FIT IoT-LAB
First Class IoT Open Experimental Testbed

E. Fleury, ENS de Lyon / Inria

Eclipse IoT Days 2015 — Grenoble France — March 30-31, 2015

Thanks to :

▷ C. Adjih, Inria

▷ E. Baccelli, Inria

▷ C. Chaudet, Institut Mines-Télécom
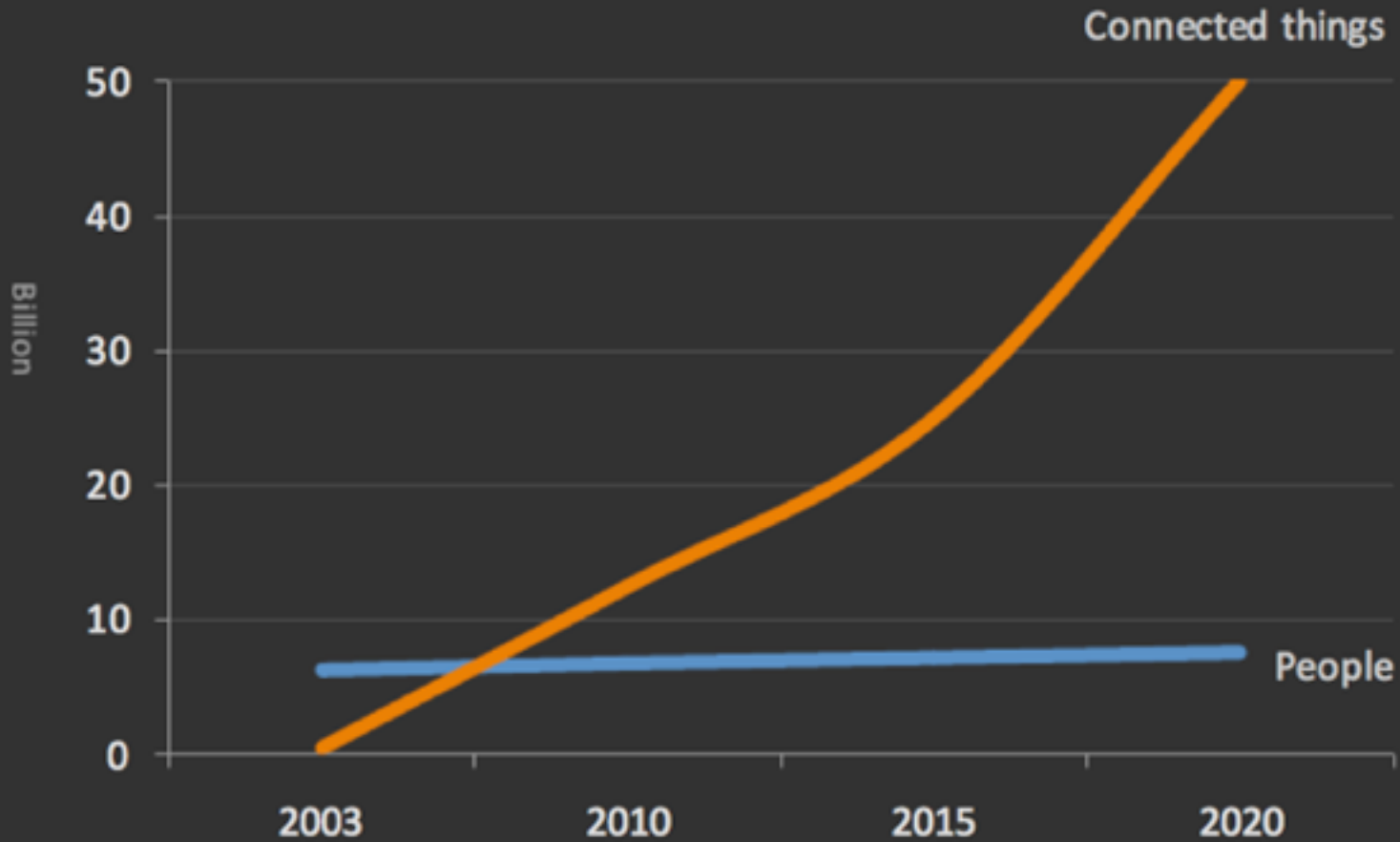
▷ N. Mitton, Inria

▷ T. Noel, University of Strasbourg

1

IoT promise

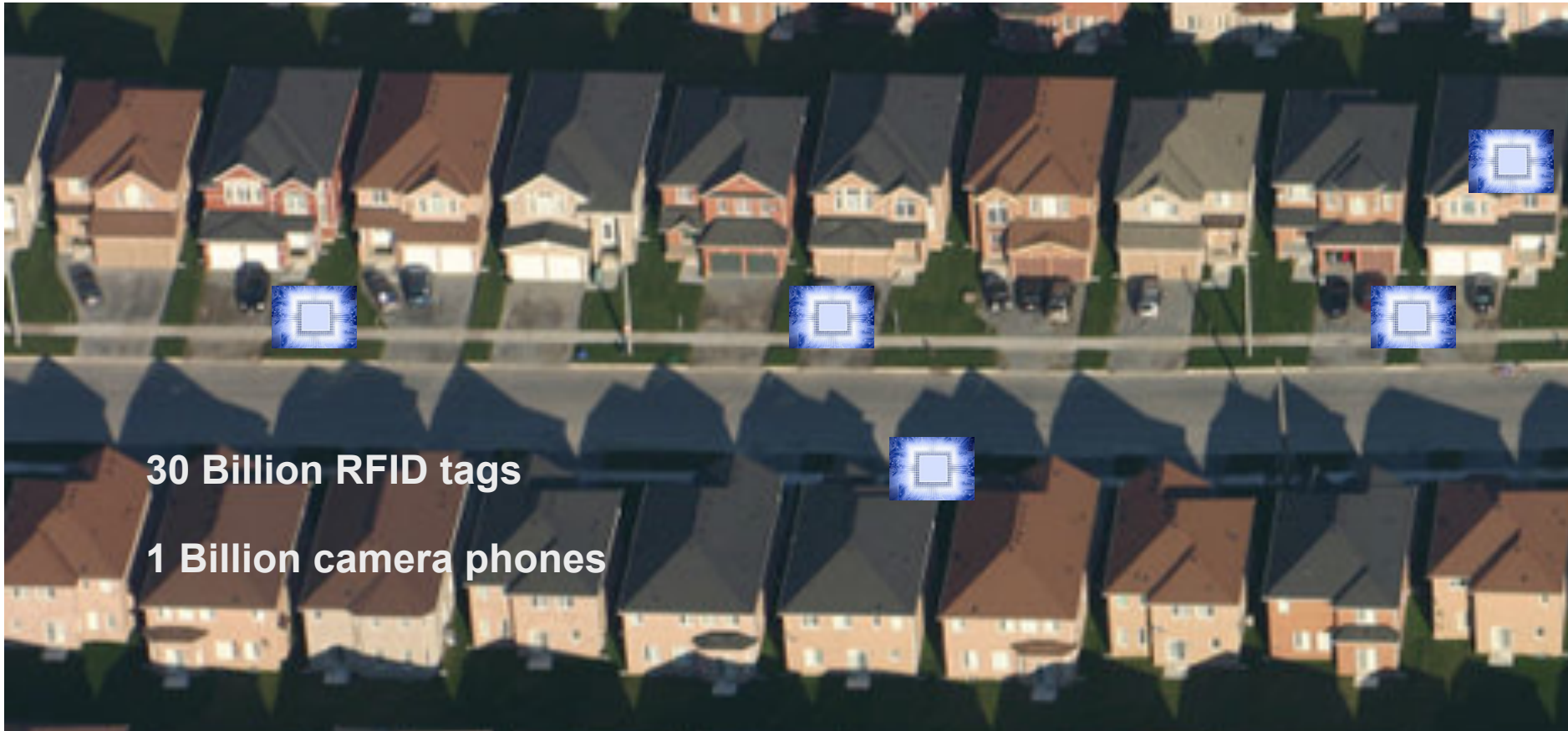## Connected objects in a numerical world

$2^{128} =$ 340.282.366.920.938.463.463.374.607.431.768.211.456

Connected things

Billion

50
40
30
20
10
0

People

2003   2010   2015   2020

Source: Cisco IoT 2011 infographic
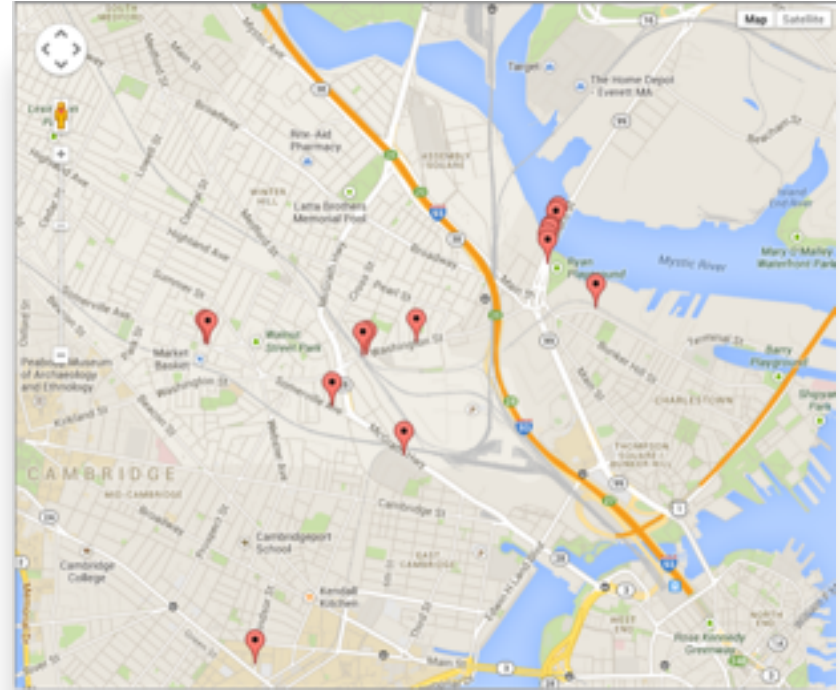
Instrumented

30 Billion RFID tags

1 Billion camera phones

source: Kim Escherich , Executive Innovation Architect sur Pan-European Chief Technology Officer Team, IBM SWG
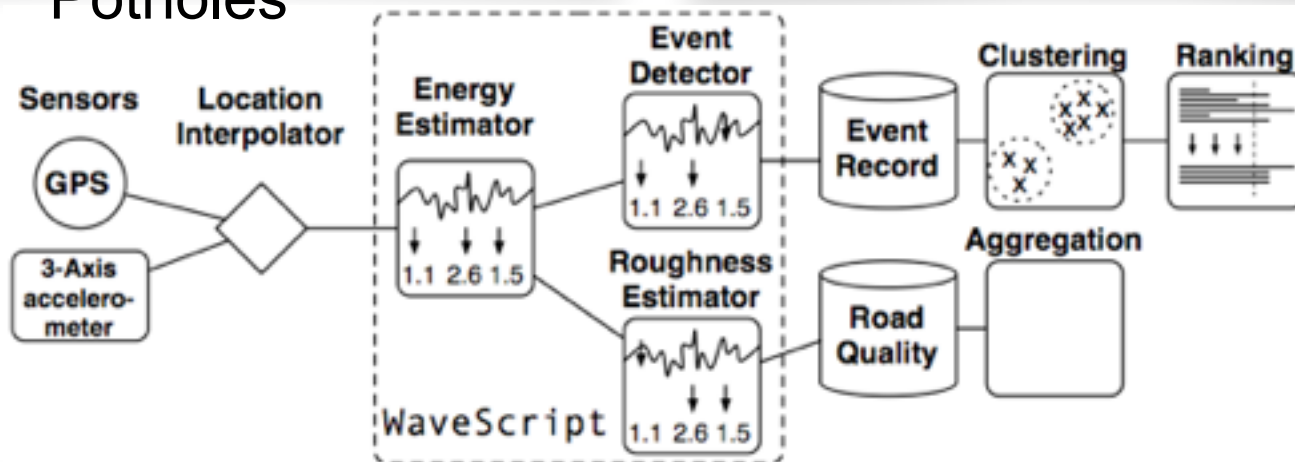
How google traffic is working?

How to monitor road condition « for free »?

Potholes

Interconnected

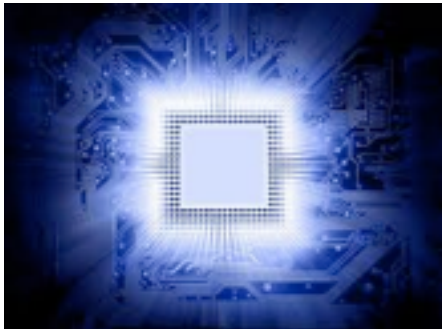**+2 Billions Internet subscribers**

+20 Billion connected device

source: Kim Escherich , Executive Innovation Architect sur Pan-European Chief Technology Officer Team, IBM SWG

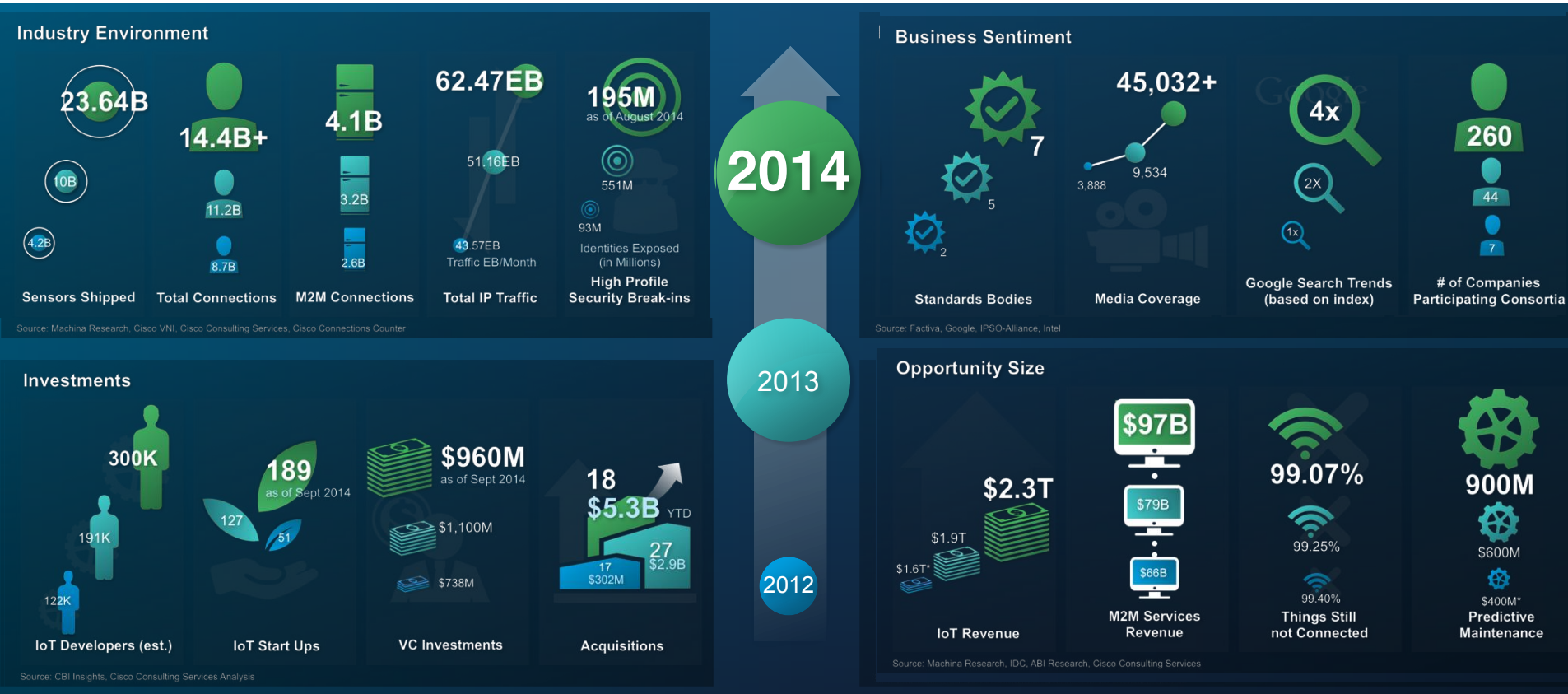# Intelligent

Every systems is becoming

+

+

NEW INTELLIGENCE

SMART WORK

GREEN

DYNAMIC INFRATRUCTURE

IoT Acceleration Dashboard 2012-2014

Source: CBI Insights, Cisco Consulting Services Analysis

First takeaways

1. **IoT Is Here**. Now. And It's Big

2. IoT Dashboard: **IoT is Accelerating**

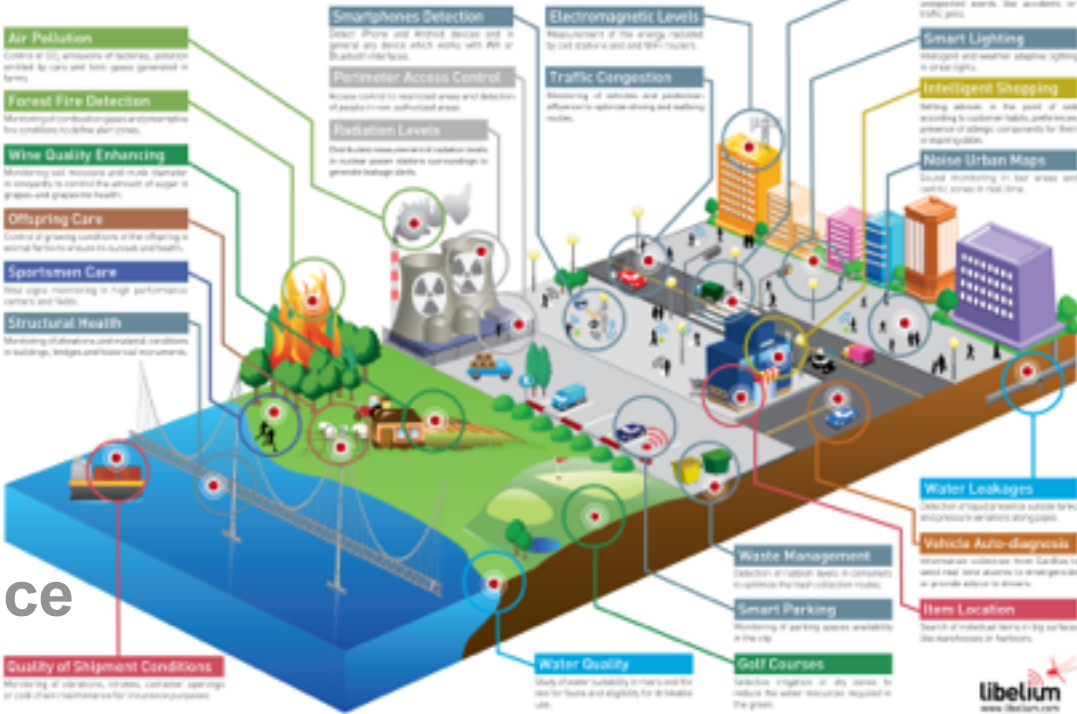3. IoT... **Huge Opportunity for Ecosystem**

Health

Home

Ecology

Security

Transport

Maintenance

Deploying real applications

Build new protocols / applications
Specification / Design
Simulation
Deployment / Experimentation

HiKoB

HiKoB

Large scale experimentation is real nightmare
Fastidious for a dozen of nodes
Manual handling / time consuming / boring

Needs for large scale scientific tools

Scientific & Reproductible experiment

2

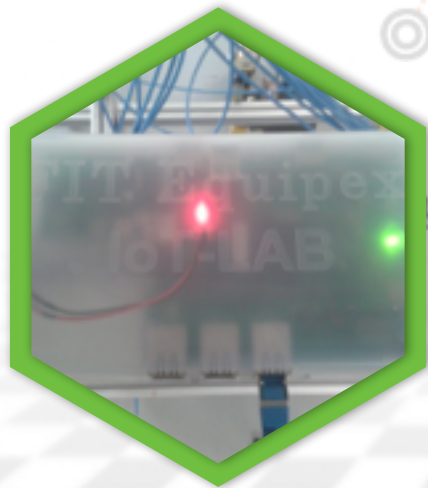**FIT IoT-LAB in the IoT Context**

WHAT / WHERE / WHY / HOW

FIT IoT LAB Objectives

▷ **Target and challenge:**
  ▷ M2M / scaling
  ▷ IoT (heterogenous)
▷ **Designing / Testing / Deploying / Monitoring**
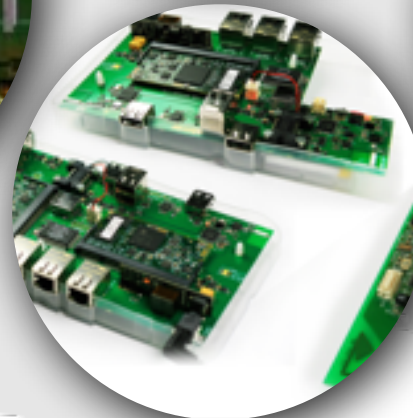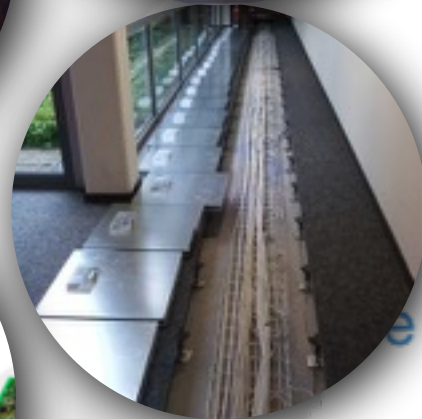
▷ **Use Cases:**
  ▷ Home Gateway
  ▷ Cloud service monitoring
  ▷ IPv6 from sensors to the Cloud
  ▷ Mobile nodes

What/Where is FIT IoT LAB?

▷ **More than 2700+ wireless nodes**

  ▷ IMS band

  ▷ IEEE 802.15.4

▷ Low Power and Lossy Networks

▷ Total Remote Access

▷ Total Open Access

▷ Mobile Nodes/Robots

Ten Commandments

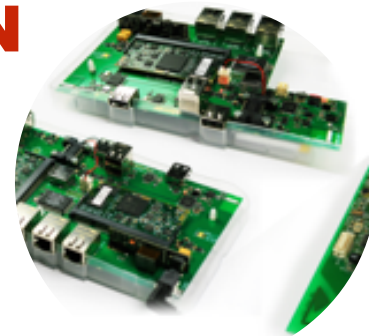**OPEN Nodes ==** **NO CONSTRAINTS AT ALL**

I. Total remote access to open nodes

II. Direct access to debugger

III. Access to serial port / aggregator

IV. On the global Internet (IPv6 end-to-end)

External Monitoring == **NO APP MODIFICATION**

V. Packet sniffer

VI. Precise end-to-end synchronisation (GPS)

VII. Accurate power consumption

Easy to use / Advance features

VIII. OS supports, tutorials, Open-source (OpenWSN)

IX. Fleet of robots (40 + 60 + 10)
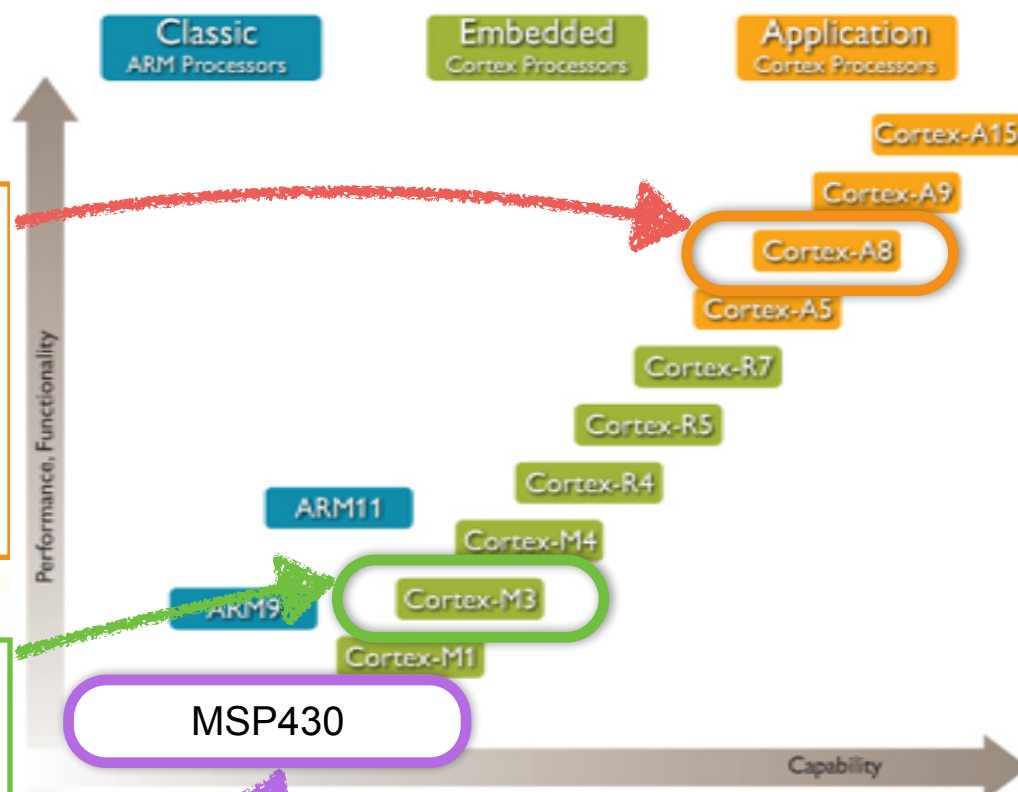
X. Free open slots for specific hardware (usb node)

IoT LAB Nodes

A8 node : TI-SITARA AM3505
- Ethernet, USB
- Linux/Android
- Indoor GPS for highly accurate synchronisation

M3 node : STM32
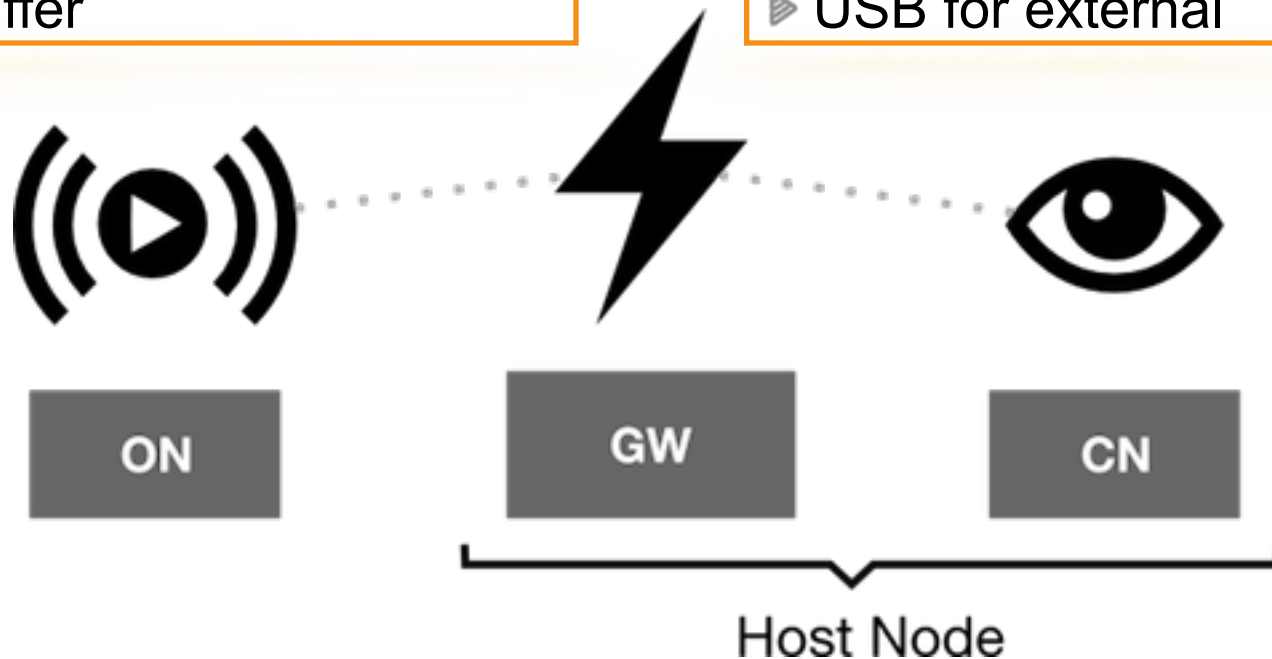- Radio Atmel AT86RF231
- Ambiant light, Temp, IMU, Pressure

WSN430 node : TI MSP430
- Radio TI CC1101 / CC2420
- Ambiant light, Temp

Classic
ARM Processors

Embedded
Cortex Processors

Application
Cortex Processors

Cortex-A15

Cortex-A9

Cortex-A8

Cortex-A5

Cortex-R7

Cortex-R5

Cortex-R4

ARM11

Cortex-M4

Cortex-M3

ARM9

Cortex-M1

MSP430

Performance, Functionality

Capability

IoT-LAB Node

▷ Feedback channel
▷ Power over ethernet
▷ SINK / Internet connexion
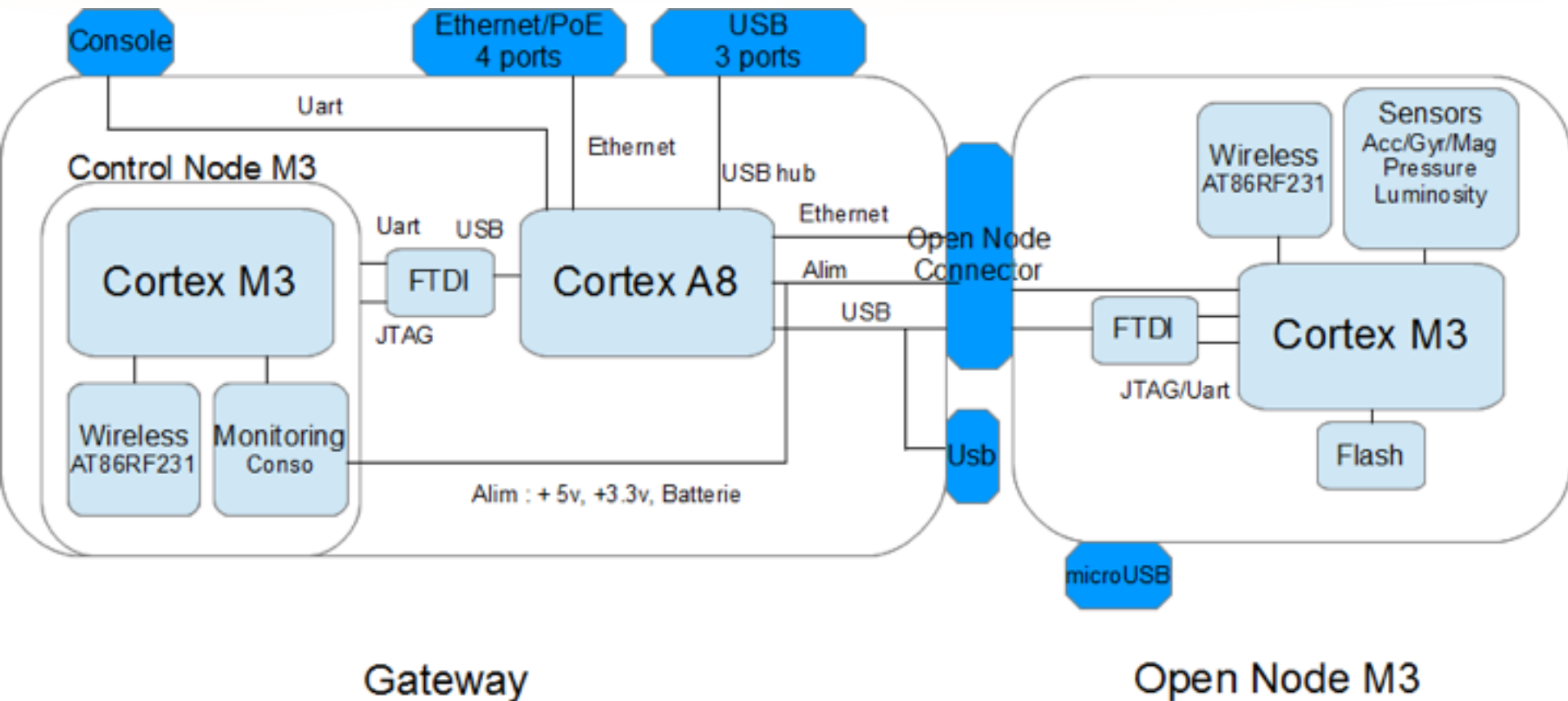▷ USB for external

ON

GW

CN

Host Node

- connection to the global infrastructure
- control and monitor the open node.
- handles the open node serial link if the node is set to be a sink node.
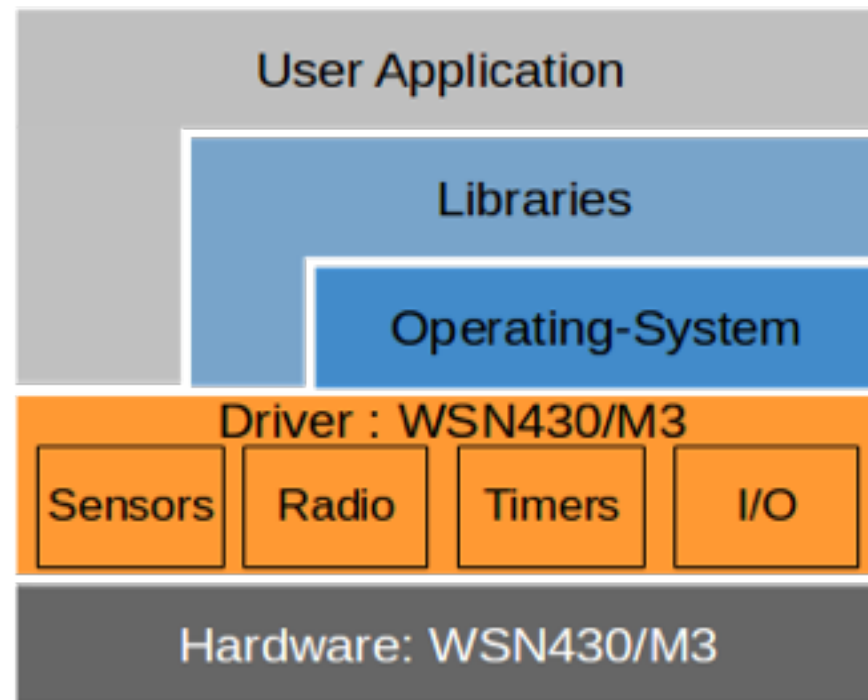
IoT-LAB Node M3 Architecture

▷ Automatic firmware deployment
▷ Consumption Monitoring
▷ Sensor polling
▷ Radio sniffer

▷ Feedback channel
▷ Power over ethernet
▷ SINK / Internet connexion
▷ USB for external

Console

Ethernet/PoE 4 ports

USB 3 ports

Uart

Ethernet

Control Node M3

Cortex M3

Uart   USB

FTDI

JTAG

Cortex A8

USB hub

Ethernet

Open Node Connector

Alim

USB

FTDI

JTAG/Uart

Wireless AT86RF231

Sensors Acc/Gyr/Mag Pressure Luminosity

Cortex M3

Wireless AT86RF231

Monitoring Conso

Alim : + 5v, +3.3v, Batterie

Usb

Flash

microUSB

Gateway

Open Node M3

Embedded User Software

▷ **IoT-LAB offers full support for embedded software development:**

    ▷ **direct access to node HW**

    ▷ **OS-level features**

▷ **Developers can leverage the different APIs to build applications.**

Several Operating Systems

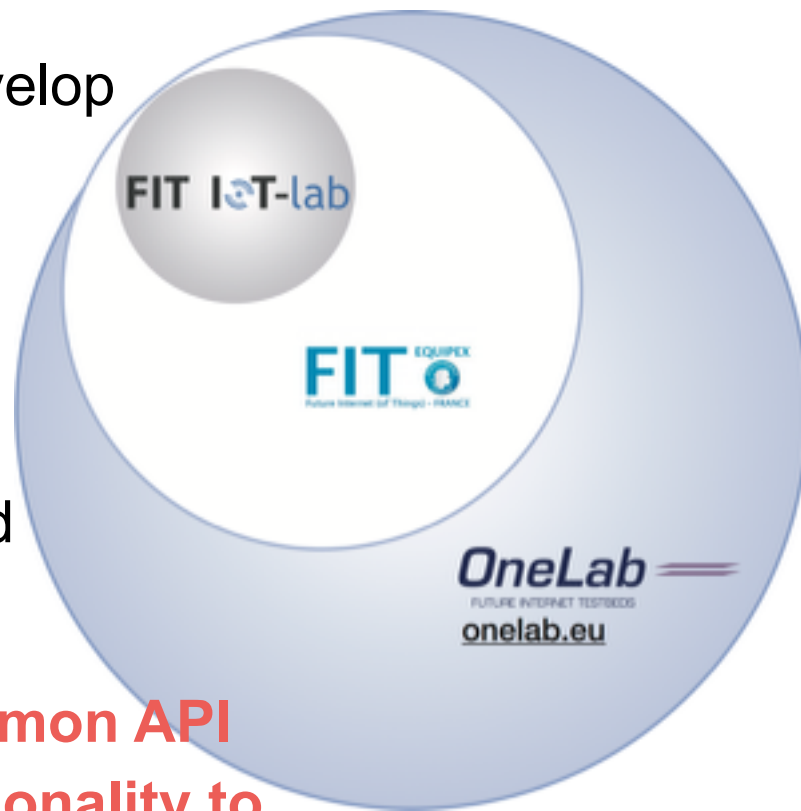|	WSN430	M3 NODE	A8 NODE
free**RTOS**	☑	☑	
Contiki	☑	☑	
RIOT	☑	☑	
TinyOS	☑		
OPENWSN	☑	☑	
Linux			☑

What's about iot.eclipse.org ?

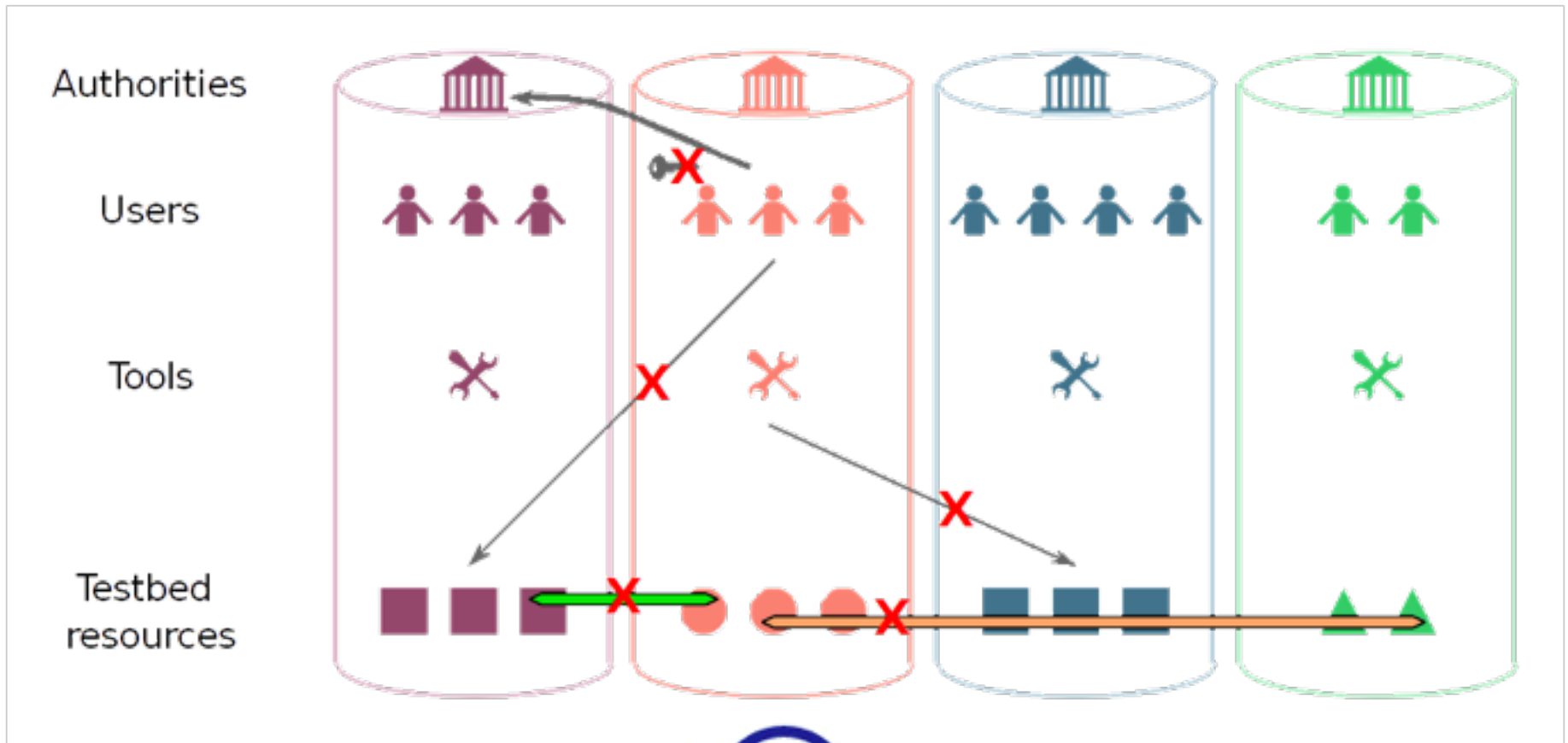# More than just an isolated testbed

▷ **An Internet of Testbeds**

  ▷ A **Facility** – A playground for the future Internet

  ▷ Wide-variety of eco-systems and develop openness

▷ **Benefits from FIT / OneLAB.eu**

  ▷ An architecture for federation

  ▷ Fundamental components for testbed federation

  ▷ **SFA aims to provide a secure common API with the minimum possible functionality to enable a global testbed federation**
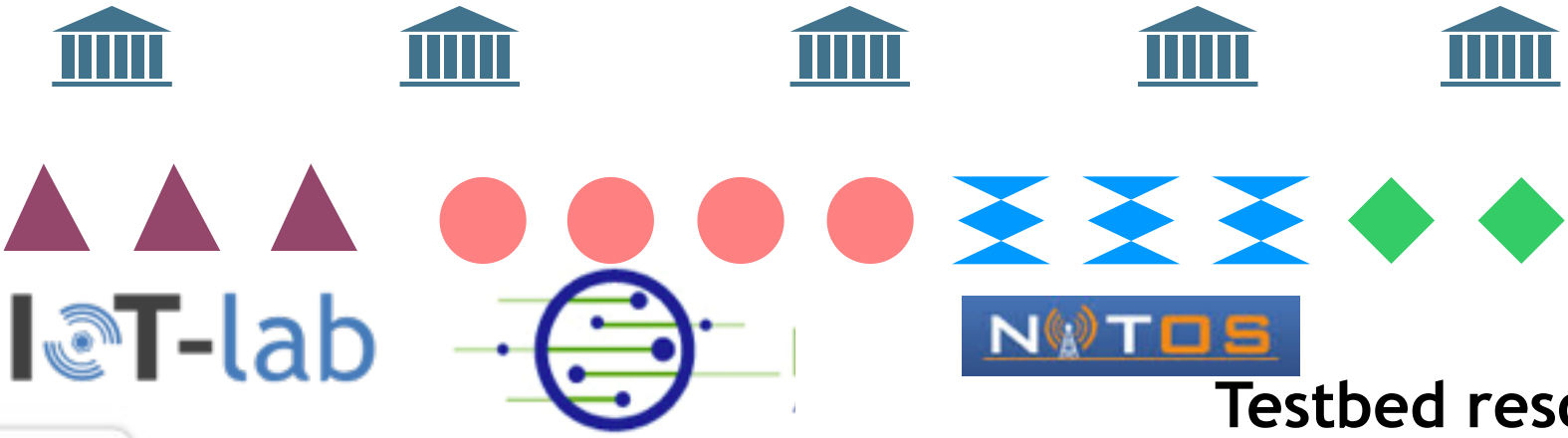
FIT IoT-lab

FIT EQUIPEX
Future Internet of Things - FRANCE

OneLab
FUTURE INTERNET TESTBEDS
onelab.eu

The issue with testbed isolation

Experimenters

compliant to SFA (Slice-Based Facility Architecture)

Common API

A secure and distributed thin waist

Testbed resources

How to run an experiment

1) Experiment configuration

2) Experiment results

Open systems
with IETF protocols
(RPL/COAP/6TiSCH/...)

How to run an experiment

▷ **Open a user account**

▷ **Ressources reservation**

   ▷ Geographical sites

   ▷ WSN430/M3/A8 nodes

▷ **Experimentation description**

   ▷ Firmware/nodes association

   ▷ Monitoring tuning

▷ **Experimentation launching**
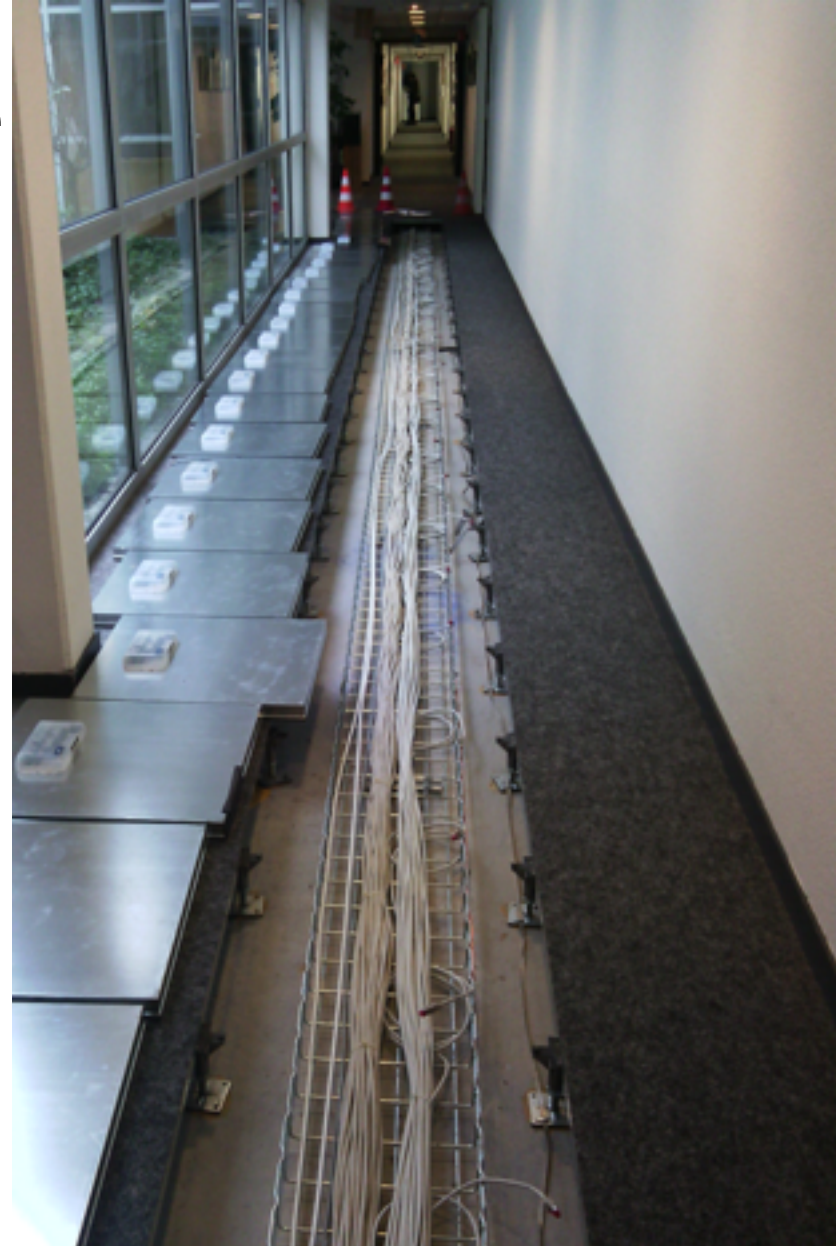
▷ **Monitoring data analysis**

3

IoT-LAB Inria Grenoble
IoT LAB Strasbourg Site

Demo

IoT LAB Inria Grenoble

- ▷ **256 WSN nodes**

- ▷ **200/384 M3 nodes**

- ▷ **256 A8 nodes**

- ▷ **32 Open nodes**

Contiki RPL IPv6 Experiment

Smart Tiles

for

Robots and Humans Detection

IoT LAB Strasbourg

- 256 WSN nodes

- 120 M3 nodes

- 25 A8 nodes

- 40 mobile nodes

Strasbourg

4

Conclusions

Time to use it !

▷ **Statistiques**

  ▷ more than 350 users registered
  ▷ in more than 45 countries
  ▷ 11K experiments launched

▷ **Futur development**

  ▷ Full iPv6 support end tho end
  ▷ Open robots

▷ **H2020 calls on IoT**

https://www.iot-lab.info

Huge collaborative and collective work

Strasbourg
- Guillaume Schreiner
- Erkan Valentin

Rocquencourt
- Ala-eddin Weslati
- Ichrak Amdouni
- Vincent Ladeveze

Lille
- Julien Vandaele
- Loic Schmidt
- Anne-Sophie Tonneau
- Raymond Borenstein

Grenoble
- Frédéric Saint-Marcel
- Roger Pissard-Gibollet
- Nicolas Turro
- Gaetan Harter
- Olivier Fambon
- Sandrine Avakian
- Fabien Vauvilliers
- Jean-Francois Cuniberto

- C. Chaudet, N. Mitton, T. Noel, C. Adjih, E. baccelli

https://www.iot-lab.info

For more information

- ▷ **I⌀T-lab**

  - ▷ **https://www.iot-lab.info**

    - ▷ **Wiki**: https://github.com/iot-lab/iot-lab/wiki
    - ▷ **Sources**: https://github.com/iot-lab/
    - ▷ **Issues**: https://github.com/iot-lab/iot-lab/issues
    - ▷ **Mailing-list**: users@iot-lab.info

- ▷ **OneLab** ══
  FUTURE INTERNET TESTBEDS

  - ▷ https://onelab.eu

- ▷ **HIKOB**
  LEARN FROM REALITY.

  - ▷ http://www.hikob.com