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A Mechanism to Reduce Power Consumption by Utilizing RMs in WSNs

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ABSTRACT*:* With wide range of potential applications Wireless Sensor Networks (WSNs) are booming technologies now a day. WSNs strongly depends on the balance between the energy storage and power consumption, so energy saving is very complicated and critical issue, since sensor nodes are basically energized by batteries for limited capacity. In sensors nodes radio is the main cause for power consumption, so there should be a limited data transmission/reception. In this paper we proposed a mechanism to reduce power consumption by utilizing RMs in WSNs. In order to represent the mobile devices such as smart phone and laptops we are using term Resourceful Mules (RMs) and energy conservation with assistance of resourceful mules (ECARM), a mechanism that opportunistically utilizes resourceful mules (RMs) such as specifically designed powerful sensors or ubiquitously used laptops, tablet PCs, and smart phones to act as assistants and save energy for WSNs. We emphasize that ECARM can also be applied in duty-cycled WSNs.

KEYWORDS: Resourceful Mules (RMs), Wireless Sensor Networks (WSNs) and Energy Conservation with Assistance of Resourceful Mules (ECARM).

I. INTRODUCTION

Wireless sensor networks (WSNs) have attracted lots of interests in research and industrial communities. In today's world, a current trend running in industry is the development of WANs. However, effectiveness in transmitting and receiving data the development of sensor techniques makes Wireless Sensor Networks (WSNs) a plausible platform of communications that is cheap and easy to deploy. The performance of WSNs is performed and boosted by optimizing the power consumption. The most challenging factor in optimizing WSNs is to achieve low energy consumption and low latency for reliable data communications with efficient node placement. However, plenty energy constraints the key factor that hinders the wide-scale deployment of WSNs. Fortunately, the new development trend of WSNs provides us opportunities to overcome the limitations. In recent years, lots of WSN applications have shifted from specific fields to domains related to people's daily lives such as health care, and intelligent home, where a variety of wireless devices coexist. For simplicity, we use the term resourceful mules (RMs) to represent these mobile devices. Movable RMs can have both mobile and static characteristics. Mobility accounts for the most important place when RMs shifts from one place to another, while static characteristics become dominant if RMs sojourn. However, most researches focus on the mobile aspect of movable RMs and little attention is paid to explore their benefits in static situations. To address these challenges, this paper presents a practical mechanism named energy conservation with assistance of resourceful mules (ECARM). We analyze typical dynamics of employees in an office building and find that if an employee has already sojourned in a spot for several minutes, he/she has a high probability to continue for a long duration. Then, we design a threshold-based method to select out that RMs with potential benefits.

From the sensor nodes which we selected from WSNs, in order to select the RM firstly we have to record the sojourn time of RM and by analyzing the movement pattern of RMs have to set threshold as a standard. Next record the time of RM passes the threshold for further process for recording the time by dong this method now RM will be allowed to take part in the network which we considered for energy conservation. Next nodes need to be classified in deployed network so this deployed network is subjected to classification it's based on the type nodes are classified as source

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node, forward node, affected node and normal node. Next RM with data is subjected to wake-up/sleep schedules, in this RM figures out wake-up/sleep schedules of forward node considered from the node classification by adopting time slot based circular schedule. The corresponding results are showcased to all RM's neighbors. By considering the obtained result nodes will adjust behaviors and among many nodes only one node will be awake. In multiple RMs source nodes do not change their behaviors but if an additional forward role is assigned to an network then old forward nodes becomes normal nodes, along with this nodes with affected and source roles at the same time become source nodes and nodes with affected and forward roles at the same time becomes affected nodes. This method will conserve the energy.

II. LITERATURE SURVEY

Fatima Almajadub et al. [1] have proposed Performance Advancement of Wireless Sensor Networks using Low Power Techniques and Efficient Placement of Nodes. In this they presented optimization techniques for WSNs for minimization of the power consumption and latency. They concentrated on the problem of minimizing the energy consumption in WSNs including hardware. ZigBee protocol is used to design nodes on WSN to achieve a very low power consumption rate. Furthermore, they proposed to use IRS protocol in WSN within a ZigBee technique to discover information from unaware locations and achieve efficiency of energy and sacrifices latency. Their main idea is to support WSNs with both ZigBee technique and IRS protocol. Thus, they evaluate the performance of specific routing and some algorithms of congestion control when wireless sensor nodes are deployed under different placements of network. Antonio Moschitta et al. [2] have proposed Power consumption Assessment in Wireless Sensor Networks. Review on power consumption measurements in WSN networks has been presented in this paper, highlighting the main WSN features, the node architecture, and the network operation. Measurement and simulation techniques adopted to assess the power consumption of a WSN node have been discussed, showing the most significant approaches, the underlying tradeoffs of each methodology, and discussing the achievable accuracy. A case study has been introduced, presenting a characterization procedure and developing improvements for an existing WSN simulator. Giovanni Pau et al. [3] have proposed a Power Consumption Reduction for Wireless Sensor Networks Using a Fuzzy Approach. In this paper, they explained a novel fuzzy logic based mechanism that according to the battery level and to the ratio of Throughput to Workload determines the sleeping time of sensor devices in a Wireless Sensor Network for environmental monitoring based on the IEEE 802.15.4 protocol. They used to find an effective solution that achieves the target while avoiding complex and computationally expensive solutions, which would not be appropriate for the problem at hand and would impair the practical applicability of the approach in real scenarios. An adoption on off-the-shelf devices proves that the proposed controller does not require powerful hardware and can be easily implemented on a low-cost device, thus paving the way for extensive usage in practice.

III. METHODOLOGY

Figure 1 represents the overall architecture of proposed system. From the sensor nodes which we selected from WSNs, in order to select the RM firstly we have to record the sojourn time of RM and by analyzing the movement pattern of RMs have to set threshold as a standard. Next record the time of RM passes the threshold for further process for recording the time by dong this method now RM will be allowed to take part in the network which we considered for energy conservation. Next nodes need to be classified in deployed network so this deployed network is subjected to classification it's based on the type nodes are classified as source node, forward node, affected node and normal node. Next RM with data is subjected to wake-up/sleep schedules, in this RM figures out wake-up/sleep schedules of forward node considered from the node classification by adopting time slot based circular schedule. The corresponding results are showcased to all RM's neighbors. By considering the obtained result nodes will adjust behaviors and among many nodes only one node will be awake. In multiple RMs source nodes do not change their behaviors but if an additional forward role is assigned to an network then old forward nodes becomes normal nodes, along with this nodes with affected and source roles at the same time become source nodes and nodes with affected and forward roles at the same time becomes affected nodes. This method will conserve the energy.

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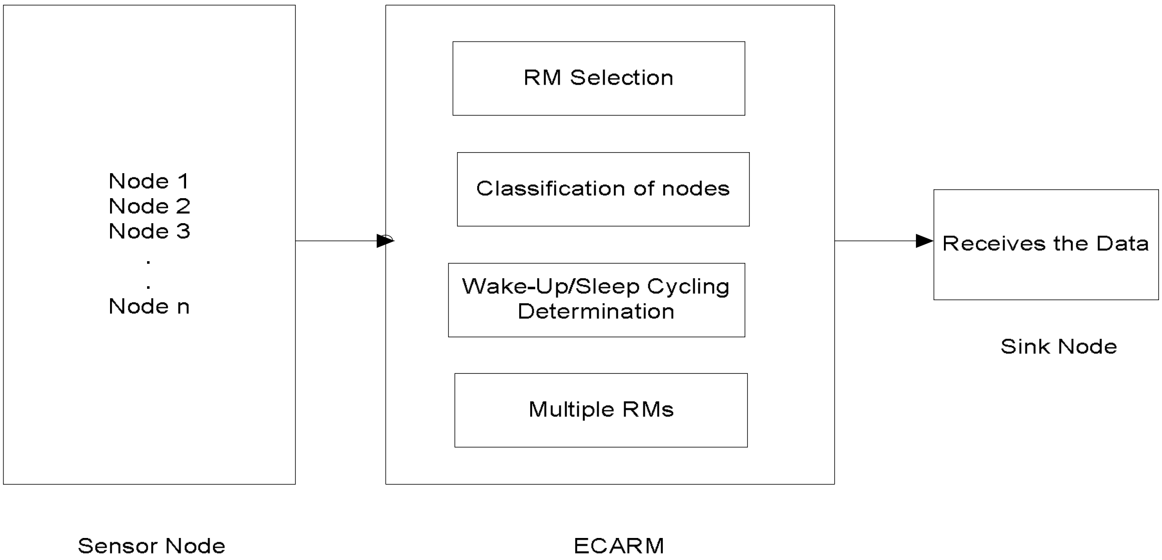

Fig. 1. Block Diagram of proposed system.

A. ECARM (ENERGY CONSERVATION WITH ASSISTANCE OF RESOURCEFUL MULES)

ECARM designed under the principle of effectiveness, low complexity, and robustness. Which can be applied even when sensors are already duty-cycled only after an RM is incorporated, source nodes send data to the RM directly without long preamble or repeated transmission, whereas forward nodes experience dual cycling's. As a result, both types of sensors enjoy energy saving, and energy conservation efficiency of ECARM is increased. Which exploits benefits from long-been-neglected static aspects of movable RMs. ECARM is suitable for scenarios with limited RM dynamics. Offices and libraries are typical applicable environments, where people (RMs) spend most of the time staying in a spot statically and seldom move. Whenever they move, they quickly leave that spot. Another requirement of ECARM is that routing protocols adopted by WSNs should ensure a structural topology.

B. RM SELECTION

The main purpose of this step is to find this RMs with a high probability to sojourn statically for a long duration. From the sensor nodes which we selected from WSNs, in order to select the RM firstly we have to record the sojourn time of RM and by analyzing the movement pattern of RMs have to set threshold as a standard. Next record the time of RM passes the threshold K_0 for further process for recording the time by dong this method now RM will be allowed to take part in the network which we considered for energy conservation. After an RM R emerges in WSNs, its neighbors will learn its existence through lower-layer neighbor discovery protocols. The sojourn time of R will be recorded and only after it passes a predefined threshold K_0 , R will be allowed to participate in WSNs and become an assistant.

C. NODE CLASSIFICATION

Source nodes prefer to choose sensors located in parts closer to the sink as data relays. However, this location awareness assumption is impractical in most WSN application scenarios. In this paper, nodes need to be classified in deployed network so this deployed network is subjected to classification it's based on the type nodes are classified as source node, forward node, affected node and normal node. Accordingly, data passing through an RM's coverage area are relayed by sensors whose next-hop is both out of that area and closer to the sink than the RM.

1) Source node: A node and its next-hop are both neighbors of the same RM.

2) Forward node: A node is a neighbor of an RM, and its next-hop is not a neighbor of that RM. 3) Affected node: A node's next-hop is a forward node of an RM. But the node itself is not a neighbor of that RM.

4) Normal node: A node satisfies that neither it nor its next-hop is the neighbor of RMs. Without RM, every sensor is regarded as normal.

By considering the obtained result nodes will adjust behaviors and among many nodes only one node will be awake. In multiple RMs source nodes do not change their behaviors but if an additional forward role is assigned to an network

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then old forward nodes becomes normal nodes, along with this nodes with affected and source roles at the same time become source nodes and nodes with affected and forward roles at the same time becomes affected nodes.

D. WAKE-UP/SLEEP CYCLING DETERMINATION

The RM figures out wake-up/sleep schedules of forward node considered from the node classification by adopting time slot based circular schedule. The corresponding results are showcased to all RM's neighbors. Within the coverage ofR, for data relay only one awake forward node is enough. Because of its simplicity and efficiency a time-slot-based circular schedule method (with time slott_s) is deployed. Parameter t_s determines the basic wake-up duration of a forward node. Will consider n_R which denote the number of forward nodes associating with R. As to forward nodei, where $i = 1, 2, \ldots, n_R$, the time-slot based circular schedule period $T_p^R$is also its wake-up/sleep cycling period, which is

$$T_p^R = n_R \times t_s = T_{sl}^i + T_{wk}^i \quad (1)$$

Where T_{sl}^i is wake-up duration of i and T_{WK}^i is sleep duration of i in a single wake-up/sleep cycling. Different from $t_s$that is allocated for relaying R's collected data, time interval $t_{ac}$is designated for the channel access delay caused by the MAC layer. Withoutt_{ac}, data received at the end of the T_{WK}^i period may not have the opportunity to be transmitted in this cycling, which may cause severe delay especially in the case where $t_s$is very long. Both $t_s$and $t_{ac}$are predefined parameters and identical for all sensors. We have already mentioned that forward node i may be the next-hop of affected nodes, where data buffered will be transmitted when i wakes up. This part of data may interfere with data from R. To avoid collision, we allocate $t_{af}^i$to deal with buffered data uniquely. Therefore, we have

$$T_{wk}^i = t_{af}^i + t_s + t_{ac} \quad (2)$$

Next, we show how to calculate t_{af}^i properly while keeping the simplicity of ECARM. As we already knew, t_{af}^i is designated to deal with data buffered in affected nodes, such that $t_{af}^i$is determined by the potential number which is denoted asP_a^i of affected nodes and their data rates. We consider thatP_a^i is related to the neighbor divergence between i and R. No affected node would exist and t_{af}^i is totally unnecessary if all neighbors of i locate in R's coverage area,. On the contrary, if most neighbors of i locate far away from R, P_a^i becomes larger and a longer $t_{af}^i$is required. Therefore, we have

$$P_a^i = 1 - \frac{n_{re}^{iR}}{n_{ne}^i} \quad (3)$$

Wheren_{ne}^imeans the number of i's neighbors, and n_{re}^{iR}stands for the number of nodes that are neighbors of both i and R. We assume that the data collection rate of R is γR, and the number of source nodes in R's range is $n_s R$. Therefore, the average data rate of source nodes is γR ns R , WSNs is a function of its distance from the sink. Hence, data rates of affected nodes and source nodes corresponding to the same RM are similar. We assume i's data reception rate duringt_{af}^iequals to that duringt_s, which can be represented by

$$\gamma R = \frac{\frac{\gamma R}{n_R^8} \times T_p^R \times p_A^I}{t_{af}^i} \quad (4)$$

By using this,t_{af}^ican be estimated.

E. MULTIPLE RMS

In this section will discuss about the multiple RM's. The RM participation will brings power conservation for sensors. Excessive RMs would cause unnecessary interaction burden and worsen the channel environment so multiple RMs are not always better. Our policy is that only one RM is allowed to participate in the WSN within its coverage. If an RM has already joined the network, the newly appeared one will be queue until the former one vanishes. However, a sensor overlapped by two or more RMs that cannot hear each other will be assigned with multiple roles, which may cause sensor behavior confusion. Although this situation rarely happens, the results would cripple WSNs seriously. To keep ECARM simple and robust we have to ensure sensors function must be in order, to achieve this we set the following rules.

1) If another source role is assigned at any condition source nodes do not change its behaviors.
2) If an additional forward role is assigned then forward nodes become normal.
3) Nodes with affected and source roles at the same time become source nodes.
4) Only one forward role exists.
5) Nodes with affected and forward roles at the same time become affected nodes.

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Based on the above five rules, sensors adjust their behaviors whenever a new role is assigned or an old role is outdated. Algorithms can be easily implemented under the above rules. By considering the obtained result nodes will adjust behaviors and among many nodes only one node will be awake. In multiple RMs source nodes do not change their behaviors but if an additional forward role is assigned to an network then old forward nodes becomes normal nodes, along with this nodes with affected and source roles at the same time become source nodes and nodes with affected and forward roles at the same time becomes affected nodes. This method will conserve the energy.

F. EXPERIMENTAL RESULTS

Figure 2 represent the experimental result of the proposed system. Firstly will consider the sensor nodes, which is shown in Figure 2(a), 2(b) and 2(c), these sensor nodes will start sending pockets to neighbor nodes as shown in Figure 2(d), next nodes need to be classified in deployed network so this deployed network is subjected to classification it's based on the type nodes are classified as source node, forward node, affected node and normal node shown in Figure 2(e) selection of forward nodes. Next RM with data is subjected to wake-up/sleep schedules, in this RM figures out wake-up/sleep schedules of forward node considered from the node classification by adopting time slot based circular schedule. The corresponding results are showcased to all RM's neighbors. By considering the obtained result nodes will adjust behaviors and among many nodes only one node will be awake. In multiple RMs source nodes do not change their behaviors but if an additional forward role is assigned to an network then old forward nodes becomes normal nodes, along with this nodes with affected and source roles at the same time become source nodes and nodes with affected and forward roles at the same time becomes affected nodes as shown in Figure 2(f). This method will conserve the energy. Figure 2(g) represent the graph for energy conservation versus time slot.

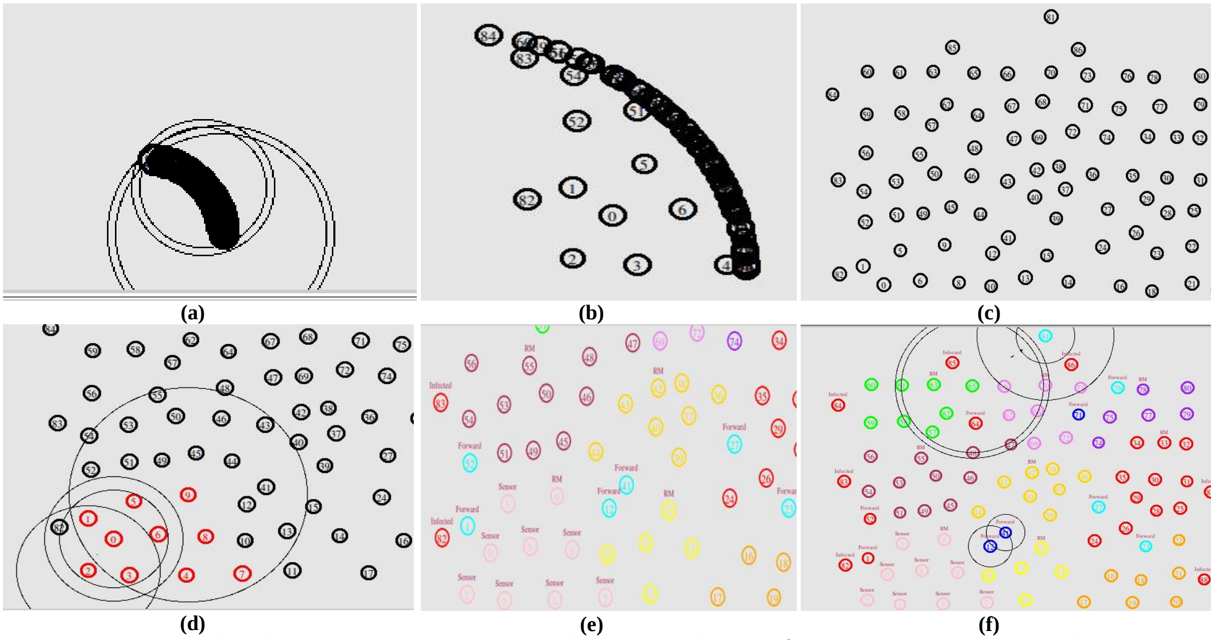

Figure 2: (a) (b) (c) Sensor Nodes; (d) Packet Sending to Neighbour Nodes; (e) Forward Nodes; (f) Aggregating pockets to Forward Node

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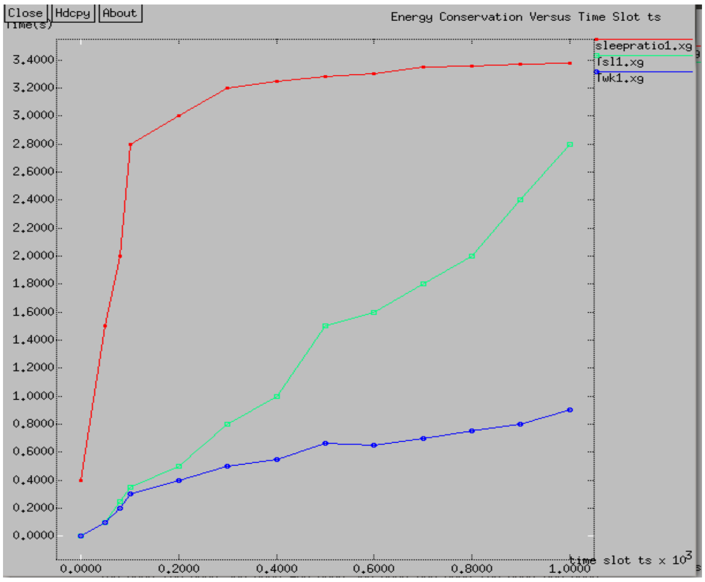

(g)
Figure 2: (g) Energy Conservation versus Time slot Graph

G. CONCLUSION

This In this paper, we adopted ECARM, a mechanism that opportunistically utilizes RMs to reduce power consumption in WSNs. We designed every part of ECARM. Through extensive results, we evidenced the correctness and energy conservation effectiveness of ECARM. However, the application of ECARM in duty-cycled WSNs in this paper is crude in some aspects and the improvement is planned as our future work. Here we just list some of them, the wake-up/sleep cycling of ECARM could be synchronized with the duty-cycling of ContikiMAC, which will reduce the data loss rate and incentive frameworks to promote deployment of ECARM considering that today's Internet is evolving to meet the continuous changing application requirements.

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