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Performance Analysis and Comparison of Ad Hoc Routing Protocols by the Impact of Node Density

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Abstract: ***An Ad-Hoc Network is a self-configuring network of mobile nodes connected by wireless links, to form an arbitrary topology. The nodes are free to move randomly. Thus the network's wireless topology may be unpredictable and may change rapidly. Minimal configuration, quick deployment and absence of a central governing authority make ad hoc networks suitable for emergency situations like natural disasters, military conflicts, emergency medical situations etc. Many routing protocols for ad hoc networks had been proposed already. The routing protocols are broadly classified into Proactive, Reactive and Hybrid protocols. This paper evaluates the performance of FSR (Proactive), AODV (Reactive) and ZRP (Hybrid) routing protocols using qualnet simulator.***

Keywords: Routing, FSR, AODV, ZRP, Performance Evaluation

1. Introduction

Regardless of the geographic position, Wireless networking is an emerging technology that allows users to access information and services electronically [1]. Two types of Wireless networks are there: infrastructure and infrastructureless (Adhoc) networks. An infrastructureless network is defined as the category of wireless networks that utilize multihop radio relaying and are capable of operating without the support of fixed infrastructure as shown in Fig. 1. The absence of any central coordinator or base station makes the routing a complex one.In an ad hoc wireless network, the routing and resource management are done in a distributed manner in which all nodes coordinate to enable communication among them. This requires each node to be more intelligent so that it can function both as a network host and as a network router.

Normal routing protocols which works well in fixed networks does not show same performance in mobile ad hoc networks. In these networks routing protocols should be more dynamic so that they quickly respond to topological changes [3],[11]. There is a lot of work done on evaluating performance of various MANET routing protocols for constant bit rate traffic. In this paper the performance of most widely used routing protocols namely FSR(Proactive),AODV(Reactive) and ZRP(Hybrid) routing protocols are evaluated.

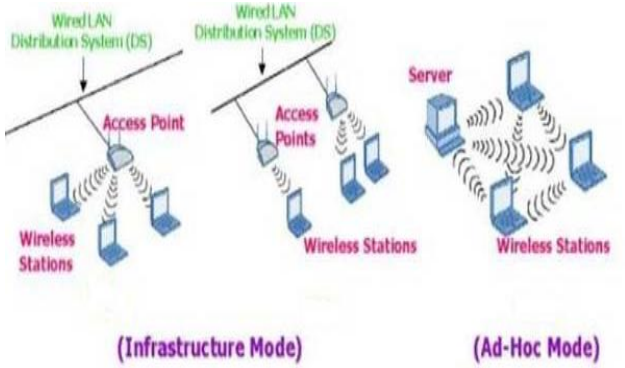

Figure 1: Comparison of infrastructure networks and ad hoc networks

2. Routing Protocols of MANET

An ad hoc wireless network consists of mobile nodes that are connected by wireless links. The network topology in such a network may keeps changing randomly. Routing protocols that find a path to be followed by data packets from a source node to a destination node in traditional wired networks cannot be directly applied in ad hoc networks. A variety of routing protocols for ad hoc networks has been proposed in the past. It can be classified into three major categories based on the routing information update mechanism. They are Proactive or Table driven, Reactive or On-Demand and Hybrid routing protocols.

A. Proactive Routing Protocol (Table-Driven Routing Protocol)

In proactive routing, each node has one or more tables that consists of latest and update information of the routes to any node in the network. Each row has the next hop for reaching a node/subnet and the cost of this route. Various table-driven protocols differ in the way the information about a change in topology is propagated through all nodes in the networks. There exist some differences between the protocols that comes under this category depending on the routing information which is updated in each routing table. Also, these routing protocols maintain different number of tables. This protocol is not well node entries for each and every node in the routing table of every node this will cause more overhead in the routing table leading to more consumption of bandwidth. Example: Conventional routing schemes, DSDV.

B. Reactive Routing Protocol

These routing protocols are also called on demand routing protocol since they do not maintain routing information or routing activity at the network nodes if there is no communication. If a node wants to send a packet to some another node then this protocol searches for the route in an on-demand manner and build the connection in order to transmit and receive the packet. The route discovery usually

occurs by flooding the route request packets throughout the network.

C. Hybrid Routing Protocols

Hybrid routing protocols are both proactive and reactive in nature [6]. These protocols are designed to increase scalability by allowing nodes with close proximity to work together .It proactively maintains routes for nearby nodes and acts reactively to far nodes. Most of the hybrid protocols proposed are zone-based, which means that the network is partitioned. Some hybrid protocols are ZRP, DST, DDR, ZHLS.

3. Protocols Evaluated

To determine the impact of node density on the performance of various types of the routing protocols, FSR(Proactive), AODV(Reactive) and ZRP(Hybrid) routing protocols are considered.

A. Fisheye State Routing (FSR)

FSR [7] uses the fisheye technique to reduce routing overhead. The basic principle behind this protocol is the property of a fish's eye that can capture pixel information with greater accuracy near its eye's focal point. This property is translated to routing in ad hoc wireless networks. The topology information exchange takes place periodically rather than being driven by an event.FSR maintains accurate distance and path quality information about the immediate neighbourhood of a node. Nodes maintain a link state table based on up to date information received from neighbouring nodes and periodically exchange it with their local neighbours only. Through this exchange process, the table entries with larger sequence numbers replace the ones with smaller sequence numbers. The reduction of routing update overhead is obtained by using different exchange periods for different entries in routing table.

B. Ad-hoc On-demand Distance Vector Routing (AODV)

AODV uses routing tables, with one route entry per destination where each entry stores next hops towards destination. It broadcast route request (RREQ) packets and this RREQ is uniquely identified by the sender address, destination address and request ID. If the node is either the destination node or has a route to the destination node then it returns a route reply (RREP) containing the route, to sender. AODV uses sequence numbers and node compares the destination sequence number of the RREQ with that of its route table entry this protocol either response with its own route if entry is fresh, or rebroadcasts the RREQ to its neighbors. In AODV, each node maintains a routing table which is used to store destination and next hop IP addresses as well as destination sequence numbers. And each entry in the routing table has a destination address, next hop, precursor nodes list, life time and distance to destination. Finally, after processing the RREP packet, the node forwards it toward the source. The node can later update its routing information if it discovers a better path or route.

C. Zone Routing Protocol (ZRP)

In ZRP [9], the nodes have a routing zone, which defines a range (in hops) that each node is required to maintain network connectivity proactively. Therefore, for nodes within the routing zone, routes are immediately available. For nodes that lie outside the routing zone, routes are determined on-demand (i.e. reactively), and it can use any on-demand routing protocol to determine a route to the required destination. The advantage of this protocol is that it has significantly reduced the amount of communication overhead when compared to pure proactive protocols. It also has reduced the delays associated with pure reactive protocols such as DSR, by allowing routes to be discovered faster. This is because, to determine a route to a node outside the zone, the routing only has to travel to a node which lies on the boundaries (edge of the routing zone) of the required destination. Since the boundary node would proactively maintain routes to the destination.

4. Performance Metrices

In order to compare the network performance of proactive, reactive and hybrid routing protocols, the following performance metrices are considered. The speed and the performance of the ad hoc networks depends mainly on these metrices.

A. Average End – to – End Delay

It includes the delays caused by buffering during route discovery, queuing at the interface queue, transmission delays at the MAC, propagation and transfer times.

B. Packet Delivery Ratio

The ratio of the number of data packets delivered to the destinations and the number of data packets generated by Constant bit rate sources.

C. System Throughput

It is measured as the total number of useful data (in bps) received at traffic destinations, averaged over the duration of the entire simulation.

5. Simulation Model and Results

A. Simulation Environment

The performance of the routing protocols is evaluated using Qualnet simulation software. QualNet Developer is ultra high-fidelity network evaluation software that predicts wireless, wired and mixed-platform network and networking device performance. QualNet offers unmatched platform portability and interface flexibility. QualNet runs on sequential and parallel Unix, Windows, Mac OS X and Linux operating systems, and is also designed to link seamlessly with modeling/simulation applications and live networks. The simulation parameters which have been considered for the comparative analysis of proactive, reactive and hybrid protocols is given below in Table I

Table 1: Simulation Parameters

Coverage Area 1500m x 1500m
Protocols FSR,AODV,ZRP
Packet Size 512 bytes
Traffic type Constant bit rate(CBR)
Maximum speed 10m/s
Mobility model Random way point
No. of nodes 10,20,40,60,80,100
Simulation time 100 seconds
Network Simulator Qualnet 5.0

B. Results and Observations

A series of simulation experiments were conducted in the qualnet network simulator using the simulation model and performance metrices outlined in the previous sections. The Simulation results, analysis and comparison are given below:

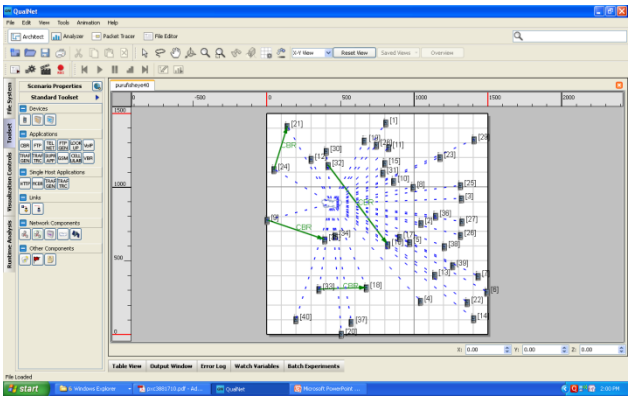

Figure 1: Simulation

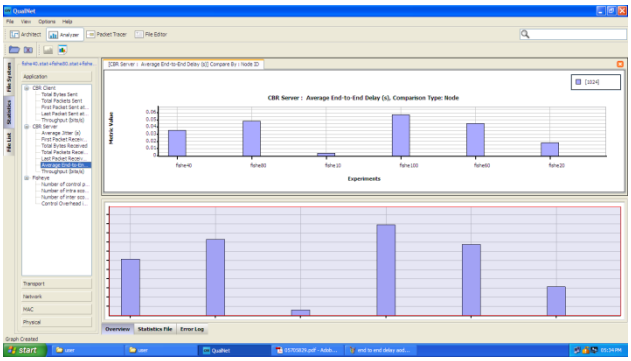

Figure 2: Analysis 1

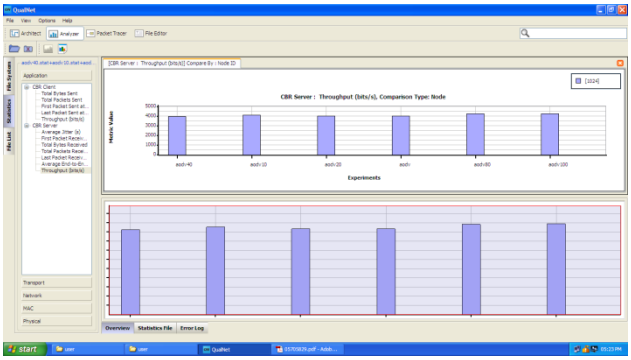

Figure 3: Analysis 2

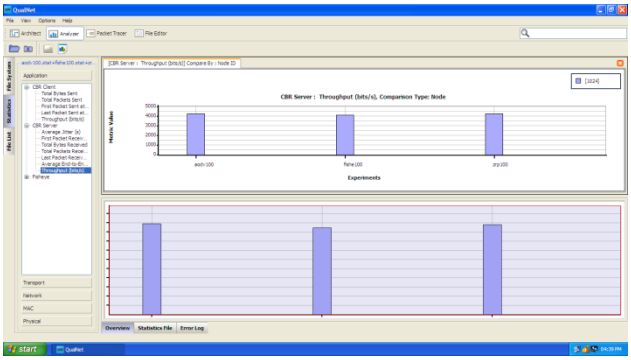

Figure 4: Comparison 1

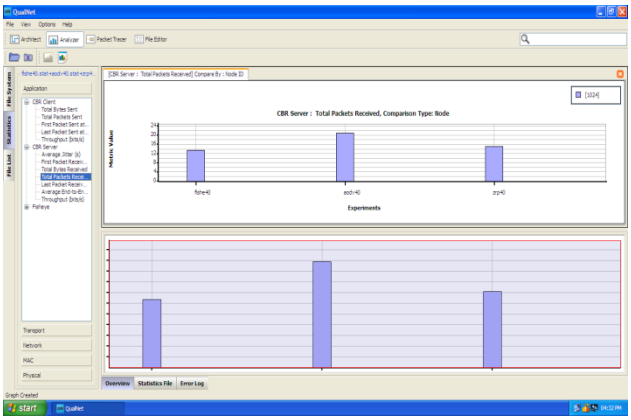

Figure 5: Comparison 2

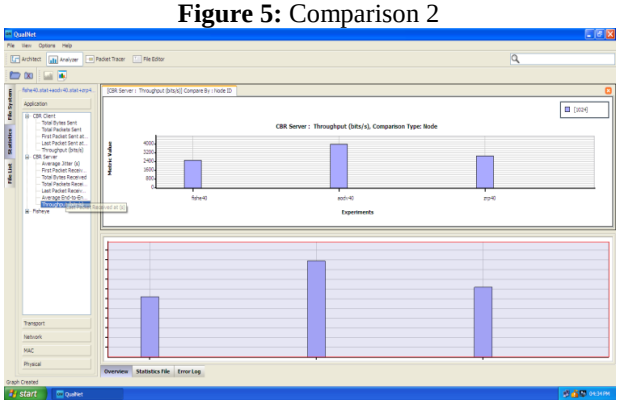

Figure 6: Comparison 3

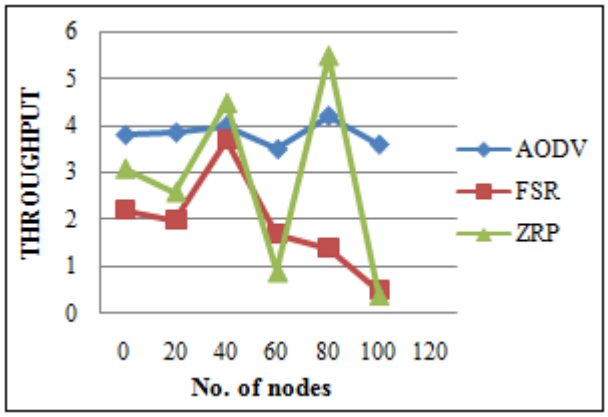

Figure 7: Variation of SystemThroughput with number of nodes

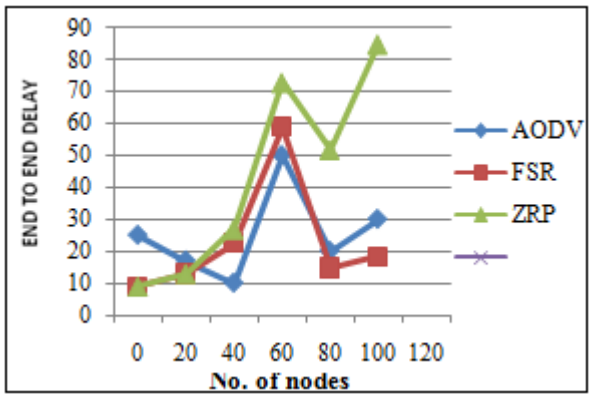

Figure 8: Variation of Delay with number of nodes

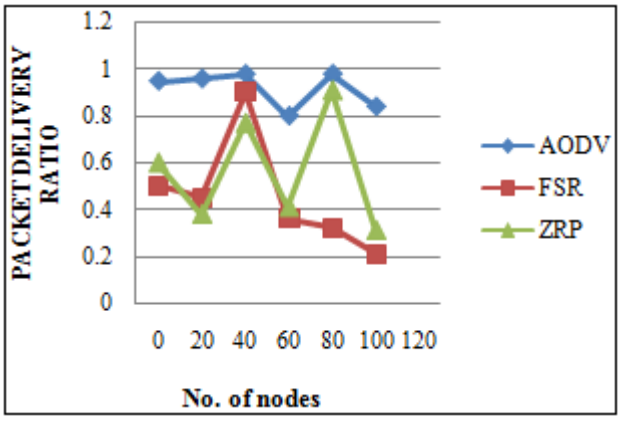

Figure9: Variation of Packet Deleivery Ratio with number of nodes

6. Conclusion

In this paper, performance evaluation of three routing protocols FSR, AODV and ZRP is done. AODV is a pure reactive protocol while FSR is a proactive and ZRP behaves as a proactive for higher routing zone. The general observation from simulation is that AODV has performed well as compared to all other protocols in terms of Average end to end delay, Packet Delivery Ratio and System Throughput.FSR and ZRP fails to respond fast enough to changing topology ascompared to AODV. The performance of ZRP can be increased by incorporating other protocols in it.FSR is more desirable for large mobile networks where mobility is high and the bandwidth is low.

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