neOCampus architecture

Data flows and micro-services

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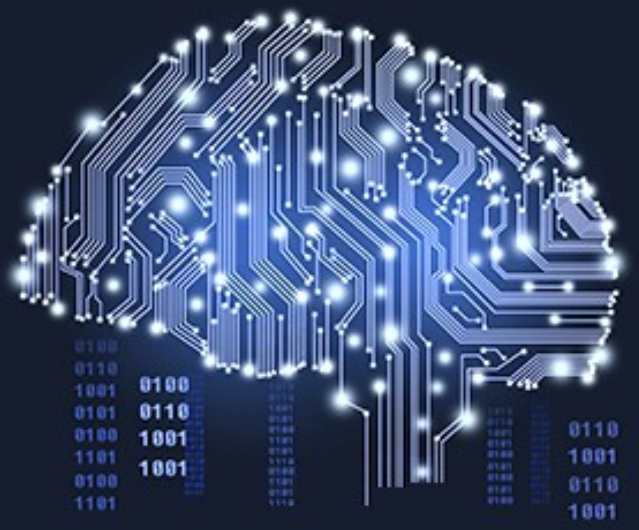
Edge Computing

AIoT

towards the next level

DATA LAKE



Université Paul Sabatier TOULOUSE III

IRIT

data ZERO as green as possible

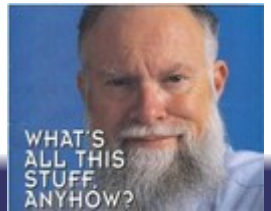
neOCampus

Q3 2020

What's all this IoT stuff, Anyhow* ?

- [Foreword] neOCampus overview,
- Data flows | the big picture,
- neOCampus micro-services@containers,
- What's next ?

**Robert Allen Pease [1940 - 2011] was a famous TI's analog engineer, his favourite programming language was ... solder!*



neOCampus operation

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

- 79 buildings ~ 410 000 m^2,
- People ~ 36 000

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

Our campus is a small-sized town like Périgueux.

B. Monthubert

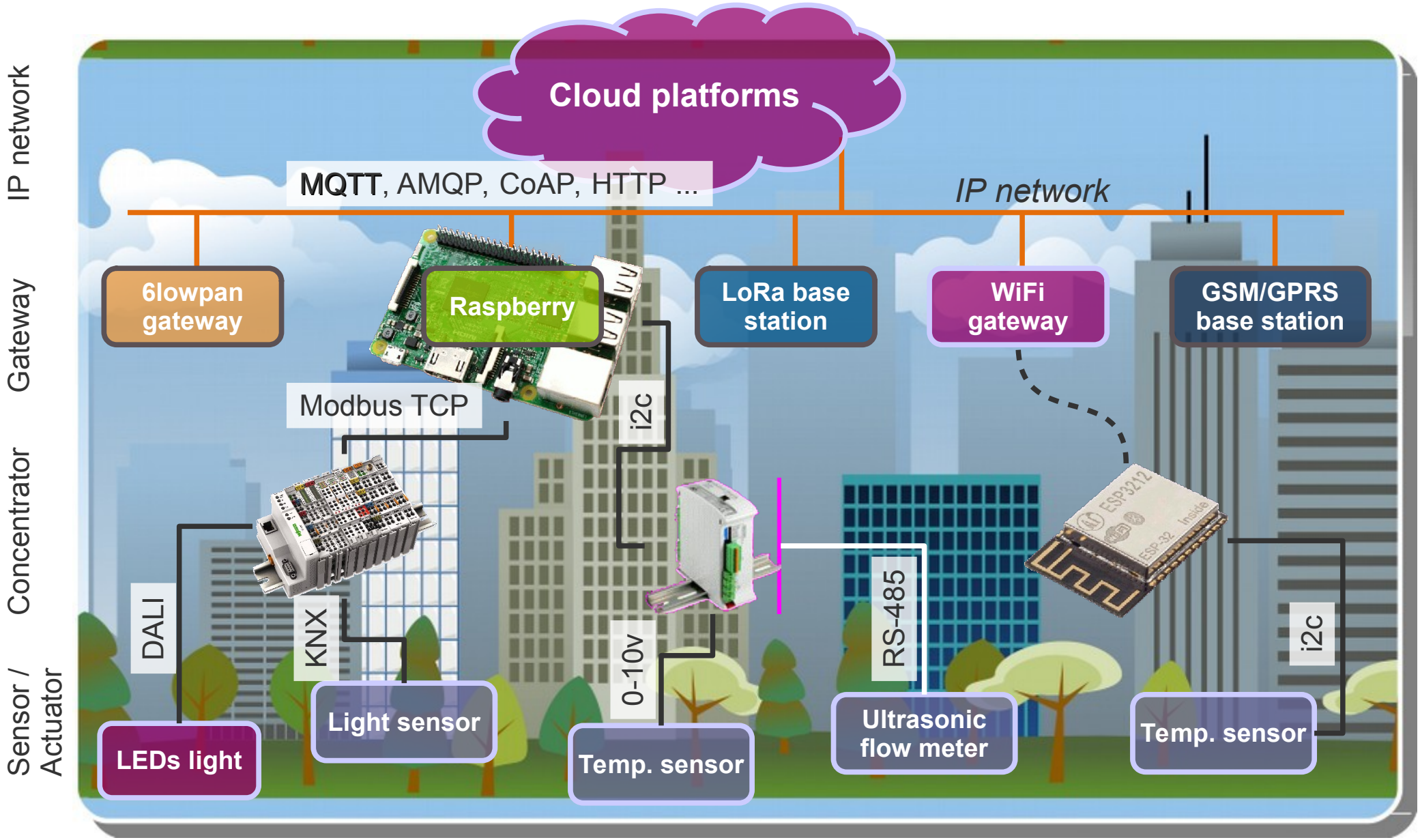
neOCampus operation

- **CESBIO** : Centre d'Etudes Spatiales de la BIOsphère
- **CIRIMAT** : Centre InterUniversitaire de Recherche et d'Ingénierie des Matériaux
- Laboratoire d'écologie fonctionnelle et environnement (formerly **ECOLAB**)
- **IRIT** : Institut de Recherche en Informatique de Toulouse
- **LAAS :** Laboratoire d'Analyse et d'Architecture des Systèmes
- **LAPLACE :** Laboratoire Plasma et Conversion d'Energie
- **LERASS** : Laboratoire d'Études et de Recherches Appliquées en Sciences Sociales
- **LISST :** Laboratoire Interdisciplinaire Solidarités, Sociétés, Territoires
- **LMDC** : Laboratoire Matériaux et Durabilité des Constructions
- **PHASE :** Physique de l'Homme Appliqué à Son Environnement
- **INSA**, **ENAC**, **N7** ...

More than 11 laboratories nowadays …

… and soon we'll become a GIS :)

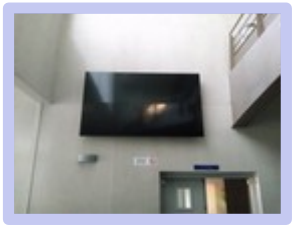
… toward Smart Cities



neOCampus infrastructure

~ 40 x Raspberry Pi
~ 3 x ConcentratOrs
(RPi + industrial Arduinos)

neOCom
(connected displays)

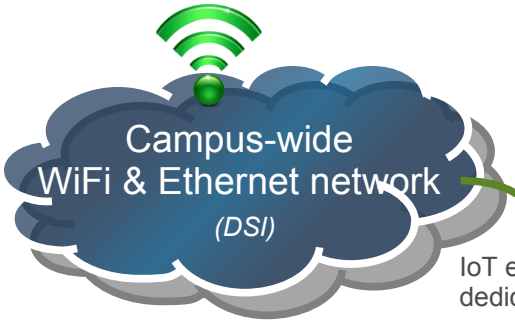


myGates
(automatic fences for autonomous vehicles)

accessOCampus
(access control system)

Federated LoRaWAN network
(868MHz, 3 gateways, BU santé & sciences, Ecolab)

neOTraffic
(attendance measurement)



IoT end-devices dedicated vlan

https://neocampus.univ-tlse3.fr

LoRaWAN server
https://lorawan.univ-tlse3.fr

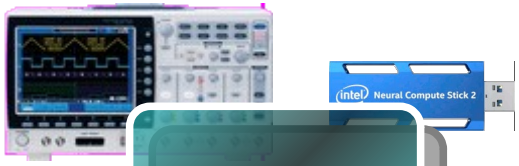
~150 million data

Comms
(MQTT)

~500 access / min.

Apps.

1 x Dell R730 @ DSI



Amilab
(IRIT2-366)

neOCampus R&D area

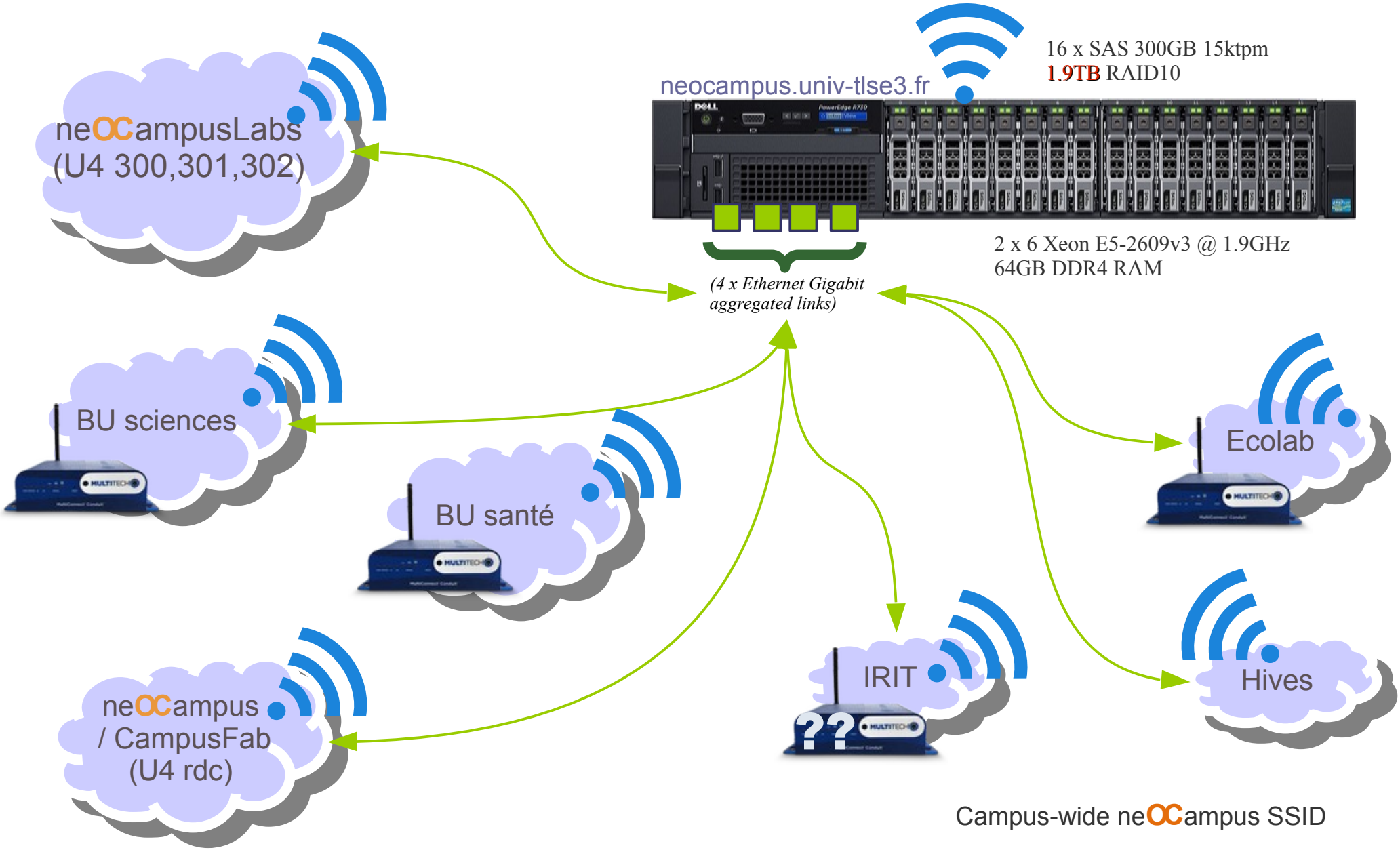
Connected hives
(Rucher université)

API campus

neOSensors
(noise, temp., lux sensors)

~ 10 x neOSensors

neOCampus infrastructure



automatic deploy & update

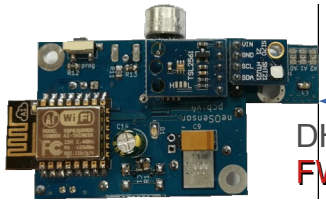
- Network automated install and configuration of our Raspberry Pi(s) :)

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

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

- ✔ 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)

neOSensors
(~15€ multi sensors)



DHCP

neocampus.univ-tlse3.fr

DHCP, app. Config and
FW upgrade :)

Plan

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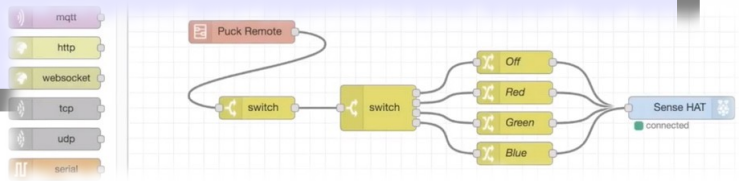
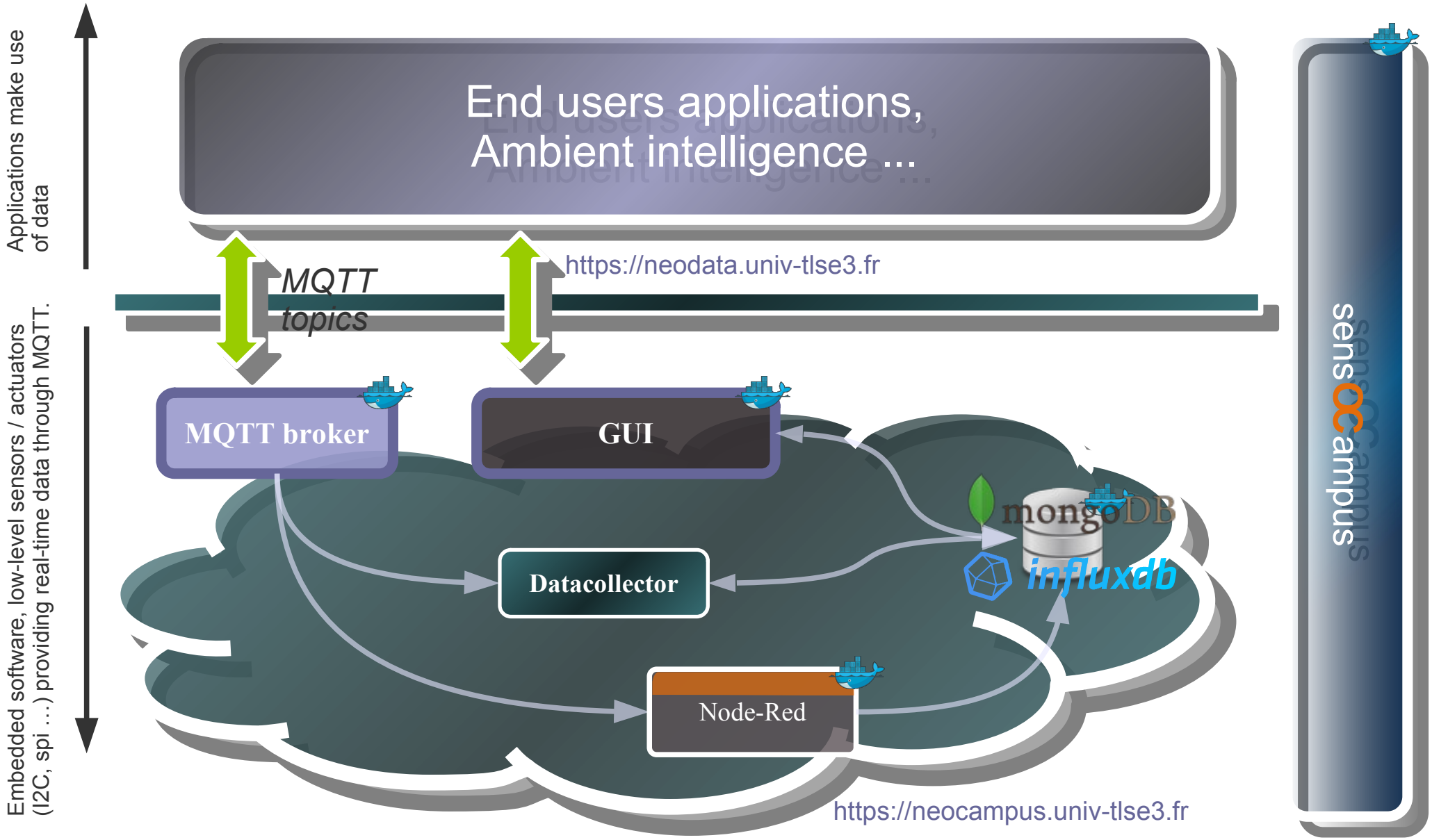
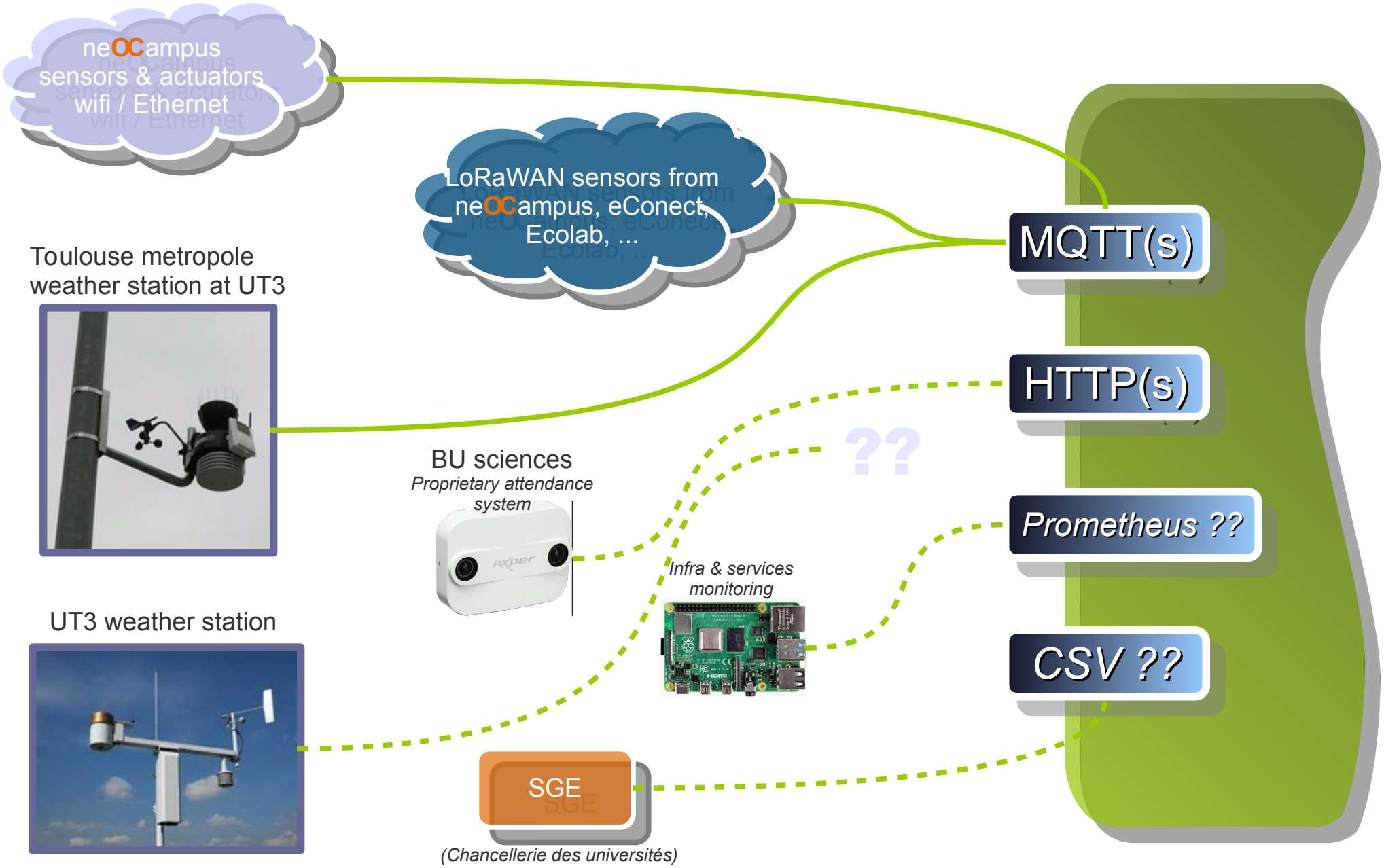


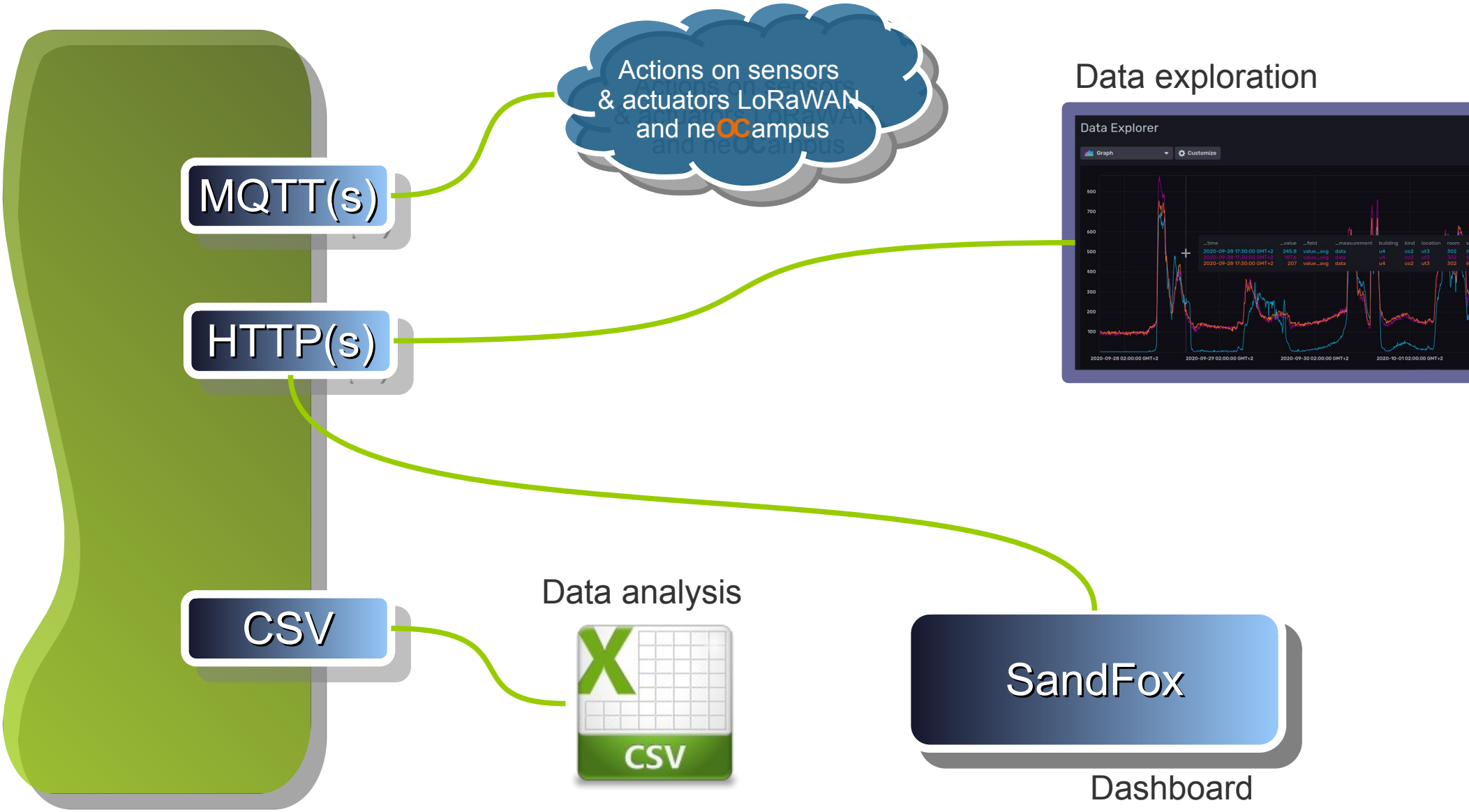
neOCampus architecture



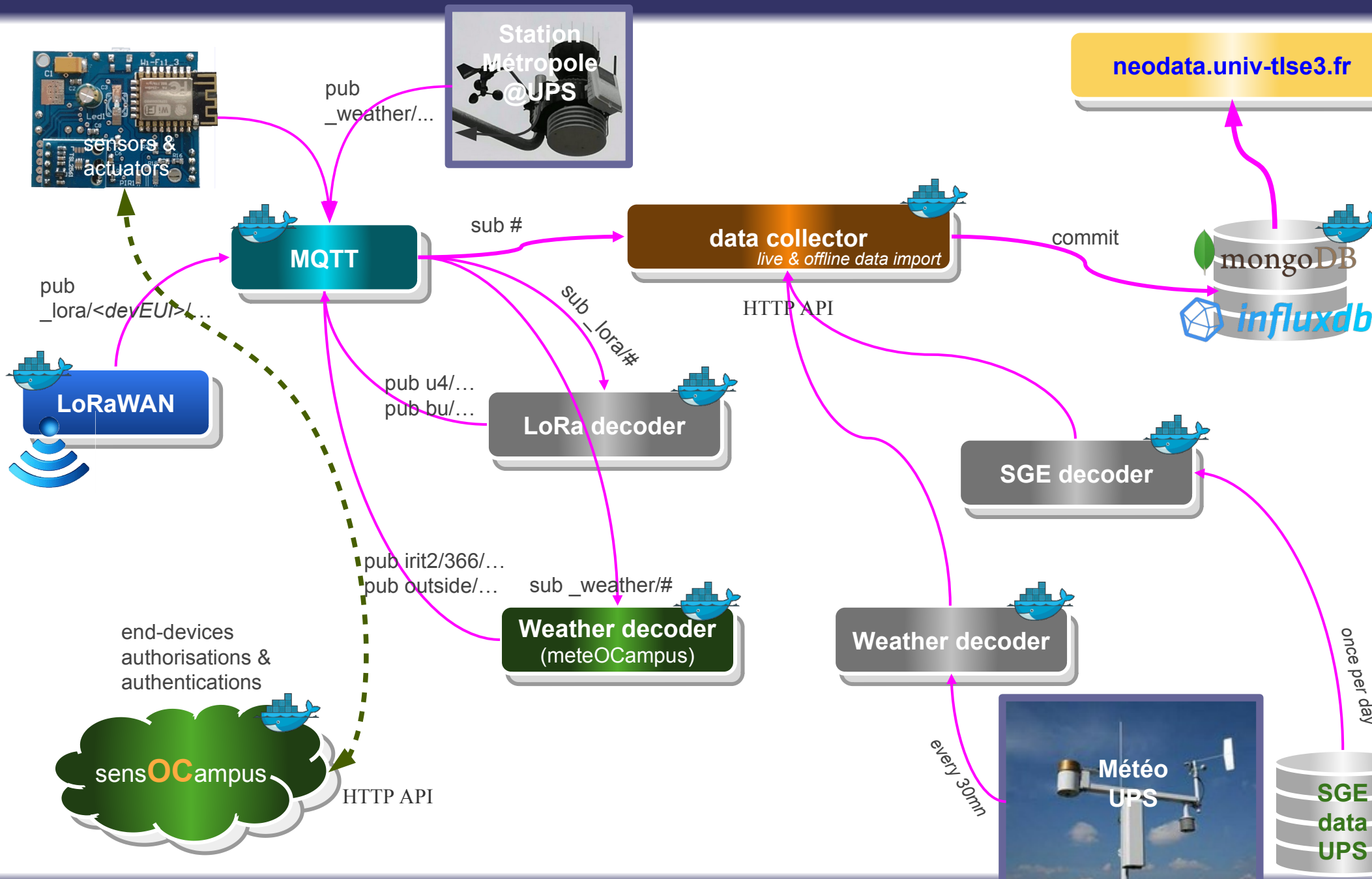
Data flows overview



Data flows overview



Data flows inner view



Plan

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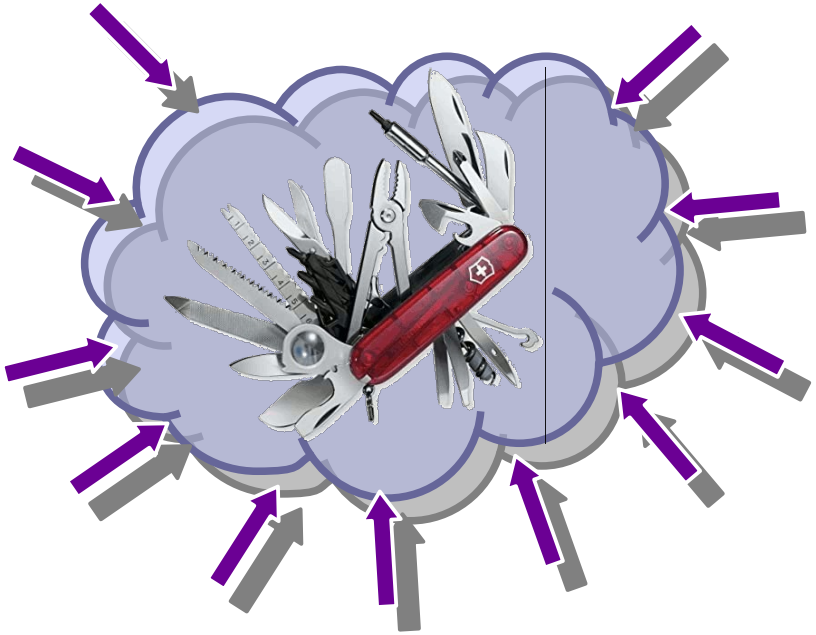
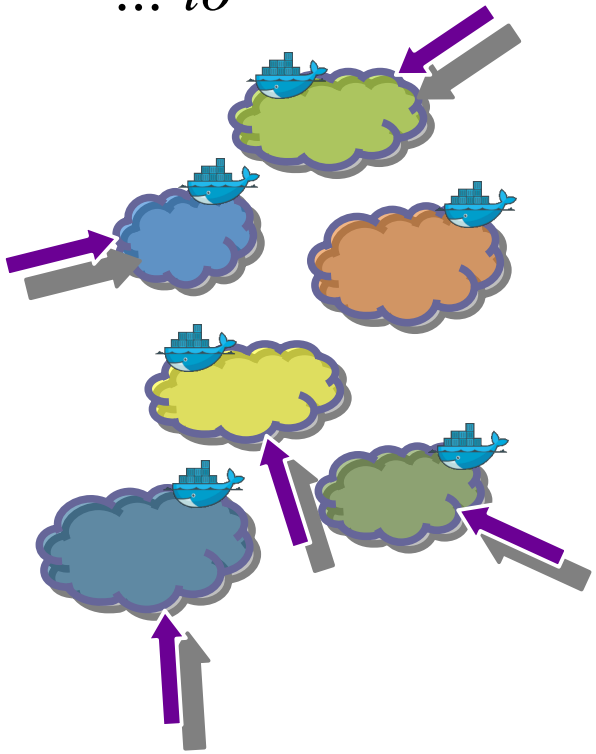
Micro-services

From…



… to



Microservices are an application architecture style where independent, self-contained programs with a single purpose each can communicate with each other over a network.

https://www.fullstackpython.com/microservices.html

Micro-services

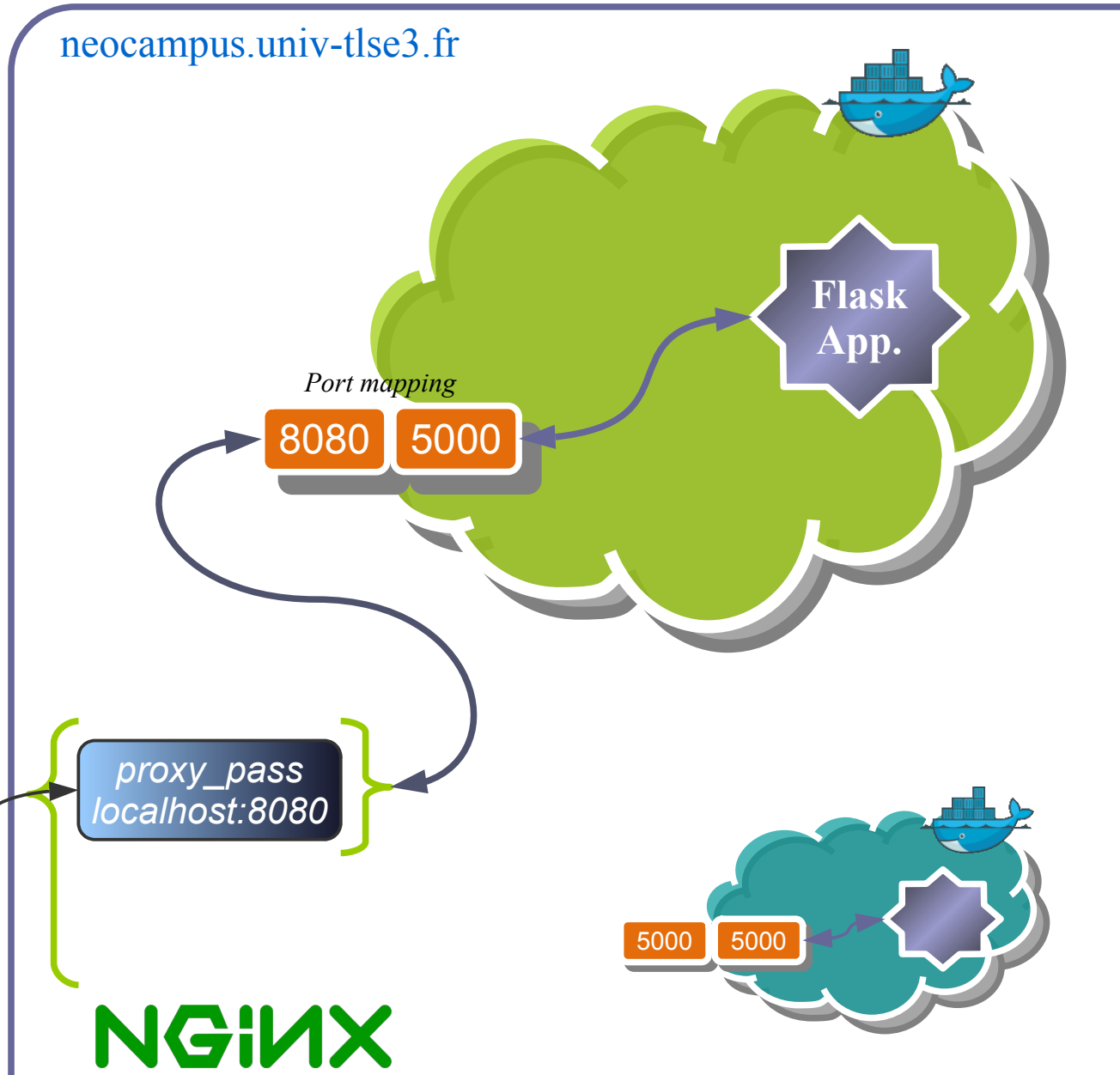
Containers everywhere !

- Each service runs on a port,
- Restful API,
- Port mapping at container deploy,

android.univ-tlse3.fr is a DNS alias of neocampus.univ-tlse3.fr

https://android.univ-tlse3.fr

... or subdomain redirection
https://neocampus.univ-tlse3.fr/android



Micro-services

- `docker` is a root-only command,
- One shot containers deployment
  → *docker-compose.yml*,
- Containers are intended to run a single command
  → *dockerfile*,

dockerfile

```
…….
RUN echo -e "Starting setup ..." \
    …….
    && dnf -y --nogpgcheck install \
        git \
        procps \
        supervisor \
        python3-pip \
        uwsgi \
        Uwsgi-plugin-python3 \
    ……
    && pip3 install -r requirements.txt

#
# Ports for sshd and uwsgi application
EXPOSE 22 5000

# CMD
CMD ["/usr/bin/supervisord", "-n" ]
```

Docker-compose.yml

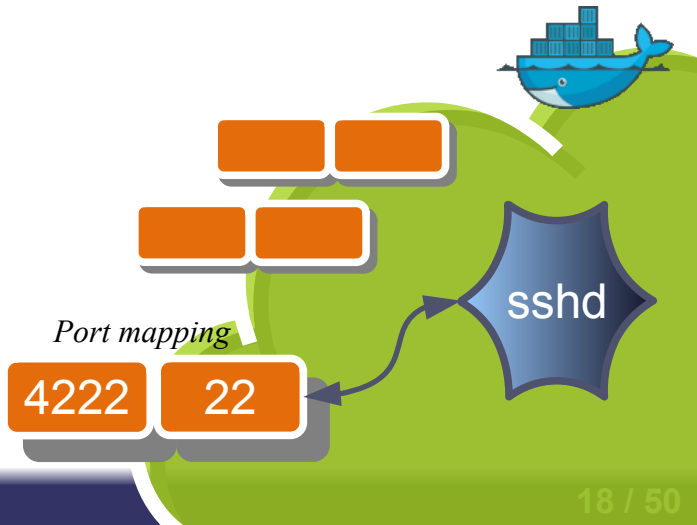
```
version: '3.5'

services:
  app:
    build: .
    image: datacollector
    # container-name implies only one instance
    container_name: datacollector
    restart: unless-stopped
    volumes:
      - /etc/localtime:/etc/localtime:ro
      #- .:/opt/app
    network_mode: bridge
    ports:
      - "8010:5000"     # Web app
      - "2230:22"       # SSH
    environment:
      - PYTHONUNBUFFERED=1
      - FLASK_DEBUG
      - FLASK_ENV
      - DEBUG
      - MQTT_SERVER
      - MQTT_PORT
      - MQTT_USER=dataCOllector
      - MQTT_PASSWD
      - MQTT_TOPICS=["u4/+/+"]
      - MQTT_UNITID
      - MONGO_USER
      - MONGO_PASSWD
      # SERVER is docker gateway
      - MONGO_SERVER=172.17.0.1
      - MONGO_PORT
      - MONGO_DATABASE
```

neOCampus Datacollector

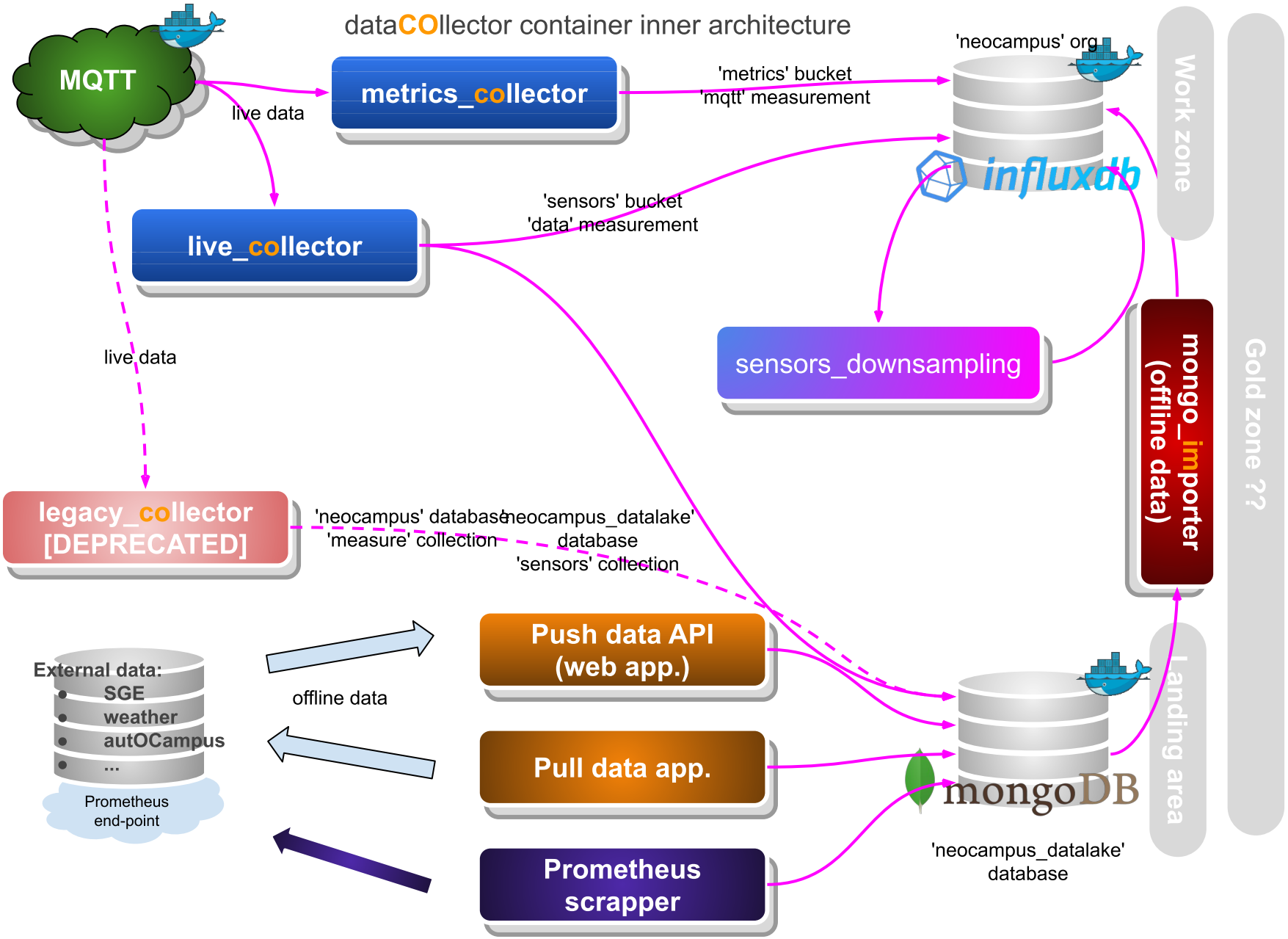
- data acquisition | dataCOllector App.
  - Python along with several modules (e.g Flask),
  - Required to run several apps within the same container,
  - Ability for end-users (I.e non-root) to connect within container as root,
  - https://github.com/fthiebolt/teaching-IoT/tree/master/tutorial-MQTT-FLASK-DOCKER

Regular users get connected to the platform ...
they then turn to root within the container :)

```
#> ssh -p 4222 root@localhost
```

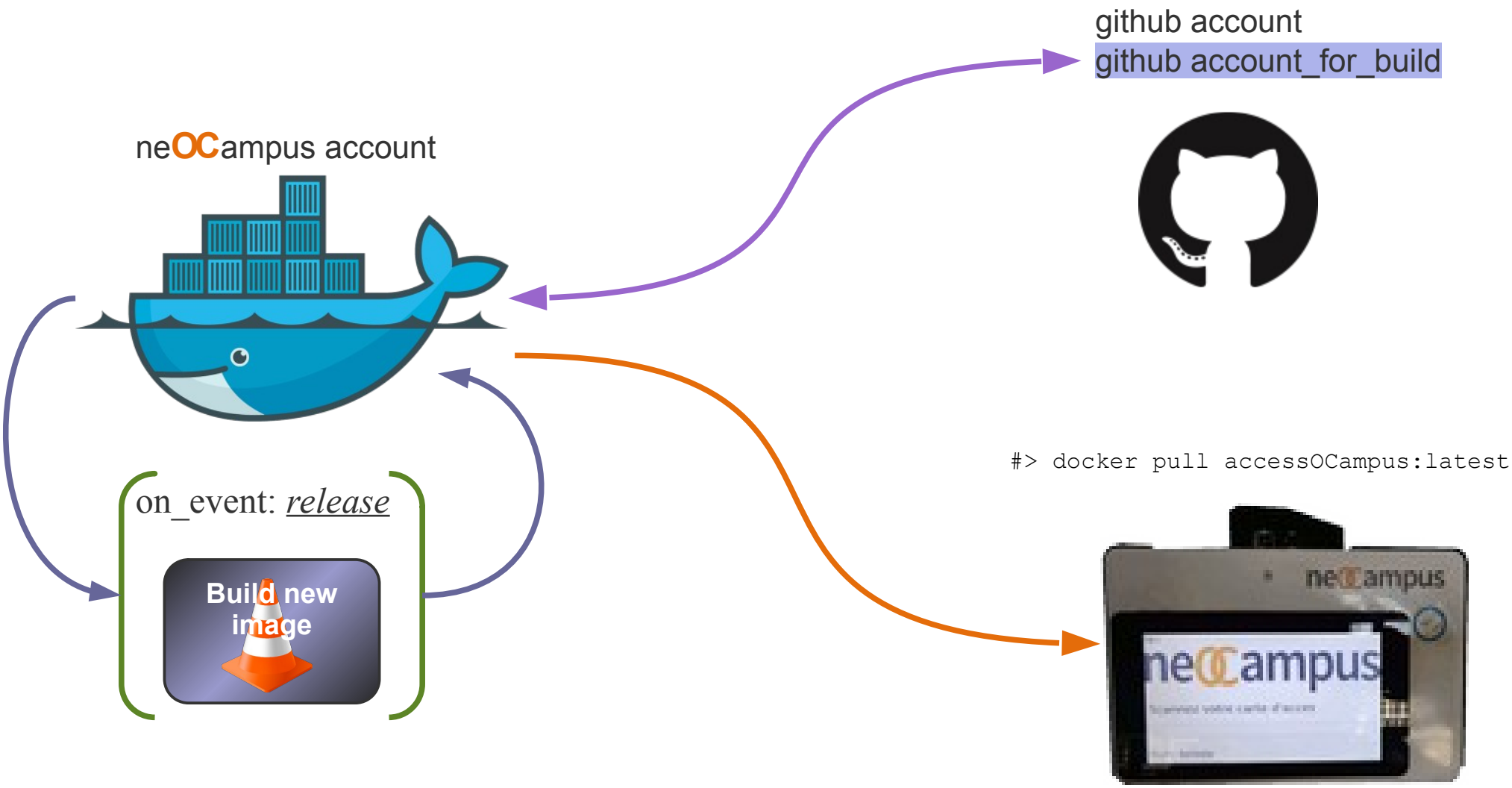


neOCampus Datacollector



Advanced micro-services

- accessOCampus: campus-wide access control system



Running containers

- neoOCampus server : active containers

```
root@frontal[~] docker ps -a
CONTAINER ID   IMAGE                          COMMAND                  PORTS                                          NAMES
7aea9fda00d6   meteocampus                    "/usr/bin/supervisor…"   0.0.0.0:2228->22/tcp                           meteocampus
2d9debf691de   gotthardp/lorawan-server:stable   "/bin/sh -c bin/lora…"   0.0.0.0:1680->1680/udp, 0.0.0.0:8008->8080/tcp   lorawan-neocampus
22cf6856e0b2   sandf0x/sandfox-docker:latest  "/usr/bin/supervisord"   27017/tcp, 0.0.0.0:2227->22/tcp, 0.0.0.0:8007->8080/tcp  sandfox
92547fa2234c   datacollector                  "/usr/bin/supervisor…"   0.0.0.0:2230->22/tcp, 0.0.0.0:8010->5000/tcp   datacollector
b4b5c2d243ac   mongo-express                  "tini -- /docker-ent…"   0.0.0.0:27016->8081/tcp                        mongo-express
cf1eefbfd371   influxdb:latest                "/entrypoint.sh infl…"   0.0.0.0:9999->9999/tcp                         influxdb
657acf1ec173   accessocampus-server           "/usr/bin/supervisor…"   0.0.0.0:2222->22/tcp, 0.0.0.0:8002->5000/tcp   accessocampus-server
4c98ab60cb8f   nodered/node-red:latest        "npm start -- --user…"   0.0.0.0:1880->1880/tcp                         nodered
f2c1d1509fd7   mongo                          "docker-entrypoint.s…"   0.0.0.0:27017->27017/tcp                       mongo-neOCampus
3fe8b1e2fb76   luxocampus                     "/usr/bin/supervisor…"   0.0.0.0:2221->22/tcp, 0.0.0.0:8001->5000/tcp   luxocampus
e5b49e4d41e3   mygates                        "/usr/bin/supervisor…"   0.0.0.0:2229->22/tcp, 0.0.0.0:8009->5000/tcp   myGates
1664a3a567e6   neocom                         "/usr/bin/supervisor…"   0.0.0.0:2226->22/tcp, 0.0.0.0:8006->8000/tcp   neOCom
9be6f708eb99   domoticz-bu:neocampus-backup   "/src/domoticz/domot…"   0.0.0.0:1809->8080/tcp                         domoticz-bu
f8fe4e3c6b08   domoticz-prod:neocampus-backup "/src/domoticz/domot…"   0.0.0.0:1808->8080/tcp                         domoticz

d6ca85fd2855   mqttocampus:latest             "/entrypoint.sh -c /…"   0.0.0.0:1883->1883/tcp, 0.0.0.0:8883->8883/tcp, 0.0.0.0:9001->9001/tcp,
0.0.0.0:9883->9883/tcp   mqttOCampus

f9b66fde7a42   c025c7107fa5                   "/usr/bin/supervisor…"   0.0.0.0:8000->8000/tcp, 0.0.0.0:2220->22/tcp   sensOCampus
1a1092e55aa2   postgres:latest                "/docker-entrypoint.…"   0.0.0.0:5432->5432/tcp                         pg-neOCampus
```

Docker images

- neOCampus server : docker images and volumes

```
root@frontal[~] docker images
REPOSITORY                    TAG                 IMAGE ID            CREATED             SIZE
grafana/grafana               latest              9ad3ce931acd        6 weeks ago         180MB
meteocampus                   latest              99a2c72dd703        2 months ago        601MB
sandf0x/sandfox-docker        latest              87126d9106b4        3 months ago        736MB
alpine                        latest              a24bb4013296        4 months ago        5.57MB
datacollector                 latest              f87b7cacde7d        5 months ago        546MB
influxdb                      latest              eaa22e2bec57        6 months ago        224MB
quay.io/influxdb/influxdb     2.0.0-beta          eaa22e2bec57        6 months ago        224MB
accessocampus-server          latest              f1ed933ec88e        6 months ago        547MB
luxocampus                    latest              d33631562b94        6 months ago        539MB
nodered/node-red              latest              37f21089d3eb        7 months ago        448MB
fedora                        31                  f0858ad3febd        11 months ago       194MB
fedora                        latest              f0858ad3febd        11 months ago       194MB
gotthardp/lorawan-server      0.6.7               02a0132420b4        15 months ago       111MB
gotthardp/lorawan-server      stable              02a0132420b4        15 months ago       111MB
mygates                       latest              dfceed6bc7d3        15 months ago       1.66GB
mongo                         latest              0fb47b43df19        16 months ago       411MB
mongo-express                 latest              85c118fcceb3        17 months ago       96.9MB
neocom                        latest              545147d92c01        17 months ago       514MB
api-neocampus                 latest              9eb827e1f971        20 months ago       605MB
fedora                        29                  26ffec5b4a8a        21 months ago       275MB
sensocampus                   production          c025c7107fa5        24 months ago       473MB
mqttocampus                   latest              68ac6d13392c        24 months ago       551MB
sensocampus                   neocampus-backup    7fe38cf5f9a3        2 years ago         471MB
domoticz-prod                 neocampus-backup    cefd257930e9        2 years ago         935MB
domoticz-bu                   neocampus-backup    c3c7039ccdb1        2 years ago         1.44GB
fedora                        28                  c582c1438f27        2 years ago         254MB
linuxserver/domoticz          stable-3.8153       39a88c341638        2 years ago         117MB
postgres                      latest              247a11721cbd        4 years ago         266MB

root@frontal[~] docker volumes ls
local               influxdb-neOCampus
local               mongo-neOCampus
local               pg-neOCampus
local               root_mongo-neocampus
local               sandfox-neOCampus
```

Plan

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What we lack :|

- ☒ Centralized authentication (e.g LDAP),
- ☒ Continuous integration (Github Actions ---Github, Pipelines ---Bitbucket),
- ✓ Automated container image build,
- ☒ Service discovery,
- ☒ Turn to docker services (or Kubernetes) with several servers,
- ☒ Prometheus for services and infrastructure monitoring,
- ☒ Containerize our apps in our Raspberry Pi,
- ✓ Datalake for multi-sources data ingestion,
- ☒ Ansible for deployment management,
- ☒ Docker secrets ??
- ✓ long-term software engineers needed!

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

Git

CI/CD

Python3

micro-services

Docker

secret ingredient*

tmux

DataZero2 path to success!

**Po's father knows it!*