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Review Paper on Hybrid Model of AODV & MTPR Routing Protocol in Mobile Ad hoc Network

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Abstract

A mobile Ad-Hoc network (MANET) is a collection of two or more devices or nodes or terminals with wireless communication i.e mobile adhoc wireless network and networking capability that communicate with each other without the aid of any centralized administrator also the wireless nodes that can dynamically form a network to exchange information without using any existing fixed network infrastructure. And it's an autonomous system in which mobile hosts connected by wireless links are free to be dynamically and same time act as routers at the same time and we discuss in this paper with basic introduction of MANET and its pros and cons. It then defines various protocols participated in routing through MANET. Ad Hoc Network must be able to adapt to changing network of this type at any time. The main classes of routing protocol are Proactive, Reactive and Hybrid. A Reactive (on-demand) routing strategy is a popular routing category for wireless ad hoc routing. It is a relatively new routing philosophy that provides a scalable solution to relatively large network topologies. In this review paper an attempt has been made to explain the all technology, problems, advantages, disadvantages and protocols used in on demand reactive routing protocols OR power routing protocols for mobile Ad hoc wireless network.

Keywords: *MANET, AODV, MTPR, Routing Protocols, Hybrid Routing Protocol.*

1. Introduction

A mobile ad hoc network is a collection of wireless nodes that can dynamically be set up anywhere and anytime without using any pre-existing network infrastructure. It is an autonomous system in which mobile hosts connected by wireless links are free to move randomly and often act as routers at the same time. The traffic types in ad hoc networks are quite different from those in an infrastructure wireless network, including:

1) Peer-to-Peer: Communication between two nodes which are within one hop. Network traffic (Bps) is usually consistent.

2) Remote-to-Remote: Communication between two nodes beyond a single hop but which maintain a stable route between them. This may be the result of several nodes staying within communication range of each other in a single area or possibly moving as a group. The traffic is similar to standard network traffic.

3) Dynamic Traffic: This occurs when nodes are dynamic and moving around. Routes must be reconstructed. This results in a poor connectivity and network activity in short bursts.

1.1. MANET

"A mobile ad-hoc network (MANET) is a self-configuring network of mobile routers and associated hosts connected by wireless links." [1]. MANET is the new emerging technology which enables users to communicate without any physical infrastructure regardless of their geographical location, that's why it is sometimes referred to as an "infrastructure less" network. Ad hoc networking allows the devices to maintain connections to the network as well as easily adding and removing devices to and from the network. Due to nodal mobility, the network topology may change rapidly and unpredictably over time. The network is decentralized, where network organization and message delivery must be executed by the nodes themselves. Message routing is a problem in a decentralize environment where the topology fluctuates. While the shortest path from a source to a destination based on a given cost function

in a static network is usually the optimal route, this concept is difficult to extend in MANET. MANET is more vulnerable than wired network due to mobile nodes, threats from compromised nodes inside the network, limited physical security, dynamic topology, scalability and lack of centralized management. Because of these vulnerabilities, MANET is more prone to malicious attacks.

Advantages

- Independence from central network administration
- Self-configuring, nodes are also routers
- Self-healing through continuous re-configuration
- Scalable: accommodates the addition of more nodes
- Flexible: similar to being able to access the Internet from many different locations

Disadvantages

- Each node must have full performance
- Throughput is affected by system loading
- Reliability requires a sufficient number of nodes. Sparse networks can have problems
- Large networks can have excessive latency

1.2. MANET Features

MANET has the following features:

1) Autonomous terminal: In MANET, each mobile terminal is an autonomous node, which may function as both a host and a router.

2) Distributed operation: Since there is no background network for the central control of the network operations. The nodes involved in a MANET should collaborate amongst themselves and each node acts as a relay as needed, to implement functions e.g. security and routing.

3) Multi-hop routing: Basic types of ad hoc routing algorithms can be single-hop and multi-hop, based on different link layer attributes and routing protocols. Single-hop MANET is simpler than multi-hop in terms of structure and implementation, with the cost of lesser functionality and applicability.

4) Dynamic network topology: Since the nodes are mobile, the network topology may change rapidly and unpredictably and the connectivity among the terminals may vary with time. MANET should adapt to the traffic and propagation conditions as well as the mobility patterns of the mobile network nodes.

5) Fluctuating link capacity: The nature of high bit-error rates of wireless connection might be more profound in a MANET. One end-to-end path can be shared by several sessions. The channel over which the terminals communicate is subject to noise, fading, and interference, and has less bandwidth than a wired network.

6) Light-weight terminals: In most cases, the MANET nodes are mobile devices with less CPU processing capability, small memory size, and low power storage. Such devices need optimized algorithms and mechanisms that implement the computing and communicating functions.

1.3. MANET Challenges

Regardless of the attractive applications, the features of MANET introduce several challenges [24] that must be studied carefully before a wide commercial deployment can be expected. These include:

1) Routing: Since the topology of the network is constantly changing, the issue of routing packets between any pair of nodes becomes a challenging task. Most protocols should be based on reactive routing instead of proactive. Multicast routing is another challenge because the multicast tree is no longer static due to the random movement of nodes within the network.

2) Security and Reliability: In addition to the common vulnerabilities of wireless connection, an ad hoc network has its particular security problems due to e.g. nasty neighbor relaying packets. The feature of distributed operation requires different schemes of authentication and key management. Further, wireless link characteristics introduce also reliability problems, because of the limited wireless transmission range, the broadcast nature of the

wireless medium (e.g. hidden terminal problem), mobility-induced packet losses, and data transmission errors [10].

3) Internetworking: In addition to the communication within an ad hoc network, internetworking between MANET and fixed networks (mainly IP based) is often expected in many cases. The coexistence of routing protocols in such a mobile device is a challenge for the harmonious mobility management [10].

4) Power Consumption: For most of the light-weight mobile terminals, the communication-related functions should be optimized for lean power consumption. Conservation of power and power-aware routing must be taken into consideration.

5) Congestion: A critical issue for MANETs is that nodes are normally power constrained and leads huge congestion in the network. The power control problem in wireless ad hoc networks is that of choosing the transmit power for each packet in a distributed fashion at each node. The problem is complex since the choice of the power level fundamentally affects many aspects of the operation of the network [3]. It determines the range of a transmission. Thus determines the magnitude of the interference it creates for the other receivers which causes congestion.

1.4. MANET Applications

With the increase of portable devices as well as progress in wireless communication, ad-hoc networking is gaining importance with the increasing number of widespread applications. Ad-hoc networking can be applied anywhere where there is little or no communication infrastructure or the existing infrastructure is expensive or inconvenient to use. Typical applications include [10, 11]:

1) Military Battlefield: Ad- hoc networking would allow the military to take advantage of commonplace network technology to maintain an information network between the soldiers, vehicles, and military information headquarters.

2) Commercial Sector: Ad hoc can be used in emergency/rescue operations for disaster relief efforts, e.g. in fire, flood, or earthquake. Other commercial scenarios include e.g. ship-to-ship ad-hoc mobile communication, law enforcement, etc.

3)Local Level: Ad hoc networks can autonomously link an instant and temporary multimedia network using notebook computers or palmtop computers to spread and share information among participants at e.g. conference or classroom. Similarly in other civilian environments like taxicab, sports stadium, boat and small aircraft, mobile ad hoc communications will have many applications.

4) Personal Area Network (PAN): Short-range MANET can simplify the intercommunication between various mobile devices (such as a PDA, a laptop, and a cellular phone). Tedious wired cables are replaced with wireless connections. Such an ad hoc network can also extend the access to the Internet or other networks by mechanisms e.g. Wireless LAN (WLAN), GPRS, and UMTS.

2. Routing Protocols

Routing is the most fundamental research issue in MANET and must deal with limitations such as high power consumption, low bandwidth, high error rates and unpredictable movements of nodes [22].Generally, current routing protocols for MANET can be categorized as:

1) Proactive (table-driven)
2) Reactive (on-demand)
3) Hybrid

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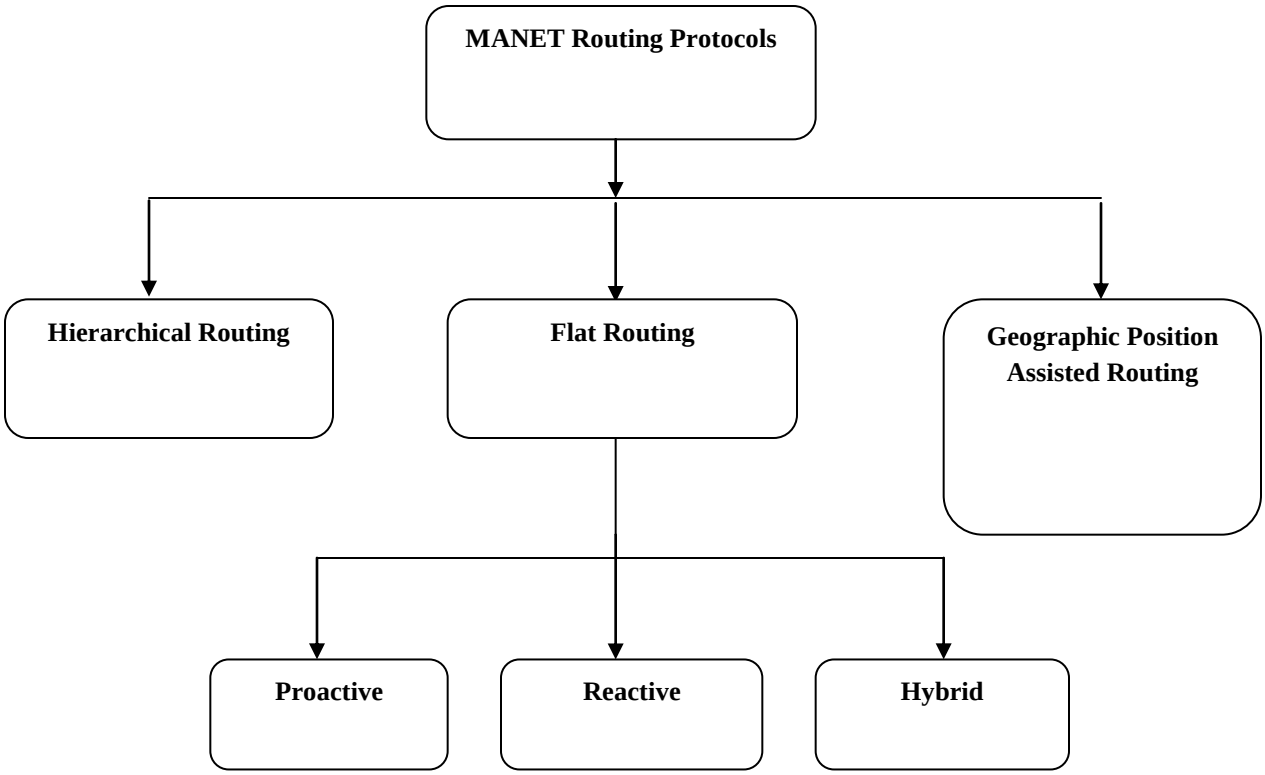

Fig.2.1: MANET Routing Protocols

2.1. Proactive (Table-Driven) Routing Protocols

In proactive routing, each node has one or more tables that contain the latest information of the routes to any node in the network. Each row has the next hop for reaching to a node/subnet and the cost of this route.

Advantage of Proactive protocols is that routes are readily available when there is any requirement to send packet to any other mobile node in the network.

Limitations are asProactive routing tends to waste bandwidth and power in the network because of the need to broadcast the routing tables/updates. Furthermore, as the number of nodes in the MANET increases, the size of the table will increase; this can become a problem in and of itself.

2.2 Reactive (On-Demand) Protocols

Reactive routing protocols take a lazy approach to routing. They do not maintain or constantly update their route tables with the latest route topology. Instead, when a source node wants to transmit a message, it floods a query into the network to discover the route to the destination. This discovery packet is called the Route Request (RREQ) packet and the mechanism is called Route Discovery. The destination replies with a Route Reply (RREP) packet. As a result, the source dynamically finds the route to the destination. The discovered route is maintained until the destination node becomes inaccessible or until the route is no longer desired.

Advantage: These are bandwidth efficient protocols. Routes are discovered on demand basis. Less Network communication overhead is required in this protocol.

Limitations: These protocols have very high response time as route is needed to be discovered on demand, when there is some packet to be sent to new destination which does not lie on active path.

2.3 Hybrid Routing Protocols

Both the proactive and reactive protocols work well for networks with a small number of nodes. As the number of nodes increases, hybrid reactive/proactive protocols are used to achieve higher performance. Hybrid protocols attempt to assimilate the advantages of purely proactive and reactive protocols. The key idea is to use a reactive routing procedure at the global network level while employing a proactive routing procedure in a node's local neighbourhood.

3. Techniques Used for Routing under Consideration

3.1 Minimum Total Transmission Power Routing (MTPR)

Most ad hoc networks today operate on battery; the power-consumption problem becomes an important issue. To maximize the lifetime of ad hoc networks, the power consumption rate of each node must be evenly distributed and the overall transmission power for each connection request must be minimized. Power-aware routing protocols have been proposed based on various power cost functions. MTPR protocol to minimize the total transmission power consumption for the multi-hop communication. Since the transmission power is proportional to the transmission distance between two neighbouring nodes, therefore MTPR protocol always selects a route with minimum total transmission power but with more hops, although the Dijkstra's shortest path algorithm was attempted to be used in MTPR protocol. However, MTPR protocol suffers longer end-to-end delay from the greater number of hopes [9].

3.2 Ad hoc on-demand Distance Vector routing (AODV)

AODV is an on-demand routing algorithm that determines a route only when a node wants to send a packet to a destination[23].It uses shortest path scheme which is based on Dijkstra algorithm [6]. AODV is distance vector type routing where it does not involve nodes to maintain routes to destination that are not on active path. As long as end points are valid AODV does not play its part. Different route messages like Route Request, Route Replies and Route Errors are used to discover and maintain links. UDP/IP is used to receive and get messages. AODV uses a destination sequence number for each route created by destination node for any request to the nodes[23]. A route with maximum sequence number is selected. To find a new route the source node sends Route Request message to the network till destination is reached or a node with fresh route is found. Then Route Reply is sent back to the source node. The nodes on active route communicate with each other by passing hello messages periodically to its immediate neighbor[13]. If a node does not receive a reply then it deletes the node from its list and sends Route Error to all the members in the active members in the route. AODV does not allow unidirectional link.

Source Address	Request ID	Destination Address	Source Sequence Number	Destination Sequence Number	Hop Count

Fig 3.1: AODV Route Request Packet

Advantages

- It is bandwidth efficient so it consumes less battery power.
- To overcome the counting to infinity problem like in other distance vector routing protocols AODV uses sequence numbers to find the fresh route to the destination.

Disadvantages

- Overhead on the bandwidth, because RREQ & RREP packets needs to carry a lot information to validate a route.
- The hello messages add a significant amount of overhead to the protocol.

3.3 Hybrid Routing Protocols

Hybrid protocols combine the features of reactive and proactive protocols. These protocols have the advantage of both proactive and reactive routing protocols to balance the delay which was the disadvantage of Table driven protocols and control overhead (in terms of control packages). Main feature of Hybrid Routing protocol is that the routing is proactive for short distances to shorten the routing discovery time and to Reduce the memory size where as reactive for long distances to reduce the size of the routing table and overhead as long distance destination nodes do not maintain routing information due to large overhead.

Disadvantages

- Large overlapping of routes.
- Longer delay if route not found immediately.
- Core nodes movement affects the performance of the protocol

4. Proposed Routing Scheme

Mobile Ad-hoc Network (MANET) is an autonomous system of mobile hosts connected by wireless links. The nodes in these networks have several constraints such: limited bandwidth, transmission range and mobility. Another parameter that significantly affects the network performance is the limited battery power of the nodes. On the basis of these two route metrics an optimal path is proposed. Our proposed protocol is better than other standard protocols such as MTPR (Minimum Total Transmission Power Routing) and AODV (Ad-hoc On-demand Distance Vector routing). Here we also proposed a routing scheme which is hybrid of MTPR and AODV. We are of the opinion that MTPR strategy decreases total transmission power but at the same time introduces congestion that can be avoided by AODV routing protocol.

4.1 Proposed Routing Scheme

Here we will explain the concept of proposed routing scheme.

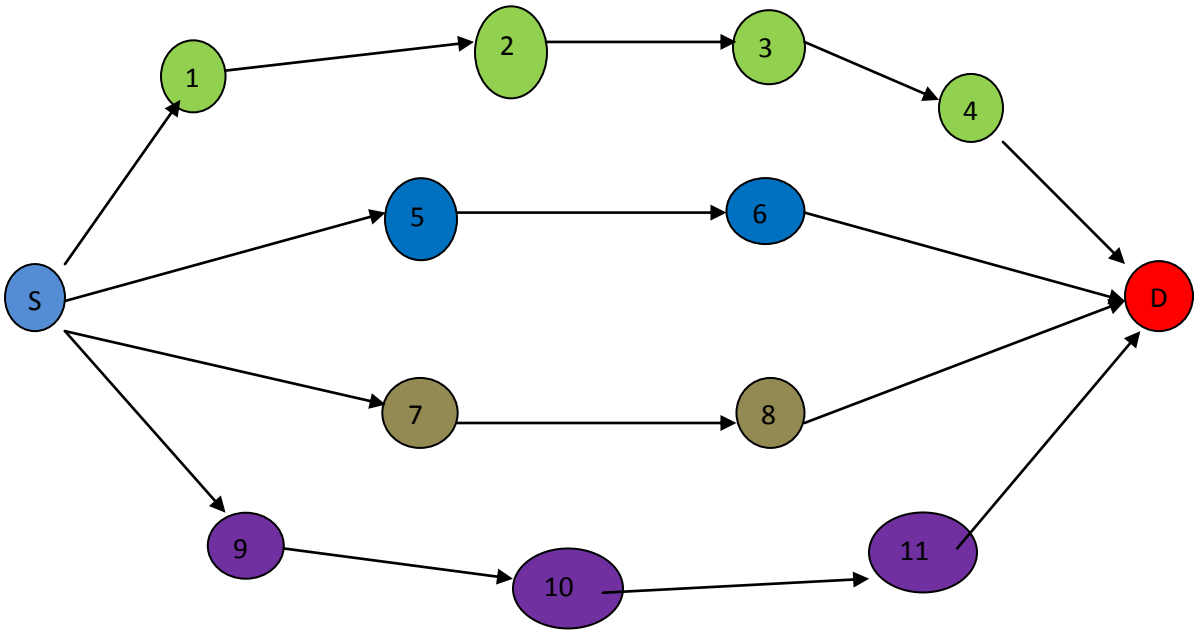

Fig.4.1: Various available paths between source and destination

Let us consider the above given diagram, here S is SOURCE node and D is DESTINATION node where we want to forward the packet. All 1-2-3-4-5-6-7-8-9-10-11 are various intermediate nodes for various possible paths. Let the distances between various nodes are given by a path matrix table as:

Table 4.1: Path Matrix for Giving Distances between Various Nodes

Nodes	S	1	2	3	4	5	6	7	8	9	10	11	D
S	0	10	--	--	--	10	--	20	--	10	--	--	--
1	--	0	5	--	--	--	--	--	--	--	--	--	--
2	--	--	0	5	--	--	--	--	--	--	--	--	--
3	--	--	--	0	5	--	--	--	--	--	--	--	--
4	--	--	--	--	0	--	--	--	--	--	--	--	5
5	--	--	--	--	--	0	15	--	--	--	--	--	--
6	--	--	--	--	--	--	0	--	--	--	--	--	20
7	--	--	--	--	--	--	--	0	10	--	--	--	--
8	--	--	--	--	--	--	--	--	0	--	--	--	15
9	--	--	--	--	--	--	--	--	--	0	10	--	--
10	--	--	--	--	--	--	--	--	--	--	0	10	--
11	--	--	--	--	--	--	--	--	--	--	--	0	15
D	--	--	--	--	--	--	--	--	--	--	--	--	0

It is well known that the total transmission power scales with transmitted distance as d^2 to d^4 depending on environmental conditions. Here we consider total transmission loss is taken as kd^2. The losses of selected paths from source to destination may be as follows:

The path1 (S-1-2-3-4-D) has total transmission loss as =k (10 * 10 + 5 * 5 + 5 * 5 + 5 * 5+ 5 *5) =200k units

The path2 (S-5-6-D) has total transmission loss as =k (10 * 10 + 15 * 15 + 20 * 20) =725k units

The path3 (S-7-8-D) has total transmission loss as =k (20 * 20 + 10 * 10 + 15 * 15) =725k units

The path4 (S-9-10-11-D) has total transmission loss as =k (10 * 10 + 10 * 10 + 10 * 10 + 15 * 15) =525k units

Here we will find mean between MTPR path and AODV path i.e. mean of a path with maximum number of intermediate hops and a path with minimum number of intermediate hops. Here MTPR path is path1 and AODV path is path2 and path3 (any one of them can be consider). Thus mean is given as [(4+2)/2] = 3

Now again difference between number of intermediate node for an adopted path and mean value calculated is considered to select the proposed optimal path. We can easily understand with a table as given below:

Table 4.2: To select optimized path with proper Hop_count and min. transmission loss

Path available	Number of intermediate nodes existed	Mean calculated	Required difference
Path1	4	3	| 4-3 |= 1
Path2	2	3	| 2-3 |= 1
Path3	2	3	| 2-3 |= 1
Path4	3	3	| 3-3 |= 0

Thus path4 with "0" calculated difference is proposed path with minimum power transmission loss as there is proper Hop_count. This path also reduces congestion problem of a network also.

5. Conclusion and Future Scope

This paper contains two parts: one is *theoretical study* and other is *empirical study*. In theoretical part it is clear that due to the random mobility of node, routing becomes a complex issue. Till now many routing protocols are used in MANET. Each routing protocol has unique features. Based on network environments, we have to choose the suitable routing protocol. Proactive routing protocols are best suited in small networks. In large and dense network, reactive routing approach plays a major role. Reactive routing protocols use destination sequence number and feasible distance to ensure a loop free routing. Hybrid routing protocols use reactive and proactive approach in routing operations.

As MTPR follow the path with maximum hops and leads to minimum loss of transmission power but leads to congestion. On the other hand AODV follows shortest path which maximize power loss but less congestion problem is introduced. Thus we proposes a hybrid scheme which follow an intermediate path among these two and leads to minimum transmission power loss along with the congestion problem.

Ad-hoc networks, the most provoke term in wireless technology; approach to be the emperor of future airs provided the vision of "anytime, anywhere" communications. At present, the general trend is toward mesh architecture and large scale. New applications call for both bandwidth and capacity, which implies the need for a higher frequency and better spatial spectrum reuse. Propagation, spectral reuse, and energy issues support a shift away from a single long wireless link (as in cellular) to a mesh of short links (as in MANET). Research on "multi-hop" architecture showed it a promising solution to the implementation of ad-hoc networks. As the evolvement goes on, especially the need of dense deployment such as battlefield and sensor networks, the nodes in MANET will be smaller, cheaper and capable. Till today there are various issues in MANET, but at what speed new routing strategies are growing, soon ad-hoc networks will reach to its advance stage.

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