OVERVIEW OF WIRELESS SENSOR NETWORK IN COMMUNICATION SYSTEM

KIRTI DHABHAI, ASHWARYA BHANDARI
JlET-School of Engineering and Technology for Girls, Mogra, Jodhpur, Rajasthan, India

Abstract—Due to rapid development of small, low-cost sensors implementation of wireless sensor network technology can be made possible for countless applications. In this paper we studied about technology, its architecture and applications that have been already applied.

Keywords—GPS, Media Access Control, Wireless Sensor Network, Nodes, Gateways, Task Manager

I. INTRODUCTION

Wireless Sensor Networks (WSNs) can be defined as a self-configured and infrastructure-less wireless networks to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to a main location or sink where the data can be observed and analyzed. A sink or base station acts like an interface between users and the network. One can retrieve required information from the network by injecting queries and gathering results from the sink. Typically a wireless sensor network contains hundreds of thousands of sensor nodes. The sensor nodes can communicate among themselves using radio signals. A wireless sensor node is equipped with sensing and computing devices, radio transceivers and power components. The individual nodes in a wireless sensor network (WSN) are inherently resource constrained: They have limited processing speed, storage capacity, and communication bandwidth. After the sensor nodes are deployed, they are responsible for self-organizing an appropriate network infrastructure often with multi-hop communication with them. Then the onboard sensors start collecting information of interest. Wireless sensor devices also respond to queries sent from a “control site” to perform specific instructions or provide sensing samples. The working mode of the sensor nodes may be either continuous or event driven. Global Positioning System (GPS) and local positioning algorithms can be used to obtain location and positioning information. Wireless sensor devices can be equipped with actuators to “act” upon certain conditions. These networks are sometimes more specifically referred as Wireless Sensor and Actuator Networks.

II. PHYSICAL LAYER

The main task of physical layer algorithms is to enable reliable delivery of bit streams over physical medium by carrying out transmission, reception and signal modulation. Other objectives include cooperation with the Media Access Control (MAC) layer to ensure error free communications and providing channel information for MAC layer to make operational decisions. Due to the inherent characteristics of WSNs, physical layer solutions have strict limitations in terms of energy consumption and processing power compared to traditional wireless systems. Hence, the sensors’ hardware abilities have to be taken into account while designing physical layer solutions. In this section we discussed about existing physical layer methods, such as signal multiplexing, modulation.

2.1. Bandwidth, modulation and multiplexing:
In general, physical layer techniques in WSNs can be divided into three different classes based on bandwidth requirements:
A. Narrow band:
1. High bandwidth efficiency
2. Vulnerable to interference, jamming and fading
3. It cannot provide robust and reliable communication
4. Uses orthogonal frequency division multiplexing
B. Spread spectrum:
1. In which bandwidth of original signal is compared over wide frequency bandwidth.
2. Low transmission power
3. Low robustness to narrow band interference
4. Offers resistance against jamming and eavesdropping
5. Enables multiple users to access the same band simultaneously
C. Ultra side band:
1. Utilize wider frequency band
2. Low transmission power
3. Suitable for short range data transmission
We conclude that spread spectrum is preferred as it provide several advantages over other methods.

III. STRUCTURE OF A WIRELESS SENSOR NODE

A sensor node is made up of four basic components such as sensing unit, processing unit, transceiver unit
and a power unit. It also has application dependent additional components such as a location finding system, a power generator and a mobilizer. Sensing units are usually composed of two subunits: sensors and analogue to digital converters (ADCs). The analogue signals produced by the sensors are converted to digital signals by the ADC, and then fed into the processing unit. The processing unit is generally associated with a small storage unit and it can manage the procedures that make the sensor node collaborate with the other nodes to carry out the assigned sensing tasks. A transceiver unit connects the node to the network. One of the most important components of a sensor node is the power unit. Power units can be supported by a power scavenging unit such as solar cells.

![Diagram](image)

**Fig. The main components of a sensor node**

### IV. CONTROLLER

The controller performs tasks, processes data and controls the functionality of other components in the sensor node. While the most common controller is a microcontroller, other alternatives that can be used as a controller are: a general purpose desktop microprocessor, digital signal processors, FPGAs and ASICs. A microcontroller is often used in many embedded systems such as sensor nodes because of its low cost, flexibility to connect to other devices, ease of programming, and low power consumption.

A general purpose microprocessor generally has higher power consumption than a microcontroller, therefore it is often not considered a suitable choice for a sensor node. Digital Signal Processors may be chosen for broadband wireless communication applications, but in Wireless Sensor Networks the wireless communication is often modest; i.e., simpler, easier to process modulation and the signal processing tasks of actual sensing of data is less complicated. Therefore the advantages of DSPs are not usually of much importance to wireless sensor nodes. FPGAs can be reprogrammed and reconfigured according to requirements, but this takes more time and energy than desired.

### Transceiver

Sensor nodes often make use of ISM band, which gives free radio, spectrum allocation and global availability. The possible choices of wireless transmission media are radio frequency (RF), optical communication (laser) and infrared. Lasers require less energy, but need line-of-sight for communication and are sensitive to atmospheric conditions. Infrared, like lasers, needs no antenna but it is limited in its broadcasting capacity. Radio frequency-based communication is the most relevant that fits most of the WSN applications. WSNs tend to use license-free communication frequencies: 173, 433, 868, and 915 MHz; and 2.4 GHz. The functionality of both transmitter and receiver are combined into a single device known as a transceiver. Transceivers often lack unique identifiers. The operational states are transmit, receive, idle, and sleep. Current generation transceivers have built-in state machines that perform some operations automatically.

Most transceivers operating in idle mode have a power consumption almost equal to the power consumed in receive mode. Thus, it is better to completely shut down the transceiver rather than leave it in the idle mode when it is not transmitting or receiving. A significant amount of power is consumed when switching from sleep mode to transmit mode in order to transmit a packet.

**External memory:** From an energy perspective, the most relevant kinds of memory are the on-chip memory of a microcontroller and Flash memory—off-chip RAM is rarely, if ever, used. Flash memories are used due to their cost and storage capacity. Memory requirements are very much application dependent. Two categories of memory based on the purpose of storage are: user memory used for storing application related or personal data, and program memory used for programming the device. Program memory also contains identification data of the device if present.

**Power source**

A wireless sensor node is a popular solution when it is difficult or impossible to run a mains supply to the sensor node. However, since the wireless sensor node is often placed in a hard-to-reach location, changing the battery regularly can be costly and inconvenient. An important aspect in the development of a wireless sensor node is ensuring that there is always adequate energy available to power the system. The sensor node consumes power for sensing, communicating and data processing. More energy is required for data communication than any other process. The energy cost of transmitting 1 Kb a distance of 100 meters (330 ft) is approximately the same as that used for the execution of 3 million instructions by a 100 million instructions per second/W processor. Power is stored
either in batteries or capacitors. Batteries, both rechargeable and non-rechargeable, are the main source of power supply for sensor nodes. They are also classified according to electrochemical material used for the electrodes such as NiCd (nickel-cadmium), NiZn (nickel-zinc), NiMH (nickel-metal hydride), and lithium-ion. Current sensors are able to renew their energy from solar sources, temperature differences, or vibration. Two power saving policies used are Dynamic Power Management (DPM) and Dynamic Voltage Scaling (DVS).[7] DPM conserves power by shutting down parts of the sensor node which are not currently used or active. A DVS scheme varies the power levels within the sensor node depending on the non-deterministic workload. By varying the voltage along with the frequency, it is possible to obtain quadratic reduction in power consumption.

Sensors
Sensors are hardware devices that produce a measurable response to a change in a physical condition like temperature or pressure. Sensors measure physical data of the parameter to be monitored. The continual analog signal produced by the sensors is digitized by an analog-to-digital converter and sent to controllers for further processing. A sensor node should be small in size, consume extremely low energy, operate in high volumetric densities, be autonomous and operate unattended, and be adaptive to the environment. As wireless sensor nodes are typically very small electronic devices, they can only be equipped with a limited power source of less than 0.5-2 ampere-hour and 1.2-3.7 volts.

Sensors are classified into three categories: passive, omni-directional sensors; passive, narrow-beam sensors; and active sensors. Passive sensors sense the data without actually manipulating the environment by active probing. They are self powered; that is, energy is needed only to amplify their analog signal. Active sensors actively probe the environment, for example, a sonar or radar sensor, and they require continuous energy from a power source. Narrow-beam sensors have a well-defined notion of direction of measurement, similar to a camera. Omni-directional sensors have no notion of direction involved in their measurements.

The overall theoretical work on WSNs works with passive, Omni-directional sensors. Each sensor node has a certain area of coverage for which it can reliably and accurately report the particular quantity that it is observing. Several sources of power consumption in sensors are: signal sampling and conversion of physical signals to electrical ones, signal conditioning, and analog-to-digital conversion. Spatial density of sensor nodes in the field may be as high as 20 nodes per cubic meter.

V. COMMUNICATION STRUCTURE OF A WSN
The sensor nodes are usually scattered in a sensor field, each of these scattered sensor nodes has the capabilities to collect data and route data back to the sink and the end users. Data are routed back to the end user by a multi-hop infrastructure-less architecture through the sink. The sink may communicate with the task manager node via Internet or Satellite.

Gateways allow the scientists/system managers to interface Motes to personal computers (PCs), personal digital assistants (PDAs), Internet and existing networks and protocols. In a Nutshell, gateways act as a proxy for the sensor network on the Internet. Gateways can be classified as active, passive, and hybrid. Active gateway allows the sensor nodes to actively send its data to the gateway server. Passive gateway operates by sending a request to sensor nodes. Hybrid gateway combines capabilities of the active and passive gateways.

The Task Manager will connect to the gateways via some media like Internet or satellite link. Task Managers comprise of data service and client data browsing and processing. These Task Managers can be visualized as the information retrieval and processing platform. All information (raw, filtered, processed) data coming from sensor nodes is stored in the task Managers for analysis. Users can use any display interface (i.e. PDA, computers) to retrieve/analyze these information locally or remotely.

VI. APPLICATIONS
WSNs have been successfully applied in various application domains:
   a. Military applications
   b. Transportation
   c. Area monitoring
   d. Health services
   e. Environmental sensing:
The term Environmental Sensor Networks has developed to cover many applications of WSNs to earth science research. This includes sensing volcanoes, oceans, glaciers, forests etc. Some other major areas are listed below:

- Air pollution monitoring
- Forest fires detection
- Greenhouse monitoring
- Landslide detection
- f. structural monitoring
g. agricultural sector

CONCLUSION

Wireless sensor network of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location. The WSN is built of "nodes" – from a few to several hundreds or even thousands, where each node is connected to one or several sensors.

REFERENCES

[2] Wireless sensor network communication architecture for wide-area large scale soil moisture estimation and wetlands monitoring, by ‘Miguel Angel Erazo Villegas, Seok Yee Tang, Yi Quan’