A Survey Paper on AODV Routing Protocol for MANET

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Abstract— Now a day, Ad-hoc network has become an indivisible part for communication for mobile devices. 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. Routing is the process which transmitting the data packets from a source node to a given destination. The main classes of routing protocols are Proactive (table driven), Reactive (on demand) and Hybrid. A Reactive (on-demand) routing strategy is a popular routing category for wireless ad hoc routing. The most efficient reactive protocol is Ad-hoc on demand distance vector (AODV) routing protocol .This paper provides an overview of AODV protocols by presenting their characteristics, functionality, various protocol property parameters such as Route Discovery, Flooding, Route Maintenance and Advantages and limitations. The NS-2 is used for the simulation purpose. In this paper we present the AODV protocol and survey various security enhancements that have been proposed for AODV by different researchers.

Key words: Wireless technologies, Ad Hoc network, Routing protocol, Proactive and Reactive routing protocols, AODV, Flooding, Route Discovery, Route Maintenance, Security

I. INTRODUCTION

MOBILE ad hoc network (*MANET*) [1] consists of a many of wireless mobile nodes communicating with each other without any centralized control or fixed network infrastructure. Today, wireless technologies such as IEEE 802.11 [2], Bluetooth [3], and third-generation cellular have led to a proliferation of mobile devices. The wireless network can be classified into two types:

- Infrastructure network
- Infrastructure less or Ad Hoc network.

In Infrastructure wireless networks, the mobile node can move while communicating, the base stations are fixed and as the node goes out of the range of a base station, it gets into the range of another base station. The fig. 1, given below, depicts the Infrastructure wireless network.

Fig.1: Infrastructure based wireless networks.[21]

In Infrastructure less or Ad Hoc wireless network, the mobile node can move while communicating, there are no fixed base stations and all the nodes in the network act as routers. The mobile nodes in the Ad Hoc network dynamically establish routing among themselves to form their own network 'on the fly'. This type of network can be shown as in fig. 2.

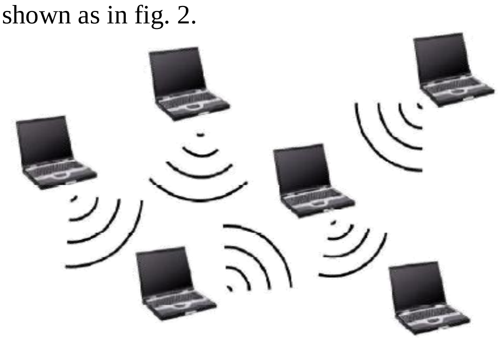

Fig. 2: Infrastructure less or Ad Hoc Wireless Networks [21]

II. ROUTING IN MANET

MANET routing protocols may be broadly classified into two major categories: Proactive and Reactive. Other category of MANET routing protocols which is a combination of both proactive and reactive is referred as Hybrid. The fig.3 shows classifying MANETs routing protocols.

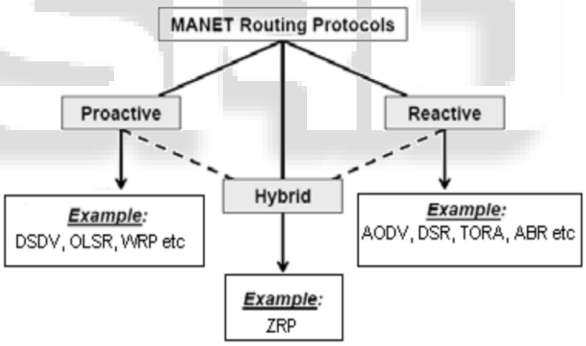

Fig. 3: Classification of MANET routing protocols

A. *Proactive Routing Protocols:*

These are table driven protocol. Proactive Protocols continuously learn the topology of the network by sharing topological information among the network nodes. All nodes keep on updating these tables to maintain latest view of the network.

1) *Proactive Routing Protocols:*

- Dynamic Destination-Sequenced Distance-Vector Routing Protocol (DSDV) [4]
- Global State Routing (GSR) [5]
- Wireless Routing Protocol (WRP) [6]

B. *Reactive Routing Protocols:*

The reactive routing protocols are based on query-reply dialog. Reactive protocols establish route(s) to the destination only when the need arises. Therefore, the latency is high; however, no unnecessary control messages are required.

1) *Reactive Routing Protocols:*
   – Ad Hoc On-Demand Distance Vector Routing (AODV)[7]
   – Dynamic Source Routing (DSR)[8]
   – Temporarily Ordered Routing Algorithm (TORA)[9]

C. *Hybrid routing protocols:*

These protocols incorporate the merits of proactive as well as reactive routing protocols. Nodes are grouped into zones based on their geographical locations or distances from each other. Inside a single zone, routing is done using table-driven mechanisms while an on-demand routing is applied for routing beyond the zone boundaries. Thus, control overhead is reduced.

– Zone Routing Protocol(ZRP)[10]

III. ADOV (AD HOC ON DEMAND DISTANCE VECTOR) [7], [11]

AODV belongs to the class of Distance Vector Routing Protocols (DV). In a DV every node knows its neighbors and the costs to reach them. Unicast and multicast routing is supported by AODV [7]. AODV is composed of three mechanisms: Route Discovery process, Route message generation and Route maintenance. AODV performs route discovery using on-demand route requests (RREQ); the same process as the DSR protocol [8].

There following four classes represent the different AODV [7] messages:

– Route Request Message (RREQ) is a route request message used whenever a new route to destination is required.
– Route Reply Message (RREP) is a reply message for a route request.
– Route Error Message (RERR) is a route error message.
– Periodic HELLO messages are broadcast to check the presence of immediate active neighbors.

AODV has improved upon the DSR route request process using an expanding ring search mechanism based upon incrementing time-to-live (TTL) to prevent excessive RREQ flooding in fig.4.

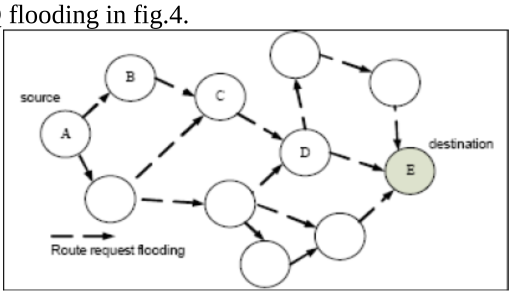

Fig. 4: Route Request (RREQ) flooding [12]

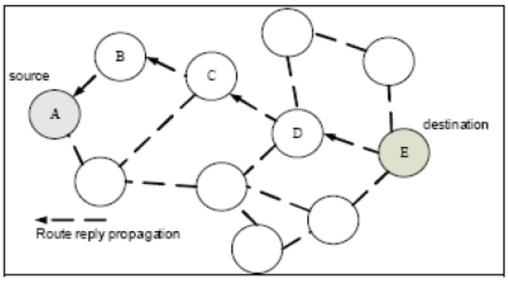

Fig. 5: Route Reply (RREP) propagation [12]

AODV builds routes using a route request route reply fig.5 query cycle. Source node broadcasts a route request (RREQ) packet across the network when it wants a route to destination. The route tables have backward pointers for nodes which receive packet and source nodes and update their information for the source node. In addition to the broadcast ID, source IP address, current sequence number the RREQ has updated sequence number for the destination. A route reply (RREP) is sent by node which receiving the RREQ, node which is the destination or has a route to the destination with greater sequence number. the RREQ's source IP address and broadcast ID [7] is maintained by nodes. Flows of AODV Protocol see fig.6,

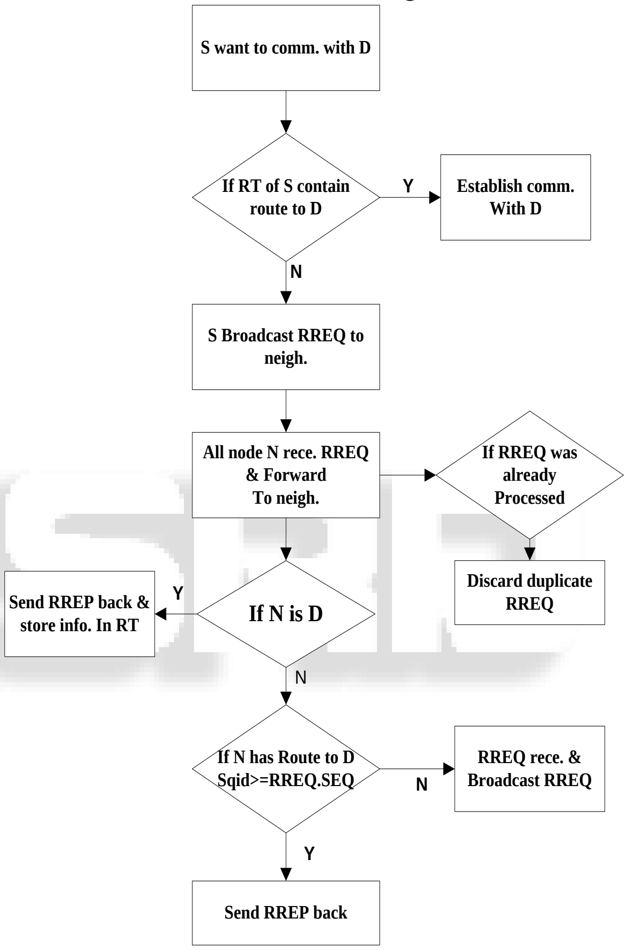

Fig. 6: Flow of AODV [18]

Already processed RREQ is not forwarded. The RREP sends back to the source by Nodes.it set forward pointers. The source node forward data packets to the destination

A. *Route Discovery*

The process broadcasts a ROUTE REQUEST packet, which is flooded across the network. In addition to the source node address and target node address, the request packet contains a route record, which records the sequence of hops taken by the request packet as it propagates through the network. RREQ packets use sequence numbers [13] to prevent duplication. Many distance vector routing protocols suffer from a condition called Count to infinity [14]. This problem can be solved in AODV by using sequence numbering scheme which is derived from DSDV. The source node looks for route by broadcasting a route request (RREQ) packet to its neighbors. The RREQ contains the following fields:

< source_addr; source_ sequence #; broadcast_ id; dest_ addr; dest _sequence #; hop cnt >

The pair < source addr; broadcast id > uniquely identifies a RREQ. The RREQ packet [15] looks like fig 7,

Type	Flag	Resvd	hopcnt
Broadcast_id			
Dest_addr			
Dest_sequence_#			
Source_addr			
Source_Sequence_#			

Fig. 7: RREQ Packet of AODV

Suppose S would like to communicate with D Fig. 6, the node sends out a RREQ to explore a route to the destination. S generates a Route Request with destination address, Sequence number and Broadcast ID and sent it to his neighbor nodes.

Creates a Route Request (RREQ),

Enters D's IP addr, seq#, S's IP addr, seq#, hopcount (=0) fig.8,

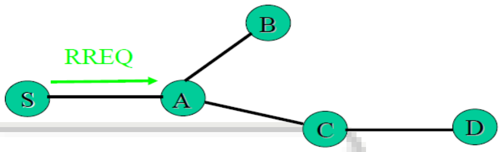

Fig. 8: Path finding in AODV (RREQ)

Each node receiving the route request sends a route back (Forward Path) to the node. Node A receives RREQ Makes a Reverse route entry for S dest=S, next hop=S, hop count=1 it has no routes to D, so it rebroadcasts RREQ fig.9

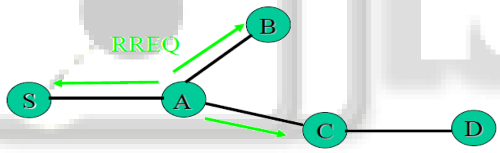

Fig. 9: Path finding in AODV (RREQ)

Now, if a node receives an RREQ packet and it has current route to the target destination, then it unicasts a route reply packet (RREP) to the neighbor that sent the RREQ packet. The RREP packet [15] looks like fig 10,

Type	Flag	prsz	hopcnt
Dest_addr			
Dest_sequence_#			
Source_addr			
lifetime			

Fig. 10: RREP Packet of AODV

Node C receives RREQ and C creates a Route Reply (RREP), Enters D's IP addr, seq#, S's IP addr, hop count to D (=1) and Unicasts RREP to A fig 11,

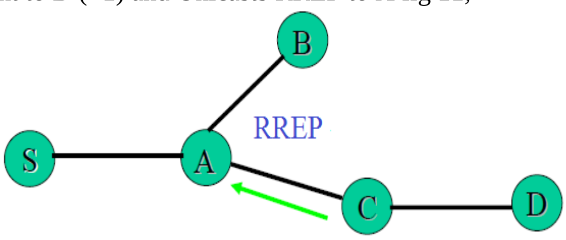

Fig. 11: Path finding in AODV (RREP)

Node A receives RREP Makes a forward route entry to when an intermediate node receives the RREP, it sets up a forward path entry to the destination in its route table. Forward path entry contains,

<IP Address of destination, IP address of node from which the entry arrived, hop-count to destination, life-time>

dest=D, nexthop=C, hopcount=2 and Unicasts RREP to S fig.12,

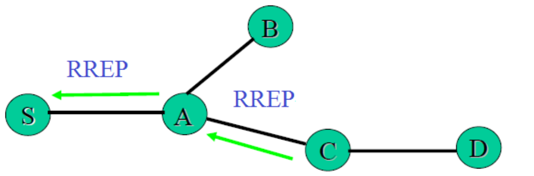

Fig. 12: Path finding in AODV (RREP)

Node S receives RREP Makes a forward route entry to D,dest=D, nexthop =A, hopcount = 3 ,Source can begin data transmission upon receiving the first RREP or May forward another RREP if that has greater destination sequence number or a smaller hop count. Data send from S to D fig.13,

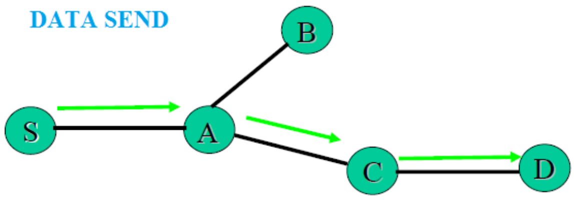

Fig. 13: Data Delivery by AODV

A. Route Maintenance

When a broken link is detected, either by a MAC layer acknowledgment or by not receiving HELLO messages, the upstream node sends Route Error (RERR) message to all predecessor nodes that use the broken link to reach their respective destinations. If the nodes have a route in their routing table with this link, the route will be erased. Node S sends once again a route request to his neighbor nodes. Or a node on the way to the destination can try to find a route to D. That mechanism is called: Local Route Repair. A RERR message is sent to other nodes when active route has broken link Fig.14,

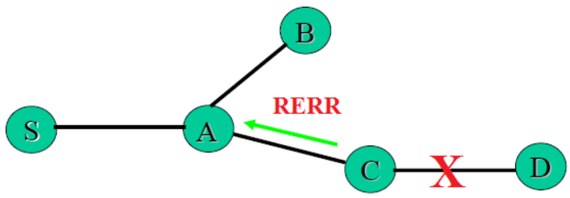

Fig. 14: Path Maintenance in AODV (RERR)

Once the source receives the RERR, it can reinitiate route discovery if it still requires broken. Node C invalidates its route table entries for both nodes D (Fig.15), creates a RERR message listing these nodes, and sends the RERR upstream towards the source.

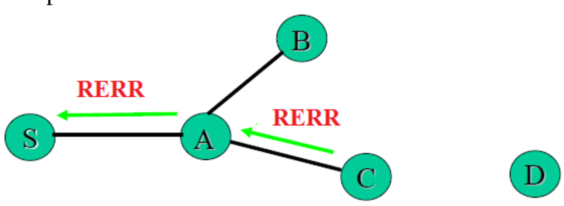

Fig. 15: Path *Maintenance* in AODV (RERR)

B. Benefits and Limitations of AODV

The benefits of AODV protocol are as under:

- The routes are established on demand and destination sequence numbers are used to find the latest route to the destination. The connection setup delay is lower.
- It also responds very quickly to the topological changes that affects the active routes.
- It does not put any additional overheads on data packets as it does not make use of source routing.
- AODV protocol is it also supports both unicast and multicast packet transmissions even for nodes in constant movement. Comparison with other protocol [17].

The limitation of AODV protocol is,

- AODV is vulnerable to various kinds of AODV attacks as it based on the assumption that all nodes must cooperate and without their cooperation no route can be established.
- Need on broadcast medium: The algorithm requires that the nodes in the broadcast medium can detect each other's broadcasts.
- Overhead on the bandwidth: Overhead on bandwidth will be occurred compared to DSR.
- High route discovery latency: AODV is reactive routing protocol
- The various performance metrics begin decreasing as the network size grows.

IV. PERFORMANCE ANALYSIS

The following two quantitative [19] performance metrics are used for this study.

- Average end-to-end delay: Delay caused by latency buffering, queuing, retransmission and route discovery all are included in this performance analysis. This delay is measured in milliseconds.
- Throughput: This is the average number of packets delivered per unit time. Throughput of received bits is measured in kilobits per second.

Other factor which affects the performance is the average end to end delay, Jitter and Graphical Analysis of delay and jitter refers [20].

V. ISSUES OF AODV – SECURITY

Security and authentication schemes for MANETs as well as extensions of AODV designed to increase security, such as Security-aware Ad-hoc On-demand Distance Vector (SAODV)[16] and Adaptive Secure Ad-hoc On-demand Distance Vector (A-SAODV). These protocols feature digital signing of routing traffic and data to ensure integrity and authenticity. Security issues which these protocols address include Message tampering attacks, Message dropping attack and Message replay, also known as the wormhole attack. AODV security protocols need the ability to authenticate and confirm the identity of a source.

VI. CONCLUSION

We have surveyed research papers on fundamentally the AODV protocol for MANET and different approaches to secure AODV. The frequent route repair causes higher route cost and delay this is due to breaking of link. Due to the popularity of the AODV protocol a number of variations and improvements on the core protocol have been proposed by researchers to address specific issues with the protocol.

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