Routing Protocol for Mobile Ad Hoc Network

Reda Farhan and Shubat Ahmeda

Abstract—**Routing protocol is the act of moving information across an inter-network from a source to a destination. Routing directs forwarding by passing of packets from their source toward their ultimate destination through intermediary nodes. The routing process usually directs forwarding on the basis of routing tables within the routers, which maintain a record of the best routes to various network destinations. Thus the construction of routing tables becomes very important for efficient routing. In wireless ad hoc networks, all nodes are mobile and can be connected dynamically in an arbitrary manner. One way to enhance the performance of routing protocol is to improve the metrics used in the route selection. This paper aims to find a way to minimize the end to end delay in the event of congestion in the primary route path and increase throughput by using the least amount of control bits. The proposed protocol is solved the congestion by using an additional factor in selecting the best available path, this factor depends on the assessment of congestion on the primary path. This has been accomplished by using the stored routing information that is not used by the primary routing table in the selecting of an alternative route. The proposed protocol has been compared with the AODV protocol and OLSR protocol. The Experimental results suggest a remarkable E-DSDV's performance in an end-to-end delay, NRL and throughput metrics are better than OLSR and AODV.**

Index Terms—**AODV, DSDV, mobile ad hoc routing protocols, OLSR.**

I. Introduction

A mobile ad-hoc network (MANET) consists of mobile computing entities such as laptop and palmtop computers which communicate with each other through wireless links and without relying on a static infrastructure such as a base station or access point [1]. Without centralized administration, a MANET is highly unpredictable due to its unstable links and resource poor as most of the nodes have limited battery power. Due to these physical limitations, nodes require the cooperation of other nodes to successfully send a message to a destination over multiple hops. In reality, this routing problem is much more complex. It is highly dependent on the environment and the topology of the network. The topology refers to the arrangement in which nodes are connected to each other. In their communications, mobile nodes also have to contend with data losses from packet collisions, electromagnetic interference, and node movement and failures, therefore routing protocols are necessary for effective multi-hop communications.

Many protocols have been proposed for MANETs with the goal of achieving efficient routing. Most of these protocols can be classified either as source-based or table-based routing protocols with a few hybrid protocols emerging in the recent years. Some of the popular table-driven algorithms are the Destination Sequenced Distance Vector (DSDV) routing protocol , the Temporally-Ordered Routing Algorithm (TORA), The Wireless Routing Protocol (WRP), Global State Routing (GSR), Fisheye State Routing (FSR) , Hierarchical State Routing (HSR), Zone-based Hierarchical Link State Routing Protocol (ZHLS), Cluster-head Gateway Switch Routing (CGSR) [2], [3]. While source-based algorithms include the Dynamic Source Routing (DSR) protocol, Ad-hoc On-demand Distance Vector (AODV) routing protocol, Cluster Based Routing protocol (CBRP), The Associatively Based Routing (ABR), Signal Stability-Based Adaptive Routing protocol (SSR). Hybrid protocols like the Zone Routing Protocol (ZRP) combine proactive and reactive approaches at different stages of the routing process [4], [5]. These algorithms differ in the approach used for searching a new route and/or modifying a known route when nodes move. They are similar in that insufficient network topology information is considered in their routing decisions. For example, the routing algorithms do not consider the physical location of the destination node when choosing a route. They are also not concerned about information like the density of the network, congestion at the node, movement speed and direction of the nodes. Excessive overhead packets required in discovering new route, in the event of failure to access the destination due to presence of congestion or failure in intermediate node. Consequently, these routing algorithms are slow in reacting to dynamic changes in the topology of the network resulting in reduced throughput when they occur. The remainder of the paper is organized as follows. Section II presented related works. Section III provides a brief overview of the proposal protocol. Section IV experimental and results. Section V concludes this work.

II. Related Work

Reference [6] presented the performance of the four MANET Routing protocols such as DSDV, AODV, OLSR and DSR. The four protocols were analyzed qualitatively and then simulated using NS-2 simulations. It is observed that OLSR had the lowest performance in terms of the packet delivery ratio in all of the simulations. OLSR presented the lowest end-to-end delay in almost all of the simulations, and in most cases the end to end delay was independent of the varying simulation parameters.

Reference [7] has outlined the analysis of simulation of the AODV routing protocol. The simulation is done using different performance metrics. It is observed that AODV routing protocol performs with satisfactory results of the packet delivery ratio but at the cost of some delay and packet

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loss. The performance of AODV can be further enhanced using fuzzy logic by taking different input parameters to reduce the uncertainty of finding an optimal path.

Reference [8] presented the realistic comparison of three routing protocols DSDV, AODV and DSR. The significant observation is, comparison results agree with expected results based on theoretical analysis. As expected, reactive routing protocol AODV performance is the best considering its ability to maintain a connection by a periodic exchange of information. DSR/AODV is based on route discovery and route maintenance mechanism. Flat Routing Philosophy is used in DSR, AODV and DSDV. Packet size is uniform for DSDV; AODV Packet size is non uniform for DSR. Loop free routing Protocol Property is available to DSR, AODV.

Reference [9] presented a bidirectional routing abstraction (BRA) to handle unidirectional links that arise frequently in mobile ad hoc networks. BRA provides routing protocols with the familiar bidirectional abstraction that they are typically designed for and thus enables them to operate efficiently on asymmetric networks. Internally, however, it actively uses both unidirectional and bidirectional links to find symmetric routes more effectively than conventional techniques; find new, asymmetric routes substantially increasing the reach ability of the network; and find alternate routes with shorter path length.

This paper aims to minimize end to end delay that occurs by congestion at the nodes that observed when using the above protocols by Enhance DSDV (E-DSDV).

III. The Proposed Protocol

This Section gives a brief overview of the proposal protocol (The Enhance Destination-Sequenced Distance-Vector Routing (E-DSDV)), in terms of its main basic operation, Route Discovery, dealing with congestion and route maintenance. The E-DSDV protocol is a Development of DSDV routing mechanism, which is a loop free routing protocol based on the shortest-path calculation. Data packets are transmitted between the nodes using routing tables stored at each node. Each routing table contains all the possible destinations in the network and the number of hops to each destination with the sequence number. Thus in case of mobile ad-hoc networks, the sequence numbers enable DSDV to maintain up to date routing information in the nodes ensuring the consistency of routing data across all routing tables. The congestion in wireless ad hoc networks is slightly different from that of wired networks. One of the causes of the congestion in wireless networks is that the buffer used to hold packets to be transmitted, overflows within a particular node.

One of the main features of the proposed protocol is using an additional factor to minimize the end to end delay that caused by congestion. If congestion factor (σ) reach certain value, then this factor will be considered as an additional factor in selecting of best available route.

A. E-DSDV Route Discovery

Both periodic and triggered route updates are initiated by E-DSDV to maintain consistency of routing information. Periodic updates fresh route discovery operations are initiated after the elapse of fixed interval of time. Triggered route updates are initiated whenever a node encounters a broken link which can be a result of the sudden network topology change or communication link failure. These update packets are broadcast throughout the network. In addition each mobile node agrees to relay data packets to other nodes upon requests. In this way even though a node does not have a direct link to a particular node in the network, it will still be able to exchange data with that node.

B. Optimization Techniques

There are many techniques that can be used to enhance protocol. This section describes one of those techniques that have been used in the proposed protocol. In the header packet, a byte has been dedicated for the congestion factor. According to this factor, a decision will be made whether or not an alternative route will be used. An alternative route will be used if it has less congestion factor. See Fig. 1, which for instance clarify the primary route and the alternative route.

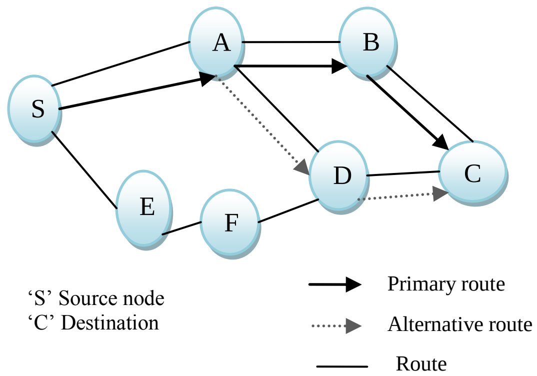

Fig. 1. Representation of routes.

C. Route Maintenance

Route maintenance is required to provide feedback about the links of the route and to allow the route to be modified in case of any disruption due to movement of one or more nodes along the route.

IV. Experimental Results

The proactive protocol OLSR and E-DSDV imposes large control traffic overhead on the network which consumes bandwidth. Maintaining an up-to-date routing table for the entire network calls for excessive communication between the nodes, as periodic and triggered updates are flooded throughout the network, but for small networks the gain is minimal. However the E-DSDV protocol has been designed to minimize end to end delay when the route path has congestion. The AODV is more sensitive to resource usage. As control traffic is almost only emitted during route discovery, most of the resource and bandwidth consumption relates to actual data traffic, but take more time to know the route path.

A. Experimental Environments

The E-DSDV protocol has been designed and implemented with experimental environments using Visual Basic V6. The network topology is represented in Fig. 2 that shows the numbers of nodes that are used in the experiments are 7 nodes, experimental time was taken 91 milliseconds, packet size 4096bits and data rate 560000 bits per sec. A mobile node is initially placed in a random location in the area of the network and the Pause time is 7 msec. “Pause time is a time in which all nodes in the network are motionless but transmitted in continued”. All the experimental works were carried out using the three routing protocol (AODV, OLSR, E-DSDV).

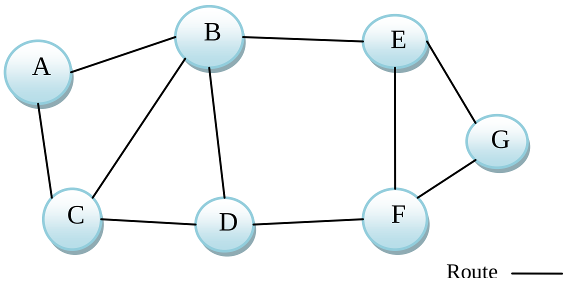

Fig. 2. The tested mobile Ad hoc network.

The performance parameter figures that have been measured were defined as follows:

1) Throughput (bits/s): - Throughput is the measure of the number of packets successfully transmitted to their final destination per unit time.
2) Average end-to-end delay (the average E2E delay): - It represents the time that spent by the packet to reach to the destination. (E2E delay = received time– sent time). The average end-to-end delay can be calculated by summing the times taken by all received packets divided by their total numbers.
3) Normalized Routing Load (NRL): - It is the number of transmitting routing packets per delivery data packets. (NRL = number of routing packets/ number of received packets).

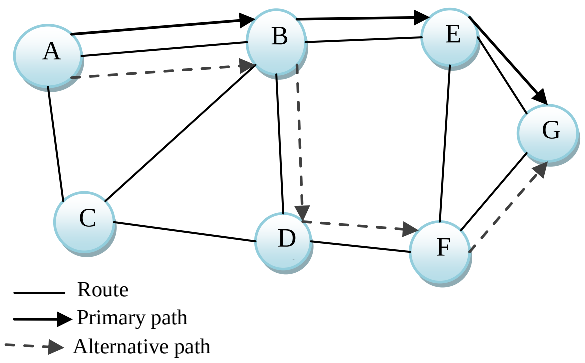

Fig. 3. The network topology

B. Results

Ad hoc networks for a short interval, the buffer space available at the destination node or intermediate node is less than that required for the arriving traffic, then node is said to be congested, hence packet loss occurs. Similarly, if the total traffic wanting to enter the link is more than its bandwidth, the link is said to be congested. In this paper, a number of experiments have been performed, to compare between the E-DSDV, AODV and OLSR protocols under the effect of congestion. In the E-DSDV protocol when congestion occur in intermediate node , there is the chance to choose a different path with less congestion based on the routing information on a secondary routing table. Fig. 3 represents the network topology of scenarios that might occur when a data packet has been sent from source node (A) to destination node (G) through the path that was selected based on a routing technique used in different routing protocols. Case 1 illustrates the transfer of data packets by applying AODV and OLSR routing protocols. And in case 2 the proposed routing protocol has been applied.

Case 1: When data packet has been transferred from source node (A) to the destination node (G), the path (A-B-E-G) has been chosen by AODV and OLSR protocols. In this scenario, due to congestion that has been imposed at node (E) delay will increase and this may cause packet discard.

Case 2: the E-DSDV Protocol has been applied; this protocol has the ability to deal with congestion. So because of congestion which has been imposed at Node (E), an alternative route with less congestion might be chosen. See Fig. 3, in which an alternative route (A-B-D-F-G) has been selected. The three routing protocols are evaluated based on the three performance metrics, which are End-to-End Delay, Throughput and the Normalized Routing Load. Fig. 4 represents an end to end delay when applying different routing protocols. The OLSR protocol exhibits longer average end-to-end delay while E-DSDV exhibits shortest end-to-end delay.

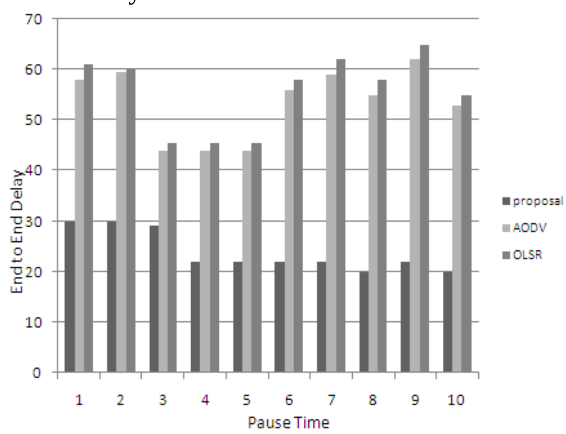

Fig. 4. End to end delay using the three routing protocols.

The Fig. 5 shows the receiving throughput that is maximum for E-DSDV protocol. This is due to the selection of an alternative route that has less congestion compared with primary route.

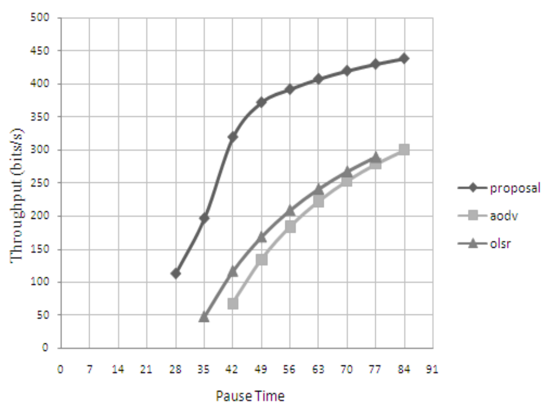

Fig. 5. Throughput v/s pause time

Fig. 6 shows the normalized routing load for the network. E-DSDV has the lowest overhead. AODV has more routing overhead, but is still nearly that of OLSR.

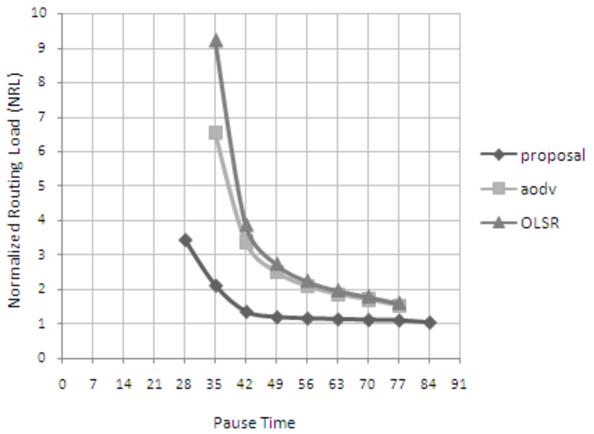

Fig. 6. NRL v/s pause time

V. Conclusion

The E-DSDV protocol has been designed and implemented to support multi-hop mobile ad hoc network. Each node within the network freely exchanges information with any other node in the network. The protocol developed in this work allows congestion factor to be considered as an additional metric of selecting an optimal route. It has been demonstrated how well the E-DSDV protocol in delay by congestion and performs routing in an ad hoc network, this protocol has been compared with AODV and OLSR. The results of experimental yield some interesting conclusions: E-DSDV on the other hand scales well in terms of end-to-end delay, NRL and Throughput.

All these results are helpful in designing ad hoc networks algorithms and in the development of routing mechanism for such networks.

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