A Comparative Analysis of Routing Protocols for Disaster Area Mobility Model in MANETS

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Abstract
A Wireless ad hoc network is a collection of autonomous mobile nodes that communicate with each other over wireless links without any fixed infrastructure. The nodes use the service of other nodes in the network to transmit packets to destinations that are out of their range. A number of ad-hoc routing protocols have been proposed and implemented which include ad-hoc on demand Vector Protocol (AODV) , dynamic source routing (DSR) and Destination sequenced Distance Vector (DSDV) routing protocols. In this paper for experimental evaluation purposes, we have considered 600m x 600m, terrain area which illustrates the performance in terms of the packet delivery fraction, average end-to-end delay ,normalized routing load and throughput for routing protocols. Our simulation results using NS-2 shows that DSDV performs best in all the cases of packet delivery fraction, average end-to-end delay , normalized routing load and throughput over other routing protocols on varying mobility speed using Gauss Markov Model. On the other hand, DSR has lowest packet delivery ratio and throughput but has highest delay and Routing Load.

Keywords **– AODV, DSDV, DSR, Packet Delivery Fraction, Throughput, End-to-End Delay, Normalized Overhead.**

1. Introduction

A Wireless ad hoc network is a collection of self-organized wireless mobile nodes dynamically forming a temporary network without the aid of any established or fixed infrastructure and centralized administration control stations, unlike cellular wireless networks.
As wireless ad hoc network does not have any fixed infrastructure and so also called as infrastructure-less network because nodes establish communication among themselves “on the fly” by adapting the dynamicallychanging network environment.
Dynamic and infrastructure-less, wireless ad-hoc networks implies that any computation on the network needs to be carried out in a decentralized manner. Also, many important problems in ad-hoc networking needs to be formulated as problems in distributed computing system. For example a Mesh Networks offers a wireless broadband network system based on 802.11 ad hoc modes and a patented peer-to-peer routing technology [2]. Further, in a wireless ad hoc network, channel bandwidth and node energy, are two important constrain factors [4] and hence it is a good idea to use reactive routing, where routing is performed only on demand. This paper discusses in detail the functioning of AODV, DSDV, and DSR how well it adapts to the dynamically changing link conditions. More specifically, we compare these routing protocols with real experimental results on Network Simulator NS-2.35[1].

The rest of this paper is organized as follows. Section 2 covers an overview of routing protocols by explaining a proactive protocol, DSDV (Destination Sequence Distance Vector), and reactive protocols, AODV(Ad-hoc on Demand Vector Protocol) and DSR (Dynamic Source Routing). Section 3 describes Gauss Markov mobility model.In Section 4, the performance metrics and result analysis is presented using Ns-2.35.Section 5 concludes this paper with discussions.

2.1 Ad-hoc on demand Vector Protocol (AODV)

AODV combines some properties of both DSR and DSDV. It uses route discovery process to cope with routes on demand basis. It uses routing tables for maintaining route information. It is reactive protocol; it doesn’t need to maintain routes to nodes that are not communicating. AODV handles route discovery

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process with Route Request (RREQ) messages. RREQ message is broadcasted to neighbor nodes. The message floods through the network until the desired destination or a node knowing fresh route is reached. Sequence numbers are used to guarantee loop freedom.

2.2 Destination-Sequenced Distance Vector (DSDV)

The Destination Sequenced Distance Vector Protocol (DSDV) is a proactive, distance vector protocol which uses the Bellmann -Ford algorithm. DSDV is a hop-by hop distance vector routing protocol, wherein each node maintains a routing table listing the "next hop" and "number of hops" for each reachable destination. This protocol requires each mobile station to advertise, to each of its current neighbors, its own routing table (for instance, by broadcasting its entries).

2.3 Dynamic Source Routing (DSR)

The Dynamic Source Routing (DSR) protocol is an on demand routing protocol based on source routing. DSR Protocol is composed by two "on-demand" mechanisms, which are requested only when two nodes want to communicate with each other. Route Discovery and Route Maintenance are built to behave according to changes in the routes in use, adjusting them-selves when needed.

3. Gauss-Markov Mobility Model(GMM)

Out of the several mobility Models [10], in this work, we consider one Disaster area mobility models that is designed to capture a wide range of mobility patterns for ad-hoc applications. These models are briefly described in the following sections.
The Gauss-Markov mobility model [3] is proposed by Liang and Haas and is used in many researches [7][8]. This model calculates the speed and direction of movement for each MN and then it moves with the calculated speed and direction for a period. After this period, the similar movement begins again. The time that is used in the movement in each interval before the change of speed and direction is constant. The current speed and direction is related to the previous speed and direction as the following equation.

$$s_n = \alpha s_{n-1} + (1-\alpha)\bar{s} + (1-\alpha^2)\sqrt{s_{x_{n-1}}}$$
$$d_n = \alpha d_{n-1} + (1-\alpha)\bar{d} + (1-\alpha^2)\sqrt{d_{x_{n-1}}}$$

As sn and dn are values of speed and direction for movement in the period time n. sn-I and dn- lare values of speed and direction for movement in the period time n-1. α is a constant value in the range [0, 1]. s and d are constants representing the mean speed and direction. sX and dX are
variablesfrom a Gaussian distribution. α is a single tuning parameter that represents the different
levels of randomness or degree of random. The degree of random effects the moving behavior of MNs. The value of α is set to zero to get the maximum speed and direction as
Sn = S + S and dn = d + dX, .The current speed and direction of each MN is independent of its previous speed and direction with a Brownian motion [6]. In the opposite way, the value of α is set to one to get the minimum speed and direction as sn = Sn-I and dn = dn- I Therefore, themovement of every MN is a linear motion. For each specific period time during the simulation run, the calculation of sn, and dn is made. The destination position of the motion can be calculated from the following equations.

$$x_n = x_{n-1} + s_{n-1}\cos d_{n-1}$$
$$y_n = y_{n-1} + s_{n-1}\sin d_{n-1}$$

While(xn,yn) and (xn-1) are positions of theirdestinations for the period time n and n- 1, respectively .

4. Simulation Results and Performance Evaluation

4.1Performance metrics

The metrics used to measure the performance of routing protocols are:

4.1.1Packet delivery ratio

The ratio of the data packets delivered to the destinations to those generated by the Constant Bit Rate (CBR) sources. PDF shows how successful a protocol performs delivering packets from source to destination. Higher value (nearest to 1.0) means the

better the results. It describes the loss rate that will be seen by the transport protocols, which in turn, affect the maximum throughput that the network can support.
As the calculation, *Packet Delivery Fraction (pdf %) = (received packets/ sent packets) * 100*

Mathematically, it can be expressed as:

$$P = \frac{1}{c}\sum_{f=1}^{c}\frac{R_f}{N_f}$$

Where, P is the fraction of successfully delivered packets, C is the total number of flow or connections, f is the unique flow id serving as index, Rf is the count of packets received from flow f and Nf is the count of packets transmitted to f [9].

4.1.2 Average End-to-End Delay

The delay experienced by packet from the time it was sent by a source till the time it reached the Destination. This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC and propagation and transfer times.
For each packet sent, calculate the send time and receive time, then average it.

4.1.3 Routing Overhead

The number of routing packets transmitted for every data packet sent. Each hop of the routing packet is treated as a packet. Normalized routing loadare used as the ratio of routing packets to the data packets.
As for the calculation, Normalized Routing Load = routing packets sent / packet received

4.1.4 Throughput

Throughput of the routing protocol means that in certain time the total size of useful packets that received at all the destination nodes. The unit of throughput is MB/s, however we have taken Kilobits per second (Kb/s).

4.2 Simulation Parameters

Our simulation models a dynamic mobile ad hoc network of varying mobile nodes moved in area of 600m by 600m rectangular area . Each node has a uniform transmission range of 150m. The simulation has been run for each of the two mobility models. The unicast source and receiver nodes are selected at random. Multiple runs are conducted for different scenarios and the collected data is averaged over these runs. The mobility scenario generator produced the Manhattan Grid and Gauss Markov mobility patterns as required by the NS-2. Each run of the simulator accepts the scenario files that describe the exact motion of each node together with exact time at which each change in motion is to occur. We generated scenario files with varying number of nodes, node speeds and pause time.

TABLE I. Simulation Parameters

Simulator	Ns-2.35
Protocols	AODV, DSDV, DSR
Simulation duration	600 seconds
Simulation area	600 m*600 m
Movement model	Gauss Markov
MAC Layer Protocol	IEEE 802.11
Traffic type	CBR
Data payload	512 bytes/packet
Pause time	0.2 s

TABLE II.Parameters for Gauss Markov Model

Number of nodes	40
Maximum speed	25,40,55,70 m/s

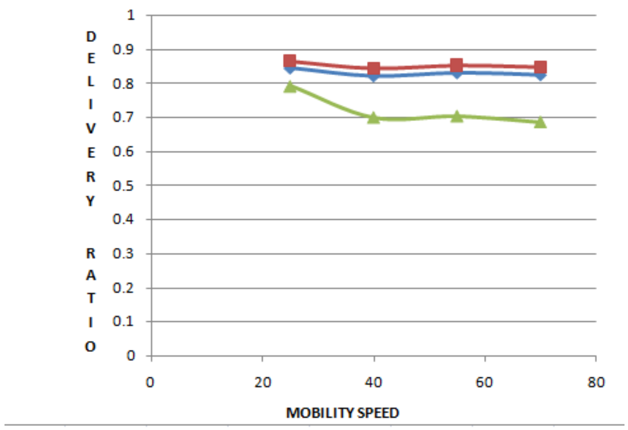

Fig. 1Mobility Speed (m/sec) versus Packet Delivery Ratio (%)

As described by the figure 1 it has been observed that Packet Delivery Ratio is almost stable for AODV and DSDV protocols. AODV shows a constant stability in PDR as mobility speed increases.For DSR it exhibits a constant drop in PDR when mobility speed increases. DSDV also exhibits a constant behavior. It remains stable, when the mobility speed increases.

DSDV on average has higher packet delivery ratio.

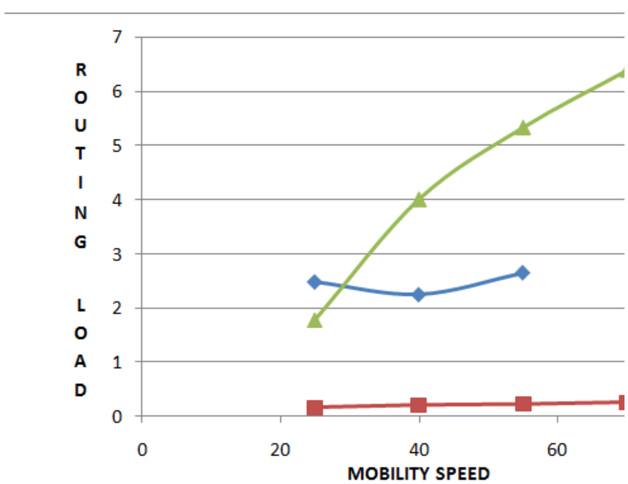

Fig. 2 Mobility Speed (m/sec) versus Routing Load (%)

As described by the figure 2 it is observed that Routing Load differs a lot for each protocol. AODV shows a small drop in Routing Load initially ,but as mobility speed increases, it regains stability. For DSR it exhibits a constant increase in Load as mobility speed increases. DSDV on contrary exhibits a constant behavior. DSDV offers lowest Routing Load.

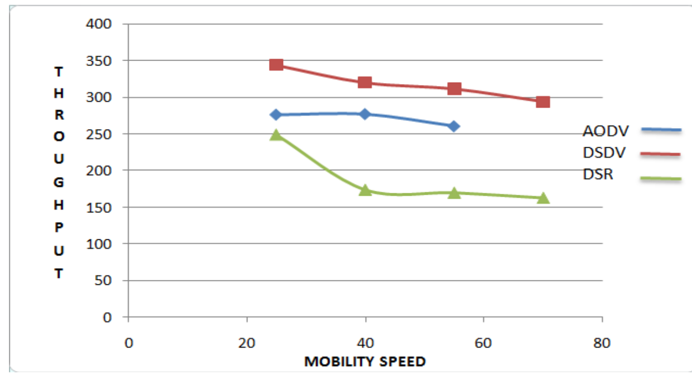

Fig. 3Mobility Speed (m/sec) versus Throughput (Kb/sec)

As described by the figure 3 it can be observed that throughput constantly decrease as mobility speed increases for all of the protocols. AODV shows a drop in throughput initially but as mobility speed increases, throughput constantly increases. For DSR it exhibits a gradual drop in throughput initially then constant decrease in throughput when mobility speed increases. DSDV also exhibits a constant decrement behavior. DSDV has highest throughput of all protocols.

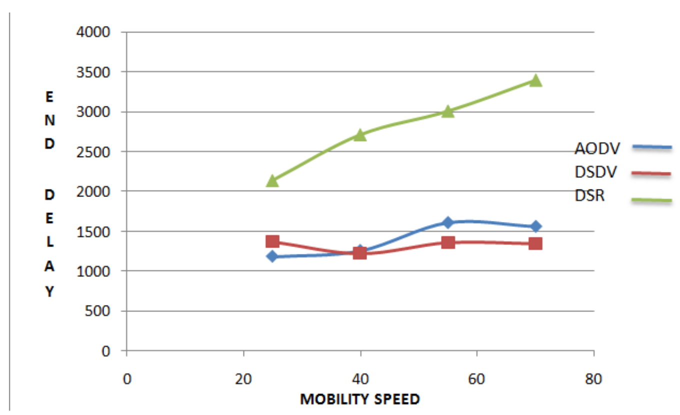

Fig. 4 Mobility Speed (m/sec) versus Average End-to-End Delay (ms)

As described by the figure 4 it can be observed that Delay is bit stable for DSDV protocol. AODV shows a constant increase in Delay as mobility speed increases. For DSR it exhibits a constant increase in Delay when mobility speed increases.DSDV exhibits a constant behavior. Initially Delay in DSDV drops a bit, then it remains stable. DSDV offers the lowest delay of all protocols.

5. Conclusion And Future Work

This paper presented a comparison of three routing protocols on the basis of Average throughput, End-to-End delay, Routing load and Packet delivery ratio. It can be summarized that when network changes occur performances of AODV and DSR also changes rapidly. While DSDV shows a constant performance as compared to the other two protocols. DSDV has highest throughput and PDR and also has lowest load and Delay. DSR is a bit immune to network changes but offers lowest PDR and throughput and has highest delay and routing load. In future these protocols must be simulated taking other mobility models and changing parameters like pause time, Node Density etc.

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