Paper Survey of Different Energy Efficient Schemes in Wireless Ad hoc Network

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Abstract— Energy efficient routing may be the most important design criteria for Mobile Ad hoc Network (MANET), since mobile nodes will be powered by batteries with limited capacity. Power failure of a mobile node not only affects the node itself but also its ability to forward packets on behalf of others and thus the overall network lifetime. This paper addresses the problem of energy-efficient and aware data routing strategies within the Wireless Ad hoc Networks using directional antennas and considers the battery power of each node as an important criteria while determining the route for data packet transmission. Energy depletion of nodes in Wireless Ad hoc Networks is one of the prime concerns for their sustained operation. Conventional routing strategies usually focus on minimizing the number of hops or minimizing route errors from the source node to the destination node. But they do not usually focus on the energy depletion of the nodes. Thus, the same node may be selected repeatedly, thereby causing its early depletion in energy. In this survey the research has done on the basis of efficient energy consumption and if a node in the network has heavily depleted its battery power, then an alternative node would be selected for routing so that not only the power of each node is used optimally.

Index Terms—*WANET, Routing, Energy, Network life time*

I. INTRODUCTION

Wireless Ad hoc mobile network (WANET) is designed to overcome the natural limitation of these wired backbone networks and infrastructure-based wireless networks [1]. Ad hoc mobile wireless networks are 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. Restricted by transmission range, each mobile node can only communicate with neighboring nodes within its radio coverage area [2].

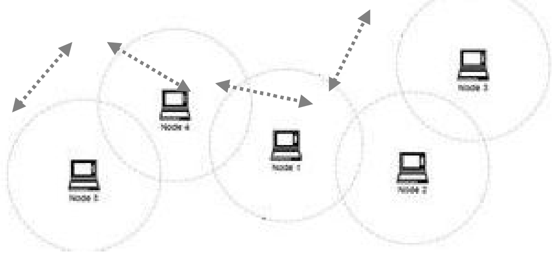

Fig. 1 Mobile Ad hoc Network

In MANET lacking of centralized framework cause on Wireless Ad hoc Network to have not a clear and special topology. In addition, an important activity in Wireless Ad hoc Networks determines a topology using high level routing protocols. Wireless Ad hoc Network nodes in most portable devices, limited by the size of the battery-powered, the whole network is an energy-limited system, to save the energy of nodes as much as possible and to maximize the total battery life of a Wireless Ad hoc Network [3] and we must minimize the energy consumption of the entire network. This is particularly important in emergency rescue, military operations, business meetings and other situations. From this perspective, the shortest route is not necessarily the best route. On the contrary, with some shortest hop configurations to replace the relatively long jump configurations may be better energy-saving choices available [4]. In a Wireless Ad hoc Network, one of the major concerns is how to decrease the power usage or battery depletion level of each node among the network so that the overall lifetime of the network can be stretched as much as possible. So while the data packets are sent from source to destination, special routing strategies need to be adopted to minimize the battery depletion level of the intermediate nodes. This paper addresses the problem of energy-efficient and power aware data routing strategies within the Wireless Ad hoc Networks using directional antennas and considers the battery power of each node as an important criteria while determining the route for data packet transmission. Conventional routing strategies usually focus on minimizing the number of hops or minimizing route errors from the source node to the destination node. But they do not usually focus on the energy depletion of the nodes. Thus, the same node may be selected repeatedly, thereby causing its early depletion in energy.

II. DESCRIPTION OF ROUTING PROTOCOLS

A routing protocol maintains the network topology for a Wireless Ad hoc Network. If a link breaks [3], routing protocols has the responsibility to repair that link in order to maintain the consistency of the network. Different routing protocols have various strategies to repair a broken link. The repair strategy is quite specific to each strategic routing protocol; therefore it is quite hard to analyze the pros and cons of each protocol. What we can do is to find the link break probabilities of different categories of routing protocols since the problem greatly influence the efficiency of a routing protocol. We will analyze the link break problem, the influence of the problem on each categories of routing protocol, and the incurred routing table update to them. The categories of most popular routing protocols, table-driven, on-demand and hybrid routing protocols, are discussed in this article [5, 6].

a. Proactive (Table-Driven)

The pro-active routing protocols are the same as current Internet routing protocols such as the Routing Information Protocol, Distance-Vector, Open Shortest Path First and link-state. They attempt to maintain consistent, up-to-date routing information of the whole network. Each node has to maintain one or more tables to store routing information, and response to changes in network topology by broadcasting and propagating. Some of the existing pro-active ad hoc routing protocols are: Destination Sequenced Distance Vector (DSDV), Wireless Routing Protocol (WRP).

b. Reactive (Source-Initiated On-Demand Driven)

These protocols try to eliminate the conventional routing tables and consequently reduce the need for updating these tables to track changes in the network topology. When a source requires to a destination, it has to establish a route by route discovery procedure, maintain it by some form of route maintenance procedure until either the route is no longer desired or it becomes inaccessible, and finally tear down it by route deletion procedure. In pro-active routing protocols, routes are always available (regardless of need), with the consumption of signaling traffic and power. Some of reactive routing protocols are Ad hoc On-Demand Distance Vector (AODV), Dynamic Source Routing (DSR).

c. Hybrid protocols

Hybrid protocols combine the features of reactive and proactive protocols. These protocols have the advantage of both proactive and reactive routing protocols to balance the delay which was the disadvantage of Table driven protocols and control overhead (in terms of control packages). Main feature of Hybrid Routing protocol is that the routing is proactive for short distances and reactive for long distances. The common disadvantage of hybrid routing protocols is that the nodes have to maintain high level topological information which leads to more memory and power consumption. Examples: ZRP (Zone Routing Protocol).

d. Description of AODV Routing Protocol

Ad hoc On Demand Distance Vector (AODV) [7] is source initiated reactive protocol. It discovers and maintains routes only if and when necessary. Route discovery works as follows. When the source requires a path to a particular destination, it broadcasts a route request (RREQ) packet in the Wireless Ad hoc Network. Nodes receiving RREQ record a *reverse* route back towards the source, using the node from which the RREQ was received as the next-hop, and then re-broadcasts the RREQ. If the same RREQ is received more than once (via different routes), it is ignored. This way the RREQ packets are flooded to every node in the connected part of the network.

When the RREQ packet reaches the destination, it sends a route reply (RREP) packet back to the source, using the reverse route. If an intermediate node has an up-to-date route to the destination, it may also send a RREP packet back to the source on behalf of the destination. As the RREP packet follows the path back to the source, the corresponding *forward* route is created at each intermediate node towards the destination. Once the RREP packet reaches the source, data traffic can now flow along this forward route.

To prevent routing loops, AODV maintains a sequence number on each node. Any routing information transmitted on routing packets or maintained on a node is tagged with the last known sequence number for the destination of the route. AODV protocol guarantees the invariant that the destination sequence numbers in the routing table entries on the nodes along a valid route are always monotonically increasing. Other than preventing loops, sequence numbers also ensure freshness of routes. Given a choice of multiple routes, the one with a newer sequence number is always chosen.

An important feature of AODV is maintenance of timer based states in each node, regarding utilization of individual routes. A route is "expired" if not used recently. A set of predecessor nodes is maintained for each routing table entry, indicating a set of neighboring nodes that use that entry to route data packets. These nodes are notified with route error (RERR) packets when the next hop link breaks. Each predecessor node, in turn, forwards the RERR to its own set of predecessors, thus effectively erasing all routes using the broken link. This RERR is thus propagated to each source routing traffic through the failed link, causing the route discovery process to be reinitiated if routes are still needed.

III. DISCUSSION ABOUT ENERGY EFFICIENT ISSUE

In a cellular network, a reduction in the number of active mobile nodes will reduce the amount of signal interference and channel contentions. However, the mobile nodes in Wireless Ad hoc Network need to relay their packets through the other mobile nodes toward the intended destinations, a decrease in the number of participating mobile nodes may lead to the network disconnected, thereby hurting the performance of the network. To prolong the lifetime of each mobile node in the network [8] as well the entire network itself, an ad hoc routing should take into account both the energy consumption at each mobile node and the total energy consumption for each connection request carefully. The effect of using it for a longer period is that the energy of the nodes along the chosen path may be quickly exhausted. If the node's energy is quickly exhausted that may result in the network being partitioned affecting the information delivery even though there might still be enough energy to some of the nodes. Therefore, energy should always be considered during energy-awareness routing that confirm the guaranty of nodes with low energy in the network stay alive. The energy consumption parameters [8] are drain the network energy is as follows:

1. Energy drains when packet sends in network.
2. Energy drains when packets receive in network.
3. Energy drains when nodes are sensing in network.
4. Energy drains when nodes are in idle mode.

Energy consumption measurements studies, determine the power consumption patterns in the different active modes. However, these studies did not directly address cases of repeated resending of control packets that may happen due to glitches in the transmission operations over the wireless communication channels. The retransmission is not in the favors of idle battery consumption.

Energy saving is important and necessary. Therefore it is imperative that at any moment some specific number of nodes be a live (sufficient energy for communication) and the rest remain is in sleep mode. We keep number of live nodes in desirable way, so network lifetime will be prolonging by far. If live nodes can cover desirable level of network, less number of live nodes will be required in total network and will not be the empty space of live node. The balancing of energy consumption of nodes are aware the network about the energy status of nodes. Therefore the energy consumption is reduces

IV. Route Maintenance in MANET

The dynamic nature of WANET is not provides the reliable connection and link breakage because of insufficient energy it means Route maintenance [9] is needed for two reasons:

Mobility

Connections between some nodes on the path are lost due to their movement. The nodes in network are having fixed movement by that not possible to observe the prediction of connection maintainability in network.

Energy Depletion

The energy resources of some nodes on the path may be depleting too quickly. In the first case, a new RREQ is sent out and the entry in the route cache corresponding to the node that has moved out of range is purged. In the second case, there are two possible approaches: semi-global and local.

Semi-global Approach:

The source node periodically polls the remaining energy levels of all nodes in the path and purges the corresponding entry in its route cache when the path cost increases by a fixed percentage. Notice that this results in very high overhead because it generates extra traffic.

Local Approach:

Each intermediate node in the path monitors the decrease in its remaining energy level (and hence increase in its link cost) from the time of route discovery as a result of forwarding packets along this route. When this link cost increase goes beyond a threshold level, the node sends a route error back to the source as if the route was rendered invalid. This route error message forces the source to initiate route discovery again. This decision is only dependent on the remaining battery capacity of the current node and hence is a local decision.

V. Previous Research Done So Far

In MANET, power aware is important challenge issue to improve the communication energy efficiency at individual nodes. Most of the researchers have recently started to consider power-aware development of efficient protocols for WANET is discussed below:-

In this paper [10], considers energy efficiency, reliability, and prolonging the network lifetime in wireless ad hoc networks holistically. We propose a novel energy-aware routing algorithm, called Reliable Minimum Energy Cost Routing (RMECR). RMECR finds energy efficient and reliable routes that increase the operational lifetime of the network. In the design of RMECR, we use an in depth and detailed systematic imitation of the energy consumption of nodes. To this end, reliability and energy cost of routes must be considered in route selection. The key point is that energy cost of a route is related to its reliability.

In this paper [11] the work is divided two parts named as destination location estimation module and node energy aware methodology that all together improve the efficiency of the network. In first, proposed energy aware technique provides the information of remaining energy level of each node and in second one the destination node provide periodically distance information to the source node .On the basis of that information source node enquiry or broadcast packet onto the specific direction and minimize the routing load.

A scalable routing protocol called LAER [12], based on the joint metric of link stability and energy drain rate, has been proposed. It is based on the local topology knowledge and it makes use of a greedy technique based on a joint metric and a modified perimeter forwarding strategy for the recovery from local maximum. Indeed, the transmission and reception operations, associated with data and control packets, are more computational expensive in comparison with the operations associated with the links ordering. This is particularly true in the case of MANET, where the node density, defined as the number of neighbor nodes, is very limited

This paper [13] proposed standard specifically designed for WMN, the IEEE 802.11s does not consider energy conservation as a priority in its protocol. The main goal of this research therefore is to minimize the total transmission energy consumed for a packet to reach the intended destination. However, the usual approach of selecting the shortest path when routing packets may drain out the energy of the nodes along the chosen paths. Using this kind of an approach may halt the delivery information in the long run causing network partitioning even though there are network nodes with enough energy for transmission. Therefore we introduced an energy optimization based path selection algorithm for IEEE 802.11s WMNs that will maximize the network lifetime. The proposed energy optimization based path selection algorithm provides a balanced energy spending among nodes which therefore maximizes the network lifetime. The balanced energy spending will reduce the amount of workload which is usually given to other nodes which are unfairly burdened to support many packet-relaying functions.

In this paper [14] there are two main ideas of energy-saving routing algorithms for Ad hoc routing protocols. The first one is to send each packet with minimum energy-consuming. The second is to maximize the network lifetime as much as possible. These two ideas are considered relatively independent of one another, the intention is to combine these two ideas, and to therefore maximize the network's lifetime and minimize energy consumption. Additionally this paper intends to show a new energy model, which will ensure that all the nodes are balanced in their energy consumption and too prolong the network's lifetime.

This paper [15] has focus on the heterogeneous Wireless Ad hoc Networks, where most nodes, denoted as *B-nodes*, are equipped with limited power sources like batteries, while some other nodes, denoted as *P-nodes*, have relatively unlimited power supplies, e.g., power scavenging units such as solar cells, or dynamos when they are installed in mobile vehicles, etc. First, following the cross-layer design philosophy, we propose a Device-Energy-Load Aware Relaying framework, named *DELAR*, to achieve energy conservation by utilizing the inherent heterogeneity of nodal power capabilities. Second, we design a hybrid transmission scheduling scheme, combining both the reservation-based and contention based medium access control schemes, to coordinate the transmissions among P-nodes and B-nodes, which attempts to make the best use of powerful nodes while controlling their interferences to other ongoing transmissions. Third, we develop "mini-routing" and asymmetric MAC (*A-MAC*) protocols to support the MAC layer acknowledgements over unidirectional links due to the use of asymmetric transmission power levels between P-nodes and B-nodes.

In this paper [16] proposed protocol Energy Reduction Aware Multicast (ERAM) aimed to find a path which utilizes the minimum energy to transmit the packets between the source and the destination. The required energy for the transmission and reception of data is evaluated at the MAC layer. The network layer makes use of it to find the minimum energy path. ERAM is implemented on Multicast Ad hoc On Demand Distance Vector Routing Protocol (MAODV) to manage the energy consumption in the transmission and reception of data. The computed power is utilized in the network layer to find the optimal path which uses the minimum power to transmit data between the source and the destination.

The amount of energy that is being consumed by the network also determines how long the network can work A probability function in energy-aware routing is used as a means of choosing suboptimal paths. This technique is also dependent on the amount of energy consumed in each path in the network [3]. The work in [17] states that choosing the shortest path might not be the best option as it may cause an energy dissipation of nodes in that path. An alternative to the use of a minimum path, multiple paths are available to route from the source node to the intended destination node. For the network lifetime to be prolonged, one among the many available paths is used with a certain probability. To advance the energy efficiency of an energy-unaware path localized rerouting techniques were proposed and presented in [3]. The above presented energy efficient routing protocol techniques can perform well in terms of energy conservation. To achieve that, neighborhood knowledge at nodes is required. The work presented in [18] shows that substantial amount of resources can be consumed in dynamic networks to update and gather the information for the node's neighbors.

In this paper the XTC topology control algorithm [19] works without either location or directional information. The algorithm has three phases. In first one each node broadcast at maximum power. Then it ranks its entire neighbor depending upon its link quality to it. The link quality could be the Euclidean distance, signal attenuation or packet arrival rate depending on various situations. In second steps each node transmits its ranking results to neighboring nodes. In the final one, each node examines the ranking results of its neighbors. Depending upon this result it select neighbor to be linked directly. The XTC algorithm follows both symmetry and connectivity feature of topology control.

VI. PROBLEM FINDING DUE TO ENERGY LOSS

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. Mobile nodes in MANETs are battery driven. Thus, they suffer from limited energy level problems. Also the nodes in the network are moving if a node moves out of the radio range of the other node, the link between them is broken. Thus, in such an environment there are two major reasons of a link breakage:

Node dying of energy exhaustion
Node moving out of the radio range of its neighboring node.

VII. Conclusion & Future Work

The main concept of the previous work is to find the multiple node disjoint routes from source to a given destination. The routes selected are such that all the links of the routes are highly stable. This will increase the lifetime of the route. Current focus in energy-aware routing is to know the energy level of nodes and to include the value into route optimization process. However mobile devices in Wireless Ad hoc Network are required to do multiple tasks, such as internal computation, data sending/receiving, and data forwarding. Therefore the absolute value of energy on a node has different meaning for each node. The different approaches uses the different techniques based on the minimum energy consumption of mobile nodes in network.

- The previous research does not represent the energy calculation of mobile nodes and also not provides the information of energy of the node mobility that affects the energy consumption.
- The research has calculated the per packet energy consumption but for considered range this energy is sufficient.
- The calculation of energy utilized by nodes is not mentioned in any research.

The survey has identified some drawbacks and provides the new innovative thought to do something new in field of energy efficient routing in MANET. This research has also advantage to proposed new scheme in field of energy and the new energy saving research can be proposed, to provide better network performance with enhancement of network life time.

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