# Using Wireless Sensor Networks for an Interactive Musical Application

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## Abstract

*In this demo a "musical" application using wireless sensor networks is presented. We will show how we can generate sounds and images depending on remote measures of ambient variables and acceleration.*

## 1. Introduction

Sensor networks are composed of a quantity of nodes that may vary from tens to thousands. The purpose is to measure different physical parameters in a given environment, in order to characterize its properties, or to take decisions depending on these measurements.

The challenges that this kind of technology imposed are related to low power consumption, reliability, communication protocols or hardware platform design, among others.

The present demo is based in a family of wireless sensor network nodes [1][2] developed in the CEI-UPM, which we call ***Cookies***. One of the main advantages of the Cookies compared to other wireless sensor nodes is its modularity, which make them specially suited for rapid prototyping, heterogeneous networks and low-cost solutions. Other groups like [3][4] follow a similar approach with different architectures. Each node is composed of four layers: communication, processing, power supply and sensors.

The demo consists of different nodes taking measures from the environment and sending data to a central node, which communicates with a PC. The data is processed and changed into sound in the PC, depending on what is happening in each node (temperature changes, strong acceleration, etc.).

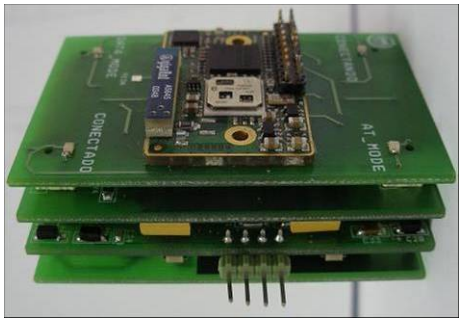


**Figure 1:** Cookies, modular platform for wireless sensor networks

## 2. The modular hardware platform

The hardware platform used in the demo is shown in Figure 1. The modular design allows redesigning the node in an easy way, encapsulating the knowledge. In this way, the adaptation of the platform to new applications would only need small redesign of the system.

The platform is composed of four layers that can be plugged/unplugged and that will be described separately:

- Communication: two different prototypes have been developed. One with Bluetooth (Figure 1) technology and the other with ZigBee technology. These two approaches allow facing different requirements depending on the application.
- Processing: this layer includes a microcontroller (ADuC831 from Analog Devices based on the 8051 architecture) and a Spartan III FPGA from Xilinx with 200k equivalent gates. This powerful processing capability makes the platform very versatile for a lot of different applications.
- Power Supply: three linear regulators that supply voltages of 3.3, 2.5 and 1.2 V.
- Sensors: two prototypes have been developed, with different analog and digital sensors: temperature, humidity, infrared, light threshold, LDR and acceleration.

## 3. Principle of operation

The system is designed to process signals from analog and digital sensors. In this context, digital sensors are processed with the FPGA, whereas the microcontroller deals with analog sensors, as it integrates an analog to digital converter.

The FPGA deals with complex digital signals from sensors, in order to release the microcontroller tasks, which is busy managing analog sensors and communications.

The hardware implemented in the FPGA is composed of modules that implement hardware interfaces for sensors [5]. These interfaces have been developed in a generic way, in order to make easier to adapt the platform to different sensors which use the same interface (I2C, 1-Wire, Period, Frequency or PMW, among others), and to make the sensors almost transparent to the user. The generic structure for the hardware interfaces can be seen in Figure 2

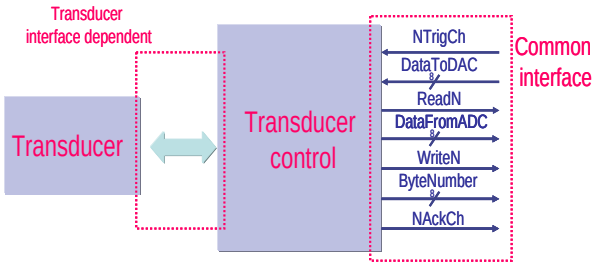


**Figure 2:** Generic structure of hardware interfaces

## 4. Application

The applications for these nodes are many. At this moment, the *Cookies* are being used in different applications, such as:

- To measure humidity, temperature and deformation in historical buildings, in collaboration with a research centre in architecture and structural analysis.
- To measure temperature, humidity, gases and acceleration in refrigerated trucks, in order to enhance traceability of the load (fruits and vegetables).
- The inclusion of WSN nodes in the mining industry, in which there are mines of kilometres and communications as GSM or GPS don't work.

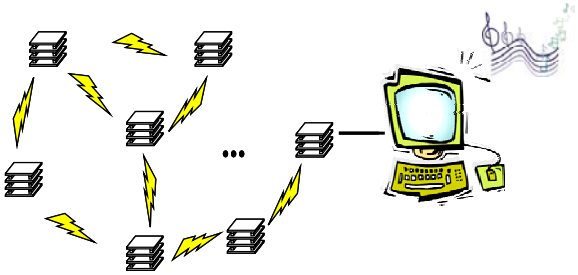

**Figure 3:** Structure of the demo

In this demo, a simpler and more amusing application is presented, to demonstrate the possibilities offered by this technology. Some nodes configure a network, using the ZigBee standard, and different parameters are measured as acceleration, temperature, or humidity. The data is sent to a central node connected to a PC. The PC, using a software, takes the data and generate different sounds and images depending on what happens to every *Cookie* (Figure 3).

## 5. Conclusions

A demo for wireless sensor networks is presented. A modular platform developed in our lab is used to create the network. This node is composed of four layers, encapsulating the knowledge and allowing rapid prototyping, reusability and adaptability to new applications.

This platform includes different sensors, analog and digital. Different measures are sent through the wireless sensor network to a central node, which is connected to a PC. The PC takes the data and generates sounds and images depending on the measures.

## 6. References

[1] *http://www.upmdie.upm.es/~jportill/*

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