PERFORMANCE COMPARISON OF ENERGY CONSUMPTION IN AODV AND DSR ROUTING PROTOCOL USING ON/OFF TRAFFIC

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ABSTRACT
A Mobile Ad-Hoc Network (MANET) is a collection of wireless mobile nodes forming a temporary network without using any centralized access point, infrastructure or centralized administration. Such a network does not possess a fixed topology thereby, rendering the topology dynamic. All the modifications done to implement a MANET are invisible to the higher layer of the protocol suite. Moreover, UDP packet is generally used to facilitate speedy transmission of data. To establish a data transmission between two nodes, typically multiple hops are required due to the limited transmission range. Mobility of the different nodes makes the situation even more complicated. Multiple routing protocols especially for these conditions have been developed during the last years, to find optimized routes from a source to some destination. The scope of this paper is to compare the performance of two popular routing protocols (AODV AND DSR) in terms of energy for variable network sizes of nodes. Network Simulator-2 has been used to perform the simulation for AODV and DSR algorithms.

INTRODUCTION
A network is defined as the group of people or systems or organizations who tend to share their information collectively [1]. A network can be characterized as wired or wireless. Wired networks are generally connected with the help of wires and cables. Wireless networks allocate radio frequencies (channel) from the available channels to transmit and receive data instead of using some physical cables.

A wireless ad-hoc network is a decentralized network (Fig 1). The network is ad hoc because it does not rely on a preexisting infrastructure, such as routers in wired networks or access points in managed (infrastructure) wireless networks. Instead, each node participates in routing by forwarding data for other nodes, and so the determination of which nodes forward data is made dynamically based on the network connectivity. In addition to the classic routing, ad hoc
networks can use flooding for forwarding the data. Wireless ad hoc networks can be further classified by their application:

![Image](networks.png)

**Fig 1 A traditional base station scheme compared to Ad-hoc multi-hop Network**

1. **Mobile ad-hoc networks (MANET)**
   A mobile ad-hoc network, MANET, is a self-configuring infrastructure less network of mobile devices connected by wireless links. The mobile nodes that are in radio range of each other can directly communicate, whereas others need the aid of intermediate nodes to route their packets. These networks are fully distributed, and can work at any place without the help of any infrastructure. This property makes these networks highly exiles and robust [5].

2. **Wireless sensor networks (WSN) [5, 6]**
   WSN consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutions and to cooperatively pass their data through the network to a main location.
   
   Energy consumption is an important factor in deciding the total lifetime of the network. The main emphasis is to increase the active lifetime of a node by adopting suitable energy efficient routing method so that the battery does not die out before broadcasting it’s whole network information or message data.

   Section 3 describes the different routing protocols adopted in MANET. In section 4 simulation results obtained by NS-2.34 are discussed. In the last sections conclusion and future scope of this paper has been discussed.

**CLASSIFICATION OF MANET ROUTING PROTOCOLS**

Ad hoc wireless network routing protocols can be classified into three major categories based on the routing information update mechanism. They are:

- **Proactive** or table driven routing protocols: In table driven routing protocols, every node maintains the network information in the form of routing tables by periodically exchanging routing information [1]. Routing information is generally flooded in the whole network,
whenever a node requires a path to a destination, it runs an appropriate path finding algorithm on the topology information it maintains. For example: DSDV, WRP, CGSR, STAR, OLSR, FSR, HSR, GSR.

**Reactive** or on demand routing protocols: Protocols that fall under this category do not maintain the network topology information. They obtain the necessary path when it is required, by using connection establishment protocols [7]. Hence these protocols do not exchange routing information periodically. For example: DSR, AODV, TORA, SSA, FORP, PLBR [2].

**Hybrid** routing protocols: protocols belonging to this category combine the best feature of the two above categories. Nodes within a certain distance from the node concerned, or within a particular geographical region, are said to be within the routing zone of the given node. For routing within this zone, a table driven approach is used. For nodes that are located beyond this zone, an on demand approach is used. For example: ZRP, ZHLS.

**A. AD HOC ON DEMAND DISTANCE VECTOR (AODV)**

This routing protocol discovers routes on an “on-demand” basis via a similar route discovery process, but uses a different mechanism to maintain routing info. AODV uses routing table, one entry per destination. It relies on routing table entries to propagate a RREP back to the source, and route data packets to the destination. A sequence number is maintained at each destination to determine freshness of routing information and to prevent routing loops. These sequence # are carried by all routing packets. AODV maintains timer-based states in each node. A routing table entry is expired if not used recently. A set of predecessor nodes is maintained for each routing table entry, indicating neighbors that use the entry to route packets. These nodes are notified with RERR when the next-hop link breaks. Each predecessor node forwards RERR to its predecessors, erasing all routes using the broken link. AODV expands ring search by controlling the RREQ flood in the route discovery process. The search is controlled by the TTL fields; increasingly larger neighborhoods are searched to find the destination [4].

**B. DYNAMIC SOURCE ROUTING (DSR)**

The Dynamic Source Routing protocol (DSR) is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. DSR allows the network to be completely self-organizing and self-configuring, without the need for any existing network infrastructure or administration. DSR follows the source routing mechanism where routes are stored in a route cache, data packets carry the source route in the packet header. A node sends data to a destination for which it does not know the route. The route discovery occurs in the following manner as source floods the network with RREQ. Each node receiving RREQ rebroadcasts it unless it is destination or it has the route to the destination in its cache. A destination node or a node knowing the route to the destination in its cache replies with RREP. RREQ and RREP are also source routed. Route carried back by RREP is cached at the source. Error handling is done by notifying the source by a RERR packet [7]. Source removes any route
using this link from its cache. A new “Route Discovery” process must be initiated by the source, if the route is needed. Optimizations are done by salvaging gratuitous route repair and promiscuous listening. Salvaging is the technique where an intermediate node uses an alternative route from its cache, when a data packet meets a failed link on its source route.

Gratuitous route repair occurs when a source node receiving RERR piggybacks the RERR in the following RREQ, to clean the caches of other nodes that may use the failed link. Promiscuous listening is done when a node overhears a packet not addressed to it, it checks whether the packet could be routed via itself to gain a shorter route. If so, sends a gratuitous RREP to the source with the new better route [7].

4. SIMULATION AND RESULTS

This section gives a description of the simulator employed along with the simulation parameters of the network. Results of simulation are explained in the latter part of the section.

Network Simulator 2 (NS-2.34) has been used for simulation. It is basically an aid to study mathematical models in order to reproduce the characteristics of system or process. It simulates a layered network from the physical radio transmission channel (bottom most layer of any networking model) to high-level (top most layer of any networking model) applications along with environment for ad-hoc networks as if in a real world environment. The foundation of NS-2 is laid using C++. Tool Command Language (TCL) is used to create the topology structure, to configure source nodes, intermediate nodes and destination nodes and to create the statistical data trace file, etc. It uses wireless channel modules (e.g. IEEE 802.11), It also supports multipath routing and mobile hosts for wireless cellular networks.

Network animator (NAM) is use to visualize the simulation of network designed using NS-2. The nam window shows the node topology and the connection establishment and release. Packet transmission as well as routing table broadcast is shown with great resolution. The current battery status of the nodes is Performance Comparison of Energy consumption in AODV and DSR Routing Protocol using On/Off Traffic also shown, depicted by the changing colors of various participating nodes (green to yellow to green).

NS-2 supports four types of traffic. Firstly, EXPO Traffic generates traffic for network using an exponential ON/Off distribution. The POO Traffic, although, identical to exponential on/off traffic distribution uses pareto distribution for on/off delay. The CBR Traffic generates traffic according to a deterministic rate and the packets are in constant size. The Trace Traffic generates traffic according to a trace file containing 32 bits field, which contains micro-seconds time until the next packet is generated. In the simulation POO traffic (Pareto) is employed.

4.1 Simulation Parameters

The simulation setup consists of square flat topology covering an area of 800 * 800 m2 and a test bed of 20 nodes randomly and uniformly distributed in the entire area. The number of wireless
mobile nodes is fixed to 20. The random waypoint model is used to model mobility. All random scenarios have been generated for a maximum speed of 15 m/s with a pause time of 5 seconds and an idle time of 500ms. Traffic sources are chosen as UDP with a packet size of 210 bytes. All traffic sessions are established at random times near the beginning of the simulation run and they remain active until the end of the simulation period. Simulations are run for 180 simulated seconds. Each of the 20 nodes has a 100 Joules of energy at the start of every simulation. The number for traffic connections were 6 and 10. Identical mobility and traffic scenarios are used across the protocol variations. Track of residual energy of a node is done by using in an inbuilt energy model of NS - 2 that uses a traditional method of keeping track of the residual energy of a node. Once the trace file is generated, AWK scripts extract the information from the trace file. Based on the output of these AWK scripts graphs were plotted for average residual energy v/s time for the network using MATLAB. Table 1 gives the simulation parameters.

Table 1 : Simulation parameters

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of nodes</td>
<td>20</td>
</tr>
<tr>
<td>Simulation Time</td>
<td>180s</td>
</tr>
<tr>
<td>Pause Time</td>
<td>5s</td>
</tr>
<tr>
<td>Environment Size</td>
<td>800m X 800m</td>
</tr>
<tr>
<td>Traffic Type</td>
<td>ON or OFF (Pareto)</td>
</tr>
<tr>
<td>Packet Size</td>
<td>210 bytes</td>
</tr>
<tr>
<td>Packet Rate</td>
<td>20 kbps</td>
</tr>
<tr>
<td>Burst Time</td>
<td>500 ms</td>
</tr>
<tr>
<td>Idle Time</td>
<td>500 ms</td>
</tr>
<tr>
<td>Maximum Speed</td>
<td>10 m/sec, 15 m/sec</td>
</tr>
<tr>
<td>Initial Energy Of Node</td>
<td>100 Joules</td>
</tr>
<tr>
<td>Transmission Power Utilised</td>
<td>5 W</td>
</tr>
<tr>
<td>Reception Power Utilised</td>
<td>10 W</td>
</tr>
<tr>
<td>Routing Protocol</td>
<td>DSR and AODV</td>
</tr>
<tr>
<td>No. of Connections</td>
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</tr>
<tr>
<td>Simulator</td>
<td>NS-2.34</td>
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<tr>
<td>Antenna Type</td>
<td>Omni directional</td>
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<tr>
<td>MAC type</td>
<td>IEEE 802.11</td>
</tr>
<tr>
<td>Agent</td>
<td>User Datagram Protocol (UDP)</td>
</tr>
</tbody>
</table>

4.2 Results

Average Residual energy has been considered to compare the performance of AODV and DSR. The average residual energy is defined as the summation of energy left at each node, after the complete broadcast of information message.
The NAM window shown in Fig. 2 illustrates the energy level of different nodes after broadcast of the data. The nodes in green depict that the present energy level is greater than 60%. The nodes in yellow have energy level in between 20% to 60%. The red coloured nodes shows died out nodes which have energy level less than 20%.

Initially the velocity of mobile nodes is set at 10m/s and six out of twenty nodes are connected (Fig. 3). AODV outperforms the DSR protocol in the context of energy efficiency parameter. As illustrated, for the network with few active nodes the AODV is the better routing method.

![Fig 2: NAM window](image)

![Fig 3: Average residual energy vs time(velocity-10m/s , sources-6/20)](image)
In the next case the velocity of mobile nodes is reset to 15m/s, connected nodes remaining the same i.e. six out of twenty (Fig. 4). This comparison shows that for the same number of nodes with different node velocity, both the AODV & DSR routing methods produce the nearly same result. Both routing methods emerge as good options for energy efficient routing method.

Fig 4: Average residual energy vs time(velocity-15m/s, sources – 6/20)

When the velocity of nodes is increased the energy falls for AODV as well as DSR as can be observed by comparing Fig. 3 and Fig. 4.

If the velocity of mobile nodes is brought back to 10m/s and the number of connected nodes is increased (ten out of twenty) then AODV stands out again in comparison to DSR and hence proves to be a better routing method (Fig. 5).

Fig 5: Average residual energy vs time(velocity-10m/s, sources-10/20)

Interestingly, a comparison between Fig. 3 and Fig. 5 shows that with an increase in the number of connected nodes the energy increases to a small extent. In the last case the number of connected nodes is set to be the same (ten out of twenty) as in the previous case. The velocity of
mobile nodes is increased to 15 m/s. As seen in the figure AODV again emerges as a better routing method in terms of energy efficiency (Fig. 6).

![Figure 6: Average residual energy vs time (velocity-15m/s, sources-10/20)](image)

The comparison between Fig. 3 and Fig. 6 shows that for AODV the energy increases and for DSR it is nearly constant, if both the velocity of nodes and number of connected nodes are increased. However, the decrease in energy is very sharp for fewer nodes and less velocity.

Hence, it can be concluded that AODV outstands DSR in terms of energy efficiency when both the routing schemes are tested under the same conditions.

**CONCLUSION**

MANET being an infrastructureless network of mobile nodes is restricted by limited availability of power supplied by Li-ion batteries. Routing of information to mobile nodes, involved is done using three protocols - proactive, reactive and hybrid. Depending of the conditions prevailing, any type of protocol can be used.

**FUTURE SCOPE**

Though ad-hoc networks are currently studied, more research has to be done to deploy this technology in a large scale to the market. Not only about routing issues, but also about security risks, social acceptance and selfishness. If a user declines to route packets for other hosts, and he only wants to use the network as transport for himself, other hosts will not get service. Research should be done to avoid this. Furthermore, security risks should be taken into account. For instance, a host, like a laptop or a PDA, can be compromised by malware; thus affecting communications between nodes. Due to the distributed routing, a node failure will not be critical but has to be studied.
REFERENCES