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AODV & DSR Reactive Routing Protocols with a Comparative Study

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Abstract— ***For any kind of network i.e. wired or wireless, routing is an important function. In routing process a node i.e. source transmit the data packets to another node i.e. destination. Routing in wireless networks have great challenges due to mobility, limited transmission range, limited bandwidth, battery constraints, and broadcast nature. A mobile ad-hoc network (MANET) is a wireless network in which mobile wireless nodes are connected is such a way that no centralized administration is required for communication. Due to mobility in nodes, we need routing protocols those can handle the topological changes without loose of communication. The MANET routing protocols are basically classified into three main categories: Proactive, Reactive and Hybrid. By using simulation we can evaluate performance of MANETs routing protocols. Performances of the protocols vary from one network scenario to another scenario. In this paper we provide an overview of AODV & DSR reactive routing protocols explained in the literature. We also provide a performance comparison between them and suggest which protocol may perform best in varying number of nodes.***

Keywords— ***AODV, CBR, DSR, ETE, MANET, RREQ, RREP, RERR, Proactive, Reactive, Hybrid,***

I. INTRODUCTION

The MANET is a short abbreviated form of Mobile Ad hoc Network. It is a wireless network without infrastructure and centralized administration. The mobile nodes are responsible for establishing and maintaining connection between each other. Since each mobile node is a router and host so they can randomly associate with each other. The ability of MANET makes this technology suitable for conferences, virtual classrooms, emergency search and rescue operations disaster-hit areas, automated battlefield, and to operate in the environments where it is difficult or expensive to setup an infrastructure.

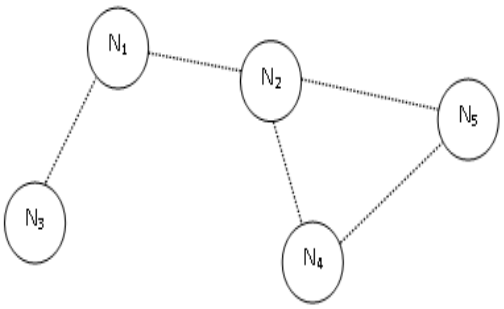

Figure 1 Mobile Ad-hoc Network (MANET)

A simple example of MANET is shown in the figure 1. Here mobile nodes are represented by a circle and dash line show the wireless connection between them. Subscript number is used to distinguish the nodes. Due to the infrastructure less and the dynamic nature of MANETs, different kind of networking policies are required and implemented to provide efficient ETE communication. Since MANETs can be deployed quickly at a very low cost and can be easily managed so in the next generation we will have more and more ad-hoc networks. The characteristics of MANET forced us to design new routing algorithms for transmitting a packet from a source node to the destination node via number of different nodes. A routing protocol must be able to decide the best path between the nodes, minimize the routing overhead, minimize the time required to converge after the topology changes and maximize the bandwidth utilization. Therefore, developing support for routing is one of the key research areas in MANETs. There are many routing protocols for MANET as AODV, CGSR, DSDV, DSR, DYMO, FSR, GSR, OLSR, STAR, TORA, WRP and ZRP etc. The categories of these protocols are Proactive, Reactive and Hybrid.

II. RELATED WORK

To achieve enhanced bandwidth utilization, minimum energy consumption, higher throughputs, less overheads and other network related constraints in MANETs a number of routing protocols have been proposed and implemented. Different

routing protocols have used different measures to determine an optimal path between the source node and the destination node. These protocols have various advantages and disadvantages. A lot of simulation studies were carried out in paper [3], [16] to analyze the quantitative properties of routing protocols. A number of comparative studies/ review papers on various MANET routing protocols have been proposed, which highlights some of the quantitative analysis or comparison between different types of protocols[1], [7]. Our efforts are to provide a qualitative as well as quantitative comparison of the two most popular MANETs routing protocols DSR [2] & AODV [6]. This paper is concentrated on the study, survey and comparison of most popular routing protocols AODV & DSR. The next section describes the DSR and AODV routing protocols. Any MANET routing protocol exhibits two types of properties:

TABLE I

MEASURES OF ROUTING PROTOCOLS

Quantitative	Throughput, End-To-End Delay, Route Discovery Time, Packets Delivery Ratio, Overhead
Qualitative	Loop Freedom, Route Stability, Demand Based Routing, Reliability, Multi-Path Routing

III. AD-HOC ON-DEMAND DISTANCE VECTOR ROUTING PROTOCOL (AODV)

Ad-Hoc On-Demand Distance Vector Routing Protocol is a single path, source initiated, On-demand routing protocol. AODV protocol follows the destination sequence number concept to preserve the recent routing information between nodes[20]. The source discovers a route by broadcasting the route request packets (RREQ). Entries in routing table are maintained dynamically at intermediate nodes. This protocol provides a loop free route and minimizes the bandwidth that is used in network control. Followings are the steps in AODV routing protocol:

- Each node maintains two numbers: sequence_num and broadcast_id.
- Only the members of an active route exchange "hello" message if they have not exchanged packets previously.
- For a route discovery, the source sends RREQ packet to its neighbours, the message contains : < src_addr, src_seq_num, broadcast_id, dst_addr, dst_ seq_num, hop_cnt >
- If any intermediate node receives a RREQ for the first time then it keeps track of the src_add, src_broadcast_id, src_seq_num, dst_add, and the address of the broadcasting node and sets a reverse path to the source node.
- When the RREQ reaches the destination node or any intermediate node that has a route for the destination with seq_num > = dst_seq_num, a RREP is sent to the source via reverse path by carrying: src_add, dst_add, dst_seq_num, hop_cnt.
- If intermediate nodes received more RREP packets carrying the same dst_seq_num but having greater hop_cnt of the first RREP received then those are ignored.

A route error packet (RERR) is broadcasted towards the source node via propagating each neighbour node whenever a link break is occurred in currently active route. In this situation the source node has to discover a new route from the source to destination by using route discovery activity. The way RREQ and RREP packets are propagating in the network is shown in an easy way in the figure 2. In the figure 2 and other figures dash lines show the connection between the nodes[23].

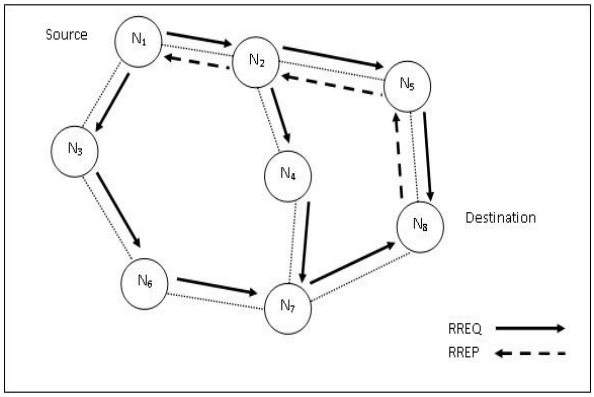

Figure 2 AODV Protocol

Advantages

- Smaller message size since routes are not a part of packet header.
- The routes which are not used within specified expiration time are expired.
- AODV also supports multicasting.
- Useful in highly mobilize MANETs.
- Routing is loop free in AODV protocol.
- The time required for a connection is less as compare to DSR.

Limitations

- Stale routes can be used when intermediate nodes have higher number as compare to source sequence number.
- Latency is higher before data transmission due to route discovery.
- Problem of scalability
- Since there are many route reply messages for single route hence higher control overheads.

IV. DYNAMIC SOURCE ROUTING PROTOCOL (DSR)

Dynamic Source Routing Protocol is a reactive protocol designed for multiple hops in MANET. The algorithm of source routing is the basis of this protocol. The complete route information i.e. ordered list of nodes towards destination is contained in each data packets. Firstly Route cache is used to discover the route to destination that is maintained by each mobile node[20]. An update in route cache is taken place whenever a new route comes in the existence. Route discovery and maintenance are the two important phases in DSR:

- Route discovery is the phase in which a source node wants to send a packet to a destination node but there is no route available between source and destination node in the route cache. In this situation source node broadcast a route request packet for route discovery. If a route between source and destination is in route cache and that route is unexpired then the routing information available in route cache is placed in the data packet by the source node.
- Route maintenance is the phase in which a node is able to overcome a broken link between the source node and the destination node. Route error packets are used to maintain the route and to remove the hop from the route cache of the related nodes.

Following are the steps at the source node while source node is sending data to destination node:

- Source node is looking for an unexpired route in route cache of source node.
- If route is found then that route is placed in the packet header and sends the data packet to the next hop in the MANET.
- Else source starts route discovery mechanism by broadcasting the RREQ packet.
- When source node received first RREP packet from the destination node, that route will be updated in the cache route and the routing information is placed in the packet header. Now source node sends the data packet to next hop in the MANET[22].

Following are the steps at the intermediate nodes:

- Intermediate node accepts the RREQ packet and searches that source in recently broadcasted request.
- If the route is present in the request list then it discard the route request and send RREP packet.
- Else appending the packet by adding it's id and broadcast to the neighbour node and store source id in the list.

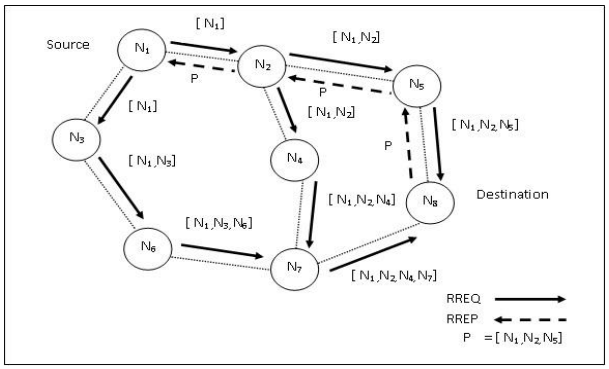

Figure 3 DSR Protocol

Advantages

- The activity of route discovery utilizes less network resources due to the availability of the route in the route cache at each node.
- Periodic messages are not required hence low overhead.
- Route maintenance is done only between the communicating nodes.
- There is no need to inform neighbouring nodes regarding they are working.

Limitations

- If the number of intermediate nodes is increases between source and destination node then the packet header size is also increases.
- A stale route can occur if the link broken rate is higher.
- In large size networks latency is higher due to increase in the overhead.

V. COMPARATIVE STUDY

This section provides comparative study between AODV and DSR MANETs routing protocols. Table 2 & 3 are used for this purpose[20]. Time complexity is defined as the number of steps needed to perform a protocol operation and communication complexity is the number of messages needed to perform a protocol operation [10], [17]. Also, the values for these metrics represent the worst case behaviour. Since reactive routing protocols were proposed to reduce the traffic control overhead and improve scalability. The DSR algorithm is specifically designed for those MANETs in which the mobility rate of the nodes is moderate with respect to packet transmission latency [2]. DSR does not make use of periodic routing advertisements hence saving bandwidth and reducing power consumption. DSR is not scalable to large size MANETs because of the small diameter assumption and the source routing. Similar to AODV, DSR employs a route discovery procedure, but the overhead is less than that of DSR because AODV packet contains the destination address only instead DSR in which packet contains the complete routing information. Another advantage of AODV is that it supports multicasting [7]. AODV exploits both a source routing from DSR and distance vector used in DSDV. AODV

has less traffic control overhead and is most scalable. Exchange of hello messages are done with their neighbouring nodes periodically to monitor link failures in AODV.

TABLE 2
QUALITATIVE MEASURES BASED COMPARISON BETWEEN AODV & DSR

Parameters	DSR	AODV
Protocol Type	Source Routing	Distance Vector & Source Routing
Multiple Routes	Yes	No
Route Maintained	Route Cache	Route table
Routing Metric	Short Path	Fresh & Short Path
Route Computation	Reactive	Reactive
Routing Structure	Flat	Flat
Loop Free	Yes	Yes
Route Cache	Yes	No
Update Period	Event Driven	Event Driven
Multicast Capability	No	Yes
Hello Message	No	Yes
Sequence Number	No	Yes
Time Complexity	O(2d)	O(2d)
Multiple Routes	Yes	No
Updates Towards	Source	Source

TABLE 3
QUANTITATIVE MEASURES BASED COMPARISON BETWEEN AODV & DSR

	No. of Nodes	DSR	AODV
End To End Delay (ms)	**10**	18	12
	20	33	11
	30	10	12
	40	33	15
	60	41	21
	80	61	28
Packet Delivery Ratio (%)	**10**	95	95
	20	99	99
	30	99	99
	40	99	99
	60	99	99
	80	98	98
Throughput (Kbps)	**10**	86	89
	20	93	93
	30	93	93
	40	93	93
	60	93	93
	80	91	91
Overhead (%)	**10**	0	0
	20	0	2
	30	0	2
	40	1	5
	60	2	10
	80	6	18

In the table 3 we showed the quantitative measures for DSR and AODV routing protocols with the respective values. These measures are calculated by using some parameters values such as Simulation area was 500m*500m, Pause Time was 100sec, Packet size was 512, Max. Node speed was 20 m/s and Traffic Sources was CBR [19].

VI. CONCLUSIONS

In this paper, an effort has been made to concentrate on the comparative study of AODV & DSR. Since a single routing protocol is not best in all kind of situations. So we must choose a protocol as per the requirements of the specific application and the environment. The routing protocols: AODV and DSR are evaluated for qualitative measures like loop free, multi route, multicasting etc. and performance metrics like packet delivery ratio, end-to-end delay, throughput and

routing overhead with increasing number of mobile nodes from 10 to 80. As a result of this study, we conclude that AODV have an upper hand on DSR in terms of end-to-end delay and throughput with increasing number of mobile nodes because of its on demand characteristics to find out the freshest routes. But in the case of packet delivery ratio, both the MANETs routing protocols performed in the same way. This table also indicates that as the number of nodes in the network increases AODV and DSR gives nearly constant throughput. Considering the overall performance, AODV performs well with varying network size.

VII. FUTURE WORK

In future research work we can propose an extension of the existing reactive routing protocols which will be better in terms of End-to-End delay, Throughput, Efficient utilization of limited resources, Packet Delivery Ratio and Overhead.

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