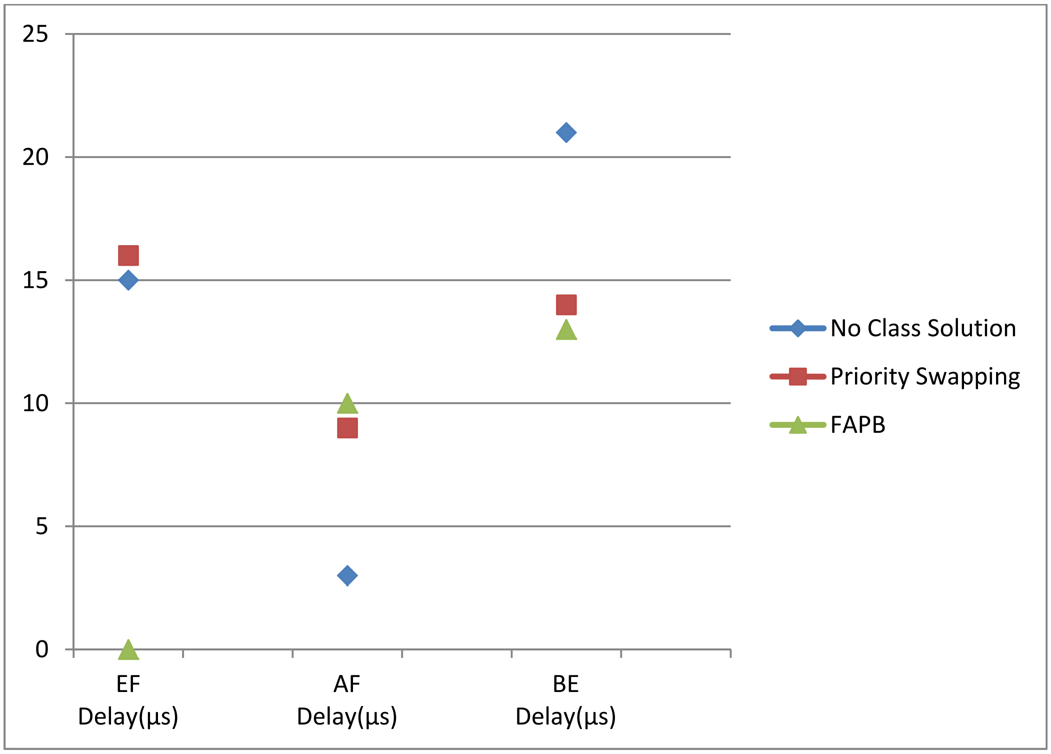
BE Delays = 13 µs

Flow Chart 3

Summary of Delays

Instances	EF (µs)	AF (µs)	BE (µs)
1st	0	4	6
2nd	0	5	2
3rd	0	1	5

Table 4


25
20
15
10
5
0
EF Delay(µs)
AF Delay(µs)
BE Delay(µs)
No Class Solution
Priority Swapping
FAPB

Graph 1

4. Results and Argument

It is observable from the graphs that in **No class Solution,** data that arrives first, occupies the timeslot. So at rush hours our important data may get very high delays and our communication is disturbed very much, such as in case of voice and video conferencing in daily life.
Priority swapping eliminates the case of high delays that are forced on our urgent transfer, however on the basis of priority there is a high chance of starvation at rush hours, also total delay that is experienced by data is higher than no classes, and there is also chance of starvation (75 % chance).
FAPB Algorithm is better than No Class Solution and Priority swapping because FAPB eliminates the drawbacks such as Latency and QoS is eliminated allocating more bandwidth to the urgent data class.

All these three solutions are compared in a scenario in last page, for same traffic.
Delay of EF was high for "no class solution", because in this solution no priority is given to any class, delay for "priority swapping" is lesser because in some cases EF has priority; in "FAPB" delay for EF is zero because data of EF moves always on first turn (Bandwidth fixed).
But AF and BE based own priority phenomenon.
Which priority is lesser than other move first (In both).

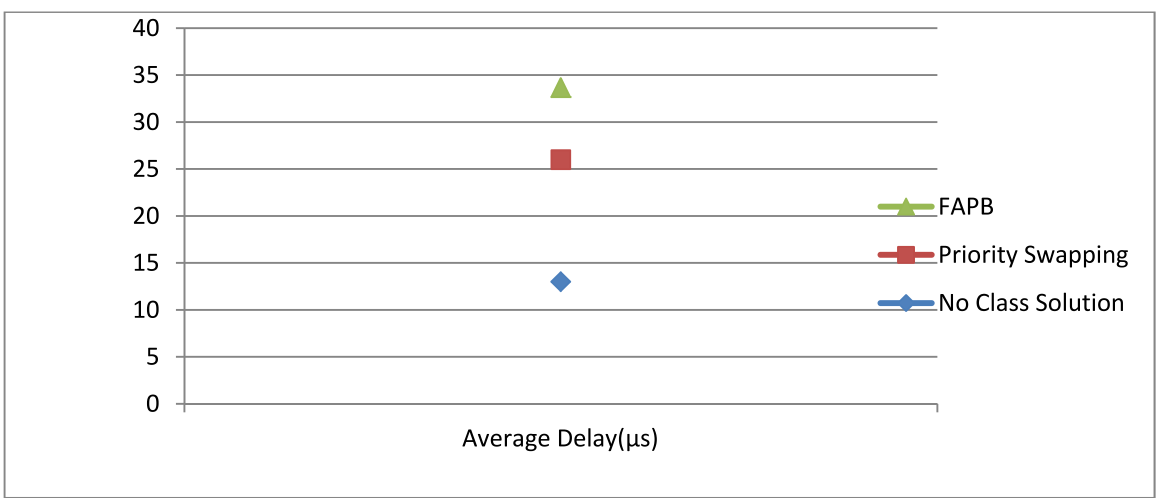
4.1 Total Delay Table & Graph:

Total Delay

Algorithms	EF Delays(µs)	AF Delays(µs)	BE Delays(µs)	Average Delays(µs)
No Class Solution	15	3	21	13
Priority Swapping	16	9	14	13
FAPB	0	10	13	7.667

Table 5

Average Delays (µs) Graph



Graph 2

6. Conclusion

It is accomplished that, TDM EPON transmission in point to multi point networks is the gainful method because all components are passive. It will be better if it is changed according to FAPB because the parameters which are affecting its QoS are handled in much better way in our solution. Hence, it is accomplished that TDM EPON is better technology till now if it is used with a better scheduler such as FAPB. Delay less than other comparison algorithms.

7. Future Directions

In future, other persons work on starvation to improve the better quality of services.
Network Traffic scheme can also be divided in more than three classes (mention IEEE classes) according to requirement so as to improve quality of service of our desired data.

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I Muhammad Bilal was born on November 14, 1987 at Faisalabad, Pakistan. I belong to a family of educationists, who are offering the best of their services for the last four decades. I recently did my B.Sc in Computer Science from UET, Lahore Pakistan. My research interest is in Computer Networks. I have already one research paper on my credit. I want to pay tribute to my parents who always encouraged, motivated me and are a constant source of inspiration throughout my academics. Apart from all above playing and watching cricket boosted up my morale high up till sky.