

A Review on Energy-Efficient Scheduling Mechanisms in Wireless Sensor Networks

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Abstract

Objectives: The design of Energy efficiency wireless sensor network is a challenging research since battery is consider as power source to the sensor nodes. Recharging battery is very difficult and impossible in some cases. **Methods/Analysis:** In Wireless sensor networks, clustering techniques consist of partitioning the network into a various number of sensor groups called clusters. The clustering technique selects the cluster heads in the rotation manner to perform data aggregation operation. **Findings:** To prolong the lifespan of a network, sensor nodes are scheduled to sleep dynamically. Sleep Scheduling (SS) mechanism is the most widely used technique for efficiently managing network energy consumption. In this paper, we provide a survey on energy-efficient scheduling mechanisms in Wireless sensor networks that has different network architecture than the traditional Wireless Sensor Networks.

Keywords: Cluster Head, Energy Efficiency, Sleep Scheduling Mechanism, Software Defined Network (SDN), Wireless Sensor Network

1. Introduction

An infrastructure less Wireless Sensor Network, low power autonomous sensor nodes are linked by wireless transportations. Each sensor node consists of the power supply, detecting component, Communication component, storage and processing component. It gathers info from the surroundings and direct to the application center. Sleep Scheduling is a well-organized energy efficient technique to systematize all sensor nodes in the networks. All sensor node life time is parted into beacon stage and execution stage. During beacon stage nodes can share the information by broadcasting the appropriate data (beacon data) to all neighbours. The broadcasting nature of the sensor node cost a very high processing energy. Software Defined Network with SS algorithm decreases the overall communication time of a network, and prolongs the network life time. EC-CKN algorithm is considered as the proto type of SDN based SS mechanism. In EC-CKN, residual energy criterion is taking into account to finding the energy status of the nodes in the network at every time interval. A further part of the paper is structured as follows: In Section 2, review the scheduling mechanisms.

Section 3, discusses the design assumption and network architecture. Section 4, SDN-ECCKN algorithm and will be presented in detail. Finally we conclude the paper in Section 5.

2. Scheduling Mechanism

Sleep scheduling mechanism is a more suitable approach to make energy management efficiently in WSNs^{25,26}. To save the energy of each sensor node, the Sleep Scheduling mechanism is to spontaneously and intentionally sleep subgroups of nodes while remaining nodes are active in each given time period. Instead of "being awake" all the time, every node has chance to "sleep" by using Sleep Scheduling mechanism. To operate sensor networks effectively, the active nodes necessity to preserve sensing coverage and network connectivity operation. We consider the energy efficient factors to describe the node scheduling algorithm. To offer high quality data service, node scheduling scheme targets to picking a collection of responsible nodes in a routine manner. To prolong the network life time, node scheduling algorithm efficiently

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decreases the amount of participation (active) nodes and redundant information.

In¹²⁻¹⁴ proposed coverage based an energy-efficient node-scheduling mechanism. During the self-scheduling stage, the nodes examine the off-duty eligibility rule. The off-duty eligibility rule checks whether a node's sensing region is covered in its neighbor's sensing region. Eligible nodes can turn off their operation and remaining nodes will do detecting process with in a particular period. In²⁴ proposed scheduling method based on a generic duty-cycling using stochastic theory. In¹⁸ proposed coverage and duty cycle properties analysis based scheduling algorithms. Two well-known Sleep Scheduling algorithms proposed by^{22,27} are Connected K Neighborhood (CKN) algorithm and Energy Consumed uniformly-Connected K-Neighborhood (EC-CKN) algorithm. In CKN algorithm, the redundant nodes are turn off when the network satisfies k-connectivity. If a node has less than k neighbors, all the nodes should be active until it has more than k neighbors. For finding the active node CKN algorithm use the rank values. The beginning stage of executing CKN algorithm gives randomly in each period, and the group of active nodes varies from period to period. There is no assurance that the uniform energy consumption in CKN. Different from CKN algorithm, in²⁷ proposed EC-CKN algorithm. In order to decrease energy consumption further nodes residual energy is taken into account to decide whether nodes become active or sleep.

3. Design Assumption

A Wireless Sensor Network can be hierarchical or flat network. In flat network, every sensor has the equal role and responsibilities. Instead certain sensors can consider as the cluster heads, they can gather the information from their neighbourhood and make the decision. These networks are often called as hierarchical or cluster-based networks in this the cluster nodes have additional prominent role than the other sensors¹⁻⁴.

3.1 Traditional WSN Architecture

The hardware platform of sensor node comprises three main components: A computation component, communication component and memory is used to keeping sensed data and routing tables.

Nodes in the sensor network can communicate straight or indirectly using intermediate nodes. Before

transmitting any information, every single node must to compute on demand using computation component and transmit the related information kept in memory numerous times to its neighbour using communication component in every time period, this required more communication energy^{33,34}.

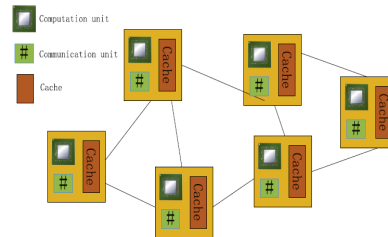


Figure 1. Traditional WSN architecture.

3.2 Software-Defined Network Architecture

SDN is called Open Flow³⁵, Open Flow capable to detach the computational component and transmission component of every single node as shown in Figure 2. The computation components are removed from sensor node and the controller perform computation process of the entire sensor node in the network. The controller has potential computation ability and connected to the power source. All the controller judgements are routed to each node using switch. Each node has only communication and memory component to communicate with switch and the controller is straight control each node. At the beginning of the data transmission there is no broadcasting processes, it decreases the total transmission period.

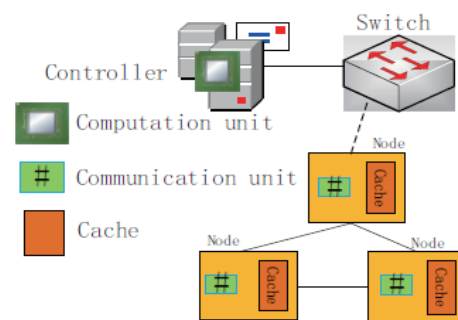


Figure 2. Software-defined network architecture.

4. SDN with ECCKN Algorithm

All the node lifespan made up of several time periods using ECCKN algorithm. Each time period consists of two parts: beacon time and execution time, as shown in Figure 3.

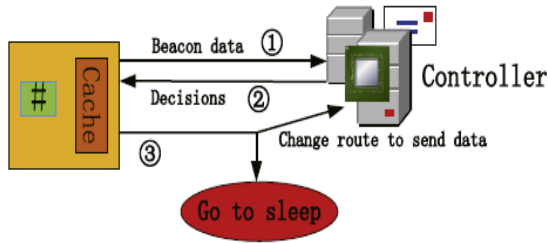


Figure 3. Data transmission between node and controller in each interval.

During beacon time, all nodes are in active to direct beacon data to the controller using initial network topology. Assume that the full network can be acquired by the controller and only communication energy consumption is required. The network acquisition energy cost is neglected because of constant power source is connected to the controller. The beacon data is very small compared to the main data, it contains only residual energy and sleeping information of next hop node ID. The sleeping status of all the nodes is calculated by controller using EC-CKN algorithm, and modifies the routing structure of the complete network based on received beacon. During the execution time, controller forwards the modified sleeping status and transmission routes to the particularly nodes and remaining nodes are in the same status.

SDN based architecture has the following advantage:

- The controller only made decisions and it is typically connected to constant power source.
- There is no broadcasting between the nodes; it can intensely decrease the total communication times of the network life time.
- The resultant nodes only receive the modified sleeping status or transmission routes and remaining nodes are in same status.

4.1 Network Residual Energy

At the end of each time interval the entire network residual energy is calculated using EC-CKN algorithm with various value of K using Residual Energy Equation.

$$\text{Residual energy} = \sum_{i=1}^n \frac{E_i}{n \cdot E_{\text{initial}}} \times 100 \%$$

Each node initial energy is denoted by E_{initial} and it is same for each node. SDN-ECCKN algorithm, increase each nodes participation intervals and the overall life time of the network. SDN based ECCKN algorithm increase residual energy of the network at the end of each interval than the WSN with EC-CKN algorithm.

5. Conclusion

Energy management is the most considerable issue in WSNs, since it affects the lifetime of the node as well as the network. Node scheduling algorithm selects particular nodes to offer the necessary requirements in a specified time period. The representative node selection process reducing the amount of participation nodes to provide the data service. For the purpose of decreasing entire transmission time and prolong the network lifetime the traditional WSN is replaced by SDN structure. SDN-ECCKN algorithm provides the great improvement than the EC-CKN algorithm in terms of the amount of alive nodes and solo node of the wireless sensor networks.

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