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An Assessment on Active Queue Management in Mobile Ad-hoc Network

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***Abstract*– The RED queue management algorithm achieves high throughput and low average delay by detecting and avoiding the incipient congestion. The detection of incipient congestion is based on calculation of average queue length and RED parameter settings. To avoid the congestion in the network, operators should have a priori estimations of average delay in congested routers, which is difficult to estimate in Mobile Ad hoc Network due to uncertainty in changing the network conditions. To achieve high throughput and low delay, it needs constant tuning of parameters according to the current traffic condition. Our goal in this paper is to achieve high throughput and low delay in congested network by efficient parameter adjustment and continuous tuning of queue parameters according to the changing of network condition.**

***Index Terms*– Throughput, AQM, Ad-hoc Network and QoS**

I. INTRODUCTION

MOBILE Ad-hoc Network (MANET) [1] is self-organizing network of mobile devices which does not relay in any fixed infrastructure. MANET nodes can be personal devices such as laptop, mobile phones and personal digital assistance (PDA's). Nodes in MANET can take part in the communication if they are in the range of network, and can move freely within transmission range of network and nodes.

Which are outside the transmission range of network cannot take part in communication. The dynamic nature of MANET with limited resources that can vary with time such as battery power, storage space bandwidth makes QoS provisioning, a challenging problem. To prevent congestion, the current internet use end-to-end congestion control [2], in this mechanism end host are responsible for detection of congestion and packet loss is treated as implicit congestion notification signal from routers. After detection of incipient congestion, packet transmission rate is reduced to decrease the congestion level.

Traditional Queue Management such as Drop-tail Queue Management, which uses FIFO policy, in which packet enter in queue from one end and packet leave the queue from other end. Drop tail allow packet to enter in queue till the queue is empty and drop the entire incoming packets when queue becomes full. In drop tail there is no any approach for early detection of congestion before queue become overflow i.e. in congested network packet drop is common problem and re-forwarding of all dropped packets will consume lot of resources such as battery power, transmission link and processing power of nodes. This technique results in some serious drawbacks. First of all, Drop tail queues are not suited to interactive network applications because the drop-tail queues are always full or close to full for long periods of time and packets are continuously dropped when the queue reaches its maximum length.

II. RANDOM EARLY DETECTION

Floyds et al proposed Random Early Detection (RED) [3], [4], [5] in 1993. The basic idea of this mechanism is that the router can detect incipient congestion by monitoring the average queue length. Once the congestion is detected, router selects the source terminal to notify the congestion. So the source terminal can reduce the data transmission rate before the queue overflow, and try to alleviate the network congestion. RED algorithm consists of two steps: the first step is to calculate the average queue length, and the second step is to calculate the packet drop probability. Packet drop probability is used to decide whether to drop the packet or not, packet drop is treated as the signal of congestion.

A. Calculation of the Average Queue Length

RED calculates the average queue length (Avg_q), by using the following formula:

$$Avg_q = (1-W_q) * Avg_q + q * W_q \ \ldots.. \qquad (1)$$

Here, W_q represents the weighted value, and q represents the actual queue length in the sampling moments.

B. Calculation of the Packets Drop Probability

RED has two thresholds Min_{th} and Max_{th}, which are related

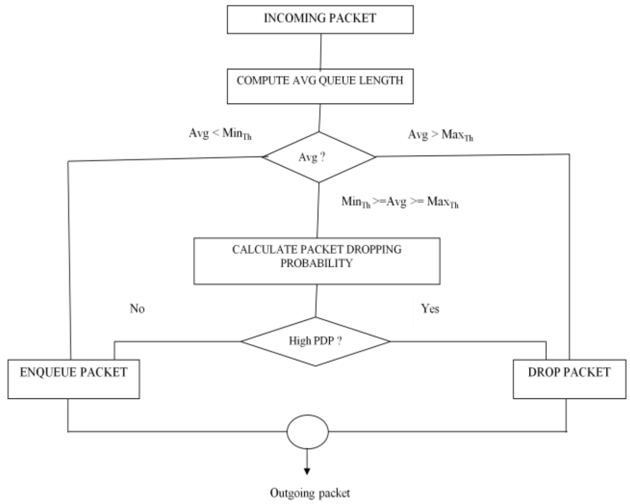

Fig. 1: RED queue management algorithm

with queue length. When the packet reaches the router, RED calculates the average of the queue length Avg_q immediately. Then it determines the packet drop probability based on Avg_q, Min_{th} and Max_{th} . When avg_q is greater than $Max_{th,}$ all packets are discarded, and the packet loss rate is 1. When Avg_q is between Min_{th} and Max_{th} , we have the following Packet Drop Probability (PDP) formula:

$$P = Max_p * (Avg_q - Min_{th}) / (Max_{th} - Min_{th}) \ldots \quad (2)$$

Packet drop probability is used to decide whether to drop the packet or not, packet drop is treated as the signal of congestion.

RED is restricted to using packet drops to detect incipient congestion thus it is not efficient because packet is dropped even queue space is available, this causes for excessive delays due to retransmission after packet lose.

RED performance is much sensitive to queue parameter setting thus for better performance, knowledge of efficient parameter setting is required.

III. EXPLICIT CONGESTION NOTIFICATION

Random Early Detection [RED] [6] proactively drops packets early, before queue becomes full to detect the incipient congestion. This mechanism has some drawbacks such as drop some packets are dropped before queue becomes full. This mechanism sometimes drop more packets than drop tail and seems worse than drop tail. ECN is an optional feature that is only used when both endpoints support it and are willing to use it. ECN allows end-to-end notification of network congestion without dropping packets. When ECN is successfully negotiated, an ECN-aware router may set a mark in the IP header instead of dropping a packet in order to signal impending congestion. The receiver of the packet echoes the congestion indication to the sender, which reduces its transmission rate as though it detected a dropped packet. Source upon reception of notification from destination reduces packet sending rate thus packet loss is reduces and conserve the resources which is critical in MANET.

IV. NETWORK PERFORMANCE PARAMETERS IN MANET

Network performance refers to the service quality of providers to the customer. Performance parameters are used to measure the quality of services of the network. These parameters are given below.

A. Average end to end Delay

The average end-to-end delay [1] of data packets is the interval between the data packet generation time and the time when the last bit arrives at the destination. End-to-end delay generally includes all delays, along the path from source to destination. This includes the transmission delay, propagation delay, processing delay, queuing delay experienced at every node in the route.

B. Network Throughput

Network throughput is the average rate of successful message delivery over a communication channel. This data may be delivered over a physical or logical link, or pass through a certain network node. The throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot.

C. Packet loss ratio

Packet loss occurs when one or more packets of data travelling across a computer network fail to reach their destination. Packet loss is calculated as total lost packet to the total no of transmitted packets.

V. RELATED WORKS

Several solutions have been proposed in the literature for the Queue Management in Mobile Ad hoc Networks (MANET’s). Some of them are as follows:

K. Dinesh Kumar et al propose a predictive queue management strategy named PAQMAN [7] that proactively manages the queue which requires negligible computational overhead and is lightweight. PAQMAN does not require any prior knowledge of the traffic model, this reduces Packet loss ratio, Increases transmission efficiency. The performance has been compared with drop tail and those results show that PAQMAN reduces packet loss ratio while at the same time increasing transmission efficiency.

Zhenyu et al propose an AQM scheme with dynamic reference queue threshold named ARTAQM [8]. Adopting a dynamic reference queue is the prominent feature of ARTAQM. Using an adaptive filtering algorithm NOEKF, the predicted traffic rate can be calculated. By means of measuring PLR and average traffic rate, the estimated average traffic rate in the next time can be deduced. The difference of the estimated average rate and the link capacity is the input of squashing function to adjust the reference queue. Therefore, the relationship between traffic condition and the reference queue length is established. Simulation results is compared with other schemes, ARTAQM offers stable and flexible queue length, lower packet loss ratio and higher link utilization. Simulation results show that ARTAQM outperforms other schemes in queue stability, packet loss ratio and link utilization.

Tolaimate Ichrak et al propose the design of improved active Queue Management [9] control scheme for time delay systems using a time approach and synthesizing the linear fluid model. This method will reduce to delay through time approach. Obtaining a system delay free, author applied to it the fundamentals of control theory as the similarity transformation, the pole placement by feedback, and by duality that construct an observer to the system. The resulting control laws are validated through numerical network estimations.

Torres Rob et al presented an innovative TCP [10] flow control method. This algorithm combines RED (Random Early Detection) with TCP window adjustment to improve the network performance. Leveraging the advantages of RED and window adjustment, the algorithm demonstrates fast response and superior stability with controlled packet dropping rate, while still fully utilizing the network resource. Author presented a novel analytical model based on the discrete Markov process in this research. Analysis and simulation show the effectiveness and robustness of the algorithm. The result of the algorithm shows that while fully utilizing the network resource this scheme achieves increased network stability with desired latency and packet dropping rate.

VI. PROPOSED SOLUTION

Random Early Detection algorithm, initialize the threshold parameters (Min_{th}, Max_{th}) to the fixed value when simulation starts, these values remains fixed during the simulation. In MANET, due to quick diversity of changing the network condition, fixed threshold parameters are not appropriate and can degrade network performance. Proposed mechanism works on variable threshold parameters which are changing according to the network congestion condition.

In Random Early Detection, queue space utilization is low due to setting of Max_{th} parameter to the fixed value in queue. To solve this problem Propose mechanism gradually adjust the maximum threshold value Max_{th} to maximum available queue size, purpose is maximum utilization of available queue space because all the incoming packet are dropped after average queue size reached to the maximum threshold (Max_{th}).

VII. EXPECTED OUTCOME

RED queue management algorithm performance is better than traditional queue management algorithm, but its performance is affected by setting of queue parameters. Dynamic parameter setting will adjust parameter for better perform instead of fixed parameter in RED queue management and this work will reduce the parameter sensitivity in mobile ad hoc network in terms of performance.

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