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The Routing Protocols (ZRP, TORA) in Mobile Ad Hoc Networks: A Review

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Abstract—

Hybrid routing protocol is one of the well known routing protocol in mobile ad hoc networks. This type of protocol combines the advantage and disadvantage of proactive and reactive routing protocol. Many researchers have discovered different routing protocol in hybrid routing protocol. In this paper, we survey the exiting routing protocol and their methods. We are not only classifies these protocols into hybrid routing protocol but also provides detailed theories about it and comparison table between them too.

Index Terms— Routing protocol, Mobile Ad Hoc Network, TORA, ZRP, Single Black Hole Attack.

1 Introduction

Mobile wireless networks are an ad hoc network which has no fixed infrastructure. In this ad hoc network each node acts as a router and sends packets from each node to other in the traffic. These types of networks are mainly used in the military application, Sensor network, Disaster area network etc. Due to the infrastructure fewer networks it is called as mobile ad hoc network with rapidly changing topology Panda, I. (2012) .In this category of network each node forwards the packet to other node. Moreover the device is small and the available transmission power is limited. The low transmission power limits the number of neighbor nodes, due to this increases the rate of change in the topology as the node moves.

In ad hoc networks, devices rely on each other to keep the network connected .Routing protocols enables multi hop communications in ad hoc networks. To achieve availability, routing protocols should be robust against both topology changes and malicious attacks. Nowadays the trend is changing and there is an increasing interest on research focused on the provisions of proposals for securing ad hoc routing protocols Hao Yang (2004). In MANET routing will become more challenged task because of no fixed Network Infrastructure, Dynamic Network Configuration, Mobility of Nodes, frequent node Failure and low battery power etc. Naveen Chauhan et al. (2011). In particular, Section 2 presents the related works with classification of routing protocols. Section 32 briefly discusses the MANET hybrid routing protocols functionality of the three familiar routing protocols TORA, ZRP. Finally, Section 3 concludes with the comparisons of the overall performance of the two TORA, ZRP.

2 Routing In Manets

Routing is the process to moving information, packet from a source node to a destination node in a mobile ad-hoc network. During routing process, at least one intermediate node within the network 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. 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 Mehran Abolhasan et at. (2012). There are many ways to classify the MANET routing protocols (Figure 1), depending on how the protocols handle the packet to deliver from source to destination. But Routing protocols are broadly classified into three types such as Proactive, Reactive and Hybrid protocols Mehran Abolhasan et al.(2003).

2.1 Proactive Protocols

These types of protocols are called table driven protocols in which, the route to all the nodes is maintained in routing table. Packets are transferred over the predefined route specified in the routing table. In this scheme, the packet forwarding is done faster but the routing overhead is greater because all the routes have to be defined before transferring the packets. Proactive protocols have lower latency because all the routes are maintained at all the times.

Example protocols: DSDV, OLSR (Optimized Link State Routing)[6].

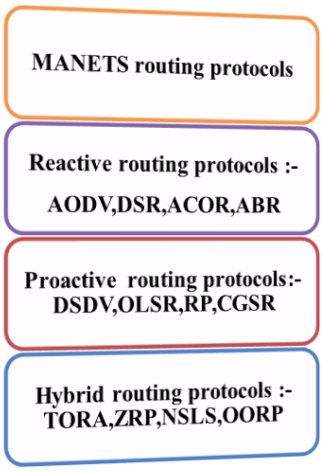

Fig. 1: MANETs Routing Protocols

2.2 Reactive Protocols

These types of protocols are also called as On Demand Routing Protocols where the routes are not predefined for routing. A Source node calls for the route discovery phase to determine a new route whenever a transmission is needed. This route discovery mechanism is based on flooding algorithm which employs on the technique that a node just broadcasts the packet to all of its neighbors and intermediate nodes just forward that packet to their neighbors. This is a repetitive technique until it reaches the destination. Reactive techniques have smaller routing overheads but higher latency.

Example Protocols**:** DSR, AODV

2.3 Hybrid 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.

Example Protocol: ZRP, TORA **P.Manickam *et al.* (2013)**

3 Hybrid Protocols

3.1 zone routing protocol

This ZRP protocol was introduced by Zygmunt Haas and Pearlman in 1997at Cornell university this protocol combines the feature of proactive and reactive protocol. It takes the advantage of proactive discovery within a nodes local neighborhood Intra-zone Routing Protocol (IARP), and using a reactive protocol for communication between these neighborhoods inter zone routing protocol (IERP) . The broadcast resolution protocol is responsible for the forwarding of a rout request ZRP divides its network in different zone that's the nodes local neighborhood. 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. It is given by a radius of length, where the number of hops is the perimeter of the zone. Each node has its own zone.

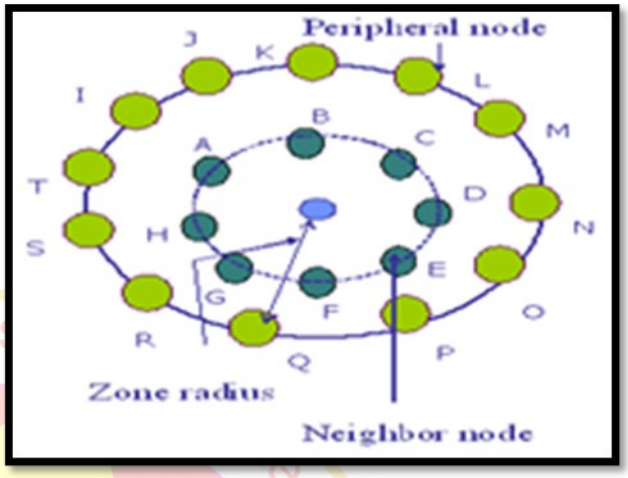

Fig.2: Zone Routing

The Zone Routing Protocol (ZRP) provides a hybrid proactive/ reactive routing framework in an attempt to achieve scalability. Each node would maintain routing tables which would only offer routes to a destination if the destination were to be within a certain maximum hop count (which is called the zone radius) from the source node. If the destination were to be outside the Zone radius, the source node would invoke an on demand search mechanism called border casting. Border casting provides an efficient means for searching for a destination by sequentially using the routing tables of the intermediate relay nodes .

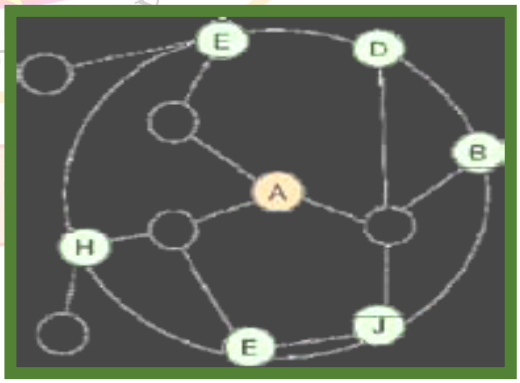

Fig.3: Radius=2-hop (node) E, D, B, J, E and are Border Nodes

Extensions to the Zone Routing Protocols:

Zone routing protocol consists of the

- Intra Zone Routing Protocol (IARP) (proactive component)
- Inter Zone Routing Protocol (IERF) (reactive - Component)

A. Intra Zone Routing Protocol (IARP)

The IARP is responsible for maintaining information about some nearby links and nodes. Every node transmits information about its inbound neighbors to nodes within a restricted neighborhood defined by the parameter called the Zone Radius. This information is used by each node to compute its outbound tree, which is the shortest path tree rooted at node to nodes from which the previously mentioned transmission restricted to Zone Radius. The nodes reachable by the computed outbound tree, define the node's zone. The goal of the IARP is to maintain an outbound tree to some nearby nodes. In case of networks with only bi-directional links, ZRP defines the zone as consisting of nodes which are within ZONE-RADIUS hops.

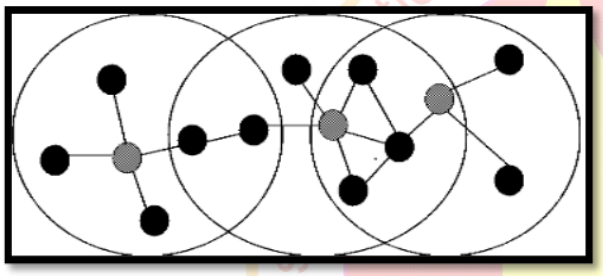

Fig. 4: IGRP

B. Inter Zone Routing Protocol (IERP) (reactive Component)

The IERP is the component that enables route computation when the outbound tree maintained by the IARP of a node does not have a path to the destination. Border casting, which refers to sending the route query by using a tree (border cast tree) to a set of nodes (the border nodes), preferably towards the periphery of the zone, is an important sub-component of IERP. The border nodes are nodes that are known to have links to other nodes that the current node cannot reach by means of its outbound tree. The border nodes upon receiving a border cast message, repeat the same procedure (as executed at the source), which involves checking if a path to the destination exists within the node's local routing table and border casting again if a path to the destination is not known locally. The intermediate nodes that initiate a border cast include their unique identifiers in the route query packet before forwarding it. Once the query reaches a node that knows a path to the destination, it includes its identifier in the response packet, and sends the response to the originator of the query. The list of nodes that stamped the packet while it traversed its forward path is used for identifying the reverse path via which a response is sent to the source of the query. Border casting usually results in an increase the number of query threads. Without implementing mechanisms for controlling these query threads, deploying the protocol could result in flooding the network with query messages. This is highly inefficient in terms of the number of messages. Some query control mechanisms have been adopted from the original ZRP proposal and have been modified to function in the presence of unidirectional links.

C. Route Discovery Process

The discovery process of ZRP operates as follows [8] [9]: The source node first checks whether the destination is within its zone. If so, destination node is known and no further route discovery process is required.

- If the destination is not within the routing zone of source, the source node border cast a route request to its peripheral nodes.
- The peripheral nodes checks whether the destination node is within their node or not. If so, a route reply is sent back to the source node indicating the route to the destination.
- If the destination node is not available in the routing zones of peripheral nodes, route requests are forwarded to their peripheral nodes. The route discovery process is shown in the Fig-5.

D. Route Maintenance

Route maintenance is important in ad hoc networks, in which links are broken and established as nodes moves relatively to each other with limited radio coverage. Route discovery or route repair must be performed if the route broken or fails. Until the new route is available, packets are dropped or delayed. In ZRP, the knowledge of the local topology can be used for route maintenance. Link failures and sub-optimal route segments within one zone can be bypassed. Incoming packets can be directed around the broken link through an active multi-hop path. The topology can be used to shorten the routes, for example, when two nodes have moved within each other's radio coverage. For routed packets, a relaying node can determine the

closet route to the destination that is also a neighbor.
P.Manickam *et al*.(2013)

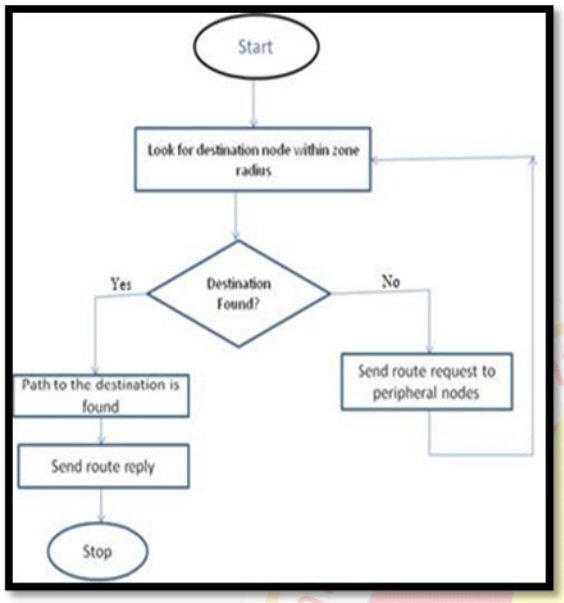

Fig.5: Shows route discovery process

E. Advantages of ZRP

- One consisting of devices equipped with wireless interface cards, which come together to form multi- hop wireless networks dynamically and automatically.
- It tries to maintain the most up-to-date map of the
- Network.
- Time required sending messages is less?
- Easy to use by everyone.
- Easy to understand the mechanism.
- It requires less band width.

F. Disadvantages of ZRP

- Hacking the messages can take place.
- When the person is not in the area of zone can't receive any information.
- It is applicable to only Linux platform.
- Short latency for finding new routes.

G. Real Time Application:

It is widely used in wireless technology such as

- Mobiles.
- Laptops.
- Wi-Fi connections.
- Blue tooth technology.

3.2 Temporary ordered routing protocol

The temporary ordered routing algorithm is an algorithm for routing data across wireless mesh network as well as mobile ad hoc network. This protocol was developed by Vincent Park and cott corson at the Maryland University at the naval research laboratory. The TORA attempts to achieve a high agree of scalability using non hierarchical algorithm. The TORA does not use shortest path solution. This builds and maintain directed acyclic graph i.e. DAG. The protocol performs three basic functions i.e. route creation, route maintenance and route erasure [11].

A. Route Creation

Initially, all nodes start off with a null height and links between the nodes are unassigned. When a node requires a route to a destination, it initiates route creation where query packets are flooded out to search for possible routes to the destination. Eventually, a query packet reaches either a node that has a route or the destination itself, or the node replies with an update packet. When a node receives an update packet, it sets its link as directed from itself to the sender of the update packet. This setting of directional links eventually reaches the node which requires the route and provides it with at least a route to the destination.

B. Route Maintenance

The availability of multiple paths is a result of how TORA models the entire network as a directed acyclic graph (DAG) rooted at the destination. Each node has a height associated with it and links between nodes flow from one with a higher height to one with a lower height. The collection of links formed between nodes forms the DAG and ultimately all nodes will have a route to the destination. For each possible destination required, a separate DAG needs to be constructed. Route maintenance occurs when a node loses its entire outgoing links. When the detection of a link failure causes a node to lose its entire out-going links, the node propagates an update packet which reverses the links to all of its neighboring nodes. Intermediate nodes that receive the update packet then reverse the links of their neighboring nodes. Links are reversed only for neighboring nodes that do not have any out-going links and have not performed link reversal recently. The link reversal needs to be repeated until

each node has at least one out-going link. This entire process ensures that the DAG is maintained such that all nodes have routes to the destination. The route maintenance function of TORA is the main problem as this function produces a large amount of routing overhead. It causes the network to be congested thus preventing data packets from reaching their destinations.

C. Route Erasure

In the event that a node is in a network partition without a route to the destination, route erasure is initiated. The detection of a network partition is undertaken by the node that first initiated route maintenance. During route maintenance, the node sends out update packets to reverse links to all its neighboring nodes and attempts to find a route to the destination. It is able to determine the presence of a network partition if a similar update packet is sent back to it by another node. This means that all nodes in the current network partition cannot find a route and are trying to find a route through the original node. Route erasure is then performed by the node by flooding clear packets throughout the network. When a node receives a clear packet, it sets the links to its neighbors as unassigned. Eventually, these clear packets propagate through the network and erase all routes to that unreachable destination.

D.TORA is offering following characteristics

1 Distributed execution
2 Loop-free routing
3 Multi-path routing
4 Reactive or proactive route establishment and Maintenance
5 Minimization of communication overhead via Localization of algorithmic reaction to topological Changes Rakesh **kumar *et al*. (2010).**

E. Advantages:

- That of an on-demand routing protocol – create a DAG only when necessary.
- Multiple paths created.
- Good in dense networks.

F. Disadvantages

- Same as on-demand routing protocols.
- Not much used since DSR and AODV outperform TORA.
- Not scalable by any means.

4 Comparion Between Zrp And Tora

Performance Constraints	*ZRP*	*TORA*
Category	Hybrid	Hybrid
Protocol Type	Link Reversal	Link Reversal and on demand type
Route Maintained	Router table	
Loop	Yes	loop free multipath routing
Route Philosophy	Flat	flat
Multiple	Yes	yes
multicast	No	----
Message Overhead	Moderate	-----
Periodic broadcast	Possible	-------
Requires sequence	Yes	--------
Route reconfiguration on methodology	link reversal and information stored in link table	----------

Conclusion

Hybrid routing protocols have the potential to provide higher scalability than pure reactive or proactive protocols. This is because they attempt to minimize the number of rebroadcasting nodes by defining a structure (or some sort of a backbone), which allows the nodes to work together in order organize how routing is to be performed. By working together the best or the most suitable nodes can be used to perform route discovery. Collaboration between nodes can also help in maintaining routing information much longer. This may potentially eliminate the need for flooding, since the nodes know exactly where to look for a destination every time. Another novelty of hybrid routing protocols is that they attempt to eliminate single point of failures and creating bottleneck nodes in the network. This is achieved by allowing any number of nodes to perform routing or data

forwarding if the preferred path becomes unavailable.

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