Rahul Fixed Priority Enhance Classes Bandwidth Exploitation in TDM EPON

Muhammad Bilal
Faisalabad, 38000, Pakistan

Abstract

A Passive Optical Network (PON) is a single, collective optical fiber that used low-cost optical splitters to divide the single fiber into split strands feed individual subscribers. PON'S are called passive because, other than at the CO (Central Office) and subscriber endpoints, there are no active electronics inside the access network. With the development of services offered by the Internet, the "last mile" restricted access problems keep it up to increase step by step.
Many algorithms were developed for making TDM EPON efficient similar to Scheduling (No class Solution) and Priority Swapping, IPACT etr. These all algorithms have problems like delay, QoS and channel under- utilization. We focused the well-organized bandwidth utilization in TDM EPON by managing time slots within ONUs and reducing latency and increasing quality of service.

Our Rahul Fixed Priority Enhance Classes Bandwidth (RFPECB) 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 RFPECB Algorithm. The main problem time slots management issue solved in RFPECB algorithm.

Keywords: Last Mile, QoS (Quality of Services), Rahul Fixed Priority Enhance Classes Bandwidth (RFPECB) Algorithm, ONU (Optical Network Unit) etr.

1. Introduction

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

PON technology is receiving additional furthermore more interest by the telecommunication production as the "last Mile" solution. The "Last Mile" solution is also called "First Mile" solution.

1.2 PON Components

There are two types of PON components.

I. Active Network Elements
II. 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):

Optical Line Terminal is placed in CO (Central Office). Its functional unit is dependent upon which type of multiplexing used a TDM, WDM or hybrid, but main functional unit is transponder. [1]

The OLT generates time stamped messages to be used as global time reference. It also assigns bandwidth and performs ranging operations. [4]

Optical Network Unit (ONU):

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

The ONU performs an auto-discovery process which Includes ranging and the assignment of both Logical Link IDs and bandwidth. [4]

1.2.2 Passive Network Element

These elements are placed between OLT and ONUs.

i. Optical Coupler/Splitter.
ii. Combiner

1.3 EPON Protocol:-

For controlling the P2MP fiber network, EPON uses the Multi-Point Control Protocol (MPCP).
MPCP perform bandwidth assignment, bandwidth polling, auto-discovery, and ranging. It is implemented in the MAC Layer, introducing new 64-byte control messages: [4]

- GATE and REPORT are used to assign and request bandwidth
- REGISTER is used to control the auto discovery process

1.4 PON Topologies:

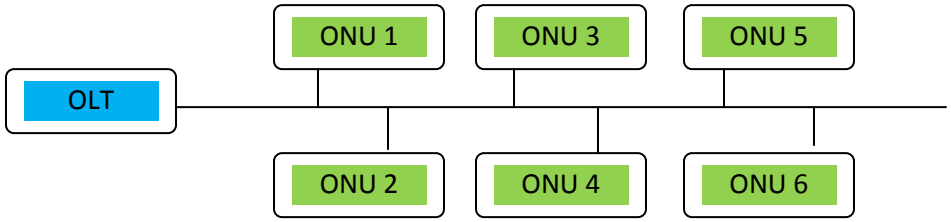


Fig. 1 Bus Topology [2]

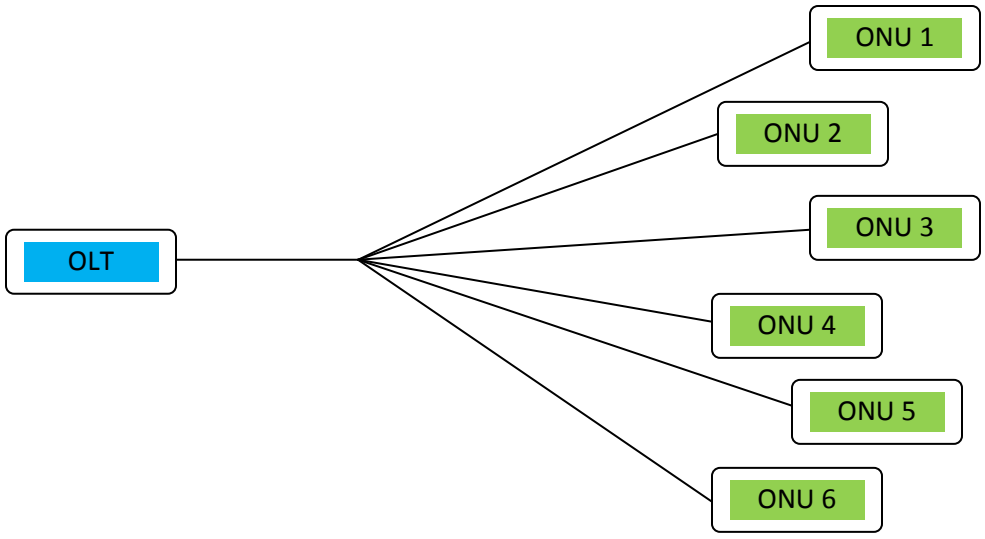


Fig. 2 Tree Topology [2]

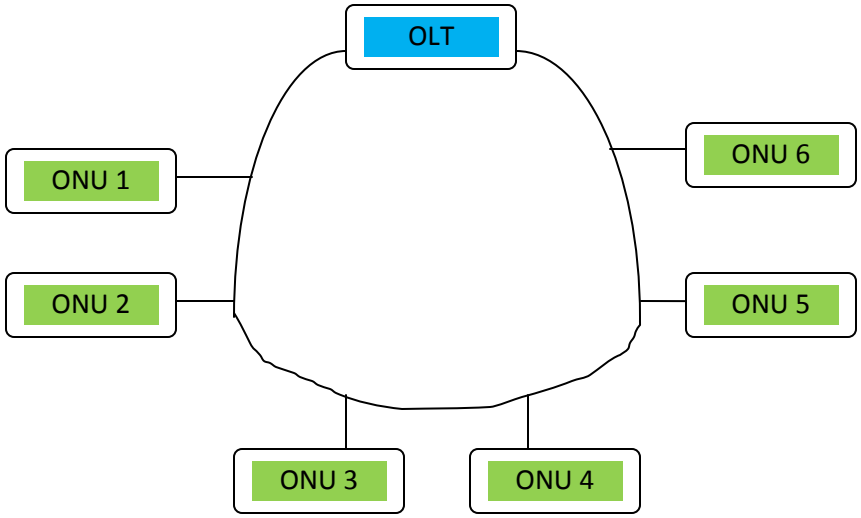


Fig. 3 Ring Topology [2]

PON Topologies

Ring Topology is better than others but mostly Tree

Topology used.

1.5 Transmission in EPON:-

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

1. Downstream (Broadcast from OLT to ONU's). Point to multipoint network.
2. Upstream (Joint from ONU's to OLT). Multipoint to point network.

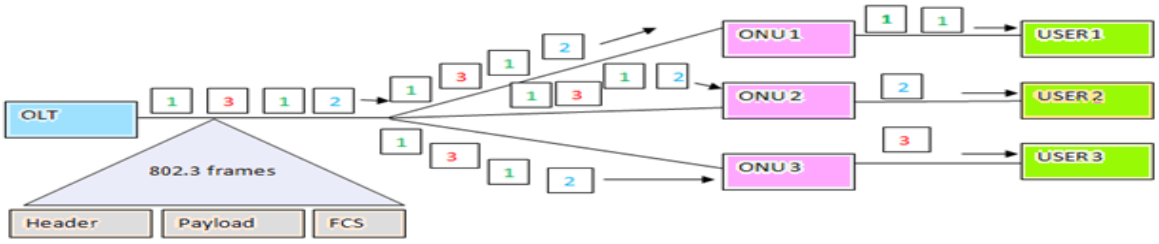


Fig. 4 Downstream Traffic in EPON [2]

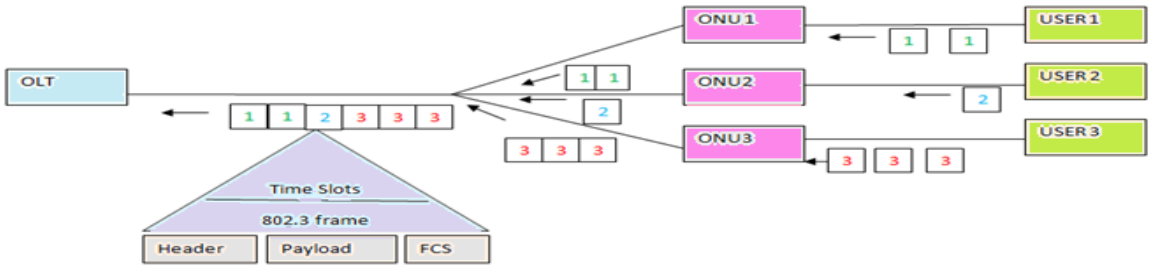


Fig. 5 Upstream Traffic in EPON [2]

2. Available Solution:-

In Scheduling algorithm (No class) except delays there is also one another part for the load administration and bandwidth deployment 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 obtainable 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. [3]

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 broadcast. [3]

Two Major Problems in available Solution are:-

- Quality of Service
- Delays

3. Stuff and Methods

Our Fixed Priority Enhance Classes Bandwidth (RFPECB) Algorithm is an intra-ONU bandwidth allocation algorithm focusing to handle in better way parameters, like channel underutilization, delay and Quality of Service.

We have compared our solution with simple "scheduling" algorithm in which no classes were implanted for the purpose of quality of service.

In RFPECB algorithm, I implemented the four classes.

- Expedited Forwarding (EF)
- Assured Forwarding (AF)
- Best Effort (BE)
- Text Forwarding (TF)

EF, AF and BE are IEEE classes. But RT is an additional class (Not an IEEE class). According to RFPECB algorithm EF deals with Video type data. AF deals with voice type data. BE deals with audio type data. TF deals with text type data.

In our RFPECB algorithm EF class bandwidth is fixed. EF bandwidth fixed as 40 %. Simply, it means 0nly 40 % data can be sent at a time in EF class (In every starting time slot). If the data is more than 40 % than second time slot T2 sent. Every time slot starts with EF data if exits. AF and BE and RT classes bandwidth are not fixed but priority phenomenon used. In three remaining classes which priority less than others move first and if tie condition exit among these three classes AF, BE, TF than AF first 2nd BE than TF move last. Because AF data is important than BE and BE data important than TF.

Network Traffic Schemes

Scheme	Class EF	Class AF	Class BE	Class TF
	300 / 30%	400 / 40%	200 / 20%	200 / 20%
	200 / 20%	300 / 30%	300 / 30%	200 / 20%
	400 / 40%	200 / 20%	100 / 10%	300 / 30%

Table 1

3.1 Relative Analysis through Gantt Charts

Network Traffic Schemes for scheduling (no class Solution) and RFPECB algorithm:-

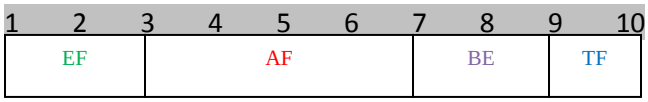
In no class solution no queue is implemented so bits have to move on the basis of their appearance, while in FPECB algorithm always EF 1st and AF, BE and TS base own priority which is less move 2nd.
In RFPECB delays are less than others.
In No class solution, I checked the delay through any given order assigns:-

Order No. 1 AF > EF > BE > TF
Order No. 2 AF < EF < BE < TF
Order No. 3 EF > AF > BE > TF
Order No. 4 EF < AF < BE < TF
Order No. 5 BE > EF > AF < TF
Order No. 6 BE < EF < AF < TF
Order No. 7 TF > EF > AF > BE
Order No. 8 TF < EF < AF < BE
Order No. 9 AF > BE > EF > TF
Order No. 10 AF < BE < EF < TF
Order No. 11 EF > BE > AF > TF
Order No. 12 EF < BE < AF < TF
Order No. 13 BE > AF > EF < TF
Order No. 14 BE < AF < EF < TF
Order No. 15 TF > AF > EF > BE
Order No. 16 TF < AF < EF < BE

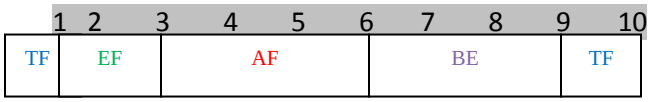
I checked the delay for scheduling algorithm through order No. 3. Because EF data is important than AF and AF data is important than BE and BE data is important than TF. Well, order No. 3 is better for comparison of RFPECB algorithm.

For No Class Solution

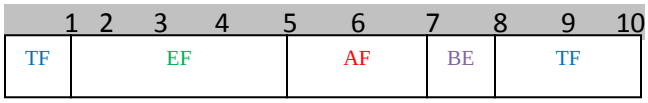
Order No. 3 enter



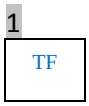
T1



T2



T3



T4

EF Delays = 2 µs

AF Delays = 11 µs

BE Delays = 20 µs

TF Delays = 25 µs

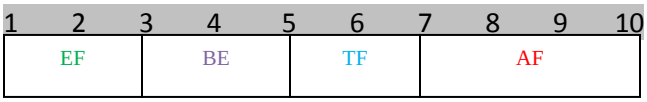
Gantt chart 1

Summary of Delays

Instances	EF (µs)	AF (µs)	BE (µs)	TF (µs)
1st	0	3	7	9
2nd	1	3	6	8
3rd	1	5	7	8

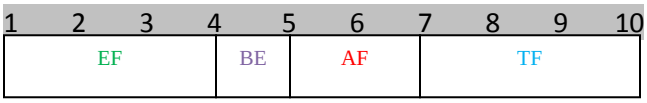
Table 1

For RFPECB Algorithm



T1

T2



T3

EF Delays = 0 µs

AF Delays = 16 µs

BE Delays = 14 µs

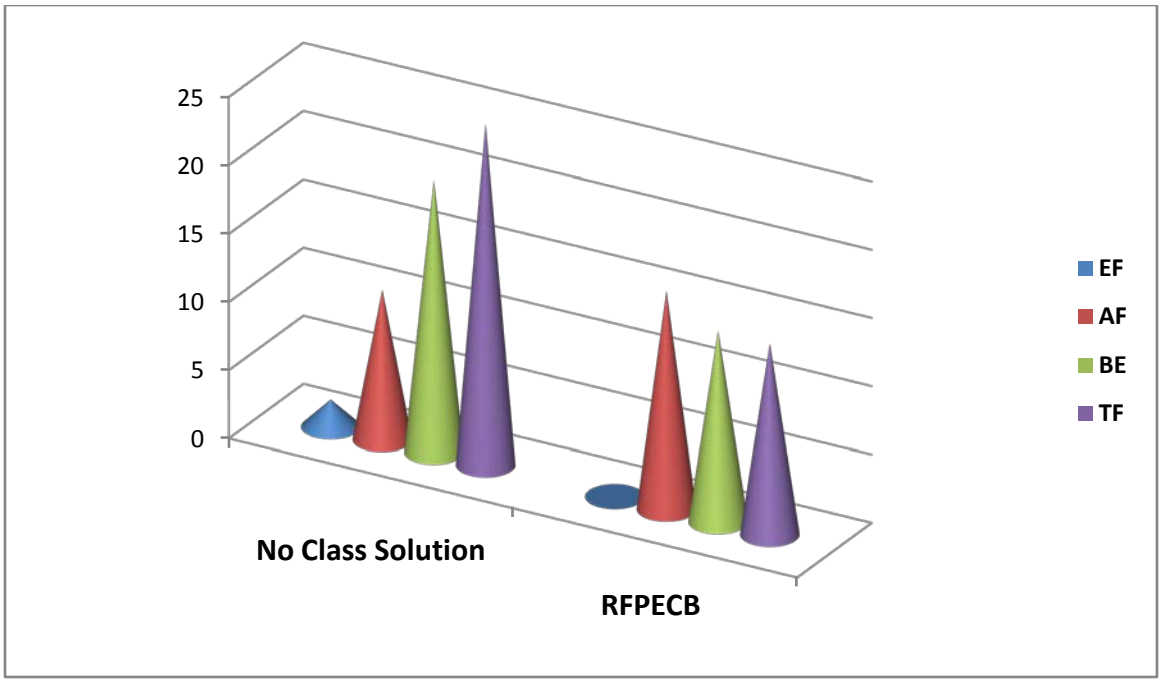
TF Delays = 14 µs

Gantt chart 2

Summary of Delays

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

Table 2



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.

RFPECB Algorithm is better than No Class Solution and because RFPECB algorithm eliminate the drawbacks such as Delay and QoS be eliminated allocating more bandwidth to the insistent data class.

Scheduling (No Class Solution) algorithm is compared with RFPECB algorithm

Delay of EF was high for "no class solution", because in this solution no priority is given to any class, delay for "FPECB" delay for EF is zero because data of EF moves always on first turn (Bandwidth fixed).

But AF, BE and TF based own priority phenomenon. Which priority is lesser than others move first.

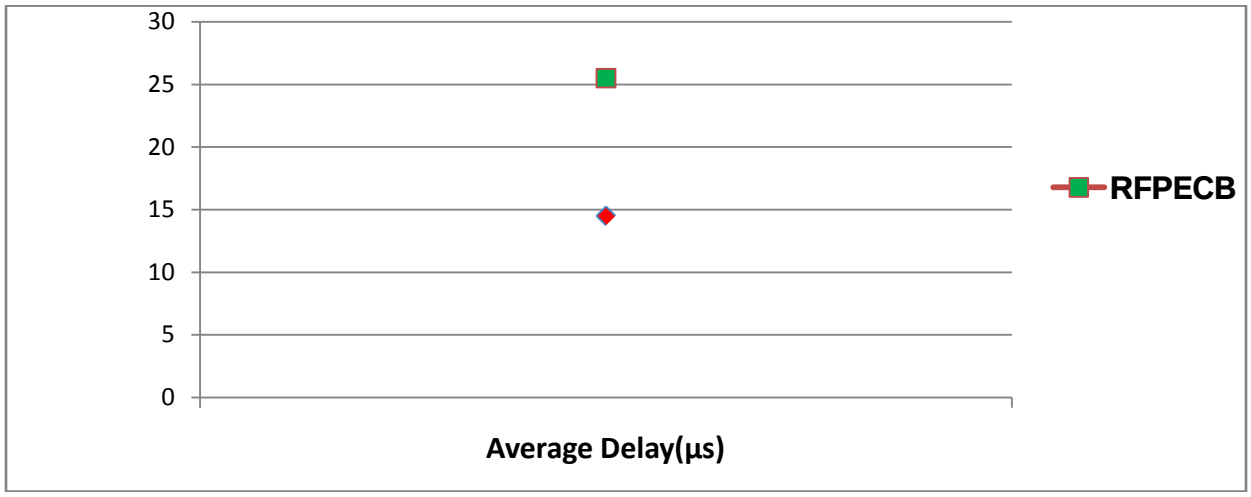
4.1 Total Delay Table & Graph:

Total Delay

Algorithms	EF Delays(µs)	AF Delays(µs)	BE Delays(µs)	TF Delays(µs)	Average Delays(µs)
No Class Solution	2	11	20	25	**14.5**
RFPECB	0	16	14	14	**11**

Table 3

Average Delays (µs) Graph



Graph 2

6. Conclusion

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

7. Future Directions

In future, other professionals work on starvation to progress the better Quality of Services (QoS).

References

[1] "Interleaved Polling with Adaptive Cycle Time (IPACT): A Dynamic Bandwidth Distribution Scheme in an Optical Access Network" Ipact.pdf
By:- Glen Kramer, Biswanath Mukherje & Gerry Pesavento

[2]*"Fixed Advance Priority based Bandwidth Utilization in TDM EPON" in IJCSI May 2011 (Volume 8 Issue 3)* by **Muhammad Bilal**
By: Glen Kramer and Gerry Pesavento, Alloptic February 2002
[3] Ethernet PON (ePON): Design and Analysis of an Optical Access Network.

By: - Glen Kramer, Biswanath Mukherjee and Gerry Pesavento

[4] Ethernet Passive Optical Network (EPON) A Tutorial

By: The Metro Ethernet Forum 2005

http://www.metroethernetforum.org

About Author

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. My research interest is in Computer Networks. I recently got the B.Sc (Hons) Computer Science degree from UET, Lahore. I want to pay tribute to my parents who always encouraged, motivated me and are a constant source of inspiration throughout my academics. I would also like to thank all my teachers who always guide and help me to explore new world. Apart from all above playing and watching cricket boosted up my morale high up till sky. My favorite batsman's are Adam Gilchrist and Misbah-Ul-Haq.