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An Improved Energy Efficient EEARP Routing Protocol Using ACO in MANeT Network

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Abstract— MANETs are dynamic and infrastructure-less networks. The major constraint of this type of networks is Energy optimization because the nodes involved in these type of networks are battery operated. The lifetime of this network can be improved using the energy levels of the individual nodes of the network. Energy conservation is necessary to reduce gap between the power consumption requirements and power availability. To maximize adhoc networks lifetime traffic should be send through route that prevents the nodes with low energy. Main objective is to use various techniques such as secure routing, power awareness and load distribution with respective of advantages and disadvantages in EEARProuting protocol.

Keywords— SIR, DSDV, WRP, OLSR, EEARP

I. INTRODUCTION TO MANET

A Mobile Ad-hoc Network is a collection of independent mobile nodes that can communicate with each other via radio waves. It is generally defined as a network composed of mobile devices that can arrange themselves in different methods and operate without strict top-down network administration. The mobile nodes that are in radio range of each other can directly communicate, whereas others needs the aid of intermediate nodes to route their packets. Each of the node has a wireless interface to communicate with each other. These networks are fully distributed, and can work at any place without the help of any fixed infrastructureas access points or base stations. Figure 1 shows a simple ad-hoc network with 3 nodes. Node 1 and node 3 are not within range of each other, however the node 2 can be used to forward packets between node 1and node 2. The node 2 will act as a router and these three nodes together form an ad-hoc network.

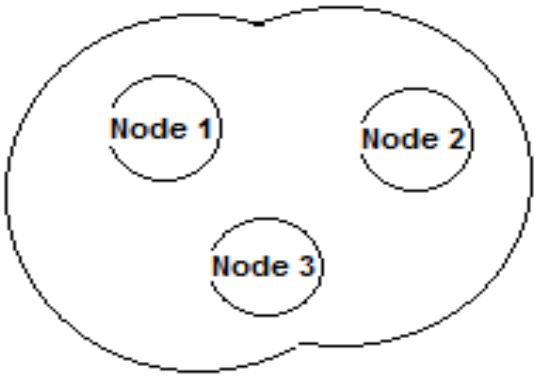

Fig 1: Example of mobile ad-hoc network

- **MANET's characteristics-**

1) Distributed operation: There is no background network for the central control of the network operations, the control of the network is distributed among the nodes. The nodes involved in a MANET should cooperate with each other and communicate among themselves and each node acts as a relay as needed, to implement specific functions such as routing and security.

2) Multi hop routing: When a node tries to send information to other nodes which is outof its communication range, the packetshould be forwarded via one or more intermediate nodes.

3) Autonomous terminal: In MANET, each mobile node is an independent node, which could function as both a host and a router.

4) Dynamic topology: Nodes are free to move arbitrarily with different speeds, thus the network topology may change randomly at unpredictable time. The nodes in the MANET dynamically establish routing among themselves as they travel around, establishing their own network.

5) Light-weight terminals: In maximum cases, the nodes at MANET are mobile nodes with less CPU capability, low power storage and small memory size.

6) Shared Physical Medium: The wireless communication medium is accessible to any entity with the appropriate equipment and adequate resources. Accordingly, access to the channel cannot be restricted.

II. PROTOCOL STACK

Protocol stack for mobile infrastructure-less networks[12] is described. The protocol stack consists of five layers (a) physical layer (b) data link layer (c) network layer (d) transport layer (e) application layer. Efficient power utilization can be achieved when one getsdeeper insight of its relation with different layers ofprotocol stack. Most of the energy efficiency of ad-hocnetwork is performed at mobile node keeping routing assole for their objective. This efficiency is mostly performed at network layer. In actual, this efficiency can be achieved at each layerof protocol stack. This section discusses the various powermanagement techniques used for reducing the powerconsumed in each layer of network. These techniques existfrom the Physical layer all the way down to the Applicationlayer of a traditional networking protocol stack.

A. Physical Layer and Wireless Device:

At the physical layer, transmission power can be adjusted. By using excessive transmission power, there can beincrease in the interference to other hosts and it may causean increase in transmission power by other hosts. Thus, physical layer functions should include transmitting data at the minimum power level to maintain links, and also adaptto changes in transmission environment. Variable clock CPUs, Proper hardware design, CPU voltage scaling, flashmemory techniques can also be used to further reduce the power consumed at the physical layer.

B. Data Link Layer:

At the data link layer, energy conservation can be achieved by using effective retransmission request schemes and sleep mode operation. Due to the presence of mobility and cochannel interference in ad hoc networks, transmission errors can occur frequently, leading to frequent retransmission requests. Since retransmissions increase power consumption and cause higher interference to other users, new efficient retransmission request scheme must be needed for ad hoc networks. There are two basic retransmission schemes: 1) Sense the channel, if it is bad then do not retransmit the data. This scheme reduces unnecessarily power wastage at the expense of transmission delay. 2) Increase the retransmission power. It reduces the possibility of transmission errors but increases the signal-to-interference ratio (SIR) of the network. A node transmitting packets to its downstream nodes will be overheard by all neighbouring nodes. Therefore, all neighbouring nodes will consume power even though the packet transmission was not directed to them. So, to reduce power consumption a node's transceiver should be powered off when not in use.

III. PROTOCOLS IN MANET

Routing is the process of establishing path and forwarding packets from source node to destination node. It consists of two steps, route selection for various source-sink pairs and delivery of data packets to the correct destination.

Various protocols and data structures (routing tables) are used to meet these two steps. This survey paper is focused on finding and selecting energy efficient routes. We are going to discuss the main approaches in the routing i.e. proactive, reactive and hybrid.

A. Classification of Routing Protocols for MANET

Routing Protocols for ad-hoc wireless networks can be classified as:

1) Proactive (Table-Driven) routing protocols: In Proactive routing protocol each node in the network has routing table for the broadcast of the data packets and establishes connection to other nodes in the network. These nodes record all the presented destinations and number of hops required to arrive at each destination in the routing table. The routing entry is tagged with a sequence number which is created by the destination node. To retain the stability, each station broadcasts and modifies its routing table from time to time that how many hops are required to arrive that particular destination and which stations are accessible, is result of broadcasting of packets between nodes. Examples of proactive routing protocols are DSDV(Destination-Sequenced Distance-Vector), WRP(Wireless Routing Protocol) and OLSR(Optimized Link State Routing).

2) Reactive (On demand) routing protocols: Reactive Protocol has lower overhead since routes are determined on demand.It employs flooding (global search) concept. Constantly updating of route tables with the latest route topology is not required in on-demand concept. Reactive protocol searches for the route in an on-demand manner and set the link in order to send out and accept the packet from a source node to destination node. Route discovery process is used in on demand routing by flooding the route request (RREQ) packets throughout the network. Examples of the reactive routing protocols are AODV(Ad hoc On Demand Distance Vector) and DSR(Dynamic Source Routing)[7][9] etc.

3) Hybrid routing protocols: Hybrid routing protocol is the combination of both reactive and proactive routing protocols. It was proposed to reduce the control overhead of proactive routing protocols and also decrease the latency caused by route discovery in reactive routing protocols. Examples of hybrid routing protocols areZRP (Zone routing protocol) and TORA (Temporarily Ordered Routing Algorithm).

IV. DEFINITION OF ENERGY EFFICIENCY

For a wireless networks, the devices operating on battery try to pursue the energy efficiency heuristically by reducing the energy they consumed, while maintaining acceptable performance of certain tasks. Using the power

consumption is not only a single criterion for deciding energy efficiency. Actually, energy efficiency can be measured by the duration of the time over which the network can maintain a certain performance level, which is usually called as the network lifetime.

Minimum energy routes(that consumes less energy)[1][6] sometimes attract more flows, and the nodes in these routes exhaust their energy very soon; hence the whole network cannot perform any task due to the failure on these nodes. In other words, the energy consumed is balanced among nodes in the networks. Routing with maximum lifetime balances all the routes and nodes globally so that the network maintains certain performance level for a longer time. Hence, energy efficiency is not only measured by the power consumption but in more general it can be measured by the duration of time over which the network can maintain a certain performance level. There are lots of ways to categorize routing algorithms. One is flooding and broadcast routing, which is often necessary during the operation of the wireless network, such as to discover node failure and broadcast some information. The second kind is multicast routing, which is very common in wireless networks, to communicate in a one-to-group fashion. The last is unicast, which is always in an end-to-end fashion and the most common kind of routing in networks.

V. RELATED WORK

K.Sumathia et al. (2015): Presented the implementation of Adaptive HELLO messaging scheme to determine the local link connectivity information for monitoring the link status between nodes along with the incorporation of Dynamic on Demand Routing Protocol to reduce the energy consumption of mobile nodes to certain extent. It motivated the need for energy management in ad hoc wireless networks. Limited battery power is one of the most important issues in mobile ad hoc network as the mobile nodes operate in limited battery power. Also there occurs a problem of broken links due to the lack of energy which cause disorder in network system. Such problem occurs due to the unawareness of energy of mobile neighbour nodes.[1]

Aarti Singh et al. (2013): Provided an in depth analysis of literature for routing protocols in MANETs and their effect on selfish behaviour of nodes. Mobile Ad-Hoc Networks (MANETs) are characterized with dynamic topology. This dynamism leads to mobility of nodes, interference, multipath propagation and path loss. A more challenging goal in MANET is to provide energy efficient routes as it is one of the major limiting factors in mobile nodes. MANETs are typically powered by batteries which have limited energy reservoir and it may not be easily replaced or recharged on the way. Hence, power consumption becomes an important issue and this lack of power with nodes leads to selfish behaviour among nodes in case of commercial MANET.[2]

Bob Briscoe et al. (2014):Found that classifying techniques according to the source delay can alleviate the following issues: 1) the structural arrangement of a network, such as placement of servers and suboptimal routes, cancontribute significantly to latency; 2) each interaction between communicating endpoints adds a Round Trip Time (RTT) to latency,especially significant for short flows; 3) in addition to base propagation delay, several sources of delay accumulate along transmissionpaths, today intermittently dominated by queuing delays; 4) it takes time to sense and use available capacity, with overuse inflictinglatency on other flows sharing the capacity; and 5) within end systems delay sources include operating system buffering, head-of-lineblocking, and hardware interaction. No single source of delay dominates in all cases, and many of these sources are spasmodic andhighly variable. Solutions addressing these sources often both reduce the overall latency and make it more predictable.[3]

GUO Jianli et al. (2007):Proposed a scheme called HEAD (a hybrid mechanism to enforce node cooperation in mobilead hoc networks) to make the misbehaviour unattractive. HEAD is an improvement to OCEAN (observation-based cooperation enforcement in ad hoc networks). It employs only first-hand information and workson the top of DSR (dynamic source routing) protocol. By interacting with the DSR, HEAD can detect themis behaviour nodes in the packet forwarding process and isolate them in the route discovery process. In orderto detect the misbehaviour nodes quickly, HEAD introduces the warning message.[4]

Kumar Prateek et al. (2013): Stated that a mobile Ad-Hoc network is a collection of wireless nodes that can dynamically be set up anywhere andanytime without using any pre-existing network infrastructure. It is an autonomous system in which mobile hostsconnected by wireless links are free to move randomly and often act as routers at the same time. Mobile ad-hoc Network have the attributes such as wireless connection, continuously changing topology, distributed operation andease of deployment. It had compared the performance of three MANET routing protocol DSDV, AODV and DSR by using NS-2. DSDV is proactive (Table driven routing Protocol) whereas AODV and DSR sharesimilar On Demand behaviour, but the protocol's internal mechanism leads to significant performance difference. Adetailed simulation has been carried out in NS-2.[5]

Anit Kumar et al. (2013):Mobile Ad-Hoc Networks are those networks which don't have any fixed infrastructure. Due to mobility of nodes, frequent link breakage takes place. Therefore routing in mobile ad hoc networks is challenging task and this has led to the development of many different routing protocols. It analyses the performance of AODV and DSR routing protocols for the metrics Packet Delivery Ratio. It would be a great help for the people conducting research on real world problems in MANET security.[6]

BhalinderKaur et al. (2013): Defined that MANET consists of mobile nodes, a router with multiple hosts and wireless communication devices. The wireless communication devices are transmitters, receivers and smart antennas. Research aims to compare performance of three routing protocols for MANET's. In present study, a comparison of reactive routing protocols i.e. AODV, OLSR and Hybrid routing protocols i.e. Gathering-based Routing Protocol has been made on the basis of throughput, delay, network load, traffic sent and traffic received by increasing number of nodes in the network. MANET routing protocols are evaluated under different scenarios using file transfer protocol (ftp).

The comparison analysis will be carrying out about these protocols and in the last the conclusion will be presented, that which routing protocol is the best one for MANET's.[7]

Rajesh Sharma et al. (2013): Defined that 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. The protocol is composed of the two mechanisms of Route Discovery and Route Maintenance, which work together to allow nodes to discover and maintain source routes to arbitrary destinations in the ad hoc network.[8]

VI. PROPOSED WORK

In this research a proposed energy efficient ant based routing protocol is developed. For the simulation of this proposal various numbers of nodes are tested and MATLAB simulation tool is used. This proposal reduces the problem of energy efficiency, load and delay using the ant based routing protocol as energy efficiency is a challenge faced especially in designing a routing protocol. In the proposed system, packet switching networks is implemented for transmitting and receiving the packets, finally calculated the delay of that packets in the network.

- **Simulation Environment-**

The simulation environment for mobile ad-hoc networks is described below:

Table 1: Simulation Environment

Simulation Parameters	Value
Area	100*100 m
Transmission Range	10*10m
Number of nodes	Min 20, max 100
Energy	0.5 joule
ETx	$50*10^{-5}$joule
ERx	$50*10^{-5}$joule

- **Steps for proposed work:**

In the very first step of research proposal, nodes of MANET will be deployed in the creation of node step:

a) Creation of Nodes: With the advances in software and hardware architecture, mobile nodes can be created according to the requirements. Each node is equipped with a transmitter and receiver and they are said to be purpose specific, autonomous and dynamic. The packets in this network contain a single field associated with the destination address in it. After the creation of the nodes of network the packet modelling, link modelling and hub modelling are defined below:

b) Defining Packet Model and Link Model: After the packet format has been created, it is specified as an attribute in a generator so that it can beformatted accordingly. The packet contains attributes such as name, type, size. Also, the set at creationattribute is changed to unset which may ensure that the field will not be assigned a default value when thepacket is created.

c) Creation of Hub Model: The hub model consists of point-to-point transceivers for each peripheral node, and a processmodel to relay packets from receiver to the appropriate transmitter. The packet streams have a unique indexwhich is an easiest method to set up a direct association, between the hub processes which indices outgoing packet stream and the peripheral destination address values.

d) Creation of Peripheral Node Model: The peripheral node model generates packet, assigns destination address, and processes received packets. It uses a user-defined process model to assign destination addresses to the generated packet and transmit them to the node's point-to-point transmitter. This process model retrieves the packet arriving from the point-to-point receiver and processes it to calculate the packet's end-to-end delay and the value is written to a global statistic so that it is accessible to multiple processes throughout the system.

After the deployment stage the proposed mechanism is to be defined that is to be used in research proposal. As it has been defined in flowchart that Ant Routing Protocol is to be used along with the hybrid scenario of reactive protocol AODV and DYMO to improve the energy efficiency of the proposed algorithm. Ant Routing Protocol is defined below:

e) Ant Routing Algorithm (ARA): The algorithm is based on swarm intelligence and especially on the ant colony based Meta heuristic. The algorithm aims to search for an optimal path based on the behaviour of ants seeking a path. These approaches try to map the solution capability of swarms to mathematical and engineering problems. The introduced routing protocol is highly adaptive, efficient and scalable. The main goal in the design of the protocol was to reduce the overhead for routing.

f) Result Generation and Analysis: In the last step the analysis of generated results is done.

VII. SIMULATION RESULTS

In current chapter with the help of comparative study, we can draw all the pros and cons of the above defined scheduling schemes. In this scenario a comparison is made between various routing schemes by taking various number of subscriber stations. The simulation parameters considered for this research are as follows:

- Throughput: Throughput, is defined as the number of data bits successfully delivered to the sink, per second, over the entire simulation time.
- Average Energy Consumption: Energy Consumption is defined as the energy consumed in transmitting and receiving the message packets in a mobile wireless sensor network.

Throughput

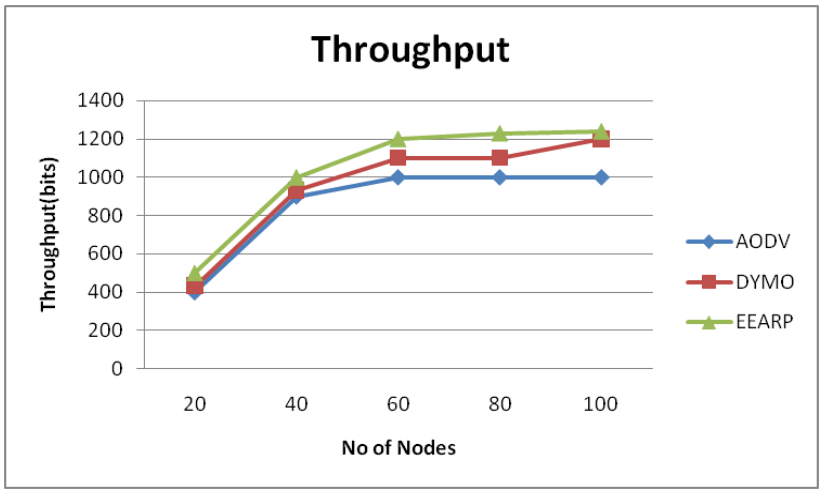

Fig 2: Throughput comparison in AODV, DYMO and EEARP

In Figure 2 EEARP shows better results as shown in graph. As the packets will take the reciprocal path, more no. of packets will reach to the destination without any loss so as a result of which throughput of EEARP is improved. From the graph it is cleared that the throughput in EEARP protocol is 1200 bits whereas in case of DYMO and AODV it is 1100bits and 1000 bits respectively.

Average energy consumption

Figure 3 shows that there is less energy consumption in EEARP than DYMO and AODV. If the packet drop is less than the retransmission attempts for sending the message to receiver is decreased.

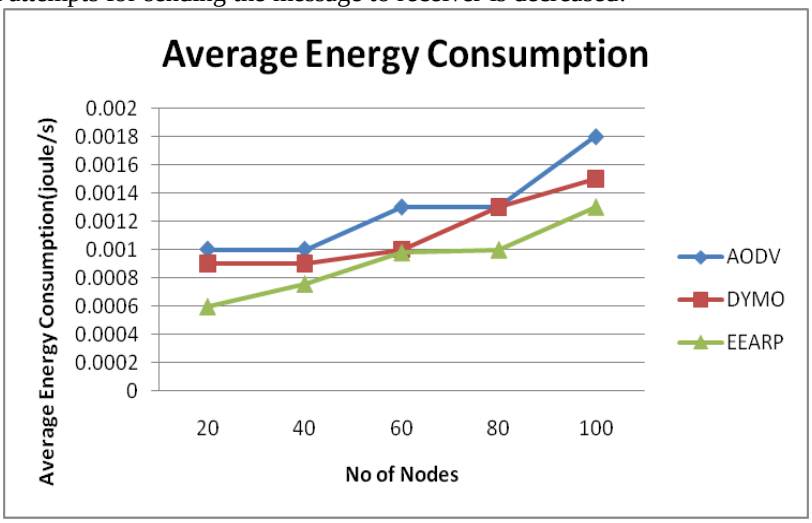

Fig 3: Average Energy Consumption in AODV, DYMO and EEARP

As a result there is less energy dissipation due to which the average consumption of energy in optimized technique is less as compared to the existing protocol.From the graph it is cleared that the energy consumption in EEARP protocol is 0.001 joule whereas in case of DYMO and AODV it is 0.0013 joule and 0.0018 joule respectively.

VIII. CONCLUSION

MANETs are the adhoc network that don't have any mounted topology and simply send information from source to destination in wireless mode through some routing protocol. Within the current analysis the improvement in the energy efficiency is done with the help of routing protocol. The protocol chosen for improvement is EEARP (Energy Efficient Aware Routing Protocol) owing to the low QOS within the existing routing protocols and therefore the load within the network is removed. The improvement technique referred to as adaptive ACO (Ant Colony Optimization) therefore the losses within the network area are also reduced. The EEARP reduces the load on the network and therefore the packet delay in network also reduced. The planned approach improvement technique makes multiple methods to send information to the destination, hence increase the network lifetime.

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