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Recent Trends in Analysis of Algorithms and Complexity Theory

An Efficient Dynamic Bandwidth Allocation Algorithm for improving the Quality of Service of Networks

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Abstract: During networking, the bandwidth is equally assigned to individual nodes. But each node can't utilize the same amount of bandwidth. The requirement of bandwidth also differs from time to time. For proper utilization of bandwidth, the dynamic bandwidth allocation algorithm can be implemented. Efficient dynamic resource provisioning algorithms are necessary to the development and automation of Quality of Service (QoS) networks. The main goal of these algorithms is to offer services that satisfy the QoS requirements of individual users while guaranteeing at the same time an efficient utilization of network resources. In this paper, we introduce a new service model that provides quantitative assignment of bandwidth guaranteeing the improvement in QoS in terms of network services. We propose an efficient bandwidth allocation algorithm that takes traffic statistics for dynamic bandwidth allocation. We demonstrate through simulation in realistic network scenarios that the proposed dynamic provisioning model is superior to static provisioning in providing resource allocation both in terms of total accepted load and network revenue.

Keywords: Bandwidth Allocation, Autonomic Networks, Service Model.

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1. Introduction

Bandwidths to computers are assigned based on the connectivity. It depends on the switched Ethernet architecture [1]. The allocated bandwidth is assigned to individual group for efficient utilization of bandwidth. The group's efficient dynamic resource provisioning mechanisms are necessary to the development and automation of Quality of Service networks. In telecommunication networks, resource allocation is performed statically on the basis of time. However, statically provisioned network resources can become insufficient or considerably under-utilized if traffic statistics change significantly [2]. Therefore, a key challenge for the deployment of Quality of Service networks is the development of solutions that can dynamically track traffic statistics and allocate network resources efficiently, satisfying the QoS requirements of users while aiming at maximizing, at the same time, resource utilization and network revenue.

Recently, dynamic bandwidth allocation has attracted research interest and many algorithms have been proposed in the literature [2, 3, 4, 5]. These approaches and related works are discussed in Section 2. Since dynamic provisioning algorithms are based on admission control algorithms. In this paper, we propose a new service model that provides quantitative perflow bandwidth guarantees, where users subscribe for a guaranteed transmission rate. Out of the total allocated bandwidth, the controller will assign the required bandwidth and maintains the remaining bandwidth for future use.

To implement this service model we propose a distributed provisioning architecture consisting of a central core where the bandwidth will be assigned. From the central core the bandwidth will be monitored and a concept called bandwidth on demand will be applied.

Moreover, if persistent congestion is detected, then different ARQ protocol can be applied to provide guaranteed data transmission [6]. For efficient utilization of resources, UPnP and SUPnP protocol can be applied [7]. Ingress routers perform a dynamic tracking of the effective number of active connections, as proposed in [8], as well as of their actual sending rate. Accordingly, the bandwidth allocation is performed. The allocation is then enforced by traffic conditioners that perform traffic policing and shaping.

In summary, this paper makes the following contributions: the definition of a new service model and the

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proposition of a distributed architecture that performs dynamic bandwidth allocation to maximize users utility and network revenue. The paper is structured as follows: Section 2 discusses related work; Section 3 presents our proposed service model and provisioning architecture; Section 4 describes the proposed dynamic bandwidth allocation algorithm; Section 5 discusses simulation results that show the efficiency of our dynamic resource allocation algorithm compared to a static allocation technique. Finally, Section 6 concludes this work.

2. RELATED WORK

The problem of bandwidth allocation in telecommunication networks has been addressed in many recent works. In a max-min fair allocation algorithm is proposed to allocate bandwidth equally among all connections bottlenecked at the same link [3, 4]. In our work we extend the max-min fair allocation algorithm proposed in [6, 7] to perform a periodical allocation of unused bandwidth to users who expect more than their subscribed rate.

When number of nodes are connected in a network and bandwidth is assigned then the whole bandwidth is equally divided among number of nodes present in the network [1]. If 10 Mbps connection is made then in case of bridged Ethernet, each of the group connected over the bridge will contain equal bandwidth and this bandwidth will be shared among the individuals in the group for faster process execution.

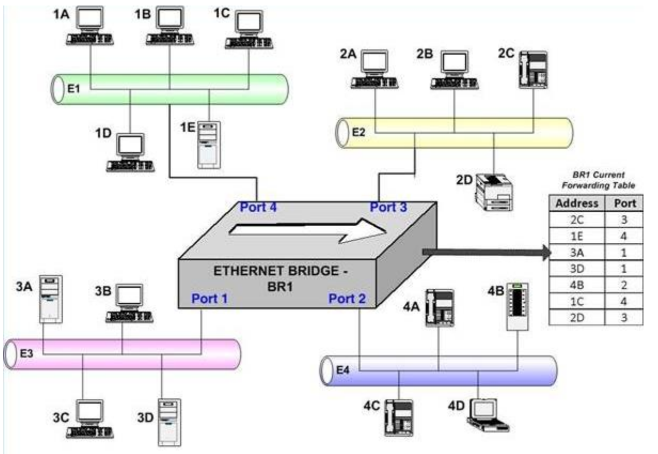


Fig – 1 : 4 Port Bridged Ethernet joining Ethernet Segments E1, E2, E3, E4

Dynamic bandwidth provisioning in Quality of Service networks has recently attracted a lot of research attention due to its potential to achieve efficient resource utilization while providing the required quality of service to network users [2, 3, 4]. In [2], the authors propose a dynamic core provisioning architecture for differentiated services IP networks. The node provisioning algorithm adopts a self-adaptive mechanism to adjust service weights of weighted fair queuing schedulers at core routers while the core provisioning algorithm reduces edge bandwidth immediately after receiving a Congestion-Alarm signal from a node provisioning module and provides periodic bandwidth re-alignment to establish a modified max-min bandwidth allocation to traffic aggregates. In this paper, we have proposed dynamic bandwidth allocation algorithm applied in the core. The bandwidth will be allocated on demand. So, it will be utilized efficiently.

In paper [6], we have introduced an efficient algorithm called incremental clustering in which the information is clustered into number of groups based on the impact. The impact is calculated in terms of click stream i.e. based on the time of individual web pages accessed, the impact factor is calculated. The higher impact web pages are maintained in different clusters and are treated differently. The paper provide 100 percent guarantee of data transmission but time of transmission may be more. A comparison study between different ARQ protocol are done and concluded that the selective repeat ARQ protocol provides the faster rate of data transmission along with least delay time.

In paper [7], an effective algorithm is applied which is based on SUPnP protocol that works that works on the principle of Universal plug and play. For security to the information, secure ring signature algorithm is applied. It provides the same efficiency as that of [6] with increase in security to the information of the group.

3. Service Model

The service model is based on a distributed architecture. The algorithm is applied in the core server. The server will allocate the band width based on demand. So it is able to control the operation during high traffic periods. For faster operation, instead of a single core, two cores are used. The core will assign the bandwidth to individual for efficient utilization of bandwidth. An incremental approach can be followed be the core. i.e. when time passes the core will assign the bandwidth to individual nodes. Initially, the complete bandwidth available at the core itself. The service model can be represented as given fig-2.

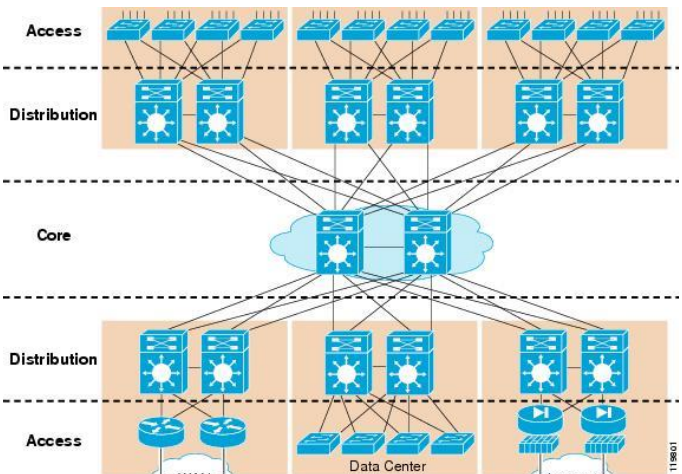


Fig2 : Service Model for Dynamic bandwidth allocation algorithm implementation

If the information is reached properly and the bandwidth is applied successfully then an ACK signal is returned to the core after specific time period. Otherwise, after a fixed time out period, NAK signal will be assigned. The model for such operation can be represented as given in fig-3.

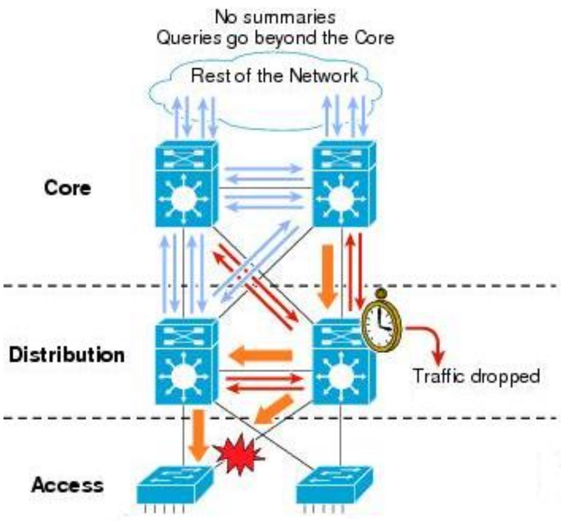


Fig-3 : Model for controlling bandwidth during traffic within the network

4. Proposed Algorithm

The paper is based on two algorithms such as:

1. Dynamic Bandwidth Algorithm using Incremental Clustering Approach
2. Algorithm for implementing the bandwidth using Selective Repeat ARQ Protocol

4.1. Dynamic Bandwidth Algorithm using Incremental Clustering Approach:

1. Initially set the bandwidth of all nodes as zero

$$F_n = 0$$

2. Calculate the impact factor of the information needed in each node and assign the bandwidth to individual nodes in incremental approach.
3. Assign the bandwidth to the individual nodes based on the demand.

$$F_n = F_n + F_d$$

4. During data transmission the traffic is calculated in terms of delay time. The delay time is calculated using a fixed time out period set by the core to individual nodes. At such condition more band width will be assigned to the specified node.
5. After completion of the each operation, if there is no information to be sent or received, the bandwidth allocated will be released.

$$F_n = 0$$

6. For proper data transmission, Selective Repeat ARQ protocol can be implemented.

4.2. Algorithm for implementing the bandwidth using Selective Repeat ARQ Protocol:

Let, MAX_SEQ = 7 and should be in the form of 2n-1
NR_BUFS = ((MAX_SEQ + 1)/2)
Sf = S = 0 and Sl = 3 for current application
Time_out = x
ack = false
no_ack = false

1. Send the S bit to the receiver end and wait for *ack* signal from the receiver end.
2. If *ack* is not received at appropriate time i.e. Time_out take place then
Set S = S+1 and send the S bit information to the receiver end and wait for *ack* signal.
3. If *ack* is received at the sender end at appropriate time (Time_out) then the sliding window moves S bits.
Set, Sf = Sf + S
Sl = Sl + S
S = 0
And apply the process from Step-1.
4. Else apply Step-2
5. If S > Sl then reset the sending process from beginning considering no frame is transferred.
6. If *no_ack* signal is send from the receiver end within the Time_out, then
Set S = S – 1
and resend the S bit information to the receiver end.
7. Apply the process until the end of information.

5. Simulation and Experimental Result

The experiment is based on the Clickstream data concept. Clickstream data is a natural by-product of a user accessing World Wide Web (WWW) pages, and refers to the sequence of pages visited and the time these pages were viewed. Clickstream data is to Internet marketers and advertisers. An instance of real clickstream records is the MSNBC dataset, which describes the page visits of users who visited msnbc.com on a single day. There are 989,818 users and only 17 distinct items, because these items are recorded at the level of URL category, not at page level, which greatly reduces the dimensionality. The 17 categories are tabulated with their category number.

Front Page	1
News	2
Tech	3
Local	4
Opinion	5
On-air	6
Misc	7
Weather	8
Health	9
Living	10
Business	11
Sports	12
Summary	13
Bbs	14
Travel	15
msn-news	16
msn-sports	17

Table 5.1. MSNBC dataset

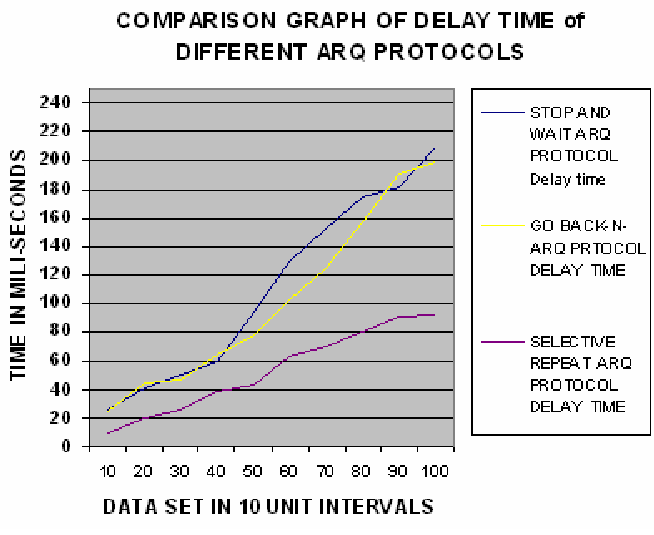
The sample sequences for the data set will be:

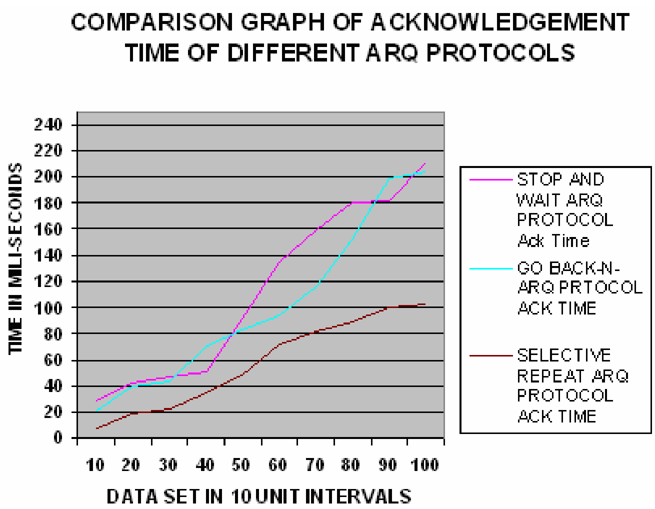
1 1
2
3 2 2 4 2 2 2 3 3
5
1
6
6 7 7 7 6 6 8 8 8 8
6 9 4 4 4 10 3 10 5 10 4 4 4
1 1 1 1 1 1 1 1

Each row describes the hits of a single user. For example, the first user hits "frontpage" twice, and the second user hits "news" once. Similarly third user hits “Tech” page once,

"News" twice, then "Local" page once and then again "News" page twice. Finally, it accesses "Tech" page twice.
The algorithm for 4.2 is applied using C++ and the delay and acknowledgement time is calculated by the result of the clustered data sets. The experimental result is given int the table 5.2.

The experimental result for the algorithm based on dynamic approach can be represented as:





6. Conclusions

The controlling of the bandwidth is done by the core of the distributed model. The bandwidth needed for static allocation will be in multiple of number of nodes but in case of dynamic allocation techniques it will be significantly less. The bandwidth needed for static allocation will be divided equally among the nodes of the group. So it will be less. Each node bandwidth requirement is also not same and it differs at each time of execution. So, dynamic bandwidth allocation techniques it will provide an efficient utilization of bandwidth. Hence the transmission speed will be faster and the system will be efficient.

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Author Profile

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SIZE OF DATASET	STOP AND WAIT ARQ PROTOCOL		GO BACK-N-ARQ PROTOCOL		SELECTIVE REPEAT ARQ PROTOCOL	
	Delay time	**Ack Time**	**Delay time**	**Ack Time**	**Delay time**	**Ack Time**
10	26	29.257019	24	21.63385	10	7.069092
20	41	42.106812	44	39.294312	20	18.628284
30	51	47.553101	46	43.735596	25	21.92218
40	60	51.188599	64	70.79541	38	35.231506
50	95	91.18634	78	83.155334	43	47.794678
60	129	134.469849	102	94.004639	63	71.675659
70	152	159.183289	124	116.169678	70	81.445923
80	174	180.92041	156	152.485718	80	88.74231
90	182	181.551086	190	198.965149	90	100.041321
100	209	211.034729	146	153.33197	93	100.041321

Table 5.2 : Experimental result of delay time and acknowledgement time of different ARQ protocol Using Incremental Clustering Algorithm