Wireless Sensor Networks: A Study on Challenges, Application Domains and Possible Synergies

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ABSTRACT
In precise, Wireless sensor network (WSN) has emerged as one of the most promising technologies for the future. This has been enabled by advances in technology and availability of small, smart and inexpensive sensors resulting in cost effective and easily deployable WSNs. However, analysers must address a variety of challenges to facilitate the widespread deployment of WSN technology in real-world domains. In this study, we give an overview of wireless sensor networks and their application domains including the challenges that should be addressed in the order to push the technology further. Then we review the recent technologies for Wireless Sensor Networks.Finally, we identify several open analysis issues that need to be inspected in future.

General Terms
Wireless sensor network, IEEE 802.15.4, Platforms, Challenges, Domains,Possible strategies.

1. INTRODUCTION
In recent years, there has been a world-wide interest in Wireless Sensor Networks(WSNs). It will not be an enlargement to consider WSNs as one of the most analysed areas in the last decade. Here is a sampling from the literature as summarized in. With several applications and business opportunities arising every day, the WSN market is forecast to rise from $0.45 billion in 2012 to $2 billion in 2022 [1].

WSN technology offers number of advantages over common networking solutions, such as, lower costs, scalability, reliability, accuracy, flexibility, and ease of deployment that enable their use in a wide range of diverse applications. With advancementsin technology and sensors getting smarter, smaller, and cheaper, billions of wireless sensors are being deployed in the various applications. Some of the possible application domains are environment, military, security and healthcare. In military,sensor nodes can be used to detect, locate, or track enemy movements. In caseofnatural disasters,sensor nodes can detect the environment to forecast disasters beforehand. In healthcare, sensor nodes can help in auditing a patient's health.In security, sensors can offer vigilant vigilance and increase alertness to possible terrorist attacks. It will not be far fetched to say that eventually the WSNs will enable the automatic auditing of forest fires, avalanches, hurricanes, failure of countrywide utility equipment, traffic, hospitals, etc. The wide range of possible WSN applications make WSN rapidly growing multibillion dollar market, but requires further major progress in WSN standards and technologies to support new applications.

2. WIRELESS SENSOR NETWORKS
A Wireless sensor network (WSN) consists of wireless sensor nodes or motes, which are devices equipped with a radio interface, an analog-to-digital converter, memory, sensors, a processor and a power supply. The processor provides the mote management functions and performs the data processing. The sensors attached to the mote are capable of sensing temperature, humidity, light, etc. Due to bandwidth and powerconstraints, motes primarily support low data units with low computational power and a low sensing rate. Memory is used to store programs (instructions executed by the processor) and data (raw and processed sensor measurements)[2]. Motes areequipped with a low-rate (10–100 kbps) and short-range (less than 100m) wireless radio, e.g., IEEE 802.15.4 radio to communicate among themselves. Since radio communication consumes most of the power, the radio must incorporate energy-efficient communication techniques. The power source commonly used is rechargeable batteries. Since motes can be deployed in remote and hostile environments they must uselittle power and must employ built-in mechanisms to extend network lifetime. For example, motes may be equipped with effective power harvesting methods, such assolar cells, so they may be left unattended for years. The sensor nodes can be deployed in an ad-hoc or a preplanned manner. An adhocdeployment is good for the large uncovered regions where a network of a very large number of nodes can be deployed to perform the auditing and reporting functions on its own. Network maintenance such as managing connectivity and detectingfailures is difficult in such a WSN due to large number of nodes. On the otherhand, preplanned deployment is good forthe limited coverage where fewer nodes aredeployed at specific locations with the advantage of lower network maintenance andmanagement cost.

3. CHALLENGES AND REQUIREMENTS
The collective nature of WSNs brings several advantages over conventional wireless ad-hoc networks, including self-organization, rapid deployment , flexibility, and innate intelligent-processing capability. However, the unique features of WSNpresent new challenges in hardware design, communication protocols, and applicationdesign. A WSN technology must address these challenges to realize the variousanticipate applications. This requires modifying the legacy protocols for conventional wireless ad-hoc networks or designing new effective communication protocols and algorithms [3].

Table 1. **Challenges vs. required mechanisms in WSN**

Challenges	Required mechanisms
Resource constraints	Efficient use of resources
Dynamic and extreme environment conditions	Adaptivenetwork operation
Data redundancy	Data synthesis and localized processing
Unreliable wireless communication	Reliability

4. APPLICATION DOMAINS AND DEPLOYMENT

WSNs have been adopted in a large number of diverse application domains. It is anticipate that in future everyday objects will be embedded with sensors to make them smart. Smart objects can explore their environment, communicate with the other smart objects, and interact with humans.

A anotomy of WSN applications is shown in Fig.2 In general, WSN applications can be of two types: auditing and tracking. As shown in the taxonomy, the leading application domains of WSNs include the military and crime prevention, environment, health (Body Area Networks), industry and agriculture, and urbanization and infrastructure. Military operations involving force protection with unattended ground sensors formed into intelligent networks around the forward operating bases are receiving much attention. VigilNet is an integrated sensor network systemfor the energy-efficient vigilance missions. Another interesting example is networkedmines called self-healing minefields that automatically rearrange themselves to ensure optimal coverage.

Several real applications have been deployed and with the advancement in the technology, new application areas keep emerging.

A. PinPtris a counter-sniper system developed to detect and locate shooters.

B. Volcanic auditing wireless sensor network of 16sensor nodes equipped with seismoacoustic sensors was deployed on VolcanReventador in northern Ecuador to monitor volcanic eruptions.

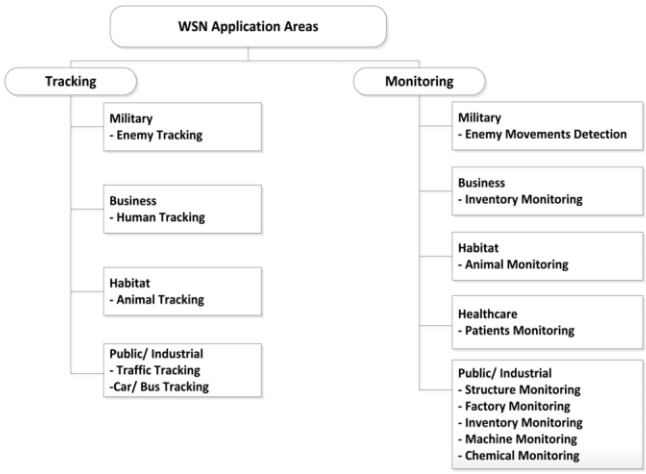


Fig 1. WSN Application Areas

5. WSN Platforms

WSN platforms consist of sensor nodes deployed in such an environment that is controlled and are designed to support experimental analysis in a real-world setting.The availability of such testing platforms provide analysers a way to test their protocols, algorithms, network issues, and applications as analysers can configure, run, and monitor their experiments remotely. Though several WSN platforms have been designed, usuallythey are geared toward specific projects and have specific features. Furthermore, there is a growing interest in large scale heterogeneous WSN testbeds in the context of Future Internet for deployment of new technologies. The design and deployment of testbeds should consider user requirements to allow easy and flexible access tolarge number of users.

In this section, we present the significant features required for a general-purpose WSN testbed, especially from the prospect of the users in terms of the ability to control and analyze the WSN experiments. Open software and access platform are preferred over closed or proprietary platform as the testbed softwaremust be ready for future extensions, especially in the context of Future Internet. We study state of the art, open access WSN platforms and highlight their salient features The testbeds are classified in three categories depending on their deployment; (1) outdoor, (2) indoor, and (3) indoor and outdoor.

6. POSITIONING IN THE INDUSTRY AND LEADING ANALYSIS PROJECTS

Though the analysis in the field of WSN is about decade old, this is considered as a new analysis area as emulated in the rise in WSN analysis and development tbudgets every year. The focus is on developing new communication protocols and management services to meet the specific requirements of sensor nodes such as limited power, processing capacity and storage. Some hotanalysis topics in WSN are related to topology creation, control, and maintenance.

Smart Santander Project has developed a state of the art smart city in theSpanish port city of Santander .It aims at the designing,deploying and validating a platform composed of cameras, actuators, sensors and screens in Santander to offer useful information to the residents. In this project, 750 Waspmotes have been deployed in different locations within the city to monitor different parameters, such as temperature, CO, noise, luminosity, CO, and free parking slots. The relevant data gathered by the sensors is transmitted to the central platform. The citizens can obtain information about their environment and other useful information, such as bus routes, shopping information using their smartphone application called Pulse of city addition to supporting applications and services for future Smart Cities, the project envisions the deployment of 20,000sensors in four European cities.

GlacsWeb projectdevelops technology to monitor glacier behavior using sensor networks. Custom sensor probes are placed in, on and under glaciers to monitor the gathering behavior of glaciers by assembling temperature, weather, pressure, stress, and sub-glacial movement data gathered by sensors. The information gathered helpsin understanding the dynamics of glaciers as well as global warming.

eDIANA project aims at achieving energy efficient buildings through inventing solutions based on networked embedded systems. The focus is on having higher ability in terms of usage of scarce energy resources and better awarenessfor the citizen as well as service and infrastructure owners. The project aims to realize this through the deployment of the eDIANA platform integrated with intelligentembedded devices in the buildings to increase total energy consumption, production and storage, and improve ability.

7. POSSIBLE SYNERGIES

A recent paradox in WSN analysis is to explore the alliance between sensor networks and other technologies. In this section, we describe how integration of WSNs with existing wireless and mobile communication technologies as well as emerging technologies such as RFID, vehicular networks, cognitive radio, cloud computing, robotics and content-centric networking, can help sensor networks achieve their full possible. We present some examples in literature that explore possiblesynergies among WSNs and other technologies to improve their overall performance.

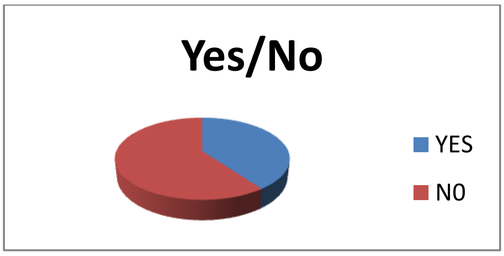
Synergy between mobile robots and WSNs: [2][3] Some analysers have focused on synergy between sovereign robots and sensor networks. The work of Kotay et al. [126] focuses on alliance between GPS-enabled robots and network sensors to provide localization services and better robot navigation.The alliance between robot and sensor networks is utilized in support of search and rescue and first response operations. WSNs enhance the robot's capabilities to sense and enable them to act in response to events outside their view point range. At the same time, mobile robots enhance sensornetworks using their ability to bring new sensors to designated locations and move across the sensor field for sensing, data collection, and communication. Gupta et al. [127] propose a mechanism for thetransporting resources by integrating robots with sensor network services. The integrationof sensor networks and robotic analysis results in an interesting problem space of interrelated issues open for exploration.

Micro-Blog: map-casting from mobile phones to virtual sensor maps: [1] The next generation sensor networks are anticipate to be interactive and large-scale. It will be possible to organize millions of global data points on a visual platform,and queried and answered through human participation.In this context, Micro-Blog is new paradigm that utilizes synergy between sensors, wireless and mobile communication and may transform the way we learn, interact, and make decisions.Micro-Blog combines four different components, which are as follows: powerful phone sensors, mobile wireless networks, information processing, and spatial visualization. The basic concept of Micro-Blog is that users can record multimedia blogs on the fly by using microphones and cameras in mobile phones. First, the application running on the mobile phone creates the microblog andassociates the blog with the time and GPS location of the device. Then the application transports the microblog over a peer-to-peer, WiFi,or cellular wireless network, to reach a server that places the blog on a map (e.g., Google Maps). This process is called map-casting. Afterward, various web services can be used to group, mine and correlate these blogs depending on user interests, social networks, etc. Moreover,in regions where microblogs are not available on a map, internet users can geocast queries to mobile phones located around that region. Human responses to thesequeries can be map-cast back that will enable knowledge-sharing between strangers. Figure10 shows the architecture for Micro-Blog. It includes implementing alight weight Java client on the Mobile phone, a WiFi / Bluetooth/ cellular based wireless routing protocol, a Micro-Blog web service, and a visualization front end.

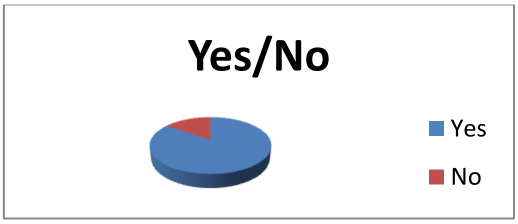
Cognitive radio sensor networks (CRSN): [2]Conventional WSNs use fixed spectrum allocation policy. Their performance is limited due to limited processing and communication power of resource- constrained sensor nodes. With significant growth in the applications that use the unlicensed spectrum bands over which WSN operates, there is a real challenge for efficient utilization of the spectrum. This challenge can be addressed by exploiting the synergy between WSNs and Cognitive Radio (CR) technology . The CR technology allows opportunistic access to the spectrum through intelligent spectrum sensing and dynamic spectrum utilization.

Survey Result -:

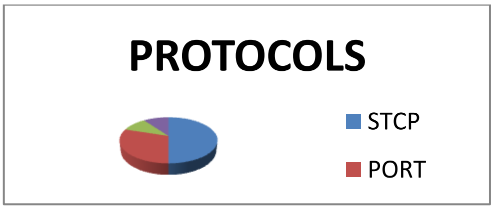
1. How Many People Are Aware Of Wireless Sensors.



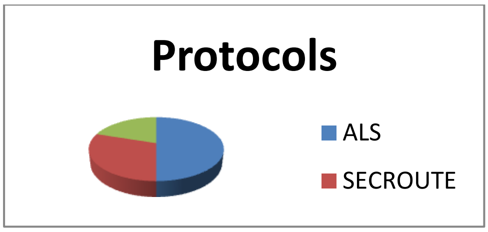
2. How many people find it reliable



3. Comparison of transport layer protocol



4. Comparison of network layer protocol



8. CONCLUSION

A. The analysis in wireless sensor networks is very dynamic, and there are high expectations regarding applications and businesspossible of sensor networks.

B. Standardization is a key issue for success of WSN markets. The choice of technology to be used should be based on the target application

C. The development of new technologies like ZigBee green power, EnOcean and Bluetooth low energy is pushing WSN into new areas of application.

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