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Enhancement of QoS in MANET using Semi Graph Model and AODV Routing Protocol

G Sathish Kumar, S Omkumar

Abstract*: *Improving the Quality of Service (QOS) in the network is a major subject to be discussed in development of MANET. Current researches are performed to generate congestion control measures to schedule the data packets from different network paths to process at the specific node. The performance of that specific node should be increased based on the capacity of routing the packets into multiple paths of the network. The performance of these mobile intermediate nodes are been improved by combining the network layer and transport layer approaches. Due to the MAC layer problems like congestion increases the packet drop, delay and error rate, decreases the delivery rate and throughput of the network. Frequent disconnection of nodes is also possible due to the mobile nature of the nodes in MANET. In order to overcome these limitations, a maximum dominant set based semi graph model is developed to frame transport layer mechanism and AODV. DSR protocols are involved to generate a routing path between the nodes of the network. The performance of the semi graph model along with the AODV and DSR routing protocols were evaluated by implementing in the hardware environment.

Index Terms*: *Quality of Service, MANET, AODV, DSR, Semi Graph model, Maximum Dominant set, Edges and Vectors.

I. INTRODUCTION

In Mobile ad hoc network (MANET) is framed between the wireless mobile nodes, which transfers information between them without any central network infrastructure to route the packets in the network. The nodes are typically mobile and battery powered. These nodes posses only a limited resources like power and bandwidth. The topology of the network is dynamic due to the mobility nature of the nodes so these networks do not require any infrastructure to regulate the data packets in the network. MANETs act as a major role in the other network services like internet. In these applications, MANETs are placed at the edge networks. These edge networks widen the internet services to the broader region of users. These applications are deployed in the disaster regions where centralised wireless network is failed. These MANETs helps the users to connect with the Internet through the MANET nodes. Internet based Mobile ad hoc network provides interface with the backbone wired network. The MANET nodes provide a communication hubs to the users, thus the resources from the internet can be shared between the users through the mobile MANET nodes.

When more communication links are involved then an issue of Quality of Service (QOS) arises. QOS is the measure of differentiating the traffic between several networks and provides the requirements by overcoming the certain constrains in the network. In other words QOS is the measure of the service provided by the network to the users apart from constrains in the requirement. The data packets transmitted within the MANET possesses different priorities, as like in the centralised network. The centralised network uses routers to handle higher priority data packets that overcome the collision in the network. However, the MANET does not possess any centralised nodes like router to avoid the congestion in the network. Thus, the topology framed by the MANET should in the way that it should self regulate the traffic generated between the nodes.

The functional behaviour of the MANET nodes generates severe challenges in maintaining QOS. In classical networks the QOS is achieved by the centralised nodes namely routers which are fixed in nature. But in the MANET the Router nodes are also mobile nodes which are used only to develop peer communication between sender and receiver nodes.

A new method is introduced to achieve QOS in MANET by framing edges and vectors between the nodes using maximum dominant sets. Semi graph model is applied to calculate the dominant set. The edges are the mobile nodes connected with each other through the vectors. The maximum dominant vector sets are selected to generate link between the nodes in the network. This helps in avoiding the congestion of data packets in the network. Two or more nodes can be connected to a single vector. This provides maximum connectivity to the edge nodes with minimum communication path. This avoids multi path routing that reduces the possibilities of occurrence of congestion in the network.

II. LITERATURE SURVEY

MANET network constantly increases in size with nodes, spreading over larger sections. Hence, to provide link between nodes in MANET multipath routing implement to improve link quality and quality of service. The routing path between nodes is selected by ant colony based multi path routing scheme. The routing path between nodes is selected based on route preference probability and node stability. The stability of node is determined by hop count delay, bandwidth and QOS parameter [1].

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***** Correspondence Author
G Sathish Kumar*, Assistant Professor, Department of Electronics & Communication Engineering, P.T.Lee Chengalvaraya Naicker College of Engineering & Technology, Kanchipuram, India.
S Omkumar, Associate Professor, Department of Electronics & Communication Engineering, SCSVMV, Kanchipuram, India.

The existing wireless sensor network incorporates with MANET network to form hybrid network. The hybrid network improves coverage region and accommodates more users in the network resulting in increased quality of service. The QOS decreases due to the absorption of Wireless sensor network in MANET, which creates race condition and invalid registration problems in MANET. The QOS in hybrid network is improved by QOS oriented distributed routing protocol. In QOS oriented distributed routing protocol (QOD), the hops for data transmission reduces to few hops and the any cast feature allows nodes in network to transmit data to group of receivers in network. The QOD forms with five algorithms namely, neighbour node selection algorithm and distributed packet scheduling to fulfil transmission delay, mobility based segment resizing to resize the segment of mobile nodes to minimize transmission time, increase transmission throughput by traffic redundant elimination algorithm and elimination of redundant data-by-data redundancy elimination algorithm [2].The VOIP transmission in Mobile Ad-hoc Networks (MANET) is implemented and its quality of service is improved by utility functions and meeting R-factor. The above factors help MANET network to connect multiple numbers of VOIP calls [3]. The energy aware routing protocol is designed based on scalable routing and mobility of nodes in network. Furthermore, the QOS is improved by reducing messages and time consumed due to route discovery process. The link stability energy aware routing (LAER) algorithm is applied to increase routing path stability and minimize energy consumption due to routing the data through a particular path. The LAER performs well compared to E-GPSR, PERRA and GPSR routing algorithm with respect to node lifetime, packet delivery ratio, link duration of nodes and energy consumption [4].Hybrid communication protocol applies to overcome limitations of RF/FSO (Free space optics) based communication networks such as, optimal Quality of service, minimizing end-to-end delay and throughput of the network. The hybrid communication protocol varies transmission power and optical power for the nodes in network to improve quality of service. Furthermore, the Integer Linear Programming is solved by iterative repair heuristics and lagrangian relaxation [5].Conventional MANET routing protocol in military applications suffers from reduced quality of service and congestion in network. Hence, air tasking order (ATO) is implemented during planning phase for optimal network performance. The nodes in network in airborne MANET forecast by parsing key information. The network routes are optimized by utilized edges which results in increased throughput. The approach enables administrators to apply network control and increases network performance [6].Gateway selection scheme is applied to improve QOS of one single parameter such as packet delivery ratio, network lifetime and end-to-end delay. However, a scheme is not available which improves the QOS of all network parameters. The overall network performance is improved by appropriate selection of gateway, route with minimum latency and path with maximum load capacity. The gateway node is selected based on latency and path availability period. The QOS parameter is improved by feedback systems and path up-dating between sender and receiver nodes [7].The video streaming in ad hoc network is limited due to variable capacity link, energy and bandwidth constraints. The mobile nodes in network cause error and constant link failures in network. Hence, the scalable video streaming evaluate for ad hoc networks. The routing protocol estimates the bandwidth availability and bit rate during video transmission [8]. All the nodes in MANET network are mobile. Hence, it is important to identify malicious node in network and prevent data from being routed through that particular node. Hence, M-Lion Whale routing algorithm is applied. The M-Lion Whale is a combination of hybrid optimization, goal programming model and Lion algorithm and incorporates into whale optimization algorithm. The M-Lion Whale optimization selects the optimal path for data transmission. The M-Lion Whale considers different parameters such as distance, delay, trust, energy and lifetime for route selection [9].The links in wireless network are loosed due to channel interference and fading. Conventionally duplicate nodes are transmitted across different routing path to improve data reliability. Hence, multicast routing protocol is implemented in loosed MANET to construct multiple trees for fulfilling bandwidth requirement. The approach reduces bandwidth consumption, at the same time not compromising on requesting and ongoing flows. Furthermore, the approach reduces the redundant data packets in network which minimizing the network overhead [10].In VANETS, all nodes in network are mobile resulting in continuous link breaks. The link reliability is improved by graph approach, which increases with respect to change in vehicular network characteristics. The graph based approach is further applied to rank route link, based on reliability [11].The distribute resource allocation problem is solved with bio inspired algorithm. The MANET is faced distinct challenges such as scalability, energy efficiency, fairness, bandwidth utilization and mobility. A bio inspired MAC protocol is applied to solve resource allocation problem and improved throughput, fairness, and delay in MANET network [12]. The node in ad hoc network is exhausted quickly due to frequent data transmission and increased distance between nodes in network. Hence, power aware multicasting scheme is applied to minimize energy consumption of nodes in ad hoc network. Specifically, genetic algorithm is applied to determine end to end delay between nodes and considered energy cost for data transmission for minimal energy utilization [13]. The issues of wireless networks such as infrastructure, mission critical protocol and hidden transmitters should be tackled, before applying wireless network for safety critical and military applications. Hence, an adaptive middleware is applied to increase timely communication via dynamic contention and predictive selection, which does not largely modify the protocol. The foresaid approach is achieved by Real time optimized Ad hoc middle ware architecture [14]. The routing and topology in wireless network is applied to minimize interference between nodes and improved the network capacity. The delay in MANET network is increased due to routing complexity between nodes.

The delay in network is minimized by controlling the topology of network. A cross layer distribute algorithm is applied to eliminate delay constrains in MANET network. The approach is designed to tackle queuing delay, transmission delay and contention delay in MANET [15].

III. METHODOLOGY

Mobile Adhoc Networks generate communication between mobile nodes in infrastructure less fashion. The mobile nodes itself act as a routing node to generate communication between the sender and receiver nodes. The bandwidth available for communication is equally divided between the nodes. Each node has its own capacity to handle available bandwidths in the network. The generation of traffic in MANET is unpredictable and time variant due to the mobility of the nodes in the network. Quality of Service (QOS) mechanisms is involved to measure the behaviour of the network to avoid network congestion and reduce the complexity in the network. The QOS is affected due to the generation of congestion in the intermediate routing nodes in the MANET. The generation of traffic is not same throughout the network. Due to the variation in traffic, occurrence of congestion is higher at intermediate nodes that affect the performance in communication path generated in the network. To avoid congestion the QOS is increased in the MANET. The maximum dominant set based topology is developed.

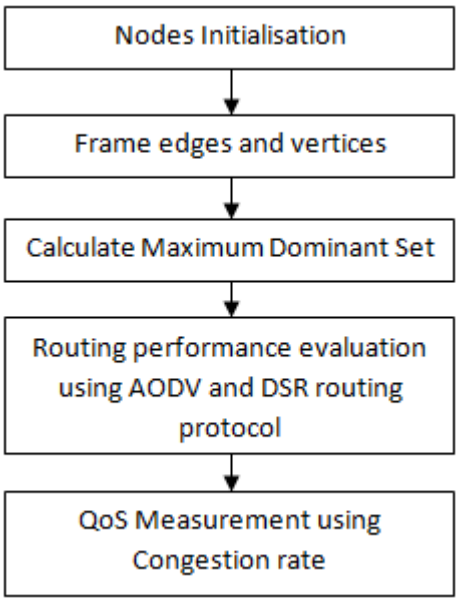

Fig.1. Block Diagram for QOS over MANET using semi graph model

Semi graph model is developed with graph theoretical model to group the nodes as edges and vectors in the network. The semi graph topology generates effective paths between the nodes in the MANET. Edges represent the nodes and vertices and that are interlink between the nodes. Semi graph model generates minimum vertices to connect all the edges together in the network. Reduction in generation of communication path reduces the occurrence of congestion in the intermediate node. Each vertex connects with more than two edges in the network. Each node in the MANET posses its own communication links with each other nodes with lesser path cost.Maximum dominant set is framed between the nodes and Steiner tree is constructed between the nodes. The redundancy between the nodes in the edges of the network was avoided based on the maximum dominant set framed by the semi graph model. The performance of the Semi graph model is analysed by generating the traffic between the paths generated in the network. AODV and DSR routing protocols are applied over the semi graph model to identify the congestion rate and QOS of the MANET system.

The performance of the system is evaluated by implementing the semi graph model in hardware environment along with AODV and DSR routing protocols to transfer data between the MANET nodes. Laptops with core i5 processor and 4Gb RAM was selected as a MANET nodes. A network is framed between the nodes using 802.11 standards (Wi-Fi). The functions are developed to generate communication between the nodes using AODV and DSR routing protocol.

Hardware Model for AODV Protocol:

The AODV routing protocol has control packets like RREQ, RREP, RERR and RREQ_ACK for generating communication path between the nodes. The figure 2 shows the functional block diagram of the AODV routing protocol in hardware environment.

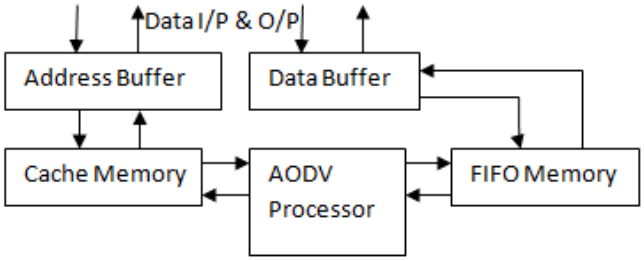

Fig.2. Block Diagram of AODV Protocol

The cache memory is used to store the route for the node to which the data to be transmitted. The information is stored in the cache memory was added along with the data packets for providing information to other routing nodes about the communication path. The cache is refreshed at end of every packet transmission. The address buffer holds the address information of the received data packet and data buffer handles the information from the received data packets. FIFO memory regulates the handling of packets, when more than one communication is performed at individual node.

AODV processor performs the fundamental functions of AODV protocol to identify the route between the sender and destination node. It generates control packets to establish communication between the nodes. It also generates acknowledgements for synchronised communication in the network.

Hardware Model for DSR Protocol:

The DSR routing protocol is source initiated routing mechanism, where the information about the routing path is maintained in the intermediate nodes itself. Thus, the path update is required for every time of the communication path between the node changes. The Figure 3 shows the functional block diagram of the DSR routing protocol in hardware environment. The DSR routing protocol undergoes two important functions namely route discovery and route maintenance.

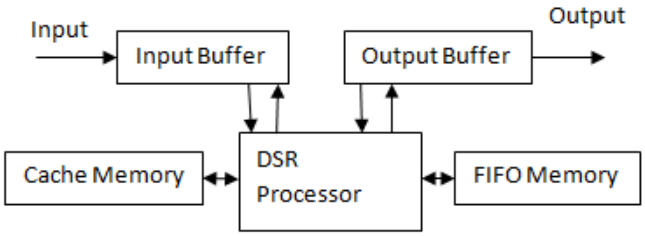

Fig.3. Block Diagram of DSR Protocol

The liveness of the selected route is identified, for every time the data is transmitted between the intermediate nodes. The acknowledgement signals are passed to the source node along with the route information. If the acknowledgement signal fails to reach, the sender node initiates the path failure and performs new route discovery process. The cached copy of the routing information is stored in the cache memory other than passing it to the routing nodes. The DSR processor monitor the control packets to update the route cache stored in the cache memory.The disadvantage of DSR routing algorithm is not suitable for larger network. The probability of path failure increases because of intermediate nodes of more than 10 numbers between the sender and receiver. Other than the route limitations, DSR provides more cost effective communication between the nodes with smaller data packets and effective congestion control.

Fig.4. Hardware Setup

The AODV and DSR routing protocols are implemented over semi graph model in the hardware environment to measure the QOS of the MANET system in terms of congestion in the routing nodes. Figure 4 represents the hardware setup to perform AODV and DSR routing protocol along with the semi graph model.

IV. RESULT AND DISCUSSION

The semi graph model is implemented in hardware environment. The performance of AODV and DSR routing protocols were analysed by implementing along with the semi graph model. The Laptops are selected as MANET nodes and interconnected with each other through Wi-Fi medium. The distance between the nodes and the number of packets transferred was altered to measure the performance of the system. Figure 5 represents the energy consumed by the nodes in percentage for various transmission time limits. The nodes were powered with equal battery capacity and with 100% initial charge. The packet size of 100bytes was transferred between two nodes for fixed time interval. The energy consumption was analysed for AODV and DSR routing protocols. From the figure 5 the AODV routing protocol consumed maximum of 57% and DSR routing protocol consumed maximum energy of 63% from total battery capacity.

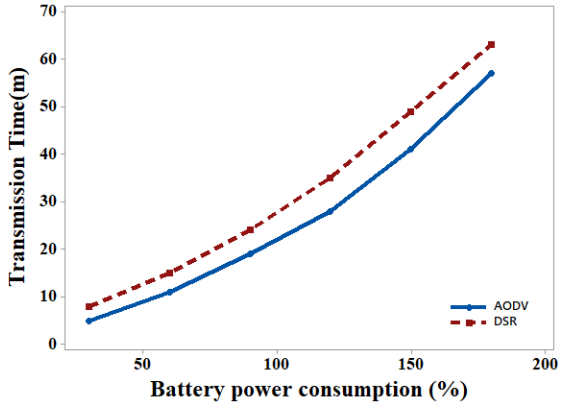

Fig.5. Energy Consumption

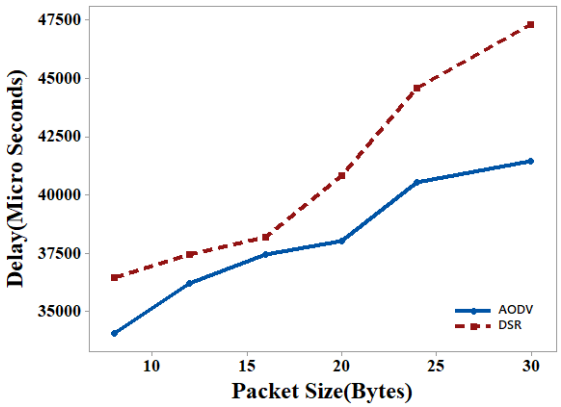

Fig.6. End to End Delay

The consumption of power is constantly rising along with the transmission time. Figure 6 shows the time delay taken to transfer data packet between the nodes. The delay is measured in microseconds. The time taken to transmit data from one node to another without any intermediate node is plotted. The delay generated by AODV protocol is lesser when compared with DSR protocol. DSR protocol generates more delay when packet size is increased above 20bytes. The AODV protocol generated the delay of about 41480microseconds and DSR routing protocol generates the delay of about 43417 microseconds.The Quality of Service measures with bandwidth consumption, Bit error rate and delay of the network. The figure 7 shows the throughput or bandwidth consumption of the network.

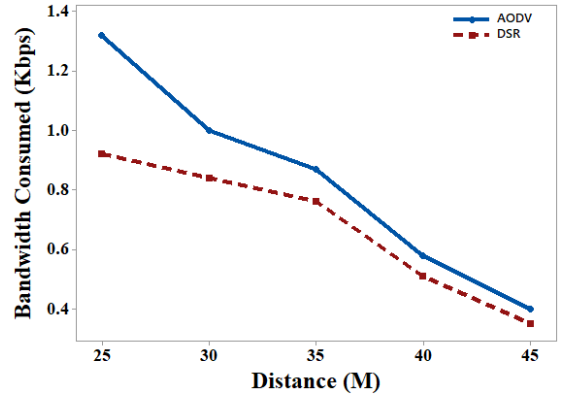

Fig.7. Bandwidth consumption

The throughput is measured with the variable distance between the nodes.

Two nodes were utilised to measure the throughput of the network. The distance between the nodes was varied simultaneously and the bandwidth consumption of the node is measured and plotted. The nodes consume maximum bandwidth, when the distance between the nodes is lesser. The bandwidth consumption reduces due to increase in distance and increase in delay in transmitting the data packet.

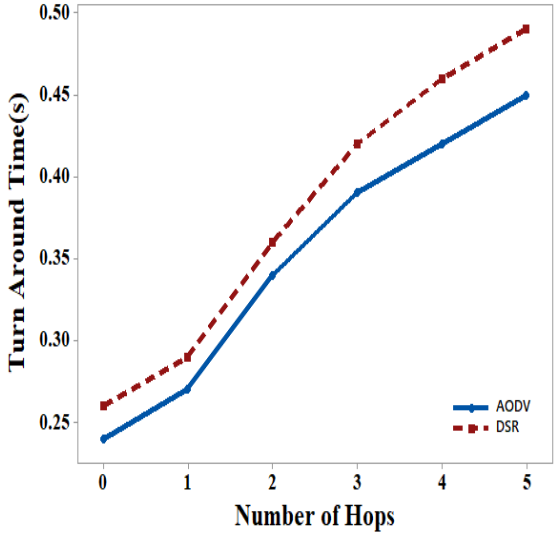

Fig.8. Turn Around Time

Turn around time is the measure of time consumed by the nodes to complete the packet transmission through the intermediate nodes. Figure 8 shows the turnaround time measured for various hop counts. The nodes between the sender and receiver nodes were increased to measure the time taken by the intermediate nodes with fixed data packet size. The AODV routing protocol generates 0.45 seconds delay for maximum hop count of about 5 nodes and DSR routing protocol generates 0.49seconds for 5 intermediate nodes. The data packet is fixed as 100bytes. The bit error rate is the measure of amount packets received with the errors due to the disturbance or congestion in the network. The bit error rate is measured by varying the size of the data packet transmitted between the nodes. Figure 9 shows the bit error rate plot for both AODV and DSR routing protocol.

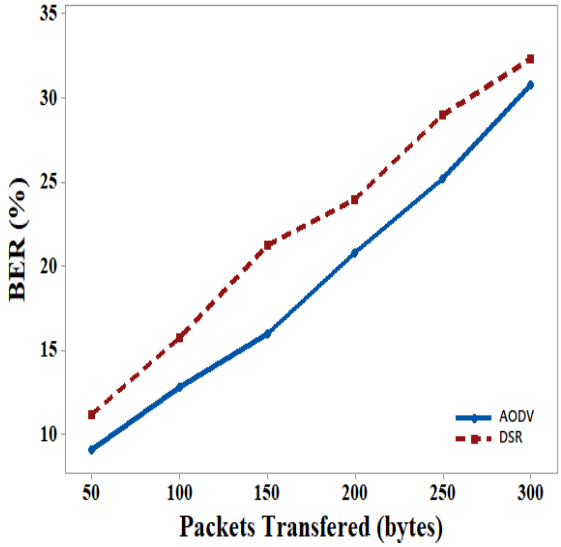

Fig.9. Bit Error Rate

The bit error rate increases when the distance between the nodes increases or when the amount of data packets transmitted between the nodes increases along with the total network traffic. The SNR value is set as 6 and the data packet size was varied between two nodes. The packet size of 300 bytes was fixed. AODV routing protocol generates BER value of about 30.6% and DSR routing protocol generates BER of about 32.4%.

V. CONCLUSION

Mobile ad hoc network comprises of mobile nodes which shares data between them without a centralised infrastructure. Due to the mobility nature of the MANET nodes, Quality of Service of the network is affected due to occurrence of congestion in the network and frequent disconnection of nodes from the network. To improve the QOS of MANET, a semi graph model is developed to maintain the topology of the network. The edges and vectors are framed based on maximum dominant set to overcome congestion in the network. From the experimental model results, the AODV routing protocol improves the Quality of Service of semi graph model in MANET than the DSR protocol.

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