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MANET, Leaky Bucket, Token Bucket, Delay, Bandwidth Optimization

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A NOVEL APPROACH TO ENHANCE THE PERFORMANCE OF MOBILE AD HOC NETWORK (MANET) THROUGH A NEW BANDWIDTH OPTIMIZATION TECHNIQUE

Abstract

Now is the age of information technology. World is advancing day by day. At present in this progressing world communication from one place to another has become so easy, less costly, and faster. This modern life is almost impossible with the help of these communication technologies. People need to talk, need to share data, need to express their emotion from long distance. So they need to use technologies to communicate with one another. Nowadays the fields of MANET have yielded more and more popularity and thus MANET have become a subject of great interest for the researchers to enforce research activities. Mobile Ad Hoc Network (MANET) is the cooperative engagement of a collection of mobile nodes without the required intervention of any centralized access point or existing infrastructure. There is an increasing trend to adopt mobile ad hoc networking for commercial uses. Mobile Ad Hoc Network (MANET) is an emerging area of research to provide various communication services to the end users. But these communication services of Mobile Ad Hoc Network (MANET) use high capacity of bandwidth and a big amount of internet speed. Bandwidth optimization is indispensable in various communications for successful acceptance and deployment of such a technology. Thinking of this, I propose a New Bandwidth Optimization Technique that Enhance the Performance of Mobile Ad Hoc Network (MANET). The new Bandwidth optimization technique which is more efficient in terms of time delay in Mobile Ad Hoc Network (MANET) can redirect a new way towards optimization development in network communication and device junction technology.

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1. INTRODUCTION

A mobile ad hoc network (MANET) sometimes called a wireless ad hoc network or a mobile mesh network is a wireless network, comprised of mobile computing devices (nodes) that use wireless transmission for communication, without the aid of any established infrastructure or centralized administration such as a base station or an access point (Siva Ram Murthy & Manoj, 2004; Basagni, Conti, Giordano & Stojmenovic, 2003). Unlike traditional mobile wireless networks, mobile ad hoc networks do not rely on any central coordinator but communicate in a self-organized way. Mobile nodes that are within each other's radio range communicate directly via wireless links, while those far apart rely on other nodes to relay messages as routers. In ad hoc network each node acts both as a host (which is capable of sending and receiving) and a router which forwards the data intended for some other node. Ad hoc wireless networks can be deployed quickly anywhere and anytime as they eliminate the complexity of infrastructure setup. Applications of ad hoc network range from military operations and emergency disaster relief, to commercial uses such as community networking and interaction between attendees at a meeting or students during a lecture (Aggelou, 2004; Agrawal & Chauhan, 2015). MANET disseminate important and real-time information to the nodes such as weather information, transit systems, internet access, mobile e-commerce, and other multimedia applications. Most of these applications or systems demand high capacity of bandwidth and a big amount of internet speed so that user can communicate among themselves. Most of the previous research on ad hoc networking has been done using exist many technique of bandwidth optimization in mobile ad hoc network (MANET) focusing only upon the efficiency of the network. There are quite a number of bandwidth optimization technique that are excellent in terms of efficiency like Leaky bucket, Token bucket, Traffic smoothing, Traffic burst shaping etc. However more time delay and big amount of packet drop is happen in many scheme like Leaky bucket and Token bucket. In Token bucket method packet drop is happened less than the Leaky bucket but the time delay is relatively more than Leaky bucket algorithm. So in order to improve the performance of mobile ad hoc network (MANET) bandwidth optimization is highly desirable.

In this paper I have put my concern on the working principle, major components and existing bandwidth optimization technique of MANET besides the basic terminologies. Finally, I proposed a new bandwidth optimization technique that Enhance the Performance of Mobile Ad Hoc Network (MANET) which will more stable in terms of time delay in MANET. With the help of the algorithm, it ensures no matter what the packet size is, the delay is relatively less than the existing schemes for a particular data interval time, provides an optimized process. The defined algorithm controlled the bandwidth by transferring data packets through measuring delay time.

2. MOBILE AD HOC NETWORKS

A mobile ad hoc network (MANET) is a wireless network, comprised of mobile computing devices (nodes) that use wireless transmission for communication, without the help of any established infrastructure or centralized administration such as a base station in cellular network or an access point in wireless local area network (Agrawal & Chauhan, 2015). The nodes are free to move randomly and organize themselves arbitrarily; thus, the network's wireless topology may change rapidly and unpredictably. In mobile ad hoc network, each node acts both as a host (which is capable of sending and receiving) and a router which forwards the data intended for some other node (Perkins, 2008). As shown in Figure 1, an ad hoc network might consist of several home-computing devices, including laptops, cellular phones, and so on.

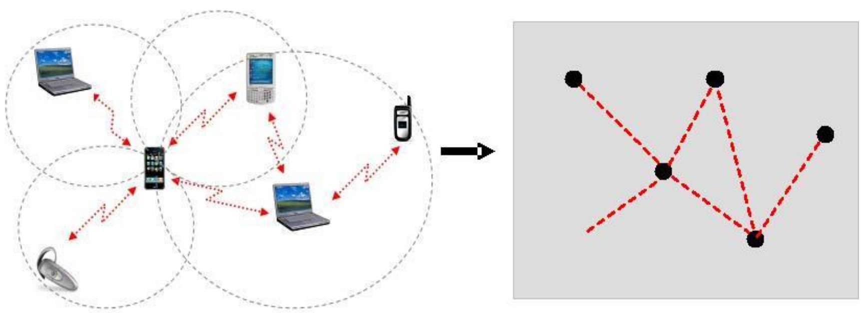

Fig. 1. A Typical Mobile Ad Hoc Network

3. ANALYSIS FOR BANDWIDTH OPTIMIZATION

Bandwidth management is the procedure of managing and controlling the communications (traffic, packets) through measurement on a network link, to ensure the avoidance of flooding the link to its maximum range of capacity or over flooding the link, which would result in a network congestion and poor performance within the network. It is measured in bits per second (bit/s) or bytes per second (B/s) (Pujolle, 2013).

Bandwidth optimization is a procedure that can measure and utilize the capacitive bandwidth within the whole system. Now a day's bandwidth management is a problem as the number of internet users are increased day by day. Even using local LAN, a limit of bandwidth must be controlled among all the users those are provided through various communication systems, or the bandwidth will be wasted among the caller and called party and also may be wasted between the link and the end point (Medhi & Ramasamy, 2010).

By thinking of it a new algorithm is proposed. It is based on leaky Bucket algorithm with some specific features. This algorithm shapes the packets between the caller and the called party also between the link and the end point of the throughout the communication system. The packets are molded with the help of specific time buffer (Nakibly, 2014). The buckets are not static as normally as leaky algorithm uses. Increase number of packets the time delay is relatively less and the data's are optimized. The waste packets from the overflow data's are saved in an optimal bucket until the process of the previous step. Then the data's are sent sequentially. Overall Process ensures an optimization scheme within the whole network area.

3.1. Existing Technique for Bandwidth Optimization

There are many Bandwidth managing and optimizing options, they are listed below:

- **Traffic Shaping (Rate limiting):** Leaky bucket, Token bucket, TCP rate control- it adjusts the TCP window size as well as controlling the rate of ACK's being returned to the sender (Farzanegan Daneshvar, Saidi & Mahdavi, 2014).
    - **Leaky Bucket Algorithm:** The Leaky Bucket Algorithm used to control data rate in a network. It is implemented as a single-server queue with constant service time. If the bucket (buffer) overflows, then packets are discarded (Rahman, 2019).
    - **Token Bucket Algorithm:** The Token Bucket Algorithm allows the output rate to vary, depending on the size of the burst. In the Token Bucket algorithm, the bucket holds tokens. To transmit a packet, the host must capture and destroy one token. Tokens are generated by a clock at the rate of one token every Δt sec. Idle hosts can capture and save up tokens (up to the max. size of the bucket) in order to send larger bursts later (Farzaneh, Mardi & Ghorashi, 2014).
- **Scheduling Algorithms:** Weighted fair queuing (WFQ), queuing, Weighted (WRR), Deficit weighted round robin (DWRR), Hierarchical Fair Service Curve (HFSC) (Ash, 2006).
- **Congestion Avoidance:** RED, WRED works as port queuing buffer network scheduler and lowers the usual property of TCP global synchronization, Policing.
- **Bandwidth Reservation Protocols / Algorithms:** Resource reservation protocol (RSVP), Constraint-based Routing Label Distribution Protocol (CR-LDP), Top-nodes algorithm.
- **Traffic Classification:** Categorizing traffic according to some policy in order that the above techniques can be applied to each class of traffic differently (Dainotti, Pescape & Claffy, 2012).

4. PROPOSED ALGORITHM

Proposed algorithm is based on the “leaky bucket” algorithm. But it is very different than normal leaky bucket. As all know the leaky algorithm uses bucket which can contain both incoming and outgoing packets, shape them send them at a constant or optimal rate. But leaky algorithm uses fixed size of buckets and that cannot contain the overflow data as a result there are fall of packets. Being modified and changed the algorithm using FIFO queue as the number of queue equal to the no of buckets for traffic shaping (burst, noise) and processing the incoming packets then resend the overflow data through the next bucket fixing a time limit to transfer all the packets within a session and so on. The algorithm is effective for shaping the traffic, since all the packets are sent ensures relatively a smaller amount delay time provides effectiveness on channel capacity, also provides optimality with capacitive controlled bandwidth to a link and endpoint channel. Same work follows in case of caller and called party through data packet transferring.

There is a delay time for packet data intervals between links to end point packet transfer. It makes the delay time relatively less for this algorithm. So, it gives every time an optimal rate of packet transfer per second (Elhanany & Hamdi, 2007). For understanding the development, it is important to know about the time delay of a network system. So, for delay

Delay = F(Traffic volume data rate, Capacity)

For a single link system it assumes that packet arrival to a network link follows a Poisson process with the average arrival rate as ‘λ’ packets per sec. The average service rate of packets by the link is assumed to be ‘μ’ packets per sec (Medhi & Ramasamy, 2017). It considers here the case in which the average arrival rate is lower than the average service rate, if $\lambda < \mu$; otherwise, it would have an overflow situation (Ponomarenko, Kim & Melikov, 2010). If it assumes that the service time is exponentially distributed, in addition to packet arrival being Poissonian, then the average delay ‘τ’ can be given by the following formula, which is based on the M/M/1 queuing model.

$$\tau = \frac{1}{\mu - \lambda} \tag{1}$$

Considering the average packet size is ‘κ’ Megabits, and that the packet size is exponentially distributed. Then, there is a simple relation between the link speed ‘c’ (in Mbps), the average packet size ‘κ’, and the packet service rate ‘μ’, which can be written as:

$$c = \kappa\mu \tag{2}$$

Combining 'κ' with the packet arrival rate 'λ', it can consider the arrival rate 'h' in Mbps as follows:

$$h = \kappa\lambda \tag{3}$$

If multiply the numerator and the denominator by 'κ', it can then transform the above equations as

$$\tau = \frac{\kappa}{\kappa(\mu - \lambda)} = \frac{\kappa}{c - h} \tag{4}$$

The relation can be written as

$$\frac{\tau}{\kappa} = \frac{1}{c - h} \tag{5}$$

Now compare Eq. (1) and Eq. (2), t the average packet delay can be derived directly from the link speed and arrival rate given in a measure such as Mbps; the only difference is the factor 'κ', the average packet size. Considering the delay proposed algorithm stands the below equation:

$$\sum y = \sum X + \sum_{i=0}^{n} x \tag{6}$$

where: y – output rate, transfer/sec or packets/sec,
X – bucket size,
x – number of packets,
n – number of packets in serial through distribution.

Condition 1: if X < x, new bucket is generated, then equation stands as

$$y = X_1 + X_2 + \cdots + X_n + \sum_{i=0}^{n} x \tag{7}$$

where: X_1 – the previous bucket with stored packets,
X_2 – Overflow packets that will flow after the stored packets

Condition 2: if X > x, new bucket is not generated:

$$y = X_1 + \sum_{i=0}^{X} x \tag{8}$$

where: x – the optimal no packets sending through to the network.

Condition 3: If X = 0, in case of first bucket is empty.

Here, $X_1 = 0$ means, emptiness of packet or packets are being transferred successfully (Rahman, 2019; Rahman & Rahat Hasan Robi, 2019). Then fetish coming packets are added to the first bucket. Following above analogy this algorithm performs less delay than both of the algorithms (leaky and token bucket). If 20 data packets are needed to be send with in a network this algorithm performs faster with a less delay time where leaky bucket and token bucket needs respectively more whether this algorithm needs a less time delay.

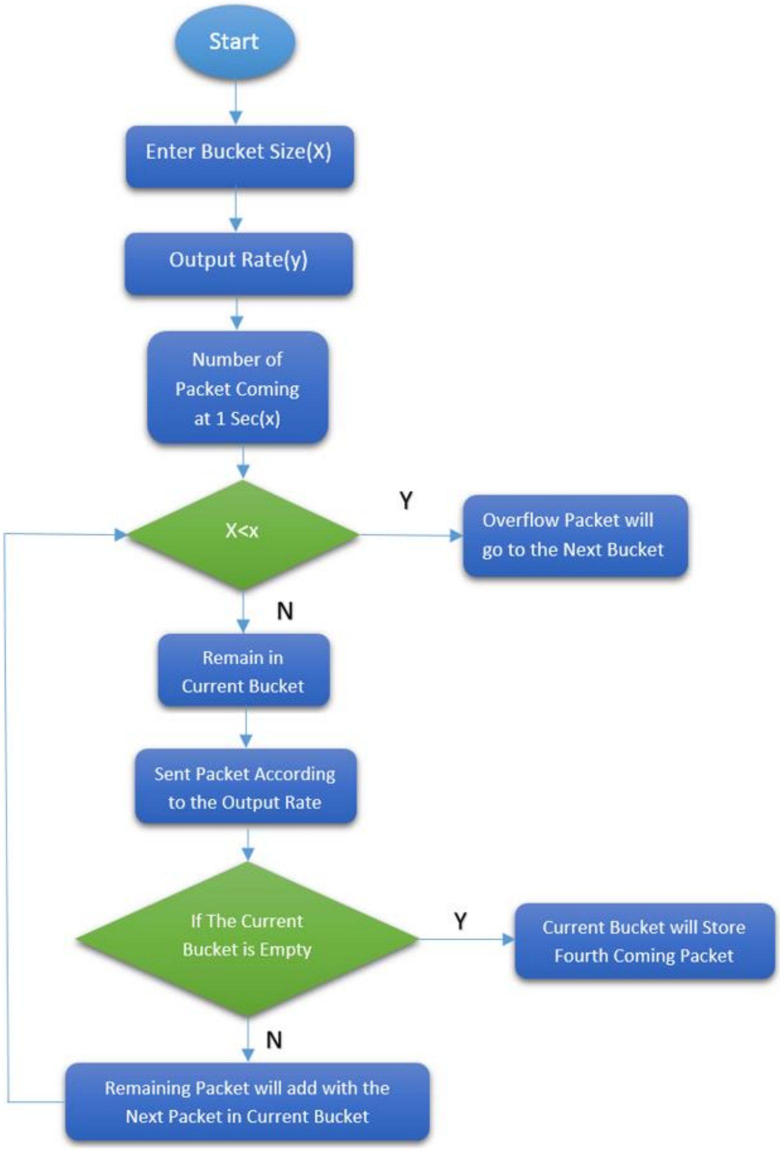

Fig. 2. Basic activity diagram of Proposed Algorithm

5. SIMULATION RESULTS

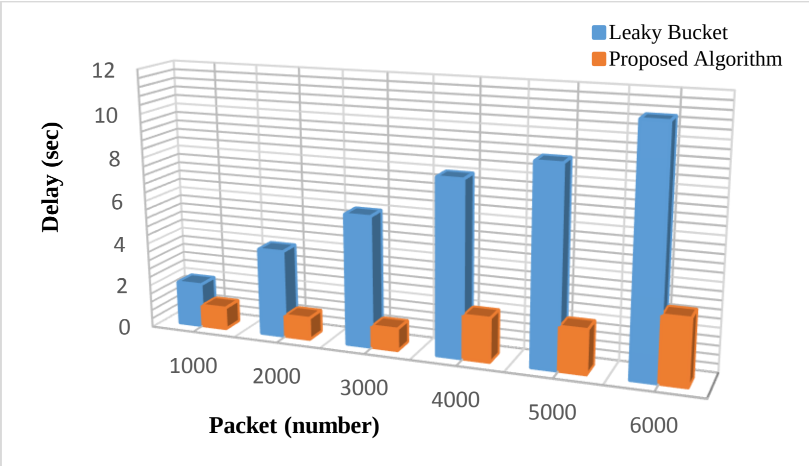

Fig. 3. Leaky Bucket vs. Proposed Algorithm (Delay)

Here leaky vs. proposed algorithm in terms of delay is shown in Figure 3. In the graph when 1000 packet send the delay is 2 second for Leaky bucket and 1 second for proposed algorithm. When 6000 packet send the delay is 11 second for Leaky bucket and 3 second for proposed algorithm. So, In Leaky bucket delay is increasing more than the proposed algorithm when the amount of packet is increased. That means less delay is happen in proposed algorithm.

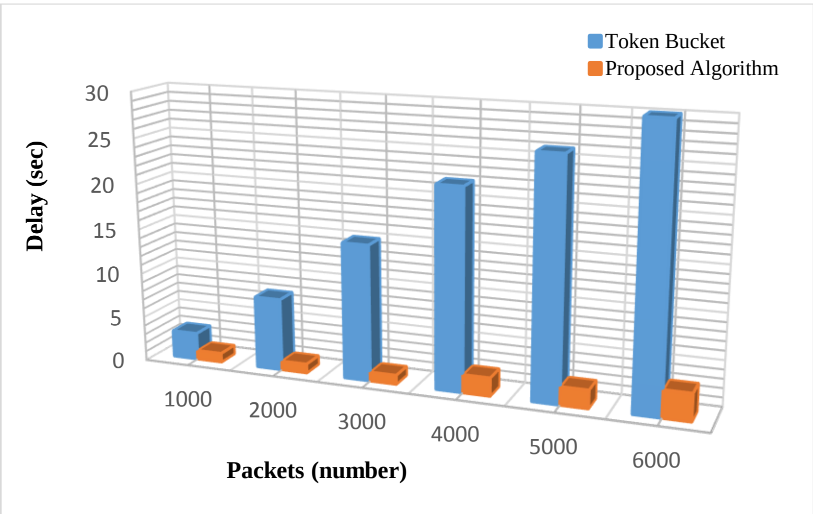

Fig. 4. Token Bucket vs. Proposed Algorithm (Delay)

Here Token vs. proposed algorithm in terms of delay is shown in Figure 4. In the graph when 1000 packet send the delay is 3 second for Token bucket and 1 second for proposed algorithm. When 6000 packet send the delay is 30 second for Token bucket and 3 second for proposed algorithm. So, In Token bucket delay is increasing more than the proposed algorithm when the amount of packet is increased. That means less delay is happen in proposed algorithm.

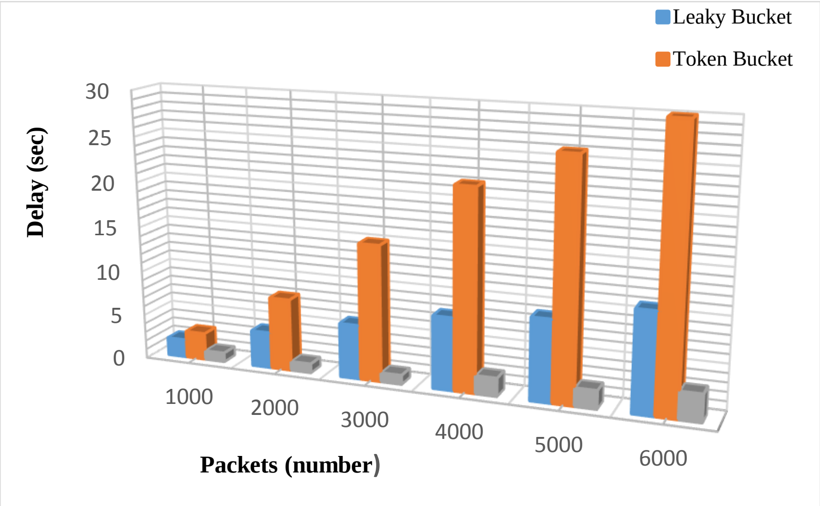

Fig. 5. Leaky Bucket vs. Token Bucket vs. Proposed Algorithm (Delay)

Here Leaky vs. Token vs. proposed algorithm in terms of delay is shown in Figure 5. Both Leaky and Token bucket make delay for sending packets. But whatever the amount of packets is sent the proposed algorithm make relatively less delay than Leaky and Token bucket.

Below performance comparison for 2000 Packets was showed.

Tab. 1. Performance Comparison

Performance (%)	Leaky Bucket	Token Bucket	Proposed Algorithm
Delay	2%	4%	0.55%

6. CONCLUSION

Mobile Ad Hoc Networks (MANET) provide one of the most emergent fields for research due to the high interest and it can offer in different sectors of our lives through the proper use of MANET. It is such an emerging technology that enables a wide range of applications. To facilities' those services and applications the proposed bandwidth optimization technique used to provide an improved communication to optimize and enhanced the performance of MANET. In this research work, I have considered the bandwidth optimization technique in mobile ad hoc networks from the delay time viewpoint. I have analyzed various issue about bandwidth optimization and presented the design and analysis of a new bandwidth optimization technique for enhancement the performance of mobile ad hoc networks which is more efficient in terms of time delay and provides an optimal solution in an open and managed-open environment in Mobile Ad Hoc Network (MANET). The effectiveness of the proposed algorithm in terms of time delay in mobile ad hoc networks can redirect a new way towards optimization development in network communication. Comparing others, it can be said that the working process of the proposed scheme is far better. With a view to different measurements, the proposed new bandwidth optimization technique for mobile ad hoc network will be effective for pursuing an optimized platform.

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