

A Survey on Congestion Control in MANET

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Abstract— Mobile ad hoc network is a type of ad hoc network that can change locations and configure itself on the fly. MANETs use wireless connections to connect various networks. There are number of issues and challenges in a mobile ad hoc network. Congestion control is a challenging task in mobile ad hoc network. Congestion occurs when the demand is greater than available resources. Different types of mechanisms have been proposed to overcome the congestion in the mobile ad hoc network. Congestion control mechanisms control congestion either before congestion occur or after congestion actually occurred. In this paper we give an overview over existing methods. The purpose of this paper is to discuss and compare different proposed congestion control mechanisms.

Key words- Mobile ad hoc network, Congestion in MANET, Congestion Control, Survey

I. INTRODUCTION

A. 1 Mobil Ad Hoc Networks (MANET)



Figure1.Mobile ad hoc network

A Mobile Adhoc Network (MANET) is a type of ad hoc network. Ad hoc means arranged or happening whenever necessary and not planned in advance. Ad hoc is a LAN which allows new network devices to be added quickly. Mobile ad hoc network is a collection of independent nodes which forms a temporary network without any fixed infrastructure or central controller. For establishing network wireless connections (wi-fi) are used or any other medium such as satellite or cellular transmission. Each device in a MANET is free to move independently in any direction. The movement of nodes is random in MANET. Therefore MANETs have a dynamic topology. There are lots of issues and challenges in designing a MANET network [6]. In MANET each node (Mobile Device) acts as a router, which helps in forwarding packets from a source to destination [16]. MANET nodes can be personal devices such as laptop, mobile phones and PDA [9]. MANET can change locations and configure itself on the fly. Mobile ad hoc networks are suited for use in situations where an infrastruc-

ture is unavailable or deploy one is not cost effective. Its application area includes military applications, local level (such as classrooms, conference), emergency operations, business applications and also used in VANET (Vehicular Ad hoc network). Following figure shows a simple mobile ad hoc network.

B. Congestion in MANET

Congestion is a situation in communication networks in which too many packets are present in a part of the subnet. Congestion may occurs when the load on the network (number of packets send to the network) is greater than the capacity of the network (number of packets a network can handle). Congestion leads to packet losses and bandwidth degradation and waste time and energy on congestion recovery [5]. In Internet when congestion occurs it is normally concentrated on a single router, where as, due to the shared medium of the MANET congestion will not overload the mobile nodes but has an effect on the entire coverage area [16]. When the routing protocols in MANET are not conscious about the congestion, it results in the following issues.

Long delay: This holds up the process of detecting the congestion. When the congestion is more rigorous, it is better to select an alternate new path. But the prevailing on-demand routing protocol delays the route searching process.

High overhead: More processing and communication attempts are required for a new route discovery. If the multi-path routing is utilized, it needs additional effort for upholding the multi-paths regardless of the existence of alternate route.

Many packet losses: The congestion control technique attempts to minimize the excess load in the network by either reducing the sending rate at the sender side or by dropping the packets at the intermediate nodes or by executing both the process. This causes increased packet loss rate or minimum throughput.

C. Congestion Control in MANET

MANET is a communication medium in daily human life and applications areas of MANET are growing rapidly. Congestion control and security are major tasks in MANET. Congestion control works very well in TCP over internet [14]. But due to dynamic topology congestion control is a challenging task in mobile ad hoc network. Many approaches have been proposed for congestion control in MANET. Congestion control technique is the method by which the network bandwidth is distributed across multiple end to end connections [8]. A congestion control scheme

ensures that the nodes place only as many packets on the wireless channel as can be delivered to the final destination. Congestion control depends on the method that how the actual control is done. Congestion can be rate based congestion control or buffer based congestion control. rate based congestion control algorithms are used during routing. Main objective of any congestion control algorithm is to balance the traffic to increase throughput of the network. Also it is possible to maximize nodes transfer, packet delivery ratio, and minimizes traffic congestion, end-to-end delay and network performance can be improved.

II. CONGESTION CONTROL ALGORITHMS

Congestion control mechanisms have improved over time. In this section we will give an overview over congestion control mechanisms. Many researchers performed valuable research in the field of congestion control. First we will discuss TCP variants for congestion control after that we will give an overview over existing congestion control algorithms.

TCP TAHOE

Van Jacobson proposed a congestion control algorithm named as TAHOE. TAHOE is the first TCP variant which is used for congestion control over TCP. TCP TAHOE goes through slow start process. AIMD technique is used for congestion avoidance.

TAHOE takes a complete timeout interval to detect a packet loss. Also it sends cumulative acknowledgments and follows go back n approach. The problem of TAHOE is that it waits for a timeout which offers a major cost in high bandwidth delay product.

TCP RENO

TCP RENO is also based on basic principle of TCP TAHOE which include slow start and congestion avoidance process but it also detects packet loss earlier. RENO gives a new method called fast retransmit. Fast retransmit states that whenever we receive 3 duplicate acknowledgments then we take it as a sign that segment was lost and then we retransmit the segment over the network without waiting for timeout. The problem of TCP RENO is that it does not work well when we have many packet losses.

TCP NEW RENO

TCP NEW RENO overcomes the problem of TCP RENO. TCP NEW RENO can also detects many packet losses. NEW RENO is also based on basic principles of TCP RENO such as slow start, congestion avoidance and fast retransmit. A new method is proposed in TCP NEW RENO called fast recovery which allows for multiple retransmissions. The problem of NEW RENO is that it takes one RTT to detect each packet loss. SACK is used to overcome the disadvantage of NEW RENO.

Soundararajan S et al [1] proposed multipath load balancing & rate based congestion control for mobile ad hoc network. In proposed method the source node forwards the data packet to the destination node through intermediate nodes. when the intermediate node receives the data packet, percentage of channel utilization and queue length are estimated and congestion status is verified. The channel utilization for the time interval t is estimated using channel busy time (T_c) and this T_c can be computed based on the category of control frame and rate and data frame size. The

queue length is the total traffic load in a mobile node. This process is repeated at every intermediate node. After the reception of the data packet, the destination node checks for the rate information in the packets IP header fields. Estimated rate is copied to an acknowledgment packet and sent as a feedback to the sender. The sender performs rate control according to the estimated rate obtained from the destination.

Tuan Anh Le et al [2] proposed an energy-aware congestion control algorithm for multipath TCP, called ecMTCP. ecMTCP moves traffic from the most congested path to the more lightly paths as well as from higher energy cost path to the lower ones, thus achieving load balancing and energy savings. A multipath TCP connection can create multiple simultaneous sub flows among the end hosts, where each sub flows maintains the ability to send data packets over a path. Proposed algorithm was an energy cost measurement model between two end hosts. The sender measures the energy costs for transmitting a data packet and for receiving an ACK at its network interface. Similarly at the receiver side, the cost for the data and ACK packets are calculated. The sender calculates the sum of the end-to-end energy costs of the successful transmission of one data packet. End-to-end energy costs known as linking function. This ecMTCP can support the exploitation of potential energy-savings between two end hosts.

Jingyuan Wang et al [3] proposed a congestion control algorithm, named TCP-FIT, which could perform in both wireless and high BDP networks. There is only one difference in parallel TCP and TCP-FIT that in TCP-FIT only one TCP connection with one congestion windows established for each TCP session and requires no changes to other layers. A novel TCP congestion control algorithm is proposed which contain high BDP links and wireless links. TCP-FIT algorithm is based on AIMD (Additive-Increase/Multiplicative-Decrease). AIMD combines linear growth of the congestion window with an exponential reduction when congestion takes place. AIMD method increase the congestion window by 1 MSS (Maximum segment size) until a loss is detected. When loss is detected, multiplicative decrease the congestion window.

Oussama Habachi et al [4] proposed a Mean Opinion Score (MOS) based congestion control mechanism for wireless networks. MOS determines an optimal congestion window updating policy. For this policy the sender requires complete knowledge of both multimedia traffic and the network environment. This approach defines a new AIMD (Additive Increase & Multiplicative Decrease) algorithm. A new process named as Partially Observable Markov Decision Process (POMDP) is proposed in this approach which determines an optimal congestion control policy. POMDP algorithm maximizes the QOE (Quality of experience) for multimedia applications. POMDP deals with computational problem that why a low computation complexity online learning algorithm is proposed.

Xiaoqin Chen et al [5] proposed a congestion aware routing protocol for mobile ad hoc network (CARM). CARM technique applies a link data rate categorization approach to prevent routes with mismatched link data-rates. CARM uses a metric incorporating data rate, MAC overhead and buffer delay. CARM utilizes two methods to improve the

routing protocol, WCD(Weighted channel delay) and ELDCs(effective link data rate categories).WCD technique is used to select high throughput routes with low congestion. ELDCs techniques are used to avoid mismatched link data rate routes. In this mechanism the congestion is controlled via several approaches.

Makoto Ikeda et al [6] proposed a congestion control mechanism, for multi-flow traffic in wireless mobile ad hoc network. OLSR(Optimized Link State Routing) protocol is applied for congestion control.OLSR is a proactive routing protocol which builds up a route for data transmission and also maintains a routing table for each node in the network.OLSR use HELLO message to find its one hop and two hop neighbour. Every node computes the path towards a destination using a shortest path algorithm. The source-destination pairs are fixed over the network.CBR flow is transported over TCP and UDP from source to destination.CBR interval is the ratio of packet size to theoretical throughput.NS-3 simulator is used for simulation.

M. Ali et al [7] proposed a congestion adaptive multipath routing for load balancing in mobile ad hoc network. Congestion control and load balancing have been major issues in mobile ad hoc network. This multipath routing technique is used to increase the throughput and avoid congestion. Multipath routing is used to enhance the reliability. This algorithm is based on Scalable Multipath On-demand Routing (SMORT) which computes fail-safe multiple paths. The fail-safe multiple paths are the nodes with least load, more bandwidth and residual energy. When the average load of an existing link increase beyond a threshold, traffic is distributed over multipath routes to reduce the load in a network. This approach achieves better throughput and packet delivery ratio.

V. Thilagavathe et al [9] proposed a cross layer based mechanism which is used to control the congestion in MAC and transport layer in MANET. The proposed mechanism is applied over a ad hoc On demand Multipath Reliable and Energy Aware QoS Routing Protocol (AOMP-REQR). This technique is also based on additive increase and multiplicative decrease (AIMD) As we discussed above AIMD method increase the congestion window by 1 MSS (Maximum segment size) until a loss is detected. When loss is detected, multiplicative decrease the congestion window. In this technique a congestion free route will be established for transmission without performing any rate control. The motivation of this technique is to reduce the packet loss in MANETs. If the congestion happens at the time of routing, it is detected and handled by congestion control and an alternative route is established for transmission. In transport layer, if the received packet rate exceeds the predefined threshold, then source decrements the sending rate. In MAC layer, if the estimated received power at current time is beyond an exponential average power of received signal, signal interference will be indicated and the link is assumed to be congested. If the congested route entries exceeds, then a new alternative route is established for transmission

Hariom Soni et al [13] proposed a mechanism which is based on Active Queue Management and Random Early Detection (RED). Queue management mechanism such as drop tail technique allow a packet to enter in queue till the queue is empty and drop the entire incoming packets when

queue gets full but there is no other method for early detection of congestion that means packet drop is common problem. RED is a congestion detection approach in which the router can detect incipient congestion with prediction of congestion level and the time in which it becomes burst. When the congestion is detected, router selects the source terminal to notify the congestion. There are two steps in RED algorithm:

- 1) Calculate the average queue length.
- 2) Calculate the packet drop probability. This mechanism is based on controlling congestion before it occurs.

Vishnu Kumar Sharma et al [14] proposed a Mobile Agent Based Congestion Control using AODV routing protocol for mobile ad hoc network. In this mechanism, the entire information about a network is collected and distributed by mobile agents (MA). When mobile nodes move through the network, they can select a less loaded neighbor node as its next hop and then update the routing table. AODV (Ad hoc on demand distance vector) is a reactive routing protocol in mobile ad hoc network. Mobile agent is a node that has a routing table that stores routing information. A mobile agent starts from every node and moves to an adjacent node. Traffic belongs to background, best effort, video or voice AC. Average queue length is estimated of the various traffic classes and the channel contention of each path. The total congestion metric is applied to the routing protocol to select the minimum congested route in the network.

Reeta Bourasi et al [15] proposed detection and removal of packet dropper nodes for congestion control over the MANET. Packet dropper node is a major issue in mobile ad hoc network and this is not only risky for the sender and receiver but also deals to congestion in mobile ad hoc network. MANET is a collection of mobile nodes without any central control. The proposed algorithm applies the concept of reliability checking during transmission of data packets. This mechanism is based on detection and retribution based approach. This proposed technique dynamically detects packet dropper nodes and eliminates the packet dropper nodes during the packet transfer.

Parmindar Kaur et al [18] proposed a systematic approach for congestion control in wireless ad hoc network. This proposed mechanism is based on OPNET. Wireless ad hoc network is a Collection of mobile platforms(nodes) which can move from one location to another. OPNET modeler 14.5 is used to determine that how better size, mobility and node power can prove to be critical. Simulation result shows that buffer size of large nodes and power level will degrade network performance more than small node buffer.

K Srinivasa Rao et al [19] proposed an energy efficient and reliable congestion control protocol for multicasting in mobile ad hoc network. The proposed congestion control mechanism is better than existing multicast congestion control protocol(AODV). This technique is divided into three steps. In first step of EERCC protocol, a multicast tree routed at the source is build than in second step, an admission control technique is proposed. In third step a scheme is proposed which adjust the multicast traffic rate. EERCC protocol overcomes the disadvantages of existing protocols. the proposed EERCC protocol has better delivery ratio, throughput and also minimizes delay and energy consumption.

III. CONCLUSION AND FUTURE WORK

This Survey paper gives an overview over different congestion control algorithms. We can conclude that there is no single algorithm for congestion control in mobile ad hoc network. Nodes in MANET have limited bandwidth, buffer space, queue etc. So it is essential to distribute the traffic among the mobile nodes. In MANET, to improve the performance, it is very essential to balance the traffic congestion. Main objective of any congestion control algorithm is to balance the traffic to increase throughput of the network. Also it is possible to maximize nodes transfer, packet delivery ratio, and minimizes traffic congestion, end-to-end packet delay and network performance can be improved. In our future work we will propose multipath load balancing with queue scheme as well as acknowledgment delay difference base estimation technique, also find out number of data drop from the network with reason that work help to rectification of our work and minimize the congestion from the network.

We will divide our work in different modules such as Multipath Routing Module (for balancing load as well as delay minimization), Queue (for data saving if rate diverge in each link), TCP New Reno (for acknowledgment delay difference calculation base data sending scheme), Drop Reason (for finding dropper node and enhancement).

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