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Router-Based 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 our previous paper we explain about static bandwidth allocation methods weaknesses and improvements. Now, in this paper related to our totally categorize of bandwidth allocation methods to three groups as Static, Router-Based and Windows-Based, we will explain seven major weaknesses on Router-Based dynamic group and describe the improvements on them one by one.Finally in this survey, we found some roles and principles in Router-Based dynamic bandwidth allocation methods which explain them separately.We hope in the next article we will explain weaknesses and improvements of Windows-based bandwidth allocation 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, Router-Based 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.

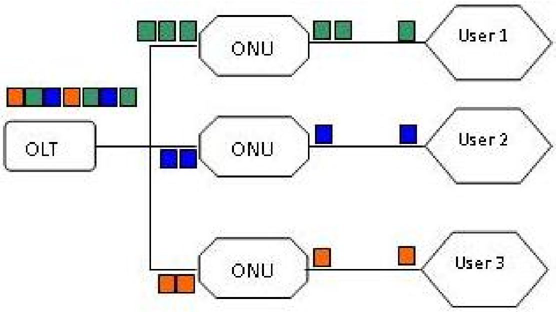


Fig. 1: downstream transmission

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.

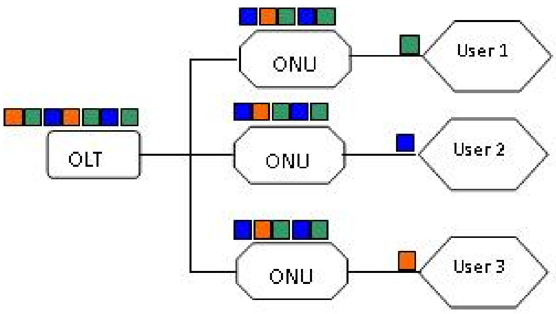


Fig. 2: Upstream transmission

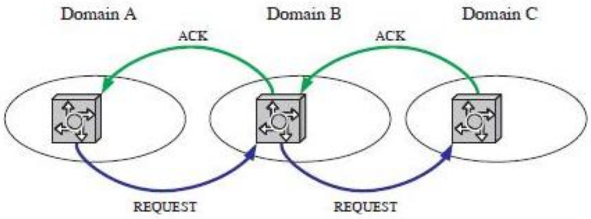
The two main features of EPON networks are that they can support Differentiated Services (DiffServ) architecture and can support various levels of QoS. In a general manner there are three classes of traffic: Expedited Forwarding (EF), Assured Forwarding (AF), and Best Effort (BE).EF services (base for 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. RBA Weaknesses

1. Achieving Fair Bandwidth Allocations: there are many desirable properties for congestion control on a router mechanisms designed to achieve fair bandwidth allocations, like Fair Queuing, in the Internet. However, such mechanisms usually need to some services as:
   - Maintain state
   - Manage buffers
   - Perform packet scheduling on a per flow basis and this complexity may prevent them from being cost-effectively implemented and widely deployed. [14]

2. Fault Tolerance: we can categorize the all objects in network such as voice, video and data into two categories: real time data and non-real time data, according to the required QoS. They request different bandwidths and have different QoS requirements. The most important features of an online approach are its adaptability, flexibility and responsiveness to current traffic conditions in the networks. The design of reliable and fault-tolerant bandwidth management algorithms networks is also an important issue. Fault tolerance techniques developed for wired networks and there is a domain-by-domain approach for multi domain network that in this approach each domain try to make interacts with neighboring domains.



In general, two approaches are available: hop-by-hop or one-to-one that tries to reserve along the path from the source to the destination domain and one-to-many communication that direct contact of the source domain with any other domain one the path to the destination domain. A domain-by-domain reservation approach is inherently more fault tolerant than the traditional hop-by-hop approach.

3. Programmable router architectures: to meet simultaneously the demands of flexibility and high performance, an alternative to general purpose processors and application-specific integrated circuits, referred to as network processors (NPUs), has emerged. Network processors, much like general purpose processors, are programmable. However, NPUs support mechanisms–such as multiple processor cores per chip and multiple hardware contexts per processor core–that enable them to process packets at high rates.In this way there are two important questions:

(1) How do properties of next-generation network services affect programmable router architectures?

(2) How do properties of programmable router architectures affect the design of next-generation network services? [4]

4.Quality of Service (QoS): In quality of service of RBA we inspect two major problems:

(1) A flow can be defined as set of packets that satisfy a certain condition that is called the flow key. In most cases the flow key is defined as some function of the following information kept from a packet header:

IP address of source and destination, port numbers, protocol ID, etc. The most important question is: What flows have the biggest rate? Thus the problem is:

For a given positive integer M identify and monitor as many as possible among the M flows with the highest sending rate using approximately 10 Mb of SRAM memories.

(2) The second problem was delay-utilization tradeoff in the congested Internet links. While several groups of authors have recently analyzed this tradeoff, the lack of realistic assumption in their models and the extreme complexity in estimation of model parameters, reduces their applicability at real Internet links.

5.Router-based Denial of Service (DoS): with the Internet emerging as the commercial communications infrastructure, it has increasingly become the target of attacks from a broad range of sources. An important category of such attacks consists of network denial-of-service (DoS) attacks, or bandwidth attacks, that directly target network resources such as link capacity and/or router buffers. [12]

6.QoS in Multicast, Multi-Streams Environments: Multicast routing protocols are responsible for creating multicast packet delivery trees and for performing multicast forwarding. There are two types of multicast trees:

(1) Source-based multicast tree

(2) Shared-based multicast trees

The above-mentioned multicast routing protocols construct only the shortest paths between the source/core and the receivers of a given multicast group without considering users' QoS requirements.

But the main problem is finding a path from the new user to the core of the tree; if the path does not offer sufficient QoS to the new user, flooding will be used starting from the node where the requirements couldn't be met**.**

7. Expenses or Price:
In Ad-Hoc Networks when a node wants to send data packets to a destination node which is outside its transmission range, then other users in the network have to relay the packets to the destination. However, users with limited bandwidth and battery resources might be reluctant to forward data packets for other users**.**

3. RBA Improvements

1. Achieving Fair Bandwidth Allocations: In this paper, writers propose an architecture that significantly reduces this implementation complexity yet still achieves approximately fair bandwidth allocations and apply this approach to an island of routers that is a contiguous region of the network and distinguish between edge routers and core routers.
Edge routers maintain per flow state; they estimate incoming rate of each flow and insert a label into each packet header based on this estimate.

Core routers maintain no per flow state; they use FIFO packet scheduling augmented by a probabilistic dropping algorithm that uses the packet labels and an estimate of the aggregate traffic at the router that in this paper, they call scheme Core-Stateless Fair Queuing. [14]

2. Fault Tolerance: A novel domain-based protocol is proposed for handling advance reservations. It requires support only at the edge routers and no changes are required at the core routers, and audit this protocol in three phase:
(1) The negotiation phase during which the flow negotiates with the network and at the end of which its reservation state is installed in the network.

(2) The storage phase during which the network stores the reservation state of the flow.

(3) The usage phase when the flow uses its reservation.

3. Programmable router architectures: As a base for address these questions, is proposed to use a programmable router based on Intel's IXP1200 network processor and a set of network services that offer a range of Quality of Service (QoS) guarantees to flows then is developed three building blocks:
Flow classification

Route selection

Packet ordering [4]

4. Quality of Service (QoS): For the first problem is proposed a highly scalable method for heavy-hitter identification that uses their small active counters architecture is developed based on heuristic argument.
For second problem is proposed an adaptive scheme that regulates the available queue space to keep utilization at desired, high, level. As a consequence, in large-number-of-users regimes, sacrificing 1-2% of bandwidth can result in queuing delays that are an order of magnitude smaller than in the standard BDP-buffering case.

5. Router-based Denial of Service (DoS): After inspect and determine whether it is possible to build router-based, two famous methods is proposed:

- Aggregate Level Defense Systems
- Flow Level Defense Systems [12]

6. QoS in Multicast, Multi-Streams Environments: Propose a protocol that allocates resources in communication networks in order to assure specific QoS characteristics as requested by new connections that uses a Bandwidth Preemptive Algorithm that permits adaptive bandwidth allocation in multicast, multi stream environments.
They use a distributed methodology where they change the behavior of the communication service and allow the continuation of the service under more severe conditions. In other words, when there is a lack of bandwidth for a new connection, the communication service will try to find the missing bandwidth within the existent connections (or streams) when looking for a feasible path on a hop-by-hop basis, starting from the destination to an on-tree node.

7. Expenses and cost: Propose a Price-Based Approach that users can charge other users for forwarding their data packets. The aim of the paper is to study how users set their prices for forwarding packets, and how much bandwidth they allocate for relaying data packets for other users.

4. The findings in RBA

- The traditional hop-by-hop approach is significantly less fault tolerant than a domain-based approach.
- The IXP1200 architecture is able to provide a range of network QoS guarantees, from traditional best-effort IP routing to Integrated Services, MPLS, or CSGS that provide per-flow delay, jitter, or bandwidth guarantees at speeds near or exceeding the router's maximum network bandwidth. [4]
- It is possible to have more than one on-tree node to permit a choice of the best path that lets the new user graft to the multicast tree.

5. Conclusions

In this paper we address a survey in Router-Based Bandwidth allocation (RBA) in Dynamic bandwidth allocation group and inspect some problems in this area such as Fault Tolerance , Quality of Service (QoS), Expenses or Price 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 IXP1200 architecture, which provide a range of network QoS guarantees, from traditional best-effort IP routing to Integrated Services, MPLS, or CSGS that provide per-flow delay, jitter, or bandwidth guarantees at speeds near or exceeding the router's maximum network bandwidth.

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