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Congestion Control in Mobile Ad Hoc Network: A Review

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ABSTRACT: - Congestion is the serious problem in MANET due to its dynamic or infrastructure less network. In MANET, any number of nodes can join or leave the network. Due to the popularity of the wireless ad hoc network it has become necessary to manage the congestion. It is one of factor by which the quality of the network can be determined. Congestion occurs when transmission of number of packets across the network is greater than the capacity of the network then it is called the network is congested. Various congestion control mechanism has been developed but these are working well for wired network but for the wireless network, they are not working properly. In this paper, a comprehensive review of literature and congestion control techniques is presented.

Keywords: **-** MANETs, Congestion, Wireless Network, Routing

I. INTRODUCTION

MANET [1] [2] is an accumulation of mobile nodes that can cooperate with each other without utilizing wires. In this, nodes inside the transmission range can convey straightforwardly else they can utilize different nodes to send packet (PKT). Organization of MANET is modest and because of this it is the major concern of research. A utilization of MANET reaches from substantial scale portable systems to little, static systems restricted by the power resources. The fundamental objectives of the MANET routing protocols are – maximize network lifetime, energy proficiency, network throughput and delay minimization. To accomplish these objectives, many routing protocols have been proposed for MANETs. The routing protocols in MANETs are categorized into three classes: proactive routing protocols, reactive routing protocols and hybrid routing protocols [3] [4]. A few difficulties confronted by MANET are dynamic topology, requirements on resources, management of data transfer capacity and PKT broadcast overhead, which makes trouble to configuration routing protocols. MANET empowers the change of data among the various detached system or all the more famously portable clients. In MANET every cell phone fills in as a switch and helps each other for effectively conveying the data. Congestion occurs in the network when a node or link carries a large amount of data that degrades the network service quality. Congestion Control is a problem of the network it occurs when there is huge data that the network cannot control anymore. Congestion is a problem for wired and wireless network. Because of congestion problem packet loss, packet delay or lockout can occur in the network [5]. It takes a long time to overcome that situation. There are number of methods or techniques that used to control congestion, for example, exponential back off, congestion control in TCP, priority Schemes, Queue management. Exponential back off is used in CSMA/CA. CSMA/CA is the sensing scheme of 802.11. Whenever senders want to send data they first sense the channel. If the channel is busy it wait for a random amount of particular time and again sense the channel if the channel is free then sender sends data immediately otherwise again sender wait for a particular time. The random period calculated by exponential back off algorithm. Congestion control in TCP consist slow start, congestion avoidance, fast retransmission and recovery. TCP consist a method to control the transmitting rate of the sender. The TCP flow starts at very low level and increases exponential to the threshold. The congestion window increase by one segment whenever a successful transmission happens in TCP flow. When congestion occurs in network Priority scheme marks the packet with different priorities and drop low priority packet when it is needed. It is helpful to improve other methods and priority scheme is not real congestion control method. For congestion control, there is a Queue management which is used to control the queue traffic and to control the queue. In the network, it is a necessity that when several nodes transmit their data to a bottleneck link their needs a queue mechanism to avoid the congestion or to better utilize the network. This paper presents the literature survey and techniques for the congestion control.

1.1 Congestion in MANETs

Congestion is a condition in communication organizes in which an excess of packets are shown in a part of the subnet. Congestion may happen when the load on the system is more well-known than the limit of the system. Congestion prompts packet losses and data transfer ability inducement and waste time and energy on blocking improvement. In Internet when congestion is done it is regularly pay attention on a single switch; because of the imparted midway of the MANET congestion won't overload the elastic nodes yet has an impact on the entire scope area. When the routing protocols in MANET are totally not conscious about the congestion, it brings about the additional issues.

1.1.1 Long delay: This holds up the methodology of locating the congestion. At the point when the congestion is more careful, it is better to choose an interchange way. Anyway the predominating on demand routing protocol defers the route looking for process.

1.1.2 High overhead: More handling and correspondence attempts are preferred for another route exposure. In the event that the multipath directing is used, it wants extra effort for maintaining the multi-ways paying small mind to the being there of interchange route.

1.1.3 Many packet losses: The congestion control method activities to reduce the overload in the system by also reducing the sending rate at the sender part or by dropping the packets at the center nodes or by executing both the procedure. This causes increased packet loss rate or least throughput. The organization of paper is done as follows: Section II presents the Routing Protocols in MANET. In section III former work done by different author/researcher is presented. Congestion control technique is presented in section IV and last section gives overall conclusion and future work of the research work.

II. ROUTING PROTOCOL IN MANET

Routing is an action to move the information from source point to destination point within the network. Routing basically divided into two types: static routing and dynamic routing. Static routing refers to the routing policy being manual. In static routing maintains a routing table by the administrator. Dynamic routing mainly depends upon the state. Mobile ad hoc network present the dynamic routing. These protocols can be divided into three types: proactive protocol, reactive protocol and hybrid protocol. [6]

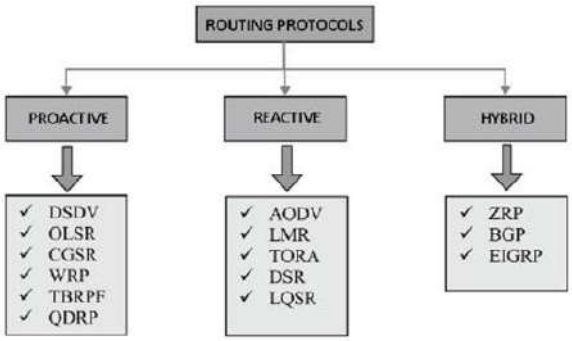

Figure 1. Types of Routing Protocols

2.1 PROACTIVE ROUTING PROTOCOL

With table-driven routing protocols, each node attempts to maintain consistent up to date routing information to every other node in the network. This is done in response to changes in the network by having each node update its routing table and propagate the updates to its neighboring nodes. Thus, it is proactive in the sense that when a packet needs to be forwarded the route is already known and can be immediately used. As is the case for wired networks, the routing table is constructed using either link-state or distance vector algorithms containing a list of all the destinations, the next hop, and the number of hops to each destination. Ex. Destination sequenced distance vector (DSDV).

2.2 REACTIVE ROUTING PROTOCOL

With on-demand driven routing, routes are discovered only when a source node desires them. They do not maintain routing information or routing activity at the network nodes if there is no communication. In contrast to table-driven routing protocols, not all up-to-date routes are maintained at every node. Ex. Ad-hoc On-demand Distance Vector routing (AODV) and Dynamic Source Routing (DSR).

2.3 REACTIVE ROUTING PROTOCOL

A hybrid routing protocol is formed by utilizing the essential feature of reactive and proactive protocol. The best known example of such protocol is Zone Routing Protocol (ZRP)

III. LITERATURE REVIEW

Sarita Simaya et al. [7] introduced an improvement of RED (IRED) algorithm for enhancement of the performance of MANET. RED

uses an Active Queue Management (AQM) to detect the early stage of Cong and convey this to the end hosts. IRED is a Priority Queue based AQM scheme. In this the PKTs are dropped on the basis of PKT arrival rate and the queue length which in turn minimize the effect of network Cong. By using IRED PKT loss rate is minimized.

S. Sheeja et al. [8] introduced an effective congestion avoidance scheme (ECAS) for MANET. Due to movement of nodes in MANET the PKT loss occurs on large scale. ECAS is a mobility based CongClt scheme, that acquires CongClt and flow control among nodes. In this scheme the Cong status is available from Cong monitoring. This scheme obtains a better throughput (TP), PKT delivery ratio (PDR) and low delay.

T. Senthilkumaran et al. [9] introduced dynamic congestion detection and control routing (DCDR) in Ad hoc Networks. In DCDR, AQL is measured at the node level. Simulation shows that DCDR is more desirable in terms of reduction delay and routing overhead. PDR is also improved in DCDR. There are some constraints in DCDR, first if the incoming traffic is heavy than DCDR still suffers from PKT loss and lastly this study did not consider any wireless losses.

Parminder Kaur et al. [10] deep study has been conducted in order to study the factors of reason congestion in an ad hoc wireless network. Our main focus in this report has been to simulate and study the effect of change in topology and number of users on network congestion. Apart from that, the impacts of network congestion and the importance of its study have also been highlighted. Congestion is a critical factor, in determining the quality of network. It also finds out the dependability and sustainability of a network. Deploying new network infrastructure to tackle congestion problem is not economically viable solution, hence it is important to understand the reasons after such network operation conditions and then design suitable methods to overcome them. In this paper, various network behaviors' have been simulated using OPNET Modeler 14.5 to learn how node's buffer space gives impact to the in-flight packets in ad hoc environment by also taking mobility and power consumption into consideration.

Anju et al. [11] aim of the congestion control is to assure that system is running at its rated capability even in worst condition (overload situation). By controlling the rate with which packets are injected in the network, the amount of information that reaches the data sinks minimizes. This fact can jeopardize the purpose of the network. Moreover, network connectivity issues arise since in most cases, this approach utilizes the shortest path from source to sink. Thus, in case of heavy data burden, this path of nodes can easily become power exhausted. To achieve this, author take advantage of the fact that mobile nodes are frequently redundantly and/or densely deployed. In this thesis, author focus on congestion detection and prevent the congestion using Ad hoc on demand routing protocol (AODV) using MATLAB.

Andreas Pitsillides et al. [12] have reviewed existing literature on IP and ATM congestion control. We have presented an illustrative example of using CI intelligence to control congestion using Fuzzy Logic. This and the literature we review on CI methods applied to ATM networks show that CI can be effective in the control of congestion. There is no doubt that we will see more and more use of these techniques, including their use in the IP world. We also expect that, as in other commercial products, CI techniques will finally make it into real products in this area, and we expect with tremendous success.

Dewariya et al. [13] proposed work the performance the existing compound TCP for wireless scenario is improved upgrade TCP give satisfactory result in high speed huge network. Upgrade TCP is a TCP for fast speed and huge network. Upgrade TCP execute congestion control with the help of a combination of open congestion window or delay based method, for transmission data or packet or mutual understanding among all sender or receiver we apply synchronization in TCP handshaking mechanism. In our propose work, we explain working of upgraded TCP. The simulation depicts that, the results of proposed approach is better than base approach. The congestion window of proposed approach is better and the good put of proposed approach is higher than base good put.

Youssef Bassil et al. [14] proposed a TCP congestion control scheme comfortable for wireless as well as system atmospheres. It is created by using any particular minute of the reticent minutes of the TCP legend to designate the variety of the connection above which a construction is recognized. If the connection is

bound, the TCP reticent bit is fixed to 0 signifying a bound way; while, if the connection is wireless, the minute is fixed to 1 signifying a wireless way. Moreover, the system usages the SNR (Signal-to-Noise) part of perceiving the consistency of the association. In wired mode, any recreation is reflected a cramming defeat; and hence, cramming is evaded by exhausting the usual TCP start-slow procedure.

Aalam et al. [15] this research directs the problems in routing of CRAHNS; particularly this research provides the optimum solution for traffic management in CRAHNS. Obtaining the optimum solution this work analyzes Jackson and Feiler theorem equations further to make it more efficient, the Lagrangian multiplier approach is utilized, and some unique mathematical expressions are derived for computing the minimum value of the congestion of the available paths of the CRAHNs. The MATLAB simulation is conducted and the results show that the proposed expressions are obtained optimum congestion value and the best path is opted based on the vale for transferring of data.

IV. CONGESTION CONTROL TECHNIQUES

Congestion control refers to the mechanism and techniques to control the congestion and keep the load below the capacity. It is a mechanism that can either prevent congestion, before it happens, or remove congestion, after it has happened. The objective of congestion control is to maintain the number of packets within the network below the level at which performance falls off dramatically. Due to the unpredictable fluctuations and burstiness of traffic flows within high speed network congestion can occur frequently. So we need efficient congestion control technique.

4.1 Adaptive Congestion Control [16]

Adaptive congestion control is a mechanism with learning capability. This learning capability enables the mechanism to adapt to dynamically changing network conditions to maintain stability and good performance. In this a feedback is send to the sender to change sending rate, according to the current network conditions. It is scalable with respect to changing delays, bandwidth and number of users utilizing the network. ACP is characterized by its learning capability which enables the protocol to adapt to the highly dynamic network environment to maintain stability and good performance. This learning capability is materialized by a novel estimation algorithm, which "learns" about the number of flows utilizing each link in the network. Previous experience in the design of congestion control algorithms has shown that at each link, the number of flows utilizing the link is necessary in order to maintain stability in the presence of delays.

4.2 Rate Control Protocol [16]

Rate Control Protocol (RCP) is a congestion control algorithm designed for fast download times. RCP is designed for the typical flows of typical users in the Internet today. RCP has two components: (1) End-host congestion control layer that sits between IP and TCP/UDP. During introduction, the end-host could adapt by testing for RCP at each end and along the path, falling back to TCP if need-be. (2) Each router maintains a single fair-share rate per link.

4.3 Explicit Congestion Control Protocol [16]

XCP is a window based congestion control protocol intended for best effort traffic. Senders maintain their congestion window and RTT and communicate this to routers via a congestion header in every packet. Sender uses the feedback field in the congestion header to request its desired window increase. Routers monitor the input traffic rates to each of their output queues. Based on the difference between the link bandwidth and its input traffic, router tells the flows sharing that link to increase or decrease their congestion window.

4.4 CBRRT (Congestion Based Route Recovery Technique) [17]: In this technique, each node estimates the parameters such as queue length, data rate, and medium access control (MAC) contention. The upper and lower limit of these parameters is compared and node is marked with the congestion status such as normal, medium or high level. When data is to be transmitted from the source to destination, the intermediate nodes along the path verify its congestion status. If the congestion status of any one node is high or congestion status of more than one node is medium, a warning message will be sent to the source. The source then selects the alternate congestion free path for data transmission. Congestion status of node can be categorized into 3 states: Normal (N), High (H) and Low (L). In this paper, three parameters are defined to control the congestion that is: Average queue length (Lq), Incoming Data Rate (Rin) and

MAC Contention (TMAC). This technique minimizes the packet drop and delay while increasing the packet delivery ratio.

4.5 CA-AODV (Congestion Adaptive AODV) [18] CA-AODV is mainly designed to ensure for availability of primary routes as well as alternative routes and control the routes overhead. If congestion happens at any point of time between source and destination nodes n primary route, concerned node warns its previous node about congestion. The previous node uses a non congested alternative route to destination node. In this approach three steps are mainly used: Congestion Setup, Route Discovery and Route Maintenance Process. In congestion Setup Process, average discovery time and delay is to be calculated. In Route discovery process, based on congestion status route request is to send and in route maintenance process if any broken route find then route error message is to be generated. So this approach, this technique gives better overhead, less delay and less packet loss.

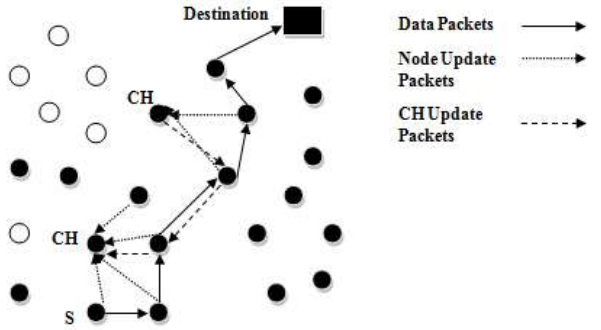

Figure 2 CBCC Network Structure

4.6 CBCC (Cluster Based Congestion Control) [21] A Cluster Based Congestion Control (CBCC) protocol that consists of scalable and distributed cluster-based mechanisms for supporting congestion control in ad-hoc networks. The distinctive feature of our approach is that it is based on the self-organization of the network into clusters. The clusters autonomously and proactively monitor congestion within its localized scope .This protocol consists of clustering mechanism, traffic rate estimation and traffic rate adjustment. By exchanging small amount of control packets along the paths, adjustment of node rates and co-operation between cluster nodes are achieved. Clustering helps to determine the interactions between the flows. In CBCC network structure, nodes in the network are grouped into clusters. Message exchanges consist of regular data packets, intra {node update packets) and inter (cluster head update packets). Nodes within a cluster periodically report their locally computed estimation of the traffic load. This information is processed by the cluster head and a collective cluster level load estimate is communicated to the cluster heads towards the source. When compared to end to- end techniques, our approach improves the responsiveness of the system.

4.7. CFR (Congestion Free Routing) [19]: In CFR, dynamic mechanism defined used to monitor the congestion by calculating average queue length at node level. While using the average queue length, the nodes' congestion status divided into the three zones (safe zone, likely to be congested zone and congested zone). CFR utilizes the non-congested neighbors and initiates route discovery mechanism to discover a congestion free route between source and destination. This path becomes a core path between source and destination. To maintain the congestion free status, the nodes which are helping data packet transmission periodically calculate their congestion status at the node level. The predecessor core path node is aware of this situation and initiates an alternate path discovery mechanism to a destination. Finally it discovers a new congestion free route to the destination. So CFR improved packet delivery ratio, reduction of End to End delay and control packets.

4.8 ABCC (Agent Based Congestion Control Protocol) [20]: In this technique, the information about network congestion is collected and distributed by mobile agents (MA). A mobile agent based congestion control AODV routing protocol is proposed to avoid congestion in ad hoc network. Some mobile agents are collected in ad-hoc network, which carry routing information and nodes congestion status. When mobile agent movements through the network, it can select a less-loaded neighbor node as its next hop and update the routing table according to the node's congestion status. With the support of mobile agents, the nodes can get the dynamic network. The MA brings its own history of movement and updates the routing table of the node it is visiting. The MA updates the routing table of the node it is visiting. In this technique, the node is classified in one of the four categories depending on whether the traffic belongs to

background, best effort, video or voice AC respectively.

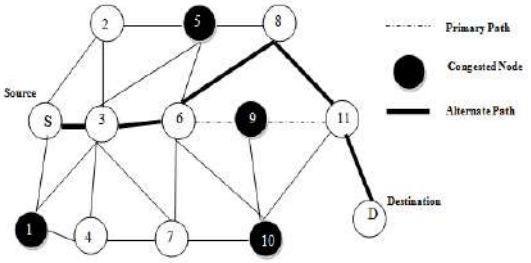

Figure 3 Alternate path finding process in CFR

Then MA estimates the queue length of the various traffic classes and the channel contention of each path. Then this total congestion metric is applied to the routing protocol to select the minimum congested route in the network. This proposed technique attains high delivery ratio and throughput with reduced delay.

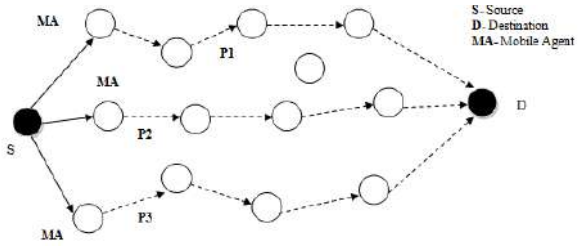

Figure 4 Agent Based Congestion Routing Structure

4.9 Congestion Aware Routing (CAR) [22]

Ye et al. proposed Congestion Aware Routing (CAR). This approach modifies routing based on the distributed congestion information, to separate TCP flows spatially. In this approach the author has proposed two solutions, centralized CAR (CCAR) and distributed (DCAR). In centralized approach, every node is assumed to be updated with the information about the source, destination and the route of each TCP flow. In distributed approach every node, depending on the load condition, computes a congestion weight. This information is shared with its neighboring nodes. A modified Ad-hoc On-Demand Distance Vector (AODV) routing is adopted for route discovery. Both these approaches surpass the shortest path routing protocol in terms of throughput for longer paths. The centralized approach performs better than distributed approach and is preferred for shortest path, when distributed approach fails. It is observed by the author that, the performance of DCAR, compared to that of CCAR is poorer due to outdated congestion information.

V. CONCLUSION

Wireless ad hoc network gaining very much popularity for the transmission of packets due to this the load on the network increases. When more no. of packet is transmitted together than the capacity of the network then congestion occurs and packet dropping started due to this the performance of network degraded. The congestion control can improve the packet delivery ration and decreases the delay and packet loss. In this a comprehensive review and congestion control techniques is presented. There are different issues that need to be met, so these networks are going to have pervasive exercise in the prospect.

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