

SURVEY: COMPARISON ESTIMATION OF VARIOUS ROUTING PROTOCOLS IN MOBILE AD-HOC NETWORK

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ABSTRACT

MANET is an autonomous system of mobile nodes attached by wireless links. It represents a complex and dynamic distributed systems that consist of mobile wireless nodes that can freely self organize into an ad-hoc network topology. The devices in the network may have limited transmission range therefore multiple hops may be needed by one node to transfer data to another node in network. This leads to the need for an effective routing protocol. In this paper we study various classifications of routing protocols and their types for wireless mobile ad-hoc networks like DSDV, GSR, AODV, DSR, ZRP, FSR, CGSR, LAR, and Geocast Protocols. In this paper we also compare different routing protocols on based on a given set of parameters Scalability, Latency, Bandwidth, Control-overhead, Mobility impact.

KEYWORDS

MANET, Routing Protocol, Reactive Proactive, Hybrid, Hierarchical, Geographic Position, Assisted Routing Protocol.

1. INTRODUCTION

Mobile Ad-hoc Network (MANET) is collection of wireless nodes that do not depend on already existing infrastructure so there is no concept of base station or access point. In MANETs, due to availability of mobility in nodes and deficiency of centralized entity, the network topology changes repeatedly and erratically [1]. In MANETs each node works as router for packet forwarding whereas in wired network router performs routing table. It is multi-hop wireless network because different sets of nodes want to establish a network & it is not compulsory that each node is within the transmission range as it might be in out of range, so another set of nodes are used to connect the out of range nodes. Therefore whenever one node sends data to another node, a set of nodes may be used in between, where data is send in different hop that's why they are also called multi-hop, wireless & distributed network [2].

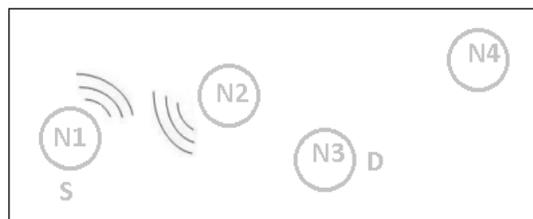


Figure 1. Hop to hop data transfer in MANET

Figure 1 depicts a multi-hop data transfer in a MANET. In the ad-hoc network nodes act as routers as well as hosts therefore node may forward packets as well as run user applications [3, 4]. The aim of MANET is to establish an accurate and efficient route between nodes such that any messages are delivered on time [5]. Nowadays, with the immense growth in wireless network applications like PDAs and cell phones, various researches are being done to improve the network services and performance. So there are various challenging design issues in wireless Ad Hoc networks [6].

Main challenges of these networks are:-

- Spectrum allocation
- Self configuration
- Medium access control
- Energy efficient
- Mobility management
- Security & Privacy
- Routing protocols
- QoS etc

Main applications of this network are home network, environmental monitoring and public wireless access in urban area, Emergency rescue and Vehicular communications in military.

2. CLASSIFICATION OF ROUTING PROTOCOLS

Routing protocols define a set of rules which helps to transfer data or message packets from source to destination in a network [6]. In MANET, there are different types of routing protocols each of them is applied according to the network situations. Figure 2 shows the classification of the routing protocols according to network structure in MANETs.

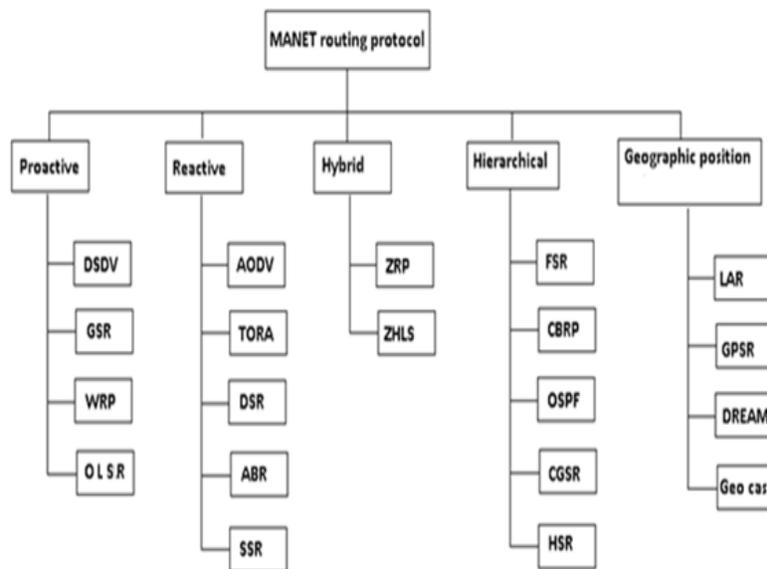


Figure 2. Classification of MANET routing protocols

2.1. Table Driven Routing Protocol

Table driven routing protocols are also known as proactive routing protocols. They are conventional routing protocols based on either link-state or distance vector principles [7]. In this routing protocol every node maintains complete information about the network topology [8, 9]. Whenever the network topology changes the routing table is updated automatically. As they need to keep node entries for each and every node in the routing table of every node therefore these protocols are not appropriate for usage in large networks. Proactive routing protocols maintain different number of routing tables varying from protocol to protocol [10]. Some popular proactive routing protocols are: DSDV, GSR, OLSR, WRP etc.

2.1.1. Destination-Sequenced Distance-Vector Routing (DSDV)

Based on the Bellman-Ford routing mechanism DSDV is a proactive routing protocol [11]. It is a loop free routing algorithm. Every mobile node in the network maintains a routing table which maintains data of all the feasible destinations within the network and the number of hops to reach each destination. Every entry is marked with a sequence number assigned by the destination node [12]. The routing table updates is done by using two methods: full dump and incremental. The neighbour receives the entire routing table, in full dump while the neighbour receives only the entries that require changes in incremental update [11].

2.1.2. Global State Routing (GSR)

Global State Routing is a proactive routing protocol based on link state routing in which each node floods the link-state information to every node in the network, each time its link changes. GSR reduces the cost of link-state information by exchange of sequenced data rather than flooding [13]. In this algorithm, each node maintains a neighbour list (contains the list of its neighbours), topology table (contains the link state information), next Hop table (contains the next hop to which the packets is forwarded) and a distance table (contains the shortest path to each destination node).

2.2. On-Demand Routing Protocol

On-Demand Routing Protocol is also known as Reactive Routing Protocol. This protocol does not maintain up to date view of all destination nodes in the network. Whenever route is needed then only it is discovered, nodes start route discovery on demand basis and connection is establishes in order to transmit and receive data packets [6, 14]. Source node sees its route cache for the available route from source to destination, if the route is not available then it initiates route discovery process. The route request packets are flooded by using flooding technique throughout the network for route discovery. These protocols require a route discovery & route maintenance process [15]. Many reactive routing protocols have been proposed example DSR, AODV, TORA and LMR.

2.2.1 Ad Hoc On-Demand Distance Vector Routing (AODV)

Ad-Hoc On-Demand Distance Vector Routing (AODV) Protocol is based on On-Demand Routing Protocol which is fundamentally an improvement on DSDV & it is designed for network in such a way that they support thousands of mobile nodes. It only supports the use of symmetric link. It minimizes the number of broadcasts by creating routes based on demand [16]. In this protocol each node maintains sequence number & broadcast-id. To send any packet from source node to destination node, a route request (RREQ) packet is broadcasted. The neighbouring nodes receive the packet and broadcast it further to their neighbours and this process continues until the

packet reaches the destination. It typically uses distance-vector routing algorithms that keep information about next hops to adjacent neighbours [17, 18].

2.2.2. Dynamic Source Routing (DSR)

Dynamic Source Routing is a Reactive Protocol based on the concept of source routing in which source initiates route discovery on demand basis in multi-hop networks. The sender determines the route from source to destination and it also includes the address of all intermediate nodes from source to destination to the route record in the packet. Also called as a beaconless protocol where HELLO messages are not exchanged between nodes to inform them about the presence of their neighbours in the network [19]. There are two key phases in DSR: route discovery and route maintenance. All nodes maintain route caches that contain the source routes of which the mobile is aware. The route caches entries are continually updated as new routes are learned. Route cache is checked first when a source node wants to send a packet. If the route is available, the source node incorporates the routing information inside the data packet before sending it [20].

2.3. Hybrid routing protocol

Hybrid routing protocol is the combination of proactive and reactive routing protocols. In this protocol each node have predefine zone called cluster & all clusters form a hierarchical infrastructure [21]. The main purpose of designing this routing protocol is for larger and complex network in order to take advantages of both Proactive and Reactive Routing Protocol. It implements the route discovery mechanism and the table maintenance mechanism of reactive protocol proactive protocol respectively in such a way so as to avoid latency and routing overhead problems in the network [22]. It uses proactive protocol inside zone & reactive outside zone. There are various hybrid routing protocols are ZRP, ZHLS, SHARP. Figure 3 and Figure 4 shows the concepts used in hybrid protocols.

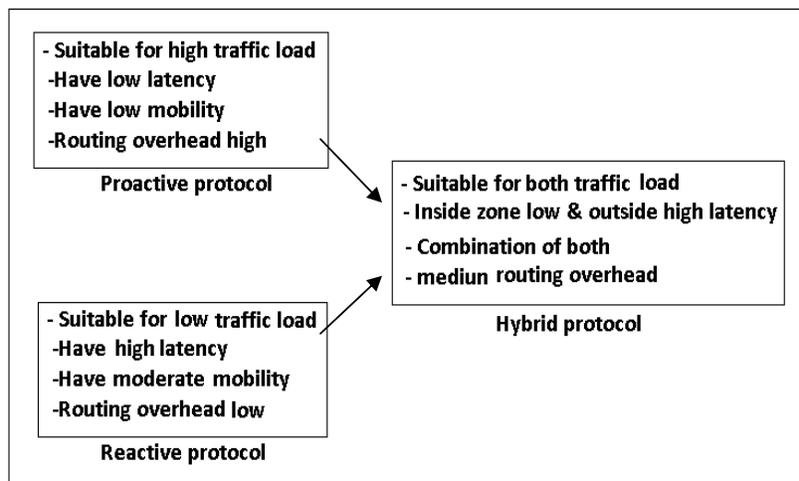


Figure 3. Combination feature of proactive and reactive routing protocol

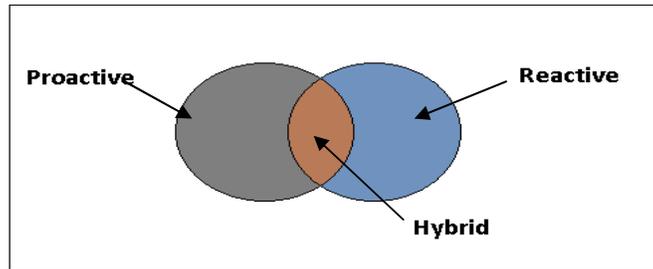


Figure 4. Hybrid routing protocol

2.3.1. Zone Routing Protocol (ZRP)

Zone Routing Protocol (ZRP) is the combination of both reactive and proactive routing protocols to make routing more scalable and efficient [23]. It is basically proposed for wireless ad-hoc networks with bi-directional links [24, 25]. This routing protocol is zone based i.e. different zones may consist of number of nodes to create route discovery and maintenance more reliable [26]. Each node has a predefined zone, in which the nodes lying Inside Zones use proactive routing and Outside Zones use on-demand routing protocol to provide more flexibility. Route creation is done using a query-reply mechanism through Reactive Routing. ZRP uses a query control mechanism to reduce route query traffic and also handles the network and perform route discovery more efficiently [23,27]. Figure 5 shows a central node, inside zone and outside zone division of nodes.

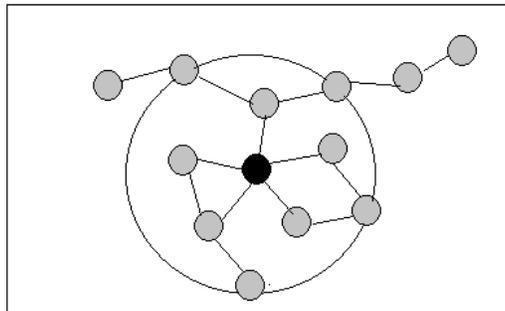


Figure 5. Example: ZRP having zone radius = 2

2.4. Hierarchical Routing Protocol

Hierarchical Routing is multilevel clustering of mobile nodes. Routing protocols for mobile ad hoc networks utilize hierarchical network architectures. The proper proactive routing and reactive routing approach are dominated in different hierarchical levels. They are also appropriate for wireless sensor networks (HSR). In case of a route failure the entire route does not need to be recalculated. These networks address the scalability. This routing provides fast and most efficient way of establishment for the communications of mobile nodes in MANET [28].

2.4.1. Fisheye State Routing (FSR)

FSR is a hierarchical routing protocol and a proactive protocol, based on link state routing protocol that is suitable for wireless ad hoc network [29, 30]. FSR is more appropriate for large networks where mobility is high and bandwidth is low. Basically FSR is an improvement of GSR. It maintains updated information from the neighbour node through a link state table. FSR uses the

'fisheye' technique to reduce the size of information required to represent graphical data. It helps to make a routing protocol more scalable by assembly data on the topology [31, 32]. Distance is calculated by hops from the node and is used to classify zones in FSR.

2.4.2. Cluster Gateway Switch Routing Protocol (CGSR)

CGSR is a multi-hop mobile wireless network with various routing schemes [15] in which nodes are organized into hierarchy of clusters. It is a multichannel operation capable protocol [33] where each node has a cluster head and packet is sent through cluster heads. Cluster heads communicate amongst themselves using DSDV and two clusters are connected through a gateway node. A packet sent by a source node is first sent to its cluster head, and then the gateway receives packet from the cluster head. The gateway then sent it over to another cluster head, and this process goes on until the cluster head of the destination node is reached. A cluster head is able to control a group of ad-hoc hosts and each node maintains two tables, first table is: cluster member table that contain the cluster head for each destination node & second table is: DV-routing table that contain the next hop to the destination.

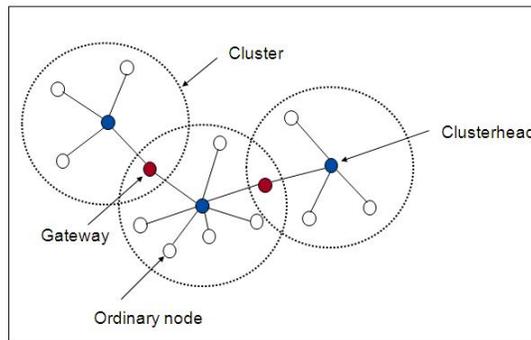


Figure 6. CGSR

2.5. Geographic position assisted routing protocols

Geographic routing protocols have a lot of attention in the field of routing protocols for ad-hoc network. They are more well-organized and scalable for ad-hoc network because these routing protocols make minimum use of the topology information and there is no necessity needed to keep routing tables up-to-date [34]. In this protocol each nodes know their geo coordinates and propagate geo info by flooding. Geographic routing protocols such as LAR, DREAM, and GPSR are the example of these routing protocols [35].

2.5.1. Location-Aided Routing (LAR)

Location information is used by LAR protocols to reduce the search space for a proper route. Each node knows its location in each moment and utilizes location information for discovering a new route to a smaller requested zone. Route discovery is initiated when source node doesn't know a route to destination or previous route from source to destination is broken. This protocol is basically based on limited flooding to discover routes.

2.5.2. Geocast Protocols

Spread of a message to a few or all nodes within a geographical area is geocast. It uses specific geographic information to specify the destination. Geocast group is only distinct by a geographic region. Its information can be used to make routing more efficient. The main goal of geocast protocols is to deliver data packets to a group of nodes that are inside a specified geographical area [36]. It provides a better scalability among group of nodes [37]. Geocast is a variety of amplification of multicast operations. The protocol to perform geocast operations can be divided into two categories: data-transmission oriented protocols (such as LBM) and routing-creation oriented protocols (Geo Tora). When a node in the geocast region receives the geocast packet, it floods the packet such that the flooding is limited to the geocast region.

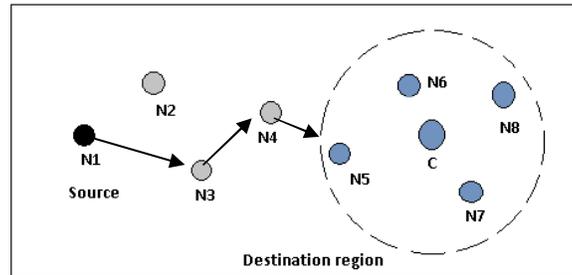


Figure 7. Geo cast

3. PERFORMANCE COMPARISONS

Since there are number of routing protocols and their different algorithms as discussed above therefore there is a need to compare different routing protocols to judge the performance and their usage over different networks. The comparison done here is based on a given set of parameters such Scalability, Latency, Bandwidth, Control-overhead, Mobility impact.

Table 1. Comparison of Various Routing Protocol

Name of protocol	Types of protocol	Scalability	Latency	Bandwidth	Control overhead	Mobility impact
Destination Sequenced DistanceVector (DSDV)	Proactive	poor	Very low Because all information saved in the routing tables	Wastage of B.W. due to unnecessary advertising of routing information even if there is no change in the network topology	High if number of node & mobility increase	It can't handle mobility at high speed due to lack of alternative routes
Global state routing (GSR)	Proactive	Fair due to using location service that dependent on global flooding	Low	Amount of B.W. is consumed (very expansive in B.W. starved wireless network)	Reduced because it avoids flooding for disconnects	No impact on control overhead

Ad-hoc on demand distancevector (AODV)	Reactive	Much more scalable	low compared to DSR and DSDV	Unnecessary bandwidth consumption due to periodic beaconing	Multiple Route Reply packets in response to a single Route Request packet can lead to heavy control overhead	It doesn't affect much as it find the routing on demand
Dynamic source routing (DSR)	Reactive	high	High ,(no route in cache, route discovery)	B.W. saving because there is no hello message needed	Reduce because intermediate nodes utilize the root cache information to reduce control overhead	Perform better if mobility is low otherwise less due to aggressive use of cache
Zone routing protocol (ZRP)	Hybrid	Scalable	decrease due to route search operations in reactive routing	Not over utilize the available bandwidth resources.	Reduced the control overhead for longer routes	When the mobility rate is less then throughput, packet delivery ratio is maximum and if the mobility rate and zone size is increase the control overhead is also increased
Fisheye state routing protocol (FSR)	Hierarchical	Better scalability compare to other link state protocol because it doesn't try to keep all node on the same knowledge level about link state	Latency is less as compare to AODV	Consumes a considerable amount of bandwidth when network size becomes large	FSR protocol uses the fisheye technique to reduce the routing overhead	As mobility increases, routes to remote destinations become less accurate
Clusterhead-Gateway Switch Routing (CGSR)	Hierarchical	Scalable	Lower latency	Better BW utilization	Routing overhead is lower compared to flooding routing information through the	-----
					entire network because each node maintains route to its cluster-head	
Geocast Routing Protocols (Geo cast)	Geographic position assisted routing	Highly Scalable	Requires more latency	Most Bandwidth is wasteful	High control overhead	Performs well under high mobility
Location-Aided Routing (LAR)	Geographic position assisted routing	Highly Scalable	No latency	Bandwidth saving	Routing overhead is widely reduced	Perform better with higher mobility

4. CONCLUSIONS

We have seen a great improvement in the field of wireless and Mobile ad hoc network .In this paper we have described a number of algorithms for routing and broadly categorized routing protocols- Table driven, on demand, Hierarchical, Hybrid and Geographic position assisted routing protocols and compared the various routing protocol of mobile ad-hoc networks and presented in the form of table for a given parameter. There is not any defined single protocol that can be perfect for usage in all type of networks. For comparatively small network proactive and reactive routing protocols are appropriate. But in large network can be either hierarchical or geographic routing protocols are suitable.

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