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Simulation & Implementation of Wireless Routing Protocol

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Abstract:-An Ad hoc wireless network is one which does not need any base station or wired network infrastructure. Communication is directly between nodes or through intermediate nodes acting as routers. In some environments, such as battlefield communications, national crises, disaster recovery (fire, flood, earth quake) the wired network is not available and Ad hoc networks provide the only feasible means for communications and information access. Also Ad hoc network is now playing important role in civilian forums such as campus recreations, conferences, electronic classrooms etc. Ad hoc routing has been an active research topic in the mobile and wireless area for at least a decade. As mobile and wireless technology proliferate, this area is receiving more attention and there are more industry and standards effort such as Internet engineering task force (IETF's) MANET group, Asynchronous transfer mode (ATM) forum and a number of efforts in third-generation wireless standards. Routing in MANET is a difficult task due to highly dynamic environment. Whenever a packet needs to be transmitted to destination via number of nodes a routing protocol is needed and numerous routing protocols have been proposed for ad-hoc network. In this project we try to judge the impact of both reactive as well proactive type protocols by increasing the density of nodes in the network, keeping source node fixed and move the destination node and then, keeping the destination node fixed and move source node. In all the three cases, the performance of the routing protocol has been analyzed to improve and select efficient routing protocol for network setup and it's designing for practical scenario. A MANET (Mobile Ad-hoc Network) consists of a number of mobile wireless nodes; the communication between these mobile nodes is carried out without any centralized control. MANET is a self organized and configurable network where the mobile nodes move arbitrarily. The mobile nodes can receive and send packets as a router. Routing is a critical issue and an efficient routing protocol makes the MANET reliable. MANET has two types of features - absence of fixed infrastructure & absence of central administration. This paper discuss about simulation & implementation of the performance of any one of the three routing protocols, Table Driven (Proactive), On-Demand (Reactive) & Hybrid Protocol using the simulation tool.

Keywords-WIRELESS ROUTING PROTOCOL, MANET, AODV, DSDV.SIMULATOR

I.INTRODUCTION

Wireless cellular systems have been in use since 1980s. We have seen evolutions of first, second and third generation's wireless systems. Wireless systems operate with the aid of a centralized supporting structure such as an access point. Access points assist the wireless users to keep connected with the wireless system, when they move from one place to the other.
Presence of a fixed supporting structure limits the adaptability of wireless systems. In other words, the technology cannot work effectively in places where no fixed infrastructure is available. Future generation wireless systems will require easy and quick deployment of wireless networks. Current existing wireless systems This quick network deployment is not possible with the existing structure of current wireless systems.
Recent developments such as Bluetooth introduced a new type of wireless systems known as mobile ad-hoc networks. Mobile ad-hoc networks also called "short live" networks operate in the absence of fixed infrastructure. They offer easy and quick network deployment in situations where it is not possible otherwise. Basically Ad-hoc is a Latin word, which means "for this or for this only." MANET is an autonomous system of mobile nodes connected by wireless links; each node operates as an end system and a router for all other nodes in the network.
Nodes in MANET are free to organize and move themselves in an arbitrary fashion. Each user is free to move about while communication with others. Multiple links may have between each pair of the users and the radio between them can be heterogeneous. This allows an association of various links to be a part of the same network. [1]
A MANET (mobile ad-hoc network) is a collection of mobile nodes forming an ad-hoc network without the assistance of any centralized structures. These networks can be well suited for an environment where either the infrastructure is lost or where deploy an infrastructure is not very cost effective.
The popular IEEE 802.11 "WI-FI" protocol is capable of providing ad-hoc network facilities at low level, when no access point is available. The nodes are limited to send and receive information but do not route anything across the network in this network MANET's can operate in a standalone fashion or could possibly be connected to a larger network such as the Internet. [1]
Mobile ad-hoc networks can complete the dream of getting connected "anywhere and at any time" into reality. Typical examples include a disaster recovery or a military operation. These networks may equally show better performance in other places not bound to specific situations. As an example, we can imagine a group of peoples with laptops, in a business meeting

at a place where no network services is available. They can easily network their machines by forming an ad-hoc network. This is one of the many examples where these networks may possibly be used.

II.LITERAUTRE SURVEY

Routing is the act of moving information from a source to a destination in an internetwork. At least one intermediate node within the internetwork is encountered during this process. This is not a new concept to computer science since routing was used in the networks in early 1970's. But this concept has got popularity from the mid-1980's. The major reason for this is because the earlier networks were very simple and homogeneous environments; but, now high end and large scale internetworking has become more popular with the latest advancements in the networks and telecommunication technology Basically the routing concept involves, two activities: determining optimal routing paths first and then, transferring the information groups (called packets) through an internetwork. The later concept is called as packet switching which is straight forward, and the path determination could be very complex [3]. Several metrics to calculate the best path are used by routing protocols for routing the packets to its destination. These metrics are a standard measurement that could be number of hops, which is used by the routing algorithm to determine the optimal path for the packet to its destination. The path determination process is that, routing algorithms initialize and maintain routing tables, which contain the total route information for the packet. This route information varies from one routing algorithm to another. Routing tables are filled with a variety of information which is generated by the routing algorithms. Most common entries in the routing table are ip-address prefix and the next hop. Routing table's ip-address prefix specifies a set of destinations for which the routing entry is valid for & Destination/next hop associations tell the router that a particular destination can be reached optimally by sending the packet to a router representing the "next hop" on its way to the final destination. Switching is relatively simple compared with the path determination. The concept of switching is like, a host determines like it should send some packet to another host. It acquires the routers address by some means and sends the packet addressed specifically to the routers MAC address, with the protocol address of the destination host. The router then examines the protocol address and verifies whether it know how to transfer the data to its destination. If it knows how to transfer the data then it forwards the packet to its destination and if it doesn't then it drops the packet. Routing is mainly classified into static routing and dynamic routing. Static routing refers to the routing strategy being stated manually in the router. Routing table usually written by a networks administrator in static routing. Routing table doesn't depend on the state of the network status, i.e., whether the destination is active or not [3]. Dynamic routing refers to the routing strategy that is being learnt by an interior or exterior routing protocol. Dynamic routing mainly depends on the state of the network i.e., the routing table is affected by the activeness of the destination. The major disadvantage with static routing is that if a new router is added or removed in the network then it is the responsibility of the administrator to make the necessary changes in the routing tables. But in dynamic routing no such requirement as each router announces its presence by flooding the information packet in the network so that every router within the network learn about the newly added or removed router and its entries. Similarly this is the same with the network segments in the dynamic routing [3].

III.CLASSIFICATION OF ROUTING PROTOCOLS

MANET's routing protocols classification can be done in many ways, but most of these are done depending on routing strategy and network structure [4]. According to the routing strategy the routing protocols can be categorized as Table-driven and source initiated, while depending on the network structure these are classified as flat routing, hierarchical routing and geographic position assisted routing [4]. Both the Table-driven and source initiated protocols come under the Flat routing see [fig 3.1].

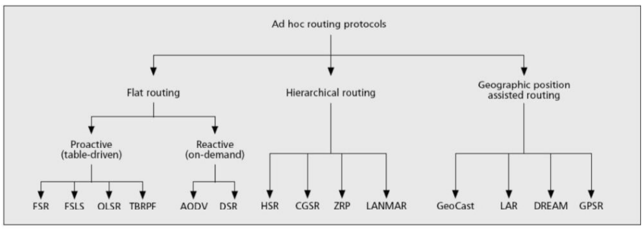

Figure 3.1: Classification of Routing Protocols In Mobile Ad-hoc Networks.

IV.PERFORMANCE ANALYSIS OF AODV

In this project an attempt has been made to find the performance of one of the Ad-Hoc routing protocol amongst the Ad Hoc On Demand Distance Vector (AODV) or Destination-sequenced distance rector (DSDV). The Performance is analyzed using varying simulation time. This simulation is carried out using suitable simulator. The result presented in this work illustrates the importance in carefully simulating & implementing the routing protocol in an ad hoc network.

4.1 Ad hoc on-demand distance vector (AODV):

AODV is a very simple, efficient, and effective routing protocol for MANET's which do not have fixed topology. This algorithm was motivated by the limited bandwidth that is available in the media that are used for wireless communications. It takes most of the advantageous concepts from DSR and DSDV algorithms. The on demand route discovery and route maintenance from DSR and hop-by-hop routing, usage of node sequence numbers from DSDV make the algorithm cope up with topology and routing information. Routes obtaining is purely on-demand makes AODV a very useful and desired algorithm for MANETs.

4.2 Working of AODV:

Each mobile host in the network acts as a specialized router and routes are obtained as needed, thus making the network self-starting. Each node maintains a routing table in the network with the routing information entries to its neighbouring nodes, and two separate counters: a broadcast-id and a node sequence number When a node (say, source node 'S') has to communicate with another (say, destination node 'D'), it increments its broadcast-id and initiates path discovery by broadcasting a route request packet RREQ to its neighbours. The RREQ contains the following fields:

– source-addr
– source-sequence# -to maintain freshness info about the route to the source.
– dest-addr
– dest-sequence# - specifies how fresh a route to the destination must be before it is accepted by the source.
– hop-cnt

The (source-addr, broadcast-id) pair is used to identify the RREQ uniquely. Then the dynamic route table entry establishment begins at all the nodes in the network that are on the path from S to D. As RREQ travels from node to node, it automatically sets up the reverse path from all these nodes back to the source. Each node that receives this packet records the address of the node from which it was received. This is called Reverse Path Setup. The nodes maintain this info for enough time for the RREQ to traverse the network and produce a reply to the sender and time depends on network size.

If an intermediate node has a route entry for the desired destination in its routing table, it compares the destination sequence number in its routing table with that in the RREQ. If the destination

Sequence number in its routing table is less than that in the RREQ, it rebroadcasts the RREQ to its neighbours. Otherwise, it unicasts a route reply packet to its neighbour from which it was received the RREQ if the same request was not processed previously (this is identified using the broadcast-id and source-addr). Once the RREP is generated, it travels back to the source, based on the reverse path that it has set in it until travelled to this node. As the RREP travels back to source, each node along this path sets a forward pointer to the node from where it is receiving the RREP and records the latest destination sequence number to the request destination. This is called Forward Path Setup. If an intermediate node receives another RREP after propagating the first RREP towards source it checks for destination sequence number of new RREP. The intermediate node updates routing information and propagates new RREP only,

– If the Destination sequence number is greater, OR
– If the new sequence number is same and hop count is small, OR

Otherwise, it just skips the new RREP. This ensures that algorithm is loop-free and only the most effective route is used [14]. The below figure 7.1 is an example, which shows how the route to the destination is found by AODV routing protocol. Step by step explanation of figure 7.1 is as follows:

1. Source 'S' has to send data to destination.
2. S sends RREQ to its neighbours A, B, C.
3. B finds the path in its routing table (with destn seq-number s1 and hop count c1) and sends RREP to S.
4. C sets up reverse path.
5. C forwards RREQ to its neighbours D and E.
6. E sets up reverse path.
7. E forwards RREQ to its neighbours F and G.
8. E deletes the reverse path after a time out period as it does not receive any RREPs from F and G.
9. D finds the path (with dest seq-number s2 which is greater than s1 and hop count c1) in its routing table and sends RREP to C.
10. C receives RREP from D and sets up forward path and forwards RREP to S.
11. A sets reverse path; forwards RREQ to its neighbours; receives RREP (with path of hop count c2 which is greater than c1); sets forward path; and forwards this RREP to S.

12. S receives a path info from C (with destn seq-number s2 and hop count c1), another path info from B (with destn seq-number s1 and hop count c1), and another path info from A (with destn seq-number x which is less than s1 and s2 and hop count c2 which is less than c1).

13. S chooses path info from C (which was originated from D), giving first priority to the path with greatest destination sequence number and then second priority to the path with smallest hop count. Though path given by A is of smallest hop count, it is ignored because the destination sequence number is greater than the path from C.

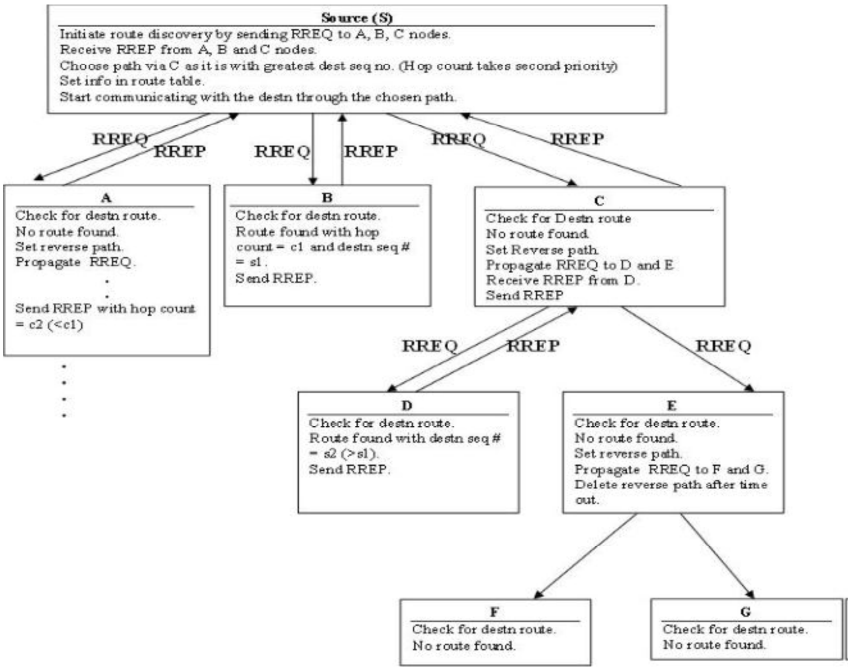

Figure 4.1: Route finding process in AODV Routing Protocol.

4.3 Interesting concepts of AODV

The concepts of AODV that make it desirable for MANETs with limited bandwidth include the following:
– Maximum utilization of the bandwidth: This can be considered the major achievement of the algorithm. As the protocol does not require periodic global advertisements, the demand on the available bandwidth is less. And a monotonically increased sequence number counter is maintained by each node in order to supersede any stale cached routes. All the intermediate nodes in an active path updating their routing tables also make sure of maximum utilization of the bandwidth. Since, these routing tables will be used repeatedly if that intermediate node receives any RREQ from another source for same destination. Also, any RREPs that are received by the nodes are compared with the RREP that was propagated last using the destination sequence numbers and are discarded if they are not better than the already propagated RREPs.
– Minimal space complexity: The algorithm makes sure that the nodes that are not in the active path do not maintain information about this route. After a node receives the RREQ and sets a reverse path in its routing table and propagates the RREQ to its neighbours, if it does not receive any RREP from its neighbours for this request, it deletes the routing info that it has recorded.
– Simple: It is simple with each node behaving as a router, maintaining a simple routing table, and the source node initiating path discovery request, making the network self-starting.
– Most current routing info: The route info is obtained on demand. Also, after propagating an RREP, if a node finds receives an RREP with greater destination sequence number, it updates its routing info with this latest path and propagates it.
– Most effective routing info: After propagating an RREP, if a node finds receives an RREP with smaller hop-count, it updates its routing info with this better path and propagates it.
– Loop-free routes: The algorithm maintains loop free routes by using the simple logic of nodes discarding non better packets for same broadcast-id.
– Highly Scalable: The algorithm is highly scalable because of the minimum space complexity and broadcasts avoided when it compared with DSDV[16].
– Coping up with dynamic topology and broken links: When the nodes in the network move from their places and the topology is changed or the links in the active path are broken, the intermediate node that discovers this link breakage propagates an RERR packet. And the source node re-initializes the path discovery if it still desires the route. This ensures quick response to broken links.

4.4 Advanced uses of AODV

–AODV can handle highly dynamic behaviour of Vehicle Ad-hoc networks because of its reactive nature [14].
–Using the 'J' (Join multicast group) flag in the packets it is used for both unicasts and multicasts [16].

4.5 Limitations/Disadvantages of AODV:

– Requirement on broadcast medium: The algorithm requires/expects that the nodes in the broadcast medium can detect each others' broadcasts.

– Bandwidth overhead: Overhead on bandwidth will be occurred as compared to DSR, when an RREQ travels from node to node in the process of discovering the route info on demand, it sets up the reverse path in itself with the addresses of all the nodes through which it is passing and it carries all this info all its way.
–Vulnerable to misuse: The messages can be misused for insider attacks including route disruption ,node isolation, route invasion, and resource consumption [15].
– No reuse of routing info: AODV lacks an efficient route maintenance technique. The routing info is always obtained on demand, including for common cause traffic [14].
– AODV not supportive for high throughput routing metrics: AODV is designed to support the shortest hop count metric. This metric favours long, low bandwidth links over short, high-bandwidth links [14].
– High route discovery latency: AODV is a reactive routing protocol which means that AODV does not discover a route until a flow is initiated. This route discovery latency result can be high in large-scale mesh networks.

V.PERFORMANCE ANALYSIS OF DSDV

5.1 Destination Sequenced Distance Vector (DSDV) Protocol:
The DSDV (destination sequenced distance vector routing protocol) is a proactive routing protocol which is a modification of Bellman-Ford routing algorithm. This protocol adds a new sequence number, attribute to each route table entry at each node. Routing table is maintained at each node and with this table; node transmits the packets to other nodes in the network. This protocol was motivated for the use of data exchange along changing and arbitrary paths of interconnection which may not be close to any base station.

5.2 Protocol Overview and activities:
Each node in the network maintains routing table for the transmission of the packets and also for the to different stations connectivity in the network. These stations list for all the available destinations, and the number of hops required to reach each destination in the routing table. The routing entry is tagged with a sequence number which is originated by the destination station. In order to maintain consistency, each station periodically transmits and updates its routing table. The packets being broadcasted between stations indicate how many hops are required to reach that particular station and which stations are accessible. The packets may be transmitted containing the layer 2 or layer 3 address [16].
Broadcasting advertises the Routing information or multicasting the packets which are transmitted periodically as when the nodes move within the network. This protocol requires that each mobile station in the network must constantly, advertise to each of its neighbours, its own routing table. Since, the entries in the table my change very quickly, the advertisement should be made frequently to ensure that every node can locate its neighbours in the network. This agreement is placed, to ensure the shortest number of hops for a route to a destination; in this way the node can exchange its data even if there is no direct communication link. Broadcast data by each node will contain its new sequence number and the following information for each new route:
– The number of hops required to reach the destination and
– The new sequence number, originally stamped by the destination
– The destination address
The transmitted routing tables contains the hardware address, network address of the mobile host transmitting them. The routing tables contain the sequence number created by the transmitter and hence the most new destination sequence number is preferred as the basis for making forwarding decisions. This new sequence number is also updated to all the hosts in the network which may decide on how to maintain the routing entry for that originating mobile host.
After receiving the route information, receiving node increments the metric and transmits information by broadcasting. Incrementing metric is done before transmission because, incoming packet will have to travel one more hop to reach its destination.
Another important factor to be considered is the time between broadcasting the routing information packets. When the new information is received by the mobile host it will be retransmitted soon effecting the most rapid possible dissemination of routing information among all the cooperating mobile hosts. Broken links cause by mobile host as they move from place to place within the network. Layer 2 protocol may be used to detect the broken link, which may be described as infinity. When the route is broken in a network, then immediately that metric is assigned an infinity metric there by determining that there is no hop and the sequence number is updated. Sequence numbers originating from the mobile hosts are defined to be even number and the sequence numbers generated to indicate infinity metrics are odd numbers. The broadcasting of the information in this protocol is of two types namely: full dump and incremental dump. Incremental dump will carry only information that has changed since last full dump while full dump broadcasting will carry all the routing information. Irrespective of the two types, broadcasting is done in network protocol data units (NPDU). Multiple NPDU's are required by full dump while incremental requires only one NPDU to fit in all the information. When an information packet is received from another node, it compares the sequence number with the available sequence number for that entry. If the sequence number is larger, then it will update the routing information with the new sequence number else if the information arrives with the same sequence number it looks for the metric entry and if the number of hops is less than the previous entry the new information is updated (if information is same

or metric is more then it will discard the information). While the nodes information is being updated the metric is increased by 1 and the sequence number is also increased by 2. Similarly, if a new node enters the network, it will announce itself in the network and the nodes in the network update their routing information with a new entry for the new node. In broadcasting, the mobile hosts will transmit their routing tables periodically but due to the frequent movements by the hosts in the networks, this will lead to continuous burst of new routes transmissions upon every new sequence number from that destination. The remedy for this is to delay the advertisement of such routes until it shows up a better metric.

5.3 Operation at Layer2

Address stored in the routing table at the mobile hosts will correspond to the layer at which the DSDV protocol is operated. Layer3 will use network layer addresses for the next hop and destination addresses and layer 2 will use the MAC address for its operation. A difficulty is arise at the layer 3 operation and a way must be provided to resolve these layer-3 addresses into MAC addresses. Otherwise, problems like broadcast address resolution would be needed and loss of bandwidth would be observed. This loss could be substantial because such mechanisms will require retransmission by every mobile node. The solution here is to provide layer3 protocol information along with the layer2 information at the layer 2 operation. Each mobile node would advertise, reach ability, information about the layer3 protocols at that destination [16].

5.4 Example for DSDV operation

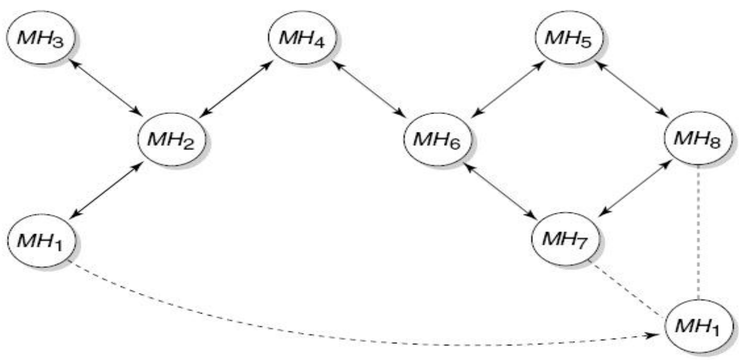

Figure 3.4: Movement of Mobile host in Adhoc Networks[18].

Consider the above fig. 6.1 which has 8 hosts in the network. We will have a look at the changes to the MH4 routing table with reference to the movements of MH1. Initially, all the nodes advertise their routing information to all the nodes in the network and hence the routing table at MH4 initially looks like

Table 5.1: Routing table of MH4[16]

Destination	Next Hop	Metric	Sequence Number	Install	Stable Data
MH1	MH2	2	S406_MH1	T001_MH4	Ptr1_MH1
MH2	MH2	1	S128_MH2	T001_MH4	Ptr1_MH2
MH3	MH2	2	S564_MH3	T001_MH4	Ptr1_MH3
MH4	MH4	0	S710_MH4	T001_MH4	Ptr1_MH4
MH5	MH6	2	S396_MH5	T002_MH4	Ptr1_MH5
MH6	MH6	1	S076_MH6	T001_MH4	Ptr1_MH6
MH7	MH6	2	S128_MH7	T002_MH4	Ptr1_MH7
MH8	MH6	3	S050_MH8	T002_MH4	Ptr1_MH8

And the forwarding table at the MH4 would look like this

Table 5.2: Forwarding table at MH4 [16]

Destination	Metric	Sequence Number
MH1	2	S406_MH1
MH2	1	S128_MH2
MH3	2	S564_MH3

MH4	0	S710_MH4
MH5	2	S392_MH5
MH6	1	S076_MH6
MH7	2	S128_MH7
MH8	3	S050_MH8

But, when the host MH1 moves its location as shown in the fig. 6.1 nearer to MH7 and MH8 then, the link between MH2 and MH1 will be broken resulting in the assignment of infinity metric at MH2 for MH1 and the sequence number will be changed to odd number in the routing table at MH2. MH2 will update this information to its neighbor hosts. Since, there is a new neighbor host for MH7 and MH8; they update their information in the routing tables and they broadcast. Now, MH4 will receive its updated information from MH6 where MH6 will receive two information packets from different neighbors to reach MH1 with same sequence number, but different metric. The selection of the route will depend on less hop count when the sequence number is the same. Now the routing table will look like

Table 5.3: Routing table after MH1 movement [16]

Destination	Next Hop	Metric	Sequence Number	Install	Stable Data
MH1	MH6	3	S516_MH1	T001_MH4	Ptr1_MH1
MH2	MH2	1	S238_MH2	T001_MH4	Ptr1_MH2
MH3	MH2	2	S674_MH3	T001_MH4	Ptr1_MH3
MH4	MH4	0	S820_MH4	T001_MH4	Ptr1_MH4
MH5	MH6	2	S502_MH5	T002_MH4	Ptr1_MH5
MH6	MH6	1	S186_MH6	T001_MH4	Ptr1_MH6
MH7	MH6	2	S238_MH7	T002_MH4	Ptr1_MH7
MH8	MH6	3	S160_MH8	T002_MH4	Ptr1_MH8

And the forwarding table will look like

Table 5.4: Forwarding table at MH4 after Movement of MH1 [16]

Destination	Metric	Sequence Number
MH1	3	S516_MH1
MH2	1	S238_MH2
MH3	2	S674_MH3
MH4	0	S820_MH4
MH5	2	S502_MH5
MH6	1	S186_MH6
MH7	2	S238_MH7
MH8	3	S160_MH8

5.5 Advantages of DSDV:

– DSDV protocol guarantees loop free paths [23].
– Count to infinity problem is reduced in DSDV [23].
– We can avoid extra traffic with incremental updates instead of full dump updates.
– Path Selection: DSDV maintains only the best path instead of maintaining multiple paths to every destination. With this, the amount of space in routing table is reduced.

5.6 Limitations of DSDV:

– Wastage of bandwidth due to unnecessary advertising of routing information even if there is no change in the network topology [16].
– DSDV doesn't support Multi path Routing.
– It is difficult to determine a time delay for the advertisement of routes [7].

– It is difficult to maintain the routing table's advertisement for larger network. Each and every host in the network should maintain a routing table for advertising. But for larger network this would lead to overhead, which consumes more bandwidth.

VI. CONCLUSION:-

We reviewed the different wireless routing protocols. These routing protocols compared in terms of packet delivery, average delay & speed. They have a lot of potentials & we try to deploy any one of them.

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