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Comparative Analysis of Routing Protocols in Wireless Networks

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Abstract: Mobile ad-hoc network (MANET) Is constructed by means of best mobile nodes. Since such self-distributed networks do not require pre-existing base stations, they're predicted to use to various conditions which include military affairs and rescue paintings in disaster web sites. In MANETs there is no path from source to destination for finding path from source to destination using routing protocols. AODV routing protocol is an On-demand distance vector. The AODV protocol builds routes between nodes only if they are requested by source nodes. DSDV is a table-driven routing protocol. Routing information is distributed between nodes by sending full dumps infrequently and smaller incremental updates more frequency. DSR is an On-demand distance vector. Network nodes cooperate to forward packets for each other to allow communication over multiple "hops" between nodes not directly within wireless.
Keywords: MANETs, routing protocols, AODV, DSDV, DSR

I. INTRODUCTION

A mobile ad hoc network (MANET), also known as ad hoc wireless network, it is a continuously self-configuring, infrastructure-less network. In a MANET each device is free to move independently in any direction, and it will, change its links to other devices frequently.

Unrelated to its own use every device must forward traffic, and therefore it will be a router. The primary challenge in building a MANET is equipping each device is maintain the information required to properly route traffic continuously. Such networks may be connected to larger network or may be operate by themselves [1].

They may contain one or multiple and different transceivers between nodes. This results in a highly dynamic, autonomous topology. MANETs are a kind of wireless ad hoc network (WANET) that usually has a routable networking environment on top of a Link Layer ad hoc network. MANETs consist of a peer-to-peer, self-forming, self-healing network. MANETs typically communicate at radio frequencies (30 MHz – 5 GHz).

A. Routing in MANETs

The absence of fixed infrastructure in a MANET poses several types of challenges. The biggest challenge among them is routing. Routing is the process of selecting paths in a network along which is send data packets. An ad-hoc routing protocol is a convention, or standard, that controls how nodes decide which way to route packets between computing devices in mobile ad-hoc network [1]. The basic idea is that a new node may announce its presence and should listen for announcements broadcast by its neighbors. Each node learns about nearby nodes and how to reach them and may announce that it can reach them too. The routing process usually directs forwarding on the basis of routing table which maintain a record of the routes to various network destinations. Thus, constructing routing tables [2].

B. Routing protocols in MANETs

The growth of laptops and 802.11/Wi-Fi wireless networking have made MANETs a popular research topic since the mid-1990s. Many academic papers evaluate protocols and their abilities, assuming varying degrees of mobility within a bounded space, usually with all nodes within a few hops of each other[2]. Different protocols are then evaluated based on measures such as the packet drop rate, the overhead introduced by the routing protocol, end-to-end packet delays, network throughput, ability to scale, etc. In MANETs no routing will be there in order to find the routing we have to use the routing protocols.

II. CLASSIFICATION OF ROUTING PROTOCOLS

The routing protocols for ad-hoc wireless network based on the routing information mechanism. This routing protocols can be defined by three types:

A. Proactive routing protocol

Every proactive routing protocol usually nodes to maintain accurate information in their routing tables. It attempts to continuously evaluate all of the routes within a network. This means the protocol maintains fresh lists of destinations and their routes by periodically distributing routing tables throughout the network. So that when a packet needs to be forwarded, a route is already known and can be as fast and easy as in the traditional wired networks. Unfortunately, it is a big, overhead maintain routing tables in the mobile ad-hoc network environment. Proactive routing protocols become less popular after more reactive routing protocol.

1) *Example of proactive routing protocol:* Destination-Sequenced Distance Vector (DSDV).

B. Reactive routing protocol

Reactive routing protocol do not maintain the routes but built them on demand. A reactive protocol finds a route on demand by flooding the network with route requests packets. It is interesting to keep the network silent when there is no traffic to be routed. It creates as per needs.

1) *Examples of reactive routing protocols:* Ad-hoc On-Demand Distance Vector(AODV), Dynamic Source Routing(DSR).

C. Hybrid protocol

The hybrid protocols support both reactive and proactive. It uses the table driven and on-demand protocols.

1) *Example of hybrid protocols:* ZRP protocol.

III. ROUTING PROTOCOLS

A. Destination-Sequenced Distance-Vector Routing (DSDV):

DSDV is a table-driven routing scheme for ad hoc mobile networks based on the Bellman–Ford algorithm. It was developed by C. Perkins and Bhagwat in 1994. The main contribution of the algorithm was to solve the routing loop problem. Each entry in the routing table contains a sequence number, the sequence numbers are generally even if a link is present; else, an odd number is used. The number is generated by the destination, and the emitter needs to send out the next update with this number [3]. Routing information is distributed between nodes by sending full dumps infrequently and smaller incremental updates more frequency. The structure of the routing table for this protocol is simple. Each table entry has a sequence number that is incremented every time a node sends an updated message. Routing tables are periodically updated when the topology of the network changes and are propagated throughout the network to keep consistent information throughout the network. Each DSDV node maintains two routing tables: one for forwarding packets and one for advertising incremental routing packets. The routing information sent periodically by a node contains a new sequence number, the destination address, the number of hops to the destination node, and the sequence number of the destination. When the topology of a network changes, a detecting node sends an update packet to its neighbouring nodes. On receipt of an update packet from a neighbouring node, a node extracts the information from the packet and updates its routing table as follows:

1) *DSDV Packet Process Algorithm*

a) If the new address has a higher sequence number, the node chooses the route with the higher sequence number and discards the old sequence number.
b) If the incoming sequence number is identical to the one belonging to the existing route, a route with the least cost is chosen.
c) All the metrics chosen from the new routing information are incremented.
d) This process continues until all the nodes are updated. If there are duplicate updated packets, the node considers keeping the one with the least-cost metric and discards the rest.

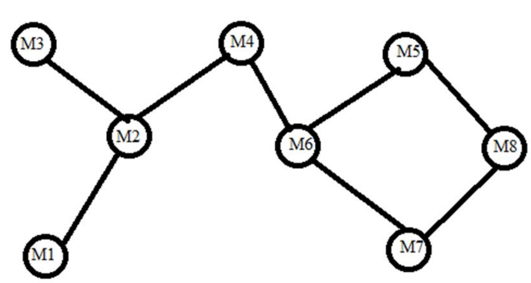

Fig1: Example of DSDV in operation.

Destination	Next hop	Metric (Hop Count)	Sequence number
M1	M2	2	S406_M4
M2	M2	1	S128_M1
M3	M2	2	S564_M2
M4	M4	0	S710_M3
M5	M6	2	S392_M5
M6	M6	1	S076_M6
M7	M6	2	S128_M7
M8	M6	3	S050_M8

Table1: Forwarding table for node M4

2) Advantages

a) Simple (like distance vector).

b) Loop free through destination sequence number.

c) No latency caused by route discovery.

3) Disadvantages

a) No sleeping nodes.

b) Most routing information never used.

B. Dynamic Source Routing(DSR)

The Dynamic Source 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. Network nodes cooperate to forward packets for each other to allow communication over multiple "hops" between nodes not directly within wireless transmission range of one another [4]. As nodes in the network move about or join or leave the network, and as wireless transmission conditions such as sources of interference change, all routing is automatically determined and maintained by the DSR routing protocol. Since the number or sequence of intermediate hops needed to reach any destination may change at any time, the resulting network topology may be quite rich and rapidly changing.

DSR is composed of the two main mechanisms:

1) Route Discovery: It is finding routes from a source node to destination. When a source node S wants to send a data packet to some destination node D, it first searches its route cache to find whether there is a route to D. If there is no route to D, then S will initiate a Route Discovery and send out Route Request message which is propagated to all the nodes within its transmission range. At the meantime, it saves the data packet in its send buffer. The Route Request message contains the addresses of source node and destination node, a unique route request identifier and a route record which records all the intermediate nodes that this route request packet has travelled through. S appends itself to the beginning of the route record when it initiates the message. When a node receives the Route Request message, it compares the destination address in the message with its own address to judge whether itself is the destination node. If it is not, it will append its own address in the route record and propagate the message to other nodes. If the node is the destination node, it will send a Route Reply message to the source node and the message contains the source route record which is accumulated when the Route Request message is forwarded along its way to the destination. When the destination sends the Route Reply, if it uses MAC protocols such as IEEE 802.11 that require a bidirectional link, it just reverse the source route record and use it as route to send Route Reply to the source node. Otherwise it should find the route by searching its route cache or sending out a Route Request which piggybacks the Route Reply for the source node. When the source node receives the Route Reply message, it puts the returned route into its route cache. From then on, all the packets destined to the same destination will use this route until it is broken.

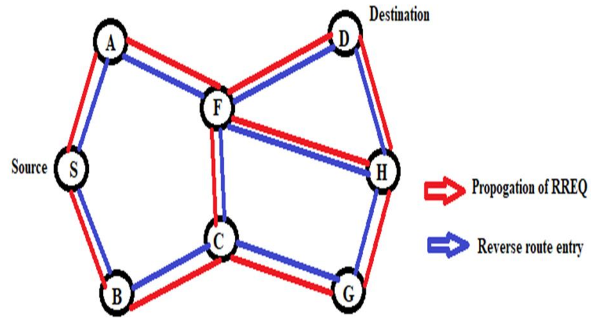

Fig2: Example of DSR

2) *Route maintenance:* Since the ad hoc network is dynamic and the topology of the network changes frequently, the existing routes maintained by nodes in their route cache are often broken. After forwarding a packet, a node must attempt to confirm the reachability of the next-hop node. If the node does not receive any confirmation from the next hop during a certain period [4], it will retransmit the packet. If after a maximum number of retransmission still does not receive any confirmation, it will think the link to the next hop is broken and will send a Route Error message to the source node.
3) *Advantages*
a) DSR uses a reactive approach which eliminates the need to periodically flood the network with table update messages which are required in a table-driven approach.
b) The intermediate nodes also utilize the route cache information efficiently to reduce the control overhead.
4) *Disadvantages*
a) DSR is that the route maintenance mechanism does not locally repair a broken-down link.
b) The connection setup delay is higher than in table- driven protocols. Even though the protocol performs well in static and low-mobility environments, the performance degrades rapidly with increasing mobility.
c) Routing overhead is involved due to the source- routing mechanism employed in DSR. This routing overhead is directly proportional to the path length.

C. Ad-hoc on-demand distance vector(AODV)

Ad Hoc On-Demand Distance Vector (AODV) is a routing protocol designed for wireless and mobile ad hoc networks. This protocol establishes routes to destinations on demand and supports both unicast and multicast routing. The AODV protocol builds routes between nodes only if they are requested by source nodes [5]. AODV is therefore considered an on-demand algorithm and does not create any extra traffic for communication along links. The routes are maintained as long as they are required by the sources. They also form trees to connect multicast group members. AODV makes use of sequence numbers to ensure route freshness. They are self-starting and loop-free besides scaling to numerous mobile nodes. In AODV, networks are silent until connections are established. Network nodes that need connections broadcast a request for connection. The remaining AODV nodes forward the message and record the node that requested a connection. Thus, they create a series of temporary routes back to the requesting node [5].

A node that receives such messages and holds a route to a desired node sends a backward message through temporary routes to the requesting node. The node that initiated the request uses the route containing the least number of hops through other nodes. The entries that are not used in routing tables are recycled after some time. If a link fails, the routing error is passed back to the transmitting node and the process is repeated.

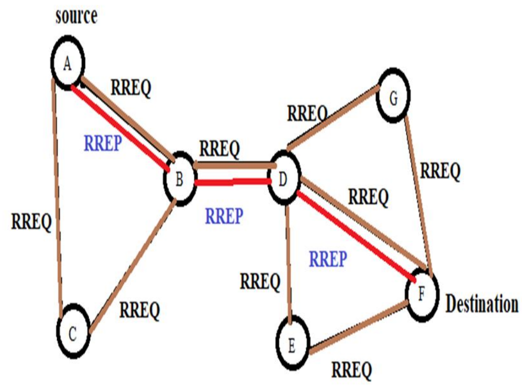

Fig3: Example of AODV protocol.

1) *Advantages*
a) Establishes routes on-demand.
b) Uses destination sequence numbers to find latest route to D.
c) Requires less time in setting up a connection.

2) *Disadvantages*
a) Unnecessary bandwidth consumption.
b) Multiple RREPs in response to a single RREQ can lead to heavy control overhead.
c) Intermediate nodes have stale entries.

IV. QoS PARAMETERS

A. *Packet delivery ratio*

Packet delivery ratio is defined as the ratio of data packets received by the destinations to those generated by the sources. Mathematically, it can be defined as

PDR= S1÷ S2……………………… (1)

Where, S1 is the sum of data packets received by each destination and S2 is the sum of data packets generated by each source. Performance of the DSDV is reducing regularly while the PDR is increasing in the case of DSR and AODV [7]. AODV is better among the three protocols.

B. *End-to-End delay*

The average time it takes a data packet to reach the destination. This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue. This metric is calculated by subtracting time at which first packet was transmitted by source from time at which first data packet arrived to destination [7]. Mathematically, it can be defined as

M Avg. EED=S/N……………. (2)

Where S is the sum of the time spent to deliver packets for each destination, and N is the number of packets received by the all destination nodes.

C. *Throughput*

It is defined as the total number of packets delivered over the total simulation time. The throughput comparison shows that the three algorithms performance margins are very close under traffic load of 50 and 100 nodes in MANET scenario and have large margins when number of nodes increases to 200 [7].

Mathematically, it can be defined as:

Throughput= N/T………… (3)

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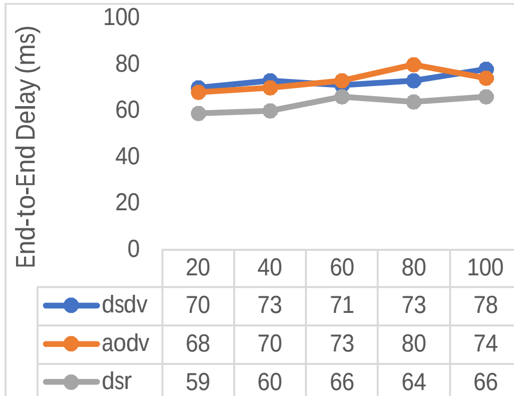
Where N is the number of bits received successfully by all destinations.

T = Time

V. RESULTS & ANALYSIS

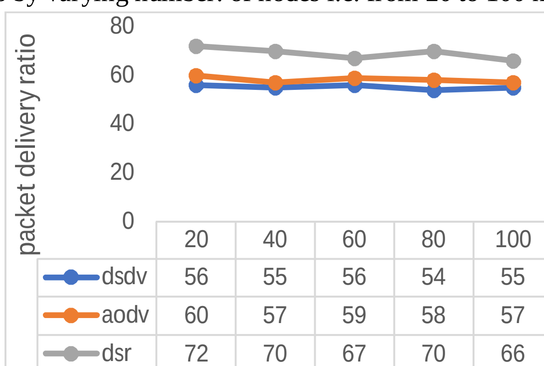
The performance of DSDV, DSR and AODV routing protocols are evaluated. The simulation results are carried out using the Network simulator (NS 2.34). The routing protocols are compared.



	20	40	60	80	100
dsdv	70	73	71	73	78
aodv	68	70	73	80	74
dsr	59	60	66	64	66

Fig4: End-to-End delay Vs number of nodes.

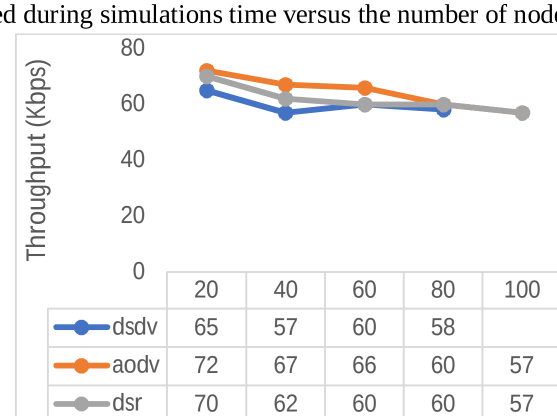
Figure. 4. Shows that the end delay is increasing with increasing number of nodes. The end-to-end delay of DSR protocol is less compare to the DSDV, AODV protocols by varying number. of nodes i.e. from 20 to 100 nodes and node speed remains constant.



	20	40	60	80	100
dsdv	56	55	56	54	55
aodv	60	57	59	58	57
dsr	72	70	67	70	66

Fig5: Packet delivery ratio Vs number of nodes.

Figure.5. Shows that the packet delivery ratio of DSDV, DSR, AODV protocols by varying number of nodes. From the simulation results DSR protocols has higher packet delivery ratio than DSDV, AODV protocols. Graphs show the fraction of data packets that are successfully delivered during simulations time versus the number of nodes



	20	40	60	80	100
dsdv	65	57	60	58	
aodv	72	67	66	60	57
dsr	70	62	60	60	57

Fig6: Throughput Vs number of nodes.

From the figure 6. It shows the throughput is increasing with increasing number of nodes i.e. from 20 to 100 nodes and node speed constant. Throughput for DSDV, DSR and AODV protocols. The AODV protocol has good throughput when compare with the DSDV and DSR protocols.

Table2: Simulation scenario

S. No	Network parameters	Value
1	Routing Protocols	DSDV, DSR, AODV
2	Simulation area	1000 X 1000
3	MAC	IEEE 802.11
4	Number of Nodes	20, 40, 60, 80, 100
5	Traffic Type	CBR
6	Date Rate	1Mbps
7	Speed	20m/s
8	Initial Energy	5 Joules
9	Simulation time	100 secs

VI. CONCLUSION

This paper does the realistic comparison of three routing protocols DSDV, DSR and AODV. In the DSDV and AODV routing protocols the results are less when compare to the DSR routing protocol. The good results are present in the DSR routing protocol. Based on the QoS parameters like the three graphs such as packet delivery ratio, end-to-end delay, throughput was calculated. And another graph energy consumption can also be calculated by this parameter.

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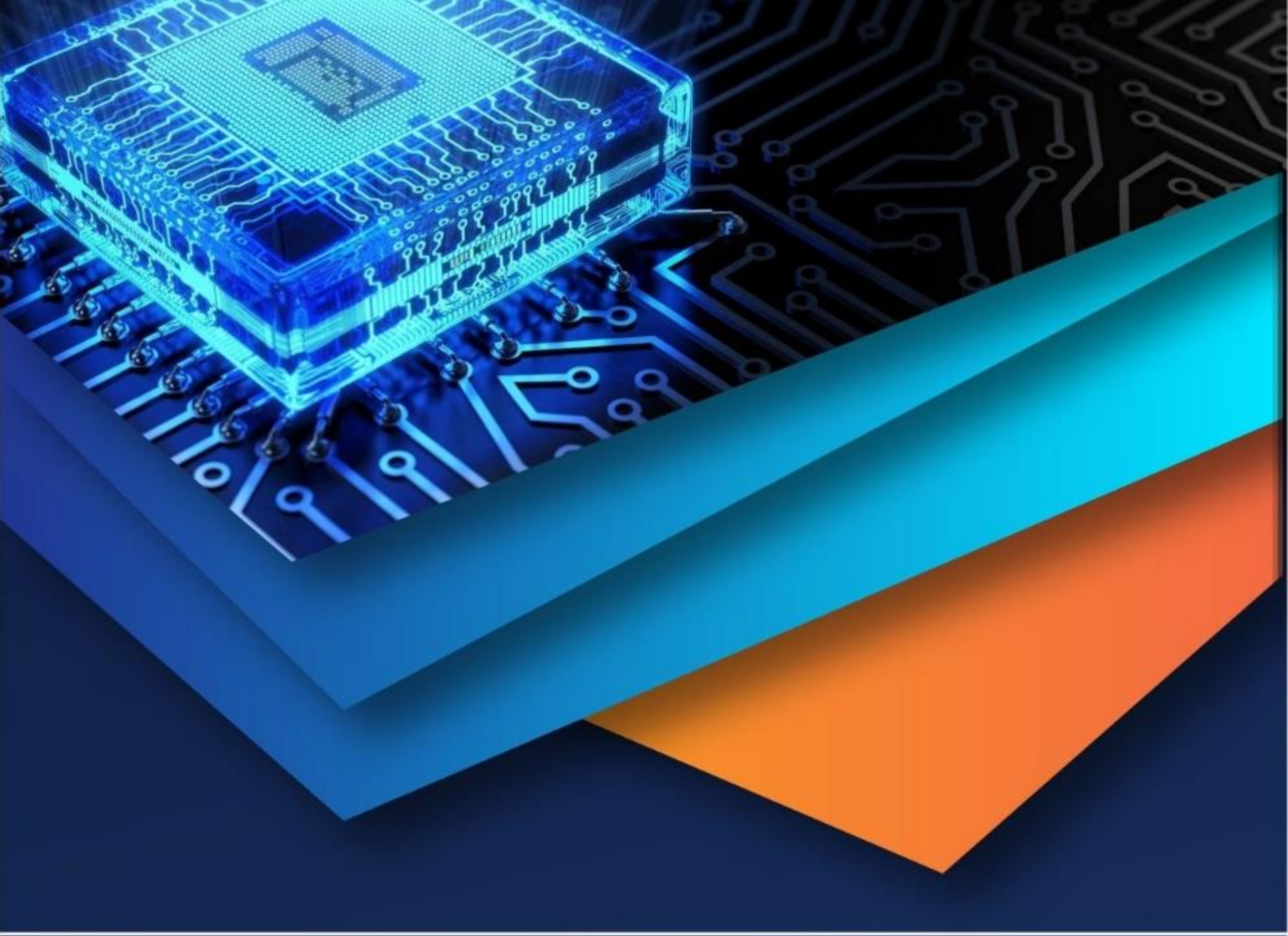

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