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Performance Comparison of Routing Protocols

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Abstract**—** A mobile ad hoc network (MANET) is a collection of wireless mobile nodes dynamically forming a network topology without the use of any existing network infrastructure or centralized administration. MANET is a self configuring network and the topology of the network keeps on changing as the nodes move randomly and organize themselves in an arbitrarily manner. Mobile nodes communicate with each other using multihop wireless links. Each node in the network also acts as a router, forwarding data packets for other nodes. In order to facilitate communication within the network, a routing protocol is used to discover routes between nodes. Due to higher mobility in nodes and dynamic infrastructure of MANETs, Routing is important issue in ad hoc networks. 'In this paper three routing protocols AODV (Ad- Hoc on-Demand Distance Vector), DSDV (Destination Sequenced Distance-Vector) and DSR (Dynamic Source Routing) are compared'. The metrics used for performance analysis are Packet Delivery Ratio, Average end-to-end Delay & Number of Packets Dropped.

Keywords**—** MANET, AODV, DSR, DSDV Performance Metrics, NS-2.35& Simulation

I. Introduction

Mobile networks can be classified into infrastructure networks and Mobile Ad Hoc Networks (MANET) according to their dependence on fixed infrastructures. In an infrastructure mobile network, mobile nodes have wired access points (or base stations) within their transmission range. In contrast, Mobile Ad Hoc networks are autonomously self-organized networks without support of infrastructure [1]. The Ad hoc network applications include military applications, casual conferences, meeting, virtual classrooms, emergency search-and-rescue operations, disaster relief operation, automated battlefield and operations in environments where construction of infrastructure is difficult or expensive[2]. In a Mobile Ad Hoc Network, nodes move arbitrarily, therefore the network may experience rapid and unpredictable topology changes. Routing paths in MANETs potentially contain multiple hops, and every node in MANET has the responsibility to act as a router. Routing in MANET has been a challenging task ever since the wireless networks came into existence. The major reason for this is the constant change in network topology because of high degree of node mobility. A number of protocols have been developed to accomplish this task [1].

II. Related Work

Several researchers have done the quantitative and qualitative analysis of Ad hoc Routing Protocols by means of different performance parameters.

1.Charles E. Perkins, Elizabeth M. Royer, Samir R. Das and Mahesh K. Marina [3] ,compared the performance of two prominent on-demand routing protocols for mobile ad hoc networks: Dynamic Source Routing (DSR) and Ad Hoc On-Demand Distance Vector Routing (AODV). They analyzed that even though DSR and AODV share similar on demand behavior, the differences in the protocol mechanics can lead to significant performance differentials. The performance differentials are analyzed using varying network load, mobility, and network size.

2. Banoj Kumar Panda, Manoranjan Das, Benudhar Sahu and Rupanita Das [4] Described a detailed analysis of performance affected due to change in mobility in different terrain area. The parameter describing the reason of variation in performance is the number of packets delivered. Using GloMoSim simulator different performance parameters related to the AODV & DSR routing protocol are calculated and analyzed. They observed that in the Low terrain area and high density network the number of link break in AODV & DSR is comparatively less. In medium terrain area node density is comparatively less than low terrain area network. As the area increases link break also increases. So in high mobility condition AODV performance is better than DSR. In medium and low mobility condition DSR performance improves still AODV outperform DSR. In large terrain area node density is low; link break is very high the Packet delivery fraction of both the protocols still decreases in compare to low and medium terrain area.

3. Laxmi Shrivastava, Sarita S.Bhadauria, G.S.Tomar [5] presented their observations regarding the performance comparison of the AODV, DSDV & DSR routing protocols for varying traffic load in mobile ad hoc networks (MANETs). They performed extensive simulations, using NS-2 simulator. Their studies have

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shown that reactive protocols (AODV, DSR) perform better than proactive (DSDV) protocols.

4. Kapil Suchdeo, Durgesh Kumar Mishra [6] compared two on-demand routing protocol namely Ad hoc on demand distance vector (AODV) and Dynamic source routing (DSR) protocol. Performance is compared on the parameters like Packet delivery fraction, Average end to end delay and Normalized routing overhead using network simulator-2. The performance analysis is done by varying mobility pattern (pause time and speed) and traffic pattern (sending rate). Results of their work shows that DSR has performed slightly better than AODV for performance parameters like Packet Delivery Ratio and Normalized Routing Overload but performed slightly poor in terms of Average Delay. This might be due to fact that DSR uses route cache very aggressively.

5. Nidhi Sharma, Sanjeev Rana, R.M. Sharma [7] compared the two popular algorithms Ad-hoc on Demand Distance Vector (AODV) and Dynamic Source Routing (DSR), both being reactive routing protocols. They analyzed and compared their performance through simulation using NS2 simulator. They used performance metrics- packet delivery rate, average time delay and routing load overhead by varying network size and transmission range of the respective nodes.

6. Mehdi Barati, Kayvan Atefi, Farshad Khosravi and Yashar Azab Dafial [8] compared performance of Dynamic Source Routing (DSR) and Ad hoc On-Demand Distance Vector (AODV) routing protocols with respect to average energy consumption and routing energy consumption are explained thoroughly. Then, an evaluation of how the varying metrics in diverse scenarios affect the power consumption in these two protocols is discussed. A detailed simulation model using Network Simulator 2 (NS2) with different mobility and traffic models are used to study their energy consumption.

III. ROUTING PROTOCOLS

As shown in Fig. 1, Adhoc routing protocols may generally be categorized as:
A. Table-driven
B. Source-initiated (demand-driven)

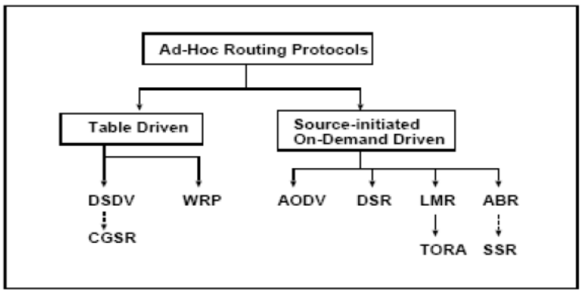

Fig. 1 Types of Routing Protocols

A. Table-Driven Routing Protocols

Table-driven routing protocols store the needed information for routing purposes in tables, which are repeatedly updated through control packets that are sent by each node. The updates can also respond to topological changes of the network. The following sections discuss one of the existing table-driven adhoc routing protocols [9].

1) Destination-Sequenced Distance-Vector Routing:

The Destination-Sequenced Distance-Vector Routing protocol (DSDV) is a table-driven algorithm based on the classical Bellman-Ford routing mechanism**.** The improvements made to the Bellman-Ford algorithm include freedom from loops in routing tables. Every mobile node in the network maintains a routing table in which all of the possible destinations within the net-work and the number of hops to each destination are recorded. Each entry is marked with a sequence number assigned by the destination node. The sequence numbers enable the mobile nodes to distinguish stale routes from new ones, thereby avoiding the formation of routing loops. Routing table updates are periodically transmitted throughout the network in order to maintain table consistency. To help alleviate the potentially large amount of network traffic that such updates can generate, route updates can employ two possible types of packets. The first is known as a full dump**.** This type of packet carries all available routing information and can require multiple network protocol data units (NPDUs). During periods of occasional movement, these packets are transmitted infrequently. Smaller incremental packets are used to relay only that information which has changed since the last full dump. Each of these broadcasts should fit into a standard-size NPDU, thereby decreasing the amount of traffic generated. The mobile nodes maintain an additional table where they store the data sent in the incremental routing information packets. New route broadcasts contain the address of the destination, the number of hops to reach the destination, the sequence number of the information received regarding the destination, as well as a new sequence number unique to the broadcast**.** The route labeled with the most recent sequence number is always used. In the event that two updates have the same sequence number, the route with the smaller metric is used in order to optimize (shorten) the path. Mobiles also keep track of the settling time of routes, or the weighted average time that routes to a destination will fluctuate before the route with the best metric is received**.** By delaying the broadcast of a routing update by the length of the settling time, mobiles can reduce network traffic and optimize routes by eliminating those broadcasts that would occur if a better route was discovered in the very near future [10].

B. Reactive (Source Initiated) Routing Protocols

In reactive routing protocols, a route is discovered only when needed. A source node initiates route discovery by broadcasting route query or request messages into the network. All nodes maintain the discovered routes in their routing tables. However, only valid routes are kept and old routes are deleted after an active route timeout; the scheme improves network routing efficiency by preventing the use

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of stale routes. A serious issue for MANETs arises when link failures occur due to high node mobility; at the same time new links may also be established between previously distant nodes. This significantly increases the network broadcast traffic with rapid link make/break effect of intermediate nodes. Therefore, reactive routing protocols are subjected to an increase in network control overhead. [11]. The following sections discuss some of the existing Reactive adhoc routing protocols.

1) Dynamic Source Routing(DSR) Protocol:

DSR is an entirely on-demand ad hoc network routing protocol composed of two parts: Route Discovery and Route Maintenance. In DSR, when a node has a packet to send to some destination and does not currently have a route to that destination in its Route Cache, the node initiates Route Discovery to find a route; this node is known as the initiator of the Route Discovery, and the destination of the packet is known as the Discovery's target. The initiator transmits a ROUTE REQUEST packet as a local broadcast, specifying the target and a unique identifier from the initiator. Each node receiving the ROUTE REQUEST, if it has recently seen this request identifier from the initiator, discards the REQUEST. Otherwise, it appends its own node address to a list in the REQUEST and rebroadcasts the REQUEST. When the ROUTE REQUEST reaches its target node, the target sends a ROUTE REPLY back to the initiator of the REQUEST, including a copy of the accumulated list of addresses from the REQUEST. When the REPLY reaches the initiator of the REQUEST, it caches the new route in its Route Cache. Route Maintenance is the mechanism by which a node sending a packet along a specified route to some destination detects if that route has broken, for example because two nodes in it have moved too far apart. DSR is based on source routing: when sending a packet, the originator lists in the header of the packet the complete Sequence of nodes through which the packet is to be forwarded. Each node along the route forwards the packet to the next hop indicated in the packet's header, and attempts to confirm that the packet was received by that next node; a node may confirm this by means of a link-layer acknowledgment, passive acknowledgment, or network-layer acknowledgment. If, after a limited number of local retransmissions of the packet, a node in the route is unable to make this confirmation, it returns a ROUTE ERROR to the original source of the packet, identifying the link from itself to the next node as broken. The sender then removes this broken link from its Route Cache; for subsequent packets to this destination, the sender may use any other route to that destination in its Cache, or it may attempt a new Route Discovery for that target if necessary[12].

2) Adhoc On-Demand Distance Vector(AODV) Routing Protocol:

The AODV routing protocol is an "on demand" routing protocol, which means that routes are established when they are required. This routing protocol is based on transmitting Route Reply (RREP) packets back to the source node and routing data packets to their destination. Used algorithm consists of two steps: route discovery and route maintenance. Route discovery process begins when one of the nodes wants to send packets. That node sends Route Request (RREQ) packets to its neighbors. Neighbors return RREP packets if they have a corresponding route to destination. However, if they don't have a corresponding route, they forward RREQ packets to their neighbors, except the origin node. Also, they use these packets to build reverse paths to the source node. This process occurs until a route has been found. Routing tables which only have information about the next hop and destination are used for routing information maintenance. When a route link disconnects, for example, a mobile node is out of range, neighbor nodes will notice the absence of this link. If so, neighbor nodes will check whether there is any route in their routing tables which uses a broken link. If it exists, all sources that send traffic over the broken link will be informed with Route Error (RRER) packet. A source node will generate a new RREQ packet, if there is still a need for packet transmission [13].

IV. Simulation Environment

A. Simulation Model

Here we give the significance for the evaluation of performance of Ad Hoc routing protocol with varying the number of mobile nodes. The network simulations have been done using network simulator NS-2. The network simulator NS-2 is discrete event simulation software for network simulations which means it simulates events such as sending, receiving, forwarding and dropping packets. The latest version, ns-allinone-2.35, supports simulation for routing protocols for ad hoc wireless networks such as AODV, DSDV and DSR[14]. NS2 is an object oriented simulator, written in C++, with an OTcl interpreter as a front-end. This means that most of the simulation scripts are created in Tcl (Tool Command Language). If the components have to be developed for ns2, then both tcl and C++ have to be used [15].To run a simulation with NS-2.35, the user must write the OTCL simulation script. We get the simulation results in an output trace file and here, we analyzed the experimental results by using the awk command. The performance parameters are graphically visualized in GRAPH. NS-2 also offers a visual representation of the simulated network by tracing nodes movements and events and writing them in a network animator (NAM) file.

B. Simulation Parameters

In our work, the performance of Routing Protocols AODV, DSDV and DSR is evaluated by varying the network size (number of mobile nodes). Table 1 shows the simulation parameters used in this evaluation.

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TABLE I
SIMULATION PARAMETERS

Parameter	**Value**
Simulator	NS-2(Version 2.35)
Channel Type	Channel/Wireless Channel
Radio Propagation Model	Propagation/Two Ray Ground
Network Interface Type	Phy/Wireless Phy
MAC Type	Mac/802.11
Interface Queue Type	Queue/DropTail/PriQueue
Link Layer Type	LL
Antenna	Antenna/Omni Antenna
Maximum Packet in ifq	50
Area(M*M)	2000*500
Number of Nodes	10,20,30,40,50
Traffic Type	TCP
Simulation Time	150
Routing Protocols	AODV,DSDV & DSR

V. PERFORMANCE METRICS

There are different kinds of parameters for the performance evaluation of the routing protocols. We have used the following metrics for evaluating the performance of three routing protocols (DSDV, AODV & DSR):

A. Packet Delivery Ratio

It is the ratio between the numbers of packets received by the application layer of destination nodes to the number of packets sent by the application layer of source nodes [16].

B. Packets Dropped

The number of data packets that are not successfully sent to the destination [17].

C. Average End to end delay

It is the average time from the transmission of a data packet at a source node until packet delivery to a destination which includes all possible delays caused by buffering during route discovery process, retransmission delays, queuing at the interface queue, propagation and transfer times of data packets [14].

Simulation Result

The simulation results are shown in the following section in the form of line graphs. Graphs show comparison between the three protocols by varying different numbers of nodes on the basis of the above-mentioned metrics.

A. Average End to End Delay

As shown in Figure 2 as the number of nodes increases Average End to End Delay also increases. Graph shows that DSR has higher Average End to End Delay than AODV & DSDV.According to our simulation result; best performance is shown by AODV having lowest Average End to End Delay.

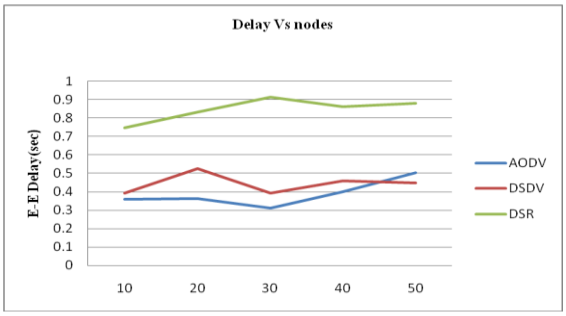

Fig. 2 Average End To End Delay Vs. Number of Nodes

B. Packet Delivery Ratio

The Packet Delivery Ratio is shown in figure 3; Demand-Driven Routing Protocols AODV & DSR perform better than Table-Driven Routing Protocol DSDV. Best performance is shown by AODV routing protocol.

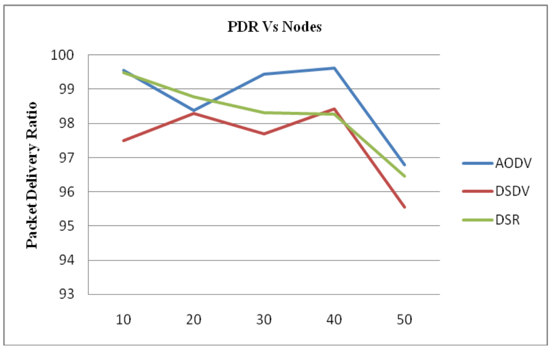

Fig. 3 Packet Delivery Ratio vs. Number of Nodes

C. Packets Dropped

Number of Packets Dropped is shown in figure 4.Number of Packets Dropped with DSR is much higher than AODV & DSDV.

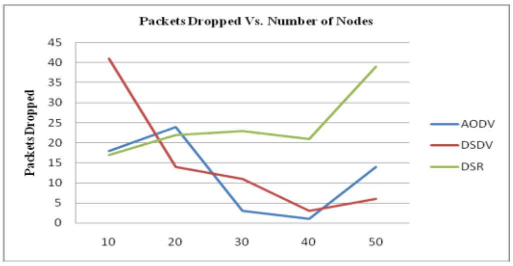

Fig. 4 Packets Dropped Vs. Number of Nodes

VI. CONCLUSION

In this paper performance comparison of DSR, AODV & DSDV routing protocols for Mobile Adhoc Networks is done as a function of number of nodes (network size).Performance of these routing protocols is evaluated with respect to performance metrics such as Average End to End Delay, Packets Dropped & Packet Delivery Ratio. In our assumed scenario AODV shows best performance than DSR & DSDV in terms of Average End to End Delay, Packet Delivery Ratio & Number of Packets Dropped. Furthermore performance comparison with other routing protocols in different classes could be done.

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