East Algorithm For A-MAC Wireless Body Area Networks

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ABSTRACT
Major challenge in design of wireless sensor networks (WSNs) is to reduce energy consumption of sensor nodes to prolong lifetime of finite capacity batteries. In this paper, we propose energy-efficient adaptive scheme for transmission (EAST) in WSNs. To achieve low power operation, several MAC protocols already proposed for WSN. In this scheme, temperature-aware link quality estimation and compensation, helps to divide the network into three logical regions to minimize overhead of control packets. Threshold on transmitter power loss and current number of nodes in the room region helps to adapt transmit power level according to temperature variation. Evaluation of the proposed scheme is done by considering body sensor nodes and reference node both static and mobile. Simulation results show that the proposed scheme effectively adapts transmission Power level to changing link quality with less control packets overhead and energy consumption as compared to classical approach with single region in which maximum transmitter Power level assigned to compensate temperature variation.

Key Words: WSN, Power, batteries, temperature, EAST, quality, power loss, energy consumption.

INTRODUCTION
Recent advancements in large scale integration and wireless communication technologies have enabled the development of small size, low cost, and multi-functional devices known as sensor nodes. Sensor nodes are capable of sensing the desired environmental parameters within their vicinity, such as temperature, pressure, moisture, and pollutants, etc., converting the sensed variable to electrical signal and transmitting the sensed data to the desired destination.
To achieve these objectives, sensor nodes are equipped with sensors, microcontrollers/microprocessors, and wireless trans-receivers. When these sensor nodes are deployed in large number to monitor an area, they form self-organizing cooperative wireless ad-hoc network, known as wireless sensor network. The wireless sensor networks are mostly deployed in remote and hazardous locations, where manual monitoring is very difficult or almost impossible.
Due to deployment of wireless sensors in unattended harsh environment, it is not possible to charge or replace their batteries. Therefore, energy efficient operation of wireless sensors to prolong the lifetime of overall wireless sensor network is of utmost importance [1, 2]. Due to their low power radio, wireless sensor nodes cannot transmit the data to large distance in single hop, which makes multi-hop communication essential in case of real life deployment. However, in multi-hop cases, if the energy consumption of sensor nodes is not managed properly it may create energy-hole problem in the network [3].

In literature, a number of protocols have been proposed to manage and reduce the energy consumption of sensor nodes [1-8]. Grouping sensor nodes into clusters has been widely used to achieve this objective. In clustered networks, one of the sensor nodes is elected as cluster head for each cluster. Sensor nodes in each cluster transmit data to their respective cluster head and the cluster head in turn forwards the data after aggregation/fusion to sink node through single/multi-hop transmission. LEACH is one of the most popular distributed single-hop clustering protocols [5].

In this protocol, the clusters are formed, based on received signal strength. The role of cluster head is periodically rotated amongst the sensor nodes present in the cluster to ensure balanced energy consumption of sensor nodes. This algorithm becomes very inefficient in case of large area sensor networks due to single hop communication of cluster heads to the sink. A number of improvements have been proposed in literature to overcome the shortcomings of LEACH [6, 15-17].

Some of them are LEACH-C [6], PEGASIS [16], TEEN [15], HEED [17], etc. Hausdorff [10] and ERP-SCDS (Energy Efficient Routing Protocol for wireless networks with Static Clustering and Dynamic Structure) [11] are recent clustering algorithms. In this paper, we propose an energy efficient protocol consisting of clustering, cluster head selection/rotation and data routing method to prolong the lifetime of sensor network. In proposed protocol, clusters are formed only once during the lifetime of sensor network, which results in substantial saving of energy.

In a wireless sensor network sensors nodes are a low cost, resource constrained devices and are often positioned randomly. In many applications they are placed in inaccessible locations, making battery replacement unfeasible. As a consequence, energy efficiency is an important requirement in a medium access control protocol for most wireless sensor networks. Radio energy consumption is a major component contributing to the overall energy consumption at each node. Many reasons related to MAC paradigms lead to energy waste and WSN life reduction, such as:

- **Idle listening**: a node doesn’t know when will be receiving a frame so it must maintain permanently its radio in the ready to receive mode, as in the DCF method of the wireless networks protocol (IEEE 802.11). This mode consumes a lot of energy, nearly equal to the one consumed in receipt mode.

This energy is wasted if there isn’t any transmission on the channel. As in the sensors networks of, the channel is most of the time free. The passive listens presents one of the major reasons of energy loss. -
Collisions: they concern the MAC contention protocols. A collision can occur when a node receives two signals or more simultaneously from different sources that transmit at the same time.

When a collision occurs, the energy provided for frame transmission and reception is lost. Let's note that although there are MAC protocols that don't produce any collisions, as TDMA (Time Division Multiple Access), the contention protocols are more used in multi-hops networks because of their simplicity and of their capacity to operate in a decentralized context.

- Overhearing: occurs when a node receives packets that are not destined to him or redundant broadcast.

- Protocol Overhead: can have several origins as the energies lost at the time of transmission and reception of the control frames. For example, the RTS/CTS (Request To Send /Clear To Send) used by some protocols transport no information whereas their transmission consumes energy. Note that the traffic generated by control frames in sensors network is far from being negligible, it could represent until 70% of the global traffic [5].

PROTOCOL DESIGN

AR-MAC is based upon TDMA approach to minimize energy consumption. AR-MAC assigns Guaranteed Times Slot (GTS) to each sensor node for communication based upon the requirements of sensor node. To reduce overhearing and idle listening, proposed system uses periodic sleep and wakeup according to node requirements. We assume a star topology; a Central Node (CN) collects data from sensor nodes and communicates with a Monitoring Station (MS), direct or through an Access Point (AP). CN is usually equipped with larger batteries and higher computational power. One or two transceivers may be used within a single CN. In case of two transceivers total time frame T Frame is allocated for communication with sensor nodes. We assume CN with single transceiver where T Frame is divided into three parts: Contention Free Period (CFP) for communication with sensors, Contention Access Period (CAP) to accommodate emergency or on-demand traffic and time TMS for communicating sensor nodes’ data to MS.

Initially, CN starts scanning for available free Radio Frequency (RF) channels. If the current RF Channel is busy, CN switches to another RF Channel. CN selects a free RF channel for communication. After successful selection of RF Channel, CN broadcasts the Channel Packet with address and channel information to sensor nodes. On the other side end nodes scan RF channels for Channel Packet from CN. Sensor node scans the RF channel if it is free it switches to another RF channel. If the channel is busy it waits for time T CP to listen Channel Packet. If sensor node does not receive the Channel Packet, it switches again to next channel. After successful reception of Channel Packet, node starts transmission and sends an acknowledgment (ACK) packet to CN.

A-MAC deals with two types of packets: data packets and control packets. Data packet includes node’s sensed data, and control packets are as follows.

(1) Channel Packet (CP): it includes CN’s address and channel information.
(2) Time Slot Request (TSR) packet: request information to CN for GTS is embedded in TSR packet.
(3) Time Slot Request Reply (TSRR) packet: this packet includes CN’s reply to node along with GTS information.
(4) SYNChronization- ACKnowledgment (SYNC-ACK) packet: DV along with ACK of the last received data are coupled in SYNC-ACK packet.
(5) Data Request (DR) packet: CN sends DR packet to node in order to meet on-demand traffic.
(6) Acknowledgment (ACK) packet for the ACK of data packet.

![Figure 1: MAC Layer Frame Format](image1.jpg)

**PROPOSED SCHEME**

Our proposed protocol uses the available resources efficiently because it is based on specific application scenario which helps in reducing energy consumption. A-MAC uses TDMA technique, and Guaranteed Time Slot (GTS) is assigned to each node for communication.

![Figure 2: WBAN Topology](image2.jpg)

The proposed scheme PRR, ACK, and RSSI loss are used to determine connectivity. ACK estimates connectivity, but it cannot determine link quality. PRR estimates connectivity accurately, but it causes significant overhead [8].

Power controller adjusts transmission $P$ level by utilizing both the number of current nodes and the temperature sensed at each node. Since power controller is operated not merely by comparing number of current nodes with desired nodes but by using temperature-compensated $P$ level, it can
reach the desired $P_{\text{level}}$ rapidly. If temperature is changing then temperature compensation is executed on basis of relationship between temperature and RSSI loss. Network connectivity is maintained with low overhead by reducing feedback process between nodes which is achieved due to logical division of network. Transmission power loss due to temperature variation was formulated using the relationship between RSSI loss and temperature experimented by Bannister et al. The mathematical expression for RSSI loss due to temperature variation is as follows [12]:

$$RSSI_{\text{loss}} = 0.1996 \times (T^\circ C - 25^\circ C) \quad (1)$$

We estimate actual required transmitter power between each sensor node.

![Flow chart based on reference node selection using MAC protocol.](image.jpg)

**Figure 3:** Flow chart based on reference node selection using MAC protocol.

A node senses temperature by using locally installed sensor and checks if a temperature change is detected. If there is any temperature change, compensation process is executed.

**RESULTS**

Simulation results of the proposed technique for energy-efficient transmission in WSNs. Simulation parameters are as follows: rounds 1200, temperature $-10$–$53^\circ C$. 

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Figure 4: Transmitting power from REGION A

Figure 5: Transmitting power from REGION B

Figure 6: Transmitting power from REGION C

Figure 7: Transmitting power at REGION New A
Figure 8: Transmitting power at REGION New B

Figure 9: Transmitting power at REGION C

Figure 10: Transmitting power save at REGION A

Figure 11: Transmitting power save at REGION B
CONCLUSION

In wireless Body area networks data transmission is among 10 nodes in the architecture of a body and transferring data packets from one node to the other which is relevant to a clustering network and can be implementable to body area networks. Therefore energy consumption, data packets transferred from source to sink is observed in this mode of active state and dead state of the nodes which provides the network life time with high rate of energy transmission and now we are extending this by tracing the best and efficient approach based on temperature variation change of power utilisation with an adaptive approach of EAST algorithm is insisted. Here based on the temperature levels the power category is changed so for the 10 nodes power utilisation improvement is observed for all the nodes transmitting data from one to other this change is observed in power only and the improvement is observed in the all the three different lines. By combining both open-loop temperature-aware compensation and close-loop feedback control, we can significantly reduce overhead of transmission power control in WBN; we further extended our scheme by dividing network into three regions on basis of threshold RSSIloss and assigned Plevel to each node in three regions on the basis of current number of nodes and the desired number of nodes, which helps to adapt \( P_t \) according to link quality variation and increase network lifetime.

REFERENCES


