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ANALYSIS OF UNIPATH AND MULTIPATH ROUTING PROTOCOLS IN MOBILE ADHOC NETWORKS.

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Abstract: A MANET is an interconnection of mobile devices by wireless links, which forms a dynamic topology. Routing protocols play a vital role in transmission of data across the network. The two major classifications of routing protocols are unipath and multipath. In this paper, we have evaluated the performance of a widely used on-demand unipath routing protocol called AODV and multipath routing protocol AOMDV and MDART . These protocol has been selected due to its edge over other protocols in various aspects, such as reducing delay, routing load etc. The evaluation of all the protocols is carried out in terms of different scenarios using NS2.

IndexTerms—*MANET, unipath, multipath routing , AOMDV,MDART,AODV,CBR,scenario patterns,N2*

I. INTRODUCTION

MANETs are considered an easy, quick and cost effective deployment option among other type of networks. Due to such features, the ad hoc network applications are no more limited to military, disaster recovery and emergency management but also extended to personal/local area networks.As MANET is a totally different kind of network, it needs a different set of protocols to perform network activities. Routing protocols are an important part of any network to discover and maintain routes between any given pair of node. Routing protocols in Ad Hoc network are differentiated in terms of hop-by-hop or source routing, reactive or proactive approach, single or multi-path, distance vector or link state based, uni-cast or multi-cast etc. Reactive approach is considered more efficient than proactive approach as it only discovers and maintains routes between nodes which need to communicate with each other .Multi-path routing protocols creates less overhead as compared to single-path routing protocols and are susceptible to high network load, frequent route failure due to mobility, congested networks etc.

The most popular on-demand routing protocol, Ad-hoc On-demand Multipath Distance Vector (AOMDV) routing protocol [1] is an improvement of Ad-hoc On-demand Routing Protocol (AODV). AOMDV discovers multiple paths between a source and destination to provide efficient fault tolerance by providing quicker and more efficient recovery from route failures in a dynamic network. As AOMDV discovering multiple paths in a single route discovery attempt, new route needs to be discovered only when all paths fail. This reduces not merely the route discovery latency but the routing overheads also.

AODV is a reactive and a single path routing protocol. It allows users to find and maintain routes to other users in the network whenever such routes are - needed. The adhoc on demand distance vector routing protocol provides unicast, broadcast and multicast communications in adhoc networks. AODV initiates route discovery whenever a route is needed by the source node or whenever a node wishes to join a multicast group. Routes are maintained as long as they are needed by the source node or as long as the multicast group exists and routes are always loop free through the use of sequence numbers [2]. A multipath enhancement to DART [3] was proposed in [4] called Augmented Tree based Routing (ATR), but in ATR the DHT system is replaced by a global lookup table which is available to all the nodes, which results in a great impact on the address discovery, which is a key process of the whole routing protocol. Among the DHT based Routing Protocols, M-DART is an enhancement of shortest path routing protocol known as Dynamic Address Routing (DART) [3]. M-DART discovers and stores multiple paths to the destination in the routing table. The remainder of this paper is organized as follows. Section II discusses Dynamic Addressing and Dynamic Hash Table (DHT). Section III discusses M-DART and AOMDV routing protocols. Section IV discusses the simulation results of the two routing protocols with different parameters. Finally, we summarize and conclude our paper in section V.

The protocol, namely the multi-path dynamic address routing (M-DART), is based on a prominent DHT-based shortest-path routing protocol known as DART [4,5]. M-DART extends the DART protocol to discover multiple routes between the source and the destination. In such a way, M-DART is able to improve the tolerance of a tree-based address space against mobility as well as channel impairments. Moreover, the multi-path feature also improves the performances in case of static topologies thanks to the route diversity.

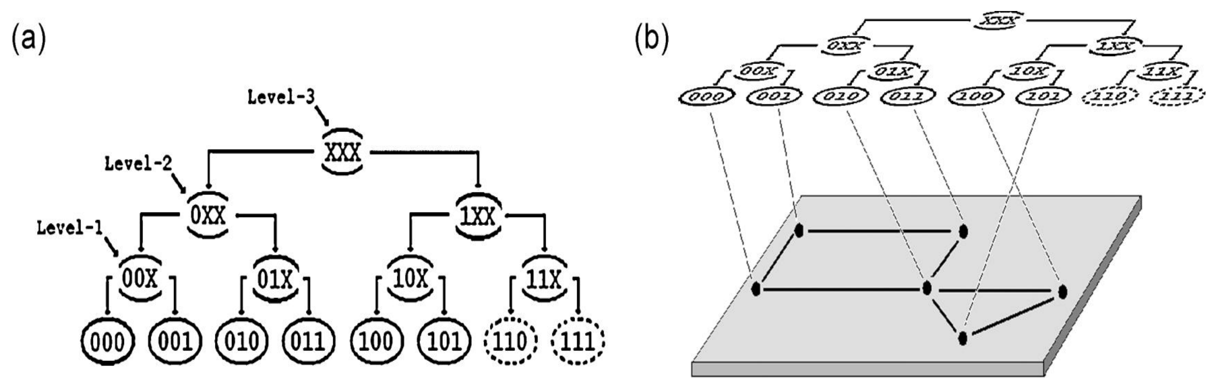


Figure 1. Relationship between the address space overlay and the physical topology

M-DART has two novel aspects compared to other multi-path routing protocols [6--7]. First, the redundant routes discovered by M-DART are guaranteed to be communication-free and coordination-free, i.e., their discovering and announcing though the network does not require any additional communication or coordination overhead. Second, M-DART discovers all the available redundant paths between source and destination, not just a limited number.

II. AN OVERVIEW OF MULTIPATH PROTOCOLS IN TERMS OF DYNAMIC ADDRESSING AND DHT.

Dynamic Addressing [3] separates the routing address and the identity of a node. The routing address of a node is dynamic and changes with movement of the node to reflect the node's location in the network topology.

a) MDART:

2.1. Address space: The network addresses are strings of l bits, thus the address space structure can be represented as a complete binary tree of l + 1 levels, that is a binary tree in which every vertex has zero or two children and all leaves are at the same level (Figure 1a). In the tree structure, each leaf is associated with a network address, and an inner vertex of level k, namely a level-k subtree, represents a set of leaves (that is a set of network addresses) sharing an address prefix of l – k bits. For example, with reference to Figure 1a, the vertex with the label 01X is a level-1 subtree and represents the leaves 010 and 011. Let us define level-k sibling of a leaf as the level-k subtree which shares the same parent with the level-k subtree the leaf belongs to. Therefore, each address has l siblings at all and each other address belongs to one and only one of these siblings. Referring to the previous example, the vertex with the label1XXis the level-2 sibling of the address 000, and the address 100 belongs only to this sibling. In Figure 1b, the address space is alternatively represented as an overlay network built upon the underlying physical topology. Its tree-based structure offers simple and manageable procedures for address allocation, avoiding to rely on inefficient mechanisms like flooding.

2.2. Route discovery and packet forwarding

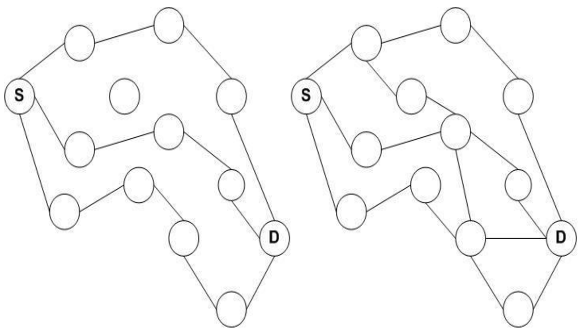
Each node maintains a routing table composed by l sections, one for each sibling, and the kth section stores the path toward a node belonging to the level-k sibling. Each section stores five fields: the sibling to which the entry refers to, the next hop, the cost needed to reach a node belonging to that sibling using the next hop as forwarder, the network id used for address validation, and the route log used by the loop avoidance mechanism.. The table has three sections: the first stores the best route, according to a certain metric, toward the node 001, the second toward a node belonging to the sibling 01X, and the last toward nodes belonging to the sibling 1XX.The routing state information maintained by each node is kept consistent through the network by means of periodic routing updates exchanged by neighbor nodes. Each routing update stores l entries, and each entry is composed by four fields: the sibling id, the cost, the network id, and the route log. The packet forwarding process exploits a hop-by-hop routing based on the network addresses and it is summarized by Algorithm 1. To route a packet, a node compares its network address with the destination one, one bit at a time starting with the most significant (left-side) bit, say the l th. If the I th bit is different, the node forwards the packet towards one the route stored in the I th section. With reference to the previous example, if the node 000 has to send a packet to the node with the address 101, then it will forward the packet to the next hop stored in the third section (i.e., the node 010).

b) AOMDV:

AOMDV [2], [3] is a multi-path routing protocol. It is an extension to AODV and also provides two main services i.e. route discovery and maintenance. Unlike AODV, every RREP is being considered by the source node and thus multiple paths can be discovered in one route discovery. Being the hop-by-hop routing protocol, the intermediate node can maintain multiple path entries in their respective routing table.

hop. To discover distinct paths, AOMDV suppresses duplicate route requests (RREQs) at intermediate nodes. Such suppression comes in two different variations, resulting in either node (illustrated in Fig. 2 (a)) or link (illustrated in Fig. 2(b)) disjoint. AOMDV can be configured to either discover the link (no common link between any given pair of nodes) or node (in addition to link disjoint, common intermediate nodes are also excluded between any given pair of nodes) disjoints paths.

Disjoint alternate paths are a good choice than overlapping alternate paths, as the probability of their interrelated and concurrent failure is smaller. This property can be helpful in an adversarial environment where malicious activity can also cause additional link failure. Finding a disjoint path is quite straightforward in source routing (as every node maintain complete path information for every path), but hop-by-hop routing i.e. AOMDV is considered more efficient in terms of creating less overhead Number of paths in any given source and destination is directly proportional to the number of nodes in entire network. AOMDV works more efficiently in dense and heavy networks.



(a) Node Disjoint (b) Link Disjoint

Fig. 2 AOMDV Multi-path

III.TRAFFIC PATTERNS

Traffic Patterns describe how the data is transmitted from source to destination. The two types oftraffic patterns employed in MANET are CBR and TCP Traffic patterns.

3.1. CBR Traffic Pattern

The qualities of **Constant Bit Rate** (CBR) traffic pattern [2,14] are i) unreliable: since it has no connection establishment phase, there is no guarantee that the data is transmitted to the destination, ii) unidirectional: there will be no acknowledgment from destination for confirming the data transmission and iii) predictable: fixed packet size, fixed interval between packets, and fixed stream duration.

3.2. TCP Traffic pattern

The qualities of **Transmission Control Protocol** (TCP) traffic pattern [8,9] are i) reliable: since connection is established prior to transmitting data, there is a guarantee that the data is being transmitted to the destination, ii) bi-directional: every packet that has to be transmitted by the source is acknowledged by the destination, and iii) conformity: there will be flow control of data to avoid overloading the destination and congestion control exists to shape the traffic such that it conforms to the available network capacity [8]. Today more than 95% of the Internet protocol traffic is carried out through TCP.

3.1 Simulation Parameters

The table below presents the parameters used in the Simulations that we can observe the parameters that Suffered variations and that stayed fixed during thesimulations. The obtaining of the communication patterns and movement felt through the use of scripts in the distribution of network simulator 2(version 2.34). The simulator uses these patterns to vary the movement of nodes and communication between them.

Table1 Simulation Parameters

Parameter	Value
Simulator	NS2.34
Area	1000m x1000m
Number of Nodes	10,30,50,100,150.
Routing Protocols	AODV,AOMDV, MDART
Traffic Type	CBR
Simulation Time	100 sec

A. Average Throughput

As shown in Figure 3, for small number of nodes (<100) , the throughput of M-DART is very slightly better than AOMDV and AODV they behaves like M-DART up to 100 nodes, but it starts to behave poorly beyond this since it works on On-Demand technology.

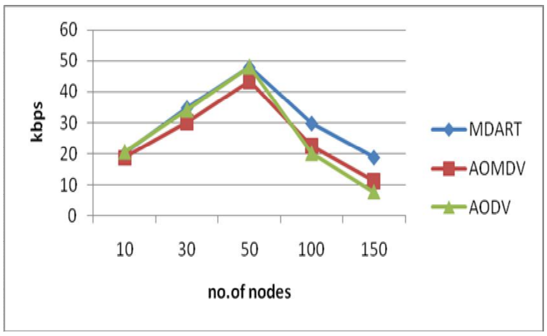


Fig.3 Throughput Vs Number Of Nodes

B. Packet Delivery Ratio (PDR)

Many protocols in MANETs use packet delivery ratio (PDR) as a metric to select the best route, transmission rate or power. As shown in Figure 4, M-DART has better throughput than both AOMDV and AODV as the number of nodes increases.

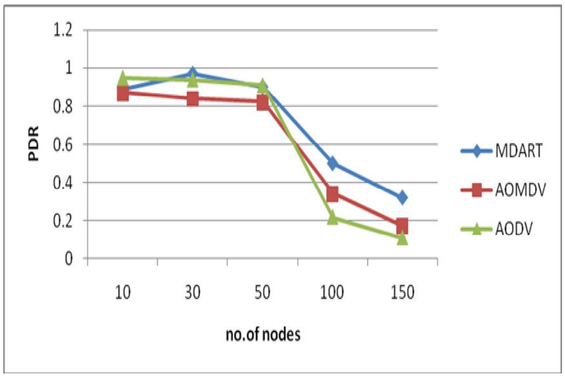


Fig. 4 PDR Vs Number of nodes

C. Average End to end delay

As shown in Figure 5, for small number of nodes, AOMDV and M-DART shows approximately same End to End Delay. As the number of nodes increases, End to End Delay of M-DART grows linearly, whereas AODV shows higher growth than both AOMDV and M-DART.

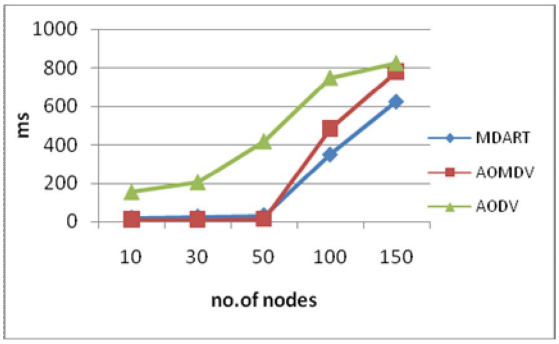
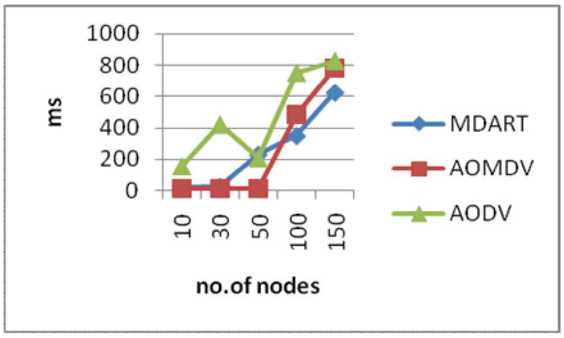


Fig.5 End To End Delay Vs Number Of Nodes

D. Normalized Routing Overhead

Normalized Routing Overhead is the number of routing packets transmitted per data packet towards destination Figure6 shows the Normalized Routing Overhead of MDART, AOMDV and AODV upto 150 nodes.



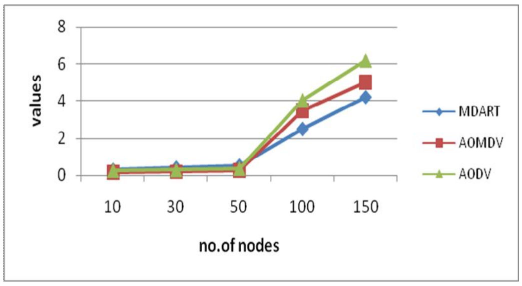


Fig.6 Nro Vs Number Of Nodes

V. CONCLUSION

DHT based multipath routing supports scalability in various wireless networks as M-DART is an efficient protocol which gives improved performance in large networks. We have also found that when number of nodes grows, the performance of other multipath and unipath routing protocols like AOMDV and AODV is not appropriate while M-DART is performing better in terms of Throughput, PDR, End to End Delay and NRO. In future the work should be carried on some different traffic scenarios and others multipath protocols.

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