REVIEW ARTICLE

A Comprehensive Survey on Routing Algorithms in Mobile Adhoc Network

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Abstract

MANET is a form of a network which has movable devices and does not have any centralized AP (Access Point). This type of network can be implemented in a different domain without having and requiring any central administration. MANET has no pre-existing infrastructure; therefore, communication can be achieved through multi-hop wireless technologies between mobile nodes. In MANET routing protocol plays a vital role to discover the best routing path between origin and endpoint. There are numerous routing protocols designed for MANETs. Different surveys have been conducted on routing algorithms used in MANET but they haven't considered various classes of routing protocols used in MANET. This paper provides a comprehensive overview of different routing protocol used in MANET and also describe different classes of these routing protocols. The purpose of this study is to perform an analysis and associate various routing protocols.

Keywords: MANET, proactive routing protocols, reactive routing protocols, hybrid routing protocol, access point.

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1 Introduction

Over the last decades, there has been an increase in demand for wireless communication over traditional wired networks. Because users may readily communicate and use network resources. Furthermore, the user has the connection ability and leaves the network at any time and from any location. These types of characteristics make wireless communication most attractive and popular. In most communication system all node communicates through some centralized access point thus centralization and infrastructure are part of the such system [1]. However, there are other techniques where nodes can utilize each other as an access point and also transmit the data without having any centralized device. MANET is a network without any infrastructure, such as a principal server, dedicated hardware, or stable routers. As it operates in a disseminated peer-to-peer format, each device acts as an independent router and creates separate data. This form of a network can be applied in various emergencies when appropriate infrastructure is unavailable, such as battlefield operations (BFO), Military reign, oceanography, medical fields, disaster

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and rescue operations, and so on. In MANET the node can configure and organize themselves without the need of any administrator. Nodes do not have any fixed position in the network and they can leave and join the network at any time [2]. The structure of MANET is shown in Figure 1.

1.1 Application of MANET

Mobile ad hoc Network (MANET) has several uses ranging from the environment to industry. Some of the most prevalent mobile ad hoc network applications are as follows.

Military – MANET is a structure-free network that is utilized in military applications such as the army and navy. This network is simple to set up. Soldiers in remote regions can utilize it for communication. The use of MANET in the military is shown in Figure 2.

Smart Home – MANET is a network that is used in home automation. This form of network, known as ZigBee, is widely employed in the creation of smart homes [3].

Disaster Rescue – In places that have recently experienced a disaster, wireless ad hoc networks could be easily built without any infrastructure. It will make rescue operations easier because rescue workers and firefighters will be able to speak with one another to locate injured people. The use of MANET in disaster is shown in Figure 3.

Healthcare – This network can be used in healthcare systems to monitor patients who live in remote locations and provide them with as much assistance as feasible. Figure 4 shows the use of MANET in healthcare.

2 Routing Protocol Categorization in Manet

In an ad hoc network, every node should be able to transmit information to other devices. To ensure appropriate functionality for ad hoc networks, various routing techniques have been anticipated. The various classes of these techniques are shown in Figure 5.

2.1 Proactive routing Protocols

Another term for this protocol is table-driven protocol. In proactive routing systems, each device keeps and updates one or more tables encompassing information to further nodes. As the system circumstances change, the information in these tables is updated regularly to sustain reliable and up-to-date routing information. Proactive protocols rely on the periodic exchange of periodic control messages among routers to guarantee that the path to every device is permanently identified [4].

2.1.1 Distance-Sequenced Distance Vector Routing (DSDV)

It falls under the category of the pro-active protocol. It works on the principle of the shortest path. With a modification of a loop-free environment, DSDV can also be used in multi-hop (MHMANET). Inside a network, a sequence number is given to all destination routing tables that also hold the information of hop count in a network. The node sporadically communicates the routing information with immediate neighbors. Flow chart of DSDV protocol is presented in Figure 6.

DSDV shared the routing information with minute changes with their neighbor it is therefore not appropriate for the highly dynamic network [5, 6].

2.1.2 Optimized Link State Routing Protocol (OLSR)

This is a proactive protocol for overthrowing data. Its firstly determines and after broadcasts the information of the link state among the entire MANET using the (MID) hello, Multiple Interface Declaration (HMID), and Topology Control messages (TC) techniques. The Multipoint Relay (MPR) process provides a more systematized and effective approach to implementing the OLSR protocol within a data channel, minimizing network overhead with signaling messages. [7, 8].

2.1.3 Fisheye State Routing (FSR)

The FSR routing method preserves extremely precise routing information from adjacent neighbors and less precise routing information from distant nodes in all nodes. Depending onthe size of the network, the tiers and radius of node scopes can be adjusted [9].

2.1.4 Global State Routing (GSR)

This algorithm is grounded on the fix relation state procedure. It is determined using a fixed length computation. Every node keeps an up-to-date link status table and will exchange its connection information with just its neighbor nodes from time to time. As a result, the amount of control messages transmitted over the network has been reduced significantly. Update messages are presently huge, and as the network expands, they will become increasingly larger [10].

2.1.5 Landmark Ad Hoc Routing (LANMAR)

This algorithm is an FSR variant that focuses on scalability. LANMAR is concerned with the no

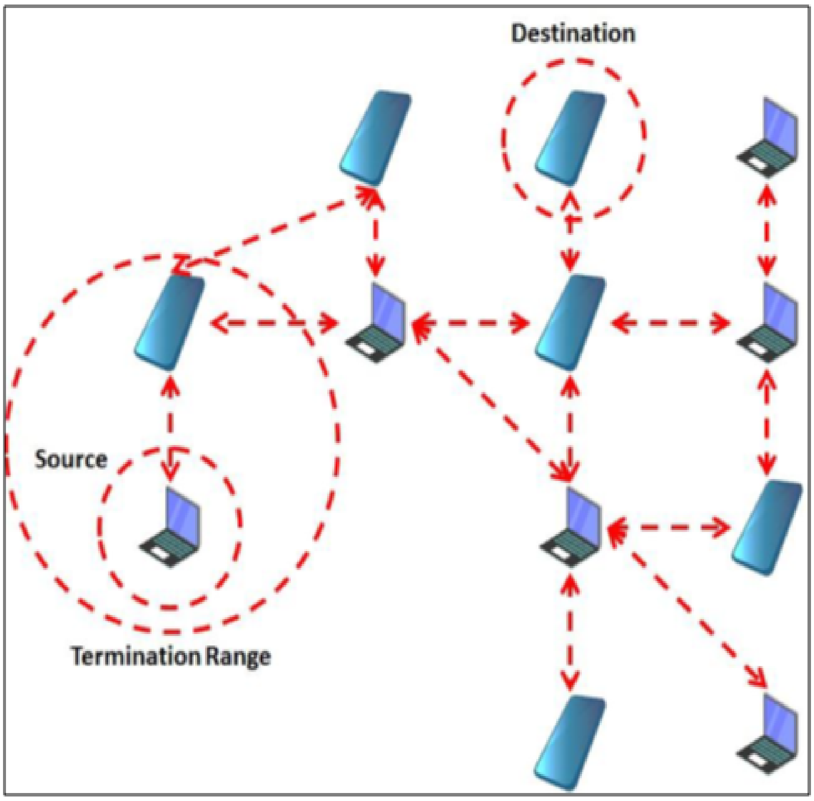

Figure 1. Structure of MANET.

uniform routing categorization of MANET, as opposed to FSR. LANMAR divides mobile nodes into logical subnets based on their movable behavior, thus all devices in a network are more likely to travel together. To keep track of the subnet, a landmark device is provided for each logic subset. LANMAR assigns each movable node a structured address including its subnet identity. A node maintains a list of all landmark nodes representing logical subnets, as well as its neighbors' topological information. LANMAR neighboring nodes, like FSR, routinely communicate topological information as well as the distance vector. When the origin transmits packets to a target within its surrounding, the necessary routing information is retrieved in the routing table of the source's nodes (i.e. the destination and the origin are on a similar subnetwork). Else, the subnet specified in the target device's IP address would be inspected. The information will be transmitted to the logical subset's landmark device based on the distance vector. This algorithm is more proficient than FSR since the requirement to communicate topological data is much lessened. LANMAR, on the other hand, can only be utilized in particular application settings since it implies that nodes be divided into subsets based on their mobility configurations and that the connection of each subnet leftovers stable throughout the network's life span [11, 12].

2.1.6 *Wireless routing protocol (WRP)*

In the Wireless Routing Protocol, each node in the network contains four tables: a) a distance table, b) a routing table, and c) a link-cost table. c) Message retransmission list table (MRL). The MRL table contains a retransmission counter, the update message sequence number, an acknowledgment necessary flag vector with one item for each neighbor, and a list of updates delivered in the update message. The MRL keeps track of which update message modifications need to be resent and which neighbors need to be aware of the discontent. Update messages are used to communicate between nodes. A message sent only between neighboring nodes contains a list of updates as well as a list of responses indicating which nodes should acknowledge the changes. Nodes transmit update messages after digesting updates from neighbors or noticing a change in a neighbor's connection. When a connection between two nodes fails, the nodes exchange update messages. After that, the neighbors change their distance table records and search for alternate paths to their destination, which are likewise recorded in the tables. Devices

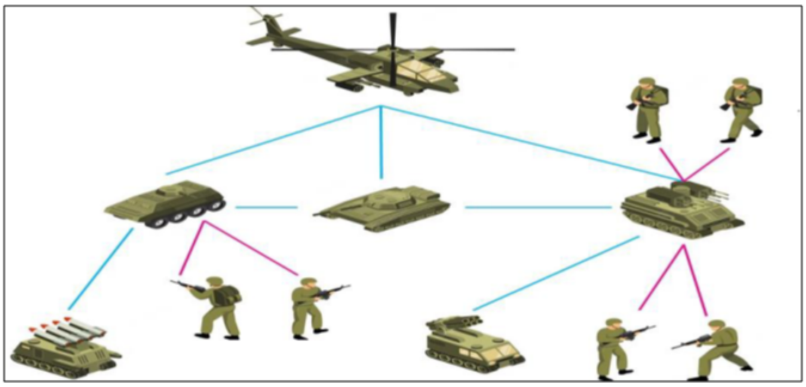

Figure 2. Application of MANET in Military.

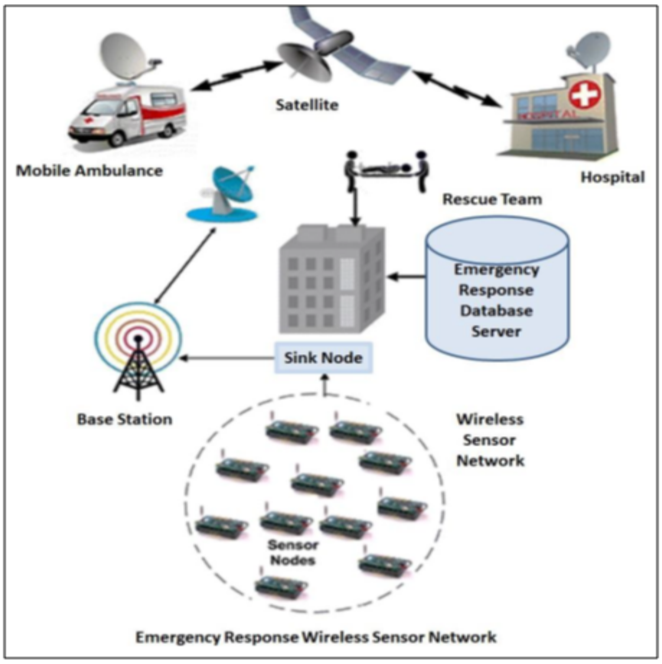

Figure 3. Application of MANET in Disaster.

get acknowledgments and other signals from their neighbors as a result, helping them to learn about their presence. A node that isn't delivering messages must transmit a hello message within a certain amount of time to maintain the connection. Then, the absence of signals from the node specifies that the connection has failed, which might result in a false alert. When a mobile receives a hello message from a new network, it adds the new node to its routing table and replicates the information in its routing table to the new node. To discover the loop-free path, wireless network routing nodes communicate the distance and second-to-last hop data for each destination [13, 14].

2.1.7 Proactive Source Routing Protocol (PSR)

PSR is presented as a mechanism for enhancing Opportunistic Data Forwarding in MANETs. Opportunistic data forwarding is a method of processing data packets in a multi-hop wireless network. Using Breadth-First Search (BFS), PSR discovers the direct pathway among origin and endpoint device BFS. It creates a BFS tree at each router and uses this tree to establish its routing table. The optimal data transmission path among the networks is provided by BFST [15].

2.1.8 Topology dissemination Based on Reverse Path Forwarding (TBRPF)

It is also a proactive routing algorithm. in a network, the shortest path to every destination is provided by TBRPF, which is grounded on Link State ideas. This protocol's core Modules are topology and neighbor discovery. The communication system's Active node is used to determine and update the source tree [16].

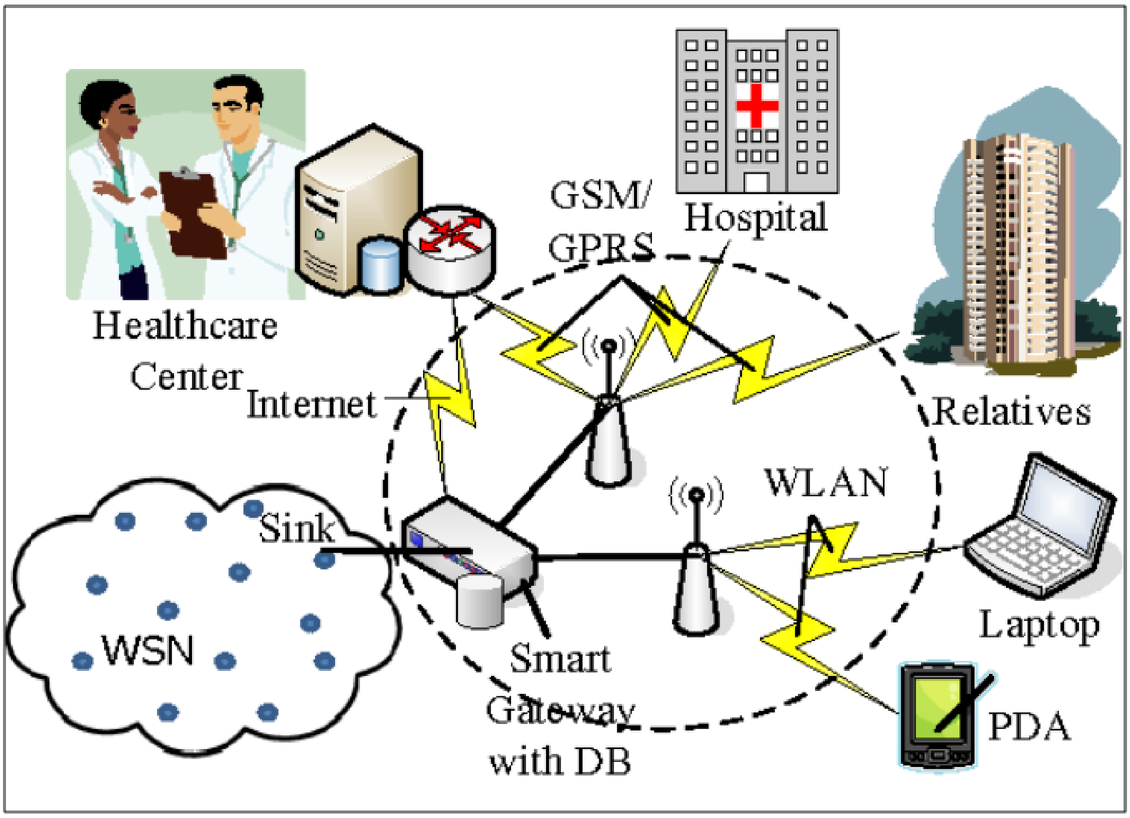

Figure 4. Application of MANET in Healthcare.

2.1.9 The Mobile Mesh Routing Protocol (MMRP)

Grounded on the "link state" perception, it is a mobile ad hoc routing system that is durable, scalable, and efficient. Each node propagates its specific LSP via each network edge over a time period. Because LSPs are mediated by devices, every node understands the whole topology of the ad hoc network. A node may estimate the lowest unicast paths across all other nodes in the mobile ad hoc network using its topology database. To boost scalability, MMRP utilizes a technique known as fish-eye routing, in which the resolution of a node's network map diminishes as a function of hop distance from the node. This is accomplished by slowing the rate at which LSPs propagate throughout the network as they move further away from their origin. This significantly reduces the cost of providing topological knowledge. Furthermore, this allows newer LSPs to "catch up" and replace older LSPs as they spread [17].

2.2 Reactive Routing Protocol

On-demand routing protocols are another name for them. In this type of routing, the route is only found when it is necessary. Route request packets are sent over the mobile network as part of the route detection procedure. It is broken down into path discovery and route maintenance.

Route Discovery: During this phase, the ideal route for transferring data packets between the destination and the source mobile nodes is selected.

Route Maintenance: Due to the changing topology of a mobile ad hoc network, there are frequent occurrences of link failure resulting in network failure among mobile nodes; hence, this phase conducts route maintenance responsibilities. The following is a list of several reactive routing protocols.

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

This algorithm includes this protocol. The goal of the feature is not maintained by this protocol. This implies that if any node wishes to communicate information, path detection will be initiated. The routes in AODV are referred to as "On-Demand" since they are generated as required. This algorithm similarly has two steps: choosing a route using the REQUEST broadcasting technique, and responding to the source using the RREP packet. Each node's timer-based states are being developed by AODV. If the information of the routing table was not utilized so, it expired. The RERR packets are transmitted

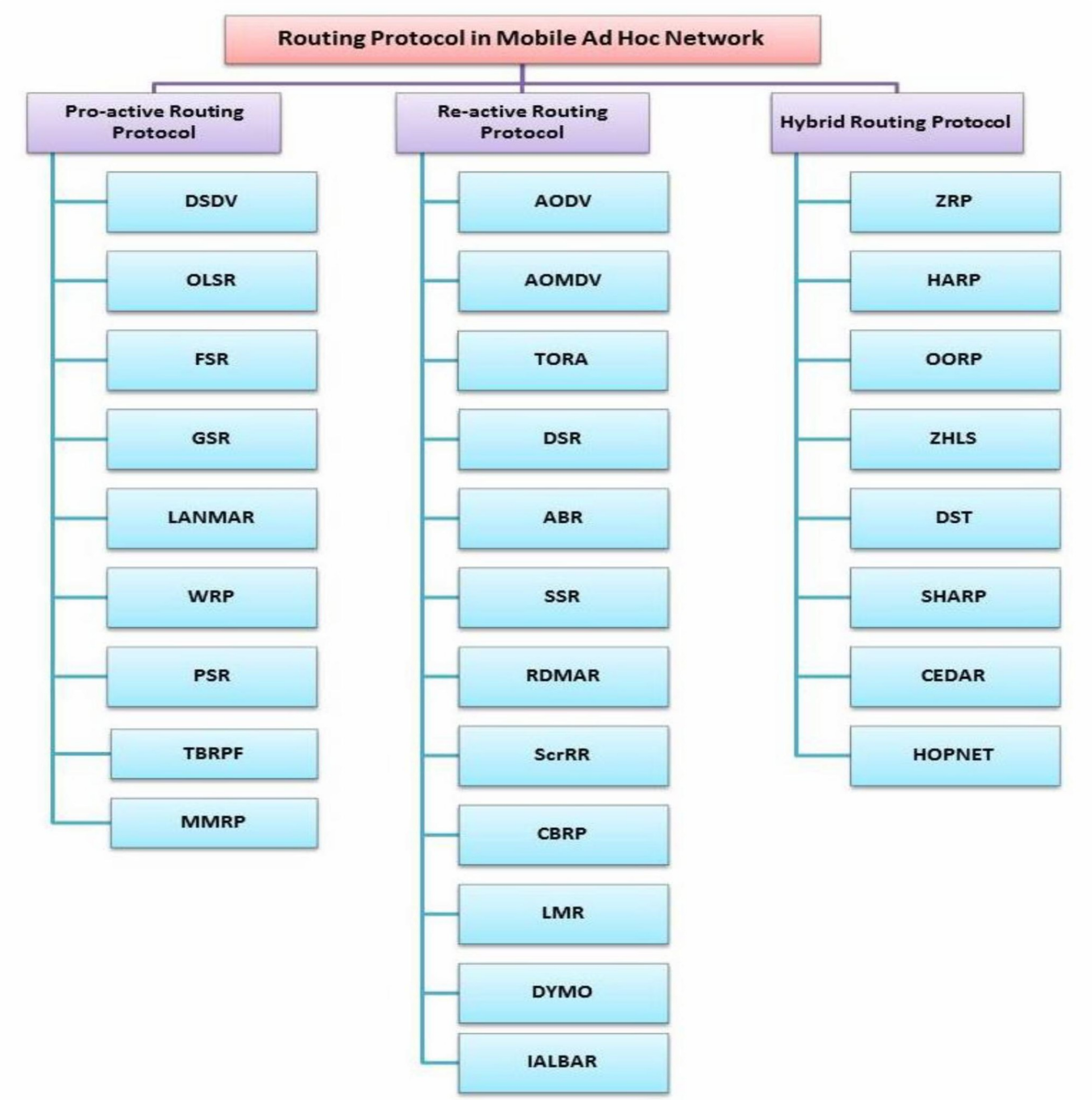

Figure 5. Classes of MANET's routing protocol.

by all preceding nodes whenever a node-link breaks [18]. To find routes to an unknown area, AODV initially employs an expanding ring search approach. Every record in the routing table has the following data. (i)The IP of the target; (ii)The order number of the destination; (iii)A valid target order number flag is present. (iv)Interface with the network, (v)Hop count(vi)Next hop, and (vii)List of precursors. (viii) Lifespan of a route, i.e. its expiry or deletion [19, 20] shows in Figure 7.

2.2.2 *Ad Hoc On-Demand Multipath Distance (AOMDV)*

It is the extension of an AODV protocol. Many pathways are generated between both the destination and the origin in AOMDV protocols. When AOMDV develops several pathways, it selects the primary (or freshest) path based on the time of route discovery. The latest will be considered the greatest, and alternate routes will simply be helpful if the foremost route is blocked. In actuality, several studies demonstrate that this tactic does not always result in the best option [21, 22].

2.2.3 *Temporally Ordered Routing Protocol (TORA)*

The three processes of this routing system are route construction, route deletion, and route maintenance. Each node has a list of its neighbors' heights. This height has five characteristics rather than just one value. The latter two attributes are for offset concerning reference, whereas the first three are for reference. Time, own-ID, replication bit, order of node, and

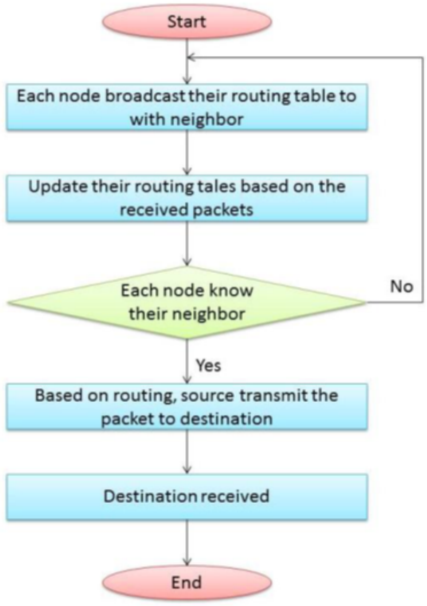

Figure 6. Flow chart of DSDV protocol.

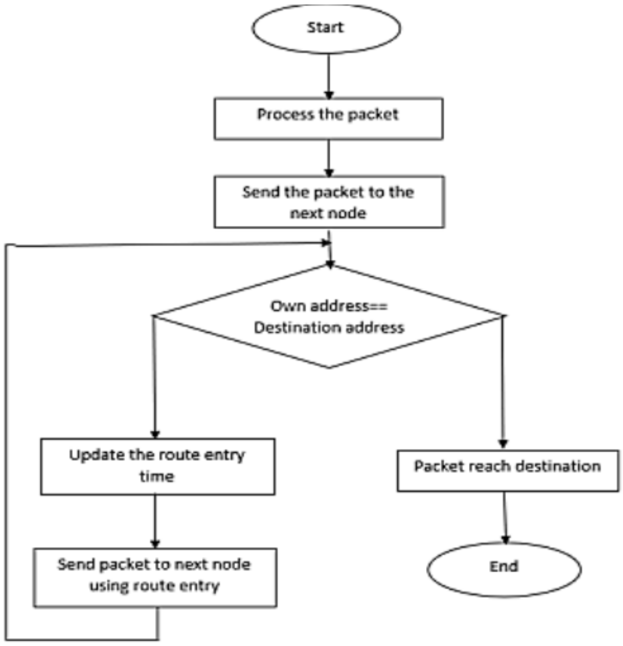

Figure 7. Flow chart of AODV Protocol.

destination-ID are the five different properties. Each node's height is initially set to zero. Height is always 0 for the target device. When a node wants to know the target path, a query packet along with the destination address will be sent to its neighbor. The node will keep going through this procedure until it reaches its target. The destination then creates and broadcasts an update packet, causing network nodes to adjust their height to match the packet's received information. Only nodes whose height exceeds that of their neighbors are permitted to send data. Only in the downstream direction is TORA effective; it is ineffective in an upstream way. If any links are damaged, the route is maintained by route maintenance [23].

TORA is based on the link reversal idea for a highly mobile, dispersed, and adaptable routing algorithm that is used in high-traffic (Multihop wireless) networks. The investigation of several paths leading from the origin to the endpoint node. Control messages are limited to a restricted number of nodes around the occurrence of a topological change in this algorithm, and the node itself keeps orientation information for the neighboring node. This protocol performs the following three major tasks utilizing three messages: a) "QRY message" route creation. b) Establishing and maintaining routes for "UDP messages." b) Erasing a route with a "CLR message" [24].

2.2.4 *Dynamic source routing (DSR)*

This algorithm has two key points: (A) Path detection and (B) Maintenance of path. Whenever information is sent from an originating node to the target node, it will check its information table. If the originator device routing database does not include the connection to the target node, it will broadcast a request and it will consist of the target device address and the sending node address. If a packet of route requests is received, the other nodes will validate their routing tables. If the node doesn't recognize the target node's address, it will attach its address to the packet before forwarding it. When the path to the destination node's address is identified or any node has that data in its routing database, a route reply is produced. The packet route reply will be sent to the nearby node till it finds the source node. Route maintenance also contains packet route errors and acknowledgments that work even if the delivered packets include mistakes or missing information. If the MAC Layer identifies a transmission fault, the reception node will communicate a packet route error to the originating transmitting node [25, 26].

2.2.5 *Associativity-Based Routing (ABR)*

It is an on-demand routing technique started by the source. It does not have any deadlocks, loops, or duplicate packets. Only sources who genuinely want the routes are maintained. ABR, on the other hand, does not reconstruct routes established on substitute route data maintained in intermediary nodes. Furthermore, routing selections are made at the endpoint, where only the optimal solution is chosen and considered. It differs from previous approaches in that it makes use of associativity ticks, which are necessary to only build routes based on node strength because it is useless to develop a route using a node that will leave the topology and break the route. Route discovery, route rebuilding, and route elimination are the three operational modes [27].

2.2.6 *Scalable source routing (SSR)*

For massive, shapeless networks like mobile ad hoc networks, SSR is a brand-new routing technique (scalable source routing). A hierarchical peer-to-peer network's semantics are delivered in real-time by SSR, it is a fully featured network layer routing protocol. It may therefore act as a solid foundation for entirely decentralized mobile applications [28].

2.2.7 *Relative Distance Micro Discovery Ad Hoc Routing (RDMAR)*

The assessment of the distance between the origin and the target is the basis for this protocol. Path discovery packets look for the best route to the endpoint. To transmit the route information back Reverse path was used by the destination node. A route maintenance process is used to maintain the path between the origin and the target. If the routes became down then the route maintenance mechanism was invoked to perform the necessary action for repairing the route. This protocol operates by estimating the distance between the source and destination. This mechanism effectively minimizes routing overhead, leading to significant conservation of battery power and bandwidth [29].

2.2.8 *Source routing for roof net (ScrRR)*

For execution of SrcRR roofnet testbed is used. The key concept of ScrRR is to use the High Throughput route for the overall route procedure. For example, if there are two node source (s) and destination (d)and the source required to find the route toward (d) they will broadcast a query packet toward a destination (d). A reply message is sent back by the destination to the origin when they found their destination [16].

2.2.9 *Cluster-Based Routing Protocol (CBRP)*

This protocol has a hierarchical clustering structure. A cluster head oversees data transmission both inside and across clusters in each one. The volume of control packets broadcast through the network is substantially less in CBRP than in typical flooding systems since only cluster chiefs exchange information. The overhead associated with building and maintaining clusters, as well as with temporary routing loops, is substantial for this hierarchical method [30].

2.2.10 *Light-weight mobile routing (LMR)*

It is another on-demand routing system that chooses its routes through a flooding process. For each targeted destination, LMR nodes maintain several routes available. Enabling the device to choose the next open directly to a certain location deprived of going through a route detection process, increases the protocol's reliability. The fact in this system is that every node just stores information regarding its neighbors' routing is an additional advantage. Inadvertent delays and storage fees related to maintaining full routes are therefore avoided [8].

2.2.11 *Dynamic MANET On-demand (DYMO)*

Another reactive ad-hoc routing algorithm is known as A Dynamic MANET On-demand (DYMO). Route discovery and route maintenance have two primary functions of this protocol. When the node has packets to send, it discovers the path to the destination. It updates its database with the path of the target node in this scenario. Message RREQ is flooded into the network by the originating node. After saving the address of the RREQ's originating node and sending the message to the surrounding nodes, an intermediate node that gets an RREQ does so. The route reply message (RREP) is sent to the source node when the final destination receives an RREQ message with its address marked as a new destination. From there, they unicast throughout the whole network. The transitional nodes relay the RREP message to the appropriate recipient after updating their routing tables. Route maintenance takes place when a path to a target point is disrupted and there is information to deliver to the node at the end of the interrupted route MANET Performance Measurement of DYMO routing protocol by varying density and node speed. Figure 8 shows the route discovery of DYMO protocol.

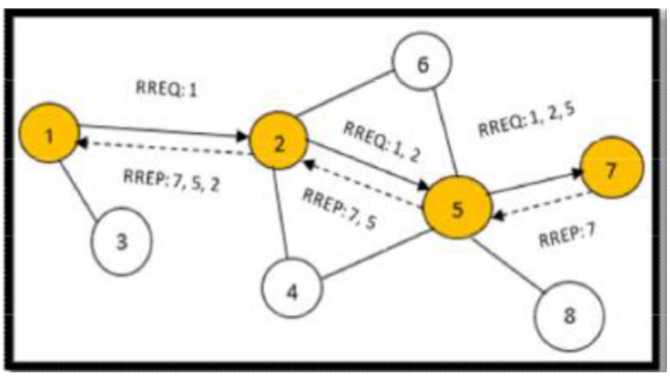

Figure 8. Route discovery of DYMO protocol.

According to the following origin node, 1 and destination node 7 require communication. It creates an RREQ packet, broadcasts it over the network, and includes its address, hop count, sequence number, and destination address. As seen with nodes 2 and 5, each intermediary node that has a viable path to the target continues to add its address and sequence number to the RREQ packet. If the source does not receive an RREP message, it will wait for one from the destination node.

If RREP is acknowledged inside a certain time to live (TTL) value, RREQ will resend. TTL is a network data transfer lifetime limit. To eliminate loops in the route and to erase stale packets, each node keeps a unique sequence number. As declared earlier, DYMO certifies a free loop. Each time an RREQ is sent to further nodes, the router updates its sequence number. Information is ignored if the arriving packet's sequence number is the same as or lower than the previous one, however, packets with higher sequence numbers are updated in the routing database.

2.2.12 *Interference Aware Load Balancing (IALBAR)*

It is a load-balancing routing technology, that served as the foundation for the development of IALBAR, as the name implies. As a routing matrix, this approach counts the load at each node and following hop. The nodes and the next hop node are linked via a channel to facilitate load evaluation at the next hop. The route with the lowest load among all nodes in the network is discovered by total network load and then saved in the routing database [31].

2.3 Hybrid Routing Protocol in MANET.

In order to provide better results, hybrid protocols integrate the characteristics of proactive and reactive protocols. A few hybrid routing protocols are listed below:

2.3.1 *Zone Routing Protocol (ZRP)*

This routing technology was created with big networks in mind. This kind of protocol is built on the idea that there were some routing zones where each node just needed the barest of details. A Zone routing protocol's central idea is (Comparison analysis of MANET routing protocols to identify LMR).

Intra-zone routing protocol (IARP). This component is utilized in proactive routing; it updates network status information for nodes outside the routing region while also maintaining routes to nodes. Inter-zone routing protocol (IERP). When a route between different zones is needed to avoid source and destination congestion, the intra-zone routing protocol is utilized [32].

2.3.2 *HYBRID AD HOC ROUTING PROTOCOL (HARP)*

It is also a hybrid method that aims to build the most stable path possible between an origin node and a target in imperative to reduce delays caused by path failure. To prevent flooding in the network, the (HARP) hybrid ad hoc routing protocol established the path detection approach within zones and in accordance with stability requirements that filter the candidate path. As stability is the utmost anticipated parameter in the network so, HARP provides adifferent techniques to anticipate path letdown as well as path maintenance techniques [33, 34].

2.3.3 *Order One Network Protocol (OORP)*

It is also a hybrid routing algorithm/protocol, its basic idea is to organize networks by themselves into a tree. In this sort of protocol, nodes find each other, and a request message is sent to each other laterally with an effective path. For the minimization of the total amount of transmission information (OORP) Order One Network Protocol used a hierarchical algorithm [35].

2.3.4 *Zone Based Hierarchical Link State Routing Protocol (ZHLS)*

The network is subdivided into non-overlapping regions in this kind of Protocol. There is no zonal head in this type of algorithm. It defines zone and node level topologies. The work of node base topology is to tell how the node of a zone is physically connected with each other's. And the zone base topology's task is to observe the connections between the zone's nodes. In ZHLS, there are dual different kinds of link state information. (A) zone LSP (B) Node LSP. A node LSP stores data on its neighbors' nodes and zones are proliferated with that data. The zone LSP, however, contains information on the zone that is widely dispersed worldwide. Because of this, each node in a zone has complete connection information on other nodes within that zone, but just zone connectivity information on nodes in other zones. Consequently, the packet will be routed to its destination by just supplying the zone and node is [6].

2.3.5 *Distributed spanning trees (DST)*

It is a dependable tree-based hybrid routing system used in MANET. The tree represents every device in the network. The tree consists of two kinds of nodes: route nodes and internal nodes. The tree's root governs the entire structure. Depending on the sort of operation being attempted, one of three states is possible for each node: Router, Merge or configure state. Each control packet is kept for a certain amount of time, known as the holding time, and sent to all nearby bridges and neighbors of the spanning tree. Holding time boosts and improves the communication channel's dependability. Control packets from the origin are spread and repeated alongside the tree edges in DST. A control is moved up the tree as it strikes a leaf node until it reaches the shuttling level, which is a predetermined height [36].

2.3.6 *Hybrid Adaptive Routing Protocol for Mobile Ad Hoc Networks (SHARP)*

This algorithm is part of the hybrid protocol family, which eagerly implements network features and traffic behavior. To route data, SHARP utilized both a proactive and a reactive approach. The proactive zone, also known as the network neighborhood, is chosen by each SHARP node. Where proactive dispersal of routing information pertaining to itself occurs. The foundation of SHARP is a cutting-edge proactive routing technique that is effective and manageable systematically. SHARP is able to use any reactive routing scheme whose expenses can be determined systematically [37].

2.3.7 *Core-Extraction Distributed Ad hoc Routing protocol (CEDAR)*

For QoS routing in ad hoc networks CEDAR is recommended with tens to hundreds of nodes for minor to middle-sized ad hoc networks. The bandwidth is the single QoS parameter utilized in CEDAR for routing. Most multimedia applications demand that communication fulfill strict standards for latency, delay-jitter, cost, and other quality-of-service measures [15]. The tendency under these conditions is to transfer away from single-constrained routing and toward multi-constrained routing. The primary goal of multi-constrained QoS routing is to develop a viable pathway that concurrently fulfills many restrictions [11].

2.3.8 *Distance Routing Effect Algorithm for Mobility (DREAM)*

DREAM provides a position service for position-based routing, which is how position-based routing is carried out. In this system, every device retains a location catalog that compiles details around other nodes in the networks. As a result, it may be categorized as an all-for-all strategy, which denotes that every node acts as a location service provider and keeps the location data for every other node. A position database entry contains information on the node's identifier, its direction and distance from the node, and the moment it was created. To maintain the accuracy of the other nodes' locations, each node routinely delivers floods of packets. A node can adjust the accurateness of its location information by regulating the frequency with which it is provided since the database's location data's accuracy depends on how old it is [11].

2.3.9 *Hybrid Ant Colony Optimization (HOPNET)*

The zone routing and ACO algorithms are used by the HOPNET routing protocol. This procedure takes into account the possibility of ants moving from one area to the next. Local proactive communication occurs within the zone, whereas inter-zone reactive communication occurs. Only the foremost ants are dispatched to the border nodes. The forwarded ants are then directed to their destination address using the routing information of adjacent nodes. The ants use the available border nodes and local routing data to move from one zone to another. Network scalability is provided via the zoning strategy. When a connection fails, the problem is resolved without using network flooding. Routing tables are used to create new routes and are constantly updated and maintained for inter- and intra-zones [38, 39].

3 Conclusion

In conclusion, this paper presents a thorough exploration of Mobile Ad hoc Networks (MANETs) and their unique characteristics, particularly focusing on their dynamic nature, lack of centralized infrastructure, and reliance on mobile devices. The absence of a central access point makes MANETs adaptable to various domains without necessitating centralized administration. Within such networks, communication is facilitated through multi-hop wireless connections between mobile nodes. Routing protocols in MANETs play a crucial role in establishing optimal paths for data transmission between source and destination. While many surveys have examined routing algorithms in MANETs, some may not have comprehensively covered all protocol categories, especially the evolving hybrid and hierarchical classes. This study aims to provide a more holistic view by comprehensively delves into the realm of MANET routing protocols, encompassing various classes of these protocols to offer a holistic view. Through this study, a comprehensive understanding of the various routing protocols employed in MANETs is presented, shedding light on their distinct characteristics, advantages, and limitations. By categorizing these protocols, the paper contributes to a more systematic analysis of their functionalities and applications. The findings of this study not only enrich the current body of knowledge on MANETs but also offer insights for future research in this dynamic and evolving field.

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Conflicts of Interest

The authors declare no conflicts of interest.

Ethical Approval and Consent to Participate

Not applicable.

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