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IMPROVISED ENERGY EFFICIENT AODV PROTOCOL FOR MOBILE AD-HOC NETWORK

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ABSTRACT: A mobile ad-hoc network which does not use a wired network and base station system is composed of a group of mobile and wireless nodes. There are various types of issues needed to be resolved for smooth and effective functioning of MANET. One critical issue for almost all kinds of mobile nodes supported by battery powers is Power Saving. Without power, any mobile node will become useless. Battery power is a limited resource and it is expected that battery technology is not likely to progress as fast as computing and communication technologies do. Hence, how to extend the lifetime of batteries is an important issue, especially for MANET, which is totally supported by batteries. The biggest restriction is the confined energy of the batteries. Within the network if energy restriction is not considered then one of the nodes consumes all the energy, that node can no longer participate in the network. In recent years, much research has been under taken to not only improve the energy storage but also to lengthen the networks lifetime.
Keyword: NS-2, MANET, AODV, mobile ad-hoc network, routing protocol

I. INTRODUCTION

A. Ad-hoc Wireless Networks

An ad-hoc network is a self-configuring network of wireless links connecting mobile nodes. These nodes may be routers and/or hosts. The mobile nodes communicate directly with each other and without the aid of access points, and therefore have no fixed infrastructure. They form an arbitrary topology, where the routers are free to move randomly and arrange themselves as required.Each node or mobile device is equipped with a transmitter and receiver. They are said to be purpose-specific, autonomous and dynamic. This compares greatly with fixed wireless networks, as there is no master slave relationship that exists in a mobile ad-hoc network. Nodes rely on each other to established communication, thus each node acts as a router. Therefore, in a mobile ad-hoc network, a packet can travel from a source to a destination either directly, or through some set of intermediate packet forwarding nodes

B. Need of Ad-hoc Networks

Wireless ad-hoc networks can be used in special areas where a wired network infrastructure may be unsuitable due to reasons such as cost or convenience. It can be rapidly deployed to support emergency requirements, short-term needs, and coverage in undeveloped areas. So there is a plethora of applications for wireless ad-hoc networks

ad hoc network applications are:

Collaborative Business Work: The need for collaborative computing might be more important outside office environments than inside for some business environments.

Disaster-management Applications: Situations arise, for example, as a result of natural disasters where the entire communications infrastructure is in disorder. Restoration of communication quickly is essential. Using ad hoc networks, a communication could be set up in hours instead of days/weeks required for wire-line communications.

C. Mobile Ad-hoc Network

A Mobile Ad Hoc Network (MANET) [16] is a set of mobile nodes that perform basic networking functions like packet forwarding, routing, and service discovery without the need of an established infrastructure. All the nodes of an ad hoc network depend on each another in forwarding a packet from source to its destination, due to the limited transmission range of each mobile node's wireless transmissions. There is no centralized administration in ad hoc network. It guarantees that the network will not stop functioning just because one of the mobile nodes moves out of the range of the others. As nodes wish, they should be able to enter and leave the network.

C. Routing Protocols in MANET

Routing in a MANET is fundamentally different from traditional routing found on infrastructure networks. Routing in a MANET is based on many factors including dynamic topology, selection of router nodes, and initiation of request and specific fundamental characteristic that could act as a heuristic in finding the path quickly and efficiently. The low resource availability needs efficient utilization and hence the motivation for optimal routing in ad hoc networks. Also, the highly dynamic nature of these networks imposes severe restrictions on routing protocols specifically designed for them, thus motivating the study of protocols which aim at achieving routing stability [2].

II. LITERATURESURVEY ON ENERGY EFFICIENT ROUTING PROTOCOLS IN MANET

The increasing progress of wireless local area networks (WLAN) has opened new horizons in the field of telecommunications. Among the various network architectures, the design of mobile ad hoc network (MANET) has attracted a lot of attention. A MANET is composed of a set of mobile hosts that can communicate with one another. No base stations are supported in such an environment, and mobile hosts communicate in a multi-hop fashion. Such networks are needed in situations where temporary network connectivity is required, such as in battle fields, disaster areas, and meetings, because of their capability of handling node failures and fast topology changes. Those networks provide mobile users with ubiquitous communication capability and information access regardless of location. A set of ad hoc routing protocols have been proposed in the IETF's MANET group to ensure the network connectivity. They operate in either proactive or reactive modes. Proactive protocols are table-driven and maintain routes for the entire network. Nodes must be in continuous communication for updating changes in the topology. In reactive protocols, a route to a destination is established only on demand, based on an initial discovery between the source and the destination [11]. Building such routing algorithms poses a significant technical challenge, since the devices are battery operated. The devices need to be energy conserving so that battery life is maximized. The shortest path is the most common criteria adopted by the conventional routing protocols proposed in the MANET Working Group. The problem is that nodes along shortest paths may be used more often and exhaust their batteries faster. The consequence is that the network may become disconnected leaving disparity in the energy, and eventually disconnected sub networks. Therefore the shortest path is not the most suitable metric to be adopted by a routing decision. Other metrics that take the power constraint into consideration for choosing the appropriate route are more useful in some scenarios (e.g. sensor networks). In this survey, I surveyed three energy efficient routing algorithms (LEAR-AODV, PAR-AODV, and LPR-AODV) that reduce energy consumption and lead to a longer battery life at the terminals. They are based on one of the most important routing protocols, AODV (Ad hoc On-Demand Distance Vector) [1]. They focus on reactive routing schemes, since they are less expensive in terms of energy consumption than proactive schemes. One critical issue for almost all kinds of portable devices supported by batteries is power saving. Without power, any mobile device will become useless. Battery power is a limited resource, and it is expected that battery technology is not likely to progress as fast as computing and communication technologies do. Hence, how to lengthen the lifetime of batteries is an important issue, especially for MANET, which is all supported by batteries.

Routing and power consumption are intrinsically connected. In conventional routing algorithms, which are unaware of energy budget, connections between two nodes are established through the shortest routes. These algorithms may however result in a quick depletion of the battery energy of the nodes along the most heavily used routes in the network.

A. AODV Protocol

AODV [1] is inherently a distance vector routing protocol that has been optimized for ad-hoc wireless networks. It is an on demand protocol as it finds the routes only when required and is hence also reactive in nature. AODV borrows basic route establishment and maintenance mechanisms from the DSR protocol and hop-to-hop routing vectors from the DSDV protocol. To avoid the problem of routing loops, AODV makes extensive use of sequence numbers in control packets [5]. When a source node intends communicating with a destination node whose route is not known, it broadcasts a RREQ (Route Request) packet. Each RREQ packet contains an ID, source and the destination node IP addresses and sequence numbers together with a hop count and control flags. The ID field uniquely identifies the RREQ packet; the sequence numbers inform regarding the freshness of control packets and the hop-count maintains the number of nodes between the source and the destination.

Each recipient of the RREQ packet that has not seen the Source IP and ID pair or doesn't maintain a fresher (larger sequence number) route to the destination rebroadcasts the same packet after incrementing the hop-count. Such intermediate nodes also create and preserve a REVERSE ROUTE to the source node for a certain interval of time [1] [5]. When the RREQ packet reaches the destination node or any node that has a fresher route to the destination a RREP (Route Reply) packet is generated and unicasted back to the source of the RREQ packet. Each RREP packet contains the destination sequence number, the source and the destination IP addresses, route lifetime together with a hop count and control flags.

Each intermediate node that receives the RREP packet, increments the hop count, establishes a FORWARD ROUTE to the source of the packet and transmits the packet on the REVERSE ROUTE. For preserving connectivity information, AODV makes use of periodic HELLO messages to detect link breakages to nodes that it considers as its immediate neighbors. In case a link break is detected for a next hop of an active route a RERR (Route Error) message is sent to its active neighbors that were using that particular route. Optionally, a Route Reply Acknowledgement (RREP-ACK) message may be sent by the originator of the RREQ to acknowledge the receipt of the RREP. RREP-ACK message has no mutable information. There are two phases of AODV routing protocol: Route Discovery Phase and Route Reply Phase.

B. Route discovery [4]:

Route Request Stag - The source node floods the network with a route request control packet (RREQ), and each node (with the exception of destination) rebroadcasts the RREQ the first time it hears as shown in fig. 2.1 (a).

Route Reply Stage - upon receiving a RREQ, the destination sends a route reply packet (RREP), which is propagated to the source in the reverse path of the RREQ as shown in fig. 2.1 (b).

C. Route maintenance [4]:

If an intermediate node is unable to transmit a data packet to the next hop in the path, it sends a route error control packet (RERR) to the source to inform the broken route.

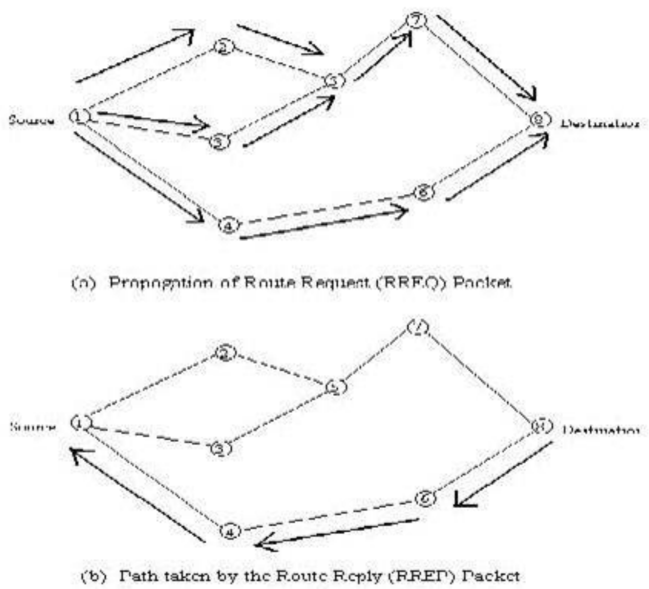


Fig. 1 (a), (b) AODV Route Request & Reply Stages [2]

III. PROPOSED ENERGY EFFICIENT AODV ROUTING PROTOCOL

Energy Efficient Routing protocol based on AODV is an improvement of conventional AODV.

A. Energy Model

Let there be k nodes, we can calculate the energy factor considering residual energy of the node at particular instance. A node in packet transmission consumes energy in following mode:

- Transmit
- Receive
- Idle
- Sleep
- Transition

Now, let assume,

$$Erk = Eik - Eck$$

Where,

- Eik: Initial Energy of node k
- Eck: Energy Consumed by node k
- Erk: Remaining Energy of node k
- Hop Count (HC) = The number of hops in a path

Th = Threshold value

B. Energy Efficient Route Discovery Process

Energy Efficient Route Discovery is initiated just when the source node S attempts to send a packet to destination node D and does not already know a route to D. The Energy Efficient Route Discovery procedure used a Route Request (RREQ) and Route Reply (RREP) messages, to find a route from source to destination.

C. At the Source Node

When a source node wants to communicate with destination node then source check route cache

if (route source to destination found)
{
then prepare route validation message and send to destination and start the timer
if (ACK arrives before timer expire)
then send packets with existing route
else
(No any update)
}
else
It has no route in its cache then it initiates route discovery process and broadcast RREQ packet to its neighbors. The RREQ packet will carry two additional information specific Th value and HC = 0.

D. At Each Intermediate Node

When node receives the RREQ message from neighbor it will calculate its remaining energy level and compare with Th value.
If (Erk>Th value)
{
Then add its own address in message header, increase HC value by 1 and rebroadcast RREQ msgto its neighbors.
}
Else
{
Drop RREQ msg
}

E. At Destination Node

When a destination receives route request it will strip HC value information from the RREQ header and wait for time interval T for more route requests. The destination will receive a ROUTE_REQ message only when all intermediate nodes along the route have good energy levels. Destination will select a path based on HC value and it will consider minimum HC value. The efficient route is replied by the destination node by RREP to theoriginator of the RREQ.

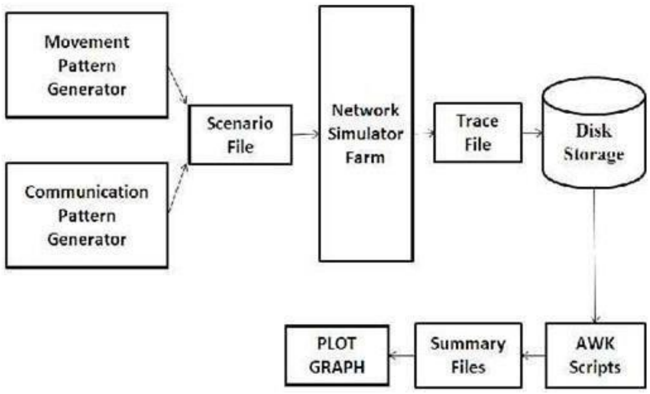
F. Route Maintenance

Route maintenance is a procedure of monitoring the proper operation of route in use. Any node, if it detects that its neighboring node, which is the next hop for a route, is not working then the node sends an error packet to the source containing its address and the address of the hop not working. On receiving the route error packet by the node removes the hop in error from its routing cache and attempts to find a new route to the intended destination. All decisions made during the routing procedure are taken either in the source or the destination. Intermediate nodes only allowed piggybacking its address in routing messages. Intermediate nodes are not allowed to provide route reply from their local cache. In this work, we design new energy-aware routing protocol that balance the traffic load inside the network so as to increase the battery lifetime of the nodes and hence the overall useful life of the ad hoc network. This protocol is based on the conventional AODV.

IV. SIMULATION & RESULTS

A. Simulation Model

All simulation experiments are developed and simulated on an Intel(R) Core 2 Duo 1.83GHz machine using Ubuntu 12.4.0 with 2 GB RAM and the network simulator NS2 version NS-2.34. The choice of this simulation package in specific is due to the various reasons that were presented in earlier chapter. The simulated network consists of 5 mobile nodes in a space of 500*500 square-meters. Interface Queue is DropTail/PriQueue, Propagation style is Two Ray Ground, Antenna type is Omni Antenna. As for the MAC layer communication, the IEEE 802.11 is used. Total simulation time is 150 sec. The below table summarized the different configuration values that were used in all the performed simulations.



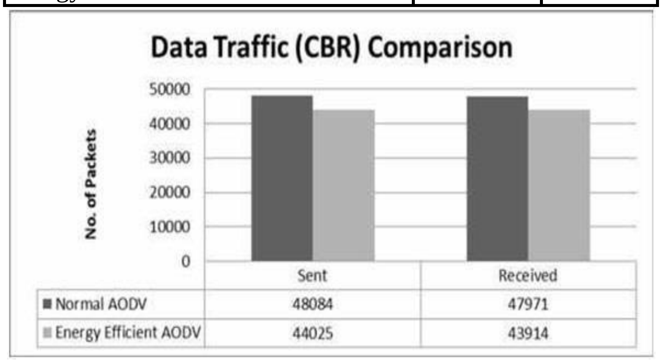
B. Results

After implementation of successful proposed Energy efficient AODV, Total three times the simulation was ran and two different trace files were generated. As indicated in figure 4.1 with the use of AWK scripts the two different trace files were analyzed. Following figures will show the snapshots that were taken for analysis.

C. Number of Packets Calculated

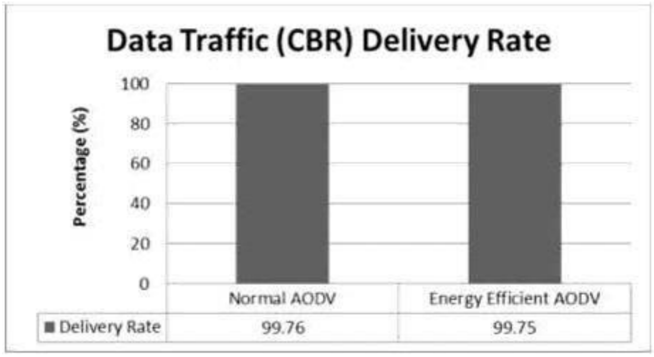
In order to measure packet delivery fraction and routing load, it is necessary to calculate total number of sent, received and routed packets. Following figures shows total number of sent and received packets for given simulation environment.

Protocol	Sent	Received
Normal AODV	48084	47971
Energy Efficient AODV	44025	43914



Data Traffic (CBR) Comparison

Protocol	Delivery Rate
Normal AODV	99.76
Energy Efficient AODV	99.75



Data Traffic (CBR) Delivery Rate

V. CONCLUSION

Throughout this thesis research, a discussion of existing mobile ad hoc networks' routing protocols' types and their advantages and disadvantages was given and a list of existing algorithm was reviewed. Next, our proposal, Increasing Energy Efficiency of AODV protocol is presented for the AODV routing protocol used in MANET. This proposal fulfills all the requirements, which makes it more easily expandable and less complex in computation. As it generates very less overhead of calculations it saves power consumption of nodes significantly. In addition, many justifications for the choice of the NS-2 simulation package to conduct all the experimental part of the thesis work were given. Last but not least, according to the many simulations that were performed, the newly proposed protocol, built on top of normal AODV routing protocol, achieves an overall good results. Thus, the proposed design proves to be more efficient and less power consuming than normal AODV.

Some of the ideas that can be further integrated to the proposed scheme are presented as follows:

- The same kind of secure mechanism can be integrated and implemented to secure other routing protocols of MANET like DSR, DSDV, TORA etc.
- The same kind of Increasing Energy Efficiency mechanism can be designed to secure wireless sensor networks also.

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