OneLab: On-demand deployment of IoT over IPv6

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Infrastructure as a service for IEEE INFOCOM community

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***Abstract*— This demonstration will explain how an experimenter can easily deploy an end-to-end IoT and Cloud infrastructure using the OneLab federation of testbeds. It will highlight the importance of using IPv6 in this context.**

Keywords—Internet of Things, Cloud, IPv6, Testbeds

I. INTERNET OF THINGS CONTEXT

Researchers and innovators are developing new hardware devices, new communication protocols and new ways to collect and analyze data in order to enable the emergence of new IoT applications. However, as any new technological field different initiatives offer different components or protocols. This technological diversity questions the interoperability capabilities of the Internet of Things. It also constitutes a risk for private companies that have to build products on top of technological components. Private companies must carefully choose the technologies they use and have to wisely bet on the technology that will win of the standardization war.

II. HOW TO ADDRESS THE IOT CHALLENGES USING ONELAB?

A. Federation of testbeds

In order to enable researchers to develop the necessary IoT technologies and to mitigate the technological risk for private companies, the OneLab facility offers a unique federation of testbed platforms. OneLab provides a single point of entry to heterogeneous technologies, enabling thus to prototype IoT applications or products.

Until very recently, large-scale testbed facilities have existed in separate silos, each with its own resources providing either wired servers or wireless resources.

There lacked a viable federation model that reconciled the challenges posed by how to provide a single entry point to access heterogeneous and distributed resources, and how to federate these resources that are under the control of multiple authorities. The OneLab experimental facility, which came online in 2014, realizes this model, making a set of world-class testbeds freely available to researchers and innovators through a unique credential for each user and a common set of tools.

OneLab offers an access to wired servers, virtual machines and cloud with PlanetLab, Virtual Wall (Belgium) and FIT Cloud (France). It also provides access to wireless testbeds thanks to Nitos (Greece), FIT Wireless (France) and W-iLab.t (Belgium).

B. FIT IoT-Lab

Last but not least is FIT IoT-Lab is a very large testbed of over 3000 physical IoT devices deployed across France, thanks to the FIT Equipex project.

FIT IoT-Lab provides different types of hardware devices such as M3, A8 and WSN430 nodes, as well as mobile robots. These devices can support several Operating Systems (FreeRTOS, Contiki, Riot, TinyOS, OpenWSN, Linux). The nodes can be deeply configured through an API and experimenters can upload their own firmware in order to test specific features.

The platform addresses thus the challenge of developing new IoT technologies relying on different hardware devices while carefully monitoring the energy consumption at the same time.

FIT IoT-Lab nodes (M3, WSN430, A8) are communicating through the 802.15.4 radio standard (IEEE). A8 nodes are running Linux and also have an Ethernet port enabling to establish a connection to the Internet. As the number of connected devices is growing, IPv6 is became a crucial enabler for IoT. Therefore, we provide a large number of nodes connected through IPv6.

III. DEMONSTRATION

This demonstration will explain how to easily deploy and remotely control a real infrastructure. This experiment is a practical use-case presenting an on-demand deployment of IoT networks connected to a Cloud over IPv6 using OneLab testbeds. This use case addresses the needs of researchers, innovators or students, who need to test new IoT communication protocols and applications at a large scale.

FIT Equipex project: ANR-10-EQPX-31-01
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A. Architecture

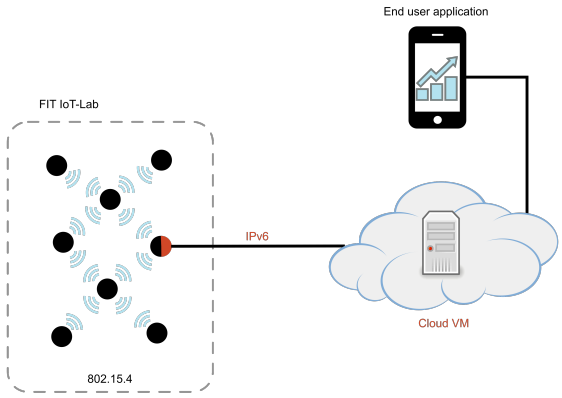

Figure 1: architecture of the IoT and Cloud experiment

OneLab federation of testbeds offers to its users a single point of access through a web portal. It allows experimenters to create an account, to browse the federated resources, select and reserve some of them for their experiment. In this demo, several FIT IoT-Lab M3 nodes will be reserved as well as a virtual machine (VM) as shown in Figure 1.

Thanks to the Slice-based Facility Architecture API, the public key of the user will be deployed on every heterogeneous testbed enabling an easy SSH login.

B. Deployment

Once logged in to the SSH gateway of the FIT IoT-Lab testbed, a Border Router firmware based on Contiki OS will be deployed on one of the nodes through a command line tool. Then, the rest of the nodes will be flashed with a CoAP server firmware (RFC 7252) also based on Contiki OS. An IPv6 prefix is chosen in order to build a bridge between the BR and the SSH gateway providing thus a direct access to the nodes from the outside world.

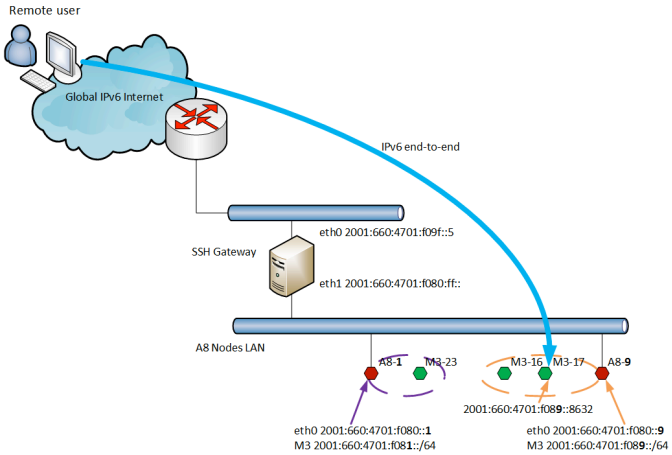

Figure 2: IPv6 mapping of FIT IoT-Lab nodes

A network between the CoAP nodes and the BR is self-organized thanks to RPL (RFC 6550), which creates a topology as a Directed Acyclic Graph (DAG). This routing protocol is used with a 6LowPAN (RFC 4944) network layer as shown in Table 1. Once the network layer is setup, the CoAP server nodes can be queried from the outside over IPv6.

Layer	Protocol
Application	CoAP Client / Server application
Transport	UDP
Network	IPv6 – 6LowPAN - RPL routing
Link	IEEE 802.15.4

Table 1: Protocol layers

C. Experiment

As shown in Figure 3, a CoAP client (txThings) is setup on the VM as well as a web server (Tornado). The CoAP client will communicate with the web server through a websocket, enabling thus to send data as soon as it is received. Finally, data observed will be presented in a web page embedding a simple Javascript websocket client.

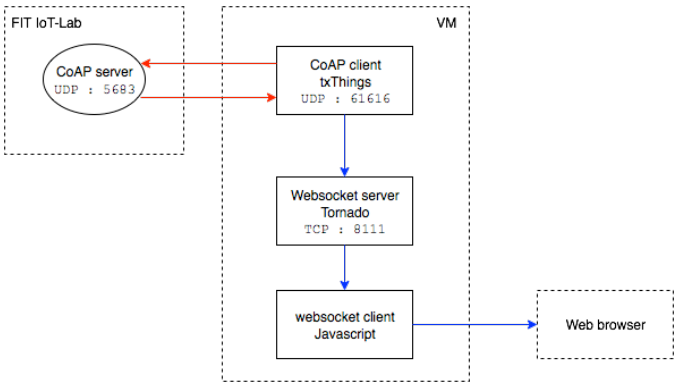

Figure 3: web server and CoAP client running on the VM

IV. Conclusion and Future Work

As presented in this demonstration, an IoT and Cloud infrastructure can easily be deployed using OneLab federation of testbeds. This experiment can and will be further automated using scripts in order to provide this heterogeneous setup as a service. This extension will enable experimenters to build applications on top of this service. One of the many applications could be to detect humans or robots presence in the room, where FIT IoT-Lab nodes are deployed. It could also be used for temperature and light sensing in the context of a smart building application.

V. Presenters

A. *Loïc BARON (UPMC, CNRS)*

Lead engineer of the OneLab facility

He received an Engineering Master degree from CNAM Paris. He has been working in ICT companies as a consultant in software development, testing and integration. He has worked for different clients such as France Telecom, Expedia, Caisse d'Epargne. He is experienced in various development technologies. He joined CNRS (National Center for Scientific Research) and UPMC (Lip6) as an engineer in 2010. He is now responsible for the development of the federation API and the OneLab web portal. He has been involved in several European (FP7) projects such as OpenLab and Fed4FIRE but also in cooperation projects with Brazil (FIBRE) and Korea (SmartFIRE). He is today involved, as a workpage technical leader, in the F-Interop European project (H2020), which aims at providing conformance testing as a service using federated testbeds.

He already presented several tutorials

a) Fed4Fire plenary meeting, Gand, April 2013

b) FIBRE workshop, Rio de Janeiro, Sept. 2013

c) Chinese Academy of Science, Pékin Nov. 2013

d) SmartFIRE Forum, Séoul, Oct. 2014

e) Fed4Fire summer school, Gand, July 2015

f) TridentCom 2015, Vancouver, July 2015

B. *Frederic Saint-Marcel (INRIA)*

Technical director of the FIT IoT-LAB testbed

Frederic Saint-Marcel received Computer Engineering master degree by the University of Grenoble, France, in 2002. He is currently a senior research engineer at INRIA Grenoble Rhône-Alpes center. Since 2012, he is the technical leader of a research and innovation team focusing on Internet of Things and the research platform named FIT/IoT-LAB (http://www.iot-lab.info). Some of the projects in which he is involved are inter-testbed federation, such as OneLAB (http://www.onelab.eu) or collaboration between France and III Taiwan institute.

He already presented several tutorials

a) Workshop Internet Of Things FIT, Lille, Oct. 2015

b) Rescom SmartCities Summer School, Lyon, July 2015

c) Workshop Internet Of Things FIT, Lille, Nov. 2014

d) TridentCom 2015, Vancouver, July 2015

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