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Efficient Security Based Energy Conservative Scheme for Wireless Ad hoc Networks.

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Abstract - For ad hoc networks energy conservation is most important. Utilizing the available limited amount of energy in the available network in the most efficient and reliable way is perhaps the greatest challenge faced by an ad-hoc network. Although there have been lots of protocols proposed to deal with this problem faced, however they do not provide a complete and energy efficient network. In this paper, we develop energy consumption scheme along with security measures that take into account energy consumption due to data packets, control packets and retransmission. We verify that our scheme match the actual energy consumption much better than existing models by simulation. In addition, we demonstrate that a minimum energy routing protocol based on an accurate scheme of ours performs much better than those based on existing models.

Keyboards: - Power control, Energy efficiency, Wireless networks, Routing, Optimization.

I INTRODUCTION

Today in wireless networks with battery operated nodes, the energy efficiency is a very important for consideration. The most important technique to achieve energy efficiency in wireless ad hoc networks is the power control scheme, in which each and every node transmits data packets to its neighbor at the minimum power level [1]. However, this scheme minimizes only the transmission power within a node's neighborhood. As the power of a transmitted signal is attenuated at the rate of 1/d n, where d is the distance between a sender and a receiver and n is the path loss exponent, transmitting data packets directly to a node may consume more energy than going through some intermediate nodes. In order to minimize the total power over all the nodes along the path between a source and a destination, there are several energy aware multi-hop routing protocols for wireless ad hoc networks. In wireless Network energy consumption models used in these protocols has been generally classified into the following three main categories. Energy conservation is a most critical issue in ad hoc wireless networks for node and network life, as the nodes are only powered by batteries. To route a communication session along the route which requires the lowest total energy consumptions is one of the one major approach for energy conservation. This optimization problem is referred to as Minimum Energy Routing. In networking an ad hoc network is a group of mobile wireless nodes that cooperatively form a network among themselves without any fixed infrastructure.

Fig.1. Mobile Ad hoc Network

In order to maximize the lifetime of an ad hoc network, it is essential to enhance each individual node (mobile) life through minimizing the total transmission energy consumption for each communication request. Therefore, the total transmission energy for each request is minimized and at the same time an efficient routing protocol must satisfy that the energy consumption rate at each node which is distributed uniformly. The power consumption within ad hoc networks is becoming a main issue for these low power mobile devices. This paper focuses on a novel scheme for energy conservation within the routing protocol of the ad hoc network. As we know that wireless network interface in sleep mode expends an order of magnitude less power than in idle mode, but no packets can be sent or received while in sleep mode. Because mobile devices are dependent on power of battery, it is important to minimize their consumption of energy. Especially for smaller devices, the energy consumption of the network interface can be significant. Most of the research work in energy conservation strategies has been targeted the wireless networks that are structured around base stations and centralized servers, which do not have the limitations associated with small, portable devices. By contrast, an ad hoc network is a group of mobile, wireless hosts which cooperatively form a network independently of any fixed infrastructure. It is sometimes assumed incorrectly that bandwidth utilization and energy consumption are roughly synonymous. There have been various studies on energy aware ad hoc routing protocols, especially for sensor networks.

1.1 Transmission Power Control (TPC)

In wireless ad hoc network TPC schemes try to balance dynamically the transmission power of the nodes such that the energy consumed is decreased the contention in the wireless channel is lowered, while the rest of the network parameters are not adversely affected. In order to increase the performance of the network, designing of effective techniques for managing the power of transmission dynamically and locally in the nodes is a critical issue in the network.

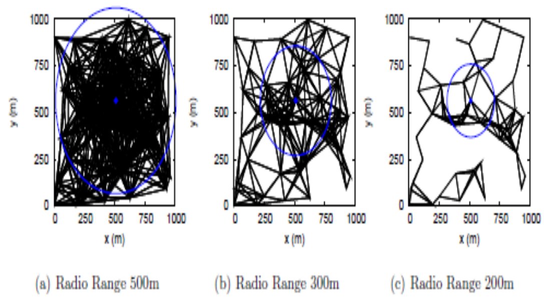
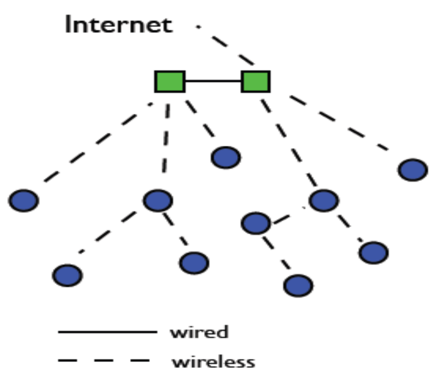


Fig.2. Topology Control: Transmission power defines the connectivity of the network (the node at the center and its transmission range shown in blue)

The Transmission Power Control schemes main aim is to change the topology of network by varying the transmission power of the nodes (see Figure 3) in order to reduce the energy and/or interference while maintaining connectivity. In recent years, ad hoc wireless networks have received significant attention due to their potential applications in battlefield, emergency disaster relief and other applications [2]. In ad hoc wireless networks there is no wired backbone infrastructure as in wired networks or cellular network. The Power Control Scheme, which uses AODV as the routing protocol to find a shortest path and adjusts the transmission power according to the distance between the sender and the receiver. The two performance metrics we investigated are: 1) Energy consumption per packet, which is defined as the total energy consumption divided by the total number of packets transmitted successfully; (2) Percentage of packets received, which is defined as the number of packets received by the destination correctly divided by the number of packets transmitted by the source.

Fig.3. Combination of Infrastructure and Ad



hoc

Either through a single-hop transmission, a communication session is achieved if the communication parties are close enough, or through relaying by intermediate nodes otherwise. All nodes use Omni directional antennas to transmit and receive signals. Each node can dynamically adjust its transmitting power based on the distance for the purpose of energy conservation, to the receiving node and the background noise in the most common power attenuation model [3]. The different power approach for transmission of data packets are as follows.

1.1.1 Total Transmission Power Approach

At each link this model simply sums up the transmission power of the data packet. In this approach a minimum energy routing protocol can use the route that minimizes the total transmission power along the path and the transmission power as the link cost. For example, PAMAS [4] uses the Dijkstra's shortest path algorithm for searching the minimum energy path, while to support minimum energy routing DSR has been modified in [5]. Power aware route optimization is performed across MAC and Network layers in PARO [6]. In order to reduce the transmission power one or more intermediate nodes may elect to relay packets between the sending node and the receiving node instead of sending packet directly between two nodes over a large-range hops.

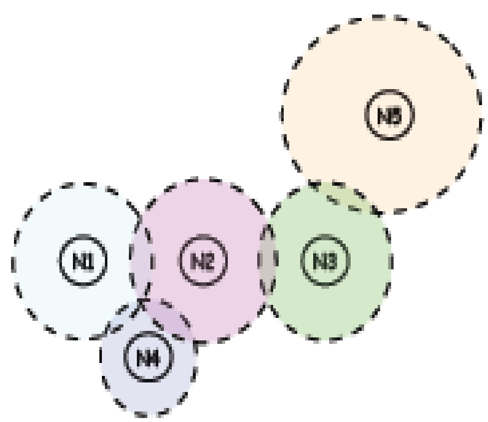


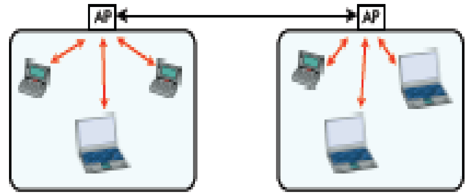
Fig.4. Transmission Area in Ad hoc Network

1.1.2 Total TransCeiving Power Approach

This approach sums up both the receiving power and the transmission power for transmitting the data packet at each link because the intermediate nodes consume energy not only when forwarding packets but also when receiving packets. The Bellman Ford shortest path algorithm is used to look for the minimum energy path for the link cost metric developed in [7] considers the transmission and receiving power.

1.1.3 Total Reliable Transmission Power Approach

If a data packet is lost during transmission at one link, such packet has to be re transmitted, which will consume some extra energy. Therefore, this mode includes the energy consumption for both the new data packet and the retransmitted packet. The authors in [8] proposed a minimum total reliable transmission power routing protocol. All the existing cost models, however, ignore additional energy consumption in exchanging control (or signaling) packets at the Data Link layer, which therefore underestimates the actual energy consumption with various wireless protocols. Unlike cellular networks, the lifetime of mobile nodes will deeply impact on the performance of ad hoc networks. In a cellular network, a reduction in the number of active mobile nodes will reduce the amount of signal interference and channel contentions. However, since the mobile nodes in an 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, there by hurting the performance of the network. In this paper, we analyze the energy consumption to achieve reliable transmission, and propose more accurate scheme for energy conservation along with security measures. We verify the accuracy of the proposed scheme and also demonstrate the usefulness of the accurate model in achieving more energy efficient routing in 802.11 based networks



(a) Infrastructure

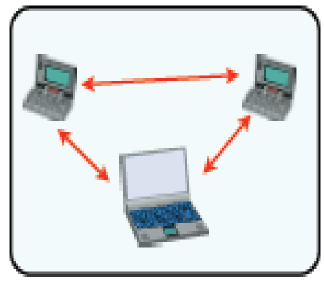

(b) Ad-Hoc

Fig.5. IEEE 802.11

In addition, each node can monitor its current battery power level. Given node power costs and link power costs, a variety of minimum energy routing algorithms have been developed based on such metrics as choosing the path with the maximum sum total of battery life, selecting the routing that minimizes the sum total of energy expended, and selecting the path with the strongest "weakest" node, i.e. maximizing the minimum energy [9]. Energy is a limiting factor in the successful deployment of ad hoc networks since nodes are expected to have little potential for recharging their batteries.

II. ROUTING IN WIRELESS AD HOC NETWORK

Route Discovery

The problem of securing the process of route discovery has been approached differently by the studied protocols. The basic requirement for secure route discovery in on-demand protocols is that the destination of a *route request* packet must be able to authenticate the path, or paths, included in the packet in order to utilize legitimate paths and not those that are fabricated by malicious nodes for sending a *route reply*. Accordingly, the initiator must be able to authenticate all the nodes that are included in the received reply.

Route Maintenance

One of the most interesting aspects for comparing the surveyed secure ad hoc routing protocols is the process of route maintenance. This function plays an important role in all ad hoc routing solutions since it is responsible for detecting topology changes and informing the corresponding nodes, so that they can update the established routes. Usually route maintenance is accomplished with the use of route error messages generated by nodes that detect a broken link, and forwarded to the nodes that utilize the broken link as part of their routes.

Fig.6.An Ad hoc Connection

In the simple case, the energy consumed by the network interface when a host sends, receives or discards a packet can be described using a linear equation.

Energy = m × size + b

Trivially, there is a fixed component associated with device state changes and channel acquisition overhead and an incremental component which is proportional to the size of the packet. While these phenomena are clearly important for the energy consumption behavior of a network, they are probably best examined probabilistically in the context of a specific model of host density, traffic load and wireless transmission environment.

III. RELATED WORK

Recently, Gobriel et. al [10] have investigated the effect of transmission power control on overall throughput and energy savings in power-aware ad hoc networks. In 1998, Bambos [11] reviewed developments in power control in wireless networks and identified the need for minimum-power routing protocols. A pioneering work regarding energy efficient routing was presented by Singh et al. [12] who studied via simulation the issue of increasing node and network life by using power-aware metrics for routing. In [13] other power-aware metrics are presented and their performance is studied via simulation. Some of the previous work regarding energy efficient routing in MANETs focused on performance comparison of existing ad hoc routing protocols (such as DSR, AODV, TORA, and DSDV [14]) with respect to energy consumption (e.g. [15]). Recently, new power-aware routing protocols for MANETs have been proposed. For example, in [16] a technique (named PARO) designed as a power-aware enhancement for MANET routing protocols has been introduced. In addition, in [17] an algorithm (named GAF) that is designed to reduce the energy consumption in the network by turning off unnecessary nodes .We note that Wieselthier et al. have published numerous papers on energy-aware broadcasting and multicasting

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(see for example, [18] and references therein) and that their work is closely related to the issue of energy efficient routing. For example, Michail and Ephremides [19] study the problem of energy efficient routing of connection oriented traffic. For instance, in [20], an energy efficient routing algorithm based on clustering is described and in [21], a methodology for computing upper bounds on the lifetime of a sensor network is presented. Energy conservation means to maximize the operational lifetime of a node, thus, enhancing the overall user experience [22]. Ramanathan and ElBatt remarked method of adjusting energy for delivering packets implement with considering levels to achieve a desired degree of connectivity in the network [23]. Bergamo etc. submitted a routing algorithm based on distributed energy control, which provide optimum transmit energy while maintaining limited degradation in throughput and delay [24]. Each node in MANET estimates the energy necessary to reach its neighbors, and this estimation is used both for tuning the transmit energy and as the link cost for minimum energy routing. At the network layer, intelligent routing protocols can minimize overhead and ensure the use of minimum energy routes [25]. Energy conservation can be achieved in one of two ways. Saving energy during active communication & saving energy during idle times in the communication. The first targets the techniques used to support communication in an ad hoc network and is typically achieved through the use of energy-efficient MAC and routing protocols. The second focuses on reducing the energy consumed when the node is idle and not participating in communication by placing the node in a low-power state.

IV. ENERGY CONSUMPTION IN WIRELESS AD HOC NETWORKS

In general there are three components to energy consumption in ad hoc networks. First, energy is consumed during the transmission of individual packets. Second, energy is consumed while forwarding those packets through the network. And finally, energy is consumed by nodes that are idle and not transmitting or forwarding packets.

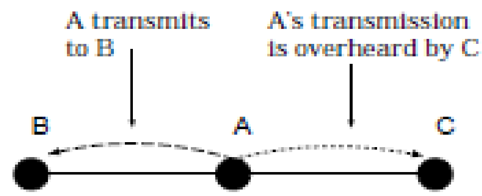

Fig.7. Unnecessary Power Consumption

End-to-end communication in ad hoc networks is supported by all nodes participating in route maintenance and data forwarding. Initial protocols use hop count as a primary metric although delay often implicitly impacts route choices [26]. More recent protocols suggest the use of extended metrics such as signal strength, stability and load all of which impact performance and so implicitly impact energy consumption [27]. Energy can also be used explicitly to choose routes that minimize energy consumption [28] or avoid nodes with limited energy resources.

V. LIMITATION OF AD HOC NETWORK

The mobile ad hoc network has the successive typical features (i) Unreliability of radio links between nodes. (ii) Constantly dynamic topology. (iii) Lack of incorporation of security features in statically configured wireless routing protocol not meant for ad hoc environments. Due the topology of the ad hoc networks is changing continually, it is necessary for each pair of adjacent nodes to incorporate in the routing issue so as to prevent some kind of potential attacks that try to make use of vulnerabilities in the statically configured routing protocol.

VI. DIFERENT ENERGY CONSERVATION APPROACHES

Once all of these costs are understood, two mechanisms affect energy consumption: Communication Time Energy Conservation and Energy Aware Routing. If these mechanisms are not used wisely, the overall effect could be an increase in energy consumption or reduced communication in the network.

6.1 Energy Conservation

The goal of communication-time energy conservation is to reduce the amount of energy used by individual nodes as well as by the aggregation of all nodes to transmit data through the ad hoc network. Although the transmission rate can also be adapted by the sender [29], we do not consider such rate control in this chapter. We present power control protocols and energy-aware routing protocols that aim to minimize energy consumption for communication in the network.

6.2 Energy-Aware Routing

Routing protocols for ad hoc networks generally use hop count as the routing metric, which does not necessarily minimize the energy to route a packet [30]. Energy aware routing addresses this problem by finding energy efficient routes for communication. Hybrid protocols explore the combination of minimum energy routing and capacity-aware routing to achieve energy efficient communication while maintaining network lifetime.

VII. CONCLUSION

Energy conservation in ad hoc networks is a relatively new field of research. Military applications of ad hoc networks are probably the area that requires the most highly secure routing functionality. On the other hand, commercial application scenarios of ad hoc networking may place higher demands on the underlying routing protocol. However, security still plays an important role since even in commercial or domestic ad hoc environments the exchanged information is usually confidential, e.g. credit card numbers, or of a private nature. Therefore, a flexible secure ad hoc routing solution should take into account the performance security trade-off associated with an application and dynamically achieve the required equilibrium. Energy aware routing technique that takes advantage of the battery power of nodes is continuously participating in communication in network.

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