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ENERGY AWARE SECURE ROUTING PROTOCOL FOR MOBILE ADHOC NETWORKS

K.Parkavi [1], Dr.P.Vivekanandan [2]

Research scholar, Department of Computer Science and Engineering, Anna University, Chennai, India[1]

Professor, Department of Chemical engineering, Anna University, Chennai, India[2]

Abstract: Ad-hoc networks are collection of mobile nodes that temporarily form a dynamic network and these nodes are communicated through the wireless link. Ad-hoc mobile networks are self organizing distributed networks in which the nodes rely on each other to transfer data without any fixed infrastructure. A routing protocol plays a vital role to handle entire network for communication and determines the efficient path. If the transmission from a source to the destination is successful, it has been assumed that the routing protocol is more suitable. In order to facilitate communication within the network, a routing protocol is used to discover routes between nodes. The primary goal of such an adhoc Network routing protocol is correct and efficient route establishment between a pair of nodes so that messages may be delivered in a timely manner. Although establishing an efficient route is a main goal, a more challenging task is to provide energy efficient routing protocols. Since, the critical factors for an ad-hoc network are the operation time that can be restricted by battery energy and propagation effects. This paper surveys the efficient energy aware routing techniques proposed for MANETs.

Keywords: Ad-hoc, routing, multi-hop, battery capacity, energy.

I. INTRODUCTION

To enable the communication between nodes that do not have direct radio contact, every node in the network must act as a wireless router and they should forward data on behalf of others without selfishness. The existence of a link between the nodes depends on many parameters such as transmission power level, distance from the receiver, inference from other transmitters, propagation delay, etc. Nodes in the network may move freely in an arbitrary fashion and select to switch their power off at any time in order to preserve their battery energy.

The dynamic changing topology in mobile ad-hoc networks make quite tough to maintain the entire network routing information accurately and it guarantees the reception of original message. The dynamic multi-hop paths are constructed to route the messages while the nodes are moving. Based on the construction of multi-hop paths, the ad-hoc network routing protocols are broadly categorized into proactive and reactive protocols. The proactive protocols are able to provide the routing information on the spot. On the other hand, a reactive protocol offers routing information with some delay since it usually needs to launch the routing discovery if it does not have the pre-determined path. By making comparison, the proactive protocols incur shorter delay in the transmission packets and they maintain the entire network topology information too. Though the nodes utilize more bandwidth, they need to periodically broadcast the routes for all the nodes in the network for the particular time interval.

Routing is the basis for all network operations. However, achieving energy saving is very difficult in the MANET. The routing operation performance will be evaluated by the lifetime of nodes in the network. So energy saving is important factor when the node broadcast the message to others. If there is no end-to-end path existing among the intermediate nodes, network partitioning may occur and the routing protocol may fail to deliver the data. To address these issues, this energy aware routing protocol is proposed.

II. RELATED WORK

This section surveys energy efficient routing protocol developed for MANETs. There are three major issues involved in this energy aware routing protocol. First, the goal is to find the path that either minimizes the absolute power consumed or balances the energy consumption of all

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mobile nodes. Balanced energy consumption does not necessarily lead to minimized energy consumption, but it keeps a certain node from being overloaded and thus, ensures longer network lifetime. Since the energy balance can be achieved indirectly by distributing network traffic, one such routing protocol is also discussed in this section. Second, energy awareness has been either implemented at purely routing layer or routing layer with the help from other layers such as MAC or application layer. For example, information from the MAC layer is beneficial because it usually supports power saving features in which the routing protocol can exploit to provide better energy efficiency. Third, some routing protocols assume that the
Nodes locality can be measurable by global addressing and transmission power is controllable. Under these assumptions, the problem of finding a path with the less power consumption becomes a conventional optimization problem. When we form a tree or a graph, the weighted link cost represents the transmission power required for transmitting a packet from one node to another node. [3]

A. Power Aware Routing Protocol (PAR)

The PAR protocol is not a new routing protocol but this suggests the use of different metrics when determining a routing path. The following energy-related metrics have been suggested instead of the shortest routing path between a source and a destination: minimizing energy consumed/packet, maximizing time to network partition, minimizing variance in node power levels, minimizing cost/packet, or minimizing maximum node cost. The first metric is useful for minimizing the overall energy consumption for delivering a packet. These most visited nodes may consume more battery energy, due to this the operation time of these nodes getting reduced and stop earlier than other nodes resulting in link disconnection and network partitioning. A better routing path is one where packets get routed through energy-rich intermediate nodes in spite of additional delay or hop count. Maximizing the second metric, time to network partition, is considered an ultimate goal of a MANET because it directly addresses the network lifetime.

However, since it is difficult to estimate the future network behavior, the next three metrics can be used to attempt to indirectly achieve the goal. For example, the third approach, minimizing variance in node power levels, is a direct approach to maintain the energy balance with information of all nodes' power levels. In the fourth and fifth approach, each path is noted with path cost measured by the accumulated battery life of all intermediate nodes and the minimal residual battery life among the intermediate nodes, respectively. The path with the maximum path cost is selected [4] [5].

B. Alternate Path Routing Protocol (APR)

The APR protocol indirectly balances energy consumption by distributing network traffic among a set of diverse paths for the same source-destination pair, called alternate route set. APR's performance greatly depends on the quality of the alternate route set, and it can be defined by the nodes which have the number of common routes. Since the movement of a common node breaks the two routes altogether, a good alternate route set consists of decoupled routes. A decoupled alternate route set can be constructed. When node S searches for a routing path to D, it may obtain alternate routes [6].

With proactive routing protocols each node is provided with a complete and up-to-date view of the network connectivity and thus, it is capable of identifying the best alternate routes that exist in the network. However, in the presence of significant node mobility, tracking all the changes in network connectivity can be prohibitively expensive. With reactive routing protocols the alternate route set is constructed during the route discovery process since a route query may produce multiple responses containing paths to the sought-after destination. It includes to forward the packets to the destination through an alternate path while the congestion and network partitioning occurs [7].

C. Power aware Localized Routing Protocol (PLR)

MANET routing algorithms based on global information, such as data generation rate or power level information of other nodes may not be practical because each node is provided with only the local information. The PLR protocol is a localized, fully distributed energy aware routing algorithm. Assuming that the location information of its neighbors and the destination is available through GPS, each node selects one of its neighbors through which the overall transmission power to the destination is minimized. Since the transmission power needed for direct communication between two nodes has super-linear dependence on distance, it is usually energy efficient to transmit packets via intermediate nodes [8].

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III. SYSTEM DESCRIPTION

There are some terms related to the energy efficiency on MANETs such as Energy per Packet, Network Lifetime, Average Energy Dissipated, Total Number of Nodes Alive, Time until the First Node Dies, Low Energy Consumption, Energy Spent per Round, Average packet delay. The most important factors are:

Energy per Packet. This term is referred to the amount of the energy that is spent while sending a packet from a source to a destination.
Average Energy Dissipated. This metric is related to the network lifetime and shows the average dissipation of energy per node over time in the network as it performs various functions such as transmitting, receiving, sensing and aggregation of data.
Total Number of Nodes Alive. This metric is also related to the network lifetime. It gives an idea of the area coverage of the network over time.
Time until the First Node Dies. This metric indicates the duration for which all the nodes on the network are alive. There are protocols in which the first node on the network runs out of energy earlier than in other protocols, but manages to keep the network operational much longer.
Energy Spent per Round. This metric is related to the total amount of energy spent in routing messages in a round. It is a short-term measure designed to provide an idea of the energy efficiency of any proposed method in a particular round.

A. Energy Aware Routing Protocol (EARP)

Compared to APR, the EARP protocol directly controls the energy consumption. In particular, it achieves balanced energy consumption among all participating mobile nodes. The EARP protocol is based on DSR, where the route discovery requires flooding of route-request messages. The nodes in the network sharing about their routing information such as battery level to confirm about their participation in route discovery process. The energy-hungry nodes can preserve their battery level by refuse to forward the data packets to others but they participated in the route recovery process. In EARP the receiver node need not to be waited for getting most energy efficient routing path to forward the data. Depending on the battery level, the nodes have the choice to determine whether or not to accept and forward the route-request message to their neighbor nodes.

When the battery level is higher than a threshold value (Thr), the intermediate node can forward route-request message to the next node; otherwise, the message is dropped. The destination node will receive a route-request message when all intermediate nodes in the determined route have good battery levels. Thus, the first arriving message is considered to follow an energy-efficient as well as a reasonably short path.

If any of the intermediate nodes along every possible path drops route-request message, the Source will not receive a single reply message even though one exists. To prevent this, the source will re-send the same route-request message, but this time with an increased sequence number. When an intermediate node receives the same request message again with a larger sequence number, it adjusts (lowers) *Thr* to allow forwarding to continue, In order to reduce the repeated request messages and to utilize the route cache, four routing-related control messages are introduced: DROP_ROUTE_REQ, ROUTE_CACHE, DROP_ROUTE_CACHE, and CANCEL_ROUTE_CACHE.

The proposed node selection method considers a new parameter known as the energy distance factor. This factor helps to select the best next hop node for optimizing the energy efficiency. Instead of considering the absolute energy level of the nodes, we are considering the residual energy of the nodes as a fraction in this proposed idea. Based on this scheme of selecting nodes with sufficient residual energy level, an energy aware routing protocol for MANETs is proposed here.

The aim of this scheme is to improve the performance of the alternate path selection by selecting the best energy level nodes along the path from the source to destination. In general, nodes in a network are having different energy level. Hence, it is important to select the best intermediate node in terms of residual energy. If the energy level of a node expired during the transmission of data, it will force a new route discovery process that interrupting the data transmission. Route discovery is costly in terms of both transmission delay and energy consumption. During the route discovery, multiple nodes search for the neighbor for the purpose of identifying and establishing the route again. This would consume more energy than that required for transmitting data.

IV. SIMULATION

To evaluate the performance of MANET energy aware routing protocols PAR, APR, PLR, EARP simulation is carried out. The simulation results presented in this paper

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has been obtained using the ns-2 simulator (version ns-2.29). Simulations are run over a1000m * 1000m topology. The number of nodes in the wireless network is fixed to 100. All random scenarios have been generated for a maximum speed of 16.67 m/s and a pause time of 0 seconds and 500 seconds. Traffic sources are chosen as TCP-IP and the scenario are established.

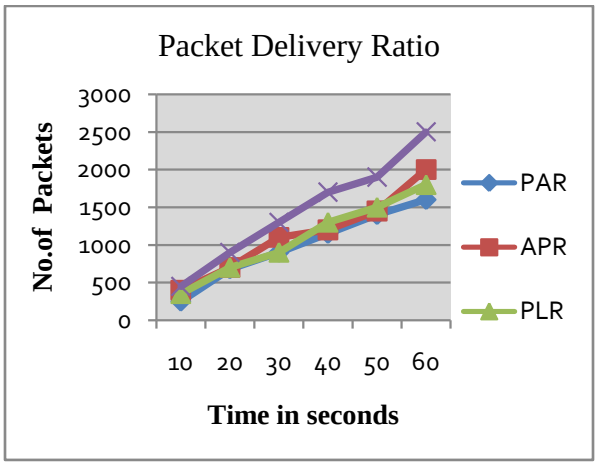

Fig 1.Packet delivery ratio

Total energy consumption is the difference of the total energy supplied to the network and the residual energy with the network, in Joules. The initial energy supplied to the network in each scenario is 5000 Joules.

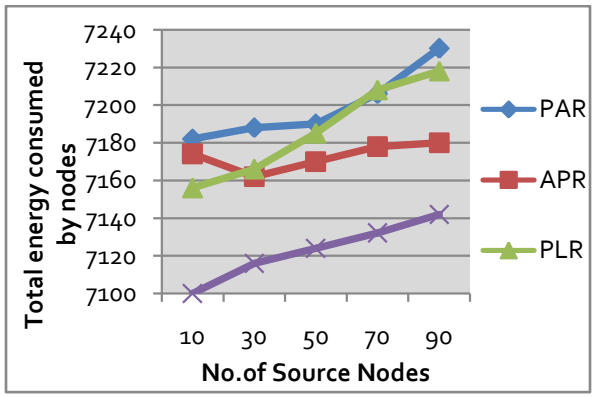

Fig 2.Energy consumption by nodes

A scenario for 100 nodes and 500 pause time has been evaluated for varying no. of sources from 10-90 and the results are shown in Fig 2. As figure shown, at the initial stage of the simulation EARP consume more energy but later on it has less energy consumption as compare to PAR, APR and PLR, while PAR do not have a clear edge in terms of energy consumption. The smooth curve is obtained for EARP in terms of energy consumption, which shows proper distribution of energy among nodes.

V.CONCLUSION

A MANET consists of autonomous, self-organizing and self-operating nodes. It is characterized by links with less bandwidth, nodes with energy constraints, nodes with less memory and processing power and more prone to security threats than the fixed networks. However, it has many advantages and different application areas from the fixed networks or the infra-structured mobile networks. The applications of ad-hoc mobile networks is rapidly growing and changing, and while there are still many challenges, it is likely that these networks will meet wide-spread use within the next few years. As we consider routing problem in MANETs, Numerous solutions have been proposed. But energy efficient routing decision is more important for reliability of network. In this chapter, we have provided descriptions of a number of energy aware routing schemes proposed for MANETs.

Each protocol has some advantages and disadvantages, and is well-suited for certain situations based on the application. Moreover, direct comparison of the energy efficient routing protocols is not possible because they are based on different assumptions such as location information availability and transmission power control. Instead, they must be carefully combined for extending the MANET lifetime.

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BIOGRAPHIES

Ms PARKAVI received her B.E. degree in Information Technology from Bharathidasan University Trichy, India, in 2004, and received her M.E. degree in Computer Science and Engineering from the College of Engineering, Guindy, Anna University, Chennai, India, in 2008. She is currently pursuing the full time Ph.D. degree in Computer Science and Engineering from the Anna University, Chennai. Her research interest includes wireless communication networks, Soft Computing, Neural Networks, Fuzzy Systems, AI, Sensor Networks, and Pervasive Computing. She served as an assistant Professor for the past 5 years.

DR VIVEKANANDAN PERIYASAMY received his Master of Science in Applied Mathematics from Madras University in 1978 and Doctor of Philosophy from Anna University in 1987. Also, he obtained his postgraduate degree in Master of Engineering in Computer Science& Engineering from Anna University in 1995. He is working as Professor of Mathematics, Department of Mathematics in Anna University from 1978. He visited Singapore, Malaysia, German, Bangladesh, Sultanate of Oman and USA for presenting research papers and Chairing sessions. He has published more than 89 research papers in national and international journals. His areas of research are Neural Network, Internet Security and Software Reliability. Currently, he is on an assignment to Department of Information Technology, Higher College of Technology, Muscat, Sultanate of Oman.