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A COMPLETE STUDY ON POWER AWARE ROUTING PROTOCOL FOR MOBILE ADHOC NETWORK

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***Abstract**: This paper presents a detailed analysis of recent work in power aware routing protocols in Mobile Ad hoc Networks (MANETs). Mobile nodes have limited battery life time, mobile networks should use battery power more resourcefully to increase the network life. The purpose of a routing protocol for MANETs is to support the transmission of packet from a source to all the destinations while trying to use the available bandwidth efficiently in the presence of continuous topology changes. However, offering power aware routing is a difficult and challenging task. This paper elaborates the review of various power aware routing protocols in addition to diverse metrics responsible for power optimization.*
***Keywords:** MANET, Network Simulator-2, Power-aware routing, Reactive protocol, Routing Protocols.*

I. INTRODUCTION

Mobile Ad Hoc networks are group of wireless mobile nodes connected with each other via radio waves without any central access point. Each node operates not only as a node, but also as a router to forward the packets. These networks are useful in any situation where impermanent network connectivity is needed, such as in emergency or rescue operations, disaster relief efforts, and military applications. In multi-hop wireless mobile ad-hoc networks, designing power aware routing protocols is important because nodes have inadequate power. However, it is also an inherently hard problem due to two important factors: First, the nodes are mobile; second, the dynamically changing topology. In ad hoc network, it wants a better routing protocol that considers more situations on ad hoc network at the same time. A better routing protocol not only increase life time of networks but also speed up data delivery between mobile nodes and consider limited energy of nodes.

Routing protocols can be broadly classified based on[1] when the power optimization is performed. A mobile node consumes its battery energy not only when it energetically sends or receives packets but also when it stays idle listening to the wireless medium for any possible communication requests from other nodes. Thus, power aware routing protocols reduce either the active communication power needed to transmit and receive packets or the power during inactive periods.

The active communication energy can be reduced by adjusting each node's radio power level to reach the receiving node but not more than that level. This transmission power control approach determines the optimal routing path that minimizes the total transmission power required to deliver packets to the destination. In the latter category, each node can save the inactivity power by switching into sleep/power-down mode or simply switch off when there is no data packet to transmit or receive. However, it needs well-defined routing protocol to data delivery even if most of the nodes sleep and do not forward packets for other nodes. Another important way to optimizing active communication power is load distribution approach. The main aim of the load distribution method is to balance the power usage in the network and to maximize the network lifetime by avoiding over-drained nodes when selecting a routing path.

Rest of the paper has been arranged as follows. Section II presents classification of routing protocols. Section III presents power aware routing protocols. Finally Section IV concludes the paper.

II. CLASSIFICATION OF ROUTING PROTOCOLS

MANET routing protocols are classified into three major categories: proactive, reactive and hybrid.

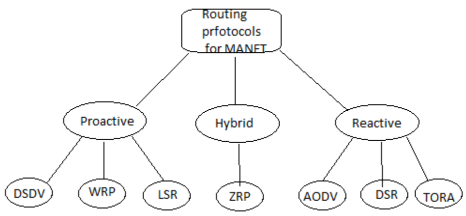

Fig 1: MANET Routing Protocols

2.1 Proactive Routing

These types of protocols are called table driven protocols in which, the information of the route to all the nodes is stored in routing table. Packets are transferred over the predefined route specified in the routing table. In this scheme, the packet forwarding is done faster but the routing overhead is higher because all the routes have to be defined before transferring the packets. Proactive protocols have lower latency because all the routes are maintained at all the times and it requires more memory. E.g. are DSDV, WRP and Optimized Link State Routing.

2.2 Reactive routing

It is also called on demand routing. It is more efficient than proactive routing. The main idea behind this type of routing is to find a route between a source and destination whenever that route is needed whereas in proactive protocols we were maintaining all routes without regarding its state of use. Discovering the route on demand avoids the cost of maintaining routes that are not being used and also controls the traffic of the network because it doesn't send excessive control messages. E.g. of Ad-hoc On Demand Distance Vector (AODV), Dynamic Source Routing (DSR).

2.3 Hybrid Routing

Hybrid protocols are the combinations of reactive and proactive protocols and takes advantages of these two protocols and as a result, routes are found quickly in the routing zone. E.g. ZRP (Zone Routing Protocol. The advantages and disadvantages of these protocols are shown in table.

TABLE 1: Comparison of routing protocols

Protocol	Advantage	Disadvantage
Proactive	Latency is reduced. Information is always available.	Routing information is flooded in the network. Overhead is high.
Reactive	Path available when needed overhead is low and free from loops.	Latency is increased in the network.
Hybrid	Suitable for large networks and up to date information available.	Complexity increases

III. REVIEW OF POWER AWARE ROUTING PROTOCOL FOR MANET

3.1 Energy-Efficient Location Aided Routing (EELAR)

Energy Efficient Location Aided Routing (EELAR) Protocol [1] was developed on the concept of the Location Aided Routing (LAR) [2]. EELAR makes considerable reduction in the energy consumption of the node batteries by limiting the area of discovering a new route to a smaller zone. Thus, control packet overhead is appreciably reduced. In EELAR, a reference wireless base station is used and the network's circular area centered at the base station is divided into six equal sub-areas. During route discovery, instead of flooding control packets to the whole network area, they are flooded to only the sub-area of the destination mobile node. The base station stores locations of the mobile nodes in a position table. Simulations results using NS-2 [3] showed that EELAR protocol makes an improvement in control packet overhead and delivery ratio compared to AODV, LAR, and DSR protocols.

3.2 Minimum Energy Routing (MER) Protocol

Minimum Energy Routing (MER) can be described [4] as the routing of a data-packet on a route that consumes the minimum amount of energy to get the packet to the destination which requires the knowledge of the cost of a link in terms of the energy expanded to successfully transfer and receive data packet over the link, the energy to discover routes and the energy lost to maintain routes [5]. MER higher routing overhead, but lower total energy and can bring down the energy consumed of the simulated network within range of the theoretical minimum the case of static and low mobility networks. However as the mobility increases, the minimum energy routing protocol’s performance degrades although it still yields impressive reductions in energy as compared performance of minimum hop routing protocol.

3.3 Power-aware Localized Routing (PLR)

The Power-aware Localized Routing (PLR) protocol [6] is a localized, fully distributed energy-aware routing algorithm but it assumes that a source node has the location information of its neighbors and the destination. PLR is equivalent to knowing the link costs from the source node to its neighbors, all the way to the destination. Based on this information, the source cannot find the optimal path but selects the next hop through which the overall transmission power to the destination is minimized [7].

3.4 Power-aware Routing (PAR) Protocol

Power-aware routing (PAR) [8] protocol gives maximum network lifetime and minimum power consumption by selecting less congested and more stable route, during the source to destination route establishment process, to transfer real-time and non real-time traffic, hence providing energy efficient routes. PAR focuses on 3 parameters: Accumulated energy of a path, Status of battery lifetime and Type of data to be transferred. At the moment of route selection, PAR focuses on its core metrics like traffic level on the path, battery status of the path, and type of request from user side. With these factors in consideration, PAR always selects less congested and more stable routes for data delivery and can provide different routes for different type of data transfer and ultimately increases the network lifetime. Simulation results shows that PAR is similar such as DSR and AODV protocols, with respects to different energy-related performance metrics even in high mobility scenarios. Although, PAR can somewhat incur increased latency during data transfer, it discover routed that can last for a long time and encounter significant power saving.

3.5 Online Max-Min Routing Protocol (OMM)

Li proposed the Online Max-Min (OMM) power-aware routing protocol [9] for wireless ad-hoc networks dispersed over large geographical areas to support applications where the message sequence is not known. This protocol optimizes the lifetime of the network as well as the lifetime of individual nodes by maximizing the minimal residual power, which helps to prevent the occurrence of overloaded nodes. In most applications that involve MANETs, power management is a real challenge and can be done at two complementary levels (1) during communication and (2) during idle time. The OMM protocol maximizes the lifetime of the network without knowing the data generation rate in advance. The metrics developed showed that OMM had a good empirical competitive ratio to the optimal online algorithm [9] that knows the message sequence and the max-min achieves over 80% of the optimal node lifetime for most instances and over 90% of the optimal node lifetime for many problem instances.

3.6 Life time-aware Multicast Tree (LMT) Protocol

The Lifetime-aware multicast tree routing algorithm [10] gives maximum ad hoc network lifetime by finding routes that minimize the variance of the remaining energies of the nodes in the network. LMT maximizes the lifetime of a source based multicast tree, assuming that the energy required to transmit a packet is directly proportional to the forwarding distance. Extensive simulation results were provided to evaluate the performance of LMT with respect to a number of different metrics in comparison to a variety of existing multicast routing algorithms and Least-cost Path Tree (LPT). These results clearly demonstrate the effectiveness of LMT over a wide range of simulated scenarios.

3.7 Power-aware Multiple Access (PAMAS) Protocol

PAMAS[11] [12] 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.

3.8 Localized Energy-aware Routing (LEAR) Protocol

Local Energy-Aware Routing (LEAR) [13] simultaneously optimizes trade-off between balanced energy consumption and minimum routing delay and also avoids the blocking and route cache problems. LEAR accomplishes balanced energy consumption based only on local information, thus removes the blocking property. Based on the simplicity of LEAR, it can be easily be integrated into existing ad hoc routing algorithms without affecting other layers of communication protocols. Simulation results show that energy usage is better distributed with the LEAR algorithm as much as 35% better compared to the DSR algorithm. LEAR is the first protocol to explore balanced energy consumption in a pragmatic environment where routing algorithms, mobility and radio propagation models are all considered [14].

Conditional Max-Min Battery Capacity Routing (CMMBCR) Protocol

The Conditional Max-Min battery capacity routing (CMMBCR) [15] 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. 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. 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.

3.10 Lifetime-aware Refining Energy Efficiency of Multicast Trees (L-REMIT)

Lifetime of a multicast tree in terms of energy is the duration of the existence of the multicast service until a node dies due its lack of energy. L-REMIT is a distributed protocol and is part of a group of protocols called REMIT (Refining Energy efficiency of Multicast Trees). It uses a minimum-weight spanning tree (MST) as the initial tree and improves its lifetime by switching children of a bottleneck node to another node in the tree. A multicast tree is obtained from the “refined” MST (after all possible refinements have been done) by pruning the tree to reach only multicast group nodes. L-REMIT is a distributed algorithm in the sense that each node gets only a local view of the tree and each node can independently switch its parent as long as the multicast tree remains connected that utilizes an energy consumption model for wireless communication. L-REMIT takes into account the energy losses due to radio transmission as well as transceiver electronics. L-REMIT adapts a given multicast tree to a wide range of wireless networks irrespective of whether they use long-range radios or short-range radios [16].

IV. CONCLUSION

A mobile ad hoc network (MANET) consists of independent mobile nodes, each of which communicates directly with the nodes within its coverage range. In order to facilitate reliable communication within a MANET, an efficient routing protocol is required to create routes between mobile nodes. The field of MNAETs is rapidly growing due to the many advantages and different application areas. Energy efficiency and security are some challenges faced in MANETs, especially in designing a routing protocol. In this paper, we surveyed a number of energy efficient routing protocols. We conclude that there is not a single protocol which can give the best performance in ad-hoc network. Performance of the protocol varies according to the variation in the network parameters. In other words, one routing protocol cannot be a solution for all energy efficient issues that are faced in MANETs, but rather each protocol is designed to provide the maximum possible requirements, according to certain required scenarios.

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