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Behaviour Analysis of Wireless Ad-Hoc Networks under Different Transmission Rate

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***Abstract* - An ad hoc wireless network is an autonomous self organizing system of mobile nodes connected by wireless links where nodes not in direct range communicate via intermediate nodes. The nodes use the services of other nodes in the network to transmit packets to destinations that are out of their range. Self configurability and easy deployment feature of the resulted in numerous applications in this modern era. Also, in case of disaster or natural calamities, the deployment of a fixed infrastructure is neither feasible nor economically profitable for establishing communication among the rescue members. In order to accomplish, a number of ad-hoc routing protocols have been proposed and implemented, which include dynamic source routing (DSR), Ad-hoc on Demand (AODV) and Destination Sequenced Distance Vector (DSDV) routing protocols. In this paper for experimental behaviour evaluation purposes, we have considered 500m x 500m, terrain area which illustrates the performance in terms of the packet delivery fraction and average end-to-end delay for DSR, AODV and DSDV routing protocols by using performance metrics, by changing the data transmission rate and basic transmission rate. Our results using NS-2 simulator shows that DSR performs better in both the case of packet delivery fraction and average end-to-end delay over DSDV and AODV routing protocol.**

***Keywords:* Ad-hoc, AODV, DSDV, DSR, NS-2, end-to-end delay, PDF.**

I. INTRODUCTION

An ad hoc network is a dynamically reconfigurable wireless network with no fixed wired infrastructure. It is a Self Configuring network that means it does not require any infrastructure to communicate. It can be connected everywhere because it has a very good adapting capability. Due to limited transmission range of wireless network nodes, multiple hops are usually required for a node to exchange information with other nodes of network. The major disadvantage in mobile network is its lack of mobility. It is very easy for Ad-hoc network to lose its routes for destination, due to this it can lose its stability and signal strength, this can affect the performance of network. Therefore, routing protocols play an important role in ad hoc communications. These networks have quite a many constrains because of uncertainty of radio interface and its limitations, e.g., in available bandwidth. Also, some terminals have limitations concerning battery energy in use. The rest of the paper is organized as follows. Section 2 covers an overview of routing protocols by explaining a DSDV (Destination Sequence Distance Vector), DSR (Dynamic Source Routing) and Ad -hoc On-Demand Distance Vector (AODV*)*. Section 3 describes an experimental setup and section 4, the performance metrics and result analysis using NS-2 simulator. Section 5 finally concludes this paper.

II. ROUTING PROTOCOL

A. Ad hoc On-Demand Distance Vector (AODV) Routing Protocol

The Ad hoc On-Demand Distance Vector (AODV) algorithm is a reactive or on demand routing protocol that enables dynamic, self-starting, multi hop routing between participating mobile nodes wishing to establish and maintain an ad hoc network [1]. AODV allows mobile nodes to obtain routes quickly for new destinations, and does not require nodes to maintain routes to destinations that are not in active communication. It maintains routes as long as necessary. It uses routing tables to store routing information. It facilitates the use of sequence number so as to prevent the loop and provide freshness for routing. AODV allows mobile nodes to respond to link breakages and changes in network topology in a timely manner. The operation of AODV is loop-free, and by avoiding the Bellman-Ford "counting to infinity" problem offers quick convergence when the ad-hoc network topology changes (typically, when a node moves in the network). It is used to build the route by using Route Request and Route Reply cycle that is shown in figure no.1. When links break, AODV causes the affected set of nodes to be notified so that they are able to invalidate the routes using the lost link. Route Requests (RREQs), Route Replies (RREPs) and Route Errors (RERRs) are message types defined by AODV [2].

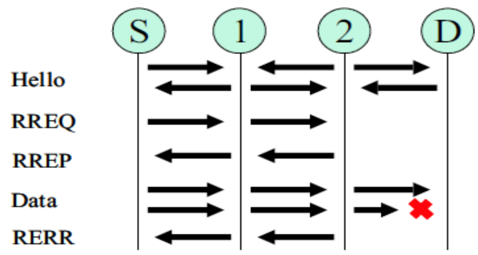

Figure 1: AODV Protocol Messaging [10]

B. Dynamic Source Routing (DSR)

The Dynamic Source Routing protocol (DSR) is, an on demand routing protocol. DSR is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. Using DSR, the network is completely self organizing and self-configuring, requiring no existing network infrastructure or administration. The DSR protocol is composed of two main mechanisms that work together to allow the discovery and maintenance of source routes in the ad hoc network [3]:

1) Route Discovery is the mechanism by which a node S wishing to send a packet to a destination node D

obtains a source route to D. Route Discovery is used only when S attempts to send a packet to D and does not already know a route to D.

2) Route Maintenance is the mechanism by which node S is able to detect, while using a source route to D, if the network topology has changed such that it can no longer use its route to D because a link along the route no longer works. When Route Maintenance indicates a source route is broken, S can attempt to use any other route it happens to know to D, or it can invoke Route Discovery again to find a new route for subsequent packets to D. Route Maintenance for this route is used only when S is actually sending packets to D. In DSR Route Discovery and Route Maintenance each operates entirely “On Demand".

C. Destination-Sequenced Distance-Vector Routing (DSDV)

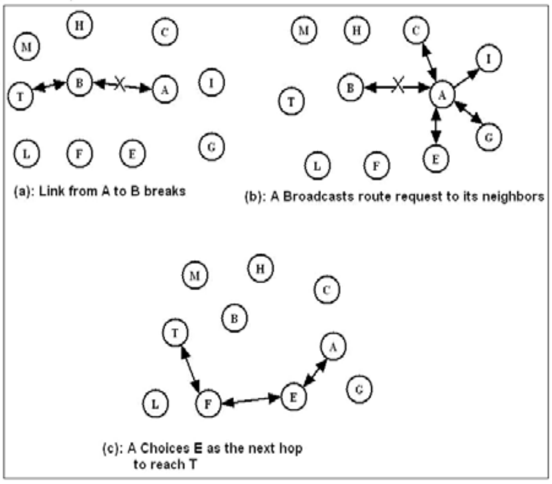

Figure 2 : Creation of route in a node [11]

Destination-Sequenced Distance-Vector Routing (DSDV) is a table-driven routing scheme for ad-hoc mobile networks based on the Bellman-Ford algorithm. It eliminates route looping, increases convergence speed, and reduces control message overhead. In DSDV, each node maintains a next-hop table, which it exchanges with its neighbours [6]. There are two types of next-hop table exchanges: periodic full-table broadcast and event-driven incremental updating. The relative frequency of the full-table broadcast and the incremental updating is determined by the node mobility. In each data packet sent during a next-hop table broadcaster incremental updating, the source node appends a sequence number. This sequence number is propagated by all nodes receiving the corresponding distance-vector updates, and is stored in the next-hop table entry of these nodes. Sequence Numbers are used to distinguish stale routes to the new ones. There is a proper maintenance of routing tables after every process. A node, after receiving a new next-hop table from its neighbour, updates its route to a destination only if the new sequence number is larger than the recorded one, or if the new sequence number is the same as the recorded one, but the new route is shorter. The creation of route is shown in figure no.2. In order to further reduce the control message overhead, a settling time is estimated for each route. The route that has most recent sequence number is always used for routing information from one node to another. A node updates to its neighbours with a new route only if the settling time of the route has expired and the route remains optimal [5].

III. SIMULATION ENVIRONMENT

The simulation is done with the help of NS-2 simulator version 2.29 [6]. This simulation uses a scenario where a total of 100 nodes are used with the maximum connection number 10 seed for the one, and a hope that have 10 CBR packets per second transfer rate and the pause time of 100 sec implemented in a 500m x 500m scope. The selected parameters are varied using setdest command.

IV. PERFORMANCE METRICS USED AND SIMULATION RESULTS

A. Average end-to-end delay of data packets

There are possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, and propagation and transfer times. Once the time difference between every CBR packet sent and received was recorded, dividing the total time difference over the total number of CBR packets gave the average end-to-end delay for the received packets. This metric describes the packet delivery time: the lower the end-to-end delay the better the application performance [7].

$$\text{AvgE2Edelay} = \sum_{1}^{n} \text{CBRsentTime} - \text{CBRrecvTime}$$
$$/\sum_{1}^{n} \text{CBRrevTime}$$

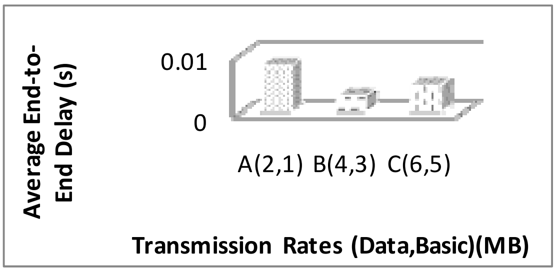

Fig 3: Avg End to End Delay vs transmission rates for DSDV

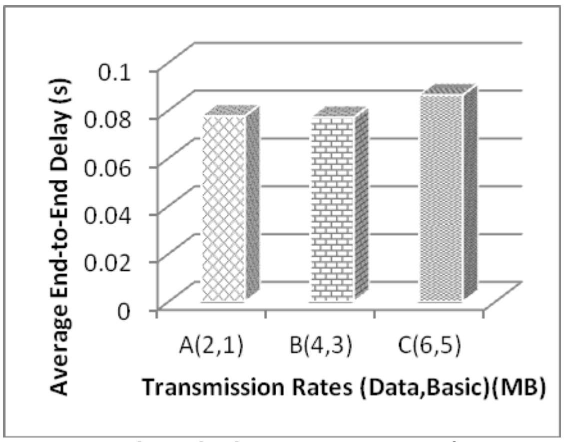

Fig 4: Avg Ed to End Delay vs transmission rates for AODV

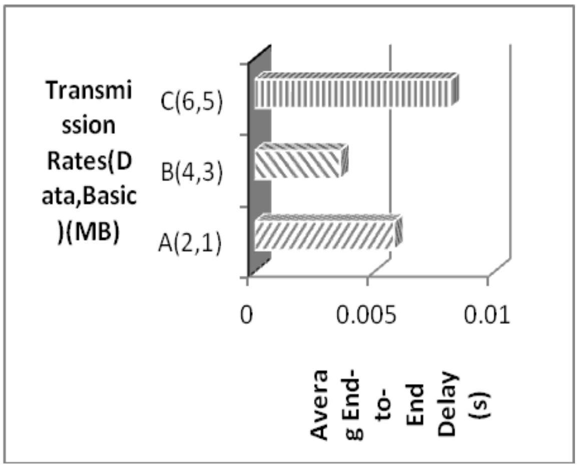

Fig 5: Average E2E Delay vs transmission rates for DSR

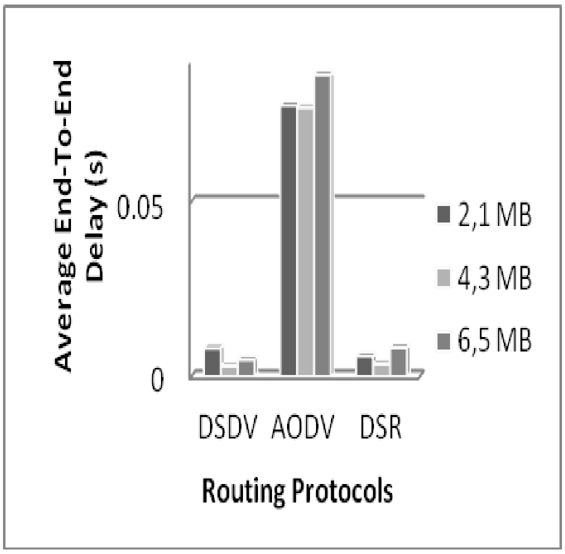

Fig 6: Average E2E Delay for various routing protocols

B. Packet Delivery Fraction (PDF)

It is the ratio of the data packets delivered to the destinations to those generated by the sources [8].

Packet Delivery Fraction (PDF) = Total Packets Delivered to destination / Total Packets Generated .Mathematically, it can be expressed as:

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

Where, P is the fraction of successfully delivered packets, C is the total number of flow or connections, f in equation 1 is the unique flow id serving as index, R_f is the count of packets received from flow f and N_f is the count of packets transmitted to f [9].

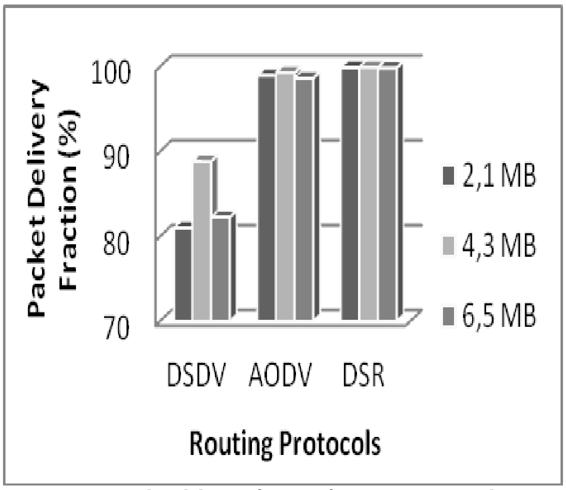

Fig 7: Packet delivery fraction for various protocols

V. CONCLUSION

In this paper we have evaluated the performance of DSDV, AODV and DSR routing protocols for ad hoc wireless networks using NS-2.29 event simulator keeping packet size of 512 Byte .DSDV uses the proactive table-driven routing strategy whereas AODV and DSR uses the reactive on demand routing strategy with different routing mechanisms. Experimental results showed that DSR perform better for Packet Delivery Fraction as there is very low packet loss ratio. Also, DSDV apply sequence numbers and contains one route per destination in its routing table whereas DSR uses source routing and route caches and maintains multiple routes per destination.

We analyzed that as transmission rate changes each of the routing protocols obtained around 97% to 99% for packet delivery ratio whereas DSDV obtained around 80% to 90%. The other observation from the experiments on DSDV, AODV and DSR protocols, with a change in a data and basic transmission rate for a fixed area of 500m x 500m illustrates that even if the terrain area of the network scenario is kept behaviour of these routing protocols changes. Average End-to-End delay of DSDV is high for both transmission rates and it starts increasing as rates increases. DSR performs well as having average end to end delay. Conclusion is presented in the Table I. It has been found that the overall performance of DSR routing protocol for performance matrices, Packet Delivery Fraction as well as Average End-To-End Delay is better than that of DSDV and AODV routing protocols.

Table 1: Performance Metric Results of The routing protocols

	DSDV(Transmission Rate)			**AODV(Transmission Rate)**			**DSR(Transmission Rate)**		
	A	*B*	*C*	*A*	*B*	*C*	*A*	*B*	*C*
PDF	Low	Low	Low	Average	High	High	High	High	High
Avg E2E Delay	Average	High	High	Low	Low	Low	Average	High	Low

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