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A Survey on Different Hybrid Routing Protocols of MANET

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Abstract- **Dispensing with the need for hardwire-based infrastructure, MANET is a self-organized and self-configurable network of mobile nodes with wireless connectivity, where the nodes move arbitrarily. Routing is a critical issue in Mobile Adhoc Network. Therefore, Routing protocols for this network have to face the challenge of frequently changing topology. Both proactive and reactive routing protocols prove to be inefficient under these circumstances. Third category, Hybrid routing protocols combines the advantage of Proactive as well as the reactive protocols. This paper describes the various Hybrid protocols with their advantages and Disadvantages.**

Keywords- **MANET, ZRP, IARP, IERP, Routing**

I. INTRODUCTION

Ad-hoc networks are mobile wireless networks having no fixed infrastructure. There are no fixed routers –instead each node acts as a router and forwards traffic from other nodes. Ad-hoc networks were first mainly used for military applications .A MANET (Mobile Ad-hoc Network) is a type of Ad-hoc network with rapidly changing topology [3]. These networks typically have a large span and can connect nodes ranging from a few to several thousand. Since the nodes in a MANET are highly mobile, the topology changes frequently and the nodes are dynamically connected in an arbitrary manner. The rate of change depends on the velocity of the nodes. In this category of network each node acts both as a host and a router which forwards the data intended for some other node. Moreover, the devices are small and the available transmission power is limited. The low transmission power limits the number of neighbor nodes, which further increases the rate of change in the topology as the node moves.

A. Routing in MANET

As MANETs are characterized by a multi-hop network topology that can change frequently due to mobility, efficient routing protocols are needed to establish communication paths between nodes. A large number of solutions have already been proposed, some of them being subject to standardization within the IETF. To this end, these protocols exchange routing control information periodically and on topological changes [1] [2].
A number of routing protocols has been suggested for the Mobile Ad-hoc Networks. These are categorized as: proactive (table-driven), reactive (source-initiated or demand-driven) and Hybrid (combination of both) [3] as shown in Fig.1.

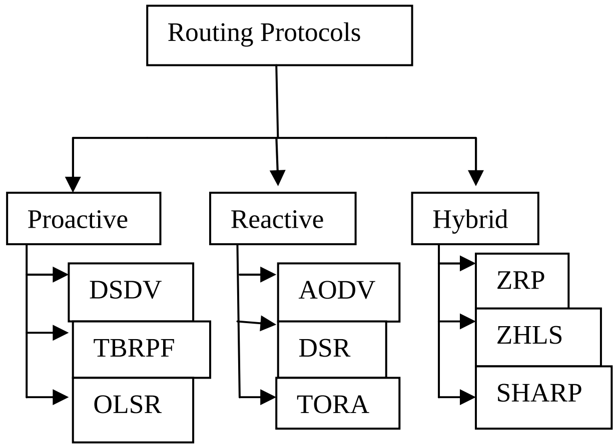

Fig. 1 Routing protocols in MANET

1) *Table-driven or Proactive Protocols:* Proactive routing protocols attempt to maintain consistent, up-to-date routing information between every pair of nodes in the network by propagating, proactively, route updates at fixed intervals. These protocols are typically modified versions of traditional link state or distance vector routing protocols encountered in wired networks, adapted to the specific requirements of the dynamic mobile ad hoc network environment. Most of the time, it is not necessary to have an up-to-date route to all other nodes. Representative proactive protocols include: Destination-Sequenced Distance- Vector (DSDV) routing, Clustered Gateway Switch Routing (CGSR), Wireless Routing Protocol (WRP), Optimized Link State Routing (OLSR) and The Fisheye State Routing (FSR) [13].
2) *On-Demand or Reactive Protocols:* A different approach to the Routing in MANET is Reactive protocols. Reactive protocols, unlike the proactive ones, only establish the routes to the destination when there is a demand for it, usually initiated by the source node through discovery process within the network. In contrast to proactive routing, reactive routing does not attempt to continuously determine the network connectivity. Instead, a route determination procedure is invoked on demand when a packet needs to be forwarded. Reactive routing protocols include: Dynamic Source Routing (DSR), Ad hoc On Demand Distance Vector (AODV) routing, Temporally Ordered Routing Algorithm (TORA) and Associatively Based Routing (ABR) [3].

3) *Hybrid Protocols:* Purely proactive or purely reactive protocols work well within limited region of network setting. Combinations of proactive and reactive protocols, where nearby routes (for example, maximum two hops) are kept up-to-date proactively, while far-away routes are set up reactively, are also possible and fall in the category of hybrid routing protocols. Both proactive and reactive routing protocols prove to be inefficient under these circumstances. Hybrid routing protocol combines the advantages of the proactive and reactive approaches [2]. Hybrid protocols include: ZRP, ZHLS routing protocol.

II. HYBRID PROTOCOLS

The discussion hereunder dwells upon Various Hybrid protocols.

A. *Zone Routing Protocol (ZRP)*

The Zone Routing Protocol (ZRP) [2] aims to address the problems by combining the best properties of both approaches. ZRP can be classed as a hybrid reactive/proactive routing protocol. In an ad-hoc network, it can be assumed that the largest part of the traffic is directed to nearby nodes. ZRP therefore, reduces the proactive scope to a zone centered on each node. In a limited zone, the maintenance of routing information is easier. Nodes that are farther away can be reached with reactive routing. Despite the use of zones, ZRP has a flat view over the network.

1) *Architecture:* The Zone Routing Protocol, as its name implies, is based on the concept of zones. A routing zone is defined for each node separately, and the zones of neighboring nodes overlap. The routing zone has a radius r expressed in hops. The zone thus includes the nodes, whose distance from the node in question is at most r hops. An Example of routing zone is shown in Fig 2, where the routing zone of A includes B-I but not k and l. Nodes of the zone are divided into two nodes — interior nodes and peripheral nodes. Peripheral nodes are nodes whose minimum distance to the central node is exactly equal to the zone radius r.

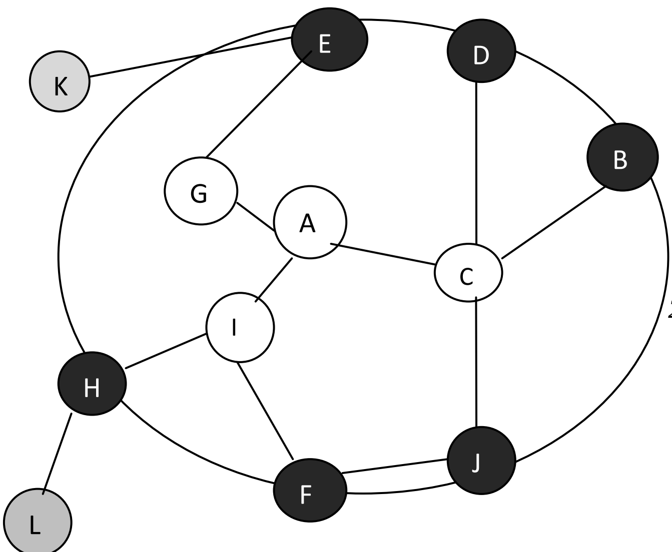

Fig. 2 Routing zone of A

The number of nodes in the routing zone can be regulated by adjusting the transmission power of the nodes. Lowering the power reduces the number of nodes within direct reach and vice versa [2].ZRP refers to the locally proactive routing component as the IntrA-Zone Routing Protocol (IARP). The globally reactive routing component is named IntEr-Zone Routing Protocol (IERP). IARP maintains routing information for nodes that are within the routing zone of the node. Correspondingly, IERP maintains routing information between the zones. Instead of broadcasting packets, ZRP uses a concept called bordercasting. Bordercasting utilizes the topology information provided by IARP to direct query request to the border of the zone. The bordercast packet delivery service is provided by the Bordercast Resolution Protocol (BRP). Fig 3 shows the overall architecture of ZRP.

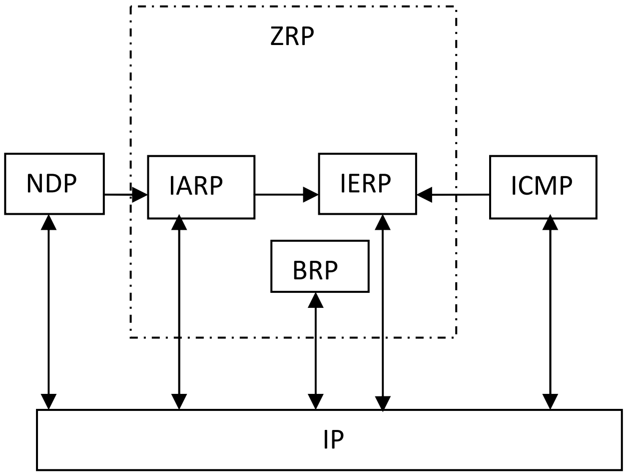

Fig. 3 ZRP architecture

The relationship between the components is illustrated in order to detect new neighbor nodes and link failures; the ZRP relies on a Neighbor Discovery Protocol (NDP) provided by the Media Access Control (MAC) layer. NDP transmits "HELLO" beacons at regular intervals. Upon receiving a beacon, the neighbor table is updated. Neighbors, for which no beacon has been received within a specified time, are removed from the table. Route updates are triggered by NDP, which notifies IARP when the neighbor table is updated. IERP uses the routing table of IARP to respond to route queries. IERP forwards queries with BRP. BRP uses the routing table of IARP to guide route queries away from the query source [2] [3] [6].

2) *Routing in ZRP:* A node that has a packet to send first checks whether the destination is within its local zone using information provided by IARP. In that case, the packet can be routed proactively. Reactive routing is used if the destination is outside the zone. The reactive routing process consists of two phases: the route request phase and route reply phase. In the route request, the source sends a route request packet to its peripheral nodes using BRP. If the receiver of a route

request packet knows the destination, it responds by sending a route reply back to the source. Otherwise, it continues the process by bordercasting the packet. In this way, the route request spreads throughout the network. If a node receives several copies of the same route request, these are considered as redundant and are discarded. The reply is sent by any node that can provide a route to the destination. To be able to send the reply back to the source node, routing information must be accumulated when the request is sent through the network. The information is recorded either in the route request packet, or as next-hop addresses in the nodes along the path. In the bordercasting process, the bordercasting node sends a route request packet to each of its peripheral nodes. This type of one-to-many transmission can be implemented as multicast to reduce resource usage. If the zone radius of one hop is used, routing is purely proactive and if the radius approaches infinity, routing is reactive.

Advantages:

- Since both reactive and proactive schemes are used, it exhibits better performance. Since hierarchical routing is used, the path to a destination may be suboptimal.
- It reduces the control traffic produced by periodic flooding of routing information packets (proactive scheme).
- It reduces the wastage of bandwidth and overhead control compared to reactive schemes

Disadvantages:

- Since each node has higher level topological information, memory requirement is greater.
- Large overlapping of routing zones

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

Zone-based Hierarchical Link State routing protocol formally known as the ZHLS [3], due to different approach to the routing protocol, is a hierarchical protocol, where the network is divided into non-overlapping zones. In addition, mobile nodes are assumed to know their physical locations with assistance from a locating system like GPS. Each node only knows the node connectivity within its zone and the zone connectivity of the whole network. The zone level topological information is distributed to all nodes as shown in Fig 4.All network nodes in ZHLS construct two routing tables, an intrazone routing table and an interzone routing table.ZHLS uses a hierarchical address scheme which contains zone ID and node ID. It is assumed that a virtual link connects two zones if there exists at least one physical link between the zones. A two-level network topology structure is defined in ZHLS-the node level topology and the zone level topology. In the same way, there are two kinds of link state updates- the node level LSP (Link State Packet) and the zone level LSP. A node periodically broadcast its node level LSP to all other nodes in the same zone. In ZHLS, gateway nodes broadcast the zone LSP throughout the network whenever a virtual link is broken or created. Consequently, every node knows the current zone level topology of the network. Before sending packets, a source firstly checks its intra-zone routing table. If the destination is in the same zone as the source, the routing information is already there. Otherwise, the source sends a location request to all other zones through gateway nodes. After a gateway node of the zone, in which the destination node resides, receives the location request, it replies with a location response containing the zone ID of the destination. The zone ID and the node ID of the destination node will be specified in the header of the data packets originated from the source. During the packet forwarding procedure, intermediate nodes except nodes in the destination zone will use inter-zone routing table, and when the packet arrives the destination zone, an intra-zone routing table will be used [6].

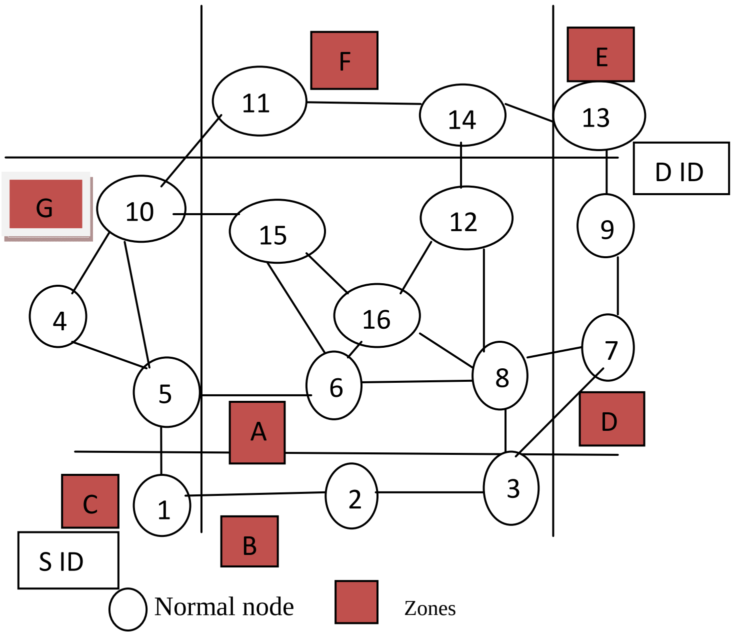

Fig. 4 A topology of ZHLS protocol

Advantages:

- No overlapping zones
- The zone-level topology information is distributed to all nodes
- Reduces the traffic and avoids single point of failure

Disadvantages:

- Additional traffic produced by the creation and maintenance of the zone-level topology.

C. *Zone Based Hierarchical Link state Routing Protocol with Gateway Flooding (ZHLS-GF)*

Zone-Based Hierarchical Link State Routing Protocol with Gateway Flooding (ZHLS-GF) [5] is a protocol, in which a new flooding scheme called Gateway Flooding was used. ZHLS-GF is based on ZHLS, a Zone-Based Hierarchical Link State Routing Protocol. The difference between ZHLS and ZHLS-GF is that the later floods ZoneLSPs only to the gateway nodes of zones to reduce the number of control packets, especially ZoneLSP, in ZHLS to reduce the communication overhead significantly. Furthermore in ZHLS-GF, only the gateway nodes store ZoneLSPs and construct inter zone routing tables and therefore the total storage capacity required in the network is less than

ZHLS.There was a need to test the simulation of ZHLS (for normal flooding and gateway flooding) and to evaluate the performance of ZHLS-GF routing protocols. There were four performance metrics under which performance of both the protocols was considered:

1 Packet Delivery ratio: The PDR shows how successfully a protocol delivers packets from source to destination. The higher value gives us better results .When comparing the results of both ZHLS and ZHLS-GF, it is seen that packet delivery ratio is better in ZHLS-GF
2 Hops: It provides an expected data route length. No. of hops remains same in both cases of Normal Flooding and Gateway Flooding.
3 Power: It is defined as the total energy used by the test bed to complete the simulation. While analyzing the power of both protocols it has been found that less power is consumed in ZHLS-GF than the normal simulation.
4 Average End to End Delay: It is an average end-to-end delay in delivery of data packets. The division of time difference between every Constant Bit Rate (CBR) packet sent and received, by the total time difference over the total number of CBR packets received gives the average end-to-end delay for the received packets. The lower the end-to-end delay, the better the application performance. Results of the first 10 packets transmission showed that end-to-end delay is less in gateway flooding.

D. *Sharp Hybrid Adaptive Routing based protocol (SHARP)*

Sharp Hybrid Adaptive Routing Protocol, formally known as SHARP [4], is one category of Hybrid Routing Protocol that maintains the balance between proactive and reactive routing by adjusting the degree to which route information is propagated proactively versus the degree to which it needs to be discovered reactively. It adapts efficiently and seamlessly between proactive and reactive routing strategies. This adaptation can be directed to optimize the user-defined performance metrics, such as loss rate, routing overhead, or delay jitter. SHARP adapts between reactive and proactive routing by dynamically varying the amount of routing information shared proactively. It does so by defining a proactive zone around some nodes. A node-specific zone radius determines the number of nodes within a given proactive zone.

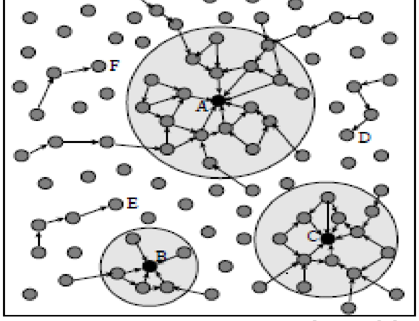

Fig. 5 The SHARP proactive zones constructed around destinations *A*, *B*, and *C*.

Nodes within the proactive zone maintain routes proactively only to the central node. This protocol amortizes the cost of maintaining routes to a given destination in a proactive zone among all the sources that communicate with that destination node. SHARP maintains proactive routing zones around popular destinations A, B, and C. Consequently, it creates relatively large zones around popular destinations, as shown in Fig 5, and relatively small proactive zones around nodes that get little traffic. For instance, nodes with little or no data traffic, such as D, E, and F, will have no proactive routing zone and will rely purely on reactive routing. By increasing the radius, this protocol can decrease the loss rate and the variance in delay, but will pay more in packet overhead to maintain routes in a larger zone. By decreasing the radius, SHARP can reduce routing overhead, as fewer nodes need to be proactively updated; however, it may pay more in delay jitter and experience higher loss rates. Using this trade-off, SHARP can act as a completely reactive protocol by setting the zone radius of all the nodes to zero. Ideally, a hybrid protocol achieves fine-grained control over this trade-off, incur low overhead for adaptation and exploit information locality for maximum efficiency.

III. CONCLUSIONS

This paper studies hybrid routing protocols in MANET. This paper also compares various hybrid routing protocols in mobile Ad hoc network. It is concluded that distinct hybrid protocols shows different performances under dissimilar circumstances. The overlapping of ZRP protocol is removed by the ZHLS-GF protocol by introducing the zone level topology. However, it produces the extra traffic. Similarly, the SHARP works perfectly when the zone radius is zero but rise in zone radius also increases the overhead in this protocol. Hence when the zone size is smaller than SHARP protocol is preferred and when extra traffic, i.e. overhead can be afforded with fewer loss ratio then ZHLS-GF protocol can be used, otherwise, ZRP protocol can be used. In future, ZRP protocol can be enhanced to reduce the delay with improved PDF. Thus ZRP is the emerging protocol.

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