A COMPARITIVE STUDY OF ENERGY EFFICIENCY IN WIRELESS SENSOR NETWORK

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Abstract

Wireless Sensor Network is a wide area for the research work. It consists of various sensor nodes. Sensor node has very limited battery power. Batteries are unattended and not possible to recharge them. Small size of a sensor node restricts embedding high power battery with it. Here in this paper we find out the energy efficiency techniques and discuss the main directions to energy conservation in WSNs. Special attention has been given to solutions which have not yet obtained in the survey, such as techniques for energy efficient data acquisition.At last we conclude about the energy efficiency in wireless sensor network.

Keywords- Sensor Nodes, Energy Efficiency, Acquisition

I. INTRODUCTION

Sensor networks have a large number of sensing devices, which are equipped with limited computing and radio communication capabilities. Although sensors may be mobile, they can be considered to be stationary after deployment. A typical network configuration consists of sensors working unattended and transmitting their observation values to some processing or control center, the so-called sink node, which serves as a user interface. Due to the limited transmission range, sensors that are far away from the sink deliver their data through multihop communications, i.e., using intermediate nodes as relays. In this case, a sensor may be both a data source and a data router. Most application scenarios for sensor networks involve battery-powered nodes with limited energy resources. Recharging or replacing of the sensors battery is inconvenient, or even impossible in harsh working environments. Thus, when a node exhausts its energy, it cannot help but ceases sensing and routing data, possibly degrading the coverage and connectivity level of the entire network. This implies that making good use of energy resources is a must in sensor networks. Various solutions have been proposed to reduce the sensors energy expenditure with the energy saving viewpoint.

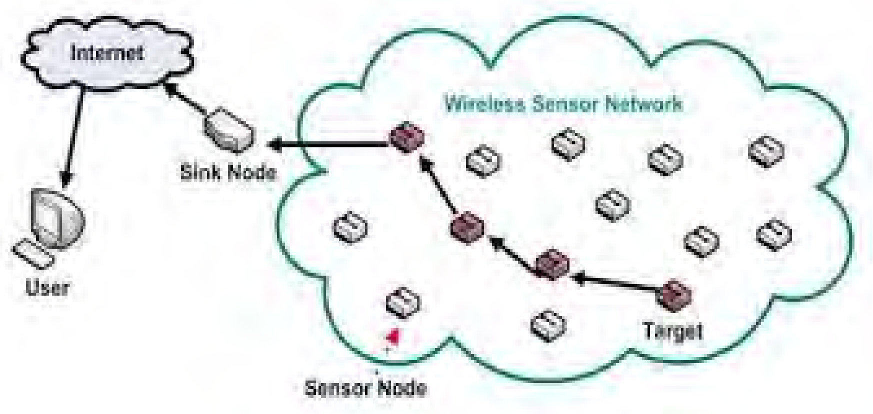

Fig: 1.1 Wireless Sensor Network

A node in a wireless sensor network can able to perform process, collect information and communicate with the other nodes in the network.

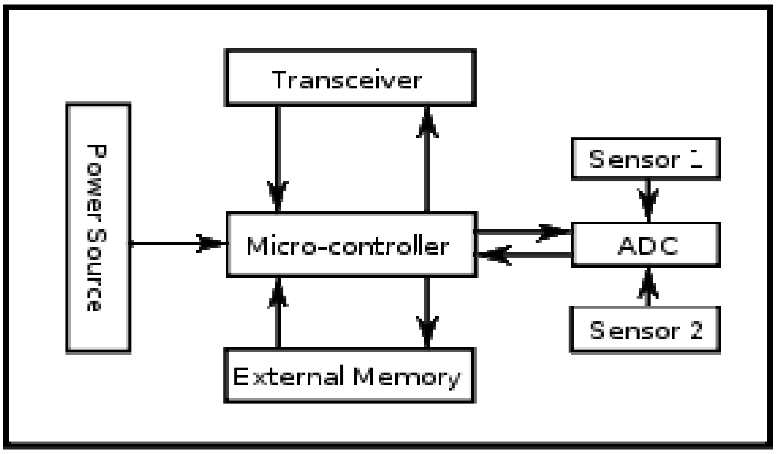

Fig: 1.2 A typical architecture of a node

A widely employed technique is to place nodes in a low-power operational mode, the so-called sleep mode, during idle periods. In idle state, sensors do not actually receive or transmit, nevertheless they consume a significant amount of power. In sleep mode, some parts of the sensor circuitry [e.g., microprocessor, memory, radio frequency (RF) components] are turned off. As more circuitry components are switched off, the power consumption as well as the operational capabilities of the sensor decreases. A sensor network with stationary nodes convey the gathered information to the sink node through multihop communications. Each sensor is characterized by two operational states: active and sleep. In active state, the node is fully working and is able to transmit/receive data, while in sleep state, it cannot take part in the network activity; thus, the network topology changes as nodes enter/exit the sleep state.

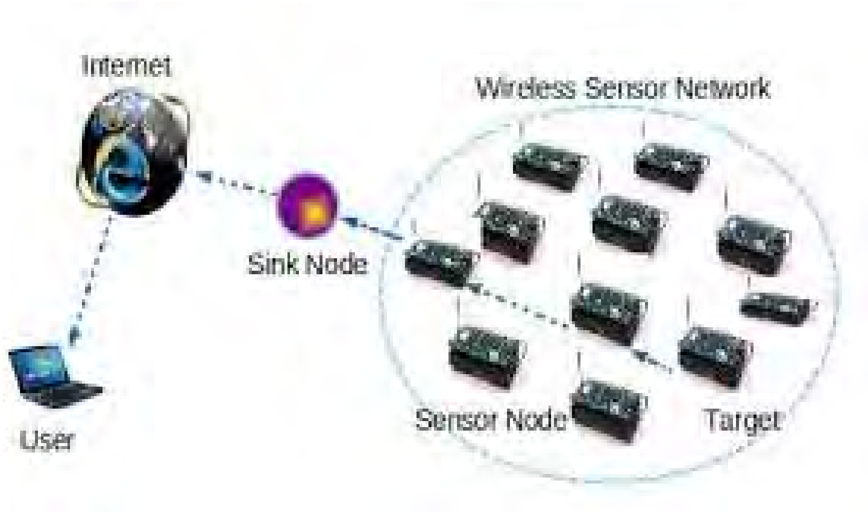

Fig: 1.3 Communication diagram for WSN

II. Features of WSN

Number of nodes in a typical sensor network is much higher than typical ad-hoc network. Sensor network hardware should be power-efficient, small, inexpensive and reliable in order to maximize network lifetime, add flexibility, facilitate data collection and minimize the need for maintenance.

a)Lifetime: It is critical for most applications and its primary limiting factor is the energy consumption of nodes, whichneeds to be self-powering. Energy consumption could bereduced by considering the existing independencies between individual layers in the network protocol stack. Energy efficient routing should avoid the loss of a node due to battery depletion.

b)Flexibility: Sensor network should be able to dynamically adapt to changes in node density and topology. Sensor network should also be robust to changes in their topology.

c)Maintenance: It is the complete or partial update of the program code in the sensor nodes over the wireless channel. All nodes should be updated and the restriction on the size of the new code should be the same as in the case of wired programming.

d)Data collection: It is related to network connectivity and coverage. A sensor network should be able to protect itself and its data from external attacks. Typical encryption schemes for instance, require large amounts of memory that are unavailable in sensor nodes.

III. NEED FOR ENERGY EFFICIENCY

Efficient energy utilization is a challenge. This is due to sensor node have very limited battery power. Batteries are unattended and not possible to recharge them. Small size of a sensor node restricts embedding high power battery with it.The challenge of improving sensor energy consumption is a key issue in wireless sensornetworks (WSNs). This is due to the fact that sensor network lifetime is directly related to operational lifetime. If sensors can operate for longer periods of time and the frequencyof node failures can be reduced, the reliability and adaptability of the sensor network will consequently improve. Furthermore, technological advances in sensor processing hardware significantly outpace progress in sensor battery capacity. Thus, it becomes imperative to enhance the energy conservation in sensor networks.Solution is efficient energy utilization. The challenging task is reliable data transmission with energy efficiency

IV. REVIEW OF LITERATURE

Marcelloni & Vecchio proposed that**[1]**The designing and deployment of Wireless Sensor Network is depending up on Energy. Sensors are powered by batteries with limited capacity. We can save energy by reducing the radio communication. Here efficient tool is data compression. Here they propose a simple **lossless entropy compression (LEC) algorithm**. It can be implemented by a few lines of code. It requires low power and it uses a very small dictionary whose size is determined by analog-to-digital converter. This LEC algorithm is suited for reduced storage and computational resources of Wireless Sensor Network node. The LEC algorithm is evaluated by compressing four temperature and relative humidity data sets collected from sensor scope deployments.

Without introducing any error in the reconstructed signals, they obtained compression ratios upto 70.81% for temperature datasets and upto 62.14% for relative humidity data sets. By comparing LEC algorithm with S-LZW, a lossless compression algorithm, we can obtain that the LEC algorithm can achieve higher compression ratios than S-LZW. By comparing LEC algorithm with a lossy compression algorithm, it is clear that there is an error in the reconstructed samples to achieve compression techniques. We can observe that the LEC algorithm achieves compression ratios in the order of 70%. Lossless compression algorithm plays an important role in wireless Sensor Networks. For proving the possibility of transforming the LEC algorithm into alossy compression algorithm, they introduce a quantization process before encoding.

After developing the framework for optimization they would like to use this framework to compare different approaches to data compression developed for audio, image and video compression. For this purpose they are analyzing light weight quantization designs with the ideas from different type of coding: Context-Sensitive Coding, Simple predictive Coding and Low-Complexity Distributed coding.

Lloret and et.al, proposed that**[2]** the communications in the sensors, the Wireless Sensor Network developers are adopting Bluetooth and Zigbee technology. This has a big problem. It has short radio coverage. The sensors are very expensive. If the coverage is short, the sensors will in need to cover wide areas. IEEE 802.11a/b/g technologies have higher coverage areas and higher bandwidth. At the same time the energy consumption is also very high. The typical structure of Wireless Sensor Network has sensor nodes. They take the data and send it to the base station. The base station is the receiver. It may be a common computer or embedded system with higher process capacity. The gateway is the interconnection between the sensor network and data network.

Bluetooth is an open specification for wireless networks. It has low energy consumption and its cost is quite low. This technology uses a small area network without infrastructure. Zigbee and 802.15.4 are standard-based protocols that provide the network infrastructure required for Wireless Sensor Network applications. Zigbee defines the network and application layers. This is focused in creating the low-rate PAN. Their objective is to develop a wireless technology in low energy consumption and low cost. The main problem in these technologies is the complexity of the protocol and the high consumption of power of the device. So we are in need of a higher coverage range than the one offered by Bluetooth or zigbee with low energy consumption. In this paper they are proposing a new protocol based on 802.11a/b/g. It minimizes the energy consumption of the whole system. They are selected IEEE 802.11b/g variants because IEEE 802.11n is expensive and IEEE 802.11a has lower radio coverage.

Here they also presented cooperative group based sensor network for several environmental application such as fire detection and for monitoring rural, agricultural, and natural crises. If the sensor detects an event, it will send an alert to its group and it is distributed to neighboring groups. Here NS_2 simulator is used to simulate the proposed protocol. Comparing with other protocols, we can able to observe energy conservation measurements. It is also proven that this protocol allows a larger lifetime for the nodes in Wireless Local Area Sensor Network.

Marcelloni and Vecchio proposed that**[3]** In Wireless Sensor Network energy saving is a critical issue. The sensor nodes are powered by batteries. They have a limited capacity. The radio transmission is the main cause of the power consumption. So we want to limit the transmission and reception as much as possible. The sensor nodes are tiny devices composed of three basic units. They are processing unit with limited memory and computational power, sensing unit for data sharing from the surrounding environment and a communication unit to transmit data to the base station. The batteries of nodes cannot be changed or recharged.

The energy consumption of the sensing unit is dependent on the type of specified sensor. The energy consumed by the sensing unit is negligible by comparing with energy consumed by communication unit and processing unit. So for extending the lifetime of a Wireless Sensor Network we want to minimize the energy consumption of communication unit. For achieving this we want to follow two approaches. They are power saving through duty cycling and in-network processing. Duty cycling schemes define sleep/wakeup scheduling among nodes. In-network processing means reduce the number of information to be transmitted by using the compression or aggregation techniques.

Here they are proposing a novel distributed approach to data aggregation. It is based on fuzzy numbers and weighted average operators which is used to reduce the data communication in Wireless Sensor Network. The basic point of this approach is that each node maintains an estimate of the aggregated value. The algorithm is able to reduce the number of received and sent messages without affecting the quality of the aggregate estimation. Here they are applying the algorithm to the monitoring of the maximum temperature in a 100-node simulated Wireless Sensor Network and a n2-node real Wireless Sensor Network. We can increase the lifetime of Wireless Sensor Network by combining both the B-MAC protocol and the proposed aggregation.

Kumar & Pantproposed that**[4]** In Wireless Sensor Network hundred or more sensor nodes are present for sensing purpose. The battery life of sensor node is limited and their recharging is difficult. By introducing many optimization techniques we can improve the lifetime of Wireless Sensor Network. For this clustering is a good proposal. In this work fuzzy based prediction has been utilized for appropriate clustering and heterogeneity will be added to the network so as to prolong the lifetime of the network. A further enhancement in network lifetime will be done by introducing mobile sensors into the network. The responsibility of these mobile sensors is to replace the dead node in the network. The simulation results of this protocol shows the improvement in various areas like FND(First Node Dead), HND(Half Node Dead) compared to LEACH(Low Energy Adaptive Clustering Hierarchy), EEHC (energy Efficient Hierarchical Clustering) & LEACH-ERE (LEACH-Expected Residual Energy). The Wireless Sensor Network nodes are less than ad-hoc networks.

The proposed algorithm analyzes many issues related to energy efficiency of Wireless Sensor Network. Those issues are:

- Sustaining the energy of Wireless Sensor Nodes in Wireless Sensor Network using fuzzy logic based clustering.
- Introducing heterogeneous sensor nodes in the network to increasing the lifetime of sensor network.
- Utilizing MSN (Mobile Sensor Nodes) to extend the lifetime of sensor network by immediately replacing a dead node with a mobile node.

The algorithm focuses on adaptive energy conservation & optimization in the Wireless Sensor Network. The replacement of dead node with mobile node can be done on the basis of geographical routing that is nearest mobile node near to the dead node will find the optimized value of mobile sensor nodes for a network mathematically.

Woiye & Deboiushestrid proposed that **[5]**A Medium Access Control (MAC) protocol designed for Wireless Sensor Network. Wireless Sensor Networks use battery-operated computing and sensing devices. Like in all shared- medium networks, MAC is an important technique that enables the successful operation of the network. The fundamental task of the MAC protocol is to avoid collisions from interfering nodes. To design a good MAC protocol, we have to consider many attributes.

1. Energy Efficiency: sensor nodes are battery powered. It is difficult to change or recharge batteries.

2. Scalability & Adaptivity: some nodes may die over time, some new nodes may join later, some nodes may move to different location.

A good MAC protocol should gracefully accommodate such network changes. Other attributes are fairness, latency, and throughput and bandwidth utilization. S-Mac reduces energy consumption, achieves good scalability and collision avoidance by utilizing a combined scheduling. Here problem is energy waste. Major sources for energy waste are:

1. Collision: when a transmitted packet is corrupted, it has to be discarded and increase energy consumption and latency.

2. Overhearing: A node picks up packets that are destined to other nodes.

3. Control packet overhead: Sending and receiving control packets consumes energy.

4. Idle listening: Listening to receive possible traffic that is not sent.

S-MAC tries to reduce energy waste from all the above sources. Technique used in S-MAC is to establish low-duty-cycle operation on nodes in a multi-hop network. It reduces idle listening by periodically putting nodes into sleep network. It will be inactive for long time. But it will be active when something is detected.

Yu and et.al proposed that **[6]** they study the reliable packet forwarding in Wireless Sensor Network with **MIMO**(Multiple Input Multiple Output) and **Orthogonal space time block codes** techniques. The objective is to propose a **Cross-layer optimized forwarding scheme** to maximize the Successful Transmission Rate**(STR)**. For improving the transmission quality we want to consider the channel coding, power allocation and route planning. The joint optimization design is a combination of global deterministic optimization and a local stochastic optimization issues. This can effectively model, analyze and solve the routing problem. The proposed scheme can reduce the **Symbol Error Rate** and active higher STR compared with two existing Energy-Efficient routing protocols.

It is hard to reliable end-to-end transmissions in many application of Wireless Sensor Network. In typical applications, the failures of end-to-end transmission of important information will lead to large loss. By following a multi-hop route we can transmit data from source to the data concentration center. SER of the end-to-end transmission is an important factor which affects the reliability. For improving the reliability we want to minimize the source-to-destination SER or maximize the Successful Transmission Rate. Like the reliability, the other issues in wireless Sensor Network are energy efficiency. Sensors are battery powered. So their operation time is limited to the battery capacity. In this paper they are considering the issues of transmission reliability and energy conservation. The main objective is to maximize the end-to-end STR with in the given power constraint.

The MIMO techniques can improve the system performance and capacity. In many cases the power consumption in the electronic circuit of a MIMO systems is more efficient than that in a SISO(Single Input and Single Output). To achieve performance on both transmission reliability and energy conservation we want to consider the cross-layer optimization problem. The work mainly focuses on four aspects

1) Devise an efficient routing protocol
2) Adaptively allocate the transmission power
3) Maximize the STR
4) Satisfy the total power constraint

Each sensor has multiple antennas using OSBTC codes. To maximize the end-to-end STR by satisfying the power constraint channel coding, power allocation and route planning are jointly optimized. By decoupling the components of forwarding decision, propose a lowcomplexity suboptimal solution to the optimization problem. Extensive simulation is carried out to evaluate the proposed forwarding scheme. The results validate the effectiveness of the proposed scheme and show that it significantlyoutperforms two traditional energy-efficient algorithms.

Chi and chang proposed that **[7]**The Wireless Sensor Network is an emerging technology. It offering many possibilities for applications like target tracking and environmental surveillance. Wireless Sensor Network often operate under certain energy constraints and reducing energy consumption to increase the lifetime of Wireless Sensor Networks. This paper presents **EAGER (Energy Aware Grid based Routing Scheme)** for Wireless Sensor Network which approaches to save more energy in the context of dynamic topology. In this paper EAGER is compared to other proposed grid-based schemes by using extensive simulations clearly show that EAGER out performs other grid-based schemes in terms of both energy-efficiency and routing performance.

By using recent technological advances, we can integrate micro-electromechanical systems, micro-sensor and wireless communication devices into low-cost, low powered nodes. The large number of nodes allows the observer to move around freely. It offers possibility in the area of target tracking and environmental observation. For ex, in military target tracking and surveillance soldiers need to be able to move in various directions at any given time in order to monitor enemy tanks. In wild animal enclosures, park administrators frequently need to move around in order to monitor animal behavior. The routing protocol for Wireless sensor Network needs to be capable of data aggregation, data dissemination and special application.

V. ANALYSIS

NUMBER	***METHOD***	***BENEFIT***
Marcelloni&Vecchio[1]	Lossless Entropy Compression (LEC) algorithm	The LEC algorithm achieves compression ratios in the order of 70%
Lloret and et.al [2]	Protocol based on 802.11a/b/g	Minimizes energy consumption of whole system
Marcelloni and Vecchio[3]	Novel distributed approach	Reduces the number of received and sent messages without affecting the quality of the aggregate estimation
Kumar & Pant[4]	Fuzzy based prediction	Replaces the dead node with mobile node
Woiye&Deboiushestrid[5]	S-MAC Protocol	Reduces energy consumption by putting nodes in to sleep network
Yu and et.al[6]	MIMO & Orthogonal space time block codes	Improve the system performance & capacity
Chi and chang [7]	EAGER	Save more energy in the context of dynamic topology

VI. CONCLUSION

In this paper we have analyzed the main approaches to energy conservation in wireless sensor networks. We gave attention to the systematic classification and the solutions proposed in the survey. Here we discussed about various methods which is used to energy conservation in Wireless Sensor Network and have also mentioned the importance of different approaches such as replacing the dead nodes with mobile nodes. We can identify final observations about the different approaches to energy management in Wireless Sensor Networks.

Here we compared different methods such as Lossless Entropy Compression algorithm, Novel Distributed Approach, Fuzzy Based Prediction, S-MAC protocol etc. Each method is useful for energy consumption in various aspects. The conclusion deal with the EAGER-based Routing Scheme is the better method than others for increasing the energy efficiency in WSN. In future work we planned to enhance this method for increasing the energy efficiency.

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