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Minimizing Delay in Heterogeneous Networks using Congestion Forecast

[1]Fazli Rahim, [2]Muhammad Fawad
[1-2]Department of Computer Science, Government Postgraduate College Dargai Malakand Khyber pukhtoonkhwa Pakistan
** Corresponding Author: Fazli Rahim*

ABSTRACT
Internet, a collection of large many packets, is expanding day by day. Every minute across the globe, billions of electronic devices, such as PDA, Tablets, mobiles, Personal Computer, laptops, are interconnected via this gigantic networking system called the internet. This interconnection of so many devices across the globe, however, is not without any problems, such as congestion. Congestion is very hot area of research because internet traffic is expanding tremendously with the passage of time because each second, billions of billions of packets may enter the network, which are controlled by buffers. The aim of the paper is to study the behavior of heterogeneous networks to achieve minimized delay through congestion forecast, to control congestion through probabilistic nature of congestion forecast and maximized throughput. All the work will be carried out through Modeler Opnet.
Keywords: *Congestion Control, congestion forecast, heterogeneous networks, IPV4, IPV6.*

I. INTRODUCTION

A system is said to be in congestion if the required resources exceed than the holding. The resources may be bandwidth and buffer space etc which are usually expensive. Even for a small file much more time is needed to download. Solving congestion through the use of infinite buffer is not a good idea because it increases queue size and compels the packet to stay in the queue for an infinite time so for each packet a finite lifetime should be assigned. [1].

The size of the internet is increasing day by day as the number of users is increasing on hourly basis. But this results in performance degradation and delay, and the loss of data packets due to congestion [2]. An internet is said to be a queue of packets where some nodes add packets while other removes it. A situation when the number of packets added to this queue exceeds the number of packets removed, congestion occurs. So to control it the packets should be added upto a specific level, to maintain the performance. Packet switching is important for this purpose.

The sources of congestion are usually internet because of its connectionless nature, routers with more traffic than its capacity and LANs Connecting WANs. The variable size of packets makes traffic prediction and guaranteed service provision difficult. So QoS is not obtained.

Congestion is usually caused by low memory, slow processors, bandwidth line and speed mismatch of devices. Congestion may be controlled using two methods i.e. Open Loop and Close Loop [3]. In open loop, preventing the system to enter the congestion by knowing the current traffic is restricted to reach the peak value while in closed loop, congestion is handled after it has been occurred.

Queuing helps in congestion resolution. Queuing is used in buffer management and hence can improve network performance. Router Algorithms may be classified into queue management and scheduling algorithms. Queue management algorithms are related to control traffic and the other is for performance and handling delay

Congestion control has two steps:

- Avoiding the congestion not to occur
- Recovering from the Congestion. Let the congestion occur and handle it after that.

II. LITERATURE REVIEW

Heterogeneous network can be categorized according to network traffics (IPV4, IPV6, Audio, Video, Text etc) or type of network (wired or wireless) or according to speed of network (high or low speed).

The best effort service model is proposed by P.Gevros et al, in [1]. This scheme is treating all the packets equally, which guarantee that no compromise upon quality of service (QOS). The best effort model has operational specification and expected that packet should be delivered while keeping congestion levels low. In this paper most of the mechanisms for congestion controls are router-based which were almost in the perspective of guaranteed real time and QoS traffic. There has been too little research in the best effort service framework, so there is a general misunderstanding that the router only implements FIFO queues for best effort service model. If other mechanisms of queues are appropriately used, they would give good result having lower delays without affecting QoS. The authors expect that their use can significantly develop the best effort service model.

Endpoint Admission Control is discussed by Ayalvadi J. Ganesh et al, in [4]. Schemes like virtual-queue marking [5], random-early marking [3] and tail drop [6] are considered to determine probing duration for better utilization and QoS. Early marking demands fewer probes packets while tail drop requires a large number of probe packets.

B. Subraman and T. Karthikeyan proposed in [6] that the cause of packet loss in a network may be either transmission errors or cause congestion. TCP's congestion control handles this problem by just discarding the packet with no acknowledgement. It treats all packets fairly by equally distributing the available bandwidth among the packets. TCP can adjust the data rates in case of congestion, but a non TCP network continue to work with the same data rate hence causing unfairness and starvation. There is a need of non TCP traffic to be TCP friendly. Congestion control protocol may be classified as Window based, Rate Based, Single Rate and Multi-rate congestion control protocols.

Ao Tang et al, proposed a design mechanisms for improving optimality and stability. Through simulation, they conclude the behavior of heterogeneous network and its equilibrium property. Router parameter and bandwidth allocation are separated. In the proposed algorithm the parameter works on slow time scale. Existing protocol deploy the new method incrementally to adopt slow time scale [7].

A Multimodal Control Protocol (MCP) is introduced by Maxim Podlesny and Sergey Gorinskyc [8] for reducing packet loss across the link. In this model host and routers take part in explicit communication. In its fair state, MCP shows stable transmission, for which it enables a flow of control mechanism. MCP uses rate-based control and adjusts uniform timing to achieve this goal.

I.Psarras et al, presented in [9] that TCP has some problems while working with wireless networks such as packet loss (which is due to fading channel). So the rules of wired networks for congestion control can't be employed in wireless networks. Generally, TCP implements fairness, performance and congestion control. These goals are achieved through adjusting congestion window, decreasing contention level, stopping transmission during handoff event and for fading channel adjusting congestion window. Two other factors that are added in this paper are Error Recovery Mechanism and Contention Estimation. In Error Recovery Mechanism, the probe cycle will not over until the sender can produced measurements of two consecutive RTT. If contention is observed then the "Immediate Recovery" strategy is called, otherwise the available bandwidth is used. In Contention Estimation, if there is high level of contention in congestion then for every RTT a congestion predictor is calculated by TCP Probe. If the predictor is high than the threshold, TCP Probing [10, 11] does not enter into probe cycle, instead a slow start strategy TCP-Reno [12] is applied. The solution proposed in this paper doesn't consider optimization.

Yao-Nan Lien et al, discussed in [13] that the main cause of congestion is due to the unawareness of the sender about the capacity of the network. Congestion may be managed by the TCP at the terminal node. This paper presents a program called "TCP Muzha" where router sends its status information to the sender so that they may control their data rates. Also a multilevel data handler is used to control data rates. TCP Muzha performs more efficiently than other TCP. Fairness is the main problem that was not handled in this paper. There is also a need of synchronization enhancement.

In a multi-user network, End-to-End congestion control is presented by K.Winstein and H.Balakrishnan in [14]. Instead of handling congestion directly they designed a program which is called "Remy" that generates algorithms to control congestion at the endpoints. This program provides high throughput and low delay. "Remy" has the ability to generate algorithms both for data and cellular networks.

Z. Ding et al presented in [15] that Quality of service (QoS) and Radio resources are basically provided by common Radio Resources management (CRRM), which works by the support of RAT (Radio Access Technologies).The fitting of incoming call into the heterogeneous network as well as its identification is one of the main function of RAT.

Jyun-Siou Fa et al presents congestion control algorithm which identify wireless errors from congestion errors and adjusts congestion windows and slow start threshold properly. It has more fairness and better utilization in bottleneck link. The weakness of this paper is extra load for setting the threshold [16].

III. OBJECTIVES

The aim of this research is:

1. To examine the behavior of heterogeneous networks that will involve the communication between different networks under overloaded traffic conditions.
2. To control congestion through probabilistic nature of congestion forecast.

3. To minimize end to end delay through congestion forecast which maximize throughput.

A scenario consists of routers and source node (traffic generator by using ping command continuously). We consider a single link of fixed bandwidth capacity i.e. 10 Mbps. The conditions for the scenario are that SNMP protocol are enabled and the time limits for congestion are defined. When keeping extra traffic on router determining probability for congestion forecast.

IV. NARRATIONS & ASSUMPTION

A model consisting of a set of L links, indexed by L1, L2, L3…….Ln with fixed finite capacity C, P denotes the packets and Pn denotes total number of packets. The set of links used by source node (j, i) is denoted by L(j, i) where j & I represents the source and sink and the total number of sources by

Sn = ∑j Sj .

V. NETWORK MODEL

The system we selected has finite population of P packets each with an arriving parameter λ, m-servers each with parameter µand finite storage. The total number of packets in the system is no more than K.

When M ≥ k ≥ m, packets arriving to find k already in the system are "Lost" and return back to the arriving state as if they had just completed service.

In this model the arrival and service process will be

$$i'_K = \begin{cases} \lambda(M-k) & 0 \le k \le K-1 \\ o & otherwise \end{cases}$$

VI. $$\mu_k = \begin{cases} k\mu & 0 \le k \le m \\ m\mu & k \ge m \end{cases}$$

For this model, we have two regions. First for the range

0 ≤ k ≤ m-1. The probability for this region will be:

$$P_k = p_0 \left(\frac{\lambda}{\mu}\right)^k \begin{pmatrix} M \\ K \end{pmatrix} \qquad 0 \le k \le m-1$$

…………. (1)

The second region we have m ≤ k ≤ K we have

$$Pk = p_0 \left(\frac{\lambda}{\mu}\right)^k \begin{pmatrix} M \\ K \end{pmatrix} \frac{k!}{m!} m^{m-k}$$

…………………. (2)

Now combined both the probabilities from equation 1 & equation 2

$$P(k) = \sum_{i=1}^{n} P_k \qquad k = 0,1,\ldots\ldots\ldots.n$$

VII. FIGURES AND TABLES

The queuing delay is least for IPV6 router B, which also provides tunneling mechanism as shown in the Figure 1. In IPV4 pure environment queuing delay is highest indicated for both router A and C. The average value of queuing delay in IPV6 only environment is also at least value in comparison to router B. This establishes that IPV6 packet provides lesser congestion in path and tunneling mechanism has least effect on congestion.

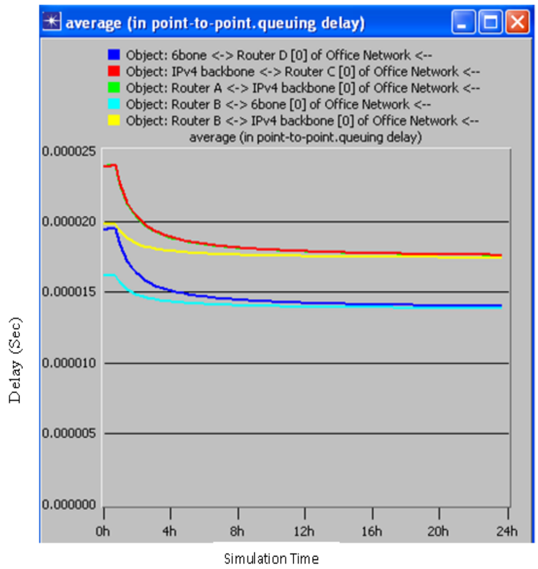

Figure 1

Figure 2 shows the overall packet drop (blue curve) in network, packet drop in tunnel and packet drops at individual routers. Router A traffic drop is similar to all other routers in IPV4 environment, but when its packets are routed to IPV6 (tunnel), the packet drop is the least. Figure 2 also shows that packet drops for IPV4 is similar at all routers, but is much smaller when packets are routed for IPV6 environment.

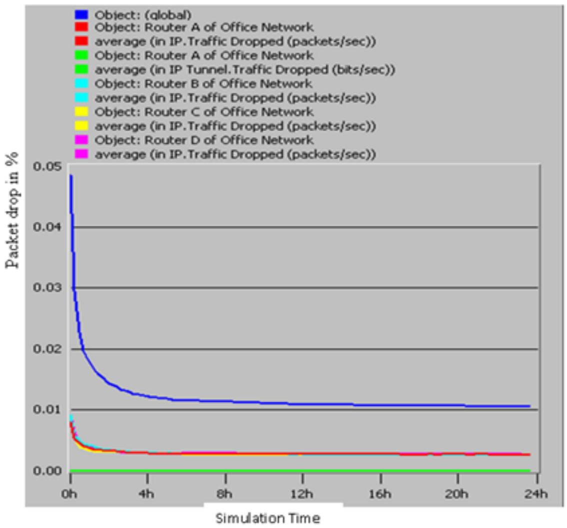

Figure 2

VIII. CONCLUSION

The queuing delay for Router B to 6bone is lesser by 23% while the throughput for the same is highest in the network. This establishes that IPV6 packet provides lesser congestion in path and tunneling mechanism has least effect on congestion, while the packet drops for IPV4 is similar at all routers, but is much smaller when packets are routed for IPV6 environment.

The future direction will be focused on developing genetic algorithm that has probabilistic nature for congestion avoidance.

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Fazli Rahim has completed his MS(IT) Degree from IM/Science (Institute of Management & Sciences Hayatabad Peshawar in 2012. Currently engaged as Lecturer of Computer Science in GPGC Dargai and supervising IT Projects at graduate level, and his interests of research is Wireless Sensor Network, IPV4 to IPV6 transitions using tunneling and IOT.

Muhammad Fawad was completed his MS Degree from Abasyn University Peshawar in 2016. Currently he is doing his PhD from University of Malakand Chakdara Dir(L). His research interests include Wireless Sensor Network, IPV4 to IPV6 transitions using tunneling and IOT. Currently, he is serving as computer Assistant Professor in GPGC Dargai and supervising IT Projects at gradaute level.

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