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MANET Congestion Control Mechanism - Challenges and Survey

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Abstract—The transport layer plays a crucial role in the Mobile Adhoc Network (MANET) protocol stack by controlling traffic flow, managing congestion, and enabling end-to-end delivery. With the help of congestion control mechanisms, numerous protocols are formed to enhance MANET performance. This paper focuses on a thorough analysis of the challenges the MANET protocol stack is facing as a result of congestion control issues such high overload, long delays, and increased packet loss. Finally, note that in order to increase MANET performance, research needs to concentrate on specific congestion control mechanisms.

Keywords- MANET, Congestion Control, TCP Transport Layer, Performance metric.

I. INTRODUCTION

One of the MANET challenges in the protocol stack is congestion control in the Transport layer . Congestion is a scenario which occur in any communication network in the form of many packets are present in the subnet . which causes when the number of packets send by the sender is more than the receiver capacity . In the wired network the congestion can be avoided by incorporating multiple subnet mask and routing path where as in wireless network especially in the MANET is not conscious about the congestion because of restricted bandwidth usage buffer size limitation, frequent rerouting scenario, energy etc. . If the network is congested which causes the delay , high overhead and more packet loss all ultimately affect the MANET performances like throughput, end to end delay jitter etc [4]. The major causes of the congestion control in the network is packet delay and internal node buffer overflow which affects the performance of the MANET.

TCP Based Congestion Control, Active Queue Management Based Congestion Control, Mobility Based Congestion Control, Load Balancing Based Congestion Control, Mobile Agent Based Congestion Control, and Cross Layer Approach Based Congestion Control are some of the congestion control mechanisms proposed for MANET. The

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sender and recover window size in TCP-based congestion control will be adjusted by the TCP protocol based on the flow of packets in the network. In the RED algorithm, an active queue management congestion control technique is developed, which forwards congestion information to the destination at an early stage. AQM dropped packets based on packet arrival rate and queue duration. Early congestion detection and self-cure AODV routing protocol (EDCSCAODV), early congestion detection and optimal control routing (EDOCR), and Dynamic congestion detection and control routing (DCDR) are the best examples of classic AQM-based congestion routing methods.

The three steps of congestion control are followed in mobility-based congestion control. In the first stage, collect complete monitoring information about MANET mobile nodes, then detect congestion using congestion impacting parameters such as queue length and channel congestion, and finally provide a congestion-free path from the source node to the destination node. Load balancing-based congestion control employs multipath rouging, which provides a greater number of pathways for packet distribution. Ad-hoc networks now contain mobile agents that hold routing data and node congestion status in the Mobile agent-based congestion control technique. The mobile agent traverses the network, selecting the nearest node with the least level of load as its next step. The routing table is then updated using mobile agents in response to the congestion state of the node. The final way for decreasing congestion is a multi-layer approach. For the route finding approach, the routing protocol was used to build a cross-layer congestion control protocol. Figure 1.1 depicts the MANET congestion control Mechanism classes.

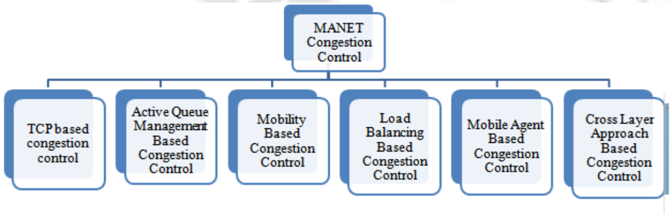

Figure 1.1 Classification of MANET Congestion Control Mechanism

This survey article elaborate the congestion control mechanism used for the MANET with a comparative study and limitation . With a comparative research and limitations, this survey article describes the congestion control system employed for the MANET. The essay is divided into two sections: a comparative examination of the congestion mentioned in section 3 and a literature review about the MANET congestion control in part 2.finally, section 4 of the survey comes to a conclusion.

II. LITERATURE SURVEY RELATED TO CONGESTION CONTROL

Rajesh M and Gnanasekar [1], in this article authors introduces the wireless agent (WA) which moves around the MANET nodes to monitor about the congestion metric based on the packets video or audio , control sequence among the routing nodes. this wireless agent in implemented in AODV protocol the result shows that there is the improvement in end to end delay , traffic load and high delivery ratio. KomalBadhran and Gautam Gupta [2] in this article the authors proposed the new protocol named wGDP which combines the congestion control and scheduling in MANET .This proposed protocol is using multicast algorithm which achieves the higher packet delivery and also reduced the overall overhead . S. Tamilselvi and O.P.UmaMaheshwari [3] , in this article authors uses the energy efficient algorithm implemented in Dynamic source routing protocol mechanism and simulation is done with the support of NS as a result shown that high level of energy is consumed but it improves the packet delivery ration and high network life time .

Anju ,Sugandha Singh [4] , in this article the authors modified the AODV protocol with congestion control to solve the traffic issue , finally proves that this congestion control mechanism find that better over load and system could able to work even in a worst condition .Bandana Bhatia [6] in this article authors uses the AODV-I and EDAODV which are improved protocols from traditional AODV protocol adapted with congestion aware and route mechanism with the support of RREQ messages for avoiding the busy node selection during the route establishment . this methods achieves the routing control overhead. Sunitha et al., [7] in this article authors proposed a triggering method for initiating the congestion when the threshold limit of the signal strength is below with channel occupied ratio which is achieved by calculating the bandwidth , delay and resource allocation . The simulation results proves the performance of the network is improved in the aspect of throughput, delay and delivery ratio. Kumar, H., & Singh [8] , authors proposed the queue length and traffic rate based congestion monitoring mechanism for establishing route in the network which takes less route by monitors the packet loss , packet drop ration and overhead. The result of this simulation achieves better performance like throughput packet delivery ratio and end to end delay.

Sreenivas et al.,[9], in this authors introduces the link layer congestion protocol inside the protocol of the mobile node which accept the data stream and adjust the outgoing data t algorithm stream with the support of RTT bandwidth and delay parameters. Simaya et al.,[10] enhanced version of Active queue management in RED algorithm for detecting the congestion earlier with the available packet arrival rate and queue length. This enhanced AQM RED algorithm reduced the congestion as well as packer loss rate. Sheeja et al [11], authors uses the introduced an effective congestion avoidance scheme (ECAS) which has three stages like complete monitoring, congestion detection and congestion free. This

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methods gives good packet delivery ratio, throughput and minimal delay .

Mallapur et al [12] suggested a multipath load balancing technique for congestion management (MLBCC) with two stages of congestion detection and selection of the best path. When compared to the ad hoc on demand multipath distance vector (AOMDV) and the Fibonacci sequence multipath load balancing protocol (FMLB), the MLBCC generated the best packet delivery ratio, end-to-end delay, and packet drop. M. Aliet al., et al.,[13] employ the adaptive multipath routing protocol to improve load balancing and congestion control with low load, high bandwidth, and residual energy. The simulation results revealed that the strategy reduced CBR traffic delay and outperformed the classic congestion control mechanism in terms of throughput and PDR.

Soundararajan et al. presented a multipath load balancing and rate-based congestion management (MLBRBCC) solution for MANET in [14].The programme employs two techniques: rate estimation and rate control. The data packet is transmitted from the source end to the receiving end via intermediary nodes. The sender node regulates the rate based on the estimated rate in the feedback packet. The simulation results showed that MLBRBCC had higher PDR values and a shorter end-to-end latency. Sharma and Bhadauria [15] use a mobile agent named Mobile agent based congestion control mechanism in the AODV protocol to collect route information and congestion status in order to determine the best way possible without meeting congestion. There was little delay, high throughput, and a high delivery ratio using this strategy.

Uthariaraj[16] employed data rate, queue length, and medium access control (MAC) contention calculations to determine how to detect and recover from congestion. If the congestion condition of a specific node is more than or equal to medium, an alert message is sent to the sender. The sender then chooses a less congested route for data delivery. The network simulation findings revealed that, in the case of high traffic loads, congestion detection-based route recovery strategies reduce packet drop and delay while enhancing packet delivery ratio. The cross-layer Congestion Control and Endurance Routing (SC3ERP) protocol created by Kamatam and Srinivas [17] controls congestion in three ways: contention, buffer overflow, and link failure. Although the MAC overhead is increased and path optimality is increased, the packet overhead is decreased.

In this method, the Ad hoc on Demand Multipath Reliable and Energy Aware QoS Routing Protocol (AOMP-REQR) described by Duraiswamy and Thilagavathe [18] was utilized to perform rate-based congestion control of the transport layer protocol, additive rise and multiplicative decline (AIMD). The source slows down sending if the received packet rate at the transport layer exceeds the threshold limit. Signal interference is signaled in the MAC layer, and the link is predicted to be congested if the expected received power at a certain point exceeds an exponential average received signal energy.

III. MANET CONGESTION CONTROL COMPARATIVE ANALYSIS

Several various types of congestion management methods were suggested in Table 3.1, each of which employs a different method to control congestion. However, no method's simulation results were able to meet every MANET performance metric.

Table 3.1 congestion control Comparative analysis

S.No	Authors	Technique Used	Problem Finding	Simulation Result Improvement Parameters
1	Rajesh M and Gnanasekar [1]	Wireless Agent (WA).	Queue Length And Channel Contention	• End-To-End Delay • Route Discovery Requests • Balances The Traffic Load
2	KomalBadhran and Gautam Gupta [2]	wGDP protocol	Multiple Disjoint Path	• Higher Packet elivery • Reduced Overhead.
3	S. Tamilselvi and O.P.UmaMaheshwari [3]	DSR	High Level Of Energy	• Packet Delivery Ratio, • Low Delay • High Network Life time.
4	Anju ,Sugandha Singh [4]	Worked On Modified AODV Routing Protocol	Traffic Bottleneck Is The Major Issue	• Overload
5	Bandana Bhatia [6]	AODV-I And EDAODV	Congestion Aware And Route Repair Mechanism.	• Minimum Routing Control Overhead.
6	Sunitha et al., [7]	Congestion control uses TCP	Channel Occupation	• Delivery Ratio • Through Put • Delay Reduced
7	Kumar, H., & Singh [8]	TCP Congestion Control	Queue Length And Traffic Rate	• Throughput, • Packet Delivery Ratio, • End To End Delay • Overhead

8	Sreenivas et al.,[9],	TCP	Bandwidth And Delay	• Delay
9	Simaya et al.,[10]	Improvement of RED	Active Queue Management	• Low Packet Loss
10	Sheeja et al [11]	ECAS	Channel Contention	• Throughput • PDR, • Delay • Routing Overhead
11	Mallapur et al [12]	Multipath load balancing technique	Flow Distribution	• End-To End Delay • Packet Delivery Ratio • Packet Drop.
12	M. Aliet al., et al.,[13]	residual energy based load and bandwidth	Load Balancing	• Throughput • Packet Delivery Ratio • Delay • CBRTraffic
13	Soundararajan et al. in [14	Multipath Rate Based Congestion Control technique	Traffic Rate	• Throughput • Packet Delivery Ratio
14	Sharma and Bhadauria [15]	Mobile Agent Based Congestion	Load	• Delivery Ratio • Throughput • Delay.
15	Uthariaraj[16]	Congestion Detection And Recovery Technique	MAC Contention	• Packet Drop • Delay • Packet Delivery Ratio
16	Kamatam and Srinivas [17]	Cross Layer Approach.	SC3ERP	• Packet Overhead • MAC Overhead • Path Optimality
17	Duraiswamy and Thilagavathe [18]	Rate Based Method	Cross-Layer Oriented Method.	• Packet Drop • Delay.

IV. CONCLUSION

This article compared and contrasted the various congestion control techniques utilised in mobile ad hoc networks. Each method employs a unique technique to produce an individual performance metric. To increase the performance metrics of End to End Delay, Throughput, Delay, Packet loss, Overhead, Path Optimality, and Route Discovery, further study needs to be done to identify the congestion control method for MANET. To adjust the length of each MANET node's queue, more study must be done on the active queue management type of congestion control.

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