A Review on Power Aware Routing in Mobile ADHOC Network

Ravikant¹ and Sunita²

¹M. Tech. Scholar, Department of Computer Science & Engineering
Shri Baba Mastnath Engineering College, Rohtak (Haryana)
ravikant140589@gmail.com

²HOD, Department of Computer Science & Engineering
Shri Baba Mastnath Engineering College, Rohtak (Haryana)
kashisuni5@gmail.com

Abstract

Ad Hoc networks are multi-hop wireless networks where all nodes cooperatively maintain network connectivity. These types of networks are useful in any situation where temporary network connectivity is needed, such as in disaster relief. An ad hoc network here would enable medics in the field to retrieve patient history from hospital database or allow insurance companies to tie claims from the field. Building such ad hoc networks poses a significant technical challenge because of the many constraints imposed by the environment. Thus, the device used in the field must be lightweight. Furthermore, since they are battery operated, they need to be energy conserving so that battery life is maximized. Several technologies are being developed to achieve these goals by targeting specific components of the computer and optimizing their energy consumption. In many cases, it is difficult to compare them directly since each method has a different goal with different assumptions and employs different means to achieve the goal. In this paper, we surveyed and classified a number of energy aware routing schemes.

Keywords: Mobile Ad-Hoc Routing, Power Aware Routing, Energy.

1. Introduction

Wireless network can be classified into two types: Infrastructured or Infrastructure less. In Infrastructured wireless networks, the mobile node can move while communicating, the base stations are fixed and as the node goes out of the range of a base station, it gets into the range of another base station. The figure 1, given below, depicts the Infrastructured wireless network [1].

In Infrastructureless or Ad Hoc wireless network, the mobile node can move while communicating, there are no fixed base stations and all the nodes in the network act as routers. The mobile nodes in the Ad Hoc network dynamically establish routing among themselves to form their own network ‘on the fly’. This type of network can be shown as in figure: 2.

Figure: 1 Infrastructured Wireless Networks [1]

Figure: 2 Infrastructureless or Ad Hoc Wireless Networks [1]
energy capacity and absence of fixed infrastructure are special features for MANET when compared to wired networks. MANET does not have centralized controllers, which makes it different from traditional wireless networks (cellular networks and wireless LAN). Due to these special features, the design of routing protocols for MANET becomes a challenge.

MANET is an infrastructure-less multi hop network where each node communicates with other nodes directly or indirectly through intermediate nodes. Thus, all nodes in a MANET basically function as mobile routers participating in some routing protocol required for deciding and maintaining the routes. Since MANETs are self-organizing, rapidly deployable wireless networks, they are highly suitable for applications involving special outdoor events, communications in regions with no wireless infrastructure, emergencies and natural disasters, and military operations [3]. 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. The performance of a mobile ad hoc network mainly depends on the routing scheme [3].

2. Routing Protocols
A routing protocol is needed whenever a packet needs to be transmitted to a destination via number of nodes and numerous routing protocols have been proposed for such kind of ad hoc networks. These protocols find a route for packet delivery and deliver the packet to the correct destination. The studies on various aspects of routing protocols have been an active area of research for many years. Many protocols have been suggested keeping applications and type of network in view. Basically, routing protocols can be broadly classified into two types as (a) Table Driven Protocols or Proactive Protocols and (b) On-Demand Protocols or Reactive Protocols. [4]

3. Power Aware Routing
Power aware routing is to choose appropriate transmission range and routes to save energy for multihop packet delivery [5]. The problem of routing in mobile ad hoc networks becomes difficult because of node mobility. Due to mobile nature of the nodes, frequent topology updates are required which result in higher message overhead, and hence causes more power consumption. The main performance metrics widely used in networks are end-to-end throughput and delay. They belong to a small set of metrics used in different routing protocols for determining optimal paths. Beside these, link quality and location stability are other performance metrics, such metrics influence the design of protocols and there is a need to optimize them by balancing the trade-offs between them. Some of these metrics can have a negative impact on some nodes of the network by selecting several paths through them. When energy metrics are used for the design of the routing protocols the ultimate goal is to maintain the network connected and extend the time until it gets partitioned [4].

3.1 Objective
The main objective of power aware routing protocols is to minimize the power consumption and maximize the network lifetime. The network lifetime is defined up to the moment when a node runs out of its own battery power for the first time. If a node stops its operation, it can result in network partitioning and interrupt communication.

Five Metrics for Power Aware Routing:
- Minimize Energy consumed per packet: the most intuitive metric, however not optimal for maximum lifetime;
- Maximize Time to Network Partition: important for mission critical applications, hard to maintain low delay and high throughput simultaneously;
- Minimize Variance in node power levels: balance the power consumption for all the node in the network, i.e., all nodes in the network have the same importance;
- Minimize Cost per packets: try to maximize the life of all the nodes;
- Minimize Maximum Node Cost: try to delay the node failures.

Then used them as the new power aware metric for determining the routes, which shows that per packet
cost is reduced by 40-70% and mean time node failure increase significantly [5].

Energy efficient routing algorithms are very important in wireless multi-hop networks, where communication costs (transmission power) are usually more expensive than computing costs, and where the constituent nodes have batteries with limited energy. Several energy-aware routing protocols define the link cost as a function of the power required to transmit a packet across the link, and then employ minimum cost routing algorithms to determine the “minimum total transmission energy” route from a source to the destination [6].

In many wireless ad-hoc scenarios, however, the metric of actual interest is not the transmission energy of individual packets, but the total operational lifetime of the network. To avoid the extinction of nodes due to exhaustion of their battery power, power-aware routing algorithms try to ensure an equitable distribution of the transmission costs among the constituent nodes. It is easy to see that the two routing objectives can be mutually contradictory. For example, if several minimum energy routes have a common host, the battery power of that host will be exhausted quickly. From a conceptual standpoint, power-aware routing algorithms attempt to distribute the transmission load over the nodes in a more egalitarian fashion, even if such distribution drives up the overall energy expenditure. Such algorithms do not, however, consider the possibility that different links can have different transmission costs.

i. Energy-Efficient Location Aided Routing (EELAR)

Energy Efficient Location Aided Routing (EELAR) Protocol [9] was developed on the concept of the Location Aided Routing (LAR). 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.

   ii. PLR (Power-Aware Localized Routing) Protocol

The PLR protocol implements a localized, fully distributed power aware routing algorithm, but it assumes that a source node has the location information of its neighbors as well as the destination. It is equivalent to knowing the link costs from itself to its neighbors and to the destination as well. In Figure, when node A has data packets to send to node D, it can either send them directly to D or through one of its neighbors (N1, N2 or N3). A to N is a direct transmission while N to D is an indirect transmission with some number of intermediate nodes between N and D. Therefore node A, whether it is a source or an intermediate node, selects one of its neighbors (N1, N2 or N3) as the next hop node which minimizes \( p((AN_1)) + q(N,D) \), where p and q are the respective path costs. Advantage of PLR protocol is that the source cannot find the optimal path but selects the next hop through which the overall transmission power to the destination is minimized. Disadvantage of PLR protocol is that the direct transmission consumes more power as compared to the indirect transmission via intermediate nodes. The path with direct transmission link may perform worse than a path with indirect transmission links in terms of latency as well as power consumption because the path with direct transmission would cause link errors that would result in more retransmissions [7].

   iii. 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 [9].

iv. Online Max-Min Routing (OMM)
This power-aware routing protocol proposed by Li et al. [10] 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 [4].

v. 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 an 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 [9].

vi. Flow Augmentation Routing (FAR) [13]
This protocol assumes a static network and finds the optimal routing path for a given source–destination pair that minimizes the sum of link costs along the path and chooses the path with least cost [4].

Local Energy-Aware Routing (LEAR) [9] 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].

4. Conclusion
MANET consists of autonomous, self-organizing and self-operating nodes, each of which communicates directly with the nodes within its wireless range or indirectly with other nodes via a dynamically computed, multi-hop route. Due to its many advantages and different application areas, the field of MANETs is rapidly growing and changing, while there are still many challenges that need to be met. Energy efficiency is one of the main problems in a MANET, especially in designing a routing protocol. This review paper provides an overview of power aware routing protocols.

References


