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A Review on Congestion Control Mechanisms In Mobile Ad-Hoc Networks

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Abstract

A mobile ad-hoc network is a collection of mobile nodes forming an ad-hoc network without the assistance of any centralized structures. MANET deals with various issues and challenges in which Congestion control is a challenging task. Congestion occurs at the time of demand is greater than existing resources. Different types of contrivances have been proposed to overcome the congestion in the MANET. These Congestion control mechanisms control the congestion either before or after the congestion occurred. In this paper we give an overview about existing methods and it compares different proposed congestion control contrivances.

Keywords: Mobile ad hoc network, Congestion in MANET, Congestion Control.

Introduction

A. Mobile Ad-Hoc Network

A mobile ad-hoc network is a collection of mobile nodes forming an ad-hoc network without the support of any centralized structures. These networks introduced a new way of network establishment and it can be well suited for an environment where either the infrastructure is lost or where deploy an infrastructure is not very cost effective. The popular IEEE 802.11 protocol is capable of providing ad-hoc network facilities at low level at the time of no access point is available. But, in this case the nodes are limited to send and receive information but do not route anything across the network.

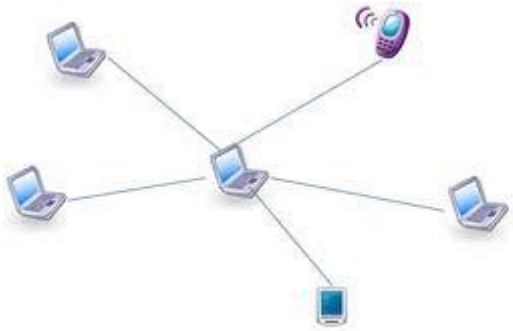

Figure 1: Mobile Ad-Hoc Network

Mobile ad-hoc networks can operate in a standalone fashion or it can be connected to a larger network such as the Internet. Mobile ad-hoc networks can be connected anywhere and at any time. Some of the applications include a disaster recovery or a military operation. MANET shows better performance in other places too. Imagine a group of peoples with laptops in a business meeting at a place where no network services is present in which we can easily network their machines by forming an ad-hoc network.

B. Characteristics of MANETs

The nodes of Mobile ad-hoc network are provided with wireless transmitters and receivers using antennas, which may be highly directional (point-to-point) or Omni directional (broadcast).

The characteristics of these networks are given as follows:

1. Communication via wireless
2. The roles of both hosts and routers can be performed by the nodes
3. Bandwidth-constrained, variable capacity links
4. Energy-constrained Operation
5. Limited Physical Security
6. Dynamic network topology
7. Frequent routing updates

C. Routing in MANET

Mobile Ad-hoc networks are self-organizing and self-configuring multihop wireless networks in which the structure of the network changes dynamically due to the mobility of the nodes [29]. Nodes in these networks utilize the same random access wireless channel in which it is not only acts as hosts but also as routers that route data to/from other nodes in network [30]. In mobile ad-hoc networks there is no infrastructure support as is the case with wireless network. Routing procedure is needed in here when a destination node might be out of range of a source node. Base station can reach all mobile nodes with in a cell without routing via broadcast in common wireless networks. In ad-hoc networks, each node must be able to forward

data for other nodes which creates additional problems along with the problems of dynamic topology which is unpredictable connectivity changes [31].

D. Factors Causing Congestion In MANET

Congestion may occur in the network when the number of packets sent to the network is greater than the number of packets that a network can handle which leads to packet losses, bandwidth degradation, waste time and energy on congestion recovery [5]. Routing protocols in MANET are not conscious about the congestion which results in long delay, heavy overload and packet loss.

E. MANET Congestion Control

Congestion control is the major task in MANET due to dynamic topology. Congestion control works very well in TCP over internet [14]. Many approaches have been suggested for congestion control in MANET in 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. It is possible to maximize nodes transfer, packet delivery ratio, and minimizes traffic congestion; end-to-end delay and network performance can be improved.

Algorithms For Congestion Control

Congestion control mechanisms are improved over time. The following section proposed an overview about congestion control mechanisms. Many researchers performed valuable research in the field of congestion control. First we will discuss about TCP variants for congestion control and after that an overview over existing congestion controls algorithms were proposed.

A. TCP Tahoe

Van Jacobson suggested a congestion control algorithmnamed as TAHOE which is the first TCP variant used for congestion control over TCP and it goesthrough slow start process. AIMD technique is used forcongestion avoidance.TAHOE consumes a complete timeout interval for detecting a packetloss. Also, it sends cumulative acknowledgments and followsgo back n approach. The problem of TAHOE is that it waitsfor a timeout which offers a major cost in high bandwidthdelay product.

B. TCP Reno

TCP RENO is mainly based on the basic principle of TCP TAHOE which includes slow start and congestion avoidance process. TCP RENO gives a new method called fast retransmit. Fast retransmit states that whenever the three duplicate acknowledgments are received then it is taken as a sign that segment was lost and

then the segment will be retransmitted over the network .The problem of TCP RENO is that it does not work well when we have many packet losses.

C. TCP New Reno

The problem of TCP RENO has been overcome by TCP NEW RENO. NEW RENO is also based on the basic principle of TCP RENO such as slow start, congestion avoidance and fast retransmit. A new method called fast recovery is proposed in TCP NEW RENO which allows multiple retransmissions. The problem of NEW RENO is that it takes one Round Trip Time 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 adhoc 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 (Tc) and this Tc 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's 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 techniqueapplies a link data rate categorization approach toprevent routes with mismatched link data-rates. CARMuses a metric incorporating data rate, MAC overhead andbuffer 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 lank 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 adhoc 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 rotes to reduce the load in a network. This approach achives 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 built 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.

Conclusion and Future Work

This review paper gives an overview about different congestion control algorithms which conclude that there is no single algorithm for congestion control in MANET. Nodes in MANET have limited bandwidth, buffer space, queue etc. So, it is necessary to distribute the traffic among the mobile nodes. For improving the performance in MANET, it is vital to balance the traffic congestion. In our future work we will propose multipath load balancing with queue scheme as well as acknowledgment delay difference base estimation technique and 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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