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Energy Efficient Enhancement of QoS-AODV Routing Protocol for MANETs

[Rachna Bagwari, Neha Garg, Emmanuel S. Pilli]

***Abstract*— Collection of mobile nodes that communicate each other without any infrastructure is called Mobile Ad-hoc Network (MANET). The nodes are free to move and can leave and join the network at any instance of time. Hence the topology of MANET changes dynamically. Due to the increasing advances in technology the applications of Mobile Ad-hoc Networks are also increasing. In both the civilian and military areas the uses of MANETs are appreciated because of their various potential applications. There are various protocols to route the packets from source to destination. This paper proposed an approach for Energy Efficiency Enhancement of QoS-AODV routing protocol by setting a threshold limit**.

Keywords: — MANETs, AODV, QoS-AODV, EEEQoS-AODV.

I. Introduction

Due to the infrastructure-less characteristic of MANETs the mobile nodes act itself as a router to route the data packet from source to destination. Ad-hoc networks are built with a facility of self organization [1] and therefore information is transferred between the node in the form of multi-hop. MANETs are easy to built because they don't have any infrastructure and easy to destroy. Therefore these are also termed as temporary networks.

AODV (Adhoc On-demand Distance Vector) is a reactive routing protocol that finds and establishes a route in on-demand bases. As long as a source node needed a route, the route maintained by AODV routing protocol remain unchanged and it is considered one of the best routing protocols in terms of power consumption and performance metrics.

Route Discovery and Route Maintenance are the two process of route creation in AODV. To route the data packet from source to destination is called routing. In AODV when a source node needs a route to destination it requests for a route discovery process.

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Whenever an intermediate node or destination node moves the node upstream of the break initiates a HELLO_Packets to affected upstream neighbor nodes. These nodes propagate this packet to source node. When HELLO_Packets is received by source node it can either stop sending the data or restart the route discovery mechanism by sending RREQ_Packet if still there is any requirement of route.

Battery life time and Mobility are two main factors that cause link failure. By reducing the energy of each node we can increase the life time of the whole network.
In case of a multimedia traffic QoS is very important [2]. The aim of QoS-AODV [3] is to improve the QoS performance metrics of existing Adhoc On-Demand Distance Vector (AODV) [4] routing protocol. Our proposed routing protocol is Energy Efficiency Enhancement of QoS-AODV (i.e. EEEQoS-AODV).

II. Routing Category for MANETs

Nodes are randomly distributed in the network. The process of finding a path from source node to the destination node among these distributed nodes is called as routing. There are various routing protocols (as shown in Fig.1) to route the data packets from source to destination, based on the way the network information is obtained in these routing protocols.

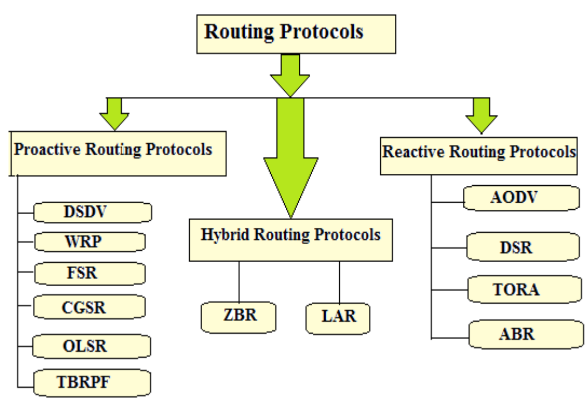

Figure 1. Routing Protocol Category for MANETs

A. *Table Driven (or Proactive) Routing Protocols*

In Proactive routing protocol a node always maintain routing information of each node in the network. A periodic updating of routing information occurs whenever topology changes due to the node mobility. And each node requires caching their routing information.

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Some different types of proactive routing protocols are:

- DSDV (Destination Sequenced Distance Vector Routing).
- WRP (Wireless Routing Protocol).
- FSR (Fish Eye State Routing Protocol).
- CGSR (Cluster Gateway Switch Routing Protocol).
- OLSR (Optimized Link State Routing Protocol)..
- TBRPF (Topology Dissemination Based on reverse Path Forwarding) [9].

B. On-Demand (or Reactive) Routing Protocols

In proactive routing protocol each node maintains all existing routing information from source to destination. Reactive routing protocols were designed to reduce the overheads of proactive routing protocols by maintaining information for active routes only. Whenever a source node demands for a route, the route discovery procedure is started by the node.

Some different types of reactive routing protocols are:

- AODV (Adhoc On-demand Distance Vector) routing protocol [4]
- DSR (Dynamic Source Routing) [5].
- TORA (Temporally Ordered Routing Algorithm) [6].
- ABR (Associativity Based Routing) [7].

C. Hybrid Routing Protocols

This inherits a property of proactive routing protocols as well as the property of reactive routing protocols.

Some hybrid routing protocols are:

- ZRP (Zone Routing Protocol) [8].
- LAR (Location Aided Routing) [9].

III. Related Work

Initially a general review of Adhoc On-demand Distance Vector (AODV) routing protocol and QoS-AODV is made and then EEEQoS-AODV route discovery is discussed.

A. AODV Route Discovery Process

I. ***Route Creation*:** When a source node needs to route a data packet to destination it first check its cache table and search if there exist any valid route from source node to destination node. If there is not any valid route found, it starts the route discovery procedure. The source node broadcasts RREQ_Packet .

Each node of MANETs has a RREQ ID, which is a unique number and whenever a node sends out RREQ_Packet this unique number incremented. This RREQ_Packet includes (RREQ_Packet contains RREQ ID, Destination IP, Destination Sequence Number, Source IP, Source Sequence Number & initially Hop Count = 0). Initially if the source node has no knowledge of destination then it is set to zero. A source node broadcasts RREQ_Packet to its neighbor nodes. A neighbor node on receiving this packet increase the hop count of the RREQ_Packet and cache the information of its neighbor node from where it get the RREQ_Packet, also cache a reverse route to source node. After creating a reverse route, the nodes send RREP_Packet to the source node if it is either the destination or it have a valid route to destination. If the node does not have a valid route to destination it then rebroadcasts the RREQ_Packet to its neighbors. Fig.2 shows the route discovery procedure for AODV.

Record of RREQ_Packet is cache by each node. This is helpful to reduce the duplicity of RREQ_Packet. When node receives duplicate RREQ_Packet it first checks the RREQ_Packet ID and source address. If both are same it discards the later one and doesn't broadcast to its neighbors. This reduces the routing overhead caused by flooding broadcast.

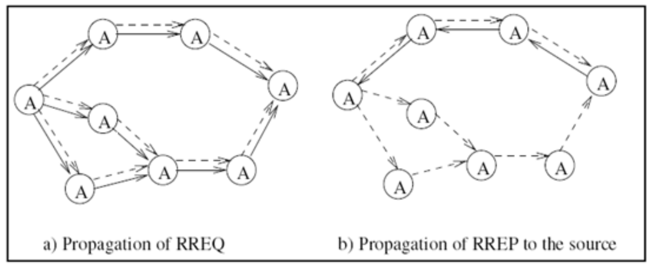

Figure 2. AODV Route Discovery Process

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RREP_Packet is unicast to the source node from the destination node or the intermediate node. All intermediate nodes cache the information about this RREP_Packet and whenever get an RREP_Packet it first increment the hop count value in the RREP_Packet, and create a forward route entry for both the destination node and the neighbor node from where it receive RREP_Packet.

```
   Source Node:
   If (a route to the destination is
available)
   {Start sending data.
   }
   Else
   {Generate a RREQ_ Packet.
   Increment the RREQ-ID by 1.
   Increment the sequence number by 1.
   }
   Destination IP address, currently
available sequence   number included,
source ID.
   Intermediate Node:
   Generate RREP_Packet
```

```
   If (A valid route exists for the
destination whose associated sequence
number is at least as great as that
contained in the RREQ_Packet)
   {Increment the hop count by 1and
forward.
   Cache the reverse route.}
   Else
   {Rebroadcast the RREQ_Packet.
   Also maintain a reverse route to source
node.
   }
   Destination:
   Sequence number of destination
increases.
   Generate a RREQ_Packet message and
   Use the reverse route in cache and sent
back to source node.
```

Figure 3. Algorithms for Route Discovery Process for AODV

The nodes follow the reverse route according to the entry in cache table until the RREP_Packet reaches the source node. The source node after receiving the RREP_Packet uses the route for transmission of data packets.

The algorithm for AODV route discovery is shown in Fig. 3

II. ***Route Maintenance***: HELLO_INTERVAL is an Interval at which HELLO_Packets are broadcasts periodically by active nodes of MANETs.

If (A neighbor node doesn't send a HELLO_Packets)
{
Link failure identified.
}
A local route repair to that next hop initiated.

After a timeout, error message is transmitted to source and destination nodes.

Entries based on the node invalidated.

B. QoS-AODV Routing Protocol

In AODV route discovery process many unnecessary packets get rebroadcasted resulting in packet loss [3]. Unlike AODV routing protocol, in QoS-AODV routing protocol the performance metrics are high with respect to no. of nodes increases. Fig.4 shows the algorithm for QoS-AODV routing protocol. It first calculates the time taken by the packets to reach the node by using the 'Send Timestamp' of the packet and 'Receive Timestamp' of the packet.

Time Taken = Receive Timestamp – Send Timestamp

Add this Time Taken by packet to reach the node in the cache of each node. It will provide Total Time taken by a packet to reach the destination, and will also provide 'Average Time' taken by packets to reach the node.

AT= Total Time taken by the packet/Count

Here AT is Average Time taken by the packet.

```
   Source Node:
   If (a route to the destination is
available)
   {Start sending data.
   }
   Else
   {
   Generate a RREQ_ Packet.
   Increment the RREQ-ID by 1.
   Increment the sequence number by 1.
   }
   Destination IP address, currently
available sequence number included, source
ID.
   Intermediate Node:
   Generate RREP_Packet
   If (A valid route exists for the
destination whose associated sequence
number is at least as great as that
contained in the RREQ_Packet)
   {Increment the hop count by 1and
forward.
   Cache the reverse route.}
   Else
   If (Destination node is known and time
taken by the packet to reach the node <=
Average Time taken by the packet)
   {
   Cache the RREQ_Packet (Increment hop
count, decrement TTL)
   Rebroadcast the RREQ_Packet
   Also maintain a reverse route to source
node.
   }

   Destination:
   Sequence number of destination
increases.
   Generate a RREQ_Packet message and
   Use the reverse route in cache and sent
back to source node.
```

Figure 4. Algorithm of QoS-AODV routing protocol

IV. Proposed Work

This paper proposed an Energy Efficient Enhancement of QoS-AODV. QoS-AODV enhances the performance metrics of AODV routing protocol [3]. But we know that power supply is also an important feature for a MANETs [10] [11]. Problem of Link breakage, packet delivery delay may increases due to shortage of energy within a node, which affect the whole network. The algorithm proposed in this paper concerned with the increment of life time of the network, by adding the concept of threshold limit within the existing QoS-AODV.

As whole EEEQoS-AODV enhances the performance metrics (i.e. Throughput, packet delivery ratio, and End-to-

End delay) and as well enhances the lifetime of the network. In this proposed protocol, minimum energy threshold limit is set to a mobile node. Whenever the battery power of mobile node reached up to this threshold limit the node goes in a sleep mode and saves its power so that it can join the event as long as possible, and we can mitigate the link breakage probability. Fig.5 shows the algorithm for EEEQoS-AODV routing protocol.

```
   Source Node:
   If (a route to the destination is
available)
   {
   Start sending data.
   }
   Else
   {
   Generate a RREQ_ Packet,
    Including the initial Power provided
to that mobile node
   Increment the RREQ-ID by 1.
   Increment the sequence number by 1.
   }
   Destination IP address, currently
available sequence number included, source
ID.
   Intermediate Node:
   Generate RREP_Packet
   If (A valid route exists for the
destination whose associated sequence
number is at least as great as that
contained in the RREQ_Packet)
   {Increment the hop count by 1and
forward.

   Cache the reverse route.
   And also cache the remaining power of
source node, and initial power of itself.
   }
   Else
   If (Destination node is known and time
taken by the packet to reach the node <=
Average Time taken by the packet)
   Cache the RREQ_Packet (Increment hop
count, decrement TTL)
   Rebroadcast the RREQ_Packet.
   Also maintain a reverse route to source
node.
   }
   If (Current power>= Threshold Limit)
   {
      Goes to sleep mode and save energy.
   }
   Destination:
   Sequence number of destination
increases.
   Generate a RREQ_Packet message and
   Use the reverse route in cache and sent
back to source node.
```

Figure 5. Algorithm for EEEQoS-AODV Routing Protocol

V. Result Discussion

QoS-AODV increases the performance metrics of AODV routing protocol. Energy management is must to increase the life time of a network to prevent it from link breakage, packet loss etc. QoS-AODV doesn't support for energy efficiency. Therefore EEEQoS-AODV is proposed to increment the life time of MANETs. Average time taken by the packet is calculated and a threshold limit is set to the MANETs.

In comparison to QoS-AODV our proposed routing protocol consumes less energy and enhances the life time of the network and as well as increases the performance metrics. Therefore by protecting the power of individual node in the network we can improve the life time of the network and can mitigate the reduction in performance metrics also. .

VI. Conclusion

In this paper we proposed an EEEQoS-AODV routing protocol that is an energy efficient routing protocol and compare it with QoS-AODV routing protocol.

End-to-End delay, packet delivery ratio, throughput and life time of network is measured and compared for QoS-AODV and EEEQoS-AODV.

As whole we conclude that EEEQoS-AODV routing protocol is good in terms of energy efficiency that increases the life time of the network and as well as the quality of service.

Future work regarding this paper is implementation of EEEQoS-AODV routing protocol and compare it with QoS-AODV routing protocol in terms of performance metrics and network life time using network simulator NS-2.34.

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