RED Performance optimization by regulating Upper Threshold Parameter

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Abstact

The Active Queue Management [AQM] algorithms achieve high throughput and low average delay by stabilizing the average queue size by mapping the congestion level into packet drop probability [PDP]. Random Early Detection [RED] is widely used AQM mechanism for detection and avoidance of incipient congestion but it is very sensitive to its parameter setting. This paper describes new mechanism to reduce parameter sensitivity and evaluate the network performance of previous research done in recent and new proposed mechanism. This mechanism will avoid congestion and it will reduce parameter sensitivity so that network performance will improve. Goal of this paper is to achieve lower end to end delay and less packet drop and higher throughput in congested network.

I. Introduction

Mobile Ad hoc Network (MANET) [1] is self-organizing network of mobile devices which does not relay in any fixed infrastructure. MANET devices can take part in the communication only if they are in the communication range of network, and can move freely within transmission range of network, and devices 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, current internet use end-to-end congestion control [2], in this mechanism end host is responsible for detection of congestion. Packet loss is treated as incipient congestion notification signal from routers. After detection of incipient congestion, packet transmission rate is reduced by the source to decrease the congestion.

One of recent research areas for the network is seeking some mechanism to avoid high packet loss rates. When a packet is dropped before it reaches to its destination, all the resources has been consumed in transit are inevitably wasted. In extreme cases, this situation can lead to congestion collapse in which high degrees of packet delay and loss occurs caused by routers discarding packets due to excessive queue size. Congestion control and queue management in the network has been one of the active areas of research in the past few years. Few enhancements have been made by some researchers to solve the problems of high packet loss rates. .Loss rates are especially high during heavy network congestion, when a large number of connections compete for limited network bandwidth. Due to an exponential increase in network traffic, many congestion control mechanisms have been proposed, including the deployment of explicit congestion notification (ECN), along with Random Early Detection (RED) techniques.

Traditional Queue Management such as Drop-tail Queue Management, this mechanism allow packet to enter in queue till the queue is empty and drop all the incoming packets when queue gets full. In drop tail there is no any such approach for early congestion detection in network 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. Drop tail results in some serious drawbacks. Thus, this mechanism is 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 will continuously dropped when the queue reached its maximum length.

II. Random Early Detection

Floyds et al proposed Random Early Detection (RED) [3] 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 [4][5] algorithm consists of two steps: the first step is to calculate the average queue length, and the second step calculate the packet drop probability. Packet drop probability to decides 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:

$Avg_q = (1-W_q) * Avg_q + q * W_q$ ………… (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 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:

$P_b = Max_p * (Avg_q - Min_{th}) / (Max_{th} - Min_{th})$…. (2)

$P = P_b / (1 – count * P_b)$ ……………………..(3)

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

```
Initialization
    avg = 0
    count = 1
end
for each packet arrival
    calculate the new average queue size 'avg'
        if the queue is nonempty
            avg = (1 - wq) * avg + wq * q
        else
            m = f(time - q_time)
            avg = (1 - wq)^m * avg
        end
        if minth <= avg < maxth
            increment count
            calculate probability 'pa'
                pb = maxp * (avg - minth) / (maxth - minth)
                pa = pb / (1 - count * pb)
            end
            with probability 'pa'
                mark the arriving packet
                count = 0
            end
        end
        else if maxth <= avg
            mark the arriving packet
            count = 0
        end
        else
            count = -1
        end
```

Fig.1: RED queue management algorithm

III. ARED

Adaptive RED, which is abbreviating for ARED [8], is a kind of improved RED algorithm. ARED presents an automatic configuration mechanism, which can configure the parameters Max_p according to the stream changes. The basic idea of ARED is make RED more or less aggressive based on the observation of the average queue length. If the average queue length remains around minimum threshold (Min_{th}) then early detection is simply too aggressive. On the other side if the average queue length remains around maximum threshold (Max_{th}), then early detection is being too conservative. The algorithm changes the packet dropping probability according to its aggressiveness sensed. Thus it can to maintain the average queue length between Min_{th} and Max_{th}. If the average queue length swings around Min_{th}, it shows the congestion control is too radical, then we decrease Max_p , and let

$Max_p = Max_p / \alpha$ ………………………………(4)

IV. 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, 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 are compared with other schemes, ARTAQM offers stable and flexible queue length reduces packet loss ratio and increases link utilization. Simulation results show that ARTAQM outperforms than other schemes in terms of queue stability, less packet loss ratio and higher link utilization.

Modified Random Early Detection (MRED) algorithm [9], it is modified from RED algorithm by applying addition condition of $Avgq > Max_{th}$, the basic idea of MRED algorithm takes an extra condition of $q > Max_{th}$ to decide packets are dropped directly or not. MRED algorithm can provide higher transmission throughput and avoid the sensitivity of RED performance to the parameter setting. And another mechanism named Progressive Random Early Detection (PRED) algorithm improved by the progressive adjustment method is proposed. It regulates the packet dropping probability (PDP) gradually by comparing the instantaneous queue size with the progressive maximum threshold (Max_{th}) parameters. PRED not only adopts the instantaneous queue size to adjust the maximum threshold adaptively, but also regulates the packet dropping probability. Hence, the PRED algorithm can keep advantages of conventional RED.

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. Taking the advantages of RED and window adjustment, the algorithm demonstrates superior stability and fast response with controlled packet dropping rate, and 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.

Chandni M Patel presented URED (Upper threshold RED) [11] that modify Random Early Detection (RED) by introducing new threshold Uth(Upper Threshold) with minimal changes to the overall RED algorithm. In this paper Simulation results show that new URED algorithm gives better performance than RED and Adaptive RED and it also increasing adaptability of RED. Comparisons are done in terms of total average throughput, total packet drops, and average packet drops.

V. 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 the 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, processing delay, propagation 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. Throughput is measured in bits per second (bps or bit/s), and sometimes in data packets per time slot or data packets per second.

C. Packet loss ratio

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

VI. Proposed Solution

Congestion occurs in the network when the demand for resources exceeding the available capacity. Congestion control mechanism can control congestion either before congestion occurs or after congestion actually occurred.

Proposed mechanism Upper Threshold Random Early Detection (UTRED) is based on controlling congestion before it occurs. Proposed mechanism is based on monitoring of average queue length (Avg) by applying an additional threshold as suggested in URED [11]. Monitoring of queue length will be based on checking its position between thresholds and try to regulate the Packet Drop Probability (PDP) and adjusting of average queue size (Avg). Adjustment of Avg will be decided based on its position and distance from the target, if Avg is below the minimum threshold the faster convergence will be made and if Avg is between minimum and maximum threshold the slow convergence will be made to reach the Avg in target range.

VII. Expected Result

RED queue management algorithm performance is better than traditional queue management algorithm, but its performance in most cases is affected by the sensitivity of queue parameters. Proposed algorithm will control the average queue size by monitoring the rate of change in congestion level in regular interval and based on the congestion proper action will be taken to decrease the congestion level, this work will reduce the congestion in Mobile Ad hoc Network [MANET] and will improve performance.

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