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Dynamic Transmission Power Assignment for Energy Conservation Routing in MANETs

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Abstract—Wireless networks are formed by the devices that run on batteries, having limited amount of energy. Different actions of the nodes like transmitting, receiving, processing etc consume available energy. In order to increase the system's life-time, energy consumption has to be minimized. The Power Assignment Minimum expected energy and reliable routing Algorithm (abbreviated as PAMEERR) is used to present reliable energy efficient routing mechanism that integrate the energy efficient routing and power assignment into one scheme. PAMEERR varies the transmission power of the packet according to the distance of the destination node from transmitting node. PAMEERR is applied for static wireless ad hoc networks. This Paper Proposes Dynamic Transmission Power Assignment for Energy conservation routing (abbreviated as DPAECR) in MANETs. DPAECR updates the transmission power for every packet transmission. For the purpose of energy conservation, each node can dynamically adjust its transmitting power based on the distance of the receiving nodes.

Keywords- MANETs, Energy Efficient Routing, Power Aware Routing, Network Lifetime, Optimal power Assignment

I. INTRODUCTION

Wireless communication networks have been deployed at an increasingly fast rate, and are expected to reshape the way we live in this physical world. In many scenarios, design of wireless communication protocols is guided by two requirements - energy efficiency and resilience to packet losses. Efficiently handling losses in wireless environments, therefore, assumes central importance.

Even under benign conditions, various factors, like fading, interference, multi-path effects, and collisions, lead to heavy loss rates on wireless links. There are two well-known ways to achieve end-to-end reliability on multi-hop paths. The first approach employs hop-by-hop retransmissions. Each link layer hop retransmits lost frames as and when necessary. The second approach assumes that link layers are unreliable and retransmissions are performed *end-to-end*. It is also possible to consider a mix of the above as a third approach, where link layers perform a few retransmissions if necessary, but perfect reliability is only guaranteed through end-to-end mechanisms. Traditional power aware routing schemes do not take link loss rates into account when computing energy efficient paths. By ignoring the impact of such losses, they implicitly assume that every link is totally reliable. That paradigm is

obviously too optimistic, and retransmissions consume power as well. In order to achieve better energy efficiency in realistic scenarios, the right metric should be the cumulative energy consumption due to all packet transmissions including retransmissions. Obviously, one can increase the transmission power to improve the link reliability and consequently reduce the retransmission times potentially.

However, this is not free: we do consume more power for single transmission. In this paper, we seek the balance of the smaller transmission power and lower link error rate.

The paper is organized as follows: Section 2 gives the related work of Energy Conservation, Section 3 presents the existing system and its drawbacks, and Section 4 presents the proposed system with the support of results presented in section 5. Section 6 concludes the paper.

II. RELATED WORK

Energy efficient routing has always been a central research topic in wireless networks, both in the paradigm of multicast/broadcast and in the paradigm of unicast. In both paradigms, our objective is to design a routing scheme such that the total transmission power is minimized. In this paper, we study the paradigm of unicast and refer interested readers to the literature for more knowledge on energy efficient multicast/broadcast routing.

By using Dijkstra's shortest path algorithm, PAMAS finds a minimum cost path where the link cost is set to the transmission power. If every link in the paths is error free, then a single transmission over each link can successfully deliver a packet from the source to its destination with minimum energy consumption.

Scott and Bamboos studied the case where link costs include power consumption on the receiver side, and proposed to find energy efficient paths using a modified form of the Bellman-Ford algorithm.

Some researchers have considered power aware routing in an alternative approach. The residual battery power is used as a routing metric, in order to achieve a more balanced distribution of power consumption among

all the nodes so that the lifetime of the whole system may be increased. From our perspective, these schemes may result in less energy efficient routes.

Unfortunately, none of these previous papers considered the lossy property of wireless links. Banerjee and Misra explored the effect of lossy links on energy efficient routing and solved the problem of find minimum energy paths in the hop-by-hop retransmission model.

Rodoplu and Meng proposed the method of reducing the number of edges while maintaining network connectivity and, in addition, preserving all minimum-energy paths. A minimum-energy path between two nodes u and v is defined as the shortest path between u and v , using transmission power as edge cost.

Srinivas and Modiano investigate the problem of minimum energy node/link disjoint paths routing in multi-hop wireless networks. Clearly, such schemes result in increased energy consumption, compared with the minimum energy single path. Moreover, they do not provide guaranteed delivery, either. Again, none of them explicitly considers link error rates. Transport protocols have also been proposed to provide reliable communication over unreliable wireless links. Unlike routing protocols, transport protocols do not pay attention to route selection hence are beyond the scope of this paper.

III. MINIMUM EXPECTED ENERGY AND RELIABLE ROUTING

An GAMER protocol uses remaining battery capacity of each host as a metric to describe the lifetime of each host.

$$f_i(c_i^t) = \frac{C_i}{P_i^t}$$

Where, $f_i(c_i^t)$ is a Battery cost function of a node n_i , P_i is the Transmit power of the node and C_i is the Battery capacity at the appropriate node n_i .

Now, suppose a node's willingness to forward packets is a function of its remaining battery capacity. The less capacity it has, the more reluctant it is. As the battery capacity decreases, the value of cost function for node n_i will increase. The remaining battery cost R_j for route i is

$$R_j = \max f_i(c_i^t)$$

Where R_j is the Remaining battery cost function.

Therefore, to find a route with the maximum remaining battery capacity, we should select a route that has the minimum battery cost.

Thus Gamer selects the route according the remaining energies of the nodes in the network. PAMEERR (Power assignment Minimum expected energy and reliable routing) integrates the energy efficient routing and power assignment into one scheme by considering the link error rate as a certain function of the transmission power.

Optimal power assignment for every link such that the expected power consumption from the source node to every other node in the network is the minimum among all possible power assignment.

The minimum expected energy and reliable routing problem (abbreviated as MEERR) is, given the power $P(u,v)$ assigned to each link (u,v) and the corresponding link error probability $E(u,v)$, to find a route from the source node to the receiver such that the expected total energy used by all wireless nodes is minimized when either reliable link layer or reliable transport layer is implemented.

$$P(u, v) = p(u, v) / (1 - E(u, v))$$

Obviously, the final path found depends on the power $P(u, v)$ used by link (u, v) . Then, the problem of power control for reliable energy efficient is to find a power assignment $P(u,v)$ for each link (u,v) such that the minimum energy efficient reliable route from the source node to the receiver consumes the least expected energy among all possible power assignments.

Energy efficient routing (MEERR), which aims to find the minimum expected energy path from the source to the destination. They assume that transmission powers and link errors are fixed at each link. In this paper, we treat link error rate as a certain function of the transmission power, then consider a joint problem of power assignment and energy efficient routing (PA-MEERR), which aims to find a power assignment and a corresponding path such that the total expected energy consumption is minimized.

PAMEERR considers the transmission power of the nodes and energy levels remaining on the node. PAMEERR perform the optimal transmission power assignment for all nodes at only once. Since PAMEERR applied only for static wireless ad hoc networks. But in real world in most of the cases we use MANETs. This is the major disadvantage of the PAMEERR.

DPAECR is implemented in the MANETS. This overcomes the disadvantage of the PAMEERR. Here the Transmission power could be updated dynamically per packet. For the purpose of energy conservation, each node can dynamically adjust its transmitting power based on the distance of the receiving nodes. Energy conservation is better achieved by DPAECR from PAMEERR.

IV. DYNAMIC TRANSMISSION POWER ASSIGNMENT

PAMEERR considers the transmission power of the nodes while selecting a route. If a route having more energy nodes but the nodes having more transmission power, the rate of decrement of energy will also be high. The goal of energy conservation is not achieved here. So PAMEERR considers the nodes transmission power for routing.

The battery cost function of each host can be described as

$$f_i(c_i^t) = \frac{C_i}{P_{t_i}}$$

Where, $f_i(c_i^t)$ is a Battery cost function of a node n_i , P_i is the Transmit power of the node and C_i is the Battery capacity at the appropriate node n_i .

The remaining battery cost R_j for route i is

$$R_j = \max f_i(c_i^t)$$

Where R_j is the Remaining battery cost function.

Therefore, to find a route with the maximum remaining battery capacity, we should select a route i that has the minimum battery cost.

$$R_j = \min \{R_j | j \in A\}$$

Where, A is the set containing all possible routes.

DPAECR also uses per packet power calculation of the links and update the sender the required transmission power. Thus the sender updates its transmission power and sends the data packets using that power. The required transmission power is calculated as

$$P_{req} = P_t - P_{recv} + P_{margin}$$

After each node receives the data packet they calculate the required transmission power and update the sender by sending a reply packet. As the sender updates the required transmission power the energy utilization will be reduced.

DPAECR is an optimal solution that reduces the energy utilization further more and avoids the disadvantage of PAMEERR. PAMEERR uses per packet replies. This again increases the energy consumption. DPAECR reduces the replies by sending them on-demand.

Each node while forwarding the data packet, it adds its transmission power to the network header of the packet.

Forward (P)

START:

...

Network_header->Pt = myPt;

...

END.

When a node receives the data packet, it calculates the required transmission power.

$$P_{req} = P_t - P_{recv} + P_{margin}$$

If the required transmission power exceeds the threshold, it will send the reply packet. Otherwise it stays calm. This passive nature of the node reduces its energy consumption.

If $P_{req} > P_{threshold}$

SendACK (p);

Forward (p);

Else

Forward (p);

DPAECR uses the same routing principle of PAMEERR as it is quite efficient for route discovery. DPAECR modifies the route maintenance phase of PAMEERR making it more effective.

V. SIMULATION RESULTS

5.1 Simulation Specifications

OS	: Red hat Linux 9
Simulator	: NS2
Topology	: Wireless topology
Number of nodes	: 24
Radio Transmission Range	: 250m
Initial energies of nodes	: 3.0
Simulation time	: 40 sec
Area of the Network	: 1000m*1000m

5.2 Simulation Results

Network Simulator (NS2) is used for simulating the existing and proposed systems. NS2 is an IEEE standardized simulator for simulating Networks.

Consider different transmission powers for different nodes and compare the results for the GAMER, PAMEERR and DPAECR with respect to the remaining energy.

The Figure 1. Graph contains three routing protocols remaining energy levels. In the graph GAMER is represented by red line, PAMEERR is represented by green line and DPAECR is represented by blue line.

The simulation results in the Figure 1. show that the final remaining energies of the nodes for the DPAECR protocol is 68.4% greater than that of the GAMER protocol and 45.6% greater than PAMEERR. The drawback of PAMEERR protocol is overcome by DPAECR protocol.

VI. CONCLUSION

The problem of routing in a wireless ad-hoc network from the viewpoint of energy efficiency has been considered. Designing a good energy-efficient routing protocol for ad hoc wireless networks is a challenging task. First, the minimal power required to transmit data from one node to the next is hard to determine.

The problem of energy efficiency in routing is being attempted to solve in GAMER and the possible solutions MEERR and PAMEERR are developed. GAMER address the problem of route selection based on the remaining energies of the nodes in the network. PAMEERR varies the transmission power per packet so that the energy consumption in the nodes can be reduced.

These two protocols are considerably efficient among the power aware routing protocols existed. Again because of per packet replies, the energy conservation is not achieved efficiently. So we introduced DPAECR where the replies are sent on demand. The simulation results show that the final remaining energies of the nodes for the DPAECR

protocol is 68.4% greater than that of the GAMER protocol and 45.6% greater than PAMEERR. The drawback of PAMEERR protocol is overcome by DPAECR protocol.

More localized routing algorithms should be developed that find energy-efficient routes or topologies. To maximally reduce energy consumption, energy saving should be considered in every layer of the protocol. Recently, a few research groups have started to work on cross-layer energy-aware protocols for ad hoc wireless networks. Finally, more work on the development of power-efficient multicasting or broadcasting protocols should be done, especially localized protocols. An interesting sub area is power-efficient geocasting, where a packet is delivered to all nodes within a specific geographical region

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Figure1.Remaining Energy Levels of GAMER, PAMEERR, DPAECR protocols .