

## Comparison of Various Unicast-Multicast Routing Protocols for Mobile Ad-Hoc Networks

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**Abstract:** A Mobile Ad-hoc Network (MANET) is a self configuring network which consists of mobile nodes with no permanent infrastructure. In a MANETs, there is no difference between a host node and a router so that all nodes can be source plus forwarders of traffic. The task of finding routes in Mobile Ad-hoc Network (MANET) is an important factor in determining the efficiency of any MANET routing protocols. This paper describes about the basic idea of different routing protocols and its efficient use in MANET. There are several routing protocols based on UNICAST and MULTICAST. This paper will conclude the main characteristics of these protocols with comparison and suggest the best suited protocol for particular topology or network.

**Keywords:** MANET, Unicast Routing Protocol, Multicast Routing Protocol.

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### I. INTRODUCTION

The rapid growth in the mobile communication is mainly due to the mobility offered to end users, providing information access to anywhere, easy deployment, and user friendliness. These types of networks have independent centralized administration; user can enter the networks and leave the networks easily. One of the important research areas in MANET is establishing and maintaining the ad hoc network through the use of routing protocols. Wireless communication technology have been developed with two primary models one is fix infrastructure based model in which much of the nodes are mobile and connected through fixed backbone nodes using wireless medium. Another model is Mobile Ad-hoc network. Mobile Ad-Hoc Networks (MANETs) are comprised of mobile nodes (MNs) that are self-organizing and there are no specific routers, servers, access points for MANET. Design issue for developing a routing protocol for wireless environment with mobility is very different and more complex than those for wired network with static nodes [1]. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. Depending upon the nature of application, appropriate routing protocol is implemented. UNICAST and MULTICAST protocols are the two classes of MANET routing protocols and each constitute a set of protocols.

#### 1.1. Characteristics of MANET

MANETS have some characteristics:

**Bandwidth-constrained:** Variable capacity links: Wireless links will continue to have significantly lower capacity than their hardwired counterparts. In addition, the realized throughput of wireless communications after accounting for the effects of multiple access, fading, noise, and interference conditions, etc. is often much less than a radio's maximum transmission rate. One effect of the relatively low to moderate link capacities is that congestion is typically the norm rather than the exception, i.e. aggregate application demand will likely approach or exceed network capacity

frequently. As the mobile network is often simply an extension of the fixed network infrastructure, mobile ad hoc users will demand similar services. These demands will continue to increase as multimedia computing and collaborative networking applications rise.

**Dynamic Topologies:** Nodes are free to move arbitrarily; thus, the network topology which is typically multichip may change randomly and rapidly at unpredictable times, and may consist of both bidirectional and unidirectional links.

**Energy-constrained operation:** Some or all of the nodes in a MANET may rely on batteries or other exhaustible means for their energy. For these nodes, the most important system design criteria for optimization may be energy conservation.

**Limited physical security:** Mobile wireless networks are generally more prone to physical security threats than are fixed- cable nets. The increased possibility of eavesdropping, spoofing, and denial-of-service attacks should be carefully considered.

**Hidden problem:** Node A and node C are in range for communicating with node B, but not with each other. In the event that both try to communicate with node B simultaneously, A and C might not detect any interference on the wireless medium. Thus, the signals collide at node B, which in turn will be unable to receive the transmissions from either node. The typical solution for this so-called "Hidden terminal" problem is that the nodes coordinate transmissions themselves by asking and granting permission to send and receive packets. This scheme is often called RTS/CTS (Request To Send/Clear To Send).

## 1.2. Issues in MANET

MANET faces many challenges [2] like issue of scalability, clock synchronization, Energy conservation, Routing etc. This paper describes about the problem of Routing. It is an important factor of reliable communication in MANET.

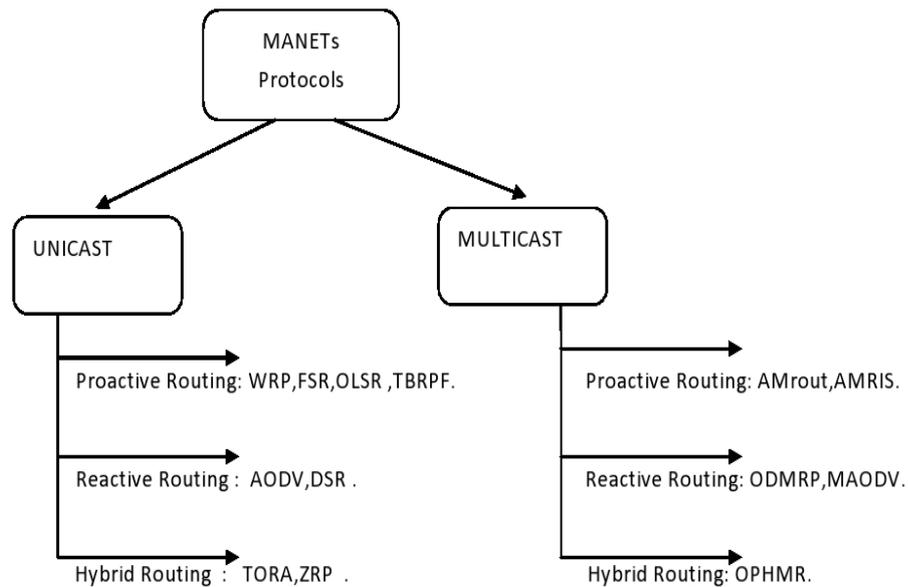
## II. ROUTING PROTOCOLS IN MANET

Routing[3,4] is the act of moving information from a source to a destination in an internetwork. During this process, at least one intermediate node within the internetwork is encountered. This concept is not new to computer science since routing was used in the networks in early 1970's. But this concept has achieved popularity from the mid-1980's. The major reason for this is because the earlier networks were very simple and homogeneous environments; but, now high end and large scale internetworking has become popular with the latest advancements in the networks and telecommunication technology. The routing concept basically involves, two activities: firstly, determining optimal routing paths and secondly, transferring the information groups (called packets) through an internetwork.

### 2.1. Classification of Routing Protocols in MANET

MANET's protocols are generally divided into two parts: Unicast and Multicast. Again in each part they are divided in three parts:

**Proactive routing protocols** are very useful for a small-scale MANETs with high mobility, while **Reactive routing protocols** are very useful for a large-scale MANETs with moderate or less topology changes. **Hybrid routing protocol** attempts to strike balance between the two such a proactive for neighborhood, and reactive for far away.



*Figure 1. Classification of MANET's Protocol*

### III. UNICAST ROUTING PROTOCOLS

In **Unicast routing protocols**, one source transmits information to one destination. The Unicast protocols are also the most common in ad-hoc environment to be developed and they are the basis on which it is a possibility to construct other type of protocols. Unicast protocols have thought some lacks when there is a need to send same message or stream of data to multiple destinations. So there is an evitable need for multicast protocols. While forwarding data packet dispatch node use the destination address in the data packet to look it up in routing table. If the destination address found in routing table the data packet will send to the corresponding next hop. But in such condition every node maintains the routing table in network. So the problem is that how the routing table is created and maintained in MANET.

#### 3.1. Proactive Unicast Routing Protocols

In Proactive Unicast routing protocol each node in MANET maintains routing information to every other node in network to compute shortest path from the source to every destination node, which consumes lots of bandwidth. Such routing information is kept in many different types of tables. Such tables are time to time updates if network topology changes or a node moves from network. Proactive routing is unsuitable for highly dynamic networks because routing tables must be updated with each topology change, this leads to increased control message overheads which can degrade network performance at high loads.

Proactive Unicast routing protocols are divided as Fishey State Routing Protocol (FSR), Optimized Link State Routing Protocol (OLSR), and Topology Broadcast Based on Reverse Path Forwarding Routing Protocol (TBRPF).

**3.1.1. Fishey State Routing Protocol (FSR):** FSR was proposed in [5] for aim at large scale and wit high mobility MANET. Name of this protocol comes from property of eye's fish. Fishey State Routing Algorithm works on following method.

- Based on distances the network is divided into different scopes. For example if the nodes are in 3 hops distance, they will come in same scope. Other node will come outer scope.
- The nodes which are in different scope, Routing entries corresponding to these nodes are sent at different frequencies and routing entries for inner nodes are sent at highest frequency and other entries are sent at lower frequency. Because of this reason the nearby node will receive more up to date link state updates compare to the node far away node.

**3.1.2. Optimized Link State Routing Protocol (OLSR):** OLSR proposed in [6] for aim at large and dense Mobile Ad-Hoc Network. OLSR works on Multipoint Relaying flooding techniques to reduced topology broadcast packets. OLSR works according to the following points.

- Every mobile node broadcast “hello” message periodically to its neighbor. With this hello message every mobile node can obtain topological information for every node in MANET.
- Now based on topological Information, A node will select a subset of its neighbor to act as multipoint relaying nodes.
- Every node contains its global topological information and update, shortest path from source node to every other node can computed with Dijkstra’s Algorithm.

**3.1.3. Topology Broadcast Based on Reverse Path Forwarding Routing Protocol (TBRPF):** TBRPF was proposed in [7] for several hundred of mobile nodes or high mobility in MANET. In TBRPF each mobile node in network keeps incomplete global topological information. To reduce routing overhead TBRPF adopts following optimization steps:

- “hello” messages are exchanged among neighboring nodes periodic and differential. Only the changes of neighbor status are included in “hello” message.
- A part of spanning tree is broadcast to its neighbors if mobile node ‘A’ finds itself is on the path from its neighbor ‘B’ to a destination ‘C’ in the ‘A’ rooted spanning tree, it will put node ‘C’ and its adjacent links in the reportable topology sent to neighbors.
- Whenever required like network topology updated, mobile node mobility etc, it will update with “hello” message.

Table-1 gives the characteristics comparison of Proactive Unicast Routing Protocols.

*Table 1. Characteristics of Proactive Unicast Routing Protocols*

<i>Characteristics</i>	<b>FSR</b>	<b>OLSR</b>	<b>TBRPF</b>
<i>Scope</i>	Large scale MANETs with high mobility	Large and dense MANETs	MANETs with hundreds of nodes and high mobility
<i>Organization of the network</i>	Hierarchical	Flat	Flat
<i>Neighbor Detection method</i>	Periodical link state updates	Periodical HELLO messages	Differential HELLO Messages
<i>Optimized Broadcast</i>	Combined with neighbor Detection	Multipoint relaying	Combined with HELLO messages
<i>Broadcast Information</i>	Link state update	MPR selector	(Partial) Spanning tree
<i>Route freshness</i>	Maybe not up-to-date	Up-to-date	Up-to-date

### 3.2. Reactive Unicast Routing Protocols

Reactive protocols are also known as on-demand routing protocol. Such protocol were reduced the overheads of proactive protocol by maintaining route information for active routes. Its mean the routing information is required and maintained only when one node wants to send data packet to destination. The concept of Reactive protocol was proposed to keep the waste of bandwidth as little as possible.

Reactive Unicast routing protocols are divided as Ad Hoc On-demand Distance Vector Routing Protocol (AODV), Optimized Link State Routing Protocol (OSPF), and Temporally Ordered Routing Algorithm (TORA).

**3.2.1. Ad Hoc On-demand Distance Vector Routing Protocol (AODV):** AODV [8] is a reactive Unicast routing protocol for mobile ad hoc networks. As a reactive routing protocol, AODV only needs to maintain the routing information about the active paths. In AODV, routing information is maintained in routing tables at nodes. Every mobile node keeps a next-hop routing table, which contains the destinations to which it currently has a route. A routing table entry expires if it has not been used or reactivated for a pre-specified expiration time. Moreover, AODV adopts the destination sequence number technique used by DSDV in an on-demand way.

**3.2.2. Dynamic Source Routing (DSR):** DSR [9] is an On Demand Unicast routing protocol that utilizes source routing algorithm. In source routing algorithm, each data packet contains complete routing information to reach its dissemination. Additionally, in DSR each node uses caching technology to maintain route information that it has discovered. For example, the intermediate nodes cache the route towards the destination and backward to the source. Furthermore, because the data packet contains the source route in the header, the overhearing nodes are able to cache the route in its routing cache.

**3.2.3. Temporally Ordered Routing Algorithm (TORA):** TORA [10, 11] is a On Demand routing algorithm based on the concept of link reversal. This Routing protocol improves the partial link reversal method by detecting partitions and stopping non-productive link reversals. TORA can be used for highly dynamic mobile ad hoc networks. TORA has three basic steps: route creation, route maintenance and route erasure. In TORA the DAG provides the capability that many nodes can send packets to a given destination and guarantees that all routes are loop-free. Because of node mobility the DAG in TORA may be disconnected. So, route maintenance step is a very important part of TORA. This routing protocol has the unique feature that control messages are localized into a small set of nodes near the topology changes occurred.

Table-2 gives the characteristics comparison of Reactive Unicast Routing Protocols.

*Table 2. Characteristics of Reactive Unicast Routing Protocols*

<i>Characteristics</i>	<b>AODV</b>	<b>DSR</b>	<b>TORA</b>
<i>Updating of Destination at Multiple Route</i>	Source	Source	Neighbors
<i>Multicast Capability</i>	YES	NO	NO
<i>Control Hello Message Requirement</i>	NO	NO	YES
<i>Design Structure</i>	Flat	Flat	Flat
<i>Unidirectional Link</i>	NO	YES	YES
<i>Multiple Route</i>	NO	YES	YES
<i>Loop free</i>	YES	YES	YES
<i>Route maintained in</i>	Route table	Route cache	Route table

<i>Advantage</i>	Adaptive to highly, dynamic topologies, Low overhead	Multiple routes, Loop free, promiscuous overhead	Multiple routes
<i>Disadvantage</i>	Scalability problems, Large delays, hello message	Scalability problems, Large delays, hello message	Temporary routing loops, overall complexity

### 3.3. Hybrid Unicast Routing Protocols

Hybrid Unicast routing protocols are the protocol which combines the nature of both proactive routing protocol and reactive routing protocol. Hybrid protocols are known as new generation protocols. Hybrid protocol reduced route discovery overheads by allowing nodes with closeness to work together to form some sort of a backbone. Hybrid protocols are proposed based on zone (region). It means a network is divided into number of zone by each mobile node. ZRP is hybrid Unicast routing protocol.

Hybrid Unicast routing protocols are divided as Zone Routing Protocol (ZRP) and Zone-Based Hierarchical Link State (ZHLS).

**3.3.1. Zone Routing Protocol (ZRP):** ZRP [12] is a hybrid routing protocol for mobile ad hoc networks. The hybrid protocols are proposed to reduce the control overhead of proactive routing approaches and decrease the latency caused by route search operations in reactive routing approaches.

**3.3.2. Zone-Based Hierarchical Link State (ZHLS):** In ZHLS [13] routing protocols are divided into hierarchical structures. The complete network is divided into non-overlapping zones. Such non-overlapping zones has unique zone ID and each node in such zone has unique node ID which is calculated by GPS. The hierarchical structure of network (topology) is form in two levels on the basis of node level topology and zone level topology. In ZHLS no cluster head is required for data transmission. This reduces extra processing overhead while data transmission. When a node want to send data packet to the node which is located in other zone, in such conditions source node broadcast a zone level location request to all other zones, which required significantly low overhead if compared to flooding approach in reactive protocols. ZHLS is Hierarchical in routing structure and can have multiple routes if more than one virtual link exists in between mobile nodes. Routing maintenance is required for both interzone and intrazone.

Table-3 gives the characteristics comparison of Hybrid Unicast Routing Protocols.

*Table 3. Characteristics of Hybrid Unicast Routing Protocols*

<i>Characteristics</i>	<b>ZRP</b>	<b>ZHLS</b>
<i>Loop free</i>	Yes	Yes
<i>Routing philosophy</i>	Flat	Hierarchical

#### IV. MULTICAST ROUTING PROTOCOLS

Multicast routing protocols try to construct a desirable routing tree or a mesh from one source to several destinations. These protocols have also to keep up with information of joins and leave ups to a multicast group which efficiently support to the group communication with the high throughput. The use of multicasting within MANETs has many benefits. It can decrease the cost of wireless communication and increase the efficiency and throughput of the wireless link between two nodes whenever we are sending multiple copies of the same messages by accomplishment the inherent broadcasting properties of wireless transmission. In place of sending same data through multiple Unicasts, multicasting decrease channel capacity consumption, sender nodes and routers processing, energy utilization , and data delivery delay, which are deliberate important for MANETs.

##### 4.1. Proactive Multicast Routing Protocols

Proactive multicast routing protocols are divided as Ad-hoc Multicast Routing (AMRoute), Ad hoc Multicast Routing Protocol Increasing id-numbers (AMRIS), and Core-Assisted Mesh protocol (CAMP).

**4.1.1. Ad-hoc Multicast Routing (AMRoute)** [14] is a tree based multicast routing protocol for mobile ad hoc networks. AMRoute creates a multicast shared-tree over mesh. AMRoute relies on the existence of an underlying Unicast routing protocol. AMRoute has two key phases: mesh creation and tree creation. This protocol can be used for networks in which only a set of nodes supports AMRoute routing function.

**4.1.2. Ad hoc Multicast Routing Protocol Increasing id-numbers (AMRIS)** [15] is a proactive shared tree based multicast routing protocol, which is independent of the fundamental Unicast routing protocol. In AMRIS, the tree maintenance procedure operates continuously and locally to ensure a node's connection to the multicast session delivery tree. In AMRIS, the tree maintenance procedure operates continuously and locally to ensure a node's connection to the multicast session delivery tree. AMRIS is an on demand protocol that constructs a shared delivery tree to support multiple senders and receivers within a multicast session.

**4.1.3. Core-Assisted Mesh protocol (CAMP)** [16, 17] is a proactive multicast routing protocol based on shared meshes. The mesh structure provides at least one path from each source to each receiver in the multicast group. CAMP relies on an underlying Unicast protocol which can provide correct distances to all destinations within finite time. Every node maintains a Routing Table (RT) that is created by the underlying Unicast routing protocol. CAMP modifies this table when a multicast group joins or leaves the network. A Multicast Routing Table (MRT) is based on the Routing Table that contains the set of known groups.

Table-4 gives the characteristics comparison of Proactive Multicast Routing Protocols.

*Table 4. Characteristics of Proactive Multicast Routing Protocols*

<i>Characteristics</i>	<b>AMRoute</b>	<b>AMRIS</b>	<b>CAMP</b>
<i>Structure of Multicast delivery</i>	Tree	Tree	Mesh
<i>Loop free</i>	No	Yes	Yes
<i>Dependency on Unicast routing protocol</i>	Yes	No	Yes
<i>Scalability</i>	Yes	No	Yes
<i>Control Packet flooding</i>	Fair	Fair	Good
<i>Dependency on Unicast</i>	Flat	Flat	Flat
<i>Periodic message requirement</i>	Yes	Yes	Yes

## 4.2. Reactive Multicast Routing Protocols

Reactive multicast routing protocols are divided as On-Demand Multicast Routing Protocol (ODMRP) and Multicast Ad-hoc On-demand Distance Vector (MAODV).

**4.2.1. On-Demand Multicast Routing Protocol (ODMRP)** [18] is a reactive mesh based multicast routing protocol. ODMRP is not only a multicast routing protocol, but also provides Unicast routing capability.

**4.2.2. Multicast Ad-hoc On-demand Distance Vector (MAODV)** [19] is a reactive tree-based multicast routing protocol. MAODV is an extension of the Unicast routing protocol Ad-hoc On-demand Distance Vector (AODV).

Table-5 gives the characteristics comparison of Reactive Unicast Routing Protocols.

*Table 5. Characteristics of Reactive Multicast Routing Protocols*

<i>Characteristics</i>	<b>ODMRP</b>	<b>MAODV</b>
<i>Multicast delivery structure</i>	Mesh	Core based Tree
<i>Loop free</i>	YES	YES
<i>Periodic messages requirement</i>	YES	NO
<i>Routing Hierarchy</i>	Flat	Flat
<i>Scalability</i>	Fair	Fair

## 4.3. Hybrid Multicast Routing Protocols

Hybrid multicast routing protocols are divided as Optimized Polymorphic Hybrid Multicast Routing Protocol (OPHMR).

**4.3.1. Optimized Polymorphic Hybrid Multicast Routing Protocol (OPHMR):** This protocol [20] is invested with different operational modes that are either proactive or reactive based on a MN's power remainder, mobility level, and vicinity density level. It attempts to address the issues of power efficiency, latency, and protocol overhead in an adaptive manner. OPHMR's reactive behaviour is based on the On-Demand Multicast Routing Protocol (ODMRP). It's relatively simplistic. It generates on-demand route paths for multicast message requests. OPHMR's proactive behaviour is based on the Multicast Zone Routing (MZR) protocol. It builds a zone around each Mobile Node (in hops) and periodically sends updates within each defined zone. For added efficiency, OPHMR utilizes an optimizing scheme adapted from the Optimized Link State Routing (OLSR) protocol. It used to decrease the amount of control overhead that is produced. OPHMR is, after a very lengthy period of time, able to extend battery life and enhance the survivability of the mobile ad hoc nodes. As a result, it decreases the end-to-end delay and increases the packet delivery ratio.

## V. CONCLUSION

A Mobile Ad-hoc Network (MANET) is a self configuring network which consists of mobile nodes with no permanent infrastructure. In a MANETs, there is no difference between a host node and a router so that all nodes can be source plus forwarders of traffic. Routing is an essential component of communication protocols in mobile ad hoc networks. Routing protocols typically fall under two categories; Unicast routing protocol and Multicast routing protocol. The design of the protocols are

driven by specific goals and requirements based on respective assumptions about the network properties or application area. According to the description and comparison of their characteristics, we can arrive at the conclusions: Hybrid Unicast or multicast routing protocol seems to be a better candidate than pure proactive and reactive routing protocols. Many of the application use Unicast protocol whereas in group communication Multicast routing gives comparatively better performance. However, its performance needs to be fully exploited and the OPHMR is a better than another Routing Protocol because OPHMR is a hybrid multicast routing protocol. For added efficiency OPHMR utilizes an optimizing scheme through a Multipoint Relay (MPR). It used to decrease the amount of control overhead that is produced. So we can say that OPHMR is a better than another routing protocol. This paper gives the comparison of various Unicast-Multicast routing protocols for Mobile Ad-Hoc Networks.

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