A Review on Enhancing Network Performance using Random Early Detection in Virtual Queue

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Abstract - Mobile ad hoc network facing multiple challenges such as dynamic configuration, energy consumption and network congestion. Congested network causes many problems such as large delay, underutilization of the link and higher packet loss rate. Queue management provides a mechanism to detect incipient congestion and to reduce packet transmission rates before queues in the network overflow. Adaptive Virtual Queue (AVQ) maintains two queues a real queue and a virtual queue. During congestion fictitious packet is drop from virtual queue instead of dropping the real packet. Drop tail mechanism is used in virtual queue which drop packets when its capacity becomes full. Random Early Detection performance is better than Drop tail in terms of queue utilization, low queueing delay and lower packet drop rate. Proposed mechanism Enhanced Adaptive Virtual Queue (EAVQ) will use RED instead of Drop tail in virtual to enhance the network performance.

Keyword: AQM, AVQ, RED, droptail, REM.

I. INTRODUCTION

Active Queue Management (AQM)[1] [2]is the most widely used research areas in the field of networking for congestion detection and avoidance. The idea used in AQM is to detect early congestion by dropping or marking packets before queue overflow. Router where congestion occurs provides a prior congestion indication to sources to avoid the large queuing delay and reduce packet losses by adjusting their packet transmission rate timely. Active Queue Management (AQM)[3][4] is an algorithm that detects and reacts to incipient congestion to avoid queue from overflows. There are in general two ways to detect congestion: first it can give congestion signal to traffic sources explicitly by setting Explicit Congestion Notification (ECN) bits, second it can be congestion signal to traffic sources implicitly by dropping packets.

The new mechanism is called Adaptive Virtual Queue (AVQ) algorithm maintains two queues a virtual queue and an actual queue. Virtual queue capacity (called *virtual capacity*) is less than the capacity of the actual queue. When a packet arrives in the real queue, the virtual queue is also updated by inserting a fictitious packet to reflect the new arrival. When the congestion occurs and packet is dropped if packet transmission rate is higher than the packet handling capacity of node/link. Packet drop is treated as congestion by the source thus source reduce packet transmission rate to eliminate congestion. Packets in the real queue are marked/dropped when the virtual buffer overflows.

II. ACTIVE QUEUE MANAGEMENT

Active Queue Management [4] is router based techniques which bring improvement over Drop-Tail queue with respect to fairness and delay. It helps to adopt the dynamic behavior of network. Objective of AQM is to notify the sender about congestion before the queue becomes full. The source is being intimated as a feedback either by dropping the packets or marking the packet by setting ECN bit in the IP header. There are many active queue management schemes has been proposed in the past. In this we considered mainly four AQM techniques namely RED, REM, PI and AVQ which is discussed below.

A. Random early detection

Random Early Detection is most widely used AQM techniques [5][6] today. RED prevents global synchronization deadlocks, and bias against bursty flows to overcome limitation of Drop Tail. RED technique detects incipient congestion by using two important parameters: minimum threshold (min_th) and maximum threshold (max_th). The average queue size (avg_q) is calculated for every packet arrived at the router. Then it compares the avg_q with two defined threshold value min_th and max_th. If avg_q is less than min_th then no packets are dropped/marked. If avg_q is in between min_th and max_th arriving packet is marked with probability Pa, where Pa is function of avg_q. if avg_q is greater than max_th then it drops all incoming packets to lower the queuing delay. If packet drop/mark is occurred in queue source reduce packet transmission rate to reduce packet loss and improve packet delivery ratio.

B. Random Exponential Marking

REM [4] is stable AQM technique which has different congestion measure and different marking probability function than RED. Marking mechanism is notified about the congestion to the end user, called source. REM measure congestion by quantity, called price rather using queue length as in RED. The buffering process of RED implicitly updated the queue length, whereas update of price is explicitly controlled by REM. The first objective of REM is to stabilize the input rate and queue irrespective of number of source sharing the link. The second objective of REM is to find aggregate link prices as a measure of congestion and notify the source through the end-to-end marking probability so as to adopt the rate.

C. Proportional Integral

The main objective of PI controller [7] is to determine marking probability of packet based on the slope of queue length. PI-controller is basically proposed as a combination of two controller units, a proportional controller and an integral controller. In the proportional controller, the feedback signal is simply the regulated output (i.e., the queue length) multiplied by a proportional ga in factor α:

$$P(n) = \alpha e(n)$$

where e(n) is the error signal at time n, i.e., the difference between the actual queue length at time n and the reference queue length qref . This error signal is usually normalized by the router buffer size B, since queue length fluctuations (and hence the error signal) grow linearly with buffer size. The α factor 'steers' the queue length to its desired length (the reference input). One of the drawbacks of the use of a purely proportional controller is the fact that its resulting steady state output will never be equal to the reference output, due to the multiplicative nature of this mechanism.

D. Adaptive Virtual Queue

AVQ [8][9] is a rate based techniques which incurs low-delay, few loss and high link utilization at the link. In this technique one virtual queue is maintained at router whose capacity is less than actual link capacity. Every time virtual queue is updated after each packet arrived in the real queue. When the virtual queue overflows then packets in virtual queue is discarded and real packets is marked/dropped in real queue.

The virtual capacity at each link is modified in such a way that total flow entering each link achieves a desired level of utilization of that link. Thus, this method control the virtual queue instead of directly controlling the real queue length using a dropping probability, AVQ controls the virtual queue capacity, which implicitly applies a dropping probability on packets in the real queue. No dropping probability is being calculated directly.

shows an AVQ specification in pseudo-code, where VQ is the number of bytes currently in the virtual queue, b is referred to as the number of bytes of the arriving packet, B is referred to as the total buffer size of real queue, and the last arrival variable is used for storing the time of the most recent packet arrival at queue. The 'update VQ' event consists of updating the variable holding the current virtual queue length, since it have changed since the previous packet arrival event, e.g., because of packets being served that have left the queue. Note that this is different from updating the virtual capacity.

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At each packet arrival do:
        Update Vq;
        If (Vq + b > B)
                Mark packet in real queue;
Else
        Vq ← Vq + b;
Endif
        Update virtual_capacity;
        Update last_arrival;
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Pseudo code of Adaptive Virtual Queue

III. RELATED WORKS

Srisankar S. Kunniyur et al proposed a mechanism called Adaptive virtual queue [8] in 2004. The basic idea of developing the AVQ algorithm is to design an AQM scheme that results in a low-loss, low-delay and high utilization operation at the link. From authors point of view the AVQ mechanism out performs a number of other well-known AQM schemes in terms of losses, utilization and average queue length. In particular, this mechanism is able to maintain a small average queue length at high utilizations with minimal loss at the routers.

Anand Rao et al presented a mechanism Compound TCP (C-TCP) [9] is presently the default transport layer protocol in the Windows operating system. In which study a non-linear fluid model of Compound TCP along with Virtual Queue (VQ) management schemes in network routers. Objective of this mechanism is to driving the link utilization to a desired level. Analysis of the AVQ policy shows that the system is liable to losing local stability with higher feedback delays, high link capacities, and with variations in the AVQ damping factor.

K.Chitra and Dr.G.Padmavathi et al discusses Classification and Performance of AQM algorithms [10]based on various congestion-metrics and classifies them supported certain factors. This helps in identifying the algorithms that regulate the congestion more effectively.

K.Chitra et al proposed a mechanism called FAVQCHOKe [11]. In this paper, arrival rate at the network link is maintained as a principal measure of congestion to enhanced the transient performances of the system and ensures the fully utilization of link capacity. This characteristic is particularly beneficial for real-time multimedia applications. Further, FAVQCHOKe achieves the above while maintaining high link utilization and low packet loss.

Mr. A.Chandra et al presented a mechanism known as Adaptive Virtual Queue with Choke Packets (AVQCP) [12]. In the proposed mechanism when the virtual buffer overflows choke packets are sent to the source. on receiving the choke packet source reduces its traffic by some percentage. Sources ignore repeating choke packet for a fixed interval of time. If no further choke packets arrive after a certain time, the source will again increase the traffic. This mechanism gives better throughput than other AQM scheme.

Chin-Ling Chen et al presented a mechanism called Proportional Rate based Control (PRC)[13], is proposed to maintain the queue length as the level 1 by adjusting maximum desired rate if arrival rate exceeding the maximum desired rate by dropping the; at level 2 virtual queue to control packet transmission if arrival rate above minimum desired rate. The performance of PRC is compared with several well-known AQM, the proposed scheme is more effective which stabilize the queue and has lesser loss rate.

Qian Yanping et al presented a rate-based stable enhanced adaptive virtual queue (EAVQ) algorithm [14]. The concepts of this algorithm are measures of congestion, as well as desired link utilization ratio. Arrival rate at network was maintained as a principal measure of congestion. the specified link utilization magnitude relation was used as a subordinate measure and a rate-based adaptive mechanism that resolve the issues, like hardness of parameters setting, poor ability of anti-disturbance, and a little link capability loss. EAVQ improved the transient performances of the system and ensured the complete utilization of link capability.

Hao Wang et al propose effective AQM algorithm, named adaptive real queue control (ARQC) [15]. In which an explicit congestion indicator, virtual regulating time, is meant to detect network congestion. This paper provides the tuning rules for the control parameters support the discrete model of TCP dynamics. Simulation results demonstrate that ARQC outperforms the other AQM schemes in terms of stability, responsiveness and robustness in dynamic networks.

Prasant Kumar et al [16] explore the impact of buffer size and round trip time (RTT) on AQM router where TCP Reno is used as transport protocol in single bottleneck dumbbell topology. Among several AQM techniques, this paper considered random early detection (RED), random exponential marking (REM), proportional integral (PI) and adaptive virtual queue (AVQ). Simulation results shows that the RED and AVQ obtain better stability than REM and PI by regulating queue length around its expected value. However RED and AVQ techniques drop more packets than REM and PI.

IV. PROBLEMS WITH AVQ

Adaptive Virtual Queue mechanism maintains two queues an actual queue and virtual queue. Every time virtual queue is also updated with real queue after each packet arrived in the real queue. When the virtual queue overflows then packets in virtual queue is discarded and real packets is marked/dropped in real queue.

This mechanism detects the congestion based on dropping of packet from virtual queue which uses Drop tail mechanism. Drop tail is a mechanism which drops packets when buffer get filled with packets and no space remains to receive in incoming packets which suffers the global synchronization and bias against busty traffic problem.

Virtual queue capacity is less than the capacity of actual queue, if packet is dropped from virtual queue treated as signal of congestion. On receiving congestion signal from router, source reduces the packet transmission rate and there will be underutilization of queue if virtual queue is much less than the actual queue.

V. PROPOSED SOLUTION

In the proposed mechanism enhanced Adaptive Virtual Queue (EAVQ) we will maintains both the queue actual and virtual queue capacity same and instead of applying the drop tail in virtual queue we will apply the RED mechanism to drop the packet. RED performance is better than the Drop tail mechanism in terms of better queue utilization, higher throughput and low packet loss rate. Thus proposed mechanism EAVQ will utilize the queue better and gives the higher performance than existing AVQ.

VI. CONCLUSION

In this paper we are trying to effort in improving the performance of mobile ad hoc network by using the enhanced adaptive virtual queue. Enhancement will increase queue utilization which will give better performance than existing adaptive virtual queue. To verify results, experiment will be performed in NS 2 and result will be compared with existing AQM.

Using of RED instead of Drop tail in virtual queue will solve the global synchronization and bias against busty traffic problem. It also increases the queue utilization in actual queue due to efficiently utilization of buffer in virtual queue and decrease the packet loss. Due to decrease the packet drop it increase the throughput and packet delivery ratio.

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