ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 6, June 2015

A Study on Power Aware Routing Schemes in Mobile Ad-hoc Networks

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ABSTRACT: An Ad-hoc network is a collection of multi-hop wireless nodes that communicate with each other without centralized controlling or without fixed infrastructure, dynamically formed by an autonomous system of mobile nodes that are connected via wireless links. The battery power is very scarce resource in this network. The network lifetime and connectivity of nodes depend on battery power. Due to energy constraint the power aware routing schemes for mobile ad hoc networks has been developed for increasing network life time by isolating low power nodes from the routing process. This paper presents a study of recently proposed power aware routing schemes based on their own feature and improvement. The power aware routing schemes are classified on the basis of approaches they use to minimize the energy consumption. The purpose of this paper is to give brief review on power aware routing schemes improvements to last few recent years.

KEYWORDS: Manets; Power Aware Schemes; network lifetime; VANET; DSR; DSDV; ZRP; QoS ; PAQMR

I. INTRODUCTION

Ad-hoc wireless networks are a comparatively new paradigm in multi-hop wireless networking that is increasingly becoming popular and will become an essential part of the computing environment, consisting of infra-structured and infrastructure-less mobile networks [1]. Mobile ad hoc network (MANET) is an infrastructure-less multi-hop network where each node communicates with other nodes directly or indirectly through intermediate nodes. The credit for growth of ad-hoc network goes to its self organizing and self configuring properties. 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 infrastructure-less, 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, mine site operations, urgent business meetings and robot data acquisition [2][3]. Figure 1.1, local Ad-Hoc network shows a simple ad hoc network with three nodes. The outermost nodes are not within transmitter range of each other. However the middle node can be used to forward packets between the outermost nodes. The middle node acts as a router and the three nodes form an ad hoc network.

Figure 1.1. Local Ad-Hoc Networks

Ad hoc networks are also capable of handling topology changes and malfunctions in nodes. It is fixed through network reconfiguration. For instance, if a node leaves the network and causes link breakages, affected nodes can easily request new routes. Although there are incremental delays, the network continues to remain operational. Wireless ad hoc networks take advantage of the inherent nature of the wireless communication medium. In a wired network, the physical cabling is done a priori, restricting the connection topology of the nodes. Provided two mobile nodes are

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ISSN (Print): 2320-9798

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Vol. 3, Issue 6, June 2015

within transmission range of each other, this restriction is easily overcome within the wireless domain, forming an instantaneous communication link. Ad hoc networks are useful for the applications such as disaster recovery, automated battlefields, agriculture fields, security and vigilance, search and rescue, crowd control, conferences, meetings, and lectures where central or fixed infrastructure is not available [4]. There are many challenges while constructing an Ad hoc network: Heterogeneity, Routing challenges, wireless medium challenges, portability challenges, security, and scalability. MANETs are characterized by the mobility of nodes, which can move in any direction and at any speed that may lead to arbitrary topology and frequent partition in the network. This characteristic of the network makes the development of routing protocols as one of the most challenging issue. The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic. Such networks may operate by themselves or may be connected to the larger Internet. They may contain one or multiple and different transceivers between nodes to transmit the data between hop to hop as shown in figure 1.2. This results in a highly dynamic, autonomous topology. MANETs are a kind of Wireless ad hoc network that usually has a routable networking environment on top of a Link Layer ad hoc network. MANETs consist of a peer-to-peer, self-forming, self-healing network in contrast to a mesh network, which has a central controller. MANETs circa 2000-2015 typically communicate at radio frequencies (30 MHz - 5 GHz). The growth of laptops and 802.11/Wi-Fi wireless networking has made MANETs a popular research topic since the mid-1990s. Many academic papers evaluate protocols and their abilities, assuming varying degrees of mobility within a bounded space, usually with all nodes within a few hops of each other.

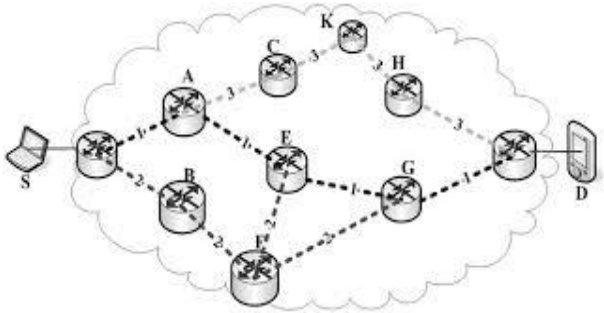

Figure 1.2. Message transmission hop by hop in MANET [19]

A mobile ad hoc network (MANET) is generally defined as a network that has many free or autonomous nodes, often composed of mobile devices or other mobile pieces that can arrange themselves in various ways and operate without strict top-down network administration. There are many different types of setups that could be called MANETs and the potential for this sort of network is still being studied [5]. Experts point out that the MANET, now a topic of commercial research, was originally used in military projects, including in tactical networks and Defence Advanced Research Projects Agency (DARPA) projects. Some use 4G networks and other wireless systems as examples of a potential topology for a MANET, while others refer to a vehicular ad-hoc network (VANET), where the free network nodes are installed in cars and other vehicles .The mobile nodes are battery operated and it is a challenging task to maximize their life time during critical applications such as emergency response. The traditional routing schemes for mobile ad hoc networks such as AODV [6], DSR [7] and DSDV [8] take into consideration the number of hops along a given route (hop count) as a route selection metric. A low power node on the shortest path may drain off its battery power and may disappear from the network during communications on the given path. The power aware routing schemes try to find a route, where each node along the given route has sufficient energy to accomplish the required communication task. The power aware routing schemes take into consideration the node's remaining battery power and other related cost metrics to find a route between a given source and destination pair [9]. The power aware routing metrics include minimum energy consumed per packet, maximum time to network partition and minimum variance in node power levels [10].

This paper presents a study of some existing power aware routing schemes for mobile ad hoc networks. The rest of the paper is organized as follows. Section II presents related works, section III presents a brief study of various power aware routing schemes for mobile ad hoc networks and section IV concludes the paper.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

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Vol. 3, Issue 6, June 2015

II. RELATED WORK

Limitation of power, mobility of hosts and changing of wireless link make it difficult for MANET to manage for all quality of services. In spite of all these difficulties MANET is a good candidate for various military and civil applications. In these days lot of research works have been carried in the area of power conservation in MANET. For efficient operations of network with the changing topology with the node mobility generates higher control message overhead and methods to reduce power consumption.

Routing is defined as the process of finding path from a source to every destination in the network. There are three main requirements for designing ad-hoc network routing protocols that is Low overhead, Adaptiveness and resilience to loss. In case of low overhead, the routing protocol requires less number of control messages to transmit each data packet. Further the size of each control messages is also very small. Hence it conserves bandwidth and battery. For adaptiveness, the routing protocol needs to be able to adapt to a highly dynamic environment in which network topology changes frequently. For resilience to loss, the routing protocol needs to operate correctly and efficiently in the presence of packet loss. The packet loss in the ad hoc network is high. There are number of routing protocols for ad hoc networks, they are categorized into three: i) Proactive routing protocol, 2. Reactive routing protocol and 3. Hybrid routing protocol as shown in figure 1.3 while depending on the network structure these are classified as flat routing, hierarchical routing and geographic position assisted routing. Flat routing covers both routing protocols based on routing strategy.

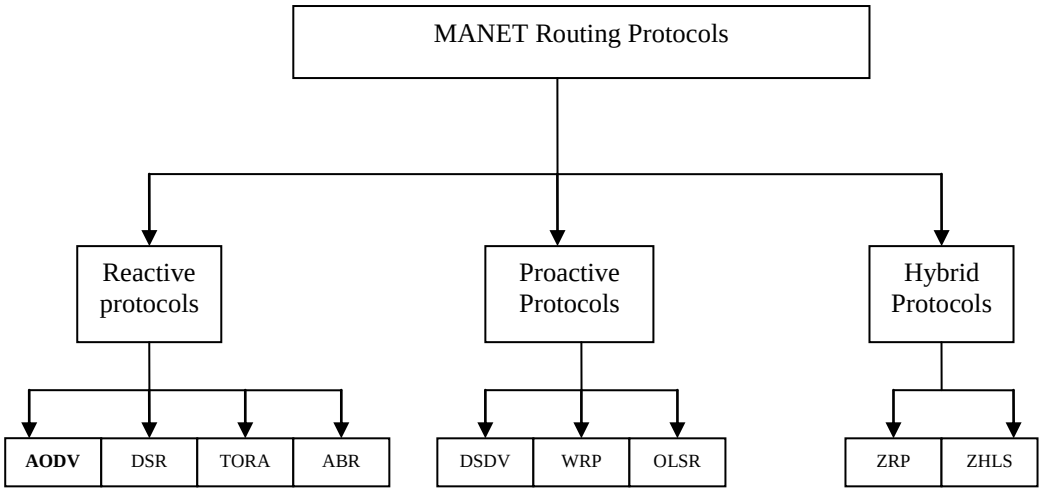

Figure1.3. Classification of Routing Protocols in MANET's [20]

III. A STUDY ON POWER AWARE ROUTING SCHEMES

In wireless Ad-hoc networks, nodes relay packets using multi-hop links. These lack any fixed infrastructure or base station for communication. Each node is capable of exchanging packets to/from other nodes, thus, each node has limited power due to which the selected route cannot remain for a long time so that the source destination pair can use it for its successful communication. To achieve the goal of getting longer lifetime and successful communication for a network, we should minimize nodes energy not only during active communication but also when they are in inactive state. Due to this problem, many power aware routing schemes have been proposed to accomplish this task. The various power aware routing schemes are reviewed along the typical characteristics of each protocol. Here, we discuss the major power aware routing schemes in MANET:

Author's [11] proposed algorithm maximizes the network lifetime & minimizes the power consumption during the source to destination route establishment. This algorithm takes special care to transfer both real time and non real traffic by providing energy efficient and less congested path between a source and destination pair. Energy efficiency is

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ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

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one of the main problems in a adhoc network, especially designing a routing protocol. The proposed work aims at discovering an efficient power aware routing scheme in MANETs which can support both real and non real time traffic.

Author's [12] give QoS based Power Aware Routing Scheme that finds an energy efficient route, which meets QoS constraints along an established path. If the application doesn't require QoS guarantees, the protocol finds a path consisting of high energy nodes. If the QoS constrained path is required, the protocol considers node energy and link capacity as route selection metrics. During route discovery, the source node specifies the minimum energy and minimum bandwidth required along the established route. Each node inserts its residual energy and available bandwidth information into the route selection packets. The destination node finds and establishes the route which meets the energy and bandwidth constraints of the user application. If an active route breaks due to link failure or battery power depletion, the local route repair is used to find a new route.

In this paper [13], power awareness is introduced in AOMDV so that shortest path along with maximum energy is established. There are 3 basic assumptions in PAAOMDV: i) Each mobile node is able to read its own physical residual energy; ii) Each mobile node knows its transmission power, based on which it could estimate the energy consumption of sending a packet and The source node of a request is capable of anticipating the number of the packets to be transmitted. In PAAOMDV, each node should maintain an Energy Reservation Table (ERT) instead of the route cache in the common on-demand protocols. Each item in ERT is mapped to a route passing this node, and records the corresponding energy reserved. The entries of an item in ERT are Request ID, Source ID Destination ID, Amount of Energy Reserved, Last Operation Time, Route, and their functions will be presented in detail below. The basic operations of PAAOMDV include route discovery, packet forwarding and route maintenance.

In this paper [14], authors proposed a new hybrid routing protocol for disaster recovery management. The Power Aware QoS Multipath Routing protocol (PAQMR) considers energy stability for route reconstruction to avoid packet loss. The goal of scheme aims to find an optimal path in terms of bandwidth and energy-constrained applications. Performance evaluation has been done using NS2 simulator tool and comparison with AODV, AOMDV shows that PAQMR protocol can effectively reduce end to end delay and energy consumption while maintaining a good packet delivery ratio. The enhanced protocol has been developed for hybrid network with heterogeneous characteristics [14]

In ref [15], author's gives the Energy Aware Variable Transmission Range Routing reduces the network energy consumption by varying the transmission range of nodes dynamically. During route discovery, each node specifies its current location in the routing packets generated by the destination node. Each intermediate node receives multiple routing packets from its downstream nodes, calculates the distance between itself and all its downstream nodes and selects the nearest node. The transmission energy is estimated based on the distance between current node and its nearest downstream node. This process continues until the route is established and data transmission takes place. To design an energy efficient protocol has been one of the main challenges in MANETs. The proposed work aims at designing an efficient energy aware routing scheme for MANETs taking variable range transmission into consideration.

Author's[16], present the proposed power aware heterogeneous AODV (PHAODV) routing protocol that uses efficiently the energy available in nodes when establishing and maintaining heterogeneous routes in the network. The protocol extends our HAODV routing protocol [19] which selects the shortest stable routes composed of nodes equipped with heterogeneous interfaces. HAODV allows heterogeneous nodes in a route regardless of the nodes' underlying technology. In this paper, we have proposed a power aware heterogeneous routing protocol that considers the node's residual energy and the power costs when establishing heterogeneous routes between nodes. Two thresholds were used by nodes to control further their energy consumption. The first threshold aims at keeping a node aware of the changes in its residual energy and enables it of invalidating routes using it as intermediate node and thus establishing new routes using up to date information about nodes' energy status. The second threshold aims at preventing nodes from being exhausted over routes when it is possible to use alternative routes. The proposed approach was implemented as an extension to the SWANS network simulator and its performance was compared to that of AODV, HAODV and energy aware OLSR.

In ref [17], proposed work minimises the energy consumption per packet and maximizes the network lifetime. The design objective of modifying DSR is to select energy efficient paths. The main features of modified DSR are: (i) minimise energy consumed per packet (ii) maximise network lifetime for network and (iii) minimize maximum node cost. However, some intermediate nodes might act selfish and drop the packets for other nodes in order to save their

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ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

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Vol. 3, Issue 6, June 2015

own battery power. The proposed algorithm can find selfish nodes and deal with them by using a modified DSR protocol, which we call as an efficient DSR (EDSR). The simulation results show an increase in the packet delivery ratio in the network. The average node lifetime of proposed EDSR model is 45–60% longer than that of DSR model.

Author's[18], present the Power efficient energy aware routing (PEEAR) for mobile ad hoc networks includes the energy spent in potential retransmissions, is the proper metric for reliable, energy efficient communications. First study the pure end-to-end retransmission model where none of the links guarantees per hop reliability, and then proceed to study the more general mixed retransmission model where some links may guarantee reliable delivery while the others may not. The lightweight distributed routing protocol PEEAR can be used for energy efficient routing in any network configuration as well. PEEAR is able to find minimum energy paths in the hop-by hop which effectively improves energy efficiency over the best known existing techniques in the general mixed model. There is a challenging question left for lifetime of the network. Further it is extent to find a routing with energy efficient, reliable and prolonging the network lifetime. PEEAR can increase the operational lifetime of the network using energy-efficient and reliable routes. In the design of PEEAR, detailed energy consumption model is used for packet transfer in wireless ad hoc networks. PEEAR was used to also increase the reliability of wireless ad hoc networks PEEAR also extends the network lifetime by directing the traffic to nodes having more amount of battery energy.

IV. CONCLUSION

This paper presents a study of power aware routing schemes for mobile ad hoc networks. A mobile ad hoc network (MANET) consists of independent mobile nodes, each of which communicates directly with the nodes within its coverage range. An efficient routing protocol is required to facilitate reliable communication within a MANET. In this paper we studied various power aware routing protocols with their feature. In other words, one routing protocol cannot be a solution for all energy efficient issues that are faced in MANETs. So research is still continued to design the protocol which could provide all the performance parameter.

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ISSN(Online): 2320-9801
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International Journal of Innovative Research in Computer and Communication Engineering

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BIOGRAPHY

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