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Performance Analysis & Behavioural Study of Proactive & Reactive Routing Protocols in MANET

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ABSTRACT— A Mobile Ad-hoc Network (MANET) consists of a number of mobile wireless nodes, the communication between these mobile nodes is carried out without any centralized control. The set of applications for MANET's is diverse, ranging from small, static networks that are constrained by power sources, to large-scale, mobile, highly dynamic networks. The design of network routing for these networks is a complex issue. Irrespective of application, MANET's need efficient distributed algorithms to determine network organization, link scheduling, and routing. In this paper we discuss about simulation & comparison of the performance between two types of routing protocols, Table Driven (Proactive) and On-Demand (Reactive) using the NS-2 simulation tool. These routing protocols compared in terms of packets delivery ratio, average delay and speed.

Keywords - Ad-hoc network, DSDV, AODV, DSR & WRP routing protocol, MANET.

I. INTRODUCTION

An ad-hoc network s a collection of wireless mobile hosts forming a temporary network without the aid of any stand-alone infrastructure or centralized administration. Mobile Ad-hoc networks are self-organizing and self-configuring multi-hop wireless networks where, the structure of the network changes dynamically. This is mainly due to the mobility of the nodes. The mobile ad hoc networks are deployed in the areas where establishing an infrastructure network cause delay in the work as well as enhances the cost. These areas include earthquake affected areas, flooded areas etc. The nodes in the mobile ad hoc networks are portable like as palmtops, cellulars , laptops , handheld devices. Nodes in these networks utilize the same random access wireless channel, cooperating in a friendly manner to engaging themselves in multi-hop forwarding. The node in the network not only acts as hosts but also as routers that route data to/from other nodes in network. A mobile ad hoc network (MANET) is a collection of wireless mobile nodes that dynamically establishes the network in the absence of fixed infrastructure. The main distinctive feature of MANET is, each node must be able to act as a router to find out the optimal path to forward a packet. MANET protocols provide an emerging technology for civilian and military applications. *A **mobile ad-hoc network*** (**MANET**) is a self-configuring infrastructure less network of mobile devices connected by wireless. *Ad hoc* is Latin and means "**for this purpose**". Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route the traffic. Such networks may operate by themselves or may be connected to the larger Internet. MANETs are a kind of wireless ad hoc networks that usually has a routable networking environment on top of Link Layer in ad hoc network [1].

Mobile Wireless Network Models

In present scenario, there are currently two variations of mobile wireless networks. The first kind is known as the infrastructure networks or Base Stations. This network communicates with the nearest base station which lies within the range. Typical applications of this type of network include office Wireless Local Area Networks (WLANs). In infrastructure network computers nodes are connected via a inter connection network such as Bus, LAN etc. This means that links between the nodes can change with time, new nodes can join the network, and other nodes can leave it [2].

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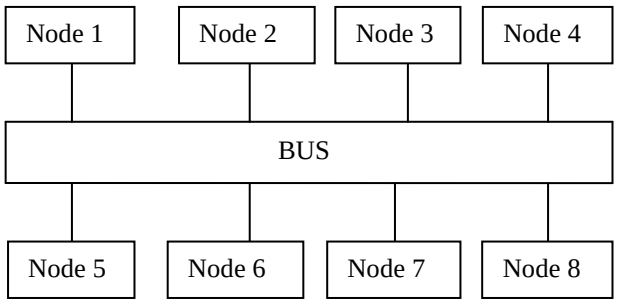

Fig.1. Infrastructure Network

The second type of Wireless network is called as infrastructure less mobile network, commonly known as an Ad hoc Network. Due to no stationary infrastructure, all nodes can move freely, topology may change rapidly and unpredictably over time, and nodes have to form their own mutual infrastructures. Example of MANET applications include law enforcement operations, automated military applications, Disaster relief applications, interactive lectures or conferences, Intelligent buildings, logistics etc. In ad hoc network, finding a path between two hosts using routing protocol is a very herculean task due to their highly dynamic topology, absence of centralized administration. Designing of routing protocol in ad hoc network depends various factors like mobility, bandwidth, resource constraint, hidden and exposed terminal problems etc. Thus, routing protocol is structured for purposes such as fully distributed, adaptive frequent and stable topology, loop free and minimum number of collisions.

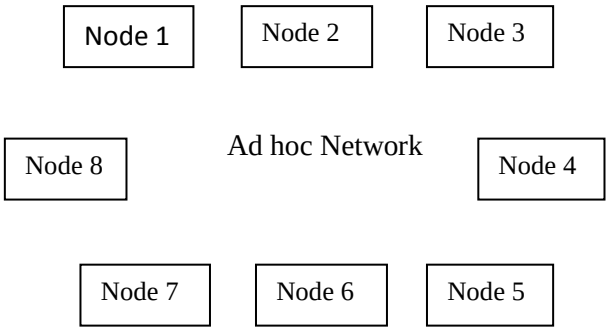

Fig.2. Infrastructure less Network

II. MOBILE ADHOCNETWORK (MANET) ROUTING PROTOCOLS

Nodes in ad hoc network also function as routers that discover and maintain routes to other nodes in the network. Thus, the primary goal of MANET is to establish a correct and efficient route between a pair of nodes and to ensure the correct and timely delivery of packets. A routing protocol is needed whenever a packet needs to be transmitted to a destination via number of nodes and numerous routing protocols have been proposed for such kind of ad hoc networks. These protocols find a route for packet delivery and deliver the packet to the correct destination. MANET routing protocols divided into three general categories [2]:

1. Proactive routing protocols
2. Reactive routing protocols
3. Hybrid routing protocol

A. Classification of Routing Protocols

The routing protocols can be classified into two parts: 1.Table driven 2. Source initiated (on demand) and 3.Hybrid protocol while depending on the network structure these are classified as flat routing, hierarchical routing and geographic position assisted routing. Flat routing covers both routing protocols based on routing strategy. The three ad hoc routing protocols are used, AODV, DSDV and DSR. AODV and DSR is Reactive (On demand) whereas DSDV is Proactive (Table driven) Routing protocol and ZRP is a hybrid protocol [2].

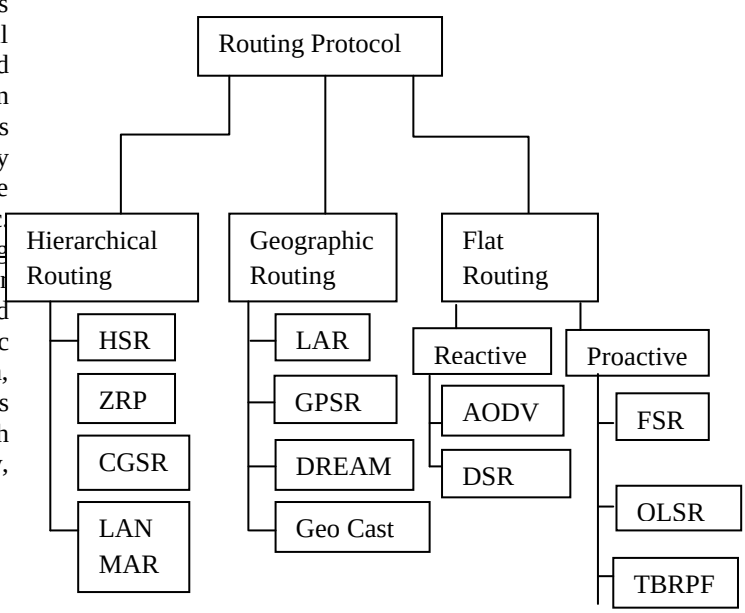

Fig.3. Classification of Routing Protocols

1) HSR (Hierarchical State Routing Protocol): The Hierarchical State Routing (HSR) [21] is a multi-level cluster-based hierarchical routing protocol. In HSR, mobile nodes are partitioned into clusters and a cluster head is chosen for each cluster. The cluster heads of low level clusters again organize themselves into upper level clusters, and so on. Inside a cluster, nodes broadcast their link state information to all others. The cluster head summarizes link state information of its cluster and sends this information to its neighbouring cluster heads via gateway nodes. Nodes in upper level hierarchical clusters flood the network topology information they have obtained to the nodes in the lower level clusters.
Each node contains a hierarchical address in HSR. The hierarchical address provides the network topology and provides enough information for packet deliveries in the network.

2) ZRP (Zone Routing Protocol):
In mobile ad-hoc network, **Zone Routing Protocol** or **ZRP [22]** was the first hybrid routing protocol with both a

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proactive and a reactive routing component. ZRP divides the whole network into small routing zones. Each node is a centres node for its zone. Hence, the entire network consists of overlapping zones. Within the zone, the **Intra-zone Routing Protocol (IARP),** which can be a specific proactive routing protocol, is used to maintain the topology information of the zone. The **Inter-zone Routing Protocol (IERP)** is responsible for discovering the global routes with destination nodes beyond the routing zone. Additionally, ZRP exploited *border casting* mechanism, which directs the query request to the border of the zone, rather than flooding. The border cast packet delivery is performed by the Border cast Resolution Protocol (BRP). ZRP was proposed to reduce the control overhead of proactive routing protocols and decrease the latency caused by route discovery in reactive routing protocols. ZRP consists of three components.

1. The proactive Intra zone routing protocol (IARP).
2. The reactive Inter zone routing protocol (IERP).
3. Border cast resolution protocol (BRP).

3) CGSR (Cluster Gateway Switch Routing):

The Cluster head Gateway Switch Routing (CGSR)[23] is a hierarchical routing protocol. The cluster structure improves performance of the routing protocol because it provides
effective membership and traffic management. Besides routing information collection, update and distribution, cluster construction and cluster head selection algorithms are important components of cluster based routing protocols.

4) LANMAR (Landmark Ad hoc Routing) :

The Landmark Ad hoc Routing (LANMAR) [24] is proposed as a modification of FSR and it focuses to improve scalability in contrast to FSR, It is a non-uniform routing protocol of mobile ad hoc networks. In LANMAR, mobile nodes are divided into predefined logical subnets according to their mobility patterns. Using LANMAR every mobile node has a hierarchical address that includes its subnet identifier. A node maintains the topology information of its neighbors and all landmark nodes, which represent logical subnets. Similar to FSR, neighboring nodes in LANMAR periodically exchange topology information and the distance vector of landmark nodes. When a source sends packets to the destination inside its neighboring scope (i.e. , the source and the destination belong to the same subnet), desired routing information can be found from the source's routing table. Otherwise , the subnet identified in the destination node's address will be searched. Then, according to the distance vector, the packets will be routed towards the landmark node of the logical subset. Landmark node is pre specified for every logic subset to keep track of the subnet.

5) LAR (Location Aided Routing):

Location aided routing decreases the overhead of route discovery by utilizing location information for mobile hosts. Such location information may be used using Global Positioning system (GPS). The LAR protocol uses location information (which may be out of date) to reduce the search space for a desired route. Limiting the search space results in less number of route discovery messages.

*6) GPSR (Greedy Perimeter Stateless Routing)***:** Greedy Perimeter Stateless Routing, GPSR[26], is a responsive and efficient routing protocol for mobile, wireless networks. Unlike established routing algorithm which use graph-theoretic notions of shortest paths and transitive reachability to find routes, GPSR exploits the correspondence between *geographic position* and connectivity in a wireless network, by using the positions of nodes to make packet forwarding decisions. GPSR uses *greedy forwarding* to forward packets to nodes that are always progressively closer to the destination. In regions of the network where such a greedy path does not exist (*i.e.*, the only path requires that one move temporarily farther away from the destination), GPSR recovers by forwarding in *perimeter mode*, in which a packet traverses successively closer *faces* of a planar sub graph of the full radio network connectivity graph, until reaching a node closer to the destination, where greedy forwarding resumes. GPRS constructs the networks which cannot scale using priori routing algorithms for wired and wireless networks. There are following classes of networks.

1. Rooftop networks: It is static, non-sparse establishment of large numbers of nodes.
2. Ad-hoc networks: mobile, having variable density, no static infrastructure.
3. Sensor networks: mobile, potentially having large density, large numbers of nodes and resources.
4.**Vehicular networks:** mobile, non-power-constrained networks, widely varying density.

7) DREAM (Distance Routing Effect Algorithm for Mobility.): DREAM protocol [27] is a restricted flooding routing protocol used in infrastructure less architectures. In this protocol each node maintains a location table about the position of all nodes of the network and periodically broadcasts location packet, called control packet, to update the position information maintained by its neighbors. Each location packet submitted by one node to other nodes to update their location tables contains its coordinates along with its speed and the time the location packet was transmitted. DREAM uses the principle of distance effect in which the location tables update frequency is determined by the distance of the registered nodes. In other words, the closer to another node, the more updates sent to this node.

8) Geo-cast Routing Protocol:

Geo-cast [30] stands for the delivery of information to a group of destinations in a network identified by their geographical locations. It is a special case of multicast addressing used by some routing protocols for mobile ad hoc networks. Geographic addressing and routing has

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wide range of applications in geographic messaging, geographic advertising, delivery of geographically restricted services, and presence discovery of a service or mobile network participant in a limited geographic area.

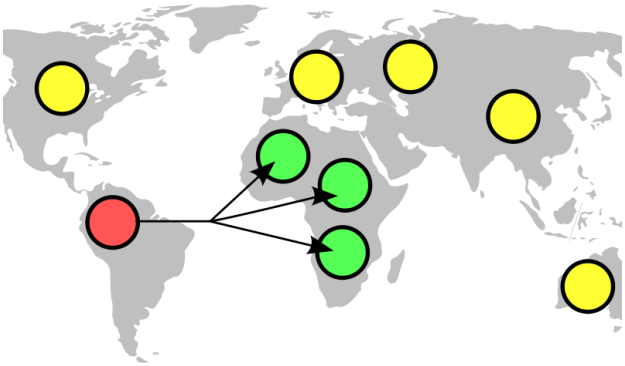

Fig 4. A node delivering the information to group of nodes in the network based on the geographical location.

9) FSR (Fish Eye State Routing):
Fisheye State Routing [31] is a link state type protocol which maintains a topology map at each node. To reduce the overhead incurred by control packets, FSR modifies the link state algorithm in the following three ways. First, link state packets are not flooded. Instead, only neighbouring nodes exchange the link state information. Second, the link state exchange in only time-triggered, not even-triggered. Third, instead of transmitting the entire link state information at each iteration, FSR uses different exchange intervals for different entries in the table. To be precise, entries corresponding to nodes that are nearby (within a predefined scope) are propagated to the neighbours more frequently than entries of nodes that are far away. These modifications reduce the control packet size and the frequency of transmission.

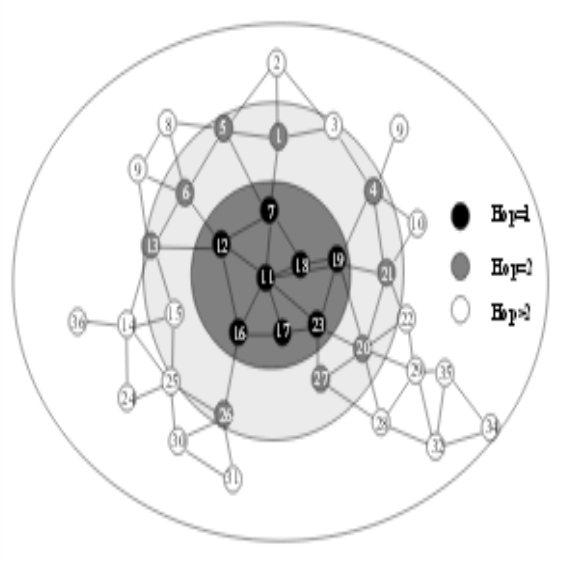

Fig 5. Scope of fisheye.

10) OLSR(Optimized Link state routing protocol): The **Optimized Link State Routing Protocol [28]** is an IP routing protocol which is optimized for mobile ad-hoc networks, which is also used on other wireless ad-hoc networks. OLSR is a proactive link-state routing protocol, which uses *hello* and *topology control* (TC) messages to discover and then spread link state information in the complete mobile ad-hoc network. Individual nodes use this topology information to compute next hop destinations for all nodes in the network using shortest hop forwarding paths. OLSR does not take care about reliability; it floods topology data often enough to make sure that the database does not remain unsynchronized for extended periods of time. The routing overhead generated, while generally greater than that of a reactive protocol, does not increase with the number of routes being created.

OLSR makes use of "Hello" messages to find its one hop neighbours and its two hop neighbours through their responses. The sender can then select its multipoint relays (MPR) based on the one hop node that offers the best routes to the two hop nodes. Each node has also an MPR selector set, which enumerates nodes that have selected it as an MPR node. OLSR uses topology control (TC) messages along with MPR forwarding to disseminate neighbour information throughout the network.

11) TBRPF (Topology-Based Reverse Path Forwarding):
It is a proactive, link-state routing protocol [29] which provides hop-by-hop routing along shortest paths to each destination. In this protocol each node, uses an algorithm similar to dijkstra and computes a source tree that is based on partial topology information stored in a topology table. The Source Tree provides the shortest paths to all reachable nodes.LSP Dissemination is sent over 'Source Trees'. A combination of periodic and differential updates is used to keep all neighbors informed. It consists of two modules which are

1. Neighbor Discovery Module
2. LSP Dissemination Module ("routing module")

Neighbor Discovery is done by using HELLO messages from all neighbours. Dissemination Module performs topology discovery and route computation..

Proactive Protocols (Table driven)
This protocol consist of the distance vector based protocol WRP and the linked state based protocol FSR. Each node in the network maintains information about every other network edge by using periodic or event-triggered routing update exchanges. These types of routing protocols generally have very high overhead due to the route. Updates exchanged periodically but very low latency for packet forwarding as the requested route path is already known. **Examples-** Destination Sequenced Distance Vector Routing Protocol (DSDV), Wireless Routing Protocol (WRP), and Optimized Link State Routing Protocol (OLSR) etc [4].

A. Destination-Sequenced Distance-Vector (DSDV) Protocol The Table-driven DSDV protocol is a modified

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version of the Distributed Bellman-Ford (DBF) Algorithm that was used successfully in many dynamic packet switched networks. In DSDV, each node is required to transmit a sequence number, which is periodically increased by two and transmitted along with any other routing update messages to all neighbouring nodes.

B. Wireless Routing Protocol (WRP)
Wireless Routing Protocol (WRP) is a distance vector based protocol designed for ad hoc networks. WRP modifies and enhances distance vector routing in the following three ways. First, when there are no link changes, WRP periodically exchanges a simple HELLO packet rather than exchanging the whole route table. If topology changes are perceived, only the 'path-vector' tuples contain the destination, distance, and the predecessor (second-to-last-hop) node ID. Second, to improve reliability in delivering update messages, every neighbour is required to send acknowledgments for update packets received. Retransmissions are sent if no positive acknowledgements are received within the timeout period. Third, the predecessor node ID information allows the protocol to recursively calculate the entire path from source to destination.

Reactive Protocol (On-demand*)*
On- demand or reactive routing protocols (DSR) are proposed specifically for ad hoc networks. These protocols do not maintain permanent route table. Instead, routes are built by the source on demand. These types of routing protocols determine route paths when required by using data dissemination techniques such as flooding. On-demand protocols are generally associated with low overheads and have been known to have good scalability properties due to the transmission of control messages in the system only when necessary. They usually have a high latency for packet forwarding as the routing path discovery is initiated when there is data to be sent. **Examples –** AODV, DSR

A. Ad Hoc On-demand Distance Vector (AODV)
The Ad Hoc On-demand Distance Vector Routing (AODV) protocol is a reactive uni cast routing protocol for mobile ad hoc networks. As a reactive routing protocol, AODV only needs to maintain the routing information about the active paths. In AODV, the routing information is maintained in the routing tables at all the nodes. Every mobile node keeps a next hop routing table, which contains the destinations to which it currently has a route [12]. A routing table entry expires if it has not been used or reactivated for a pre-specified expiration time. In AODV, when a source node wants to send packets to the destination but no route is available, it initiates a route discovery operation. In the route discovery operation, the source node broadcasts route request **(RREQ**) packets which includes Destination Sequence Number. When the destination or a node that has a route to the destination receives the **RREQ**, it checks the destination sequence numbers it currently knows and the one specified in the RREQ.

B. Dynamic Source Routing (DSR)
DSR is a pure reactive routing protocol which is based on the concept of source routing. DSR protocol is composed of two important phases: *route discovery* and *route maintenance.* DSR does not employ any periodic routing advertisement packets, link status sensing or neighbour detection packets [15]. Therefore, the routing packet overhead is less because of its on-demand nature. Every node maintains a route cache to store recently discovered paths. Whenever a route is required for a particular destination then that particular node will consult route cache to determine whether it has already a route to the destination or not. If available route is not expired then that route will be used otherwise a route discovery process is initiated by broadcasting the *route request packet (RREQ)*. When any of the nodes receives RREQ packet, the node will check from their cache or from their neighbours whether it knows a route to the destination. If it does not, the node will add its own address to the route record of the packet and forwards it to their neighbours. Otherwise; a *route reply packet (RREP)* is generated that is uni-cast back to the original source.

3. Hybrid Protocols
Hybrid protocol combine characteristics from active and passive routing protocols to achieve properties such as hierarchical routing. These types of protocol are generally implemented in clustered networks, where nodes are grouped into small clusters to form smaller networks within a large network. Intra-cluster routing among nodes are usually proactive, while Inter-cluster routing is done on-demand. Examples are Zone Routing Protocol (ZRP). Some of these protocols have been submitted for RFCs (Request for Comments) to the IETF while others are still being improved upon. Extensions to these protocols have also been developed that make use of redundant paths for the specialized case of multicast routing where a sender tries to transmit data to multiple receivers. **Examples -** Ad hoc On-Demand Multiple Distance Vector Routing Protocol (AOMDV), Multipath Dynamic Source Routing Protocol (MDSR) etc.

III. PROPOSED PROBLEM AND SOLUTION

The objective of this paper is to study the simulation and comparison in mobile ad hoc networks and evaluate proposed routing protocols for wireless ad hoc networks based on performance. This evaluation could be done through simulation. The work comprises to simulate and implement Mobile Ad Hoc Routing protocol and detect the various possible properties of various protocols. The simulation environment that could be used as a platform is based on Network Simulator NS-2. The IETF currently has a working group named Mobile Ad hoc Network (MANET) that is working on routing specifications for Ad hoc Networks. Mobile networks that meet the demand for instantaneous communications establishment are called

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Mobile Ad hoc Networks. Like the Internet, datagram in an ad hoc network may travel along multiple hops until they reach their destination. In ad hoc networks, routing is a major challenge. Several routing protocols for ad hoc networks emphasis on stable and shortest routes while ignoring major issue of delay in response whenever break occurs. Some other areas of consideration are [4]:-

- A general understanding idea of ad-hoc networks.
- Security techniques in ad hoc networks.
- Implement the proposed routing protocols for wireless networks and ad hoc network.
- Analyze the protocols through simulation in different mobility scenarios.

A. Simulation Parameters For AODV, DSDV & WRP Routing Protocol

In this analysis, we have chosen the simulation of 5 nodes in 500x400 square meter area, in other words we have chosen two dimensional area (2D) rectangles. The position of each mobile node is represented in 2D grid, the X-axis value is chosen from the range of (0,500) and Y-axis value is chosen from the range of (0,400). The mobile node then moves to the destination at given speed. Once the destination is reached, the mobile node stops for a given pause time. The mobile node then chooses another random destination for mobile node's next movement. The complete simulation parameter are-

1. Numbers of nodes – (5) this is constant during the simulation. We used 5 nodes for simulations.

2. Total simulation time – (270 sec.) The time for which simulations will be run i.e. time between the starting of simulation and when the simulation ends.

3. Transferred packet size – (512 bytes) Packet Delivery Ratio in this simulation is defined as the ratio between the numbers of packets sent by constant bit sources (CBR) and numbers of packets received by CBR sink at destination.

4. Routing protocol – AODV, DSDV& WRP.

5. Network size – 500*400(square meter) It determines the number of nodes and size of area that nodes are moving within. Network size basically determines the connectivity.

6. Pause time – (0.01 sec) Nodes will stop a "*pause time*" amount before moving to another destination point.

7. Traffic type – Constant Bit Rate. In the simulation work we, apply same parameters for each MANET routing protocol (AODV, DSDV & WRP).

IV.SIMULATION AND PERFORMANCE ANALYSIS OF AODV, DSDV, AND WRP

The simulation results are focused in analyzing the performance on routing overhead, throughput and packet delivery ratio. The performance of the AODV,DSDV and WRP has been analyzed on the ns2 simulator on the basis of various performance metrics such as the packet delivery ratio, average routing overhead, average throughput, average end –to- end delay.

Performance Metrics - Mobile ad hoc networks have several inherent characteristics (e.g. dynamic topology, time varying and bandwidth constrained wireless channels, multi-hop routing, and distributed control and management). Design and performance analysis of routing protocols used for mobile ad hoc network (MANET) is currently an active area of research. To judge the merit of a routing protocol, one needs metrics—both qualitative and quantitative--with which to measure its suitability and performance. Specifically, this paper evaluates the performance comparison of AODV, DSDV and WRP protocols on the following performance metrics: Average routing overhead, Packet delivery ratio and end-to-end delay, Throughput.

1. Packet Delivery Ratio (PDR) - The number of data packets sent from the source to the number of received at the destination.
PDR = (control packets sent-delivery packet sent) / (control packets sent).

2. Average routing head (ARH) - Average routing overhead is the total number of routing packets divided by total number of delivered data packets.ARH=Total no of routing packets/Total no of delivered data packets.

3. Average End-to-End Delay (AEED) - Average End-to-End delay (seconds) is the average time it takes a data packet to reach the destination.

4. Throughput - The rate of successfully transmitted data per second in the network during the simulation.

TABLE 1
SIMULATION PARAMETERS

Parameter	Value
No. of Nodes	5
Simulation Time	270 sec.
Network Size	500*400
Pause Time	0.01 sec.
Traffic Type	Constant Bit
Packet Size	512 bytes
Routing Protocol	AODV, DSDV WRP

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A. Average Routing Head (ARH)

ARH shows that the Random Direction Model is generated the highest routing overhead compared with the other mobility model due to the movement of the each MN are being forced to the border of the simulation area before changing direction. Random Waypoint Model performs lowest routing overhead and it's good for the routing communication. All the mobility models show that the routing overhead is increased when the number of nodes is increased.

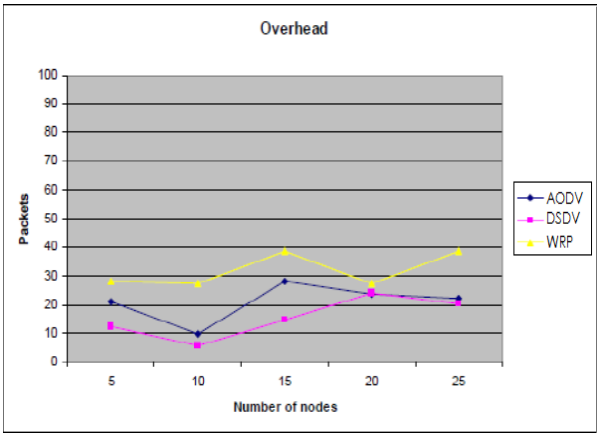

Fig.6. Average Routing Head (ARH)

B. Packet Delivery Ratio (PDR)

This figure shows Random Waypoint Model performed better in delivering packet data to destination by considering the pause time every time changing their directions.

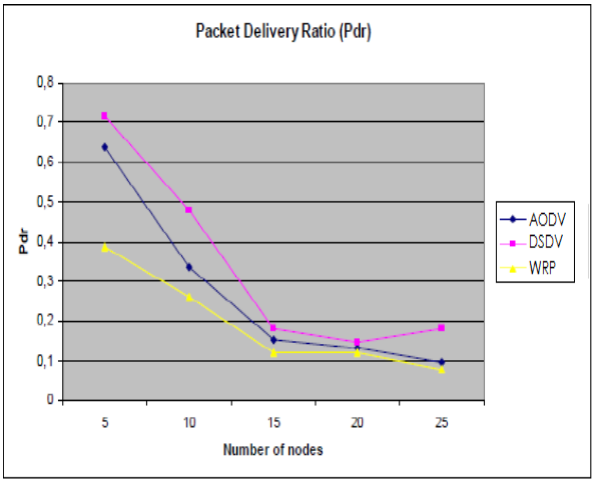

Fig.7. Packet Delivery Ratio (PDR)

C. Throughput

The relative throughput performance of three routing protocols although implicitly related to the pause time metric, we found it relevant to use another terminology for the "mobility" of the nodes, which basically show how fast the nodes are moving to a wide range of speeds for our mobile nodes from 1 m/s (3.6 km/hour) that corresponds to walking at a slow pace, to 50 m /s (180 km/hour).

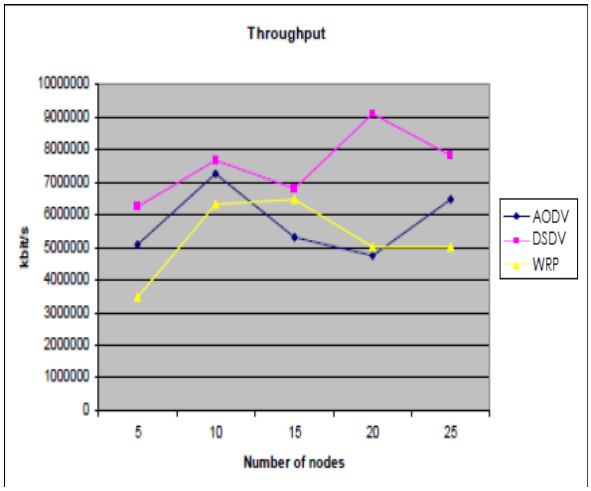

Fig.8. Throughput

V. CONCLUSION

This paper presents a performance & simulation of routing protocols which are proposed for ad-hoc mobile networks and also provides a classification of these protocols according to the routing strategy (i.e. table driven and on-demand routing protocol). It has also presented a comparison of AODV, DSDV and WRP, and reveals their average routing head (ARH) packet delivery ratio and throughput. The performance of these protocols is analyzed with NS2 simulator with scenario of 5 nodes. The observations are made with variation in node speed in network. After analysis in different situations of network it is to be observed that AODV perform better than DSDV and WRP in terms of throughput and average routing head while WRP is proved to be best in case of packet delivery ratio. If reliability and throughput are main parameters for selection then AODV gives better results compared to others because its throughput is quite good as compared to others.

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