Congestion Aware and Control routing in Mobile Ad-hoc Networks: Current State of the Art

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Abstract—With the increase of multimedia traffic over the past few years and traffic differentiation introduced by IEEE 802.11e, nodes with packet loss, delay-sensitive multimedia traffic tend to be busy for long periods, thus exacerbating the congestion problem in mobile ad hoc networks (MANETs). In this paper, we first expose that the performance of MANETs routing protocols is highly dependent on the type of traffic generated or routed by intermediate nodes and also recent inventions and updates in congestion aware and control routing in mobile ad hoc networks.

Keywords— Mobile ad hoc network, congestion, QOS

I. INTRODUCTION

With the fast moving and increasing population the developments in the communications has also increased, and this demanded for the mobility in communications led to mobile Ad Hoc Networks [MANETS] and I would like to present their implementation with the routing protocols along with the new methods for saving power consumption, cost and also increasing the efficiency of transmission. MANETS is rather a group of nodes which form a wireless network where transmission of data takes place between 2 nodes. In these two, one sends the message where as the other receives MANETS are infrastructure free and they create their own connected network of nodes at that particular instant of time. So, these are self adaptive and self organized networks particularly for WLANS and WLLS etc. Factors like transmitted power, receiver sensitivity and propagation loss the effect the transmission range where as this is handled dynamically by constructing a network which forwards the packets of data through multihop paths where nodes and routers are free to move randomly.

Apart from these advantages there are some hurdles which are needed to be focused on like:

Restricted Bandwidth: The network capacity is relatively less than the total application demand when compared with that of the wired communications.

Lapse in physical security: Here, transfer of data takes place blindly by mutual trust relationship between nodes. So, wireless network provides fast and free access to many applications like distributed mobile computing to disaster recovery, law reinforcement and military communications.

Non-period link capacity: This effect is observed during high bit transmission rate and there is also high error rate in WLAN compared to Wired.

Fixed energy resources: MANETS get their power from time limited batteries so power consumption mechanisms involving algorithms and protocols must efficiently designed by Making the nodes to hibernate when not in use, Selection of routing path for minimal consumption, Reduction in networking overhead, Selection of nodes depending on energy status.

II. ASSORTMENT OF ROUTING PROTOCOLS FOR AD-HOC MOBILE NETWORKS

An ad hoc routing protocol [12] is a convention, or standard, that controls how nodes decide which way to route packet between computing devices in a mobile ad hoc network. Here nodes do not start out familiar with the topology of their networks; instead, they have to discover it. The basic idea is that a new node may announce its presence and should listen for announcements broadcast by its neighbors. Each node learns about nodes nearby and how to reach them, and may announce that it, too, can reach them. The factors of consideration for designing are: Minimum route acquisition delay, Quick route reconfiguration in the case of path breaks, Loop-free routing, Distributed routing protocol, Low control overhead, Scalability with network size, QoS support as demanded by the application, Support of time-sensitive traffic, Security and privacy.

The following is a list of some ad hoc network routing protocols like table driven (proactive), on demand (reactive) and hybrid routing protocol.
A. Table Driven Routing Protocols: In Table-driven routing protocols [3] each node maintains one or more tables containing routing information to every other node in the network. All nodes update these tables so as to maintain a consistent and up-to-date view of the network. When the network topology changes the nodes propagate update messages throughout the network in order to maintain consistent and up-to-date routing information about the whole network. These routing protocols differ in the method by which the topology change information is distributed across the network and the number of necessary routing-related tables. The following sections discuss some of the existing table-driven ad hoc routing protocols.

The Destination-Sequenced Distance-Vector (DSDV) [9] Routing Algorithm: It is based on the idea of the classical Bellman-Ford Routing Algorithm with certain improvements. Every mobile station maintains a routing table that lists all available destinations, the number of hops to reach the destination and the sequence number assigned by the destination node. The sequence number is used to distinguish stale routes from new ones and thus avoid the formation of loops. The stations periodically transmit their routing tables to their immediate neighbors. A station also transmits its routing table if a significant change has occurred in its table from the last update sent. So, the update is both time-driven and event-driven. The routing table updates can be sent in two ways - a "full dump" or an incremental update. A full dump sends the full routing table to the neighbors and could span many packets whereas in an incremental update only those entries from the routing table are sent that has a metric change since the last update and it must fit in a packet.

Wireless Routing Protocol (WRP): The Message Retransmission list (MRL) contains information to let a node know which of its neighbor has not acknowledged its update message and to retransmit update message to that neighbor. The nodes present on the response list of update message (formed using MRL) are required to Acknowledge the receipt of update message. If there is no change in routing table since last update, the node is required to send an idle Hello message to ensure connectivity. On receiving an update message, the node modifies its distance table and looks for better paths using new information. Any new path so found is relayed back to the original nodes so that they can update their tables. The node also updates its routing table if the new path is better than the existing path. On receiving an ACK, the node updates its MRL. A unique feature of this algorithm is that it checks the consistency of all its neighbors every time it detects a change in link of any of its neighbors. Consistency check in this manner helps eliminate looping. Situations in a better way and also have fast convergence.

Global State Routing (GSR)[12]: It takes the idea of link state routing but improves it by avoiding flooding of routing messages. The routing messages are generated on a link change as in link state protocols. On receiving a routing message, the node updates its Topology table if the sequence number of the message is newer than the sequence number stored in the table. After this the node reconstructs its routing table and broadcasts the information to its neighbors.

Landmark Ad Hoc Routing (LANMAR): LANMAR reduces the control overhead largely through the truncation (i.e., scoping) of local routing tables and the "summarization" of routing information to remote groups of nodes. The above features reduce line and processing O/H and thus greatly improve routing scalability to large, mobile ad hoc networks. As a final note, we must stress that the LANMAR addressing and routing scheme has significance only within the ad hoc network (e.g., battlefield). Each node has also an IP address, which is distinct from the LANMAR address.

Fisheye State Routing: Fisheye State Routing (FSR) is an improvement of GSR. The large size of update messages in GSR wastes a considerable amount of network bandwidth. In FSR, each update message does not contain information about all nodes. Instead, it exchanges information about closer nodes more frequently than it does about farther nodes thus reducing the update message size. So each node gets accurate information about neighbors and the detail and accuracy of information decreases as the distance from node increases.

Optimized Link State Routing Protocol: OLSR protocol, at each node discovers 2-hop neighbor information and performs a distributed election of a set of multipoint relays (MPRs). Nodes select MPRs such that there will be a path to each of its 2-hop neighbors via a node selected as an MPR. These MPR nodes then source and forward TC messages that contain the MPR selectors. This functioning of MPRs makes OLSR unique from other link state routing protocols in a few different ways: The forwarding path for TC messages is not shared among all nodes but varies depending on the source, only a subset of nodes source link state information, not all links of a node are advertised but only those that represent MPR selections.

Hierarchical State Routing: The characteristic feature of Hierarchical State Routing (HSR) is multilevel clustering and logical partitioning of
mobile nodes. The network is partitioned into clusters and a cluster-head elected as In a cluster-based algorithm. In HSR, the cluster-heads again organize themselves into clusters and so on. The nodes of a physical cluster broadcast their link information to each other.

Zone-based Hierarchical Link State Routing Protocol: In ZHLS, the network is divided into non-overlapping zones. Unlike other hierarchical protocols, there is no zone-head. ZHLS defines two levels of topologies - node level and zone level. A node level topology tells how nodes of a zone are connected to each other physically. A virtual link between two zones exists if at least one node of a zone is physically connected to some node of the other zone. Zone level topology tells how zones are connected together.

Cluster head Gateway Switch Routing Protocol: CGSR uses as basis the DSDV Routing algorithm. The mobile nodes are aggregated into clusters and a cluster-head is elected. All nodes that are in the communication range of the cluster-head belong to its cluster. A gateway node is a node that is in the communication range of two or more cluster-heads. In a dynamic network cluster head scheme can cause performance degradation due to frequent cluster-head elections, so CGSR uses a Least Cluster Change (LCC) algorithm. In LCC, cluster-head change occurs only if a change in network causes two cluster-heads to come into one cluster or one of the nodes moves out of the range of all the cluster-heads.

B. On-Demand Routing Protocols: These protocols take a lazy approach to routing [12]. In contrast to table-driven routing protocols all up-to-date routes are not maintained at every node, instead the routes are created as and when required. When a source wants to send to a destination, it invokes the route discovery mechanisms to find the path to the destination. The route remains valid till the destination is reachable or until the route is no longer needed. The following are a few on-demand routing protocols:

Cluster based Routing Protocol: In Cluster Based Routing protocol (CBRP) the nodes are divided into clusters. To form the cluster the following algorithm is used. When a node comes up, it enters the "undecided" state, starts a timer and broadcasts a Hello message. When a cluster-head gets this hello message it responds with a triggered hello message immediately. When the undecided node gets this message it sets its state to "member". If the undecided node times out, then it makes itself the cluster-head if it has bi-directional link to some neighbor otherwise it remains in undecided state and repeats the procedure again. Cluster heads are changed as infrequently as possible.

Ad hoc On-demand Distance Vector Routing: Ad hoc On-demand Distance Vector Routing (AODV) is an improvement on the DSDV algorithm. AODV minimizes the number of broadcasts by creating routes On-demand as opposed to DSDV that maintains the list of all the routes. To find a path to the destination, the source broadcasts a route request packet. The neighbors in turn broadcast the packet to their neighbors till it reaches an intermediate node that has recent route information about the destination or till it reaches the destination. A node discards a route request packet that it has already seen. The route request packet uses sequence numbers to ensure that the routes are loop free and to make sure that if the intermediate nodes reply to route requests, they reply with the latest information only.

Dynamic Source Routing Protocol: The Dynamic Source Routing Protocol [23] is a source-routed on-demand routing protocol. A node maintains route caches containing the source routes that it is aware of. The node updates entries in the route cache as and when it learns about new routes. The two major phases of the protocol are: route discovery and route maintenance. When the source node wants to send a packet to a destination, it looks up its route cache to determine if it already contains a route to the destination. If it finds that an unexpired route to the destination exists, then it uses this route to send the packet. But if the node does not have such a route, then it initiates the route discovery process by broadcasting a route request packet.

Temporally Ordered Routing Algorithm: The Temporally Ordered Routing Algorithm (TORA) is a highly adaptive, efficient and scalable distributed routing algorithm based on the concept of link reversal. TORA is proposed for highly dynamic mobile, multihop wireless networks. It is a source-initiated on-demand routing protocol. It finds multiple routes from a source node to a destination node. The main feature of TORA is that the control messages are localized to a very small set of nodes near the occurrence of a topological change. To achieve this, the nodes maintain routing information about adjacent nodes. The protocol has three basic functions: Route creation, Route maintenance, and Route erasure.

Associatively Based Routing: ABR defines a new metric for routing known as the degree of association stability. It is free from loops, deadlock, and packet duplicates. In ABR, a route is selected based on associatively states of nodes. The routes thus selected are liked to be long-lived. All node generate periodic beacons to Signify its existence. When a neighbor
node receives a beacon, it updates its associatively tables. For every beacon received, a node increments its associatively tick with respect to the node from which it received the beacon.

Signal Stability Routing: Signal Stability-Based Adaptive Routing protocol (SSR) presented is an on-demand routing protocol that selects routes based on the signal strength between nodes and a node’s location stability. This route selection criterion has the effect of choosing routes that have “stronger” connectivity. SSR comprises of two cooperative protocols: the Dynamic Routing Protocol (DRP) and the Static Routing Protocol (SRP). The DRP maintains the Signal Stability Table (SST) and Routing Table (RT). The SST stores the signal strength of neighboring nodes obtained by periodic beacons from the link layer of each neighboring node. Signal strength is either recorded as a strong or weak channel. All transmissions are received by DRP and processed. After updating the appropriate table entries, the DRP passes the packet to the SRP.

III. UNDERSTANDING CONGESTION IN WIRELESS NETWORKS

The occurrence of a high density of nodes within a single collision domain of a wireless network can result in congestion, thereby causing a significant performance bottleneck. Effects of congestion include drastic drops in network throughput, unacceptable packet delays, and session disruptions. In contrast, the back-haul wire line portion of a wireless network is typically well provisioned to handle the network load. Therefore, there arises a compelling need to understand the behavior of the wireless portion of heavily utilized and congested wireless networks. [6]

Acknowledgments for data sent, or lack of acknowledgments, are used by senders to infer network conditions between the TCP sender and receiver. Coupled with timers, TCP senders and receivers can alter the behavior of the flow of data. This is more generally referred to as congestion control and/or network congestion avoidance.

In addition, senders employ a retransmission timeout (RTO) that is based on the estimated round-trip time (or RTT) between the sender and receiver, as well as the variance in this round trip time. There are subtleties in the estimation of RTT. For example, senders must be careful when calculating RTT samples for retransmitted packets; typically they use Karn’s Algorithm or TCP timestamps. These individual RTT samples are then averaged over time to create a Smoothed Round Trip Time (SRTT) using Jacobson’s algorithm. This SRTT value is what is finally used as the round-trip time estimate.

IV. CHALLENGES FOR TCP IN MANETS

TCP assumes that network congestion has happened whenever a packet is lost. It then invokes appropriate congestion control actions including window size reduction. Although this assumption is reasonable for wired networks; it is questionable for wireless networks especially MANETs. The main causes of errors in wireless channels are the following:

- Signal attenuation: This is due to a decrease in the intensity of the electromagnetic energy at the receiver (e.g. due to long distance), which leads to low signal-to-noise ratio (SNR).
- Doppler shift: This is due to the relative velocities of the transmitter and the receiver. Doppler shift causes frequency shifts in the arriving signal, thereby complicating the successful reception of the signal receiver.
- Path asymmetry: Path asymmetry in ad hoc networks may appear in several forms as bandwidth asymmetry, loss rate asymmetry, and route asymmetry.
- Route failures: In MANETs route failures are frequent events. The main cause of route failures is node mobility. Another factor that can lead to route failures is the link failures caused by the contention on the wireless channel, which is the main cause of TCP performance degradation.
- Energy efficiency: As power is limited at mobile nodes, any successful scheme must be designed to be energy efficient. In some scenarios where battery recharge is not allowed, energy efficiency is critical for prolonging network lifetime. Because batteries carried by each mobile node have limited power supply, processing power is limited.

V. CURRENT STATE OF THE ART

Duc A. Tran et al.[10] published a research paper on Congestion Adaptive Routing in Mobile Ad Hoc Networks. In this context they argued that Mobility, channel error, and congestion are the main causes for packet loss in mobile ad hoc networks. Reducing packet loss typically involves congestion control operating on top of a mobility and failure adaptive routing protocol at the network layer. In the current designs, routing is not congestion-adaptive. Routing may let a congestion happen which is detected by congestion control, but dealing with congestion in this reactive manner results in longer delay and unnecessary packet loss and requires significant overhead if a new route is needed. This problem becomes more visible especially in large-scale transmission of heavy traffic such as multimedia data.
where congestion is more probable and the negative impact of packet loss on the service quality is of more significance. We argue that routing should not only be aware of, but also be adaptive to, network congestion. Based on this argument Duc A. Tran et al [10] proposed a routing protocol (CRP) with such properties.

CRP Overview: Congestion Adaptive Routing protocol (CRP) is a unicast routing protocol for MANETs. The preliminary concepts of the CRP explored in their earlier work. In proposed CRP, every node appearing on a route warns its previous node when prone to be congested. The previous node uses a “bypass” route for bypassing the potential congestion area to the first non-congested node on the primary route. Traffic is split probabilistically over these two routes, primary and bypass, thus effectively lessening the chance of congestion occurrence. CRP is on-demand and consists of the following components: Congestion monitoring, primary route discovery, Bypass discovery, Traffic splitting and adaptive congestion, Multipath minimization, and Failure recovery.

A bypass is a sub-path connecting a node and the next non-congested node. If a node is aware of a potential congestion ahead, it finds a bypass that will be used in case the congestion actually occurs or is about to. Part of the incoming traffic will be sent on the bypass, making the traffic coming to the potentially congested node less. The congestion may be avoided as a result. Because a bypass is removed when the congestion is totally resolved, CRP does not incur heavy overhead due to maintaining bypass paths. The bypass maintenance cost is further reduced because a bypass is typically short and a primary node can only create at most one bypass.

Observation: Since CRP attempted to prevent congestion from occurring in the first place, rather than dealing with it reactively, it experienced fewer packet losses than routing protocols that are not adaptive to congestion. A key in CRP design is the bypass concept. A short end-to-end delay is also provided by CRP. Indeed, since CRP makes the network less congested, the queuing delay is less. Furthermore, since recovery of a link breakage is realized gracefully and quickly by making use of the existing bypass paths, the delay due to new-route establishment is also low. The simulation results indicated the advantages of CRP over AODV and DSR in routing and energy efficiency.

Santhosh Baboo et al [7] argued that congestion with limited resources occurs in heterogeneous mobile ad hoc networks (MANETs). Packet transmissions suffer from interference and fading because of the shared wireless channel and dynamic topology. In heterogeneous ad hoc networks, throughput via a given route depends upon the minimum data rate of its entire links. In a route of links with various data rates, there is a chance of congestion if a high data rate node passes more traffic to a low data rate node and this leads to long queuing delays in such routes. The conventional hop count routing metric does not adapt well to mobile nodes. The transmission capability, reliability and congestion around a link are included in a congestion-aware routing metric for MANETs. In the context of this argument Santhosh Baboo et al[7] proposed an energy efficient congestion aware routing protocol which uses a combined weight values as a routing metric. This proposed protocol is based on the data rate, queuing delay, link quality, residual energy and MAC overhead. The energy efficiency is justified since the route with minimum cost index is selected among the discovered routes, which is based on the node weight of all the in-network nodes.

Overview of the protocol [7]:A congestion-aware routing metric for MANETs should incorporate transmission capability, reliability, and congestion around a link. The proposed energy efficient congestion aware routing protocol (EECARP) employed the following routing metrics: Data-rate, Buffer queuing delay, Link Quality, Residual Energy, MAC Overhead. These metrics were used to find and prefer less congested high throughput links to improve channel utilization. After estimating the above metrics, a combined weight value will be calculated for each node. A multi path on-demand routing protocol, which discovers multiple disjoint routes from a source to destination is used as under lying protocol. Among the discovered routes, the route with minimum cost index will be selected, which is based on the node weight of all the in-network nodes for each packet successfully delivered from the source node to the destination node. The node’s cost index will be calculated in a backward propagating way. The cost indices of a node’s possible downstream neighbors are obtained by the feedbacks of its downstream neighbors.

Observation: The proposed energy efficient congestion aware routing protocol employs a combined weight value as a routing metric, based on the data rate, queuing delay, link quality, residual energy and MAC overhead. A multipath on demand routing protocol used as under lying routing protocol that discovers multiple disjoint routes from a source to destination. Among the discovered routes, the route with minimum cost index is selected, which is based on the node weight of all the in-network nodes from the source node to the destination node. By simulation results explored, indicating that the proposed routing protocol attains high throughput and
packet delivery ratio, by reducing the energy consumption, packet drop and delay.

Yuvaraju, B.N et al[4] proposed a protocol independent congestion control method in short can refered as PICCO, which uses mobile relays. In the context of the proposed method, they argued that the limited lifetime of batteries and the bandwidth limitation of channels are the major issues in Ad-hoc networks. The term Congestion is usually associated with the bandwidth issues. The bandwidth keeps varying and when there is insufficient bandwidth to satisfy the demand, hence there is congestion problem. Congestion control methods are partially implemented in the network elements (e.g.; routers) inside the network and partially in the transport protocols running on the end hosts. All congestion control methods were developed depending on the underlying transport protocol TCP and hence cannot be used when the underlying transport protocol changes to UDP. In real time applications, where UDP is mostly used with Real time Transport Protocol (RTP), lost data packets cannot be resent. So it becomes all the more critical to have a proper congestion control method which can be used by UDP as well. Hence the PICCO method to solve the congestion problem can be implemented only in the network elements and is independent of the underlying transport protocols and can be used for TCP as well as UDP. This method aimed to reduce the number of packets being dropped in the network, thus improving the overall performance of the network.

Overview of Picco [4]: The proposed idea is based on Ad-hoc networks where the nodes themselves act as the routers (network elements). As and when the node becomes congested (starts dropping the packet due to queue overflow), it calls for the service of a mobile relay [9]. The mobile relay shares the load of the congested node. As and when the load on the congested node reduces to efficient level, the mobile relay is released so that it can provide service to other congested nodes in the network. This method reduces the number of packets being dropped in the network, thus improving the overall performance [14] of the network. The two assumptions in this method are that every node in the network is capable of calling the service of a mobile relay and that mobile relay has sufficient queue size to provide service to the congested nodes in the network.

Observation: The PICCO is based on Ad-hoc networks where the nodes themselves act as the routers (network elements). This method to solve the congestion problem can be implemented only in the network elements (e.g.; routers, etc) and is independent of the underlying transport protocols. Hence this congestion control method can be used for Transmission Control Protocol (TCP) as well as User Datagram Protocol (UDP). This method aimed to reduce the number of packets being dropped in the network, thus improving the overall performance of the network. The lack of an Ad-hoc Networks capacity theory has stunted the development and commercialization of many types of wireless networks including emergency, military, sensor and community mesh networks. Information theory, which has been vital for links and centralized networks, has not been successfully applied to decentralized wireless networks [4]. PICCO acts as a probe to analyze the performance of these decentralized wireless networks.

Raza.I et al[5] proposed a model called Congestion Aware Nodes based scheme, which is using cross layer design to exchange congestion statistics between Media Access Control (MAC) layer and routing layer. The parameters used by CAN based scheme for congestion detection at MAC layer are MAC overhead, packet retransmission, back off interval and queuing delay. This scheme is based on CAN and implemented at MAC Layer for Dynamic Source Routing (DSR) protocol. Raza.I et al[41] argued that TCP congestion detection and avoidance mechanism in ad hoc networks is vulnerable to spurious congestion attacks and acclaimed fallowing two reasons for implementing CAN based scheme at MAC layer.

1) The channel conditions can be monitored effectively by continuously observing contention window, queuing delay and overhead at MAC layer.
2) The TCP congestion detection and avoidance mechanism will not be triggered as congestion will be handled at MAC layer, resulting in better end-to-end throughput.

Observation: CAN is implemented at MAC layer and it monitors different MAC layer parameters such as MAC overhead, packet retransmissions, back off intervals and queuing delay to detect congestion. Each node after detecting congestion passes the congestion information to routing layer which selects alternate paths and removes congested links from the route cache. CAN is implemented on each node to handle congestion locally. This property seems to be avoiding transmission of control overhead messages. The explored simulation results indicating that DSR with proposed CAN based scheme capability in presence of congestion has high throughput gain, low access delay, less data drop rate, less packet retransmissions and less number of back off intervals. But on contradict side this model is not considering the energy efficiency, which is critical issue in ad hoc network infrastructure.
T. Senthil kumaran et al[2] proposed an early congestion detection and optimal control routing in MANET called as EDOCR. The proposed EDOCR initially segregates network into to sparse and dense region by using mean of neighbors. After segregation of networks, it initiates an optimal route discovery process to find a route to destination. This optimal route discovery is reducing the RREQ overhead during the route discovery operation. All the primary path nodes periodically calculate its queue status at node level. While using early congestion detection technique, node detects congestion that is likely to happen and sends warning message to Neighbors. Then EDOCR utilizes the non-congested predecessor node of a congested node and initiates optimal route discovery process to find an alternate non-congested path for a destination. In the context of EDOCR proposal T. Senthil kumaran et al[2] argued that in ad hoc networks, broadcast storm and congestion are major issues listed below.

First During route discovery, conventional on demand route discovery methods in mobile ad hoc networks (MANET) employ simple flooding method, where a mobile node blindly rebroadcasts received route request (RREQ) packets until a route to a particular destination is established, it is usually costly and results in serious redundancy, contention and collisions in the network. These problems are widely referred to as the broadcast storm problem.

Second, Congestion occurs in any intermediate node when data packets travel from source to destination and they incur high packet loss and long delay, which cause the performance degradations of a network.

The performance of EDOCR was compared with EDAODV, EDCSCAODV and AODV using the Ns-2 simulator. Based on the simulation results the authors justified the significant improvement of EDOCR over EDAODV, EDCSCAODV and AODV routing schemes.

Overview of the EDOCR [2]: Early congestion detection and optimal control routing protocol (EDOCR) is a uni-cast routing protocol for MANET. In EDOCR, every node appearing on a route warns its neighbor nodes when prone to be congested. The congested nodes’ neighbors when aware of this situation, try to find an alternate path with limited number of control packets by using optimal control routing. EDOCR consists of the following components: Network Classification, Optimal Route discovery, Early congestion detection, Alternate path Discovery. In EDOCR, a node every second checks the occupancy of its link-layer queue by using an early congestion detection technique to detect the congestion well in advance. An early congestion detection technique is a queue management algorithm with an optimization of random early detection (RED) model that makes use of direct measurement congestion status well in advance in a network.

Observation: The proposed EDOCR to accomplish congestion control in wireless multihop networks attempted to detect congestion in advance from occurring in the first place, rather than dealing with it reactively. The ancestor node is aware of a potential congestion ahead. It efforts to find a non-congested route between source and destination helps to control the congestion as a result. The efforts of EDOCR design to avoid the brute force attitude of simple flooding which causes very high overhead can be observable at large dense networks. EDOCR design boosted with optimal route discovery method for reducing the RREQ overhead during the route discovery operation, which helps not to incur heavy overhead to find non-congested paths. The simulation results explored indicated that this technique substantially reduces the overhead as compared to the existing flooding mechanism and also provided a short end-to-end delay compared to other techniques.

Chen, R.R et al [6] proposed A ”Markovian Jump Congestion Control Strategy for Mobile Ad-Hoc Networks with Differentiated Services Traffic” to model the changes in the number of neighboring nodes and subsequently a Markovian Jump Congestion Control (MJCC) strategy is proposed for mobile ad hoc networks. The MJCC strategy does take into account the associated physical network resource limitations and is shown to be robust to the existing unknown and time-varying network delays. Furthermore, the MJCC controller is developed on the basis of Differentiated Services (Diff-Serv) architecture by utilizing a robust adaptive technique. A Linear Matrix Inequality (LMI) condition is obtained to guarantee the stochastic stability of the closed-loop system.

Overview of the MJCC [6]: The ordinary traffic controller needs to simultaneously regulate the incoming flow rate and allocate its capacity by also using an adaptive controller. Finally, for the best effort traffic no explicit active control is designed since this traffic does not have any QoS requirements. Suppose each node of an ad hoc network with N nodes has three queues corresponding to the premium, the ordinary and the best-effort traffics[15]. The congestion controller is implemented at the output port of each node. The control objective for the premium traffic is to allocate the output capacity by incorporating an adaptive estimator to cope with the incoming traffic uncertainties.

Observation: A novel Markovian jump queuing model corresponding to the premium and the ordinary
traffics are obtained by using a fluid flow model and conservation principles. LMI conditions are derived to facilitate the design of the controller parameters as well as the network traffic compression/transmission gains. These conditions are shown formally to guarantee stochastic stability properties for the closed-loop system. The simulation results presented demonstrate that the resulting steady state and the transient behavior of our proposed congestion control strategies are satisfactory. The main limits observed in MJCC are lack of energy efficient system in congestion discovery and no congestion control strategy in hop level and neighbor level.

Dhurandher S.K et al[3] proposed a mechanism for reducing congestion while routing bulky data in mobile ad hoc networks that aimed to provide a solution to the problem of network congestion that arises when huge amount of data such as multimedia data is transferred in mobile ad hoc networks. This issue has been addressed by designing a protocol that performs routing intelligently and minimizes the delay in data transmission. The objective of this work is to move the traffic away from the shortest path that is obtained by a suitable shortest path calculation algorithm to a less congested path so as to minimize the number of packet drops during data transmission and to avoid unnecessary delay. In this context Dhurandher S.K et al[44] proposed a protocol named as Congestion Aware Selection of Path with Efficient Routing (CASPER). In CASPER a router play a key role that runs the shortest path algorithm after pruning those links that violate a given set of constraints.

CASPER[3] overview: CASPER is a circle based routing technique for forwarding data. Instead of calculating and storing the path from the source node to all the nodes in the topology, it calculates and store path between the source node, destination node and the intermediate nodes that lie in a restricted circular topology. Also the shortest path is calculated such that it satisfies the minimum bandwidth requirement of the data to be sent so as to minimize the chances of congestion in the network. Thus, instead of complete topology graph for shortest path calculation, it considers a portion of the graph extracted using constrained circular routing technique. This technique seems to help in reduction in the number of control packets as lesser number of nodes are involved in the shortest path calculation and which is so in the routing process as well. This attempts to reduce the probability of congestion in the network, which is due to the fact that, this is done in order to satisfy the minimum bandwidth criteria taking into consideration the bandwidth requirement of the message that needs to be transmitted. This further would help in better routing table space since only those routes that are obtained through the constrained circular routing are stored in the routing table.

Observation: The CASPER protocol design attempted to decrease the average drop in packets and evident to improvement in terms of eradication of traffic congestion by taking care of the bandwidth requirements of the data to be transmitted. CASPER significantly proved itself as better design to avoid the unnecessary calculations and processing of each node, thereby saving time. It involves less storage consumption in routing tables as only the constrained shortest paths from a source to the destination node and intermediate nodes are stored at a time instead of paths between all possible nodes in topology, which are not even involved in routing.

Liu Ban-teng et al[1] put forward the importance of node degree theory to achieve congestion control routing for Mobile Ad Hoc Networks. The proposed Node degree theory based congestion control model select nodes with low degree to forward data packets in the process of routing searching.

Overview of node degree routing algorithm [1]: The routing algorithm based on node degree thought can be divided into the following several process steps:

1. Initialization: Using GPS to determine the location of each node in the network, then determine the adjacency matrix A and each node's degree values, turns to Step5.
2. Judgment: Through the adjacency matrix, local node determines whether exist a goal node within a jump communication range, if a goal node is in a jump communication range, then show that we have successfully built a routing.
3. Calculation: If the adjacent nodes assembly of local node doesn’t include goal nodes, then calculate whether the number of hops exceeds the limit. If it exceeds the limit, then you show that we have failed to build a routing, turns to Step5.
4. Update: Compare this node degree value with the previous nodes, and fill the smaller in routing degrees values in routing establish request form.
5. End: record hops required to successfully find routes, when destination node received multiple route setup requests, will choose the lesser degrees value data sent routing. Above is the first search process.

Observation: The principle of the node degree algorithm considered that selects nodes with high probability to forward data, thus reducing network congestion. The proposed model is mainly concentrating on to identify the path with low congestion possibilities. Due to ad hoc infrastructure and node mobility it is obvious to identify the
dynamic changes in congestion state; hence the adaptive congestion control is crucial requirement in mobile ad hoc networks, which is not a part of this proposed model.

V. CONCLUSION

In conclusion, the mobile ad hoc networks continue to move forward in the areas of implementing and testing routing protocol draft proposals. Varied participants are beginning to report both simulation and “live” network testing results. Also, additional mobile ad hoc networks protocol enhancements areas (e.g., security, multicast, and quality of service) continue to be discussed and presented within the group. Also two approaches one is to maintain compatibility with wide spread protocols mainly with TCP and other is to gain freedom in protocol design and hence better fit the specific needs of mobile ad hoc networks. The solutions discussed in this paper represent the solutions for a subset of the identified problems, which can serve as building blocks for application specific protocol stacks. There is still a lot of scope for the development of new congestion prevention models in mobile ad hoc network protocols. Particularly current experiments can be done to derive a generic cross layer congestion control stack for mobile ad hoc network. The further investigations in this context can consider two remarkable issues: The support hops can be expected to equip with significant memory and computational power in relation to the available network bandwidth and a certain homogeneity of the nodes in different application scenarios. These two considerations offer many opportunities for a protocol design to exploit both cross-layer information and sophisticated support by the intermediate hops. Therefore in this field the experiments can be inevitable that leads to develop a generic cross layer congestion control stacks, which can easily adopt by various mobile ad hoc network protocols.

References


