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Abstract. This paper presents a novel solution for the effective reduction of power consumption in sensor nodes of wireless sensor networks. Possible alternatives to reduce the power consumption in generic sensor nodes are presented. After, these alternatives are evaluated for a specific sensor node, the Crossbow Mica2. The case analysis for this sensor node showed that, among the possible alternatives to reduce the power consumption, the radio communication channel presented the best opportunity. A novel solution that integrates the transmitted signal power control with the received information quality is presented in a dynamic mechanism called Maximal Survival Capacity.

1 Introduction

A Wireless Sensor Network (WSN) is composed of many autonomous and compact devices called sensor nodes. The objective of this network is to collect data. The availability of integrated low-power sensing devices, embedded processors, wireless communication kits, and power equipment are enabling the design of sensor nodes. WSN has the potential for many applications from monitoring large metropolis traffic density to road conditions; in a forest for fire detection; in precision agriculture; in condition based maintenance devices like powerplants; in biomedicine. Other applications include managing complex physical systems like airplane wings and complex ecosystems, and animal tracking.

A sensor node is composed of a power unit, processing unit, sensing unit, and communication unit. The power unit has the purpose to supply energy to the node. The processing unit collects and processes signals captured from sensors and transmit them to the network. Sensors devices are devices that produce a measurable response to a change in a physical condition like temperature and pressure. The wireless communication channel enables a medium to transfer signals from sensors to exterior world (provided by a gateway), and also an internal mechanism of communication to establish and maintain the WSN. Sensor nodes of WSN have limited resources, such as computational capacity, memory, communication and energy. In most applications, WSN will have large quantities of...
distributed sensor nodes in remote or inhospitable places. That’s why batteries are their main source of energy. Network lifetime depends on quantity of energy available and sensor nodes should balance their limited resources to increase the lifetime of the network.

The objective of this work is to present a novel approach to reduce the power consumption in sensor nodes. Several alternatives to reduce the power consumption are presented and analyzed. The case study focus at the Crossbow commercial sensor node called Mica2 Mote.

The Maximal Survival Capacity (MSC) is the ability of a WSN node to increase its operational lifetime. MSC is based on the amount of internal energy (supplied by its batteries) and the processing of the Maximal Survival Algorithm (MSA) which is based on the control of the node transmitted power and the quality of the received data at the base station.

2 Power Consumption in Sensor Nodes

To maximize the sensor node’s lifetime after its deployment, aspects such as circuits, architecture, algorithms and protocols have to be energy efficient [1]. Once the system has been designed, it becomes necessary to identify how the power consumption is distributed among hardware components in the sensor node in order to obtain additional energy savings using Dynamic Power Management (DPM). The majority of the hardware components used, such as, microcontrollers, memories, and transceivers have at least two power management modes. Traditional Power Consumption reduction techniques use DPM and Static Power Management (SPM) which involves the control of power supply voltages and frequency of operation. In the case of WSN most used techniques are the Power Supply scaling, CPU Power states and peripheral Power Supply Control (on and off).

Microcontroller: Processing is effected by the microcontroller unit (MCU) of the sensor node. The MCU is composed by a central processing unit (CPU), a small internal program memory and, in general, a large data memory (usually non-volatile), and a set of peripherals such as timers, I/O modules and interfaces, and analog to digital converters. To increase the data memory capacity, an external is added and acts as a secondary memory not addressed in the CPU memory space. The MCU is responsible for the control of the sensors and execution of the communication protocols and algorithms of signal processing, applied to the data collected from the sensors. The StrongARM microprocessors from the Intel [2], microcontrollers AVR from the Atmel [3] and microcontrollers MSP430 of the Texas [4] are the MCUs often used in sensor nodes for WSN. DPM implemented in CPU makes possible the reduction of the power consumption in idle or sleep states. These modes permit that the application turn off modules not used. For example, the ATMEGA128L has six sleep modes, each one with a different set of internal modules turned on. There are also techniques that make possible the reduction of the power consumption in the active state of the MCU, such as DVS/DFS (Dynamic Voltage Scaling/Dynamic Frequency