

AODV Route Discovery Optimization: Performance Insights into Counter vs Distance- Based Schemes

Aba Kawsar

Lecturer, Department of Computer Science and Engineering, Dhaka Commerce College.

Abstract

Mobile Ad-hoc Network (MANET) is a wireless setup devoid of stationary arrangement. The main usefulness of MANETs is that it does not require any base station. MANETs is the network in which all the devices worked as a host and as a router. Easy deployment feature of (MANET) resulted in numerous applications in present era. Efficient routing protocol can make this reliable. Ad-Hoc On-demand Distance Vector (AODV) is a stateless responsive routing decorum for mobile ad hoc networks (MANETs). It decreases the routing overhead more than the other protocols and henceforth advances the presentation of the network. In this research an attempt is made to know Ad-hoc On Demand Distance Vector (AODV) routing protocol, its route discovery mechanism, and study on flooding control technique of AODV. AODV use two diverse procedures to discover and conserve directions: the route detection process operation and the route upkeep maneuver. In this paper the mechanism messages that used in AODV: RREQ, RREP. Propagation is a mutual maneuver in a network to determination of many concerns. Broadcasting is done by saturating. Assessment between flooding control procedure here counter based and distance based is also shown in this scheme focuses on the criteria like reachability, end-to-end delay, packet redundancy.

Keywords: AODV, Flooding Method, Probabilistic Scheme, Route Discovery Process, Reachability, End-to-End Delay

1. Introduction

AODV is a reactive protocol. It creates the route on demand and maintain the routes as long as it is necessary. AODV is a reliable protocol for mobile ad-hoc network. Where the packet transfer between the source and destination is done by the broadcasting mechanism. The source node creates the (RREQ) message packet and broadcast it. The broadcast is done by the flooding mechanism. There are several algorithms is found to control the flooding into the network.

Route Discovery process in AODV is start with the creating of RREQ message by the source node and broadcasting it into its neighbors. The broadcasting process is continued until the path between the source and destination is found. A search mechanism is used to find the neighbor node into the network. Then a reverse path and forward path is setup to discover the route between the source and destination.

Flooding is the most common way to broadcasting the message. AODV perform flooding of control packet instead of data packet. In flooding if a node broadcast the packet all the intermediate into the network find the packet and all of them re broadcast the packet into the network.

In route discovery process the sender node Broadcast RREQ messages. Then the intermediate nodes which is between the sender and the receiver update their routing table. Then the intermediate node forwards their RREQ if it is not the destination. Each node also maintains back-path to the originator. Destination generates RREQ message. RREQ sent back to source using the reverse pointer set up by the intermediate nodes. RREQ reaches destination, communication starts.

The route is needed to discovery when the source node requests to transfer data packet to the destination node. Without discovering the route this is not possible.

Here we discussed all about how the route is discovered and several packet structure which is also required to discovering the route. The route is discovery by the broadcasting process. The source node is broadcast packet and the intermediate node take the packet and rebroadcast them to the other nodes. The comparison of flooding control technique between a counter-based scheme and the distance-based scheme is shown based on two parameter reachability and the average end to end delay.

2. Contributions and Related Works

The review of recent research in MANET for the past few years found out very few important areas such as study about MANET, routing protocol, data loss model etc. For instance, Reference [1] briefly discussed about the broadcast storming problems and the solution. While Reference [2] architecture of different protocols. The reference [3] shows the detailed study on distance-based scheme based on RFI and GPS. The reference [4] shows distance quantification algorithm. Reference [5] was about performance analysis about AODV & DSR algorithm. On the other hand, Reference [5] was discussed about the probabilistic scheme of the AODV. Despite extensive research the performance analysis of distance based or counter based probabilistic scheme and the route discovery process based on flooding remains underexplored. This paper is based on study about the route discovery process from source node to destination node and the performance measure between counter based probabilistic scheme and distance-based scheme based on reachability and end to end delay to transfer packet between source node to destination node in MANET.

3. Methodology

In this section shows the methodology that used to study on the route discovery mechanism and also analyze the flooding control technique in the AODV protocol. The overall methodology divides into three main phases:

1. Examination of the Route Discovery Mechanism.
2. Analysis of Flooding and Control Schemes.
3. Performance Metrics Evaluation.

3.1 Examination of the Route Discovery Mechanism

The AODV protocol relies on its reactive nature to discover routes only when required. The key steps in the route discovery mechanism are as follows:

- Route Request (RREQ):
- When a source node intends to send data to a destination, it checks its routing table for an available route. If no valid route exists, it generates a RREQ packet containing:
- Source and destination identifiers (IP and sequence numbers).
- Broadcast ID.
- Time-to-Live (TTL) value.

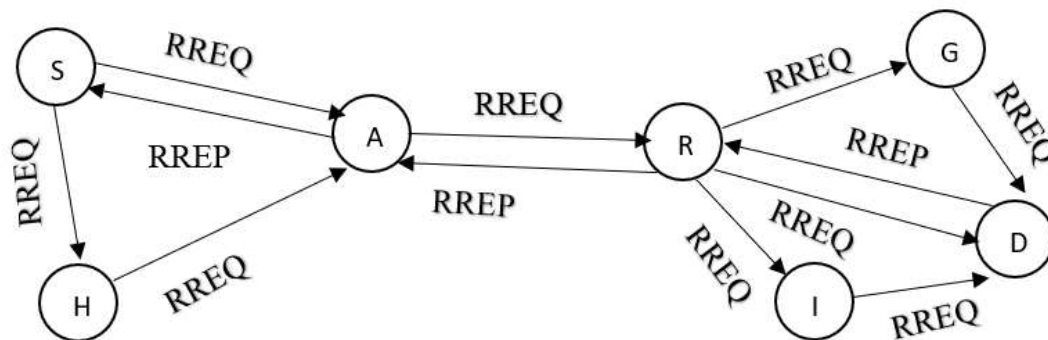
- Other necessary flags and counters.

Table 1: RREQ Packet Format

TYPE	J	R	G	RESERVED	HOP COUNT
RREQ ID					
Destination IP address					
Destination Sequence Number					
Originator IP Address					
Originator Sequence Number					

- Reverse Path Setup: Each intermediate node that receives the RREQ that creates a reverse route for the source node. This entry includes the address of the neighbor from which the RREQ was received and other related details like sequence numbers and TTL.
- Route Reply (RREP): Once the RREQ message reaches into destination node or the node between source and destination with a valid route. Then a Route Reply (RREP) message is generated. After that sent back along the reverse path to the source.

Figure 1: Route Discovery Process in AODV



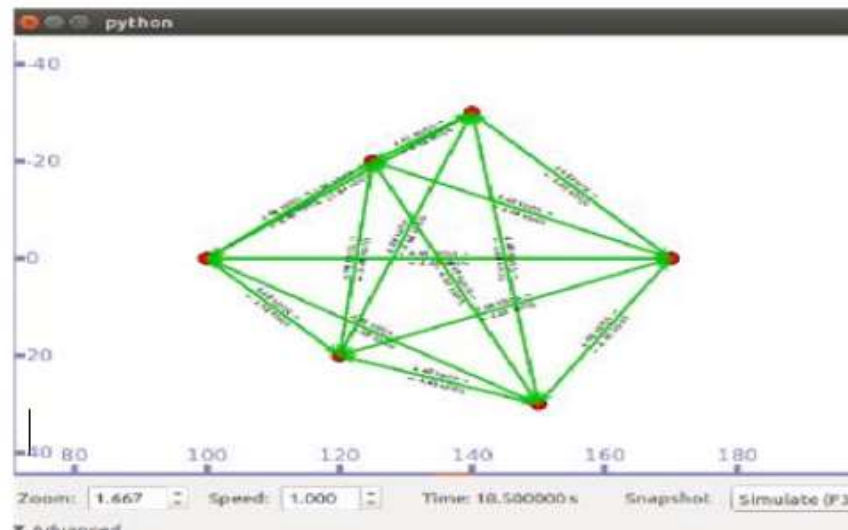
Here in the figure 1: S node is the source node and D is the destination. S node sends the RREQ message to all the neighboring node to detect the path to send data. The neighbor node then transfer the request to the intermediate node. This is called forward path setup. When a path is set between source and destination RREP message is sent to the sender from the destination and a route is discovered.

- Forward Path Setup: As the RREP replies back each intermediate node establishes a forward path from the source to the destination. Once the source receives the RREP it begins data transmission of data.
- Route Maintenance: Routes are maintained from the source to the destination through a Hello messages. If no activity is observed in a predefined time the message is deleted.

3.2 Analysis of Flooding and Control Schemes

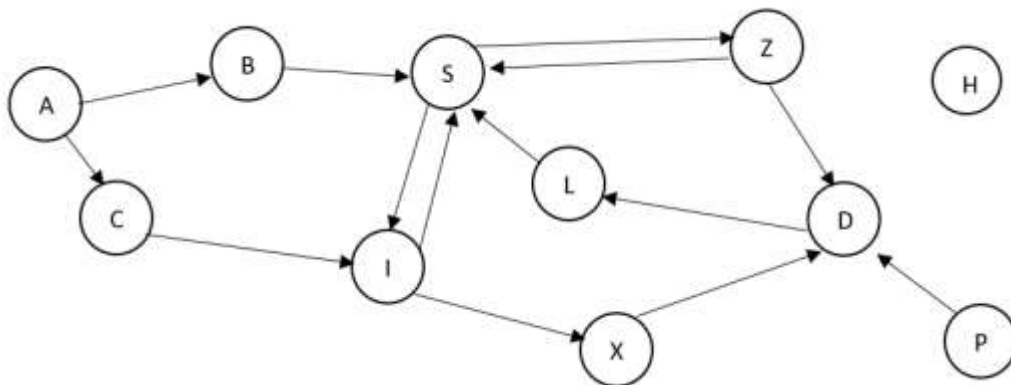
The default flooding mechanism used by AODV, while simple leads to significant overhead in dense networks due to redundant rebroadcasts. To mitigate this several flooding control schemes were evaluated such as:

Figure 2: Flooding Process to Transfer Data Using NS3



- Probabilistic Scheme: Each node rebroadcasts a received packet with a fixed probability. This reduces redundancy but may decrease reachability in the network.
- Counter-Based Scheme: the nodes count of how many times they received a broadcast. If the count surpasses a predefined threshold value, then node suppresses further rebroadcasts.
- Distance-Based Scheme: The distance between the sender and the receive the decision of rebroadcasting is depends on. Nodes farther apart are more likely to rebroadcast, ensuring better coverage with fewer redundant transmissions.

Figure 3: Mechanism of Flooding Control Schemes in AODV



- To discover routes the control packets are used
- Route discovering are mainly used to send data packets.

- Overhead of the control packet of flooding technique is repaid over data packets. That is transmitted between successive control packet floods.
- Here in Figure 3: Sender S broadcasts a control packet P to all of the neighbor node.
- Every node than receive P Forwards P to its neighbors.
- Sequence numbers helps to avoid the opportunity to forward the same data packet more than once.
- The packet P than reaches to the destination node D provided. The D is reachable from sender node S.
- The packet does not forward by node D. Because node D which is the projected destination of packet P.
- Process of flooding completed.

3.3 Performance Metrics Evaluation

The effectiveness of the flooding control schemes was evaluated based on the following performance metrics:

- Reachability: The proportion of nodes in the network that successfully receive the broadcast packet.
- Average End-to-End Delay: It is denoted by the average time takes for transferring data packet from the source node to the destination node.

The performance is measured in various conditions node density, mobility to transfer data, the overall network size and assess the act of each control scheme of flooding technique.

4. Algorithm Used in AODV

4.1 A Counter-Based Probability Scheme

Counter based probability scheme is used to control the flooding process in AODV. That makes the protocol more efficient. We can prevent a host from rebroadcasting when the expected additional coverage of the host's rebroadcast becomes too low. This is what the counter-based scheme is based on. Specifically, a counter c is uses for keeping track how many times the broadcasting message is received. A counter threshold C is chosen. Whenever $c \geq C$, the rebroadcast is inhibited. The scheme is formally derived below:

- S1: Initialize counter $c = 1$ when a broadcast message (msg) is heard for the first time.
 - The S2 if message is perceived again.
 - Perform S4 and interrupt the waiting.
- S2: Wait for a random number of slots. After that submit message for transmission and wait until the transmission actually starts. The message is on the air. The procedure exits.
- S3 Increase c by one. If $c < C$
 - Resume the interrupted waiting in S2. Otherwise, $c = C$, proceed to S5.
- S4: Cancel the transmission of msg if it was submitted in S2. The host is prohibited from rebroadcasting msg.
- Then exits.

4.2 Distance-Based Probability Scheme

Here suppose that before a rebroadcast message is actually sent, host H has heard the same message several times. Let d_{min} be the distance to the nearest host from which the same message is heard. Then H's

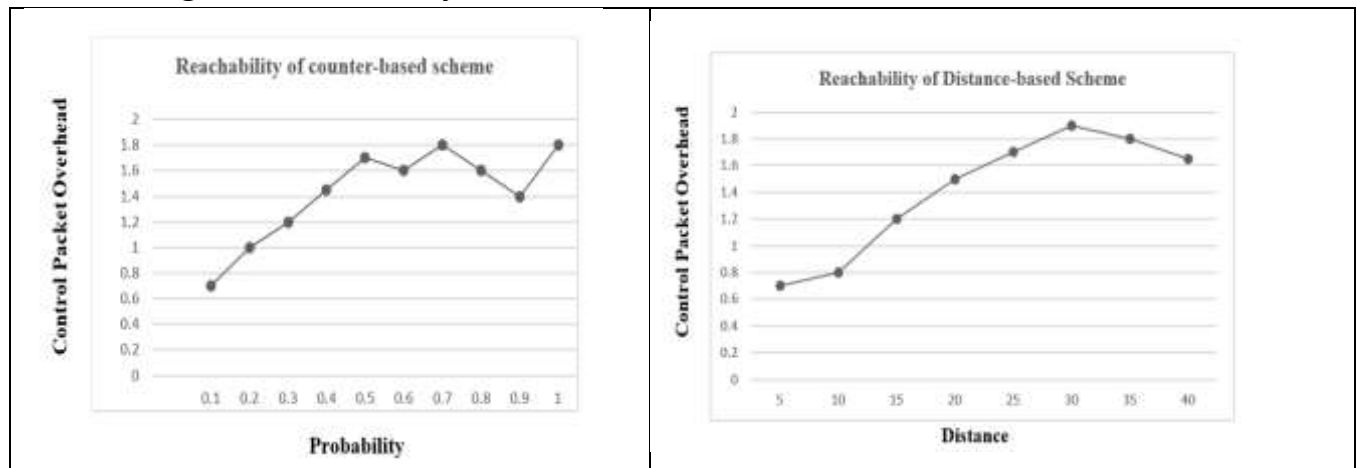
rebroadcast will provide additional coverage no more than πr^2 - INTC (dmin). In our distance-based scheme, we will use dmin as the metric to evaluate whether to rebroadcast or not. If dmin is smaller than some distance threshold D, the rebroadcast transmission of H is cancelled. The scheme is formally derived below.

- S1: If a broadcast message is heard that named as msg for the first time, the value of dmin is initialized, to the distance to the broadcasting host.
- If $d_{min} < D$, that is proceed to the S5.
- In S2: if msg is heard again then interrupt the waiting and perform S4.
- S2: Waiting period continues for arbitrary slots number. Then submit message which denote as msg for transmission process and wait until the transmission actually starts.
- S3: Here the message is on. After that the process exits.
- S4: Update the value of dmin if the distance to the host from destination is smaller.
- If $d_{min} < D$, S5 is proceed.
- Otherwise, interruption waiting for S2 is resumed.
- S5: If it was submitted in S2 then cancel the transmission of the message msg. The host withdrawn from rebroadcasting the msg.
- Then exits.

5. Outcome Exploration

- The comparison between a counter-based scheme and the distance-based scheme is shown based on two parameter reachability and the average end to end delay. Which is shown in the below figure.

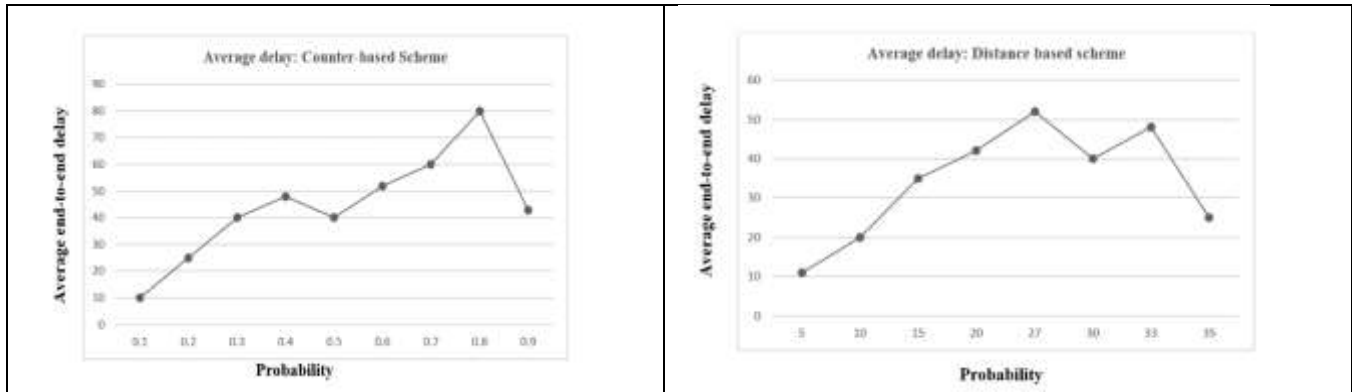
Figure 4: Reachability of Counter-Based Scheme and Distance-Based Scheme



In Figure 4: Reachability was analyzed based on control packet overhead versus probability. The counter-based scheme demonstrated that at a probability of 0.7, redundant packets in the network were minimized to 891 at a node mobility of 8m/s. This resulted in optimal reachability while reducing unnecessary packet rebroadcasts.

In difference the distance-based scheme displayed that packet redundancy is increased at higher distances. But this also ensured that source packets reached the destination with minimal loss. That also introduced additional network overhead.

Figure 5: Average End-to-End Delay in Counter-Based Scheme and Distance-Based Scheme



In Figure 5: Average end to end delay is shown based on the probability. As node mobility increases, the average delay increases because when node mobility increased in counter-based scheme more RREQ packets fail to reach their destination. In such circumstances more RREQ packets are generated and retransmitted, that leads to higher chance of collision.

Above figure we see that after the mobility speed is rise the end-to-end delay to the source to destination is lower in distance-based scheme which is higher in counter-based scheme in flooding control in ad-hoc on-demand distance vector protocol.

6. Summary of Findings

Table 2: Findings of Counter-Based and Distance-Based Schemes

Metric	Counter-Based Scheme	Distance-Based Scheme
Reachability	Efficient control over flooding but slightly lower reachability.	Higher reachability due to extended rebroadcasts.
End-to-End Delay	Higher due to re-transmissions under mobility	Lower as unnecessary rebroadcasts are suppressed
Packet Redundancy	Lower redundancy with probabilistic control	Higher redundancy at greater distances

The findings show that while both schemes improve the efficiency of AODV's route discovery mechanism, their effectiveness depends on network conditions. In future we can explore additional parameters such as packet delivery ratio and energy consumption to further evaluate the performance of these flooding control techniques.

7. References

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