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A Survey on Manet Routing Protocols

Harvaneet Kaur
ECE Department , ITM University, Gurgaon,
Haryana, India

Abstract: Ever wondered how a group of ships in the sea communicate with each other and with aircrafts which are in air! How a vehicle moving in one zone communicate with the vehicle moving in another zone! Well all these kind of communications in our surroundings can be well understood by the concept of ad-hoc networks. MANETs (Mobile Ad-Hoc Networks) is basically the concept which can explain such kind of mobile communication. In this survey, I am going to cover the routing protocols (DSDV, AODV) that are responsible for the communication of mobile nodes and also which protocol is better in which environment. The routing mechanism for different protocols along with the example in the real world has been explained for different protocols.

Keywords: MANET, AODV, DSDV , Count to Infinity , Loop Problem etc.

I. INTRODUCTION

With the increase in development of wireless technology its area of application has extended many folds. Basically the wireless technology has been broadly classified into two categories: infrastructure-based and infrastructure-less technology. As the name specified the infrastructure based technology involves the use of an access point which is used for connecting a wired network with the wireless nodes. Example of this can be seen in airports, school etc. On the other hand, the infrastructure-less technology also known as the ad-hoc network connects the wireless nodes without the requirement of any access points. When such kind of wireless nodes are moving then they become mobile ad-hoc networks also known by the name MANETs. Some of the examples of MANETs are building-to-building, vehicle-to-vehicle, ship-to-ship etc. The clear definition of MANETs has been given by many institutes such as Internet Engineering Task Force (IETF) [1], National Institute of Standard and Technology [2], INTEC Research Group [3].

In MANETS the mobile nodes are connected by multi-hop without any infrastructure requirement. The main aim of the MANETs is to provide robust and efficient operation in mobile environments. In ad-hoc networks all the mobile nodes are dynamically connected in an arbitrary manner. Nodes in such network maintain their own routes to other nodes in the network. Examples like in search and rescue operations, meetings and in defence services. Let us say that there are three ships in sea which are not at the same line-of-sight as shown below:

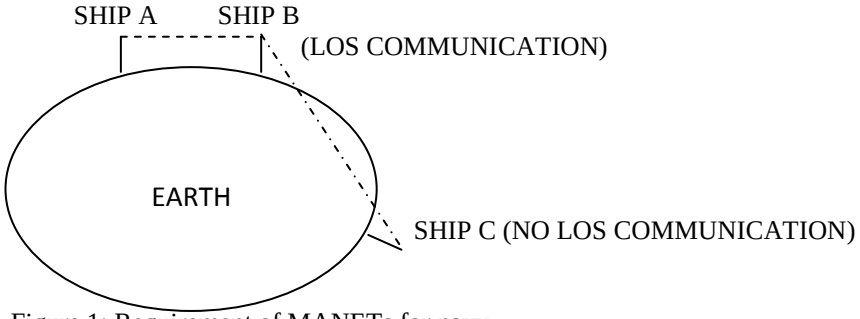

Figure 1: Requirement of MANETs for navy

Figure 1 clearly shows that when ship A wants to communicates with ship B then there is direct communication and this can be done easily but when ship B wants to communicate with ship C then due to the curvature of the earth the communication is not that easy and for this to occur the proper routes have to be developed and this is achieved by the help of MANET routing protocols.

II. CLASSIFICATION OF MANET ROUTING PROTOCOLS

Before classifying the MANETs routing protocols let's have a look at the different broadcasting techniques that is used in MANETs:

- **Unicasting:** It is defined as a broadcasting process where the information is send from the source to a single destination.
- **Multicasting:** It is defined as a broadcasting process where the information is send from a source to asset of destinations.
- **Broadcasting:** It is defined as a broadcasting process where the messages are flooded from a source to all other nodes in the specified networks.

- **Geocasting:** It is the process of sending of information from the source to all other nodes inside a geographical region.

The classification of the routing protocols in MANETs [4] is broadly based on two approaches: Qualitative approach and Quantitative approach. Now the Qualitative approach basically includes the following metrics –

- **Loop Freedom:** In wireless environment where the bandwidth is limited the interference from the neighbouring nodes will lead to the collision of the transmitted packets. And thus the packet is transmitted again and again until it is not received by the destination leading to the formation of a loop. Thus avoidance of these loops for the efficient bandwidth utilization and time processing is required.
- **On demand routing behaviour:** For the proper bandwidth utilization the routes for a particular path are made on demand by disseminating the flow of control messages. This kind of reactive routing introduces medium to high latency.
- **Proactive behaviour:** In order to achieve low latency and where the bandwidth requirement is not the prime issue, in such places this type of routing protocol is used.
- **Security:** In wireless network technology all the nodes should actively participate in the routing process thereby, introducing much security vulnerability in the process. Thus these security vulnerabilities should be checked in the routing protocols.
- **Unidirectional link support:** the node sin the wireless environment may communicate in a unidirectional link. So the routing protocol should be such that it should support both the unidirectional and bidirectional links.

Thus from above Qualitative approach we come to the conclusion that the MANET protocol should be such that the latency, routing overhead, energy consumption , node participation in the routing process and security vulnerability should be properly maintained.
The next type of approach is the quantitative approach which includes the following metrics:

- **End to end data throughput and delay:** In order to check the effective working of the routing protocols in a way that the delays should be minimized and also that the throughput should be increased this kind of approach is useful.
- **Route acquisition time:** In order to minimise the delays in a routing protocols the route should be so developed that the route should take the smaller time for its route discovery and this can be done by this metric.
- **Out of order delivery:** The delivery of the data packets should be in a specific order, if it goes out of order then it will affect the performance of the routing protocol.
- **Efficiency:** Some other metrics are required to check the efficiency of the routing protocols such as packet delivery ratio, bandwidth utilization.

All these attributes are based on the networks with same topology , energy resources , network density , network mobility etc..
Now after having a look on the different approaches and broadcast techniques the routing protocols are broadly classified into three categories as shown below:

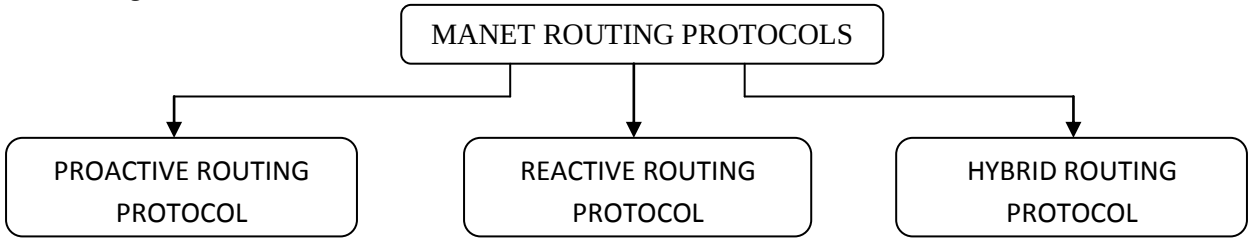

Figure 2: Classification of MANET routing protocol

a. Proactive Routing Protocol

As the name suggested proactive routing protocol, the routes to all the nodes are already stored in routing table of the nodes. One of the well known type of this protocol is the DSDV protocol.

Destination Sequenced Distance Vectored (DSDV)

Let us say that there are three nodes in a network and they want to communicate with each other, let A communicate with node C. In this communication path, node A knows the path to C is from node B i.e. A-B-C as shown in the figure below:

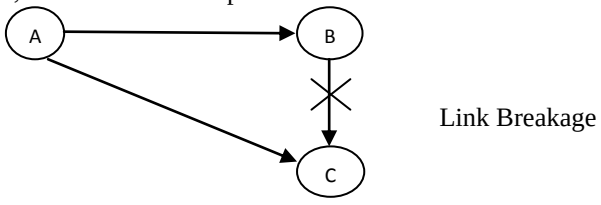

Figure 3: The Loop Problem

Now let us say that the path B is broken or there is some problem in the link B-C. In this scenario the node A will transmit its data packet to node B because it knows that the path to node C is via B but the link at node B is broken so it will find that the path to node C is via node A so it transmit the data packet back to node A. This process will get repeated as both the nodes don't know about the broken path and thus a loop is formed.

In order to avoid this problem of routing loop and to find out the best possible path for the data packets to be transmitted in between the less number of nodes and also where the speed of the nodes is of not much concern then this protocol is used. This is based on distance vector approach [5] and is thus based on the Bellman-ford algorithm [6] for shortest distance path.

The problem of routing loops[7] in this protocol can be solved by the addition of the new attribute, sequence number, to the routing table that is used to distinguish the stale route information from the new. Thus the routing table in DSDV protocol comprises of the available destination, the metric, the next hop and the sequence number in its routing table. These routing tables get updated each time the data is transmitted and received between the nodes. In case the node received the same data time and again then it will update its routing table with the most recent sequence number. Now with the help of these routing tables that are stored for every node the data packets are transmitted between the nodes and the path is find. And therefore each node periodically updates its routing table for the dynamically changing topology. Let us take a scenario for this:

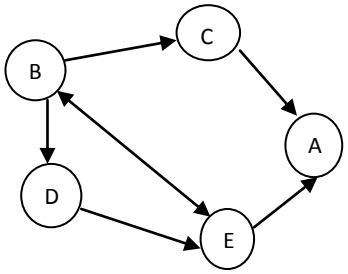

Figure 4: Example for DSDV

The figure above shows the case of five nodes where we want to send our data from node B to node A. Thus for this the node B will maintain its routing table which will be as followed:

DESTINATION	NEXT HOP	METRIC	SEQUENCE NUMBER	INSTALL TIME
A	C	2	S104_A	T001_B
B	B	0	S045_B	T002_B
C	C	1	S128_C	T001_B
D	D	1	S111_D	T001_B
E	D	2	S101_E	T002_B

Figure 5: The routing table for node B

The Install time shown above is the time that tells us the time at which the stale routes have to be purged. Now when node B wants to transmit the data from node B to node A then the node B will look at its routing table and find out that the its (Destination) node A is two hops (Metric) from it and its (Next hop) for the transmission will be at node C. So this routing procedure will get repeated unless the destination node is not reached. The node will tag the data packet each time with a sequence number that is an increasing number for every new update and it distinguishes between the stale routes.

Now let's say that the link in between the two nodes is broken (which can occur due to the movement of the nodes from place to place or any of the nodes have been shutdown or any other problem) then in this case the Metric of the broken link is assigned as infinity with an updated sequence number[8]. Since the link is broken, the route has to follow some other path, then during this time the detecting node will immediately broadcast an updated packet and release the modified routes.

b. Reactive Routing Protocol

As per the above discussion, we have discussed the proactive protocol where the nodes have to maintain the routing tables which get updated every time the data is transmitted or received. This however, leads the wastage of the bandwidth and the latency of the system also gets increased along with that this protocol is not suitable in large environments where the number of nodes considered are large. So to overcome all these factors another protocol known as the Reactive Routing protocol have been introduced. In this paper, I will be covering one of its most renounced examples known by the name AODV.

Ad-Hoc On Demand Distance Vector (AODV)

Unlike DSDV, it is also based on Bellmon-ford algorithm and instead uses the sequence number of both the destination and the originator for avoiding the loop problem. Instead of maintaining the routing tables for all the nodes in the

network, this protocol maintain the routing table for that routes only whose routing information is already in the routing table of the node. This avoids the wastage of the bandwidth and the latency of the network also improves.
Let us take the following example as shown below

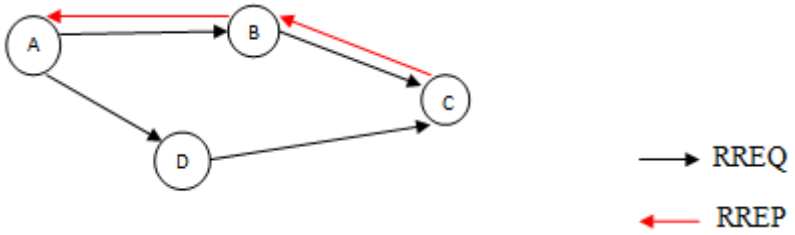

Figure 6: An example of AODV

As shown above, node A wants to send the data packet to node C. Then, according to this protocol the node A will store all its messages in the message queue and then it initiates the RREQ message in the network. While transmitting its RREQ message to the neighbouring node the originator node will set a TTL time [9] and it will also increments its RREQ id , involving expanding ring search technique[10]. Now when the neighbouring (intermediate) node receives this RREQ message it will update its routing table with this RREQ id and the sequence number in order to prevent any duplication of the message again at the same node and store them in the route request buffer [11]. If the intermediate node have a valid route to the destination then it will send a RREP message back to the originator node and if there is no path to the destination then it will further broadcast the message, this can also be said in a way, that when TTL is greater than zero and the message is not the duplicate one then the intermediate node will rebroadcast that message again to the next neighbouring nodes unless the final destination is not reached.
In case of any link failure the routes get updated as they don't get the RREP message from the broken path and then rebroadcast their message to other paths to find out the next possible routes. The RERR message eventually ends up at source node.

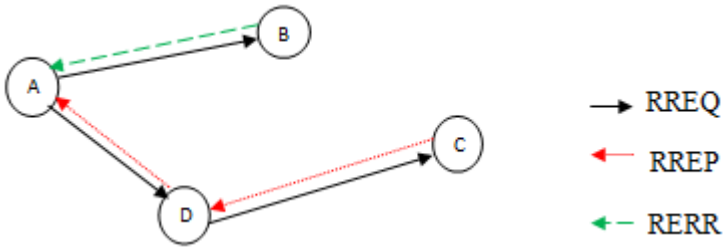

Figure 8: RERR Message in AODV

The figure above shows us that when the link between the intermediary node B and C is broken the when node A(source) wants to send data to node C (destination) rather than following the path A-B-C the node B will send A, RERR message and then the node A will follow some other path that is from A-D-C.

III. CONCLUSION AND FUTURE SCOPE

In this paper we have studied the proactive and reactive routing protocol. Under proactive routing protocol we have seen that DSDV presents a low latency in the network but it is not well supported for the high mobility nodes and this will degrade the performance of the network. DSDV also doesn't support high power consumption and also it doesn't hold well with multicasting routing. On the other hand reactive routing protocol wherein we have covered the AODV routing protocol have low routing overhead and also it have the ring search technique. These two factors make AODV a better protocol as compared to DSDV for an environment involving more number of nodes. However considering both scenarios i.e. with high nodes and less nodes, the major concern is related to security. Thus, the protocols can be enhanced by applying security mechanism.

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