CSE 6811: Wireless Ad Hoc Networks

Project Report: *AODV-DSR Hybrid Reactive Routing Protocol and its Generalization for Mobile Ad-Hoc Networks*

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1. Introduction

The paper "AODV-DSR Hybrid Reactive Routing Protocol and its Generalization for Mobile Ad-Hoc Networks" explores the increasing importance of efficient routing protocols in Mobile Ad-hoc Networks (MANETs), which are essential for wireless communication in infrastructure-less environments. It highlights the decentralized nature of MANETs, where each node acts as a router, leading to challenges such as frequent link failures due to unpredictable node mobility. The authors discuss two existing reactive routing protocols, Dynamic Source Routing (DSR) and Ad-Hoc On-Demand Distance Vector Routing (AODV), noting their limitations. To address these issues, the paper proposes a hybrid routing protocol that combines the strengths of both DSR and AODV, aiming to enhance routing efficiency and Quality of Service (QoS) in MANETs. The structure of the paper includes sections on design constraints, protocol descriptions, the proposed hybrid routing, performance analysis, and concluding remarks

2. Context

- Mobile Ad-Hoc Networks (MANETs) are essential for wireless communication, especially in infrastructure-less environments.
- They require efficient routing protocols to overcome challenges like dynamic topologies, limited resources, and frequent link failures.
- Existing reactive routing protocols, such as Dynamic Source Routing (DSR) and Ad-Hoc On-Demand Distance Vector (AODV), provide distinct advantages but also face significant limitations:
  - DSR relies on source routing and route caching but incurs increased overhead with longer paths.
  - AODV uses forward and reverse links for routing, reducing overhead but lacks DSR's reliability in maintaining route consistency.
- The hybrid approach proposed combines the strengths of both protocols to improve reliability and efficiency.

3. Problem Statement

The paper "AODV-DSR Hybrid Reactive Routing Protocol and its Generalization for Mobile Ad-Hoc Networks" addresses several critical issues faced in the deployment and operation of mobile ad-hoc networks (MANETs).The problem statement can be summarized as follows:

Routing protocols such as AODV or DSR have their restrictions which make them less appealing to use in mobile and resource-scare scenarios. The source routing algorithm in DSR increases in the size of the packets transmission headers and the lengths of the routes which further adds to the probability of link breakage.Moreover, in AODV, the whole path from source to destination is not available as it keeps only the next hop information. So, this protocol lacks reliability compared to DSR. In addition to this, both these protocols notify the source node if any link falilure occurs and the source re-initiates the route discovery again which adds to additional overhead and cmplexity.

This problem is important because AODV and DSR suffer limitations in mobile and resource-constrained environments. DSR's source routing increases packet overhead and route fragility due to long paths. AODV, with only next-hop information, lacks reliability and requires frequent route rediscovery upon link failures. These limitations are critical as they drain limited battery life and processing power in mobile devices and exacerbate bandwidth and processing constraints in resource-constrained networks.

4. Idea

- The hybrid AODV-DSR protocol integrates features of AODV and DSR to create a more robust routing solution:
  - Nodes operate primarily using AODV's link-based routing structure.
  - Select intermediate nodes are designated to behave like DSR nodes, storing their identities in Route Request (RREQ) messages.
- Mechanism:
  - When an RREQ is forwarded, alternate intermediate nodes append their identity to the message, creating a node-list.

  - The destination node returns a Route Reply (RREP) containing the node-list to the source.
  - Data packets are transmitted using the established links (from AODV) and the node-list (from DSR), combining the benefits of both approaches.

- Generalization:
  - If all intermediate nodes are included in the node-list, the protocol behaves like DSR.
  - If no nodes are included, the protocol behaves like AODV.
  - By varying the number of nodes included, the protocol adapts to different network requirements, balancing reliability and efficiency.

5. Key Contributions

Here are the main contributions outlined in the paper:

Hybrid Routing Protocol Development: The paper proposes a hybrid routing protocol that combines the strengths of two well-known protocols, AODV (Ad-hoc On-Demand Distance Vector) and DSR (Dynamic Source Routing). This hybrid approach aims to enhance routing efficiency and reliability in MANETs, particularly in resource-limited environments

Generalization of Existing Protocols: The conceived hybrid protocol introduced here can be viewed as a generalization of AODV and DSR protocols. This implies that it covers the beneficial aspects from both of the protocols while bridging their gaps individually hence offering a more complete solution of routing in MANETs.

Addressing Limitations of DSR & AODV: The paper identifies specific disadvantages of the DSR and AODV protocol, such as increased network overhead due to flooding and larger data packet sizes leading to higher link breakage probabilities. Besides, AODV lacks in reliability. The hybrid protocol aims to mitigate these issues by leveraging AODV's mechanisms, thus improving overall network performance and reliability.

Reducing overhead using Secondary Source Nodes: In the hybrid protocol, certain intermediate nodes are designated to act as secondary source nodes. This means

that even if the primary source node encounters issues, these secondary nodes can take over the responsibility of forwarding data packets to the destination. This capability is particularly beneficial during multi-path failures, where multiple routes may become unavailable simultaneously. By having secondary sources, the protocol ensures that data communication remains uninterrupted and reliable, even in adverse conditions.

6. Advantages

- **Improved Reliability:** The hybrid protocol combines the strengths of both AODV and DSR, enhancing reliability in data transmission. If some entries in the routing table are corrupted, the protocol can still send the packet using the partial path stored in its header. Also by utilizing secondary source nodes, it ensures that communication can continue even during multi-path failures, reducing the risk of data loss.

- **Reduced Overhead:** AODV improves upon DSR by reducing the size of data packet headers. This is achieved by storing route information in intermediate nodes rather than in all the packet header, which minimizes the overhead associated with data transmission .

- **Efficient Route Maintenance:** The protocol uses the concept of secondary routes during the path break. The node that detects the path failure, act as secondary source and performs route discovery. So, it does not need to notify the source node about the link failure.

7. What to Evaluate

- Key metrics include:
  - Packet delivery ratio: Indicates reliability.
  - Routing overhead: Measures protocol efficiency.
  - End-to-end delay: Evaluates overall performance.
- Justification:

- These metrics highlight the trade-offs between AODV's efficiency and DSR's reliability in the hybrid approach.

8. Evaluation Results

- The paper did not provide any simulated results or comparison with existing protocols.

9. Limitations, Drawbacks, and Extensions

- Limitations:
  - **No Results and Simulations :** The authors didn't give any result or any kind of tabular data to compare its performance with the existing routing protocols.
- Drawbacks:
  - **Complexity in Implementation:** The hybrid protocol may introduce additional complexity in its implementation compared to using either AODV or DSR alone. The need to manage both forward links and secondary source nodes could complicate the routing process and require more sophisticated algorithms for effective operation
  - Additional processing may increase computational overhead for intermediate nodes.
  - **Lack of Detailed Route Maintenance Mechanism:** While the paper mentions the combination of route maintenance mechanisms from both AODV and DSR, and gives notion about the secondary route discovery but it didn't give any detailed explanation of the route maintenance mechanism.
  - **Potential for Increased Overhead:** Although the hybrid protocol aims to reduce overhead, the introduction of additional routing mechanisms and the need to maintain secondary source nodes could inadvertently lead to increased overhead in certain situations. This could counteract the intended benefits of the hybrid approach, especially in dense network

- Extensions:
  - Generating some simulations using software like NS-2 or NS-3 and performing comparisons with other protocols.
  - Further optimization to minimize computational costs.
  - The AODV-DSR hybrid protocol for MANETs enhances AODV by selectively including intermediate nodes in its Route Request (RREQ) messages, inspired by DSR. This inclusion frequency can be varied (e.g., every alternate node, every 3rd node, etc.) based on the network's mobility and reliability
  - Application in heterogeneous network environments with varying device capabilities.
  - Investigation into energy-efficient adaptations to reduce power consumption.

10. Conclusion

- The proposed hybrid AODV-DSR protocol leverages the strengths of both routing methodologies to enhance MANET performance.
- It provides a generalized framework adaptable to various network scenarios, balancing reliability and efficiency.
- Future work includes exploring simulations, additional optimizations and extending the protocol's applicability.