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A survey on Bandwidth Allocation methods in 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 survey, first I prepare an introduction to Ethernet passive optical networks structure. Then related to two categories of bandwidth allocation methods as Static and Dynamic, I make a framework for classifying bandwidth allocation methods in three categories as Fix, Router-Based and Windows-Based. So I provide a Survey on these three groups' bandwidth allocation methods by focus on problems and best solutions that have been submitted till now.

Index Terms—**Dynamic Bandwidth Allocation, Router-Based Bandwidth Allocation, Static Bandwidth Allocation, Windows-Based Bandwidth Allocation.**

I. 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 I show in Fig1, Fig2. In a downstream transmission (Fig1) 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.

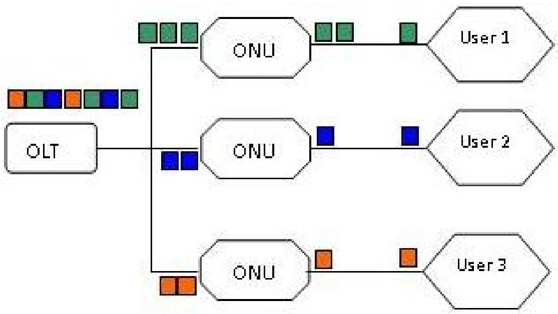

Figure 01: downstream transmission

In the upstream transmission (Fig2) 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.

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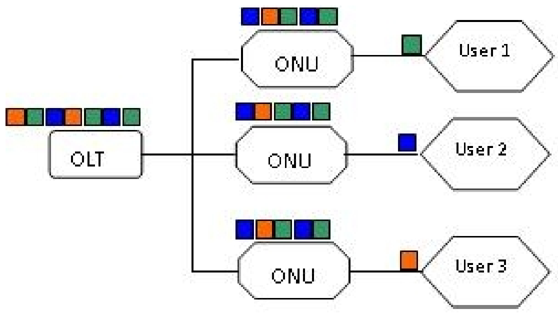


Figure 02: Upstream transmission

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.

Now I explain my three categories of bandwidth allocation as Static, Router-Based and Windows-Based algorithms with three main parts in each category as weaknesses, Improvements and Findings.

II. SBA Weaknesses

1) Differentiated Services Support (DiffServ): The obvious disadvantage of SBA is that bandwidth cannot 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[16]
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. [29][13][30]

   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 I 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]

   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][28]

III. SBA Improvements

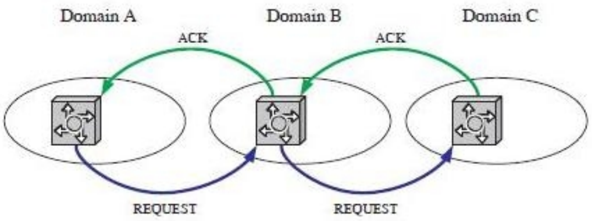
1) Differentiated Services Support (DiffServ): Propose an algorithm that could be used with EPONs supporting different classes of service:
   - DBA with Priority Transmission Order DBA-P
   - DBA with a Guaranteed Minimum bandwidth DBA-GM. [7]
2) The major defects of traffic types: Propose a new algorithm "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. [16]
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. [29] [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: One is inter scheduling, which is a difference (delta) DBA with burst polling, 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][28]

IV. 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. [29][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. [16]
- 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. [28]
- The contributions of employing traffic predictor for QoS provisioning have been justified by the performance improvement. [2]

V. 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. [20][30]
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 I 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. [25]
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. [21]
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. [19]

VI. 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. [20][30]
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. [25]
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. [21]
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. [19]

VII. RBA Findings

- The traditional hop-by-hop approach is significantly less fault tolerant than a domain-based approach. [20]
- 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. [21]

VIII. WBA Weaknesses

1) Window-Based Congestion Control: when you study the existence of fair end-to-end congestion control schemes, more precisely, the question is that of the existence of congestion control protocols that converge to a fair equilibrium without the help of the internal network nodes, or routers. Using such a protocol, end-nodes, or hosts, monitor their connections. By so doing, the hosts get implicit feedback from the network such as round-trip delays and throughput but no explicit signals from the network routers. The hosts implement a window congestion control mechanism. Such end-to-end control schemes do not need any network configuration and therefore could be implemented in the Internet without modifying the existing routers or the IP protocol.
The first problem in this way is: In TCP as a windows-based protocol, congestion control is based on controlling the end-to-end window; an important attribute of TCP congestion control mechanisms is that TCP sources do not have any explicit support for the congestion state from the network. [17]
And the second problem is: The current version of the Transmission Control Protocol (TCP) results in large queuing delays at bottlenecks, and poor quality for real-time applications that share a bottleneck link with TCP. [22]
And the third problem is: In window-based congestion control schemes, increase rules determine how to probe available bandwidth, whereas decrease rules determine how to back off when losses due to congestion are detected. The control rules are parameterized so as to ensure that the resulting protocol is TCP-friendly in terms of the relationship between throughput and loss rate. [24][26]
2) Utility Fair Congestion Control: there are several algorithms that solve congestion control of communication networks as a distributed algorithm at sources and links in order to solve a global optimization problem. Some applications, especially real-time applications have non-concave bandwidth utility functions. A voice-over-IP flow, for instance, receives no bandwidth utility, if the rate is below the minimum encoding rate. Its bandwidth utility is at maximum, if the

rate is above its maximum encoding rate. Then the problem is on the user-received side utility. [23]

3) Bandwidth-delay tradeoff: increasing bandwidth-delay product of high-speed wide-area networks is well-known to make conservative dynamic traffic control schemes. Still, most existing schemes use dynamic control, among which TCP and ATM Forum's rate-based flow control are prominent examples. So far, little has been investigated as to how the existing schemes will scale as bandwidth further increases up to gigabit speed and beyond. The effect of large bandwidth-delay product on dynamic window protocols such as TCP, show the scalability problem. [10]
4) End-to-end Flow Control: the complexity of Internet was brought out by some factors listed below:
   - The number of the users and sub-systems are tremendous.
   - The diversity of the network services and resources.
   - Both users and network nodes can obtain only some limited information.
   - The resources of the Internet are limited, and they are owned by many different organizations. So the Internet cannot be managed in central way.
   - Distributed systems (such as Internet) are dynamic, cannot be controlled in static way.

   Due to these reasons, traditional network control and management mechanisms cannot adapt to new requirements and complexity in the Internet, new mechanisms and analysis tools must be developed. [27]
5) Congestion Control for Future High Bandwidth-Delay Product: as the per-flow product of bandwidth and latency increases, TCP becomes inefficient and prone to instability, regardless of the queuing scheme. This failing becomes increasingly important as the Internet evolves to incorporate very high-bandwidth optical links and more large-delay satellite links. [8]
6) Fair and Efficient in Multi-Application Networks: in today’s telecommunication enterprises Multi-application networks are increasingly predominant. The convergence trend towards IP technology has facilitated the deployment of environments where a wide variety of applications, ranging from highly adaptive to strict real-time, coexist and have their traffic transmitted over the same network infrastructure. In this case, as opposed to the homogeneous scenario, the amount of resources required by each type of application to perform well may differ substantially imposing an extra difficulty to the resource allocation problem. The concept of utility function can be used to provide information about the amount of resources needed by each application and also to support the determination of an adequate solution for the bandwidth allocation problem. [3]
7) Expenses and cost: router mechanisms designed to achieve fair bandwidth allocations, such as Fair Queuing, have many desirable properties for congestion control in the Internet. However, such mechanisms usually need to maintain state, manage buffers, and/or perform packet scheduling on a per-flow basis, and this complexity may prevent them from being cost-effectively implemented and widely deployed. [15]

IX. WBA IMPROVEMENTS

1) Window-Based Congestion Control: for the first problem an algorithm is proposed which uses the successive binary congestion information provided by ECN. Based on the explicit network information, and estimate the fair window size proportional to the propagation delay. [17]
   For second problems a new model is proposed for the dynamic relationship between window sizes, sending rates, and queue sizes. This system is:
   - Window sizes as inputs
   - Queue sizes as outputs

   And is the inner loop at the core of window-based congestion control. [22]
   And for the third problem in congestion control they proposed a spectrum of TCP-like window-based congestion controls. Unlike memory less controls such as AIMD and binomial controls, our controls utilize history information. They are TCP-friendly and TCP-compatible under RED queue management. [24] [26]
2) Utility Fair Congestion Control: in this problem after to translate the theoretical framework into practical application a mathematical method is proposed that enabled us to efficiently construct bandwidth utility functions for real-time applications [23]
3) Bandwidth-delay tradeoff: the simplest (but unreal) solution is to eliminate the feedback delay would be to "move" the control point (i.e. congestion control algorithm at the source) to where the control action actually applies (i.e. the congested switch), eliminating the physical distance barrier. But they proposed Bandwidth-Latency Tradeoff (BLT) as a new approach that has 2 steps:
   (1) A data stream to the network carries multiple performance parameter values at the same time. To create the parameter space, the source uses the bandwidth otherwise wasted unused, due to the inherent conservativeness of dynamic control methods.
   (2) The controller (switch/destination) can then choose an appropriate parameter value that exactly fits the network condition at the time of its control action. Since the source yields the right to exercise the control action to the controller, the control point is effectively "moved" to where the controller is. [10]
4) End-to-end Flow Control: they proposed an evolutionary game based end-to-end flow control algorithm that is TCP alike. In this new flow control algorithm, there are five strategies can be used by each network user, and in the stage game of our model, these strategies will be played when every ACK is received and every timeout is detected. [27]
5) Congestion Control for Future High Bandwidth-Delay Product: for solve this problem they proposed explicit Control Protocol (XCP) that is a novel approach to Internet congestion control that outperforms TCP in conventional environments, and remains efficient, fair, scalable, and stable as the bandwidth-delay product increases. This protocol generalizes the Explicit Congestion Notification proposal (ECN). In addition,

XCP introduces the new concept of decoupling utilization control from fairness control. This allows a more flexible and analytically tractable protocol design and opens new avenues for service differentiation. [8]

6) Fair and Efficient in Multi-Application Networks: they propose a dynamic algorithm based on weighted fair queuing (WFQ) to promote fairness and efficiency in the allocation of bandwidth for multi-application networks. [3]
7) Expenses and cost: they proposed CSFQ as a new architecture that approximates the service provided by an island of Fair Queuing router, but has a much lower complexity in the core routers.
8) The architecture has two key aspects:
   - To avoid maintaining per-flow state at each router, we use a distributed algorithm in which only edge routers maintain per-flow state, while core (non edge) routers do not maintain per-flow state but instead utilize the per-flow information carried via a label in each packet's header.
   - To avoid per-flow buffering and scheduling, as required by Fair Queuing, we use FIFO queuing with probabilistic dropping on input. [15]

X. WBA Findings

- Window sizes are changed in bandwidth domain without the help of feedback information. Conceptually, since the change of window size occurs in the bandwidth domain, the window change occurs at the same instance in time. So the traffic source sends out the whole spectrum of windows at the same time. It takes more bandwidth to create this spectrum of windows, but it can help alleviate the delay problem. [10]
- The bottleneck switch chooses the right window size among the array of window sizes, discarding all others. Since the switch does not need communication with the traffic source to negotiate on the window.[10]
- The cross-traffic does not merely reduce the capacity available for the congestion controlled traffic.[22]
- But the dynamical properties of the congestion control are also affected[22]
- For the inner-loop, increasing the cross-traffic increases the static gain between window size and queue size, and it slows down queue convergence. [22]

XI. Conclusions

In this paper I address a survey in three categories of bandwidth allocation as:

- Fixed Bandwidth allocation (FBA)
- Router-Based Bandwidth allocation (RBA)
- Windows-Based Bandwidth allocation (WBA)

And inspect some problems in each category such as:
In FBA Differentiated Services Support (DiffServ), Quality of Service (QoS), MAP message and Class of Service (CoS) and in RBA Fault Tolerance, Quality of Service (QoS), QoS in Multicast, Multi-Streams Environments, Router-based Denial of Service (DoS) and Expenses or Price and in WBA Window-Based Congestion Control, Utility Fair Congestion Control, Bandwidth-delay tradeoffs, End-to-end Flow Control, Congestion Control for Future High Bandwidth-Delay Product and Expenses or cost are the major problems and found the best solution for them. Finally try to explain some theoretical or experimental result as finding items in each section such as:
In WBA to avoid per-flow buffering and scheduling, as required by Fair Queuing, I use FIFO queuing with probabilistic dropping on input, or in RBA The traditional hop-by-hop approach is significantly less fault tolerant than a domain-based approach, or in FBA 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.

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References

[1] AMOTZ BAR-NAY, Y. M. A. B. S. (1998) Competitive Dynamic Bandwidth Allocation. PODC 98 Fbxto Vallarta Mexico.
[2] ANSARI, Y. L. A. N. (2005) Limited sharing with traffic prediction for dynamic bandwidth allocation and QoS provisioning over Ethernet passive optical networks. JOURNAL OF OPTICAL NETWORKING.
[3] BARRIA, R. M. S. A. J. A. (2004) Fair and Efficient Dynamic Bandwidth Allocation for Multi-Application Networks. Imperial College London.
[4] BEN HARDEKOPF, T. R., JAYARAM MUDIGONDA, MICHAEL DAHLIN AND HARRICK VIN (2003) Impact of Network Protocols on Programmable Router Architectures.
[5] BOUTABA, Y. I. A. R. (1999) A Dynamic Bandwidth Allocation Algorithm for MPEG Video Sources in Wireless Networks. ACM.
[6] DAWID NOWAK, P. P. A. J. M. (2004) Bandwidth Allocation for Service Level Agreement Aware Ethernet Passive Optical Networks.
[7] DAWID NOWAK, P. P. A. J. M. (2004) Bandwidth Scheduling Techniques for Differentiated Services Support in Ethernet Passive Optical Networks.
[8] DINA KATABI, M. H. A. C. R. (2003) Internet Congestion Control for Future High Bandwidth-Delay Product Environments.
[9] EVANS, R. P. A. J. B. (2002) Experiences with Class of Service (CoS) Translations in IP/MPLS Networks. University of Kansas.
[10] FARBER, H. K. A. D. J. (1994) Congestion control by bandwidth-delay tradeoff in very high-speed networks: the case of window-based control. University of Pennsylvania.
[11] G. BOGGIA, P. C., L. A. GRIECO AND G. TOMASICCHIO (2007) A Dynamic Bandwidth Allocation Algorithm for Supporting Real-time Applications in 802.15.3 WPANs. ACM.
[12] GUERIN, Y. X. A. R. A. (2005) On the Robustness of Router-based Denial-of-Service (DoS) Defense Systems. ACM.
[13] IBRAHIM KHALIL, B. M. A. A. M. R. M. (1995) Bandwidth allocation in high speed networks with multiple nested charge class. IEEE.
[14] ION STOICA, S. S. A. H. Z. (1999) Core-Stateless Fair Queueing: Achieving Approximately Fair Bandwidth Allocations in High Speed Networks.
[15] ION STOICA, S. S. A. H. Z. (2003) Core-Stateless Fair Queueing: A Scalable Architecture to Approximate Fair Bandwidth Allocations in High-Speed Networks. IEEE/ACM.
[16] KUNG, H. T. (1998) Bandwidth Allocation. Harvard University.
[17] LIM, H.-J. B. A. J.-T. (2003) Window-based Congestion Control in TCP with Explicit Congestion Notication: Multiple Congestion. Korea Advanced Institute of Science and Technology.
[18] LUN LI, D. A., WALTER WILLINGER AND JOHN DOYLE (2004) A First Principles Approach to Understanding the Internet's Routerlevel Topology. ACM.

[19] MARBACH, Y. Q. A. P. (2003) Bandwidth Allocation in Ad Hoc Networks: A Price-Based Approach. IEEE.

[20] NATH, S. B. A. B. (2002) an Edge Router Based Protocol for Fault Tolerant Handling of Advance Reservations. Rutgers University.

[21] NAWEL CHEFAI, N. D. G. A. G. V. B. (2001) Preemptive Bandwidth Allocation Protocol for Multicast, Multi-Streams Environments. ACM.

[22] OLLER, N. M. (2008) Window-based congestion control. Stockholm, Sweden.

[23] POSCHWATTA, T. H. A. T. (2006) Utility Fair Congestion Control For Real-Time Track.

[24] SHUDONG JIN, L. G., IBRAHIM MATTA AND AZER BESTAVROS (2003) A Spectrum of TCP-Friendly Window-Based Congestion Control Algorithms. ACM.

[25] STANOJEVIC, R. (2007) Router-Based Algorithms for Improving Internet Quality of Service. National University of Ireland.

[26] WALRAND, J. M. A. J. (1999) Fair End-to-End Window-Based Congestion Control. IEEE.

[27] WEI ZHAO, M. K. A. S. K. T. (1997) Evolutionary Game Theoretic Model and End-to-end Flow Control in the Internet. University of Maryland.

[28] YEON-MO YANG, J.-M. N. A. B.-H. A. (2004) An Enhanced Burst-Polling based Delta Dynamic Bandwidth Allocation Scheme for QoS over E-PONs. ACM.

[29] YONGJOO TCHA, M.-S. K., SEONG-CHOON LEE KT (2004) A compact MAP message to provide a virtual multi-frame structure for a periodic fixed bandwidth assignment scheme. IEEE.

[30] VORGELEGT VON (2004) Advance Reservations of Bandwidth in Computer Networks. University of Berlin.

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