A

Seminar report

On

WIRELESS SENSOR NETWORKS

Submitted in partial fulfillment of the requirement for the award of degree
of Bachelor of Technology in Computer Science

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Preface

I have made this report file on the topic **Artificial Neural Networks**; I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to …………..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

CONTENTS:

ABSTRACT

Wireless sensor networks (WSNs) enable new applications and require non-conventional paradigms for protocol design due to several constraints. Owing to the requirement for low device complexity together with low energy consumption (i.e., long network lifetime), a proper balance between communication and signal/data processing Capabilities must be found. This motivates a huge effort in research activities, standardization process, and industrial investments on this field since the last decade.

This survey paper aims at reporting an overview of WSNs technologies, main applications and standards, features in WSNs design, and evolutions. In particular, some peculiar applications, such as those based on environmental monitoring, are discussed and design strategies highlighted; a case study based on a real implementation is also reported.

Trends and possible evolutions are traced. Emphasis is given to the IEEE 802.15.4 technology, which enables many applications of WSNs. Some example of performance characteristics of 802.15.4-based networks are shown and discussed as a function of the size of the WSN and the data type to be exchanged among nodes.

1. INTRODUCTION

A **wireless sensor network (WSN)** consists 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 more modern networks are bi-directional, also enabling *control* of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on.

1.1 WSN TECHNOLOGY

The WSN is built of "nodes" – from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting.

A sensor node might vary in size from that of a shoebox down to the size of a grain of dust, although functioning "motes" of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from a few to hundreds of dollars, depending on the complexity of the individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth. The topology of the WSNs can vary from a simple star network to an advanced multi-hop wireless mesh network. The propagation technique between the hops of the network can be routing or flooding.

2.2 HISTORY

The origins of the research on WSNs can be traced back to the Distributed Sensor Networks(DSN) program at the Defense Advanced Research Projects Agency (DARPA) at around 1980. By this time, the ARPANET (Advanced Research Projects Agency Network) had been operational for a number of years, with about 200 hosts at universities and research institutes. DSNs were assumed to have many spatially distributed low-cost sensing nodes that collaborated with each other but operated autonomously, with information being routed to whichever node was best able to use the information.

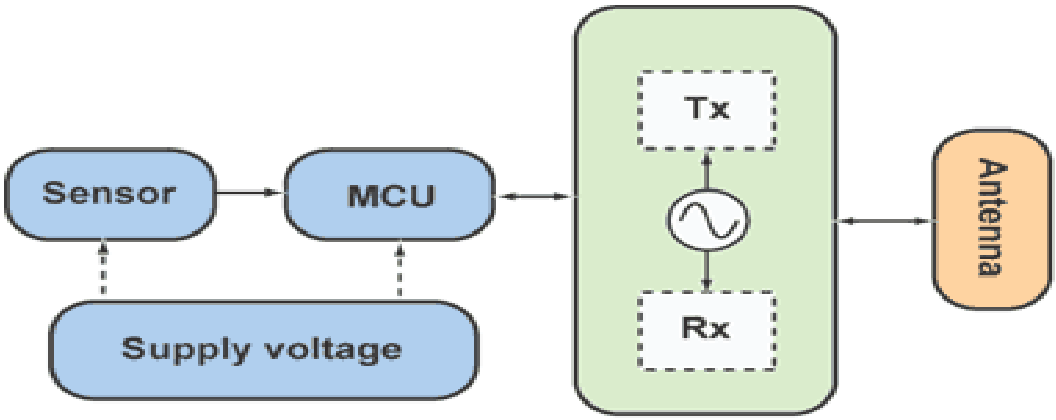
At that time, this was actually an ambitious program. There were no personal computers and workstations; processing was mainly performed on minicomputers and the Ethernet was just becoming popular. Technology components for a DSN were identified in a Distributed Sensor Nets workshop in 1978 (*Proceedings of the Distributed Sensor Nets Workshop*, 1978). these included sensors (acoustic), communication and processing modules, and distributed software. Researchers at Carnegie Mellon University (CMU) even developed a communication-oriented operating system called Accent (Rashid & Robertson, 1981), which allowed flexible, transparent access to distributed resources required for a fault-tolerant DSN. A demonstrative application of DSN was a helicopter tracking system (Myers et al., 1984), using

a distributed array of acoustic microphones by means of signal abstractions and matching techniques, developed at the Massachusetts Institute of Technology (MIT). Even though early researchers on sensor networks had in mind the vision of a DSN, the technology was not quite ready. More specifically, the sensors were rather large and This work was carried out during the tenure of an ERCIM “Alain Bensoussan” Fellowship Program and is part of the MELODY Project, which is funded by the Research Council of Norway under the contract number 187857/S10.

In the new wave of sensor network research, networking techniques and networked information processing suitable for highly dynamic ad hoc environments and resource constrained sensor nodes have been the focus. Further, the sensor nodes have been much smaller in size (i.e. pack of cards to dust particle) and much cheaper in price, and thus many new civilian applications of sensor networks such as environment monitoring, vehicular sensor network
and body sensor network have emerged. Again, DARPA acted as a pioneer in the new wave of sensor network research by launching an initiative research program called SensIT. Which provided the present sensor networks with new capabilities such as ad hoc networking, dynamic querying and tasking, reprogramming and multitasking. At the same time, the IEEE noticed the low expense and high capabilities that sensor networks offer. The organization has defined the IEEE 802.15.4 standard (*IEEE 802.15 WPAN Task Group 4*, n.d.) for low data rate wireless personal area networks. Based on IEEE 802.15.4, ZigBee Alliance (*ZigBee Alliance*, n.d.) has published the ZigBee standard which specifies a suite of high level communication protocols which can be used by WSNs. Currently, WSN has been viewed as one of the most important technologies for the 21st century (*21 Ideas for the 21st Century*,1999). Countries such as China have involved WSNs in their national strategic research programmer's (Ni, 2008). The commercialization's of WSNs are also being accelerated by new formed companies like Crossbow Technology (*Crossbow Technology*, n.d.) and Dust Networks

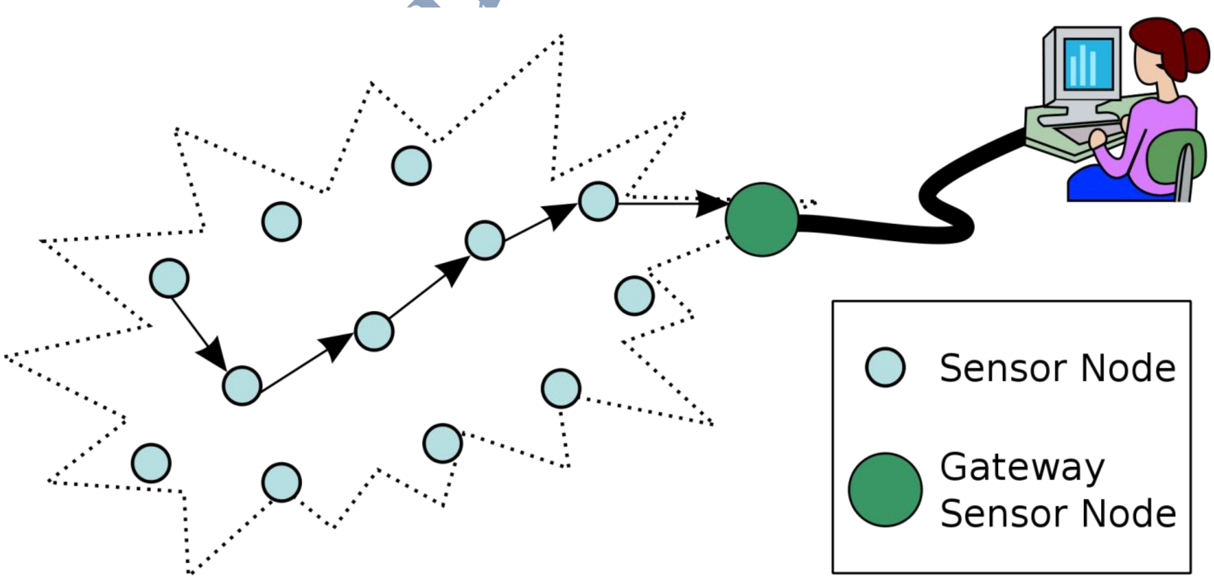
2.3 **WSN ARCHITECTURE**

The architecture of wsn consist of sensor microcontroller unit antenna and transmitter & receiver of the system.sens0r and control units are connected to the battery for required power supply voltage sensor sense the physical environment and send the input to the A/D converter to convert it into digital form and then it is send to the control unit of microcontroller from where the o/p's are controlled by the mechanism stored in microcontroller unit



3. This diagram shows a wireless sensor node architecture.

The topology of the WSNs can vary from a simple star network to an advanced multi-hop wireless mesh network. The propagation technique between the hops of the network can be routing or flooding.



Typical multi-hop wireless sensor network architecture

3. SENSOR

Sensors are the very important part of any sensor network it is the primery hub of wireless sensor networks. All wireless technology is depend upon these sensors in our general life we use many sensors ,do u know that how much sensors are working in your system or in your mobile cell. U can not think about a network without sensor

3.1 DEFINITION

A 'sensor' is a device that measures a physical quantity and converts it into a 'signal' which can be read by an observer or by an instrument. For example, a mercury thermometer converts the measured temperature into the expansion and contraction of a liquid which can be read on a calibrated glass tube.

3.2 TYPE OF SENSOR

There are a lot of different **types** of **sensors**. Sensors are used in everyday objects.

Thermal sensors

A sensor that detects temperature. Thermal sensors are found in many laptops and computers in order to sound an alarm when a certain temperature has been exceeded.

- temperature sensors: thermometers
- heat sensors: bolometer, calorimeter

Electromagnetic sensors

An electronic device used to measure a physical quantity such as pressure or loudness and convert it into an electronic signal of some kind (e.g. a voltage).

- electrical resistance sensors: ohmmeter
- electrical voltage sensors: voltmeter
- electrical power sensors: watt-hour meter
- magnetism sensors: magnetic compass
- metal detectors
- Radar

Mechanical sensors

- Pressure sensors: barometer
- Vibration and shock sensors

Motion sensors

A motion sensor detects physical movement in a given area.

- radar gun, tachometer

Car sensors

- reversing sensor
- rain sensor

3 The trend of sensors

Because of certain disadvantages of physical contact sensors, newer technology non-contact sensors have become prevalent in industry, performing well in many applications. The recent style of non-contact sensors shows that “Thin (g) is In”. Market trends show that form and size are important.

Users are looking for smaller and more accurate sensors. New technologies for the sensing chips are breaking application barriers. For the future, the trend will be to continue to provide smaller, more affordable sensors that have the flexibility to fit even more applications in both industrial and commercial environments.

4. **FEATURES:**

In spite of the diverse applications, sensor networks pose a number of unique technical features due to the following factors:

4.1. **Ad hoc deployment:**

Most sensor nodes are deployed in regions which have no infrastructure at all. A typical way of deployment in a forest would be tossing the sensor nodes from an aeroplane. In such a situation, it is up to the nodes to identify its connectivity and distribution.

4.2 .**Unattended operation:**

In most cases, once deployed, sensor networks have no human intervention. Hence the nodes themselves are responsible for reconfiguration in case of any changes.

4.3. **Unmetered:**

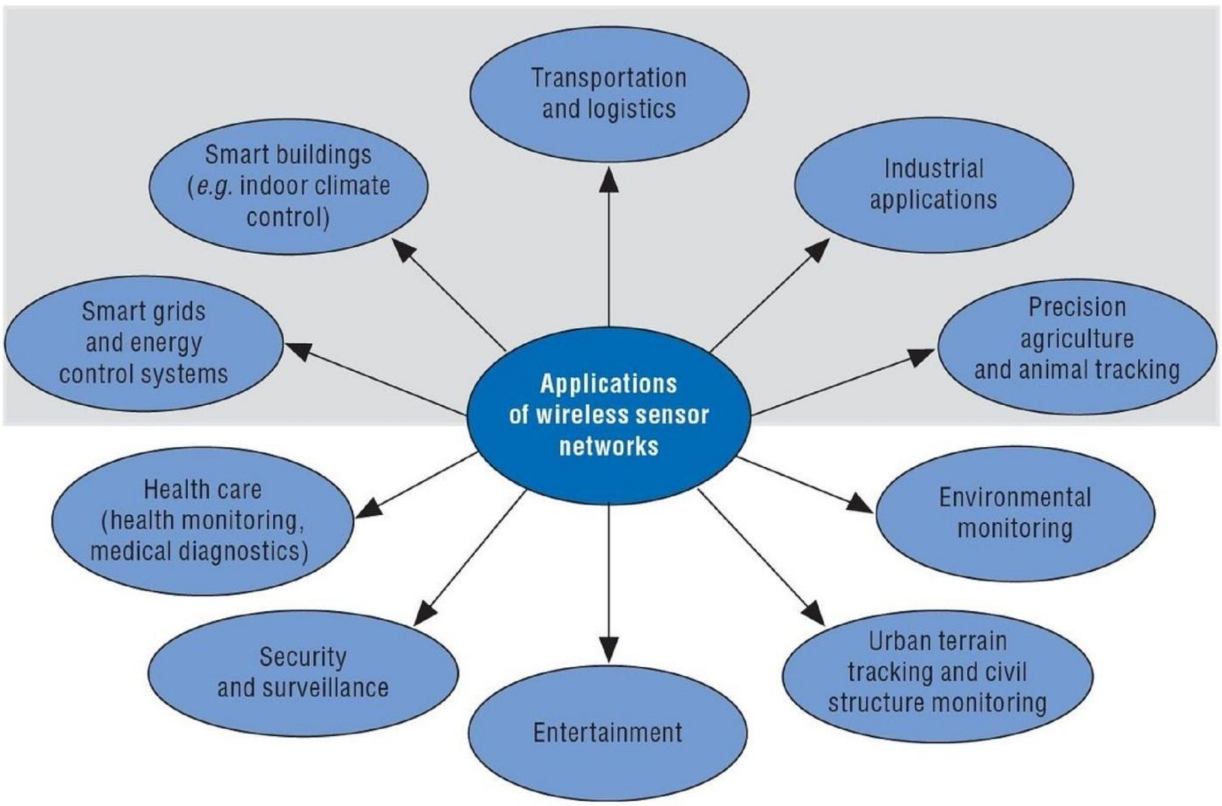
The sensor nodes are not connected to any energy source. There is only a finite source Of energy, which must be optimally used for processing and communication? An interesting fact is That communication dominates processing in energy consumption. Thus, in order to make optimal Use of energy, communication should be minimized as much as possible.

4.4 **Dynamic changes:**

It is required that a sensor network system be adaptable to changing Connectivity (for e.g., due to addition of more nodes, failure of nodes etc.) as well as changing Environmental stimuli. Thus, unlike traditional networks, where the focus is on maximizing channel throughput or minimizing node deployment, the major consideration in a sensor network is to extend the system lifetime as well as the system robustness.

5. APPLICATIONS

The original motivation behind the research into WSNs was military application. Examples of military sensor networks include large-scale acoustic ocean surveillance systems for the detection of submarines, self-organized and randomly deployedWSNs for battlefield surveillance and attaching microsensors to weapons for stockpile surveillance (Pister, 2000). As the costs for sensor nodes and communication networks have been reduced, many other potential applications including those for civilian purposes have emerged. The following are a few examples.



5.1 Environmental Monitoring

Environmental monitoring (Steere et al., 2000) can be used for animal tracking, forest surveillance, flood detection, and weather forecasting. It is a natural candidate for applying WSNs, because the variables to be monitored, e.g. temperature, are usually distributed over a large region. One example is that researchers from the University of Southampton have built a glacial environment monitoring system using WSNs in Norway (Martinez et al., 2005). They collect data from sensor nodes installed within the ice and the sub-glacial sediment without the use of wires which could disturb the environment.

5.2 Health Monitoring

WSNs can be embedded into a hospital building to track and monitor patients and all medical resources. Special kinds of sensors which can measure blood pressure, body temperature and electrocardiograph (ECG) can even be knitted into clothes to provide remote nursing for the elderly. When the sensors are worn or implanted for healthcare purposes, they form a special kind of sensor network called a body sensor network (BSN). BSN is a rich interdisciplinary area which revolutionizes the healthcare system by allowing inexpensive, continuous
and ambulatory health monitoring with real-time updates of medical records via the Internet.

5.3 TRAFFIC CONTROL

Sensor networks have been used for vehicle traffic monitoring and control for some time. At many crossroads, there are either overhead or buried sensors to detect vehicles and to control the traffic lights. Furthermore, video cameras are also frequently used to monitor road segments with heavy traffic. However, the traditional communication networks used to connect these sensors are costly, and thus traffic monitoring is usually only available at a few critical points in a city (Chong & Kumar, 2003). WSNs will completely change the landscape of traffic monitoring and control by installing cheap sensor nodes in the car, at the parking lots, along the roadside, etc. Street line, Inc. (*Street line, Inc.*, n.d.) is a company which uses sensor network technology to help drivers find unoccupied parking places and avoid traffic jams. The solutions provided by Street line can significantly improve the city traffic management and reduce the emission of carbon dioxide.

5.4 SMART BUILDINGS

The New York Times Building - a Smart Building

The headquarters of the New York Times is an example of how different smart building technologies can be combined to reduce energy consumption and to increase user comfort. Overall, the building consumes 30% less energy than traditional office skyscrapers. Opened in November 2007 and designed by Renzo Piano, the building has a curtain wall which serves as a sunscreen and changes color during the day. This wall consists of ceramic rods, “a supporting structure for the screen and an insulated window unit” (Hart, 2008).

The building is further equipped with lighting and shading control systems based on ICT technologies. The lighting system ensures that electrical light is only used when required. Further day lighting measures include a garden in the centre of the ground floor which is open to the sky as well as a large area skylight.

The electrical ballasts in the lighting system are equipped with chips that allow each ballast to be controlled separately. The shading system tracks the position of the sun and relies on a sensor network to automatically actuate the raising and lowering of the shades.

The high-tech HVAC system is equipped with sensors that measure the temperature. It is further able to rely on free air cooling, *i.e.* fresh air on cool mornings is brought into the HVAC system. An automated building system monitors in parallel “the air conditioning, water cooling, heating, fire alarm, and generation systems” (Siemens, 2008).

The system relies on a large-scale sensor network composed of different kinds of sensors which deliver real-time information. Consequently, energy can be saved as only as few systems are turned on as needed.

5.5 SECURITY

While the future of WSNs is very prospective, WSNs will not be successfully deployed if security, dependability and privacy issues are not addressed adequately. These issues become more important because WSNs are usually used for very critical applications. Furthermore, WSNs are very vulnerable and thus attractive to attacks because of their limited prices andhuman-unattended deployment .IT provide kee management, authentication, intrusion detection, privacy protection which makes WSN secure.

6. STANDARDIZATION

In the area of WSNs, several standards are currently either ratified or under development. The major standardization bodies are the Institute of Electrical and Electronics Engineers (IEEE), the Internet Engineering Task Force (IETF), the International Society for Automation (ISA) and the HART Communication Foundation, etc. These standardization bodies have different focuses and they provide global, open standards for interoperable, low-power wireless sensor devices. Table 1 provides the comparisons of different standards currently available for the communication protocols of WSNs.

6.1 IEEE 802.15.4

IEEE 802.15.4 is a standard which specifies the physical layer and MAC layer for low-rate wireless personal area networks. It is the basis for the ZigBee and Wireless HART specification, each of which further attempts to offer a complete networking solution by developing the upper layers which are not covered by the standard. The features of IEEE 802.15.4 include (*IEEE 802.15 WPAN Task Group 4*, n.d.):

- Data rates of 250 kbps, 40 kbps, and 20 kbps.
- Two addressing modes; 16-bit short and 64-bit IEEE addressing.
- Support for critical latency devices, such as joysticks.
- CSMA-CA channel access.
- Automatic network establishment by the coordinator.
- Fully handshaked protocol for transfer reliability.
- Power management to ensure low power consumption.
- 16 channels in the 2.4GHz ISM band, 10 channels in the 915MHz ISM band and one channel in the 868MHz band.

7. CONCLUSION

WSNs have been identified as one of the most prospective technologies in this century. This chapter provides information concerning both its history and current state of the art. In concrete terms, the authors provide an overview about the hardware, software and networking protocol design of this important technology.

The authors also discuss the security and ongoing standardization of this technology. Depending on applications, many other techniques such as localization, synchronization and in-network processing can be important, which are not discussed in this chapter.

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