“Mobile Ad Hoc Network Routing Protocols on the Basis of Energy Consumption”—A Review

Najme Zehra Naqvi¹, Upasana Gupta², Surbhi Kochhar³ and Rashi Agarwal⁴
¹,²,³,⁴ Department of Computer Science Engg.
Indira Gandhi Institute of Technology, GGSIPU
¹naqvizehra@rediffmail.com, ²upasana.2688@gmail.com, ³kochhar.surbhi@gmail.com and ⁴rashia15@gmail.com

ABSTRACT
MANET is a group of mobile nodes connected to form an infrastructure-less network. Due to limited band-width and energy capacity of nodes the energy conservation in MANET is a significant issue. We will analyze the energy consumption by the most commonly used routing protocols-AODV and DSR varied according to the parameters- (i) Mobility pattern (ii) Traffic pattern (iii) Area Shape (iv) Data traffic pattern and (v) number of nodes. The paper presents the results of all the research done on energy consumption patterns of AODV and DSR till date. Conclusion compares the behavior of two protocols in terms of energy consumption.

KEYWORDS
MANET, AODV, DSR, Proactive, Reactive.

1. INTRODUCTION
A Manet is a wireless network that operates independently of any fixed infrastructure or central administration [6].The nodes communicate through each other by the routes that are computed dynamically. Each node acts as a router that forwards the data packets between source and destination. Nodes communicate through wireless network links. The nodes are free to move randomly and organize themselves arbitrarily thus the network’s topology may change rapidly and unpredictably [9, 10].The routing protocol should be able to keep up with high degree of node mobility. Therefore on demand mobile adhoc protocols were designed. On-demand routing protocols use two main processes- Route Discovery and Route Maintenance. Source generates route request to be sent to the neighbors. Intermediate nodes rebroadcast the route request to the neighbor in a similar way until destination is reached. The destination then sends route reply back to the node which sent the request packet and a reverse path is established from destination to source. Communication between source and the destination starts when reply is received by the source.

The two most commonly used routing protocols are AODV and DSR. AODV supports unicast, multicast and broadcast operations. It is based on next-hop model. AODV has less routing overhead in comparison to DSR.AODV is more adaptable to highly dynamic networks but at the same time it suffers from large delays. The source node and the intermediate nodes store the next-hop information corresponding to each flow for data packet transmission [8]. Nodes update the information by overhearing control messages.

In DSR, the nodes carry full address of the hops in the final path between source and destination. DSR is not effective in large networks whereas performs better in small and moderate networks. Also, it does not require periodic beaconing and nodes can enter sleep mode to conserve their power which is not the case with AODV.

The main focus of this paper lays on the energy consideration of the adhoc protocols i.e. the energy consumption of the mobile nodes in an active network. Energy is the main constraint of the adhoc networks as the nodes in the Manets carry limited energy. When the nodes are a part of the active network energy is consumed during the receiving and sending of packets and also during the maintenance of the network.

There may be case when the number of nodes participating in the network increase to a level that can not be adjusted and maintained in the current network which leads to the breakdown of the network, wastage of battery power and reduces the lifetime of the nodes i.e. the energy content of the nodes.

In adhoc networks there is no centralized authority for keeping a check on the packets transmission between the nodes which sometimes result in collision and loss of transmitted packets. This causes retransmission of the lost packets and hence wastes energy [13].

When the connections in a network are established, the packets are broadcasted across all the nodes which consume energy at each node proportional to the size of the transmitted packet. The main point to be noted here is that energy is consumed even if the packet transmitted is corrupted.

Due to the above discussed reasons the energy consumption forms an important parameter of the adhoc networks. This paper is divided into sections where section 2 explains the proactive and reactive protocols, section 3 defines the conventional adhoc protocols, section 4 gives the various parameters to be studied and section 5 shows the various studies conducted by the different researchers and relationship of parameters with energy.
2. PROACTIVE AND REACTIVE PROTOCOLS

Proactive protocols
These protocols are referred as the table driven protocols as they maintain tables at each node for the routing information. The tables are updated for every change in the topology or routing considerations in the network. These protocols maintain up to date and consistent information of the network. Advantage of these protocols is that the source node does not have to use a procedure to determine the complete route to the destination, as the information is already maintained by the tables at each node.

Main drawback of these protocols is that the maintaining of the tables requires messaging overhead which consumes bandwidth and power [7] and in turn reduces throughput mainly when there is large number of high node mobility.

Reactive protocols
These are the on demand protocols i.e. the path in the network is established on demand. In these protocols the nodes are discovered at the time of need. It includes two main procedures- Route discovery process and Route maintenance process. Route maintenance is done till either the destination becomes unapproachable along every path from the source or route is no longer desired [7]. The benefit of using these protocols is that the overhead of messages is comparatively reduced. The drawback of these protocols is delay in discovering a new route every time it is needed. The most common examples of reactive protocols are AODV and DSR.

3. CONVENTIONAL ADHOC NETWORK PROTOCOLS

1. Distance Source Routing
DSR uses source routing and maintains route cache. [3]. The source node knows the complete path to destination and the packets carry full address of the path. Each node checks its route cache for a route to destination. If the route is not available then it initiates a route discovery process. The source node sends route request to the neighbors. This process is repeated until destination is reached and then it sends reply packet back to the source. The path followed by the route reply packet is used to send the data packets. It allows multiple routes to destination node and routing is loop-free. If any link is broken then it is notified to the source.

2. Ad-Hoc on Demand Distance Vector protocol-
AODV is a loop free routing protocol for adhoc networks. It is designed to be self starting in an environment of mobile nodes. It withstands variety of network behavior such as node mobility, link failures and packet losses [4]. Routing table at each node contains three fields - a next hop node address, a sequence no., and a hop count. Sequence number is a form of a time stamping and is a measure of the freshness of a route. Hop count represents the current distance to the destination node. All packets destined to the destination are sent to the next hop node. In AODV, nodes discover routes in request-response cycles. At the end of the request-response cycle, a bidirectional route is established between the requesting node and the destination node [15]. The destination sends a reply packet to the source and the source node sends the packet on the forward route. If a node looses connectivity to its next hop, the node invalidates its route by sending a route request to all nodes that potentially received its reply. AODV requires less memory and computation and does not create extra traffic for communication along existing links. The main drawback of AODV is that it requires more time to establish a connection.

4. COMPARISON OF AODV AND DSR IN TERMS OF PARAMETERS

In this, we compare these two adhoc routing protocols in terms of energy consumption versus mobile node numbers, number of sources, moving area dimensions, node mobility pattern, data traffic pattern and the comparison of results obtained by various researchers in this area.

- Metrics considered for evaluation [1]
  - Mobile Node Numbers-
    This is the total number of nodes that are part of the network at a particular moment.
  - Number of Sources-
    The number of sources is the number of nodes that are permitted to send packets to other nodes.
  - Moving Area Dimensions-
    The area in which a node will be in the transmission zone i.e. it can receive packets and can send packets. Since the nodes might be always moving, the area occupied by majority of nodes may also change.
  - Node mobility pattern-
    In the simulation, nodes move according to a model called “random waypoint” [16]. Motion is characterized by two factors: (a) maximum speed and (b) pause time [1]. During simulation, each node starts moving from its initial position to a random target point, selected inside the simulation area. The motion speed value is uniformly distributed between 0 and the maximum speed. When a node reaches the target point, it waits for the pause time and then, by selecting another random target point, moves again. According to this scheme, a pause time value equal to the simulation time corresponds to a static network, while a 0 second pause time corresponds to a continuously changing network.
  - Data traffic pattern
    All the traffic structure is defined by two factors: sending rate and packet size. Sending rate is the rate at which source nodes send packets. Packet size is the size of the packet sent and received and is measured in bytes.

5. RESULTS AND ANALYSIS

The aim of the paper is to compare the different results and derive the conclusion. The simulation tool used in this study is NS2. Communication Management Unit’s wireless extension to NS2 provides the implementation of DSR, AODV protocols.

1. Mobile node numbers

In [1], Juan-Carlos Cano et al, observed that energy increment for AODV and DSR was quite similar and is about 220% when the number of nodes is varied from 25 to 50. The reason behind...
this energy increment is due to route maintenance process in these protocols. In [2], it was noticed that when number of nodes is varied between 30, 40, 50, 60, 70, 80, both protocols show increment in energy consumption due to increase in the maintenance process. DSR performed better with the increase in the number of nodes than AODV but AODV performed better at low number of nodes. Thus, it can be found that as number of nodes increase the routing packet overhead in DSR compensates against other factors making it more energy efficient than AODV.

2. Varying number of sources
In [4], total energy consumption (joules) is more for DSR with the number of sources varying from 10 to 45 except when number of sources is 30, AODV consumes more energy. Pause time considered is 0 sec.

In [2], the total energy consumed (Joules) by all the nodes is observed by varying the number of connections by 10, 20, 30, 40, 50 and 60. With the increase in number of sources, the routing packets are increased the energy consumption of both AODV and DSR increases but DSR performed better than AODV due to route cache. Pause time considered is 10 sec.

In [1], when traffic sources vary from 10 to 20, the routing energy increases by 7.31% in DSR and 88.97% in AODV. While moving from 20 to 30 sources the routing energy increases by 41.73% in DSR and 15.88% in AODV. This behavior is mainly because the on-demand routing protocols allow nodes to learn new route information from packets previously sent. Thus, DSR is better than AODV.

3. Varying moving area dimensions
In [1], the selected areas were: 250m x 250m, 250m x 500m, 500m x 250m and 1000m x 500m. When incrementing the area, DSR and AODV protocols increase their routing energy consumption as with the increasing number of nodes, overhead in route discoveries and route maintenance also increases.

In [2], the selected grid areas were: 500m x 250m, 500m x 500m, 750m x 500m, 750m x 750m, 1000m x 750m and 1000m x 1000m. The result shows that DSR outperformed AODV up to 750m x 750m. After this area AODV outperformed DSR because the routing table in AODV helps the nodes to learn about new routes that result in less route discovery and maintenance process.

4. Varying node mobility pattern
Pause time and speed defines the mobility of the nodes where high pause time is equivalent to low speed and vice-versa [1].

In [2], the total energy consumed (Joules) by all the nodes is observed when the speed is varied as 0m/s, 1m/s, 5m/s, 10m/s, 15m/s, and 25m/s. DSR performed better while at high speed AODV shows an improvement because at high speed the route cache becomes useless. This results in more route discovery in DSR which leads to more RREQ packets. Hence the overhead increases in DSR.

Also, when the pause time is varied by 0, 50, 250, 500, and 800 and 1000 seconds, the total energy consumed is measured. Due to the route cache in DSR that stores multiple paths, less route discovery process is needed as compared to AODV resulting in less overhead.

In [1], the total energy consumed (Joules) by all the nodes when speed is varied as 0 m/s, 1 m/s, 5 m/s, 10 m/s, 15 m/s, 25 m/s and it was observed that at low speed DSR performed better. At high speed AODV shows an improvement because the route cache becomes useless at high speed, which results in more route discovery in DSR that results in more request packets and hence increases the overhead.

Varying the pause times from 0, 30, 120, 600 and 900 sec, the energy consumption by AODV protocol is decreasing but DSR has relatively same energy consumption even though pause time is being increased with lower energy consumption by DSR over AODV for the same initial pause time.

5. Varying sending rate
In [2], when the sending rate is varied by 16 packets/s, 32 packets/s, 48 packets/s, 64 packets/s, 80 packets/s, 96 packets/s, the total energy consumed is more for AODV than DSR.

In [1], energy consumed for the nodes when the data packet sending rate of 1, 2, 4 and 8 packets/sec is considered, both the protocols show a steady behavior. This steadiness is caused by their ability to learn route information from previous packets.

6. OBSERVATIONS
When we are increasing the number of sources from 25 to 45, the number of exhausted nodes are more in DSR than AODV when each node was supplied energy 100 joules with pause time as 500 seconds. Since the number of exhausted nodes is the number of nodes that die out after each simulation run (that is end energy is 0), therefore total energy consumption by DSR is more in comparison to AODV.

CONCLUSION AND FUTURE SCOPE
The different parameters were considered and the two protocols were compared on the basis of energy consumption. The analysis of the protocols can be used to find optimum values of the metrics of a network and thus obtaining optimum energy consumption. Also, on the basis of this analysis new compatible additions can be done to the existing protocols thus making them more energy efficient.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>AODV</th>
<th>DSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Nodes</td>
<td>More</td>
<td>Less</td>
</tr>
<tr>
<td>Number of sources</td>
<td>Less</td>
<td>More</td>
</tr>
<tr>
<td>Area traffic pattern</td>
<td>(till 750x750)</td>
<td>More</td>
</tr>
<tr>
<td>Node Mobility pattern</td>
<td>More</td>
<td>Less</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Data traffic pattern</td>
<td>More</td>
<td>Less</td>
</tr>
</tbody>
</table>

REFERENCES