100% OPEN SOURCE

EU GDPR COMPLIANT

PEN Test Passed

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SNAP4CITY on EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE

Node-RED

SNAP4CITY

KM4CITY

SNAP4 Appliances and Dockers Installations

Be smart in a SNAP!

LIVING LAB

Smart IOT Applications & IOT Networks

04 April 2021, Course

https://www.snap4city.org/577

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

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scalable Smart aNalytic APplication builder for sentient Cities: for Living Lab and co-working with Stakeholders

https://www.Snap4City.org

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Smart IOT Applications & IOT Networks

04 April 2021, Course
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Paolo Nesi, paolo.nesi@unifi.it
https://www.Km4City.org
https://www.disit.org

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FREE TRIAL

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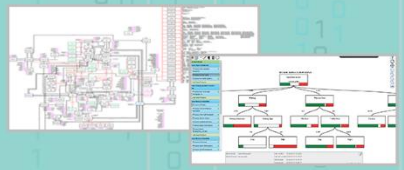
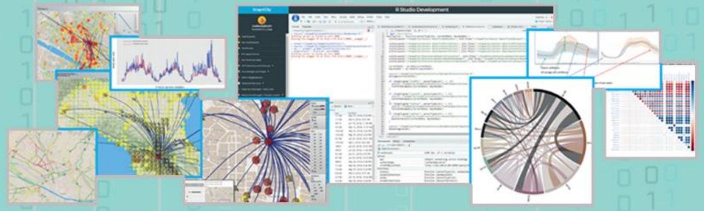
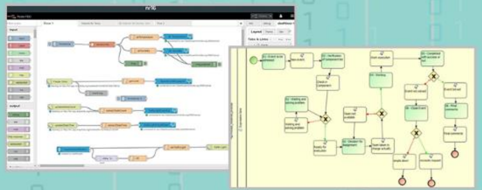
DASHBOARDS AND APPS - CONTROL ROOMS - DECISION SUPPORT SYSTEMS - WHAT-IF ANALYSIS



EXPERT SYSTEM
KNOWLEDGE BASE
STORAGE

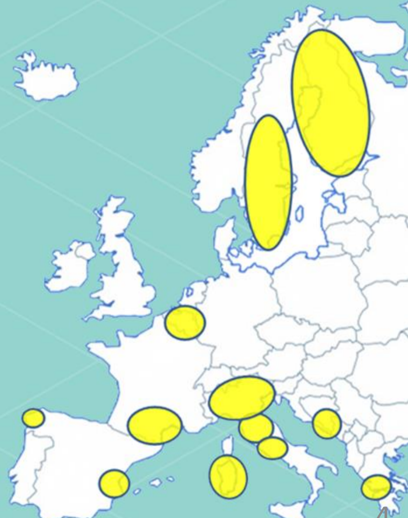


BIG DATA ANALYTICS
ARTIFICIAL INTELLIGENCE
BUSINESS INTELLIGENCE
MACHINE LEARNING

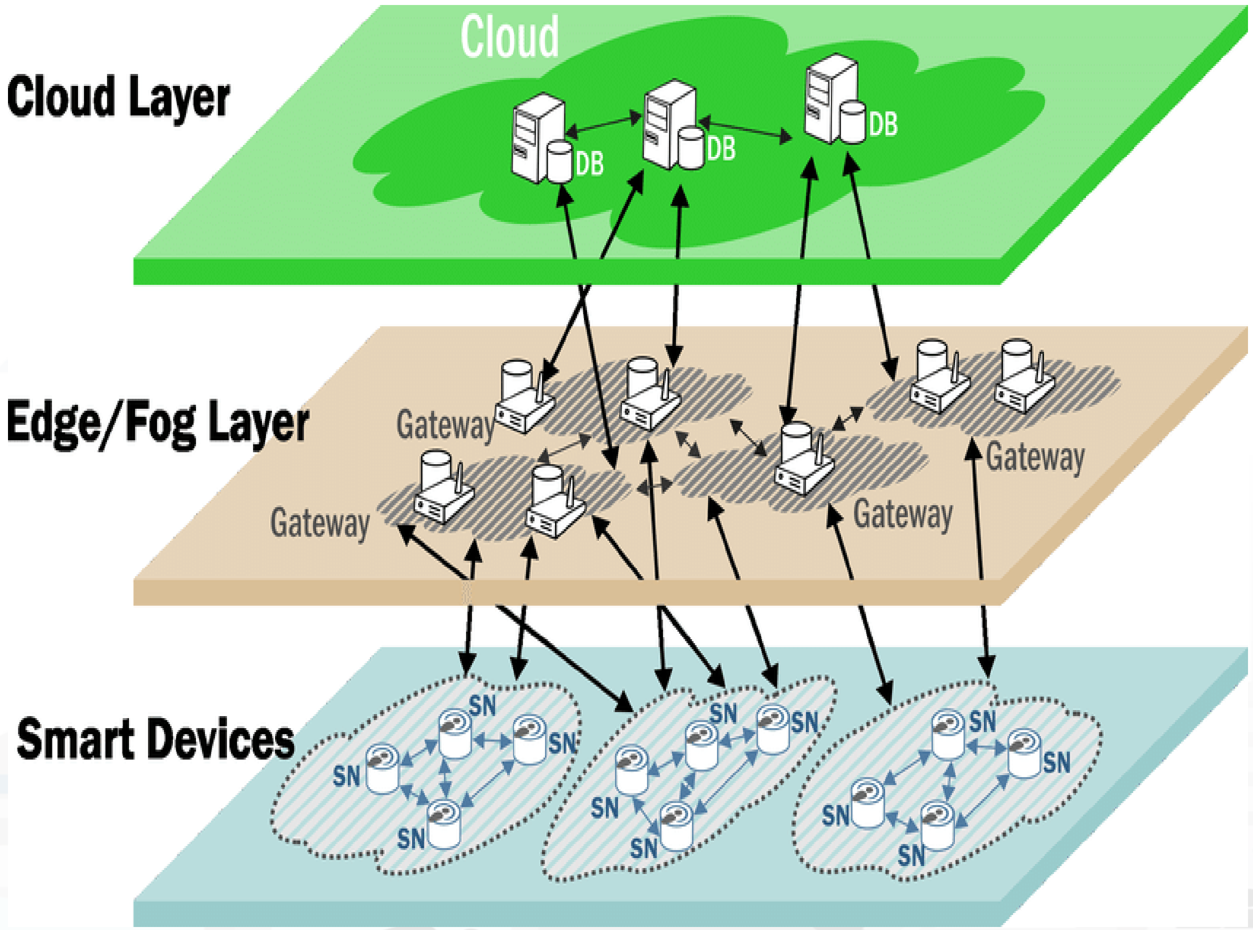


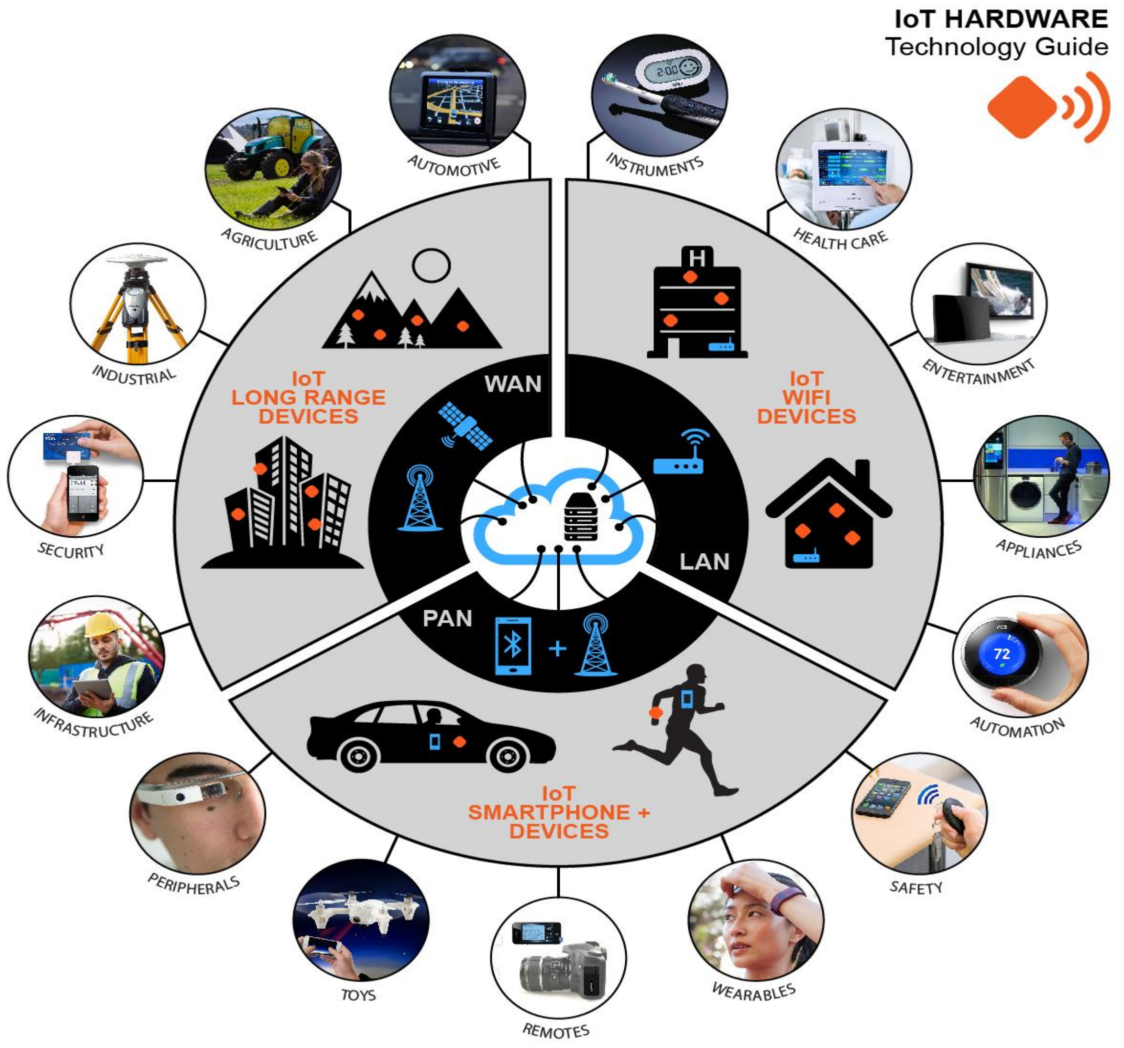
DATA FLOWS, WORKFLOWS
MICROSERVICES
MANAGEMENT

METHODOLOGIES
COURSES AND COMMUNITY
LIVING LABS
DEVELOPMENT TOOLS



Cloud vs Fog/Edge Computing





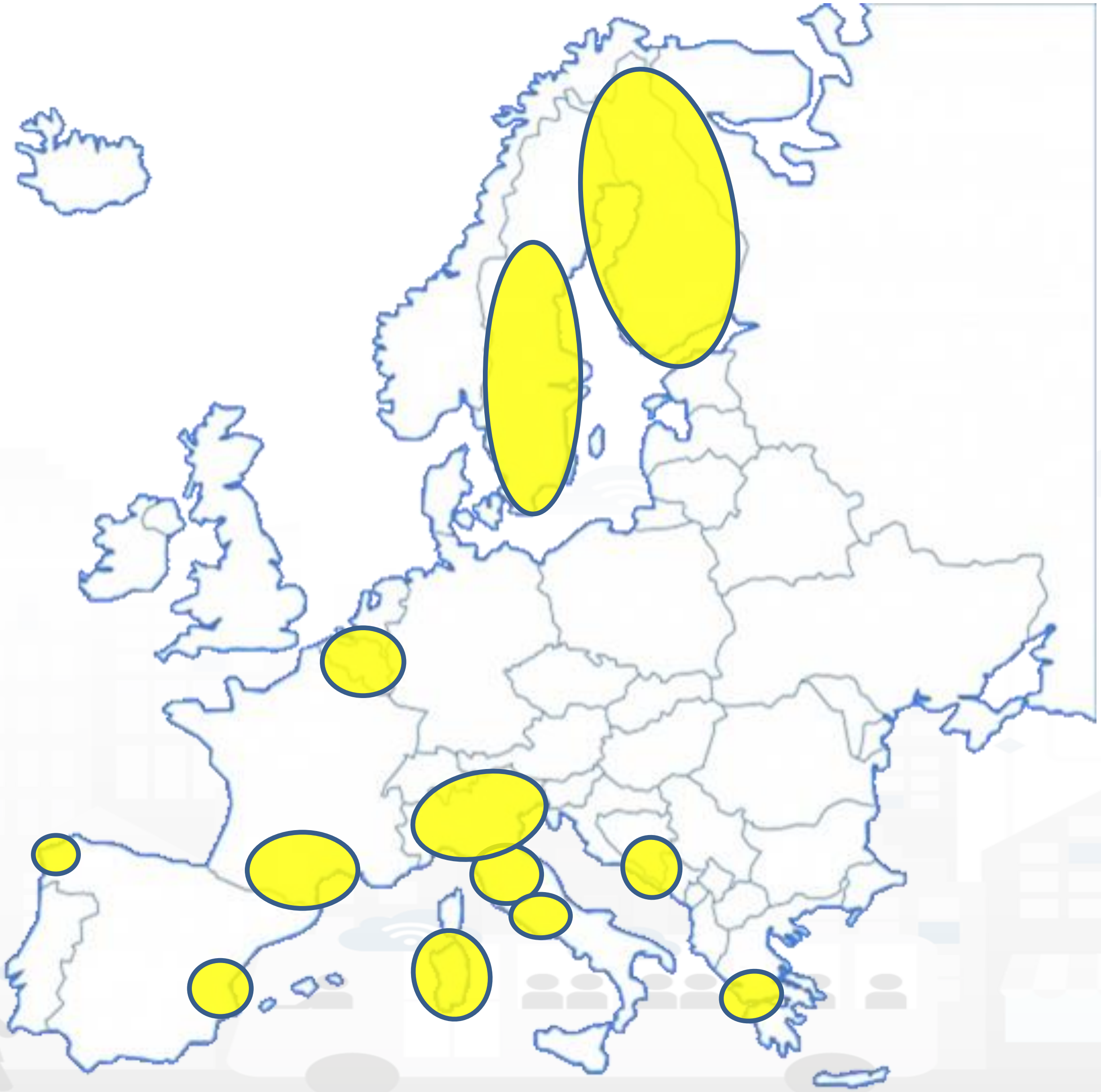
Snap4City/Industry structure

- The **Snap4xxxx** solution is released in Open Source, VM and Docker with fully support of MultiTenant/multiple-Organizations
  - Each Organization may be configured for a separate environment with a set of Maps, Menus, Users, Data, Dashboards, IOT Apps, MicroApplications, Custom Widgets, Models, resources, open data, etc.
- **Https://www.Snap4City.ORG** is the main instance of Snap4xxxx solution managed by DISIT Lab. The main documentation is located and updated on Snap4City.org, GitHUB, dockerHub and Node-Red Library. Snap4City.org is where the last tools are tested and news published.
  - Organizations on Snap4City.org have been created with contracts as for *Platform as a Service*, for testing and for providing *SmartCity as a Service* as well as *Industry 4.0 as a Service*

Coverage 2020

Main Organizations/areas

- Antwerp area (Be)
- Capelon (Sweden: Västerås, Eskilstuna, Karlstad)
- DISIT demo (multiple)
- Dubrovnik, Croatia
- Firenze area (I)
- Garda Lake area (I)
- Helsinki area (Fin)
- Livorno area (I)
- Lonato del Garda (I)
- Modena (I)
- Mostar, Bosnia-Herzegovina
- Pisa area (I)
- Pont du Gard, Occitanie (Fr)
- Roma (I)
- Santiago de Compostela (S)
- Sardegna Region (I)
- SmartBed (multiple)
- Toscana Region (I), SM
- Valencia (S)
- Venezia area (I)
- WestGreece area (Gr)



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Snap4City/Industry Community

- Most of Organizations on Snap4City.org also correspond to companies or institutions that have an installation of Snap4City tools on their Premise,
  – such as: Pisa, SmartGarda Lake, Snap4, ALTAIR, etc.
- This double way allows them to:
  – test the news,
  – share experiences with other groups,
  – get visibility,
  – work in the collaborative environment, and
  – be better supported by Snap4City.org and DISIT Lab personnel.
- Each instance of Snap4xxxx solution ***can decide to join the federation*** of Smart City API to exploit shared data.
  – This allows to exploit regional data for city installations applications (web, mobile, dashboards, etc.) without reloading them for example.

Main Organizations/areas

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- Capelon (Sweden: Västerås, Eskilstuna, Karlstad)
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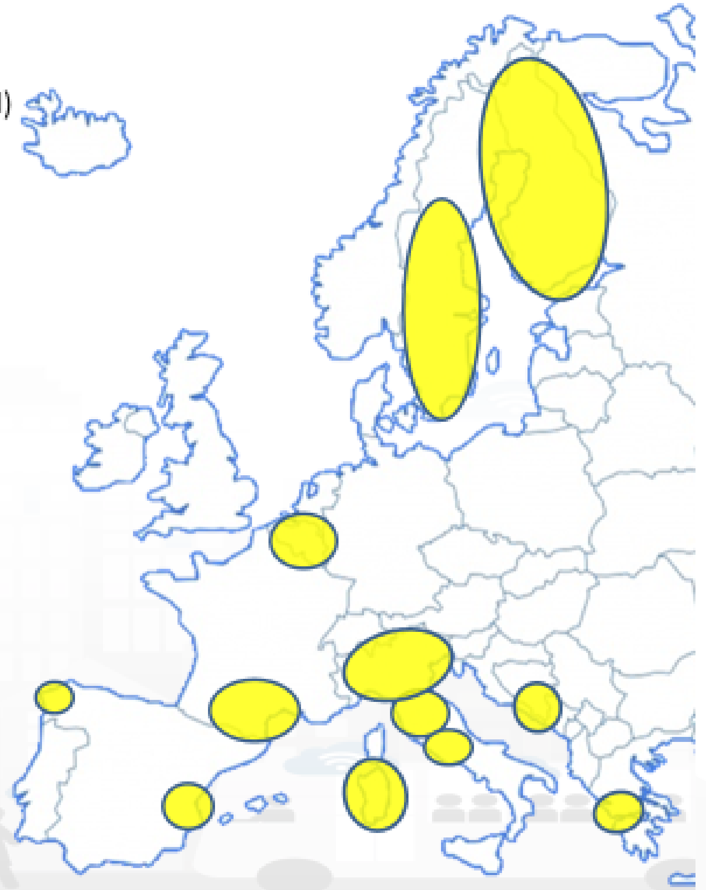
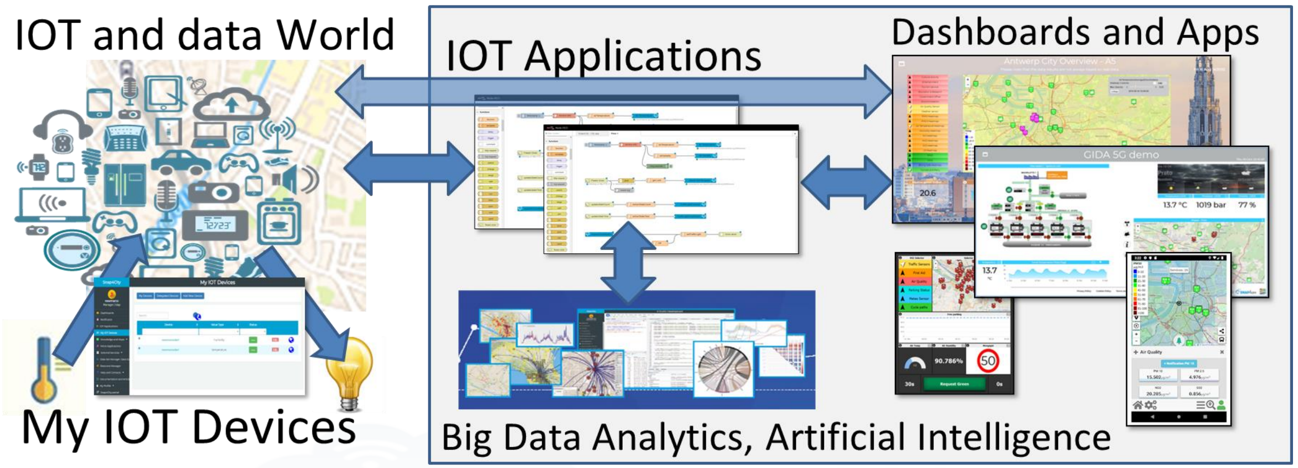


Snap4City (C), October 2020

Free Trial

- Register on WWW.snap4city.org
  - Subscribe on **DISIT Organization**
- **You can:**
  - Access on basic Tools
  - Access to a large volume of Data
  - Create Dashboards
  - Create IOT Applications
  - Connect your IOT Devices
  - Exploit Tutorials and Demonstrations



IF you need to go more in deep you can ask us to pass at the next Role becoming full AreaManager with full rights of development, also for Data Analytics, machine learning, etc.

https://www.snap4city.org/577

On Line Training Material (free of charge)

	1st part (*)	2nd part (*)	3rd part (*)	4th part (*)	5th part (*)	6th part (*)	7th part (*)
what	General	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App
PDF							
Inter active							
Video1							
Video2							
Video3							
Video4				none		none	none
duration	2:55	3:16	3:41	2:00	2:48	2:35	1:47

General Overview of the full Course 2021

- ***1st part:*** *General Overview*
- ***2nd part:*** *Dashboards Creation and Management*
- ***3rd part:*** *IOT Applications development, IOT Devices, IOT Networks*
- ***4th part:*** *Data Analytics, in R Studio, in Python, how to Exploit and Manage Data Analytics in IOT Applications*
- ***5th part:*** *Data Ingestion, Data Warehouse, Data Gate, IOT Device Data ingestion, IOT App for Data Ingestion, Interoperability, etc.*
- ***6th part:*** *Snap4City Development, Extension, Administration, and Installation*
- ***7th part****: Smart city API (internal and external) Web and Mobile App development tool kit*

A number of the training sections include exercitations

Updated versions on: https://www.snap4city.org/577

See also courses in ITALIANO: https://www.snap4city.org/485

this part Agenda

GO • **IOT App Smartening Dashboards and Solutions**
  – IOT App Smartening Devices and Dashboards, Smart Parking, IOT App vs Smart City Solutions
  – IOT App Smart Industry 4.0 Snap4Industry, ModBus Integration
  – IOT App vs Smart Home Snap4Home, Moving IOT Devices / Sensors, Tracking Devices

GO • **Managing IOT Applications and Containers all**
  – Remote control of IOT Applications on IOT edge devices, and Containers all

GO • **Creating IOT Applications with Node-RED**
  – Node-RED Hello World

GO • **IOT App = Node-RED + Snap4City**
  – IOT App = Node-RED + Snap4City solution, demo, Synoptics, NGSI
  – IOT App self training, IOT App examples, IOT App and Dashboard Integration, dynamic widgets, IOT App vs Synoptics in real time data driven

GO • **Data Analytics and web Scraping**
  – IOT App vs Data Analytics: R-Studio, Python; IOT App and web scraping,

GO • **IOT App = Node-RED + Snap4City examples**
  – Demo + exercises, Data processing with IOT Applications

GO • **Integration of External Services into IOT Applications**
  – Integration/Automating with: Ticketing Systems Workflow, Twitter Vigilance for social media analysis, CKAN open data portals
  – Automated production of MicroServices for IOT app from External REST CALL APIs
  – Integration with Telegram: SnapBot Solution

GO • **IOT Network Management and Control**
  – IOT Networks on Snap4City, Data Ingestion Strategy, IOT Broker Registration, IOT Brokers with Service paths, IOT Brokers with MultiTenant
  – IOT Directory, IOT Device vs Time Series, IOT Device Model, IOT Device Management, IOT Device Registration, exploiting model

GO • **Complete examples**
  – Time Series, automating security, IOT device moving sensors
  – Snap4City Self training sources

GO • **IOT Devices hardware-software integration**
  – Open and Proprietary devices, Open HW and Open SW, IOT Devices, IOT Gateway, IOT Edge (Arduino, Raspberry, etc.)
  – (IBE CNR, Libelium, SIGFOX, Lora..), IOT Gateway/IoT Edge, IOT Tracking devices

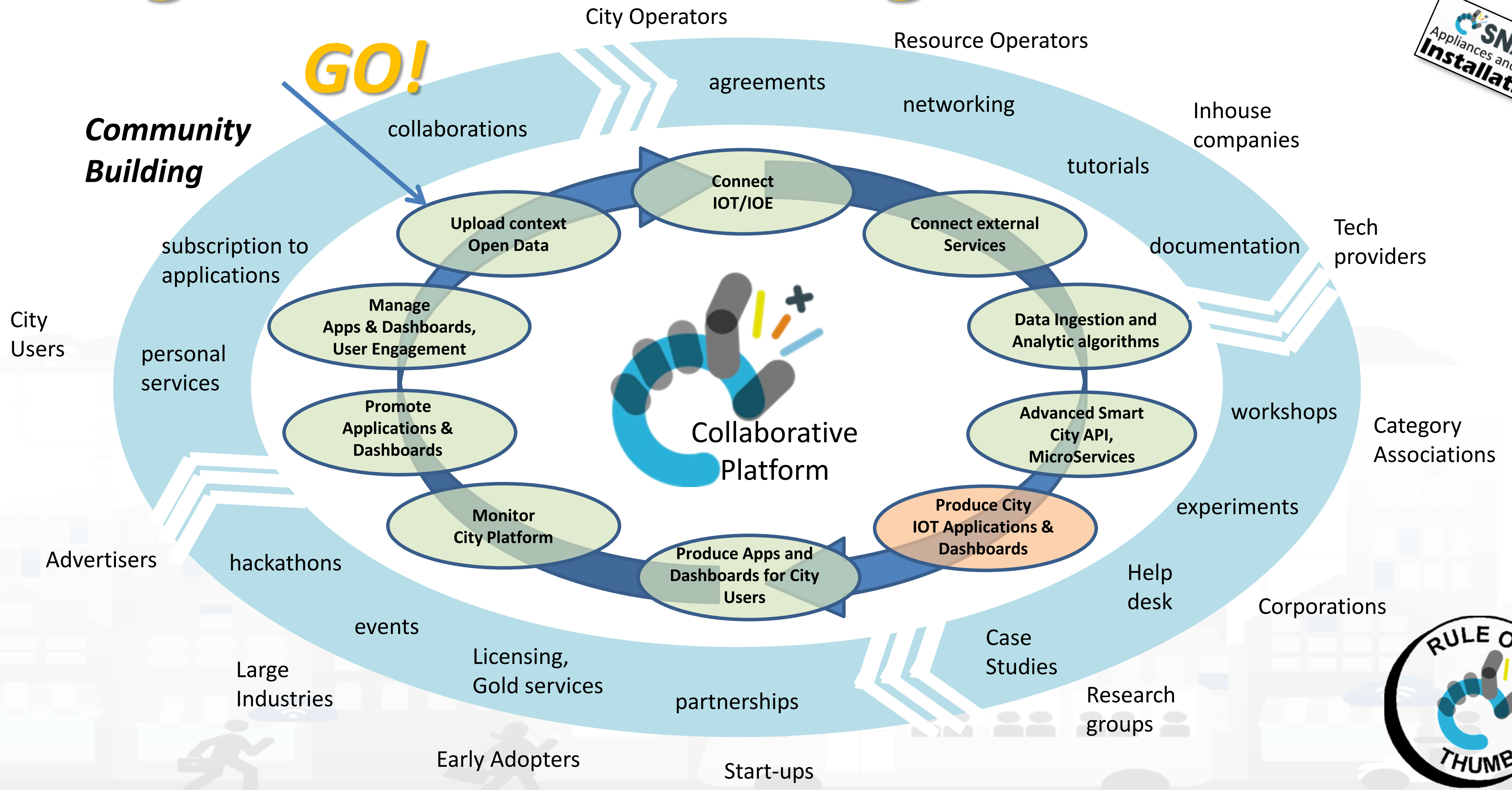
GO • **IOT end-2-end Secure Stack, IOT ←→ Dashboards**

GO • **Comparison with other Platforms and Fi-Ware**
  – FiWare & Snap4City

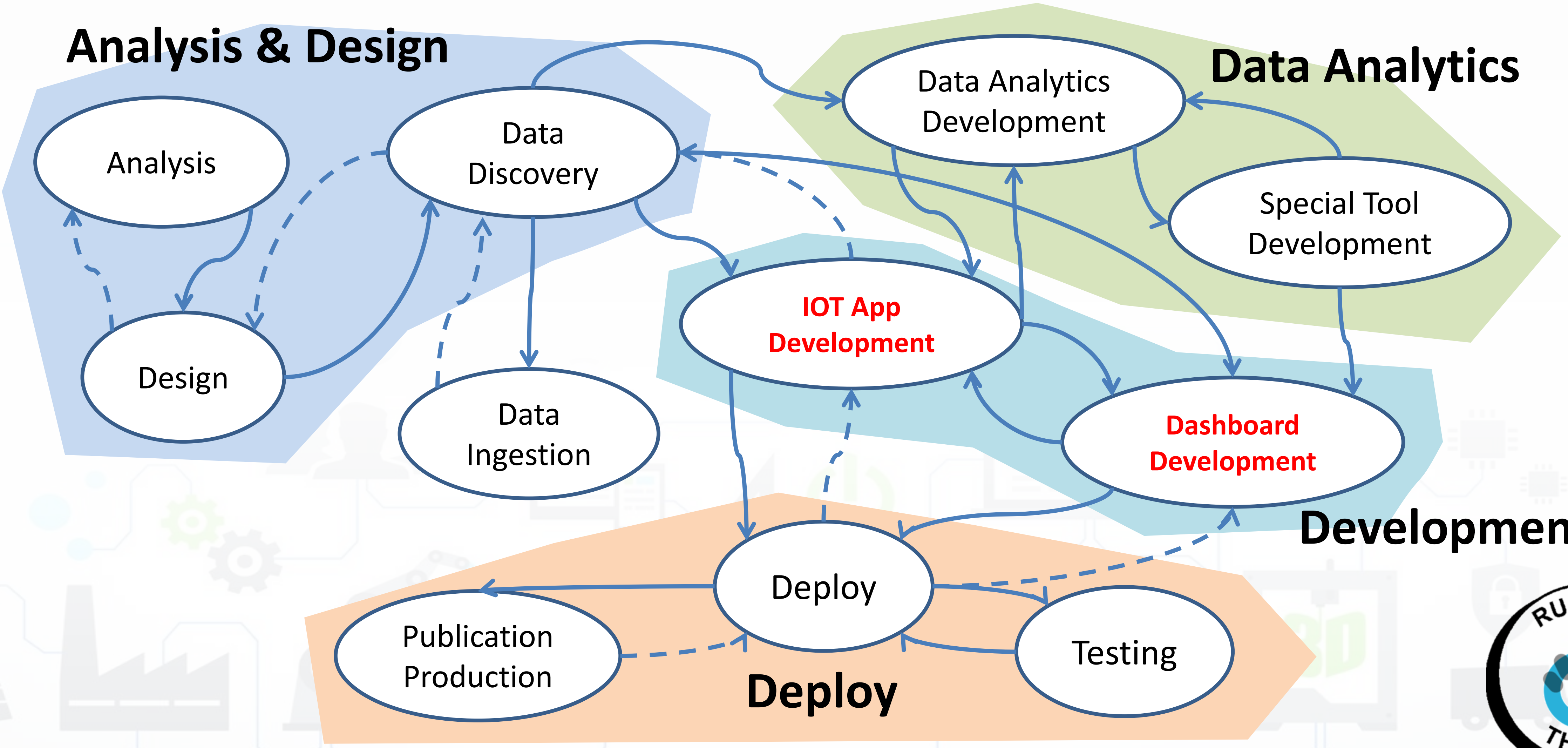
GO • **Acknowledgments**

Living Lab Accelerating

GO!



Development Life Cycle
Smart City Services



Levels of Difficulty

• Easy.		non programmer level
• Moderate.		Some JavaScript rudiment coding
• Good.		JavaScript programming
• Golden.		Programming in R Studio
• Professional.		Exploiting Smart City API
• Excellent.		Developing Full IOT Applications, Dashboard and Mobile Apps

TOP

IOT App for Smartening Solutions

URBAN PLATFORM: SMART CITY IOT AS A SERVICE AND ON PREMISE

100% OPEN SOURCE

APPLIANCES CONTAINERS

- LOCAL GOVERN
- STAKEHOLDERS
- CITY USERS
- IN-HOUSE
- ENERGY OPERATORS
- MOBILITY OPERATORS
- COMMERCIAL OPERATORS
- SECURITY OPERATORS
- INDUSTRIES
- RESEARCHERS
- START-UPS
- ASSOCIATIONS

- GDPR
- SECURITY
- PRIVACY
- ASSESSMENT
- AUDITING
- PENTESTED

- OPEN IOT DEVICES
- IOT EDGE
- IOT GATEWAY
- PAX COUNTERS
- IOT BUTTONS

- TEST CASES, SCENARIOUS, VIDEOS, HACKATHONS
- OPEN SOURCES, COMMUNITY OF CITIES
- TRAINING TUTORIALS, COMMUNITY MANAGEMENT

IOT APPLICATIONS - INSTANT APPS

DATA DRIVEN APPLICATIONS • REAL TIME PROCESSING • BATCH PROCESSING • ANY PROTOCOL & FORMAT

DASHBOARDS & APPLICATIONS

CONTROL ROOM • SITUATION ROOM • OPERATOR DASHBORDS • BUSINESS INTELLIGENCE • WHAT-IF ANALYSIS • DECISION SUPPORT • SIMULATIONS • RISK ANALYSIS • RESILIENCE ANALYSIS

MOBILE & WEB APPLICATIONS

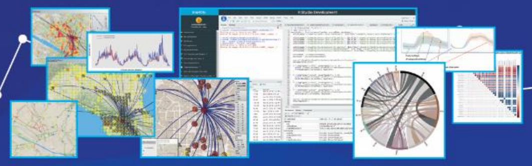
DEVELOPMENT KIT • SUGGESTIONS • MOBILE APPS • MONITORING PANELS • PLATFORM UTILITIES • READY TO USE SMART APPLICATIONS

MICROSERVICES & ADVANCED SMART CITY API

LIVING LAB - DEV TOOLS - COWORKING

IOT DIRECTORY • SERVICE MAP • RESOURCE MANAGER • DATA GATE • R STUDIO • ETL

BIG DATA - DATA ANALYTICS



DATA ANALYTICS TOOLS - MICRO-APPLICATIONS

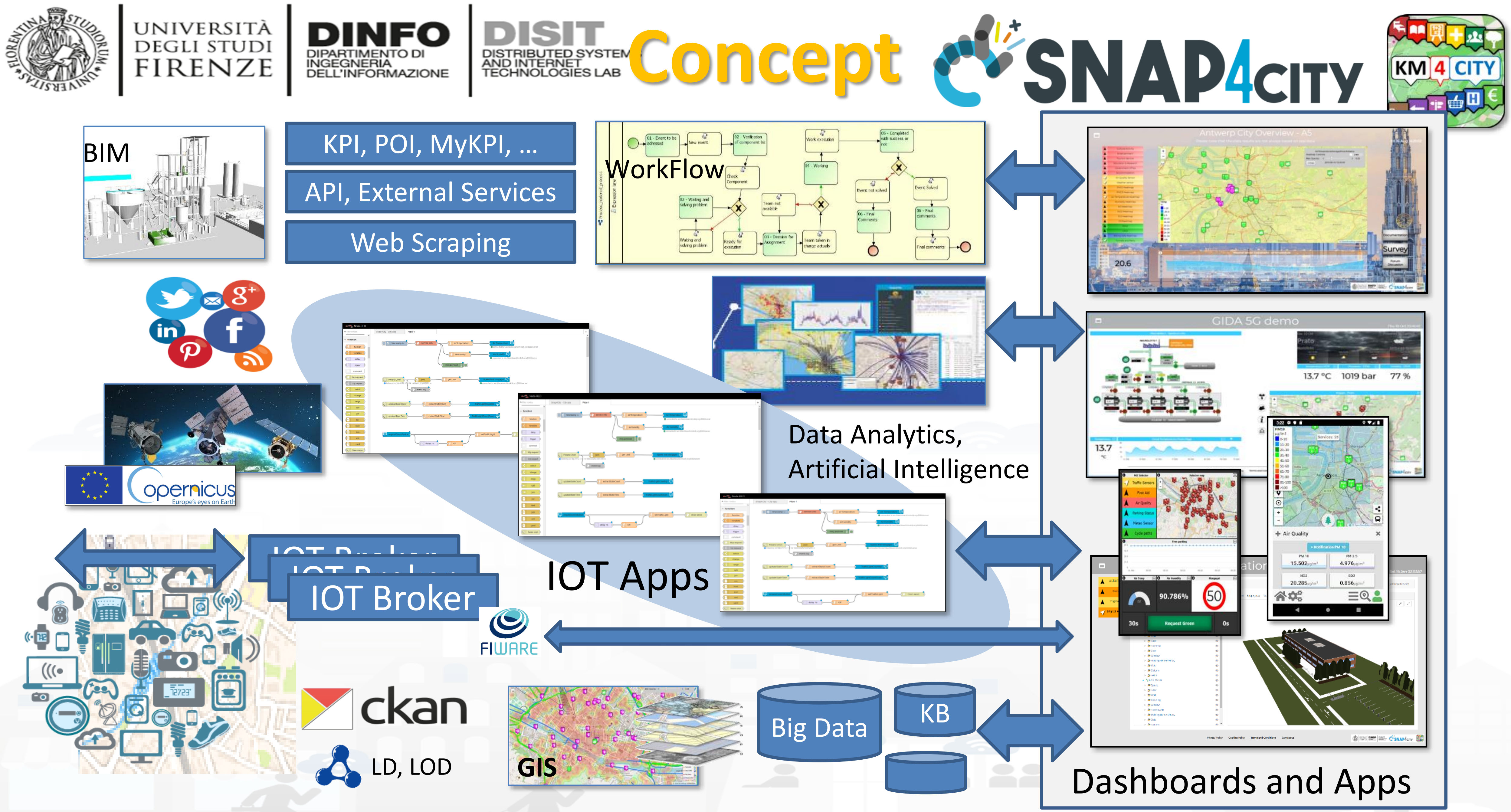
PREDICTIONS • ANOMALY DETECTION • WHAT-IF ANALYSIS • TRAFFIC FLOW RECONSTRUCTION • ORIGIN-DESTINATION MATRICES • SOCIAL MEDIA ANALYSIS • OFFER VS DEMAND ANALYSIS • ENVIRONMENTAL DATA ANALYSIS AND PREDICTIONS • REAL TIME HEATMAPS • ROUTING • ALERTING • EARLY WARNING • PERSONAL AND VIRTUAL ASSISSTANTS • SMART SOLUTIONS • SMART SHARING • PARTECIPATORY

KM4CITY DATA AGGREGAT KNOWLEDGE BASE - EXPERT SYSTEM OF THE CITY – BIG DATA STORE

IOT MNG - DATA MNG - DATA INSPECTOR – PROCESS MNG – USER ENGAGEMENT – GDPR MNG ...

GIS	CITY UTILITIES	OPEN DATA	LEGACY & EXTERNAL SERVICES	PERSONAL DATA	IOT / IOE	BROKERS	KPI	INDUSTRY 4.0	SOCIAL MEDIA

Concept



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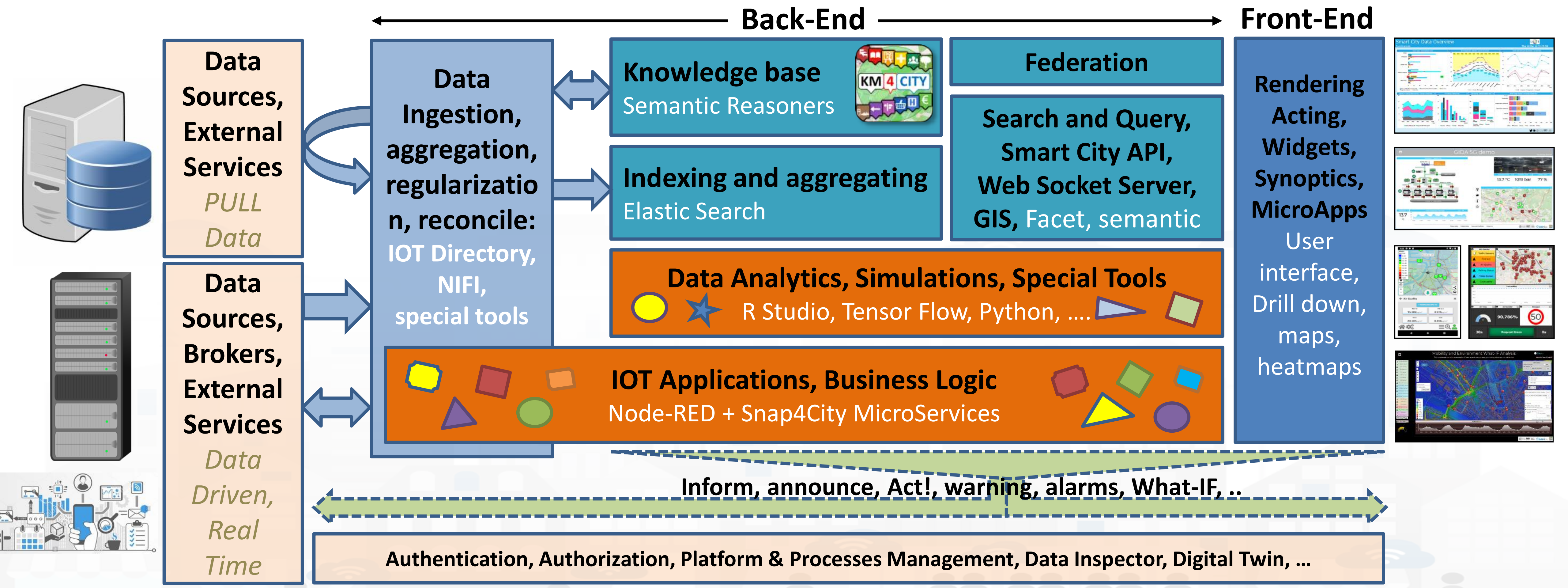
SNAP4CITY
KM4CITY
BIM
KPI, POI, MyKPI, …
API, External Services
Web Scraping
WorkFlow
Data Analytics,
Artificial Intelligence
opernicus
Europe's eyes on Earth
IOT Broker
IOT Apps
FIWARE
ckan
LD, LOD
GIS
Big Data
KB
Antwerp City Overview
GIDA 5G demo
Dashboards and Apps

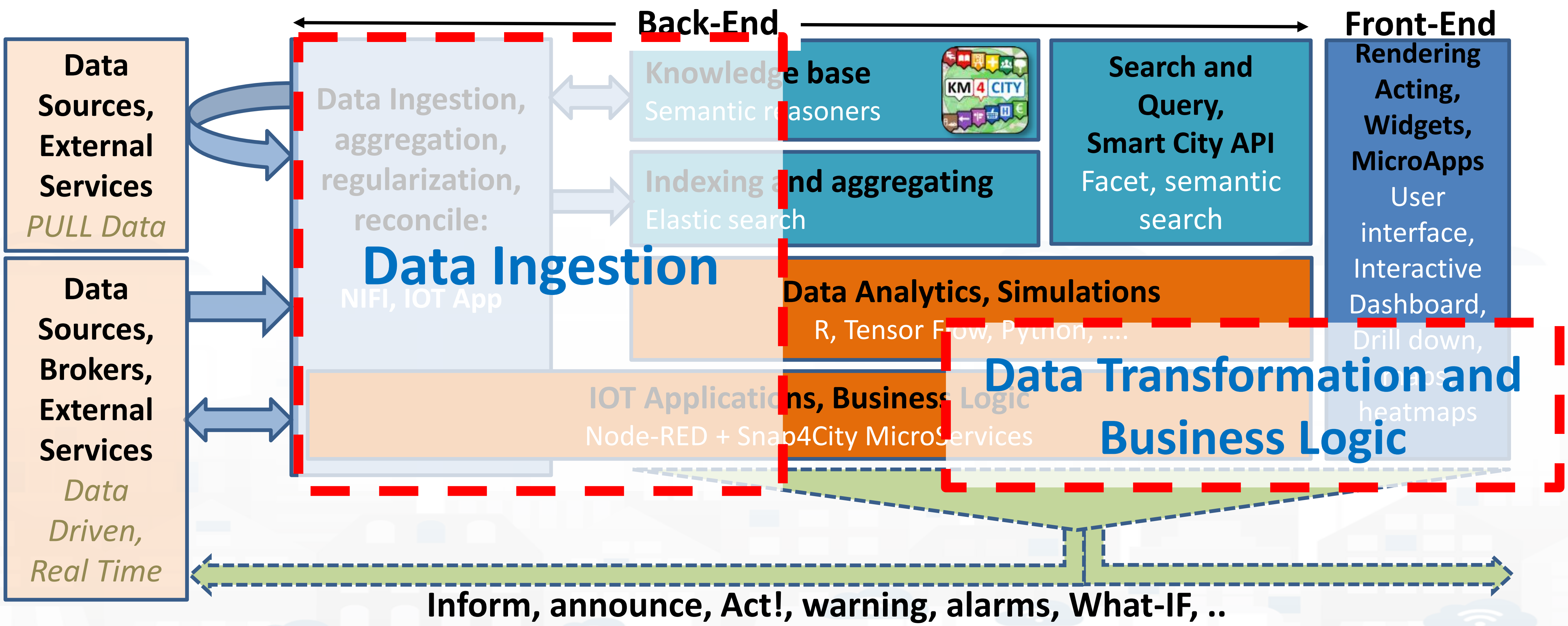
Snap4City, Snap4Industry Architecture, V2 (2020)



The usage of IOT Applications

- IOT Applications = Node-RED + Snap4City Libraries
- Used for:
  - **Data Ingestion, Transformation, Extract, Load, and Adaptation** (format and protocol), See Part 5 of the Course
  - **IOT Edge Devices logic**, for implementing logic on IOT Edge, including **IOT Device control** (see on Part 3 of the course, this part)
  - **Business Logic** control of Dashboards, via Web Sockets secure
    - see Part 2 of the Course
  - **Control and schedule of Data Analytic**, and Machine Learning (see part 4 of the Course)
  - **Firing and condition identification and alerting**.

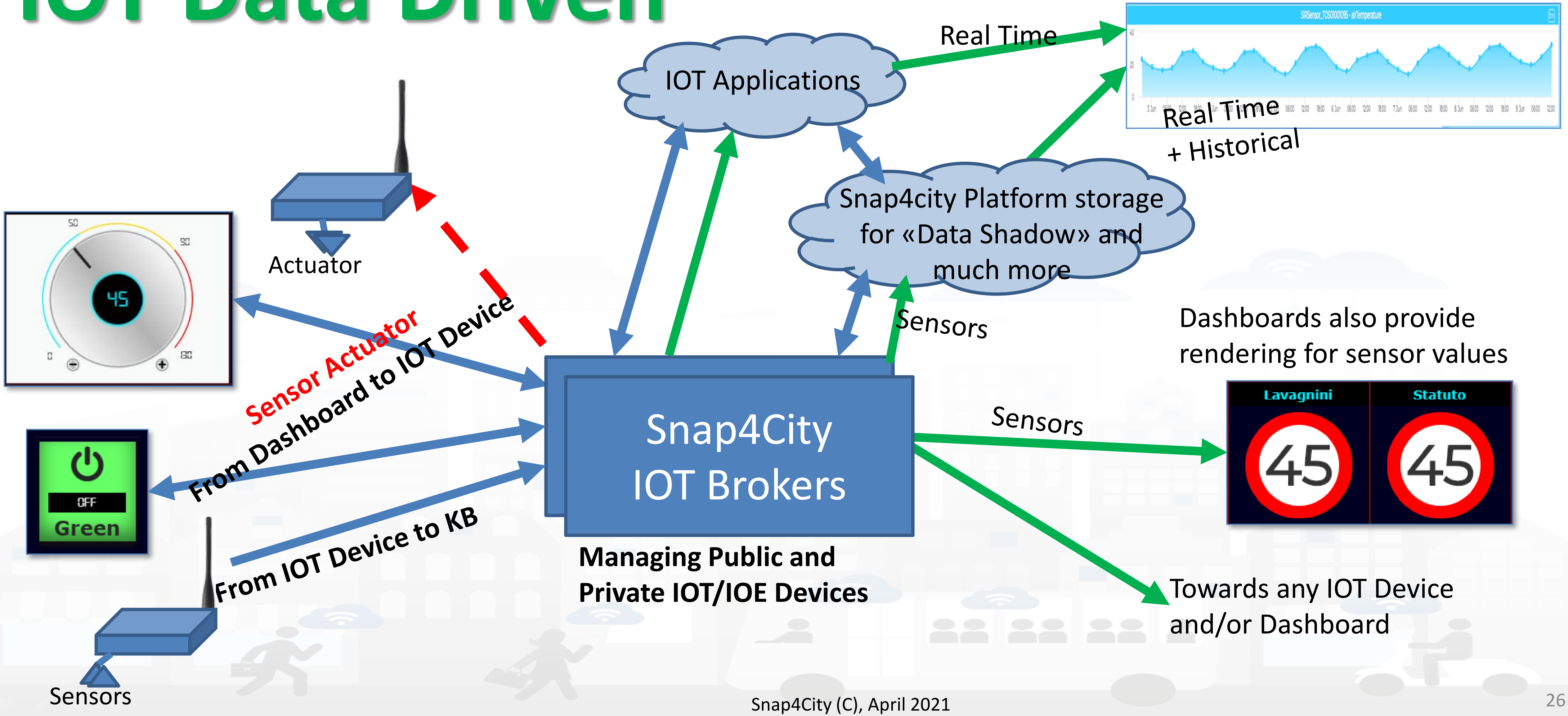
Snap4City Architecture vs Data Ingestion



Standards and Interoperability

Compliant with: AMQP, COAP, MQTT, OneM2M, HTTP, HTTPS, TLS, Rest Call, SMTP, TCP, UDP, NGSI, LoRa, LoRaWan, TheThingsNetwork, SigFOX, DATEX II, SOAP, WSDL, Twitter, FaceBook, Telegram, SMS, OLAP, MySQL, Mongo, HBASE, SOLR, SPARQL, EMAIL, FTP, FTPS, WebSocket, WebSocket Secure, ModBUS, OPC, GML, RS485, RS232, WFS, WMS, ODBC, JDBC, Elastic Search, Phoenix, XML, JSON, CSV, db, GeoJSON, Enfuser FMI, Android, Raspberry Pi, Local File System, ESP32, Libelium, IBIMET/IBE, OBD2, SVG, XLS, XLSX, TXT, HTML, CSS, KNX, Enocean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, BACnet, TALQ, Copernicus, Protocol Buffer, IFC, XPDL, etc.

IOT Data Driven



TOP

IOT App Smartening Dashboards

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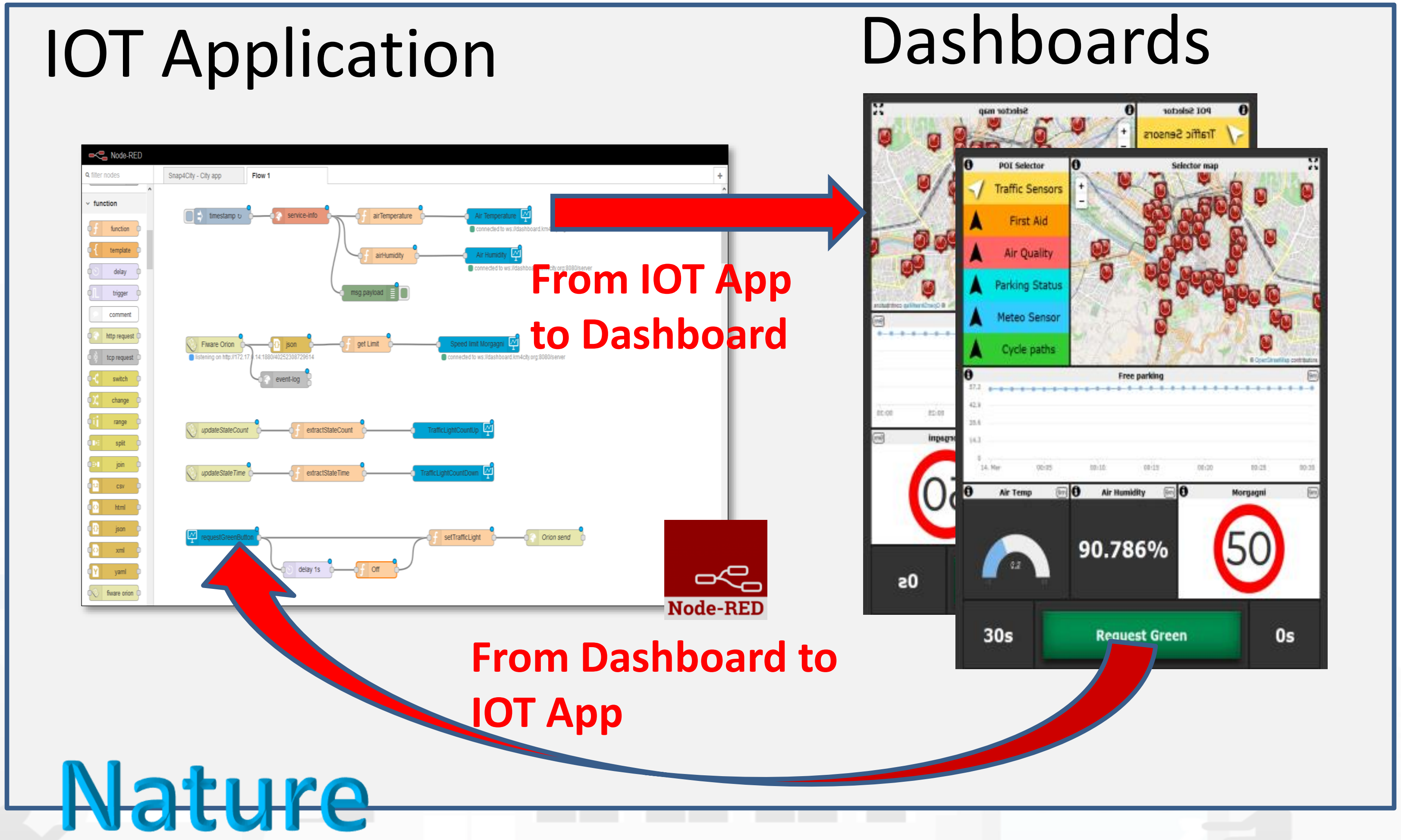
HLT: Sensors-Actuators

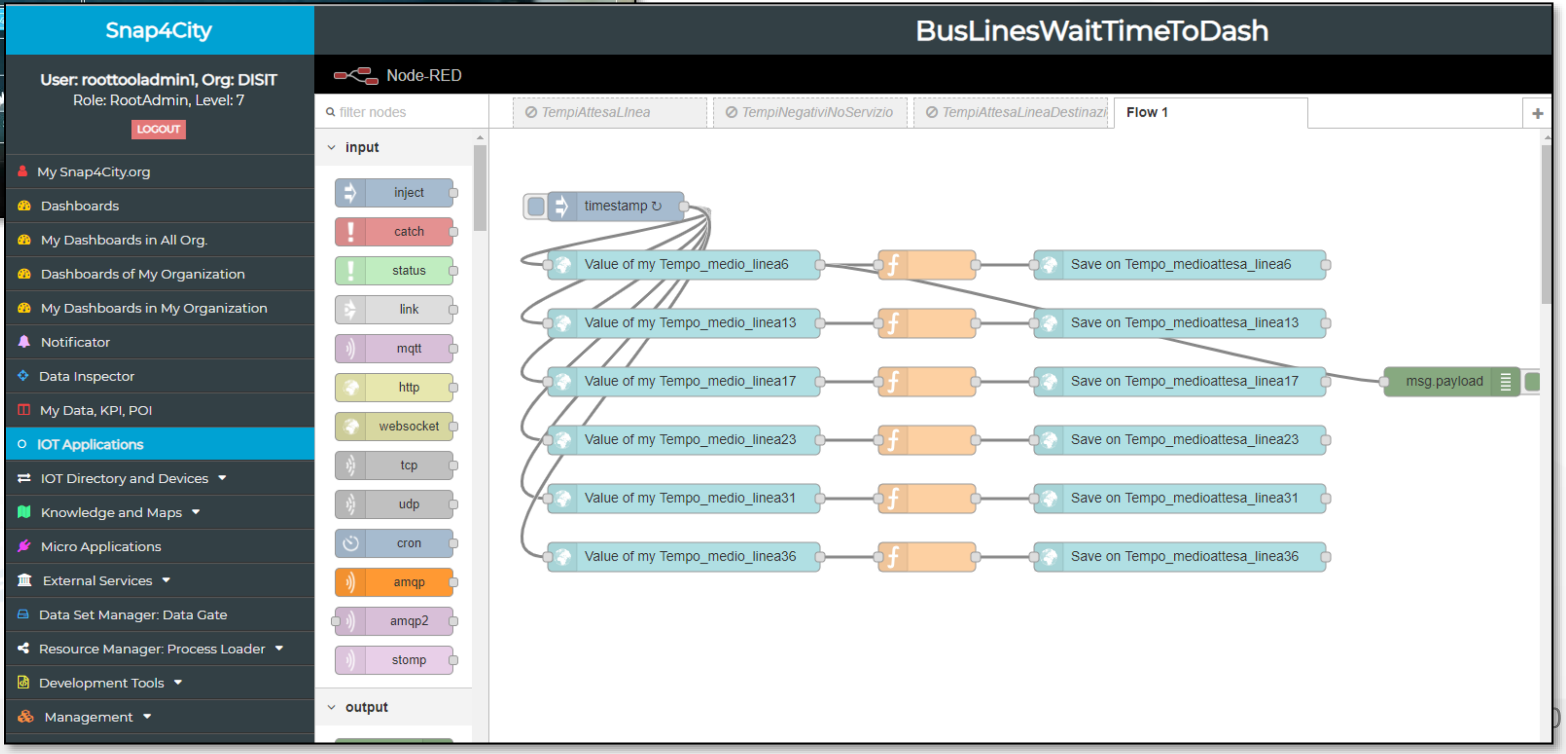
High Level Types

- **Complex Event**
- **Dashboard-IOT App**
- **External Service**
- **Heatmap**
- **KPI (Key Performance Indicator)**
- **MicroApplication**
- My Personal Data
- MyKPI
- MyPOI
- **POI (Point of Interest)**
- **Sensor**
- **Sensor Actuator**
- **Special Widget**
- Wfs (GIS)



Florence

Estimation of the mean waiting time at bus stops



Antwerp

TOP

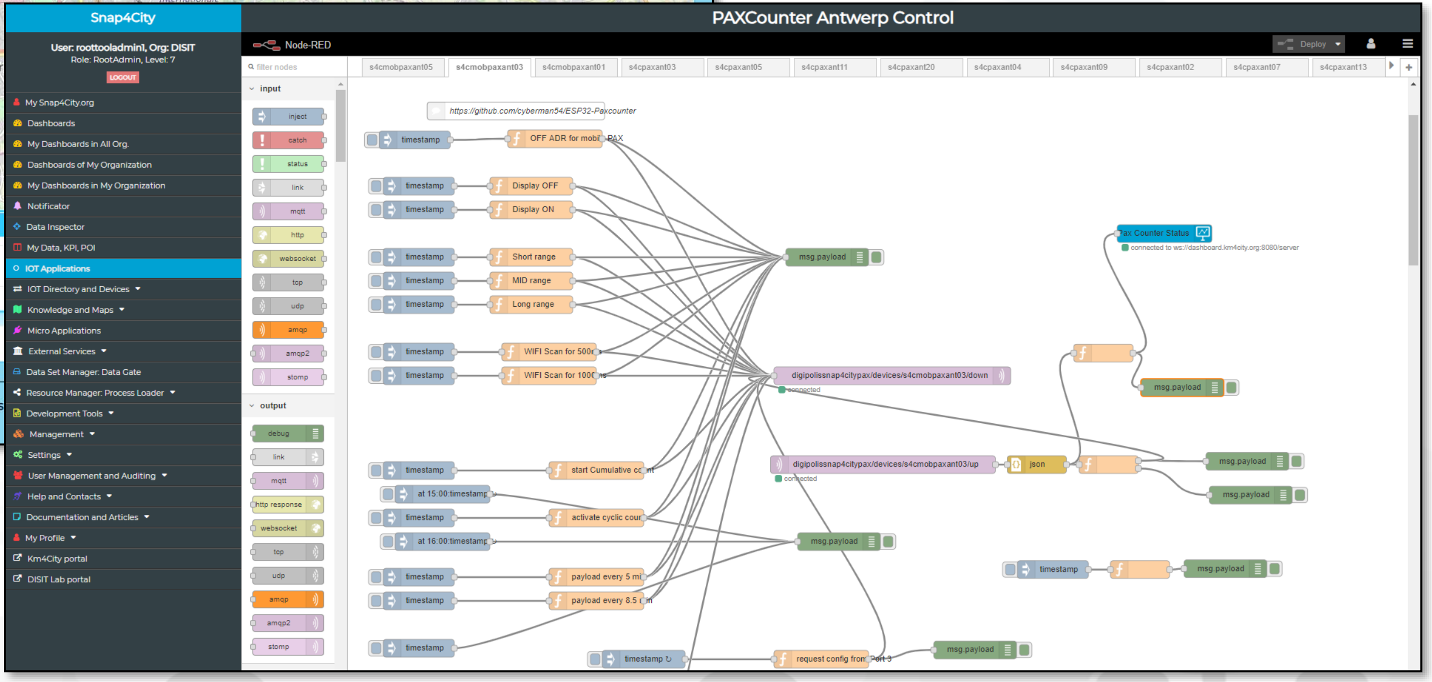
IOT App Smartening Devices and Dashboards

PaxCounter devices

- **Fix PaxCounter LoraWan**
  - sniffing on: Wi-Fi, Bluetooth
  - Sending data via LoraWan
- **Mobile PaxCounter LoraWan**
  - sniffing on: Wi-Fi, Bluetooth
  - Sending data via LoraWan
- **Fix PaxCounter, multiple out**
  - Sending data via LoraWan and Wi-Fi
  - sniffing on: Wi-Fi, Bluetooth

https://www.snap4city.org/456

Programmable PAX counting



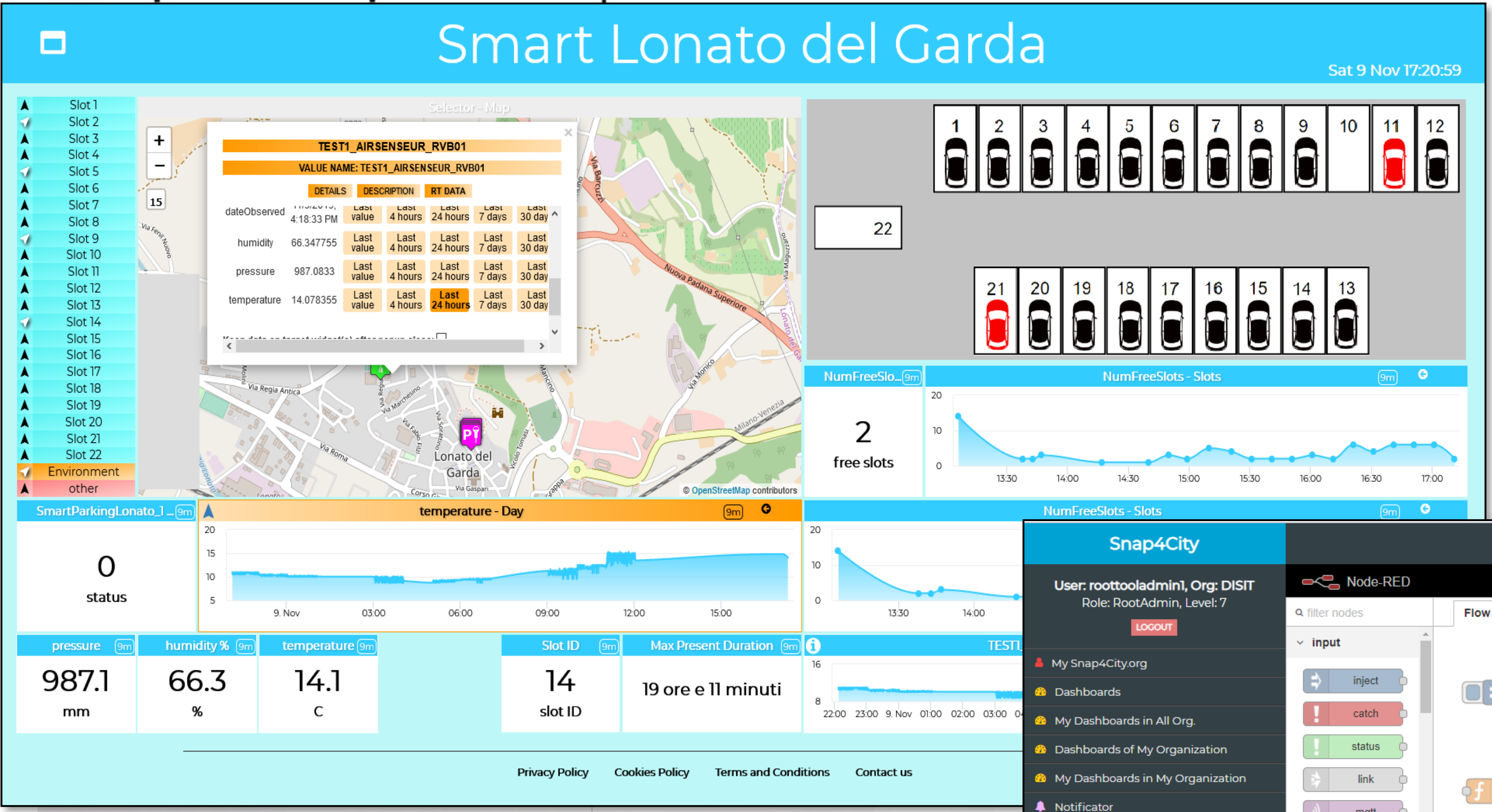
Antwerp

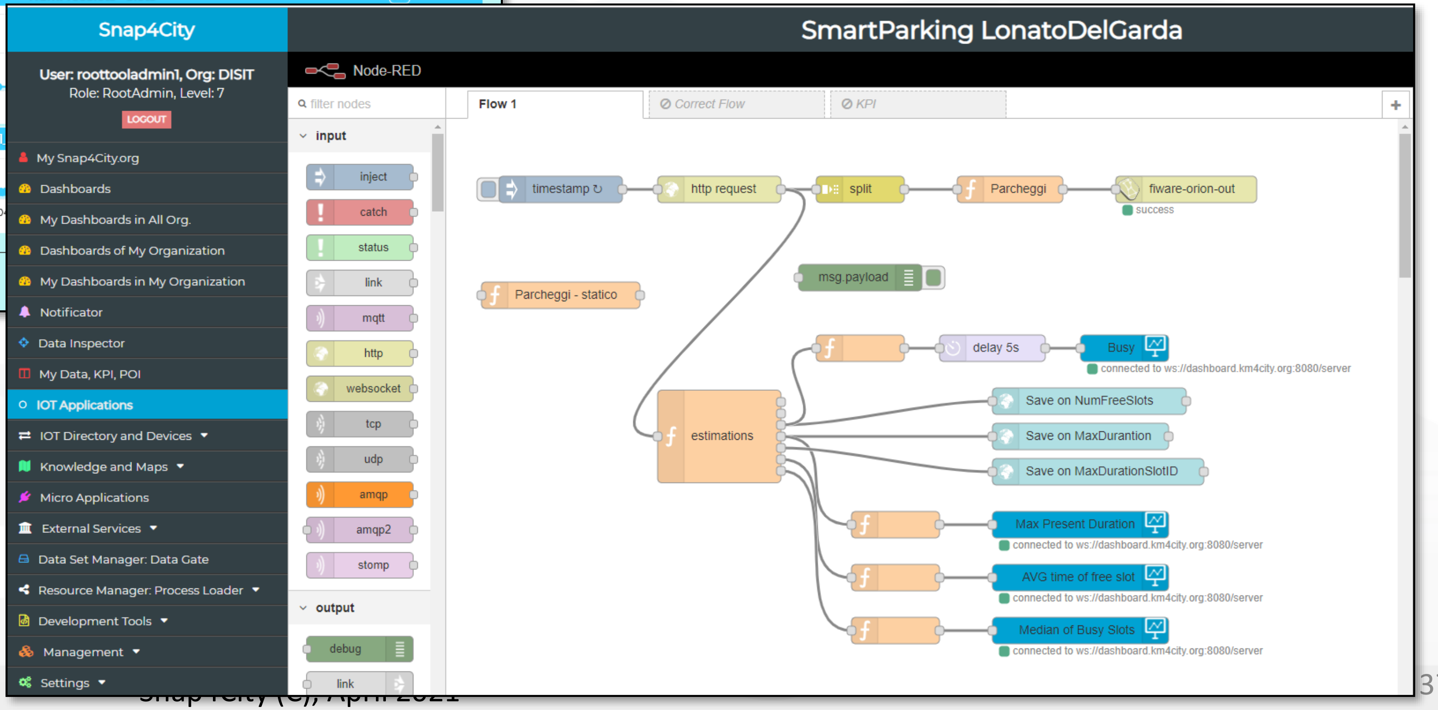
TOP

IOT App Smart Parking


Lonato del Garda

Smart Parking Monitoring





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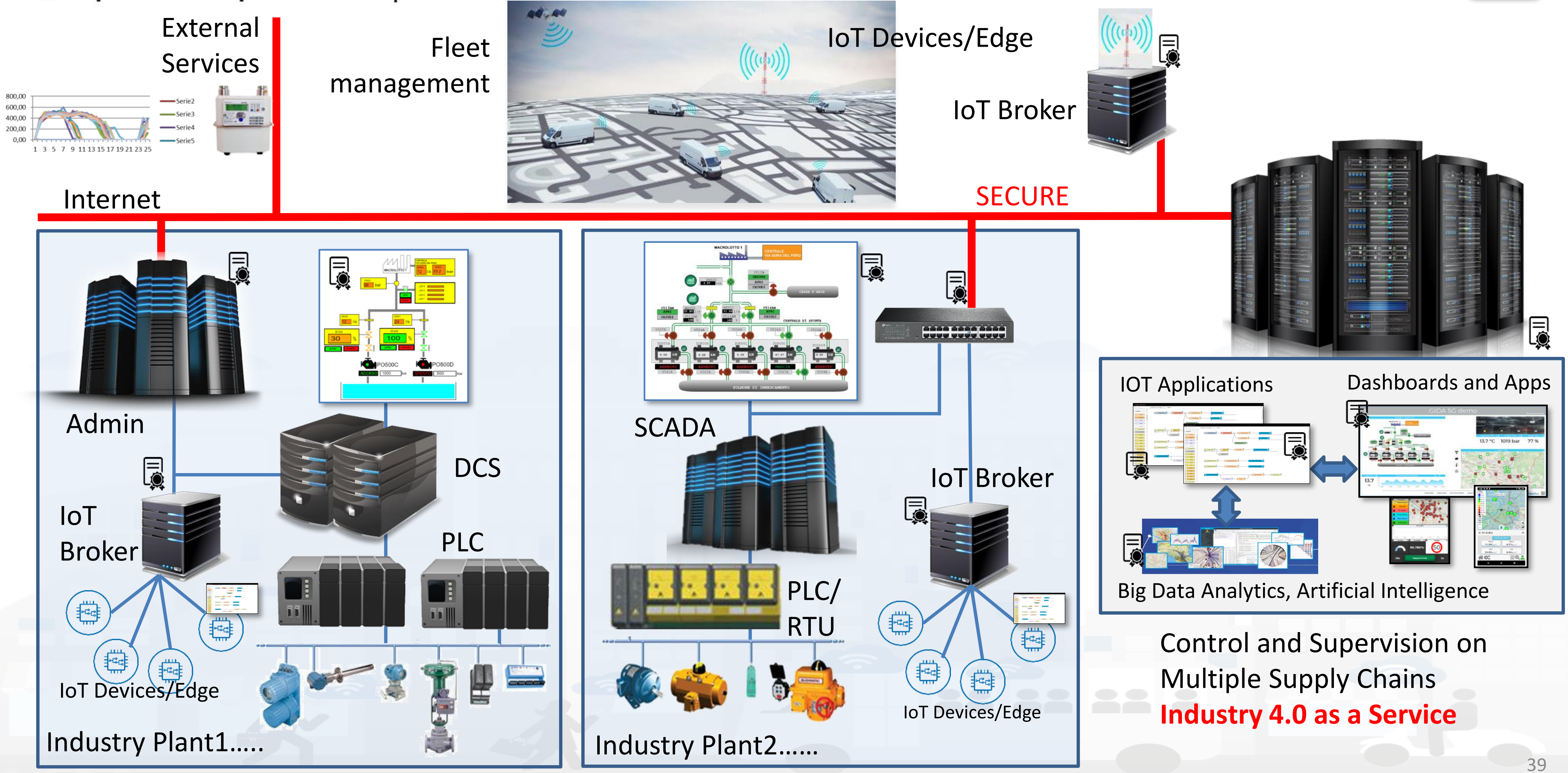
IOT App Smart Industry 4.0
Snap4Industry

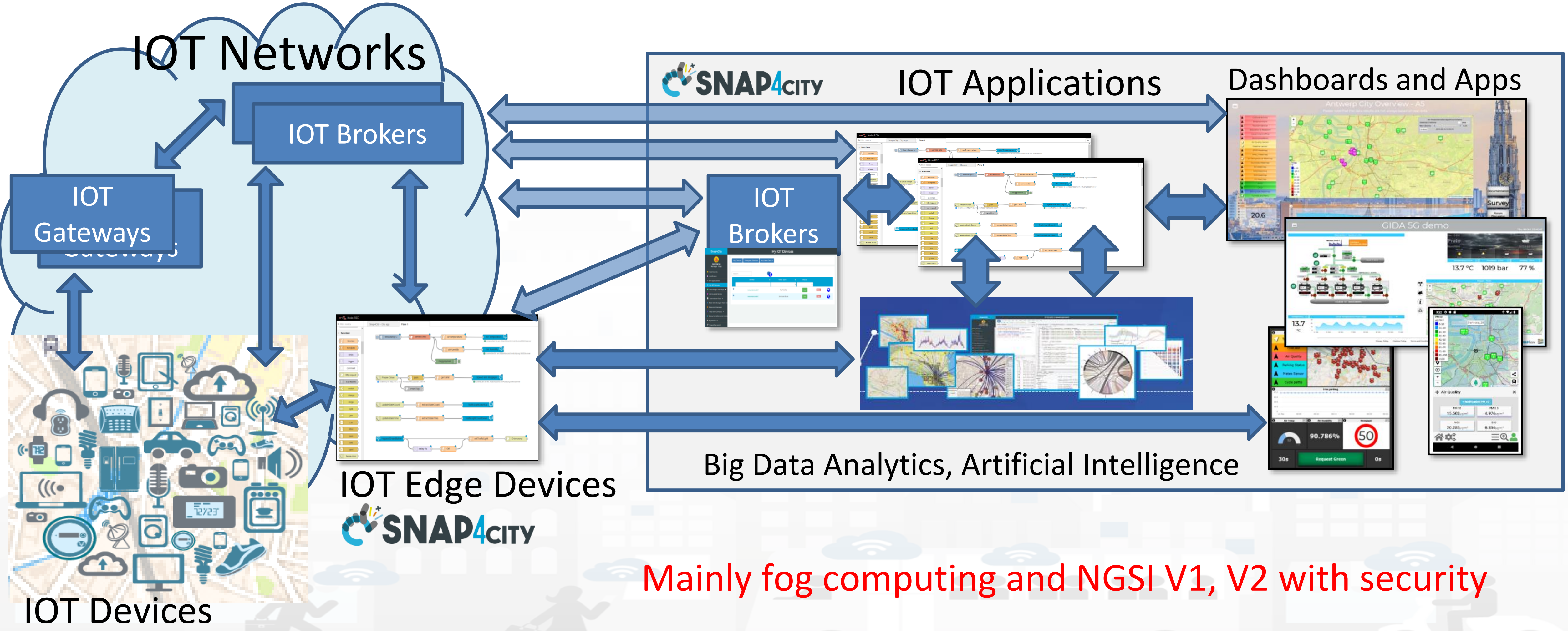
https://www.snap4city.org/369



Control and Supervision on Multiple Supply Chains

Industry 4.0 as a Service

Snap4City Services also on IOT Edge!!!

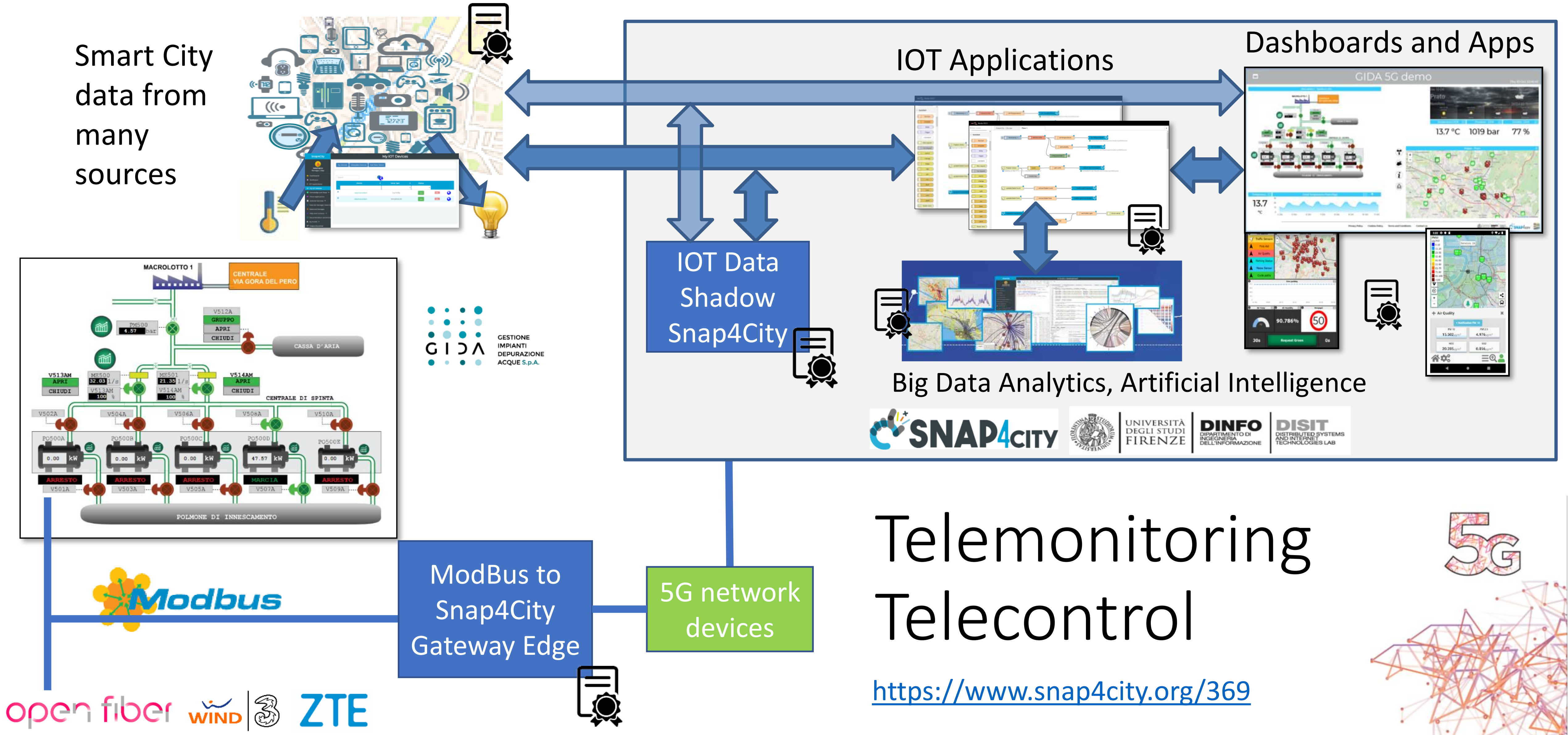


Mainly fog computing and NGSI V1, V2 with security


Prato
Smart City vs Industry 4.0

GIDA set up

GESTIONE IMPIANTI DEPURAZIONE ACQUE S.p.A.



Telemonitoring
Telecontrol

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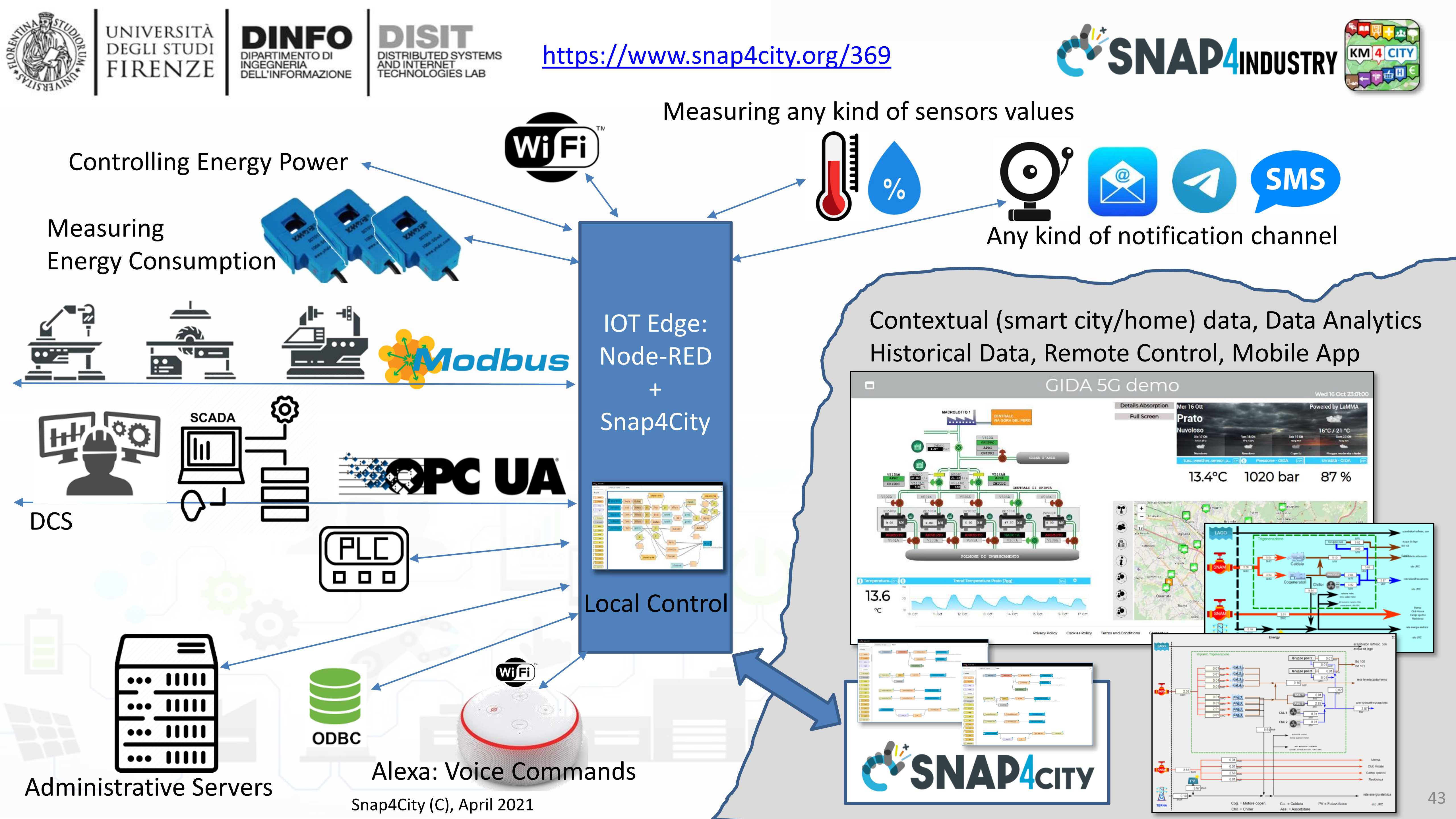
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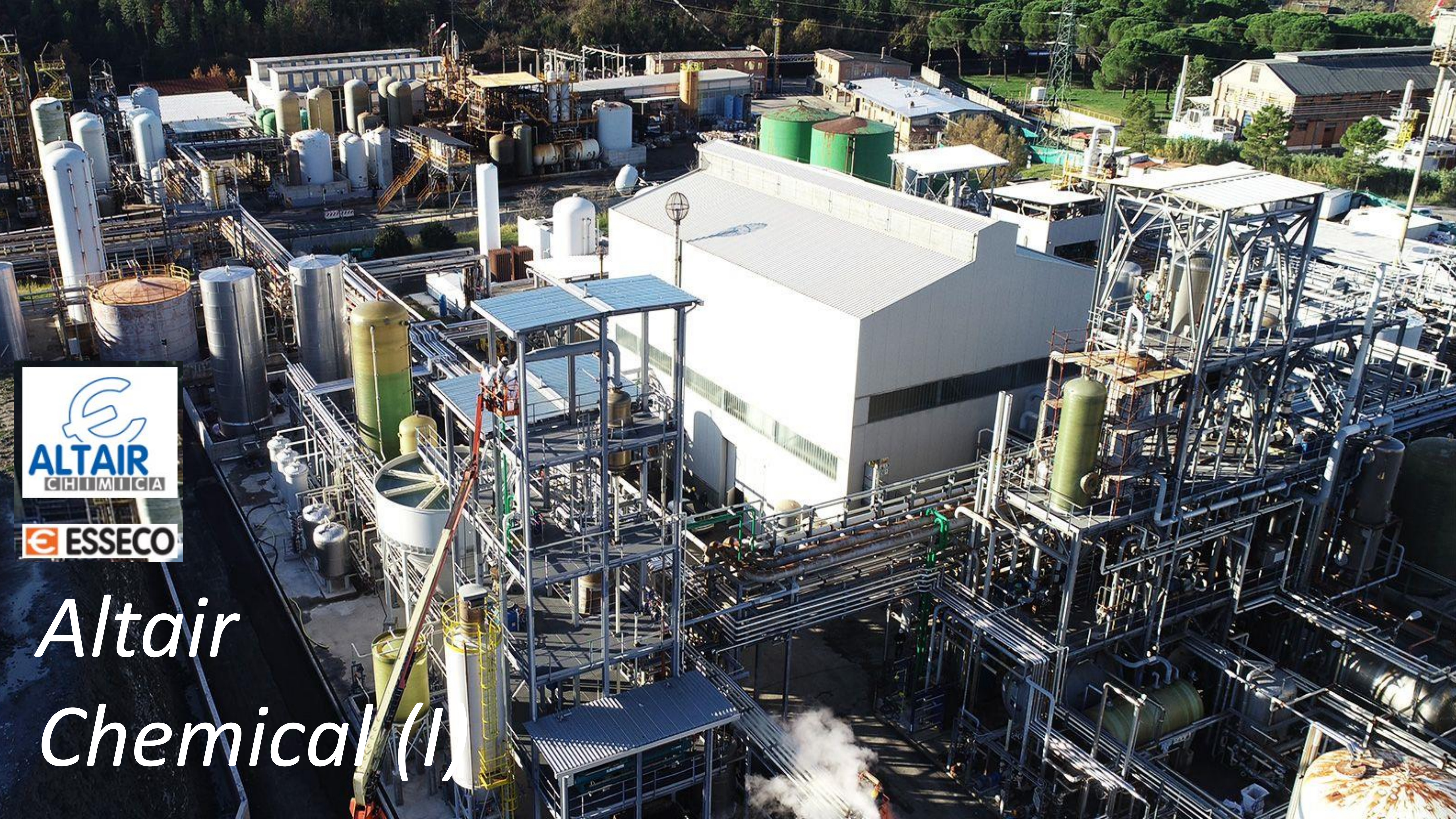
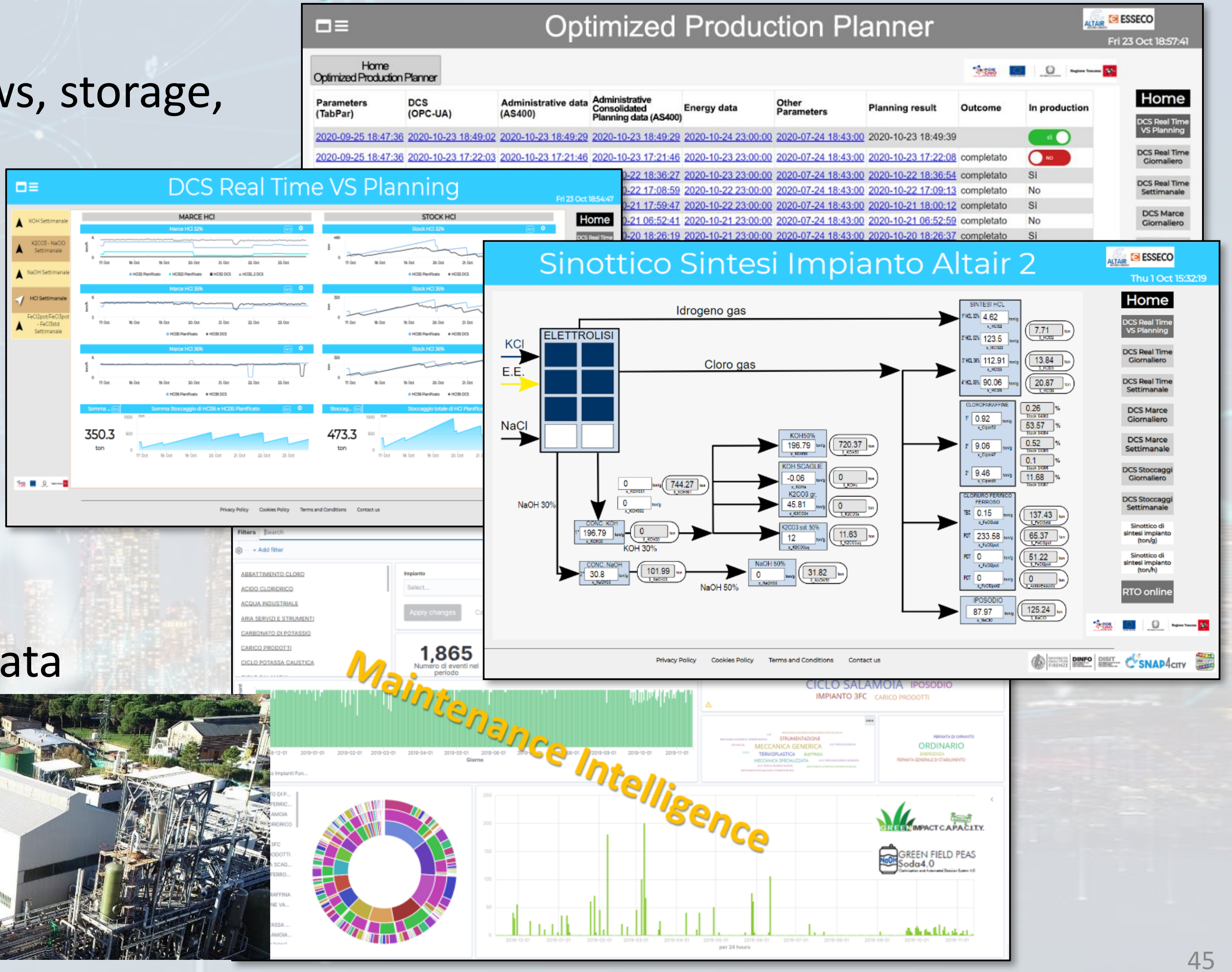
SNAP4INDUSTRY
KM4CITY
Measuring any kind of sensors values
Controlling Energy Power
Wi Fi
Measuring Energy Consumption
SMS
Any kind of notification channel
IOT Edge: Node-RED + Snap4City
Local Control
Modbus
SCADA
OPC UA
DCS
PLC
Contextual (smart city/home) data, Data Analytics
Historical Data, Remote Control, Mobile App
GIDA 5G demo
Prato
13.4°C
1020 bar
87 %
13.6
ODBC
Administrative Servers
Alexa: Voice Commands
SNAP4CITY

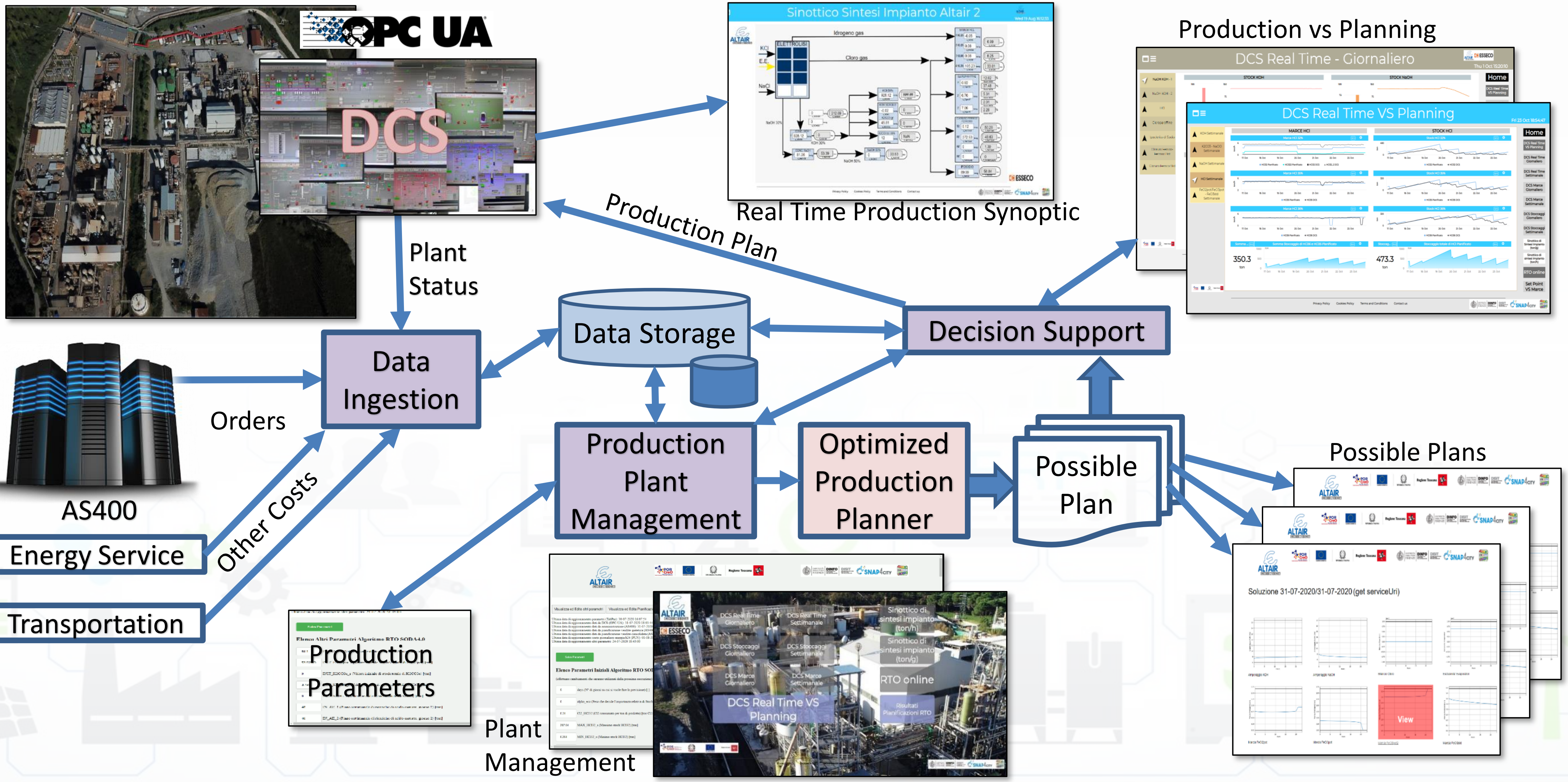

ALTAIR
CHIMICA
ESSECO
Altair Chemical (I)

Snap4Altair Decision Support supervision and control, Industry 4.0

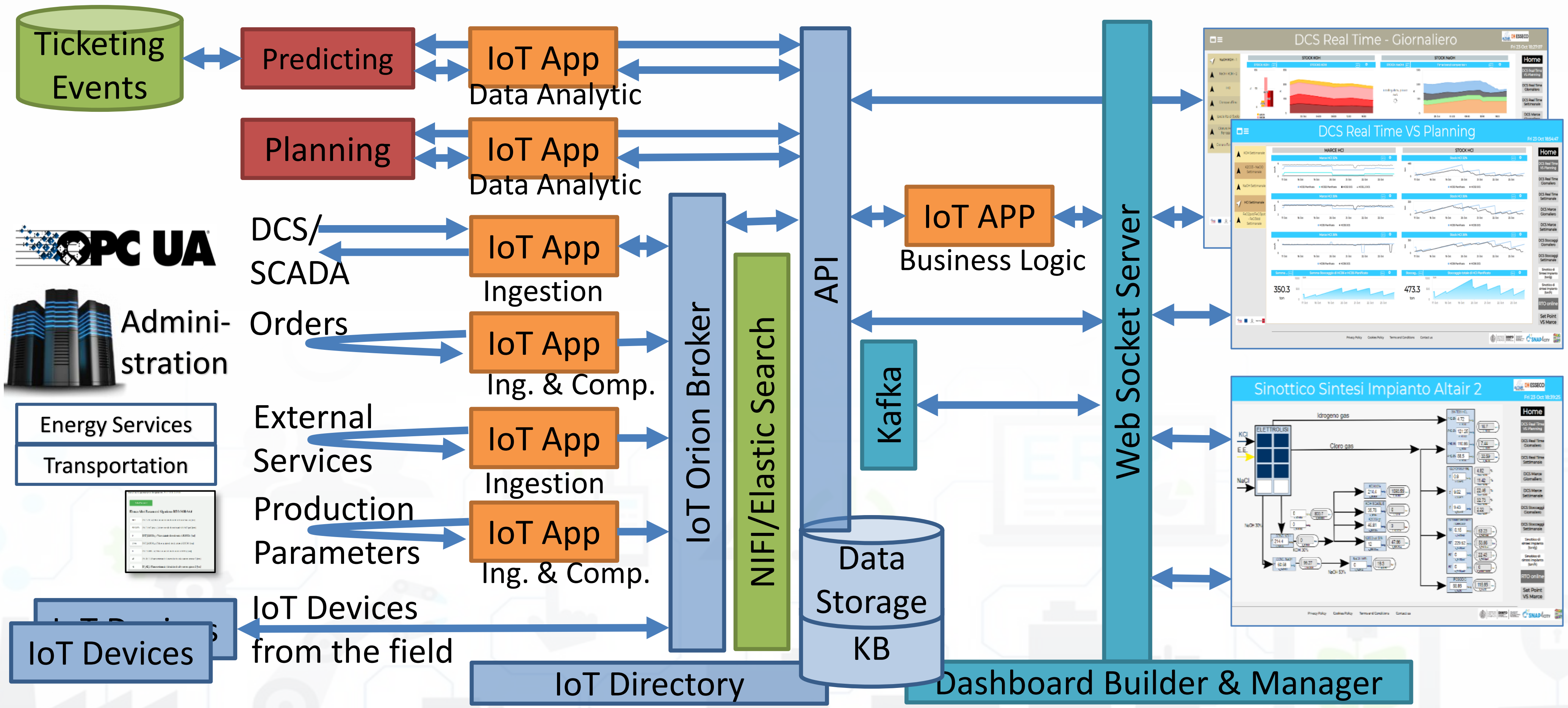
reference

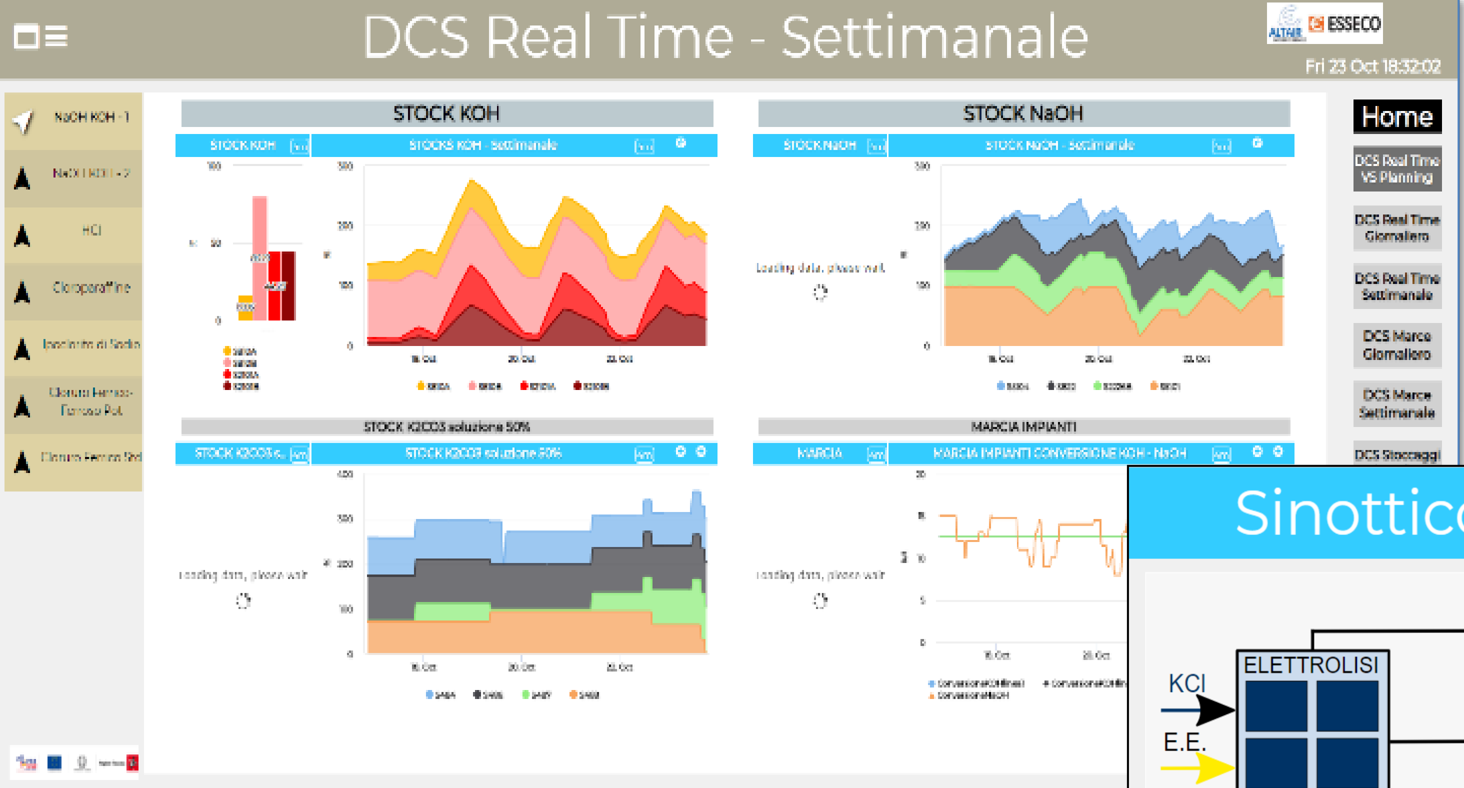
- **Multiple Domain Data**
  - Distributed Control System: energy, flows, storage, chemical data, settings, ..
  - Cost of energy
  - Orders
  - Production Parameters
  - Maintenance data
- **Multiple Levels & Decision Makers**
- **Historical and Real Time data**
  - Billions of Data
  - Optimized planning on chemical model
  - Business Intelligence on Maintenance data
- **Services Exploited on:**
  - Multiple Levels, Mobile Apps, API
- **Since 2020**

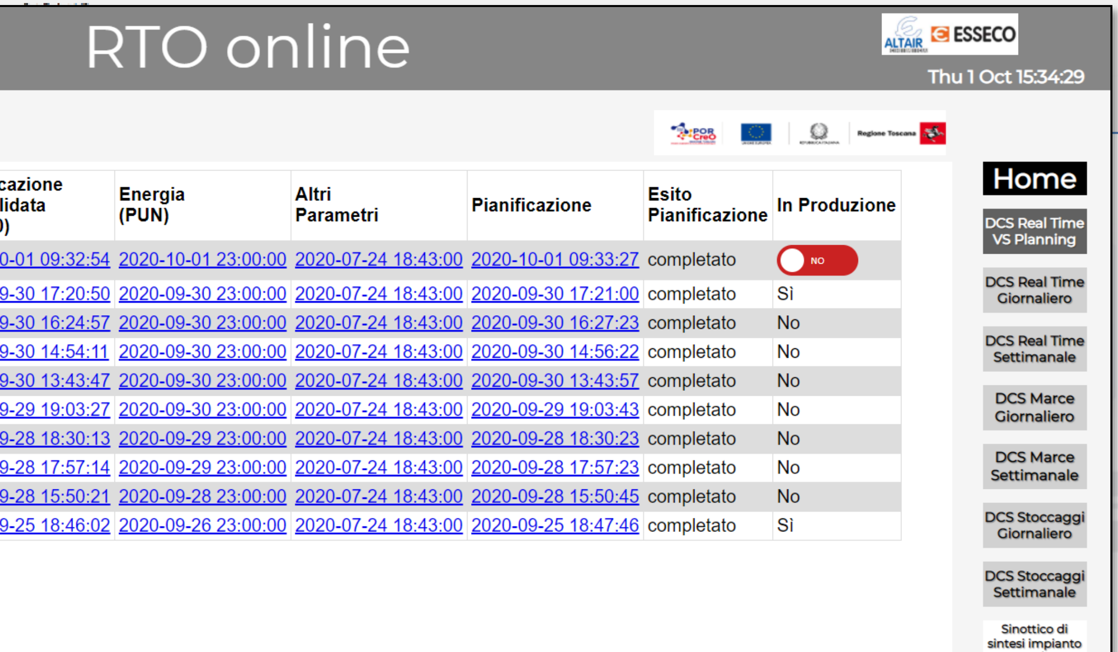



OPC UA
DCS
Sinottico Sintesi Impianto Altair 2
Real Time Production Synoptic
Production vs Planning
DCS Real Time - Giornaliero
DCS Real Time VS Planning
Production Plan
Plant Status
Data Storage
Decision Support
Data Ingestion
Orders
AS400
Energy Service
Transportation
Other Costs
Production Plant Management
Optimized Production Planner
Possible Plan
Possible Plans
Soluzione 31-07-2020/31-07-2020 (get serviceUri)
Production Parameters
Plant Management
DCS Real Time VS Planning
RTO online

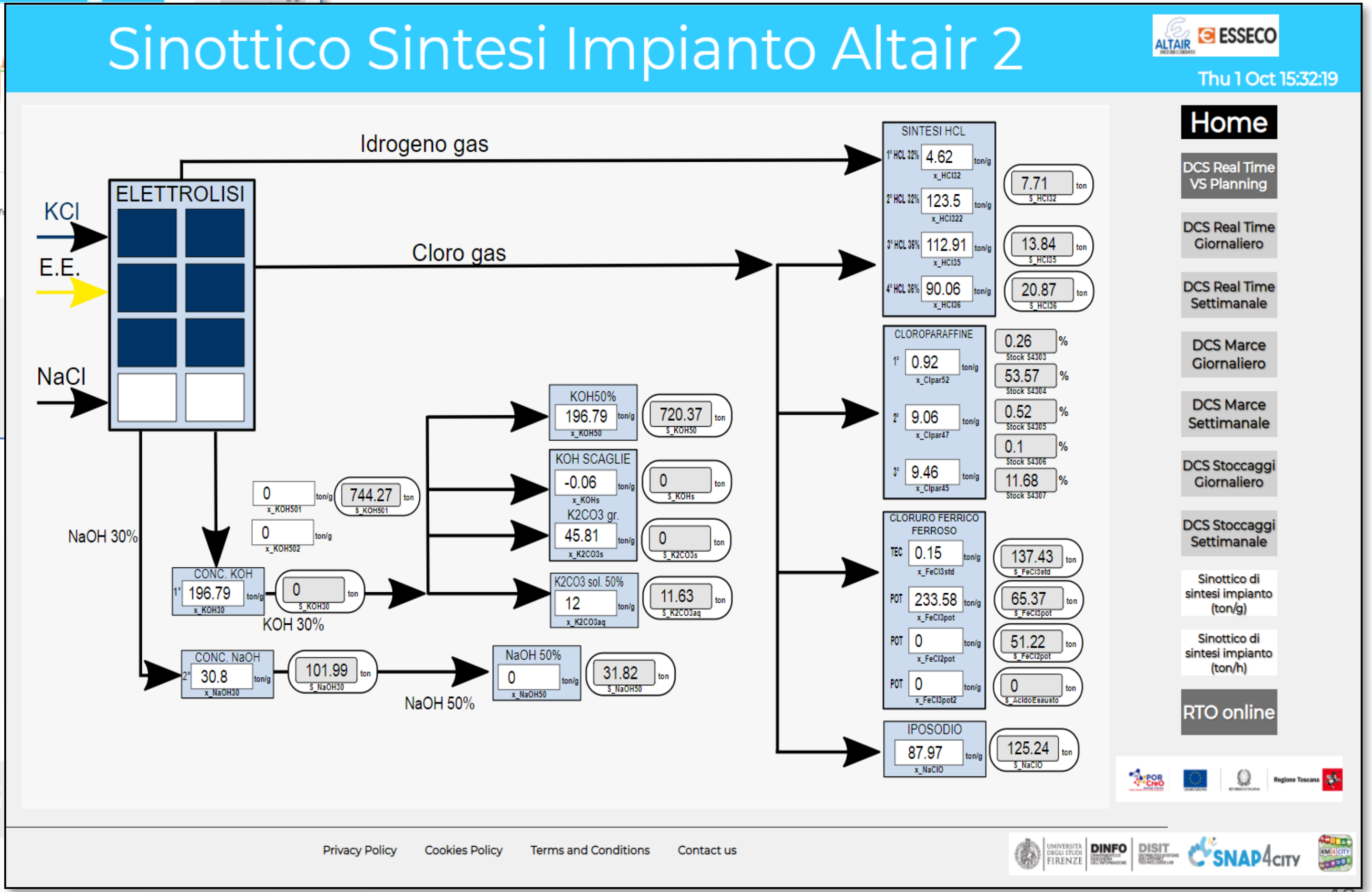
Snap4Industry IOT Architecture







cazione lidata)	Energia (PUN)	Altri Parametri	Pianificazione	Esito Pianificazione	In Produzione
0-01 09:32:54	2020-10-01 23:00:00	2020-07-24 18:43:00	2020-10-01 09:33:27	completato	NO
9-30 17:20:50	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-30 17:21:00	completato	Sì
9-30 16:24:57	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-30 16:27:23	completato	No
9-30 14:54:11	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-30 14:56:22	completato	No
9-30 13:43:47	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-30 13:43:57	completato	No
9-29 19:03:27	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-29 19:03:43	completato	No
9-28 18:30:13	2020-09-29 23:00:00	2020-07-24 18:43:00	2020-09-28 18:30:23	completato	No
9-28 17:57:14	2020-09-29 23:00:00	2020-07-24 18:43:00	2020-09-28 17:57:23	completato	No
9-28 15:50:21	2020-09-28 23:00:00	2020-07-24 18:43:00	2020-09-28 15:50:45	completato	No
9-25 18:46:02	2020-09-26 23:00:00	2020-07-24 18:43:00	2020-09-25 18:47:46	completato	Sì



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SNAP4INDUSTRY

Optimized Production Planner

ALTAIR | ESSECO

Fri 23 Oct 18:57:41

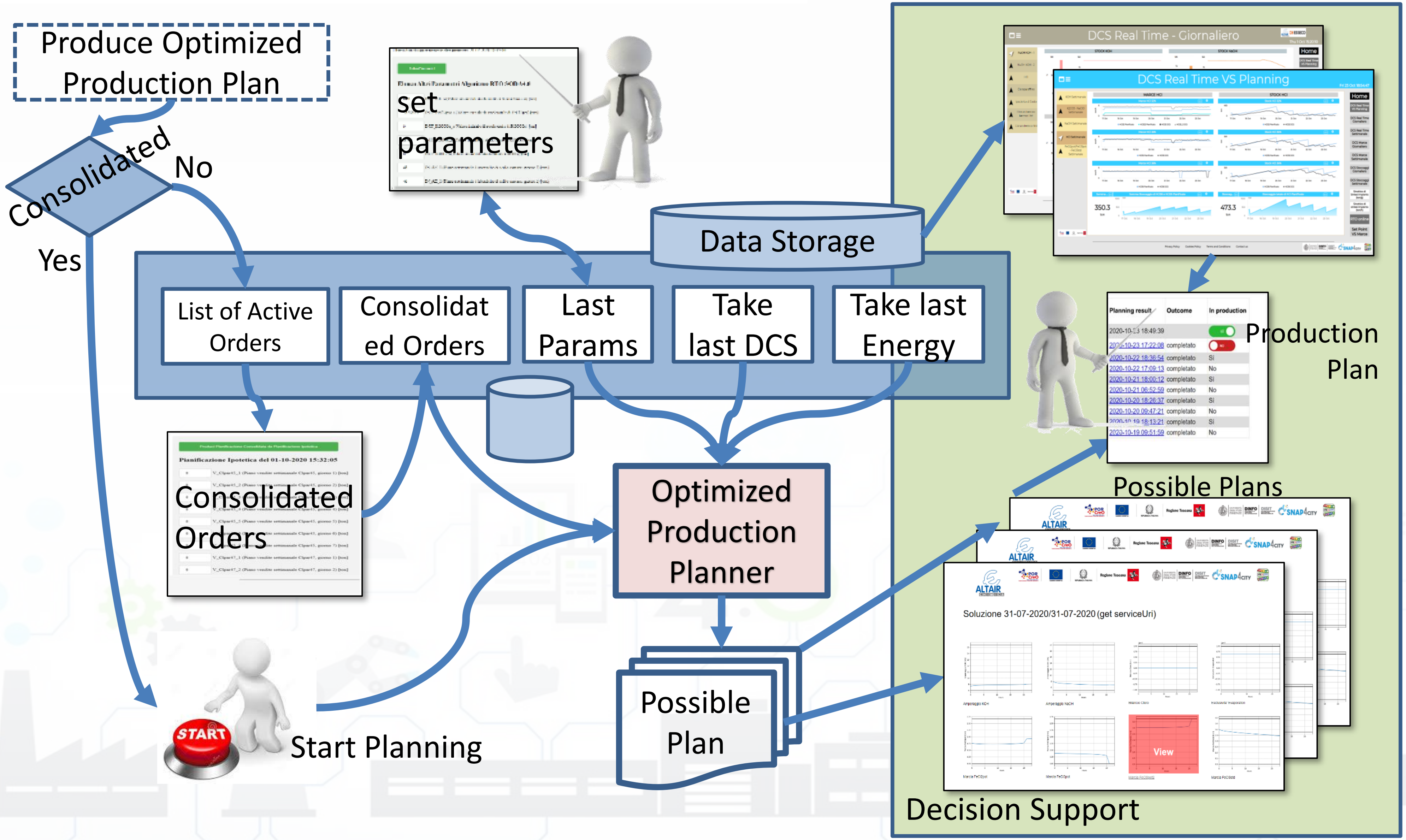
Home
Optimized Production Planner

Parameters (TabPar)	DCS (OPC-UA)	Administrative data (AS400)	Administrative Consolidated Planning data (AS400)	Energy data	Other Parameters	Planning result	Outcome	In production
2020-09-25 18:47:36	2020-10-23 18:49:02	2020-10-23 18:49:29	2020-10-23 18:49:29	2020-10-24 23:00:00	2020-07-24 18:43:00	2020-10-23 18:49:39		sì
2020-09-25 18:47:36	2020-10-23 17:22:03	2020-10-23 17:21:46	2020-10-23 17:21:46	2020-10-23 23:00:00	2020-07-24 18:43:00	2020-10-23 17:22:08	completato	NO
2020-09-25 18:47:36	2020-10-22 18:36:02	2020-10-22 18:36:27	2020-10-22 18:36:27	2020-10-23 23:00:00	2020-07-24 18:43:00	2020-10-22 18:36:54	completato	Sì
2020-09-25 18:47:36	2020-10-22 17:09:02	2020-10-22 17:08:59	2020-10-22 17:08:59	2020-10-22 23:00:00	2020-07-24 18:43:00	2020-10-22 17:09:13	completato	No
2020-09-25 18:47:36	2020-10-21 18:00:02	2020-10-21 17:59:47	2020-10-21 17:59:47	2020-10-22 23:00:00	2020-07-24 18:43:00	2020-10-21 18:00:12	completato	Sì
2020-09-25 18:47:36	2020-10-21 06:52:02	2020-10-21 06:52:41	2020-10-21 06:52:41	2020-10-21 23:00:00	2020-07-24 18:43:00	2020-10-21 06:52:59	completato	No
2020-09-25 18:47:36	2020-10-20 18:26:02	2020-10-20 18:26:19	2020-10-20 18:26:19	2020-10-21 23:00:00	2020-07-24 18:43:00	2020-10-20 18:26:37	completato	Sì
2020-09-25 18:47:36	2020-10-20 09:47:03	2020-10-20 09:47:05	2020-10-20 09:47:05	2020-10-20 23:00:00	2020-07-24 18:43:00	2020-10-20 09:47:21	completato	No
2020-09-25 18:47:36	2020-10-19 18:13:02	2020-10-19 18:13:09	2020-10-19 18:13:09	2020-10-20 23:00:00	2020-07-24 18:43:00	2020-10-19 18:13:21	completato	Sì
2020-09-25 18:47:36	2020-10-19 09:51:02	2020-10-19 09:51:08	2020-10-19 09:51:08	2020-10-19 23:00:00	2020-07-24 18:43:00	2020-10-19 09:51:59	completato	No

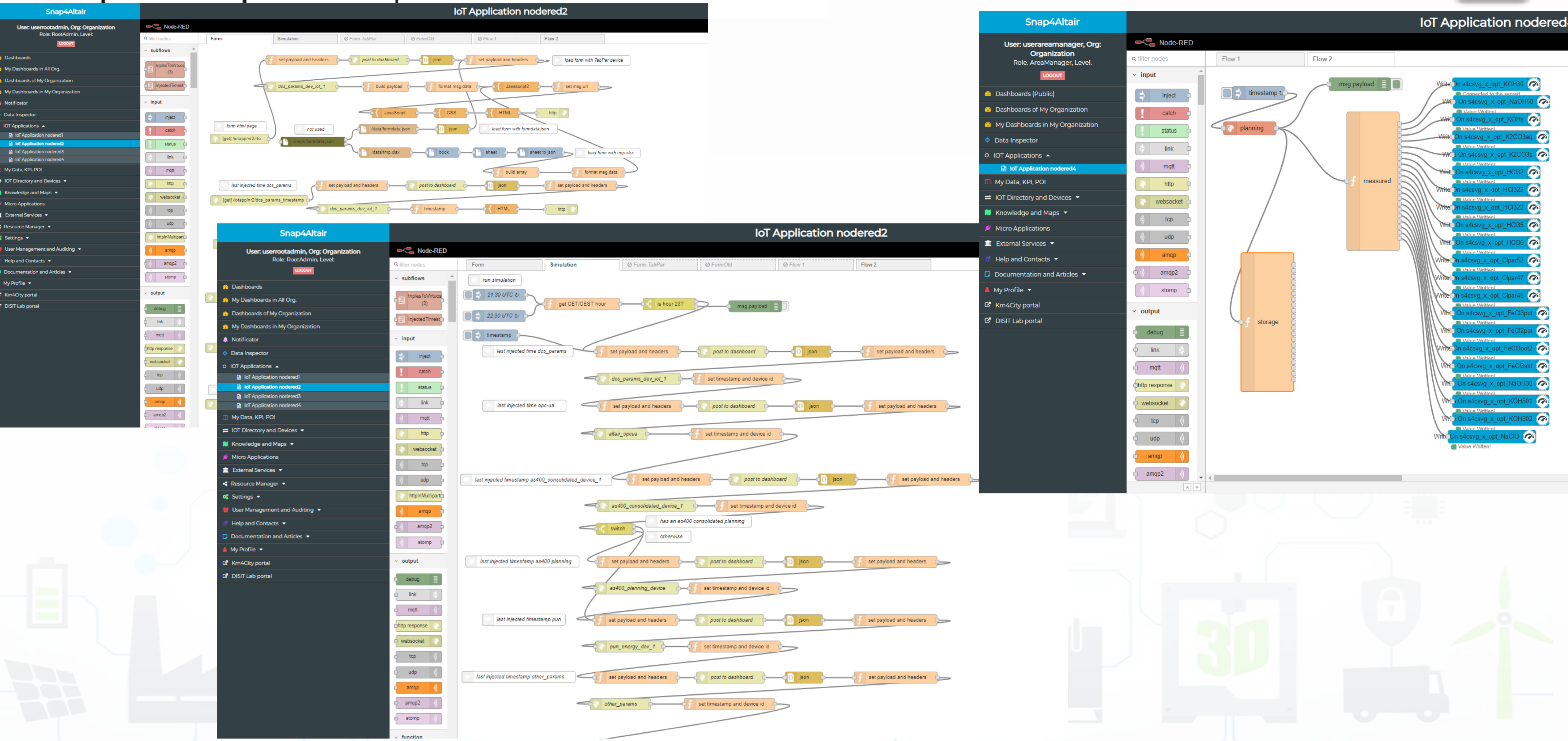
<< 1 2 3 4 5 6 7 8 9 10 11 12 13 14 >>

- Home
- DCS Real Time VS Planning
- DCS Real Time Giornaliero
- DCS Real Time Settimanale
- DCS Marce Giornaliero
- DCS Marce Settimanale
- DCS Stoccaggi Giornaliero
- DCS Stoccaggi Settimanale

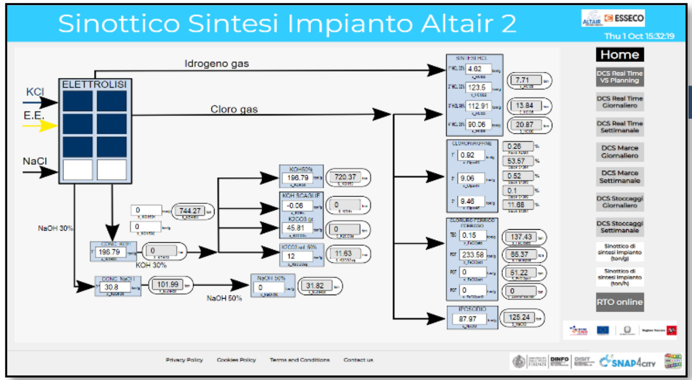
Business Logic



Some Flows

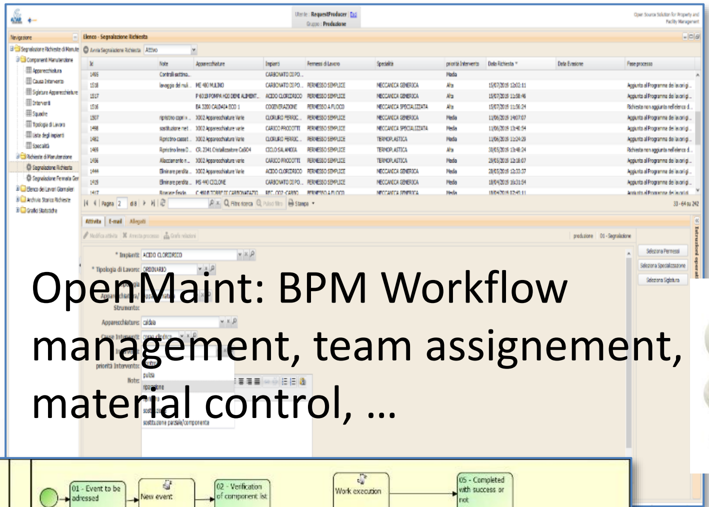

Snap4Altair
IoT Application nodered2
Node-RED
User: userrootadmin, Org: Organization
Role: RootAdmin, Level:
Form
Simulation
Flow 2
run simulation
21:30 UTC
22:30 UTC
get CET/CEST hour
is hour 23?
msg.payload
timestamp
last injected time dcs_params
set payload and headers
post to dashboard
json
dcs_params_dev_iot_1
set timestamp and device id
last injected time opc-ua
altair_opcua
last injected timestamp as400_consolidated_device_1
as400_consolidated_device_1
switch
has an as400 consolidated planning
otherwise
last injected timestamp as400 planning
as400_planning_device
last injected timestamp pun
pun_energy_dev_1
last injected timestamp other_params
other_params
Dashboards
My Dashboards in All Org.
Dashboards of My Organization
My Dashboards in My Organization
Notificator
Data Inspector
IOT Applications
IoT Application nodered1
IoT Application nodered2
IoT Application nodered3
IoT Application nodered4
My Data, KPI, POI
IOT Directory and Devices
Knowledge and Maps
Micro Applications
External Services
Resource Manager
Settings
User Management and Auditing
Help and Contacts
Documentation and Articles
My Profile
Km4City portal
DISIT Lab portal
IoT Application nodered
User: userareamanager, Org: Organization
Role: AreaManager, Level:
Flow 1
planning
measured
storage

Workflow for Ticket management

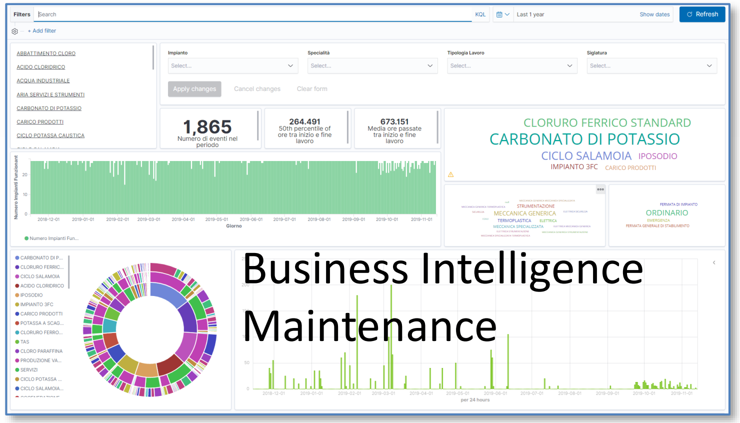


Consumptions/productions

Dashboards and actions

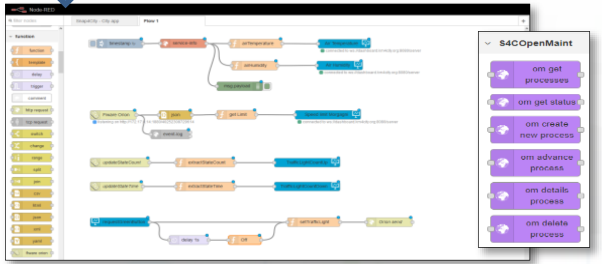


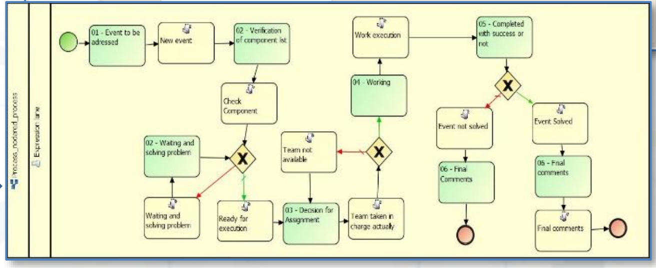
Events/actions



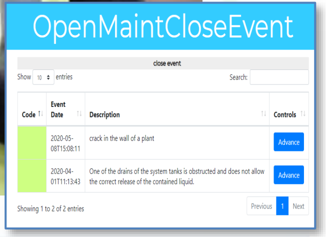
Business Intelligence Maintenance

OpenMaint: BPM Workflow management, team assignement, material control, …





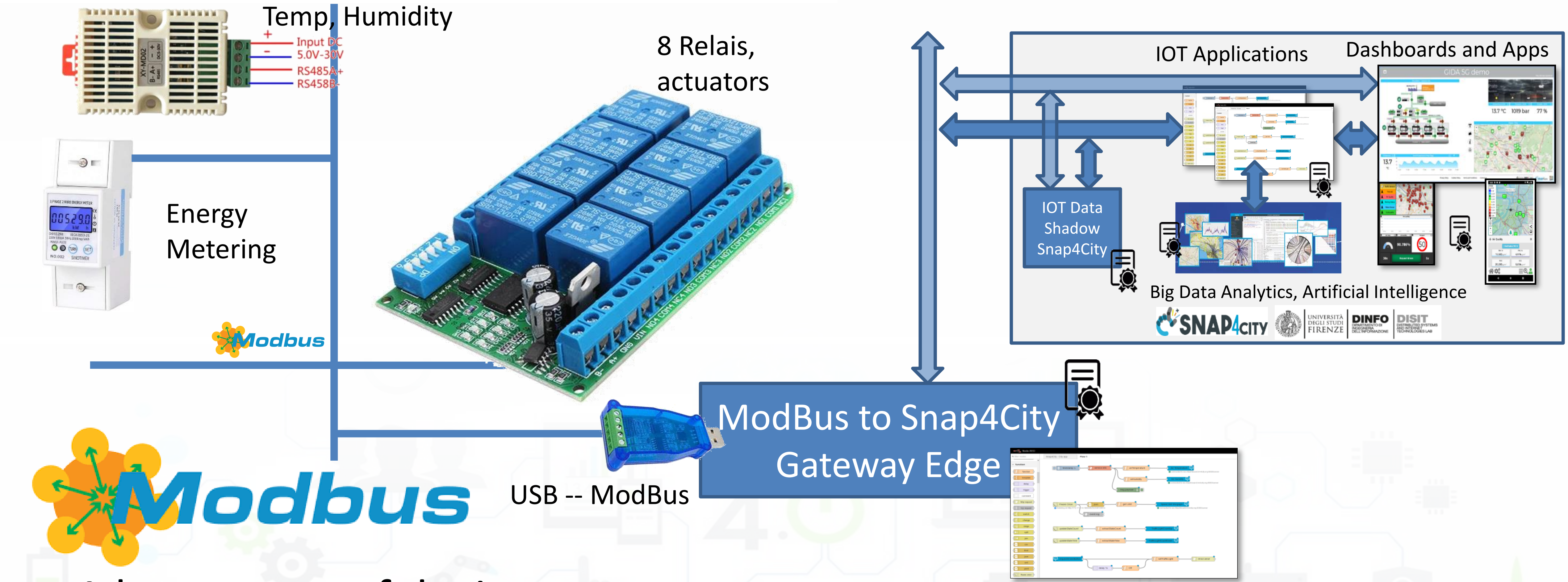
IOT App, Data event firing, event detection and firing Critical event management



TOP

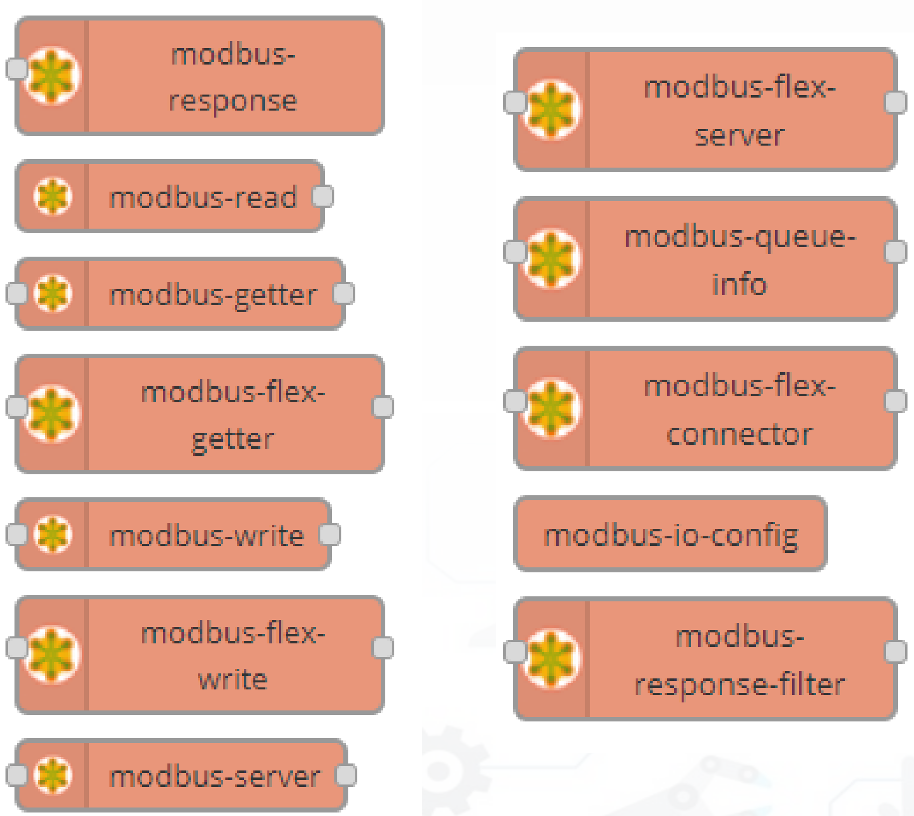
IOT App Smart Industry 4.0 ModBus Integration

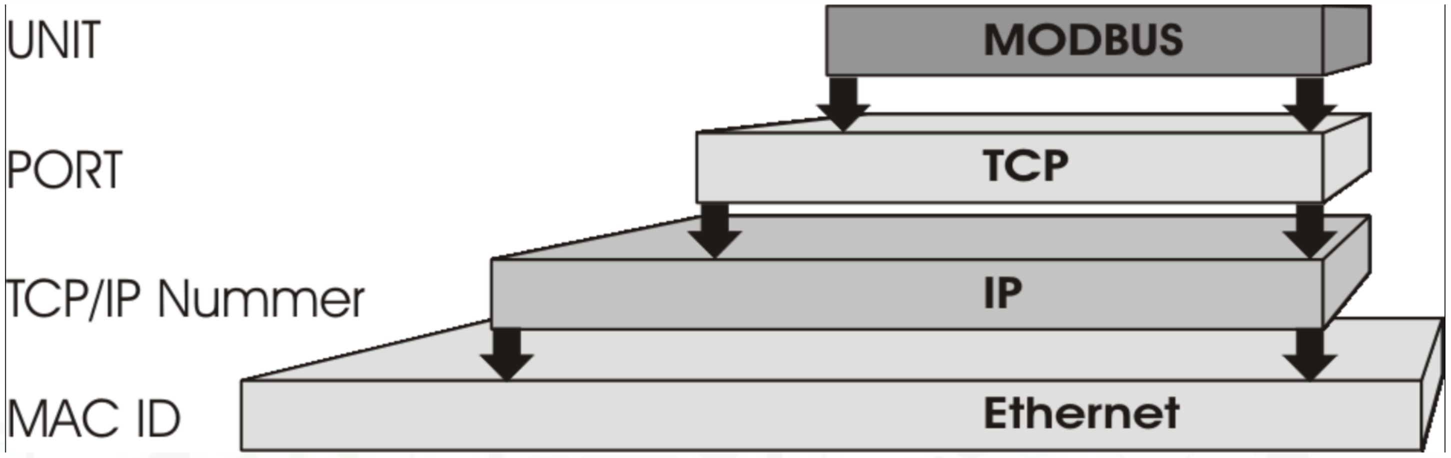
Devices



- A large range of devices: sensors and actuators
- Over serial as RS485 and/or IP

Modbus


modbus-response
modbus-read
modbus-getter
modbus-flex-getter
modbus-write
modbus-flex-write
modbus-server
modbus-flex-server
modbus-queue-info
modbus-flex-connector
modbus-io-config
modbus-response-filter


UNIT
PORT
TCP/IP Nummer
MAC ID
MODBUS
TCP
IP
Ethernet

- ..

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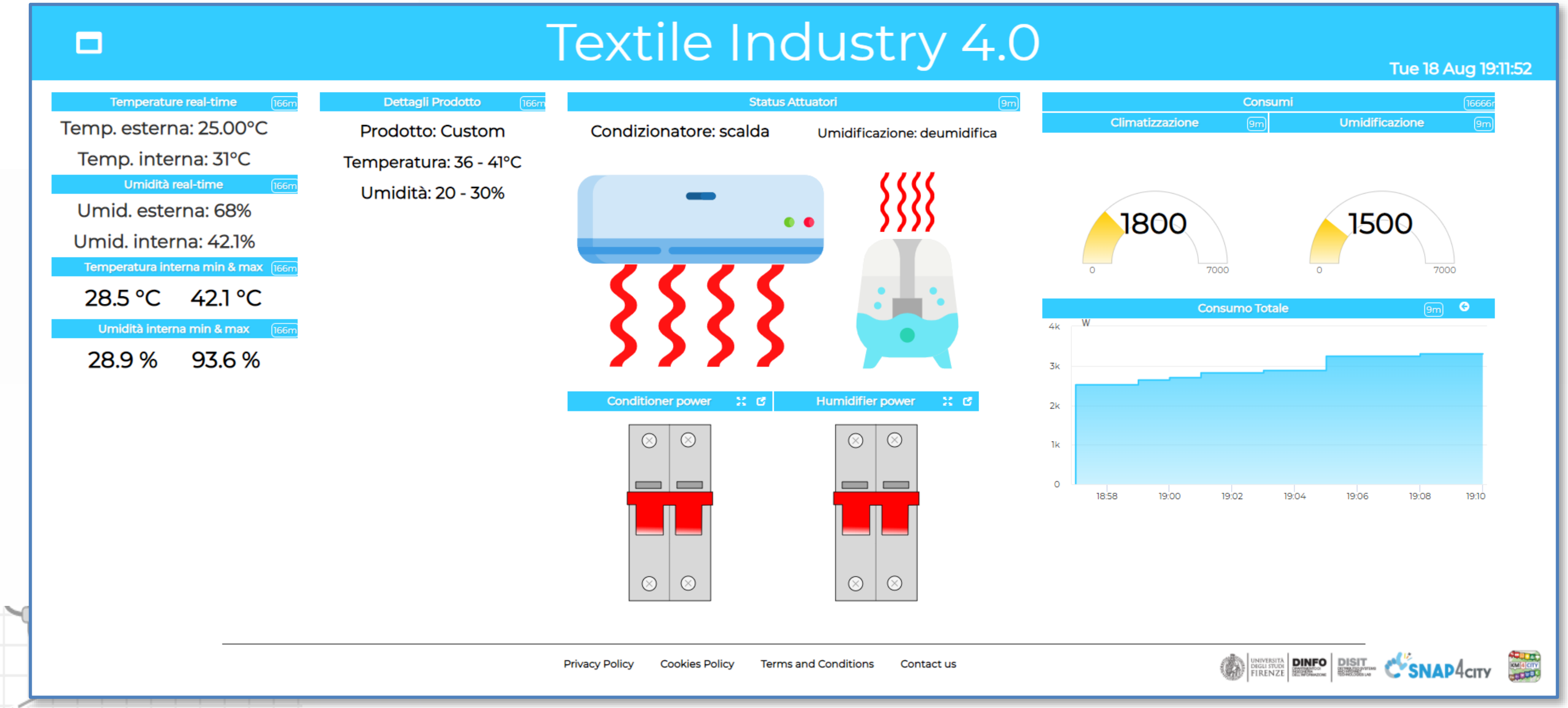
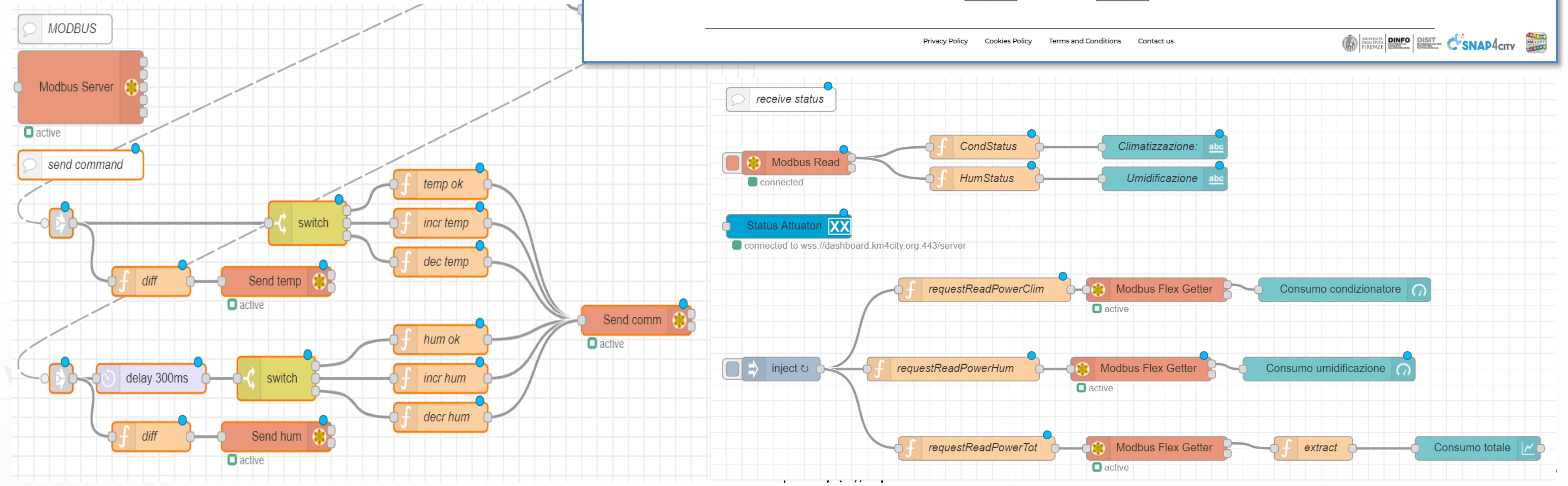
Modbus



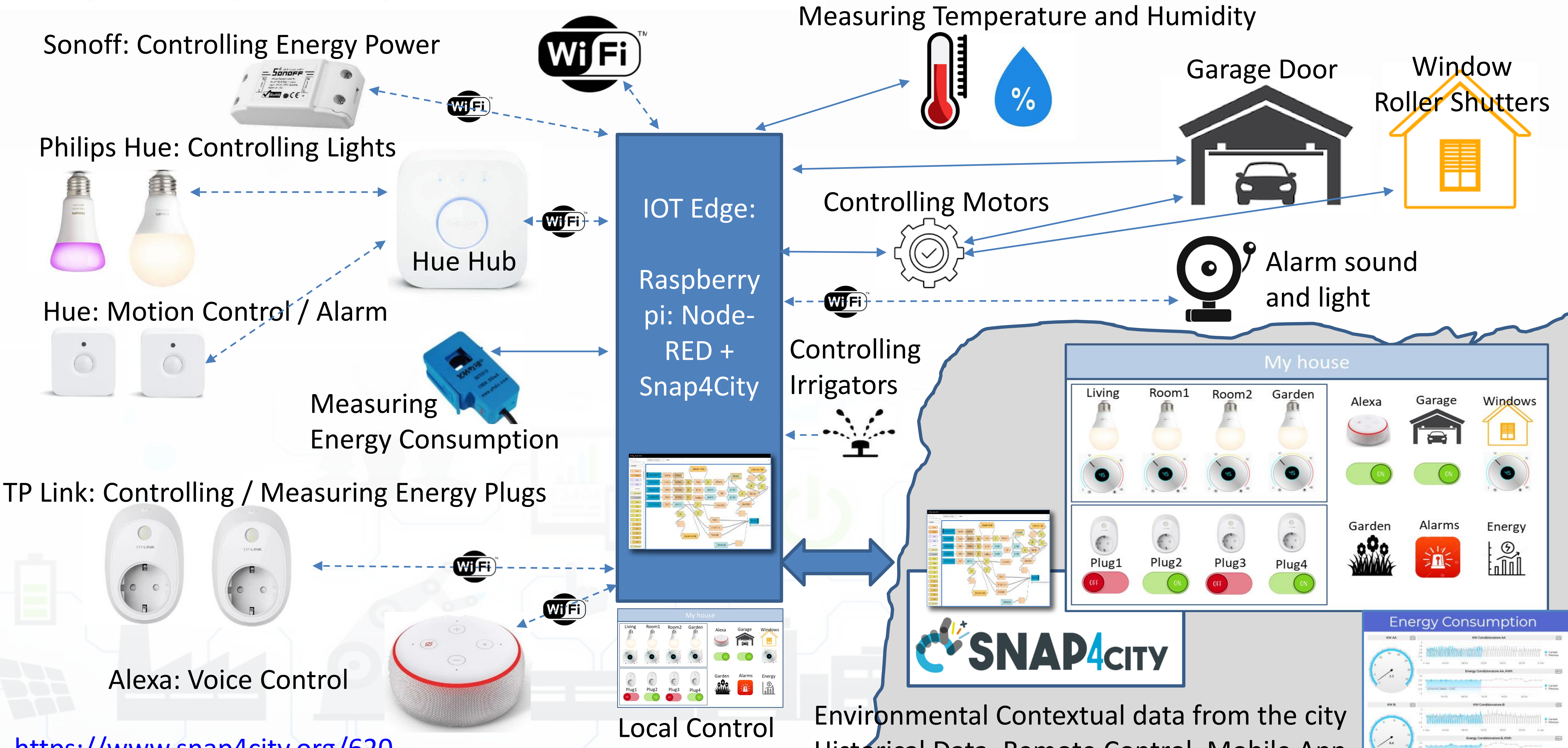


TOP

IOT App vs Smart Home Snap4Home

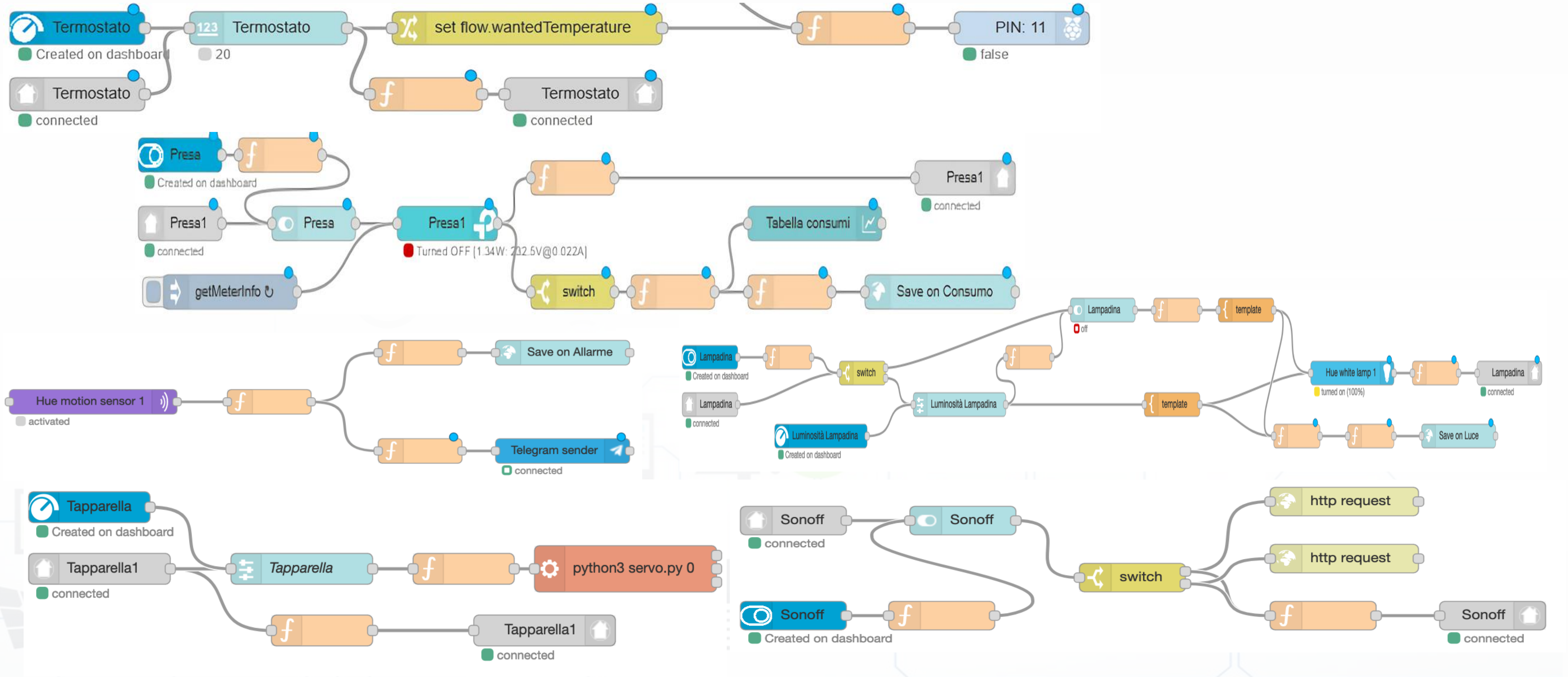
Prato
Smart City vs Smart Home Estra

Snap4Home



https://www.snap4city.org/620

Example: IOT App on Snap4Home



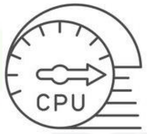
Snap4Home

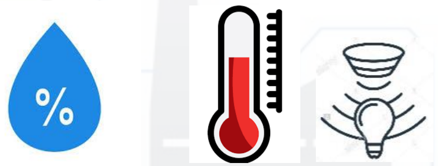
Hue Hub

Motion Control / Alarm

TP Link plugs: meter

Alexa: Voice Control





IOT Edge:

Raspberry pi: Node-RED + Snap4City MicroService Library

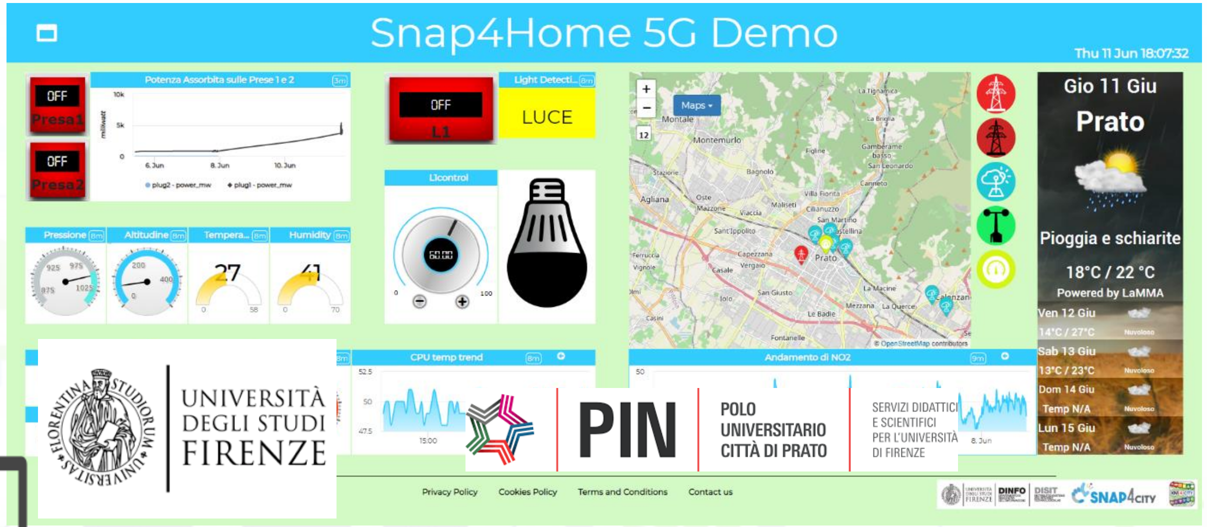
5G gateway

FIWARE Orion Broker

Dashboards

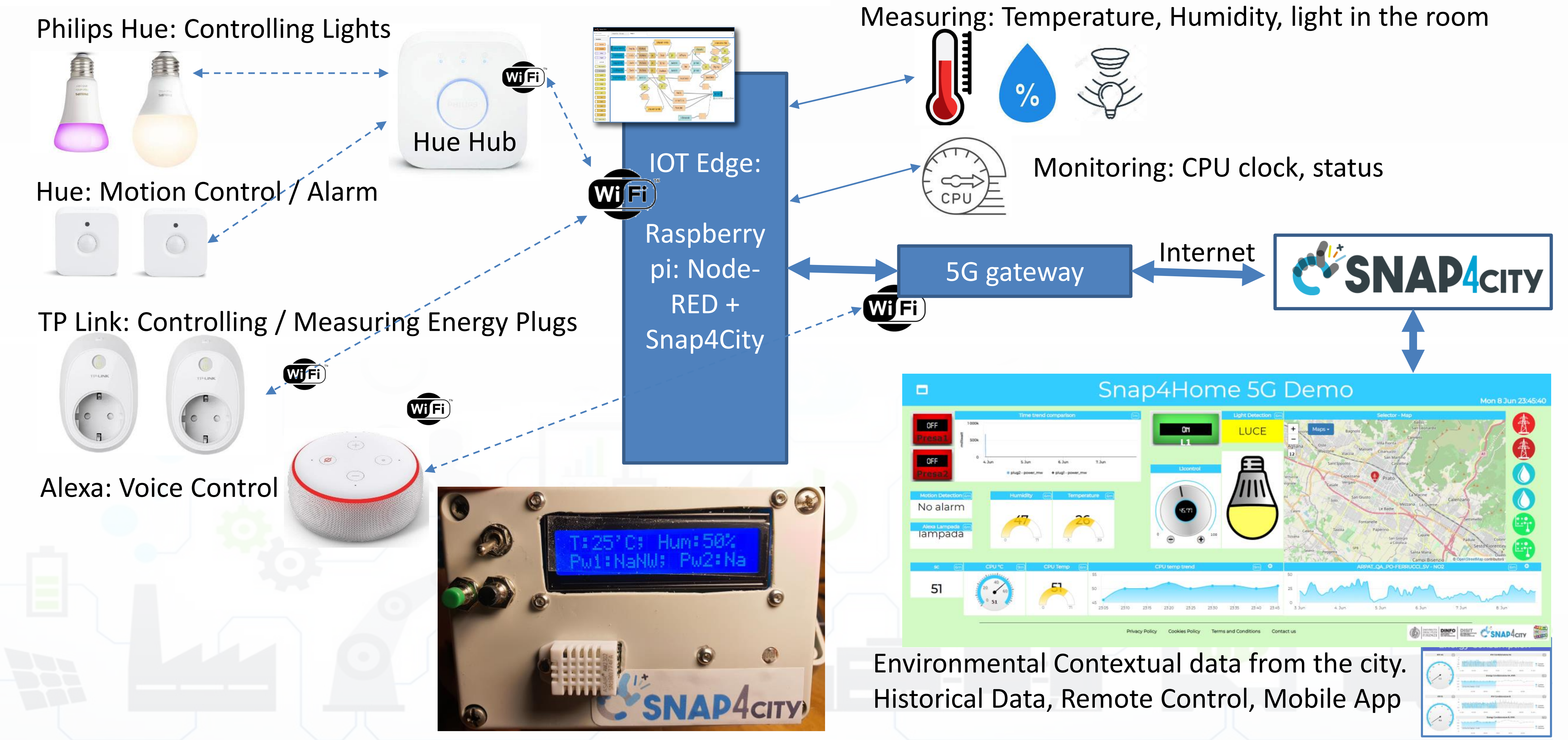
Advanced Smart City API

Environmental Contextual data from the city. Historical Data, Remote Control, Mobile App

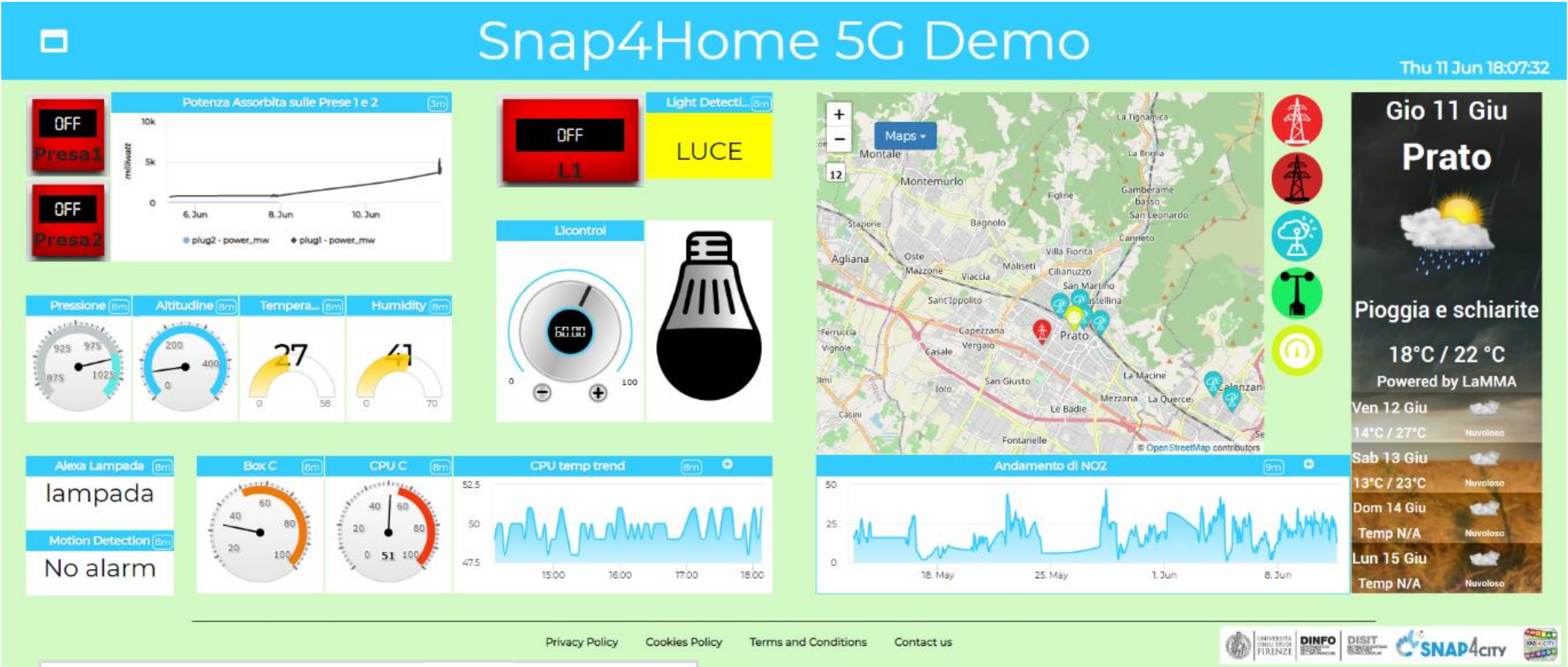


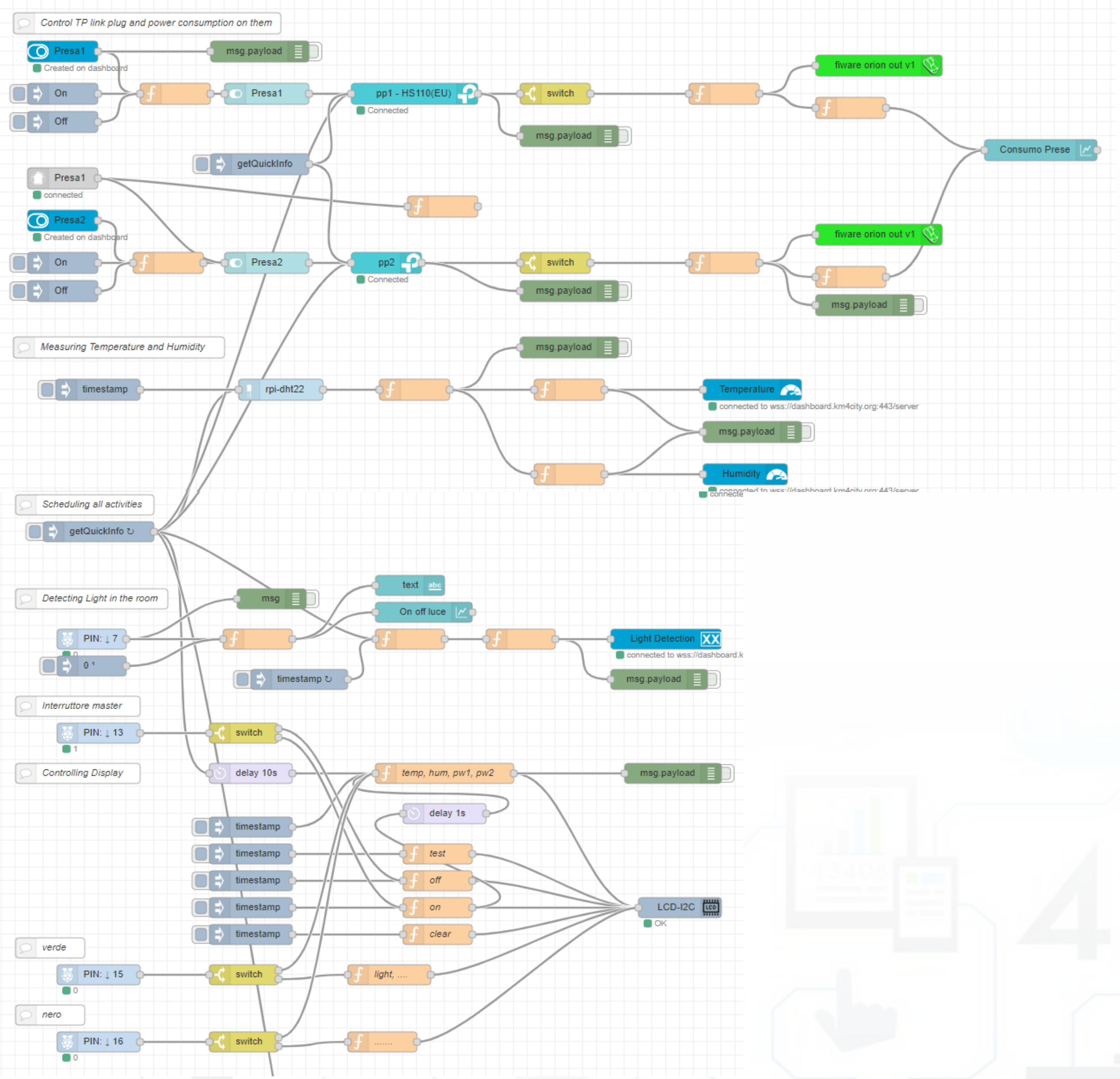
https://www.snap4city.org/369

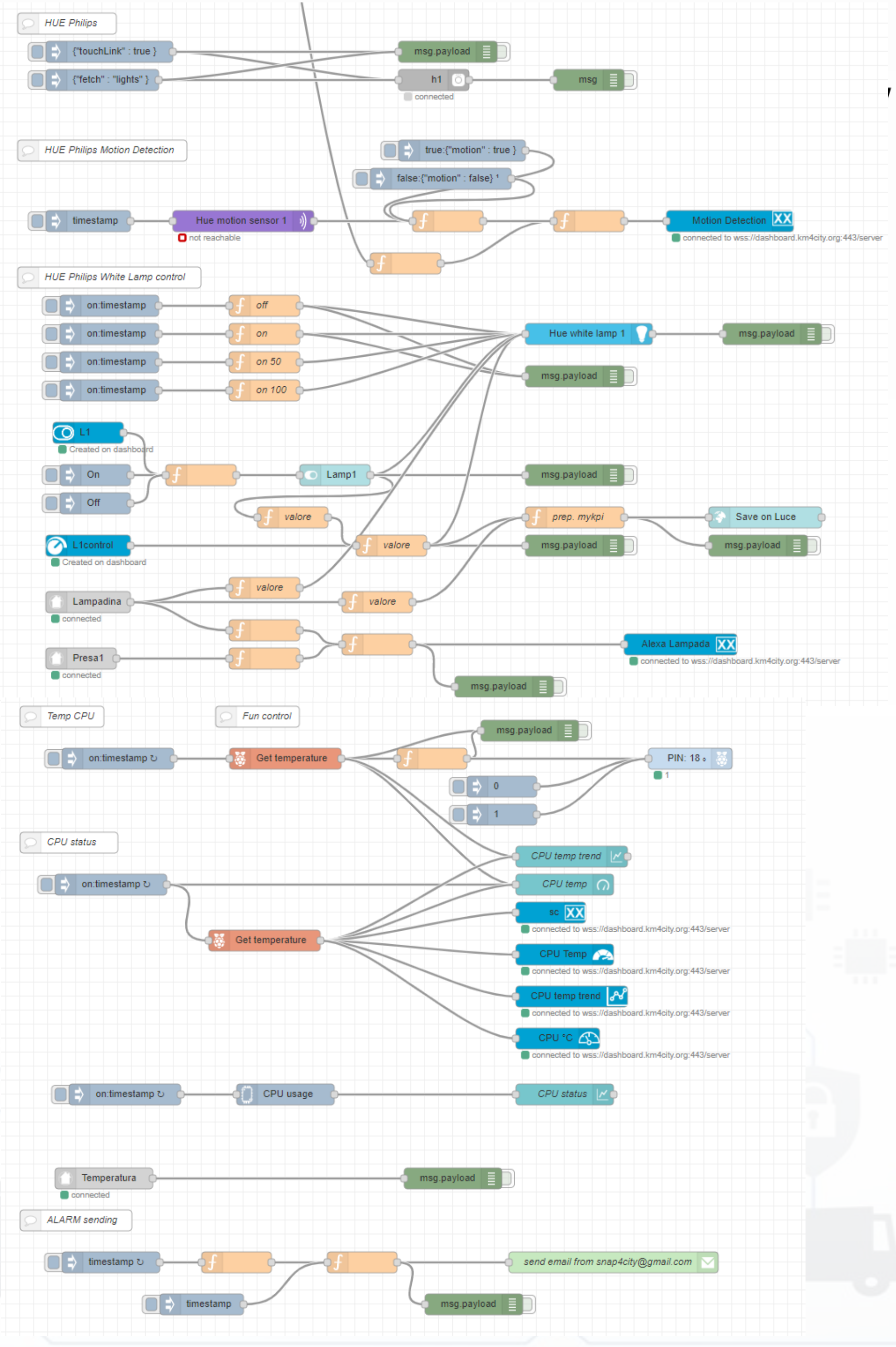
Snap4Home



Philips Hue: Controlling Lights
Hue Hub
Hue: Motion Control / Alarm
TP Link: Controlling / Measuring Energy Plugs
Alexa: Voice Control
IOT Edge: Raspberry pi: Node-RED + Snap4City
Measuring: Temperature, Humidity, light in the room
%
CPU
Monitoring: CPU clock, status
5G gateway
Internet
SNAP4CITY
Snap4Home 5G Demo
T:25'C; Hum:50%
Pw1:NaNW; Pw2:Na
Environmental Contextual data from the city.
Historical Data, Remote Control, Mobile App

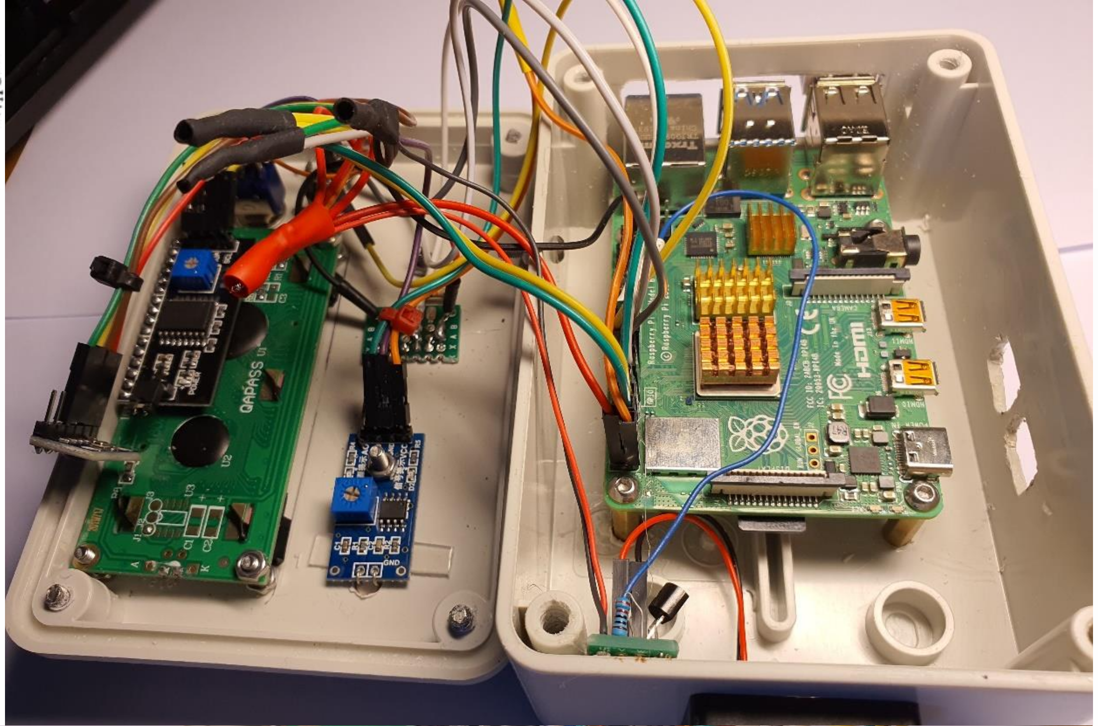

Snap4Home 5G Demo
Thu 11 Jun 18:07:32
OFF
Presa1
OFF
Presa2
Potenza Assorbita sulle Prese 1 e 2
milliwatt
10k
5k
0
6. Jun
8. Jun
10. Jun
plug2 - power_mw
plug1 - power_mw
OFF
L1
Light Detecti...
LUCE
Llcontrol
0
100
Pressione
Altitudine
Tempera...
Humidity
27
41
Maps
Montale
Montemurlo
Agliana
Bagnolo
Prato
Gio 11 Giu
Prato
Pioggia e schiarite
18°C / 22 °C
Powered by LaMMA
Ven 12 Giu
14°C / 27°C
Nuvoloso
Sab 13 Giu
13°C / 23°C
Nuvoloso
Dom 14 Giu
Temp N/A
Nuvoloso
Lun 15 Giu
Temp N/A
Nuvoloso
Alexa Lampada
lampada
Motion Detection
No alarm
Box C
CPU C
CPU temp trend
15:00
16:00
17:00
18:00
Andamento di NO2
18. May
25. May
1. Jun
8. Jun
Privacy Policy
Cookies Policy
Terms and Conditions
Contact us

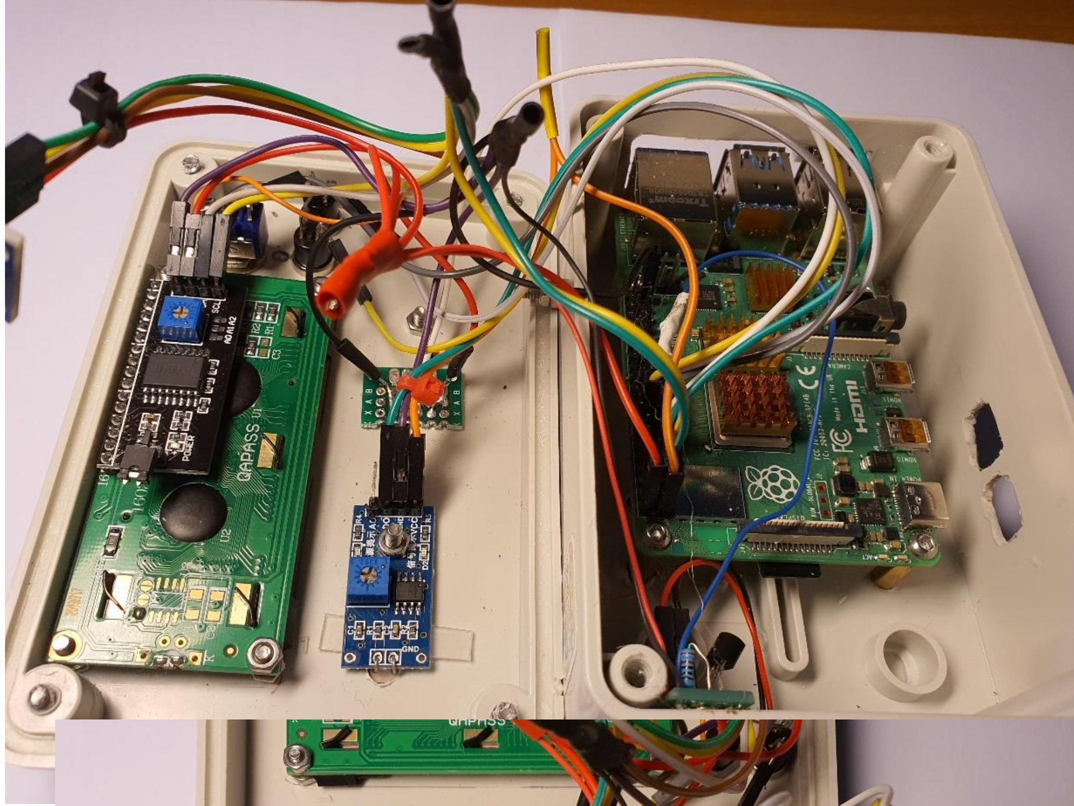

Control TP link plug and power consumption on them
Presa1
msg.payload
Created on dashboard
On
Off
Presa1
pp1 - HS110(EU)
Connected
switch
fiware orion out v1
msg.payload
getQuickInfo
Consumo Prese
Presa1
connected
Presa2
Created on dashboard
On
Off
Presa2
pp2
Connected
switch
fiware orion out v1
msg.payload
msg.payload
Measuring Temperature and Humidity
msg.payload
timestamp
rpi-dht22
Temperature
connected to wss://dashboard.km4city.org:443/server
msg.payload
Humidity
Scheduling all activities
getQuickInfo
Detecting Light in the room
msg
text
On off luce
PIN: 7
Light Detection
connected to wss://dashboard.km4city.org:443/server
timestamp
msg.payload
Interruttore master
PIN: 13
switch
Controlling Display
delay 10s
temp, hum, pw1, pw2
msg.payload
delay 1s
timestamp
timestamp
test
timestamp
off
timestamp
on
timestamp
clear
LCD-I2C
OK
verde
PIN: 15
switch
light, ...
nero
PIN: 16
switch

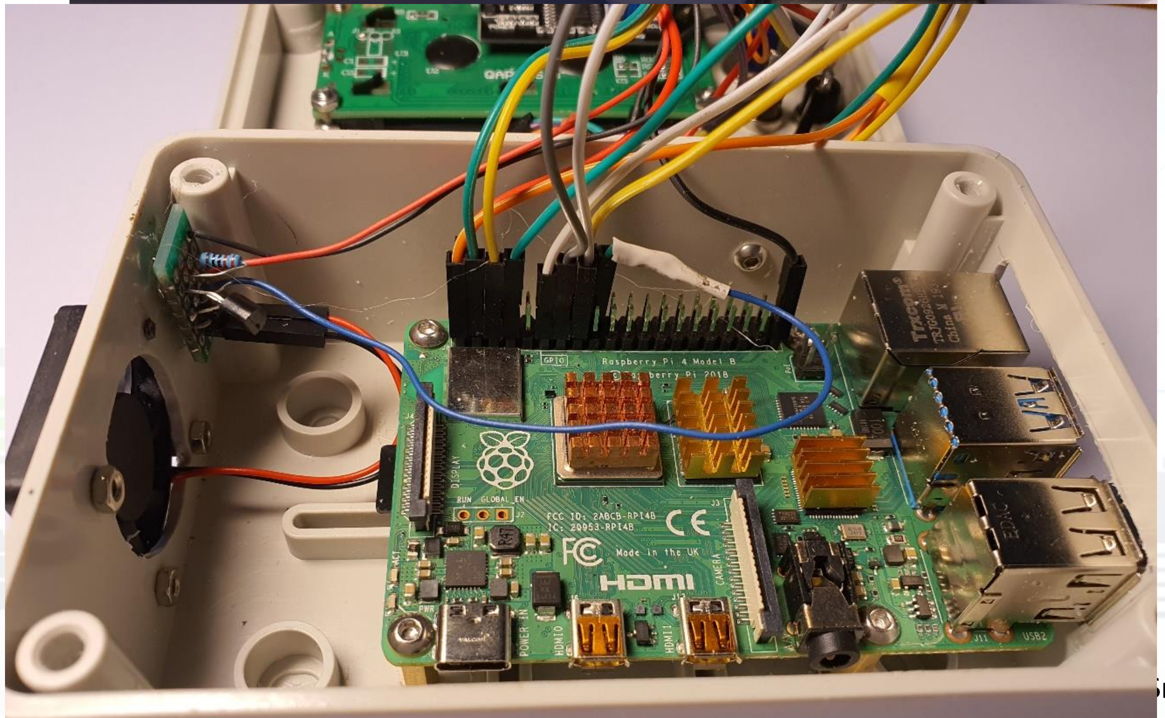

HUE Philips
{"touchLink" : true }
{"fetch" : "lights" }
msg.payload
h1
connected
msg
HUE Philips Motion Detection
true:{"motion" : true }
false:{"motion" : false }
timestamp
Hue motion sensor 1
not reachable
Motion Detection
connected to wss://dashboard.km4city.org:443/server
HUE Philips White Lamp control
on:timestamp
off
on:timestamp
on
on:timestamp
on 50
on:timestamp
on 100
Hue white lamp 1
msg.payload
msg.payload
L1
Created on dashboard
On
Lamp1
msg.payload
Off
valore
prep. mykpi
Save on Luce
L1control
Created on dashboard
valore
msg.payload
msg.payload
valore
Lampadina
connected
valore
Alexa Lampada
connected to wss://dashboard.km4city.org:443/server
Presa1
connected
msg.payload
Temp CPU
Fun control
msg.payload
on:timestamp
Get temperature
PIN: 18
0
1
CPU status
CPU temp trend
on:timestamp
CPU temp
sc
connected to wss://dashboard.km4city.org:443/server
Get temperature
CPU Temp
connected to wss://dashboard.km4city.org:443/server
CPU temp trend
connected to wss://dashboard.km4city.org:443/server
CPU °C
connected to wss://dashboard.km4city.org:443/server
on:timestamp
CPU usage
CPU status
Temperatura
connected
msg.payload
ALARM sending
timestamp
send email from snap4city@gmail.com
timestamp
msg.payload

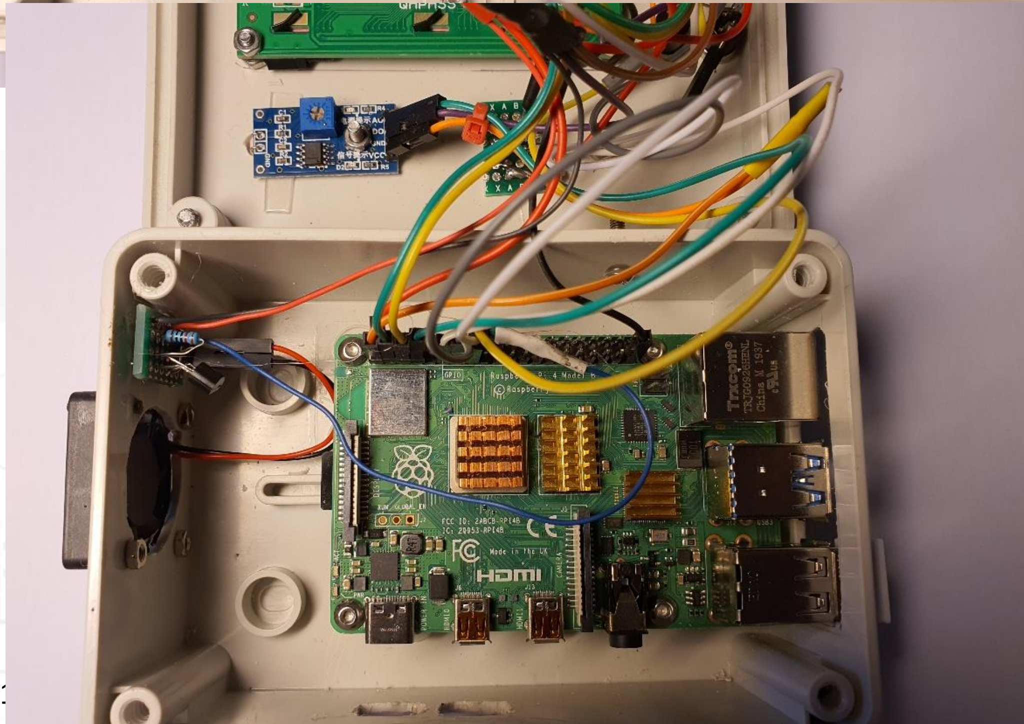
USTRY


T:27'C; Hum:43%
P1:NaNW;P2:NaNW
806 Lumen
SNAP4CITY
PHILIPS
tp-link





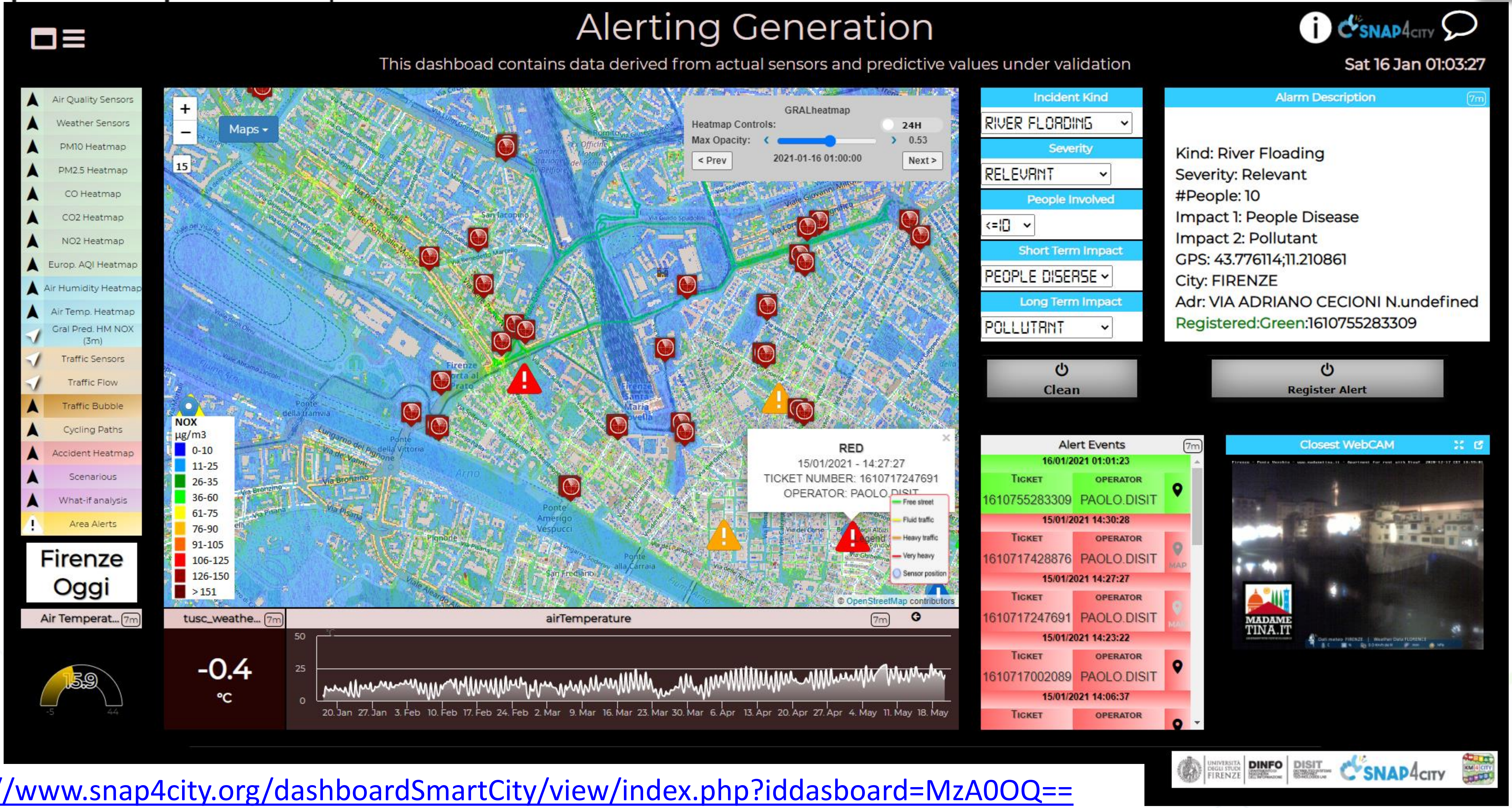




TOP

IOT App vs Smart City Solutions

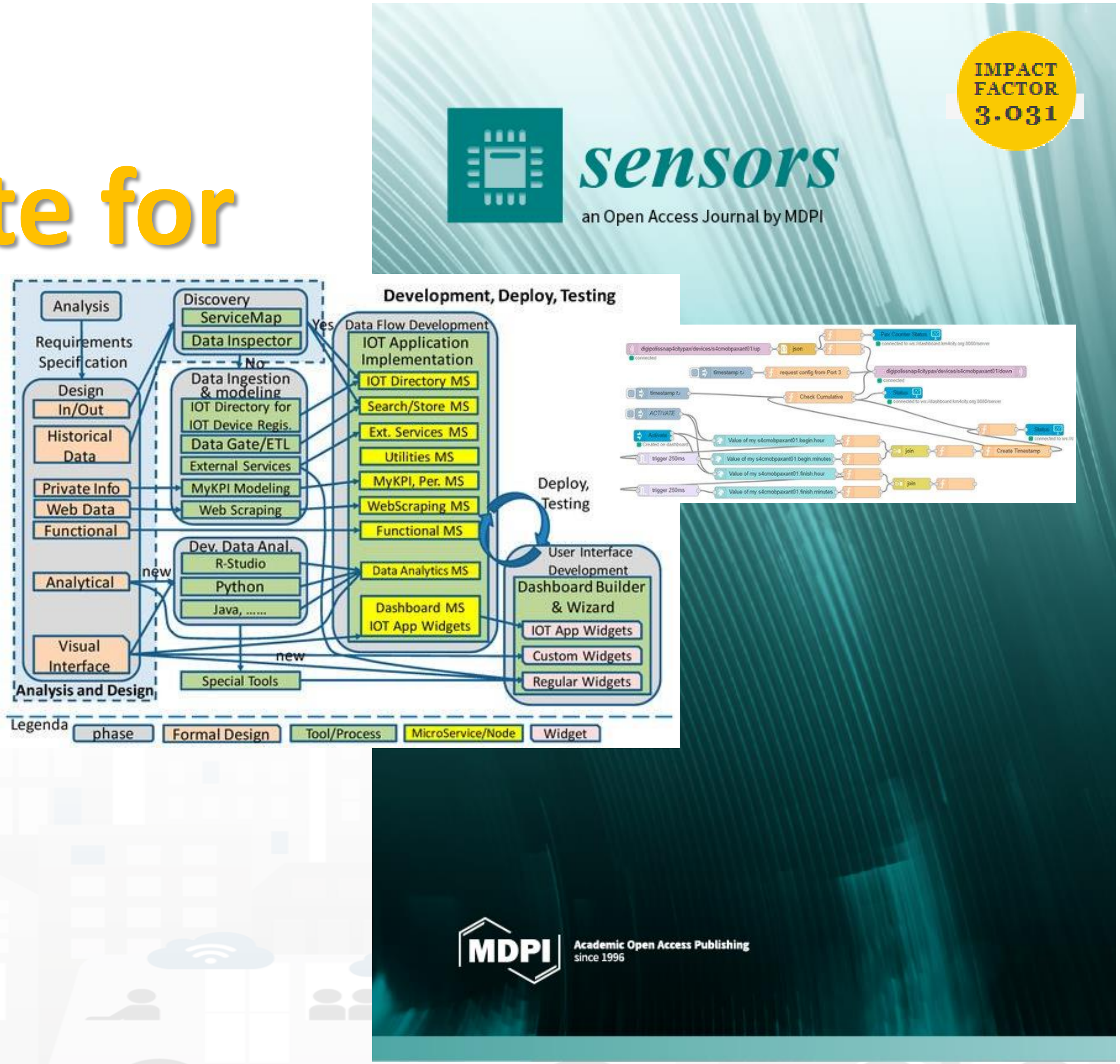
Alert Registration



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA0OQ==

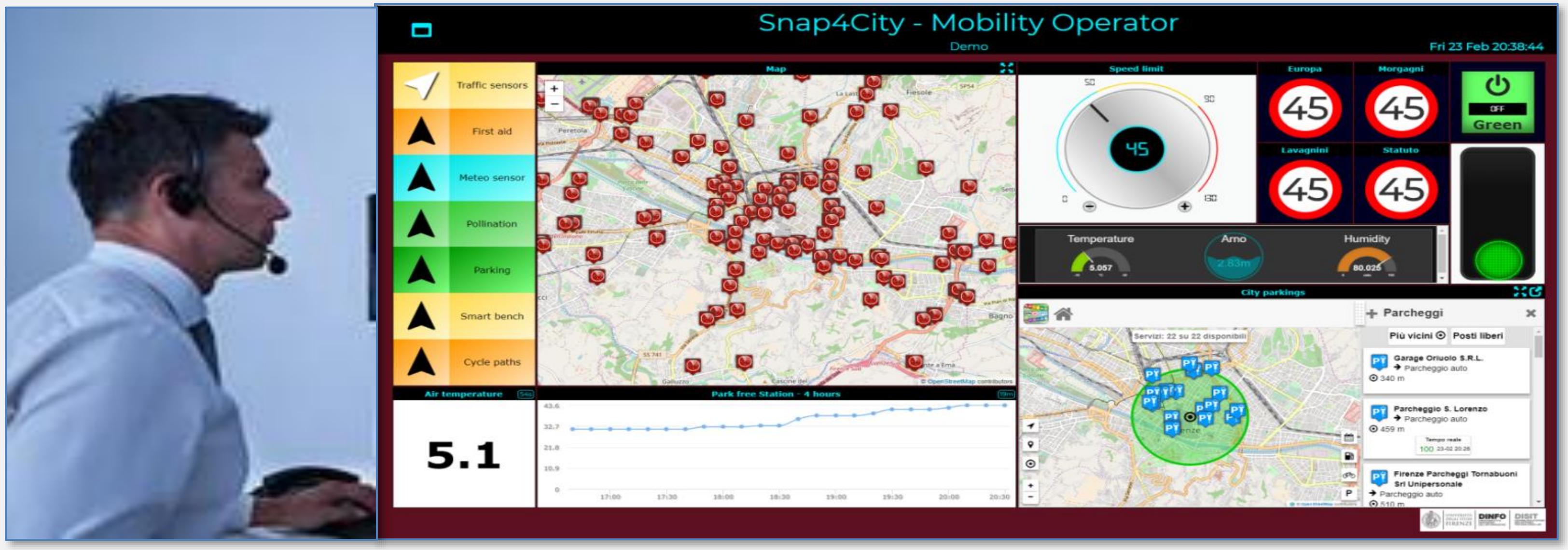
MicroServices Suite for Smart City

- Badii, C.; Bellini, P.; Difino, A.; Nesi, P.; Pantaleo, G.; Paolucci, M. MicroServices Suite for Smart City Applications.
- *Sensors* **2019**, *19*, 4798.
- https://www.mdpi.com/1424-8220/19/21/4798/pdf

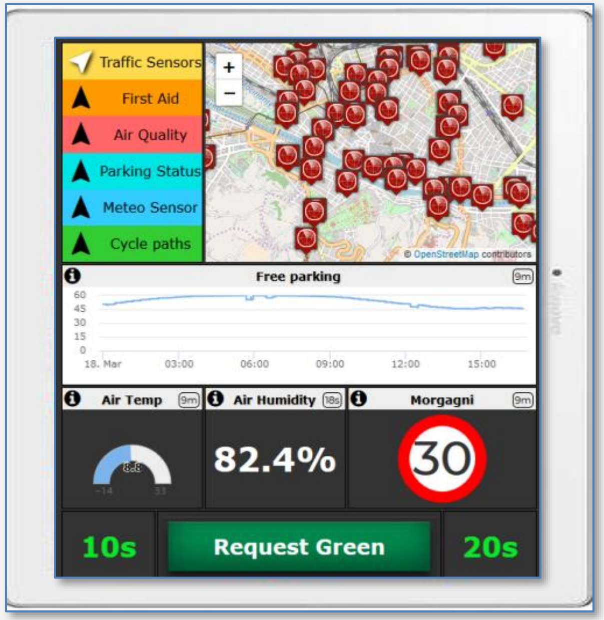


City Dashboard + IOT App

Control Room Operator
Would like to:
- **Monitor** traffic flow, Environment, Car parking, Cycling, First aid, temp., ..
- **Act and** monitor Dynamic Plates
- **Act and** monitor red lights



Driver, Policeman
Would like to:
- Monitor traffic, Parking, traffic events, speed limit, …
- **Act and** monitor red lights



Dashboards with city data and your data/actuators

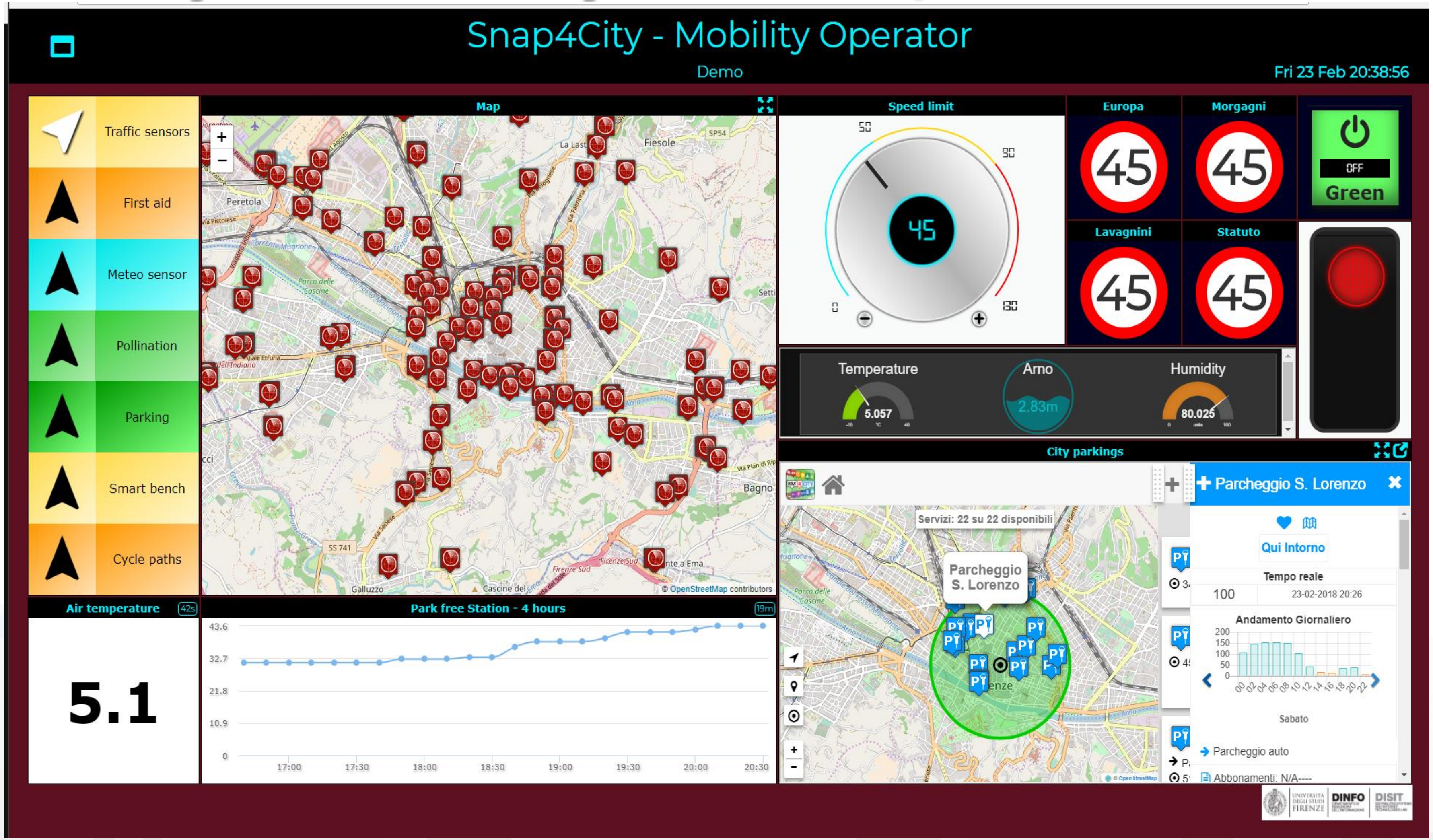
Sensors:

- Values
- Status

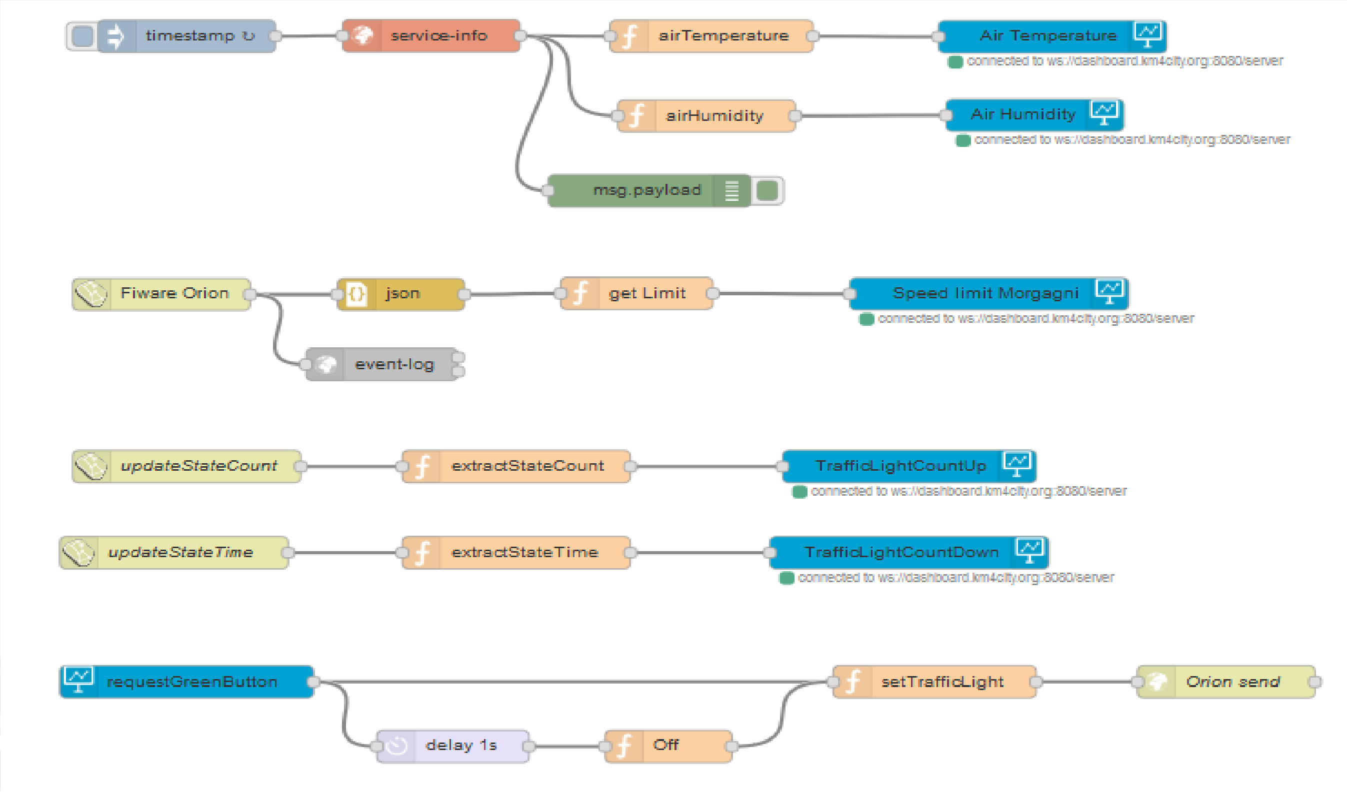
Actuators:

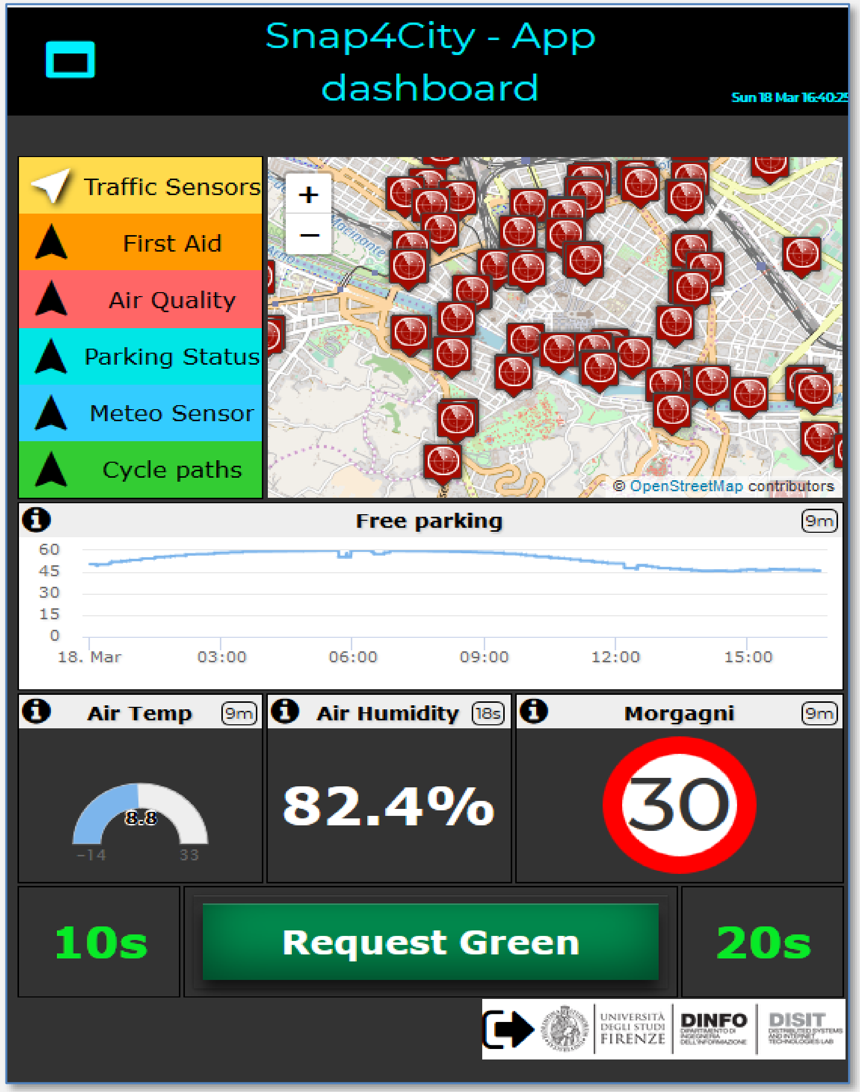
- Buttons
- Dimers
- Etc.

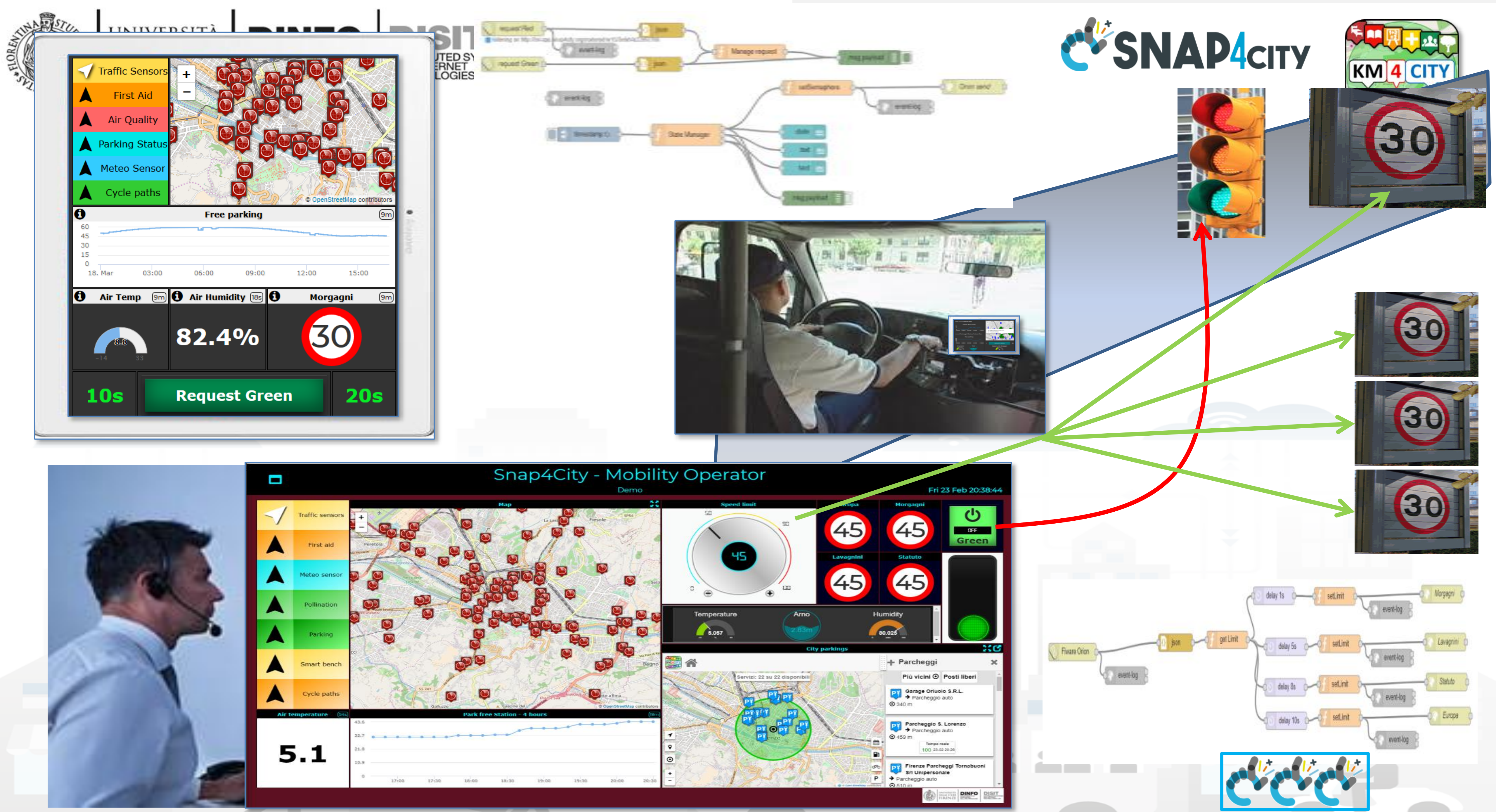
Virtual Sensors and Actuators



IOT Application with City Dashboard simple development





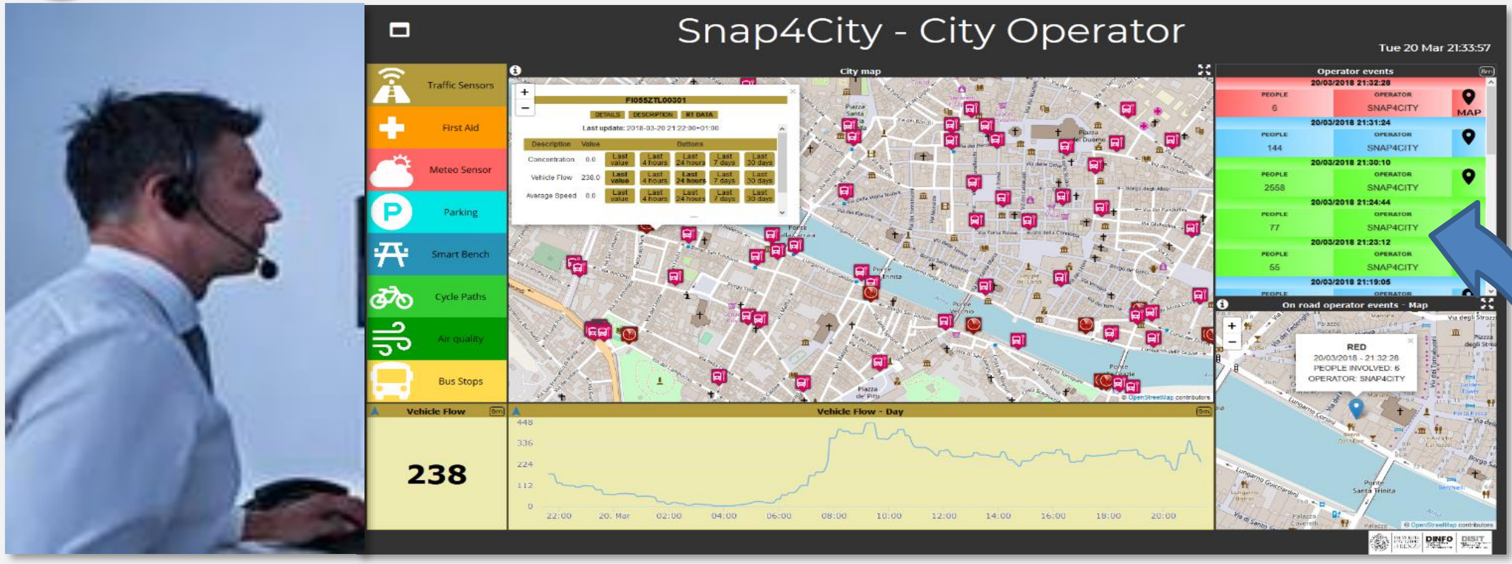

SNAP4CITY
KM4CITY
Traffic Sensors
First Aid
Air Quality
Parking Status
Meteo Sensor
Cycle paths
Free parking
Air Temp
Air Humidity
82.4%
Morgagni
30
10s
Request Green
20s
Snap4City - Mobility Operator
Demo
Fri 23 Feb 20:38:44
Speed limit
Morgagni
Lavagnini
Statuto
45
Green
Temperature
Arno
Humidity
City parkings
Parcheggi
Air temperature
5.1
Park free Station - 4 hours

Reporting Critical Events

Control Room Operator

Would like to:

- **Monitor** events vs services in the city and receive critical event notifications from on the road operators.
- **Assess contextual condition,** services status

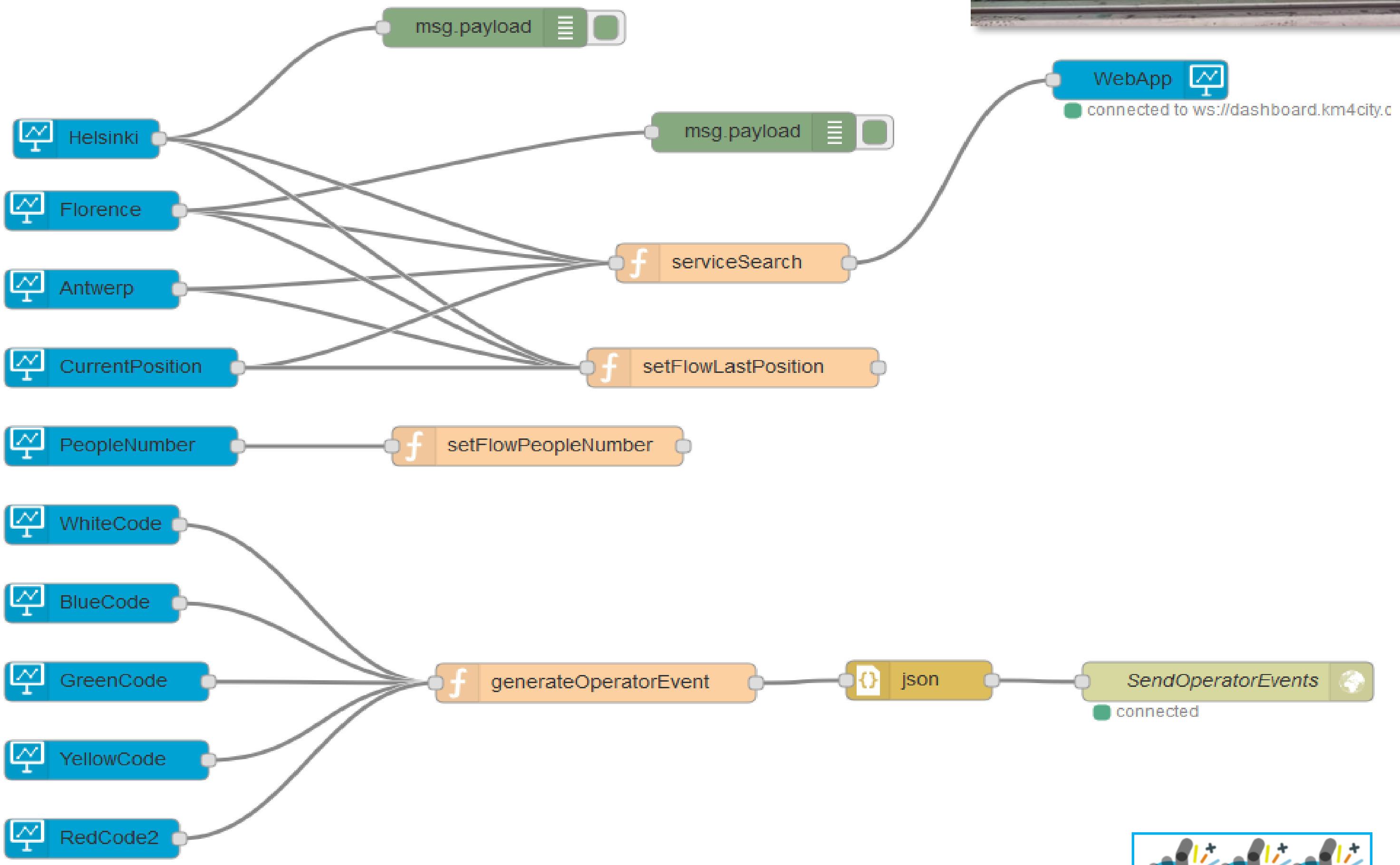


On the road operator

Would like to:

- Monitor data of traffic, Parking, environment, speed limit, services,
- **Send critical event notifications via coded description**

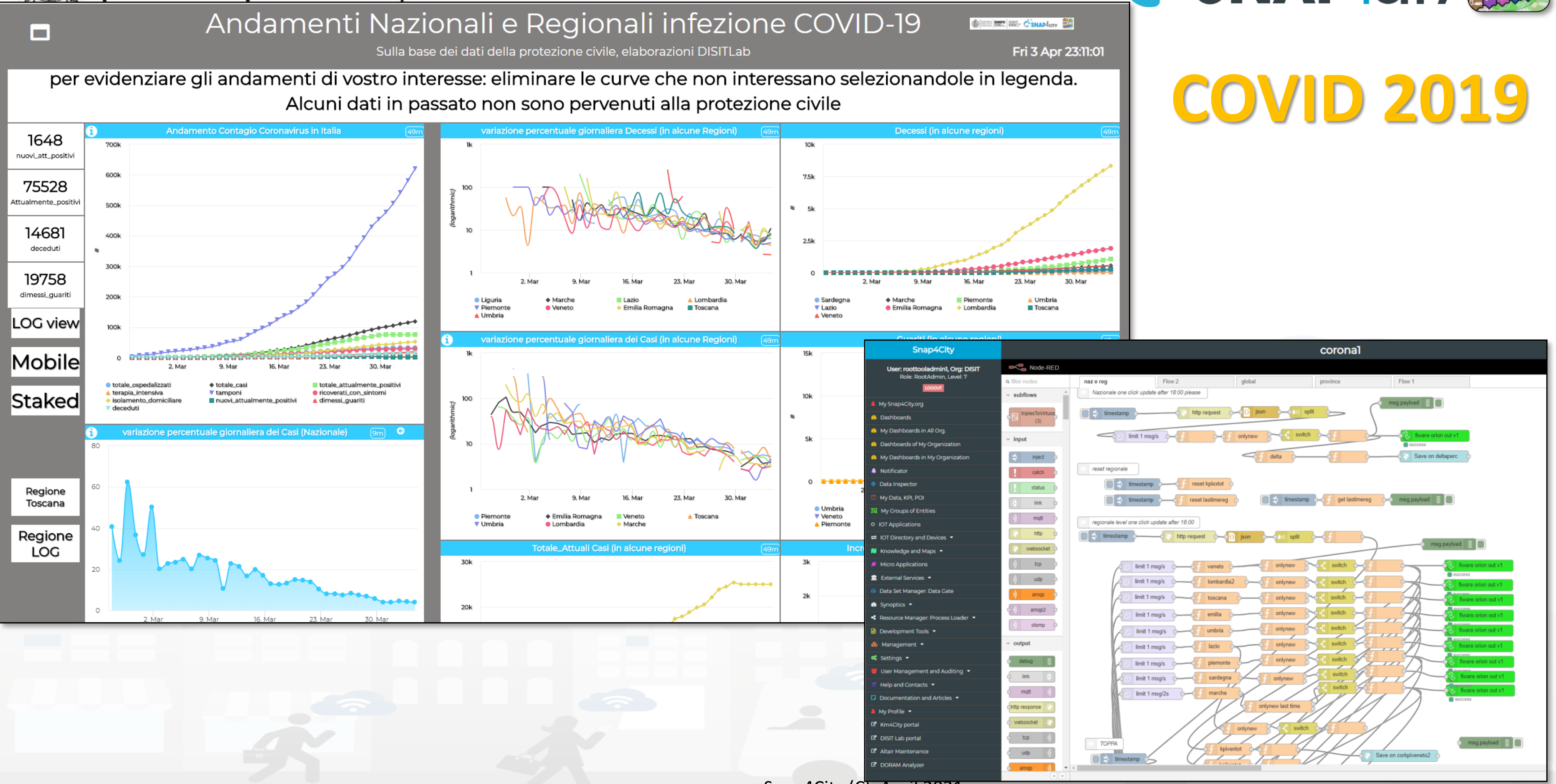
IOT Application with City Dashboard simple development



Other Cases

- *Telecontrol for water depuration plant*
- *Traffic Flow computing in Florence*
- *Snap4Home: Casa Domotica*
- *Snap4Industry: industry control*
- COVID 2019
- Computing of public transport quality
- Managing Heatmap production
- Managing Smart Parking
- Managing Smart Bike Sharing
- Telecontrol of Energy Plant

COVID 2019


Andamenti Nazionali e Regionali infezione COVID-19
Sulla base dei dati della protezione civile, elaborazioni DISITLab
Fri 3 Apr 23:11:01
per evidenziare gli andamenti di vostro interesse: eliminare le curve che non interessano selezionandole in legenda.
Alcuni dati in passato non sono pervenuti alla protezione civile
1648
nuovi_att_positivi
75528
Attualmente_positivi
14681
deceduti
19758
dimessi_guariti
LOG view
Mobile
Staked
Regione Toscana
Regione LOG
Andamento Contagio Coronavirus in Italia
variazione percentuale giornaliera Decessi (in alcune Regioni)
Decessi (in alcune regioni)
variazione percentuale giornaliera dei Casi (in alcune Regioni)
variazione percentuale giornaliera dei Casi (Nazionale)
Totale_Attuali Casi (in alcune regioni)
Snap4City
corona1
Node-RED

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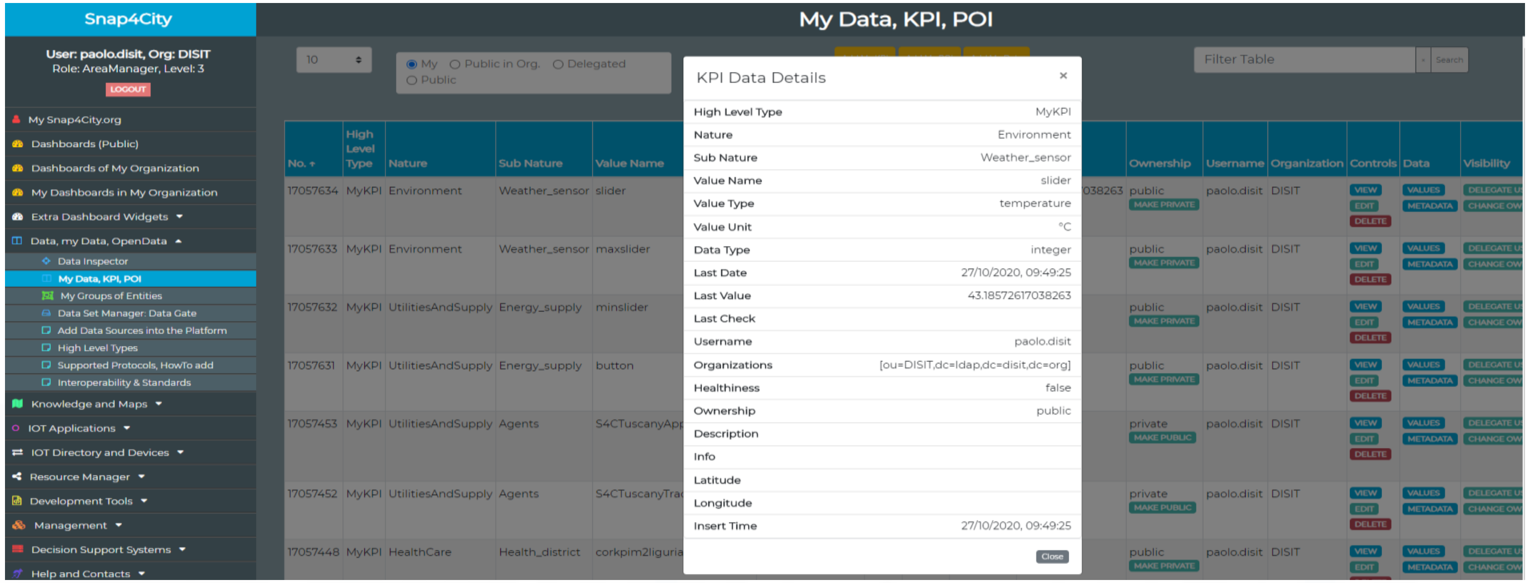
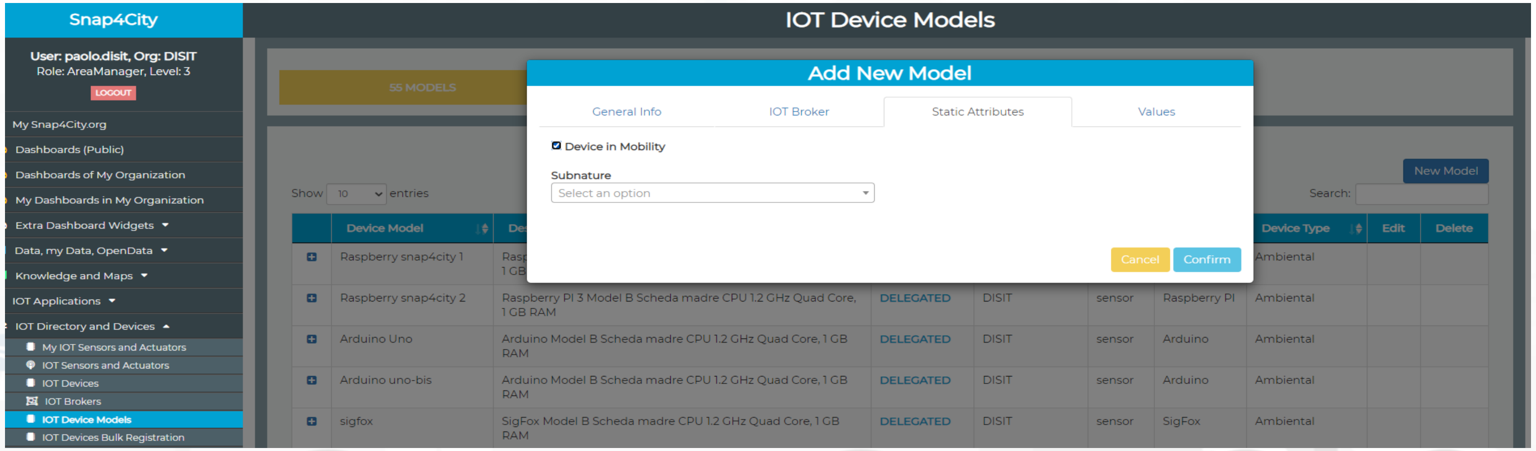
TOP

Moving IOT Devices / Sensors, Tracking Devices

Working with Sensor Data from Moving Devices

- Moving data can be collected by using:
  - **MyKPI**: in which each MyKPI has a ValueName, Unit, Type, etc.. And also GPS location
  - **IOT Device in Mobility**: which generates a new HLT SensorMobile which is partially developed so far



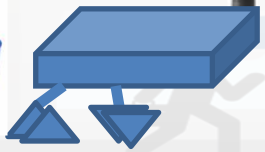


MyKPI: Tracking of Devices and Mobiles

- Real Time Trajectories for
    - Mobile Phone
    - Moving IOT Devices
    - OBU, Vehicular Kits
    - Multiple tracks
    - Day by day
- Micro Application

Mobile
PAX Counter

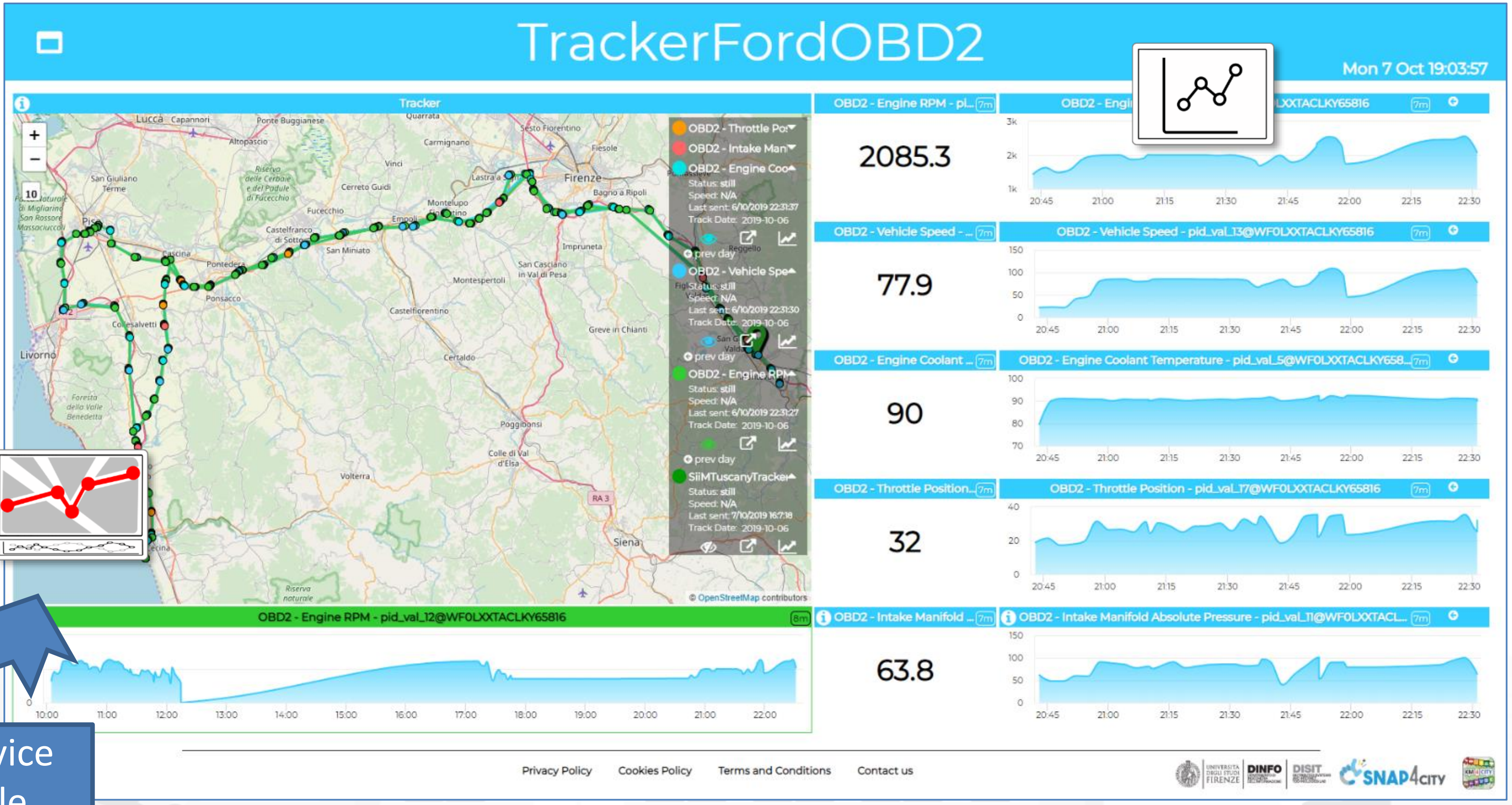
Apps



OBU

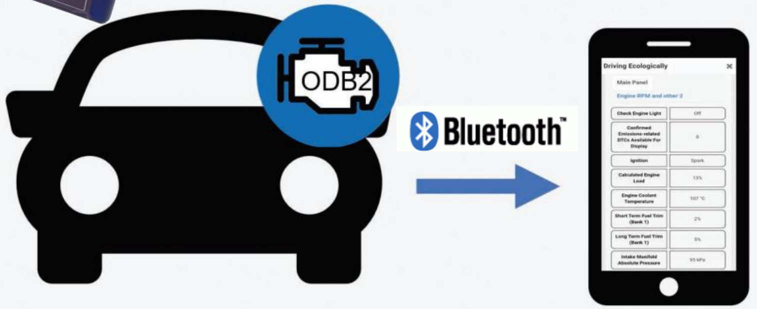
OBD2

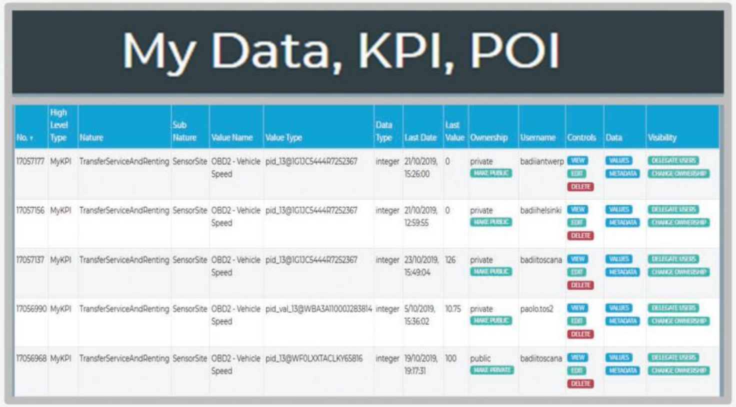
IOT Device MObile

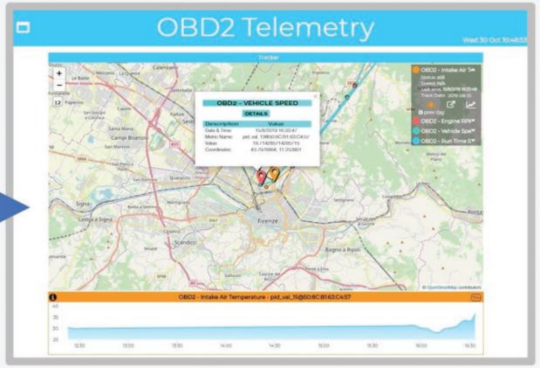


IOE – Vehicle Monitoring

CANBUS
sniffer

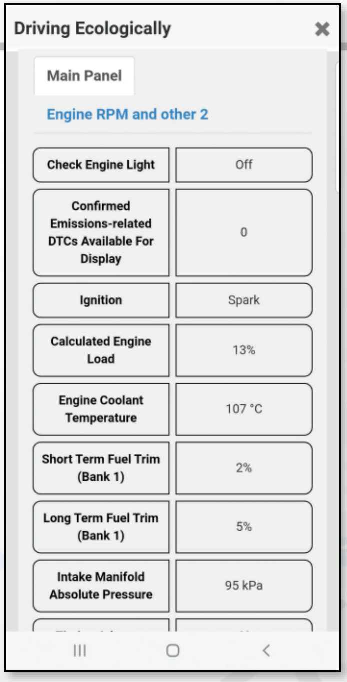


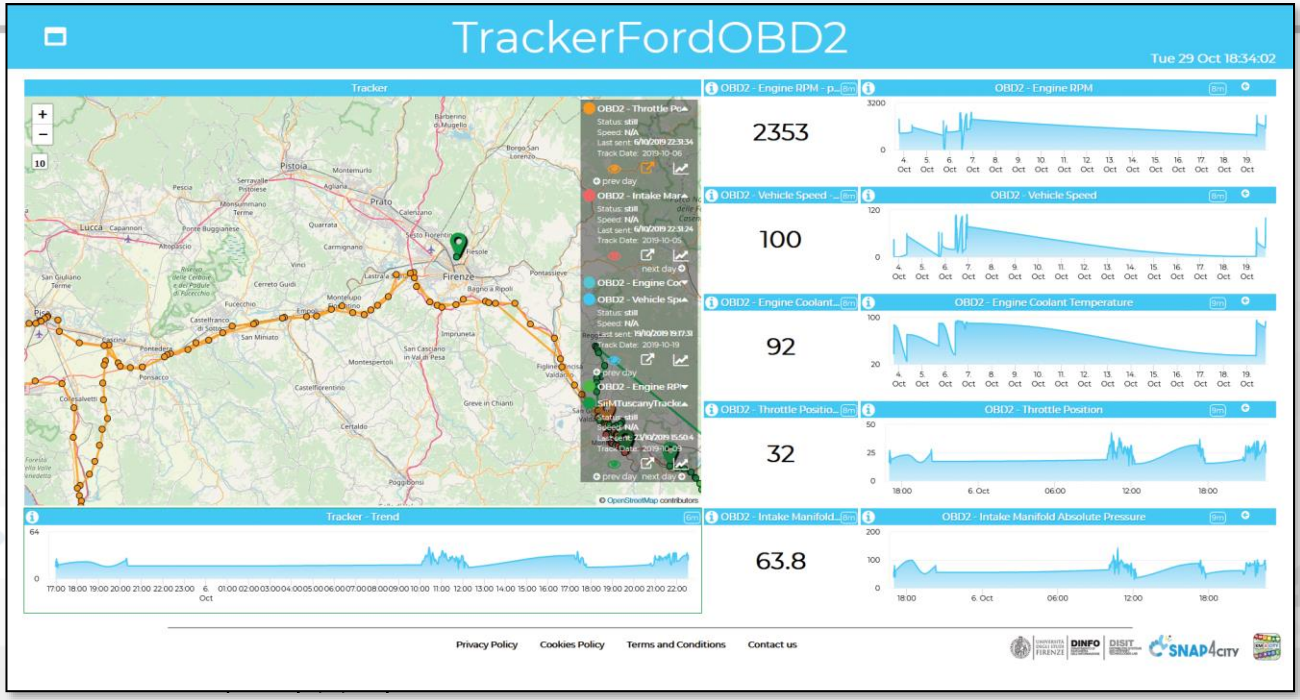




Tuscany in a Snap Mobile App on Android

GET IT ON Google play



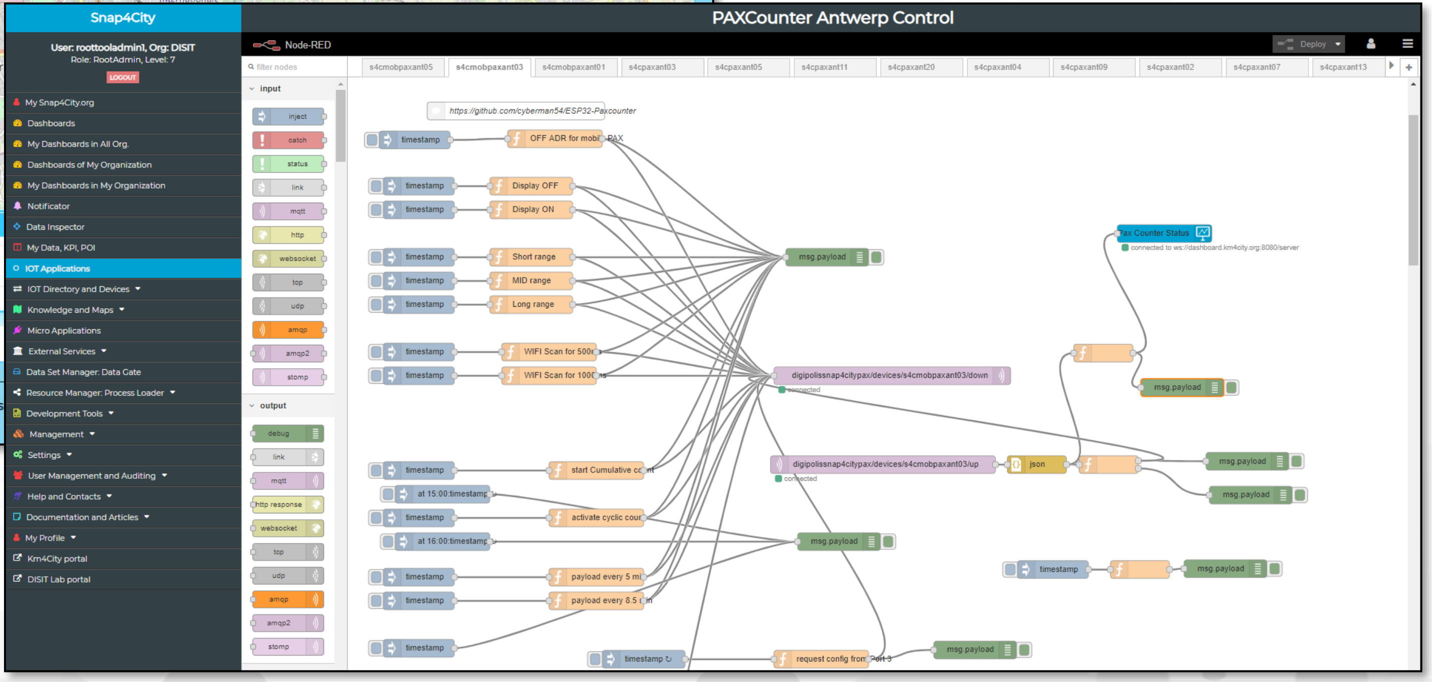


PaxCounter devices

- **Fix PaxCounter LoraWan**
  - sniffing on: Wi-Fi, Bluetooth
  - Sending data via LoraWan
- **Mobile PaxCounter LoraWan**
  - sniffing on: Wi-Fi, Bluetooth
  - Sending data via LoraWan
- **Fix PaxCounter, multiple out**
  - Sending data via LoraWan and Wi-Fi
  - sniffing on: Wi-Fi, Bluetooth

https://www.snap4city.org/456

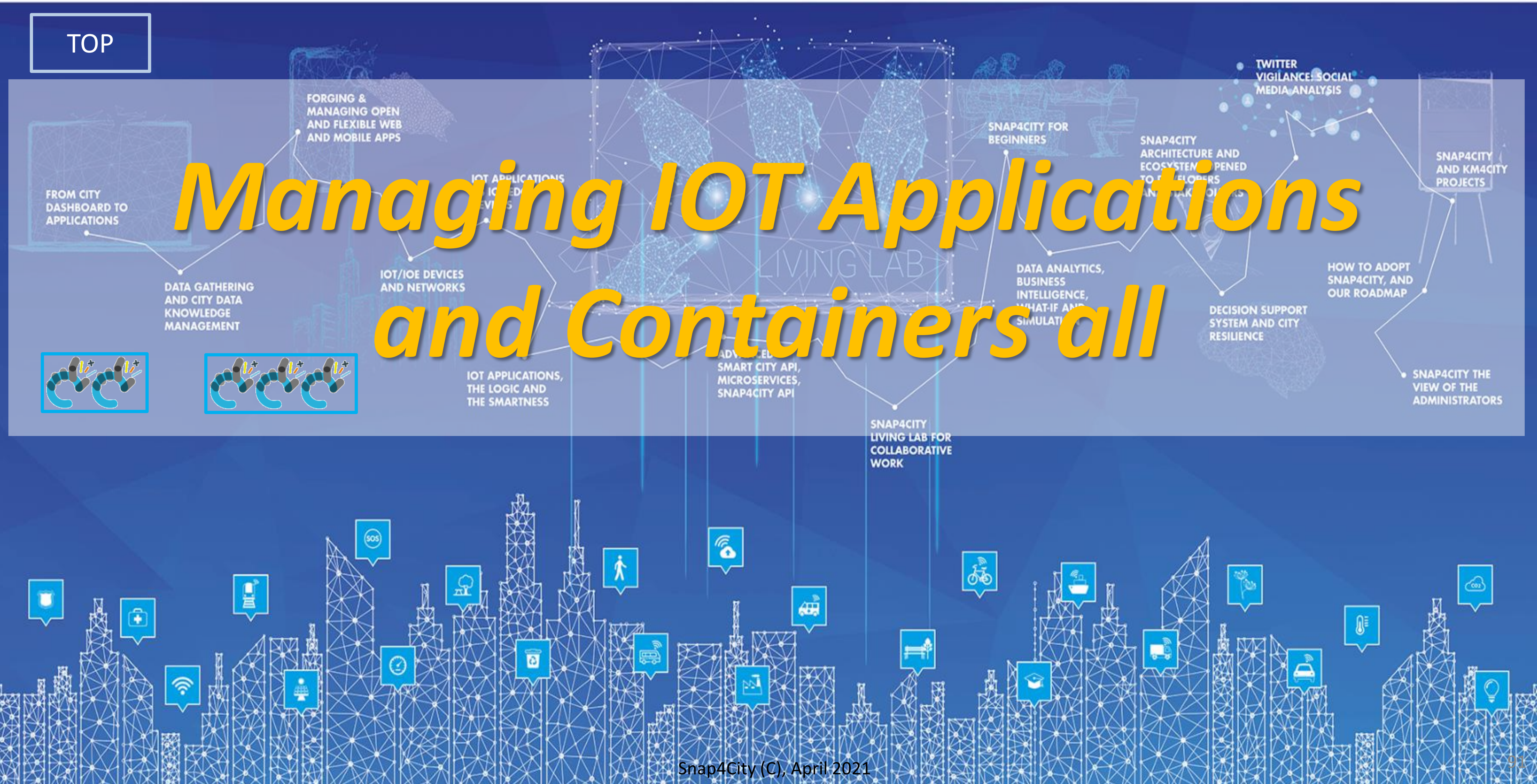
Programmable PAX counting



Antwerp

TOP

Managing IOT Applications and Containers all



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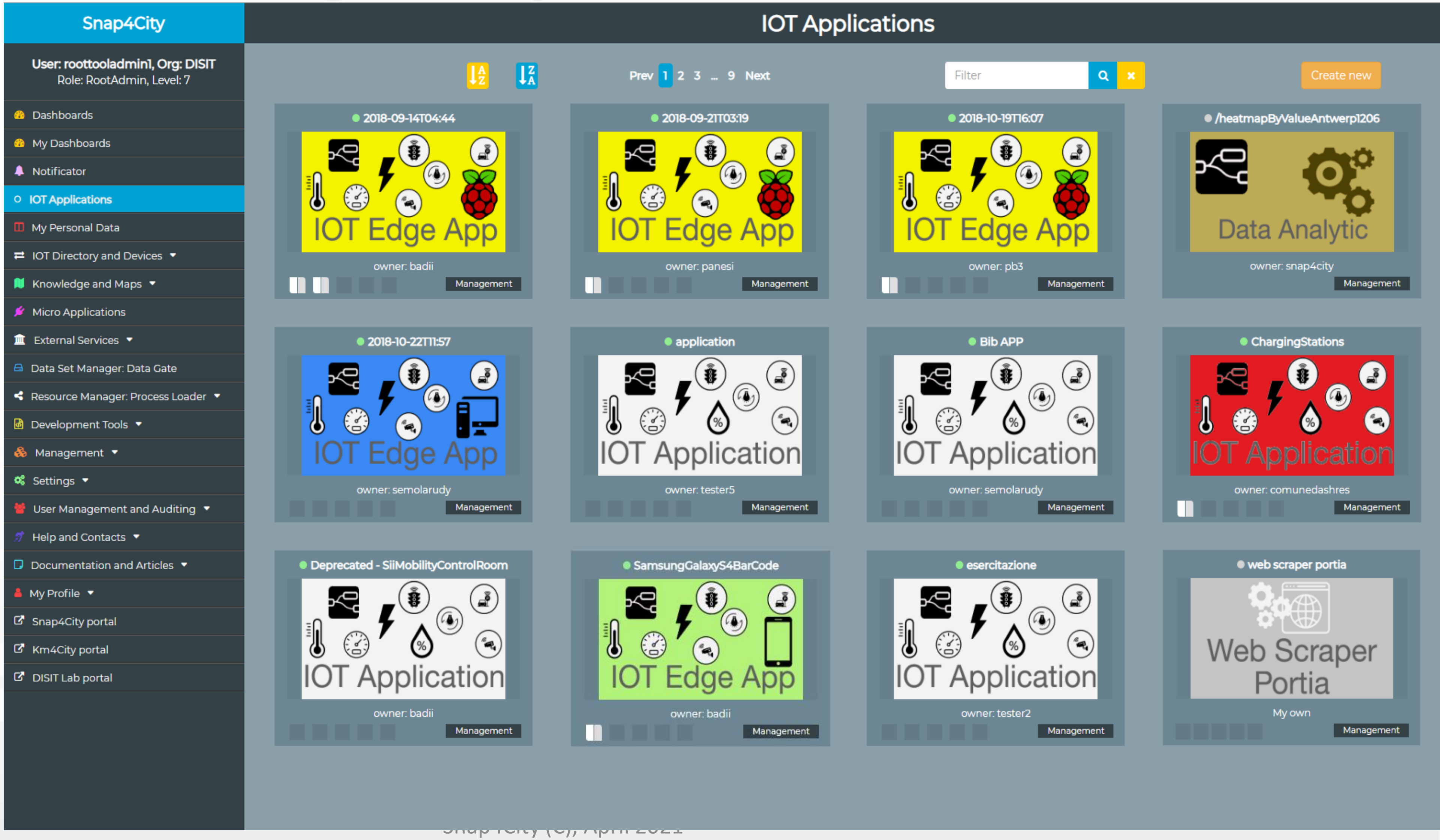
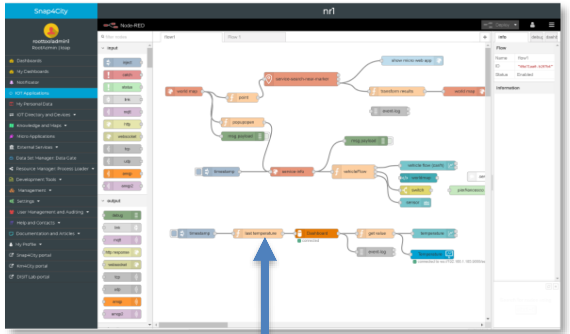
IOT Application Listing, they can be

- Basic (white)
- Advanced (red)
- IOT Edge
  - Raspberry Pi
  - Android
  - Win/Linux
- Data Analytic (Plumber)
- Web Scraper (Portia)

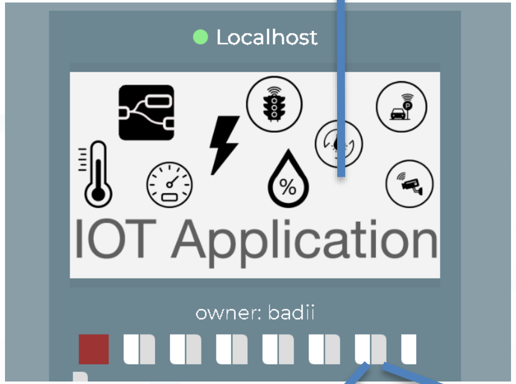


IOT Applications Listing

- Basic / Advanced
- On IOT Edge Raspberry Pi
- On IOT Edge Android
- On IOT Edge Win/Linux

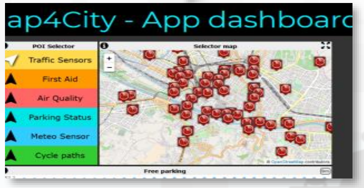


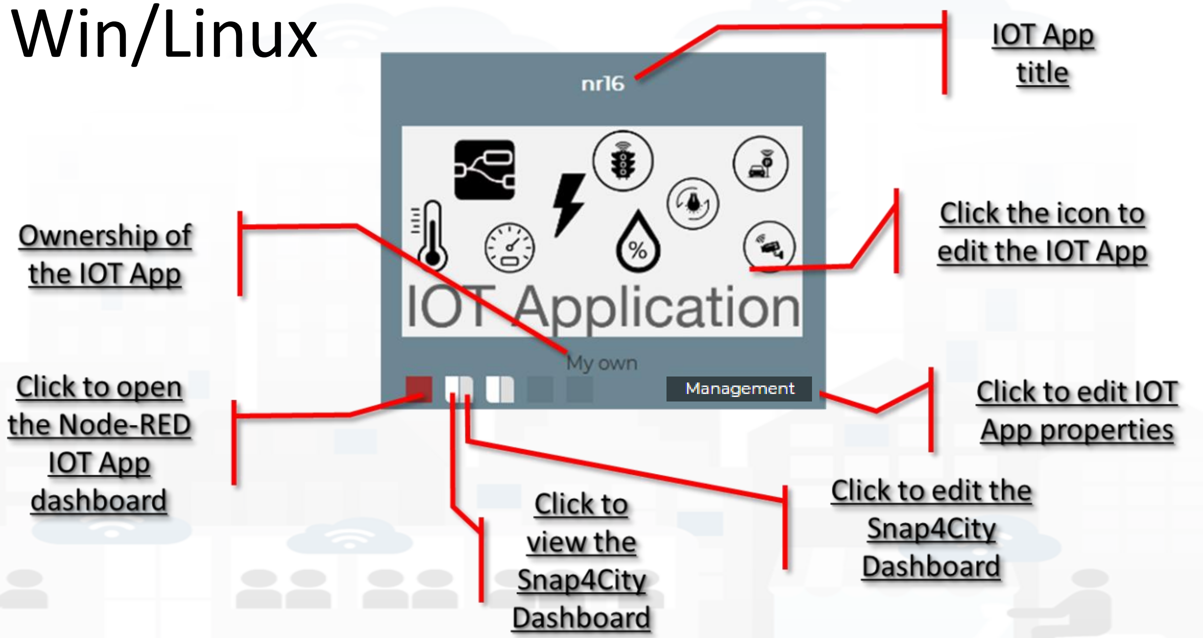
EDIT IOT APP



VIEW

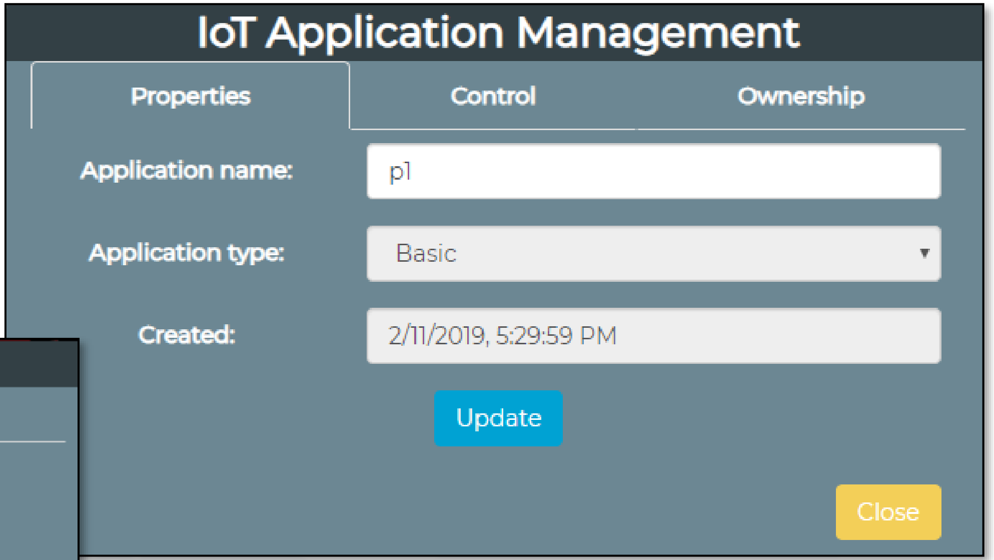
EDIT

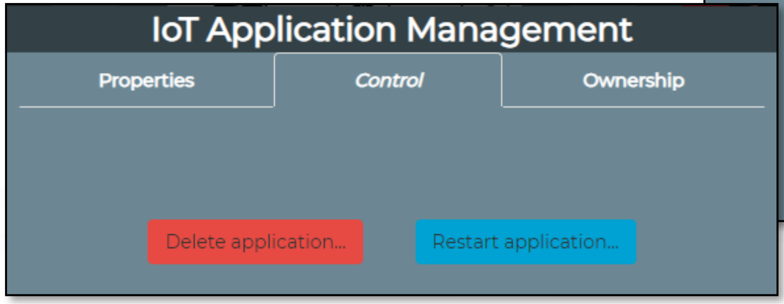


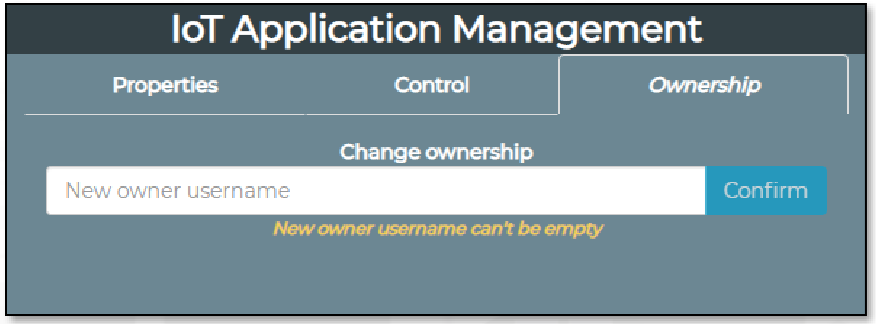


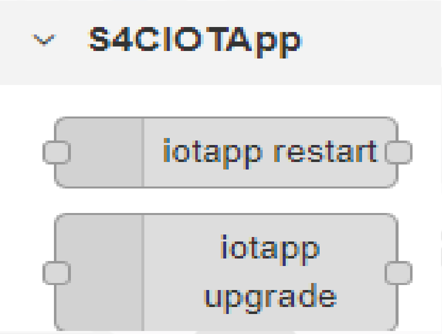
IOT Application Self Control

- **Properties**
  - Name, Type, Creation date
- **Control**
  - Restart Container
  - Delete IOT App
- **Change of ownership**
  - Pass to another Snap4City User
- **From inside the IOT App**
  - Restart
  - Update Snap4City Library







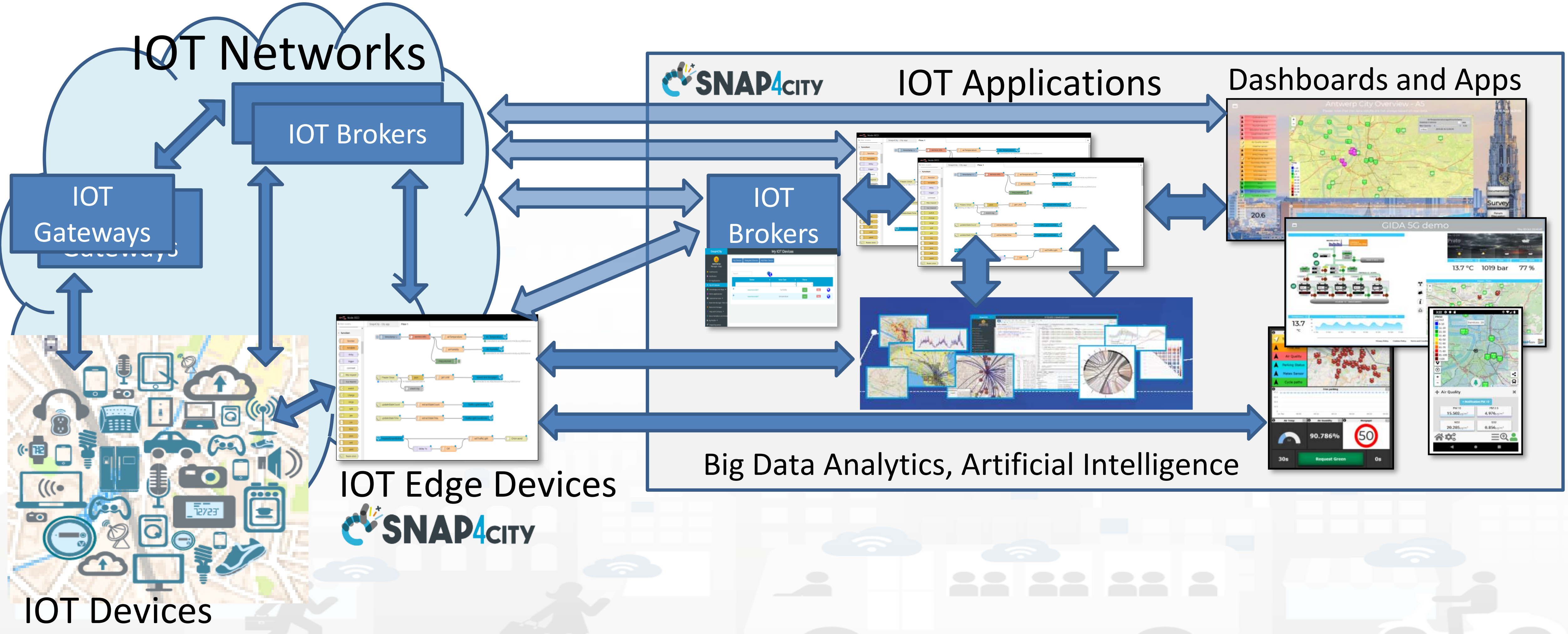


Automating restart and update

TOP

Remote Control of IOT Applications on IOT Edge Devices

Snap4City Services also on IOT Edge!!!



Why it is useful

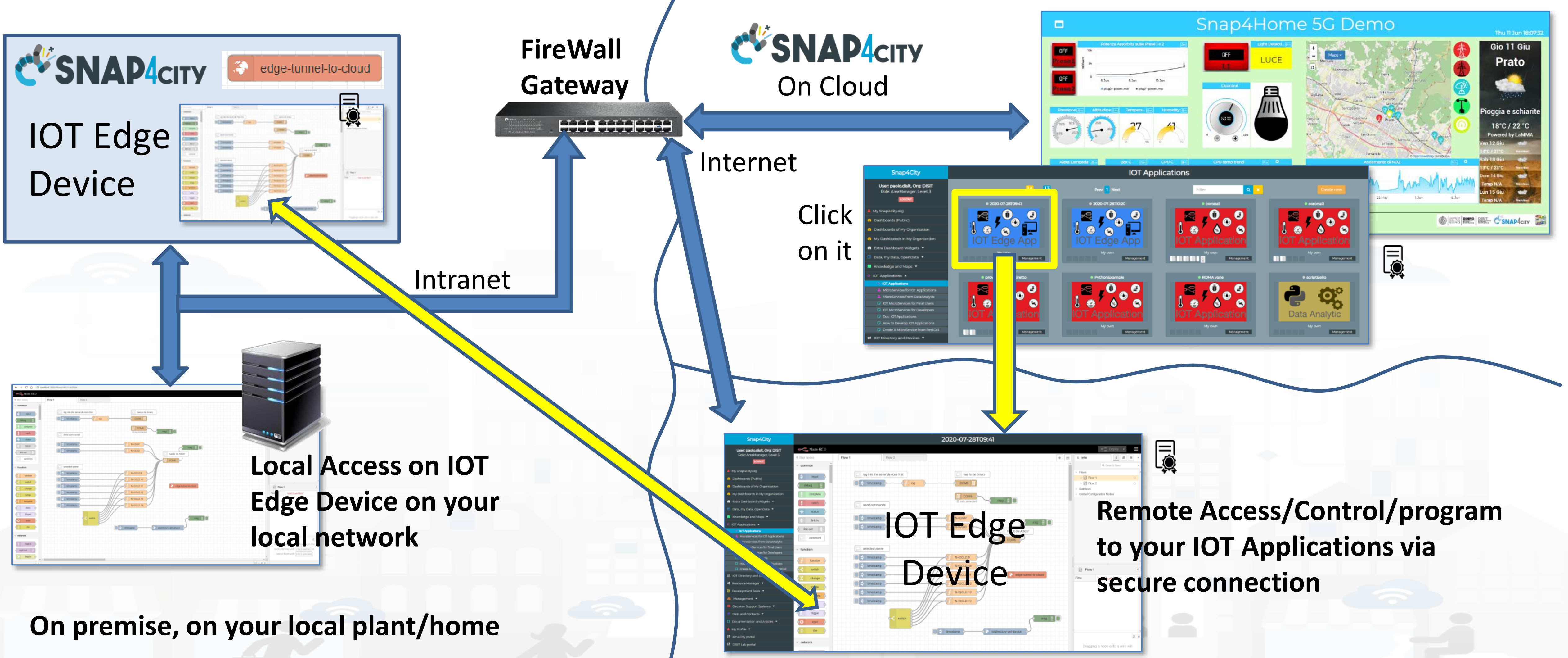
- **Need to transform** data from your local devices to Snap4City devices or data storage or dashboards,

- **Need to play the role of multiprotocol HUB** as in:
  - **Snap4Home**: Scenario: Snap4Home, how to exploit Snap4City solution on home automation
  - **Snap4Industry**:
    - **Scenario: High Level Control of Industrial Plant**
    - **Snap4Industry: Snap4City for Industry 4.0**
    - **Scenario: 5G Enabled Water Cleaning Control**

IOT Edge Device for Snap4City

- **Computer based solutions with *Node-RED + Snap4City Library***
- **Node-red supports:**
  - Raspberry pi, Linux based, Windows based, android with Termux, and also on a several servers. https://nodered.org/docs/getting-started/
- **Snap4City Library:**
  - From Node-RED: "manage palette" in the main menu'.
  - From Node-RED library: https://flows.nodered.org/search?term=snap4city
- ***You can add any kind of protocol and interface to IOT Edge Device***

Remote Control/Management of IOT Edge



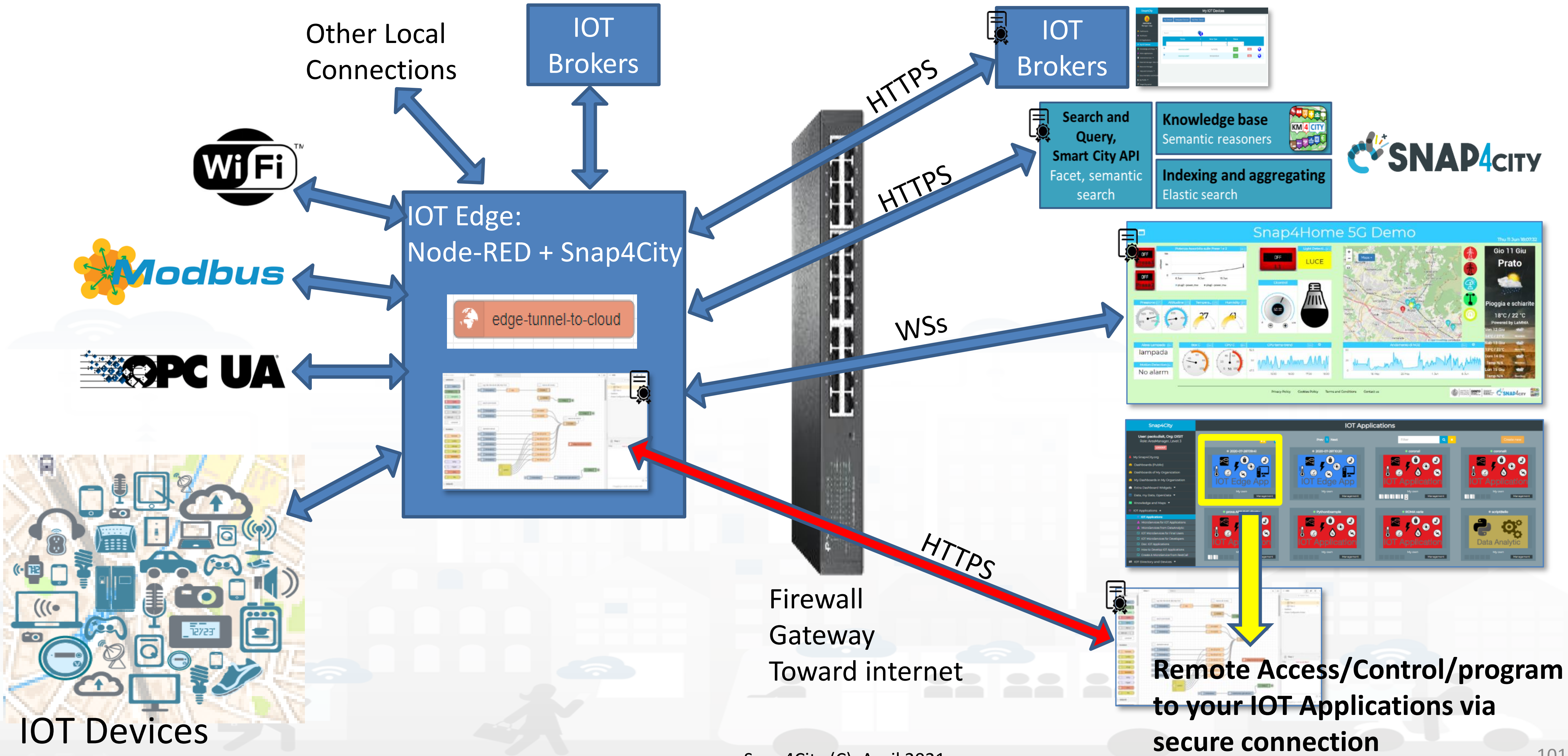
Advantages of IOT Edge remote control/program

- You do not need to be/move in the local network to access at Your IOT Edge Devices for programming or maintenance, SINCE With Snap4City:
  - *You can update the logic flow of your IOT Edge Devices from remote,*
  - *You can perform remote maintenance of your IOT Edge Devices and programms without moving from your office*

AND

- You can access to the IOT edge from remote by using a secure connection
- You can activate the remote control feature singularly for each IOT Edge Device
- You do not need to reconfigure your Firewall or Gateway in most of the cases

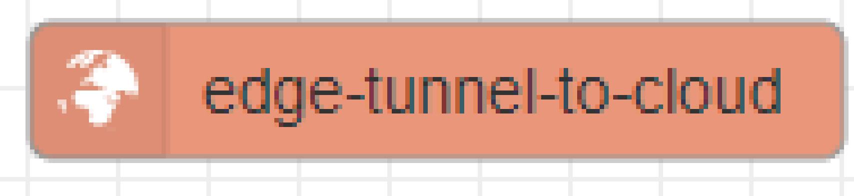
IOT Edge Device



HOW To install IOT Edge Remote Control feature

- **The installation is very simple**

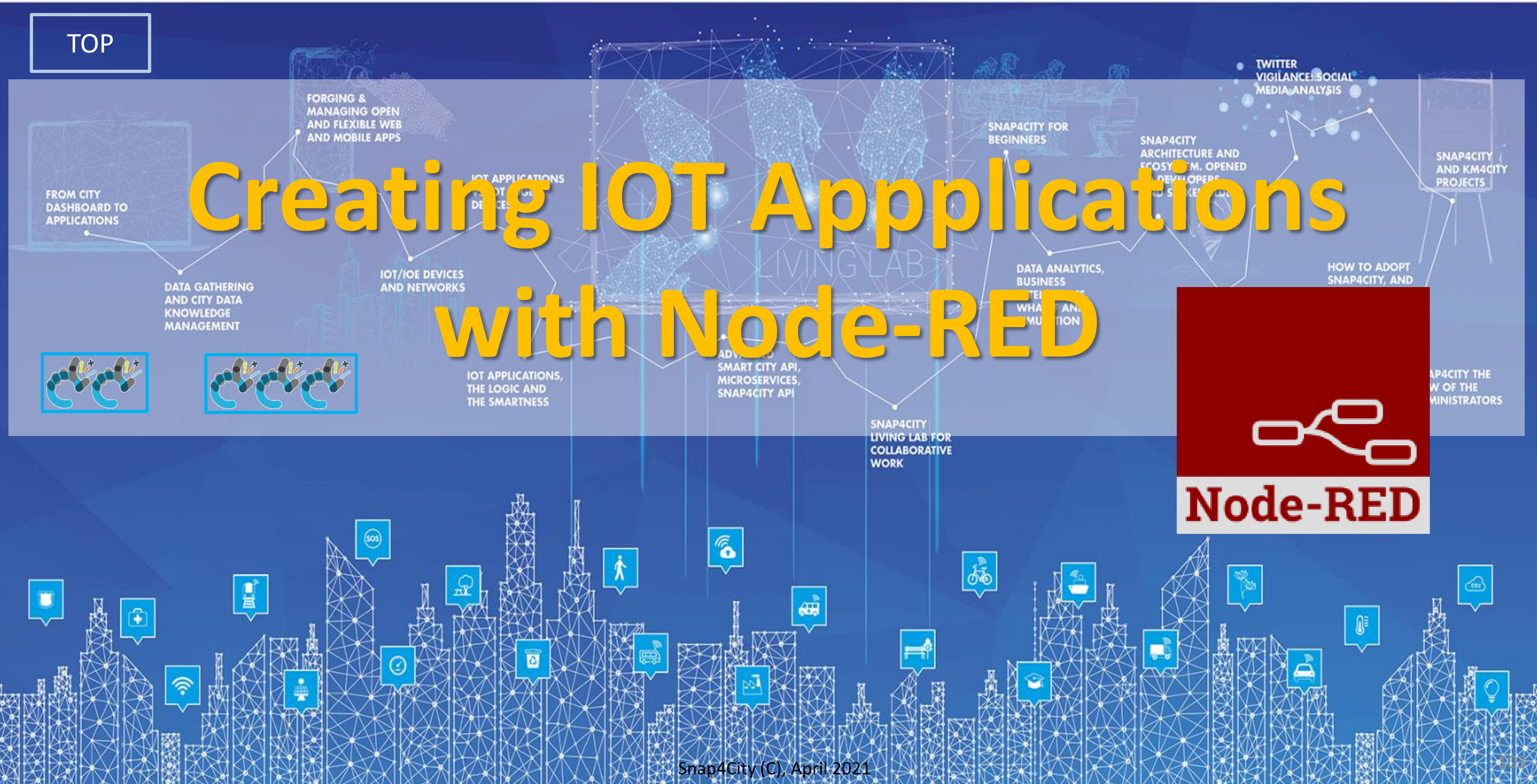
1. install Snap4City basic library
2. Drag and drop block from S4CUtility



3. Configure the block with your credentials
4. Deploy of the IOT App
5. Go in the list of Your IOT Applications on Snap4City.org or other cloud or on premise installations
6. Identify the IOT Edge IOT App and click on it to open the view on the IOT Applications flows

TOP

Creating IOT Appplications with Node-RED



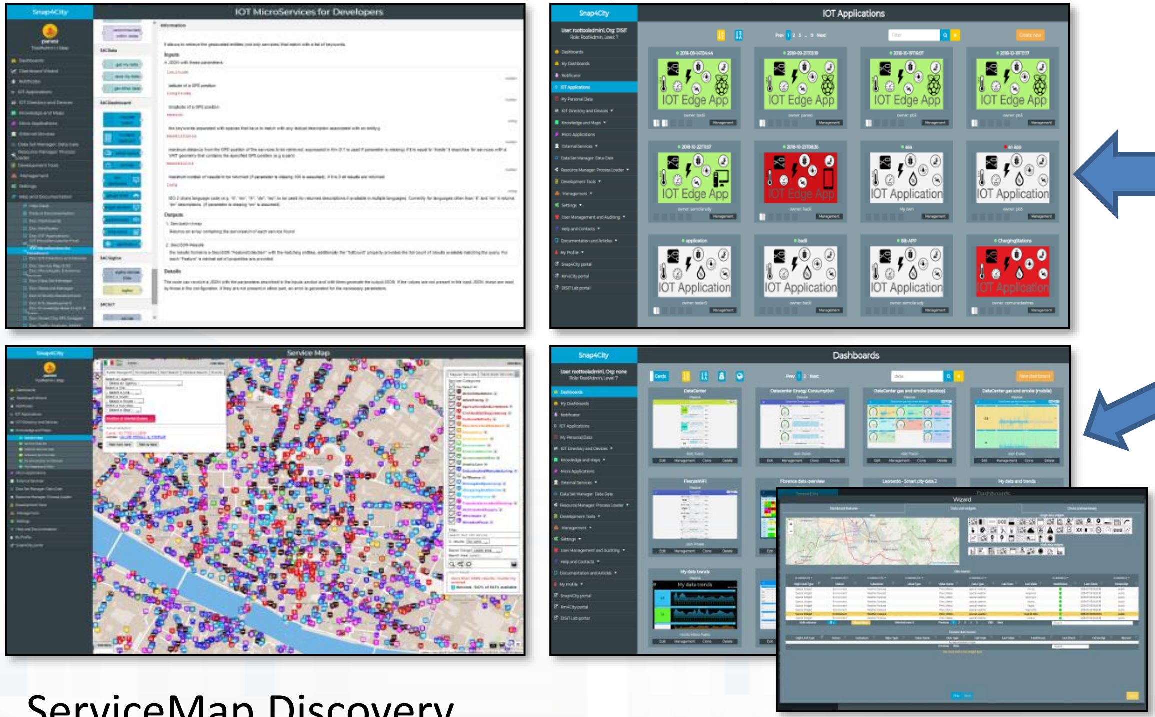
Node-RED

IOT Applications Development

IOT Discovering

MicroServices collections

My IOT Applications



ServiceMap Discovery

Dashboard Collection, Editor and Wizard

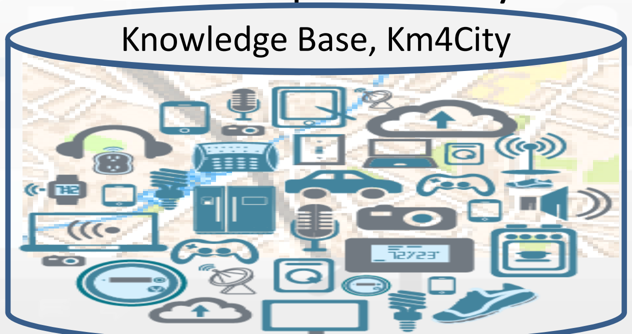
IOT App. Editor

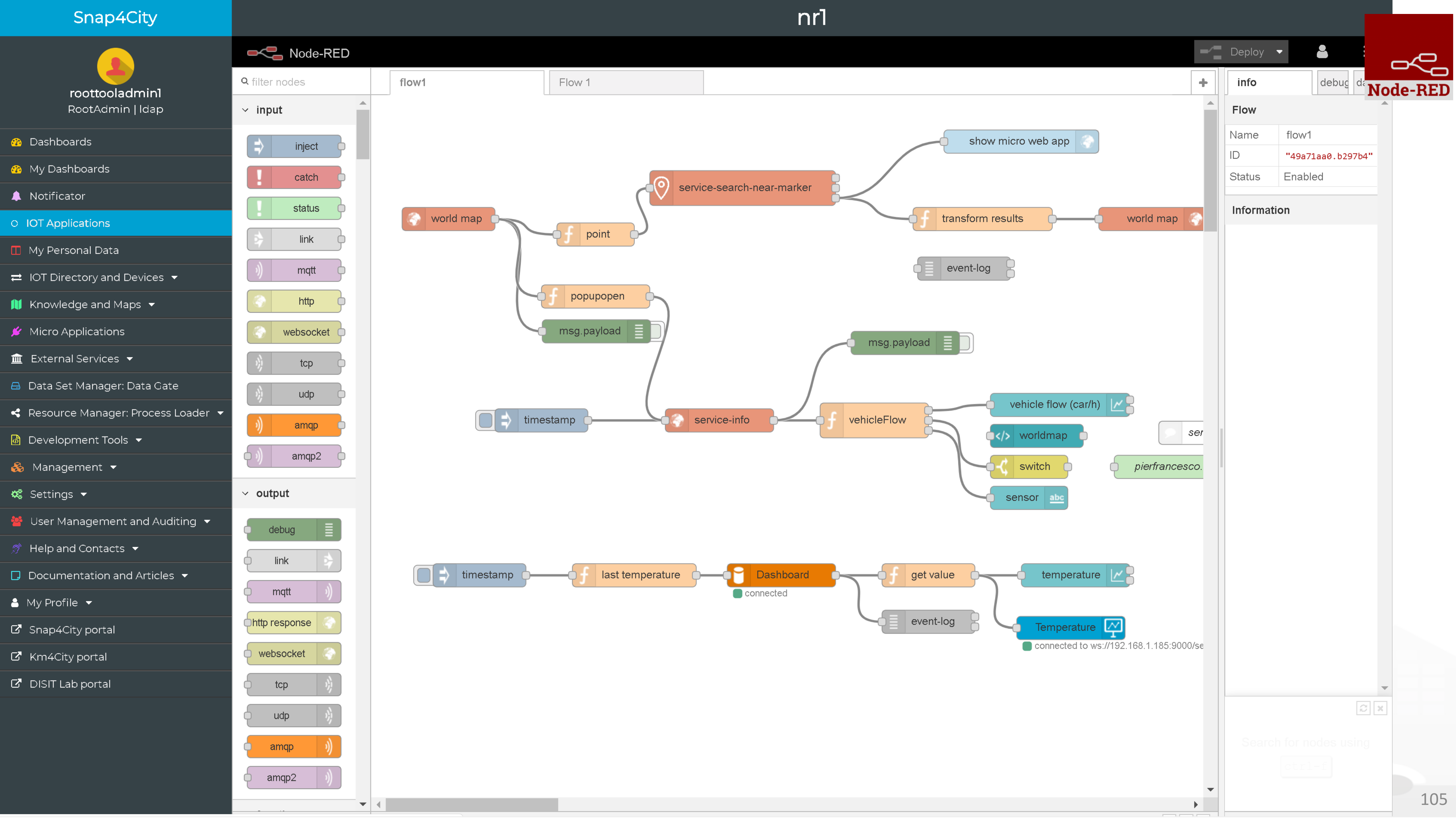
Generating IOT App With Dashboard

Sharing/saving reusing IOT App

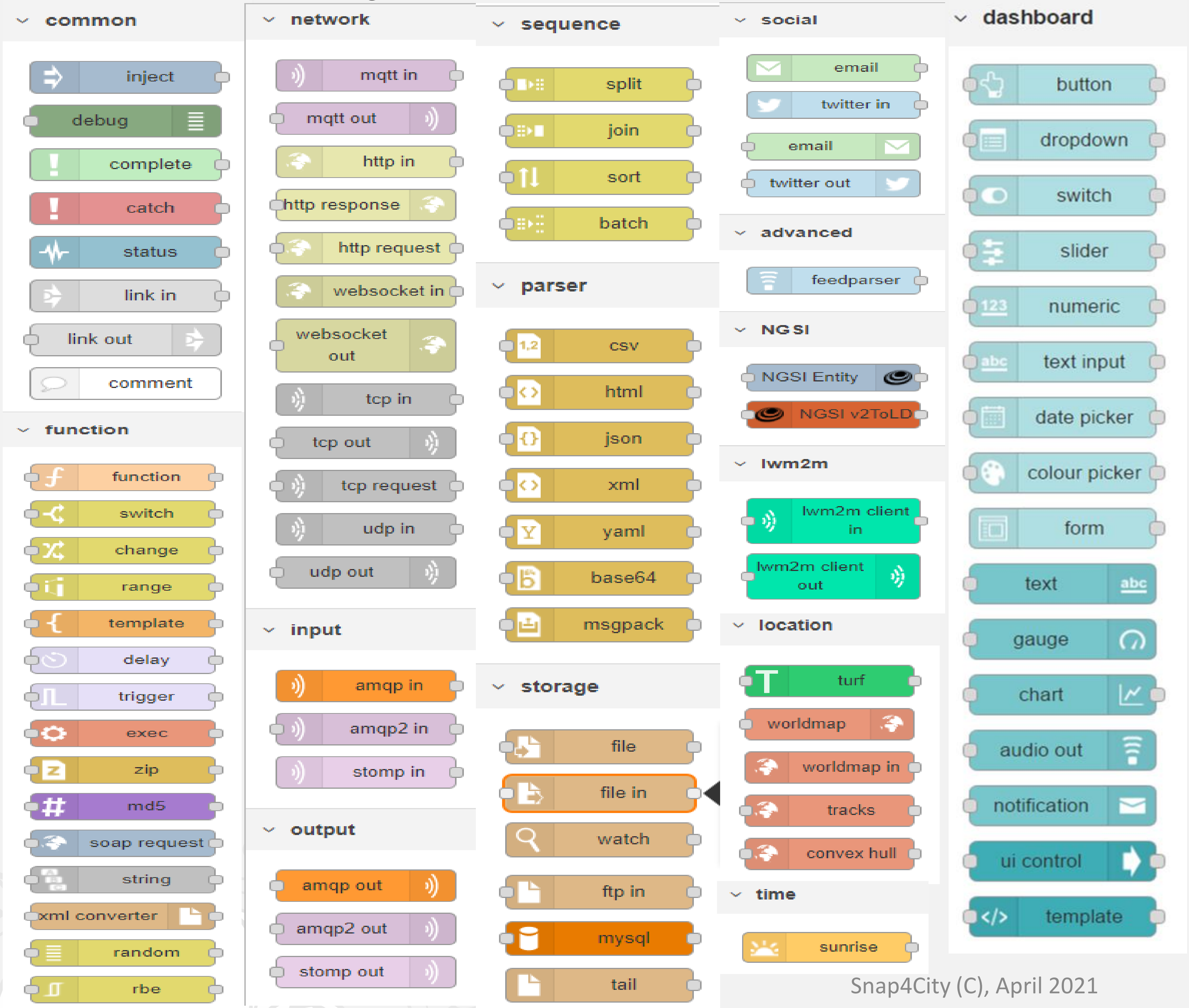
Resource Manager

Knowledge Base, Km4City

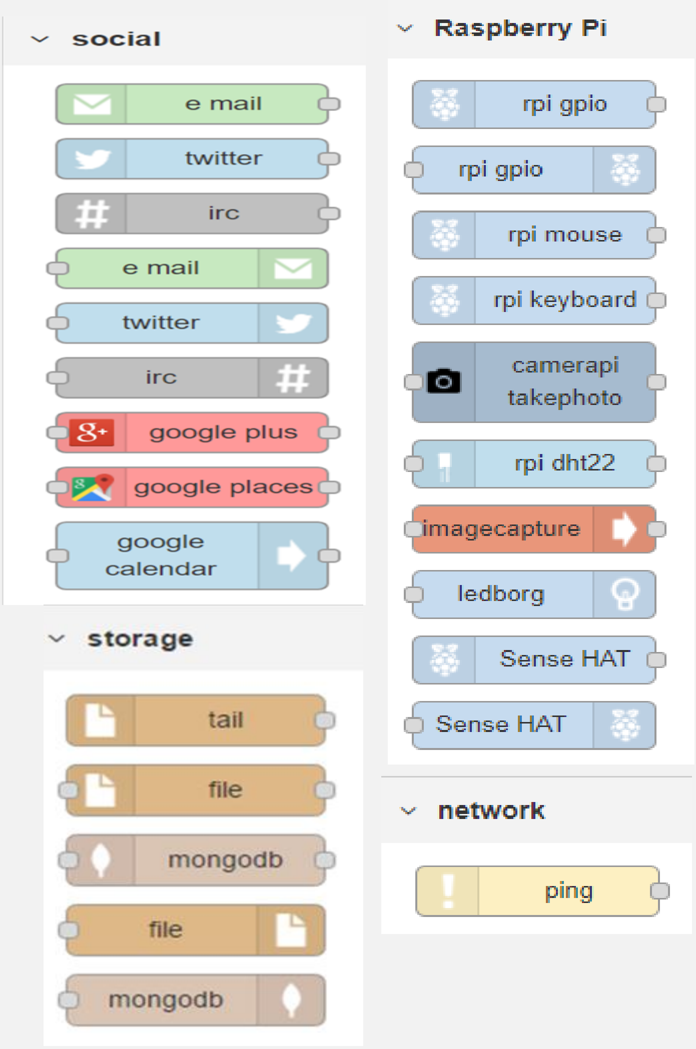



Snap4City
nr1
Node-RED
Deploy
roottooladmin1
RootAdmin | ldap
Dashboards
My Dashboards
Notificator
IOT Applications
My Personal Data
IOT Directory and Devices
Knowledge and Maps
Micro Applications
External Services
Data Set Manager: Data Gate
Resource Manager: Process Loader
Development Tools
Management
Settings
User Management and Auditing
Help and Contacts
Documentation and Articles
My Profile
Snap4City portal
Km4City portal
DISIT Lab portal
filter nodes
input
inject
catch
status
link
mqtt
http
websocket
tcp
udp
amqp
amqp2
output
debug
link
mqtt
http response
websocket
tcp
udp
amqp
amqp2
flow1
Flow 1
show micro web app
service-search-near-marker
world map
point
transform results
world map
event-log
popupopen
msg.payload
msg.payload
timestamp
service-info
vehicleFlow
vehicle flow (car/h)
worldmap
switch
sensor
pierfrancesco.
timestamp
last temperature
Dashboard
connected
get value
temperature
event-log
Temperature
connected to ws://192.168.1.185:9000/se
info
debug
Flow
Name
flow1
ID
"49a71aa0.b297b4"
Status
Enabled
Information
Node-RED

Basic Node.js Blocks on NodeRed on our Advanced IOT Apps



+ on IOT Edge Raspberry

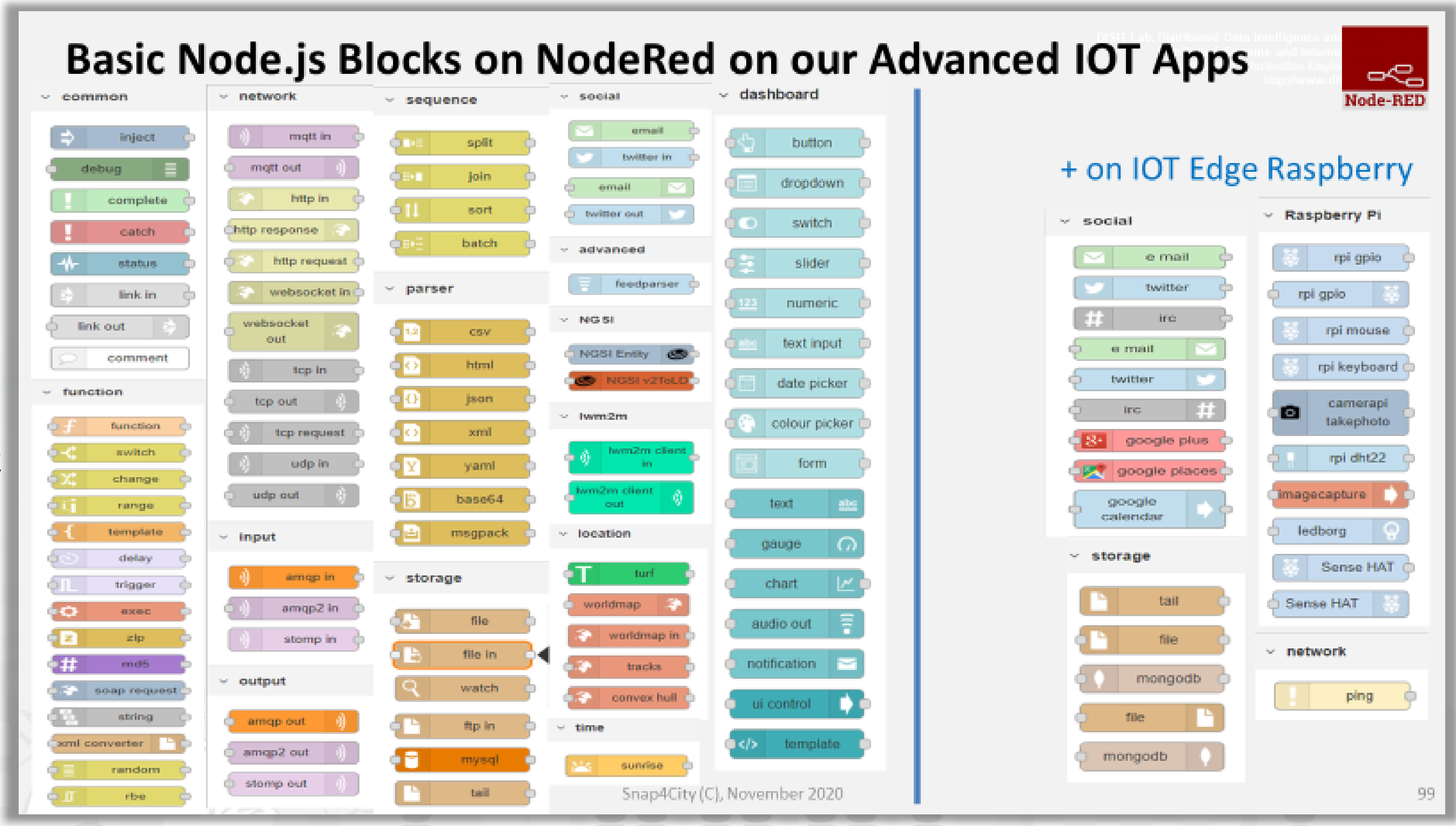


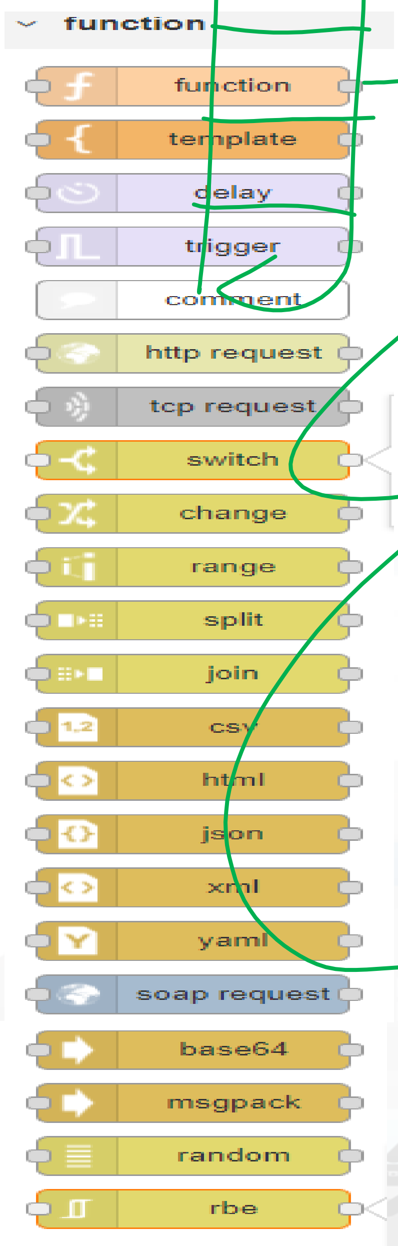
Node-RED Basic Blocks

It is provided with **a minimum set** of functionalities (the building blocks/nodes) while other blocks can be easily added loading them from a **large library** made available by the **JS Foundation**.

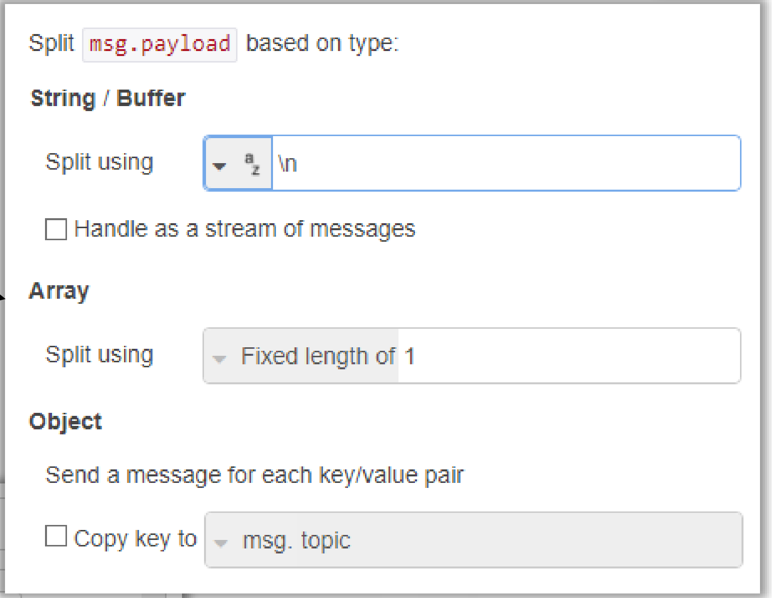
Despite to its diffusion, for the usage in the context of Smart City it was **not powerful** to cope with the **basic requirements** of the domain.

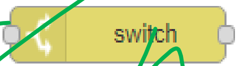
The classical nodes provided in the standard version can be classified as: input, output, function, social, storage, analysis, advanced, and dashboard.



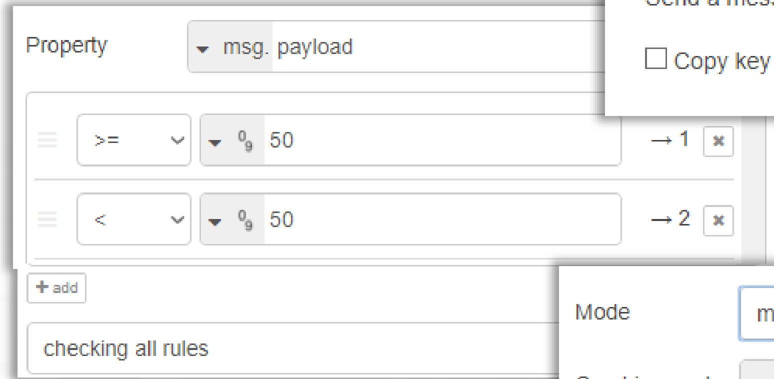


Divides the input message into multiple messages as indicated in the configuration. If you have an array at the input, you can configure it to send each element of the array individually at the output.

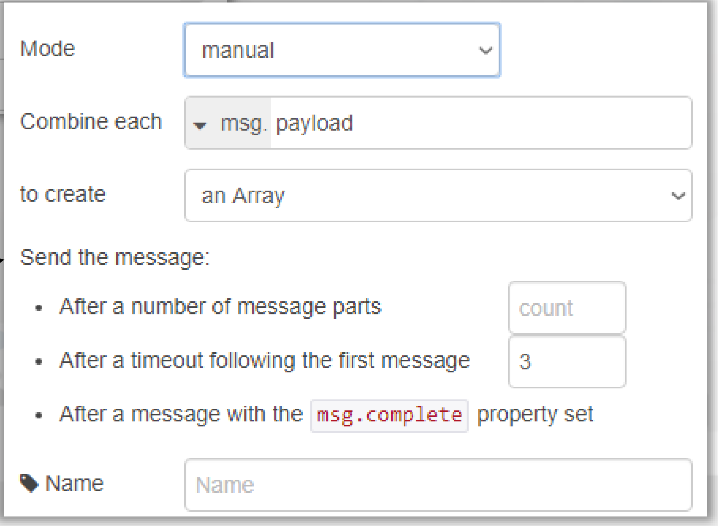




Treads the input message on possible different outputs based on a comparison made on the input message.

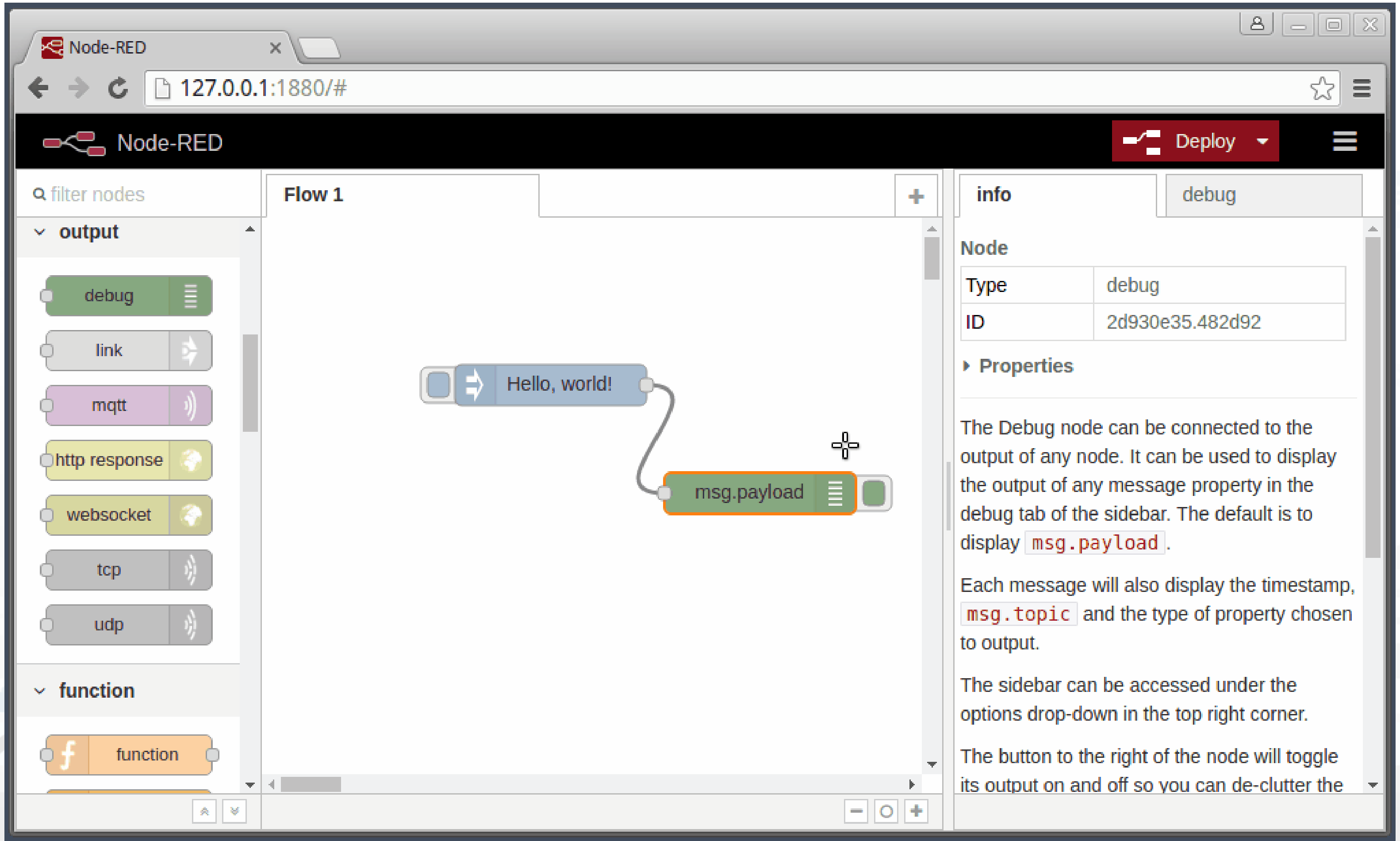


Operates in reverse order to the split. Joins the incoming messages in the mode indicated in the configuration.



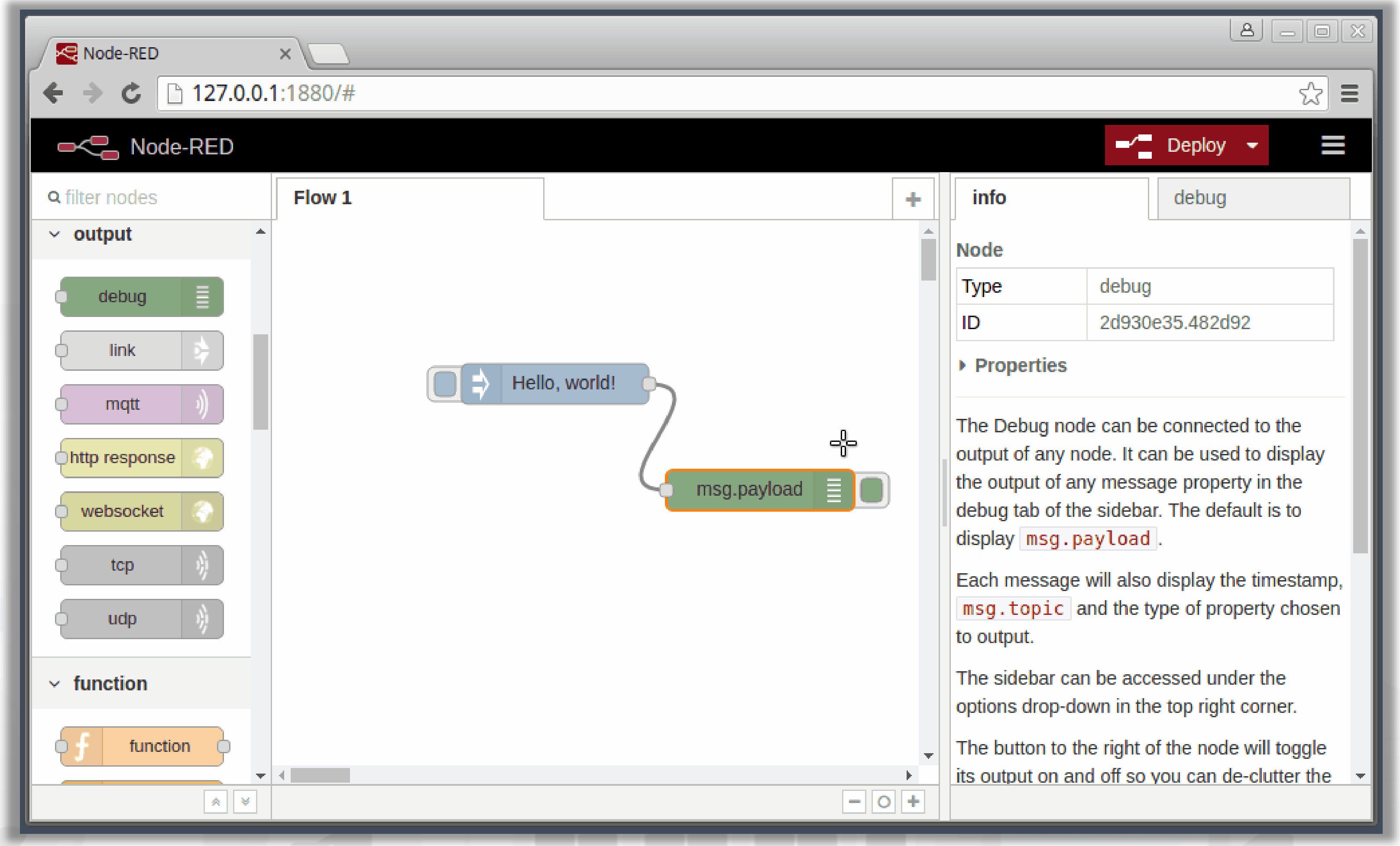
Hello World of Node-RED

- http://developer.opto22.com/nodered/general/getting-started/node-red-hello-world/



Node-RED

- Node-RED is a **flow-based** development tool for visual programming proposed by **JS Foundation**
- The Node-RED approach is a mix of **visual composition** of **nodes/blocks** to compose the so-called **flows** that are concurrently executed by an engine **Node.js**.
- It is quite diffuse being also directly provided into **official releases** of IOT devices as **Raspberry Pi** family
- Based on **Node.js**
- 100% **open source**



DEMO Section 1

TOP

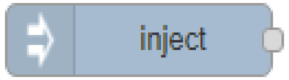
Node-RED Hello World

Example of simple IOT Application

In this demo let's create an IoT Application that:

- generate a random value,
- the value is switched on the correct path
- the value is showed in the local dashboard of NodeRed

Nodes for flow



Generates an input for the other nodes. It can be repeated at predefined intervals, entered manually and of various types (timestamp, string, number, boolean, JSONetc)

Each message that enters the debug node is shown in the "debug" tab on the right of nodered (you can choose which part of the message to show)

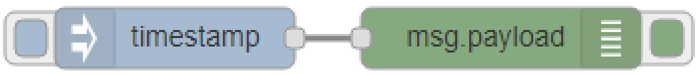
Generates a random number. You can configure the number generation interval and the type (integer or float).

Evaluates the input message and routes it to the correct output according to the desired configuration

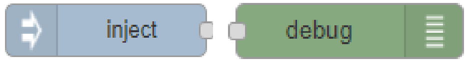
Shows a number inside a gauge counter.

Shows a text inside the local dashboard

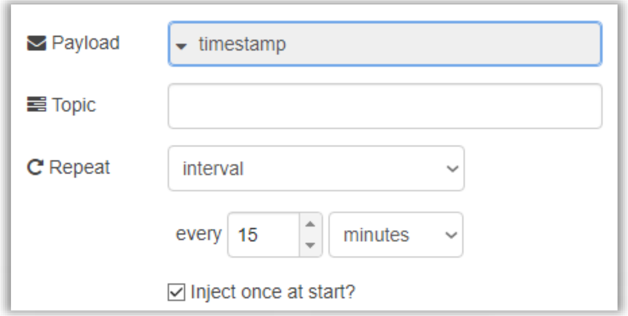
Step 1



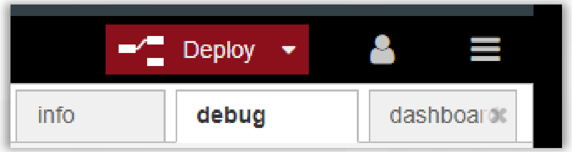
- Inject and Debug



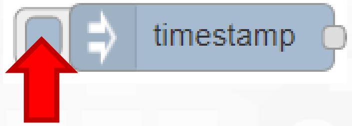
- Connect
- Configure



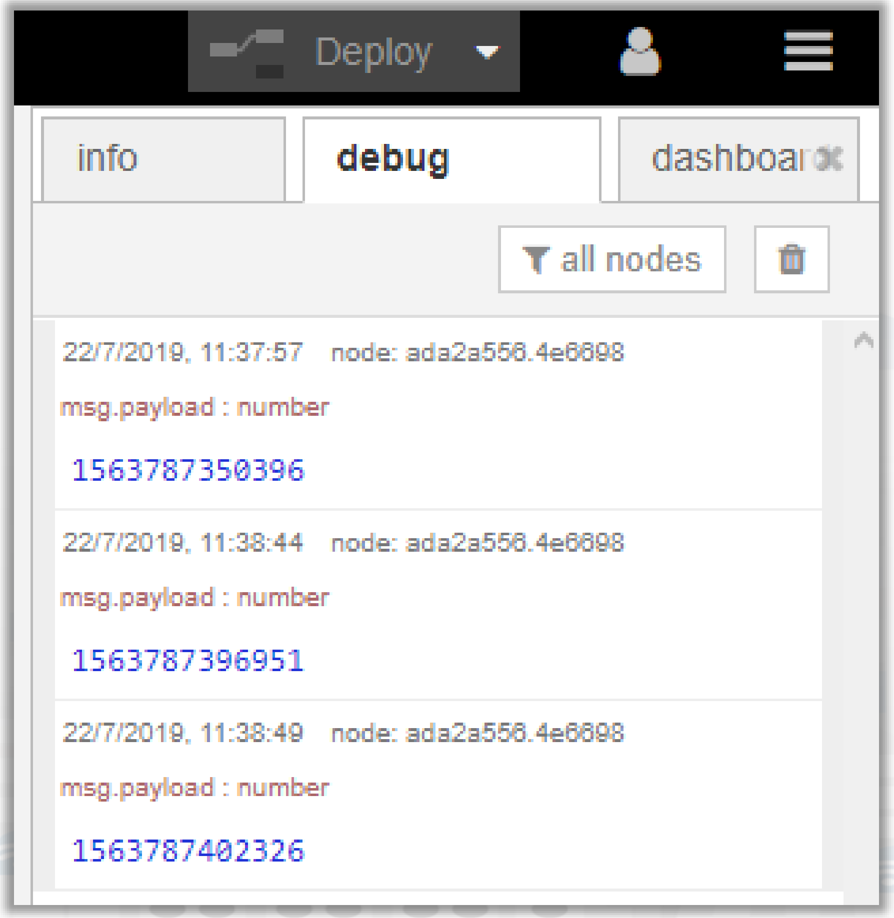
- Deploy



- Click



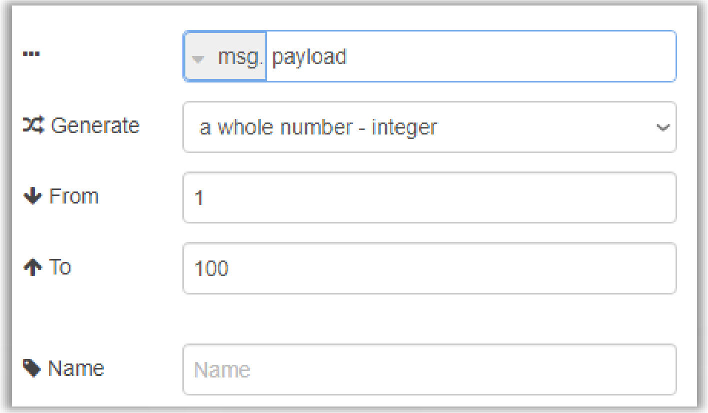
- Observe



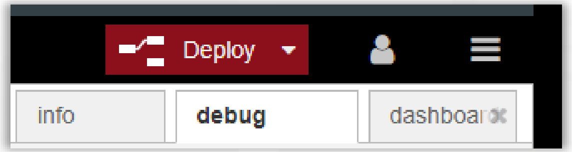
Step 2

- Random

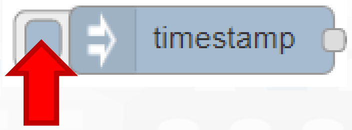
- Connect
- Configure



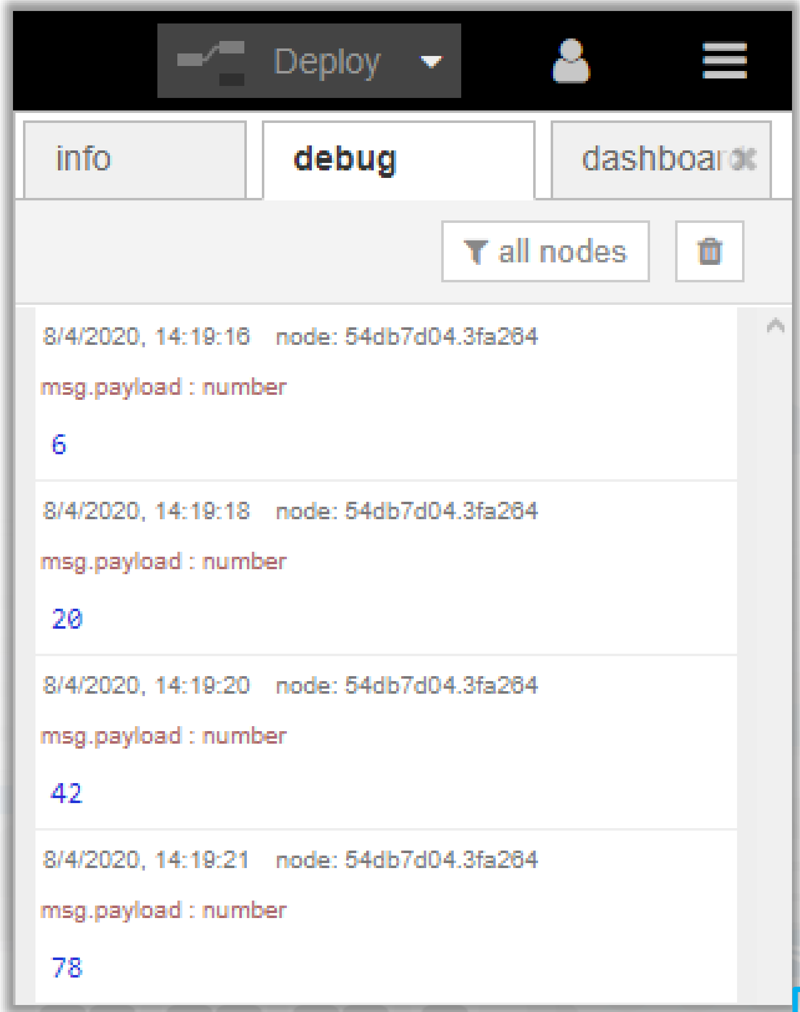
- Deploy



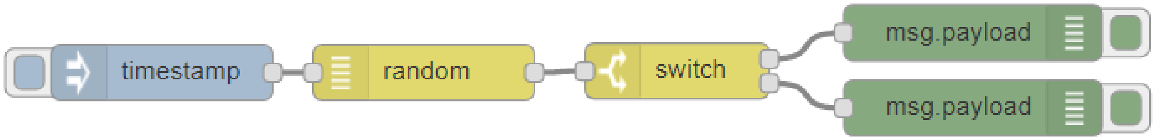
- Click



- Observe

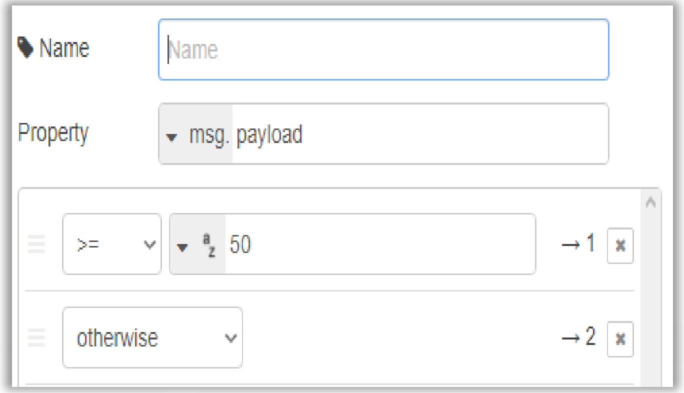


Step 3

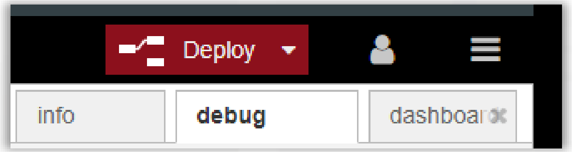


- Switch

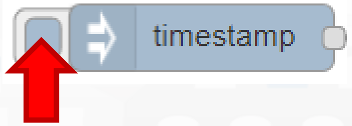
- Connect
- Configure



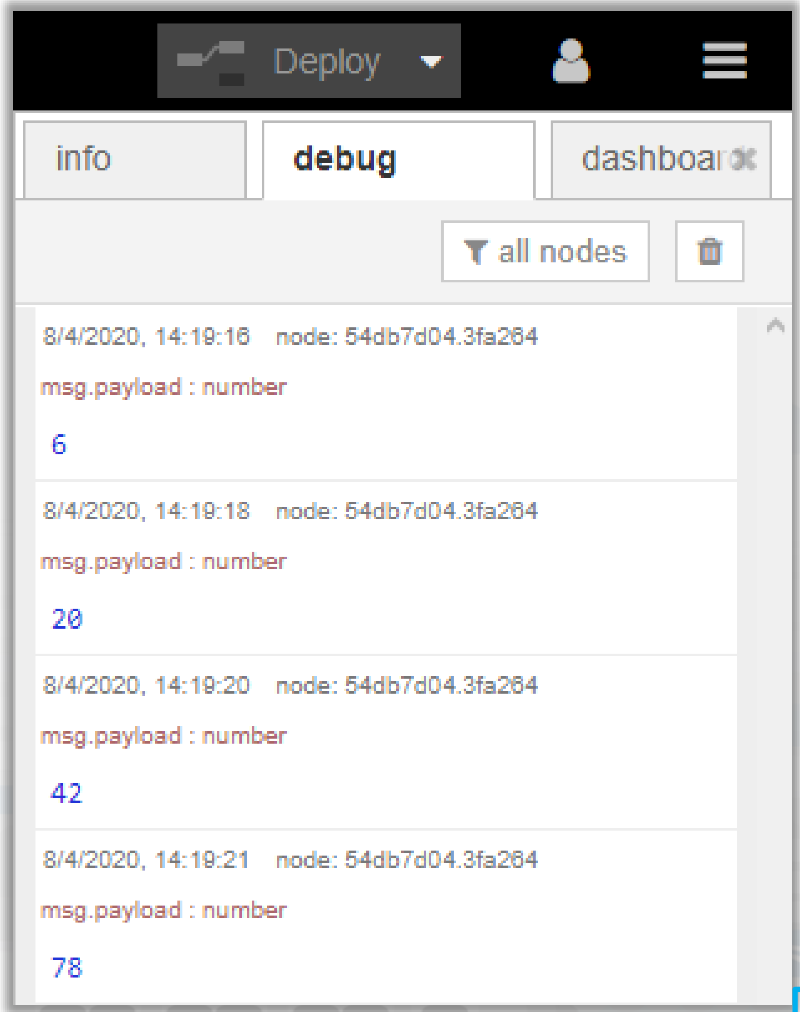
- Deploy



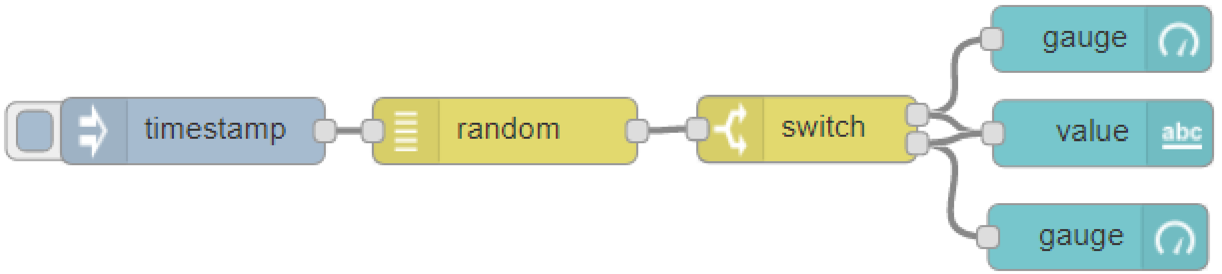
- Click

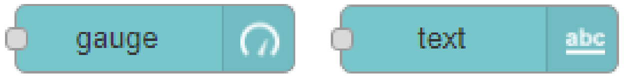


- Observe

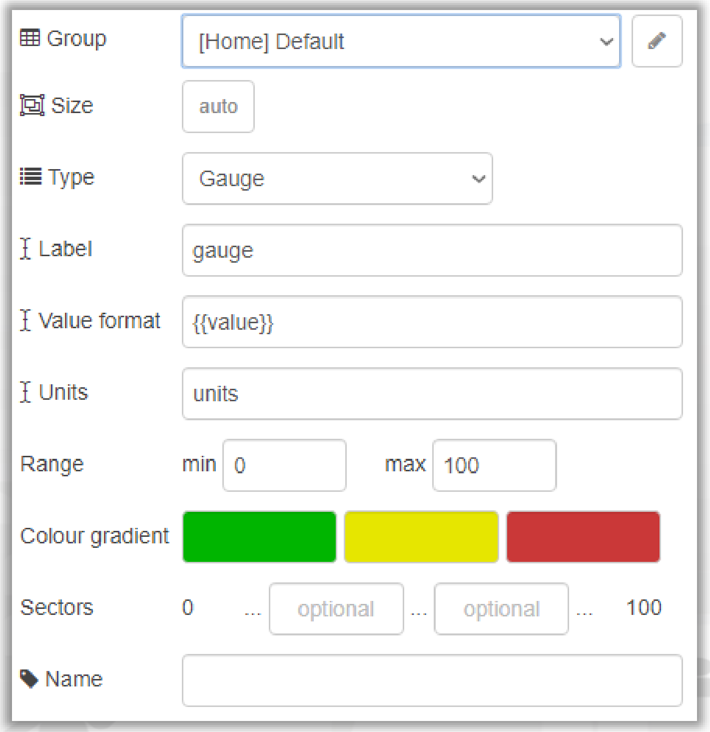


Step 4

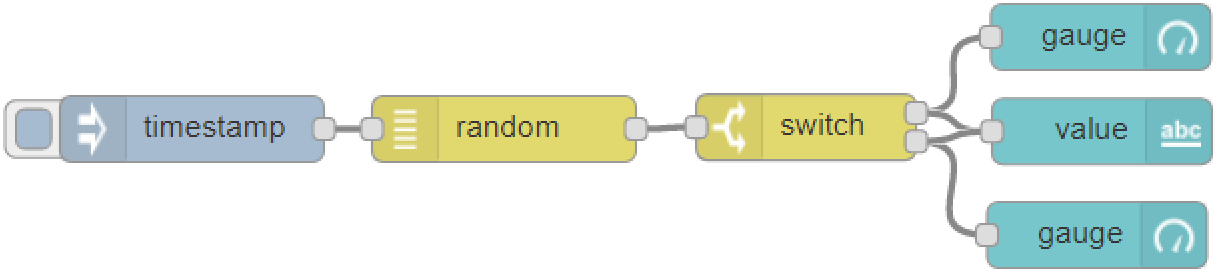


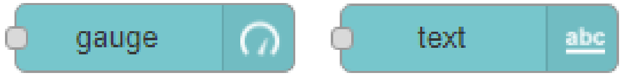
- Gauge and text 

- Connect
- Configure gauge

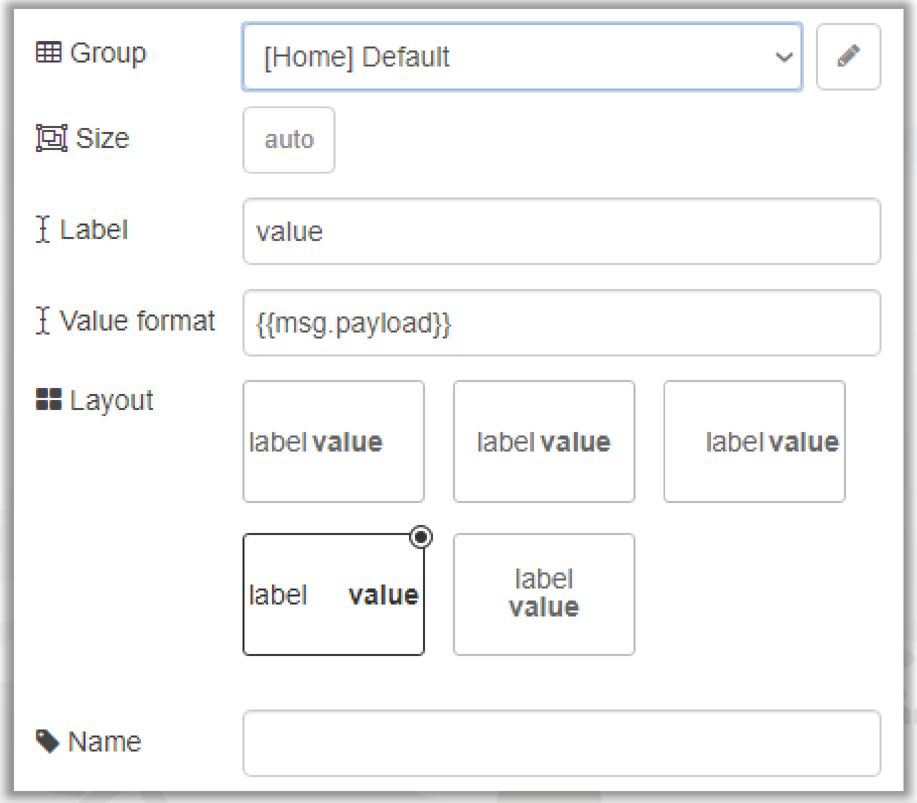


Step 4 Bis

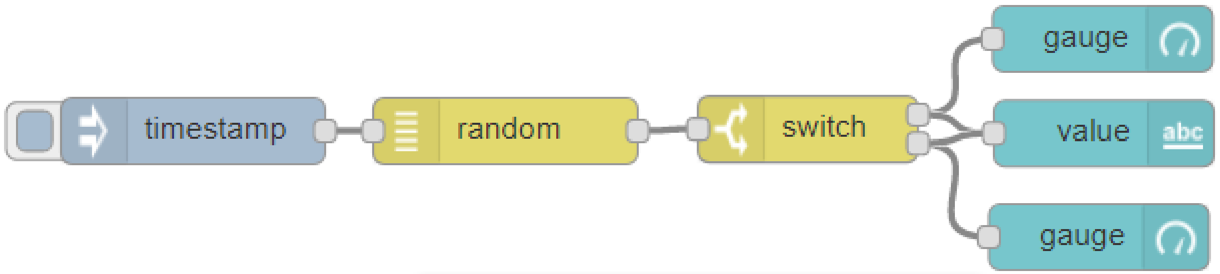


- Gauge and text 

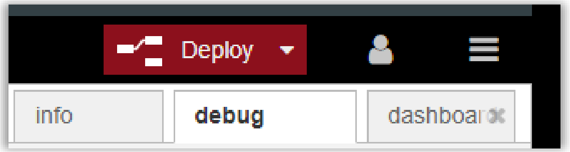
- Connect
- Configure text



Step 5

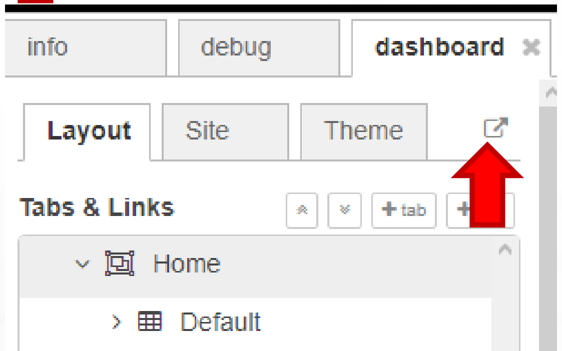


- Deploy

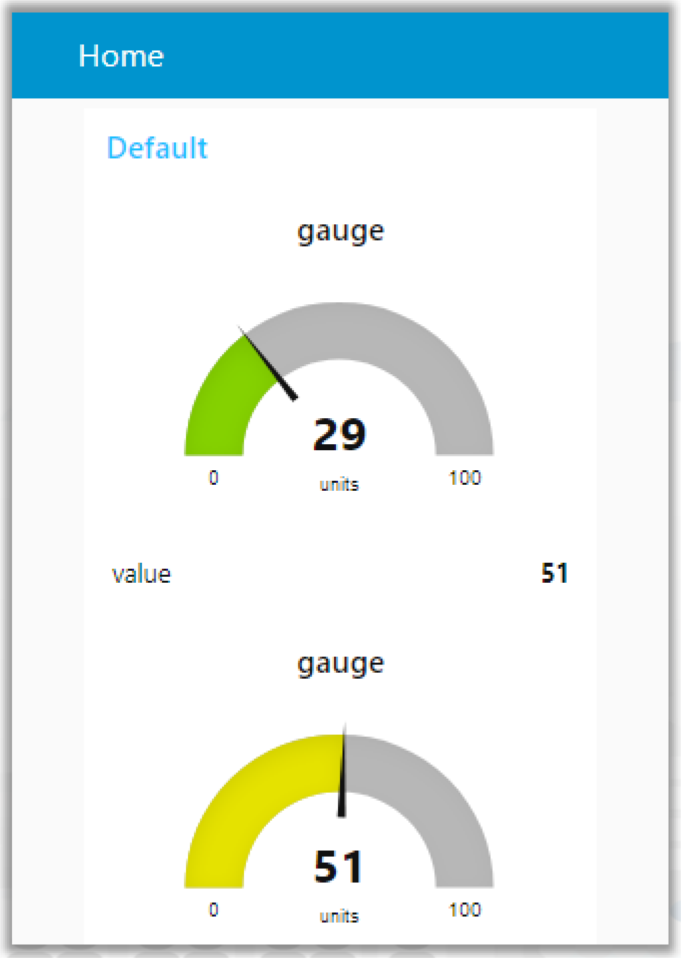


- Click

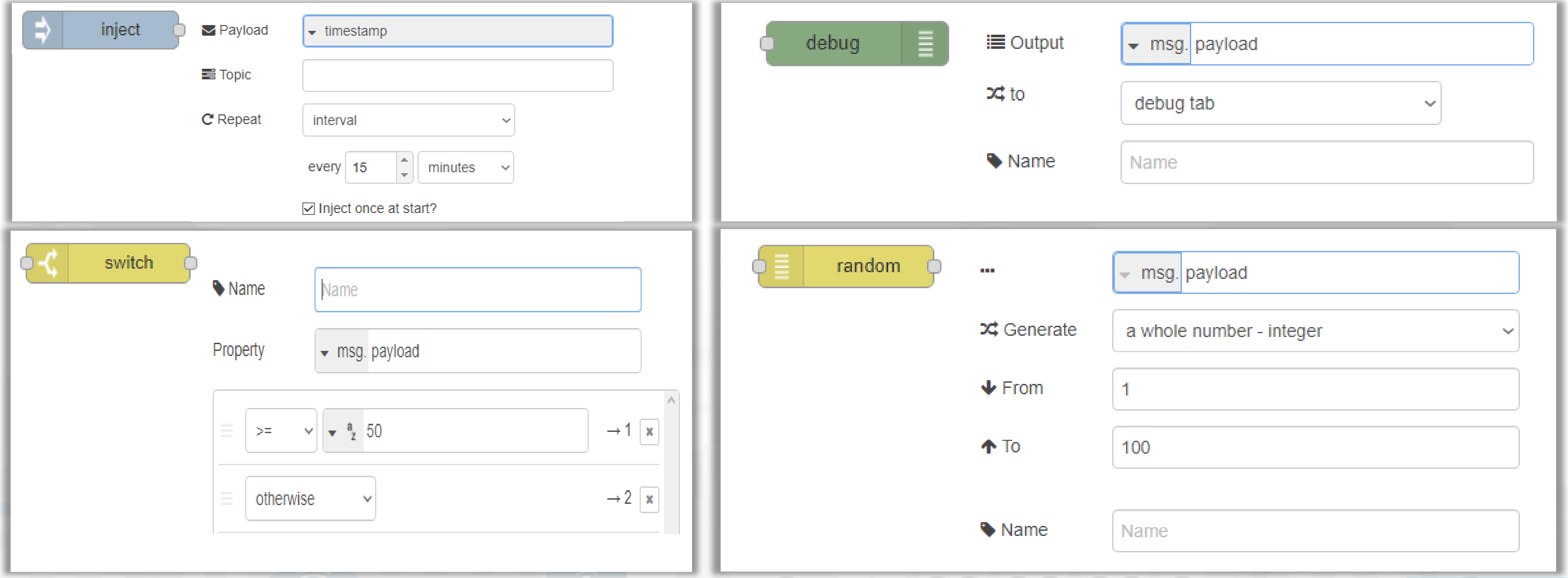
- Click



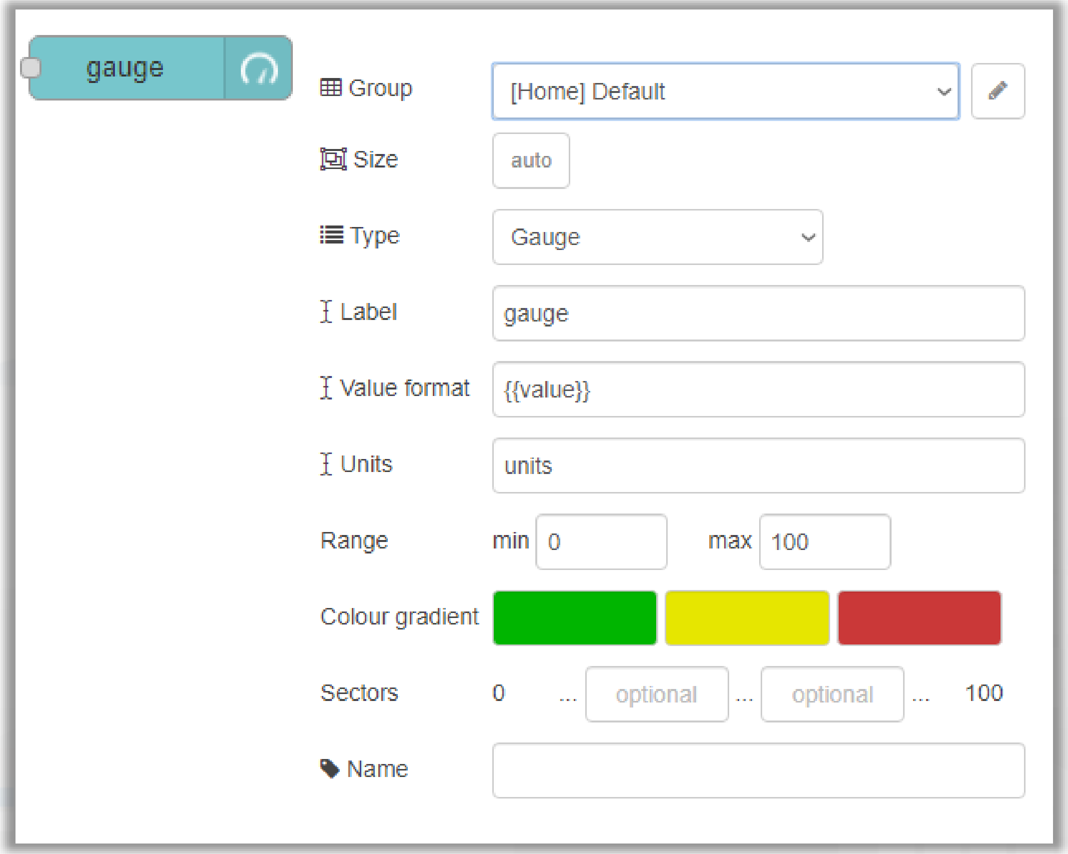
- Observe

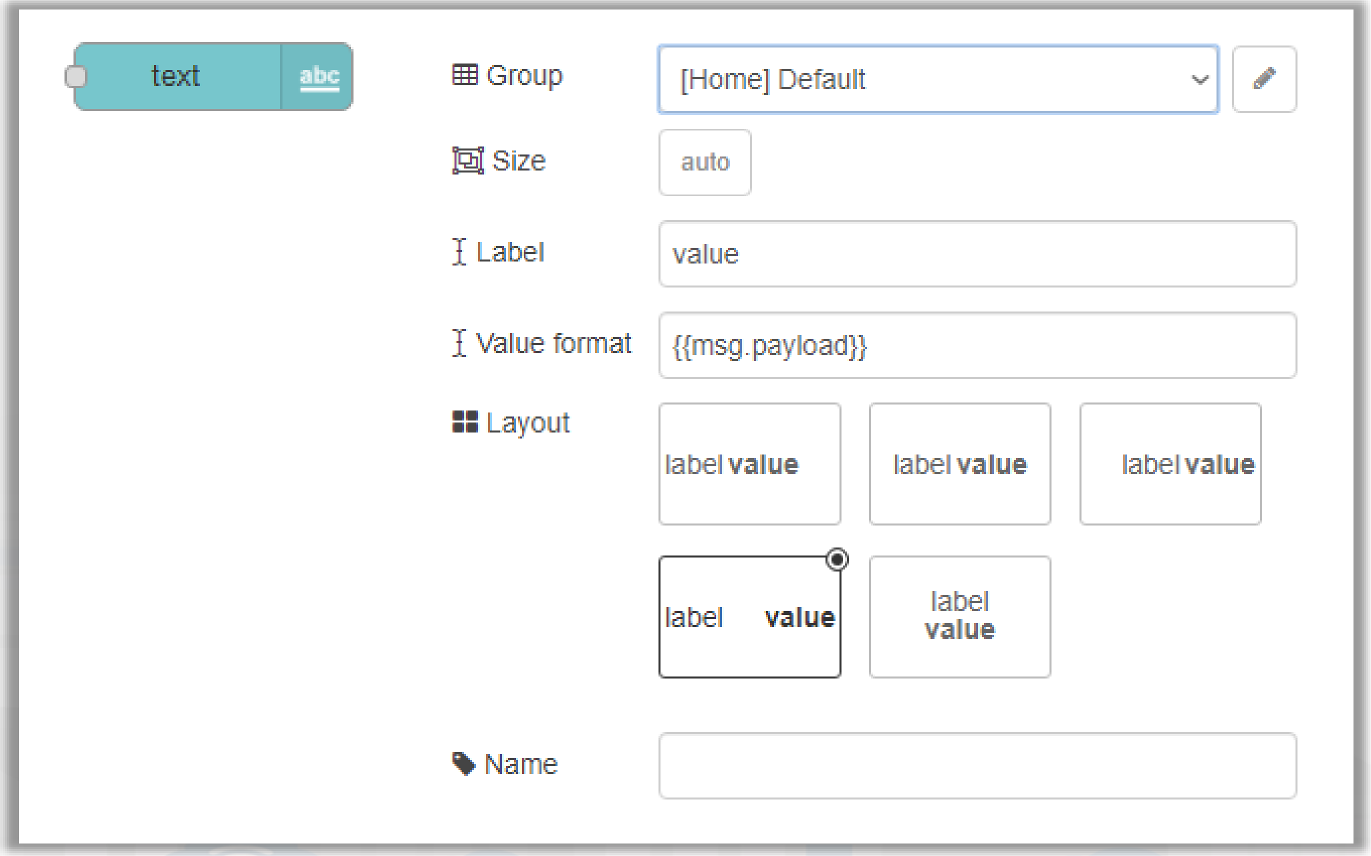


Nodes configuration 1/2

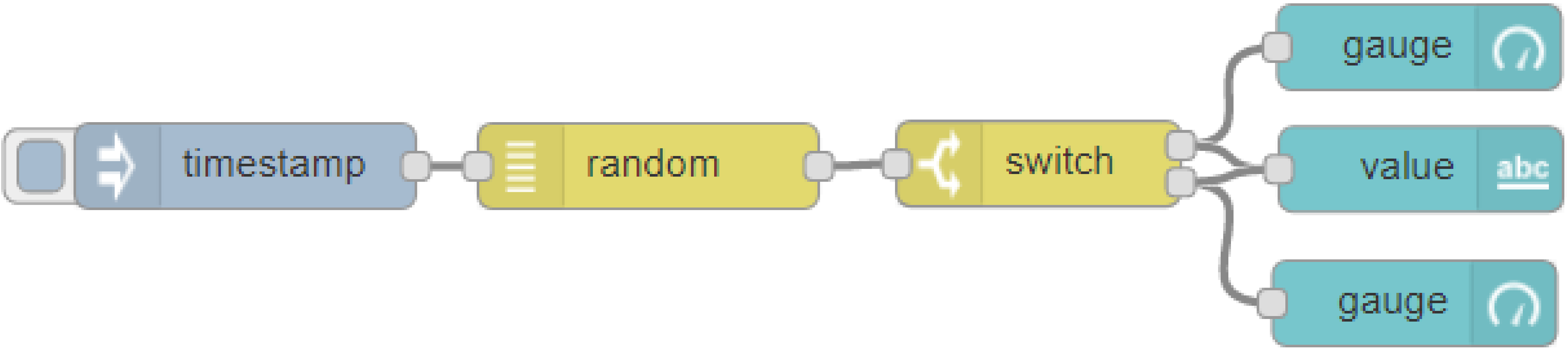


Nodes configuration 2/2





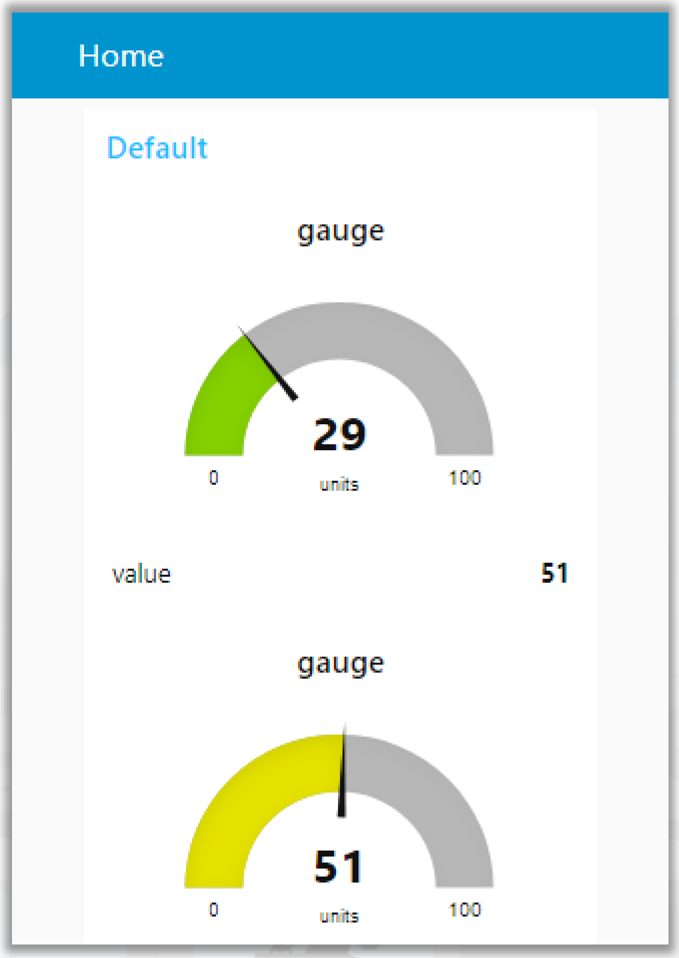
Nodes connections



Explaining: IOT Application Flow

- On Click or Every 15 minutes the ***timestamp*** node sends a message to the ***random*** node.
- When the message arrives, the ***random*** node generates a random number as output message.
- The **switch** node routes the value on the correct output based on the configuration .
- The Number can be sent to Different kinds of nodes to show it on NodeRed Dashboard.

Resulting Dashboard



This is a local Node-RED dashboard.

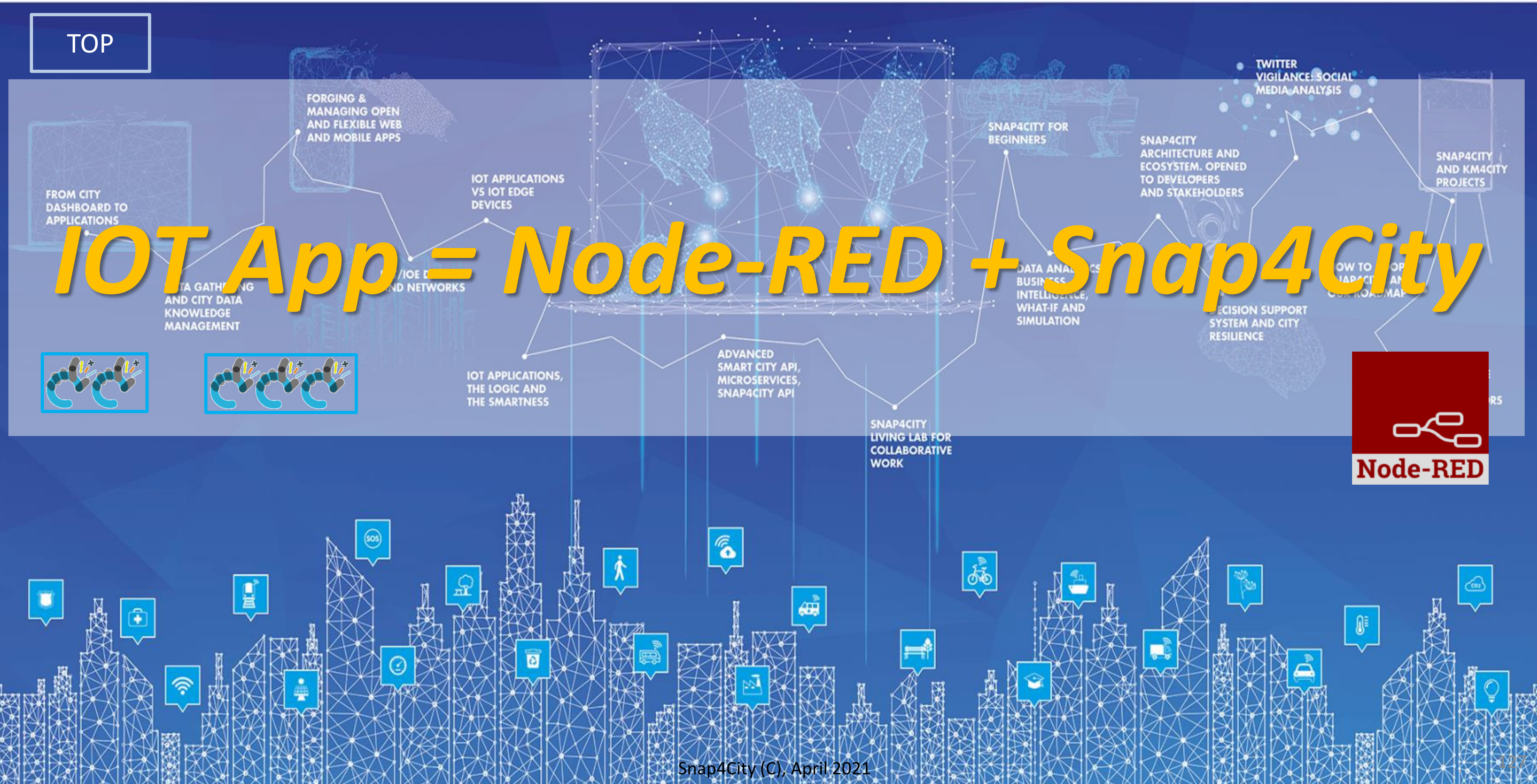
The dashboards created within the Snap4city platform are more :

- Powerful
- Flexible
- Secure

end DEMO Section 1

TOP

IOT App = Node-RED + Snap4City



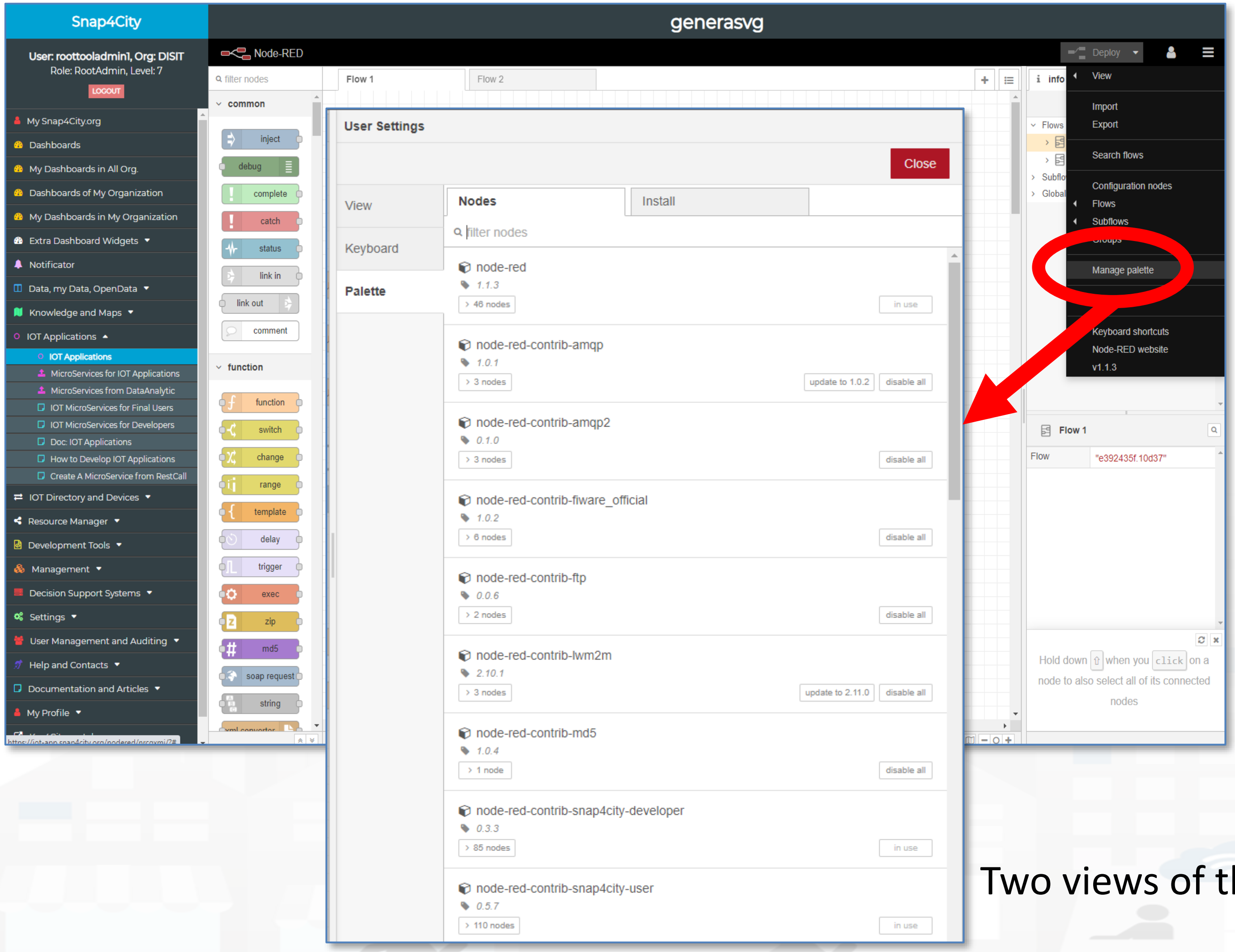
IOT Application Editor: NODE-RED

- In the **IOT Application of Snap4City**, it is possible to:
  – Execute flows that process data as: Event Driven, Batch (periodic or not)
  – Create multiple concurrent Flows for each IOT Application
  – Create subflows as macros to be reused
  – Create Groups of nodes as macro
  – **Save/load**, **share**, of nodes, flows and applications with other users via
    - the Snap4City Resource Manager or
    - with JS Foundation or
    - via email, skype, file sharing in general
  – ..

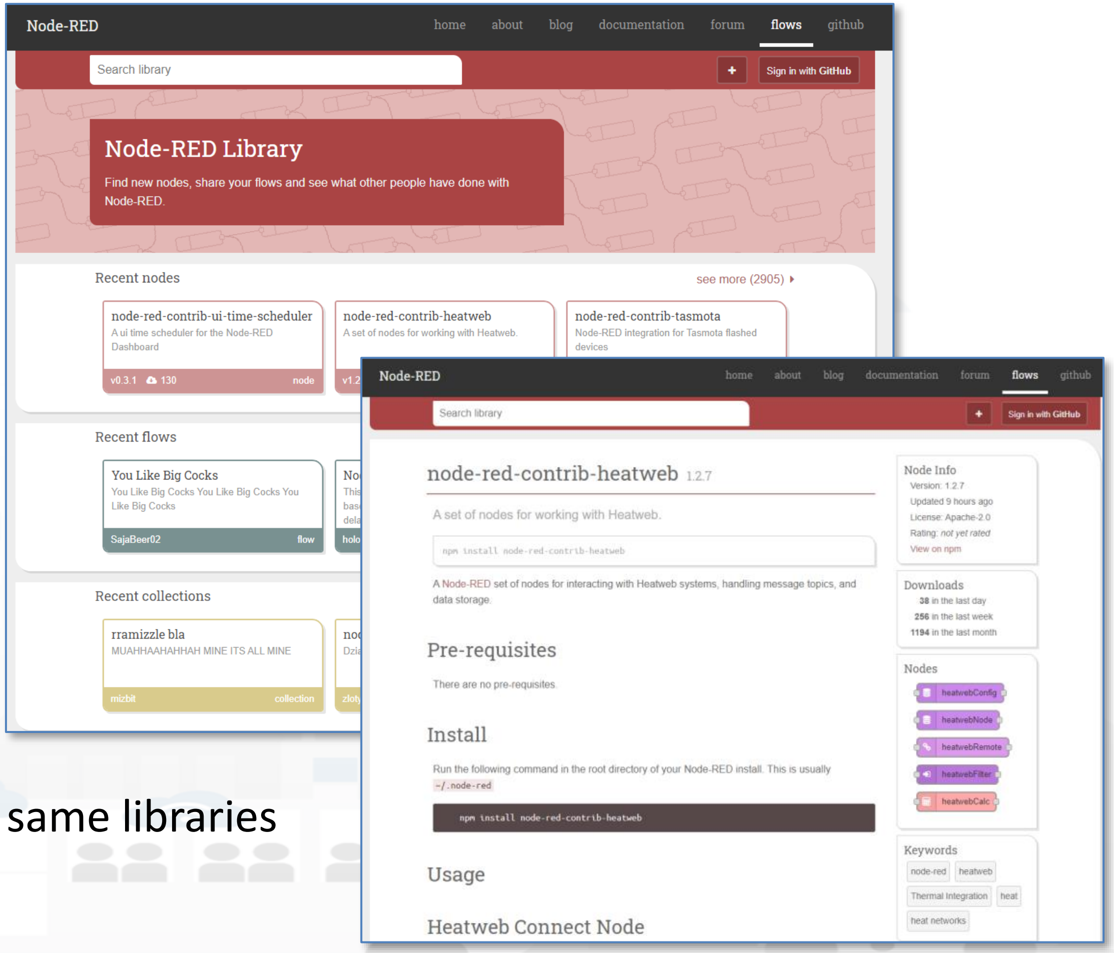
IOT Application Editor: NODE-RED

- In the **IOT Apps of Snap4City**, it is possible to Extend the Capabilities:
  - Load other Nodes, segments of flow and entire flows from several sources: email, libraries, S4C repository, etc.
  - Load other libraries of MicroServices/Nodes/Blocks from **Manage Palette**
    - A large set of Libraries of Node is available.
    - The loading may have some limitations for security reasons
  - **Get more IOT Apps** above the Limit that may depend on the organization and/or on personal authorizations, ask to Admin
  - ..

Load Library from Palette

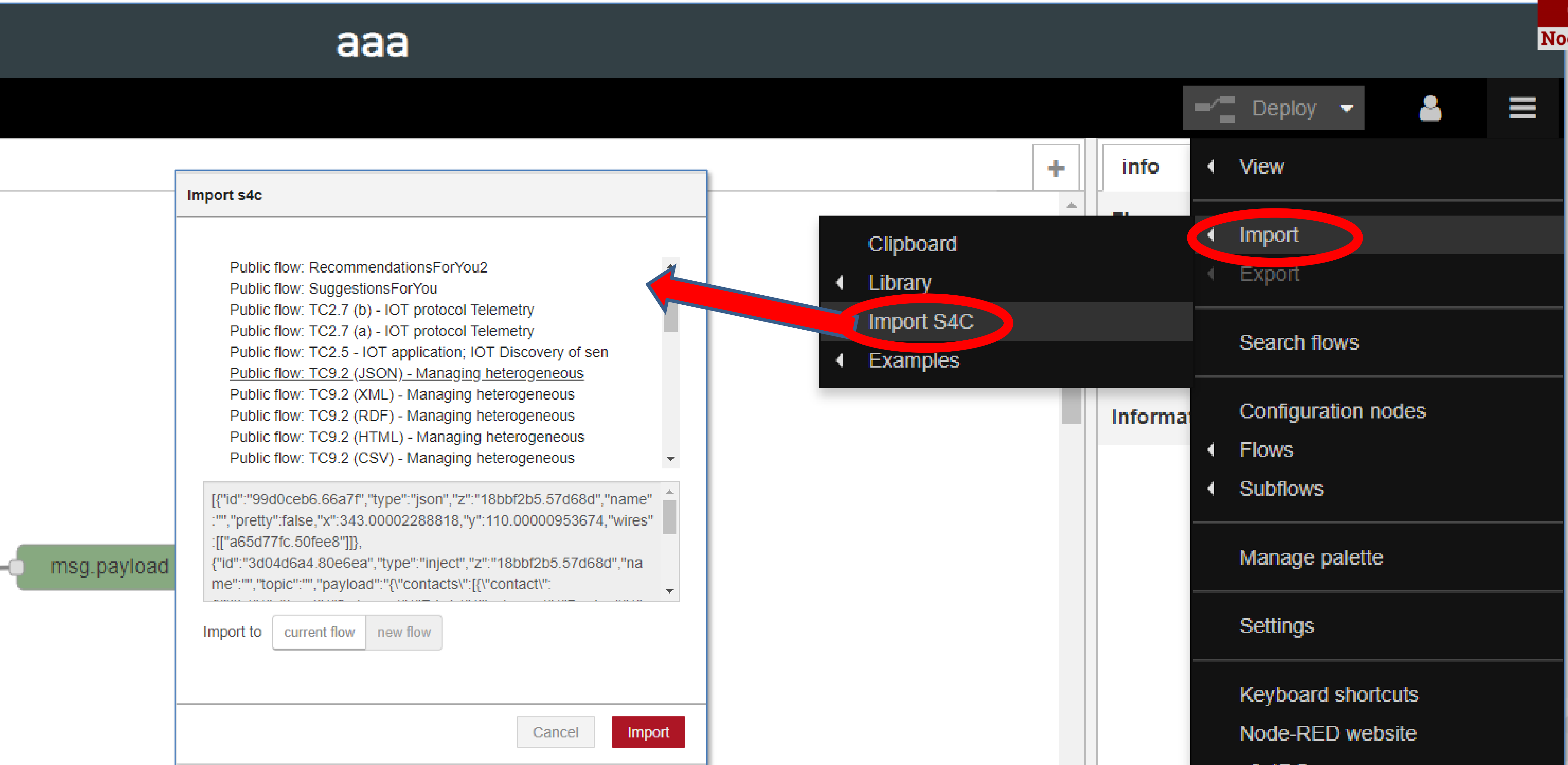


https://flows.nodered.org/



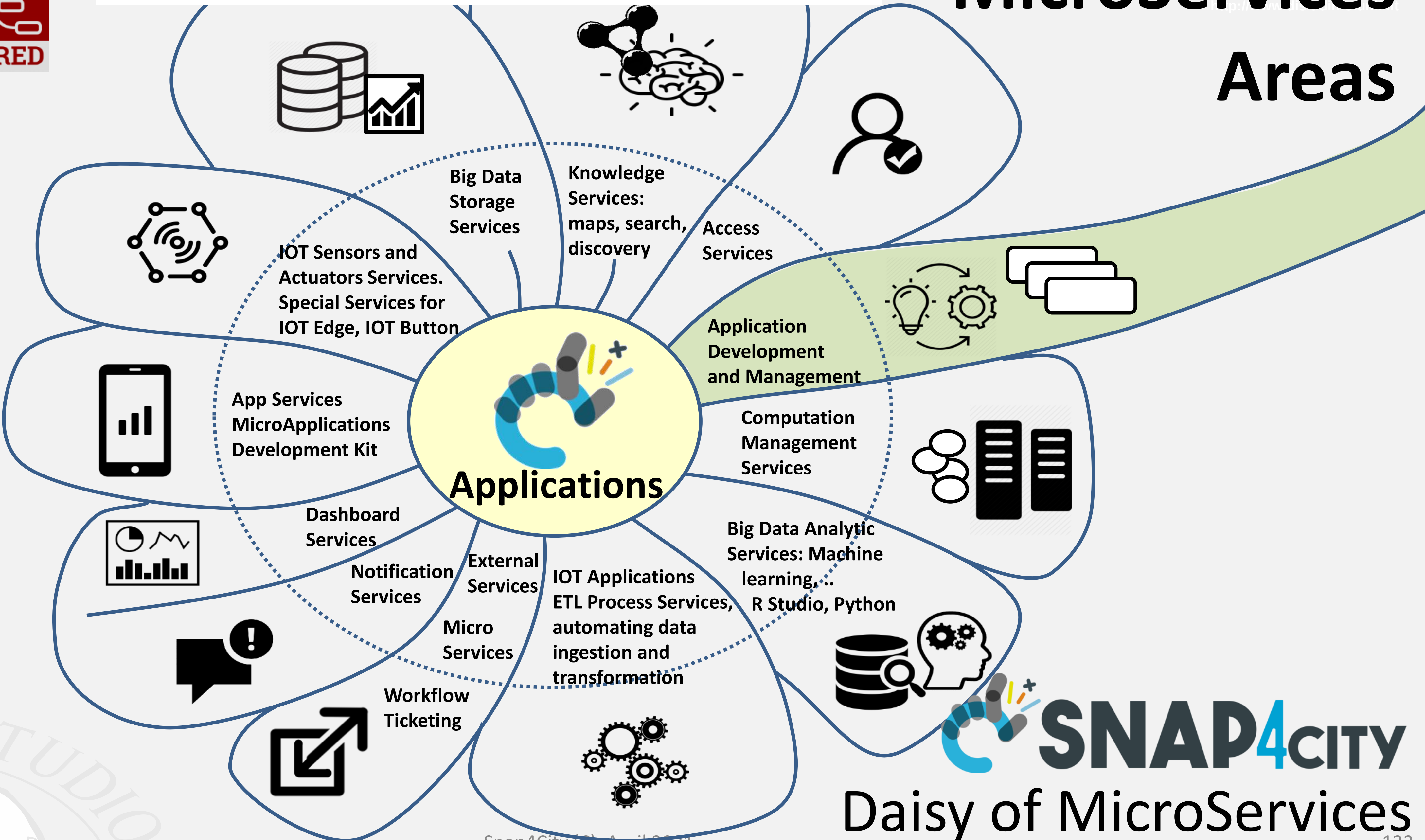
Two views of the same libraries

Load an IOT application of example



https://flows.nodered.org/?term=snap4city

MicroServices Areas



Daisy of MicroServices

Smart City and IOT main needs

Smart City Entities Search: search and access to city entities and their relationships in the city.

Historical Data: search and access to data collected over time into the smart city data aggregator.

Save and Get Personal Data: for many smart city applications, the possibility of saving and retrieval of personal data enables a large variety of smart scenarios for the final users and operators.

Advanced Dashboards: This means to have the possibility of developing a real user interface of the IOT App (to render and produce data for the IOT network).

Data Analytic: The real need in the context of smart City is to have the possibility for a data-analysts of creating some data analytic processes and use it into the flow as MicroService without the intervention of a programmer nor administrator.

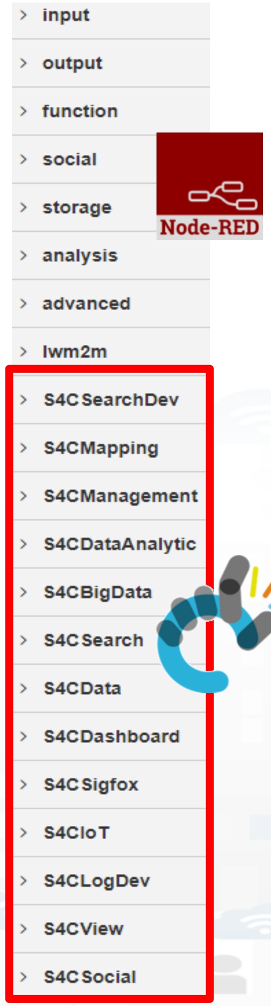
IOT Device Connection: This means that the developers expect to have the possibility of using nodes for connecting to a large set of IOT devices using different protocols, and thus connecting to different kind of IOT brokers.

IOT Directory: It should be a single point service for searching, managing and discovering all the IOT Devices which can be connected to the infrastructure by means of a large set of heterogenous IOT Brokers.

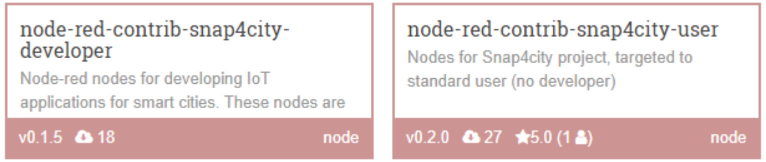
IOT Applications

IOT Applications = Node-RED + Snap4City Platform

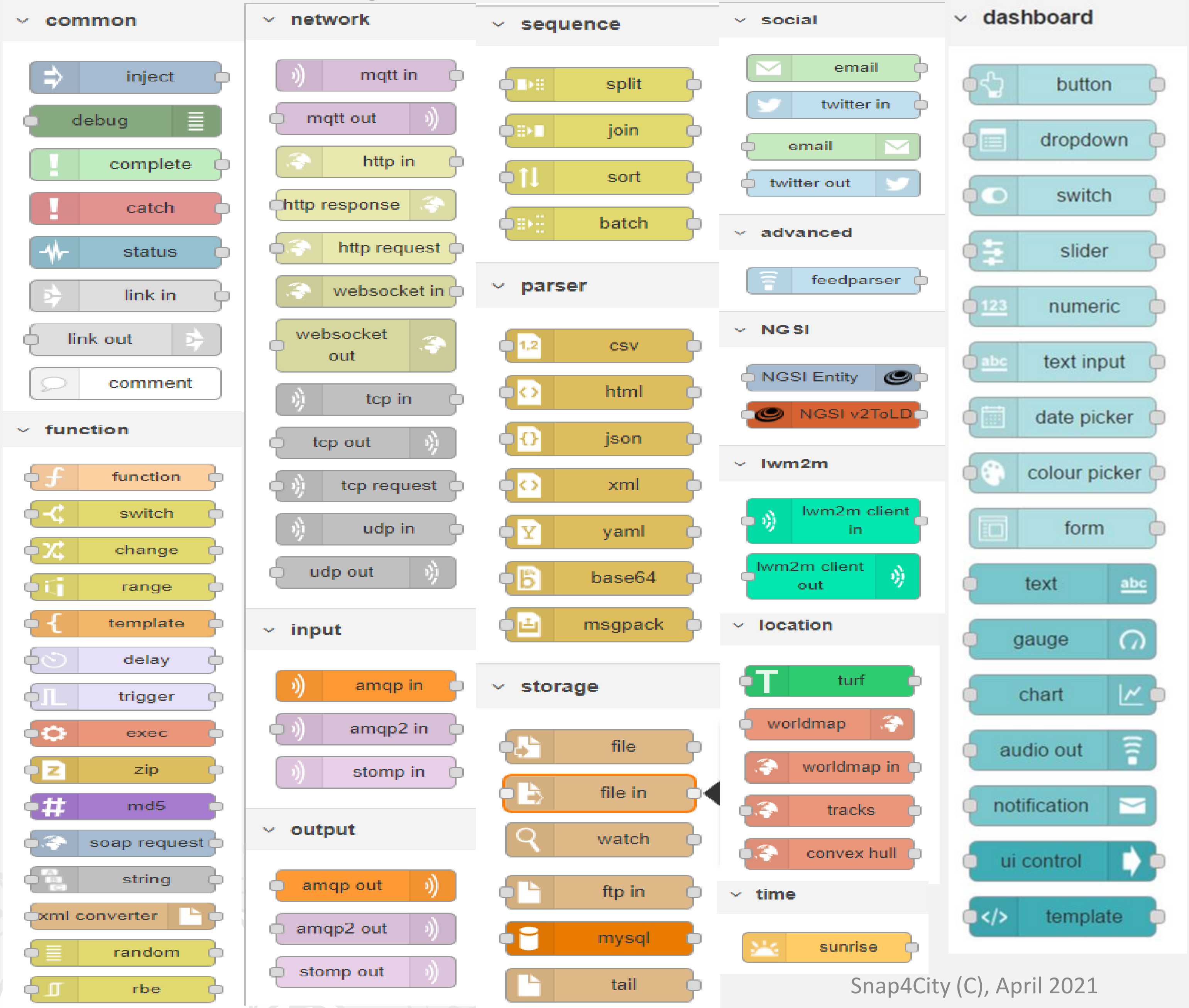
- A collection of more than **150 MicroServices** have been developed covering the above-mentioned requirements and much more.
- The issue was not only to formalize the MicroServices, but also to create the infrastructure that enable their usage. In many cases, the simple MicroServices hide very **complex** and **sophisticate tools and algorithms (Snap4city Platform)**.
- They are formally distributed as two official libraries of Node-RED nodes (**Snap4City Basic and Advanced**) by the JS Foundation portal.
- They can be **directly installed** in any Node-RED tool of any operating system.



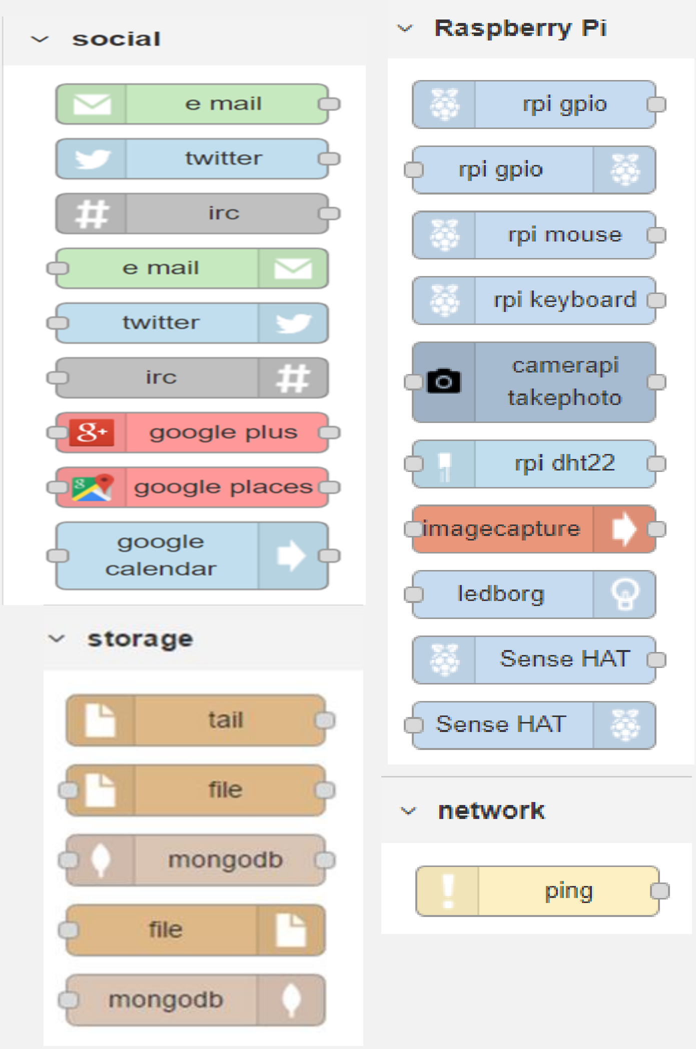
https://flows.nodered.org/?term=snap4city



Basic Node.js Blocks on NodeRed on our Advanced IOT Apps

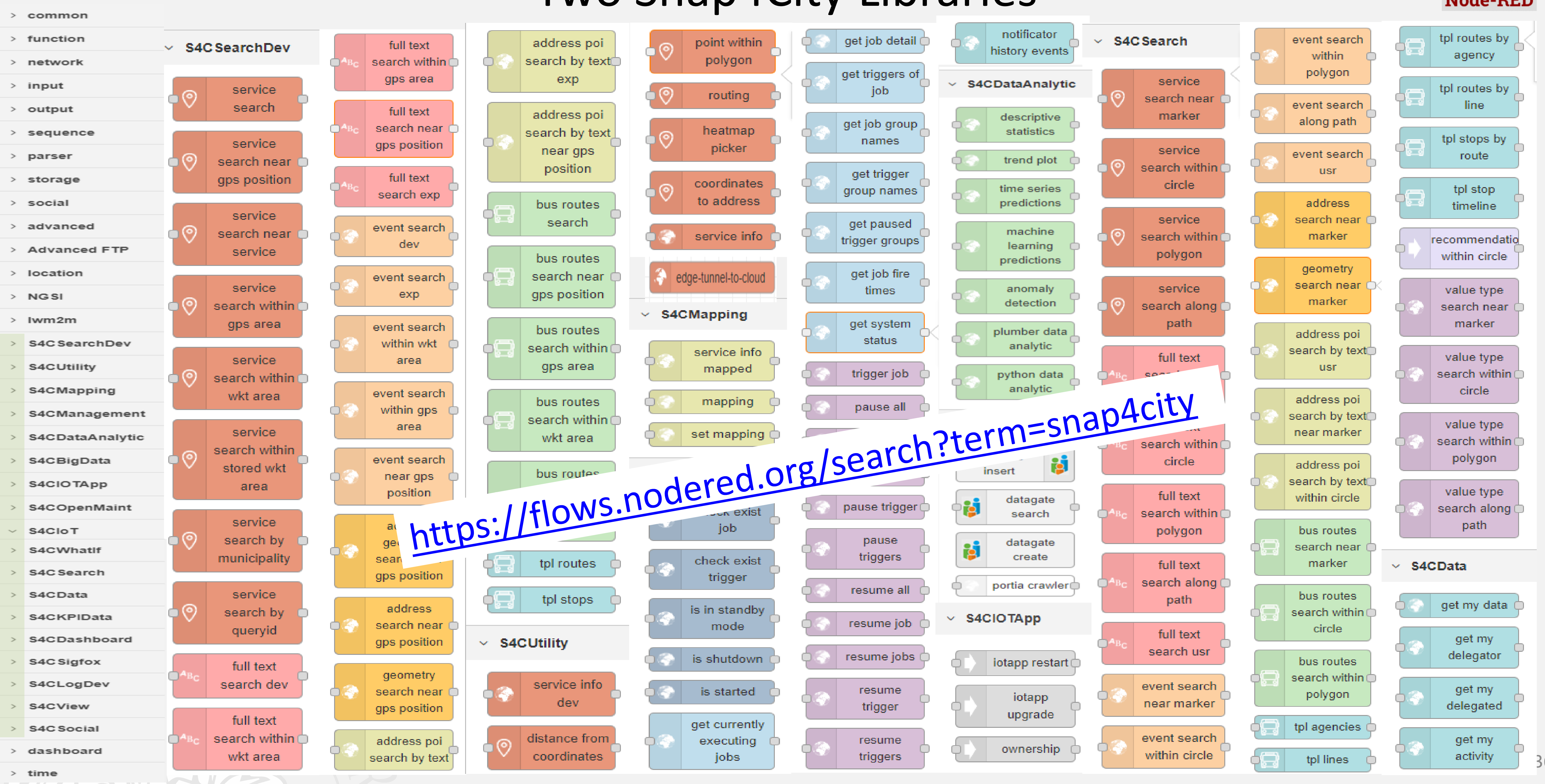


+ on IOT Edge Raspberry



April 2021 collection

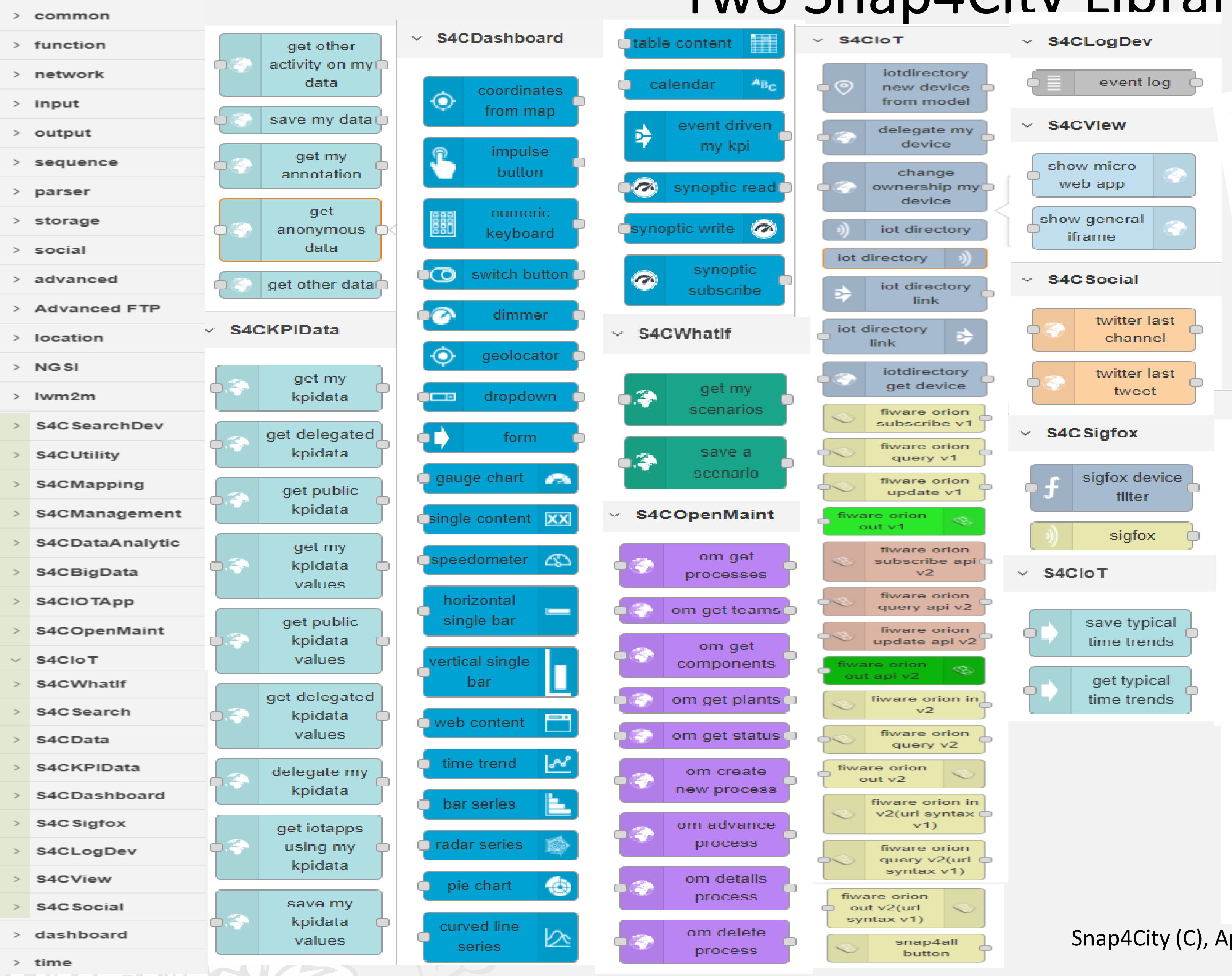
Two Snap4City Libraries



https://flows.nodered.org/search?term=snap4city

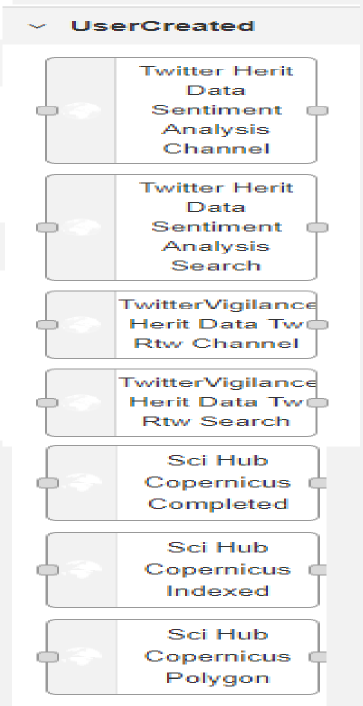
April 2021 collection

Two Snap4City Libraries

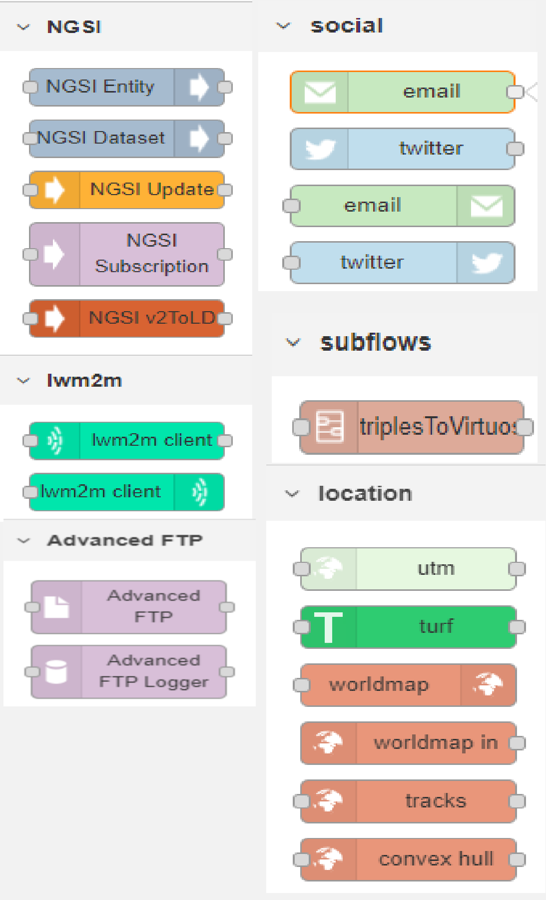


https://flows.nodered.org/search?term=snap4city

AND: From Resource Manager



We suggest also to install:



MicroServices Suite for Smart City Applications

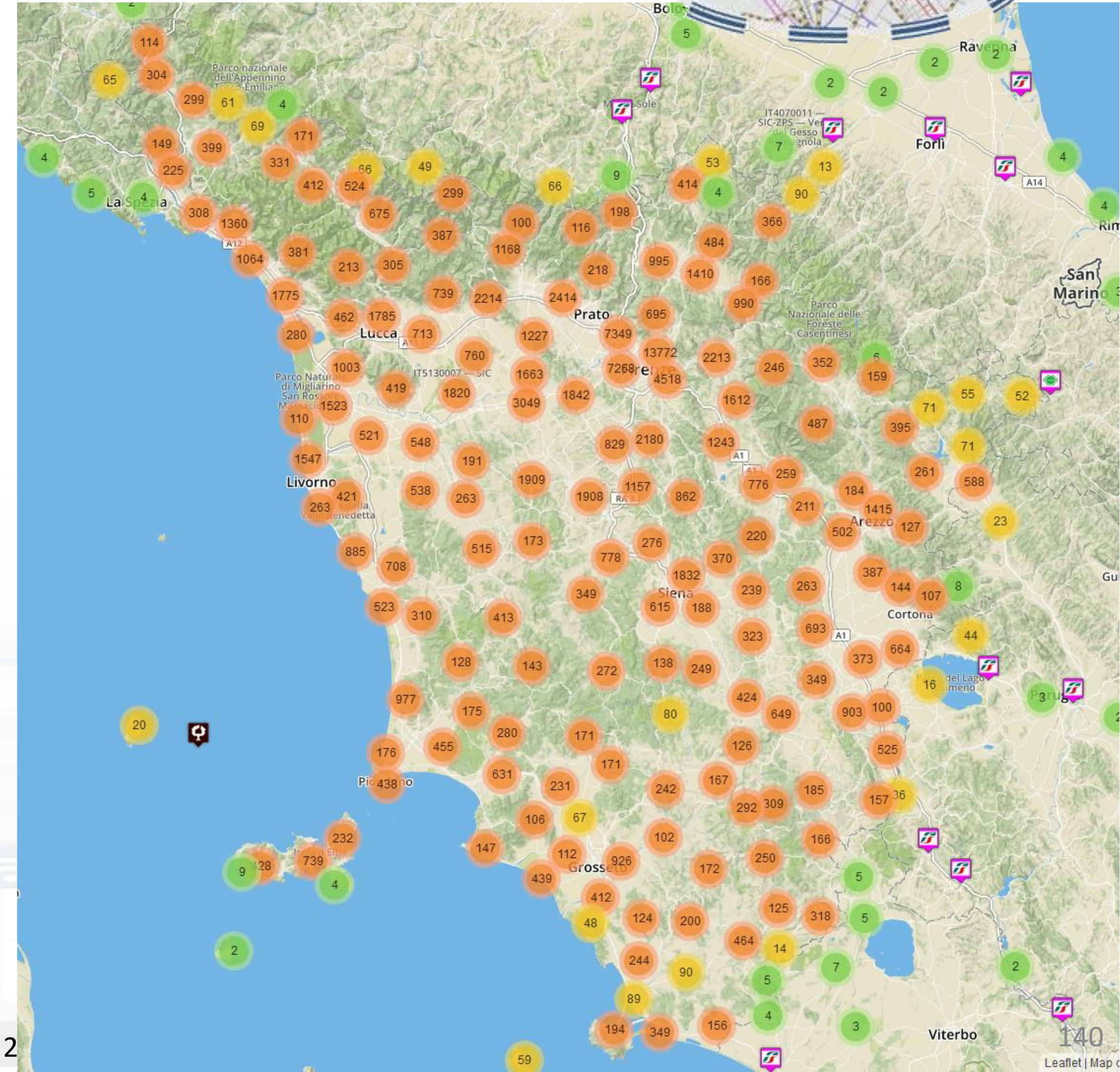
- C. Badii, P. Bellini, A. Difino, P. Nesi, G. Pantaleo, M. Paolucci, Sensors, Vol.19, 2019, ISSN 1424-8220
- https://doi.org/10.3390/s19214798
- https://www.mdpi.com/1424-8220/19/21/4798/pdf

TOP

IOT App = Node-RED + Snap4City
search vs services, the ServiceURI

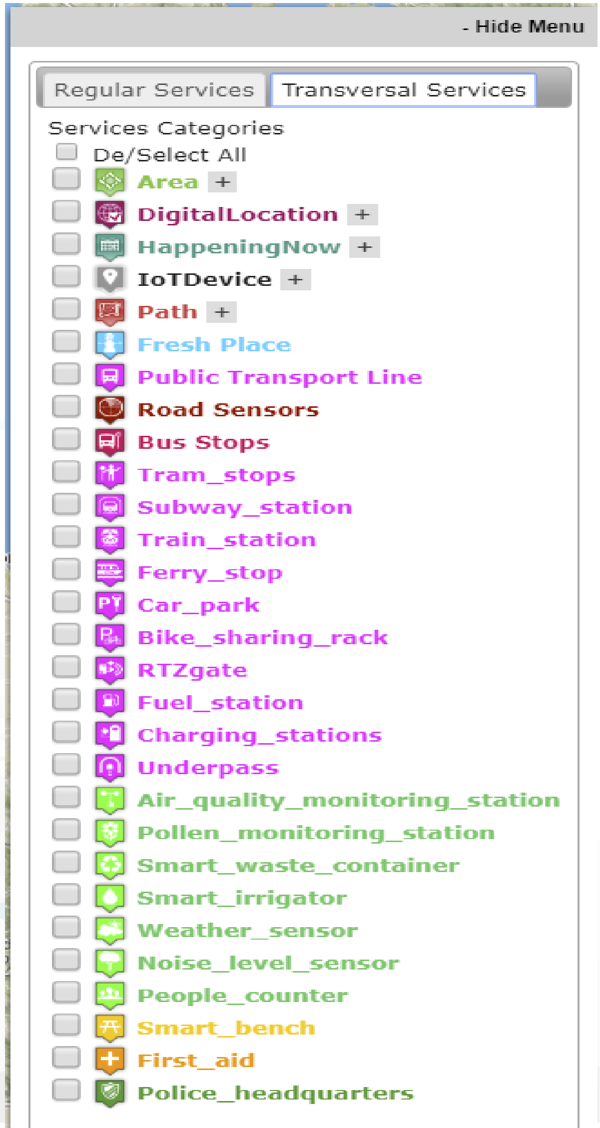
Data Domains

- **Street and geoinformation of the territory and details for routing, navigation, …**
- **GeoResolution, Environmental data**
- **Mobility and Transport**: public and private, public transport, parking status, fuel stations prices, traffic sensors, etc.
- **Culture and Tourism**: POI, churches, museum, schools, university, theatres, events in Florence
- **Environmental**: pollution real time, weather forecast, etc.
  - Environmental data geo resolution
- **Social Media**: twitter data
- **Health**: hospital, pharmacies, status of the first aid triage in major hospitals, …
- **Alarms**: civil protection alerts, hot areas, …



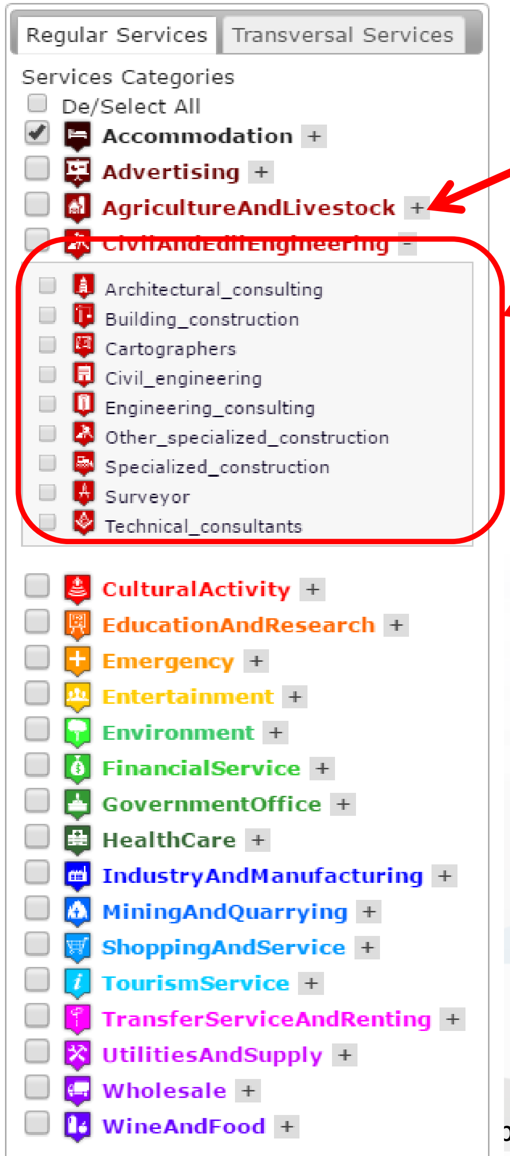
Access to Point of Interest information, POI

- **POI**: point of interest
- **type**: macro (nature) and subcategories (subnature)
- **Position**: GPS, address, telephone, fax, email, URL, …
- **Description**: textual, multilingual, with images, …
- **Link** to dbPedia, Linked Open Data
- **Links to other services**
- **Real time data if any:** sensors data, timeline, events, prices, opening time, rules of access, status of services, status of queue, etc..
- *See transversal services on ServiceMap*
  – *Regular and in test platform*



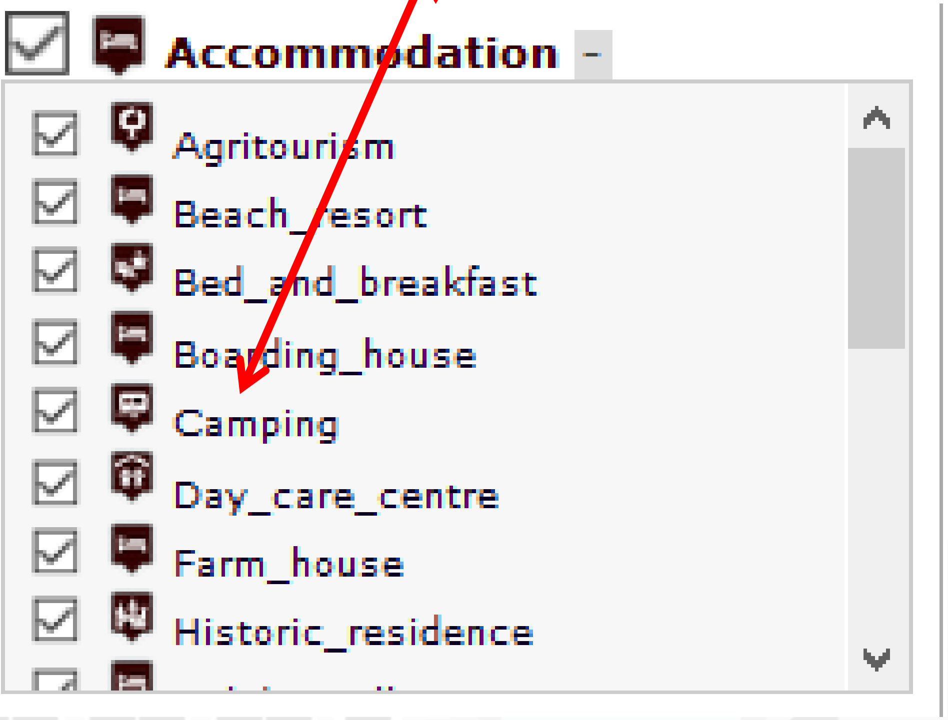
Concepts of Services: Macro and subcathegory

A SKOS area into the Km4CIty Ontology and Knowledge base for modeling POI and any element on map

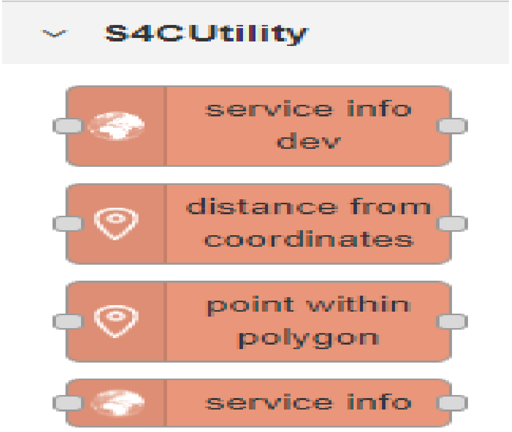


20 Service Macro Classes (The Nature)

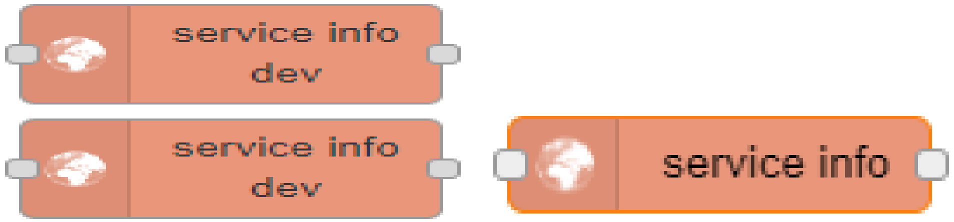
Service subClasseses (the SubNature)

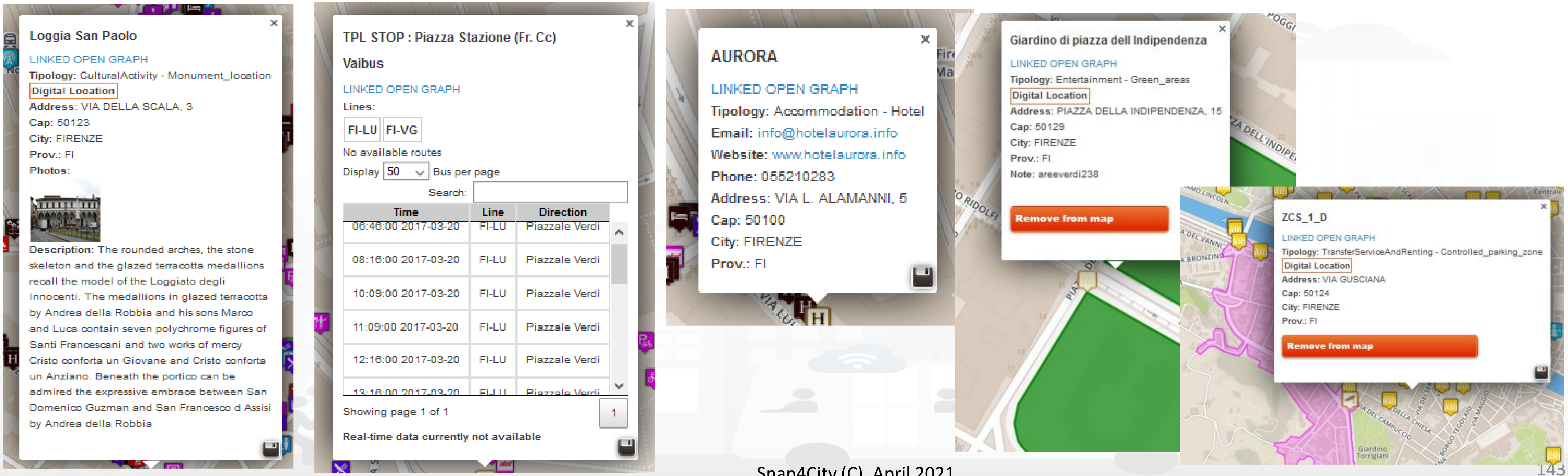


S4CSearch



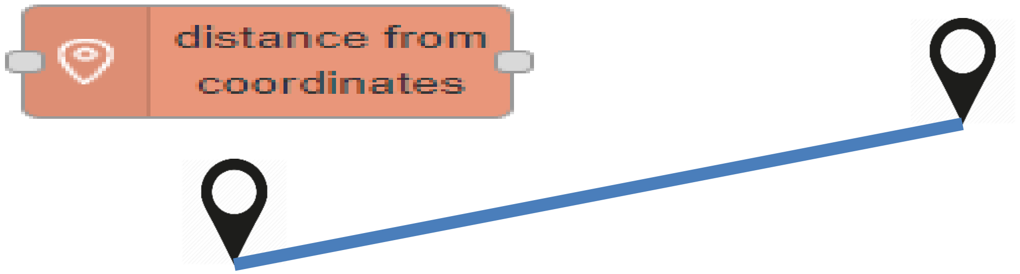
- ANY kind of sensors
- **To Get DATA of a Service / POI /sensor**
  - Historical and real time
  - Real Time



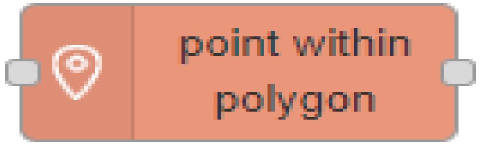


S4CSearch

- Distance from GPS point



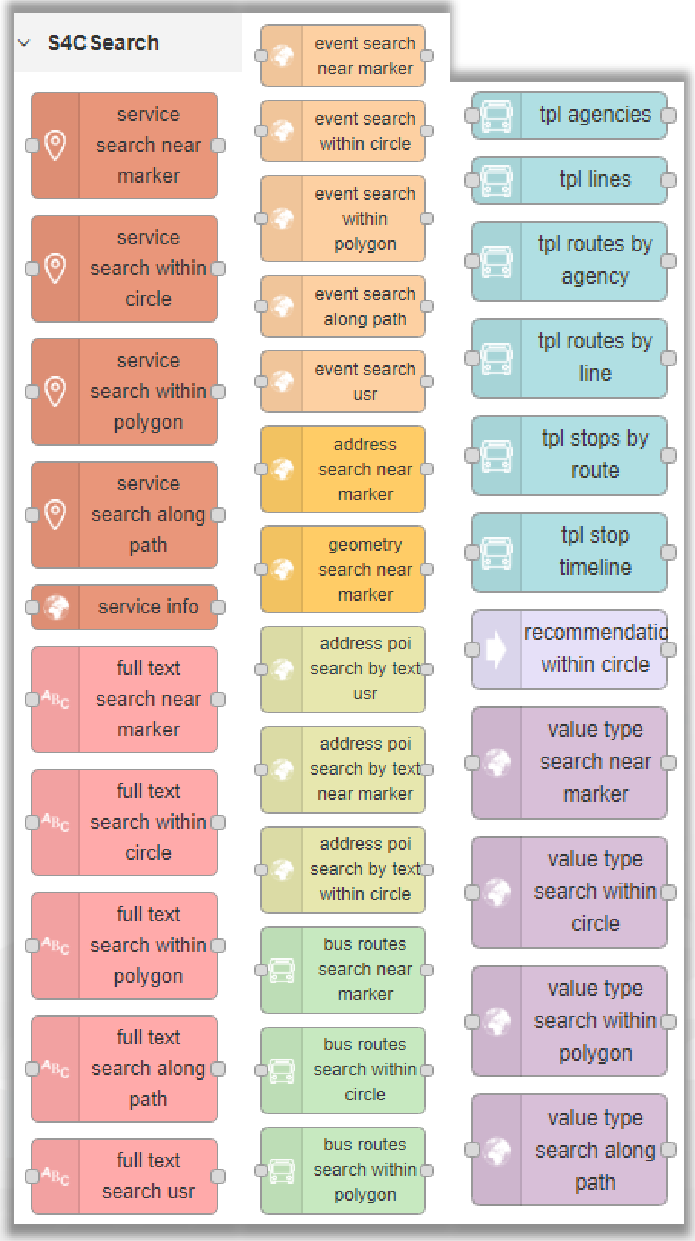
- Point is in Polygon ?
  – Polyline as WKT



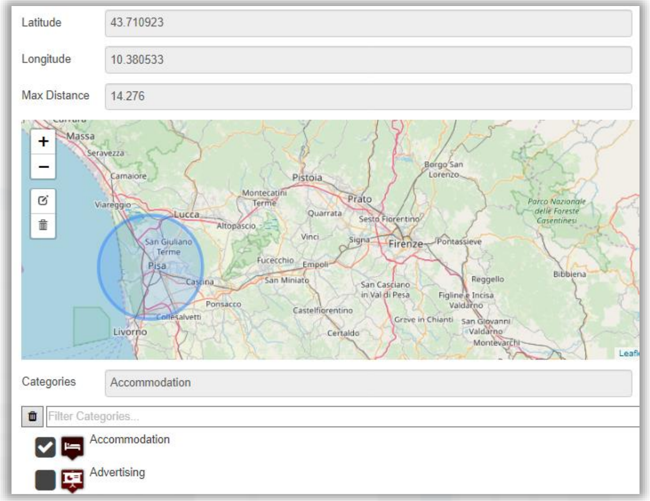
S4CSearch

Smart City Entities Search

Simple and Fast

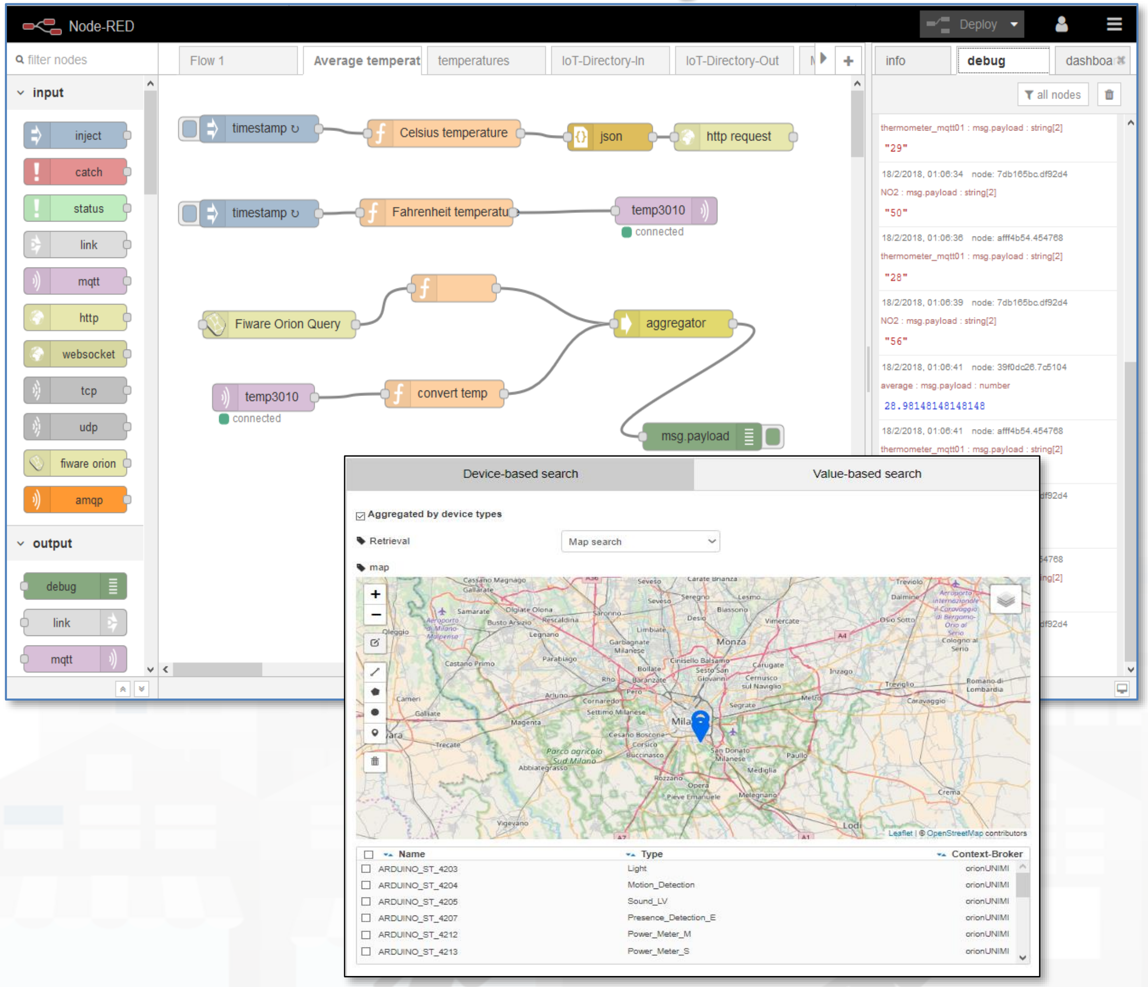


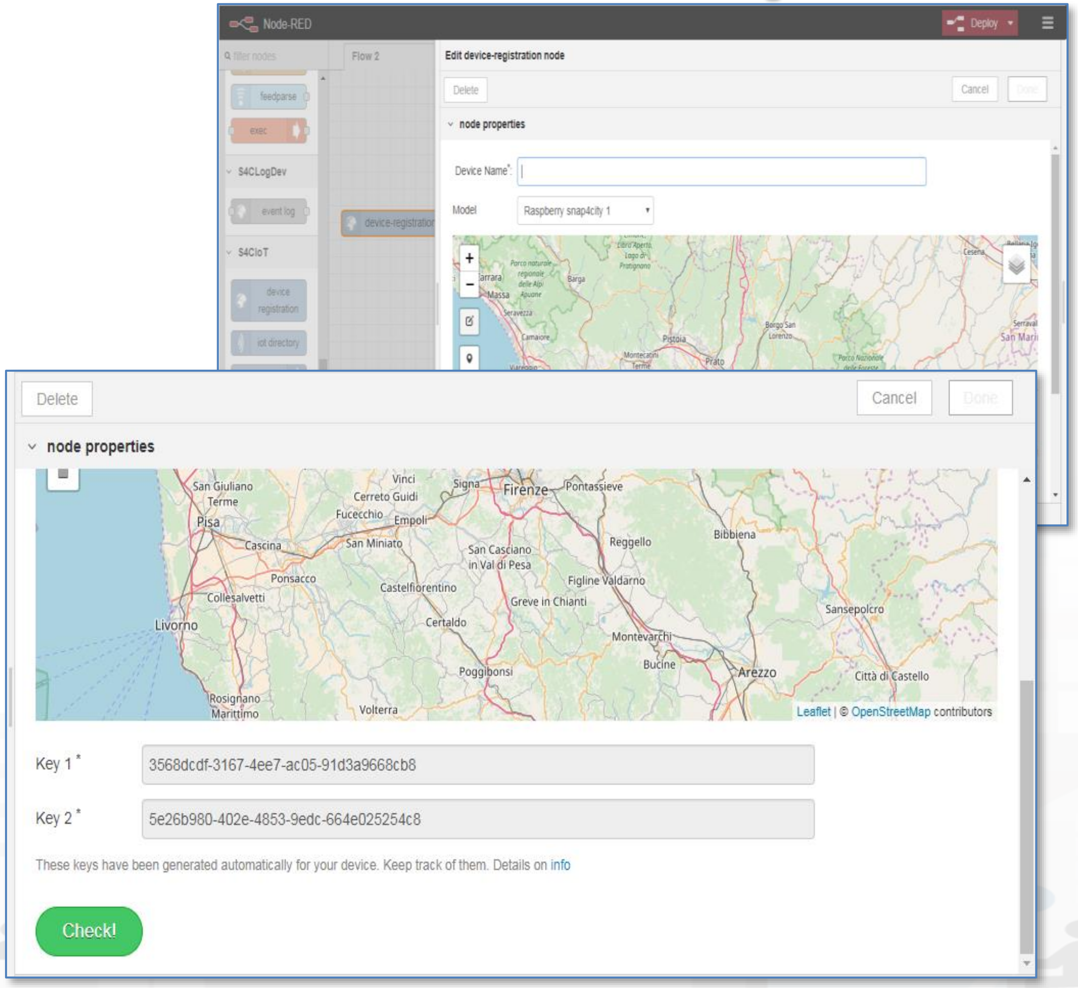
- **For example to search for:**
  - POIs:
    - near a GPS position, from text, along a path, in an area, etc..
  - Public Transport information / data
  - Suggestions
  - Public Transport Means Routes/Paths
  - Events in the area
  - Value Type (kind of data)
  - Etc.
- **To Get DATA of a Service / POI /sensor**
  - Real Time
  - ANY kind of senso



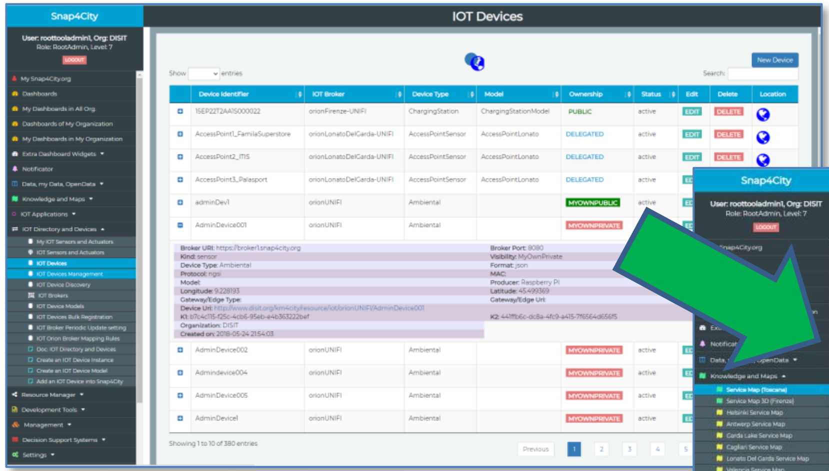
service info

IOT Discovery on IOT Application Development

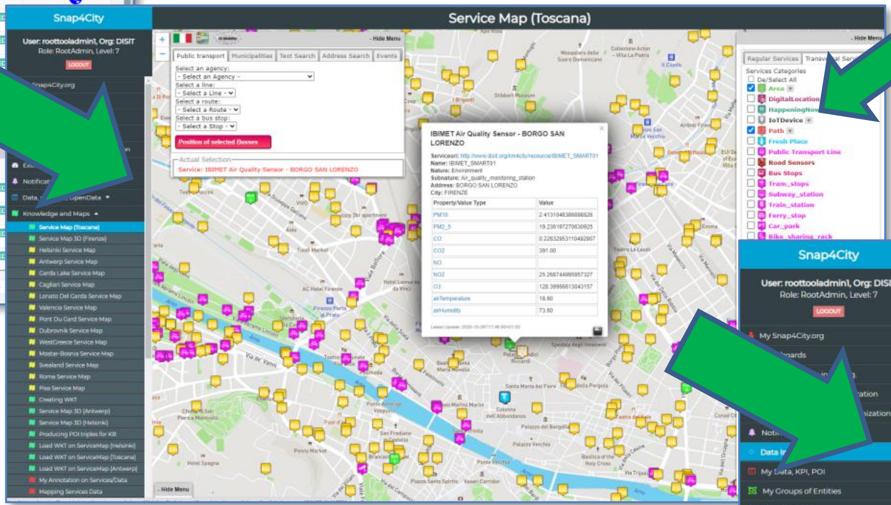




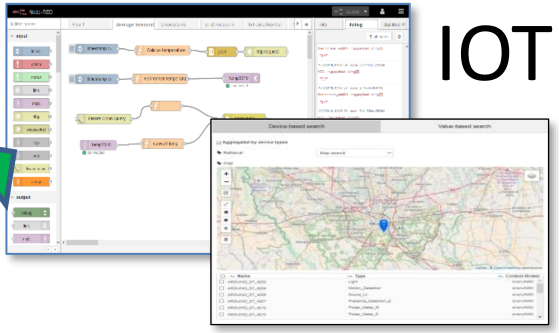
Data Registration Flow at a Glance



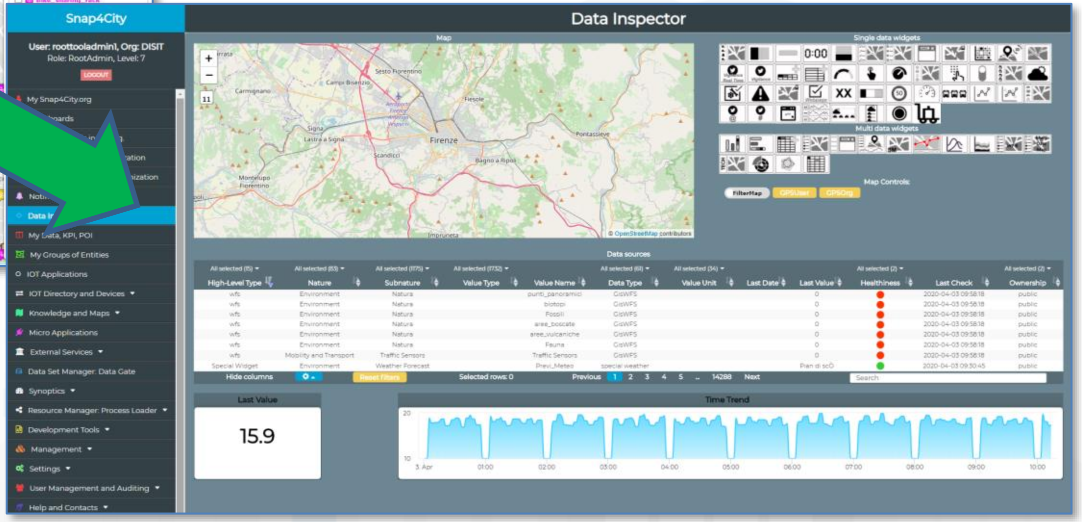
IOT Directory:
Devices…
Sensors..
Actuators…



Knowledge Base,
ServiceMap,
SmartCity API,
ASCAPI



IOT Apps



DataInspector
Dashboard Wizard

Notation Terminology

WHERE	Are synonymous at level of service which can be IOT device or entity with data	Are synonymous at level of the single attribute of the entity, device, service, etc.
IOT Directory	IOT Device	Sensor, Actuator, Attributes, Values (value name)
Knowledge Base, ServiceMap, SmartCity API, ASCAPI	Service, ServiceURI, SURI	Attribute, Metric
DataInspector, Wizard, Dashboard	ValueName	Sensor, Sensor Actuator, ValueType
IOT Applications, Node-RED	ServiceURI, SURI	SURI and its real time results of the objects into the data structure

ServiceURI, **SURI of a sensor device:**

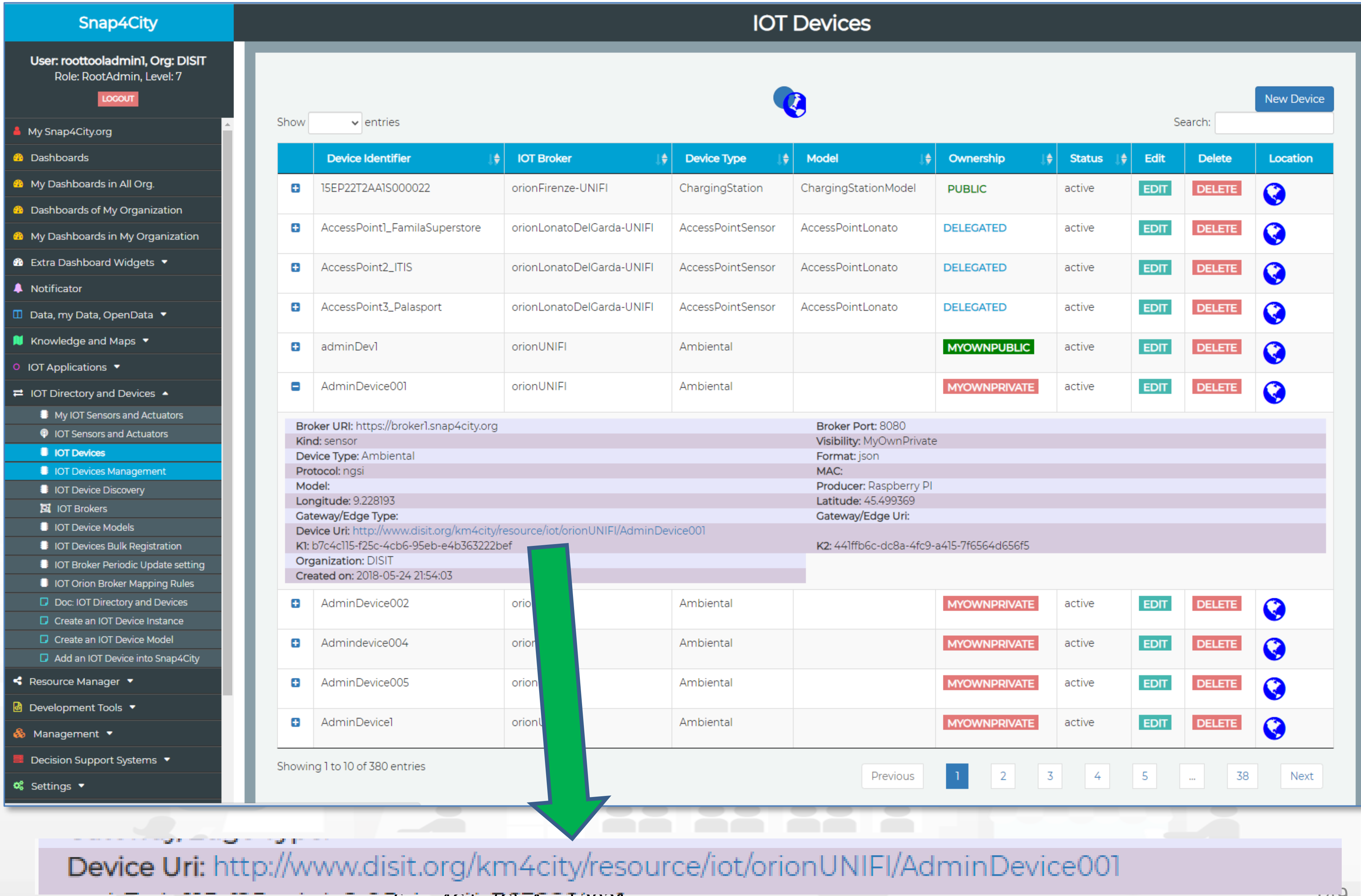
- http://www.disit.org/km4city/resource/METRO759
- http://www.disit.org/km4city/resource/iot/orionCAPELON-UNIFI/CAPELON/Streetlight%3A90FD9FFFFEBD5A7F

ServiceURI, **SURI extended with attribute/variable/value:**

- http://www.disit.org/km4city/resource/METRO759&metric=vehicleFlow
- http%3A%2F%2Fwww.disit.org%2Fkm4city%2Fresource%2FMETRO759&metric=vehicleFlow
- In some cases
    - http://www.disit.org/km4city/resource/METRO759/vehicleFlow

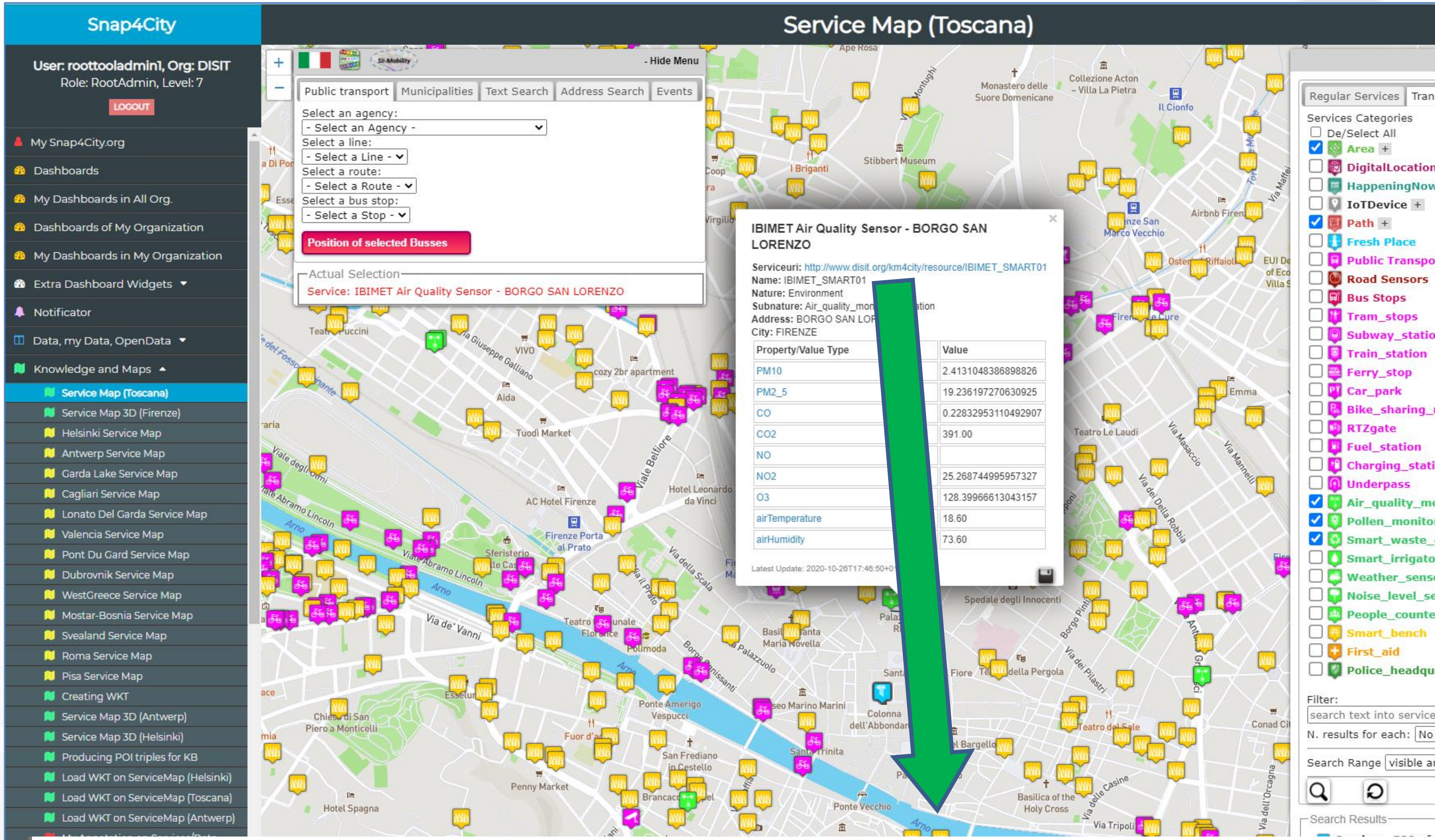
IOT Directory

- **For:** IOT Devices, Sensors, Sensor mobile, Actuators, Virtual Sensors, etc.
- Accessible as
  - ServiceURI
  - **Device URI**

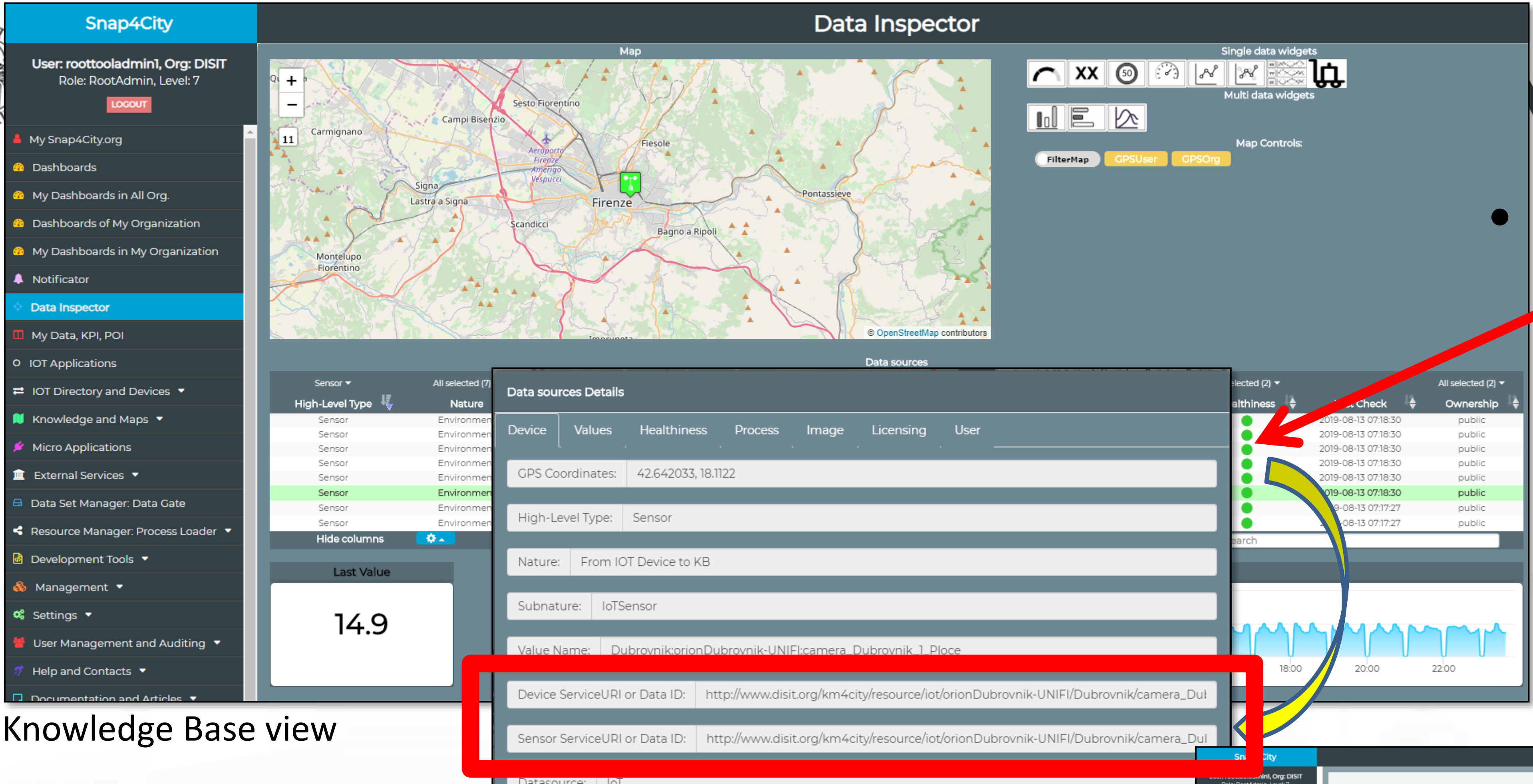


ServiceMap

- **For PUBLIC**:
  - IOT Devices, Sensors,
  - Sensor mobile,
  - Actuators,
  - Virtual Sensors,
  - POI, etc.
- See as
  - ServiceURI



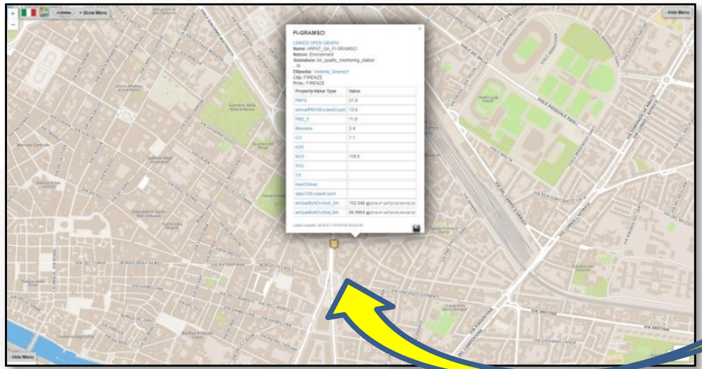
Serviceuri: http://www.disit.org/km4city/resource/IBIMET_SMART01

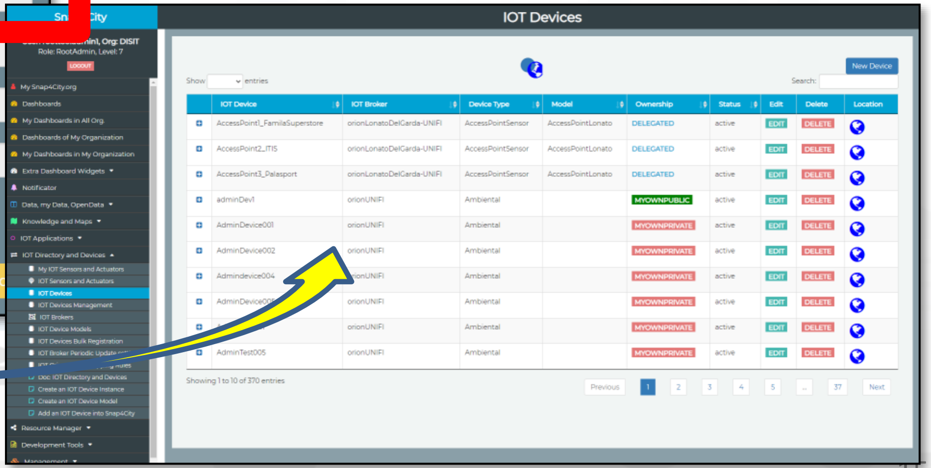


- Click with the mouse on it

Data Inspector Wizard

Knowledge Base view

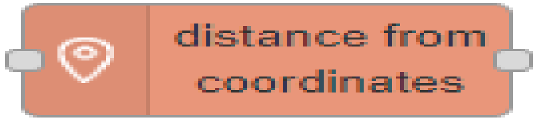




Some functionalities are limited to certain roles

S4CSearch

- **For example to search for:**
  - POIs:
    - near a GPS position, from text, along a path, in an area, etc..
  - Public Transport information / data
  - Suggestions
  - Public Transport Means Routes/Paths
  - Events in the area
  - Value Type (kind of data)
  - Etc.
- **To Get DATA of a Service / POI /sensor**
  - Real Time
  - ANY kind of sensors
- **Distance from GPS point**

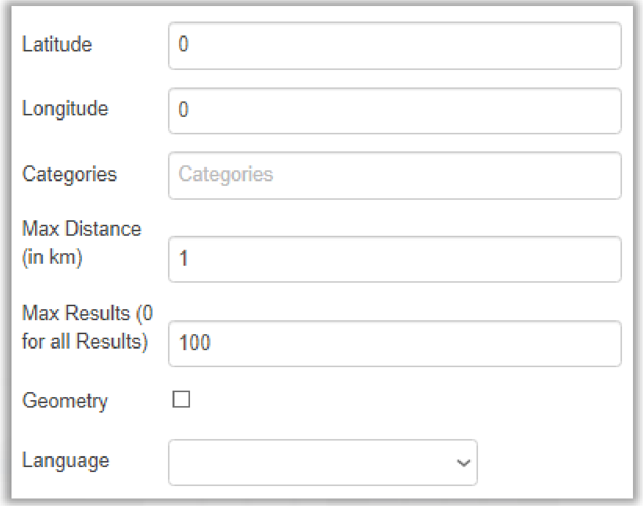


S4CSearch Adv

Smart City Entities Advanced Search

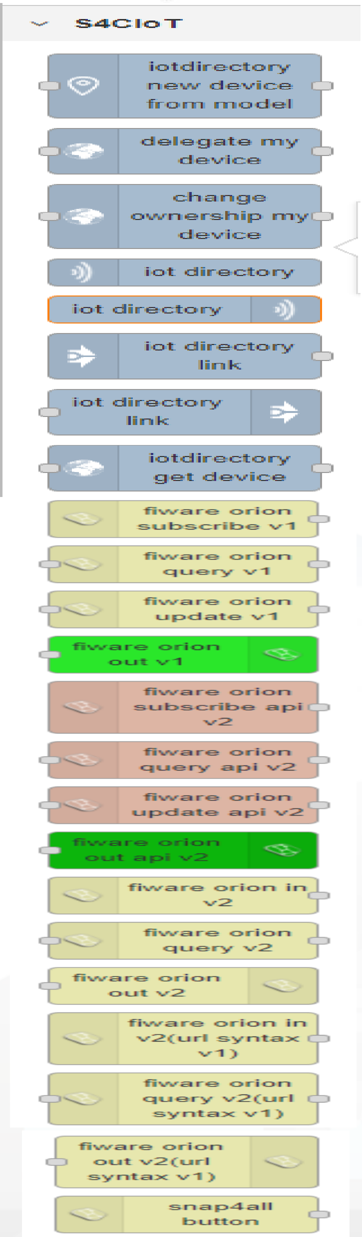
Flexiblity

- Similar to basic Search functions but with more flexibility of the function for programming the search
- Adding Dynamic behavior:
  - Getting in input JSON with parameters
- **To Get DATA of a Service / POI /sensor**
  - Historical and real time
  - ANY kind of sensors

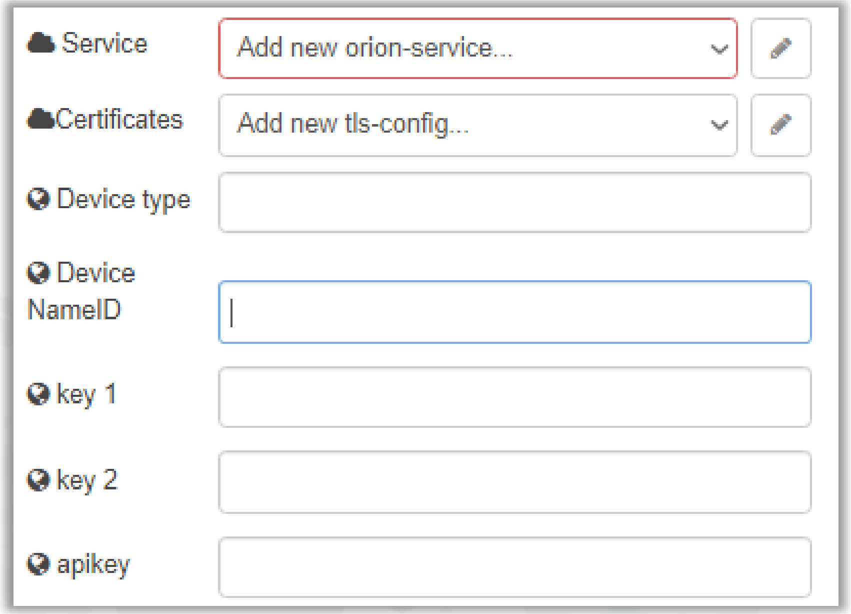


IOT App = Node-RED + Snap4City

IOT Devices NGSI just list see later



- **Search** for IOT Devices in a given area, or for kind (temperature, model, location, producer, Broker, …)
- **Subscribe** to one or more IOT Devices independently on their protocol, broker, owner, etc.
- **Send** data to IOT devices
- Establish with IOT Devices **Secure** certified Connections



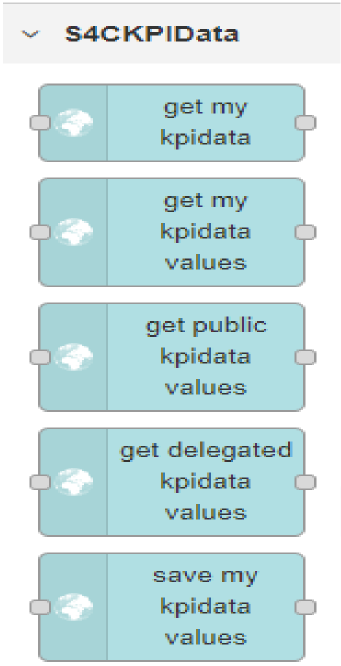
- Please note that many other protocols can be also added, adding mode nodes, or registering IOT brokers to the Snap4City IOT Directory

TOP

IOT App = Node-RED + Snap4City

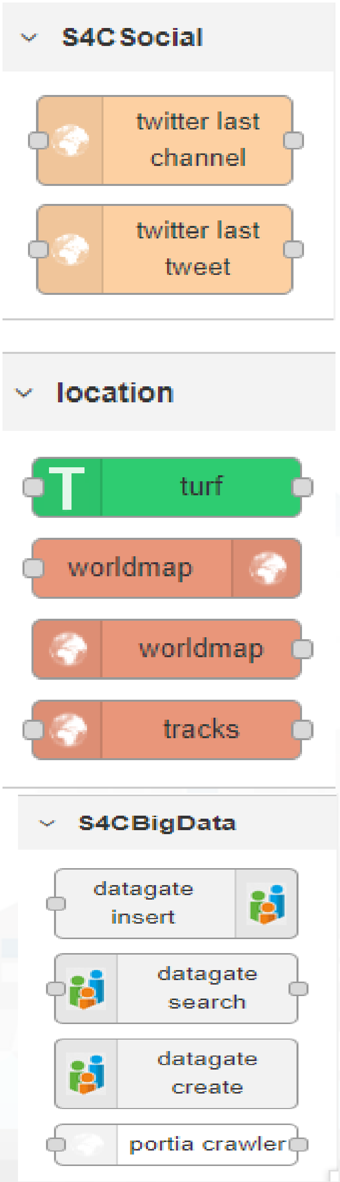
Others nodes

S4CKPIData



- Save and retrieve MyKPI into the safe personal data storage
- Access to MyKPI and to those that other user have delegated to Me
- **MyKPI are:**
  - Time series of data with GPS coordinates that can chage over time
  - Suitable for: moving sensors, trajectories, data from OBU, data from mobile, sensor data (if needed), etc. etc.
- **MyPOI are:**
  - POI with full metadata description and static coordinates

Mixt

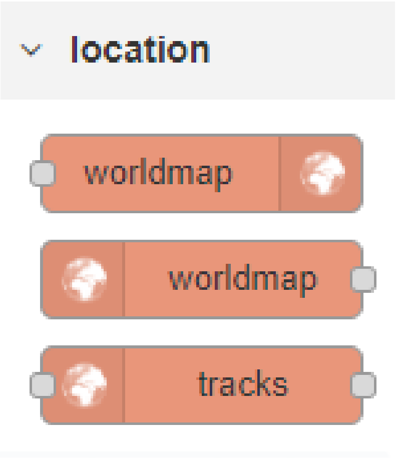


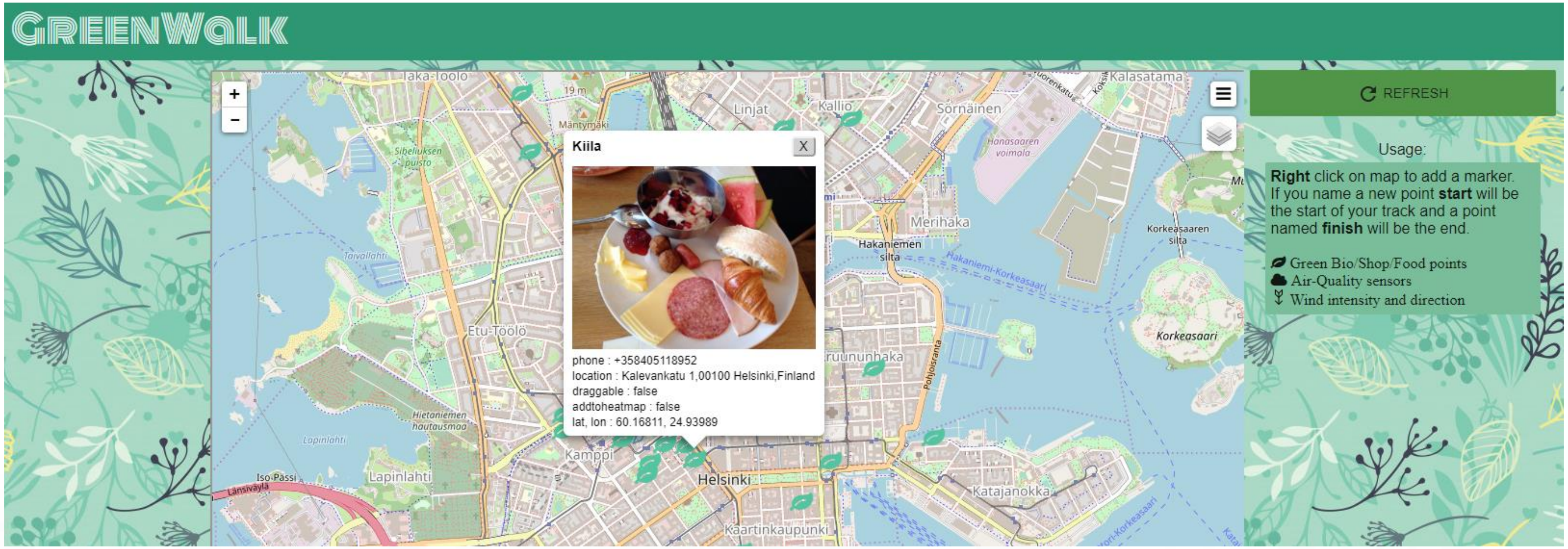
- Request metrics from Twitter Vigilance Channel service and engine of DISIT Lab
  - Different Twitter Vigilance services may be attached according to the Organization, different metrics and values

- Location services
- Maps and get position (raw solution)

- Getting data from DataGate/CKAN
- Publishing data to DataGate/CKAN
- Managing time series on DataGate/CKAN

Third party solution to: Control Maps from IOT Apps



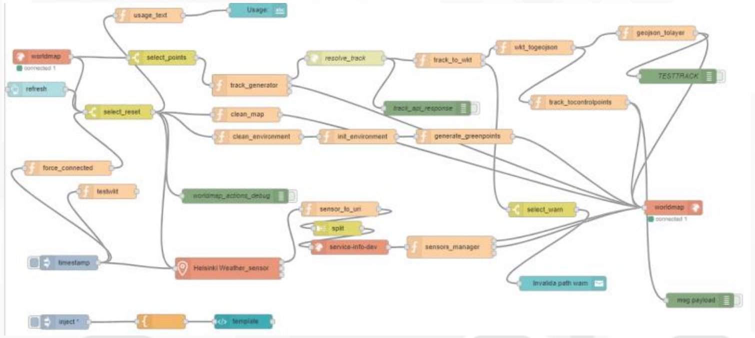


https://iot-app.snap4city.org/nodered/nrve0e3/ui/#!/0

- Show points on maps
- Get Points
- Tracks
- See examples on:

https://www.snap4city.org/409

https://www.snap4city.org/417

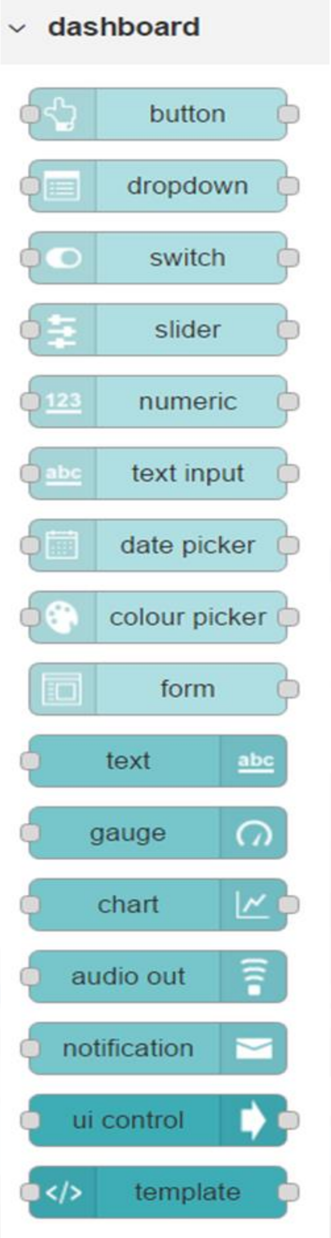


TOP

IOT App = Node-RED + Snap4City

Dashboard Integration

Dashboard



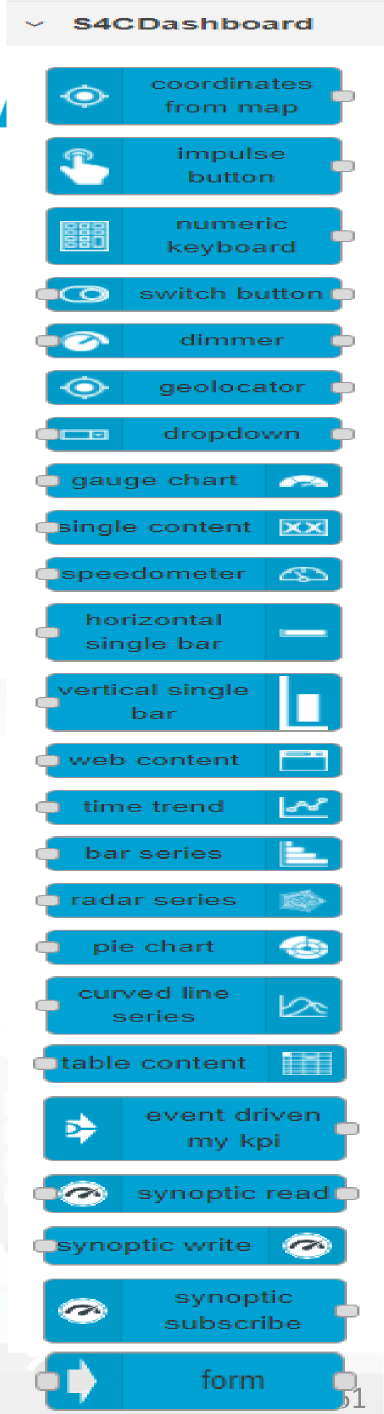
Native Local or Snap4City

- Input/output
- non secure
- Limited in graphics
- No authentication
- No HLT
- No integration
- No historical data
- No Synoptics
- Etc..

- Local on IOT Edge

- Input/output
- Secure
- Advanced in graphics
- Single Sign On
- Several HLT
- Fully integrated
- Historical data
- Full Synoptics
- Etc..

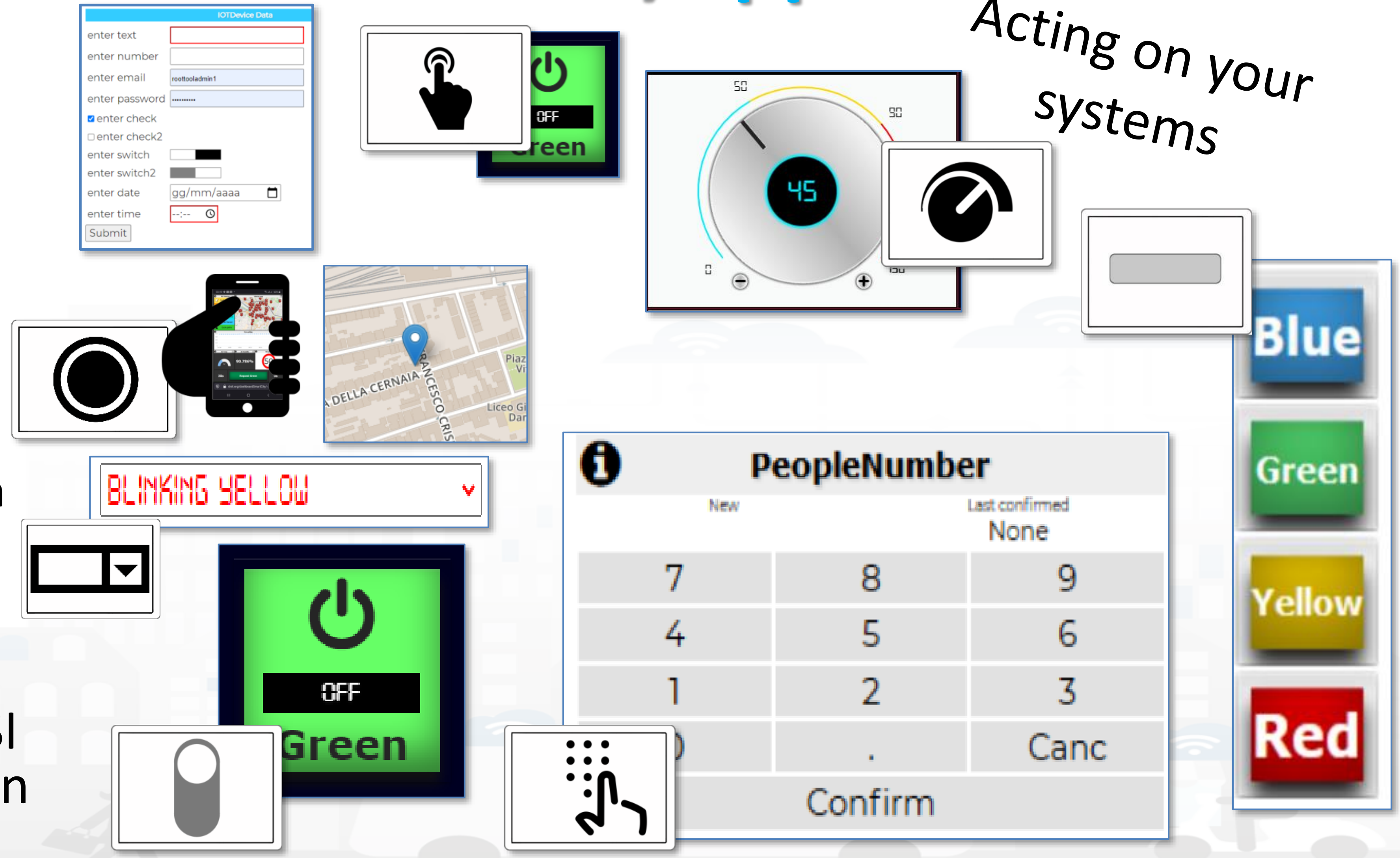
- Remote for IOT Edge via WebSocket Secure



From Dashboard to IOT Devices/App

- **Widgets:**
  - Impulse Button
  - Button
  - Switch
  - Dimer/Knowb
  - KeyPad
  - Geolocator
  - Selection/Dropdown
  - Form
  - Map Picking
- **Registered** on some IOT brokers with NGSI mutual authentication

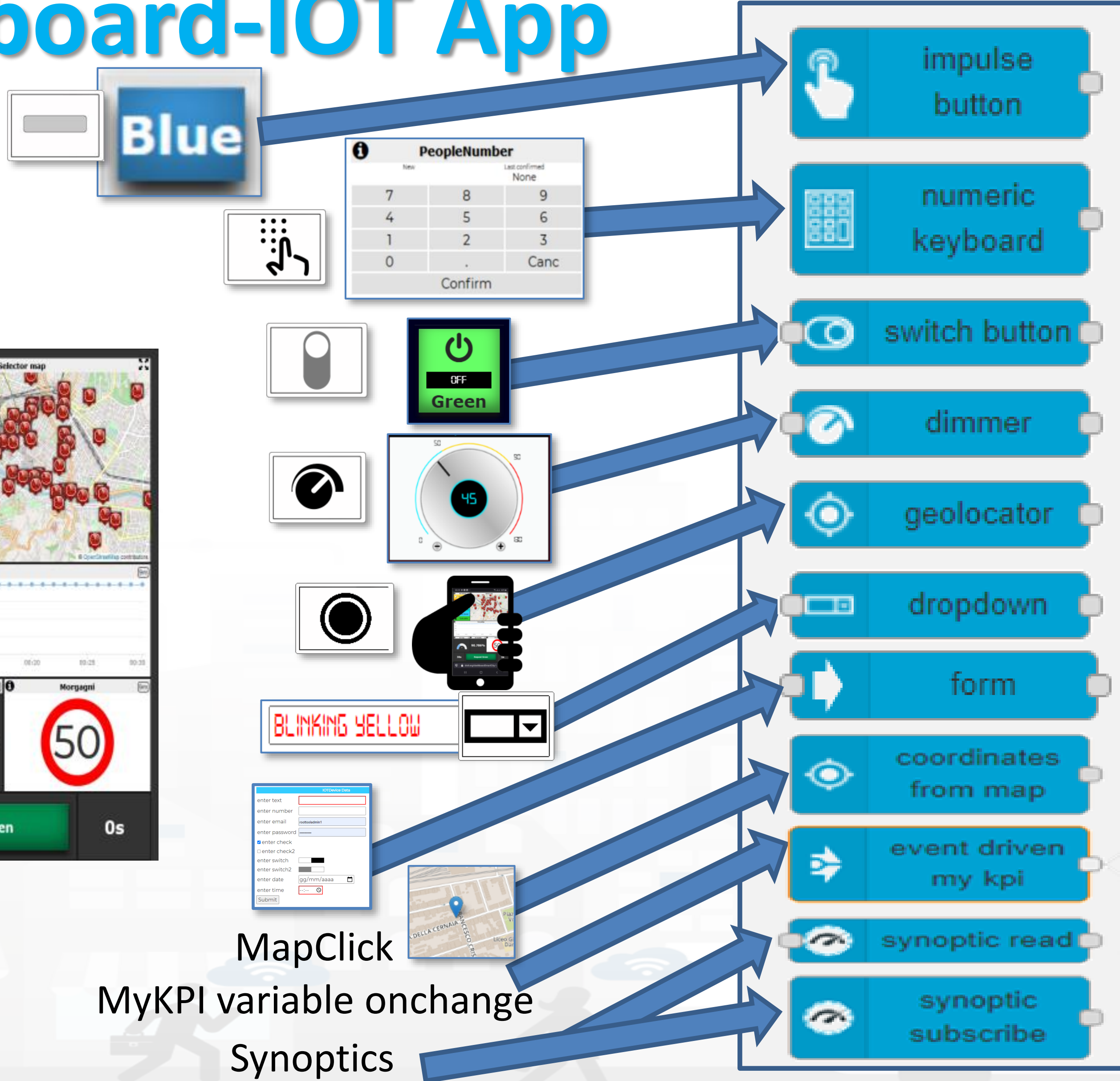
Acting on your systems

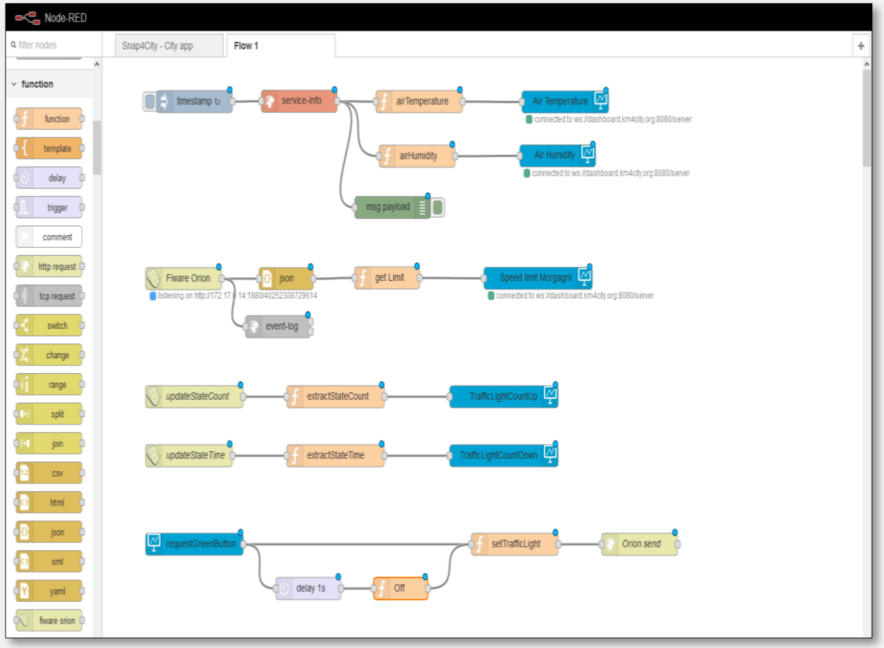


Nature

Dashboard-IOT App

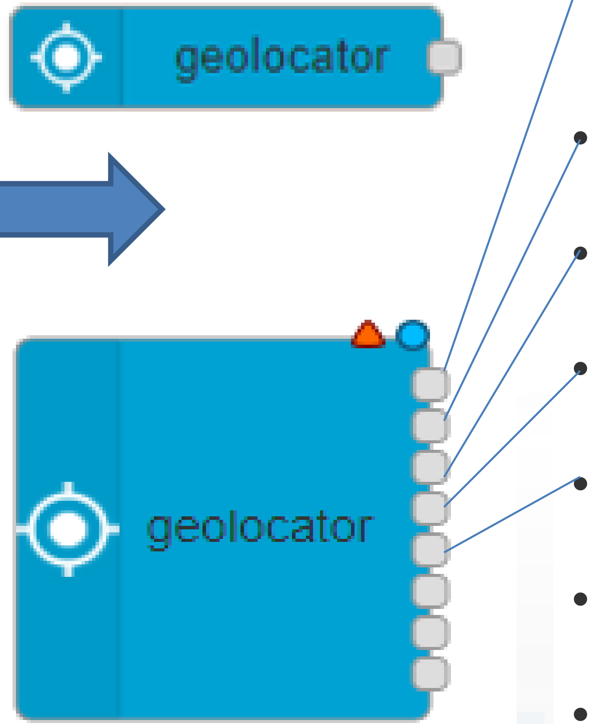
From Dashboard to IOT App





IOT Application

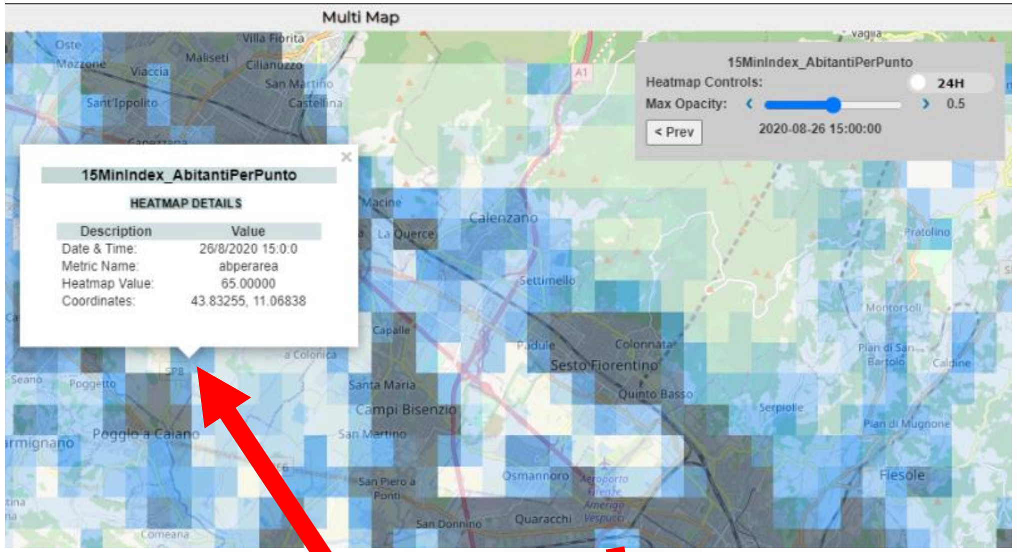
Geolocation of Mobile Device



Web Browser GPS data rendering the Snap4City Dashboard can be passed to IOT Applications and saved ☺

- Complete message
  - Returns a JSON containing all information about geolocation
- Latitude
  - Returns the latitude
- Longitude
  - Returns the longitude
- Accuracy
  - Returns the accuracy of latitude and longitude
- Altitude
  - Returns the altitude
- Altitude Accuracy
  - Returns the altitude accuracy
- Heading
  - Returns the heading
- Speed
  - Returns the speed

Multi Data Map GPS Location Picking vs IOT App

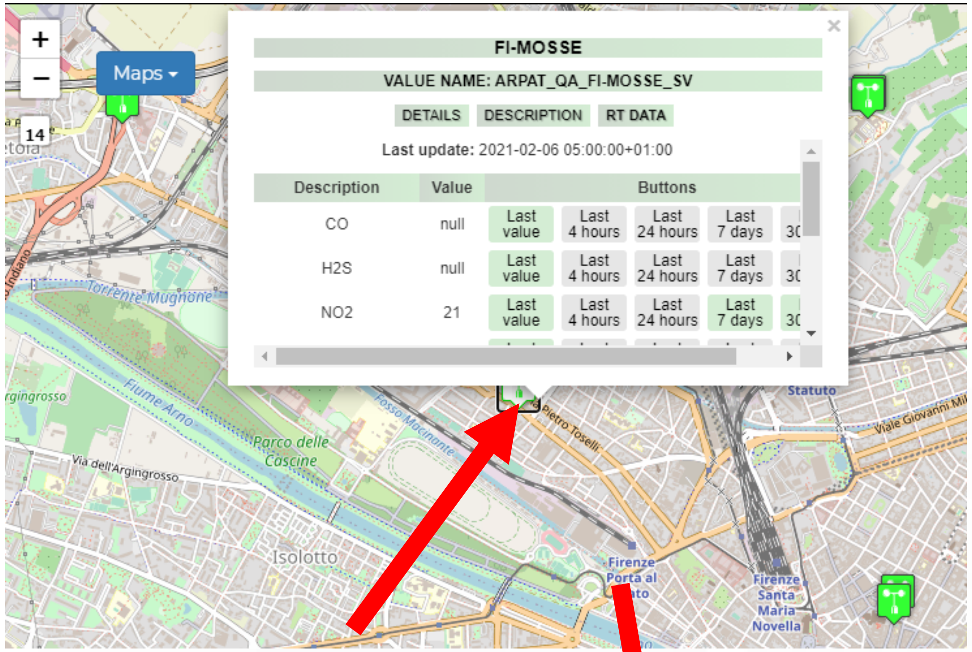


1) Click

2) GET event with:
-- Lat,Long
-- ServiceURI

- 3) The click on the map passes GPS coordinates into IOT App. Thus you can use them to:
  – search for location
  – picking the value of one or more heatmaps
  – dynamically change data on widgets and dashboards
  – Etc.

Multi Data Map ServiceURI selection vs IOT App



1) Click on PIN

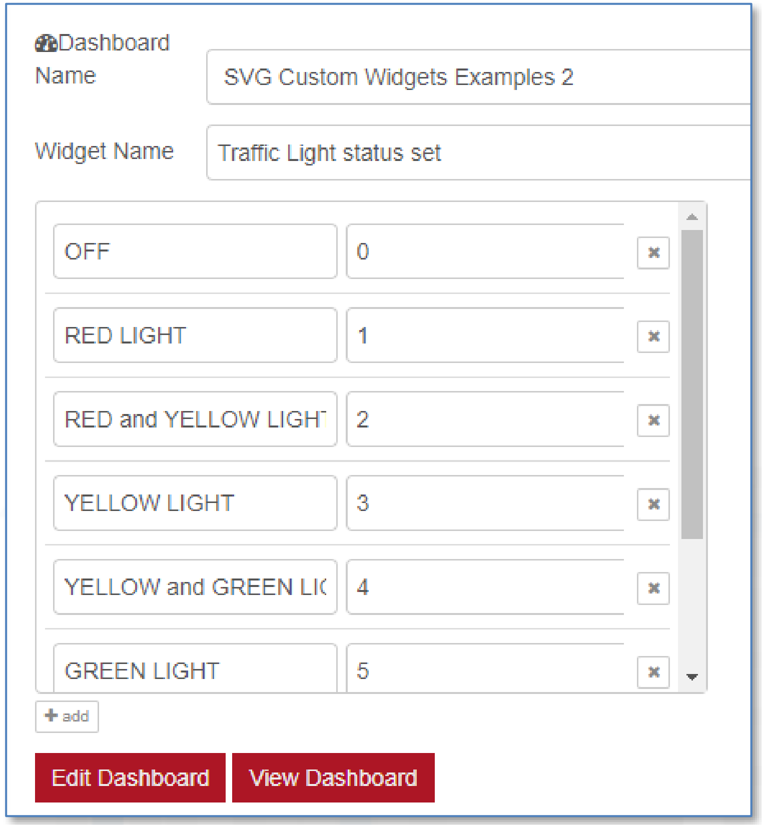
2) GET event with:

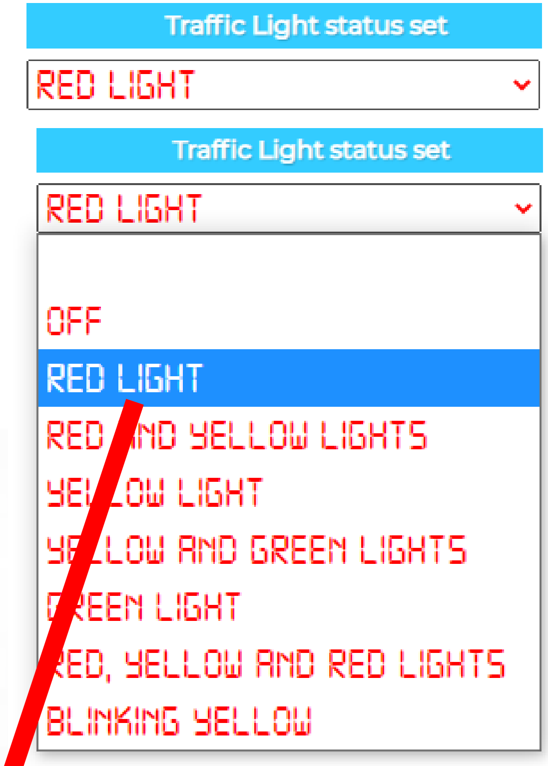
- Lat,Long
- **ServiceURI**

- 3) The click on the map passes GPS coordinates into IOT App and the ServiceURI. Thus you can use them to:
  – search for location
  – picking the value of one or more heatmaps
  – dynamically change data on widgets and dashboards
  – Get all the ServiceURI information and exploit them on Business Logic
  – Etc.

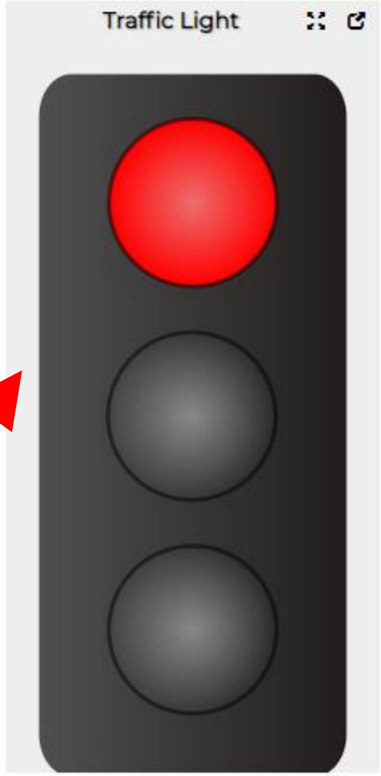

UNIVERSITÀ DEGLI STUDI FIRENZE
DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE
DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB
SNAP4CITY
KM4CITY
SVG Custom Widgets Examples 2
Tue 17 Nov 18:46:47
SVG shucko plug
70 kW
Schuko switch
Charging Station Status
Legenda
Charging Station Status
Set on the keypad one of the following values
0 = ERROR (RED)
1 = AVAIBLE (GREEN)
2 = BOOKED (YELLOW)
3 = CHARGING
9999 = white icon
Charging Station status
New
Last confirmed
None
7 8 9
4 5 6
1 2 3
0 . Canc
Confirm
Underpass
Set tunnel st...
ON
Traffic Light
Traffic Light status set
YELLOW LIGHT
Speed Limit Set
New
Last confirmed
None
7 8 9
4 5 6
1 2 3
0 . Canc
Confirm
Dynamic Speed Limit Sign
24
Speed Limit Explaination
Speed Limit Custom Widget example
Write the speed limit by using the keypad and click CONFIRM.
9999 = white sign.
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjk4Ng==
Privacy Policy
Cookies Policy
Terms and Conditions
Contact us

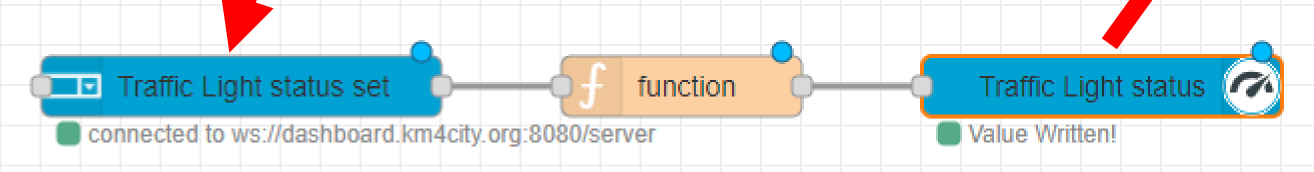
Selector





- Selecting MSG to be sent on the Business Logic IOT Application

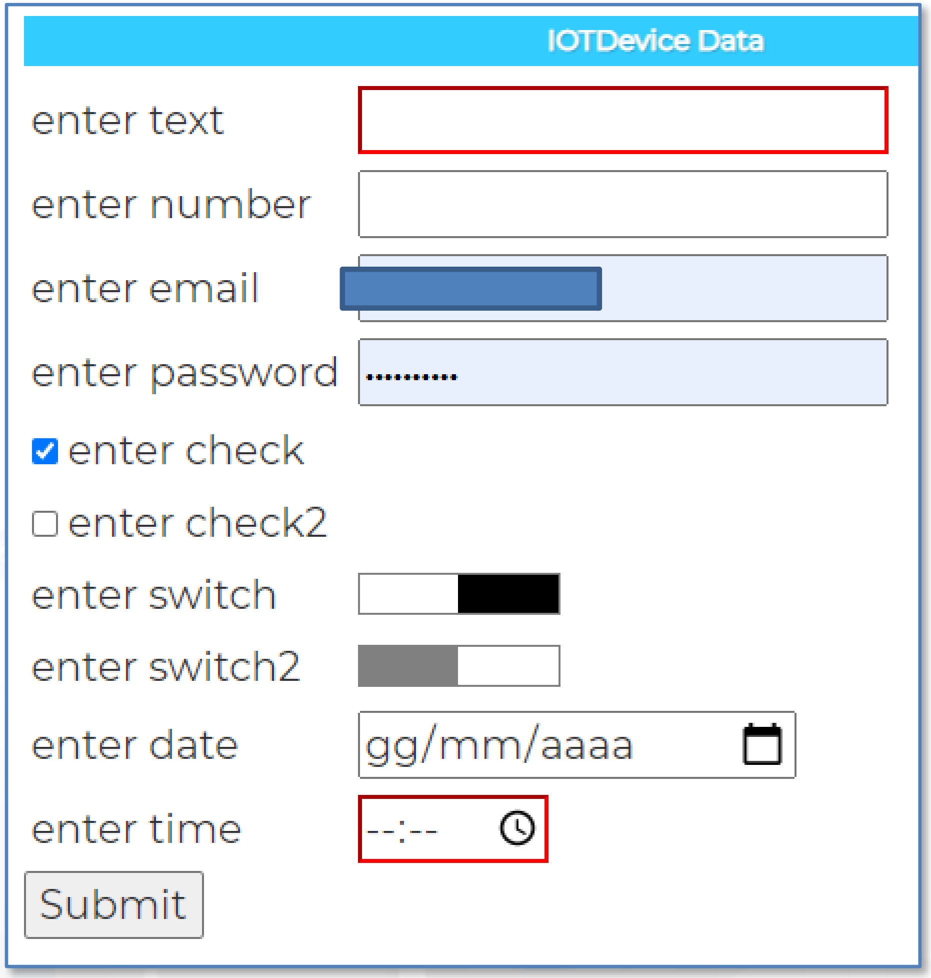





```
msg.payload = {value:JSON.parse(msg.payload).selected};
return msg;
```

Form

```
msg.payload ={ "form": { "options": [
{ "label": "enter text", "value": "", "type": "text", "required": true },
{ "label": "enter number", "value": "", "type": "number", "required": false },
{ "label": "enter email", "value": "", "type": "email", "required": false },
{ "label": "enter password", "value": "", "type": "password", "required": false },
{ "label": "enter check", "value": "checked", "type": "checkbox", "required": false },
{ "label": "enter check2", "value": "", "type": "checkbox", "required": false },
{ "label": "enter switch", "value": "on", "type": "switch", "required": false },
{ "label": "enter switch2", "value": "", "type": "switch", "required": false },
{ "label": "enter date", "value": "", "type": "date", "required": false },
{ "label": "enter time", "value": "", "type": "time", "required": true }
 ], "selected": [] } }
return msg;
```



Form

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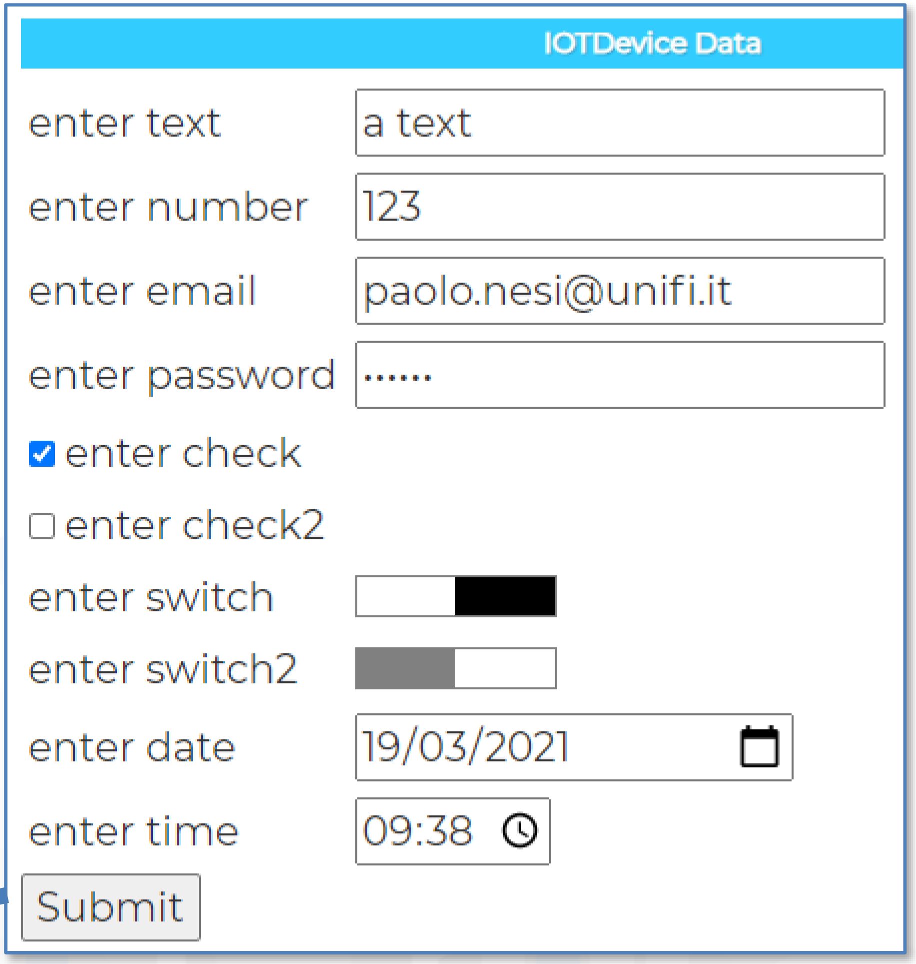
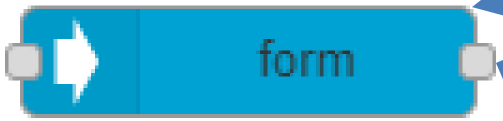
msg.payload ={ "form": { "options": [
{ "label": "enter text", "value": "", "type": "text", "required": true },
{ "label": "enter number", "value": "", "type": "number", "required": false },
{ "label": "enter email", "value": "", "type": "email", "required": false },
{ "label": "enter password", "value": "", "type": "password", "required": false },
{ "label": "enter check", "value": "checked", "type": "checkbox", "required": false },
{ "label": "enter check2", "value": "", "type": "checkbox", "required": false },
{ "label": "enter switch", "value": "on", "type": "switch", "required": false },
{ "label": "enter switch2", "value": "", "type": "switch", "required": false },
{ "label": "enter date", "value": "", "type": "date", "required": false },
{ "label": "enter time", "value": "", "type": "time", "required": true }
 ], "selected": [] } }
return msg;
```



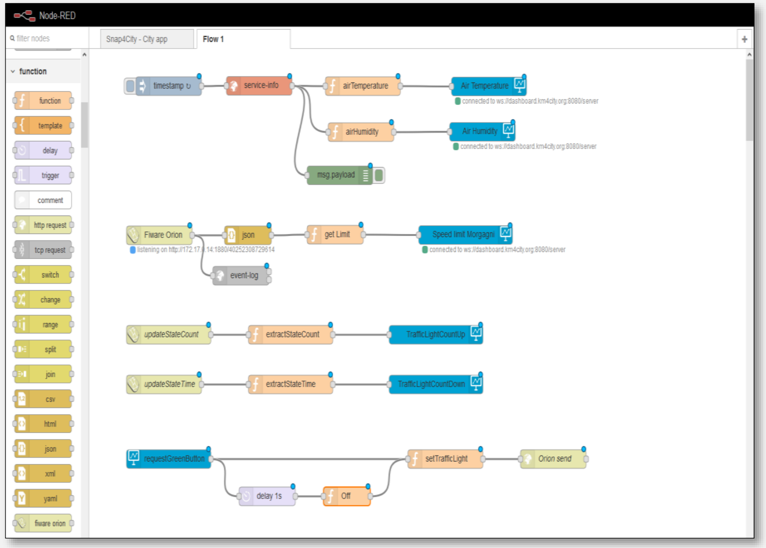


"selected":["a text","123", "paolo.nesi@unifi.it","aaaaaa", "checked","","on","","2021-03-19","09:38"]

Dashboard-IOT App

Nature

From IOT App to Dashboard



IOT Application

- gauge chart
- single content
- speedometer
- horizontal single bar
- vertical single bar
- web content
- time trend
- bar series
- radar series
- pie chart
- curved line series
- table content
- synoptic write
- calendar

Single Content Widget (flexibility)

From Dashboard Editor and IOT Applications, accepts in input:

- Numbers
- String
- HTML code

https://www.snap4city.org/578

TOP

Dynamic Widgets data on Dashboard from IOT Applications

How the Dashboards exchange data

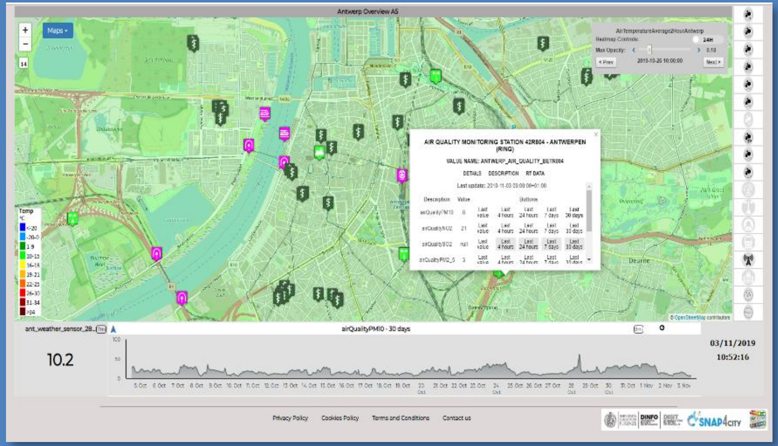
Snap4City BigData Storage and KB

IOT Broker Orion Quantum Leap

ServiceMap Super ServiceMap

- Req. ServiceURI

Dashboards



Metric, KPI

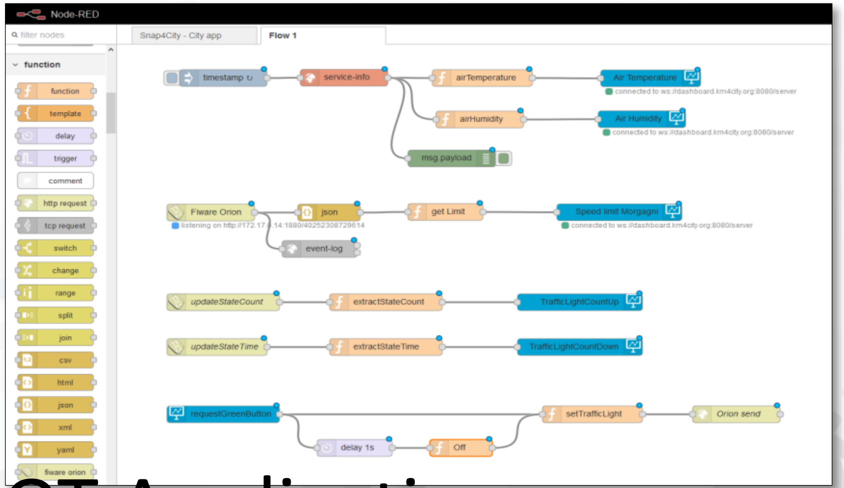
- Req. KPI, Metric ID

MyKPI, MyPOI, …

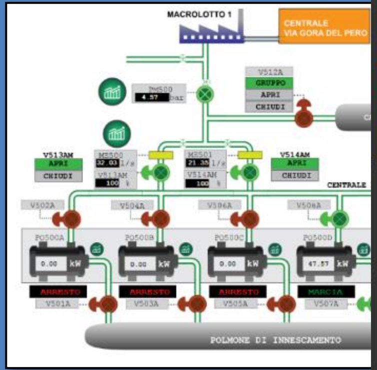
- Req. MyKPI ID

API, External Services, MicroApp

- Traffic Flow, MAPS, Heatmaps
- GIS, HTTPs URLs



- ServiceURI (ID)
- MyKPI, Metric (ID)
- Dynamic Data, computed into IOT Application



- Rx. Dynamic Data
- Event Driven Synoptics
- Actions, Show

IOT Application

Dynamic (2021)

Widgets ICONS	Widget Name, Description	IOT App	Dashboard-IOT App	KPI (metric)	MyPersonalData	MyData	My KPI	Sensor
	Single Content single content	X (cs)	X (DD)	X	X	X	X	X
	Speed Limit			X				X
	Speedometer speedometer	X (cs)	X (DD)	X	X	X	X	X
	Gauge gauge chart	X (cs)	X (DD)	X	X	X	X	X
	Single Bar, V/H horizontal single bar vertical single bar	X	X (DD)	X				
	Single and Multiple Bars, stacked or not Bar series	X (cs)	X (DD)	X	X	X	X	X
	MultiSeries, shaded, staked and non staked curved line series	X (cs)	X	X	X	X	X	X
	Time Trend (single) time trend	X	X (DD)	X	X	X	X	X
	Time trend Compare			X			X	X
	SpiderNet, radar, Kiviat radar series	X (cs)	X (DD)	X	X	X	X	X
	Pie, Donut, 2 layers Donut pie chart	X (cs)	X (DD)	X	X	X	X	X
	Table table content	X (cs)	X (DD)	X	X	X	X	X
	Calendar calendar	X	X				X	X

DD: Data Driven

Legenda

- **IOT APP column in previous table:**
  - **X**: means that from the IOT App you can send a new value or array to the widget directly, without the need to have is stored into Sensor or MYKPI variable, etc.
  - **CS, widget supports Change (data) Source**, in the sense that: from the IOT App is possible to send a command to the Widget to change the data source. E.g., selecting sources among: Sensors (serviceURI), MyKPI (ID), any value produced on the IOT App directly. (cs) recent additions
- **Dashboard IOT App column in previous table**:
  - **X:** there is a MicroService / node on IOT App to act on those widgets on dashboard. The data are visualized.
  - **DD, widget is Data Driven**, in the sense that new data in push can be sent and the widget is updated in real time on web page without web page realoading

TC4.9: New Support Widgets for Bars, Barseries, Trend, and Series, on Dashboards and IOT Applications (partially obsolete)

Dynamic Widget data

▾0: object
metricId: "http://www.disit.org/km4city/resource/tusc_weather_sensor_ow_3166540"
metricHighLevelType: "Sensor"
metricName: "tusc_weather_sensor_ow_3166540"
metricType: "airTemperature"
▾1: object
metricId: "https://servicemap.disit.org/WebAppGrafo/api/v1/?serviceUri=http://www.disit.org/km4city/resource/tusc_weather_sensor_ow_3182522&format=json"
metricHighLevelType: "Sensor"
metricName: "tusc_weather_sensor_ow_3182522"
metricType: "airTemperature"
▾2: object
metricId: "17056320"
metricHighLevelType: "MyKPI"
metricName: "SiiMTuscanyTrackerLocation"
metricType: "Velocity"
▾3: object
metricId: ""
metricHighLevelType: "Dynamic"
metricName: "BatteryTemperatureGalaxyNote"
metricType: "Gradi Centigradi"
metricValueUnit: "°C"
measuredTime: "2019-11-21T14:51:00Z"
value: 6.688898111364505
▾4: object
metricId: ""
metricHighLevelType: "Dynamic"
metricName: "BatteryTemperaturemia"
metricType: "Gradi Centigradi"
metricValueUnit: "°C"
measuredTime: "2019-11-21T14:51:00Z"
value: 62.8502788741156

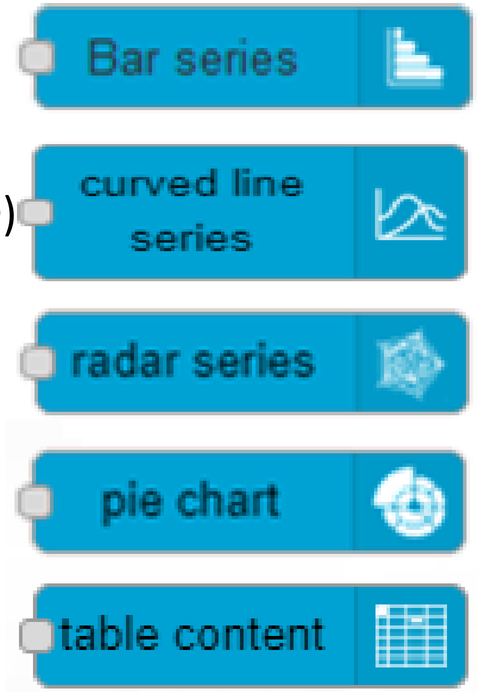
ServiceURI (ID)

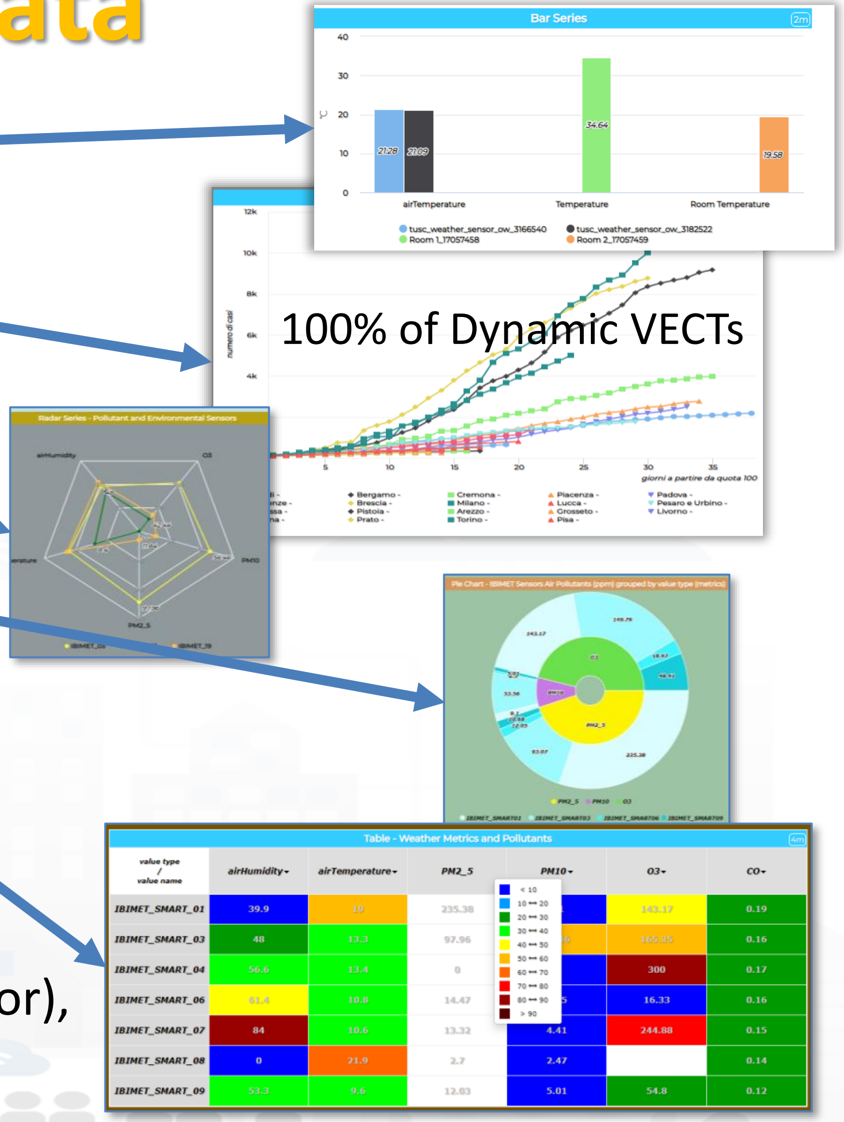
ServiceURI (ID)

MyKPI (ID)

Dynamic

Dynamic





- **ServiceURI** (ID)
- **MyKPI (ID)**, Metric (ID)
- **Dynamic** Data in JSON (single or Vector), computed into IOT Application

[TC4.9: New Support Widgets for Bars, Barseries, Trend, and Series, on Dashboards and IOT Applications]

TOP

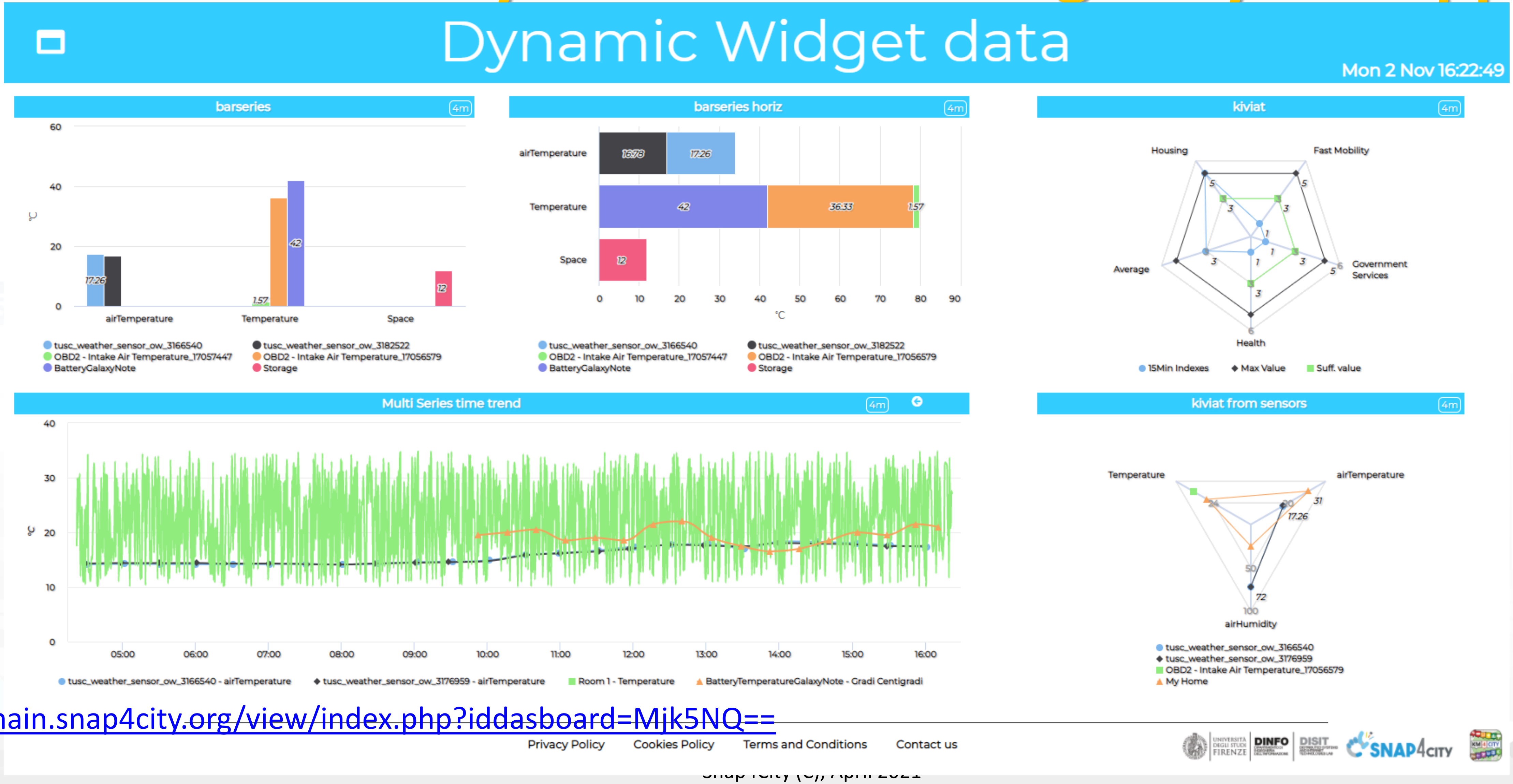
Example of: Dynamic Widgets data on Dashboard from IOT Applications

How to send the Dynamic Data to Widgets

- [TC4.9: New Support Widgets for Bars, Barseries, Trend, and Series, on Dashboards and IOT Applications]

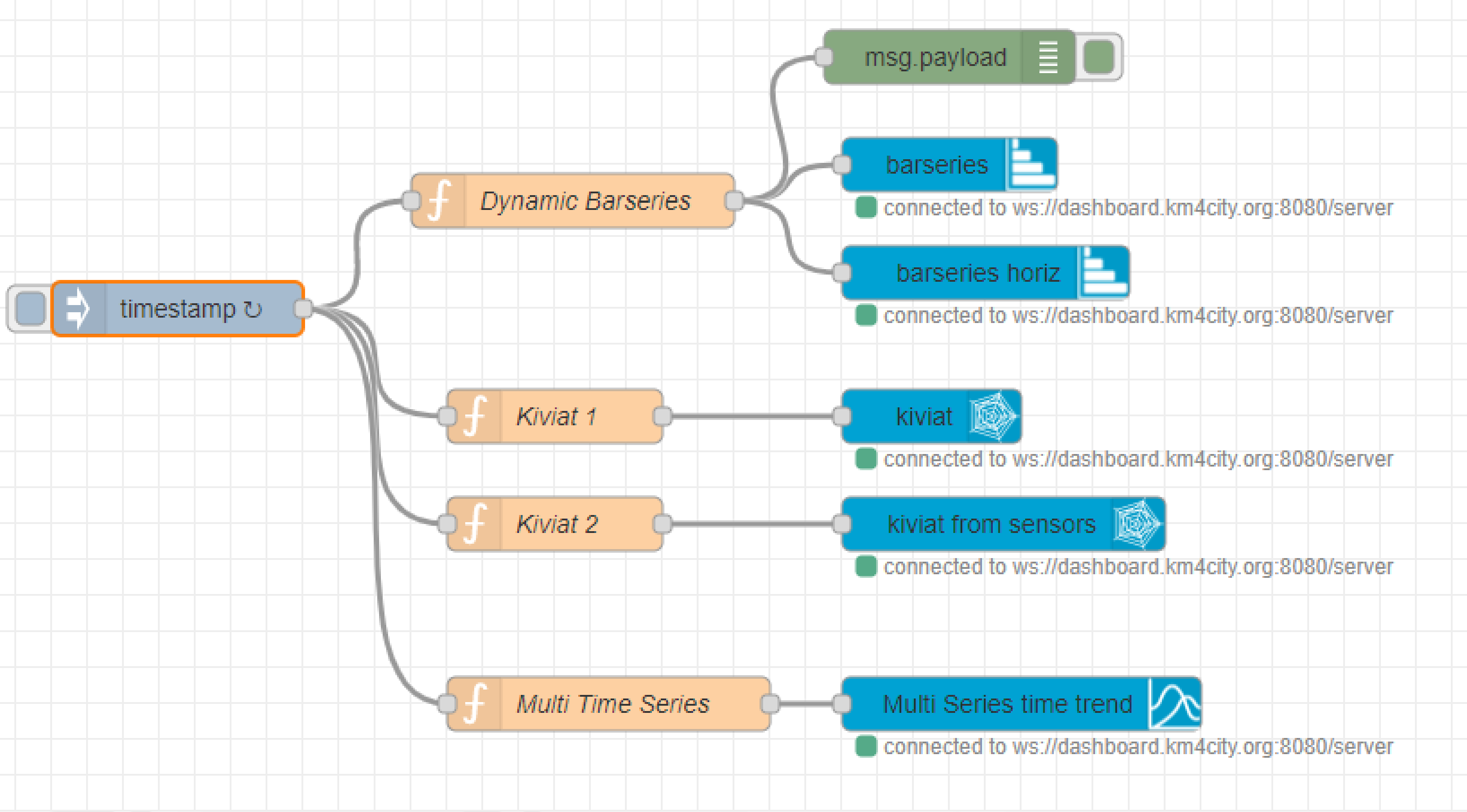
- Dynamic Data are used to control the Widget from the IOT App. To dynamically change:
  - **ServiceURI** (as metricID) to change the data source of a Dashboard Widget
  - **MyKPI** (as metricID) to change the data source of a Dashboard Widget
  - **Dynamic**, data computed somehow into IOT App, and sent to some Dashboard Widget without to save them on some Storage

Dashboard with Dynamic Data Managed by IOT App



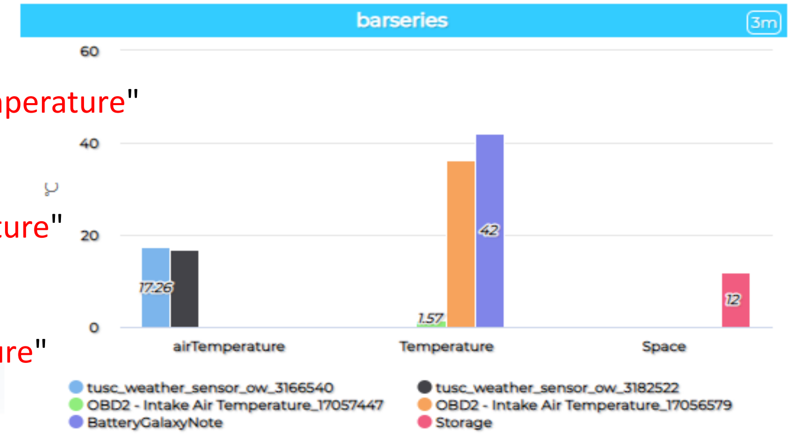
https://main.snap4city.org/view/index.php?iddasboard=Mjk5NQ==

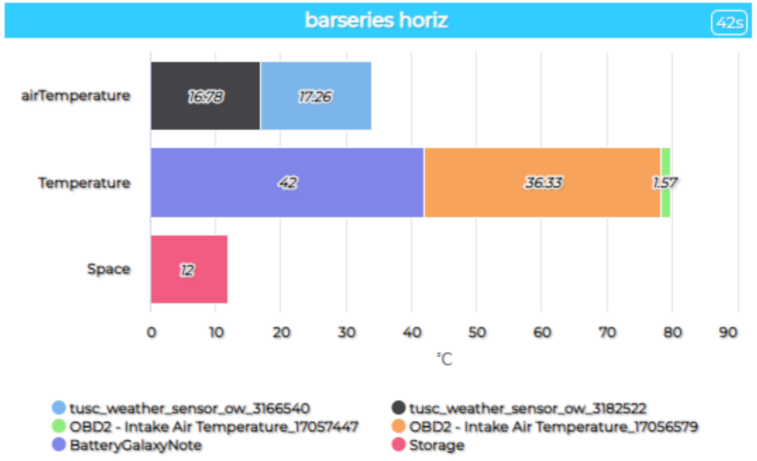
The IOT App controlling the Dashboard data



Dynamic BarSeries

```
msg.payload =[
  {     "metricId":"http://www.disit.org/km4city/resource/tusc_weather_sensor_ow_3166540",
    "metricHighLevelType":"Sensor",
    "metricName":"tusc_weather_sensor_ow_3166540",       "metricType":"airTemperature"
  },
  {     "metricId":"http://www.disit.org/km4city/resource/tusc_weather_sensor_ow_3182522",
    "metricHighLevelType":"Sensor",      "metricName":"tusc_weather_sensor_ow_3182522",       "metricType":"airTemperature"
  },
  {     "metricId":"17057447",
    "metricHighLevelType":"MyKPI",      "metricName":"OBD2 - Intake Air Temperature",          "metricType":"Temperature"
  },
  {     "metricId":"17056579",
    "metricHighLevelType":"MyKPI",      "metricName":"OBD2 - Intake Air Temperature",          "metricType":"Temperature"
  },
  {     "metricId":"",
    "metricHighLevelType":"Dynamic",   "metricName":"BatteryGalaxyNote",            "metricType":"Temperature",
    "metricValueUnit":"°C",
    "measuredTime":"2019-11-21T14:51:00Z",
    "value":42
  },
  {     "metricId":"",
    "metricHighLevelType":"Dynamic",      "metricName":"Storage",      "metricType":"Space",
    "metricValueUnit":"Gb",
    "measuredTime":"2019-11-21T14:51:00Z",
    "value":12
  }
]
return msg;
```





Sensors, MyKPI and dynamic in this case

May be aggregated by Metric Type or by ValueName, staked, oriented .. see More Options

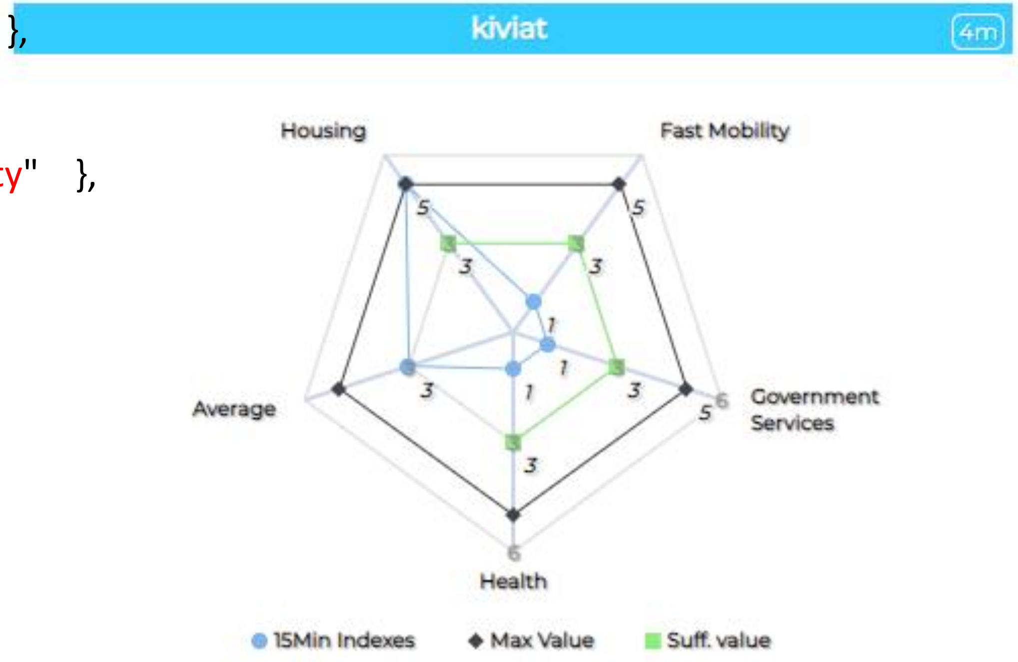
Kiviat 1

```
msg.payload = [
  {  "mapName":"15MinIndex_FastMobilityIndex",     "metricName":"15Min Indexes",     "value":1,
     "metricHighLevelType":"Dynamic",     "metricValueUnit":"",     "metricType":"Fast Mobility"    },
  {   "mapName":"15MinIndex_GovernmentServicesIndex",    "metricName":"15Min Indexes",    "value":1,
      "metricHighLevelType":"Dynamic",   "metricValueUnit":"",    "metricType":"Government Services"   },
  {   "mapName":"15MinIndex_HealthIndex",    "metricName":"15Min Indexes",    "value":1,
     "metricHighLevelType":"Dynamic",    "metricValueUnit":"",    "metricType":"Health"  },
  {   "mapName":"15MinIndex_AverageIndex",    "metricName":"15Min Indexes",    "value":3,
      "metricHighLevelType":"Dynamic",    "metricValueUnit":"",    "metricType":"Average"  },
  {   "mapName":"15MinIndex_HousingIndex",    "metricName":"15Min Indexes",    "value":5,
      "metricHighLevelType":"Dynamic",    "metricValueUnit":"",    "metricType":"Housing"  },

  {   "mapName":"15Min Indexes",    "metricName":"Max Value",    "value":5,
    "metricHighLevelType":"Dynamic",   "metricValueUnit":"",    "metricType":"Fast Mobility"    },
  {    "mapName":"15Min Indexes",    "metricName":"Max Value", ................
..................

  {   "mapName":"15Min Indexes",   "metricName":"Suff. value",   "value":3,
    "metricHighLevelType":"Dynamic",   "metricValueUnit":"",   "metricType":"Health","   },
   ..................
]
return msg;
```

Aggregated by MetricType



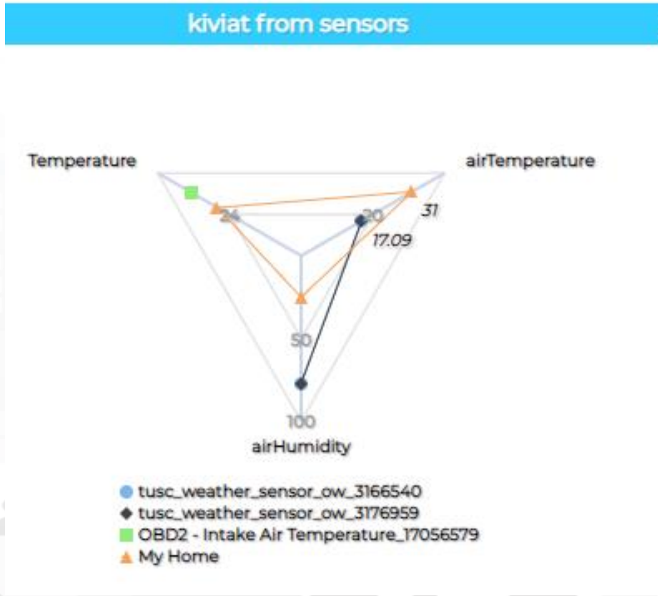
All dynamic in this case

Kiviat 2


```
msg.payload = [
{       "metricId": "http://www.disit.org/km4city/resource/tusc_weather_sensor_ow_3166540",
"metricHighLevelType": "Sensor",
"metricName": "tusc_weather_sensor_ow_3166540",
 "metricType": "airTemperature"
},
{       "metricId": "http://www.disit.org/km4city/resource/tusc_weather_sensor_ow_3166540",
"metricHighLevelType": "Sensor",        "metricName": "tusc_weather_sensor_ow_3166540",        "metricType":
"airHumidity"    },
 {       "metricId": "http://www.disit.org/km4city/resource/tusc_weather_sensor_ow_3176959",
"metricHighLevelType": "Sensor",        "metricName": "tusc_weather_sensor_ow_3176959",        "metricType":
"airHumidity"    },
{       "metricId": "http://www.disit.org/km4city/resource/tusc_weather_sensor_ow_3176959",
"metricHighLevelType": "Sensor",        "metricName": "tusc_weather_sensor_ow_3176959",        "metricType":
"airTemperature"    },
{       "metricId": "17056579",       "metricHighLevelType": "MyKPI",       "metricName": "OBD2 - Intake Air
Temperature",       "metricType": "Temperature"    },
{       "metricId": "",       "metricHighLevelType": "Dynamic",       "metricName": "My Home",       "metricType":
"airTemperature",       "metricValueUnit": "°C",       "measuredTime": "2019-11-21T14:51:00Z",       "value": 31
},
{       "metricId": "",       "metricHighLevelType": "Dynamic",       "metricName": "My Home",       "metricType":
"Temperature",       "metricValueUnit": "°C",       "measuredTime": "2019-11-21T14:51:00Z",       "value": 28     },
{       "metricId": "",       "metricHighLevelType": "Dynamic",       "metricName": "My Home",       "metricType":
"airHumidity",       "metricValueUnit": "%",       "measuredTime": "2019-11-21T14:51:00Z",       "value": 25     }]

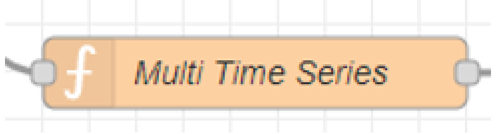
return msg;
```

Aggregated by MetricType

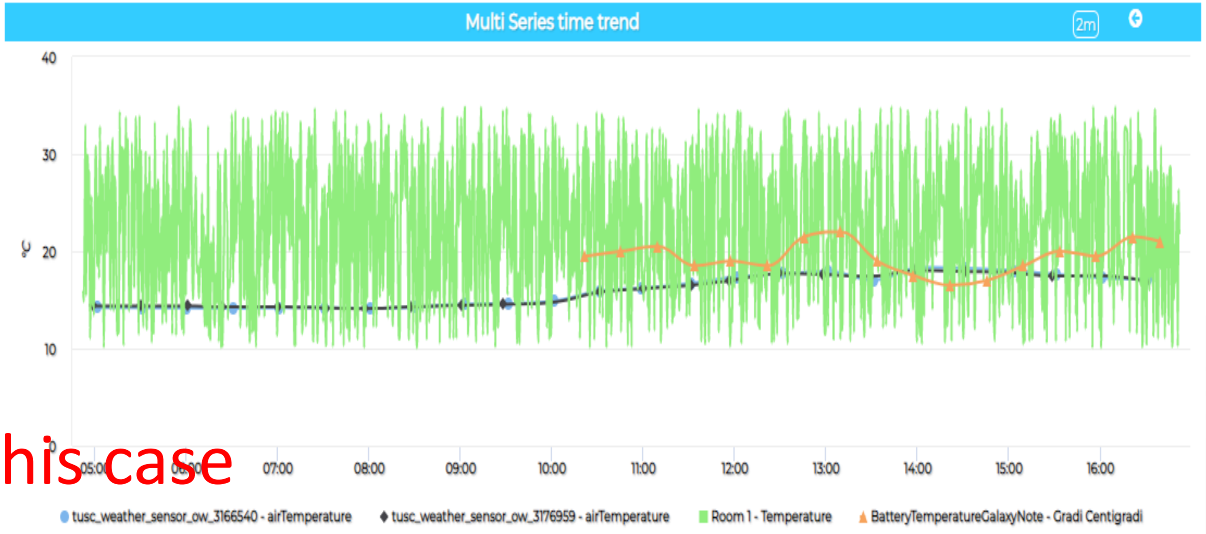


Sensors, MyKPI and dynamic in this case

Multi TimeSeries




```
var now = new Date();
var base =60*60*100;
msg.payload =[
  { "serviceUri":"http://www.disit.org/km4city/resource/tusc_weather_sensor_ow_3166540",
    "metricHighLevelType":"Sensor",     "metricName":"tusc_weather_sensor_ow_3166540",
    "smField":"airTemperature" // as MetricType
  },
  {  "serviceUri":"http://www.disit.org/km4city/resource/tusc_weather_sensor_ow_3176959",
    "metricHighLevelType":"Sensor",     "metricName":"tusc_weather_sensor_ow_3176959",
    "smField":"airTemperature"
  },
  {  "serviceUri":"17057458",     "metricHighLevelType":"MyKPI",     "metricName":"Room 1",      "metricType":"Temperature"   },
  {    "metricId":"",     "metricHighLevelType":"Dynamic",      "metricName":"BatteryTemperatureGalaxyNote",     "smField":"Gradi Centigradi",
    "metricValueUnit":"°C",
    "values":[
        [now-64*base, 19.5],   [now-60*base, 20.0],    [now-56*base, 20.5],
        [now-52*base, 18.5], [now-48*base, 19], [now-44*base, 18.5],
        [now-40*base, 21.5],   [now-36*base, 22.0],    [now-32*base, 19],
        [now-28*base, 17.5],  [now-24*base, 16.5],  [now-20*base, 17.0],
        [now-16*base, 18.5],   [now-12*base, 20.0],    [now-8*base, 19.5],
       [now-4*base, 21.5],    [now-1*base, 21]
         ]
  }
]
return msg;
```



Sensors, MyKPI and dynamic in this case

Multi Series without Time

- multi series with ordinal data

{ "metricId":"", "metricHighLevelType":"**Dynamic**", "metricName":"BatteryTemperatureGalaxyNote", "smField":"Gradi Centigradi",

"metricValueUnit":"°C",

"values":[

[1, 19.5], [2, 20.0], [3, 20.5],

[4, 8.5], [5, 19], [6, 18.5],

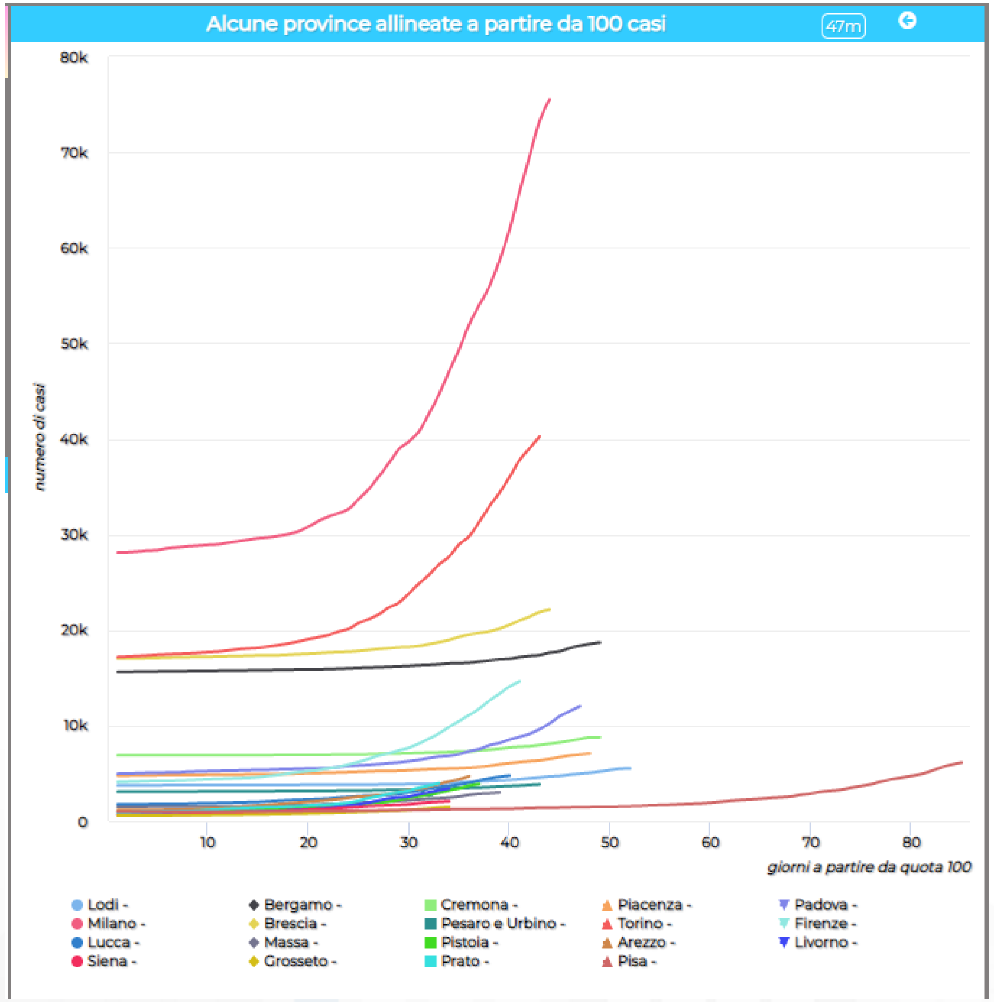
....

[50,5], [51, 21]

]

}

- You can set Staked via MoreOption



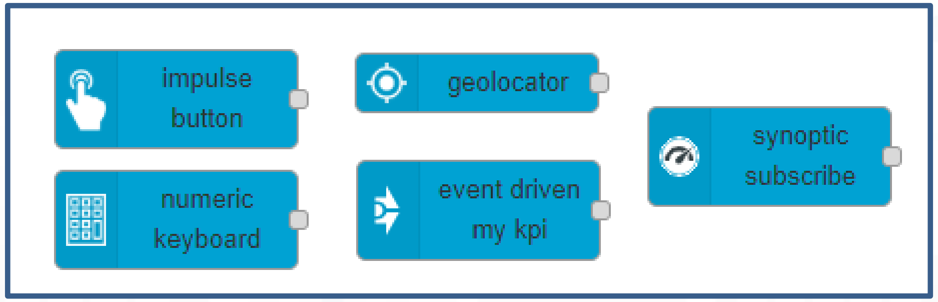
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjU3NQ==

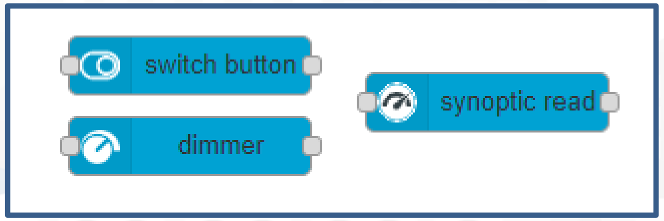
TOP

IOT Application stressing Virtual Sensors Actuators concepts

Advanced Feature of Snap4City Dash Widgets

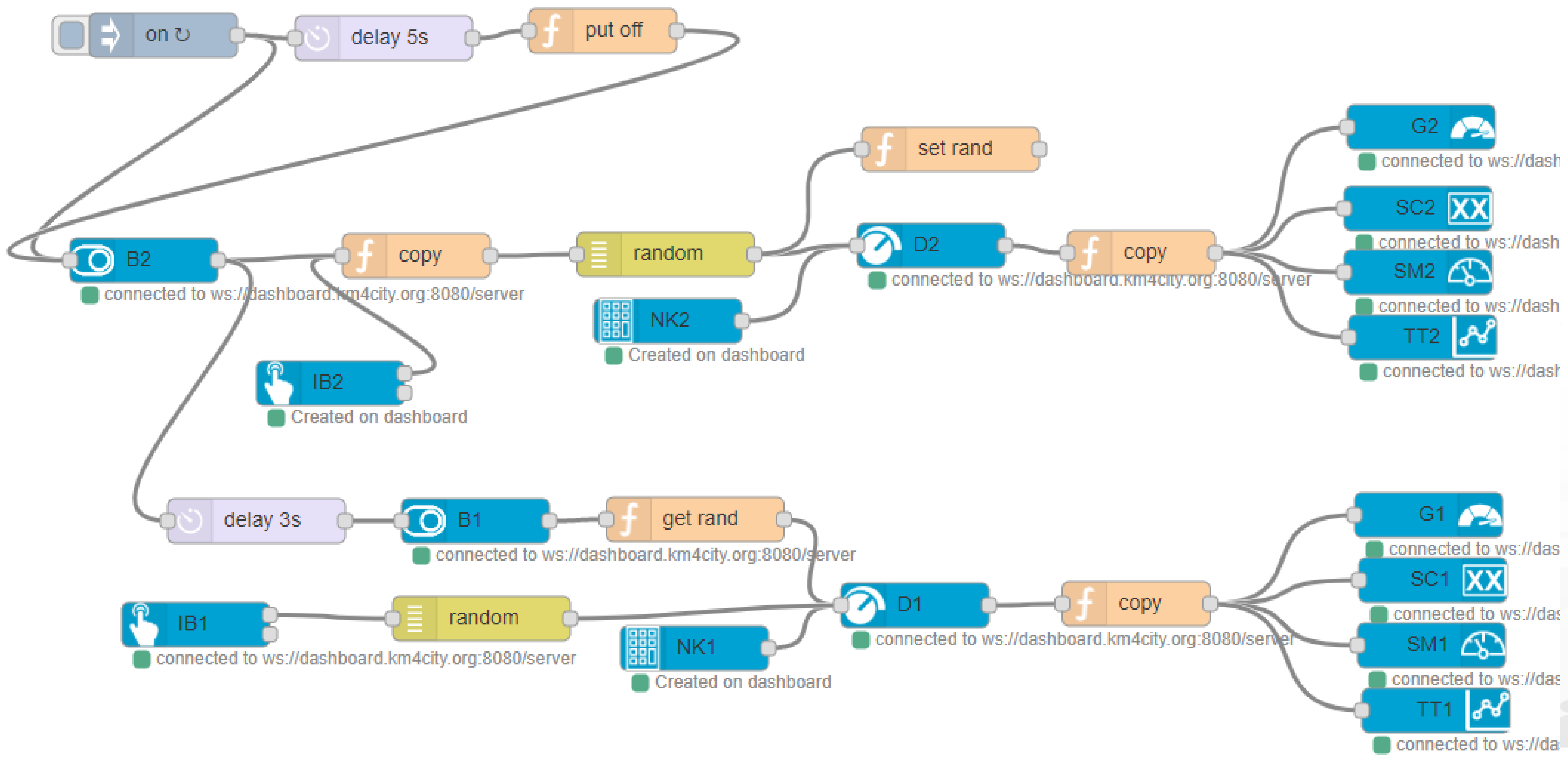
- Dashboard widgets can be classified in:
  - **Virtual Sensors**
    - Those that produce the data
      From IOT App on Dashboard
  - **Virtual Actuators**
    - Those that produce the data
      From Dashboard to IOT App
  - **Virtual Sensors Actuators**
    - Those that produce/receive the data
      From/to Dashboard to/from IOT App



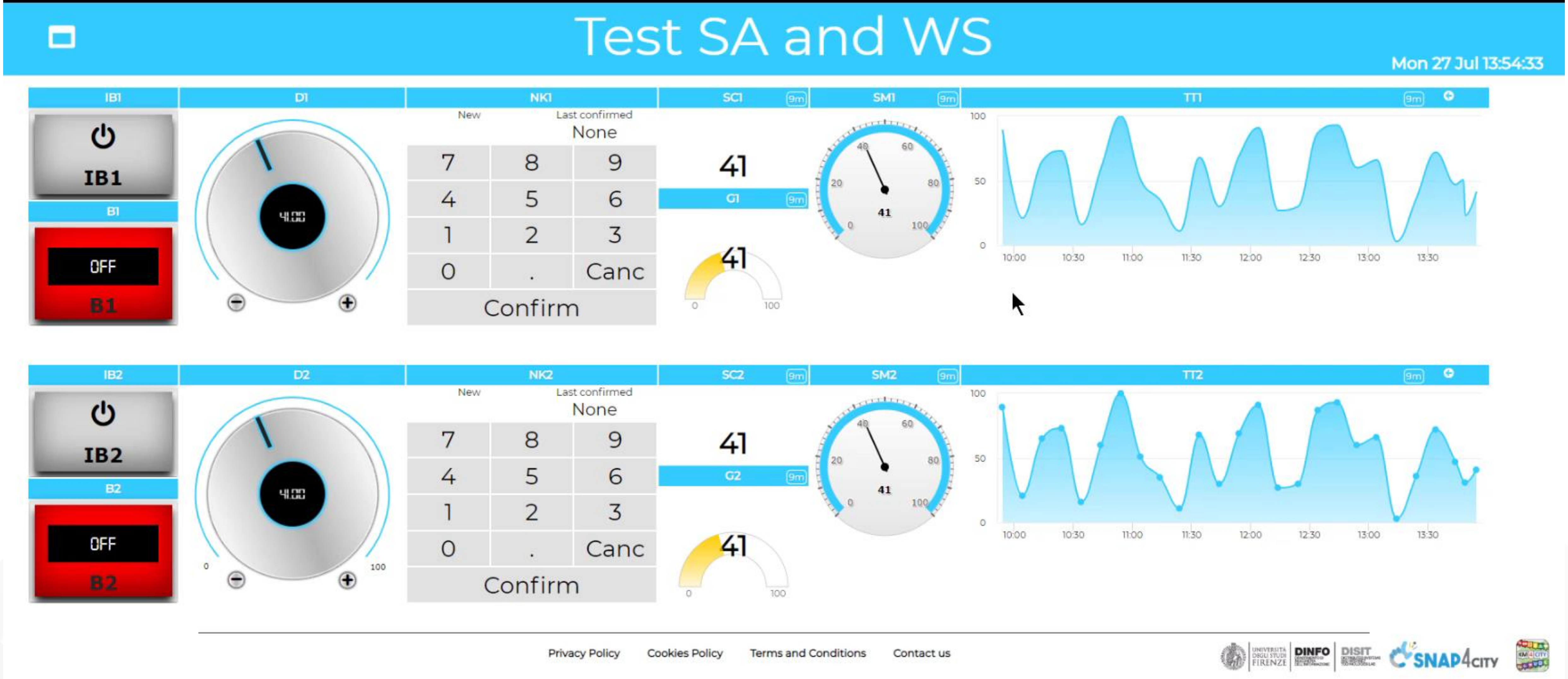


[TC9.18: Advanced Features of Sensors Actuators of Dashboards vs IOT App]

Sensors Actuators Allow to change the set up

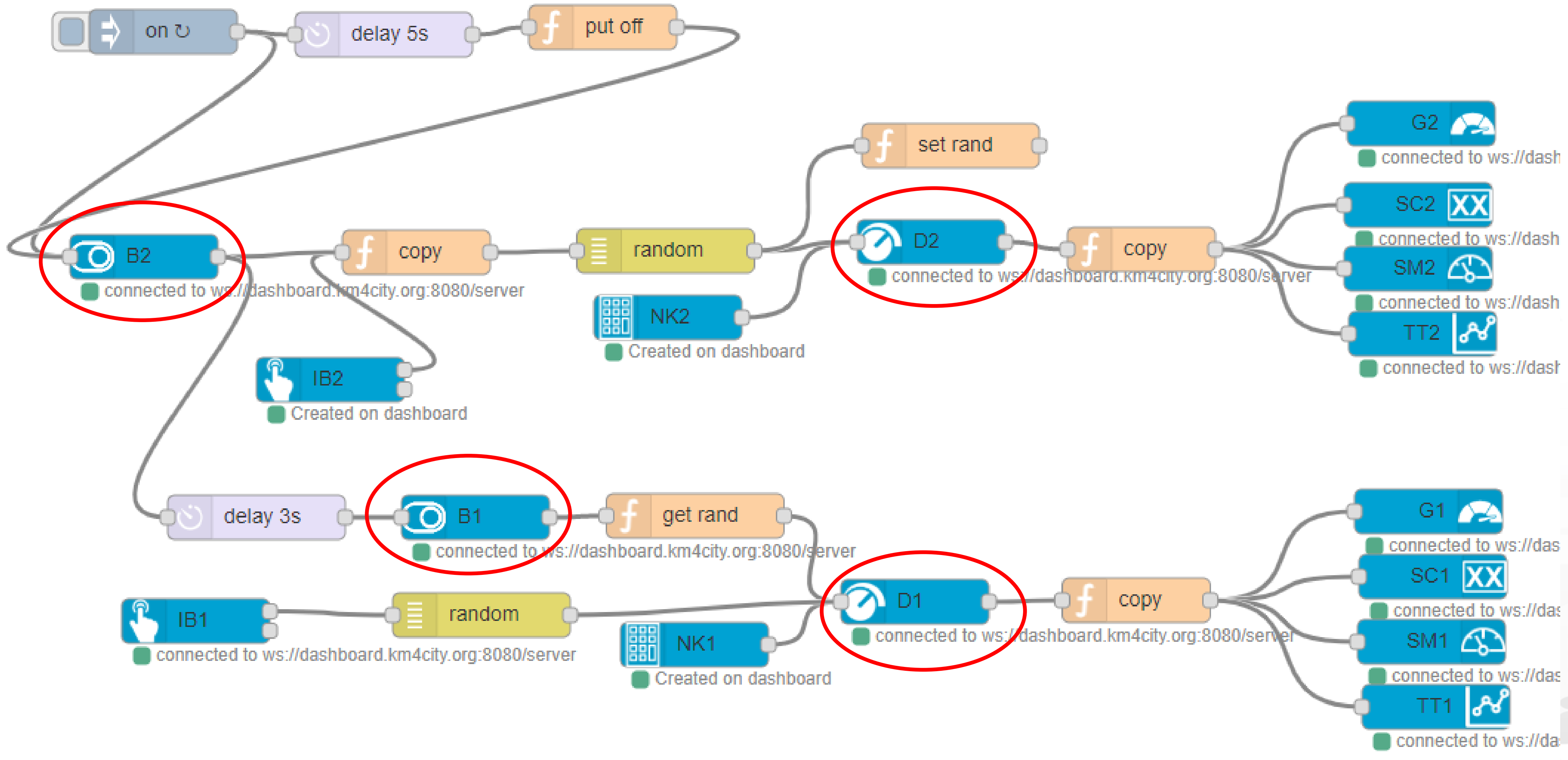


The SATEST Dash



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjc2NA==

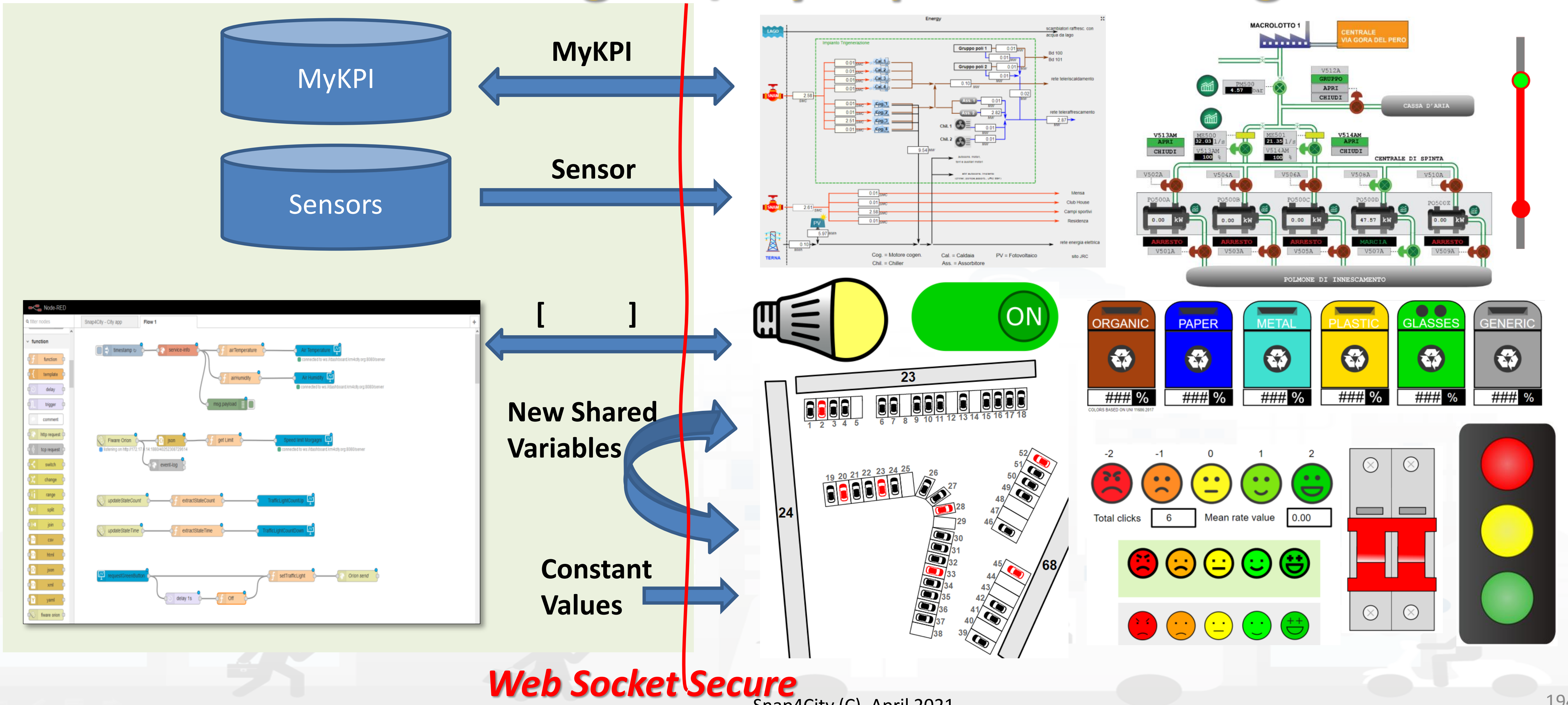
Sensors Actuators Allow to change the set up

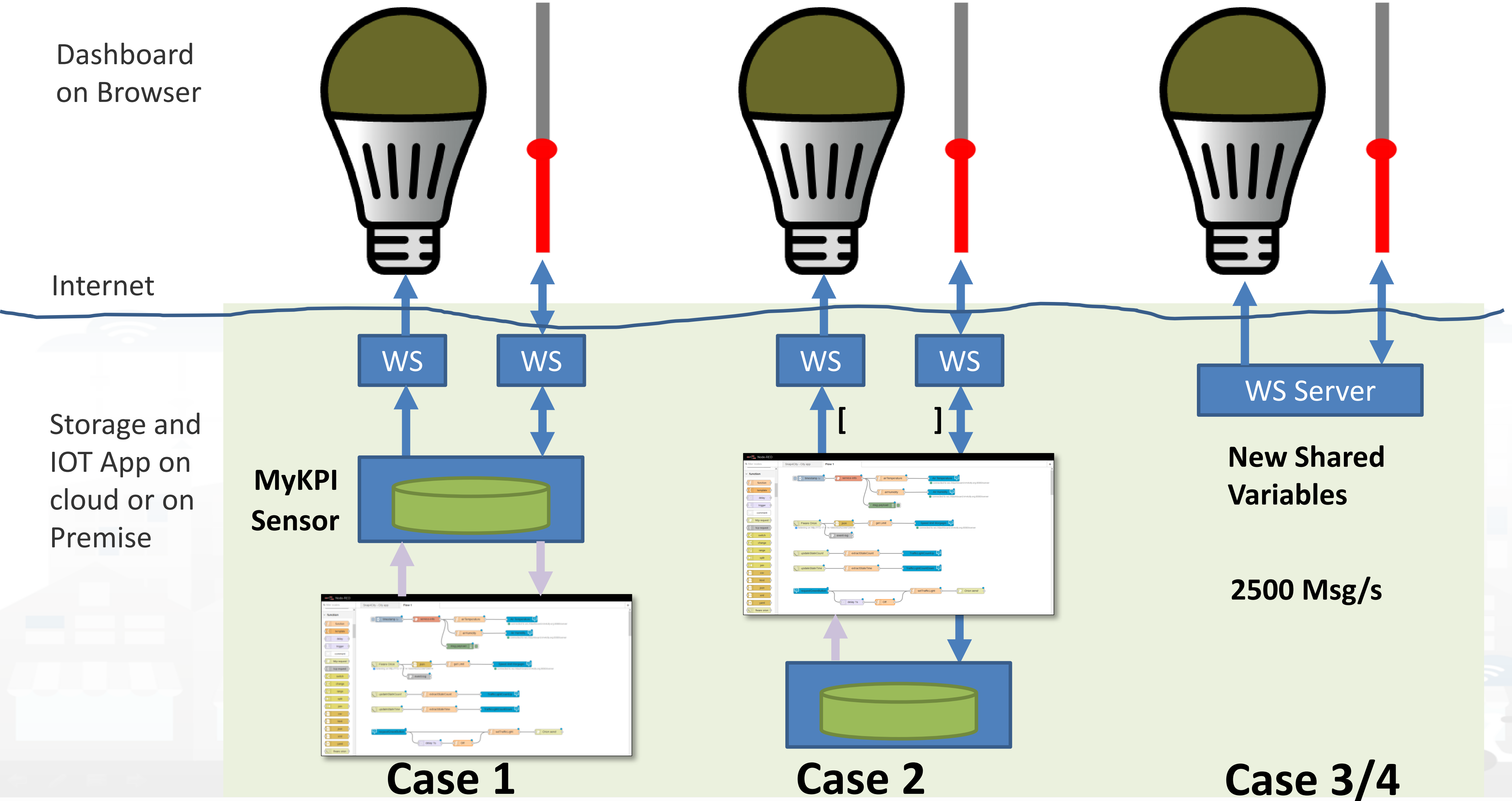


TOP

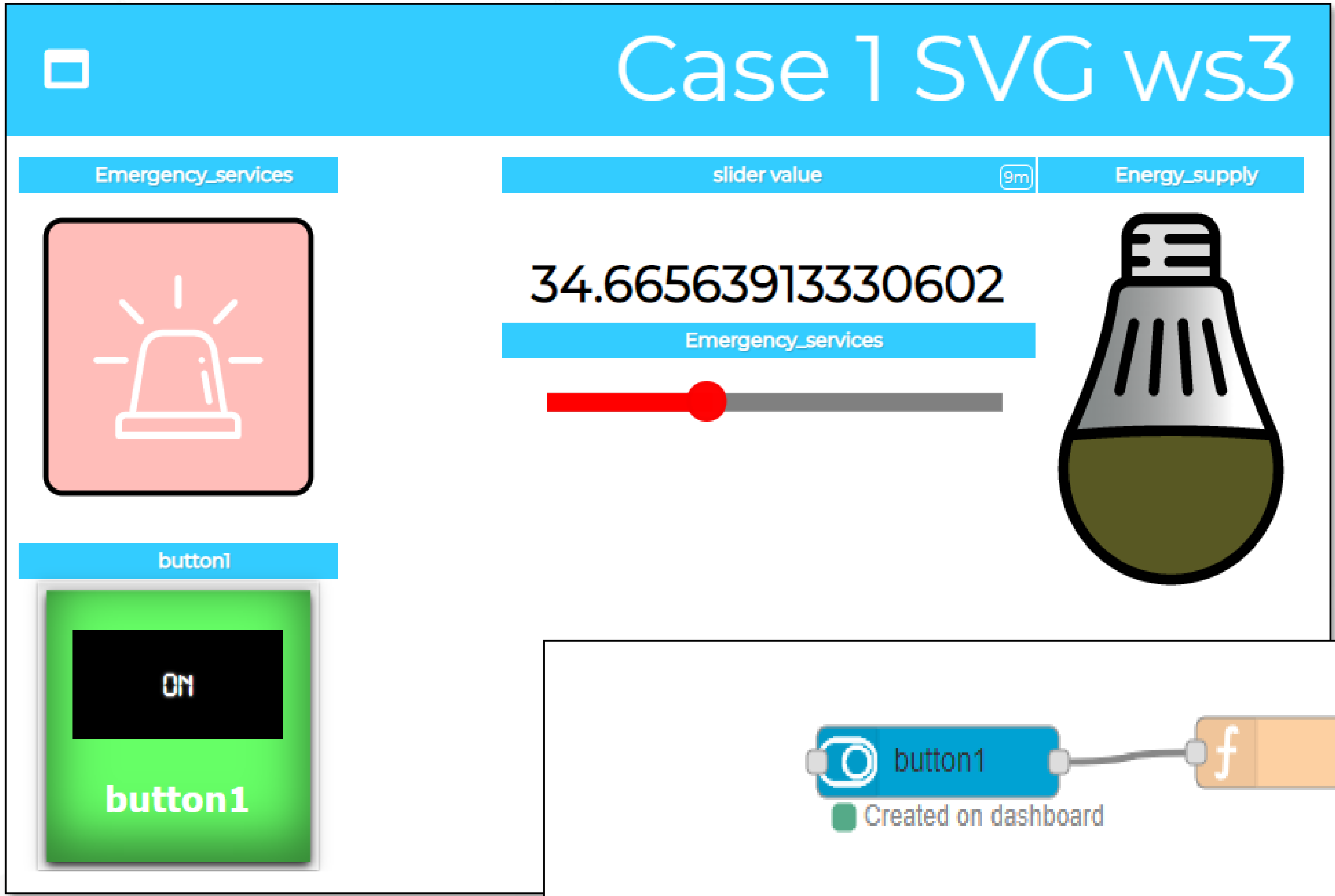
IOT Application Integration with Synoptics

From-To Custom Widgets / Synoptics to Storage in WS



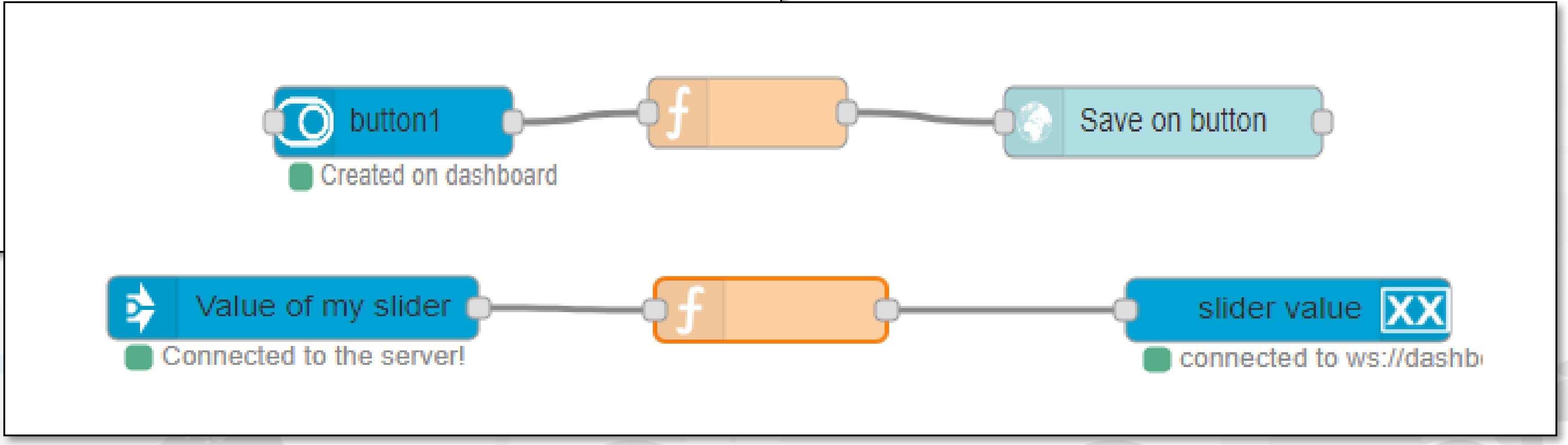

Dashboard
on Browser
Internet
Storage and
IOT App on
cloud or on
Premise
WS
WS
MyKPI
Sensor
WS
WS
[
]
WS Server
New Shared
Variables
2500 Msg/s
Case 1
Case 2
Case 3/4

Case 1

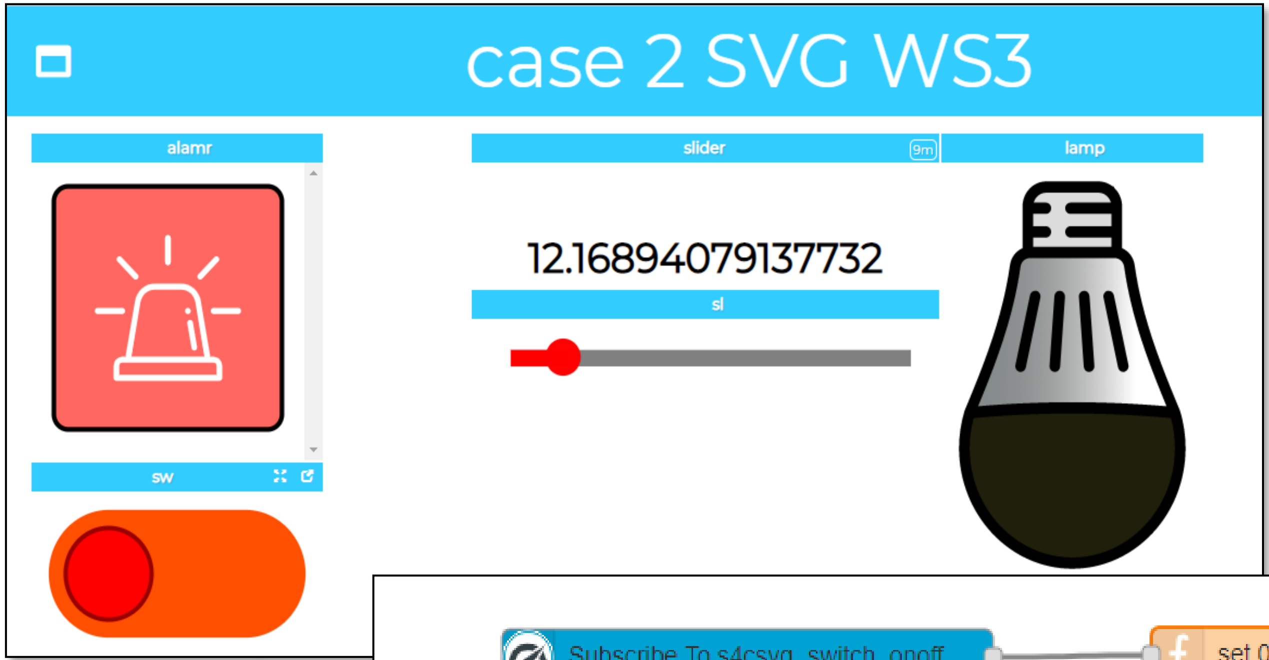


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjc4NA==

10 WS messages per second

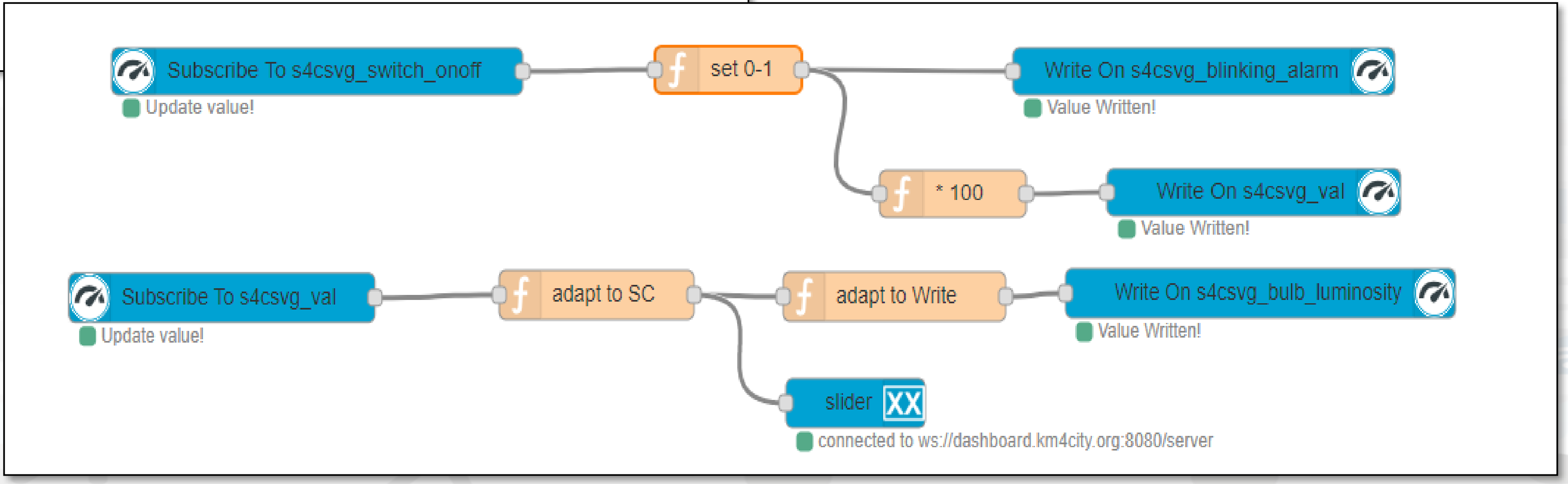


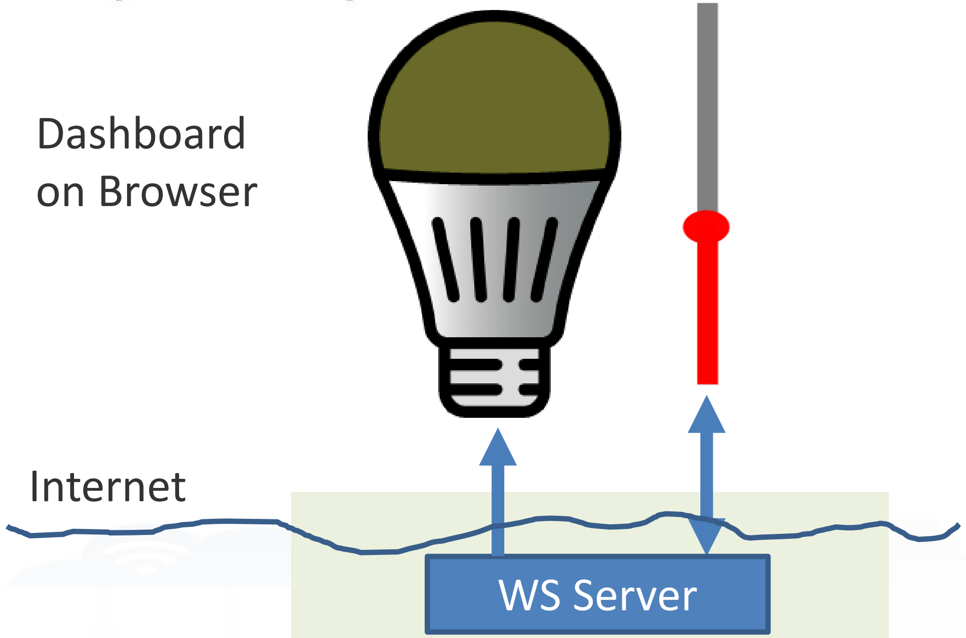
Case 2: Event Driven 100%



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjc4NQ==

40 messages per second



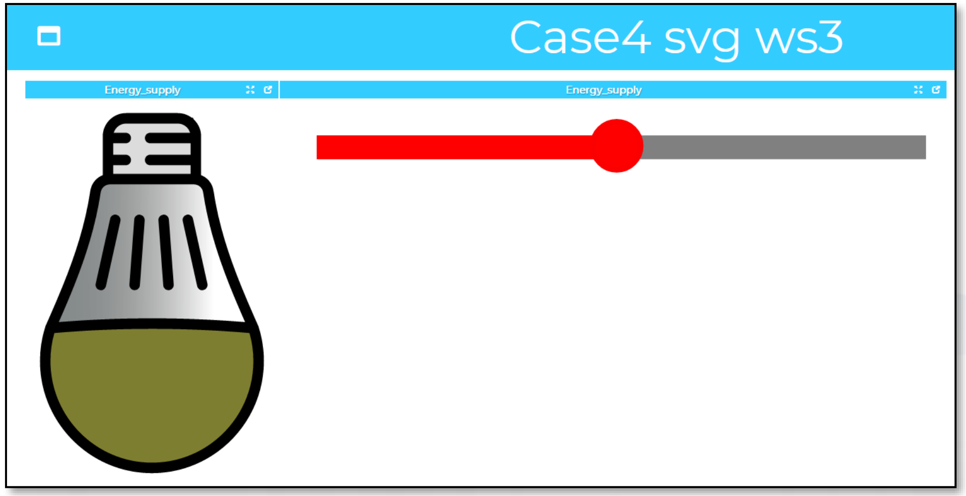


WS Server
on cloud or
on Premise

New Shared Variables

2500 Msg/s

Case 3/4



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjgyNg==

Read more on

- TC9.19: Custom Widgets / Synoptics controlled by IOT Applications
- Custom Synoptics and Widgets for Dashboards
- Scenario: 5G Enabled Water Cleaning Control
- Snap4Industry: Snap4City for Industry 4.0
- TC1.22: Create and configure a Snap4City SVG Custom Widget for real-time interaction

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DEMO Section 2

TOP

Demo IOT Application exploiting Snap4City Dashboard

Example of complex IOT Application

In this demo let's create an IoT Application that:

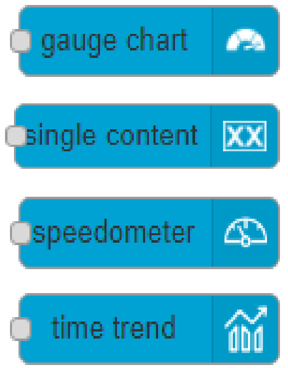
- send random values on Snap4city's Dashboard
- create complex widget based on MyKPI e SURI

Nodes for flow

Generates an input for the other nodes. It can be repeated at predefined intervals, entered manually and of various types (timestamp, string, number, boolean, JSONetc)

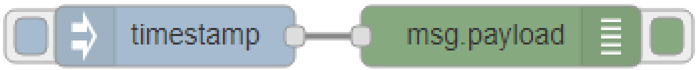
Each message that enters the debug node is shown in the "debug" tab on the right of nodered (you can choose which part of the message to show)

Generates a random number. You can configure the number generation interval and the type (integer or float).

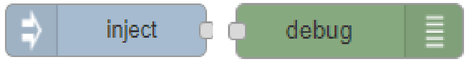


Display values in different modes on a dashboard. The node called single content accepts strings, numbers and html. The others only accept numbers.

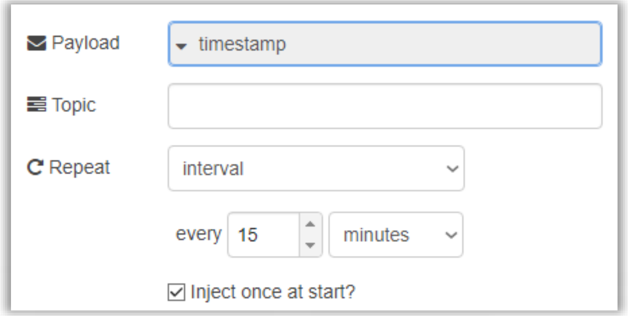
Step 1



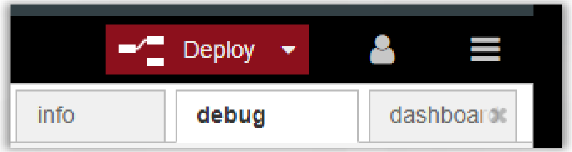
- Inject and Debug



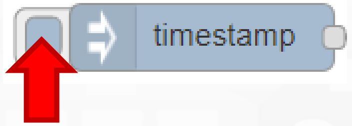
- Connect



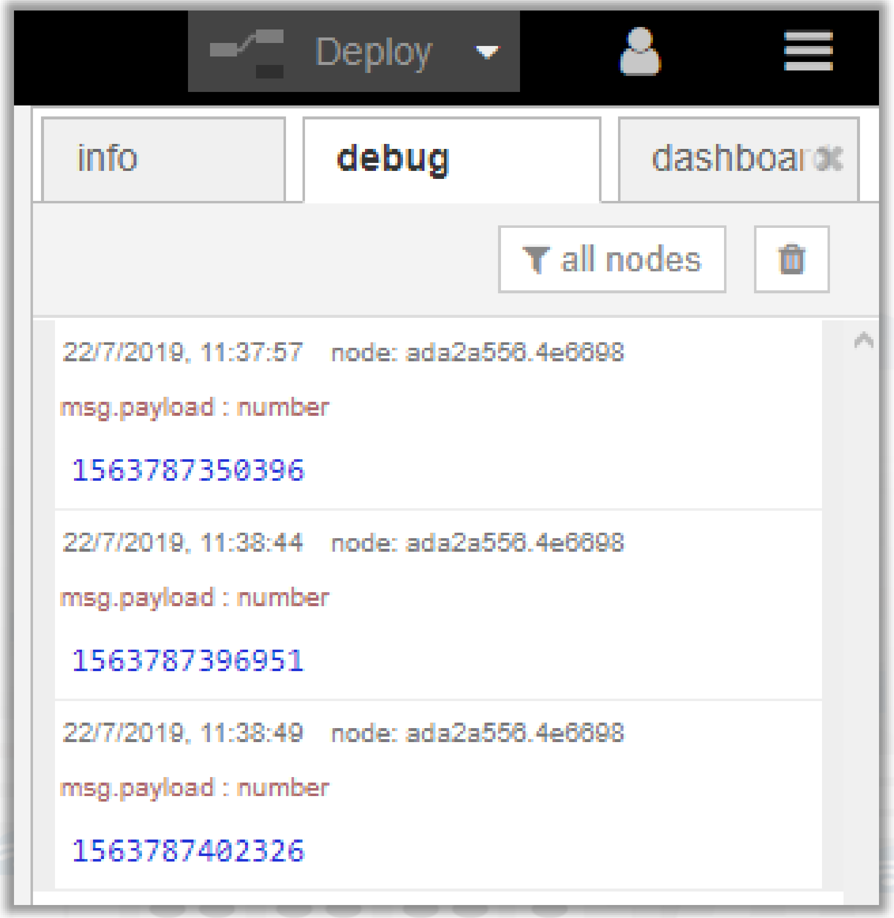
- Configure
- Deploy



- Click



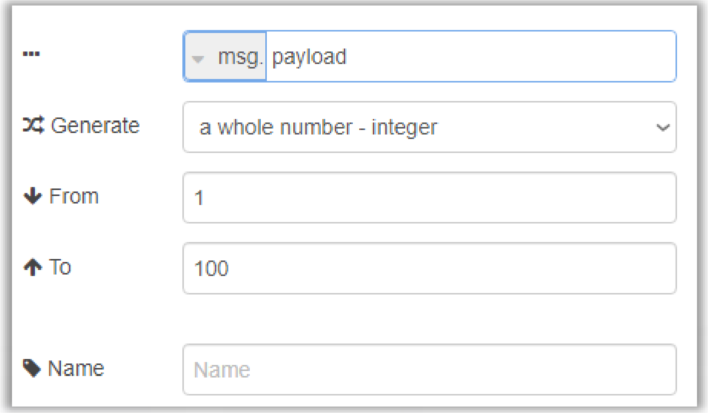
- Observe



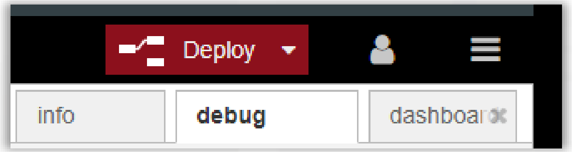
Step 2

- Random

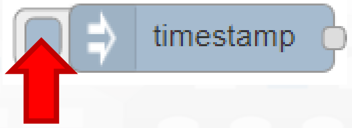
- Connect
- Configure



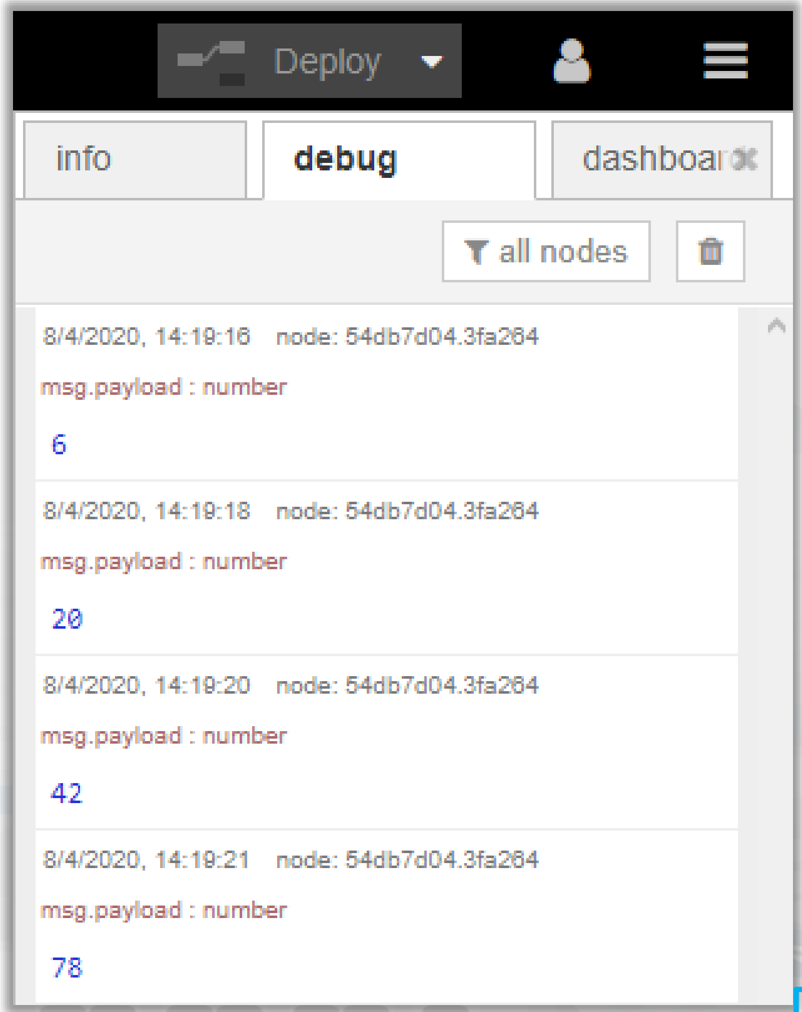
- Deploy



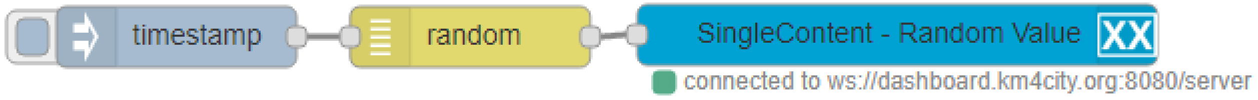
- Click



- Observe

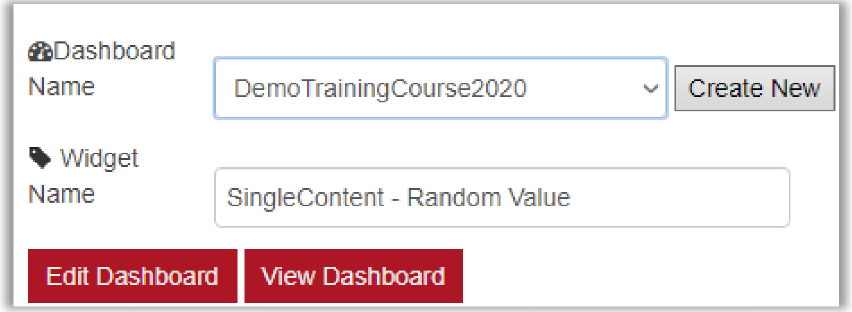


Step 3

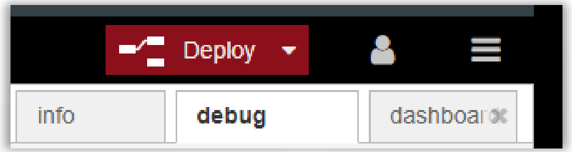


- Single content

- Connect
- Configure



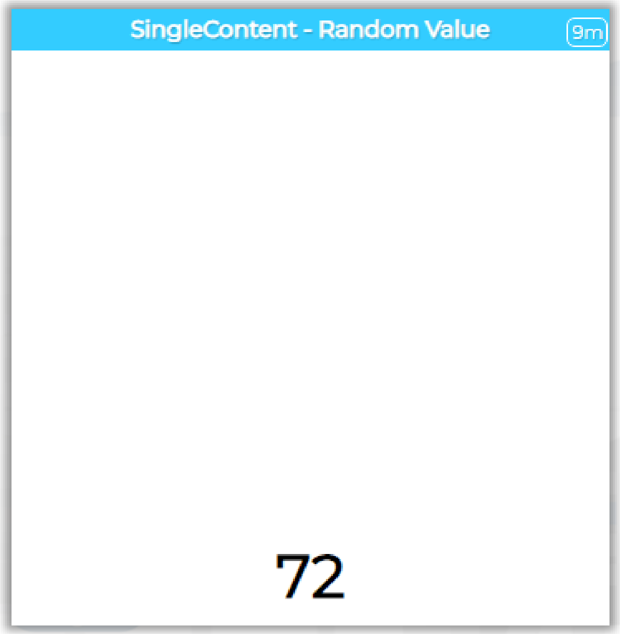
- Deploy



- Click

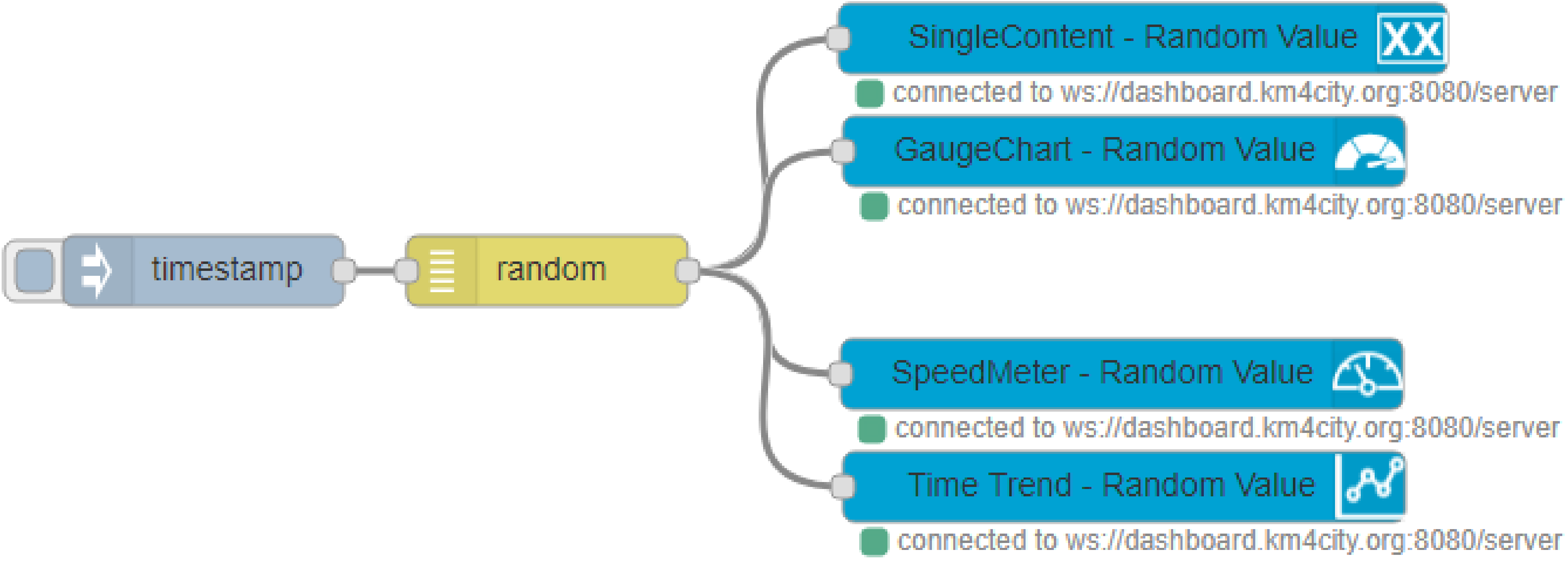
Click

- Observe



Nodes configuration

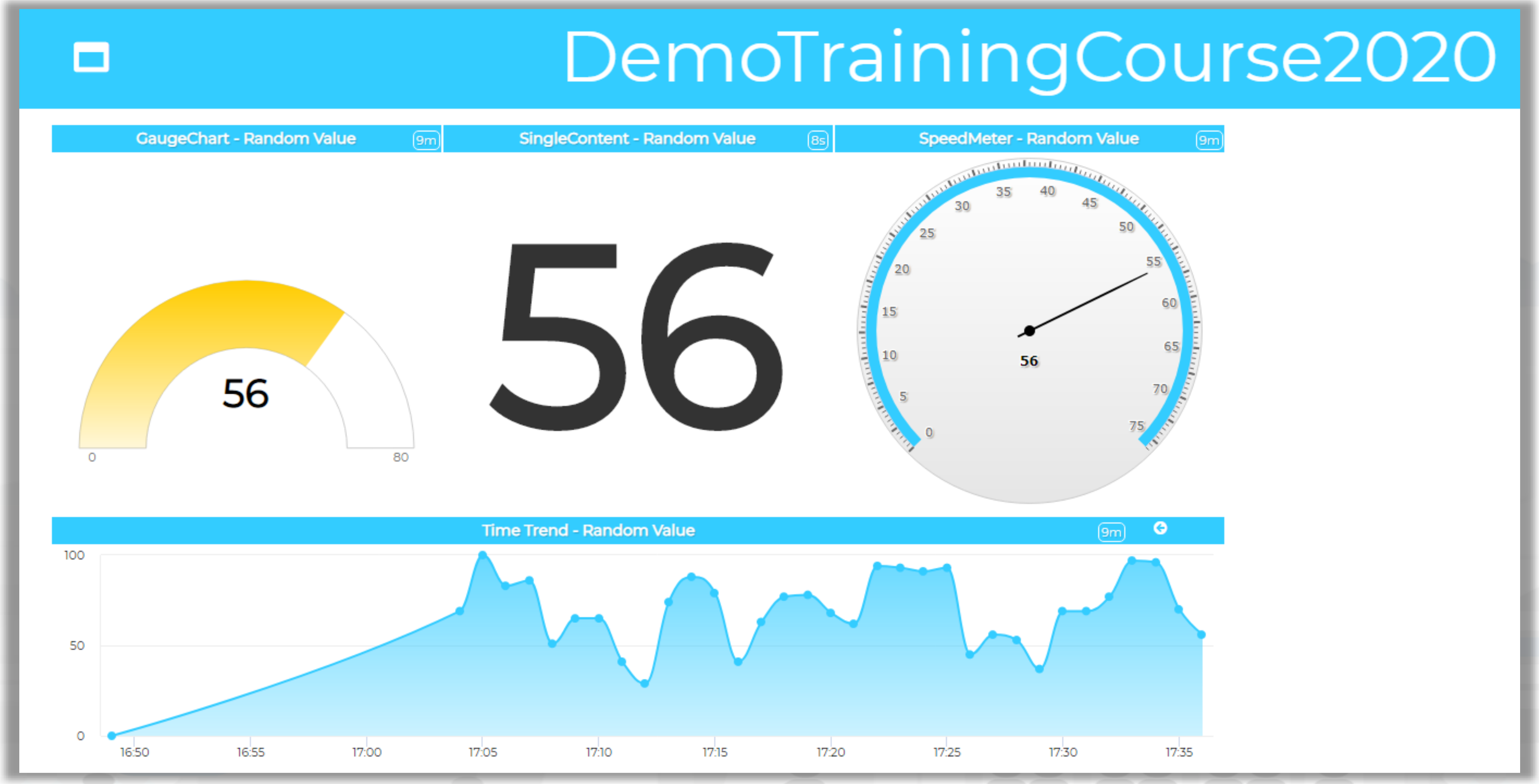
Nodes connections



Explaining: IOT Application Flow

- On Click or Every 15 minutes the ***timestamp*** node sends a message to the ***random*** node.
- When the message arrives, the ***random*** node generates a random number as output message.
- The Number can be sent to Different kinds of nodes to show it on NodeRed Dashboard.

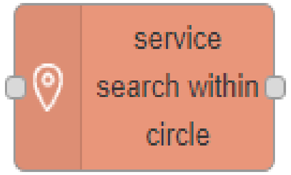
Resulting Dashboard



Nodes for flow

Generates an input for the other nodes. It can be repeated at predefined intervals, entered manually and of various types (timestamp, string, number, boolean, JSONetc)

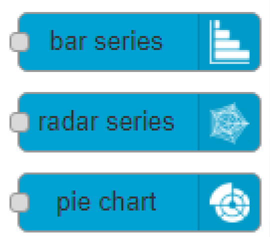
Each message that enters the debug node is shown in the "debug" tab on the right of nodered (you can choose which part of the message to show)



Search in around a certain point of the indicated service. It returns:

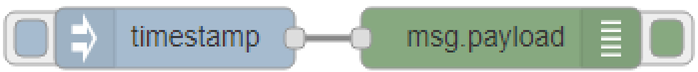
- servicesUri of all the services found,
- a GeoJSON containing a minimum of information about the services found, including the coordinates and the name of the service.

Retrieve the information about My KPIData saved on the Snap4city platform

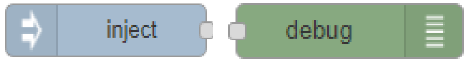


Display values in different modes on a dashboard. Check info of the node in the Node-RED tab.

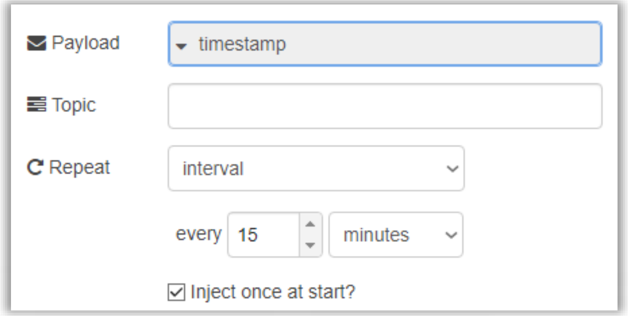
Step 1



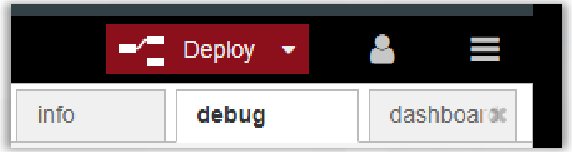
- Inject and Debug



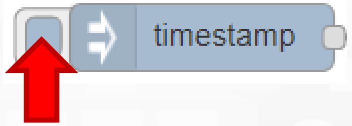
- Connect
- Configure



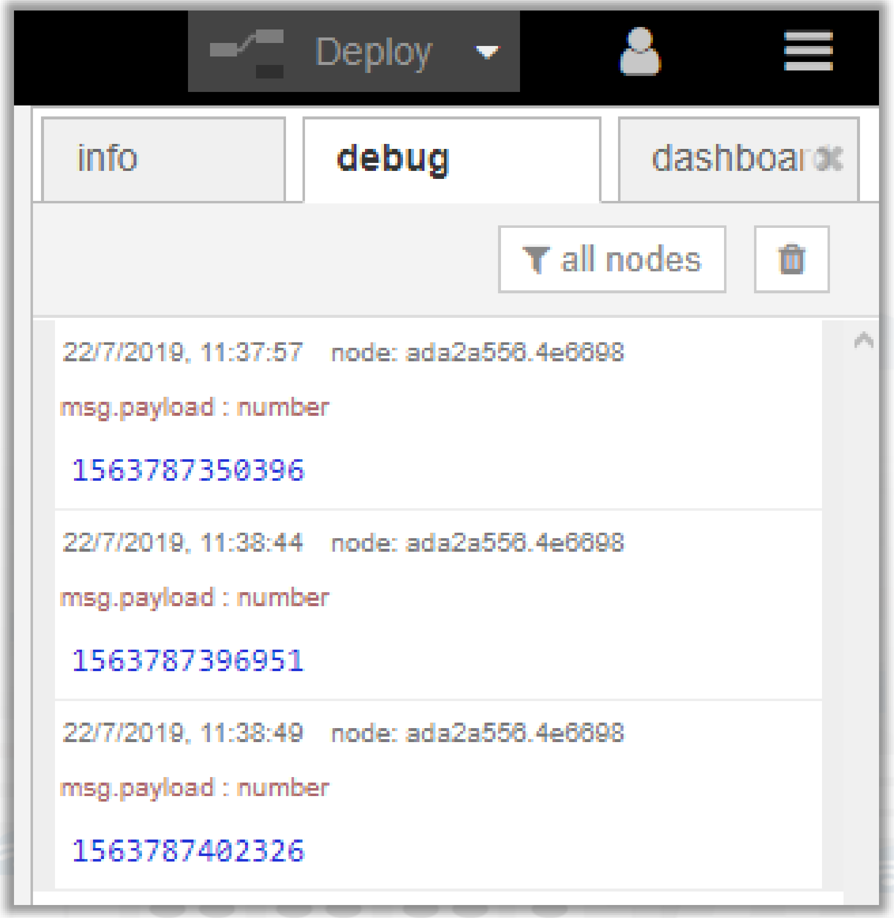
- Deploy



- Click

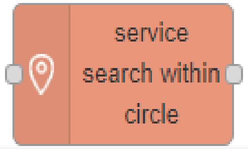


- Observe

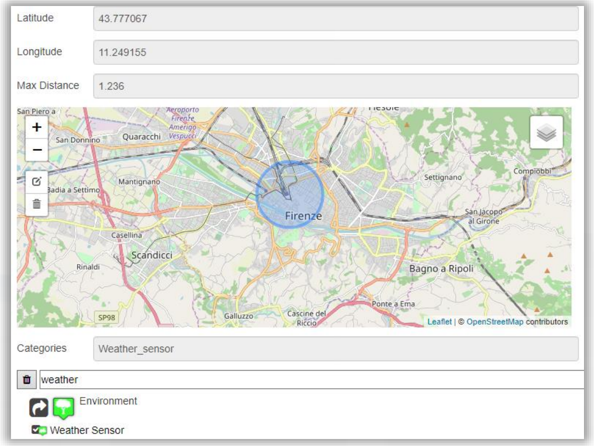


Step 2

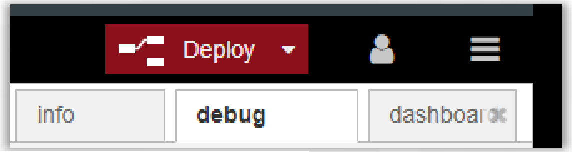
- Service Search Within Circle



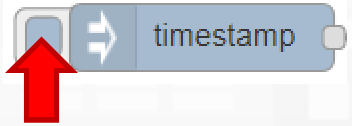
- Connect
- Configure



- Deploy



- Click

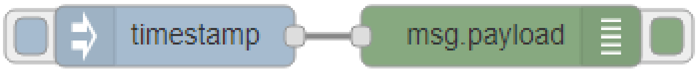


- Observe

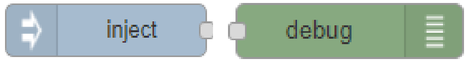
Copy the path

Copy the value

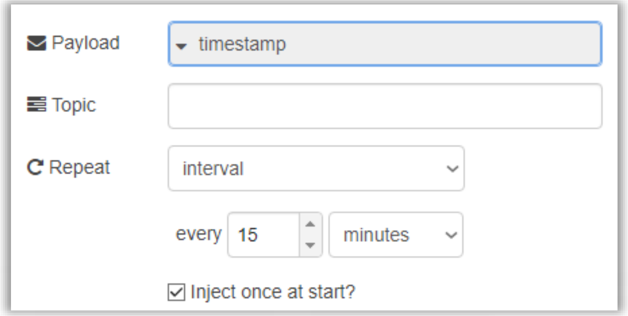
Step 1 Bis



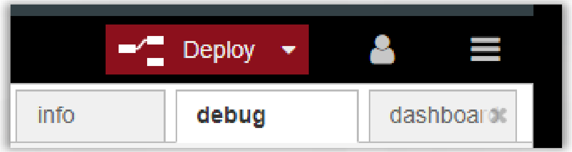
- Inject and Debug



- Connect
- Configure

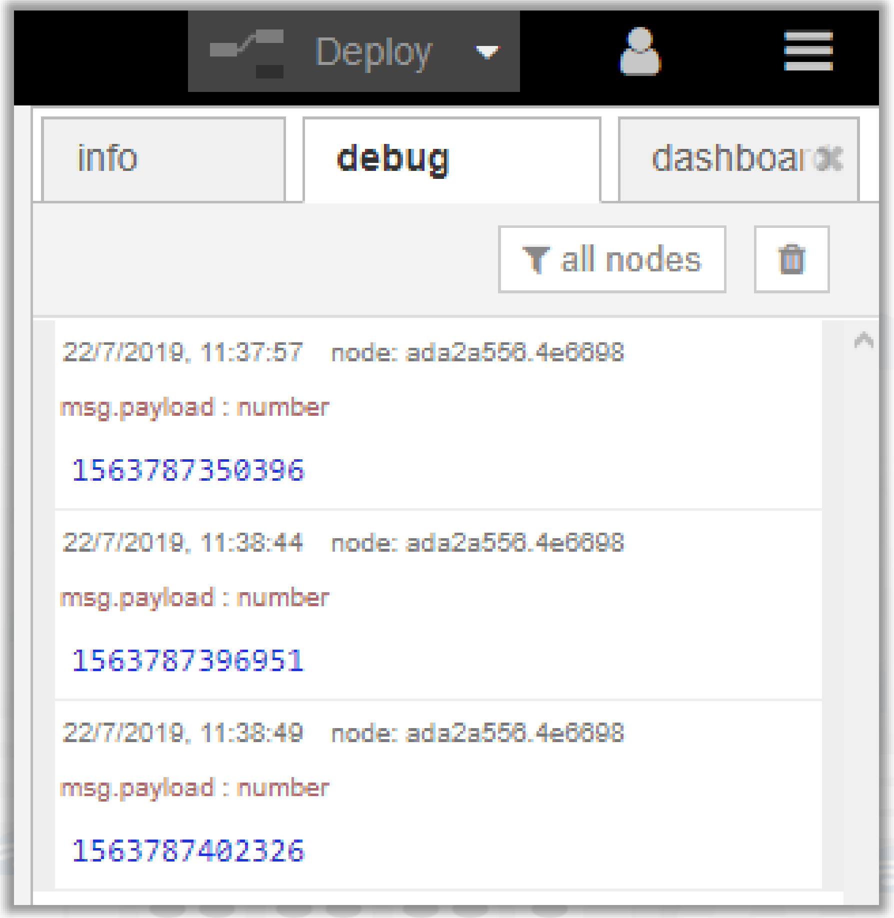


- Deploy

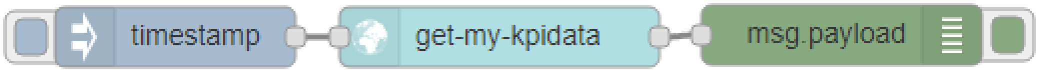


- Click

- Observe

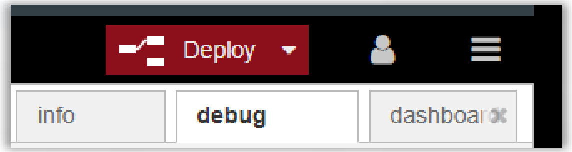


Step 2 Bis

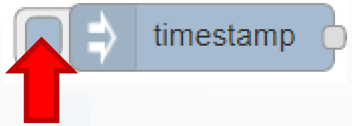


- Get My KPIData

- Connect
- Deploy



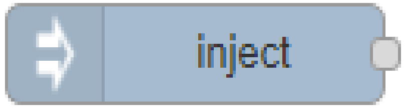
- Click

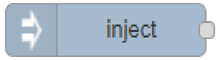


- Observe

id: 17057458
description: ""
healthiness: "false"
highLevelType: "MyKPI"
info: ""
insertTime: 1586359858000
valueName: "Room 1"
lastDate: 1586359858000
lastValue: "0.054644625420117166"
latitude: ""
longitude: ""
valueType: "Temperature"
valueUnit: "°C"
nature: "Environment"
organizations: "[ou=DISIT,dc=ldap,dc=disit,dc
ownership: "private"
subNature: "Weather_sensor"
dataType: "float"
username: "badii"
[40 … 40]
40: object
id: 17057459
description: ""
healthiness: "false"
highLevelType: "MyKPI"
info: ""
insertTime: 1586359858000
valueName: "Room 2"
lastDate: 1586359858000
lastValue: "1.3839476707239307"

Step 3



- Inject Node 

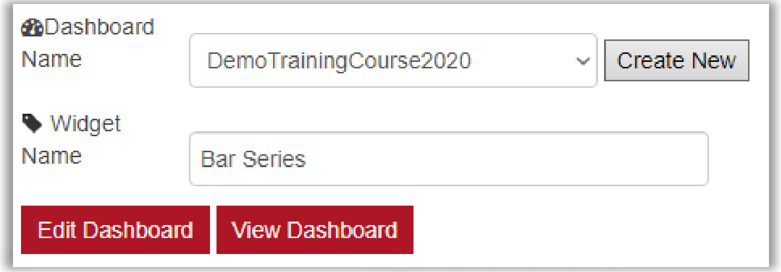
- Configure with data of Weather Sensors and MyKPI retrieved at the previous steps


```
[
    {
        "metricId": "http://www.disit.org/km4city/resource/tusc_weather_sensor_ow_3166540",
        "metricHighLevelType": "Sensor",
        "metricName": "tusc_weather_sensor_ow_3166540",
        "metricType": "airTemperature"
    },
    {
        "metricId": "http://www.disit.org/km4city/resource/tusc_weather_sensor_ow_3182522",
        "metricHighLevelType": "Sensor",
        "metricName": "tusc_weather_sensor_ow_3182522",
        "metricType": "airTemperature"
    },
    {
        "metricId": "17057458",
        "metricHighLevelType": "MyKPI",
        "metricName": "Room 1",
        "metricType": "Temperature"
    },
    {
        "metricId": "17057459",
        "metricHighLevelType": "MyKPI",
        "metricName": "Room 2",
        "metricType": "Room Temperature"
    }
]
```

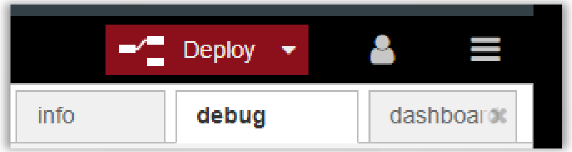
Step 4

- Bar Series 

- Connect
- Configure

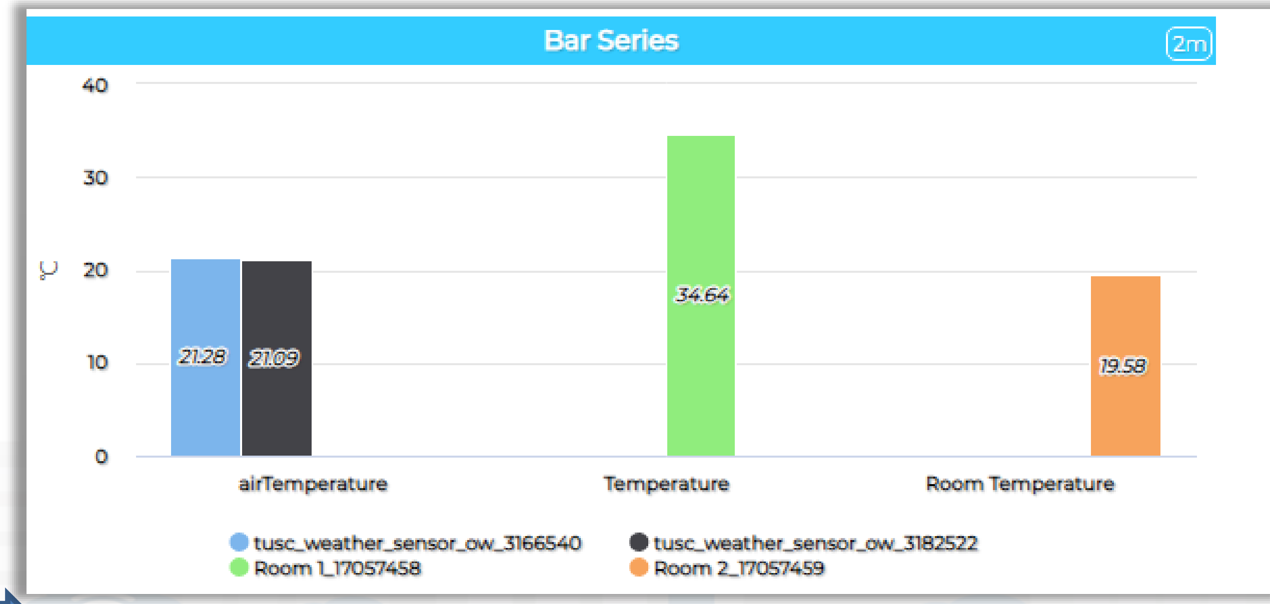


- Deploy

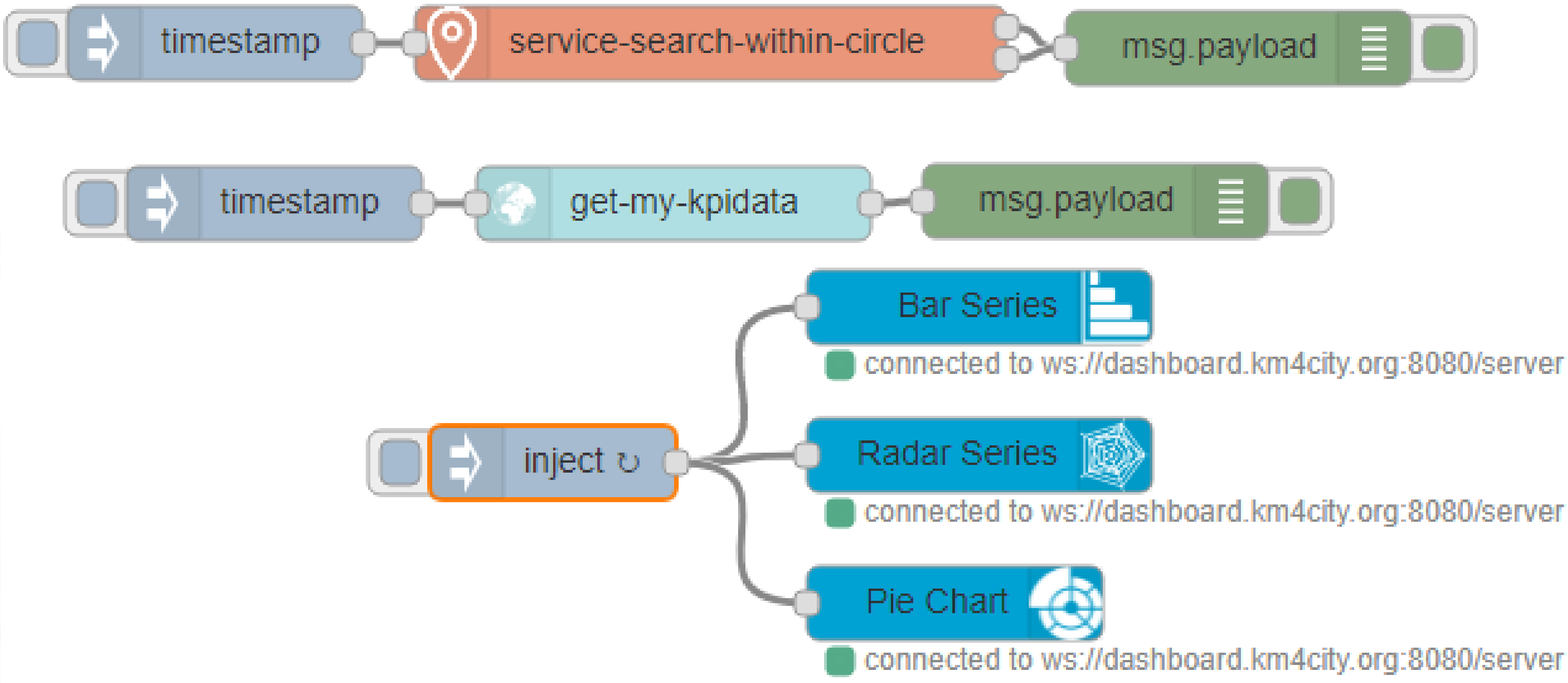


- Click

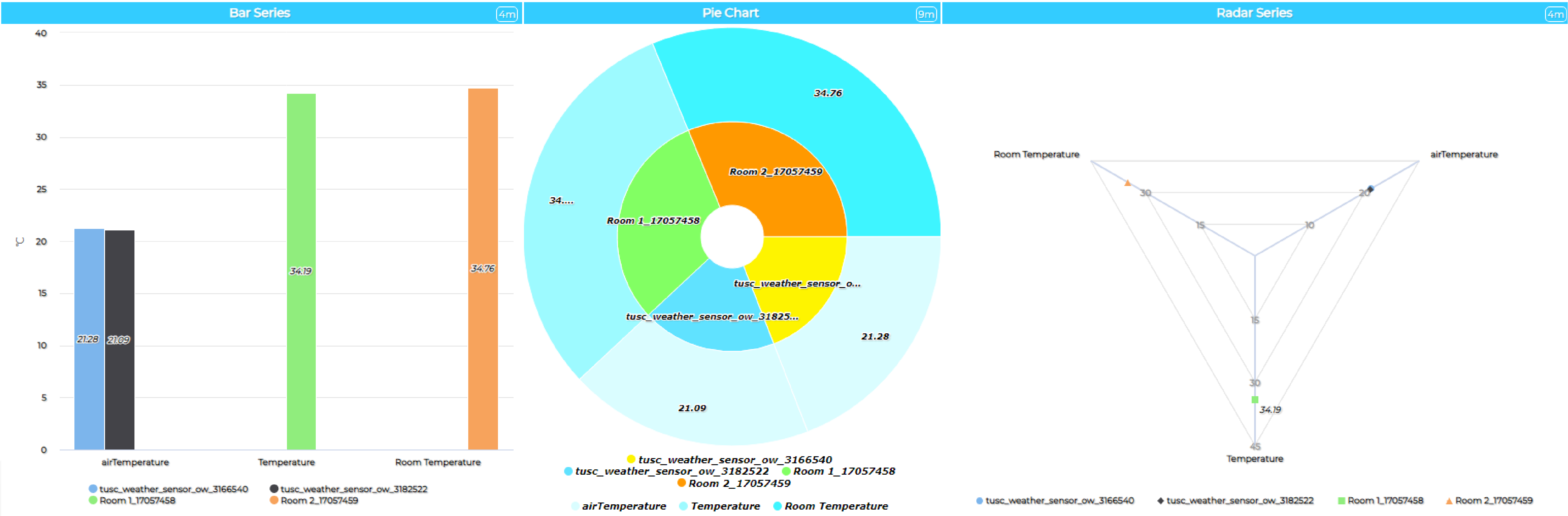
- Observe



Nodes connections



Resulting Dashboard



end DEMO Section 2

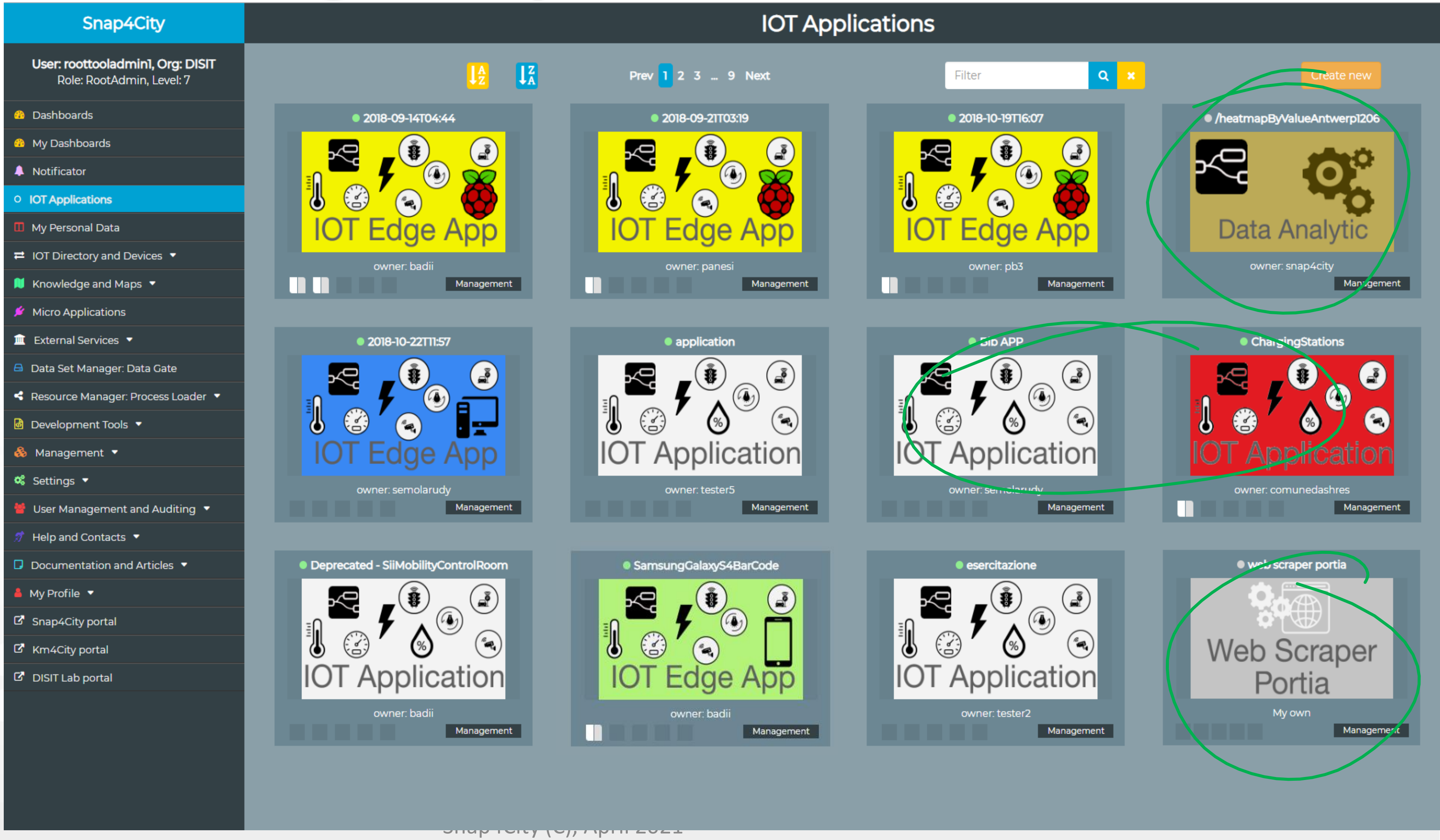
TOP

IOT App = Node-RED + Snap4City

Data Analytics and WebScraping

IOT Application Listing, they can be

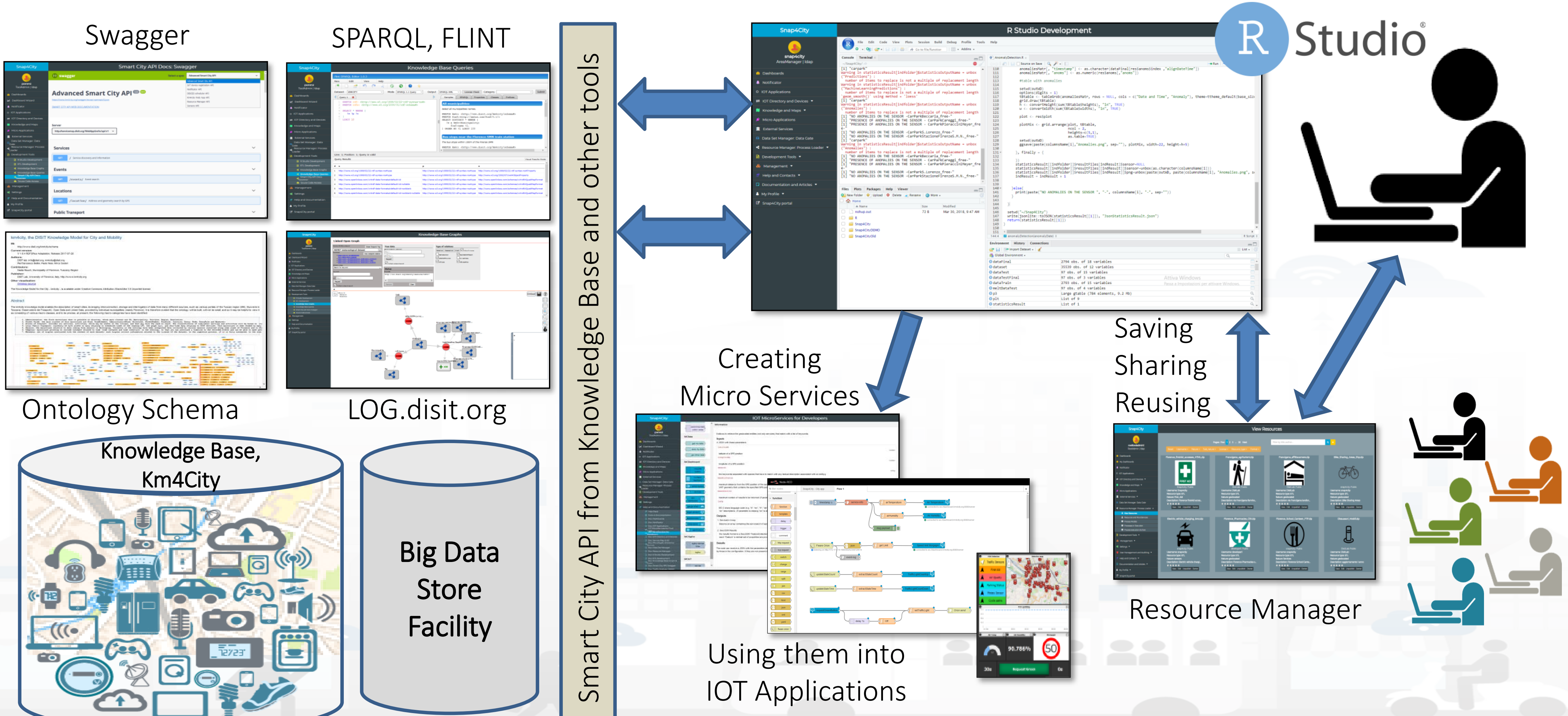
- Basic (white)
- Advanced (red)
- IOT Edge
  - Raspberry Pi
  - Android
  - Win/Linux
- Data Analytic (Plumber)
- Web Scraper (Portia)



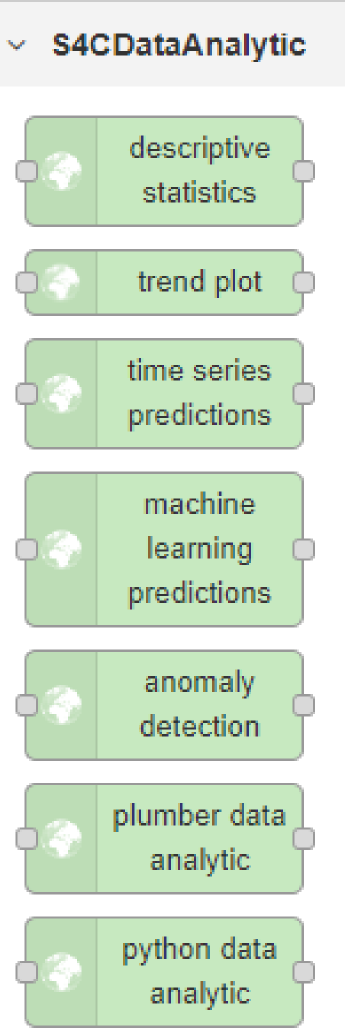
TOP

IOT App vs Data Analytics in R-Studio

Data Analytics Dev. in R Studio and/or Tensor Flow



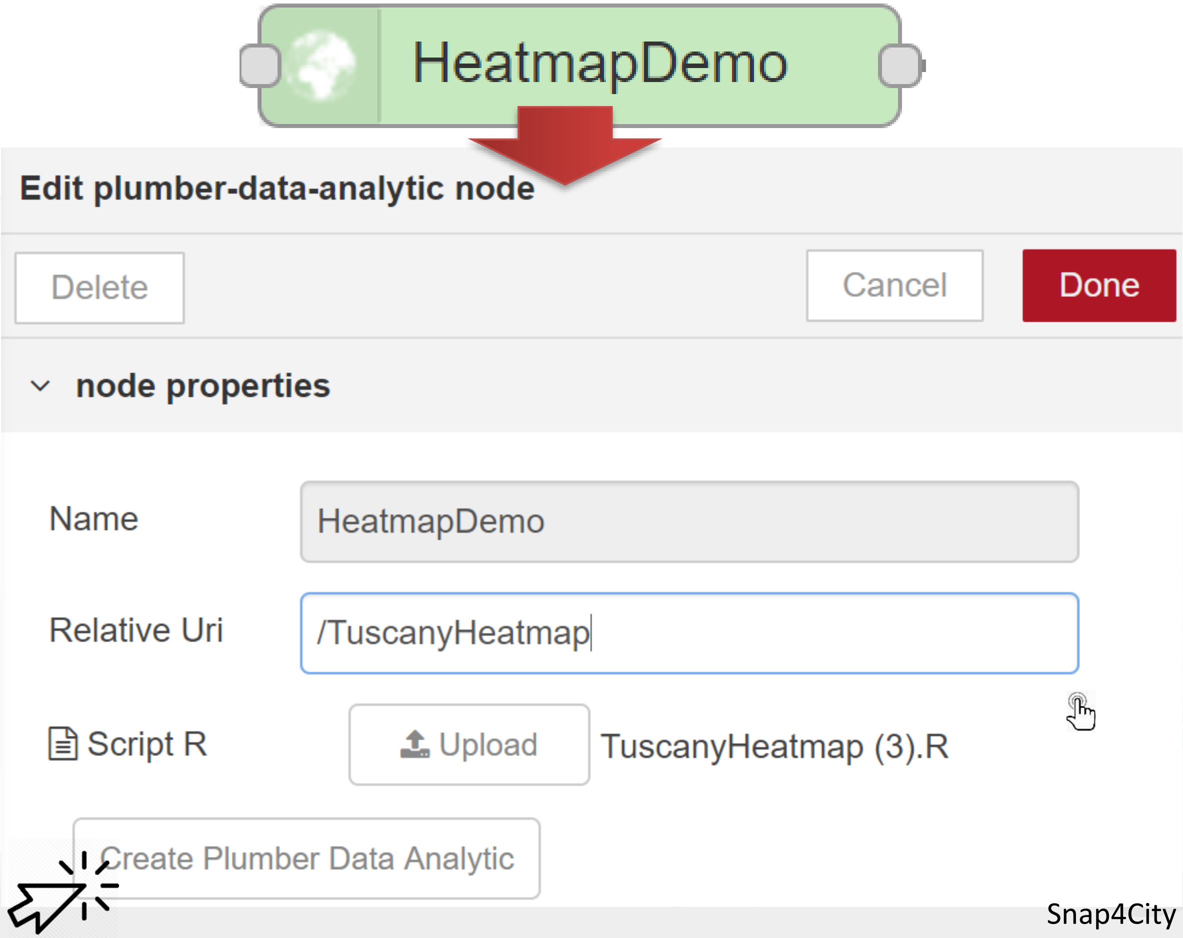
Data Analytics to MicroServices



R Studio and Python algorithms are **automatically** transformed into **MicroServices** for your IOT Applications

Data Analytics to MicroServices with Plumber

How to configure the **plumber data analytic** node:

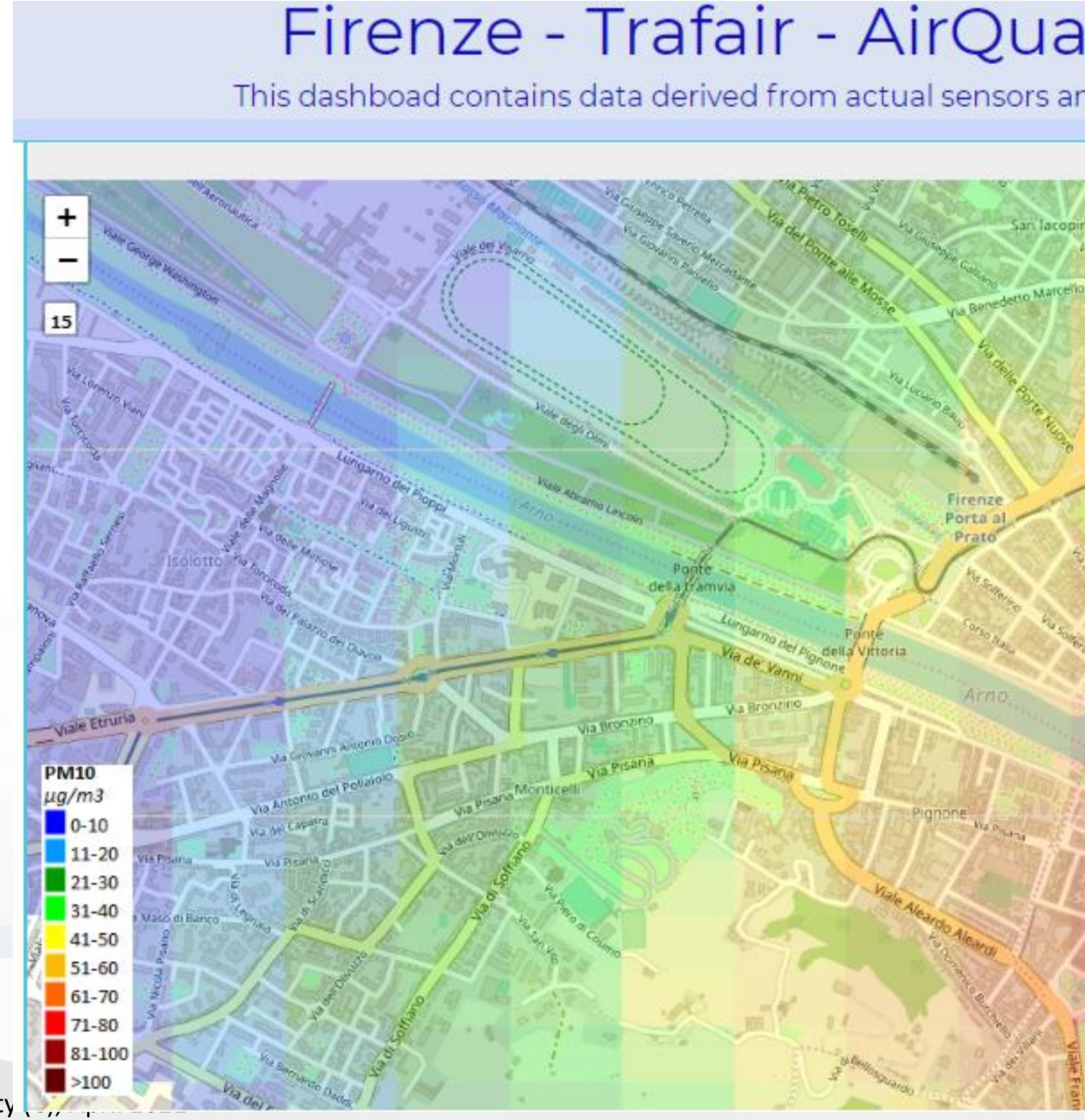


Relative Uri is the same of the R @get annotation:

```
#' @get /TuscanyHeatmap
```

Automatic_IDW_Heatmaps_Creation.R

```
#' @get /heatmapIDW
#' @serializer unboxedJSON
heatmapIDW <- function (city, long_min,
long_max, lat_min, lat_max, epsgProjection,
subnature, valueType, fromDateTime,
toDateTime, heatmapName, colorMap) {
...
}
```

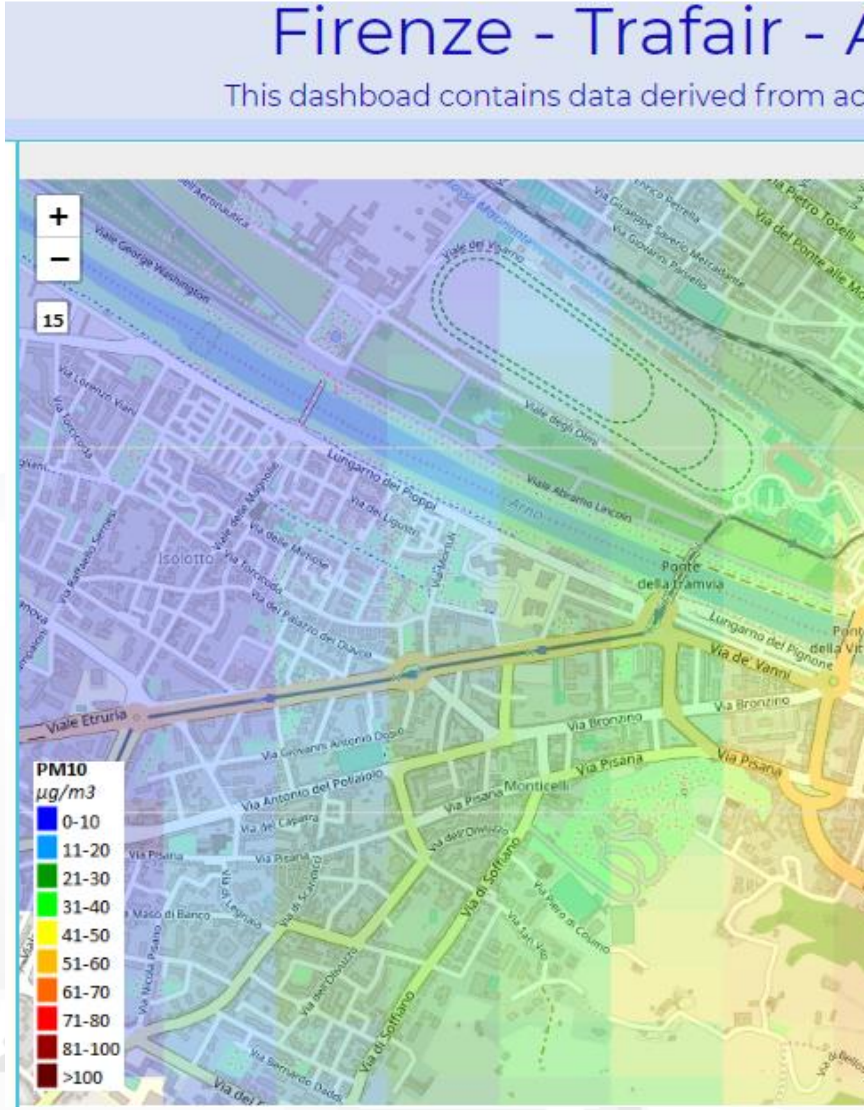


More Information

- [HOW TO: produce heatmaps, custom heatmaps on any data]()
- [TC1.19: Creating and Exploit heatmaps for Dashboards and as reference data services]()

PARAMETERS EXPLANATION

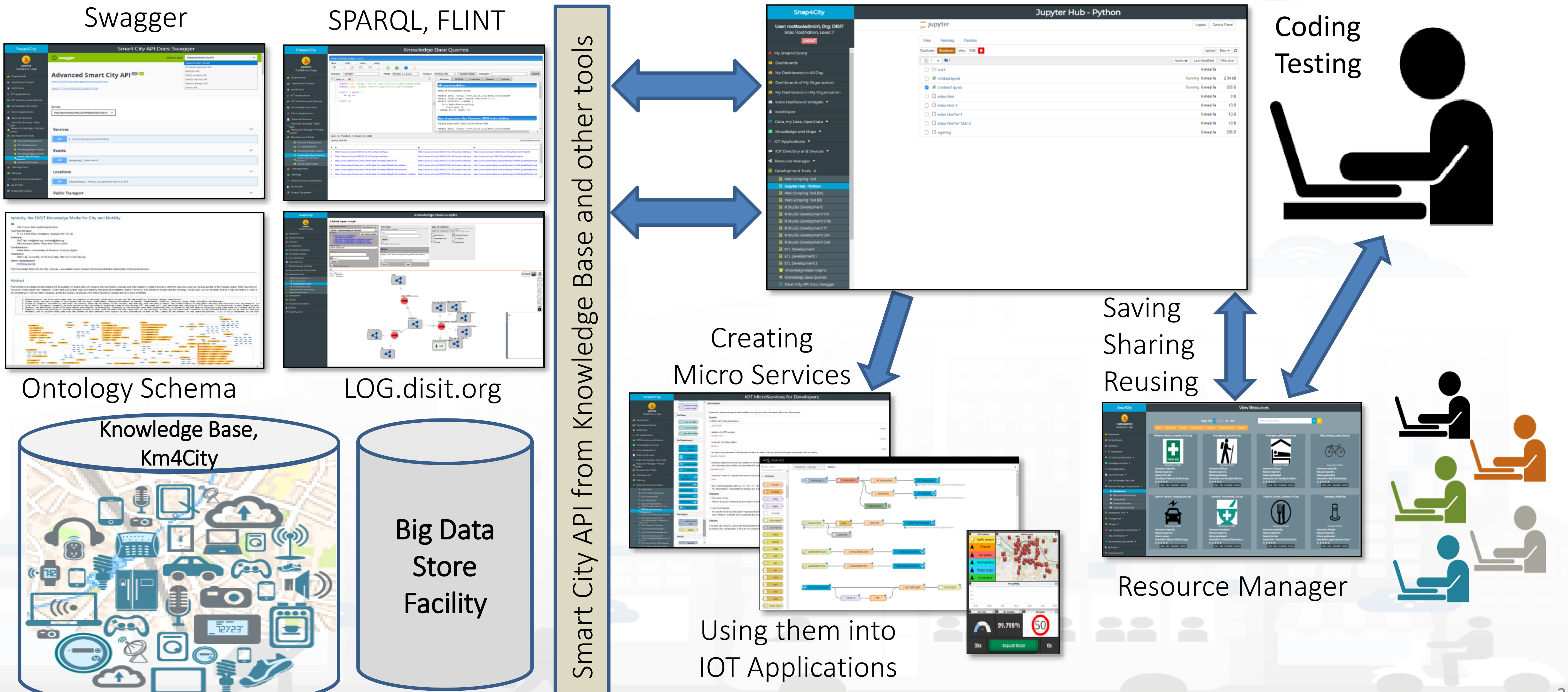
- city = name of the city related to the heatmap bbox (e.g., Rome, Florence, Helsinki, Antwerp etc.)
- long_min, long_max, lat_min, lat_max = heatmap bbox parameters (latitude and longitude coordinates)
- epsgProjection = UTM Projection related to the heatmap zone
- subnature = subnature of the sensor of interest (e.g., airQuality)
- valueType = single parameter or parameters array with the names of the measure of interest (the case of the array is related to multiple names for a single measure and NOT to multiple different measures - e.g, NO2, no2, airQualityNO2 etc.)
- fromDateTime = start date and time interval in timestamp format
- fromDateTime = end date and time interval (for example 1-hour or 1-day or the timestamp format 2020-05-25T15:00:00)
- heatmapName = name of the heatmap
- colorMap = name of the color map associated to the type of measure of interest



TOP

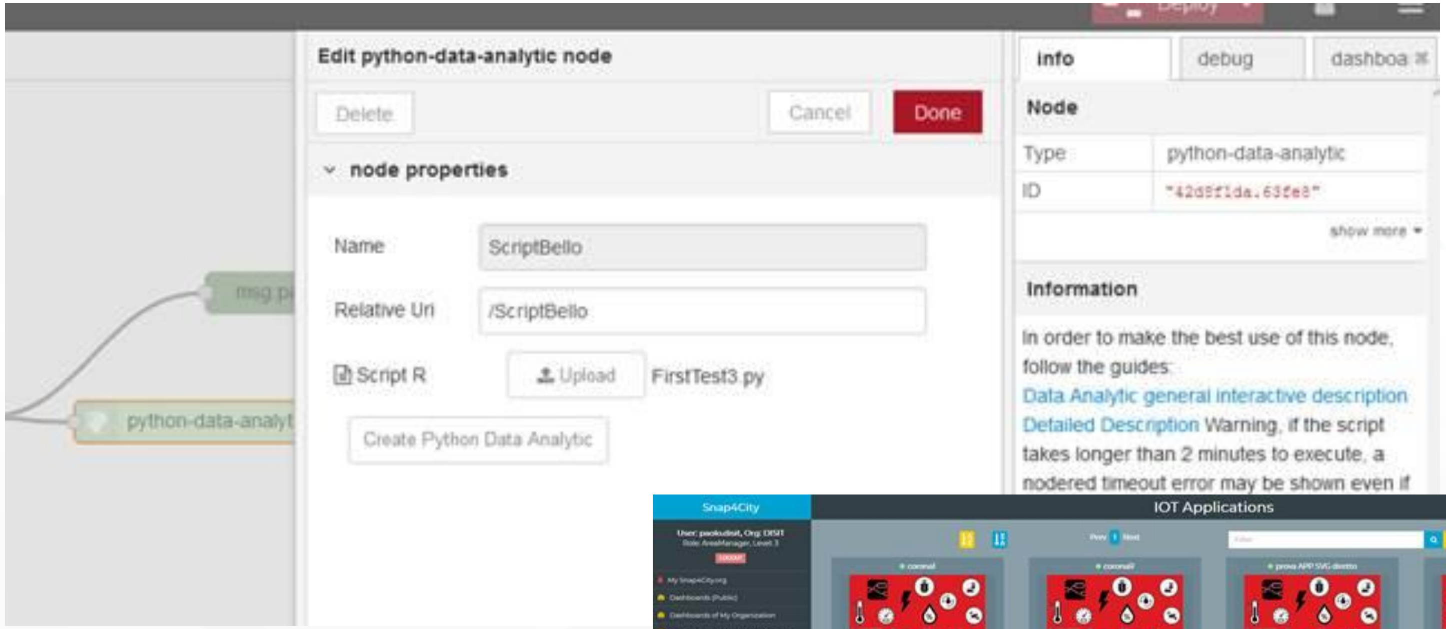
IOT App vs Data Analytics in Python

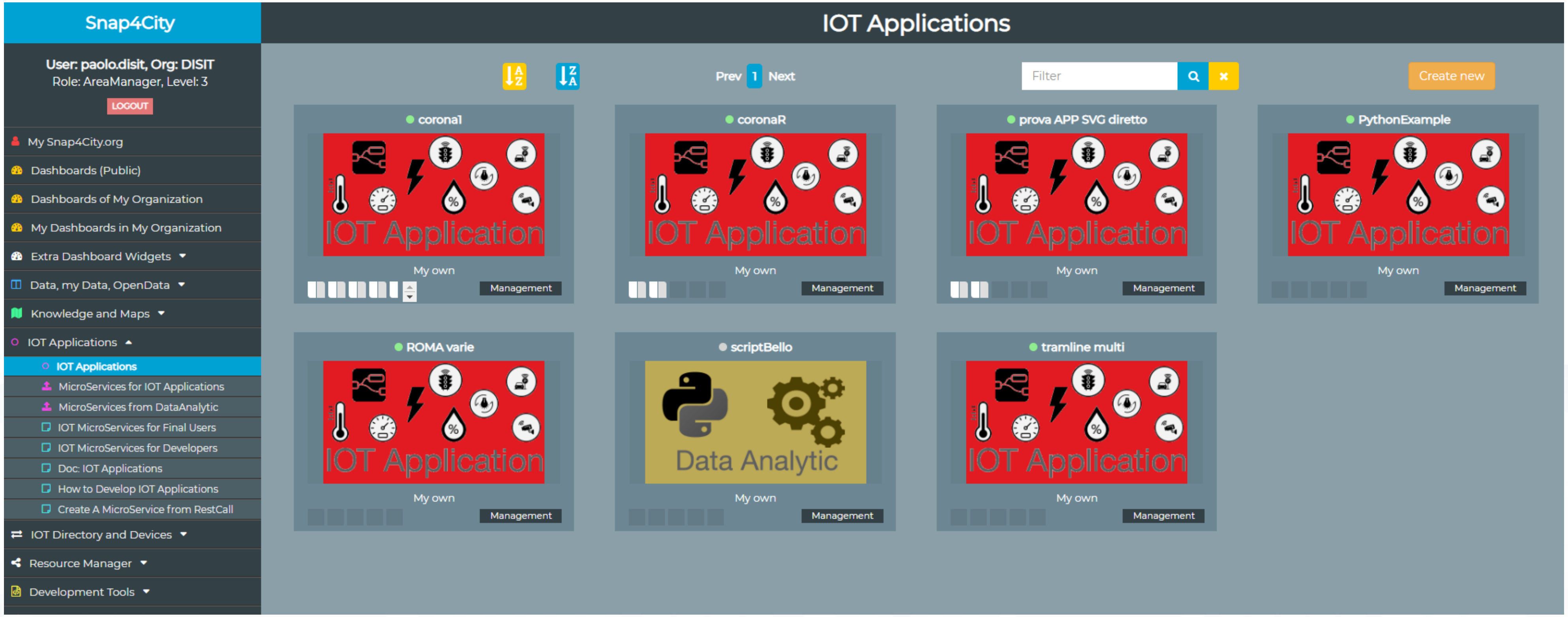
Data Analytics Development in Python,



Python process

- Develop Python code exploiting Flask calls
- Test on local for the Call
- Test on Cloud for API
- Deploy via IOT App





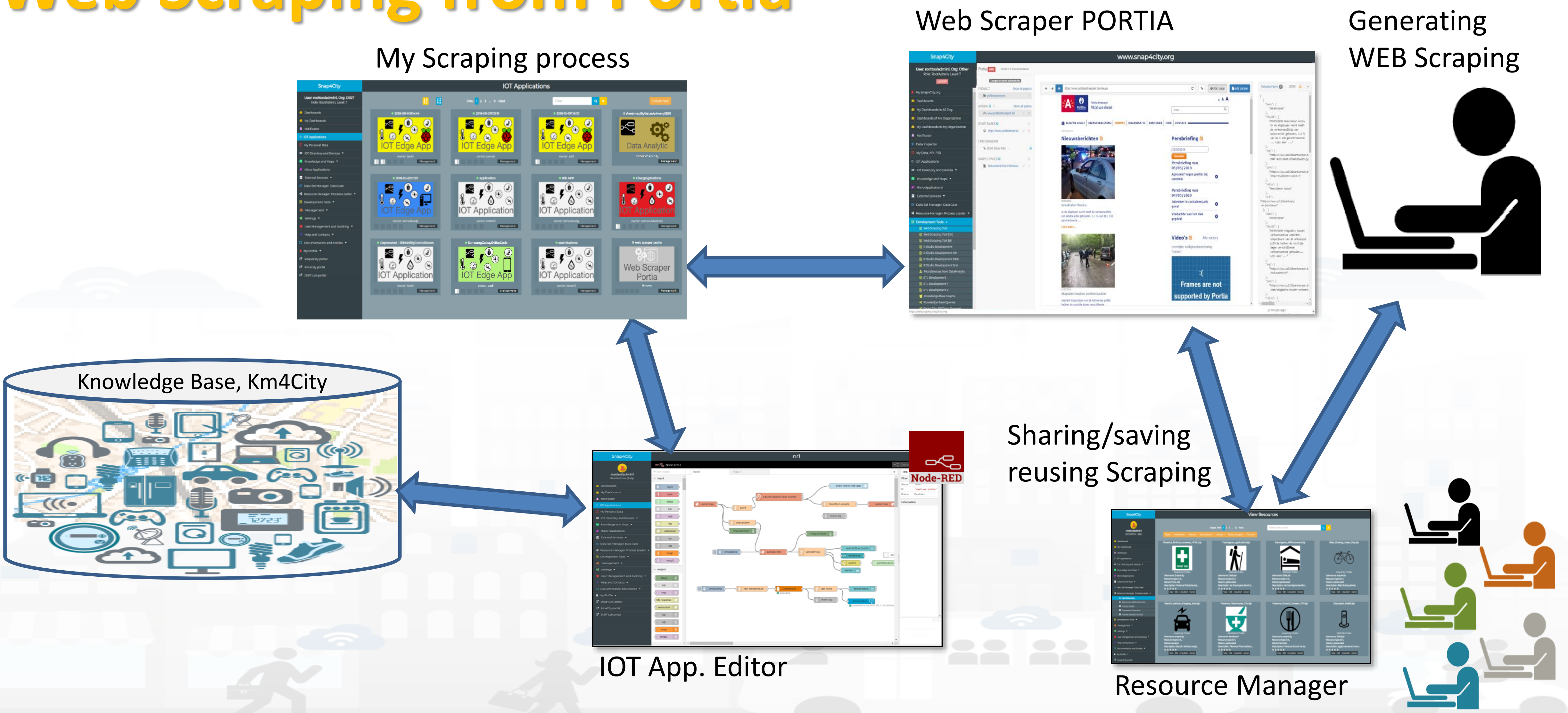
More information

- [HOW TO: develop DataAnalytic in Python and manage them via IOT App]()

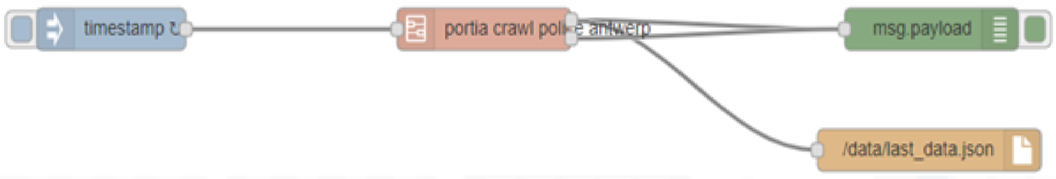
TOP

IOT App vs Web Scraping

Web Scraping from Portia

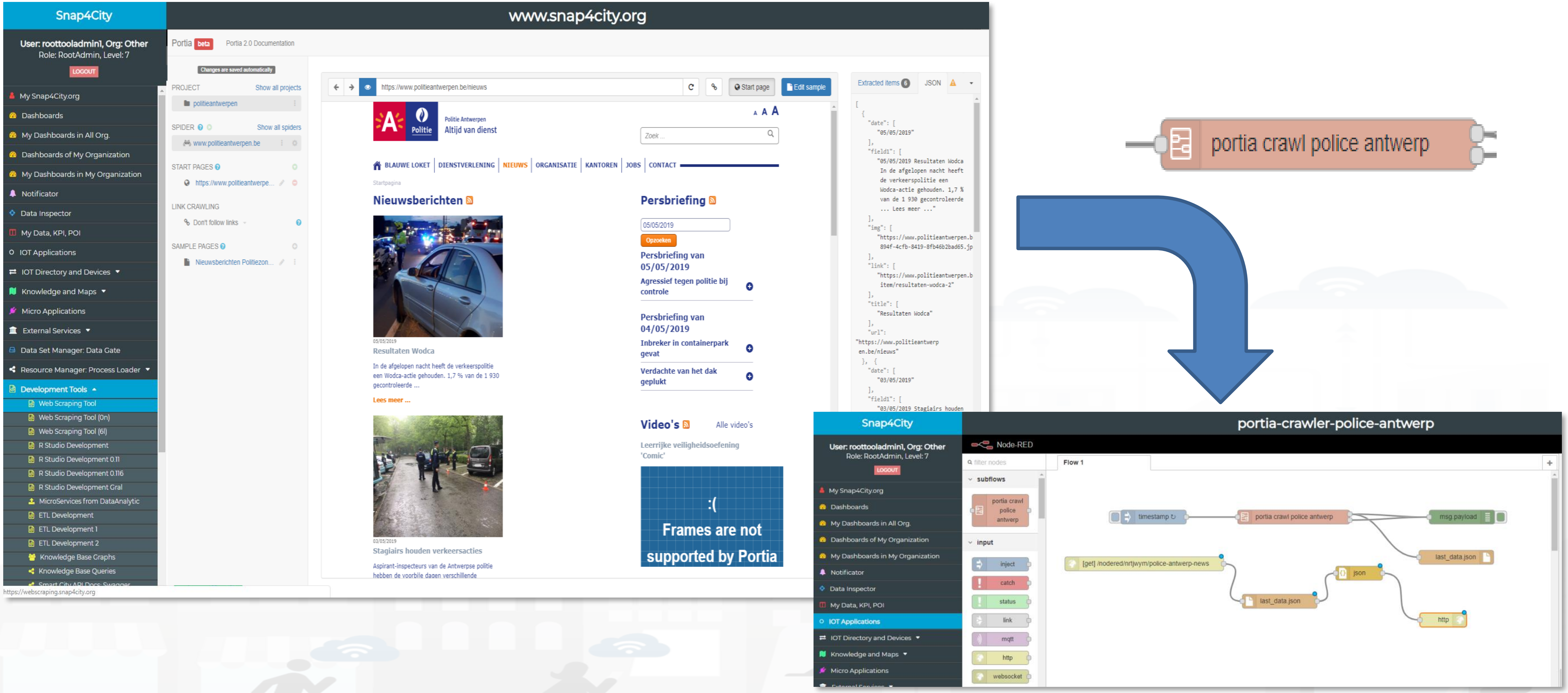


Web scraping



- [TC9.16 – Web Scraping to get data from web pages]()

Web Scraping



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IOT App self training

Self Training main path

- **Please start a fully guided training cases:**
- HOW TO: create a Dashboard in Snap4City
- HOW TO: add a device to the Snap4City Platform
- HOW TO: add data sources to the Snap4City Platform
- HOW TO: define privacy rules for personal data, produced by the end-users own device
- HOW TO: Develop Smart Applications, Snap4City development Life Cycle
- HOW TO: HLT vs Ingestion, and HLT vs Widgets
- HOW TO: Develop an IOT Application for Data Ingestion
- HOW TO: Upload data into Knowledge Base, ServiceMap (triple upload)
- HOW TO: Create as set of Devices with BulkProcessing
- HOW TO: Create an IOT Device Model
- HOW TO: Create an IOT Device Instance from IOT Directory tool

IOT Applications vs Dashboards (self training)

- IOT Applications, realized by using Snap4City Node-RED and integrated with Snap4City Nodes/MicroServices block, can be behind dashboards to get data from them with Virtual Sensors and Actuators.
  - Dashboards may be connected to multiple IOT Applications and IOT devices
  - IOT Applications may be connected with multiple Dashboards and IOT devices
- A network of Dashboards, IOT Apps and IOT Dev and data is easily realized exchanging data via secure connections.
- see the following Training Cases
  - **US2. Using and Creating Snap4City Applications with Dashboards**
  - **TC2.3 - List of MicroServices and the Help, for Final Users and Developers**
  - **TC2.4 - The daisy of MicroServices for Snap4City Dashboard and IOT App**
  - **TC2.28 - Snap4City MicroServices for Snap4City platform management from IOT Applications, feature of reflection**

IOT Applications vs Dashboards (self training)

- see the following Training Cases
  - US2. Using and Creating Snap4City Applications with Dashboards
  - TC2.3 - List of MicroServices and the Help, for Final Users and Developers
  - TC2.4 - The daisy of MicroServices for Snap4City Dashboard and IOT App
  - TC2.28 - Snap4City MicroServices for Snap4City platform management from IOT Applications, feature of reflection
  - TC2.24 - IOT Applications developed exploiting MicroServices, also supporting GDPR, real time, data sharing, etc.
  - US9. Creating Snap4City IOT Applications, different formats, protocols, brokers, communications
  - TC6.8 - ETL processes for data transformation, and exploiting MicroServices/API/RestCall
  - TC2.13 - Import of any new Block/MicroService or library of MicroServices into IOT Application Builder tools

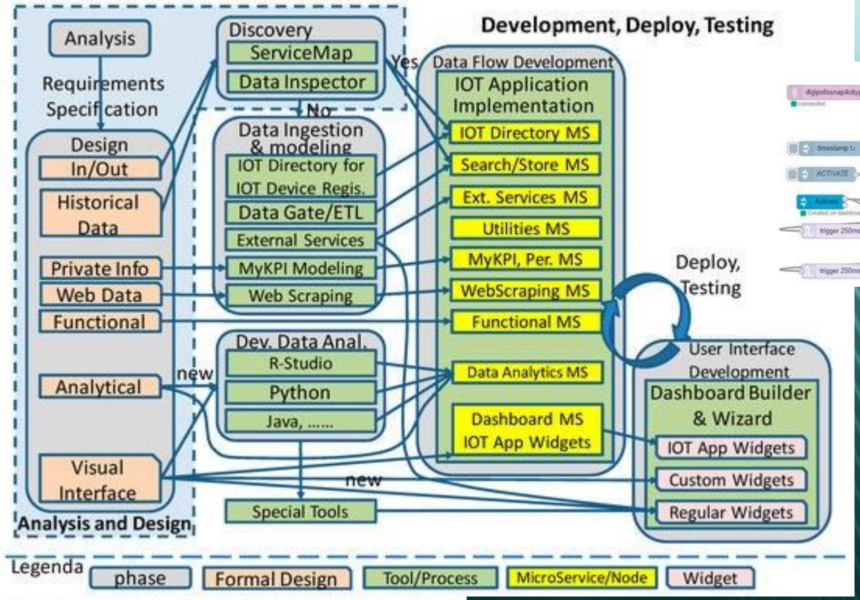
Self Training articles

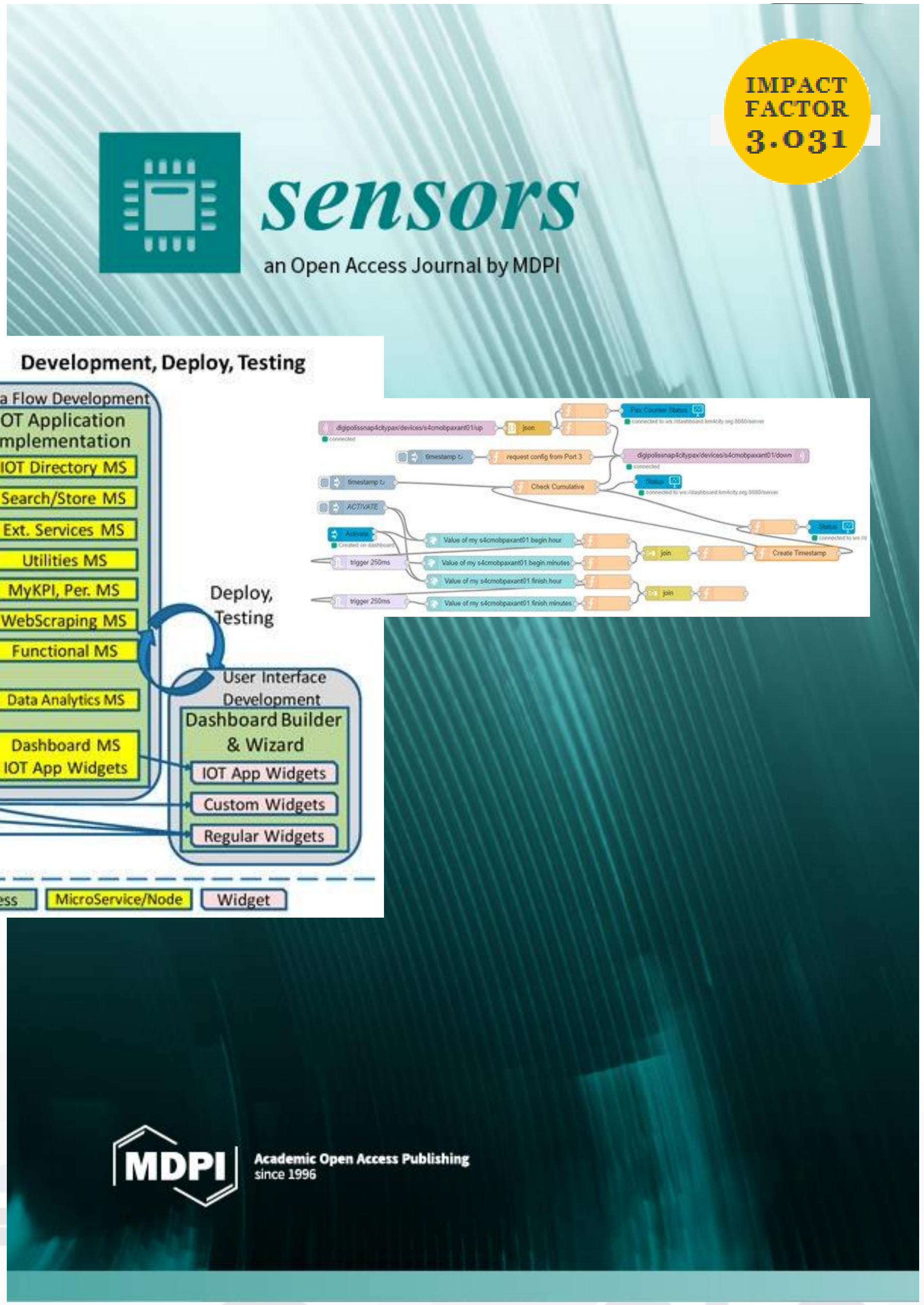
- C. Badii, P. Bellini, A. Difino, P. Nesi, "Smart City IoT Platform Respecting GDPR Privacy and Security Aspects", accepted for publication on IEEE Access, 2020. 10.1109/ACCESS.2020.2968741 https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8966344
- C. Badii, P. Bellini, A. Difino, P. Nesi, G. Pantaleo, M. Paolucci, MicroServices Suite for Smart City Applications, Sensors, MDPI, 2019. https://doi.org/10.3390/s19214798
- C. Badii, P. Bellini, A. Difino, P. Nesi, "Sii-Mobility: an IOT/IOE architecture to enhance smart city services of mobility and transportation", Sensors, MDPI, 2019. https://doi.org/10.3390/s19010001 https://www.mdpi.com/1424-8220/19/1/1/pdf
- See also courses in ITALIANO: https://www.snap4city.org/485

UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

MicroServices Suite for Smart City

- Badii, C.; Bellini, P.; Difino, A.; Nesi, P.; Pantaleo, G.; Paolucci, M. MicroServices Suite for Smart City Applications.
- *Sensors* **2019**, *19*, 4798.
- https://www.mdpi.com/1424-8220/19/21/4798/pdf





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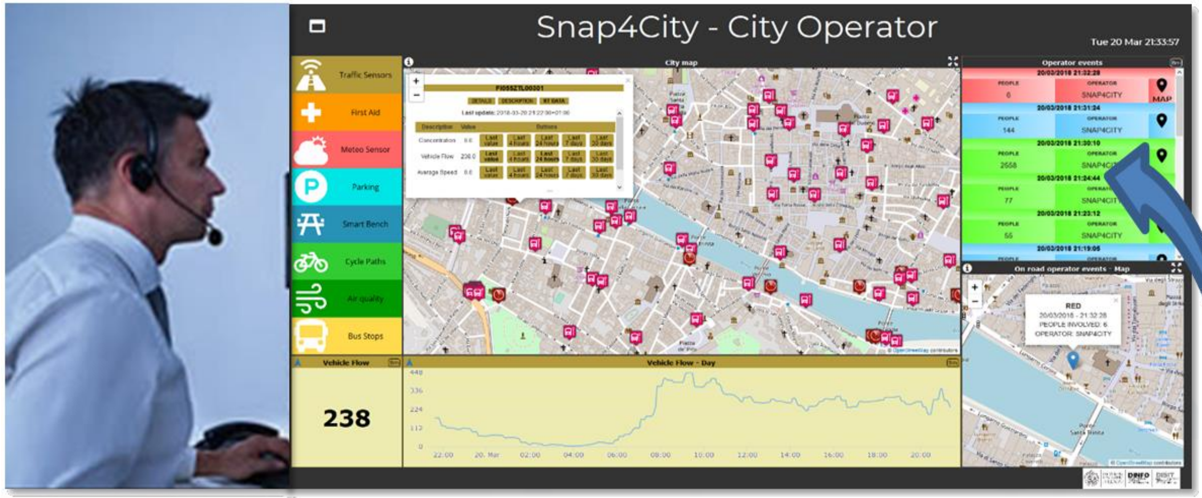
IOT App = Node-RED + Snap4City

examples

Alerting about critical events involving people in a specific area

A public operator (Road Operator) on the field, like a policeman or a public transport driver, **notifies to a control room** operator (City Operator) a **critical event** in the city.

The notification includes the reporting in real time of the **event position, the number of involved people** and the **gravity** of the event.



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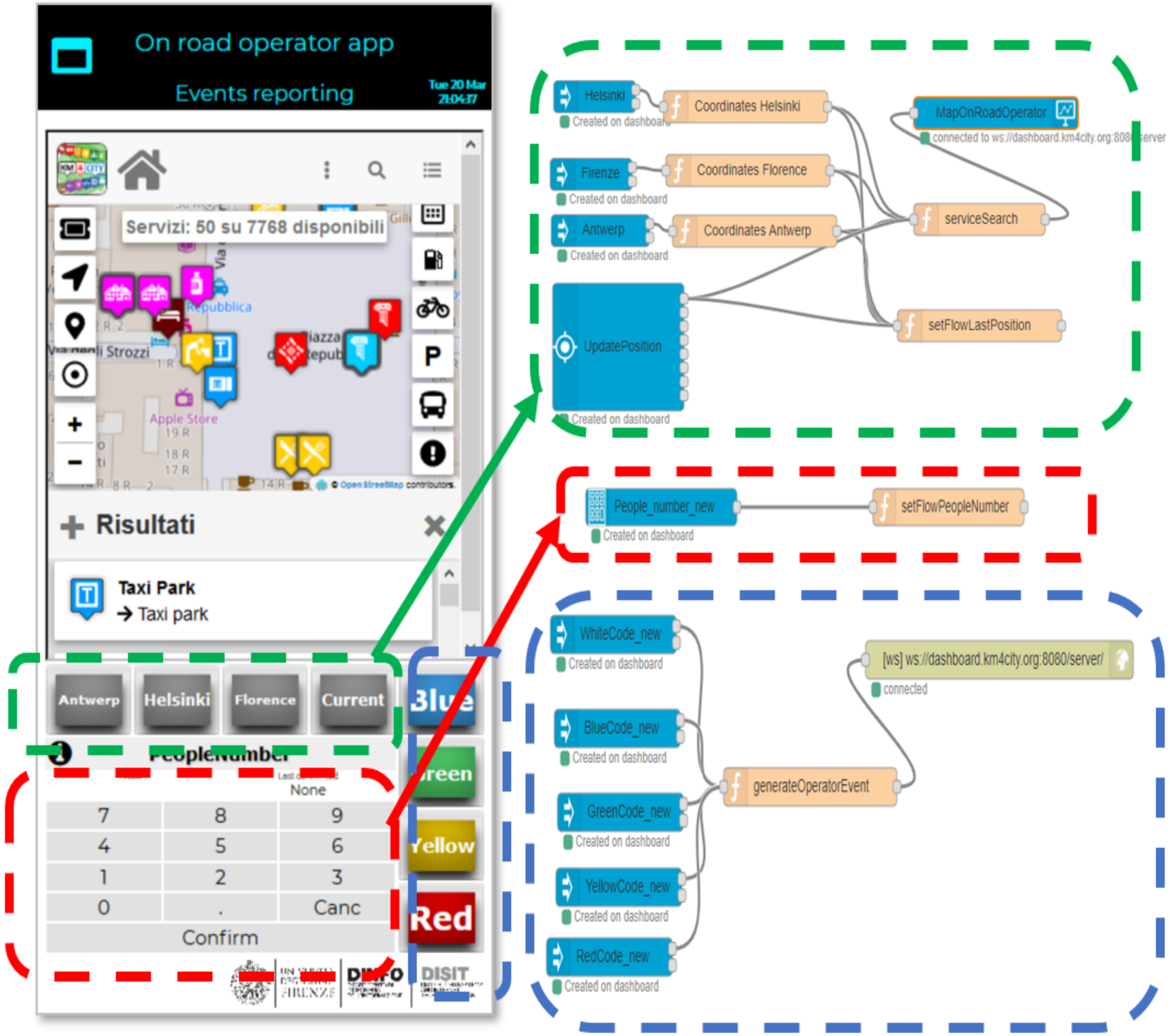
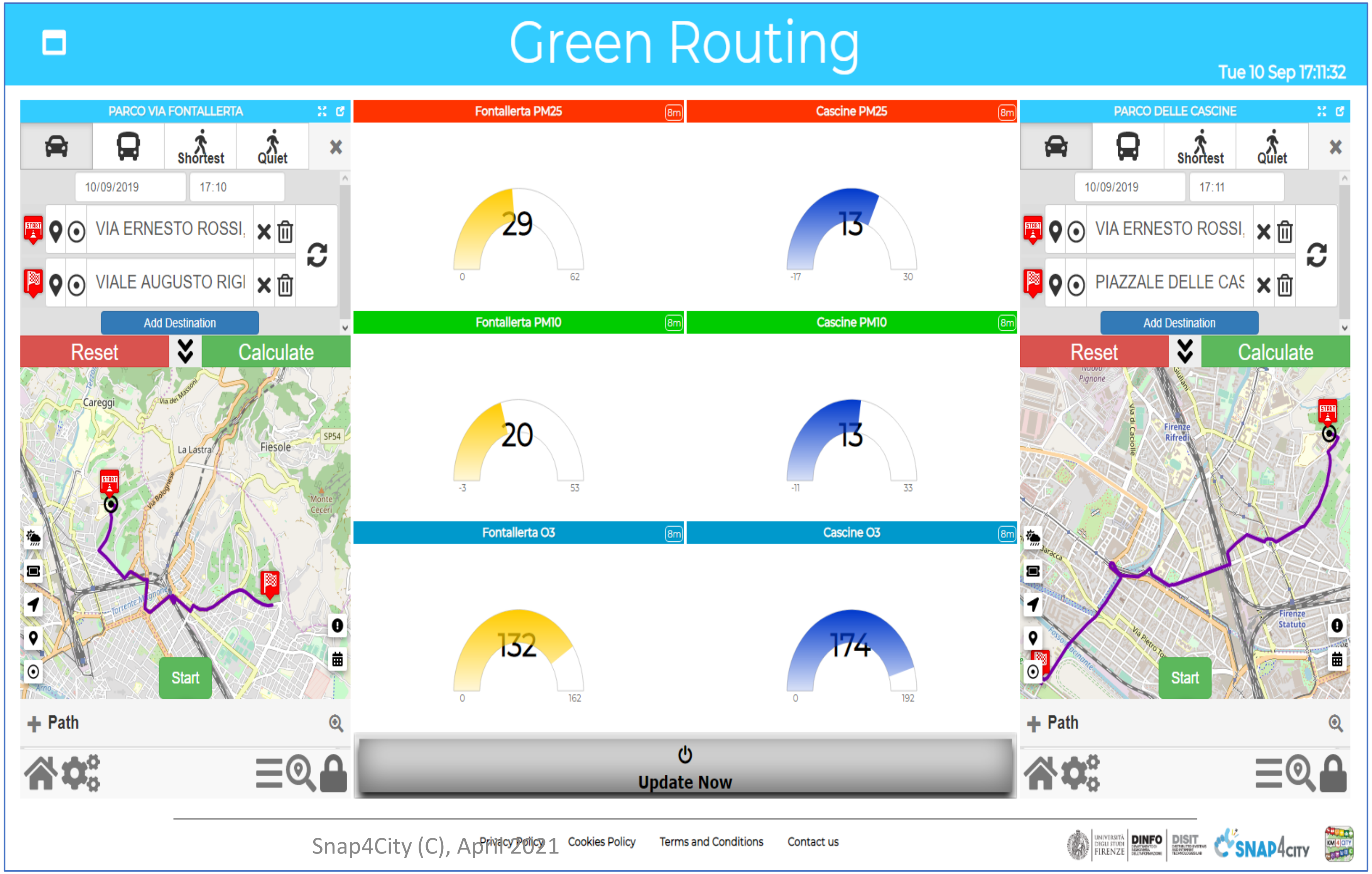


Check which route is less polluted

In this example, microServices **retrieve information** from **the Smart City storage** and info to create a dashboard that tells the user which is the less polluted path at a precise moment to go jogging.

If predictive data are available, it can work on **predictions**



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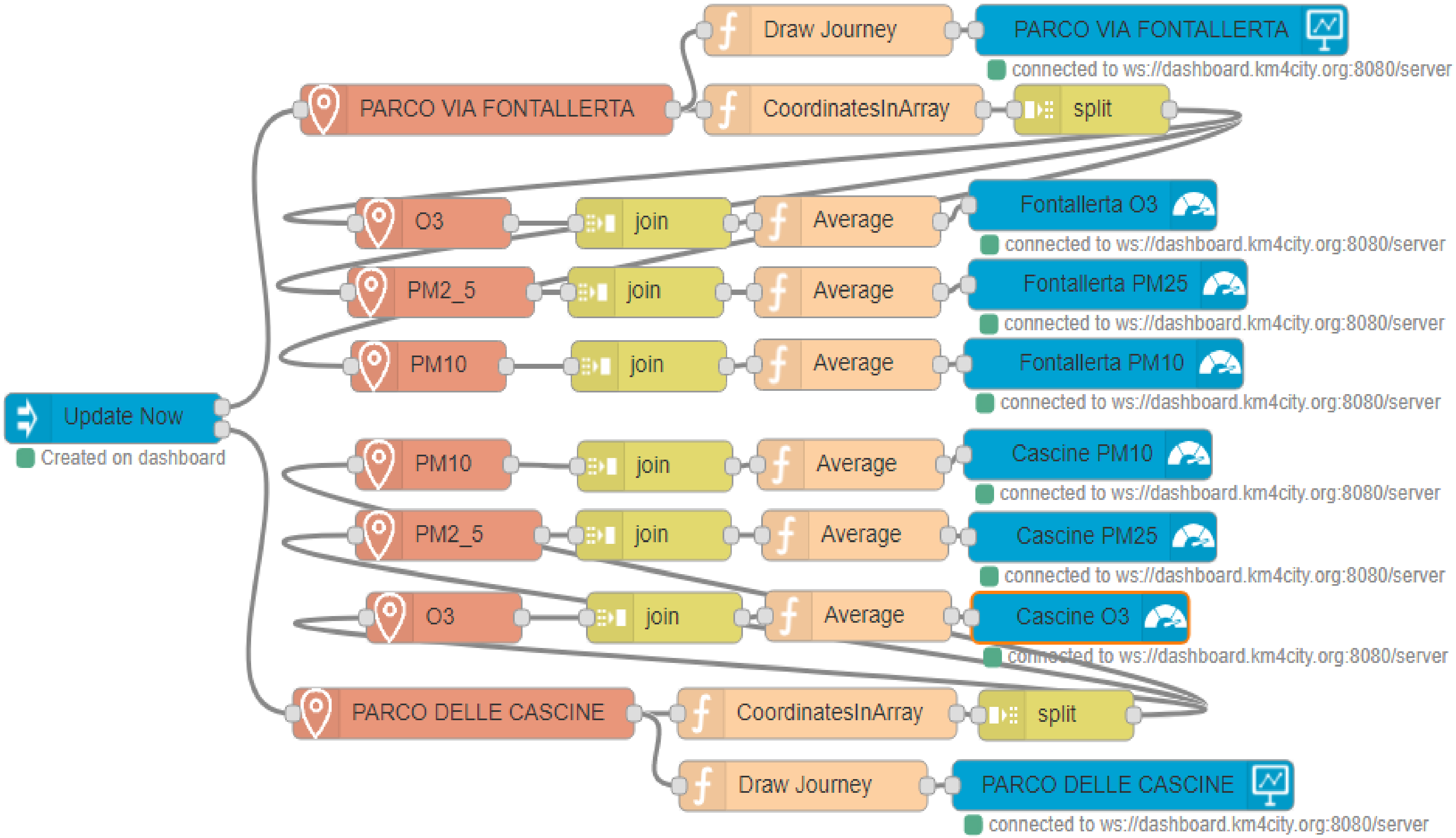
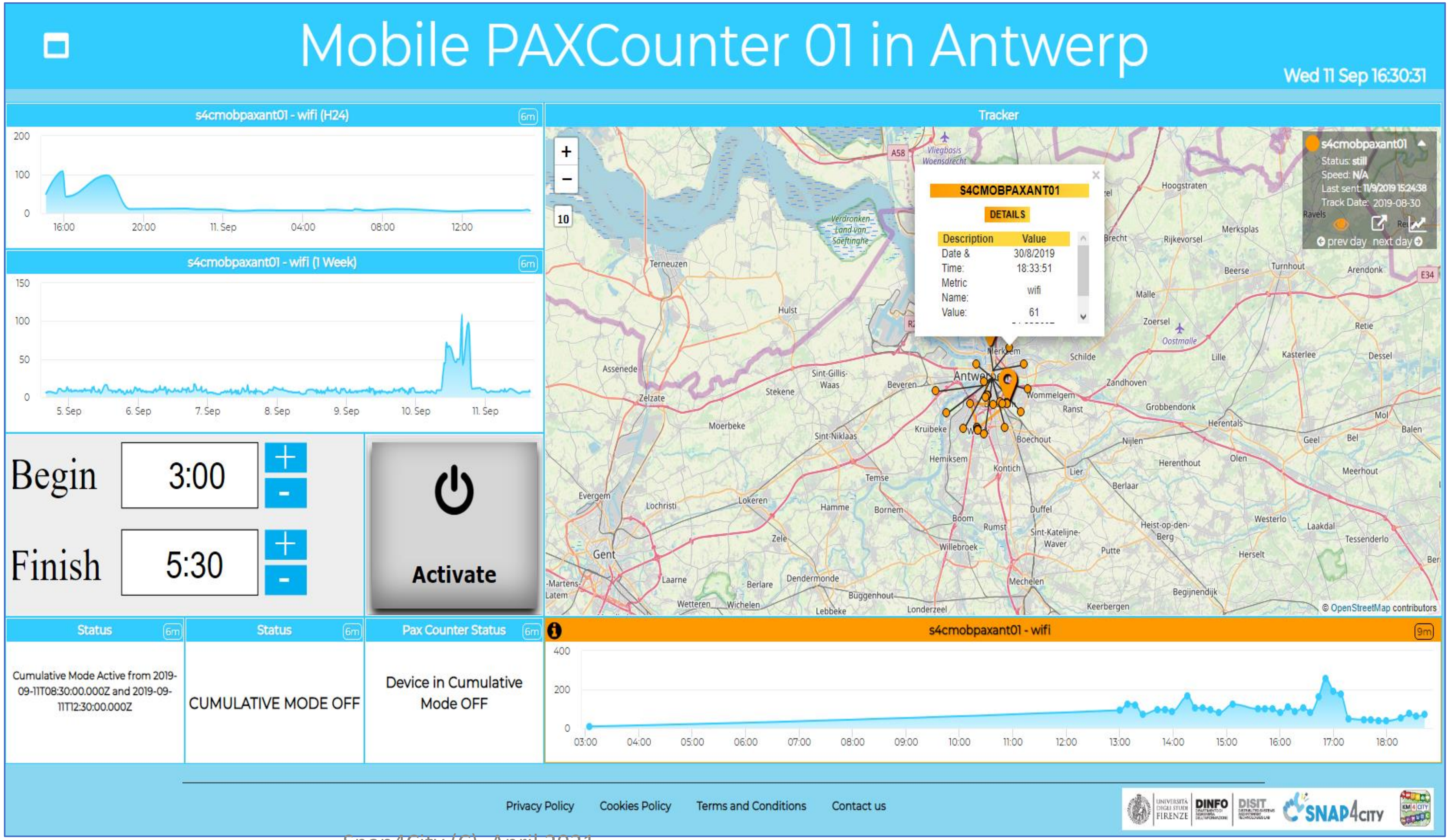


Controlling Personal Mobile PAX Counter

In this example, the **interaction with IOT Devices** counting people by using Wi-Fi and Bluetooth sniffing in its vicinity (according to GDPR)



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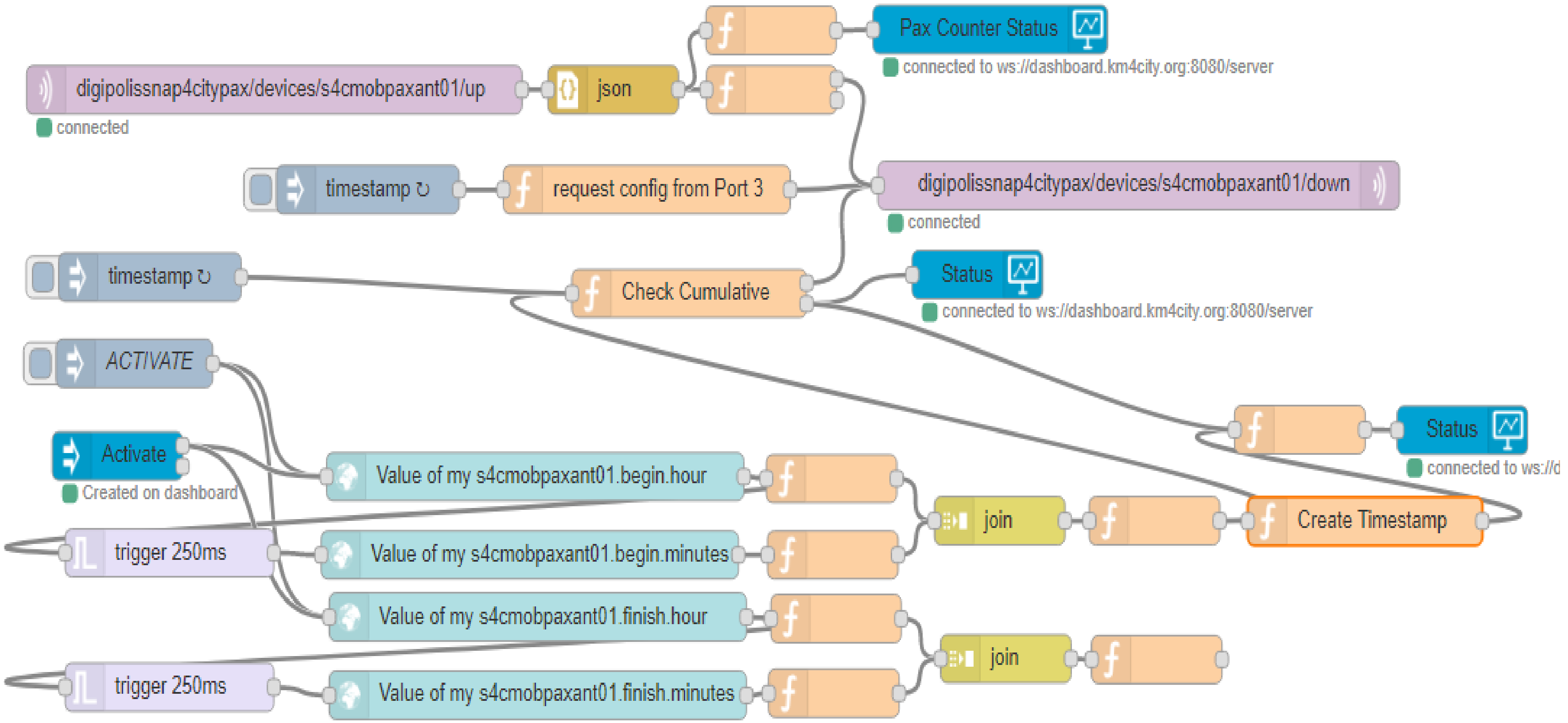


What we are going to do now!

- Create a Simple IOT Application (Demo)
- Production of IOT Application (Exercitation)
- Data Processing with IOT Application (Demo)
- Processing Data with IOT Applications (Exercitation)

Start DEMO Section 3

Start DEMO Section 3

TOP

Create a Simple IOT Application (DEMO)

Demo of Simple IOT Application

In this demo let's create an IOT Application that:

- reads a realtime value of a service and
- publishes it on a dashboard
- sends email to someone

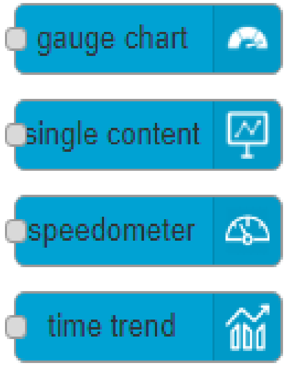
Nodes for flow

Generates an input for the other nodes. It can be repeated at predefined intervals, entered manually and of various types (string, number, Boolean, json etc.)

Requests detailed information for a specific service on the platform (such as a car park, hotel, etc.)

Executes a Javascript code once the input message is received

Transforms the incoming message into a JSON



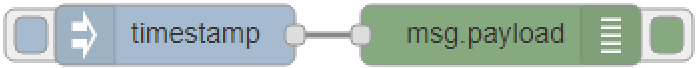
Display values in different modalities on a Dashboard (or on different Dash)

The node called single content accepts strings, numbers and html.

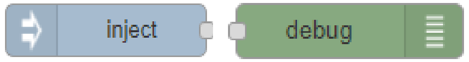
The others only accept numbers.

Send an email to the desired recipient. You must enter the username and password of an active email.

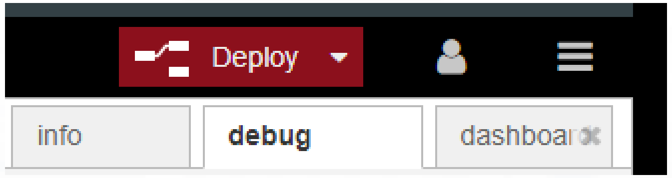
Step 1



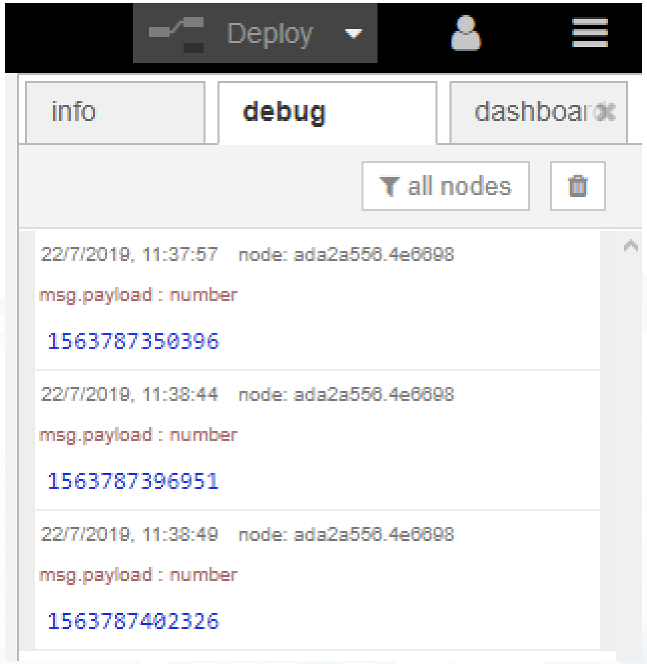
- Inject and Debug



- Connect
- Deploy



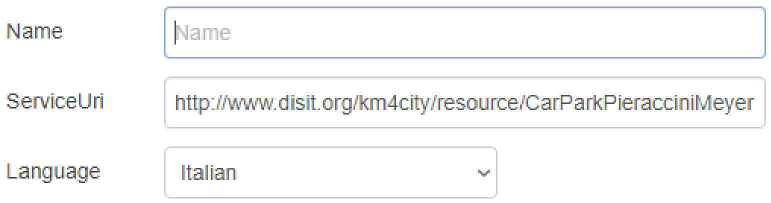
- Click and Observe
- Play with results



Step 2

- Service Info

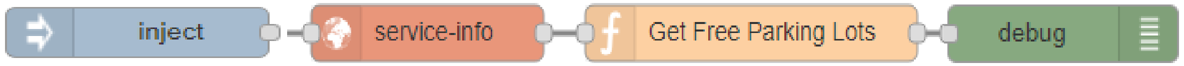
- Connect
- Configure



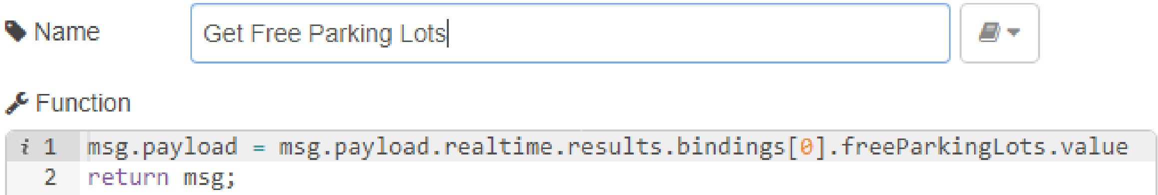
http://www.disit.org/km4city/resource/CarParkPieracciniMeyer

- Deploy
- Click and Observe
- Play with results

Step 3



- Function
- Connect
- Configure
- Deploy
- Click and Observe
- Play with results



msg.payload = msg.payload.realtime.results.bindings[0].freeParkingLots.value

Step 4

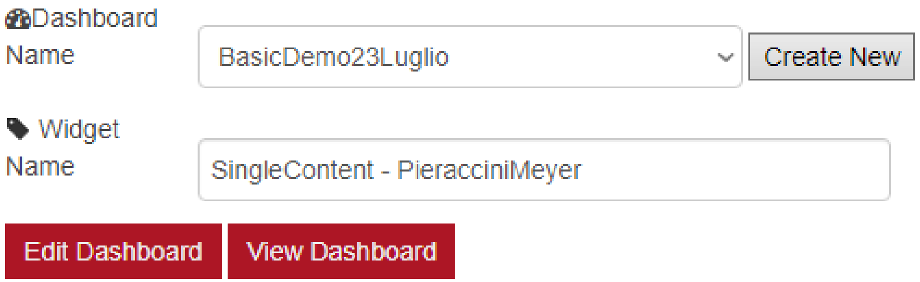
- JSON 

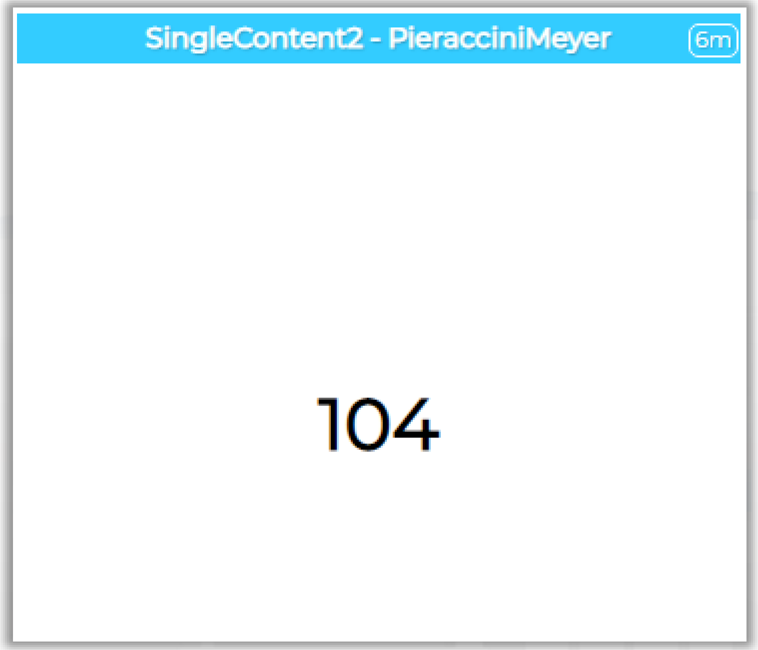
- Connect
- Deploy
- Click and Observe
- Play with results

Step 5

- Single content

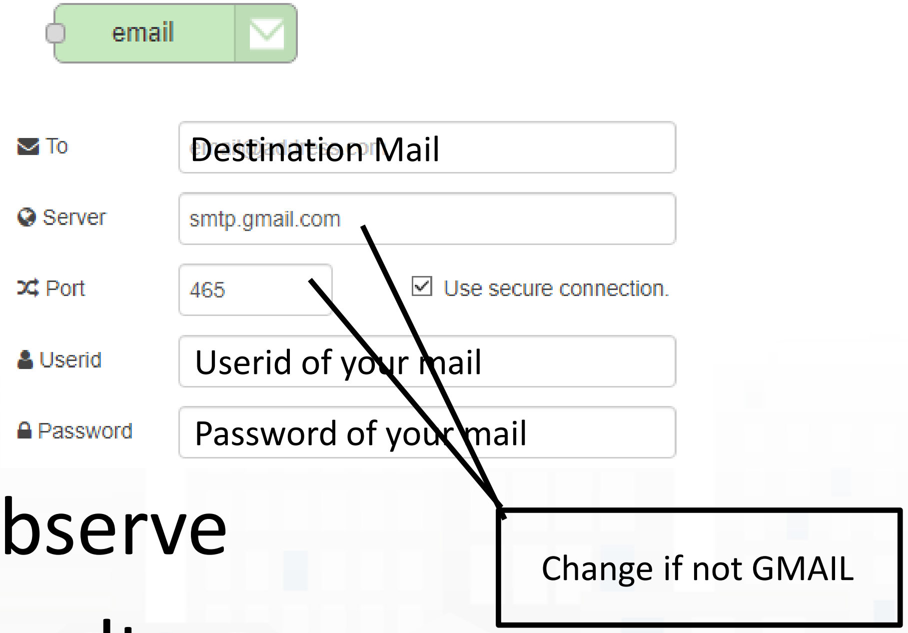
- Connect
- Configure
- Deploy
- Click and Observe
- Play with results

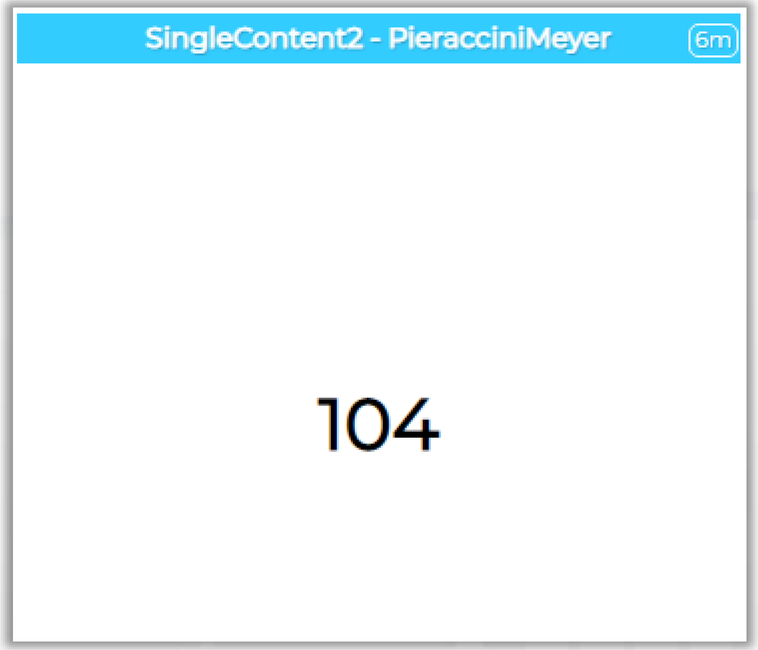




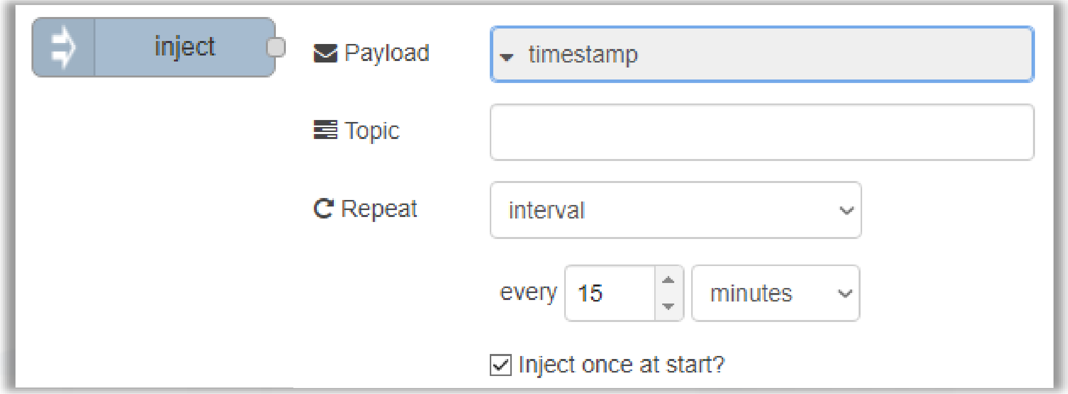
Step 6

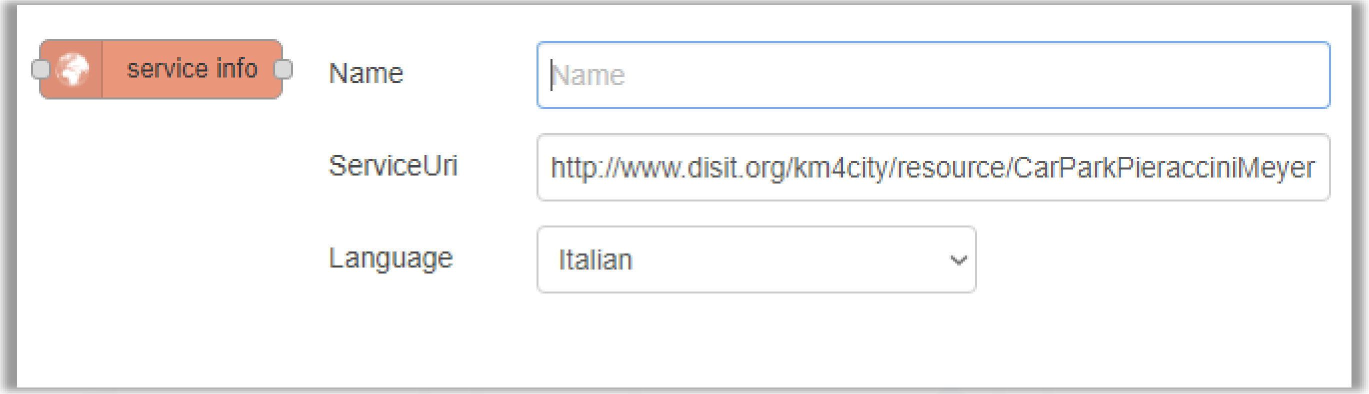
- Email
- Connect
- Configure
- Deploy
- Click and Observe
- Play with results

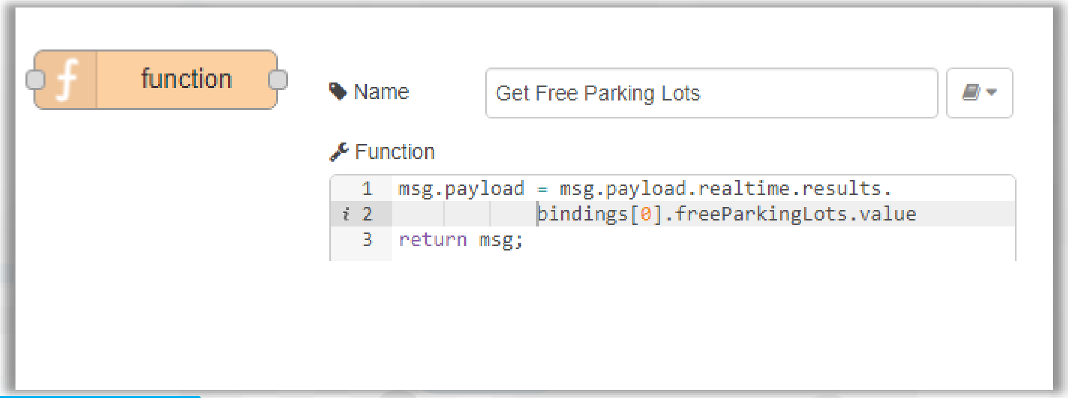


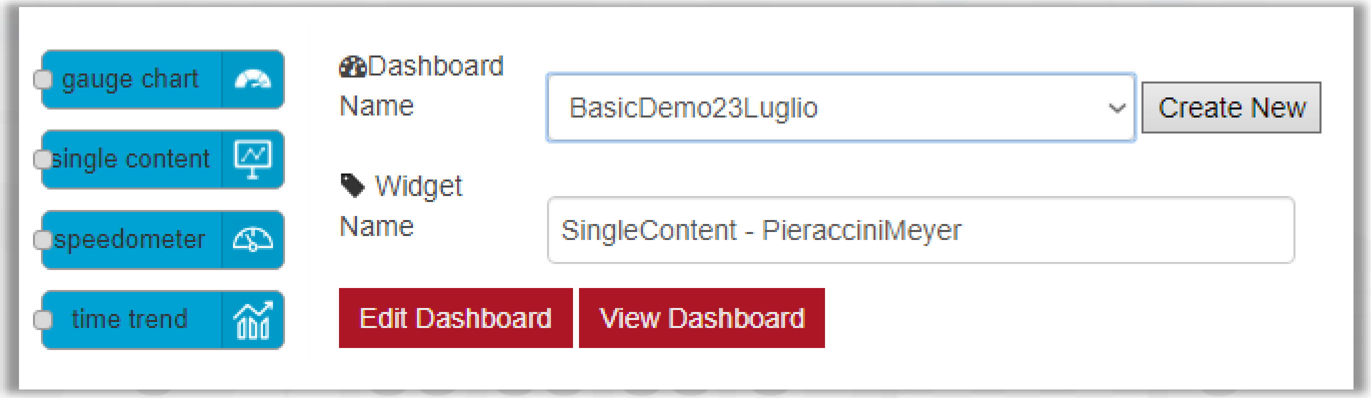


Nodes configuration

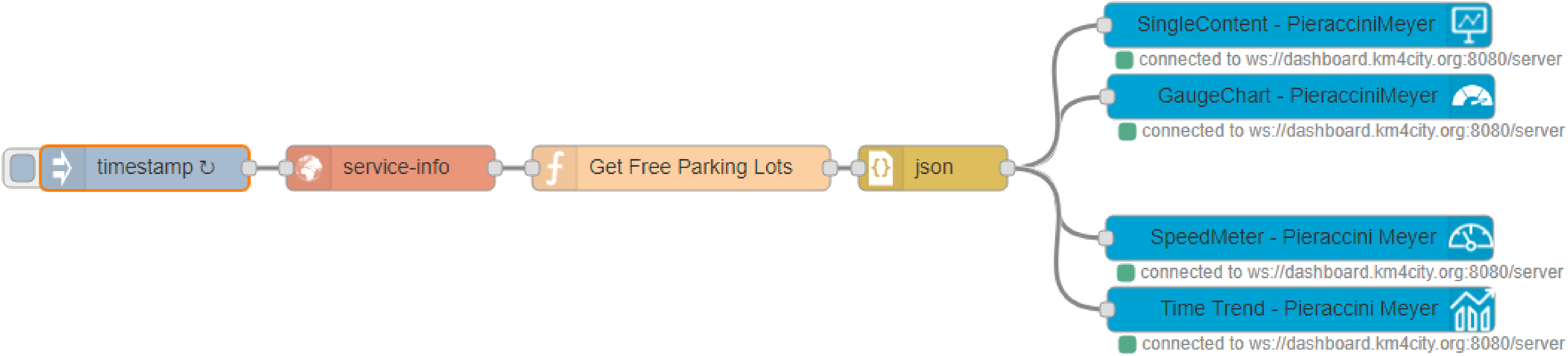








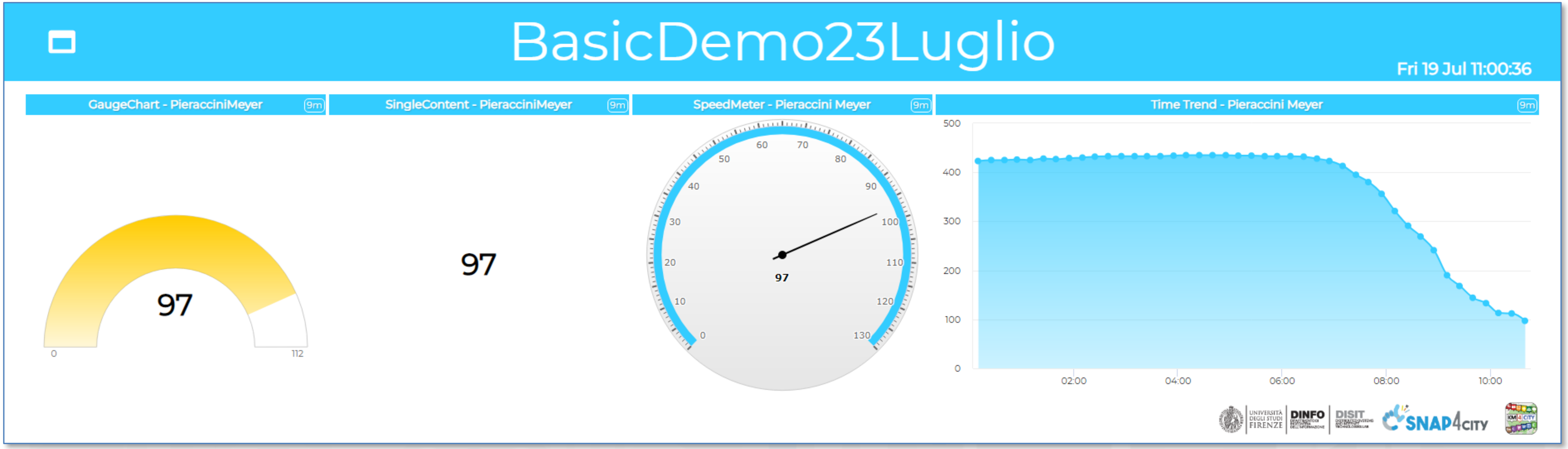
Nodes connections



Explaining: IOT Application Flow

- On Click or Every 15 minutes the ***timestamp*** node sends a message to the ***service-info*** node.
- When the message arrives, a request is sent to get details of the service URI entered in the configuration, in this case the ***Pieraccini Meyer car park***.
- The details are sent to the node named ***"Get Free Parking Lots"***, which recovers the value of the current free places and ignores all the other data received in response.
  - The values in output of node ***Get Free Parking Lots*** is a string.
- THUS ! node ***json*** may transform it into a number (for those who know JavaScript could be used function *parseInt()* inside the function node). Then a number has been obtained!
- The Number can be sent to Different kinds of nodes to show it on Dashboards Widgets.

Resulting Dashboard



https://main.snap4city.org/view/index.php?iddasboard=MTk1OQ==

end DEMO Section 3

TOP

Production of IOT Applications Exercitation

IOT Application Exercitation

Goal:

Create an IOT App (flow) that reads a value from a service (for example the parking lot seen in the previous demo)

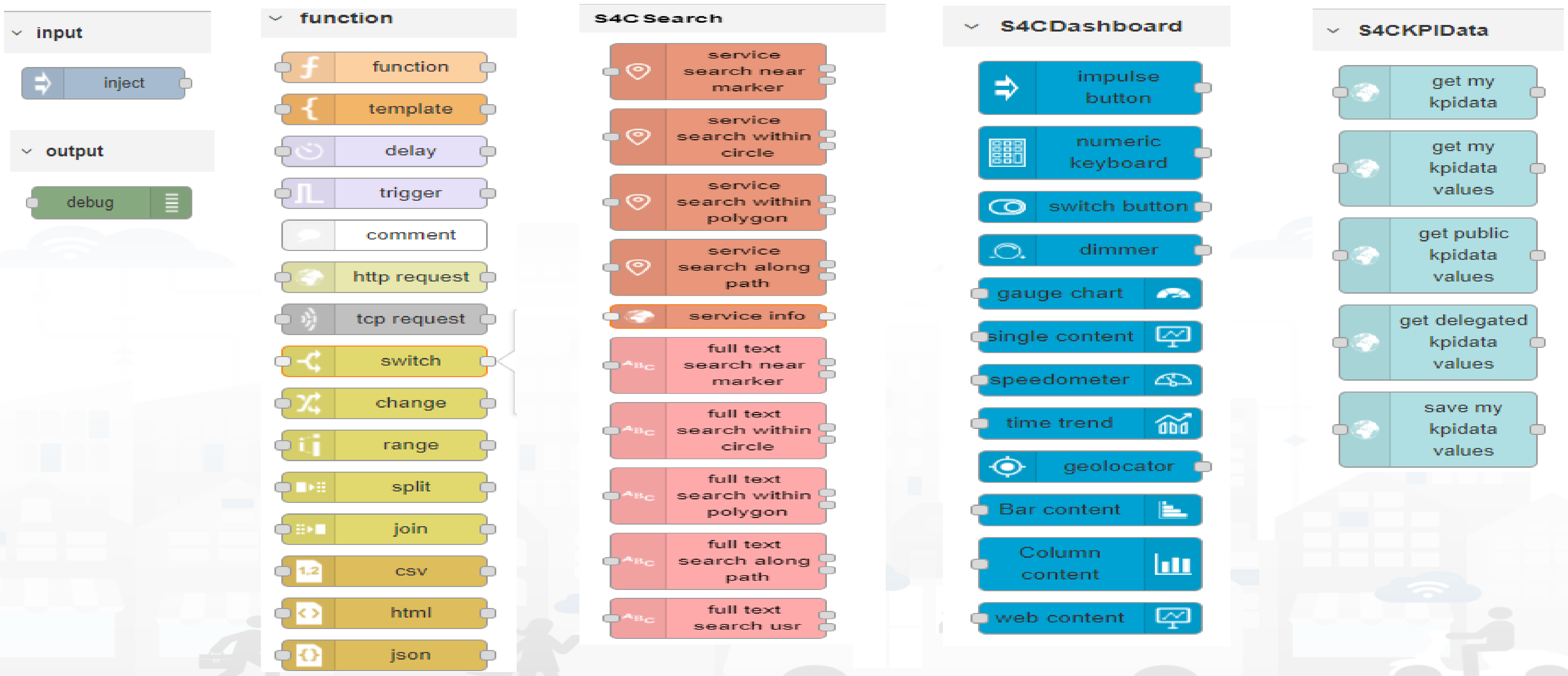
serviceUri: http://www.disit.org/km4city/resource/CarParkPieracciniMeyer

and:

based on a certain threshold sends a different message on the dashboard. For example, **Almost Full Parking or Free Parking**.
OR Send to **you an email** ☺ !

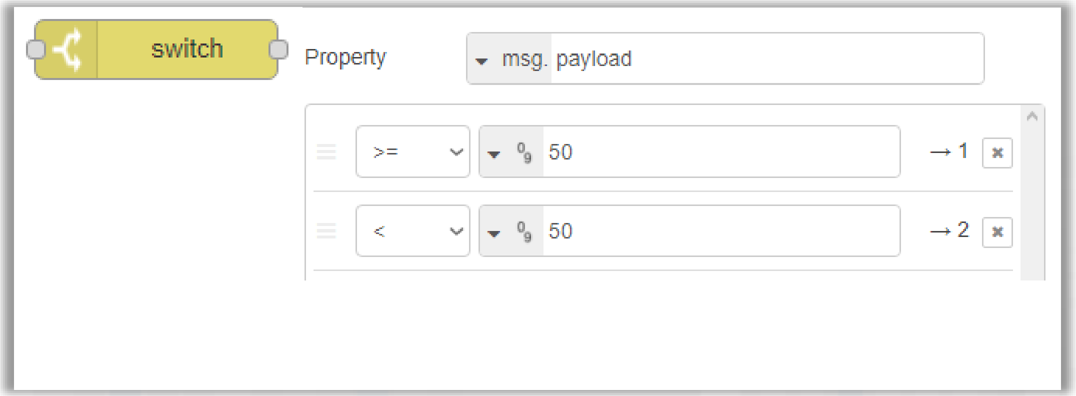
You have 15 Minutes!

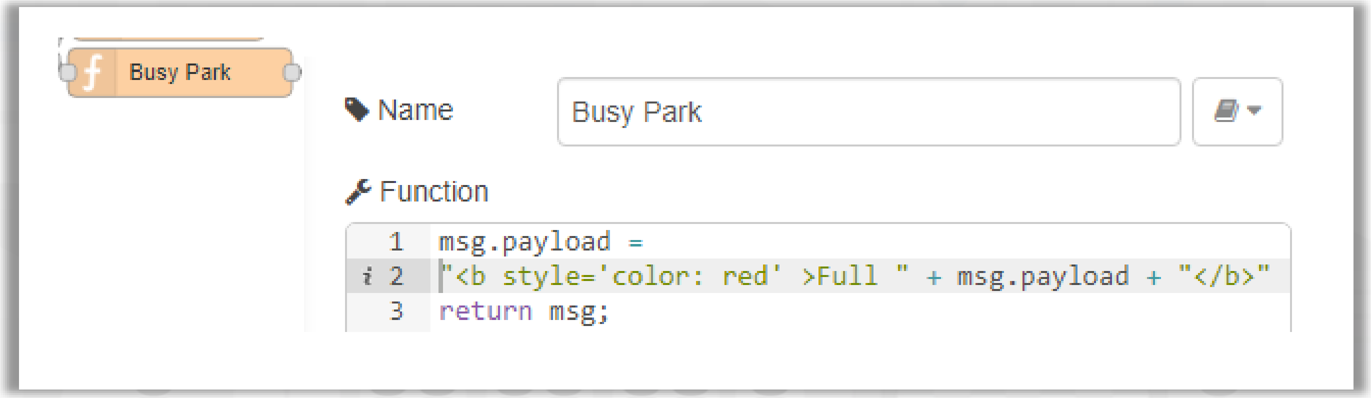
Ex1: Your NickName: ………………………………



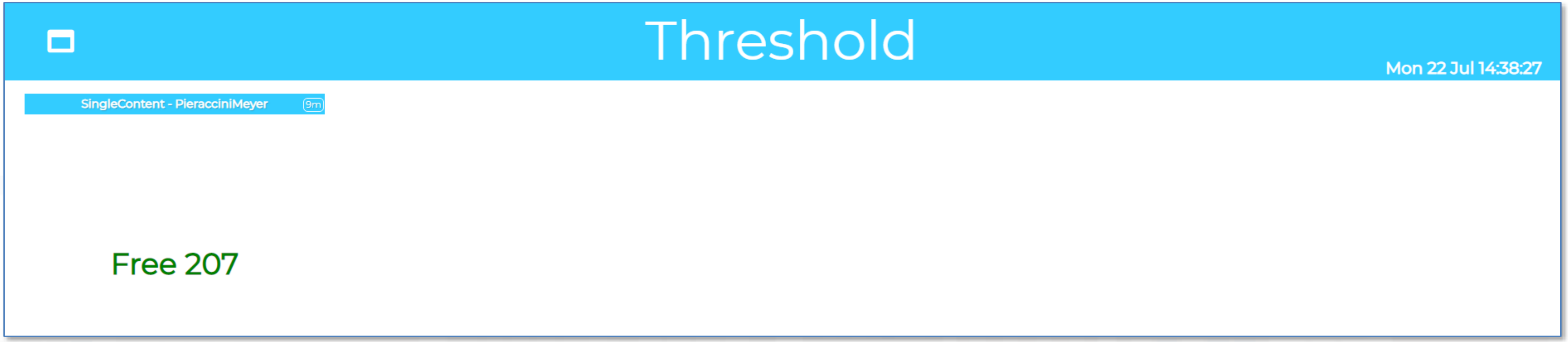
One Possible Solution

Nodes configuration





Resulting Dashboard



https://main.snap4city.org/view/index.php?iddasboard=MTk2MQ==

Start DEMO
Section 4

Start DEMO Section 4

TOP

Data Processing with IOT Application (DEMO)

Example of more Complex IOT Application

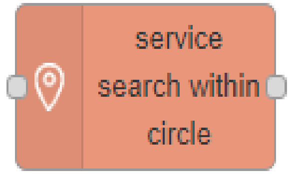
In this demo let's create an IoT Application that:

- reads a realtime values from a list of services,
- makes the sum of the value and
- publish the result on a dashboard

Nodes for flow 1/2

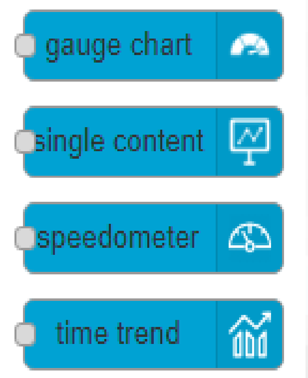
Generates an input for the other nodes. It can be repeated at predefined intervals, entered manually and of various types (string, number, Boolean, json etc)

Requests detailed information for a specific service on the platform (such as a car park, hotel, etc.)



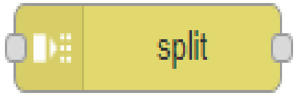
Search in around a certain point of the indicated service. It returns:
- servicesUri of all the services found,
- a GeoJSON containing a minimum of information about the services found, including the coordinates and the name of the service.

Executes Javascript code. For example, exploiting data arrived on input message and producing an output message in JSON

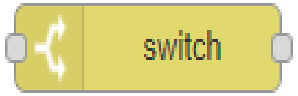


Display values in different modes on a dashboard. The node called single content accepts strings, numbers and html. The others only accept numbers.

Nodes for flow 2/2



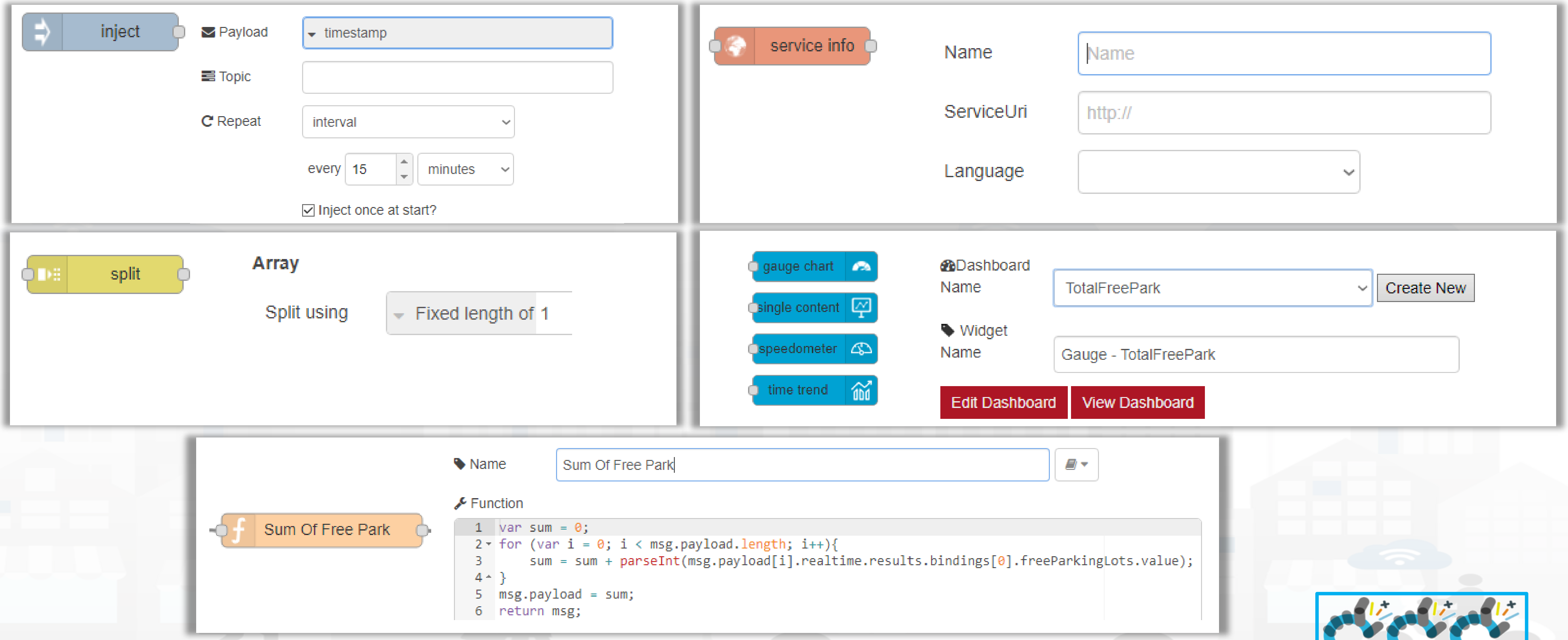
Divides the input message into multiple messages as indicated in the configuration.
If you have an array at the input, you can configure it to send each element of the array individually at the output.



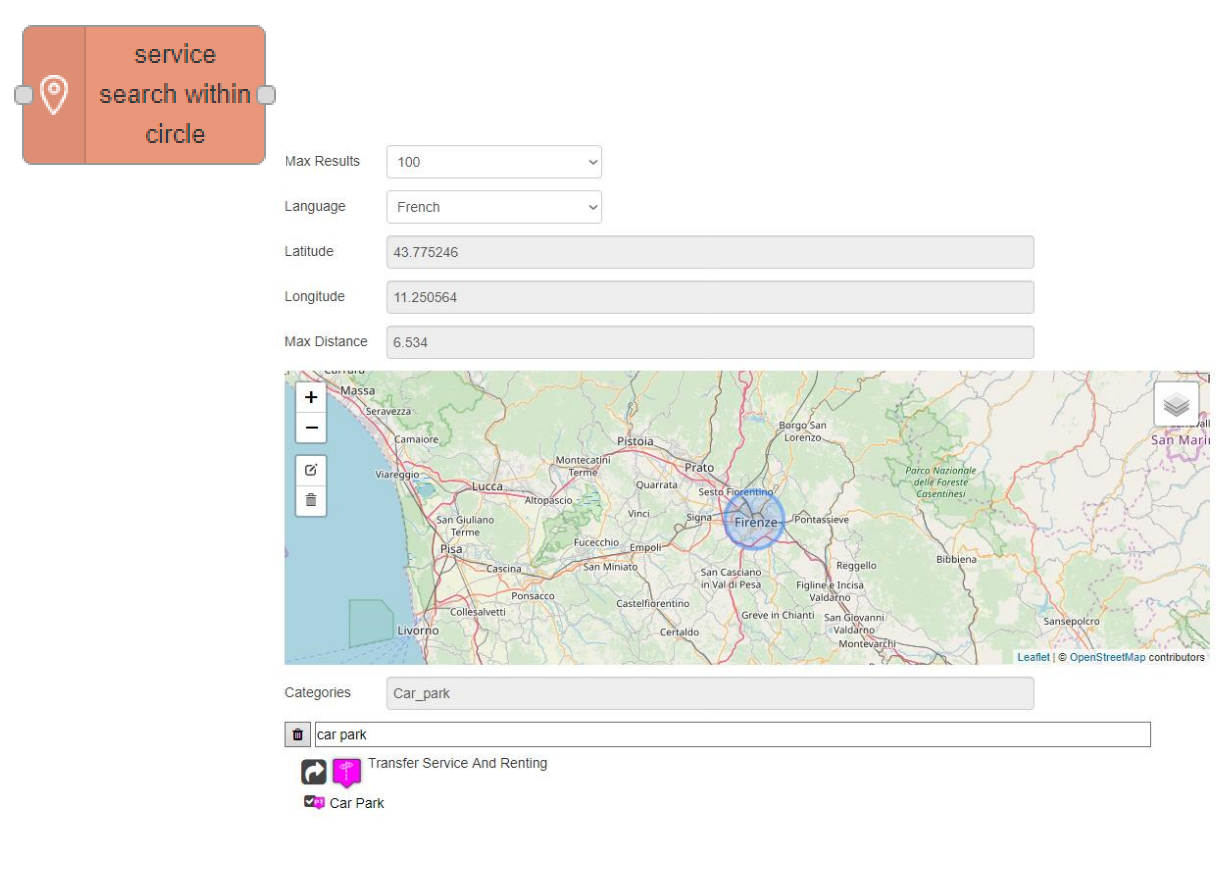
Treads the input message on possible different outputs based on a comparison made on the input message.

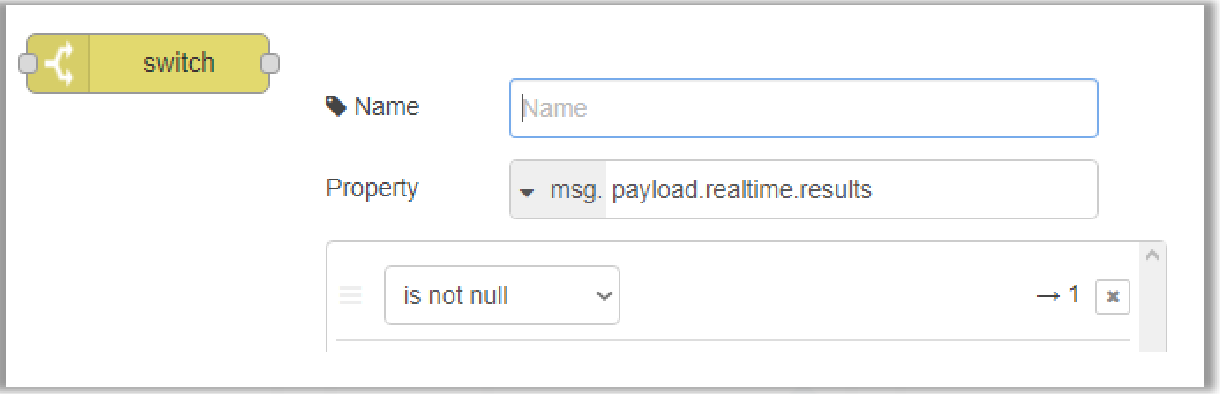
Operates in reverse order to the split. Joins the incoming messages in the mode indicated in the configuration.

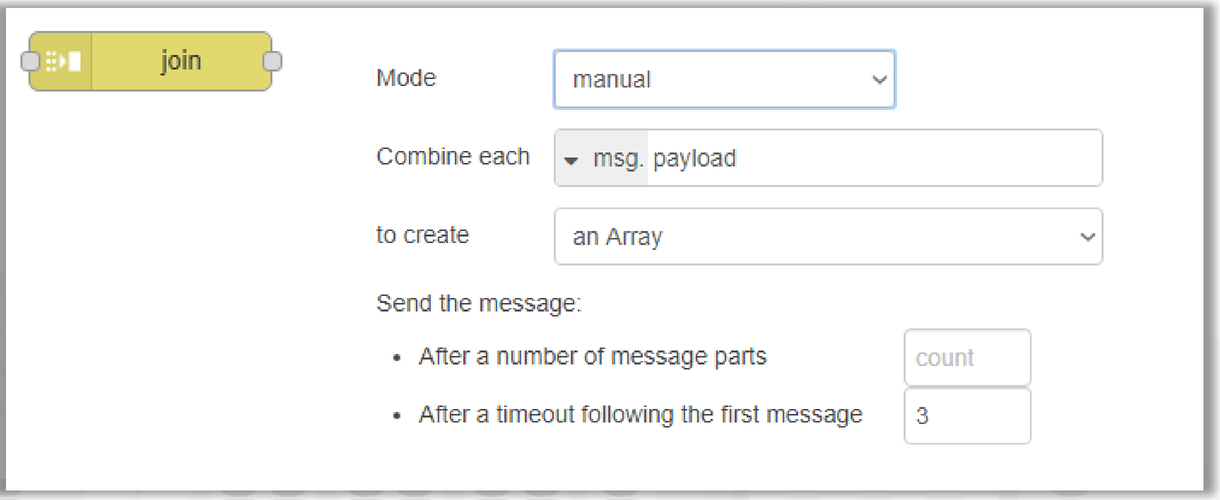
Nodes configuration 1/2



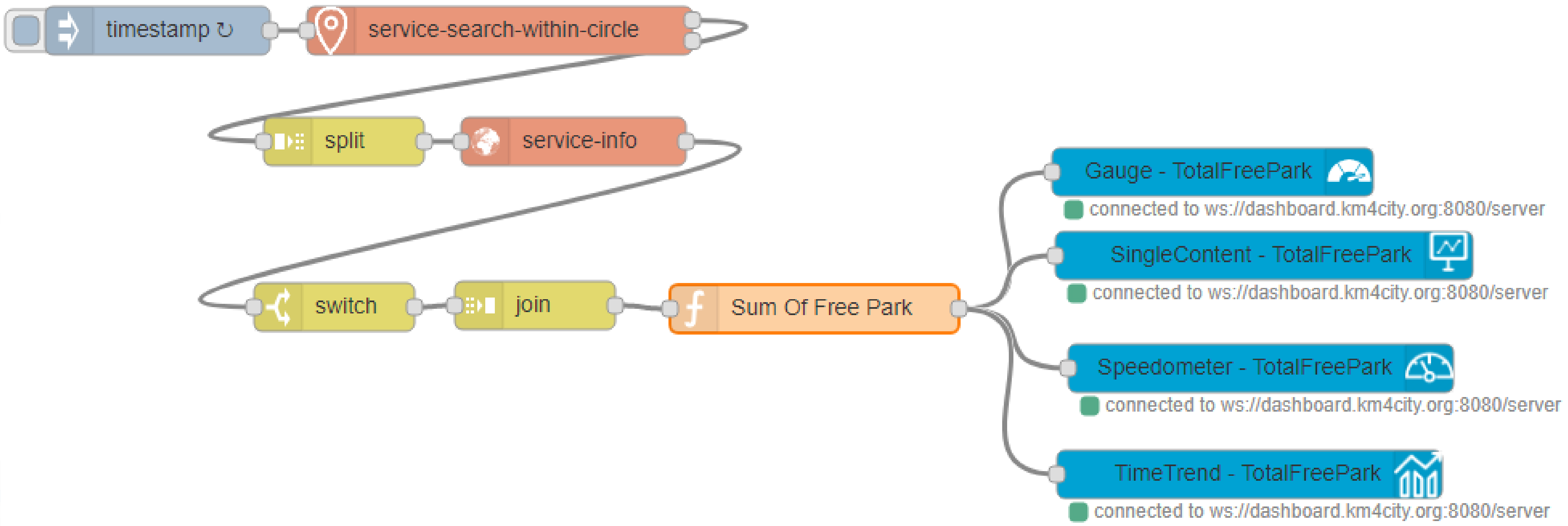
Nodes configuration 2/2



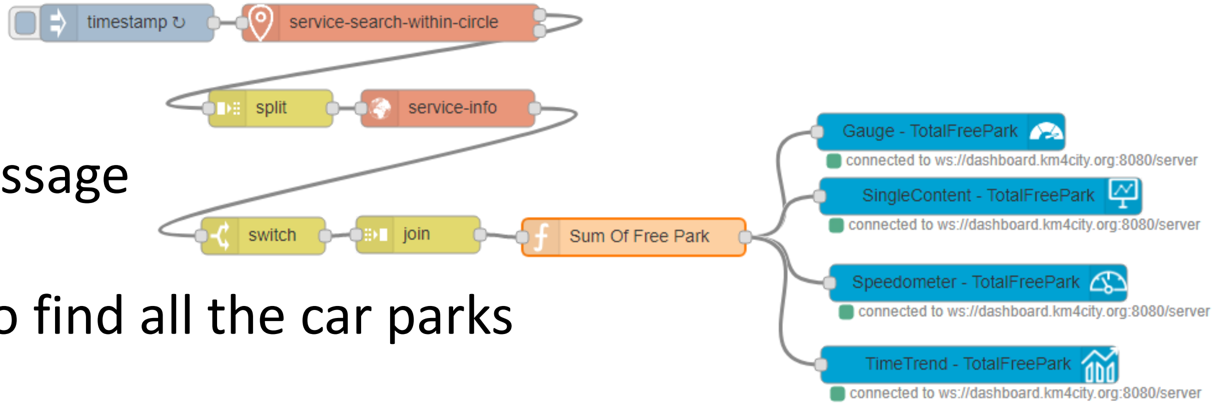




Nodes connections

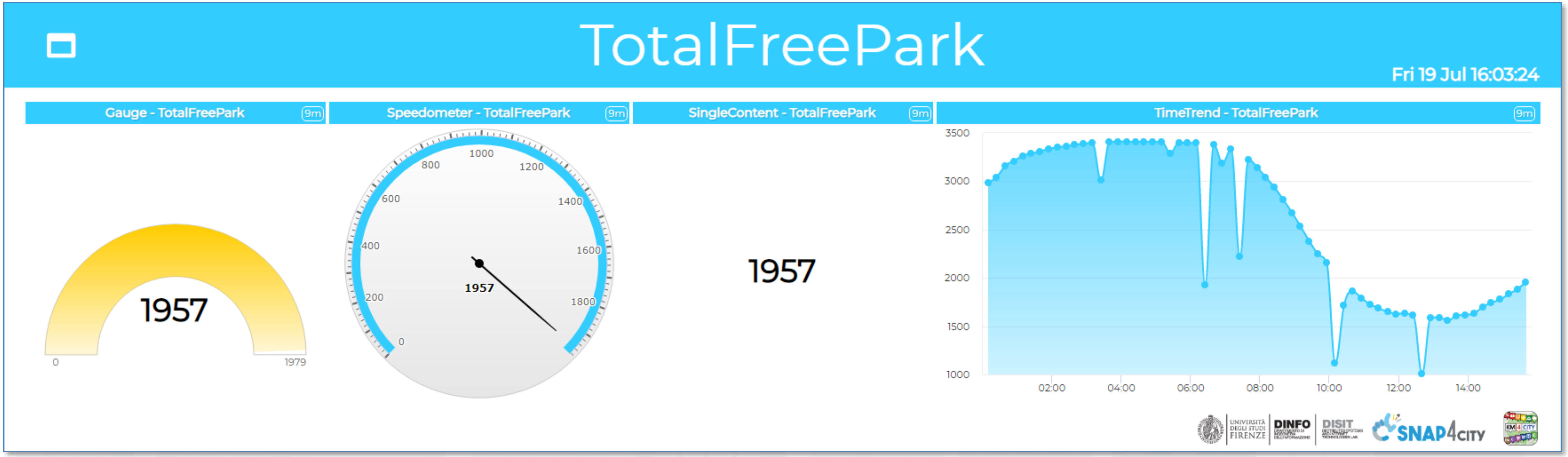


Nodes explanation 1/2



- Every 15 minutes the ***timestamp*** node sends a message to the ***service-search-within-circle node.***
  - When this message arrives, a request is sent to find all the car parks in the search area entered in configuration
- The first output of the ***service-search-within-circle*** node returns an array containing all the uri services of the car parks found. On such array we effect a ***split*** so that in input to ***service-info*** all the services uri arrive as distinct messages in a sequence.
- The configuration of the ***service-info*** node has not been filled because the URI service comes from the incoming message and is considered that URI service for retrieving service details.
- The ***switch*** and ***join*** nodes are used respectively to filter the results eliminating those parking lots that have no value in realtime (because for example that parking lot has no sensor) and bring together the various messages in a single array.
- On this array, node ***Sum of Free Park*** the perform the sum of the free places of all Florence parking and sent to the value to nodes representing Dashboard Widgets.
-

Result



https://main.snap4city.org/view/index.php?iddasboard=MTk2MA==

end DEMO Section 4

TOP

Processing data with IOT Applications (Exercitation)

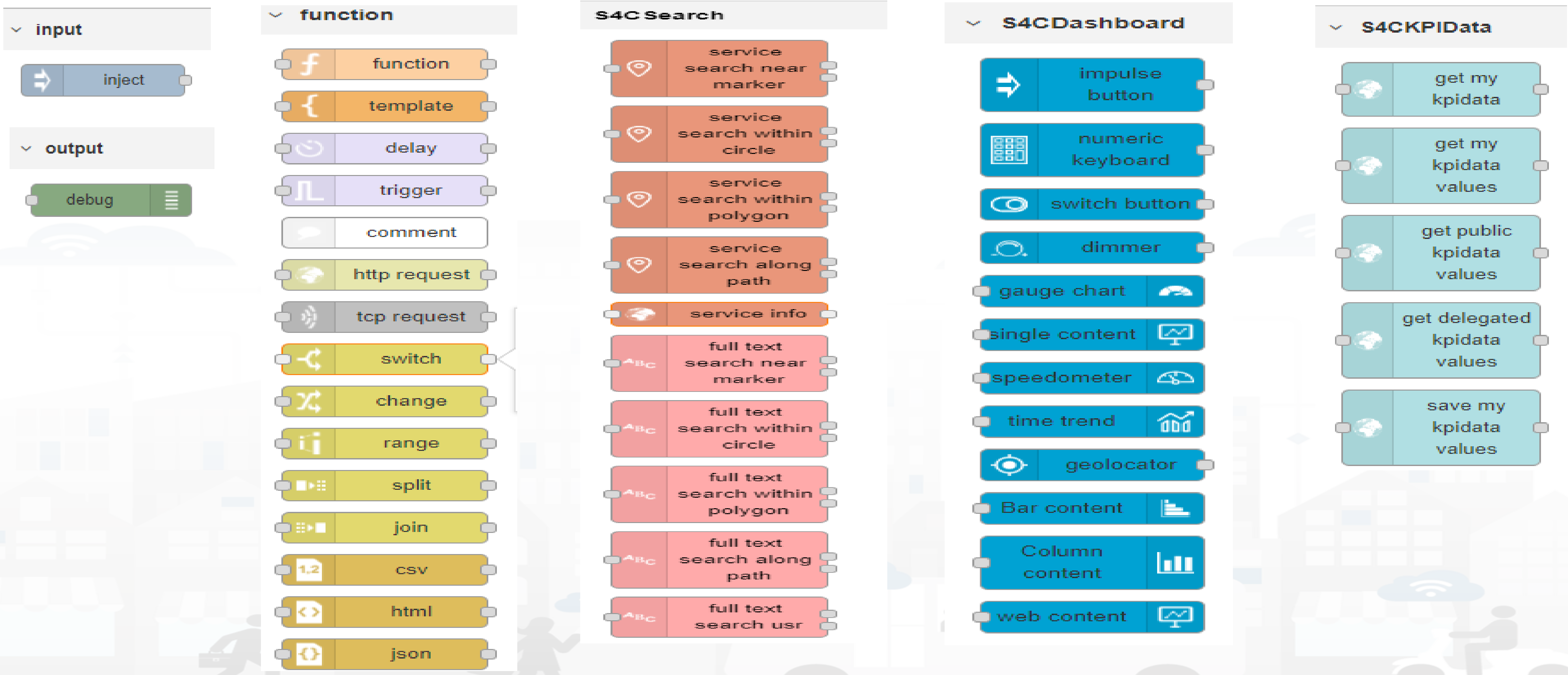
Average IoT Application

Create an IOT Application / flow that:

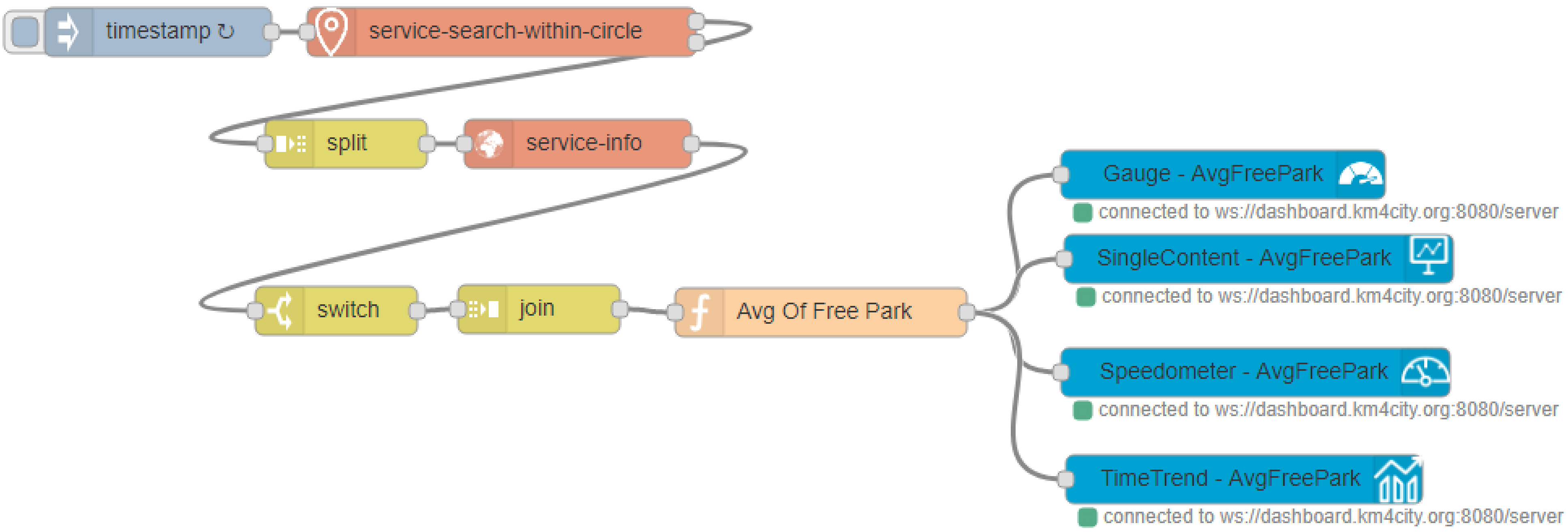
- reads a value from a list of service, for example the car parks in the Florence City Area, as seen in previous demo and
- calculates the average of Free Parking Lots and
- sends the value on a dashboard with the four possible nodes seen in the demo.

Execution Time: 20 Minutes

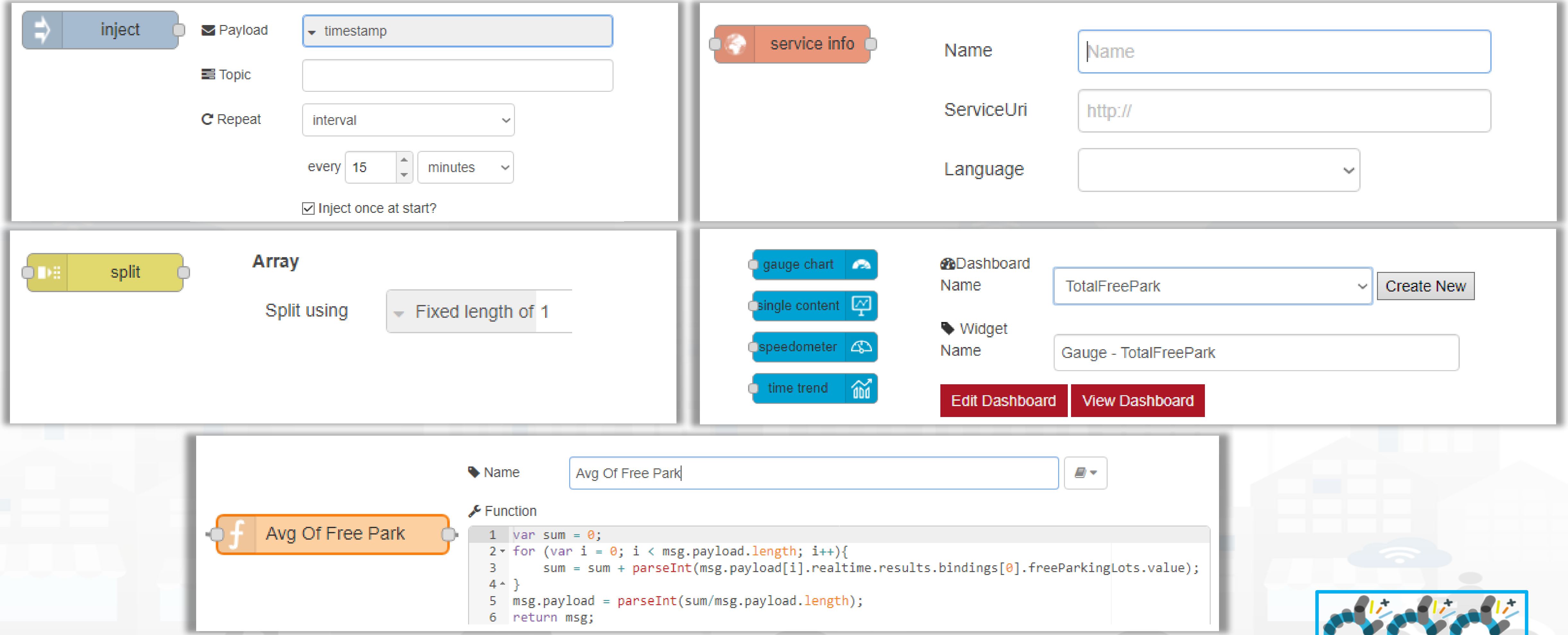
Ex2: Your NickName: ……………………………….



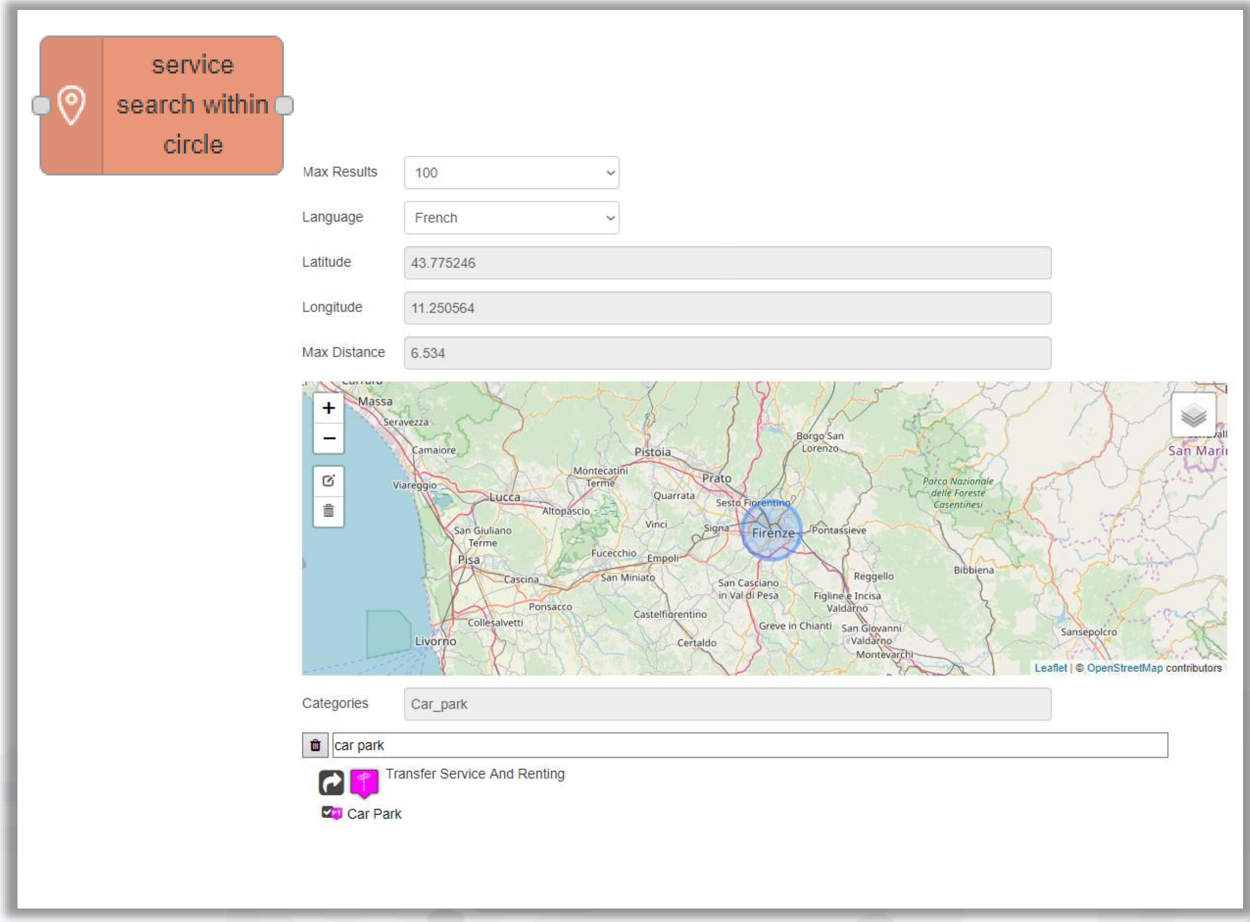
One Possible Solution

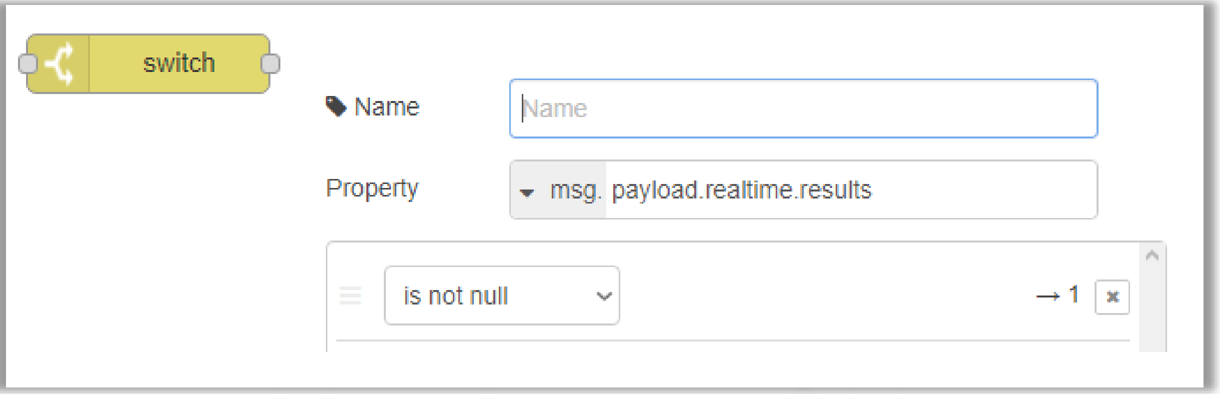


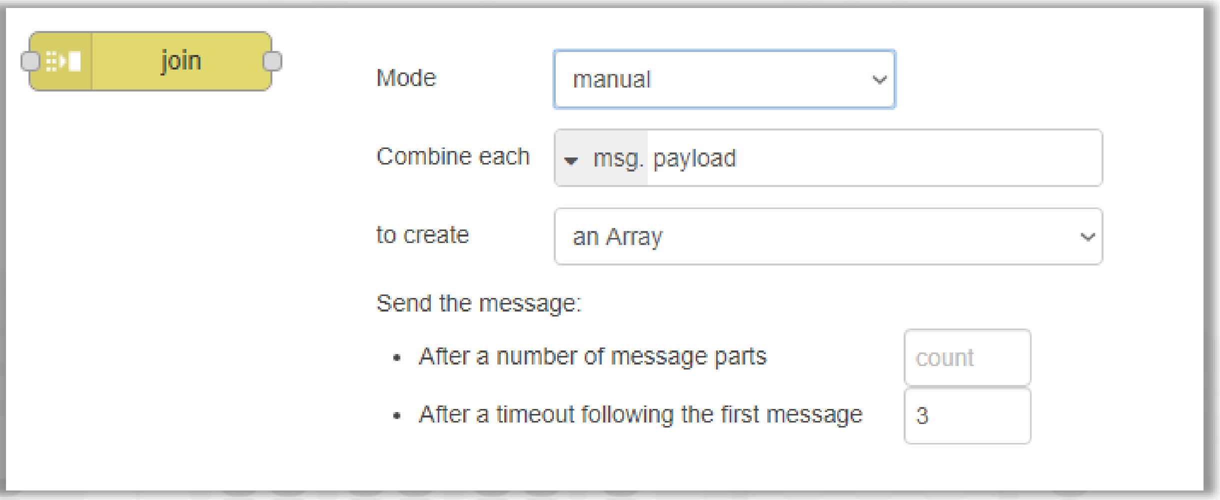
Nodes configuration 1/2



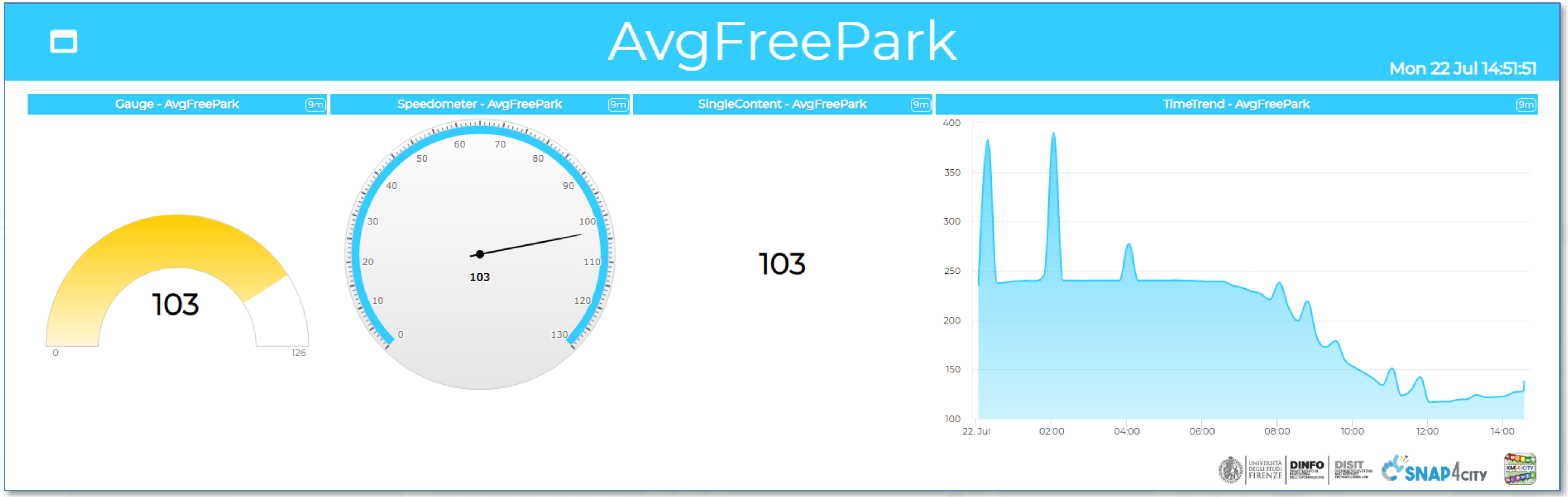
Nodes configuration 2/2







Resulting Dashboard



https://main.snap4city.org/view/index.php?iddasboard=MTk2Mg==

Self Training articles

- C. Badii, P. Bellini, A. Difino, P. Nesi, "Smart City IoT Platform Respecting GDPR Privacy and Security Aspects", accepted for publication on IEEE Access, 2020. 10.1109/ACCESS.2020.2968741 https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8966344
- C. Badii, P. Bellini, A. Difino, P. Nesi, G. Pantaleo, M. Paolucci, MicroServices Suite for Smart City Applications, Sensors, MDPI, 2019. https://doi.org/10.3390/s19214798
- C. Badii, P. Bellini, A. Difino, P. Nesi, "Sii-Mobility: an IOT/IOE architecture to enhance smart city services of mobility and transportation", Sensors, MDPI, 2019. https://doi.org/10.3390/s19010001 https://www.mdpi.com/1424-8220/19/1/1/pdf
- See also courses in ITALIANO: https://www.snap4city.org/485

TOP

Integration of External Services into IOT Applications

External Services

- **Any service having some API** (rest, WS, web services, etc..) can be called and exploited from IOT App. Also for example machine learning tool on AWS, MicroSoft cloud, Google Cloud. They can access to Snap4City Data by using Smart City API, ASCAPI

- Any REST Call can be transformed into a Block/Node for Node-red and thus exploited in IOT Apps.

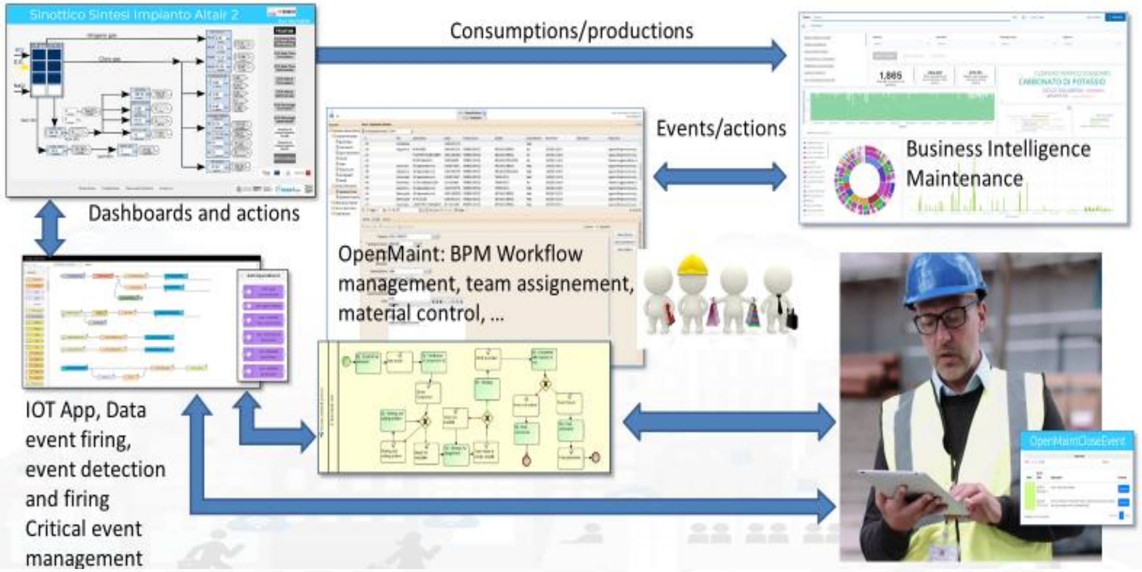
- **Example of integration of IOT App Snap4City with:**
  - Workflow management system for Ticketing and Incident Maintenance
  - Twitter Vigiliance, data collection
  - CKAN for Open Data gathering and publication
  - Video Wall for Control Room
  - Copernicus, etc.

TOP

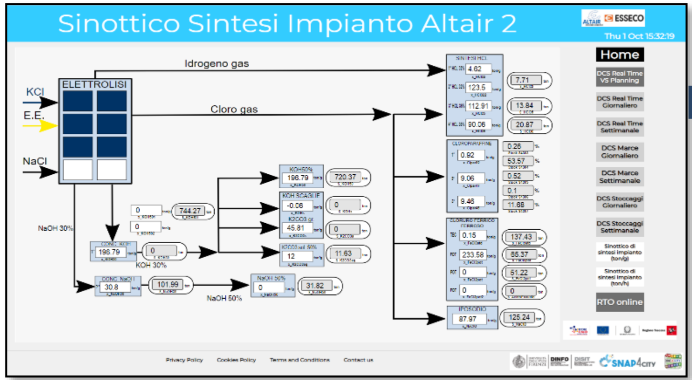
Integration with Ticketing Systems Workflows, Incident Management

Snap4City Maintenance Solution

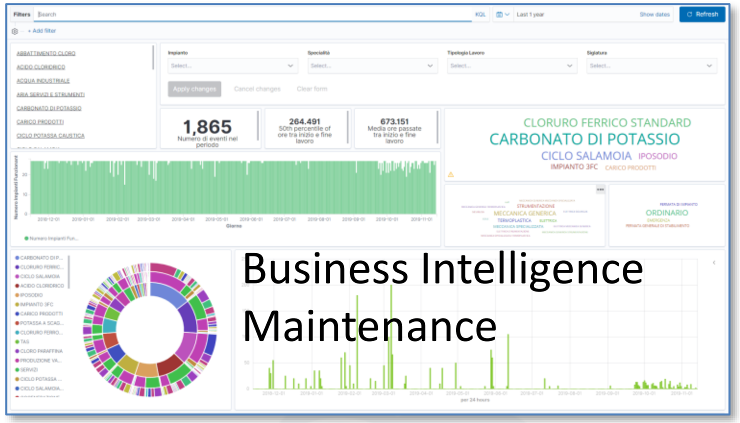
- **OpenMaint** open source solution for property & facility management which is a BPM;
  - Inventory of industry assets (movable, logistics, equipments, etc.)
  - Tickets management for corrective maintenance
  - User management with different levels of access
  - BIM Server integrated with OpenMaint
- **Snap4City OpenMaint Extension**
  - **Extended API** developed by Snap4City
    - Create new tickets
    - Manage steps, workflow
    - Collecting feedbacks and results from teams
    - Manage all phases of the workflow on the fields via IOT Apps and logics
    - The integration if via API and MicroServices into IOT App.
  - **MicroServices** integrated with Snap4City via IOT Applications
- **Business Intelligence** which is the **Snap4City tool based on** Elastic Search: which work on top of the database of tickets collected on OpenMaint
- **BIMServer** integration with Snap4City Dashboards;



Example of Integrated workflow



Consumptions/productions

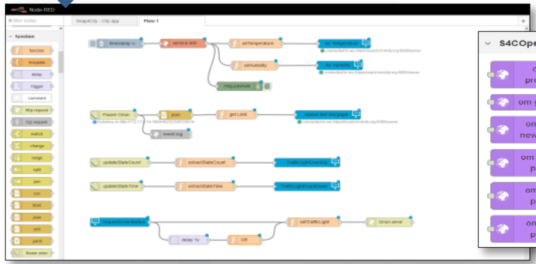


Events/actions

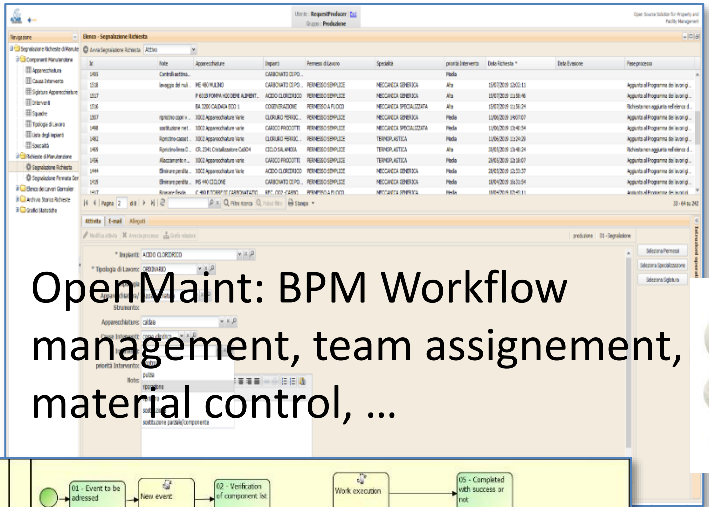
Business Intelligence

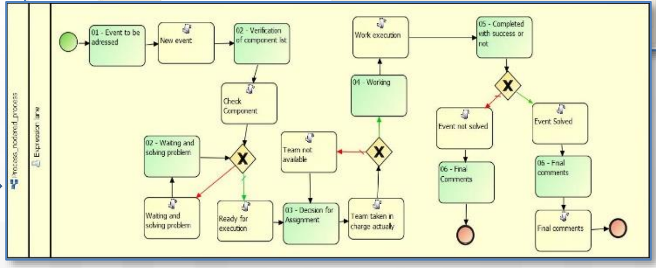
Maintenance

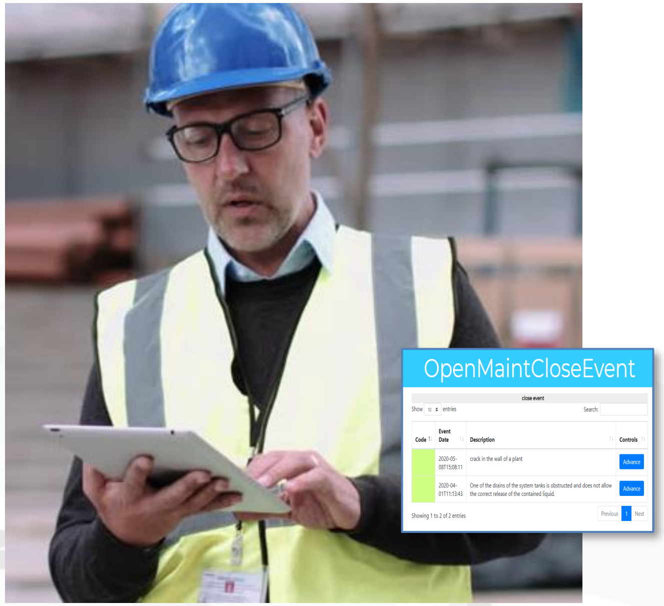
Dashboards and actions



OpenMaint: BPM Workflow management, team assignement, material control, …





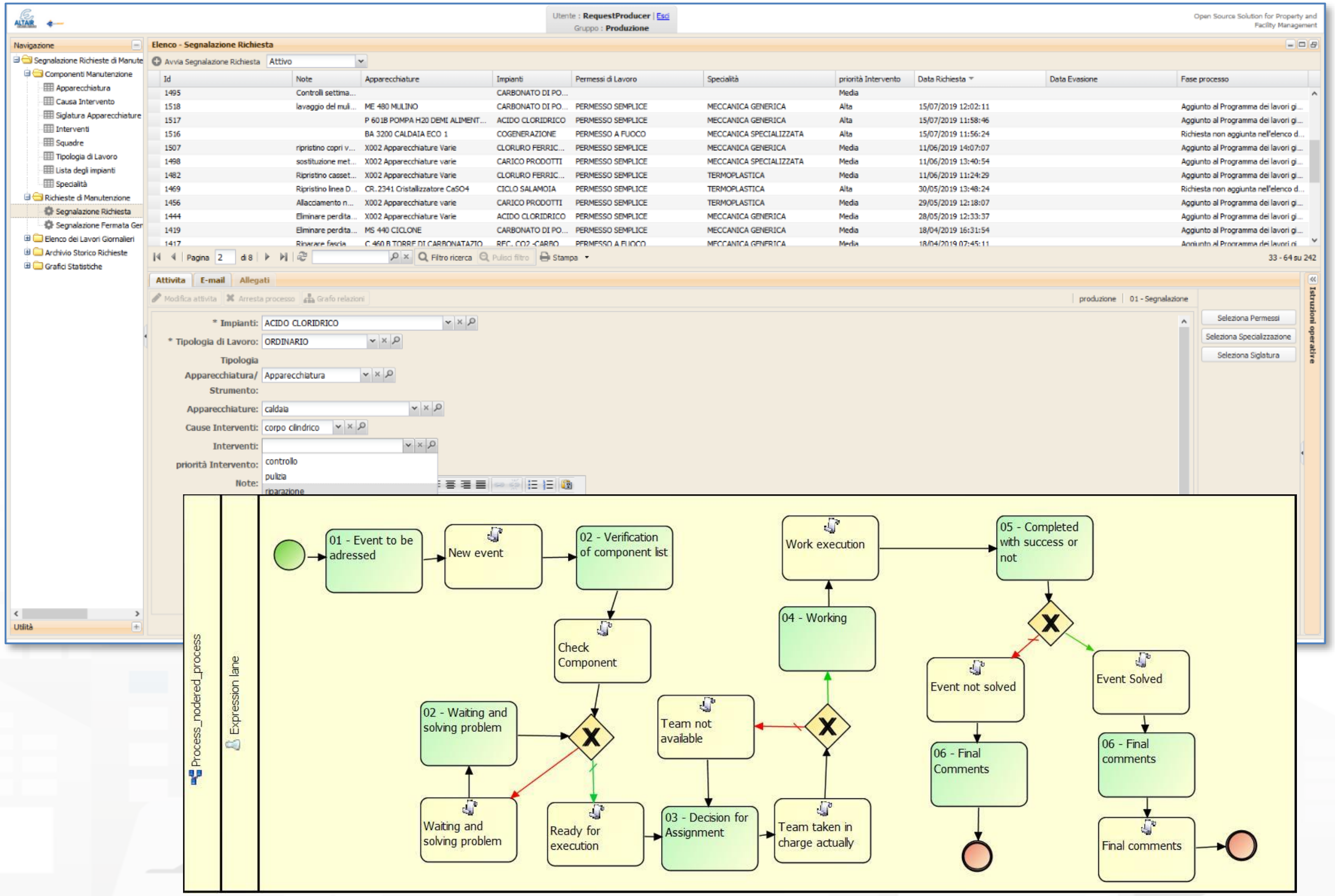


IOT App, Data event firing, event detection and firing Critical event management

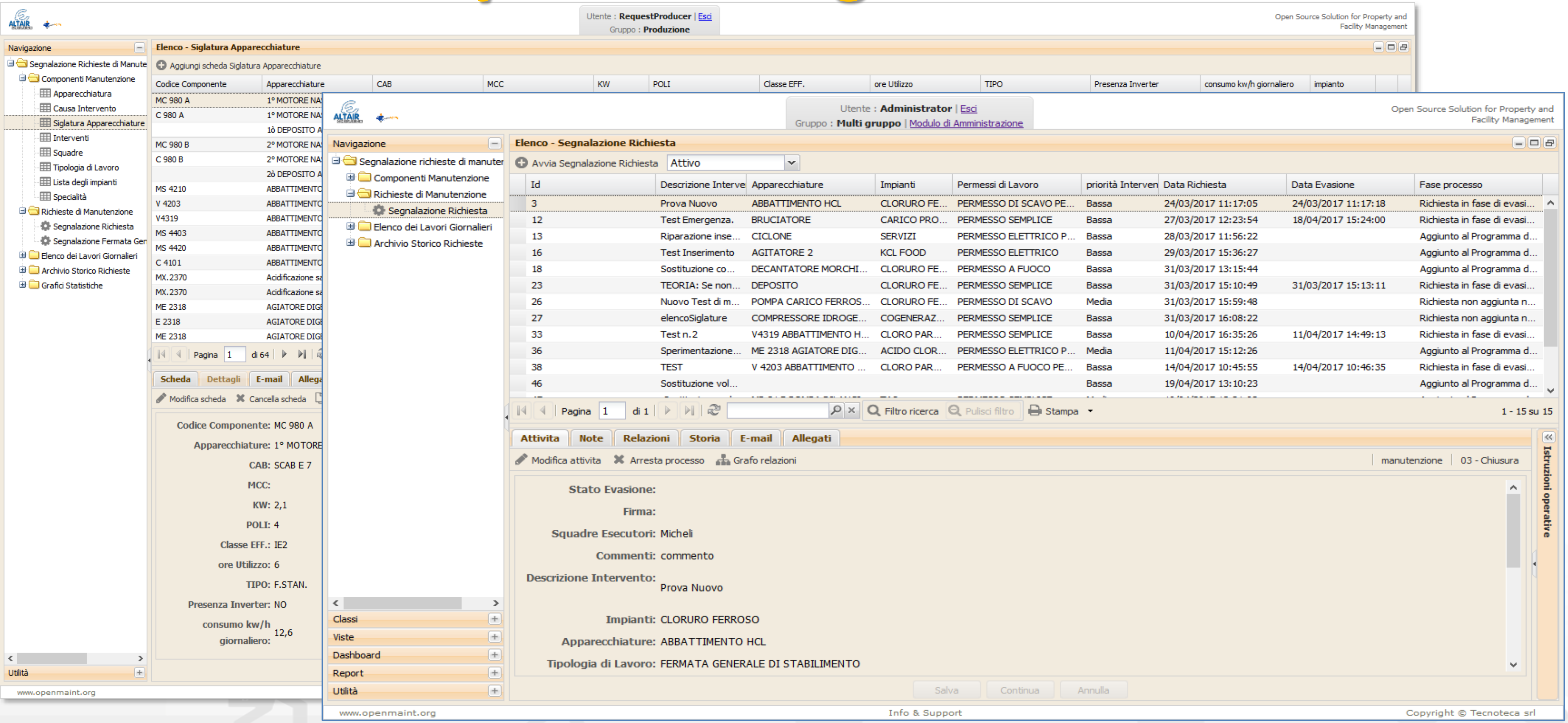
Integration with Ticketing Systems Workflow

- **Snap4City is integrated with OpenMaint Ticketing system. An Open Source solution for ticketing and workflow management, incident management.**

- Any ticketing systems can be integrated with Snap4City, by means of IOT Applications and Dashboards
- https://www.snap4city.org/597



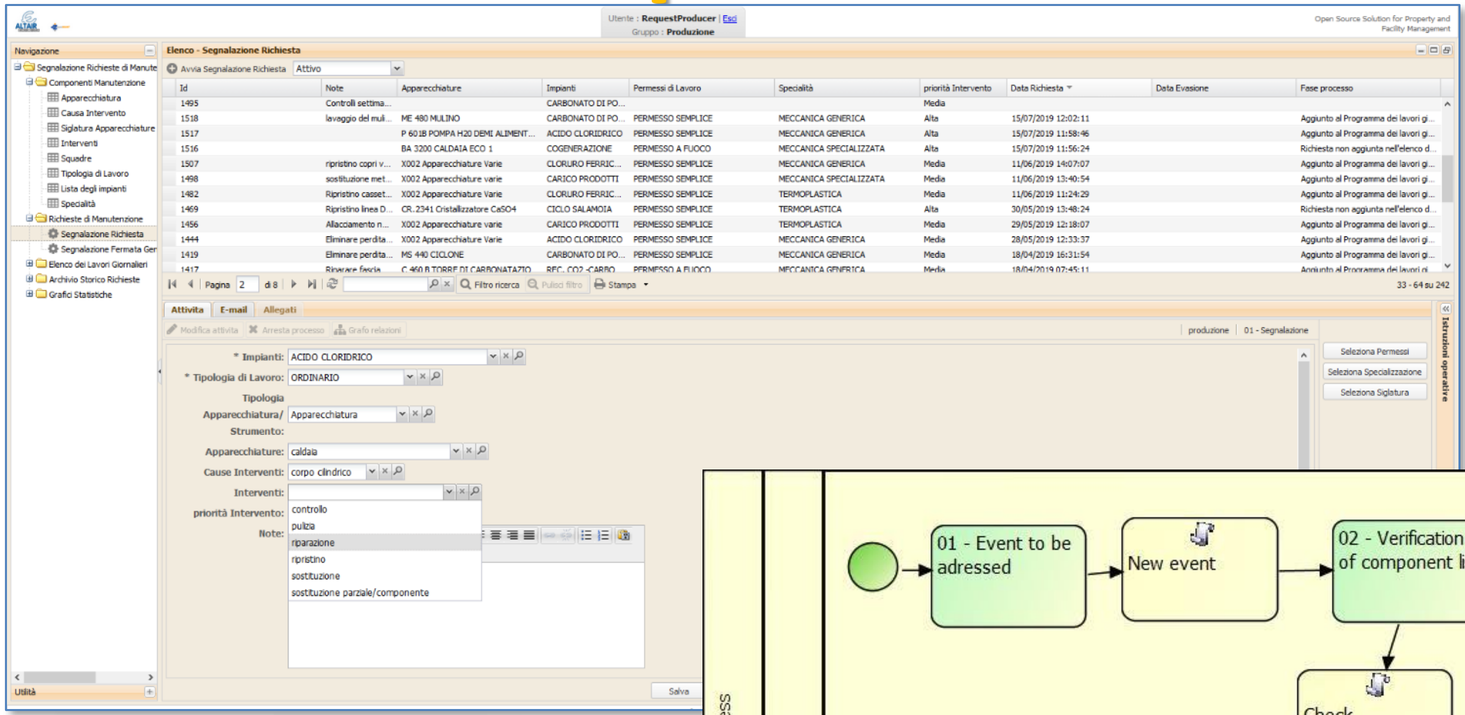
Assets inventory and management



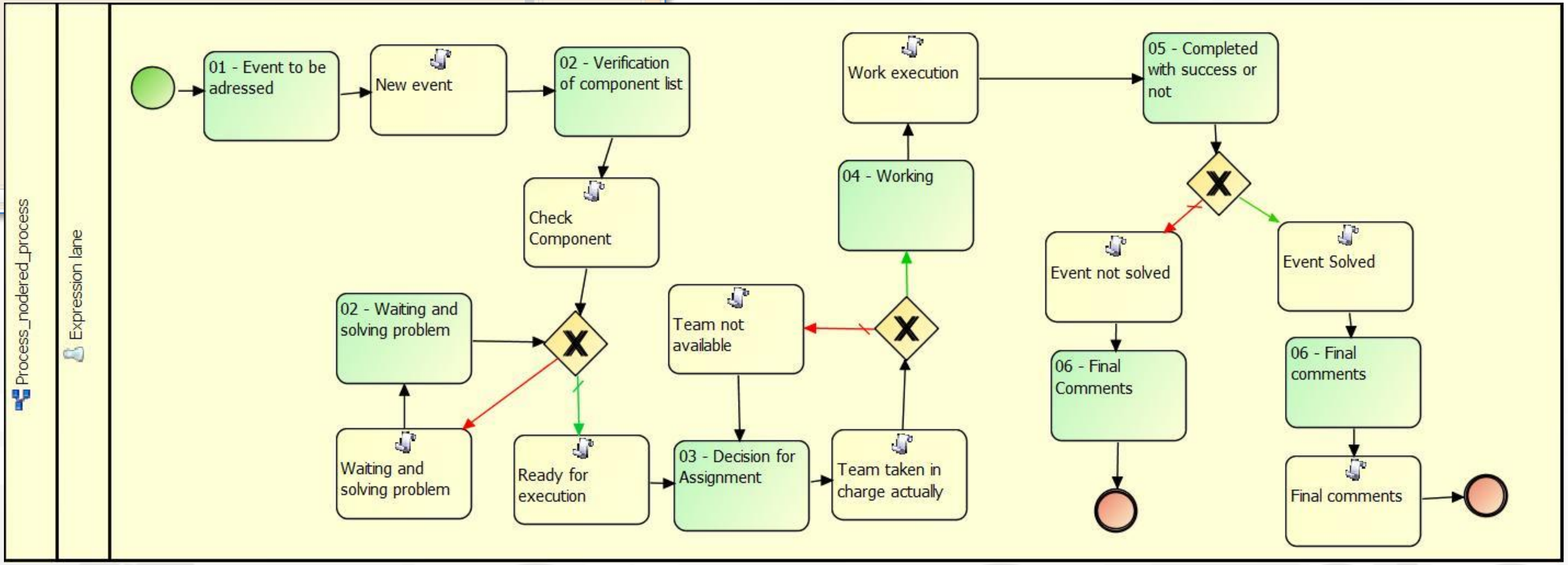
Solution for Asset Management and Maintenance

- Inventory of industry assets (movable, logistics, equipments, etc.)
- Tickets management for corrective maintenance
- Reports and Dashboards
- Predictive maintenance and Early Warning support via analytics
- Business Intelligence support
- User management with different levels of access

OpenMaint Ticketing System

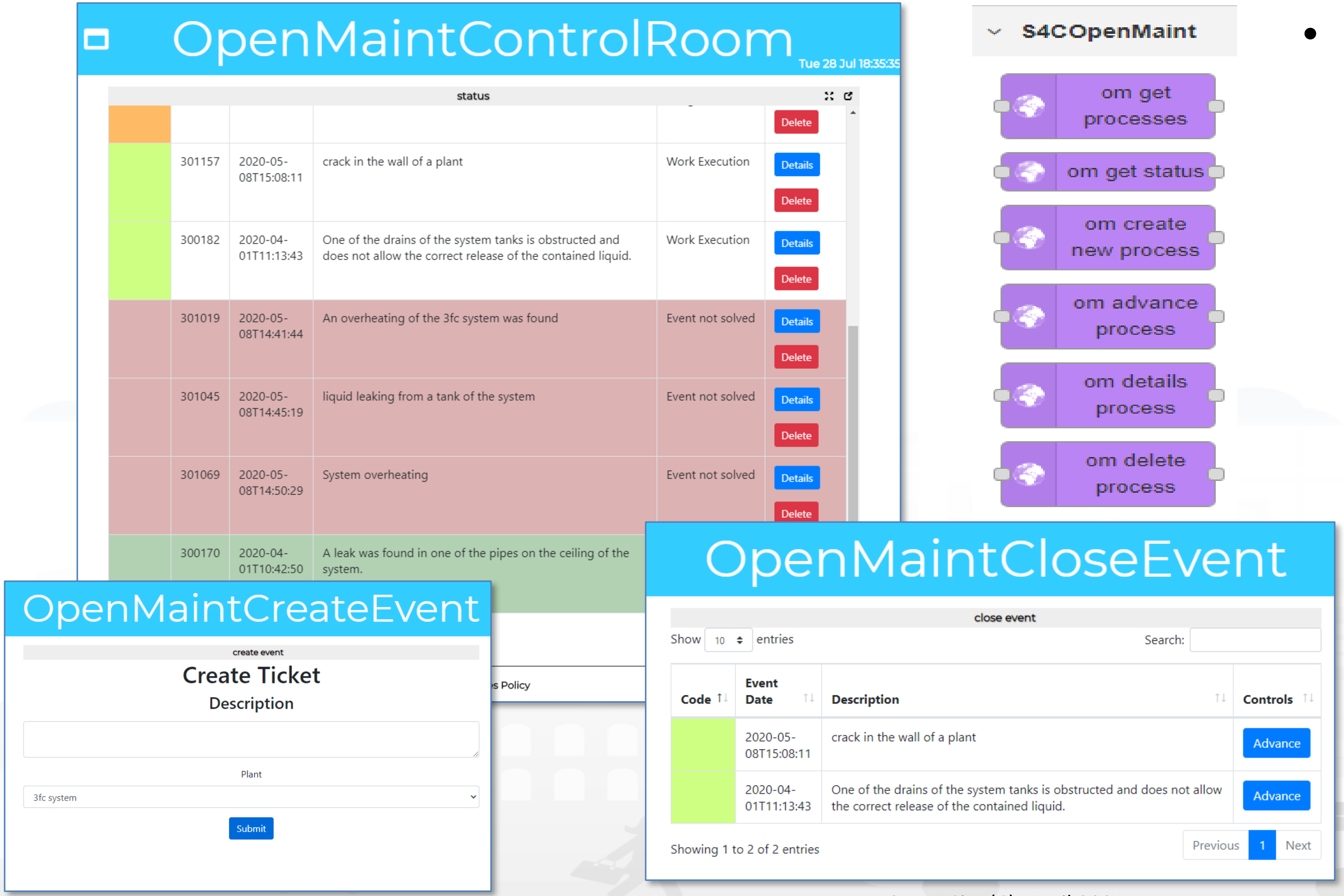


- Define the workflow
  - Activate events
  - Manage steps
  - Collecting feedbacks and results from teams

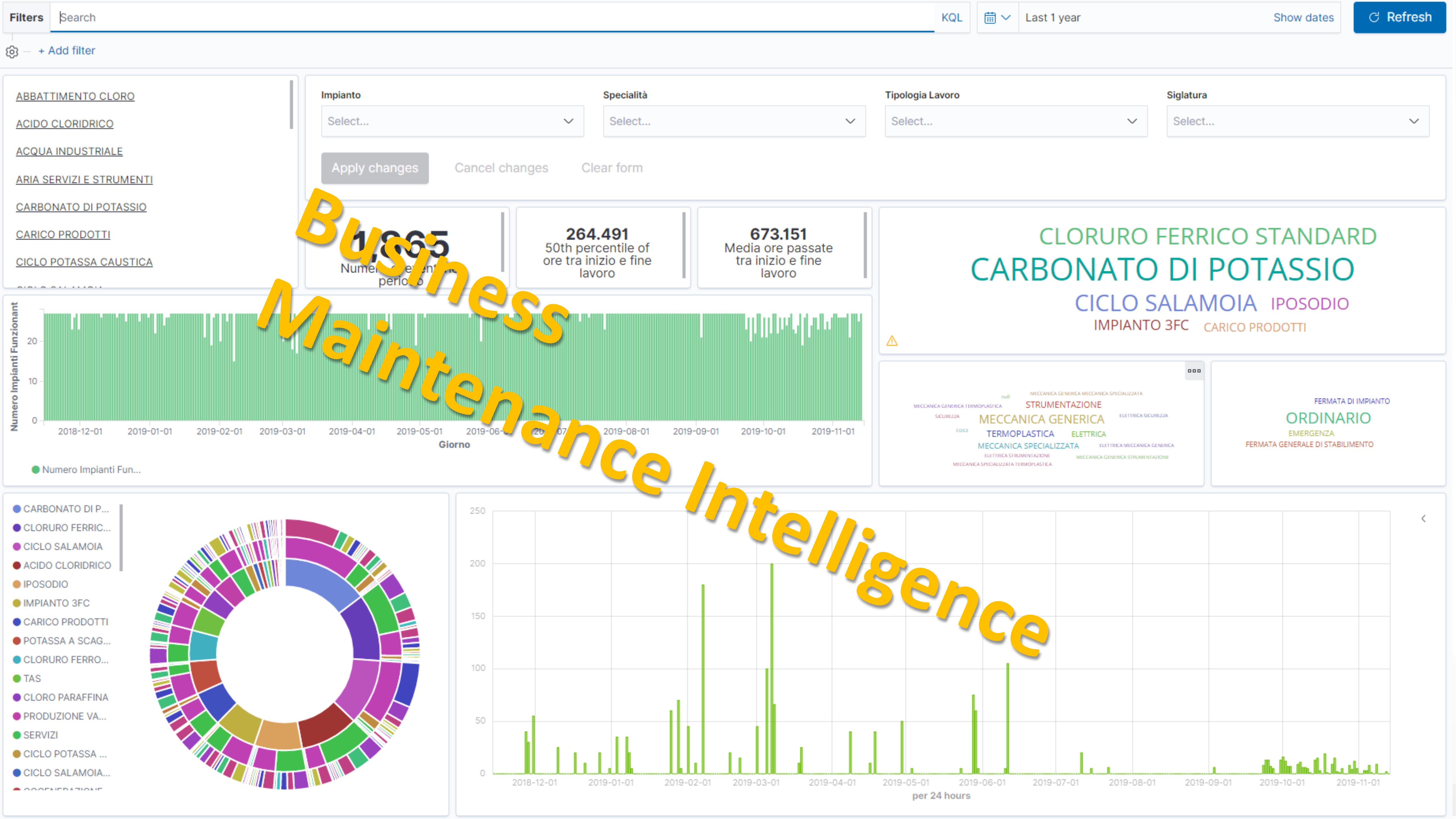


- Activities
- Teams
- Phases
- Athorization
- Checking points
- Events and conditions
- …

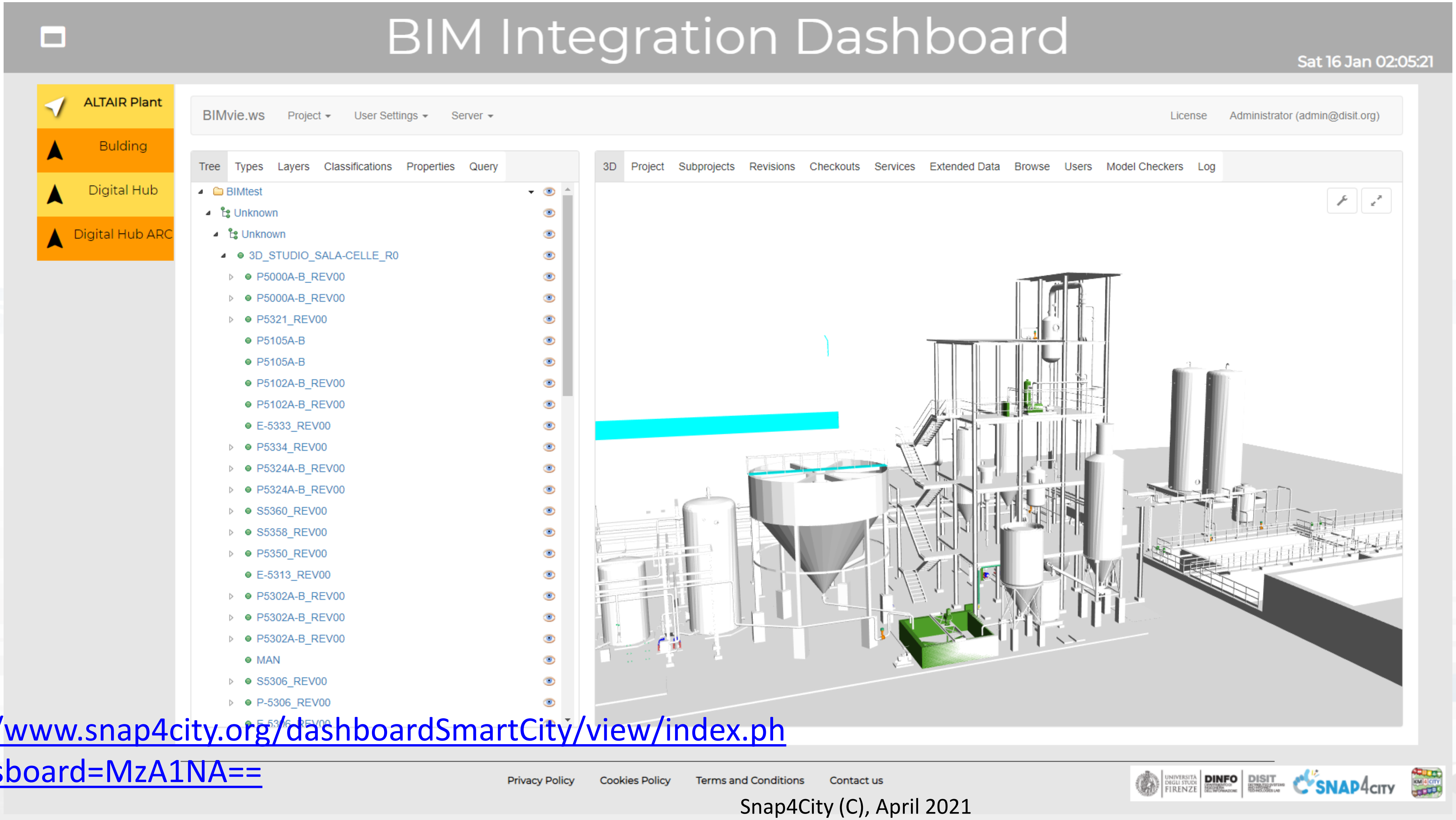
Dashboards



- **Snap4City can**
  - Create new tickets
  - Manage steps, workflow
  - Collecting feedbacks and results from teams
  - Manage all phases of the workflow on the fields via IOT Apps and logics
  - The integration if via API and MicroServices into IOT App.


Business Maintenance Intelligence
Filters
Search
KQL
Last 1 year
Show dates
Refresh
+ Add filter
ABBATTIMENTO CLORO
ACIDO CLORIDRICO
ACQUA INDUSTRIALE
ARIA SERVIZI E STRUMENTI
CARBONATO DI POTASSIO
CARICO PRODOTTI
CICLO POTASSA CAUSTICA
Impianto
Specialità
Tipologia Lavoro
Siglatura
Select...
Apply changes
Cancel changes
Clear form
264.491
50th percentile of ore tra inizio e fine lavoro
673.151
Media ore passate tra inizio e fine lavoro
CLORURO FERRICO STANDARD
CARBONATO DI POTASSIO
CICLO SALAMOIA
IPOSODIO
IMPIANTO 3FC
CARICO PRODOTTI
Numero Impianti Funzionant
Giorno
Numero Impianti Fun...
STRUMENTAZIONE
MECCANICA GENERICA
TERMOPLASTICA
ELETTRICA
MECCANICA SPECIALIZZATA
FERMATA DI IMPIANTO
ORDINARIO
EMERGENZA
FERMATA GENERALE DI STABILIMENTO
CARBONATO DI P...
CLORURO FERRIC...
CICLO SALAMOIA
ACIDO CLORIDRICO
IPOSODIO
IMPIANTO 3FC
CARICO PRODOTTI
POTASSA A SCAG...
CLORURO FERRO...
TAS
CLORO PARAFFINA
PRODUZIONE VA...
SERVIZI
CICLO POTASSA ...
CICLO SALAMOIA...
per 24 hours

BIM view of the Altair Chemical Plant



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA1NA==

TOP

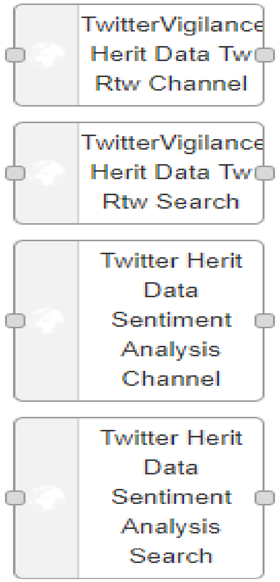
Integration with

Twitter Vigilance

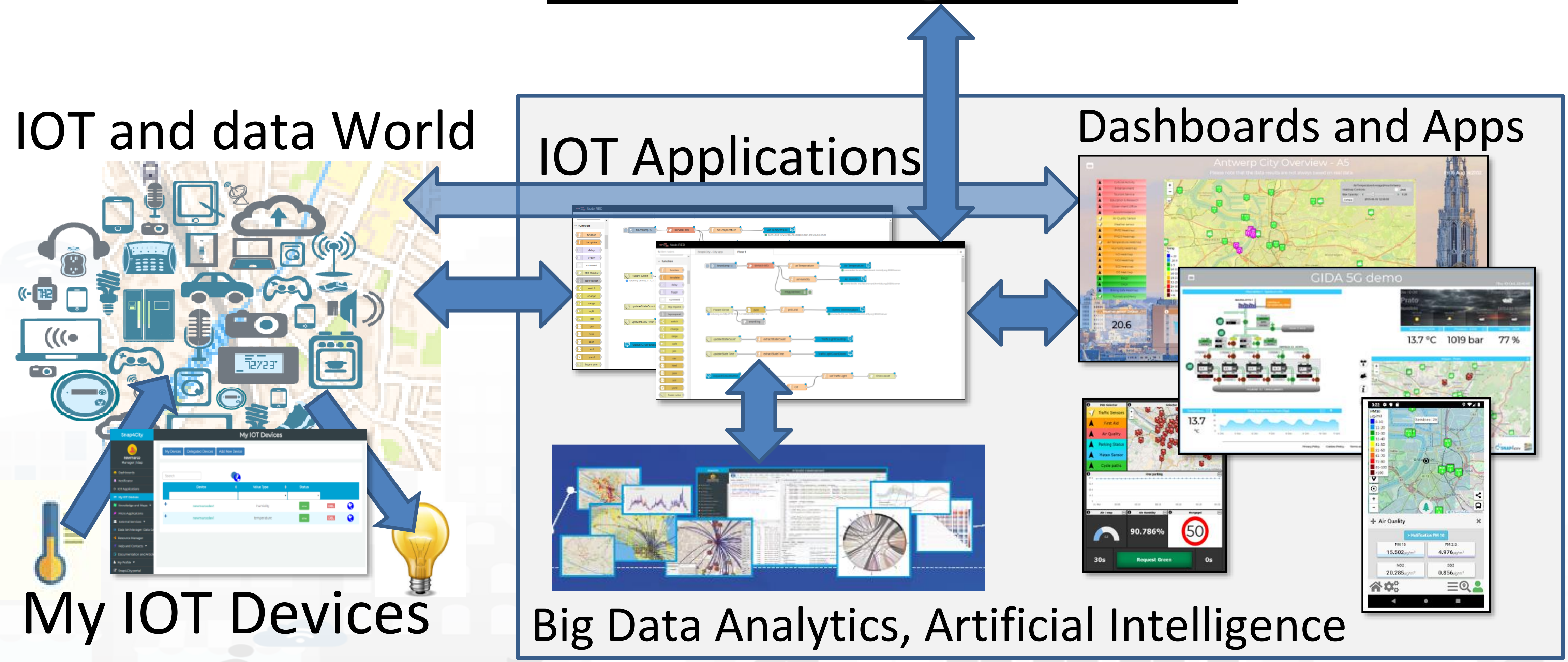
Twitter Vigilance

- A separate tool of DISIT lab: provided in different versions
  - Described into Data Analytic part of the training course
- It can be used to:
  - Collect and Monitor Twitter data
  - Perform Multilingual processing: English, France, Italia, etc.
  - Estimated in real time metrics: volume, sentiment, ratio,
  - Provide data into the smart city and thus alerting and firing
  - Compute predictions
  - Set up Early Warning systems

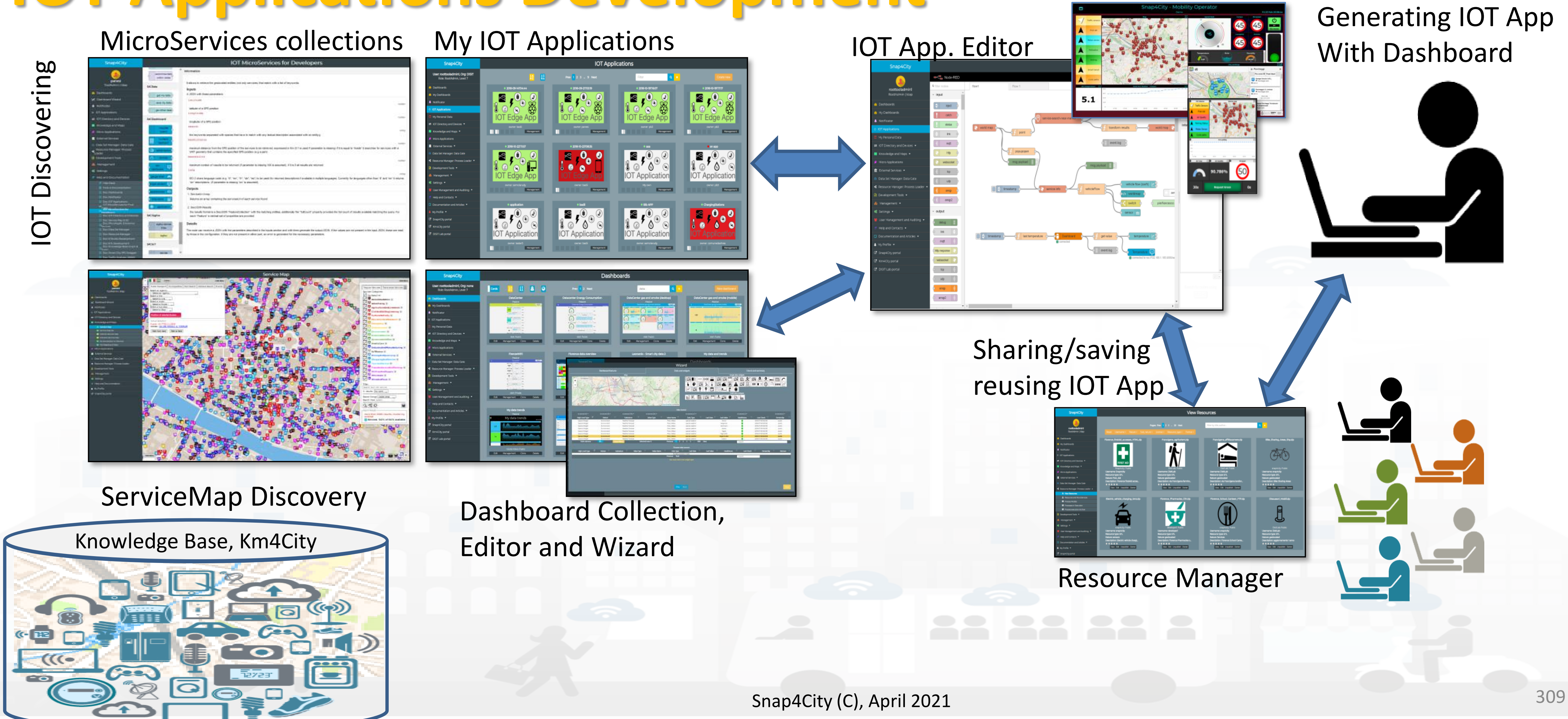
- **Snap4City** integration is done via API and MicroServices into IOT App.



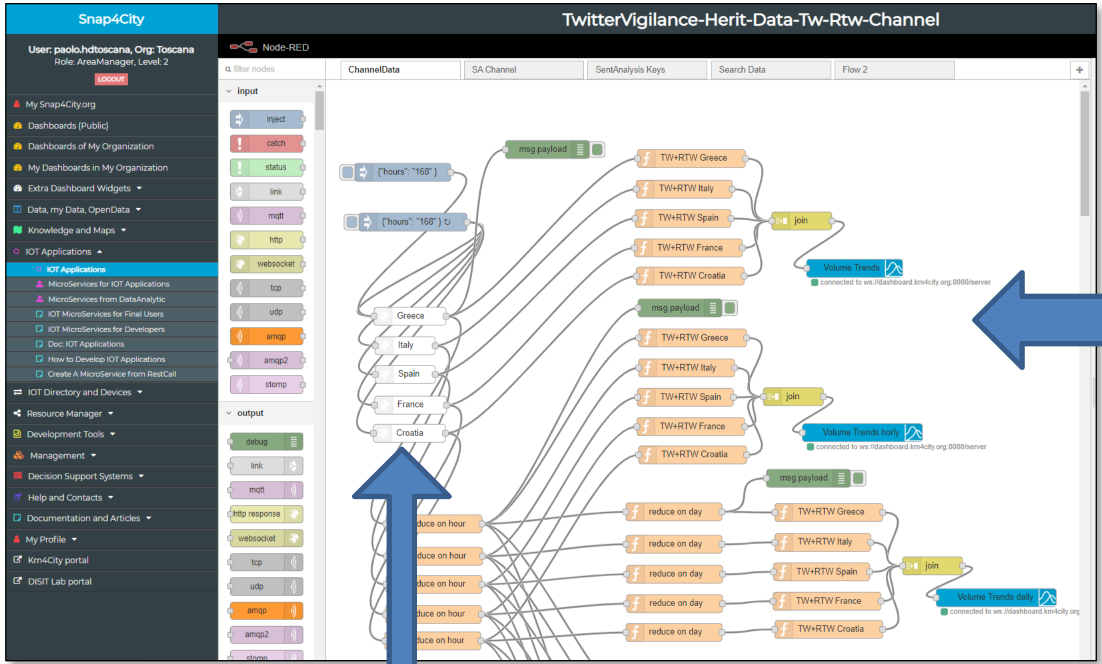
Twitter Vigilance

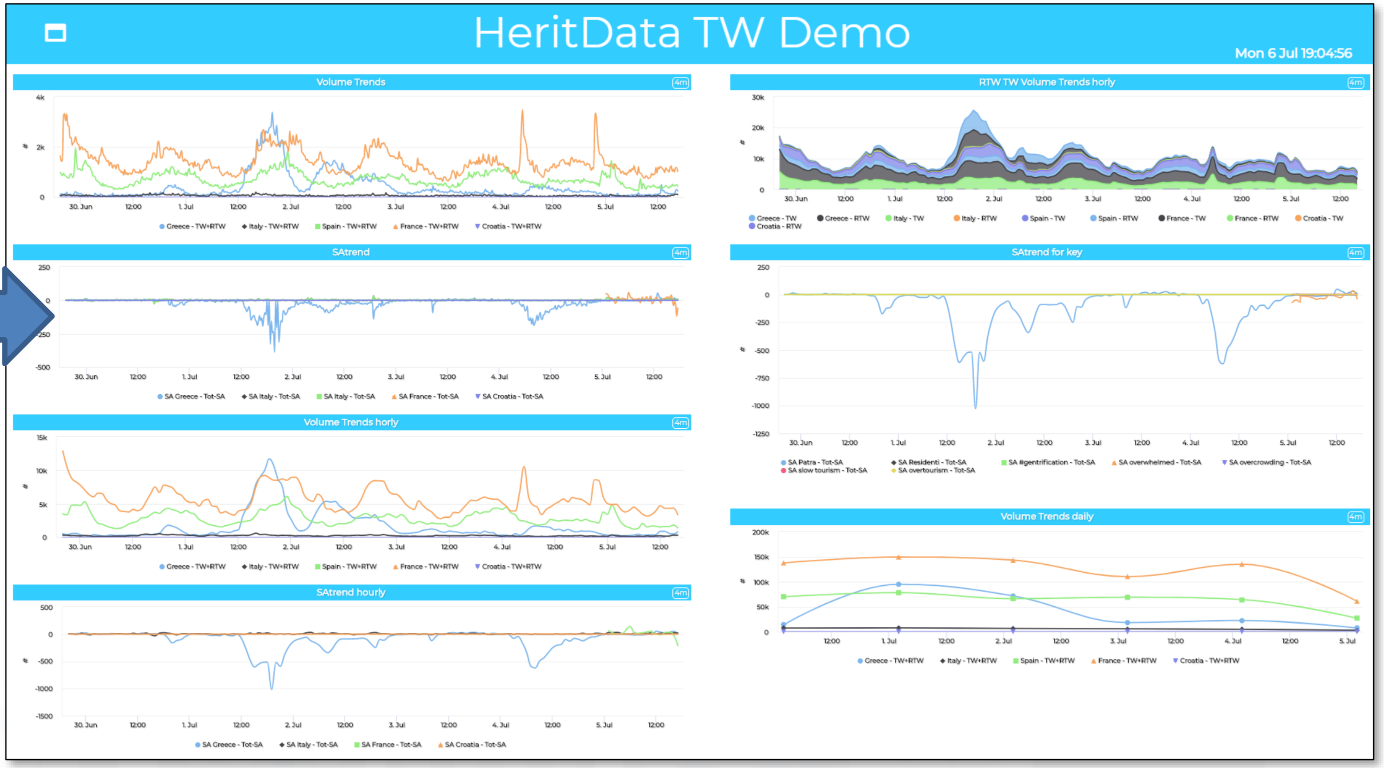


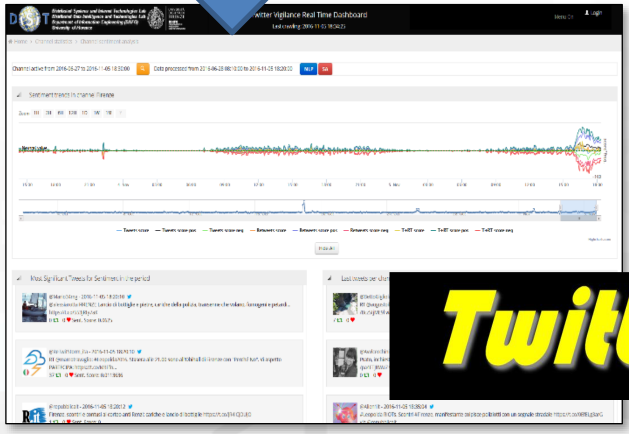
IOT Applications Development



Twitter Vigilance

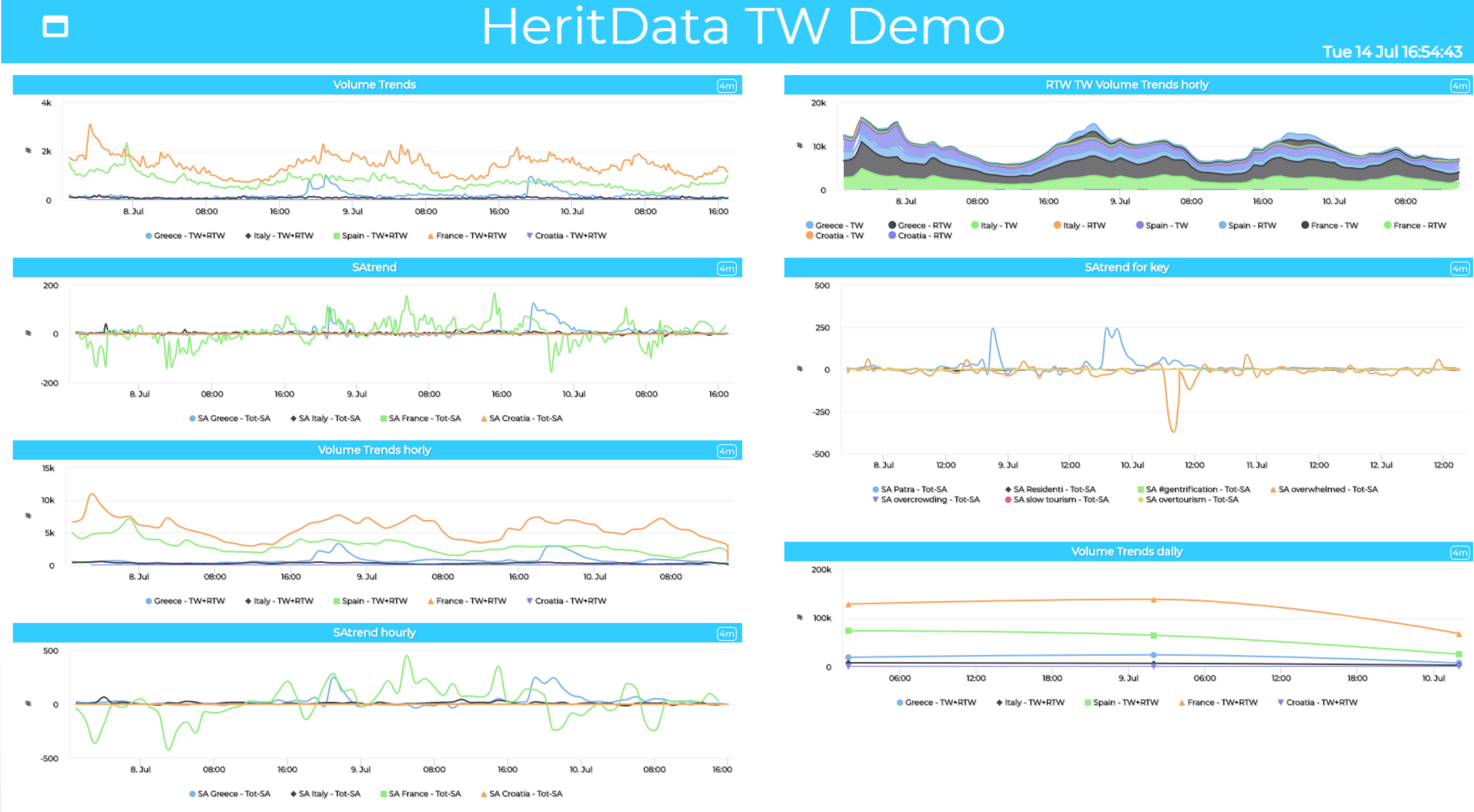


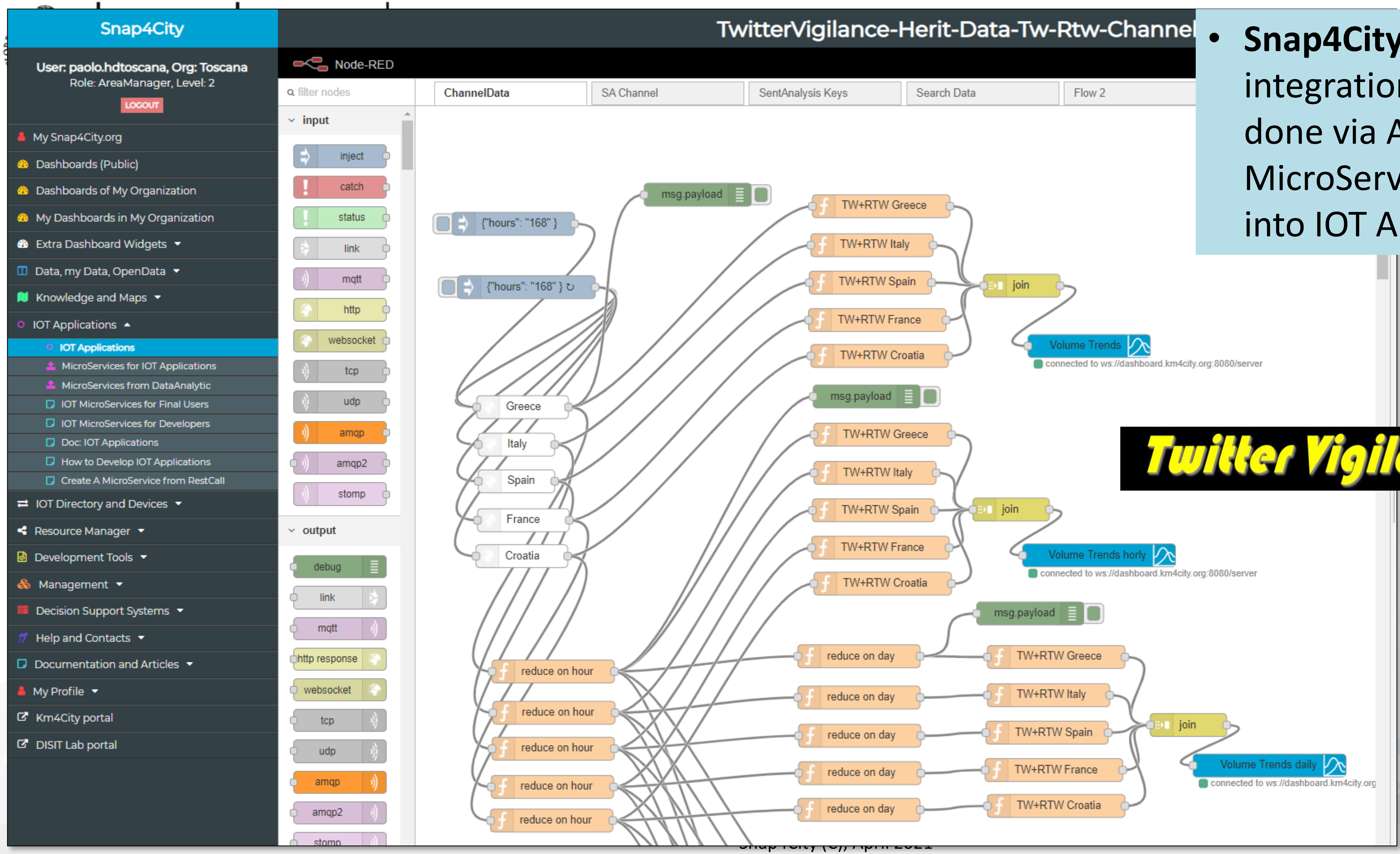




Twitter Vigilance

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjc3NQ==


HeritData TW Demo
Tue 14 Jul 16:54:43
Volume Trends
4m
Greece - TW+RTW
Italy - TW+RTW
Spain - TW+RTW
France - TW+RTW
Croatia - TW+RTW
RTW TW Volume Trends horly
Greece - TW
Greece - RTW
Italy - TW
Italy - RTW
Spain - TW
Spain - RTW
France - TW
France - RTW
Croatia - TW
Croatia - RTW
SAtrend
SA Greece - Tot-SA
SA Italy - Tot-SA
SA France - Tot-SA
SA Croatia - Tot-SA
SAtrend for key
SA Patra - Tot-SA
SA Residenti - Tot-SA
SA #gentrification - Tot-SA
SA overwhelmed - Tot-SA
SA overcrowding - Tot-SA
SA slow tourism - Tot-SA
SA overtourism - Tot-SA
Volume Trends horly
Volume Trends daily
SAtrend hourly



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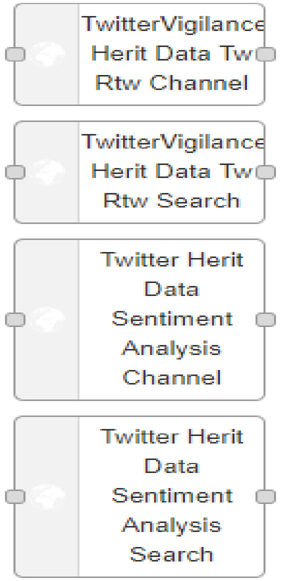
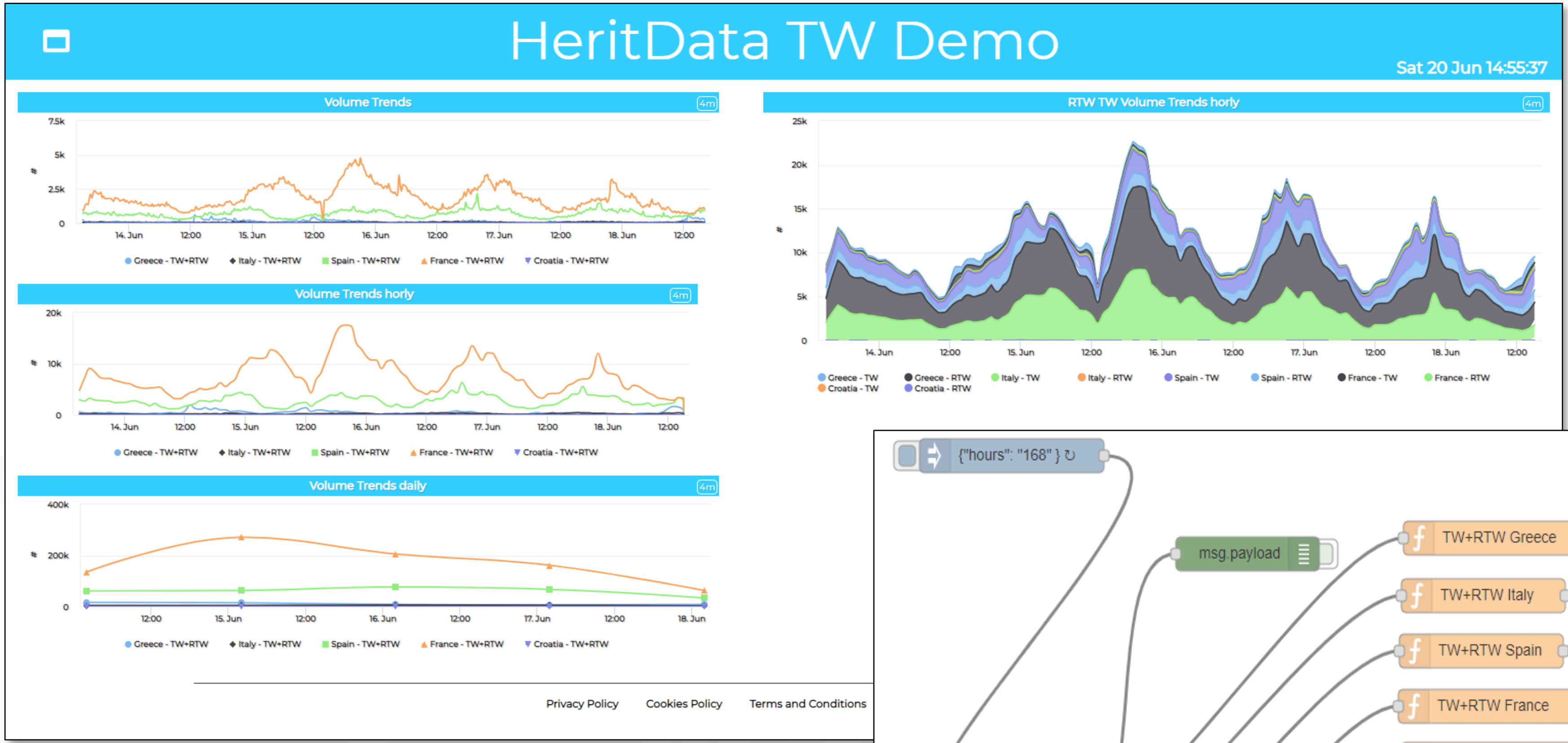
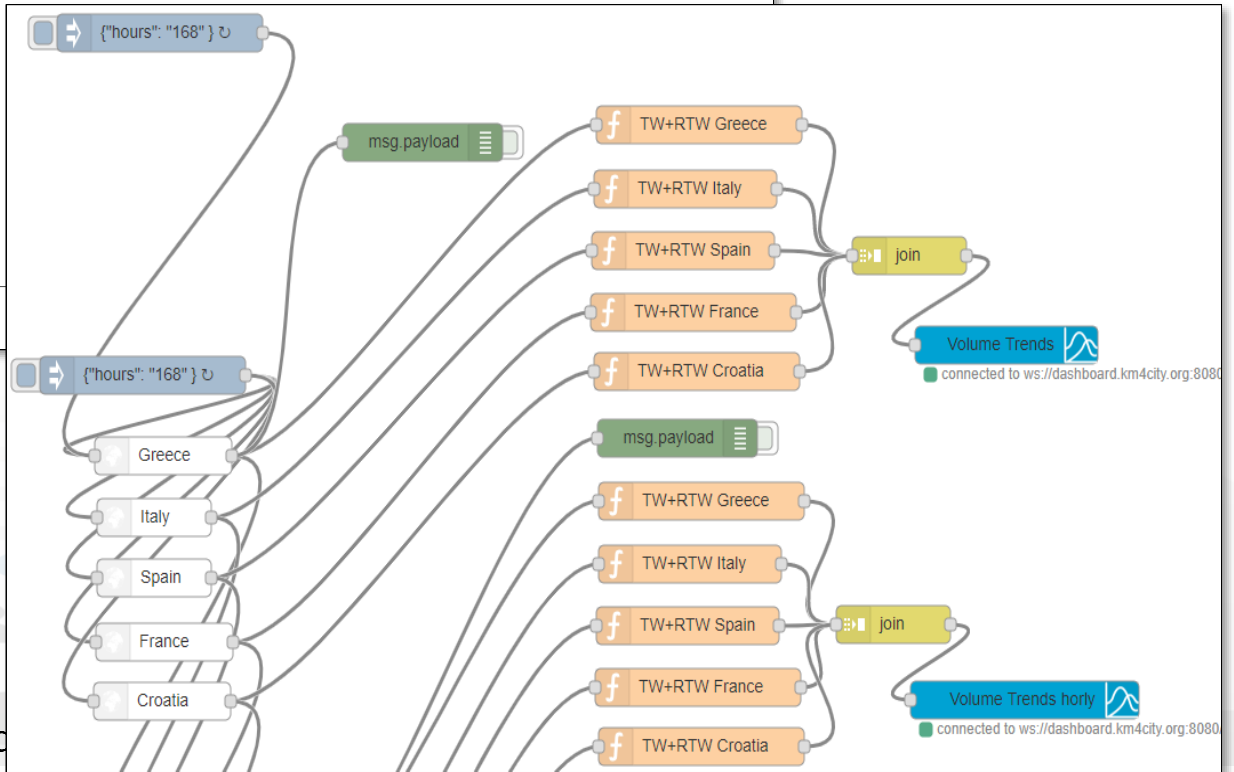
Twitter Vigilance

Twitter Vigilance



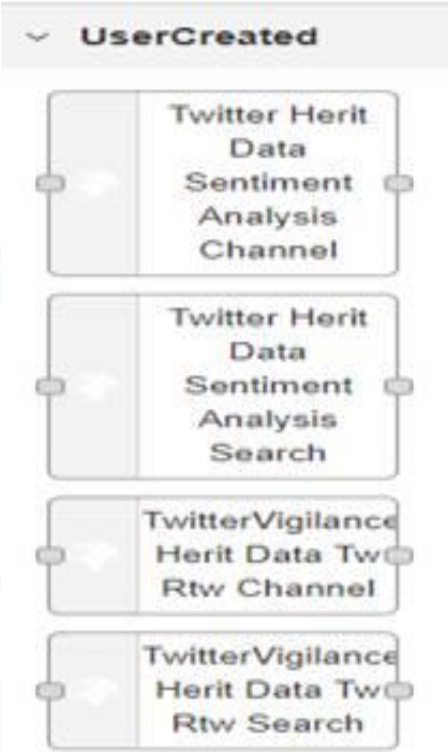




- This is an example of Dynamic Widget Data production for MultiSeries
- Each country block produce a vector and the vectors are joined and sent to the Multiserie Widget

Further reading on Social Media

- TC2.22- Exploiting Twitter Vigilance as External Service, in Dashboard, and as RestCall as MicroService in IOT applications
- TC2.21- IOT Applications with Social Media Actions, and cultural scenarious
- External Services
- TC2.21- IOT Applications with Social Media Actions, and cultural scenarious



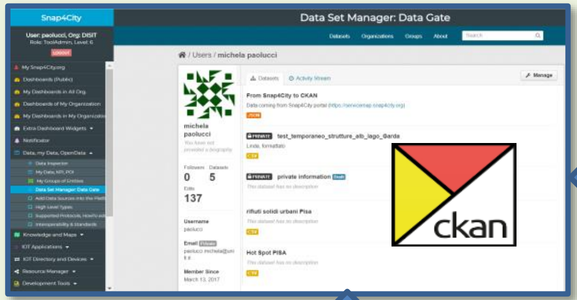
TOP

Integration with CKAN: automated data set (i) ingestion and (ii) production via IOT App

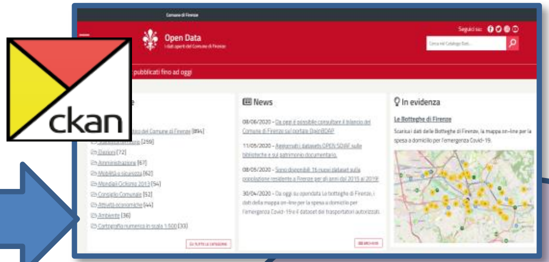
Snap4City vs CKAN

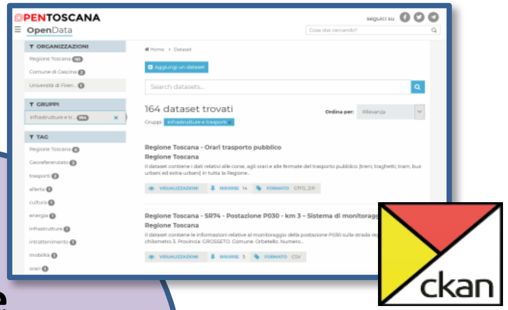
Datagate

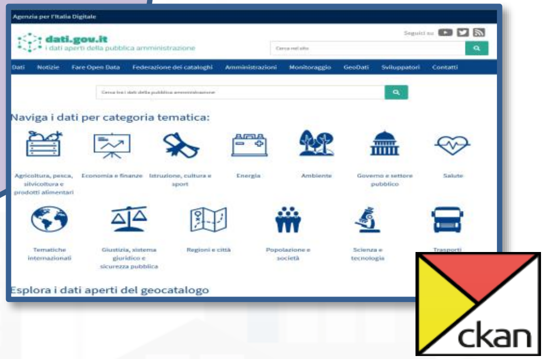
Snap4City Portal
and
Integrated tools



Advanced Snap4City APIs and MicroServices

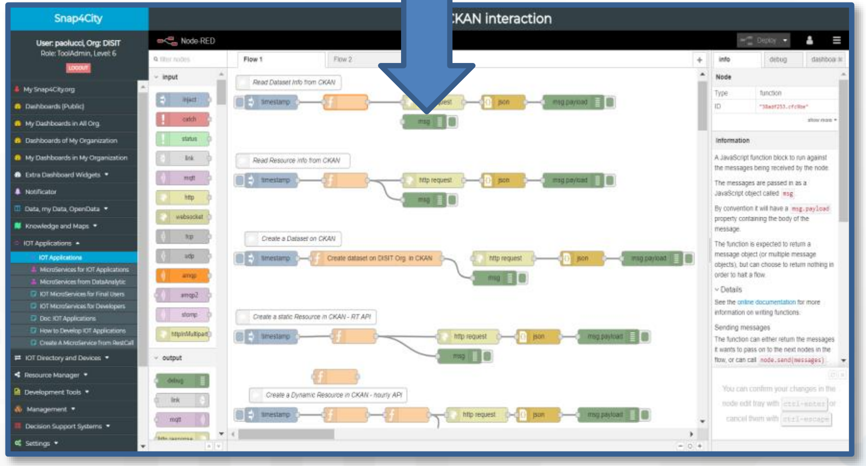






Harvesting and
Publishing

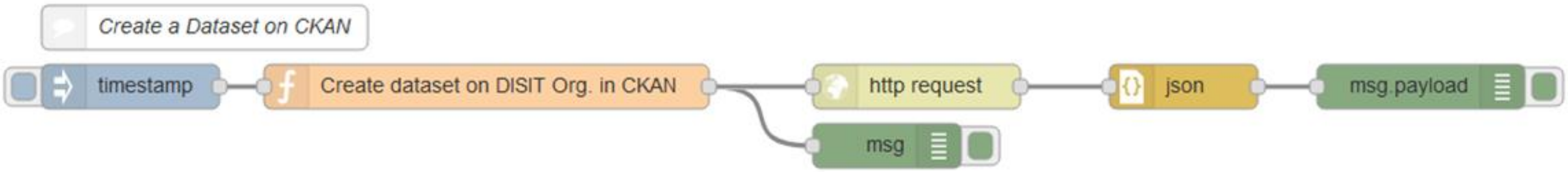
Open or Private
External CKAN
Data Portals



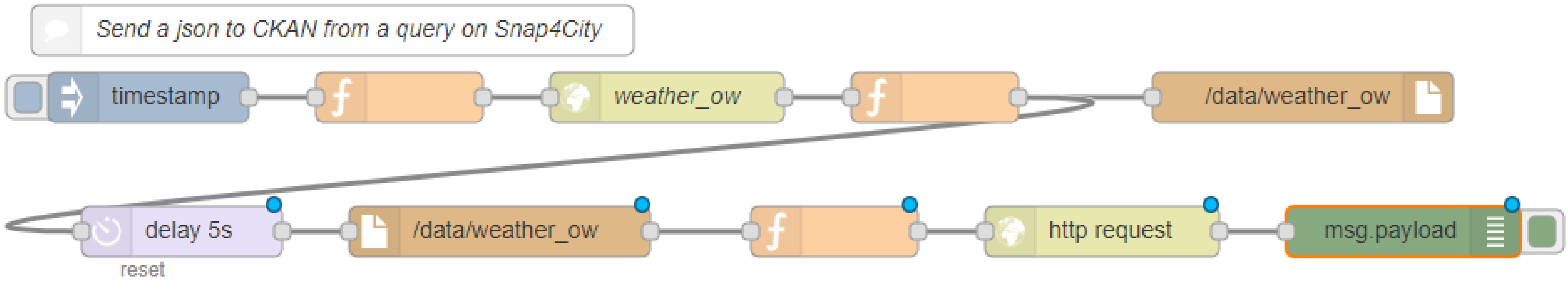
Automatize:

- Import data from CKAN to Snap4City
- Upload Public Data from Snap4City to CKAN
- Data Harvesting
- Dashboards and Mobile/Web Apps creation

Some IOT App segments



Almost all the calls to CKAN are quite similar



Read more on

- **[TC9.17 – CKAN vs Snap4City Integration and Interaction]**
  - automating the *Read of a Dataset Info from* *CKAN*
  - automating the *Read of a Resource info from* *CKAN*
  - automating the *Creation of a Dataset on* *CKAN*
  - automating the *Creation of a static Resource in* *CKAN*
  - automating the *Creation of a dynamic Resource in* *CKAN*
  - automating the *Sending of a json to* *CKAN* *from a query to Snap4City to perform any other action on the Smart City*
- **Data Set Manager: Data Gate / CKAN federated**

Automated production of MicroService for IOT App from External REST CALL API

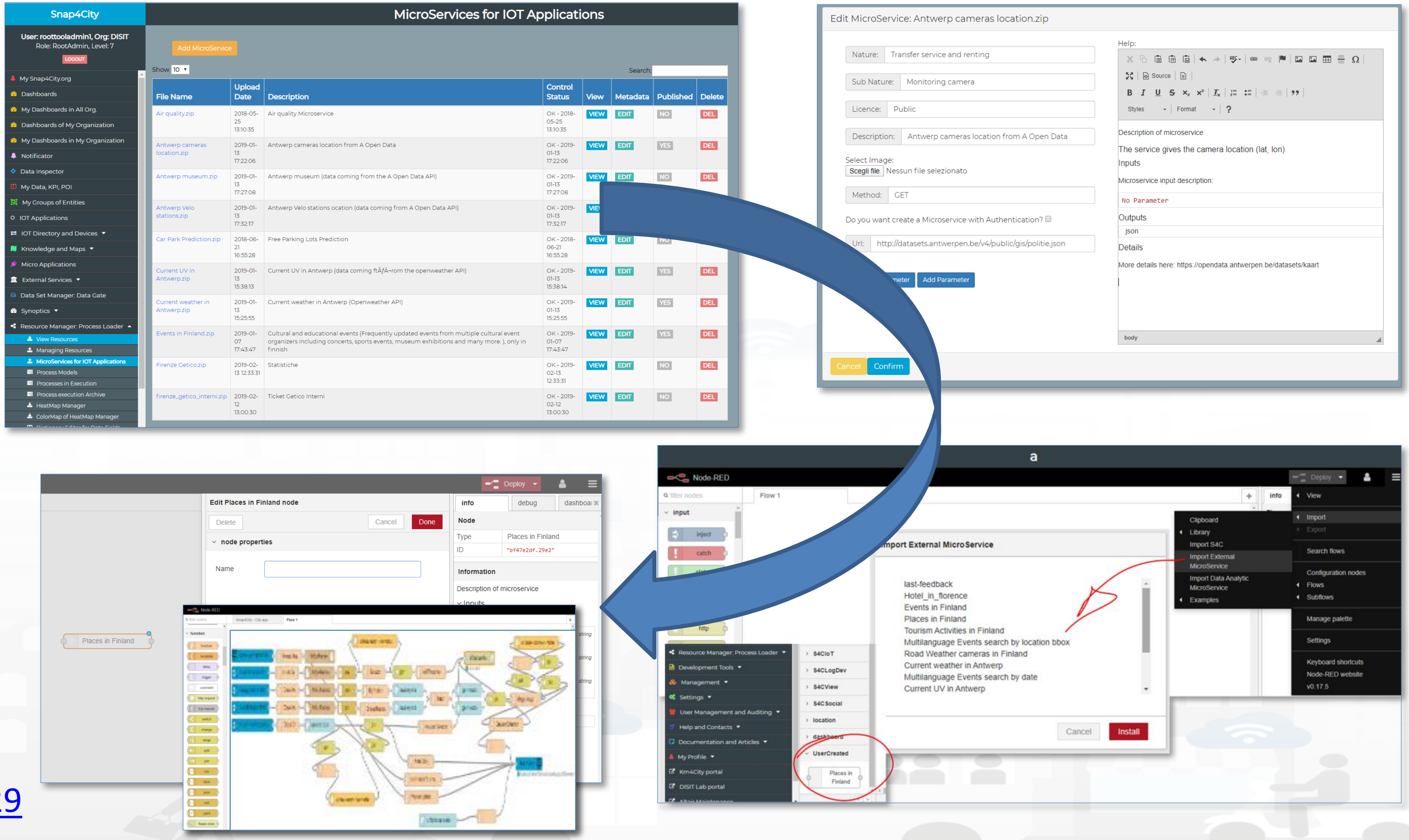
General solution, bring data from API to Dashboards

- You can **save/consolidate your rest API** transforming it in a MicroService usable for many colleagues into IOT Applications:
  - TC2.25- Registering external MicroService calling RestCall services, using it on IOT applications https://www.snap4city.org/129

- IF your REST API is going to use credentials as username and password, we suggest you to save them into MyPersonalData of Snap4City
  - so that the code will not provide clear credentials and you can update from user interface on your personal data profile.
  - The IOT App can retrieve the Username and Password at the moment in which they are used with the security shield of Snap4City

External REST Call API vs MicroServices

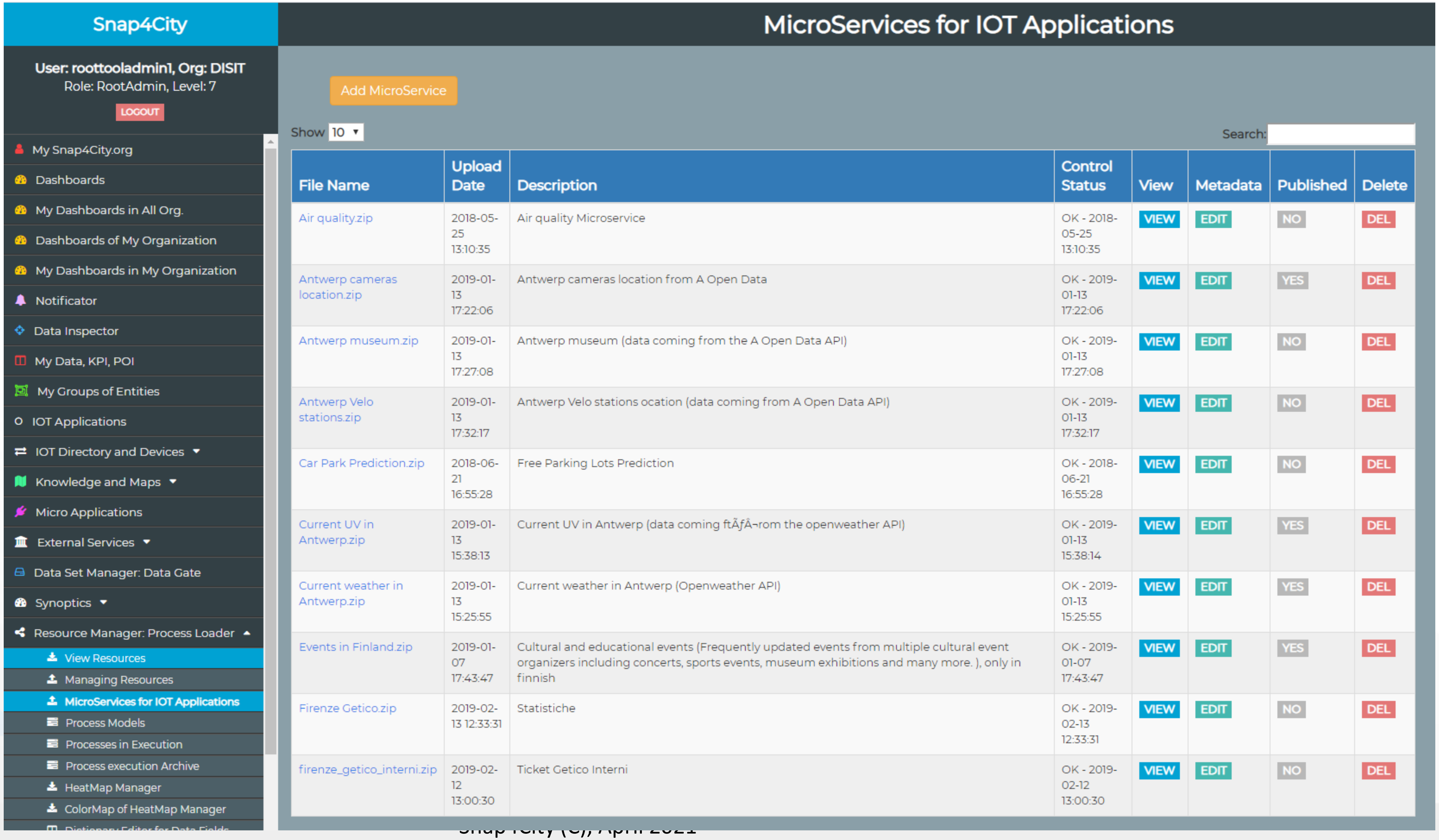
- Each Rest Call API can be automaticaly transformed into e MicroService for the IOT Applications



https://www.snap4city.org/129

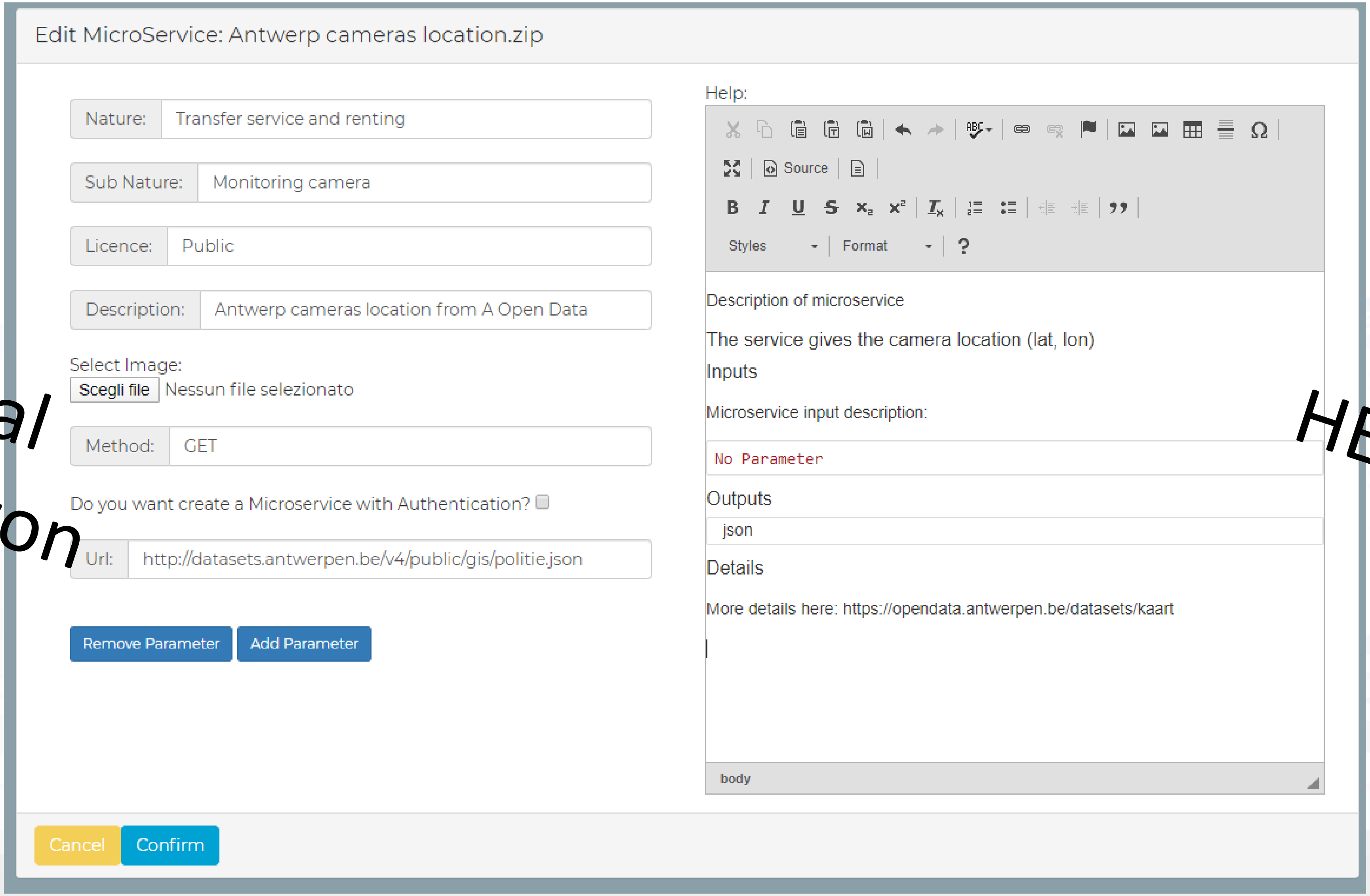
External REST Call API vs MicroServices

- Each Rest Call API can be automaticaly transformed into e MicroService for the IOT Applications



File Name	Upload Date	Description	Control Status	View	Metadata	Published	Delete
Air quality.zip	2018-05-25 13:10:35	Air quality Microservice	OK - 2018-05-25 13:10:35	VIEW	EDIT	NO	DEL
Antwerp cameras location.zip	2019-01-13 17:22:06	Antwerp cameras location from A Open Data	OK - 2019-01-13 17:22:06	VIEW	EDIT	YES	DEL
Antwerp museum.zip	2019-01-13 17:27:08	Antwerp museum (data coming from the A Open Data API)	OK - 2019-01-13 17:27:08	VIEW	EDIT	NO	DEL
Antwerp Velo stations.zip	2019-01-13 17:32:17	Antwerp Velo stations ocation (data coming from A Open Data API)	OK - 2019-01-13 17:32:17	VIEW	EDIT	NO	DEL
Car Park Prediction.zip	2018-06-21 16:55:28	Free Parking Lots Prediction	OK - 2018-06-21 16:55:28	VIEW	EDIT	NO	DEL
Current UV in Antwerp.zip	2019-01-13 15:38:13	Current UV in Antwerp (data coming ftÃƒÂ¬rom the openweather API)	OK - 2019-01-13 15:38:14	VIEW	EDIT	YES	DEL
Current weather in Antwerp.zip	2019-01-13 15:25:55	Current weather in Antwerp (Openweather API)	OK - 2019-01-13 15:25:55	VIEW	EDIT	YES	DEL
Events in Finland.zip	2019-01-07 17:43:47	Cultural and educational events (Frequently updated events from multiple cultural event organizers including concerts, sports events, museum exhibitions and many more.), only in finnish	OK - 2019-01-07 17:43:47	VIEW	EDIT	YES	DEL
Firenze Getico.zip	2019-02-13 12:33:31	Statistiche	OK - 2019-02-13 12:33:31	VIEW	EDIT	NO	DEL
firenze_getico_interni.zip	2019-02-12 13:00:30	Ticket Getico Interni	OK - 2019-02-12 13:00:30	VIEW	EDIT	NO	DEL

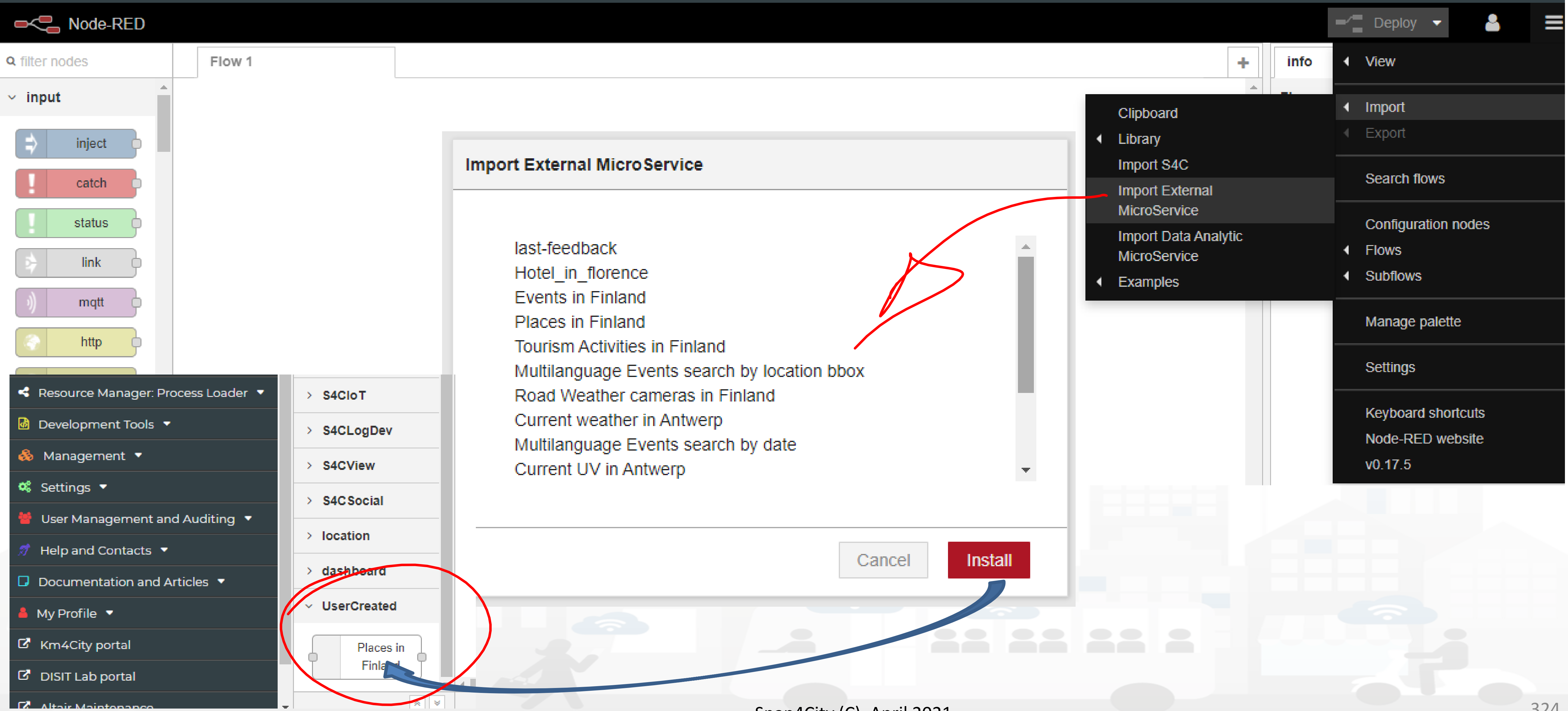
Edit MicroService Call: call and help editing



Formal definiton

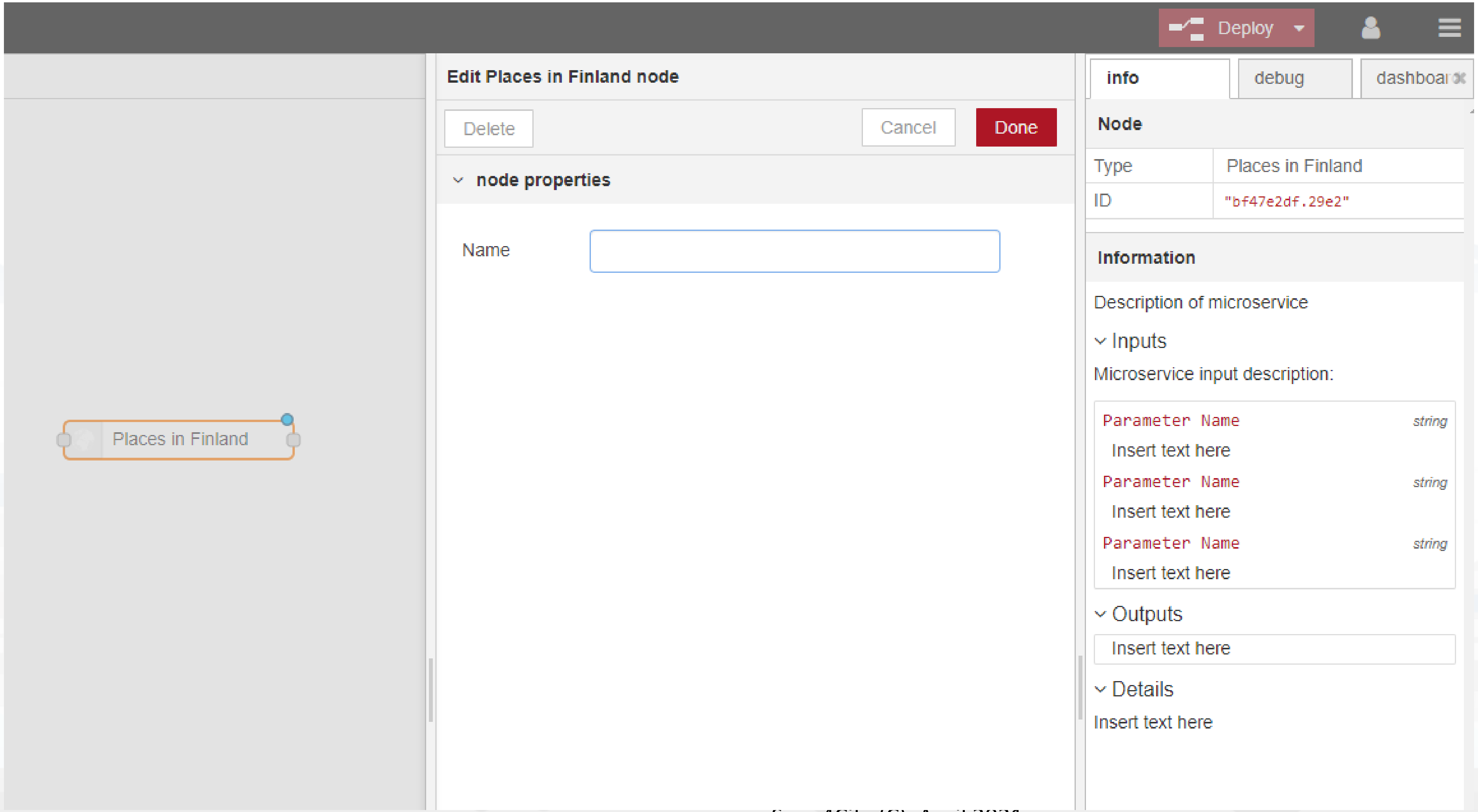
HELP

a



Node-RED
Deploy
filter nodes
Flow 1
info
input
inject
catch
status
link
mqtt
http
View
Import
Export
Search flows
Configuration nodes
Flows
Subflows
Manage palette
Settings
Keyboard shortcuts
Node-RED website
v0.17.5
Clipboard
Library
Import S4C
Import External MicroService
Import Data Analytic MicroService
Examples
Import External MicroService
last-feedback
Hotel_in_florence
Events in Finland
Places in Finland
Tourism Activities in Finland
Multilanguage Events search by location bbox
Road Weather cameras in Finland
Current weather in Antwerp
Multilanguage Events search by date
Current UV in Antwerp
Cancel
Install
Resource Manager: Process Loader
Development Tools
Management
Settings
User Management and Auditing
Help and Contacts
Documentation and Articles
My Profile
Km4City portal
DISIT Lab portal
S4CIoT
S4CLogDev
S4CView
S4CSocial
location
dashboard
UserCreated
Places in Finland

Usage of the MicroService from IOT App

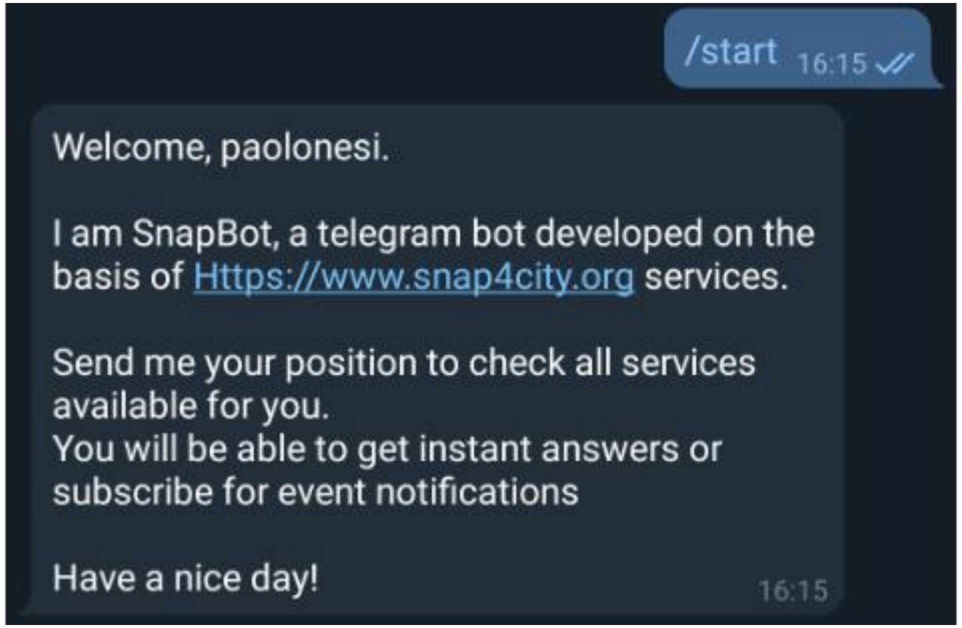


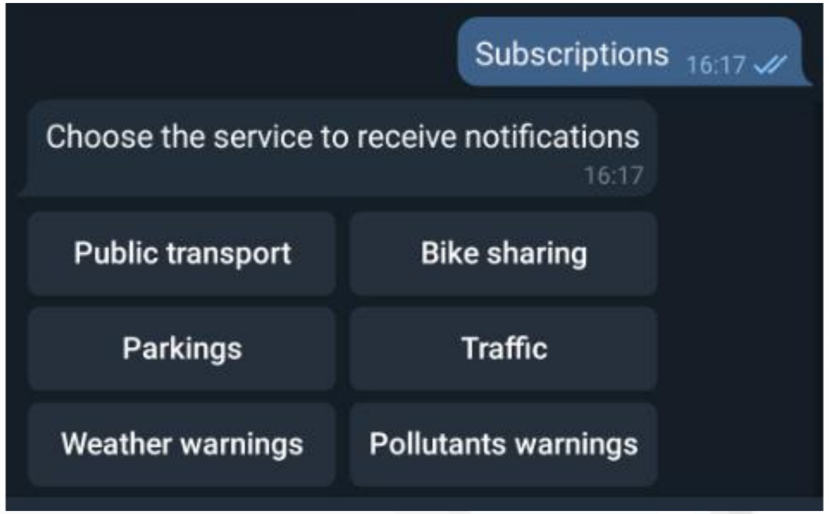
TOP

Integration with Telegram: SnapBot solution

SnapBot

- provides real time smart city services to Telegram users, geolocalized, when you like, what you like
- active on Tuscany in all provinces and cities according to the data accessible on Https://www.snap4city.org
- Services on
  - Public Transport (more than 10 different operators),
  - bike sharing, parking lots,
  - traffic flow, weather warnings,
  - Air quality, pollutant,
  - find your location, etc.





SnapBot

Tap on the hour you prefer to receive 3 notification everyday for the Bike Sharing service 16:18

00:00	01:00	02:00	03:00	04:00	05:00
06:00	07:00	08:00	09:00	10:00	11:00
12:00	13:00	14:00	15:00	16:00	17:00
18:00	19:00	20:00	21:00	22:00	23:00

Public transport 16:41

Choose a bus stop: 16:42

Giorgini | Giorgini
Vittorio Emanuele | Montelatici

Giorgini - FM0256

17:12 - [55] → Cappuccini
17:29 - [55] → Cappuccini
17:45 - [55] → Cappuccini
18:01 - [55] → Cappuccini
18:17 - [55] → Cappuccini
18:33 - [55] → Cappuccini 16:43

Qualità dell'aria 02:22

Qualità dell'aria rilevata dal sensore più vicino alla posizione:

- Temperatura: 8.10 °C
- Umidità: 97.50%
- CO: 0.3 µg/m3
- CO2: 499.0 µg/m3
- NO: NaN µg/m3
- NO2: 56.1 µg/m3
- O3: 20.9 µg/m3
- PM10: 13.8 µg/m3
- PM2.5: 12.2 µg/m3

SnapBot

Trasporti pubblici 14:53

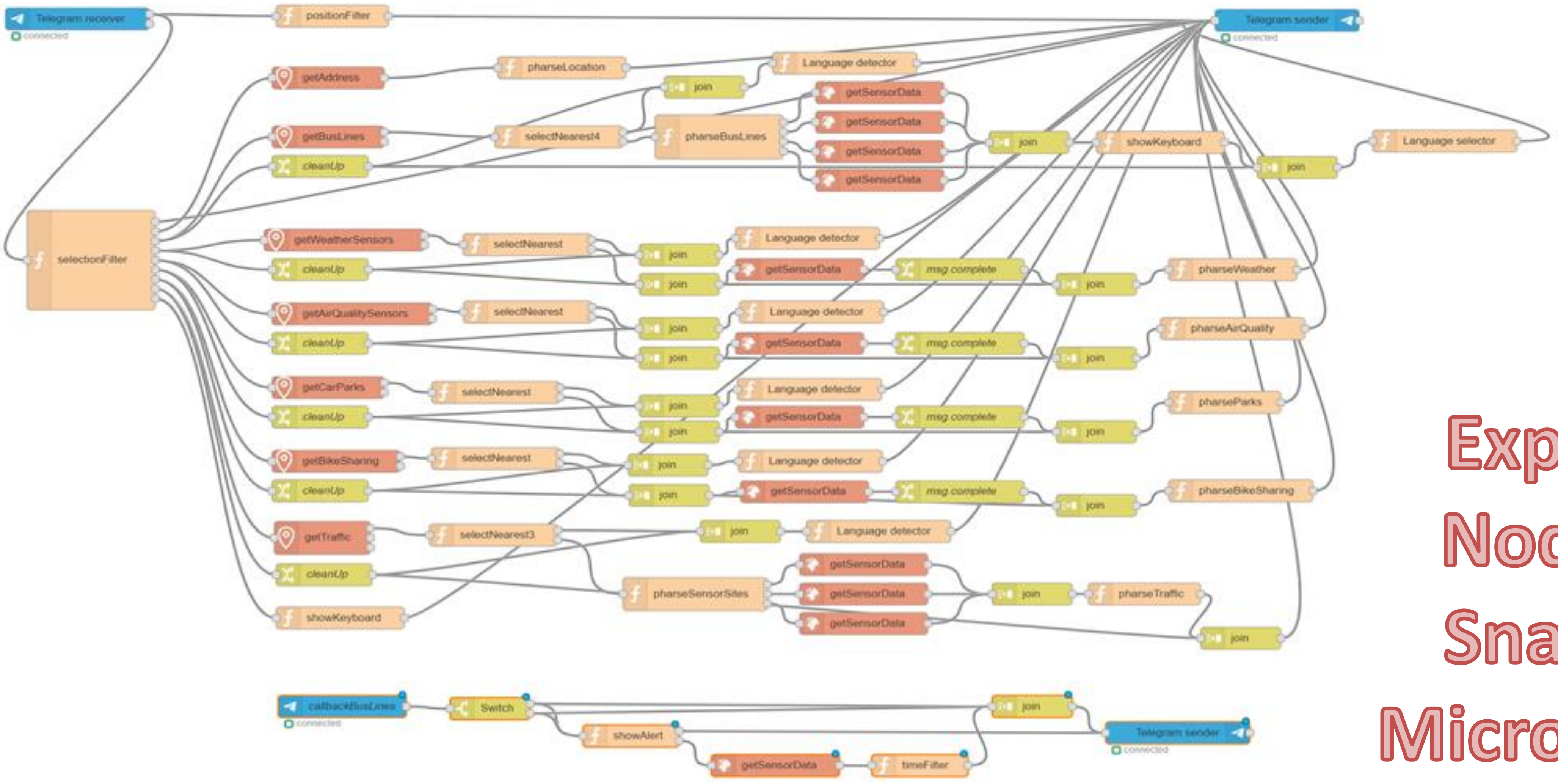
Ho trovato 6 linee vicino a te:

24 - ATAF&LINEA
Grassina → Bagno A Ripoli Robinson

49 - ATAF&LINEA
Grassina 02 → Bagno A Ripoli Robinson

48 - ATAF&LINEA
Il Roseto 01 → Bagno A Ripoli Robinson

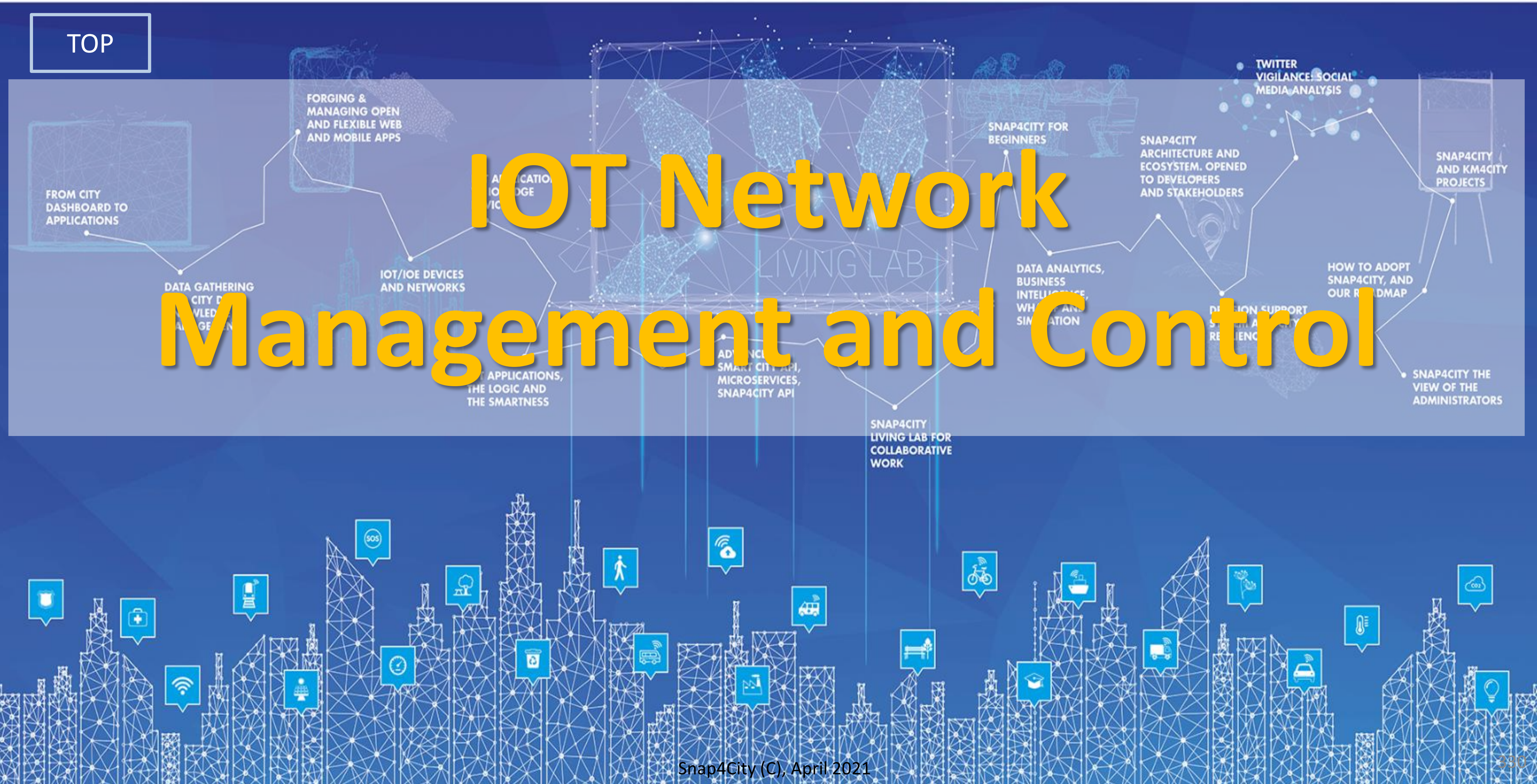
IOT App of SnapBot: OneShot Services



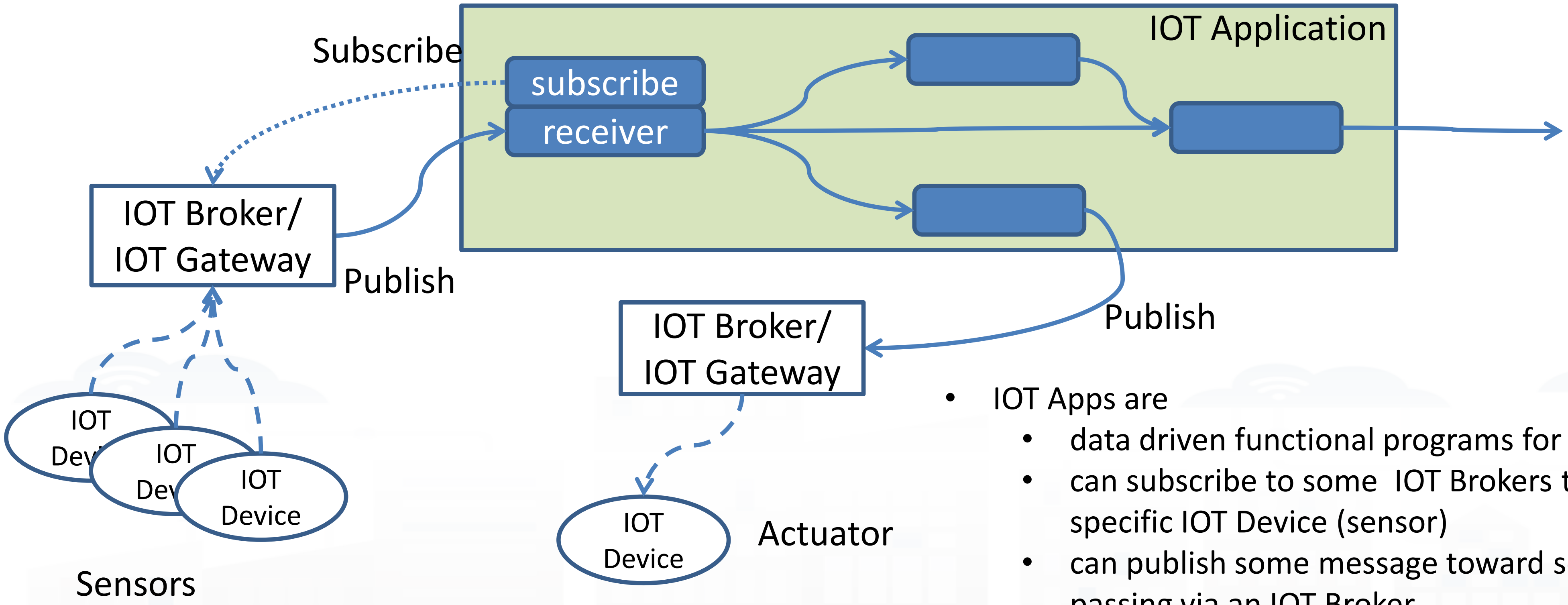
Exploiting Node-RED Snap4City MicroServices

TOP

IOT Network Management and Control



IOT Basic

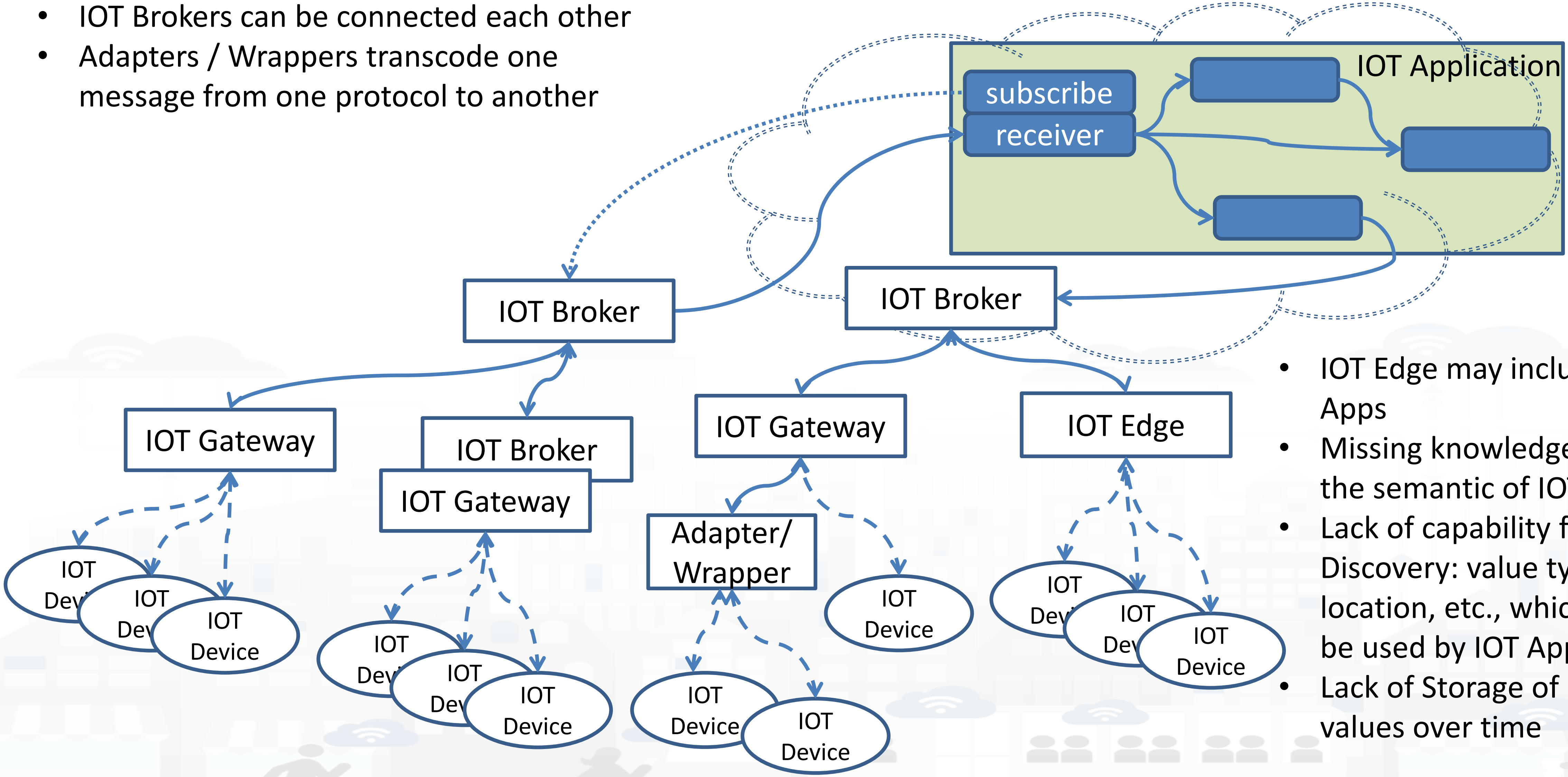


- Sensors are programmed to send data (i) periodically, or (ii) when a relevant change occurs in the sensor value, or (iii) when events occur (for example a change of status of something), etc.
- Actuator perform some action on the field: change of status, reset, turn on something, change setting value, etc.

- IOT Apps are
  - data driven functional programs for data transformation.
  - can subscribe to some IOT Brokers to receive data in Push from a specific IOT Device (sensor)
  - can publish some message toward some IOT Device (Actuator), passing via an IOT Broker.
  - Can be used to create ADAPTERs of any kind
- Continuous lines are messages via TCP/IP
- Dashed lines are message via some radio channel (Lora, BT, Wi-Fi, …)
- IOT Brokers and IOT Gateway can be distinct servers
- IOT Brokers can be on cloud
- IOT Gateway performs the SW update, the business management, access in Push and Pull

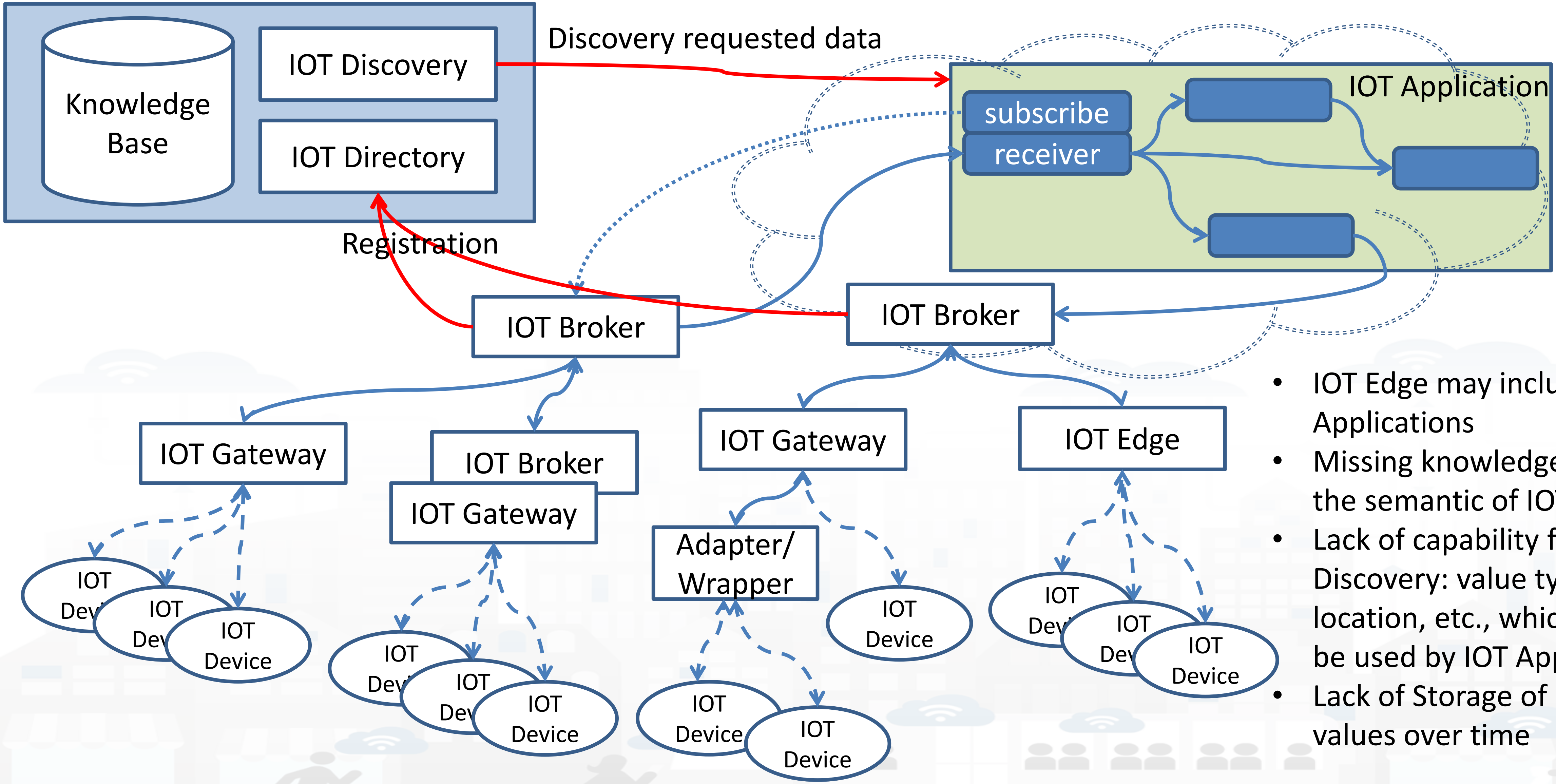
Definitions

- IOT Brokers can be connected each other
- Adapters / Wrappers transcode one message from one protocol to another



- IOT Edge may include IOT Apps
- Missing knowledge about the semantic of IOT devices
- Lack of capability for IOT Discovery: value type, location, etc., which could be used by IOT App
- Lack of Storage of data values over time

Definitions



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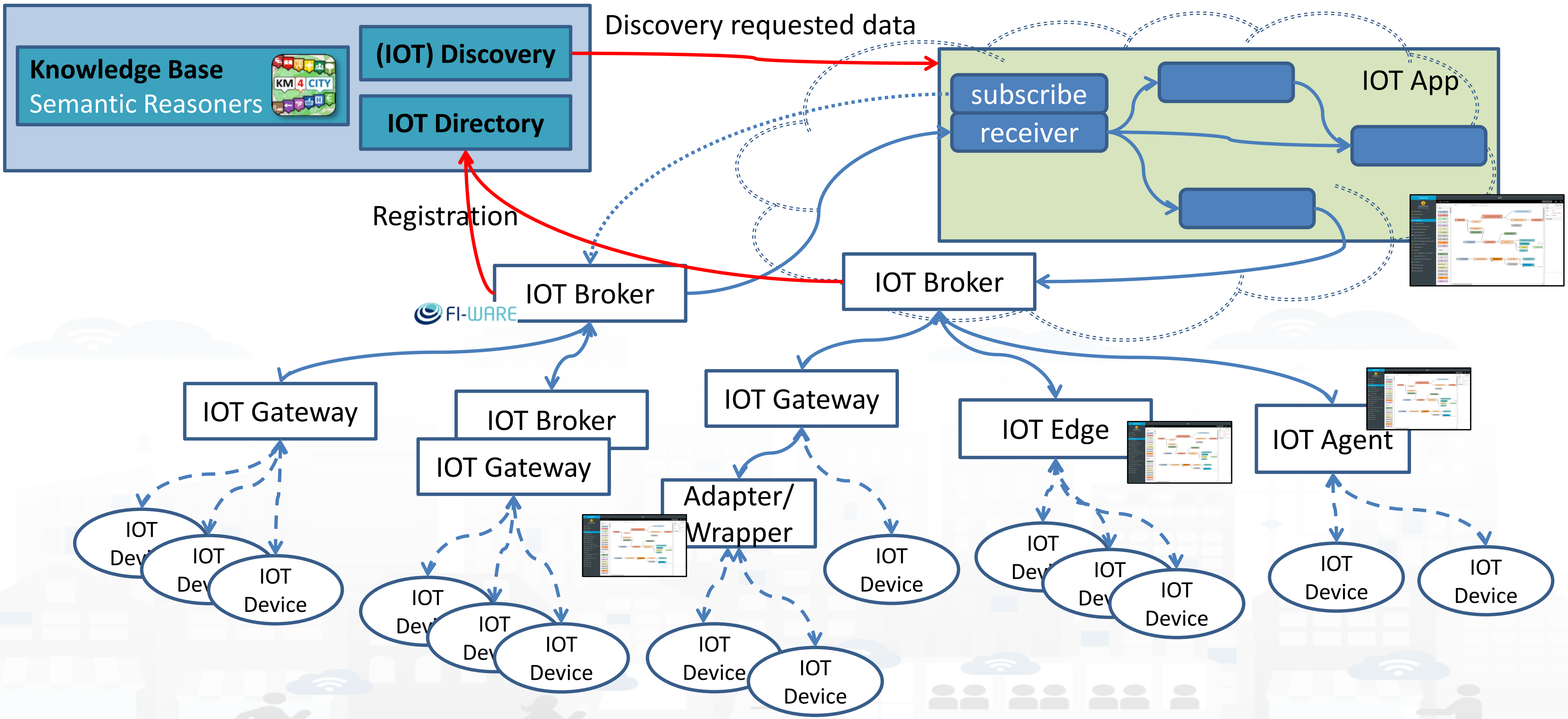
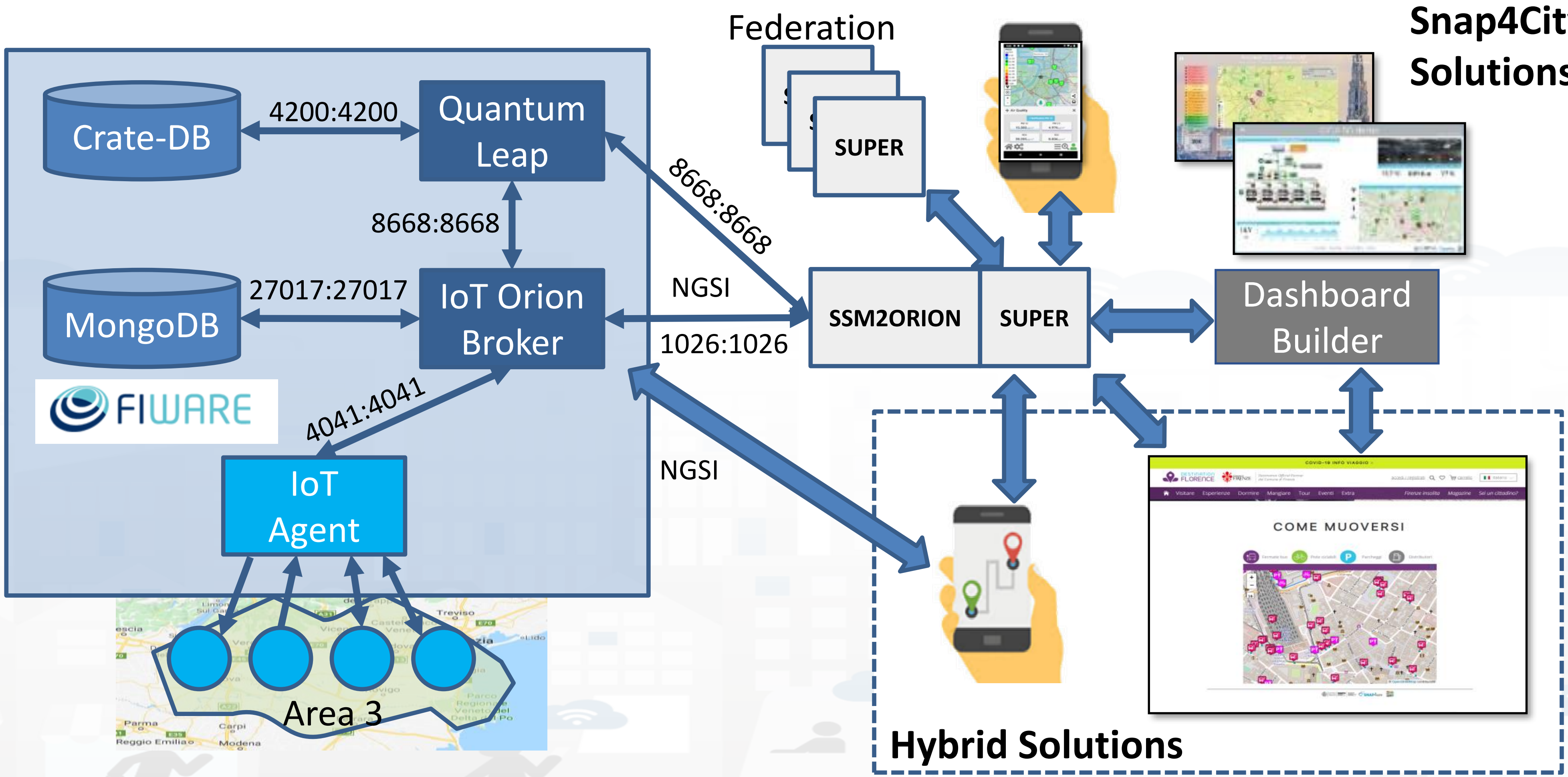
IoT Network

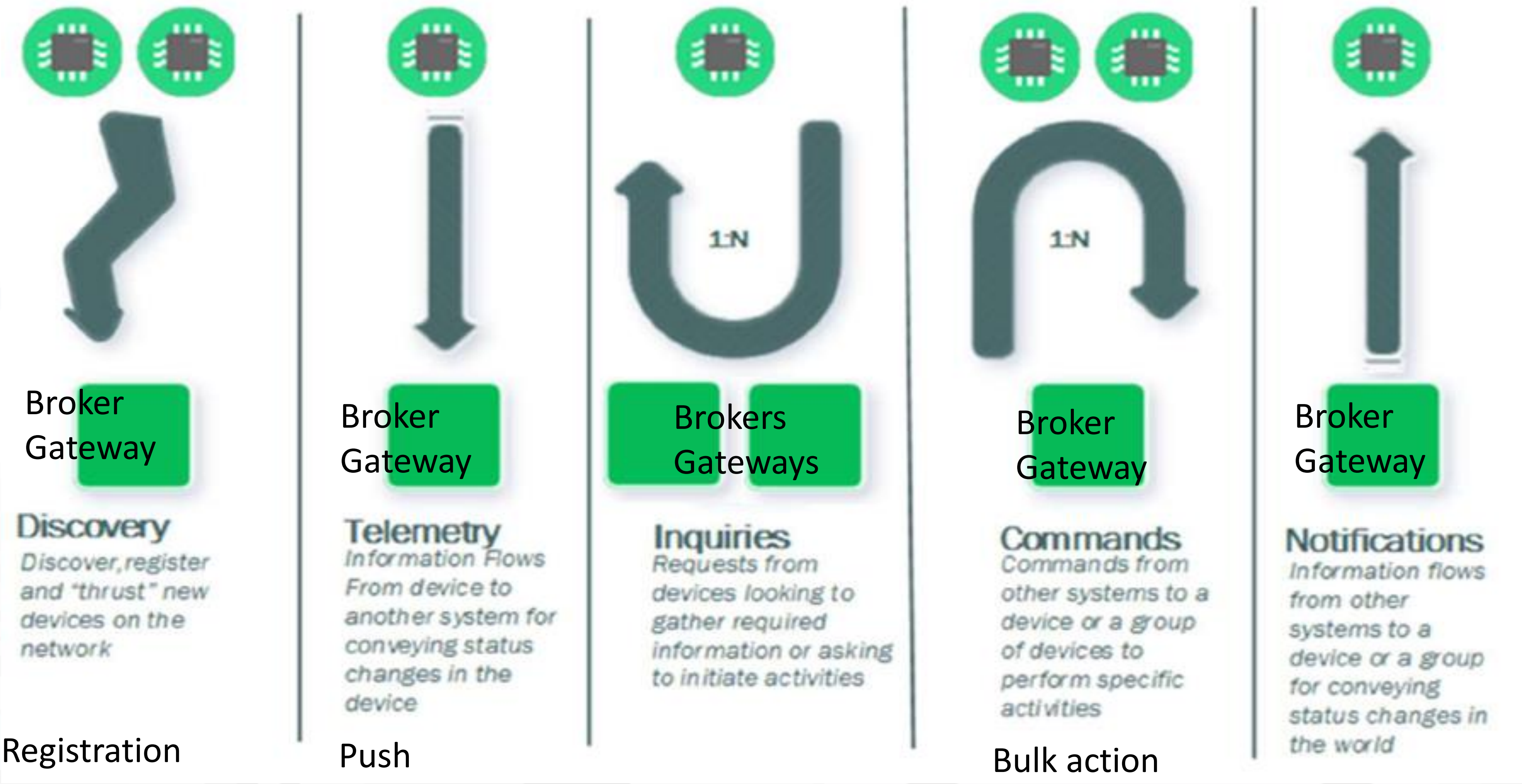

Knowledge Base
Semantic Reasoners
(IOT) Discovery
IOT Directory
Discovery requested data
IOT App
subscribe
receiver
Registration
IOT Broker
FI-WARE
IOT Broker
IOT Gateway
IOT Broker
IOT Gateway
IOT Gateway
IOT Edge
IOT Agent
Adapter/ Wrapper
IOT Device
IOT Device
IOT Device
IOT Device
IOT Device
IOT Device
IOT Device
IOT Device
IOT Device
IOT Device

Federation of Snap4City vs IOT ORION Broker



IOT/IOE Protocols

Communication Patterns



- MQTT
- HTTP(s)
- AMQP
- COAP
- NGSI
- OneM2M
- WebSockets
- ……..
- Etc.

Note on Communication patterns

- Not all Communication Patterns are supported by all Protocols
- Protocols implement Patters, + formats, + sequences, etc.
- They are referred at level of communications
  - IOT Device ← → IOT Gateway ←→IOT Broker
- IOT Protocols mostly used at level of IP are:
  - NGSI V1/2, MQTT, COAP, AMQP, OneM2M, WS, ModBUS,
- Radio protocols are: Lora, ZigBee, 3G, Wi-Fi, etc.
- Formats: JSON, Geo-JSON, Linked Data, XML, CSV,

TOP

IOT Networks on Snap4City

SNAP4CITY — KM4CITY

URBAN PLATFORM: SMART CITY IOT AS A SERVICE AND ON PREMISE

100% OPEN SOURCE

APPLIANCES CONTAINERS

- LOCAL GOVERN
- STAKEHOLDERS
- CITY USERS
- IN-HOUSE
- ENERGY OPERATORS
- MOBILITY OPERATORS
- COMMERCIAL OPERATORS
- SECURITY OPERATORS
- INDUSTRIES
- RESEARCHERS
- START-UPS
- ASSOCIATIONS

- GDPR
- SECURITY
- PRIVACY
- ASSESSMENT
- AUDITING
- PENTESTED

- OPEN IOT DEVICES
- IOT EDGE
- IOT GATEWAY
- PAX COUNTERS
- IOT BUTTONS

- TEST CASES, SCENARIOUS, VIDEOS, HACKATHONS
- OPEN SOURCES, COMMUNITY OF CITIES
- TRAINING TUTORIALS, COMMUNITY MANAGEMENT

IOT APPLICATIONS - INSTANT APPS

DATA DRIVEN APPLICATIONS • REAL TIME PROCESSING • BATCH PROCESSING • ANY PROTOCOL & FORMAT

DASHBOARDS & APPLICATIONS

CONTROL ROOM • SITUATION ROOM • OPERATOR DASHBORDS • BUSINESS INTELLIGENCE • WHAT-IF ANALYSIS • DECISION SUPPORT • SIMULATIONS • RISK ANALYSIS • RESILIENCE ANALYSIS

MOBILE & WEB APPLICATIONS

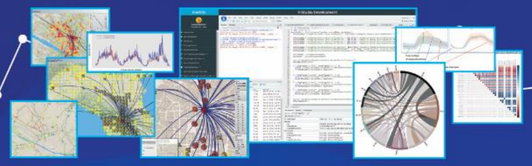
DEVELOPMENT KIT • SUGGESTIONS • MOBILE APPS • MONITORING PANELS • PLATFORM UTILITIES • READY TO USE SMART APPLICATIONS

MICROSERVICES & ADVANCED SMART CITY API

LIVING LAB - DEV TOOLS - COWORKING

IOT DIRECTORY • SERVICE MAP • RESOURCE MANAGER • DATA GATE • R STUDIO • ETL

BIG DATA - DATA ANALYTICS



DATA ANALYTICS TOOLS - MICRO-APPLICATIONS

PREDICTIONS • ANOMALY DETECTION • WHAT-IF ANALYSIS • TRAFFIC FLOW RECONSTRUCTION • ORIGIN-DESTINATION MATRICES • SOCIAL MEDIA ANALYSIS • OFFER VS DEMAND ANALYSIS • ENVIRONMENTAL DATA ANALYSIS AND PREDICTIONS • REAL TIME HEATMAPS • ROUTING • ALERTING • EARLY WARNING • PERSONAL AND VIRTUAL ASSISSTANTS • SMART SOLUTIONS • SMART SHARING • PARTECIPATORY

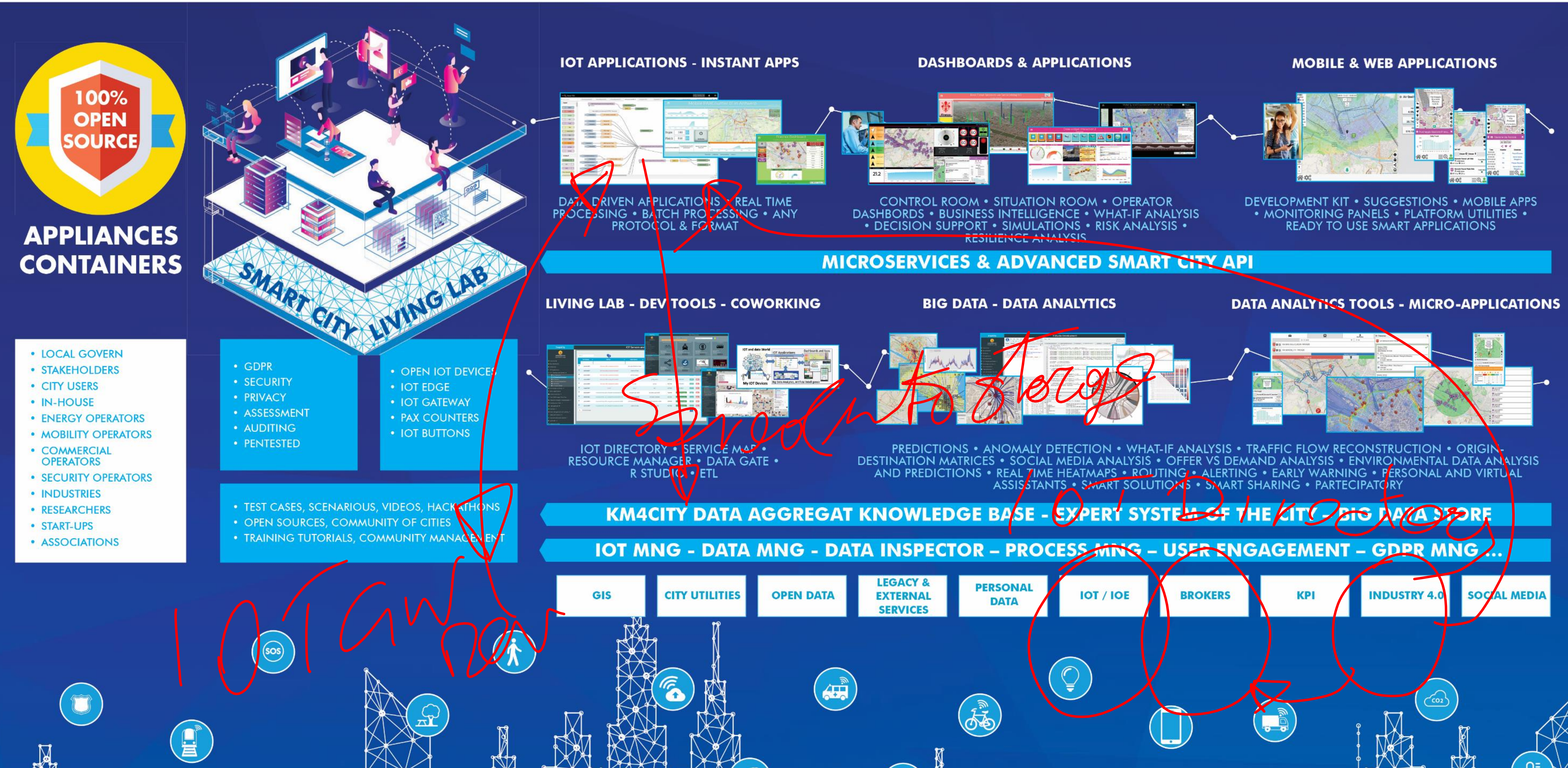
KM4CITY DATA AGGREGAT KNOWLEDGE BASE - EXPERT SYSTEM OF THE CITY – BIG DATA STORE

IOT MNG - DATA MNG - DATA INSPECTOR – PROCESS MNG – USER ENGAGEMENT – GDPR MNG ...

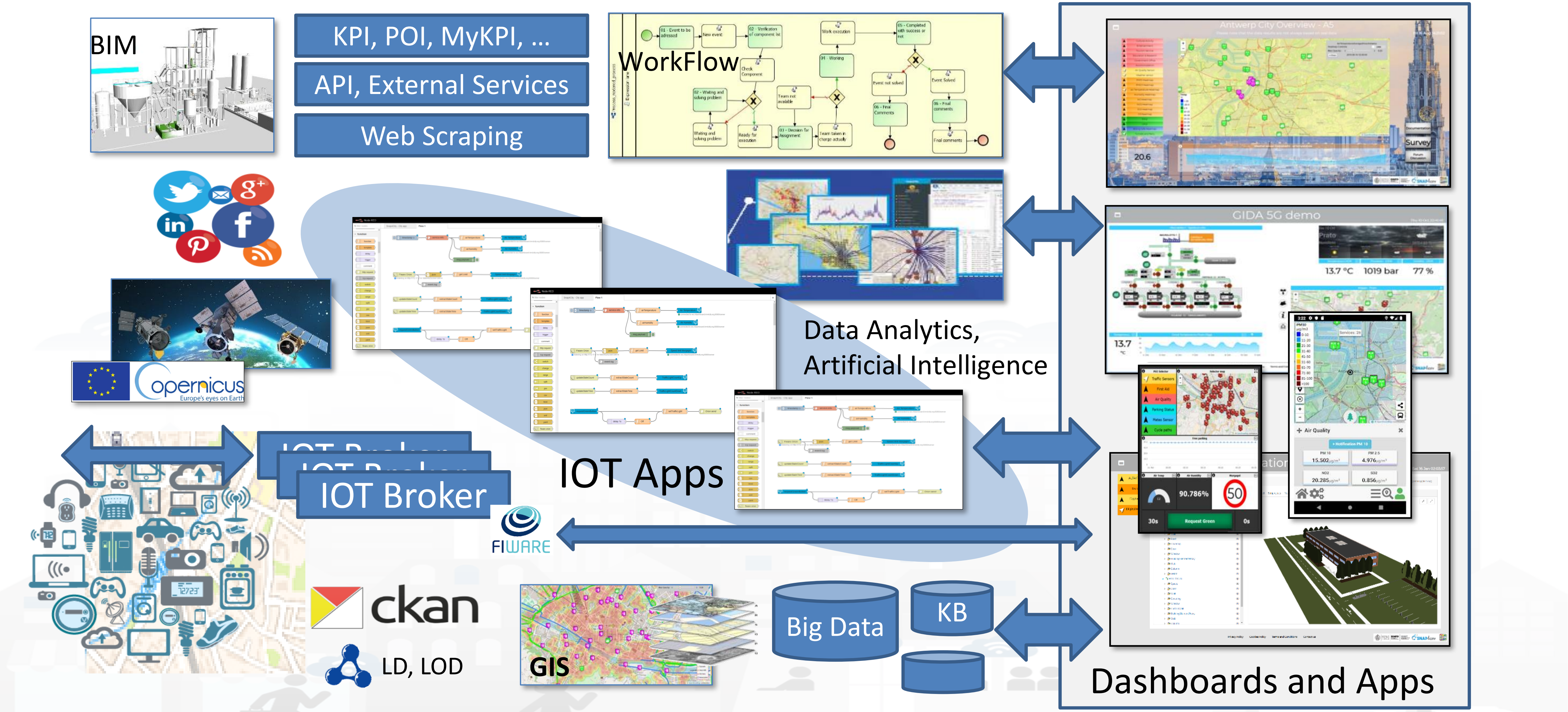
GIS	CITY UTILITIES	OPEN DATA	LEGACY & EXTERNAL SERVICES	PERSONAL DATA	IOT / IOE	BROKERS	KPI	INDUSTRY 4.0	SOCIAL MEDIA

SNAP4CITY KM4CITY

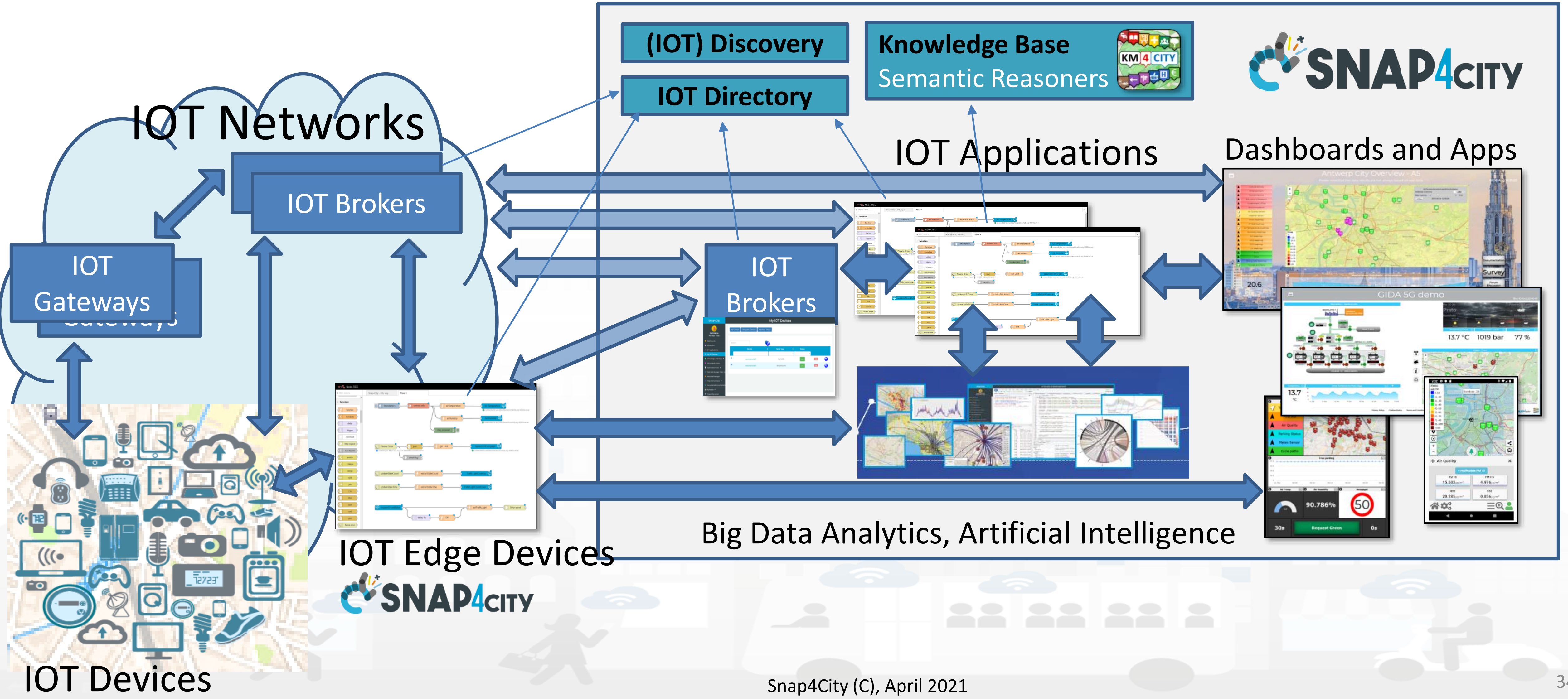
URBAN PLATFORM: SMART CITY IOT AS A SERVICE AND ON PREMISE



Concept


BIM
KPI, POI, MyKPI, …
API, External Services
Web Scraping
WorkFlow
Data Analytics,
Artificial Intelligence
IOT Apps
IOT Broker
FIWARE
ckan
LD, LOD
GIS
Big Data
KB
Dashboards and Apps
Antwerp City Overview
GIDA 5G demo
copernicus
Europe's eyes on Earth

Snap4City: IOT Directory and data/device Discovery



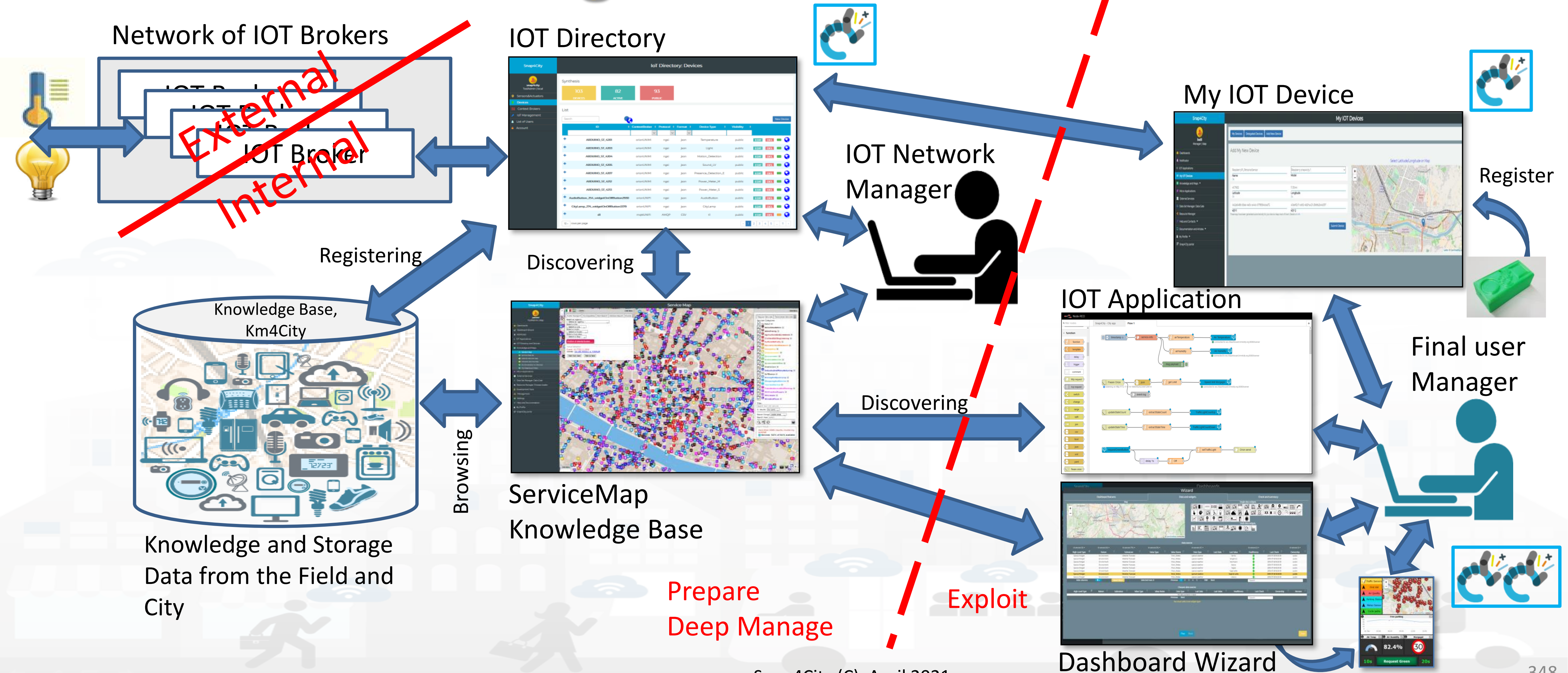
Standards and Interoperability

Compliant with: AMQP, COAP, MQTT, OneM2M, HTTP, HTTPS, TLS, Rest Call, SMTP, TCP, UDP, NGSI, LoRa, LoRaWan, TheThingsNetwork, SigFOX, DATEX II, SOAP, WSDL, Twitter, FaceBook, Telegram, SMS, OLAP, MySQL, Mongo, HBASE, SOLR, SPARQL, EMAIL, FTP, FTPS, WebSocket, WebSocket Secure, ModBUS, OPC, GML, RS485, RS232, WFS, WMS, ODBC, JDBC, Elastic Search, Phoenix, XML, JSON, CSV, db, GeoJSON, Enfuser FMI, Android, Raspberry Pi, Local File System, ESP32, Libelium, IBIMET/IBE, OBD2, SVG, XLS, XLSX, TXT, HTML, CSS, KNX, Enocean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, BACnet, TALQ, Copernicus, Protocol Buffer, IFC, XPDL, etc.

Snap4City vs Formats

- Snap4City is capable to ingest and work with any format:
  - Data **exchange**: JSON, GeoJSON, XML, HTML, HTML5, DATEX, GTFS, binary, etc.
  - **Table**: CSV, XLSX, XLS, database, …
  - Any **archive** file format: zip, rar, 7z, tgz, …
  - Any **image** format: png, gif, tiff, ico, jpg, …
  - Any **video** format: mp4, avi, mov, …
- Search the format you need to cope on the search box of Snap4City portal!

IOT Network Manager vs Final User



Main Features of the Snap4City IOT Directory:

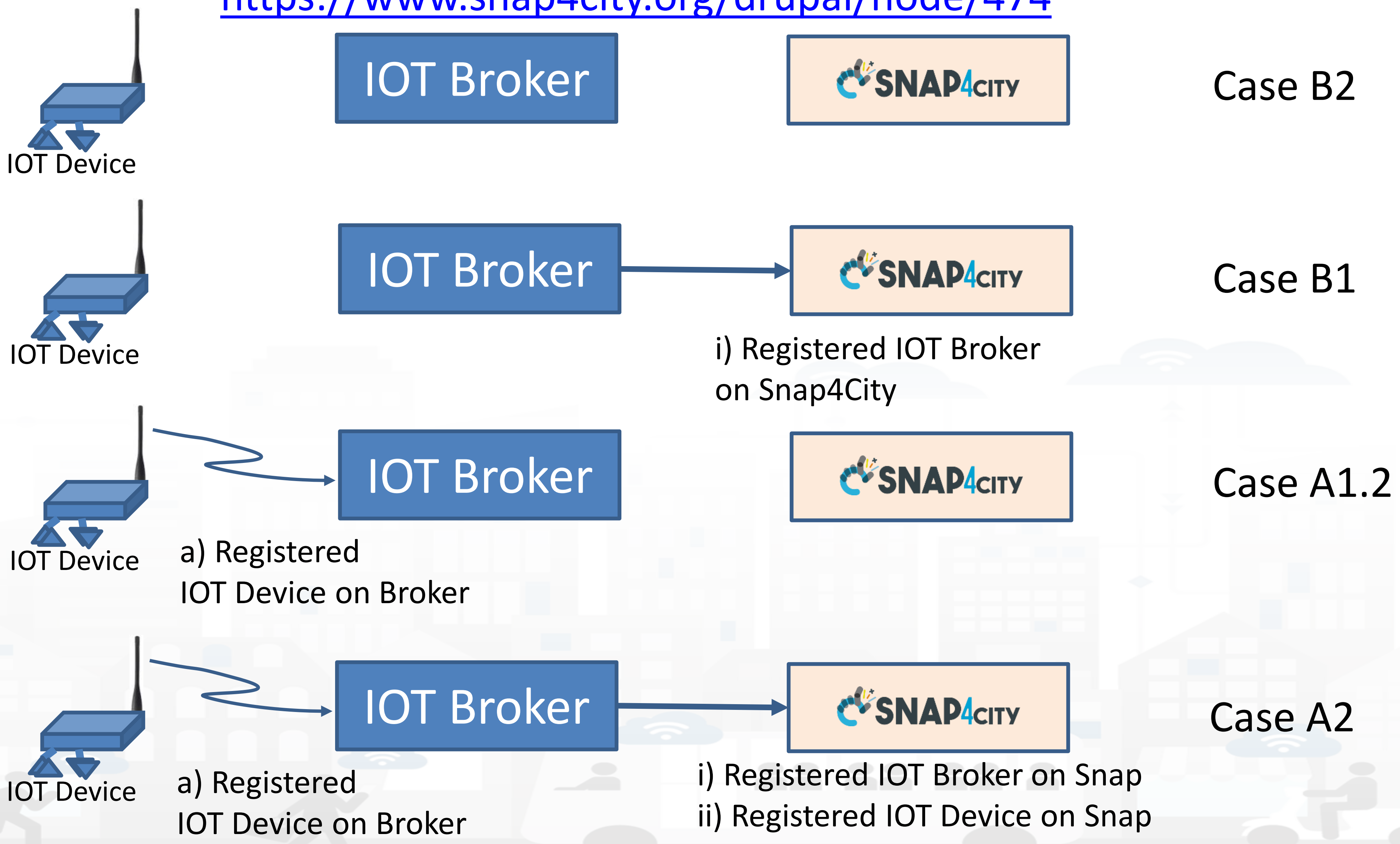
- **IOT Directory is a technology of Snap4City ONLY**
- **Register IOT Brokers**
  - Different kind of Brokers, different kinds of authentications and protocols
  - Registered IOT Orion Brokers can be queried for collecting their managed devices (typically for External IOT Brokers), so that those IOT Devices are registered
  - IOT Brokers/Gateways are registered on NIFI to send messages into the Data Shadow, automatically
- **Register IOT Devices**: singularly or at groups (in Bulk)
  - Registration can be custom or based on IOT Device Model
  - IOT Edge are registered as IOT Devices as well
  - Registered IOT Devices are saved into local DataBase and into the Knowledge Base
- **Provide support for security aspects**:
  - Generation of Certificates, Keys, etc., according to the model
  - Collection of keys when IOT devices are on some IOT Gateway or Second Level IOT Broker.
- **Manage Ownership and Delegation** for
  - IOT Brokers, IOT Devices, IOT Device Values also called Sensors/actuators, IOT Device Models

IOT Directory Features vs Users Roles

Entities	what	By using IOT Directory and:	Manager	AreaManager	ToolAdmin/ RootAdmin	IOT App microservices
IOT Sensor/Actuator	Browse, use	Several Tools	X	X	X	Yes
	Delegate	API, ..	X	X	X	
	Discovery	KB, API, ..	X	X	X	Yes
IOT Devices	Browse, use	Several Tools	X	X	X	Yes (use)
	Create, change, delete	API, ..	X	X	X	Yes
	Register in Bulk	API, ..		X	X	Yes
	Delegate, Change Owner	API, ..	X	X	X	Yes
	Discovery	KB, API, ..	X	X	X	Yes
IOT Device Model	Browse, Use		X	X	X	
	Create, change, delete			X	X	
	delegate, change ownership			X	X	
IOT Broker	Browse, use		use	Browse, use	X	Yes (use)
	Register/change/Delete				X	
	Delegate				X	
	Periodic Update				X	

In which case you are?

https://www.snap4city.org/drupal/node/474



A. Already registered on an IOT Broker of your/city organization. In this case, who provided you the IOT Device may have provided also at least: an IOT Device Identifier, a description of the data produced by the Device, the protocol kind and the IOT Broker in which it is registered, etc. **For example**: device ID: es286481295, temperature and humidity, NGSI, the "orionFinland" IOT Broker on https://ngsi.fvh.fi or the "Antwerp" IOT Broker on https://ext-api-gw-p.antwerpen.be. **In order to** exploit the data of your IOT Device in the Platform, you

1. have an **IOT Device which is registered** on an **IOT Broker** (for example, you received with the IOT Device the name of the IOT Broker) that is registered to Snap4City. You have two cases:
   1. **the IOT Device has been **already registered** on Snap4City by the organization/city**. This case can be verified by using the steps described in:
      - See in this case: HOW TO: verify if an IOT device is registered and accessible for me.
      - if the IOT device is registered please note that you are in case A3, if not, go at case A1.2
   2. **the IOT Device is **not yet registered** on Snap4City** (for example when a IOT Broker is managed by a third organization for security aspects, for example the FHV or DIGIPOLIS, or IMEC, ...), they given to your the device to test on different platforms.
      - See in this case: HOW TO: Add an IOT Device on Snap4City platform that is already registered on an external IOT Broker
   3. need to access IOT Device data **without registering the IOT Device in the Snap4City platform and Broker**, you need to know some configuration parameter of the IOT Broker and IOT Device, and Snap4City IOT App can get data directly from the IOT broker of your device without the need of having the Broker officially registered on snap4City.
      - See in this case: HOW TO: add IOT Device data source from external broker to the platform.
2. have an **IOT Device which is already registered to an internal Snap4City IOT Broker** (a IOT Broker managed by Snap4City for security aspects). In this case, the IOT Device and corresponding data are immediately accessible, and you can find them into the list of your data in the Data Inspector view, for Dashboards, etc., go in the Data Inspector to search your data by GPS location, name, nature as you like.

A. **Already registered on an IOT Broker** … see above
B. **Not registered to an IOT Broker**. In this case, you need to know, at least, how the IOT Device works and how it can be internally configured to communicate with an IOT Broker: to authenticate, register, etc. So that you need to know: an IOT Device Identifier, a description of the data produced by the device, the protocol, etc. For example: device ID: 286481295, temperature and humidity, NGSI with basic authentication,
   1. **In this case,** the first step is to register the IOT Device to an IOT Broker. Snap4City offers you a number of **Snap4City IOT Brokers** compliant with different protocols to which you can connect your device. To this end, please follow this tutorial:
      – See in this case: HOW TO: Add an IOT Device on Snap4City platform by registering it on an Internal Snap4City IOT Broker
   2. in alternative you can find some other brokers in your area according to the protocol of your device.
   3. **Once registered the IOT Device to an IOT Broker please restart from case (A); if you registered with a Snap4City IOT Broker it will be easy an (A2).**

How to setup and IOT Data Stream

Managers/AreaManagers:

1. Register the IOT Broker you want to use.
   – If you do not have one, you can ask one to Snap4City
2. Register the IOT Device you want to use.
   – If it is only one Device to reg, you can do it manually,
   – if they are many, we suggest you to create an IOT Device Model, then register the device (only AreaManagers)
3. Use IT

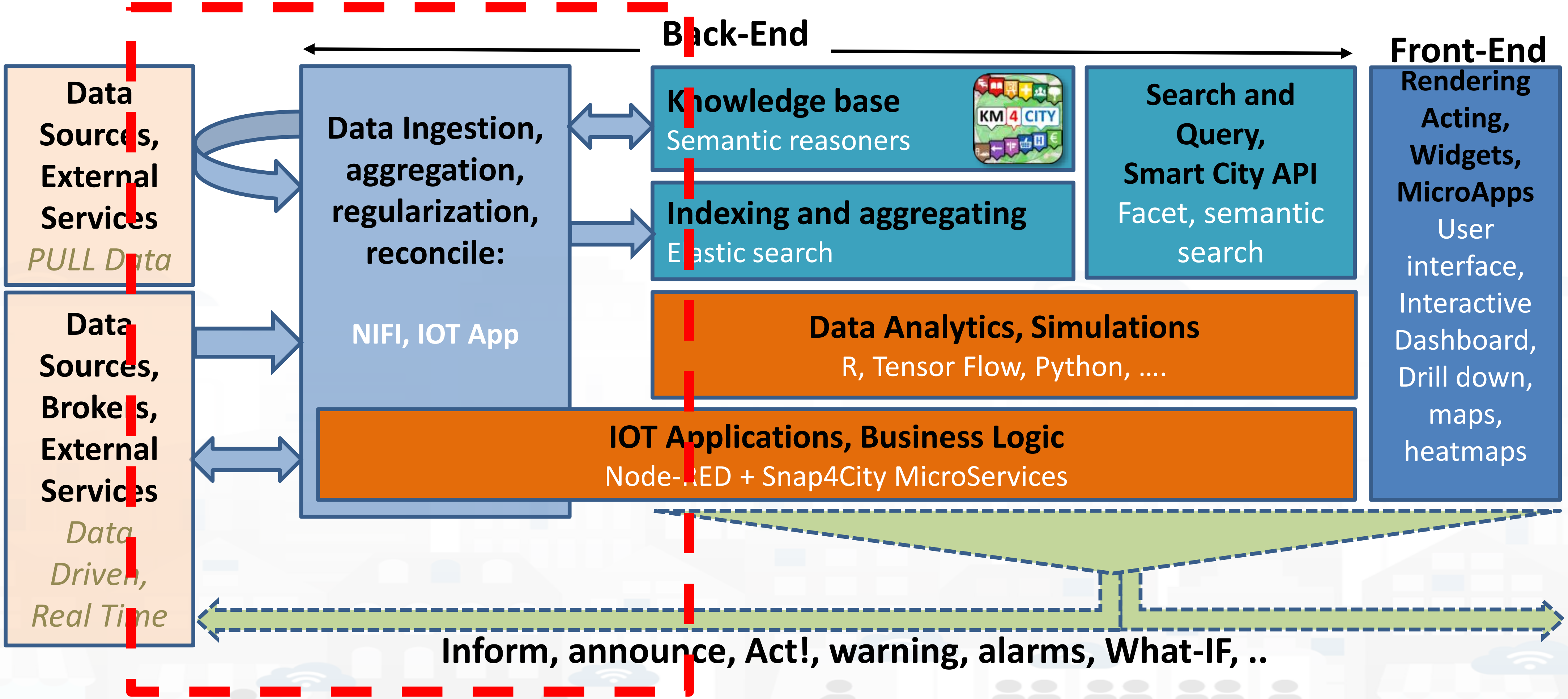
Administrators:

1. Register the IOT Broker you want to use, or use one already registered.
   – If the IOT Orion Broker has IOT Devices registered in you can use the procedure for automated registration (from your Broker to the IOT Directory and KB), with rule for transformation, etc.
   – If not see points 2 and/or 3
2. Register a single IOT Device manually
3. Register a group of IOT Devices
   – create a IOT Device Model
   – Create a CVS file for Registering devices in Bulk
4. Use IT

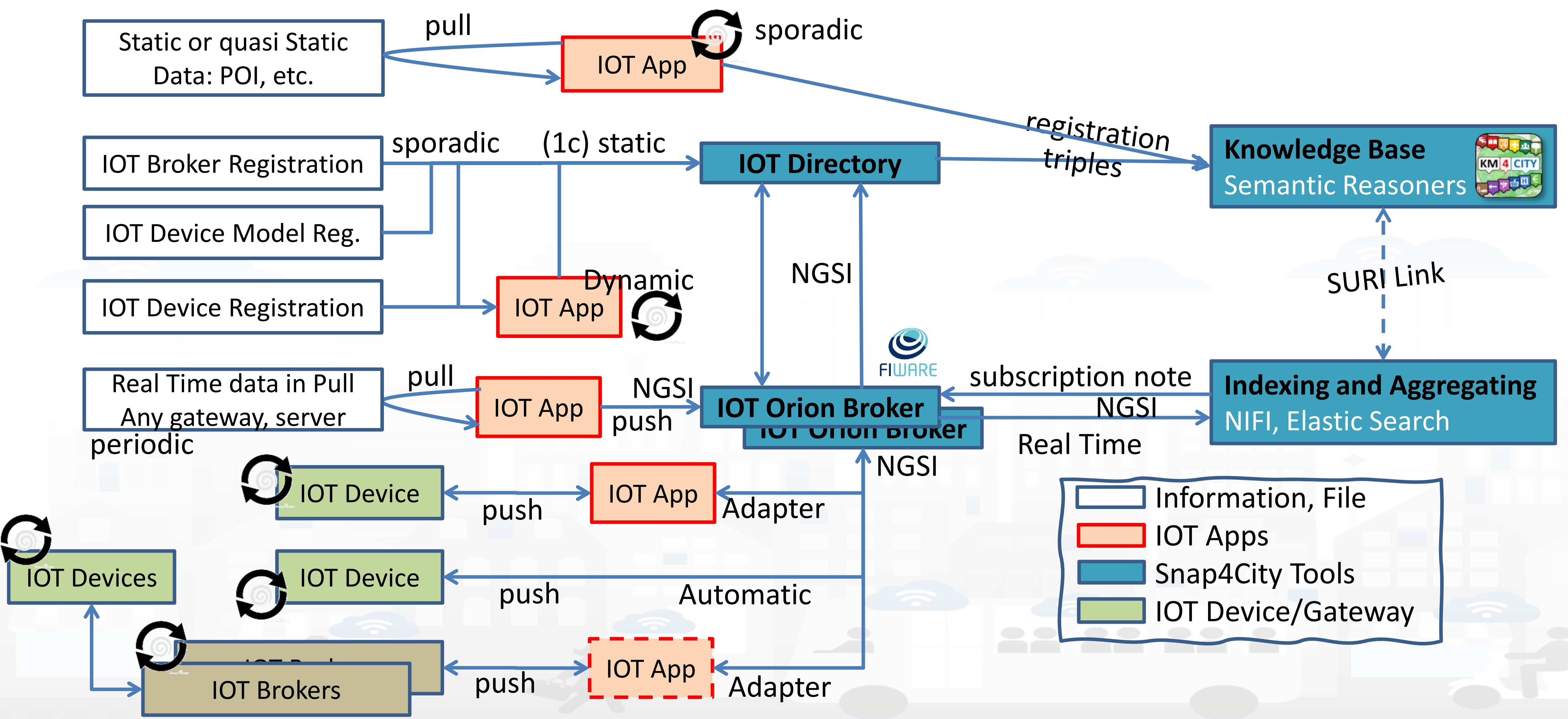
TOP

Data Ingestion Strategy

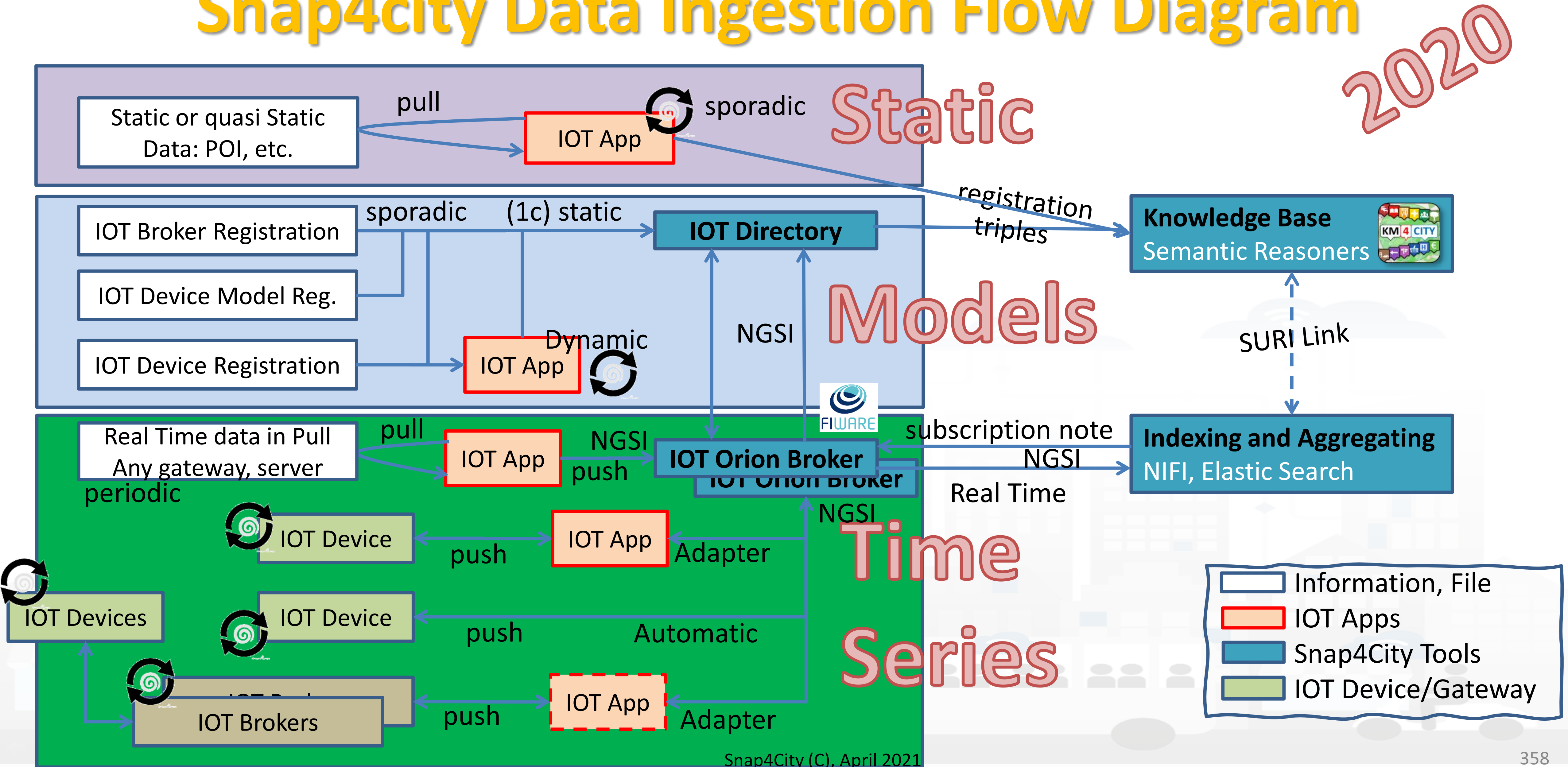
Snap4City Architecture vs Data Ingestion



Snap4city Data Ingestion Flow Diagram



Snap4city Data Ingestion Flow Diagram



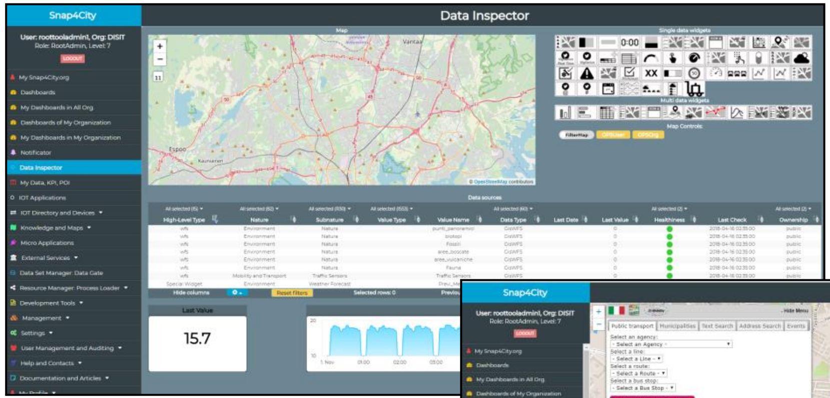
On the Flow Diagram

- **Static** (unified model for multidomain indexing)
  - Geodata, Open Data as POI, Data Bases, records, etc.
  - They change over time sporadically
- **Models** (Registration of IOT Device Models, IOT Devices, Brokers)
  - Registration of entities with their metadata and data structures
    - Brokers, Devices, structures of real time data, machine models for IOT Industry 4.0, sensor models/structure, etc.
- **Time Series (dynamic data)**
  - Any instance of IOT Devices over time and space with any kind of entity relationship each other and with other city entities

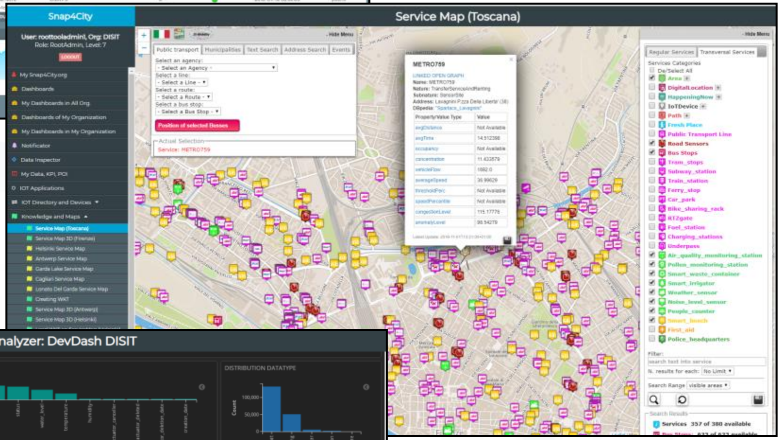
Checking data ingestion results

Knowledge base
Semantic reasoners

- **Data Inspector**
- **ServiceMap**, SCAPI
  - LOG / LOD viewer
  - Super Service Map
- IOT Directory
- SCAPI: Swagger
- IOT Broker



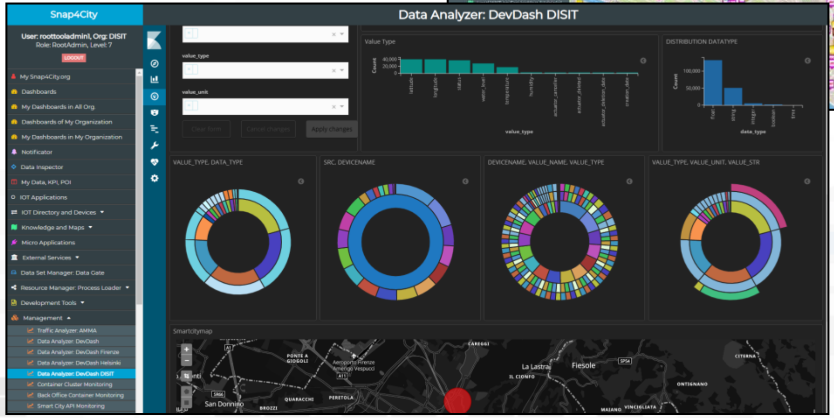
Data Inspector
Digital Twin view



ServiceMap

Indexing and aggregating
Elastic search

- **Data Inspector**
- **ServiceMap**, SCAPI
- **My Data Dashboard** (Kibana), DevDash
- Elastic Search

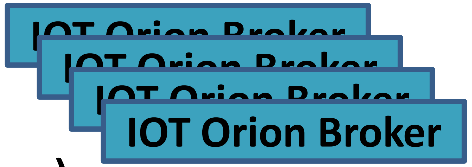


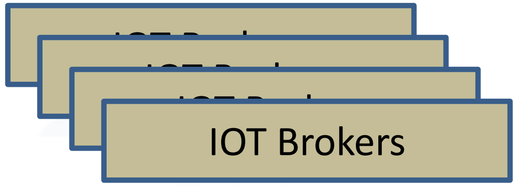
My Data Dashboard
DevDash

Some functionalities are limited to certain roles

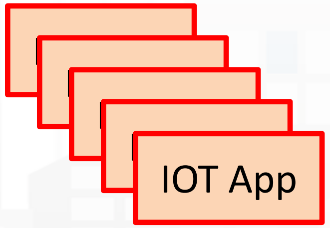
Additional Notes

- The **IOT Orion Brokers** can be feed by means of
  - **IOT App** of Snap4City (to implement Agents and/or Adapters)
  - **IOT Agents** and/or **NGSI Adapters** by FiWare for different protocols
  - **IOT Brokers** of any kind, different protocols and producers, also as Gateways, and they can be located on premise and/or on any cloud





- **IOT App, IOT Agents, Adapters** can
  - be on IOT Edge
  - be implemented as IOT App of Snap4City
  - be on other clouds and services
  - work on a large range of different protocols and kinds
  - have or not Snap4City libraries installed



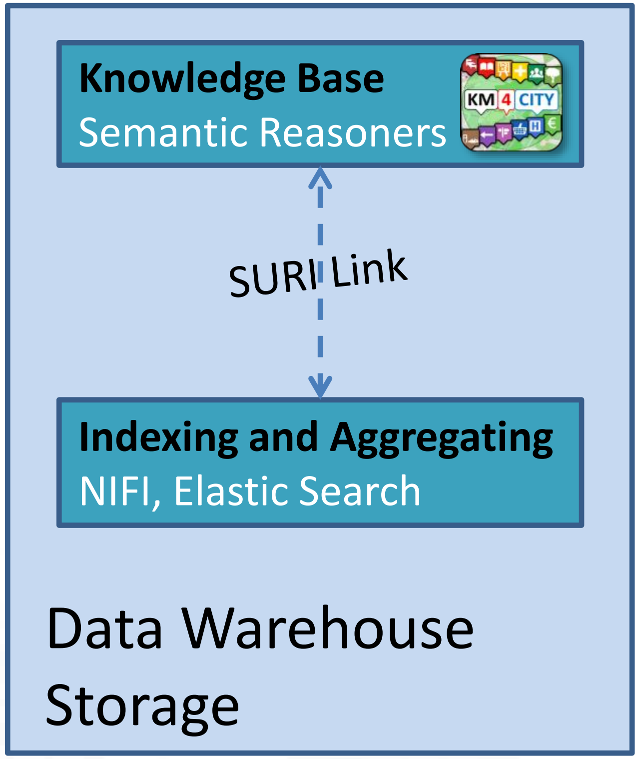
Additional Notes

- The **Internal IOT Orion Brokers** at Snap4City IOT Orion Broker are used as gate for data ingestion and actuations. Since they are
  - connected with the IOT Directory and discovery of the Knowledge Base to make easy the production of Dashboards by wizard, Data Inspector;
  - Synchronized automatically with NIFI/ElasticSearch for the Automated Data Shadow and Indexing
  - Ready to be used by IOT App to subscribe for creating even driven IOT Apps, on IOT Edge and Cloud, etc...
  - Compatible and harmonized with FiWare networks

Direct Ingestion

- **Direct Data Ingestion is also possible:**
  - **From data sources to Data Warehouse Storage of Snap4City, Snap4Industry**

- **Data Warehouse Storage includes:** KB, and I&A, reported on right side can be acted via API REST Call
  - for direct feeding data into store and retrieval,
  - which can be exploited by:
    - IOT Applications
    - applications in Python, R Studio, Java



Notation Terminology

WHERE	Are synonymous at level of service which can be IOT device or entity with data	Are synonymous at level of the single attribute of the entity, device, service, etc.
IOT Directory	IOT Device	Sensor, Actuator, Attributes, Values (value name)
Knowledge Base, ServiceMap, SmartCity API, ASCAPI	Service, ServiceURI, SURI	Attribute, Metric
DataInspector, Wizard, Dashboard	ValueName	Sensor, Sensor Actuator, ValueType
IOT Applications, Node-RED	ServiceURI, SURI	SURI and its real time results of the objects into the data structure

How to access at SURI

See Part 3

ServiceURI, SURI of a sensor device:

- http://www.disit.org/km4city/resource/METRO759

ServiceURI, SURI extended with attribute:

- http://www.disit.org/km4city/resource/METRO759&metric=vehicleFlow
- http%3A%2F%2Fwww.disit.org%2Fkm4city%2Fresource%2FMETRO759&metric=vehicleFlow
- In some cases
  - http://www.disit.org/km4city/resource/METRO759/vehicleFlow

TOP

IOT Broker Registration

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IOT Brokers

SNAP4CITY

Snap4City

IOT Brokers

User: roottooladmin1, Org: DISIT
Role: RootAdmin, Level: 7
LOGOUT

- My Snap4City.org
- Dashboards
- My Dashboards in All Org.
- Dashboards of My Organization
- My Dashboards in My Organization
- Notificator
- Data Inspector
- My Data, KPI, POI
- My Groups of Entities
- IOT Applications
- IOT Directory and Devices
  - My IOT Devices
  - IOT Sensors and Actuators
  - IOT Devices
  - IOT Devices Management
  - IOT Brokers
  - IOT Device Models
  - IOT Devices Bulk Registration
  - IOT Broker Periodic Update setting
  - IOT Orion Broker Mapping Rules
- Knowledge and Maps
- Micro Applications
- External Services
- Data Set Manager: Data Gate
- Synoptics
- Resource Manager: Process Loader
- Development Tools
- Management

New IOT Broker

Show 10 entries

Search:

	IOT Broker	Access Link	Access Port	Protocol	Ownership	Organization	Owner	Created	Edit	Delete
+	Antwerp	https://ext-api-gw-p.antwerpen.be/digipolis/aovmma/v1/entities		ngsi	DELEGATED	Antwerp	iotdirectory.antwerp	2019-03-13 14:57:17	EDIT	DELETE
+	Antwerp2	https://ext-api-gw-p.antwerpen.be/imec/smartzone/v1		ngsi	DELEGATED	Antwerp	iotdirectory.antwerp	2019-01-01 00:00:00	EDIT	DELETE
+	iotobsf-smartbed	192.168.1.47	8443	ngsi	DELEGATED	SmartBed	angelo.difino	2019-11-29 15:31:51	EDIT	DELETE
+	mqttUNIFI	192.168.1.10	1883	mqtt	DELEGATED	DISIT	iotdirectory.disit	2018-02-07 15:14:39	EDIT	DELETE
+	mqttUNIMI	159.149.129.184	1884	mqtt	DELEGATED	DISIT	iotdirectory.disit	2018-04-30 16:49:05	EDIT	DELETE
−	orionAntwerp-UNIFI	broker3.snap4city.org	8080	ngsi	PUBLIC	Antwerp	iotdirectory.antwerp	2019-06-03 14:25:16	EDIT	DELETE

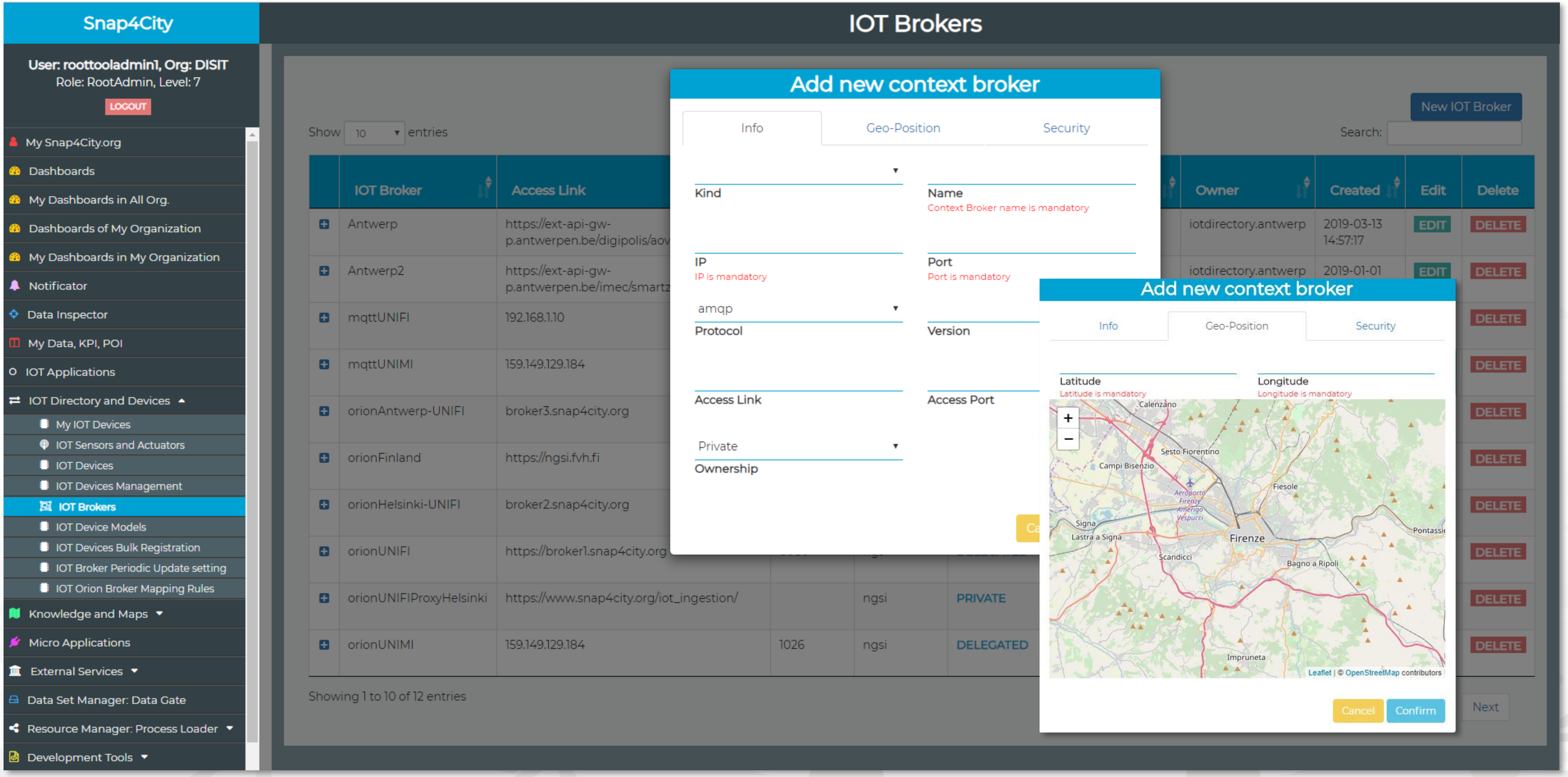
IP: 192.168.1.12 **Port:** 1026
Latitude: 43.76666 **Longitude:** 11.26242
Login: **Password:**
SHA:

	IOT Broker	Access Link	Access Port	Protocol	Ownership	Organization	Owner	Created	Edit	Delete
+	orionFinland	https://ngsi.fvh.fi		ngsi	PUBLIC	Helsinki	iotdirectory.helsinki	2018-11-21 16:05:24	EDIT	DELETE
+	orionFirenze-UNIFI	192.168.1.17	8443	ngsi	PRIVATE	Firenze	iotdirectory.firenze	2019-10-28 10:01:53	EDIT	DELETE
+	orionHelsinki-UNIFI	broker2.snap4city.org	8080	ngsi	PUBLIC	Helsinki	iotdirectory.helsinki	2019-06-03 10:26:34	EDIT	DELETE
+	orionLonatoDelGarda-UNIFI	192.168.1.46	8443	ngsi	DELEGATED	LonatoDelGarda	iotdirectory.ldg	2019-10-28 10:04:05	EDIT	DELETE

Showing 1 to 10 of 17 entries

Previous 1 2 Next

Register IOT Broker



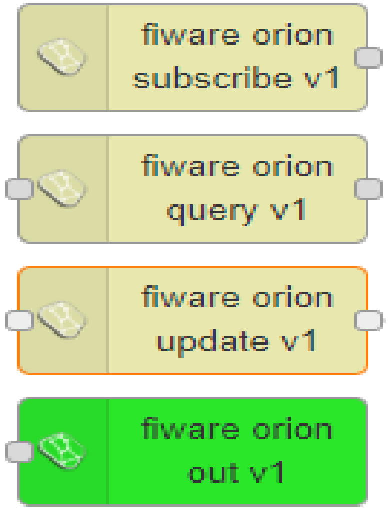
Snap4 technology is broker Agnostic

- **IOT Brokers**
  - are associated with an Organization
    - Each **Organization** has a **Knowledge Base** of reference (KB, ServiceMap)
    - Each **KB** may host multiple **Organizations** and addresses multiple **Geographic areas**
  - can be compliant with
    - **NGSI version**: V1, V2-1, V2, etc…
      - with Snap4City Security or regular NGSI FiWare
    - other protocols as well such as: MQTT, COAP, AMQP, etc.
  - can
    - expose different **authentication methods**: K1/K2, Certificate, etc.
    - be accessible from IOT Devices and IOT App **in Cloud only**
    - be accessible **from Internet to post data from outside, etc.**

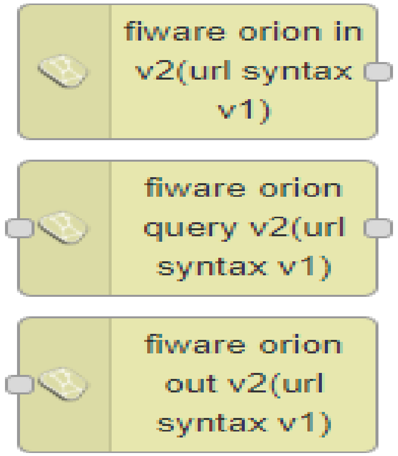
IOT Orion Broker Network: V1 and V2

- **IOT Broker can be Internal (on Snap4City Cloud)**
  - Registration of IOT Devices can be performed by the IOT Directory
  - Authentication is automatic, K1 and K2 are not needed since the security is performed via Access Token, M2M secure communication, on the basis of IOT App ownership
  - The **NIFI Cluster** automatically subscribes to all the entities on the Broker, to post data into the Data Shadow enriched with data of the KB
- **IOT Broker can be External (managed by third party)**
  - Registration of IOT Devices is managed by third parties
  - The registered IOT Devices can be collected and queried from the IOT Directory as well
  - The NIFI Cluster **may** automatically subscribes to all the entities on the Broker, to post data into the Data Shadow enriched with data of the KB
- **IOT Brokers can be networked**
  - Services, Service paths: for managing the IOT Broker network
  - Multi-tenant: more than one user/org on the same IOT Broker

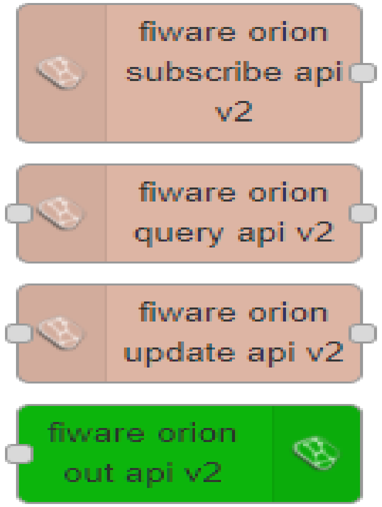
NGSI versions



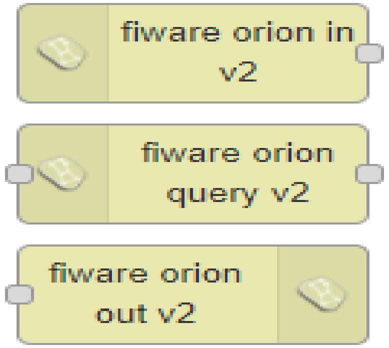
- Orion Broker of V1 with **NGSI syntax of V1** + Secure Filter of Snap4city



- Orion Broker of V2 with NGSI syntax of V1



- Orion Broker of V2 with **NGSI syntax of V2** + Secure Filter of Snap4city



- Orion Broker of V2 with NGSI syntax of V2

TOP

IOT Devices / Brokers with Service / Service paths (SP)

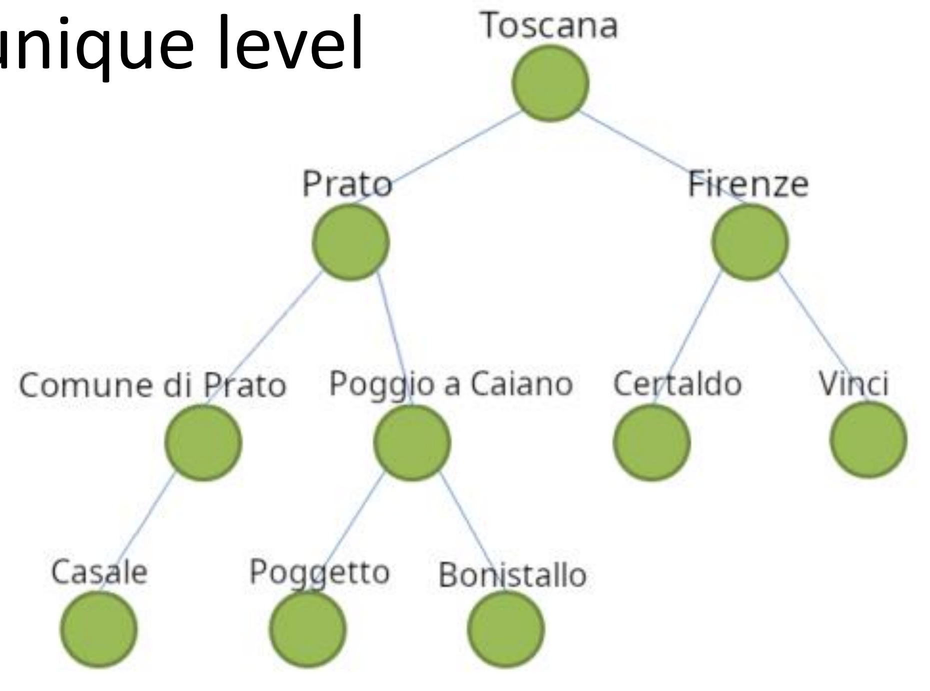
IOT Orion Broker: Service and Service Paths

- The concept of Service Path (SP) allows to organize the IOT Devices managed by a Brokers in Directories and SubDirectories.
  - This implies that IOT Devices with identical ID may be located on different paths
  - Path may be used for logica organization:
    - **Quadrant1 of the City**
      - **Lamps: L1, L2, ………**
      - **Waste…………**
    - **Quadrant2 of the city**
      - **Lamps: L1, L2, ………**
      - **Waste…………**

- Lamps
  - Street 1. d1., d2..
  - street 2, …
  - street 3, ..
- Waste
  - street 1: d1, d2, …
  - street 2
  - street 3

The Paths

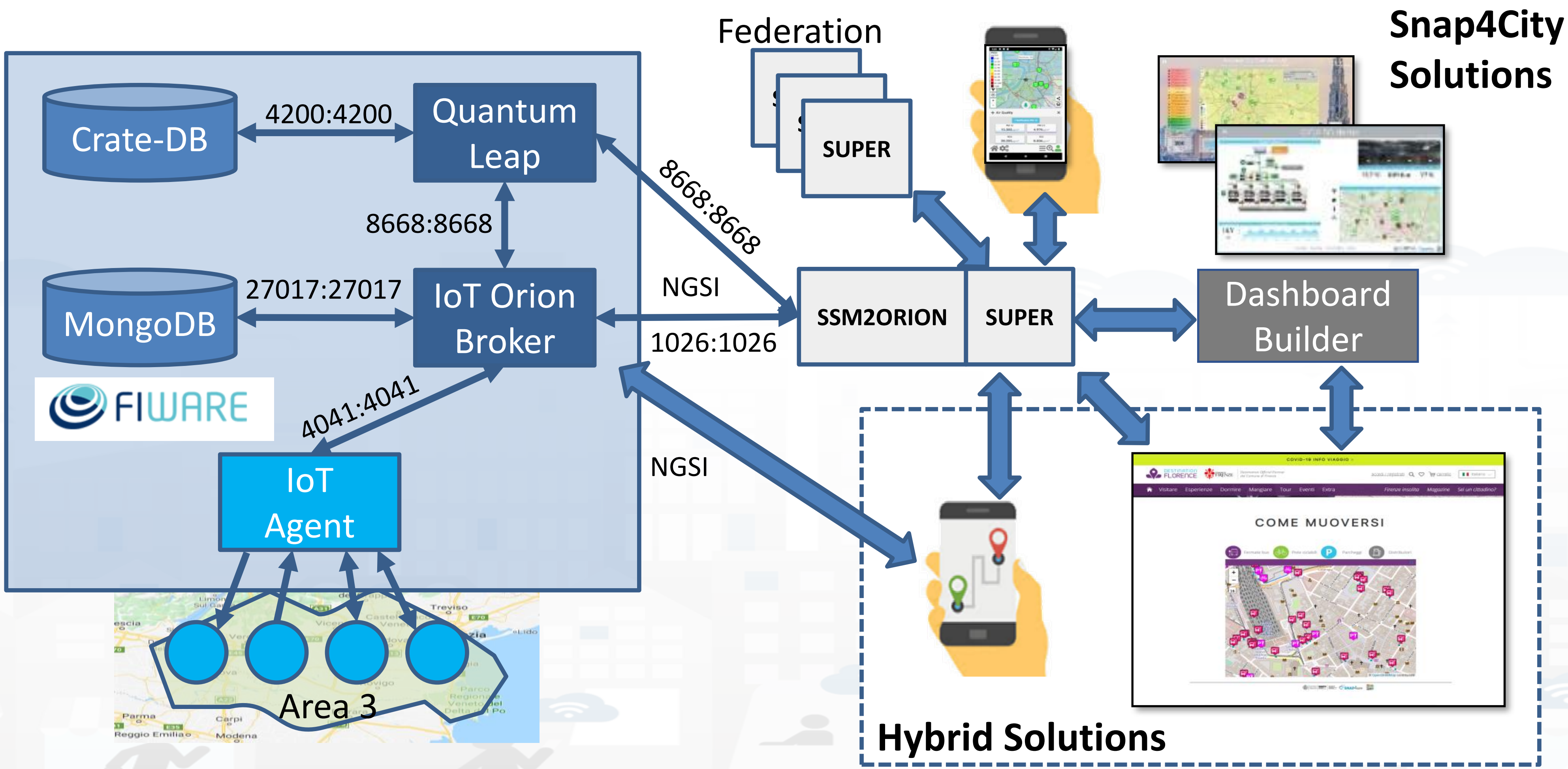
- Have to start with /, only absolute
- Max 10 levels
- Max 50 chars for each level
- A Device can belong only to a unique level




```
POST orioncb:1026/v2/entities
Content-Type: application/json
Fiware-ServicePath: /toscana/prato/comune_di_prato/casale
```

```
{
    "id": "Sensor1",
    "type": "MicroController",
    "temperature": {
        "value": 23.4,
        "type": "Float"
    },
    "pressure": {
        "value": 980,
        "type": "Integer"
    }
}
```

Federation of Snap4City vs IOT ORION Broker



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IOT Devices / Brokers with Multi Tenant (MT)

IOT Orion Broker: MultiTenant

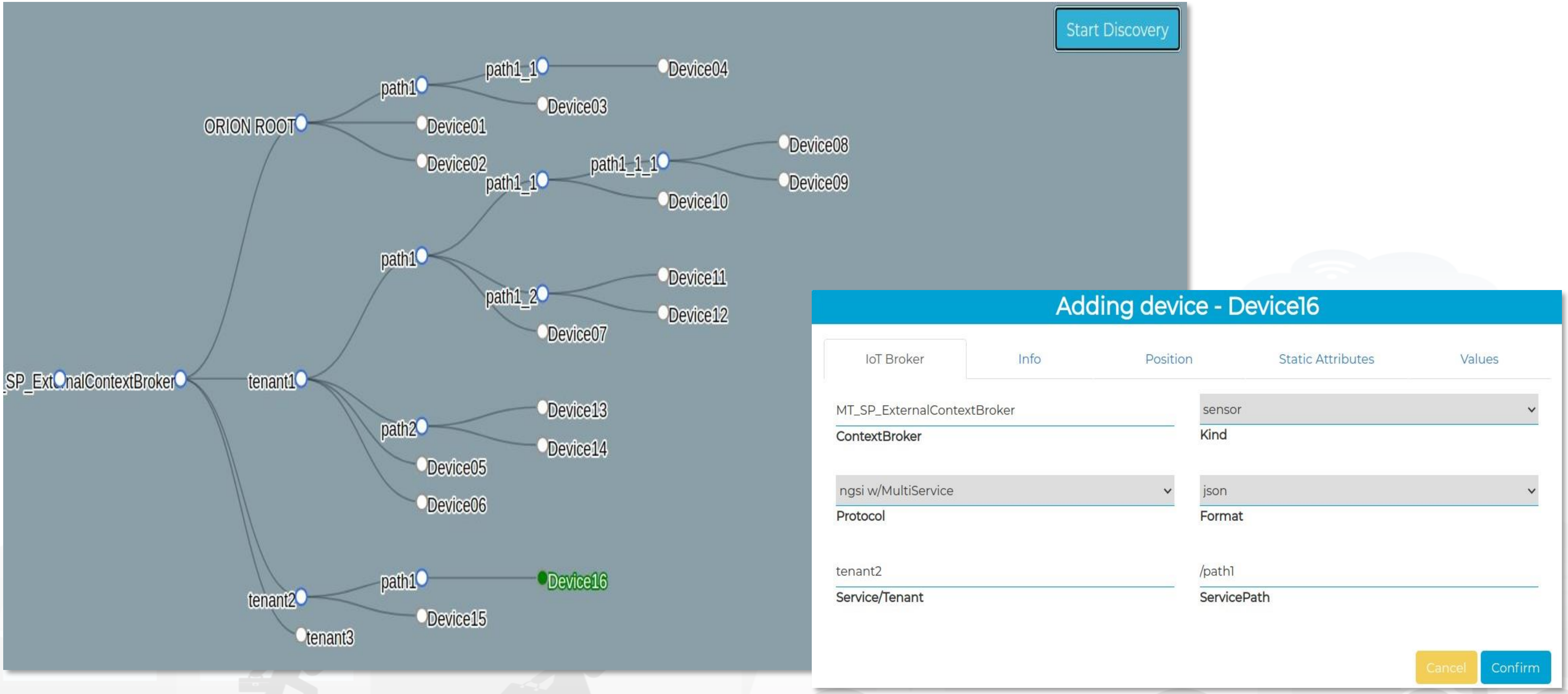
- The usage of **Service** can be used as **Tenant** of the same Broker
- The IOT Orion Broker and NGSI protocol do not allow to brose the whole set of Services, ServicePaths.
  - So that the single user may know its own Service which can be regarded as its own Tenant

```
Fiware-Service: tenant2
Fiware-ServicePath: /path1
```

TOP

Discovery of IOT Devices on External Brokers with SP/MT

Device Discovery MT/SP on External Brokers



TOP

IOT Device vs Time Series

What About IOT Devices, time series

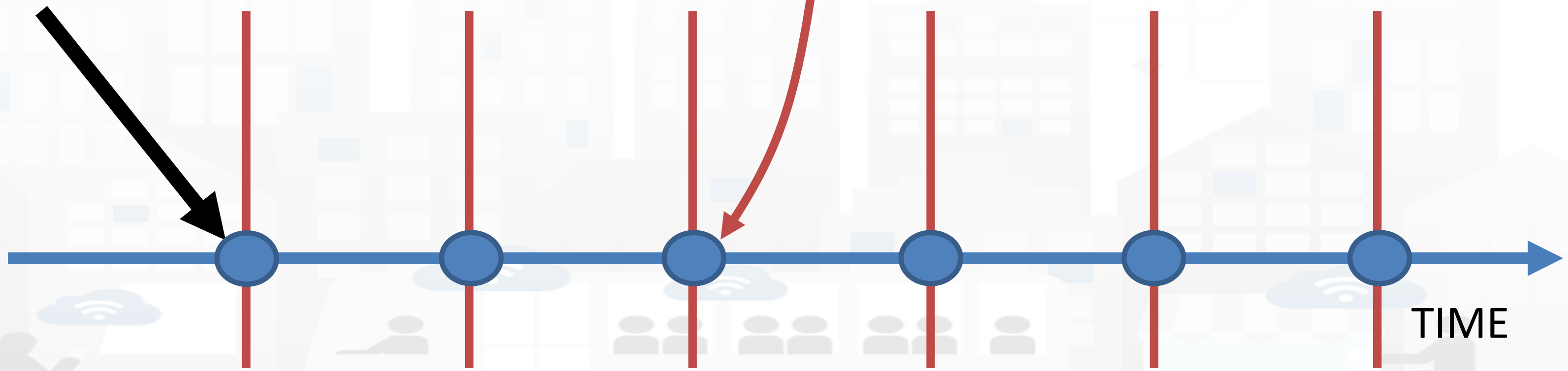
IOT Device

Sends a message

Message (
timestamp: «02-04-2020 at 10:30»,
Temperature: 29.34,
Humidity: 35
)

- A set of data coming from an IOT Device with multiple sensor become a time series of values for devices.
- For example taking a new measure every 10 minutes (Red Lines)
- Each new measure in Snap4City is conventionally time located in «dateObserved»

dateObserved	Temp	Humidity
02-04-2020 10:30	34.5	23
02-04-2020 10:40	36.5	24
02-04-2020 10:50	36.0	22.5



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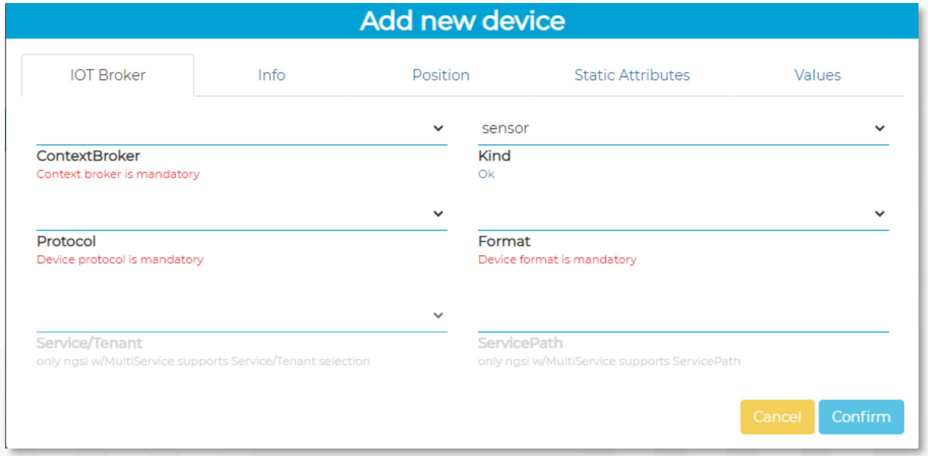
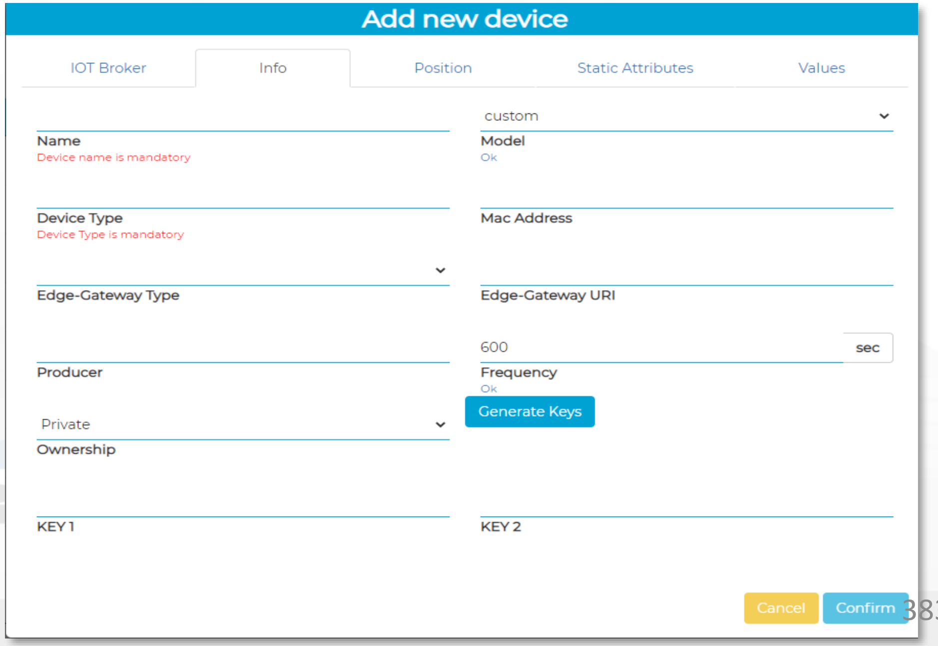
IOT Device Model

IOT Device Data Model (1)

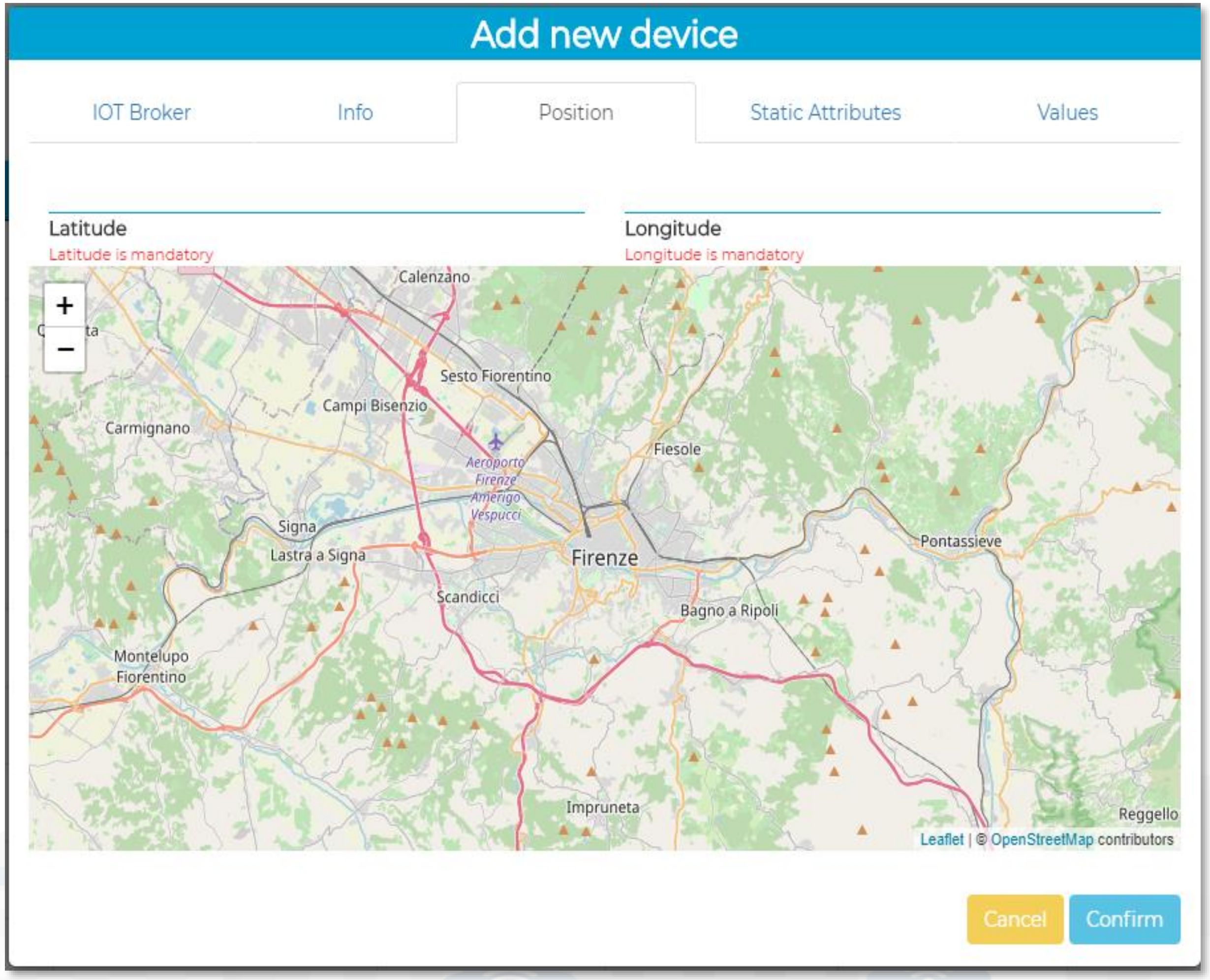
- IOT Broker
  - Name of the Brokers: among those registered
  - Protocol: NGSI, AMQP, MQTT, etc..
  - Format: CSV, JSON, XML.
  - Service/Tenant:……….
  - ServicePath:………

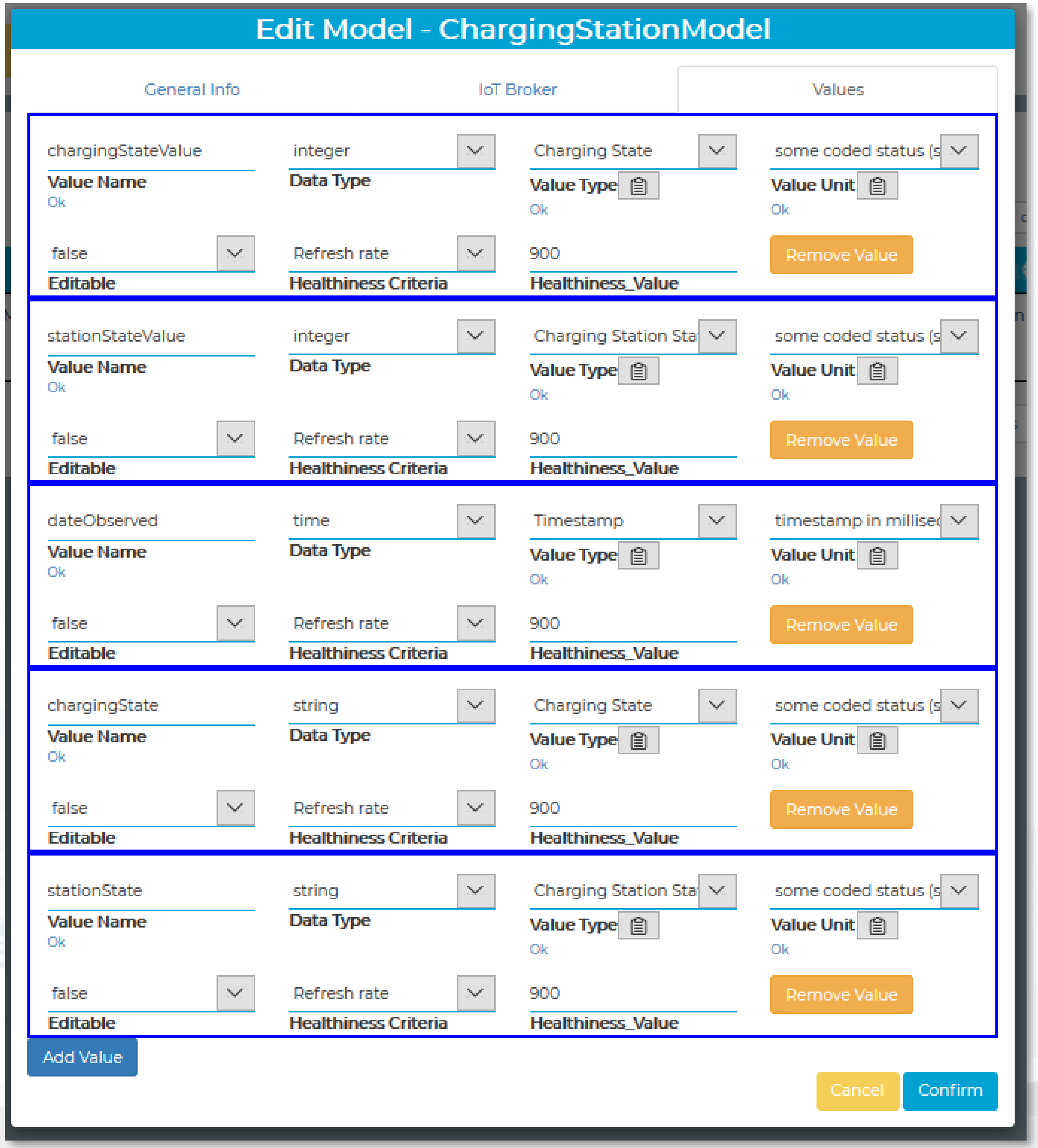


- Info
  - Name (Identifier)
  - Model: Custom or Model ID
  - DeviceType: ..a string..
  - MAC address: …optional…
  - Edge-GW: Raspberry, Android, …
  - Edge-GW: URI
  - Producer
  - Owner
  - Freq: ….. Sec
  - Keys: K1, K2



IOT Device Data Model (2)





IOT Device Data Model (3): Attributes

Where	IOT Device Model	IOT Device	A Temporal Instance
IOT Broker	Broker: OrionUNIFI		
IOT Broker	Protocol: NGSI		
Info	ID: string	ID: “park45”	park45
Position	GPS: lat, long	GSP Position: 43.12, 11.34	GSP Position: 44.12, 11.12
Static attribute	Description: string	Description: “parking massaia”	
Static attribute	Location: string	Location: “Via Massaia”	
Static attribute	Civic Number: string	Civic Number: 3	
Static attribute	MaxCapacity: number, cars	MaxCapacity: 456	
Values	dateObserved: Timestamp		23-12-2019T20:13:12…
Values	FreeSlots: Integer, #		345
Values	Humidity: float, %		25,5
Values	Temperature: float, celsius		34.4

Model meaning

- **ID:** is the unique identifier for reconnecting Temporal Instances with registered IOT Devices
- **Static Attributes:**
  - Are typically associated with instances of the IOT Device.
    E.g.:, You have a set of parking areas, each of them is located in a specific street, and has its one name, etc.
  - Different kinds of attributes can be set for each SubNature. Their definition has to be prepared into the Knowledge Base ☺ for automated indexing.
- **Values**: they are time varying variables (temporal values/instances)
  - They change over time, the timestamp of the time series is conventionally «dateObserved» in Snap4City
  - In new *SensorMobile* HLT, also GPS can be changing over time as in the MyKPI

Using the IOT Device Model notes!!!

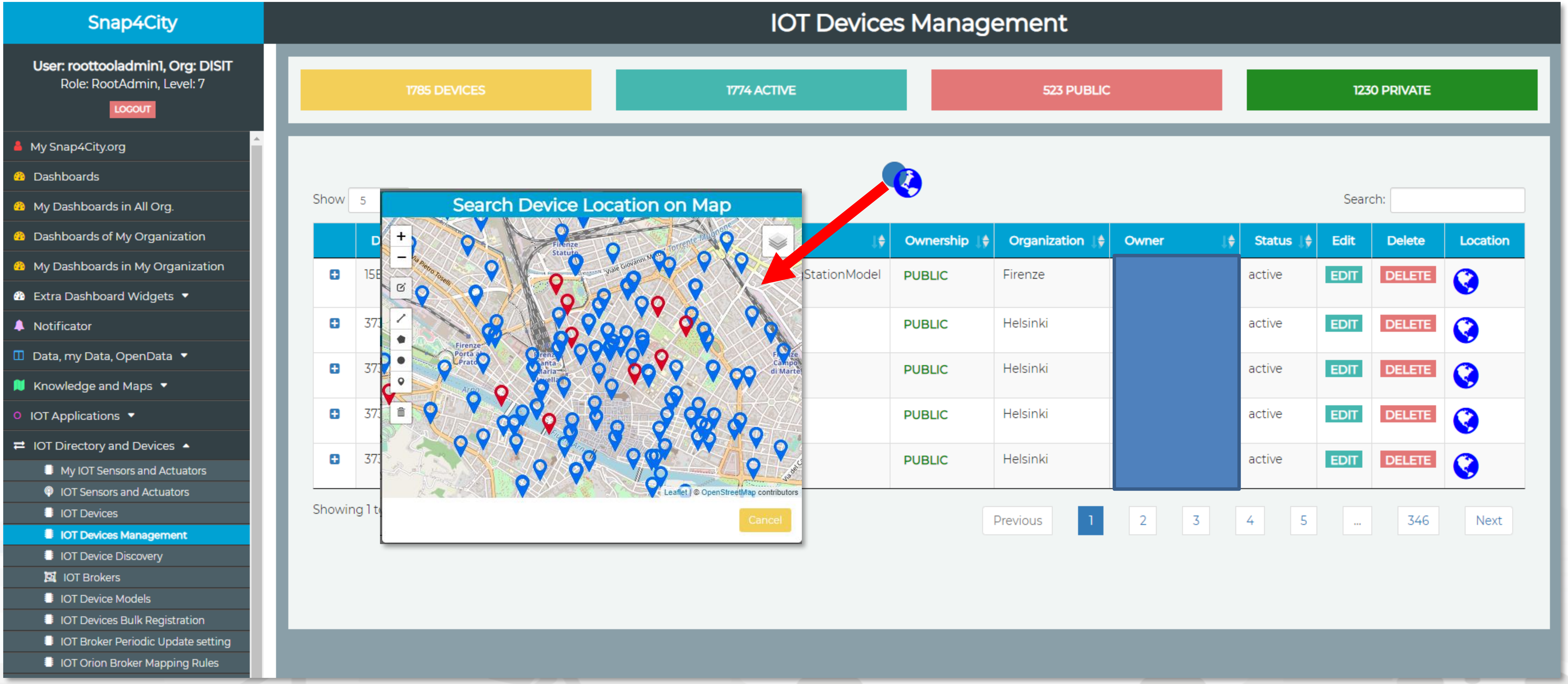
- Once performed the IOT Device Model, a number of IOT Devices can be produced **using the model as a Template**
  - **NOTE:** the produced IOT Devices are not going to change if the IOT Device Model is modified.
  - *Your biscuits are not changing if the template is modified after the printout*

TOP

IOT Device Management

(only for: RootAdmin and ToolAdmin)

IOT Device Management



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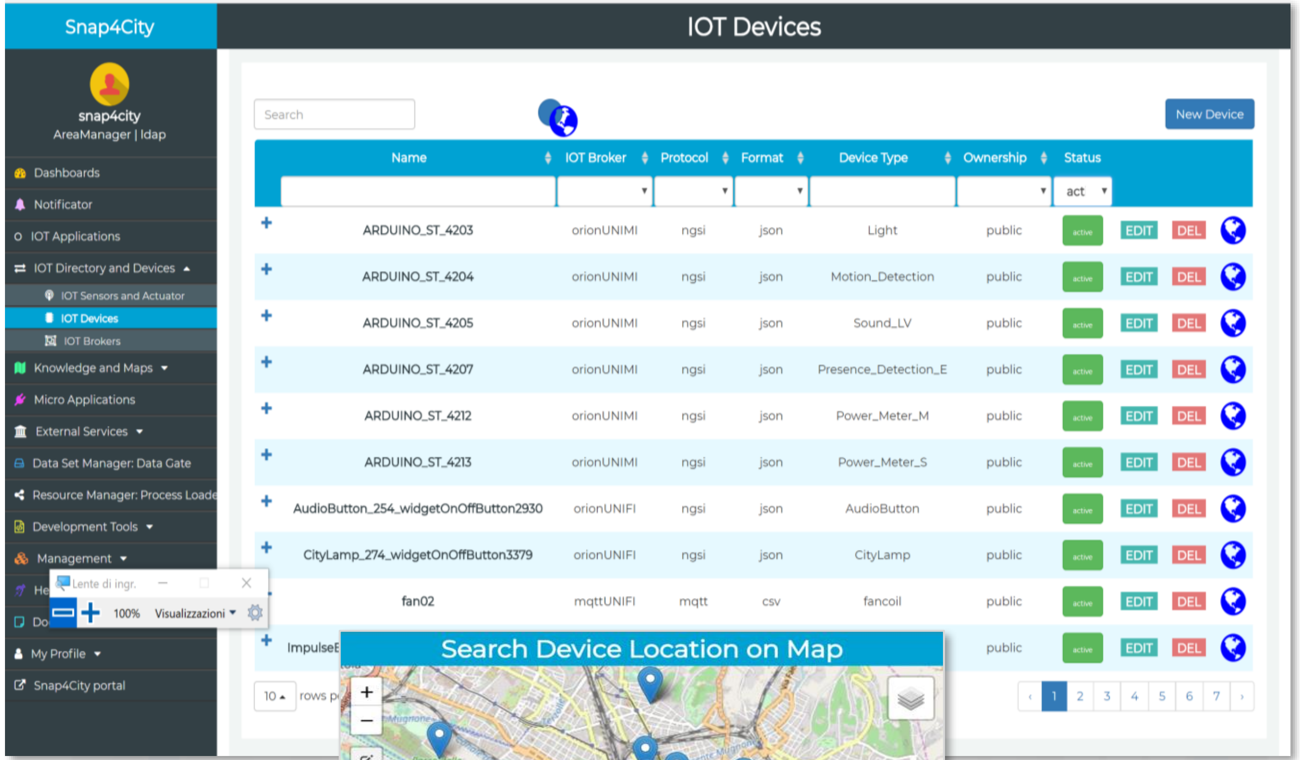
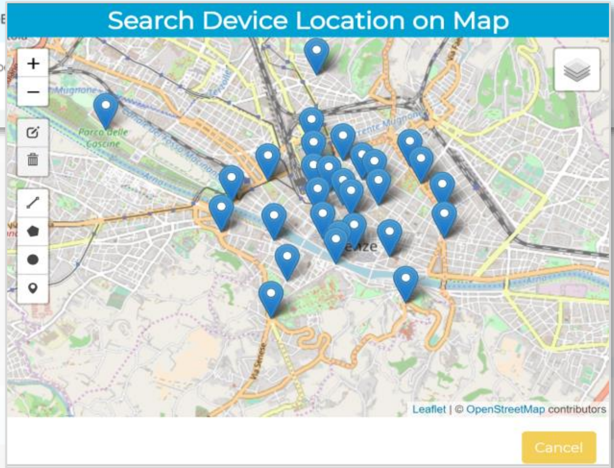
IOT Device Registration

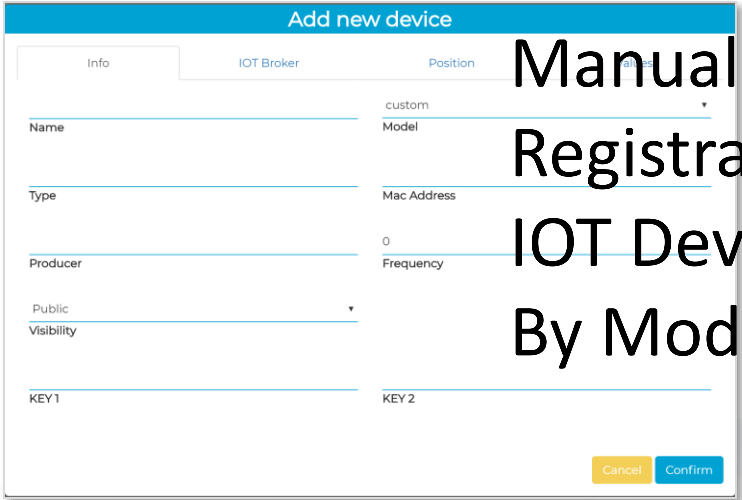
Activities for IOT Device Registration

- **Registration of**
  - an IOT Device Manually from Zero or from an IOT Device Model
  - a set of IOT Devices with the same IOT Device Model from IOT App
  - a set of IOT Devices in BULK loading a CSV (with or without a reference IOT Model)
- The IOT Device registration implies the **automated production of the Digital Twin Device into the Knowledge Base**, which implies:
  - Activation of the Storage “DataShadow” for historical data access
  - Activation of all the relationships
  - Activation of Discovery mechanisms via IOT Directory, KB
  - Activation of Dashboard Wizard (after a few minutes), and Data Inspector
  - Etc.

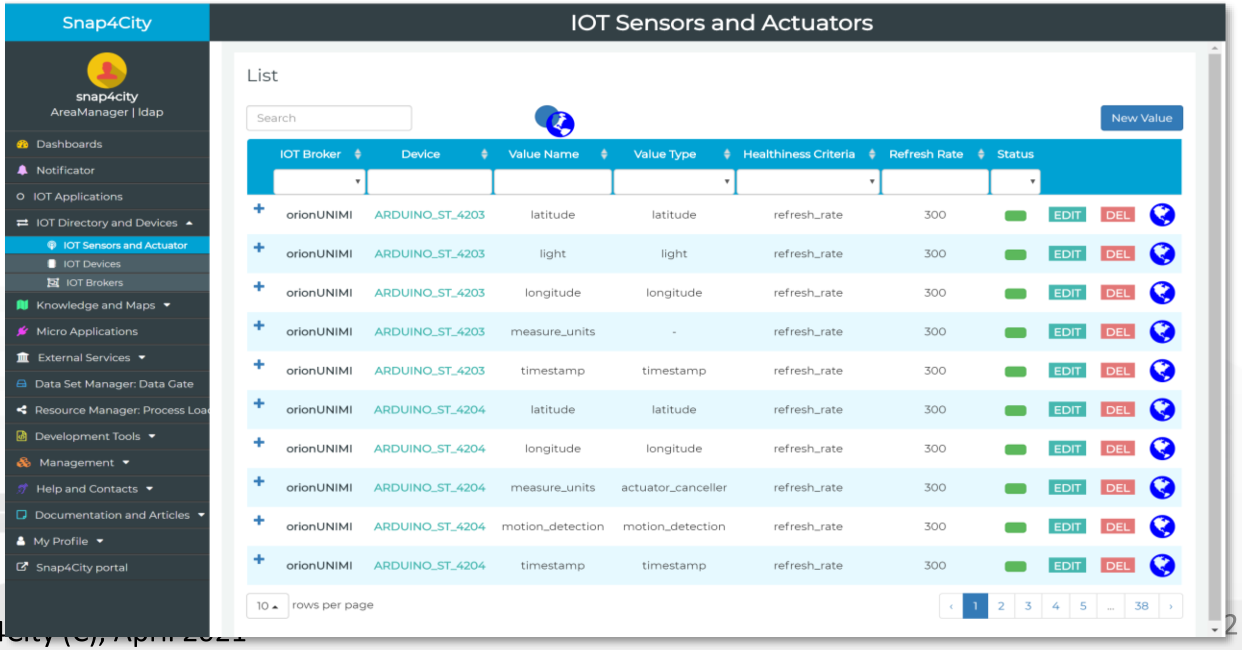
IOT Directory, IOT Device Management



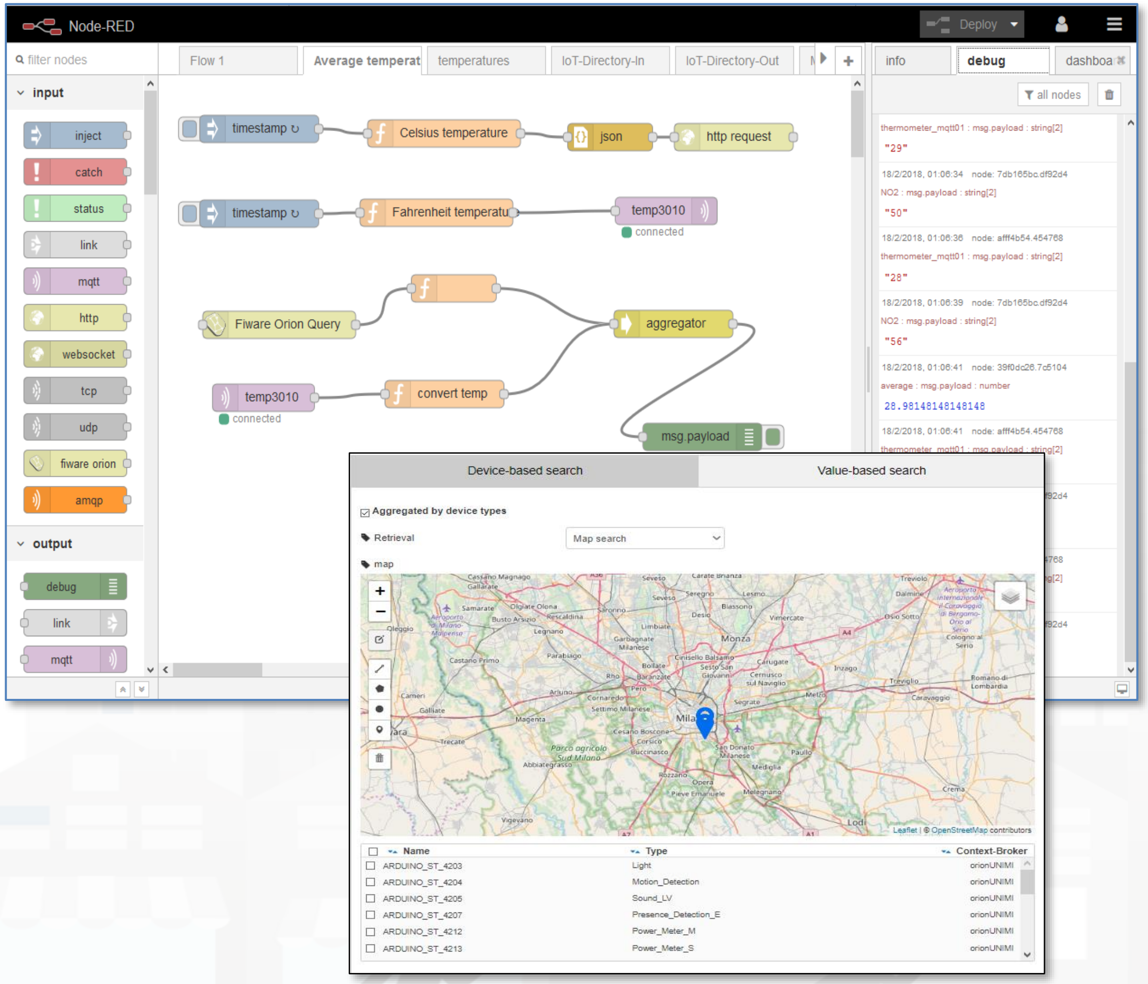


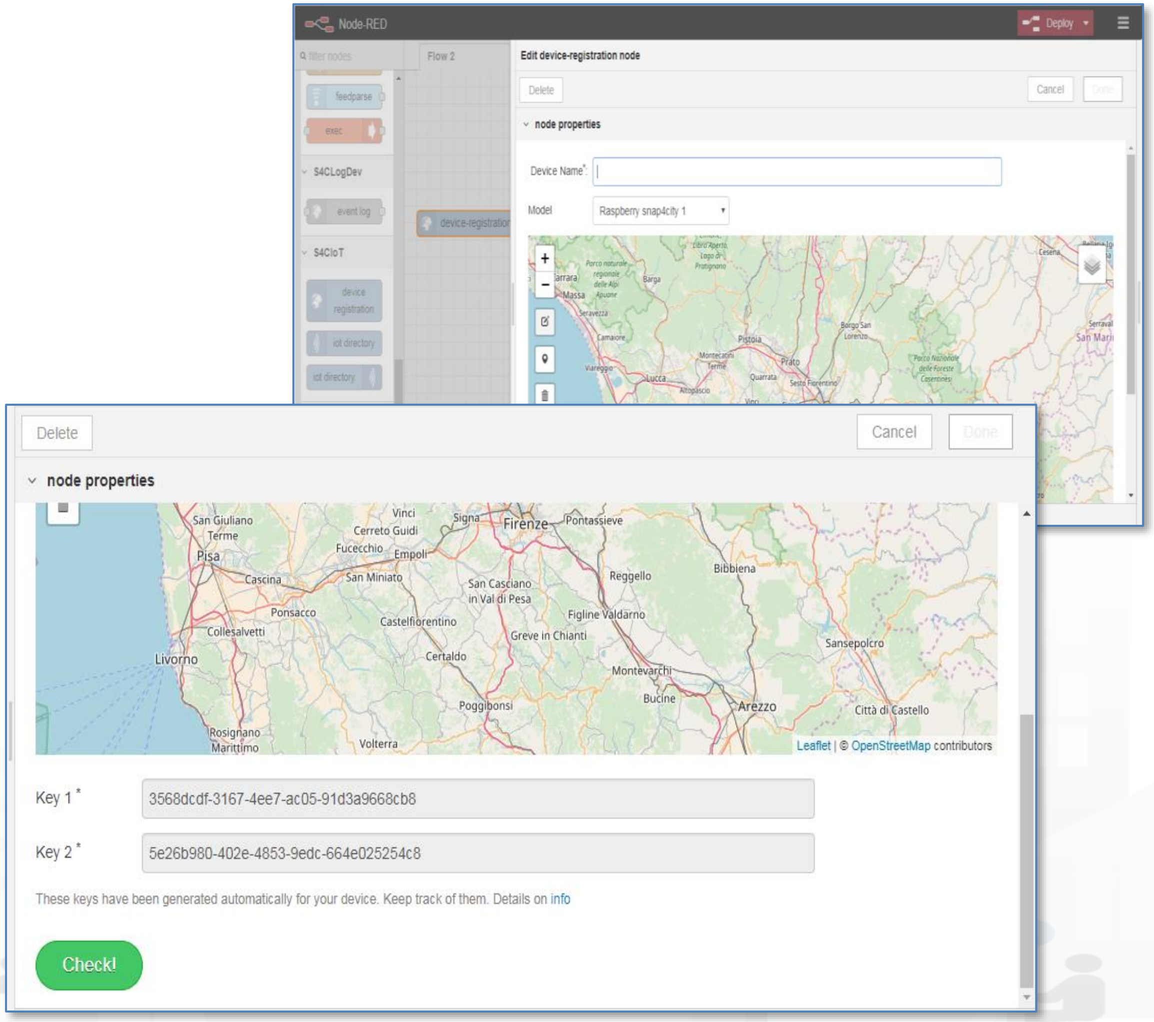


Manual Registration of IOT Device or By Model



IOT Discovery on IOT Application Development





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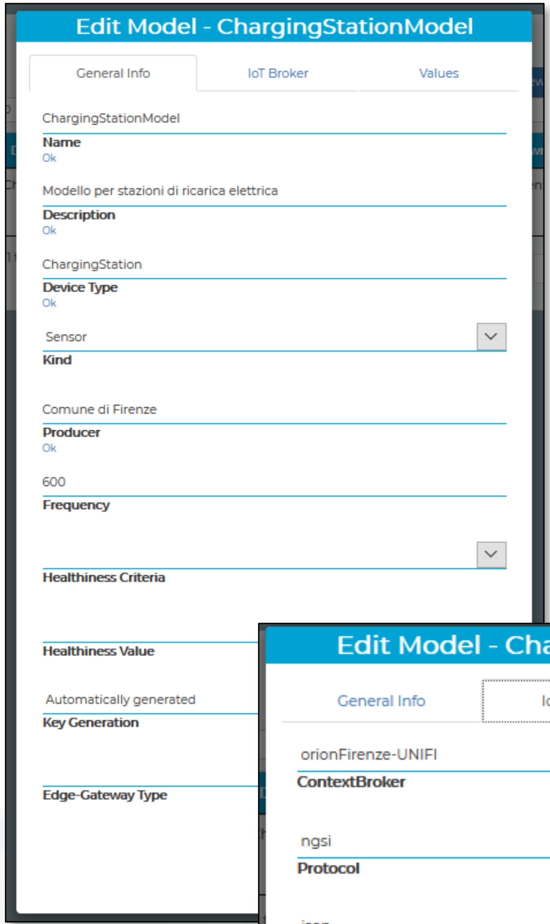
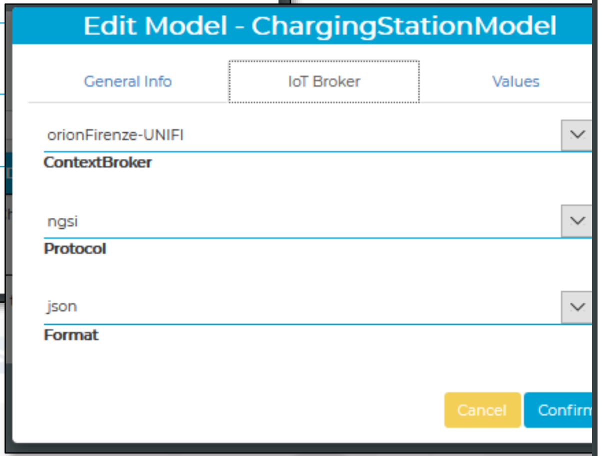
IOT Device Registration via IOT Device Model

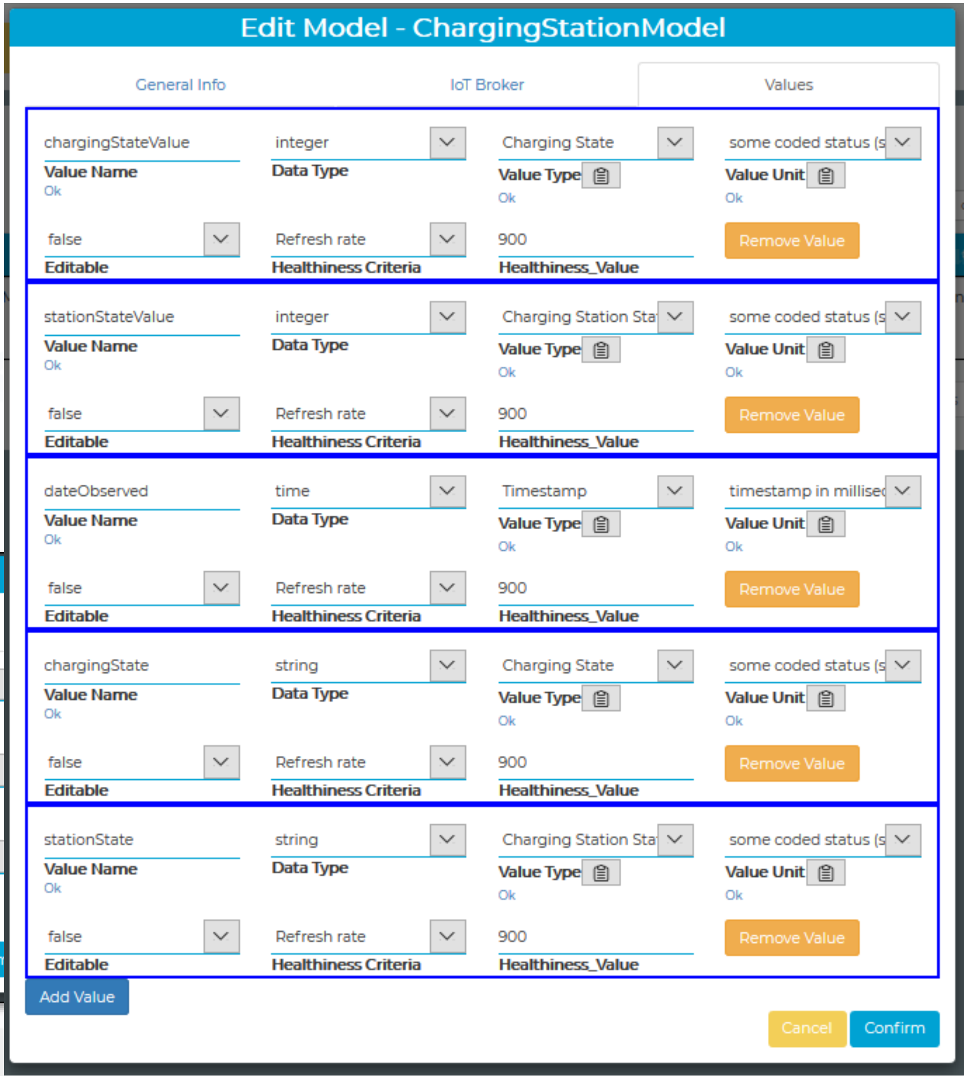
Many IoT Devices? IOT Device Model!!!

Example: ChargingStationModel

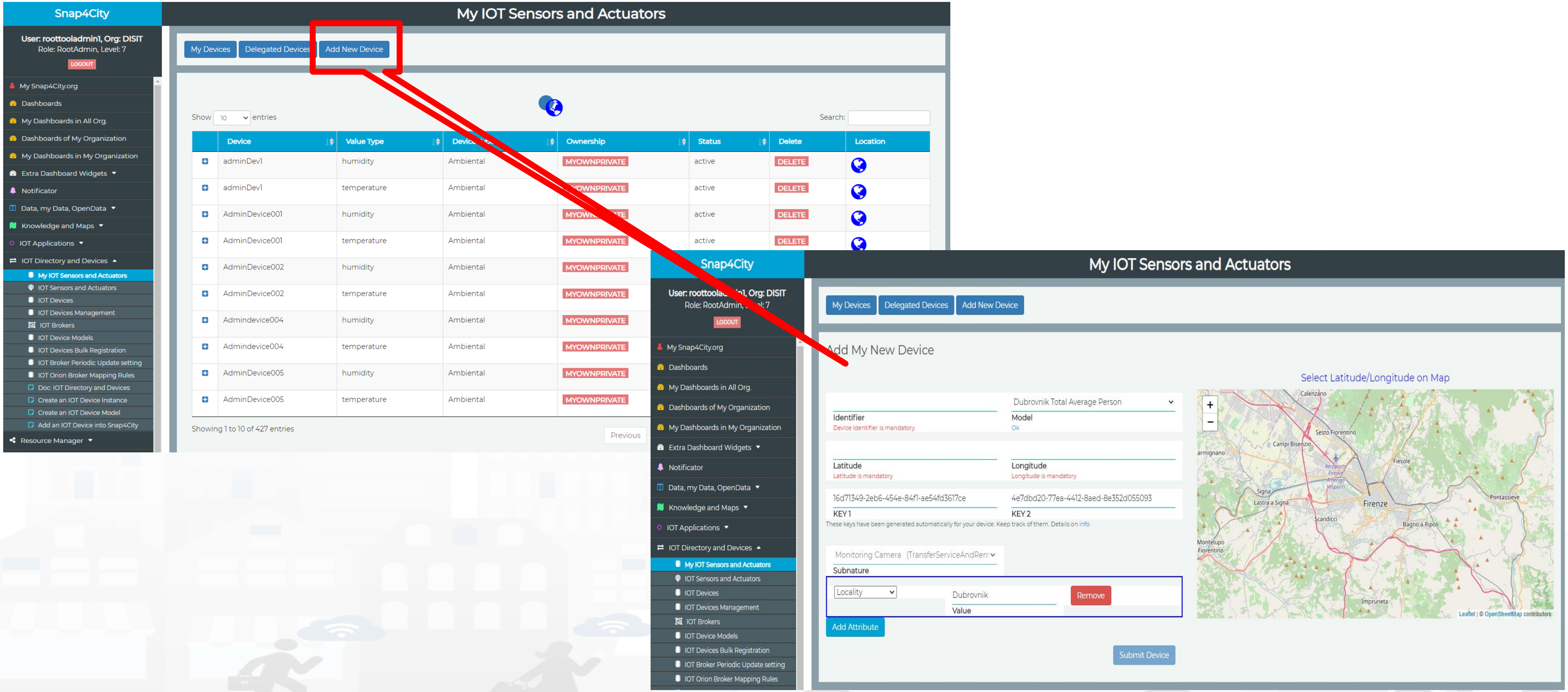
- **Prerequirements**: only for AreaManager users
- If you have a set of sensors with the same features,
  - you can create a model and then a set of instances (IoT Devices) in compliance with the model (not time consuming and avoiding errors)
- IoT Directory and Devices > IoT Device Models > 'New Model' button







Add IOT/IOE Devices, exploiting an IOT Device Model



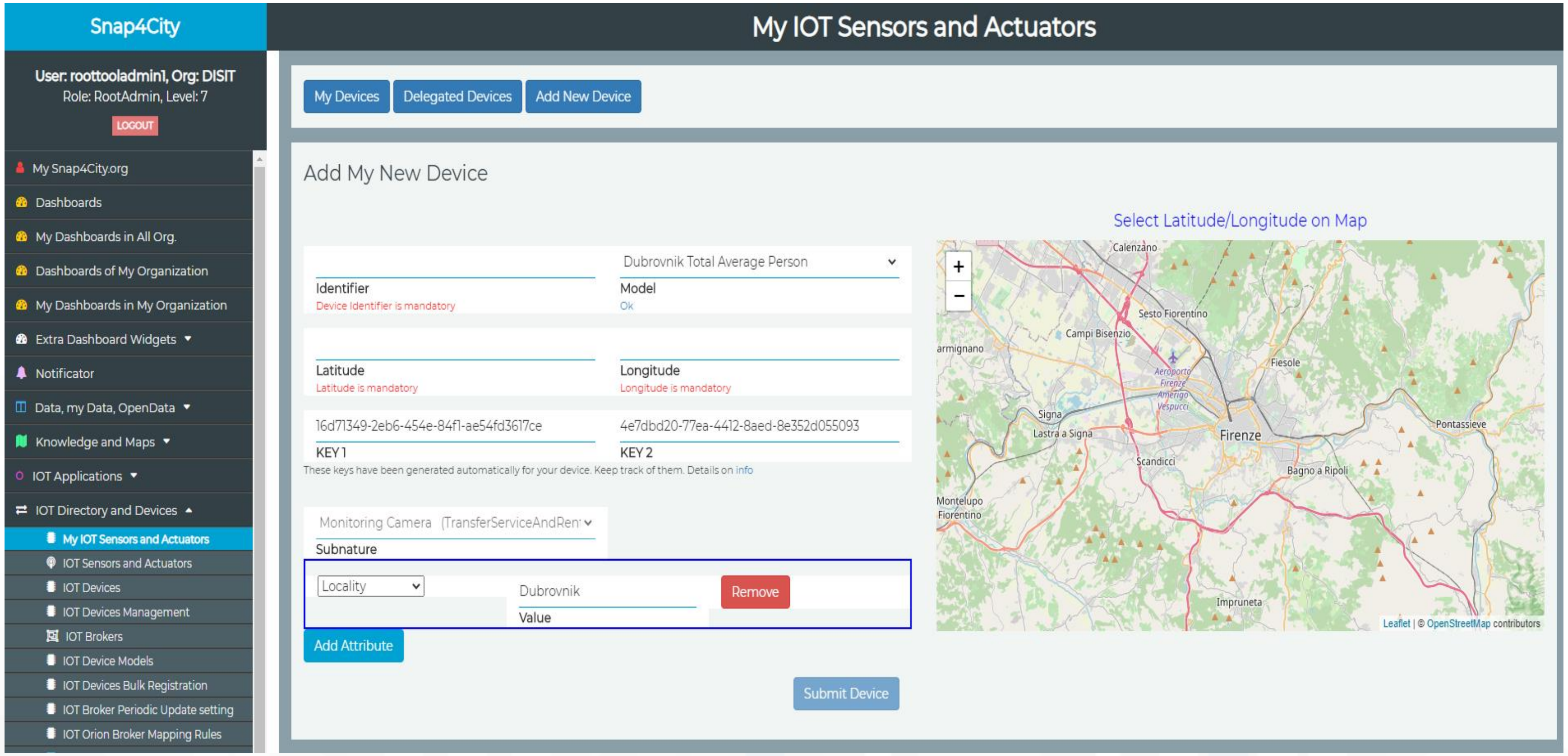
Add IOT/IOE Devices, exploiting an IOT Device Model

Just Buy an IOT Device and register: SigFOX, MQTT, NGSI (FiWare), …

- Attach them by
  - Models
- A range of protocols, formats, approaches

Create your own devices:

- Arduino,
- Raspberry,
- Android,
- LoraWAN + Arduino,
- etc.

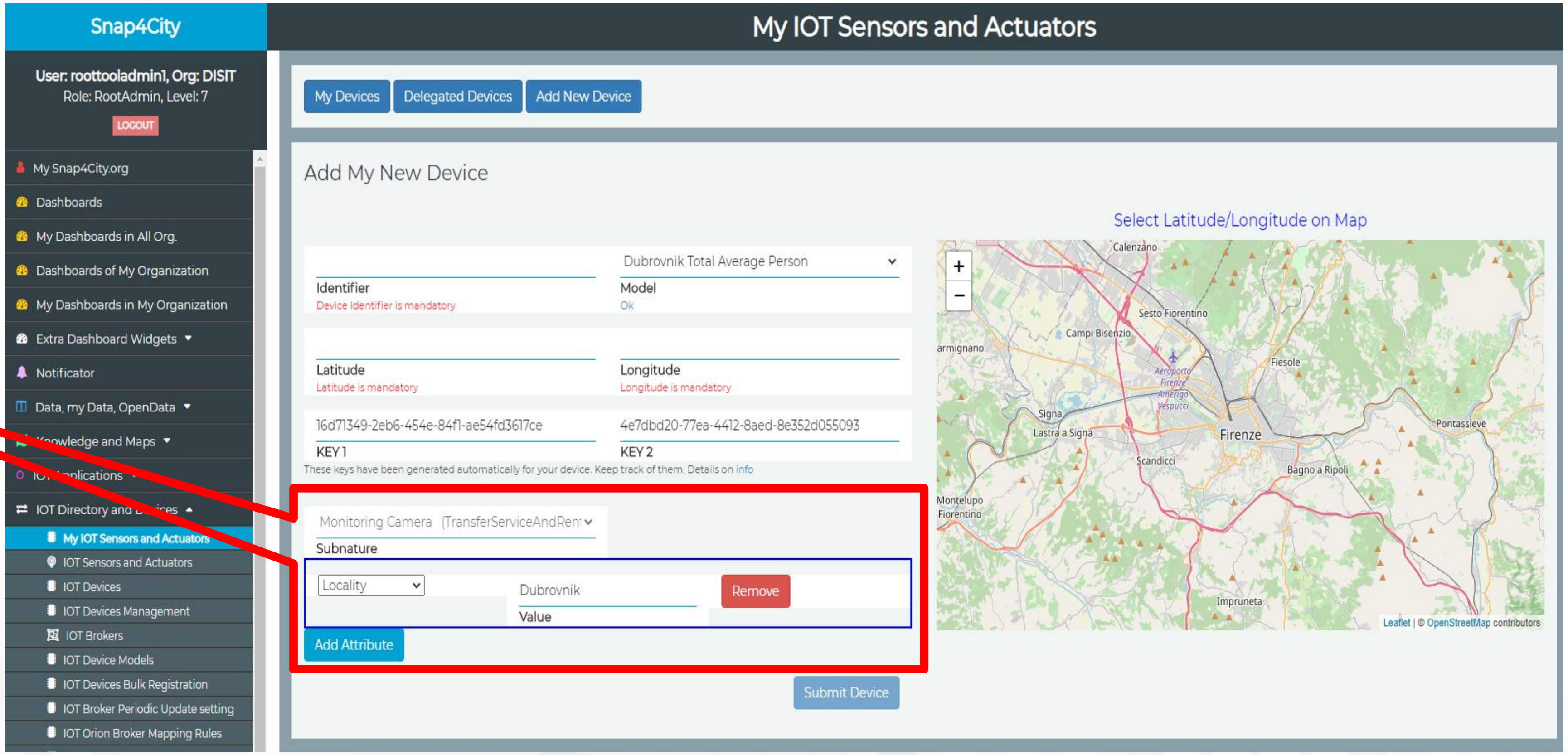


Secure Communication: HTTPS, TLS (K1, K2), Certificates

Add IOT/IOE Devices, exploiting an IOT Device Model

Addition of Static Attributes of the IOT Device

Only if you enabled from model



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IOT Device Registration via IOT Device Model in Bulk

From CSV → register IoT Devices in BULK

- Create a CSV from the CSV Model provided
- The columns must respect the CSV Model (every field present in the Model)
- One row of the CSV is one new IOT Device
- You have to create to create two keys (called k1, k2) that are necessary to read and write access to the device. They must be different each other.
- Each group of devices, that has the same IoT Model (data set), could/should have the same K1, K2. In this way, it is easier to read or write all the IOT Devices of the same set at the same time.
- These keys are in the UUID v4 format and can be generated online on this website: https://www.uuidgenerator.net

[Available example: https://www.snap4city.org/592](https://www.snap4city.org/592)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	name	devicetype	mac	frequency	kind	protocol	format	producer	lat	long	valuename	data_type	value_type	editable	value_unit	health_criteria	healthiness_value	K1	k2
2	eCharging_16ZP22T2AA1S000003	ChargingStations	3D:F2:C9:A6:B3:3F	600	sensor	ngsi	json	Comune di Firenze	4.377.222	1.125.338	chargingState	string	charging_state	false	-	refresh_rate	900	c6f03a41-880e-46f0-879a-993501ca6b50	80466a36-2b5a-4ac9-a7c3-db12c480da38
3	eCharging_16ZP22T2AA1S000003	ChargingStations	3D:F2:C9:A6:B3:3F	600	sensor	ngsi	json	Comune di Firenze	4.377.222	1.125.338	chargingStateValue	integer	charging_state	false	#	refresh_rate	900	c6f03a41-880e-46f0-879a-993501ca6b50	80466a36-2b5a-4ac9-a7c3-db12c480da38
4	eCharging_16ZP22T2AA1S000003	ChargingStations	3D:F2:C9:A6:B3:3F	600	sensor	ngsi	json	Comune di Firenze	4.377.222	1.125.338	stationState	string	charging_station_state	false	-	refresh_rate	900	c6f03a41-880e-46f0-879a-993501ca6b50	80466a36-2b5a-4ac9-a7c3-db12c480da38
5	eCharging_16ZP22T2AA1S000003	ChargingStations	3D:F2:C9:A6:B3:3F	600	sensor	ngsi	json	Comune di Firenze	4.377.222	1.125.338	stationStateValue	integer	charging_station_state	false	#	refresh_rate	900	c6f03a41-880e-46f0-879a-993501ca6b50	80466a36-2b5a-4ac9-a7c3-db12c480da38
6	eCharging_16ZP22T2AA1S000003	ChargingStations	3D:F2:C9:A6:B3:3F	600	sensor	ngsi	json	Comune di Firenze	4.377.222	1.125.338	dateObserved	time	timestamp	false	s	refresh_rate	900	c6f03a41-880e-46f0-879a-993501ca6b50	80466a36-2b5a-4ac9-a7c3-db12c480da38
7	eCharging_15EP22T2AA1S000051	ChargingStations	3D:F2:C9:A6:B3:3F	600	sensor	ngsi	json	Comune di Firenze	4.377.483	1.125.993	chargingState	string	charging_state	false	-	refresh_rate	900	c6f03a41-880e-46f0-879a-993501ca6b50	80466a36-2b5a-4ac9-a7c3-db12c480da38
8	eCharging_15EP22T2AA1S000051	ChargingStations	3D:F2:C9:A6:B3:3F	600	sensor	ngsi	json	Comune di Firenze	4.377.483	1.125.993	chargingStateValue	integer	charging_state	false	#	refresh_rate	900	c6f03a41-880e-46f0-879a-993501ca6b50	80466a36-2b5a-4ac9-a7c3-db12c480da38
9	eCharging_15EP22T2AA1S000051	ChargingStations	3D:F2:C9:A6:B3:3F	600	sensor	ngsi	json	Comune di Firenze	4.377.483	1.125.993	stationState	string	charging_station_state	false	-	refresh_rate	900	c6f03a41-880e-46f0-879a-993501ca6b50	80466a36-2b5a-4ac9-a7c3-db12c480da38
10	eCharging_15EP22T2AA1S000051	ChargingStations	3D:F2:C9:A6:B3:3F	600	sensor	ngsi	json	Comune di Firenze	4.377.483	1.125.993	stationStateValue	integer	charging_station_state	false	#	refresh_rate	900	c6f03a41-880e-46f0-879a-993501ca6b50	80466a36-2b5a-4ac9-a7c3-db12c480da38
11	eCharging_15EP22T2AA1S000051	ChargingStations	3D:F2:C9:A6:B3:3F	600	sensor	ngsi	json	Comune di Firenze	4.377.483	1.125.993	dateObserved	time	timestamp	false	s	refresh_rate	900	c6f03a41-880e-46f0-879a-993501ca6b50	80466a36-2b5a-4ac9-a7c3-db12c480da38

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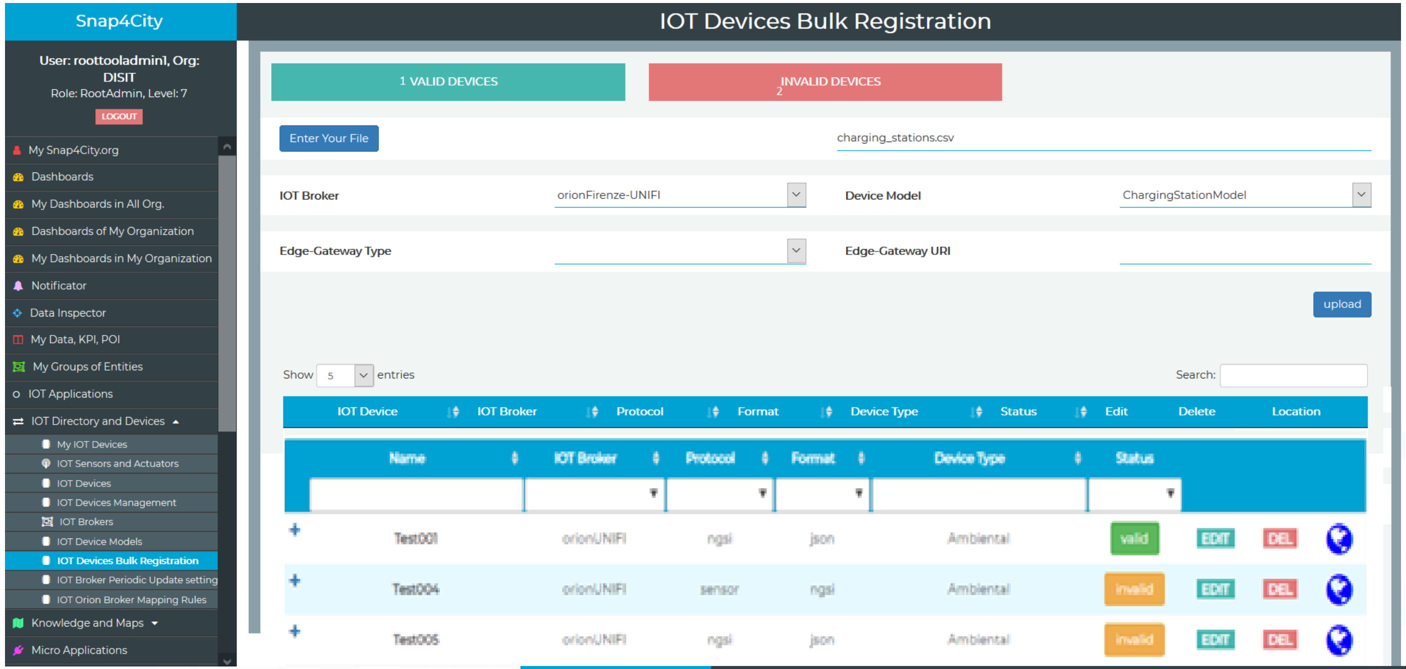
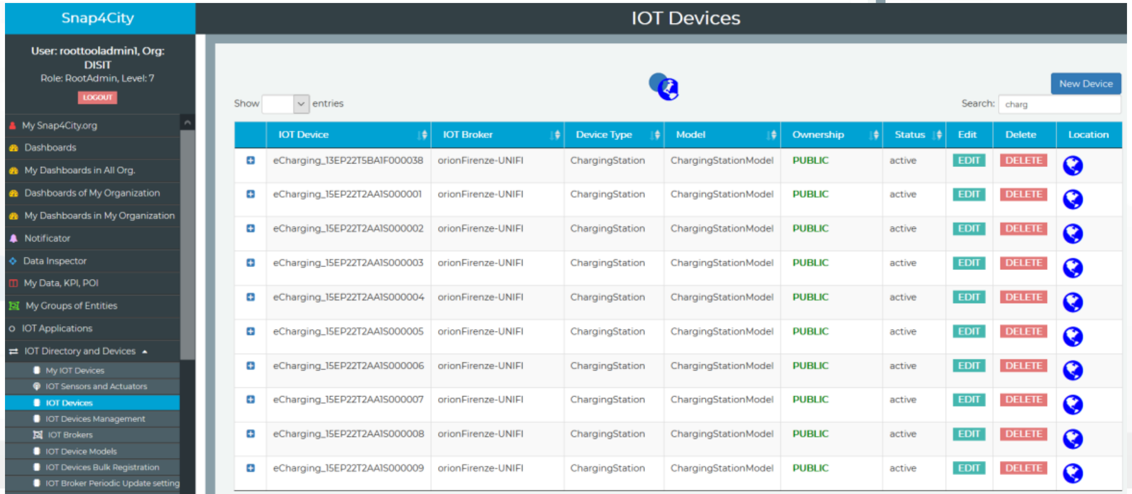
Register IoT Devices in BULK

- IoT Directory and Devices > IoT Devices Bulk Registration
- Select: Model, Broker
- Upload the CSV file
- Wait
- Verify the presence of your Devices in:
  - IoT Directory and Devices > IoT Devices
- https://www.snap4city.org/289





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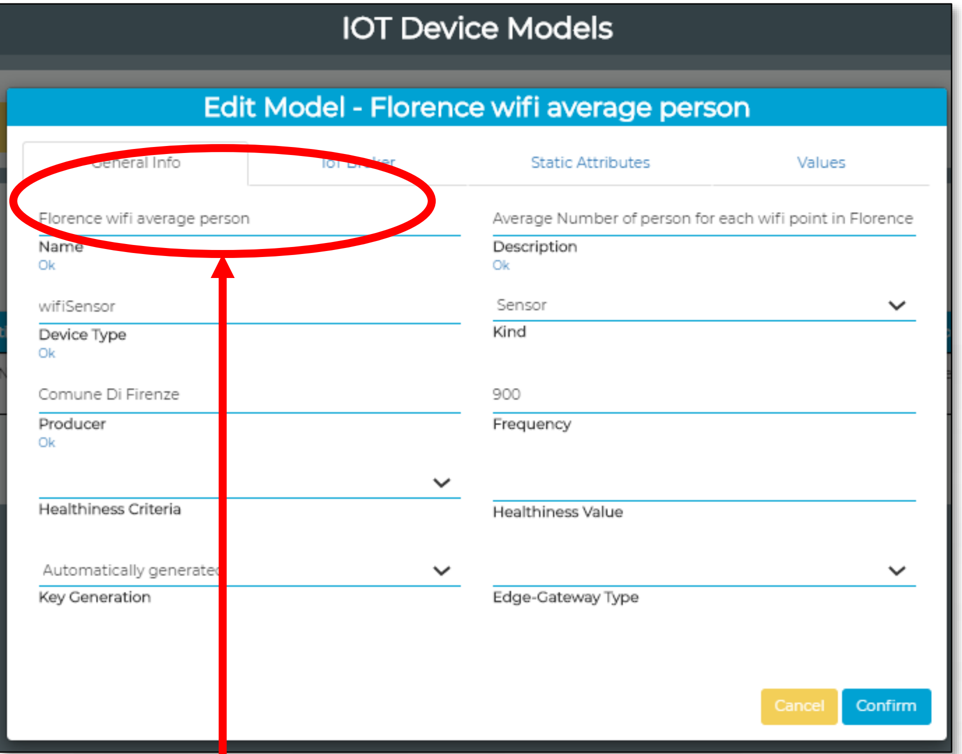
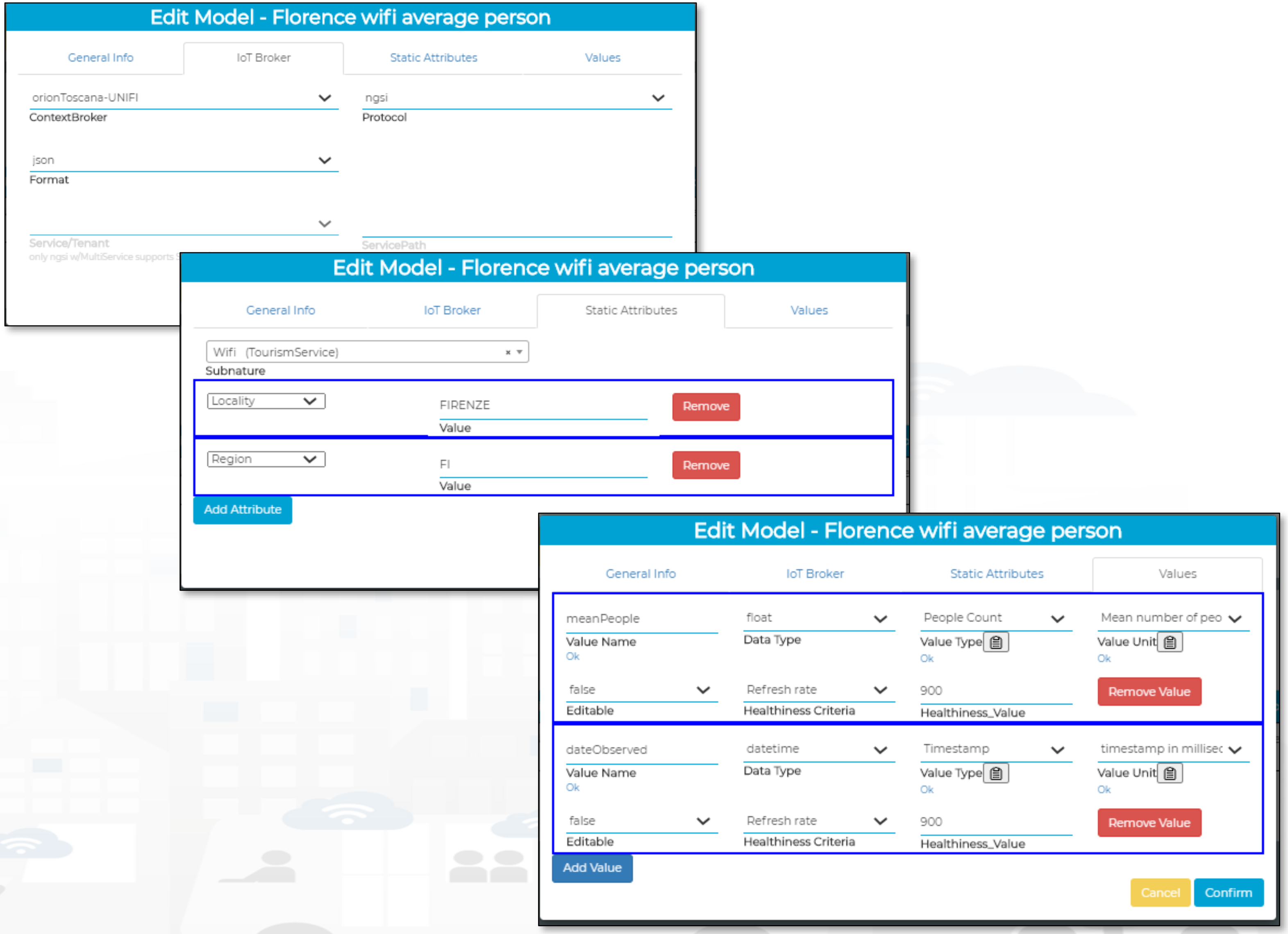
IOT Device Registration from IOT App (automation)

Dataset Creation

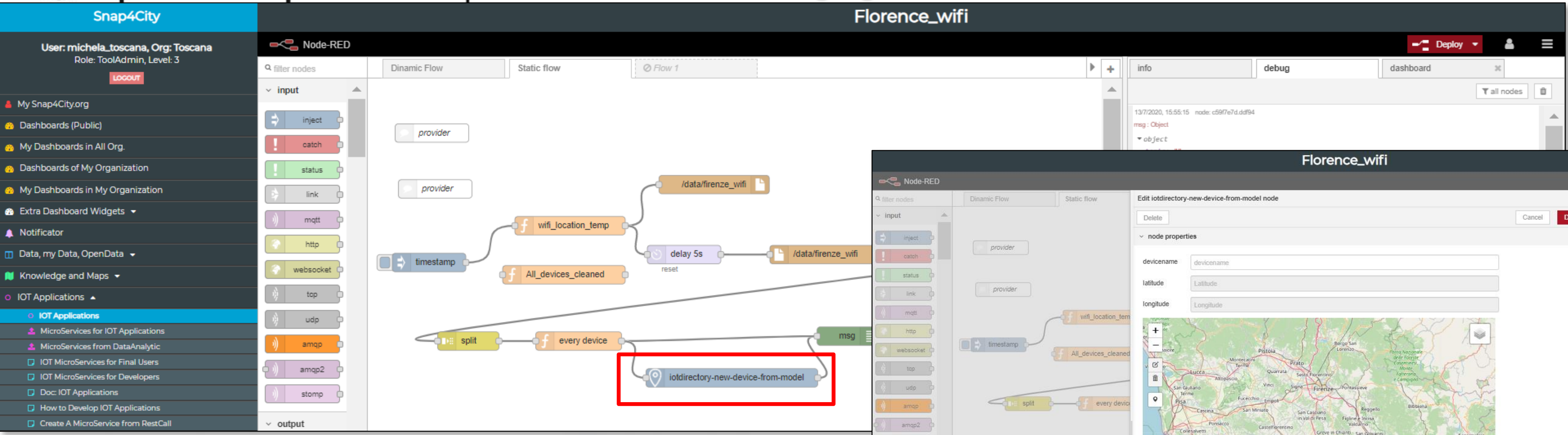
1) Model creation

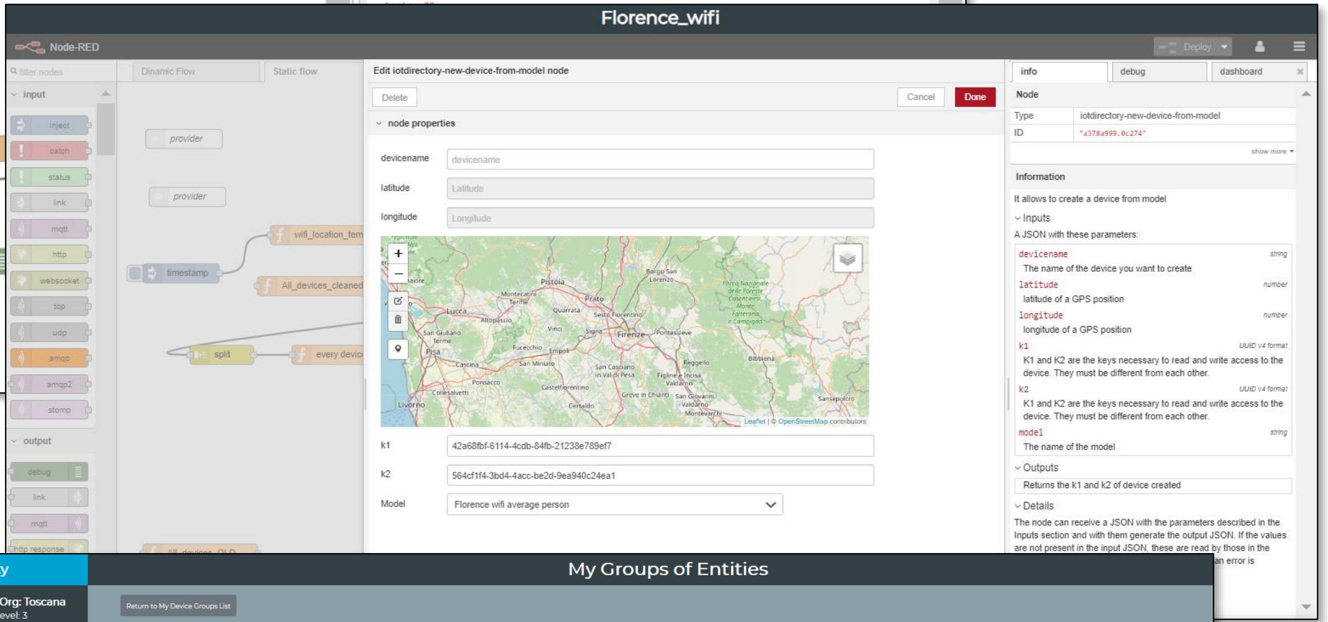




Model name: Florence wifi average person

IoTApp static flow

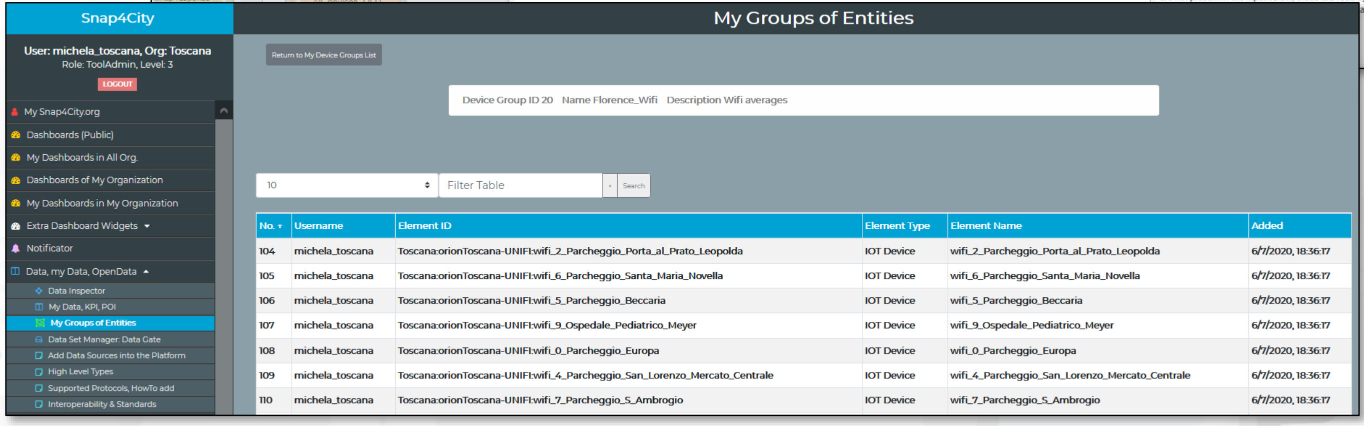




2) IoT Devices Creation

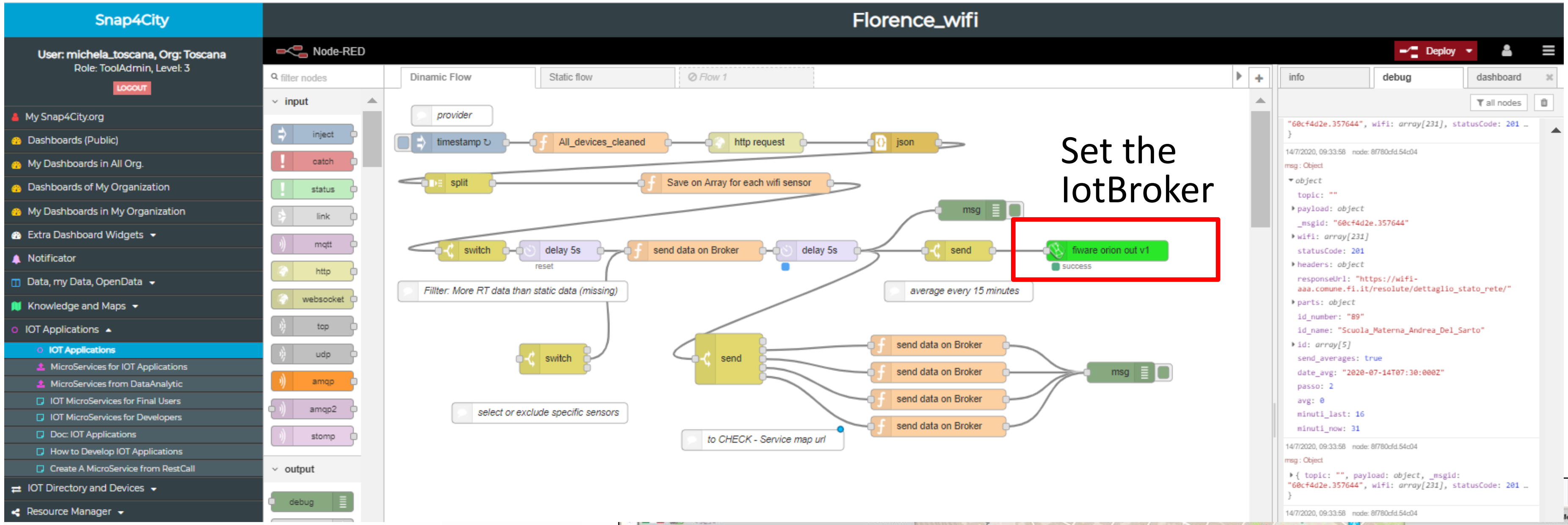
BLOCK: ‘IoTDirectory-new-device-from-model’
Model name: Florence wifi average person

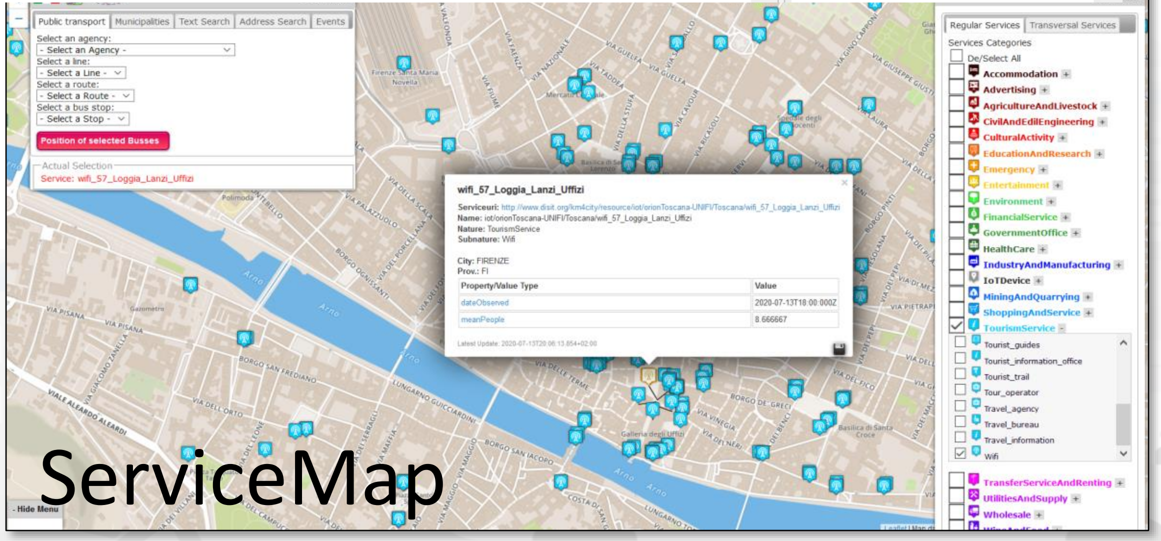
3) Group Creation (more than 200 devices) -> put all the devices in the group and put them as ‘public’ (or they remain private)

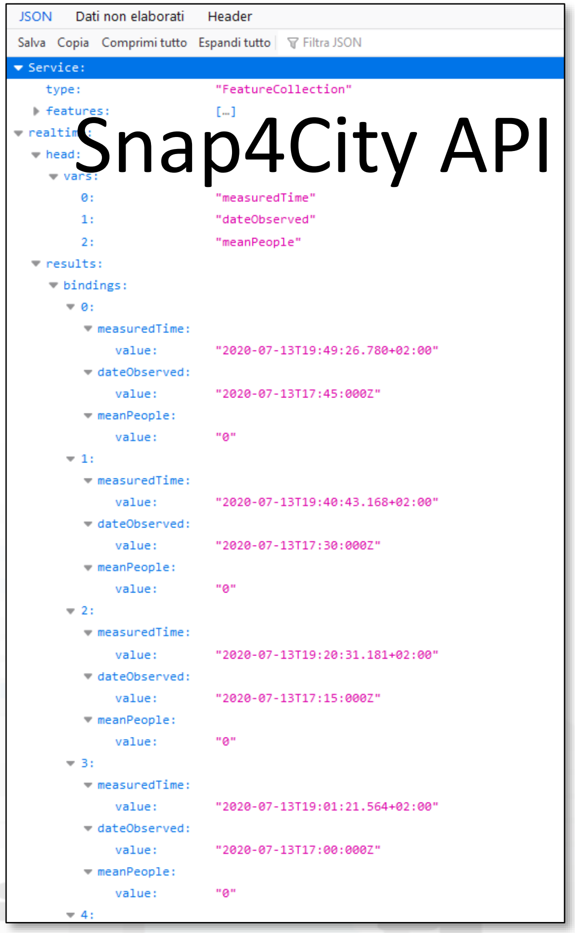


No.	Username	Element ID	Element Type	Element Name	Added
104	michela_toscana	Toscana:orionToscana-UNIFI:wifi_2_Parcheggio_Porta_al_Prato_Leopolda	IOT Device	wifi_2_Parcheggio_Porta_al_Prato_Leopolda	6/7/2020, 18:36:17
105	michela_toscana	Toscana:orionToscana-UNIFI:wifi_6_Parcheggio_Santa_Maria_Novella	IOT Device	wifi_6_Parcheggio_Santa_Maria_Novella	6/7/2020, 18:36:17
106	michela_toscana	Toscana:orionToscana-UNIFI:wifi_5_Parcheggio_Beccaria	IOT Device	wifi_5_Parcheggio_Beccaria	6/7/2020, 18:36:17
107	michela_toscana	Toscana:orionToscana-UNIFI:wifi_9_Ospedale_Pediatrico_Meyer	IOT Device	wifi_9_Ospedale_Pediatrico_Meyer	6/7/2020, 18:36:17
108	michela_toscana	Toscana:orionToscana-UNIFI:wifi_0_Parcheggio_Europa	IOT Device	wifi_0_Parcheggio_Europa	6/7/2020, 18:36:17
109	michela_toscana	Toscana:orionToscana-UNIFI:wifi_4_Parcheggio_San_Lorenzo_Mercato_Centrale	IOT Device	wifi_4_Parcheggio_San_Lorenzo_Mercato_Centrale	6/7/2020, 18:36:17
110	michela_toscana	Toscana:orionToscana-UNIFI:wifi_7_Parcheggio_S_Ambrogio	IOT Device	wifi_7_Parcheggio_S_Ambrogio	6/7/2020, 18:36:17

IoTApp Dynamic Flow





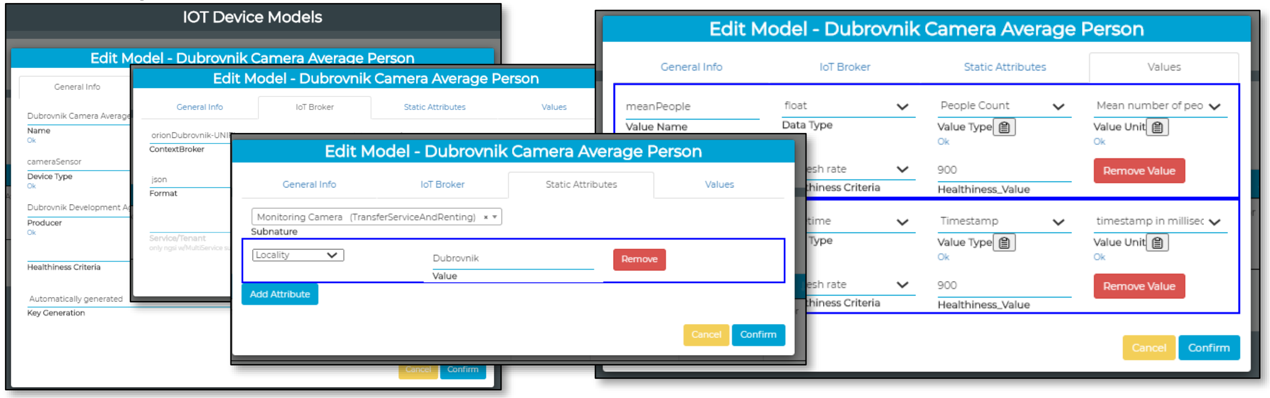


4) Send RT data to the IoTDevices

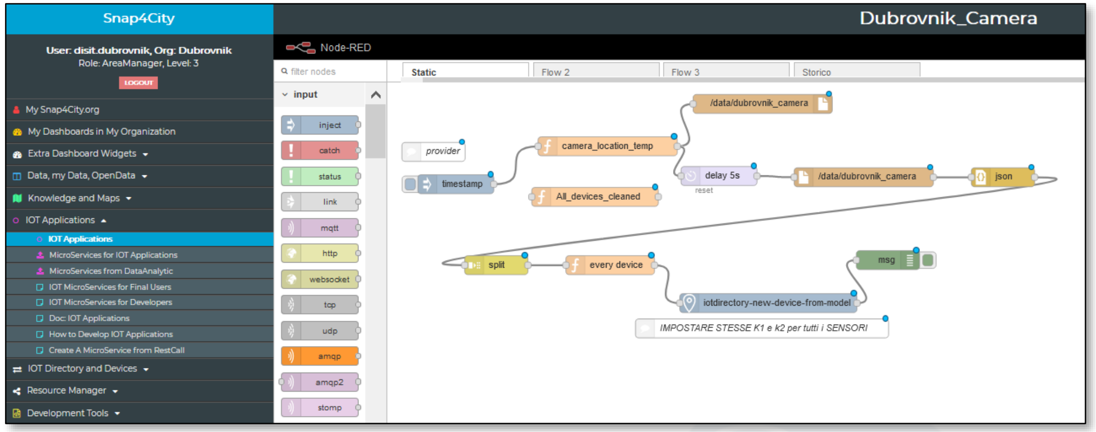
5) Verify RT Data via Snap4City API or via ServiceMap

Work in Progress... SNAP4CITY

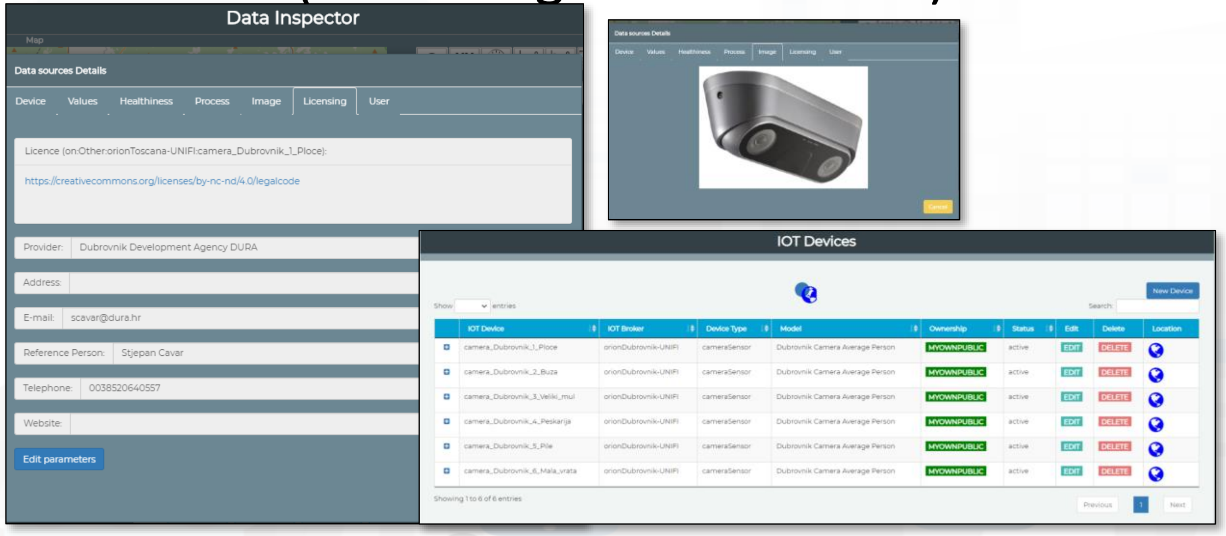
1) IoTModel



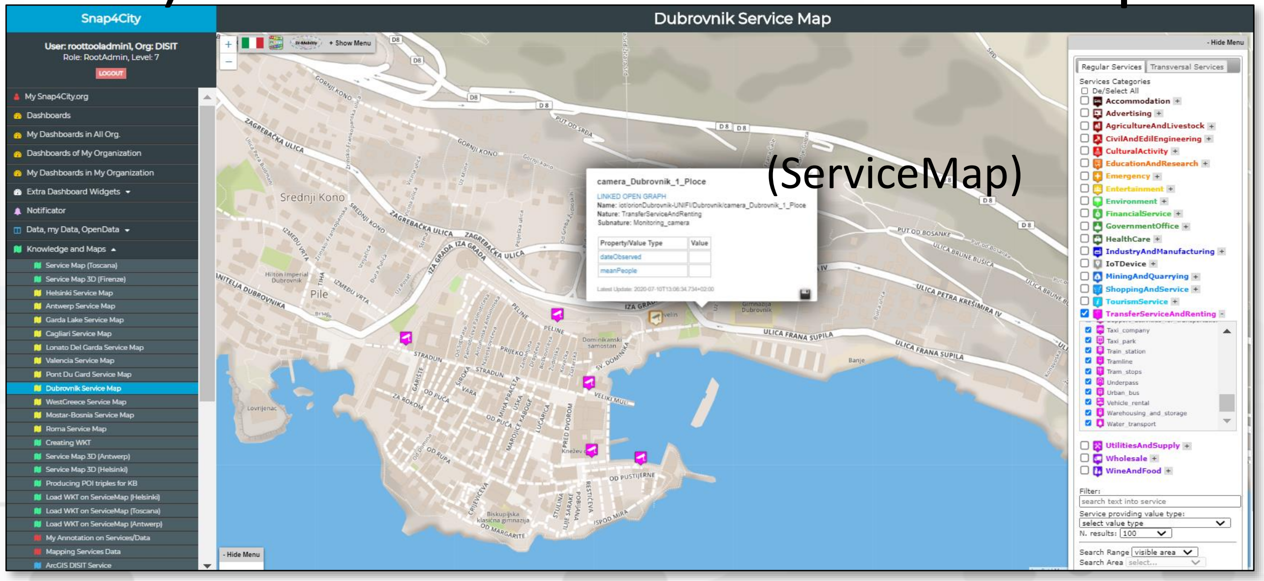
2) Static Flow to create IoTDevices



3) Add the license and Make Public the IoTDevices (according to the license)



3) Search for the Cameras on Map



5) **Working on** Dynamic Flow to save Average #people every 15 minutes for each IoTDevice

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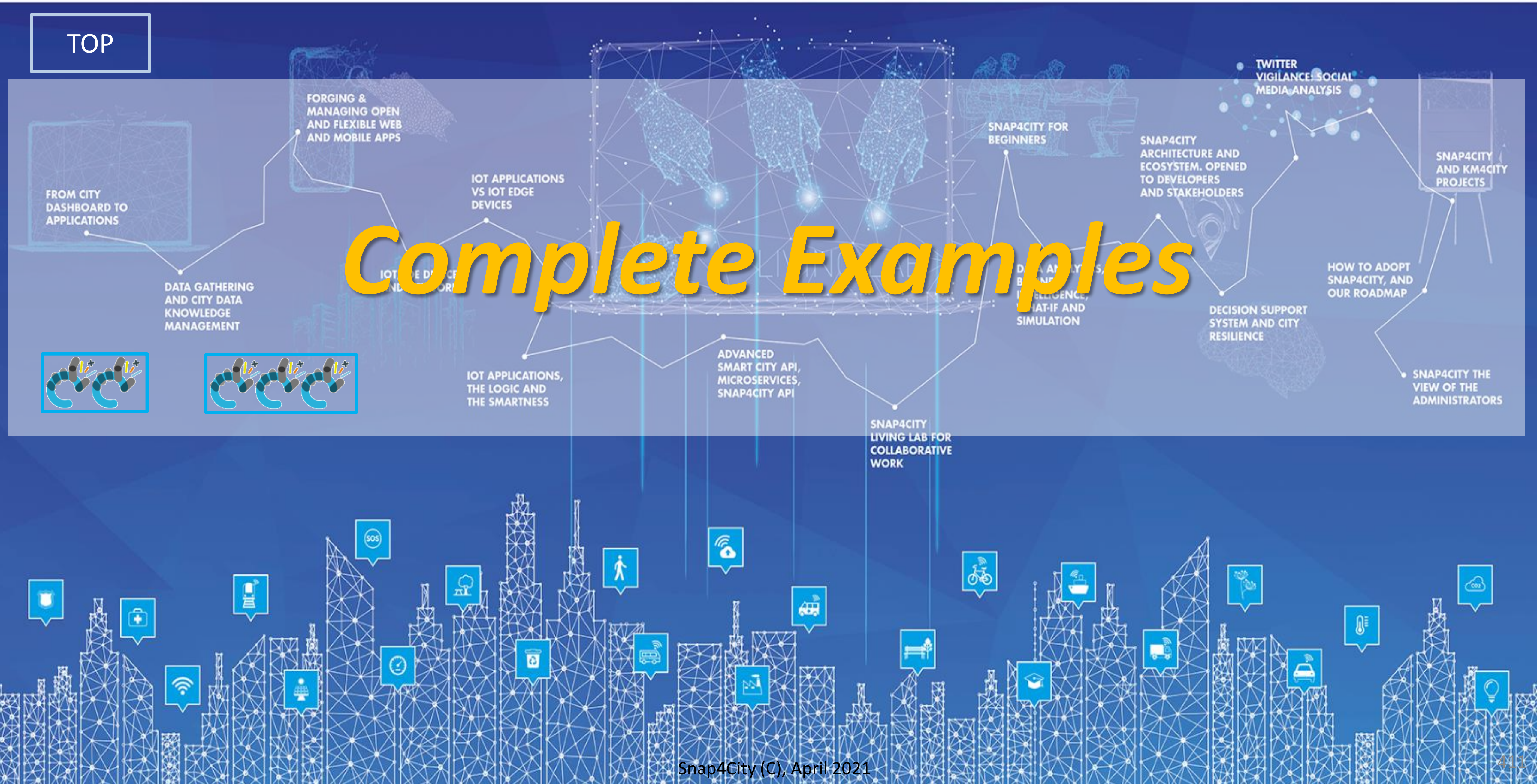
Complete Examples



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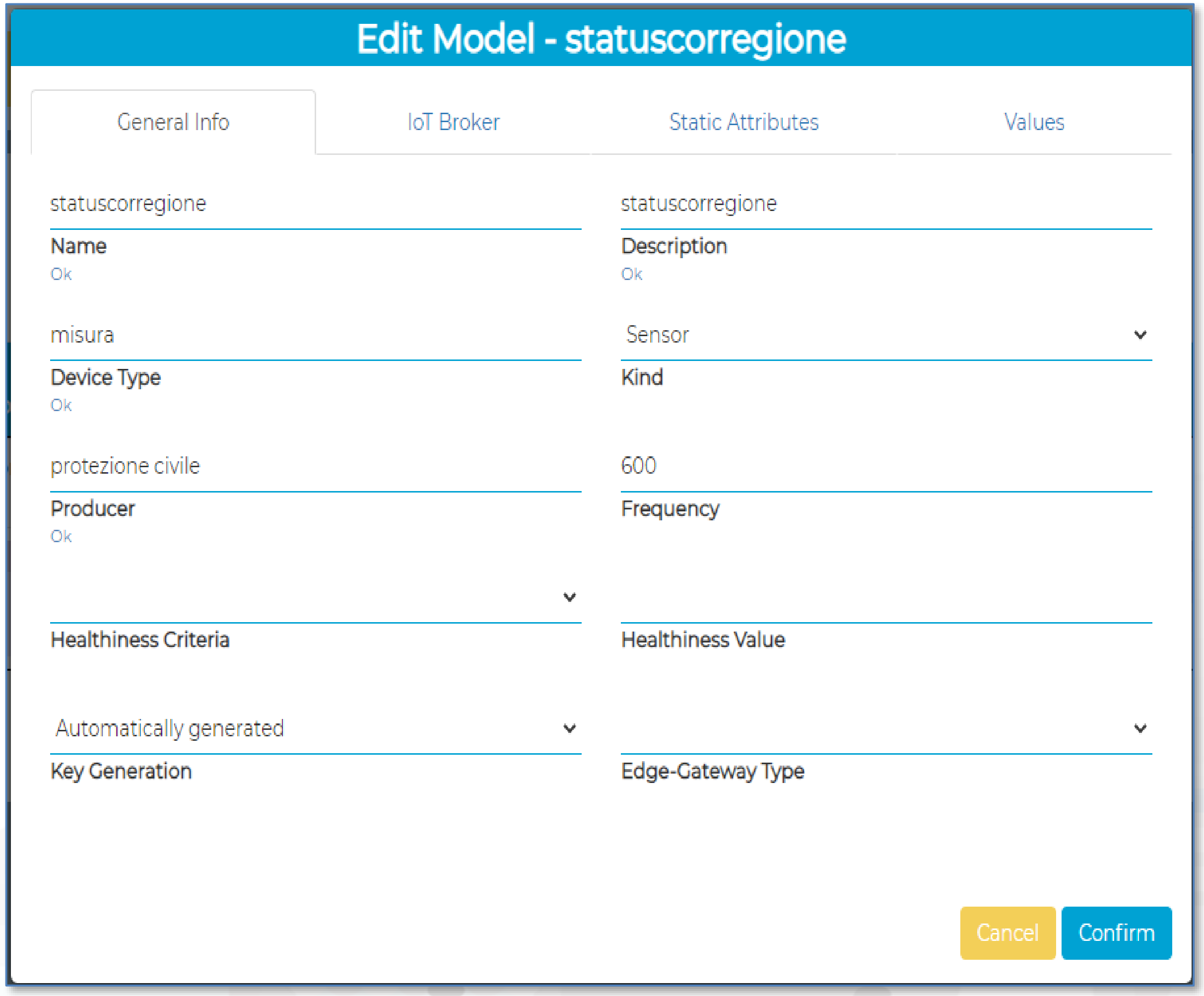
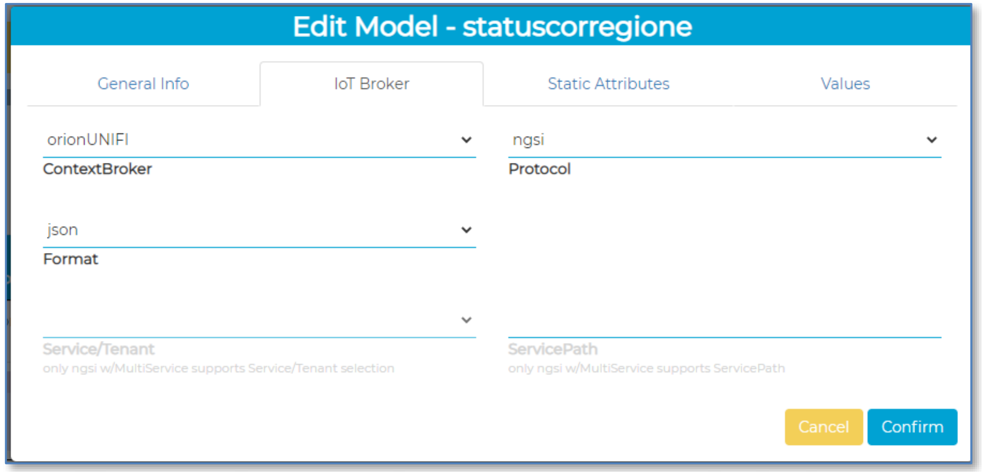
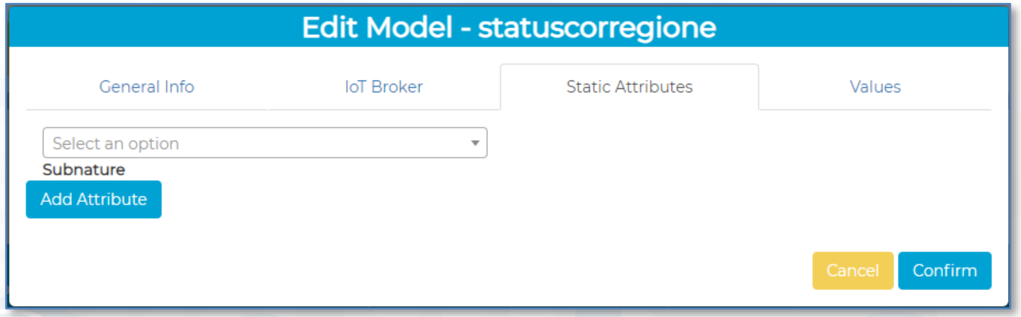
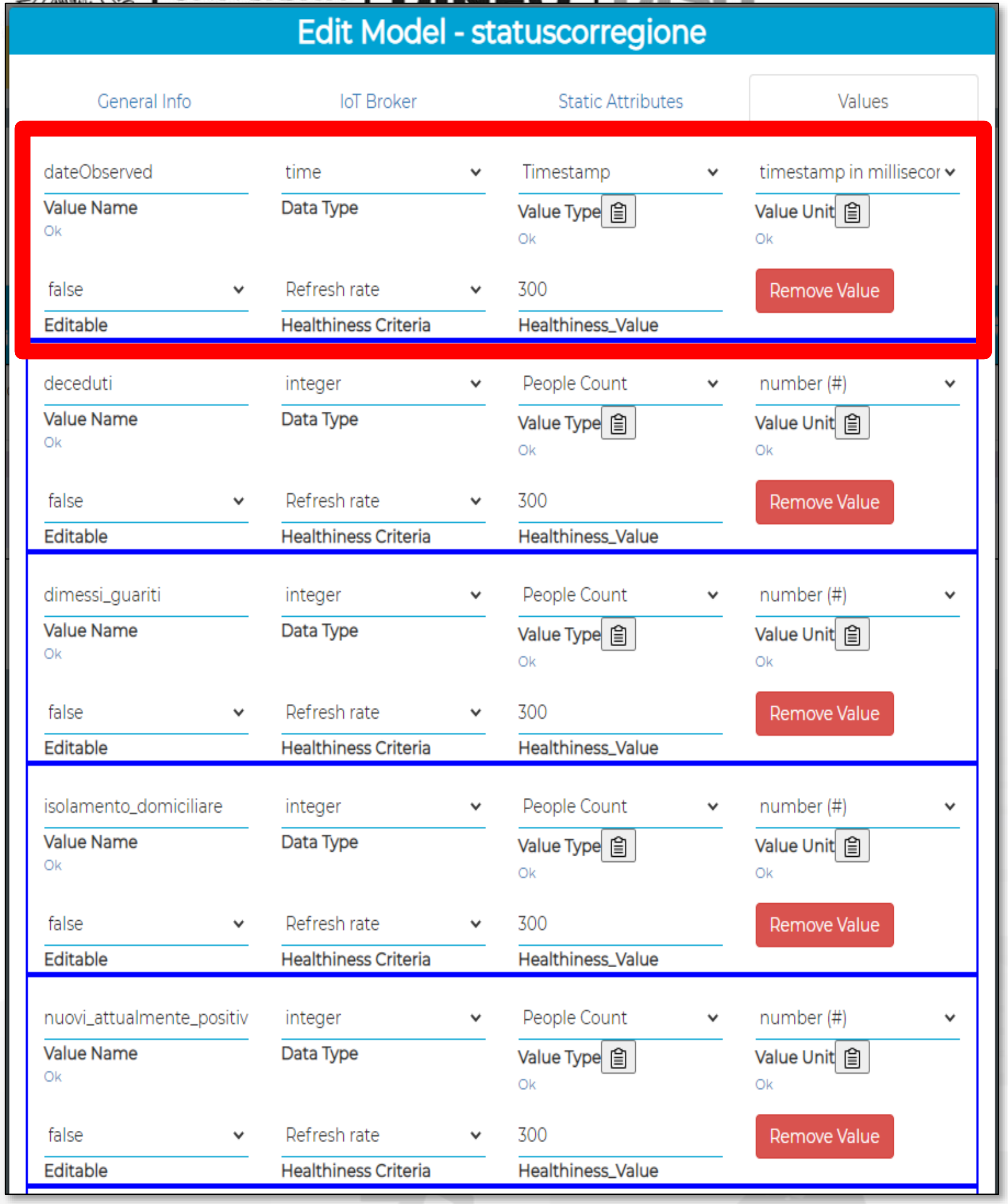
A Complete Example for Time Series: IOT Device Model + IOT Data Ingestion

I have created an IOT Device Model as:



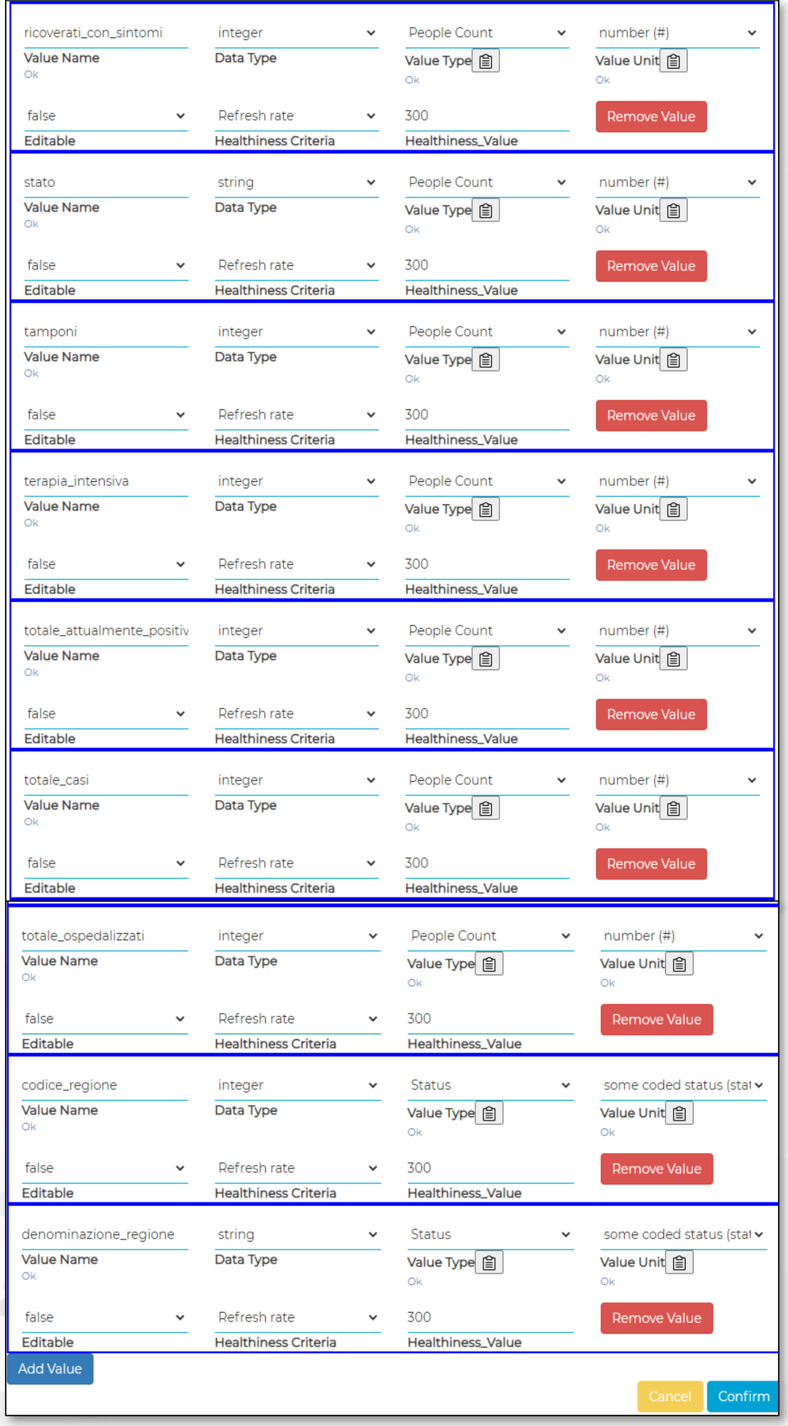






For Time Series

- **ValueName:** dateObserved
- **DataType:** time
- **ValueType:** timestamp
- **ValueUnit:** timestamp in millisecond
- E.g.: ISO string of the date-time



From IOT Model I have created some instances: the IOT Devices

Snap4City

User: paolo.disit, Org: DISIT
Role: AreaManager, Level: 3
LOGOUT

- My Snap4City.org
- Dashboards (Public)
- Dashboards of My Organization
- My Dashboards in My Organization
- Extra Dashboard Widgets
- Data, my Data, OpenData
- Knowledge and Maps
- IOT Applications
- IOT Directory and Devices
  - My IOT Sensors and Actuators
  - IOT Sensors and Actuators
  - IOT Devices
  - IOT Brokers
  - IOT Device Models
  - Doc: IOT Directory and Devices
  - Create an IOT Device Instance
  - Create an IOT Device Model
  - Add an IOT Device into Snap4City
- Resource Manager
- Development Tools
- Management
- Decision Support Systems

IOT Devices

New Device

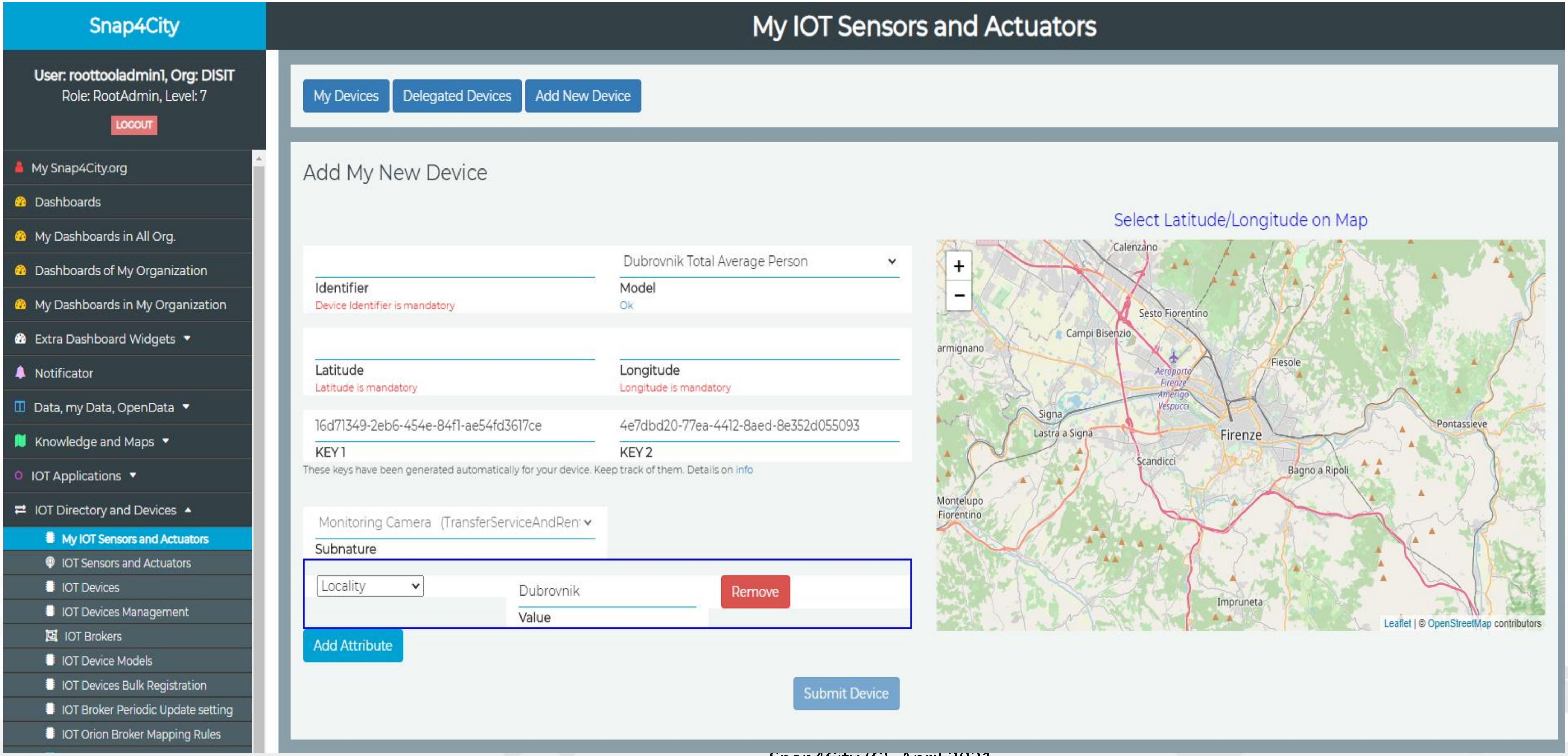
Show entries — Search: cor

	IOT Device	IOT Broker	Device Type	Model	Ownership	Status	Edit	Delete	Location
+	corarezzo	orionUNIFI	misura	statuscorregione	MYOWNPUBLIC	active	EDIT	DELETE	
+	coremilia	orionUNIFI	misura	statuscorregione	MYOWNPUBLIC	active	EDIT	DELETE	
+	corfirenze	orionUNIFI	misura	statuscorregione	MYOWNPUBLIC	active	EDIT	DELETE	
+	corgrosseto	orionUNIFI	misura	statuscorregione	MYOWNPUBLIC	active	EDIT	DELETE	
+	corhubei	orionUNIFI	misura	statuscorregione	MYOWNPUBLIC	active	EDIT	DELETE	
+	corlazio	orionUNIFI	misura	statuscorregione	MYOWNPUBLIC	active	EDIT	DELETE	
+	corlivorno	orionUNIFI	misura	statuscorregione	MYOWNPUBLIC	active	EDIT	DELETE	
+	corlombardia2	orionUNIFI	misura	statuscorregione	MYOWNPUBLIC	active	EDIT	DELETE	
+	corlucca	orionUNIFI	misura	statuscorregione	MYOWNPUBLIC	active	EDIT	DELETE	
+	cormarche	orionUNIFI	misura	statuscorregione	MYOWNPUBLIC	active	EDIT	DELETE	

Showing 1 to 10 of 21 entries

Previous 1 2 3 Next

They have been created by «Add new Device»



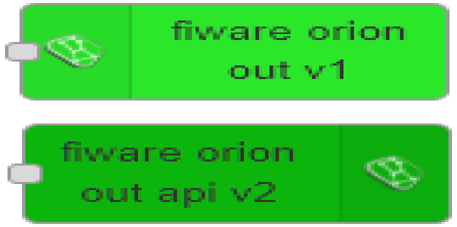
IOT Device from IOT Model by Providing:

- **NAME (it has to be unique)**
- Select the IOT Model: «**statuscorregione**»
  - Thus the K1, K2 appears since the model is associated to an Orion Broker that needs to have them, the tool generate them for you but you can impose if you like
  - See in previous slide the ID name of the IOT Broker used
- **Lat** and **Lon**, GPS coordinates you can:
  - pick on the map
  - Write the coordinates manually and see the pin on map

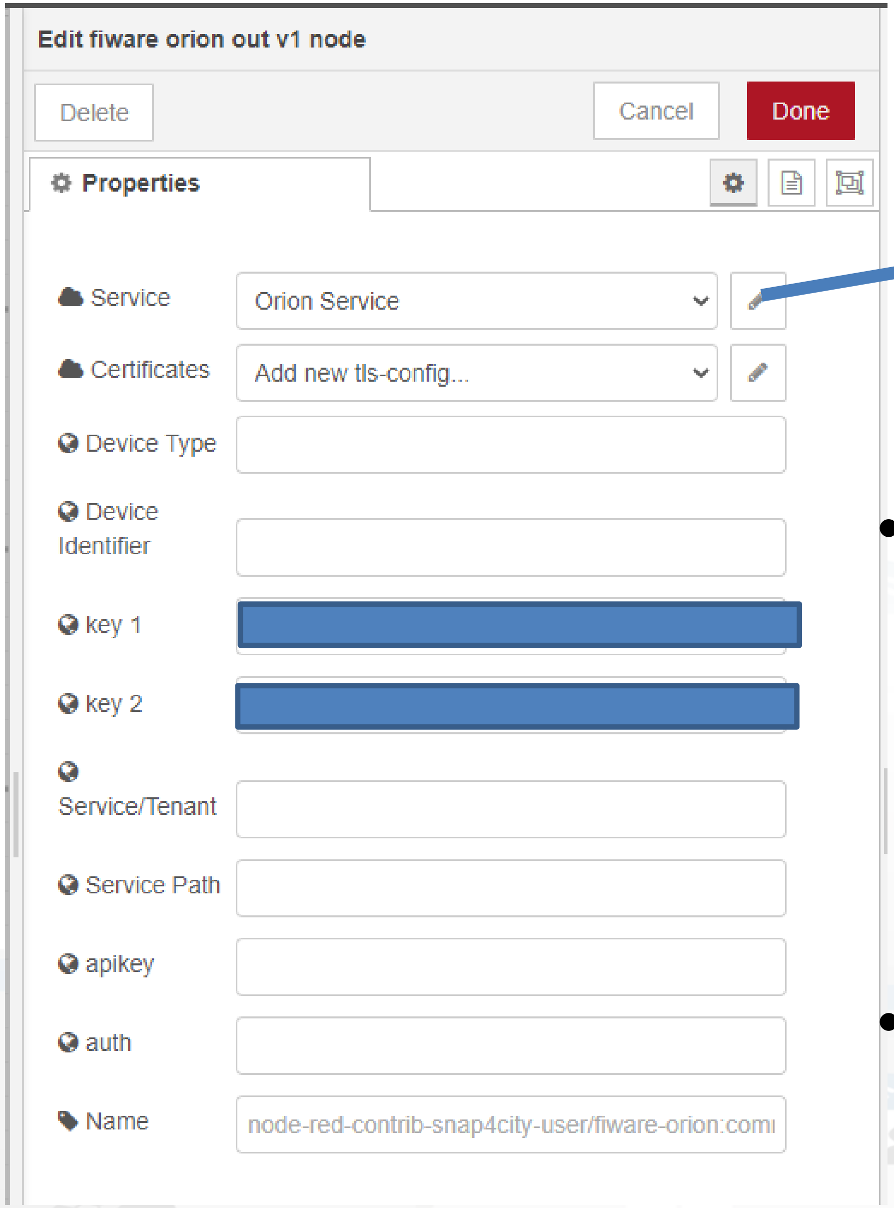
Once created the IOT Device you may send data on it

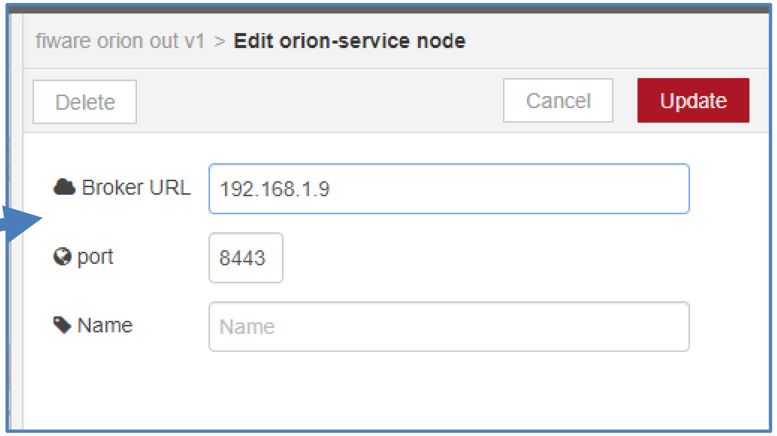
- You may create an IOT App, where:
  - Function: is preparing the JSON package
  - Block «Fi-Ware Orion OUT V1» or V2 is sending the data to the Orion Broker. Namely: «OrionUNIFI»
  - Please note that several version of IOT ORION Brokers and protocols exists:
    - So that you have to know which protocols you need to use for your broker

Settings ?



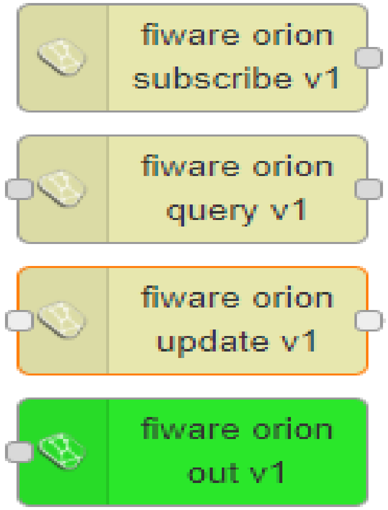
- Certificates are automatically loaded at the first authentication
- Done!!



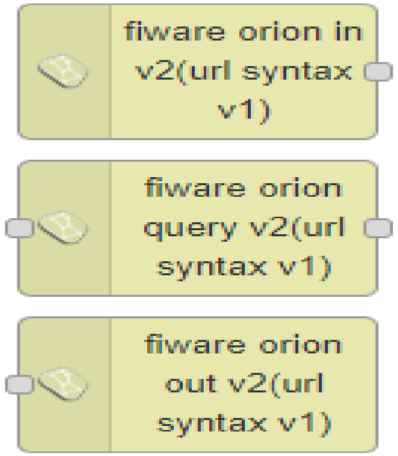


- IP if the Broker is in cloud (internal)
  - List of brokers is automatically provides
  - The K1, K2 is automatically provided if you are authenticated
- Symbolic address of IOT Broker can be taken from IOT Directory

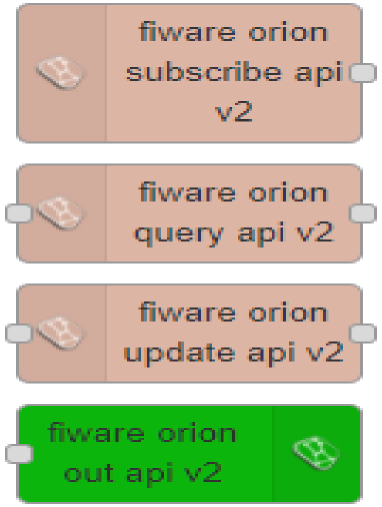
NGSI versions



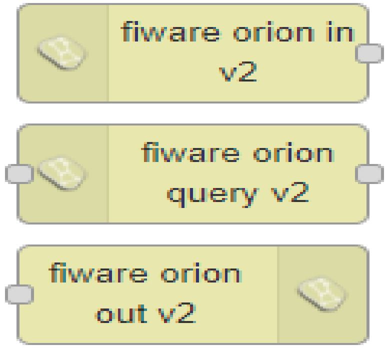
- Orion Broker of V1 with **NGSI syntax of V1** + Secure Filter of Snap4city



- Orion Broker of V2 with NGSI syntax of V1



- Orion Broker of V2 with **NGSI syntax of V2** + Secure Filter of Snap4city



- Orion Broker of V2 with NGSI syntax of V2

- A Json from the IOT App
- **ID**: The Name of the IOT Device: «corveneto»
- **Type** as that defince in the IOT Device when you created
- The **Time stamp**: "dateObserved" to have a time series data
  - "str" is a string with the date and time in standard ISO, such as ,
  - "2020-08-04T04:00:00+02:00",
  - "2020-08-03T00:00:00.000Z"
- And the **vector** of "**attributes**"

```
msg = { payload : {
  "id": "corveneto",
  "type": "misura",
  "attributes":[
 {  "name": "dateObserved",    "value": str,  "type": "time"  },
 {  "name": "stato",   "value": “active”,   "type": "string"  },
 {  "name": "ricoverati_con_sintomi",   "value": 12,   "type": "integer"  },
 {  "name": "terapia_intensiva",   "value": 34,   "type": "integer"  },
 {  "name": "totale_ospedalizzati", "value": 34,  "type": "integer"  },
 {  "name": "isolamento_domiciliare",  "value": 334,  "type": "integer"  },
 {  "name": "totale_attualmente_positivi",   "value": 12,   "type": "integer"  },
 {  "name": "nuovi_attualmente_positivi", "value": 33,   "type": "integer"  },
 {  "name": "dimessi_guariti",   "value": 22222,   "type": "integer"  },
 {  "name": "deceduti",    "value": 2,  "type": "integer"   },
 {  "name": "totale_casi",    "value": 2222,    "type": "integer"   },
 {  "name": "tamponi",    "value": 222222344,    "type": "integer"   }
 ]
 }
}
return msg;
```

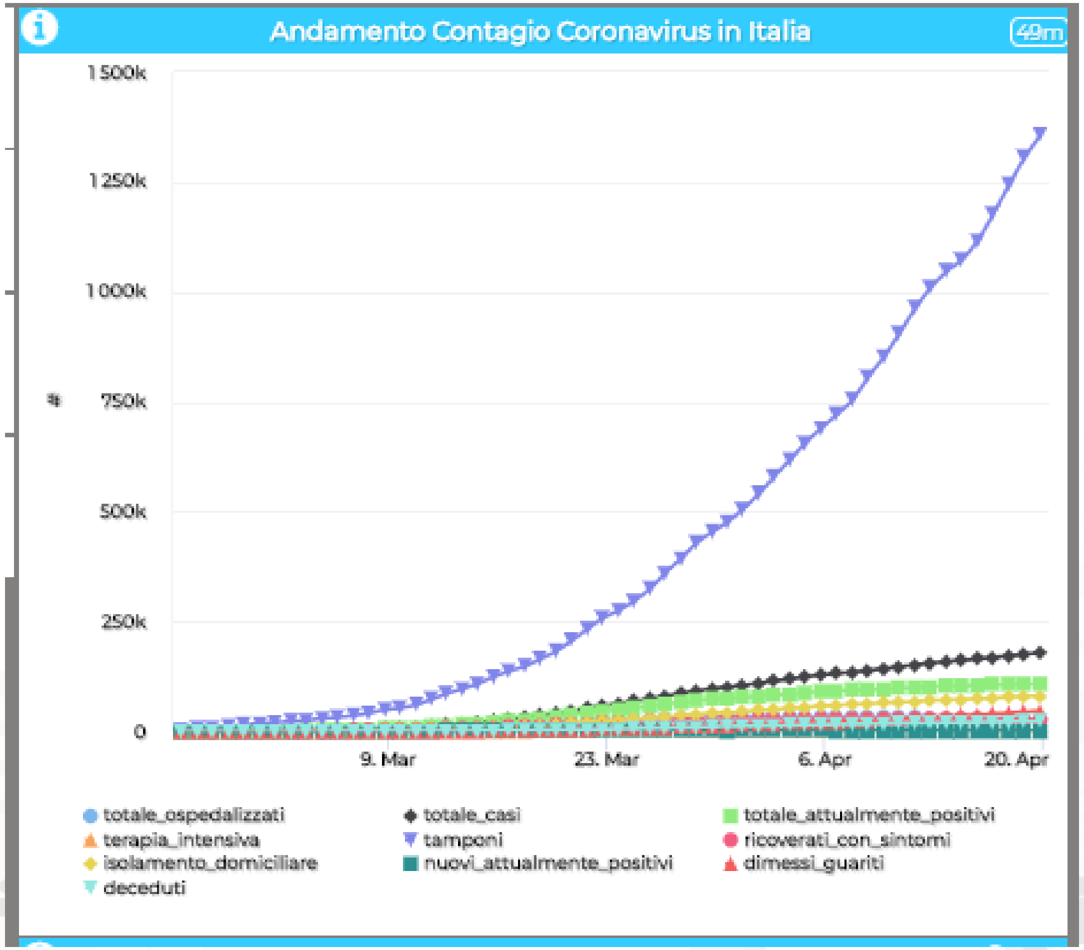
DateObserved

- The **Time stamp**: “dateObserved” to have a time series data
  - “str” is a string with the date and time in standard ISO, such as ,
  - “2020-08-04T04:00:00+02:00”,
  - “2020-08-03T00:00:00.000Z”
- In JavaScript you can obtain by using:
  - Var datetimeofnow = new Date() ;
  - Var str = datetimeofnow.toISOString();

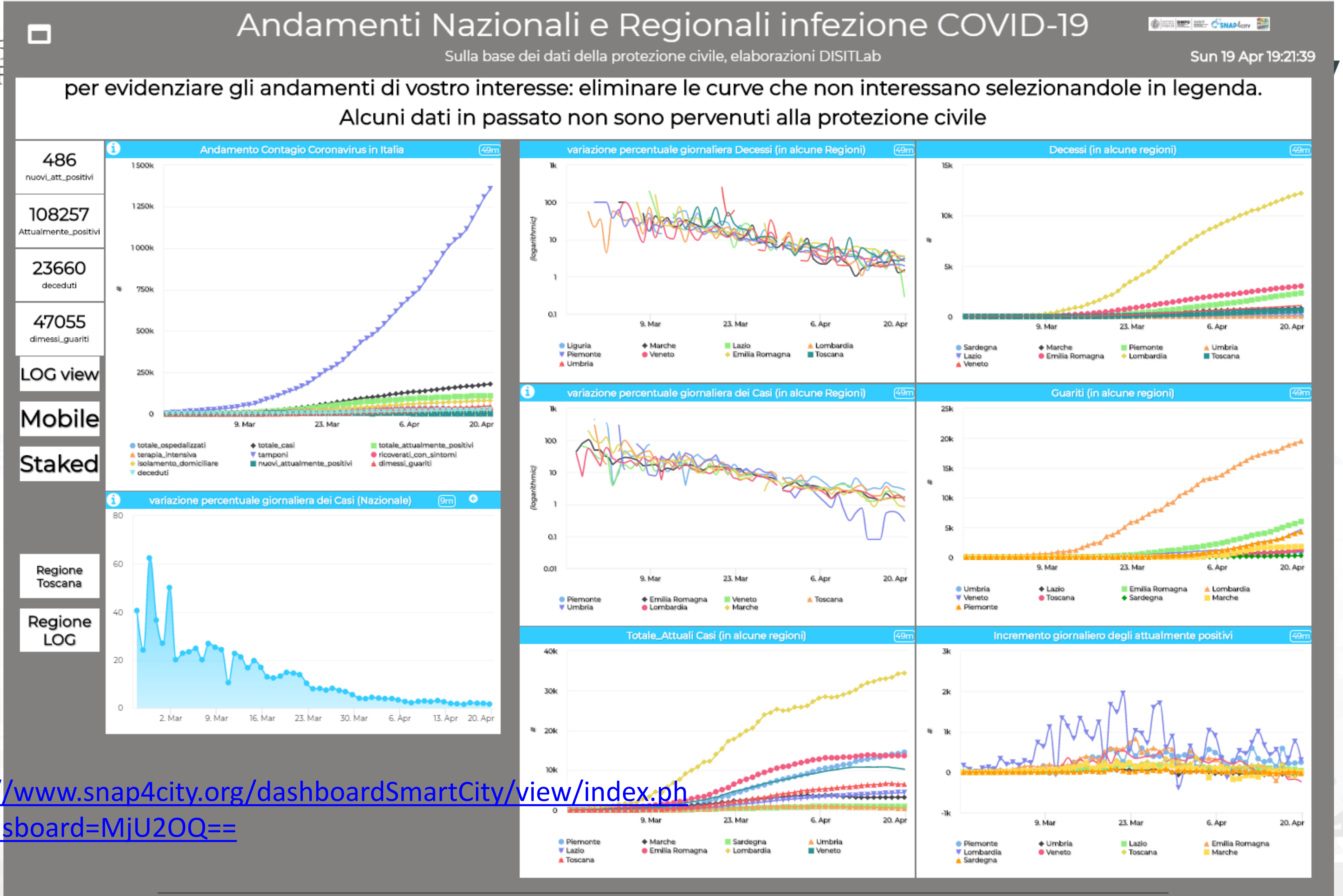
  - **Str** has to be the ISO date string of today-now (at the current time).

Multi Series Widget coming from the same IOT Device

- Over on the serie label to highlight
- Click on the serie label to on/ok
- Over on the graph to see the values



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjU2OQ==

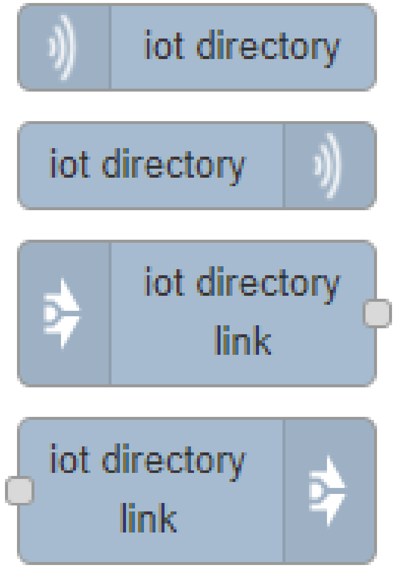


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjU2OQ==

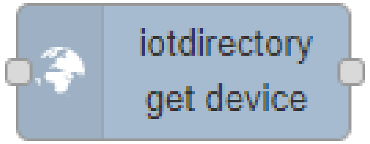
JSON for Authentication as well

- msg.auth= {
- "k1": "1ef0e5e8-yyyy-xxxx-9462-0aa4cfcf5e19",
- "k2": "b2b34425-yyyy-xxxx-818d-2d6cac2314a6",
- "apikey":"apikey",
- "basicAuth": "basicAuthKey"
- };

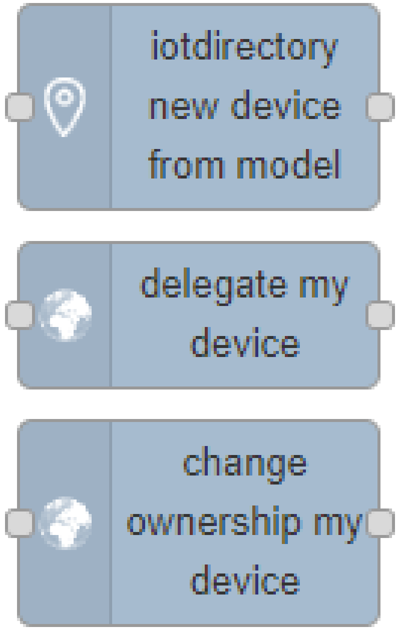
You may use other functions from IOT Directory



- IOT Discovery in an area
- Query on IOT Directory

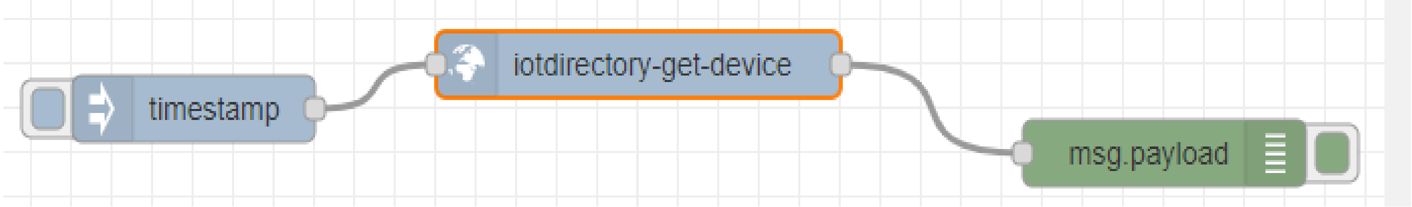


- Get IOT Device Info



- Registering an IOT Device from model
- Delegate an IOT Device
- Change Ownerhip of an IOT Device

Get IOT Device Info



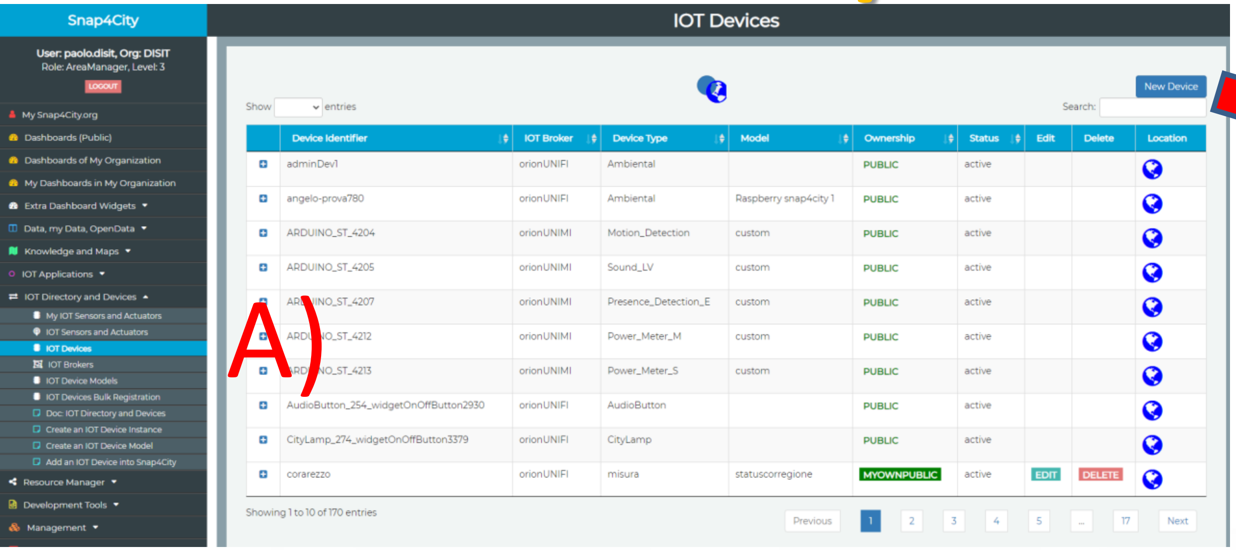
- You can create smart IOT Applications that on t he basis of the list of IOT Devices would request all what you need to load data into **YOUR OWN** IOT Devices including:
  - **Service URI**
  - **K1, K2**
  - Authentication

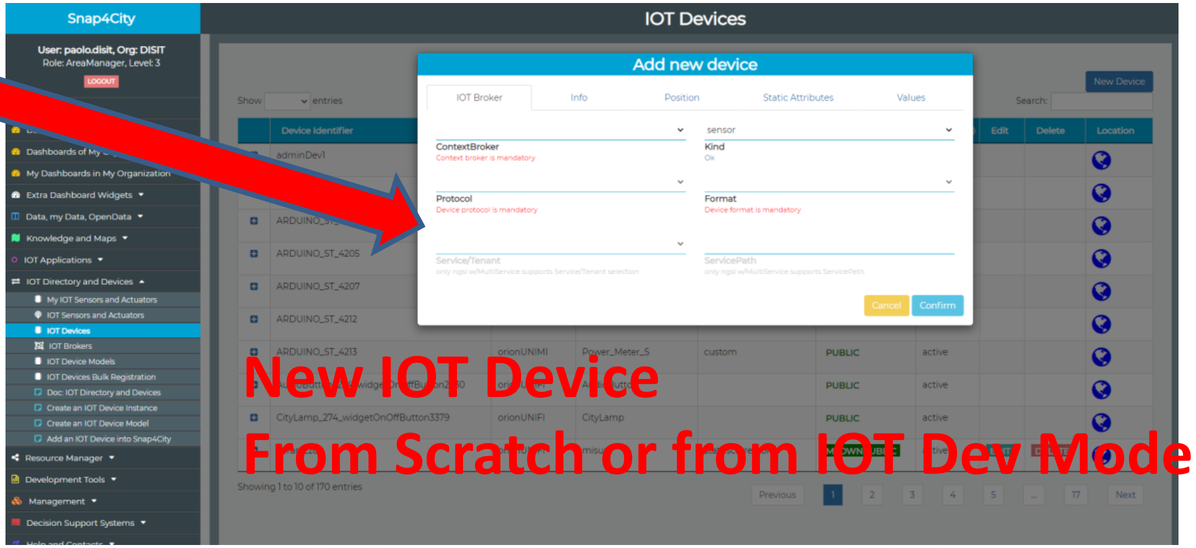
msg.payload : Object
▾object
status: "ok"
▾content: object
uri: "http://www.disit.org/km4city/resource/iot/orionUNIFI/DISIT/corarezzo"
devicetype: "misura"
kind: "sensor"
status1: "active"
macaddress: ""
model: "statuscorregione"
producer: "protezione civile"
longitude: "11.88228"
latitude: "43.46642"
protocol: "ngsi"
format: "json"
visibility: "public"
frequency: "600"
created: "2020-03-21 18:34:32"
privatekey: ""
certificate: ""
organization: "DISIT"
accesslink: "https://broker1.snap4city.org"
accessport: "8080"
sha: "C61E32DBFAE7F14C0B10177F2D2300843C41C550"
subnature: null
static_attributes: null
k1: "bf739214-f6b4-45fe-85f7-97cd09fe8e57"
k2: "c19e0b6f-8f98-4130-b135-e7a1dfae9273"
error_msg: ""

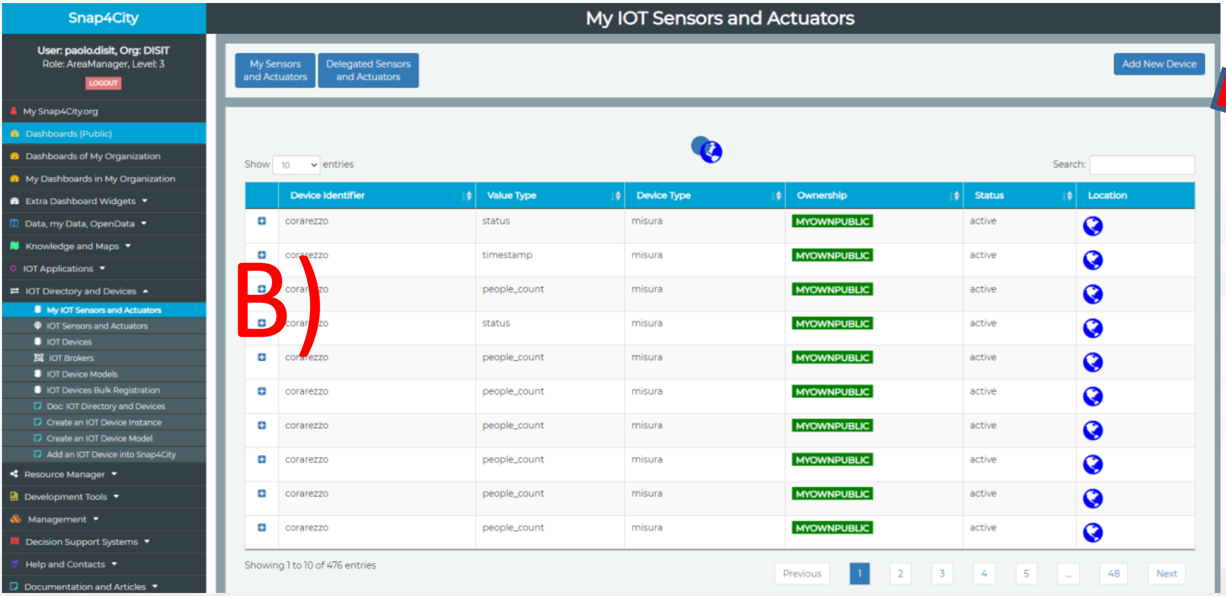
TOP

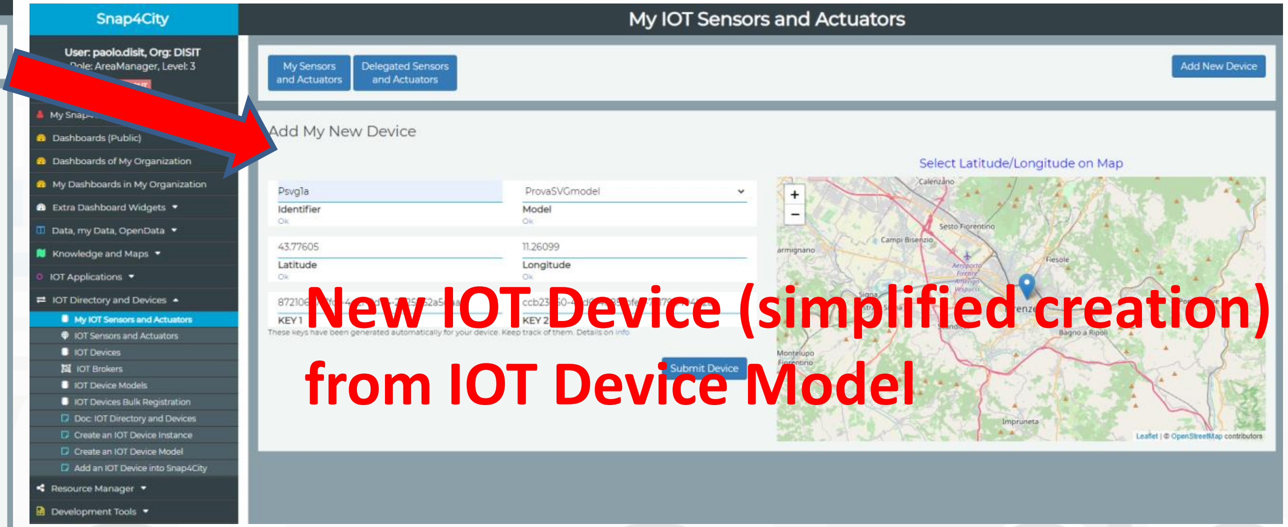
A Complete Example: Time Series, IOT Device Model, IOT Data Ingestion, Dynamic K1,K2 Management

Create/instantiate IOT Devices



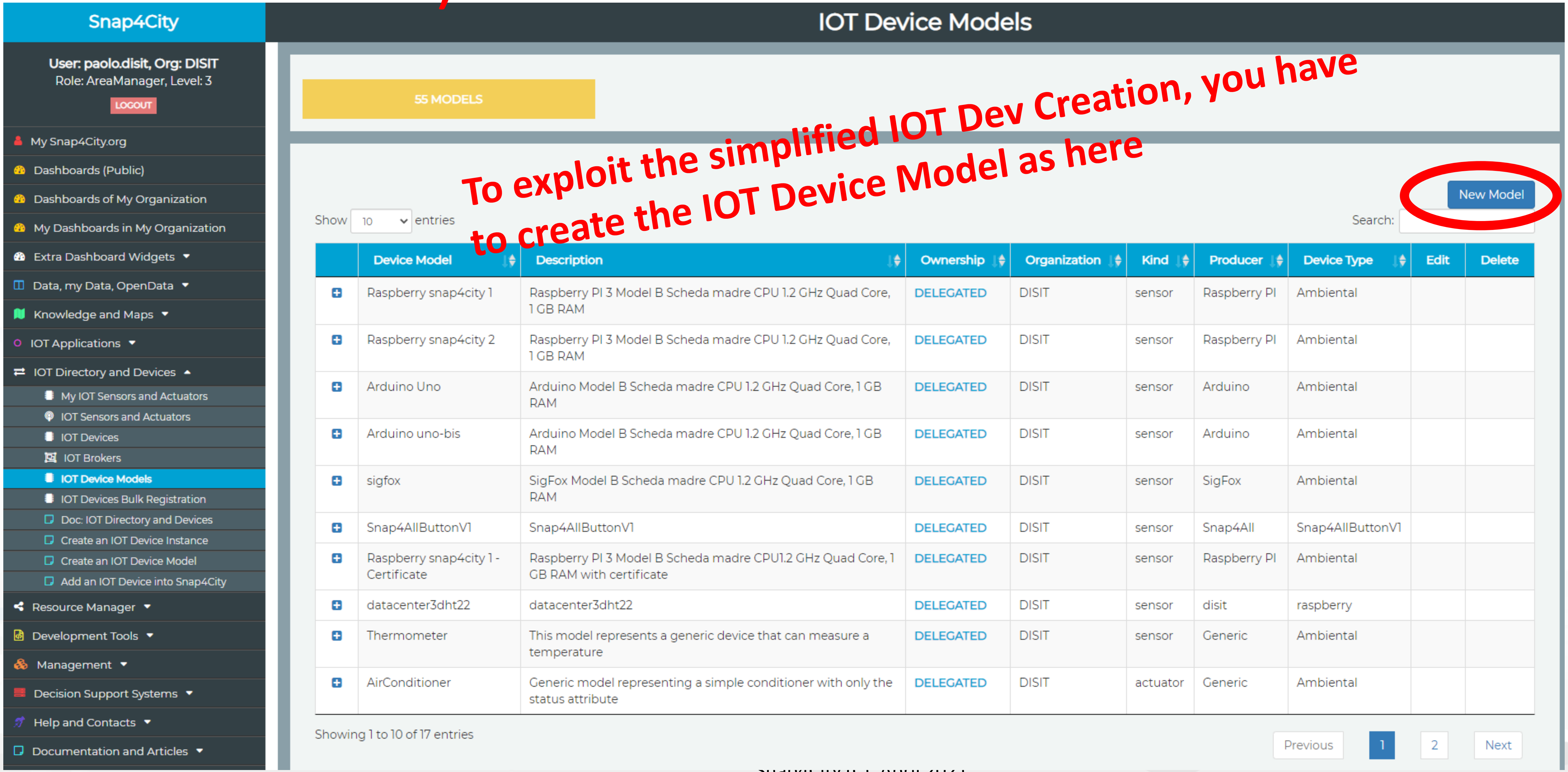






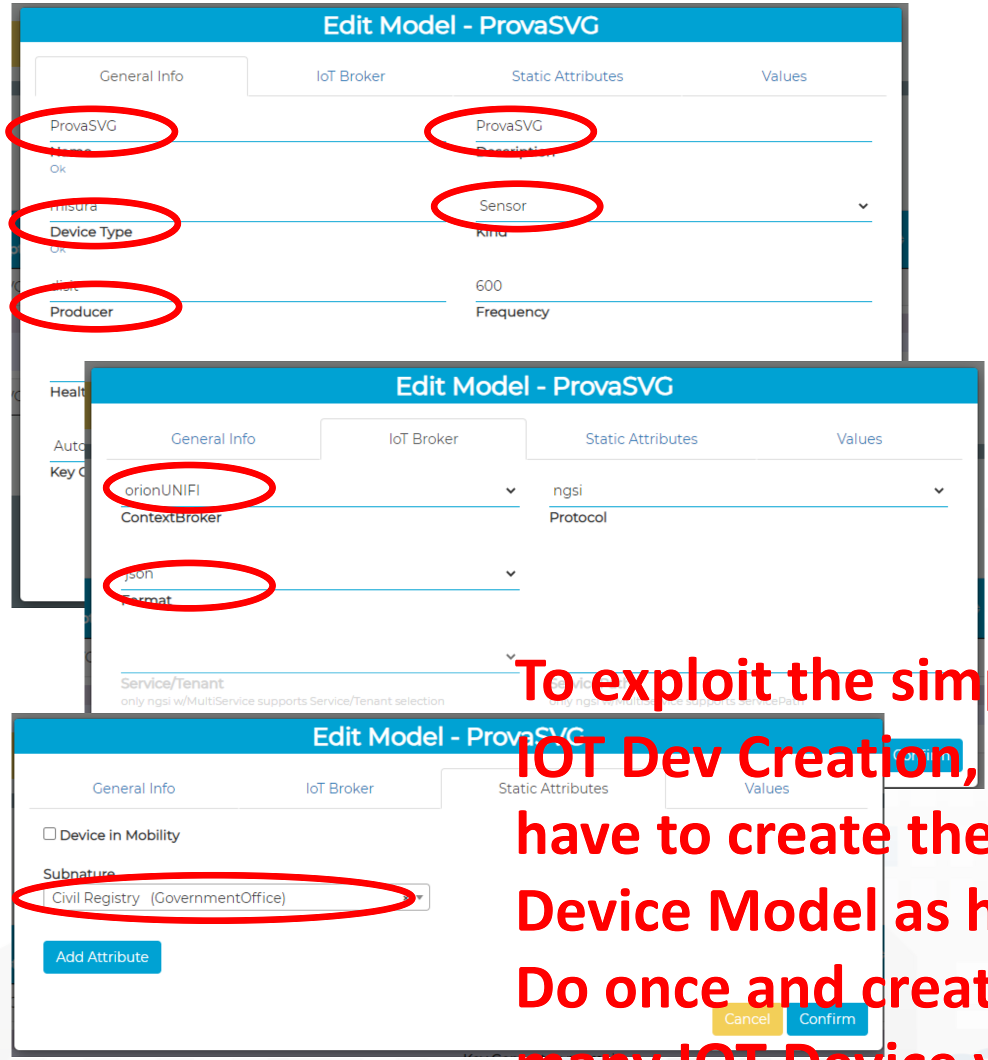
B) IOT Device Model

To exploit the simplified IOT Dev Creation, you have to create the IOT Device Model as here

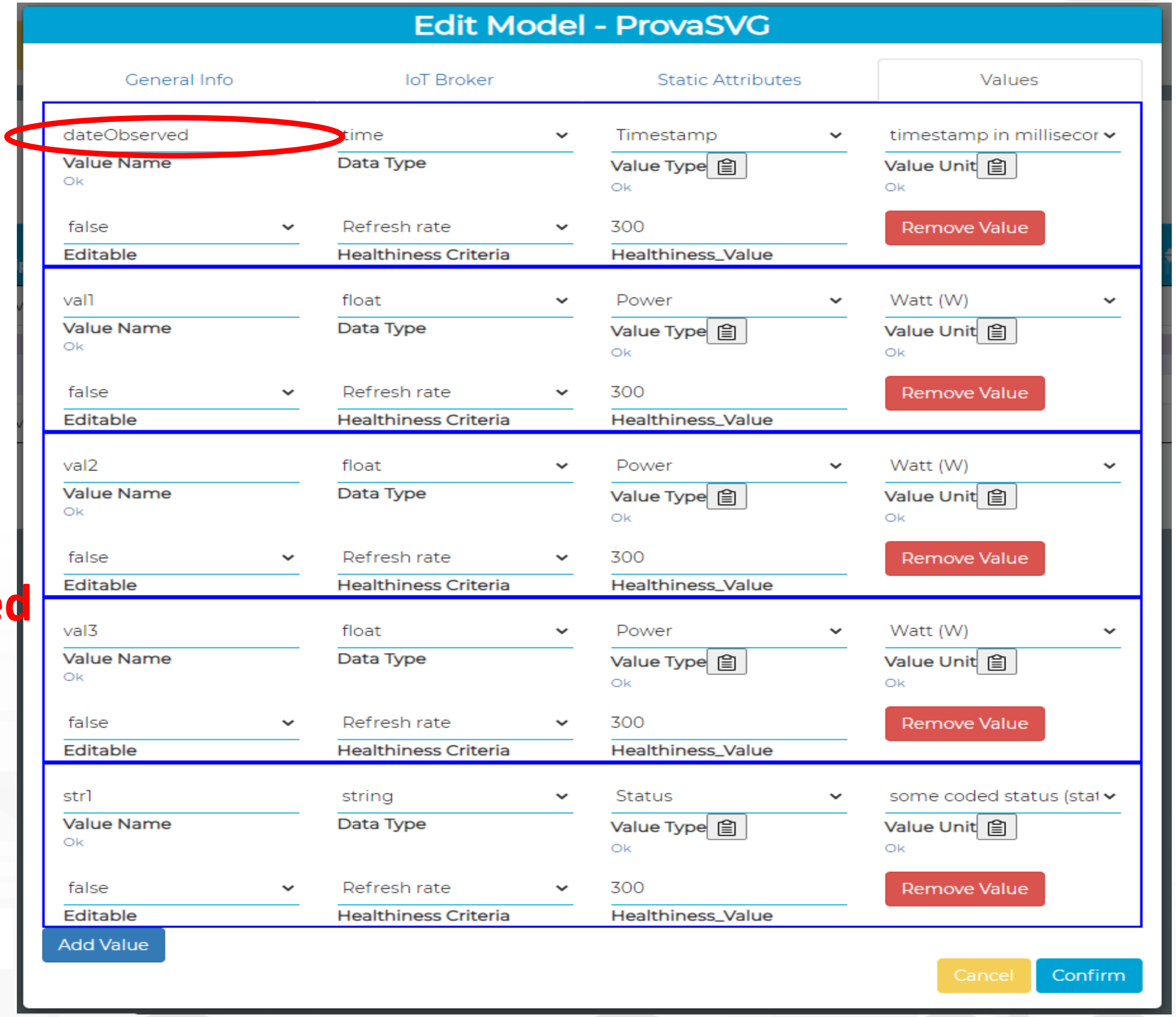


	Device Model	Description	Ownership	Organization	Kind	Producer	Device Type	Edit	Delete
+	Raspberry snap4city 1	Raspberry PI 3 Model B Scheda madre CPU 1.2 GHz Quad Core, 1 GB RAM	DELEGATED	DISIT	sensor	Raspberry PI	Ambiental		
+	Raspberry snap4city 2	Raspberry PI 3 Model B Scheda madre CPU 1.2 GHz Quad Core, 1 GB RAM	DELEGATED	DISIT	sensor	Raspberry PI	Ambiental		
+	Arduino Uno	Arduino Model B Scheda madre CPU 1.2 GHz Quad Core, 1 GB RAM	DELEGATED	DISIT	sensor	Arduino	Ambiental		
+	Arduino uno-bis	Arduino Model B Scheda madre CPU 1.2 GHz Quad Core, 1 GB RAM	DELEGATED	DISIT	sensor	Arduino	Ambiental		
+	sigfox	SigFox Model B Scheda madre CPU 1.2 GHz Quad Core, 1 GB RAM	DELEGATED	DISIT	sensor	SigFox	Ambiental		
+	Snap4AllButtonV1	Snap4AllButtonV1	DELEGATED	DISIT	sensor	Snap4All	Snap4AllButtonV1		
+	Raspberry snap4city 1 - Certificate	Raspberry PI 3 Model B Scheda madre CPU1.2 GHz Quad Core, 1 GB RAM with certificate	DELEGATED	DISIT	sensor	Raspberry PI	Ambiental		
+	datacenter3dht22	datacenter3dht22	DELEGATED	DISIT	sensor	disit	raspberry		
+	Thermometer	This model represents a generic device that can measure a temperature	DELEGATED	DISIT	sensor	Generic	Ambiental		
+	AirConditioner	Generic model representing a simple conditioner with only the status attribute	DELEGATED	DISIT	actuator	Generic	Ambiental		

IOT Device Model

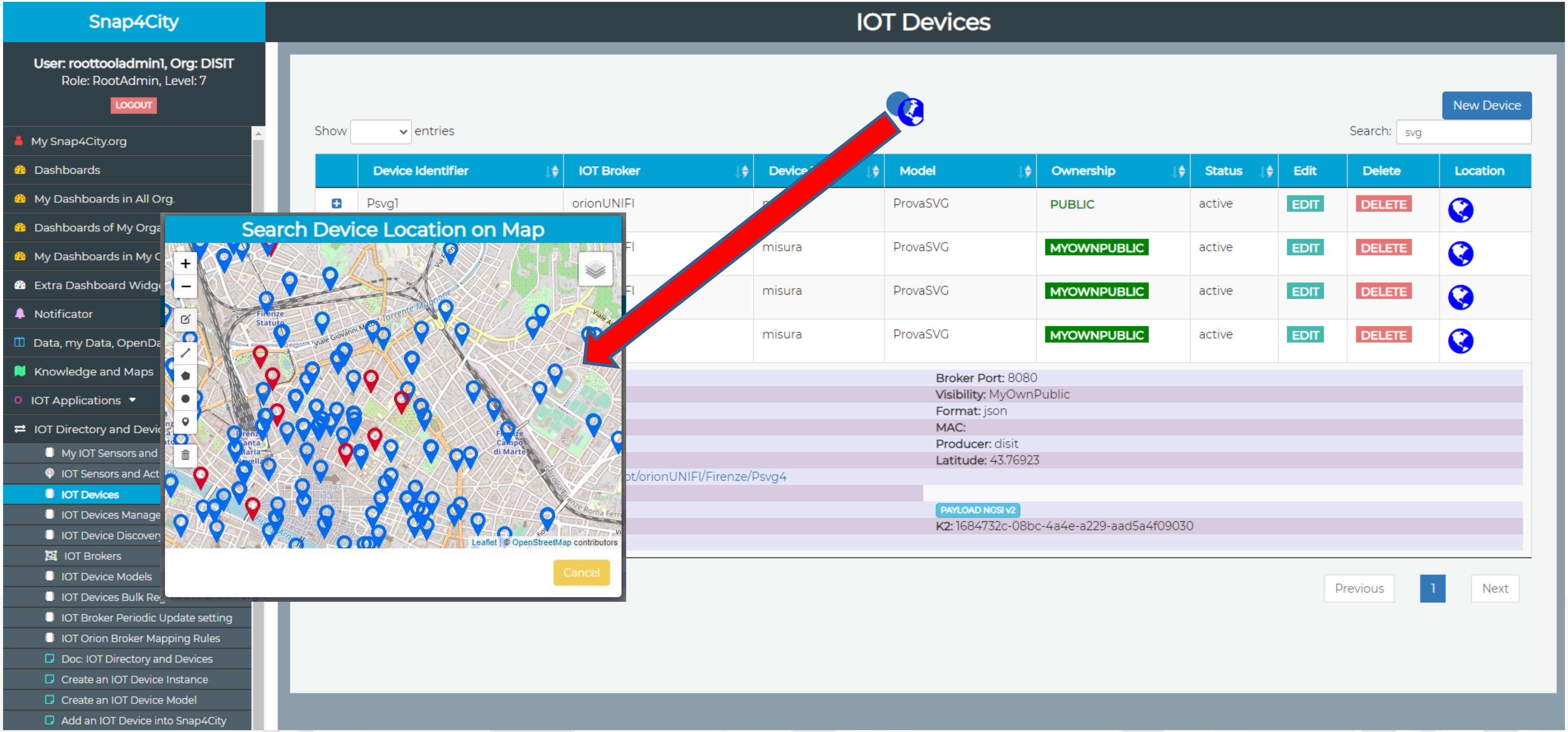


To exploit the simplified IOT Dev Creation, you have to create the IOT Device Model as here
Do once and create as many IOT Device you like in shorter steps

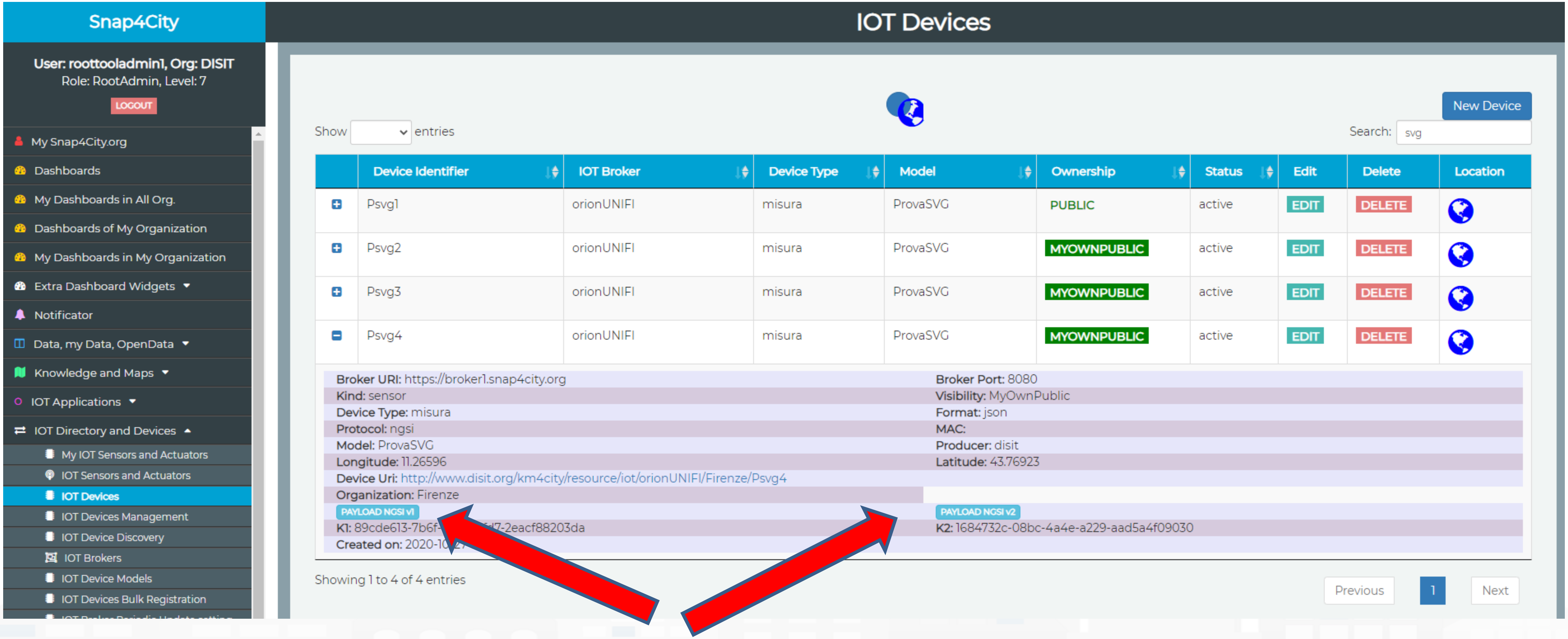


B)

IOT Devices


Snap4City
IOT Devices
User: roottooladmin1, Org: DISIT
Role: RootAdmin, Level: 7
LOGOUT
My Snap4City.org
Dashboards
My Dashboards in All Org.
Dashboards of My Orga
My Dashboards in My C
Extra Dashboard Widg
Notificator
Data, my Data, OpenDa
Knowledge and Maps
IOT Applications
IOT Directory and Devic
My IOT Sensors and
IOT Sensors and Act
IOT Devices
IOT Devices Manage
IOT Device Discovery
IOT Brokers
IOT Device Models
IOT Devices Bulk Re
IOT Broker Periodic Update setting
IOT Orion Broker Mapping Rules
Doc: IOT Directory and Devices
Create an IOT Device Instance
Create an IOT Device Model
Add an IOT Device into Snap4City
New Device
Show entries
Search: svg
Device Identifier
IOT Broker
Device
Model
Ownership
Status
Edit
Delete
Location
Psvg1
orionUNIFI
ProvaSVG
PUBLIC
active
EDIT
DELETE
misura
MYOWNPUBLIC
Search Device Location on Map
Leaflet | © OpenStreetMap contributors
Cancel
Broker Port: 8080
Visibility: MyOwnPublic
Format: json
MAC:
Producer: disit
Latitude: 43.76923
ot/orionUNIFI/Firenze/Psvg4
PAYLOAD NGSI v2
K2: 1684732c-08bc-4a4e-a229-aad5a4f09030
Previous
1
Next

See IOT Devices



Example of msg.payload to be used on IOT App compliant with the NGSI V1 and V2

Examples of NGSI V1 and V2, JSON Payload

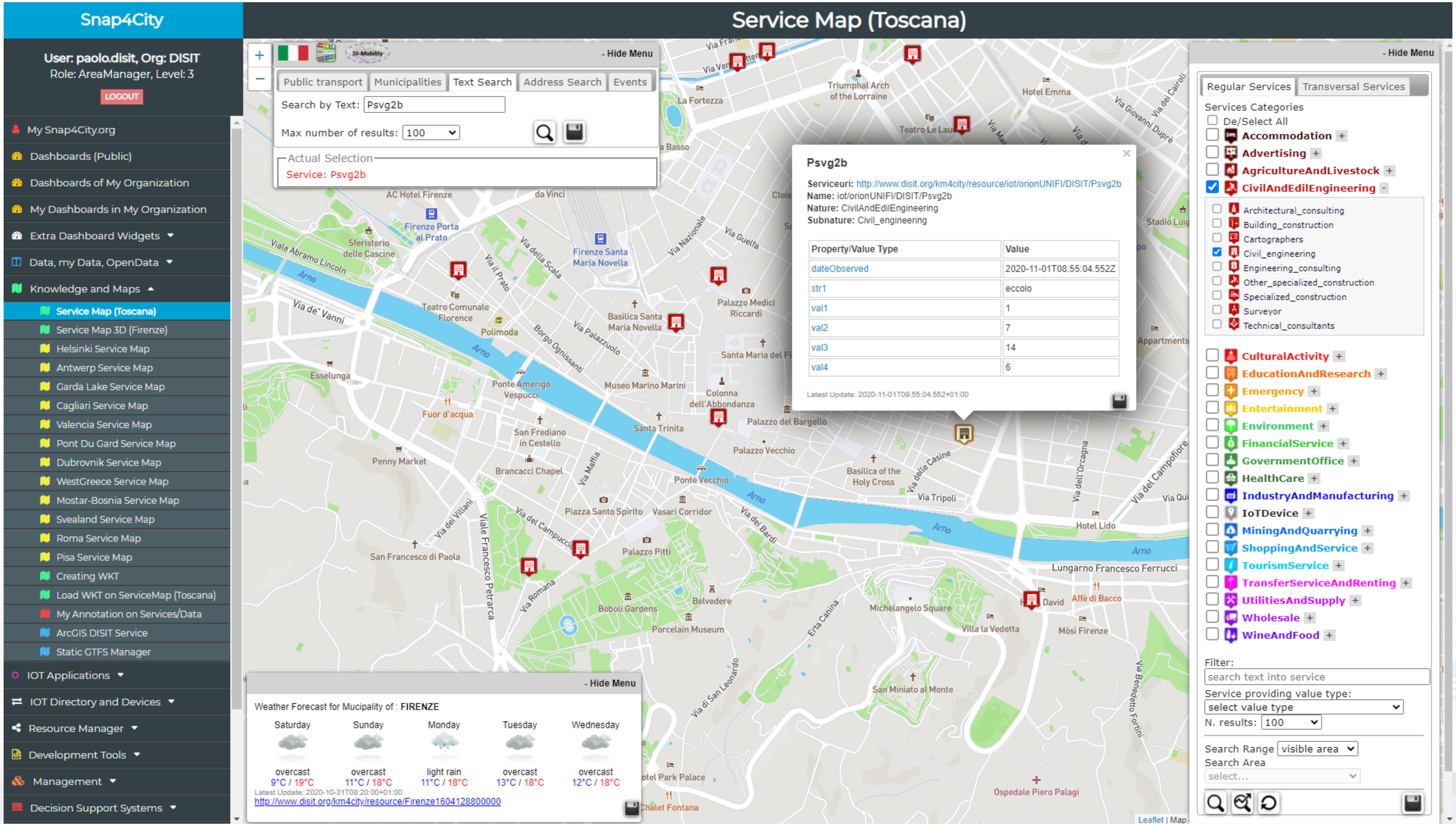
NGSI V1

{
"type":"misura","id":"Psvg4",
"attributes":[
{"name":"dateObserved","type":"time",
"value":"2020-11-06T13:25:12.191Z"},
{"name":"latitude","type":"float","value":"43.76923"},
{"name":"longitude","type":"float","value":"11.2659s"},
{"name":"str1","type":"string","value":"la mia"},
{"name":"val1","type":"float","value":"3.6"},
{"name":"val2","type":"float","value":5.77},
{"name":"val3","type":"float","value":“6.78"}
]
}

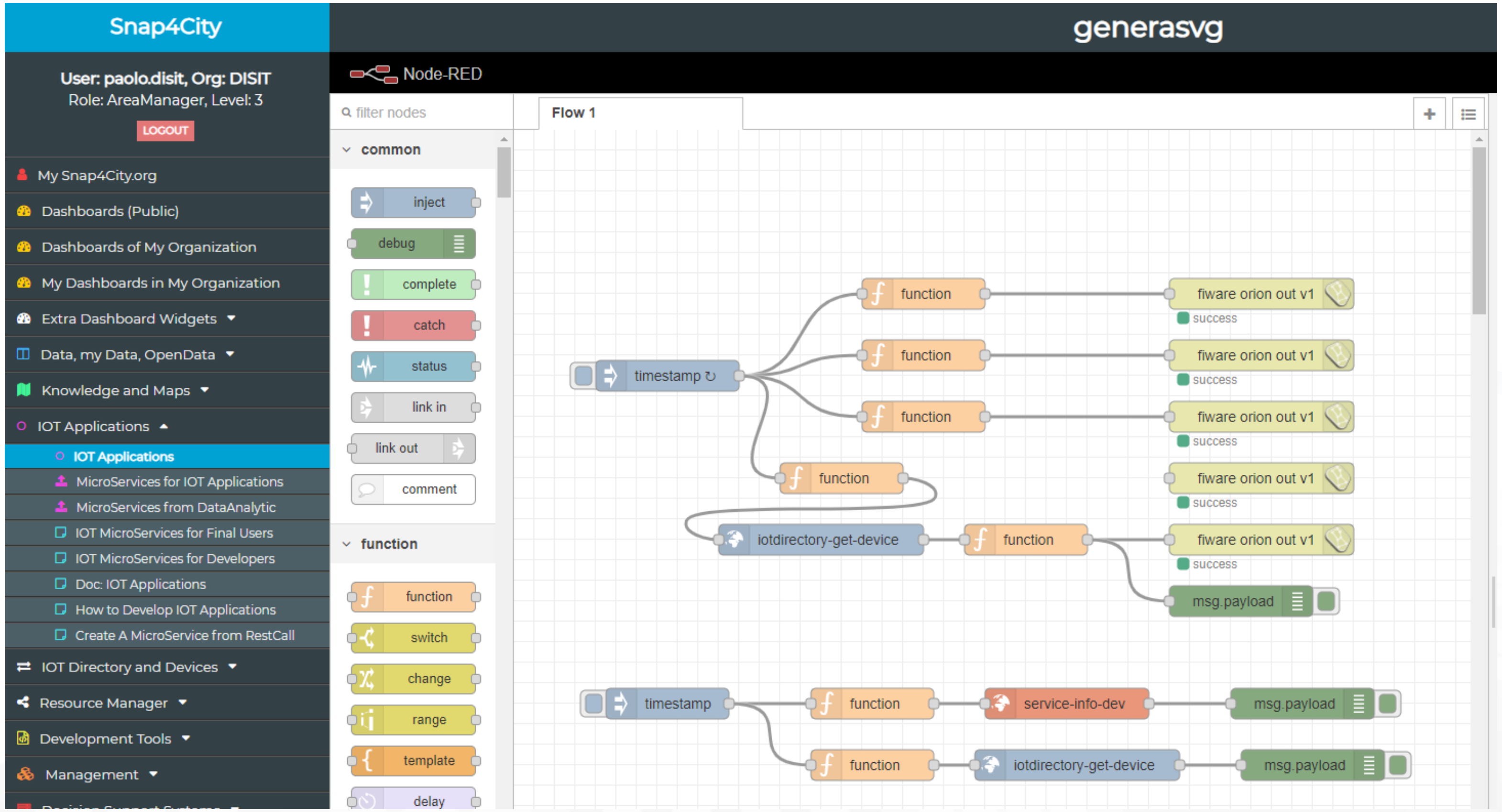
NGSI V2

{
"id":"Psvg4","type":"misura",
"dateObserved":{"type":"time",
"value":"2020-11-06T13:25:12.191Z"},
"latitude":{"type":"float","value":"43.76923"},
"longitude":{"type":"float","value":"11.26596"},
“str1":{"type":"string","value":"eccolo"},
"val1":{"type":"float","value":4.3},
"val2":{"type":"float","value":“4.6"},
"val3":{"type":"float","value":""}
}

Opla! See them Created on ServiceMap



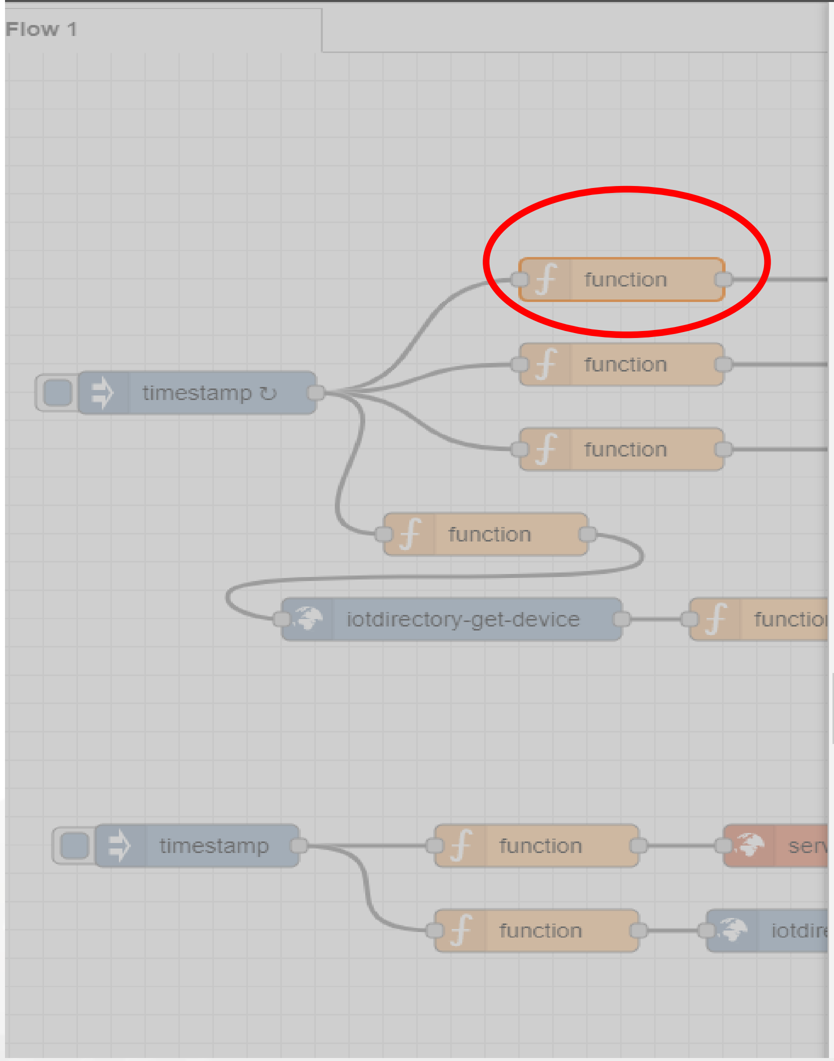
Saving Data in the IOT Device: Data Shadow



- Generation of random values of the 4 IOT devices
- Send the values to IOT Broker,
  - which in turn send automatically the value to the Storage
- Inspection of the IOT Device Information

Function Block

generasvg



Edit function node

Delete | Cancel | Done

Properties

Name: Name

Setup | Function | Close

```
var data = new Date();

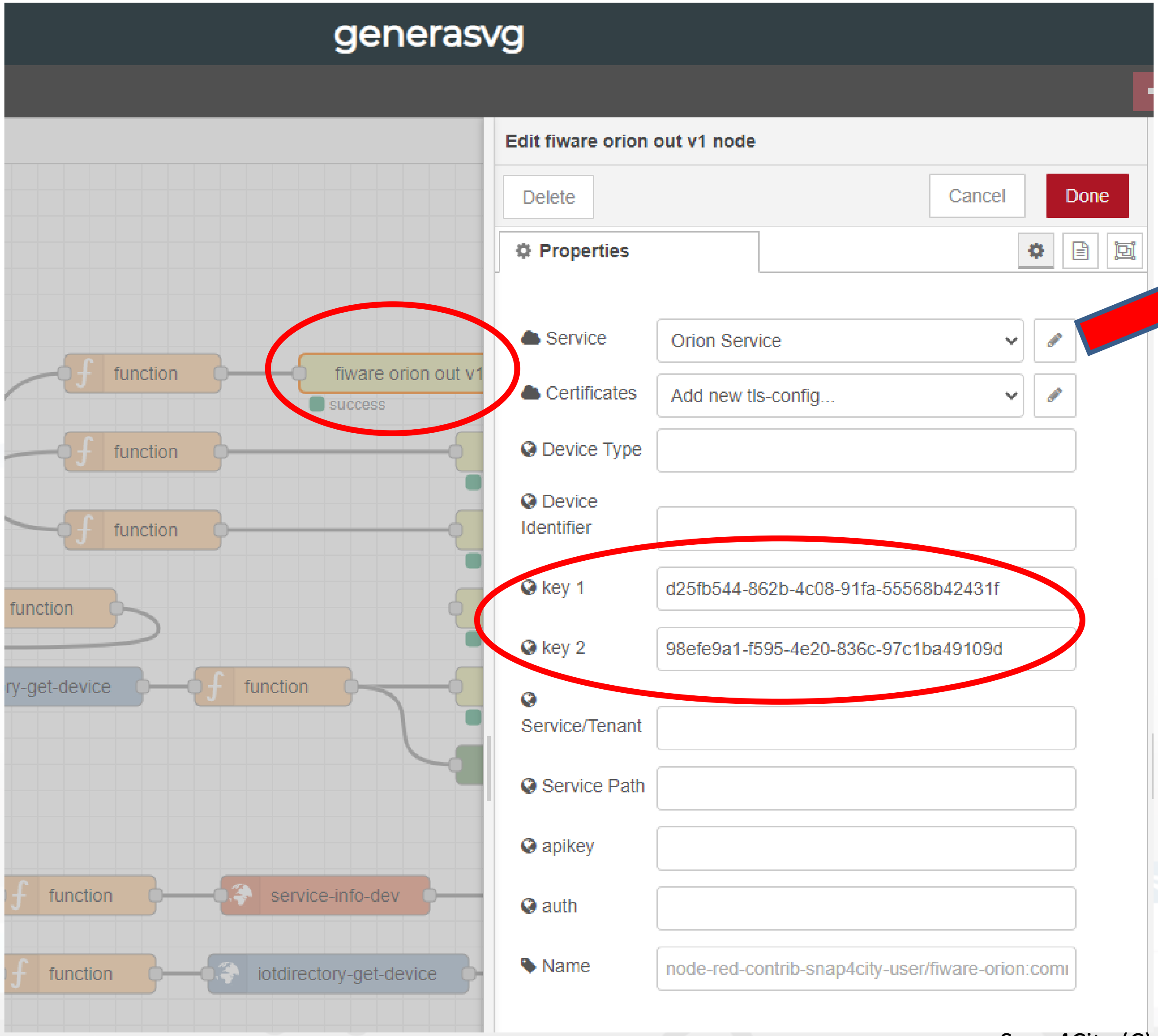
var rnd1 = Math.random();
if (rnd1>=0.5) rnd1=0; else rnd1=1;

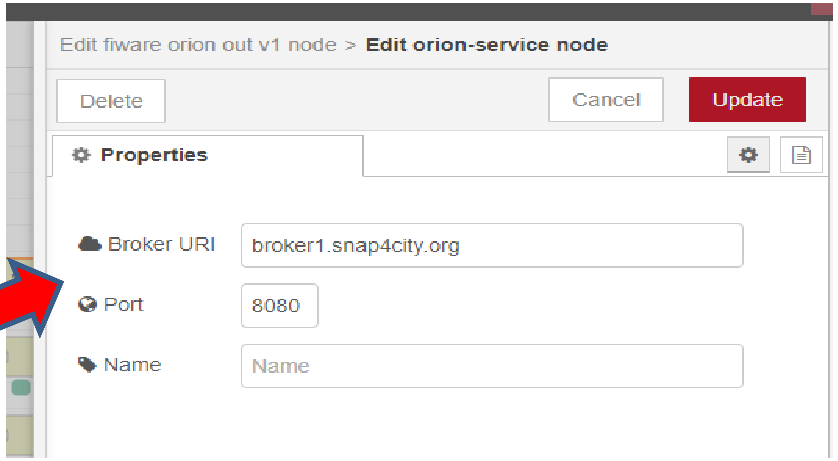
var rnd2 = Math.random()*12;
rnd2 = parseInt(rnd2);
var rnd3 = Math.random()*100;
rnd3 = parseInt(rnd3);
var rnd4 = Math.random()*7;
rnd4 = parseInt(rnd4);

msg = { payload : {
   "id": "Psvg1b",
   "type": "misura",
   "attributes":[
  {  "name": "dateObserved",  "value": data,  "type": "time"  },
  {  "name": "val1",   "value": rnd1,   "type": "float"  },
  {  "name": "val2",   "value": rnd2,   "type": "float"  },
  {  "name": "val3",   "value": rnd3,   "type": "float"  },
  {  "name": "val4",   "value": rnd4,   "type": "float"  },
  {  "name": "str1",   "value": "eccolo",   "type": "string"  }
  ]
 }
}
return msg;
```

- Data values Random generation
- dateObserved with the actual datetime
- Example in NGSI V1

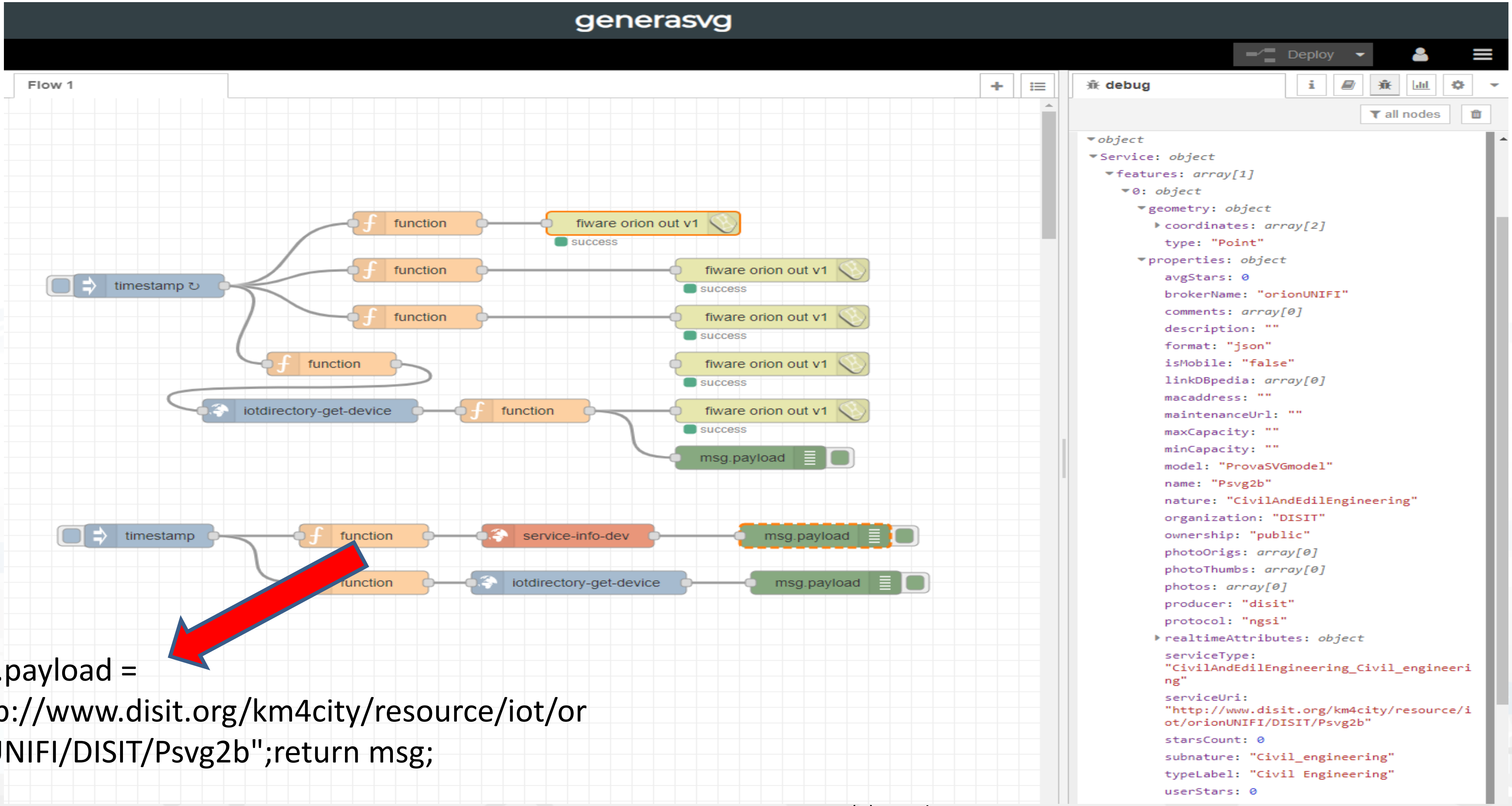
Send data to Broker





- This case is with K1 and K2 directly written into the Orion OUT V1 Node

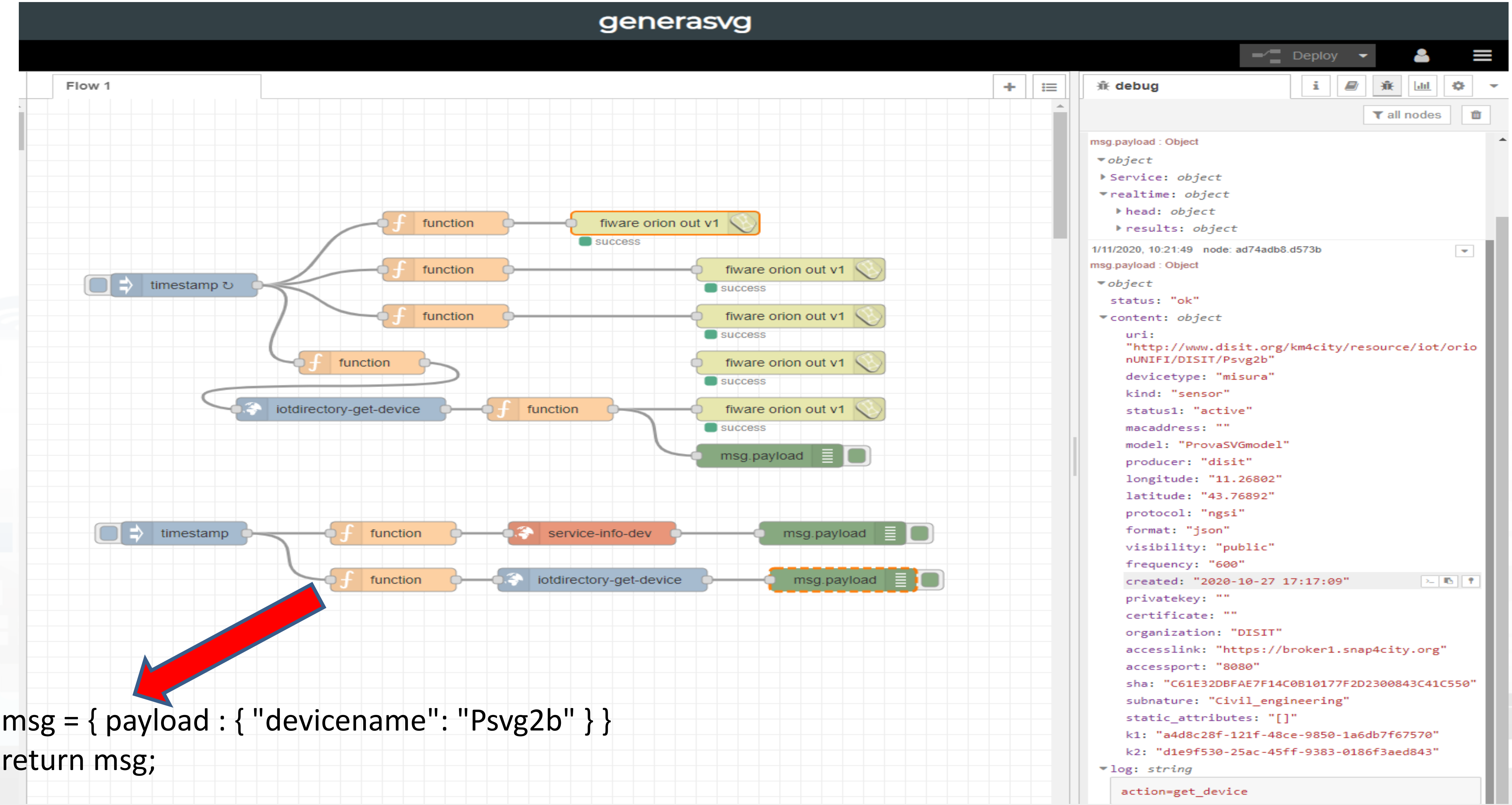
Service Info Dev



object
Service: object
features: array[1]
0: object
geometry: object
coordinates: array[2]
type: "Point"
properties: object
avgStars: 0
brokerName: "orionUNIFI"
comments: array[0]
description: ""
format: "json"
isMobile: "false"
linkDBpedia: array[0]
macaddress: ""
maintenanceUrl: ""
maxCapacity: ""
minCapacity: ""
model: "ProvaSVGmodel"
name: "Psvg2b"
nature: "CivilAndEdilEngineering"
organization: "DISIT"
ownership: "public"
photoOrigs: array[0]
photoThumbs: array[0]
photos: array[0]
producer: "disit"
protocol: "ngsi"
realtimeAttributes: object
serviceType: "CivilAndEdilEngineering_Civil_engineering"
serviceUri: "http://www.disit.org/km4city/resource/iot/orionUNIFI/DISIT/Psvg2b"
starsCount: 0
subnature: "Civil_engineering"
typeLabel: "Civil Engineering"
userStars: 0

msg.payload = "http://www.disit.org/km4city/resource/iot/orionUNIFI/DISIT/Psvg2b";return msg;

IOTdirectory-get-device information

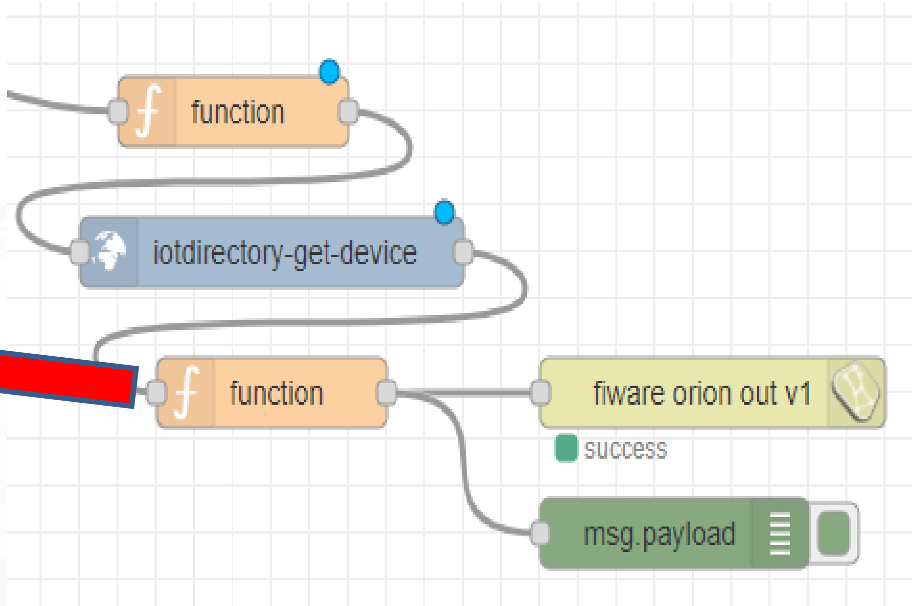



```
msg = { payload : { "devicename": "Psvg2b" } }
return msg;
```

Exploitiong IOT Directory for getting K1,K2

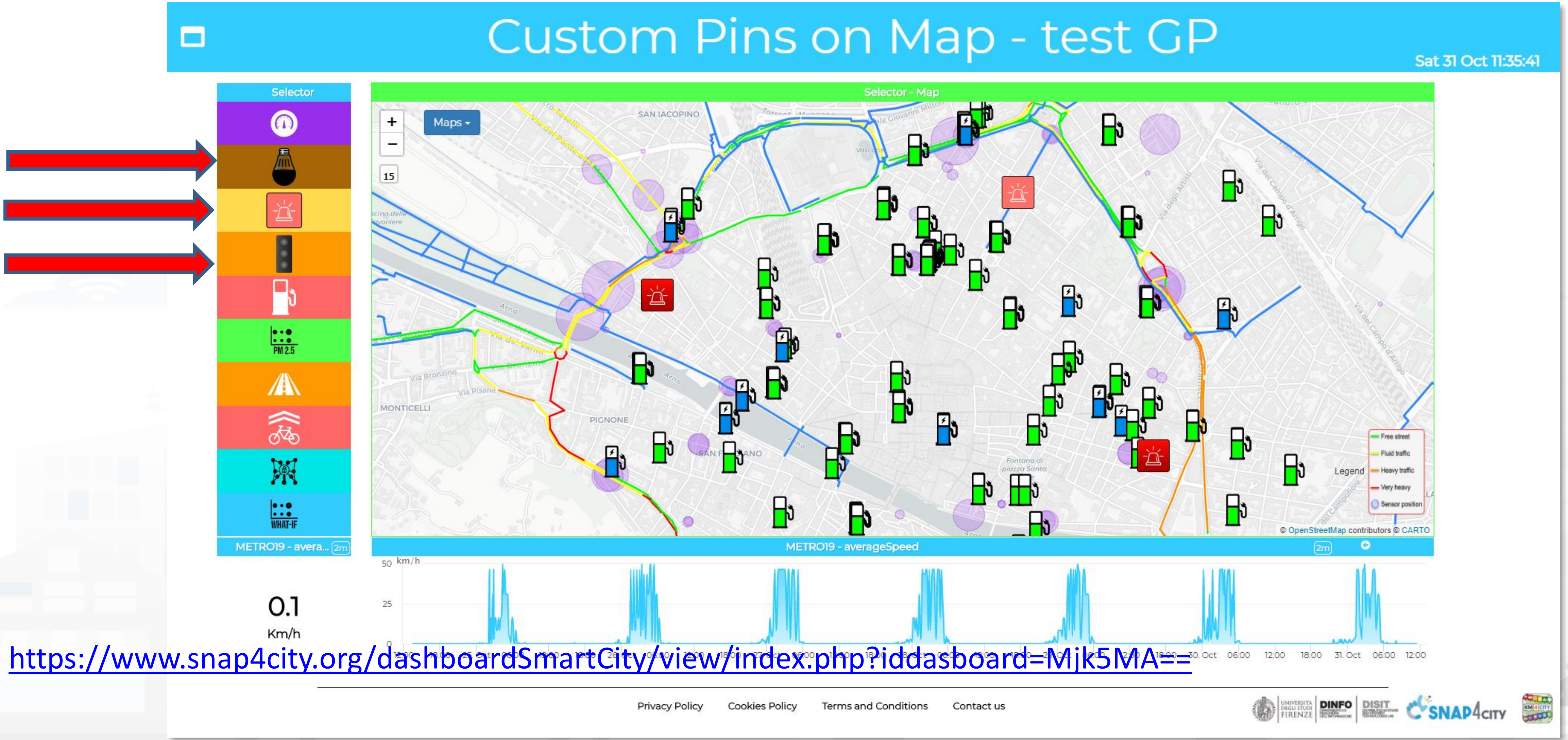
```
msg = {  payload : {
  "id": flow.get("devid"),
  "type": "misura",
  "attributes":[   {  "name": "dateObserved",  "value": data,  "type":
"time"  },
           {  "name": "val1",   "value": rnd1,   "type": "float"  },
           {  "name": "val2",   "value": rnd2,   "type": "float"  },
           {  "name": "val3",   "value": rnd3,   "type": "float"  },
           {  "name": "val4",   "value": rnd4,   "type": "float"  },
           {  "name": "str1",   "value": "eccolo",   "type": "string"  } ]
           },
 auth : {
    "k1": msg.payload.content.k1,
    "k2": msg.payload.content.k2
 }
}
```

// payload in NGSI V1 format



// the values of K1, K2 arrive from
// the iotdirectory-get-device

The four IOT Devices on Dashboard

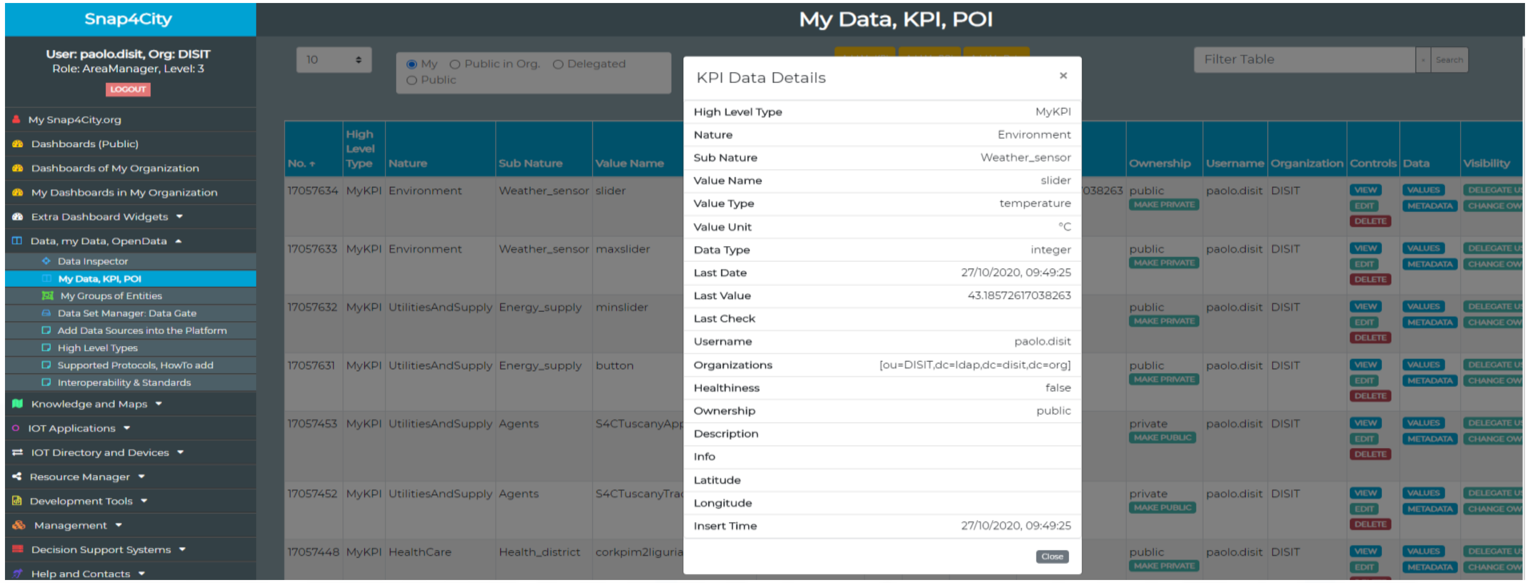


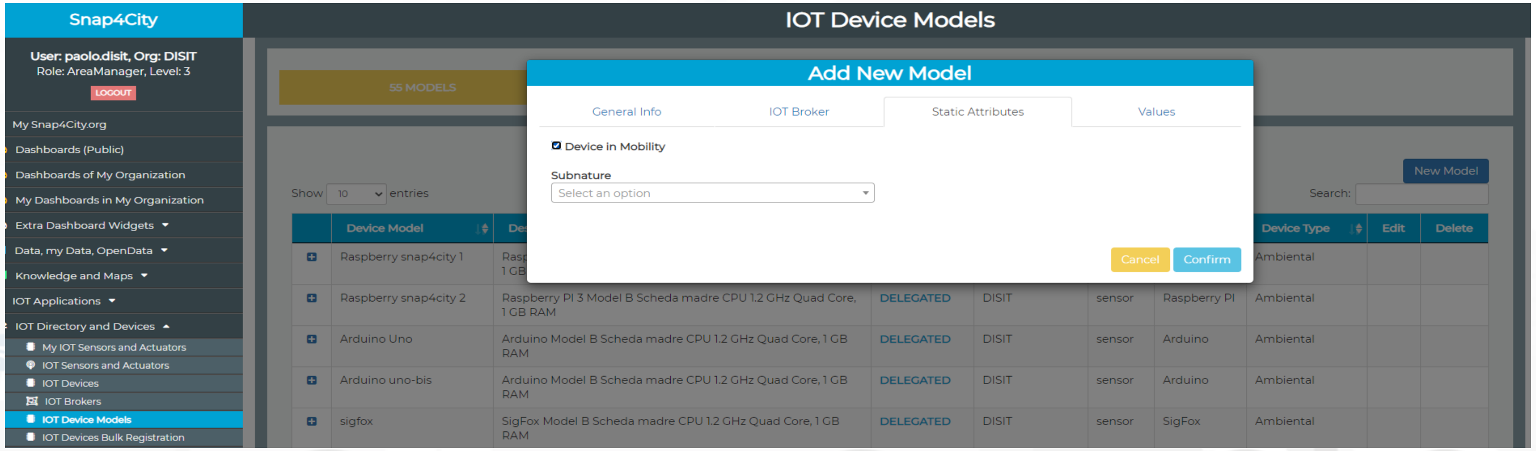
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjk5MA==

A Complete Example: IOT Device Mobile

Working with Sensor Data from Moving Devices

- Moving Data can be collected by using:
  - **MyKPI**: in which each MyKPI has a ValueName, Unit, Type, etc.. And also GPS location
  - **IOT Device in Mobility**: which generates a new HLT SensorMobile, creating a TimeSeries with changing value and GPS coordinates over time





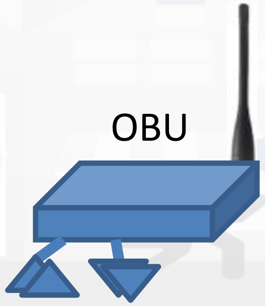
MyKPI: Tracking of Devices and Mobiles

- Real Time Trajectories for
  - Mobile Phone
  - Moving IOT Devices
  - OBU, Vehicular Kits
  - Multiple tracks
  - Day by day
- Micro Application

Mobile PAX Counter

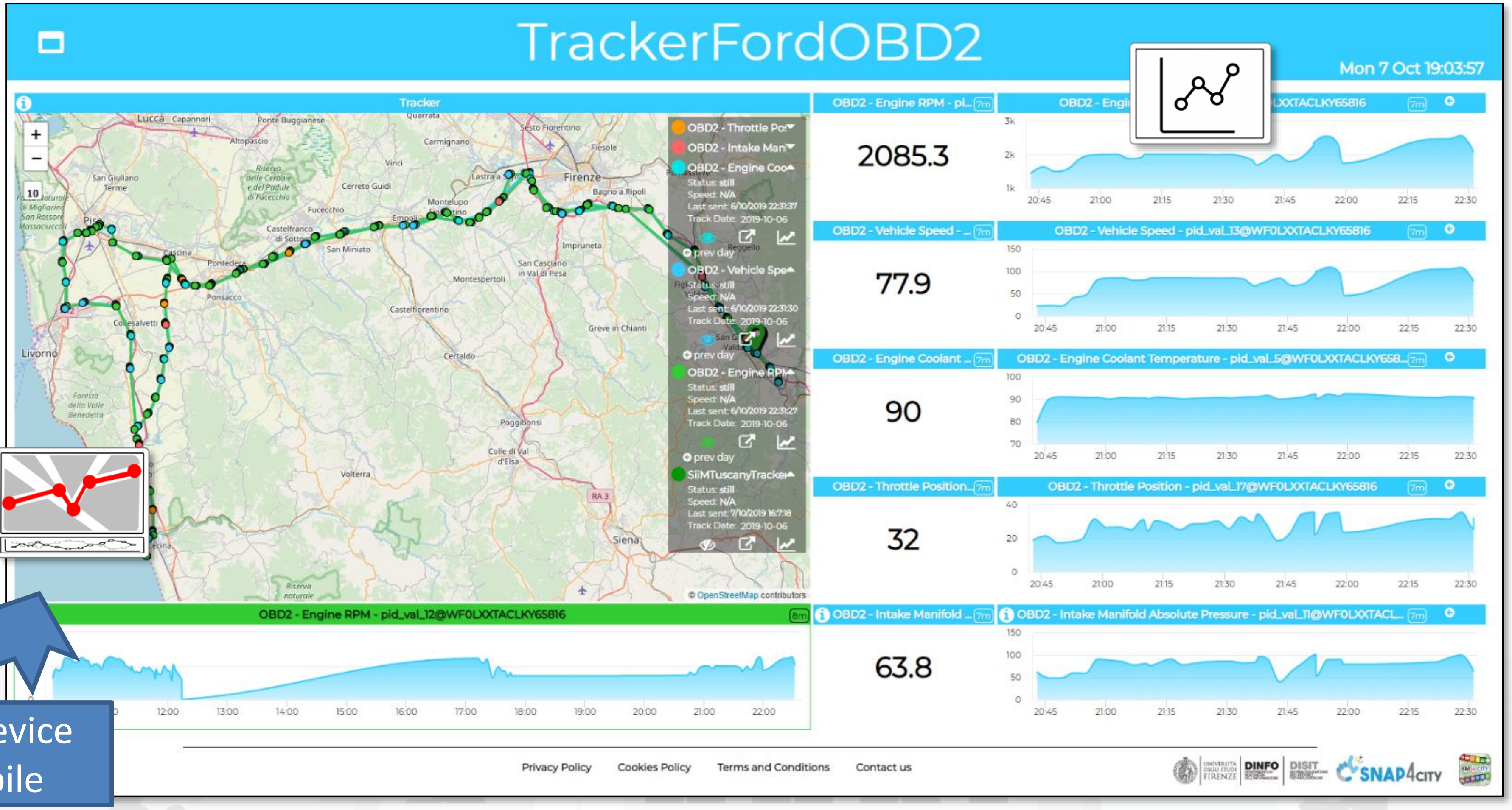
Apps

OBD2

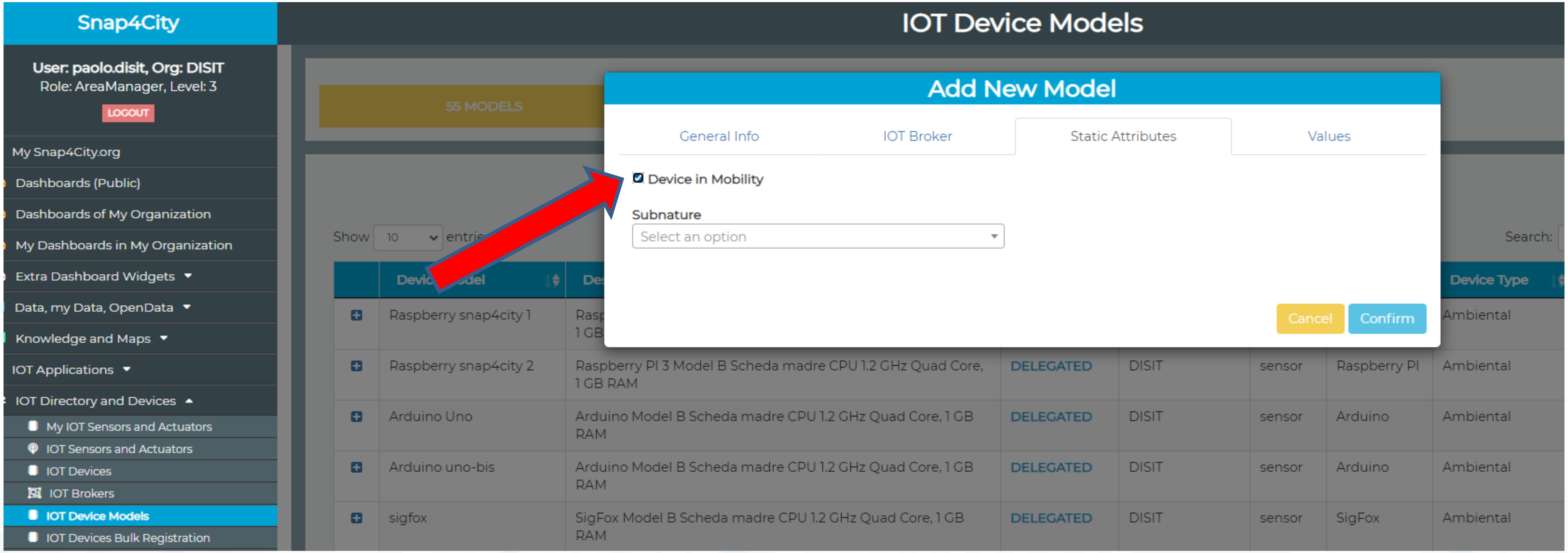


OBU

IOT Device Mobile



IOT Device in Mobility



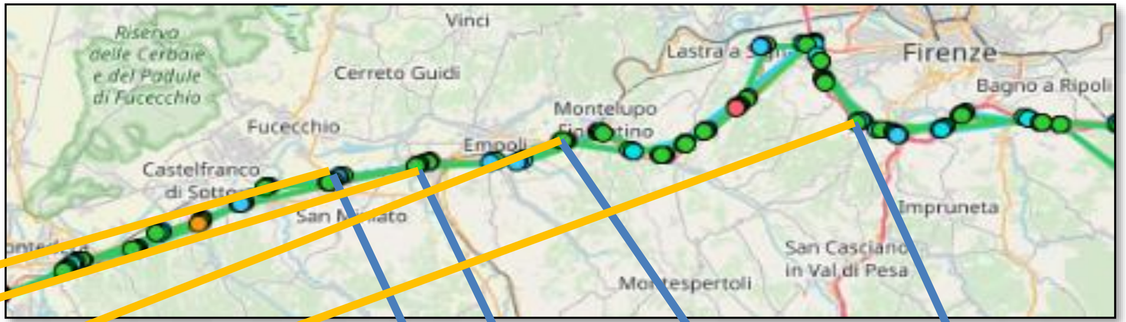
- **IOT Device in Mobility**: which generates a new HLT SensorMobile, creating a TimeSeries with changing value and GPS coordinates over time

IOT Devices in Mobility as time series

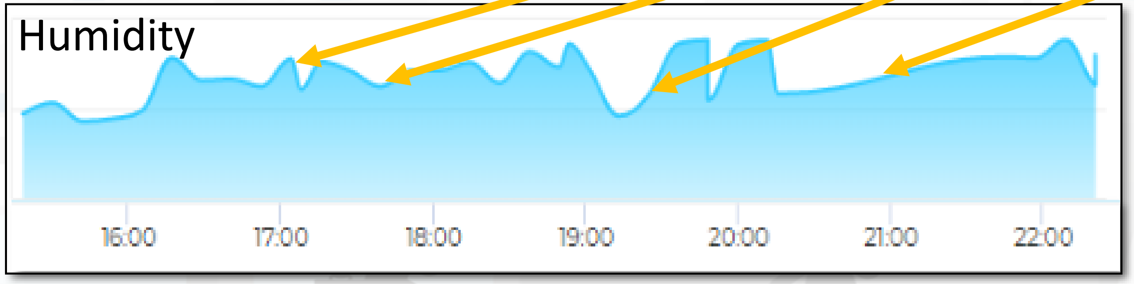
Message (
timestamp: «02-04-2020 at 10:30»,
Temperature: 29.34,
Humidity: 35,
Latitude: 11.456,
Longitude: 43.24314
)

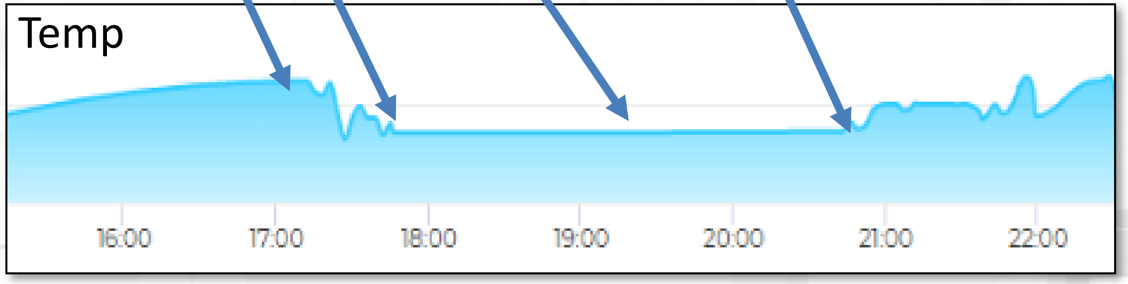
dateObserved	Temp	Humid.	LAT	LON
02-04-2020 10:30	34.5	23	11.11	43.21
02-04-2020 10:40	36.5	24	11.13	43.12
02-04-2020 10:50	36.0	22.5	11.45	43.18

- A set of data coming from an IOT Device with multiple sensor become a time series of values for devices.
- For example taking a new measure every 10 minutes (Red Lines)
- Each new measure in Snap4City is conventionally time located in «dateObserved»
- LAT,LONG is changing over time



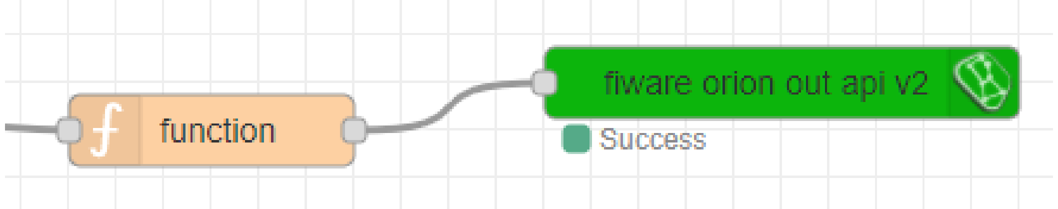
SPACE



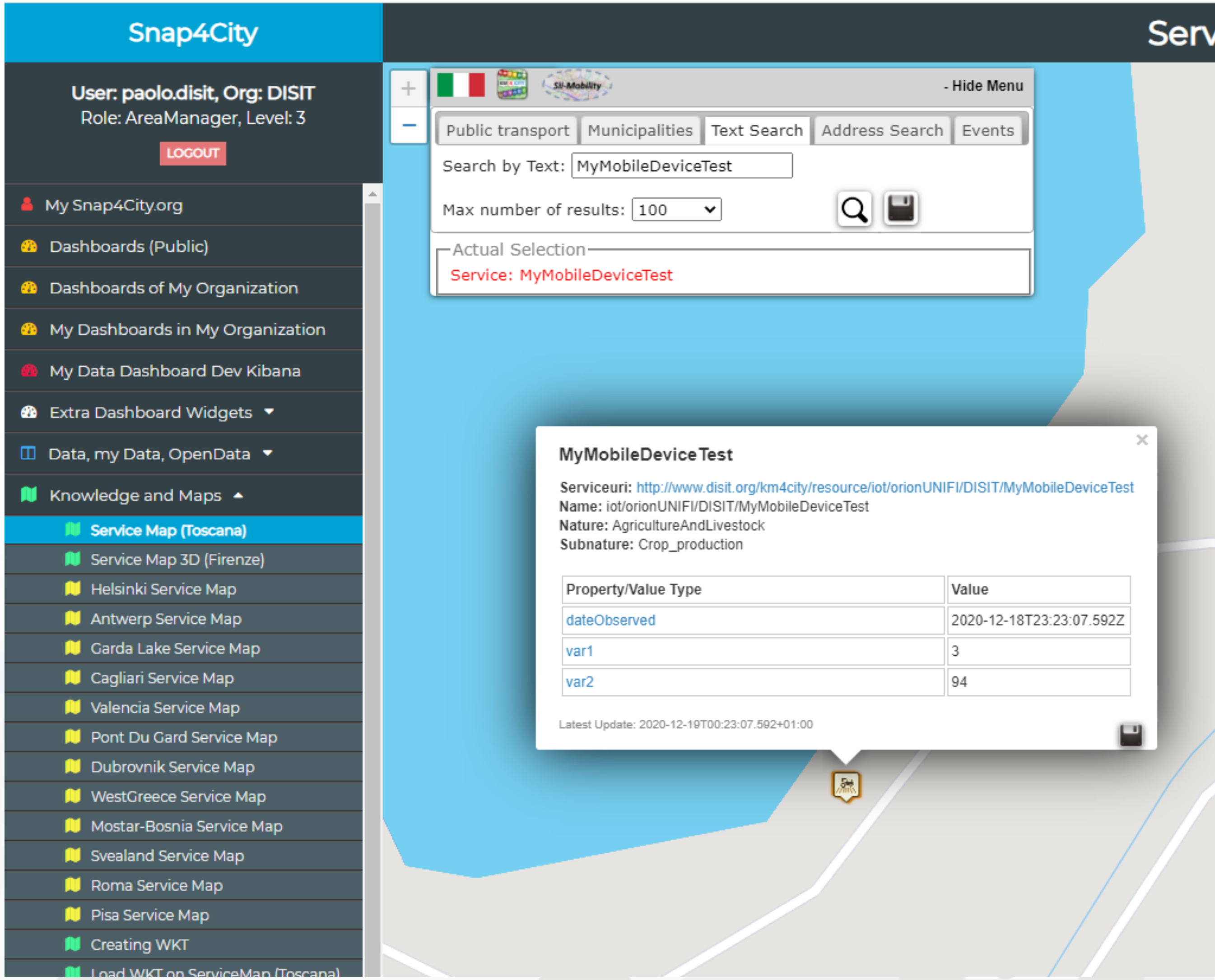


TIME

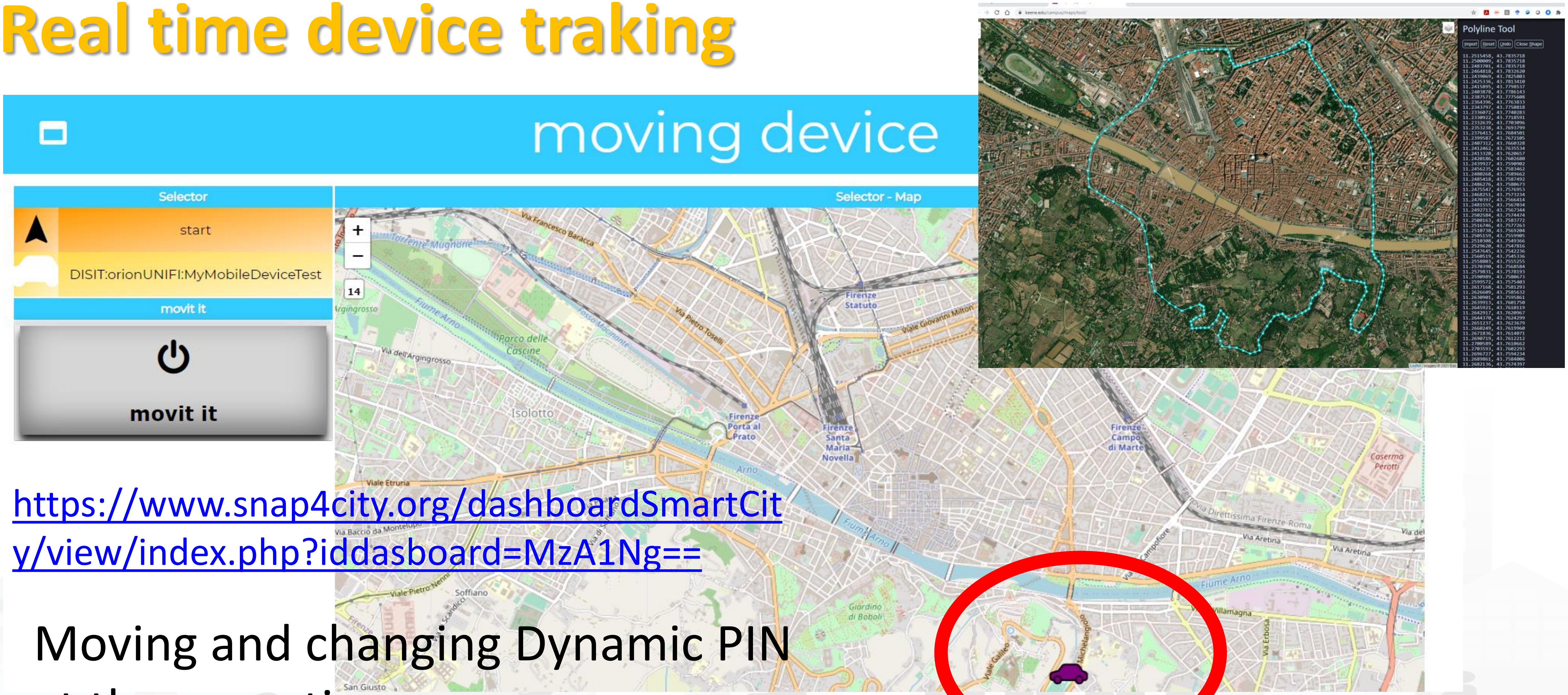
Sending data of Moving IOT Device




```
msg = {   payload :
{"id":"MyMobileDeviceTest",
"type":"misura",   "dateObserved":
            {"type":"time","value":data},
            "latitude":{"type":"float","value":lat},
            "longitude":{"type":"float","value":lon},
            "status":{"type":"string","value":""},
            "var1":{"type":"float","value":rnd2},
            "var2":{"type":"float","value":rnd3}
            }
}
```



Real time device traking

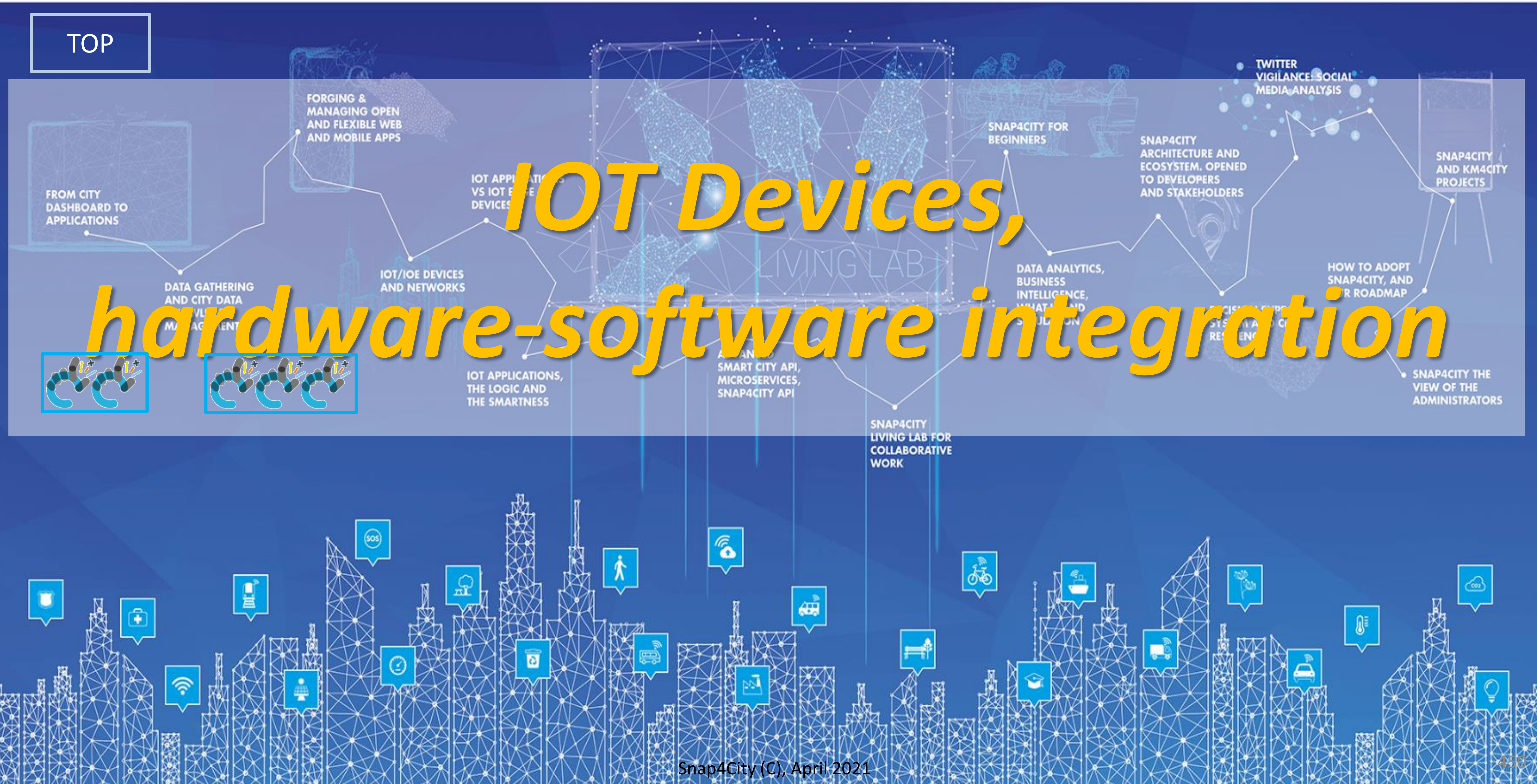


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA1Ng==

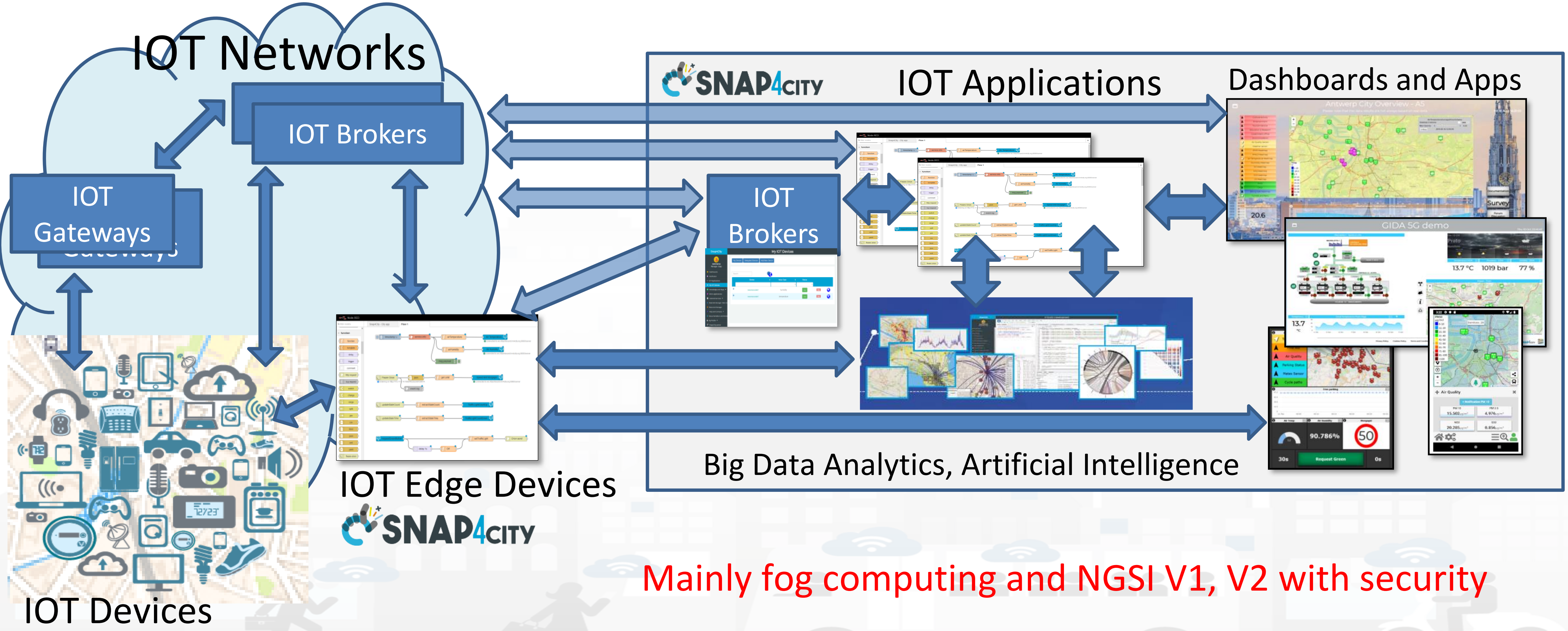
Moving and changing Dynamic PIN at the same time

TOP

IOT Devices, hardware-software integration



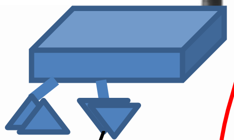
Snap4City Services also on IOT Edge!!!



Mainly fog computing and NGSI V1, V2 with security

TOP

Proprietary IOT Devices as well as Open Hardware / Open Software

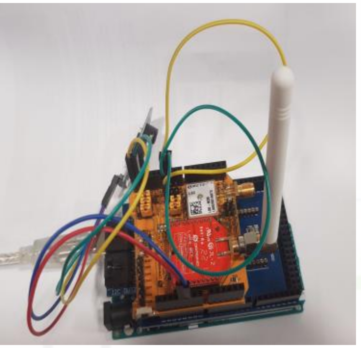


Sensors/
Actuators

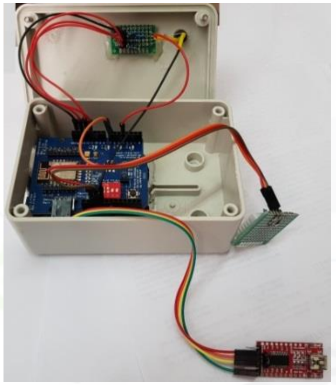
IOT Devices

IOT Edge Devices

LoraWAN + Arduino + I2C, NGSI



Arduino, Wi-Fi, NGSI

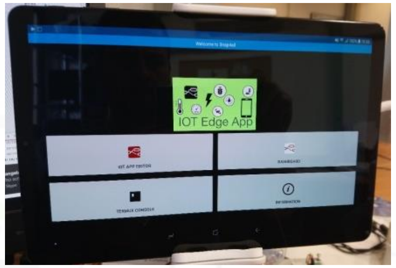


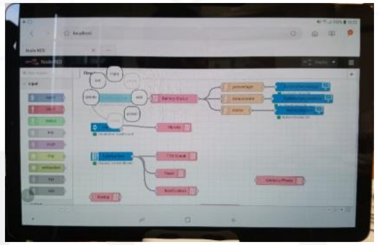
Snap4All IOT Button ESP, NGSI, Wi-FI, BT

Snap4All PAX Counter LoraWAN WIFI, NGSI, GPS

IOT Edge NodeRED: Raspberry Pi, NGSI, WiFi, RJ45,..

IOT Edge NodeRED: Android, LINUX, Windows, …





LoraWan Gateway: IOT Edge, NGSI, WIFI, RJ45, GPS

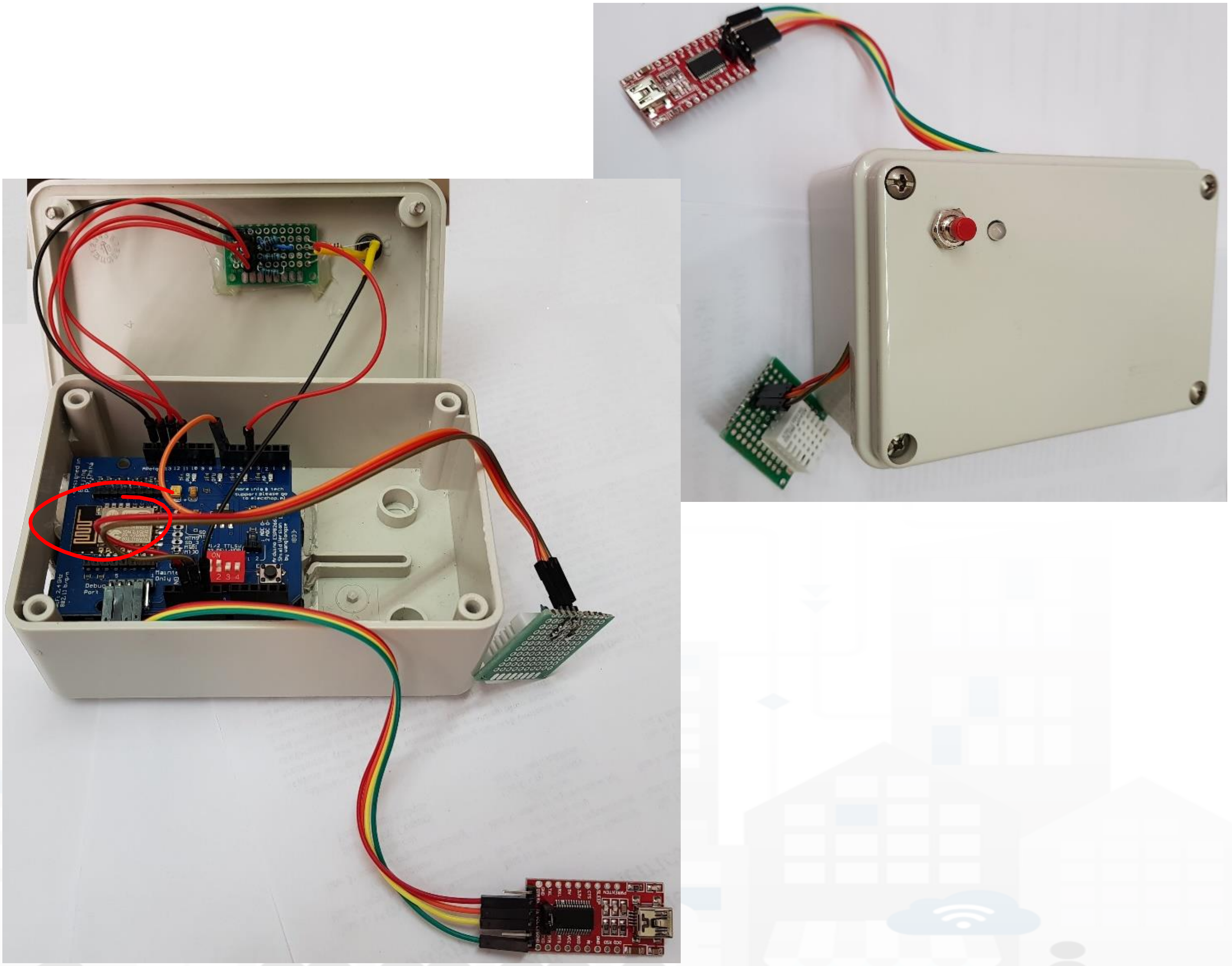
Any Sensor / Actuator
Open to other protocols

IOT Dev Management: activities

- **IOT Devices connected to Snap4 can be open or proprietary**
- **IOT Devices**: a large range of protocols, formats and kind
  - IOT Devices (single or in bulk) are **registered** on IOT Directory and thus according to Knowledge base are registered to be used in IOT Applications, Dashboards, etc. with Shadow values, etc.
  - IOT Models are saved on IOT Directory for shortening the registration process
  - IOT Device healthiness is automatically monitored
- **IOT Devices can be public or private**
  - **Full support of Proprietary protocols and devices**
  - **Providing Open Hardware and Open Software** IOT Devices/IOT Edge: NGSI fully secure
- **IOT Edge** are devices with some computing capability, realized by using: Raspberry, Android, Linux, Windows, etc.
  - **Release as**: OS images on SD, APK for Android, Virtual Machine, Docker Container, etc.
- IOT Devices are connected via **Secure Encrypted Mutual Authenticated** channel of communication, TLS and certificates

IOT Device with Arduino

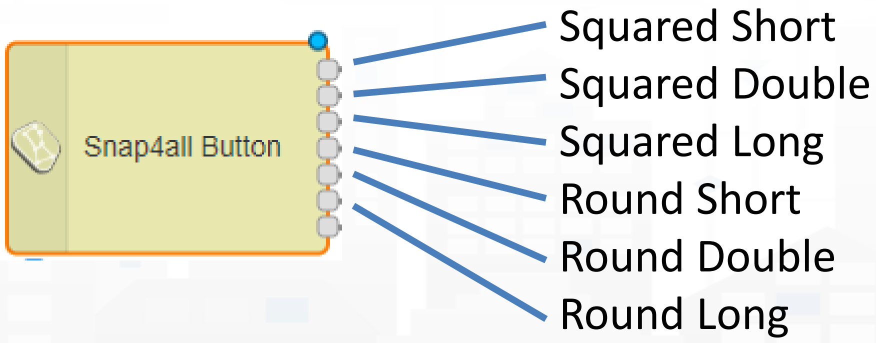
- Arduino Uno
- Wi-Fi shield, standard
- Mutual Authentication with certificates, or K1,K2,sha
- Secure encrypted connection, NGSI
- Open Source
- Fully Customizable
  - Any sensor
  - NGSI or any other protocol



Snap4All IOT Button

version: 3

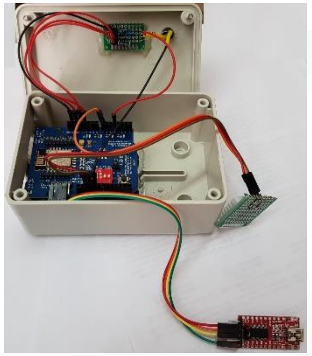
- Multi Wi-Fi
- Ready to use BLE Bluetooth
- ESP 32 based, cheap & easy
  - low/no energy consumption/ standby
- Mutual Authentication with certificates, or K1,K2,sha
- secure encrypted connection, NGSI
- Open Source, Fully Customizable
- HW extensible to sensors

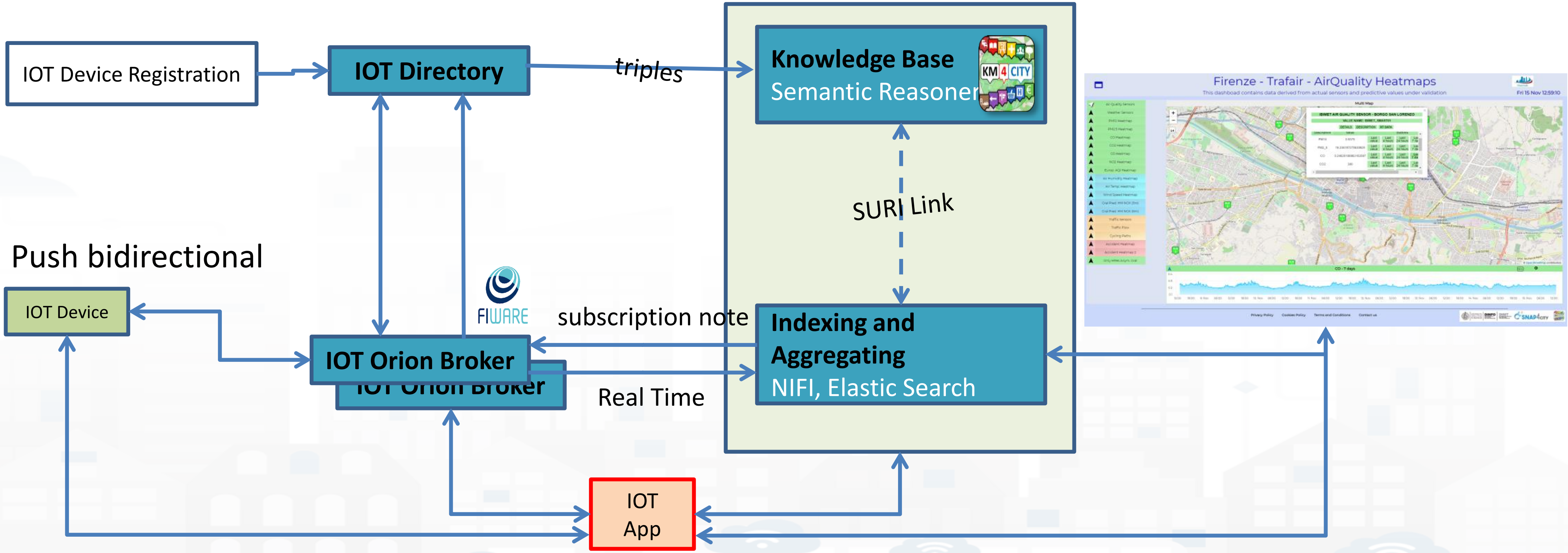


https://www.snap4city.org/276
https://www.snap4city.org/297 help config

AirQINO vs SNAP4CITY

- Can be connected (i) directly to Snap4City (data driven) or (ii) Indirectly via CNR IBE (only in push)





TOP

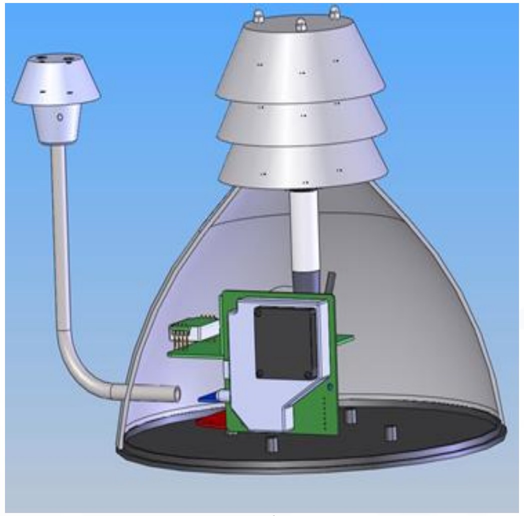
CNR IBE AirQino

Consiglio Nazionale delle Ricerche

AirQino

Consiglio Nazionale delle Ricerche

- CNR developed a circuit board "AirQino", Arduino Shield compatible, integrated with low cost and high resolution sensors, dedicated to the monitoring of environmental parameters and air quality pollutants
  - Noise, Humidity, Temperature,
  - CO, CO_2, O_3, NO_2, CH_4,
  - road pavement quality (accelerometer) and the indices of well-being (globethermometer to calculate the index of thermal comfort) in an urban environment.
- The board integrates a microprocessor unit that acquires all the sensors installed and analyses fast data from accelerometer and noise sensor.



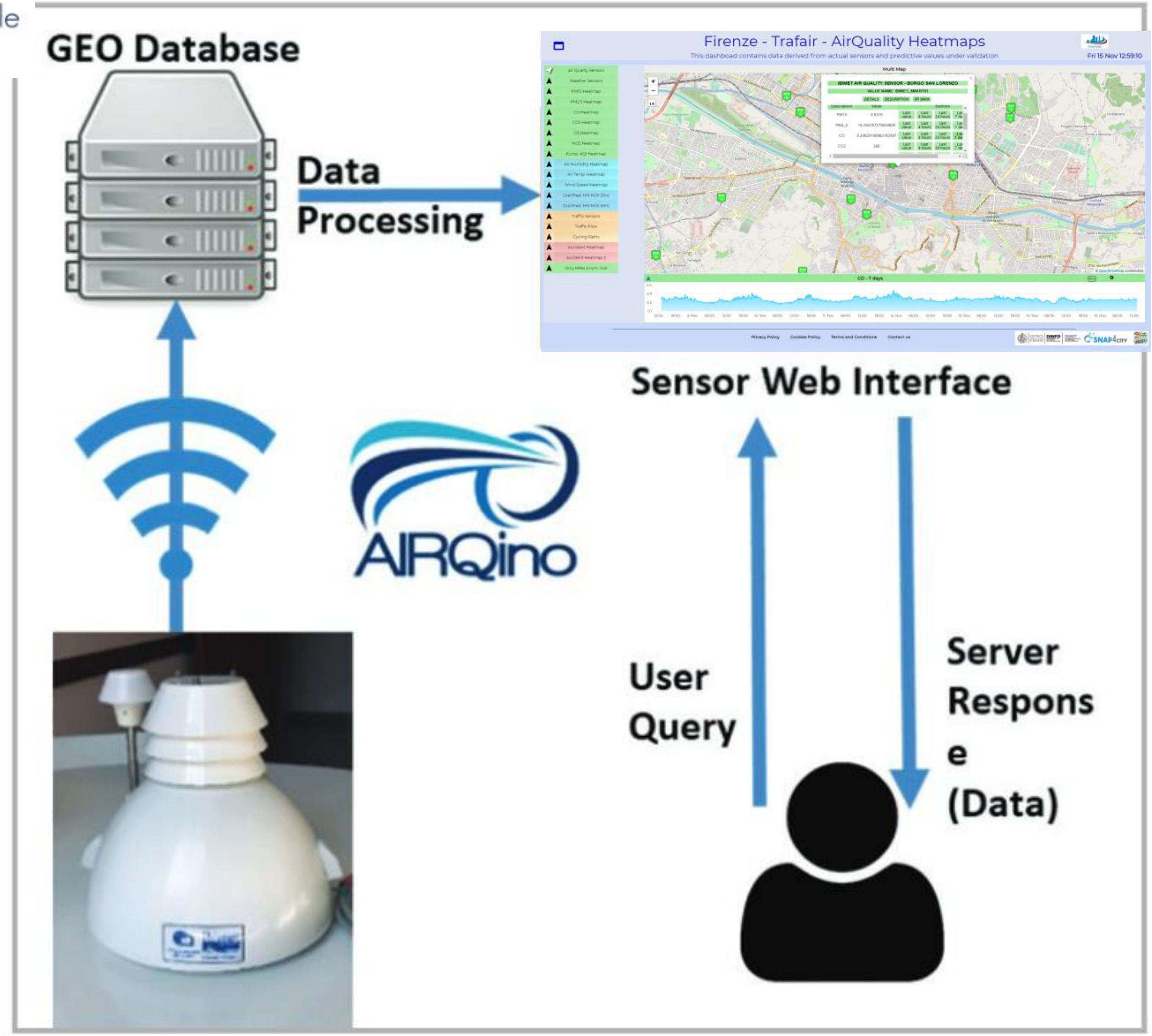
Parameter	Unit	Range
Temperature	°C	-40 – 80
Relative Umidity	%	0 – 100
CO2	ppm	0 – 2000
O3	ppb	0 – 400
NO2	ppm	0.05 – 5
CO	ppm	1 – 30
PM	µg/m3	0 – 999
VOC	ppm	1 – 100

https://www.snap4city.org/658 how to set up on Snap4City

https://www.snap4city.org/508

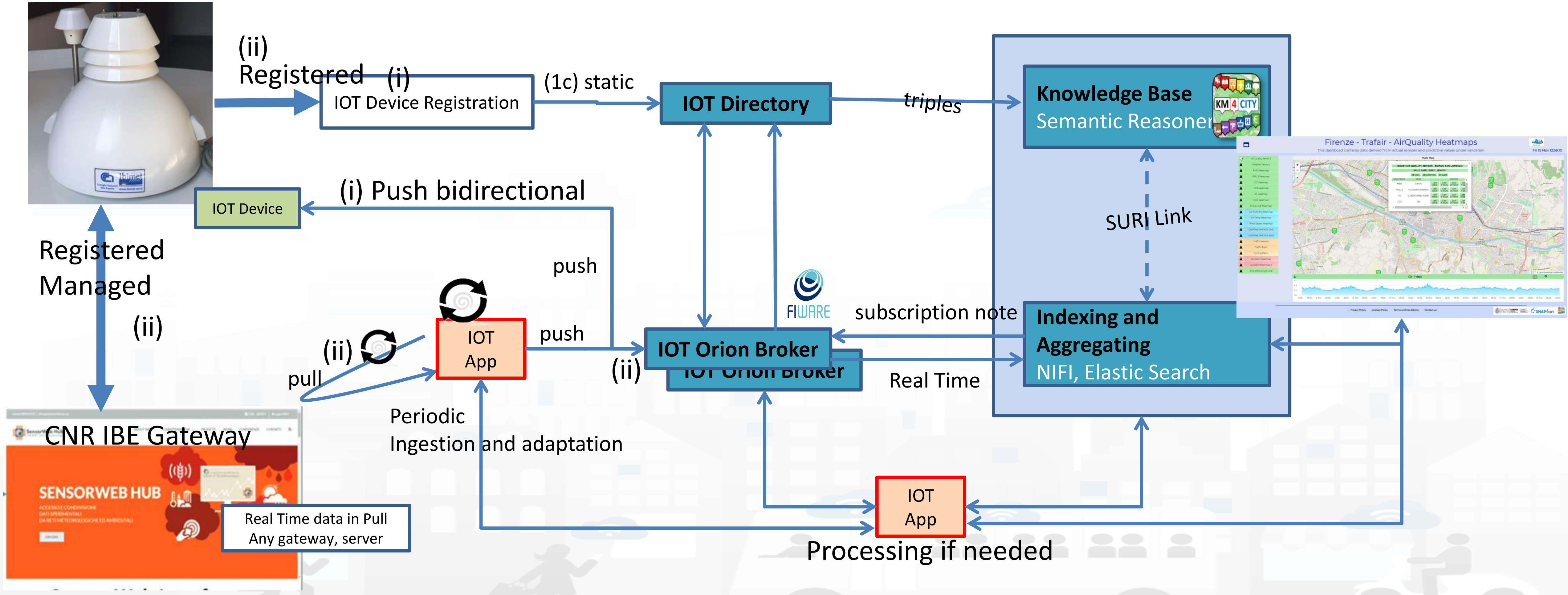
https://www.snap4city.org/download/video/tn/ARQuino-CNR.pdf


T2 Peretola Aeroporto
1012
GEST


GEO Database
Data Processing
Firenze - Trafair - AirQuality Heatmaps
Sensor Web Interface
AIRQino
User Query
Server Respons
e
(Data)

AirQINO vs SNAP4CITY

- Can be connected (i) directly to Snap4City (data driven) or (ii) Indirectly via CNR IBE (only in push)



TOP

Libelium Waspmote Plug&Sense Smart Environment PRO

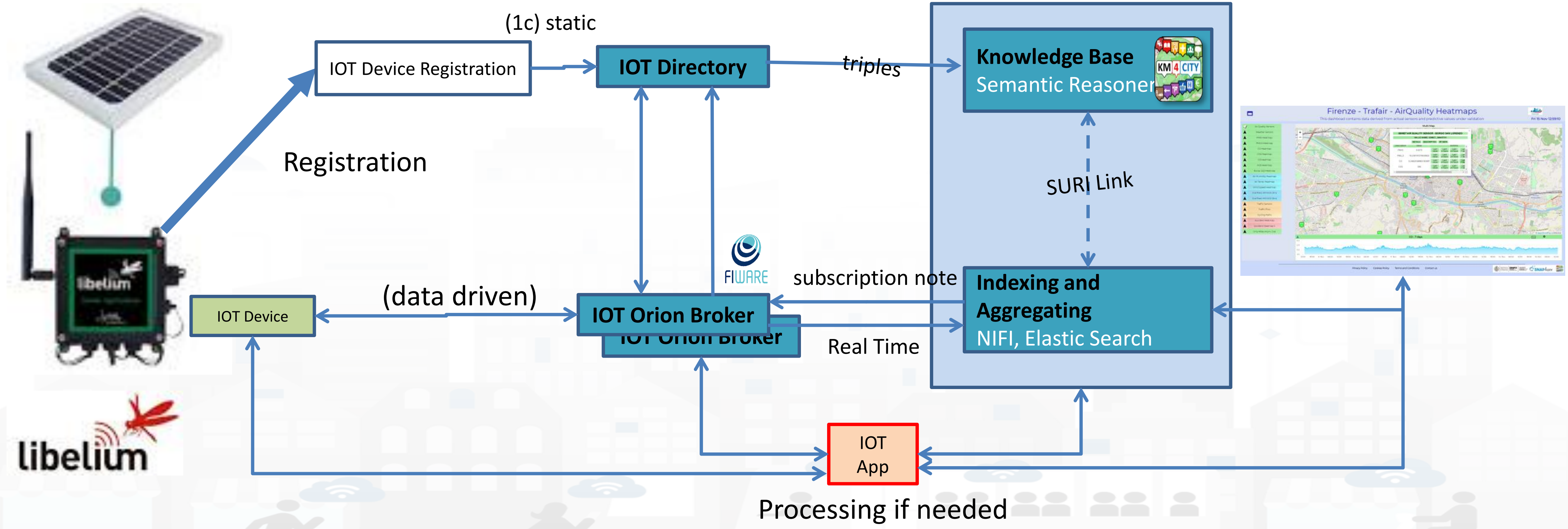
Libelium

- PM10
- Temp
- Humidity
- Pm2.5
- NO
- NO2
- CO2
- Etc.

https://www.snap4city.org/659 how to set up on Snap4City

Libelium vs SNAP4CITY

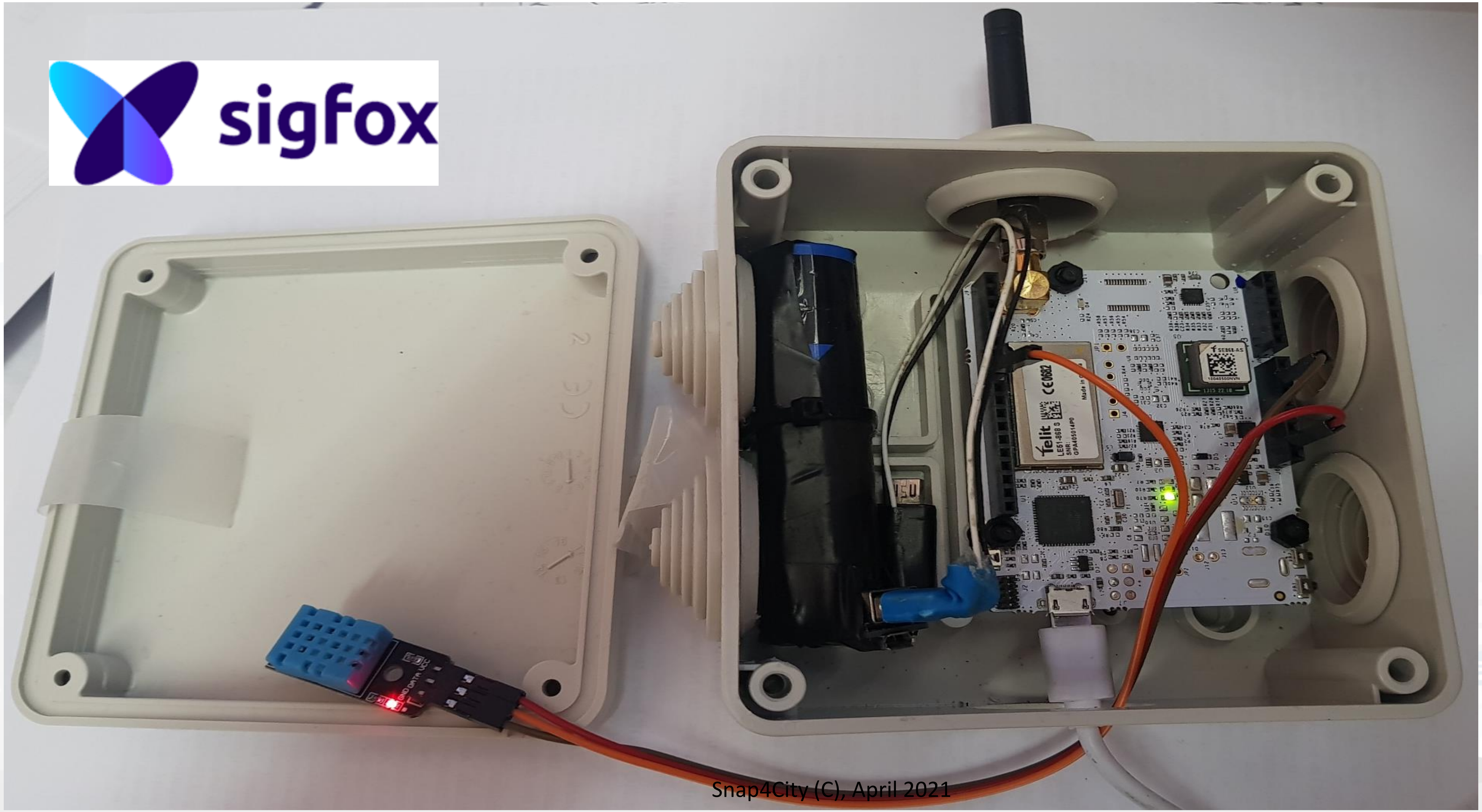
- Can be directly connected to Snap4City (data driven)



TOP

SigFox Integration

SigFOX: example of a develoment platform

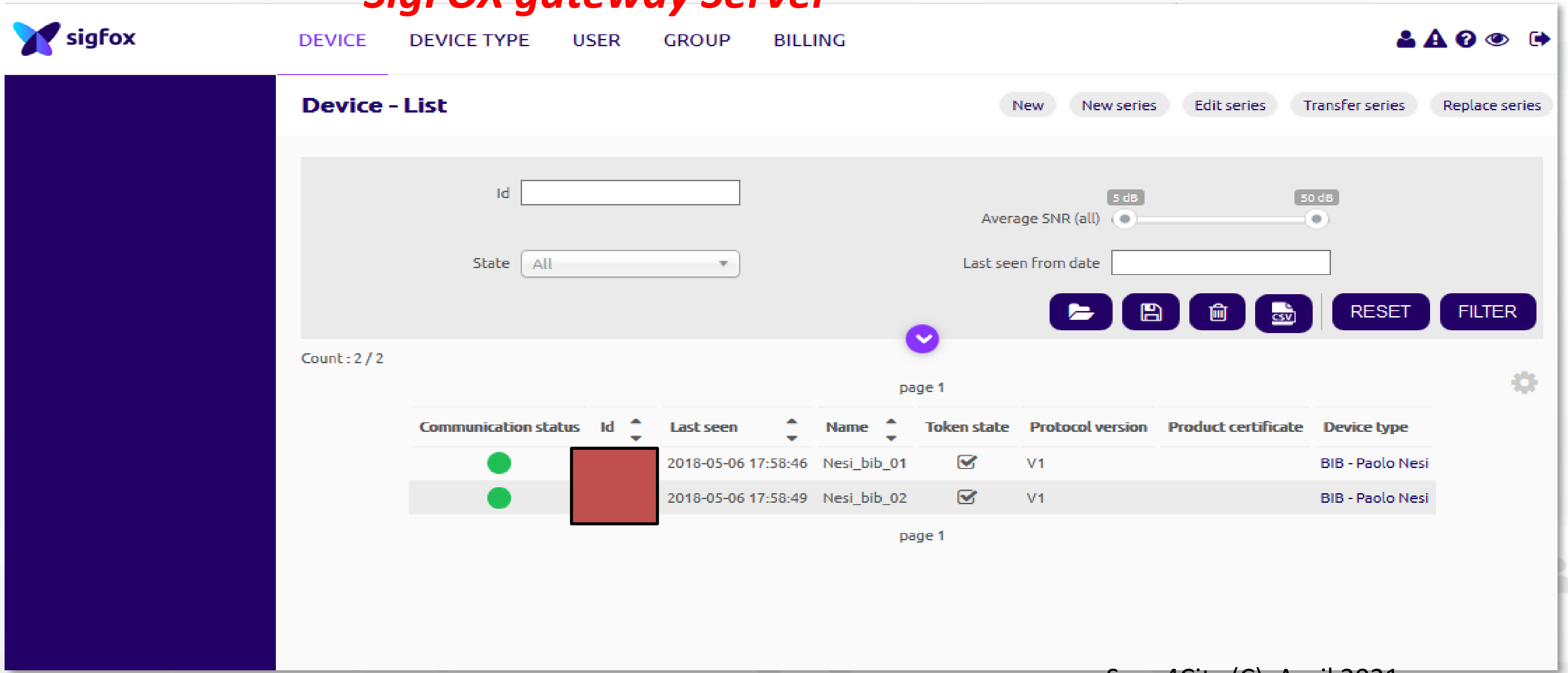


SigFOX Server Side

- Proprietary Protocol, freq similar to Lora
- Final users, consumers may buy SigFox devices and subscribe to network to register their devices
- 1 msg per every 10 minute, max num msg per day, per year…

Registered
Managed

SigFOX gateway Server

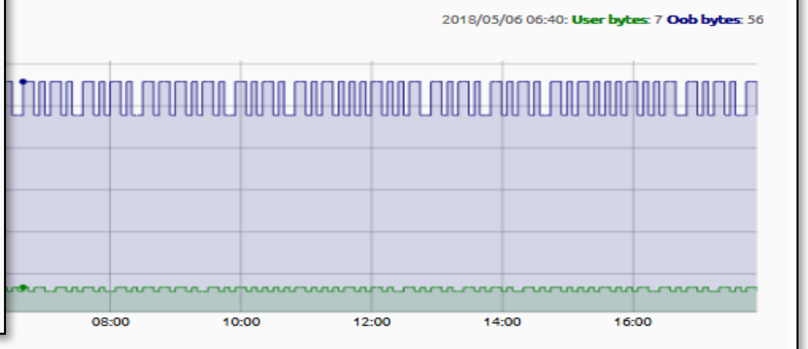


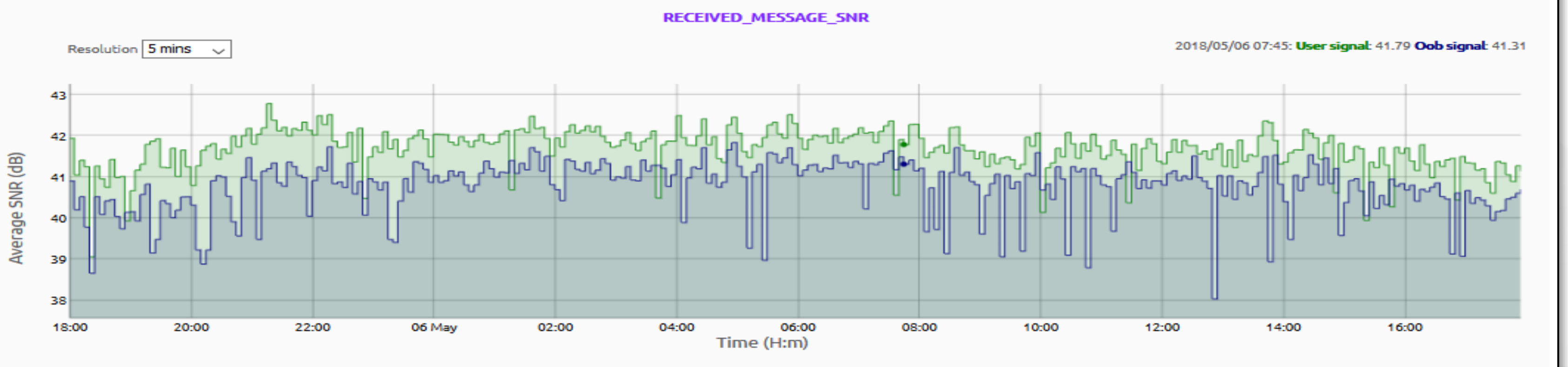
SigFOX

page 1

Frame reception time

Time	Delay (s)	Header	Data / Decoding	Location	Base station	RSSI (dBm)	SNR (dB)	Freq (MHz)	Frames	Callbacks
					Base station reception attributes					
2018-05-06 18:03:27	< 1	0000 ack required	24		28A8	-122.00	29.40	868.1491	3/3	
					2896	-136.00	15.60	868.1420	3/3	
					25F2	-119.00	32.03	868.1373	3/3	
2018-05-06 18:03:25	< 1	0010	09dd0b4f0b040103 Temp: 26.0 °C VDD idle: 3.037 V VDD tx: 2.895 V RSSI: -97.0		25F2	-120.00	31.57	868.1187	1/3	
					28A8	-122.00	29.05	868.1185	1/3	
					2627	-141.00	10.48	868.1173	1/3	
2018-05-06 18:02:51	< 1	0000 ack required	24		28A8	-122.00	29.39	868.1357	3/3	
					2896	-136.00	14.81	868.1347	3/3	
					2884	-134.00	17.36	868.1229	3/3	
2018-05-06 18:02:23	< 1	0010	09d30b4a0b0e0102 Temp: 27.0 °C VDD idle: 3.027 V VDD tx: 2.890 V RSSI: -98.0		23DB	-110.00	41.00	868.1449	1/3	
					2896	-137.00	14.40	868.1442	1/3	
					2889	-137.00	13.67	868.1447	1/3	
2018-05-06 18:01:48	< 1	0000 ack required	24		23DB	-109.00	41.66	868.1553	1/3	
					2889	-136.00	15.06	868.1550	3/3	
					28C8	-139.00	11.81	868.1546	1/3	

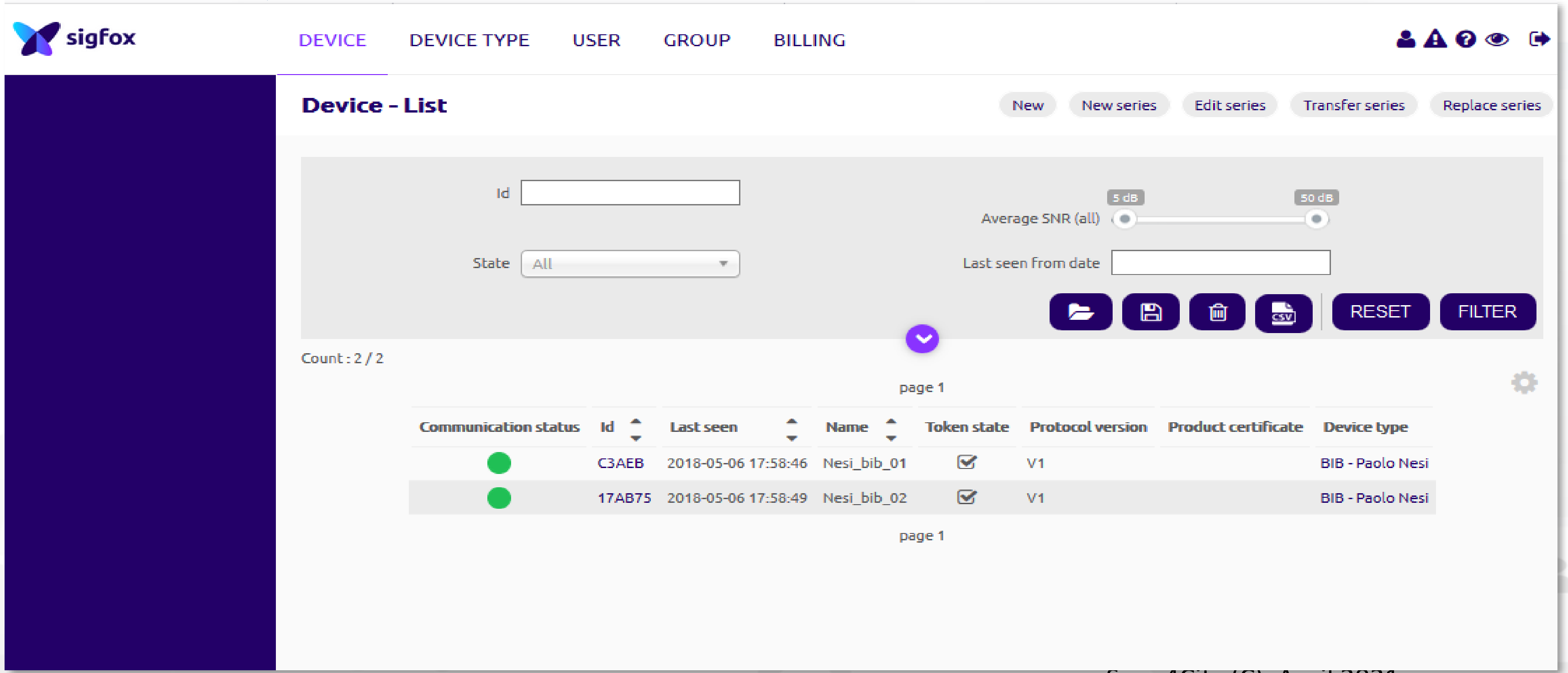




SigFOX vs SNAP4CITY

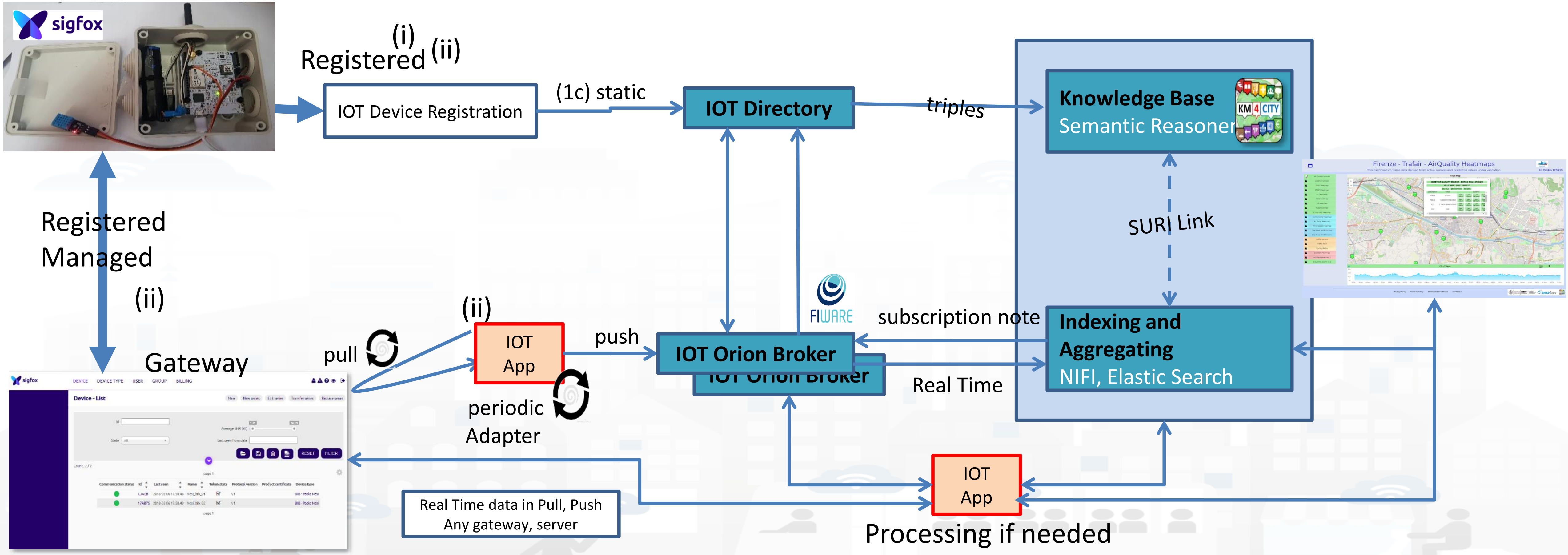
- Possible connection in PUSH and PULL
- Ingestion via IOT Application on Cloud or on IOT App on Edge
- Suggested connection in PULL

Registered
Managed



SigFOX vs SNAP4CITY

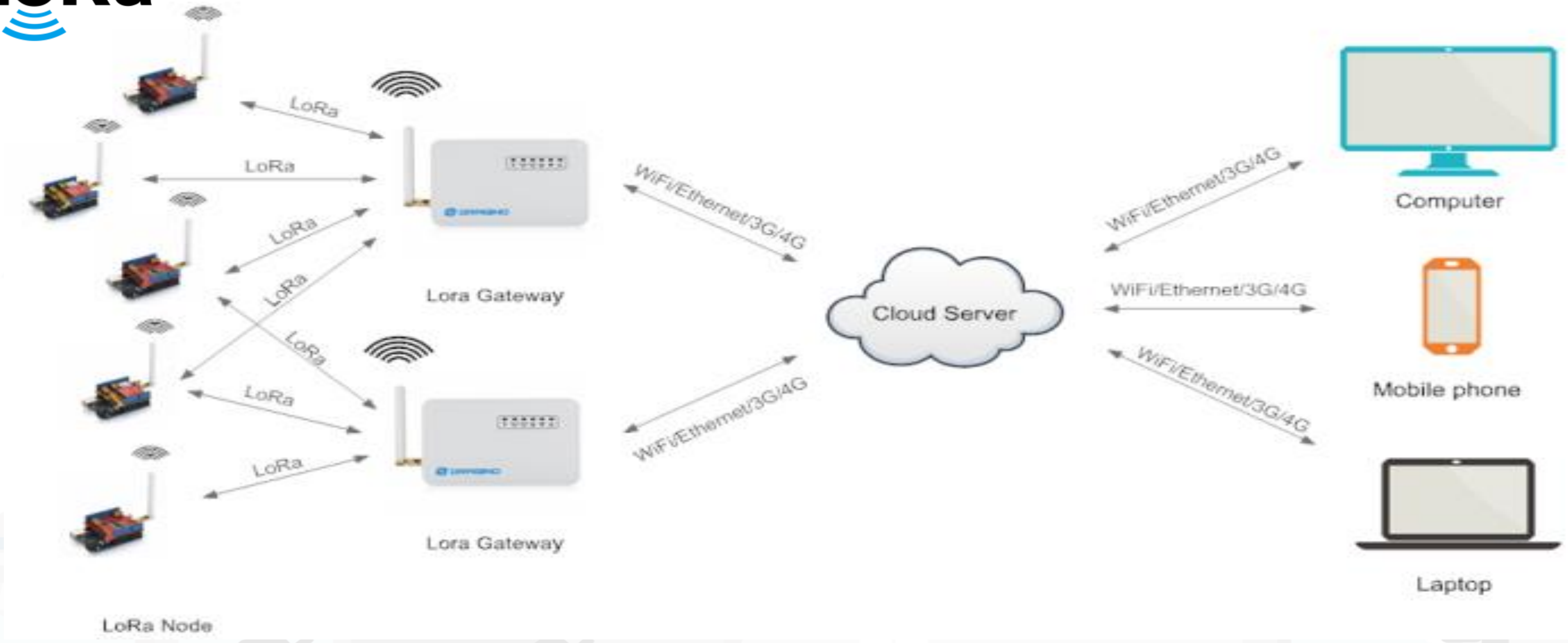
- Can be connected Indirectly via SigFox gateway (in push or pull), here represented in PULL



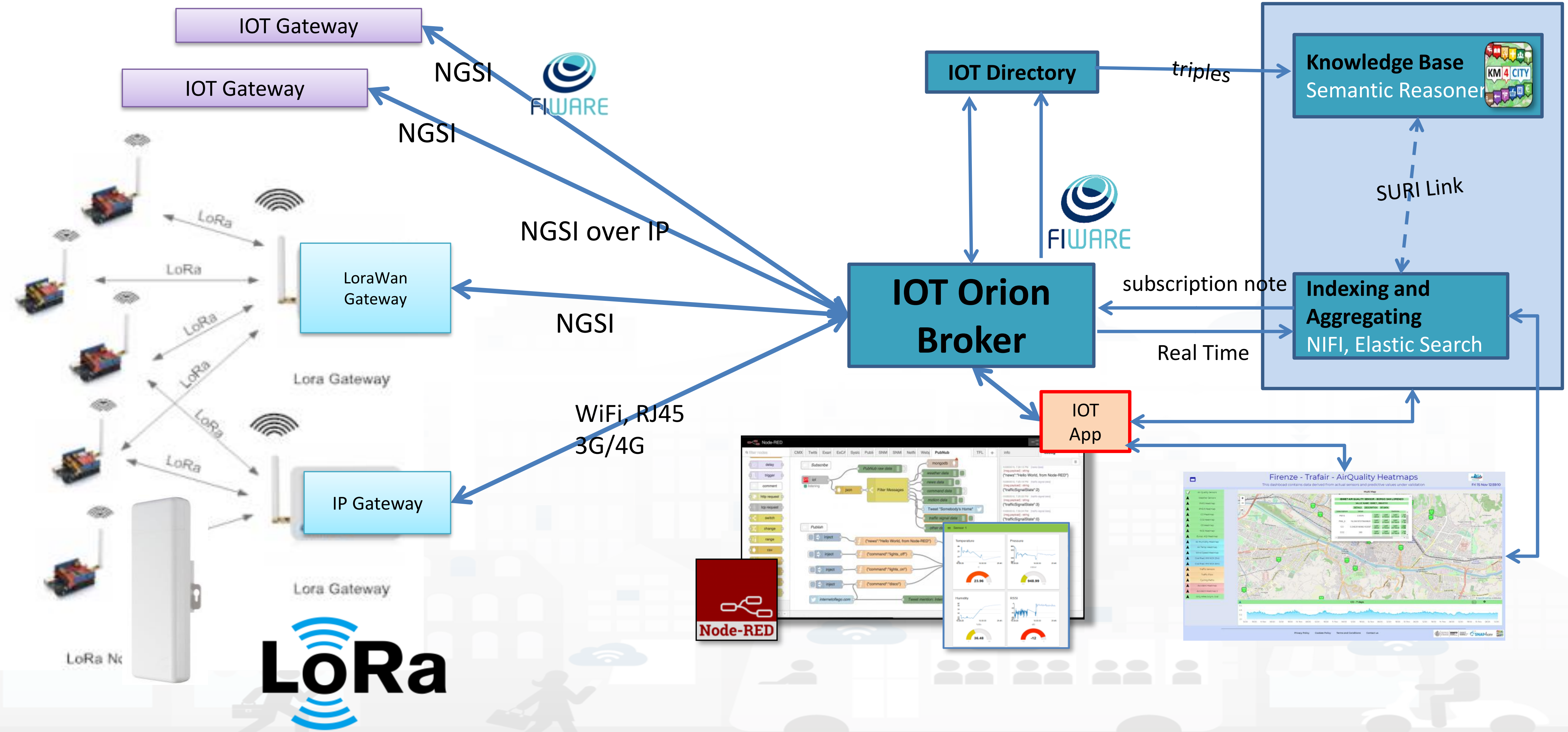
TOP

LoRa Lora IOT Gateway vs NGSI

LoraWAN Dragino (Arduino)

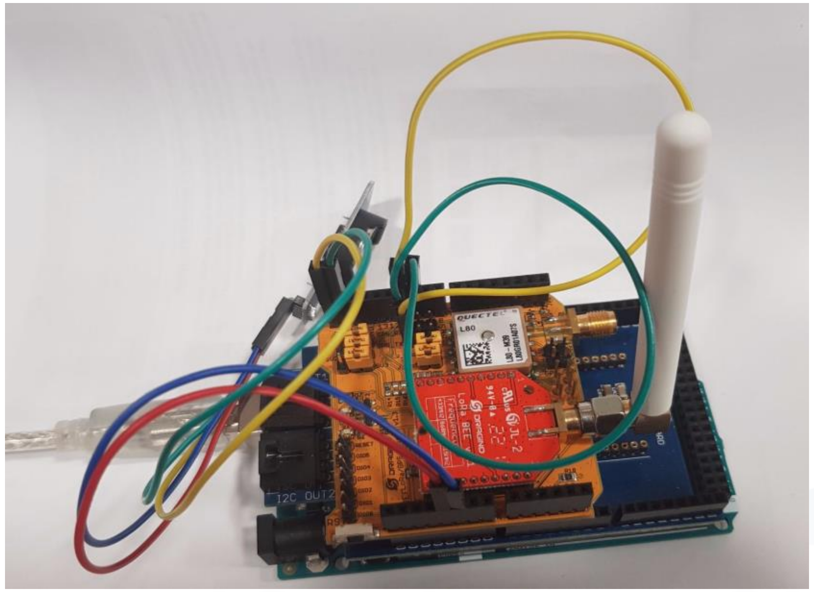


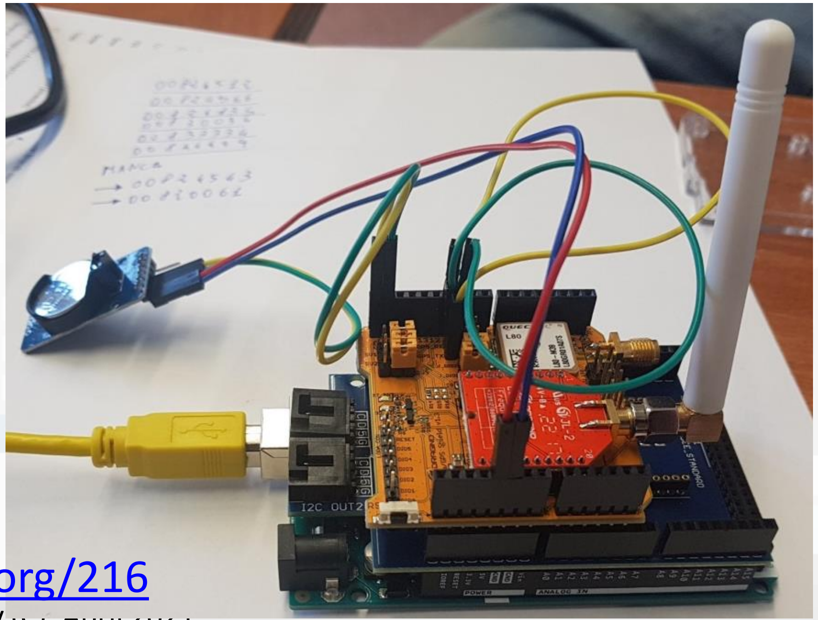
Lora IOT Management



Lora IOT Device, Arduino

- Arduino Uno, Mega
- LoraWan Connection
- Any sensor, + I2C
- Fully Customizable
- Open Source
- NGSI or any other protocols
- Gateway: Lora-NGSI Snap4





https://www.snap4city.org/216

LoraWan Gateway/Edge out of the Box

- Raspberry Pi Based LoraWan Gateway
  - Powered 5V, Wi-Fi, RJ45, …
  - GeoLocated GPS Antenna
- **IOT Edge Snap4City**
  - **Including** Node-RED, IOT APP
- Logical UpLink: LoraWAN TheThingsNetwork, NGSI V1, V2 (mutual authenticated Snap4City) toward IOT Broker

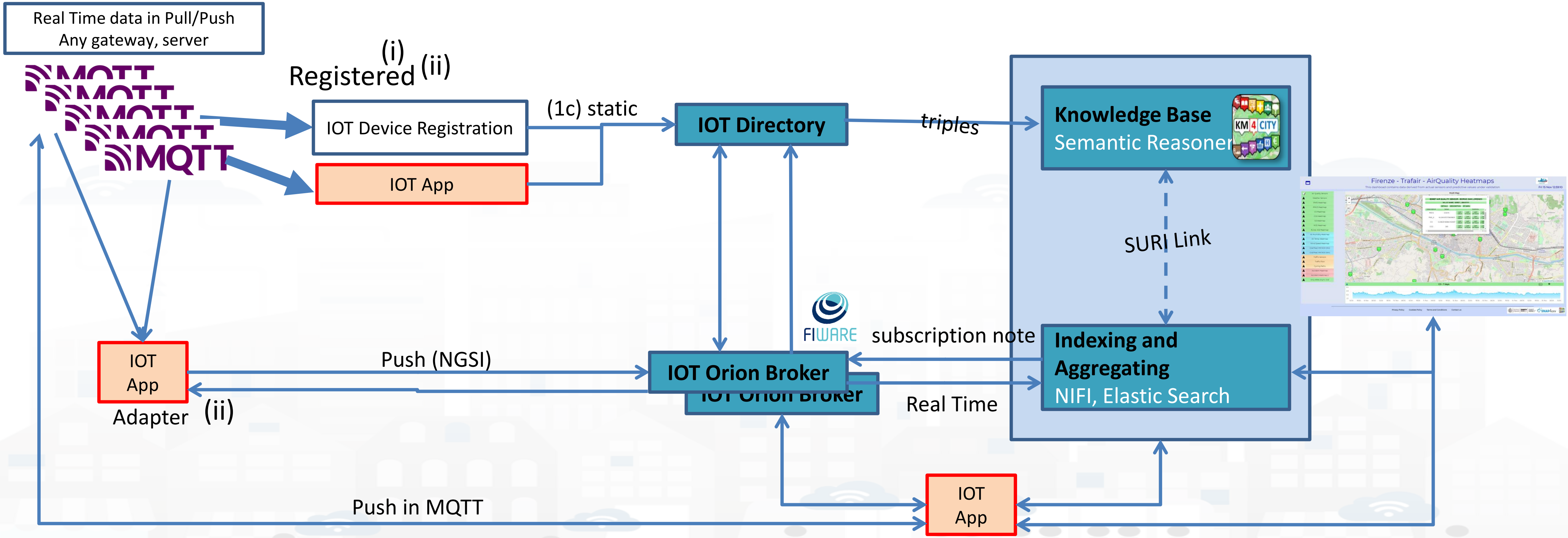
Physical UpLink as: Wi-Fi, RJ45

TOP

MQTT Integration

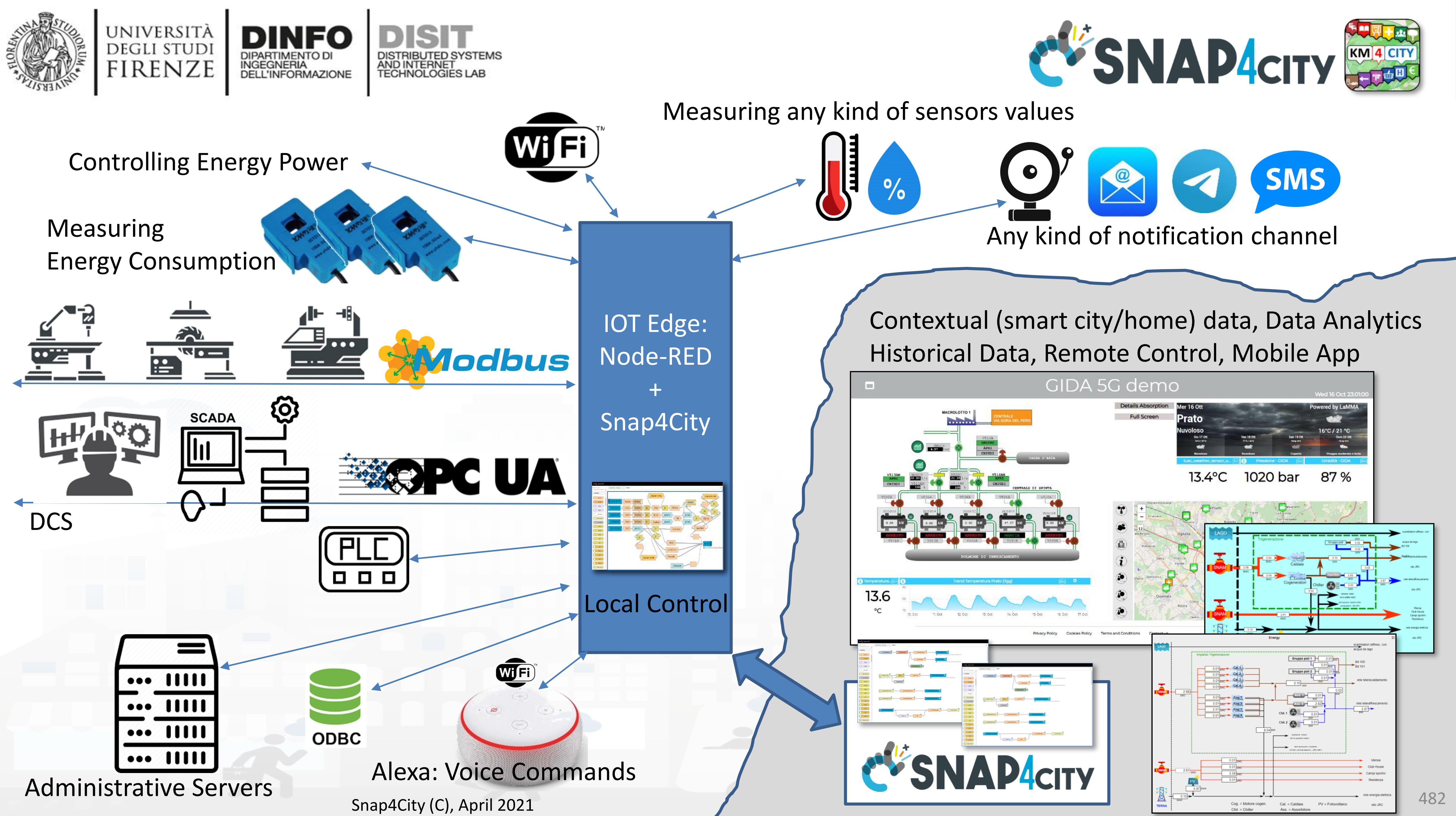
SigFOX vs SNAP4CITY

- Can be connected from/to MQTT devices or gateways in push



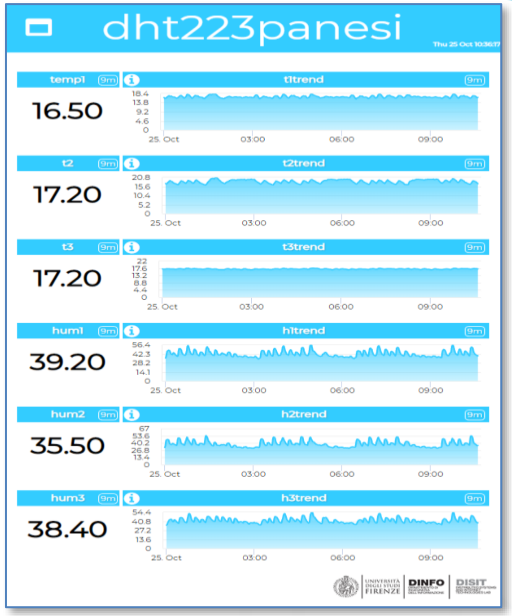
TOP

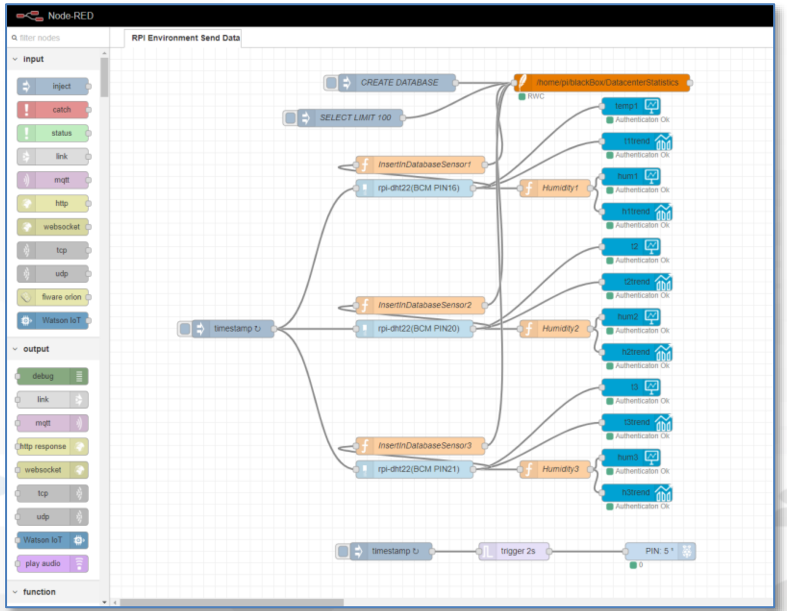
IOT Gateway / IOT Edge


UNIVERSITÀ DEGLI STUDI FIRENZE
DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE
DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB
SNAP4CITY
KM4CITY
Measuring any kind of sensors values
Controlling Energy Power
Measuring Energy Consumption
Any kind of notification channel
SMS
IOT Edge: Node-RED + Snap4City
Local Control
Modbus
SCADA
OPC UA
DCS
PLC
Contextual (smart city/home) data, Data Analytics Historical Data, Remote Control, Mobile App
GIDA 5G demo
Prato
13.4°C
1020 bar
87 %
13.6
ODBC
Administrative Servers
Alexa: Voice Commands

IOT Edge on Raspberry Pi

- Raspberry Pi
- Mutual Authentication with certificates
- Secure encrypted connection
- IOT Application inside
- Any sensor
- Any protocol from IOT devices
- NGSI or any other protocol
- Fully Customizable
- Local and Cloud Dashboard
- **Special MicroServices**

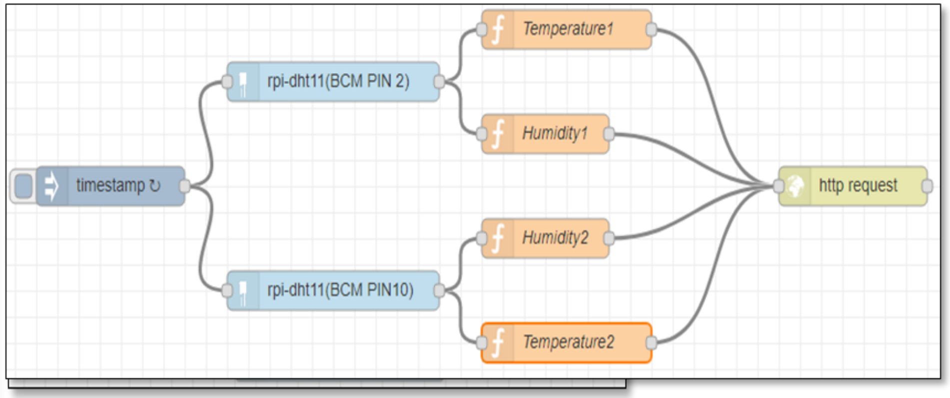


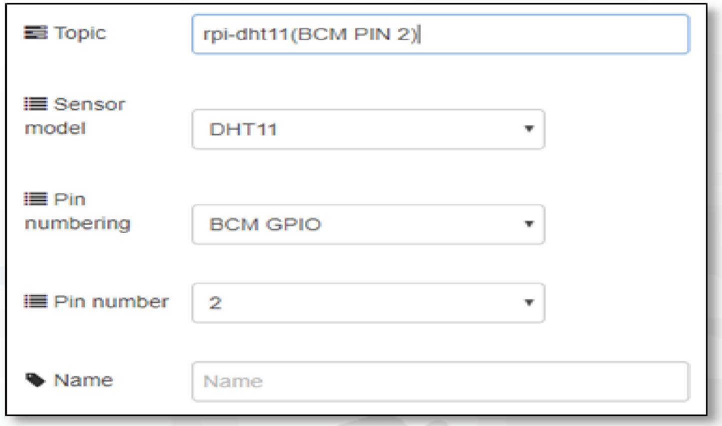


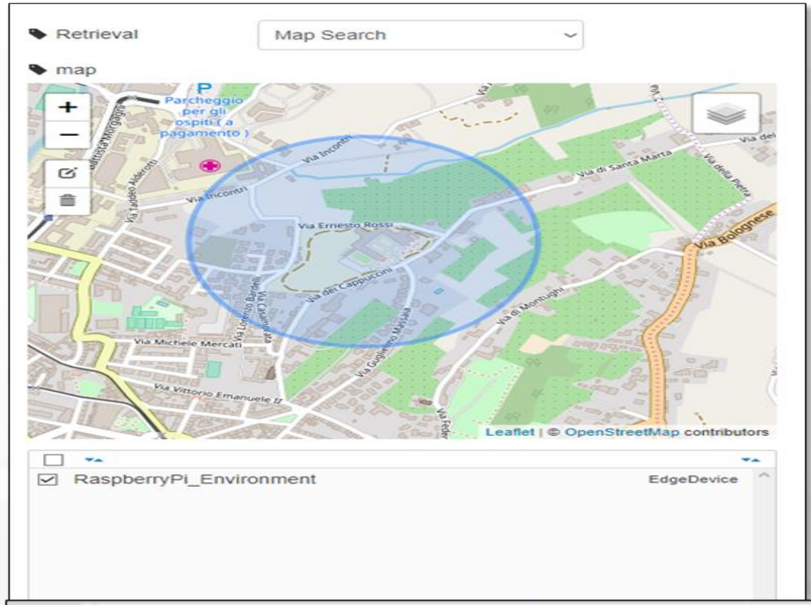
MicroServices:
- DHT
- ModBus
- any shield
- etc….

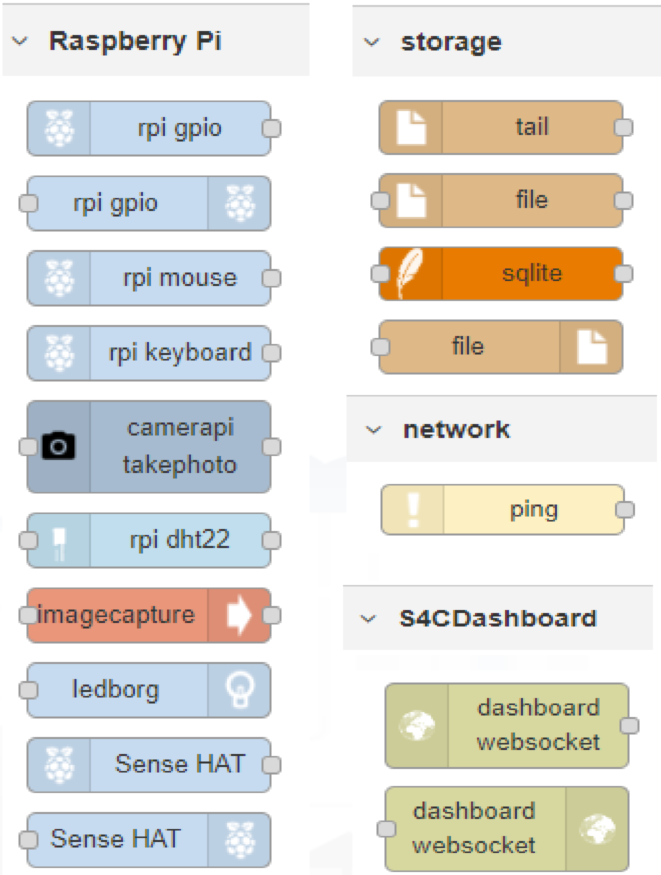
Raspberry for Edge

3.3V Power - 1	2 - 5V Power
SDA1 - GPIO02 - 3	4 - 5V Power
SCL1 - GPIO03 - 5	6 - Ground
GPIO04 - 7	8 - GPIO14 - TxD
Ground - 9	10 - GPIO15 - RxD
GPIO17 - 11	12 - GPIO18
GPIO27 - 13	14 - Ground
GPIO22 - 15	16 - GPIO23
3.3V Power - 17	18 - GPIO24
MOSI - GPIO10 - 19	20 - Ground
MISO - GPIO09 - 21	22 - GPIO25
SCLK - GPIO11 - 23	24 - GPIO8 - CE0
Ground - 25	26 - GPIO7 - CE1
SD - 27	28 - SC
GPIO05 - 29	30 - Ground
GPIO06 - 31	32 - GPIO12
GPIO13 - 33	34 - Ground
GPIO19 - 35	36 - GPIO16
GPIO26 - 37	38 - GPIO20
Ground - 39	40 - GPIO21










```
msg.payload={"temperature1":{"value":msg.payload , "type":"Float"}};
return msg;
```

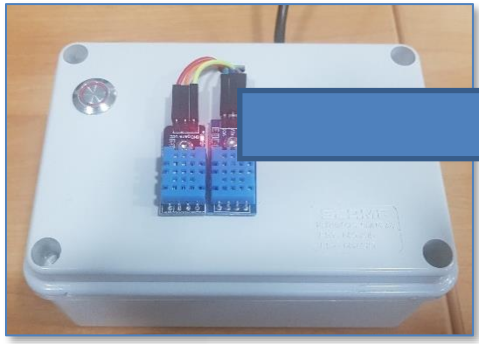
Snap4City on Raspberry Pi, IOT edge

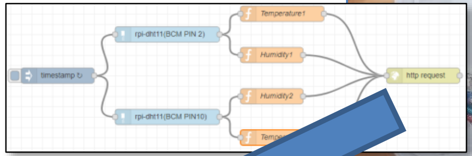
IOT Edge Computing

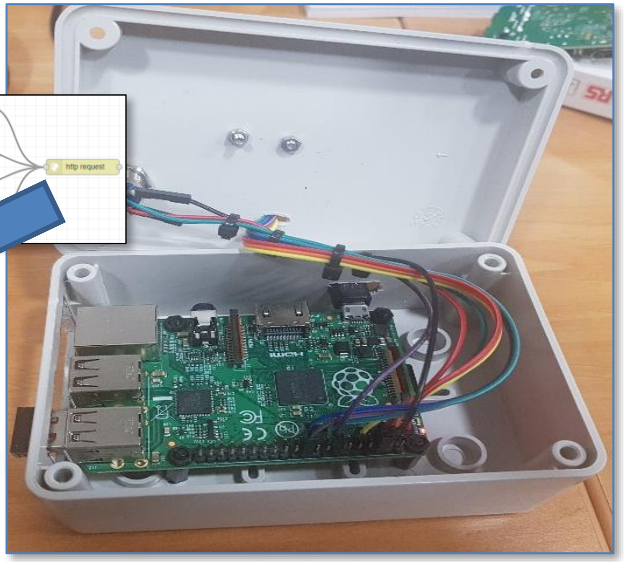
City user

Would like to:

- **Monitor and exploit temperature and humidity**
- **Manage sensors**
- **Perform edge computing**
- **Using these data for multiple applications**





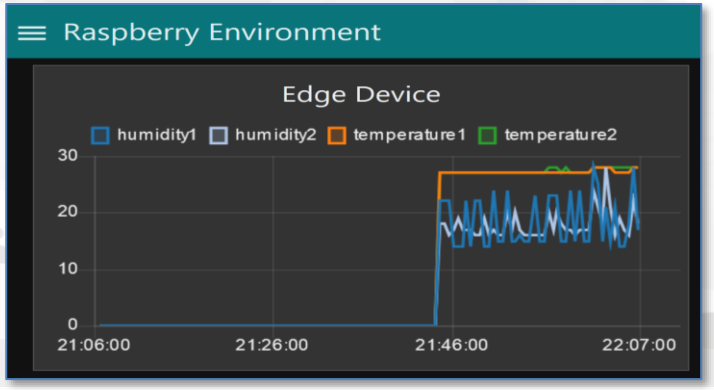


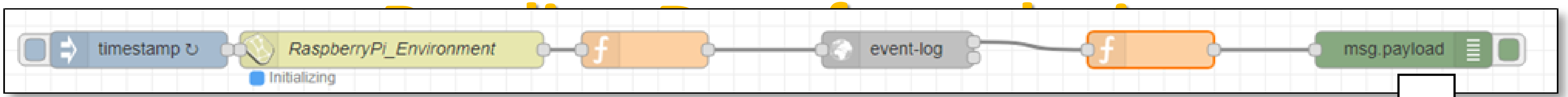
IOT Broker

Click here

Steps:

1. **Registering the device and sensors**
2. **Create flow on edge device using NodeRed with Snap4City, sending data to Broker**
3. **Use data from Broker on Snap4City IOT App**

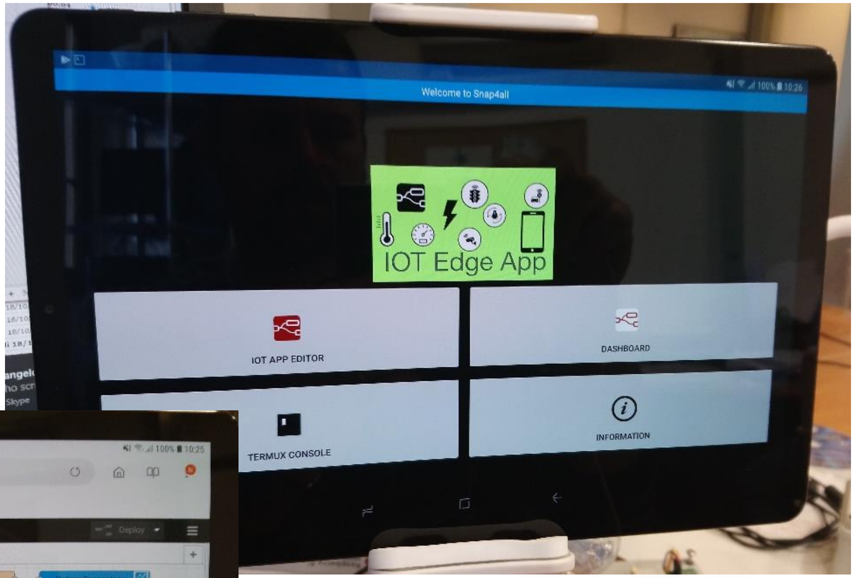


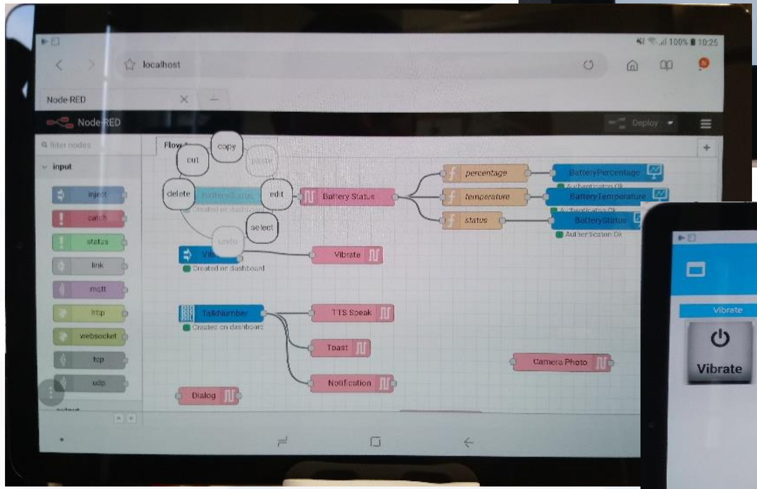


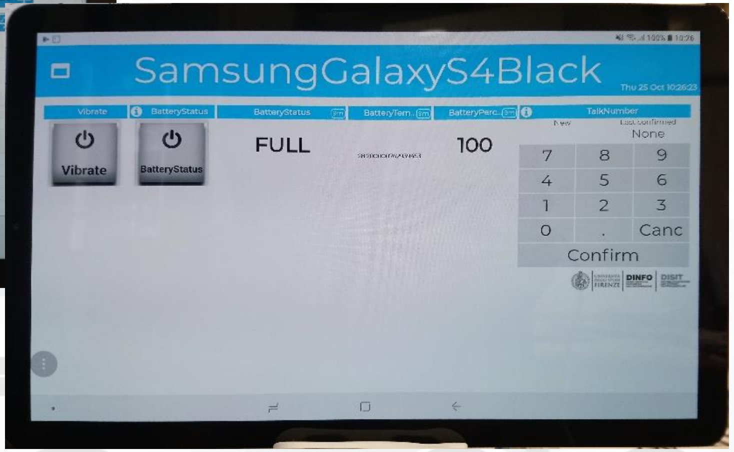
19/3/2018, 22:20:48 node: 1fc37579.28dbfb
msg.payload : string[459]
"[{"type":"EdgeDevice","id":"RaspberryPi_Environment","attributes":
[{"name":"geolocalization_lat","type":"Float","value":"43.798778"},
{"name":"geolocalization_lon","type":"Float","value":"11.253522"},
{"name":"humidity1","type":"Float","value":"30.00"},
{"name":"humidity2","type":"Float","value":"33.00"},
{"name":"model","type":"String","value":""},
{"name":"temperature1","type":"Float","value":"26.00"},
{"name":"temperature2","type":"Float","value":"26.00"}]}]"
19/3/2018, 22:21:02 node: 1fc37579.28dbfb
msg.payload : string[459]
"[{"type":"EdgeDevice","id":"RaspberryPi_Environment","attributes":
[{"name":"geolocalization_lat","type":"Float","value":"43.798778"},
{"name":"geolocalization_lon","type":"Float","value":"11.253522"},
{"name":"humidity1","type":"Float","value":"30.00"},
{"name":"humidity2","type":"Float","value":"35.00"},
{"name":"model","type":"String","value":""},
{"name":"temperature1","type":"Float","value":"26.00"},
{"name":"temperature2","type":"Float","value":"26.00"}]}]"
19/3/2018, 22:21:08 node: 1fc37579.28dbfb
msg.payload : string[459]
"[{"type":"EdgeDevice","id":"RaspberryPi_Environment","attributes":
[{"name":"geolocalization_lat","type":"Float","value":"43.798778"},
{"name":"geolocalization_lon","type":"Float","value":"11.253522"},
{"name":"humidity1","type":"Float","value":"30.00"},
{"name":"humidity2","type":"Float","value":"35.00"},
{"name":"model","type":"String","value":""},
{"name":"temperature1","type":"Float","value":"26.00"},
{"name":"temperature2","type":"Float","value":"26.00"}]}]"
19/3/2018, 22:21:20 node: 1fc37579.28dbfb
msg.payload : string[459]
"[{"type":"EdgeDevice","id":"RaspberryPi_Environment","attributes":
[{"name":"geolocalization_lat","type":"Float","value":"43.798778"},
{"name":"geolocalization_lon","type":"Float","value":"11.253522"},
{"name":"humidity1","type":"Float","value":"30.00"},
{"name":"humidity2","type":"Float","value":"35.00"},
{"name":"model","type":"String","value":""},
{"name":"temperature1","type":"Float","value":"26.00"},
{"name":"temperature2","type":"Float","value":"26.00"}]}]"

IOT Edge Snap4All App for Android

- **Android**, any version, App from: https://www.snap4city.org/download/video/Snap4All.apk
- **Mutual Authentication** with certificates
- *Secure encrypted connection*, NGSI
- **IOT Application inside**
- **Any sensor** + Local device sensors
- **Any protocol** from IOT devices
- **NGSI** or any other protocol
- **Fully Customizable**
- Local and Cloud Dashboard
- **Special MicroServices**

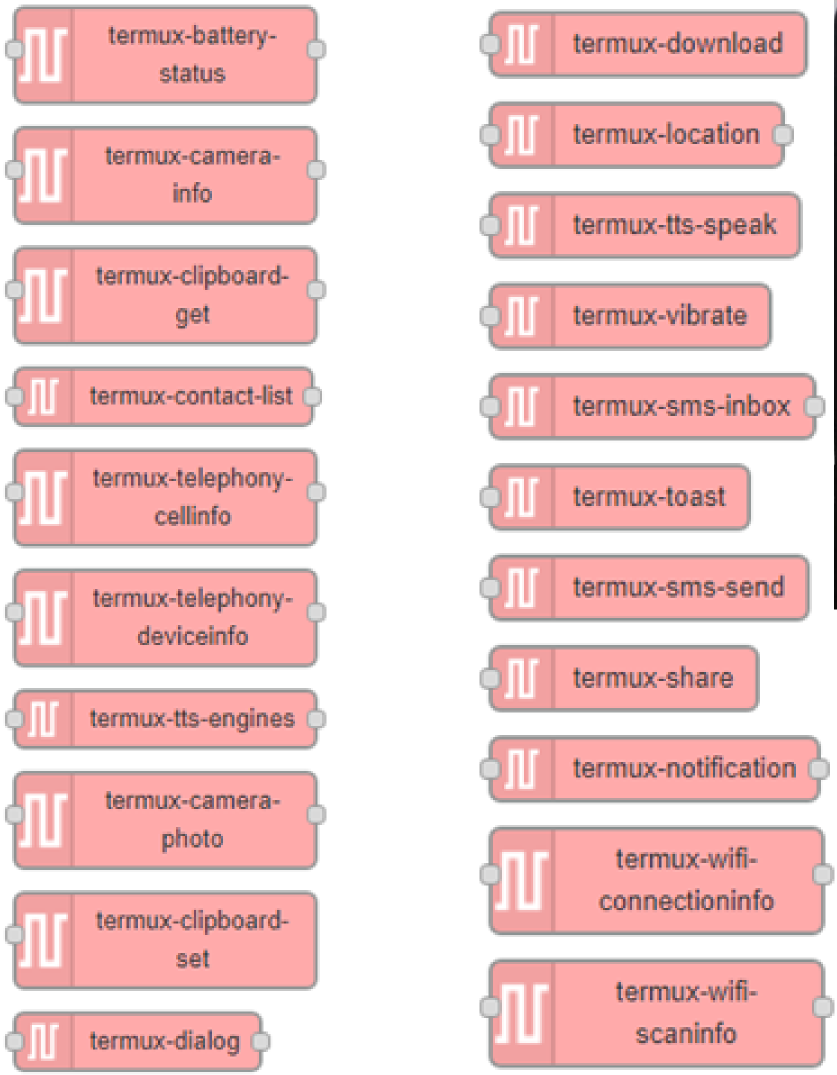


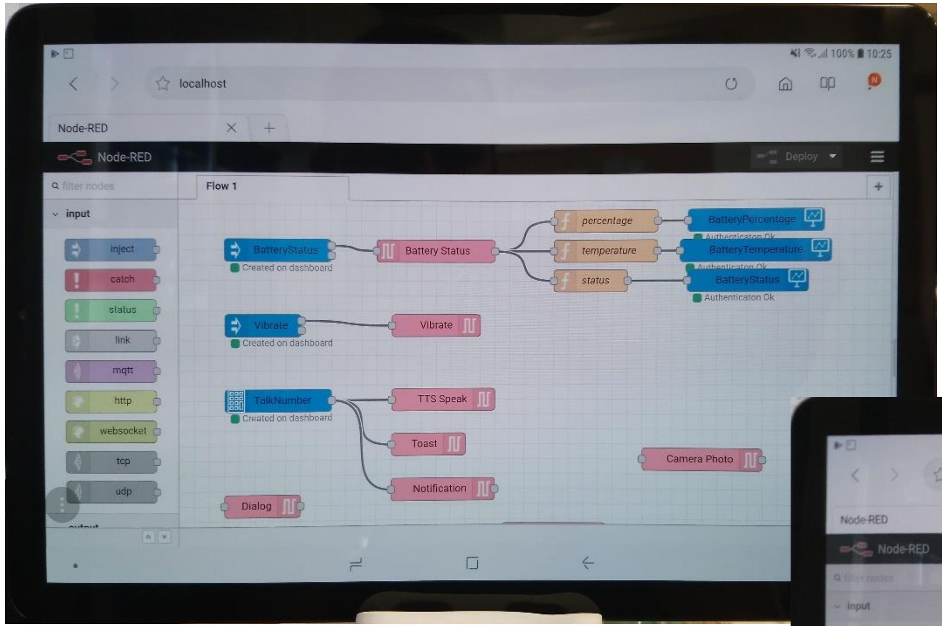


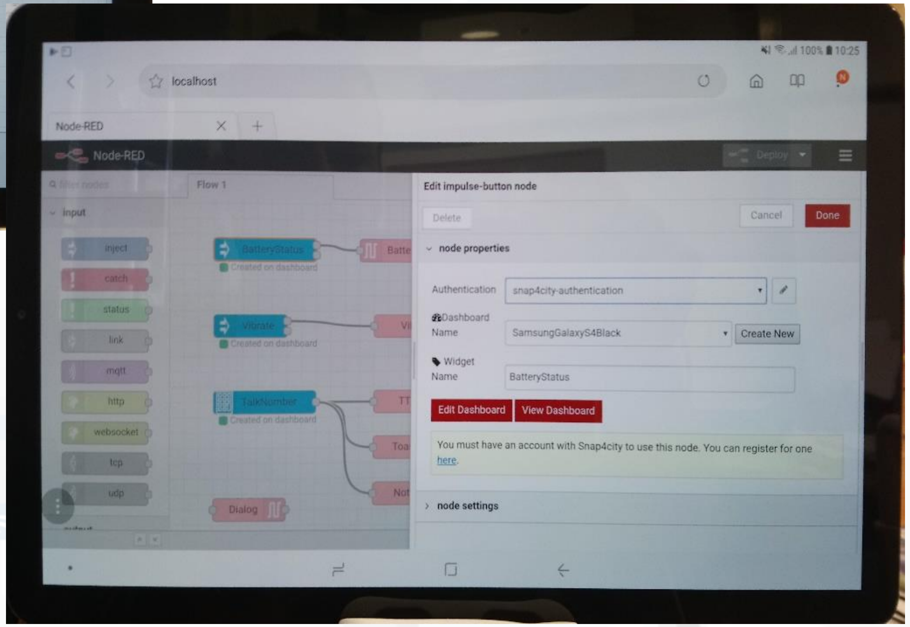


https://www.snap4city.org/drupal/node/278

IOT Edge Snap4All App for Android

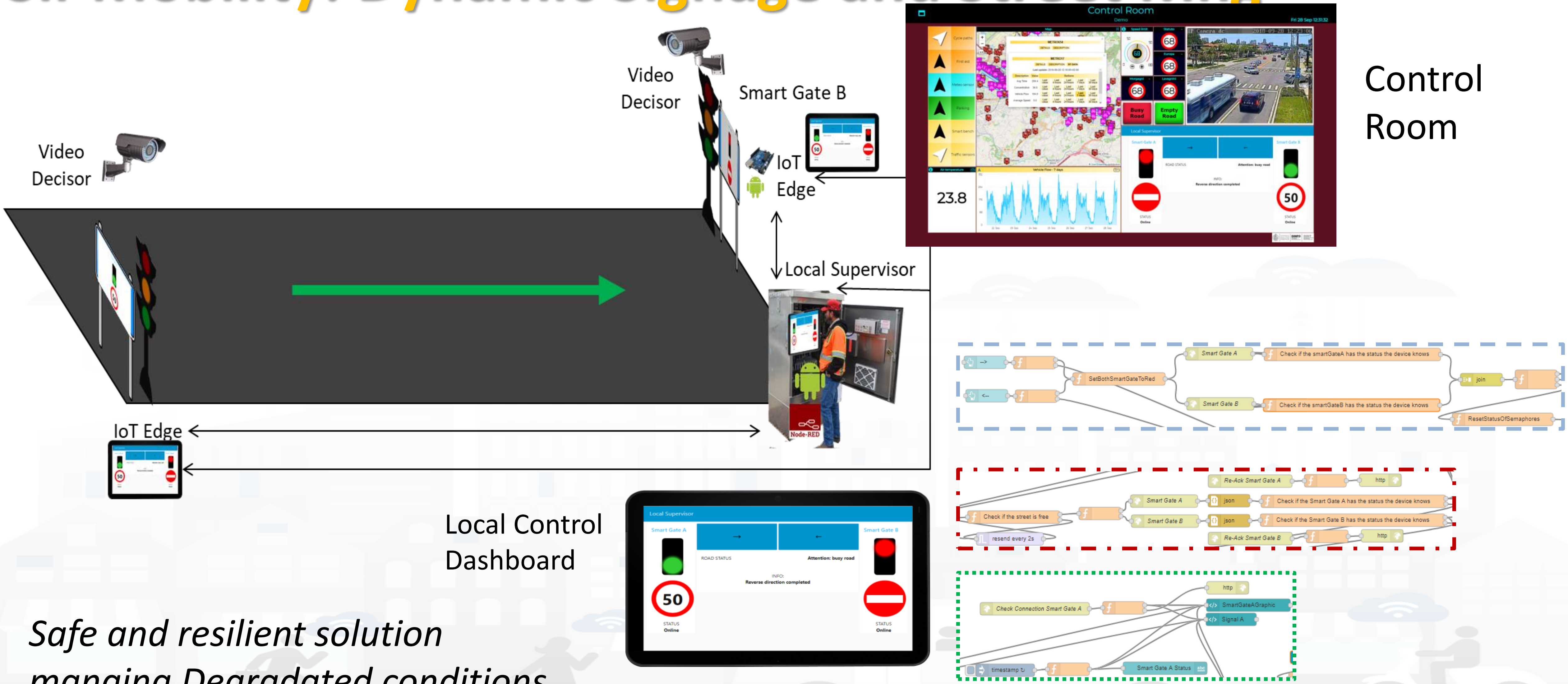






MicroServices:
- Snap4City
- Termux Snap4City specific
- etc.

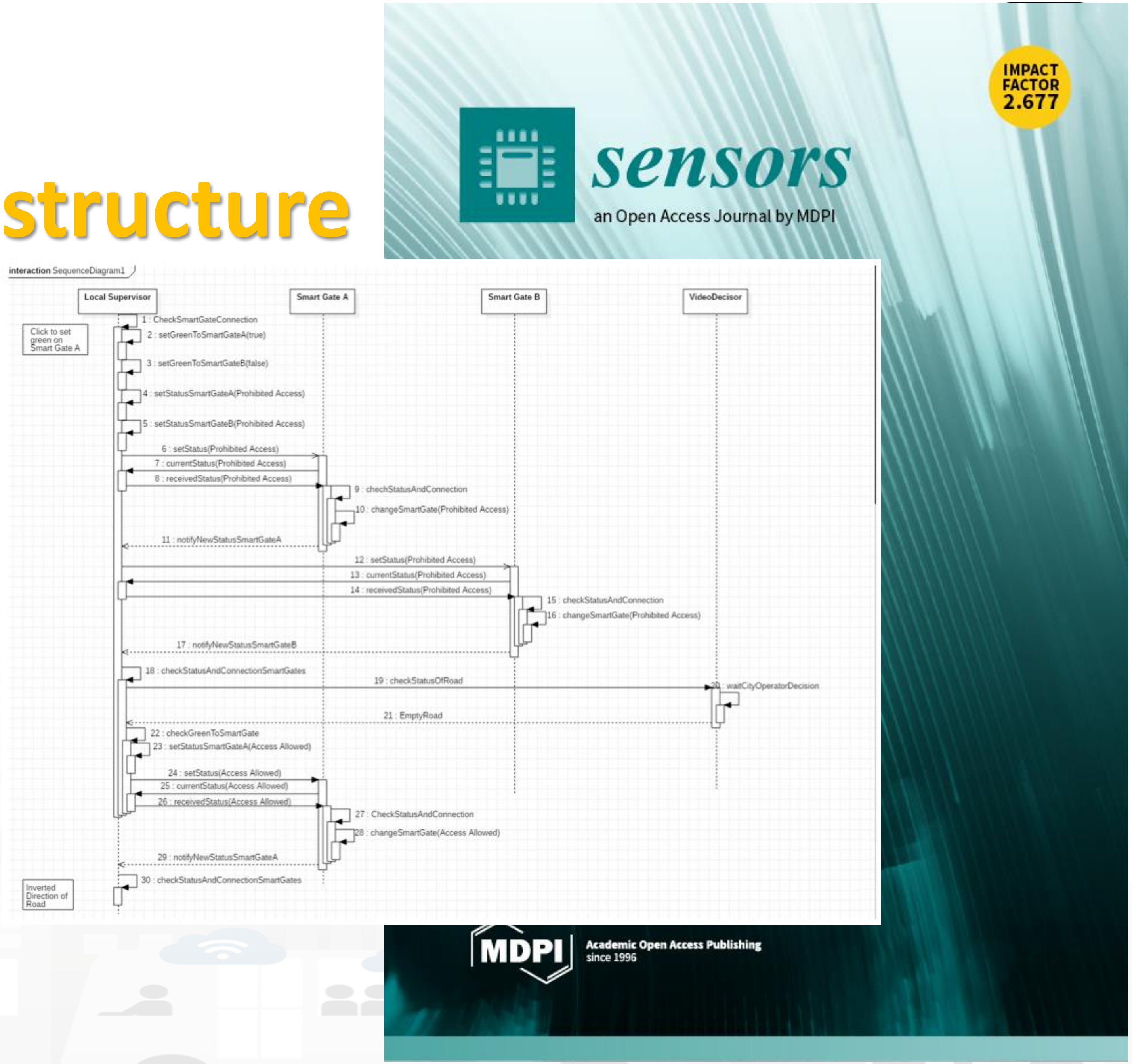
Sii-Mobility: Dynamic Signage and Street Mng



Safe and resilient solution manging Degradated conditions

IOT for Mobility Infrastructure

- C. Badii, P. Bellini, A. Difino, P. Nesi, "*Sii-Mobility: an IOT/IOE architecture to enhance smart city services of mobility and transportation*", Sensors, MDPI, 2019
- https://www.mdpi.com/1424-8220/19/1/1/pdf



TOP

IOT Tracking Devices

PaxCounter devices

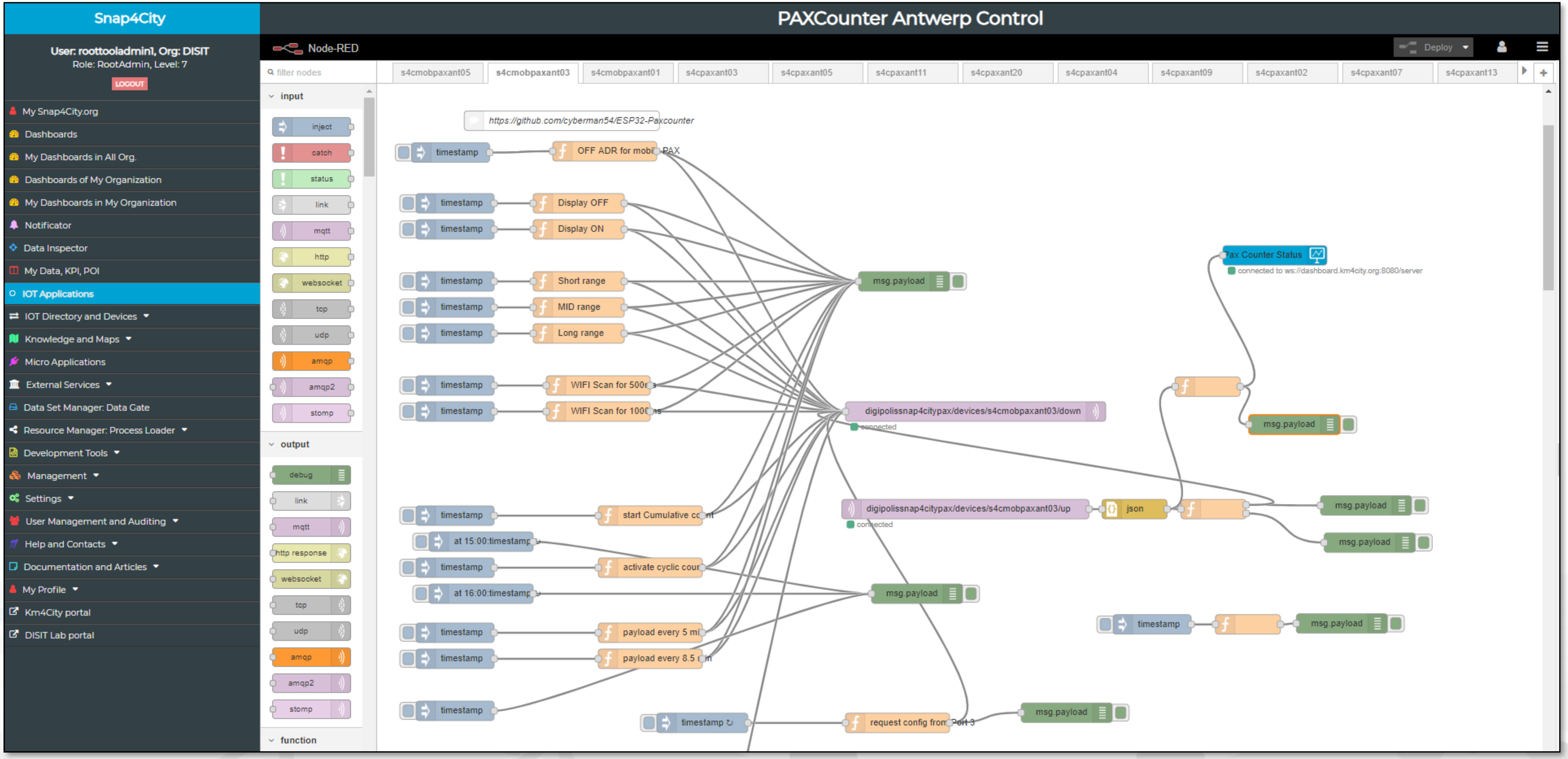
- **Fix PaxCounter LoraWan**
  - sniffing on: Wi-Fi, Bluetooth
  - Sending data via LoraWan
- **Mobile PaxCounter LoraWan**
  - sniffing on: Wi-Fi, Bluetooth
  - Sending data via LoraWan
- **Fix PaxCounter, multiple out**
  - Sending data via LoraWan and Wi-Fi
  - sniffing on: Wi-Fi, Bluetooth

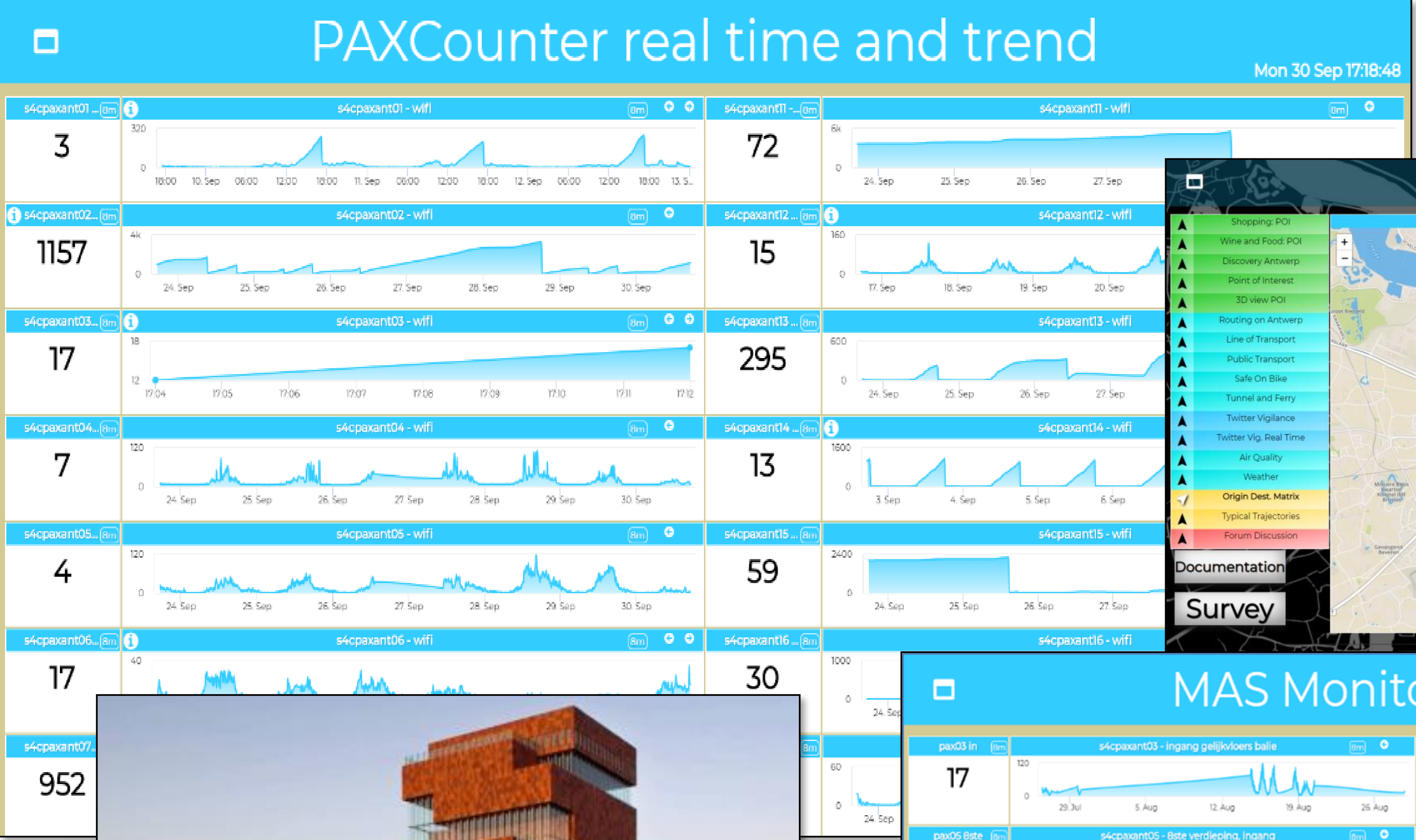
LoRa® Wi Fi Bluetooth™

https://www.snap4city.org/456

Programmable PAX counting

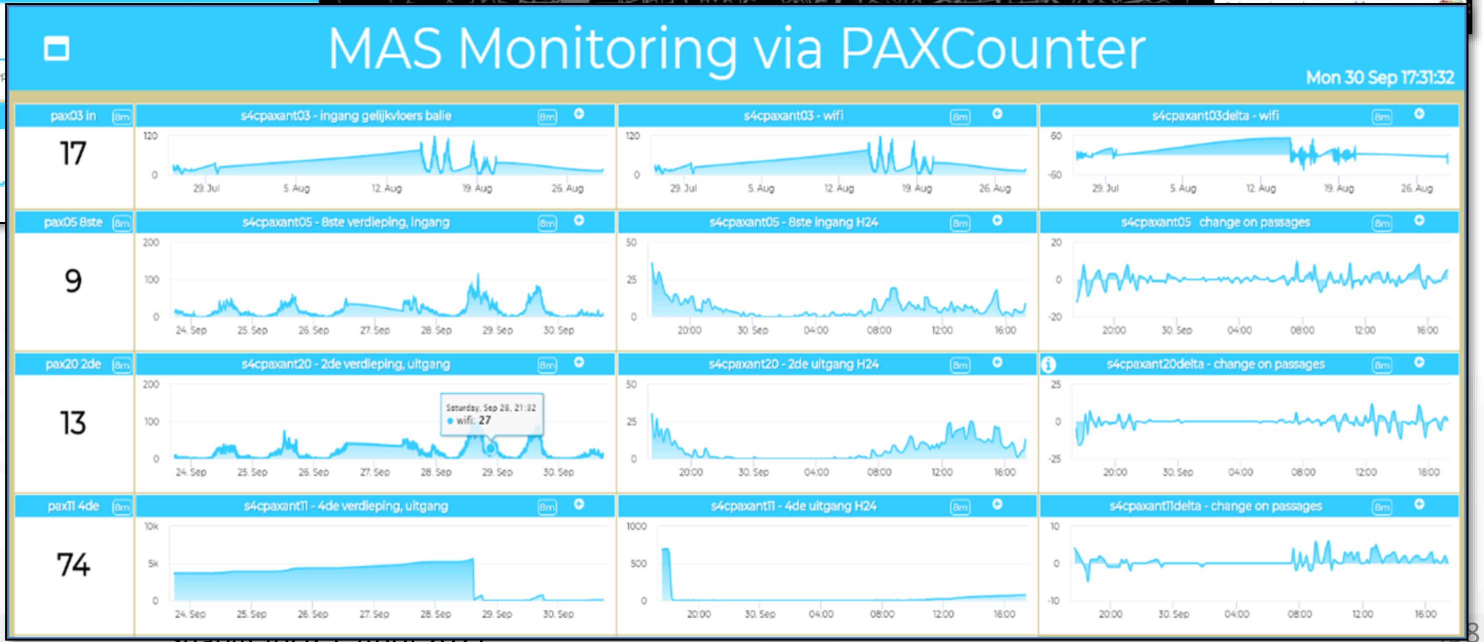
IOT App behind





PAXCounter real time and trend
Mon 30 Sep 17:18:48
s4cpaxant01 - wifi
3
s4cpaxant02 - wifi
1157
s4cpaxant03 - wifi
17
s4cpaxant04 - wifi
7
s4cpaxant05 - wifi
4
s4cpaxant06 - wifi
17
952
s4cpaxant11 - wifi
72
s4cpaxant12 - wifi
15
s4cpaxant13 - wifi
295
s4cpaxant14 - wifi
13
s4cpaxant15 - wifi
59
s4cpaxant16 - wifi
30

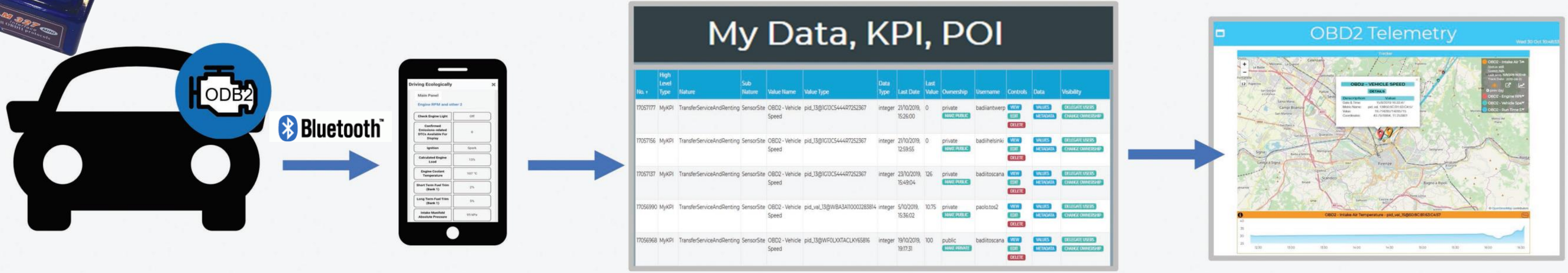
The Life of Antwerp
Please note that the data results are not always based on real data.
Sun 29 Sep 00:26:08
Shopping: POI
Wine and Food: POI
Discovery Antwerp
Point of Interest
3D view POI
Routing on Antwerp
Line of Transport
Public Transport
Safe On Bike
Tunnel and Ferry
Twitter Vigilance
Twitter Vig. Real Time
Air Quality
Weather
Origin Dest. Matrix
Typical Trajectories
Forum Discussion
Documentation
Survey



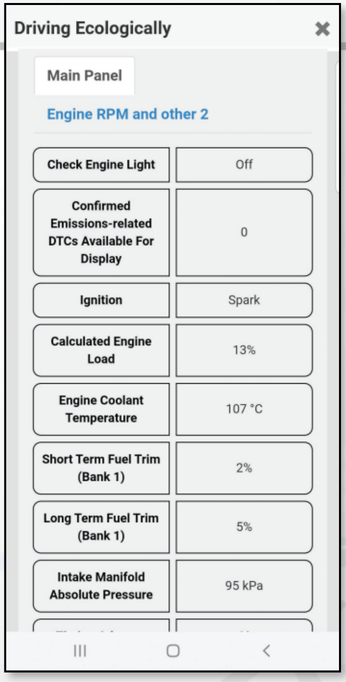
MAS Monitoring via PAXCounter
Mon 30 Sep 17:31:32
pax03 in
17
s4cpaxant03 - ingang gelijkvloers balie
s4cpaxant03 - wifi
s4cpaxant03delta - wifi
pax05 8ste
9
s4cpaxant05 - 8ste verdieping, ingang
s4cpaxant05 - 8ste ingang H24
s4cpaxant05 change on passages
pax20 2de
13
s4cpaxant20 - 2de verdieping, uitgang
s4cpaxant20 - 2de uitgang H24
s4cpaxant20delta - change on passages
pax11 4de
74
s4cpaxant11 - 4de verdieping, uitgang
s4cpaxant11 - 4de uitgang H24
s4cpaxant11delta - change on passages

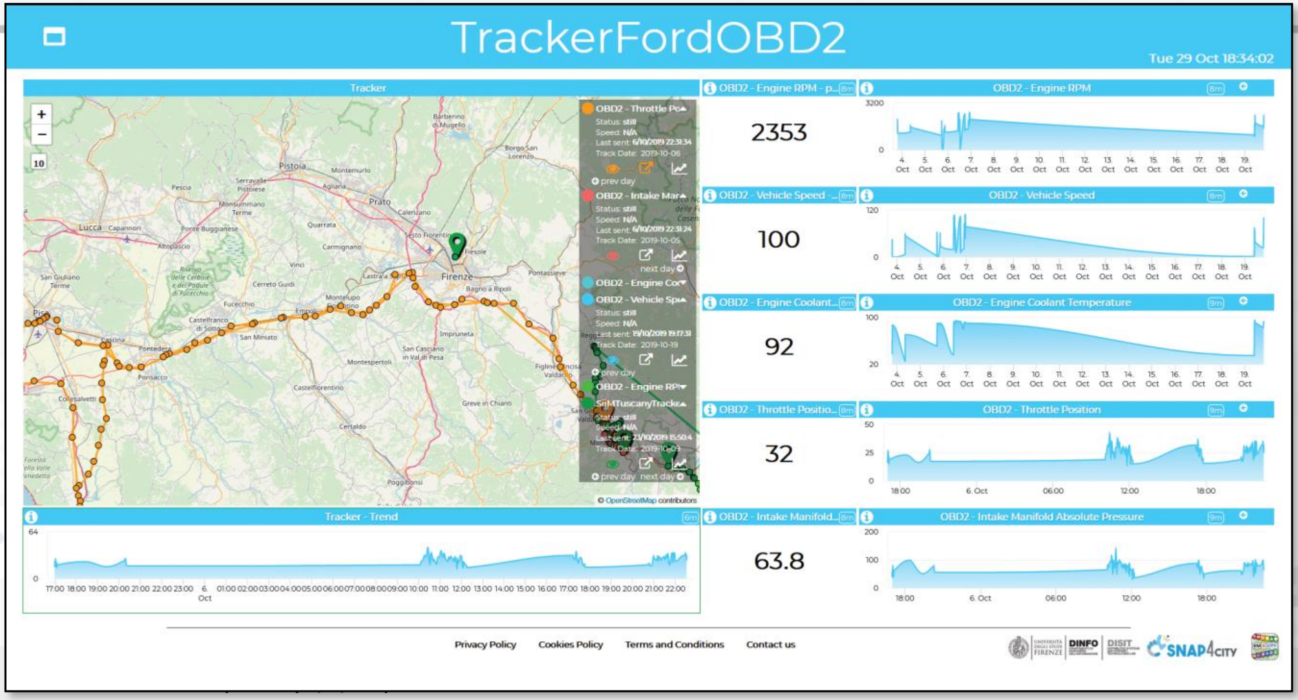
IOE – Vehicle Monitoring

CANBUS
sniffer



Tuscany in a Snap Mobile App on Android



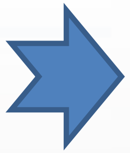


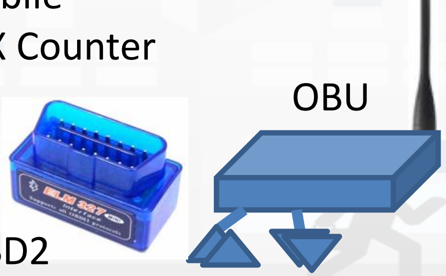
MyKPI: Tracking of Devices and Mobiles

- Real Time Trajectories for
  - Mobile Phone
  - Moving IOT Devices
  - OBU, Vehicular Kits
  - Multiple tracks
  - Day by day
- Micro Application

Apps

Mobile
PAX Counter

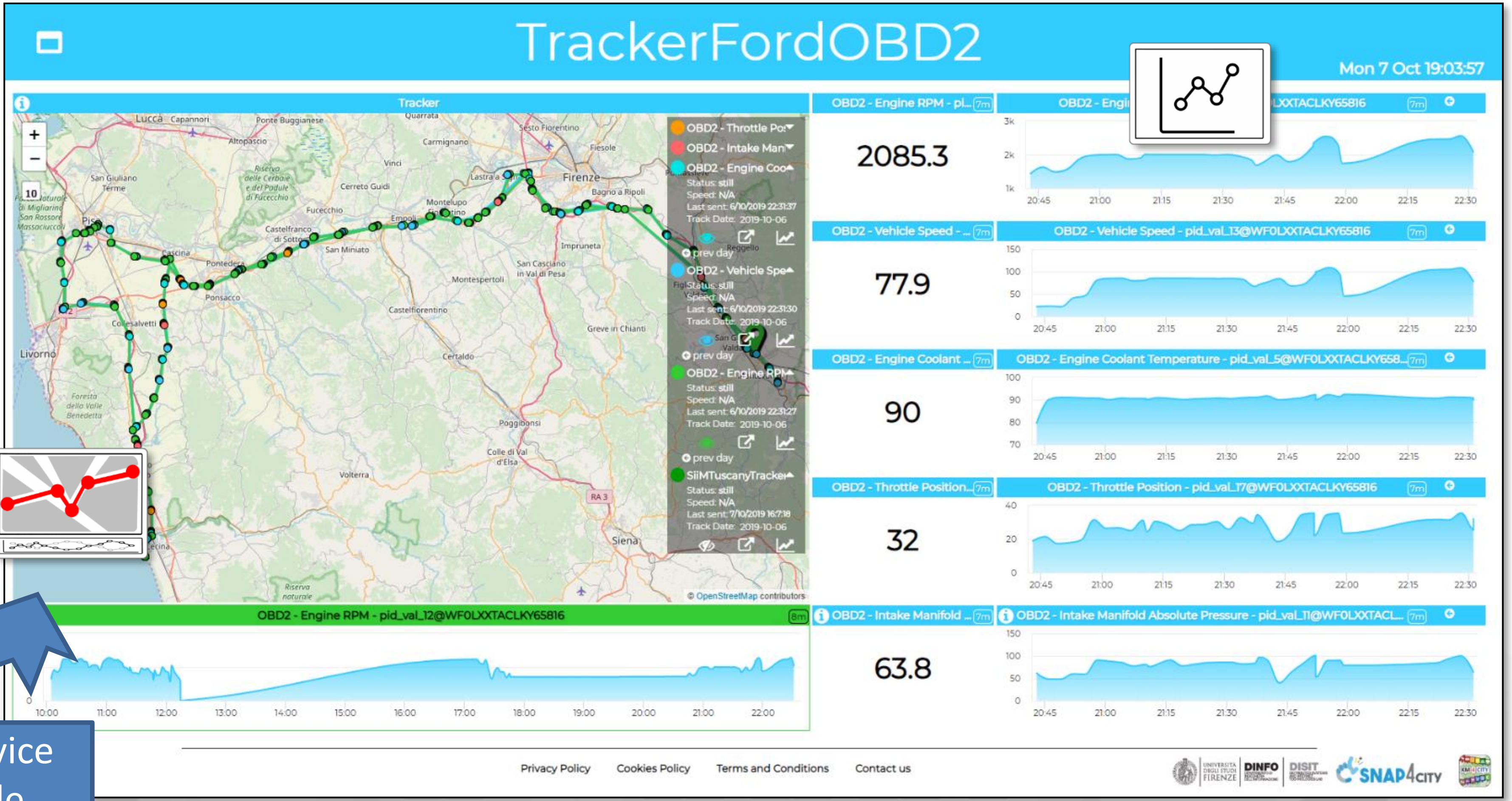




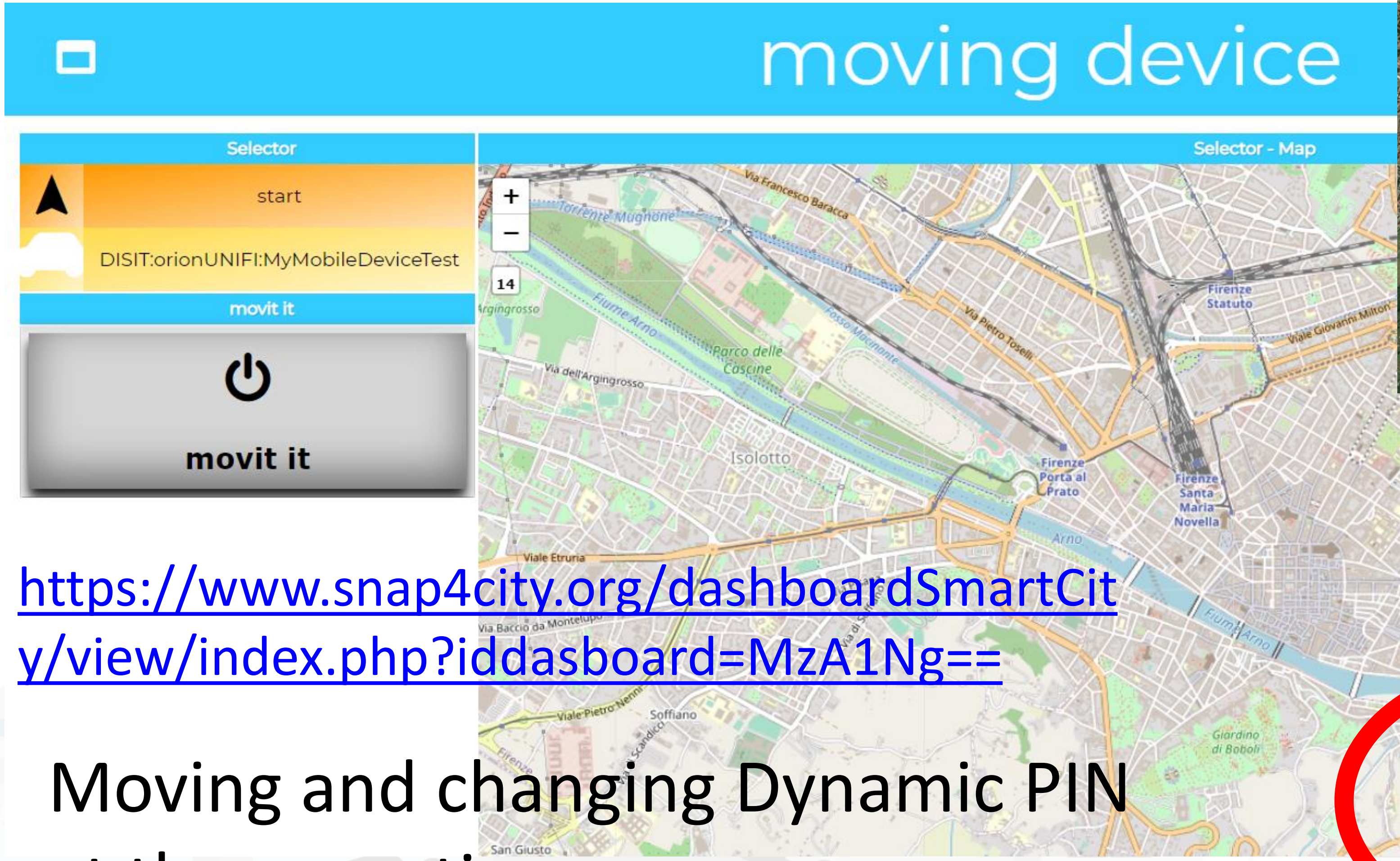
OBU

OBD2

IOT Device Mobile



Real time device traking



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA1Ng==

Moving and changing Dynamic PIN at the same time

IOT Devices and IOT Edge (Self Training)

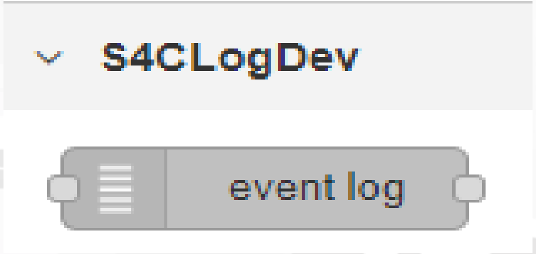
- **A large range of Devices** can be used on Snap4City:
  - Proprietary or Open HW/SW.
  - Devices of/for makers on which we provide Open source code
- **Documentation and instructions:**
  - **TC9.4 - IOT application exploiting Edge computing with Raspberry**
  - **TC9.7 - Connection from LoraWan Dragino/arduino to Orion broker**
  - **Snap4City: Arduino & ESP8266 IOT Device NGSI**
  - **Snap4City IOT Devices Registration**
  - **Snap4All IOT Button: based on ESP32, NGSI compliant secure connection**
  - **IDE Setup for Snap4All IOT Button, and source code**
  - **Registering IOT Edge: example of Raspberry Pi, total security**
  - **Creating: IOT Device, Raspberry Pi based, totally compliant with Snap4City**

TOP

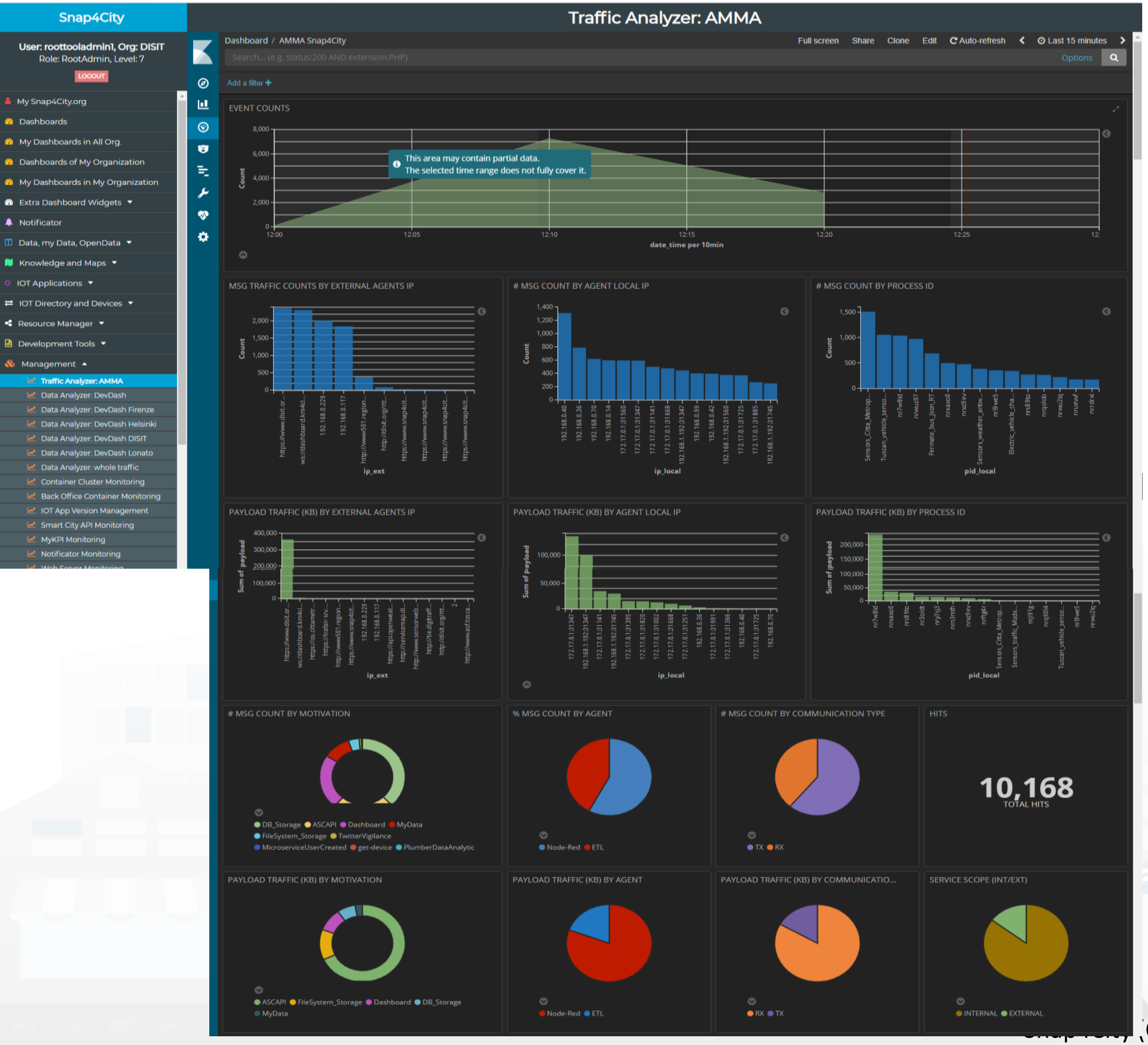
Logging Internal Events

Event Logger

- There are API for Event Logger, REST API
  - They are automatically used by most of the Snap4City MicroServices
  - They log in standard Rsyslog API
    - https://www.snap4city.org/56
- The Logs regarding messages passed and usage are logged and accessed with the AMMA tools that is based on Elastic Search and Kibana.
  - Former version was made in Hbase and SOLR, and Banana
- Additional Logs events can be logged by using a dedicated MicroService in Node-RED, IOT Apps



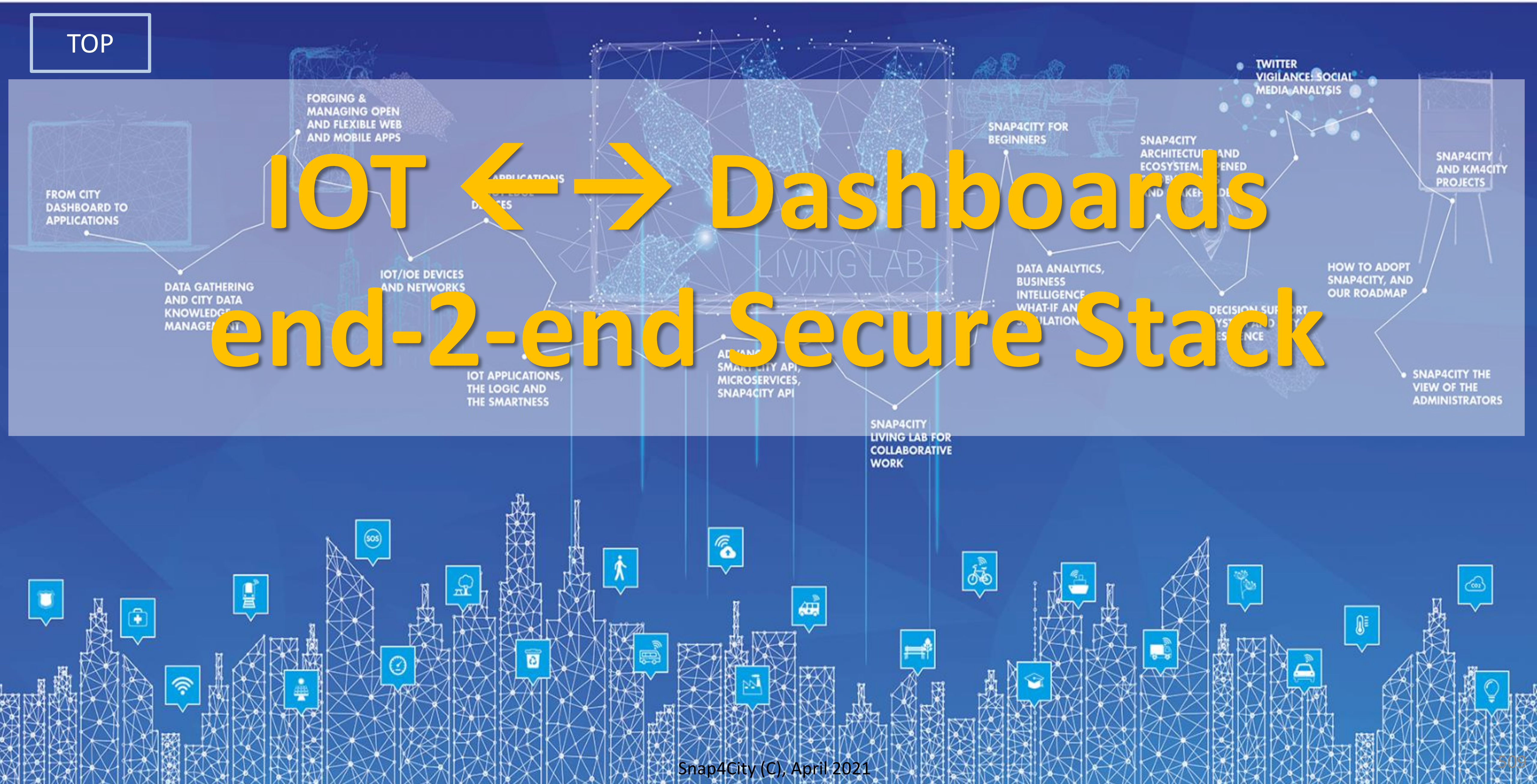
AMMA



- ***Managing and Monitoring Data-Traffic in the BackOffice***
- Data Traffic Analyzer
  - Business intelligence
  - Faceted searches
  - Drill down on time
- Several different views and details on data traffic among the main entities in the platform:
  - IOT APP
  - Storage
  - Data sources,
  - ….

TOP

IOT ←→ Dashboards end-2-end Secure Stack

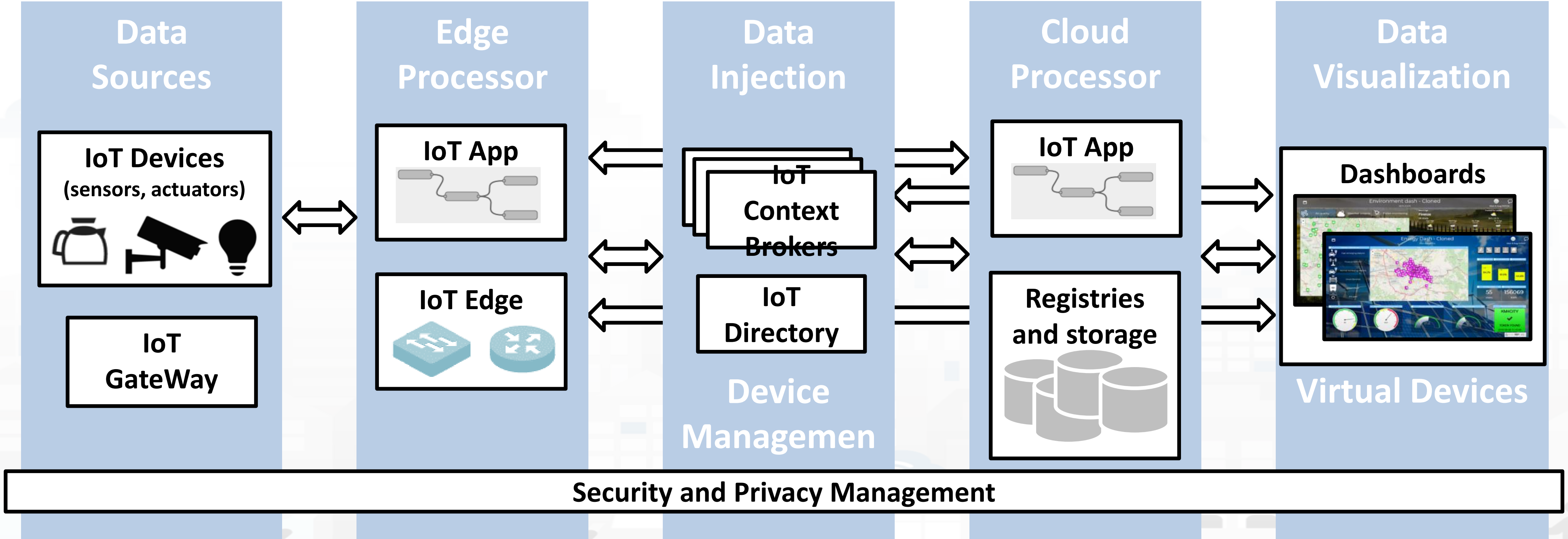


Complexity in Smart City IOT Platforms

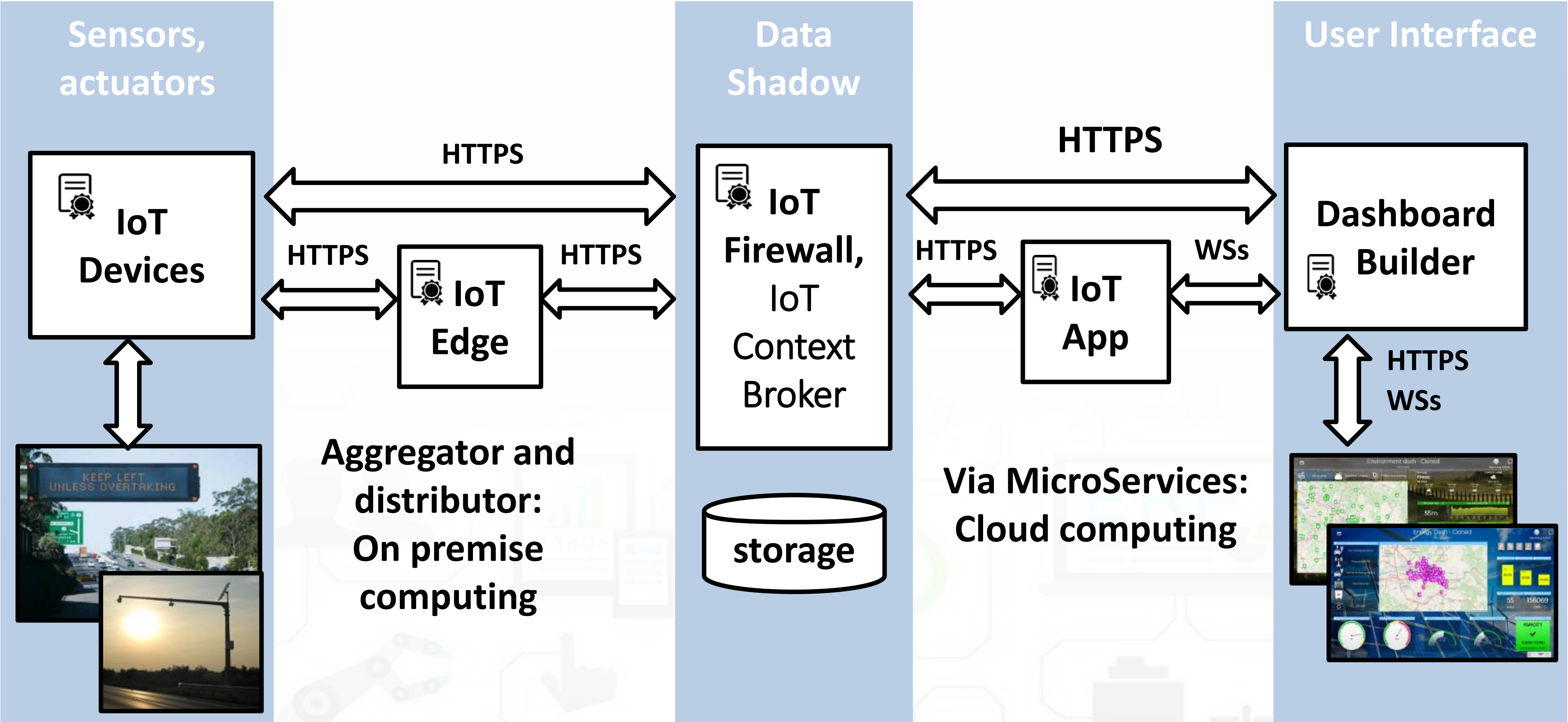
End to End security

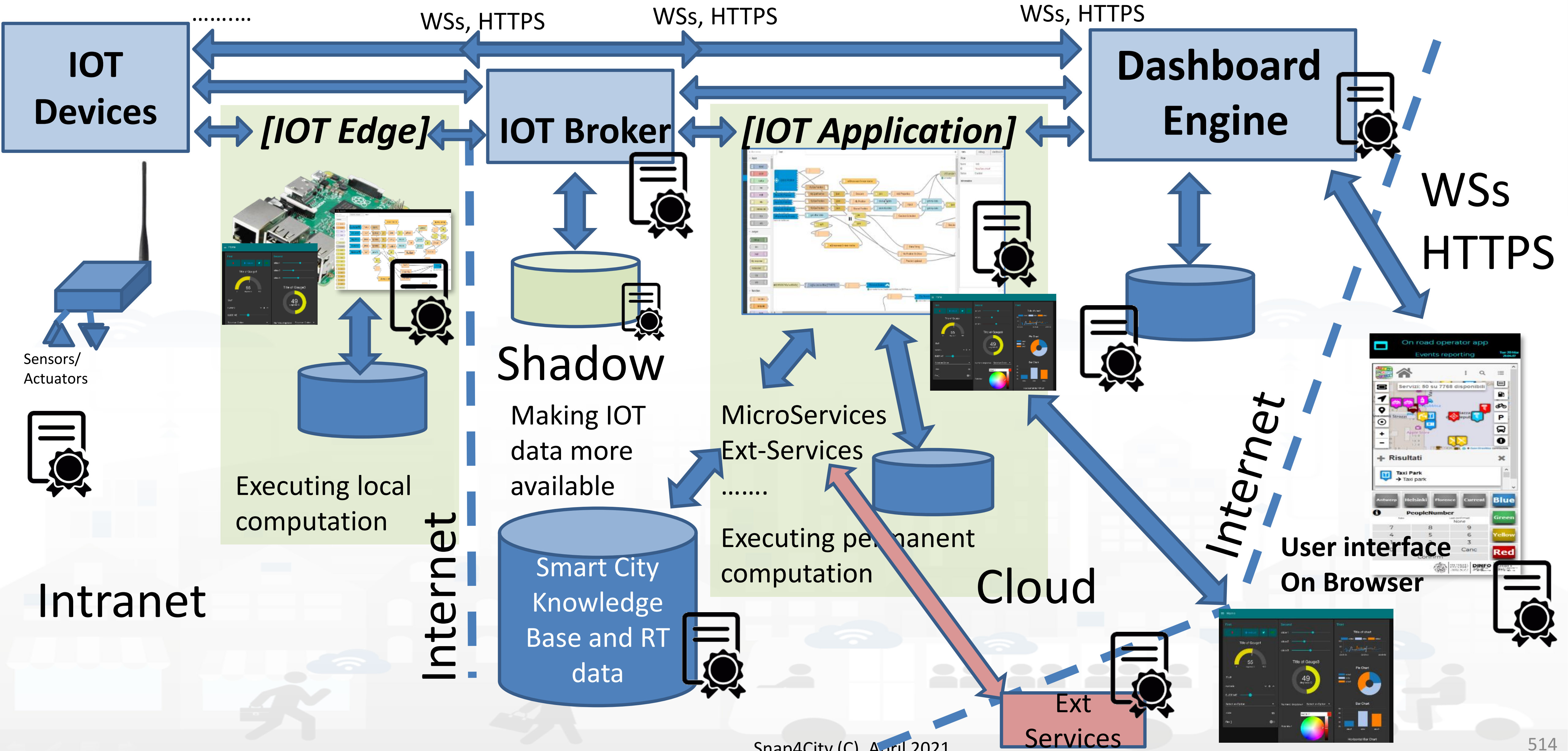
– From IOT Devices to Dashboard (user interface)

- H2M
- M2M



The secure stack




....
WSs, HTTPS
WSs, HTTPS
WSs, HTTPS
IOT Devices
[IOT Edge]
IOT Broker
[IOT Application]
Dashboard Engine
WSs HTTPS
Sensors/ Actuators
Shadow
Making IOT data more available
MicroServices
Ext-Services
....
Executing local computation
Executing permanent computation
Smart City Knowledge Base and RT data
Internet
Internet
Intranet
Cloud
User interface On Browser
Ext Services

UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

IEEE Access

- C. Badii, P. Bellini, A. Difino, P. Nesi, "Smart City IoT Platform Respecting GDPR Privacy and Security Aspects", accepted for publication on IEEE Access, 2020. 10.1109/ACCESS.2020.2968741 https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8966344

IEEE Access
Received January 7, 2020, accepted January 19, 2020, date of publication January 22, 2020, date of current version February 6, 2020.
Digital Object Identifier 10.1109/ACCESS.2020.2968741

Smart City IoT Platform Respecting GDPR Privacy and Security Aspects

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This work was supported in part by the European Union's Horizon 2020 Research and Innovation Program under Agreement 688196.

ABSTRACT The Internet of Things (IoT) paradigm enables computation and communication among tools that everyone uses daily. The vastness and heterogeneity of devices and their composition offer innovative services and scenarios that require a new challenging vision in interoperability, security and data management. Many IoT frameworks and platforms claimed to have solved these issues, aggregating different sources of information, combining their data flows in new innovative services, providing security robustness with respect to vulnerability and respecting the GDPR (General Data Protection Regulation) of the European Commission. Due to the potentially very sensible nature of some of these data, privacy and security aspects have to be taken into account by design and by default. In addition, an end-to-end secure solution has to guarantee a secure environment at the final users for their personal data, in transit and storage, which have to remain under their full control. In this paper, the Snap4City architecture and its security solutions that also respect the GDPR are presented. The Snap4City solution addresses the full stack security, ranging from IoT Devices, IoT Edge on premises, IoT Applications on the cloud and on premises, Data Analytics, and Dashboarding, presenting a number of integrated security solutions that go beyond the state of the art, as shown in the platform comparison. The stress test also included the adoption of penetrations tests verifying the robustness of the solution with respect to a large number of potential vulnerability aspects. The stress security assessments have been performed in a piloting period with more than 1200 registered users, thousands of processes per day, and more than 1.8 million of complex data ingested per day, in large cities such as Antwerp, Helsinki and the entire Tuscany region. Snap4City is a solution produced in response to a research challenge launched by the Select4Cities H2020 research and development project of the European Commission. Select4Cities identified a large number of requirements for modern Smart Cities that support IoT/IoE (Internet of Things/Everything) in the hands of public administrations and Living Labs, and selected a number of solutions. Consequently, at the end of the process after 3 years of work, Snap4City has been identified as the winning solution.

INDEX TERMS End-2-end, GDPR, IoT, security, smart city.

I. INTRODUCTION
IoT (Internet of Thing) is becoming a disruptive technology, especially for city users of metropolitan areas. The pervasiveness of IoT Devices, integrated in common objects, is becoming increasingly deeper. The addresses' space for these devices would be enough to point any sensors of any devices at any moment without restrictions. Diffuse products that implement *Low-Power Wide Area Networks* (LPWAN) technologies for IoT introduced by SigFox and Semtech (LoRa, Long Range) have been gaining interest and have been under intense deployment campaigns worldwide [1]. At the same time, *short range* IoT devices (based on technologies such as IEEE 802.15.4 or Bluetooth Low Energy, BLE, [2]) are sold in increasing quantities and are already able to support scenarios for smart homes, energy metering and industrial automation. On the other hand, the start of the diffusion of *5G devices* and services is creating high expectations in networking IoT technologies, as the killer application of previous technologies in metropolitan areas.

The associate editor coordinating the review of this manuscript and approving it for publication was Adnan M. Abu-Mahfouz.

TOP

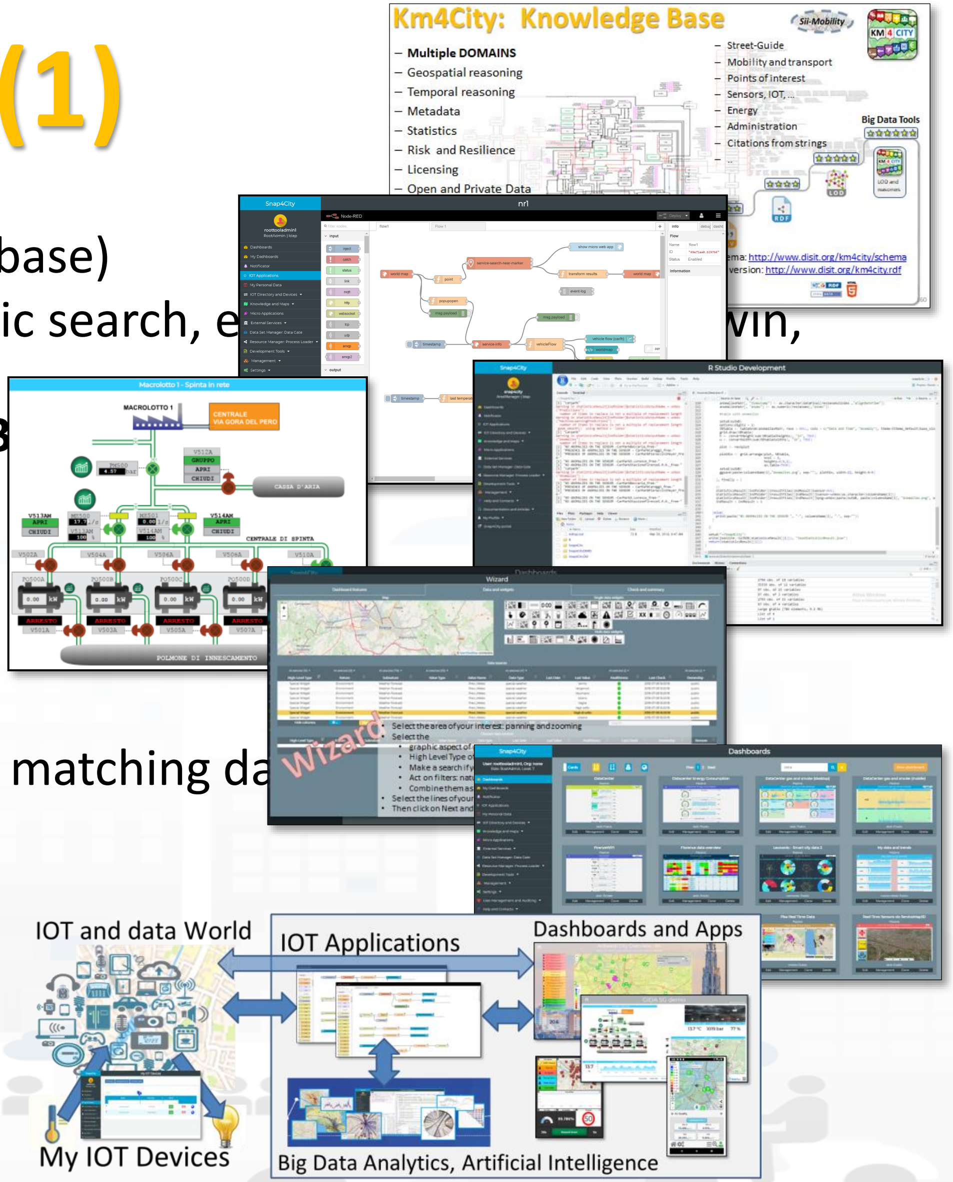
Comparison With other platforms

State of the Art Solutions vs Snap4City

	IOT Discovery Abstraction	Authentication, Authorization	Security end-2-end, secure on IOT and Dashboards	Open HW and Open SW	Integrated Community management	Data Types: IOT Devices, IOT App, Dashboard, Data	Data Type: Publish/share, Delegation, Consent and change	Data Type: Download and Delete	Auditing on Data Type Access	Open Source end-to-end	Scalability IOT	Visual Programming end-to-end applications	Advanced Smart City API, MicroServices	Multi Domain Semantic Platform	Standard based Modules and IOT, Open Devices	Resource Sharing	Data Analytics integrated	Dashboard H24/7, protected connection	Multi-protocol on IOT
		G				G	G	G	G										
Snap4City	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KAA [53]	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	N	(Y)	N	N	Y	Y
Thingsboard [55]	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	Y	MQTT,coap, http
IOT eclipse.org [56]	N	N	N	(Y)	N	Y	N	N	N	Y	Y	N	N	N	Y	N	N	N	Y
IOT IGNITE [57]	N	Y	N	Y	N	Y	N	Y	Y	Y	Y	Y	N	N	N	N	N	Y	MQTT
FIWARE [47]	N	Y	N	Y	N	N	N	Y	N	Y	(Y)	(N)	Y	N	Y	N	N	Y	Y
ARM mbed IoT [48]	Y	Y	Y	Y	Y	N	(N)	N	Y	Y	Y	N	N	N	Y	N	N	Y	Limited
Airvantage [51]	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	Y	MQTT, HTTP
AWS [43]	Y	Y	Y	Y	N	Y	(N)	Y	Y	N	Y	N	N	N	Y	Y	(Y)	Y	Limited
Azure IOT [44]	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	N	N	Y	Y	(Y)	Y	Limited
PTC ThingWorkx [59]	N	Y	Y	Y	Y	Y	N	N	Y	N	Y	Y	N	N	Y	N	N	Y	Y
Bosch IoT Suite [58]	Y	Y	Y	Y	Y	(Y)	(N)	Y	Y	N	Y	Y	Y	N	Y	N	Y	Y	Y
CISCO Jasper [55]	Y	Y	Y	Y	N	(Y)	(N)	N	Y	N	Y	N	N	N	N	--	(Y)	Y	N
Siemens MindSphere [60]	Y	Y	Y	(Y)	N	Y	(N)	Y	Y	N	Y	Y	N	N	Y	N	Y	Y	Y
Carriots [54]	Y	Y	Y	(Y)	N	Y	N	N	Y	N	Y	N	N	N	--	N	N	Y	MQTT
Google IOT [45]	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	N	N	N	N	N	(Y)	(Y)	MQTT, HTTP
Homekit Apple [50]	Y	Y	Y	Y	N	Y	N	N	Y	N	(Y)	N	N	N	N	Y	N	Y	Limited
Smarthing Samsung [52]	Y	Y	Y	Y	Y	Y	(Y)	Y	Y	N	(Y)	N	N	N	N	N	N	Y	Limited

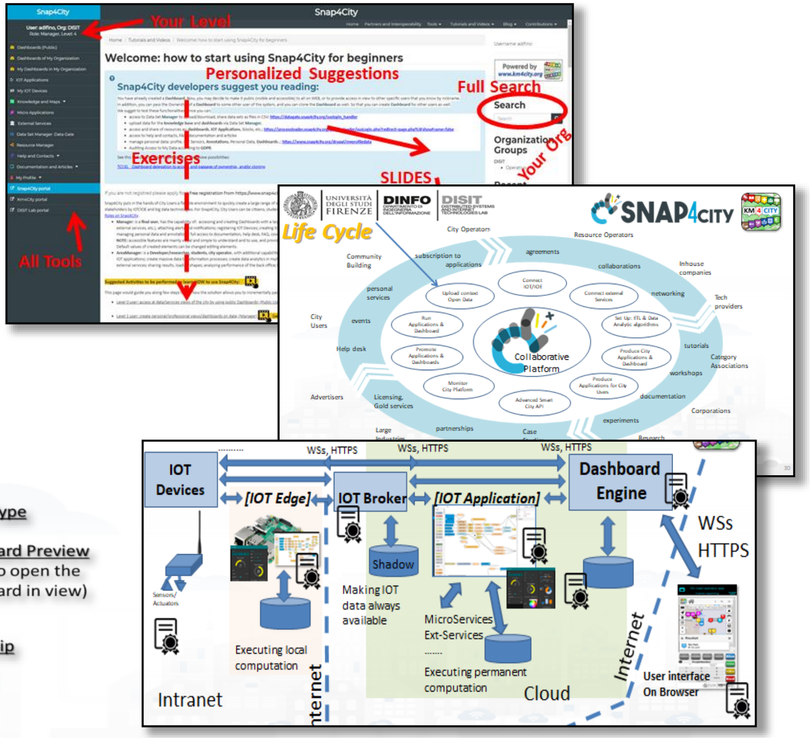
Unique of Snap4City Platform (1)

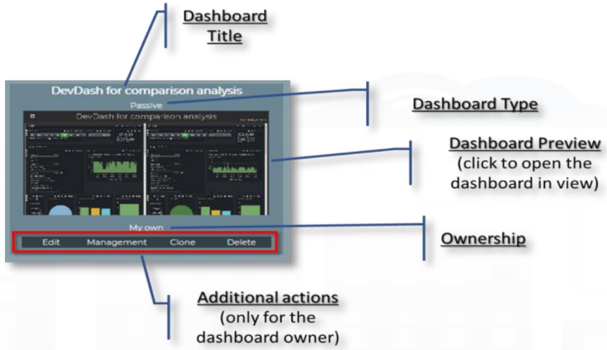
- Data ingestion and model
  - **Unified data model** (exploited in the Wizard and Knowledge base)
  - **Semantic Reasoner** modelling city entities, supporting sematic search, e… …win, etc.
  - **IOT Directory abstracting complexity of IOT Devices, Edge, B…**
- Data Analytics and Data Processes
  - **Flexible and extensible IOT Applications**
  - **Data Analytic:** multiple programming languages,
- Visual Analytics, dashboarding, Apps
  - **Wizard: expert system** for immediate dashboard production matching da… representation
  - **Dashboards specialized** multidomain for Smart Cities
  - **Custom Widgets and Synoptics**
  - **Ready to use Mobile App, instant App, MicroApplication**
  - **Strategies** formalization supports

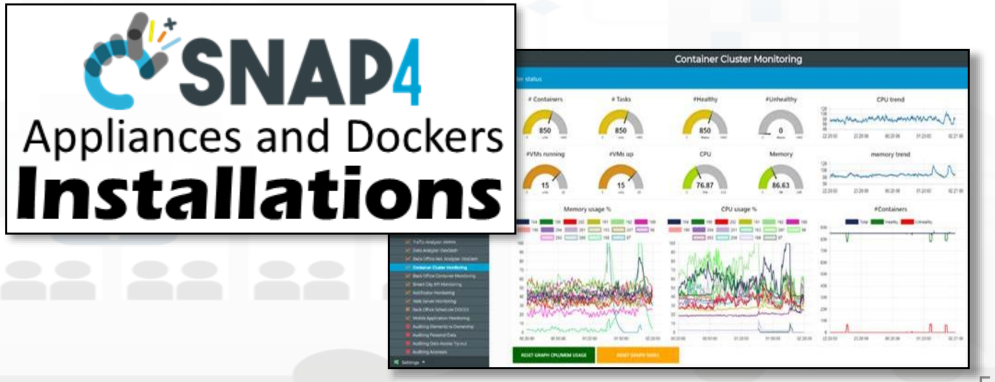


Unique of Snap4City Platform (2)

- Openness to any developers
  - **Living Lab support for coworking, sharing, and delegating**
  - **Multitenacy, multiorganization and geoareas**
  - **Advanced Smart City APIs and MicroServices**
  - **100% Open Source, Open hardware**
- Security and Privacy
  - **End-2-end encrypted communication**, on devices, platform, ... dashboards
  - **GDPR compliant** privacy/security
- Non functional
  - **on cloud and on premise,** your private installation
  - **Ready to use Appliance** Virtual Machines and/or Containers for a modules and tools.
  - **Flexible, Modular, Elastic, scalable and robust**

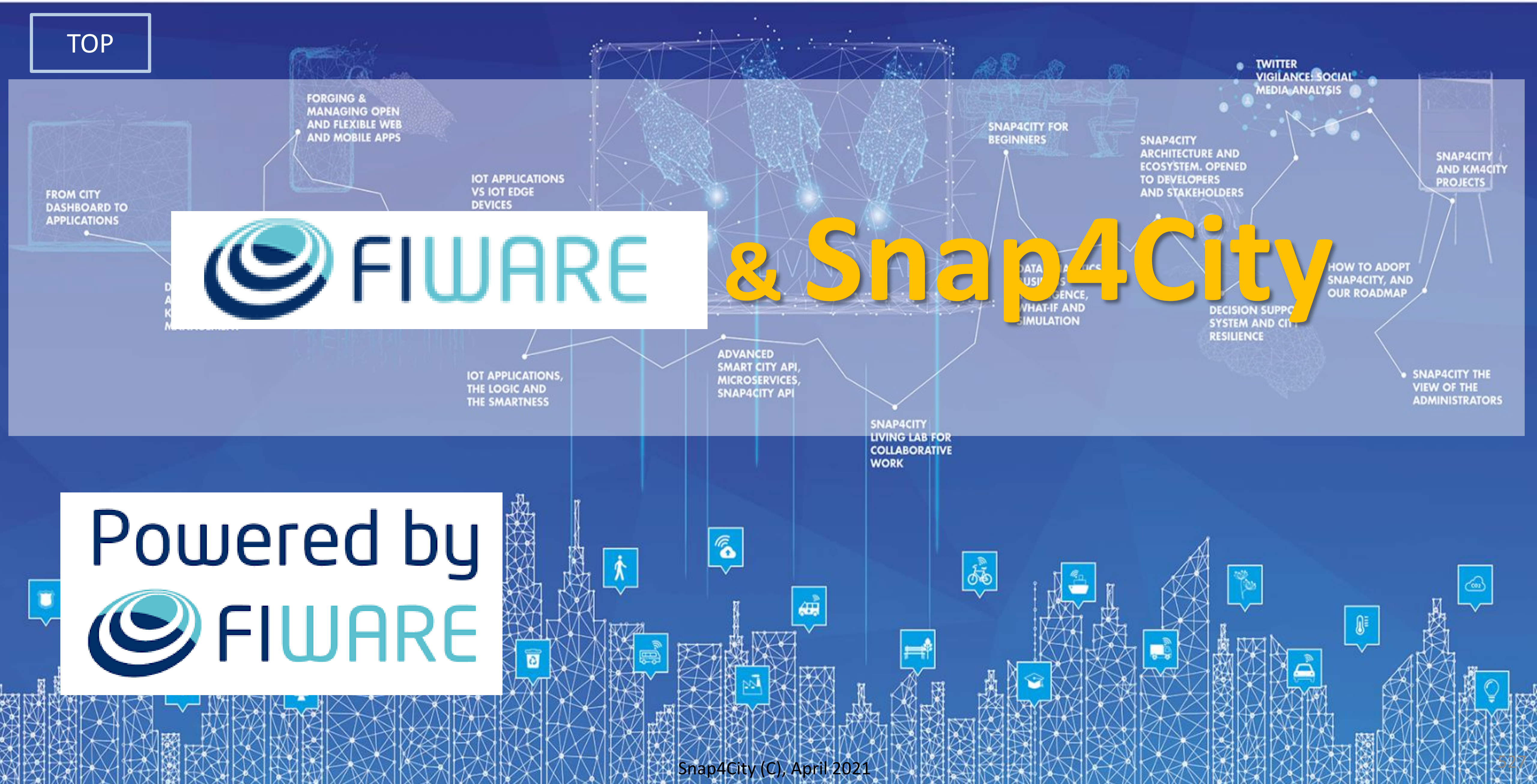






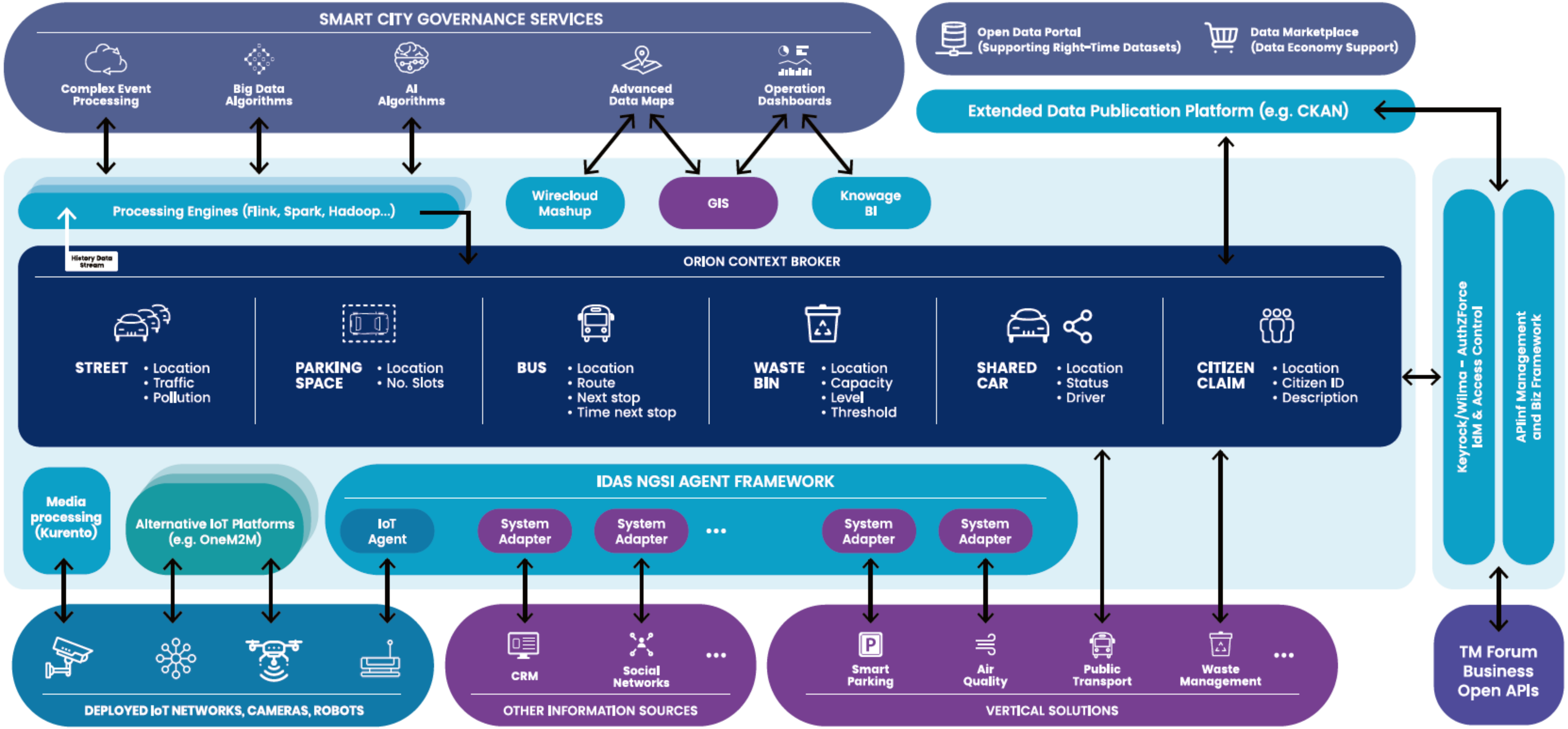
TOP

FIWARE & Snap4City



Powered by FIWARE

THE FIWARE SMART CITIES REFERENCE ARCHITECTURE



- Snap4City - Powered by FIWARE Solution:
  - https://marketplace.fiware.org/pages/solutions/b8905e91973b420189cce972
  - NGSI V1, V2 The IOT Orion Broker
  - IOT Orion Broker can connect JSON, MQTT, Lightweight M2M, LoraWAN, OPC, SigFOX, etc. see FiWare Https://www.fiware.org
- Snap4City - FIWARE Training Services:
  - https://marketplace.fiware.org/pages/solutions/03bccd83a0e1b0398ba7a0bf
- Snap4City - FIWARE Consultancy Services:
  - https://marketplace.fiware.org/pages/solutions/907f5ecc63927f643dd8421b
- **Snap4City is compatible** with all the above protocols
  - via IOT Orion Broker,
  - via IOT Applications.
  - via direct connection on ETL processes on their corresponding IOT brokers, and/or
- **Snap4City is also compatible** with many other protocols, see the table reported in page: https://www.snap4city.org/65

Powered by FIWARE

- In Snap4City you can chose to connect your devices at Snap4City Platform in different manners:
  - (a) directly to Snap4City with some Broker, or on IOT App, Brokers, MyKPI
  - (b) via an IOT Orion Broker (external IOT Broker or those provided by Snap4City), or
  - (c) via any third party IOT Brokers in any protocol you have.
- **Snap4City has**
  - **Improved IOT Orion Broker** with the so called Orion Broker Filter (Orion Broker Filter, NGSI Security Wrapper) which is a secure wrapper for NGSI V1 and V2 protocol for enforcing Mutual Authentication, Security, roles, etc.
  - **Produced open hardware and open software NGSI Compliant:** as
    - **IOT Devices** with mutual authentication and security based for NGSI on: Android, Arduino and ESP32, IOT Button, etc.
    - **IOT Edge** devices with mutual authentication and security based for NGSI on: Raspberry PI, Windows, Linux.

URBAN PLATFORM: SMART CITY IOT AS A SERVICE AND ON PREMISE

100% OPEN SOURCE

APPLIANCES CONTAINERS

- LOCAL GOVERN
- STAKEHOLDERS
- CITY USERS
- IN-HOUSE
- ENERGY OPERATORS
- MOBILITY OPERATORS
- COMMERCIAL OPERATORS
- SECURITY OPERATORS
- INDUSTRIES
- RESEARCHERS
- START-UPS
- ASSOCIATIONS

- GDPR
- SECURITY
- PRIVACY
- ASSESSMENT
- AUDITING
- PENTESTED

- OPEN IOT DEVICES
- IOT EDGE
- IOT GATEWAY
- PAX COUNTERS
- IOT BUTTONS

- TEST CASES, SCENARIOUS, VIDEOS, HACKATHONS
- OPEN SOURCES, COMMUNITY OF CITIES
- TRAINING TUTORIALS, COMMUNITY MANAGEMENT

IOT APPLICATIONS - INSTANT APPS

DATA DRIVEN APPLICATIONS • REAL TIME PROCESSING • BATCH PROCESSING • ANY PROTOCOL & FORMAT

DASHBOARDS & APPLICATIONS

CONTROL ROOM • SITUATION ROOM • OPERATOR DASHBORDS • BUSINESS INTELLIGENCE • WHAT-IF ANALYSIS • DECISION SUPPORT • SIMULATIONS • RISK ANALYSIS • RESILIENCE ANALYSIS

MOBILE & WEB APPLICATIONS

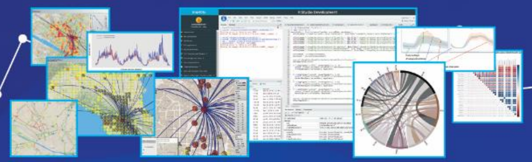
DEVELOPMENT KIT • SUGGESTIONS • MOBILE APPS • MONITORING PANELS • PLATFORM UTILITIES • READY TO USE SMART APPLICATIONS

MICROSERVICES & ADVANCED SMART CITY API

LIVING LAB - DEV TOOLS - COWORKING

IOT DIRECTORY • SERVICE MAP • RESOURCE MANAGER • DATA GATE • R STUDIO • ETL

BIG DATA - DATA ANALYTICS



DATA ANALYTICS TOOLS - MICRO-APPLICATIONS

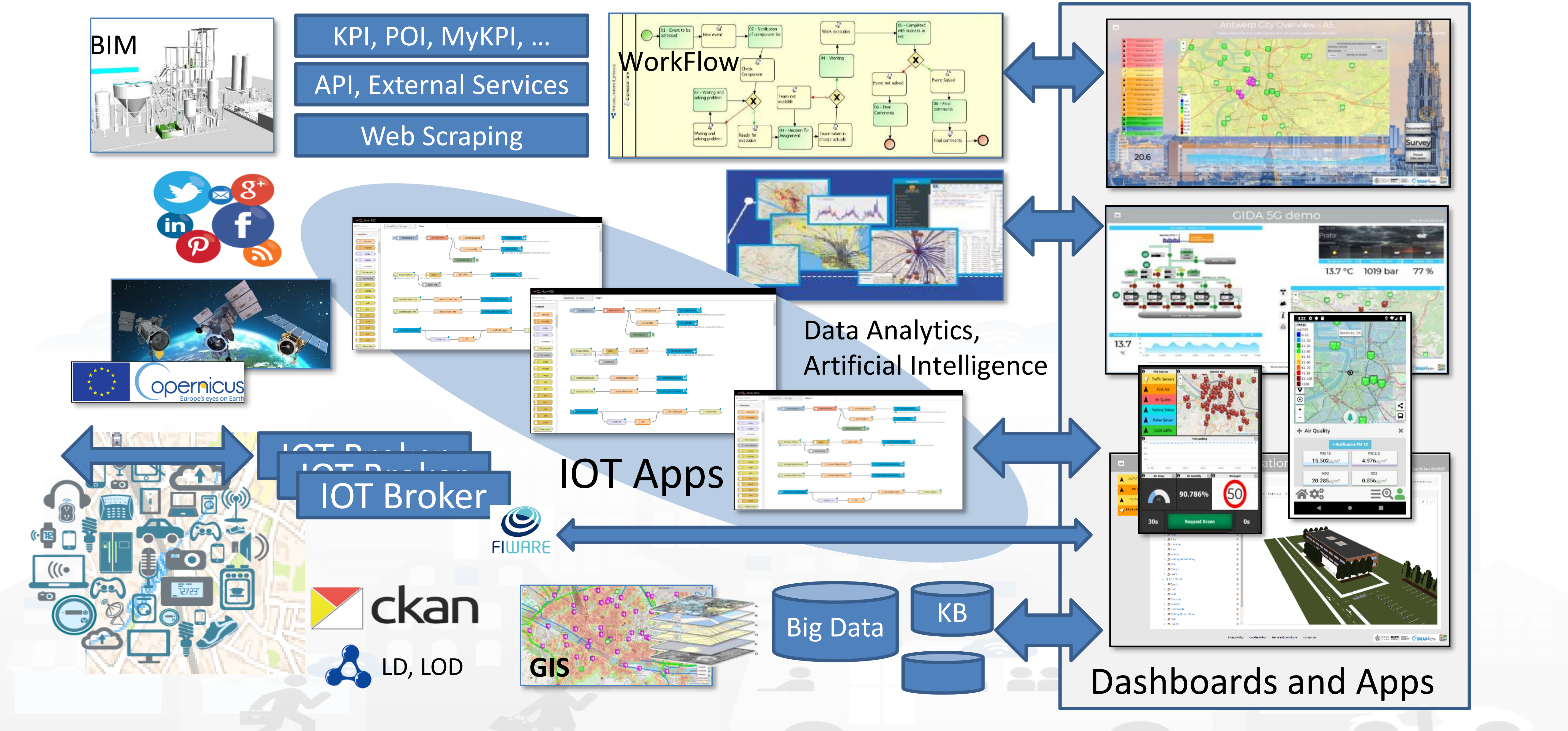
PREDICTIONS • ANOMALY DETECTION • WHAT-IF ANALYSIS • TRAFFIC FLOW RECONSTRUCTION • ORIGIN-DESTINATION MATRICES • SOCIAL MEDIA ANALYSIS • OFFER VS DEMAND ANALYSIS • ENVIRONMENTAL DATA ANALYSIS AND PREDICTIONS • REAL TIME HEATMAPS • ROUTING • ALERTING • EARLY WARNING • PERSONAL AND VIRTUAL ASSISSTANTS • SMART SOLUTIONS • SMART SHARING • PARTECIPATORY

KM4CITY DATA AGGREGAT KNOWLEDGE BASE - EXPERT SYSTEM OF THE CITY – BIG DATA STORE

IOT MNG - DATA MNG - DATA INSPECTOR – PROCESS MNG – USER ENGAGEMENT – GDPR MNG ...

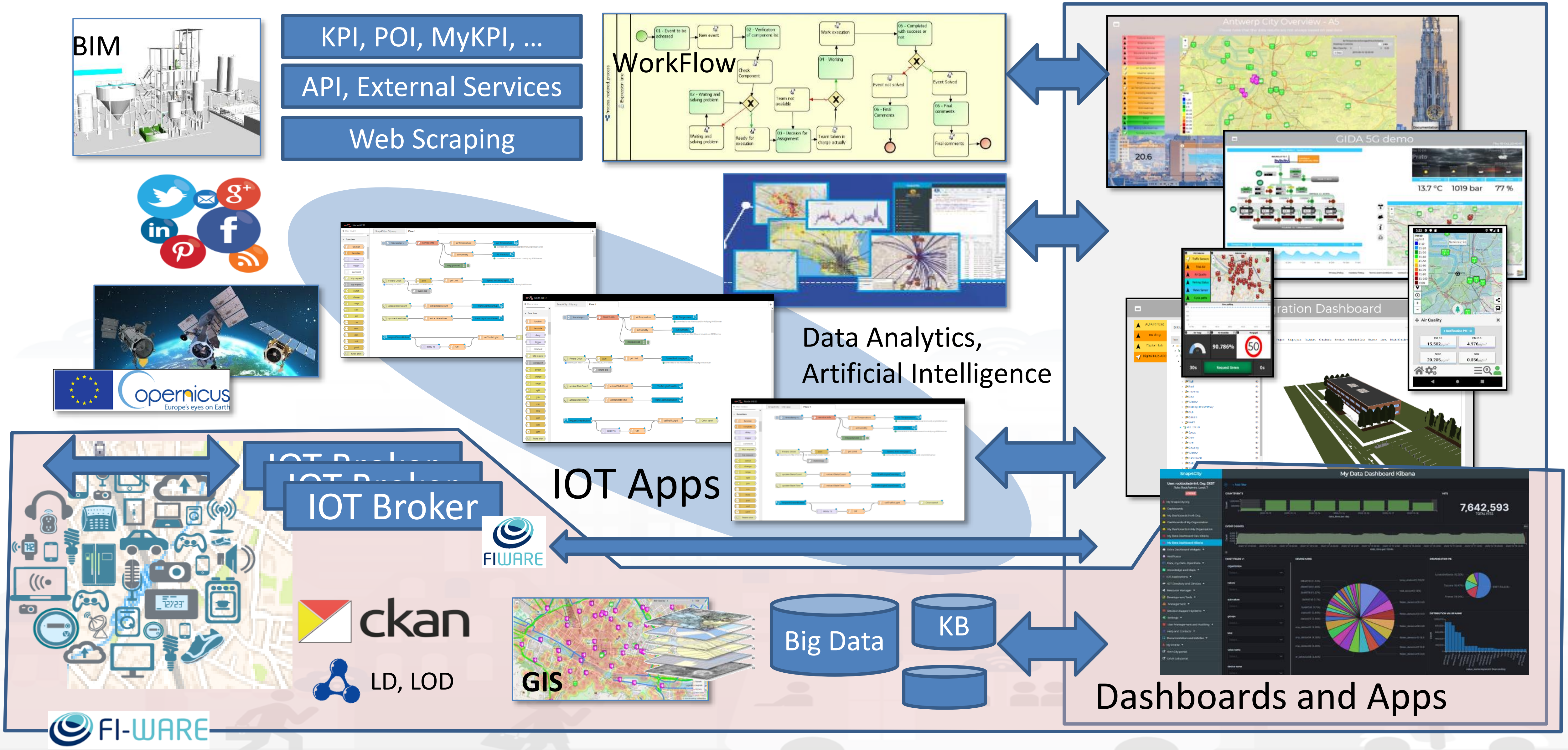
GIS	CITY UTILITIES	OPEN DATA	LEGACY & EXTERNAL SERVICES	PERSONAL DATA	IOT / IOE	BROKERS	KPI	INDUSTRY 4.0	SOCIAL MEDIA

Concept



BIM
KPI, POI, MyKPI, …
API, External Services
Web Scraping
WorkFlow
Data Analytics,
Artificial Intelligence
IOT Apps
IOT Broker
FIWARE
ckan
LD, LOD
GIS
Big Data
KB
opernicus
Europe's eyes on Earth
Antwerp City Overview - A5
GIDA 5G demo
Dashboards and Apps

Concept



BIM
KPI, POI, MyKPI, …
API, External Services
Web Scraping
WorkFlow
Data Analytics,
Artificial Intelligence
IOT Apps
IOT Broker
FIWARE
ckan
LD, LOD
GIS
Big Data
KB
FI-WARE
Dashboards and Apps

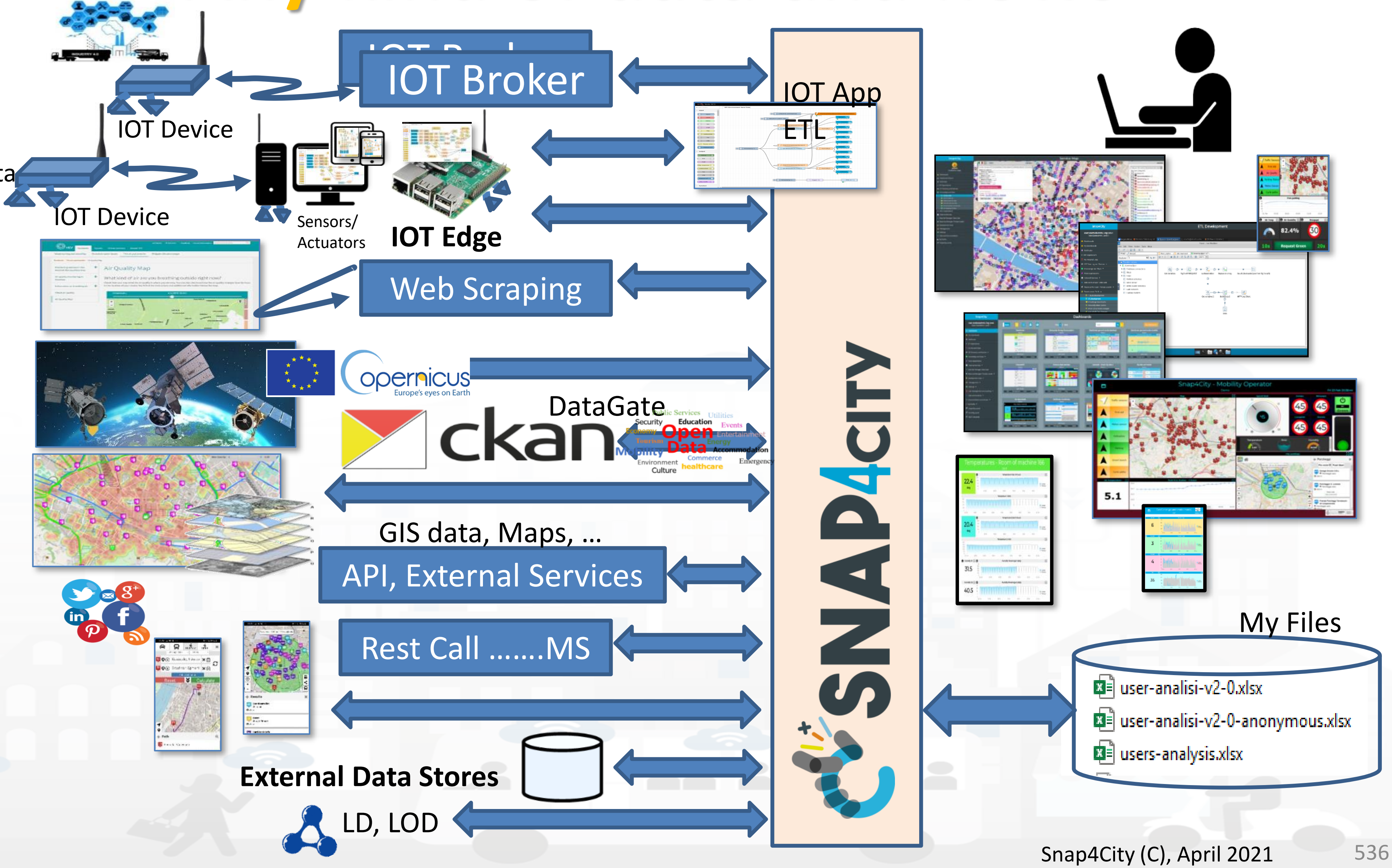
Functional: FiWare OS Solutions wrt Snap4City solutions

	FiWare	Snap4City
Multiple Protocols: IoT, Databases, etc..	10 on IOT, Limited on databases, etc.	More than 200, very very wide
Large set of high level types: maps, trends, heatmaps, traffic, trajectories, scenarios,…	No	Yes:
Integration with workflows, BPM	Not Supported	Yes: bidirectional
Integration and Modeling Digital Twin BIM	Not Supported	Yes: bidirectional
Integration with GIS: WFS, WMS	Not fully supported	Yes: bidirectional
Integration with Heatmaps and Satellite	Partially, and satellite not supported	Yes: fully
Smart City API	no	Yes
Open Data Management	Partial with CKAN	Yes, Fully automated with CKAN
Federation of platforms	Partial on brokers	Full on Brokers and Knowledge base and API
Semantic model and queries	No, probably with NGSI-LD in the future	Yes since 2013
Multiple kinds of IoT Brokers	No, only agents	Yes: NGSI, COAP, AMQP, MQTT, SigFOX, etc.
Data Transformation	Coding	Yes: IOT App, Node.JS, Visual Programming, scalable
Data Analytics, on line development	No, no	Yes, Yes: Rstudio, Python, Tensor Flow, MapReduce, etc.
Dashboard on data	Grafana no LDAP	Yes: Dashboard Builder, Kibana with GDPR, LDA (Open Distro)
Dashboard Widgets	Limited, no custom, coding needed	Yes: A wide range including custom widgets, secure compliant, animations, configuration, also open to new development
MicroApplications	No	Yes
Auditing, Assessment, accounting	No, no, no	Yes, Yes, Yes
Multitenacy on data management	No only on broker	Yes: on Broker, on data management, on dashboards, etc..
Living Lab for creating/managing communities/groups	Not supported	Yes: provided in the open source

Interoperability
Openess
Process
Graphics
Manag.

Any kind of data and flows

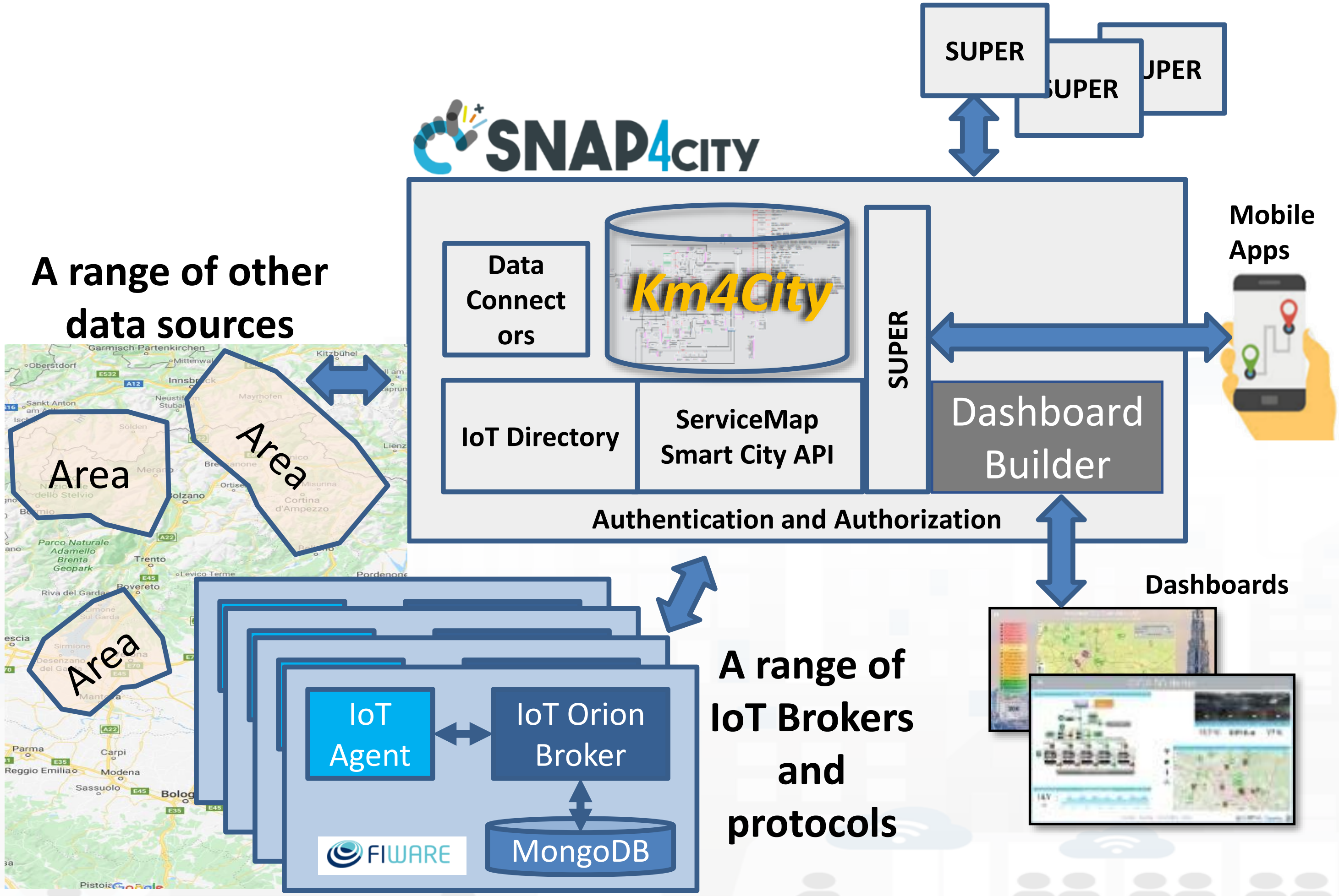
- **Open Data:**
  - Data gate, federation of Open Data Portals
  - IOT App, ETL proc(PULL)
- **IOT Networks:**
  - IOT Application processes, data driven or PULL
  - IOT Brokers (Push) → IOT Shadow
- **Web Pages:**
  - Web scraping, crawling processes
- **Satellite data**
- **Social media: Twitter, Facebook,..**
  - Twitter Vigilance, IOT App
- **Mobile Apps**
  - Smart City API
- **Files upload: CSV, Excel, etc.**
  - IOT Applications, ETL
- **REST API, WS, FTP, LD, LOD, etc.**
  - IOT Applications, ETL
- **Data base accesses**
  - GIS: WFS, WMS
  - ETL, IOT Application



Snap4City and FiWare integration

- **A) IoT Orion Broker as an External Broker** of a Snap4City platform
  - Devices are mainly managed by Orion Broker only
  - IoT Directory can harvest devices on Broker to registered them
- **B) IoT Orion Broker is an Internal Broker** of a Snap4City platform
  - This implies that Snap4City facilities are exploited for:
    - IoT Devices registration, IoT discovery, Ontology, Bulk registration, optimization of stored data, adaptation, filtering crontrol, etc.
  - All the devices are registered into IoT Directory that performs the registration on both IoT Orion Broker and KB automatically
- **C) Federation of an IoT Orion Broker** with storage by using SSM2ORION
  - Devices are managed by Orion Broker only
- **D) hybrid solutions** in which Web and Mobile App can exploit both Orion API and Snap4City services and API

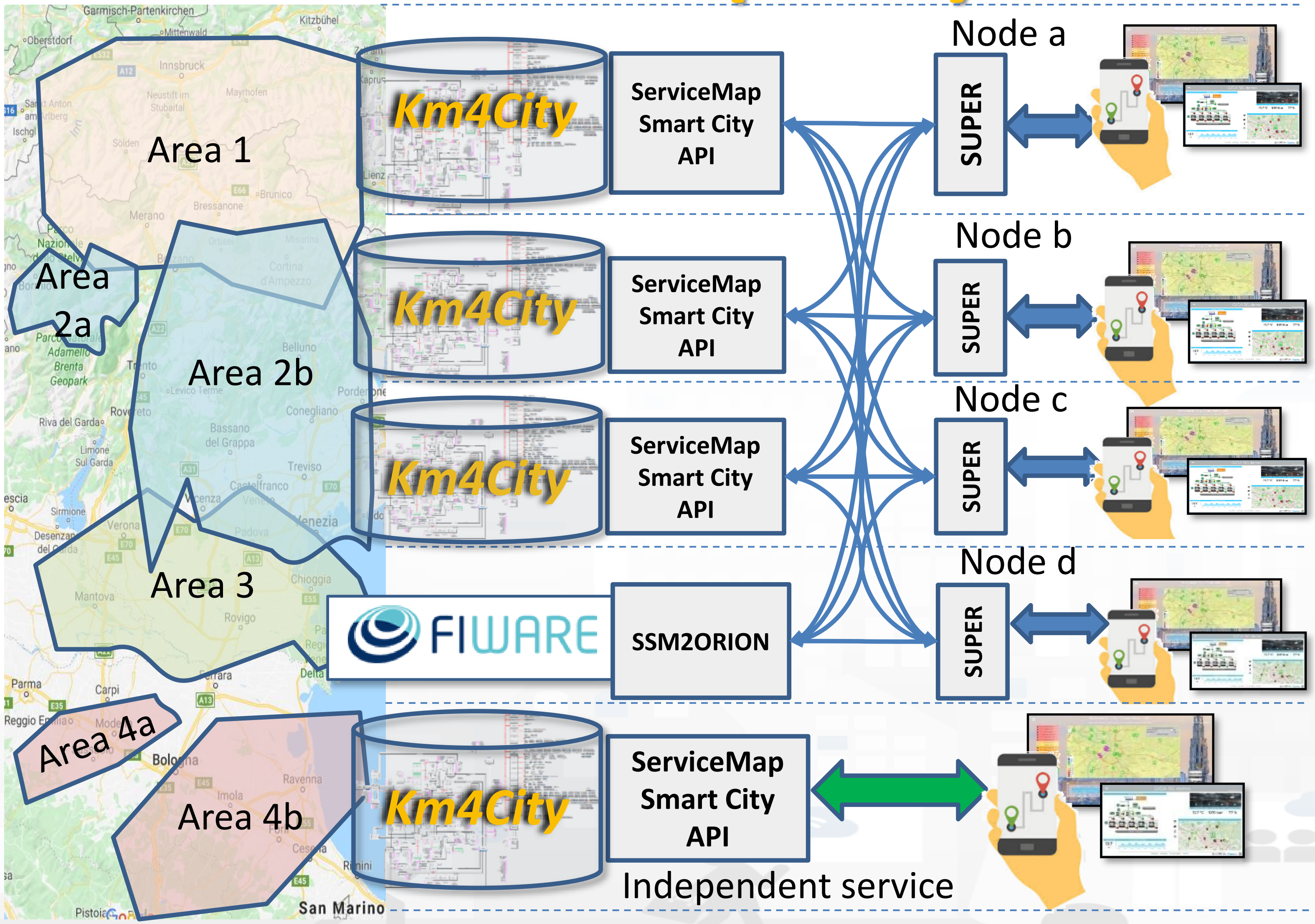
Snap4City IoT Registration and Access



UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

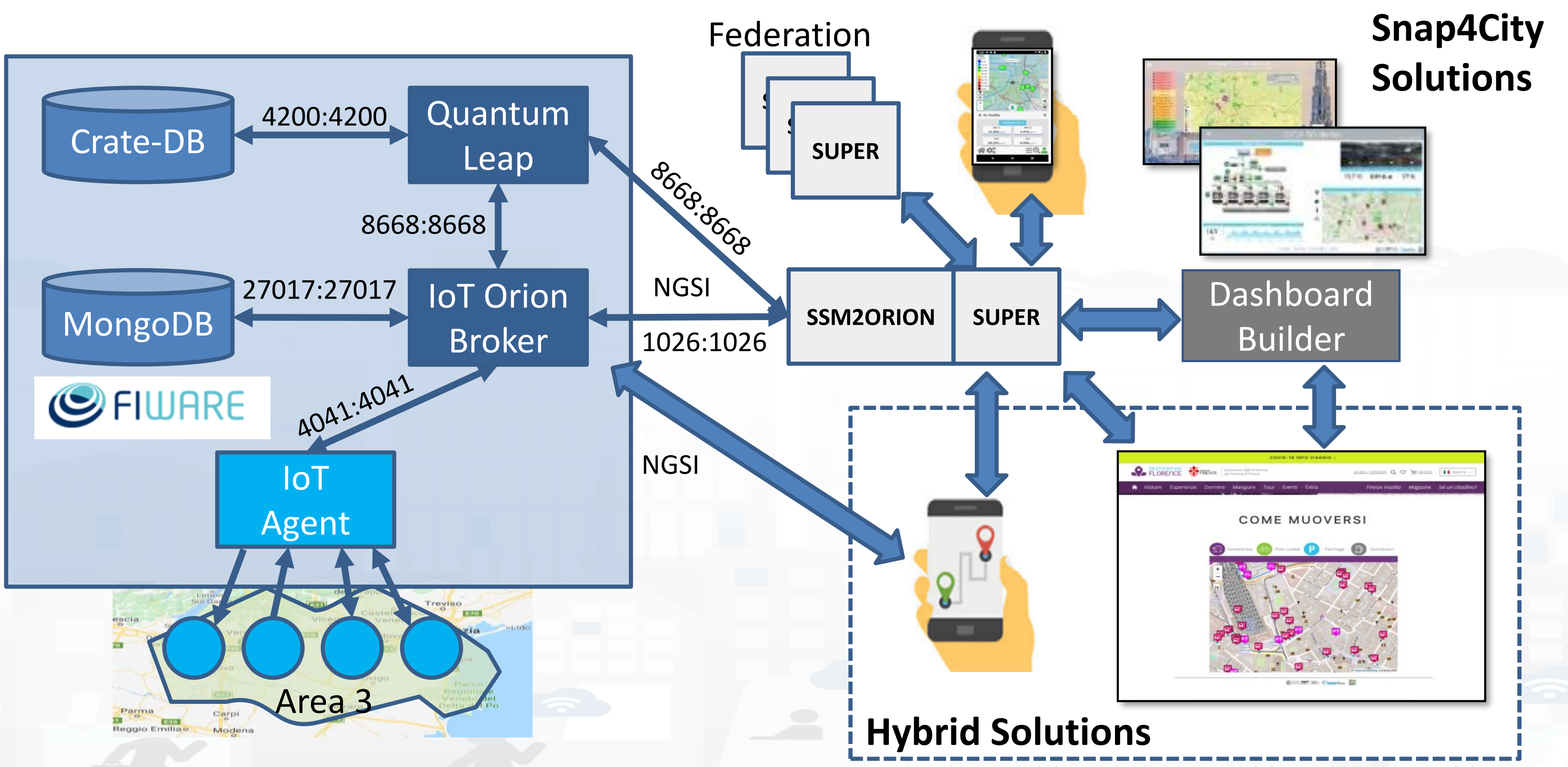
Knowledge Base
Semantic Reasoners

Federation of Snap4City Services



- A Mobile App may refer to one Smart City API Server (for Area 1) via SUPER and receive data from the Federated SUPERS (Area 2) if navigation, queries, etc. are leading to discover out of the addressed KB.
  - SUPER can be used for creating redundant and/or balanced distributed solutions for Federated KB. See Area 2, the two KB in the front.
  - Federated SUPER can have overlapped KB even totally.
  - A Mobile App can be developed to support multiple Smart City API servers, for balancing and
- The usage of Super is not mandatory so that separate services can be produced as well
- Super and Nodes presents the same Smart City APIs.

Federation of Snap4City vs IOT ORION Broker



Non Functional

FiWare OS Solutions wrt Snap4City solutions

	FiWare	Snap4City
Security	TLS	Yes: End to end, TSL and dashboards, event driven, mutual authentication, Access Token, OpenID Connect
Privacy	Not on all data	Yes: GDPR compliant full stack
Access Control, authorization	To be done, Partial	Yes: User Roles, and management tools
Scalability	Limited on data No on processes	Yes
Full stack Open Source	No (proprietary applicative levels)	Yes: open source also application level
Full Modular	Not all modules are Open Source	Yes
Interoperable	Partial, see previous table	Yes at all levels, in all modules, 100% open source
Full training course	Partial	Yes
Examples and code shared	Partial	Yes

Two Main Lines for Dashboarding are present

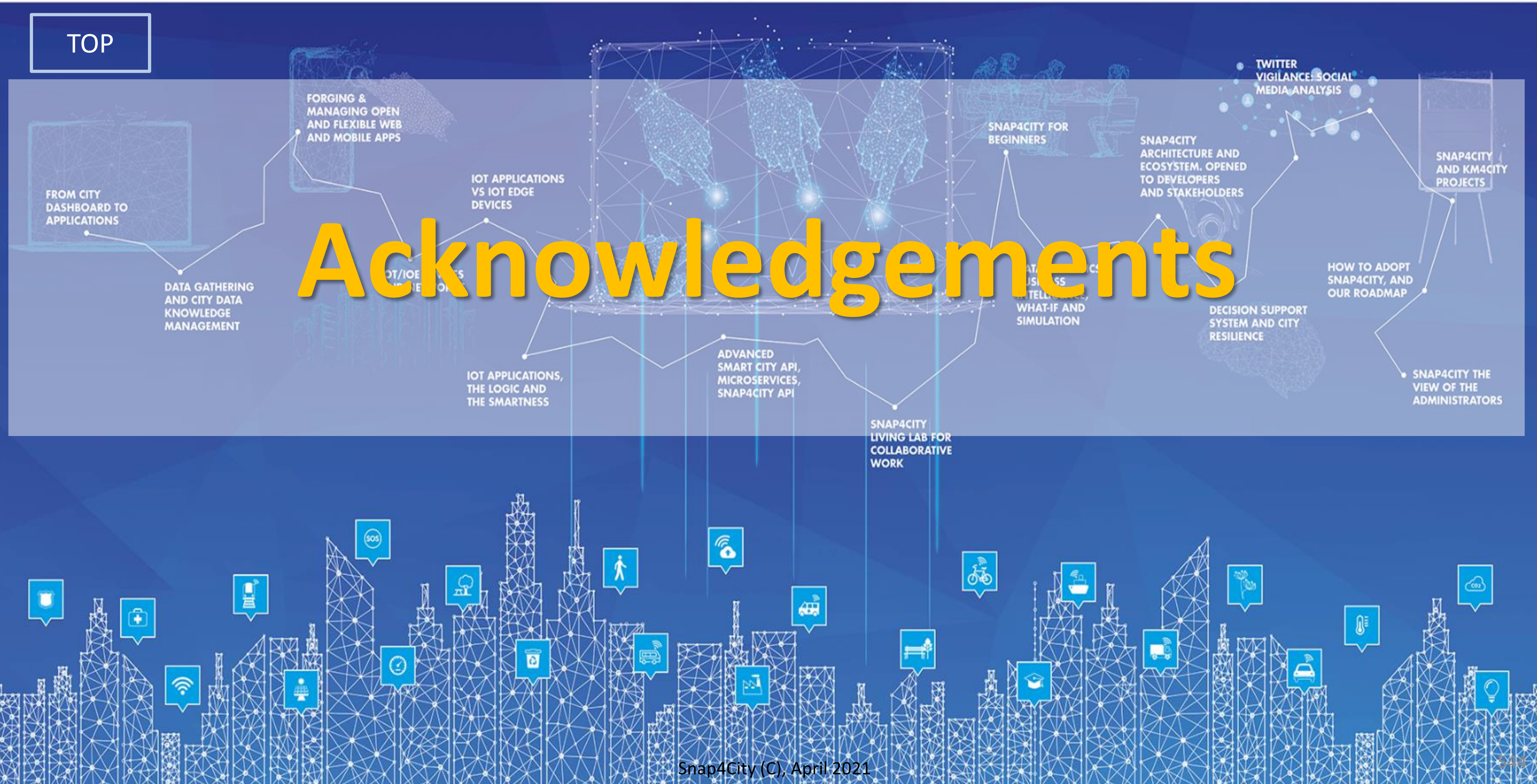
- **Dashboard Builder of Snap4City**
  - For accessing and browsing data on: Elastic Search, Mongo, MySQL, Smart City API, Super and thus from federated Smart City API, etc.
  - Supports sensors/actuators: data driven data, maps in extended manner, data driven widgets, large collection of widgets, direct IoT Connections, custom widgets, animated PIN on maps, a large set of panel/widgets, etc.
  - Very simple to be used for control room, decision makers, situation rooms, operators, etc.
  - Very well integrated with IoT App, Custom widgets, animation, external services.
  - Very simple to be customized for non programmers since all the tools are visual.
  - Support for GDPR and deep control of access.
  - Can integrate Kibana/Grafana Views into a Widget
- **Kibana** (so called **DevDash**, **AMMA** and recently **My Dashboard (Dev) Kibana**), also accessible as Grafana
  - For accessing and browsing data on Elastic Search storage and other sources supported
  - No Support for real time event driven widgets/panels, actuators and synoptics, no sophisticated maps, etc.
  - Not simple for control room, decision makers, etc.
  - Not integrated with IoT App, Custom widgets, animation, external services.
  - Oriented to developers, complex production of custom views, etc.
  - Partial support of GDPR and deep control of access.

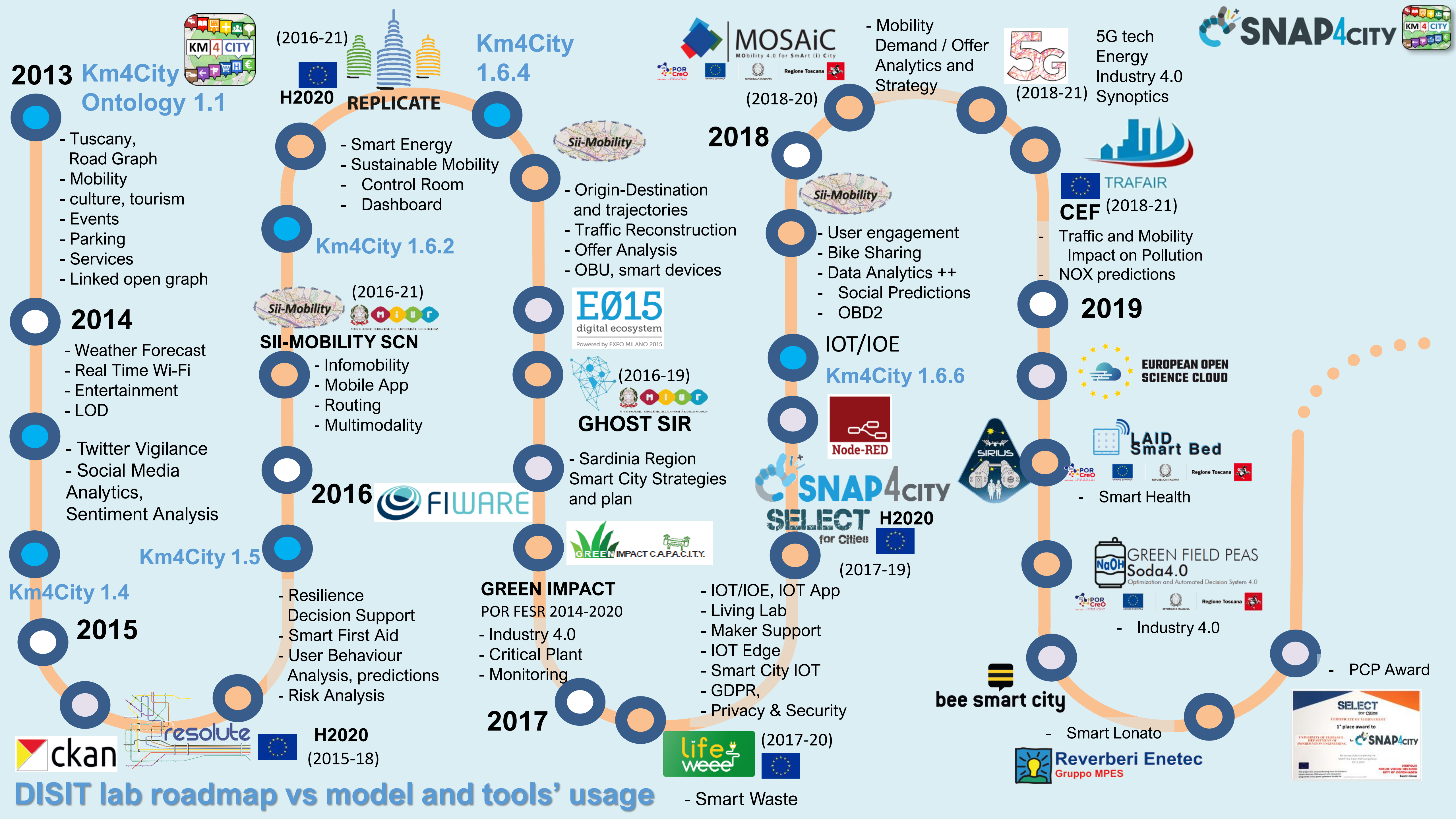
Snap4City Dashboard Builder vs Kibana

Features	Snap4City Dashboard Builder	Kibana, Grafana
Large Collection of Widgets	YES	Nothing
Custom Widgets SVG of any kind, full defined process for customization	YES	Nothing
Real time event driven widgets and data	YES	Nothing
Business Logic for data transformation with visual programming: Node-RED	YES	Some coding
Maps with custom PIN, bubbles, animated and moving, etc.	YES	Nothing
Maps with paths, shapes, traffic flow, scenarios, routing, heatmaps, what-if, …	YES	Nothing
Maps with Orthomaps from WFS, WMS, GIS connection, etc.	YES	Nothing
TV camera integration and selection	YES	Nothing
Widgets for business logic integration on real time: buttons, selector, switch, etc.	YES	Nothing
Kiviat, Spider net, Calendar	YES	Nothing
Typical Time Trends: day hours, month week, month days, …..	YES	Nothing
Time Trend Compare: day, eek, month, year	YES	Nothing
Selectors/Menus: text, icons, etc., also in connection with IOT APP, Node-RED	YES	Nothing
Full control of graphic layout, font, colours, refresh per widget, etc.	YES	Nothing
Iframe integration of third party widgets and web pages, nesting dashboards, embedding Kibana	YES	Nothing
Connection among multiple Dashboards and Widgets	YES	Nothing
Synchronization with Video Wall, and Operators Views	YES	Nothing
Multiseries, bar lines, charts, pie, donut, simple selectors, trends, etc., also from business logic	YES	Limited
Single content, string, html, any data, etc.	YES	Limited
Special widgets: Weather forecast, civil protection, road plates, Twitter, etc…	YES	Nothing
Faceted search	possible with selectors	YES

TOP

Acknowledgements




2013 Km4City Ontology 1.1
- Tuscany, Road Graph
- Mobility
- culture, tourism
- Events
- Parking
- Services
- Linked open graph
2014
- Weather Forecast
- Real Time Wi-Fi
- Entertainment
- LOD
- Twitter Vigilance
- Social Media Analytics, Sentiment Analysis
Km4City 1.5
Km4City 1.4
2015
ckan
resolute
H2020
(2015-18)
(2016-21)
H2020
REPLICATE
- Smart Energy
- Sustainable Mobility
- Control Room
- Dashboard
Km4City 1.6.2
Sii-Mobility
(2016-21)
SII-MOBILITY SCN
- Infomobility
- Mobile App
- Routing
- Multimodality
2016
FIWARE
- Resilience Decision Support
- Smart First Aid
- User Behaviour Analysis, predictions
- Risk Analysis
Km4City 1.6.4
Sii-Mobility
- Origin-Destination and trajectories
- Traffic Reconstruction
- Offer Analysis
- OBU, smart devices
EØ15 digital ecosystem
Powered by EXPO MILANO 2015
(2016-19)
GHOST SIR
- Sardinia Region Smart City Strategies and plan
GREEN IMPACT C.A.P.A.C.I.T.Y.
GREEN IMPACT
POR FESR 2014-2020
- Industry 4.0
- Critical Plant
- Monitoring
2017
life weee
(2017-20)
- Smart Waste
MOSAiC
MObility 4.0 for SmArt (i) City
POR CreO
Regione Toscana
(2018-20)
- Mobility Demand / Offer Analytics and Strategy
2018
Sii-Mobility
- User engagement
- Bike Sharing
- Data Analytics ++
- Social Predictions
- OBD2
IOT/IOE
Km4City 1.6.6
Node-RED
SNAP4CITY
SELECT for Cities
H2020
(2017-19)
- IOT/IOE, IOT App
- Living Lab
- Maker Support
- IOT Edge
- Smart City IOT
- GDPR,
- Privacy & Security
5G
(2018-21)
5G tech
Energy
Industry 4.0
Synoptics
SNAP4CITY
TRAFAIR
CEF (2018-21)
- Traffic and Mobility Impact on Pollution
- NOX predictions
2019
EUROPEAN OPEN SCIENCE CLOUD
SIRIUS
LAID Smart Bed
POR CreO
Regione Toscana
- Smart Health
GREEN FIELD PEAS
Soda4.0
Optimization and Automated Decision System 4.0
Regione Toscana
- Industry 4.0
bee smart city
- Smart Lonato
Reverberi Enetec
Gruppo MPES
- PCP Award
SELECT
SNAP4CITY
DISIT lab roadmap vs model and tools' usage

SNAP4CITY roadmap

2019

EUROPEAN OPEN SCIENCE CLOUD

SIRIUS

LAID Smart Bed

POR CreO — Regione Toscana

- Smart Health

GREEN FIELD PEAS Soda4.0

Optimization and Automated Decision System 4.0

POR CreO — Regione Toscana

- Industry 4.0

bee smart city

Smart Lonato del Garda

Reverberi Enetec Gruppo MPES

Winner of Select4Cities PCP

2020

JRC EUROPEAN COMMISSION

Interreg Mediterranean HERIT-DATA

- Smart Tourism
- 6 Pilots
- Data Analytics
- Extended platform

Interreg MARITTIMO-IT FR-MARITIME

MOBI MART

- Smart Mobility
- PISA, PUMS
- Living lab

smartGARDAlake

Km4City 1.6.7

CAPELON

- Smart Light
- Sweden

Winner of Open Data Challenge of enel x

PC4City (2020-21)
Monitoring Terrain

2021

JRC EUROPEAN COMMISSION

Smart Ambulance
(2021-22)

Enterprise
(2021-22)
Industry 4.0

Almafluida
(2021-22)

AMPERE (2021-22)
Industry 4.0

2022

Main running instances

- Sii-Mobility → mobility and transport, sustainability
- REPLICATE → ICT, smart City Control room, Energy, IOT
- RESOLUTE → Resilience, ICT, Big Data
- GHOST → Strategies, smart city
- TRAFAIR → Environment & transport
- MOSAIC → mobility and transport
- WEEE Life → Smart waste, environment
- Smart Garda Lake → Castelnuovo del Garda, SMARTEA
- 5G → Industry 4.0 vs SmartCity
- Green Impact → Industry 4.0, Chemical Plant
- SmartBed (Laid) → smart health
- Green Field Peas (Soda) → Industry 4.0, Chemical plant
- MobiMart and PISA Agreement → data aggregation, mobility and transport, Living Lab
- Lonato del Garda → smart parking, environment
- Herit Data → tourism, culture and management
- ISPRA JRC → site management and services
- Capelon (Sweden) → smart light solutions

Acknowledgements

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Trafair: CEF project with several Cities http://trafair.eu/
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Mobile Emergency:
    http://www.disit.org/5404

Trace-IT

RAISSS

Further readings

https://www.snap4city.org/108

- HOW TO: create a Dashboard in Snap4City
- HOW TO: add a device to the Snap4City Platform
- HOW TO: add data sources to the Snap4City Platform
- HOW TO: define privacy rules for personal data, produced by the end-users own device
- HOW TO: Develop Smart Applications, Snap4City development Life Cycle
- HOW TO: HLT vs Ingestion, and HLT vs Widgets
- HOW TO: Develop an IOT Application for Data Ingestion
- HOW TO: Upload data into Knowledge Base, ServiceMap (triple upload)
- HOW TO: Create as set of Devices with BulkProcessing
- HOW TO: Create an IOT Device Model
- HOW TO: Create an IOT Device Instance from IOT Directory tool

TOP

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