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Wireless Sensor Network

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Abstract

The history of sensor network technology originates in the first distributed sensing idea implementations. The continuous work of researchers and engineers over sensor networks which lately became wireless sensor networks (WSNs). Wireless sensor network is one of the growing technology for sensing and performing the different tasks. Such networks are beneficial in many fields, such as emergencies, health monitoring, environmental control, military, industries and these networks prone to malicious users' and physical attacks due to radio range of network, un-trusted transmission, unattended nature and get access easily. Security is a fundamental requirement for these networks. In this paper, our center of attention is on physical attacks and issues in wireless sensor networks. Through this review, easily identify the purpose and capabilities of the attackers. Further, we discuss well-known approaches of security detection against physical attacks. The template is used to format your paper and style the text. All margins, column widths, line spaces, and text fonts are prescribed; please do not alter them.

Introduction

We The WSN is based on the dense deployment of disposable low energy, low cost The cost of nature of hetrogeneous systems and tiny nodes for gathering real time information with many potential applications wireless sensor Common functions of WSN are broadcasting, networks garnered a great deal of attention by multicasting and routing. These nodes consist of researchers. The wireless networks contain hundred or three major components sensing, processing and thousand tiny and low cost; low power and self organize communication. Various types of sensor network play a sensor nodes perform their functions in network. Significant role in the different field. In terrestrial wireless The sensor nodes are highly distributed inside the sensor network nodes are dispersed and randomly or system. These sensor nodes are used for monitoring pre-planned manner placed into the target area. different environments in the cooperative manner and The battery power is limited in these networks. compute the data for analyzing. The two components of Another type is underground WSNs, in this type the wireless sensor network aggregation and base station, nodes are buried underground like cave or mine for aggregation collect the information from there nearby monitoring the conditions. The nodes are expensive in sensors, integrate them and send to the base station for this type compare to terrestrial type. The multimedia processing. The wireless sensor network nature of sensor network has low cost nodes and equipped with communication is unprotected and unsafe because of microphones and cameras. This type of network needs deployment in hostile environment, limited resources, more bandwidth and high energy and quality of service an automated nature and untrusted broadcast for processing the data. The underwater sensor networks transmission media. The most of security techniques are located underwater for gathering the data and network are not sufficient in WSN network and security nature is sparse[ref 1]. In 1980s Defense Advanced Research Projects Agency (DARPA) is working over *Distributed Sensor Networks* (DSN) program [3 ,2]. The main task of the program was to test applicability of a new approach to machine communications, introduced for the first time in Arpanet (predecessor of the Internet). The task of researchers was to engineer a network of area-distributed sensors. At the same time, sensors had to be inexpensive, work autonomously and exchange data independently. Such demands are still made for developing sensor networks for modern applications. Hence, it is possible to say that the DARPA research was a base for modern WSNs. A sensor network of acoustic sensors tracking aircrafts appeared as a result of collaboration of researchers from Carnegie Mellon University (CMU), Pittsburgh, PA, and Massachusetts Institute of Technology (MIT), Cambridge. For a demonstration there was a platform made to passively detect and track low-flying aircraft. Connection between mobile nodes and a central computer was implemented through wireless transmission channel. Certainly, this system included not so many wireless nodes, and it was necessary to transport mobile nodes in the lorries, also system was able to track only low-flying objects with simple trajectory in rather short distance [4]. However, this work was well in advance of that time and gave a considerable impetus to sensor networks developing.

But for practical use distributed sensing with a great number of sensor nodes is of much more interest. The first steps to creating such systems were the following projects: *Wireless Integrated Network Sensors* (WINS), which started in 1993, and *Lowpower Wireless Integrated Microsensors* (LWIM), which started in the mid-1990s.

WINS combine sensor technology, signal processing, computation, and wireless networking capability in integrated systems [5]. The project was carried out in the University of California at Los Angeles in collaboration with the Rockwell Science Center. The project elaboration included working over various aspects of WSNs: sensing elements (*micro-electro-mechanical system (MEMS) sensor*), closer integration between transceiver and other elements in order to reduce the size, signal processing points, network protocol design. The researchers have aimed at distributed network and Internet access to sensors. The network from WINS supported a great number of sensor nodes with small transceiver coverage area and low-speed data transmission (1-100 kbps) [6]. The first WINS devices had been demonstrated in 1996, and then work continued as the project WINS NG (new generation).

Sensor node's hardware platform, worked out in the framework of the WINS project, included sensitive element, analog-to-digital converter, spectrum analyzer, buffer memory. This platform was meant for continuous measurements. In addition to that, sensor nodes included digital signal processor and low power transceiver. All the sensor node's components mentioned above have been worked out with tight restrictions on energy consumption, because every sensor node's supply was provided by a simple Li-Ion battery which had a diameter 2.5 cm [7], wherein the sensor nodes had to be working on one battery for a long time. Such an efficient energy use was achieved by reducing speed of signal processing, decreasing sensor nodes connection range, reducing radio channel data throughput, applying MEMS and CMOS (*Complementary metal–oxide–semiconductor*) technologies for sensing elements and integration circuits production, and also by reducing the demands on WSN response delays.

WINS technologies have offered the brand-new opportunities for distributed sensing and controlling. A range of low-power integrated circuits have been worked out: interface, signal processing and communicative circuits. Its results allowed the researchers to create a great number of new ways to use WSNs for both military and civil tasks.

The LWIM project by University of California at Los Angeles (UCLA) was funded by DARPA [8]. The aim of the project was to create low-power wireless sensor network modules. Researchers wanted to work out compact wireless measurement devices that may be installed immediately and anywhere. As a result a module was created which included vibration sensor, infrared sensor, low power transceiver which provided communication range in 30 m, data transmission speed about 1 kbps [9]. The possible transceiver's frequency range was 902-928 MHz. The supposed fields for developed modules were monitoring and control applications: manufacturing processes (wireless presence monitoring), vehicle condition monitoring (wireless motor maintenance), medicine (wireless patient monitoring), defense (size reduction).

Elaborations in the framework of *SensIT* project gave new opportunities for WSNs. WSNs became interactive and programmable, and this gave a possibility to make demands and change tasks dynamically. A multitasking feature in the system allows multiple simultaneous users. Also, short distances between sensor nodes reduce distance between threat object and the nearest sensor node, improving the accuracy of the target identification and tracking. The system was designed in such a way which made both software and hardware able to support energy-saving functioning, short term response, autonomy and high survivability.

SensIT developers and researchers have conducted two experiments in 2000 and 2001. The U.S. Marine Corps took the part in those experiments. The aim of them was to check collaborative signal processing capabilities at the Marine Corps Air Ground Test Facility at Twentynine Palms, California. As a result of the SensIT project, sensor nodes supporting targets detection, identification and tracking have been produced. Also the network had an additional function of connectivity on the battlefield.

Another important development work in the WSN field was the study of the University of California at Berkeley, which had started PicoRadio [10] program in 1999. The goal of the program was to support the assembly of an ad hoc (application specific) WSN of low-cost, low-energy sensor nodes, able to operate on the natural sources of energy, such as solar energy. Development started not with hardware, as usually, but with software, what made it possible to provide the platform flexibility for various applications due to extensive opportunities of PicoRadio protocol. [11].

It is worth mentioning that Berkeley was also working over one more elaboration — *"Smart Dust"* program. The goal of this program was to create unusually small sensor nodes which could be dropped from the air like the dust, could move with air masses and cooperate during a few hours or days. The authors of the project planned to integrate a sensor, laser diode and MEMS mirror in a single compact MEMS case in order to receive and transmit optical radiation [12].

Within the framework of this project the ways of data transmitting with the help of the light rays reflected from the micromirror have been developed and tested. The following results were achieved: temperature, humidity, barometric pressure, light intensity, tilt and vibration, and magnetic field sensors all in a cubic inch package, including the bi-directional radio, the microprocessor controller, and the battery, 20 meter communication range, one week lifetime in continuous operation, 2 years with 1% duty cycling [13]. This project finished in 2001, but many additional projects have grown out of it. Among these are: Berkeley Webs, Network of Embedded Systems (NEST), Center for Embedded and Networked Sensing at UCLA.

Technology

WSNs form a particular class of ad hoc networks that oper-atewith little or no infrastructure. WSNs are gaining momen-tum as they have great potential for both research and commer-cial applications. The sensor network nodes themselves are ideally low-priced, very small devices. They typically consist of a collection of application specific sensors, a wireless trans-ceiver, a
simple general purpose processor, possibly assisted by limited amount of special-purpose hardware, and an energy unit that may be a battery or a mechanism to obtain energy from the environment. We cannot assume that sensor nodes will be tam-per resistant, although we will consider the availability of such tamper-resistant nodes for future applications. Sensor nodes
are distributed over a potentially vast geographical area to form a static, multi-hop, self-organizing network. However, also mobile WSNs and mobility within WSN are conceivable.

Some Models and Their Relevance in WSNs

Typical functions in a WSN include sensing and collecting data, processing and transmitting sensed data, possibly storing data for some time, and providing processed data as information e.g. to a so called sink node. A particular kind of processing that is essential, as will be explained later, is aggregation of data in the sensor nodes. Securing such functions turns out to be very challenging. The Dolev-Yao1) threat model often used to formally analyze crypto-protocols in communication networks has its limitations in the context of WSNs and for ubiquitous computing. The Dolev-Yao threat model assumes that the two communicating parties, say A(lice) and B(ob), communicate over an insecure channel. If an intruder gains control over the communication network, she/he can overhear messages between the partners, intercept them and prevent their delivery to the intended recipient. But this threat model also assumes that the end-points, Alice and Bob, are not themselves subject to attack. A WSN adapted threat model should reflect that the channel is assumed to be insecure and the end-points cannot in general be trusted. An attacker may physically pick up sensor nodes and extract sensitive information .

Applications

From the point of view of practical application, WSNs offer unique opportunities for monitoring and data collecting from a number of spatially distributed sensor nodes. In addition to providing distributed sensing of one or a few parameters of a big object like a building or open space, WSNs also allow to control the processes in the object.

For example, WSN may be installed in a building for automatic control of load-bearing constructions' conditions. For this reason engineers determine the places on the building most appropriate for data measuring. In these places autonomous sensor nodes with necessary sensing elements are installed. After installation they start to interact and exchange data. Receiving these data from the sensor nodes and comparing measurement data from each of the sensor node with its position, building structure specialists can in real time mode supervise, control and predict emergency situations.

For the last twenty years researchers groups and industry representatives have been showing a lot of interest in WSNs. This interest is caused by the fact that WSN applications are highly promising and help to solve a wide range of problems which are to be described below. Also, technological progress in the microelectronics made it possible to produce rather small, productive, energy effective and cheap sensor nodes, and it allows to introduce and use advantages of WSN technology everywhere and right now.

WSNs technologies started to actively develop in mid 1990s, and in the beginning of 2000s the microelectronics development made it possible to product rather inexpensive elementary base for sensor nodes. It also became possible due to the rapid development of wireless technologies and micro electro mechanical systems. Constant wireless devices price decreasing, their operating parameters improving make it possible to gradually migrate from using wire line technologies in telemetric data collecting systems, remote diagnostics techniques, data exchange. A lot of branches and market segments (production, constructing, different types of transport, life support, security, warfare) are interested in WSNs deployment, and their number is permanently increasing. It is caused by technological processes complication, production development, increased needs in security field and resources use control. In emergency management, sensor nodes can sense and detect the environment to forecast disasters before they occur. In biomedical applications, surgical implants of sensors can help monitor a patient's health. For seismic sensing, ad hoc deployment of sensors in volcanic areas can detect occurrence of earthquakes and eruptions [21]. With the development of semiconductor technology there are new WSNs practical applications appearing in industry, household and also in military field. The usage of inexpensive wireless sensor devices for remote monitoring opens up new fields for telemetry and control systems applications, such as:

- Military target tracking and surveillance [22 ,23];
- Timely detecting of possible mechanism failure, when controlling such parameters as vibration, temperature, pressure, etc.;
- Control of access to remote monitoring object systems in real time mode;
- Buildings and constructions condition control automation ;
- Smart house ;
- Energy saving and resource saving ;
- Biomedical health monitoring [24 ,25];
- Ecological parameters of environment control;
- Natural disaster relief [26] ;
- Hazardous environment exploration and seismic sensing [27]

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