

# Poster Abstract: A Reliable Support Tool for Monitoring, Testing and Debugging Wireless Sensor Cookie Nodes

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**Abstract.** In this work a WSN Support Tool for developing, testing, monitoring and debugging new application prototypes in a reliable and robust way is proposed, by combining a Hardware-Software Integration Platform with the implementation of a parallel communication channel that helps users to interact to the experiments in runtime without interfering in the operation of the wireless network. As a pre-deployment tool, prototypes can be validated in a real environment before implementing them in the final application, aiming to increase the effectiveness and efficiency of the technology. This infrastructure is the support of CookieLab: a WSN testbed based on the Cookie Nodes Platform.

**Keywords:** Testbeds, HW-SW integration, Monitoring & Debugging.

## 1 Introduction

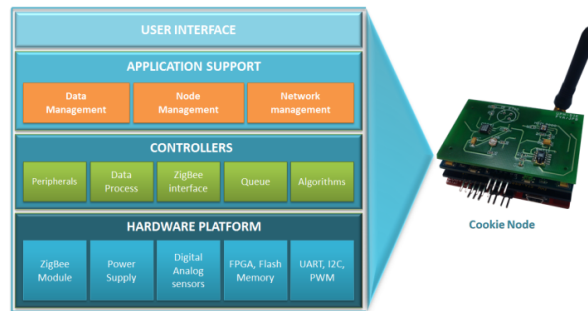
The field of the Wireless Sensor Networks is becoming more challenging and new research lines have been appearing during the last years due to the limitations and constraints that a real deployment, management and maintenance of hundreds of in-field-nodes involve. Hardware platforms as well as open architectures and operating systems have been proposed for covering the main features that wireless sensor nodes have to include, such as communication protocols and wireless link management, integration of low power consumption processing cores and sleep mode algorithms on the wireless devices, analog and digital sensor signal processing, etc.

Although such developments have been verified and implemented in real applications, there is not still a robust and efficient way for debugging, testing and maintaining a WSN. An integration platform that helps users to develop, control and monitor in real time a completed application in order to test and validate new hardware and software prototypes before being included in real scenarios is nowadays still pending. This is the main reason why new research lines focused on covering these challenging issues are emerging, such as the implementation of what is called TestBeds for WSNs. The main target of the testbeds is to provide a completed infrastructure as a pre-deployment tool for testing and validating functionalities, helping developers to create new applications in a robust and reliable way. This work is focused on this challenging goal, by means of combining a hardware-software platform for controlling Cookie-Based wireless sensor nodes that has already been proposed [1], with the

concept of a reliable infrastructure based on a backchannel that allows debugging the deployment in runtime without interfering in the main wireless link among the nodes.

## 2 Proposed Architecture

The hardware-software integration platform that has already been developed in [1] is focused on the modular structure and the flexibility of the Cookie Nodes. This HW-SW platform is based on several abstractions layers, starting from the hardware level in which the communication module, the power supply system, analog and digital sensors, processing cores and physical interfaces between elements are included. In the upper layers, libraries for controlling the hardware platform as well as the application support level libraries for managing the deployment of the Cookie-Based WSNs are available. This structure is shown in figure 1.



**Fig. 1.** HW-SW Integration platform proposed.

With this integration platform users are able to monitor and control all the sensors of every node included in the network in runtime, estimate the power consumption and the battery budget of each node, low power modes management, reprogram and update the firmware using the wireless link, apart from the management of the network from the application point of view (monitoring of the reconnection of each node, route maps, node identification, link quality, etc.).

The work proposed in this paper aims to create a completed infrastructure focused on giving a feedback to the HW-SW integration platform in order to test and debug in real time applications by using a robust and reliable parallel interface to the nodes. This “Backchannel” has to provide a way to interact to the sensor nodes and the whole network without interfering to the main wireless link and, therefore, without mixing the information related to the application with the debugging tasks. As a pre-deployment tool, the testbed helps users to optimize prototypes from the laboratory stage before implementing them in the final application, in order to assure the efficiency and effectiveness of the nodes. Moreover, as a robust laboratory infrastructure, this backchannel has to be able to provide the power supply system to each nodes allowing developers to switch on/off different nodes at different times, configuring these events in order to test the connectivity of the nodes, the redirection of the packets in case paths are changed, topology tests, route map tests, etc. Besides, the remote

programming functionality for updating the firmware of the nodes in runtime has to be covered without occupying the limited bandwidth of the wireless network.

Based on these requirements, the proposed architecture for the testbed is shown in fig. 2. The infrastructure, that uses Ethernet as the backchannel interface, is composed of three main levels of interaction. First of all, the server where the application for testing, monitoring and debugging is running; second, the Power Source Equipments (PSE) based on Midspan routers with Power over Ethernet (PoE); and finally the Powered Devices (PD), which are the nodes connected to the PSEs, having data and power supply through the same plug.

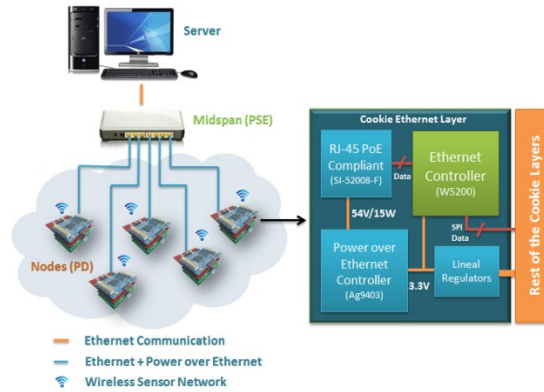


Fig. 2. Proposed Architecture.

### 3 Implementation & Experiments

In order to obtain the compliance of the Cookie nodes with the Ethernet standard and the PoE technique, a new hardware layer has been designed and implemented, allowing the establishment of the parallel communication to the nodes. This layer provides the voltage levels to the rest of the layers by means of converting the input voltage of the PoE. It includes a BelFUSE SI-52008-F RJ-45 to receive both the power supply and data lines from the Midspan, and the Silvertel Ag9403 module for adapting up to 54V of PoE input voltage to 3.3V for the Cookie platform. In terms of the Ethernet communication, a WIZNet W5200 module with SPI interface has been included for establishing the communication with the processor of the Cookie node. A general view of the implemented architecture is shown in fig. 2. The first approach of the CookieLab's infrastructure has been implemented and tested in the Center of Industrial Electronic (CEI), by means of deploying a WSN that includes the HW-SW integration platform. In this scenario (fig. 3), 7 nodes have been used to test both the interaction with the HW-SW platform and the parallel communication through the backchannel. One of them has been connected to the Midspan (a Netgear GS110TP) using the Cookie-based Ethernet layer in order to establish the parallel communication to the server. In this case, a low power processing layer has also been used, which includes a microcontroller C8051F930 from Silicon Labs as well as an FPGA IgLoo IGL030 from Actel.

Apart from the monitoring and the management of the whole network by means of using the HW-SW platform, the main target was to test the backchannel of the net-

work and to be able to reconfigure the node updating its firmware (by sending the configuration file to the microcontroller). Therefore, the reprogramming process has been performed in both ways, using the wireless link of the network and also through the parallel communication. In the last case, the configuration file has been transferred in a reliable way with up to 250 KB/s rate and without interfering in the wireless communication, so that the process is totally transparent to the rest of the devices. Therefore, the parallel infrastructure presented assures the reliability and robustness of the configuration and the debugging tasks in real time of the WSN deployment.

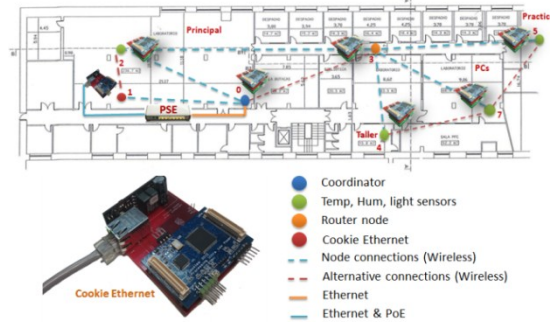


Fig. 3. CookieLab's Deployment at CEI.

#### 4 Conclusions & Future Works

The work presented in this paper is focused on facing most of the limitations that developing, testing and debugging a WSN in runtime imply, using a reliable Ethernet-based infrastructure as a parallel debugging task manager channel. Being part of CookieLab, the first approach of the proposed backchannel has been tested by deploying a WSN at CEI laboratory, verifying the connectivity and reliability of the parallel channel. The Cookie-Ethernet prototype has also been validated as the main element to establish the interaction to the testbed; therefore the next step is to deploy a larger number of Cookie-nodes equipped with this new layer in order to complete the hardware infrastructure of the testbed. One of the most important advantages of this parallel interaction is that users will be able to access the nodes via internet connection, so the remote management of the network from work stations outside the laboratory will be possible in an easy but reliable way.

#### References

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