International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 09 | Sept - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Performance Analysis of Routing Protocols in Mobile Ad-hoc Networks (MANETs) Using NS2: A Comparative Study of AODV, DSR, and DSDV

Suraj Patel
Automotive IT Infrastructure, Detroit, USA
surajbpatel88@gmail.com

Abstract: MANET stands for Mobile Adhoc Network also called a wireless Adhoc network or Adhoc wireless network that usually has a routable networking environment on top of a Link Layer ad hoc network. A MANET can be defined as an autonomous system of nodes or MSs(also serving as routers) connected by wireless links, the union of which forms a communication network modeled in the form of an arbitrary communication graph. The characteristics of an ad-hoc network can be explored on the base of routing protocols. Simulation can be defined as "Imitating or estimating how actions might happen in a real situation". It can engage in the complex mathematical modeling, combinations and role playing without the aid of technology. The value deceit in the pacing you under realistic conditions that modify as a result of behavior of others involved, so you cannot expect the sequence of events or the final result. For this purpose we first study and explain these protocols and then we use the Network Simulator – 2.35 (NS2) tool and analysis the performance metrics Packet Delivery ratio, End to End delay, Throughput and Residual Energy.

Keywords: Ad-hoc Network, DSDV, NS2, AODV, DSR, Routing Protocols.

1. INTRODUCTION

Network simulation has become an integral part of most research works in the field of Computer Networks. Whether it understands the behavior of presented protocols, and how to decide the performance of a new protocol, one doesn't often get access to existent network devices [1, 2]. This problem has been solving by network simulation to a great performance. In this experiment we will get familiar with one of the most popular open source network simulators, then we used Network Simulator version 2 (NS2). The experiment makes familiar and good performance with fundamental concepts of NS2, and provides one-by-one instructions on how to install it [2, 3].

PLATFORM REQUIRED RUNNING NETWORK SIMULATOR:

- Unix and Unix like systems
- Linux
- Free BSD
- Windows 95/98/NT/2000/XP (requires Cygwin) [4, 5].

Network Simulator version 2 (NS-2) is discrete event packet level simulator. The network simulator describe and work on a very large number of application of different kind of protocols of different network types consisting of different network elements and traffic models. Here work on NS-2 [3, 4]. Then NS-2 is a package of tools that simulates behaviour of networks such as creating network topologies, analyze the events, log events that happen under any load and understand the network.

2. **Running NS2 Program**
   Network Simulator is based on two languages: C++ and Otcl [5]. OTcl is the object oriented version of Tool Command Language. While the core of NS-2 is written in C++, one uses OTcl to write simulation scripts [6, 7, 8]. C++ helps in the following way [9, 10].

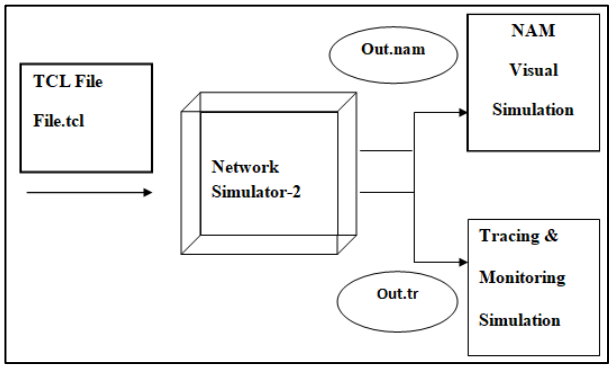

Fig. 1 Running NS2 Program

- It helps to increase the efficiency of simulation.
- It is used to provide details of the protocols and their operation.
- It is used to reduce packet and event processing time.

Network simulation with NS-2 would involve the following general steps:

- Initialization and termination aspects of network simulator object
- Defining the network topology: nodes, links, queues, mobility of nodes, if any
- Defining the network traffic: creating agents and their applications
- Setting trace for Network Animator (NAM) [optional]
- Tracing

3. AGENTS AND APPLICATIONS

3.1 TRANSMISSION CONTROL PROTOCOL (TCP)

TCP is used to provide reliable transport of packets from one host to another host by sending acknowledgements on proper transfer or loss of packets [9]. Thus, TCP requires bi-directional links in order for acknowledgements to return to the source.

Now we will show how to set up TCP connection between two nodes [11, 12]:

```
#Create TCP connection
set tcp [new Agent/TCP]
$ns attach-agent $n0 $tcp
set sink [new Agent/TCPSink]
$ns attach-agent $n4 $sink
$ns connect $tcp $sink
$tcp set fid_1
$tcp set packetSize
```

The command set tcp [new Agent/TCP] gives a pointer called 'tcp' to the TCP agent object of ns. The command $ns attach-agent $n0 $tcp defines the source node of TCP connection. Next the command set sink [new Agent/TCPSink] defines the destination of TCP by a pointer called 'sink' [12]. The next command $ns attach-agent $n4 $sink defines the destination node as n4. Next, the command $ns connect $tcp $sink makes the TCP connection between the source and the destination i.e n0 and n4. When we have several flows (such as TCP, UDP) in a network, to identify these flows we set their flow ID by using the command $tcp set fid_1. In the last line we set the packet size of TCP as 552 byte. The default packet size of TCP is 1000 B [13, 14].

3.2 FILE TRANSFER PROTOCOL (FTP) OVER TCP

File Transfer Protocol (FTP) is a standard mechanism provided by the Internet for transferring files from one host to another. FTP differs from other client server applications in that it establishes two connections between the client and the server. One connection is used for data transfer and other one is used for providing control information. FTP uses the services of the TCP. The well Known port 21 is used for control connections and the other port 20 is used for data transfer [10, 11].

Here we will learn in how to run a FTP connection over a TCP:

 # Initiating FTP over TCP
set ftp [new application/FTP]
$ftp attach-agent $tcp.
In above, the command set ftp [new Application/FTP] gives a pointer called 'ftp' which indicates the FTP application. Next, we attach the ftp application with tcp agent as FTP uses the services of TCP [13].

4. THE NETWORK ANIMATOR (NAM)

When we will run the above program in ns then we can visualize the network in the NAM. But instead of giving random positions to the nodes, we can give suitable initial positions to the nodes and can form a suitable topology. The network animator began in 1990 as a simple tool for animating packet trace data. This trace data is typically derived as output from a network simulator like ns or from real network measurements, e.g., using tcpdump. Steven McCanne wrote the original version as a member of the Network Research Group at the Lawrence Berkeley National Laboratory, and has occasionally improved the design, as he's needed it in his research. Marylou Orayani improved it further and used it for her Master's research over summer 1995 and into spring 1996. The nam development effort was an ongoing collaboration with the VINT project. Currently, it is being developed at ISI by the SAMAN and Conser projects [8, 15, 16, 17, 18].

5. SIMULATION ENVIRONMENT

The simulation for this study is done by using Network Simulator modeler 2.35. Ns2 is a network and application management simulation tool offered, Packet levels simulation is operated through network simulator. NS2 provides solutions to help the academic research through its R&D in the areas, evaluation and design of MANET, power management schemes in sensor networks, analysis the optical network designs, enhancement and evaluation of wireless technologies, UMTS, WiFi, WIMAX and enhancement in the MPLS, IPV6 the core network technologies [7, 12, 14]. There are also other tools like OPNET, GloMoSim. The following Table 1 shows comparison of these tools.

Table 1: Comparison of Simulation Tools

Simulation Tool	License	Open Source	Programming Languange
NS-2	Not Required	Yes	OTCL, C++
OPNET	Required	No	C
GlomoSim	Limited	YES	Parsec

We use NS2 in our study. NS2 is network level and event level simulation tool. Four main steps involve in its use are modeling, statistics, run simulation, view and analysis of results. OPNET is not an open source built in programming language C and it required a licence for for installing in your system. GlomoSim (Global Mobile

Information System Simulator) is a network protocol simulation software use to simulate wired and wireless network. It uses Parsec compiler for compiling the simulation protocols. [18]

6. MODEL DESIGN

The first step while creating the network is to generate blank scenario by using startup wizard. Project editor workspace opens by this in order to design the network. The design is completed either manually or automatically. There are two cases involves for designing. In the first case the objects are dragged from the object palette on the project editor workspace. In the second case the topologies are generated using rapid configuration automatically. In case the predefined scenarios match the user requirements, it can be imported. However, designing of wireless networks cannot be done by importing scenarios [13, 19]. When the network has been designed the nodes should be configured either by the pre-defined parameters or manually.

7. SIMULATION AND RESULT ANALYSIS

We use the Network Simulator 2.35 in order to simulate the routing protocols involves in our study. The Fig.2 shows the setup of one simulation environment of 50 nodes, which are static and the pause time of 100 sec. The details of simulation parameters are given in Table 2.

Table 2: Performance Parameters

Parameters	Values
No of nodes	30(Intial Phase), 40(Second Phase), 50(Final Phase)
Routing Protocols	AODV, DSDV, DSR
Performance Metrics	Packet Delivery Ratio, Throughput, End-to-End Delay
Simulation Area	2000m*2000m
Packet Size	Random
Pause time	100 Seconds

- In initial phase, we use 30 nodes in our scenario and simulate using mobility of the nodes for the performance metrics packet delivery ratio, end to end delay and throughput of routing protocols AODV, DSR and DSDV.

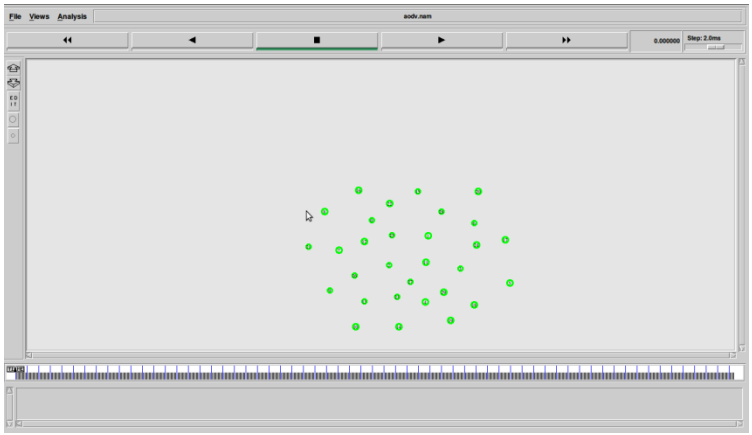

Fig. 2: Simulation Setup

- In the second phase, we use 40 nodes in our scenario and simulate using static nodes for the performance metrics packet delivery ratio, end to end delay and throughput of AODV, DSR and DSDV the routing protocols.
- In the final phase, we use 50 nodes in our scenario and simulate using static nodes for the performance metrics packet delivery ratio, end to end delay and throughput of AODV, DSR and DSDV the routing protocols.

In the Fig.3 below which shows Packets are delivering between nodes those are ready to communicate to each other.

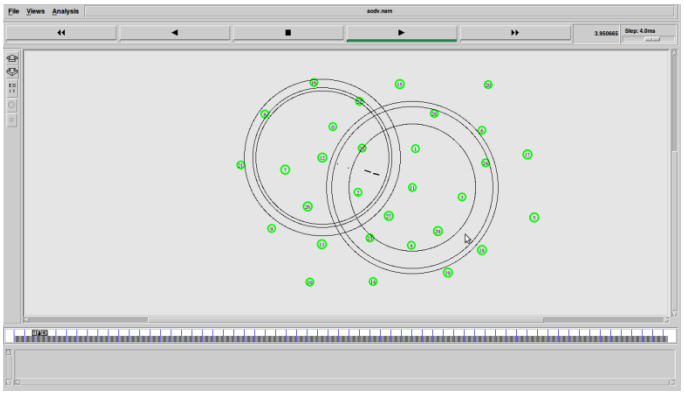

Fig. 3: Packet Delivery between Nodes

In the Fig. 4 below which shows the mobile nodes, they are communicating to each other and figure also shows the communication range through the circles.

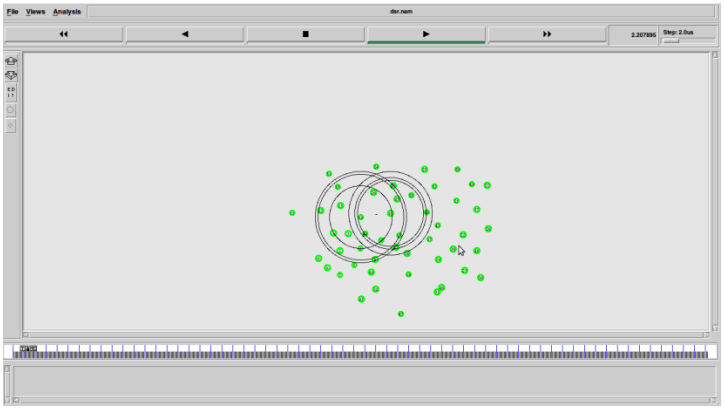

Fig. 4 Communication Range

In the Fig. 5 below, which shows the nodes are communicating to each other with some packets at dropped between the communication and figure also shows the communication range through the circles.

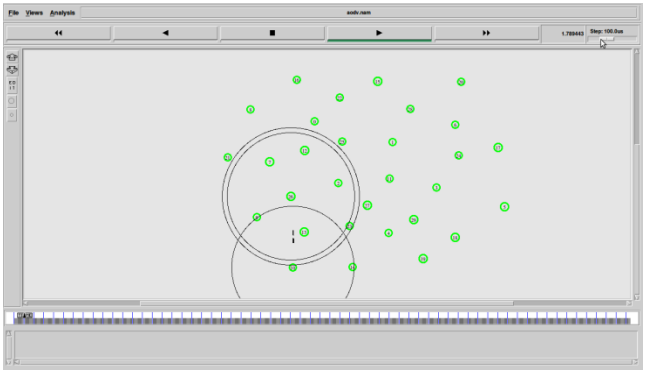

Fig. 5: Packet Drop between Communications

This research provides a detailed evaluation of routing protocols in MANETs using the **NS2** simulator. The analysis demonstrates that AODV is the most balanced protocol in terms of packet delivery, throughput, and energy efficiency, making it ideal for larger, dynamic networks. DSR**,** while also effective, struggles with higher delays in larger networks, though it performs well in environments with high mobility. DSDV, being a proactive protocol, is more suited for smaller or less dynamic networks where route maintenance overhead is not as detrimental. Overall, the study highlights the trade-offs between proactive and reactive routing approaches, offering practical guidance for selecting appropriate routing protocols based on network size, mobility, and application requirements.

8. CONCLUSION

The analysis and simulation of routing protocols in Mobile Ad-hoc Networks (MANETs) using NS2 provided valuable insights into the performance of key protocols such as AODV, DSR, and DSDV under different network conditions. The study focused on critical performance metrics including Packet Delivery Ratio, Throughput, End-to-End Delay, and Residual Energy across varying network sizes (30, 40, and 50 nodes). It was found that AODV and DSR generally outperformed DSDV in dynamic environments due to their reactive nature, where routes are established on demand rather than maintained continuously. As the network size increased, performance metrics such as packet delivery and throughput declined due to the greater number of hops and potential for congestion, particularly in static node scenarios. The simulation results also highlighted that AODV provided the most consistent performance in terms of packet delivery and throughput, while DSR excelled in environments where mobility was high.

REFERENCES

[1] Prabhakar Ranjan and Kamal Kant Ahirwar, “Comparative Study of VANET and MANET Routing Protocols”, in the International Conference on Advanced Computing and Communication Technologies (ACCT 2011)

[2] Monika, Sanjay Batish and Amardeep Dhiman, “Comparative Study of AODV, DSDV and DSR Routing Protocols in Vehicular Network Using EstiNet Simulator”, International Journal of Scientific & Engineering Research, Volume 3, Issue 6, June-2012

[3] Patel, R., & Singh, P. (2022). Visualizing network topologies in ns-3: A study on the impact of node positioning and mobility models. Journal of Network and Systems Management, 30(2), 98-115. https://doi.org/10.1007/s10922-022-09678-9

[4] Chen, L., & Huang, Y. (2021). Development of real-time network visualization tools in NS and their applications in IoT environments. Future Internet, 13(7), 160. https://doi.org/10.3390/fi13070160

[5] Patidar, M. et al. (2024). Efficient Design of Half-Adders and EXOR Gates for Energy-Efficient Quantum Computing with Delay Analysis Using Quantum-Dot Cellular Automata Technology. In: Al-Turjman, F. (eds) The Smart IoT Blueprint: Engineering a Connected Future. AIoTSS 2024. Advances in Science, Technology & Innovation. Springer, Cham. https://doi.org/10.1007/978-3-031-63103-0_22

[6] Manmeet Kaur , Amandeep Kaur Virk,”Comparative Study of AODV, DSR and DSDV in Vehicular Ad-Hoc Networks” in International Journal of Advanced Research in Computer Science and Software Engineering 5(5), May- 2015, pp. 892-897.

[7] Sheetal Goyal, “A Comparative Performance Analysis of AODV and DSR Routing Protocols for Vehicular Ad-hoc Networks (VANETs)” ,International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 4 Issue 4, April 2015

[8] Soumen Saha , Dr.Utpal Roy and Dr. D.D. Sinha, “Comparative Study of Ad-Hoc Protocols in MANET and VANET”, Advance in Electronic and Electric Engineering. ISSN 2231-1297, Volume 3, Number 8 (2013), pp. 1083-1096

[9] Shreyaskumar Patel. (2022). Performance Analysis of Acoustic Echo Cancellation using Adaptive Filter Algorithms with Rician Fading Channel. In International Journal of Trend in Scientific Research and Development (Vol. 6, Number 2, pp. 1541–1547). IJTSRD. https://doi.org/10.5281/zenodo.11195267

[10] Patidar, M., Gupta, N. (2022). An ultra-efficient design and optimized energy dissipation of reversible computing circuits in QCA technology using zone partitioning method. Int. j. inf. tecnol. 14, 1483–1493. https://doi.org/10.1007/s41870-021-00775-y

[11] Sabih ur Rehman , M. Arif Khan, Tanveer A. Zia and Lihong Zheng, "Vehicular Ad-Hoc Networks (VANETs) - An Overview and Challenges" ,Journal of Wireless Networking and Communications 2013, 3(3): 29-38.

[12] Ayaz Ahmad , Mahfuzul Huda , Mohd Atif Kaleem , Rajendra Kr Maurya," Mobile Ad-Hoc Networks: AODV Routing Protocol Perspective" International Journal of Advanced Research in Computer and Communication Engineering Vol. 4, Issue 12, December 2015

[13] Gupta, R., & Shen, L. (2020). A review of network animators: Evolution from NAM to modern visualization tools in network simulation. ACM Computing Surveys, 53(6), 1-22. https://doi.org/10.1145/3418047

[14] Sun, Q., & Lee, S. (2024). Integrating tcpdump traces with NAM for enhanced packet flow visualization in next-generation networks. IEEE Communications Magazine, 62(1), 79-88. https://doi.org/10.1109/MCOM.2024.3254712

[15] Sharma D.K et al. (2023). An efficient design and demonstration of fault-effects in full-adder circuits based on quantum-dot computing circuits, Materials Today: Proceedings, 2214-7853. https://doi.org/10.1016/j.matpr.2023.03.374

[16] Shreyaskumar Patel. "Optimizing Wiring Harness Minimization through Integration of Internet of Vehicles (IOV) and Internet of Things (IoT) with ESP-32 Module: A Schematic Circuit Approach", International Journal of Science & Engineering Development Research (www.ijrti.org), ISSN:2455-2631, Vol.8, Issue 9, page no.95 - 103, September-2023, Available :http://www.ijrti.org/papers/IJRTI2309015.pdf

[17] Mehran Abolhasan, Tadeusz Wysocki, and Eryk Dutkiewicz, "A review of routing protocols for mobile ad hoc networks" in Telecommunication and Information Research Institute, University of Wollongong, Wollongong, Australia, 2003.

[18] Shreyaskumar Patel. (2021). Enhancing Image Quality in Wireless Transmission through Compression and De-noising Filters. In International Journal of Trend in Scientific Research and Development (Vol. 5, Number 3, pp. 1318–1323). IJTSRD. https://doi.org/10.5281/zenodo.11195294

[19] Zhang, J., & Wu, X. (2023). Enhancements in network simulation and visualization using NAM for dynamic node positioning. IEEE Transactions on Network and Service Management, 20(3), 134-147. https://doi.org/10.1109/TNSM.2023.3154671