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Detailed study of Routing Protocols in MANETs

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Abstract *– Mobile Ad Hoc Networks (MANETs) are self-configuring and self-organizing multihop wireless networks. They are infrastructure-less networks of mobile devices allowing dynamic changes in structure. Standard Wi-Fi connection and mobile hotspots are examples of MANETs. They are typically not very secure and one needs to be cautious about the type of data being sent.*

They consist of a peer-to-peer, self-forming, self-healing network. The components of MANETs lack a physical connection and hence can move independent of each other in any direction giving rise to a highly dynamic, autonomous topology.

A routing protocol ensures the proper working of functionalities such as mobility of nodes, multipath propagation, interference and path loss in the constantly changing topology of MANETs. Major routing protocols that have been developed are Proactive Protocol, Reactive Protocol and Hybrid protocol.

The distinction of these protocols is primarily based on parameters such as routing approaches, structure, selection route, routing table, maintenance, operation of protocols, strengths and weaknesses. The method of determining routes within source-destination pairs decides the uniqueness as well as efficiency of these protocols..

Keywords- MANET, Routing protocols, DSDV, AOD..

INTRODUCTION

A Mobile Ad Hoc Network (MANET) is a collection of wireless nodes forming a temporary, infrastructure-less network. MANETs do not require a fixed topology and rely on wireless terminals for routing and transport services. MANETs are characterized as peer-to-peer, self-forming, self-healing networks without any physical connections. The structure of the network changes dynamically and due to this mobility of the nodes, MANETs are self-organizing and self-configuring. They may contain one or more different trans-receivers between the nodes resulting in a highly dynamic, autonomous topology. Each node in a MANET sends to as well as receives data from other nodes thereby acting as a router. Each router forwards traffic unrelated to its own data. Each device or node in a MANET must continuously maintain information required to properly route traffic. MANETs are mostly employed in Battlefields, Disaster areas and meetings because of their ability to handle node failures and fast topology changes. MANETs allow seamless communication between devices or people in even in the absence of a proper communication architecture. In MANETs, routing protocols are required to establish specific paths between the source and the destination. The primary aim of a routing protocol is to establish an efficient route between any two nodes with minimum routing overhead and bandwidth consumption. Factors such as interference, mobility of nodes, multipath propagation and path loss continuously change the topology of MANETs for which a dynamic routing protocol is required. There are three major categories of MANET routing protocols: Proactive Protocol, Reactive Protocol and Hybrid Protocol.

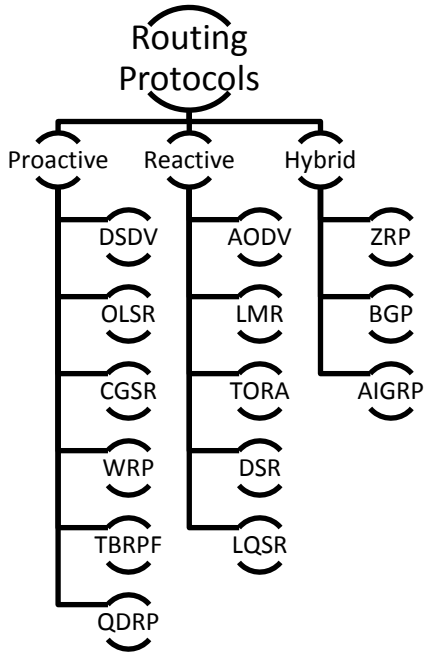
The paper focusses on MANET protocols, its types and the examples in each category. It discusses DSDV and AODV protocols in detail. The section ahead of it provides comparative study of various protocols.

METHOLOGY

A MANET routing protocol must necessarily perform the following three functions:

1. Keep the routing table up-to-date and reasonably small.
2. Select the best route for given destination.
3. Converge within an exchange of a small amount of messages.

As mentioned, the three categories of MANET routing protocols are Proactive, Reactive and Hybrid. These protocols are designed to handle a number of nodes with limited resources.



1. Proactive Routing Protocols: Proactive routing protocols use link-state routing algorithms to link information about neighbours. This information is stored in the routing tables maintained at each node. The maintenance and updating of information is done by exchanging the control packets with their neighbours.

Proactive protocols are table-driven with high routing overhead. They maintain a low latency rate due to routing tables. Proactive routing protocols function on low scalability yet the routing information is always available. They receive periodic updates whenever the topology of the network changes and their mobility is highly dependent on these updates.

Examples of Proactive routing protocols are: DSDV, OLSR, CGSR, WRP, TBRPF and QDRP.

The Destination Sequenced Distance Vector (DSDV) protocol is highly used across all applications of MANETs. It provides independence from loops in routing tables and is much dynamic in nature. In DSDV, each node maintains a routing table containing the destination node address, the minimum number of hops to that destination and the next hop in the direction of that destination. Say a given node receives two updates from the same source node, then the receiving node decides as to which update is to be placed in its routing table based on the sequence number. A higher sequence number denotes a more recent update sent by the source node. Therefore, it can update its routing table with the latest information and avoid any route loops or false routes.

S. No	Author	Routing Protocol	Functionality	Description
1	C.P.P Bhagwat	DSDV	Routing table, Sequence Number, Damping	Two types of route updates; full dump packets, incremental packets, to send packet it forwards to neighbors using routing table to reach destination.
2	S Murthy	WRP	Routing distance, second-to-last hop information, eliminates looping, avoids call to infinity Problem	Maintains four tables to send packet to the destination; distance table, routing table, link cost table, MRL table for the packet Transmission
3	C.C Chiang	CGSR	Clustering, distributed cluster head selection algorithm, cluster member table , routing table , gateway node, cluster head.	Packet sent by node is routed to cluster head (CH), and it is again routed to CH via gateway node and so on until destination is reached
4	J.J Garcia	STAR	OSA, neighbor discovery protocol, source tree , route selection algorithm, sequence no., LSU, LORA	No need for the periodic updates. Provide optimum paths. Each node in source tree runs a route selection algorithm to drive routing table that specifies the how to reach the destination node
5	T.W Chen, M. Gerla	GSR	Link state table, neighbor table update, neighbor list, topology table, distance table, next hop tab le	Each node maintains knowledge on network topology and optimizes routing decision. It avoids flooding of routing message. Periodically broadcasts topology information to neighbors
6	M. Gerla	FSR	No updating table, accurate distance, path quality information, information on neighbor nodes.	Divide nodes neighborhood to zones. Exchanges information to closer node more frequently. The amount of bandwidth, size of message small. It is suitable smaller networks than larger networks.

Table: Comparison of various Proactive Protocols

2. Reactive Routing Protocols: Reactive routing protocols reduce the overhead on Proactive protocols and use the distance-vector routing algorithms. They help in finding a route to the destination on-demand. This on-demand route acquisition is based on request made by a node for the initiation of route discovery process. The routing overhead in reactive protocols is low due but they have high latency due to flooding. These protocols are not suitable for large networks and they make routing information available only when required. They do not require any periodic updates and they achieve mobility through route maintenance. Examples of Reactive routing protocols are AODV, LMR, TORA, DSR and LQSR. The Ad hoc On-Demand Distance vector (AODV) Protocol is the most highly used Reactive protocol. It performs Route Discovery using Control messages Route Request (RREQ) and Route Reply (RREP). The forward path sets up an intermediate node in its route table with a permanent association to RREP. When either destination or intermediate node using moves. A route error (RERR) is generated and sent to the affected source node every time when one among this intermediate node or the destination moves. Upon receiving the error, the source node can reinitiate the route and the required neighbourhood information is obtained from broadcast Hello packet. AODV protocol is a flat routing protocol and does not need any central administrative system to handle the routing process. It tends to reduce the control traffic messages overhead at the cost of increased latency in finding new routes. The AODV has great advantage in having less overhead over simple protocols which need to keep the entire route from the source host to the destination host in their messages. The RREQ and RREP messages do not increase the overhead from these control messages. AODV reacts relatively quickly to the topological changes in the network and updates only the hosts that may be affected by the change, using the RRER message. The Hello messages are also limited so that they do not create unnecessary overhead in the network. The AODV protocol uses sequence numbers and thus, is loop free. It avoids counting to infinity problem, which was a characteristic of the classical distance vector routing protocols.
3. Hybrid Routing Protocols: Hybrid routing protocols are a combination of both Proactive

and reactive protocols designed with a scalability suitable for large networks. The route acquisition in Hybrid Protocols is again a combination of on-demand and table driven methods. It has a medium routing overhead with a latency similar to that of reactive protocols on the outside. It is open to receiving periodic updates and handles routing information depending on the situation. If available, the information is supplied or else it is generated according to the demand. Examples of Hybrid Routing Protocols are: ZRP, BGP and AIGRP.

Comparison between routing protocols:

Table 2:Comparsion between routing protocol

S.No	Parameters	DSDV	CSGR	WRP	AODV	OLSR	DSR	TORA	ZRP	ZHLS	DYMO
1	Protocol type	Destination sequence distance vector	Cluster switch gateway routing	Wireless routing protocol	Adhoc on demand distance vector routing	Optimized Link State Routing Protocol	Dynamic source routing	Temporally Ordered Routing Algorithm	Zone Routing Protocol	Zone-based Hierarchical Link State	Dynamic MANET On-demand
2	Routing approaches	Proactive	Proactive	Proactive	Reactive	Proactive	Reactive	Reactive	Hybrid	Hybrid	Reactive
3	Routing structure	Flat structure	Hierarchical Structure	Flat structure	Flat structure	Flat structure	Flat structure	Flat structure	Flat structure	Hierarchical	Flat
4	Route selection	Link state	Shortest path	Shortest path	Shortest and updated path	Link State	Shortest and updated path	Link Reversal	Link Reversal	zone-based hierarchical link state	unicast multipath routes
5	Route	Single route	Single and multiple route	Single route	Multiple Route	Multiple Route	Multiple Route	Single route	Multiple Route	Multipath	Multipath
6	Routing table	Each node maintain a complete address to each destination	Two table 1.Routing table 2.Cluster member table	Four tables	Each node maintain a route table in which next hop routing information for destination node is stored	Each node maintain a complete address to each destination	Route cache Full route to destination	Use the Direction of the next destination Construct the Direct Acyclic Graph	Route Table	Depended on the performance of proactive and reactive routing protocols chosen	Route. Address, Route.Prefix, Route.SeqNum, Route.NextHop-Address, Route.NextHop-Interface, Route.Forwarding, Route.Broken
7	Route maintenance	Each node in the mobile network maintains a routing table	Each node maintains a routing table which is used to determine the next hop to reach the destination.	Routing node maintains the distance and second to last hop information for each destination	Every node maintains two counters Sequence no and broadcast ID.	Control messages sent in advance	Two different processes: 1.Hop by hop acknowledgement 2.End to end acknowledgement	Link reversal and Route Repair	Link Reversal and information stored in link table	Proactive routing for intrazone communication and reactive routing for interzone	It perform route discovery again for that destination when receive RERR message
8	Operation of protocols	Routing information is always available, whether the source node require a route or not because each node in the mobile network maintains a routing table.	Mobile nodes are grouped into cluster and each cluster has cluster head and cluster head to gateway routing approach to move traffic from source to destination.	In WRP, routing nodes communicate the distance and second to last hop information for each destination in wireless network and it belong to path finding algorithm.	1.RREQ broadcast 2.RREP Propagation 3.RERR message	OLSR supports three mechanisms: neighbor sensing, efficient flooding of control traffic and sufficient topology informaion.	1.RREQ broadcast 2.RREP Propagation 3.RERR message	Route Creation, Route Maintenance and Route Erasure	1.RREQ broadcast 2.RREP Propagation 3.RERR message	two routing tables, an intrazone routing table and an interzone routing table	1.RREQ broadcast 2.RREP Propagation 3.RERR message
9	Advantages	1.Loop free 2. Shortest path to every destination is chosen.	1.Cluster head can control a group of adhoc hosts. 2. Cluster provide a framework for code separations, channel access, routing, bandwidth allocation.	1. Avoid the count to infinity problems by forcing each node to perform consistency checks. 2. Routing information is accurate, mobile send updates messages periodically to their neighbors.	1.Adaptable to high dynamic topology. 2. loop free 3 AODV has higher bandwidth efficiency because of lesser overheads	1. Minimize the overhead 2. Improve the transmission quality	1.Support Multipath routing	1. Able to rapidly build routes 2. Decrease the communication's overhead, Multiple routes	1.With properly configured zone radius, outperform both proactive routing protocols and reactive routing protocols.	1. Generates less overhead than the schemes based on flooding 2. Reduces the traffic and avoids a single point of failure	1.It is loop-free protocol 2.Handles a wide variety of mobility patterns, handles a wide variety of traffic patterns 3. Supports routers with multiple interfaces
10	Limitation	1.High overhead 2.It does not support multipath routing	1. If a cluster head is changing frequently and nodes will be spending a lot of time converging to a cluster head.	1. More overheads are required due to „hello" messages.	1.Scalability problems due to large delay 2.AODV takes more time to build the routing table.	1.Require more processing power and bandwidth	1 Scalability problems due to source routing and flooding. 2. Being a reactive protocol DSR suffers from high route discovery latency.	1. In large networks the overhead, consume a large bandwidth, Temporary routing loops and Overall complexity	1. Path to a destination may be suboptimal . 2. Memory requirement is greater	1. Additional traffic produced by the creation and maintaining of the zone level topology, needed a system location assistance such as GPS	1. Increases the size of the routing packets

CONCLUSION

This paper provides a study of Routing Protocols in Mobile Ad Hoc Networks. They are classified as Proactive or table-driven, Reactive or on-demand and Hybrid. The main factor that distinguishes these protocols is the method of determining routes within the source-destination pairs. DSDV in Proactive and AODV in reactive are the two main protocols used.

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