ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

A Novel Energy Efficient Routing for Data Intensive MANETs

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ABSTRACT: Mobile ad hoc networks (MANETs) consist of a collection of wireless mobile nodes which dynamically exchange data among themselves without the need of fixed infrastructure or a wired backbone network. Energy consumption in MANET is one of the important issues in this research. Reliable data delivery in MANET consumes lot of energy. The efficient node-energy consumption in wireless ad hoc networks is essential as ad-hoc nodes operate with limited battery power. Routing protocol scheme for wireless networks are support by two essential requirements, minimize energy metrics or maximize network throughput. The objective of this paper is to minimise the energy expenditure of the network by using the concept of duty cycle and thereby increasing the throughput. The performance analysis and simulation are carried out using Network Simulator-2.

KEYWORDS: MANET, Network performance, Energy, Duty cycle, Throughput

I.INTRODUCTION

Mobile ad-hoc networks have gained importance in the recent years due to their flexible ways of operation, wherein mobile nodes form the network and communicate with each other without the aid of any fixed infrastructure. The self-organized characteristic of such networks makes them particularly suited for the scenarios where quick deployment of communication network is desired without depending on an existing infrastructure, such as defence operations and emergency search-and-rescue operations. Due to the limitation imposedby the transmission range of each node, such networks evolve into multi-hop networks wherein the communication between two nodes is made possible by a few (possibly none)intermediate nodes forwarding packets for them. Thus each node of a mobile ad-hoc network acts not only as a host but also as a router – forwarding data packets for the other participating nodes. The nodes also need to actively participate in discovering new routes for their own requirements as well as for the benefit of other nodes. Mobile nodes forming the adhoc networks are generally autonomous and can move at their own free will, resulting in dynamic topologies of such networks. In the absence of a fixed infrastructure, discovering and maintaining routes under such dynamic conditions is a nontrivial task.

In order to facilitate communication within the network a routing protocol is used to discover routes between nodes. The primary goal of such ad hoc network routing protocol is correct and efficient route establishment between a pair of nodes so that packets can be delivered in a timely manner. Along with that energy efficiency is a critical issue in ad hoc network for longer network connectivity.

Energy consumption in MANET is one of the important issues in ad hoc networks. Reliable data delivery in MANET consumes lot of energy. There will be many retransmissions and the data need to be propagated to the destination node. The nodes will have limited energy resources and this retransmissions etc., will consume lot of energy compared to energy available to the MANET node. Routing protocol scheme for wireless networks are support by two essential requirements, minimize energy metrics or maximize network throughput. Here we use duty cycling concept as an effective solution for energy efficiency maximization. by using low duty cycle data transmission delay can be reduced. The bandwidth efficient data transmission provides a reduced bandwidth by dropping the duplicate messages before forwarding. Due to this congestion control can also be done in the network which reduces the time delay in transferring messages from source to destinations.

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II.RELATED WORKS

There are Different routing protocols to minimize the energy consumption in ad hoc networks. May Cho Aye and Aye Moe Aung present an energy efficient multipath routing for mobile ad hoc networks[1]. In this paper they propose an energy efficient multipath routing protocol for choosing energy efficient path. This system also considers transmission power of nodes and residual energy as energy metrics in order to maximize the network lifetime and to reduce energy consumption of mobile nodes. The objective of this system is to find an optimal route based on two energy metrics while choosing a route to transfer data packets. This system is provided to reduce energy consumption and end to end delay to improve the network lifetime and throughput.

In optimized energy aware routing (OEAR) [2] scheme, SeemaVerma, Rekha Agarwal and Pinki Nayak presents an which finds the most stable path out of the entire existing paths from source to destination using on-demand routing. This algorithm not only considers energy of the node while selecting the route but also takes into account the number of packets buffered in the node. More number of buffered packets means remaining energy will be less and time taken to deliver a packet will be more. Further optimization in energy is done by varying the transmission range of the individual nodes. Induty cycle using energy efficient extremely opportunistic Routing Protocol (EEEOR) [3], S.Velmurugan uses duty cycle to asynchronous sleep-wake scheduling is an effective mechanism to reduce energy consumption by appropriately arranging nodes to sleep. This maximizes the network lifetime.

III.THE PROPOSED PROTOCOL

In route discovery phase, the source node initiates the RREQ message to the destination node. When the destination node receives the Route Request (RREQ) packet, it will produce the Route Reply (RREP) packet and send back to the source node. The RREQ packet will be received by the intermediate nodes within the range of wireless transmission. If these nodes are not destination and do not receive the RREQ with the same packet ID, they will forward the RREQ.

In route selection phase, when the source node receives the RREPs packets from the neighbour nodes, it starts a timer and collects the RREPs during the period. Then the source node begins to compare the paths having different duty cycle based on the corresponding records and choose the path having shortest duty cycle as the optimal route. Finally, data packets are sent through this path with the transmission power recorded in RREP.

For data transmission we are using bandwidth efficient routing. When a message is sent to the node, that node first determines the message that was send by other node is received for the first time or not. If the message is received for the first time, the node will forward that message, otherwise it drops the message. Each sending message is stamped by the source with a unique sequence number. The duplicates can be detected by storing a record of source and sequence number for previously received messages. So, bandwidth efficient routing provides a reduced bandwidth by dropping the duplicate messages before forwarding. Due to this, congestion control can also be done in the network which reduces the time delay in transmissions.

Bandwidth efficient routing is implemented with respect to the incoming flow rate and available bandwidth; it can able to manage its own queue. Queue is the technique by which the data are sent from storage, one after the other from the sender to avoid unnecessary collision. If large amount of supplementary data packets are comes in the intermediate nodes then some packets may drop by unavailable space in queue of intermediate node, It is just because of queue length is fixed. So here we use an adaptive queue technique. In adaptive queue technique queue length is not fixed it can vary and dependent on number of upcoming data packets. The queue size is also determined by available bandwidth. For this purpose we uses two queues i.e. drop tail queue and priority queue.This adjusting technique integrates the above two queues providing two queues for a communicating device.

Energy conservation is an important issue in ad hoc networks as nodes are usually battery powered. Even though a node may not have any message of its own to transmit, its battery is drained when it acts as a router and forwards packets for other nodes. In ad hoc network, all nodes are deployed anywhere where fast network establishment is required. For route maintenance we are using hello messages and RERR messages. When a node finds a failure of route, it will send a route error (RERR) packet to the previous node to indicate the route breakage. The intermediate node which receives this RERR message informs to the source node. Then the source node will remove the corresponding item from the routing table and switch to alternate path.

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IV.DUTY CYCLE BASED DELAY MINIMIZATION

The source computes the minimum duty cycle for all possible nodes (intermediates) till the destination the path with minimum delay /cycle is chosen to send and receive data. Consider one source and destination having same number of intermediates. The chance of sending data is possible in both the paths but we need to broadcast a RREQ (Route Request) whose corresponding packet is RTS (Request To Send). After sending the RTS, the source will wait for 't1' and 't2' seconds respectively for the two paths. For example, if either of the path encounters a light weight process the waiting time of the source with respect to that path that will be high. There by one path waiting time is greater than the other path. The path with higher wait time is the long duty cycle and the path with lesser wait time is the short duty cycle. Then the source prefer short duty cycle path to minimize the transmission delay.

Duty cycle is the combination of both long and short cycle per transmission. To conserve energy, we are not going to keep the nodes in active state always rather we are switching the nodes from active to sleep when there is no packet to transmit and switching the nodes from sleep to active when there are packets to transmit. The source prefers short duty cycle and makes the long duty cycle nodes to sleep. A node comprises of both long and short cycle and is active in one half of the duty cycle and idle in the other half of the duty cycle .Which means we are not using the entire duty cycle of the node, only one half is used for any transmission. For the first time alone the route is pre-determined from the next transmission onwards, the routes are dynamic for route discovery we are using RTS and broadcast discovers all possible paths and RTS confirms one path among the all. Here the source terminates the links when there is no active transmission that is before transmission, the node checks for the intermediates duty cycle if the duty cycle is long, it terminates if not it transmits data.

V.DUTY CYCLE BASED ENERGY CONSERVATION

For route discovery route request packets are propagated throughout the network thereby establishing multiple paths at destination node and at the intermediate nodes. In this approach our aim is to minimize the dropping of packets when it delivers from the source to destination. A duty cycle is the percentage of one period in which a signal is active. A period is the time it takes for a signal to complete an on-and-off cycle.

In our algorithm, we propose that after getting one path the nodes of that path are going to the sleep mode to avoid unnecessary energy consumption. In their next requirement they will wake up and participate in path finding procedure. Fig. 1 gives an idea about node's duty cycle. The concept behind this duty cycle is to make a nodesynchronized with its neighbor's node in order to achieve reliable message forwarding, as well as, energy conservation. Having knowledge of its neighbor's duty cycle a node if in an idle state can be changing its state to sleep mode in order to reduce energy consumption. During sleep mode a node stops any computation and communication with its neighbor's node.

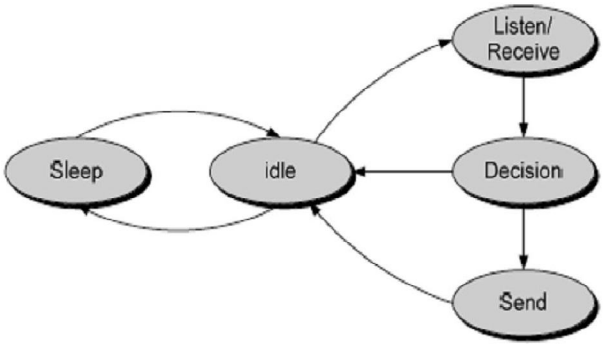

Fig. 1Node's duty cycle

From the finite state machine[4], a communication node first listens for incoming message. In our algorithm the control message is sent to all neighbor nodes of a particular node according to its adjacent list. A node listens to this message and receives it. After receiving it will decide which nodes is its neighbor node as given in adjacent listand send the

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control messages to those nodes. This process is repeated till we get the destination node and finding the path. The nodes which have already participated in this pat finding procedure go to idle state, or to Status=0 state, from which node then go to sleep mode in order to reduce energy consumption.

VI. SIMULATION RESULTS

Fig. 2 shows the network topology and data transmission. Here the nodes are distributed in the network. The paths for data transmission are selected based on the duty cycle.

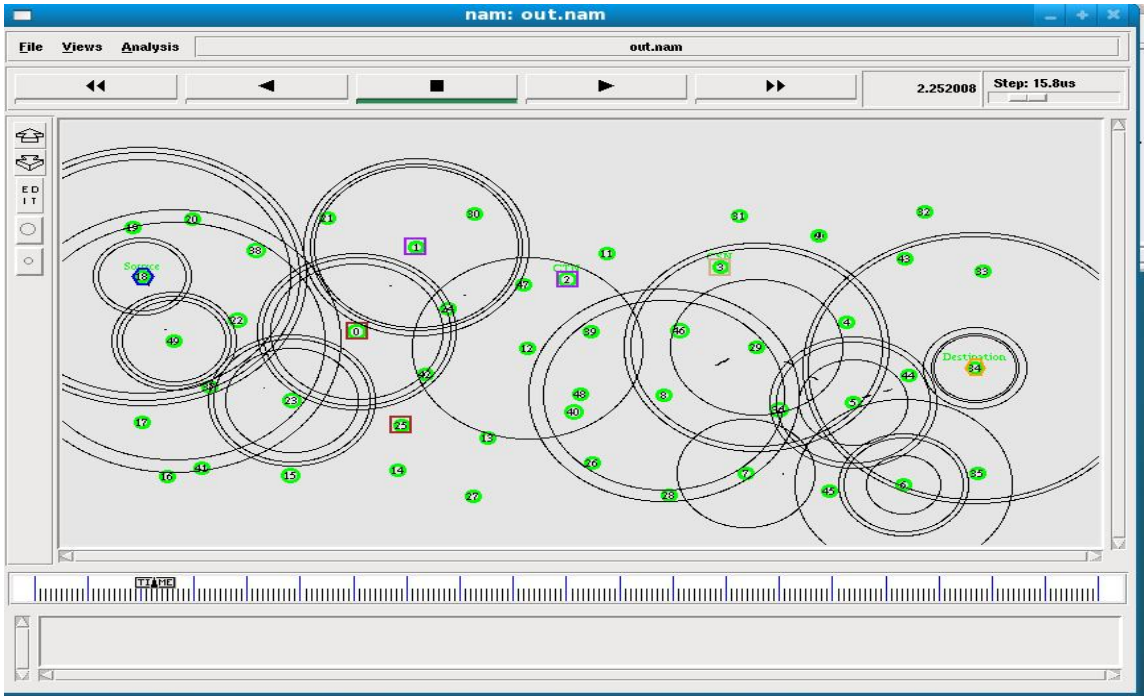

Fig. 2Network Topology

Fig. 3 shows the energy consumption graph plotted between short cycle and energy utilization. when cycle count increases the energy is decreasing .When the duty cycle begins, the node transmits data with the amount of energy left back i.e. the residual energy .The duty cycle algorithm utilizes lesser amount of energy from the available residual energy for transmission which indirectly means we are prolonging the node's life time.

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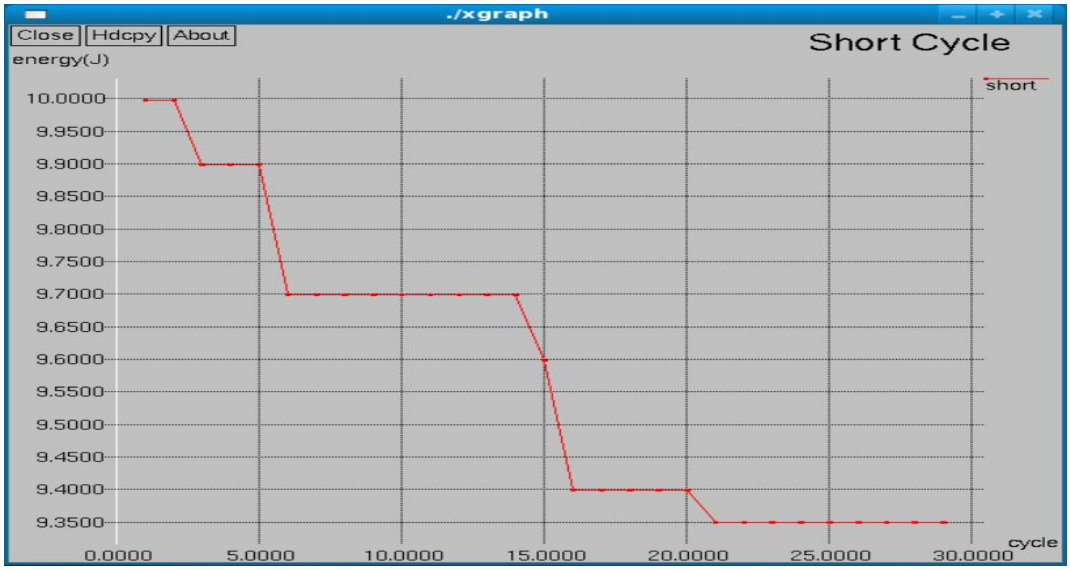

Fig. 3 Energy vs. Short cycle

Fig. 4 shows the throughput graph plotted between data rate and time. Throughput is the data transferred or handled per unit time. The proposed method increases the throughput of the network.

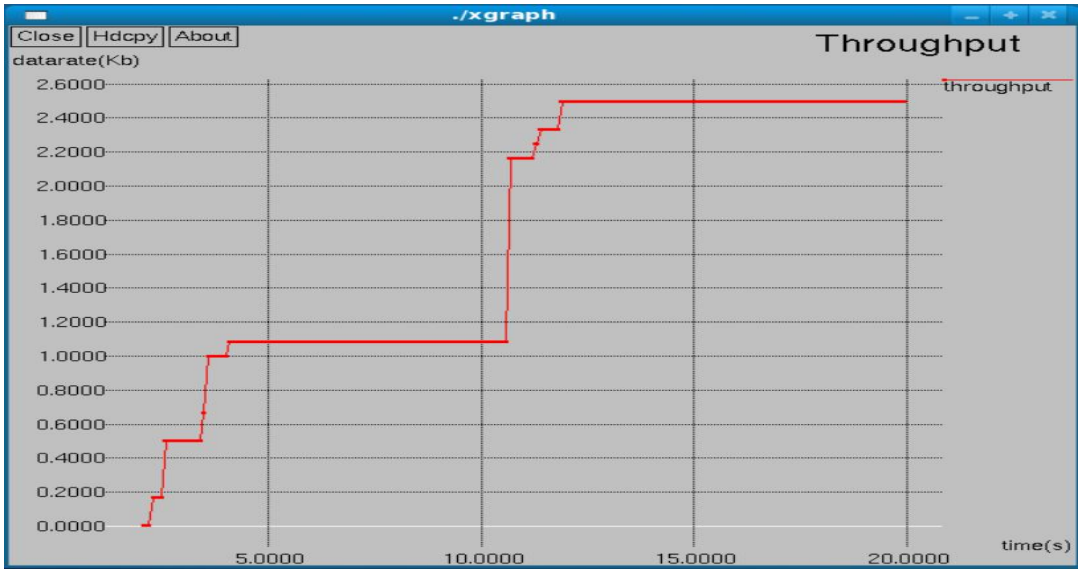

Fig. 4 Data rate vs. Time

Fig. 5 shows arrival rate graph. The data transferred between two nodes for a particular time limit is called arrival rate. Here the end to end delay decreases arrival rate increases.

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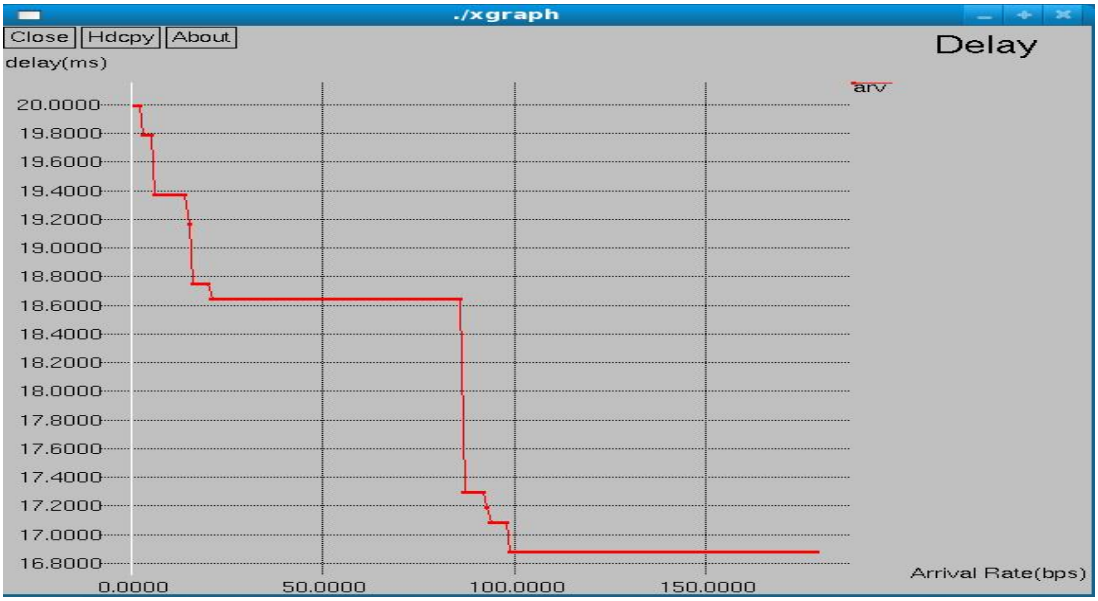

Fig. 5 Delay vs. Arrival rate

VII.CONCLUSION

Energy conservation is an important issue in ad hoc networks as nodes are usually battery powered. Routing protocol scheme for wireless networks are support by two essential requirements, minimize energy metrics or maximize network throughput. In order to satisfy these requirements here we are using an energy efficient routing scheme. Here the path selection for data transmission is based on lowest duty cycle. Simulation result shows that the throughput is increased and also the transmission delay is minimized.

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