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A New Congestion Control Algorithm Based on Novel AQM

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Abstract--- **The Congestion Control and queue management are important to the robustness and fairness of the Internet and other network application. The Congestion Control is concerned with allocating the network resources such that the network can operate at an optimum fair performance level when the demand exceeds or it is near the capacity of the network resources. The Active Queue Management algorithms identified earlier show weaknesses to detect and control congestion under dynamically changing network topologies. This has been proposed in order to continuously reduce the packet dropping possibility, and improve the link utilization ratio. The Congestion Control algorithm has been designed AQM and TCP and tuned to work fine for wired networks where packet loss is mainly due to network congestion. In wireless networks, however, communication links suffer from transmission bit errors and handoff failures. As a result, the performance of TCP flows is significantly degraded. To mitigate this and many other drawbacks of the existing algorithms the new active queue management has been projected. In this paper a new AQM algorithm, is proposed to improve on both fairness and congestion control in heterogeneous networks. It can find the congestion at the earliest time and make the best of network resource. The simulation result shows the proposal can detect the congestion in time in the changing network condition, and make the output smooth. Finally, a simulation platform is being developed, tested and validated to demonstrate the merits and capabilities of the proposed AQM through a set of experiments and scenarios. The performance of modified AQM is compared to the existing BLUE AQM algorithm. The results of the simulations show that the proposed AQM is very promising with respect to responsiveness and robustness in time-varying networks.**

I. Introduction

The congestion control over network plays a vital role for all types of media traffic and this has been an active area of research in the last decade [1]. This is due to the flourishing increase in the network traffic of digital convergence. It is very imperative to avoid high packet loss rates in the Internet. When a packet is dropped before it reaches its destination, all of the resources it has consumed in transit are wasted. In extreme cases, this situation of packet loss can lead to congestion collapse. Improving the congestion control and queue management algorithms in the Internet has been one of the most active areas of research in the past few years. While a number of proposed enhancements have made their way into actual implementations, connections still experience high packet loss rates. Loss rates are especially high during times of heavy congestion, when a large number of connections compete for scarce network
Increasingly, new applications which are being deployed do not use TCP congestion control and are not responsive to the congestion signals given by the network. Such applications are potentially dangerous because they drive up the packet loss rates in the network and can eventually cause congestion collapse [2, 5]. In order to overcome the problem of non-responsive flows, a lot of work has been done to provide routers with mechanisms for protecting against them [3 and 4]. The idea behind these approaches is to detect non-responsive flows and to limit their rates so that they do not impact the performance of responsive flows in the network.

II. Active Queue Management in Congestion Control

The concentrate of Internet congestion control is that a sender adjusts its transmission rate according to the congestion measure of the underline networks. There are two approaches to accomplish this. One is a source algorithm that dynamically adjusts the transmission rate in response to the congestion along its path; the other one is a link algorithm that implicitly or explicitly conveys information about the current congestion measure of the network to sources using that link. In the current Internet, the source algorithm is carried out by TCP, and the link algorithm is carried out by Active Queue Management [8] technique at the routers.

According to the measurement metrics congestion, AQM technique can be classified into three catalogs queue-based, rate based, and schemes based on concurrent queue and rate metrics. In queue-based schemes for finding the queue length, the congestion is observed by average or instantaneous queue length and the control aim is to stabilize the queue length. Rate- based methodology provides accurate prediction of the utilization of the link, and determines congestion and take actions based on the packet arrival rate. Rate-based schemes can provide early feedback for congestion Other AQM methodologies deploy a combination of queue length and input rate to measure congestion and achieve a tradeoff between queues stability and responsiveness. The existing queue management algorithm provides the methodologies to find the queue length but has drawbacks that they are not efficient to produce instantaneous queue length at a future time. So, the proposed AQM algorithm has been developed to provide the queue length instantaneously.

III.THE IMPACT OF UNRESPONSIVE FLOWS ON AQM PERFORMANCE

The Unresponsive flows contributing to about 70-80% in the overall network flows. This small volume of Unresponsive flows produces a significant impact on transient behavior of AQMs [10, 11 and 12]. The short lived TCP flows can dominate the dynamic of traffic increase when congestion is low and long lived TCP flows dominate the dynamic of traffic decrease .The mean sending rate of unresponsive flows reduces the bandwidth available to long lived TCP traffic, which in turn makes the AQM more robust, but less responsive by nature. Queue averaging is the issue that deals with an AQM's response to variation in unresponsive traffic. It results in a tradeoff between AQM responsiveness, robustness and response to the uncontrolled flows in the network. For robustness the queue averaging time constant should be chosen outside the range (R, R2C⁄N) where R is the round trip time is link capacity and N is the number of active TCP flows [6].

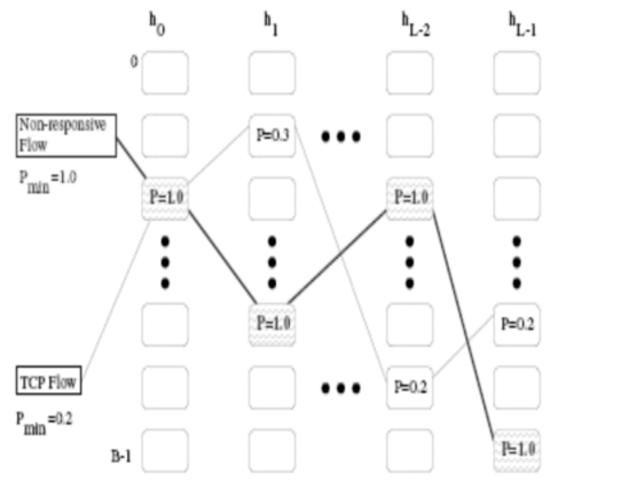

Figure 1 Impact of Unresponsive Flows on AQM

AQM responsiveness is inversely related to the queue averaging time constant. It is also impossible via selection of the averaging time constant, to sufficiently and simultaneously smooth the variations in queue length and loss probability due to variations in Unresponsive flows [7]. Thus the algorithms to find the average queue length at the earliest time and provide instantaneous information about the congestion in future are not much effective and the limitations of the impact of unresponsive flows in AQM has a major drawback to overcome all these measures the new AQM methodology is introduced.

IV.MODIFIED ACTIVE QUEUE MANAGEMENT ALGORITHM

The basic mechanism matches every incoming packet against a random packet in the queue. If they belong to the same flow, both packets are dropped. Otherwise, the incoming packet is admitted with a certain probability. However, a high-bandwidth flow may have only a few packets in the queue. A minor modification to this active queue management policy ensures efficient operation as well as reasonable fairness, which is done in Modified Active Queue Management algorithm.

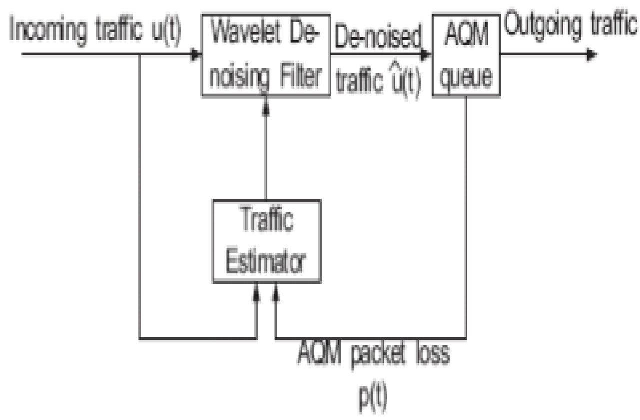

Figure 2 System Overview for proposed AQM

To implement the proposed methodology, the average periodic cycle of the responsive traffic is estimated using a traffic estimator. Then, based on the estimated responsive traffic, the wavelet de-noising filter is applied to remove the non-responsive traffic bursts before they enter the AQM queue [13]. To avoid unnecessary drops of non responsive traffic, the wavelet filter also let the non-responsive traffic pass the router without being counted in the AQM queue size, when extra buffer space is available. The Figure 2 shows the overview of the proposed scheme.

The biggest difference is that instead of having separate queues, Modified AQM uses the hash function for accounting purposes. Thus, it has two fundamental advantages over other methodologies. The first is that it can make better use of its buffers [14]. It gets some statistical multiplexing of buffer space as it is possible for the algorithm to overbook buffer space to individual bins in order to keep the buffer space fully-utilized. The partitioning the available buffer space adversely impacts the packet loss rates and the fairness amongst TCP flows. The other key advantage is that this methodology is a FIFO queuing discipline. As a result, it is possible to change the hash function on the fly without having to worry about packet re-ordering caused by mapping flows into a different set of bins. Without additional tagging and book-keeping, applying the moving hash functions to SFQ can cause significant packet re-ordering.

V. EXPERIMENTAL RESULTS AND DISCUSSION

5.1 Modification proposed

The modification proposed is to use the sum of input and output lengths as the congestion measure. The instantaneous queue length formula is replaced by the weighted sum of q_{output} and q_{input} where q_{output} is the length of the output queue and q_{input} is the sum of lengths of all VOQs corresponding to that output. In this way, the input queue length also contributes to the probability of dropping packets. The dropping itself is done only from the output queue, as the AQM is applied only to the output queue. Thus, we get

$$Qavg(i) = (1-w_q)\times Qavg(i-1)+w_q \times(\nu q_{input} + q_{output}) \quad (1)$$

where ν is the weighting factor for the input queue length. This parameter is important because it provides a means to balance the reduction in the average backlog on the one hand, and the increase in the loss rate on the other hand [15]. The key advantage of this is that the RED (output) queue need not get filled up as much as in original RED to start reacting to congestion. An important point to note is that, only if VOQs are used, it is easy to take into account the input queue length meant for a particular output. If instead, normal input queues are used, then it is difficult to find out how much of the input queue length is due to packets meant for a particular output. Thus, this strategy is best implemented only in VOQ based switches. The AQM block at each output needs to know the sum of VOQ lengths corresponding to that output, besides the output queue length itself. Obtaining the sum of lengths is possible as all the queues are within the same switch.

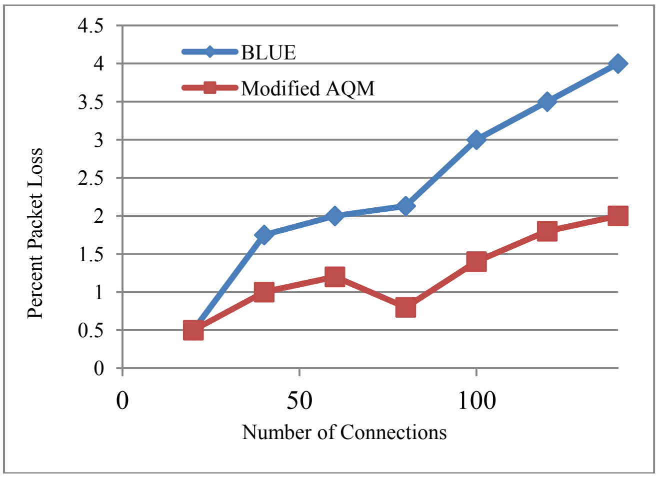

Figure 3 Modified AQM Performance - Percent Packet Loss Vs Number of Connections

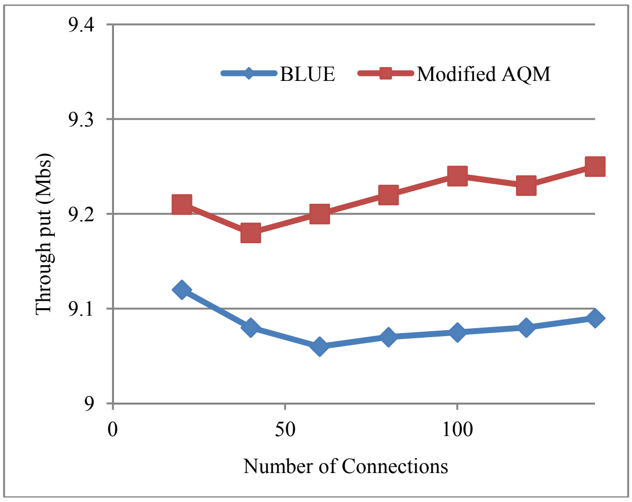

Figure 4 Modified AQM Performance - Throughput Vs Number of Connections

The AQM block at each output level of information flow in the network needs to know the sum of VOQ lengths corresponding to that output, besides the output queue length itself. Obtaining the sum of lengths is possible as all the queues are within the same switch.

The experiment is performed with the proposed AQM and BLUE AQM technique. During the simulation, the number of connection is increased between the nodes. Meanwhile, the Chariot 3.2 [16] tool is used to generate the traffic. Chariot is an application emulator that can generate various applications' traffic.

The performance of the proposed modified AQM is compared with the BLE AQM technique in terms of percentage of packet loss which is shown in figure 3. The increase in throughput for the proposed modified AQM than the BLU AQM technique is clearly represented in figure 4. From these figures, it can be clearly observed that the modified AQM technique outperforms the BLUE technique in any increase of number of connections.

VI. Conclusion and Future Work

In this paper, we have demonstrated the inherent weakness of current active queue management algorithms which use queue occupancy in their algorithms. In order to address this problem, we have designed and evaluated a fundamental queue management algorithm called Modified AQM algorithm. In the proposed methodology, the packet loss and link utilization of the congested queue is minimized, instead of queue lengths to manage congestion. It is a novel algorithm for scalable and accurately enforcing fairness amongst flows in a large aggregate. Using the proposed methodology the non-responsive flows can be identified and rate-limited using a very small amount of state. The experimental results show the tremendous improvement in the proposed Modified AQM algorithm. The New AQM that predicts the instantaneous queue length at a future time instant using adaptive filtering techniques Finally the paper proposed a new congestion control algorithm, which by predicting the instantaneous queue length of next time to decide congestion.

As in the case with an evolving research area, several unsolved issues remain. The Congestion control is one of the most vigorous places in the field of research and it needs much of research to be processed on. Congestion control algorithm based on the AQM for finding the instantaneous queue length decides congestion and to avoid congestion collapse is to be more concentrated and avoidance of the unresponsive flows on AQM in the network traffic is also to be taken into consideration.

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