SensorLab2

In-the-field IoT Validation Platform

a look back

Early IoT years

- A typical experiment
  - few nodes
  - custom hardware
  - custom observation tools

before 2006

a look back

Large Scale Experiment platforms

- SensLab
  - up to 256 on-site nodes (multi-site)
  - custom hardware
  - custom monitoring / observation

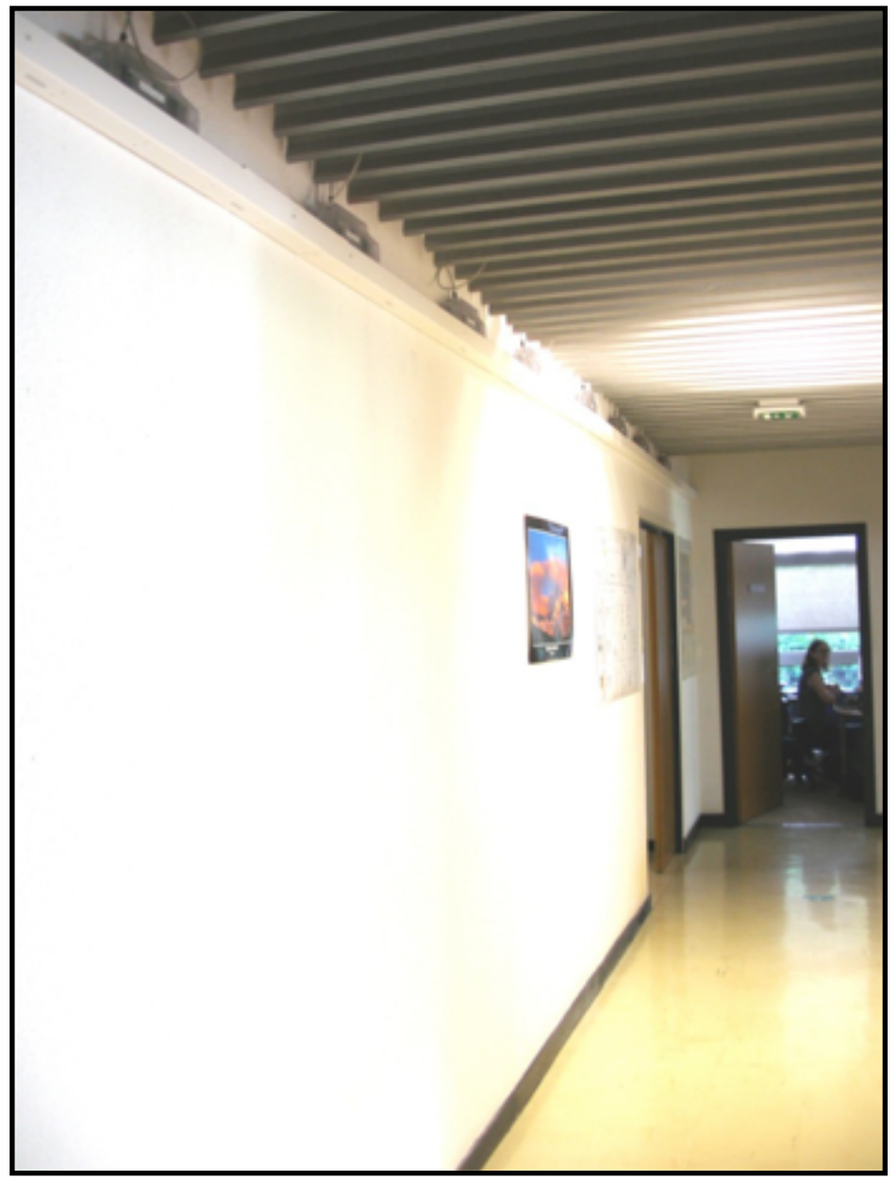
Strasbourg Testbed, SensLab

2006 around 2010

a look back

Large Scale Experiment platforms

- SensOrLab
  - 82 on-site nodes
  - custom hardware
  - generic monitoring / observation toolchain

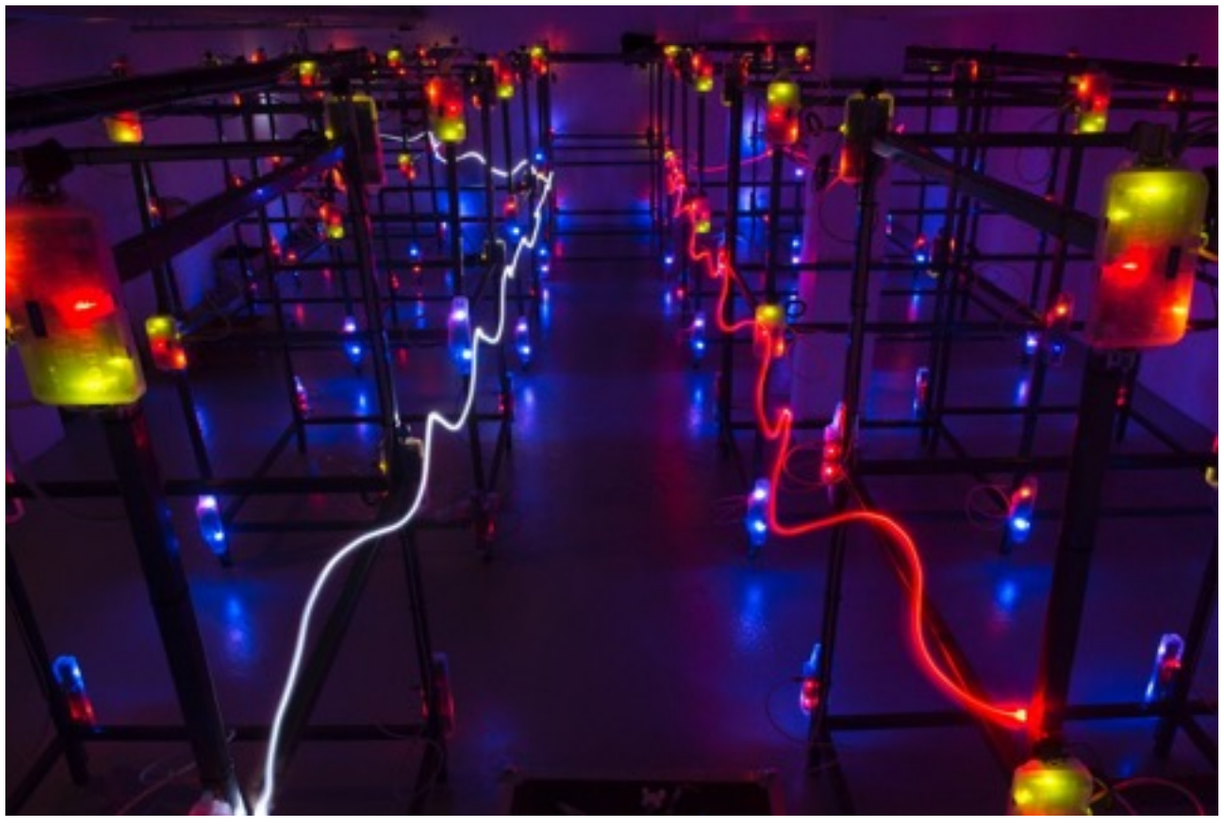


2006 2010 end of 2013

a look back

Large Scale Experiment platforms

- IoT-Lab
  - 2728 nodes
    multi-site, up to 928 on-site nodes
  - generic node interface
  - open hardware
  - custom monitoring / observation



Rocquencourt Testbed, Iot-Lab

2006 2010 2013 Today

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In-the-field Experimentation Platform

- Portable IoT validation platform
  - brief-case sized equipments
    - GPS positioning and sync.
    - WLAN / WAN backdoor connectivity
    - autonomous energy supply /w monitoring
  - generic node interface

    IoT-Lab M3 node, STM32 Nucleo /w LoRa radio, OpenMote… you name it!

Today

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Open Experimentation Platform

- Off-the-shelf equipment
  - Raspberry Pi 2 Model B
  - Raspberry compatible GPS shield (Adafruit Ultimate GPS Hat)
  - Generic USB Battery (Anker Astro 25600 mAh)
  - Generic 4G USB modem (Orange branded 4G+ dongle)

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Open Experimentation Platform

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approx. 200€

+ cost of node

Today

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Open Experimentation Platform

- Open Hardware

current monitoring circuit
—> CC-BY-SA 3

- Open Source Code

tools running on the Raspberry Pi 2
—> MPL (Mozilla Public License)

Wireshark dissector (more on that later on)
—> GPLv.2

- Open Specifications

SensorLab observation (more on that later on) specs —> CC-BY-SA 3

Today

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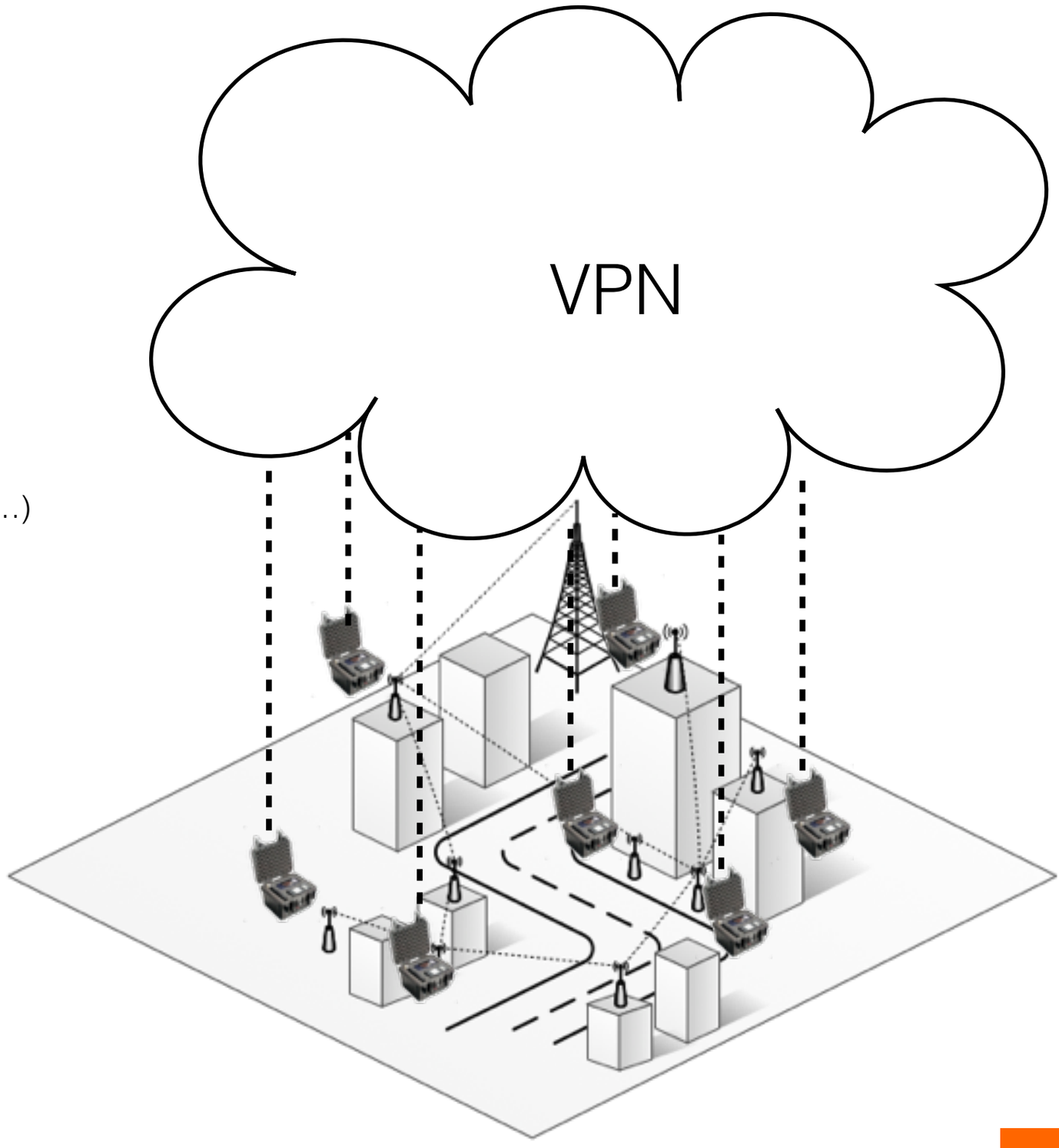
Platform architecture

- Easy to setup
  - setup a bridged VPN
  - flash RPis with provided µSD image
  - setup RPis to use the VPN
    —> emulates a Local Network
  - connect to the VPN (openvpn, tunnelblick, …)

Raspberry Pi 2 image & how-to provided
(no sweat required!)



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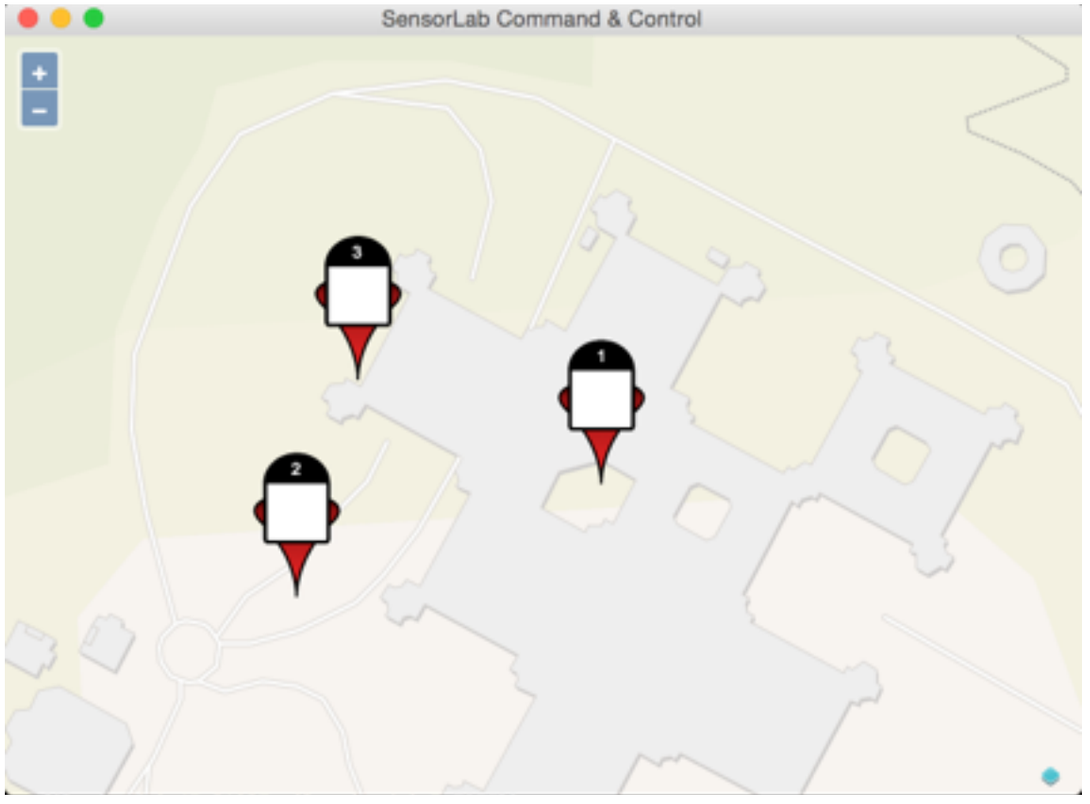
Platform architecture

- Easy to use
  - Observers (our software on the RPi) use Bonjour to advertise their services (REST API) fully-documented
  - python CLI module & GUI App. provided (SensorLab Command & Control)
    - setup & control nodes (flash/start/stop)
    - setup an experiment scenario (executed by the observer)
    - data & log collection

Today

```
→ manager-orange git:(master) ✗ python3
Python 3.4.3 (default, Mar 26 2015, 22:03:40)
[GCC 4.9.2] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> from manager import manager as m
>>> m.location_status()
Node n° 1: (Request code : 200)
        Latitude:       45.21026
        Longitude:      5.7955
Node n° 2: (Request code : 200)
        Latitude:       45.21
        Longitude:      5.7945
Node n° 3: (Request code : 200)
        Latitude:       45.2105
        Longitude:      5.7947

>>>
```



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Observation Toolchain

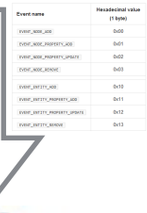
OR HOW NOT TO REINVENT THE WHEEL

- Full-featured
  - Ready to use event logging format
    fully documented & code provided
  - Automatic log time-stamping & re-ordering
  - Integration with well-known network tools
    Wireshark dissector provided
  - Human readable output, easy to parse
  - Output processable by SensorLab2
    Visualisation tools

Today

node

event logging format



time-stamping

observer

re-ordering

python App

debugging & analysis

WIRESHARK

SensorLab dissector

SensorLab2

Observation Toolchain

OR HOW NOT TO REINVENT THE WHEEL

- Principles

Describe nodes activity using the event logging format (logging library available for OpenWSN !)

- Declare entities & their properties
  e.g. RPL / DAGRank
- Declare entities relations
  e.g. 802.15.4 neighbour discovery /w address <hex address>
- Declare frames and TX / RX events
  e.g. RPL creates a frame of type DIO
- Notify properties updates
  e.g. RPL DAGRank updated to value 256

Today

```
void icmpv6rpl_init() {

   [.......]
   /* declare the ICMPv6 RPL entity along with 2 properties */
   observer_entity_add( COMPONENT_ICMPv6RPL, COMPONENT_NAME_ICMPv6RPL, 2);
   /* declare the IPv6 address property */
   observer_property_declaration_byte_array(
        PROPERTY_L3_NODE_ADDRESS,
        PROPERTY_NAME_L3_NODE_ADDRESS,
        16, dodagid
    );
   /* declare the DAGRank property */
   observer_property_declaration_uint16(
        PROPERTY_L3_NODE_DAGRANK,
        PROPERTY_NAME_L3_NODE_DAGRANK,
        PREFIX_NONE, UNIT_NONE, DEFAULTDAGRANK
   );
}

[.......]
void icmpv6rpl_receive(OpenQueueEntry_t* msg) {

   [.......]
   switch (icmpv6code) {

      case IANA_ICMPv6_RPL_DIO:
         /* add a type property to the received frame */
         owsn_observer_frame_property_add(msg, 1);
         observer_property_declaration_ASCII_array(
            PROPERTY_L3_FRAME_TYPE, PROPERTY_NAME_L3_FRAME_TYPE,
            strlen(PROPERTY_NAME_L3_FRAME_TYPE_DIO),
            PROPERTY_NAME_L3_FRAME_TYPE_DIO
         );
         [.......]
   }
   [.......]
   /* frame has been handled, declare its consumption */
   observer_frame_consume(
       COMPONENT_ICMPv6RPL,
       msg->id, msg->length, msg->payload
   );
   openqueue_freePacketBuffer(msg);
}
```

Code excerpt from icmpv6rpl.c, OpenWSN

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Observation Toolchain

OR HOW NOT TO REINVENT THE WHEEL

- Benefits

Fully generic

- Stack instrumentation in a breeze
  (working on the mbed LoRa stack as we speak)

No recoding of the debugging / observation tools

- SensorLab2 dissector & visualisation tools already know how to handle your new protocol

Today

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15:14:28.963235	1	NodeAdd	[Node 1]
15:14:45.825414	1	EntityAdd	[Node 1](IEEE 802.15.4 radio) <osi_lev
15:14:45.843309	1	EntityAdd	[Node 1](IEEE 802.15.4e) <osi_level: 2
15:14:45.873449	1	EntityAdd	[Node 1](6TOP) <osi_level: 2.500000>
15:14:45.890529	1	EntityAdd	[Node 1](IPHC) <osi_level: 2.750000>
15:14:45.901297	1	EntityAdd	[Node 1](IETF RPL) <osi_level: 3.0000
15:14:45.902411	1	EntityAdd	[Node 1](UDP)
15:14:45.906914	1	EntityAdd	[Node 1](COAP) <osi_level: 7.000000>
15:14:48.735387	1	FrameRX	[Node 1](IEEE 802.15.4 radio) :: 00:ea
15:14:48.742975	1	FrameUpdate	[Node 1](IEEE 802.15.4e) link: <type: c
15:14:48.762458	1	FrameUpdate	[Node 1](IEEE 802.15.4e) link: <absolu
15:14:48.771885	1	LinkAdd	[Node 1](IEEE 802.15.4 radio) target: <
15:14:48.830501	1	LinkAdd	[Node 1](IEEE 802.15.4e) target: <add
15:14:48.881770	1	LinkAdd	[Node 1](IETF RPL) target: <address (
15:14:48.890559	1	FrameConsume	[Node 1](6TOP) :: <no data>
15:14:52.381947	1	FrameRX	[Node 1](IEEE 802.15.4 radio) :: 01:e8
15:14:52.402339	1	FrameUpdate	[Node 1](IEEE 802.15.4e) link: <type: c
15:14:52.405874	1	LinkUpdate	[Node 1](IEEE 802.15.4 radio) link: <R
15:14:52.409659	1	LinkUpdate	[Node 1](IEEE 802.15.4e) link: <link sta
15:14:52.432241	1	FrameUpdate	[Node 1](IPHC) :: 9b:01:ad:f5:00:00:01
15:14:52.437595	1	FrameUpdate	[Node 1](IETF RPL) :: 9b:01:ad:f5:00:0
15:14:52.456696	1	FrameUpdate	[Node 1](IETF RPL) :: 00:00:01:00:88:3
15:14:52.459530	1	FrameUpdate	[Node 1](IETF RPL) link: <type: DIO>
15:14:52.466626	1	LinkUpdate	[Node 1](IETF RPL) link: <neighbor DA
15:14:52.468759	1	EntityUpdate	[Node 1](IETF RPL) <DAG rank: 7936>
15:14:52.481735	1	FrameConsume	[Node 1](IETF RPL) :: 00:00:00:01:88:3
15:14:56.273405	1	FrameProduce	[Node 1](IETF RPL) :: 9b:01:05:c5:00:0
15:14:56.286191	1	FrameUpdate	[Node 1](IETF RPL) :: 9b:01:05:c5:00:0
15:14:56.294042	1	FrameUpdate	[Node 1](IPHC) :: 78:3b:3a:40:1a:9b:01
15:14:56.348888	1	FrameTX	[Node 1](IEEE 802.15.4 radio) :: 01:e8
15:15:02.652411	1	FrameRX	[Node 1](IEEE 802.15.4 radio) :: 01:e8
15:15:02.670907	1	FrameUpdate	[Node 1](IEEE 802.15.4e) link: <type: c
15:15:02.673193	1	LinkUpdate	[Node 1](IEEE 802.15.4 radio) link: <R
15:15:02.685461	1	LinkUpdate	[Node 1](IEEE 802.15.4e) link: <link sta
15:15:02.698976	1	FrameUpdate	[Node 1](IPHC) :: 9b:01:ad:f5:00:00:01
15:15:02.714841	1	FrameUpdate	[Node 1](IETF RPL) :: 9b:01:ad:f5:00:0
15:15:02.727960	1	FrameUpdate	[Node 1](IETF RPL) :: 00:00:01:00:88:3
15:15:02.740864	1	FrameUpdate	[Node 1](IETF RPL) link: <type: DIO>
15:15:02.753531	1	LinkUpdate	[Node 1](IETF RPL) link: <neighbor DA
15:15:02.756007	1	EntityUpdate	[Node 1](IETF RPL) <DAG rank: 7936>

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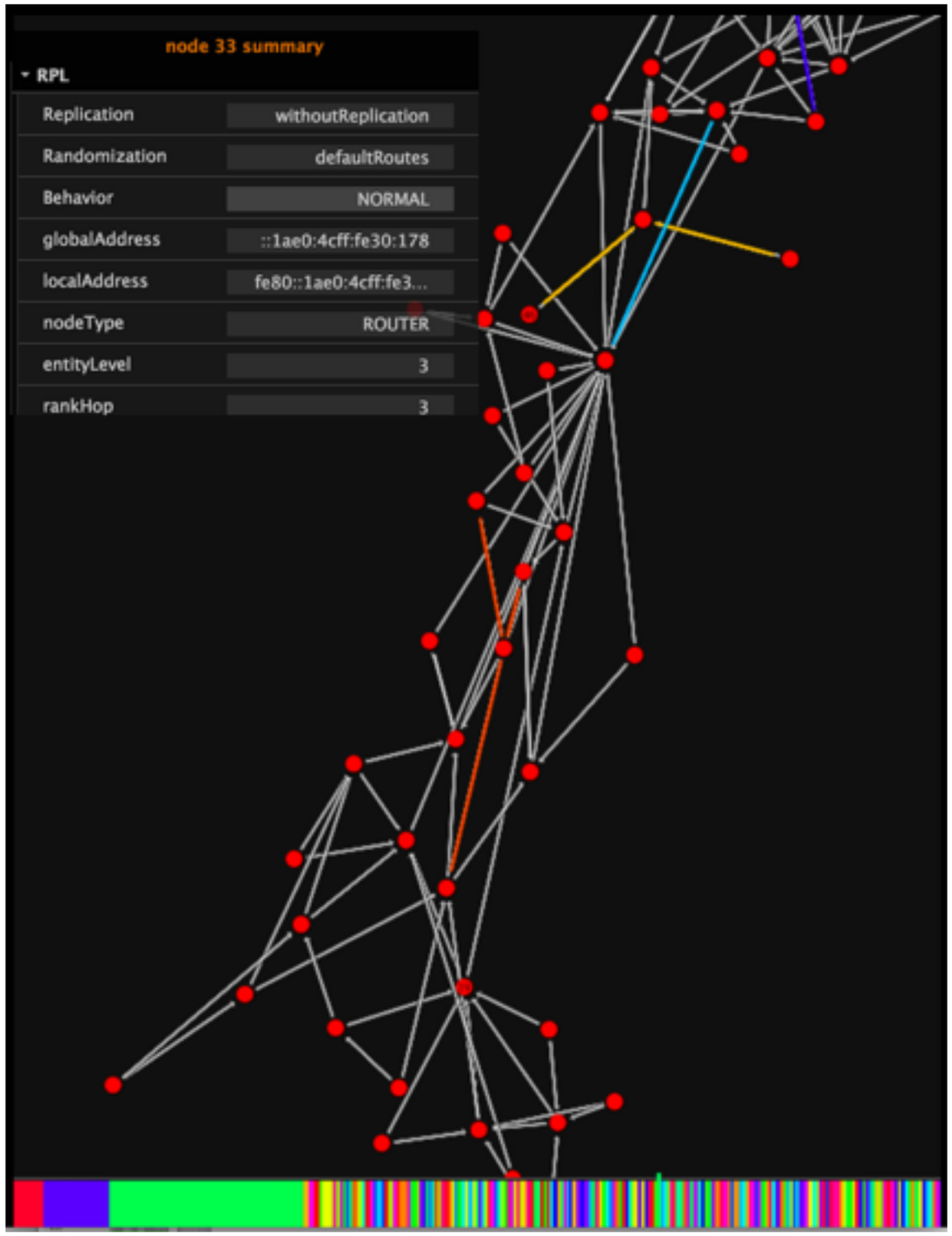

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Today

The Way forward

Observation Toolchain on IoT-Lab ?

Little modification required

- Time-stamping, PCAP encapsulation at the gateway

Benefits

- Same tools for both platforms !

The Way forward

Build your very own SensorLab2…

Experiment In-the-Field

- share results, discoveries, improvements !

And join us in collaborative projects

We’re open to collaborations (ANR, European Projects, etc). Don’t hesitate to contact us!

(quentin.lampin@orange.com, dominique.barthel@orange.com)

Demo

SensorLab2

The way forward

Thank you

The way forward