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AN POWERCOMPETENT ROUTING PROTOCOL WITH MAXIMUM LIFETIME IN MANET-SURVEY

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stract – An ad-hoc network is a collection of wireless mobile nodes dynamically forming a temporary network without the use of any preexisting network infrastructure or centralized administration. However, due to the absence of central infrastructure the devices in the ad-hoc network can move randomly gives rise to various kind of problems, such as routing and security. The nodes in ad- hoc networks are typically battery powered. The need for energy efficiency in MANETs requires power enhancement features. Power is one of the most important design criteria for ad-hoc networks as batteries provide limited working capacity to the mobile nodes. In order to facilitate communication within a mobile ad-hoc network, an efficient routing protocol is required to discover routes between mobile nodes Power failure of a mobile node not only affects the node itself but also its ability to forward packets on behalf of others and hence affects the overall network lifetime. Much research efforts have been devoted to develop energy aware routing protocols. In this paper surveys various approaches pursued for energy efficiency for different routing protocols an efficient algorithm, which maximizes the network lifetime by minimizing the power consumption during the source to destination routeestablishment.

Index Terms – ***MANET, Routing Protocols, Power Aware Route discovery, Energy Efficieny.***

1. INTRODUCTION

A mobile ad-hoc network (MANET) is a self-configuring network of mobile nodes connected by wireless links, the union of which forms an arbitrary topology. The nodes are free to move randomly and organize themselves arbitrarily; thus, the network's wireless topology changes rapidly and unpredictably.[1]

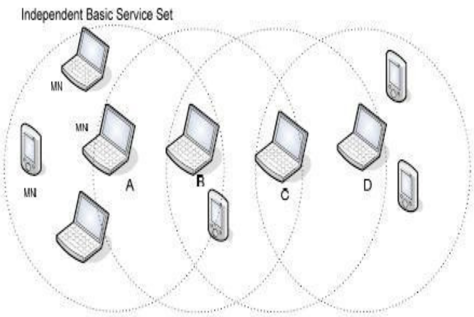

Figure 1. A scenario for a Mobile Wireless Ad Hoc Network (MANET).

Figure 1, shows a typical example of a MANET. Suppose node D is outside the range of node A's transmission range (the dotted circle around node A) and node A is outside the range of node D's transmission range. Therefore, these two nodes cannot directly communicate with each other. If nodes A and D wish to exchange a packet, nodes B and C act as routers and forward the packet on behalf of A and D, since B and C are intermediate nodes that are within the transmission range of A andD.

Mobile ad-hoc networks can turn the dream of getting connected "anywhere and at any time" into reality. Typical application examples include a disaster recovery or a military operation. Not bound to specific situations, these networks may equally show better performance in other places. As an example, we can imagine a group of peoples with laptops, in a business meeting at a place where

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no network services is present. They can easily network their machines by forming an ad-hoc network. This is one of the many examples where these networks may possibly be used. The basic objectives of MANET routing protocols are to maximize energy efficiency, maximize network throughput, maximize network lifetime and to minimize end-to-end delay innetwork.

APPLICATION OF MANETS [1]

Tactical networks

- Military communication andoperations
- Automatedbattlefields

Emergency services

- Search and rescueoperations
- Disasterrecovery
- Replacement of fixed infrastructure in caseof environmentaldisasters
- Policing and firefighting
- Supporting doctors and nurses inhospitals

Commercial and civilian

- E-commerce: electronic payments anytimeand anywhereenvironments
- Business: dynamic database access, mobileoffices
- Vehicular services: road or accident guidance, transmission of road and weather conditions, taxicab network, inter-vehiclenetworks
- Sports stadiums, trade fairs, shoppingmalls
- Networks of visitors atairports

Education

- Universities and campussettings
- Virtualclassrooms
- Ad hoc communications during meetings orlecturesulti-usergames
- Wireless P2Pnetworking
- Outdoor Internetaccess
- Roboticpets
- Themeparks

Home and enterprise

- Home/office wireless networkingnetworking
- Conferences, meetingrooms
- Personal area networks (PAN), Personalnetworks (PN)
- Networks at constructionsites

Sensor networks

- Home applications: smart sensors andactuators embedded in consumerelectronics
- Body area networks(BAN)
- Data tracking of environmental conditions,animal movements, chemical/biologicaldetection

Context aware services

- Follow-on services: call-forwarding,mobile workspace
- Information services: location specific services,time dependentservices
- Infotainment: touristicinformation

Coverage extension

- Extending cellular networkaccess
- Linking up with the Internet, intranets,etc.

RESEARCH ISSUES IN MANETS

As is clear from above discussion that MANET are useful in many areas of importance .Despite this wide applicability there are some issues still prevailing in this field. This section explores such open research challenges [1].

- Limiting powersupply
- Dynamically ChangingTopology
- LimitedBandwidth
- Security
- Mobility-induced routechange
- Batteryconstraints

Routing is one of the key issues in MANETs due to their highly dynamic and distributed nature. In particular, *energy efficient routing* may be the most important design criteria for MANETs since mobile nodes will be powered by batteries with limited capacity. Power failure of a mobile node not only affect the node itself but also its ability to forward packets on behalf of others and thus the overall network lifetime. For this reason, many research efforts have been devoted to developing energy aware routing protocols. Based on the forementioned discussions, this paper surveys and classifies numerous energy efficient routing mechanisms proposed for MANETs [4-17]. They can be broadly categorized based on *when* the energy optimization is performed. A mobile node consumes its battery energy not only when it actively sends or receives packets but also when it stays idle listening to the wireless medium for any possible communication requests from other nodes. Thus, energy efficient routing protocols minimize either the *active* communication energy required to transmit and receive data

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packets or the energy during *inactive* periods. For protocols that belong to the former category, the active communication energy can be reduced by adjusting each node's radio power just enough to reach the receiving node but not more than that. This *transmission power control approach* can be extended to determine the optimal routing path that minimizes the total transmission energy required to deliver data packets to the destination. For protocols that belong to the latter category, each node can save the inactivity energy by switching its mode of operation into *sleep/power-down mode* or simply turns it off when there is no data to transmit or receive. This leads to considerable energy savings, especially when the network environment is characterized with low duty cycle of communication activities. However, it requires well-designed routing protocol to guarantee data delivery even if most of the nodes sleep and do not forward packets for other nodes. Another important approach to optimizing active communication energy is *load distribution approach*. While the primary focus of the above two approaches is to minimize energy consumption of individual nodes, the main goal of the load distribution method is to balance the energy usage among the nodes and to maximize the network lifetime by avoiding over-utilized nodes when selecting a routingpath.

The routing in MANET is completely dependent on the flooding of routing packets in network by that the nodes energy is wasted in flooding. Due to limited working capacity of mobile nodes is the major problem in MANET. In MANET the energy is the limited resource because there is a no source is available in network by that the nodes are regain their energy. It means if the node is lost their energy then the battery replacement is only the option to retain the node in network with full capability and the second one option is to utilize the energy of nodes efficiently. The meaning of efficient use of battery power is to reduce the possibility of packet loss and retransmission in network. The routing protocol has no capability to reduce the motion of mobile nodes that is the major region of link breakage and energy wastage. The energy efficient routing scheme is utilizes the nodes power in communication.

Classification of Routing Protocols in MANETs

MANET routing protocols could be broadly classified into two major categories based on the routing information update mechanism[2] :

1. *Proactive Routing Protocols:* Proactive protocols continuously learn the topology of the network by exchanging topological information among the network nodes. Thus, when there is a need for a route to a destination, such route information is available immediately. If the network topology changes too frequently, the cost of maintaining the network might be very high. If the network activity is low, the information about actual topology might even not be used. Ex: DSDV, WRP, CGSR,etc.

2. *Reactive Routing Protocols:* The reactive routing protocols are based on some sort of query-reply dialog. Reactive protocols proceed for establishing route(s) to the destination only when the need arises. They do not need periodic transmission of topological information of the network. Ex: DSR, AODV, TORA,etc.

3. *Hybrid Routing Protocols:* Often reactive or proactive feature of a particular routing protocol might not be enough;

nstead a mixture might yield better solution. Hence, in the recent days, several hybrid protocols are also proposed.

Proactive approaches introduce more overhead compared to reactive ones. This is because even when there are no changes in network topology, control messages are flooded in order to maintain a full knowledge of the network in each node. In proactive routing protocols first packet latency is less when compared with on-demand protocols. Proactive (Table- driven) protocols are inherently more energy consuming compared to Reactive (On-demand) ones, hence most of the proposals involve modifications to reactive protocols. In Reactive protocols, AODV is found to be the most energy efficient routing protocol. Hence many

II. ROUTEDISCOVERY

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Route discovery is done with two sub steps that is, Route Request (RREQ) and Route Reply (RREP) [3].

Route Request:
The route discovery comes in play when a mobile node has some data/packet to send to any destination and it does not have any route to the destination in its route cache. Then it initiates route discovery by broadcasting a route request packet. This route request contains address of the destination, address of the source and a unique identification number that is generated by the source node only. Each node receives the packet and checks whether the packet is meant for it or not. If it is not the destination node then it simply forwards the packet to the outgoing links adding its own address in the packet. To avoid duplicate route request which is generated from the same source, a node only forwards the route request that has not yet been seen appear in the route request with the

Route Reply

As soon as the packet arrives at the destination node or arrives at a node that contains in its route cache an unexpired route to the destination, then a route reply is generated. Not only the packet contains all the adder of the intermediate node it has come across but the sequence of hops is also stored in it. The Route reply is generated by the destination placing the route record contained in the route request into route reply. During the route reply if the destination node has the route to the initiator in its route cache, it may use that route for route reply. Otherwise destination node may reverse the route in the route record if the link is symmetric. If the symmetric links are not supported then the node may initiate its own route discovery piggy backing the route reply on the new route request. When any intermediate node receives any route reply from destination node or any other node then they append their route record and forward it to its neighbornodes.

Route Maintenance

Route maintenance is a process of identifying link whether it is reliable and capable of carrying packet on it or not. This process is executed by the use of route error packets and acknowledgements. When the data link layer encounters a fatal transmission problem then a route error message isenerated. Suppose a packet is retransmitted (up to a maximum number of attempts) by some hop the maximum number of times and number of receipt conformation in received, then this node returns a packet error message to the original sender of the packet, identifying the link over which the packet could not be forwarded.

Benefits and Limitations
As the entire route is contained in the packet header, there is no need of having routing table to keep route for a given packets. The caching of any initiated or overheard routing data can significantly reduce the number of control message being sent, reducingoverhead.

III. LITERATURESURVEY

The Multi-Path routing protocols are used to reduce the routing overhead, delay, and to increase the data rate (Banner R., Orda A., 2007) [4]. These are obtained from the achievement of limited energy utilization. However, the availability of multiple paths for a single Destination Node renders collision in the network[3]. Since, Energy Efficient and Collision Aware protocol is proposed (Zijian Wang et al. 2009). In order to avoid this collision, the multiple disjoint paths are determined for the required Destination Node. It aids to reduce the congestion formation in the network. It determines the collision free paths using the location information. The mobile node position information is obtained from the cross layer. The path discovery broadcasting is limited within the immediate neighbor nodes along the determined routes to the Destination Node. The Mobile Nodes in the path transmit the advertisement and data packets with proper utilization of battery and bandwidth power. The main drawback of this protocol is that it increases the routing overhead due to the maintenance of locationinformation.

The On-Demand routing protocols discover the paths only when it is required to communicate with other nodes. The advantage of this protocol is that it incurs low routing overhead. In order to increase the lifetime of the network, the depleted node energy should be conserved. There is a need for energy aware routing protocol to conserve node energy. Several techniques are suggested to energy conservation. In energy aware On-Demand routing, the radio interface is switched off to conserve the node battery (Nishant Gupta and Nishant Gupta, 2002).The selection of optimal paths to the Destination Node from the Source Node considers the shortest hop count. The selected paths for the data transmission are sorted. The minimum hop count path is selected as a primary route to the Destination Node. Other nodes are act as secondary paths to the Destination Node. The selected paths are used to conserve the node battery during the node mobility. In that, the depleted node energy is reduced through the MAC layer. During the rest period, the Mobile Nodes are switched off to save the battery power. The main drawback of this protocol is that it needs to retain the routing information to switch off the Mobile Nodes during the restperiod.The minimum-hop maximum-power routing can significantly reduce the energy consumption during the data transmission. The main drawback of the existing routing protocols is that it is difficult to obtain location information. Since, the existing protocols cannot provide accurate node power information. In order to obtain the power saving, the node is power down when inactive. This process is done in the MAC layer. In order to determine and save the node battery power, some modifications are introduced in the existing On-Demand protocols (Sheetalkumar Doshi and Timothy X Brown, 2009). Mostly, the node power is consumed for the routing process. The power consumption is increased with the network size and the node mobility.[5] In that, the number of advertisement packets for the routing is reduced to obtain the power savings. The proposed scheme to conserve the node power is that the node power down during the inactive time. It aids to decrease the power depletion and increase the power savings. The main drawback of this protocol is that it makes trade off between the routing overhead and the powersavings.

Minimizing the Maximum used Power Routing (MMPR) (Kim et al 2008) takes into account the power consumption and remaining power. MMPR selects the path that consumes minimum power for data transmission. In addition, MMPR also considers the remaining power under the selection of the desired path to prolong the network lifetime. However, MMPR does not consider the transmission amount of the selected path, so that the path may break during the data transmission. Energy-aware routing schemes have been employed to prolong the lifetime of energy constrained mobile nodes in ad-hoc networks (Kim et al 2003). This has also been discussed by Mohanoor et al (2009). The routes have been mainly identified by considering the energy spent to transmit packets from source nodes to destination nodes, or the RE of nodes.

Minimum Energy Dynamic Source Routing (MEDSR) and Hierarchical MEDSR (HMEDSR) were introduced by Tarique & Tepe (2009) to improve energy efficiency and network lifetime. MEDSR is incorporated in two phases: route discovery and link-by-link power adjustment in order to discover low energy routes in data transmission. But it results in more overhead. Therefore, to minimize overheads, HMEDSR have been proposed to work in a hierarchical fashion. The hierarchical approach limits the number of routing control packets, and the minimum energy approach limits the energy use of the HMEDSR protocol. But in this study, the mobility which is an important aspect of ad-hoc networks, has not been dealt and the network may have number of pathbreakages[7].

Ying Zhu et. al has been proposed a “Energy-Efficient Topology Control in Cooperative Ad Hoc Networks” in this work researcher introduce a new topology control problem: name is energy-efficient topology control problem with cooperative communication, and proposed two topology control algorithms to build cooperative energy spanners in which the energy efficiency of individual paths are guaranteed. both proposed algorithms can be performed in distributed and localized fashion while maintaining the globally efficient paths by proposed mechanism and control the topology change behavior on the bases of energy efficient mechanism[8].

Vinay Rishiwal in his work titled “Power Aware Routing in Ad Hoc Wireless Networks” they propose an efficientlgorithm and maximize the network lifetime by minimizing the power consumption during the source to destination route establishment. As on thier case study proposed algorithm has been incorporated along with the route discovery procedure of AODV and by simulation it is observed that proposed algorithm’s performance is enhanced as compare to AODV and DSR in terms of various energy base parameters like total Energy

Consumption, Average Energy Left Per Alive Node, Node Termination Rate, and Network Lifetime for different network scenarios[9].

Dahai Du, Huagang Xiong in [10] proposed location aided protocol. The development of GPS technology makes it possible to use the low cost Global Position System (GPS) in the mobile node, which knows its geographical location. Though GPS may consume some energy, the LEER protocol consumes less energy with the aid of nodes location information. This is because the location information can help the relaying nodes to find the destination nodes with less route discovery messages. Based on this, any node in the network can get its coordinate with the aid of GPS. Location aided Energy-Efficient Routing protocol (LEER) protocol finds out the all-possible paths from source to destination and selects minimum energy path to route the packets. The selection of next hop node is based on whether it is situated near to destination than to source as well as transmit power of that node.

Niranjan Kumar Ray and Ashok Kumar Turuk have discussed different energy efficient techniques for wireless adhoc network. One of the techniques is based on reduction of number of route request messages. In second Power control technique, next hop node is chosen depending on the power level of the node. Topology control technique is used to remove the energy-inefficient link from the network by examining the power level of the node. This technique helps network devices to take decision about their transmission range[11].

Ravneet Kaur, (2013) proposed A Energy Efficient Routing Protocols in Mobile Ad hoc Network based on AODV Protocol. In this paper discuss different energy efficient routing algorithms (LEAR-AODV, PAAODV, EEAODR, OAODV and LPR-AODV) that reduce energy consumption and lead to a longer battery life at the terminals. They achieve balanced energy consumption with Minimum overhead[12].

Vazifehdan et al (2011) proposed energy-aware routing algorithms for wireless ad-hoc networks with heterogeneous power supplies[13] , where nodes may run on battery or can be connected to the mains (grid network). They can be modeled by directing the traffic load dynamically towards mains-powered devices keeping the hop count of selected routes minimal. The route selected is formulated as a bi- criteria decision making problem based on the weighted sum approach and the lexicographic method. The main problem with this approach is heterogeneous power supply and this is not practically suitable for real time applications where the mains supply was not there.

n order to make this energy efficient, its enhanced version EE-AODV is proposed in which Dijkstra algorithm [14] is enhanced with AODV to improve the overall performance of the network were introduced by Kartik Sharma (2015). Existing systems are not capable of finding the shortest and energy based path among the nodes in the network if multiple nodes fail simultaneously. EE-AODV checks the Energy/Distance ratio of each path available in the network. When source node wants to communicate with destination node to transfer the data it starts the route discovery process and broadcast the route request packets to their neighbor along with its energy after receiving the RREQ the neighbor node update their routing table and forward request to their own neighbor along with energy level. After receiving the route request (RREQ) the destination node checks the Energy/Distance ratio for each path in which path having maximum energy and minimum distance is selected in the E/D ratio and after calculating ratio destination replies back to source paths having maximum ratio and after getting the route reply (RREP) source node transmit data through path having maximumratio.

Optimal path selection in MANET (OPSM) were introduced by Dr.V.Ramesh (2016), A new routing method that consists of path finding, selection and maintenance, named OPSM, has been designed and implemented to provide an energy efficient communication with enhanced lifetime. Path finding is designed first for accomplishing this task with the inclusion of power ratio and LD in finding the eligibility of node for forwarding. The selection method utilizes the mathematical model that chooses a path with less EC and the number of hops for extending the network lifetime. This selection process also involves finding a reliable node-disjoint path that satisfies the mathematical model. Node-disjoint path selection has been done to avoid the path failure due to sharing of nodes by multiple paths[15].

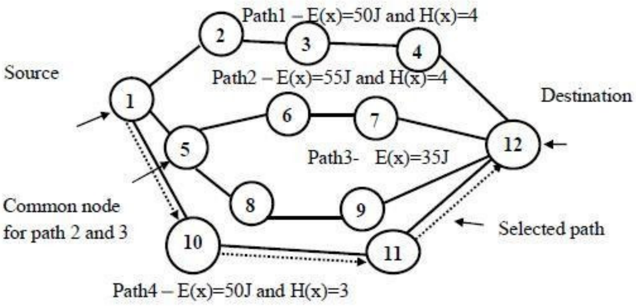

Fig 2.1: Path Selection

Path selection involves finding the node-disjoint paths from the received multiple paths. These are given as RREPs back to the source by the destination node. The source stores a maximum of three optimal node-disjoint paths in its cache and selects one. The optimal path in the sense is the path with minimum energy and hop. The focus is to reduce the path breakage and to increase the network lifetime. The path selection based on the optimal node-disjoint is shown diagrammatically with an example in Figure2.1 It can be noticed from the Figure 2.1 that it contains two node-disjoint paths namely path 1 and path 2. The selection at the source is subject to the objective function based on the energy and hop. So, the path chosen for data transfer is path 4 which is shown in dotted lines and path 1 is stored as a backup path in the source cache. In this scheme PAR is delivering more packets in different network scenarios as well as network life time of the PAR is better even in high mobility scenarios. Although this scheme can somewhat enhance the latency of the data transfer but it results in a significant power saving and long lasting routes. This scheme is one of its types in ad-hoc networks which can provide different routes for different type of data transfer and ultimately increases the network life time.

Dr.V.Latha[16] in his work titled " Design of Routing Protocol For MANET Through Energy Optimization Technique" they propose an efficient algorithm EPAR it satisfies both medium and large size network but DSR and MTPR only used for small size network. It produces good results in terms of throughput and leads to good packet delivery ratio. In EPAR , before forwarding its packets to next hop, the source itself analyze the entire path and its ability. The source node calculates the expected energy spent over each path available and its lifetime changes if, the packet routed through each path. On analyzing the entire route path available, the source node decides not only the next hop and also the entire path to be used and route its packet as calculated. It increased Network lifetime. In EPAR, selection of path decided only based on the residual energy of full path. How about the residual energy of all intermediate nodes have taken care in selection of next hop. It increases in life time of nodes further decreases packet loss.

III. CONLUSION

This work explored various routing protocols existing in MANETs. The energy consumption behavior of various routing protocols is being analyzed. With energy optimization proper delivery of packets with optimum cost is also concerned. Path finding is designed first for accomplishing this task with the inclusion of power ratio and LD in finding the eligibility of node for forwarding. The selection method utilizes the mathematical model that chooses a path with less EC and the number of hops for extending the network lifetime. This selection process also involves finding a reliable node-disjoint path that satisfies the mathematical model. Node-disjoint path selection has been done to avoid the path failure due to sharing of nodes by multiplepaths.

In Future find a new routing method that consists of path finding, selection and maintenance, has been designed and implemented to provide an energy efficient communication with enhanced lifetime.

REFERENCE

[1] Hoebeke J, Moerman I., Dhoedt B. and Demeester P., "An Overview of Mobile Ad Hoc Networks : Applications and Challenges", Published in Journal-Communications Network, Vol. 3, No. 3, Pp .60-66, 2005.

[2] Kumar G.V., Reddyr Y.V. and.Nagendra .M, "Current Research Work on Routing Protocols for MANET: ALiterature Survey", (IJCSE) International Journal on Computer Science and Engineering. Vol. 2, No. 3, Pp.706-713,2010.

[3] Nileshkumar R. Patel "Energy Saving and Survival Routing Protocol for Mobile Ad Hoc Networks" *International Journal of Computer Applications (0975 –*

888)Volume 48– No.2, June 2012.

[4]Banner R., Orda A.. Multi-path Routing Algorithms for Congestion Minimization. *IEEE/ACM Transactions on Networking,* vol. 15(2), April 2007, pages 413-424.

[5] Sheetalkumar Doshi and Timothy X Brown, "Design Considerations for an On-demand Minimum Energy Routing Protocol for Wireless Ad Hoc Network," Mobile Computing and Communication Review, Vol.6, No.2, July 2002.

[6] Jin-Man Kim, Jong-Wook Jang, "AODV based Energy Efficient Routing Protocol for Maximum Lifetime in MANET," aict-iciw, p. 77-82, Advanced International Conference on Telecommunications and International Conference on Internet and Web Applications and Services (AICT-ICIW'06), 2006.

[7] Tarique, M & Tepe, KE 2009, Minimum energy hierarchical dynamic source routing for Mobile Ad Hoc Networks , Journal Ad Hoc Networks, vol. 7, no. 6, pp. 1125 1135.

[8] Ying Zhu, Minsu Huang, Siyuan Chen, and Yu Wang, Energy-Efficient Topology Control in Cooperative Ad Hoc Networks, IEEE transactions on parallel and distributed systems, vol. 23, no. 8, august 2012.

[9] Vinay Rishiwal , Mano Yadav , S. Verma and S. K. Bajapai, Power Aware Routing in Ad Hoc Wireless Networks, JCS&T Vol. 9 No. 2, October2009.

[10] Dahai Du & Huagang Xiong, "A Location aided Energy- Efficient Routing Protocol for Ad hoc Networks", 19^{th} Annual Wireless and Optical Communications Conference (WOCC), pp1-5,2010.

[11] Niranjan Kumar Ray & Ashok Kumar Turuk, "Energy Efficient Techniques for Wireless Ad Hoc Network" International Joint Conference on Information and Communication Technology, pp.105-111, 2010.

[12] Ravneet Kaur "Energy Efficient Routing Protocols in Mobile Ad hoc Network based on AODV Protocol" *(IJAIEM)* Volume 2, Issue 1, January 2013 ISSN 2319 – 4847.

[13] Meng Li, Lin Zhang1, Victor O. K. Li, Xiuming Shan, Yong Ren, "An Energy-Aware Multipath Routing Protocol for Mobile Ad Hoc Networks" ACM Sigcomm Asia'05, Apr. 10- 12, 2005, Beijing,China.

[14] Barritt, Brian J.; Sheikh, Shaya; Al-Najjar, Camelia; Malakooti, Behnam "Mobile ad hoc network broadcasting: Amulti-criteria approach" , International Journal of Communication Systems, Vol. 24, Issue 4, pp. 438-460, April2011.

[15] V.Ramesh, Dr.P.Subbaiah, "Load Balancing: Energy Management Scheme for Preemptive DSR to increase Packet Delivery Ratio & to decrease Delay" , published in the Journal of Theoretical and Applied Information Technology , Vol 47, Issue 3, pp 1112-1119, January2013.

[16] Dr.V.Latha "Design of Routing Protocol For MANET Through Energy Optimization Technique" International Journal of Innovations & Advancement in Computer Science IJIACS ISSN 2347 – 8616 Volume 4, Special Issue March 2015.

[17] Safa, H.; Mirza, O. "A load balancing energy efficient clustering algorithm for MANETs", International Journal of Communication Systems, Vol. 23, Issue 4, pp.463-483, April 2010.