

# Two demos using SensLAB: Very Large Scale Open WSN Testbed

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**Abstract**—We present SensLAB, a very large scale wireless sensor network testbed<sup>1</sup>. SensLAB is distributed among 4 sites having different topologies and consists of 1024 wireless nodes based on open source hardware & software. Within a given site, each one of the 256 nodes is able to communicate via its radio interface (868Mhz or 2.4Ghz) to its neighbors. Furthermore, every sensor node is potentially configurable as a sink node and can exchange data with any other sink node of the whole SensLAB testbed and/or Internet application. The testbed is designed to achieve reproducibility of experimentation, while also supporting evaluation of protocols and applications in real world settings. It allows to monitor transparently, *i.e.*, without any insertion/modification within the code, any deployed application in terms of energy consumption or radio activity. The main benefits of SensLAB for the users are to reduce the costs in terms of: infrastructure investment, maintenance cost and operating cost. With SensLAB you can be up and running minutes after you are assigned an account! SensLAB's main and most important goal is to offer an accurate open access multi-users scientific tool to support the design, development, tuning, and experimentation of real large-scale sensor network applications. During this demo, we propose to demonstrate the interests of the SensLAB testbed by developing and running two experimental scenarios that highlight the services offered by SensLAB.

## I. INTRODUCTION

Wireless sensor networks (WSN) have emerged as a premier research topic. However, due to their massively distributed nature, the design, the implementation, and the evaluation of sensor network applications, middleware and communication protocols are tedious and really time-consuming tasks. It appears strategic and crucial to offer to researchers and developers accurate software tools, physical large scale testbeds to benchmark and optimize their applications and services. There is an increasing demand among researchers, industrials and production system architects to access testbed resources they need to conduct their experiments.

During these demos, we describe SensLAB an open access multi-user WSN testbed, which has been designed and deployed to answer all these needs (see Figure 1). SensLAB provides appropriate tools, methods, experimental facilities for testing and managing large scale wireless sensor network applications. As such, it lowers the entry cost to experimentation, often considered as a complex and heavyweight activity, with no extra management burden, accelerating proof-of-concept evaluation and competitiveness. We show how easy

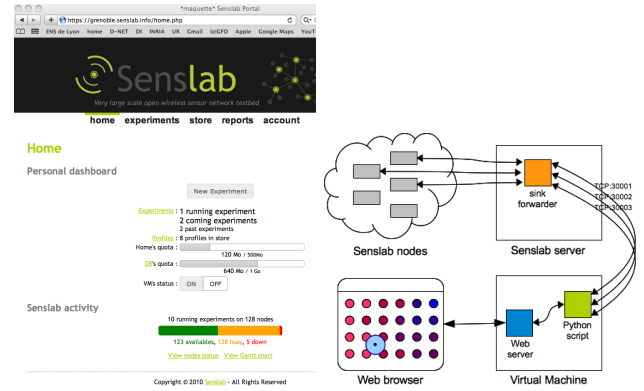


Fig. 2. (left) SensLAB user dashboard: User can assign specific firmware to nodes, configure the node monitoring and reserve nodes using the OAR experiment scheduler. (right) Each node could be configured as a sink and gather data towards a web application.

and efficient it is to use it through a couple of application examples that highlight the services offered by SensLAB:

- Describe an experiment, configure nodes and flash specific firmware remotely (Fig 2-(left));
- Use the WSN nodes provided by SensLAB without any restriction in terms of OS, programming language, drivers or API;
- Gather monitoring parameters without any code intrusion/modification within the application deployed;
- Configure each node as a *sink* and establish a bidirectional communication link through its serial port redirected to a TCP/IP port in order to allow Internet communication between all sink nodes and/or with any Internet application (Fig 2-(right));
- Incorporate mobile WSN nodes in the experiment

## II. ADDITIONAL MATERIALS

More details on SensLAB could be found on:

- <http://www.senslab.info> All hardware specifications are available under creative common license. Softwares, ready to use with SensLAB are also available: drivers, MAC protocols, OS ports (TinyOS, Contiki, FreeRTOS), communication libraries (gradient routing or SimpliciTI ports).
- A movie<sup>2</sup> describing WSN and the use of SensLAB is

<sup>2</sup><http://www.senslab.info/wp-content/uploads/movies/INRIA-687-senslab-en-1024x576.mp4>

<sup>1</sup>Project funded by ANR

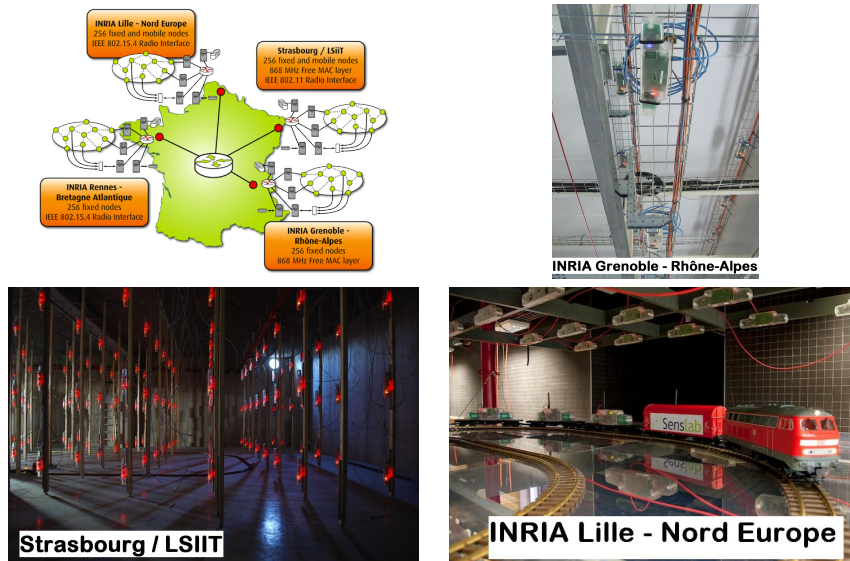


Fig. 1. SensLAB sites main characteristics. Each site has its own topology. In Lille and Strasbourg, mobile nodes are available.

also available on the web site. Several short movies<sup>3</sup> describing demos running on the SensLAB Strasbourg site are also available.

### III. DEMOS

#### A. Tracking mobile nodes

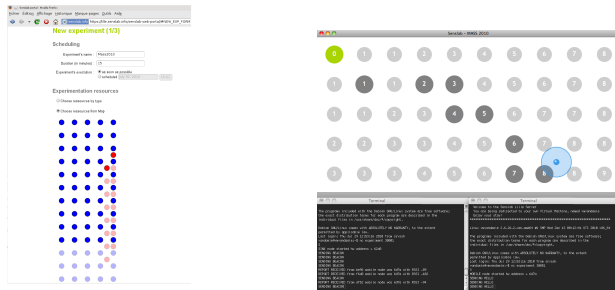


Fig. 3. The SensLAB web portal on the left. Demo visualization interface showing routes, messages transmission and mobile nodes location in the upper window, and messages printing on serial links for sink and mobile nodes on lower windows.

Our first demo illustrates mobile node tracking. To geolocalize them, some fixed nodes called *anchors* are spread and receive signals from mobile nodes as soon as they are in range. *Anchor* nodes register the mobile node identifier, the RSSI (Received Signal Strength Indicator) of the signal and the date. Then, these data need to be routed to a *sink* node. This latter is connected to a computer gathering data and computing *mobile* node location based on these data. Note that geolocalization application has been as simplified as possible since the main purpose here is to highlight SensLAB benefits. When *anchors* are deployed and powered on, the *sink* is initialized. It then starts to send BEACON and every *anchor* receiving this BEACON attaches itself to the sink. The *sink* becomes its parent. Then every attached *anchor*  $x$

forwards the BEACON. Every unattached *anchor* receiving a beacon from  $x$  chooses  $x$  as its parent. When every *anchor* has chosen a parent, the whole area is covered and *mobile* messages can be forwarded to the *sink* as follows. When an anchor receives a data message from another anchor or needs to send its own data, it forwards it to its parent. Step by step, the message eventually reaches the *sink*. The *sink* sends data through its serial link and the computer connected to it gathers the different messages and estimates mobile node positions.

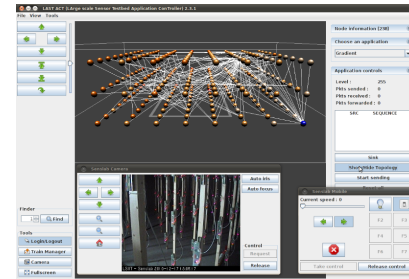


Fig. 4. Overview of the application controller that allows to remotely control the mobile node speed, monitor radio link quality...

#### B. Using an interactive demo controller

Our large scale sensor testbed application controller consists in a 3D graphical interface that interacts with static and mobile nodes in real-time. It enables easy retrieving of every logged parameter as well as a feedback of some current characteristics of the environment. For instance, in addition to the data sensed at every node, transmission statistics can be inferred from packets exchanges thus leading to a real-time monitoring of radio link states (Fig. 4). Last act also allows users to control the mobile train that embeds some of the wireless sensors. A look at the real testbed can be taken via a high-definition video camera, whose position, angle and many other features can also be set from our interface.

<sup>3</sup><http://www.senslab.info/?p=356>