Energy Survey in WSNs

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Abstract: **Wireless sensor network (WSN) technology is promising and is therefore gaining popularity day by day in a wide area of different applications. The WSN nodes operates on battery power which is often deployed in a rough physical environment; changing the batteries is therefore a complicated task, as some networks may consists of hundreds to thousands of nodes. Such large physically distributed networks increase the difficulty of changing batteries and makes recharging almost impossible during operations. This problem has forced node, network and system developers to make changes in the basic WSN architecture to minimize the energy consumption especially of the nodes in order make the network and overall system application more energy efficient. Recently the IEEE 802.15.4 standard was developed for low data-rate application which needed to last for longer duration by consuming relatively less energy. One of the challenging topics in wireless communication techniques to be used for WSN applications is energy efficiency. The life time of a wireless sensor node depends on available energy sources and its overall energy consumption. Further, increasing the capacity of batteries is not possible due to the small size requirement of the nodes.**

***Keywords*— WSNs, SN,**

I. INTRODUCTION

A Wireless Sensor Networks (WSN) are emerging as both an Important new tier in the IT ecosystemand a rich domain of Active research involving hardware and system design, networking, distributed algorithms, programming models, data management, security and social factors. The basic idea of sensor network is to disperse tiny sensing devices; which are capable of sensing some changes of incidents/parameters and communicating with other devices, over a specific geographic area for some specific purposes like target tracking, surveillance, environmental monitoring etc. Today's sensors can monitor temperature, pressure, humidity, soil makeup, vehicular movement, noise levels, lighting conditions, the presence or absence of certain kinds of objects or substances, mechanical stress levels on attached objects, and other properties [4]. In case of wireless sensor network, the communication among the sensors is done using wireless transceivers. The attractive features of the wireless sensor networks attracted many researchers to work on various issues related to these types of networks. The routing strategies and wireless sensor network modeling are getting much preference. Basically the major challenge for employing any efficient routing scheme in wireless sensor networks is created by the size of sensors, consequently the processing power, memory and type of tasks expected fromthe sensors

Wireless Sensor Network (WSN) contains hundreds or thousands of these sensor nodes. These sensors have the ability to communicate either among each other or directly to an external base-station (BS). A greater number of sensors allows for sensing over larger geographical regions with greater accuracy. Basically, each sensor node comprises sensing, processing, transmission, mobilizer, position finding system, and power units as shown in Figure1. Sensor nodes are usually scattered in a sensor field, which is an area where the sensor nodes are deployed. Sensor nodes coordinate among themselves to produce high-quality information about the physical environment. Each sensor node bases its decisions on its mission, the information it currently has, and its knowledge of its computing, communication, and energy.

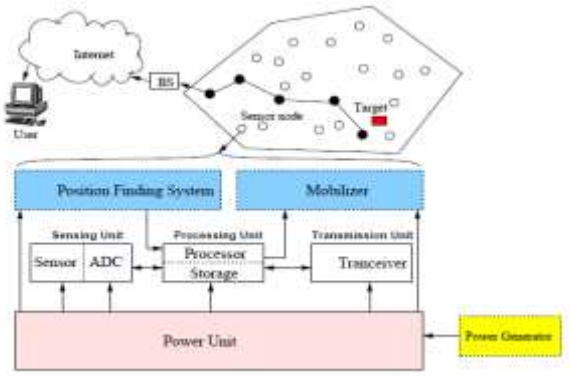

Figure 1: Basic Components of a Sensor Node.

Each of these scattered sensor nodes has the capability to collect and route data either to other sensors or back to an external base station(s). A base-station may be a fixed node or a mobile node capable of connecting the sensor network to an existing communications infrastructure or to the Internet where a user can have access to the reported data. The main design goal of routing protocols in WSNs, is on uniform load distribution among the SNs in order to increase the network lifetime. Many protocols existing in the literature minimize the energy consumption on routing paths[2-4], but they do not prolong network life time. even if dynamic routing is used to forward data with highest residual energy, it may cause unbounded delays and routing loops, hot spot etc. In WSNs density of nodes brings in an inbuilt redundancy in the amount of data sensed by the overall network since the nearby nodes

will sense almost the same data and send it over the network. This unnecessarily cause bandwidth wastage, congestion and dissipation of energy resulting in reduced overall network lifetime.

II. RELATED STUDY

As energy saving of wireless sensor network is one of the hot topics in the WSN field much research has already been done and more is expected. Much of the recent works has targeted a single factor influencing energy consumption of a network either at hardware or communication level. This survey however has been done by identifying and collecting the most influential of the factors effecting energy efficiency in WSN.

The following issues will be addressed here:

1. Analyzing the architecture of a WSN node to minimize energy consumption.
   This involves proper selection of the node components with mechanisms to conserve energy such as support for sleep modes. A diverse set of sleep modes will help in programming the node to respond to different event scenarios such as periodic

transfer of parameter data, different sleep modes for the different types of nodes in the network – end devices, routers and base stations. The analysis will also focus on the operating system requirements to support activities such as scheduling of tasks, responding to external wake-up calls, modification of execution paths as per available energy in the node, duty cycle for sleep and wake-up.

2. Comparing different microcontrollers and RF transceivers on energy level and on different modes of operation.
3. Studying network infrastructure, factors influencing energy consumption at network level and things to be look for while making wireless sensor network for more efficiency.
4. Estimation methods for energy consumption of a node based on the battery data sheet supplied by the manufacturer can be an estimate on the remaining life of the battery. This information can make use of routing algorithms that favour nodes running with low power so that there is uniform consumption in the entire network.

The approach is basically to delineate/define energy saving methods first and then focus on some energy saving estimates. In addition, the study of energy saving methods will focus on the physical layer, the choice of components and the choice of network topology as the areas where savings can be affected by putting in efforts. The thesis work takes a holistic approach and divides the methods as pertaining to a node or to the entire network. It is probable that only a combination of methods that attempt to reduce energy consumption at the node level and the network level will lead to a practical network that is energy efficient. Some of the methods that were thought of as promising are:

- Allowing nodes in a network to sleep for much longer periods during non-transmission of data
- Minimize the time it takes for nodes to get into sleep mode and to awake from sleep mode
- Allowing node to sleep even in deeper mode as described in

An integrated scheme that involves the component selection of the node, the operating system that runs in the node, the tasks that run and are controlled by the operating system, the configuration of the MAC and finally a network wide energy efficient application were presented in the present thesis. This thesis is a survey of methods currently available. Further some new methods and techniques have been discussed. This thesis gives a comprehensive solution that can be practically implemented. It is a solution that integrates techniques and components in their individual capacities but not in an integrated manner.

III. SYSTEM SURVEY

The methods in which energy savings can be affected or can be classified under two heads:

1. **Device Level** -Hardware component selection and their configuration to achieve low energy consumption in a wireless sensor node.
2. **Network Level** -Choice of communication methods and protocols to minimize energy consumption.

A. Overall Design

In a Sensor node there are four essential parts:

1. processing unit,
2. sensing unit,
3. transceiver unit
4. power unit,

This part of Wireless sensor mote (WSM) is built on the Integrated Chip (IC). One needs to choose proper Peripheral of WSM and configure the entire network which will be more energy efficient.

The architecture of the node can be designed base on the following conditions:

- Criteria for component selection based on the end goal of energy saving
- A viable combination of components that satisfy the end criteria

A WSN node can be described in three parts, processor, sensor and power unit.

1. Processor

Basically the processor is built on the microcontroller which reads sensor data and makes the data ready for transfer. In other words, processor is a core module for the calculation in a wireless sensor node. This part of the node helps to control the task scheduling, to calculate energy, to define communication protocols, to make suitable coordination, and for data manipulation and data transfer. The processor is therefore the most important part, which is why it is necessary to choose a suitable energy-efficient processor for WSM. The

power consumption of processor mainly depends on how long it supports sleep mode because sleep mode has a straight connection with the operation of node. The power consumption of node depends on operating voltage, duty-cycle internal logic and above all on efficient manufacture technology.

2. Radio and Transceiver

The Radio transmission and reception has proven to be the major energy consumer in the sensor network. In most of the sensor networks, energy conservation involves two methods to minimize communication overhead. Configuring MAC and networking layer is the first method for which the multi-hop communications nodes switch off their radios when they are not in use (Adaptive duty cycle). Data reduction and data aggregation is the second method where exploitation of the correlation in the data is achieved to decrease the size of data and also the communication cost.

The selection of different transceivers is made on the basis of their key features such as:

- Power consumption requirements
- Availability of modes to support low power operation
- Throughput
- transmitted power,
- current in receiving/transmitting mode
- Ease of interface to microcontrollers
- Range etc.

3. Battery

Generally sensor nodes are designed to run on ordinary AA batteries. It is vital to approximate the power consumption needs of the sensor node. Appropriate selection in the design phase of the transceiver and microcontroller will make sure that the hardware platform on which the sensor node is built is power conscious, and this will be useful in managing the power of the system.

We can differentiate batteries in two categories, chargeable and rechargeable. It can be also compare according to their different properties like,

- Electro material (such as NiCd, AgZn, NiMH etc).
- Capacity (how much mile-amp-hours (mAh) of current the cell can store.
- Energy density (how much energy can be store in the cell per unit volume).
- Battery Mechanical Specifications.
- Battery Environmental Specifications.

There are many commercial batteries available in the market. However it is preferable that

batteries are chosen by the three approaches described in developed at the University of Michigan by K: A Cook and A.M Shastry.

1. Specification of a single, aggregate power supply, resulting in a single battery electrochemistry and cell size.
2. Specification of several power supplies, by a priori division of power sources by power range.
3. Specification of an arbitrary number of power "bundles", based on available space in the device.

Characteristic	Alkaline	Alkaline	Alkaline	Nickel-cadmium	Alkaline
Manufacturer	Panasonic	Duracell	Maxell	Panasonic	Energizer
Volumne	55.9ml	23ml			8.34
Voltage	1.5V	9V	3.6V	1.2V	1.2V
Capacity	2.4Ah	280Ah	1.8Ah	1.08Ah	2.3Ah
Energy density	3.5	5.22		1.296	3.3
Weight	141g	49g	10g	23g	27g
Rechargeable	No	No	No	Yes	No

Comparison of different AA Batteries

This approach helps to select the commercial batteries that are available in the market.

IV. CONCLUSION

The main sources for reduction of energy consumptions lie in followings:

1. The distance of communication over which a SN has to transmit the sensed data
2. Also the number of nodes sending the redundant data i.e. nodes sensing the similar data that will ultimately be forwarded.

Hence if we can anyhow reduce these two factors then much energy savings are feasible.

So to minimize the overall power consumption of WSNs here are the factors which helps in achieving the same, so if we can anyhow improve these we ultimately leads to enhanced life time of network.

Factors are:

1. Root level Deployment
2. Battery type selection
3. Routing algorithm used for transmission
4. Distance of transmission
5. Type of transmission: Continuous, Periodical or Event based
6. Level of data aggregation

Minimization of energy consumption, routing protocol and data transmission are co-related which means that each influences the other

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