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# Effect of Scalability and Mobility on MANET

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***Abstract*— Mobile ad-hoc networks (MANETs) are self-configuring networks of nodes connected via wireless without any form of centralized administration. In MANETs, each node acts both as host and as router, thus, it must be capable of forwarding packets to other nodes. Due to mobility, connections in the network can change dynamically and nodes can be added and removed at any time. In this thesis, we have analyzed the performance of AODV, DSDV and ZRP by varying the number of nodes and speed. The performance matrix includes PDF (Packet Delivery Fraction), Throughput, Average End to End Delay and Normalized Routing Load. The simulations are performed using the network simulator NS-2. The results presented in this work illustrate the importance in carefully evaluating and implementing routing protocols in an ad hoc environment**.

***Keywords*— Mobile Adhoc Network, AODV, DSDV, ZRP, ZHLS, DSR, TORA, OLSR, WRP**.

## I. INTRODUCTION

Mobile ad-hoc networks may be used in areas with little or no communication infrastructure: think of emergency searches, rescue operations, or places where people wish to quickly share information, like meetings etc. Considering the special properties of MANET, when thinking about any routing protocol, generally the following properties are expected, though all of these might not be possible to incorporate in a single solution.In order to increase the trustworthiness routing protocol for MANET should be distributed in a accurate manner. A routing protocol must be designed making an allowance for unidirectional links this reason is that because wireless links can be opened in unidirection only because of physical factors of wireless medium.

The power efficiency is provided by routing protocolsThe routing protocol should consider its security.Proactivity provided by hybrid routing protocol to avoide overhead. A routing protocol must be aware of Quality of Service (QoS).

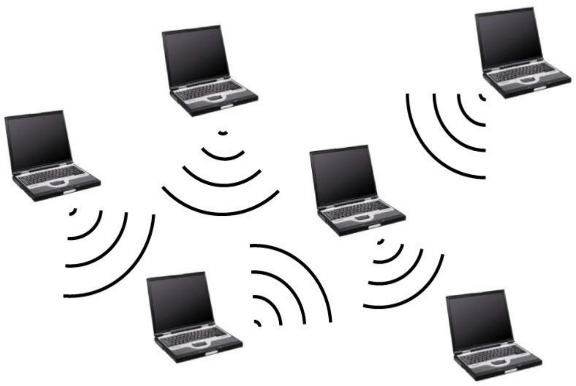

**Fig 1: A mobile ad-hoc network.**

Characteristics and complexities of mobile ad hoc networks

- Device heterogeneity
- Dynamic Network Topology
- Energy constrained operation
- Limited physical security
- Network scalability
- Multi-hop routing
- Independent and infrastructure less
- Self-construction, self-association and self-management.

Advantages and drawbacks of MANET routing protocols

**Advantages:**

- Arbitrarily movement of node
- Spectrum reuse possibility
- More economical
- Easily connected

**Disadvantages:**

- Energy Constraints
- Bandwidth constraints
- High Latency
- Attenuation and interferences
- Security

## II. CLASSIFICATION OF ROUTING PROTOCOL

Routing protocols of identified destinations are used in Proactive protocols they are based upon routing tables of identified destinations, because of this amount of control traffic overhead has been reduced that are generated by proactive routing protocols. The overhead is controlled because the packets are forwarded immediately by given routes in table, Updation of the routings table is necessary. The memory is used for this purpose. Updated messages are sent by nodes periodically however routing tables must be kept up-to-date; this uses memory and nodes periodically send updated messages to neighbors.

The topology of the network is constantly learned by exchanging topological information around the network nodes. Thus, such route information is accessible soon when there is a need for a route to a destination. Each node is required by the protocol is to maintain a single or multiple tables to store up to date routing information and to spread updates among all the network.

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**DSDV (**Destination Sequenced Distance Vector**)**
DSDV is proposed by Perkins and Bhagwat. The Destination-Sequenced Distance-Vector (DSDV) routing protocol is based on the idea of the classical Bellman-Ford Routing Algorithm with certain improvements such as making it loop-free. Each DSDV node maintains a routing table which stores; destinations, next hop addresses and number of hops as well as sequence numbers; routing table updates are sent periodically as incremental dumps limited to a size of 1 packet containing only new information. Each table entry is tagged with a sequence number, which is originated by the Destination node. DSDV protocol requires each mobile node in the network to advertise its own routing table to its current neighbors. The advertisement is done either by broadcasting or by multicasting. By the advertisements, the neighboring nodes can know about any change that has occurred in the network due to the movements of nodes. The routing updates could be sent in two ways: one is called a ''full dump'' and another is ''incremental.'' In case of full dump, the entire routing table is sent to the neighbors, where as in case of incremental update, only the entries that require changes are sent.

**Reactive protocol:**
The reactive or on-demand routing protocols are based on Query-Reply topology in which they do not attempt to continuously maintain the up-to-date topology of the network. Reactive routing protocol is also known as on demand routing protocol. In this protocol route is discovered whenever it is needed Nodes initiate route discovery on demand basis. Source node sees its route cache for the available route from source to destination if the route is not available then it initiates route discovery process. Flooding is a reliable method of disseminating information over the network, however it uses bandwidth and creates network overhead, reactive routing broadcasts routing requests whenever a packet needs routing, this can cause delays in packet transmission as routes are calculated, but features very little control traffic overhead and has typically lower memory usage than proactive alternatives, this increases the scalability of the protocol.

**AODV (**Ad-hoc On-Demand Vector**)**
AODV [10] is basically an improvement of DSDV. But, AODV is a reactive routing protocol instead of proactive. By creating routes based on demand the number of broadcast has been reduced, which are not with the case for DSDV. The On Demand Protocol which is widely accepted in Ad Hoc network is AODV , Proposed by C. E. Perkins and E. M.Royer. Ad hoc On-demand Distance Vector (AODV) [25] is a combination of both DSR and DSDV. It follows the basis on-demand mechanism of Route Discovery and Route Maintenance basis on demand mechanism are followed by AODV. from DSR, with the addition they are using sequence numbers , periodic bacons and hop by hop routing from DSDV. Route Request packet(RREQ) is broadcasted by AODV When any source node wants to send a packet to a end point or destination. The process continues until the packet reaches the destination and in the process the adjacent nodes in turn broadcast the packet to their neighbors or adjacent nodes and the process continues until the packet reaches the end point or destination. During the process of sending the route request or when the route requests are forwarded, the address of the neighbor is recorded by intermediate nodes from which the first copy of the broadcast packet is received. The reverse path can be established because the record is kept or stored in their route tables, If extra copies of the same RREQ are later received, these packets are discarded. The reverse path is followed to send the reply. Route discovery process has been reinitiated when route maintenance or a source node movement takes place. Then the route is reestablished by the source node with the destination using higher layers. AODV does not provide any type of security.

**Hybrid protocol:**
There is a trade-off between proactive and reactive protocols. Proactive protocols provides less latency and large overhead while reactive protocols have less overhead and more latency. So the shortcomings of both proactive and reactive routing protocols are overcome by hybrid protocol or we can say that hybrid protocol is used to overcome the shortcoming of both proactive as well as reactive protocols. Hybrid routing protocol is combination of both proactive and reactive routing protocol. The trouble that has to be faced in case of all hybrid routing protocols is how to establish the network according to network parameters. The more routing information is maintained by the node that is having high level topological information that comes under the common disadvantage of hybrid routing protocols, which leads to more memory and power consumption. Some examples of hybrid protocols are ZRP, SHARP.

**ZRP** (Zone Routing Protocol)
Haas and Pearlman proposed Zone Routing Protocol. ZRP [40] is a hybrid routing protocol for mobile ad hoc networks. In ZRP the nodes are localized in to sub networks called Zones. It incorporates the merits of on-demand and proactive routing protocols. ZRP [21] is appropriate for wide variety of MANETs, particularly they are good for the networks that is having for the networks with large span and diverse mobility patterns. Query control mechanism is used by ZRP to minimize or reduce route query traffic messages. It pointing the query messages external or outward from the query source and away from covered routing zones. A node which belongs to routing zone and received a route query is known as

## III. PERFORMANCE METRICS

Performance Metrics are quantitative measures that can be used to evaluate any MANET routing protocol. We have used following four metrics:

**Average end-to-end delay**
Average End-to-End delay is the average time of the data packet to be successfully transmitted across a MANET from source to destination including buffering time, queuing time at the interface queue, retransmission delay at the MAC (Medium Access Control), the propagation and the transfer time. The average end-to-end delay can be calculated by summing the times taken by all received packets divided by their total numbers. The Average End-to-End Delay should be less for high performance.

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**Packet delivery fraction (PDF)**
PDF can be measured as the ratio of the data packets delivered to the destinations to those generated by the CBR sources. The higher the values give us the better results. This metric characterizes both the completeness and correctness of the routing protocol also reliability of routing protocol by giving its effectiveness.

**Normalize Routing Load (NRL)**
It is the number of transmitted routing packets per delivery data packets.

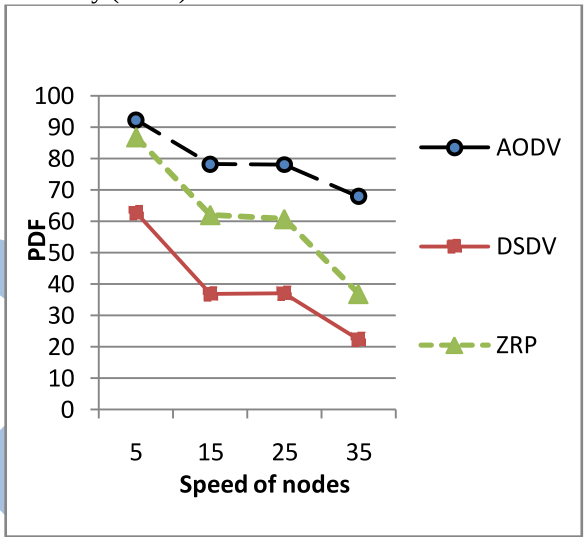
*Simulation Overview*
This section presents the topology and different parameters used in the simulation process. This simulation process considered a wireless network of five static nodes which are placed within a 1000m x 1000m area. CBR (constant bit rate) traffic is generated among the nodes. The simulation runs for 500 Seconds. The simulation was done for varying nodes number and speed.different values are used for speed and number of nodes. For each set of parameters simulation is repeated 10 times and average results are taken. Table shows the important simulation parameters used in the simulation process.

**Table 3.1 Different Parameters and their values**

| Parameters | Values |
|---|---|
| Routing Protocol | DSDV, AODV, ZRP |
| Simulation Time (sec) | 150 |
| Simulation Area | 1000m X 1000m |
| Simulation Model | TwoRayGround |
| Mobility Model | Random Waypoint |
| MAC Type | 802.11 |
| Number of nodes | 10, 30, 50, 70 |
| Pause Time (sec) | 2 |
| Mobility of nodes (m/s) | 5, 15, 25, 35 |
| Packet Size (Kb) | 512 |
| Queue Length | 100 |
| Traffic Type | CBR |
| Link Layer Type | LL |
| Interface Type | Queue/DropTail |
| Maximum number of connections | 50, 100, 150, 200 |
| Data Rate | 0.25 |

*3.1.1 Varying speed of nodes*
Varying the degree of mobility, or the moving speed of each node in the network, is a useful way to test how adjustable a routing protocol is to the dynamic environment. In this model, the node's speed changes from 5 m/s to 35 m/s with constant
pause time of 1 second and number of nodes 30. For ZRP as discussed earlier the most important thing is zone radius. In our simulation environment the zone radius is taken 2 nodes distance.

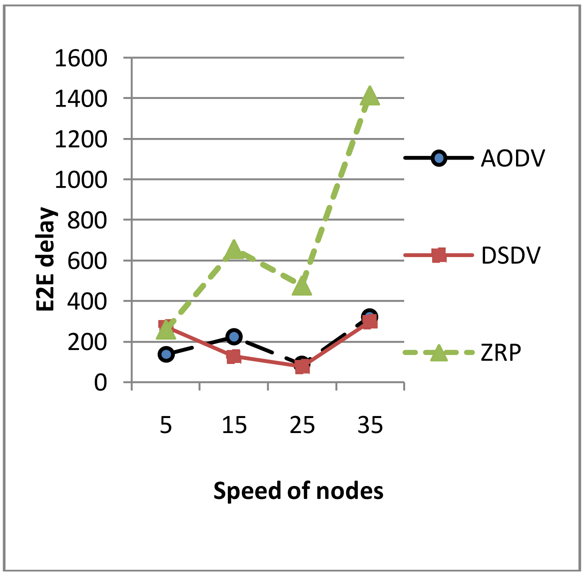
Graph 3.1 shows PDF as function of speed of mobile nodes. The number of dropped packets increases with increasing speed thus performance further degrades and the best routing protocol is AODV. In terms of PDF, DSDV's performance is the worst. AODV performs consistently well with PDF ranging between 92.29 and 67.99 with increasing speed from 5 m/s to 35 m/s. In DSDV, PDF drops from 62.77 to 22.39. ZRP being hybrid shows PDF between AODV and DSDV i.e 86.91 to 37.01. AODV shows highest PDF 92.29 with low mobility (5 m/s).



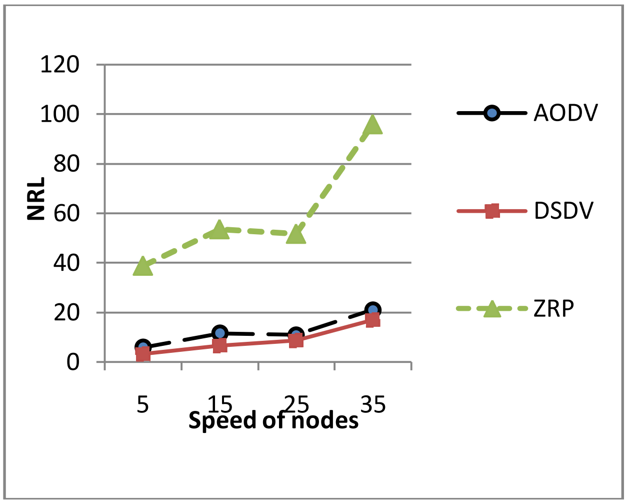

**Graph 3.1 PDF vs Speed of nodes**

In graph 5.2, AODV and ZRP have higher End-to-End delay where as DSDV has less End-to-End delay as it is proactive in nature and routes are always available. As speed of node increases, delay also increases due to more link failures.

Graph 3.3 illustrates routing cost introduced in network. DSDV maintained an average of 6.88 NRL throughout the simulation. As speed increased, routing overhead of AODV also increased and reached up to 24.33. ZRP showed a high routing load. The maximum recorded NRL at high mobility was 146.37.




**Graph 3.2 E2E Delay vs Speed of nodes**

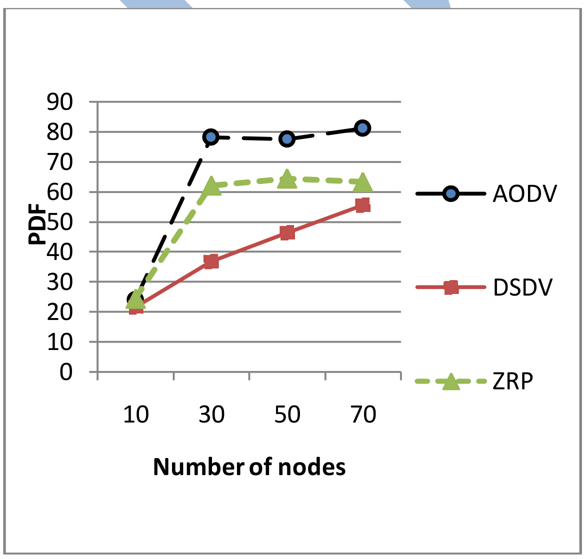



**Graph 3.3 NRL vs Speed of nodes**

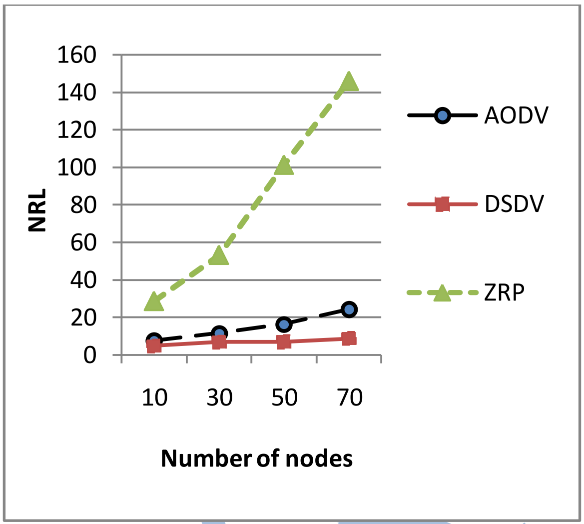
*3.1.2 Varying number of nodes*

The node density has a significant impact on the performance of routing protocols. In general, low density may cause the network to be frequently disconnected and high density increases the contention, resulting in a low per-node throughput. The number of nodes varies from 10 to 70 nodes keeping the rest of the simulation parameters remain unchanged.

Graph 3.5 shows the effect of changing number of nodes on PDF. With larger number of nodes, all protocols perform well even during small pause time 1 seconds and mobility 15 m/s. In terms of packet delivery ratio, when the number of nodes is less, say 10, ZRP performs well. However its performance declines with increased number of nodes due to more traffic in the network. The performance of AODV is better with more number of nodes than in comparison with ZRP so ZRP is not scalable for large networks. The performance of AODV is consistently uniform with increasing number of nodes from 30 to 70. PDF of AODV increases from to 24.14 to 81.21, DSDV increases from 21.69 to 55.57, in ZRP increases from 24.62 to 63.30 as number of nodes rises from 10 to 70 in steps of 20.

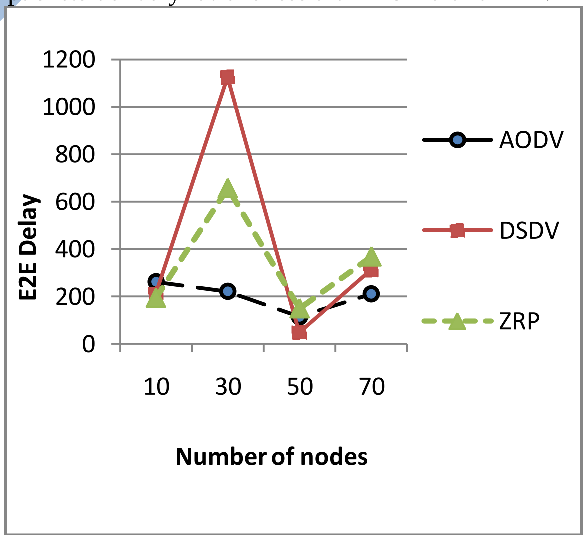



**Graph 3.5 PDF vs Number of nodes**




**Graph 3.6 NRL vs Number of nodes**

Graph 3.6 shows NRL as a function of number of nodes. DSDV protocol has almost constant overhead when the number of nodes increases from 10 to 70. As the number of nodes increases all the routing protocols suffer from heavy routing overhead due to dense topology. When network becomes dense, a general observation is increase in routing overhead. We can see a linear growth in routing traffic of AODV, DSDV and ZRP. However, routing overhead of ZRP is very high. As the nodes increases more routes become available to destinations. Since AODV is reactive protocol and reacts very fast in order to compute routes. Because it uses one active route therefore we can see best delivery fraction of AODV. But establishing routes on demand increases the flooding of RREQ and RREP queries. DSDV on the other hand gives low routing overhead than AODV but packets delivery ratio is less than AODV and ZRP.




**Graph 3.7 E2E Delay vs Number of nodes**

In terms of delay, Graph 5.7, AODV showed slightly consistent performance with an average delay of 0.01s. But delay of AODV varies in between 262.05 ms and 210.25 ms during whole simulation. AODV, on the other hand, gave lowest delay as compared to ZRP and DSDV until network size of 50 nodes. From network size of 50 nodes to 70 nodes, we saw slight increase in delay value of all the three

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protocols. The maximum delay we calculated for DSDV is 1124.60 ms.

## IV. CONCLUSION AND FUTURE SCOPE

In this thesis, we reviewed the performance of routing protocols with respect to performance metrics. AODV performs better compared to other protocols. With increasing the number of nodes throughput also increases. DSDV has low throughput compared to AODV and ZRP. AODV and ZRP have higher average end-to-end delay than DSDV. When speed increases, there is no effect on average end-to-end delay in DSDV. When number of nodes increases, the average end-to-end delay increases due to time consumed in computation of routes. In ZRP, with increase in 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. AODV routing overhead is higher than DSDV, this is because of its periodic Hello messages to maintain active roués, while DSDV makes use of alternative routes that is why its routing overhead is lower than AODV. For ZRP the routing overhead is too high. Our future research will be to study the behaviour of routing protocols with other mobility models in which mobile nodes move together or incorporation of obstacles such as Reference Point Group Mobility (RPGM) model.

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