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Inclusive performance scrutiny of DSDV, AODV and ZRP MANETs Routing Protocols

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Abstract

A Mobile Ad-hoc network (MANET) is a Multi-hop wireless network established by a group of nodes, without any central administration. Due to Mobility, the nature of the node is dynamic. Routing in MANET has immense challenges due to Dynamic network topology, limited bandwidth, and limited transmission range and battery constraints. If two mobile nodes are within each other transmission range, then they can communicate with each other directly; otherwise the nodes in between have to forward the packet for them. Due to mobility nature in the network, we need routing protocols that can handle the numerous changes in the topology without any lose in communication. In this paper, an attempt is made to compare performance of Proactive, reactive and hybrid protocol for the MANET. A proportional study of DSDV (proactive), AODV (reactive) and ZRP (hybrid) is done in the basis of performance in MANETs by varying number of nodes, Speed and Pause time. Routing overhead, Average End-to-END delay, Packet Delivery Ratio, Drop Rate and Throughput are measured as performance parameter for evaluating the performance of DSDV, AODV and ZRP protocol.

Introduction

MANET is impermanent wireless networks composed of mobile modes, where topology changes occur instinctively where there are no dedicated access points and cables. A Discussion of MANET can be found in RFC 2501[1]. If two mobile nodes are within each other's transmission range, they can communicate with each other directly without any intermediate. If not the nodes in between have to forward the packets for them. Numerous ad-hoc routing protocols have been proposed by Internet Engineering Task Force Mobile Ad-hoc Network Working Group. Ad-hoc routing protocols are designed to provide a loop free path for data transmission. MANET routing protocols are categorized into three main categories depending upon the criteria when the source node possesses a route to the destination [2] as shown in Fig1.

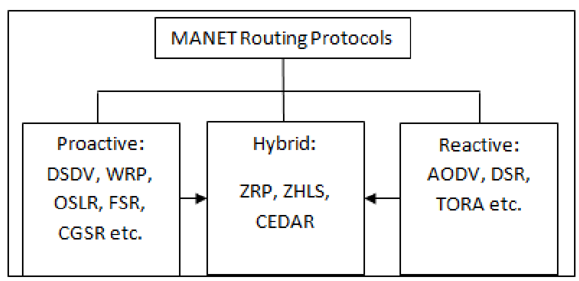

Figure 1: Classification of MANET routing protocols

The paper is organized as follows: Section 2 gives an idea on related work. Section 3 gives a brief description of three major MANET routing protocols – DSDV, AODV,ZRP that have been used for performance scrutiny of proactive, reactive and hybrid protocols of MANET. Section 4 describes the NS2 Simulation. Section 5 talks about some result and scrutiny and finally section 6 discuss the conclusion of this paper.

MANET Characteristics

The routing protocol for ad hoc wireless network should have the following characteristics [3].

1. It must be fully distributed.
2. It must be loop free and free from old routes.
3. Route computation and maintenance must involve a minimum number of nodes.
4. It must be adaptive to regular topology changes by the mobility of nodes.
5. It must optimally use scarce resources such as bandwidth, computation power, memory and battery power.

MANET Applications

There are many applications of MANET. Some of them are discussed below.

1. Military network
2. Sensor network
3. Emergency services
4. Wearable computing

Related Work

The Work done by the researchers on MANETs Routing Protocols as Table 1, some of researchers have done a comparative study on reactive, proactive and Hybrid protocols**.**

Table 1: Related work

Author Name Reference	Protocols Used	Simulator	Performance Metrics	Variable Parameters
Zaiba Ishrat et al.[3]	DSDV,DSR,ZRP	NS2	Packet delivery fraction ratio, Throughput.	Pause time, Number of nodes.
Kavitha pandey et al.[4]	DSDV,AODV, DSR,ZRP	NS2	Routing over head, Average delay, Throughput, number of packets dropped.	Pause time, Number of nodes, speed.
Jaspal kumar et al.[2]	AODV,IAODV	NS2	Packet delivery fraction ratio, Throughput, Average end-to-end delay.	Number of nodes.
Vinay kumar et al.[5]	AODV,DSR	-	Routing over head, Average delay, Throughput, Packet delivery fraction ratio.	Number of nodes.
Pooja Guta et al.[6]	DSDV,AODV, DSR	NS2	Packet delivery fraction ratio, Packet loss Percentage, Average end-to-end delay.	Number of nodes, Number of Connections.
Li Layuan et al.[7]	DSDV,AODV, DSR, TORA	NS2	Routing over head, Throughput, number of packets dropped, Jitter.	Network size
Vijayalaskhmi et al.[8]	DSDV,AODV	NS2	Packet delivery fraction ratio, Throughput, Average end-to-end delay.	Number of nodes,speed,Time
S. Sridhar et al.[10]	AODV,EN-AODV	NS2	Packet delivery fraction ratio, Throughput, Average end-to-end delay, Energy of the node.	Number of nodes.

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It is proved that from table 1, no one has presented the comparison of performance differentials among only DSDV, AODV, ZRP Protocols.

MANETs Routing Protocols

DSDV (Destination Sequence Distance Vector)

Destination Sequence Distance Vector routing protocol (DSDV) is a proactive protocol. It is an advanced version of Bellman ford algorithm [3] as it handles infinite loop problems. Every node in the network maintains consistent routing information by means of periodic exchange of control information updates even if there is no change in topology. The structure of Routing Table is as shown in Table 2.

Table 2: Routing Table Structure

Destination IP Address
Next Node IP Address
Cost Metric
Seq no.
Install Time

DSDV uses sequence number to avoid the problem of routing loops by associating each route entry in a routing table with a unique sequence number [4]. Every node has its own sequence number. The discoverer of the sequence number is known as the owner node. The owner node increments the sequence number after each broadcast. Even a non-owner can update a sequence number is when it detects a link break on that route [5] [6]. In order to maintain the routing information up-to-date, each node periodically broadcast its route and updates its routing table on the basis of received information from the neighbor routing table [5]. The main drawback of the periodic broadcast is the route fluctuation (unwanted broadcasting of any unfortunate route). To handle this problem the node waits for a certain period broad casting the route updates. The waiting time is roughly equal to length of network setting time. The network settling time required for mobile nodes to automatically organize it and transmit the first task constantly [6].

AODV (Adhoc On-Demand Distance Vector)

AODV routing protocols is another reactive routing protocol, which consists of the following procedures:

1. Path/Route Discovery
2. Path/Route Maintenance

Path/Route Discovery: it is initiated whenever a node needs to send data packet to the destination when there is no valid route available in its routing table. Here, each node maintains two separate control information as shown.

Type	Reserved	Hop Count
Broadcast ID		
Destination IP Address		
Destination Sequence Number		
Source IP Address		
Source Sequence Number		
Request Time		

Figure 2: Structure of an RREQ packet.

AODV succeed to the concepts of Sequence number from DSDV protocols in order to retain the freshest route in the network. A RREQ (Route Request) [7] is broadcast throughout the network with a search ring technique. Upon receiving RREQ by a node which can be either destination node or an intermediate node with a fresh route to destination reacts with a RREP (Route Reply) unicast packet to the source node. As the RREP is routed back along the reverse path, the RREP has reach source node, a route is said to be established between source and destination node as Route is said and structure of packet referred.

Path/Route Maintenance: The route is maintained at source end. If a node does not receive a control message or data packets from a neighbor for certain tie period, the intermediate link is broken.

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When any link break or failure is occurred, it is marked as invalid and a route error (RERR) message [8] is flooded to all the nodes in the network. Once RERR reaches the source node, it reinitiates the route discovery procedure local connectivity among the nodes can be maintained with the help of HELLO message, but it increases traffic overhead in the network.

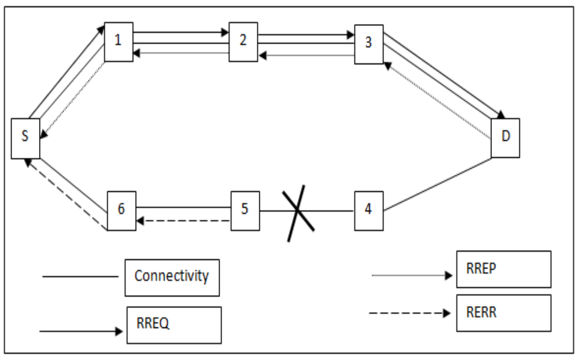

Figure 3: Behavior of AODV Routing Protocols

ZRP (Zone Routing Protocol)

It is a hybrid protocol combination of both proactive and reactive. ZRP overcome the disadvantage of control overhead caused by proactive protocols and also decreases the latency in reactive protocols [9]. It takes advantage of proactive discovery with in a node close immediately/ local neighborhood, and using a reactive approach for communication between their neighborhoods. Packet is routed proactively if it is within the zone and if the destination is outside the zone reactive routing is used [4]. Every node has a zone which is defined to be the node with in the distance of n hops (i.e. zone radius). Each zone may have different in size and each node may be within multiple overlapping zones [11].

The Advantages

1. The change of link status at one end of the network will not affect the other end of the network [8] [9].
2. The path between different zones is built on demand.
3. The broken link can be bypassed with the aid of local topology information [10].
4. Route optimization can be achieved within the zone.

Characteristics summary of DSDV, AODV and ZRP routing protocols are as shown Table 3 [6].

Table 3: Comparison of DSDV, AODV and ZRP

Metrics	DSDV	AODV	ZRP
Loop free	yes	yes	yes
Multicasting	NO	yes	yes
Mobility	Performance will demean	High	High
Large Network size	NO	yes	yes
Communication link	Uni-directional	Bi-directional	Bi-directional

NS2 Simulation

Ns2 is most widely used simulator by researchers; it is event driven object oriented simulator, developed in C++ as backend and OTcl as front end. If we want to deploy a network then both TCL (Tool Command Language) as scripting language with C++ to be used [13].

Performance Metrics

The following the performance metrics that are considered for evaluation of MANETs routing protocols.

Packet Delivery Ratio (PDR): The ratio of the data packets delivered to the destinations to those generated by the CBR sources. The PDF shows how successful a protocol performs delivering packets from source to destination. The higher the PDR better the result. This metric characterizes both the completeness

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and correctness of the routing protocol also reliability of routing protocol by giving its effectiveness.

$$\text{Packet delivery ratio} = \frac{\sum \text{CBR packets received by CBR sinks}}{\sum \text{CBR packets sent by CBR sources}} \quad (1)$$

Drop rate: It is defined as number of control packets dropped by a mobile node in a process of establishing a shortest loop free path between source node and destination node.

```
#grep "^d" simple.tr | grep "CBR" | grep "_ | _ RTR >
```
(2)

This command is used to filter the Dropped packets from the Trace file sample.tr generated in ns2.

Average end-to-end delay: There are possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, and propagation and transfer times. The Average end-to-end delay is an average end-to-end delay of data packets. It also caused by queuing for transmission at the node and buffering data for detouring. Once the time difference between every CBR packet sent and received was recorded, dividing the total time difference over the total number of CBR packets received gave the average end-to-end delay for the received packets. This metric describes the packet delivery time: the lower the end-to-end delay the better the application performance.

$$\text{Average end-to-end delay} = \frac{\sum(\text{CBRsent Time} - \text{CBRrecv Time})}{\sum \text{CBRrec}} \quad (3)$$

Throughput: It is a ratio of received size of a data packet to difference between stop time and end time of a mobile node. Number of data bits transferred per second excluding the Header size.

```
HEADER_SIZE = PACKET_SIZE % 512
PACKET_SIZE = PACKET_SIZE - HEADER_SIZE
RECEIVED_SIZE = RECEIVED_SIZE + PACKET_SIZE
AVERAGE THROUGHPUT[KBPS] = RECEIVED_SIZE/(STOP_TIME - START_TIME))*(8/10000)
```
(4)

Routing Overhead: It is total number of control information packets needed for route establishment & route maintenance. RTR is notation used in trace file which stands for routing. This is to calculate the number of packets sent to or from the network layer. For a good routing protocol the packet delivery ratio, throughput should be high, where as the routing overhead, Average end-to-end delay and packet dropping ratio should be less.

```
if ( LAYER == "RTR" && EVENT == "S" || EVENT == "R" ) { OVERHEAD++; }
```
(5)

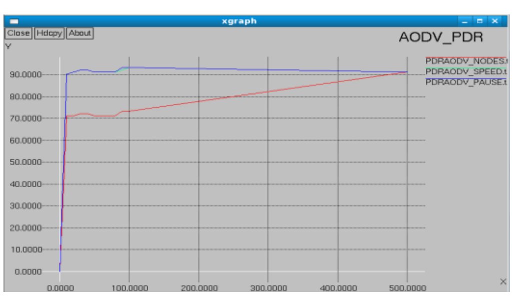
Implementation

Ns2 provides the implementation of DSDV, AODV and ZRP protocols, for implementing ZRP a patch as been integrated into NS2 package[11][12]. The TCL file generates different trace files for different MANETs routing protocols, trace files have to be parsed with the help of AWK language to extract the information needed to measure the performance metrics. XGraph utility is used to plot the graphs. Network Animator (NAM) is used to visualize the simulation graphically [13].

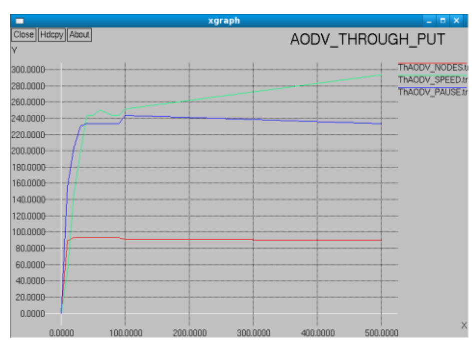
Table4: Simulation setup parameters

Parameter Name	DSDV	AODV	ZRP
NS Version	NS 2.35	NS 2.35	NS 2.35
channel type	Wireless Channel	Wireless Channel	Wireless Channel
netif	Phy/WirelessPhy	Phy/WirelessPhy	Phy/WirelessPhy/802_15_4
mac protocol	Mac/802_11	Mac/802_11	Mac/802_15_4
Radio propagation	Two Ray Ground	Two Ray Ground	Two Ray Ground
Antenna Type	Omni Antenna	Omni Antenna	Omni Antenna
Mobility Model	Random waypoint	Random waypoint	Random waypoint
Mobility	60 m/s	60 m/s	60 m/s
ifq	Queue/DropTail/PriQueue	CMUPriQueue	Queue/DropTail/PriQueue
ifqlen	50	50	50
Packet size	512 Bytes	512 Bytes	512 Bytes
number of nodes	15 and 200	15 and 200	15 and 200
routing protocol	DSDV	AODV	ZRP
Zone Radius	-	-	2
Area	1000×1000 m	1000×1000 m	1000×1000 m
Transmission range	250 m	250 m	250 m
simulation time	1500 sec	1500 sec	1500 sec
Topology	Random	Random	Random
Traffic type	CBR(UDP)	CBR(UDP)	CBR(UDP)

Results



Graph 1.1 AODV_Packet Delivery Ratio Vs Varying Number of nodes, speed, pause time



Graph 1.2 AODV_Throughput Vs Varying Number of nodes, speed, pause time

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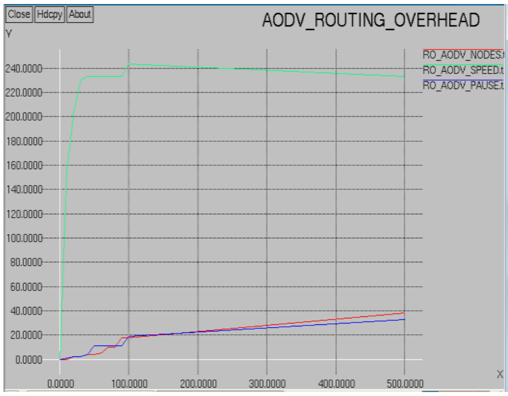
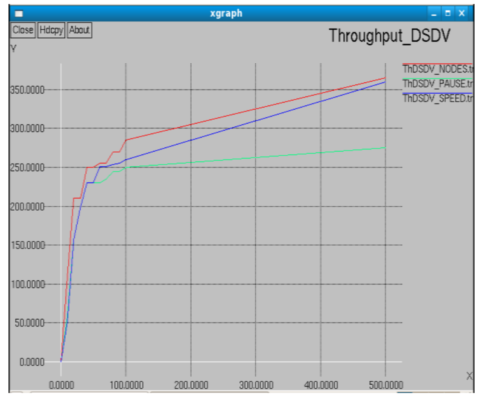
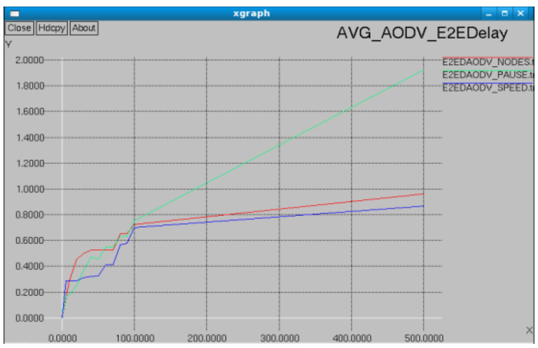


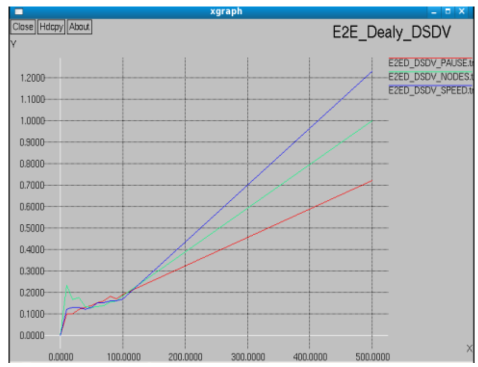
Graph 1.3 AODV_ Routing overhead Vs Varying Number of nodes, speed, pause time



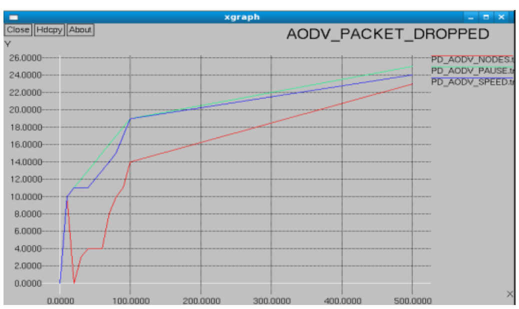
Graph 2.1 DSDV_ Through put Vs Varying Number of nodes, speed, pause time



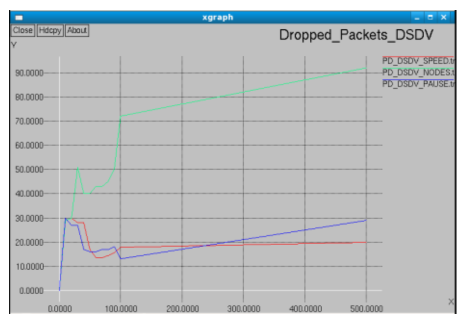
Graph 1.4 AODV_ Average End-to-End Delay Vs Varying Number of nodes, speed, pause time



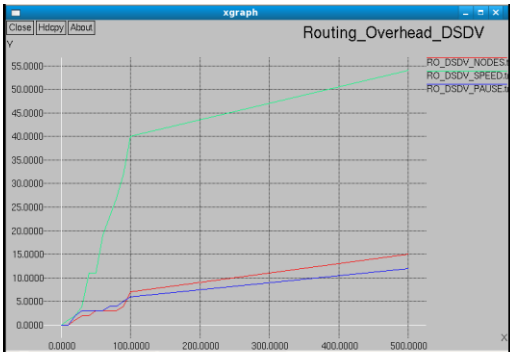
Graph 2.2 DSDV_ Average End-to-End dealy Vs Varying Number of nodes, speed, pause time



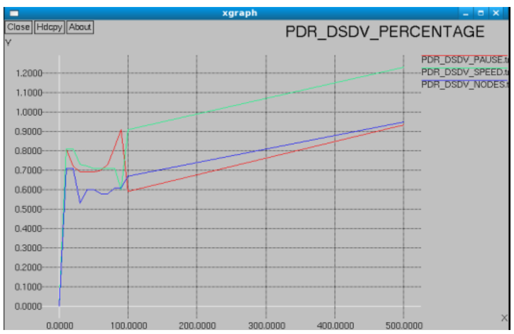
Graph 1.5 AODV_ Packet Dropped Vs Varying Number of nodes, speed, pause time



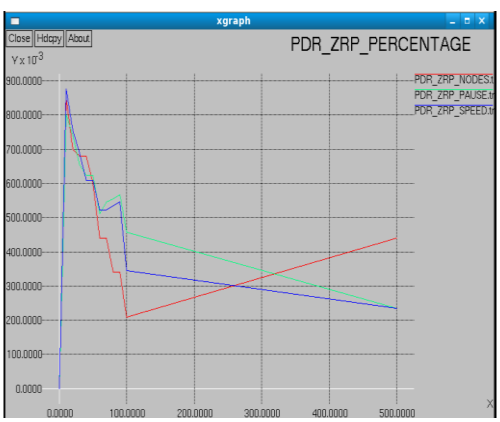
Graph 2.3 DSDV_ Dropped Packets Vs Varying Number of nodes, speed, pause time



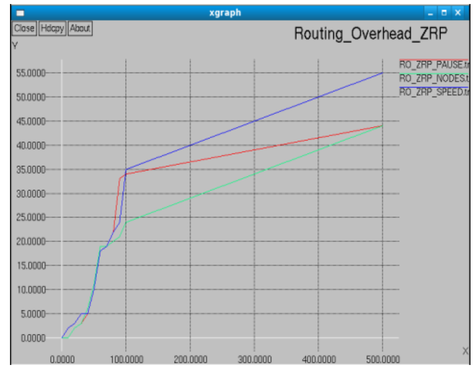
Graph 2.4 DSDV_ Routing overhead Vs Varying Number of nodes, speed, pause time



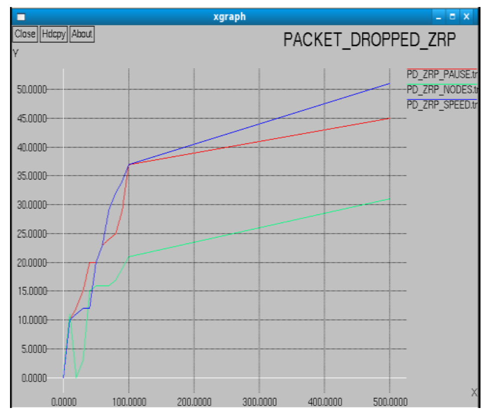
Graph 2.5 DSDV_ Packet Delivery Ratio Vs Varying Number of nodes, speed, pause time



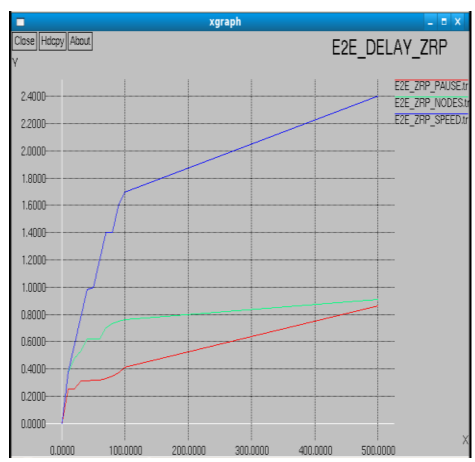
Graph 3.1 ZRP_ Packet Delivery Ratio Vs Varying Number of nodes, speed, pause time



Graph 3.2 ZRP_ Routing Overhead Vs Varying Number of nodes, speed, pause time



Graph 3.3 ZRP_ Dropped Packets Vs Varying Number of nodes, speed, pause time



Graph 3.4 ZRP_ Average End-to-Delay Vs Varying Number of nodes, speed, pause time

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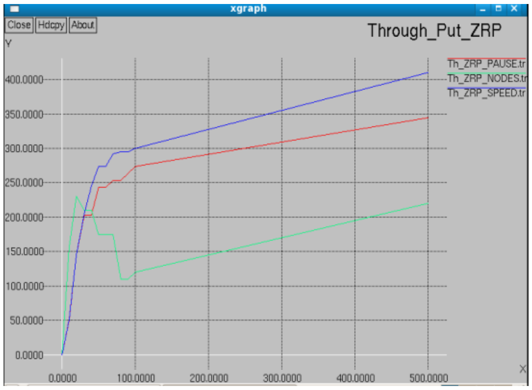
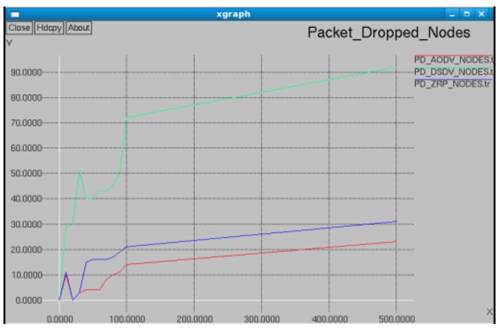
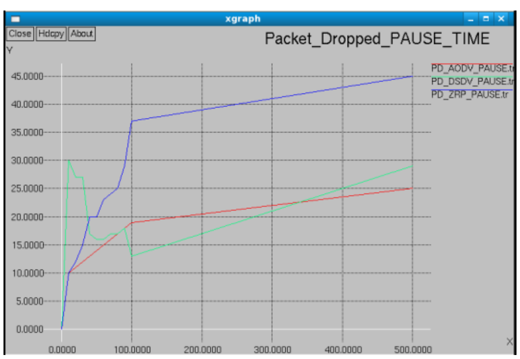


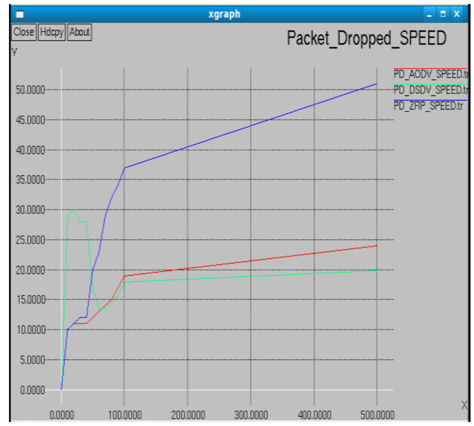
Graph 3.5 ZRP_ Through put Vs Varying Number of nodes, speed, pause time



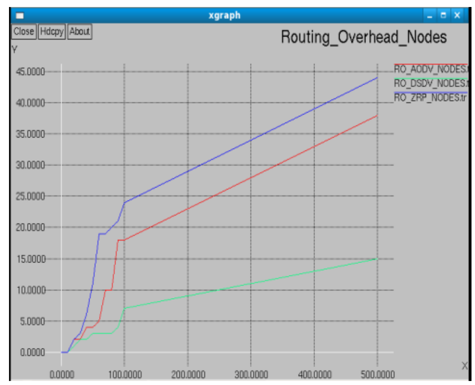
Graph 4.1 AODV_DSDV_ZRP_ Dropped packets Vs Varying Number of nodes



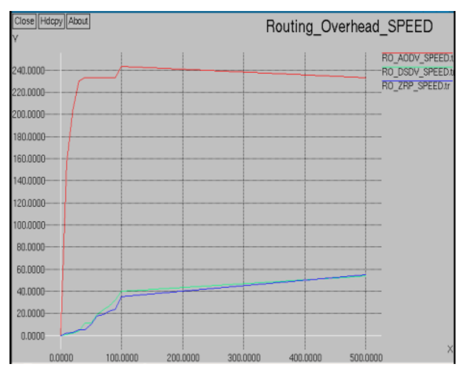
Graph 4.2 AODV_DSDV_ZRP_ Dropped packets Vs Pause Time



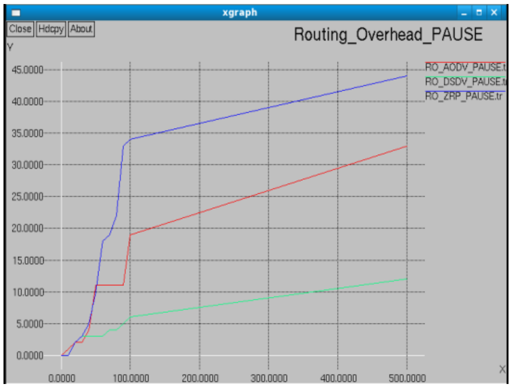
Graph 4.3 AODV_DSDV_ZRP_ Dropped packets Vs speed



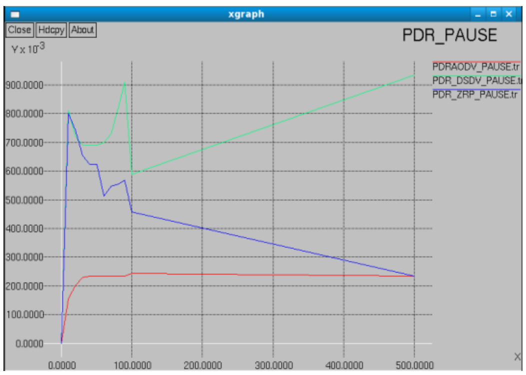
Graph 5.1 AODV_DSDV_ZRP_ Routing Overhead Vs Varying Number of nodes



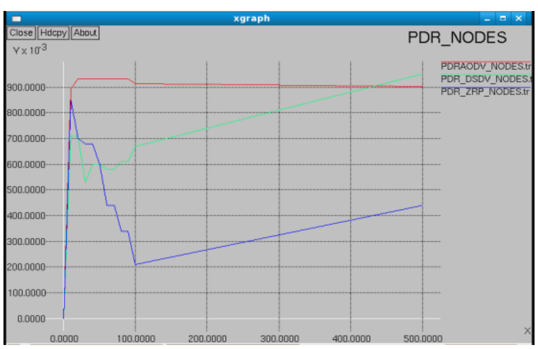
Graph 5.2 AODV_DSDV_ZRP_ Routing Overhead Vs speed



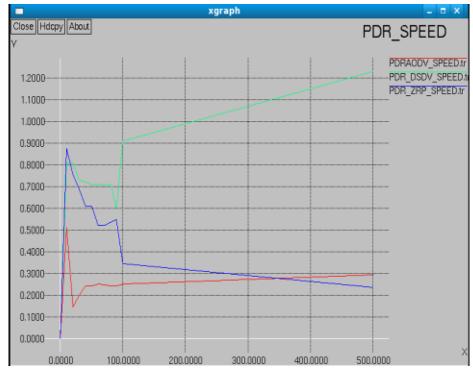
Graph 5.3 AODV_DSDV_ZRP_ Routing Overhead Vs Pause Time



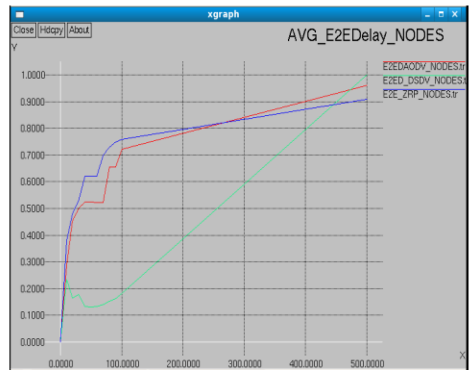
Graph 6.1 AODV_DSDV_ZRP_ Packet Delivery Ratio Vs Pause Time



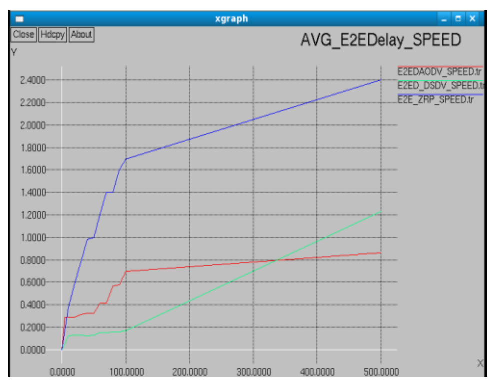
Graph 6.2 AODV_DSDV_ZRP_ Packet Delivery Ratio Vs Number of Nodes



Graph 6.3 AODV_DSDV_ZRP_ Packet Delivery Ratio Vs speed



Graph 7.1 AODV_DSDV_ZRP_ Average End-to-End Delay Vs Number of nodes



Graph 7.2 AODV_DSDV_ZRP_ Average End-to-End Delay Vs Speed

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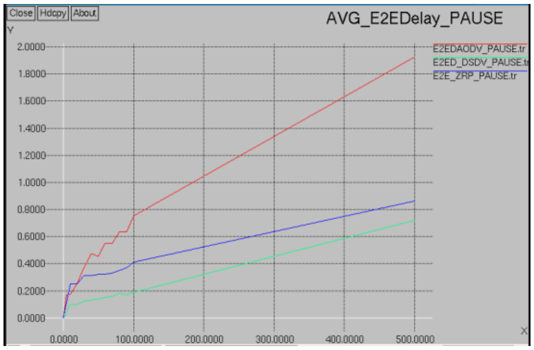
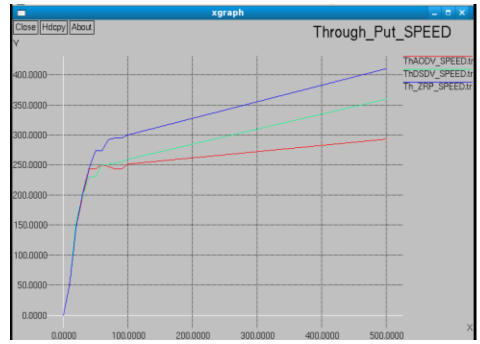
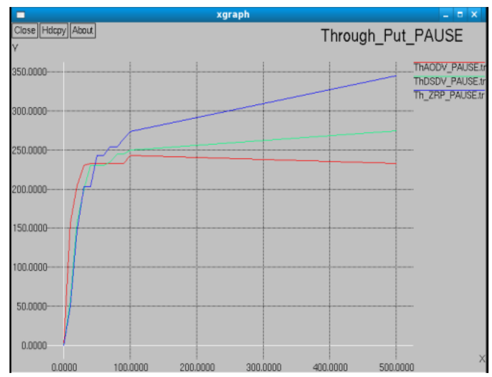


Graph 7.3 AODV_DSDV_ZRP_ Average End-to-End Delay Vs Pause Time



Graph 8.2 AODV_DSDV_ZRP_ Through put Vs Speed

Graph 8.1 AODV_DSDV_ZRP_ Through put Vs Number of nodes



Graph 8.3 AODV_DSDV_ZRP_ Through put Vs Pause Time

Conclusion

In this paper, we reviewed the performance of routing protocols with respect to following five performance metrics namely Routing Overhead, Average End- to-End Delay, Packet Delivery Ratio (PDR) Drop Rate and Throughput. Finally, AODV is better compared to other protocols, changes in pause time does not have any effect on AODV performance. Increasing the number of nodes throughput also increases. DSDV has low Throughput compared to AODV and ZRP. The Throughput of ZRP doesn't change even on changing the pause time, number of nodes and speed of the nodes due to fixed zone radius. AODV and ZRP have higher Average End-to-End delay where as DSDV has less Average End-to-End delay. When speed increases, there is no effect on Average End-to-End delay. When number of nodes increases the Average End-to-End delay increases due to time consumed in computation of routes. In ZRP, increases speed and number of nodes the Average End-to-End delay increases because of difficulty in setting routes due to contention and high mobility. In every protocol, the number of Packet dropped increases on increasing the speed due to difficulty in path creation. In ZRP and AODV, routing over head increases by large amount where as in DSDV it increases marginally. In ZRP Packet Delivery Ratio is less while compared to other protocols, with increases in number of nodes, Pause time and speed of a mobile node, there is a decrease in Packet Delivery Ratio due to number of nodes available in a network for a given instance of time.

Acknowledgments

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