ZONE ROUTING PROTOCOL (ZRP) IN AD-HOC NETWORKS

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ABSTRACT

Routing protocols for wireless ad-hoc networks face the challenge of dynamic topology due to node mobility, limited channel bandwidth and low transmission power. Both proactive and reactive protocols have trade-off in them. Proactive protocols have large overhead and less latency while reactive protocols have less overhead and more latency. The ZRP is a hybrid protocol that overcomes the shortcomings of both proactive and reactive routing protocol. ZRP divides the entire network into overlapping zones of variable size where routing inside the zone is performed using proactive approach and outside the zone is performed using reactive approach.

Keywords: *Ad-hoc Networks, Routing, Reactive, Proactive, ZRP.*

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1. INTRODUCTION

Ad-hoc networks are wireless networks that have no fixed infrastructure. They are characterized by dynamic topology with no fixed routers. These networks are gaining popularity within the computing industry for their attractive features and applications. Many more applications exist already or are imaginable in the near future as it is expected that ad-hoc networking will be more intensively used for different applications such as digital battlefield communications, movable base-stations, and range extension for cellular telephone [4].

One of the most demanding and challenging aspects of ad-hoc networks is the routing issue. Routing can be defined as the process of finding a path from the source to the destination to deliver packets to the destination nodes while the nodes in the network are moving freely [4].

Secure routing is also a vital factor for mobile ad-hoc networks because of the sensitive applications of these networks. However, achieving security goals, such as confidentiality, authentication, integrity, availability, and access control in these networks is a challenging task. In general, a mobile ad-hoc network is particularly vulnerable to attacks due to its fundamental characteristics of open medium, dynamic topology, distributed cooperation, constrained capability, and absence of central authorities [5].

2. ROUTING IN AD-HOC NETWORKS

Routing in ad-hoc networks is the process of selecting paths in a network by which a packet travels from a source to a destination. The nodes which are in the transmission range of each other communicate directly otherwise communication is done through intermediate nodes. Thus each node may act as router or as host. Depending on how node establish and maintain a route to the destination, protocols can be classified into three categories: proactive (table driven), reactive (demand driven), hybrid routing protocols.

2.1 Proactive Routing

Proactive approach is a table driven protocol where each node maintains consistent up-to-date information to every other node in the network by maintaining routing table(s). Therefore a routing path is known and is immediately available to the source node if it needs one. Using a proactive routing protocol nodes continuously calculate routes to all nodes that are reachable and thus maintains a consistent view of topology. Some of the proactive routing protocols are:

- DSDV
- WRP

- OLSR
- FSR

Proactive protocols have the advantage of minimum initial delay but causes significant signaling traffic and power consumption problem. These protocols results in a large overhead due to the route maintenance and frequent route updates.

2.2 Reactive Routing

Reactive routing protocols are on-demand protocols where routing information is acquired only where it is needed. In reactive routing, a route determination process is invoked on demand when a node request for a route. The reactive routing protocols do not maintain the information about the routes; rather routes are maintained only during the communication or for some period of time. Some of the reactive routing protocols are:

- AODV
- DSR

Reactive routing adds latency to the network due to the route discovery mechanism. These protocols decrease the routing overhead but at the cost of increased latency.

2.3 Hybrid Routing

Hybrid protocol combines the advantage if both proactive and reactive routing protocol. Hybrid protocol is presented to overcome the shortcomings of both Proactive and Reactive protocol. It uses the route discovery mechanism of proactive protocol. Some of the hybrid routing protocols are:

- ZRP
- SHRP

3. ZONE ROUTING PROTOCOL

Zone routing protocol uses the hybrid approach for routing. It uses the advantages of both proactive and reactive protocol. ZRP [2] aims to address excess bandwidth and long route request delay of proactive and reactive routing protocols. ZRP divides the entire network into zones of variable size. Every node in the network has a zone associated to it. The size of a zone is not determined by geographical measurement but is given by a radius of length ρ, where ρ is the number of hops to the perimeter of the zone. ZRP is not a very distinct protocol; it provides a framework for other protocols [1].

4. ZRP ARCHITECTURE

In zone routing protocol, a routing zone is defined for each node separately and the zones of neighboring nodes overlap [2]. The routing zone has a radius ρ expressed in hops. The zone

thus includes the nodes, where distance from center node is at most ρ hops. A routing zone with radius two can be seen in figure 1, where the routing zone of S includes nodes A-K but not L.

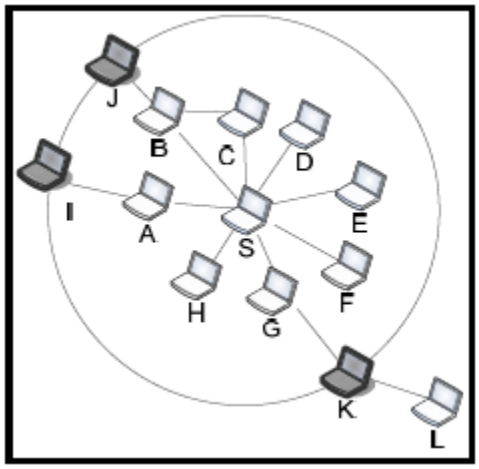

Fig.1 Routing Zone with radius, ρ=2

In figure 1, the nodes A-H are interior nodes, the nodes I-K are peripheral nodes and node L is outside the routing zone. Node J can be reached by two paths, one with length 2 hops through B and one with length 3 hops through C and B. The node is within the zone, since the shortest path is equal to the zone radius.

ZRP uses proactive approach for routing inside the zone i.e. intra-zone routing protocol (IARP) and reactive approach for routing outside the zone i.e. inter-zone routing protocol (IERP).

The Architecture of ZRP is illustrated in Figure 2.

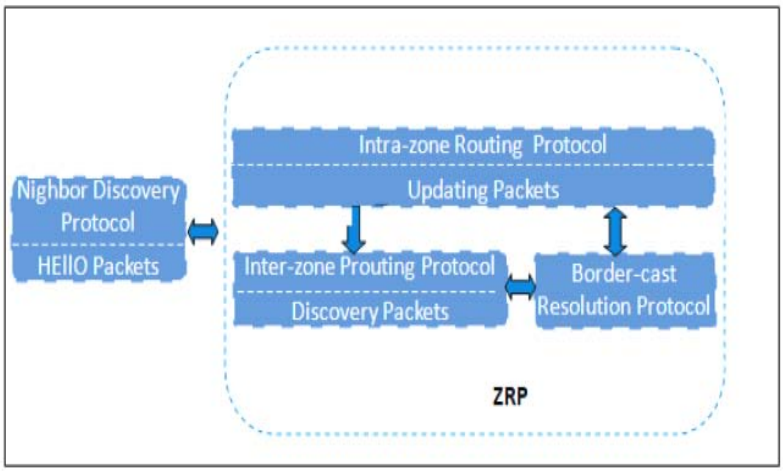

Fig.2 ZRP Architecture

4.1 Intra Zone Routing Protocol (IARP)

IARP is used by a node to communicate with the interior nodes of its zone and is limited by the zone radius [6]. It maintains routes inside the zone, each node continuously needs to update the routing information in order t determine the peripheral nodes as well as maintain a map of which nodes can be reached locally.

4.2 Inter Zone Routing Protocol (IERP)

IERP is used to communicate between nodes of different zones. It is reactive routing component which offers enhanced route discovery [7]. The IERP needs to be able to take advantage of the local connectivity provided by IARP. Route discovery is done through a process called *bordercasting* that uses a Bordercast Routing Protocol (BRP) to only transmit route requests to peripheral nodes.

4.3 Bordercast Routing Protocol (BRP)

BRP is used to direct the route requests initiated by the IERP to the peripheral nodes and also utilizes the topology information provided by IARP to construct a bordercast tree. For route requests away from areas of network, a query control mechanism is employed by BRP. [8]

5. ROUTING IN ZRP

In the route discovery mechanism the source initiates the route discovery, it first checks whether the destination is inside or outside the zone [9]. If the destination node is within the zone, the packet is routed using proactive approach and if the destination node is outside the zone, reactive routing is used.

Reactive approach for routing the packet to the destination outside the zone includes two phases: route discovery phase and route reply phase. In route discovery phase, using Bordercast Resolution Protocol (BRP), the source node sends a RREQ (route request) packet to its peripheral nodes. If the node receiving the RREQ packet knows the destination send s a route reply to the source, otherwise the process continues by bordercasting the packet. A node that can provide a route to the destination node sends a route reply to the source node.

6. QUERY CONTROL MECHANISMS

Bordercasting can be more efficient than flooding, since route request packets are only sent to the peripheral nodes and thus only on the corresponding links. However, each node may forward route requests several times due to overlapping zones which results in more traffic than in flooding. The excess traffic is a result from queries returning to covered nodes as in traditional flooding [2].

ZRP uses query control mechanisms, query detection, early termination and random query processing delay to solve this problem. In *query detection* mechanism, it is possible to detect queries relayed by other nodes in the same zone to prevent them from reappearing in the covered zone. Also, a node can prevent route request from entering already covered regions by using *early termination.* The information obtained through query detection combined with the knowledge of the local topology can be used to prune bordercasting to peripheral nodes inside covered regions.

Finally, a random query processing delay can be employed to reduce the probability of receiving the same request from several nodes. Each broadcasting node waits a random time before the construction of the bordercast tree and the early termination. During this time the waiting node can detect queries from other bordercasting nodes and prune the bordercast tree [9].

7. CONCLUSION

Zone routing protocol is targeted for large networks that combines the proactive and reactive approach in one protocol. Inside the routing zone, proactive component IARP maintains the routing tables. Outside the zone, route discovery mechanism is done by reactive component IERP using route requests and route replies. A bordercasting process is used for oute discovery using Bordercasting Resolution Protocol (BRP). To reduce the amount of query traffic, query control mechanisms query detection and early termination can be used. ZRP rather than a distinct protocol, can be taken as routing framework.

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