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Analyzing Network Efficiency by Using AD-HOC Routing Protocols

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ABSTRACT

Network performance analysis plays a vital role in ensuring network security and efficient management. The continuous expansion of network size, resources, and distances has led to increased complexity in network traffic and behavior. Network congestion has become a common challenge in network management, necessitating the smooth and secure operation of IP networks. This study proposes the utilization of NS2, a network simulator tool, to implement network performance analysis specifically for Mobile Ad hoc Networks (MANETs). By using NS2, it becomes possible to theoretically replicate actual networks on computers for in-depth analysis. This replication allows for the early detection of potential failures or issues, enabling proactive improvements. The simulator tool collects, analyzes, and specifies network protocols while simulating the desired network environment for comprehensive testing. Moreover, it provides user-friendly visual analysis by employing trace files to replay network simulations through animations, facilitating precise analysis and effective network traffic monitoring. The main contributions of this study encompass the implementation of a comprehensive system for network performance analysis. This includes network flow collection, transmission, storage, analysis, and the visual display of network traffic. By focusing on these aspects, the study aims to enhance network security and overall performance.

Keywords: NS2 simulator, DSR Protocol, AODV protocol, DSDV protocol, TCL Script, Radio propagation model.

1. Introduction

In today's era of technological advancements, the Internet has become an integral part of our daily lives, with people relying on it for various tasks. It can be defined as a vast interconnected network of networks, where data can be transmitted between computers and devices in real time. With the rapid technological revolution, the Internet has also emerged as a valuable resource for education and learning. Consequently, network usage has been increasing dynamically as users utilize various applications for accessing online resources. The efficient management of networks has become crucial as the future of network management presents continuous challenges. Network management and security are significant technological innovations that have evolved over the past few decades. While it is impossible to predict the exact pattern of future network development, their growth will undoubtedly continue and significantly impact areas such as business, government, sciences, industry, and the arts and entertainment. In the corporate world, computer networks form the backbone of communication systems. It is essential to design networks appropriately, ensure optimal efficiency, and establish robust security measures. This project focuses on the implementation of performance analysis for Mobile Ad hoc Networks (MANETs) within the context of small organizations. Small organizations typically consist of 10 to 100 computers and often lack formal policies, planning, and security measures, as mentioned by Michael E. Whitman in "Management of Information Security Third Edition." The study utilizes Network Simulation Version 2 (NS2), an open-source event-driven simulator designed specifically for researching computer communication networks. NS2 simulates the functioning of computer networks, modeling devices, traffic, and analyzing performance. It supports widely used protocols like IPv4, IPv6, UDP, and TCP. NS2 serves as a foundation for various network-related tasks, including network traffic analysis, network security assessments, anomalous behavior analysis, and intrusion detection and protection. In summary, this project aims to analyze the performance of MANETs through the implementation of network simulation using NS2, focusing specifically on small organizations. The goal is to gain insights into network behavior, optimize performance, and enhance network security.

2. Mobile Ad-hoc Network (MANETS):

Mobile Ad-Hoc Network(MANET) is an infrastructure-less network because it is a self-figured type and does not have any central administration. Each node can act as a router and it can forward the packet to other specified nodes in the network. Due to a self organized network, the nodes freedomly can enter or leave the network anytime and this situation consequently makes the topology often changing.

The uses of MANET as its own application can vary from the small network, constrained by a limited power source to a large scale with a highly dynamic network. Dynamic communication is used in a

battlefield or military environment, search and rescue operation or disaster operation. MANET widely used in this situation because of its specialty that allows the users to access and exchange any information regardless of whatever the geographic location or infrastructure-less situation.

One of the main reasons to apply MANET in the disastrous environment is stated earlier, it is dynamic topologies where all the nodes in the network can move autonomously thus the network topology can change over time. Because of this environment, a routing protocol that can adapt actively with these changes is needed. There are several characteristic routing protocols in MANET. MANET routing protocol such as DSDV, AODV and TORA will be described briefly to be studied in our simulation.

2.1. Ad-hoc On-demand Distance Vector (AODV) :

The AODV (Ad hoc On-Demand Distance Vector) routing protocol combines the characteristics of on demand and distance vector routing methods, When a node needs to establish a route to a specific destination, it initiates a ROUTE REQUEST. This request is then forwarded by intermediate nodes, which also create a reverse route for themselves towards the destination. Once the request reaches a node that has a route to the destination, it generates a REPLY message containing the number of hops required to reach the destination. All nodes participating in forwarding this reply to the source node establish a forward route towards the destination. It's important to note that the route created by each node from the source to the destination is maintained hop-by-hop, rather than specifying the entire route in a source routing approach.

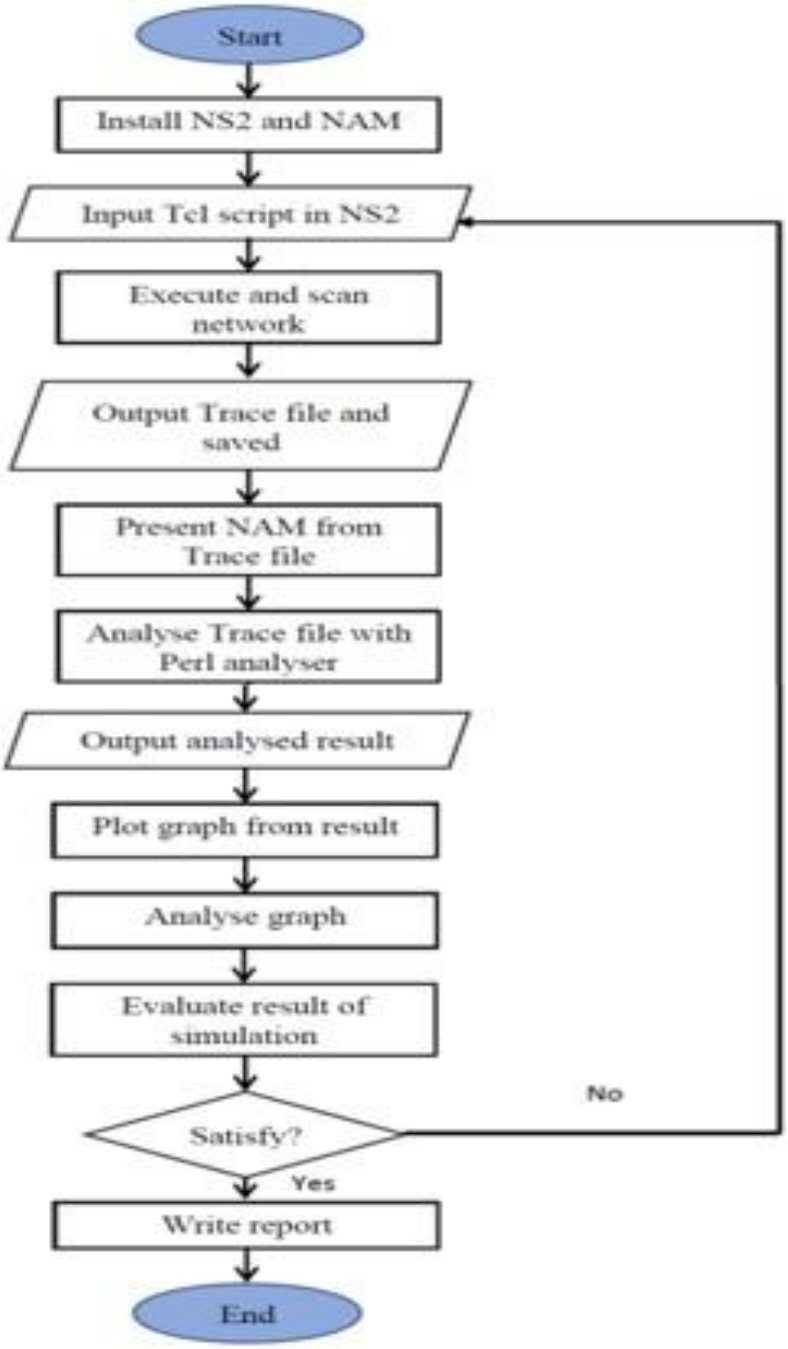
2.2. Destination Sequenced Distance Vector (DSDV) :

The DSDV (Destination-Sequenced Distance Vector) routing protocol is a hop-by-hop distance vector algorithm that relies on periodic broadcasting of routing updates by each node. It is based on the classical Bellman-Ford Routing algorithm. Each node maintains a routing table that includes information such as the next hop for each reachable destination, the number of hops required to reach a destination, and a sequence number assigned by the destination node. The sequence number is used to differentiate between outdated and new routes, thereby preventing the formation of loops. Nodes in the network periodically broadcast their routing tables to their immediate neighbors. Additionally, a node sends its routing table if a significant change has occurred since the last update. Therefore, the updates can be both time-driven and event-driven. These updates can be transmitted in two ways: a "full dump" where the entire routing table is sent, or an "incremental" update where only the changes are transmitted. In summary, the DSDV routing protocol employs hop-by-hop distance vector routing. Each node maintains a routing table and broadcasts periodic updates to its neighbors. By using sequence numbers, stale routes are distinguished from new ones to prevent loop formation. The routing table updates can be sent either as a complete dump or as incremental updates.

2.3. Dynamic Source Routing (DSR) :

DSR (Dynamic Source Routing) belongs to the category of reactive routing protocols, similar to AODV, as it discovers routes from source to destination only when necessary. This routing protocol utilizes a "Route Discovery Mechanism" to find the route for data packets from the source node to the destination node by leveraging intermediate nodes. In contrast, proactive routing protocols like DSDV require each node to periodically broadcast routing updates without maintaining a separate table. In DSR, the process of sending a "Route Request" packet from the destination to the source makes it convenient for the sender to transmit data packets along a predetermined path instead of sending them through multiple paths to evaluate the total distance. This approach simplifies the routing process and reduces overhead. To summarize, DSR is a reactive routing protocol that utilizes the Route Discovery Mechanism to find routes on-demand. Unlike proactive protocols like DSDV, DSR does not require periodic routing updates and allows for the selection of a fixed path based on route requests, making it more efficient for data packet transmission..

3. System Design



4. Simulation Methodology and Performance Metrics

In our project, we chosen AODV, DSDV, DSR protocols with other parameters to compare and analyze the network efficiency.

They are:

Energy Model

Instant Throughput

Average Throughput

Packet Delivery Ratio

The advantage of this studies is evaluation of performance of routing protocols with ns2 tool graphically.

4.1 Parameters

Energy Model:

The residual energy of nodes plays a vital role in evaluating the network efficiency of ad hoc routing protocols like AODV, DSDV, and DSR. These protocols may differ in their routing approach and how they handle changes in the network topology, but they all rely on nodes with sufficient residual energy to forward packets towards their intended destinations. It is important to consider the availability of nodes with adequate energy levels as a low residual energy can hinder a node's ability to actively participate in the routing process. Such nodes may either be unable to forward packets or experience packet drops, resulting in a reduced packet delivery ratio. Therefore, the analysis of network efficiency in these ad hoc routing protocols heavily relies on considering the residual energy of nodes as a critical parameter.

Instant Throughput:

Instant throughput is a crucial parameter that quantifies the amount of data that can be transmitted through a network at a specific moment in time. It serves as a key metric for assessing the network efficiency of ad-hoc routing protocols like AODV, DSDV, and DSR, as it directly reflects the network's capability to deliver data packets effectively. The instant throughput of a network is influenced by various factors, including the network topology, the chosen routing protocol, the packet size, and the residual energy of nodes. Notably, in ad-hoc routing protocols, the residual energy of nodes can significantly impact the instant throughput of the network. When a node possesses low residual energy, its ability to efficiently forward packets may be compromised, leading to an increase in packet loss and a subsequent reduction in instant throughput. Therefore, evaluating the instant throughput parameter becomes vital for analyzing the network efficiency of ad-hoc routing protocols such as AODV, DSDV, and DSR.

Average Throughput:

Average throughput is a fundamental metric used to measure the volume of data that can be transmitted over a network within a specific timeframe. It serves as a crucial parameter for evaluating the network efficiency of ad-hoc routing protocols like AODV, DSDV, and DSR, as it provides insights into the overall data delivery capacity of the network. The average throughput of a network is influenced by various factors, including the network topology, the routing protocol employed, the packet size, and the residual energy of nodes. Specifically, in the context of ad-hoc routing protocols, the residual energy of nodes plays a significant role in determining the average throughput of the network. Nodes with low residual energy may encounter challenges in efficiently forwarding packets, resulting in increased packet loss and a subsequent decline in average throughput. Therefore, the analysis of average throughput becomes crucial in assessing the network efficiency of ad-hoc routing protocols such as AODV, DSDV, and DSR. Optimizing the utilization of energy-efficient routing protocols and employing energy conservation techniques can help maximize the network's performance and improve its average throughput

Packet Delivery Ratio:

Packet Delivery Ratio (PDR) is a crucial metric that calculates the percentage of data packets successfully delivered to their intended destinations within a network. It serves as a significant parameter for evaluating the network efficiency of ad-hoc routing protocols like AODV, DSDV, and DSR, as it directly reflects the network's ability to deliver data packets reliably. The PDR of a network is influenced by various factors, including the network topology, the routing protocols utilized, the packet size, and the residual energy of nodes. Notably, the residual energy of nodes can have a substantial impact on the PDR of the network. Nodes with low residual energy may encounter difficulties in efficiently forwarding packets, resulting in an increase in packet loss and a subsequent reduction in PDR. In summary, the packet delivery ratio is a significant parameter for analyzing the network efficiency of adhoc routing protocols such as AODV, DSDV, and DSR. The residual energy of nodes plays a critical role in determining the PDR of the network. By optimizing the utilization of energy-efficient routing protocols and employing energy conservation techniques, the network's performance can be maximized, leading to an improved packet delivery ratio.

5. Result Analysis

Simulation of AODV, DSR, DSDV Routing Protocol

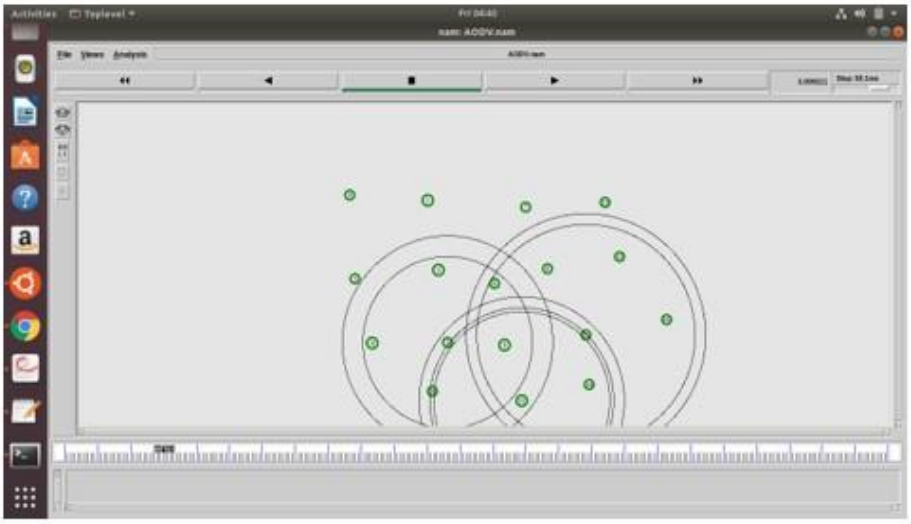


Fig: Simulation of AODV

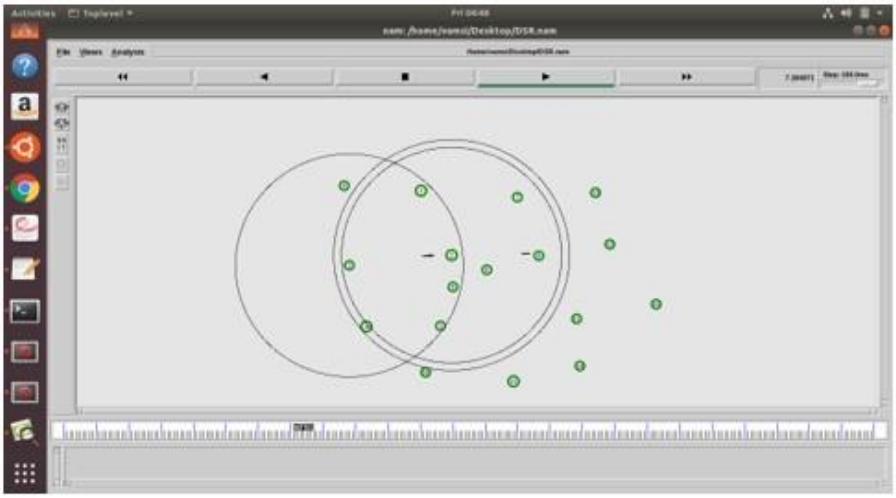


Fig: Simulation of DSR

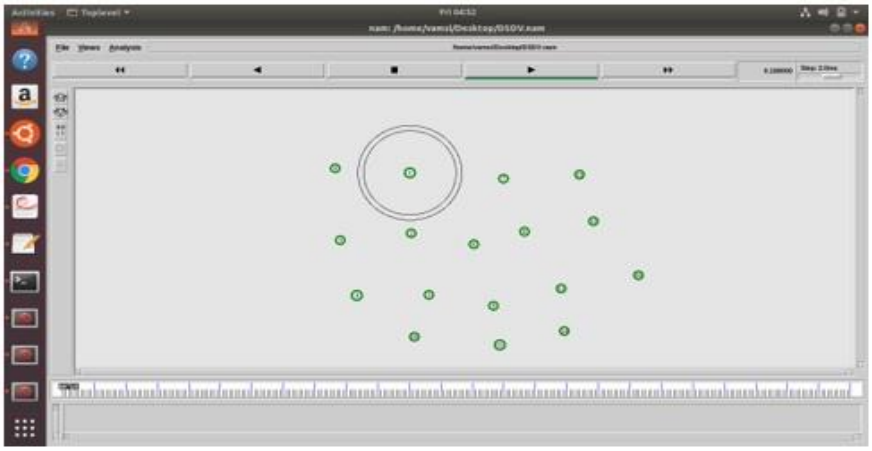
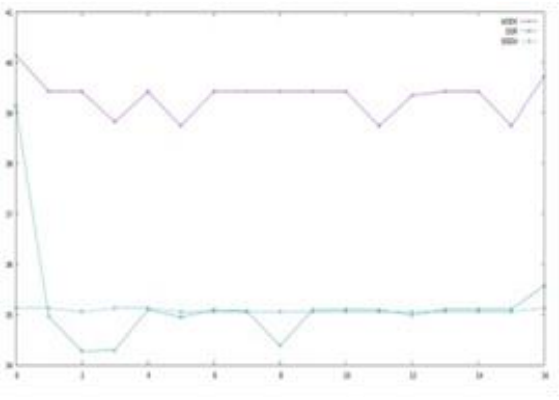
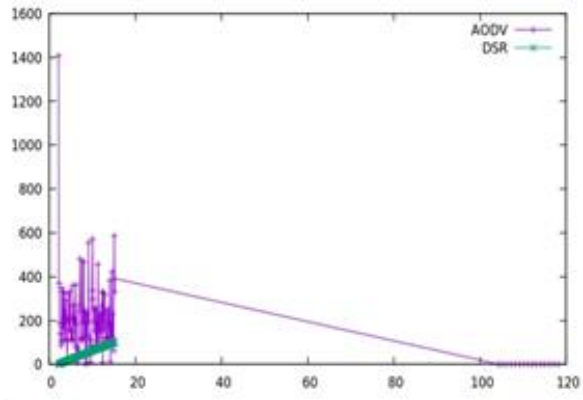


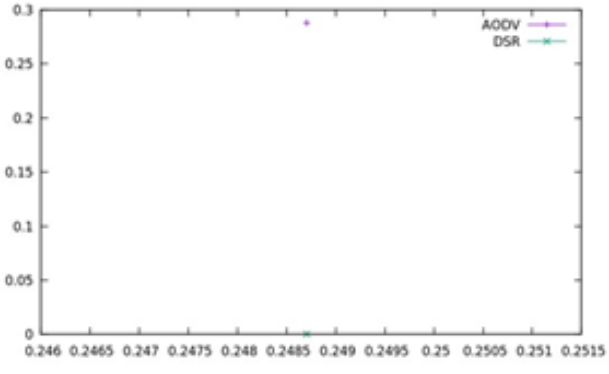
Fig: Simulation of DSDV



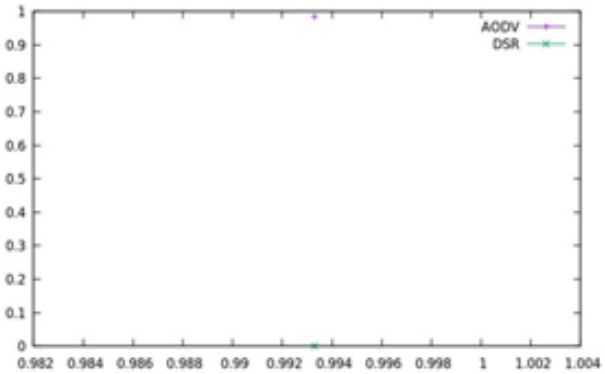
(a) Graph of Energy Model



(b) Graph of Instant Throughput



(c) Graph of Average Throughput



(d) Graph of Packet Delivery Ratio

According to the simulation results obtained, Figures in this chapter shows the performance results of routing protocol in Energy model, Instant Throughput, Average Throughput, Packet Delivery Ratio. By considering all the results we can conclude that AODV routing protocol is the best efficiency routing protocol.

5. Conclusion

In this project, the implementation of performance analysis by using network simulation NS2 is proposed to improve a better quality of service in routing. Therefore, routing protocol of MANET which is DSDV, AODV and DSR was proposed to analyse its performance in simulation rather than in actual world. The results for each of the simulation are recorded and shown in previous chapter. The analysis of performance is evaluated with average throughput, Instant throughput, packet delivery ratio and Energy model. After evaluating, graph is generated for each and every parameter of all routing protocol. So by comparing each and every graph with another graph, we are concluding that AODV routing protocol is having high efficiency compared to DSDV, DSR.

In this chapter, the contributions of the project and the challenges faces throughout the entire development process is concluded. Moreover, the future work pinpointed in this chapter could possibly be helpful for the users in the future. Besides, the simulation of MANET environment by using NS2 is one of the network simulators used by the researcher that could give better understanding and concept on how MANET operated in real world. The implementation of MANET in real world requires high cost, manpower and takes longer time to be developed. Therefore, this simulation project is employed to cope with these problems operatively.

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