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Impact of Node Density and Pause Time on the Performance of Ad Hoc Routing Protocols

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Abstract

Mobile Ad Hoc Networks are wireless networks which do not require any infrastructure support for transferring data packet between two nodes. In these networks nodes also work as a router that is they route packet for other nodes. Nodes are free to move, independent of each other, topology of such networks keep on changing dynamically which makes routing much difficult. Therefore routing is one of the most concerns areas in these networks. It finds applications in military communications, emergency operations, hybrid wireless network architectures and wireless mesh networks. A variety of routing protocols for ad hoc networks has been proposed in the past. 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 with respect to node density and pause time. The simulation is done using qualnet simulator.

Keywords: *Routing,AODV,FSR,ZRP,Performance Analysis*

1. INTRODUCTION

Wireless networking is an emerging technology that allows users to access information and services electronically regardless of their geographic position [1]. Wireless networks can be classified into infrastructure and infrastructureless (Ad hoc) networks. An ad hoc wireless networks or infrastructureless network are 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. 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 [2].

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.

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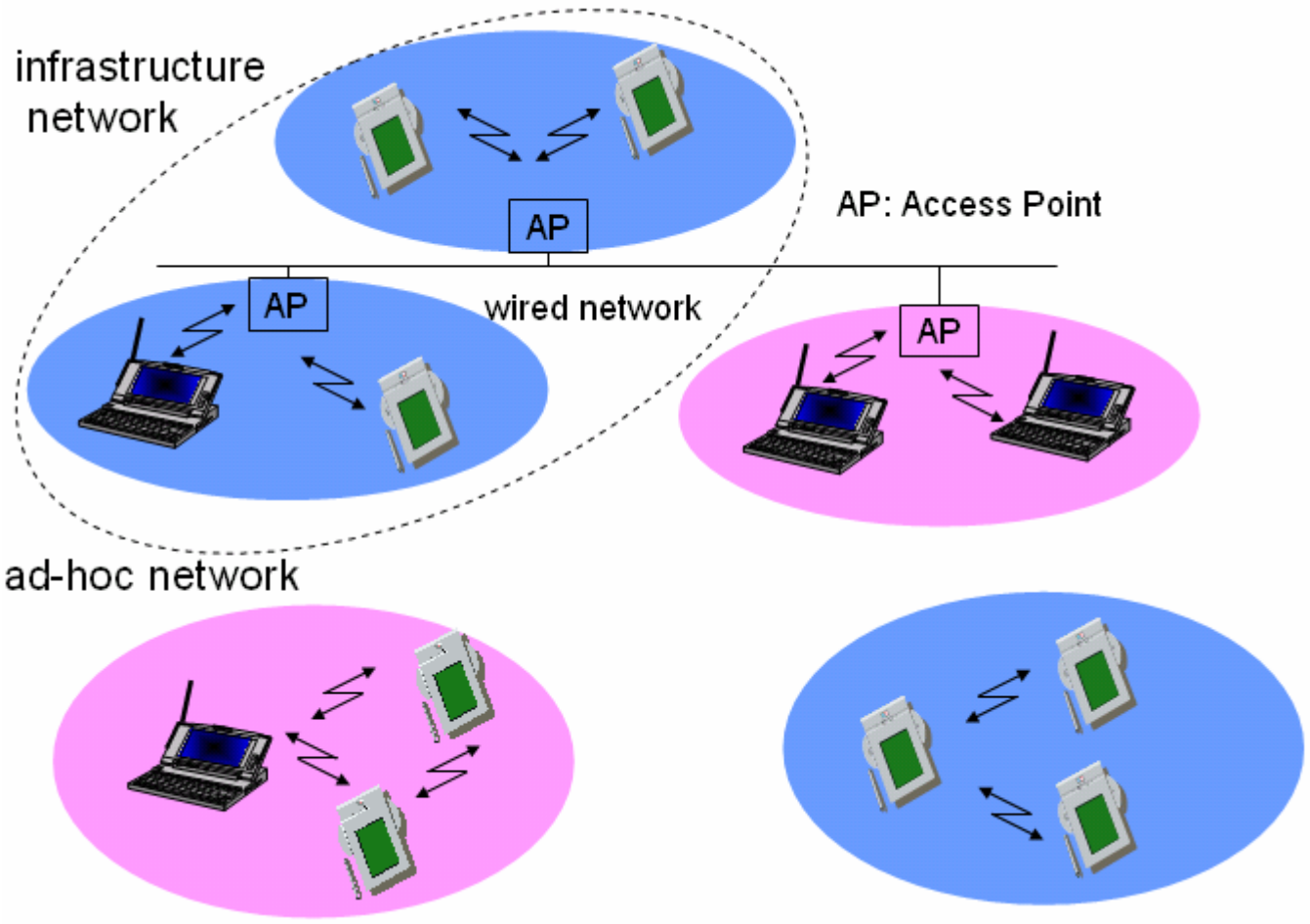

Fig. 1 Comparison of infrastructure networks and ad hoc networks

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 or Table-Driven Routing Protocols

In Proactive routing protocols, every node maintains the network topology information in the form of routing tables by periodically exchanging routing information [4]. These tables are periodically updated when the network topology changes. Whenever a node requires a path to a destination, it runs an appropriate path finding algorithm on the topology information it maintains. The differences between these protocols exist in the way the routing information is updated, detected and the type of information kept at each routing table. Some mostly widely used proactive routing protocols are FSR,GSR,DSDV,STAR,CGSR,OLSR,WRP.

B. Reactive or On-Demand Routing Protocols

Protocols under this category do not maintain the network topology information [5], [12]. They obtain the necessary path when it is required, by using a connection establishment process. These protocols were designed to reduce the overheads in proactive protocols by maintaining

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information for active routers only. The routes are determined and maintained for nodes that require to send data to a particular destination. Route discovery usually occurs by flooding a route request packets through the network .Some of the reactive protocols are DSR,AODV,LAR,TORA,CBRP,ARA.

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(AODV*)*

Route Requests (RREQs) and Route Replies (RREPs) are the two message types defined by AODV [8]. When a route to a new destination is needed, the node uses a broadcast RREQ to find a route to the destination. A route can be determined when the request reaches either the destination itself or an intermediate node with a fresh route to the destination. The route is made available by unicasting a RREP back to the source of the RREQ. Since each node receiving the request keeps track of a route back to the source of the request, the RREP Reply can be unicast back from the destination to the source, or from any intermediate node that is able to satisfy the request back to the source. A hello message is a local advertisement for the continued presence of the node. Neighbours that are using routes through the broadcasting node will continue to mark the routes as valid. If hello messages from a particular node stop coming, the neighbour can assume that the node has moved away. When that happens, the neighbour will mark the link to the node as broken and may trigger a notification to some of its neighbours telling that the link is broken. In AODV, each router maintains route table entries with the destination IP address, destination sequence number, hop count, next hop ID and lifetime. This information must be kept even for ephemeral routes, such as those created to temporarily keep track of reverse paths towards nodes originating the RREQs.

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

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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 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 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 analysis of proactive, reactive and hybrid protocols is given below in Table I

TABLE I. 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
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 are given below. The simulation results in in Fig. 2, Fig. 3 and Fig. 4 shows the variation of the Average end-to-end delay, Packet Delivery Ratio and System Throughput as a function of Node Density for Random way point model.

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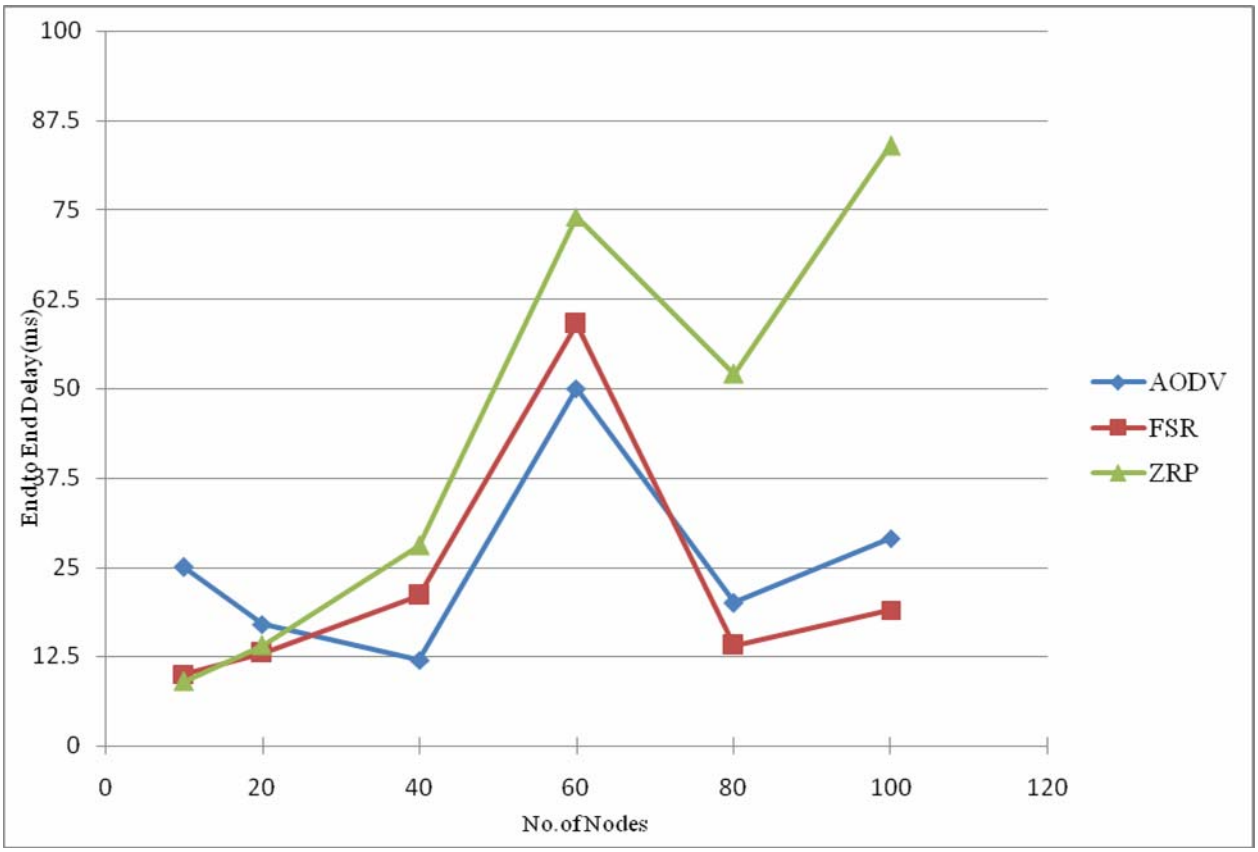

Fig. 2 Variation of Delay with number of nodes

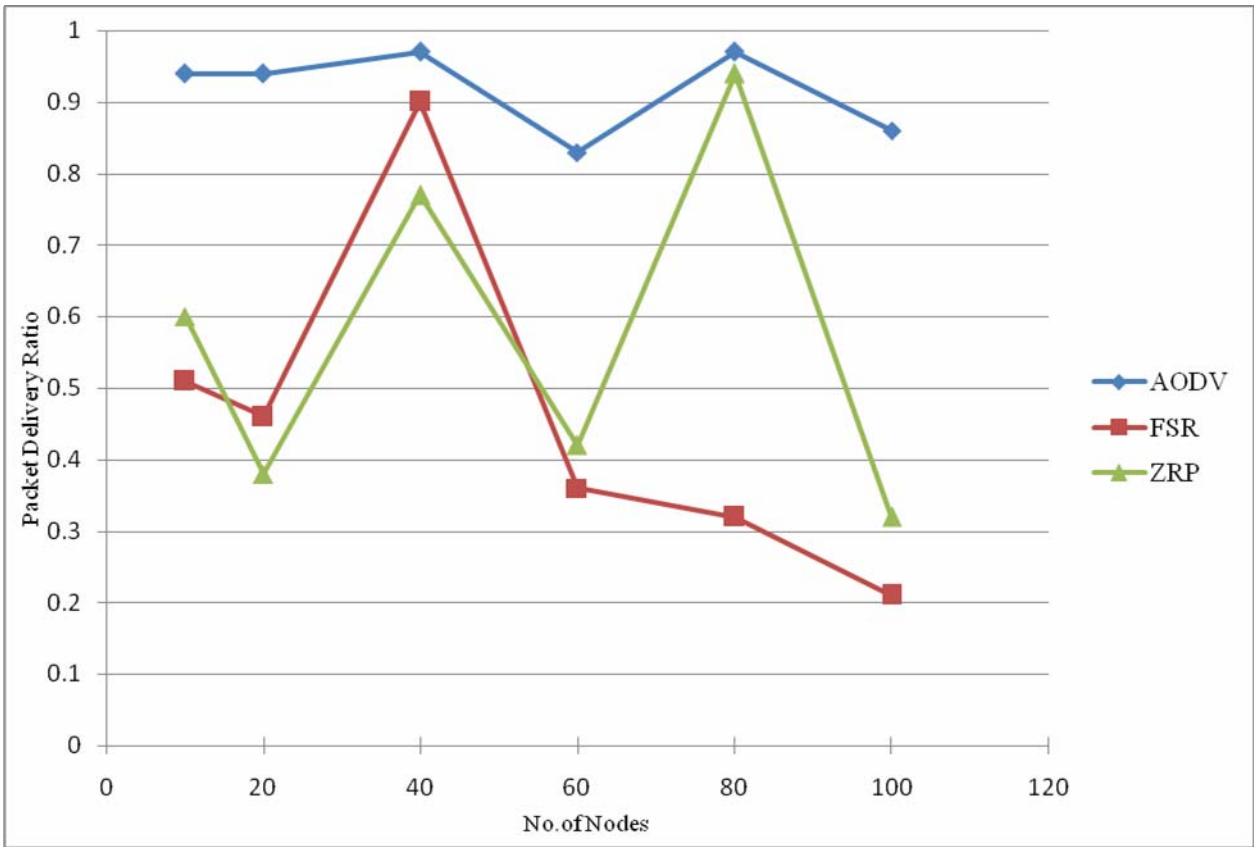

Fig. 3 Variation of Packet Delivery Ratio with number of nodes

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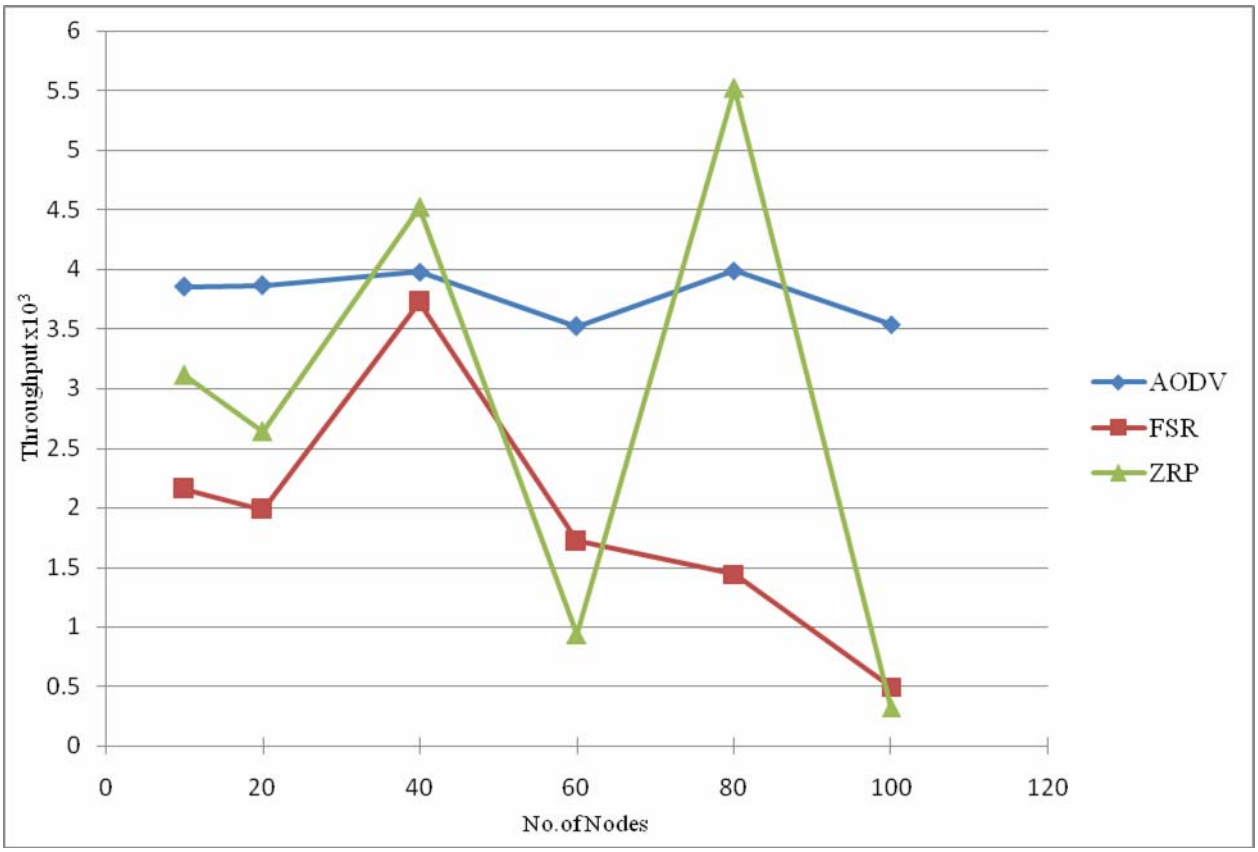

Fig. 4 Variation of System Throughput with number of nodes

The simulation results in in Fig. 5, Fig. 6 and Fig. 7 shows the variation of the Average end-to-end delay, Packet Delivery Ratio and System Throughput as a function of Pause Time.

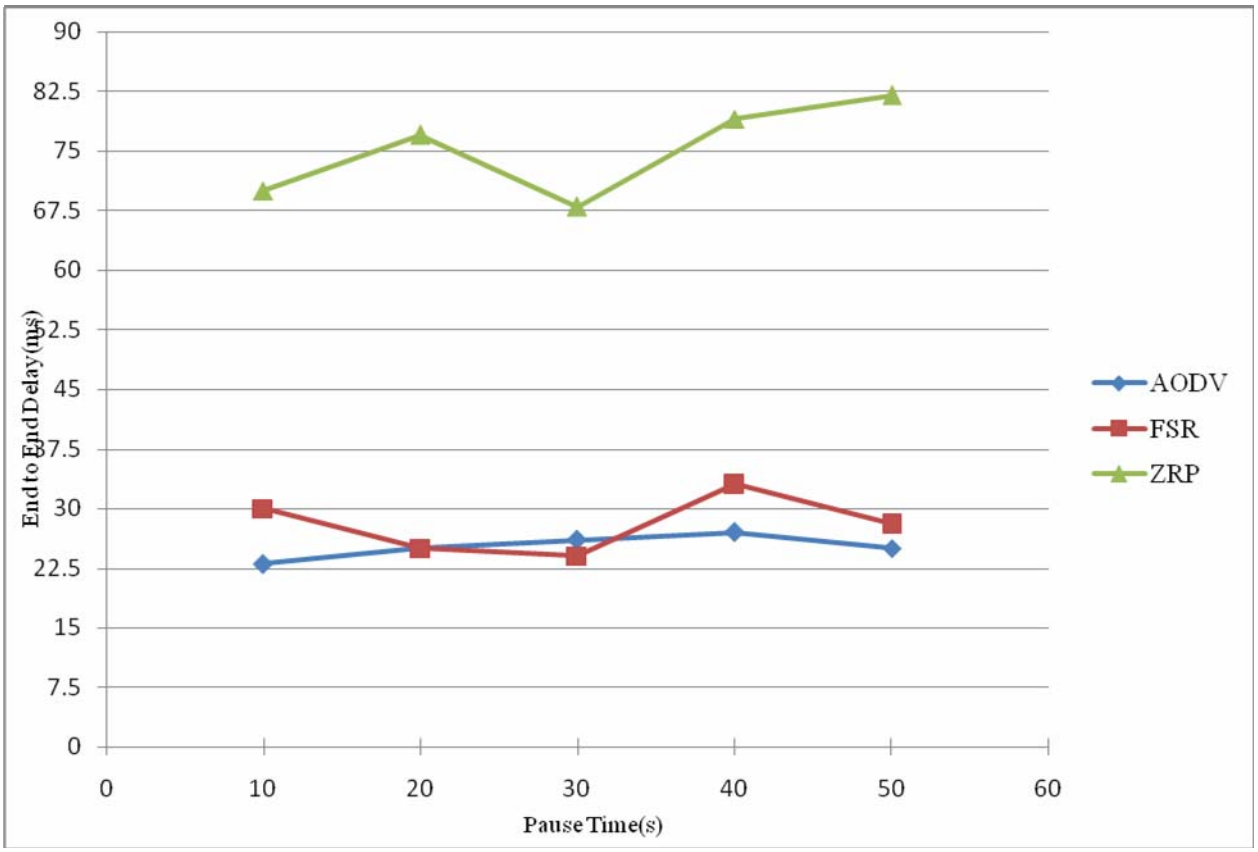

Fig. 5 Variation of Delay with pause time

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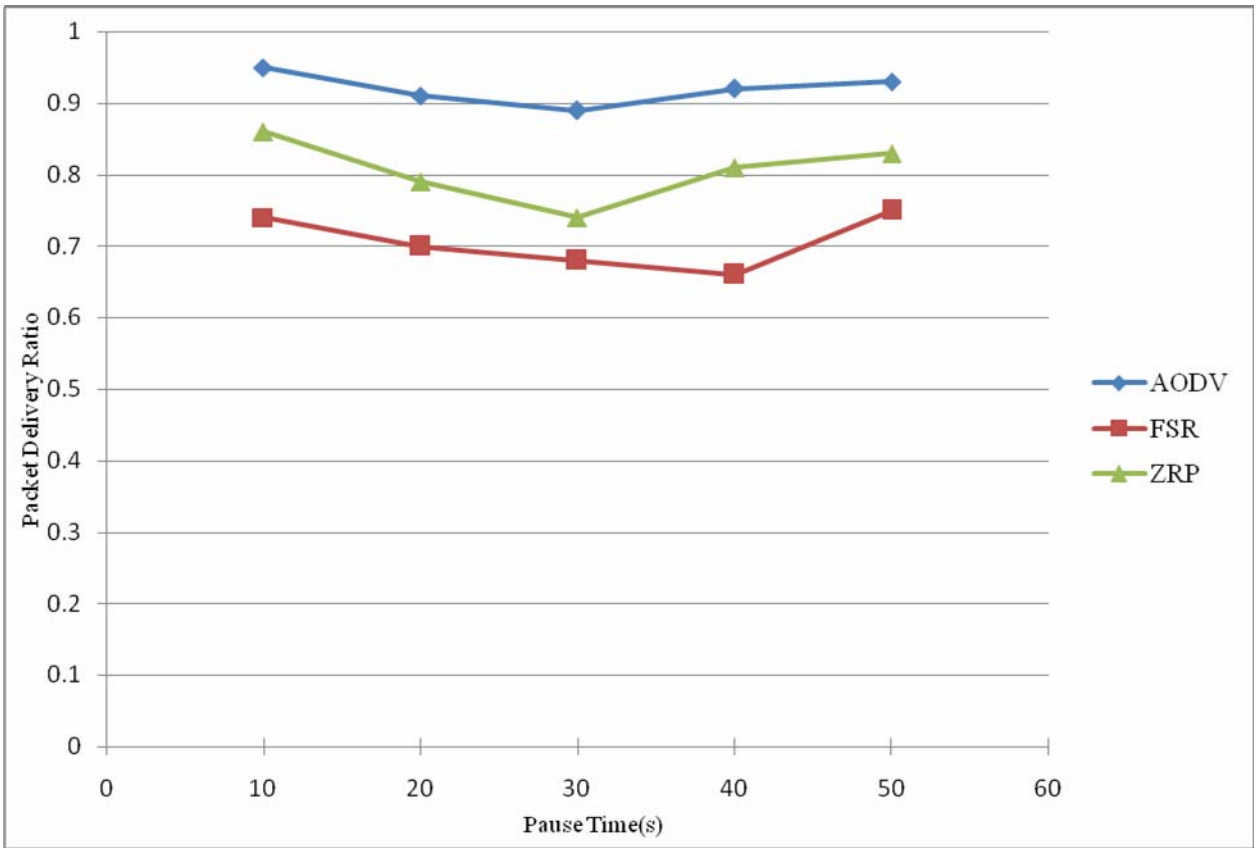

Fig. 6 Variation of Packet Delivery Ratio with pause time

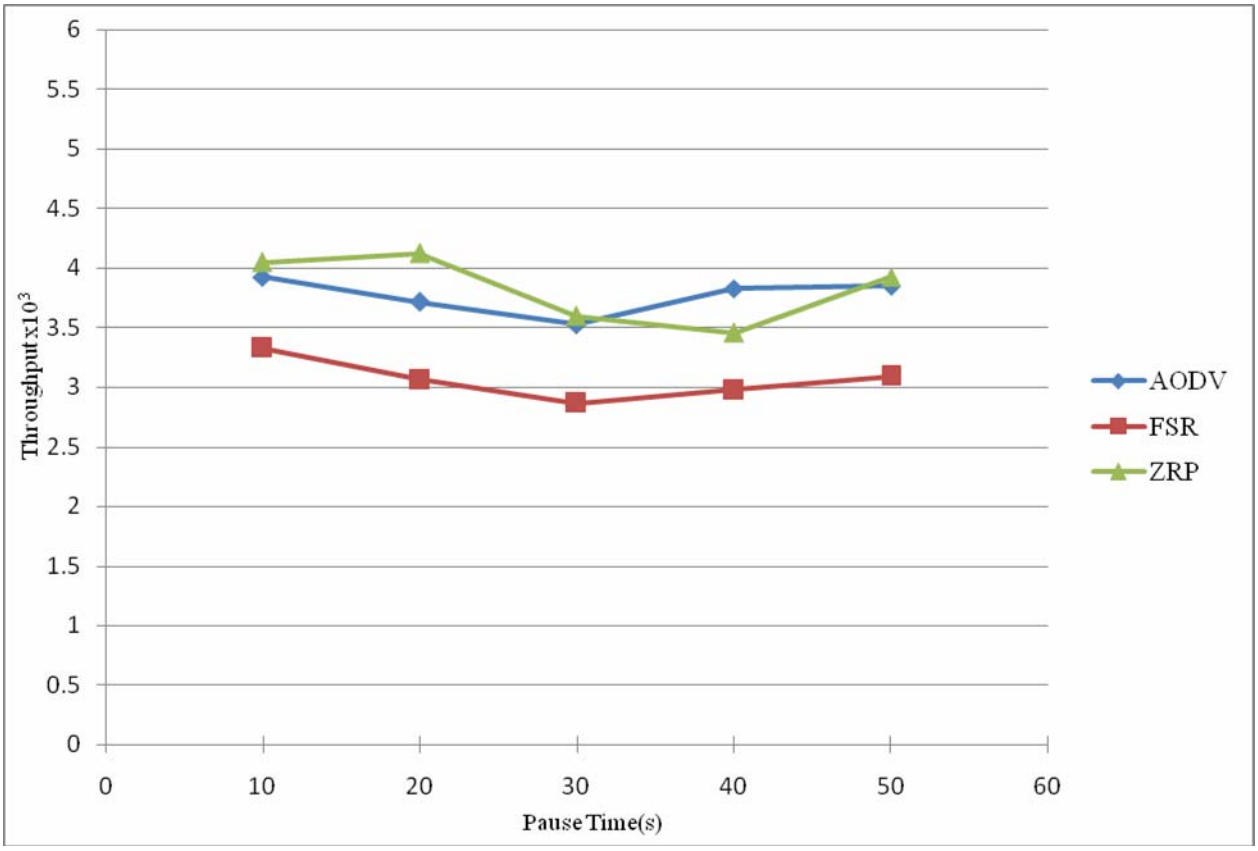

Fig. 7 Variation of System Throughput with number of nodes

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The simulation result brings out some important characteristic differences between the routing protocols. In all the simulation results AODV outperforms the other protocols. This is because AODV is a pure reactive protocol and it determines the route whenever needed. It uses destination sequence numbers to ensure loop freedom at all times and it offers quick convergence when the network topology changes.

FSR updates the network information for nearby nodes at a higher frequency than for the remote nodes, which lie outside the fisheye scope. This makes FSR more scalable to large networks. However, scalability comes at the price of reduced delivery ratio, throughput and increased delay.

ZRP performs according to the zone radius. When the zone radius is high it behaves like a pure proactive protocol [10]. Hence in these experiments the delay is increased, delivery ratio and throughput are reduced due to their proactive nature.

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 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 as compared 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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