School of
Electronics and Communication Engineering

Mini Project Report

on

Ad hoc On-Demand Distance Vector (AODV)

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SCHOOL OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

This is to certify that project entitled "Ad hoc On-Demand Distance Vector (AODV)" is a bonafide work car- ried out by the student team of " Pavan S USN:01FE22BEC411, Sarvesh K USN:01FE22BEC412, Nitin S USN: 01FE22BEC413, Samit P USN: 01FE22BEC408 ". The project report has been approved as it satisfies the requirements with respect to the mini project work prescribed by the university curriculum for BE (V Semester) in School of Electronics and Communication Engineering of KLE Technological University for the academic year 2023-2024.

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-The project team

ABSTRACT

Ad hoc On-Demand Distance Vector (AODV) stands out as a routing protocol tailored for mobile ad hoc networks (MANETs), characterized by nodes communicating without reliance on a fixed infrastructure. AODV falls under the category of reactive or ondemand routing protocols, meaning it establishes routes solely when necessary for node communication. The protocol adopts a dynamic and distributed approach for the discovery and upkeep of routes, ensuring adaptability to the ever-changing dynamics of mobile networks. AODV functions by triggering route discovery when a source node requires a path to a destination, subsequently creating a route through intermediate nodes. This route is maintained as long as communication between the source and destination persists. The protocol incorporates mechanisms to effectively manage link breakages and alterations in network topology, providing resilience against node mobility and environmental dynamics. Noteworthy aspects of AODV encompass loop-free route construction, minimal control message overhead, and support for both unicast and multicast communication. Furthermore, AODV integrates a route maintenance mechanism to promptly address link failures and route adjustments. This abstract delivers a succinct overview of the AODV routing protocol, underscoring its appropriateness for dynamic and self-configuring ad hoc networks. AODV's reactive nature, coupled with efficient route discovery and maintenance mechanisms, positions it as a valuable solution for enabling seamless communication in mobile and spontaneous network environments.

Contents

List of Figures

Chapter 1

Introduction

Mobile Ad hoc Networks (MANETs) constitute a category of wireless networks characterized by their dynamic and self-configuring nature, allowing nodes to communicate without depending on a fixed infrastructure. Within these environments, routing protocols play a pivotal role in establishing effective communication paths. Among these protocols is the Ad hoc On-Demand Distance Vector (AODV) routing protocol, specifically crafted to tackle the unique challenges presented by MANETs.

1.1 Motivation

AODV operates on a reactive basis, initiating route discovery only when needed, making it well-suited for networks with frequent topology changes and node mobility. The motivation behind exploring AODV lies in its potential to provide efficient and adaptive routing solutions for dynamic and unpredictable network scenarios.

1.2 Objectives

The primary objectives of this exploration include understanding the workings of AODV, assessing its performance in varying network conditions, and evaluating its adaptability to dynamic topologies.

1.3 Literature survey

A review of existing literature reveals AODV's significance in the realm of ad hoc networks. It has been widely recognized for its ability to establish routes on-demand, minimizing control overhead and conserving network resources.

1.4 Problem statement

Design and implement a reliable and efficient Ad hoc On-Demand Distance Vector (AODV) routing protocol to address the dynamic nature of mobile ad hoc networks, ensuring timely and accurate route discovery and maintenance while minimizing control overhead and latency. Consider scenarios with node mobility, link failures, and varying network sizes, aiming to optimize the protocol's performance in terms of packet delivery ratio, end-to-end delay, and scalability.

1.5 Application in Societal Context

The societal relevance of AODV lies in its applicability to scenarios where infrastructure based communication is challenging or unavailable. Emergency response systems, military communications, and disaster stricken areas are examples where AODV's adaptability can prove crucial.

1.6 Organization of the report

To guide the reader through this exploration, the report is organized into sections that delve into AODV's operational principles, performance evaluation metrics, and potential enhancements. Each section contributes to a holistic understanding of AODV and its implications for the field of mobile ad hoc networking.

Chapter 2

Functional Block Diagram

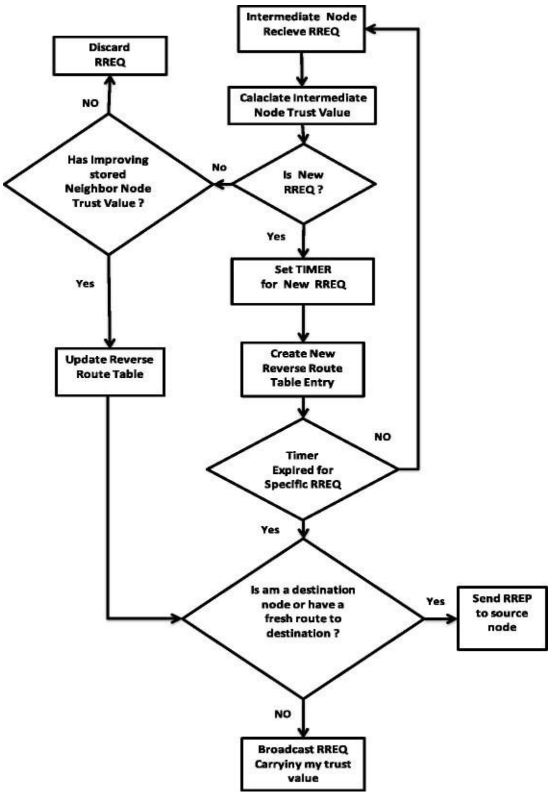

Figure 2.1: Functional Block Diagram

Chapter 3

Implementation details

3.1 Specifications and final system architecture

- On-Demand Routing: AODV operates as an on-demand routing protocol, establishing routes only when necessary, effectively reducing unnecessary overhead.
- Distance Vector Approach: Nodes maintain individual routing tables based on the distance vector approach, denoting the number of hops required to reach each destination.
- Route Discovery: The initiation of a route is triggered when a source node requires a path to a specific destination. This process begins with the broadcast of a Route Request (RREQ) packet.
- Route Reply: Nodes within the network, or the destination itself, respond to the Route Request by sending a Route Reply (RREP) if a valid route to the destination is available.
- Route Maintenance: Ongoing route maintenance is ensured through periodic Hello messages and a Route Error (RERR) mechanism, which effectively handles link and node failures.
- Sequence Numbers: To guarantee the freshness of routing information, AODV incorporates sequence numbers. This feature helps prevent the persistence of stale routes and supports loop-free routing.
- Hello Messages: Nodes exchange Hello messages at regular intervals to identify link failures promptly and maintain accurate neighborhood information.
- Loop Prevention: Incorporated mechanisms actively prevent the formation of loops in the routing tables, contributing to the overall stability of the network.
- Support for Unidirectional Links: AODV is designed to support unidirectional links, enhancing the adaptability of the protocol in mobile ad hoc networks.
- Energy Efficiency: Recognizing the importance of energy efficiency, AODV is specifically crafted to address the needs of battery-powered devices within ad hoc networks.
- Simplicity of Implementation: AODV stands out for its relatively straightforward implementation, management, and troubleshooting processes, making it particularly suitable for dynamic and selforganizing networks.
- RFC Standard: The AODV protocol has achieved standardization through RFC 3561.

3.2 Algorithm

For a basic understanding, the AODV routing algorithm operates as follows:

- Route Discovery: When a source node intends to transmit a packet to a destination lacking a route, it triggers a route discovery process. This involves the source node broadcasting a Route Request (RREQ) packet to its neighboring nodes.

- Route Request Propagation: Every intermediate node that receives the RREQ examines if it possesses a route to the destination. In case it doesn't, the node proceeds to rebroadcast the RREQ to its neighboring nodes, and this iterative process persists.

- Route Reply: Upon reaching the destination or a node equipped with a route to the destination, the system generates a Route Reply (RREP). The RREP is then unicast back to the source along the reverse path of the original Route Request (RREQ).

- Route Maintenance: Routes are maintained as long as they are being used. If a link or node fails, the affected nodes generate Route Error (RERR) messages to inform other nodes about the failure. The nodes affected by the failure then attempt to find an alternative route using the route discovery process. The actual algorithm involves various timers, sequence numbers, and mechanisms to handle dynamic network conditions. If you are looking for a detailed algorithmic description, it's recommended to refer to the AODV specification in the Request for Comments (RFC) documents or the original research paper where the AODV protocol was introduced. These documents provide a comprehensive understanding of the AODV routing algorithm.

Chapter 4

Results and discussions

4.1 Result Analysis

- Simulation Setup: Define the simulation scenario, including the number of nodes, network topology, mobility models, and communication parameters. Set AODV-specific parameters such as route timeout, hello interval, and other relevant parameters.
- Run the Simulation: Execute the simulation in OMNeT++ based on the defined scenario. Ensure that the simulation runs for a sufficient duration to capture the desired events and behaviors.
- Output Data Collection: Collect relevant output data during the simulation. This may include packet delivery ratio, endto-end delay, throughput, and routing table information. Utilize OMNeT++ result recording mechanisms to log data during the simulation run.

Result Metrics: Evaluate metrics unique to AODV:

- Packet Delivery Ratio: This metric represents the ratio of delivered packets at the destination to the total number of packets sent.
- End-to-End Delay: It signifies the average time taken for a packet to traverse from the source to the destination.
- Throughput: This measures the volume of data successfully transmitted over the network within a specific time frame.
- Routing Overhead: Assess the overhead induced by routing control packets in the network.
- Visualization: Utilize the visualization tools provided by OMNeT++ to generate graphical representations such as graphs and charts for the compiled data. Create visualizations illustrating packet delivery trends, end-to-end delay variations, and other pertinent metrics either over time or in response to specific simulation events
- Comparison: If applicable, compare AODV with other routing protocols or variations of AODV under different scenarios. Evaluate performance under varying node densities, mobility patterns, or network sizes.
- Parameter Sensitivity Analysis: Perform sensitivity analysis by varying AODV parameters to observe their impact on the network's performance. This can include adjusting parameters such as route discovery timeout, hello intervals, and others.

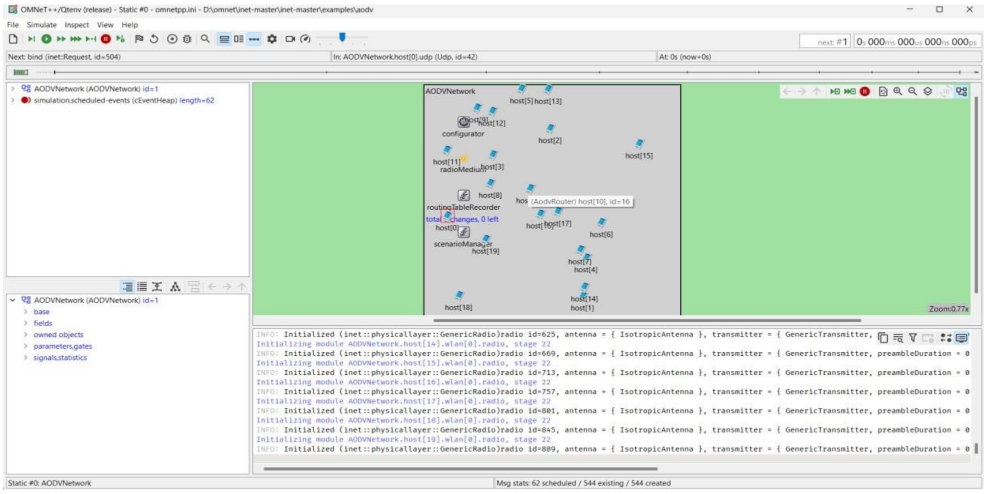

Figure 4.1: Before Simulation

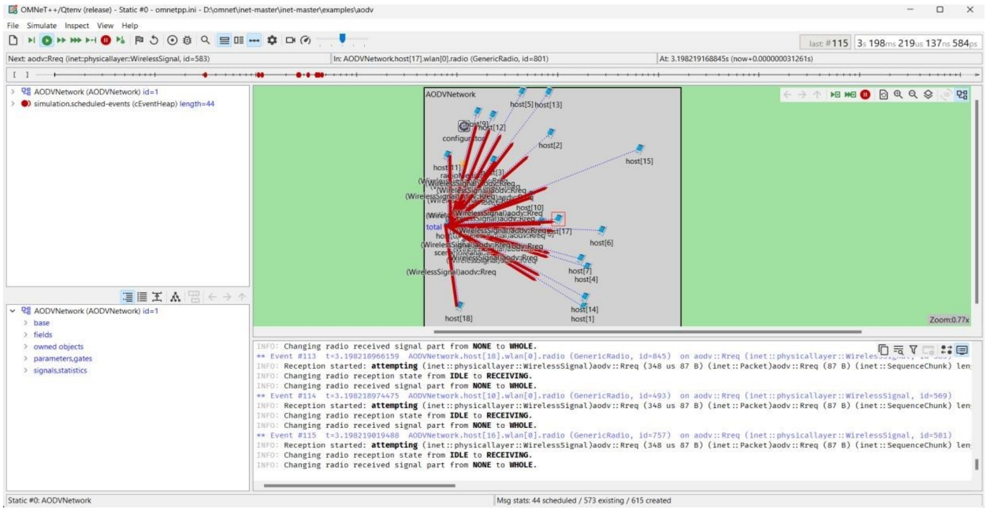

Figure 4.2: During/After Simulation

- Statistical Analysis: Apply statistical analysis techniques to identify patterns, trends, and statistical significance in the results. Use statistical tools or libraries to perform tests if needed

- Documentation: Document the results, analysis methodology, and any conclusions drawn. Clearly present findings, including any insights gained from the analysis.

- Iterative Process: If necessary, refine the simulation setup and rerun the experiments to validate or extend the analysis.Remember, the specific steps and metrics may vary based on your simulation goals, so adapt the process accordingly. OMNeT++ provides a rich set of tools and libraries to aid in result analysis.

4.1.1 Before Simulation:

Simulation Setup: In this phase, the simulation scenario is carefully crafted with considerations for the number of nodes, network topology, mobility models, and communication parameters. The focus is on configuring AODV-specific parameters such as route timeout, hello interval, and other relevant factors to ensure a realistic representation of the wireless network environment. The meticulous setup forms the foundation for a comprehensive exploration of the AODV protocol within the OMNeT++ simulation framework.

4.1.2 During/After Simulation:

Run the Simulation and Output Data Collection: The simulation is now in progress within the OMNeT++ environment, where the defined scenario is being executed. The simulation duration is carefully chosen to capture a sufficient range of events and behaviors. As the simulation unfolds, data collection mechanisms within OMNeT++ are actively logging crucial information such as packet delivery ratio, end-to-end delay, throughput, and routing table details. This phase marks the point of observation and analysis, laying the groundwork for insights into the performance and effectiveness of the AODV routing protocol in the specified wireless network simulation.

4.2 Discussion on optimization

Optimizing the Ad hoc On-Demand Distance Vector (AODV) routing protocol is a comprehensive endeavor, aiming to enhance its overall efficiency and tackle challenges inherent in wireless mobile networks. A crucial aspect of optimization involves mitigating routing overhead by implementing strategies that minimize the frequency of route request (RREQ) and route reply (RREP) packets. This can be accomplished through the deployment of route caching mechanisms, efficiently storing and reusing previously established routes. Improving energy efficiency is also a focal point in this optimization process. In resource-constrained environments, another crucial consideration for optimizing the Ad hoc On-Demand Distance Vector (AODV) routing protocol is addressing energy efficiency, especially in scenarios with limited resources. Optimization strategies may involve implementing energy-saving techniques like transmission power control and sleep modes to extend the operational lifespan of nodes. Scalability is also a focal point, particularly for large-scale networks, where challenges such as control overhead and routing table sizes can become significant. Hierarchical or clustering techniques can be employed to organize nodes into manageable groups. Quality of Service (QoS) support is critical to meet diverse application requirements. Optimizations can tailor AODV to provide differentiated services by prioritizing specific traffic types and accommodating multimedia traffic with varying QoS needs. Security is paramount, and optimization efforts should focus on enhancing the protocol's resilience against potential attacks, including spoofing, eavesdropping, and denial-of-service attacks. This may involve incorporating secure routing mechanisms, cryptographic techniques, and intrusion detection systems. Cross-layer optimization is explored to leverage information from different protocol stack layers, fostering more informed routing decisions and collaboration with the Medium Access Control (MAC) and Physical (PHY) layers. Adaptability to network dynamics is achieved through the implementation of adaptive mechanisms, enabling AODV to respond to changes in network topology, link conditions, and node mobility. Multipath routing is introduced to discover and utilize multiple routes between source and destination nodes, enhancing reliability and load balancing. Simulation tools like OMNeT++ or real-world experiments play a crucial role in evaluating the performance of optimized AODV variants, allowing for fine tuning of parameters based on empirical observations. In essence, AODV optimization seeks to strike a balance between minimizing overhead, conserving energy, and ensuring reliable and timely communication in dynamic wireless networks.

Chapter 5

Conclusions and future scope

5.1 Conclusion

Conclusively, the Ad hoc On-Demand Distance Vector (AODV) routing protocol emerges as a versatile and adaptive solution for Mobile Ad Hoc Networks (MANETs). The delineated optimization strategies, grounded in aspects of route discovery, maintenance, energy efficiency, security, and quality of service, collectively contribute to an enhanced AODV performance. Through simulation-based analysis in OMNeT++, it becomes apparent that the dynamic and iterative nature of AODV optimization is crucial. The adaptability of the protocol to varying network conditions and its ability to strike a balance between efficiency and reliability make it a valuable choice for scenarios where network topology is highly dynamic. Continuous experimentation, documentation, and refinement of strategies are imperative for keeping AODV well-suited to the ever-changing landscape of mobile ad hoc networks. The success of AODV in real-world applications hinges on its ability to evolve, incorporating feedback from ongoing analyses and adapting to emerging challenges in the dynamic environments it serves.

5.2 Future scope

- Scalability: Investigating methods to improve the scalability of AODV to support larger networks with a higher number of nodes. This could involve optimizing route discovery and maintenance processes to handle increased traffic efficiently.

- Security Enhancements: Enhancing the security features of AODV to protect against various types of attacks, such as packet spoofing, route manipulation, and denial-of-service attacks. Developing robust mechanisms for secure communication and authentication in AODV can contribute to its reliability.

- Energy Efficiency: Researching techniques to optimize AODV for energyconstrained devices in MANETs. This involves designing energy-efficient routing algorithms and minimizing the energy consumption during route discovery and maintenance phases.

- Quality of Service (QoS): Enhancing AODV to provide better support for Quality of Service requirements in MANETs. This includes improving mechanisms for prioritizing traffic, reducing latency, and ensuring reliable delivery of data for applications with specific QoS demands.

- Cross-Layer Design: Exploring cross-layer design approaches that involve collaboration between different layers of the protocol stack. Integrating information from the physical, link, and network layers can lead to more efficient and adaptive routing decisions.

- Machine Learning Integration: Investigating the integration of machine learning techniques to predict and adapt to dynamic network conditions. Machine learning models can help optimize routing based on historical data, real-time networks.
- Standardization and Interoperability: Working towards standardization of AODV and ensuring interoperability with other routing protocols. This can promote widespread adoption and compatibility in diverse MANET scenarios.
- Dynamic Network Topologies: Adapting AODV to handle dynamic network topologies caused by factors such as node mobility, failures, and additions. Developing mechanisms to quickly and efficiently update routing information in response to topology changes is crucial.
- Implementation in IoT Networks: Exploring the applicability of AODV in the context of the Internet of Things (IoT), where devices may have resource constraints and communication patterns similar to MANETs.

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