

A glimpse of neCCampus

Facts and lessons learned

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Edge Computing



AIoT

towards the next level

D
A
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A

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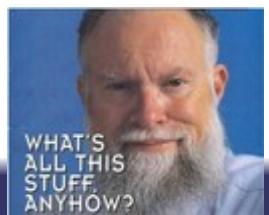
neCCampus



What's all this IoT stuff, Anyhow* ?

- [Foreword] the painful way to deploy connected objects,
- Where is my Data ??
- neOCampus,
- What's next ?

* Remember Ti's great analog engineer, Bob Pease



WHAT'S
ALL THIS
STUFF
ANYHOW?

Foreword

The painful way to deploy connected objects ...

➡ Connected objects need:

- Power



... solar panel,
RF energy harvesting,
Temp. gradient ...

- Network



WiFi



Bluetooth



Zigbee



LPWAN

- Infrastructure



AWS IoT



OVH.com



yours





Foreword

* Connected objects deployment : the manager's vision ...



- (1) you **buy** (\$\$) a sensor,
- (2) you plug,
- (3) it works !

...

- ...
- (4) \$ renewal / maintenance
- (5) \$ renewal / maintenance

etc etc ...



*LPWAN
subscription*



*Subscription
renewal &
maintenance*



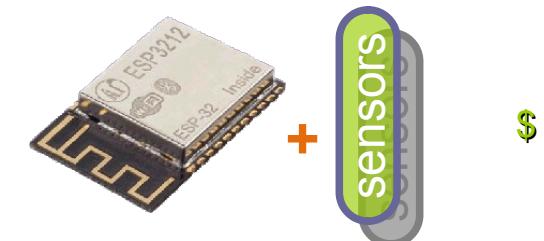
It \$\$\$ a lot, that's normal ... maybe not !

≡ \$\$\$\$\$...

Foreword

* *Connected objects deployment : the researcher's vision ...*

- (1) power is everywhere and costs nothing (!),
- (2) network ... hey, it's already there :)
- (3) you buy cheap components (from far far away),
- (4) you build your cheap wonderful sensor,
... it works ...
... but ...



You just forgot the most important thing ...

= di\$a\$ter..

Foreword

... the uttermost ingredient you need is ... TRUST!

YOU 

Managers don't care about how cheap your sensor is
... they're accustomed to tenths of millions Euro budgets,

they want:
- availability,
- maintenance,
- certifications,
- ...



.. just in case of an unexpected event ...

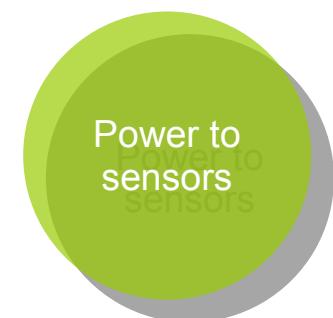
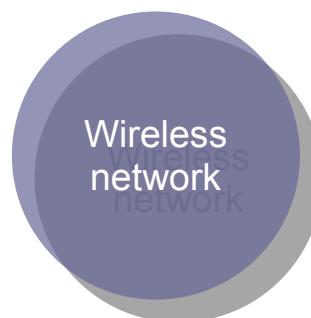
Circle of
TRUST*

** Meet the Parents ;)*

Foreword

The painful way to deploy connected objects ...

- ▶ How can our sensors escape our labs ?



[> 6 months] IoT vlan + 1st switch

[> 2 years] spreading across the campus.

Fails to deploy @ BU ...



... but DC network @ MRL



... future LMDC renewal





Plan

- [Foreword] the painful way to deploy connected objects,
- Where is my Data ??
- neOCampus,
- What's next ?

Where's my Data* ?

* ... probably the first question you'll get asked ...

▶ OK, you finally convinced someone about your cheap, neat and wonderful sensor ...

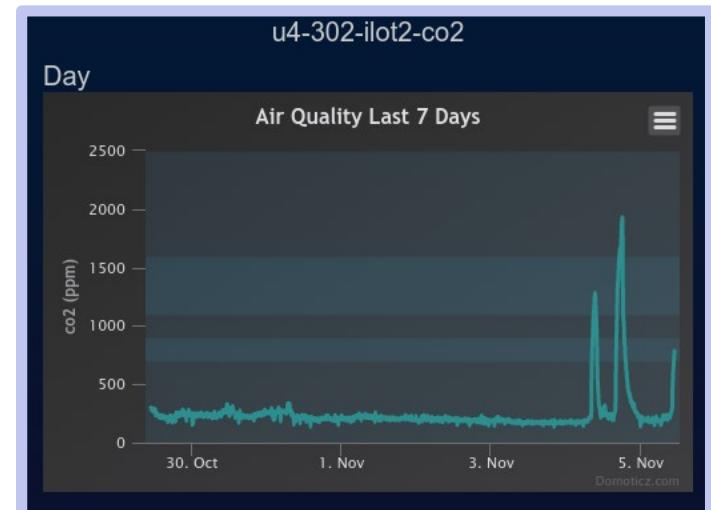
... they accepted to give it a try ...

... you found power and network ...

... but now ... they want to **see** the data !



a *HUGE* gap !!

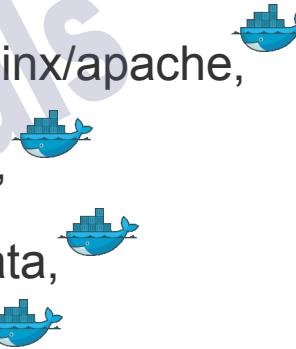


Where's my Data ?

* now you try bridging such gap via different paths:

[1] the Jedi way ...

- A fully featured Linux server with nginx/apache,
- A broker (**MQTT**) to collect the data,
- A database to store the collected data,
- A web application to **see** the data !



@neOCampus

2 years

... with a lot of background
in Linux system, network,
web server, databases,
containers, ...

[2] the lazy (right?) way ...

- **\$\$** to rent an IoT server,
- Configuration of existing tools,
- It works !

Plan

- [Foreword] the painful way to deploy connected objects,
- Where is my Data ??
- neOCampus,
- What's next ?



- 2013, June, kick-off,
- ECO-CAMPUS Toulouse,
- B. Monthubert President



- Well-being for users in the university community,
- Improvement of the ecological footprint of our buildings,
- Reduction of operating costs, especially for fluids.



- Buildings ~ 407 000 m²,
- People ~ 36 000

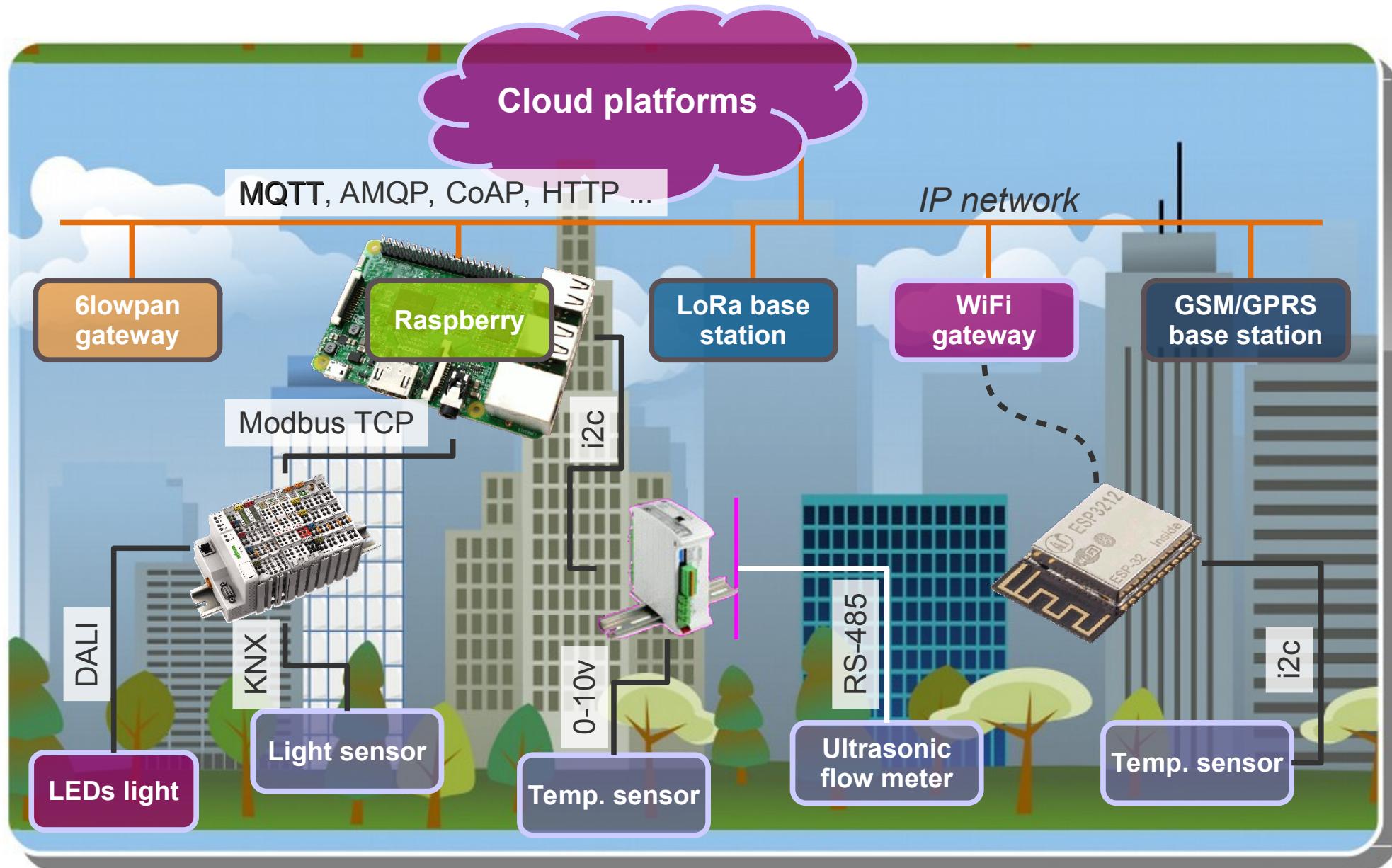


Our campus is a small-sized town like Périgueux.

B. Monthubert

... toward Smart Cities

IP network
Gateway
Concentrator
Sensor / Actuator



RPi auto deploy & update

- Network automated install and configuration of our Raspberry Pi(s) :)



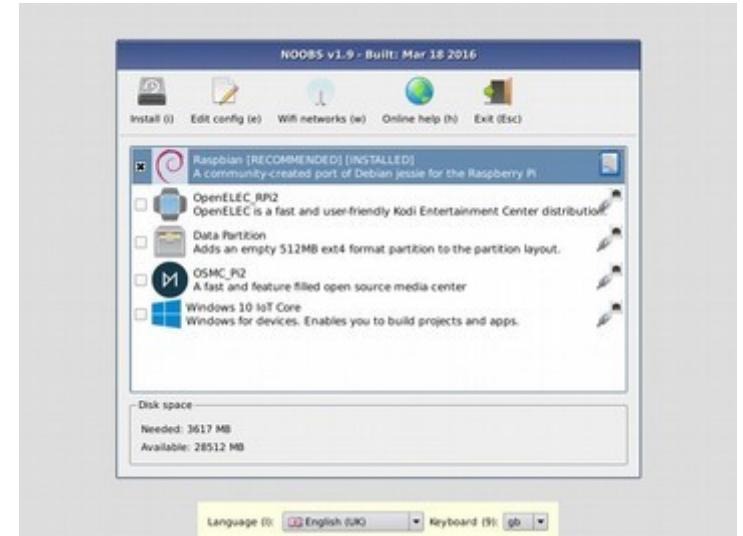
- ✓ FAT32 formatted SDCard
- ✓ Unzip <http://neocampus.univ-tlse3.fr/images/noobs.zip>
(custom NOOBS tailored to suit our needs)



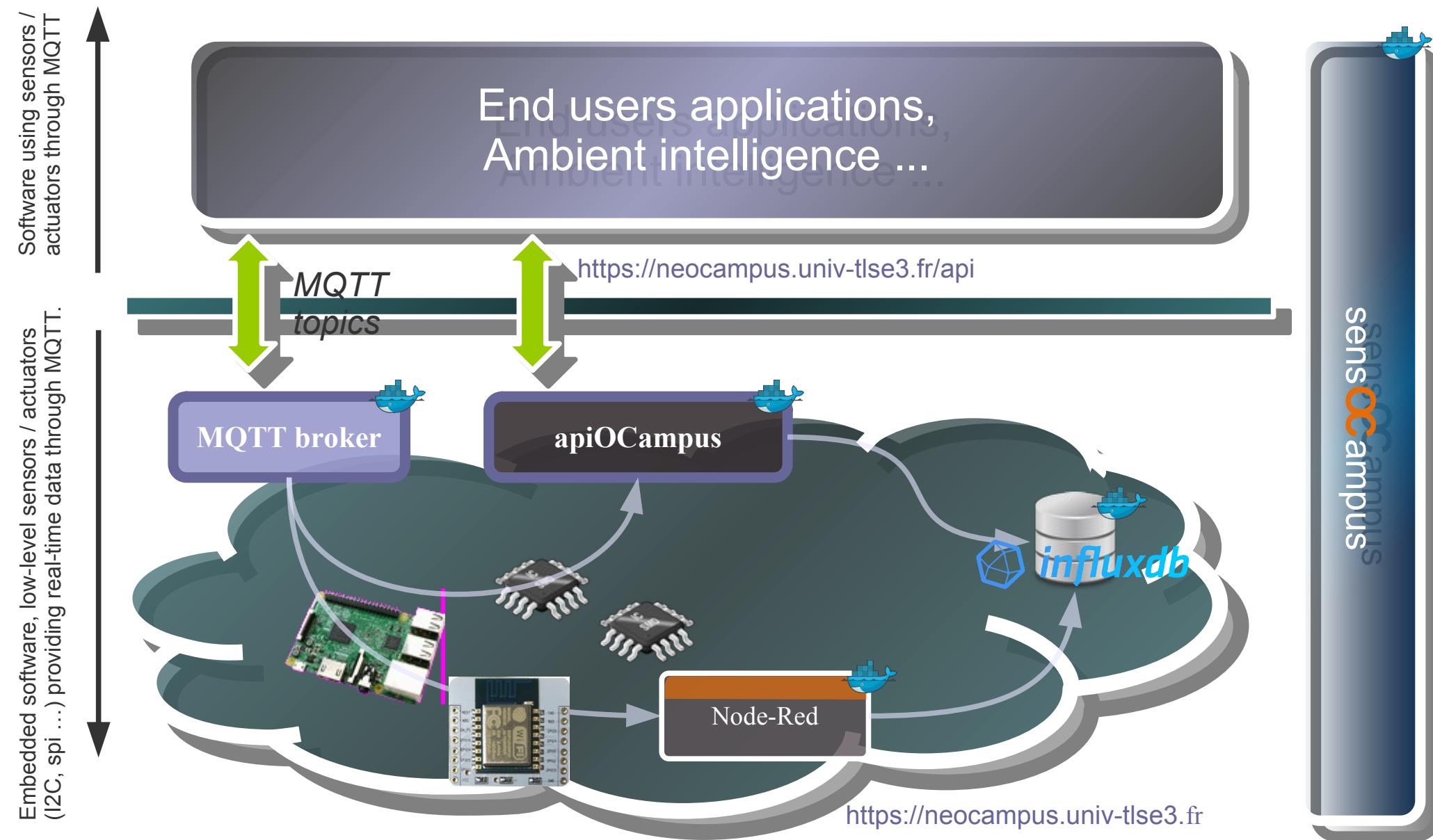
DHCP

neocampus.univ-tlse3.fr

- ✓ Download & install latest neOCampus-Raspbian
- ✓ Git retrieval of fully automated setup of the OS & application to deploy.
+ works at home (depends on your internet provider)

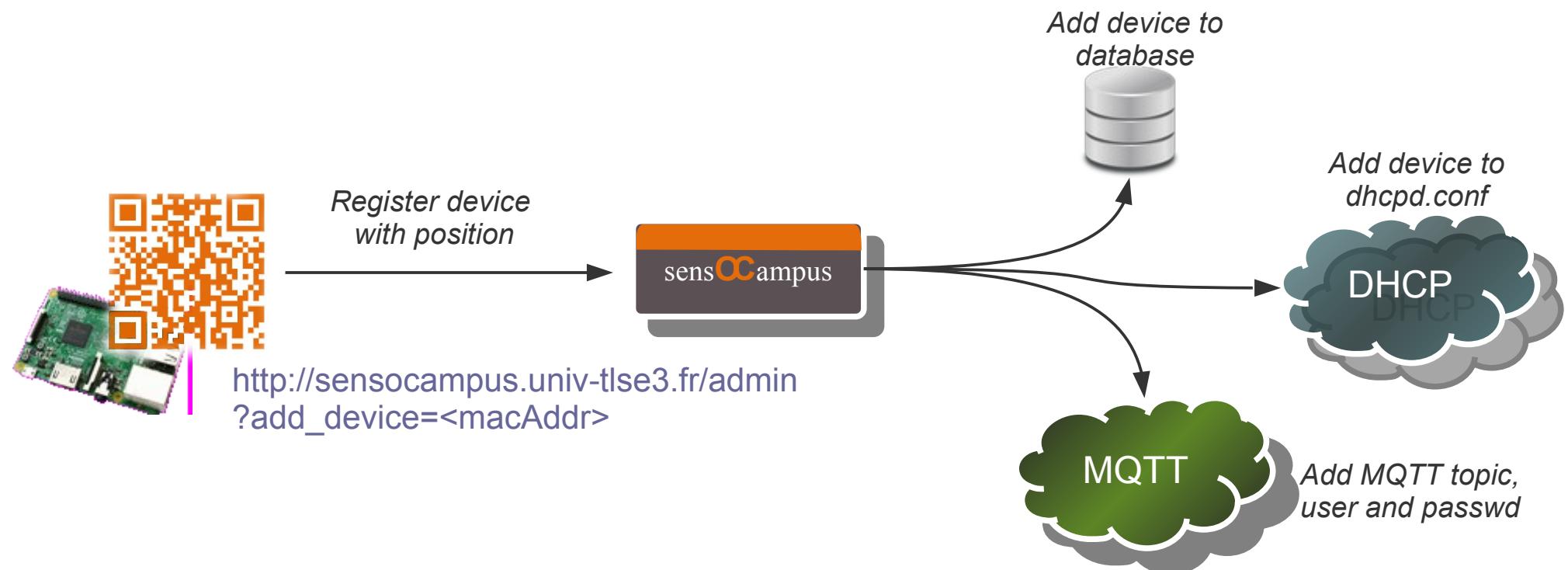


Network automated installation of our customized Raspbian has been successfully tested on RPi, RPi2 and RPi3 :)

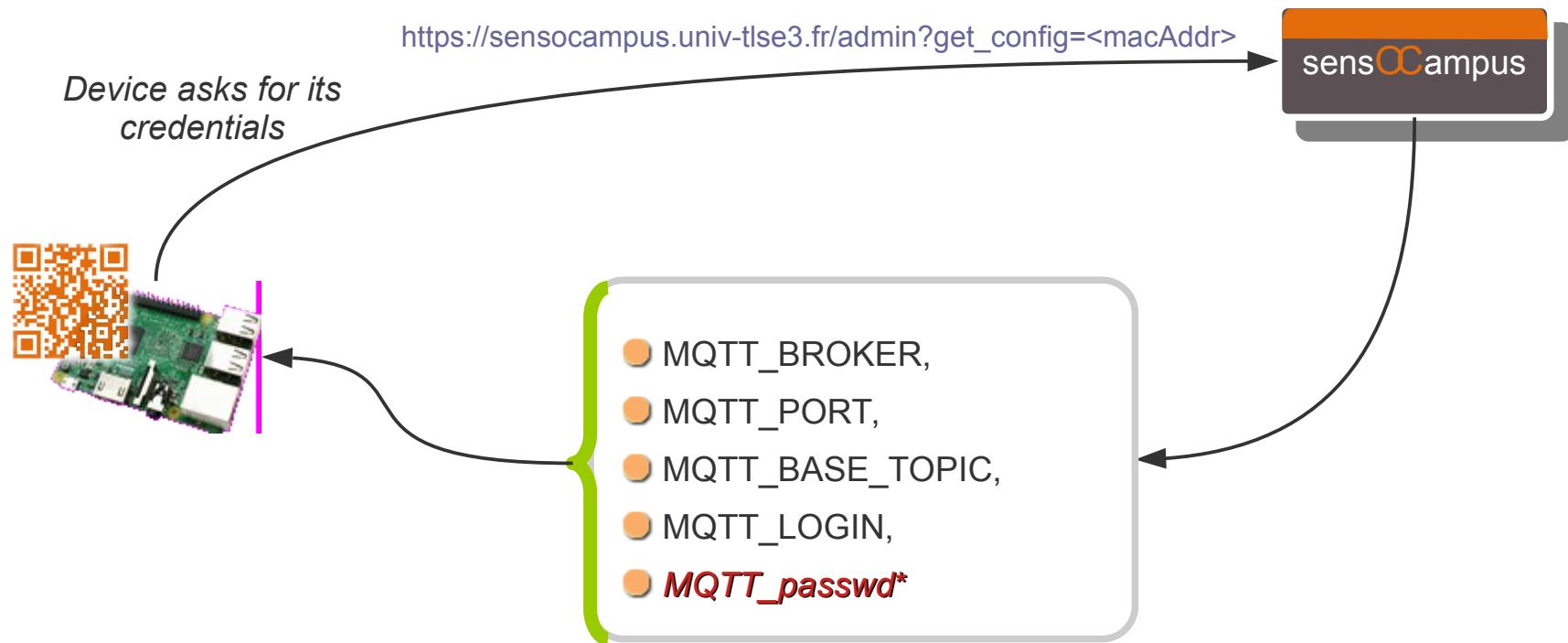


- Device registration | sensOCampus web. App. (Django)

A **device** is a physical embedded system connected to a network
(eg. Raspberry Pi, esp8266, stm32 ...).



- ... then registered device fetches its configuration from sensOCampus

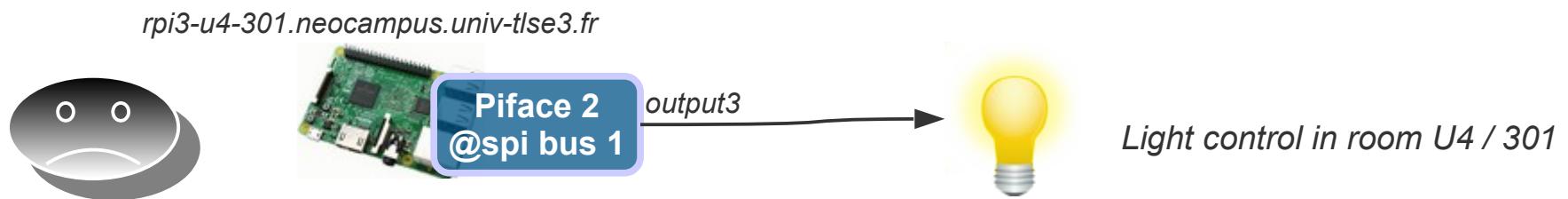


Minimum configuration sent from sensOCampus to a device

*MQTT passwd is only sent on **first call** (admin action required to create a new one otherwise)

- neOCampus gives users / applications access to useful data without hassle about networks, sensors technology or underlying embedded systems.

- ✗ High level of hardware details



- ✓ Useful data

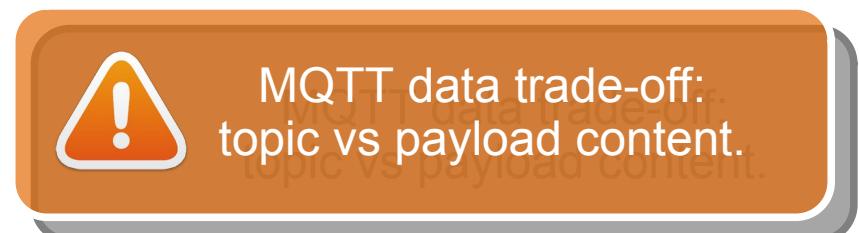




Data acquisition

- **MQTT**, almost the ‘de facto’ IoT protocol ;)

- Network addressing independent,
- Works behind firewalls,
- publish / subscribe paradigm (no more pooling),
- embedded security (login / passwd) + TLS,
- Support for WebSockets,
- Bindings for almost all languages,
- Paho-mqtt (python client), Mosquitto (C written client & server),
- MQTT bridges for multiples brokers setup,
- Topics based real-time exchanges,
- Topics are arbitrary tokens separated with ‘/’
- Payload agnostic (mainly json).



You may also have a look to AMQP (e.g RabbitMQ) or CoAP (Constrained Application Protocol)
Adafruit provides a free MQTT broker with a data visualisation GUI on a per-user basis.

Data acquisition

- Topics segmentation in neOCampus



Base : defined at device registration time according to location

e.g `u4 / 300` or `bu / hall ...`

Type : kind of sensor / actuator (module) defined by sensOCampus or automatically detected

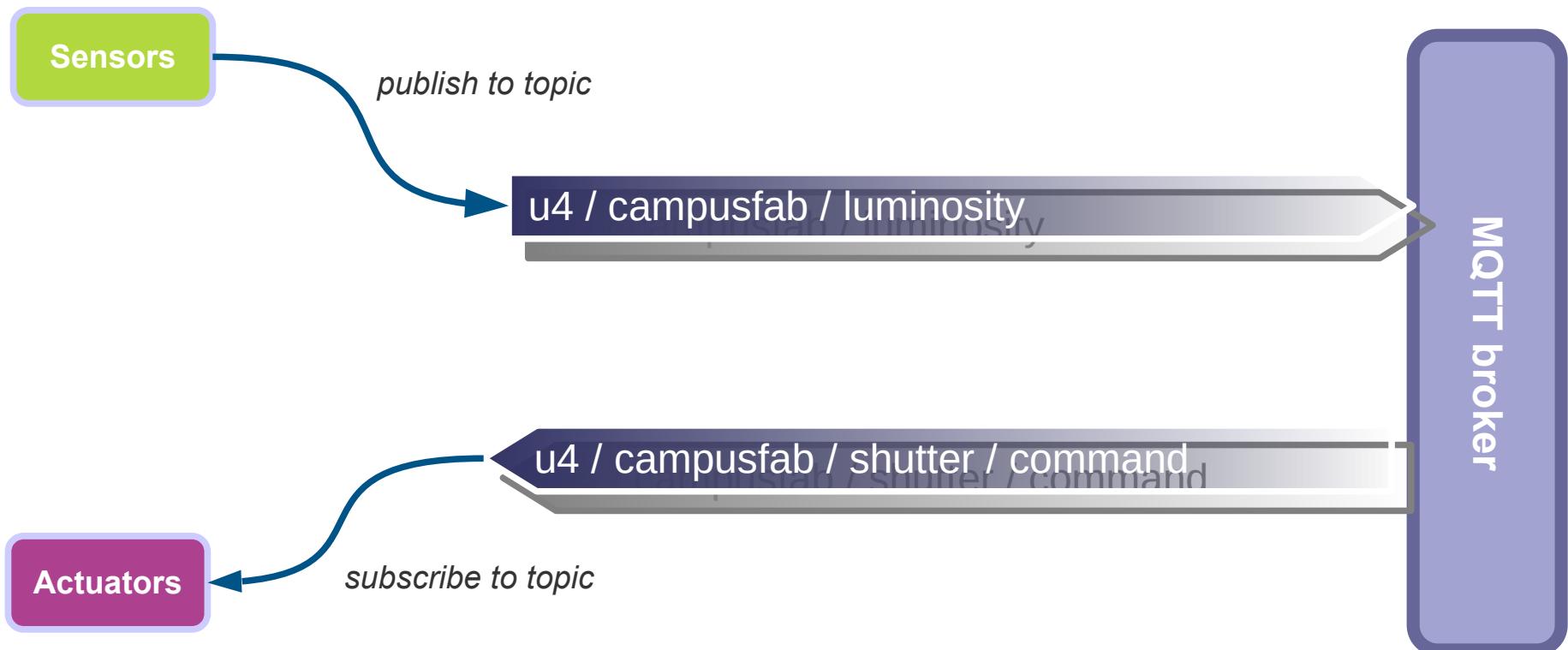
e.g `shutter, luminosity, temperature, sound, lighting ...`

Command : to send orders to a sensor / actuator (module)

e.g `orders to shutter like UP, STOP, DOWN`

Data acquisition

- Real-time data exchange through topics



Since actuators initiate a TCP connection to the broker, they can be sent data back from the broker even when they are located behind a firewall (e.g Internet box).

Data acquisition

MQTT payloads @ neOCampus

- ✓ Sending order to a shutter (with proper mqtt login / passwd)

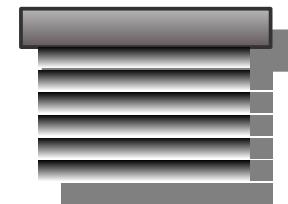
```
order: "up"  
dest: "all"  
or "<shutter_ID>"
```

Json frame as mqtt payload



u4 / campusfab / shutter / command

Shutter



- ✓ ... then shutter publish its status back

```
order: "idle"  
unitID: "<shutter_ID>"  
status: "open"
```

Json frame as mqtt payload



u4 / campusfab / shutter

One caveat is that you can't send an order to a single module (shutter), hence the dest field.

Data acquisition

- Wildcards for multi-topics subscribing

u4 / # / temperature

multi-level subscribing (e.g u4 / campusfab / temperature, u4 / hall / box1 / temperature)

u4 / + / temperature

single-level subscribing (e.g u4 / campusfab / temperature, u4 / 301 / temperature)

- Single topic publishing



MQTT specifications does not allow to publish to topics containing wildcards.

The multiple method enables you to publish multiple data to multiple topics in a one-shot way.



Flow processing

● Node-RED

IBM open-source technology preview,

NodeJS written,

Will glue IoT elements together (e.g connecting IFTTT to MQTT, Amazon Echo to Domoticz etc etc).

Open-source,

Large range of inputs / outputs (MQTT, HTTP, TCP, UDP, LoRa),

... lots of functions (nodes) for storage (MongoDB, files), javascript user code, email, social networks ... ,

Custom dashboards :) → <https://neocampus.univ-tlse3.fr/nodered/ui>

Docker available

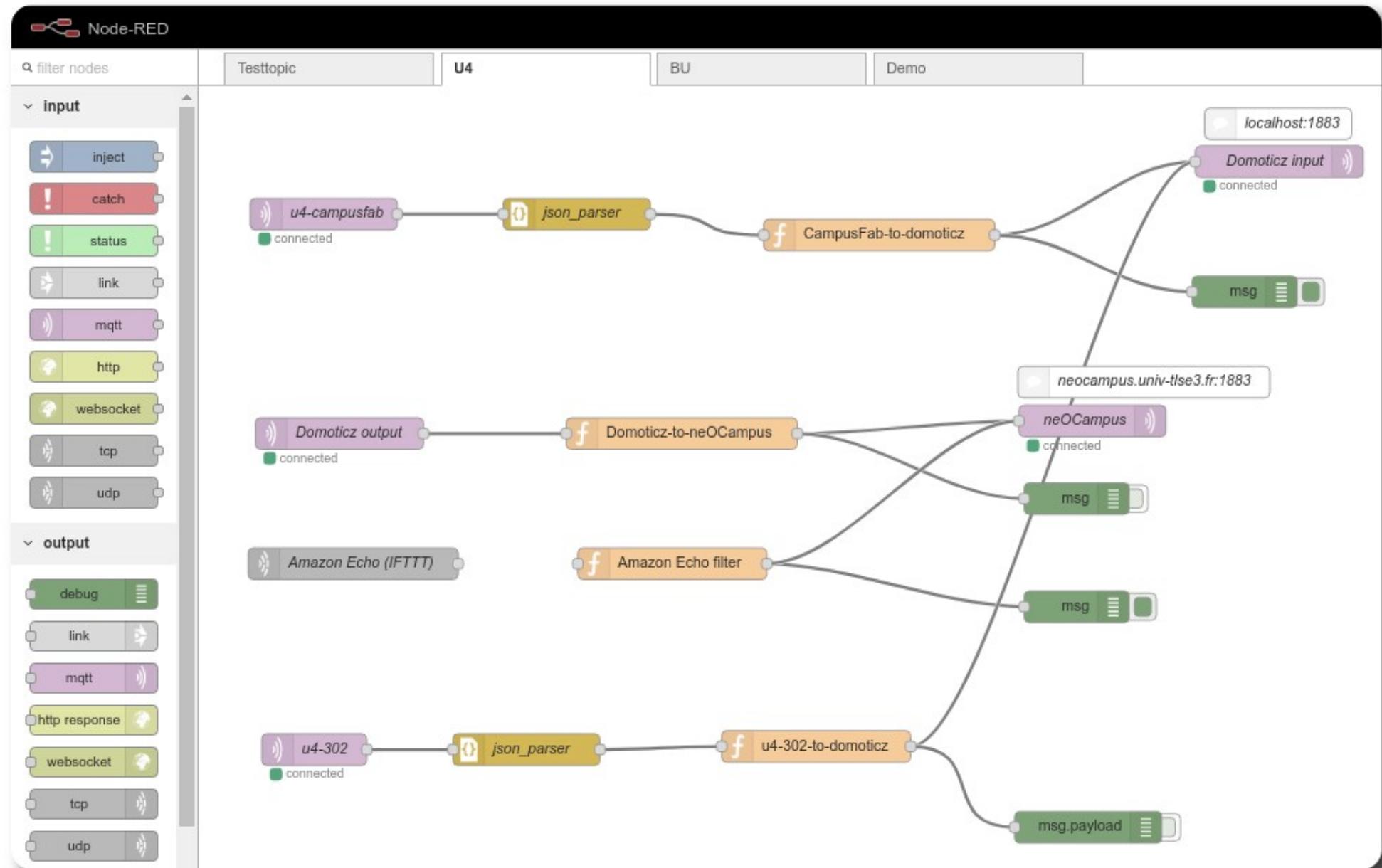
Server-side execution of scripts (!),

No per-user flows.

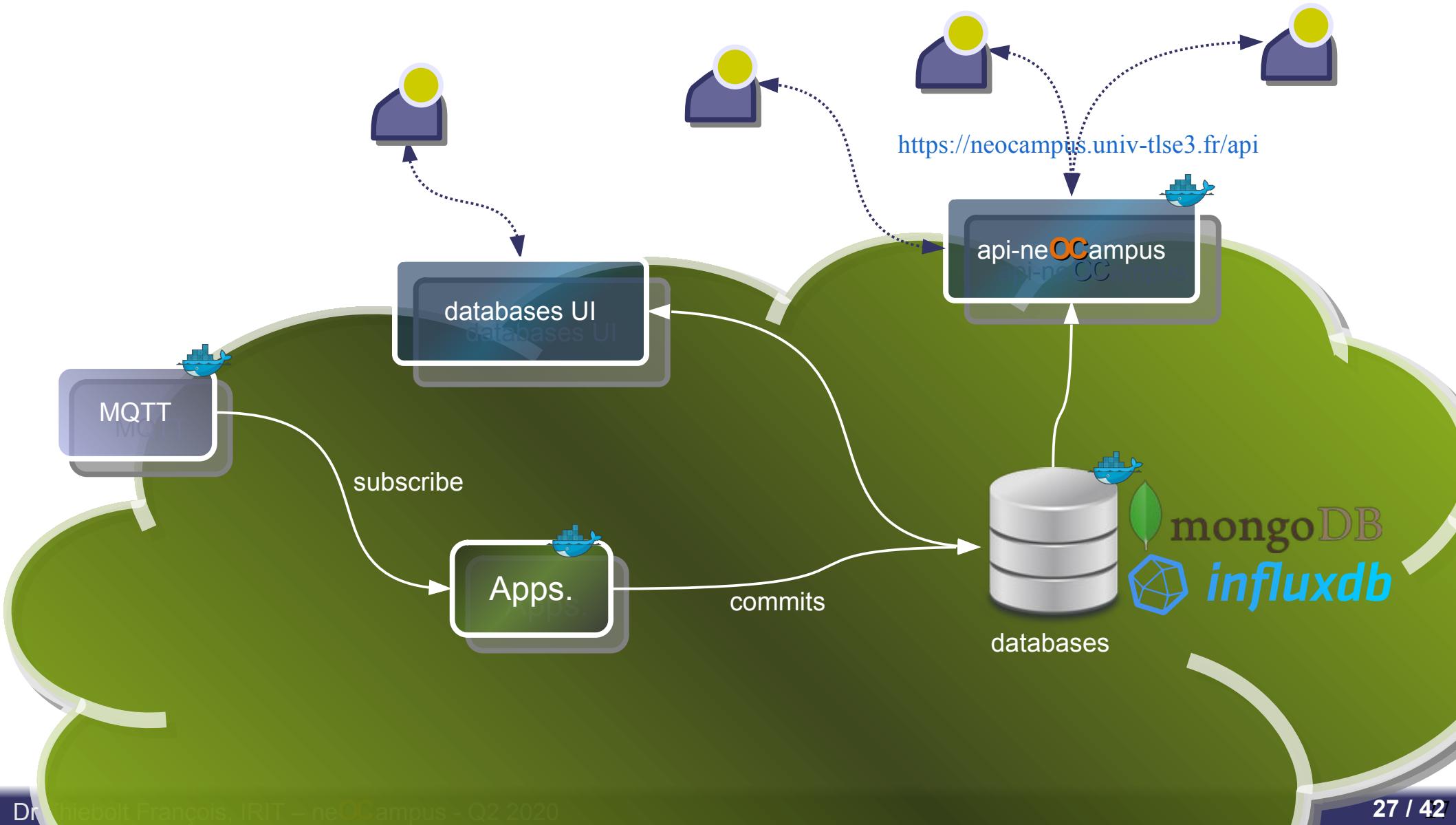
You may also have a look to IFTTT (i.e If This Then That)



Flow processing



Data storage & access





Presentation

● Domoticz

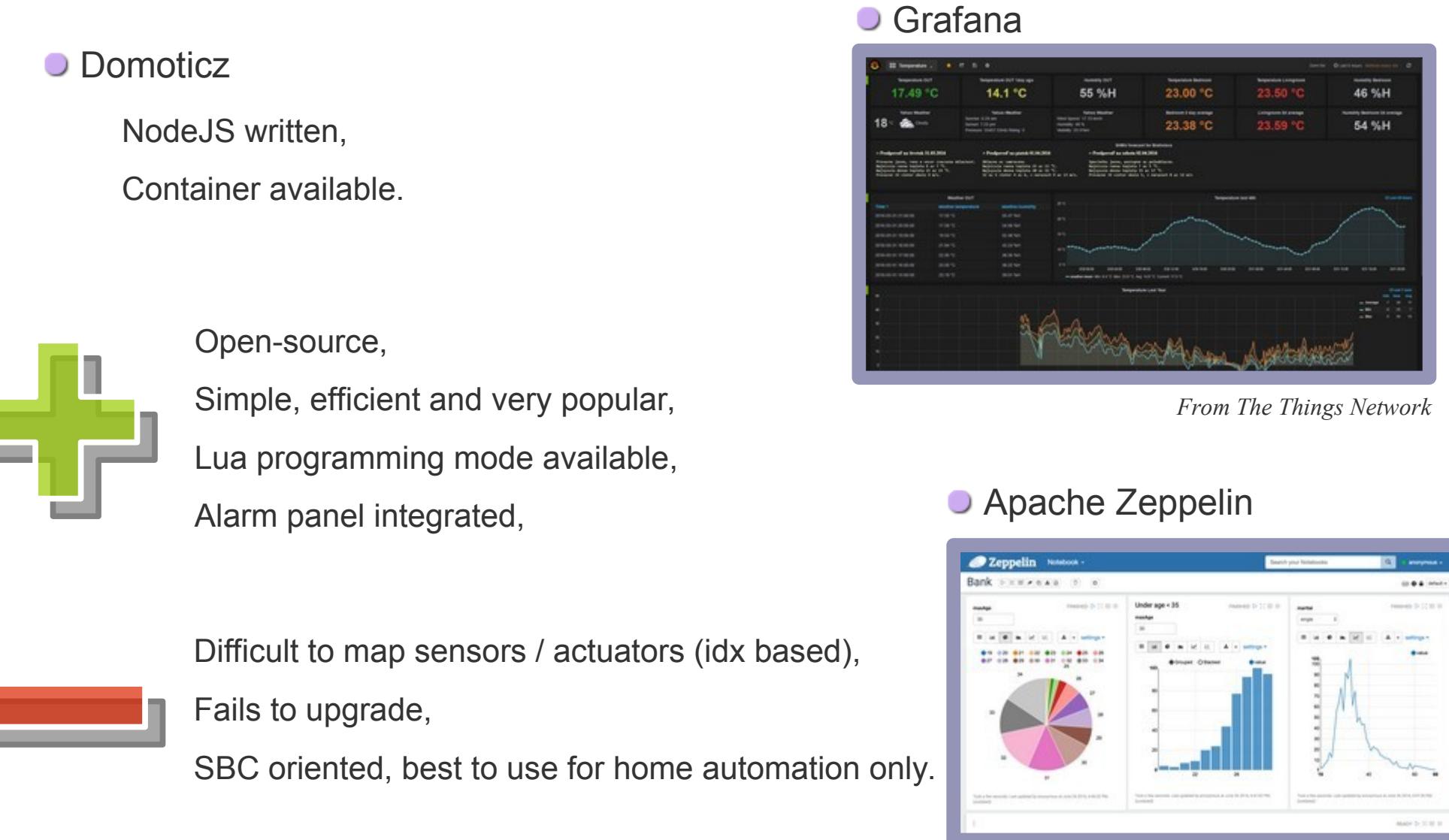
NodeJS written,
Container available.



Open-source,
Simple, efficient and very popular,
Lua programming mode available,
Alarm panel integrated,

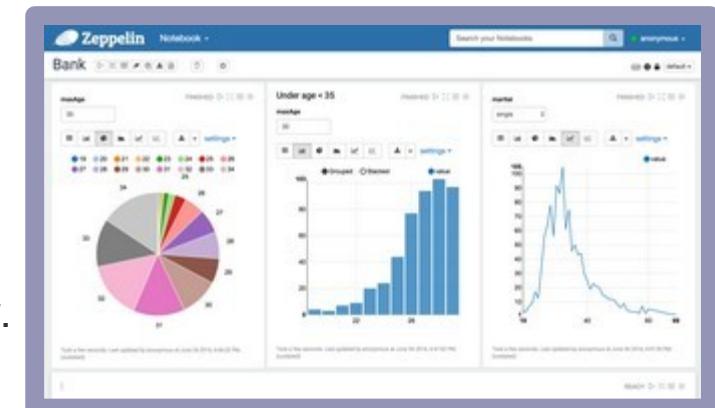


Difficult to map sensors / actuators (idx based),
Fails to upgrade,
SBC oriented, best to use for home automation only.



From The Things Network

● Apache Zeppelin



You may also have a look to EmonCMS, OpenHAB and Grafana.



Presentation

Domoticz v2.6802

2017-09-11 15:10:22 ▲07:30 ▼20:10

Light/Switch Devices:

- CampusFab lighting **Off**
Last Seen: 2017-08-01 11:54:54
- neOCampusDemo light
Last Seen: 2017-09-04 11:54:54

Temperature Sensors:

- CampusFab temperature **27.375°C**
Last Seen: 2017-09-11 15:09:30
- neoCampusDemo temp
Last Seen: 2017-09-11 11:54:54

Utility Sensors:

- CampusFab luminosity **456 Lux**
456 Lux
Last Seen: 2017-09-11 15:10:14
- neoCampusDemo lux
1 Lux
Last Seen: 2017-09-11 11:54:54
- u4-302-ilot1-presence
clear zone :)
Last Seen: 2017-09-11 15:02:50
- u4-302-ilot2-presence
clear zone :)
Last Seen: 2017-09-11 11:54:54
- neOCampusDemo presence
ALERT INTRUSION!
Last Seen: 2017-09-11 15:10:20
- neOCampusDemo voltage
234.810 V
Last Seen: 2017-09-11 11:54:54

Day

Lux Last 7 Days

Month

Lux Last Month

Year

Lux Last Year

Back

Logout

Dashboard Floorplan Switches Scenes Temperature Weather Utility



Ambient applications

- Ambient intelligence ...

Ambient systems are not a collection of technological objects that communicate but a multidisciplinary, user-centred, approach.

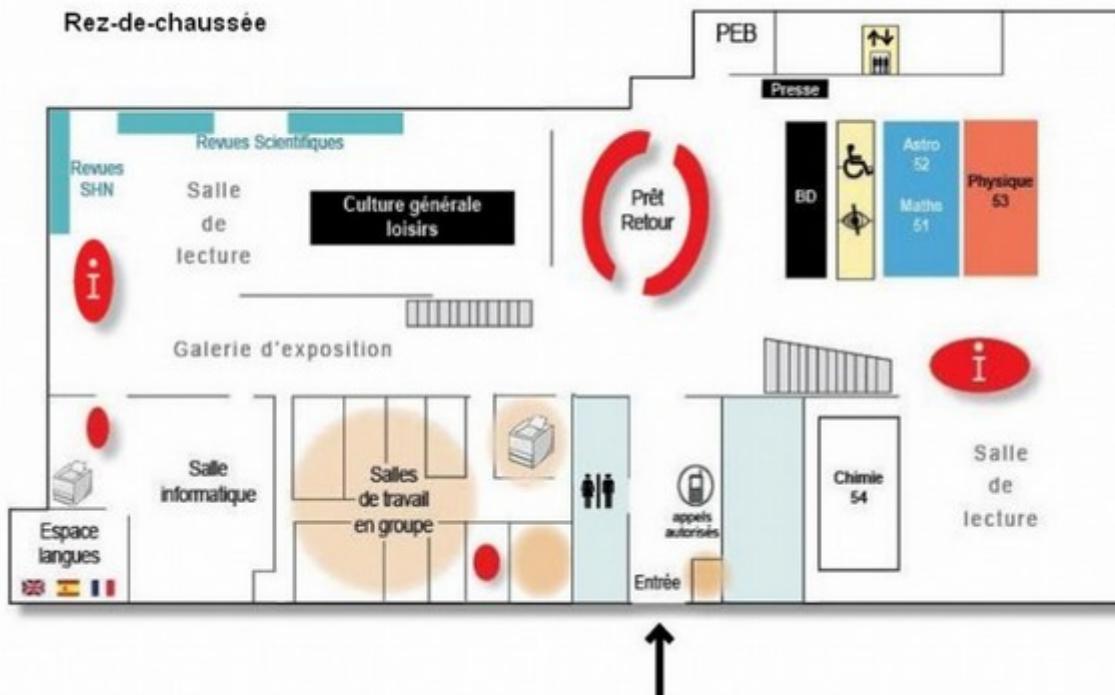
Ambient intelligence provides a service through cooperation between agents spread across the network.

- ... applied to Edge/FOG computing

Deployment of agents within the network nodes and/or end-devices ...

*... but how to ensure in-between applications insulation ?
==> Linux containers !!*

- Noise detectors @ BU Sciences



Zone

hall

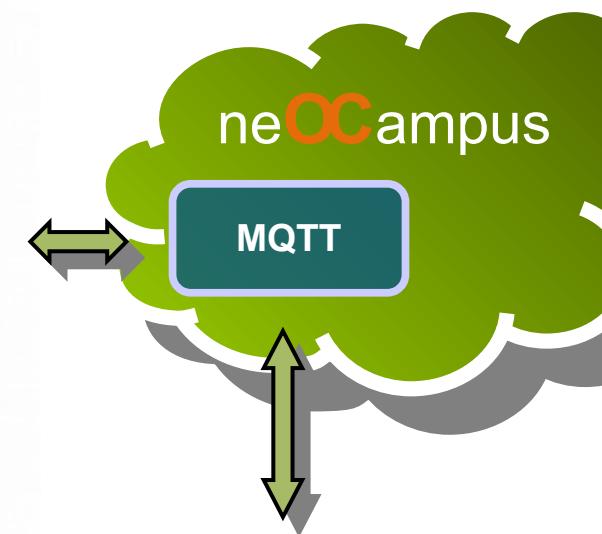
Paramètres avancés

Sensibilité

Durée de détection

Nombre de pulsos

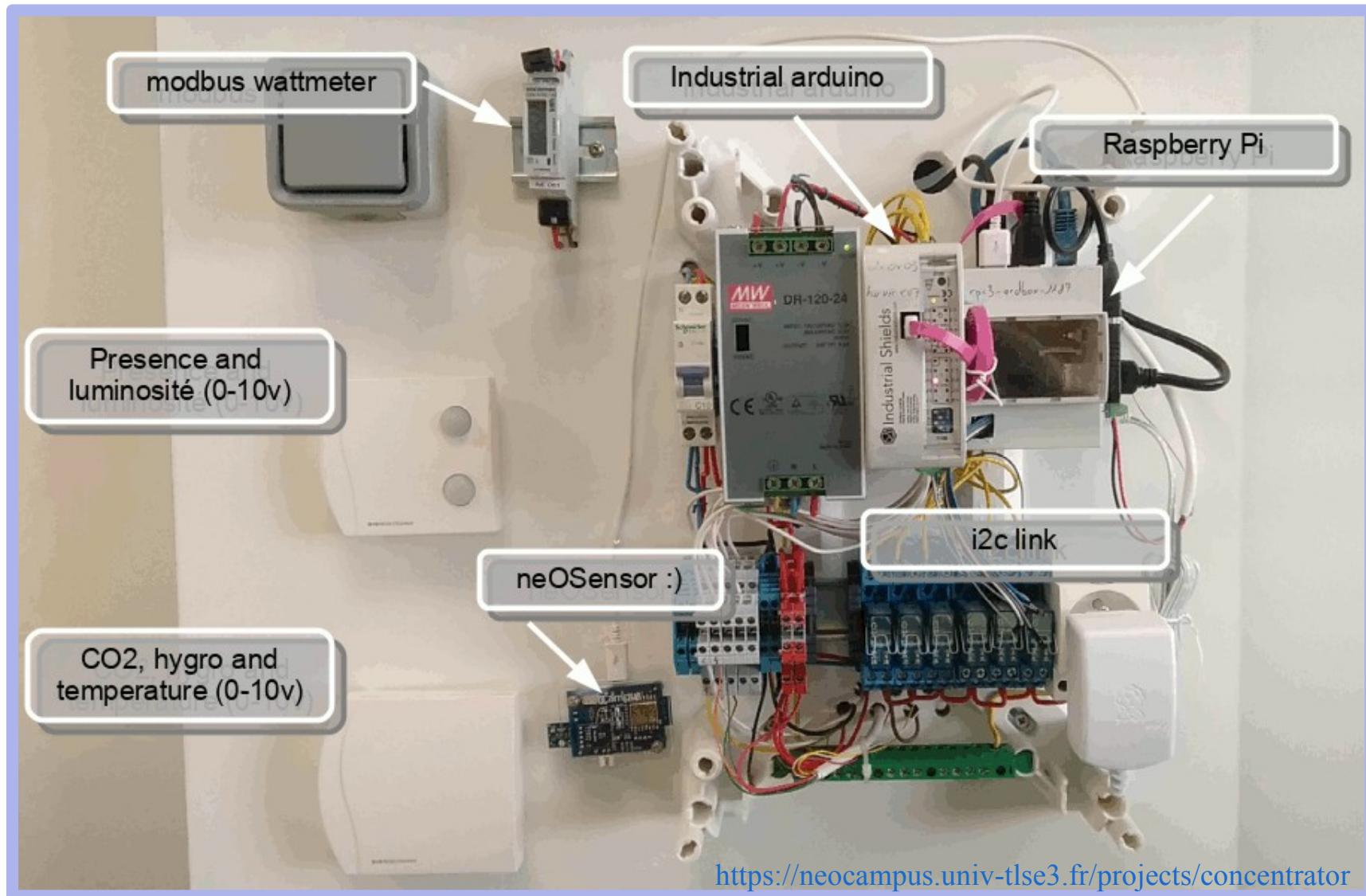
Envoyer



<http://affluences.univ-tlse3.fr>

cOnCenTrator

- An open-source PLC that works!



Control Panel



Group of sensors: 3 times per room

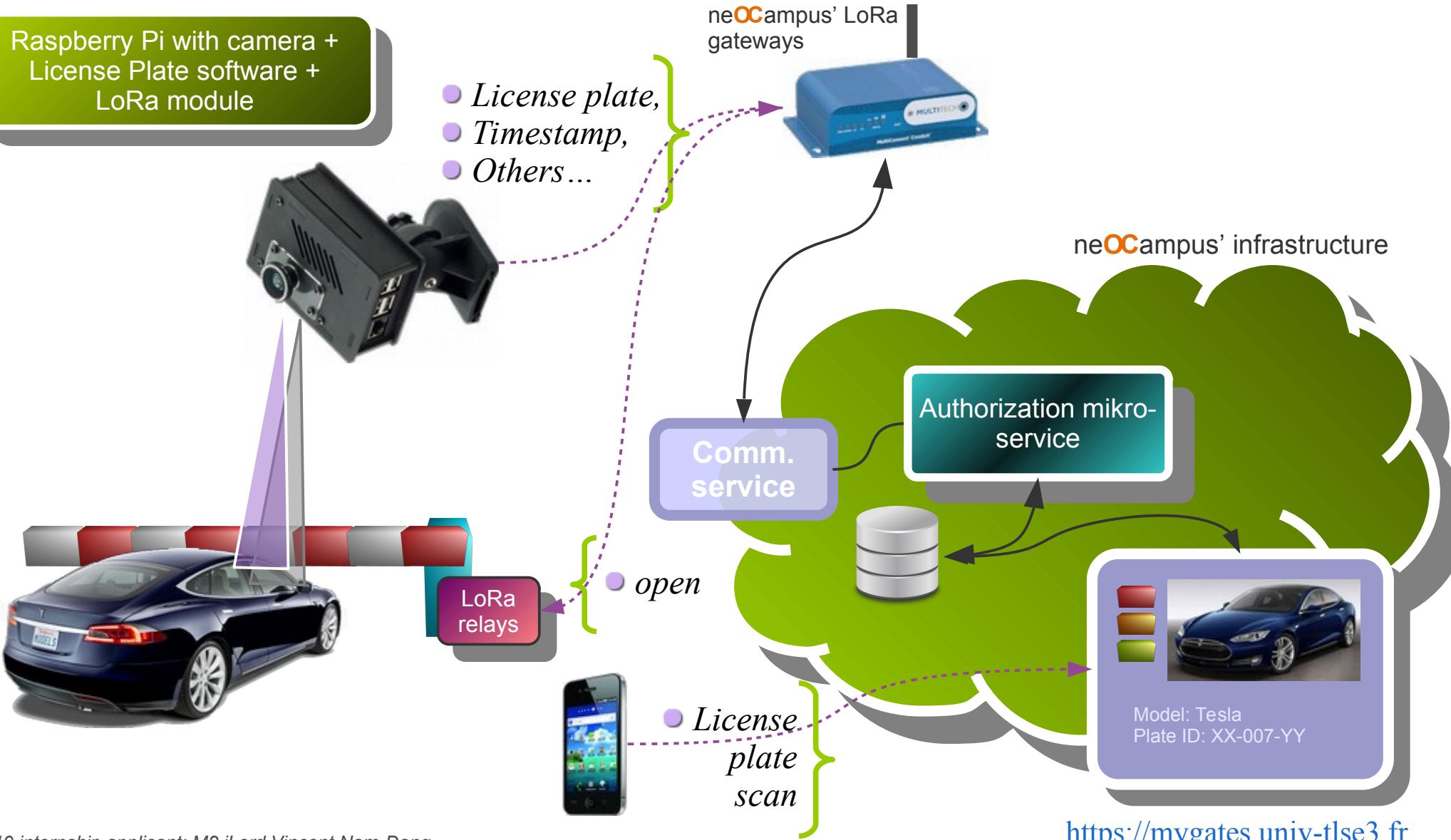


- Luminosity,
- Temperature,
- Humidity,
- CO₂,
- Presence.

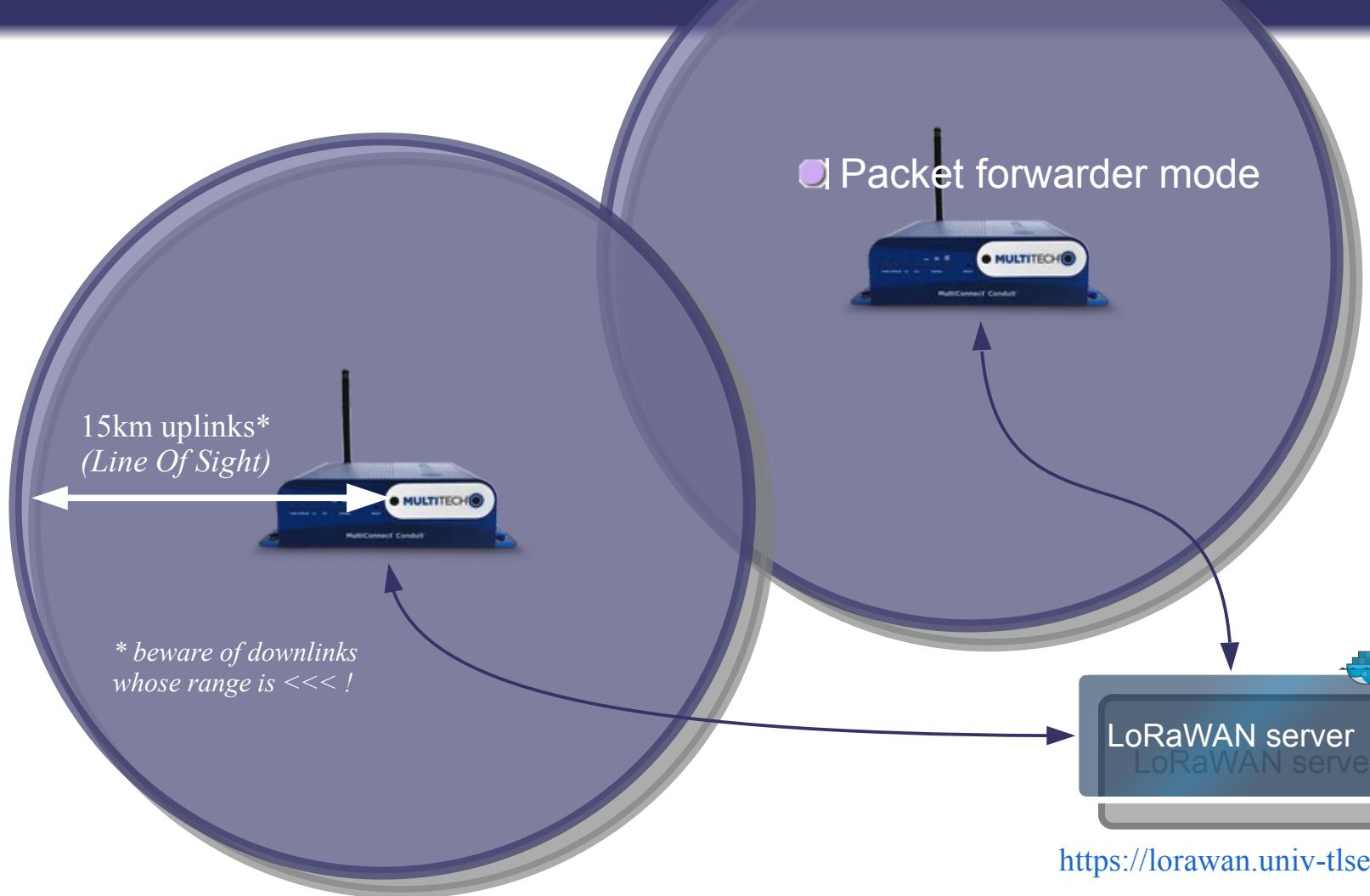


[LoRaWAN] myGates

Raspberry Pi with camera +
License Plate software +
LoRa module



LoRaWAN infrastructure



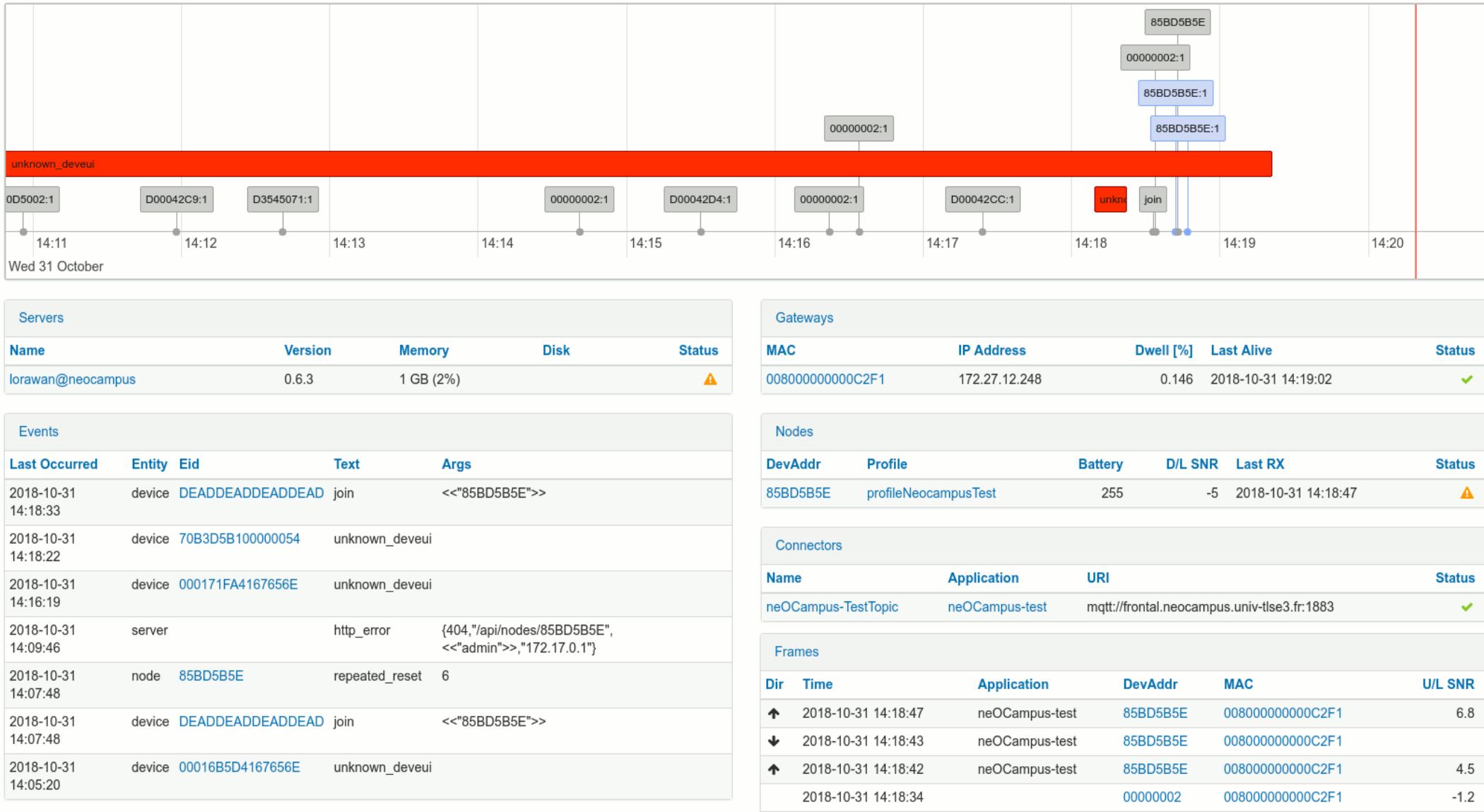
Federated LoRaWAN gateways → centralized authentication & authorization

... ok, but what about inter-operability ??



LoRaWAN server

- Dashboard <https://lorawan.univ-tlse3.fr>





LoRaWAN end-device

* How to create your own end-device ??

- Latest Arduino IDE,

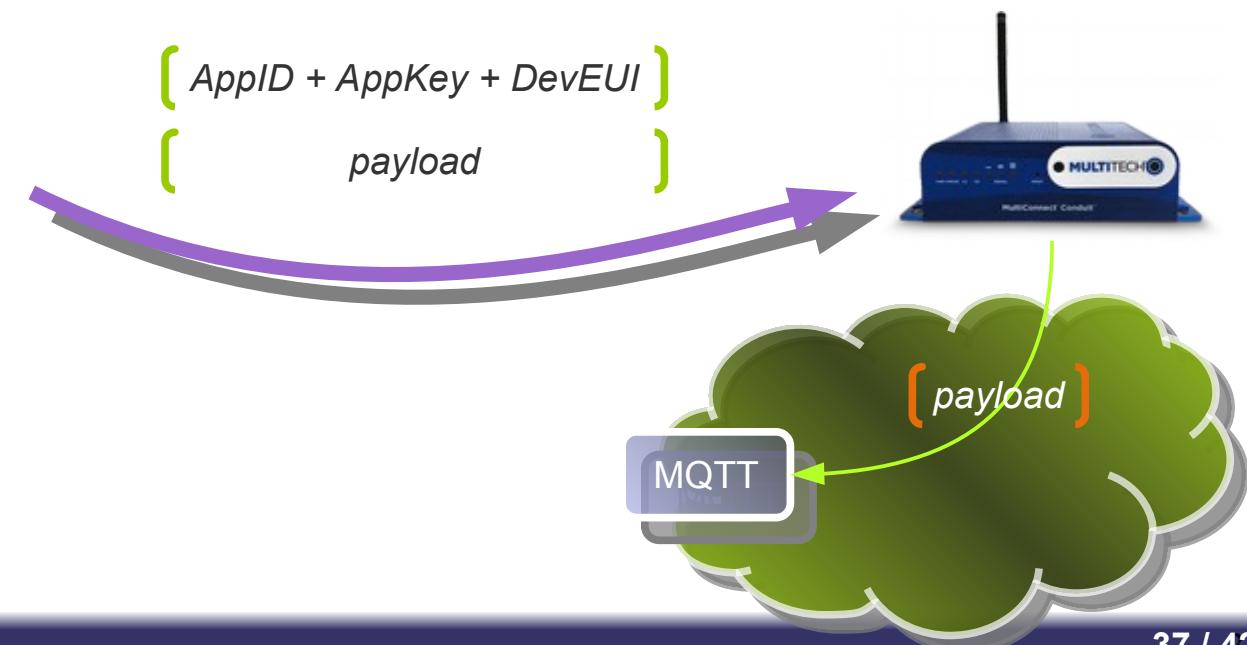
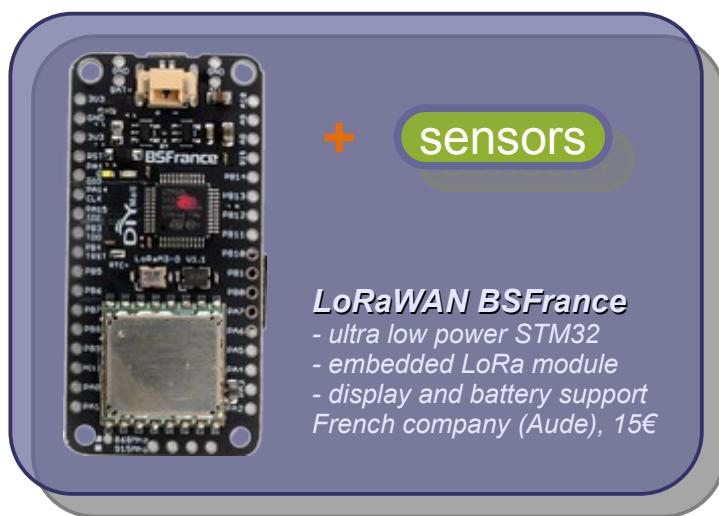
- stm32duino

https://github.com/stm32duino/Arduino_Core_STM32

- Heltec & BSFrance variant files

https://github.com/fthiebolt/bsfrance_stm32duino

- LMIC library + samples 😊





Plan

- [Foreword] the painful way to deploy connected objects,
- Where is my Data ??
- neOCampus,
- What's next ?





What's all this autOCampus stuff, Anyhow* ?

autonomous vehicles going in and out of our campus

- myGates automation for autonomous vehicles,

License plate has been recognized and neOCampus gave authorization :)

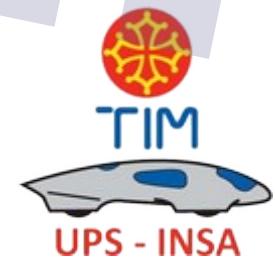
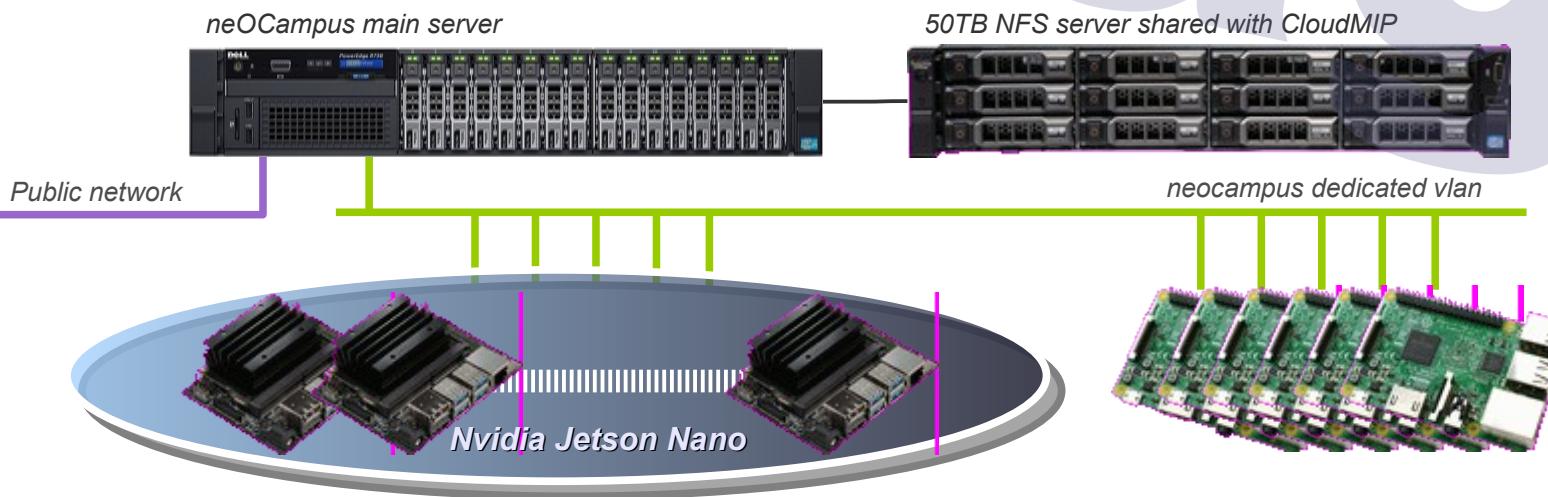
Vehicle model recognition

(Vincent Nam-Dang ---M2 internship)

- V-to-X 5G infrastructure deployment,
(Orange & R.Kacimi)

Fast-data (i.e low latency) from vehicles (raw cameras, sensors, CAN bus ...)

- toward an **AIoT** infrastructure ...

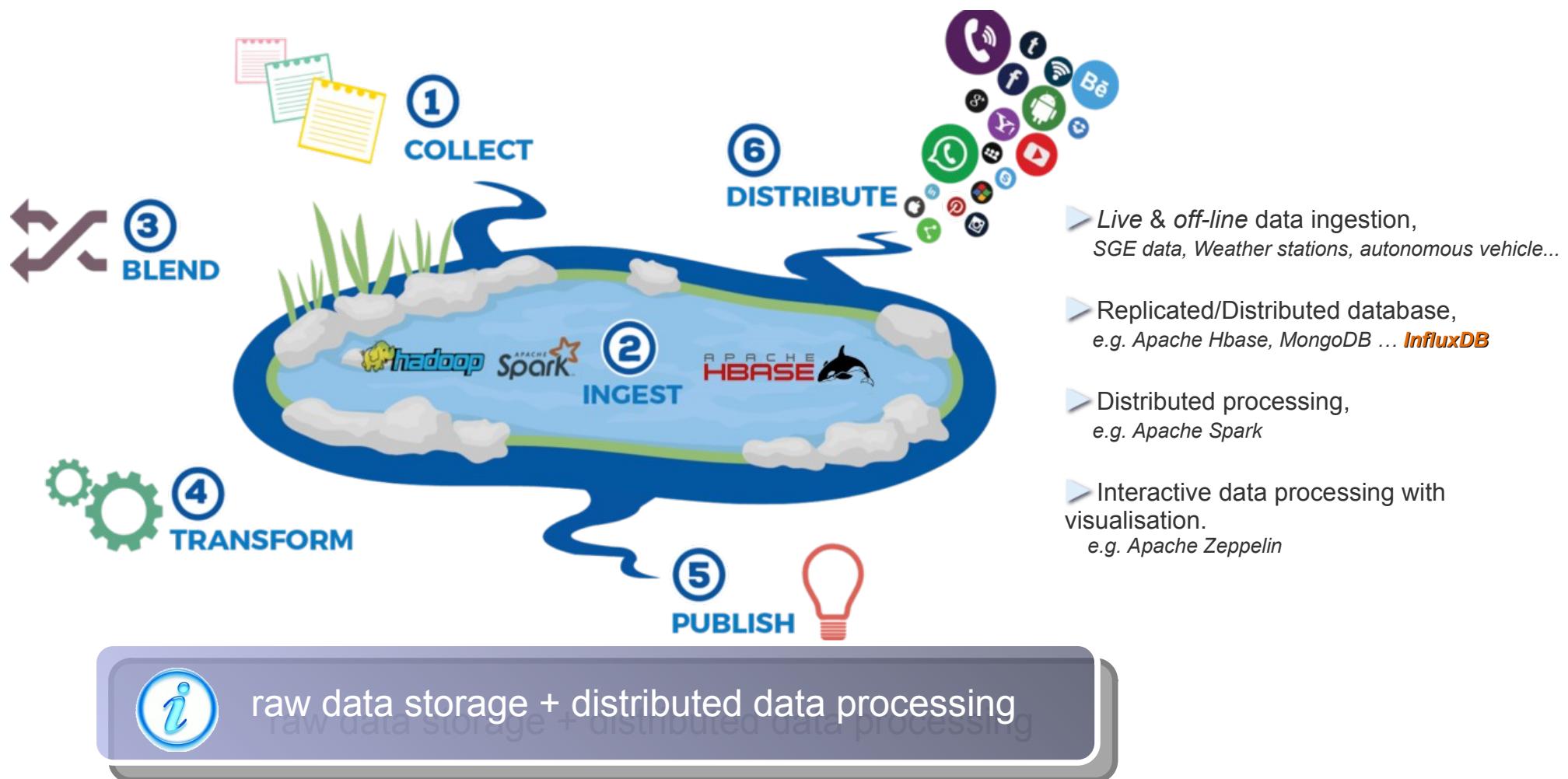


* Remember Bob Pease

towards a Data Lake

- A major concern for both University's services, SGE ... and neOCampus

→ towards a **data lake** ...



what's next ?

- [IoT] neOCampus High Availability (*part of future data lake*),
- [IoT] APIcampus connected hives infrastructure,
- [end-devices] neOSensor v5,
eConnect* LoRaWAN environment sensors, ...
- [buildings infra] DC networks deployment**, LoRaWAN extension @ Ecolab,
neOCCom connected displays @ MRL ...
- new DGS patrimoine & *future* neOCampus GIS → tighter integration with University services, part of building renovation/construction planning teams
... and BIM integration later :)



* Feder project jan.20 - dec.22, 1.8M€, mostly about biodiversity, leader: Ecolab.

** is a SEC & STI university services joint effort.

END

- Proposal for new buildings :



Hey, that's the law!

1% for art (**200K€**)

Proposal for our local PME/PMI and labs !

1% for **local** innovations



Nvidia Jetson Nano

- 4GB RAM
- 4 x ARM 64bits CPU
- 128 cores GPU up-to 472GFlops
- 10w max.

autoOCampus Edge computing horsepower
Jun.19 worldwide availability, #100€



MyOpenCam project

- custom built firmware
- M1 UE projet
- cheap open-source IP camera



LoRaWAN BSFrance

- ultra low power STM32
 - embedded LoRa module
 - display and battery support
- French company (Aude), 15€



Google TPU

- USB3 NN accelerator