R2TB: An Innovative Congestion Control Methodology for Real Time Data Transmission in MANET

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Abstract: Maximum real time solicitations require Quality of Service (QoS) during data communication. Therefore many routing protocols for Mobile Adhoc Network (MANET) associating Real Time Applications have been established that uses improved Real time structure for optimization of delay and energy efficiency, basic objective being great deployment of resource in resource limited environment. Congestion Control is another important issue while directing towards QoS achievement specifically with highly transferrable mobile stations. This paper highlights on congestion control issues in real time environment as well as proposes an upgraded traffic shaping mechanism called R2TB (Real Time Token Bucket) at the transport layer of TCP/IP protocol suite of network model for real time applications with basic concept of token bucket traffic shaping mechanism during packet routing at the intermediate nodes. Simulation findings illustrates that our proposed method performs better in highly congested traffic scenario with reduced queuing delay and improved packet delivery ratio.

Keywords: MANET, AODV, PDR, Throughput, QoS

1. Introduction

The main focus of congestion control and quality of service is data traffic. In congestion control we try to avoid traffic congestion. In quality of service, we try to create an appropriate environment for the traffic. So while considering congestion control and quality of service, it is essential to deliberate the data traffic. Generally three types of traffic profiles work in the network, Constant Bit Rate (CBR), Variable Bit Rate (VBR) and Bursty. Congestion in a network may occur if the load on the network which is the amount of packets directed to the network is higher than the capability of the network, ie. The number of packets a network can handle. Congestion control discusses about the mechanisms and techniques adopted to control the congestion and keep the load below the capacity of the network. Packet Delay and Throughput are affected greatly as they act as function of network load. The delay increases when the load increases and the throughput keeps on increasing till the load reaches the network capacity but when the load crosses the network capacity, there is reduction in throughput due to congestion.

2. Related Work

Based on congestion control approach many researchers have contributed their improved approaches for better performance of the network. The important findings have been described in this section. A superior end to end congestion control platform has been proposed in [3] as per the parameters available in the channel in a non-uniform manner. The congestion control mechanism in this approach takes care and prevents the congestion as well as solves the related challenges from physical layer to transport layer.

Considering the complexity of traffic, congestion status are introduced in paper [4] which allocates the portion of traffic across many sub-routes and simulation result obtained using Qualnet proves validity of this approach.

Voice over Internet Protocol (VOIP) performance and its analysis about traffic congestion has been presented in [1] with a concluding remark regarding relation between channel quality and VOIP performance. Chief functionality MAC (Medium Access Protocol) in Mobile Adhoc Network is to dispense the channel among numerous users uniformly who need to transmit. A QoS related MAC protocol has been proposed in [2] which talks about fairness of channel distribution in multi-hop environment. Comprehensive survey and argument on several real time protocols have been presented in [14] and [15]. Paper [16] and [17] offers detailed issues and research carried out in real time scenario, power management, security aspects in MANET. An improved AODV Protocol with energy efficiency issues has been presented in [18] and performance analysis has been carried out in [19]. A detailed comparative analysis regarding various network parameters has been presented with various improved MANET routing protocols in [20].

3. Analysis of Congestion Control Issues in Real Time Scenario

To check congestion, many practices have been proposed and developed by researchers, some mechanisms are used for removing congestion and some avoids it. Depending on their operational activity, this controlling mechanism can be open loop congestion control for prevention of congestion or close loop congestion control [12] for elimination of congestion. Under open loop congestion control policies the re-transmission policy is important which is used when the sender feels that a sent packet is lost or its bits have been corrupted, and then it re-transmits the packets. This is one of the conventional ways which faces the issue of delaying in data transmission in window policy. The selective repeat window flow control policy is used than the go-back n windows policy for congestion control. Then there is an acknowledgement policy, in which a receiver may send an acknowledgement only if it has packet to be sent or a specially programmed timer gets expired, other cases it will not send an acknowledgement. It prevents congestion by not sending too many acknowledgement packets which create congestion in the traffic. In discarding method, the routers discard some packets randomly without any basic criteria simply to avoid congestion that can be retransmitted at a later stage. In admission method, there are different switches that regulate the flow by checking the resource requirements before admitting it to the network. Hence this way avoiding chance of congestion in future. The provision of back pressure technique is a controlling mechanism of congestion in which a congested node does not receive any data from its immediate upstream node.

The provision of back pressure technique is a controlling mechanism of congestion in which a congested node does not receive any data from its immediate upstream node. Another Choke Packet method is used in which a package sent by a node to the source regarding the event of congestion, so that the source pauses for some time without continuously sending the packets, and it starts when the congestion at that particular node is under control. When there is no communication between the congested node and the source node of the data transmission, the source assumes that a congestion event has occurred, so it stops sending more packets in this path and does not wait for receiving acknowledgement. This method is called implicit signaling. Similarly, in explicit signaling concept, the congested node explicitly sends a signal to the source computer. Congestion control also influences the Quality of Service during transmission which is a set of services that should be supported by a network, while transporting a packet from source to destination. By controlling and maintaining the flow characteristics of traffic, QoS can be achieved. The basic characteristics of a flow are Reliability, Delay, Jitter and Bandwidth. Bandwidth is an important parameter which is considered during video and multimedia data transmission. Different applications need different bandwidths. In video conferencing we need to send millions of bits per second to refresh a color screen while the total number of bits in an e-mail may not reach even a million.

4. Mechanism of the Proposed Approach

The proposed process is an extension of our previous research work presented in [18] and [19]. Originally we have developed a basic platform for Quality of Service using congestion control and traffic shaping at the transport layer. The cross layer design architecture communicates with many layers including Optimized Power and Delay AODV (PDOAODV) protocol at network layer and a superior channel access method for real time applications at the MAC layer [18] and [19]. Fig. 1 describes the basic architecture of our proposed policy. In this paper the congestion control technique used in the above architecture has been discussed with prominence on ‘shaping’ the traffic with improved token bucket based technique for real time applications.

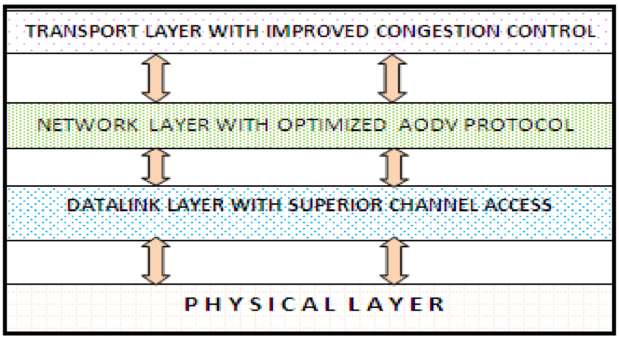

Fig 1. Basic architecture of our proposed policy

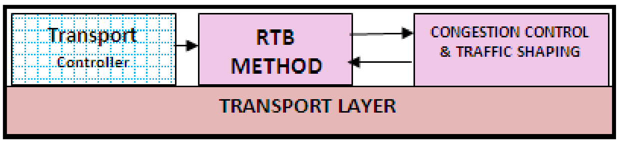

Fig 2. Functional Block diagram

Fig.2 shows the basic functional diagram of the proposed R2TB method which is otherwise known as RTB (Real Time Token Bucket) method. Under the control of Transport Controller at the transport layer the improved RTB method shapes the real time traffic in an organized manner using the algorithm, the program code snippet of which is depicted in fig. 4 and fig.5. This method checks the incoming traffic flow and streamlines it before inflowing to the network. The proposed method controls the rate of sending flow of traffic by introducing a set up time (Δt) decided by negotiation among the sending station and the carrier which decide a traffic pattern. In Real Time Token Bucket (RTB)/R2TB algorithm, there are two types of tokens generated by the system and the bucket holds the token. To transfer a packet, a station has to seize one token of its application type and delete it. As shown in fig. 4, the tokens are produced by the system at a rate of one token in every Δt second.

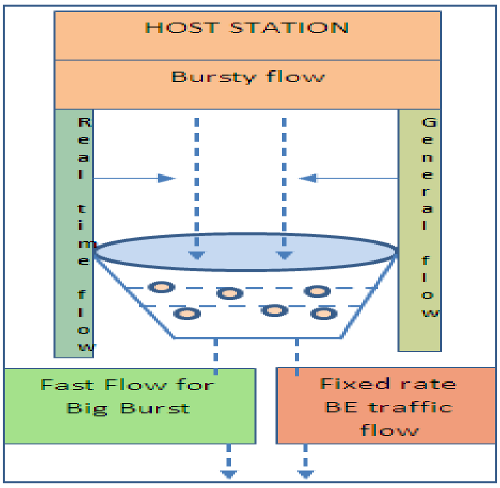

Fig 3. Block diagram of RTB Method

According to our proposed Improved R2TB/RTB (Real Time Token Bucket), in every alternative unit time, real time token and best effort tokens are produced. Stations which currently do not have anything to send, can capture the tokens and preserve for future transmission purpose when they have higher bursts of flow. But it is limited to extreme size of the bucket. Leaky bucket discards the packets, but packets are not discarded in our proposed method RTB .Using RTB, a packet can only be communicated only if there is sufficient tokens to shelter its length. Leaky bucket directs the packets at an average constant rate. But improved RTB permits for bigger bursts to be sent quicker by more rapidly sending up the output. RTB allows redeeming the tokens (authorizations) to send bulky bursts, which are not allowed in Leaky Bucket.

5. Performance Improvement in Our Approach

For traffic shaping and congestion control Leaky bucket algorithm [12] is normally used in MANETs which has some limitation such as it does not profit a host that does not have anything to send. When a station has nothing to send, then its bucket turn into empty. In such case, if a station has burst data, there will be average data flow in leaky bucket. But the idle period in which the station was silent, will not be taken into account. But in token bucket algorithm, it is allowed for the silent stations to gather the acclaim for future in the means of token. For every clock tick, the system transmits n token to the bucket. This method eliminates one token for every bite of data transmitted. It can be understood that a station can transmit burst data s long as the bucket is not empty. As shown in fig. 4, the token bucket method can use a counter for implementation. As per our improved proposal in Token Bucket Algorithm for real time applications, there are three components, i.e Interface Queue Real Time Token Queue and Release Queue .The Interface Queue receives the packets at a fixed rate, stores then as per SJF (Shortest Job First) scheduling method, and waits for the token bucket to fulfill the required tokens. When there are many tokens for one packet, it sends them to release queue and deletes those tokens which are already used.

```
Function consume (self,tokens):
"Consume tokens from the bucket;
# returns True if there were sufficient tokens otherwise False;
If ( tokens < = self.tokens)
Then self.tokens = tokens
Else
Return False;
Return True;
```

Fig. 4 Algorithm for Token Consumption

The server processes the received packets from the release queue in its own fixed rate. Every queue and the buckets have their own processing rate and the bucket of tokens has a fixed rate to store the tokens without overflow. Functionality of our Improved Real Time Token Bucket Method is explained in following algorithm. The algorithm consists of a bucket with a maximum capacity of N tokens which refills at a rate R tokens per second. Each token typically represents a quantity of whatever resource is being rate limited (network bandwidth, connections, etc.)This allows for a fixed rate of flow R with bursts up to N without impacting the consumer.

```
def get_tokens(self):
        if self._tokens < self.capacity:
            now = time()
            delta = self.fill_rate * (now - self.timestamp)
            self._tokens = min(self.capacity, self._tokens + delta)
            self.timestamp = now
        return self._tokens
```

Fig 5. Code snippet for checking bucket capacity

In the proposed approach the output rate from release queue varies depending on the size of the burst flow. The bucket holds the token to transmit a packet, the clock timer produces the tokens one token in every t second. Silent stations with nothing to send currently can capture and save in a later stage for transmitting large bursts. This method is Real Time token dependent. If the bucket becomes full, then the RT Tokens are discarded, and not the packets. When number of tokens is more, then the packets can transmit. Large burst flow can be sent quicker. Leaky bucket and token bucket concepts are merged in our approach. The two techniques have been combined to credit an idle host and at the same time regulate the traffic. The leaky bucket is applied after the token bucket; the rate of the leaky bucket needs to be higher than the rate of tokens dropped in the bucket.

6. Simulation and Results

Network Simulator NS 2is used for simulation and the simulation parameters are as given in Table1.We have simulated our approach with Optimized AODV protocol as part of the QoS architecture. Table 1 shows the network parameters considered during the simulation.

Table 1. Simulation Parameters

Parameter Name	Parameter Value
Channel Type	Wireless Channel
Radio Propagation Model	Two Ray Ground
Network Interface Type	Wireless Phy
Type of Traffic	V B R
Simulation Time	2 Minutes
MAC Type	Mac/802_11
Max Speed	50 m/s
Network Size	1600 x 1600
Mobile Nodes	120
Packet Size	512 Kb
Interface queue Type	Queue/Droptail
Protocol	PDOAODV with R2TB
Simulator	Ns2

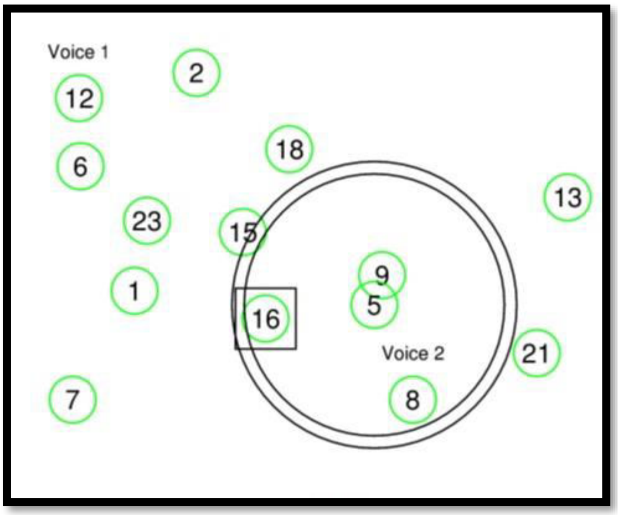

Fig. 6. Simultion scenario with voice data

Fig.6 shows simulation scenario carried out in Ns2 with voice data transmission between two nodes using RT2B approach embeded in our previous work done in PDO AODV protocol[18] and [19]. Similarly fig.7 shows another simulation scenario that shows the packets transmitting in load balanced path between nodes 8 and 12 using the proposed RT2B methode with PDO AODV [18].

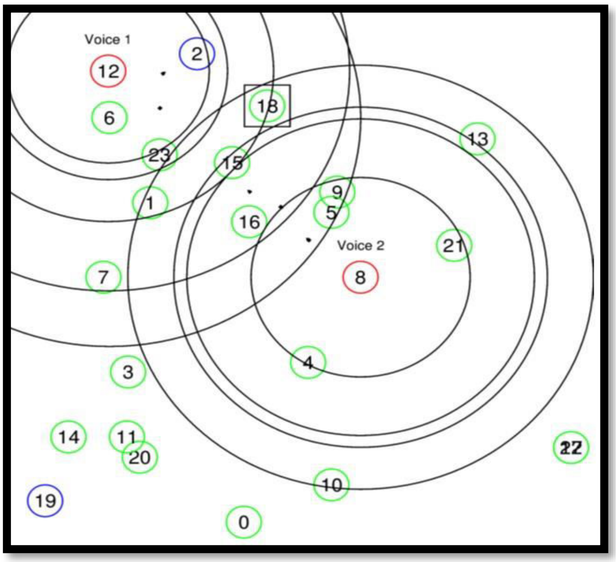

Fig 7. Simulation scenario with packets transmission

Jitter can be termed as the variation is delay during packet arrival from source to destination. For real time packet delivery if there is non uniform delay during packet arrival time, then the video streaming problem occurs during a video display. Fig.8 shows the comparison of jitter in video file transmission during packet arrival which has been calculated considering packet arrival time for different segments during the simulation process. Awk script has been used to extract the delay information from the output trace file that is generated after the simulation.

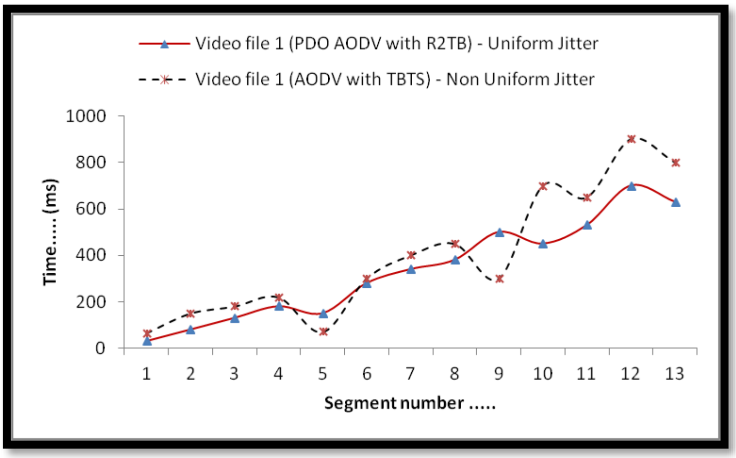

Fig 8. Comparison of Jitter

From fig. 8 it can be depicted that our proposed congestion control approach R2TB with PDO AODV protocol exhibits lesser delay between packet arrival with better jitter performance than the TBTS (Token Bucket Traffic Shaping [12] with AODV protocol in MANET. Fig.9 shows the comparative graph between the Token Bucket Congestion Control with Traffic Shaping [12] and Our Proposed Improved RTB in terms of Packet

Delivery Ratio(PDR) It clearly shows that our approach has a higher PDR percentage in a highly mobility scenario.

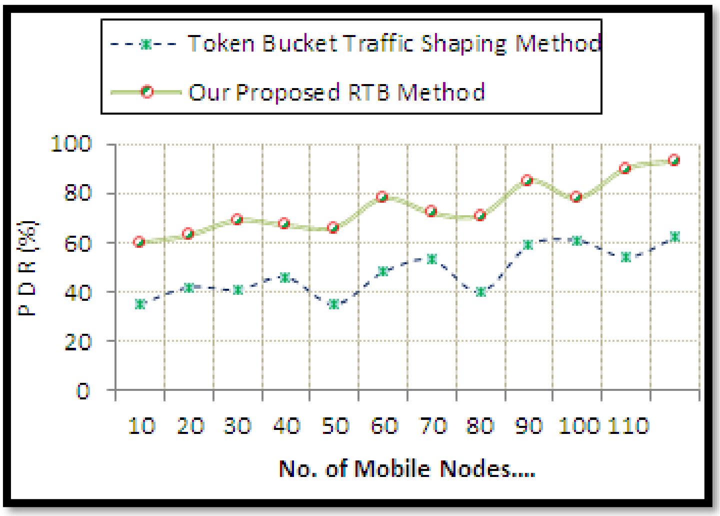

Fig 9. Comparison of Packet Delivery Ratio (PDR)

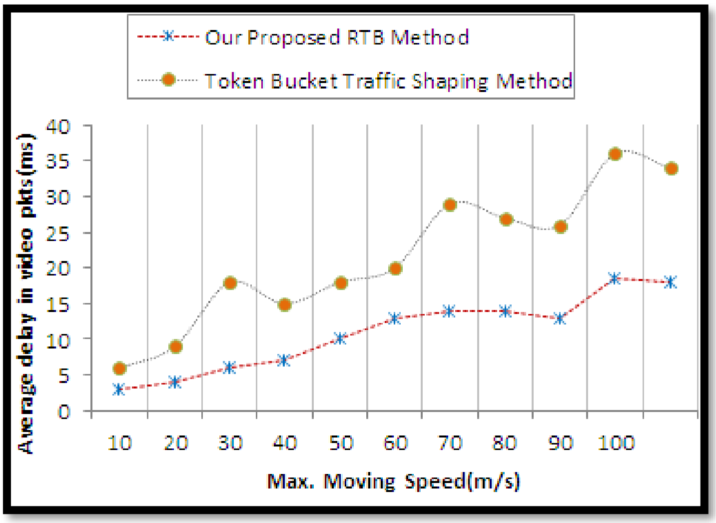

Fig 10. Delay Comparison

Fig 10. depicts that due to improved congestion control mechanism in our approach, the average delay in packet transmission reduces up to a greater extent in our approach.

7. Conclusion and Future Work

This research work concentrates on one of the dynamic concerns in real time data transmission in Mobile Adhoc Network. It resolves the stimulating difficulty of congestion due to queuing delay at the rouetr interface during routing by proposing an enriched process called Real Time Token Bucket for fascinating control of inward as well as outbound traffic at the access point of the stations. This mechanism performs fantacstically when embeded as a part of our original Multi-Layer Communication based QoS architecture.In our future work we have scheduled to device this procedure in real podium and to focus on the other related technical issues including performnce appraisal under variable parameters.

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