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Comparative Study and Analysis of DSR, DSDVAND ZRP in Mobile Ad-Hoc Networks

Ritika Kachal[1] and Shrutika Suri[2*]

[1, 2*]*Department of Computer Science, MRIU, India*
rkacchal@gmail.com, shrutika.fet@mriu.edu.in

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Abstract— Wireless networks where mobile nodes relay on each other to keep network connected without help of pre-existing infrastructure or centralized control are the mobile ad-hoc networks. These are the self organizing temporary wireless networks. An efficient and effective routing protocol for real MANETs is a major design issue, therefore to achieve optimum values of performance parameter under network scenarios where nodes are subjected to different type of mobility that dynamically change the network topology. Due to the link instability and mobility of node, the topology of ad-hoc network changes and routing become difficult. Many ad-hoc routing protocols have been proposed in the recent years. These protocols can be classified in three main categories: proactive, reactive and hybrid routing protocols. In this paper study of these existing routing protocols is done and comparison analysis of DSDV, DSR and ZRP is performed.

Keywords— Mobile ad-hoc netwrok, DSDV, DSR and ZRP

I. INTRODUCTION

A set of wireless mobile nodes which form a temporary network communicate with each other without using any existing infrastructure or central administration is defined as Mobile Ad-Hoc Network (MANET). Ad-hoc networks are multi-hop self organizing temporary wireless networks. In such network, no router, the central controller in other routing network is needed to perform the function in managing the functionality of the system. Each node in the system can play the role in transmitting and receiving packets and thus it act as relay server in the network between source and destination. Quick and easy deployment of ad-hoc network makes them feasible to use in military, law enforcement and emergency response efforts [2]. Ad-hoc networks can also play a role in civilian forums such as electronic classroom, convention centers, and construction sites. With such a broad scope of applications, it is not difficult to envision ad-hoc networks operating system over a wide range of coverage areas, node densities, and velocities. However, change in topology in ad-hoc networks is inherent. The reasons for the change in topology may be are low transmission power. Because of interference and fading due to high operating frequency in an urban environment, the links are unreliable. Ad-hoc networks have low bandwidth links. Because of difference in transmission capacity; some of the links may be unidirectional. Especially, the proliferation of Mobile Ad Hoc Networks (MANETs) has introduced new requirements to service discovery due to the inherent characteristics of these networks. Due to the link instability and mobility of node, the topology of ad-hoc network changes and routing become difficult. A plethora of routing protocols has been proposed for wireless ad-hoc networks.

Corresponding Author: *Ritika Kachal, rkacchal@gmail.com*

II. CLASSIFICATION OF ROUTING PROTOCOLS

In Mobile Ad-hoc Networks there are different types of routing protocols each of them is applied according to the network circumstances. Below given figure shows the routing protocols classification [3].

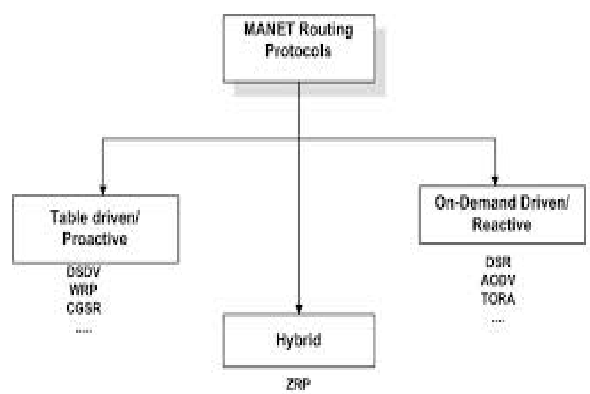

Figure 1: Classification of routing protocols

A. *Proactive Routing Protocols*

Pro-active protocols follow an approach similar to the one used in wired routing protocols. By continuously evaluating the known and attempting to discover new routes, they try to maintain the most up-to-date map of the network. This allows them to efficiently forward packets, as the route is known at the time when the packet arrives at the node.

Pro-active or table-driven protocols, in order to maintain the constantly changing network graph due to new, moving or failing nodes, require continuous updates. Examples of this class of ad-hoc routing protocols are the Destination Sequenced Distance Vector (DSDV) and the Optimized Link State Routing (OLSR) protocols. The matter of concern is bandwidth and power utilization is more as it need to broadcast the routing tables. As the number of nodes in the MANET increases, the size of the table will increase [1].

1) Destination-sequence-distance-vector (DSDV)

DSDV is a proactive routing protocol. Each mobile maintains a routing table that stores for all reachable destinations, the next hop and number of hops to reach the destination and the sequence number assigned by the destination. This transmission takes place also in topology change cases. DSDV applies two types of routing updates: full dump or incremental update. Full dump carries the full information with all available routing information and this is suitable for fast changing networks. Incremental dump carries only the updated entries since last dump, which must fit in a packet is suitable when network is stable. DSDV posses routes availability to all destinations at all times, which involves much less delay in the route setup process. The use of sequence number distinguishes stale routes from new ones, where routes with higher sequence numbers are favorable. However, the updates due to broken links lead to a heavy control overhead during high mobility, proportional to the number of nodes in the network and therefore affecting scalability.

B. Reactive Routing Protocols

Reactive protocols determine the proper route only when required, that is, when a packet needs to be forwarded. In this instance, the node floods the network with a route request and builds the route on demand from the responses it receives. This technique does not require constant broadcasts and discovery. Examples of reactive routing protocols are the Ad Hoc on-demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR). The matter of concern is the route to destination will have to be acquired just before communication begins due to which the latency period for most applications is likely to increase drastically.

1) Dynamic source routing (DSR)

Dynamic Source Routing (DSR) is a routing protocol for wireless mesh networks and is based on a method known as source routing. It is similar to AODV in that it forms a route on-demand when a transmitting computer requests one. Except that each intermediate node that broadcasts a route request packet adds its own address identifier to a list carried in the packet. The destination node generates a route reply message that includes the list of addresses received in the route request and transmits it back along this path to the source. Route maintenance in DSR is accomplished through the confirmations that nodes generate when they can verify that the next node successfully received a packet. These confirmations can be link-layer acknowledgements, passive acknowledgements or network-layer acknowledgements specified by the DSR protocol. However, it uses source routing instead of relying on the routing table at each intermediate device. When a node is not able to verify the successful reception of a packet it tries to retransmit it. When a finite number of retransmissions fail, the node generates a route error message that specifies the problematic link, transmitting it to the source node. When a node requires a node to a destination, which it doesn't have in its route cache, it broadcasts a Route Request (RREQ) message, which is flooded throughout the network. The first RREQ message is broadcast query on neighbors without flooding. Each RREQ packet is uniquely identified by the initiator address and the request id. A node processes a route request packet only if it has not already seen the packet and its address is not present in the route record of the packet. This minimizes the number of route requests propagated in the network. RREQ is replied by the destination node or an intermediate node, which knows the route, using the Route Reply (RREP) message. The return route for the RREP message may be one of the routes that exist in the route cache (if it exists) or a list reversal of the nodes in the RREQ packet if symmetrical routing is supported. In other cases the node may initiate it owns route discovery mechanism and piggyback the RREP packet onto it. Thus the route may be considered unidirectional or bidirectional. DSR doesn't enforce any use of periodic messages from the mobile hosts for the maintenance of routes. Instead it uses two types of packets for route maintenance: Route Error (RERR) packets and ACKs. Whenever a node encounters fatal transmission errors so that the route becomes invalid, the source receives a RERR message.

ACK packets are used to verify the correct operation of the route links. This also serves as a passive acknowledgement for the mobile node. DSR enables multiple routes to be learnt for a particular destination. DSR does not require any periodic update messages, thus avoiding wastage of bandwidth.

C. Hybrid Routing Protocols

Hybrid protocols are the combinations of reactive and proactive protocols and takes advantages of these two protocols and as a result, routes are found quickly in the routing zone. The routing is initially established with some proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding. These protocols exploit the hierarchical network architecture and allow the nodes with close proximity to work together to form some sort of backbone, thus increasing scalability and reducing route discovery Example Protocol: ZRP (Zone Routing Protocol), TORA (Temporally-Ordered Routing Algorithm) [7].

1) Zone routing protocol (ZRP)

The Zone Routing Protocol, or ZRP, as described in this paper combines the advantages of both into a hybrid scheme, taking advantage of pro-active discovery within a node's local neighborhood, and using a reactive protocol for communication between these neighborhoods. ZRP is not so much a distinct protocol as it provides a framework for other protocols.

III. INTRODUCTION TO ZRP

Both a purely proactive or purely reactive approach to implement a routing protocol for a MANET have their disadvantages. The Zone Routing Protocol, or ZRP, combines the advantages of both into a hybrid scheme, taking advantage of pro-active discovery within a node's local neighborhood, and using a reactive protocol for communication between these neighborhoods. In ZRP the separation of a nodes local neighborhood from the global topology of the entire network allows for applying different approaches – and thus taking advantage of each technique's features for a given situation. These local neighborhoods are called zones (hence the name); each node may be within multiple overlapping zones, and each zone may be of a different size. The "size" of a zone is not determined by geographical measurement, as one might expect, but is given by a radius of length ρ, where ρ is the number of hops to the perimeter of the zone. By dividing the network into overlapping, variable-size zones, ZRP avoid a hierarchical map of the network and the overhead involved in maintaining this map. Instead, the network may be regarded as flat, and route optimization is possible if overlapping zones are detected [5].

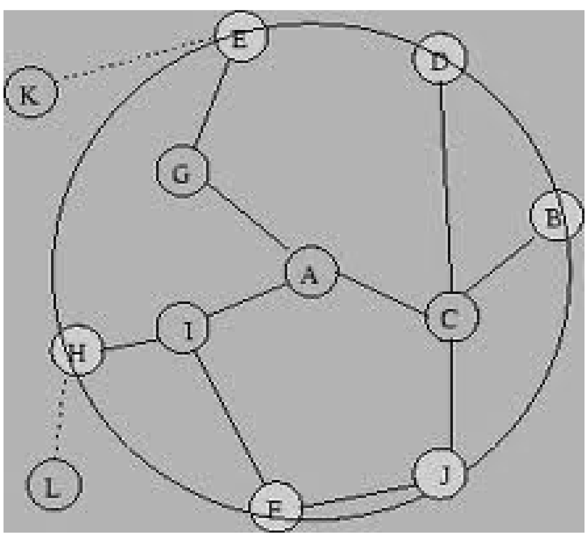

Figure 2: Routing Zone of node A with ρ=2

Note that in this example node A has multiple routes to node F, including one that has hop count of $c > \rho$. Since it also has a route with $c \le \rho$, F still belongs to A's zone. Node G is out of A's zone, the nodes on the perimeter of the zone (i.e. with a hop count $hc = \rho$) are referred to as peripheral nodes (marked gray), nodes with $hc < \rho$, are interior nodes.

Obviously a node needs to first know about its neighbors before it can construct a routing zone and determine its peripheral nodes. In order to learn about its direct neighbors, a node may use the media access control (MAC) protocols directly. Alternatively, it may require a Neighbor Discovery Protocol (NDP). Again, we see that ZRP, as a framework, does not strictly specify the protocol used but allows for local independent implementations. Such a Neighbor Discovery Protocol typically relies on the transmission of "hello" beacons by each node. If a node receives a response to such a message, it may note that it has a direct point-to point connection with this neighbor. The NDP is free to select nodes on various criteria, such as signal strength or frequency/delay of beacons etc. Once the local routing information has been collected, the node periodically broadcasts discovery messages in order to keep it's map of neighbors up to date. In doing so, it is assumed that these "link layer (neighbor) unicasts are delivered reliably and in-sequence." If the MAC layer of the nodes does not allow for such a NDP, the Intrazone Routing Protocol must provide the possibility of direct neighbor discovery. This protocol is responsible for determining the routes to the peripheral nodes and is commonly a proactive protocol.

Communication between the different zones is guarded by the Interzone Routing Protocol, or IERP, and provides routing capabilities among peripheral nodes only. That is, if a node encounters a packet with a destination outside its own zone – i.e. it does not have a valid route for this packet – it forwards it to its peripheral nodes, which maintain routing information for the neighboring zones, so that they can make a decision of where to forward the packet to. Through the use of a bordercast algorithm rather than flooding all peripheral nodes, these queries become more efficient.

A. ZRP Architecture

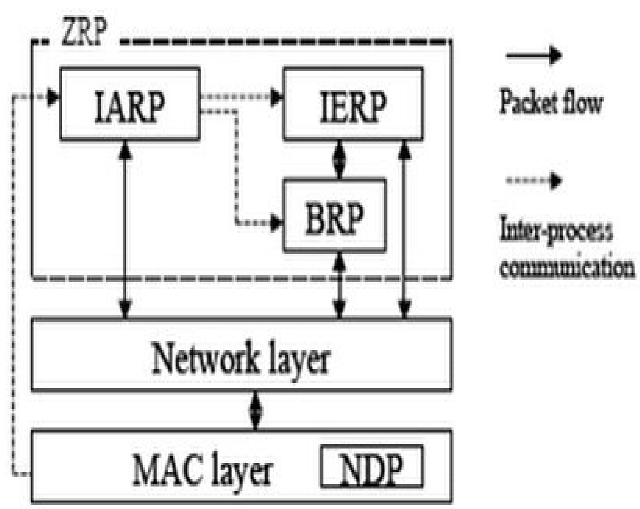

Figure3: ZRP architecture

The Zone Routing Protocol consists of several components, which only together provide the full routing benefit to ZRP. Each component works independently of the other and they may use different technologies in order to maximize efficiency in their particular area. Figure illustrates the different protocols and their interactions.

1) Intrazone routing protocol (IARP)

Since ZRP assumes that local neighbor discovery is implemented on the link-layer and is provided by the NDP, the first protocol to be part of ZRP is the Intrazone Routing Protocol, or IARP. This protocol is used by a node to communicate with the interior nodes of its zone and as such is limited by the zones radius ρ (the number of hops from the node to its peripheral nodes). Since the local neighborhood of a node may rapidly be changing, and since changes in the local topology are likely to have a bigger impact on a nodes routing behavior than a change on the other end of the network, the IARP is a pro-active, table-driven protocol. The node continuously needs to update the routing information in order to determine the peripheral nodes as well as maintain a map of which nodes can be reached locally. The IARP allows for local route optimization through the removal of redundant routes and the shortening of routes if a route with fewer hops has been detected, as well as bypassing link failures through multiple (local) hops, thus leveraging global propagation.

Due to its pro-active nature, local route discovery is very efficient and routes to local destinations are immediately available. In order to not over utilize the available bandwidth resources, the IARP is restricted to routing within the zone.

Global route discovery, communication with nodes in a different zone, is done by guiding the route queries to the peripheral nodes instead of flooding all local nodes. In order to adopt a traditional pro-active link state protocol for use as the IARP in the ZRP, the scope of the protocol needs to be limited to the size of the zone ρ. This may be implemented by adding a Time to Live (TTL) to the route discovery requests, initialized to ρ – 1 and decremented by each node until it reaches (when it is discarded).

2) Interzone routing protocol

As the global reactive routing component of the ZRP, the Interzone Routing Protocol, or IERP, takes advantage of the known local topology of a node's zone and, using a reactive approach enables communication with nodes in other zones. Route queries within the IERP are issued on demand that is only when a request for a route is made. The delay caused by the route discovery (in contrast to IARP, where the route is immediately available) is minimized through the use of bordercasting, an approach in which the node does not submit the query to all local nodes, but only to its peripheral nodes. Furthermore, a node does not send a query back to the nodes the request came from, even if they are peripheral nodes. In order to convert an existing reactive routing protocol for use as the IERP in the ZRP, it is necessary to disable pro-active updates for local routes, since this functionality is provided by the IARP. Furthermore, the IERP needs to be able to take advantage of the local routing information provided by the IARP, as well as change the way route discovery is handled: Instead of flooding a route request to all nodes, it should instead use the Bordercast Resolution Protocol (BRP) to only initiate route requests with peripheral nodes.

3) Bordercast resolution protocol

The Bordercast Resolution Protocol or BRP is used in the ZRP to direct the route requests initiated by the global reactive IERP to the peripheral nodes, thus removing redundant queries and maximizing efficiency. In doing so, it utilizes the map provided by the local pro-active IARP to construct a bordercast tree. Unlike IARP and IERP, it is not so much a routing protocol, as it is packet delivery service. The BRP keeps track of which nodes a query has been delivered to, so that it can prune the bordercast tree of nodes that have already received (and relayed) the query. When a node receives a query packet for a node that does not lie within its local routing zone, it constructs a bordercast tree so that it can forward the packet to its neighbors. These nodes, upon receiving the packet, reconstruct the bordercast tree so that they can determine whether or not it belongs to the tree of the sending node. If it does not, it continues to process the request and determines if the destination lies within its routing zone and taking the appropriate action, upon which the nodes within this zone are marked as covered. In the context of ZRP, the BRP can be seen as the glue which ties together the IARP and the IERP in order to take full advantage of the proactive and reactive components where they are best used.

IV. COMPARATIVE STUDY OF AD-HOC ROUTING PROTOCOLS

Parameter	DSDV	DSR	ZRP
Periodic message	Yes	No	Yes (Locally)
Functioning proactively	Yes	No	Yes (Locally)
Functioning reactively	No	Yes	Yes (Globally)
Source routing	No	Yes	No

Table 1: Parameter comparison of DSDV, DSR and ZRP

Protocol property	DSDV	DSR	ZRP
Loop free	Yes	Yes	Yes
Multicast routes	No	Yes	No
Distributed	Yes	Yes	Yes
Unidirectional link support	No	Yes	No
Multicast	No	No	Yes
Periodic broadcast	Yes	No	Yes
QoS support	No	No	No
Routes maintained in	Route table	Route cache	Route Table
Route cache/table timer	Yes	No	Yes
Reactive	No	Yes	Yes

Table 2: Property comparison of DSDV, DSR and ZRP

V. Conclusion

This paper presents the comparative study of various routing protocols in ad-hoc network. The study of these routing protocols shows that DSR reactive routing protocol performance is the best considering its ability to maintain connection by periodic exchange of information while DSDV and ZRP are traffic based and requires this ability. At all mobility rates and movement speeds DSDV was good. In order to receive the topology update messages DSDV continuously requires some bandwidth. DSR keeps on improving in packet delivery ratio in dense networks. Performance of ZRP has been concluded better for high mobility and high traffic networks where as the DSDV and ZRP performs well in low mobility and low traffic networks.

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