# Review on Energy Conservation in Wireless Sensor Network

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***Abstract-*** This is a review paper discussing what Wireless Sensor Networks are. Sensor nodes are battery powered devices and the main issue is how to reduce the energy consumption of nodes so that the networks lifetime can be increased to a sufficient level. Energy can be conserved using three schemes: duty cycling, data driven and mobility based. Various duty cycle based MAC protocols are introduced to save the energy consumption and increase the performance of the wireless sensor network. In this paper we will discuss about S-MAC, U-MAC and TA-MAC. We also discuss about the Minimum-Energy Multicast Tree Construction and Scheduling (MEMTCS) problem in duty-cycle wireless sensor networks (DC-WSNs).

***Keywords -*** Wireless sensor network, duty cycling and MAC protocols.

## *I.* INTRODUCTION

A **wireless sensor network (WSN)[11]** consists of autonomous sensors deployed over a geographical area to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, humidity, motion or pollutants and to pass their data through the network to a main location. The WSN is built of "nodes" where each node is connected to one (or several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery. A sensor node might vary in size from that of a shoebox down to the size of a grain of dust. It is observed that the energy cost of transmitting a single bit of data is approximately the same as that needed for processing many operations in a typical sensor node. Energy-saving techniques focus on two subsystems: the networking subsystem and the sensing subsystem. In networking subsystem, energy management of every single node is considered along with the design of networking protocols.In sensing subsystem, various techniques are considered to minimize the frequency of energy-expensive data samples.

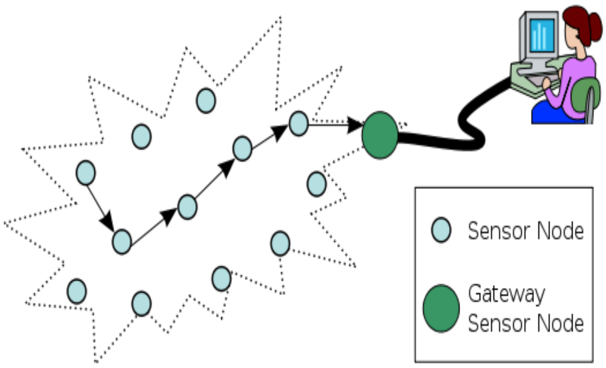


Fig. 1 Sensor network architecture [12]

## II. DIFFERENT SCHEMES OF ENERGY CONSERVATION [1]

### *A. Duty-cycling approach*

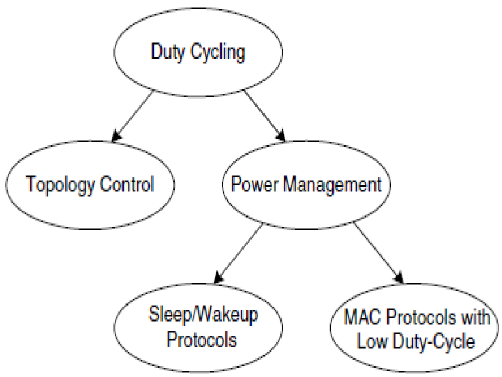


Fig. 2 Taxonomy of Duty-cycling approach

In duty-cycling approach, nodes alternate between active and sleep periods depending on the network activity. It mainly focuses on the networking subsystem. In topology control, the optimal set of nodes is found that ensures connectivity. Nodes that are currently not needed for connectivity can go in sleep mode and save energy. On the other hand, active nodes can put their radios in off state when there is no network activity going on, thus switching between sleep and wakeup periods. Duty cycling that is operated on the active nodes is called as power management. Sleep/wakeup protocol can be implemented on network or application layer but the latter approach is strictly implemented on MAC protocols. Sleep/wakeup protocols permit a greater flexibility.

### *B. Data driven approach*

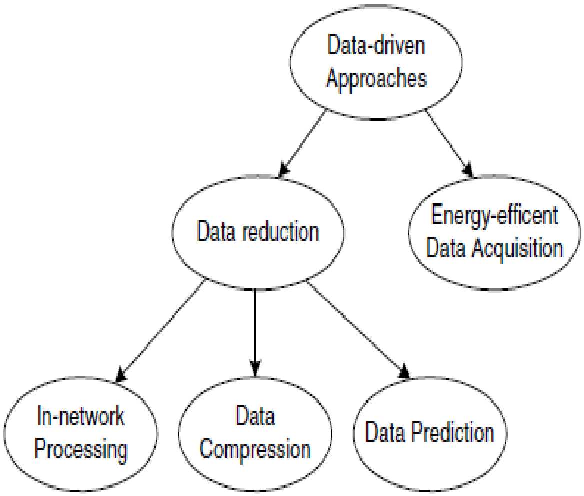


Fig. 3 Taxonomy of Data driven approach

Data driven approaches are classified according to the problem they handle. A data reduction schemes refer to the case of unneeded samples. In this the samples that are not needed are not communicated to the sink node, thus saving the energy. Energy-efficient data acquisition schemes reduce the energy spent by the sensing subsystem. In-network processing performs data aggregation (i.e. it calculates the average of values) at forwarding nodes between source and destination (sink node). In data compression the information sent by the source node is reduced. At source, the information is encoded and at sink, it is again decoded. Data prediction evolves a model describing data evolution.

### *C. Mobility-based schemes*

In this, sensor nodes are made mobile in nature. But when mobility is added to the sensor nodes, the resulting energy consumption is much higherthan the energy gain to mobility itself. There are two ways of making it convenient. One is,instead of making each sensor node mobile, mobility should be limited to some special nodes which consume less energy. Second is, instead of setting up the mobilizers, sensors can be placed on objects which are mobile at their own.

## III. MAC PROTOCOLS

Duty-cycle based MAC protocols are introduced to let nodes go into sleep mode when nodes are in idle listening, to minimize the energy consumption. We will discuss here three protocols: S-MAC, U-MAC and TA-MAC.

### *A. S-MAC [2]*

S-MAC stands for Sensor MAC protocol. This protocol specifies within a frame that when nodes are in active state and when they are in sleep state. In S-MAC, a uniform duty-cycle is assigned to all the nodes in the network. It is not suitable for all the nodes as all the nodes do not handle the same workload. If uniform duty cycling is set too long, it may result in energy wastage on sensor nodes with low data traffic as the nodes will be in idle listening. If the uniform duty cycling is set too short, then it may increase transmission latency on sensor nodes along with heavy data traffic as the nodes will not be having sufficient time to transmit all the gathered data.

### *B. U-MAC [3]*

U-MAC stands for Utilization MAC protocol. In WSN, if nodes are in sleep state for long duration to conserve the energy then it results in higher transmission latency. To solve this problem, U-MAC protocol assigns duty cycle according to the traffic load in the network. It adopts a utilization function to calculate the traffic load on sensor nodes. The node then adjusts its duty cycle according to the calculated utilization (a node calculates its traffic utilization since the last synchronization time) and then broadcasts this information to its neighbours. When traffic load is high, U-MAC can have good throughput and when traffic load is low, it saves energy. However, the problems of duty cycle synchronization between sender and receivernodes are not well solved.

### C. *TA-MAC [4]*

TA-MAC protocol stands for Traffic-aware MAC protocol. TA-MAC protocol adjusts node’s duty cycle according to status of sending/receiving buffer, traffic loading and battery life. This protocol is based on the demand of data transmission of sensor nodes. This protocol has two main goals: to conserve energy with low data traffic and to decrease transmission latency and to increase data throughput with heavy data traffic. In U-MAC, the intermediate node has higher duty cycle because of its high traffic load. Senders keep on sending the data to receivers, which makes theintermediate node, continues to increase the duty cycle to adapt to the current traffic load. But with this scenario, the senders and receivers do not have such a high traffic load. So, both will lower their duty cycle. To solve this synchronization problem between two sensor nodes TA-MAC protocol utilizes an additional control message. The receiving node can decide whether to keep the same duty cycle as of the forwarding node or not. If both have the same duty cycle, the sensor nodes can have more time to transmit the data.

## IV. MEMTCS [5]

In duty cycled WSN, the nodes switch between active and sleep states. Each node is capable of determining its active/sleep schedule independently. This complicates the Minimum-Energy Multicasting problem that was studied in [6]-[10]. Hence, MEMTCS problem was formulated. A WSN is shown by an undirected graph G= (V, E), where V is set of nodes and E is set of links between the wireless nodes. An assumption is made that all the nodes have same fixed transmission power and a link exists between two nodes only if they are within the transmission range of one another. Another assumption is that every node has unique ID and it knows the IDs of its one-hop neighbours. Time is divided into equal-length slots. It is also assumed that a node can wake up its transceiver to transmit data packet at any time slot but it can receive any data packet only when it is in active state.

*MEMTCS Problem*

While designing an energy efficient multicasting algorithm in DC-WSNs, two things need to be considered. Firstly, the forwarding nodes should be selected properly to construct a tree. Secondly, transmission of each selected node should be scheduled smartly to cover the end nodes and minimize the transmission redundancy.

*Algorithm Proposed*

Firstly, a small satellite node set is found. A satellite node set in graph G' are the possible transmitting time slots of the nodes in graph G, where G' is the transformed graph of the original graph G. Then a node 'v' is found which has the maximum number of adjacent nodes in the uncovered node set. Then add 'v' into satellite node set and update uncovered node set. At last, an approximate Steiner algorithm is applied on the satellite node set to construct a tree.

## V. CONCLUSION

In this paper we have discussed the main approaches to energy conservation. We concluded that energy consumption of radio is much higher than the energy consumption due to data processing. We also conclude that the proposed protocol provides better data transmission rate when sensors are with high traffic loading and meanwhile can save energy when sensors are with low traffic loading. From the proposed algorithm for MEMTCS problem, it is concluded that this algorithm is beneficial in minimizing the energy cost and the transmission redundancy.

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