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Energy Efficient Routing in MANET: A Survey

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***Abstract*—Mobile Ad Hoc networks (MANET) allow a set of wireless hosts to exchange information without any special infrastructure. Limited battery power is one of the most important issues in mobile ad-hoc network by that efficient utilization of battery power or energy is must in routing process. Among the various factors which cause disorder in such a network and routing process the problem of broken links is occur due to the lack of energy is the most important ones. Due to the unawareness of energy of mobile nodes that problem will occur. The numbers of mobile nodes that are take part in communication are aware about the energy statue of rest of the mobile nodes then energy efficient routing approaches will maintain the network condition so that the packet can be delivered reliably without any link failure. There are lot of work has been done in this field and some of them are proposed a good approaches. Now in this paper we presents the some latest approaches that are reduces the energy consumption of mobile nodes and increases the life time of battery by that also enhance the life of network.**

***Index Terms*—MANET, energy efficiency,**

I. Introduction

Mobile hosts and wireless networking hardware [1,2] are becoming widely available, and extensive work has been done recently in integrating these elements into traditional networks such as the Internet. Oftentimes, however, mobile users will want to communicate in situations in which no fixed wired infrastructure such as this is available, either because it may not be economically practical or physically possible to provide the necessary infrastructure or because the expediency of the situation does not permit its installation.

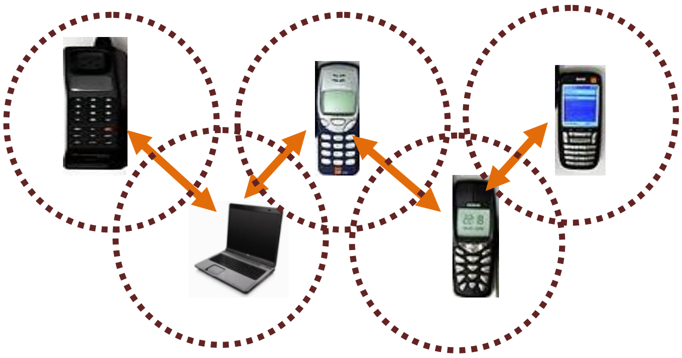

Fig.1. Ad hoc Network

Figure 1.1 represents the mobile ad hoc network. Nodes within an ad hoc network generally rely on batteries (or exhaustive energy sources) for power. 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.

For example, in a class of students can need to interact during a lecture, friends or business associates may run into each other in an airport terminal and wish to share files, or a group of emergency rescue workers may need to be quickly deployed after an earthquake or flood. In such situations, a collection of mobile nodes with wireless network interfaces can form a temporary network without the support of any established infrastructure or centralized administration. This type of wireless network is known as an ad hoc network.

There are different sources of power or energy [2, 3, 4] consumption in a mobile ad hoc network. Communication is one of the main sources of energy consumption. Since the rate of battery performance improvement is rather slow currently, and in the absence of breakthroughs in this field, other measures have to be taken to achieve the goal of getting more performance out of the currently available battery resources.

To overcome the restrictions of wired backbone networks, wireless networks are proposed to provide mobile users with ubiquitous communication capability and Information access regardless of their locations. The flexibility and mobility the wireless networks offer makes them the network of choice. There are two categories of wireless networks, i.e., infrastructure-based wireless networks and wireless ad hoc networks. An ad hoc wireless network is designed to overcome the natural limitation of wired backbone networks and infrastructure based wireless networks. The network is a collection of mobile nodes sharing a wireless channel and dynamically forming a temporary network topology without the existence of network infrastructure or centralized administration.

The environment of an ad hoc network is characterized by unpredictable connectivity changes, unreliable wireless medium, resource-constrained nodes, and dynamic topology. These features make a MANET prone to numerous types of failures including: transmission errors, node failures, link failures, route breakages, and congestions. The environment of ad hoc network can be categorized into three main states: an ideal state, wherein the network is relatively stable with sufficient resources; a congested state, wherein some nodes, regions or the whole network is experiencing congestion; and an energy critical state, wherein the energy capacity of nodes in the network is critically low. Under these conditions, designing an efficient and reliable routing protocol that adapts to the current state of the network is an important and challenging task. To our knowledge none of the current routing protocols designed and evaluated for ad hoc networks in literatures has demonstrated effective operation in a wide range of network dynamics or states.

II. Applications in MANET

MANET operating as a stand-alone network or with one or multiple points of attachment to cellular networks or the Internet covers the way for numerous new and exciting applications. Application [5, 2] scenarios include, but are not limited to emergency and rescue operations, conference or campus settings, car networks, personal networking. The applications of ad hoc network are mentioned below in details:-

A. Tactical networks

- Military communication and operations
- Automated battlefields

B. Emergency services

- Search and rescue operations
- Disaster recovery
- Replacement of fixed infrastructure in case of environmental disasters
- Policing and fire fighting
- Supporting doctors and nurses in hospitals

C. Commercial and civilian

- E-commerce: electronic payments anytime and anywhere Environments
- Business: dynamic database access, mobile offices
- Vehicular services: road or accident guidance, transmission of road and weather conditions, taxi cab network, inter-vehicle networks
- Sports stadiums, trade fairs, shopping malls
- Networks of visitors at airports

D. Home and enterprise networking

- Home/office wireless networking
- Conferences, meeting rooms
- Personal area networks (PAN), Personal networks (PN).
- Networks at construction sites.

E. Education

- Universities and campus settings
- Virtual classrooms
- Ad hoc communications during meetings or lectures

F. Entertainment

- Multi-user games
- Wireless P2P networking
- Outdoor Internet access
- Robotic pets
- Theme parks

G. Sensor networks

- Home applications: smart sensors and actuators embedded in consumer electronics
- Body area networks (BAN)
- Data tracking of environmental conditions, animal movements, chemical/biological detection

III. MANET Advantages

Despite the many design constraints, mobile ad hoc networks offer numerous advantages [6, 2]. First of all, this type of network is highly suited for use in situations where a fixed infrastructure is not available, not trusted, too expensive or unreliable. Because of their self-creating, self-organizing and self-administering capabilities, ad hoc networks can be rapidly deployed with minimum user intervention. There is no need for detailed planning of base station installation or wiring. Also, ad hoc networks do not need to operate in a stand-alone fashion, but can be attached to the Internet, thereby integrating many different devices and making their services available to other users. Furthermore, capacity, range and energy arguments promote their use in tandem with existing cellular infrastructures as they can extend coverage and interconnectivity. As a consequence, mobile ad hoc networks are expected to become an important part of the future 4G architecture, which aims to provide pervasive computer environments that support users in accomplishing their tasks, accessing information and communicating anytime, anywhere and from any device.

IV. Challenges in MANET

Regardless of the attractive applications, the features of MANET introduce several challenges that must be studied carefully before a wide commercial deployment can be expected. These include [7, 8]:

A. Routing:

Since the topology of the network is constantly changing, the issue of routing packets between any pair of nodes becomes a challenging task. Most protocols should be based on reactive routing instead of proactive. Multi cast routing is another challenge because the multi cast tree is no longer static due to the random movement of nodes within the network. Routes between nodes may potentially contain multiple hops, which is more complex than the single hop communication.

B. Security and Reliability:

In addition to the common vulnerabilities of wireless connection, an ad hoc network has its particular security problems due to e.g. nasty neighbor relaying packets. Further, wireless link characteristics introduce also reliability problems, because of the limited wireless transmission range, the broadcast nature of the wireless medium (e.g. hidden terminal problem), mobility-induced packet losses, and data transmission errors.

C. Quality of Service (QoS):

Providing different quality of service levels in a constantly changing environment will be a challenge. The inherent stochastic feature of communications quality in a MANET makes it difficult *to* offer fixed guarantees on the services offered to a device. An adaptive QoS must be implemented over the traditional resource reservation to support the multimedia services.

D. Inter-networking:

In addition to the communication within an ad hoc network, inter-networking between MANET and fixed networks (mainly IP based) is often expected in many cases. The coexistence of routing protocols in such a mobile device is a challenge for the harmonious mobility management.

E. Power Consumption:

For most of the light-weight mobile terminals, the communication-related functions should be optimized for lean power consumption. Conservation of power and power-aware routing must be taken into consideration.

F. Location-aided Routing:

Location-aided routing uses positioning information to define associated regions so that the routing is spatially oriented and limited. This is analogous to associatively-oriented and restricted broadcast in ABR.

V. Energy Efficiency Issue

The major task is energy consumption measurement and according to threshold energy level new route discovery process generation [4]. Ad hoc wireless networks are energy 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, possible node energy consumption should be balanced in order to increase the energy awareness of networks and find out the scheme has been proposed that utilizes energy status of each mobile node and alternate paths. Energy efficiency can be improved in two different ways:

Reducing the energy used for active communication activities and reducing the energy spent during an inactive period.

Firstly we set initial energy of each node ex. 100 joules and energy consumption parameter like

- Energy consumed while nodes sending a packet.
- Energy consumed while nodes receiving a packet.
- Energy consumed while nodes in idle mode.
- Energy consumed while nodes in sleep mode.

A few reasons for energy efficient routing in MANET:

- 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.

VI. Routing Protocols

Routing [9, 10, 11] is necessary to deliver the data in between sender to destination. The routing protocols can be done via the type of cast property. The different types of routing protocols are mentioned below:-

A. Unicast Routing

A primary goal of Unicast Routing Protocols is the correct and efficient route establishment and maintenance between a pair of nodes, so that messages may be delivered reliably and in a timely manner. MANET characteristics make the direct use of these protocols infeasible. MANET Routing Protocols must operate in networks with highly dynamic topologies where routing algorithms run on resource-constrained devices. MANET Routing Protocols are typically subdivided into two main categories: proactive routing protocols and reactive routing protocols.

1) Proactive Routing

Proactive routing protocol is the constant maintaining of a route by each node to all other network nodes. The route creation and maintenance are performed through both periodic and event-driven messages. The various proactive protocols are Destination- Sequenced Distance-Vector (DSDV) [12], Optimized Link State Routing (OLSR) [13].

2) Reactive Routing

With these protocols, to reduce overhead, the route between two nodes is discovered only when it is needed. There are different types of reactive routing protocols such as Ad Hoc

On-Demand Distance Vector (AODV) [14], Dynamic Source Routing (DSR) [15].

3) Hybrid Protocols

In addition to proactive and reactive routing protocols, another class of Unicast Routing Protocols that can be identified is hybrid protocols. The Zone-Based Hierarchical Link-State Routing Protocol (ZRP) [16] is an example of a hybrid protocol that combines both proactive and reactive approaches, thus trying to bring together the advantages of the two approaches. ZRP defines around each node a zone that contains the neighbors within a given number of hops from the node. Proactive and reactive algorithms are used by the node to route packets within and outside the zone, respectively.

VII. LITERATURE SURVEY

In 2012 In 2012 Peyman Arebi [17] proposes a novel method based on energy estimation to restore broken links and reconstruct the paths of them. So investigate Effect of broken links on topology control and routing process in Ad Hoc network. It was indicated that these effects were harmful in the mentioned couple of network portions. This work has been used Hardware Method for estimation energy in ad hoc node, so this method has a high speed and finally find out the or Investigating the effect of link break on ad hoc network, one may find out that both routing algorithms and also topology control will be negatively affected and, in some cases, the entire network is disorder. These effects may cause to some serious problems in data transferring and efficiency of different parts of network. For this purpose a strategy was made in order to prevent link break and disordering. This strategy could give some suggestions to route the network through prediction and time estimation of link break.

In 2009 by Mansoor-uz-Zafar Dawood,Noor Zaman,Abdul Raouf Khan,Mohammad Salih [18] provide an effort in designing of energy efficient Wireless Sensor Network (WSN) routing protocol, under certain parameters consideration. Research report discusses various existing WSN routing protocols and propose a new Location Aware (LA) WSN energy efficient routing protocol and finally has been proposed a new Location Aware LA WSN protocol and results show a great improvement in energy enhancement and WSN life cycle.

In 2011 by Nicola Costagliola · Pedro Garçia López · Francesco Oliviero · Simon Pietro Romano [19] discuss how we improved the *MChannel* group communication middleware for Mobile Ad-hoc Networks (MANETs) in order to let it become both delay- and energy-aware. MChannel makes use of the Optimized Link State Routing (OLSR) protocol, which is natively based on a simple hop-count metric for the route selection process. Based on such metric, OLSR exploitsDijkstra's algorithm to find optimal paths across the network and added a new module to MChannel, enabling unicast routing based on two alternative metrics, namely end-to-end delay and overall network lifetime. With such new module, we prove that network lifetime and average end-to-end delay improves, compared to the original OLSR protocol implementation included in the mentioned middleware and finally have evaluated and proposed two extensions of the OLSR protocol aimed at considering the mentioned metrics.

In 2012 by Sofy Harold and A. Vija Y Alakshmi proposed [20] a new reliable protocol called Enhanced Power Control MAC Protocol for Wireless Ad Hoc Networks (EPCMAC) the key concept of this EPCMAC protocol is to improve the throughput and to save energy by sending all the packets with optimal transmit power. This communication approach promises improved throughput and delay performance by effective use of spatial diversity in wireless ad hoc networks. Also, the power of the data packets is periodically raised to a suitable level but not to the maximum so that it will avoid interference and unnecessary contention between nodes.

In 2009 by Mohammad A. Mikki [21] introduce an Energy Efficient Location Aided Routing (EELAR) Protocol for MANETs that is based on the Location Aided Routing (LAR). EELAR makes significant reduction in the energy consumption of the mobile nodes batteries by limiting the area of discovering a new route to a smaller zone. Thus control packets overhead is significantly reduced. To show the efficiency of the proposed protocol we present simulations using NS-2. Simulation results show that EELAR protocol makes an improvement in control packet overhead and delivery ratio compared to AODV, LAR, and DSR protocols and say about the conclusion an Energy Efficient Location Aided Routing Protocol (EELAR) that is an optimization to the Location Aided Routing (LAR). EELAR makes significant reduction in the energy consumption of the mobile nodes batteries through limiting the area of discovering a new route to a smaller zone. Thus control packets overhead is significantly reduced and the mobile nodes life time is increased.

In 2011 by Wei Liu, Chi Zhang, Guoliang Yao and Yuguang Fang introduce the [22] addresses energy conservation, a fundamental issue of paramount importance in heterogeneous mobile ad hoc networks (MANETs) consisting of powerful nodes (i.e., P-nodes) as well as normal nodes (i.e., B-nodes). By utilizing the inherent device heterogeneity, we propose a cross-layer designed Device-Energy-Load Aware Relaying framework, named *DELAR*, to achieve energy conservation from multiple facets, including power-aware routing, transmission scheduling and power control and present a multi-packet transmission scheme to improve the end-to-end delay performance.

In 2011 by Nini Wei,Yi Song [23] introduce a new energy-aware routing policy based on dynamic priority factor named EDSR for ad hoc is proposed, which is based on the classic DSR (the routing protocol on demand). Simulation with the NS2 then compared with the on-demand routing DSR from the energy-consuming and the number of remaining nodes, the performance superior to the traditional DSR protocol. The EDSR routing which spends less energy and own larger link capacity, be synthetically analyzed and then selected, so it can save more energy, delay the network split. The EDSR routing which spends less energy and own larger link capacity, be synthetically analyzed and then selected, so it can save more energy, delay the network split**.**

In 2011 by Ajina [24] propose an energy efficient-power aware routing algorithm where integrated energy efficient with power awareness parameters for routing of packets and finally control the early depletion of energy in the network and also increase the network life.

In WSN, the main task of a sensor node is to sense data [25] and sends it to the base station in multi hop environment for which routing path is essential. The design of routing protocols for WSNs must consider the power and resource limitations of the network nodes, the time-varying quality of the wireless channel, and the possibility for packet loss and delay.

The Conditional Max-Min battery capacity routing (CMMBCR) [26] protocol utilizes the idea of a threshold to maximize the lifetime of each node and to fairly use the battery fairly. If all nodes in some possible routes between a source-destination pair have larger remaining battery energy than the threshold, the min-power route among those routes is chosen [27]. If all possible routes have nodes with lower battery capacity than the threshold, the max-min route is chosen. CMMBCR protocol selects the shortest path if all nodes in all possible routes have adequate battery capacity (i.e. the greater threshold). When the battery capacity for some nodes goes below a predefined threshold, routes going through these nodes will be avoided, and therefore the time until the first node failure, due to the exhaustion of battery capacity is extended. By adjusting the value of the threshold, we can maximize either the time when the first node powers down or the lifetime of most nodes in the network [28].

SPAN: An energy-efficient coordination algorithm for topology maintenance [29] is a distributed synchronization technique for multi hop ad hoc wireless networks that minimizes energy consumption without notably diminishing the connectivity of the network. SPAN coordinates the “stay-awake and sleep” cycle of the nodes and also performs multi-hop packet routing within the ad hoc network, while other nodes remain in power saving mode and periodically check if they should remain awaken and become a coordinator.

SPAN adaptively elects coordinators by allowing each node to use a random back-off delay to decide whether to become a coordinator in the network and rotates them in time. The back-off delay for a node is a function of the number of other nodes in the neighborhood and the amount of energy left in these nodes. This technique not only preserves network connectivity, it also preserves capacity, decreases latency and provides significant energy savings. The amount of energy saving provided by SPAN increases only slightly as density decreases. Current implementation of span uses the power saving features, since the nodes practically wake up and listen for traffic advertisements [27].

PAMAS [30] is an extension to the AODV protocol; it uses a new routing cost model to discourage the use of nodes running low on battery power. PAMAS also saves energy by turning off radios when the nodes are not in use. Results show that the lifetime of the network is improved significantly. There is a trivial negative effect on packet delivery fraction and delay, except at high traffic scenarios, where both actually improve due to reduced congestion. Routing load, however, is consistently high, more at low traffic scenarios. For the most part,

PAMAS demonstrates significant benefits at high traffic and not-so-high mobility scenarios. Although, it was implemented on the AODV protocol, the technique used is very standard and can be used with any on-demand protocol. The energy-aware protocol works only in the routing layer and exploits only routing-specific information [31].

Geographical adaptive fidelity (GAF) protocol [32], [33] reduces energy consumption in ad hoc wireless networks; it is used for extending the lifetime of self-configuring systems by exploiting redundancy to conserve energy while maintaining application fidelity. By identifying nodes that are equivalent from a routing perspective and then turning off unnecessary nodes, maintaining a constant level of routing fidelity, this protocol is able to conserve energy.

GAF also uses application-and system-level information; nodes that source or sink data remain on and intermediate nodes monitor and balance energy use. GAF is independent of the underlying ad hoc routing protocol; simulation studies of GAF show that it can consume 40% to 60% less energy than other ad hoc routing protocol. Also, network lifetime increases proportionally to node density [27].

The Prototype Embedded Network (PEN) protocol [23] exploits the low duty cycle of communication activities and powers down the radio device when it is idle. Nodes interact asynchronously without master nodes and thus, the costly master selection procedure as well as the master overloading problem can be avoided. But in order for nodes to communicate without a central coordinator, each node has to periodically wake up, make its presence by broadcasting beacons, and listens a moment for any communication request before powering down again. A transmitting source node waits until it hears a beacon signal from the intended receiver or server node. Then, it informs its intention of communication during the listening period of the server and starts the communication. Due to its asynchronous operation, the PEN protocol minimizes the amount of active time and thus saves substantial energy. However, the PEN protocol is effective only when the rate of interaction is fairly low, thus more suited for applications involving simple command traffic rather than large data traffic.

VIII. Conclusion & Future Work

A mobile ad hoc network (MANET) consists of autonomous mobile nodes, each of which communicates directly with the neighbor nodes within its radio range or indirectly with other nodes in a network. In order to facilitate reliable communication within a MANET, an efficient routing protocol is required to discover routes between mobile nodes. The field of MNAETs is rapidly growing due to the many advantages and different application areas. Energy efficiency is a challenge faced in MANETs, especially in designing a routing protocol. In this paper, we surveyed a number of energy efficient routing protocols and in many cases, it is difficult to compare these protocols with each other directly since each protocol has a different goal with different assumptions and employs mechanisms to achieve the goal. According to the study, these protocols have different strengths and drawbacks. A routing protocol can hardly satisfy all requirements. In other words, one routing protocol cannot be a solution for all energy efficient protocol that designed to provide the maximum possible requirements, according to certain required scenarios.

In future we try to design a new procedure that reduces the energy consumption and increases the energy utilization of nodes in network.

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