FIT IoT-LAB: The Largest IoT Open Experimental Testbed

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Teaser: The universal proliferation of intelligent objects is making Internet of Things (IoT) a reality; to operate on a large scale it will critically rely on new, seamless, forms of communications. But how could innovations be validated in a controlled environment, before being massively deployed into the real world? FIT IoT-LAB answers this challenge by offering a unique open first class service to all IoT developers, researchers, integrators or developers: a large scale experimental testbed allowing to design, develop, deploy, test the innovative IoT applications, in order to test the Future and make it safe.

IoT is not simply emerging as a major technology trend, IoT is already a reality, today, with billions of existing devices. The Internet of Things represents a tremendous paradigm shift since Internet was designed; an evolution from pure end-to-end communication between an end-user device and a server in the Internet, to an Internet interconnecting physical objects that are freely able to communicate with each other and with humans. IoT builds on three pillars [1], related to the ability of smart objects to:

i. to compute;

ii. to communicate;

iii. to sense and interact with their environment.

Even if IoT is a reality, it is still maturing and waiting for its "iPhone moment". Several challenges remain, more specifically related to the standardization of efficient and universal protocols, and to the design and test of IoT services and applications. Due to their massively distributed nature, their design, implementation, and evaluation are inherently complex and

tend to be daunting, time-consuming, tasks. To overcome this critical hurdle, it appears crucial to offer to researchers, IoT designers, developers and engineers a representative, large scale, platform to construct, benchmark and optimize their protocols, applications and services.

The **FIT IoT-LAB** testbed is our answer to these main challenges. It offers a first class facility with thousands of wireless nodes to evaluate and experiment very large scale wireless IoT technologies ranging from low level protocols to advanced services integrated with Internet, accelerating the advent of groundbreaking networking technologies. IoT-LAB also provides dozen of robots to test and improve the impact of IoT devices' mobility. FIT IoT-LAB's main and most important goal is to offer an accurate open access multi-user scientific tool to support design, development, tuning, and experimentation related to IoT.

IoT-LAB is part of the FIT (Future Internet of Things) project which develops experimental facilities within a federated and competitive infrastructure with international visibility and a broad panel of customers. All facilities come with complementary components that enable experimentation on innovative services for academic and industrial users. FIT is granted by Equipex research grant program and it received an amount of 5.8Millions €. The FIT consortium is coordinated by University Pierre et Marie Curie and composed of Inria, ICube laboratory from University of Strasbourg, Institut Mines-Télécom and CNRS. FIT is a platform federation. Such a federation of independent network experimental facilities is arguably the only meaningful way to achieve the required scale and representativeness for supporting Future Internet research. IoT-LAB testbeds are dispatched over six different locations across France, which gives forward access to 2728 wireless IoT fixed and mobile nodes equipped with various sensors:

	Grenoble	Lille	Paris	Strasbourg	Rennes	Institut Telecom	**Total**
WSN430 (800MhZ)	256	-	-	256	-	-	512
WSN430 (2.4GhZ)	-	256	120	-	256	-	632
M3	384	320	24	120	-	90	938
A8	256	-	200	24	-	70	550
Host Node	32	64	–	–	–	–	96
Total	928	640	400	344	256	160	2728

Users can select and reserve the number and type of nodes they wish with

respect to different features, such as microcontroller (TI MSP430, ARM Cortex M3 and ARM Cortex A8), radio chip (2.4GHz or 800MHz) and additional functionalities (mobility/robots, accelerometer, magnetometer and gyrometer). Resources can be reserved on one or several sites at once. Here is a selection of services offered by IoT-LAB:

i. Total remote access to nodes reserved, e.g. allowing users to flash any firmware, without any condition or constraint. Any language or OS can be used to design, build, and compile applications;

ii. Direct access to a debugger server on each node so that all debugging can be performed remotely on the node (such as step by step code execution)

iii. Access to the serial ports of all nodes for a real-time interaction, with optional aggregation;

iv. Each node could be visible from Internet with end-to-end IP connection using IPv6 and 6LoWPAN for example;

v. A very accurate power consumption monitoring of every node.

vi. Packet sniffer and analyzer on each node.

vii. A GPS module for some A8 nodes allowing a very precise end-to-end time synchronization, accurate monitoring and performance evaluation of communication protocols.

viii. A set of useful detailed tutorials, OS supports (Contiki, FreeRTOS, TinyOS, and RIOT) including full protocol stacks and communication libraries like OpenWSN providing open-source implementations of IoT protocol standards;

ix. A unique fleet of mobile robots (WifiBot and TurtleBot).

x. Strong extensibility through the availability of more than 100 empty slots on which users can physically plug their own hardware devices, while benefiting from the IoT-LAB services and monitoring tools (a feature frequently required by both academic and industrial users)

Overall, FIT-IoT LAB testbed is a unique pioneer in the domain of IoT testbeds.

(a) Strasbourg ©ICube (b) Grenoble. ©Inria (c) Lille. ©Inria

Figure 1: FIT-IoT LAB platform.

Useful Links:

IoT-LAB: `https://www.iot-lab.info`

FIT: `https://www.fit-equipex.fr`

OpenWSN: `https://openwsn.atlassian.net/`

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References

[1] D. Miorandi, S. Sicari, F. D. Pellegrini, and I. Chlamtac. Internet of things: Vision, applications and research challenges. *Ad Hoc Networks*, 10(7):1497 – 1516, 2012.