Performance Analysis of Different Ad hoc Routing Protocols under Different Mobility Conditions

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Submitted by

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CERTIFICATE

I hereby certify that the work which is being presented in this dissertation entitled "**Performance Analysis of Ad hoc Routing Protocols under Different Mobility Conditions**" by me in fulfillment of requirements of the award of degree of Masters of Wireless Communication from Thapar University, Patiala, is an authentic record of my own work carried out under the supervision of Sukhwinder Kumar, Lecturer, ECED and refers other researchers works which are duly listed in the reference section.

The matter presented in this dissertation has not been submitted in any other University/Institute for the award of any other degree.

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It is certified that the above statement made by the student is correct to the best of my knowledge and belief.

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ABSTRACT

A mobile ad hoc network is a collection of wireless nodes, all of which may be mobile, dynamically create a wireless network themselves without using any infrastructure. Ad hoc wireless networks come into being solely by peer-to-peer interactions among their constituent mobile nodes, and it is only such interaction, that are used to provide the necessary control and administrative functions supporting such networks. Each node must be able to function as a router as well to relay packets generated by other nodes. As the nodes move in and out of range with respect to other nodes, including those that are operating as routers, the resulting topology changes must somehow be communicated to all other nodes. The limited bandwidth of wireless channels and their generally hostile transmission characteristics impose additional constraints on how much administrative and control information may be exchanged, and how often.

Ad hoc routing protocols make routing decisions based on individual node mobility even for applications such as disaster recovery, battlefield combat, conference room interaction and collaborative computing etc.

In this thesis, the performance analysis is done for three routing protocols AODV, DSR and DSDV by using three different mobility models on the basis of parameters packet delivery ratio, throughput, end to end delay and normalized routing load. The performance is analyzed into two parts by using NS2 simulator. In first part, for all protocols have a varying number of mobile nodes but with fixed maximum speed of nodes for three mobility models. In second part, number of mobile nodes is fixed with varying speed of mobile nodes for mobility models. The results of simulations shows that random waypoint mobility model is best than others models, and appropriate performance of routing protocol AODV and other protocols in all mobility’s models with different parameters is analyzed.

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ABBREVATIONS

AODV	Ad-hoc On-demand Distance Vector (routing)
DSDV	Destination Sequence Distance Vector (routing)
DSR	Dynamic Source Routing
GPS	Global Positioning System
MAC	Medium Access Control
NS	Network Simulator
RREQ	Rout Request
RREP	Route Reply
RERR	Route Error
TCP	Transmission Control Protocol
RTT	Round Trip Time
NLR	Normalized Routing Load
PDR	Packet Delivery Ratio
E2E	End to End
RPGMM	Reference Point Group Mobility Model
MANET	Mobile Ad hoc Networks
LAN	Local Area Networks
UDP	User Data Protocol
TTL	Time to Live
DSN	Destination Sequence Number
ACK	Acknowledgement
CBR	Constant Bit Rate

CHAPTER 1

INTRODUCTION

1.1 PREMBLE

Wireless network is very popular these days in computing industry. These wireless networks are basically divided into two main classes, infrastructure networks and ad hoc networks. Infrastructure networks are LAN networks, cellular networks and infostation networks. The infrastructure known are access point in LAN, base station in cellular and infostation in infostation networks, and these are connected mutually to backbone network by wires. On the other hand, ad hoc networks are decentralized networks or without any infrastructure. There are no conditions on these nodes to join or leave the network. Thus the network has no essential infrastructure network. Ad hoc networks are of two types; static ad hoc network (SANET) and mobile ad hoc network (MANET).

Wireless ad hoc network understand end to end communication in cooperative manners. In this, multiple nodes are used to form a multi hope route. It is a combination of mobile nodes, each node is equipped with receiver and transmitter. In order to communication in this network, every node acts as a router and a routing protocol is used to find the routes in nodes or in source and destination. Both source and destination are not within range of communication in the network, when communication is required to take place. Intermediate nodes are used for the communication between these two nodes. Nodes can connect to each other randomly and making illogical topologies. Nodes communicate to each other and also forward packets to neighboring nodes as a router. This is a quick remedy for any of the disaster situation. These networks inherit the traditional problems of wireless and mobile communications, like as transmission-quality enhancement, power control, and bandwidth optimization. In addition, their multi hop nature and the possible lack of a fixed infrastructure introduce new research problems such as network configuration, Topology maintenance and device discovery, as well as ad hoc addressing and self-routing. In this thesis, we worked on simulation on ad hoc networking by using traffic source CBR on different protocols and also for different movements of source and destination nodes. This study will help for the research work in future [1]. Commercial implementation of ad hoc networking is possible due to the development of 802.11 technologies.

1.2 MANET (Mobile Ad hoc network)

As mention above ad hoc network is infrastructure less network. Mobile ad hoc networking is referred to as a wireless ad hoc network whose nodes are free to move randomly and mobile nodes can transmit and receive information. Mobile nodes can also acts like a router by forwarding the neighboring traffic to the destination node as the routers are multi hop devices [2]. Due to the self organized network, the mobile nodes in a wireless network range can communicate with each other. The mobile nodes form a network decentralized and infrastructure less automatically. The mobile nodes have transmitter and receiver with smart antennas, and these antennas are making mobile nodes to communicate with each other.

The topology of the network moves all time by getting mobile nodes in and out in the network. Early, MANET was designed for military purpose but now the MANET is used in many fields, e.g. in disaster hit areas, in rescue missions, conferences, data collection in some region and virtual classes. Security in a mobile ad hoc network is very critical and important issue also and many techniques were defined for it. Investigated technique was Intrusion detection. Mobile nodes in the wireless network waste much energy by making a links again and again between nodes. These connection and reconnection make energy limitation in this network. The main purpose of developing the ad hoc routing protocols is to deal with the vibrant nature of MANET. The efficiency can be determined by the battery power consumption. During the participation of nodes in the network an also in routing traffic energy is consumed. The routing protocols as considered vital which adapts to the connection tearing and mending. Such routing protocols are DSDV, AODV, DSR, OLSR, TORA, WRP and TZRP (two zone routing protocol) [3]. Further we will discuss on reactive and proactive routing protocols and in this thesis AODV, DSR and DSDV are taken.

1.3 HISTORY AND DEFINATION OF AD HOC NETWORKS

The concept of mobile ad hoc networking is not a new one and its origins can be traced back to the DARPA Packet Radio Network project in 1972 (Freebersyser & Leiner, 2001). Then, the advantages such as flexibility, mobility, resilience and independence of fixed infrastructure, elicited immediate interest among military, police and rescue agencies in the use of such networks under disorganized or hostile environments. For a long time, ad hoc network research stayed in the realm of the military, and only in the middle of 1990, with the advent of commercial radio technologies, did the wireless research community become aware of the great potential and advantages of mobile ad hoc networks outside the military domain, witnessed by the creation of the Mobile Ad Hoc Networking working group within the IETF (IETF MANET Working Group). In our days because of the emergence of real-time applications and the widespread use of wireless and mobile devices, mobile Ad Hoc networks are receiving attention due to many potential military and civilian applications (Ade & Tijare). Mobile Ad-hoc Networks are a collection of two or more devices equipped with wireless communications and networking capability. These devices can communication with other nodes that immediately within their radio range or one that is outside their radio range. For the later, the nodes should deploy an intermediate node to be the router to route the packet from the source toward the destination (Han, 2004). Furthermore, devices are free to join or leave the network and they may move randomly, possibly resulting in rapid and unpredictable topology changes. In this energy- constrained, dynamic, distributed multi-hop environment, nodes need to organize themselves.

1.4 APPLICATIONS OF MANET

Because of the adaptability and self-configuration of MANET there is a wide range of applications. Mobile ad hoc can be used in natural disasters, virtual issues and conferences also. In other words we can say that mobile ad hoc networks are used in such areas where infrastructure is not possible or not available before. As earthquakes are comes in areas where the fixed infrastructure is destroyed, or in flooded, explosion and fire hit areas MANET can be easily used [3]. The only and key quality that makes MANET ideal is their self-configuration and low cost of deployment.

1.5 REQUIREMENTS OF AD HOC ROUTING PROTOCOLS

In Ad hoc Networking, some of the requirements are required to reach at goal of, to find and maintain routes between nodes in a dynamic topology with possibly unidirectional links, using minimum resources. These requirements are-:

1. Simple, reliable and efficient
2. Distributed but lightweight in nature
3. Quickly adapts to change in topology
4. Protocol reaction to topology changes should result in minimal control overhead
5. Bandwidth efficient
6. Mobility management involving user location and hand-off management

1.6 ADVANTAGES OF MOBILE AD HOC ROUTING

- *Fast installation:* the level of flexibility for setting up MANET is high, since they do not require any previous installation or infrastructure and, thus, they can be brought up and torn down in very short time.
- *Dynamic topologies*: nodes can arbitrarily move around the network and can disappear temporally from the MANET, so the network topology graph can be continuously changing at undetermined speed.
- *Fault tolerance*: owing to the limitations of the radio interfaces and the dynamic topology, MANETs support connection failures, because routing and transmission control protocols are designed to manage these situations.
- *Connectivity*: the use of centralized points or gateways is not necessary for the communication within the MANET, due to the collaboration between nodes in the task of delivering packets.
- *Mobility*: the wireless mobile nodes can move at the same time in different directions. Although the routing algorithms deal with this issue, the performance simulations show that there is a threshold level of node mobility such that protocol operation begins to fail.
- *Cost*: MANETs could be more economical in some cases as they eliminate fixed infrastructure costs and reduce power consumption at mobile nodes.
- *Spectrum reuse possibility*: owing to short communication links (node to-node instead of node to a central base station), radio emission levels could be kept at low level. This increases spectrum reuse possibility or possibility of using unlicensed bands.

1.7 DISADVANTAGES OF MOBILE AD HOC ROUTING

- *Bandwidth constraints*: as commented above, the capacity of the wireless links is always much lower than in the wired counterparts. Indeed, several Gbps are available for wired LAN, while, nowadays, the commercial applications for wireless LANs work typically around 2 Mbps.
- *Processing capability*: most of the nodes of the AND are devices without a powerful CPU. Furthermore, the network tasks such as routing and data transmission cannot consume the power resources of the devices, intended to play any other role, such as sensing functions.
- *Energy constraints*: the power of the batteries is limited in all the devices, which does not allow infinitive operation time for the nodes. Therefore, energy should not be wasted and that is why some energy conserving algorithms have been implemented, PARO and MBCR. A study of the energy saving and capacity improvement potential of power control in multihop wireless networks is done.
- *High latency*: when an energy conserving design has been applied it means that the nodes are sleeping or idle when they do not have to transmit any data. When the data exchange between two nodes goes through nodes that are sleeping, the delay may be higher if the routing algorithm decides that these nodes have to wake up.
- *Transmission errors*: attenuation and interferences are other effects of the wireless links that increase the error rate.
- *Security*: analyses some of the vulnerabilities and attacks MANETs can suffer. The authors divide the possible attacks in passive ones, when the attacker only attempt to discover valuable information by listening to the routing traffic; and active attacks, which occur when the attacker injects arbitrary packets into the network with some proposal like disabling the network. Other security issues such as availability, authenticity, integrity, confidentiality and privacy are discussed.
- *Location*: the addressing is the another problem for the network layer in MANETs, since the information about the location the IP addressing used in

fixed networks offers some facilities for routing that cannot be applied in MANETs. The way of addressing in MANETs, of course, has nothing to do with the position of the node. In a recent proposal on an IPv6-based addressing scheme for MANETs can be seen.

- *Roaming*: the continuous changes in the network connectivity graph involve that the roaming algorithms of the fixed network are not applicable in MANETs, because they are based on the existence of guaranteed paths to some destinations
- *Commercially unavailable*: MANETs are yet far from being deployed on large-scale commercial basis.

1.8 AD HOC ROUTING PROTOCOLS

The concepts of ad hoc routing protocols and the behavior of reactive and proactive routing protocols are discussed below.

1.8.1 Routing

Routing means to find of choose path. Routing in mobile ad hoc network means to choose a right and suitable path from source to destination mobile node. Routing terminology is used in different kinds of networks such as in the internet, electronic data and telephony network. Commonly we are more appreciating about the mobile ad hoc networks. In mobile ad hoc networks routing protocols means that the mobile nodes will search for a route or path to connect to each other and share information or the data packets. Protocols are the set of rules through which two or more mobile nodes can communicate with each other. In mobile ad hoc networks routing is mostly done with the help of routing tables. These tables are reserved in the memory cache of these mobile nodes. When routing process is going on, it route the data packets in different mechanisms. First one is unicast, in which source is directly send the data packets to the destination. Second is multicast, in this source node sends data packets to the specified multiple nodes in the network. The last one is broadcast, in this the source nodes floods the message to all near and far nodes in the network.

1.8.2 Types of Routing

It is basically of two types, static and dynamic routing which are as under.

A. **Static Routing:** this type of routing is done by the administrator manually to forward data packets in the network and it is permanent. Other administrator cannot change its settings [4]. These static routers are configured by administer, which means there is no need to make routing tables by the router itself.
B. **Dynamic Routing**: is automatically done by the choice of router. It can route the traffic on any route depend on the routing table. In dynamic routing, it allows the routers to know about the networks and the interesting thing is to add this information in their routing table. In this routing, the routers exchange the routing information if there is some change in the topology [5]. Exchanging information between dynamic routers study to know about the new routes and network. The dynamic routing is more flexible than static routing, and the dynamic routing have capability to overcome the over load traffic. This type of routing uses different paths to forward the data packets. At the end, dynamic routing is better than the static routing.

1.9 Routing Protocols

There any many types of routing protocols for wireless ad hoc networks. Routing protocols are characterized as reactive and proactive routing protocols [4]. The ad hoc routing protocols which have a properties of both reactive and proactive, is known as hybrid routing protocols. The first one protocol type is called as reactive or on demand routing protocol. The second kind of routing protocol is proactive or table driven routing protocol. In the reactive routing protocols communication is possible on when source node needs to communicate with the destination or other nodes. These MANET protocols are mostly learnt for nodes that transmit data rarely or with a high mobility. These reactive routing protocols are AODV and DSR.

Second type is proactive routing protocols also known as table driven routing protocols. These protocols detect the layout of the network very actively, and routing table can be maintained at each node from which route can v determined with less delay. These routing protocols provide good reliability on the presently available network topology [3]. In these routing protocols low latency for deciding a route. Proactive routing protocol is DSDV.

Ad hoc routing protocol is a standard which controls the decisions of nodes, which route the nodes have to choose from source to destination node. Routing protocols discovers the topology by announcing its presence and listening to broadcasts from other nodes, when node wants to join a network. The routing discovery is performed differently according to the routing protocol algorithm implemented in the network.

1.9.1 Reactive Routing Protocols

Reactive routing protocols are called on-demand routing protocols. In these type of routing protocols routes are build when they need routes. These routes can find by sending route requests through the network. The main disadvantage of this algorithm is that it offers high latency in sending a network. In this thesis AODV, DSR routing protocols are considered based on reactive routing protocols.

1.9.1.1 AODV

AODV is Ad hoc on demand distance vector routing protocol. The algorithm of AODV gives an easy way to get change in the link situation. Consider if link fails notification are sent only to the affected nodes in the network, and these notifications cancels all the routes through this affected node. In this network usage is less because routes are unicast from source to destination. In this protocol routes are build on demand so the network traffic is also less. Extra routing which is not in use is not allowed in AODV [6]. When two nodes wants to establish a connection between them in an ad hoc network then ad hoc on demand distance vector is responsible to enable them to build a multihop route. AODV is loop free because it uses a Destination Sequence Number (DSN) to avoid counting to infinity. Thin one is the characteristic of this algorithm. When source node send a request to a destination node, it sends its DSNs together with all routing information and also selects the most favorable route based on the sequence number [7]. There are basically tree AODV messages i.e. Route Request (RREQ), Route Reply (RREP) and Route Errors (RERR) [8]. With the use of UDP (user datagram protocol) packets, source to destination route is discovered and maintain by these messages. For example the node which request, it will use its IP address as originator

IP address for the message for broadcast. This means the AODV not blindly forward every message. Number of hops of routing message in ad hoc network is determined by time to live (TTL) in the IP header. When the source node wants to make a new route to the destination node, the requesting node broadcast an RREQ message in the network [9]. In Figure1.1, the RREQ message is broadcast from source to destination. The source node broadcasts a RREQ message in the neighboring nodes. When the neighbor node receives the RREQ message, then it creates a reverse route to the source node. The neighbor node is the next hop to the source node. The hop count of the RREQ is incremented by one and then the neighbor node will check if it has an active route to the destination. If it has an active route so it will forward a RREP to the source node. If it does not have an active route to the destination it will broadcast the RREQ message in the network again with an incremented hop count value. In Figure 1.1 procedure for finding the destination node is shown. The RREQ message is flooded in the network in searching for finding the destination node. The intermediate nodes can reply to the RREQ message only if they have the destination node. The intermediate nodes can reply to the RREQ message only if they have the destination sequence number (DSN) equal to or greater than the number contained in the packet of RREQ.

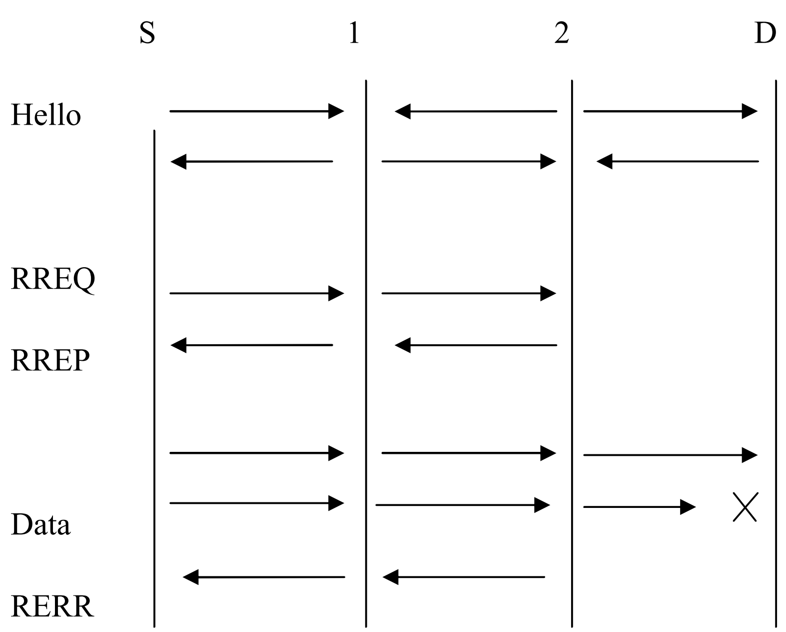

Figure 1.1: Route maintains procedure in MANET using AODV

The intermediate nodes forward the RREQ message to the neighbor nodes and record the address of these nodes in their routing cache. After that, this information will be used to make a reverse path for RREP message from the destination node, as shown in Figure. The destination node replies with RREP message, the RREP reached to the originator of the request. So, this route is only available by unicasting and a RREP back to the source. The nodes receiving these messages are cached from originator of the RREQ to all nodes. When a link is failed an RERR message is generated and this RERR message contains information about nodes that are not reachable.

The IP addresses of all the nodes which are as their next hop to destination. In table all the information about the network is stored in the table. The routing table have these route entries; destination IP address, Destination Sequence Number (DSN), Valid Destination Sequence Number flag, other state and routing flags (e.g. valid, invalid, repairable being repaired), network interface, hop count, next hop and the list of precursors and life time.

1.9.1.2 DSR

DSR is Dynamic Source Routing Protocol. It is a reactive routing protocol and is called on demand routing protocol. DSR is a source routing protocol that is why it is a simple and efficient protocol. This protocol can be used in multi hop wireless ad hoc network [10]. And the network of this protocol is totally self-organizing and self-configure. The protocol is just the combination of two mechanisms that are route discovery and route maintenance. This protocol regularly updates its route for the sake of new available trouble-free routes. When some new available routes were found the node will directs the packet to that route. Then the packet has to know about the route was set in the packet to reach its destination from its sender. The whole information was kept in the packet to avoid periodic findings it has the capability to find out its route by this way. It has two basic mechanisms for its operation i.e. Route request (RREQ) and route reply (RREP). In Fig 1.2 shows the route discovery procedure. Here we take a four nodes; source node S, intermediate nodes 1, 2 and destination node D. When a node wishes to send a message to a destination node, then node broadcastsor flood the RREQ packets in the network. In the broadcast range all the neighbor nodes receive this RREQ message and add their own address and again rebroadcast. If this RREQ message reached to the destination, so this is the route to the destination node. In the case if the message did not reached to the destination then the node which received the RREQ packet will look that previously a route used for the destination node or not. Every node maintains its route cache for the discovered route which is kept in the memory. Before rebroadcasting the RREQ message the node will check its route cache for the desired destination. Every node in the network by maintaining the route cache at, it reduces the memory overhead which is generated by the route discovery procedure in DSR. If a route is found in that node route cache then it will not rebroadcast the RREQ in the network, it will forward the RREQ message to the destination. The first message reached to the destination has full information about the route from source to destination. That node will send a RREP packet to the sender having complete route information. This route is considered the shortest path taken by the RREQ packet. The source node now has complete information about the route in its route cache and can starts routing of packets (DP) on the discovered route; if it didn't discover the route from first neighbor node to destination node so it forwards the message RREQ to the next neighbor node and store the route in the cache. The process is going on until the RREQ message reached to destination node. The destination node caches the routes in its memory and sends a RREP message to the source nodes.

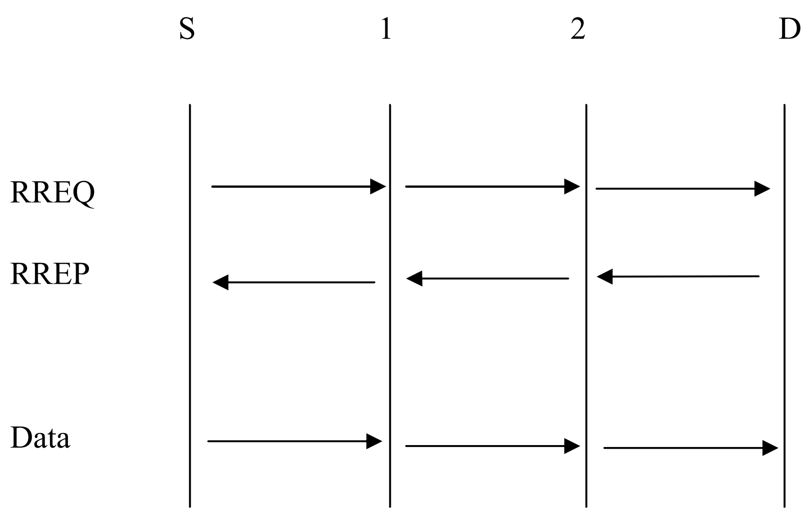

Figure 1.2: Route discovery procedure in MANET using DSR

The next mechanism is the route maintenance. The route maintenance uses two types of message; one is route error (RERR) and second is acknowledgement (ACK). If the messages successfully received by the destination nodes send an acknowledgement ACK to the sender. So the packets transmitted successfully to the next neighbor nodes gets acknowledgement, if there is some problem in the communication network a route error message denoted by RERR is transmitted to the sender, that there is some problem in the transmission. In other words we can say that, the source didn't receive the ACK packet due to some problem. Due to this, the source gets the RERR packet in order to re initiate a new route discovery. After receiving the RERR message the nodes remove the route entries. In Figure1.3 four nodes are shown i.e. Source node S, intermediate nodes 1, 2 and destination node D. The source node sends a message to destination node. The message goes on up to the neighboring node, while receiving the ACK message up to neighboring node. When the next neighboring node forward the RREQ message to the destination node and it does not receive the ACK message from destination node. The node recognizes that there is some problem in the transmission. So the next neighboring node sends a RRER message to the source node, which in return searches for a new route to the destination node D.

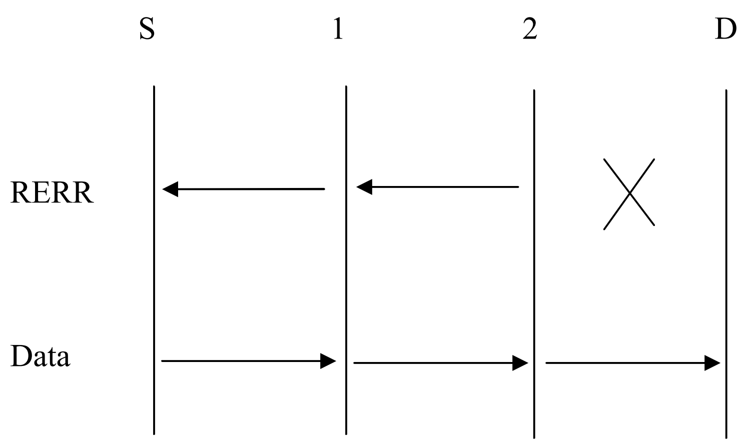

Figure 1.3: Route maintenance procedure in MANET using DSR

1.9.2 Proactive Routing Protocols

Proactive Routing protocols are also known as a table driven routing protocols. The routing information about all the nodes is build and maintained by the proactive protocols and these are independent of whether or not the route is needed [11]. Control messages are transmitted with periodically intervals. Whenever there is no data flow still control messages are transmitted. Due to these control messages proactive routing protocols are not bandwidth efficient. The proactive routing protocols have many advantages and disadvantages. One of its advantages is that the nodes can easily get routing information, and it easily starts a session. Other side disadvantages are, too much data kept by the nodes for route maintenance, when there is a particular link failure its reform is too slow.

1.9.2.1 DSDV

DSDV [12] is Distance vector routing protocol and it is based on Bellman-Ford routing algorithm. It is a proactive routing protocol. It is a hop-by-hop distance vector routing protocol that in each node has a routing table that for all reachable destinations stores the next-hop and number of hops for that destination. DSDV assumes a bidirectional links and thus does not have a unidirectional links. Like distance-vector, DSDV requires that each node periodically broadcast routing updates. The advantage with DSDV over traditional distance vector protocols is that DSDV guarantees loop-freedom. To guarantee loop-freedom DSDV uses a sequence numbers to tag each route. The sequence number shows the freshness of a route and routes with higher sequence numbers are favorable. A route R is considered more favorable than R' if R has a greater sequence number or, if the routes have the same sequence number but R has lower hop-count. The sequence number is increased when a node A detects that a route to a destination D has broken. So the next time node A advertises its routes, it will advertise the route to D with an infinite hop-count and a sequence number that is larger than before. DSDV basically is distance vector with small adjustments to make it better suited for ad-hoc networks. These adjustments consist of triggered updates that will take care of topology changes in the time between broadcasts. To reduce the amount of information in these packets there are two types of update messages defined: full and incremental dump. The full dump carries all available routing information and the incremental dump that only carries the information that has changed since the last dump.

Because DSDV is dependent on periodic broadcasts it needs some time to converge before a route can be used. This converge time can probably be considered negligible in a static wired network, where the topology is not changing so frequently. In an ad-hoc network on the other hand, where the topology is expected to be very dynamic, this converge time will probably mean a lot of dropped packets before a valid route is detected. The periodic broadcasts also add a large amount of overhead into the network.

1.10 Mobility Models

The mobility model is designed to describe the movement pattern of mobile users, and how their location, velocity and acceleration change over time. Since mobility patterns may play a significant role in determining the protocol performance, it is desirable for mobility models to emulate the movement pattern of targeted real life applications in a reasonable way. Figure 1.4 shows the classification of mobility model.

Mobility model is classified into entity mobility and group mobility. In this thesis three mobility models are used, random way point mobility model, column mobility model and reference point group mobility model. Random way point mobility models come under the entity mobility model and other two come in group mobility model. These mobility models are described below:

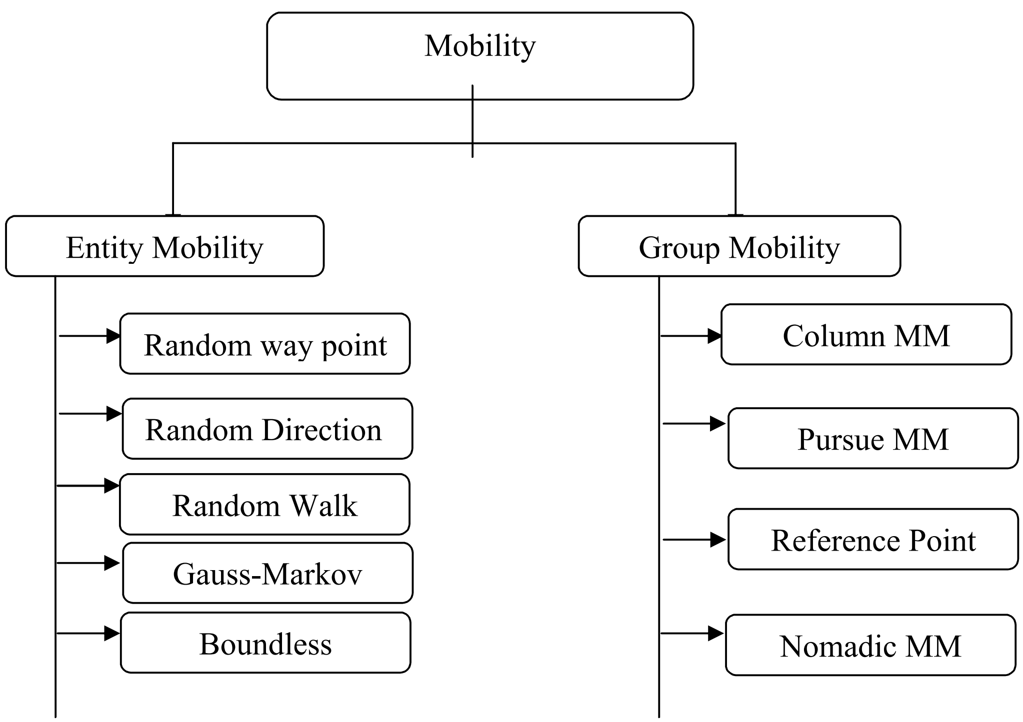

Figure 1.4: Classification of Mobility Models

1.10.1 Random way point mobility model

Random way point mobility model used by Johnson [13] and Lee [14] includes pause times between changes in speed and direction. In random based mobility models, the mobile nodes are set free to move randomly in any direction within the simulation area. In other words, we can say that a node is free to select its destination, speed and direction independent of neighboring nodes, as shown in Fig 1.5. Random way point mobility model is the model that is widely used and analyzed in simulation of ad hoc routing protocols because of its simplicity and availability. This model was first proposed by Johnson and Maltz [15]. In the starting of simulation each mobile node waits for a specified time known as a pause time 't' and randomly select its one location. A mobile node choose a random destination after staying at its previous position for a time period of 't' till its expiry. A node travels across the area at t a random speed distributed uniformly from minimum velocity to maximum velocity. This process of choosing random directional destination at random velocity is repeated again and again until the simulation is finished. If maximum velocity is less and the time 't' is long then the network is stable otherwise it is dynamic. When time period 't' equals to zero then it becomes a continues mobility. This continues mobility is known as random walk mobility model.

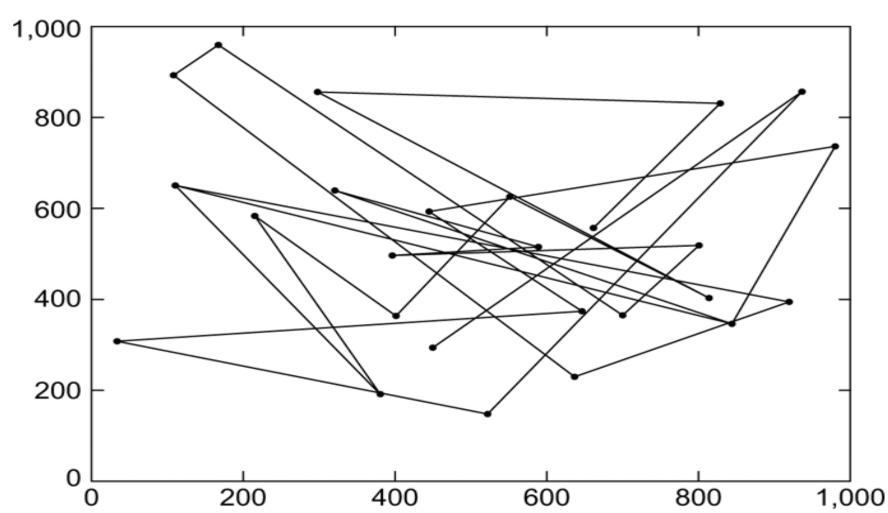

Figure 1.5: Random way point mobility model

1.10.2 Column mobility model

The Column Mobility Model proves useful for scanning or searching purposes [16]. This model represents a set of mobile nodes that move around a given line or column, which is moving in a forward direction (e.g., a row of soldiers marching together towards their enemy). A slight medication of the Column Mobility Model allows the individual mobile nodes to follow one another. For the implementation of this model, an initial reference grid (forming a column of mobile nodes [17]. Each mobile node is then placed in relation to its reference point in the reference grid; the mobile node is then allowed to move randomly around its reference point via an entity mobility model. The new reference point for a given mobile node is defined as:

new reference point =old reference point +advance vector

Where *old reference point* is the mobile nodes previous reference point and *advance vector* is a predefined offset that moves the reference grid. The predefined offset that moves the reference grid is calculated via a random distance and a random angle (between 0 and 180^0since movement is in a forward direction only). Since the same predefined offset is used for all MNs, the reference grid is a 1-D line. Figure 1.6 gives an illustration of four mobile nodes

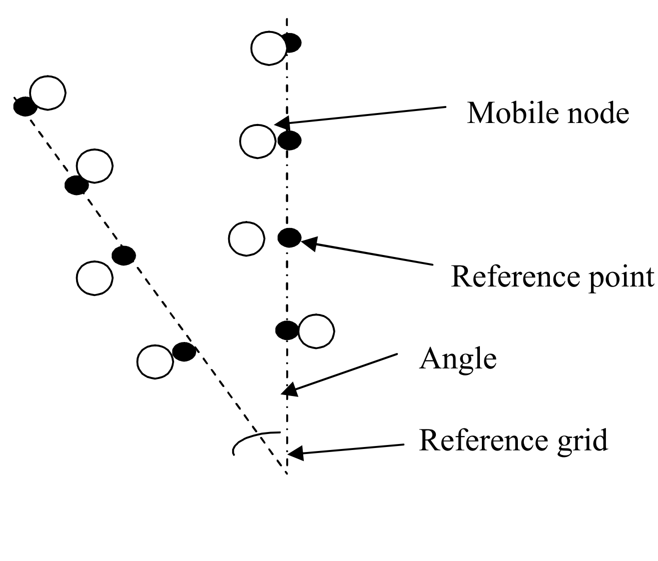

Figure 1.6: Column mobility model

moving in the Column Mobility Model. As shown, the mobile nodes roam closely around their respective reference points. When the reference grid, the mobile nodes follow the grid and then continue to roam around their respective reference points. One group in the figure is using the original Column Mobility Model, where the MNs move perpendicular to the direction of movement. The second group is using the modified Column Mobility Model, where the mobile nodes move parallel to the direction of movement.

1.10.3 Reference Point Group Mobility Model

The Reference Point Group Mobility model represents the random motion of a group of mobile nodes as well as the random motion of each individual mobile node within the group [18]. Group movements are based upon the path traveled by a logical center for the group. The logical center for the group is used to calculate group motion via a group motion vector, *GM*. The motion of the group center completely characterizes the movement of its corresponding group of mobile nodes, including their direction and speed. Individual mobile nodes randomly move about their own predefined reference points, whose movements depend on the group movement. As the individual reference points move from time t to $t+1$, their locations are updated according to the group's logical center. Once the updated reference points, $RP(t+1)$, are calculated, they are combined with a random motion vector, *RM*, to represent the random motion of each mobile node about its individual reference point. Figure1.7 gives an illustration of three mobile nodes moving with the RPGM model. The figure illustrates that, at time t, three black dots exist to represent the reference points, $RP(t)$, for the three mobile nodes. As shown, the RPGM model uses a group motion vector *GM* may be randomly chosen or predefined. The new position for each mobile node is then calculated by summing a random motion vector, *RM* is uniformly distributed within a specified radius centered at $RP(t+1)$and its direction is uniformly distributed between 0 and 360^0. Movement patterns using the RPGM model are shown in Figure1.8. Three mobile nodes moving together as in one group and the total five groups moving, such that each group has a different number of mobile nodes. Both the movement of the logical center for each group, and the random motion of each individual mobile node within the group, is implemented via the Random Waypoint Mobility Model. One difference is that individual mobile node never using pause times while the group is in movement. Pause times are only used when the group reference point reaches a destination and all group nodes pause for the same period of time. The RPGM model was designed to depict scenarios such as an avalanche rescue. During an avalanche rescue, the responding team consisting of human and canine members work cooperatively. The human guides tend to set a general path for the dogs to follow, since they usually know the approximate location of victims. The dogs each create their own “random” paths around the general area chosen by their human counterparts. The RPGM model was originally defined in [18] and then used in [19]. If appropriate group paths are chosen, along with proper initial locations for various groups, many different mobility applications may be represented with the RPGM model. In [18], three applications for the RPGM model are defined. First, the In-place Mobility Model partitions a given geographical area such that each subset of the original area is assigned to a specific group; the specified group then operates only within that geographic subset.

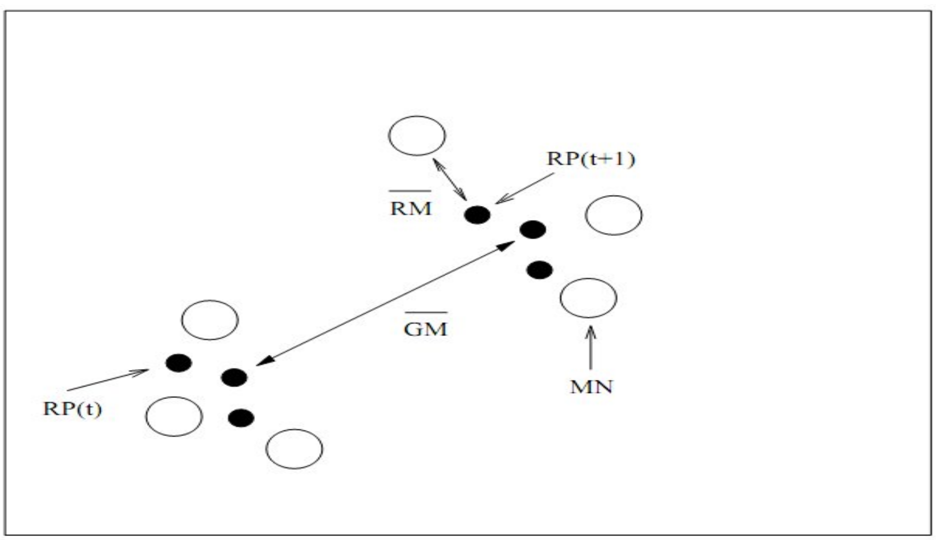

Figure 1.7: Movements of three MNs using the RPGM model

Second, the Overlap Mobility Model simulates several different groups, each of which has a different purpose, working in the same geographic region; each group within this model may have different characteristics than other groups within the same geographical boundary. For example, in disaster recovery of a geographical area, one might encounter a rescue personnel team, a medical team, and a psychologist team, each of which have unique traveling patterns, speeds, and behaviors. Lastly, the Convention Mobility Model divides a given area into smaller subsets and allows the groups to move in a similar pattern throughout each subset. Similar to the Overlap Mobility Model, some groups in the Convention Mobility Model may travel faster than others same as column mobility model which is described on the base of reference point group mobility model.

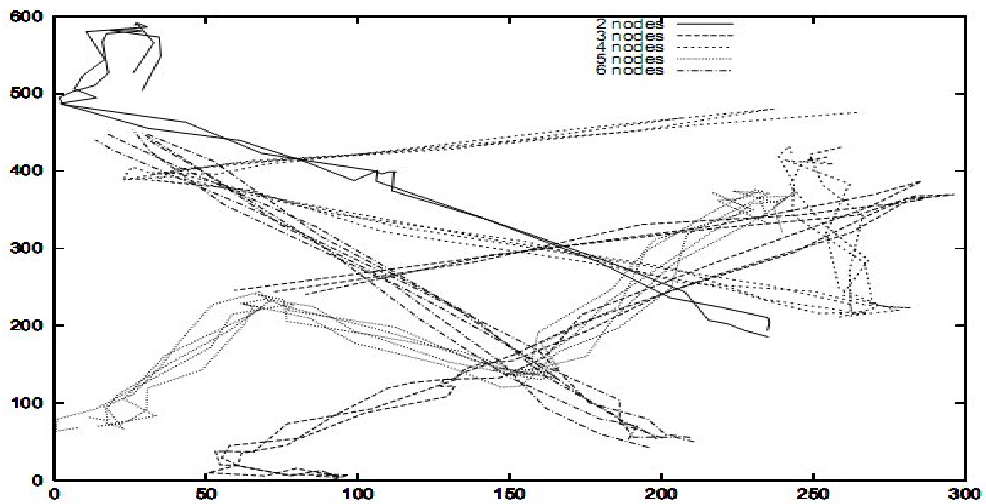

Figure 1.8: Traveling pattern of five groups using the RPGM model

CHAPTER 2

LITERATUREREVIEW

This chapter gives the overview of the work which has been done by:

Saleem *et al.* evaluated the performance of four prominent ad hoc routing algorithms: DSDV, DSR, AODV-LL (AODV-link layer) to model the most widely-used performance metric of wireless ad hoc routing algorithms namely, routing overhead. They derive a model for the overhead routing and apply on all these protocols. It gives generic expression. In an attempt to quickly discover a route, reactive protocols completely or partially flood RREQs in a network. Because, depending on the routing scheme being used, the neighboring nodes may or may not forward the RREQs, tracking this flooding pattern is complicated. In this section, first modeling of the routing overhead of reactive routing protocols as a function of expected forward degree which is later extended to proactive routing algorithms as well [20]. First they describe Generic Routing Overhead Model in Terms of Expected Forward Degree and find the expected routing overhead, the routing overhead increases with an increase in path length between given (source, destination) pair. Routing overhead model of DSR is same as AODV-LL. Overhead routing in DSDV is different than last model, in DSDV nodes only broadcast their routing table entries to their neighbors. The routing overhead of DSDV approximately remains constant with little variation under dynamic conditions. **Lakshmikanth** *et al.* compared the Performance Analysis of Ad hoc Routing Protocols DSDV, AODV and DSR. The performance measures of two parameters, packet delivery ratio (PDR) and average end-to-end delay (AED) for best effort traffic. The normalized routing load (NRL) is used to evaluate the efficiency of the routing protocol while the normalized MAC load is a measure of the effective utilization of the wireless medium for data traffic. After dividing the 41 scenarios in four parts, and get the graphs. All of the procedure shows different results. The performance of routing protocols is most affected by the Number of Nodes. By increasing the Maximum Speed of the Mobile Nodes the Packet Delivery Ratio is not much affected but the Normalized Routine Load and Average End to End Delay is not stable at all. As the pause time is increased the time that a node will be mobile is decreased and hence decreasing the Normalized Routing Load. When the transmission power of the node is increased, transmission range is increased. But when the transmission range is increased interference between the nodes increases due to that, simultaneous transmissions of the node decreases and the packet droppings increase. AODV and DSR performs better than DSDV, because it is a table driven protocol and it consumes more power and packet handling rate is less [21]. But there is no significant difference between AODV and DSR in terms of packet delivery ratio. The performance of DSR was very good at all mobility rates and movement speeds, even though its use of source routing increases the number of routing overhead bytes required by the protocol. AODV performs almost as well as DSR at all mobility rates and movement speeds and accomplishes its goal of eliminating source routing overhead. Other side, it still requires the transmission of many routing overhead packets and at high rates of node mobility is actually more expensive than DSR. Finally, AODV and DSR performance is better than DSDV when transmission power is increased. At higher transmission powers AODV routing load is increased.

Lee *et al.* studied the simulation and performance study on some routing protocols (DSR, ABR) for ad hoc networking. And evaluate the performance of traditional table-driven routing algorithm in multi hop wireless networks. After comparing with ABR and DBF they shows DSR is on demand protocol, its Routing metric is shortest path, none periodic message and loop free.ABR and DSR has less overhead then DBF. When topology changes sending routes updates result in excessive control message overhead which is not acceptable to wireless environment with low BW. So, that DSR has less overhead than ABR when network is in static. In case of throughput comparison DBF has very low performance then other.ABR has higher throughput then DSR. In DSR a route is chosen based on the shortest delay at the instance of route establishment. Although this path may be the best route at that instant, it may be a route that lacks routing stability or has unacceptably high load [22]. End to end delay of DSR is at middle like throughput. ABR has very low end to end delay and DBF has very high end to end delay then DSR. DBF incurs extensive bandwidth and computation overhead in the presence of mobility, yielding inferior performance to on-demand routing protocols (ABR and DSR) in ad hoc networks. We also report that ABR has better throughput, smaller delay, and lower control overhead than DSR. At the end, ABR is a strong candidate for the multi hop mobile wireless environment along with DSR.

Tomar *et al.* proposed an algorithm to overcome flooding problem in the network. It is proposed to minimize the number of packets within the network and this reduces the routing Packet overhead. After simulating, they found DSR and AODV perform well and delivered ninety five percent of data packets regardless mobility rate, but DSDV fails to converge. When the overhead of DSR and AODV drops then mobility rate drops [23]. The performance of DSDV is good at low mobility rate and at low movement speed, but when mobility increases its performance degrades. DSR performance is very good at all mobility rate and movement speed, but it required high routing overhead bytes DSR performance is very good at all mobility rate and movement speed, but it required high routing overhead bytes but it still requires the transmission of many routing overhead packets and at high rate of node mobility is more expensive than DSR. In this paper, network is improved in terms of throughput and delivery rate. **Putta** *et al.* studied the performance analysis of reactive protocols AODV, DSR and proactive protocol OLSR. Comparative study will be presented with number of networking context consideration and the results show the appropriate routing protocol for two kinds of communication services (data and voice).All studied routing protocols perform identically but when the traffic load increases, OLSR performs better for delay. However, routing load is higher because it periodically sends routing packets in order to maintain the routing table up-to-date [24]. DSR seems to produce higher percentage of data packets for ftp sources even if it produces higher delay. Also observe packet delivery ratio higher compared to CBR sources because ftp uses TCP protocol which insures packets retransmission when dropped. The proactive protocol (OLSR) offers better performances for CBR (Constant Bit Rate) sources then AODV, DSR. There is no clear winner among DSR and AODV since routing load and delay are quite identical.

Reddy *et al.* compared the performance analysis of the different routing protocols (DSDV, DSR, AODV and TORA) using ns2 simulation. In this paper, comparison of the protocols by using a simulation by taking the five merits: Throughput, Routing overhead, Path optimality, Packets lost, Average Delay. The results of the simulation of different protocols are shown by graphs. The simulation results bring out some important characteristic differences between the routing protocols. There is a little difference in throughput of AODV and DSDV. DSR outperforms all the protocols as far as throughput is concerned. DSR, AODV, and TORA show little performance variation as the mobility increases but the impact of mobility on DSDV is significant and the performance of DSDV decreases drastically with increase in mobility. The overhead of AODV decreases as the mobility decreases. The overhead of DSDV and DSR is negligible. The routing overhead introduced by TORA is significant and indicates poor utilization of the available bandwidth. According to this paper DSDV drops more number of packets than any other protocol. The average delay introduced by AODV is very less similar in case of DADV [25]. TORA introduces spikes in delay of packets. The path optimality characteristic of DSDV is significantly better than other protocols. DSR has similar characteristic. In this paper, proactive routing protocol DSDV performance is poor indicating that it is not suitable for ad hoc networks.DSR is better than all other protocols. TORA's performance is not stable particularly due to short-lived loops. There is only slight variation in performance between AODV and DSR. **Kalia** *et al.* analyzed the performance of ad hoc routing protocols AODV, DSDV and DSR. Increase in the density of nodes yields to an increase in the mean End-to-End delay but Increase in the pause time leads to a decrease in the mean End-to-End delay [26]. AODV has the best in end to end delay and throughput performance.DSR and AODV drop a considerable number of packets during the route discovery phase. Buffering of data packets while route discovery in growth, has a great probable of improving DSR, AODV and DSDV performances. AODV has a little lower packet delivery performance than DSR. It has an improvement of DSR and DSDV. DSR is suitable for networks with moderate mobility rate and has low overhead that makes it suitable for low bandwidth and low power network. DSDV is suitable for large mobile networks having dense population of nodes. The major benefit is its excel-lent support for multiple routes and multicasting.

Kapang *et al.* analyzed the performance of ad hoc routing protocols DSDV, AODV, DSR and TORA.AODV have the best overall performance [27]. DSR and DSDV drop a considerable number of packets during the route discovery phase but TORA can be quite sensitive to the loss of routing packets compared to the other protocols. While route discovery in progress, has a great potential of improving DSR, AODV and TORA performance but AODV has a slightly lower packet delivery than DSR because of higher drop rates. In case of Delay AODV and DSR have poor characteristics for a short period of time. DSR Route Discovery is fast, therefore shows a better delay performance than the other reactive protocols For over head ,packet overhead and the byte overhead of DSR are less than a quarter of AODV's overhead but TORA shows a better performance for large networks with low mobility rate. It shows that AODV has the best all round performance. DSR is suitable for networks with moderate mobility rate. **Tamilarasan** compared the study of multi hop wireless ad hoc network routing protocols of MANET. He studied the logical survey on routing protocols AODV, DSR and TORA. In this study, TORA performs buffer at high mobility but in other cases throughput is lower. AODV protocols have the overall better performance. Other side, DSR and DSDV drop the considerable number of packets during the route discovery. The route achievement takes a time relative to the distance between the source and destination. Packet drops are less in proactive routing protocols as alternate routing table entries can always be assigned in reply for to link breakdown. The ad hoc routing protocol TORA is quite sensitive to the loss of the routing packets than the other routing protocols. When routing discovery is in progress, buffering of data packets has a great latent of improving the performance of AODV, DSR and TORA. AODV has lower packet delivery performance than DSR, because of higher drop rates. It uses route expiry, dropping some packets when a route expires and new route must be found. AODV has a little better performance in case of delay and can possibly do even better with some fine-turning of this time out period by making it a function of node mobility. Because of the loss of distance data packets with progress, TORA has worst characteristics of delay, and route construction may not occur quickly in TORA. On the other side, route discovery is very fast in DSR, so it has a better performance in case of delay than other reactive routing protocols at low pause time with high mobility. In DSR if traffic is high then control messages get loss, then its start working opposite to its advantage of fast new route establishing. DSR outperforms without any periodic hello messages than other protocols in terms of overheads. AODV has a quarter high over heads then the DSR's packet overhead and the byte over heads. At the end DSR perform better due to the optimization possible by virtue of source routing. Performance of TORA is not very competitive with the on demand and distance vector routing protocols. At last he concluded that, when the density of nodes increases then end to end delay also increases [28]. Increases in the pause time leads to fall in end to end delay. Mean time for loop detection increases if the number of nodes is increases. AODV has best all over performance. DSR is good for network with a moderate mobility rate, and it has a lower over heads that makes it suitable for less bandwidth and low power network. For large mobile network TORA is good like in dense population of nodes. The main benefit is its excellent support for multicasting and multiple routes.

Vijaya *et al.* studied AODV, DSR and DSDV and analyze the performance and characterized by mobility, load and size, throughput, delivery ratio, and end-to-end delay. They analyze that, DSDV has the poorest throughput due to dealing with mobility and DSR is superior for low loads with small number of nodes and AODV is better at higher loads. The highest amount of routing traffic is sent by AODV is followed by DSR and lastly by DSDV. The reason for incurring less overhead is that it sends the routing traffic only when it has data to transmit. This in turn eliminates the need to send unnecessary routing traffic. The routing protocol AODV has routing overhead little higher than DSR because of multiple route replies to a single route request. AODV and DSR use reactive approach to route discovery, but with different mechanism [29]. DSR generates lower overhead than AODV while DSDV generates almost constant overhead due to proactive nature. In DSDV, high mobility results in frequent link failures and the overhead involved in updating all the nodes with new routing information compared to DSR and AODV, where the routes are made and when required. In DSDV, high mobility results in frequent link failures and the overhead involved in updating all the nodes with new routing information compared to AODV and DSR, where the routes are created as and when required. **Khan** *et al.* studied and compared the performance of three routing protocols AODV, DSR and DSDV based on varying number of nodes in the ad hoc network. In terms of packet delivery ratio, DSR performs well when the number of nodes is less as the load will be less otherwise performance will declines. DSDV perform better with more number of nodes than in comparison with the other two protocols [30]. The performance of AODV is consistently uniform and for the average end-to-end delay, the performance of DSR and AODV are almost uniform. The performance of DSDV is degrading due to increase in the number of nodes the load of exchange of routing tables becomes high and the frequency of exchange also increases due to the mobility of nodes. Routing overhead performance of DSR and AODV is almost the consistent. DSDV is again degrading. It indicates that the performance of the two on demand protocols namely DSR and AODV is superior to the DSDV.

Gupta *et al.* studied the comparison of AODV, TORA and OLSR routing protocols of MANET. Protocols are compared based on the performance metrics like packet delivery fraction, throughput and end to end delay. In this study, mobile ad ho c network has the ability to deploy a network where a traditional network infrastructure environment cannot possibly be deployed [31]. With the importance of MANET comparative to its vast potential it has still many challenges left in order to overcome. Performance comparison of routing protocol in MANET is one of the important aspects. In this paper, the behavior and different performance matrices for MANETs using different protocols. (AODV, OLSR and TORA) are analyzed and compared their performance matrices, like End to end delay, Packet delivery Fraction and Throughput For Throughput and PDF, AODV behaving the best and for End to End delay is concern TORA is taking less delay. **Khiavi** *et al.* evaluated the performance of ad hoc routing protocols AODV, DSDV, DSR and TORA to determine the best operational conditions for each protocol. They use NS-2 simulator to analyze these protocols and show that how pause time and number of nodes effect their performance [32]. Performance of these protocols is measured on the basis of packet delivery ratio, system life time, network life time, routing overheads and end to end delay. They evaluation performance of four commonly used mobile ad hoc routing protocols namely AODV, DSDV, DSR and TORA. By using simulation results we can understand that DSDV gives better performance in wide range of simulation conditions. When performance is based on the pause time, in case of packet delivery ratio DSR has a better performance. In case of network life time and system life time DSDV has a better performance, but is case of end to end delay AODV, DSDV and DSR have a relative performance. Other side, for routing overheads DSDV performs better. When we take a function of number of nodes, over heads increases with increases in number of nodes. DSR has better packet delivery ratio and in overall DSDV has better performance. TORA has low performance in our simulation network has middle dynamic. AODV and DSR have middle performance.

Kumar *et al.* gave the overview of these routing protocols as well as the characteristics and functionality of these routing protocols along with their pros and cons. They compare the performance of routing protocols AODV, DSDV, DSR and CBRP. These protocols are compared on the basis of various parameters such throughput, delay and packet delivery ratio. If the mobility increases AODV gives maximum throughput, DSR, DSDV and CBRP throughput is decreased with the increase in node speed. If the speed of node is increases, average delay of AODV decreases while in other protocols average delay increases with the increases in the node speed. That means packet delivery takes the less time as the node speed increases in AODV. The packet delivery ratio of AODV and DSDV decreases while it increases in DSR and CBRP [33]. Packet delivery ratio is better in CBRP. At the end AODV perform better than others in terms of throughput and average delay while CBRP is proved to be better in terms of packet delivery ratio. Performance of AODV is better in allover. **Morshed** *et al*. compared the performance of DSDV and AODV routing protocol. AODV transmission throughput is better than DSDV is describes in different sending and receiving times. Delay is increasing in terms of AODV because of the distance between sending and receiving nodes [34]. DSDV has less delay but later on increased because DSDV performs well under low node mobility. In AODV delay decreases when the source and destination nodes close to each other while having free channel and minimum traffic. Beside this, delay increases for DSDV because of high node mobility. In AODV initially high jitter and after a certain time interval low jitter value appears. And in the beginning DSDV has very low jitter rate and after situation remained unstable.

Dalal *et al.* compared the AODV and DSR performance, AODV although is an On-Demand routing protocol yet it maintains routing tables. It has features of both table driven and reactive routing protocol. It has only one entry per source/destination pair, so it has to resort to route discovery more often than DSR. DSR do not make use of any routing tables. Instead it can have more than one route per source/destination pair. It makes complete use of source routing, that means the source or the initiator of the data packet has to determine the complete hop by hop route to the destination [35]. Due to the availability of many alternate routes it has to resort to route discovery less often than AODV.DSR has high end to end delay then AODV and average throughput is also less than AODV. So, the performance of AODV is best. **Mahmoud** *et al.* compare the performance between two routing algorithms AODV and DSDV [36]. Throughput of AODV decreases as speed increases. AODV uses flooding for route Discovery which makes the throughput decrease as the number of nodes increases but in DSDV protocol throughput decreases as speed increases. DSDV generates much more routing traffic than its counterpart, AODV. This is due to the fact that DSDV periodically generates routing traffic as opposed to the on demand nature of AODV and it is not as affected by speed increase as DSDV. However, DSDV perfectly scales to a small network with low node speeds. In this case, the simplicity of DSDV is preferred over the other more complex techniques without sacrificing the performance.

Zou *et al.* presented a comprehensive review for routing features and techniques in wireless ad hoc networks. For different type of typical existing routing protocols, and compare their properties according to different criteria, and categorize them according to their routing strategies and relationships. There are different criteria for designing and classifying routing protocols for wireless ad hoc networks. For example, what routing information is exchanged; when and how the routing information is exchanged, when and how routes are computed and so on. In this paper they identify various techniques used for classifying routing protocols for wireless ad hoc networks and examine qualitative comparisons of their characteristics and categorizing them according to their routing strategies and relationships [37]. Here, they compare fifteen typical routing protocols according to different criteria introduced. These protocols are: DSDV, DSR, AODV, WRP etc. They compare these protocols based on Stored Information, Update Period, Update Information, Update Destination, Update Method, Route Computation, Structure, Routes, Source Routing, RRM, and BR and made a table of all. But there are still many challenges facing wireless ad hoc networks. However, because of their inherent advantages, wireless ad hoc networks are becoming more and more prevalent in the world. **Tuteja** *et al.* analyzed the comparative performance of AODV, DSDV and DSR by using NS 2.34 simulator. They analyze the performance of protocols includes the matrix packet delivery ratio, throughput, end to end delay and routing overhead. Protocols are compared in this analysis when the packet size changes, time interval between packet sending changes and when mobility of nodes is also changing. From results they analyze that performance of DSDV protocol is not good as throughput is very low and routing load is very high as compared to AODV and DSR protocols. The number of packet received in AODV is decreasing with increases in packet size so the packet delivery ratio is also decreasing. Average delay between packet sending is also decreasing with increasing packet size. Throughput also decreasing with increasing packet size or the performance of AODV protocol decreases with the increasing packet size. Packet delivery ratio of DSR is falling with rising packet size. Other side, end to end delay is also decreasing with the growing of packet size [38]. So, AODV performed good in some situations than DSR protocol but overall DSR is performing better than AODV protocol like if we compare average end to end delay. There is no effect on the performance of DSDV protocol if packet size varies. AODV and DSR protocols perform better at less packet size. Performance of these three protocols decreases as mobility of nodes increases.

Kumar *et al.* analyzed the performance of routing protocols AODV, DSDV, OLSR and TORA by using a simulator NS2. These routing protocols are compared based on the results of different parameters such as throughput, control overhead, packet delivery ratio and end to end delay [39]. It is concluded that DSR protocol is the best in terms of average packet delivery ratio. For high mobility conditions of nodes DSR gives a better packet delivery ratio than other protocols making it suitable for highly mobile random networks. Similarly for network size analysis it is observed that the DSR protocol outperforms other protocols if the network size is less. And if packet delivery ratio and throughput are the prime criteria, the OLSR protocol is the better solution for high mobility condition. **Parvez** *et al.* improved the comparative analysis of the mobile ad hoc networks. They deal with a four routing protocols, AODV, DSR, TORA and DSDV by using a NS2 simulator. To analyze these protocols by taking a five metrics: bandwidth, throughput, end to end delay, packet drop and routing overhead. In this study, throughput is increasing with simulation time. And this simulation shows that the performance of AODV and DSR is better in case of throughput. TORA has higher packet dropping than DSDV and then in AODV. Other side, DSR packet dropping rate is much lower than other protocols, so it perform better for packet dropping. Next metric is end to end delay, in this analysis DSR has the lowest end to end delay in reactive protocols and DSDV has lowest, but when the number of node has been increases the end to end delay also increased [40]. In TORA, end to end delay is much greater than in AODV. But the end to end delay of DSR and DSDV is less so these are best performer. In case of routing overhead, DSDV protocol has less overhead as compare to AODV and TORA. DSR protocol is less as compare to other three routing protocols. The reason for SR, incurring less overhead is that, it sends the routing traffic only when it has data to transmit, which eliminate the need to send unnecessary routing traffic. AODV has routing overhead much higher than DSR because of multiple route replies to single route request. The routing overhead for TORA is same to the overhead of AODV routing protocol is because of the periodic update and HELLO packets, which is sent on the network for route discovery. As a result DSR performs better as compared to the other routing protocols. At last, in AODV routing protocol bandwidth consumption is much higher than other routing protocols. Bandwidth consumption is much lower in DSR and DSDV routing protocols and compare to the AODV and TORA routing protocols. As a result DSR and DSDV perform better. Allover performance of DSR routing protocol is best in different situations.

Taksande *et al.* compared the performance of AODV, DSR and DSDV protocol with IEEE 802.11 MAC for chain topology using NS2 simulator for ad hoc mobile networks. With the increasing number of nodes metrics are packet delivery ratio, packet received, total packet dropped and average end to end delay taken [41].These routing protocols were compared in terms of Packet delivery ratio, Average routing overhead and Average end-to-end delay when subjected to varying no. of nodes. It is concluded that the competitive reactive routing protocols, AODV and DSR, both show better performance than the other in terms of certain performance metrics. It is still difficult to determine which of them has overall better performance in MANET for Chain topology. **Rohankar** *et al.* analyzed the performance of various routing protocols for random mobility models of ad hoc networks. This analysis has been done with respect to end to end delay, packet delivery ratio and throughput. If mobility model is random waypoint, End to end delay for routing protocol AODV is less if number of nodes are less, but it increases with increases number of nodes. In second case if mobility mode random direction is used then the highest delay is generated for less number of nodes and delay decreases when the number of nodes is increases. Random waypoint model out performs both random direction and random walk in calculating the throughput which measured the hopes performed by each packet. The lowest throughput of random direction mobility model contributes the higher delay because of more number of hop. For packet delivery ratio random waypoint model perform better than other. All mobility models decreased significant with the increasing of number of nodes. For the next routing protocol DSR, when random waypoint mobility model and random walk is used end to end delay is lowest. And it decreases in random direction with the increases number of nodes. For the delivering of data packets to the destination random mobility model and random walk perform better than the random direction mobility model [42]. At the end for the proactive routing protocols random walk outperforms, random waypoint. For reactive routing protocol, they have slight variations in the performance between random waypoint and random walk.

Random direction performance was poor in case of both proactive and reactive routing protocols because of its behavior to travel to the border of simulation area in chosen random direction.

Khatkar *et al.* evaluated the performance of hybrid routing protocols in mobile ad hoc networks by taking a FSR, CBRP on the basis of packet delivery ratio, and to end delay and average throughput and after that compare them with AODV, DSR and FSR routing protocols by varying number of nodes. The throughput of ZRP is better than other routing protocols with varying number of nodes. Packet delivery ratio for CBRP is better than that of others routing protocols with changing number of nodes. Average end to end delay for ZRP is less than other routing protocol with the varying number of nodes [43]. Finally from that comparison it is concluded that hybrid routing protocols for ad hoc networks perform well as compared to AODV, DSR and FSR in terms of packet delivery ratio and end to end delay. **Dembla** *et al.* compared and introduced some ad hoc protocols. Power and bandwidth utilization are least in case of DSR. AODV performs better than DSR in more stressful situations as it has lower overhead due to the transmission of only the destination address. AODV does support multicasting. DSR needs to include in every packet the full routing information and also keep the full source routes in its memory creating potentially more overhead. TORA was found to be suitable for large networks with dense population of nodes [44]. Ability of TORA to support multiple routes through the creation of directed acyclic graphs (DAG) aids bandwidth conservation as newer routes need not be discovered till all the existing routes are deemed invalid.

Kulkarnit *et al.* studied the overview of the existing on demand routing protocols and a parametric comparison is made with the recently developed protocols. These protocols are the multipath extensions of AODV with break avoidance (AODV-BR) and comparison with DSR. Describe the comparative analysis into two parts, first gives the comparative analysis of conventional routing protocols and second gives the comparative analysis of extensions of AODV. Every protocol has its own advantage and disadvantages [45]. A comparative analysis of all these protocols shows that the recently proposed multipath extensions of AODV has more advantages over the conventional routing protocols in terms of the routing overhead, latency introduced in route discovery, route repair and various other parameters.

Sen *et al.* attempted has been made to understand the behavior of AODV and DSDV routing protocols when operating in more challenging environment such as frequent change in network topology and node density. The performance of AODV is better than DSDV in a low node density environment but with a rise in node density DSDV out performs AODV. The average end-to end delay of AODV is higher than DSDV but when increase in node density, AODV outperforms DSDV [46]. THE normalized routing load for AODV will always be higher than DSDV. it observe that in high node density the performance of both protocols decreases significantly, but the performance of both routing protocols increases with the increment of pause time.

Khiavi1 *et al.* compared the AODV, DSDV, DSR and TORA Routing Protocols in terms of Packet Delivery Ratio, Network Life Time, System Life Time, End-to-End Delay and Routing Overhead. DSR has better packet delivery ratio and in overall DSDV has better performance but TORA has low performance [47]. System Life time DSDV has better performance. In case of End-to-End Delay AODV, DSDV and DSR have relative performance. In case of Routing Overhead, DSDV has better performance. **Sharma** *et al.* studied the performance of AODV and DSR routing protocols of ad hoc networks and compare their performance on the basis of small and highly dense region of mobile devices. For this study they use OPNET 14.5 as a simulator. The routing protocols ate evaluated for performance metrics like packet delivery ratio, end to end delay; throughput and network load with increasing number of devices with varying network size [48]. As a result of this study, it is concluded that AODV have an upper hand and on DSR in terms of end to end delay and throughput with increasing number of mobile devices because of it's on demand characteristics to find out the freshest routes. But after certain time end to end delay is nearly constant. But in the case of packet delivery ratio DSR routing protocol performed exceptionally well. Network load is high in AODV routing protocol. In overall performance comparison AODV perform well with varying network size and varying number of mobile nodes.

CHAPTER 3

SIMULATION METHODOLOGIES

In this chapter different metrics considered in the performance evaluation of proactive and reactive routing protocols. First, performance parameters considered in the comparison will be discussed. After that simulation environment as well as methodology will discuss.

3.1 PERFORMANCE PARAMETERS

There are different kinds of parameters for the performance evaluation of the routing protocols. These have different behaviors of the overall network performance. In this thesis, four parameters for the comparison of our study on the overall network performance will be evaluated. These parameters are delay, Normalized routing load, packet delivery ratio and throughput for protocols evaluation. These parameters are important in the consideration of evaluation of the routing protocols in a communication network. These protocols need to be checked against certain parameters for their performance. To check protocol effectiveness in finding a route towards destination, we will look to the source that how much control messages it sends; It gives the routing protocol internal algorithm's efficiency; If the routing protocol gives much end to end delay so probably this routing protocol is not efficient as compare to the protocol which gives low end to end delay. Similarly a routing protocol offering low network load is called efficient routing protocol [49]. The same is the case with the throughput as it represents the successful deliveries of packets in time. If a protocol shows high throughput so it is the efficient and best protocol than the routing protocol which have low throughput. These parameters have great influence in the selection of an efficient routing protocol in any communication network.

Routing overhead can be computed either as a count of the total bytes sent out as routing packets or a count of total number of routing packets sent out. Here we have used the number of routing packets as our metric because, as we claim that the new routing algorithm suppresses the unnecessary periodic updates sent out by nodes, so we needed a measure of how many routing packets were saved as a result of the new routing algorithm. With more routing overhead, the amount of delay experienced by data packets in reaching their destination would be more as there would be congestion, collision and queuing delay. But now as we are reducing the routing overhead, it naturally would lead to better packet delivery times.

3.1.1 Delay

The packet end-to-end delay is the time of generation of a packet by the source up to the destination reception. So this is the time that a packet takes to go across the network. This time is expressed in sec. Hence all the delays in the network are called packet end-to-end delay, like buffer queues and transmission time. Sometimes this delay can be called as latency; it has the same meaning as delay. Some applications are sensitive to packet delay such as voice is a delay sensitive application. So the voice requires a low average delay in the network. The FTP is tolerant to a certain level of delays. There are different kinds of activities because of which network delay is increased. Packet end-to-end delay is a measure of how sound a routing protocol adapts to the various constraints in the network to give reliability in the routing protocol. We have several kinds of delays which are processing delay (PD), queuing delay (QD), transmission delay (TD) and propagation delay (PD). The queuing delay (QD) is not included, as the network delay has no concern with it [50]. Mathematically it can be shown as equation (1).

$$d_{end\text{-}end} = N[d_{trans} + d_{prop} + d_{proc}] \qquad (1)$$

Where,

$d_{end\text{-}end}$ = end to end delay

d_{trans} = transmission delay

d_{prop} = propagating delay

d_{proc} = processing delay

Suppose if there are n number of nodes, then the total delay can be calculated by taking the average of all the packets, source destination pairs and network configuration.

3.1.2 Throughput

Throughput is defined as; the ratio of the total data reaches a receiver from the sender. The time it takes by the receiver to receive the last message is called as throughput [51]. Throughput is expressed as bytes or bits per sec (byte/sec or bit/sec). Some factors affect the throughput as; if there are many topology changes in the network, unreliable communication between nodes, limited bandwidth available and limited energy [51]. A high throughput is absolute choice in every network. Throughput can be represented mathematically as in equation (2)

$$\text{Throughput} = \frac{\text{number of delivered packek} * \text{packet size} * 8}{\text{total duriation of simulation}} \qquad (2)$$

3.1.3 Packet delivery ratio

The ratio between the number of packets originated by the application layer CBR source and the number of packets received by the CBR sink to final destination or it is the ratio of the number of data packets delivered to destination. In other words, it depicts the level of delivered data to destination. Mathematical form is expressed in equation (3)

$$\text{PDR} = \frac{\text{number of packek received}}{\text{number of packet sent}} \qquad (3)$$

3.1.4 Normalized routing load

It is the fraction of all routing control packets sent by each node over the number of received data packets at the destination nodes. We can say that, it is the ratio among the total number of routing packets sent over the network to the total number of data packets received. The total number of routing packets transmitted during the simulation. For packets sent over multiple hops, each transmission of the packet (each hop) counts as one.

3.2 SIMULATION ENVIRONMENT

To simulate ad hoc routing protocols in this thesis simulator NS2 version 2.34 is used. The primary reason for choosing NS2 was its support of a multi-hop wireless environment. Secondly, as most of the studies cited in the literature, they have used NS2 as their simulation environment, their performance results of the ad hoc routing protocols.

3.2.1 NS2 SIMULATOR

NS2 is a discrete event simulator developed by University of Berkley. It provides support for both wired as well as wireless networks in addition to various other types of networks. It is an object oriented simulator, written in C++ with OTCL/Tk as its scripting language. To conduct experiments on existing protocols under different scenarios such as different routing algorithms or mobility, one can write an OTCL script where in various components such as nodes, links, protocols, traffic etc can be defined and run. However to modify the working of an existing routing algorithm or to implement a new routing algorithm, one has to implement it in C++. NS2 reports each event during the simulation in a trace format, which can later on be analyzed to obtain the desired statistics.

For our simulations, we mostly had to deal with the DSDV, DSR and AODV module and the mobility scenario generation module of NS2.

3.3 SIMULATION METHODOLOGY

Having previewed the simulation environment, in this section of thesis report our simulation methodology will put forward. In an effort to stick to our goals while at the same time, conduct comparisons of routing protocols results, we choose our network for two different scenarios. In first part, maximum nodes are 40 with 20 m/sec speed of ad hoc networks throughout the simulation. In second part, 20 nodes are taken with varying maximum 40 m/sec speed. We also keep other variable parameters such as the amount of data traffic, size of the data packets and link capacity constant throughout the simulation. Thus the different test scenarios by varying the underlying mobility pattern along with the employed routing algorithm to see how the routing protocols and the mobility pattern aware of routing protocols perform in various scenarios.

In the rest of the section we present the topography, mobility model, traffic model, protocol implementation and the metrics used for performance evaluation.

3.3.1 SIMULATION TOPOGRAPHY

The network simulations carried out for our study are based in 1000 x 1000 meter flat grid topography. The reason for selecting a square topography is that, it results in a larger number of hop counts between source and destination. Since an evaluation of a routing protocol for ad hoc network must test its forwarding ability along with its ability to effectively deal with link breakage and route repair scenarios. Thus square topography seemed to a right choice for our simulations which provides a more rigorous environment for performance comparison.

3.3.2 TRAFFIC MODEL

For all simulation we have used the same traffic model that is CBR sources, transmitting per sec with the size of each packet 512 byte, larger sized data packets lead to higher packet drops due to queuing delay. And as the ad hoc network under the consideration of maximum 40 nodes, and make sure no node acts as both source and destination. So each CBR have different sinks for the CBR packets. The advantage of having a uniform traffic model for all test case scenarios is that, with total number of data packets sent out being constant, the total number of data packets successfully received at the destination will reflect a measure of the overall packet delivery ratio, end to end delay, normalized routing load and throughput whichis tern is a measure of how well the routing algorithm had performed under various scenarios with different mobility patterns, routing algorithm, number of nodes and speeds.

3.3.3 Mobility Pattern and Movement Scenarios

In this thesis three types of mobility patterns are used for simulation that is random waypoint mobility model, reference point group mobility model and column mobility model explained in last chapter. Here the mobility pattern refers to the movement pattern of the nodes in the ad hoc network as a whole, whereas the movement scenario is generated for individual nodes and refers to the individualistic node movements, which is in accordance to the mobility pattern it is following.

The random mobility pattern's movement scenario for our simulations were generated using the *setdest* utility of NS2 with the number of mobile nodes, the grid area, the maximum speed and pause time as its parameters. *Setdest,* uses the random waypoint model to generate random mobility. at the start of simulation, all the nodes are laid out randomly on the topography and then start moving towards a random destination at some random speed, which is a value between 0m/sec and the maximum speeds are taken. After reaching the destination, the node pauses for a certain time as specified by the pause time parameter before moving towards the next randomly chosen destination. The speed however doesn't change when the nodes are mid-way to destination.

In random waypoint model even though the max speed is specified, it has been observed that the average speed of the nodes in the network is less than half of the maximum specified speed and this goes on decaying with the duration of simulation. In our study where we are trying to measure the performance of the new routing algorithm with respect to different mobility pattern, the average speed of the nodes in the network forms an important aspect and performing simulations with ever decaying average speed is not a good measure of performance for the routing algorithm, as we cannot claim the results to be valid at some particular speed. So we modified the existing *setdest* utility so as to restrict the speeds chosen after every pause between some maximum and minimum value which is in same as the maximum speed and we call this type of mobility as random mobility with no trailing effect. Thus for our simulation with random mobility we use two type of movements scenarios that is, one with trailing and one without trailing.

Other mobility models are reference point group mobility model and column mobility model. In reference point group mobility model, 4 to 5 nodes are selected for one group. Every group has a reference point which moves randomly by selecting random direction and at random speed, every group of mobile nodes will follow their reference point. Different groups have different reference points and select their own random destination. Last mobility is column mobility, in this model number of mobile nodes are in straight line, then *setdest* gives to all nodes, and these nodes moves around their reference point in a column.

In this thesis we chose two types of scenario for the results of comparison of performance. In first speed is set below 20m/sec for all mobility models. In this simulation total time for simulation process is 30sec. And number of node is different e.g. 5, 10, 15, 20, 25, 30, 35,

40. For different nodes different results are comes for different protocols. For all these different nodes different mobility models are used. In second scenario, number of nodes are taken 20, but with varying speed of each model. In this speed is varying from 5 m/sec to 40m/sec with the difference of 5 m/sec. Total time for simulation is same as above scenario.

CHAPTER 4

RESULTSAND ANALYSIS

In this section our simulation results are present for the performance comparison between AODV, DSR and DSDV and mobility for different mobility models. As described earlier, for all the simulations the traffic pattern, the number of mobile nodes, the duration of simulation, the data packet size, the transmission range of the nodes and the link capacity are kept uniform. The variable parameters for every simulation are node speed, pause times, the routing algorithm, the underlying mobility pattern and the initial layout of nodes on the square grid. As we discussed above in this thesis two types of scenarios are taken, their results and discussion given below.

4.1 ANALYSIS OF VARYING NODES

Performance analysis of routing protocols by using different mobility models when a number of mobile nodes are varying.

In this analysis number of node are increasing with given maximum 20 m/sec speed. AODV, DSR and DSDV routing protocols are compared by taking three different mobility models (random waypoint mobility, reference point group mobility and column mobility) based on parameters end to end delay, packet delivery ratio, throughput and normalized routing load.

4.1.1 Throughput

Throughput indicate rate of communication per unit time. Throughput in this experiment evaluate for AODV, DSDV and DSR for all these three mobility models. Figure 4.1 shows the throughput (bytes per simulation time 30 sec) versus increasing number of nodes of protocols by using column mobility movement of nodes in given environment of 1000 x 1000m, and the speed of nodes is less than 20 m/sec. In this simulation AODV perform better than other protocols, but when number of nodes are less, then performance of all protocols is almost same.

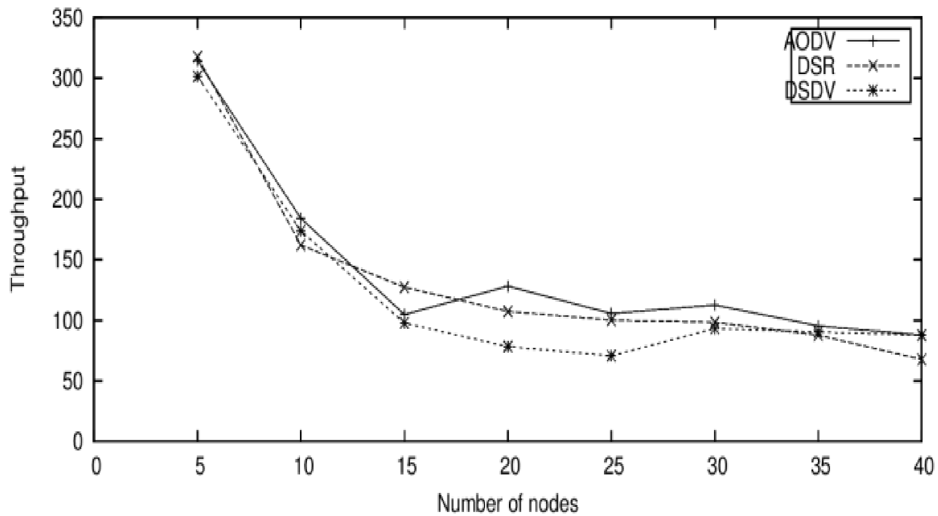

Figure 4.1: Throughput v/s number of nodes in column mobility model

Throughput of protocols with respect increasing number of nodes for group mobility model is shown in Figure 4.2. It shows that throughput of AODV is good than DSR, and DSDV perform least. In Figure 4.3, throughput by using random mobility model is much better than other two mobility models. In this case all three protocols perform better but AODV is much better.

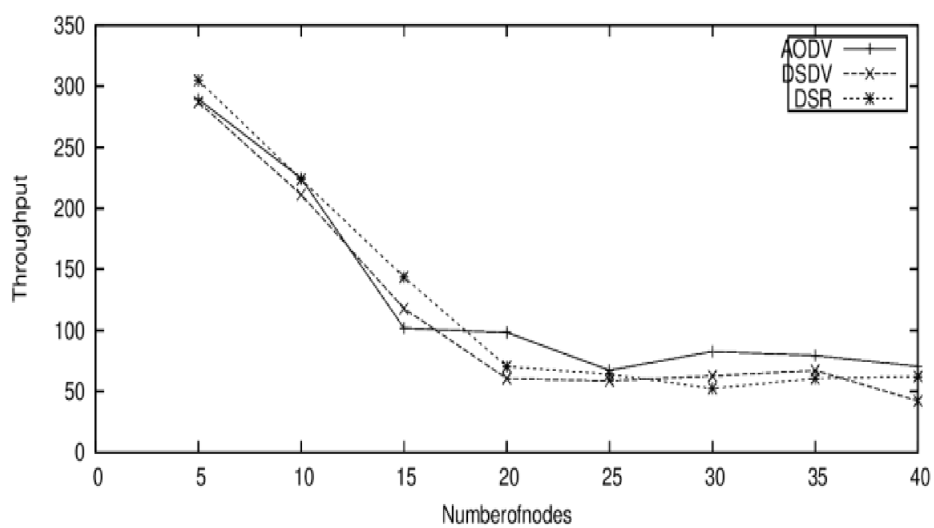

Figure 4.2: Throughput v/s number of nodes in group mobility model

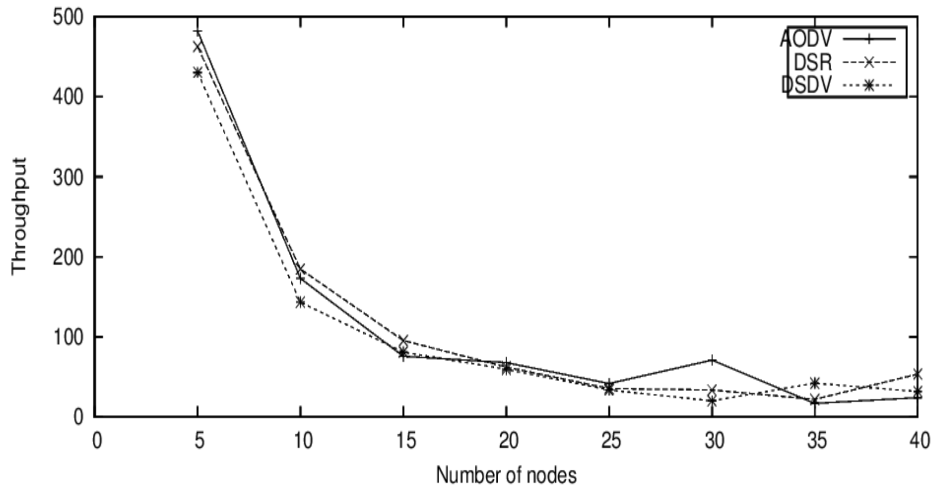

Figure 4.3: Throughput v/s number of nodes in random way point mobility model

4.1.2 Packet delivery ratio

As we discussed when defining the simulation metrics, packet delivery ratio is calculated by dividing the total number of data packets received at all the nodes, by the total number of data packets sent out by the CBR sources. Packet delivery ratio forms an important metric for performance evaluation of an ad hoc routing protocol because, given similar scenarios, the number of data packets successfully delivered at the destination depends mainly on path availability, which in turn depends on how effective the underlying routing algorithm is in a mobile scenario.

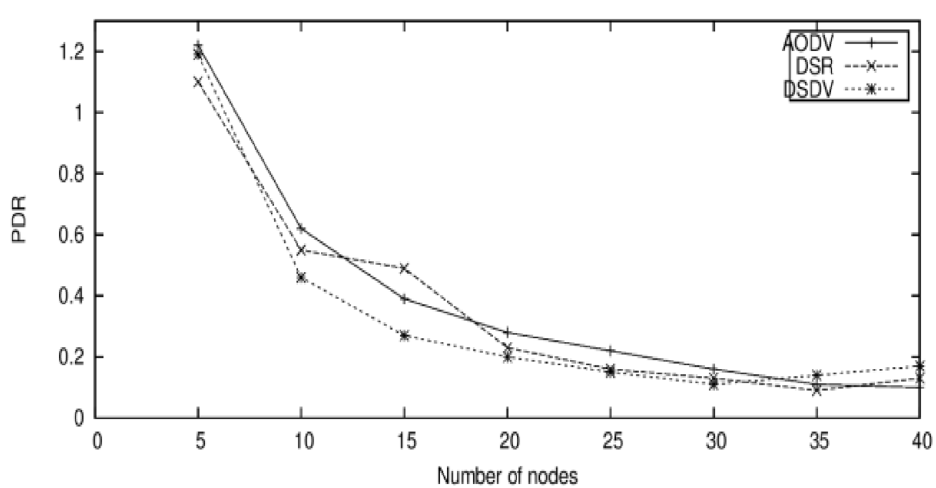

Figure 4.4: Packet delivery ratio v/s number of nodes in column mobility model

The packet delivery ratio of AODV, DSDV and DSR versus increasing number of nodes, Figure 4.4 shows the PDR by using column mobility model of nodes. PDR of AODV is good for lesser number of nodes but when nodes increase then PDR fall down. In case of group mobility model shown in Figure 4.5 DSR have highest PDR, but DSR have lowest value of PDR. Figure 4.6 shows the PDR of random waypoint mobility model, which have very highest value of PDR with all protocols. AODV have high value of PDR but DSR and DSDV have almost same but lower then AODV.

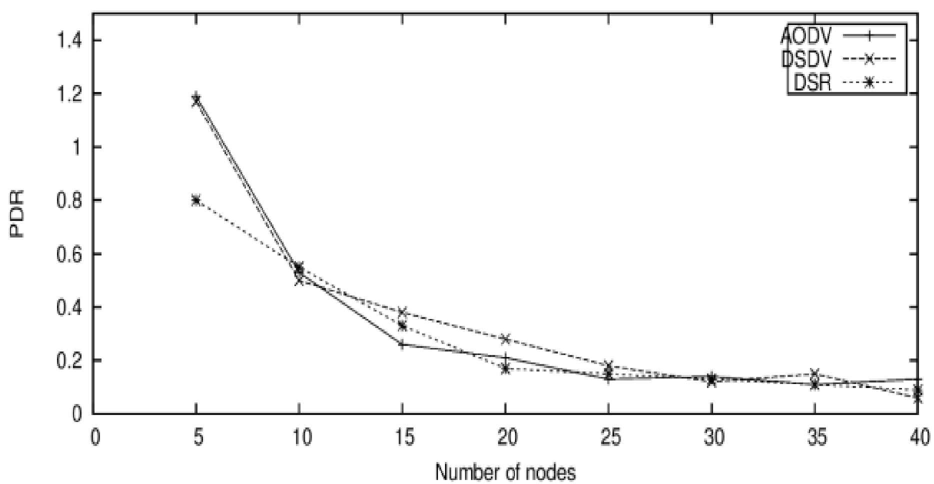

Figure 4.5: Packet delivery ratio v/s number of nodes in group mobility model

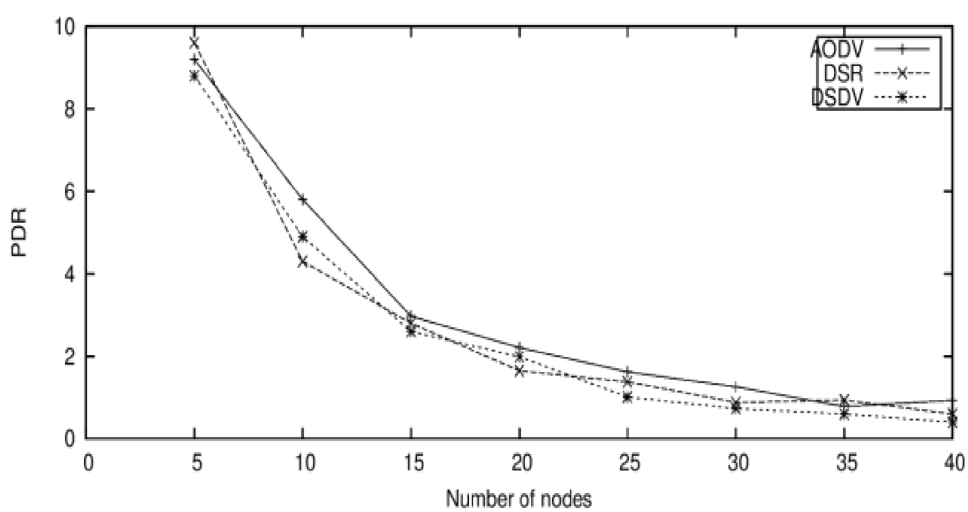

Figure 4.6: Packet delivery ratio v/s number of nodes in random way point mobility model

4.1.3 End to end delay

End to end delay is the time a data packet of size 512 byte takes in traversing from the time it is sent by the source node till the point it is received at the destination node. This metric is a measure of how efficient the underlying routing algorithm is, because primarily the delay depends upon optimality of path chosen, the delay experienced at the interface queues and delay caused by the retransmission at the physical layer due to collision. Routing overhead is a major factor affecting the interface queuing delay as well as the retransmission. Because the higher the routing overhead the delay experienced at the queues will be longer as well as the number of collision would be high.

It is the amount of time taken by packet to reach from one node to other. Figure 4.7 shows end to end delay versus increasing number of nodes by using column mobility model. At lesser number of nodes the end to end delay of DSR is at its peak value but DSDV at its least value, after increasing number of nodes end to end delay of DSR start decreasing but oppositely DSDV and AODV start increasing. Figure 4.8 shows end to end delay when group mobility model is used, DSR have higher end to end delay but DSDV have least. Figure 4.9 shows random way mobility have higher values of delay. DSR is on its lowest value and DSDV have its largest point. With the increasing number of nodes the delay of these protocols gradually decreasing.

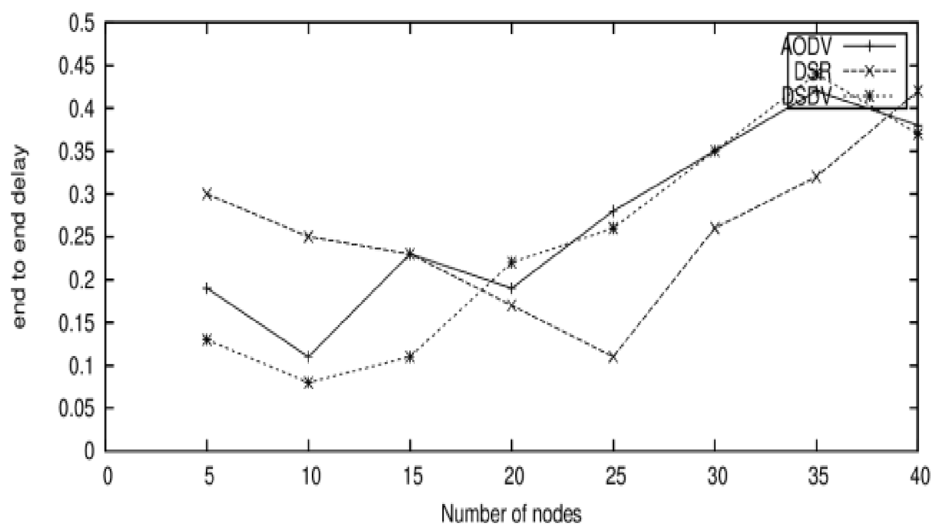

Figure 4.7: End to end delay v/s number of nodes in column mobility

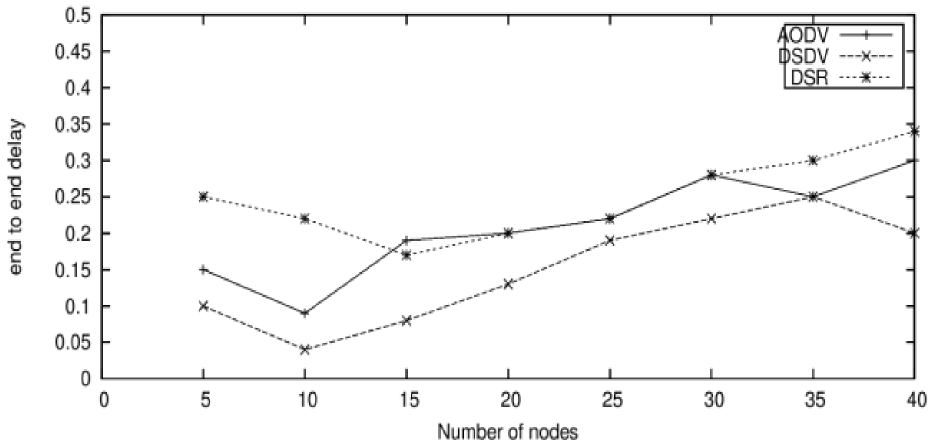

Figure 4.8: End to end delay v/s number of nodes in group mobility

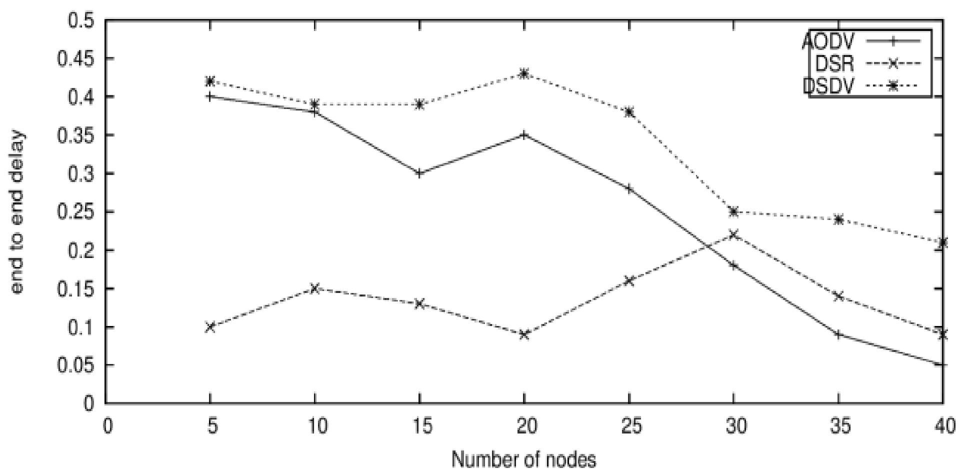

Figure 4.9: End to end delay v/s number of nodes in random way point mobility

4.1.4 Normalized routing load

It is the metadata and network routing information sent by a source node to destination node, which uses a portion the available bandwidth of a protocol. It is the fraction of all routing control packets sent by each node over the number of received data packets at the destination nodes. In other words we can say that, it is the ratio among the total number of routing packets sent over the network to the total number of data packets received. The total number of routing packets transmitted during the simulation. For packets sent over multiple hops, each transmission of the packet counts as one. Figure 4.10 shows the NLR versus number of nodes when column mobility model was used. In this AODV have a higher NLR but DSV is on bottom. Initially value of NLR is zero, but with number of nodes it's gradually starts increasing. Value of NLR in DSDV is very lesser. In case of group mobility model shown in Figure 4.11, NLR is high when routing protocol is DSR and less when DSDV. Figure 4.12 shows the normalized routing load when random way point mobility model is used. It shows a less values of DSDV but high value of DSR and AODV.

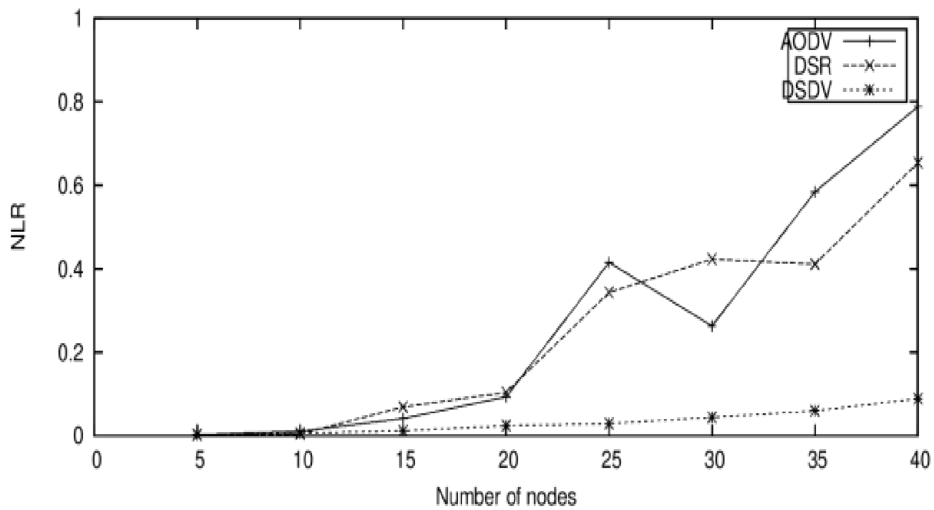

Figure 4.10: Normalized routing load v/s number of nodes in column mobility

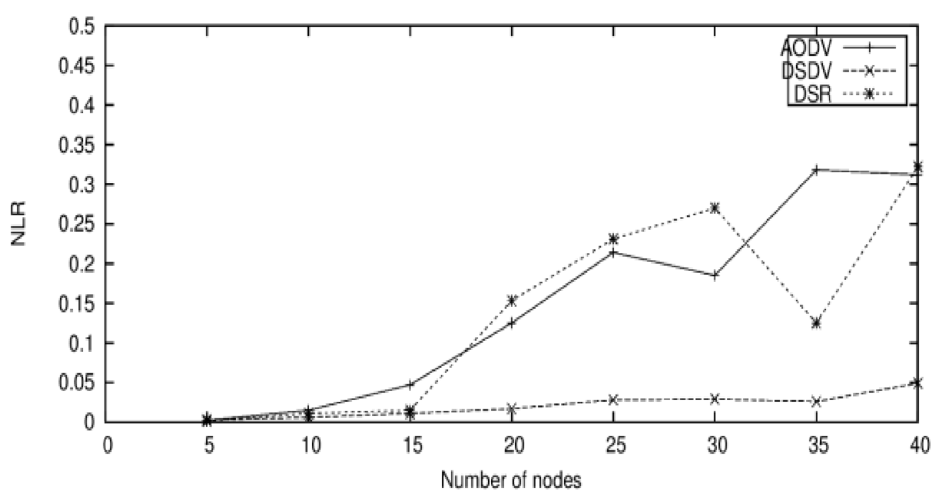

Figure 4.11: Normalized routing load v/s number of nodes in group mobility

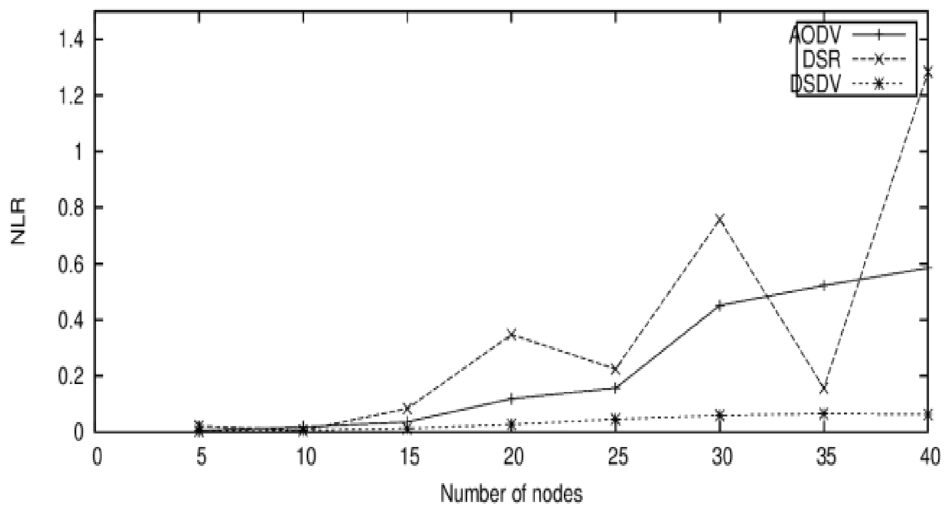

Figure 4.12: Normalized routing load v/s number of nodes in random way point mobility

4.2 ANALYSIS OF VARIATIONS IN SPEED

In this simulation, three routing protocols are compared by taking fixed number of nodes but speed of nodes is varying. Here the simulation of different protocols has been done on the basis of different mobility models by increasing a speed of nodes. In this paper, simulation is carried out by using constant bit rate (CBR) within the 1000 x1000 meter area. Time for the simulation is 30 sec by taking a fixed number of nodes with the increasing speed.

4.2.1 Throughput

It is defined as the ratio of the total data reaches a receiver from the sender. The time it takes by the receiver to receive the last message is called as throughput. In this simulation throughput is evaluated for AODV, DSDV and DSR for three mobility models in time of 30 sec. When column mobility model is used in simulation, Figure 4.13 shows that AODV has good throughput when speed is less but with the increasing of speed throughput fluctuating, when speed is at its peak then throughput is lesser then other protocols. On the other side, throughput is less affected by speed in DSDV protocol. DSR have extremely up and downs in throughput with changing speed. When reference point group mobility model is used as shown in Figure 4.14, AODV perform better and DSDV has worse throughput performance. At last, when random waypoint mobility model is used shown in Figure 4.15 to analyze the

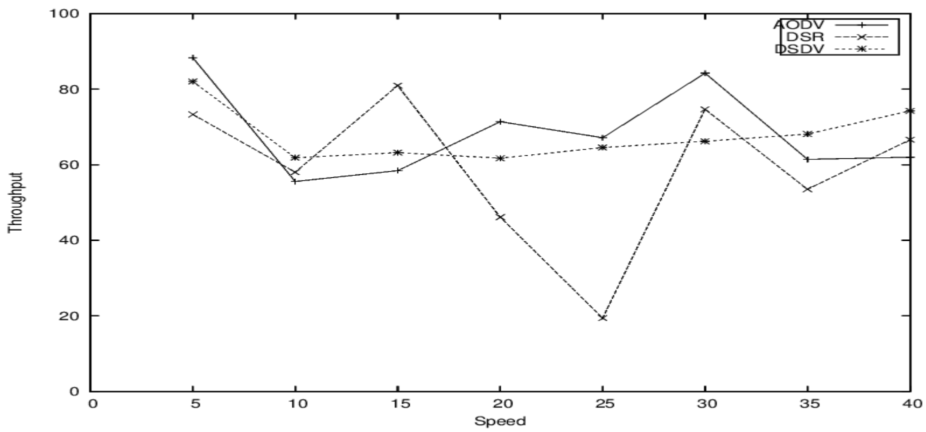

Figure 4.13: Throughput v/s speed in column mobility model

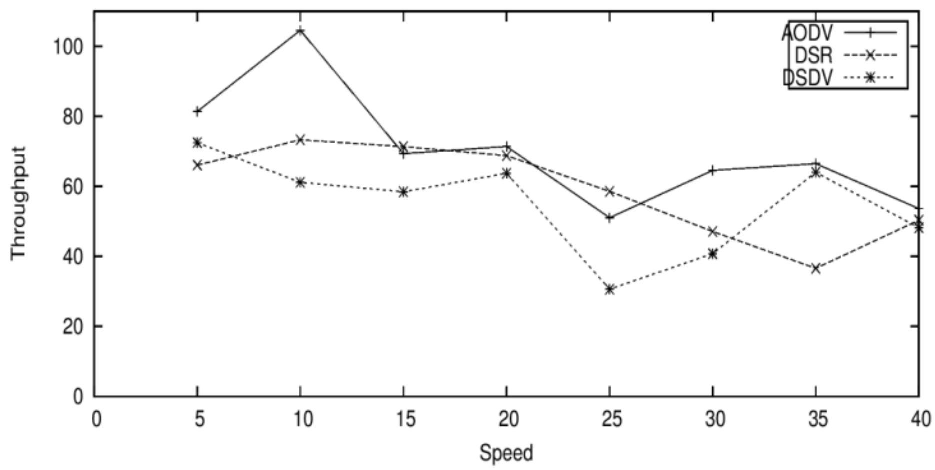

Figure 4.14: Throughput v/s speed in group mobility model

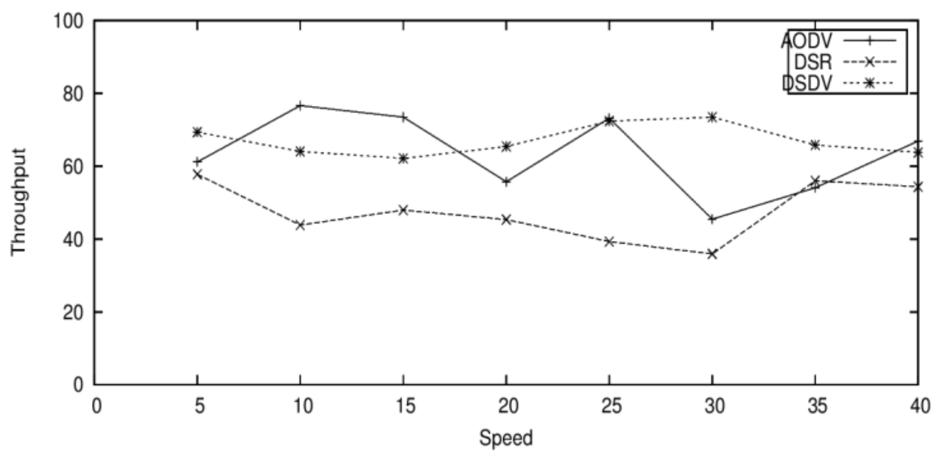

Figure 4.15: Throughput v/s speed random way point mobility model

performance of throughput, steady throughput of protocols at different speeds. DSDV has excellent but DSR has poor performance.

4.2.2 Packet delivery ratio

It is the ratio of the number of data packets that delivered at the destination. In Figure 4.16, AODV have better but DSDV have bitter packet delivery ratio performance. Figure 4.17 shows a graph when reference point group mobility is used, AODV perform better but DSR have fluctuating PDR with the increasing speed of nodes. As shown in Figure 4.18, AODV, DSDV and DSR has better packet delivery ratio when random waypoint mobility is used.

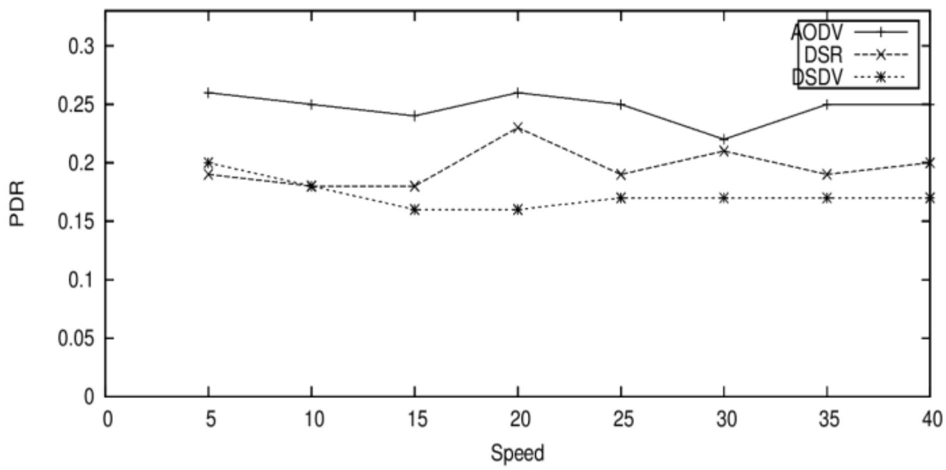

Figure 4.16: Packet delivery ratio v/s speed in column mobility model

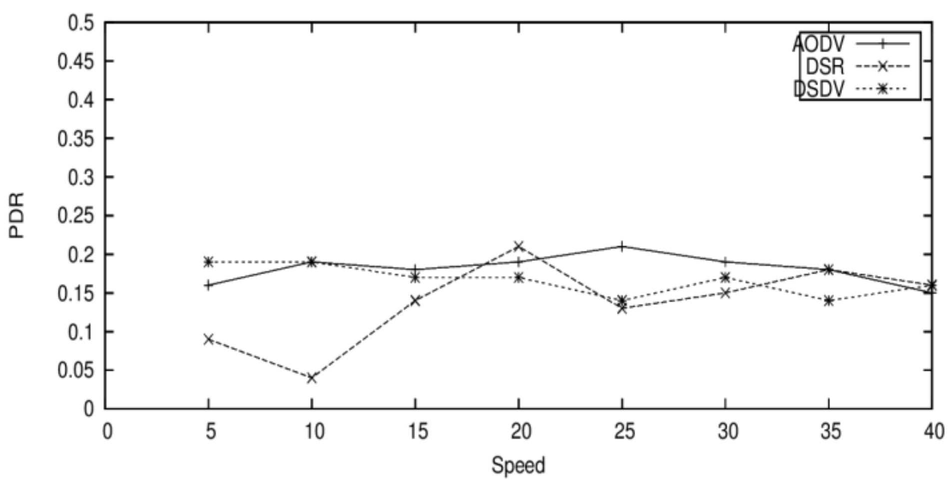

Figure 4.17: Packet delivery ratio v/s speed in group mobility model

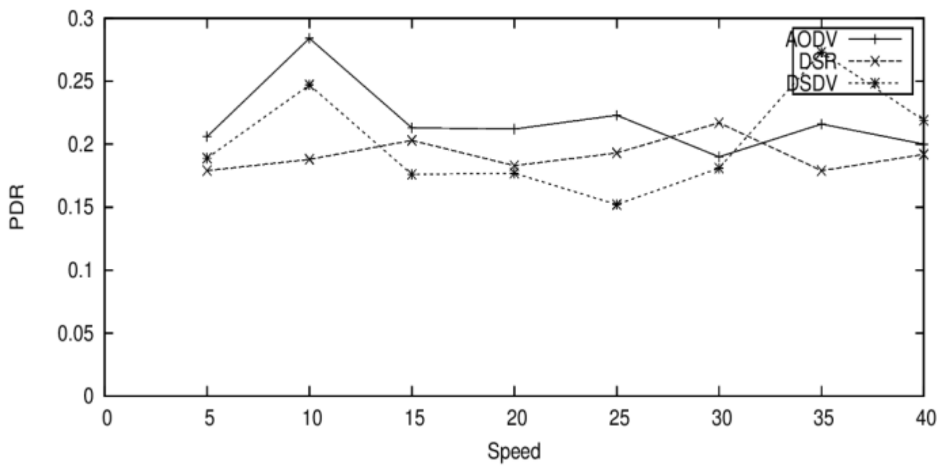

Figure 4.18: Packet delivery ratio v/s speed in random waypoint mobility model

4.2.3 End to end delay

It is the average time taken by packet to reach from sender to destination. In column mobility model DSDV perform worse because high end to end delay and DSR has lesser delay as in Figure 4.19. Delay becomes more in AODV and less in DSDV when reference point group mobility model is used as shown in Figure 4.20. If random waypoint mobility shown in Figure 4.21 is used the AODV has least delay and DSDV has more end to end delay.

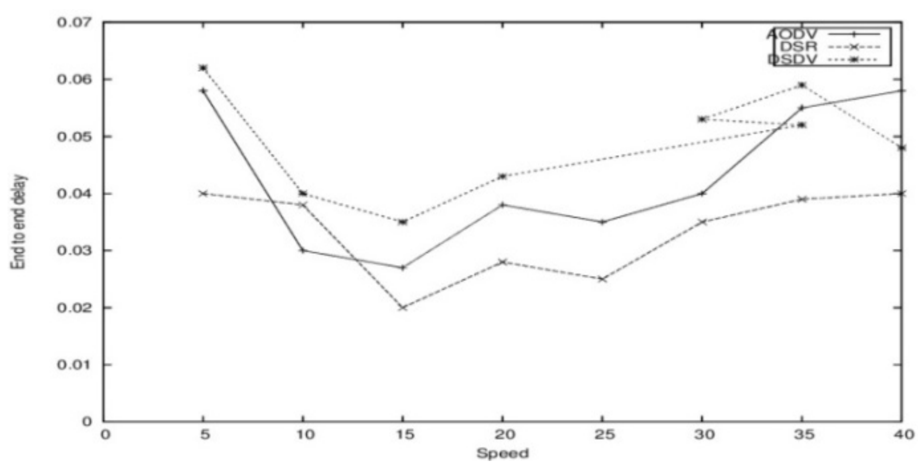

Figure 4.19: End to end delay v/s speed in column mobility model

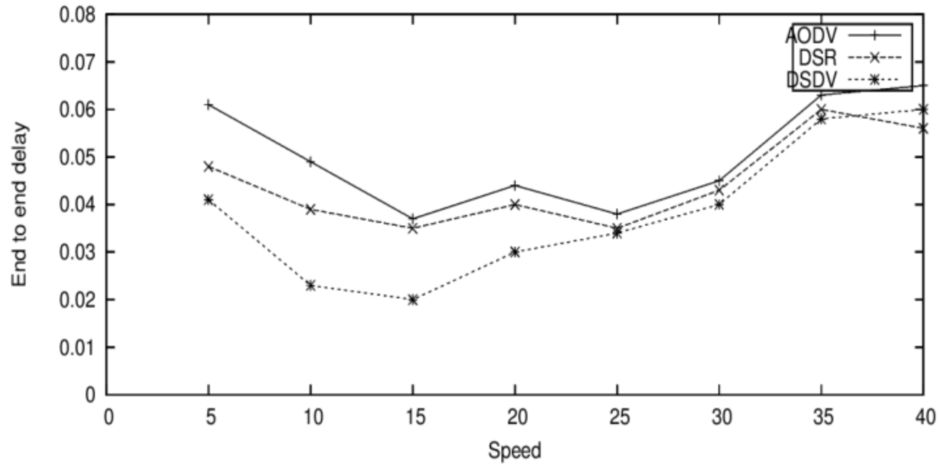

Figure 4.20: End to end delay v/s speed in group mobility model

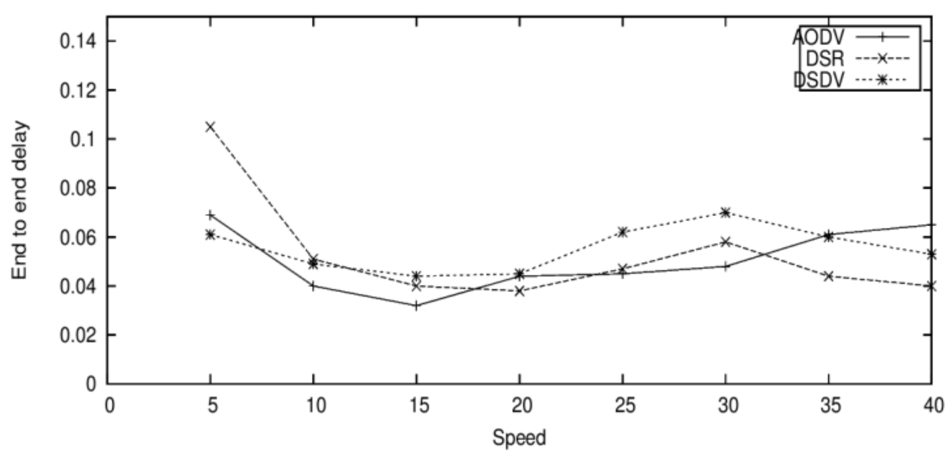

Figure 4.21: End to end delay v/s speed in random way point mobility model

4.2.4 Normalized routing load

It is used for the evaluation of the efficiency of routing protocols. DSDV has a less NLR and almost same value with the changing of nodes speed. DSR has higher value of NLR, and it is on its peak value at speed of 15 m/sec in Figure 4.22.

When reference point mobility model is used shown in Figure 4.23, NLR is lesser in DSDV and AODV but DSR have higher value. At last, Figure 4.24 random waypoint mobility model is used the values of NLR of AODV and DSDV increased then other models. DSR have higher NLR at the speed of nodes 35m/s.

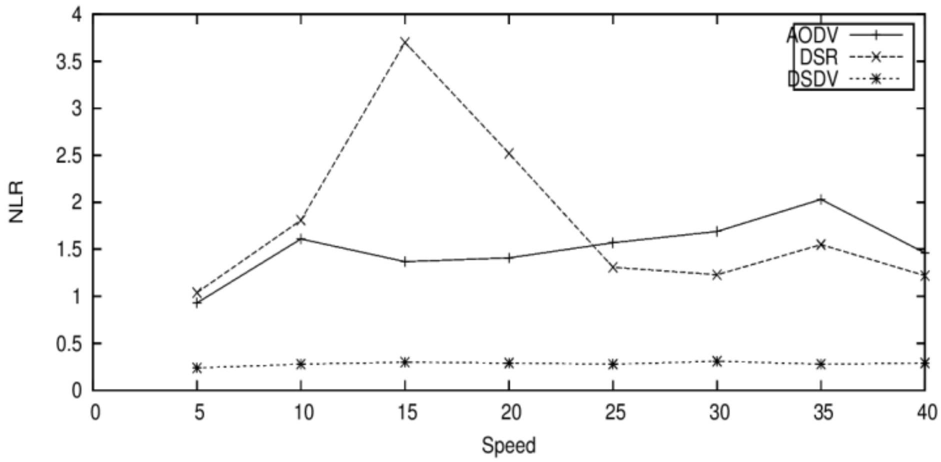

Figure 4.22: Normalized routing load v/s speed in column mobility model

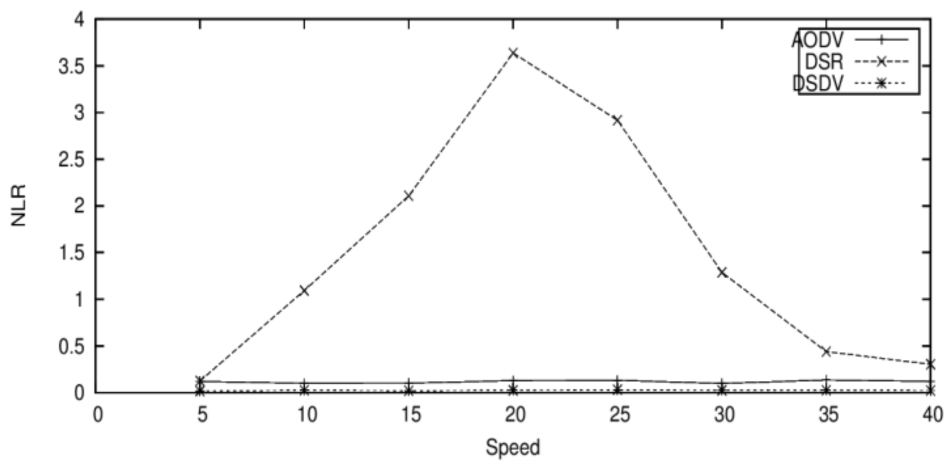

Figure 4.23: Normalized routing load v/s speed in group mobility model

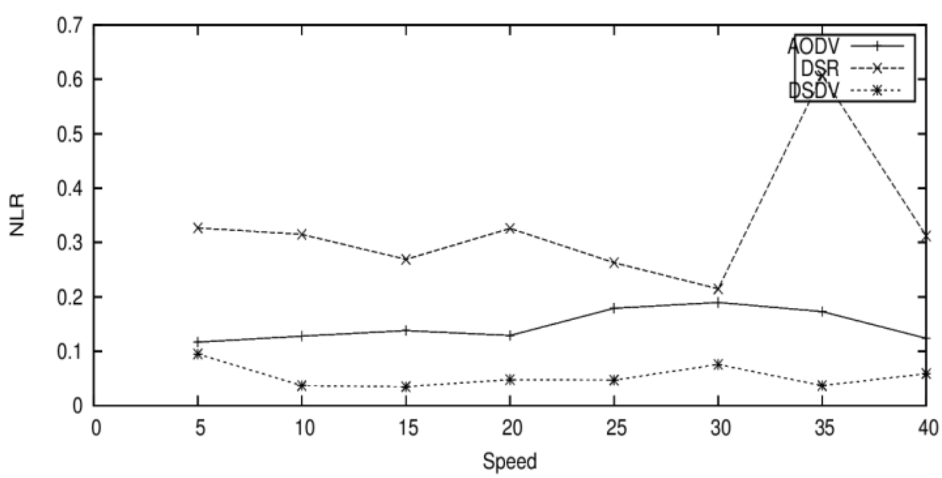

Figure 4.24: Normalized routing load v/s speed in random way point mobility model

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

5.1 CONCLUSION

In this thesis, we analyze the performance of three protocols AODV, DSR and DSDV by using three different mobility models (Random waypoint mobility, column mobility and reference point mobility) on the basis of parameters i.e. Throughput, Packet delivery ratio, End to end delay and Normalized routing load. We use NS2 simulator to find out the results of simulation. First, number of nodes is varied and maximum speed is fixed, secondly speed of nodes is varied but the maximum number of nodes is fixed. On the basis of simulation results concluded that, it is observed that AODV has better throughput in all models, but random waypoint performs better in case of throughput than other models, i.e. AODV is more scalable. PDR is satisfactory in DSDV when group mobility model is used, but in other models AODV perform better. Delay to send the packet at the destination is less in group mobility model and column mobility model when protocol is DSDV, DSR has lesser delay when random mobility model is used. At last, for normalized routing load DSDV has most satisfactory performance among all three mobility models.

When number of nodes is fixed but speed is varied it conclude that, AODV have a better throughput than other protocols and performance is good when random waypoint model is used i.e. AODV is more scalable. Packet delivery ratio is satisfactory high for AODV protocol when random movement of mobile nodes is used. Delay to send the packets from source to destination is less in DSDV when group mobility model is used, but when column mobility model is used the least delay in DSR. AODV also have lesser delay when model is random waypoint. Normalized routing load is high for DSR in both column and group mobility model but less in random waypoint mobility model. DSDV has least value of normalized routing load in each model that is used in this paper.

5.2 FUTURE SCOPE

The future work suggested is the development of modified version of the selected routing protocols which should consider different aspects of routing protocols such as rate of higher Performance Analysis of AODV, DSR and OLSR in MANET route establishment with lesser route breakage and the weakness of the protocols mentioned should be improvised. According to results, it known that which protocols is good for which type of mobility. in future we can use sufficient routing protocols on the basis of traffic.

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