# Implementation of Energy Optimized Protocol in IEEE 802.15.4 Based Mobile WSN Using Cross Layer Approach

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***Abstract*— The proposed cross-layer operation model is implemented to improve the energy consumption and system throughput of IEEE 802.15.4 Mobile Wireless Sensor Network (MWSN). The proposed model integrates four layers in the network operation: 1) application is used for node location; 2) network is designed to construct the route routing; 3) medium access control used for message forwarding; and 4) physical layers. The location of the mobile nodes is embedded in the routing operation after the route discovery process. The location information is then utilized by the MAC layer transmission power control to adjust the transmission range of the node. This is used to minimize the power utilized by the network interface to reduce the energy consumption of the node(s). The model employs a mechanism to minimize the neighbor discovery broadcasts to the active routes only. Reducing control packet broadcasts between the nodes reduces the network's consumed energy. It also decreases the occupation period of the wireless channel. The model operation leads the network to consume less energy while maintaining the network packet delivery ratio.**

***Keywords*— cross-layer operation, energy consumption, Mobile Wireless Sensor Network, mobile nodes.**

## I. Introduction

Mobility in Wireless Sensor Network is introduced because the nodes in this network are mobile nodes Sensor node mobility can be divided into two categories: limited mobility where there are specific nodes that roam around the network to perform an exclusive task (e.g., mobile sink nodes) and random mobility where the nodes (sensor nodes) roam around the area of deployment to collect the data needed for the application. Advantages of introducing mobility to the network are Applications, Topology and Network Connectivity. Mobility can introduce a critical challenge to the operation of the deployed network if mobility is random. i.e., sensor nodes are also mobile in the network, the effect is greater as the network topology changes become rapid and that affects the connectivity of the nodes because we can't predict in which direction the mobile nodes will move. Topology changes have an effect on the routing operation as the links need to be rebuilt frequently; therefore, there is an increase energy consumption of the nodes. Mobility affects the MAC protocol operation because the connectivity can suffer from broken connections due to the transmission range of the wireless interface. The location of the sensor node(s) in random mobility is of importance because the sensed event is attached to the location of the sensor node [3].

## II. Existing System

In existing system SAMAC [2] is used, SAMAC is a cross-layer model that combines the slotted operation of the MAC protocol with the direction of the attached sectored direction antennas. It uses a different approach by using sectored antenna which helps in increasing throughput, delivery ratio and the energy consumption. Here the time schedule is computed centrally at the sink node and is then distributed to all other nodes which help in improving the energy consumption and delay. The communication interferences between the nodes are lowered because the communication is between the directional antennas as Omni-based antennas can infer higher interference. Transmission power control is utilizes a TDMA-based MAC mechanism with a clustering routing algorithm. The transmission power control is achieved based on the path-loss characteristic of one hop between connected nodes. If the nodes are mobile, the transmission recalibration operation of the whole network has to be performed in a frequent manner. Drawbacks of existing system are it consumes more energy, decrease the network lifetime.

## III.PROPOSED SYSTEM

To overcome these drawbacks a new scheme is introduced a cross-layer operation model that can improve the energy consumption and system throughput of IEEE 802.15.4 MWSNs. This project proposed a simple and efficient model for the effective cross layer model for the MWSN. It based on the two mechanisms the first one is to control the packets being broad cast. The second one is transmission power control. The transmission control is only active when the route is on .The cross layer model that is not efficient in each mechanism process. The mechanism that should be implemented in each layer is important for the secure transmission. The proposed model integrates four layers in the network operation: 1) application (node location); 2) network (routing); 3) medium access control (MAC); and 4) physical layers. The location of the mobile nodes is embedded in the routing operation after the route discovery process. The location information is then utilized by the MAC layer transmission power control to adjust the transmission range of the node. This is used to minimize the power utilized by the network interface to reduce the energy consumption of the nodes. This model is further effective for the best of our knowledge.

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## IV. SYSTEM OVERVIEW

The location of the mobile node is also identified by the GPS module attached to each and every node in the network. All the collected information about the node such as location, distance between the mobile nodes are stored in a list named as neighbour's list (NB-List). Based on the distance calculated the transmission power is adjusted.

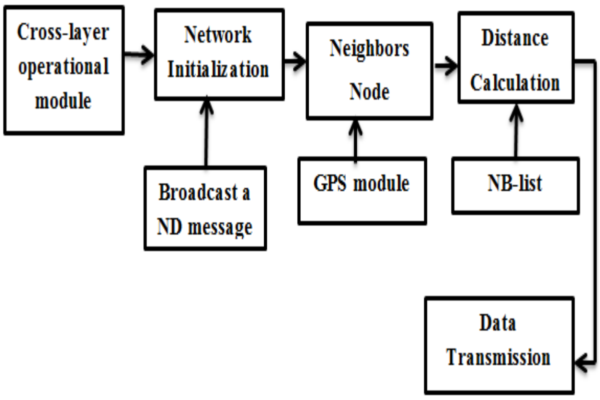


Fig.1 System Overview

In Figure 1, it shows the relationship between different components of system. The Cross-layer operational model integrates four layers which are used to perform different operations during the data transmission in Wireless Personal Area Network. First the operations start by broadcasting Neighbour discovery packet which is used for Network Initialization. Before broadcasting Neighbour discovery packet don't know how many mobile nodes are there within a particular range, after broadcasting the Neighbour discovery packet it is easy to identify the mobile nodes in the network. The operational model target application was mobile node tracking for social purposes [4]. Mobile sensor nodes roamed around a fixed deployment area. The application environment is assumed as given below

1. The system was homogenous, i.e., the nodes had the same type of equipment and capabilities (Hardware and software).
2. All sensor nodes were mobile.
3. A stationary sink node was deployed in the network.
4. The deployment surface was flat.
5. A line-of-sight was present between the nodes in the transmission range vicinity of each other.

The propagation model utilized in the evaluation process was the Two-Ray Ground model as the nodes had a present line-of-sight and no obstacles in between. The Two-Ray Ground model had been used for evaluating mobile WSN operations in [5], [6], [7], [8], and [9]. The energy model that the nodes followed contained the following states: transmission power, reception power, idle/listening power, sleep power and state transition power.

## V. MODULES

There are four modules they are

- Network Initialization
- Neighbor Node Finding
- Distance Calculation
- Data Transmission

### *A. Network Initialization*

This is the first module that is used to set the topology in Cross layer Network. At network initialization, the mobile node started to broadcast a neighbor discovery message to initiate neighbor(s) information collection and store it in a neighbors' list (NB-List). After the initialization process, if a node in the network had data of interest to send, attached with this data was the location information of the mobile node.

### *B. Neighbor Node Finding*

The location information in the node is provided by either a GPS module attached to the node or any other methods where the nodes are able to estimate their individual locations. This node then started sending route request (RREQ) packets to establish a route to the destination node. The routing protocol utilized in the operation model utilizes a periodic neighbor maintenance message which is a hello packet. Hello packets are broadcast packets; therefore, it was possible to utilize the neighbor list from the network layer in the data-link layer. This eliminated the need for neighbor discovery messages to be sent by the MAC protocol. The Routing Protocol used in this operation is AODV (Ad-hoc On-demand Distance Vector) routing protocol. AODV discovers routes as and when necessary, it does not maintain routes from every node to every other. Routes are maintained just as long as necessary. Every node maintains its monotonically increasing sequence number which increases every time the node notices change in the neighborhood topology.

AODV utilizes routing tables to store routing information they are:

1. A Routing table for unicast routes
2. A Routing table for multicast routes

- The route table stores: <destination addr, next-hop addr, destination sequence number, lifetime>.
- For each destination, a node maintains a list of precursor nodes, to route through them. Precusor nodes help in route maintenance.
- Life-time updated every time the route is used ,If route not used within its life time means then it expires.

In Figure 2, it specifies the route discovery process. In the above diagram node s wants to send the data to node D. Node S which is a source sends RREQ packet to the next node A, node A receives the packets and make a reverse entry to the node S and maintain the information such as dest=S, nexthop=S, hopcount=1.The route discovery process of AODV is given below

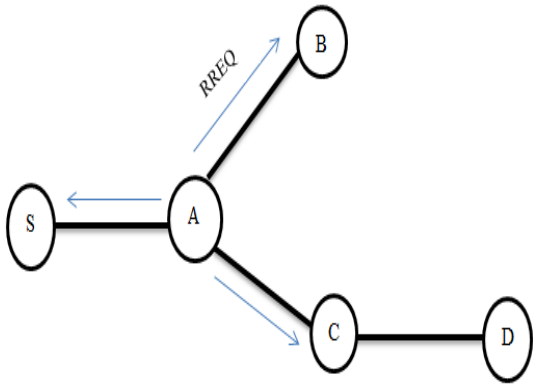


Fig.2 Route discovery process

When node C receives RREQ then C creates a Route Reply (RREP) packet with the information's such as D's IP addr, seq#, S's IP addr, hop count to D(=1) and sends an Unicasts RREP message to A.

### *C. Distance Calculation*

After the destination node received the RREQ packets, it replied by sending a unicast route reply (RREP) packet. The destination node embedded its own location information in the RREP message and sent it back to the next hop node in the reverse route. The Figure given below illustrates the RREP packet structure after embedding the location information. The next hop node in the reverse route calculated the distance between it and the destination node and exported this information to the data-link layer. The MAC protocol utilized the transmission power control-based. The distance between two nodes is calculated as the Euclidian distance between two points. In Figure 3, it specifies the message structure of RREP packet; RREP packet is send back in reverse order in a unicast direction from the destination to source. While sending the RREP packet the information about the source is included in the packet with its IP address and location information. The size of RREP packet is 32 bits. A 32-bit field is required for the location information as it is relevant to the implemented simulations 16 bits for the Xaxis and 16 bits for the Y-axis. It is possible to store the location information.

| Type | [R\|A] | Reserved | Prefix | Hop Count |
|---|---|---|---|---|
| Destination IP Address | | | | |
| Destination Sequence Number | | | | |
| Originator (source) IP Address | | | | |
| Lifetime | | | | |
| Location information | | | | |

Fig.3 RREP Message Structure

### *D. Data Transmission*

The MAC protocol utilized the transmission power control based on the distance information and calculated the required power to use when sending data packets back to the destination node. The transmission power and range is calculated by implementing the radio propagation model according to the distance calculated by the nodes. To minimize the broadcast of the control packets, the nodes that were only in the active route(s) were allowed to periodically broadcast hello packets to their neighbors. Active route is the route that has been established to transmit data from source node to destination node after the route discovery operation. This operation was repeated through all nodes until the source node. After the established route passed its lifetime and there was no data of interest to send, the nodes engaged in the operation went into sleep state. Nodes which were still involved in another route were active as the operation required. The data is transmitted by consuming less energy and lifetime of network is also increased. The proposed system used only less amount of broadcast message for control packets for data transmission between the source and destination.

### **E. Performance Analysis**

The proposed operational model consumed energy lower than the standard IEEE 802.15.4 model. The energy consumption per packet was also lower for the cross-layer model than the standard model. The low energy consumed per packet was because the packet delivery ratio for the cross-layer model was higher than the standard model and the network energy consumption was lower.

## VI. RESULTS

After implementing the proposed system on NS2 platform, the results obtained are as follows:

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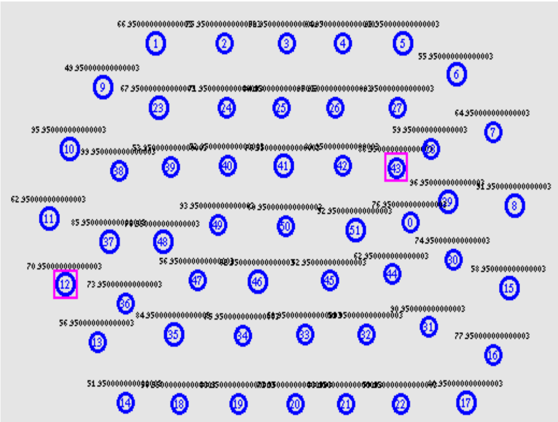

Fig.4 Network Creation

The above image shows the network creation stage of the operation, where we can able to see the wirelessly placed nodes with location information.

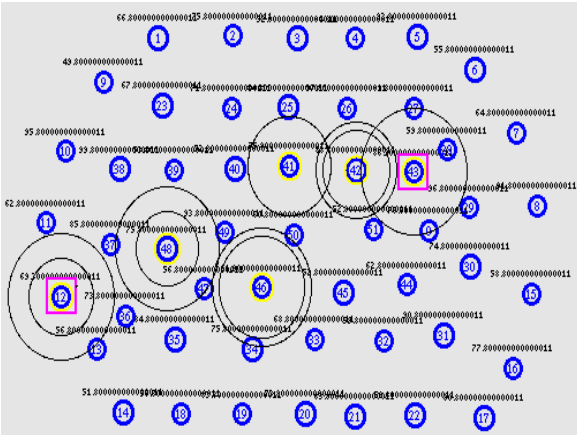

Fig.5 Route Discovery Process

In the above image we can see a path formed, through which packets are transmitted from source to the destination. The nodes continuously updating their location to perform the transmission operation.

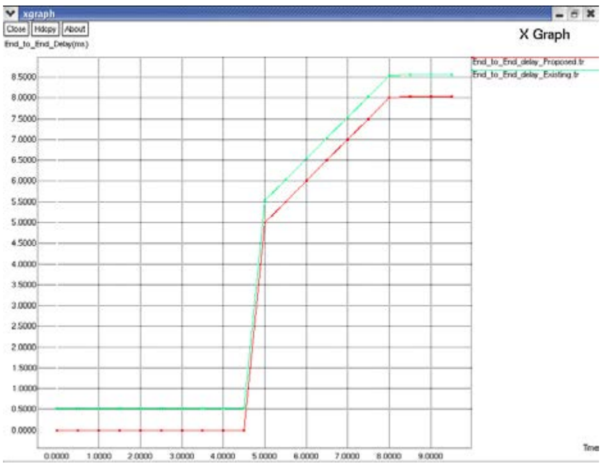


Fig.6 End-to-end delay Comparison graph

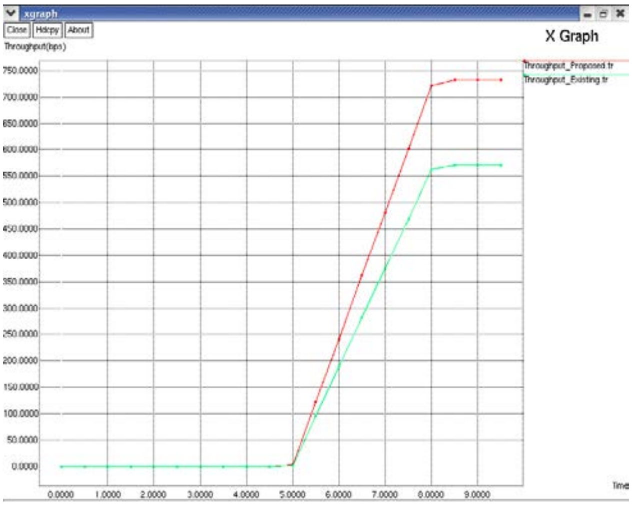


Fig.7 Throughput Comparison graph

The figure 5 shows the comparison graph of end-to-end delay drawn using Xgraph function in NS2. The graph shows that the proposed system performance (end-to-end delay is less) is better than the existing system.

The figure 6 shows the comparison graph of throughput drawn using Xgraph function in NS2. The graph shows that the proposed system performs well (throughput is high) as compared to existing system.

## VII. Conclusion

The proposed method is simple, intuitive yet highly effective cross-layer network operational model for MWSNs. The proposed model integrates four layers in the network operation: 1) application (node location), 2) network (routing), 3) medium access control (MAC), and 4) physical layers. The location of the mobile nodes is embedded in the routing operation after the route discovery process. The network model employs two major mechanisms: the first is controlling the amount of control packets being broadcast in the network to provide a relief for the communication channel between the nodes. The control packet minimization process focuses on the broadcast packets, mainly neighbor, discovery mechanism at the MAC layer and the neighbor discovery packets (hello packets) at the routing layer. The second mechanism is transmission power control that is dependent on the node'(s') location. The transmission power control mechanism is only active when the route is established; therefore, its effect is guaranteed at the data transmission state. Combined together results in energy efficiency, higher throughput and lower end-to-end delays than the standard model.

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