A Comparative Analysis for Detecting Uncertain Deterioration of Node Energy in MANET through Trust Based Solution

Shilpa Bade*
H K Sawant*

Abstract

ABSTRACT: Energy is consumed in MANET during the transmission and reception of data, propagation of control packets, retransmission and overhearing. We concentrate in reducing the energy consumption during the transmission and reception of data. Each node in MANET transmits data with the maximum energy regardless of the distance between the nodes. Also the mobile nodes expend some energy in transmission and reception of data. We have utilized the metrics received signal strength, link quality and the distance between the nodes to compute the energy required to transmit the data from a node to its neighboring node. The energy computed is involved in the selection of the optimal path which requires minimum energy to route the data from source to destination. Nodes within an ad hoc network generally rely on batteries (or exhaustive energy sources) for energy. Since these energy sources have a limited lifetime, power availability is one of the most important constraints for the operation of the ad hoc network.

Keywords: MANET, Adhoc Networks, Routing Protocols, Re-transmission

1. Introduction

Mobile Ad-hoc networks are self-organizing and self-configuring multihop wireless networks, where the structure of the network changes dynamically. This is mainly due to the mobility of the nodes [1]. Nodes in these networks utilize the same random access wireless channel, cooperating in an intimate manner to engaging themselves in multihop forwarding. The node in the network not only acts as hosts but also as routers that route data to/from other nodes in network. In mobile ad-hoc networks there is no infrastructure support as is the case with wireless networks, and since a destination node might be out of range of a source node transferring packets; so there is need of a routing procedure. This is always ready to find a path so as to forward the packets appropriately between the source and the destination. Within a cell, a base station can reach all mobile nodes without routing via broadcast in common wireless networks. In the case of ad-hoc networks, each node must be able to forward data for other nodes. This creates additional problems along with the problems of dynamic topology which is unpredictable connectivity changes.

1.1 Properties of Ad-Hoc Routing protocols

The properties that are desirable in Ad-Hoc Routing protocols

*Department of Information Technology, Bharati Vidyapeeth Deemed University, College Of Engineering, Pune, India

are:

- **Distributed operation:** The protocol should be distributed. It should not be dependent on a centralized controlling node. This is the case even for stationary networks. The dissimilarity is that the nodes in an ad-hoc network can enter or leave the network very easily and because of mobility the network can be partitioned.
- **Loop free:** To improve the overall performance, the routing protocol should assurance that the routes supplied are loop free. This avoids any misuse of bandwidth or CPU consumption.
- **Demand based operation:** To minimize the control overhead in the network and thus not misuse the network resources the protocol should be reactive. This meansthat the protocol should react only when needed and should not periodically broadcast control information.
- **Unidirectional link support:** The radio environment can cause the formation of unidirectional links. Utilization of these links and not only the bi-directional links improves the routing protocol performance.
- **Security:** The radio environment is especially vulnerable to impersonation attacks so to ensure the wanted behavior of the routing protocol we need some sort of security measures. Authentication and encryption is the way to go and problem here lies within distributing the keys among the nodes in the ad-hoc network.
- **Power conservation:** The nodes in the ad-hoc network can be laptops and thin clients such as PDA's that are limited in battery power and therefore uses some standby mode to save the power. It is therefore very important that the routing protocol has support for these sleep modes.
- **Multiple routes:** To reduce the number of reactions to topological changes and congestion multiple routes can be used. If one route becomes invalid, it is possible that another stored route could still be valid and thus saving the routing protocol from initiating another route discovery procedure.
- **Quality of Service Support:** Some sort of Quality of service is necessary to incorporate into the routing protocol. This helps to find what these networks will be used for. It could be for instance real time traffic support.

1.2 Problems in routing with MANET

- **Asymmetric links:** Most of the wired networks rely on the symmetric links which are always fixed. But this is not a case with ad-hoc networks as the nodes are mobile and constantly changing their position within network.
- **Routing Overhead:** In wireless ad hoc networks, nodes often change their location within network. So, some stale routes are generated in the routing table which leads to unnecessary routing overhead.
- **Interference:** This is the major problem with mobile ad-hoc networks as links come and go depending on the transmission characteristics, one transmission might interfere with another one and node might overhear transmissions of other nodes and can corrupt the total transmission.
- **Dynamic Topology:** Since the topology is not constant, so the mobile node might move or medium characteristics might change. In ad-hoc networks, routing tables must somehow reflect these changes in topology and routing algorithms have to be adapted. For example in a fixed network routing table updating takes place for every 30sec. This updating frequency might be very low for ad-hoc networks.

2. Analysis of Energy Aware Routing Techniques

The main focus of research on routing protocols in MANETs has been network performance. There has been some study on Energy aware routing protocols for MANETs. Presented below is a brief review of some of them.

2.1 Node Alarming Mechanism (NOAL)

Node Alarming Mechanism (NOAL) [24] where an intermediate node having low energy alarms its status to others. With NOAL, we propose two routing algorithms: LEAR with NOAL (LENOAL) and FEAR with NOAL (FENOAL) that can balance the energy consumption among mobile nodes in ad hoc networks. The simulation study shows that LENOAL and FENOAL can balance energy consumption over networks Node Alarming Mechanism (NOAL), in which a node forwarding data packet alarms its energy status to others when it has low energy. The basic idea of NOAL is to protect node against consuming much energy. By notifying its energy status to others, it can prevent others from sending more data to itself, which stops consuming more energy by forwarding data packets. NOAL to energy-aware algorithms called LEAR with NOAL which can achieve an energy balancing even after route discovery.

2.2 Low Energy Routing Protocols

The main focus of research on routing protocols in MANETs has been network performance. There has been some study on energy aware routing protocols for MANETs. Presented below is a brief review of some of them.

2.2.1 Minimum Energy Routing

Reference [23] proposes a routing algorithm based on minimizing the amount of energy per bit required to get a packet from source to destination. More precisely, the problem is stated as:

$$\text{Minimize } \sum_{i \in E} E\,(I, i+1)$$

Where *E(i,i+1)* denotes the energy expended for transmitting (and receiving) between two consecutive nodes, i and i+1(a.k.a. link cost), in the route. This link cost can be defined for two cases:

- When the transmit energy is fixed.
- When the transmit energy is varied dynamically as a function of the distance between the transmitter and intended receiver.

For the first case, energy for each operation (receive, transmit, broadcast, discard, etc.) on a packet is given by [8],

$$E(packet)=b \times packet\_size+c$$

Where *b* and *c* are the appropriate coefficients for each operation. Coefficient *b* denotes the packet size-dependent energy consumption whereas *c* is a fixed cost that accounts for acquiring the channel and for MAC layer control negotiation. Route selection depends on the packet size; hence in case of variable packet size transmission many routes should be selected. The second case is more involved. Reference [23] proposes a local routing algorithm for this case. The authors assume that the power needed for transmission and reception is a linear function of dα where d is distance between the two neighboring nodes and α is a parameter that depends on the physical environment. They make use of the GPS position information to transmit packets with the minimum required transmit energy. The key requirement of this technique is that the relative positions of nodes are available to all nodes. However, this information may not be easy readily available. The GPS-based routing algorithm has two drawbacks. One is that GPS cannot provide the nodes much information about the physical environment and the second is the power dissipation overhead of the GPS device is additional.

2.2.2 Max-Min Battery Cost Aware Routing

The main disadvantage of the problem formulation of the previous approach is that it always selects the least-power cost routes. As a result, nodes along these routes tend to "die" soon because of the battery energy exhaustion. This is doubly harmful since the nodes that die early are precisely the ones that are needed most to maintain the network connectivity (and hence useful service life). Therefore, it is better to use a higher power cost route if it avoids using nodes that have a small amount of remaining battery energy. This observation has given rise to a number of "battery cost-aware routing" algorithms as described next.

1. Minimum battery cost routing algorithm [12] that minimizes the total cost of the route. It minimizes the summation of inverse of remaining battery capacity for all nodes on the routing path.
2. Min-Max battery cost routing algorithm [22] is a modification of minimum battery cost routing. This metric always tries to avoid the route with nodes having the least battery capacity among all nodes in all possible routes. Thereby, it results in fair use of the battery of each node.
3. Conditional Max-Min battery capacity routing algorithm proposed in [12, 25]. This algorithm chooses the route with minimal total transmission power if all nodes in the route have remaining battery capacities higher than a threshold; otherwise routes including nodes with the lowest remaining battery capacities are avoided. Several experiments have been done in [22] to compare different battery cost-aware routing in terms of the network lifetime. The result showed that the first node in "Shortest Path routing" metric died sooner than all the battery-cost-aware routing but most of the other nodes had longer expiration time. In that result Minimum battery cost routing showed better performance than Min- Max routing in terms of expiration time of all nodes. Conditional Max-Min routing showed different behavior that depended on the how the threshold value of chosen.

2.3 Lifetime Prediction Routing

Lifetime Prediction Routing (LPR) [25] is an on demand source routing protocol that uses battery lifetime prediction. The objective of this routing protocol is to extend the service life of MANET with dynamic topology. This protocol favours the path whose lifetime is maximum. We represent our objective function as follow:

$$\text{Max } T_\pi(t) = \text{Min } (_{Ti}(t)), i \in \pi.$$

$T_\pi(t)$: lifetime of path π

$T_i(t)$: predicted lifetime of node i in path

In Lifetime Prediction Each node tries to estimate its battery lifetime based on its past activity. This is achieved using a Simple Moving Average (SMA) predictor by keeping track of the last N values of residual energy and the corresponding time instances for the last N packets received/relayed by each mobile node. This information is recorded and stored in each node. We have carefully compared the predicted lifetimes based on the SMA approach to the actual lifetimes for different values of N and found N=10 to be a good value. Motivation of using lifetime prediction is that mobility introduces different dynamics into the network. In [13] the lifetime of a node is a function of residual energy in the node and energy to transmit a bit from the node to its neighbours. This metric works well for static networks for which it was proposed. However, it is very difficult to efficiently and reliably compute this metric when we have mobility since the location of the nodes and their neighbours constantly change. PSR does not use prediction and only uses the remaining battery capacity. We believe LPR is superior to PSR since LPR not only captures the remaining (residual) battery capacity but also accounts for the rate of energy discharge. This makes the cost function of LPR more accurate as opposed to just using battery capacity. This is true in MANETs since mobility can change the traffic patterns through the node, which thereby affects the rate of depletion of its battery. Also, recent history is a good indicator of the traffic through the node and hence we chose to employ lifetime prediction. This approach is a dynamic distributed load balancing approach that avoids power-congested nodes and chooses paths that are lightly loaded. This helps LPR achieve minimum variance in energy levels of different nodes in the network.

2.4 Local Energy-Aware Routing (LEAR)

In generic on-demand ad hoc algorithms, all nodes participate in the phase of path searching, while the final decision is made in the source or destination node. The Woo et al. [18] algorithm grants each node in the network permission to decide whether to participate in route searching, which thus spreads the decision making process among all nodes. The Local Energy-Aware Routing (LEAR) algorithm has as a main criterion the energy profile of the nodes. The residual energy defines the reluctance or willingness of intermediate nodes to respond to route requests and forward data traffic. When energy E_i in a node *i* is lower than a predefined threshold level *Th*:

$$E_i < Th,$$

the node does not forward the route request control message, but simply drops it. Thus, it does not participate in the selection and forwarding phase. The technique of shifting the responsibility for reacting to changes in the energy budget of the nodes from the source-destination nodes to the intermediate nodes avoids the need for the periodic exchange of control information, which exchange translates into bandwidth and energy consumption. It has been commonly used for improving the performance of the routing protocols in many more recent approaches. This mechanism is inventive but depends on the way it is implemented.

According to Analysis of energy (power) aware routing protocol we analyze that in local energy aware routing after applying threshold value the neighbored nodes are also trying to establish connection among low energy level node and uncertainly loss their energy. Now in this dissertation we focus on that problem.

3. Proposed Method For Energy Aware Deterioration Routing

The power at the network layer can be conserved by reducing the energy consumed for two main operations, namely, communication and computation. The communication related power consumption is mainly due to transmit-receive module present in the nodes. Whenever a node remains active, that is, during transmission or reception of a packet, energy gets consumed. Even when the node is not actively participating in communication, but is in the listening mode waiting for the packets, the battery keeps discharging. The computation power refers to the power spent in calculations that take place in the nodes during routing and power adjustments.

3.1 Energy Awareness

Network partitioning interrupts communication sessions and can be caused by node movement or by node failure due to energy depletion. Whereas the former cannot be controlled by the routing protocol, the latter can be avoided through appropriate routing decisions. Operational lifetime is therefore defined in this survey as the time until network partitioning occurs due to battery outage.

A few reasons for energy deterioration in MANETs are limited energy of the nodes, difficulties in replacing the batteries, lack of central coordination, constraints on the Battery source, selection of optimum transmission power, and channel utilization.

3.2 Proposed Solution for Energy Deterioration Scheme

Ad hoc wireless networks are power constrained since nodes operate with limited battery energy. If some nodes die early due to lack of energy, they cannot communicate with each other. Therefore, inordinate consumption of nodes' energy should be prevented. In fact, nodes energy consumption should be balanced in order to increase the energy awareness of networks. Here we proposed a new energy aware deterioration scheme in MANET. In this scheme we set a threshold value for energy consumption by mobile nodes in our network. If the energy level of any node/s in the network reaches to threshold level that are not participated in communication means it will be inactive in the network. According to our proposed approach a new energy aware deterioration routing (EADR) to make aware our network about the energy of nodes by that we remove the problem of suddenly loss of session to recognize the unfaithful nodes and extend the life cycle of network.

Energy aware deterioration routing scheme deals with efficient utilization of energy resources. By controlling the early depletion of the battery, adjust the power to decide the proper power level of a node and incorporate the low power strategies into the protocols used in various layers of protocol stack. There are little issues and solutions which witnesses the need of energy aware routing in ad hoc wireless networks.

Idle energy consumption constitutes a significant percentage of the overall energy consumed by the wireless interfaces of network nodes. Therefore, reducing this energy should be a cornerstone in any energy conservation efforts. As will be seen, our proposed algorithm, EADR, addresses the issue of idle energy consumption in a manner fair to all network nodes. Different nodes are given equal opportunities to conserve idle energy. When idle energy is addressed, another factor remains that may still affect energy fairness within the network. This is explained as follows:

Since ad hoc network nodes also assume the role of traffic routers, some nodes may need to cooperate in order to direct traffic that may not have been intended for them in the first place. Many routing strategies aim at finding the fastest and shortest routes for the traffic between two nodes that need to communicate. This may penalize some nodes that happen to be in a location that causes it to be part of several optimal routing paths. As an example, consider the network topology of Fig.1. If the decision is to use the shortest path, node 7 would be the obvious choice when routing data between node pairs (1,4), (2,5) and (3,6). This will always be the case as long as node 7 is alive, despite the existence of other routes. For example, if we want to route packets between nodes 2 and 5, and assuming that all adjacent nodes are within radio range of each other, we can use the routes (2-1-6-5) or (2-3-4-5), in addition to (2- 7-5). The problem with continuously using node 7 for packet routing is that it will run out of energy much faster than other nodes in the network.

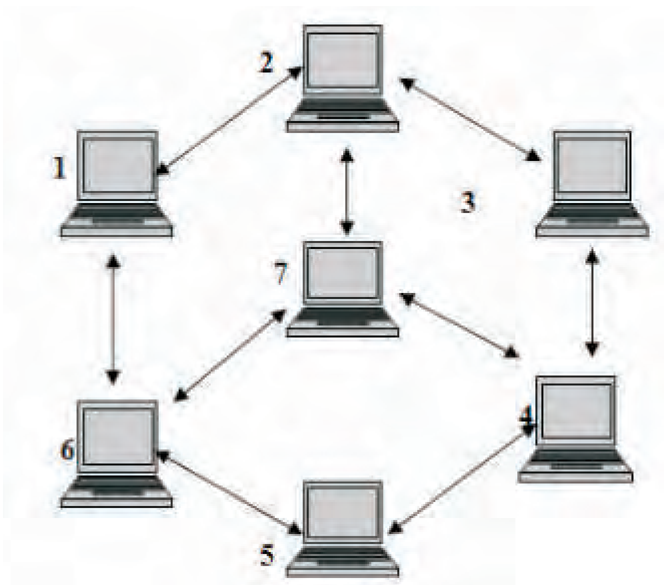

Fig. 1: Topology with a node having highest energy consumption in a network

From an energy point of view, this causes two issues:
Nodes are not treated as equal, which means that some nodes will run out of energy faster than the others due to their strategic location, thus causing them to cease to serve their own users faster than others. This presents a 'local' problem that affects node users.

Network partitioning may occur. Since some nodes may be critical for routing between certain nodes at some point of time, if these critical nodes run out of energy, routing between these nodes can no longer be done. This presents a 'global' problem that affects parts of the network or the whole network depending on the case.

The EADR algorithm helps address these issues. It provides the underlying routing protocol with the capability to make and implement routing decisions that take into consideration the energy state of the nodes that can be used for routing traffic. This can transform the existing routing algorithm into an energy-conscious one. This strategy helps to maximize the lifetime of network nodes and hence the network operation as a whole. The main goals of the EADA algorithm are fair energy conservation via:

- Rotating sleep periods equally among network nodes thus giving nodes equal opportunity for reducing energy consumption
- Assisting routing algorithms in making routing decisions based on energy fairness
- Little impact on network operation, for example, EADR introduces slight or no additional traffic or energy cost.
- Distributed processing of the algorithm which ensures robust operation that is not affected by the failure of one or more nodes.
- Modular nature which facilitates integrating it with existing routing algorithms

4. Description of Proposed EADR Algorithm

Proposed energy aware deterioration routing algorithm is protocol independent their route establishment and data delivery procedure is according to threshold value and given condition.

Initial energy = E
// (Suppose E = 100 Joule)
Threshold energy = Q_1 (10% of E) //for alert the energy level.

1. If {(E > Q_1) && (radio range from source to next hop (up to destination) < 250m)
Then
{Establish connection from source to destination}
Else
{ No connection establishment }
2. If {(E == Q_1)}
{Nodes will stop their working & goes to sleep mode}
3. If {(Node gain energy == 100) && (radio range from source to next hop $\leq$ 250m)}
{Go to step 1}
End

From a functional point of view, EADR algorithm can be considered to consist of two main units. One of these units handles the energy conservation operation. This is done through managing the nodes' energy level periods. The other unit or aspect of the algorithm takes care of supporting the routing protocol, as far as energy management decisions are concerned. It helps to ensure the routing protocol makes routing decisions that serve a specific goal. For example, whenever possible, nodes carry out routing duties that are proportional to their energy levels compared to each other. Fig.2 shows the interactions of

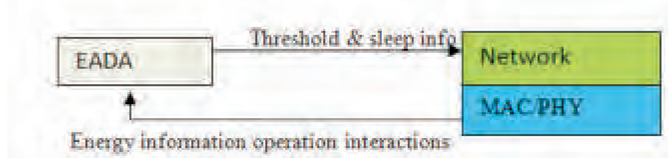

Fig. 2: Energy information operations

EADA with the network and MAC/PHY layers.

4.1 Energy Consumption Management

When EADR algorithm is enabled, nodes operate in one of two main modes: *"asleep"* or *"awake"*. In order to ensure maximum energy fairness, EDA enforces a configurable two-step cycle of operation for each node of the network. One portion of the cycle is a *asleep* period while the other portion is a *wakeup* period. While *awake*, a node can communicate normally with other nodes as per the routing protocol that is in use. The length of the mandatory wakeup period affects the connectivity of the network as nodes establish their knowledge of the current neighbors and network conditions during this period. While sleep mode, a node cannot exchange data with the external world. The only exception is sending broadcast messages that pertain to the routing protocol. In this case, the node goes to what is called *"asleep-pending"* state, where it wakes up for the duration of the broadcast and then it goes back to the sleep state to resume sleeping for whatever is left of the current sleep period. The reason behind not allowing unicast traffic and allowing only the sending of broadcast traffic is as follows. If we are to allow the node to send unicast messages during the sleep period, the node will have to abort the sleep and make sure it remains awake for the period of exchanging the control messages (RTS, CTS and ACK) as well as the data with the other end. This will not only complicate the operation of the algorithm, but will also potentially deprive the node from having a decent sleep period since the amount of time taken by this exchange can be unpredictably long in cases such as transmission errors. This contradicts with the goal of fair energy conservation for all nodes. However, we still allow broadcast messages to be sent by the sleeping node since the interruption of the sleep mode will be minimal in this case and at the same time this permission will help preserve healthy operation of the routing algorithm. Fig. 3 gives a description of how transitions between modes occur. While the node is asleep, other nodes may have some traffic that they need to send or forward to it. In order to make sure that this traffic will not be lost, nodes need to know when the node in question will start its sleep period and when it

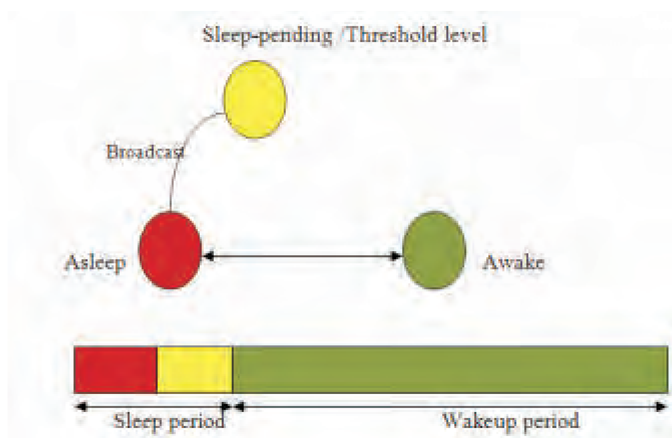

Fig. 3: EADR modes of operation

will become awake again which in turn determines if the node is asleep or awake. With this knowledge, the sending nodes buffer the traffic going to the sleeping node during its sleep period and then release it when it wakes up. This can be achieved via going-to-sleep and waking-up notifications that the node can send to the outside world upon going to sleep and waking up, respectively.

4.2 EADR with AODV

The second on-demand routing protocol we propose is called EADR with AODV (Energy-Aware Deterioration Routing with AODV). The main objective is to extend the useful service life of an ad hoc network. We are using the following formula to solves the problem of finding a route , at route discovery time t, such that the following cost function is minimized:

$$C(\pi,t) = \sum_{i \in \pi} C_i(t)$$

$$\text{Where } C_i(t) = \varrho_i \left(\frac{F_i}{R_i(t)}\right)^{\gamma}$$

ϱ_i = Transmit power of node i.
Fi = Full charge capacity of node i
Ri = Remaining battery capacity of node i at time t.
γ = Transmit connection request to all reachable neighbour nodes

The route discovery for EADR with AODV is described below.

In AODV, activity begins with the source node flooding the network with RREQ packets when it has data to send. An intermediate node broadcasts the RREQ unless:

- It gets a path to the destination from its cache, or
- It has previously broadcast the same RREQ packet.
  (This fact is known from the sequence number of the RREQ and the sender ID.)

Consequently, intermediate nodes forward only the first received RREQ packet. The destination node only replies to the first arrived RREQ since that packet tends to take the shortest path. In EAD, all nodes except the destination calculate their link cost, and add it to the path cost in the header of the RREQ packet. When an intermediate node receives a RREQ packet, it starts a process to forward the connection establishment request and keeps the cost in the header of that packets transmission or receiving. If the new node has a lower cost, means their energy is less than the threshold value then no connection will establish with this node new value and the new RREQ packet is forwarded other node having value greater then threshold value. Otherwise, the new RREQ packet is dropped. In EADR, the fig.4 represented routing with relible nodes. During the communication in the network each node of different behaviour has do their work properly. Green nodes having a sufficient energy for forwarding and reception of packets. Yellow colour indicates threshold energy level of node forward the route alert (RALE) message to their neighbour and Red colour indicates

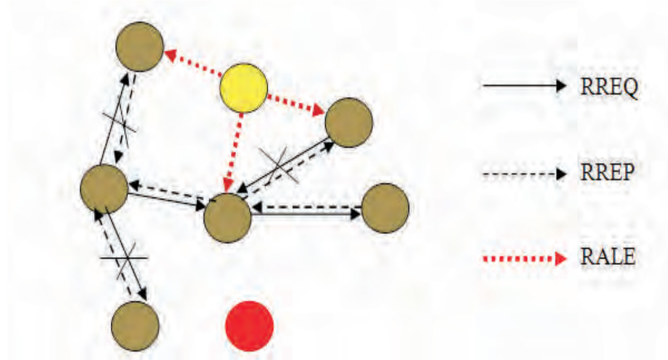

Fig. 4: Routing with reliable nodes

node is in sleep mode.
When the session expires, the source node selects the route with the energy greater than threshold value and replies. Subsequently, it will drop any received RREQs. The reply also contains the cost of the selected path appended to it. Every node that hears this route reply adds this route along with its cost to its route cache table. The node having value is less than threshold value has not participated in routing, this node is called *unfaithful node* in the network. Unfaithful nodes present in the network till they reached to sleep mode state but their functioning in the network is continuously forward their energy status to their neighbour nodes. Although this scheme can somewhat increase the latency of the data transfer, it results in a significant energy saving as will be shown in result and graph section.

5. Simulation of Energy Aware Deterioration Scheme

Our simulation model has five major components: ad hoc mobile network formation, packet delivery event generator, mobile nodes migration engine, routing protocol engine and statistics

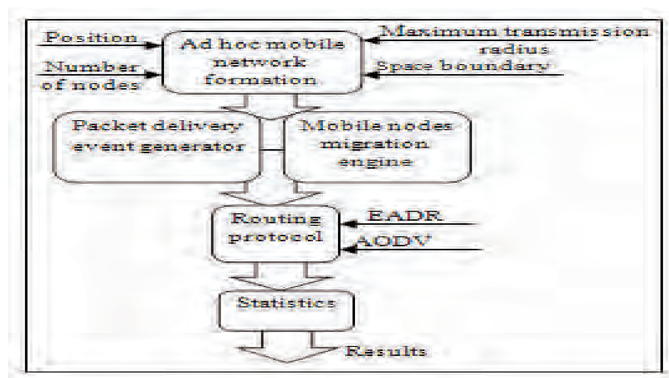

Fig. 5: Energy aware deterioration simulation model

analyzer, as illustrated in Fig.5
The module of ad hoc mobile network formation takes in parameters of the space boundary, number of network nodes, their positions in space and their maximum transmission radius. This module is implemented using TCL script [26]. The network formation is the simulation ground for packet delivery and mobile node migration events. The number of active communicating flows can be varied and the mobile nodes' migration speed and pause interval is node dependent. These are parameters inputted at simulation setup. Both events are

generated using TCL script and are subsequently handled by the routing protocol engine. The routing protocol engine employs EADR on top of AODV, in which EADR handles route selection, AODV manages route discovery, route maintenance, route refreshments and through cooperating with MAC and physical layers in the TCP/IP stack, it achieves reliable packet delivery.

6. Conclusion

The proposed EADR algorithm effectively utilizes the node energy consumption of nodes and minimizes total energy consumption in the network. Such a network lives longer than the others. With proposed algorithm, the life of route nodes increases and it utilizes their energy efficiently. The algorithm monitors energy status of each mobile node and select the reliable paths. All parameters shows good results in threshold level as compare to without threshold level with little enhancement in delay. This method can be incorporated into any ad hoc on-demand routing protocol to improve reliable packet delivery in the face of node movements and minimize the route breaks. Alternate routes are utilized only when data packets cannot be delivered through the primary route. In case studies, EADR has been applied to AODV and performance has been studied via simulations. Simulation results have indicated that new technique provides robustness to mobility and enhances protocol performance. Its performance has been found much better than other existing protocols in dense medium as probability of finding active routes increases. Our work is aimed at realizing architecture for achieving effective energy awareness across different levels in mobile adhoc network.

7. References

1. *http://compnetworking.about.com/cs/wirelessfaqs/f/adhocwireless.htm.*
2. *http://www.ietf.org/internet-drafts/draft-ietf-manet-aodv-08.txt.*
3. *B. SOUJANYA, T. SITAMAHALAKSHMI and C. H.DIVAKAR, "Study of Routing Protocol in MANET", International Journal of Engineering Science and Technology, Vol. 3, No. 4, pp. 2622-2631, 2011.*
4. *M. Mohammed, "Energy Efficient Location Aided Routing Protocol for Wireless MANETs", International Journal of Computer Science and Information Security, Vol. 4, No. 1 & 2, 2009.*
5. *Jie Xiang, Samba Sesay, Yiming Wang and Jianhua He, " Ad Hoc State Aware Routing Protocols", IEEE Communication Society Proc. WCNC, pp. 3749-3753, 2007.*
6. *K. ARULANADAM and Dr. B. P PARTHASARATHY, "A New Energy Level Efficiency Issue in MANET", International Journal of Reviews in Computing, Vol. 1, No.5 pp. 104-109, 2009.*
7. *Dhiraj Nitnaware & Ajay Verma, "Performance Evaluation of Energy Consumption of Reactive Protocols under Self- Similar Traffic", International Journal of Computer Science & Communication, Vol. 1, No. 1, pp. 67-71, 2010.*
8. *Hussein Elattar, Hussen Abdelety, and Mohamed About-Dahab, "Improving the Life Time of Wireless Ad Hoc Networks Using Power Aware Routing", 18 Telecommunications forum TEFOR, pp. 416-419, 2010.*
9. *Z. Guo, & , B. Malakooti, "Energy Aware Proactive MANET Routing with Prediction on Energy Consumption", Proc. 2007 International Conference on Wireless Algorithms, Systems and Applications, pp. 287-293, 2007.*
10. *V. Kanakaris, D. Ndzi and D. Azzi, "Ad-hoc Networks Energy Consumption: A Review of the Ad-Hoc Routing Protocols", Journal of Engineering Science and Technology Review Vol. 3, No. 1, pp. 162-167, 2010.*
11. *L. Cao, T. Dahlberg, & Y. Wang, "Performance Evaluation of Energy Efficient Ad hoc Routing Protocols", Proc. IPCCC, IEEE, pp. 306-313, 2007.*
12. *G. Allard, P. Minet, D. Q. Nguyen, & N. Shresta, " Evaluation of the Energy Consumption in MANET", Adhoc-Now, pp. 170 - 183, 2006.*
13. *Marco Fotino and Floriano De Rango, "Energy Issues and Energy Aware Routing in Wireless Ad-hoc Networks" INTEC Open Access publisher of scientific Books and Research, University of Calabria Italy, pp. 156-167, 2011.*
14. *Natalia Vassileva, and Francisco Barcelo, "A Survey of Routing Protocols for Maximizing the Lifetime of Ad Hoc Wireless Networks", International Journal of Software Engineering and Its Applications, Vol. 2, No. 3, pp. 77-89, 2008.*
15. *C. E. Jones, K. M. Sivalingam, P. Agrawal, & J. C. Chen, "A Survey of Energy Efficient Network Protocols for Wireless networks", Wireless Network Journal, pp. 343–358, 2010.*
16. *S. Kannan, S. Karthik and V. P Arunachalam, "Performance Analysis and Comparison of Mobile Ad hoc Network Routing Protocols", Research General of Applied Sciences, Vol. 6, No. 5, pp. 424-428, 2010.*
17. *F.Xie, L Du, Y Bai, L.chen, "Energy Aware Reliable Routing Protocol for Mobile Ad hoc Network," Proc. Wireless Communication and Networking Conference (WCNC), IEEE, pp. 4316- 4320, 2007*
18. *S. Busalo, Olagbegi and Natarajan Meghanathm, "A Review of the Energy Efficient and Secure Routing Protocols for Mobile Ad hoc Networks", GRAPH-HOC, Vol.2, No.2, pp. 62-68, 2010.*
19. *R. Lent, "Simulating the power consumption of computer networks," in the 15th IEEE International Workshop on Computer Aided Modeling, Analysis and Design of Communication Links and Networks (CAMAD'10), pp. 96-100, 2010.*
20. *V. Rishiwal, M. Yadav, S. Verma, S. K. Bajapai, "Power Aware Routing in Ad Hoc Wireless Networks, Journal of Computer Science and Technology", Vol. 9, No. 2, pp. 101-109, 2009.*
21. *M. Bheemalingaiah, M. M Naidu., D. S. Rao, "Energy Aware Clustered based Multipath Routing in Mobile Ad Hoc Networks", I.J Communications, Network and System Sciences, pp. 91-168, 2009.*
22. *Jhade Srinivas and Dr. P. Chenna Reddy, "Enhancement Study of Power-Aware Routing Protocols in Ad hoc Networks", International Journal of Advanced Research In Technology, Vol. 1, No. 1, pp. 66-70, 2010.*
23. *F. De Rango, F. Guerriero and P. Fazio, "Link-Stability and Energy aware Routing Protocol in Distributed Wireless Networks," to be published on IEEE Transaction on Parallel and Distributed Systems, pp. 148-153, 2008.*
24. *Eunkyu Lee, Minsoo Kim, ChansuYu and Myungchul Kim "Node Alarm Mechanism for Energy Balancing in Mobile Ad hoc Network", Proc. of Mobile Computing and Networking (Mobicom), pp. 85-96, 2002.*
25. *Morteza Maleki, Kartik Dantu And Massoud Pedram "Life Time Prediction Routing in MANET", Wireless Communications and Networking(WCNC), IEEE, pp. 1185-1190, 2005.*