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Comparison of Wireless Ad Hoc Routing Protocols

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Abstract – Routing protocols are crucial for efficient data transmission in computer networks, determining the best paths for data to traverse between devices. Their significance lies in ensuring reliable and scalable communication within and across networks, enhancing their functionality and interconnectedness. Network simulators, like NS-2 (Network Simulator 2), play a vital role in network engineering, research, and education due to their powerful features, open-source nature, and flexibility. This paper compares DSDV and AODV protocols, analyzing performance, energy consumption, packet loss, throughput, and End-to-End Delay. Results demonstrate that both protocols can be effectively used in diverse applications based on the evaluated parameters. Understanding the differences between these routing protocols empowers network designers and researchers to make informed choices, optimizing network performance and reliability for specific scenarios.

Keywords – Ad Hoc, Routing, AODV, DSDV, Ns-2

I. Introduction

Routing protocols are critical components of computer networks, determining the best paths for data to travel from one network device to another. Their importance lies in several key aspects [1].

Routing protocols ensure efficient, reliable, and scalable communication within and between networks [2]. Without these protocols, data packets would struggle to find their way to their intended destinations, and computer networks would not be as functional and interconnected as they are today [3, 4].

Network simulators offer several powerful aspects that make them indispensable tools for network engineers, researchers, and educators. NS-2 (Network Simulator 2) is a widely used discrete event network simulator with several strengths that make it a popular choice for network research and simulation, such as open source and flexibility [8].

The main goal of this paper is to find and visualize the differences between DSDV and AODV protocols in terms of performance, energy consumption, packet loss, throughput and End-to-End Delay.

Results show that both protocols can be efficiently used in different application areas according to the evaluated parameters.

II. Wireless Networks and Protocols.

Wireless Networks are all computer networks comprising wireless data connections connecting different wireless nodes [11]. Routing protocols are the rules that decide the data movement between the wireless nodes. We will discuss the two main routing protocols [5].

A. Ad-hoc on-demand Distance Vector (AODV)

AODV stands for Ad hoc On-Demand Distance Vector, a popular routing protocol used in mobile ad hoc networks (MANETs) [6]. It is designed to establish routes between nodes in a dynamic and self-organizing network, where nodes can move, join, or leave the network anytime.

AODV is a reactive or on-demand routing protocol that establishes routes only when needed rather than maintaining a continuous routing table for all destinations. When a node wants to communicate with another node without a route, it initiates a route discovery process. During this process, the source node broadcasts a route request (RREQ) packet, which propagates through the network until it reaches the destination or a node with a valid route to the destination. Upon receiving the RREQ, intermediate nodes create reverse routes back to the source node [7].

Once the RREQ reaches the destination or an intermediate node with a route to the destination, a route reply (RREP) is generated, which follows the reverse path created by the RREQ. This process establishes a bi-directional route between the source and destination nodes. Additionally, AODV employs route maintenance mechanisms to handle route breaks caused by node mobility or network changes.

AODV is a widely used routing protocol in MANETs due to its simplicity, low overhead, and ability to adapt to dynamic network conditions. It balances the overhead of maintaining routing information and establishing routes as required.

B. Destination Sequenced Distance Vector (DSDV)

DSDV stands for Destination-Sequenced Distance Vector. It is a proactive or table-driven routing protocol used in mobile ad hoc networks (MANETs). The primary objective of DSDV is to maintain up-to-date routing information for all nodes in the network at all times.

In DSDV, each node maintains a routing table that contains information about the routes to all other nodes in the network. The routes are assigned sequence numbers, which help determine the most recent information about a particular route. The routing table is periodically updated, and these updates are sent to neighboring nodes.

When a node joins or leaves the network or changes in the network topology, such as link failures or node movements, the nodes exchange routing updates to keep their routing tables updated. DSDV employs "advertisement" to disseminate these updates throughout the network.

To prevent routing loops and count-to-infinity issues (common in distance-vector protocols), DSDV uses a technique called "route poisoning." When a route becomes invalid, the node advertises this information to its neighbors with an infinite metric value, indicating that the route is no longer available.

DSDV is suitable for small to medium-sized mobile ad hoc networks and works well in relatively stable environments. However, due to its proactive nature, it may consume higher bandwidth and overhead as the network size increases or in highly dynamic or rapidly changing environments.

It's worth noting that DSDV is an older routing protocol, and other more advanced routing protocols, like AODV (Ad hoc On-Demand Distance Vector) and DSR (Dynamic Source Routing), have gained popularity in the MANET research community due to their improved efficiency in handling dynamic network conditions[10].

C. Ns-2

NS-2 (Network Simulator 2) is a widely used discrete event network simulator, and it has several strengths that make it a popular choice for network research and simulation:

Open Source: NS-2 is an open-source simulator, making it freely available to the community. This encourages collaboration, allows researchers to modify the code to suit their specific needs, and facilitates the sharing of simulation models and enhancements.

Extensive Community Support: NS-2 has a large and active user community. This community support includes forums, mailing lists, and online resources where users can ask questions, share knowledge, and find solutions to common problems.

Flexibility: NS-2 provides an extensible framework for simulating various network protocols and scenarios. Researchers can create custom network topologies, define new protocols, and integrate their algorithms easily.

Protocol Support: NS-2 has built-in support for many networking protocols, including TCP, UDP, IP, routing protocols (e.g., OSPF, BGP), and application-layer protocols. This makes it suitable for studying different aspects of network behavior.

Realistic Models: NS-2 offers realistic models for network components, such as nodes, links, and queues. Users can configure these models to closely resemble real-world network characteristics.

Performance Analysis: NS-2 allows researchers to analyze and evaluate network performance metrics, such as throughput, latency, packet loss, and queue size. This analysis is essential for understanding the behavior of networking protocols and systems.

Wireless Network Simulation: NS-2 provides strong support for simulating wireless networks, including support for various wireless technologies (e.g., IEEE 802.11, 802.15.4), mobility models, and interference modeling.

Visualization: NS-2 includes visualization tools that aid in understanding and analyzing simulation results. These tools can display network topologies, packet traces, and other data to help users gain insights into network behavior.

Education and Research: NS-2 is widely used in academic settings for teaching networking concepts and conducting network-related research. Its flexibility and comprehensive features make it suitable for a broad range of educational and research purposes.

Cross-Platform Support: NS-2 is compatible with multiple operating systems, including Linux, macOS, and Windows. This cross-platform support allows researchers to run simulations on their preferred operating systems.

Despite its many strengths, it's essential to note that NS-2 also has some limitations. For instance, it is a discrete event simulator, which means it might not be suitable for modeling certain real-time or continuous aspects of networking. Additionally, its learning curve can be steep for users without prior experience in network simulation. However, with its numerous strengths and the active user community, NS-2 remains a valuable tool for network simulation and research.

III. SIMULATION EXPERIMENTS

A. Topology Configuration

Simulation of a network gives us an idea of its output performance in real-time situations. This has been done in the network simulator NS2 in VMware Workstation with the Ubuntu operating system.

We defined 50 nodes to do our experiment. We defined TCP connections between the first seven nodes as the sources of the connections and the last seven nodes as the sink of the TCP connections. FTP Connections were also built on the TCP connections. The nodes also moved during the simulation (see Figure 1).

Fig. 1 Ns-2 view of the wireless model.

B. Model Script

The randomness validates that the experiment will simulate reality, so the nodes were generated randomly. However, to ensure that the same conditions will be met for the two experiments (The AODV and DSDV experiments), we generate the nodes separately in a tcl file called “generate_nodes.tcl”. And then, we copy the generated code to each experiment manually.

The nodes were generated and assigned their positions randomly. Also, the movements were generated randomly [9] (see Figure 1).

IV. EVALUATION

We evaluated the difference between the two experiments based on four calculated metrics.

A. Energy Change

To measure the energy change, we assigned an initial energy value for the nodes and then measured the new energy for each node at each packet. To notice the difference, we selected one node from the 50 nodes and measured its energy.

AODV shows that it consumes less power because, after the experiment's end, the node “0” energy level is 104 while it is 102.5. However, the two results were very close, and we cannot say one protocol was better than the other (see Figure 2).

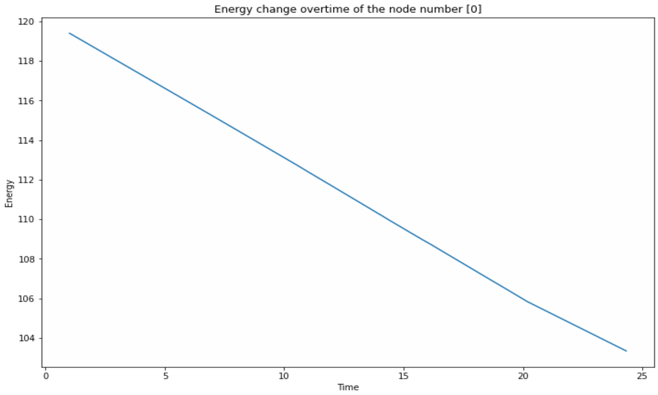


Fig. 2 DSDV Energy Change

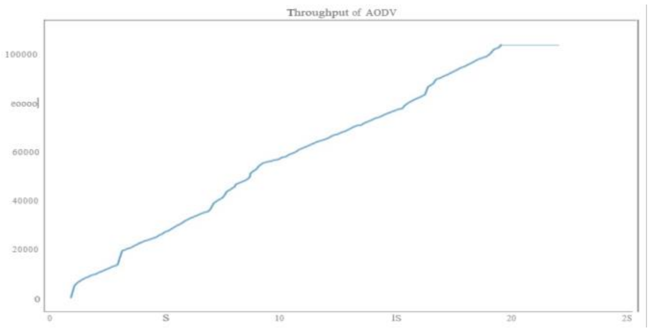
B. Throughput

Throughput is the total received packets in bytes divided by the execution time. The next graph (Figure 3. a and b.) also shows that DSDV and AODV have approximately the same throughput values (110000).

C. Packet Loss

We have visualized the dropped packets over the time of each experiment, and we noticed that AODV has more packet loss than DSDV (see Figure 4).

AODV has a total of 101, while DSDV has only 39 dropped packets.



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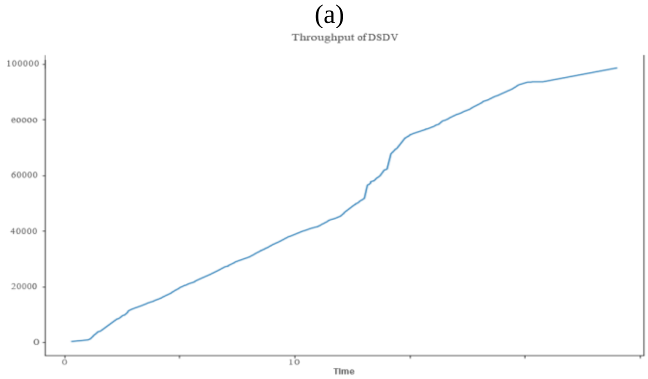
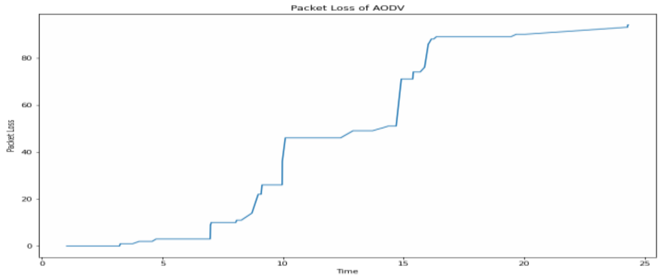


(b)

Fig. 3 Throughputs of the algorithms



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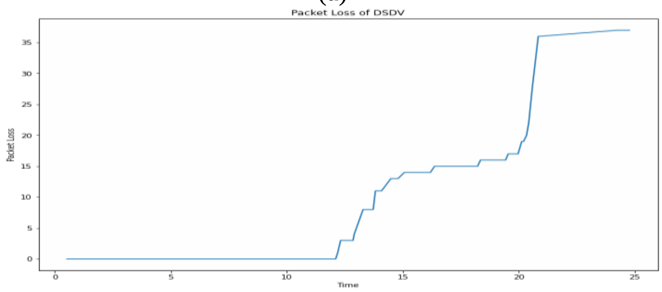


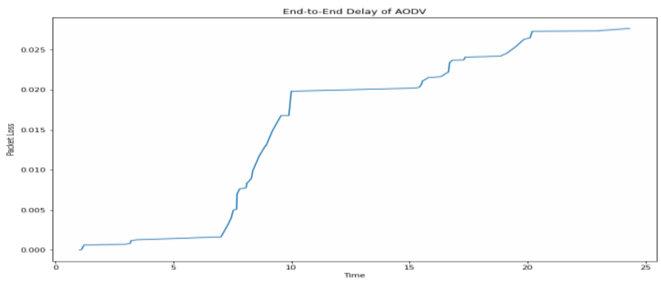
(b)

Fig. 4 Losses

D. Average Delay Time

The average delay time is the total time to receive all the packets. And then, it is divided by the successfully received packets to take the average.

From the graphs in Figure 5. a and b. we can be sure that DSDV is better than AODV in the delay time because it measured only 0.006 seconds as an average delay while AODV has 0.027.



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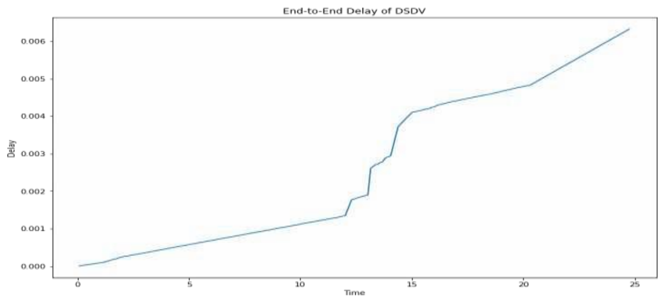

(b)

Fig.5 End-to-end delays

V. CONCLUSION

From the above relative analysis, it has been concluded that AODV and DSDV registered approximately the same energy loss and Throughput results. However, DSDV is better than AODV when considering Packet Loss and Average Delay Time. The results demonstrate that both protocols can be efficiently used in different application areas according to the above-evaluated parameters.

ACKNOWLEDGMENT

The heading of the Acknowledgment section and the References section must not be numbered.

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