Performance Variations of AODV, DSDV and DSR Protocols in MANET under CBR Traffic using NS-2.35

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Abstract
Basically Mobile Ad Hoc Network (MANET) is an autonomous system with the collection of mobile nodes, these nodes are connected to each other by using wireless networks. A mobile ad hoc network poses this quality which makes topology in dynamic manner. As this type of network is Ad Hoc in nature hence it doesn't have fixed infrastructure. If a node wishes to transfer data from source node to a sink node in the network, the data must be passed through intermediate nodes to reach the destination node, hence in this process data packet loss occurs in various MANET protocols. This research study gives a comparison of various Mobile Ad Hoc Network routing protocols like proactive (DSDV) and reactive (AODV, DSR) by using random topology with more intermediate nodes using CBR traffic. Our simulation used 50, 100, and 150 nodes variations to examine the performance of the MANET routing protocols. We compared the performance of DSDV, AODV and DSR, MANET routing protocols with the result of existing protocol using NS-2 environment, on the basis of different performance parameters like Packet Delivery Ratio, average throughput and average end to end delay. Finally we found that our results are better in terms of throughput and packet delivery ratio along with low data loss.

Keywords:

MANET, NS-2, AODV, DSDV, DSR, FTP, PDR.

1. Introduction

Mobile ad hoc networks (MANET) consist of wirelessly connected mobile routers that self configure and are infrastructure free, a random graph is formed by the combination of these elements. Infrastructure that is present in fixed networks is absent in the MANET. In routing, information groups (usually called packets) are transported through an internetwork by determining the optimal routing paths. The routers are free to move around randomly and arrange themselves arbitrarily, so the topology of the wireless network may change quickly and unpredictably. It may operate independently, or it may be connected to the larger Internet. In this Study, using the random topology, we have simulated a mobile ad hoc network with 50, 100 and 150 nodes. Using various simulation parameters in NS2, the performance of the MANET was assessed based on AODV, DSR and DSDV protocols.

This research study is divided into the following sections:

Section I – Introduction
Section II – Previous Work
Section III – System and Energy Model
Section IV – MANET Routing Protocols
Section V – Simulation Tools and Environment Setup
Section VI – Simulation Results
Section VII – Conclusion

2. Previous Work

In this research, we started by surveying the different

Various research papers have demonstrated the importance of MANET protocols using various performance criteria.

The following are some of the factors that influenced and inspired us to conduct this research:

[I] Ritesh Kumar Mohapatra, Subhasarthak Samantaray Et al. in 2018 performed the analysis and simulation of DSDV, AODV and DSR routing protocols for different node variations and for different performance matrix like throughput, normalized routing overhead, Packet Delivery Ratio and End to End Delay and they observed that DSR is better for parameters throughput, normalized routing overhead and Packet delivery ratio.

[II] The performance of AODV, DSDV & DSR MANET routing protocols was studied and compared with average end to end delay, packet delivery ratio and number of packet dropped by Santosh Kumar

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Soni in 2012 [2], and he observed that performance of DSDV protocol is better for limited number of nodes in the horizontal and vertical topology.

[III] Thakor Hirenkumar Sureshbhai, Makul Mahajan, Mritunjay Kumar Rai in 2018 [3] studied and analyzed the performance of DSDV, AODV and DSR routing protocols based on packet delivery ratio, end to end delay and throughput. Their results shows that, for Throughput and packet delivery ratio performance of DSR protocol is better than AODV and DSDV and performance of DSDV is better than AODV and DSR for end to end delay.

[IV] Murad Ghazy Khalaf Alabdullah, Bassam Mohsin Atiyah, Kaesar Sabah Khalaf and Saber Hameed Yadgar in 2019 [4] provides performance analysis of DSR, DSDV and AODV protocols based on mobility, network size and network load using NS 2 Simulation and observed that AODV and DSR are more efficient than DSDV.

[V] Julia Rahman, Md. Al Mehedi Hasan and Md. Khaled Ben Islam in 2012 [5] done the analysis and simulation of DSDV, AODV and DSR routing protocols for different scenarios and for different performance matrix like throughput, Packet Delivery Ratio, Normalized Routing Load and End to End Delay and they observed that for high density networks DSDV performs good and DSR performs good for smaller network.

[VI] Salma S. Mohamed,Abdel-Fatah and Mohamed A. Mohamed in 2020 [6] discussed the comparison and performance analysis of AODV and DSDV routing protocols based on packet delivery ration, average throughput, energy consumption and average jitter. And simulation result shows that AODV and DSDV protocols are less energy efficient.

3. System and Energy Model

We presented the network model, basic assumptions, energy model and our contribution in this section.

3.1 Network Model

We deployed multiple nodes (50, 100 and 150) in a random topology on a rectangle area with a variety of variations (700x700, 800x800, and 900x900). All nodes are homogeneous and static in nature. One source and one destination is used for simulation.

3.2 Basic Assumptions

In this research study, we have assumed the following:

1. All nodes deployed have a static nature.
2. All nodes are homogeneous.
3. The network environment is free from any physical obstacles.
4. Initially, all WSN nodes have the same amount of energy.
5. Every WSN node shares information with its neighbors.

3.3 Energy Model

In this study, we used first radio energy model [19] as an energy model for calculating energy consumption. Transmission and reception are the two modes of energy consumption. The following equation (1) depicts the transmission of a l-bit message (energy consumption):

$$E_{Tx}(l,d) = \begin{cases} l.E_{elec} + l.\varepsilon_{fs}.d^2, & \text{when } d_0 > d \\ l.E_{elec} + l.\varepsilon_{mp}.d^4, & \text{when } d_0 \le d \end{cases} \quad (1)$$

$$E_{Rx}(l) = l.E_{elec} \quad (2)$$

Where, Energy consumption is represented by E_{elec} . ε_{fs} Represents amplification coefficient for free space model and ε_{mp} represents amplification coefficient for multipath fading model. The equation (2) shows how reception energy consumption is calculated.

3.4 Contribution

In this research study, we contributed the following:

1. Comparison of DSDV, DSR and AODV mobile ad-hoc Network routing protocols with existing result [1] for better performance of our simulation result.
2. Contributed substantially to the concept or design of the research paper.
3. Accepted the version for publication.

4. MANET Routing Protocols

The MANET routing protocols can be categorized into two types: proactive and reactive. Proactive protocols use routing tables formed by the exchange of signals to find another station, while reactive protocols use flooding to find another station. DSDV (Destination Sequenced Distance Vector) is example of proactive routing protocol and examples of reactive routing protocols are AODV (Ad-hoc On-demand Distance Vector) and DSR (Dynamic Source Routing). Following are the brief details of such protocols:

4.1 AODV (Ad-hoc On-demand Distance Vector)

AODV [Fig 4.1] is a reactive routing protocol for MANETs, it is a request based algorithm so only on demand it creates a route to a destination. Any change in the neighbouring topology is informed via a sequence number in AODV. Whenever a route is searched, the sequence number allows the selection of the most current route. By using multicast and unicast routing tables, it saves the corresponding routing information by connecting neighbouring nodes. AODV also reacts to changes in topology that have a rapid impact on active paths. Routes are constructed with very few routing control messages and without any additional network protocol load. As an output, any extra protocol over data packets is not loaded as it does not use resource routing.

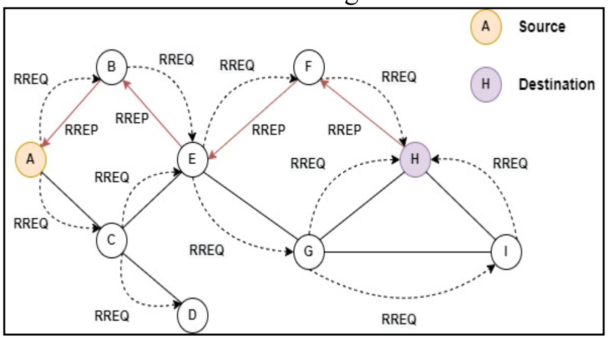

Fig 4.1 – Ad-hoc On-Demand Distance Vector (AODV) MANET Routing Protocol

4.2 DSR (Dynamic Source Routing)

It is a type of reactive routing protocol which reduces the protocol load on the bandwidth of the network, saves energy and eliminates extensive routing updates across the network. Route guard and route search are the two main operating models in DSR. A node can find its way to any destination using DSR [Fig 4.2] along with multiple network tabs. Instead of transmitting a signal the host machine enters the sleep state, battery power is maintained in the mobile hosts and there is no compulsion to send and receive ad messages. DSR has the advantage that it does not require the acceptance of any symmetrical connections and it responds faster to changes than distance vector based protocols.

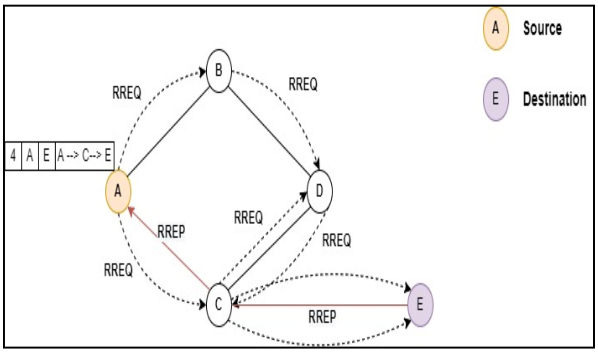

Fig 4.2 – Dynamic Source Routing (DSR) MANET Routing Protocol

4.3 DSDV (Destination Sequenced Distance Vector)

DSDV [Fig 4.3] is based on the algorithm of Distributed Bellman-Ford. The basic Distributed Bellman-Ford is improved to eliminate the loop issue. Record numbers are assigned to each route table to prevent loop formation. In DSDV, packets are transmitted between nodes using routing tables. in DSDV each routing table contains information about all possible paths and number of hops to each destination on each node. To ensure consistency of routing tables, DSDV uses periodic and triggered routing updates. The advantage of DSDV is that without looping it can transmit data at any time. DSDV also has some drawbacks, such as the difficulty of determining the ideal stability time for a specified goal. Fake path announcements will lead to path changes, and bandwidth can be occupied unnecessarily as a result.

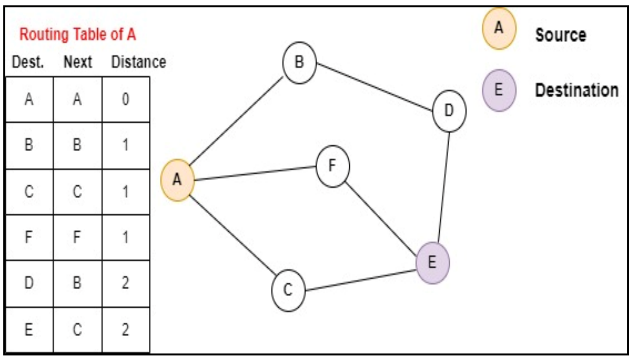

Fig 4.3 – Destination Sequenced Distance Vector (DSDV) MANET Routing Protocol

5. Simulation Tools and Environment Setup

In this research paper, we have compared, evaluated and simulated the three on demand MANET routing protocols DSDV, AODV and DSR using NS-2 simulator and compared our simulation results with result of base algo.[1]. C++ is the core language of NS-2, which also combines tcl and C++. Otcl is used for simulation scripts in NS-2. A network of 50,100 and 150 nodes were analyzed for performance. The traffic used for this simulation is CBR. A comparison was made on the basis of Packet Delivery Ratio, average end to end delay and average throughput.

5.1 Methodology

Methodology used in our research study is shown in "Fig 5.1". First we create a scenario and generate tcl code using NS-2 Scenario generator. Then we run/simulate the tcl code generated from NSG using NS-2. The output of NS-2 Simulation is trace file. We analyze this trace file using NsGTFA, trace file analyzer tool and compare our result with the existing result if it is better than existing one then stop otherwise repeat the same steps.

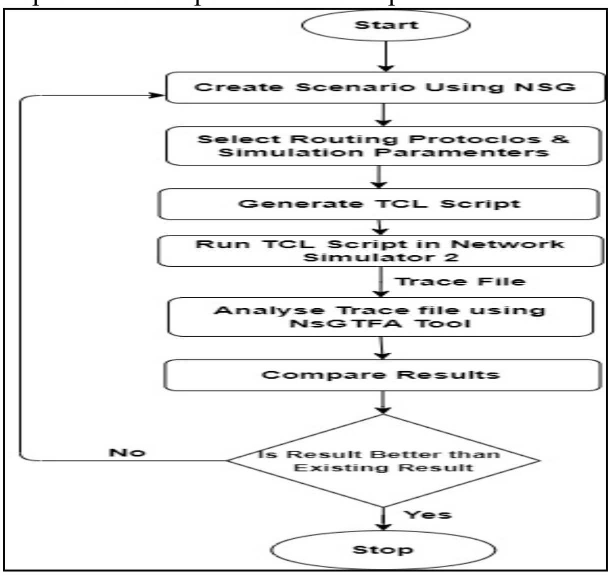

Fig 5.1 – Flow Chart of Methodology Used

5.2 Simulation Tools

Setup and simulation of our network were done using the following three tools:

1. NSG – NSG 2.1 (NS-2 Scenario Generator 2.1) [Fig 5.2] is based on Java and provides NS2 scenarios. NSG2.1 can be run on any platform since it's written in Java. NSG2.1 is able to generate TCL scripts for both wired and wireless NS2 applications. Some key functions of NSG 2.1 are creation of simplex and duplex link between the nodes using wireless and wired nodes, creation of UDP and TCP agents and Creation of FTP and CBR applications.
2. NS 2 – NS 2 is short for Network Simulator Version 2. NS 2 [Fig 5.3] is an open-source, event-driven simulator for computer communication networks. Some key features of NS 2 are for networking research it is discrete event simulator, Simulates a variety of protocols including UDP, FTP, TCP, https and DSR, primarily it is Linux based, Tcl is used for scripting language.
3. NsGTFA - NS2 trace files can be read with Ns2 GUI Trace File Analyser [Fig 5.4] software. NsGTFA is a Windows application that has a friendly graphical user interface and used to generate number of sent packets, number of received packets, number of dropped packets, end to end delay, throughput, packet delivery ratio and normalized routing load by reading trace file.

Out of the three tools mentioned above, first we will generate desired tcl code using NS-2 scenario generator 2.1 (NSG 2.1) with random topology containing various simulation parameters mentioned in Table 5.1.

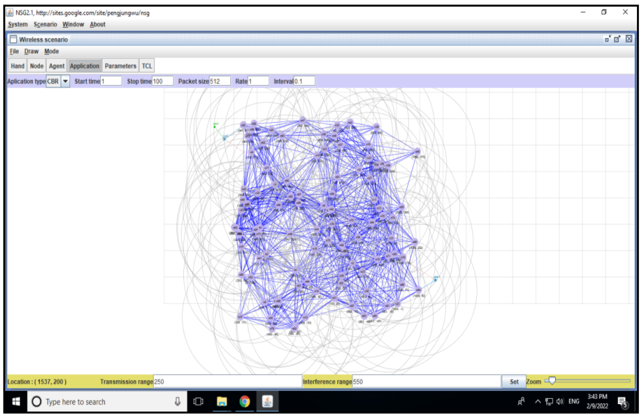

Fig 5.2 – NSG Topology Creation using Random Topology for 100 Nodes

TABLE 5.1 - SIMULATION PARAMETERS

Parameters	Nodes		
	50	100	150
Area (m2)	700 x 700	800 x 800	900 x 900
Traffic	CBR	CBR	CBR
Interval	0.1	0.1	0.1
Packet Size	512	512	512
Simulation Time	100 Sec	100 Sec	100 Sec
No. of Source	1 TCP Source	1 TCP Source	1 TCP Source
No. of Destination	1 TCP Sink	1 TCP Source	1 TCP Source
Protocols	AODV, DSDV & DSR	AODV, DSDV & DSR	AODV, DSDV & DSR
Simulator	NS-2.35	NS-2.35	NS-2.35
Topology	Random	Random	Random
Max Packet in Queue	50	50	50
MAC Protocol	IEEE 802.11	IEEE 802.11	IEEE 802.11
Propagation Model	Two Ray ground	Two Ray ground	Two Ray ground

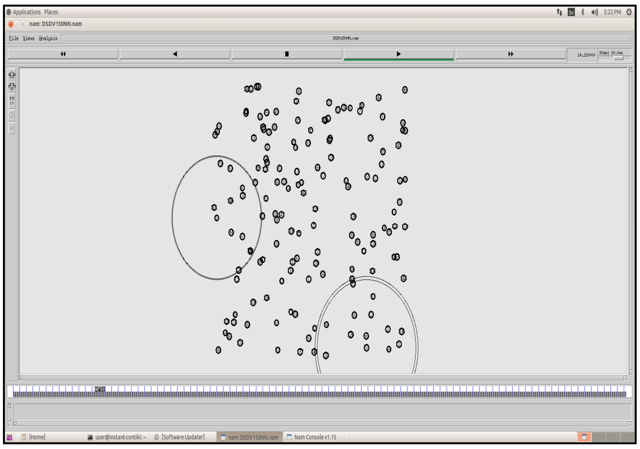

Fig 5.3 – NS-2 Simulation for AODV Protocol with 150 Number of nodes

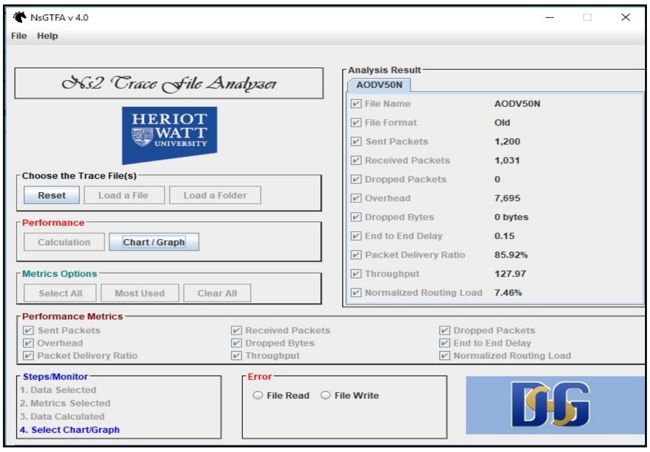

Fig 5.4 - AODV Trace File Reading by NsGTFA, Trace file Analyzer Tool for 50 Nodes

“Fig 5.2” shows a visual representation of the random topology of our network simulation using NSG. With the help of NSG tool we have generated Tcl code, which we have simulated in NS2 as shown in “Fig 5.3”. Through NS2 we receive simulation results as trace files. This trace file was analyzed in NsGTFA software to determine the MANET routing protocol simulation results like Packet Delivery Ratio, average end to end delay, and throughput as shown in “Fig 5.4”. In the next section, we present the simulation results from our research study.

6. Simulation Result

The routing protocols are simulated for 50, 100 & 150 nodes along with CBR traffic. One source and one destination node is used for simulation. TABLE 6.1 represents the Comparison of Our Results with Result of Base Algo. [1], Parameter used as Packet Delivery Ratio (%) with 50, 100 & 150 Nodes, TABLE 6.2 represents the Comparison of Our Results with Result of Base Algo. [1], Parameter used as Throughput (Kbps) with 50, 100 & 150 Nodes and TABLE 6.3 represents the Comparison of Our Results with Result of Base Algo. [1], Parameter used as End to End Delay (Seconds) with 50, 100 & 150 Nodes.

The following Performance metrics are used to compare various routing protocol performances.

[I] Packet Delivery Ratio: We calculate Packet Delivery ratio by comparing the number of packets successfully received with the number of packets sent. Comparison of packet Delivery Ratio is shown in “Fig 6.1”. After simulation when we compared our result with the result of Base Algorithm [1], we observed that we are receiving improvement in DSDV protocol for all node variations (50, 100 and 150 Nodes), in DSR protocol for 100 nodes and in AODV protocol for 150 nodes. Formula to calculate Packet Delivery ratio is

$$\text{Packet Delivery Ratio} = \frac{\text{Total No. of Received Packets}}{\text{Total No. of Transmitted Packets}}$$

[II] Average Throughput: Throughput is a measurement of the amount of data transmitted over a network, interface, or channel in a given period of time. Average throughput Comparison of DSR, AODV and DSDV routing protocols are shown in “Fig 6.2”. After comparing our result with the result of Base Algorithm [1], we observed that we are receiving improvement in all three protocols and all node variations (50, 100 and 150 Nodes). Formula to calculate throughput is

$$\text{Throughput} = \frac{\text{Packet Size x No. of Sucessful Packets}}{\text{Total Simulation Time}}$$

[III] Average End to End Delay: Average end to end delay is defined as measure of time delay for transmit data packet from the source node to destination node. Comparison of average end to end delay is shown in “Fig 6.3”. After comparing our result with the result of Base Algorithm [1], we observed that we are not receiving good results for all node variations (50, 100 and 150 Nodes) in AODV, DSDV and DSR protocols. Our result is satisfactory but not up to optimal result. In future study one can try to improve the result of end to end delay. End to end delay is calculated as

$$\begin{aligned}\text{Average End to End Delay} \\ &= \text{Packet Receiving Time} \\ &- \text{Packet Sending Time}\end{aligned}$$

TABLE 6.1: Comparison of Our Results with Result of Base Algo. [1], Parameter used as Packet Delivery Ratio (%) with 50, 100 & 150 Nodes

No. of Nodes	AODV		DSDV		DSR	
	Our Result	Base Algo.[1]	Our Result	Base Algo. [1]	Our Result	Base Algo. [1]
50	85.92 %	97.001 %	83.67 %	75.567 %	98.35%	99.745%
100	92.29 %	95.552 %	94.94 %	61.014 %	99.17%	96.327%
150	91.53 %	87.297 %	93.62 %	57.931 %	99.01%	99.595%

TABLE 6.2: Comparison of Our Results with Result of Base Algo. [1], Parameter used as Throughput (Kbps) with 50, 100 & 150 Nodes

No. of Nodes	AODV		DSDV		DSR	
	Our Result	Base Algo.[1]	Our Result	Base Algo. [1]	Our Result	Base Algo. [1]
50	127.97	10.022	166.59	9.197	133.34	10.002
100	65.83	9.508	83.21	9.228	76.06	9.843
150	50.20	8.730	76.34	8.702	79.30	10.001

TABLE 6.3: Comparison of Our Results with Result of Base Algo. [1], Parameter used as End to End Delay (Seconds) with 50, 100 & 150 Nodes

No. of Nodes	AODV		DSDV		DSR	
	Our Result	Base Algo.[1]	Our Result	Base Algo. [1]	Our Result	Base Algo. [1]
50	0.15	0.043	0.30	0.009	0.46	0.012
100	0.16	0.083	0.17	0.011	0.38	0.034
150	0.18	0.1691	0.26	0.0170	0.39	0.016

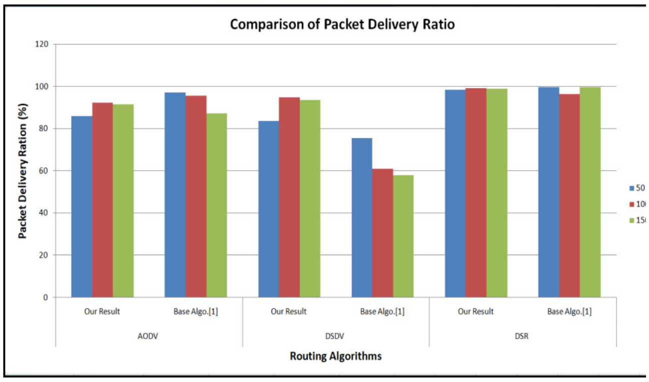

Fig 6.1 – Packet Delivery Ratio, comparison of Our Result and Base Algo.[1] with 50, 100 & 150 Nodes for AODV, DSDV & DSR MANET Routing Protocols

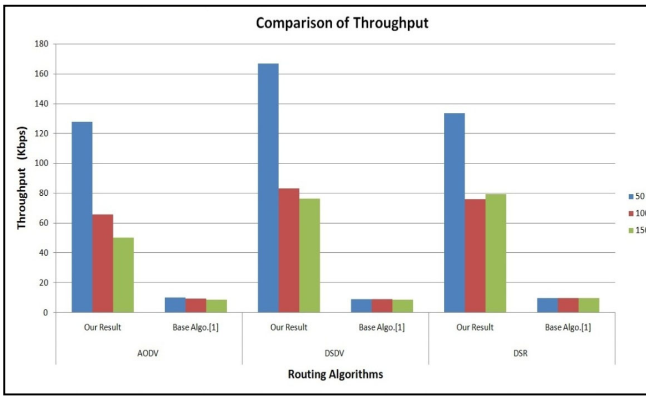

Fig 6.2 – Average Throughput, comparison of Our Result and Base Algo.[1] with 50, 100 & 150 Nodes for AODV, DSDV & DSR MANET Routing Protocols

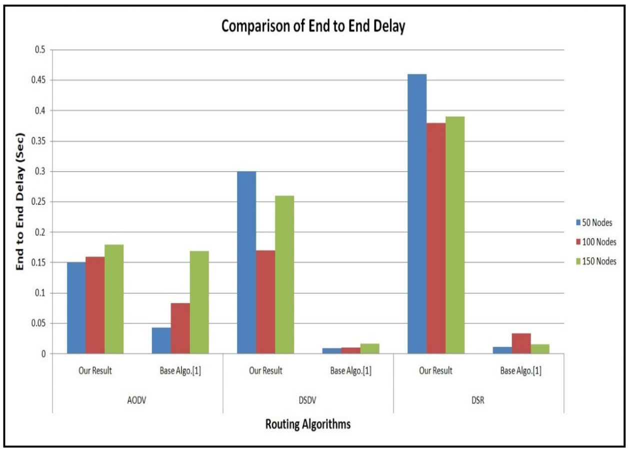

Fig 6.3 – Average End to End Delay, comparison of Our Result and Base Algo.[1] with 50, 100 & 150 Nodes for AODV, DSDV & DSR MANET Routing Protocols

7. Conclusion

To evaluate and measure the efficiency of three MANET routing protocols DSDV, DSR and AODV are compared with the base algorithm in this research study. In the simulation, the effect of 50, 100 and 150 nodes is presented in terms of packet delivery ratio, end-to-end delays, and throughput. After comparing our simulation result with the result of base algorithm, it is clear that in terms of throughput and packet delivery ratio and result of base algorithm is performing better only for end to end delay. In future research work, we can simulate such scenario in heavy traffic load with larger simulation time and large number of nodes. The analysis will be extended to include some additional performance evaluation parameters in future.

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