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SMART SENSOR INTERFACE FOR ENVIRONMENTAL MONITORING IN IoT

TAMILARASI B,SARAVANAKUMAR P

Abstract-**The Internet of Things (IoT) provides a virtual view, via the Internet Protocol, to a huge variety of real life objects, ranging from a car, to a teacup, to a building, to trees in a forest. Lifetime extension possibilities, which are the result of application characteristics, by (i) reducing energy consumption (ii) increasing packet delivery ratio(iii) reducing the packet drop (iv) increasing throughput. The Internet of Things is a network of physical object interface with software, sensor, network connectivity and electronics, which enables these objects to collect the data and exchange. Wireless sensor networks (WSN) are well suited for long term environmental data acquisition for IoT. This paper deals with the functional design and implementation of WSN platform that can be used for long-term environmental monitoring in IoT application. The application requirements for low cost, high quality of service, long life time, low maintenance, fast deployment, low power are considered in the specification of this platform.**

Keyword-IOT(Internet of Things),WSN (Wireless Sensor Network)ECC (Environmental cloud computing)

I.INTRODUCTION

More than decade ago, the Internet of Things (IoT) was coined in which the computers were able to access data about the objects and environment without human interaction. Two technologies were considered as key enablers for IoT paradigm: Radio Frequency Identification (RFID) and the Wireless Sensor Network (WSN).While the former is well established for low cost identification and tracking, WSN bring IoT applications richer capabilities for both sensing and actuation. In fact, WSN solution already covers a broad range of research and technology advances continuously expand their application field.Based on the advantages WSN concepts bring to a vast amount of different applications, interest in the corresponding technology is high. Ideally, the WSN allows for the deployment of large amount of sensor nodes, which configure themselves, depending the network topology and neighborhood situation.

After sensing the physical environment and processing the obtained data locally, nodes communicate their data towards a network sink, where data is further processed and made available for readout.As transmitted data should find the best route towards its destination automatically.

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Tamilarasi B,*Applied Electronics, Bannari Amman Institute of Technology, Erode, India, 9944734132.*
Saravanakumar P*, Assistant Professor, Department of Electronics and Communication Engineering , Bannari Amman Institute of Technology, Erode, India,*

A.Environmental Monitoring

Although EM can mean the monitoring of any kind of environment, it is most often defined as the observation and study of natural environment. Scientifically, EM includes the field the of physics, chemistry and biology. The motivation based on the ever increasing the world population, means that environmental monitoring is not limited to the understanding of environments, but also includes the monitoring preservation reasons. Typical, application in addition to purely environmental science purposes, include the protection of water supplies, air pollution monitoring, radioactive waste treatment, natural recourse protection, weather forecasting, enumeration and monitoring of species.Environmental monitoring strives to determine the status of changing environment by analyzing representative sample of the environment. The open environmental monitoring is especially challenging because of the typical harsh operating condition and difficulty, cost of physical access to the field for deployment and maintenance .The generic WSN platform can be used a good results in a broad class of IoT environmental monitoring application. However, many IoT applications may have stringent requirements, such as low cost, large number of nodes, ease of deployment, low maintenance which makes the generic WSN platforms less suited.

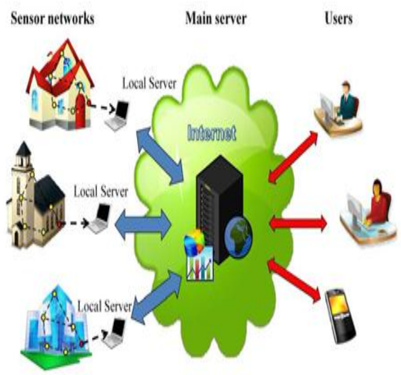
II.ENVIRONMENTAL MONITORING IN IoT

Integrating cloud computing, wireless sensor network, RFID sensor networks, satellite network, and other intelligent transportation technologies, a new generation of IoT-based environmental data clouds can be developed and deployed to bring many benefits, such as include the protection of water supplies, air pollution monitoring, radioactive waste treatment, natural recourse protection, weather forecasting, enumeration and monitoring of species.

A.IoT Environmental Monitoring Requirements

WSN data acquisition for IoT environmental monitoring applications is challenging, especially for open nature fields. In its simplest event-driven form, each sensor node performs periodic measurements of the surrounding air temperature and sends alert surveillance personnel if they exceed a threshold.

For a fast response time, the coverage of even small areas requires a large number of sensor nodes, making this application representative for cost, networking and deployment issues of the event-driven high- density IoT application class. In the simplest star topology, the sensor nodes connect directly to the gateways, and each gateway autonomously connects to the server. Ideally, the field deployment procedure ensures that each sensor node is received by more than one gateway to avoid single points of failure of the network.



Structure of WSN platform

The sensor is the size of a matchbox; in its standard form it measures moisture and temperature. All measurements are transmitted wirelessly to a computer, and it is then possible to read and regulate energy consumption in a room or a building over the internet via a web browser, thus basically wherever you might be. The technology is currently used to monitor humidity and heat in around an environment. A sensor that allows to reduce the temperature in rooms at night, turn down the lights when no one is there, all while ensuring that the humidity is correct so that no exhibits are damaged. Several hospitals are equipped to monitor the temperature in labs where sensitive tests are carried out.The battery in the sensor only needs to be changed once every ten years and outdoors the system has a radio range between sensor and computer of 1.6 km. **Measurement and regulation** of humidity and temperature is one use, but the research group is looking beyond that. In this particular project they will also test the technology for environmentalsensors that measure carbon dioxide levels and otherenvironmental data.Since these and many related applications typically use fewer sensor nodes, they are less demanding on the communication channels (both in field and with the server).,and for sensor node energy and cost. Consequently, the in situ wildfire detection application can be used as reference for the design of a WSN plat- form optimized for IoT environmental monitoring and the platform should be easily reusable for a broad class of related applications. Thus, the requirements of a WSNplatform for IoT long-term environmental monitoring can be defined as follows:

- Low-cost, small sensor nodes with on-board processing, self-testing, and error recovery capabilities.
- Detection of field events on-board the gateway to reduce network traffic.
- Fast and reliable field node deployment procedure.
- Remote configuration and update of field nodes.

III. ENVIRONMENTAL CLOUD COMPUTING

Environmental Cloud Computing (ECC) is a new hybrid technology that has a remarkable impact on environment management by instantly using environment resources, such as computing, storage and internet for decision making. The cloud computing paradigm has enabled the exploitation of excess computing power.Each of the layers provides a specific service for users, which are explained as:

A.Infrastructure as a Service (IaaS):

Several types of virtualization occur in this layer. Among the other resources, computing, network, hardware and storage are also included. In the bottom layer of the framework, infrastructure devices and hardware are virtualized and provided as a service to users to install the Operating System (OS) and operate software applications. Therefore, this layer is named Infrastructure as a Service.

B. Platform as a Service (PaaS):

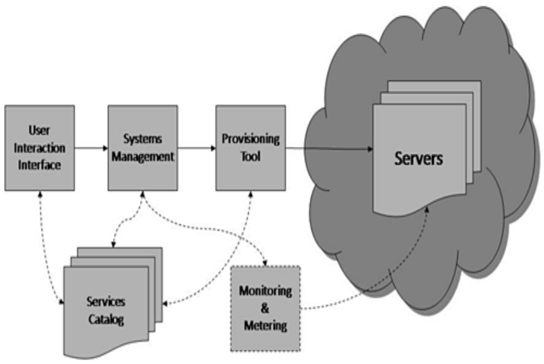
In PaaS, mobile operating systems such as Android, iPhone, Symbian and other OS, as well as database management and IMS are included in this and other system management tools for cloud computing section.This layer contains the environment for systems and other system management tools for cloud computing.

C. Software as a Service (SaaS):

Analytical, interactive, transaction and browsing facilities are included in the Application layer. SaaS delivers several simple software programs and applications as well as customer interfaces for the end users. Thus, in the application layer, this type of services is called Software as a Service (SaaS). By using the client software or browser, the user can connect services from providers via the internet and pay fees according to their consumed services, such as in a pay as you go model.

D. Environmental Cloud Architecture

The Environmental cloud computing(ECC) architecture relies on three layers: sensing, communicationand cloud. The first layer is the sensing, which is responsible for monitoring the environmental condition and collecting information from environment such as humidity, CO concentration in air , light intensity and temperature by using sensors. Then, the information collated via sensors should be sent to the cloud for storage or for use as input for various software programs in the application layer.



ECC Architecture

E. IoT ENVIRONMENT

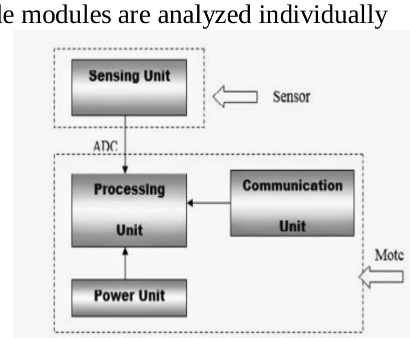
The Internet of Things (IoT) is the interconnection of uniquely identifiable embedded device within the existing internet infrastructure. Typically, IoT is expected to offer advanced connectivity of devices, systems, and services that beyond Machine-To-Machine Communications (M2M) and covers a variety of protocols, domains, and applications. The interconnection of these embedded devices is expected to use in automation in nearly all fields, while also enabling advanced applications like a smart grid. Things, in the IoT, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, automobiles with built-in sensors, or fieldoperation devices that assist fire-fighters in search and rescue.IoT explains a future in which a variety of physical objects and devices around us, such as various sensors, Radio Frequency Identification (RFID) tags, GPS devices, and mobile devices, will be associated to the Internet and allows these objects and devices to connect, cooperate, and communicate within social, environmental, and user contexts to reach common goals. As an emerging technology, the IoT is expected to offer promising solutions to transform transportation systems and automobile services in the automobile industry. By integrating with cloud computing, wireless sensor network, RFID sensor networks, satellite network, and other intelligent transportation technologies, a new generation of IoT-based environmental data clouds can be developed and deployed to bring many business benefits, such as low cost, large number of nodes, ease of deployment, low maintenance which makes the generic WSN platforms less suited.

IV.SYSTEM IMPLEMENTATION

In the following are presented the most important implementation choices for the platform devices that are based on the requirements are suitable for long-term environmental monitoring IoT applications. A. Sensor Node Implementation .The node for in situ wildfire monitoring is optimized for cost since the reference application typically requires a high number of nodes(up to tens of thousands).

A.ConsumersIn Wireless Sensor Networks

The basic architecture of wireless sensor nodes has not significantly changed during the last decade. It usually contains modules for computation, communication, sensing and power management. Application specific tasks can require some additional functions ,however ,in most cases these functions can be classified as belonging to one of the basic modules, mentioned previously. In the following ,the sensor node modules are analyzed individually



Architecture of WSN

B. Processing Unit

The processing module of a sensor node usually has several tasks to fulfill. It controls the other components on the platform ,processes and stores data, and provide an interface to the user/programmer. While the implementation of the computational module will truly depend on the specific application, the node used form implementations consist of some sort of flow- power microcontroller. This is due to the long lifetime expectations of the system and the typically limited energy supply available. Popular choices for the microcontrollers include Atmel's ATmega series Texas Instruments, MSP430 as well as PIC controllers from Microchip. However, for processing intensive applications, Instead of or additional to the microcontroller, Field Programmable Gate Arrays or Digital Signal Processors may be used. The microcontroller is usually responsible for the application, meaning it is programmed with some sequential code taking control over the processes necessary in order to fulfill the application tasks.

C. Communication Unit

In a similar manner to the computational module, the communication module implementation also depends to some degree on the application .Never the less, it is also the case that the majority of system use similar communication devices, namely low power Radio Frequency (RF) transceiver, typically operating in the license-free ISM-band. Other communication methods, such as acoustical or optical are only used seldom. This communication module is used for the local communication between nodes in the sensor network. This means that the main purpose of this communication link is to transfer measured data from the sensor node to a common gathering point, and in return to send commands towards the individual sensor nodes.

D. Sensor Unit

While the implementation of computation and communication modules changes depending on the resource requirements of the application, it is definitely the case that the most application- specific part of a sensor node is its sensing module. A given application will be required to monitor certain physical parameters or detect specific events. This in turn requires specific sensor units that have the ability to fulfill these application demands.

E. Power Unit

Underlying all other node module is the power module. Its main task is as simple as it isimportant, namely in providing as table power supply to all active components of the sensor node system. This means it converts the input from the energy source into acceptable levels in order to power the connected devices. How this conversion actually appears will generally depend on the type of energy source used for the sensor nodes. In some cases the sensor node might be able to receive power from the main power supply ,requiring some kind of AC-DC conversion. However, especially in EM-WSN applications, this is seldom the case.

F. Sensor Node Design

Since IoT applications may require large numbers of sensor nodes, their specifications are very important for application performance, e.g., the in situ distributed wildfire detection selected as reference for the reusable WSN platform design. One of the most important requirements is the sensor node cost reduction. Also, for low application cost the sensor nodes should have a long, maintenance-free service time and support a simple and reliable deployment procedure. Their physical size and weight is also important, especially if they are transported in backpacks for deployment. Node energy source can influence several of its characteristics. Batteries can provide a steady energy flow but limited in time and mayrequire costly maintenance operations for replacement. Energy harvesting sources can provide potentially endless energy but unpredictable in time, which may impact node operation. Also, the requirements of these sources may increase node, packaging and deployment costs. Considering all these, the battery powered nodes may improve application cost and reliability if their energy consumption can be satisfied using a small battery that does not require replacement during node lifetime.

The sensor node energy consumption can be divided into:

- RF communication, for data and network maintenance.
- Processing, e.g., transducer data, self-checks.
- Sensing, e.g., transducer supply, calibration.
- Safety devices, e.g., watchdog timer, brown-out detector. Power down energy required by the node components in their lowest power consumption mode.

V. CONCLUSION

The lifetime of wireless sensor network for an environmental monitoring has been presented, allowing them to operate as autonomous measurement system for long period of time. The energy consumption of the system has been addressed and methods to reduce the energyconsumption have been identified. WSNs are traditionally considered key enablers for Packet delivery ratio has been increased, while transmitting the data using WSN. This paper deal, all phases of the practical development from scratch of a full custom WSN platform for a environment monitoring IOT application. All aspects of the wireless platforms are considered: reusability and flexibility, platform structure, optimization of the sensor node and gateway node, error recovery in communication and node operation, high availability of service, application server reliability and interface with IOT. The particular importance of IOT is low cost, fast deployment, long unattended service time.

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