Performance analysis of Zone Resolution Protocol (ZRP) under varying transmission range

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ABSTRACT

In this paper we describes and analyzes the Zone Routing Protocol (ZRP),which is a hybrid mobile ad-hoc protocol which fragments the network into overlapping routing zones, allowing for the use of independent protocols within and between the zones. ZRP performance better than other protocols ,but increase network load by use of useless control packets and decrease of network performance.

Introduction

This paper describes and analyzes the Zone Routing Protocol or ZRP for Mobile Ad-Hoc Networks (MANETs). The basics of MANET is to provide an introduction to the problems resulting from a rapidly changing topology without a fixed router, where as ZRP, in contrast to other MANET routing protocols, utilizes a hybrid pro-active/reactive approach to maintain valid routing tables without too much overhead. Furthermore, ZRP does not provide a single protocol, but rather outlines a routing framework suitable for inclusion and extension of other existing protocols. We can relate Ad-hoc network with same as connected graph G (v,e), having set of vertices v and a set of edges e. Vertex of the each set v represents a network node and edge of the each set e represents an wireless link. Number of total nodes is $n=|v|$. We directly connect two nodes, if two nodes are geographically close enough, as to ensure quality of service better (e.g., Bit Error Rate). In a mobile network, depending on the propagation conditions, the relative distances between nodes change all the time links are broken and new links are established continuously, in case of mobile network.

Manet

A Manet (Mobile Ad-hoc Network) is a type of Ad-hoc network with rapidly changing topology, having a large span and connect hundreds to thousands of nodes [1]. Similarly, Reconfigurable Wireless Networks (RWN) refers to Ad-hoc networks which are large and that can be deployed without infrastructure rapidly and having highly mobile nodes [2]. Nodes in a MANET are highly mobile, the topology changes frequently and there is dynamically connection of nodes. Velocity of the nodes decide the rate of change. Transmission power is limited, if the devices are small. Hence there is small radio coverage of a nodes. Number of neighbor nodes, are limited by low transmission power, hence rate of change in the topology as the node moves increases. The links are unreliable due to interference and fading, which further lead to high operating frequency in an urban environment. Low bandwidth links is characterization of Ad-Hoc networks. Some of the links may be Unidirectional, due to differences in transmission capacity. Thus due to this , we have link instability and mobility of nodes there is frequent change in topology and difficulty in routing. Here , it is important to check out important difference to approaches related to conventional routing: In wired networks, there is presence of link which is bi-directional. If a node X can send packets to a node Y, we know that node Y can send packets back to node X, and a reverse path can be entered. In wireless network, this may not be happen as we have the great influence of physical location and the individual power resource upon a capacity of transmission nodes and signal strength. The protocols are IP based that are used in routing the MANET and various approaches may be use like unicast, multicast or hybrid approaches and IP services can be allowed to interact as a completely separate entity. Mobile Ad-Hoc Networking's detailed explanation is given in [3].

Pro-active vs. reactive

A number of protocols for mobile ad-hoc networks, have been researched or developed by the IETF MANET Working Group which have been described in [4], [5], [6], [7] and [8]. Base upon this, they are classified in to two groups: pro-active and reactive protocols. Pro-active protocols exactly analyze an similar approach that is used by wired routing protocols. The up-to-date path of the Network is find by continuously evaluating the known and attempting to discover new routes, hence we can Efficiently forward packets, as we are familier with the route and the time when there is possibility of arriving a packet at the node. Pro-active are also known as the table-driven protocols as they require continuous modifications in governance with the change in network graph which is present due to new, moving or not completing nodes which may consume large amounts of bandwidth and this is the disadvantage. As we know that the routes may exist only for very limited periods of time, we can not use the accumulated routing information. Pro-active

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protocols can best explain the family of Distance-Vector protocols, including Destination-Sequenced Distance-Vector Routing ([9]), which describe the path only when a packet is need to be forwarded. In this technique, we have request on-demand procedure is followed. On the advantageous part, this method does not demand continuously supervising the network, but on the other hand , it increases delay in the system, which further increases overload on the network.

.**Introduction To Zrp**

As explained above, we are having some disadvantages of both a purely proactive or purely reactive approach to implement a routing protocol for a MANET. Thus the Zone Routing Protocol, or ZRP, is described ,which combines the advantages of both into a hybrid scheme, which utilizing the advantage of pro-active discovery that is present with in a node's local neighborhood, and by using a reactive protocol that helps for communication between these neighborhoods. In a MANET, we have assumption that communication takes place between those type of nodes that are present close to each other. There is limited impact on local neighborhoods, when there is addition or the removal of a node on the other side of the network. ZRP is also provides a framework for other protocols, as there is not so much difference. We can apply different approaches by the separation of a nodes local neighborhood from the global topology of the entire network, which provides a advantage of each technique's features for a given situation and these local neighborhoods which are present are known as zones (hence the name); having same or different zone radius or size and each node may be within multiple overlapping zones. Geographical measurement, as one might expect is not the measure to find the zone size, but is given by a radius of length ñ , where ñ is the number of hops to the perimeter of the zone. ZRP prevents a hierarchical map of the network and the overhead involved in maintaining this map by fragmenting the network into overlapping, variable-size zones. If overlapping zones are detected, the network may be regarded as flat, and route optimization is possible. Cellular phone services are a typical example of zones, and each node is confined in to it's own zone. Figure 1 shows an example routing zone with ñ=2.
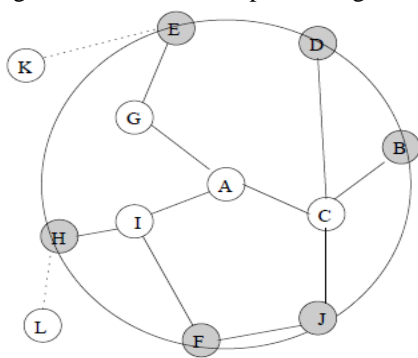

Fig 1. Routing zone of node A with ñ=2.

Note that in this example node A has multiple routes to node F, including one that has a hop count of c> ñ.

Since it also has a route with c≤ ñ 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=ñ) are referred to as peripheral nodes (marked gray), nodes with hc < ñ are interior nodes. Before constructing a routing zone a node needs to first know about it's neighbors nodes and knowledge of peripheral distance .Media access control (MAC) protocols have to used to access directly the nodes or there is requirement of Neighbor Discovery Protocol (NDP). There is no proper specification of the protocol

used in the ZRP framework, but it allows for independent implementations that occurs locally in a network and this type of protocol, such a Neighbor Discovery Protocol based on the transmission of "hello" beacons by each node. The direct point-to-point connection with this neighbor is present, if a node receives a response to such a message. Based on various parameters like signal strength or frequency/delay of beacons etc, the NDP is free to select nodes. The node continuously broadcasts discovery messages in order to have it's map of neighbors up to date, if once the local routing information has been collected. During this process, it is assumes that "link layer (neighbor) unicasts are delivered reliably and in-sequence."[10] The Intra zone Routing Protocol must provide the possibility of direct neighbor discovery, if the MAC layer of the nodes does not allow for such a NDP, which is responsible for determining the routes to the peripheral nodes and is commonly a proactive protocol. The Intra zone Routing Protocol, or IARP, is described as follows. Inter zone Routing Protocol, or IERP is used to provide communication between the different zones and provides routing capabilities among peripheral nodes only. It means that a packet with a destination outside it's own zone is encountered by its node or in other words it does not have a valid route for this packet and than it forwards it to it's peripheral nodes, that are accessing the routing information for the neighboring zones and on the basis of this, a decision is made that where we to forward the packet. Bordercast algorithms more efficient in resolving these queries rather than flooding algorithm. The Inter zone Routing Protocol and the Bordercast Resolution Protocol are presented in the next part. In the following figure 2, it is shown that the Zone Routing Protocol consists of several components, that together provide the full routing benefit to ZRP. The component which are present works independently of the other and may use different technologies for maximization of efficiency in their respective fields. For example, a reactive protocol such as AODV might be used as the IARP, while the IERP is most commonly a pro-active protocol such as OLSR [11]. Hierarchical nature of ZRP protocol is concluded from the fact that it allows the usage of the rest two protocols and ZRP is in fact a flat protocol. In a hierarchical network architecture, two different protocols are maintained for communication among (a) cluster's nodes of each individual and (b) the different clusters. There is a one-to- one correspondence between nodes and routing zones in the previous case of ZRP, thus responsible for maintaining overlapping by each individual nodes [10].
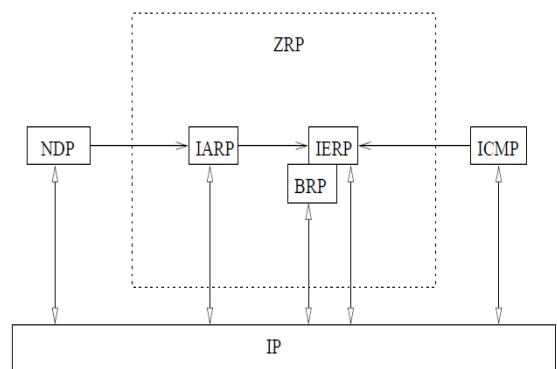

Fig 2. ZRP Components

Intra zone Routing Protocol (IARP)

As ZRP occupies that the link layer is implemented local neighbor Discovery, which further provided by the NDP and Intra zone Routing Protocol, or IARP is the first protocol to be

part of ZRP. IARP is used by a node to communicate with the interior nodes of it's zone and as such is limited by the zones radius. In Figure 1, uninterrupted lines indicate the areas where the IARP is used to provide routing between the nodes.

Inter zone routing protocol (IERP)

The Inter zone Routing Protocol, or IERP is the global reactive routing component of the ZRP, which is having advantage of the known local topology of a node's zone and, using a reactive approach, that enables communication with other nodes in other zones.

Border cast resolution protocol (BRP)

The Border cast Resolution Protocol, or BRP, is used in the ZRP and used to direct the route requests initiated by the global reactive IERP to the peripheral nodes. Due to this it maximizes the efficiency by removing redundant queries, by utilizes the map provided by the local pro-active IARP to construct a border cast tree. As it is packet delivery service, thus it is not so much a routing protocol, unlike IARP and IERP.

Results and Conclusions

The following performance metrics are used to evaluate and analyze the performance of routing protocols:

- Packet Delivery Ratio
- Average End to End Delay
- Throughput
- Routing Message Overhead

These metrics are defined as follows:

Packet Delivery Ratio

The ratio of data packets delivered to the destinations to those generated by the sources

Average End-to-End Delay

The average delay a data packet takes to travel from the source to the destination node.

Throughput

Number of bits delivered successfully per second to the destination. It is the measure of effectiveness.

Routing Message Overhead

It is calculated as total number of control packets transmitted. The increase in routing message overhead reduces the performance of the ad hoc network.

Table 1. Salient Simulation Parameters

Parameter	Value
Simulation Time	150 sec
Terrain Area	1000×1000 m^2
Number of Nodes	50
Node Placement Strategy	Random Point
Propagation Model	Two-Ray Model
Transmission Range of each Node	50 ,75,100,125,150,175 and 200m
Data Rate	2 Mbps
Propagation Model	Random-Waypoint
MAC Layer Protocol	IEEE 802.11
Routing Layer Protocols	ZRP,TORA
Traffic Type	Constant Bit Rate (CBR)
MAC Method	CSMA/CD

Results showing the impact of varying transmission range (50 to 200 meters) in Table 2.

Table 2. Parameter Analysis

Parameter	Transmission Range (varying)			
	50m	75 m	100 m	125m
Packet Delivery Ratio	992.79	997.11	998.05	998.07

Thus we can say that as we are increasing the transmission range, the value of packet delivery ratio Increases, which is beneficial for transmission of packets over the entire range of network and the rest parameters analysis is done in the same way by using the NS 2.33 simulator.

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