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Congestion Control Mechanism in Wireless ADHOC Networks: Review

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Abstract: ***Mobile Ad-hoc network (MANET) is a network in which two or more hops are used to convey information from source to destination. It consists of group of mobile nodes. MANET is a temporary and infrastructure-less network. Each node in MANET acts as host as well as router. In MANET, network topologies changes as nodes are movable. Congestion is a serious problem in MANET. Congestion means that when transmission of packets over network is greater than capacity of network then problem of congestion arises. Packets are dropped and network performance decreases due to congestion. Congestion control protocols are Reactive routing protocols (DSR, AODV), Proactive routing protocols (DSDV, OLSR) and Hybrid routing protocols (ZRP). The objective of this paper is to present review on all the researches on congestion control in ad-hoc network till date.***

Keywords: ***MANET, DSR, AODV, AOMDV ZRP, DSDV, OLSR, VANET, INVANET, IMANET, Congestion, Congestion Control.***

I. INTRODUCTION

MANET stands for Mobile Ad-hoc Network. It is a network which has number of mobile nodes that are connected to each other through wireless links. Ad-hoc network refers to a mode of operation of IEEE 802.11 wireless network. It is decentralized type of wireless network. Each node participates in routing by forwarding data to other nodes, so the determination of which node forward data is made dynamically on the basis of network connectivity. In also refers to a network device's ability to maintain link status information for any number of devices. Nodes are not familiar with the topology of their networks. Instead, they have to discover it.

In MANET, there is no fixed infrastructure. The network topologies changes in MANET from time to time as nodes are freely movable according to requirement. In MANET, there is an important issue called routing because of absence of any router. Each node acts as both router and host. Different types of MANET are Vehicular Ad-hoc Network (VANET), Intelligent Vehicular Ad-hoc Network (INVANET) and Internet Based Mobile Ad-hoc Network (IMANET) [1].

Figure1. Mobile Ad hoc Network

Nodes can form any type of topology as nodes can move freely. Topology can be of any type either homogenous or heterogeneous.

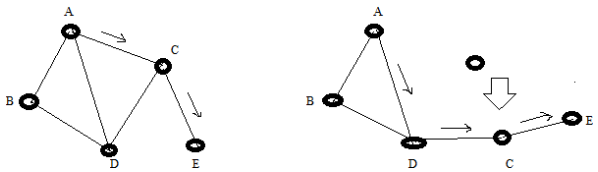

Figure2. Change in Topology due to Movement of node C

The challenges exists in ad-hoc network are security, congestion control, routing, power management, topology control, quality of service etc. Out of all congestion is the most important issue in ad-hoc network. Simply congestion means overcrowding. In ad-hoc network overloading of packets is present at all the nodes which cause loss of packets so data is not successfully delivered at destination.

There are three types of routing protocols in MANET.

A) Proactive/Table – Driven Ad-hoc Routing Protocol

This type of protocols maintains lists of destinations and their routes by periodically distributing routing tables throughout the network. Disadvantages of such algorithms are slow reaction on restructuring and failures and respective amount of data for maintenance. Examples are Optimized Link State Routing Protocol (OLSR) and Destination Sequence Distance Vector (DSDV).

B) Reactive/On-demand Ad-hoc Routing Protocol

This type of protocols finds a route on demand by flooding the network with Route Request packets. The disadvantages of these algorithms are high latency time in route finding and excessive flooding can lead to network clogging. Examples of these algorithms are Ad-hoc on-demand Multipath Distance Vector Protocol (AOMDV), Ad-hoc on-demand Distance Vector (AODV) [2], Dynamic Source Routing (DSR) [3] [4], Flow State in the Dynamic Source Routing [5], Power Aware DSR-based [6].

C) Hybrid Ad-hoc Routing Protocol

These types of routing protocol combine the advantages of both proactive and reactive routing protocols. Disadvantages of such algorithm are its advantage depends on number of other nodes activated and reaction to traffic demand depends on gradient of traffic volume. Examples of hybrid algorithm are Zone Routing Protocol (ZRP).

Congestion Control in MANET

Allocation of resources among collection of users is an important issue. When there are too many packets in queue waiting for transmission contending for same link then situation of congestion arises and packets are dropped. In MANET mobile nodes themselves acts as router. The congestion control methods that use Transmission Control Protocol (TCP) are able to inform the source about congestion problem. TCP congestion control is for each source to determine how much capacity of network is available so that it knows how many packets it can safely transfer. When TCP is used in ad-hoc network it misinterprets the packet losses due to link failure as packet losses due to congestion.
Various congestion control protocols are used. They include slow start, congestion avoidance algorithm, fast retransmit, fast recovery, retransmission mechanism and selective acknowledgement.

Variants of TCP

1) TCP Tahoe

Principle of conservation of packets is implemented in TCP that explained if connection is running at available bandwidth capacity then a packet is not injected into the network until and unless a packet is removed from the network.TCP Tahoe uses slow start and congestion avoidance algorithm. Problem with Tahoe is that it takes a complete timeout interval to detect a packet loss. Also it does not send immediate acknowledgement.

2) TCP Reno

The Reno uses same basic principle of Tahoe as Slow Start and Congestion Avoidance algorithm. Also it adds intelligence over it so that lost packets are detected earlier. It also allows immediate acknowledgement whenever packet is received. Reno uses a new algorithm called Fast Re-transmit. Concept of duplicate acknowledgement is used. Problem with Reno is that it performs well only when packet losses are small.

3) TCP New Reno

New Reno is modification of Reno. It is more efficient than Reno when multiple packet losses occur. It also enters into fast retransmit like Reno but it does not come out from fast recovery phase until all outstanding is acknowledged. Problem with New Reno is that it takes one RTT to detect each packet loss.

4) TCP SACK

TCP with Selective Acknowledgements is an extension of TCP New Reno. It allows receiver to acknowledge out-of-order segments selectively rather than just cumulatively acknowledging the last correctly received in order segment. It retains the Slow Start and Fast Re-transmit part of Reno. It overcomes the problems faced by TCP Reno and TCP New Reno.

5) TCP Vegas

It is different from other variants. It uses new Re-Transmission mechanism, Congestion Avoidance algorithm and modified Slow Start algorithm. It detects congestion before the packet losses occur. It does not depend only on loss of packet as a sign of congestion. It also overcomes the problem of requiring enough duplicate acknowledgements to detect packet loss.

II. LITERATURE REVIEW

Razia Nisar Noorani [2] proposed a scheme for comparison between different congestion control routing protocols in MANET. This consists of simulations that are carried out using Network Simulator-2 (NS-2) with two routing protocols i.e. Ad-hoc On-demand Distance Vector (AODV) and Dynamic Source Routing (DSR) Protocol. Simulation indicates that AODV has low average end to end delay and a better throughput performance as compared to DSR.
S.R. Biradar [3] proposed a technique for Design of Robust Routing Algorithms in MANET that adapt to the frequent and randomly changing network topology. The proposed algorithm contains comparison and evaluation of the

performance of two types of On-demand routing protocols-Ad-hoc On-demand Distance Vector (AODV) routing protocol and Ad-hoc On-demand Multipath Distance Vector (AOMDV) routing protocol. Result shows that AOMDV has more routing overhead and packet delay than AODV but it incurs a better efficiency.

Sunita Nandgave-Usturge [4] designed a routing mechanism in MANET to avoid link failure due to its mobility feature, interference and congestion. Interference occurs due to collision and hidden node. Hidden node interference can be reduced by using RTSCTS-handshake method of 802.11 MAC. This scheme showed that AODV has better congestion avoidance mechanisms.

Lawal Bello [5] described a simulation study of the impact of topology control and traffic models on the performance of Mobile Ad-hoc Wireless Network routing protocol in a dynamic changing topology. Simulation result shows that Constant Bit Rate outperformed TCP (Transmission Control Protocol) in all chosen metrics except for Transmission Control Protocol which was able to handle packet delivery in large topologies than CBR but at the cost of increase in overall delay in the network. Simulation result showed that growth in spurious packet drops in TCP is due to its slow start which invokes its congestion control algorithm.

S.A. Jain [6] ET .al. performed a work "An Improvement in Congestion Control Using Multipath Routing in MANET". Here the author described the ad-hoc connections, which open many opportunities for MANET applications.

Christian Lochert [7] et. al. performed a survey "A Survey on Congestion Control for Mobile Ad-hoc Network". Here author described that the congestion control is a key problem in mobile ad-hoc network.

Essam Natsheh [8] et.al., performed a works "Fuzzy Active Queue Management for Congestion Control in Wireless Ad-hoc Network". In this study, a novel AQM algorithm (Fuzzy- AQM) based on fuzzy logic system was suggested. This algorithm for early packets dropping is implemented in wireless ad-hoc network in order to provide effective congestion control by achieving high queue utilization, low packet losses and delay.

L. khoukhi [9] et al performed a work "Intelligent Solution for Congestion Control in Wireless Ad-hoc Network". Here author presented approach includes a fuzzy logic techniques for buffer threshold management in order to show the ability of fuzzy threshold to adapt to the dynamic condition over the classical flexible thresholds.

Makoto Ikeda [10] proposed TCP Congestion Control for Multiple Traffic in MANET. For network simulation ns-3 network simulator is used considering Ad-hoc On-demand Distance Vector (AODV) and Optimized Link State Routing (OLSR) routing protocols.

S.C. Sharma [11] proposed an analysis to find a finest routing protocol, which can be used to transmit information among all neighbors and thus route establishment. This approach makes it quite challenging to control channel contention problem, redundant rebroadcasts, packet collision and bandwidth congestion.

Stefan Stancescu [12] performed comparative analysis for the best routing protocol for specific application of Wireless Sensor Networks (WSN). The proposed work consists of simulated and tested routing protocols such as proactive DSDV and reactive DSR, AODV and AOMDV protocols in WSN. Parameters like end to end delay, throughput, number of packets received, time of finding the routes, percentage of receiving and normalized routing load are measured and monitored in this work.

Hitesh Gupta [13] performed a survey on routing based congestion control algorithms un Mobile ad-hoc network. In this survey multipath routing and load aware techniques both provide a more reliable as well as load awareness of each node to minimize the data drop but all given approaches use routing based congestion control. In this survey, the congestion control is through dynamic queue management technique and simulation parameters.

Shamurailatpam susanta Sharma [14] describes a comparison of different routing protocols in 4G Mobile Ad-hoc Network. Multimedia real time systems like voice, videoconferencing and data with Quality of service support challenging task MANET. The new generation technology need increase in routing efficiency, security, bandwidth, power consumption, collision control due to mobile nodes for achieving 4G Network and resulting best.

Soundararajan S et al [15] proposed multipath load balancing and 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 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 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 send as a feedback to the sender. The sender performs rate congestion according to the estimated rate obtained from the destination.

Oussama Habachi et al [16] 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 and Multiplicative Decrease) algorithm.

Xiaoqin Chen et al [17] proposed a congestion aware routing protocol for mobile ad hoc network (CARM). This 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.

M. Ali et al [18] 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 increases beyond a threshold, traffic is distributed over multipath routes to reduce the load in the network. This approach achieves better throughput and packet delivery ratio.

III. CONCLUSION

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. Due to congestion performance of the network decreases. So it is necessary to distribute the traffic among mobile nodes. To improve the performance in MANET, it is important to balance the traffic congestion. Main objective of any algorithm is to balance the traffic to increase the throughput of network.

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