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Reactive and Proactive Routing Protocols Performance Metric Comparison in Mobile Ad Hoc Networks NS 2

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Abstract: Wireless networks use some sort of radio frequencies in air to transmit and receive data instead of using some physical cables. The most admiring fact in these networks is that it eliminates the need for laying out expensive cables and maintenance costs. When we are setting up a wireless network at home or in the office, there are many features available to you with the network installation. From sharing information directly to connecting to the same Internet source, wireless networks may using multiple computers in the same location far easier than having each computer run individually. The purpose of this paper is to study, understand, analyze and performance comparison between two mobile ad-hoc routing protocols DSDV and AODV where the first one is a proactive protocol and other one is a reactive protocol. DSDV is best suited for only smaller networks and AODV is suited for large-scale mesh networks.The performance of the AODV is better than the performance of the DSDV routing protocol. A network simulator- called MobiREAL simulator has been designed and developed for performance evaluation of AODV and DSDV routing protocol in this paper. To compare the performance of AODV and DSDV routing protocol, the simulation results were analyzed by graphical manner and trace file based on Quality of Service metrics: such as throughput, PDR and delay. In this paper we simulate performance with different node such as $5,15,30,40,60,80$ and 100 and different mobility speed such as $25m/s, 35m/s$ and $50m/s$.

Keywords: DSDV, AODV,MANET,PDR,Throughput, delay, NS-2 and QoS

I. INTRODUCTION

A Mobile Ad hoc Networks represents a system of wireless mobile nodes that can freely and dynamically self-organize in to arbitrary and temporary network topologies, allowing people and devices to seamlessly communicate without any pre-existing communication architecture. Each node in the network also acts as a router, forwarding data packets for other nodes. A central challenge in the design of ad hoc networks is the development of dynamic routing protocols that can efficiently find routes between two communicating nodes. An Ad hoc routing protocol is a convention or standard that controls how nodes come to agree which way to route packets between computing devices in a mobile ad hoc network (MANET). Initially Computer networks were started as a necessity for sharing files and printers but later this has moved from that particular job of file and printer sharing to application sharing and business logic sharing. Proceeding further Tenenbaum [1] defines computer networks as a system for communication between computers. These networks may be fixed (cabled, permanent) or temporary.

A network can be characterized as wired or wireless. Wireless can be distinguished from wired as no physical connectivity between nodes are needed.

Due to the limited wireless transmission range of each node, data packets then may be forwarded along multihops. Route construction should be done with a minimum of overhead and bandwidth consumption. Since their emergence in the 1970s, wireless networks have become increasingly popular in the computing industry. This is particularly true within the past decade, which has seen wireless networks being adapted to enable mobility. AODV is perhaps the most well-known routing protocol for MANET [2], which is a hop-by-hop reactive (On demand) source routing protocol, combines DSR and DSDV mechanisms for routing, by using the on-demand mechanism of routing discovery and route maintenance from DSR and the hop-by-hop routing and sequence number from DSDV. For each destination, AODV creates a routing table like DSDV, while DSR uses node cache to maintain routing information [3]. It offers quick adaptation to dynamic link conditions, low processing and

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memory overhead, low network utilization, and determines unicast routes to destinations within the Ad-hoc network [2]. Destination-Sequenced Distance Vector (DSDV) routing protocol is a typical routing protocol for MANETs, which is based on the Distributed Bellman-Ford algorithm [4]. In DSDV, each route is tagged with a sequence number which is originated by destination, indicating how old the route is [3]. All nodes try to find all paths to possible destinations nodes in a network and the number of hops to each destination and save them in their routing tables. New route broadcasts contain the address of destination, the number of hops to reach the destination, the sequence number of the information receive regarding the destination, as well as a new unique sequence number for the new route broadcast [3].

Our goal is to carry out a systematic performance study of three routing protocol for ad hoc networks Ad hoc On Demand Distance Vector (AODV) and Destination Sequenced Distance Vector (DSDV).

II. CLASSIFICATION OF ROUTING PROTOCOL IN MANET'S

First, confirm Classification of routing protocols in MANET's can be done in many ways, but most of these are done depending on routing strategy and network structure [5, 6]. According to the routing strategy the routing protocols can be categorized as Table-driven and source initiated, while depending on the network structure these are classified as flat routing, hierarchical routing and geographic position assisted routing [5]. Both the Table-driven and source initiated protocols come under the Flat routing see figure 1.

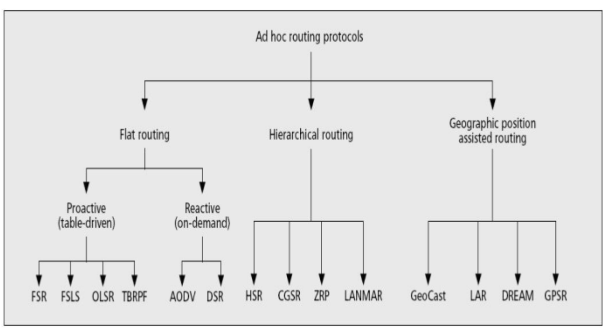

Figure 1: Classification of Routing Protocols In Mobile Ad-hoc Networks.

III. AD-HOC ON-DEMAND DISTANCE VECTOR

Define Reactive protocols discover routes only as needed. When a node wishes to communicate with another node, it checks with its existing information for a valid route to the destination. If one exists, the node uses that route for communication with the destination node. If not, the source node initiates a route request procedure, to which either the destination node or one of the intermediate nodes sends a reply back to the source node with a valid route [7]. A soft state is maintained for each of these routes, if the routes are not used for some period of time, the routes are considered to be no longer needed and are removed from the routing table. Example of this type algorithm is DSR and AODV.

AODV is a reactive protocol, even though it still uses characteristics of a proactive protocol [8]. AODV takes the interesting parts of DSR and DSDV in the sense that it uses the concept of route discovery and route maintenance of DSR and the concept of sequence numbers and sending of periodic hello messages from DSDV.

The protocol uses different messages to discover and maintain links:

- **Route Requests (RREQs):**Route request packet is filled through the entire network when path is not accessible for target system or end system. The opinion are covered in the route request packet are as follows.

- Initiator address
- Request id
- Initiator sequence number
- Destination Address
- Target Sequence Number
- Hop count

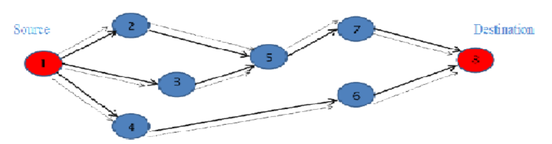

Figure 2: Propagation of Route Request (RREQ) Packet.

A Route request is standard by the initiator information and the request ID, each and every time source system send a new request and request ID is increased. After some times receives of request information, every node verify the appeal ID and initiator address match up. The new route request is lasting, if there is existing path request information with equal join up of point of view.

- **Route Reply Message:**Route Reply Message on having a suitable path to target, if that node is target, a path reply (RREP) message is sent to the source by the node.

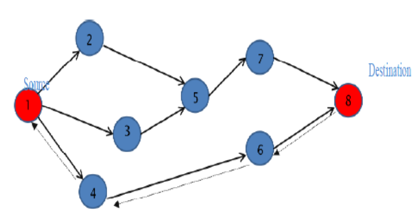

Figure 3: Propagation of Route Reply (RREP) Packet.

- **Route Error message:** The neighbourhood nodes are monitored. When a route that is active is vanished, the neighbourhood nodes are notified by RERR (Route Error Message) on both sides of link.

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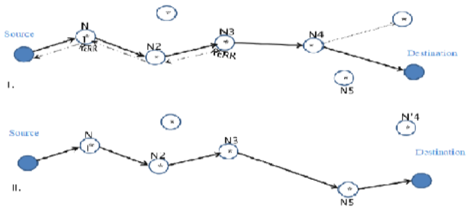

Figure 4: I. Route Error II. Route maintenance

- **HELLO messages:** These are broadcasted in order to know neighbourhood nodes. The neighbourhood nodes are in a straight away communicated. In AODV, HELLO messages are broadcasted in order to tell the nearest neighbours about the creation of the linkage. These messages are not broadcasted for the reason that of short time to live with a value equal to one.

A. *Advantages*

The advantages of AODV are as follows -

- Routes are established on demand and destination sequence numbers are used to find the latest route to the destination.
- Lower delay for connection setup.

B. *Disadvantages*

The disadvantages of AODV are as follows -

- AODV doesn.t allow handling unidirectional links.
- Multiple Route Reply packets in response to a single Route Request packet can lead to heavy control overhead.
- Periodic beaconing leads to unnecessary bandwidth consumption.

IV. DESTINATION-SEQUENCED DISTANCE VECTOR

DSDV is one of the most well known table-driven routing algorithms for MANETs. The DSDV routing algorithm is based on the classical Bellman-Ford Routing Algorithm (BFRA) with certain improvement [4]. Every mobile station maintains a routing table with all available destinations along with information like next hop, the number of hops to reach to the destination, sequence number of the destination originated by the destination node, etc. DSDV uses both periodic and triggered routing updates to maintain table consistency.

The broadcasting of the information in the DSDV protocol is of two types namely: full dump and incremental dump. Full dump broadcasting will carry all the routing information while the incremental dump will carry only information that has changed since last full dump. Irrespective of the two types, broadcasting is done in network protocol data units (NPDU). Full dump requires multiple NPDU's while incremental requires only one NPDU to fit in all the information.Mobile nodes cause broken links when they move from place to place. When a link to the next hop is broken, any route through that next hop is immediately assigned infinity metric and an updated sequence number. This is the only situation when any mobile node other than the destination node assigns the sequence number. Sequence numbers assigned by the origination nodes are even numbers, and sequence numbers assigned to indicate infinity metrics are odd numbers. When a node receives infinity metric, and it has an equal or later sequence number with a finite metric, it triggers a route update broadcast, and the route with infinity metric will be quickly replaced by the new route. When a mobile node receives a new route update packet; it compares it to the information already available in the table and the table is updated based on the following criteria:

- If the received sequence number is greater, then the information in the table is replaced with the information in the update packet.
- Otherwise, the table is updated if the sequence numbers are the same and the metric in the update packet is better.

A. *Advantages*

The advantages of DSDV are as follows -

- DSDV protocol loop free paths .
- Count to infinity problem is reduced in DSDV .
- We can avoid extra traffic with incremental updates instead of full dump updates.
- Path Selection: DSDV maintains only the best path instead of maintaining multiple paths to every destination. With this, the amount of space in routing table is reduced.

B. *Disadvantages*

The disadvantages of AODV are as follows -

- DSDV requires a regular update of its routing tables, which uses up battery power and a small amount of bandwidth even when the network is idle.
- Whenever the topology of the network changes, a new sequence number is necessary before the network re-converges; thus, DSDV is not suitable for highly dynamic networks.

V. SIMULATION ANALYSIS AND PERFORMANCE METRICS

For the simulation of the developed system, latest version 2.34 of NS-2 has been used in this paper. Ns-2 is a discrete event simulator targeted at networking research [9]. It began as a part of the REAL network simulator and is evolving through an ongoing collaboration between the University of California at Berkeley and the VINT project [10].

A. *Performance Metrics*

The following different performance metrics are evaluated to understand the behavior of DSDV and AODV routing protocols

- Throughput
- The average end to end delay

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- Packet Delivery Ratio

B. *NS2 Environment*

We have used Linux for NS2.The hardware specification of the Linux that we have used is an follows.
Processor: Intel(R)Core(TM)i3CPU M 370@2.40
Linux Kernel Version: Linux 2.6.18-53.el5 i686
Total Memory: 515524 KB

The Simulation environment that we have used for my simulation are:

TABLE I
SIMULATION ENVIRONMENT.

Parameter	Values
Simulator	NS2(Version 2.34)
Channel Type	Channel/Wireless Channel
Radio-propagation model	Propagation/TwoRayGround
Network Interface Type	Phy/WirelessPhy
MAC Type	Mac/802.11
Interface Queue Type	Queue/DropTail/PriQueue
Link Layer Type	LL
Antenna Model	Antenna/OmniAntenna
Maximum packet in ifq	50
Area(M*M)	800
Source Type	CBR
Routing Protocol	DSDV and AODV

C. *Simulation Model*

The objective of this paper is the performance evaluation of two routing protocol for mobile ad hoc networks by using an open-source network simulation tool called NS-2. Two routing protocols: DSDV and AODV have been considered for performance evaluation in this work. The simulation environment has been conducted with the LINUX operating system, because NS-2 works with Linux platform only.

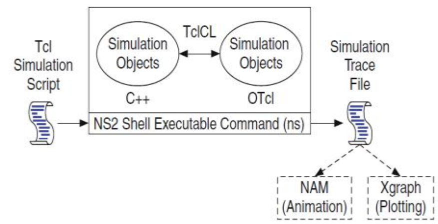

Figure 5: Simulation Overview.

Whole simulation study is divided into two part one is create the node (that may be cell phone, internet or any other devices) i.e. NS-2 output. It.s called NAM (Network Animator) file, which shows the nodes movement and communication occurs between various nodes in various conditions or to allow the users to visually appreciate the movement as well as the interactions of the mobile nodes. And another one is graphical analysis of trace file (.tr). Trace files contain the traces of event that can be further processed to understand the performance of the network.
Figure 5 depicts the overall process of how a network simulation is conducted under NS-2. Output files such as trace files have to be parsed to extract useful information. The parsing can be done using the awk command (in UNIX and LINUX, it is necessary to use gwak for the windows environment) or perl script. The results have been analyzed using Excel or Matlab. A software program which can shorten the process of parsing trace files (Xgraph and TraceGraph) has also been used in this paper. However, it doesn.t work well when the trace file is too large. To generate trace file and nam file, we call tcl script in CYGWIN command shell. By varying the simulation parameter shown in table 1, we can see the graphical variation between various performance metrics like throughput, PDR, delay, jitter etc.

D. *Result*

Generated trace file that is (.tr)
s -t 2.000000000 -Hs 1 -Hd -2 -Ni 1 -Nx 282.78 -Ny 298.25 -Nz 0.00 -Ne 10.000000 -Nl AGT -Nw — -Ma 0 -Md 0 -Ms 0 -Mt 0 -Is 1.0 -Id 3.0 -It cbr -Il 210 -If 0 -Ii 0 -Iv 32 -Pn cbr -Pi 0 -Pf 0 -Po 1
r -t 2.000000000 -Hs 1 -Hd -2 -Ni 1 -Nx 282.78 -Ny 298.25 -Nz 0.00 -Ne 10.000000 -Nl RTR -Nw — -Ma 0 -Md 0 -Ms 0 -Mt 0 -Is 1.0 -Id 3.0 -It cbr -Il 210 -If 0 -Ii 0 -Iv 32 -Pn cbr -Pi 0 -Pf 0 -Po 1
setdest Syntax:
setdest -n val -M val -P val -t val -x val -y val
Setdest is a command used to create the runtime environment for NS2.
-n: Numbers of nodes.
-M:speed(Mobility).
-P:pause time.
-t:similuation time.

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-x: x coordinate.
-y:y coordinate.

E. *Nam file output*

NAM is a Tcl/TK based animation tool for viewing network simulation traces and real world packet traces. A network animator that provides packet-level animation and protocol-specific graphs to aid the design and debugging of new network protocols have been described. Taking data from network simulators (such as ns) or live networks, NAM was one of the first tools to provide general purpose, packet-level, and network animation, before starting to use NAM, a trace file needs to create [10]. This trace file is usually generated by NS. Once the trace file is generated,NAM can be used to animate it. A snapshot of the simulation topology in NAM for 16 mobile nodes is shown in figure 6, which is visualized the traces of communication or packets movements between mobile nodes [11]. And figure 7 shows the running TCL script in cygwin command shell.

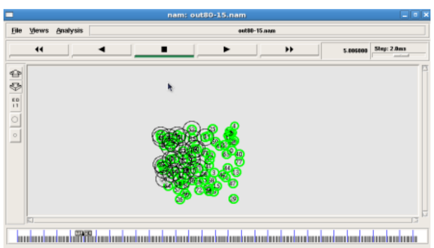

Figure 6: AODV-node Communication(Hellow Message)

VI. GRAPHICAL ANALYSIS

A. *Delay*

Avoid the stilted expression, 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 [16]. Mathematically it can be shown as equation 1

$$d_{end-end} = N[d_t rans + d_p rop + d_p roc] \qquad (1)$$

Where

$d_{end-end}$ = End to end delay

$d_t rans$ = Transmission delay

$d_p rop$ = Propagating delay

$d_p roc$ = 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.

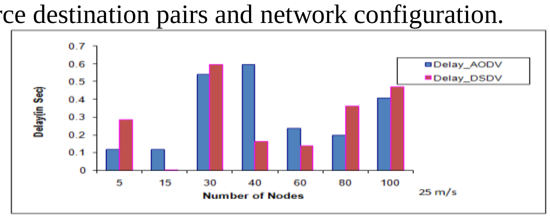

Figure 7: Delay at 25*m/s*.

In this above figure at $25m/s$ we say that DSDV shows comparatively more delay.

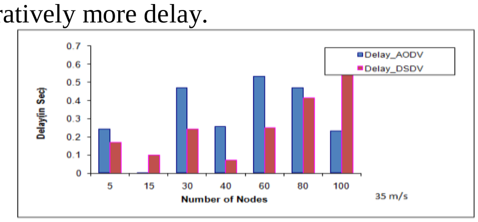

Figure 8: Delay at $35m/s$.

In this above figure at $35m/s$ we say that AODV gives the better performance.

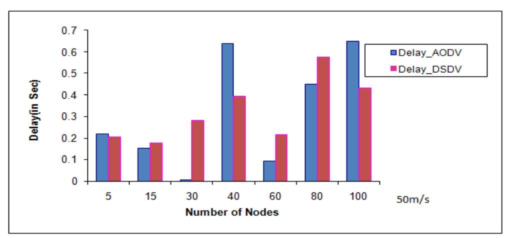

Figure 9: Delay at $50m/s$.

In this above figure at $50m/s$ we say that AODV may be better in the long run.

B. *Packet Delivery Ratio*

It is the ratio between the number of packets delivered to the receiver and the number of packets sent by the source. The ratio of the data packets delivered to the destinations to those generated by the CBR sources; also, a related metric, received throughput (in kilobits per second) at the destination has been evaluated in some cases. PDR is determined as:

$$PDR = \frac{P_r}{P_s} * 100$$

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where P_r is the total packets received and P_s is the total packets sent.

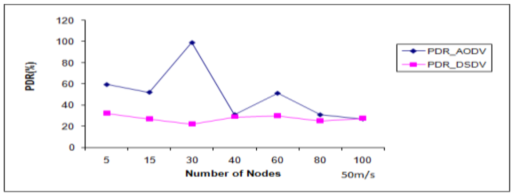

Figure 10: Packet Delivery Ratio (PDR) at $25m/s$.

In this above figure at $25m/s$ we say that AODV is better than DSDV.Packet Delivery Ratio (PDR) is defined as the ratio of data packets delivered successfully to destination nodes and the total number of data packets generated for those destinations.

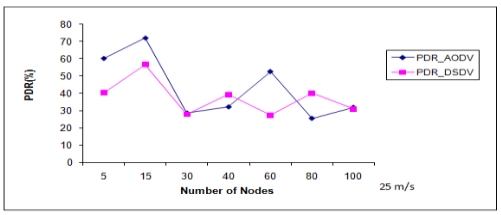

Figure 11: Packet Delivery Ratio (PDR) at $35m/s$.

In this above figure at $35m/s$ we say that AODV is best and in the long run it shows very good result.

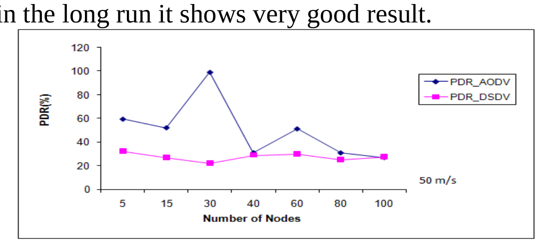

Figure 12: Packet Delivery Ratio (PDR) at $50m/s$.

In this above figure at $50m/s$ we say that AODV is better than DSDV , but when the number of nodes is increased we see that AODV shows linear increase while DSDV shows constant rate.

C. *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 . 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 . A high throughput is absolute choice in every network.

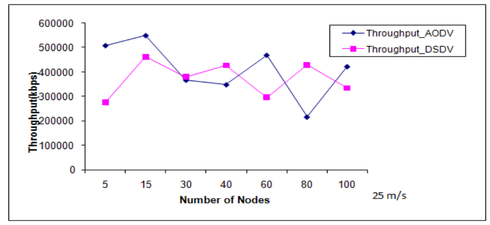

Figure 13: Throughput at $25m/s$.

In this above figure at $25m/s$ we say that AODV is shows good result and in the long run its shows constant throughput.

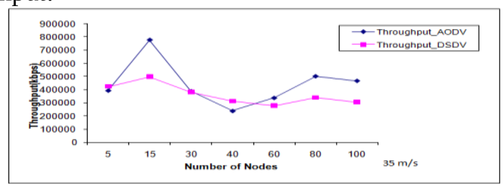

Figure 14: Throughput at $35m/s$.

In this above figure at $35m/s$ we say that AODV shows very good throughput and others throughput shows linear decrease.

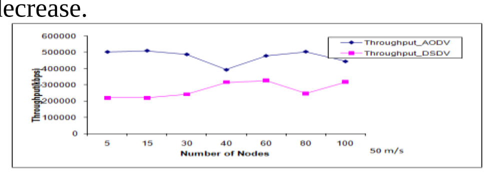

Figure 15: Throughput at $50m/s$.

In this above figure at $50m/s$ we say that AODV is better as compared to DSDV.

VII. RESULT

The delay is shown in figure 7 here we take the number of nodes is 7. We see that out of 7 nodes , 6 nodes that DSDV shows comparatively more delay. In figure 8 and figure 9 shows here we take the number of nodes is 7. We see that out of 7 nodes , 5 nodes shows that AODV may be better in the long run.

The packet delivery ratio is shown in figure 10 and figure 12 we take the number of nodes is 7. We see that out of 7 nodes , 6 nodes that we say that AODV is better than DSDV. In figure 11 we take the number of nodes is 7. We see that out of 7 nodes , 5 nodes that we say that AODV is better than DSDV , but when the number of nodes is increased we see that AODV shows linear increase while DSDV shows constant rate.

The throughput is shown in figure 13, we take the number of nodes is 7. We see that out of 7 nodes , 4 nodes that AODV is shows good result and in the long run its shows constant throughput. In figure 14, we take the number of nodes is 7. We see that out of 7 nodes , 5 nodes that AODV is shows good result and in the long run its shows constant throughput.In figure 15, we take the number of nodes is 7. We see that out of 7 nodes , 7 nodes that AODV is better as compared to DSDV.

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After analysis is done using random runtime environment of $NS2$ because of which we have come across sharp increase and decrease for some values in the graph.So after analyzing all the graphs of different parameters at different mobility, we find that AODV gives better result for all the performance metrics.

VIII. CONCLUSION

After the execution,we seen that AODV indicating its highest efficiency and performance under high mobility than DSDV, and the performance of TCP and UDP packets with respect to the delay, throughput and PDR, and the performance of AODV is better than DSDV routing protocol for real time applications from the simulation results.

In this paper, DSDV and AODV routing protocol using different parameter of QoS metrics have been simulated and analyzed. As a reactive protocol AODV transmits network information only on-demand and DSDV maintains table driven routing mechanism as proactive routing protocol.DSDV and AODV routing protocol, packet delivery ratio is independent of offered traffic load. AODV protocols delivering 60% to 80% of the packets in all cases, while DSDV delivering 30% to 65%.DSDV packet delivery fraction is very low for high mobility scenarios.So we can conclude that AODV indicating its highest efficiency and performance under high mobility than DSDV. Simulation results show the performance of TCP and UDP packets with respect to the average end to end delay, throughput, and PDR. Finally, it is concluded that the performance of AODV is better than DSDV routing protocol for real time applications.

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