

Improving Tcp/Ip Traffic Shaping For Real-Time Congestion Management For Effective Performance In Manet

K Abdul Rasak , Dr. Rajendra Singh Kushwah

Department of Computer Application, Sri Satya Sai University
of Technology & Medical Sciences, Sehore, M.P., India.

ABSTRACT :

From emergency response to military operations, mobile ad hoc networks (MANETs) have shown to be a reliable and flexible method of wireless communication. However, owing to MANETs' inherent instability and scarcity of resources, guaranteeing QoS for real-time traffic is still a significant obstacle. This article provides a traffic shaping technique for the TCP/IP protocol suite as a network model, with a primary emphasis on real-time congestion management. The output of the flow determines the number of tokens in the buffer and the size of the bucket used for tokens in real time. The findings presented here show that the recommended strategies fare better in the case of heavy traffic congestion. The special difficulties presented by MANETs' dynamic topologies and few resources are examined in the context of congestion, a major barrier to attaining QoS.

Keywords: Packet, Token, Receiver, Controller, Real-time.

I. INTRODUCTION

Achieving high-quality of service (QoS) for real-time traffic in Mobile Ad Hoc Networks (MANETs) presents a formidable challenge in the realm of wireless communication. As the proliferation of wireless devices continues to soar, the demand for efficient and reliable data transmission for real-time applications such as voice and video becomes increasingly critical. MANETs, characterized by their dynamic and self-configuring nature, lack a fixed infrastructure and rely on multi-hop communication among

mobile nodes. This inherent mobility and resource-constrained environment makes the attainment of QoS for real-time traffic a complex endeavor. In this technological landscape, the implementation of effective congestion control mechanisms emerges as a pivotal solution to ensure the seamless delivery of time-sensitive data while maintaining network stability.

Mobile Ad Hoc Networks (MANETs) have gained prominence in recent years due to their versatility and adaptability in a wide range of scenarios. These networks are composed of mobile nodes that communicate with each other in a decentralized manner, forming temporary connections to facilitate data exchange. Unlike traditional wired networks, MANETs operate without a fixed infrastructure, making them suitable for applications in remote areas, disaster-stricken regions, military operations, and vehicular communication. However, this very attribute of dynamic self-organization gives rise to several challenges, one of the most pressing being the effective management of Quality of Service (QoS) for real-time traffic.

QoS is a measure of the network's ability to provide a certain level of service to different types of traffic, ensuring that applications such as voice and video conferencing experience low latency, minimal packet loss, and high throughput. While achieving QoS is a well-established goal in wired networks, the dynamic and resource-constrained nature of MANETs amplifies the complexity of this task. Real-time applications demand stringent QoS requirements, making it imperative to find innovative solutions for ensuring their seamless operation in MANETs.

One of the primary obstacles to achieving QoS in MANETs is congestion. Congestion occurs when the demand for network resources surpasses its capacity, leading to packet loss, increased delay, and a degraded user experience. In a wired network, congestion control mechanisms are relatively straightforward to implement due to the stability of the infrastructure. However, in MANETs, where nodes move unpredictably, network topology changes dynamically, and resources are limited, congestion control becomes a daunting challenge.

In the ever-evolving landscape of wireless communication, where the demands for real-time data transmission continue to escalate, the quest for efficient congestion control mechanisms in MANETs remains an ongoing and dynamic field of research. We will explore recent developments and emerging trends, including machine learning-based approaches, software-defined networking (SDN) integration, and the impact of the Internet of Things (IoT) on congestion control strategies.

II. CONGESTION CONTROL MECHANISMS IN MANETS

Congestion control mechanisms in Mobile Ad Hoc Networks (MANETs) are crucial for managing network traffic to ensure efficient data transmission and maintain Quality of Service (QoS) parameters. In this section, we will delve into the various congestion control mechanisms used in MANETs, including both proactive and reactive approaches, as well as hybrid strategies. Each mechanism operates differently to address congestion in MANETs:

Proactive Congestion Control

- **Source Quenching:** In this method, the source node periodically monitors network conditions and adjusts its transmission rate based on congestion feedback. If congestion is detected, the source node reduces its transmission rate to alleviate congestion. However, this approach may not be suitable for MANETs due to their dynamic nature, as network conditions can change rapidly.
- **Rate-Based Congestion Control:** This mechanism focuses on controlling the data transmission rate of source nodes. It regulates the sending rate based on network feedback to prevent congestion. While it can be effective in some scenarios, it may not adapt well to MANETs' frequent topology changes and node mobility.

Reactive Congestion Control

- **Explicit Signaling (RSVP):** The Resource Reservation Protocol (RSVP) is often used in MANETs to reserve resources along the communication path for real-time traffic. When congestion is detected, RSVP can signal source nodes to reduce their data rates or reroute traffic

to less congested paths.

- **Random Early Detection (RED):** RED is a well-known congestion control mechanism that works by monitoring the queue length at network routers. When the queue length exceeds a certain threshold, routers start randomly dropping packets. This signal is sent back to source nodes, prompting them to reduce their transmission rate. However, RED may not be suitable for MANETs due to their dynamic topology.

Hybrid Congestion Control

- **Adaptive Rate Control:** This hybrid approach combines proactive and reactive elements. Source nodes initially transmit data at a conservative rate, and if congestion is detected (reactive), they adjust their transmission rate based on network feedback (proactive). This approach strikes a balance between adaptability and control.
- **Cross-Layer Congestion Control:** This approach leverages information from multiple layers of the network stack (e.g., physical, MAC, and routing layers) to make congestion control decisions. By combining information from different layers, it can provide a more holistic view of network conditions and make more informed congestion control decisions.

It's important to note that the effectiveness of these congestion control mechanisms in MANETs depends on several factors, including network size, node mobility, traffic patterns, and application requirements. Additionally, the choice of a congestion control mechanism should align with the specific QoS metrics (e.g., throughput, delay, packet loss) that are critical for the applications running on the MANET.

III. REVIEW OF LITERATURE

Kanellopoulos, Dimitris (2021) Congestion control within a mobile ad hoc network (MANET) must be done under time-critical circumstances due to the network's distinctive queuing dynamics, which arise from a number of fundamental properties. Meanwhile, the Named Data Networking (NDN) architecture has gained fresh interest as a key component of the future internet

due to its proven ability to optimize network traffic. Dynamic content routing and congestion management strategies may benefit from the complementary nature of NDN and MANETs. Congestion control for NDN-based MANETs is broken down into its core ideas here. Existing congestion management systems for NDN-based MANETs are also categorized and their benefits and drawbacks are discussed. Congestion management in NDN-based MANETs is also emphasized as a future concern.

Krishnamoorthy, Devarajan et al., (2020) Congestion control approaches (including of routing techniques) and control flows at the network layer may help reduce the impact of packet loss as a barrier in mobile ad hoc networks (MANETs). For maximum system performance, we provide a link matrix approach for MANETs that eliminates congested connections according to the distance before distortion level of each chosen transmission node. Capacity Optimized Co-operative Communication (COCO) is used as a benchmark against which the selected traffic matrix approach may be evaluated. Based on experimental evidence, it seems that the traffic matrix approach greatly enhances the precision with which MANET traffic patterns may be derived. Throughput (41%), latency (28%), energy (60%), overhead (48%), and packet delivery ratio (5%), were all significantly better using the suggested technique compared to the COCO method in the simulations.

Kanellopoulos, Dimitris (2018) In a MANET, nodes are able to interact with one another without the deployment of any specialized infrastructure. Congestion management is made more difficult by the nature of MANETs. The unique characteristics of a wireless multi-hop channel are difficult to manage using the conventional TCP congestion management technique. The wireless channel is a shared resource, and the network architecture is dynamic and always changing, both of which provide substantial obstacles. In light of this, several methods of congestion management for MANETs have been developed. TCP improvements for wireless networks are the subject of this study. It discusses congestion management strategies for MANETs and examines the design difficulties of an

improved transport protocol.

Prakash, Jay et al., (2017) Wireless data transmission is complicated by factors such as channel congestion and inconsistent network quality. Whether the nodes in a network are mobile or fixed, the quality of the connection between them will always vary. Congestion is a fascinating problem that arises when the quality of service (QoS) of the network used to transmit data declines. This article explains how the Internet, which is essentially a backbone network with a physical connection, may be used to improve network performance in more ways than one. In a Mobile Ad hoc Network (MANET), this backbone network may be used to reroute data between nodes in order to create a more efficient, less congested network. Transit routing is the term for this method. There is a comparison between the suggested protocol and the standard method of traffic distribution. The experimental results show that the suggested strategy is superior to the current ones in terms of congestion reduction. Additionally, it improves system dependability by decreasing the percentage of lost packets.

Rath, Mamata et al., (2017) Quality of Service (QoS) in data transmission is essential for real-time solicitations of the highest possible volume. With the primary goal of maximizing resource deployment in a constrained setting, numerous routing protocols for Mobile Ad hoc Networks (MANETs) have been designed that include Real Time Applications and make use of an enhanced Real Time structure to optimize latency and energy efficiency. When working toward QoS with highly mobile stations, congestion control is a key topic to consider. An improved traffic shaping mechanism in the TCP/IP protocol suite of the network model for real-time applications is proposed, with the paper's foundational concept resting on the use of the token bucket traffic shaping mechanism during packet routing at the intermediate nodes. The simulation results show that our suggested strategy improves the packet delivery ratio and decreases the queuing latency in a highly crowded traffic environment.

Sirauddin, Mohammad et al., (2016) A mobile ad hoc network (MANET) is a wireless network that doesn't rely on fixed infrastructure and allows individual nodes to connect with one another in a short-term fashion. Congestion is a

serious problem with the MANET. As a result, the network's efficiency drops. TCP allows for the secure transmission of time-sensitive data via MANET. However, due of node mobility and dynamic topology, the TCP's congestion management approaches are insufficient for such networks. In addition, the congestion is difficult for the MANET-specific routing protocols to address. We present a novel TCP congestion control strategy, TCP-R, for detecting the congestion, and a new dynamic routing algorithm, ADV-CC (Adhoc Distance Vector with Congestion Control), for controlling congestion in MANET. As an added feature, ADV-CC's congestion status property makes the network more efficient than AODV. The performance findings and analysis of TCP-R and ADV-CC are the paper's key strengths.

Maheshwari, Geetika et al., (2014) A mobile ad hoc network is a self-configuring and relocating ad hoc network. MANETs are networks that link other networks together using wireless links. A mobile ad hoc network faces a variety of difficulties. Mobile ad hoc network congestion management is a difficult problem to solve. When there is more demand than supply, traffic jams form. Congestion in mobile ad hoc networks has been handled using a variety of suggested techniques. Congestion management systems may be used either to prevent congestion from occurring or to alleviate congestion after it has begun. In this work, we provide a survey of the various approaches currently in use. In this work, we will examine and evaluate many alternative approaches to congestion reduction.

Abdul Rejab, Mohamad Rizal et al., (2012) While much research has gone into understanding TCP's behavior in MANET, little is known about how TFRC operates in this setting. This study has a dual function. We began by analyzing throughput, latency, and jitter while using AODV and DSR as the underlying routing protocols while running TFRC and TCP, respectively. The second goal was to figure out whether the transport protocols are affected by the MANET routing protocols. All of the tests, including those of TFRC over AODV, TFRC over DSR, TCP over AODV, and TCP over DSR, were performed in Network Simulator 2 (NS-2). We set up 30 nodes on a 1000 by 1000 meter grid, and gave each node its own transport protocol, routing policy, and CBR traffic. We used a Random Waypoint mobility model with speeds of 5, 10, 15, and 20 meters per second (m/sec)

and a stop interval of 10 seconds to mimic the movement of the nodes. Using DSR as its routing protocol, we found that TFRC throughput rises by over 55%, but TCP throughput shows no significant change across various underlying protocols. However, both AODV and DSR have an effect on TFRC and TCP of more than 50% with respect to jitter and delay. Because AODV offers lower jitter, a key performance indicator for multimedia applications, the findings also suggest that TFRC or TCP should utilize it as its routing protocol.

IV. PROPOSED MODEL

Congestion is managed in the present work by using a Real time Token Bucket as a middleman between the sender and the recipient. There was a gap between the sender and the recipient in the current system. The suggested system is what we're employing to fix this issue.

Our suggested system consists of three distinct parts.

1. Packet-generating and token-acquiring node module.
2. The RTB system, which creates tokens and distributes them to nodes, then retrieves data from the nodes, stores it in a buffer, and sends it to its final destination using a predetermined bucket size.
3. The destination node, which must be able to accept packets and store them in the appropriate manner.

The system's intake and outflow rates can be adjusted beforehand. Such as the speed at which data may be transmitted from one node to another and from the sender's system to the receiver's. Before sending data, nodes should verify that they have enough packets to do so. The data rates from the RTB to the receiver system are standardized. During a fixed-rate flow, just one buffer's worth of data is transmitted at a time. In order to send the remaining packet, it must wait till its time again. In this case, tokens are unnecessary. To successfully transfer data in an RTB node, enough tokens must be acquired. If a node has enough tokens, it can send the entire packet to the controller without pausing for a handoff. All the information from the nodes will be stored in this buffer. Transfers from the buffer to the bucket will be made on a

first-come, first-served basis. By using a token-based bucket system, we can manage congestion in front of data transmission, guaranteeing packet delivery and quality of service.

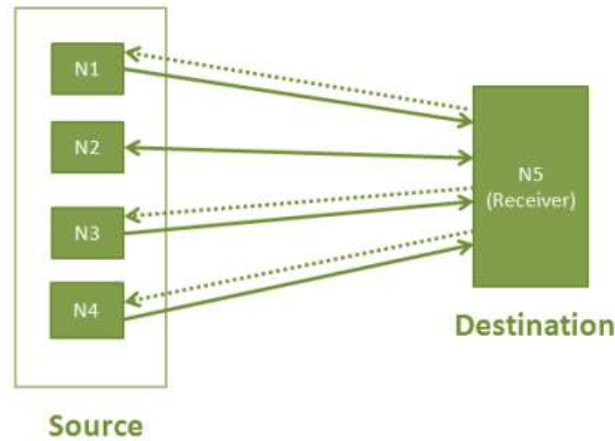


Figure 1: Existing System

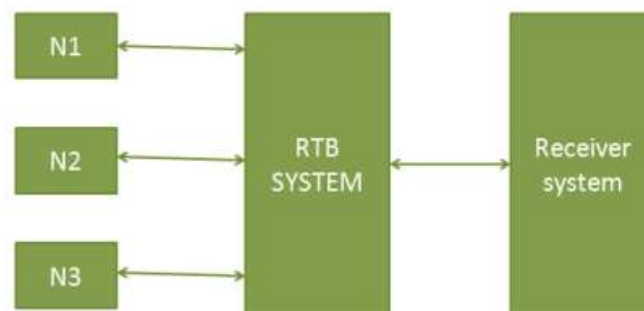


Figure 2: Proposed System

V. EXPERIMENTAL PROCESS

This article details the development of JAVA applications utilizing the Netbeans 9.X integrated development environment (IDE) and operating on a Windows 10 (64-bit) laptop (with 2 GB of RAM) setting to perform the event functions of a congestion control node and receiver system. The front end is built with the Swings/AWT API, while the back end is built with the Sockets API.



Figure 3: Setting buffer rate and bucket rate

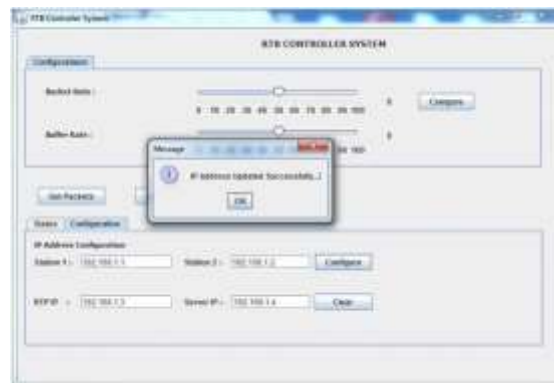


Figure 4: Setting IP addresses

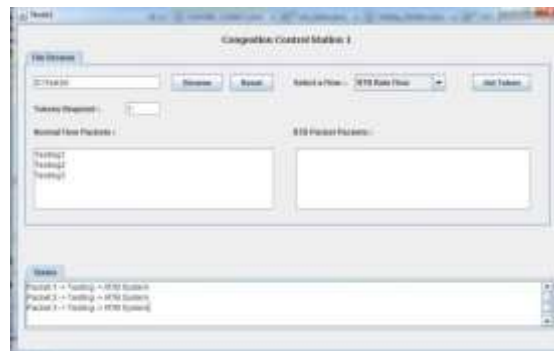


Figure 5: Congestion control station 1

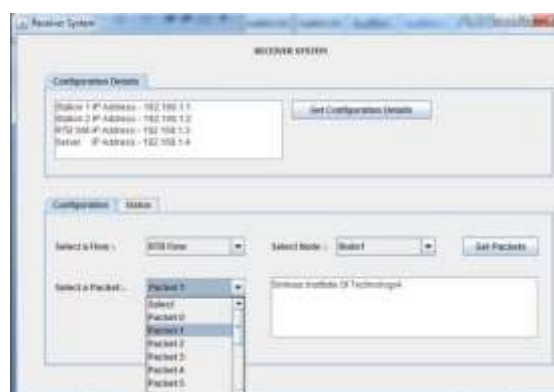


Figure 6: Receiver system

Algorithm between nodes and controller system

Step 1: Data Format: RTB or Fixed.

Step 2: Create a packet.

Step 3: Gather a sufficient quantity of tokens.

Step 4: Drop the node's packet off at the controller.

Algorithm between controller system and server

Step 1: Token value should be refreshed by server.

Step 2: Use a predetermined "bucket size" to transmit data from the controller system to the server system.

Step 3: Data packets are saved in the appropriate locations.

VI. RESULTS AND DISCUSSION

The intermediate nodes employ a token bucket traffic system that applies the fundamental principle of real-time application to the transfer of packets. The output of the flow determines the real-time token bucket's buffer size and bucket size. Alter the buffer and bucket sizes accordingly. The size of the buffer between the first node and the controller, and the size of the bucket between the controller and the receiver, are also discussed. Token-based, real-time bucket service has allowed us to at last achieve service quality.

VII. CONCLUSION

In the dynamic world of Mobile Ad Hoc Networks (MANETs), where nodes self-configure, form temporary connections, and operate without a fixed infrastructure, achieving Quality of Service (QoS) for real-time traffic is a formidable challenge. Congestion control mechanisms emerge as crucial tools in managing this challenge, ensuring that real-time applications experience low latency, minimal packet loss, and high throughput. It has illuminated the multifaceted nature of congestion in these networks and the diverse strategies available to address it. As wireless communication technologies continue to evolve and real-

time data transmission becomes increasingly critical, this knowledge will serve as a guidepost for future innovations and improvements. The pursuit of seamless, reliable, and low-latency communication in Mobile Ad Hoc Networks remains an ongoing journey, and congestion control mechanisms stand at the forefront of this endeavor, ensuring that QoS for real-time traffic is realized.

REFERENCES: -

1. Kanellopoulos, Dimitris. (2021). Congestion Control for NDN-Based MANETs: Recent Advances, Enabling Technologies, and Open Challenges. *Journal of Organizational and End User Computing*. 33. 111-134. 10.4018/JOEUC.20210901.0a6.
2. Krishnamoorthy, Devarajan & Vaiyapuri, Padmathilagam & A, Dr. Ayyasamy & Robinson, Y. & Kumar, Raghvendra & Long, Hoang & Son, Le. (2020). An Effective Congestion Control Scheme for MANET with Relative Traffic Link Matrix Routing. *Arabian Journal for Science and Engineering*. 45. 10.1007/s13369-020-04511-9.
3. Singh, Gagandeep & Sharma, A. & Bawa, Onkar & Kaur, Harneet. (2020). Effective Congestion Control In MANET. 86-90. 10.1109/ICIEM48762.2020.9160130.
4. Kanellopoulos, Dimitris. (2018). Congestion control for MANETs: An overview. *ICT Express*. 5. 10.1016/j.icte.2018.06.001.
5. Pooja. J. Kotian, Preethika. P. Kotian, Mrs. Shifana Begum, P. Vaishnavi & Vaishnavi. K. Shetty. (2018). Enhanced Technique to Attain QOS for Real Time Traffic Using Congestion Control Mechanism in MANET's. *International Journal of Engineering Research & Technology (IJERT)*. ISSN: 2278-0181. ICRTT - 2018 Conference Proceedings.
6. Prakash, Jay & Kumar, Rakesh & Saini, J.. (2017). A New Congestion Avoidance and Mitigation Mechanism Based on Traffic Assignment Factor and Transit Routing in MANET. 10.1007/978-981-10-1678-3_48.
7. Rath, Mamata & Rout, Umesh & Pujari, Niharika & Nanda, Surendra & Panda, Sambhu. (2017). Congestion Control Mechanism for Real Time Traffic in Mobile Adhoc Networks. 10.1007/978-981-10-3226-4_14.
8. De Cicco, Luca & Carlucci, Gaetano & Mascolo, Saverio. (2017). Congestion Control for Real-Time Communication. *IEEE/ACM Transactions on Networking*. to appear. 10.1109/TNET.2017.2703615.
9. Sirauddin, Mohammad & Rupa, Ch & Prasad, A.. (2016). Advanced Congestion Control Techniques for MANET. 10.1007/978-81-322-2755-7_28.

10. Sharma, Neelam & Gupta, Avadhesh & Rajput, Shyam & Yadav, Virendra. (2016). Congestion Control Techniques in MANET: A Survey. 280-282. 10.1109/CICT.2016.62.
11. Maheshwari, Geetika & Gour, Mahesh & Chourasia, Umesh. (2014). A Survey on Congestion Control in MANET. International Journal of Computer Science and Information Security. 5. 998-1001.
12. Abdul Rejab, Mohamad Rizal & Mohd Zaini, Khuzairi & Hassan, Suhaidi & Habbal, Adib & Azzali, Fazli. (2012). An Interaction between Congestion-Control Based Transport Protocols and MANET Routing Protocols. Journal of Computer Science. 8. 468-473. 10.3844/jcssp.2012.468.473.