An Efficient Network Lifetime Extension-Aware Cooperative MAC Protocol for WSNs with Optimized Power Control

R.Monika, S.Rama Devi, S.Rameeja Beevi & Dr.V.Jeevanantham, Assistant Professor,

Department of ECE, SSM Institute of Engineering and Technology, Dindigul, Tamil Nadu, India

ABSTRACT

The aim of this study a cooperative medium access control (CMAC) protocol, termed network lifetime extension-aware CMAC for wireless sensor network (WSNs) is evaluated. The main feature of the LEA-CMAC protocol is to enhance the network performance through the cooperative transmission to achieve a multi-objective target orientation. The unpredictable nature of wireless communication links results in the degradation of network performance in terms of throughput, end-to-end delay, energy efficiency, and network lifetime of WSNs. Through cooperative transmission, the network performance of WSNs can be improved, provided a beneficial cooperation is satisfied and design parameters are carefully selected at the MAC layer. To achieve a multi-objective target-oriented CMAC protocol, we formulated an optimization problem to extend the network lifetime of WSNs. The optimization solution led to the investigation of symmetric and asymmetric transmits power policies. We then proposed a distributed relay selection process to select the best retransmitting node among the qualified relays, with consideration on a transmit power, a sufficient residual energy after cooperation, and a high cooperative gain. To improve the network performance of wireless network through the exploitation of spatial diversity gain in the medium access control (MAC) layer stack of cooperative communication, an efficiently designed cooperative medium access control (CMAC) protocol becomes essential and challenging to achieve in practice. The simulation results show that the LEA-CMAC protocol can achieve a multi-objective target orientation by exploiting an asymmetric transmit power policy to improve the network performance.

Key Words: CMAC, LEA-CMAC, WSN, network lifetime, power control, optimization.

INTRODUCTION

Wireless communications have developed tremendously over the past few decades due to the large demand for mobile and wireless access. Compared to wired communications, the signals transmitted over wireless channels suffer from severe attenuation. The overall reliability of wireless communication can be significantly improved by transmitting multiple copies of the same signal over multiple independent fading channels. Wireless sensor networks (WSNs) are widely used in many applications, such as environmental monitoring, traffic control, product quality monitoring, mineral survey and disaster relief. Cooperative communication has evolved as one of the mitigating techniques in combating the ever-changing nature of wireless networks. By exploring the broadcast nature and independent fading characteristics of wireless channel, mobile terminals in the vicinity of an ongoing transmission can assist in forwarding their successfully decoded packets to its intended destination via a dual-hop transmission i.e. reactive relaying. This arrangement has proven to drastically reduce the high cost of deploying infrastructural based networks such as multiple input multiple output (MIMO) systems through the exploitation of virtual antennas to achieve spatial diversity, improve throughput, delay and extend the coverage area of wireless networks. On the other hand, harnessing the virtual antenna array of mobile terminal comes with the high cost of energy consumption and shortens the network lifetime of energy-constrained mobile terminals due to size and lifetime-limited battery capacity which results in instability and unreliability of communication networks. Sensor networks are generally deployed in real time applications where humans cannot stay to collect information. Usually, the data collected by the sensors are transmitted to a fusion center and the information retrieval task is accomplished through the cooperation of bandwidth and energy limited sensors.

In this project, we propose a network lifetime extension aware cooperative medium access control (LEA-CMAC) protocol that is oriented to achieve a multi-objective target.

LITERATURE SURVEY

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- X. Wang and J. Li: Improving the network lifetime of MANETs through cooperative MAC protocol design. In this paper, a cross-layer distributed energy-adaptive location based CMAC protocol (DEL-CMAC) was proposed , mainly for prolonging the network lifetime of mobile ad-hoc networks (MANETs),2015

PROPOSED APPROCH

In this paper, we propose a network lifetime extension aware cooperative medium access control (LEA-CMAC) protocol that is oriented to achieve a multi-objective target. The contributions of this paper

are as follows:

We propose multi-objective oriented CMAC protocol that integrates an efficient relay selection process, to improve network lifetime, energy efficiency and throughput in decode and forward (DF) reactive relaying. We formulate an optimization problem with an objective of extending the network lifetime of WSNs, while constraining the power control, post cooperation residual energy and link quality dependent cooperative gain. We exploit an asymmetric transmit power i.e. the transmit power allocation

at both the source and helper nodes to be adaptive. In proposed system, all nodes in the network share the same wireless channel medium and exchange control packets transmitted at a fixed rate of 1 Mbps and data packets transmitted at a higher rate greater than the direct transmission rate between the source and destination nodes. The nodes are uniformly distributed with source nodes always having data packet to transmit to the destination node. The N relay nodes can assist in forwarding the correctly decoded transmitted data packet to the destination node at a reduced transmission cost and therefore, improves the overall network performance. In this network, group of nodes are clustered. Every cluster contains a cluster head which will be selected based on highest energy available among nodes in the cluster. If a member node gets a data, it will be forwarded to cluster head instead of sending all the cluster members. Hence energy could not be lost for all the members of a cluster unnecessarily**.** Lastly, we propose an efficient best relay selection procedure that ensures sufficient residual energy after cooperation while also balance the energy consumption in the network.

In this paper, unless stated otherwise, relay, nodes, and retransmission are used interchangeably. The remainder of this paper is organized as follows. In Section II, the details of network model for the protocol are provided. Section III describes the proposed protocol which includes protocol description, relay selection algorithm, network lifetime and energy model, and optimization based distributed power allocation.

PROTOCOL

In this paper, Leach (Low Energy Adaptive Cluster Hierarchy) protocol is used here. LEACH is a hierarchical protocol in which most nodes transmit to cluster heads, and the cluster heads aggregate and compress the data and forward it to the base station (sink). Each node uses a stochastic algorithm at each round to determine whether it will become a cluster head in this round. The principal aim of this protocol is to improve the lifespan of wireless sensor networks by lowering the energy consumption

required to create and maintain Cluster Heads.

ALGORITHM

In this paper the SCH (secondary cluster head) algorithm is used. We propose a secondary cluster head to avoid the cluster head death and minimize the dead node count for small runs. The SCH accumulate the data from cluster members and forward the data to the CH which in turn forwards to the sink node. The main reason for choosing two cluster heads is to divide the task of transmission of data packets to the BS such that the distance

between the latter and the nodes is minimal. The distance between the cluster head and its other members must also be minimal to ensure optimal power saving.

BLOCK DIAGRAM

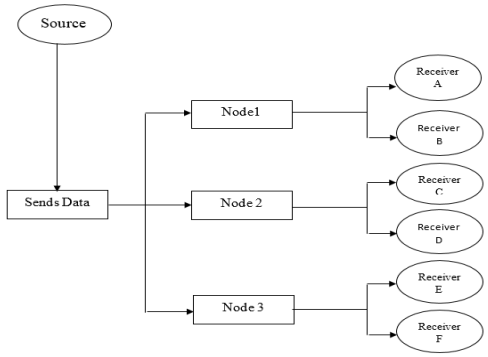

FIGURE 1

MODULES DESCRIPTION

Network model

Each node estimates the channel gain between itself and the source and destination nodes in terms of signal-to-noise ratio (SNR) of their received control packets which is a function of distance, path-loss and fading to correctly decode the data packet. The fading channel between two nodes is assumed to be an independent-identically-distributed (i.i.d) block Rayleigh fading during the transmission of a data packet. Each node in the network is half duplexed with a constraint maximum transmission power.

Relay Selection:

The relay selection procedure of the proposed LEA-CMAC protocol is based on extending the network lifetime and maintaining a high network throughput with reduced transmit power. Since the relaying nodes are randomly distributed in the vicinity of the source and destination nodes and can assist in forwarding the overheard data packets, the throughput of the

network can be enhanced provided that the data-rate in the two-hops is greater than that of the direct transmission.

LEA-CMAC Protocol

This algorithm allocates network lifetime and energy model, and the optimized transmit power allocation. The HRF frame is used to select the best helper node in a distributed manner. This control frame is transmitted/broadcast by the winning best relay node after a successful relay selection period. This is to inform the source, destination and other nodes in the network of its intention to assist in forwarding the successfully decoded data packet. In this paper, the best relay node is defined as the helper node that can achieve higher throughput, reduce the total transmit power and extend the lifetime of the network. All control frames are transmitted at a basic rate of 1 Mbps to reserve the channel medium for successful transmission to take place between communicating nodes by setting their network allocation vector

Network Lifetime and Energy Model:

This protocol is designed for a distributed ad-hoc network where there exists no centrally controlled coordination in sharing or allocating network resources. The network lifetime of a node has been defined by many researchers as the average time for a node in the network to totally exhaust it power and quit the network. Since each node is powered by an energy source (battery), its lifetime is a function of its initial energy and energy consumption per unit time. Therefore, to maximize the lifetime of a network, emphasis is laid on the node's battery to ensure that a node does not totally run out of power.

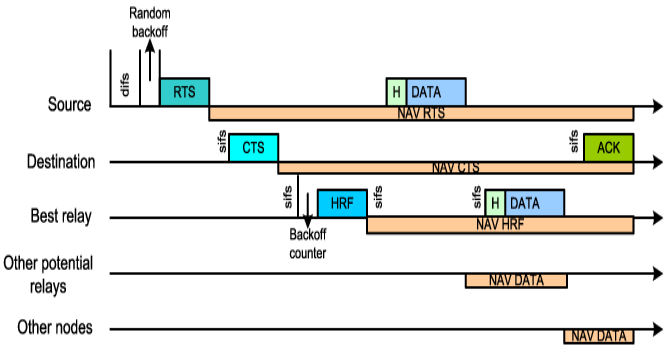

FIGURE2 Packet Transmission of LEA-CMAC

SIMULATION

1.**Throughput**:

The number of successfully received data bits at the destination node in a unit time.

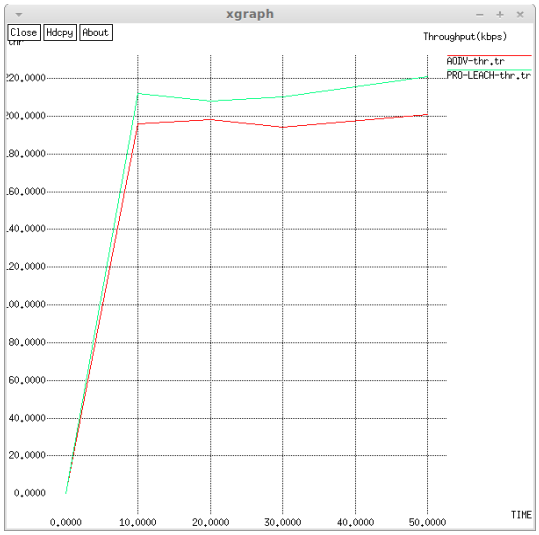

FIGURE 3 The network throughput against packet size of simulated protocols at N = 50.

2. **Delay**:

It is the time spent between when a packet is ready to be transmitted until it is successfully received at its intended destination.

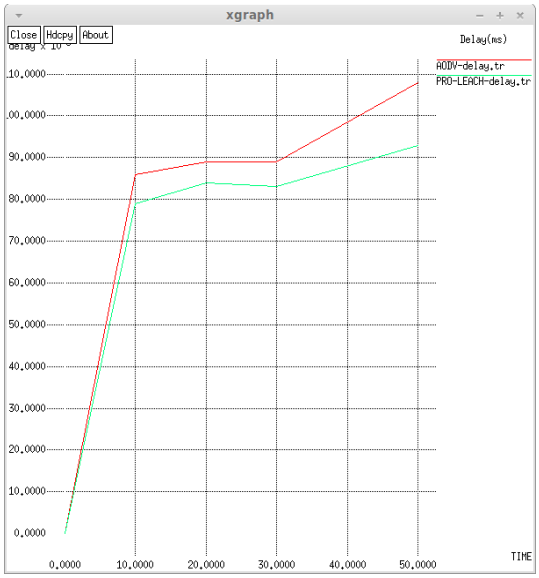

FIGURE 4 The delay of simulated protocols with varying number of nodes

3.Packet delivered:

It is the average number of packets successfully delivered during the lifetime of a network.

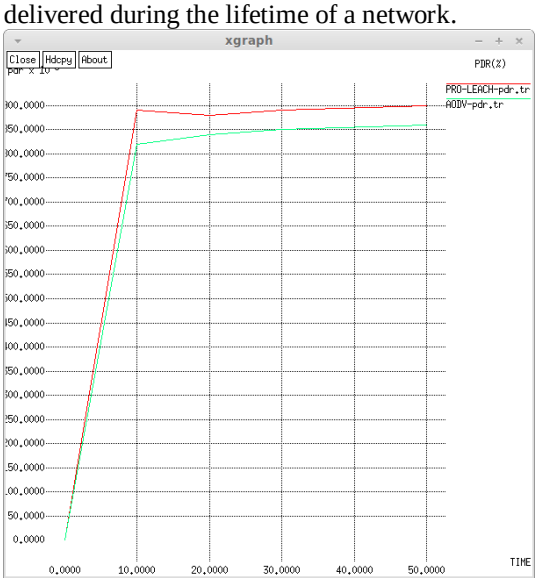

FIGURE 5 The total packet delivered of simulated protocols with varying number of nodes

4. Energy efficiency:

It is the energy consumed to successfully transmit one data packet to its intended destination.

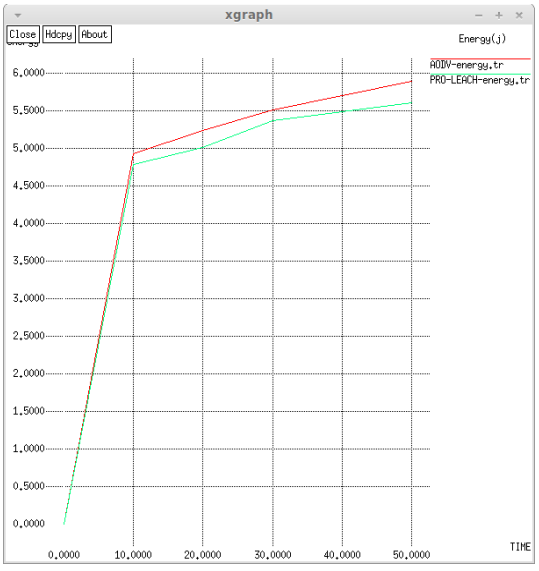

FIGURE 6 The energy efficiency of simulated protocols with varying number of nodes

5.Network lifetime:

It is the time it takes one of the node in the network to totally run out of energy supply.

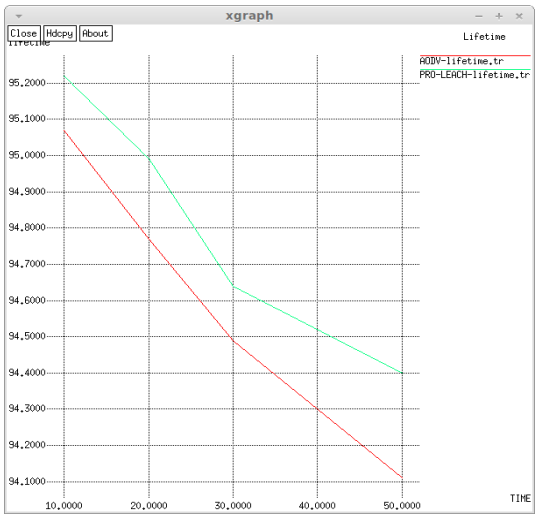

Figure 7 The network lifetime of protocols with varying number of nodes

CONCLUSION

In this project, we proposed a multi-objective target oriented network lifetime extension-aware cooperative MAC protocol termed LEA-CMAC for WSNs. To extend the network lifetime, a distributed relay selection algorithm was developed and the best helper node is selected with different transmit power allocated at the source and helper nodes respectively. Also, transmission gain and residual energy were considered in selecting the best helper node in the MAC layer. Our proposed protocol significantly improves the overall network performance in network lifetime, energy consumption, and still achieves a better network throughput as compared to other existing CMAC protocols. Through extensive simulation, our protocol shows that the best optimal relay can be selected with asymmetric transmit power control to achieve a multi-objective target oriented protocol.

FUTURE ENHANCEMENT

The proposed scheme accomplished better results in terms of detection accuracy, certification delay, saving network energy and computational overheads. The simulated results and comparative analysis demonstrate that the proposed algorithm achieves better results in terms of increasing network life time. Sharing large amount of information into wireless sensor network ensured reliability and effectiveness of the proposed scheme. In future, we shall try to optimize the data management and resources of the framework for effective results.

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