2009 International Conference on Machine Learning and Computing
IPCSIT vol.3 (2011) © (2011) IACSIT Press, Singapore

Static Bandwidth Allocation on Optical Networks

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Abstract. A detailed understanding of the many facets of the Internet's topological structure is critical for evaluating the performance of networking protocols, for assessing the effectiveness of proposed techniques to protect the network from nefarious intrusions and attacks, or for developing improved designs for resource provisioning. In this way Available bandwidth estimation is a vital component of admission control for quality-of-service (QoS) on Internet in the world.In coming years, Optical networks are come to dominate the access network space. Ethernet passive optical networks, which influence the all of subscriber locations of Ethernet, seems bound for success in the optical access network. In this Review Paper we first prepare an introduction to Ethernet passive optical networks structure, then related to our totally categorize the bandwidth allocation methods to three groups as Static and Router-Based and Windows-Based, we will explain seven major weaknesses on static group and describe the improvements on them one by one.
Finally in this survey, we found some roles and principles in static bandwidth allocation methods which explain them separately.We hope in the next article we will explain the Dynamic bandwidth allocation weaknesses and improvements then make a comparison between static and dynamic bandwidth allocations. Following that, at the end, we will propose an algorithm on dynamic bandwidth allocation and evaluate it.

Keywords: Bandwidth Allocation, Optical Network, Static Bandwidth Allocation, Dynamic Bandwidth Allocation

1. Introduction

In these years with the increasing popularity of the Internet, the traffic produced by medium and small business users has been growing firmly. Several technologies have been spread out broadband access to the networks. As network operators try hard for cost efficiencies, it seems that Passive Optical Network (PON) to be the next jump in the development of Access Networks (AN). A PON is a point-to-multipoint optical network that there is not any active element in the path between the source and the destination. On the network's side there is an Optical Line Terminator (OLT) unit that is usually placed in the local exchange and it acts as a point of access to the Wide or Metropolitan Area Network (WAN or MAN).

On the customer's side there is an Optical Network Unit (ONU) that can be placed either in the building or home. The primary task of ONU is convert data between optical and electrical domains.

The protocols Asynchronous Transfer Mode (ATM) and Ethernet have been recommended as the transmission protocol in PONs. In these years for this reason that the EPONs are flexible they have gained more attention from the industry. The architecture of an Ethernet network is simple yet highly operative. The ability of work between old and new networks can easily be support and inheritance solutions can be used as EPON data is coming in standard Ethernet frames.

Naturally the EPON networks are accept in a tree topology with multiple ONUs that is linked to a OLT as a splitters. There are two type of transmission that we show in Fig1, Fig2. In a downstream transmission (Fig.

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1) the OLT uses all bandwidth to broadcast packets through the splitter to each ONU. Each ONU excerpt packets by check the Medium Access Control (MAC) address in packets.

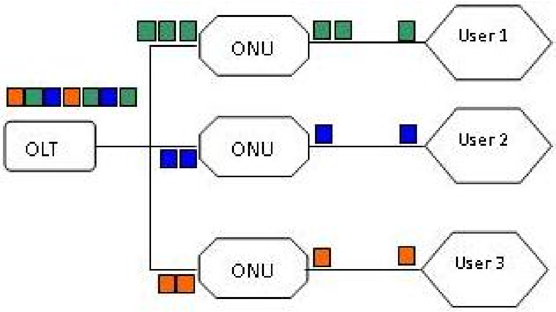

Fig. 1: downstream transmission

In the upstream transmission (Fig. 2) the OLT split the packets as a splitter and send the related packet to ONU and prevent that an ONU reach a packet from other ONUs. So that to escape from collisions that maybe happen between frames from different ONUs the optical splitter must be shared all available bandwidth among all ONUs. The OLT is manager of assigning a non-overlapping time-slot to each ONU, and ONUs can only transfer packets during this time-slot that means in the duration of the off period packets are buffered and when the time-slot come they send packets by using all the available bandwidth.

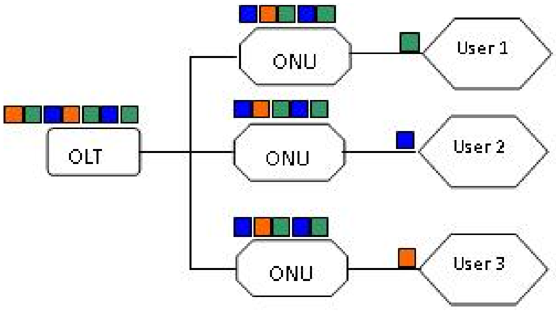

Fig. 2: Upstream transmission

The two main features of EPON networks are that they can support Differentiated Services (DiffServ) architecture and can support various levels of QoS. In a general manner there are three classes of traffic: Expedited Forwarding (EF), Assured Forwarding (AF), and Best Effort (BE).EF services (base for voice and video) have most severe necessity and require a constant low delay and jitter. AF services be given to the less sensitive to packet delay but require an assured amount of bandwidth. BE traffic is generated by applications that have no powerful necessaries regarding to traffic properties.

In this paper we examine various Bandwidth Allocation (BA) algorithms and have been done a survey on Router-Based Bandwidth Allocation (RBA). The inspection of major problems, find one of the best solutions and explain the founding techniques were our view point in this survey.

2. SBA Weaknesses

1. Differentiated Services Support (DiffServ): The obvious disadvantage of SBA is that bandwidth can not be utilized efficiently. This is especially true in the case where the difference between bandwidth requested by and bandwidth assigned to the source is large. The main disadvantage of this approach is that to fully support DiffServ, an ONU has to have knowledge about the SLA between a customer and the network provider. [7]
2. The major defects of traffic types: EF services (primarily voice and video) have very strict requirements and demand a constant, low end-to-end delay and jitter. AF services tend to be less sensitive to packet delay but require a guaranteed amount of bandwidth. BE traffic is generated by applications that have no strong requirements regarding traffic properties. [6]
3. Quality of Service (QoS): In the days to come wireless networks are looked forward to support a large range of traffic types such as audio, video, data and speech. These traffic types have special bandwidth and

quality of service (QoS) necessities. Supporting all these traffic types in one network, invite us to engage in the wide range of contests. The extensively differing properties of these traffic types e.g., data traffic use up more bandwidth than voice and the limited wireless resources have to be utilized in actual fact and allocated practically to the special traffic types. In the some studies, QoS metrics, such as data delay and data loss, have only been addressed from an experimental aspect, and no theoretical analysis has been conducted to justify their performance. [2]

4. Major characteristics of a link bandwidth:

Allocate Link Bandwidth over a Network that:

- Must be easily understood by customers
- Must be implement able by service providers
- Must be able to achieve high degrees of network utilization and fairness
- Must be able to handle both TCP and UDP traffic load

Allocate Bandwidths for Traffic Classes over a Link that:

- Classify and monitor flows
- Provide differentiated treatments to packets based on their classes

5. MAP message: Throughout common operations, in the downstream channel the head end (HE) usually sends control signals that contain MAP messages to describe the allocation of upstream bandwidth. Any station that desires to request an allocation must contend for access during periods specified in this MAP message with short minislot-sized messages that contain the station’s id and the number of minislots needed. If successful, the HE will allocate a proper portion of the upstream bandwidth for the station in a future allocation MAP message.

In the current specification, MAP message is required for bandwidth allocation, MAP message required for every frame in which the bandwidth is allocated. In general, it may permit from very large overhead associated with the dynamic bandwidth allocation, especially when the number of connections increases. [13]

6. Class of Service (CoS): A bandwidth allocation equipment and a bandwidth allocation method are provided for distinguish classes of service (Cos) in an Ethernet Passive Optical Network (EPON), which includes an optical line termination (OLT), an optical distribution network (ODN), and a plurality of optical network units (ONUs) that we expalin them in introduction part completely and some internet service providers use CoS because the customers usually use from competitive nature of the Internet and the diversity.

CoS has been provided by a variety of queuing and scheduling mechanisms, two of the most important ones being Weighted Fair Queuing (WFQ) [1] and Class Based Queuing (CBQ).these two mechanisms primarily utilize the precedence bits in the IP header to determine the behavior a packet has to receive at a particular node in the network.

The behavior that a packet receives as it traverses the path from the source to the destination is also partly dictated by the Quality of Service (QoS) guarantees that the link-layer can provide. QoS guarantees and traffic-engineering capabilities have led to more efficient techniques that address the IP CoS to layer- 2 QoS translation problems. The IP to MPLS CoS mapping techniques is one of the major problems in Class of Service (CoS) translation in IP and MPLS based networks. [9]

7. Inflation grows in their bandwidth demand: The statistical results in telecommunications shows that Internet traffic has doubled every year, the inflation in bandwidth demand will grow then the communication networks come to phenomenal proliferation. Although the available bandwidth is increasing dramatically, it is still one of the bottleneck resources in communication networks. As of response to these massive bandwidth requirements, both core backbone networks (usually optical networks) and local area networks (LAN) have experienced tremendous advances in recent years but we saw the limited progress has been achieved in metropolitan area network (MAN) and access networks. [1][5]

3. SBA Improvements

1. Differentiated Services Support (DiffServ): Propose an algorithm that could be used with EPONs supporting different classes of service:

- DBA with Priority Transmission Order DBA-P
- DBA with a Guaranteed Minimum bandwidth DBA-GM. [7]

2. The major defects of traffic types: Propose a new algorithm “SLA AWARE DYNAMIC BANDWIDTH ALLOCATION ALGORITHM (SLA-DBA)” that suggest to keep the ONU’s functionality as simple as possible and move all necessary access control mechanisms to the OLT for two main reasons:
   - As no access control or packet scheduling is done in an ONU, various algorithms can be deployed in the OLT without the need for reconfiguration of the equipment on the customer’s side. It also allows for SLAs to be created, modified and deleted during normal network operation.
   - An ONU with a simple and generic architecture is less expensive to produce and thus EPON becomes a more affordable choice. [6]

3. Quality of Service (QoS): Propose a bandwidth management scheme, called “limited sharing with traffic prediction (LSTP)”, to tackle the DBA issue over EPONs. This proposal has the following characteristics:
   - First, we enable dynamic bandwidth negotiation by employing the control messages in MPCP, implying that the LSTP scheme is seamlessly compatible with the IEEE standard 802.3ah.
   - Second, online traffic prediction is facilitated based on network traffic self-similarity, and data delay is thus reduced by allocating flexible time slots dynamically.
   - Third, the aggressive bandwidth competition among multiple ONUs is restricted by upper bounding the allocated bandwidth to each ONU.
   - Fourth, improved QoS provisioning is achieved by reducing the data loss in the upstream transmission.[2]

4. Major characteristics of a link bandwidth: In the first segment that was Allocate “Link Bandwidth over a Network” are suggested to use from three services in the network that help us to receive to the all of major characteristics that they are:
   - Diff-Serv-PS-GMB: Diff-Serv Premium Services.
   - Diff-Serv-AS-GMB: DiffServ Assured Services, with GMB.
   - TCP-Trunking-GMB

   For the second segment that was “Allocate Bandwidths for Traffic Classes” is suggested to put two operations in traffic classes:
   - Classify traffic based on IP address, port/service, URL, TOS, etc.
   - Shape traffic by making modifications to TCP ACK packets.

5. MAP message: For reduce the large overhead of MAP message is suggested to use the periodic fixed bandwidth assignment scheme, which allows for refreshing the MAP message in a periodic manner. [13]

6. Class of Service (CoS): For solving the IP to MPLS CoS mapping problem are suggested to use two techniques:
   - The ToS octet in the IP header is copied onto the EXP field of the MPLS shim header and appropriate packet treatment is given based on the value contained in the EXP field.
   - An MPLS signaling protocol like LDP or RSVP-TE is used to signal N labels per class per IP source-destination pair.

7. Inflation grows in their bandwidth demand: Two ways is proposed:
   - A realistic theoretical model for dynamic bandwidth allocation that takes into account the two classical qualities of service parameters: latency and utilization, together with a newly introduced parameter: number of bandwidth allocation changes, which am costly operations in today’s networks. Their model assumes that sessions join the network with a certain delay requirement rather than a bandwidth requirement as assumed in previous models.
   - A burst-polling based delta dynamic bandwidth allocation (DBA) scheme for quality of services (QoS) using class of services (CoS) in Ethernet passive optical networks (EPON) that consists of two parts:

- o One is inter scheduling, which is a difference (delta) DBA with burst polling,
- o And the other is intra scheduling, a differentiated priority queuing method at ingress/egress, in which three kinds of traffic classes have been considered such as Expedited Forwarding (EF), Assured Forwarding (AF), and Best Effort (BE). [1][5]

4. SBA Findings

- The proposed fixed allocation scheme is applied just at voice and video traffic and is not applied at Ethernet traffic and the just diversity channel MAP in the result of MAP symbol overhead ratio, because using the only diversity sub channel. [13]
- DBA-GM algorithm performance was comparable but not as good as the DBA scheme. Considerable improvement in the values of average delay for EF classes was achieved when a mechanism of priority transmission was applied. [7]
- New bandwidth allocation methods will provide elastic bandwidth, and use of the bandwidth will be class-based.
- The BP-DDBA, which performs early bandwidth allocation for light loaded ONUs, will bring about better downstream throughput compared with some previous DBA algorithms. In other words, it is suggested that the proposed burst-polling scheme provides higher downstream bandwidth utilization under light-load high frequency polling situation.
- The contributions of employing traffic predictor for QoS provisioning have been justified by the performance improvement. [2]

5. Conclusions

In this paper we address a survey in Static / Fixed Bandwidth allocation (SBA) / (FBA) and inspect some problems in this area such as FBA Differentiated Services Support (DiffServ), Quality of Service (QoS), MAP message and Class of Service (CoS) then found the best solution for them in previous researched that has been done. Finally try to explain some theoretical or experimental result as finding items in each section such as BP-DDBA, which performs early bandwidth allocation for light loaded ONUs, will bring about better downstream throughput compared with some previous DBA algorithms. In other words, it is suggested that the proposed burst-polling scheme provides higher downstream bandwidth utilization under light-load high frequency polling situation.

6. Acknowledgment

We would like to express our appreciation to our parents and all the teachers and lecturers who help us to understand the importance of knowledge and show us the best way to gain it.

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