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Performance analysis in Passive Optical Networks (PONs)

Ruchi Malhotra[1], Dr. ManindarPal[2]

M.Tech(student) [1], *Prof. & Coordinator*[2]

M.M. Engg. College[1], *Mullana(Ambala)* [2]

ruchimalhotra29@gmail.com[1], drmanindarpal@gmail.com[2]

Abstract - ***When the data is transferred over the network, a reliable end packet delivery is one of basic requirement of both user and network but there are many major causes that can result packet loss, such as Congestion over the network. Because of this there is requirement of some methodology that can reduce the packet loss and return reliable data transmission over the network. In this paper, the proposed work is representing the solution of the same problem as the major Hypothesis. The Proposed system is the advancement of existing PON- technology with the inclusion of bandwidth utilization as well improving the network throughput by utilizing the bandwidth in an effective way. The proposed system will benefit the higher reliability of data communication in a Private Network. The reliability is presented here in terms of lower packet loss than the existing system. The proposed approach will work dynamically. In first approach, the system will first detect the packet loss and then provide the solution of the problem by reducing the packet loss. Another approach is in aggregation based bottle-neck network where a secure system is implemented using SHA. Thus increase the capacity over network and reduced the packet delay.***

***Keywords*- Packet delay, PON, Capacity, Secure hash algorithm (SHA).**

I INTRODUCTION

The growing popularity of the Internet, IPTV, Video On Demand, Video Conferencing, Gaming are the key factors behind the development of new access method which would meet the bandwidth requirement. Access network based on copper has distance and bandwidth limitation and will start running out of capacity in near future. The access methods based on the optical fiber are getting more and more attention as they offer the ultimate solution in delivering different services to the customer premises. Due to the lack of active units in the light path the architecture of PON is simple, cost effective and offered bandwidth that is not possible to achieve by other access methods [1]. Optical networking is well-established in long-haul and backbone networks. It is rapidly becoming the technology of choice in metropolitan and local area networks as well and may penetrate to the home and office. The PON is an access network based on Optical Fiber. It is designed to provide virtually unlimited bandwidth to the subscriber. A passive Optical network is a single, shared optical

fiber that uses a passive optical splitter to divide the signal towards individual subscribers. PON is called passive because other than at the central office there are no active elements within the access network. A PON enables an service provider to deliver a true triple play offering of voice, video and data, an important component of the data offering can be IPTV.PON are getting more widespread in rollout of Fiber To The Home (FTTH) infrastructure.

In this paper we evaluate the capacity and packet delay of sub-networks that form PON through analysis and simulations and then make a comparison with IEEE 802.15.4a standard. In this paper we uses the 2 lane system that is based on ring topology to reduce the packet loss than existing system and also aggregation based bottleneck network where a secure system is

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Vol. 1, Issue 4, June 2012

implemented using SHA algorithm. Thus increase capacity over the network and reduced packet delay.

This paper is organized as follow: Section I gives the introduction of Passive optical Network. Section II is helpful to understand the background of related work. Section III explains related methodology of the network modeling. Section IV presents the network models. Section V show the performance of proposed technique and at last section VI concludes the paper and followed by the references.

II RELATED WORK

In this paper, we briefly review the related work on analysis of passive optical network. Passive Optical Network (PON) is one of the most widely deployed access networks due to its unique benefits, including signal format as well as high data rates and reliability. Since the optical networks offers a wide bandwidth in metropolitan and wide area networks (WANs), there still exists a bottleneck between local area networks (LANs) and the networks service providers. Thus by using fiber optic networks access bandwidth gap can overcome [2].

The Key parameters for analysis of PONs are:-

1) **Throughput**- It is average rate of successful message delivery over a communication channel.
2) **Capacity**- Maximum number of users.
3) **Delay**- Delay means average time from when packet is generated until it is successfully received.
4) **Congestion control**- Congestion occurs when a link or node is carrying so much data that its quality of service deteriorates and congestion control involves finding places that violate conservation & fixing them.
5) **Jitter**- Jitter means variation of packet delay over time. It is caused by EM interference, crosstalk with carriers of other signals.

In this paper, we analyze/ evaluate 2 key parameters of PON i.e. Capacity and Delay of PON.

Frank Aurzada et al. [3], performed a work on probabilistic analysis of NG-PONs through taking the minimum capacity of the sub networks forming the NG-PON and weighing the packet delays of the sub networks. J. B. Helonde et al. [4], introduce the MRA algorithm to see the effect of changing link capacity and find the PDR (Packet Delivery Ratio) and bounded end-to-end delay. Yun Wang et al. [5] consider two node mobility model for multicast capacity and delay analysis in Mobile Ad-hoc Networks (MANETs). The delay and capacity tradeoff for Motion cast was studied by Xinbing Wang et al. [6]. Wansu Lim et al. [7], presented a quality of service (QoS) aware medium access control (MAC) protocol for next generation OFDMA-PONs. The end-to-end delay and network throughput are investigated in the presence of class-off service and service-level differentiation. In addition, authors propose a new dynamic subcarrier allocation (DSA) algorithm. Masaki Tanaka et al. [8], propose a new DBA algorithm: Adaptive DBA (AD-DBA) which is adaptively switching status-reporting method and traffic monitoring method according to the traffic load and achieves high data throughput and low data transmission delay. Then, Author report the evaluation results of proposed algorithm with presented 10G-EPON prototype system. Neeharika et al. [9], Jana performed a work on analysis of existing Dynamic Bandwidth Allocation (DBA) algorithms, when applied to Long Reach Passive Optical Networks (LR-PON). Bjorn Skubic et al. [10], compare the typical characteristics of DBA, such as bandwidth utilization, delay, and jitter at different traffic loads, within the two major standards for PONs, Ethernet PON and gigabit PON. A particular PON standard sets the framework for the operation of DBA and the limitations it faces. Author illustrates these differences between EPON and GPON by means of simulations for the two standards. Moreover, Authors consider the evolution of both standards to their next-generation counterparts with the bit rate of 10 Gb/s and the implications to the DBA. A new simple GPON DBA algorithm is used to illustrate GPON performance. It is shown that the length of the polling cycle plays a crucial but different role for the operation of the DBA within the two standards. Moreover, only minor differences regarding DBA for current and next-generation PONs were found. Luo and Ansary [11-12] propose and analyze a DBA scheme with traffic prediction, whereby a prediction error is assumed to be Gaussian. The average delay is expressed in term of Gaussian prediction error distribution.

The capacity and delay performance with a variety of protocol is analyzed in numerous studies. In this paper we analyze PON that interconnects multiple sub-networks on Tree and Ring network.

III PROPOSED METHODOLOGY

To represent the complete PON system, ring based architecture with N number of Nodes is taken. All Nodes are identical and placed at equal distance in a ring from. To monitor the nodes and to track the network faults placed save points over the path of Ring. We have placed N number of Checkpoints placed at equal distance from each Node. Now as the communication

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Vol. 1, Issue 4, June 2012

begins, selected a source and the receiver node dynamically. If no fault occurs the data will be transferred uninterruptedly. As the fault occurs the fault is detected by the previous save-point and it will find the alternative path to transmit the data over the network. The complete bandwidth is divided in two parts, one for the normal communication and other for the recovery option. As the fault occurs the data will be transferred from this recovery path. The system has given the better results as compared to existing approach. In another approach Bottleneck problem in PON architecture is considered. Here to represent the bottleneck problem we have taken a hierarchal architecture. In this 4 sub-networks is taken that connect in a hierarchal way. In this work we have shown the concept of Data Aggregation travelling over the network, it means a large amount of data is being travelled over the network. Now to travel the data efficiently and to resolve some load from the channel we are presenting a filtration approach.

IV NETWORK MODEL

In this paper we define two types of network for the analysis of capacity and delay over network, one is based on the ring topology for reducing the packet loss when data is transmitted over it and another is based on tree topology that uses SHA algorithm for increase capacity over the network. Matlab is used for simulation purposes.

A) Ring based Network Model

The proposed work is about to find the optimal solution of any broken link or data loss in a high speed WIRELESS PON-network. The proposed work is about the generation of such an approach that will dynamically compensate the problem of link failure and provide the optimize solution without any data loss. In this proposed work, a scenario is defined that is based on ring topology with 10 numbers of nodes with same number of save points. The dimension of topography is about 750m * 750m. CBR is used for traffic generation with packet size of 512 bytes at the rate of 25 Mbps. Red circles defines the nodes and green color diamond shapes represents the save points over the ring network. In this proposed work any random node can start communication by taking any random node as the destination node. The figure.1, shows the network communication in the ring form. Where the sender is fixed at node 1 and the receiver is selected at random. Time taken for successful packet delivery is 2.07 seconds.

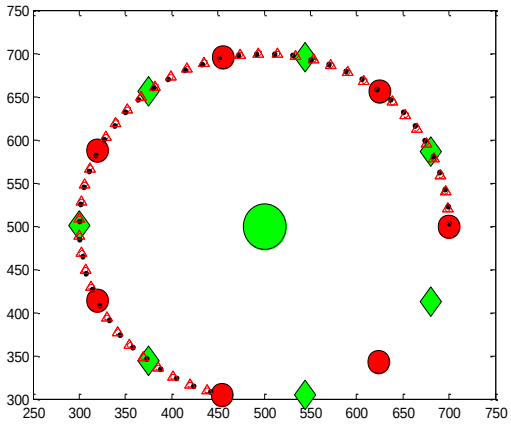

Fig. 1: Network Communication

In figure 2, the fault is generated at some random position and find the destination node from the opposite side. And perform the packet delivery successfully.

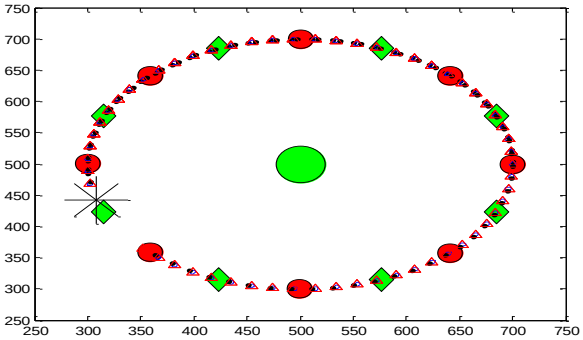

Fig. 2: Fault Recovery in Existing Method

The time taken by existing method for packet delivery is 12.41seconds as fault occur over the network.

Here figure 3, shows the successful packet delivery in case of proposed approach where the recovery path will be selected to transfer data over the network for successful packet delivery. The time taken by the proposed approach is 3.7378 seconds.

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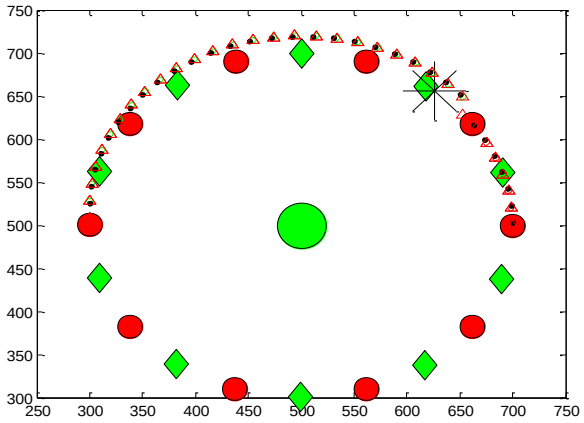

Fig. 3: Successful Packet Delivery (Proposed Approach)

A) Tree Based Network Model

In this particular scenario, we deal with Bottleneck problem in PON architecture. Here to represent the bottleneck problem we have taken a hierarchal architecture. We have taken 4 sub-networks that connection in a hierarchal way. In this work we have shown the concept of Data Aggregation travelling over the network, it means a large amount of data is being travelled over the network. Now to travel the data efficiently and to resolve some load from the channel we are presenting a filtration approach. The authentication is being done using SHA algorithm. The distance between each node is constant and it is 42.4264m and coverage region of each node is about 8 m.

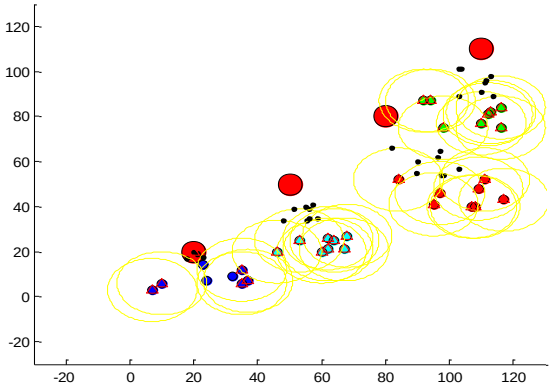

Fig. 4: Hierarchical Network

B) Performance Metrics

End-to-End Delay

- End-to-End delay is the time taken for a packet to reach the destination from the source node.

$$\text{End to End delay (ms)} = \frac{\sum (\text{Delay of each entities data packet})}{\text{Total number of delivered data packets}}$$

Capacity over network – Maximum No. of users.

V RESULTS and DISCUSSION

The Analysis is showing the comparison of existing and proposed approach in terms time taken.

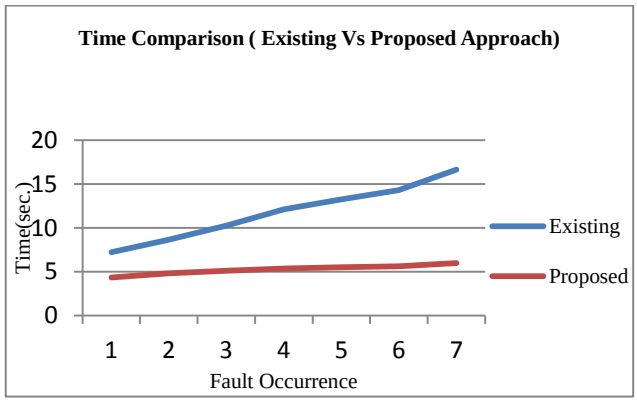

Fig. 4: Time Comparison (Existing Vs. Proposed)

Here figure 4 is showing the comparison of existing and proposed approach. As we can see the proposed work has improved the overall time taken by the network in case of fault recovery.

ISSN : 2278 – 1021

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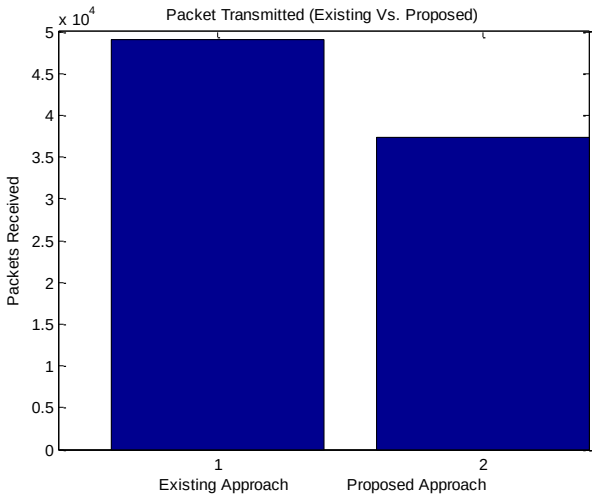
Vol. 1, Issue 4, June 2012



As in above figure the proposed approach has reduced the data communication over the network, because of this the network reliability and efficiency both will be achieved. In the proposed approach total packet received 37292 and in existing approach total packet received 49100.

CONCLUSION

We have developed a comprehensive probabilistic analysis for evaluating the packet delay performance of next-generation PONs (NG-PONs). Our analysis also improves the network reliability and efficiency. We also demonstrate the identification of network bottlenecks using our analysis.

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