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A Survey on various routing protocols in mobile ad hoc networks

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Abstract: A Mobile Ad-hoc Network forms the self-configuring wireless network with collection of nodes and these mobile nodes dynamically communicate to other nodes without any centralized infrastructure. Mobile nodes resemble as router and forwards packets to other nodes in the network. Various protocols are involved in Mobile Ad hoc Network for communicating and transferring of packets from peer to peer networks. Due to mobility of mobile nodes in the network, topology changes continuously, thus each protocol uses different methods for transferring data in network to the end points. This paper provides various types of routing protocols used in MANET and its uses.

Keywords: MANET, Routing protocols, Proactive, Reactive and Hybrid.

I. INTRODUCTION

MANET (Mobile Ad hoc Network) is generally defined as a network that has many free or autonomous nodes forms the wireless networks, often composed of mobile devices or other devices, which can arrange themselves in various ways and operate without any support of any fixed infrastructure or centralized administration. Hence they are known as infrastructure less networks. The mobile nodes are connected in to each other during communication. The nodes in the mobile network have the mobility to some distance during the communication. The mobile agent acts as the intermediate nodes. The mobile nodes in the MANETs will be either bi-directional or unidirectional links. Each node in the network acts as the sender or receiver. The mobile nodes operate in the network because they have their individual battery power.

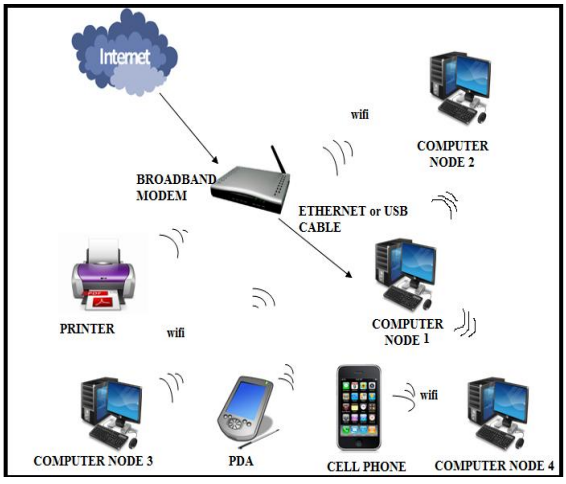

Fig. 1 Mobile Ad Hoc Network

Number of mobile nodes such as laptop, mobile phones and personal digital Assistant etc forms the wireless infrastructure by accessing internet connection without any base station. All the nodes operate independently by transferring data with other devices as depicted in Fig1.

II. VARIOUS TYPES OF ROUTING PROTOCOLS USED IN MANET

In order to route the packets from source to destination, there is a need of protocol for routing packets to specified destinations. Numbers of protocols are provided in MANET to work in different situations in networks.

In MANET, there exist 3 different types of routing protocol such as

A. Proactive
B. Reactive
C. Hybrid

A. Proactive routing protocol

Proactive routing protocol is also known as table-driven protocol, which acts upon the routing tables, which are kept regularly at each node min the network. Thus the maintenance of routing tables of known destination results in reduction in control traffic overhead. Since all the packets are forwarded to the destination immediately with routing tables, each node sends broadcast message to entire network due to dynamic change in topology.

B. Reactive routing protocol

Reactive routing protocol also known as On demand protocol, works in establishing of routes from source to destination whenever there is a request from sender for initiating the packet transfer mechanism. Only on the basis of demand, path will be provided for routing packets. Nodes will not maintain any table for storing information about destination.

C. Hybrid routing protocol

It combines both the reactive and proactive routing protocol In case of the intra-domain routing, these protocols uses the table driven approach, while in case of inter-domain routing these protocols uses the on demand approach.

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TABLE 1: VARIOUS TYPES OF ROUTING PROTOCOL USED IN MOBILE AD HOC NETWORKS

ROUTING PROTOCOLS		
PROACTIVE	REACTIVE	HYBRID
CGSR	ABR	ZRP
DRF	AODV	ZHLS
DSDV	CHAMP	DZTR
STAR	DSR	CEDAR
FSR	TORA	
TBRPF	LBR	
LCA	SSR	
HSLS	SMP	
OLSR	RDMAR	
	LMR	

III. TYPES OF PROACTIVE ROUTING PROTOCOL

A. Cluster head Gateway Switch Routing Protocol (CGSR)

CGSR routing protocol forms the multicasting networks. In this protocol, Number of nodes forms the clusters in this protocol. Each node maintains neighbor node information and also consists of next hop, where as cluster head will be chosen dynamically by using cluster head election procedure.

Packets are sent directly from source node to cluster head then forwarded to the gateway or boundary nodes that are formed based on the communication ranges between the cluster heads. Gateway node will further forwards the packets to the nearest destination cluster head.

Each node maintains 2 tables in it,

1. Cluster member table: It maintains the cluster head for each destination node.

2. Routing table: It maintains next hop to reach the destination.

B. Directional Flow Routing (DRF) Protocol

DFR protocol is the source routing protocol. Packets are routed based on DFV (Directional Flow Vector) with varying time. In high mobility rate, DFR protocols route the Packets efficiently to destination. All the nodes maintain the information's such as relative position and velocity information about the neighborhood nodes.DFR protocol first uses the route discovery method to route the packets from source to destination, once the packets reaches its destination, Computation of the Direction Flow Vector is calculated by finding relative velocity and location positioning between source and sink.

C. Wireless Routing Protocol (WRP)

Wireless routing protocol also included in table driven method. Similar to DSDV protocol, Routing tables stores the distance of destination, predecessor and successor.

4 tables are maintained in this WRP protocol, they are

1. Distance table (DT)-contains nodes neighbor information.
2. Routing table (RT)-stores destination information with regular updating.
3. Link-cost table (LCT)-provides link cost to each neighbor.
4. Message Retransmission list table (MRL)-contains retransmitting message that are updated correctly.

In this protocol, nodes will exchange the information within its neighbor nodes. Nodes will verify the consistency of neighbor node after link changes. If any link becomes failure, nodes calculate its distance and send to neighbor a new updated message with new predecessor changed.

Storing of predecessor and successor in table helps to detect the routing loops and avoids Count-to-infinity problem. Since a node doesn't send any packets, it must send HELLO message within some amount of time, resembles that node is still alive. And these messages are updated to the table results in Large storage memory and resources to maintain several tables are required for this type of protocol

D. Fisheye State Routing (FSR) Protocol

It is based on proactive link state routing protocol. Network is divided into different scopes while communicating. This protocol allows for exchanging of link state message at different intervals between nodes. To reduce the size of link state message, periodic updates are required. From the protocol name, it specifies fish eye that caches pixels near focal. Likewise this protocol maintains accurate distance and quality path of neighbor nodes.

Each node in this protocol maintains the following

1. Neighbor list
2. Topology table
3. Distance table
4. Next hop

As the packets became closer to the destination, accuracy is increased and this protocol provides best solution.

E. Destination Sequenced Distance Vector (DSDV) Protocol

DSDV protocol is a table driven, pro-active protocol based on the Bellman-Ford Routing algorithm. This algorithm helps in solving Routing loop problem, which occurs when an error in operation of routing results in group of nodes, path to particular destination forms a loop.

Every node maintains a routing table as follows as,

1. Available destination
2. Next hop
3. Number of hops

In this DSDV protocol, Sequence numbers are used in order to distinguish stale routes from fresh ones and avoid loop formation. All nodes update routing information to its neighbor either by event driven or time driven. If any network topology change occurs, new sequence numbers are allocated. Thus it provides the loop free method.

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F. Source Tree Adaptive Routing (STAR) Protocol

In this table driven protocol, it works based on link state algorithm. Source tree maintains the priority based destination in set of links.

Least overhead routing approach (LORA) is used to exchange routing information and change in link state updates its results only changes occurs. Router communicates with neighbor of source tree, which has available destination. If any node doesn't contain destination, source initiates absence message and sent it to the neighbor. Alterations in source tree will be reported by the neighbor node results in each node maintains changes in the topology graphs of the networks.

Star protocol helps in reducing bandwidth and time latency. Also maintains of link breakage due to overhead.

G. Topology Broadcast Reverse Path Forwarding (TBRPF) Protocol

In TBRPF, each node consists of the state of each link in the network. The protocol uses the concept of reverse path forwarding (RPF) to disseminate its update packets in the reverse direction along the spanning tree, which is made up of minimum-hop path from the nodes leading to the source of the update message [7].Transmission of the routing messages is very less, since only differences in current and old network states are sent via networks.

Each node receives the update information over multiple paths and every node forward to its neighbors and also repetitions are omitted. It takes the advantages of alternate paths and disjoint paths are immediately available allowing faster recovery from the failures and changes in topology.

H. Link Cluster Architecture (LCA) Routing Protocol

Constructing an LCA is to reduce the routing-related control overhead involved with searching for the destination node in a large network. Each master node can easily maintain the location information of ordinary nodes in its cluster using local communications. Multi-hop MANET is divided into a number of nodes, 2-hop networks, called clusters network, and the clusters are

Independently controlled and dynamically reconfigured as nodes move [5].within the nodes, master will be chosen and other nodes performs gateways between cluster.LCA improves the scalability and reduces routing-related control overhead.

I. Hazy Sighted Link State Routing (HSLS) Protocol

In this protocol, it provides the optimal route for communication and forwarding of set of messages by using link state algorithm. Periodic link state updates are included in this hazy protocol in order to maintain the available information to be consistent. This algorithm allows nodes to communicate through digital radio in a mesh network to forward messages from one device to another device.

J. Optimized Link State Routing (OLSR) Protocol

OLSR protocol is proactive in nature and it uses the link state algorithm. All the links with neighbor nodes are stored and flooded in the entire network. This protocol minimizes the size of control packet. All the nodes in the OLSR protocol sends packets to destination by recent activity from hop to hop mechanism. It exchanges topology information with all other nodes of the network regularly. At every node, it chooses a collection of neighbor nodes called Multi-Point Relays (MPR). Nodes that are selected from the MPR are responsible for sending control traffic, deliberated for diffusion into the whole network. An efficient flooding control traffic mechanism for flooding control traffic by reduces the transmissions included.

IV. TYPES OF REACTIVE ROUTING PROTOCOL

A. Ad-Hoc On Demand Vector (AODV) Routing Protocol

AODV protocol is also known as on demand protocol, it works by establishing the path for packet routing from source to destination. It is source-initiated routing scheme capable of both unicast and multicast routing. Route discovery process begins with RREQ(Route REQuest) messages are sent to destination by broadcast method via intermediate nodes, once the messages reached destination, Further destination will send the RREP(Route REPly) messages are on the same route. Sequence numbers are used for loop prevention and as route freshness criteria. When a node receives an RERR message, it conclude that the route to the destination as invalid. When a source node receives an RRER, it can reinitiate the route discovery and further processes are carried out.

B. Associative-Based Routing (ABR) Routing Protocol

In ABR, the destination node provides the preferred route, by node associativity mechanism. ABR does not work for small networks, as it provides route discovery in faster manner and produces the shortest paths through associativity. The mobility of nodes are observed by any other nodes in the whole network. Each node consists of information about associativity by forwarding messages periodically, by identifying itself and updates the associativity information to its neighbours. If the associativity exceeds a maximum value, node has stability with its neighbours. In other words, a low value number of associativity ticks provides the node's high movements, and high associativity shows sleep mode. The associativity ticks can be reset when a node or its neighbour moves to a new location. Each point-to-point routing in ABR is connection based, with all nodes participating in setting up and computing a route. In point-to-point path, the source node or any intermediate node decides the details of routes. If the communication must be broadcast type, the source node broadcasts all the packets in the manner of connectionless routing fashion.

C. Dynamic Source Routing (DSR) Protocol

From the name suggests, It works on the concept of source initiated and on the basis of demand, path will be established between source and destination. It is designed

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specifically for use in multi-hop wireless ad hoc networks of mobile nodes.

1. Route maintenance and
2. Route discovery

These are the process carried out in this protocol, whenever the sender node needs to send data, it checks for route cache, where recent destination information are stored, it will find and give the request and send the data to destination If it finds that an unexpired route to the destination then results in routing the packet to the route defined. But if there is no further route, then it starts the route discovery process by broadcasting a route request packet. In Route maintenance includes monitoring the routes against failure through route error messages and route cache .The intermediate nodes also utilize the route cache information efficiently to reduce the control overhead.

D. Temporally-Ordered Routing Algorithm (TORA) Routing Protocol

TORA is an on-demand routing protocol, It limits the control message propagation in the highly dynamic mobile computing environment. Each node has to explicitly initiate a query when it needs to send data to a particular destination. The key feature of TORA is that reaction to link breakage or failures and it deletes the invalid routes, and searches for new routes and builds route with distributed algorithm as the basis.

TORA essentially performs three tasks:

Route Creation: Creating routes consists of establishing a sequence of directed links from the source to the destination. This forms a destination based Directed Acyclic Graph; the destination node is the sink of the graph.

Route Maintenance: If the topology changes, reacts for it, in order to re-establish routes within a finite time.

Route Erasure: When a partition is detected in network, incorrect routes must be removed from the network. It includes 3 messages for packet transfer

- QRY message for create a route.
- UPD message to create and maintain the routes.
- CLR message for erase a route.

E. Load Balancing Routing (LBR) Protocol

This on-demand routing protocol uses the concepts of node activity and traffic interference to select the best source-destination path that would encounter the minimum traffic load in transmission and minimum interference by neighboring nodes. The activity of a node is defined as the number of active s-d paths (s-d paths that currently use the node as one of the intermediate forwarding nodes) the node is part of. The traffic interference at a node is the sum of all the activities of the neighbors of the node. For a given source s and destination d, LBR chooses an s-d path such that the sum of the traffic interferences and the activities of the intermediate forwarding nodes on the path is the minimum. The route selection metrics recorded in the RREQ packets are the activity and traffic interference of each of the intermediate forwarding nodes of the RREQ packet [10].

F. Light-Weight Mobile Routing (LMR) Prtocol

The LMR protocol is based on-demand routing protocol, which uses a flooding technique to determine its routes. A node maintains the multiple routes to each required destination. This increases the reliability of the protocol by allowing nodes to select the next neighbor available route to a particular destination without initializing a route discovery Procedure. Also node only maintains routing information to their neighbors. This means avoids extra delays and storage overheads associated with maintaining complete routes. It provides the invalid routes that introduce extra delay in finding correct loops.

G. Link Lifetime Based Backup Routing (LBR) Routing Protocol

Link lifetime based Backup Routing (LBR) is also known as reactive protocol increases the stability of route. It provides the shortest path between source and destination via limited flooding as the preliminary path, and then makes the backup path at each link in the preliminary path by considering link lifetime. This method effectively prevents the backup paths being out-of-date previously and increases the available of backup paths.If any node has to send packets to destination, it first checks in routing table for presence of destination previously. Route discovery process begins and send broadcast message RREQ. These requests are flooded in request zone to find the source and destination. Duplicate requests are deleted to reduce control overhead. Then the destination receives the request and choose the least count hop and send reply RREP message to source and path will be established.

H. Scalable Source Routing (SSR) Protocol

Scalable Source routing protocol is also known as on-demand routing protocol that uses the peer-to-peer overlay network. It combines the source routing along with virtual ring. Virtual ring helps to route the packets by considering the physical networks that changes dynamically by providing virtual address to be static. Each node involved in virtual ring consists of Unique ID which stays constant during routing helps to avoid flooding .Packets are routed along the virtual ring by knowing predecessor and successor nodes, so that delivery of packets are guaranteed. This protocol provides efficient message routing in dynamic topology and requirement of memory space is very less.

I. Split Multi-Path Routing (SMP) Protocol

In this routing protocol, two paths will be established such as Primary path and Backup path. It follows the mechanism as in the DSR routing protocol, when a source needs to send a packet, it then first establishes the Route Request (RREQ) to destination. Only the specific destinations are allowed to reply by Route Reply (RREP) message back to the source. Multiple routes are established to reduce route recovery and control overhead. In this protocol, per packet allocation mechanism is included so as to distribute packets evenly to all active session in multiple routes, thus leads to effective utilization of network resource and network congestions are prevented.

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J. Caching And Multipath (CHAMP) Routing Protocol

Champ protocol works on the basis of reactive protocol, it provides combined packet caching and increases fault tolerant method and routes are kept newer by using Round-Robin allocation algorithm .Each node maintains two states in it,

- Route Cache
- Route Maintenance

Forwarding data and recently received data are stored respectively. If any node receives the (RERR) RouteError message, once again the node forwards the data to destination via other route. Nodes in this protocol send the packets destination which has shortest distance with least weight.

K. Relative Distance Microdiscovery Ad-Hoc Routing (RDMAR) Routing Protocol

This on demand protocol reacts to the link failure that is localized to the small regions that is nearer to change. By knowing the Relative Distance (RD) between the two terminals, query floods are localized. On each transfer of data, route discovery between 2 terminals are triggered, so as to calculate the RD. no periodic beacons are stored to update the routing tables thus it reduces the bandwidth utilization and more scalability and minimizes the flooding by reducing route request to certain number of hops.

V. TYPES OF HYBRID ROUTING PROTOCOL

A. Zone Routing (ZRP) Protocol

ZRP protocol performs both the reactive and proactive routing method; it maintains an up-to-date topological information of a zone at each node. For each node, routing zone is defined and overlap between the zones of neighbor nodes.

ZRP consists of two types

- Intra-zone routing protocol (Proactive routing) is used in between zones .It breaks all the nodes in the routing zone into the interior nodes and peripheral nodes. Each node maintains the path for routing the packets to destination by periodic up-to-date.
- Inter-zone routing protocol (Reactive routing) is used interior routing in zones.

During the transfer of packets from source, node will check whether the destination is within the zone, then it send directly and get the reply message at same path. but, if the node of destination is in outside of Zone, then it broadcast the Request message to all destination and specified node will reply for the message.

B. Zone-Based Hierarchical Link State (ZHLS) Routing Protocol

ZHLS is a hybrid protocol, within each node in the network zone, consists of Zone ID, Node ID and location information. Intra-Zone method is used by implementing shortest path algorithm results in up-to-date information. Inter-Zone method is used to obtain node topology information. Every node in Zone, finds the gateway zone and neighbor node, when the packets are sent from source, data are received from destination, if destination is within zone, else source generates location request and broadcast to all nodes. Communication overhead and storage requirements are reduced in this protocol.

C. Core Extraction Distributed Adhoc Routing (CEDAR) Routing Protocol

Core nodes perform the route establishment process by on demand and reactive routing as the concept.

3 components in this protocol namely

- Extraction of core
- Link-State propagation
- Route computation

In CEDAR protocol, first phase performs the core finding a core route from the source node to the destination and the second phase provides calculating feasible path over core path. A node tries to send request to the destination by considering core information's stored in table of each node, then core node in the destination replies with reply message. If any path becomes failure, source nodes stops sending packets and reinitiate the route establishment process. Thus the Traffic overheads are reduced by utilizing core nodes and perform quality-of-service with the core elements.

D. Dynamic Zone Topology Routing Protocol (DZTR)

DZTR protocol separates the network into number of different zone by using GPS, which reduces the route discovery process.

Two types DZTR protocol

- Overlapping zones- every node finds its zone and updates its routes to all nodes which are present inside the zone.
- Non overlapping zones-every zone has its unique ID, to assign node in the corresponding zone and helps in route discovery and transmission of data.

Topology creation and maintenance and routing operations are carried out in this hybrid network.

VI. CONCLUSION

This paper presents a survey on various types of Routing protocols such as Table-driven, On-demand and Hybrid routing protocols and their working in the MANET network and also provides the clear view over the MANET Routing Protocol and its functions.

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