BatNet: An Implementation of a 6LoWPAN Sensor and Actuator Network

Jorge Martín, Igor Gómez, Eduardo Montoya, Jie Song, Jorge Olloqui, Rocío Martínez

CeDInt-Universidad Politécnica de Madrid

Campus de Montegancedo s/n, Pozuelo de Alarcón

28223 Madrid (Spain)

+34 914524900 ext. 1749

jmartin@cedint.upm.es

ABSTRACT

This demo presents *BatNet*, a 6LoWPAN Wireless Transducer Network, in a Home Automation context. Its suitability for such application is shown by means of several performance and usability tests.

Categories and Subject Descriptors

J.2.2 [**Physical Science and Engineering**]: Engineering

General Terms

Measurement, Performance, Reliability, Experimentation, Verification.

Keywords

WSN; 802.15.4; 6LoWPAN; RPL; CoAP; Contiki OS; Home Automation; IoT.

1. INTRODUCTION

Improving energy efficiency in buildings is one of the goals of the Smart City initiatives and a challenge for the European Union [1]. The use of Wireless Transducer Networks to improve energy management in buildings has increased lately. In this demo, we show a 6LoWPAN Wireless Transducer Network (*BatNet*) as part of an open energy management system. This network has been designed to operate in buildings, to collect environmental information (temperature, humidity, illumination and presence) and electrical consumption in real time (voltage, current and power factor) as well as to control loads and systems such as HVAC (Heating, Ventilation and Air Conditioning), lighting or blinds.

2. SYSTEM DECRIPTION

BatNet system design [2] focuses on avoiding the traditional Home Automation systems (e.g.: LonWorks, KNX, X10) limitations in terms of cost, interoperability, power consumption and complexity. Its main characteristics are:

- *6LoWPAN-based network*: adaptation of IPv6 to Personal Area Networks. Physical and data link layers are based on IEEE 802.15.4 wireless protocol. RPL is used as routing protocol.

- *CoAP (Constrained Application Protocol):* (currently an IETF draft) specific web transfer protocol designed to be used with constrained nodes and networks.

- *Contiki OS*: open source operating system from SICS that enable**s** multitasking and implements both IPv6 and IEEE 802.15.4 standards under low-capacitance hardware requirements.

BatNet is based on a modular functional architecture, which eases the development of the different transducers and the integration of external devices. Each node of the *BatNet* comprises a processing and communications module (*BatMote*) plus a transducer module.

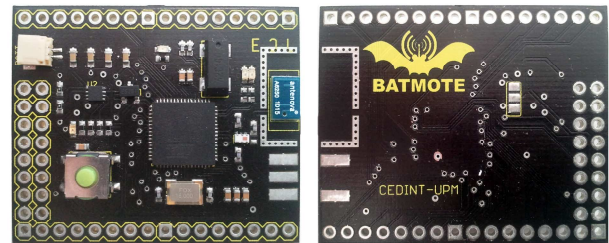The core of the *BatMote* is the ATmega 128RFA1 from Atmel

Figure 1. *BatMote* communications module

Corporation, which allows easy connection of transducer modules. *BatMote* can be powered by batteries or by other external power source (3.3-12V) and allows different low power operation modes[1].
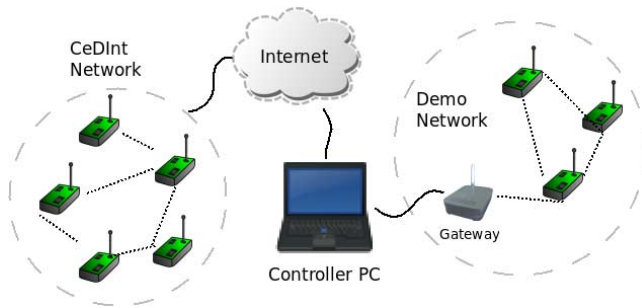
In order to make information available remotely, several CoAP resources have been implemented for each mote, including those resources intended for the acquisition of parameter values, the system operating configuration or the display of system information.

---

[1] http://www.batmote.net

Figure 2. Demo deployment

The transducer modules that have been implemented are:

BatMeter: power meter sensor to be allocated in the distribution board, which calculates electrical power and energy consumption simultaneously.

BatSense: ambient multi-sensor module which includes temperature, humidity, illumination and presence sensors all together in a single device.

BatPlug: electric load controller and power meter based on TRIAC and relays to control the ON/OFF status. It also integrates a Hall Effect sensor to measure the electric current.

BatAmbientLight: RGB LED ambient light controller.

BatLink: Gateway device provided with both Ethernet and 802.15.4 interfaces.

3. DEMO SCENARIO

In this demo we show the proper functioning of the *BatNET* network in a Home Automation scenario. The demo will comprise the following elements:

- An ambient sensor mote, *BatSense*.

- A load controller and consumption meter, *BatPlug*.

- An ambient light controller, *BatAmbientLight*.

- An 802.15.4 to Ethernet gateway, *BatLink*.

- A PC connected to the Internet and to the 6LoWPAN network.

Besides, another Home Automation 6LoWPAN network will be set up in CeDInt building in Madrid, and accessed via Internet.

The existence of two networks, one local and one remote, allows us to simulate a real situation for an Internet of Things user regarding Home Automation, both when he or she is at home or away.

In the CeDInt building network other devices not present in the demo will be also accessible, such us a *BatMeter*, whose installation requires specific power grid conditions.

By the use of different software tools, attendees will be able to understand the following network related topics:

1. Network formation and evolution. IPv6 addressing. RSSI. Used software: Java based application, GNU/Linux IP commands.

2. Parameters visualization (real time and records) and control. Used software: Specific web-based interface.

3. Remote configuration of motes. Used software: Copper (Cu) CoAP user-agent for Firefox [3]

4. Ease of programming. Used software: Eclipse and GNU/Linux AVR tools.

More specific questions such as devices accuracy or development issues can be discussed during the demo.

4. CONCLUSIONS

In this demo we present an easy to deploy and affordable Home Automation network based on self-developed 6LoWPAN motes (*BatMotes*). Technical suitability is proved by different on-site and remote experiments.

Future work is required for achieving a higher delivery ratio for network packets, since the currently implemented path selection metric (ETX) does not optimize this factor [4].

5. REFERENCES

[1] Luis Pérez-Lombard, José Ortiz, Christine Pout. "A Review on buildings energy consumption information", Energy and Building, Elsevier, March 2007.

[2] G. Campo, E. Montoya, J. Martín, I. Gómez, A. Santamaría. "BatNet: a 6LoWPAN-based Sensors and Actuators Network", UCAmI, Vitoria, December 2012.

[3] Matthias Kovatsch. " Human–CoAP Interaction with Copper". Proceedings of the 7th IEEE International Conference on Distributed Computing in Sensor Systems (DCOSS 2011), Barcelona, Spain, June 2011.

[4] Bor-rong Chen, Kiran-Kumar Muniswamy-Reddy and Matt Welsh. "Lessons Learned from Implementing Ad-Hoc Multicast Routing in Sensor Networks". Harvard University Technical Report TR-22-05, November 2005.