Efficient AODV using Improved flooding with Sectorized Antenna for Mobile Adhoc Networks

Rajesh Kumar Yadav
Computer Engineering
Delhi Technological University
Delhi, India

Dr. Daya Gupta
Computer Engineering
Delhi Technological University
Delhi, India

Viomesh Kumar Singh
Computer Engineering
Delhi Technological University
Delhi, India

Abstract—Mobile Adhoc Networks (MANET) is decentralized, self configuring, wireless network of mobile devices without using any infrastructure. MANET required dynamic routing to respond to the topological changes as nodes are dynamic in nature. Dynamic routing protocol such as Adhoc on demand distance vector routing (AODV) with Expanding Ring Search (ERS) is widely used technique to reduce energy consumption and broadcast cost of searching in MANET. In AODV, network-wide flooding is initiated whenever any node wants to communicate with some other node to find the route between source and destination whereas in ERS, flooding performed in successively larger area in network. In this paper, we reduce number of transmissions by each forwarding node using sectorized antenna in high density networks. The selective flooding shows expected 35% reduction in the routing overhead during route discovery when applied to various standard regular models.

Keywords— Mobile Adhoc Networks, Adhoc on Demand Distance Vector Routing, Expanding Ring Search, Directional Antenna, Sector Antenna

I. INTRODUCTION

Mobile Ad hoc Networks (MANETs) is a collection of mobile wireless devices (nodes) that form decentralized, self organizing and infrastructure-less wireless network among them [1]. The communication between any two nodes is accomplished via forwarding of messages by other member nodes known as intermediate nodes. Nodes in MANET are with limited power, independent of each other and free to move. Due to the mobility of nodes, multipath propagation, path loss and interference topological changes occur in network which makes routing difficult, Dynamic routing is required to respond to the topological changes as nodes are dynamic in nature. Routing protocols in MANET are categorized as flat routing, hierarchical routing and geographic position assisted routing. According to routing strategy flat routing is further subdivided into proactive routing and reactive routing [2]. The proactive routing algorithms (e.g. FSR,OLSR) are table driven that find the routes constantly and maintain routing information for all source-destination pairs in routing table which cause high routing overhead. Reactive routing protocols such as AODV, DSR discover the route between source and destination pair only when it needed. These algorithms also known as on demand routing protocols.

Adhoc On Demand Distance Vector (AODV) routing protocol is widely used routing algorithm for MANET [3]. Whenever any source need to communicate with some other node it starts blind flooding of RREQ (Route request packet, message initiated by the source to find the destination) in whole network to find and establish unicast route between source and destination. Due to network-wide flooding, Each and every nodes of the network have to entertain the Route request packet which causes overhead in terms of wireless node processing, energy consumption and bandwidth. Overhead in bandwidth occurred when an RREQ broadcasted by source in the process of on demand route discovery. To solve this problem Expanding Ring Search (ERS) concept is applied [4]-[6]. In ERS based on AODV, flooding performed in successively larger area in network to avoid network-wide broadcast. In this paper we perform selective flooding to improve AODV and ERS routing algorithms which utilizes a sectorized antennas at each mobile wireless node. Each node is equipped with multiple identical directional antennas facing in different directions covering all 360 degrees in non-overlapping manner instead of single omnidirectional antenna. It divides omnidirectional transmission range into multiple sectors. Each node can broadcast only in selected sectors to reduce the total number of transmissions compared to broadcasting using blind flooding.

In a comparative analysis between blind flooding and selective flooding applied on AODV and ERS using three sector, four sector and eight sector antenna, considerable reduction of up to 35% in the routing overhead during route discovery is achieved. We perform this analysis based on standard eight neighbor regular 2D grid model, four neighbor regular 2D grid model, and hexagonal model and also describe their behavior in a general model.

II. OVERVIEW OF AODV AND ERS

The topologies in MANET are so unstable and dynamic in nature as it is formed by mobile nodes; So MANET required dynamic routing to respond to the topological changes. Reactive routing protocols such as Adhoc On Demand Distance Vector (AODV) Routing and Expanding Ring Search (ERS) based on AODV are most widely used reactive
routing protocol, in which routes are establish only when they are needed. At each node in the network, Route information is maintained in traditional routing tables, one entry per destination, distance information (total number of inter mediate nodes), sequence numbers to determine whether routing information is up-to-date and to prevent the routing loop. Routing entries which are not recently used are expired in AODV. AODV fallsow simple blind flooding, i.e. when a node want to communicate with some other node (unknown destination), it broadcast RREQ for that destination. If receiving node (has not received RREQ before) has route to destination or itself is the destination node, it generates a RREP (Route Reply) back to the source in hope-by-hope fashion via all intermediate nodes, otherwise it simply rebroadcasts the RREQ [3]. When the source receives the RREP for desired destination, it records the path for the same and start unicasting the data. In case of multiple RREP received by the source, the route with minimum hop count is chosen.

In AODV, network-wide flooding is performed and route is established whenever needed. Each nodes of the network have to entertain the RREQ, it causes overhead in terms of energy consumption, node processing and bandwidth [7]. To overcome the network wide broadcast problem, expanding ring search (ERS) technique is applied. To discover the route to the required destination, ERS performs searching in successively larger area in network to avoid network-wide broadcast.

In ERS based on AODV, flooding of RREQ starts with small TTL (time to live) counter value for route discovery. Time-to-Live (TTL) counter is used to count the number of hops to end of the current ring. Each node decrement the TTL value by 1 before rebroadcasting RREQ. Nodes encounter RREQ with TTL zero; do not forward RREQ any further and flooding halts. Using TTL value, source node can control flooding radius. If source does not receive any RREP within the predefined time-out period, it modify old TTL value to a new value by adding some appropriate pre-decided TTL_incriment (to increase the search radius) and the flooding is repeated up to new TTL. A TTL_incriment variable is used to gradually increase the size of successive rings. This repetitive process is continues until TTL threshold value encounters or destination found. Whenever source receives RREP, source records the route and won’t modify TTL again and flooding stops. If TTL reaches to threshold value the RREQ is broadcast throughout the entire network like AODV. Using TTL value, source node can control flooding [4]-[6].

III. SECTORIZED ANTENNA

An antenna redirects the energy it receives from the transmitter. It provides three fundamental properties direction, gain and polarization. Gain measure the amount of energy increase to a radio frequency by that antenna [8][9]. Direction measure the transmission coverage angle or radiation pattern in degrees. These angles are measured in degrees and are called beamwidths. Omnidirectional antenna provides uniform two-dimensional radiation pattern. In other words, Omnidirectional antenna has perfect 360 degree horizontal beamwidth radiation pattern. Omni antenna is used in order to increase the probability of receiving signal in a multipath environment. Omnidirectional antennas such as Cisco Aironet Antennas (HGA9N and HGA7S) are used for small office environments.

Directional antenna is used to redirect the energy in some specific direction as it decreases angle of radiation [10][11]. The coverage angle is measured in degrees and called beamwidths. Directional antenna focus reduced coverage angle but increase coverage distance in one direction. Therefore, we can transmit RF energy to farther distances in particular direction as effective beamwidth decreases. In this system, antenna should face in the direction where the coverage is desired. Sectorized antenna is made of multiple identical directional antennas radiating at equal size coverage angle in non-overlapping manner that makes a angularly-separated sector-shaped radiation pattern which divides transmission range into equal size sectors. Sectorized antenna system can be used to transmit in one or more selective sectors as well as in whole 360° omnidirectional transmission range. This configuration provides good data rates and good signal consistency within the coverage area. Sectorized antenna systems are mainly used to reduce interference. If any sectorized system built up of k directional antennas aimed in different direction then each node in this system is assigned different channels to different interfaces is assigned to reduce interface. In this paper, we are applying sectorized antenna system for efficient broadcasting to reduce routing over head by selective transmission of RREQ.

IV. SELECTIVE FLOODING IN AODV AND ERS USING SECTORIZED ANTENNA

Nodes equipped with single omnidirectional antenna is replaced with k directional antennas that equally divide the omnidirectional transmission range into k non-overlapping sectors where one or more such sectors can be switched on for selective transmission. Each antenna supports communication with multiple nodes using different channels. In this proposed scheme using sectorized antenna, each node is capable of selective transmission over multiple sectors. At each node efficient broadcasting is performed by switching on some of the sectors for transmission using directional antennas to avoid broadcast storm problem caused by blind flooding [12]. Each node can control RREQ broadcast which follows blind flooding. In this technique, routing overhead can be reduced and channel capacity can be improved by switching on some of the sectors for transmission using directional antennas while restricting the transmission in others sectors by switching them off.

In this paper, we analyze selective flooding in AODV and ERS routing protocols using sectorized antenna. In this configuration, each node is capable of selective transmission in specific direction with its neighbours. In conventional flooding mechanism, each node sends the RREQ to all its neighbours by following uniform two-dimensional radiation pattern. The improved flooding technique uses sectorized antenna to greatly reduce number of transmission links in route discovery process to reduce routing overhead. As shown in the Fig 1. Node A transmits the RREQ packet only to the sectors with black nodes, in contrary node A do not broadcast RREQ to sectors with white nodes. This mechanism provides increased efficiency by reducing redundant transmission. In this paper, the sectorized antenna of each node provides selective communication in specific direction with it’s neighbours. We are using three kind of different sectorized
antenna system using 3 sector antenna, 4 sector antenna and 8 sector antenna system. In an adhoc system of mobile nodes which all consist of identical 3 sector antenna or 4 sector antenna, Nodes do not transmit RREQ to the sector from where it receive RREQ packet, whereas in 8 sector antenna configuration, the sector of the source node of RREQ and its adjacent sectors do not receive RREQ packet.

V. **REGULAR TOPOLOGIES**

We consider three regular topologies here: standard eight neighbours regular 2D grid model, standard four neighbours regular 2D grid model and hexagonal topologies. These topologies are shown in Figure 2. In regular topology [5], total nodes belonging to the rings follow a regular pattern.

There are total R rings in the topology, ring R being R hops away from the source node. For hexagonal and 2D grid(8 neighbours and 4 neighbours), nodes that are 1 hop away from the source belong to first ring, nodes that are 2 hop away from the source belong to second ring. In standard eight neighbours regular 2D grid model, standard four neighbours regular 2D grid model, each node has directly connected to 8 neighbours and 4 neighbours respectively, whereas in hexagonal topology each node has 6 neighbours.

VI. **ANALYSIS AND RESULT**

To analyze the efficiency of route discovery cost in AODV and ERS using sectorized antenna, we compare the number of RREQ transmitted in omnidirectional antenna, three sector antenna, four sector antenna and eight sector antenna. To
theoretically analyze the performance, we use standard eight neighbor regular 2D grid model, four neighbor regular 2D grid model, and hexagonal model. The standard model provides a set of nodes with uniform density and distribution [5]. We also provide a comparative general description of ERS and EAODVSA.

Here first we analyze effect of selective flooding in AODV in terms of number of RREQ for route discovery process afterwards we analyze its effect on ERS for various standard model.

Fig. 3. No. of Links used in route discovery in AODV

Fig. 4. Comparative reduction of routing overhead graph of selective flooding and blind flooding in AODV

Fig. 5. No. of Links used in route discovery in ERS
When we applied selective flooding in ERS, it provides exactly the same result for the number of transmitted RREQ packet showed in Fig 5, and reduction in number of transmitted link showed in Fig 6, as we got in case of AODV because ERS is based on AODV and follows the same flooding concept.

VII. CONCLUSION

In this paper, we analyze efficient broadcasting applied on AODV and ERS routing algorithm using sectorized antenna. Sectorized antenna is able to provide selective flooding in required direction, is used to reduce redundant rebroadcast during route discovery.

REFERENCES