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Implementation of IZRP for MANETS

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ABSTRACT

An ad hoc wireless network has a dynamic nature that leads to constant changes in its network topology. As a consequence, the routing problem becomes more complex and challengeable, and it probably is the most addressed and studied problem in ad hoc networks. Based on the routing information update mechanism Ad hoc wireless networks routing protocols are classified into Proactive, Reactive and Hybrid Routing Protocols. Out of these, Hybrid Routing Protocol combines the best futures of the first two categories. The Zone Routing Protocol (ZRP) is one of the hybrid routing protocols in which every network node proactively maintaining routing information about its routing zone, while reactively acquiring routes to destinations beyond the routing zone. In this paper, I proposed the Independent Zone Routing Protocol (IZRP) an enhancement of the Zone Routing Protocol which allows adaptive and distributed configuration for the optimal size of each node's routing zone, on per-node basis. I demonstrate the performance of IZRP with various performance metrics. Furthermore, I compared the performance of IZRP and ZRP by considering performance metrics Packet Delivery Fraction, Normalized Routing Overhead and End-to-End Delay.

Key words -- Ad hoc wireless networks, End-to-End Delay, Hybrid routing, Independent Zone Routing, Routing Zone, Zone Routing Protocol.

1. INTRODUCTION

A mobile ad hoc network (MANET) is comprised of mobile hosts that can communicate with each other using wireless links. In this environment a route between two hosts may consist of hops through one or more nodes in the MANET. An important problem in a mobile ad hoc network is finding and maintaining routes since host mobility can cause topology changes. MANETs have been employed in scenarios where an infrastructure is unavailable, the cost to deploy a wired networking is not worth it, or there is no time to set up a fixed infrastructure. Some scenarios where an ad hoc network can be used are business associates sharing information during a meeting, emergency disaster relief personnel coordinating efforts after a natural disaster such as a hurricane, earthquake, or flooding, and military personnel relaying tactical and other types of information in a battlefield. Algorithms for a MANET must self-configure to adjust to environment and traffic where they run, and goal changes must be posed from the user and application. Ideally, a routing algorithm for an Ad hoc network should not only have the general characteristics of any routing protocol but also consider the specific characteristics of a mobile environment—in particular, bandwidth and energy limitations and mobility [2] [3].

Based on the routing information update mechanism, Ad hoc wireless network routing protocols are basically divided into pro-active routing and re-active protocols. The Proactive routing algorithms aim to keep consistent and up-to-date routing information between every pair of nodes in the network by proactively propagating route updates at fixed time intervals. The pro-active routing protocol learns the network topology before a request comes in for forwarding. Since the proactive routing algorithms maintain routing tables for all nodes in the network, a route is found as soon as it is requested. The advantage of these protocols is low latency in discovering new routes and minimizes the end-to-end delay. Examples of proactive protocols are Destination-Sequenced Distance Vector (DSDV) [9], Optimized Link-State Routing (OLSR) [7], Cluster-Head Gateway Switch Routing Protocol(CGSR) [11], Wireless Routing Protocol(WRP)[11] and Topology-Based Reverse Path Forwarding (TBRPF) [8] Protocols.

Reactive on-demand routing algorithms establish a route to a given destination only when a node requests it by initiating a route discovery process. Once a route has been established, the node keeps it until the destination is no longer accessible, or the route expires. The re-active routing protocol becomes active only when a node is willing to forward a request. Reactive protocols tend to be more efficient than proactive protocols in terms of control overhead and power consumption because routes are only created when required. Some of the reactive routing protocols are Dynamic Source Routing Protocol (DSR) [6], Ad Hoc On-Demand Distance-Vector Routing Protocol (AODV) [4] [5], Temporally Ordered Routing Algorithm (TORA) [10], Associativity-Based Routing (ABR) and Preferred Link-Based Routing Protocol (PLBR) [9] [10].

In spite of a reactive protocol gives the low overhead of control messages, it has higher latency in discovering routes as it determine the route using flooding route request packet in the network and builds the route on demand from the responses it receives. On the other hand, proactive protocols need periodic route updates to keep information updated and valid, also many available routes might never be needed all these increases the routing overhead and consume large amounts of bandwidth [3].

2. INDEPENDENT ZONE ROUTING PROTOCOL (IZRP)

IZRP [25] refers to the locally proactive routing component as the Adaptive IntrA-zone Routing Protocol (AIARP) [26] and the globally reactive routing component is named Adaptive IntEr-zone Routing Protocol (AIERP) [26] [27]. The topology of the Intrazone of each node is used to reduce traffic in global route discovery [29]. In IZRP [25], Border casting utilizes the topology information provided by AIARP [27] to direct query request to the border of the zone using the Border cast Resolution Protocol (BRP) [18]. BRP [18] constructs bordercast trees for the query packets using extended routing zone (2ρ-1) information. Like in ZRP, here query control mechanisms which are explained in the previous section are used to direct the route requests away from areas of the network that already have been covered [20].

2.1 ADAPTIVE IARP (AIARP)

Each node has its own zone radius depends on the mobility values. Faster node keeps a smaller zone radius; while slower node keeps a larger zone radius.

When a node's zone radius is '1', it does not send any proactive packets, neither HELLO packets nor IARP [16] packets; does not receive any proactive packet from other nodes, either. This zone radius is used for very high mobility nodes, e.g., 30 – 40 m/s and no pause times. When a node's zone radius is a non-zero value, say 'n', it sends HELLO packets periodically and maintains 'n' hops routing zone around it. When it receives a HELLO packet from one of its neighbors, it adds the neighbor into its neighbor list if and only if the neighbor's zone radius is higher than or equal to its zone radius. This means that a node keeps in its neighbor list only those nodes that have equal or less mobility. When it hears an IARP [27] packet, the node receives it if and only if the sender's zone radius is equal to its zone radius. That is, the exchange of IARP [16] packets is limited to nodes of identical mobility.

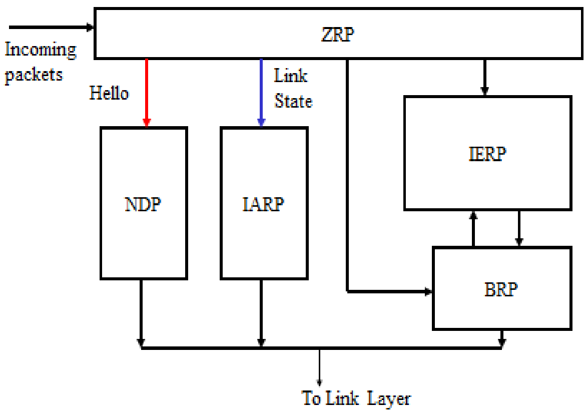

Fig. 1 Hello and Link-State Packets

2.2 ADAPTIVE IERP (AIERP)

A node which needs a route first check its routing table and its routing zone, if a route exists in the routing table or the destination node is in its routing zone, there is no need to do a route query.

Otherwise, the node will initiate a route query by using its IERP [17] and BRP [18] enabled with the query control mechanism. This phase is different from the original ZRP [28].

In ZRP the same value of zone radius is maintained for all nodes in the network. When a node initiates a route query, all nodes will participate in the query process irrespective of their mobility's and can be part of the final route. In this routing the nodes with higher mobility and nodes with lower mobility get same opportunity in constructing a route. This causes fragile and unreliable routes because link breakage may occur frequently due to the movement of the fast intermediate nodes.

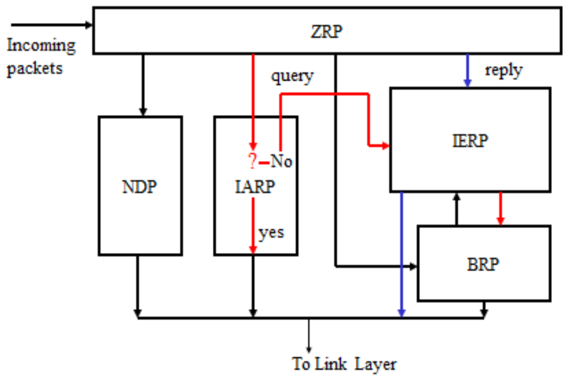

Fig. 2 Route Query and Reply

3. ZRP vs IZRP

While in IZRP [25], different zone radii values are maintained for different nodes in the network depends on their mobility's. Nodes from different zone radius groups have different views of the network topology. This causes the network nodes to establish more reliable, effective and efficient routes. In IZRP [25] when a node initiates a route query, it sets multiple zone radius values in the route request packet before bordercasting the request to its peripheral nodes. Its neighbors eavesdrop the query by using QD2, and according to the zone radius values set in the route request packet, the neighbors decide whether to join the query phase or not. Thus, the query is injected into different zone radius groups and exchanged in each group. Multiple zone radius values are set in the route request packet, so as to

i. Allow specific zone radius groups to join the query, thereby controlling the type of nodes that can be the intermediate nodes.

ii. Limit the number of zone radius groups that can join the request, thereby controlling the amount of the routing traffics.

3.1 PERFORMANCE METRICS

We have considered the performance metrics as follows:

Packet Delivery Fraction: It is the ratio of successfully delivered data packets to packets generated by CBR sources. It describes how successfully protocol delivers packet from source to destination.

Packet Delivery Fraction (PDF) = (Σ CBR Packet received /Σ CBR Packet Sent) *100

End-to-End Delay: It includes factors causing delay in network, such as, queuing delay, buffering during routes discovery, latency and retransmission delay.

4. PROTOCOL PERFORMANCES

The performance comparisons between ZRP and IZRP are done for 50, 100, 150 and 200 nodes and the obtained values show the better performance for IZRP. GAWK script is used to analyze the Trace files, which are generated during simulations.

In this paper we proposed IZRP which is modified ZRP with independent zones and its performance is evaluated. Like ZRP, IZRP also combines reactive and proactive protocols into one protocol. Within the routing zone, the proactive component AIARP maintains up-to-date routing tables. Routes outside the routing zone are discovered with the reactive component AIERP using route requests and replies. The amount of route query traffic is reduced by introducing features like border casting, query detection and early termination. We can also extend our research work to the actual implementation of AIARP and AIERP so that the overall performance will be improved.

Zone Radius	Packet Delivery Fraction (%)			
	50 Nodes	100 Nodes	150 Nodes	200 Nodes
ZR = 1	56.12	48.27	62.49	62.18

ZR = 2	54.28	45.18	44.28	45.29
ZR = 3	38.65	29.34	21.73	32.18
IZRP (ZR = variable)	76.81	84.13	81.28	81.29

TABLE 1: PACKET DELIVERY FRACTION FOR ZRP AND IZRP

Zone Radius	End – End Delay (mSec)			
	50 Nodes	100 Nodes	150 Nodes	200 Nodes
ZR = 1	192.16	213.81	171.72	158.63
ZR = 2	191.32	160.58	195.69	192.41
ZR = 3	188.27	205.73	196.25	194.82
IZRP (ZR = variable)	108.45	204.18	194.37	192.71

TABLE 2: END –TO- END DELAY FOR ZRP AND IZRP

IZRP makes an extension for ZRP protocol that can adapt well to the complicated network with nodes moving non-uniformly. IZRP utilizes the excellent performance of the hybrid-driven manner of ZRP and simultaneously overcomes the bad adaptability of ZRP which assumes each node move uniformly and presets the same zone radius. Simulation results show that IZRP performs better than ZRP when nodes move with different velocity. IZRP doesn't fluctuate obviously and has a trend to converge. This is not true for ZRP. When the new algorithm is used, the packet delivery fraction increases while the system routing overhead and the route discovery delay are reduced. For the mobility of nodes is variable in the practical networks, our future work may focus on the change of the zone radius aroused by the mobility change of nodes.

5. CONCLUSIONS

In this paper we proposed IZRP which is modified ZRP with independent zones and its performance is evaluated. Like ZRP, IZRP also combines reactive and proactive protocols into one protocol. Within the routing zone, the proactive component AIARP maintains up-to-date routing tables. Routes outside the routing zone are discovered with the reactive component AIERP using route requests and replies. The amount of route query traffic is reduced by introducing features like border casting, query detection and early termination. I can also extend my work to the actual implementation of AIARP and AIERP so that the overall performance will be improved. IZRP makes an extension for ZRP protocol that can adapt well to the complicated network with nodes moving non-uniformly. IZRP utilizes the excellent performance of the hybrid-driven manner of ZRP and simultaneously overcomes the bad adaptability of ZRP which assumes each node move uniformly and presets the same zone radius.

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