Poster: FIT IoT-LAB Testbed, to Interoperability and Beyond

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Abstract

FIT IoT-LAB is a very large scale experimentation testbed distributed over 6 different sites in France. This poster gives an updated view of the facility regarding the recent achievements and the new experimentation opportunities brought.

The first to be developed is the brand-new re-deployment of the Lille site, bringing a building-scale topology. Then we detail how we are making the testbed more heterogeneous with the support of new hardware platforms. Finally, we explain how IoT-LAB will provide a way of testing interoperability between different types of radios.

1 Introduction

IoT-LAB is one of the most important experimentation platforms for WSN and IoT experimentation in Europe. Its greatest asset is its number of nodes, giving a very large scale experimentation capacity in various physical topologies, in an attempt to cover a large range of application scenarios. As key features, it provides: socket I/O access to individual nodes, mobility, fine-grained non-intrusive monitoring and OS support. For a detailed description of the IoT-LAB design and features, we refer the reader to [1].

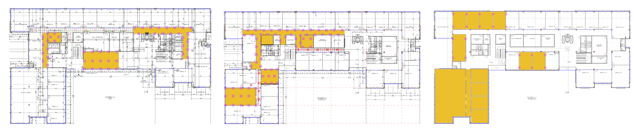
Despite its success shown by usage statistics in §3, we can notice some limitations: 1) some physical topologies are too dense for multi-hop networking; 2) there is not that much heterogeneity in deployed hardware; 3) a lack of diversity on deployed sites, i.e. it is not possible to test interoperability.

2 Limitations and Recent Evolutions

The following section details the limitations listed previously and the evolution we made recently to push them back.

2.1 Lille's New Physical Topology

In its original deployment, the Lille nodes were deployed over a 225 m^2 area, hosting 256 M3 nodes. The nodes were dispatched over a regular 2D-grid, plus a few number deployed vertically on wood poles. Deployment details with maps and pictures are available on the IoT-LAB website[1].



(a) 48 nodes at 1st floor (b) 69 nodes at 2nd floor (c) 139 nodes at 3rd floor

Figure 1. Re-deployment zones of the 256 nodes across the Inria Lille building.

The main drawback of this deployment was the density of the network – each node was able to communicate directly with any other node. Users interested in multi-hops networks had to tune the radio configuration, limit the radio transmission power, set a RSSI threshold or hack their routing stack to achieve having such networks, yet potentially biasing the experimentation. Thus, we considered benefic to propose an actual multi-hop network where the nodes are not all in range of each other. That is why we decided to make our deployment sparser and re-deploy more than half of the nodes.

The final scenario adopted is, in addition to the original dedicated room on the third floor, a distribution of nodes through offices, corridors, meeting or storage rooms across the three floors of our building, providing a connected network. Fig. 1 shows an overview of the new topology. Furthermore, offering such a topology, provides an actual deployment at a building scale, relevant for Internet of Things large-scale experimentations related to smart home, smart building, smart city or smart factory contexts for example.

2.2 Bringing New Hardware

An IoT-LAB node is made of three components: 1) the Open Node, an IoT device made available to the user during his experiment; 2) the Gateway, connecting the constrained device to the infrastructure; 3) the Control Node, in charge of automatic monitoring. The connection of the Open Node to its Gateway can be made through a USB port, thus we can easily plug another board instead of the usual IoT-LAB M3 or A8 boards. This design allows us to evolve and extend the platform hardware. And since we have only a very few radio technologies available, we have the opportunity here to enlarge and update the radio scope.

[1] `https://www.iot-lab.info/deployment/lille/#lille`

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Adding software support. Support for some commercial boards (listed later) is already available. We are also open to contributions. Developing the support is not an hard task and consists in a few steps. To ease this development, we provide a docker environment and a test suite to validate the new implementation. Board support implementation is made into the IoT-LAB Gateway Manager application [2], the main software running in the linux environment of the Gateway. It is an open source Python application, exposing a REST API managing interaction with the Open Node.

1. Since its modular architecture is based on a plugin system, the support of a new Open Node consists only in a Python class. The minimal implementation requires the writing of eight methods, documented in the `DEVELOPER.md` file.
2. Then, the developer has to figure out which dependencies will be necessary for the new board into the Gateway environment (e.g. BSL scripts or flashing tools). This step can be validated by customizing the docker image thanks to the Dockerfile.
3. Finally, the developer has to write udev rules for the new board to expose the new device through a templated name.

We suggest developers to submit a Pull Request to the official repository to be validated by the IoT-LAB developer team, before we can consider its integration into the platform.

Boards support already developed. Regarding the needs, works and concerns of the different research teams on sites, some boards support have already been developed. They are the following: Atmel SAMR21 Xpro, Arduino Zero, STM32 L0 Lora, Zigduino r2, Zolertia Firefly. We also started the deployment of new boards with fifteen SAMR21 nodes deployed in the Saclay site and plan to spread soon a few Firefly boards among the Lille site to add long range communications across the building.

2.3 Experimenting Interoperability

Regarding the possibilities brought by the work detailed in the previous section, and the existing of a deployment of 64 Gateways without any Open Node connected in Lille (illustrated by Fig. 2), we had here the opportunity to provide a testbed dedicated to interoperability experimentations.

We tried to figure out the characteristics of the hardware expected from the users and supported by the Operating Systems to define a list of boards that we want to support and deploy there. Tab. 2.3 lists the targeted boards and their main characteristics regarding MCU and radio chip. We made a selection among the most used MCUs and wireless communications in embedded devices, introducing new possibilities like multi-radio boards and long-range communications.

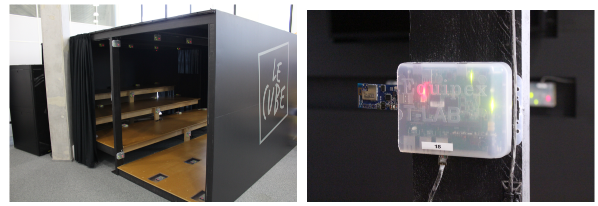
Moreover, we think that this testbed could be interesting for embedded open source communities, like those of Operating Systems, to run nightly/weekly builds on actual hardware, and improve their quality process.

3 Conclusion

At present, IoT-LAB has 2522 users registered and 74302 experiments run for 5 years. Since 2015, we count more than 500 registrations per year for an average of 20000 experiments per year over the two last years. Fig. 3 shows the evolution of these statistics. These curves, increasing continuously, illustrate the strong adoption of the testbed by the community. The number of registrations is a good indicator of the testbed's visibility and popularity; as for the number of experiments which is a good indicator of the testbed's usefulness, ease of use and relevance.

The continual evolution of the testbed, in features and possibilities, should keep it as a first-rate experimentation tool, achieving is goal: helping our scientific community in the development of wireless embedded solutions for the IoT.

[2] https://github.com/iot-lab/iot-lab-gateway/



(a) Overall view (b) A TelosB connected

Figure 2. Le Cube, an heterogeneous deployment of 64 open Gateways for interoperability testing.

Table 1. Characteristics of nodes to be deployed.

Board	**MCU / SoC**	**Radio(s)**			
		2.4GHz	Sub-1GHz	BLE	LoRa
Atmel SAMR21	Cortex M0	•			
Zolertia Firefly	Cortex M3	•	•		
STM32L0 LoRa	STM32L0				•
TelosB / Tmote Sky	TI MPS430	•			
CC2650 LaunchPad	TI CC2650	•		•	
NXP USB-KW41Z	KW41Z	•		•	
NRF 52840	nRF52840	•		•	
BBC micro:bit	Cortex M0			•	

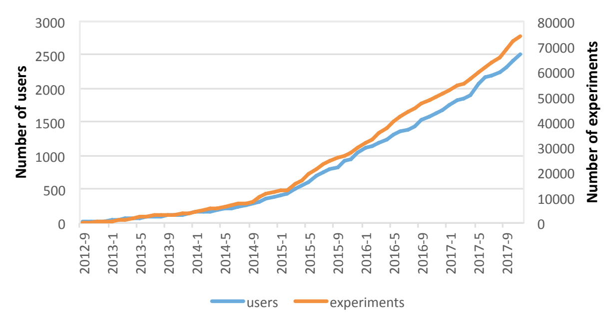


Figure 3. Evolution of users registrations and experimentations run since 2012.

4 Acknowledgments

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5 References

[1] C. Adjih et al. FIT IoT-LAB: A large scale open experimental IoT testbed. In *IEEE WF-IoT*, 2015.