SNAP4CITY

KM4CITY

100% OPEN SOURCE

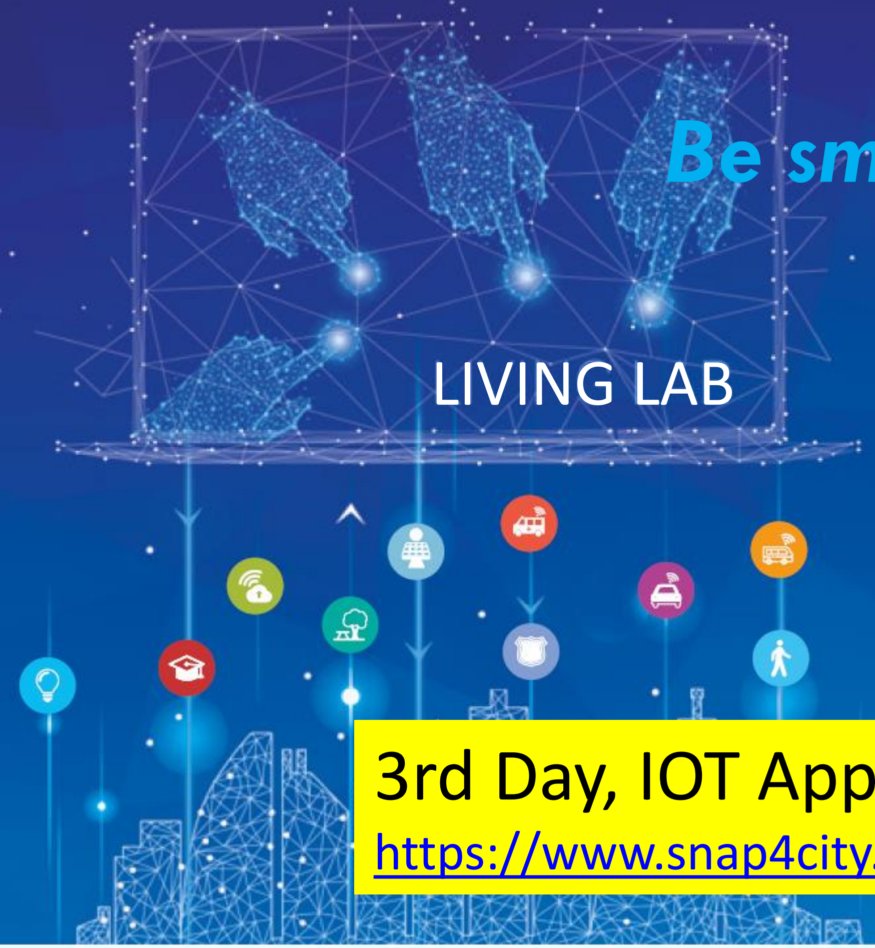
EU GDPR COMPLIANT

PEN Test Passed

SNAP4CITY on EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE

SNAP4 Appliances and Dockers Installations

Be smart in a SNAP!



3rd Day, IOT Applications, Nov 2019.

https://www.snap4city.org/501

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

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

UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

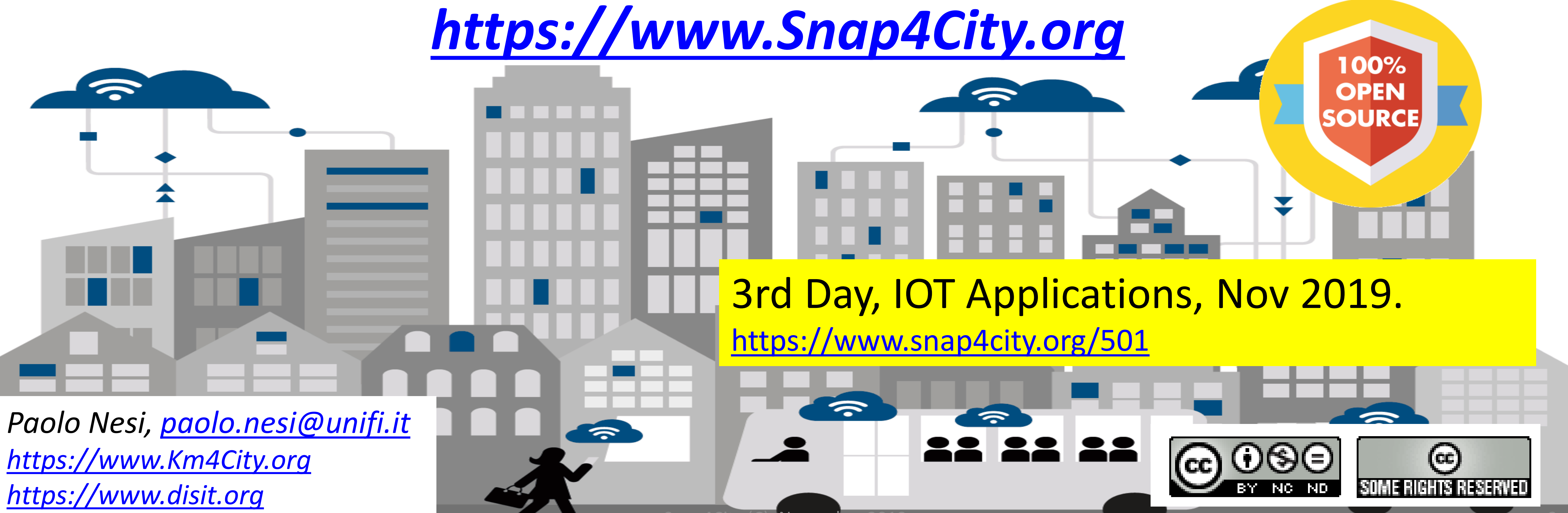
DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

SNAP4CITY

KM4CITY Powered by

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

https://www.Snap4City.org



3rd Day, IOT Applications, Nov 2019.
https://www.snap4city.org/501

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

General Overview of the full Course

- **1st Day:** *General overview (1 day, 6 hours)*
- ***2nd Day:*** *Dashboards, how to build and manage them (4 hours)*
- ***3rd Day:*** *IOT Applications development, IOT Devices, IOT Networks (4 hours)*
- ***4th Day:*** *Data Analytics, in R Studio, In Python, how to integrate with IOT Applications (4 hours)*
- ***5th Day:*** *Data Ingestion, Data Warehouse, ETL Development, Data Gate, IOT Device Data ingestion, etc.. (5 hours)*
- ***6th Day:*** *Snap4City Architecture, How To Install Snap4City (3 hours)*
- ***7th Day****: Smart city API (internal and external) Web and Mobile App development tool kit (4 hours)*

A number of the training sections include exercitations

Updated versions on: https://www.snap4city.org/501

3rd day Agenda

GO

- **IOT Applications, Devices and Dashboards**
  - Managing IOT Applications, Authoring IOT Applications
  - IOT App vs Data Analytic, IOT App vs Web Scraping
  - IOT Apps Examples

GO

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

GO

- **IOT Network Support**
  - Proprietary IOT Devices as Well as Open hardware / Open Software

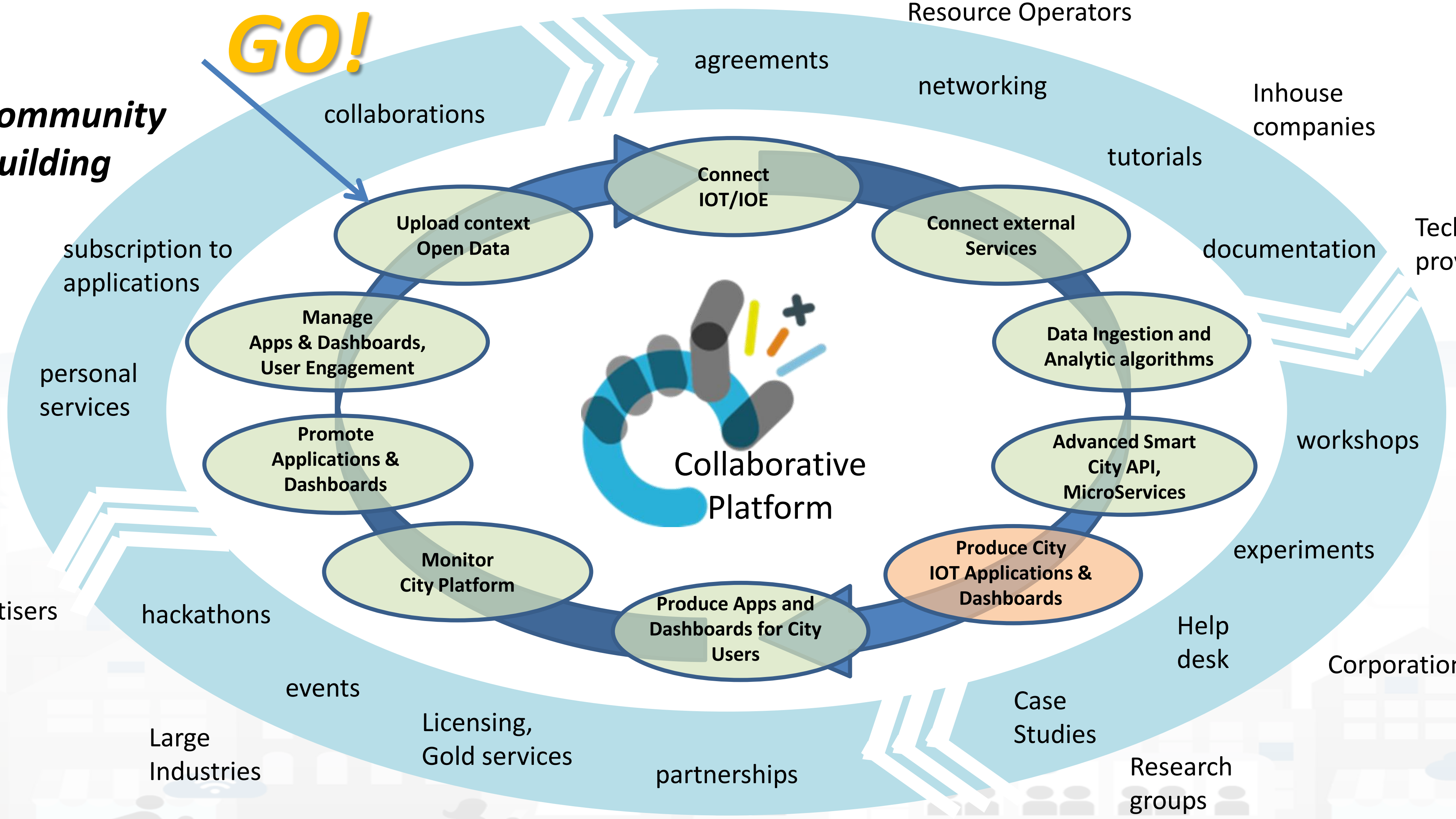
GO

- **IOT end-2-end Secure Stack**

Living Lab Accelerating

GO!

Community Building



Collaborative Platform

Connect IOT/IOE

Connect external Services

Data Ingestion and Analytic algorithms

Advanced Smart City API, MicroServices

Produce City IOT Applications & Dashboards

Produce Apps and Dashboards for City Users

Monitor City Platform

Promote Applications & Dashboards

Manage Apps & Dashboards, User Engagement

Upload context Open Data

collaborations

agreements

networking

tutorials

documentation

workshops

experiments

Help desk

Case Studies

partnerships

Licensing, Gold services

events

hackathons

personal services

subscription to applications

City Operators

Resource Operators

Inhouse companies

Tech providers

Category Associations

Corporations

Research groups

Start-ups

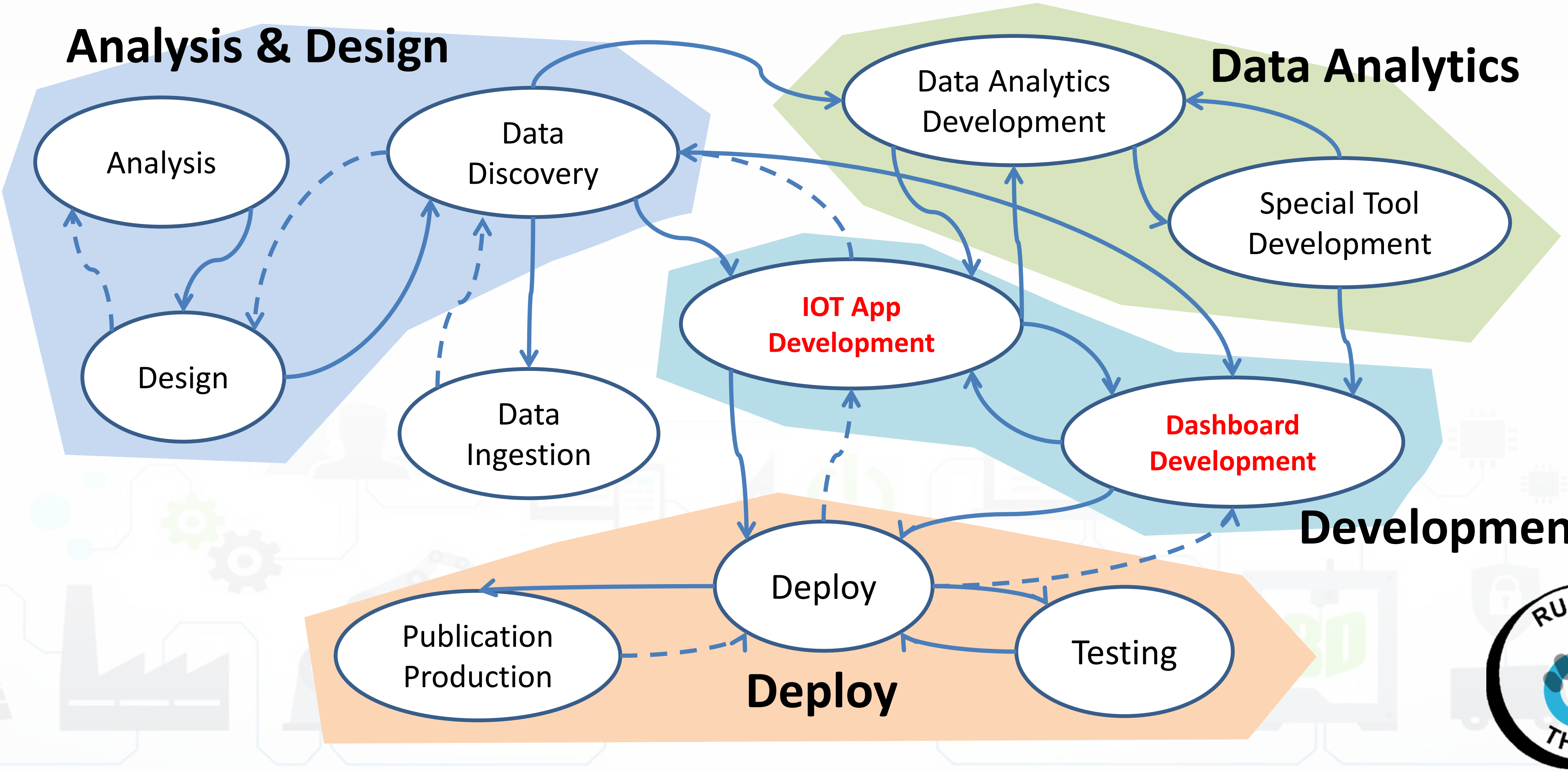
Early Adopters

Large Industries

Advertisers

City Users

Development Life Cycle
Smart City Services



Levels of Difficulty

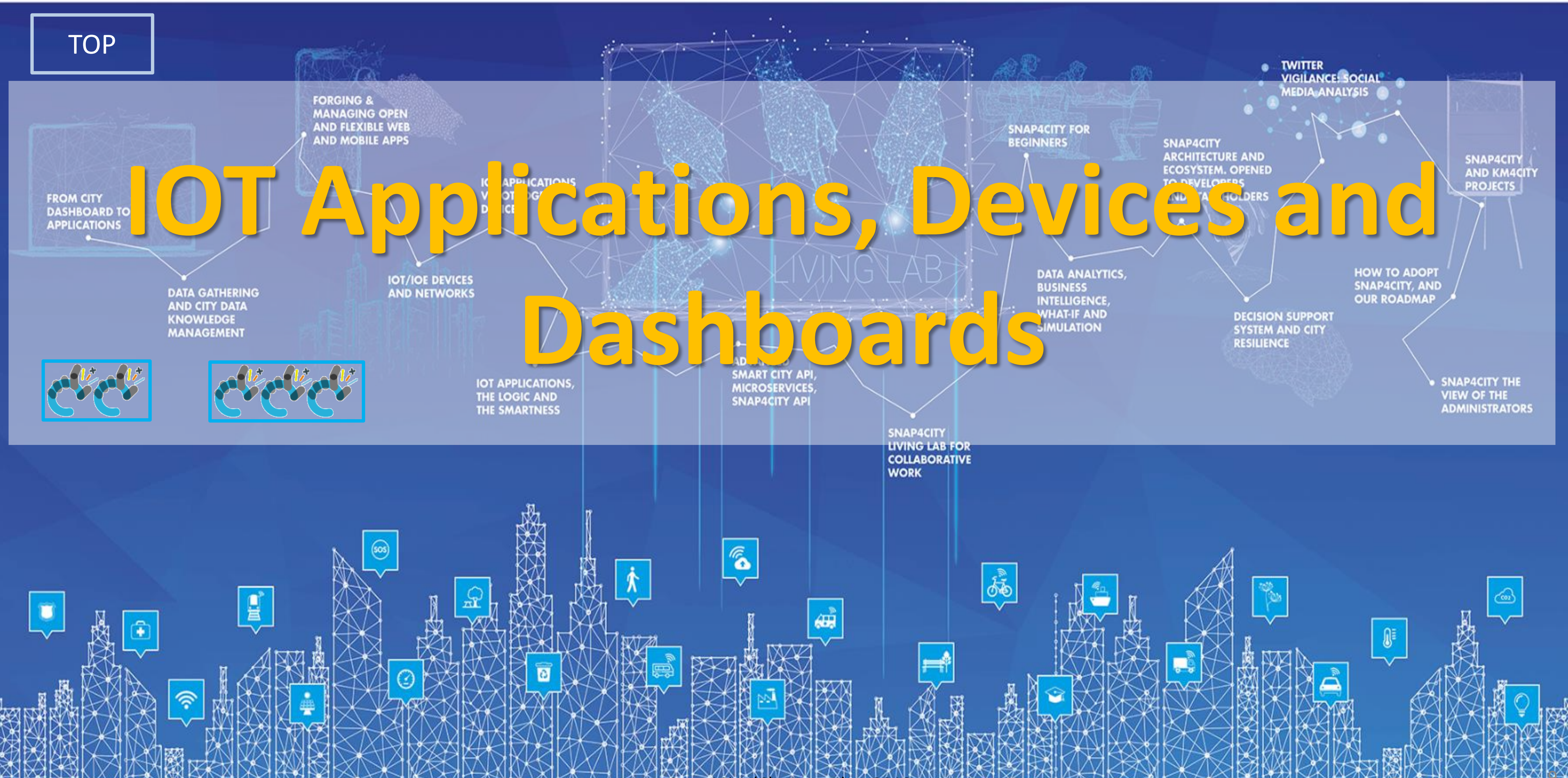
• Easy.	●	non programmer level
• Moderate.	●●	Some JavaScript rudiment coding
• Good.	●●●	JavaScript programming
• Golden.	●●●●	Programming in R Studio
• Professional.	●●●●●	Exploiting Smart City API
• Excellent.	●●●●●●	Developing Full IOT Applications, Dashboard and Mobile Apps

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

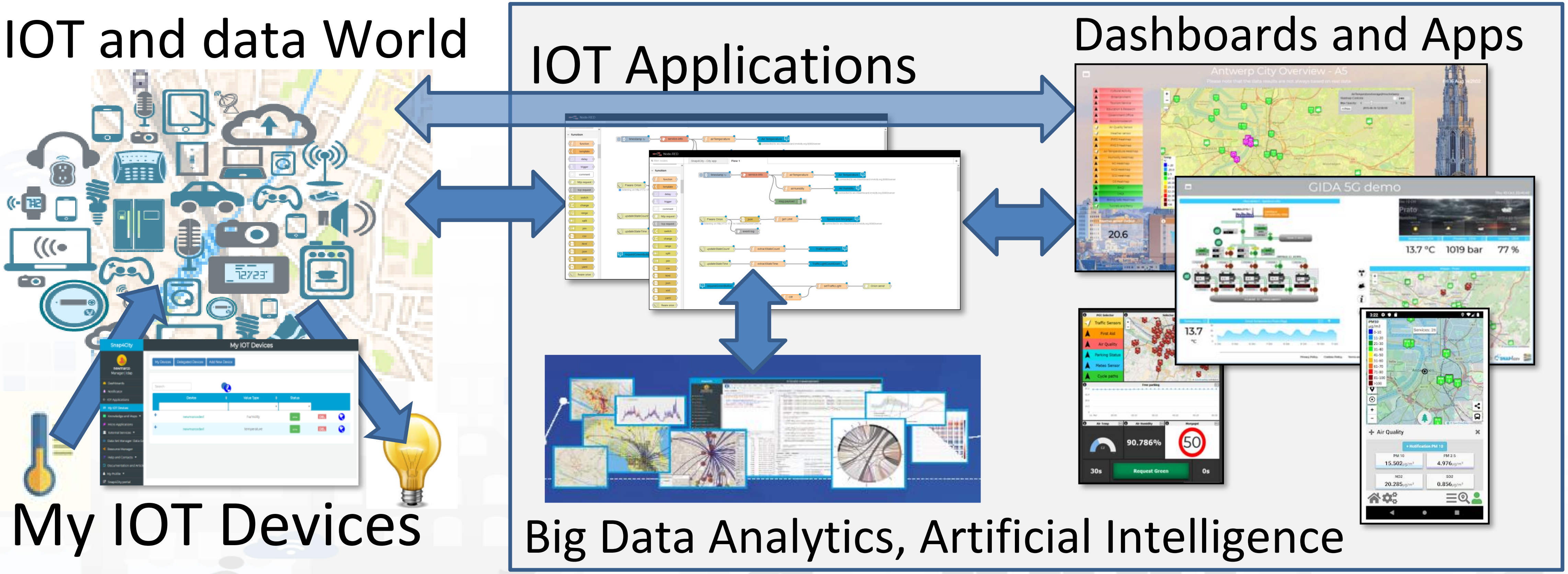
TOP

IOT Applications, Devices and Dashboards


FORGING & MANAGING OPEN AND FLEXIBLE WEB AND MOBILE APPS
FROM CITY DASHBOARD TO APPLICATIONS
IOT APPLICATIONS VIA IOT ... DEVICES
DATA GATHERING AND CITY DATA KNOWLEDGE MANAGEMENT
IOT/IOE DEVICES AND NETWORKS
IOT APPLICATIONS, THE LOGIC AND THE SMARTNESS
ADVANCED SMART CITY API, MICROSERVICES, SNAP4CITY API
LIVING LAB
SNAP4CITY LIVING LAB FOR COLLABORATIVE WORK
SNAP4CITY FOR BEGINNERS
TWITTER VIGILANCE: SOCIAL MEDIA ANALYSIS
SNAP4CITY ARCHITECTURE AND ECOSYSTEM. OPENED TO DEVELOPERS AND STAKEHOLDERS
SNAP4CITY AND KM4CITY PROJECTS
DATA ANALYTICS, BUSINESS INTELLIGENCE, WHAT-IF AND SIMULATION
DECISION SUPPORT SYSTEM AND CITY RESILIENCE
HOW TO ADOPT SNAP4CITY, AND OUR ROADMAP
SNAP4CITY THE VIEW OF THE ADMINISTRATORS
SOS

Snap4City: Builder of Sentient Cities Solutions

Dashboards with data driven IOT Applications enforcing intelligence



IOT and data World

IOT Applications

Dashboards and Apps

My IOT Devices

Big Data Analytics, Artificial Intelligence

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

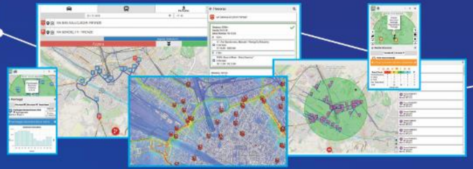
MICROSERVICES & ADVANCED SMART CITY API

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



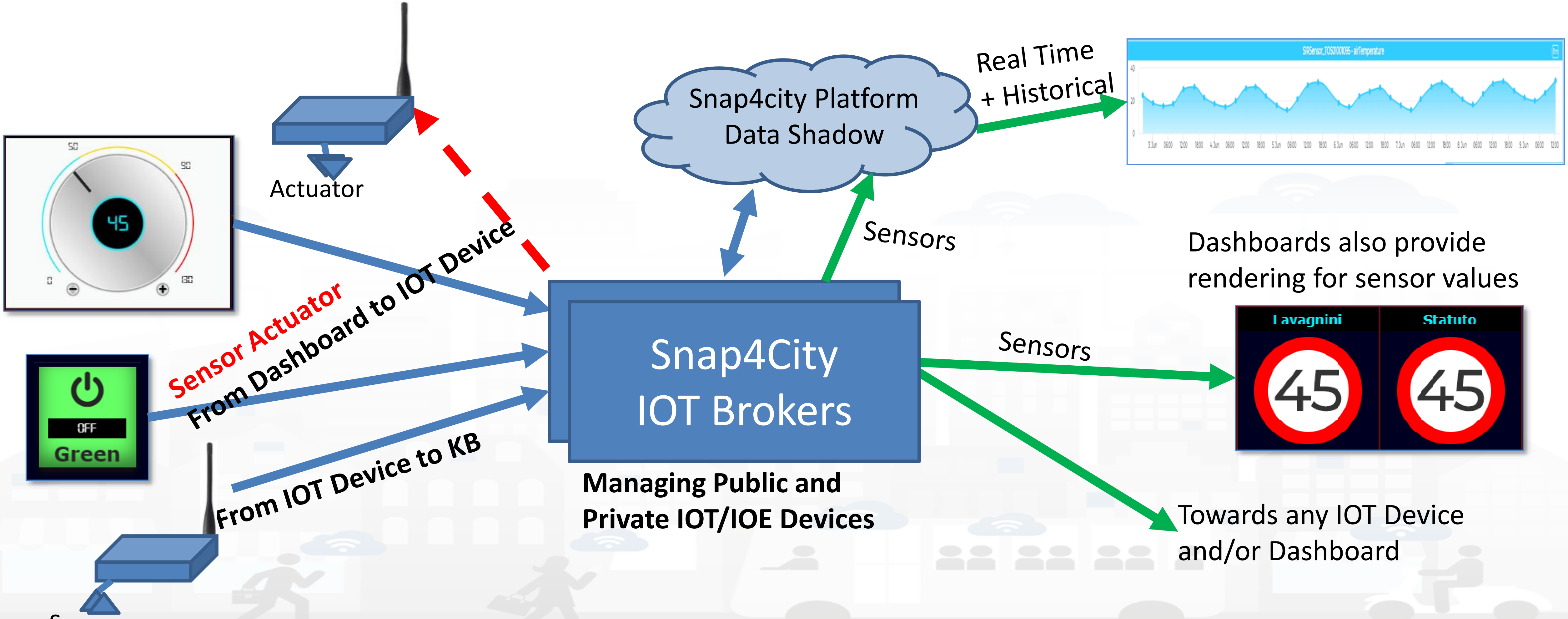
PREDICTIONS • ANOMALY DETECTION • WHAT-IF ANALYSIS • TRAFFIC FLOW RECONSTRUCTION • ORIGIN-DESTINATION MATRICES • SOCIAL MEDIA ANALYSIS • OFFER VS DEMAND ANALYSIS • ENVIRONMENTAL DATA ANALYSIS AND PREDICTIONS • REAL TIME HEATMAPS • ROUTING • ALERTING • EARLY WARNING • PERSONAL AND VIRTUAL ASSISSTANTS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

IOT Data Driven



Actuator

Snap4city Platform Data Shadow

Real Time + Historical

Sensors

Dashboards also provide rendering for sensor values

Sensor Actuator

From Dashboard to IOT Device

From IOT Device to KB

Snap4City IOT Brokers

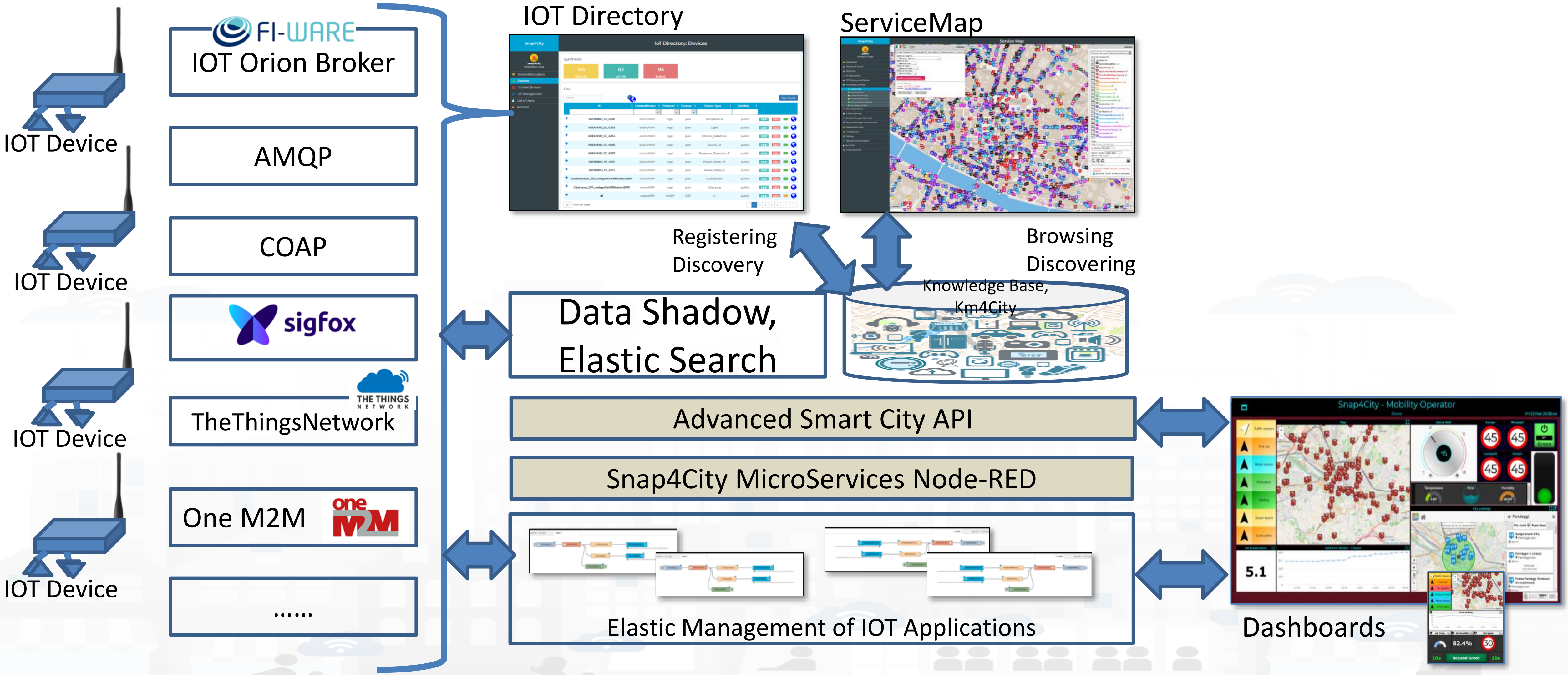
Sensors

Managing Public and Private IOT/IOE Devices

Towards any IOT Device and/or Dashboard

Sensors

IOT Architecture



IOT Device

IOT Device

IOT Device

IOT Device

FI-WARE

IOT Orion Broker

AMQP

COAP

sigfox

THE THINGS NETWORK

TheThingsNetwork

One M2M

……

IOT Directory

ServiceMap

Registering
Discovery

Browsing
Discovering

Knowledge Base,
Km4City

Data Shadow,
Elastic Search

Advanced Smart City API

Snap4City MicroServices Node-RED

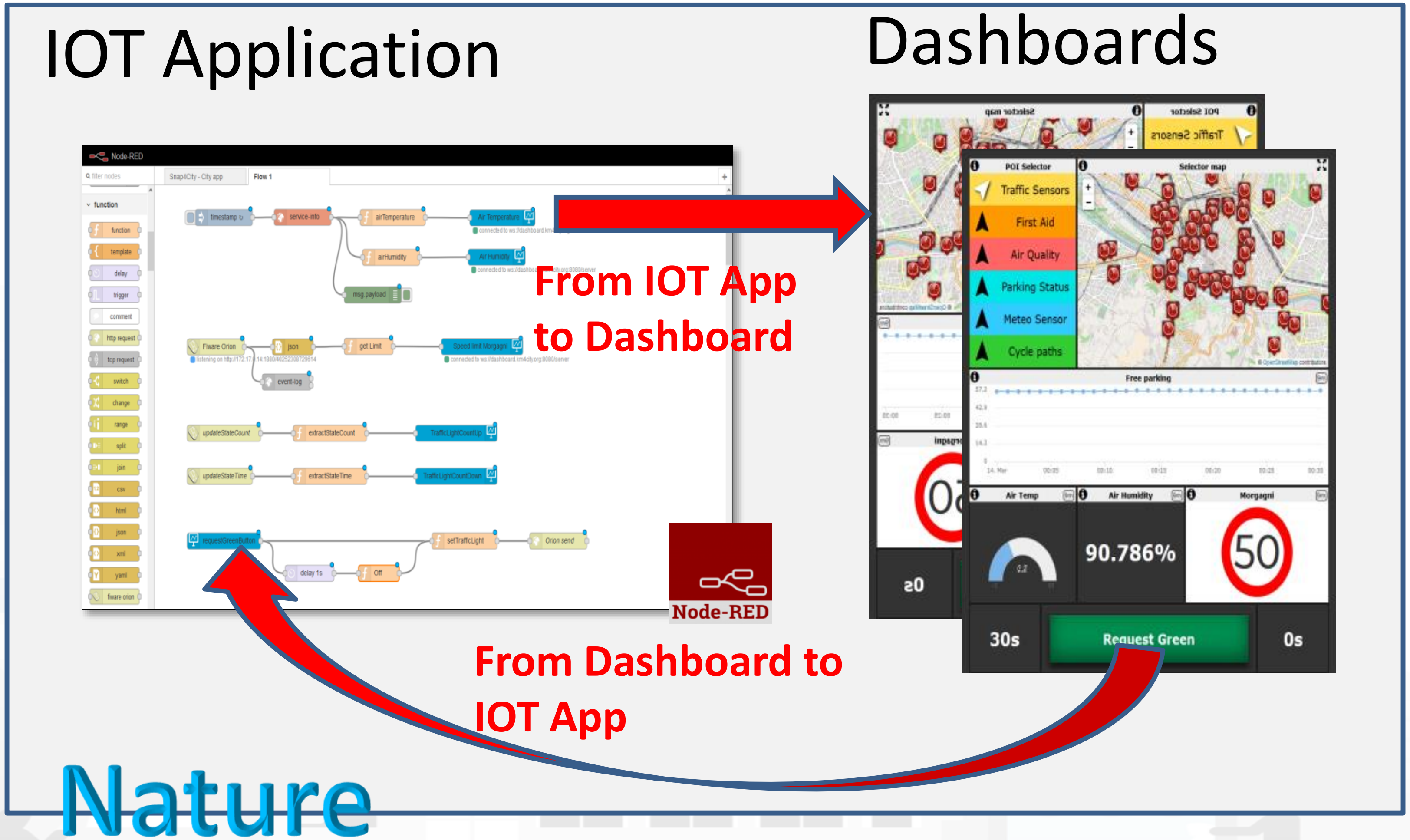
Elastic Management of IOT Applications

Dashboards

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)


IOT Application

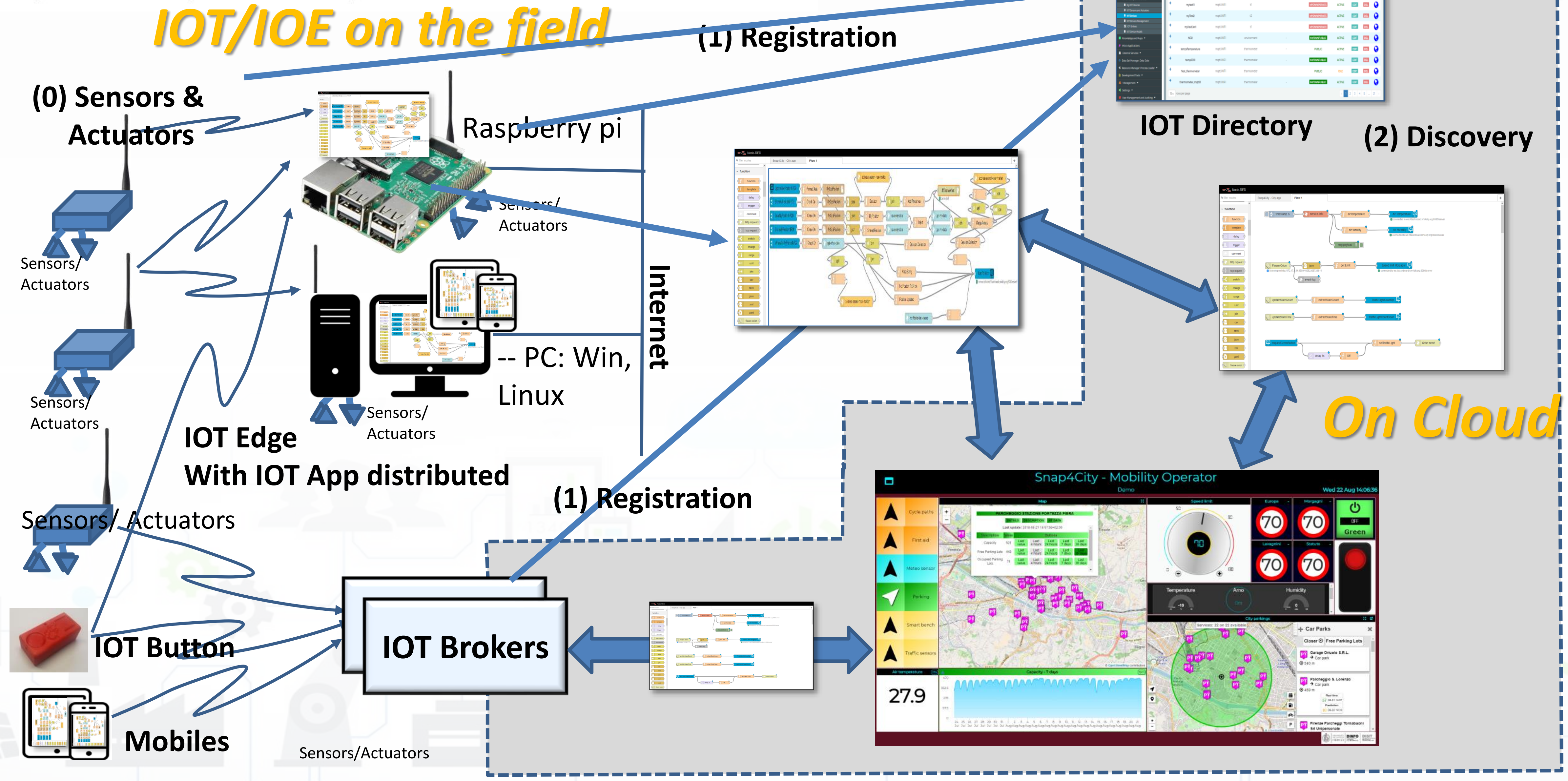
Dashboards

From IOT App to Dashboard

From Dashboard to IOT App

Nature

IOT/IOE on the field



(0) Sensors & Actuators

(1) Registration

Raspberry pi

Sensors/ Actuators

Sensors/ Actuators

Sensors/ Actuators

Sensors/ Actuators

-- PC: Win, Linux

Internet

IOT Directory

(2) Discovery

On Cloud

IOT Edge
With IOT App distributed

(1) Registration

Sensors/ Actuators

IOT Button

IOT Brokers

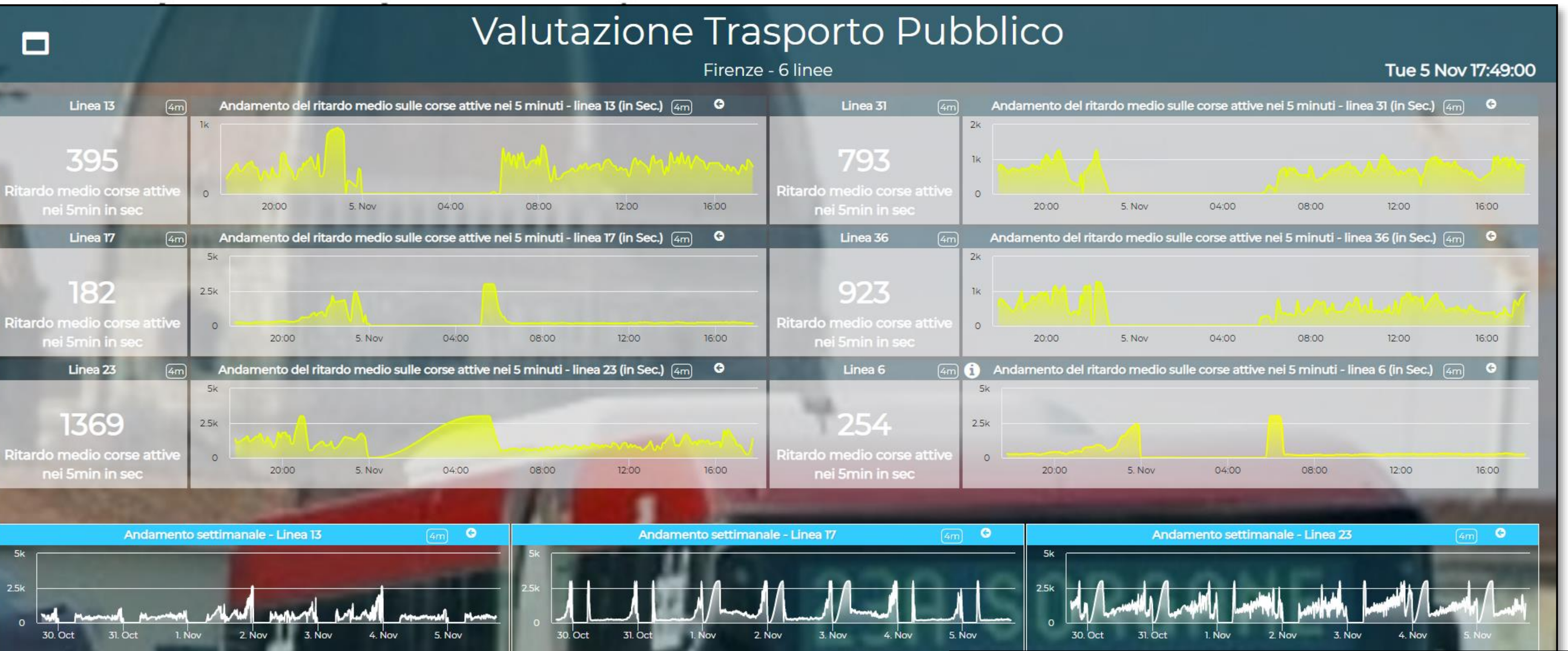
Mobiles

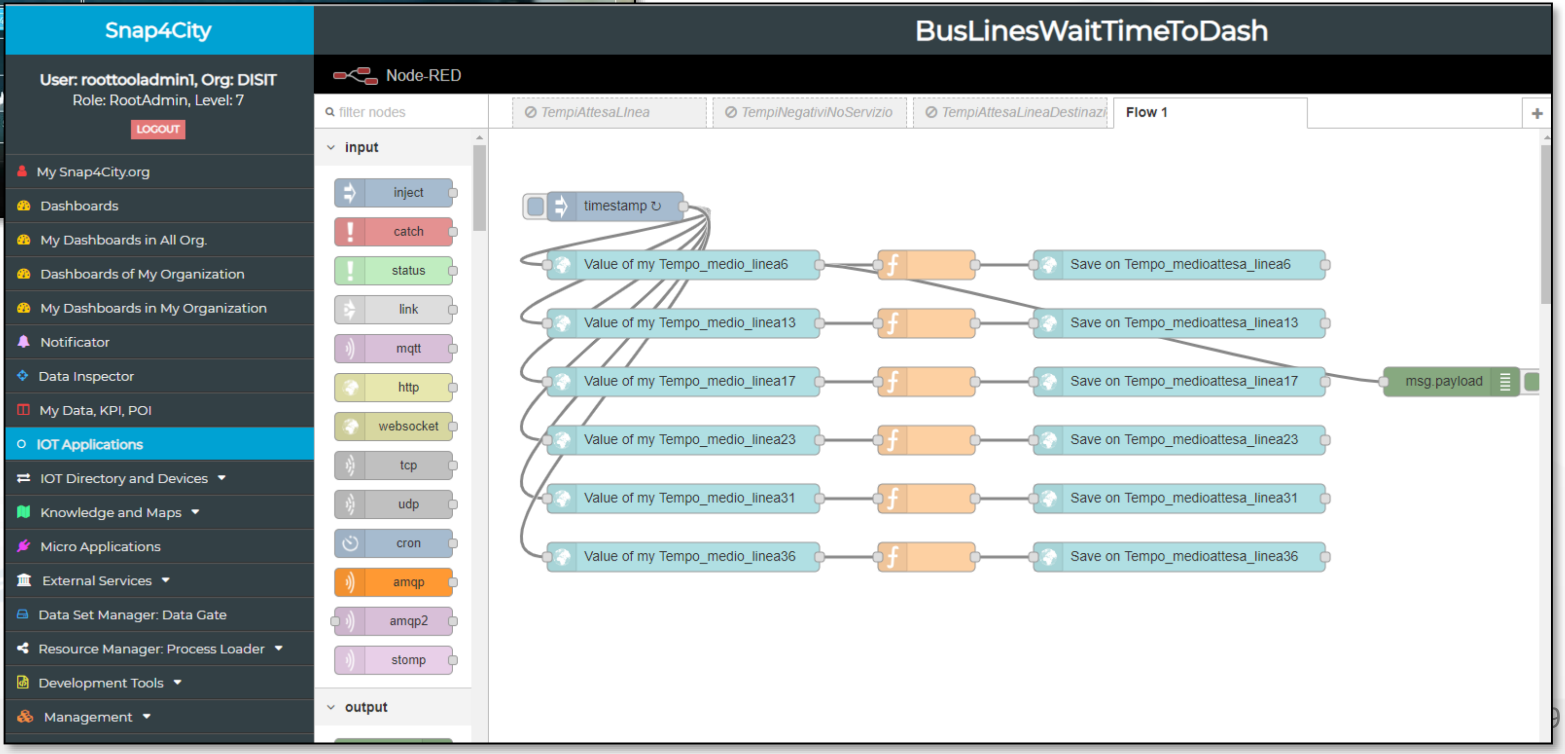
Sensors/Actuators

IOE Devices

Florence

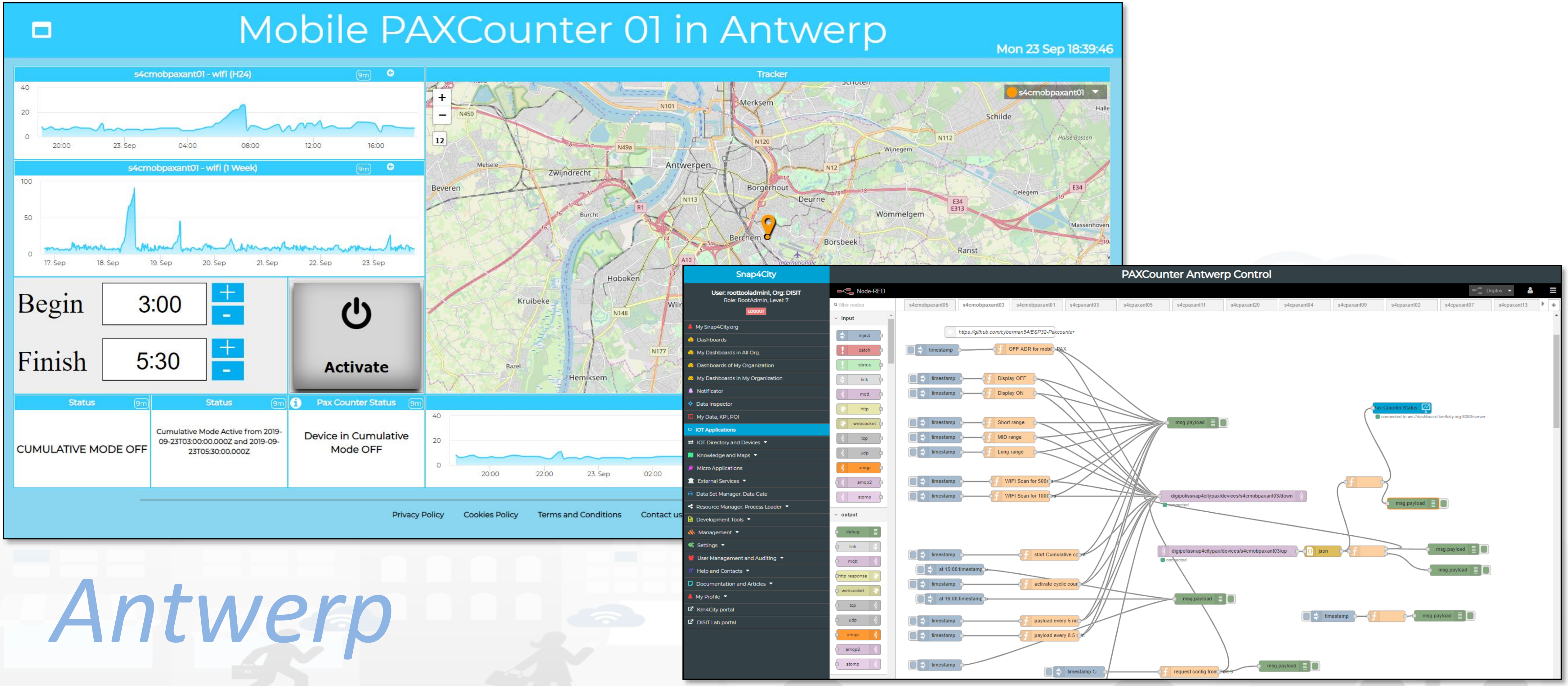
Estimation of the mean waiting time at bus stops


Valutazione Trasporto Pubblico
Firenze - 6 linee
Tue 5 Nov 17:49:00
Linea 13
395
Ritardo medio corse attive nei 5min in sec
Andamento del ritardo medio sulle corse attive nei 5 minuti - linea 13 (in Sec.)
Linea 31
793
Ritardo medio corse attive nei 5min in sec
Andamento del ritardo medio sulle corse attive nei 5 minuti - linea 31 (in Sec.)
Linea 17
182
Ritardo medio corse attive nei 5min in sec
Andamento del ritardo medio sulle corse attive nei 5 minuti - linea 17 (in Sec.)
Linea 36
923
Ritardo medio corse attive nei 5min in sec
Andamento del ritardo medio sulle corse attive nei 5 minuti - linea 36 (in Sec.)
Linea 23
1369
Ritardo medio corse attive nei 5min in sec
Andamento del ritardo medio sulle corse attive nei 5 minuti - linea 23 (in Sec.)
Linea 6
254
Ritardo medio corse attive nei 5min in sec
Andamento del ritardo medio sulle corse attive nei 5 minuti - linea 6 (in Sec.)
20:00
5. Nov
04:00
08:00
12:00
16:00
Andamento settimanale - Linea 13
Andamento settimanale - Linea 17
Andamento settimanale - Linea 23
Andamento settimanale - Linea 31
Andamento settimanale - Linea 36
30. Oct
31. Oct
1. Nov
2. Nov
3. Nov
4. Nov
5. Nov
Privacy Policy
Cookies Policy


Snap4City
BusLinesWaitTimeToDash
User: roottooladmin1, Org: DISIT
Role: RootAdmin, Level: 7
LOGOUT
My Snap4City.org
Dashboards
My Dashboards in All Org.
Dashboards of My Organization
Dashboards in My Organization
Notificator
Data Inspector
My Data, KPI, POI
IOT Applications
IOT Directory and Devices
Knowledge and Maps
Micro Applications
External Services
Data Set Manager: Data Gate
Resource Manager: Process Loader
Development Tools
Management
Node-RED
filter nodes
TempiAttesaLinea
TempiNegativiNoServizio
TempiAttesaLineaDestinazi
Flow 1
input
inject
catch
status
link
mqtt
http
websocket
tcp
udp
cron
amqp
amqp2
stomp
output
timestamp ↻
Value of my Tempo_medio_linea6
Value of my Tempo_medio_linea13
Value of my Tempo_medio_linea17
Value of my Tempo_medio_linea23
Value of my Tempo_medio_linea31
Value of my Tempo_medio_linea36
Save on Tempo_medioattesa_linea6
Save on Tempo_medioattesa_linea13
Save on Tempo_medioattesa_linea17
Save on Tempo_medioattesa_linea23
Save on Tempo_medioattesa_linea31
Save on Tempo_medioattesa_linea36
msg.payload

Antwerp

Programmable PAX counting



Mobile PAXCounter 01 in Antwerp

Mon 23 Sep 18:39:46

Begin 3:00

Finish 5:30

Status: CUMULATIVE MODE OFF

Status: Cumulative Mode Active from 2019-09-23T03:00:00.000Z and 2019-09-23T05:30:00.000Z

Pax Counter Status: Device in Cumulative Mode OFF

PAXCounter Antwerp Control

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

https://github.com/cyberman54/ESP32-Paxcounter

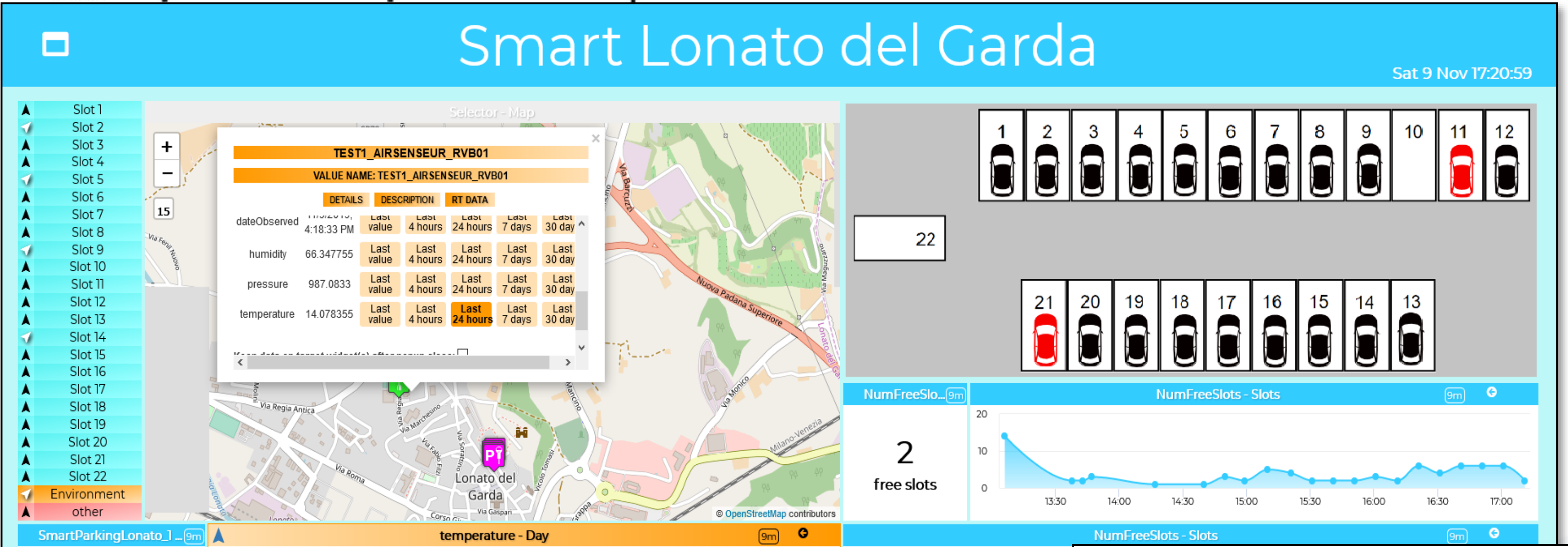
connected to ws://dashboard.km4city.org:8080/server

Antwerp

Snap4City (C), November 2019

Lonato del Garda

Smart Parking Monitoring


Smart Lonato del Garda

Sat 9 Nov 17:20:59

TEST1_AIRSENSEUR_RVB01

VALUE NAME: TEST1_AIRSENSEUR_RVB01

DETAILS DESCRIPTION RT DATA

dateObserved	11/9/2019, 4:18:33 PM	Last value	Last 4 hours	Last 24 hours	Last 7 days	Last 30 day
humidity	66.347755	Last value	Last 4 hours	Last 24 hours	Last 7 days	Last 30 day
pressure	987.0833	Last value	Last 4 hours	Last 24 hours	Last 7 days	Last 30 day
temperature	14.078355	Last value	Last 4 hours	Last 24 hours	Last 7 days	Last 30 day

NumFreeSlo... 9m

2
free slots

NumFreeSlots - Slots 9m

SmartParkingLonato_1_... 9m

0
status

temperature - Day 9m

NumFreeSlots - Slots 9m

pressure 9m	humidity % 9m	temperature 9m	Slot ID 9m	Max Present Duration 9m
987.1 mm	66.3 %	14.1 C	14 slot ID	19 ore e 11 minuti

TEST1...

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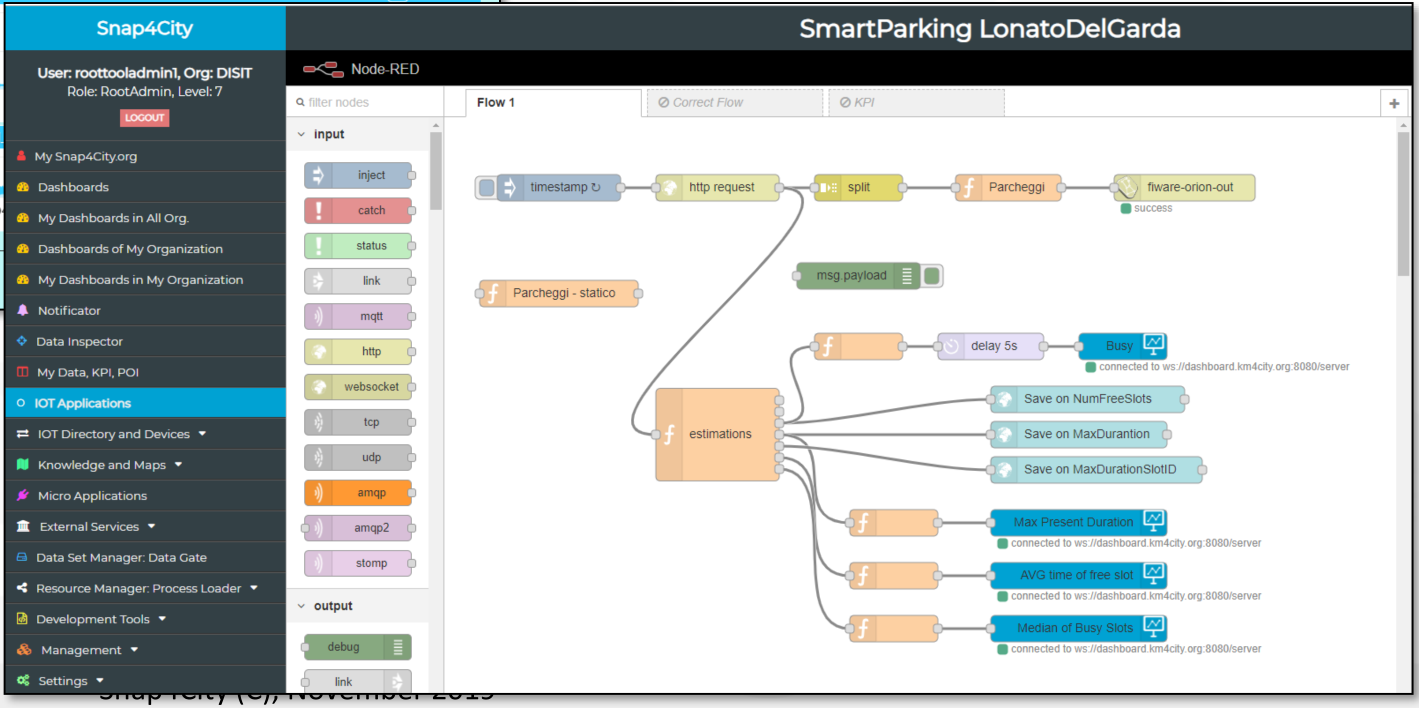

SmartParking LonatoDelGarda

Snap4City

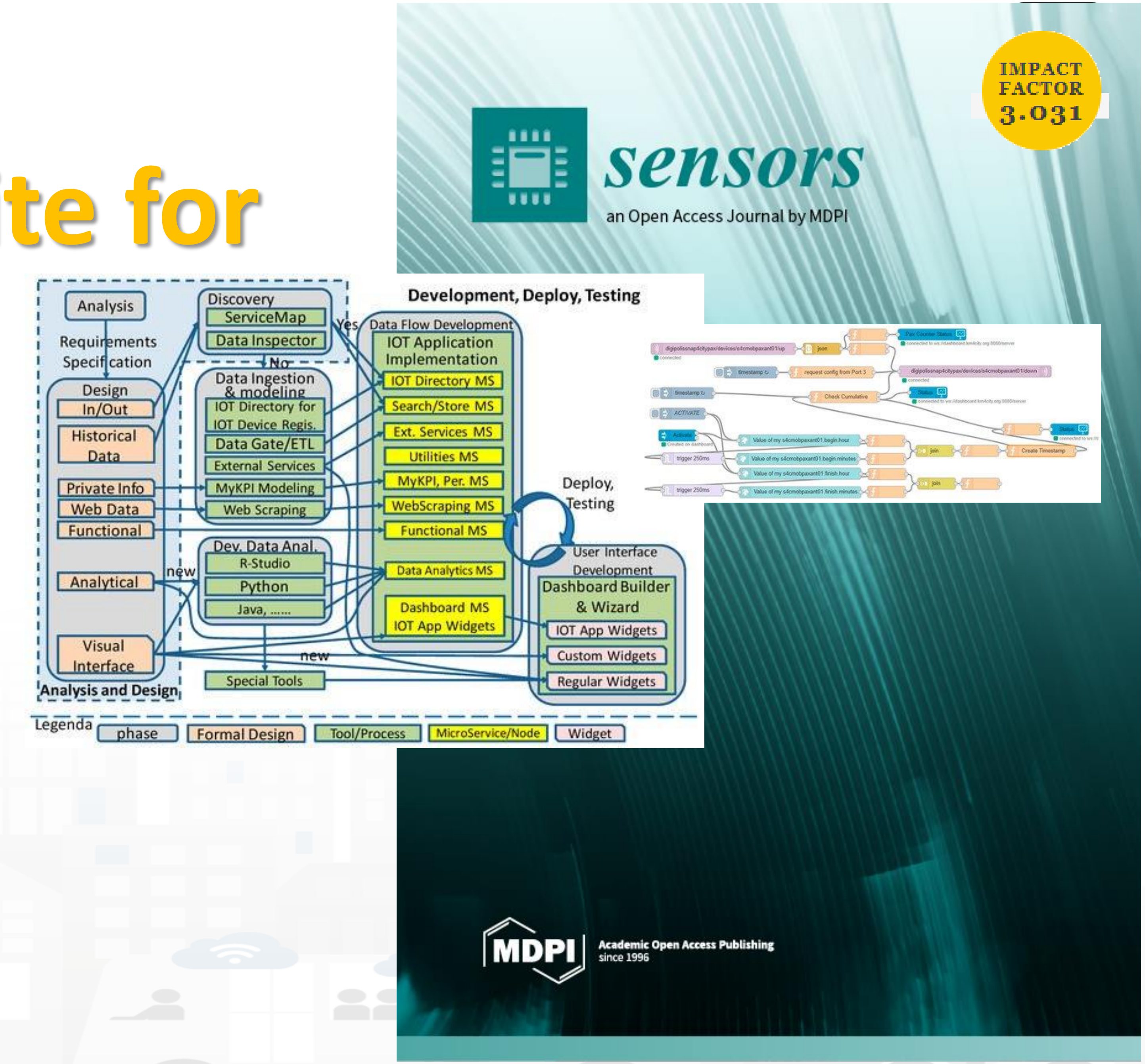
User: roottooladmin1, Org: DISIT
Role: RootAdmin, Level: 7

LOGOUT

Lonato del Garda

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



Analysis
Requirements Specification
Design In/Out
Historical Data
Private Info
Web Data
Functional
Analytical
Visual Interface
Analysis and Design
Discovery
ServiceMap
Data Inspector
Yes
No
Data Ingestion & modeling
IOT Directory for IOT Device Regis.
Data Gate/ETL
External Services
MyKPI Modeling
Web Scraping
Dev. Data Anal.
R-Studio
Python
Java, ……
new
Special Tools
Development, Deploy, Testing
Data Flow Development
IOT Application Implementation
IOT Directory MS
Search/Store MS
Ext. Services MS
Utilities MS
MyKPI, Per. MS
WebScraping MS
Functional MS
Data Analytics MS
Dashboard MS
IOT App Widgets
Deploy, Testing
User Interface Development
Dashboard Builder & Wizard
IOT App Widgets
Custom Widgets
Regular Widgets
Legenda: phase, Formal Design, Tool/Process, MicroService/Node, Widget

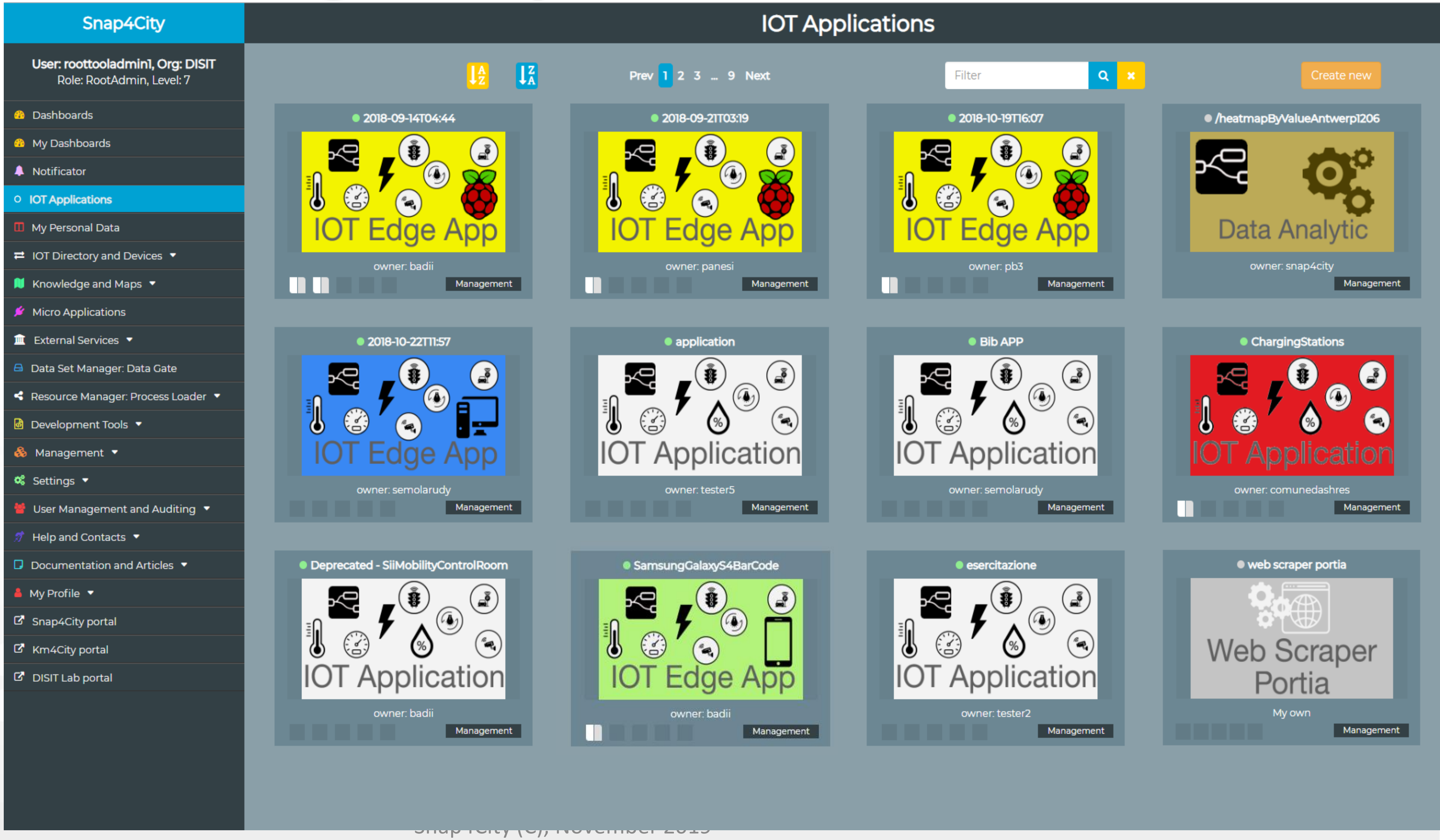
IMPACT FACTOR 3.031
sensors
an Open Access Journal by MDPI
MDPI
Academic Open Access Publishing since 1996

TOP

Managing IOT Applications

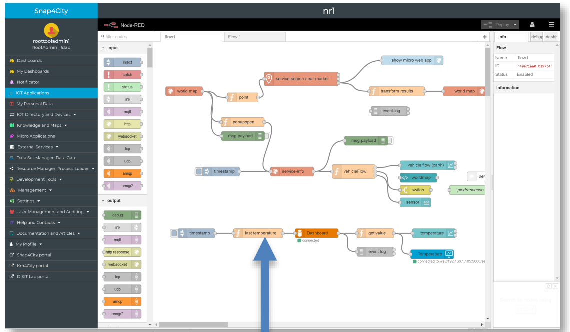
IOT Application Listing, they can be

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

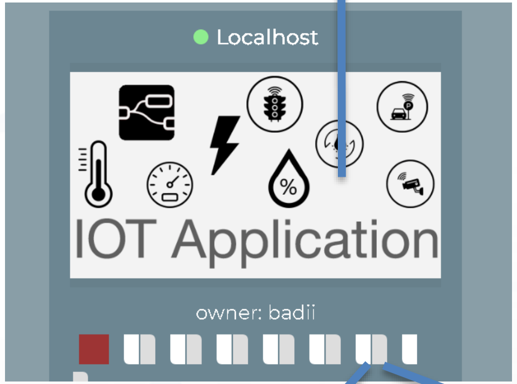


IOT Applications Listing

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

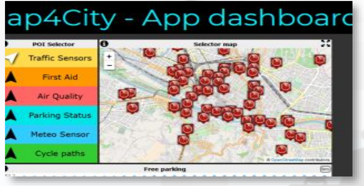


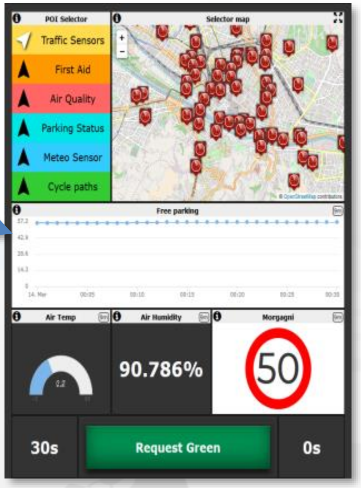
EDIT IOT APP

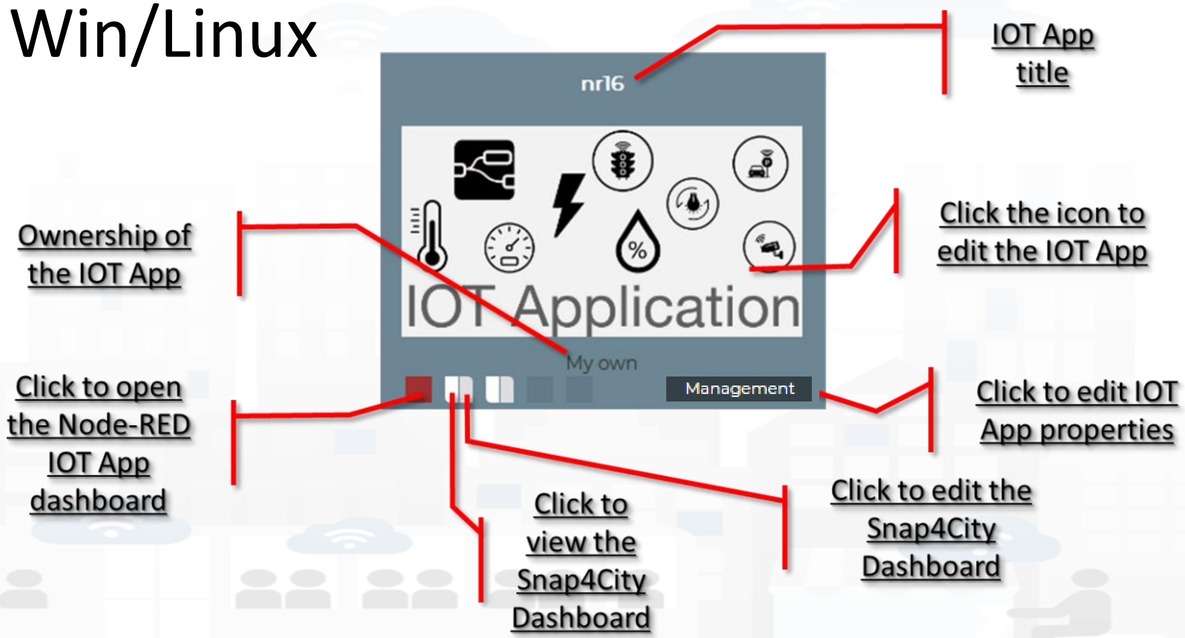


VIEW

EDIT







IOT App title

Click the icon to edit the IOT App

Ownership of the IOT App

Click to open the Node-RED IOT App dashboard

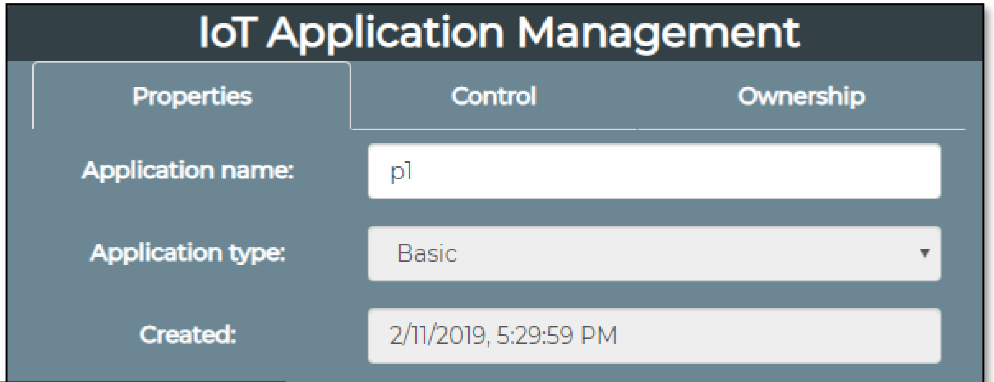
Click to edit IOT App properties

Click to edit the Snap4City Dashboard

Click to view the Snap4City Dashboard

IOT Application Management

- **Properties**
  - Name, Type, Creation date
- **Control**
  - Restart
  - Delete
- **Change of ownership**
  - Toward another Snap4City User



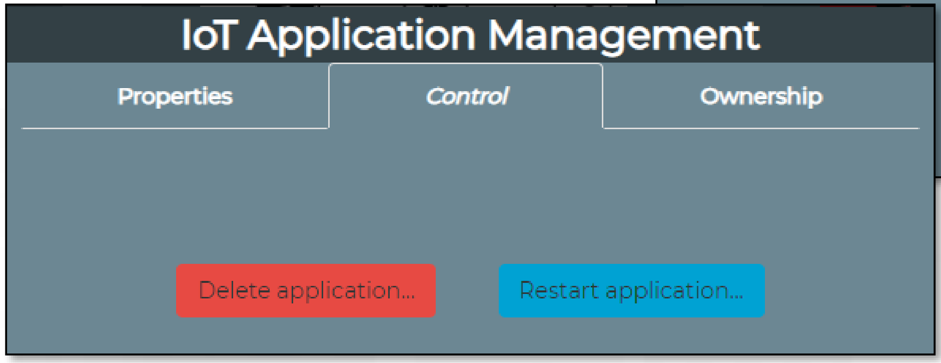
IoT Application Management

Properties | Control | Ownership

Application name: p1

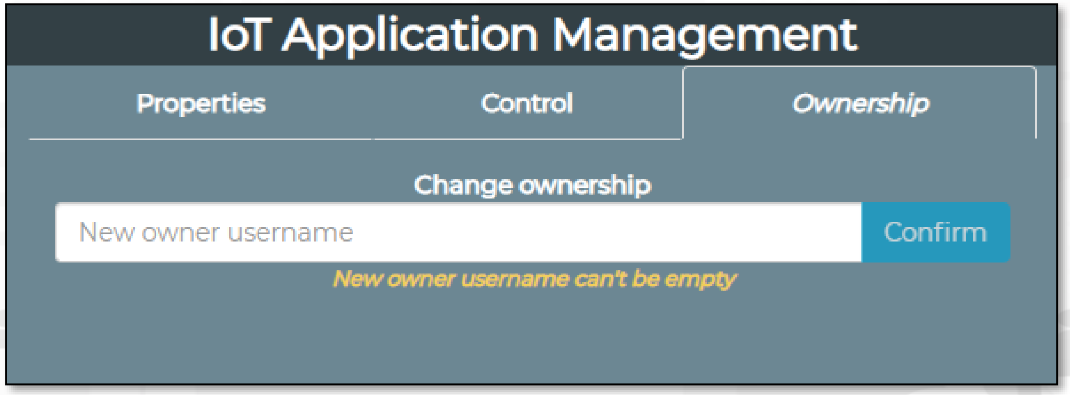
Application type: Basic

Created: 2/11/2019, 5:29:59 PM



IoT Application Management

Properties | *Control* | Ownership



IoT Application Management

Properties | Control | *Ownership*

Change ownership

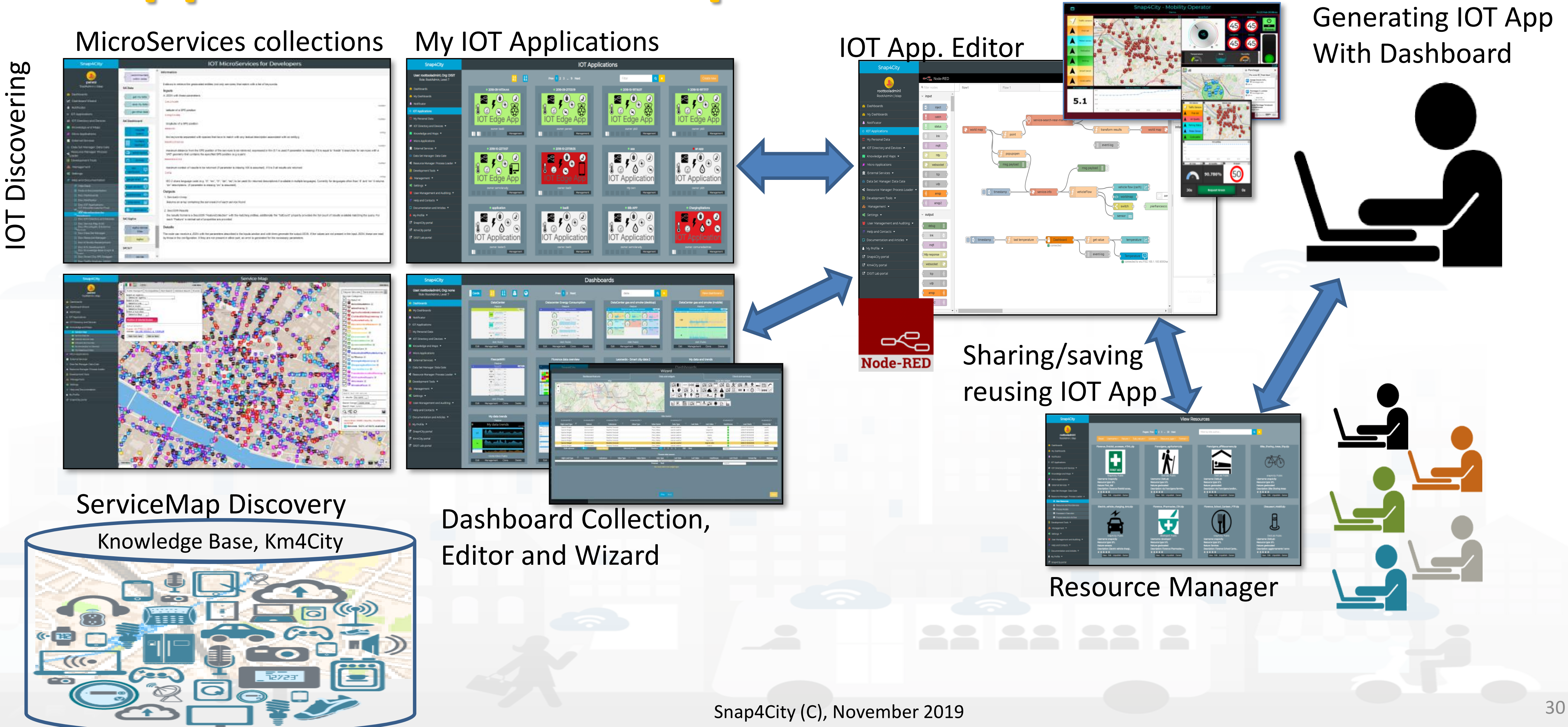
New owner username

New owner username can't be empty

TOP

Authoring IOT Applications

IOT Applications Development



IOT Discovering

MicroServices collections

My IOT Applications

IOT App. Editor

Generating IOT App With Dashboard

Node-RED

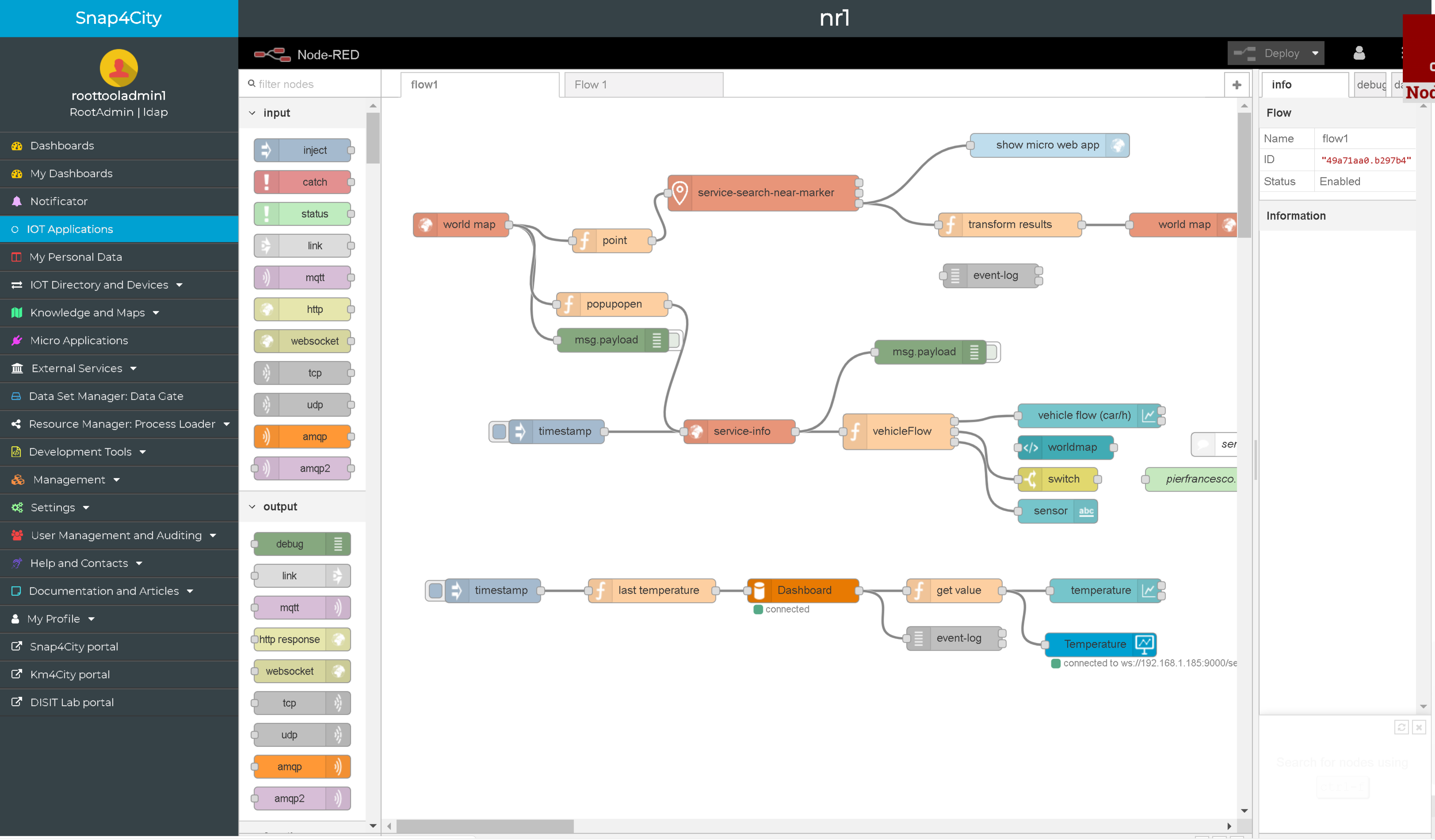
Sharing/saving reusing IOT App

ServiceMap Discovery

Knowledge Base, Km4City

Dashboard Collection, Editor and Wizard

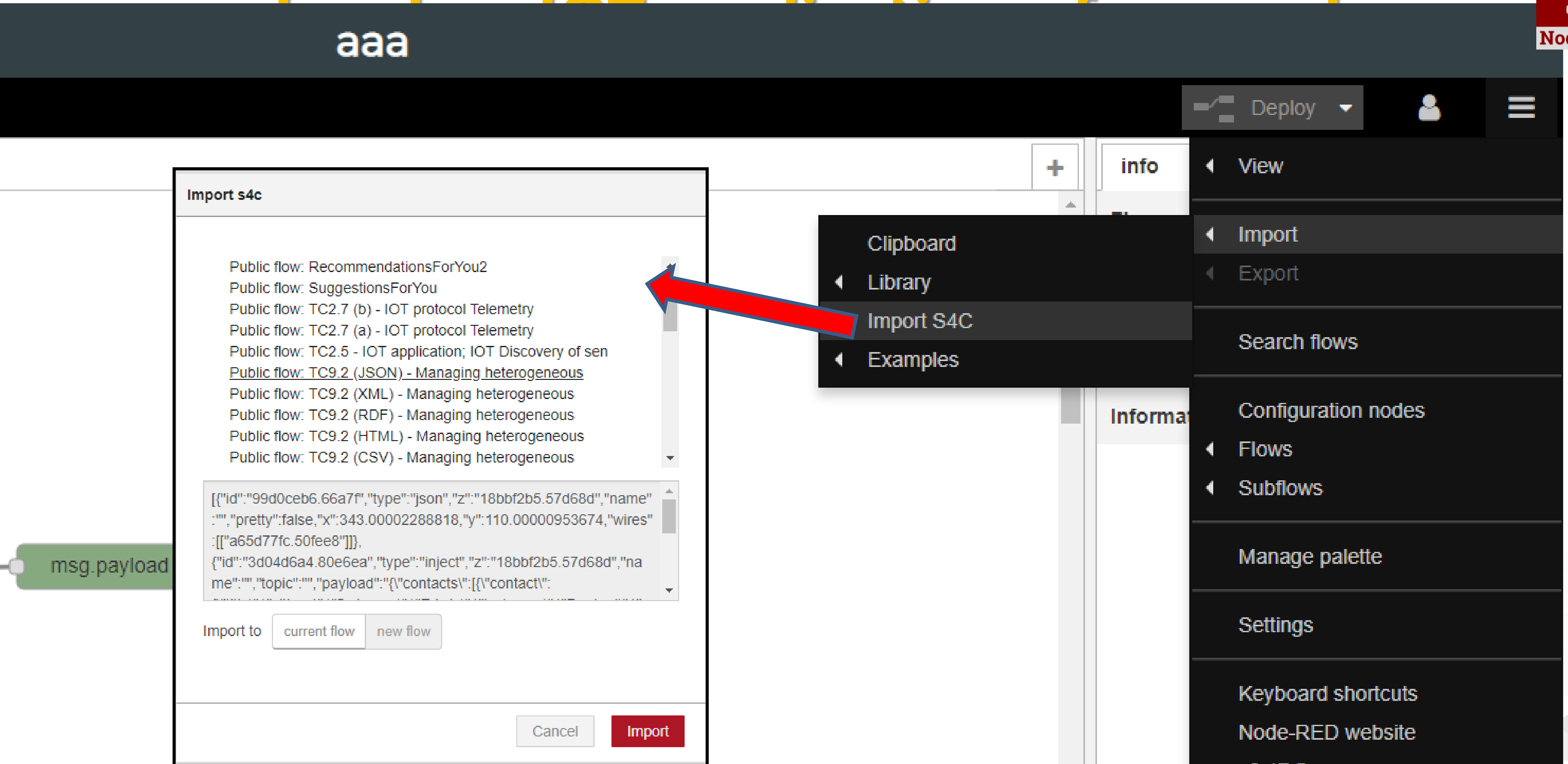
Resource Manager


Snap4City
nr1
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
Node-RED
Deploy
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
abc
ser
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

IOT Application Editor: NODE-RED

Node-RED

- In the IOT Application of Snap4City, it is possible to:
  - Create multiple concurrent Flows for each IOT Application
  - Execute flow that process data as: Event Driven, Batch (periodic or not)
  - Load other libraries of MicroServices/Nodes/Blocks
    - The loading is allowed only for Administrators for security reasons
  - Save/load, share, Flows, and applications with other users via the Resource Manager or with JS Foundation
  - Ask a limited number of IOT Applications.
    - The Limit may depend on the organization or on personal authorization
  - ..



Import s4c

Public flow: RecommendationsForYou2
Public flow: SuggestionsForYou
Public flow: TC2.7 (b) - IOT protocol Telemetry
Public flow: TC2.7 (a) - IOT protocol Telemetry
Public flow: TC2.5 - IOT application; IOT Discovery of sen
Public flow: TC9.2 (JSON) - Managing heterogeneous
Public flow: TC9.2 (XML) - Managing heterogeneous
Public flow: TC9.2 (RDF) - Managing heterogeneous
Public flow: TC9.2 (HTML) - Managing heterogeneous
Public flow: TC9.2 (CSV) - Managing heterogeneous

[{"id":"99d0ceb6.66a7f","type":"json","z":"18bbf2b5.57d68d","name"
:"","pretty":false,"x":343.00002288818,"y":110.00000953674,"wires"
:[["a65d77fc.50fee8"]]},
{"id":"3d04d6a4.80e6ea","type":"inject","z":"18bbf2b5.57d68d","na
me":"","topic":"","payload":"{\"contacts\":[{\"contact\":

Import to current flow new flow

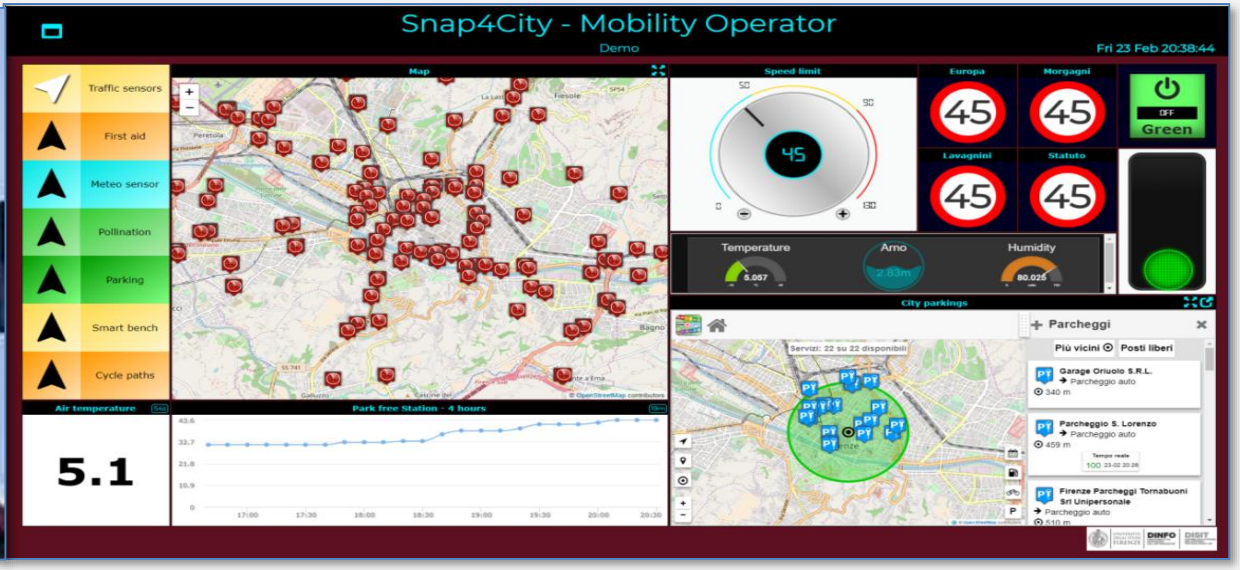
Cancel Import

City Dashboard + IOT App

Control Room Operator

Would like to:

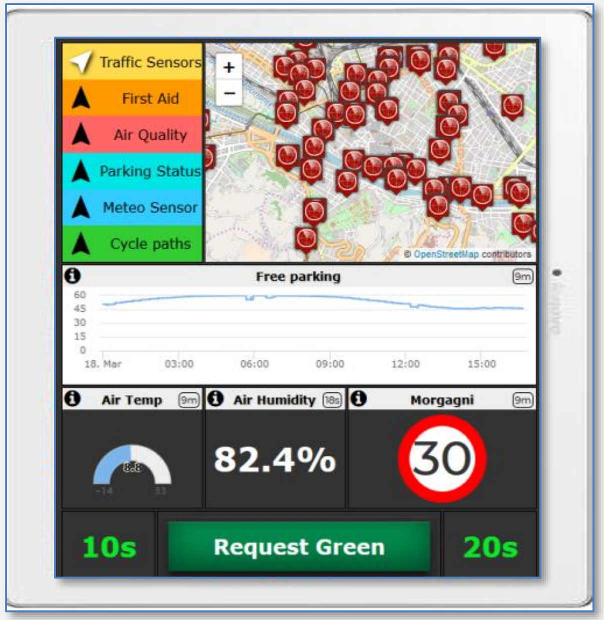
- **Monitor** traffic flow, Environment, Car parking, Cycling, First aid, temp., ..
- **Act and** monitor Dynamic Plates
- **Act and** monitor red lights



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

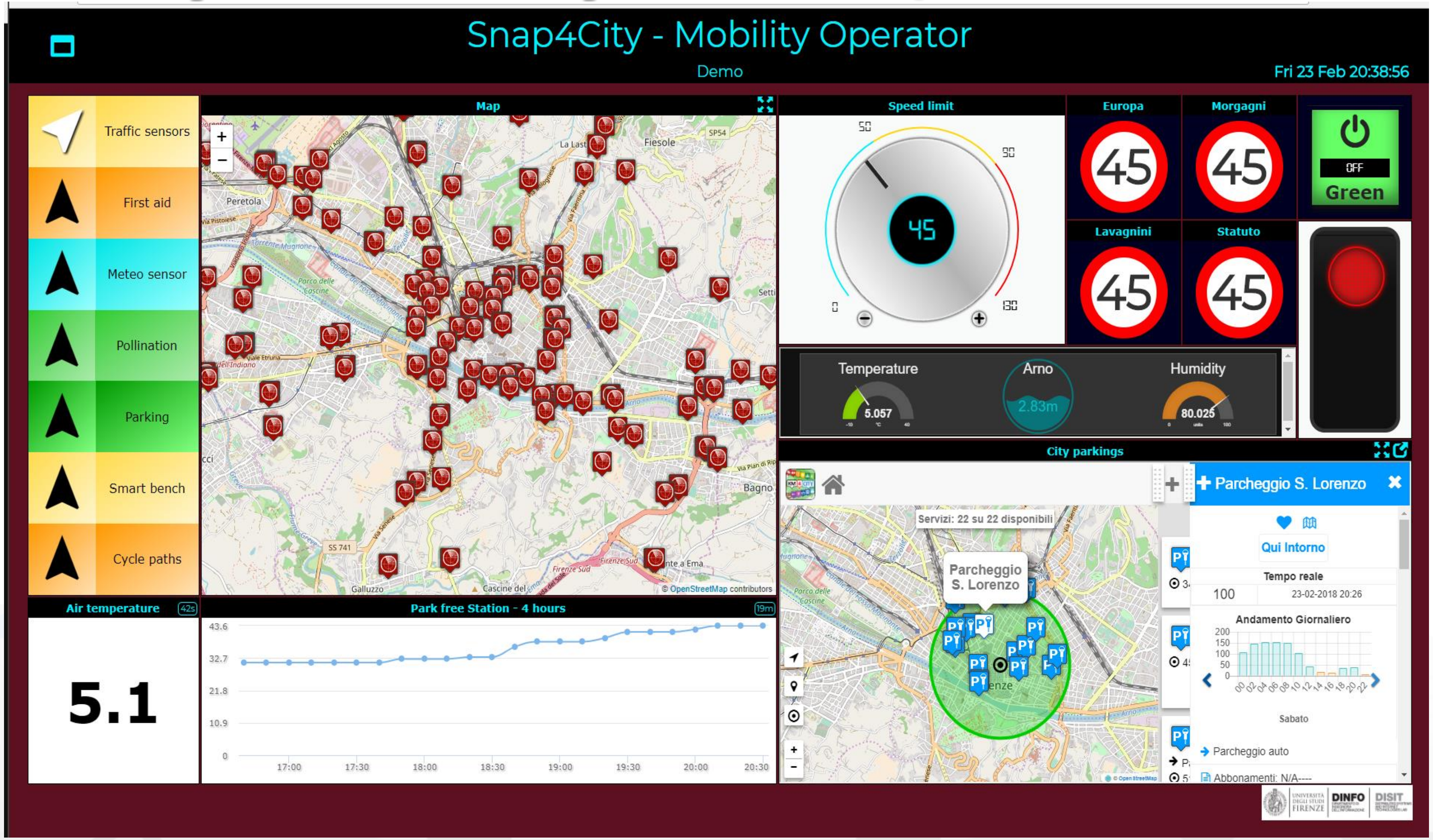
Sensors:

- Values
- Status

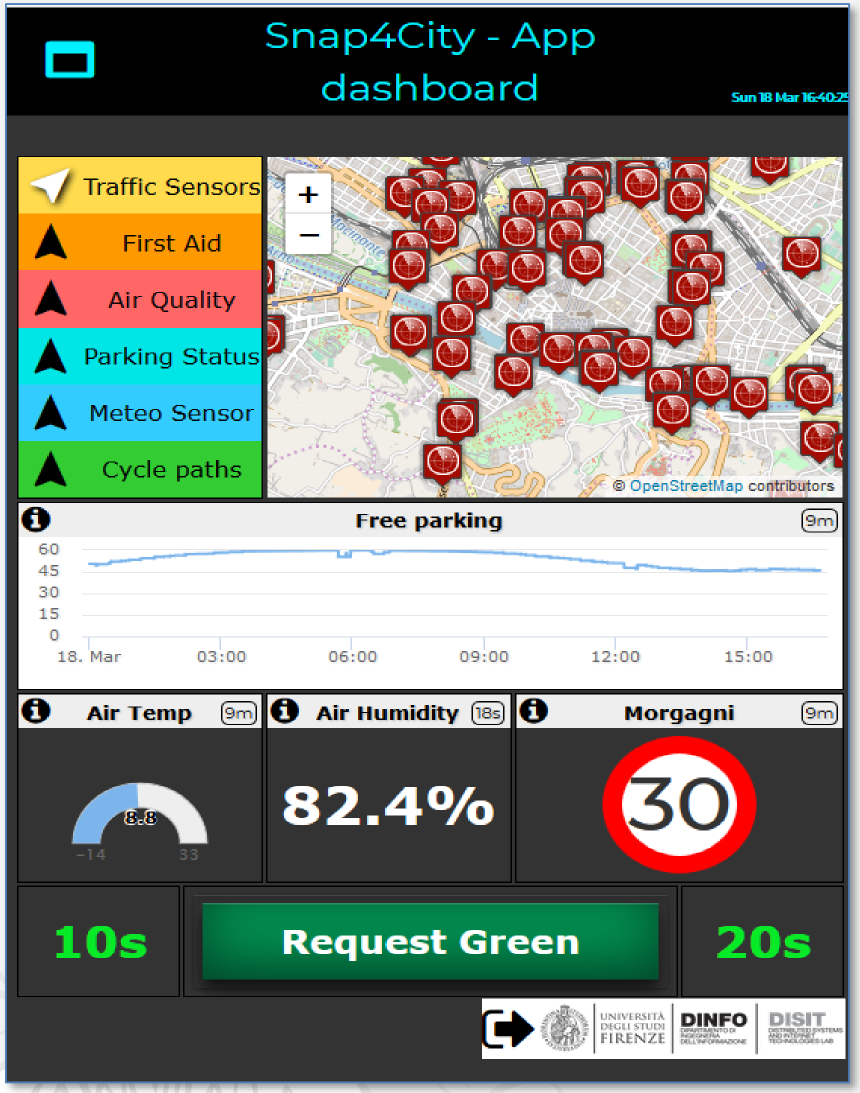
Actuators:

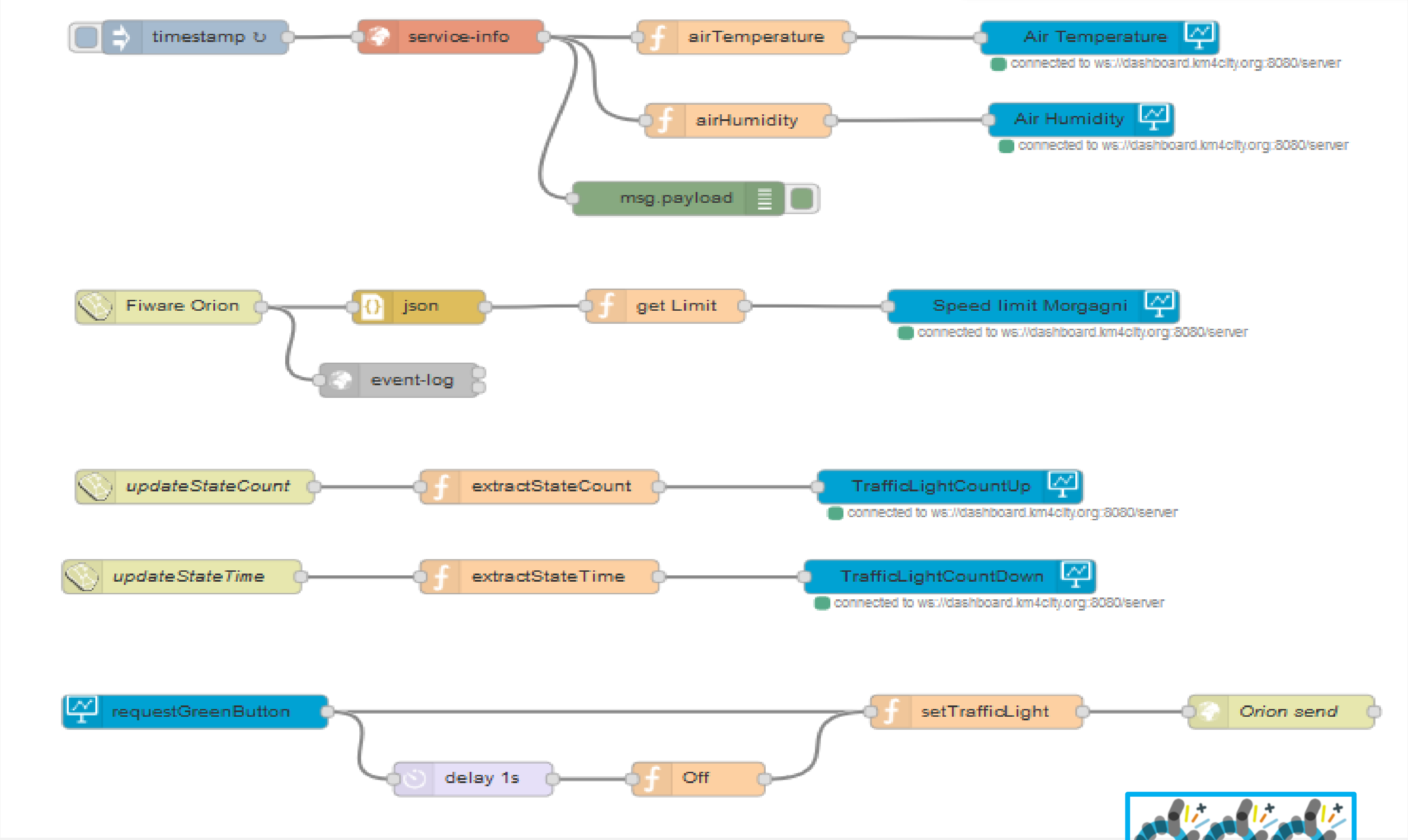
- Buttons
- Dimers
- Etc.

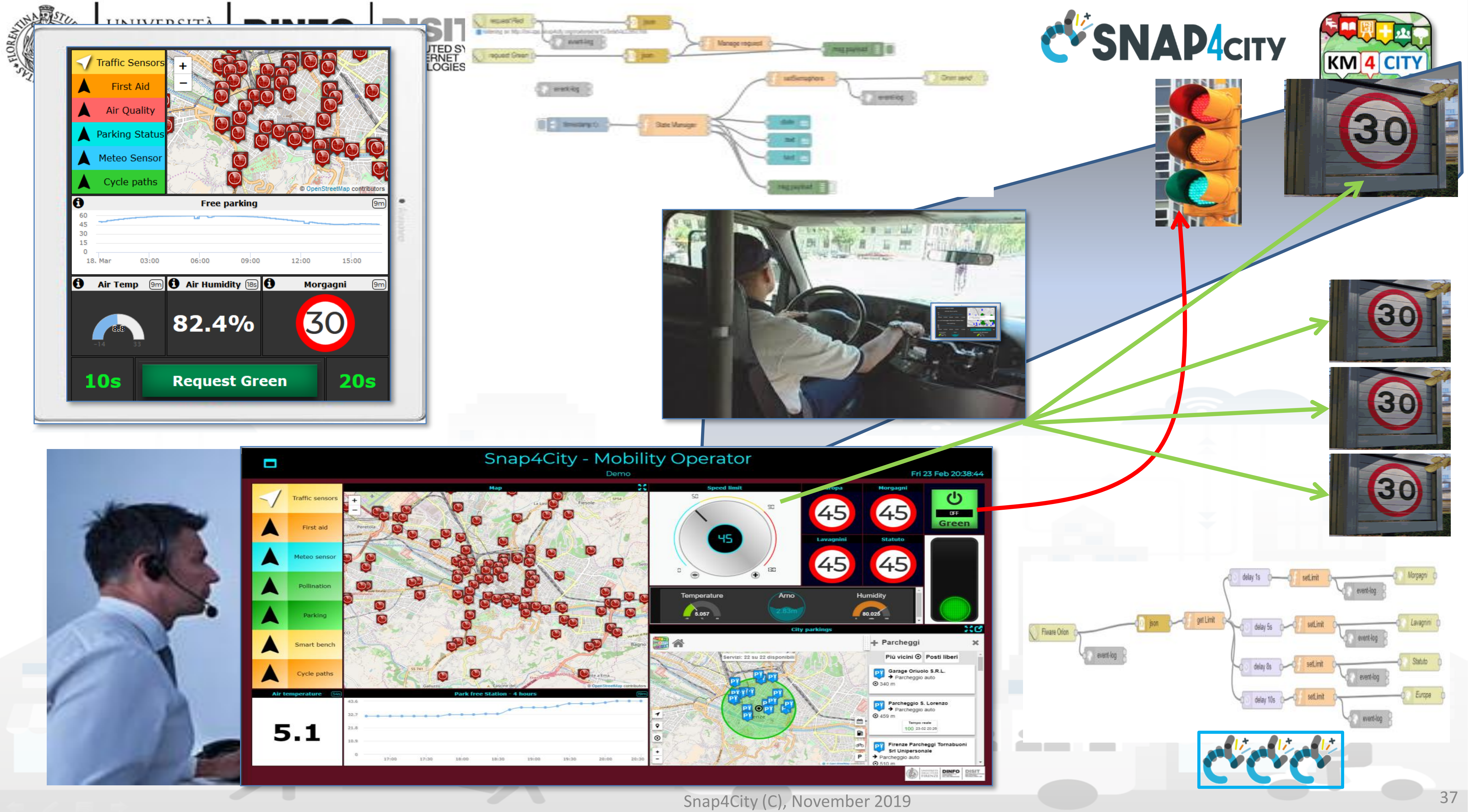
Virtual Sensors and Actuators



IOT Application with City Dashboard simple development





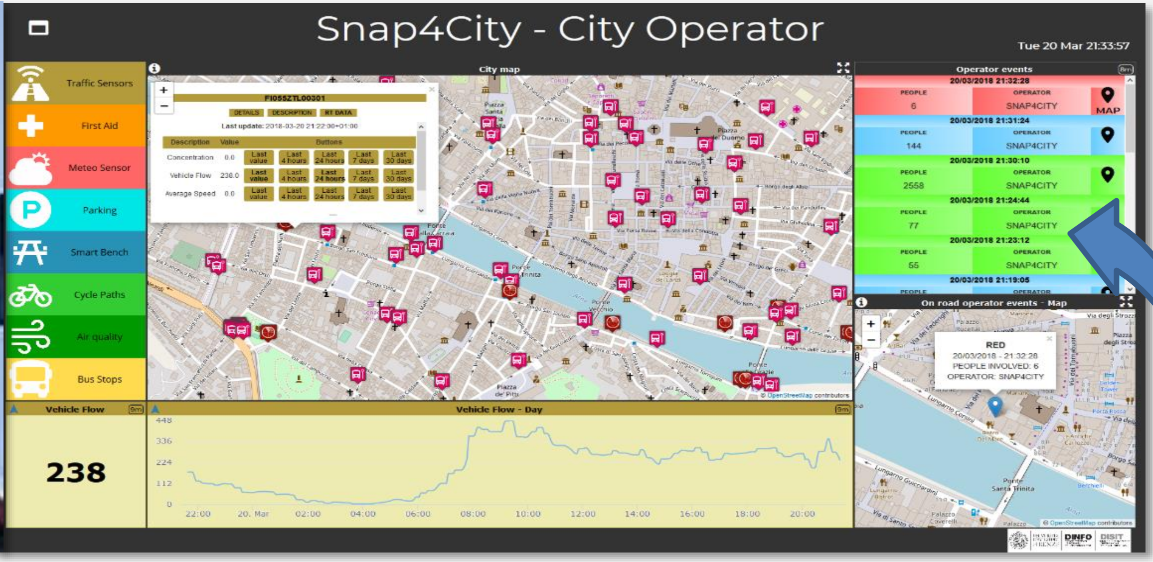

Traffic Sensors
First Aid
Air Quality
Parking Status
Meteo Sensor
Cycle paths
© OpenStreetMap contributors
Free parking
9m
60
45
30
15
0
18. Mar
03:00
06:00
09:00
12:00
15:00
Air Temp
9m
8.8
-14
33
Air Humidity
18s
82.4%
Morgagni
9m
30
10s
Request Green
20s
request Red
json
event-log
Manage request
msg.payload
request Green
json
setSemaphore
Green send
event-log
event-log
timestamp
State Manager
state
text
text
msg.payload
SNAP4CITY
KM4CITY
30
30
30
30
Snap4City - Mobility Operator
Demo
Fri 23 Feb 20:38:44
Traffic sensors
First aid
Meteo sensor
Pollination
Parking
Smart bench
Cycle paths
Map
Speed limit
45
Europa
Morgagni
Lavagnini
Statuto
45
45
45
45
OFF
Green
Temperature
5.057
Arno
2.83m
Humidity
80.025
City parkings
Parcheggi
Più vicini
Posti liberi
Garage Oriuolo S.R.L.
Parcheggio auto
340 m
Parcheggio S. Lorenzo
Parcheggio auto
459 m
Firenze Parcheggi Tornabuoni Srl Unipersonale
Parcheggio auto
510 m
Air temperature
5.1
Park free Station - 4 hours
Fiware Orion
event-log
json
get Limit
delay 1s
setLimit
event-log
Morgagni
delay 5s
setLimit
event-log
Lavagnini
delay 8s
setLimit
event-log
Statuto
delay 10s
setLimit
event-log
Europa
DINFO
DISIT

Reporting Critical Events

Control Room Operator

Would like to:

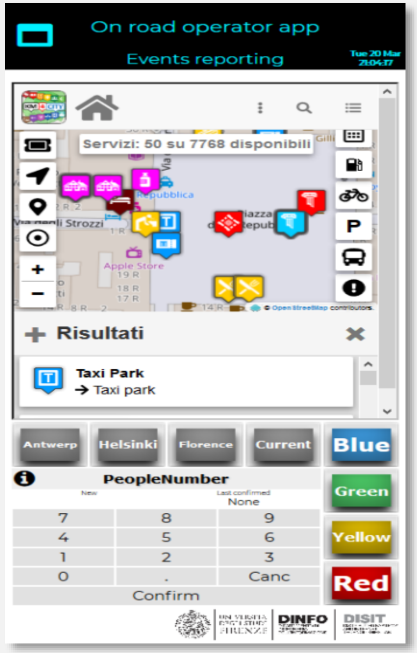
- **Monitor** events vs services in the city and receive critical event notifications from on the road operators.
- **Assess contextual condition,** services status



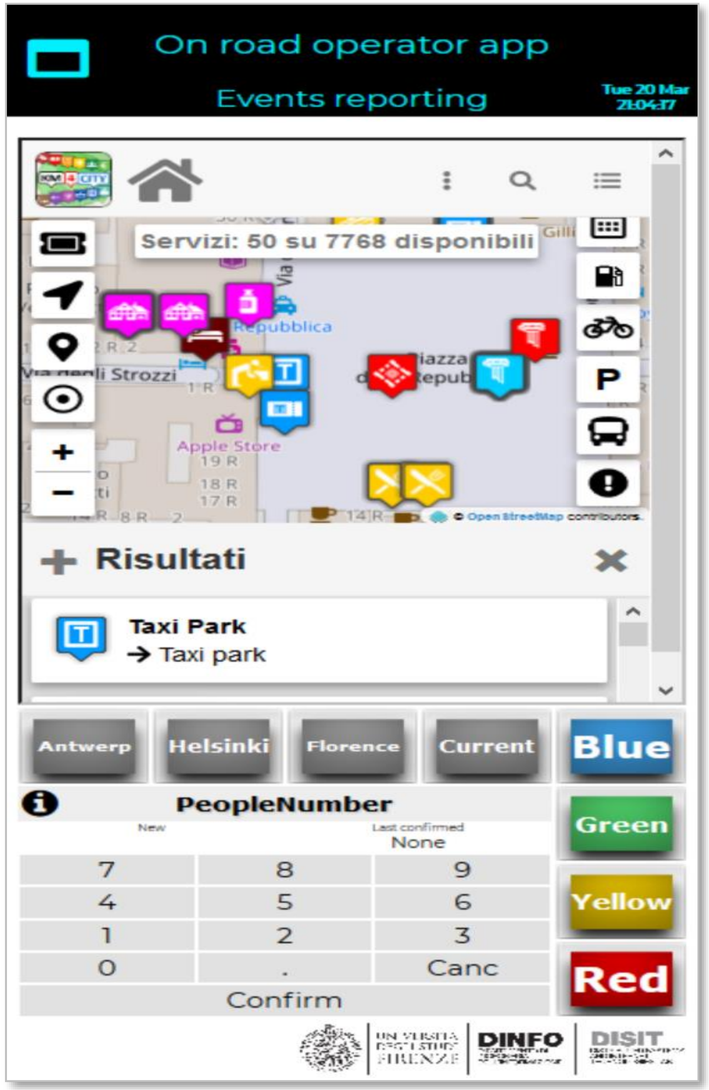
On the road operator

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



On road operator app

Events reporting

Tue 20 Mar 21:04:37

Servizi: 50 su 7768 disponibili

Risultati

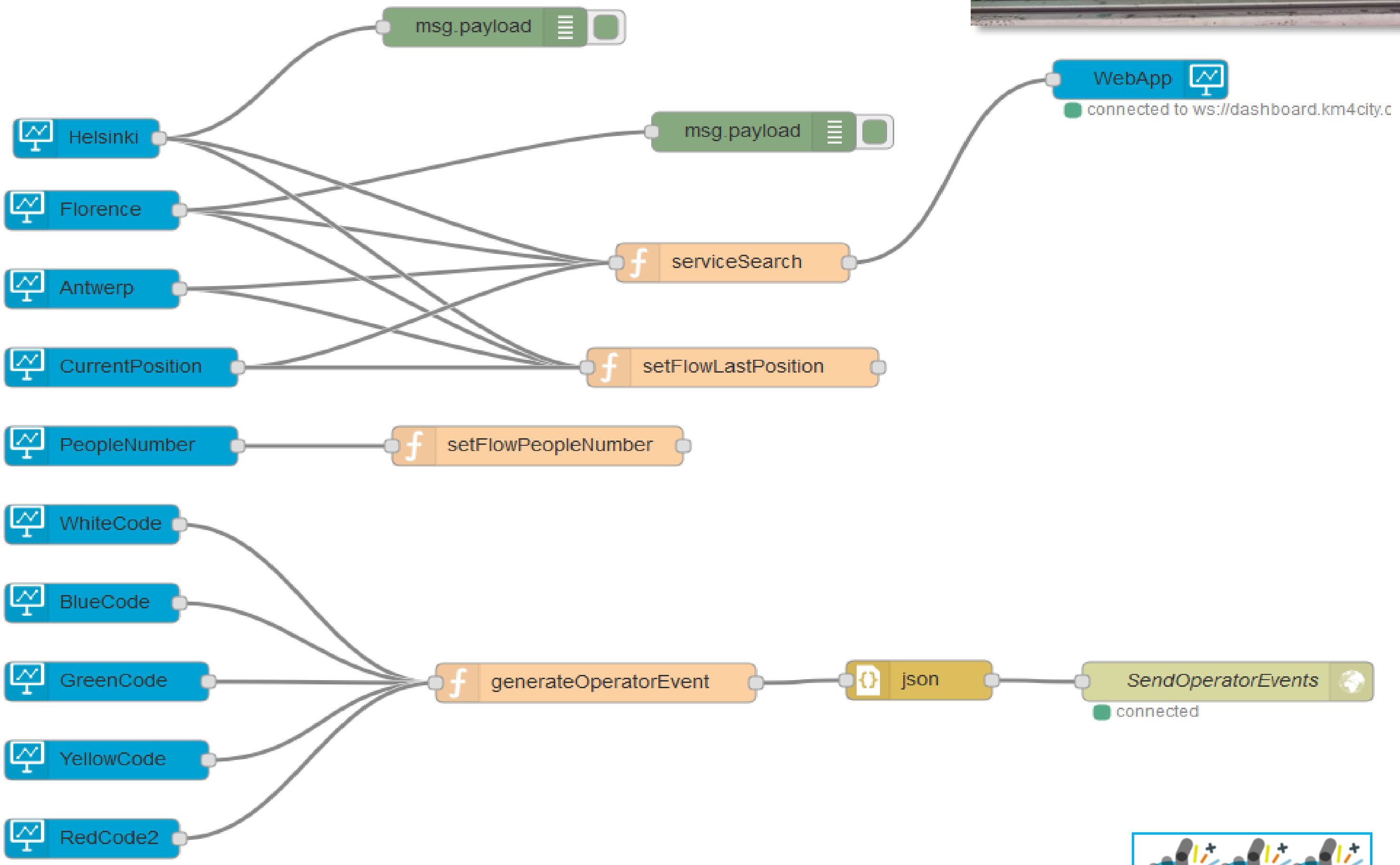
Taxi Park
→ Taxi park

PeopleNumber

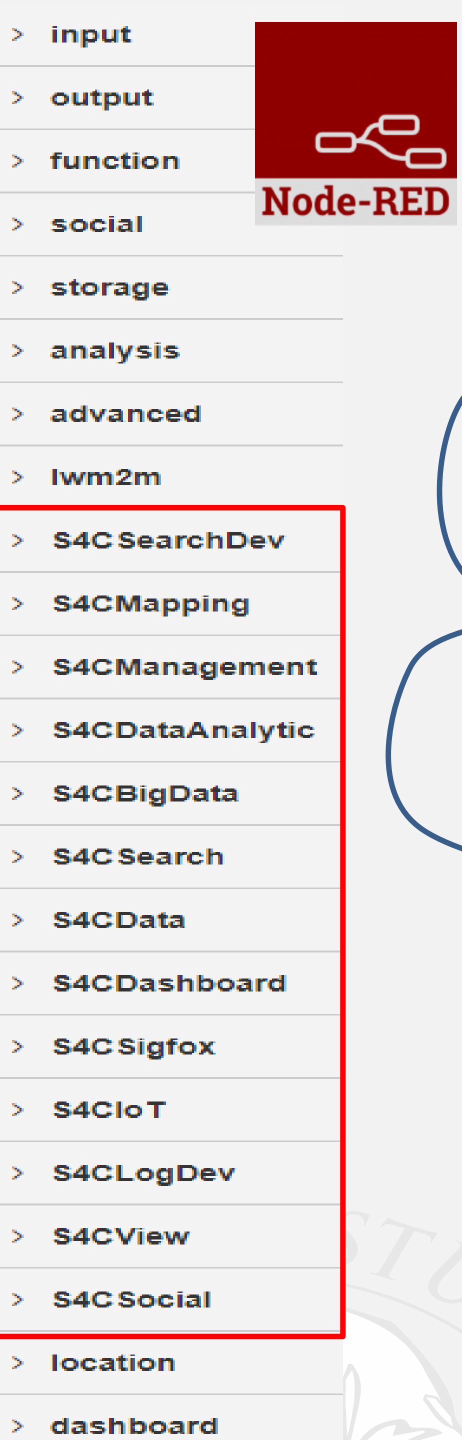
New

Last confirmed
None

Confirm

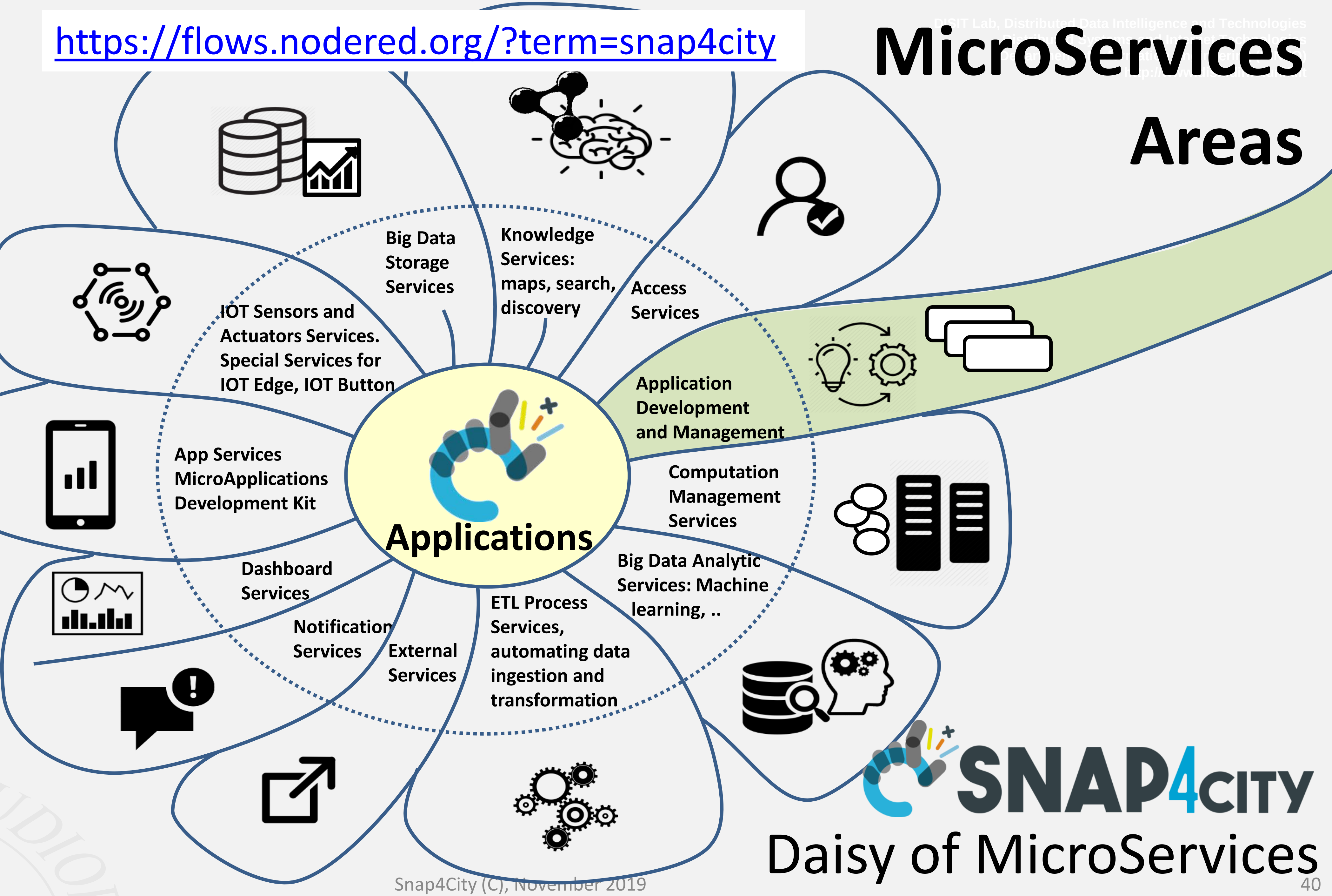


MicroServices Areas



- input
- output
- function
- social
- storage
- analysis
- advanced
- lwm2m
- S4CSearchDev
- S4CMapping
- S4CManagement
- S4CDataAnalytic
- S4CBigData
- S4CSearch
- S4CData
- S4CDashboard
- S4CSigfox
- S4CIoT
- S4CLogDev
- S4CView
- S4CSocial
- location
- dashboard

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



Applications

Big Data Storage Services

Knowledge Services: maps, search, discovery

Access Services

Application Development and Management

Computation Management Services

Big Data Analytic Services: Machine learning, ..

ETL Process Services, automating data ingestion and transformation

External Services

Notification Services

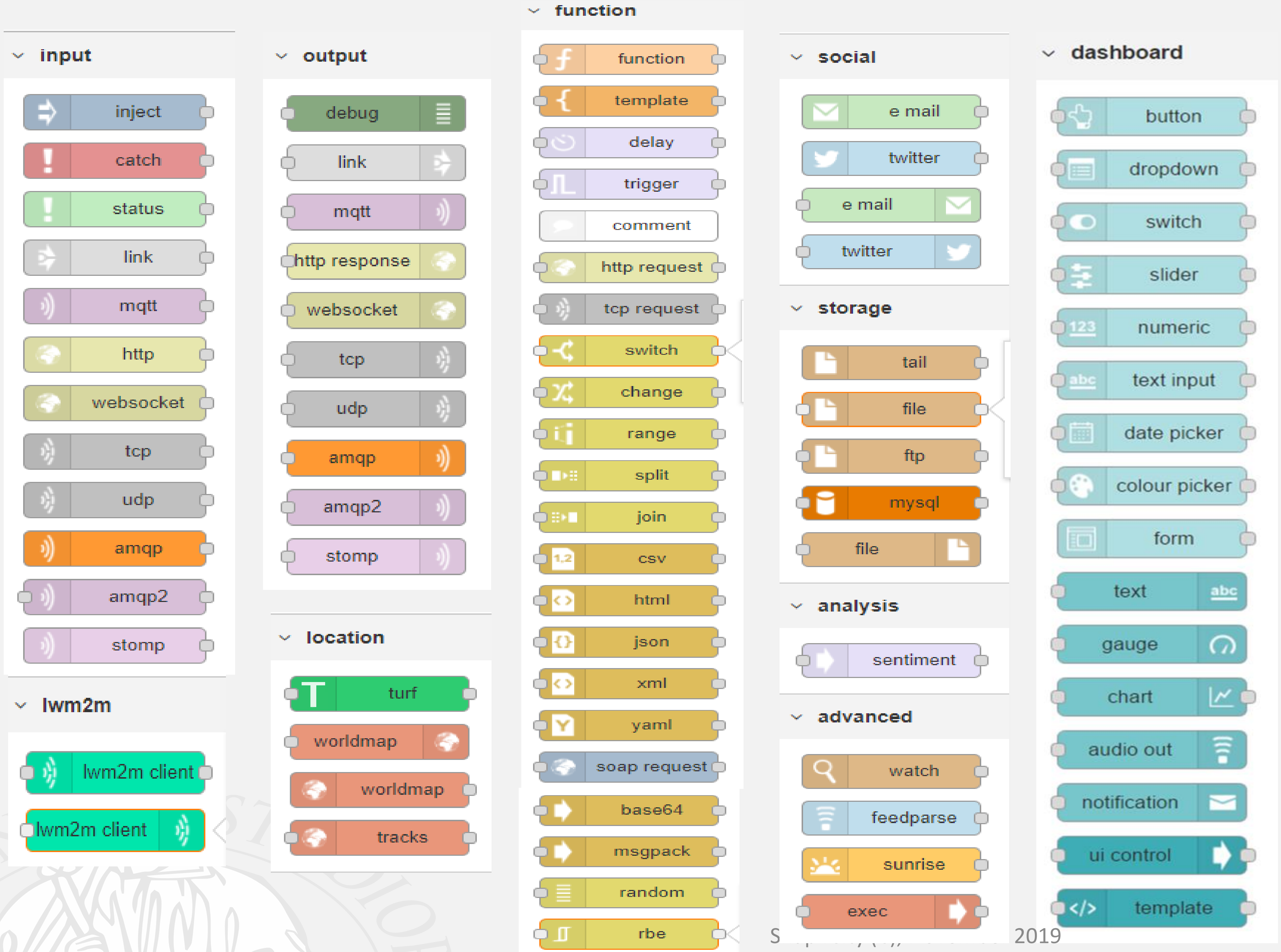
Dashboard Services

App Services MicroApplications Development Kit

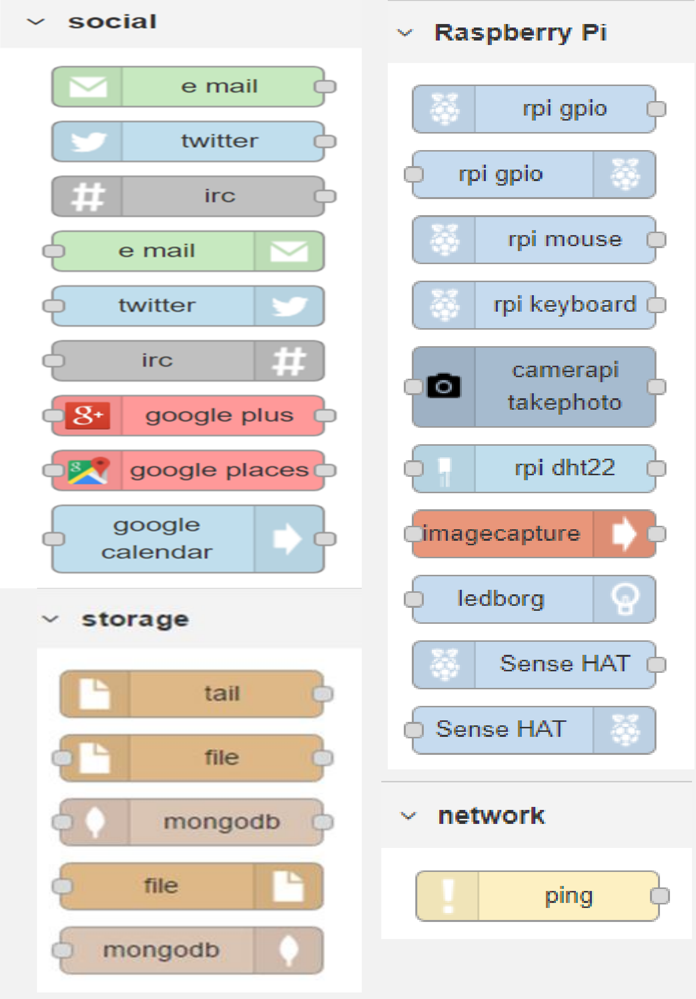
IOT Sensors and Actuators Services. Special Services for IOT Edge, IOT Button

Daisy of MicroServices

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



+ on IOT Edge Raspberry

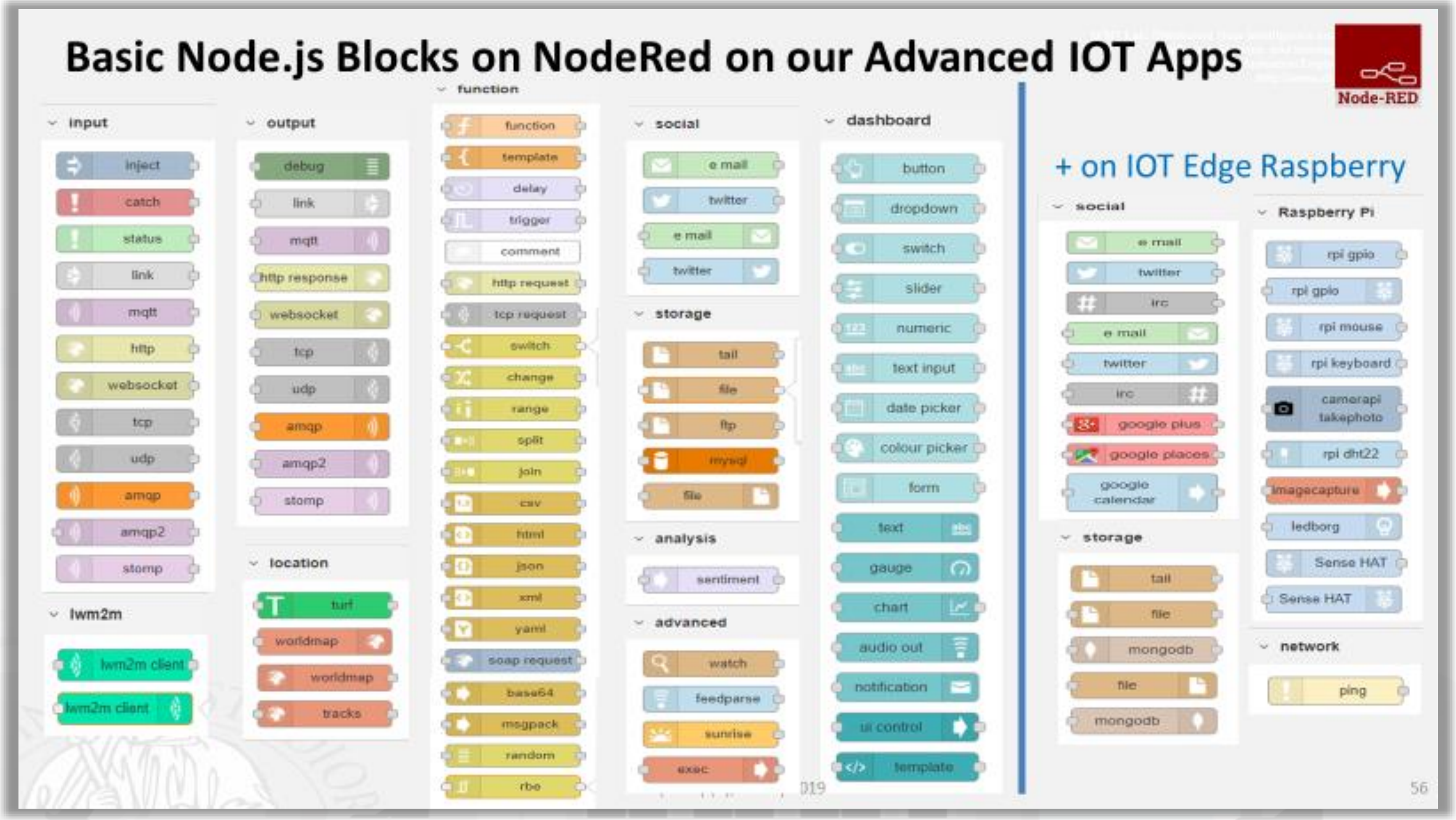


Node-RED Basic Blocks

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.

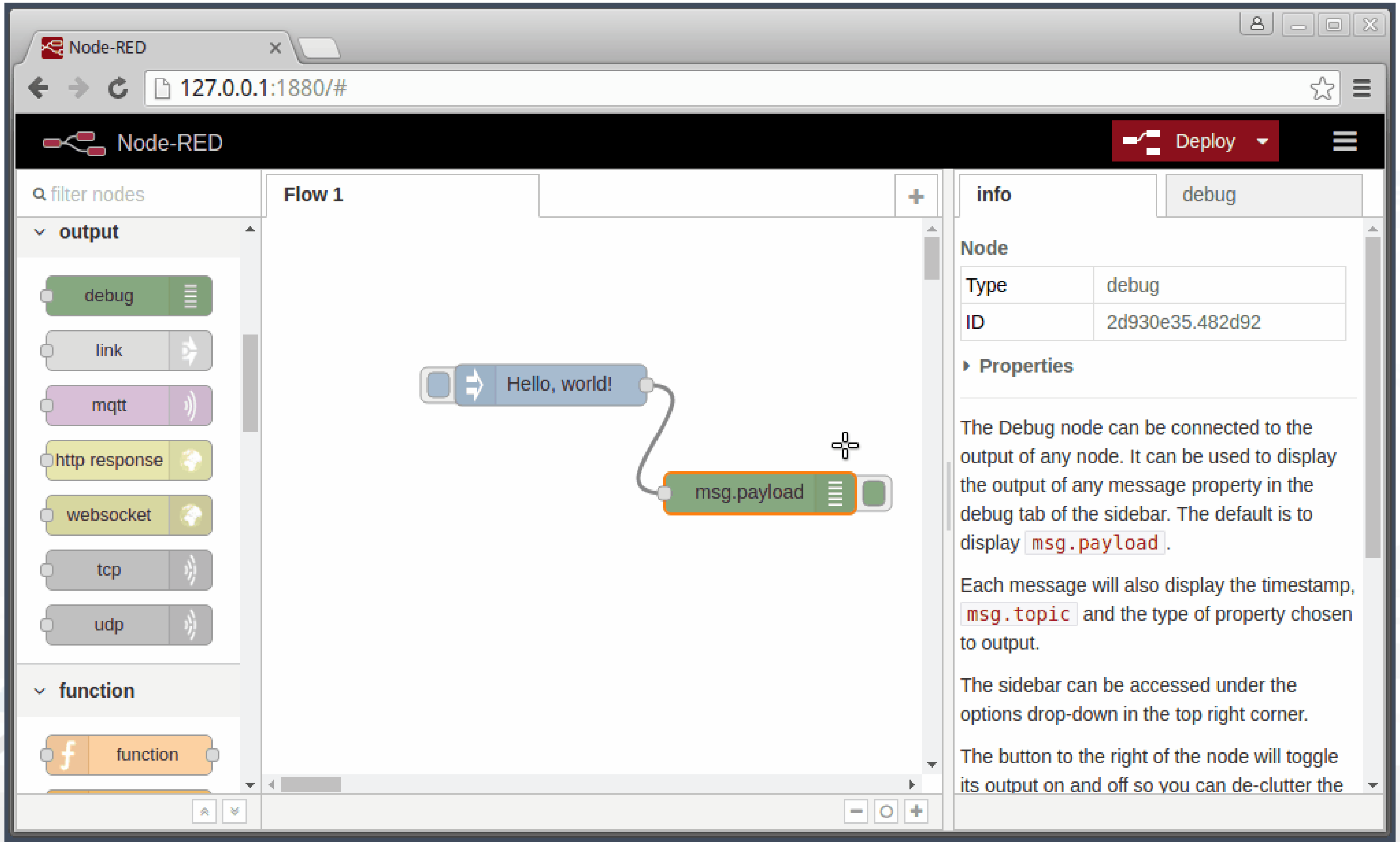


Basic Node.js Blocks on NodeRed on our Advanced IOT Apps

+ on IOT Edge Raspberry

Hello World of Node-RED

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



Node

Type	debug
ID	2d930e35.482d92

▸ Properties

The Debug node can be connected to the output of any node. It can be used to display the output of any message property in the debug tab of the sidebar. The default is to display `msg.payload`.

Each message will also display the timestamp, `msg.topic` and the type of property chosen to output.

The sidebar can be accessed under the options drop-down in the top right corner.

The button to the right of the node will toggle its output on and off so you can de-clutter the

Node-RED

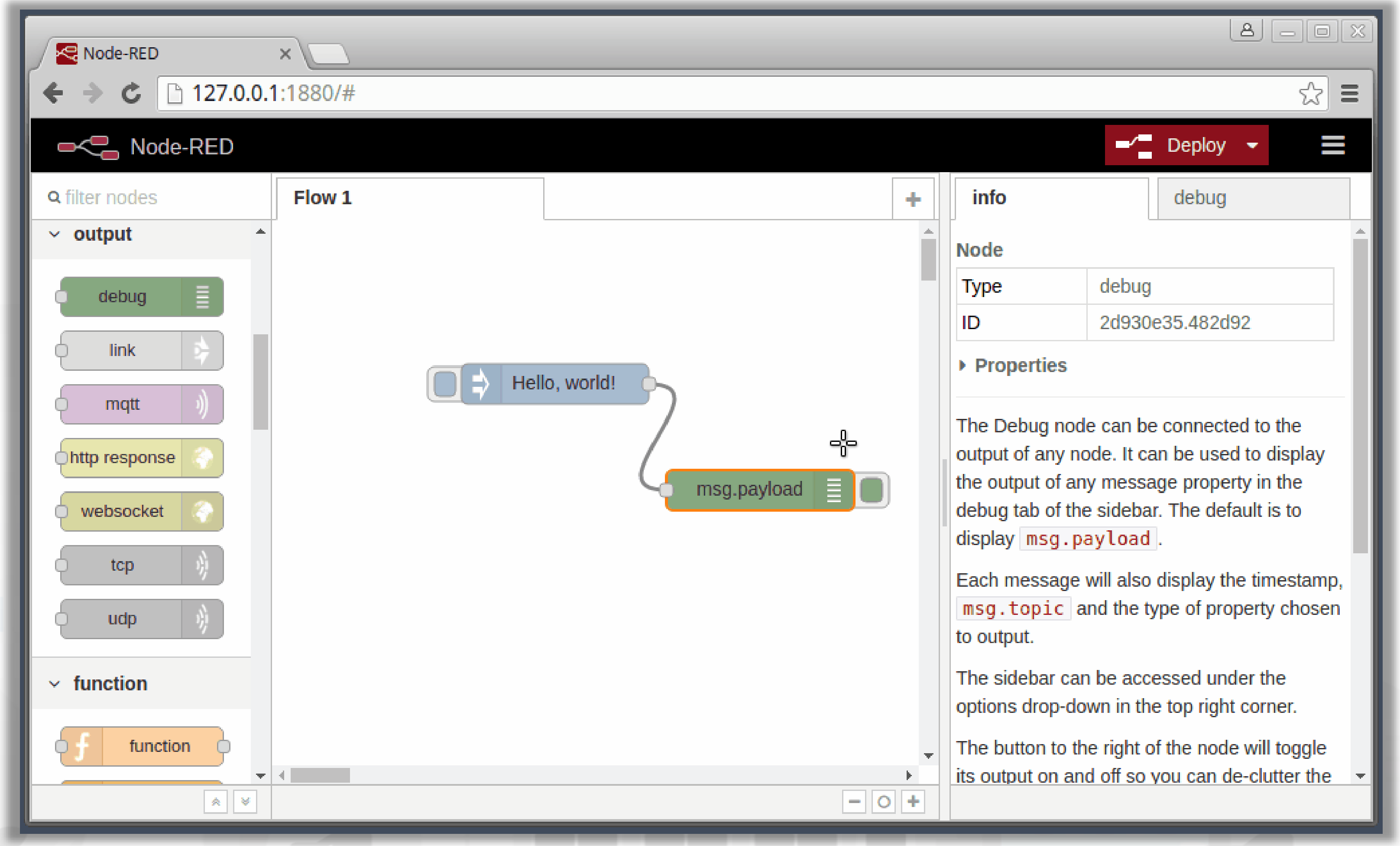
- Node-RED is a **flow-based** development tool for visual programming proposed by **JS Foundation**

- 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**



Node

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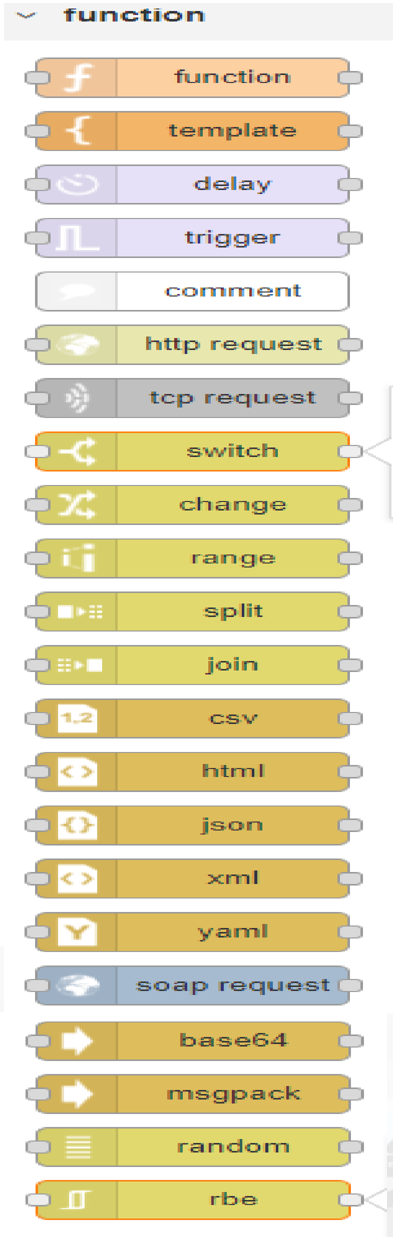
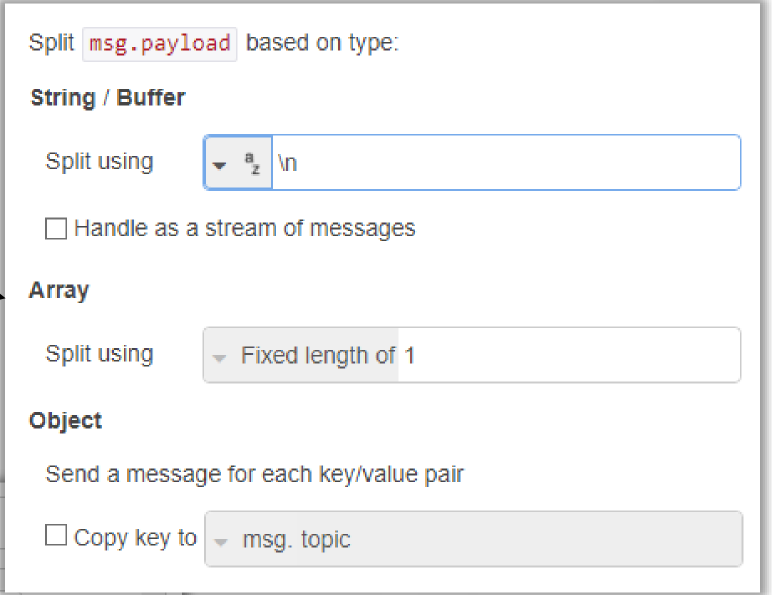


Divides the input message into multiple messages as indicated in the configuration. If you have an array at the input, you can configure it to send each element of the array individually at the output.



Split `msg.payload` based on type:

String / Buffer

Split using \n

□ Handle as a stream of messages

Array

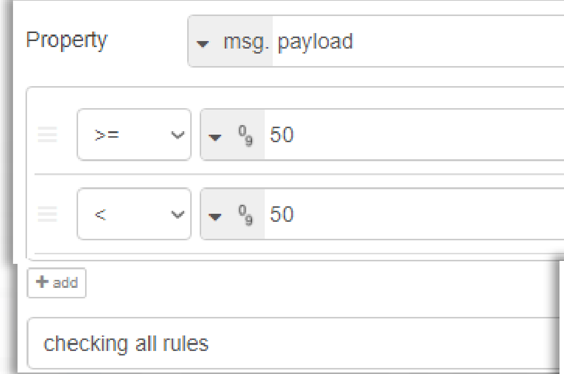
Split using Fixed length of 1

Object

Send a message for each key/value pair

□ Copy key to msg. topic

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



Property msg. payload

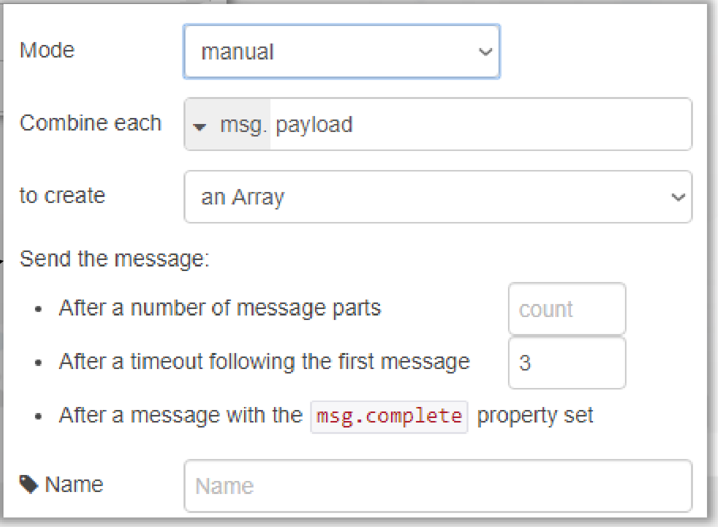
>= 50 → 1

< 50 → 2

+ add

checking all rules

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



Mode manual

Combine each msg. payload

to create an Array

Send the message:

- After a number of message parts count
- After a timeout following the first message 3
- After a message with the `msg.complete` property set

Name Name

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.

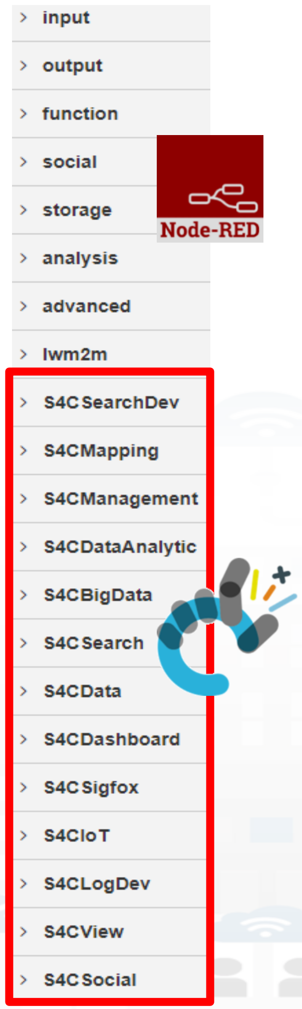
IOT Device Connection: This means that the developers expect to have the possibility of using nodes for connecting to a large set of IOT devices using different protocols, and thus connecting to different kind of IOT brokers.

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.

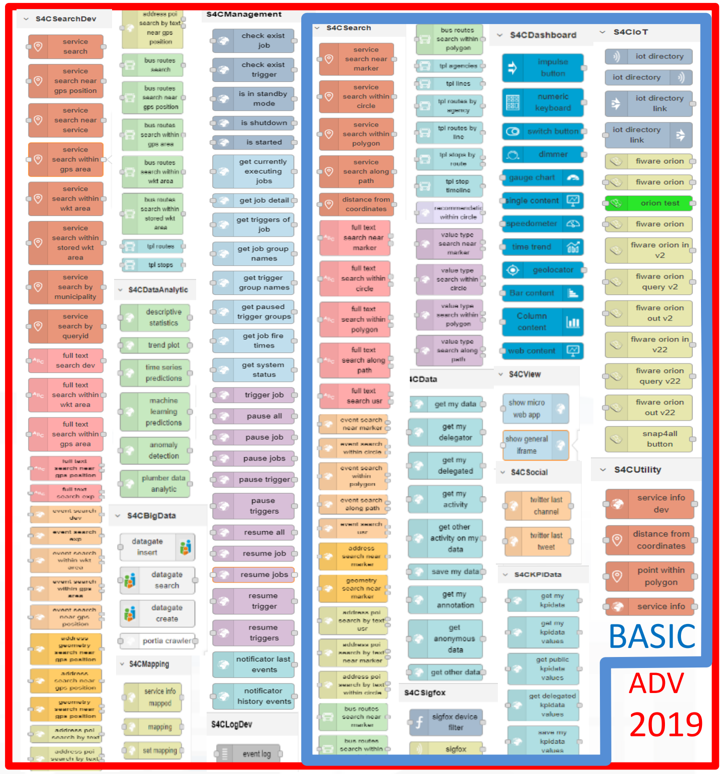
IOT Applications

IOT Applications = Node-RED + Snap4City Platform

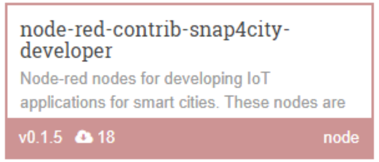
- A collection of more than **150 MicroServices** have been developed covering the above-mentioned requirements and much more.
- The issue was not only to formalize the MicroServices, but also to create the infrastructure that enable their usage. In many cases, the simple MicroServices hide very **complex** 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.



- input
- output
- function
- social
- storage
- analysis
- advanced
- lwm2m
- S4CSearchDev
- S4CMapping
- S4CManagement
- S4CDataAnalytic
- S4CBigData
- S4CSearch
- S4CData
- S4CDashboard
- S4CSigfox
- S4CIoT
- S4CLogDev
- S4CView
- S4CSocial

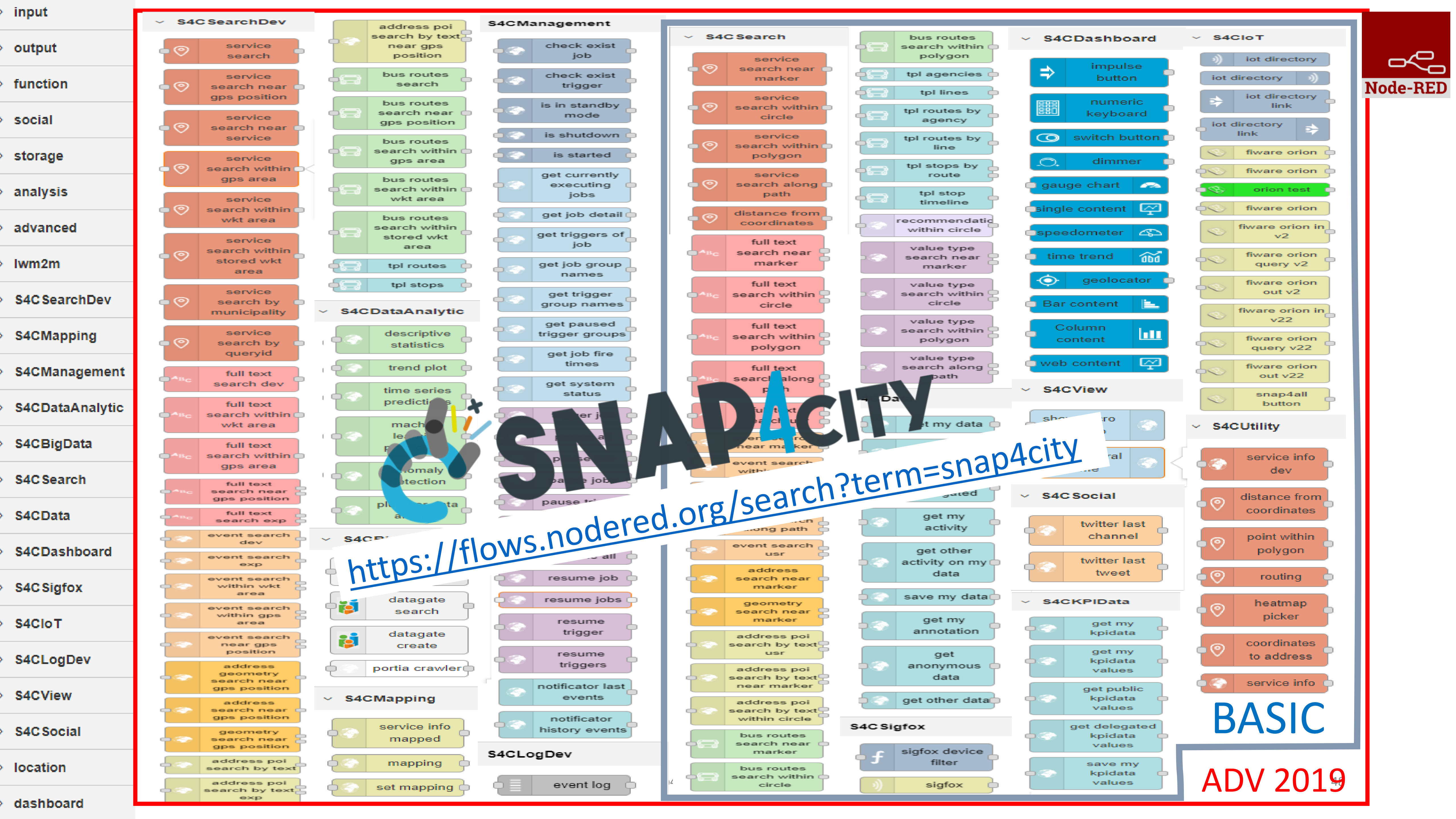


https://flows.nodered.org/?term=snap4city



node-red-contrib-snap4city-developer
Node-red nodes for developing IoT applications for smart cities. These nodes are
v0.1.5 18 node

node-red-contrib-snap4city-user
Nodes for Snap4city project, targeted to standard user (no developer)
v0.2.0 27 ★5.0 (1) node



input
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lwm2m
S4CSearchDev
S4CMapping
S4CManagement
S4CDataAnalytic
S4CBigData
S4CSearch
S4CData
S4CDashboard
S4CSigfox
S4CIoT
S4CLogDev
S4CView
S4CSocial
location
dashboard

S4CSearchDev
service search
service search near gps position
service search near service
service search within gps area
service search within wkt area
service search within stored wkt area
service search by municipality
service search by queryid
full text search dev
full text search within wkt area
full text search within gps area
full text search near gps position
full text search exp
event search dev
event search exp
event search within wkt area
event search within gps area
event search near gps position
address geometry search near gps position
address search near gps position
geometry search near gps position
address poi search by text
address poi search by text exp

address poi search by text near gps position
bus routes search
bus routes search near gps position
bus routes search within gps area
bus routes search within wkt area
bus routes search within stored wkt area
tpl routes
tpl stops

S4CDataAnalytic
descriptive statistics
trend plot
time series predicti
mach le
anomaly detection
pl ta a
S4CB
datagate search
datagate create
portia crawler

S4CMapping
service info mapped
mapping
set mapping

S4CManagement
check exist job
check exist trigger
is in standby mode
is shutdown
is started
get currently executing jobs
get job detail
get triggers of job
get job group names
get trigger group names
get paused trigger groups
get job fire times
get system status
er j
job
pause tr
all
resume job
resume jobs
resume trigger
resume triggers
notificator last events
notificator history events

S4CLogDev
event log

S4CSearch
service search near marker
service search within circle
service search within polygon
service search along path
distance from coordinates
full text search near marker
full text search within circle
full text search within polygon
full text search along path
near marker
event search within
along path
event search usr
address search near marker
geometry search near marker
address poi search by text usr
address poi search by text near marker
address poi search by text within circle
bus routes search near marker
bus routes search within circle

bus routes search within polygon
tpl agencies
tpl lines
tpl routes by agency
tpl routes by line
tpl stops by route
tpl stop timeline
recommendatic within circle
value type search near marker
value type search within circle
value type search within polygon
value type search along path
Da
get my data
gated
get my activity
get other activity on my data
save my data
get my annotation
get anonymous data
get other data

S4CSigfox
sigfox device filter
sigfox

S4CDashboard
impulse button
numeric keyboard
switch button
dimmer
gauge chart
single content
speedometer
time trend
geolocator
Bar content
Column content
web content

S4CView
sho ro
ral ne

S4CSocial
twitter last channel
twitter last tweet

S4CKPIData
get my kpidata
get my kpidata values
get public kpidata values
get delegated kpidata values
save my kpidata values

S4CIoT
iot directory
iot directory
iot directory link
iot directory link
fiware orion
fiware orion
orion test
fiware orion
fiware orion in v2
fiware orion query v2
fiware orion out v2
fiware orion in v22
fiware orion query v22
fiware orion out v22
snap4all button

S4CUtility
service info dev
distance from coordinates
point within polygon
routing
heatmap picker
coordinates to address
service info

Node-RED

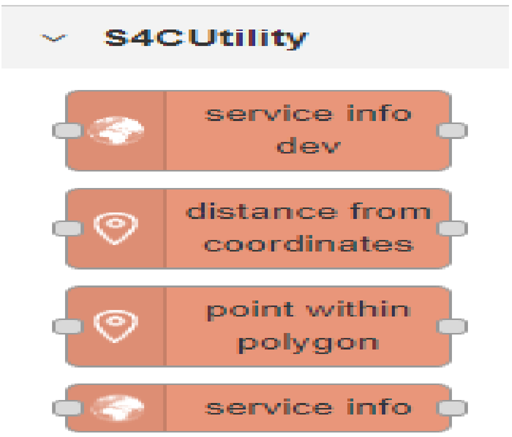
SNAP4CITY

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

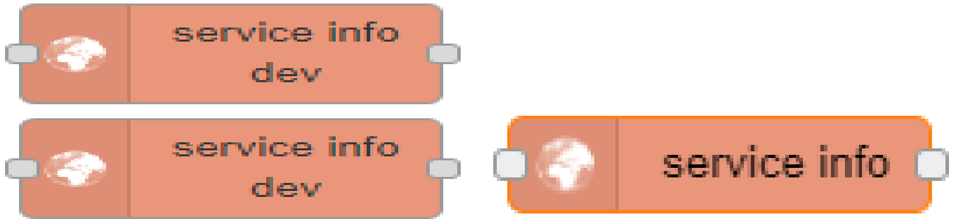
BASIC

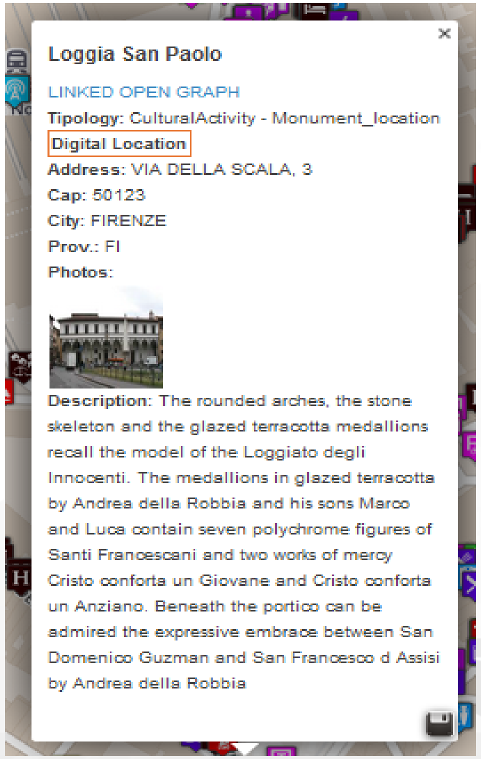
ADV 2019

S4CSearch



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





Loggia San Paolo

LINKED OPEN GRAPH

Tipology: CulturalActivity - Monument_location

Digital Location

Address: VIA DELLA SCALA, 3

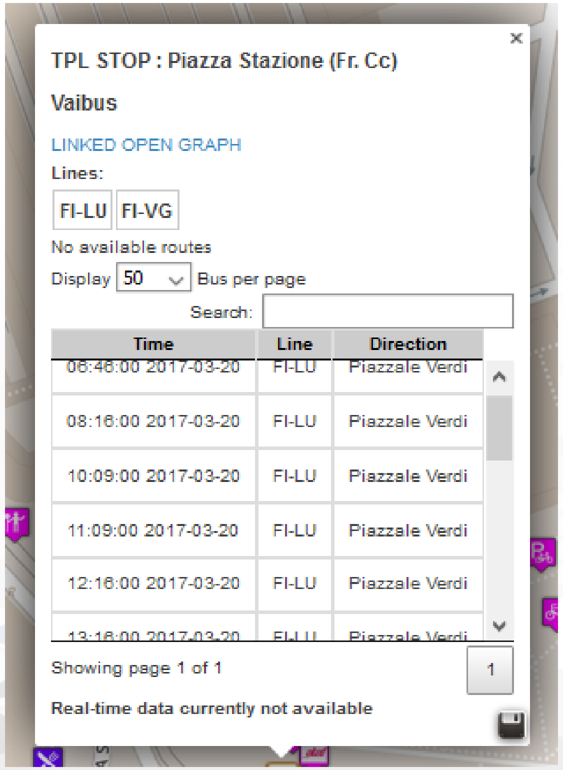
Cap: 50123

City: FIRENZE

Prov.: FI

Photos:

Description: The rounded arches, the stone skeleton and the glazed terracotta medallions recall the model of the Loggiato degli Innocenti. The medallions in glazed terracotta by Andrea della Robbia and his sons Marco and Luca contain seven polychrome figures of Santi Francescani and two works of mercy Cristo conforta un Giovane and Cristo conforta un Anziano. Beneath the portico can be admired the expressive embrace between San Domenico Guzman and San Francesco d Assisi by Andrea della Robbia



TPL STOP : Piazza Stazione (Fr. Cc)

Vaibus

LINKED OPEN GRAPH

Lines:

FI-LU FI-VG

No available routes

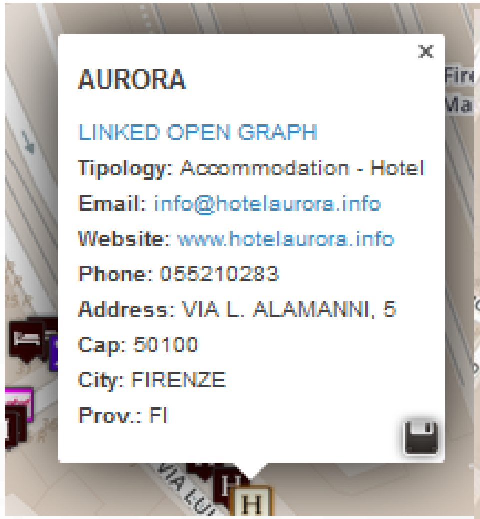
Display 50 Bus per page

Search:

Time	Line	Direction
06:46:00 2017-03-20	FI-LU	Piazzale Verdi
08:16:00 2017-03-20	FI-LU	Piazzale Verdi
10:09:00 2017-03-20	FI-LU	Piazzale Verdi
11:09:00 2017-03-20	FI-LU	Piazzale Verdi
12:16:00 2017-03-20	FI-LU	Piazzale Verdi
13:16:00 2017-03-20	FI-LU	Piazzale Verdi

Showing page 1 of 1

Real-time data currently not available



AURORA

LINKED OPEN GRAPH

Tipology: Accommodation - Hotel

Email: info@hotelaurora.info

Website: www.hotelaurora.info

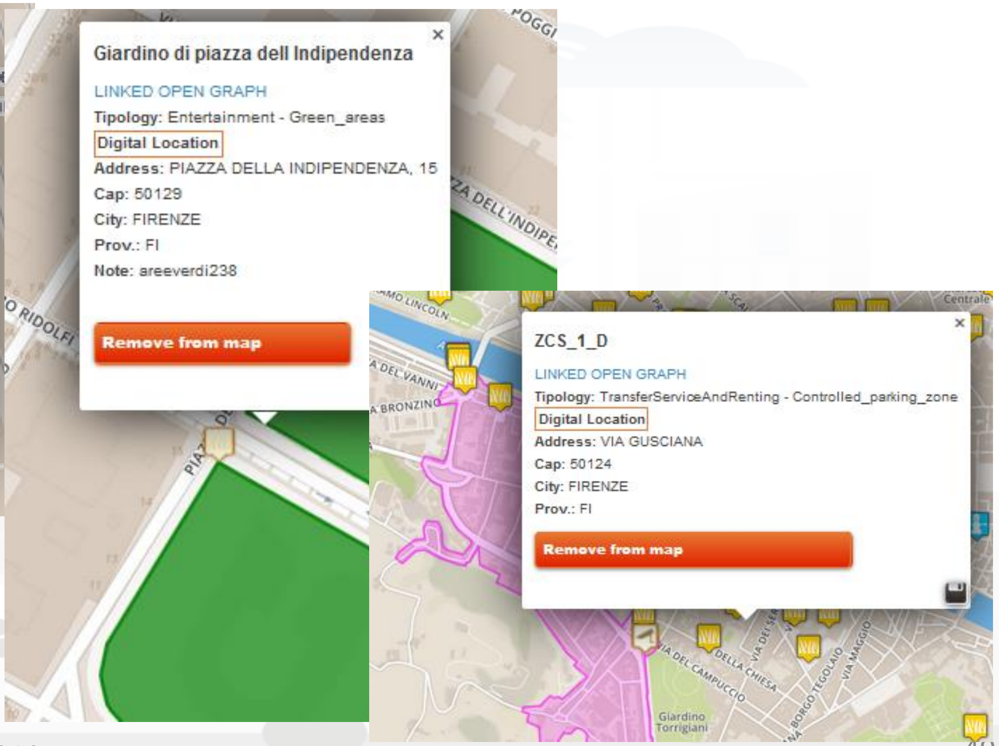
Phone: 055210283

Address: VIA L. ALAMANNI, 5

Cap: 50100

City: FIRENZE

Prov.: FI



Giardino di piazza dell Indipendenza

LINKED OPEN GRAPH

Tipology: Entertainment - Green_areas

Digital Location

Address: PIAZZA DELLA INDIPENDENZA, 15

Cap: 50129

City: FIRENZE

Prov.: FI

Note: areeverdi238

Remove from map

ZCS_1_D

LINKED OPEN GRAPH

Tipology: TransferServiceAndRenting - Controlled_parking_zone

Digital Location

Address: VIA GUSCIANA

Cap: 50124

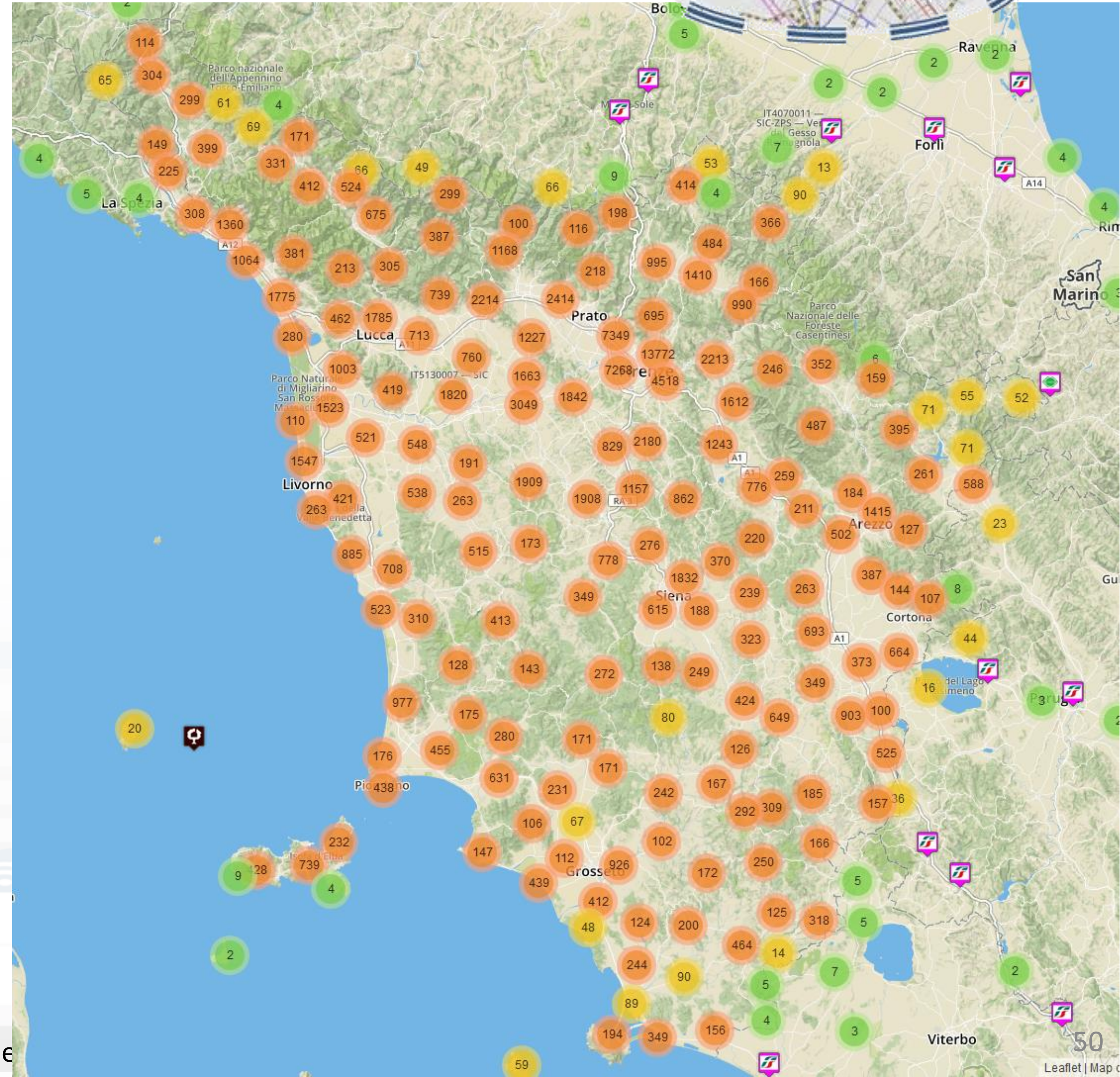
City: FIRENZE

Prov.: FI

Remove from map

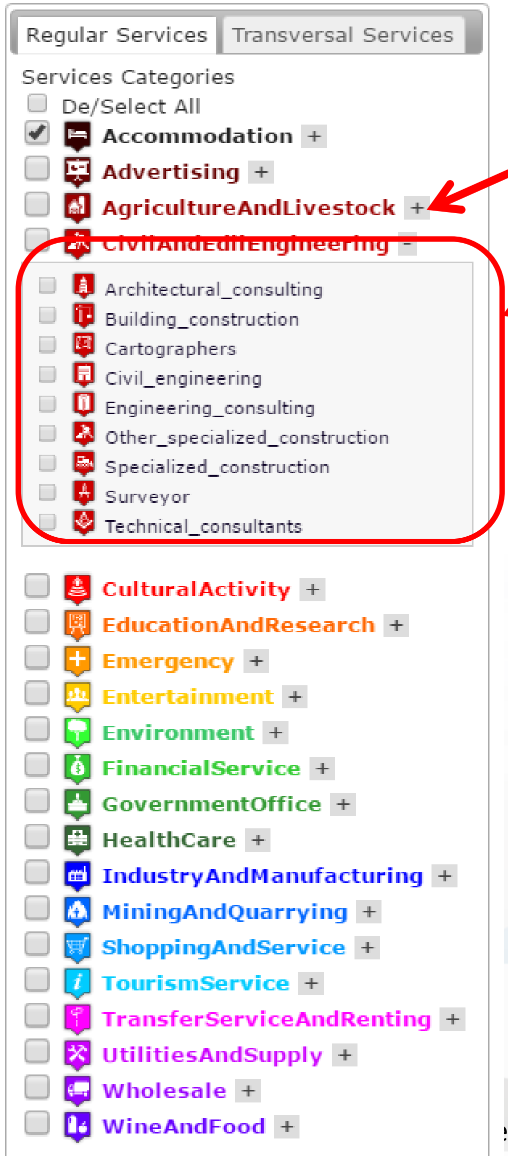
Data Domains

- **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, …



Concepts of Services: Macro and subcathegory

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



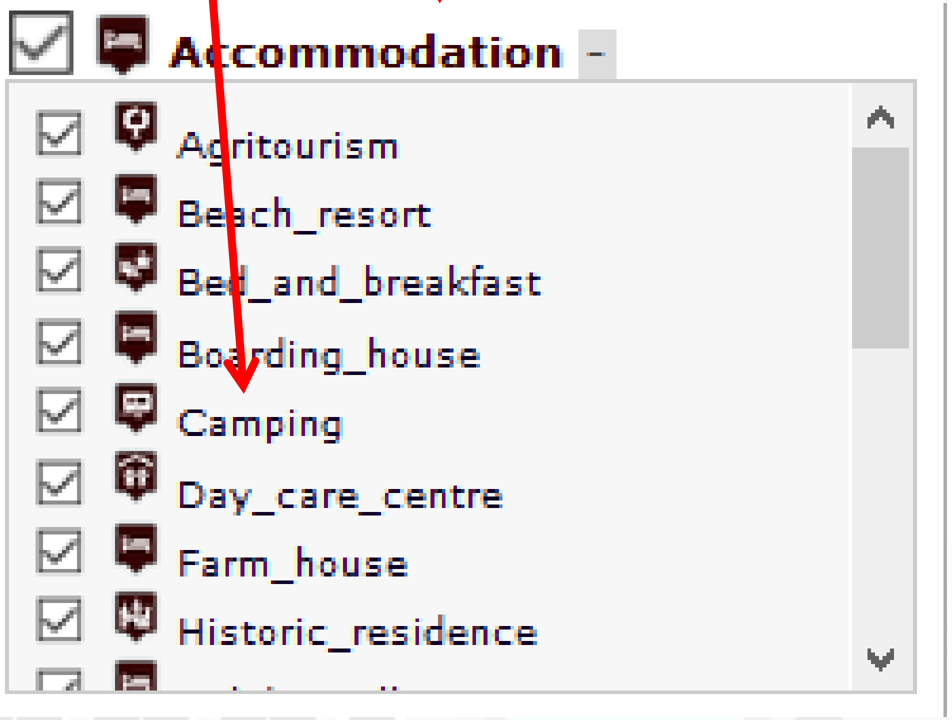
Regular Services | Transversal Services

Services Categories

- □ De/Select All
- ☑ Accommodation +
- □ Advertising +
- □ AgricultureAndLivestock +
- □ CivilAndEdilEngineering -
  - □ Architectural_consulting
  - □ Building_construction
  - □ Cartographers
  - □ Civil_engineering
  - □ Engineering_consulting
  - □ Other_specialized_construction
  - □ Specialized_construction
  - □ Surveyor
  - □ Technical_consultants
- □ CulturalActivity +
- □ EducationAndResearch +
- □ Emergency +
- □ Entertainment +
- □ Environment +
- □ FinancialService +
- □ GovernmentOffice +
- □ HealthCare +
- □ IndustryAndManufacturing +
- □ MiningAndQuarrying +
- □ ShoppingAndService +
- □ TourismService +
- □ TransferServiceAndRenting +
- □ UtilitiesAndSupply +
- □ Wholesale +
- □ WineAndFood +

20 Service Macro Classes

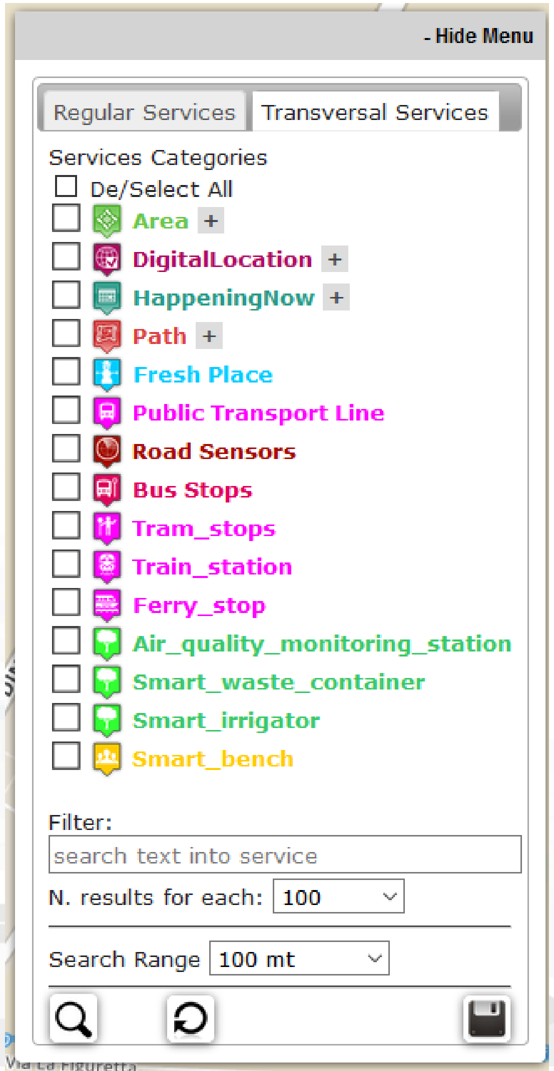
Service Class



- ☑ Accommodation -
  - ☑ Agritourism
  - ☑ Beach_resort
  - ☑ Bed_and_breakfast
  - ☑ Boarding_house
  - ☑ Camping
  - ☑ Day_care_centre
  - ☑ Farm_house
  - ☑ Historic_residence

Access to Point of Interest information, POI

- **POI**: point of interest
- **type**: macro and subcategories
- **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*



- Hide Menu

Regular Services | Transversal Services

Services Categories

□ De/Select All
□ Area +
□ DigitalLocation +
□ HappeningNow +
□ Path +
□ Fresh Place
□ Public Transport Line
□ Road Sensors
□ Bus Stops
□ Tram_stops
□ Train_station
□ Ferry_stop
□ Air_quality_monitoring_station
□ Smart_waste_container
□ Smart_irrigator
□ Smart_bench

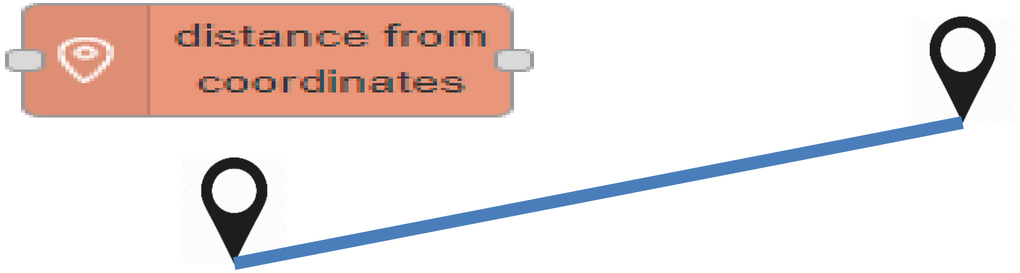
Filter: search text into service

N. results for each: 100

Search Range 100 mt

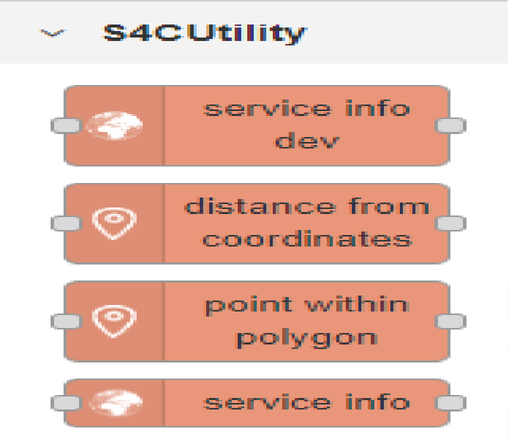
S4CSearch

- **Distance from GPS point**



- **Point is in Polygon ?**

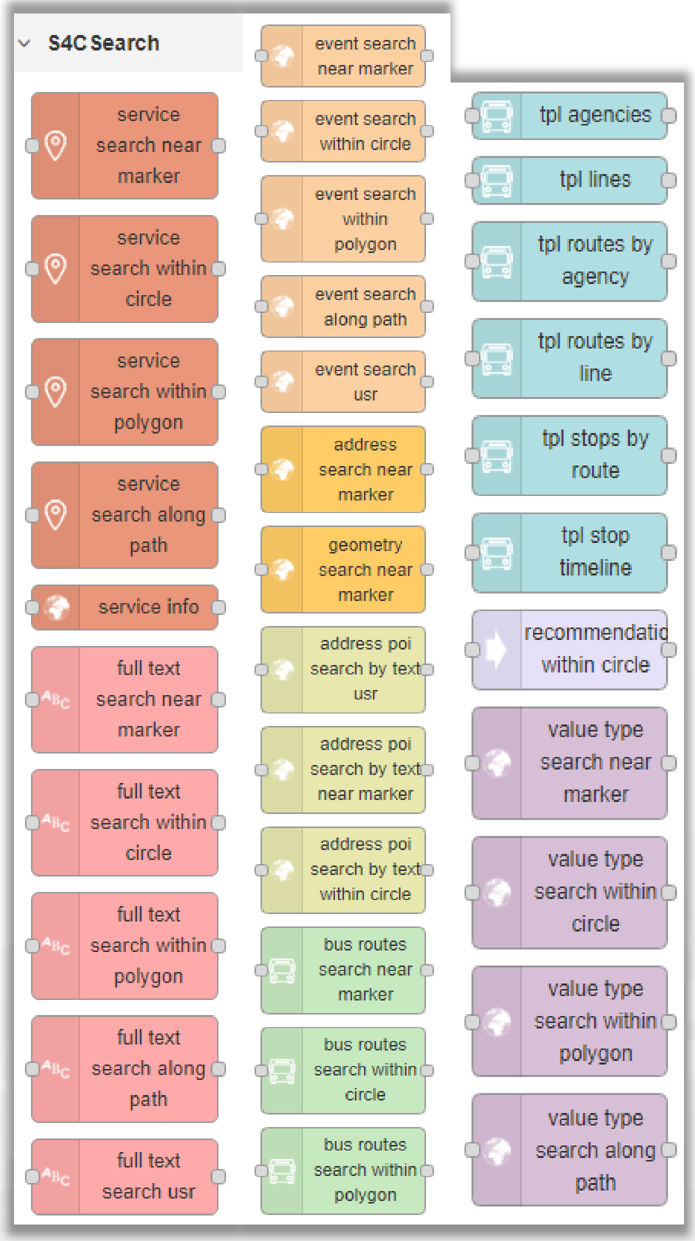
AOUC Ospedale Careggi
Fiesole
Ponte Alla Badia
Cave di Maiano
Maiano
Piazza della Libertà
Parco delle Cascine
Museo di San Marco
Poggio Gherardo
Nelson Mandela Forum
Cattedrale di Santa Maria del Fiore
Sinagoga e Museo Ebraico di Firenze
COVERCIANO
Firenze
Bellosguardo
Piazzale Michelangelo
Porta Romana
Giardino di Boboli
Giardino Bardini



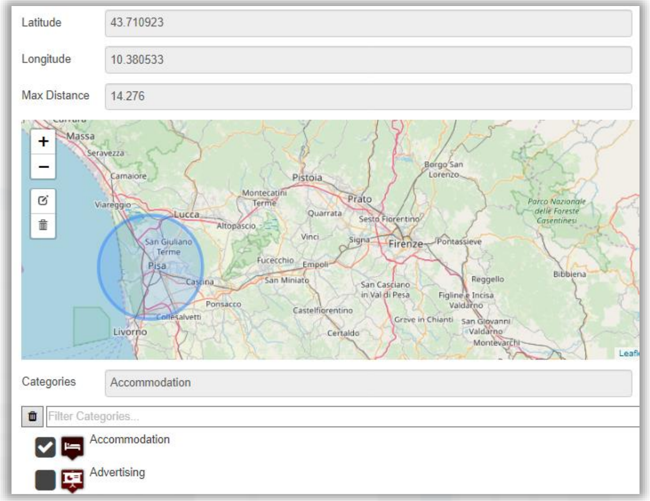
S4CSearch

Smart City Entities Search

Simple and Fast


S4C Search
service search near marker
service search within circle
service search within polygon
service search along path
service info
full text search near marker
full text search within circle
full text search within polygon
full text search along path
full text search usr
event search near marker
event search within circle
event search within polygon
event search along path
event search usr
address search near marker
geometry search near marker
address poi search by text usr
address poi search by text near marker
address poi search by text within circle
bus routes search near marker
bus routes search within circle
bus routes search within polygon
tpl agencies
tpl lines
tpl routes by agency
tpl routes by line
tpl stops by route
tpl stop timeline
recommendatio within circle
value type search near marker
value type search within circle
value type search within polygon
value type search along path

- **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


Latitude 43.710923

Longitude 10.380533

Max Distance 14.276

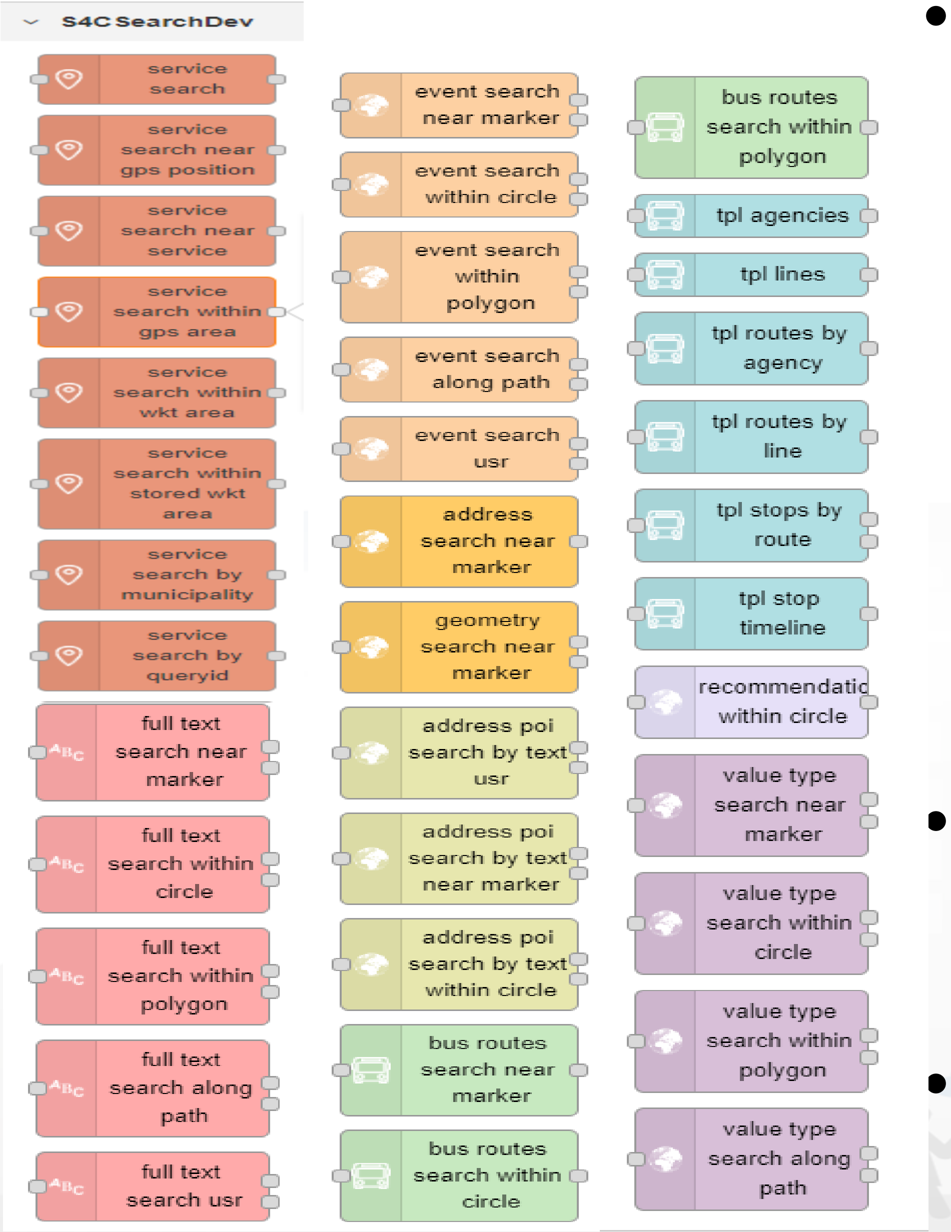
Categories Accommodation

Filter Categories...

☑ Accommodation

■ Advertising

S4CSearch


S4CSearchDev
service search
service search near gps position
service search near service
service search within gps area
service search within wkt area
service search within stored wkt area
service search by municipality
service search by queryid
full text search near marker
full text search within circle
full text search within polygon
full text search along path
full text search usr
event search near marker
event search within circle
event search within polygon
event search along path
event search usr
address search near marker
geometry search near marker
address poi search by text usr
address poi search by text near marker
address poi search by text within circle
bus routes search near marker
bus routes search within circle
bus routes search within polygon
tpl agencies
tpl lines
tpl routes by agency
tpl routes by line
tpl stops by route
tpl stop timeline
recommendatic within circle
value type search near marker
value type search within circle
value type search within polygon
value type search along path

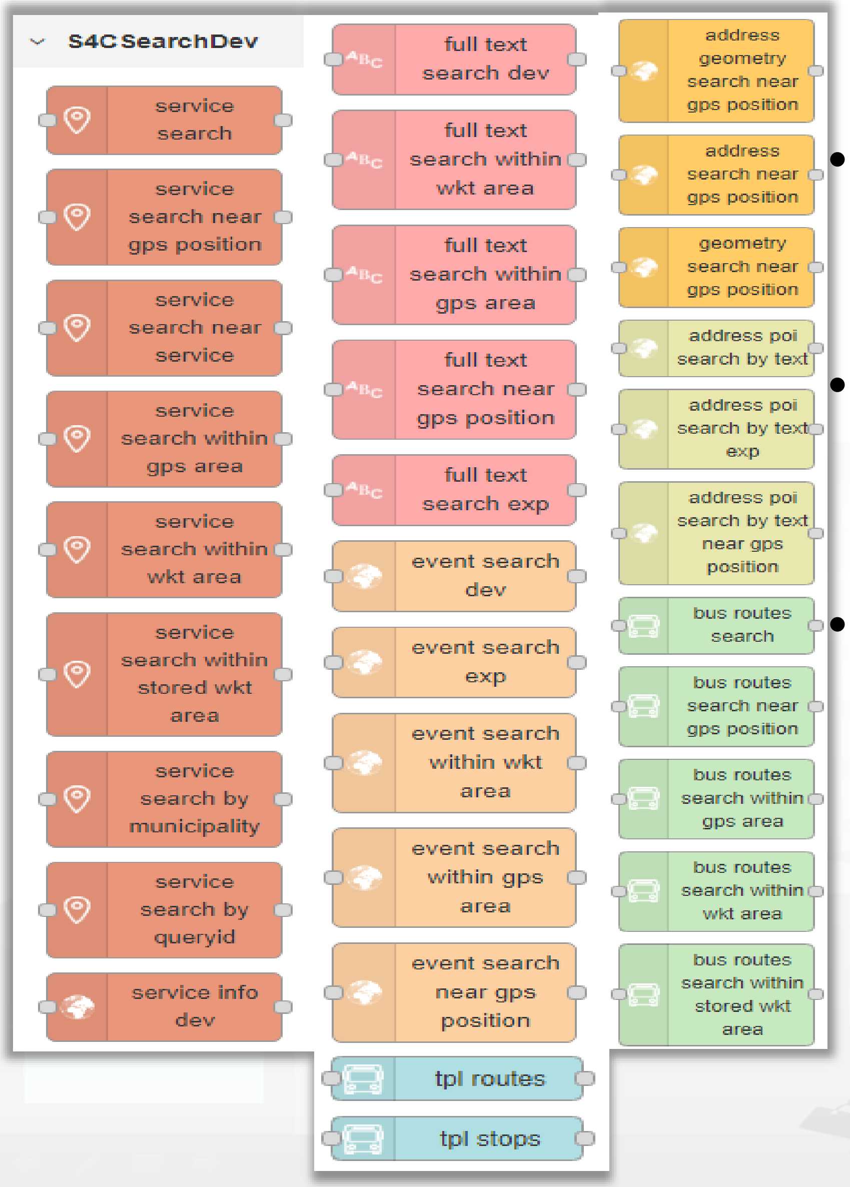
- **For example to search for:**
  - POIs:
    - near a GPS position, from text, along a path, in an area, etc..
  - Public Transport information / data
  - Suggestions
  - Public Transport Means Routes/Paths
  - Events in the area
  - Value Type (kind of data)
  - Etc.
- **To Get DATA of a Service /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

- **Distance from GPS point**

S4CSearch Adv

Smart City Entities Advanced Search

Flexiblity



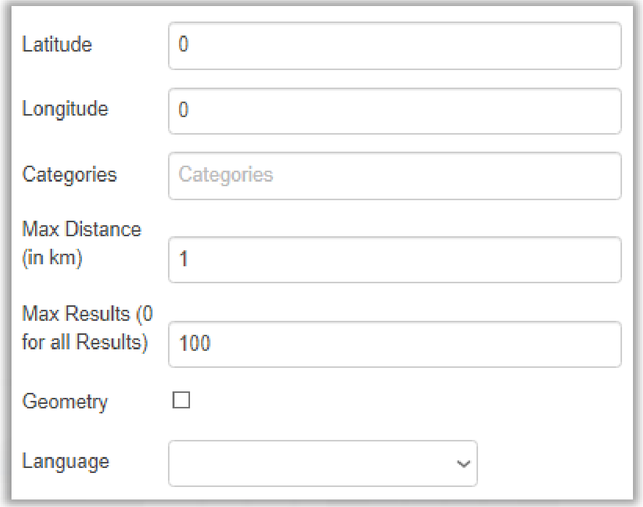
S4CSearchDev

service search
service search near gps position
service search near service
service search within gps area
service search within wkt area
service search within stored wkt area
service search by municipality
service search by queryid
service info dev

full text search dev
full text search within wkt area
full text search within gps area
full text search near gps position
full text search exp
event search dev
event search exp
event search within wkt area
event search within gps area
event search near gps position
tpl routes
tpl stops

address geometry search near gps position
address search near gps position
geometry search near gps position
address poi search by text
address poi search by text exp
address poi search by text near gps position
bus routes search
bus routes search near gps position
bus routes search within gps area
bus routes search within wkt area
bus routes search within stored wkt area

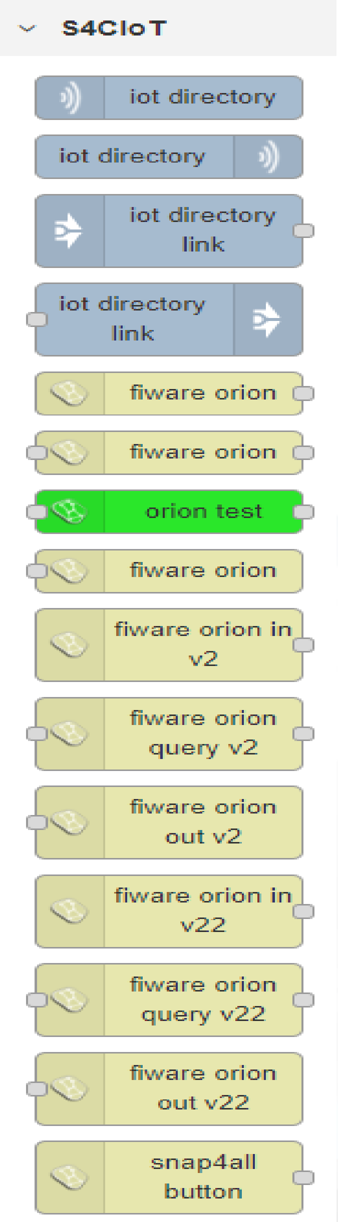
- Similar to basic Search functions but with more flexibility of the function for programming the search
- Adding Dynamic behavior:
  - Getting in input JSON with parameters
- **To Get DATA of a Service / POI /sensor**
  - Historical and real time
  - ANY kind of sensors



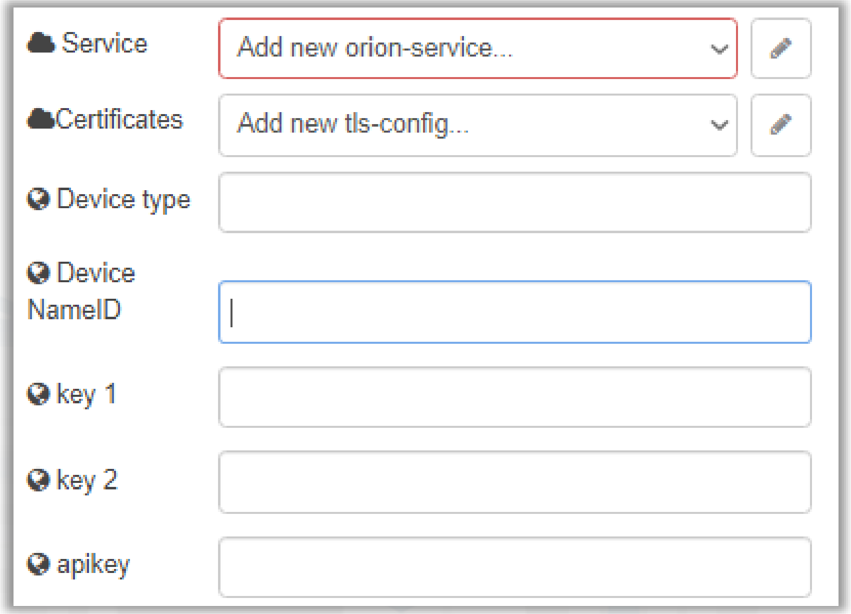
Latitude	0
Longitude	0
Categories	Categories
Max Distance (in km)	1
Max Results (0 for all Results)	100
Geometry	□
Language	

service info dev

S4CIOT



- **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

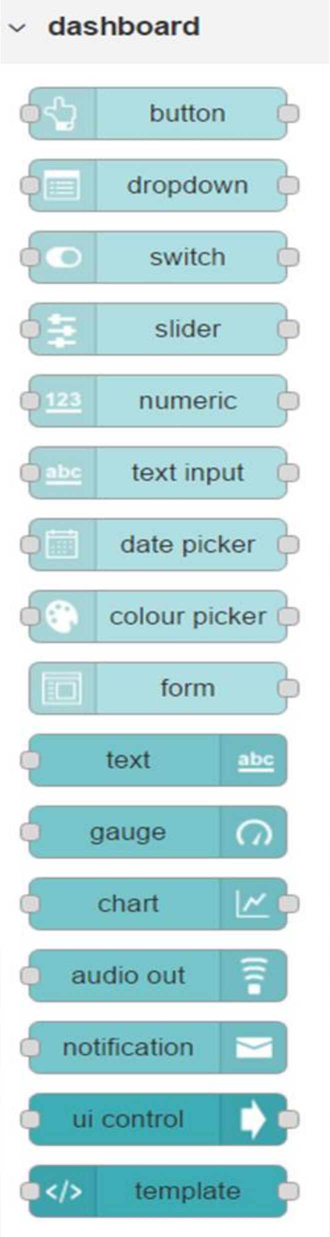


Service	Add new orion-service...
Certificates	Add new tls-config...
Device type	
Device NameID	
key 1	
key 2	
apikey	

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

Dashboard

Native Local or Snap4City

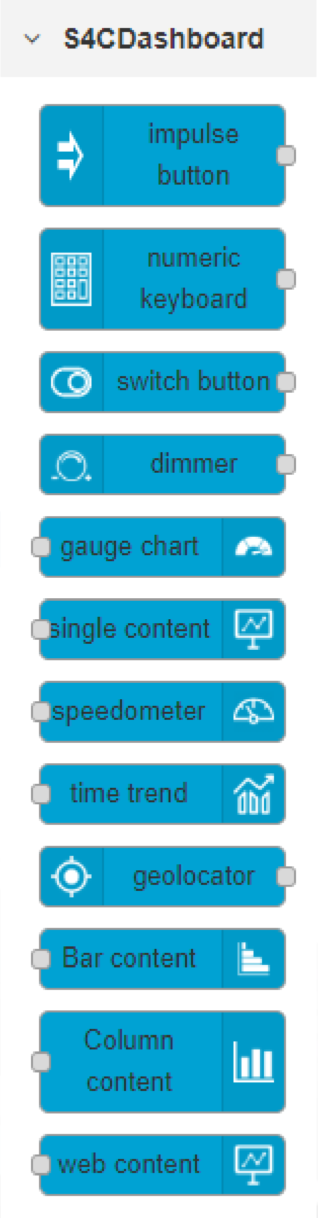


- Input/output
- non secure
- Limited in graphics
- No authentication
- No HLT
- No integration
- Etc..

- Local on IOT Edge

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

- Remote for IOT Edge via WebSocket Secure

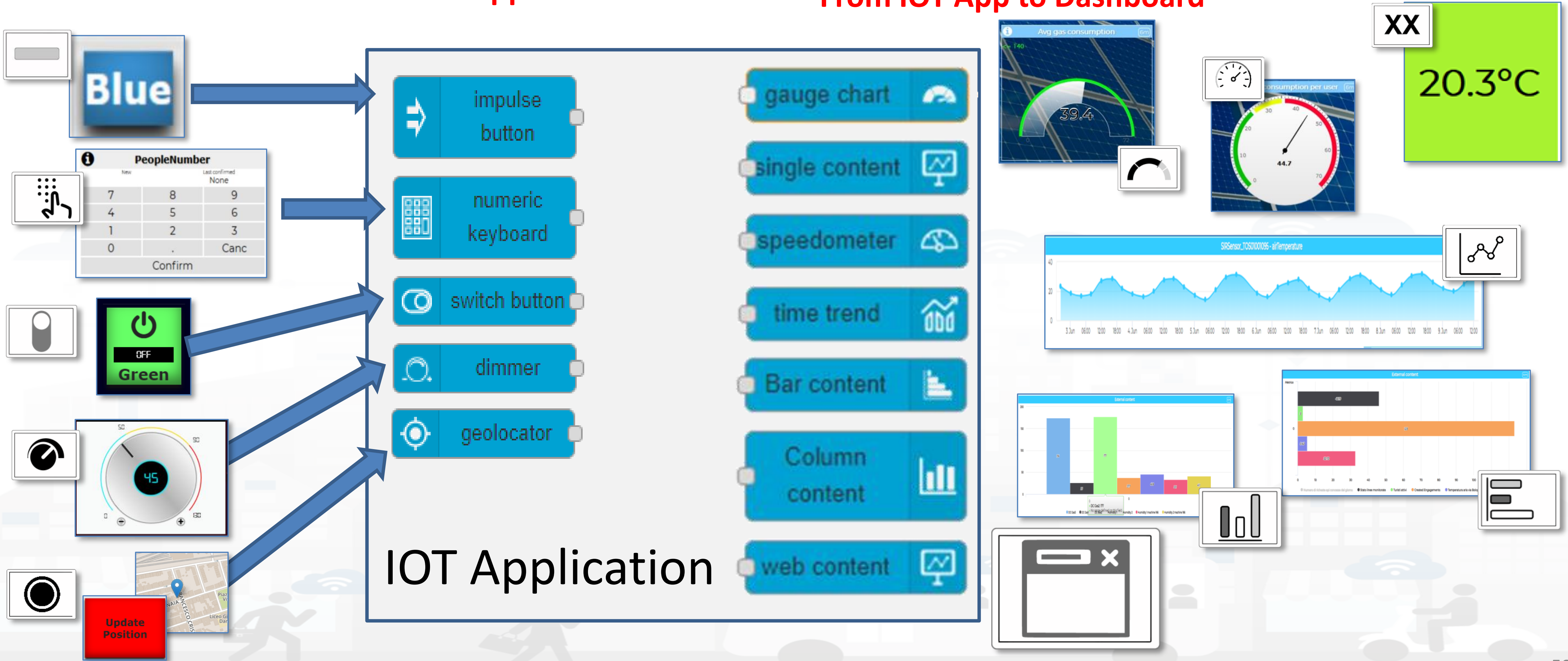


Dashboard-IOT App

Nature

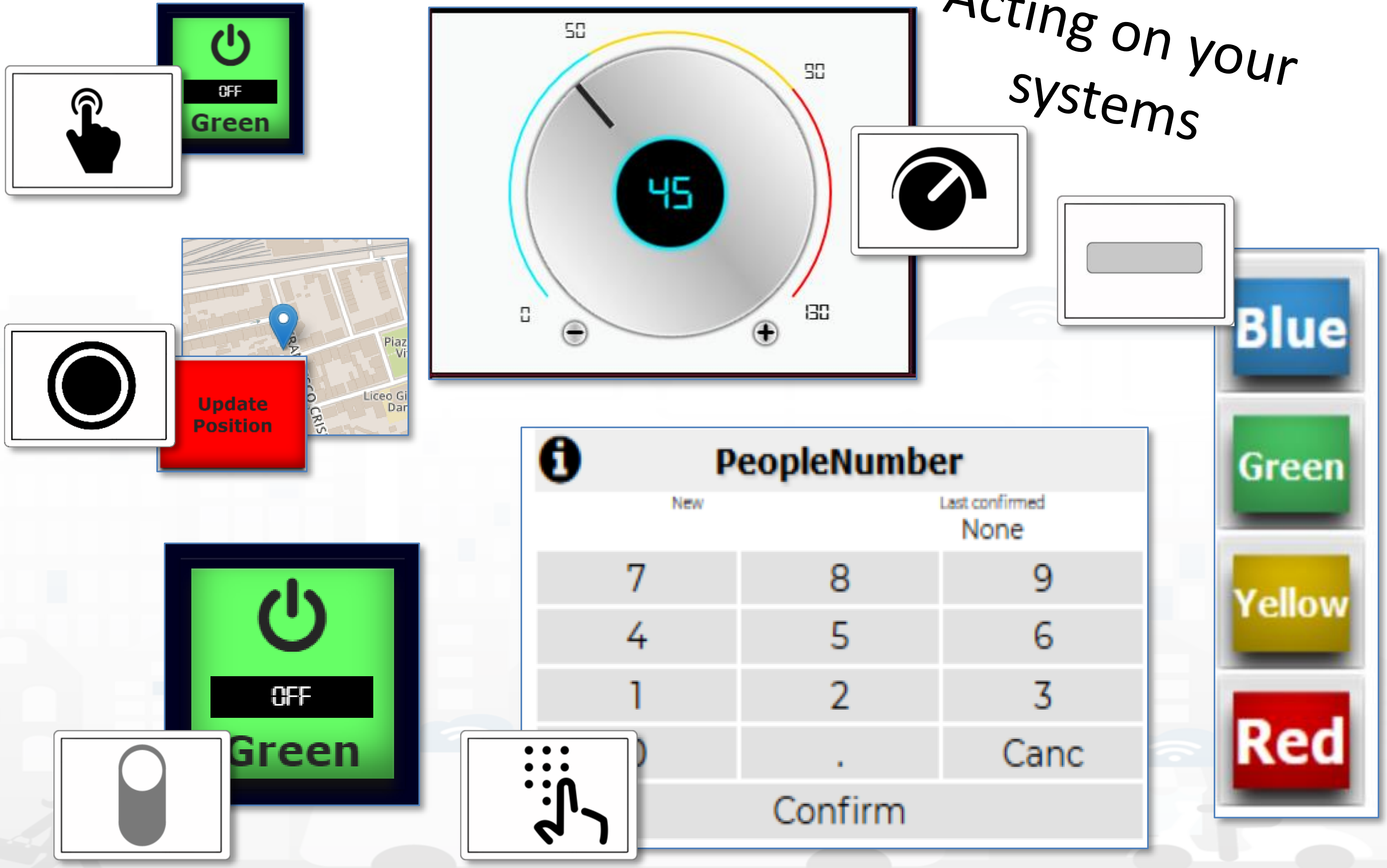
From Dashboard to IOT App

From IOT App to Dashboard



From Dashboard to IOT Devices

- **Widgets:**
  - Impulse Button
  - Button
  - Switch
  - Dimer/Knowb
  - KeyPad
  - geolocator
- **Registered** on some IOT brokers with NGSI mutual authentication

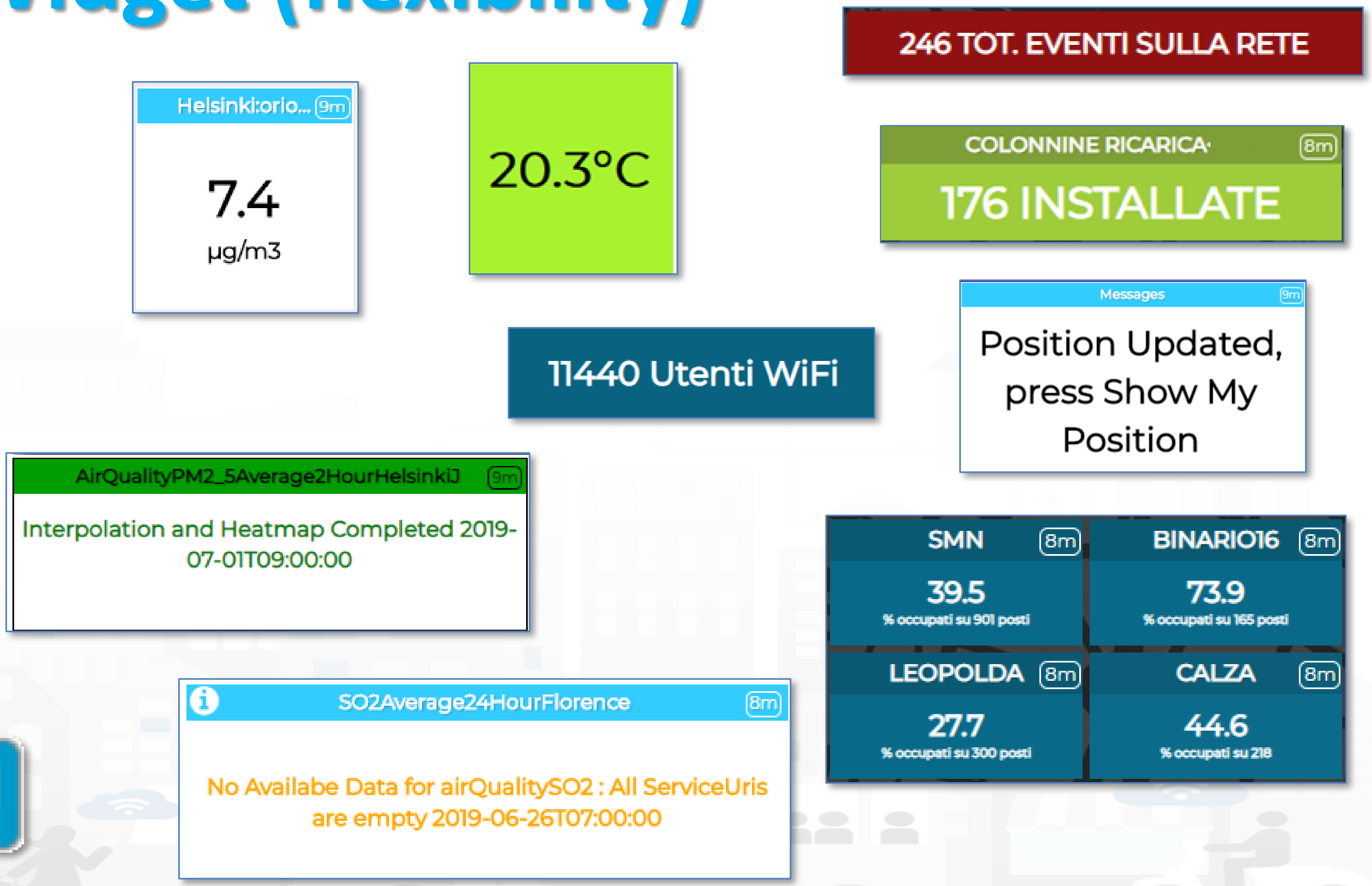


Acting on your systems

Single Content Widget (flexibility)

From Dashboard Editor and IOT Applications, accepts in input:

- Numbers
- String
- HTML code



246 TOT. EVENTI SULLA RETE

Helsinki:orio... 9m

7.4

μg/m3

20.3°C

COLONNINE RICARICA 8m

176 INSTALLATE

11440 Utenti WiFi

Messages 9m

Position Updated, press Show My Position

AirQualityPM2_5Average2HourHelsinkiJ 9m

Interpolation and Heatmap Completed 2019-07-01T09:00:00

SMN 8m

39.5

% occupati su 901 posti

BINARIO16 8m

73.9

% occupati su 165 posti

LEOPOLDA 8m

27.7

% occupati su 300 posti

CALZA 8m

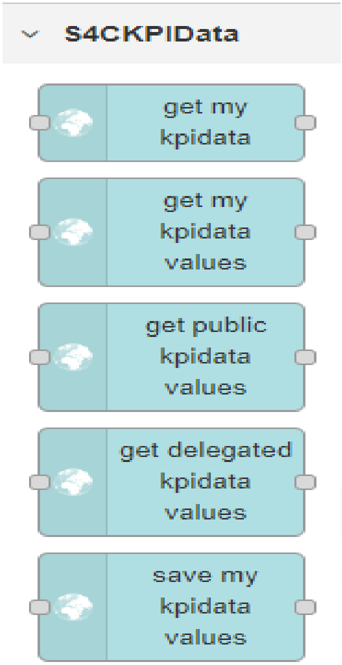
44.6

% occupati su 218

SO2Average24HourFlorence 8m

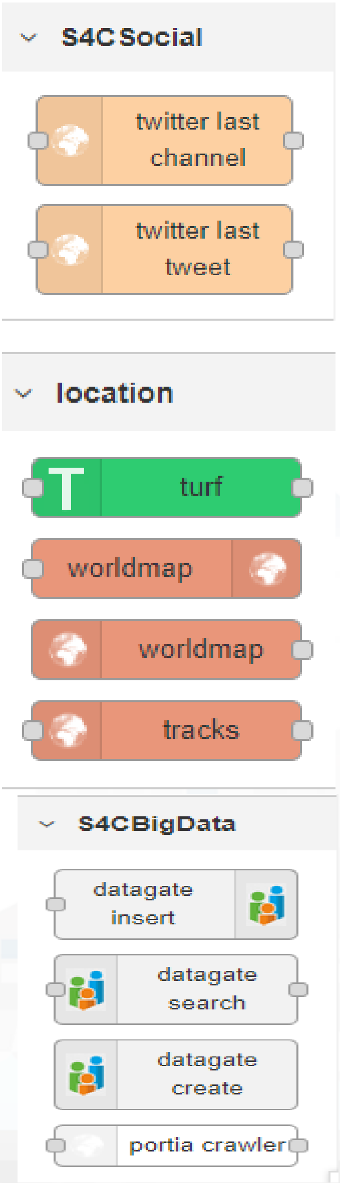
No Availabe Data for airQualitySO2 : All ServiceUris are empty 2019-06-26T07:00:00

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

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

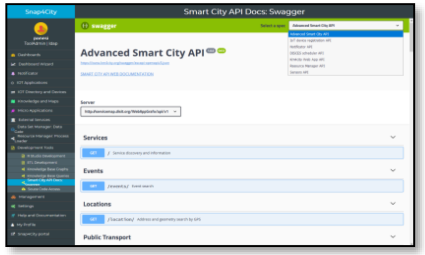
- Getting data from DataGate/CKAN
- Publishing data to DataGate/CKAN
- Managing time series on DataGate/CKAN

TOP

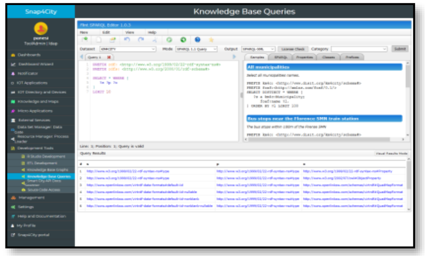
IOT App vs Data Analytics

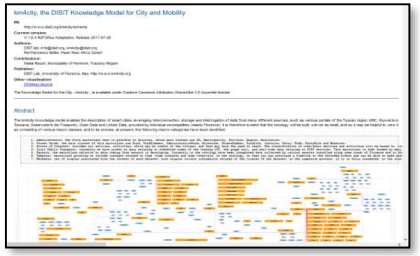
Data Analytics

Swagger



SPARQL, FLINT



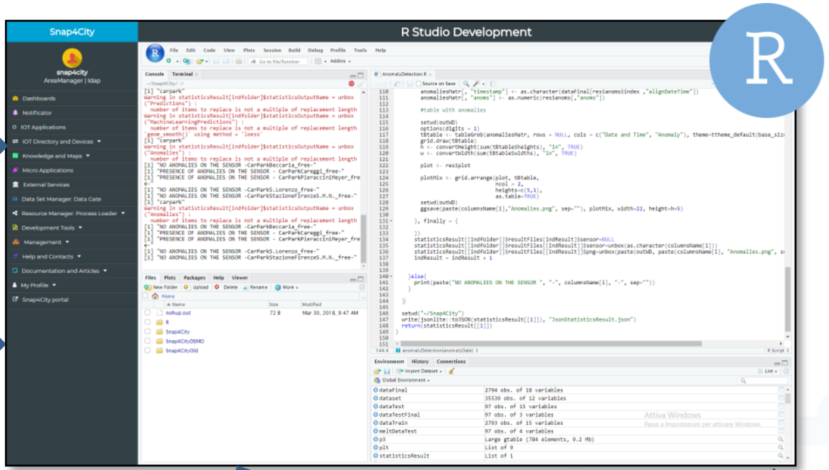


Ontology Schema

LOG.disit.org

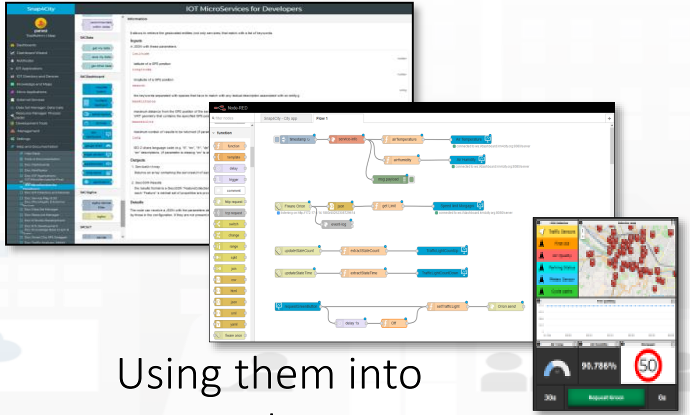
Big Data
Store
Facility

Smart City API from Knowledge Base and other tools



Creating
Micro Services

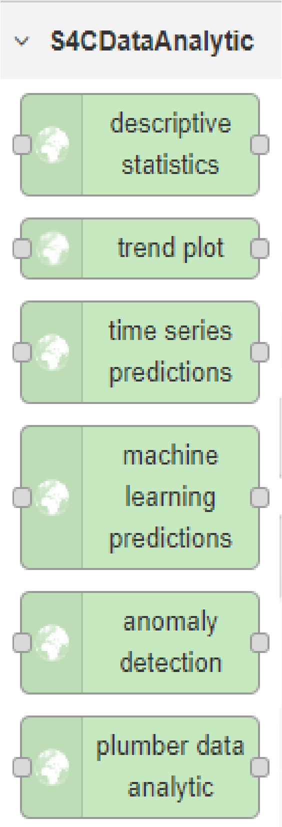
Saving
Sharing
Reusing



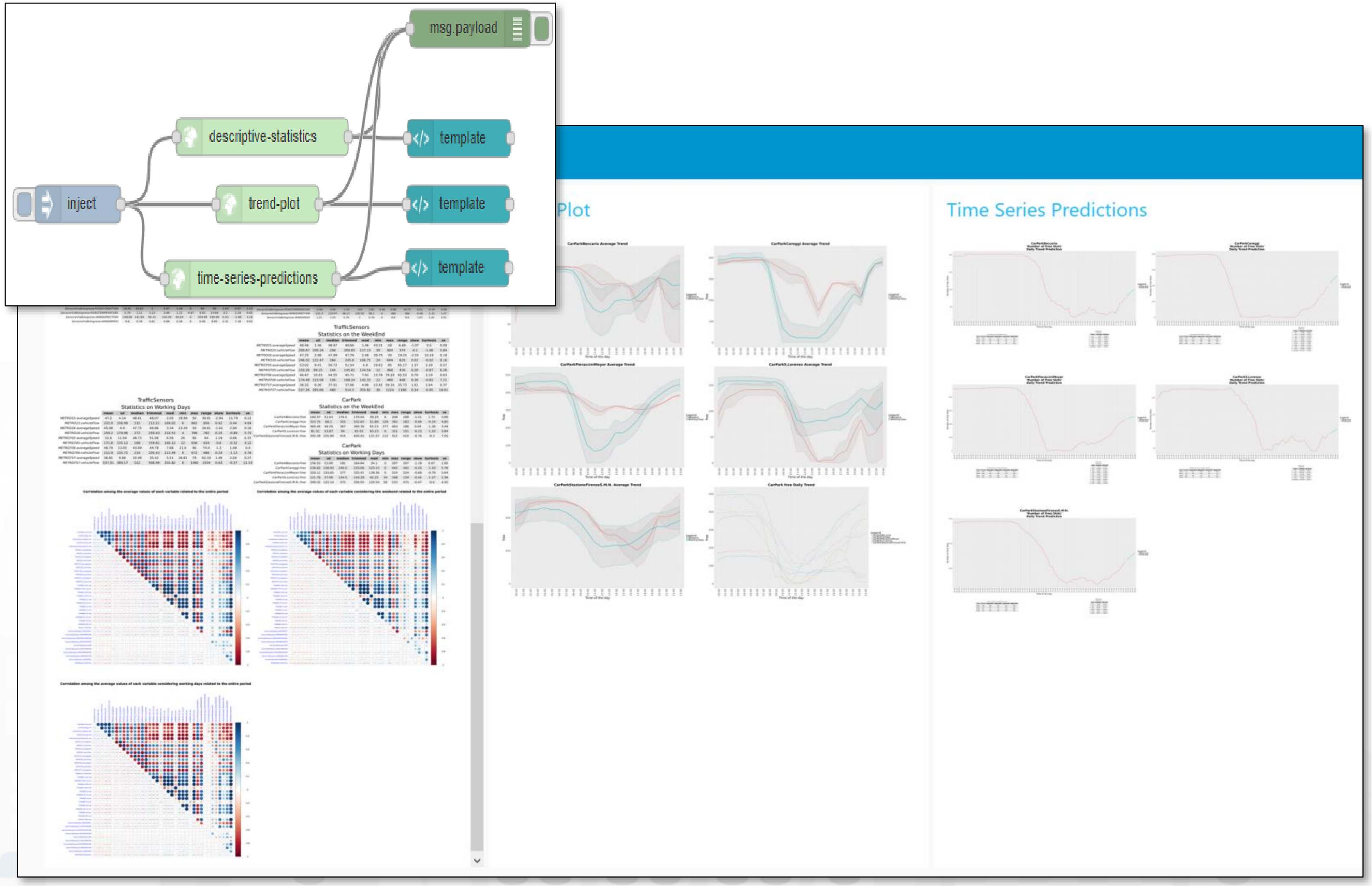
Using them into
IOT Applications

Resource Manager

Data Analytics to MicroServices

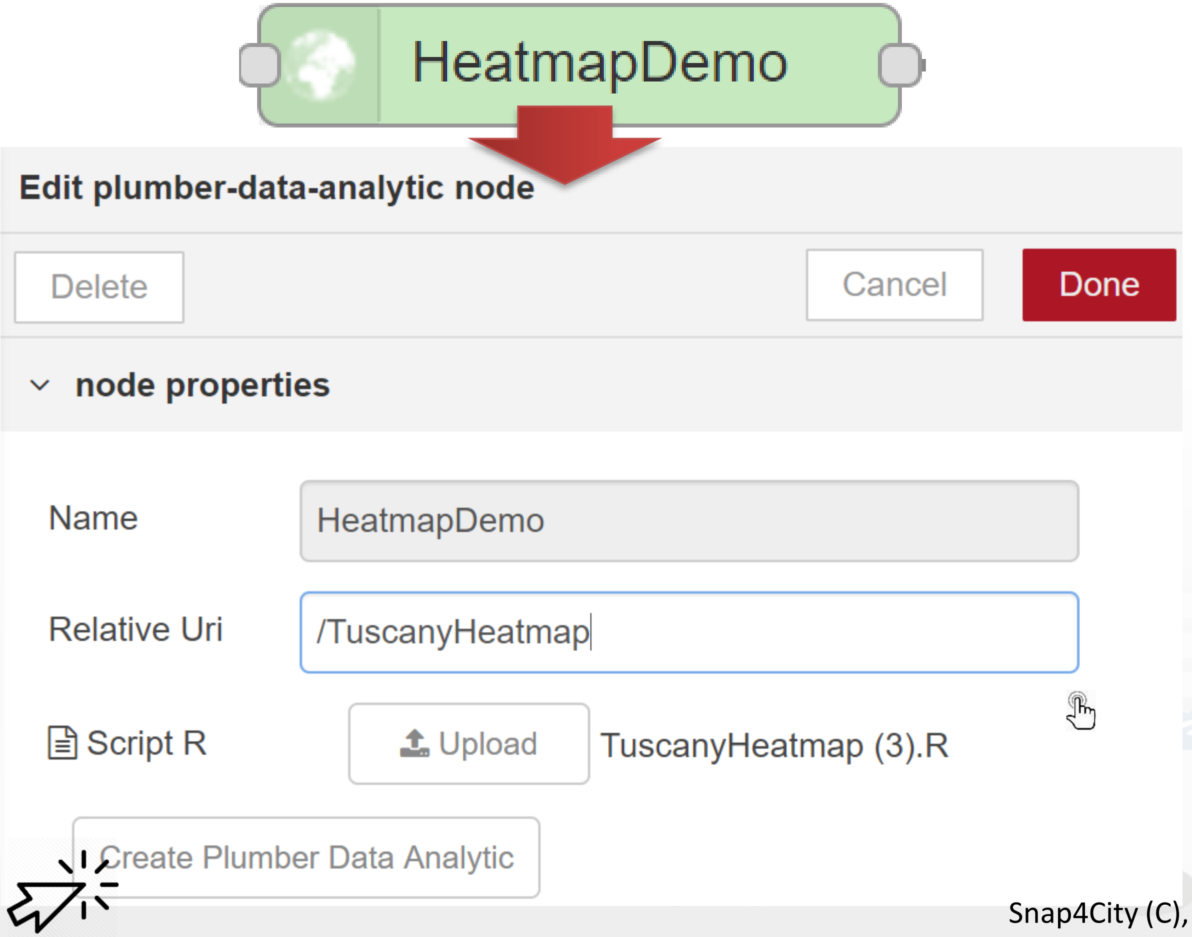


R Studio algorithms are **automatically** transformed into **MicroServices** for your IOT Applications



Data Analytics to MicroServices with Plumber

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



Edit plumber-data-analytic node

Name: HeatmapDemo

Relative Uri: /TuscanyHeatmap

Script R: Upload TuscanyHeatmap (3).R

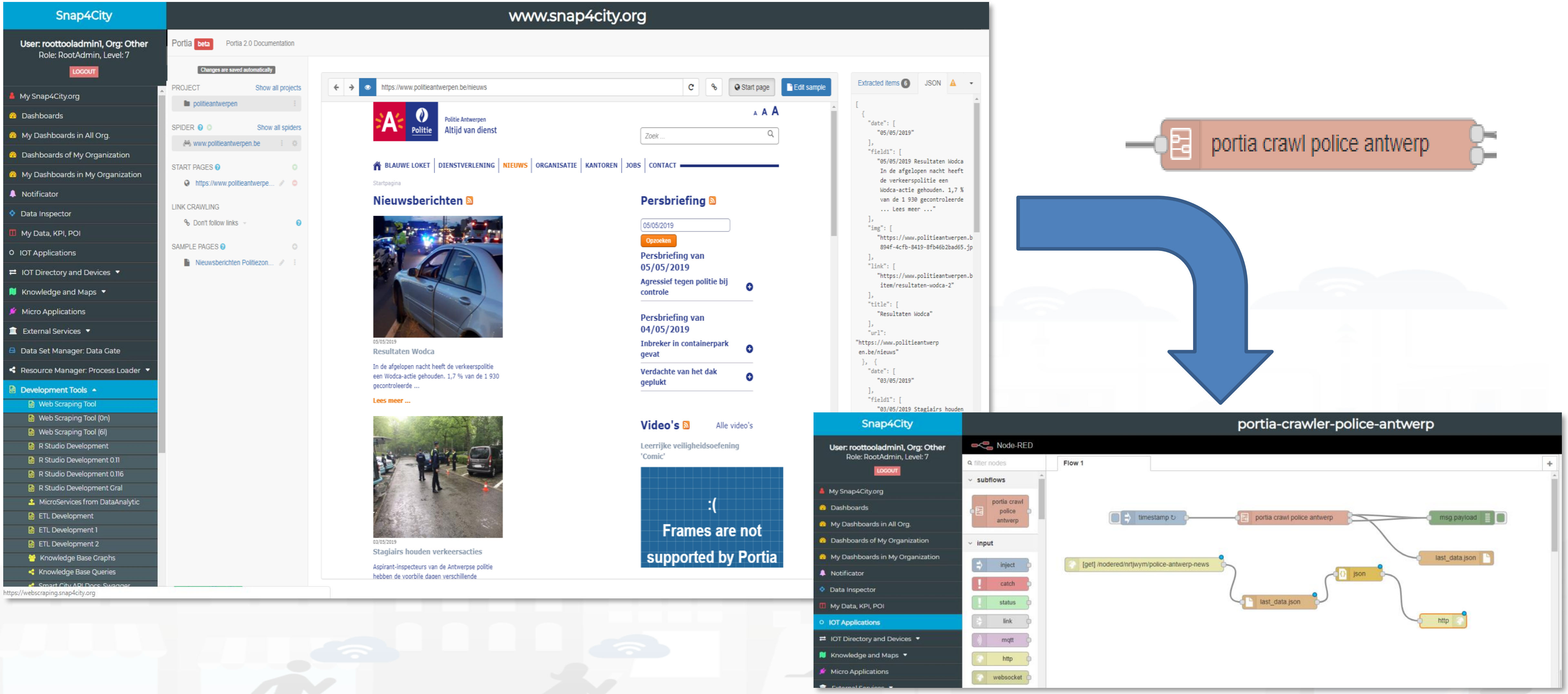
Relative Uri is the same of the R @get annotation:

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

TOP

IOT App vs Web Scraping

Web Scraping



Nieuwsberichten

05/05/2019

Resultaten Wodca

In de afgelopen nacht heeft de verkeerspolitie een Wodca-actie gehouden. 1,7 % van de 1 930 gecontroleerde ...

Lees meer ...

03/05/2019

Stagiairs houden verkeersacties

Aspirant-inspecteurs van de Antwerpse politie hebben de voorbije dagen verschillende

Persbriefing

05/05/2019

Opzoeken

Persbriefing van 05/05/2019

Agressief tegen politie bij controle

Persbriefing van 04/05/2019

Inbreker in containerpark gevat

Verdachte van het dak geplukt

Video's

Alle video's

Leerrijke veiligheidsoefening 'Comic'

:(
Frames are not supported by Portia

```
[
  {
    "date": [
      "05/05/2019"
    ],
    "field1": [
      "05/05/2019 Resultaten Wodca
       In de afgelopen nacht heeft
       de verkeerspolitie een
       Wodca-actie gehouden. 1,7 %
       van de 1 930 gecontroleerde
       ... Lees meer ..."
    ],
    "img": [
      "https://www.politieantwerpen.b
       894f-4cfb-8419-8fb46b2bad65.jp
    ],
    "link": [
      "https://www.politieantwerpen.b
       item/resultaten-wodca-2"
    ],
    "title": [
      "Resultaten Wodca"
    ],
    "url":
"https://www.politieantwerp
 en.be/nieuws"
  }, {
    "date": [
      "03/05/2019"
    ],
    "field1": [
      "03/05/2019 Stagiairs houden
```

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

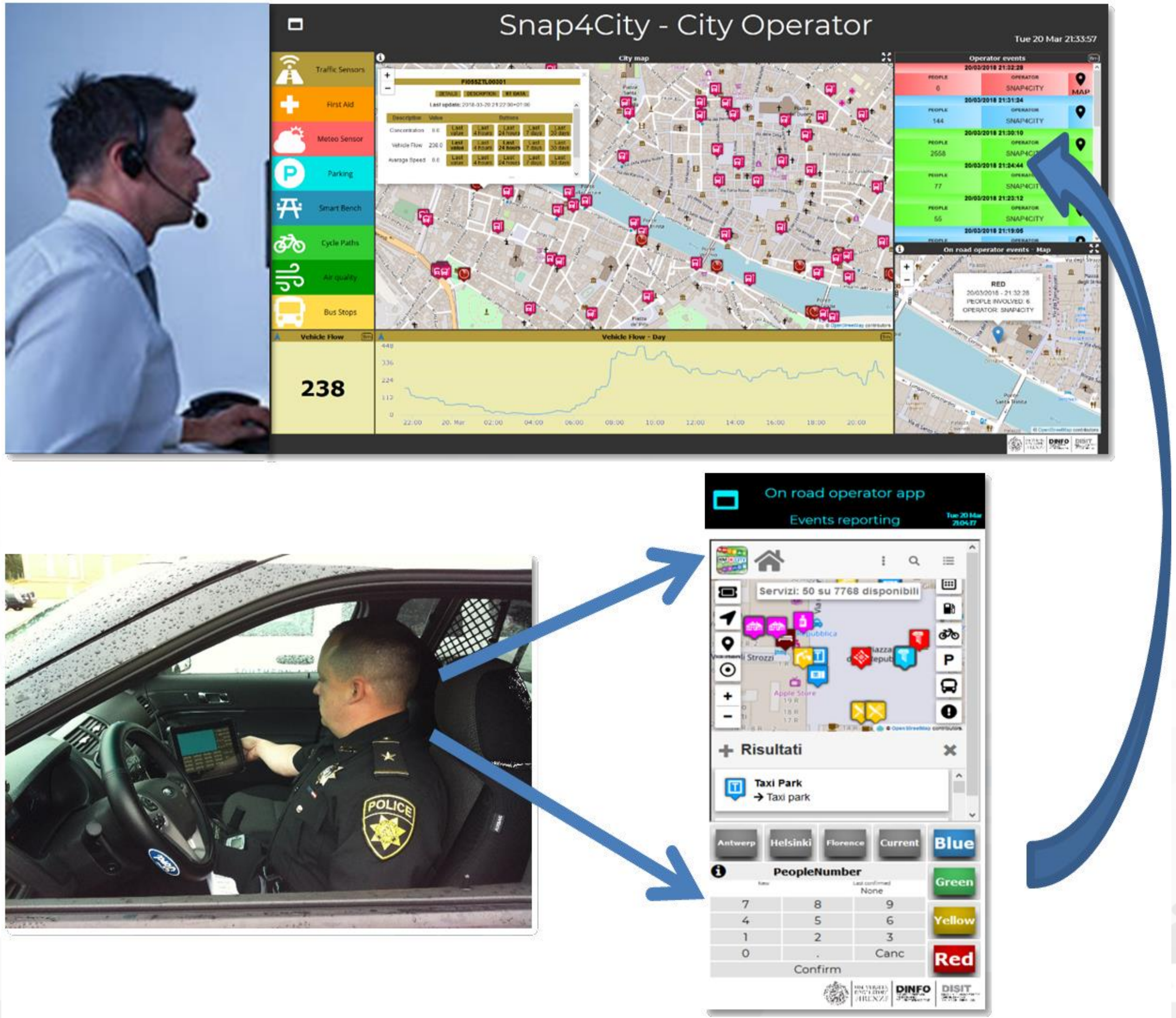
TOP

IOT App 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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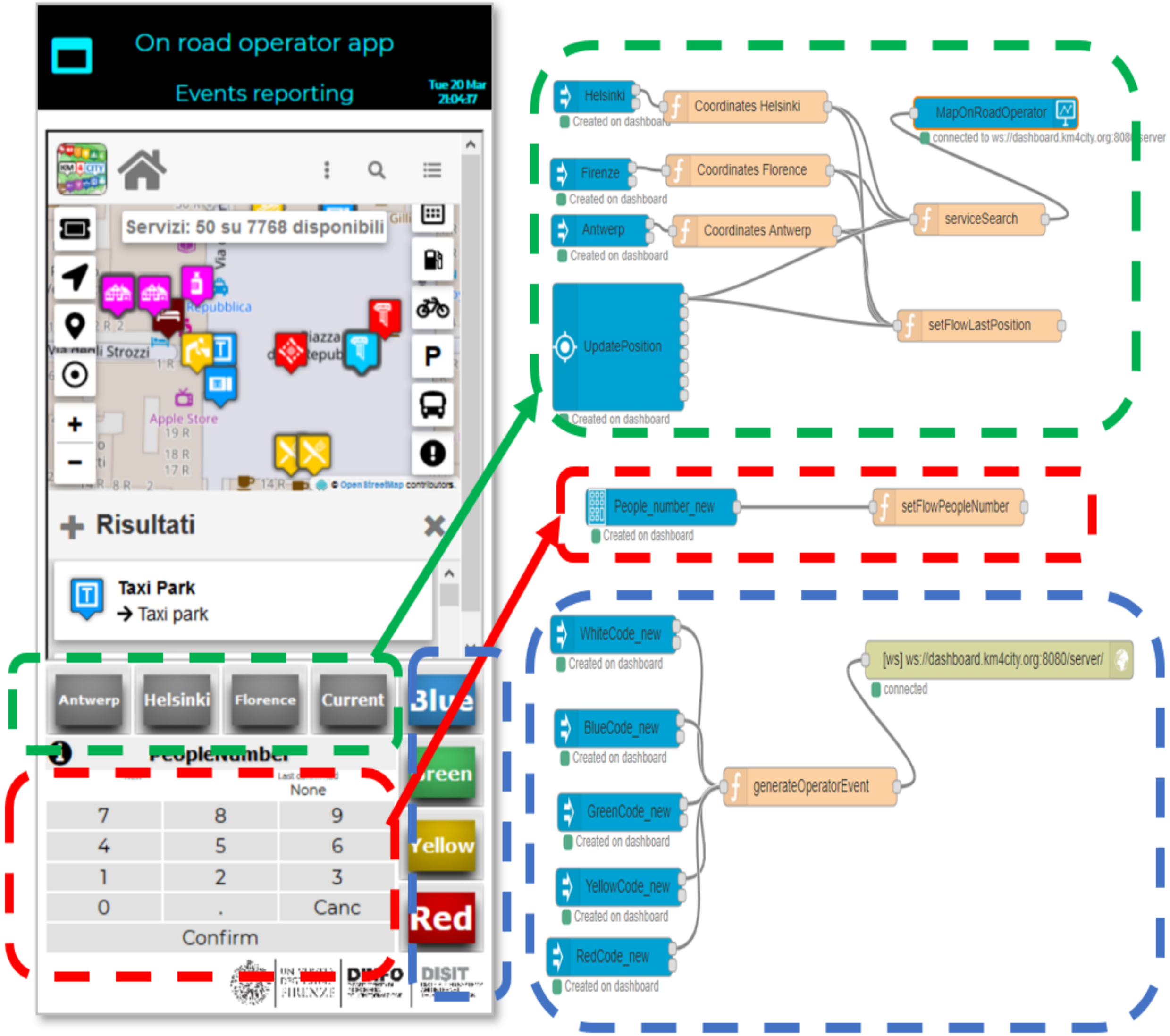
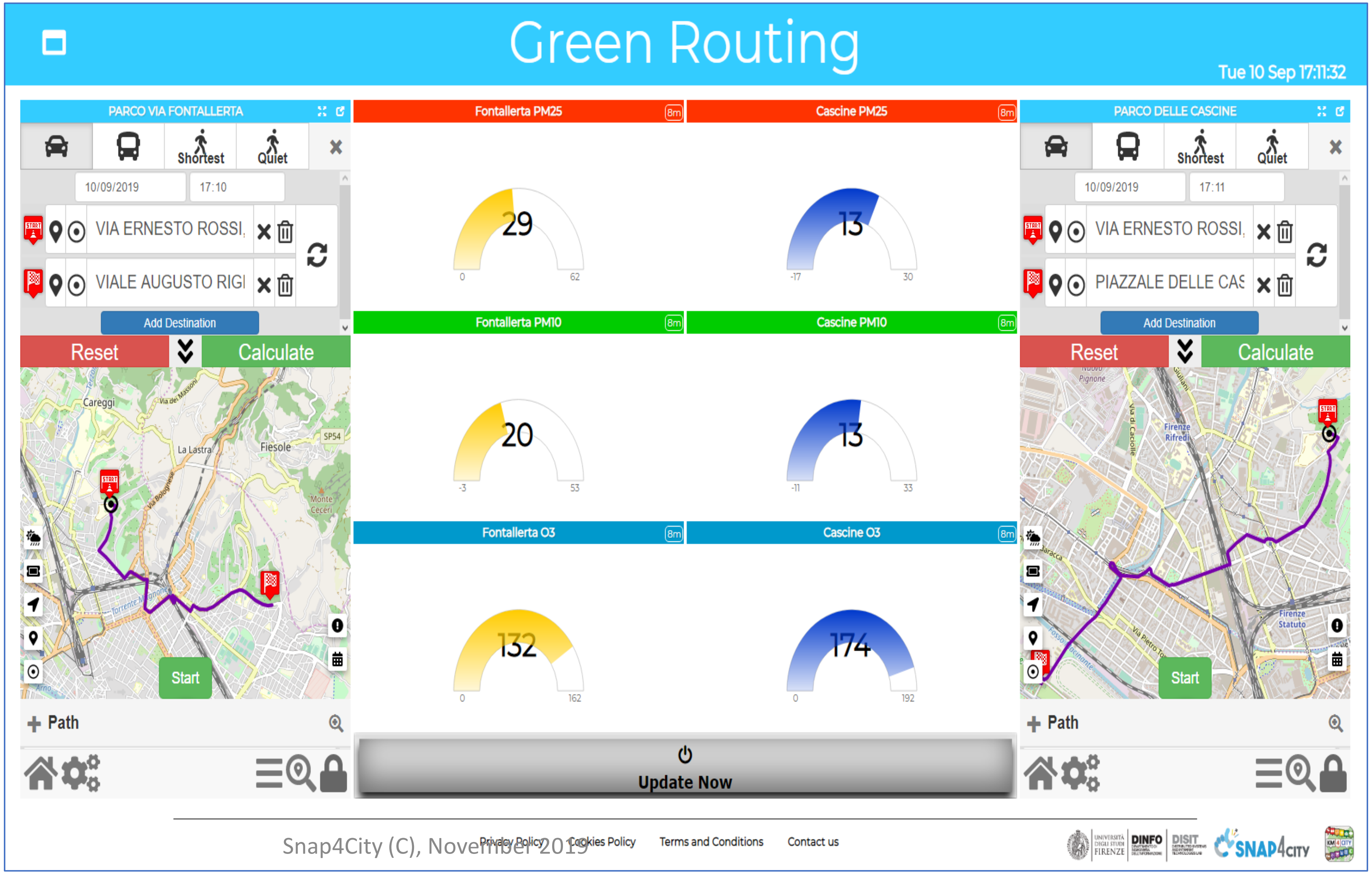


Check which route is less polluted

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**



Green Routing

Tue 10 Sep 17:11:32

PARCO VIA FONTALLERTA: 10/09/2019, 17:10; VIA ERNESTO ROSSI, → VIALE AUGUSTO RIGI

Fontallerta PM25: 29 (0–62)

Cascine PM25: 13 (-17–30)

Fontallerta PM10: 20 (-3–53)

Cascine PM10: 13 (-11–33)

Fontallerta O3: 132 (0–162)

Cascine O3: 174 (0–192)

PARCO DELLE CASCINE: 10/09/2019, 17:11; VIA ERNESTO ROSSI, → PIAZZALE DELLE CAS

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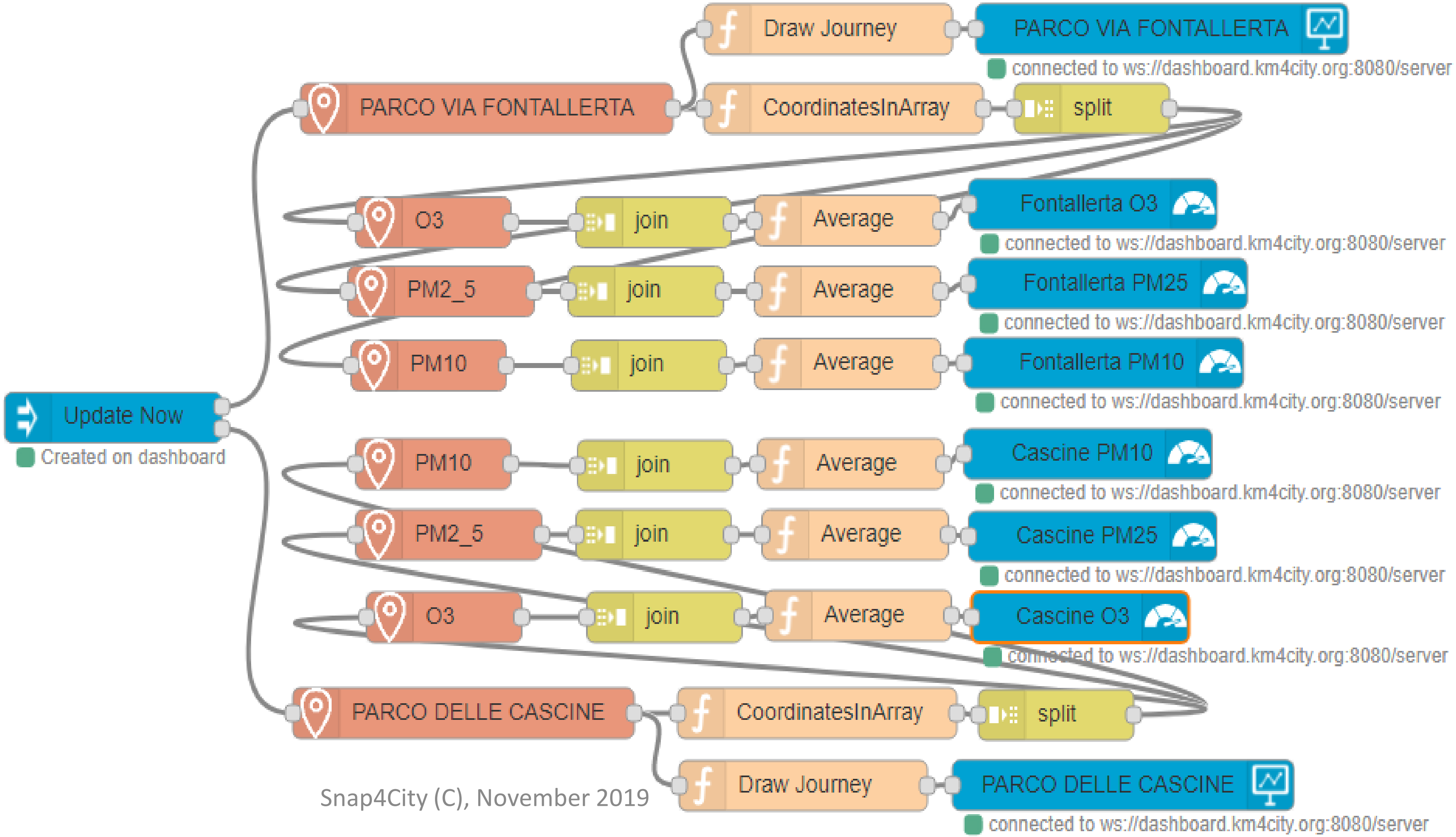
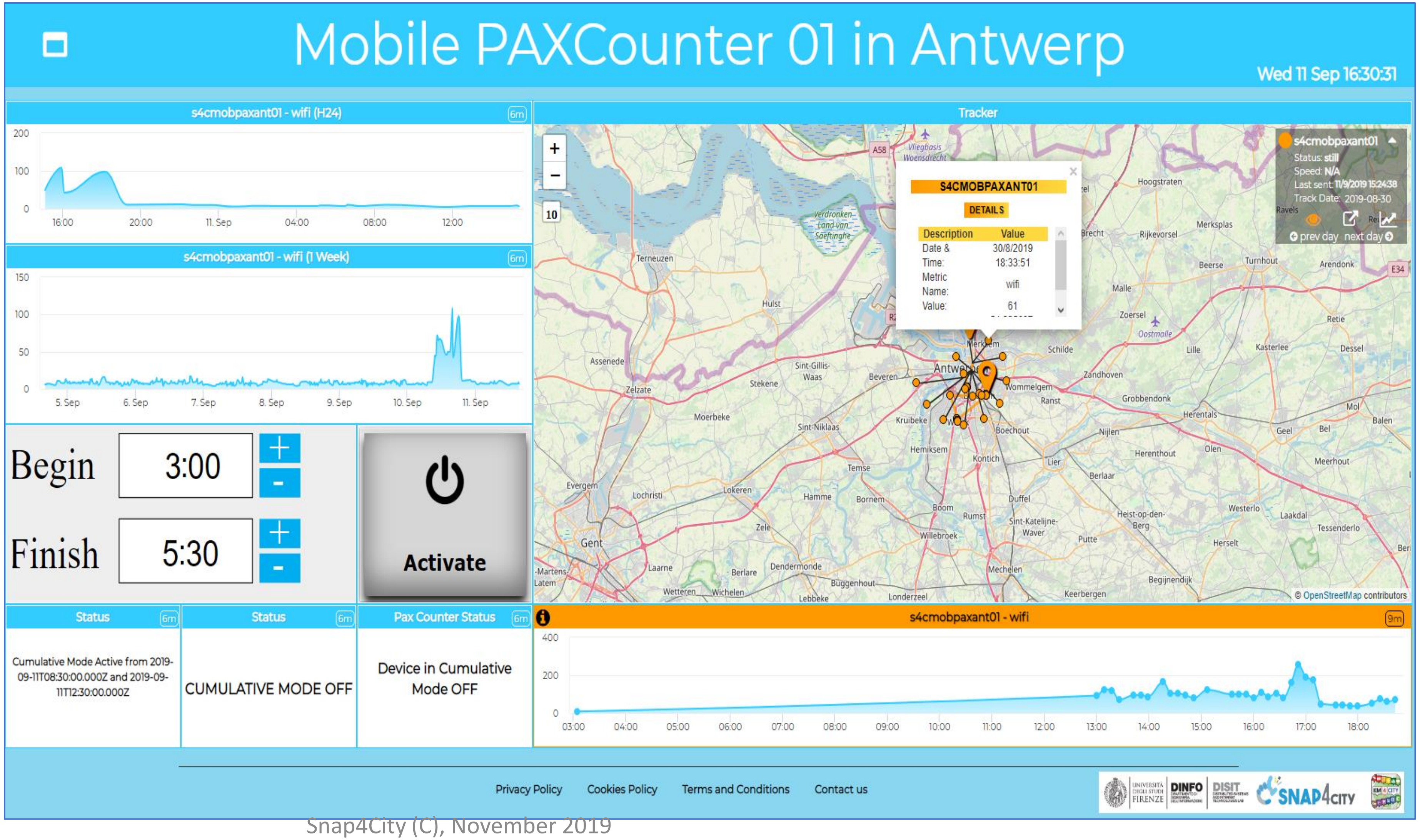


Draw Journey
PARCO VIA FONTALLERTA
connected to ws://dashboard.km4city.org:8080/server
PARCO VIA FONTALLERTA
CoordinatesInArray
split
O3
join
Average
Fontallerta O3
connected to ws://dashboard.km4city.org:8080/server
PM2_5
join
Average
Fontallerta PM25
connected to ws://dashboard.km4city.org:8080/server
PM10
join
Average
Fontallerta PM10
connected to ws://dashboard.km4city.org:8080/server
Update Now
Created on dashboard
PM10
join
Average
Cascine PM10
connected to ws://dashboard.km4city.org:8080/server
PM2_5
join
Average
Cascine PM25
connected to ws://dashboard.km4city.org:8080/server
O3
join
Average
Cascine O3
connected to ws://dashboard.km4city.org:8080/server
PARCO DELLE CASCINE
CoordinatesInArray
split
Draw Journey
PARCO DELLE CASCINE
connected to ws://dashboard.km4city.org:8080/server

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)



Mobile PAXCounter 01 in Antwerp

Wed 11 Sep 16:30:31

s4cmobpaxant01 - wifi (H24)

s4cmobpaxant01 - wifi (1 Week)

Begin 3:00

Finish 5:30

Activate

Tracker

S4CMOBPAXANT01

DETAILS

Description	Value
Date & Time:	30/8/2019 18:33:51
Metric Name:	wifi
Value:	61

s4cmobpaxant01

Status: still

Speed: N/A

Last sent: 11/9/2019 15:24:38

Track Date: 2019-08-30

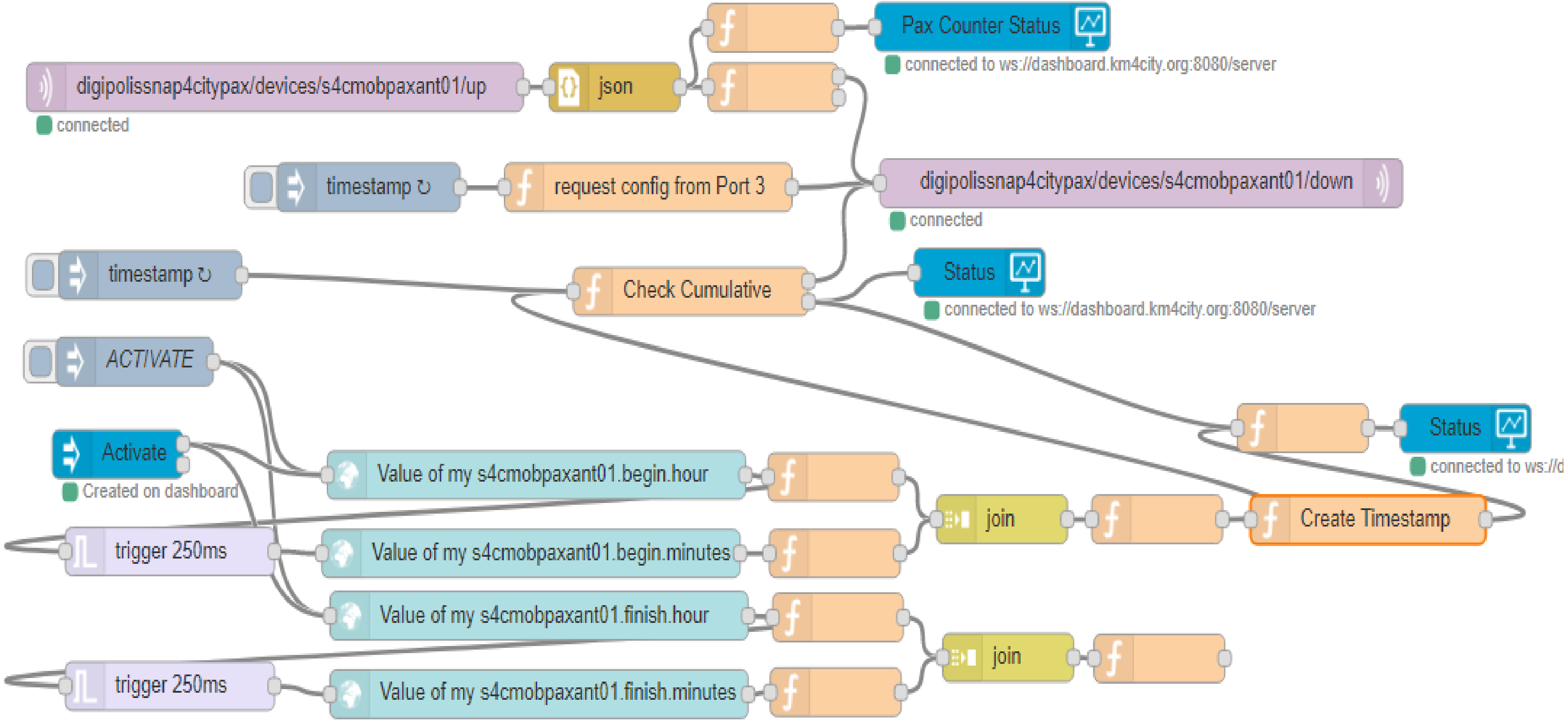
Status	Status	Pax Counter Status
Cumulative Mode Active from 2019-09-11T08:30:00.000Z and 2019-09-11T12:30:00.000Z	CUMULATIVE MODE OFF	Device in Cumulative Mode OFF

s4cmobpaxant01 - wifi

Privacy Policy Cookies Policy Terms and Conditions Contact us

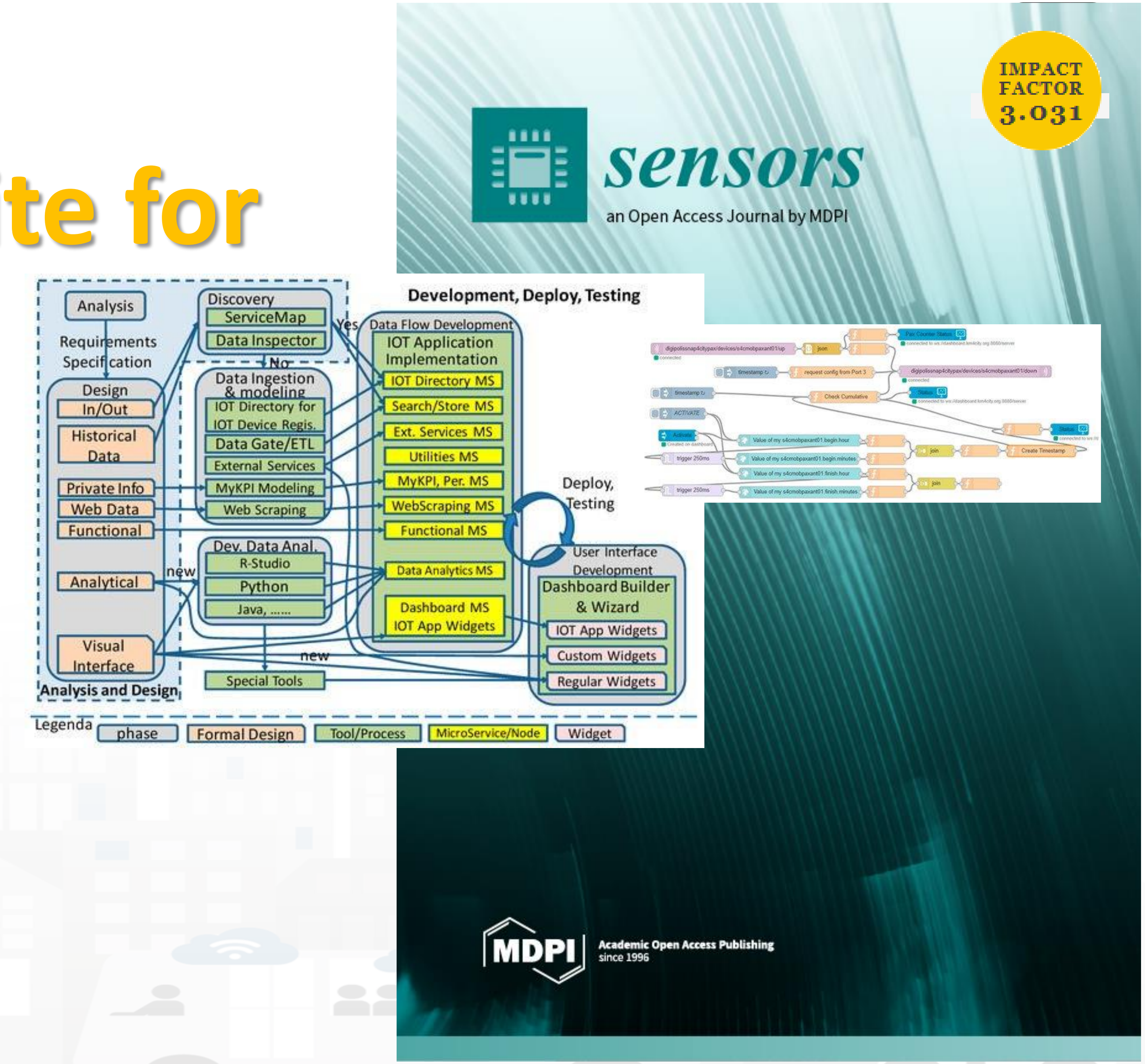
Controlling Personal Mobile PAX Counter

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


digipolissnap4citypax/devices/s4cmobpaxant01/up
connected
json
Pax Counter Status
connected to ws://dashboard.km4city.org:8080/server
timestamp ↻
request config from Port 3
digipolissnap4citypax/devices/s4cmobpaxant01/down
connected
timestamp ↻
Check Cumulative
Status
connected to ws://dashboard.km4city.org:8080/server
ACTIVATE
Status
connected to ws://d
Activate
Created on dashboard
Value of my s4cmobpaxant01.begin.hour
trigger 250ms
Value of my s4cmobpaxant01.begin.minutes
join
Create Timestamp
Value of my s4cmobpaxant01.finish.hour
trigger 250ms
join
Value of my s4cmobpaxant01.finish.minutes

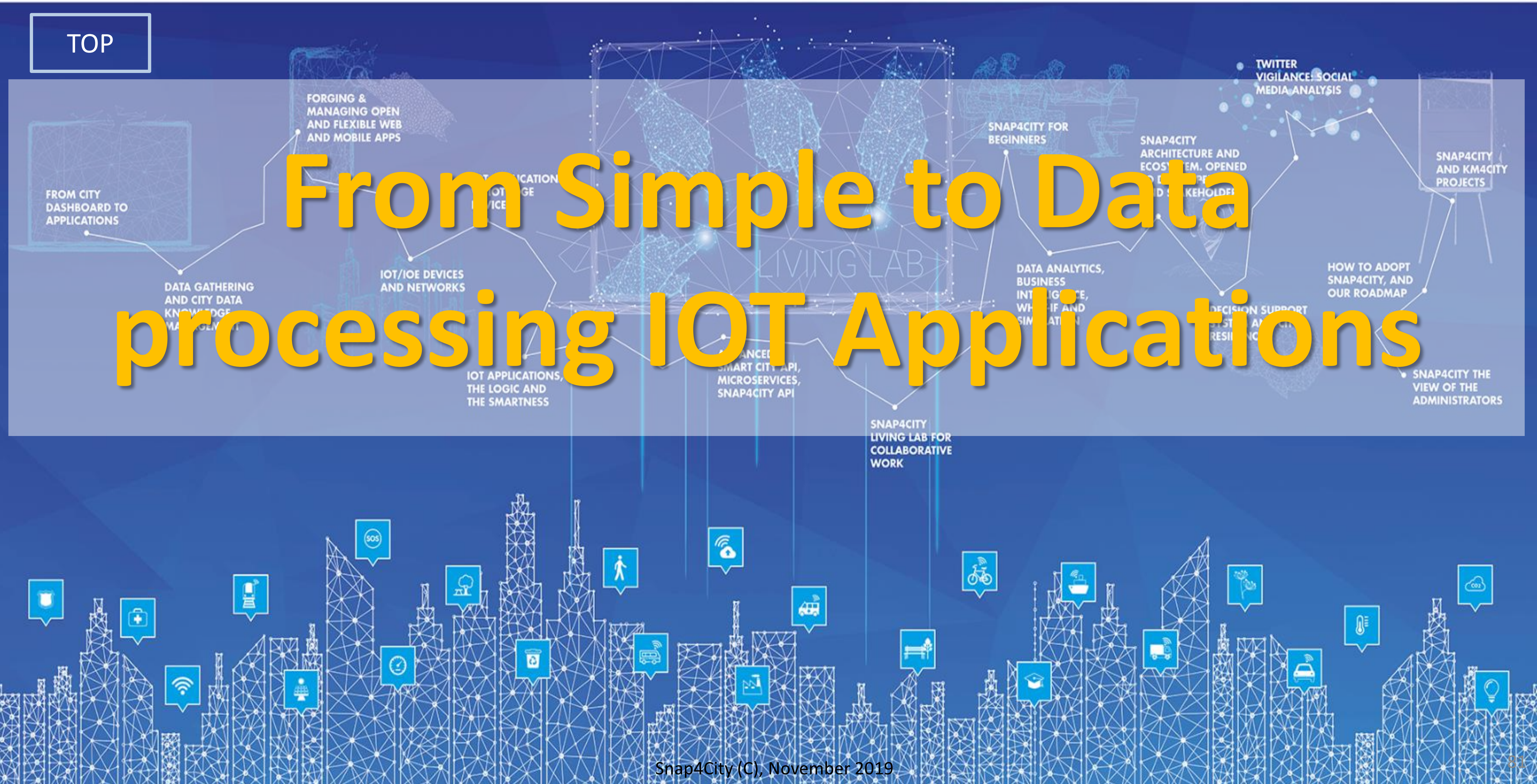
MicroServices Suite for Smart City

- 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



TOP

From Simple to Data processing IOT Applications


FORGING & MANAGING OPEN AND FLEXIBLE WEB AND MOBILE APPS
TWITTER VIGILANCE: SOCIAL MEDIA ANALYSIS
SNAP4CITY FOR BEGINNERS
SNAP4CITY ARCHITECTURE AND ECOSYSTEM. OPENED
SNAP4CITY AND KM4CITY PROJECTS
FROM CITY DASHBOARD TO APPLICATIONS
LIVING LAB
DATA GATHERING AND CITY DATA KNOWLEDGE
IOT/IOE DEVICES AND NETWORKS
DATA ANALYTICS, BUSINESS
HOW TO ADOPT SNAP4CITY, AND OUR ROADMAP
DECISION SUPPORT
IOT APPLICATIONS, THE LOGIC AND THE SMARTNESS
SMART CITY API, MICROSERVICES, SNAP4CITY API
SNAP4CITY THE VIEW OF THE ADMINISTRATORS
SNAP4CITY LIVING LAB FOR COLLABORATIVE WORK
SOS

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)

TOP

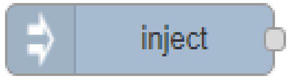
Create a Simple IOT Application (DEMO)

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

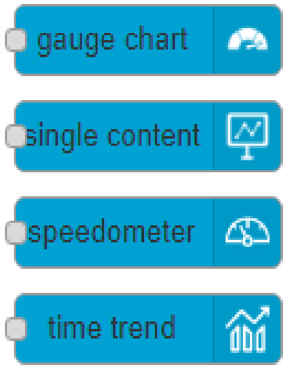


Generates an input for the other nodes. It can be repeated at predefined intervals, entered manually and of various types (string, number, Boolean, json etc.)

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



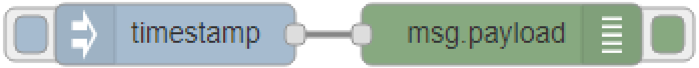
Display values in different modalities on a Dashboard (or on different Dash)

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

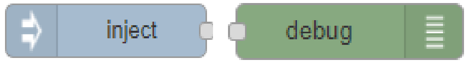
The others only accept numbers.

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

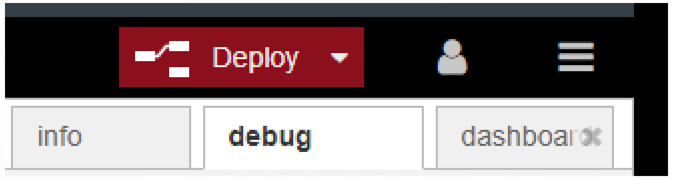
Step 1



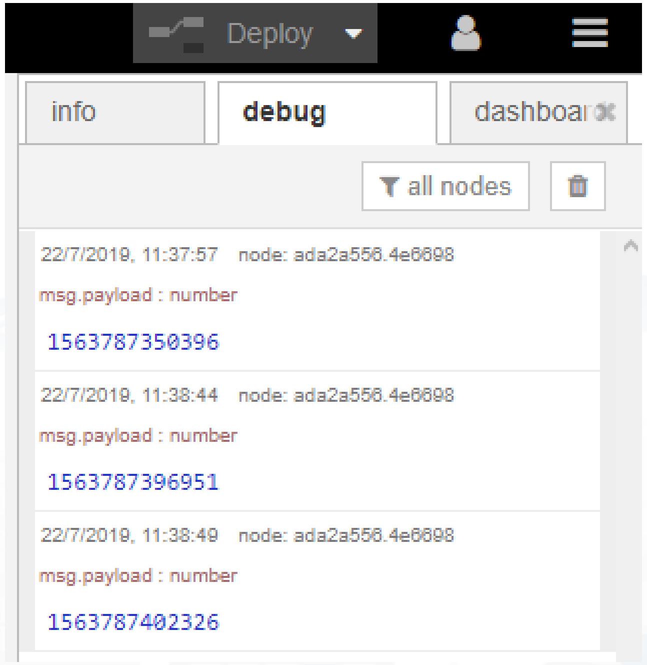
- Inject and Debug



- Connect
- Deploy

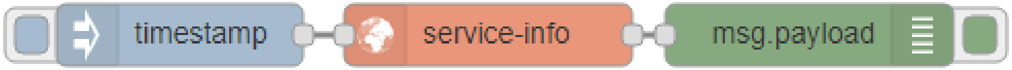


- Click and Observe
- Play with results



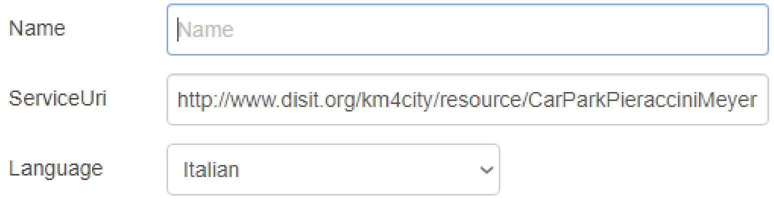
```
22/7/2019, 11:37:57   node: ada2a556.4e6698
msg.payload : number
1563787350396
22/7/2019, 11:38:44   node: ada2a556.4e6698
msg.payload : number
1563787396951
22/7/2019, 11:38:49   node: ada2a556.4e6698
msg.payload : number
1563787402326
```

Step 2



- Service Info

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

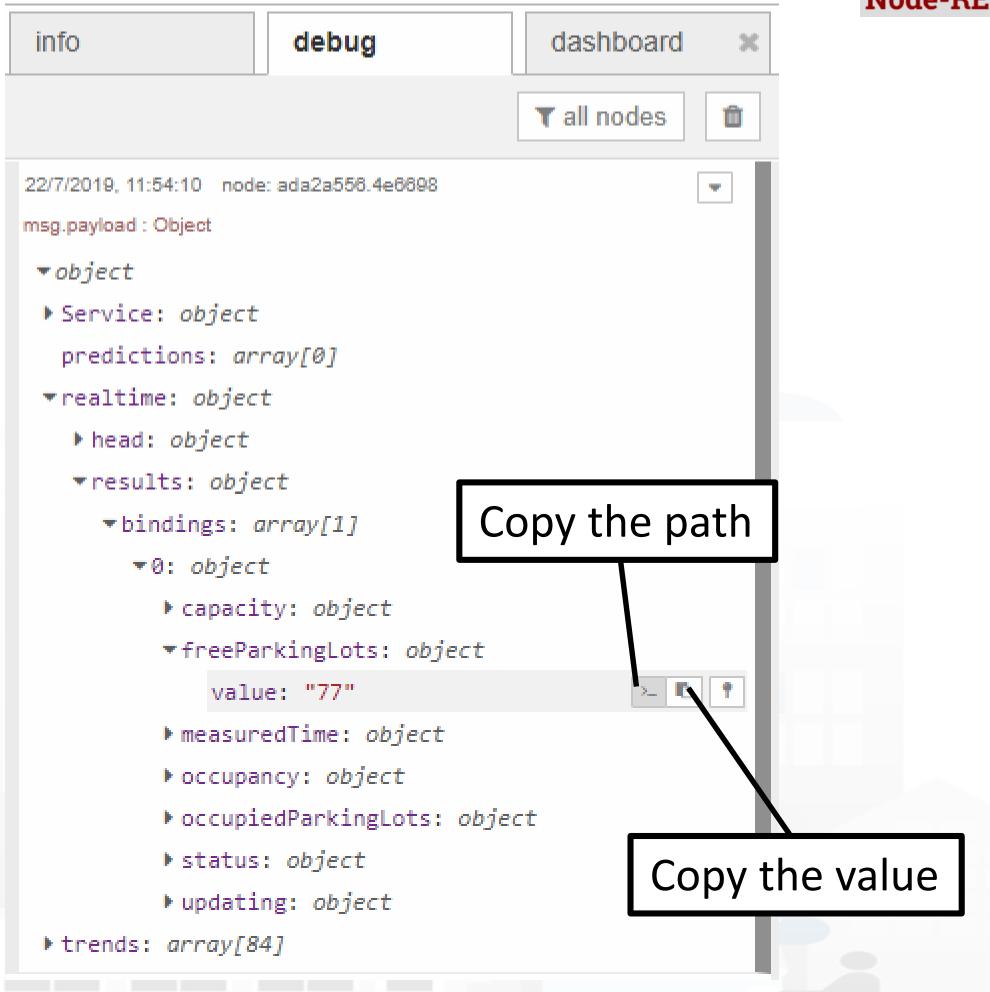


Name: Name

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

Language: Italian

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

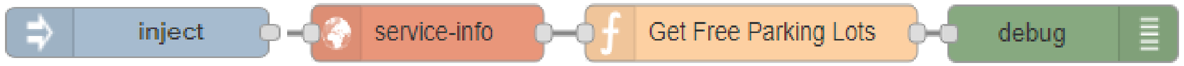


```
22/7/2019, 11:54:10   node: ada2a556.4e6698
msg.payload : Object
▾object
 ▸Service: object
  predictions: array[0]
 ▾realtime: object
   ▸head: object
   ▾results: object
     ▾bindings: array[1]
       ▾0: object
         ▸capacity: object
         ▾freeParkingLots: object
            value: "77"
         ▸measuredTime: object
         ▸occupancy: object
         ▸occupiedParkingLots: object
         ▸status: object
         ▸updating: object
 ▸trends: array[84]
```

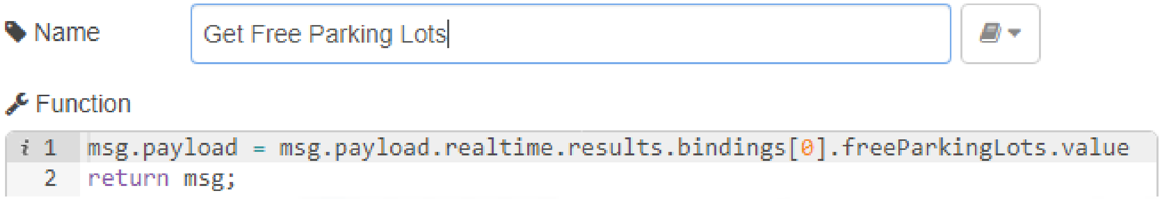
Copy the path

Copy the value

Step 3



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

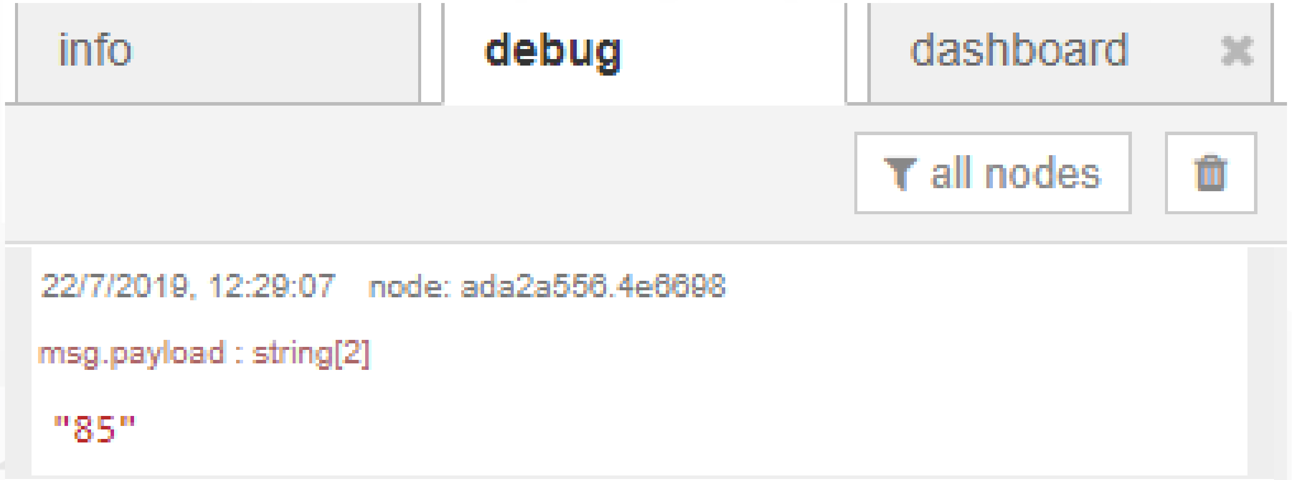


Name: Get Free Parking Lots

Function

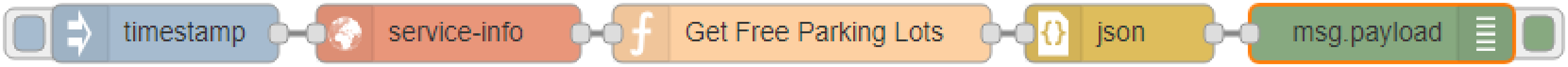
```
msg.payload = msg.payload.realtime.results.bindings[0].freeParkingLots.value
return msg;
```

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



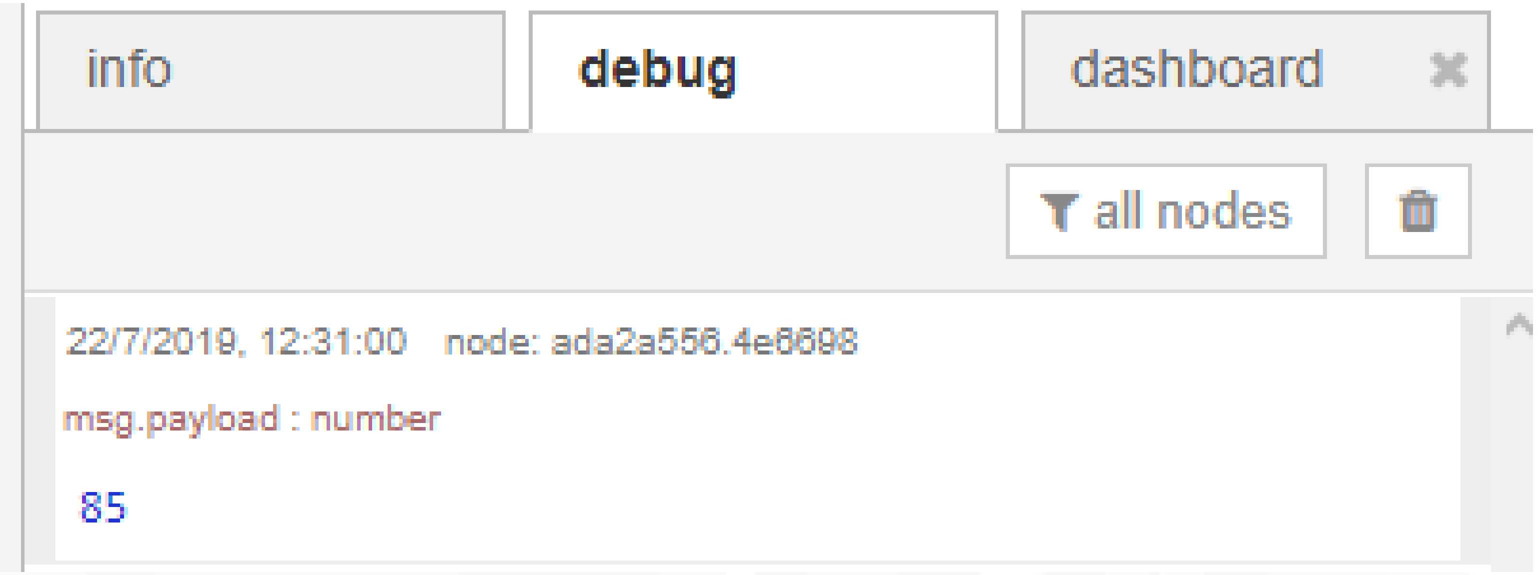
```
22/7/2019, 12:29:07   node: ada2a556.4e6698
msg.payload : string[2]
"85"
```

Step 4



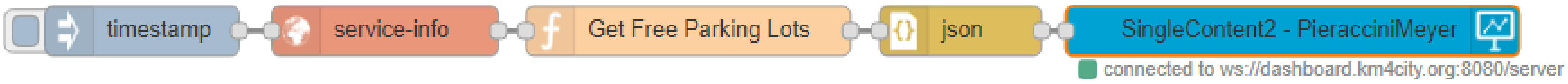
- JSON

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



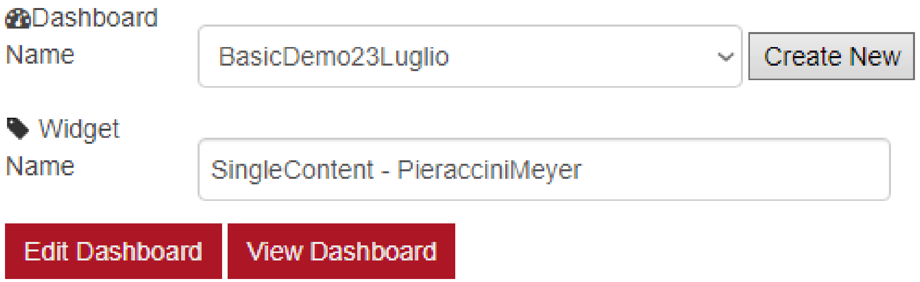
```
22/7/2019, 12:31:00   node: ada2a556.4e6698
msg.payload : number
 85
```

Step 5



connected to ws://dashboard.km4city.org:8080/server

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

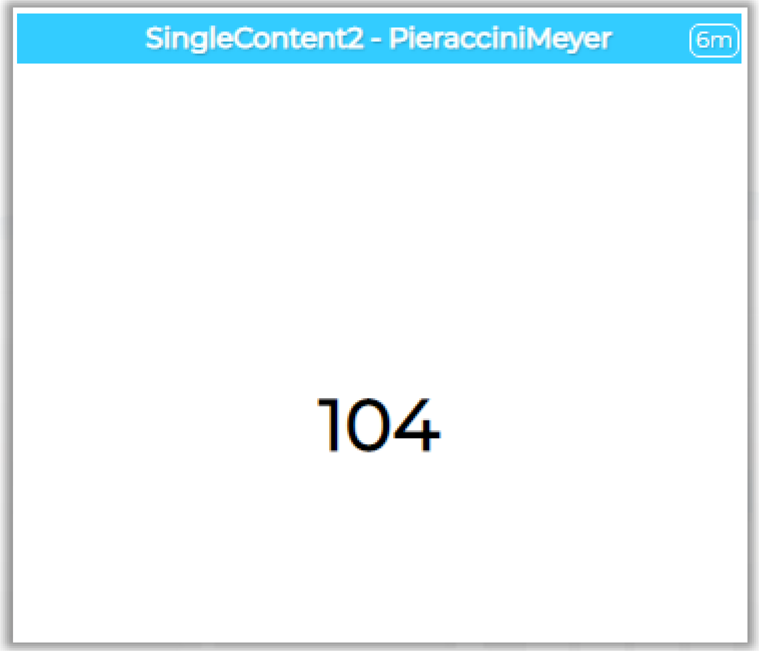


Dashboard Name: BasicDemo23Luglio

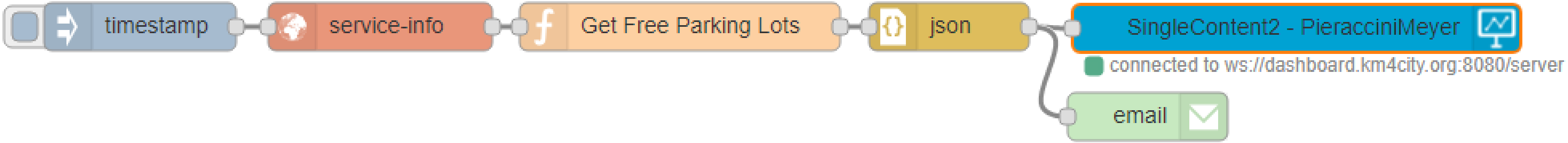
Create New

Widget Name: SingleContent - PieracciniMeyer

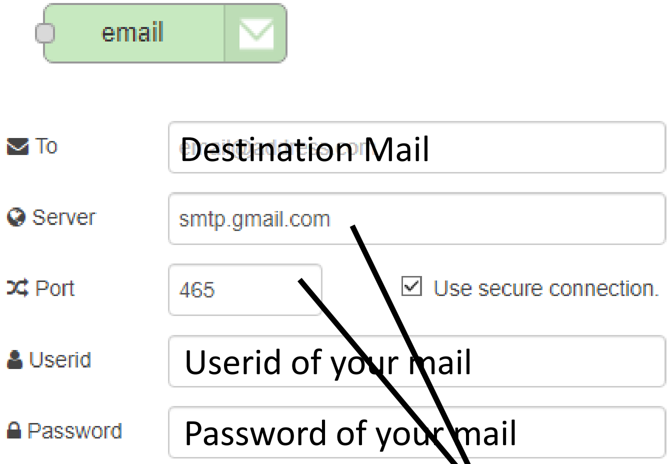
Edit Dashboard | View Dashboard



Step 6


timestamp
service-info
Get Free Parking Lots
json
SingleContent2 - PieracciniMeyer
connected to ws://dashboard.km4city.org:8080/server
email

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



To: Destination Mail

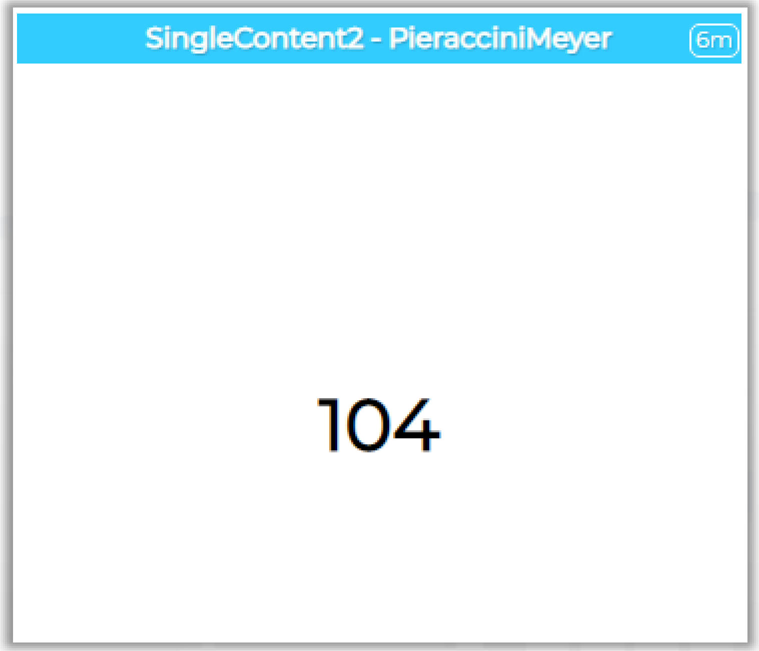
Server: smtp.gmail.com

Port: 465 ☑ Use secure connection.

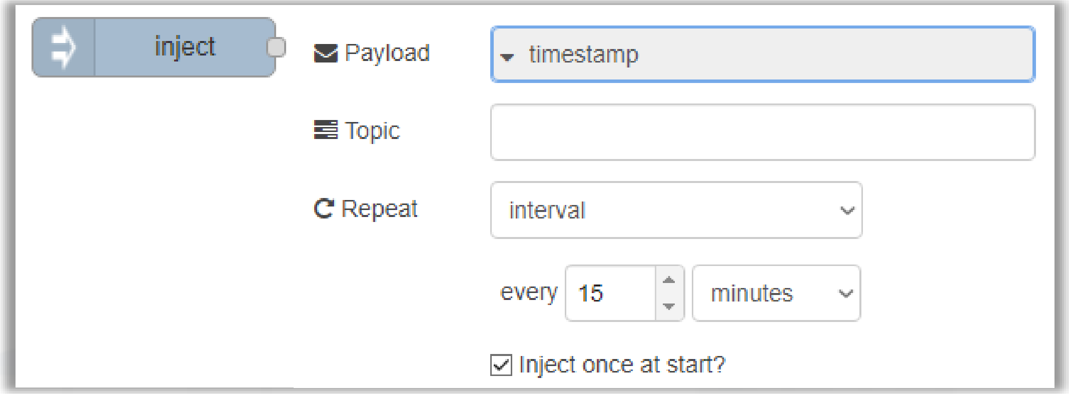
Userid: Userid of your mail

Password: Password of your mail

Change if not GMAIL



Nodes configuration



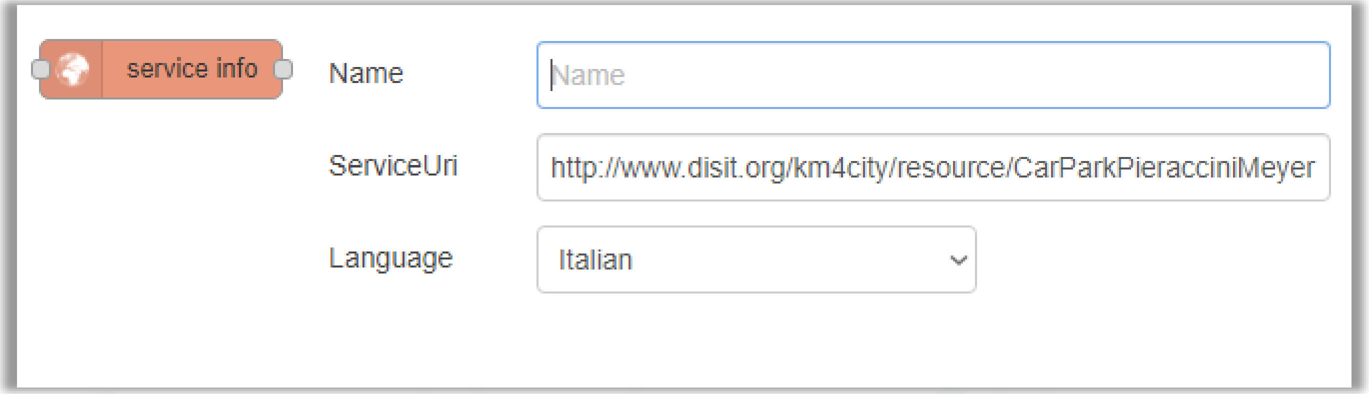
Payload: timestamp

Topic:

Repeat: interval

every 15 minutes

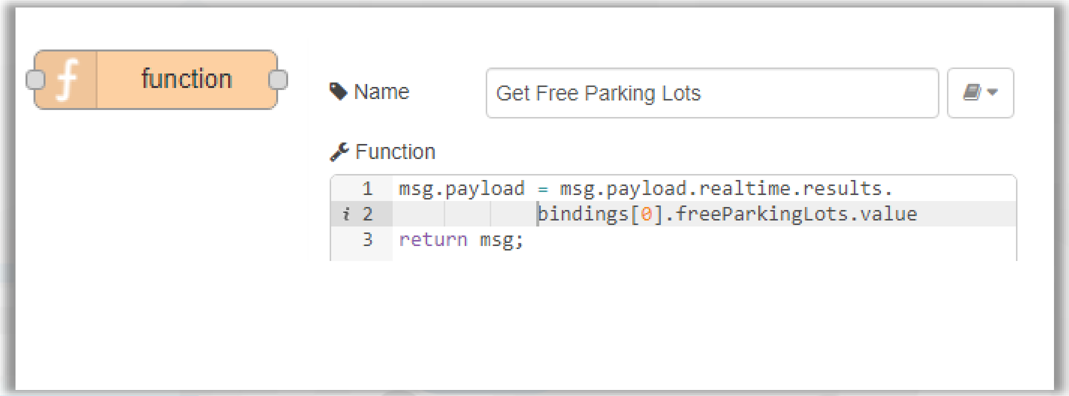
☑ Inject once at start?



Name: Name

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

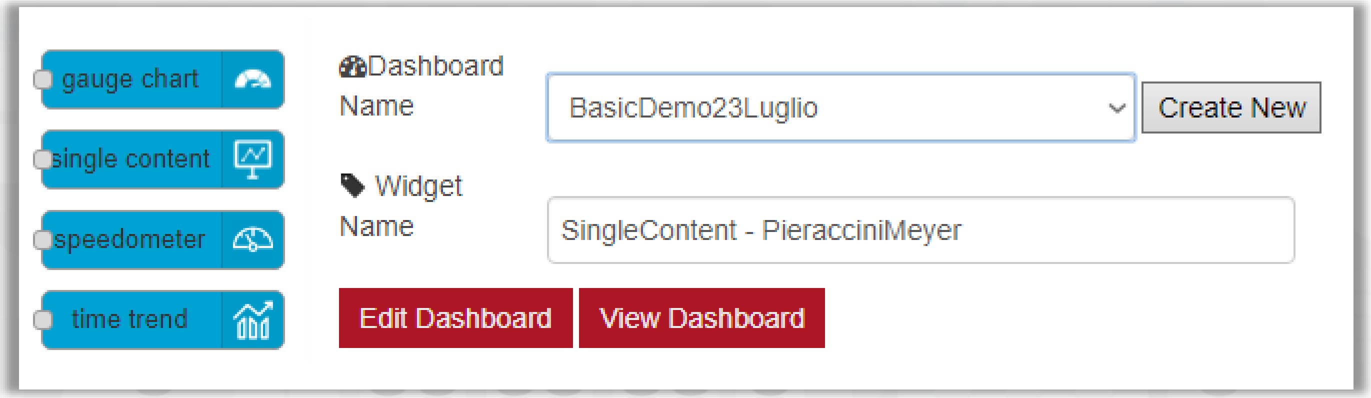
Language: Italian



Name: Get Free Parking Lots

Function

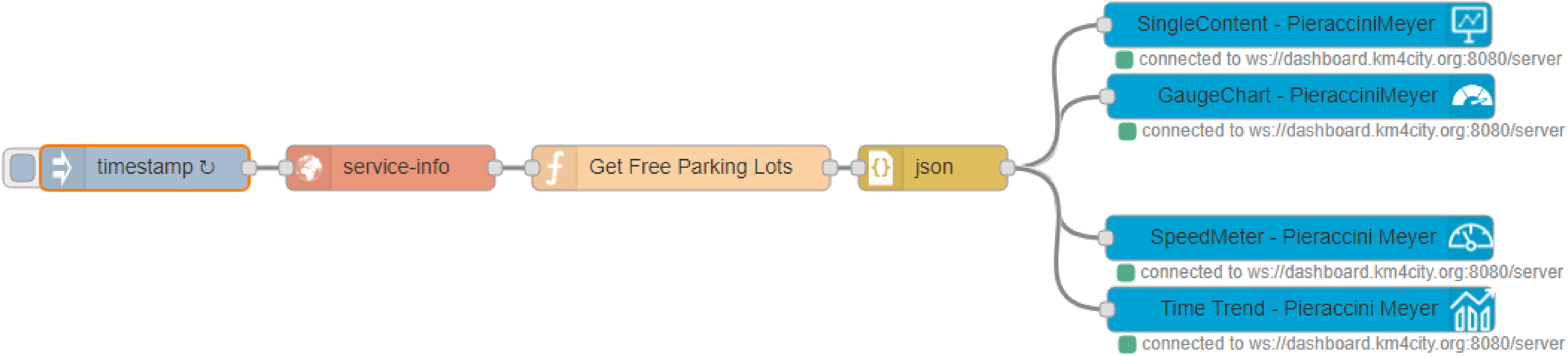
```
msg.payload = msg.payload.realtime.results.
              bindings[0].freeParkingLots.value
return msg;
```



Dashboard Name: BasicDemo23Luglio

Widget Name: SingleContent - PieracciniMeyer

Nodes connections



timestamp ↻

service-info

Get Free Parking Lots

json

SingleContent - PieracciniMeyer

connected to ws://dashboard.km4city.org:8080/server

GaugeChart - PieracciniMeyer

connected to ws://dashboard.km4city.org:8080/server

SpeedMeter - Pieraccini Meyer

connected to ws://dashboard.km4city.org:8080/server

Time Trend - Pieraccini Meyer

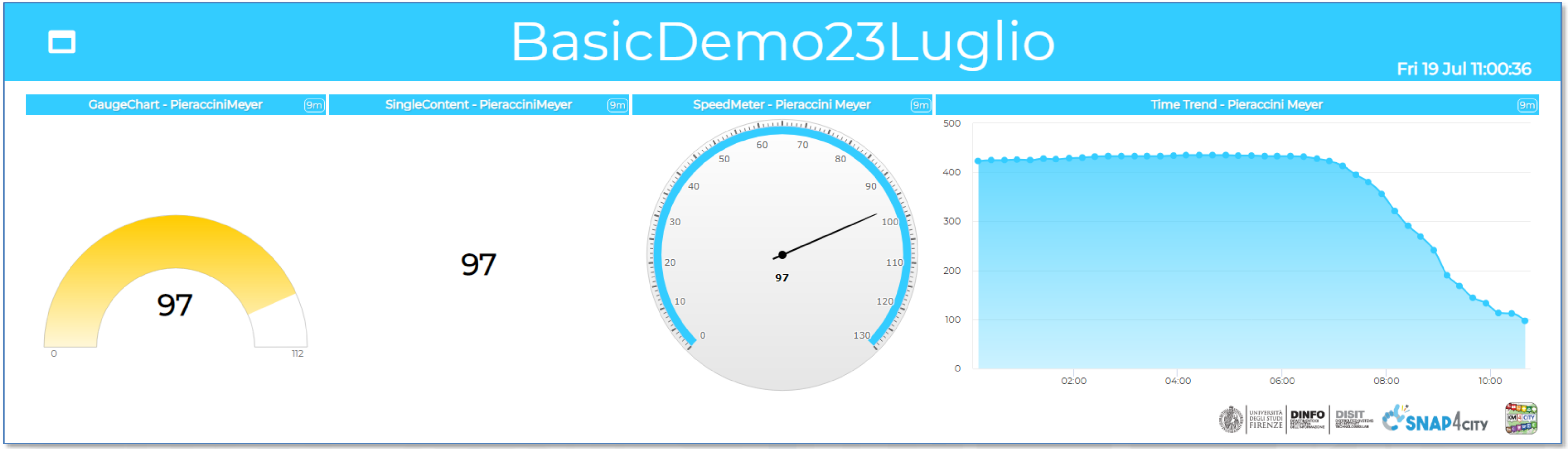
connected to ws://dashboard.km4city.org:8080/server

Explaining: IOT Application Flow

Node-RED

- 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==

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)

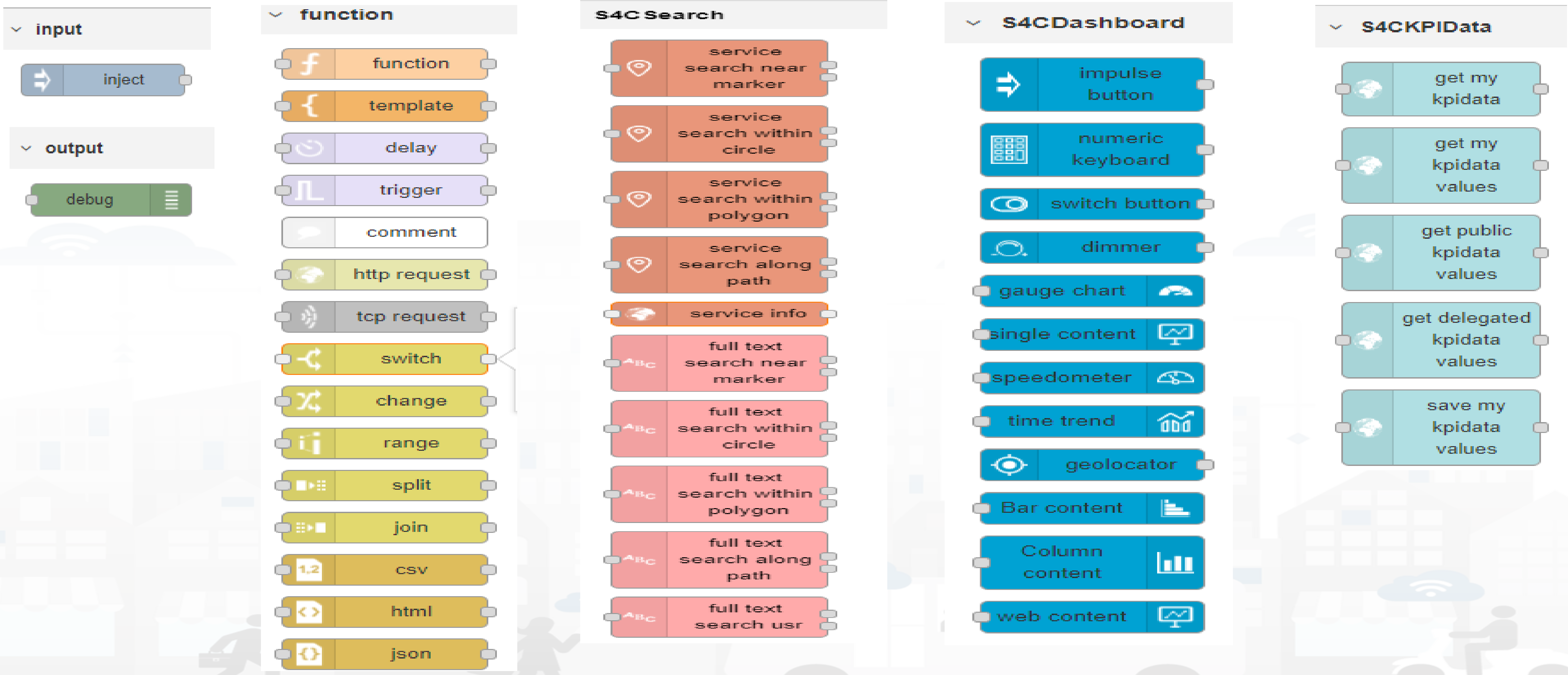
serviceUri: http://www.disit.org/km4city/resource/CarParkPieracciniMeyer

and:

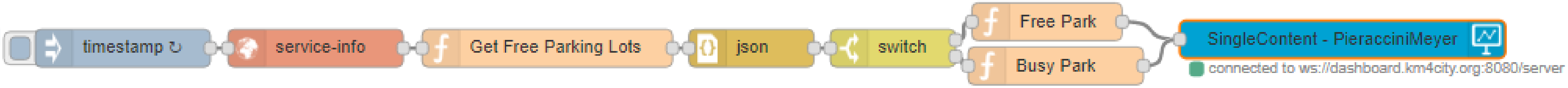
based on a certain threshold sends a different message on the dashboard. For example, **Almost Full Parking or Free Parking**. OR Send to **you an email** ☺ !

You have 15 Minutes!

Ex1: Your NickName: ………………………………

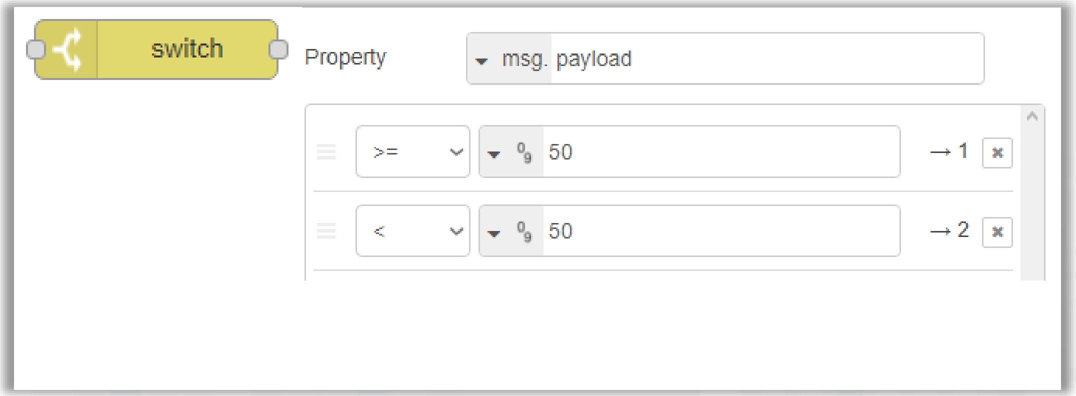


One Possible Solution



connected to ws://dashboard.km4city.org:8080/server

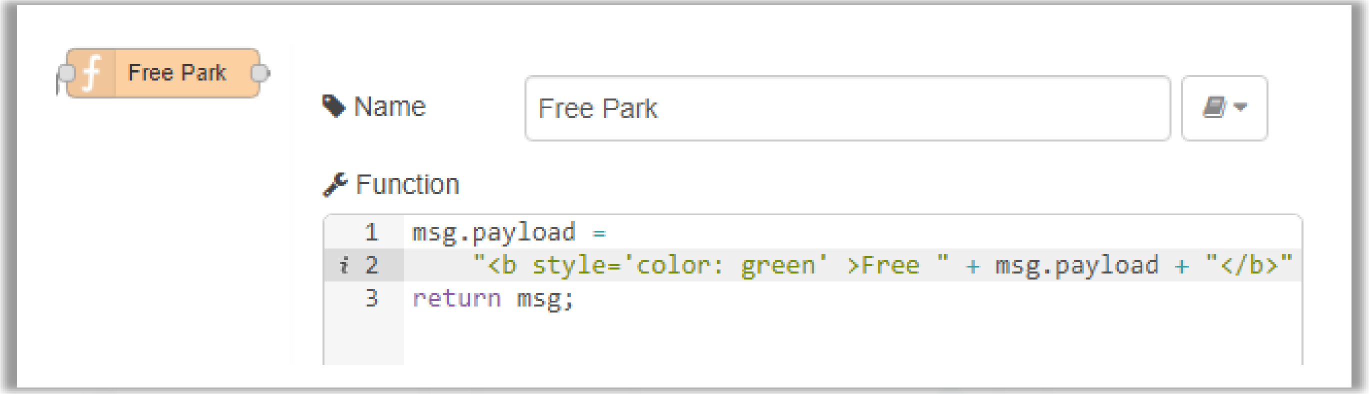
Nodes configuration



switch

Property: msg. payload

>=	50	→ 1
<	50	→ 2

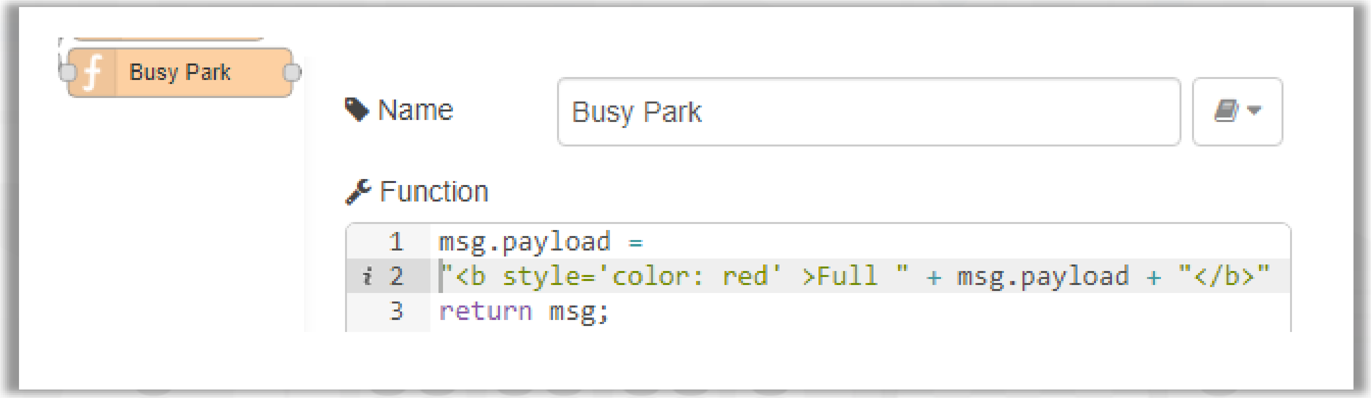


Free Park

Name: Free Park

Function

```
msg.payload =
    "<b style='color: green' >Free " + msg.payload + "</b>"
return msg;
```



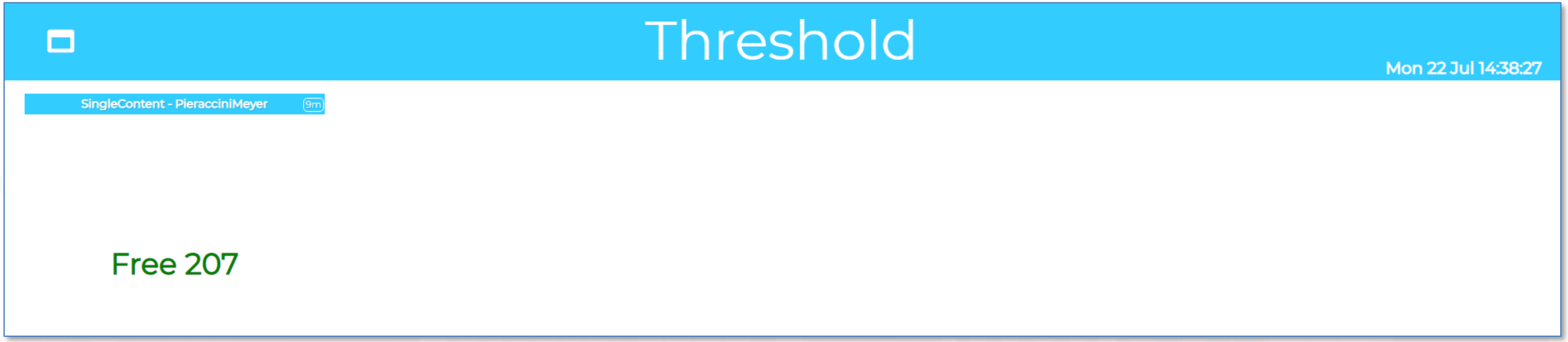
Busy Park

Name: Busy Park

Function

```
msg.payload =
"<b style='color: red' >Full " + msg.payload + "</b>"
return msg;
```

Resulting Dashboard



Threshold

Mon 22 Jul 14:38:27

SingleContent - PieracciniMeyer 9m

Free 207

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

TOP

Node-RED

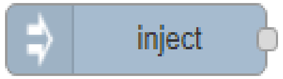
Data Processing with IOT Application (DEMO)

Example of more Complex IOT Application

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

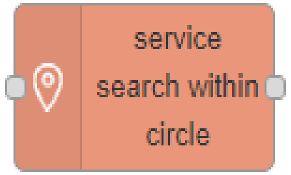
- reads a realtime values from a list of services,
- makes the sum of the value and
- publish the result on a dashboard

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)

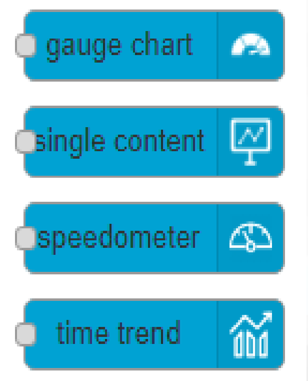
Requests detailed information for a specific service on the platform (such as a car park, hotel, etc.)



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

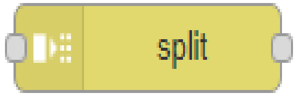
- servicesUri of all the services found,
- a GeoJSON containing a minimum of information about the services found, including the coordinates and the name of the service.

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

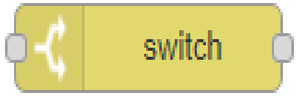


Display values in different modes on a dashboard. The node called single content accepts strings, numbers and html. The others only accept numbers.

Nodes for flow 2/2



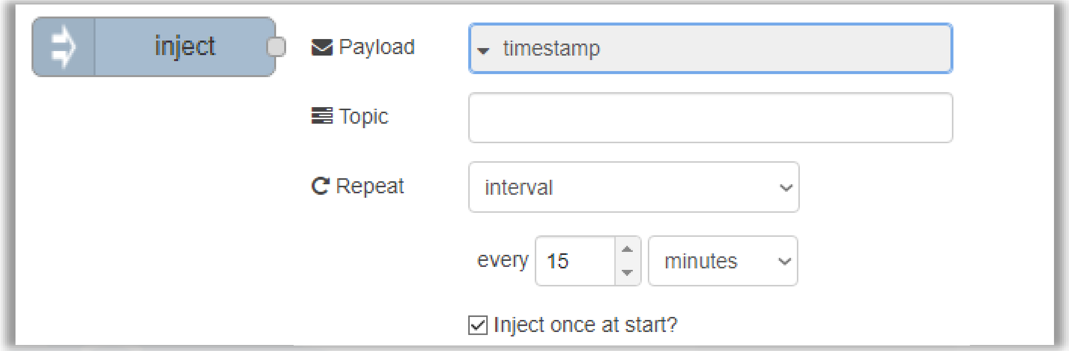
Divides the input message into multiple messages as indicated in the configuration.
If you have an array at the input, you can configure it to send each element of the array individually at the output.



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



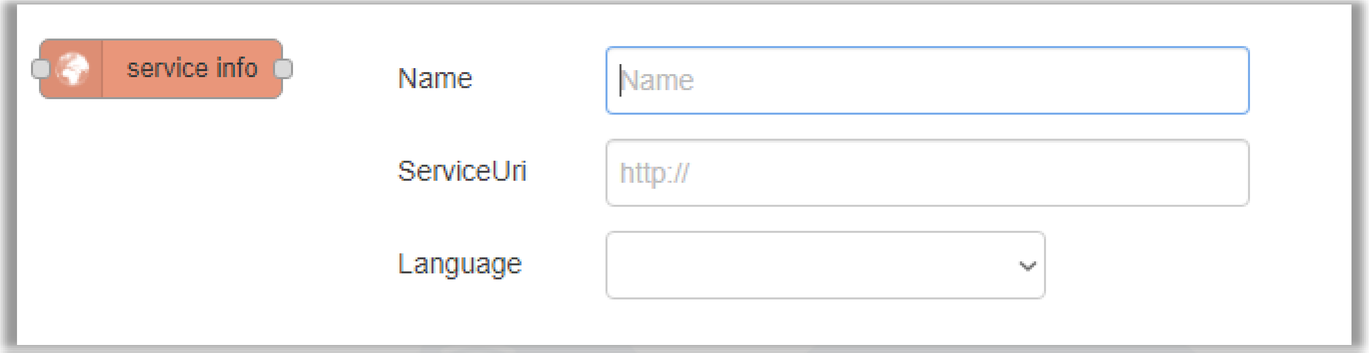
Payload: timestamp

Topic:

Repeat: interval

every 15 minutes

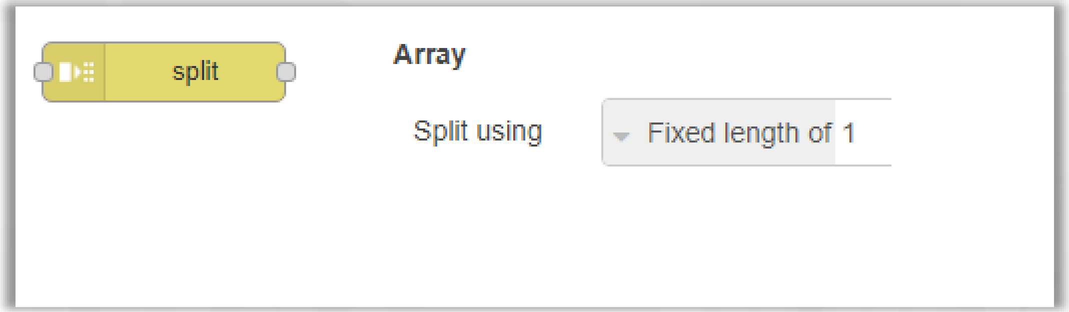
☑ Inject once at start?



Name: Name

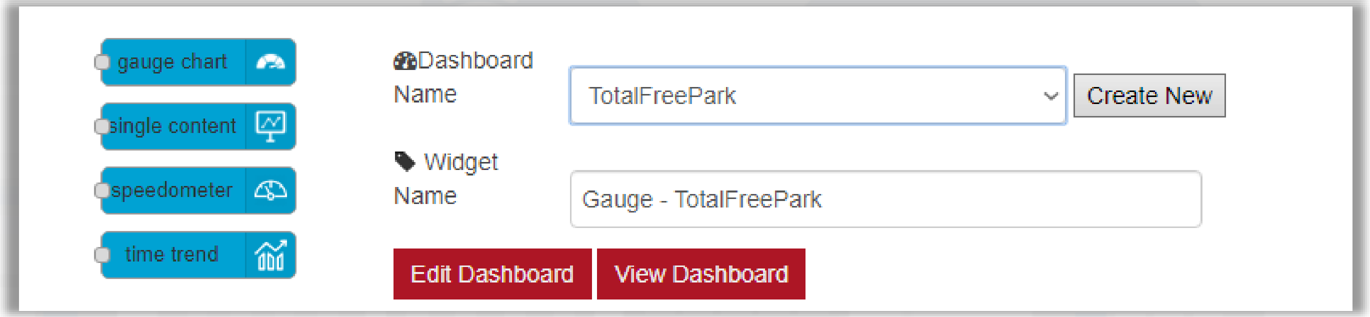
ServiceUri: http://

Language:



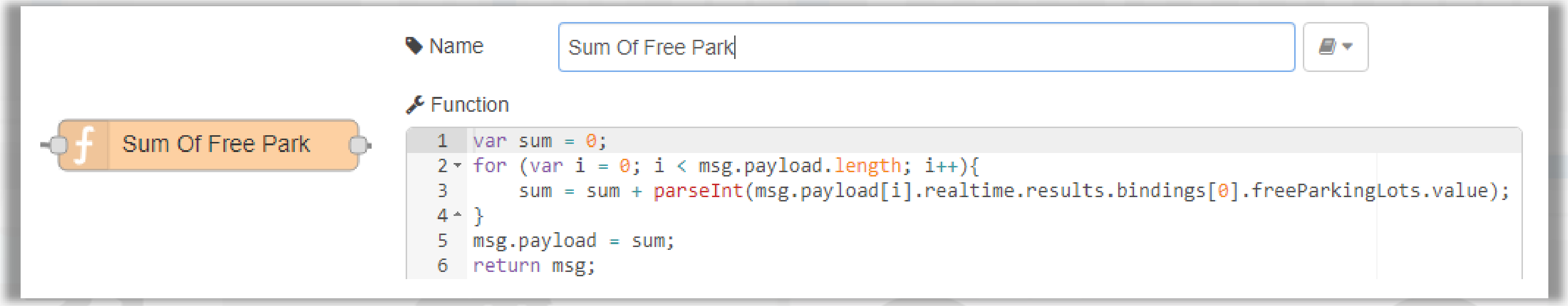
Array

Split using: Fixed length of 1



Dashboard Name: TotalFreePark

Widget Name: Gauge - TotalFreePark

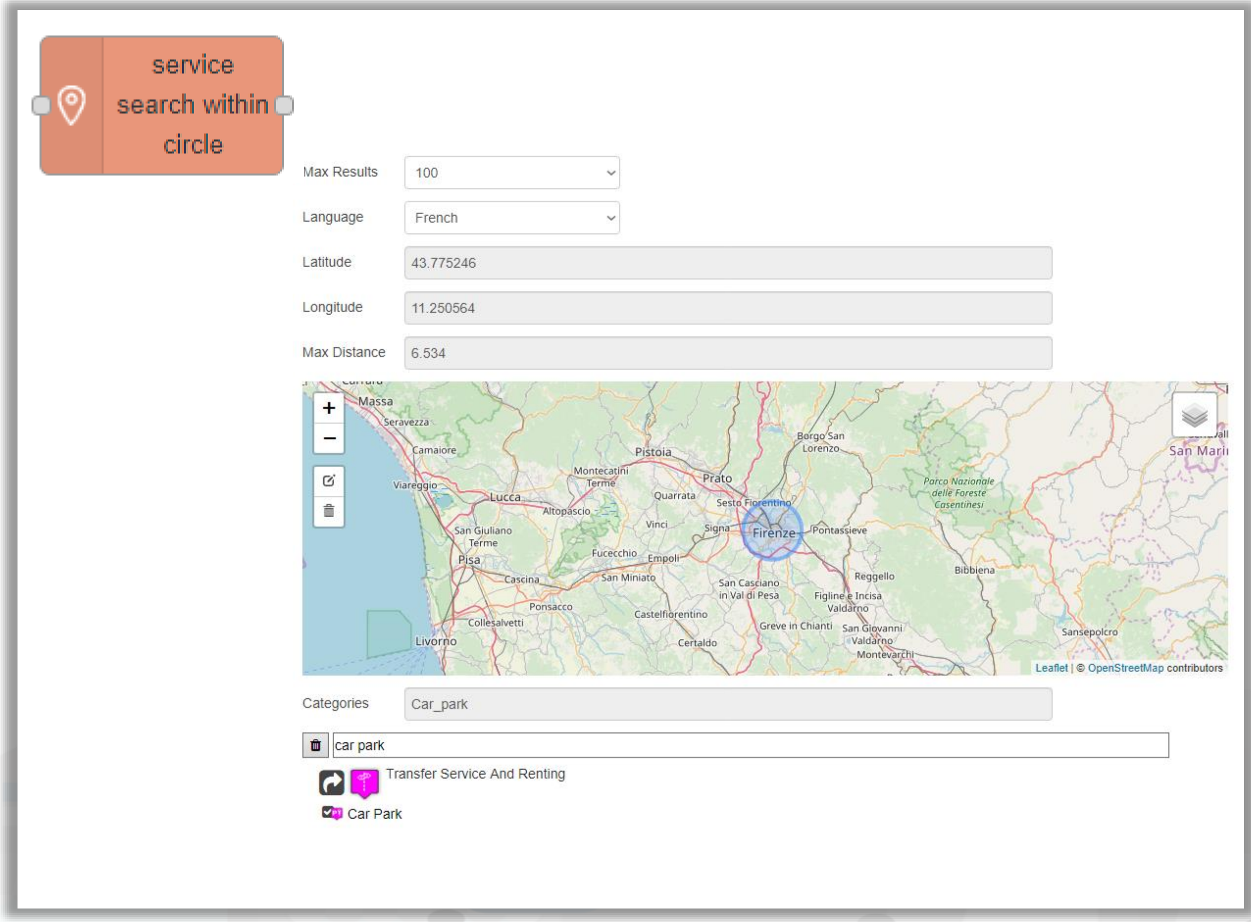


Name: Sum Of Free Park

Function

```
var sum = 0;
for (var i = 0; i < msg.payload.length; i++){
      sum = sum + parseInt(msg.payload[i].realtime.results.bindings[0].freeParkingLots.value);
}
msg.payload = sum;
return msg;
```

Nodes configuration 2/2



Max Results: 100

Language: French

Latitude: 43.775246

Longitude: 11.250564

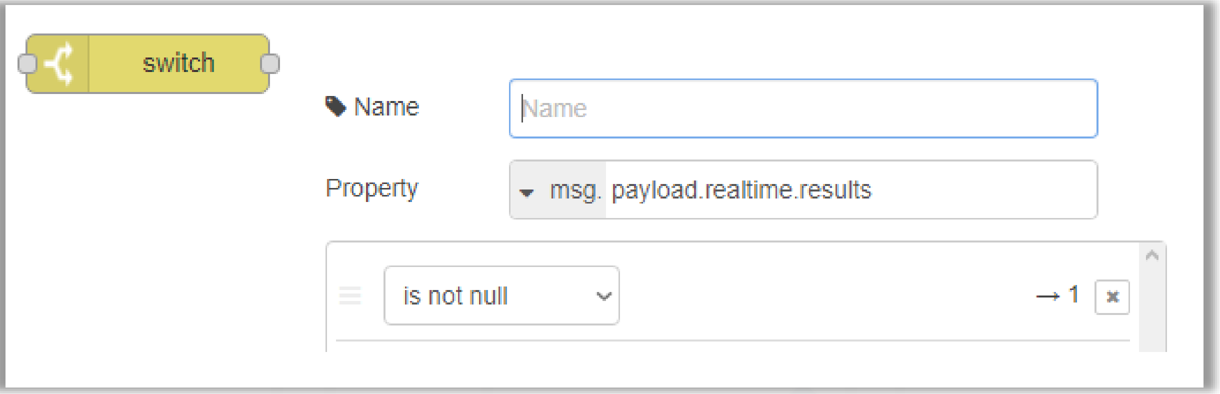
Max Distance: 6.534

Categories: Car_park

car park

Transfer Service And Renting

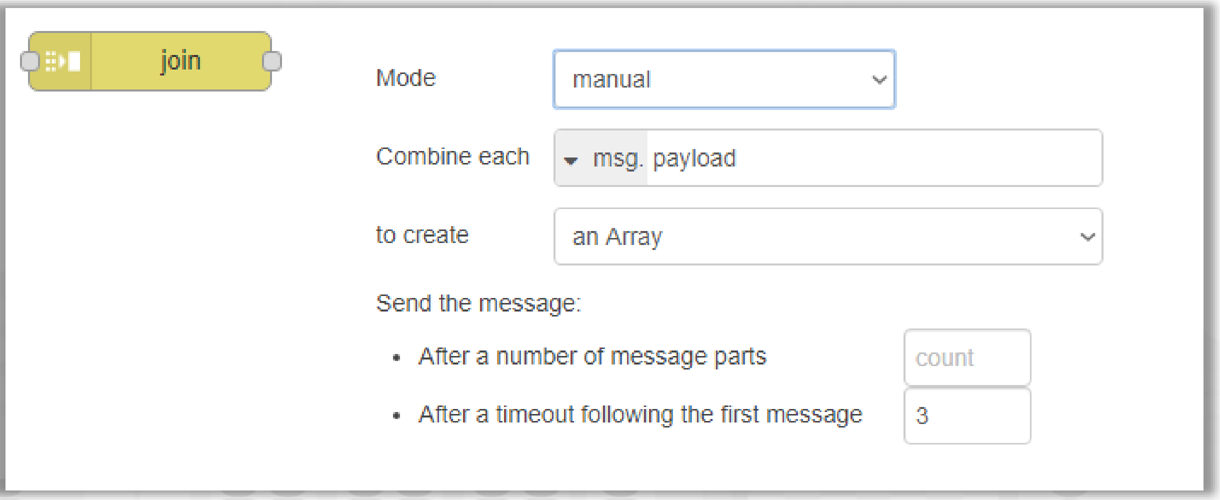
Car Park



Name: Name

Property: msg. payload.realtime.results

is not null → 1



Mode: manual

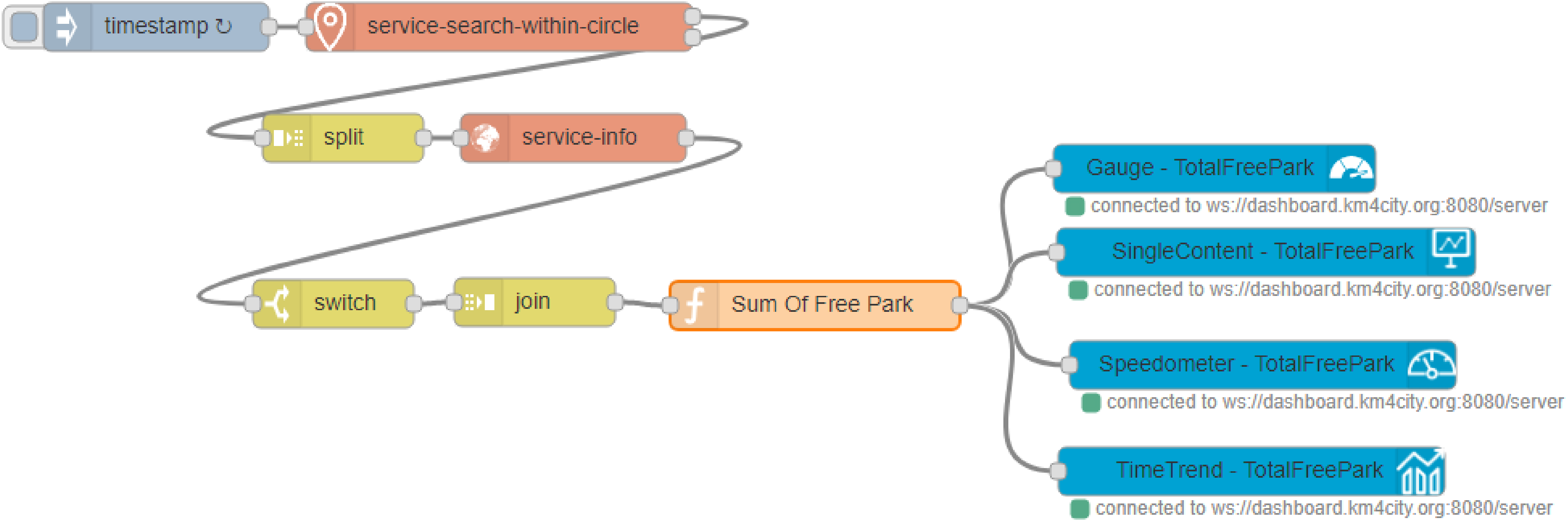
Combine each: msg. payload

to create: an Array

Send the message:

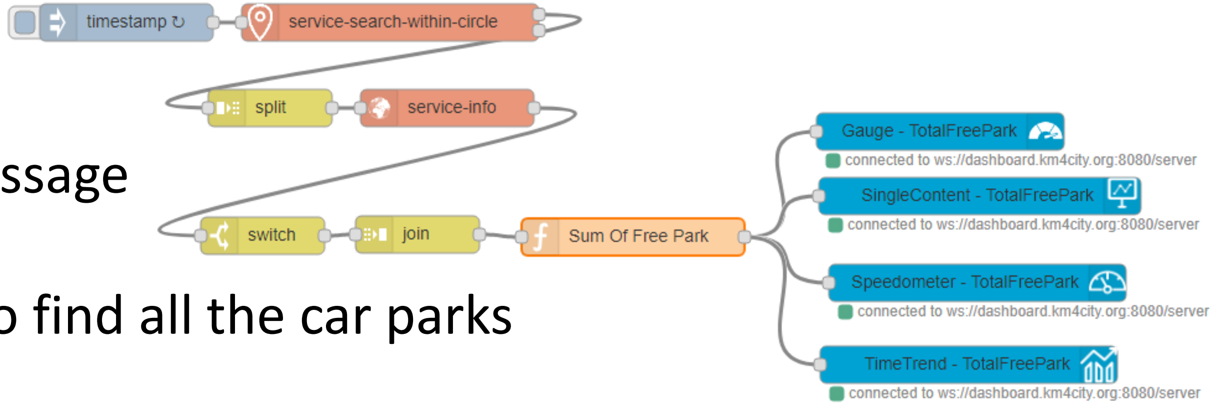
- After a number of message parts: count
- After a timeout following the first message: 3

Nodes connections



timestamp ↻
service-search-within-circle
split
service-info
switch
join
Sum Of Free Park
Gauge - TotalFreePark
connected to ws://dashboard.km4city.org:8080/server
SingleContent - TotalFreePark
connected to ws://dashboard.km4city.org:8080/server
Speedometer - TotalFreePark
connected to ws://dashboard.km4city.org:8080/server
TimeTrend - TotalFreePark
connected to ws://dashboard.km4city.org:8080/server

Nodes explanation 1/2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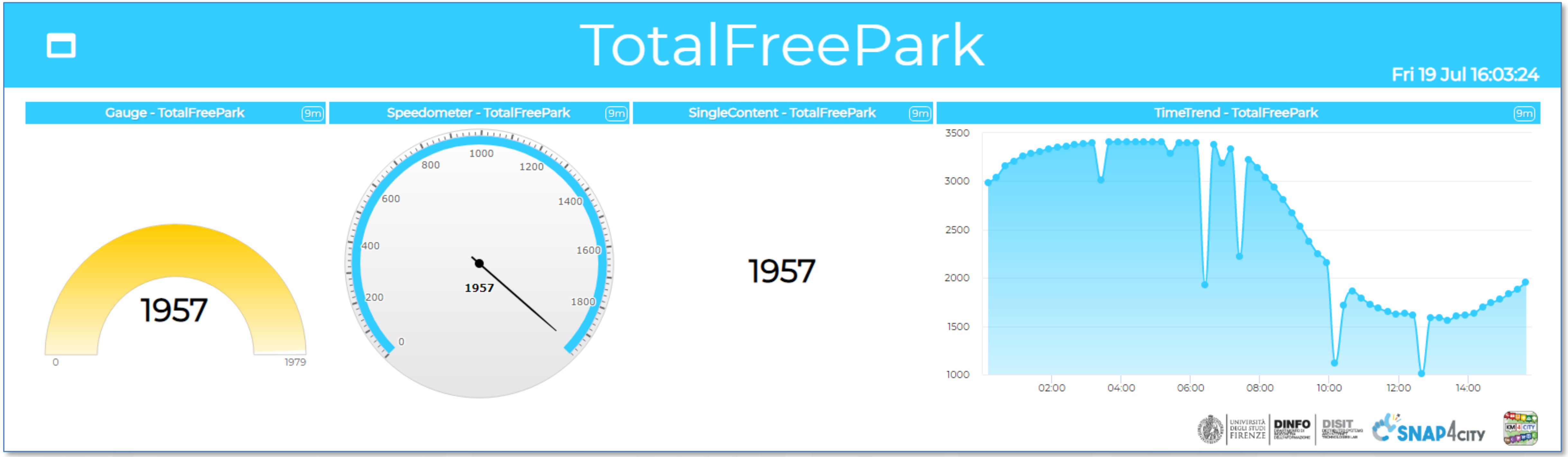
- Every 15 minutes the ***timestamp*** node sends a message to the ***service-search-within-circle node.***
  - When this message arrives, a request is sent to find all the car parks in the search area entered in configuration
- The first output of the ***service-search-within-circle*** node returns 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==

TOP

Processing data with IOT Applications (Exercitation)

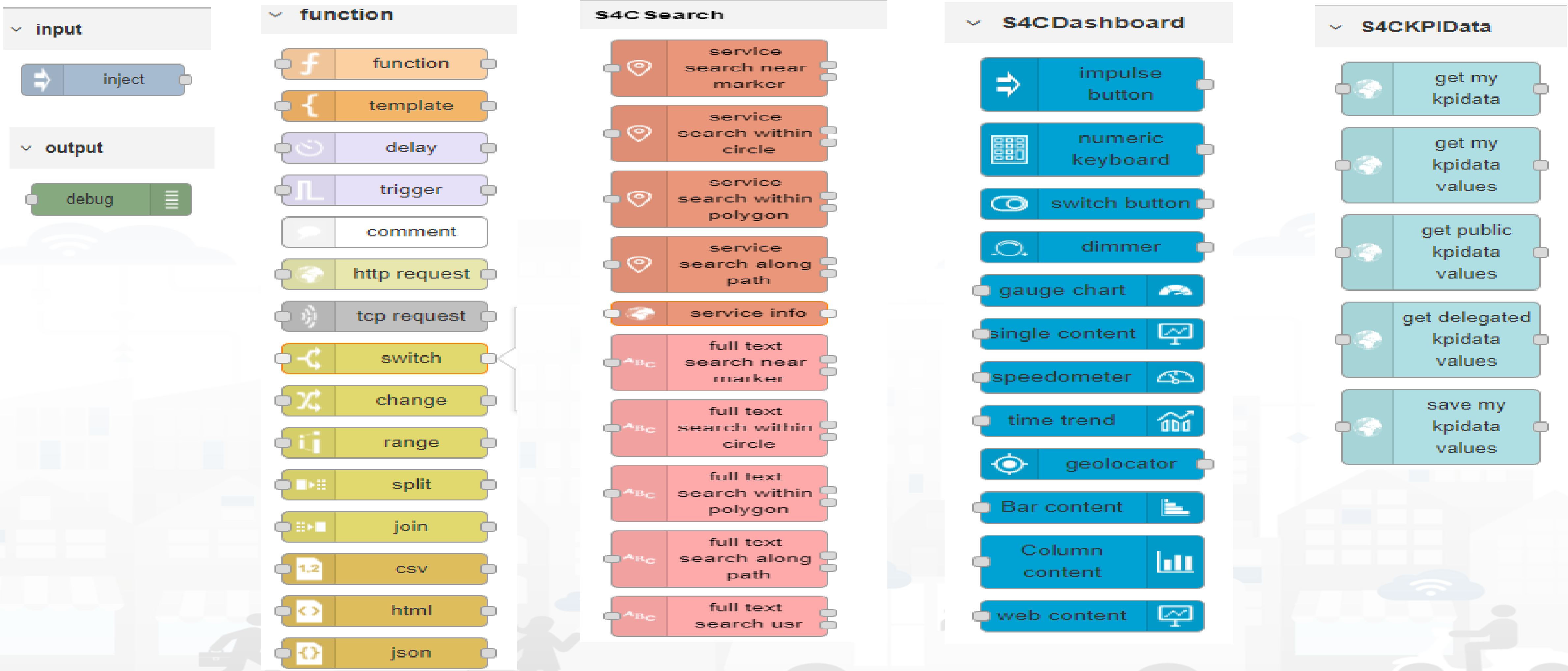
Average IoT Application

Create an IOT Application / flow that:

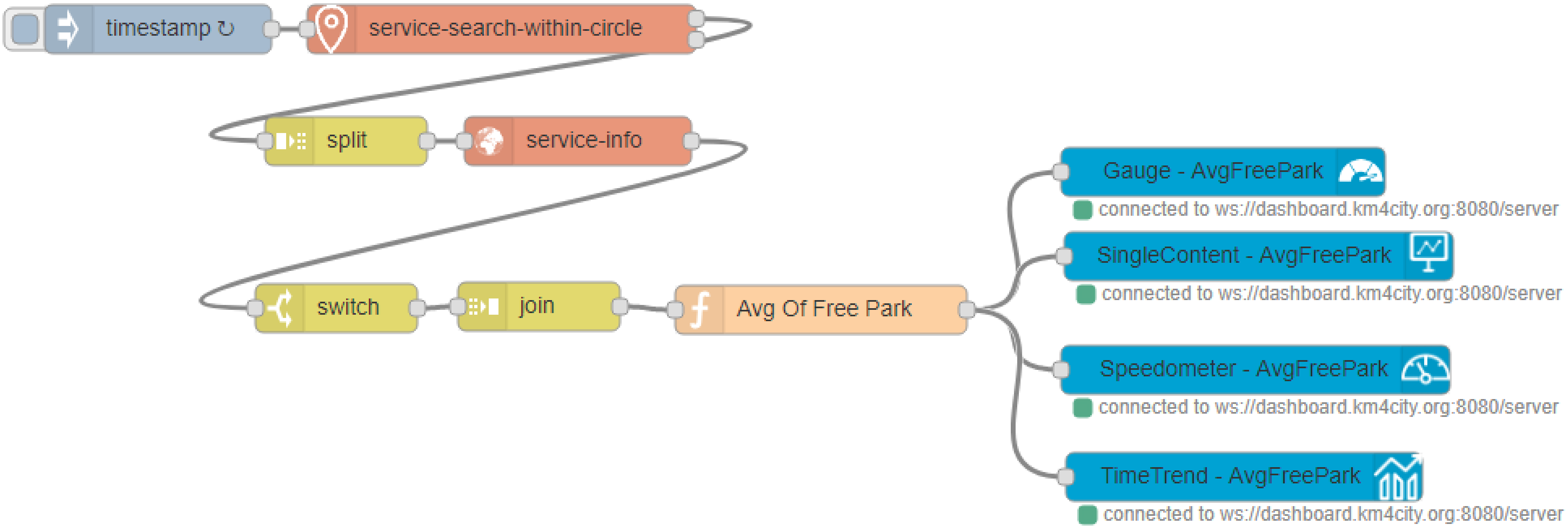
- reads a value from a list of service, for example the car parks in the Florence City Area, as seen in previous demo and
- calculates the average of Free Parking Lots and
- sends the value on a dashboard with the four possible nodes seen in the demo.

Execution Time: 20 Minutes

Ex2: Your NickName: …………………………………



One Possible Solution



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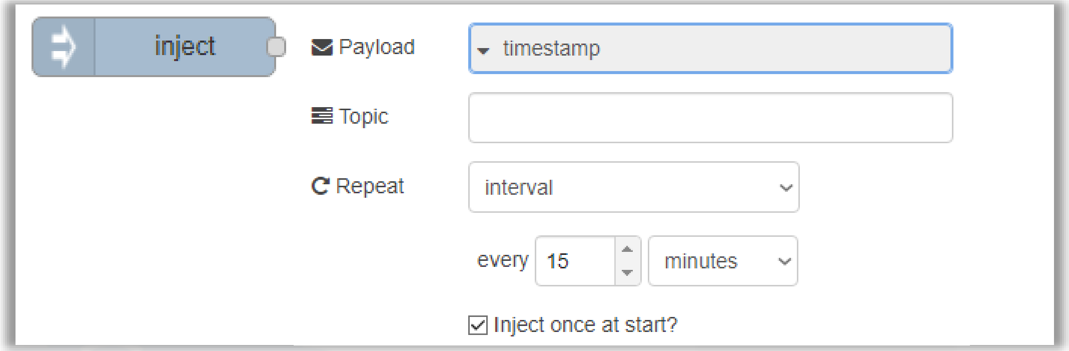
Nodes configuration 1/2



inject

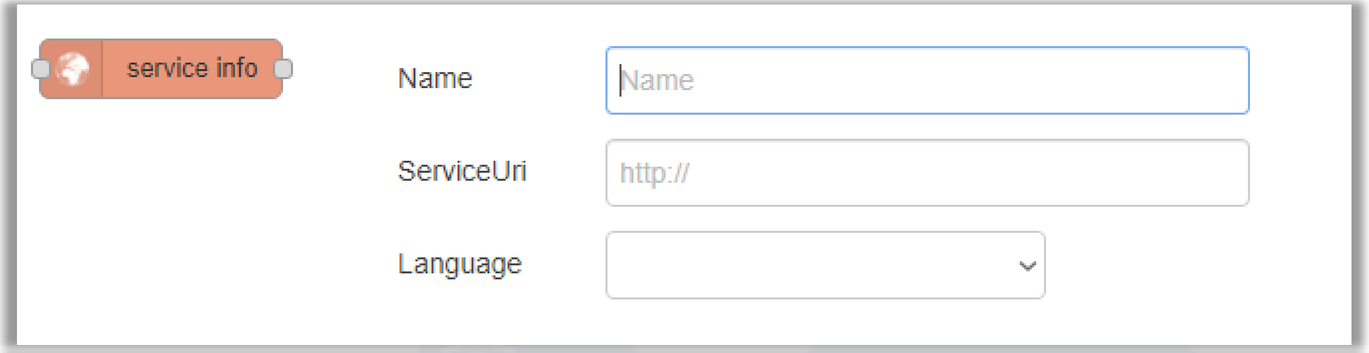
Payload: timestamp

Topic:

Repeat: interval

every 15 minutes

☑ Inject once at start?

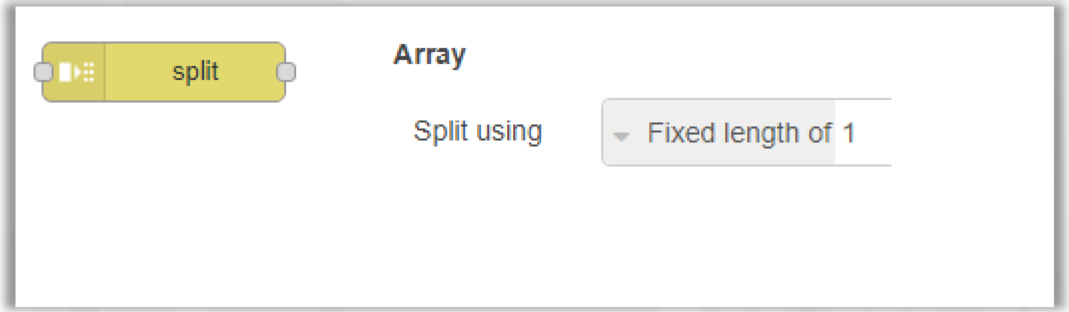


service info

Name: Name

ServiceUri: http://

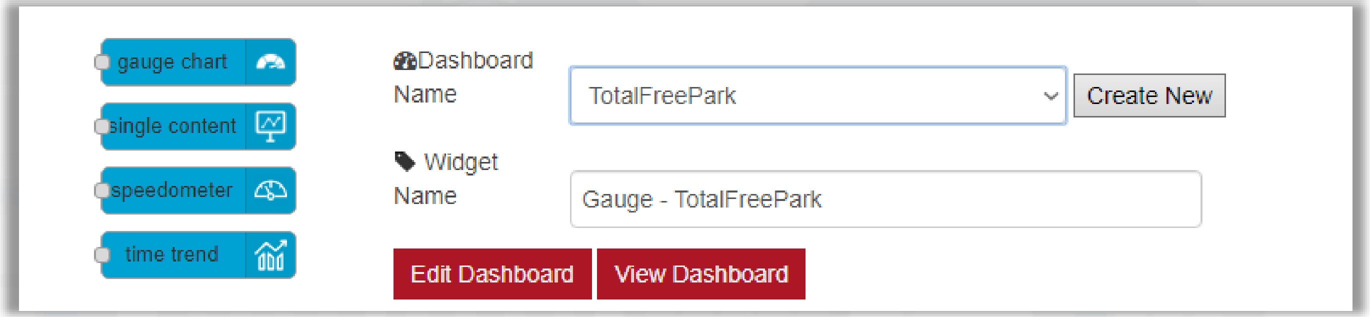
Language:



split

Array

Split using: Fixed length of 1



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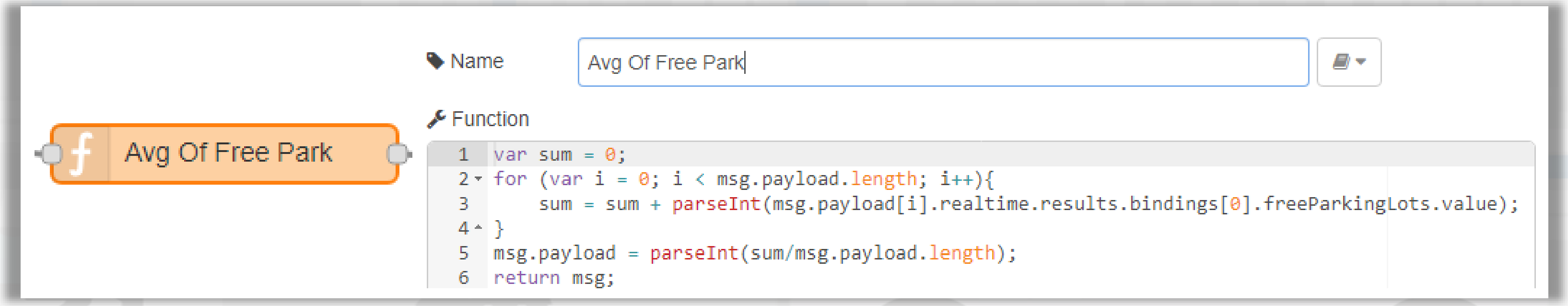


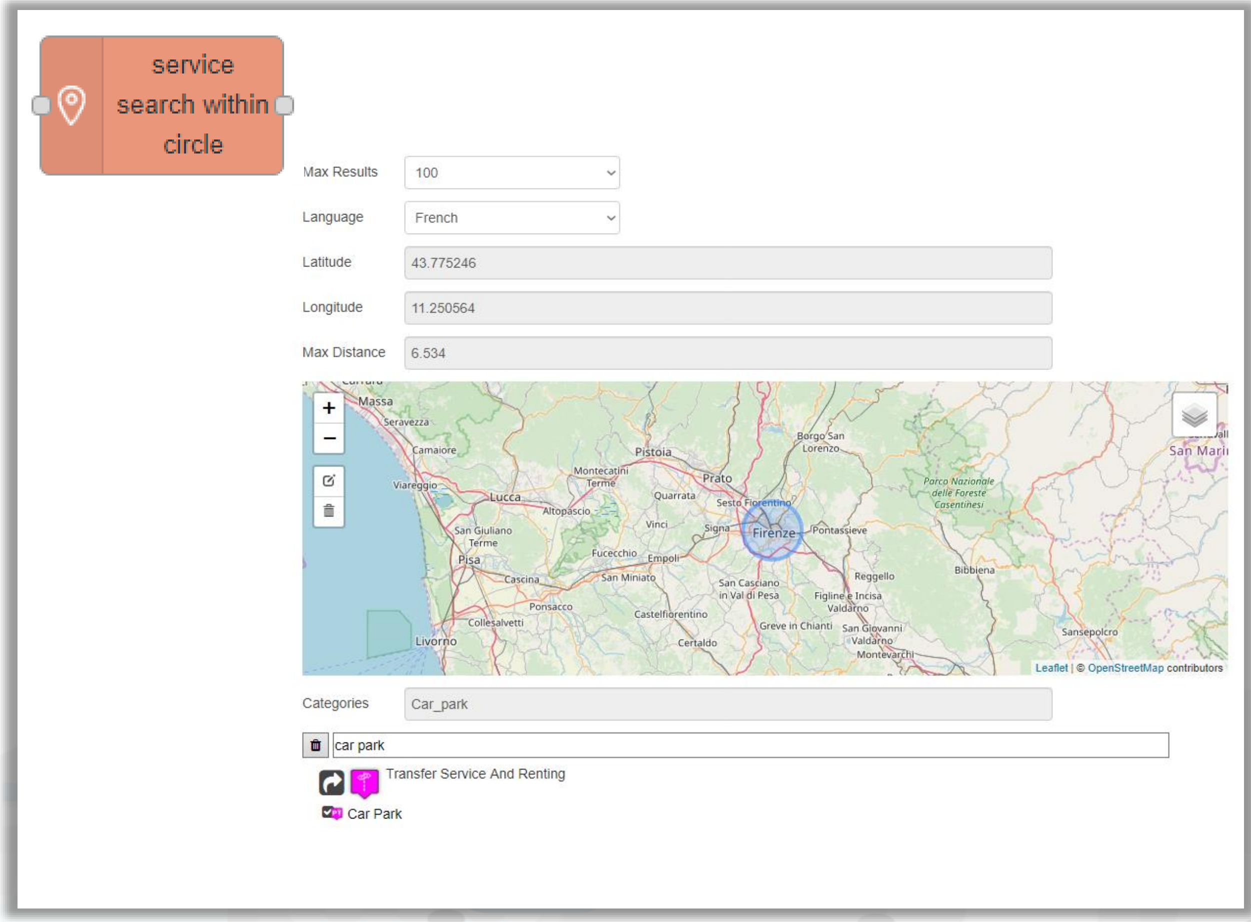
Avg Of Free Park

Name: Avg Of Free Park

Function

```
var sum = 0;
for (var i = 0; i < msg.payload.length; i++){
    sum = sum + parseInt(msg.payload[i].realtime.results.bindings[0].freeParkingLots.value);
}
msg.payload = parseInt(sum/msg.payload.length);
return msg;
```

Nodes configuration 2/2



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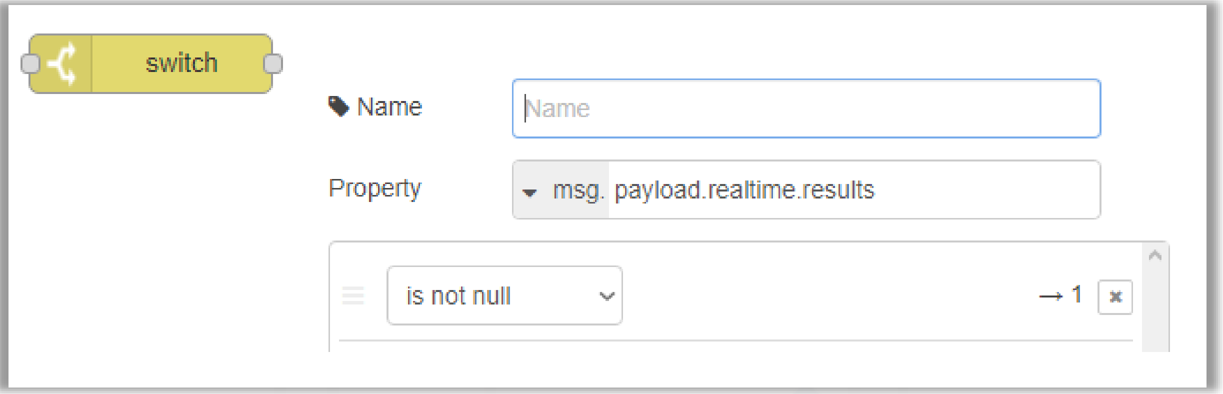
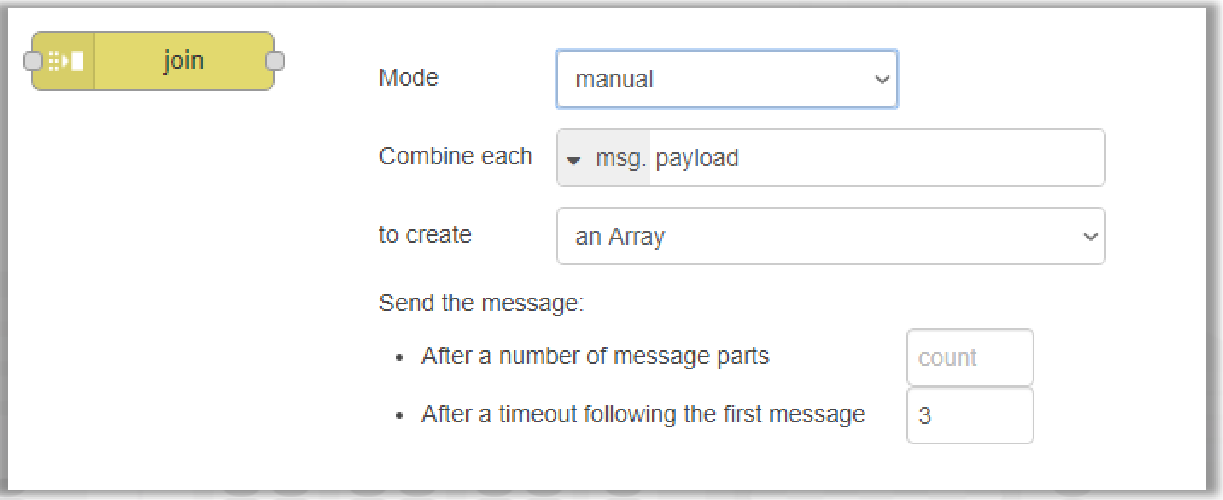


switch

Name: Name

Property: msg. payload.realtime.results

is not null → 1



join

Mode: manual

Combine each: msg. payload

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Send the message:

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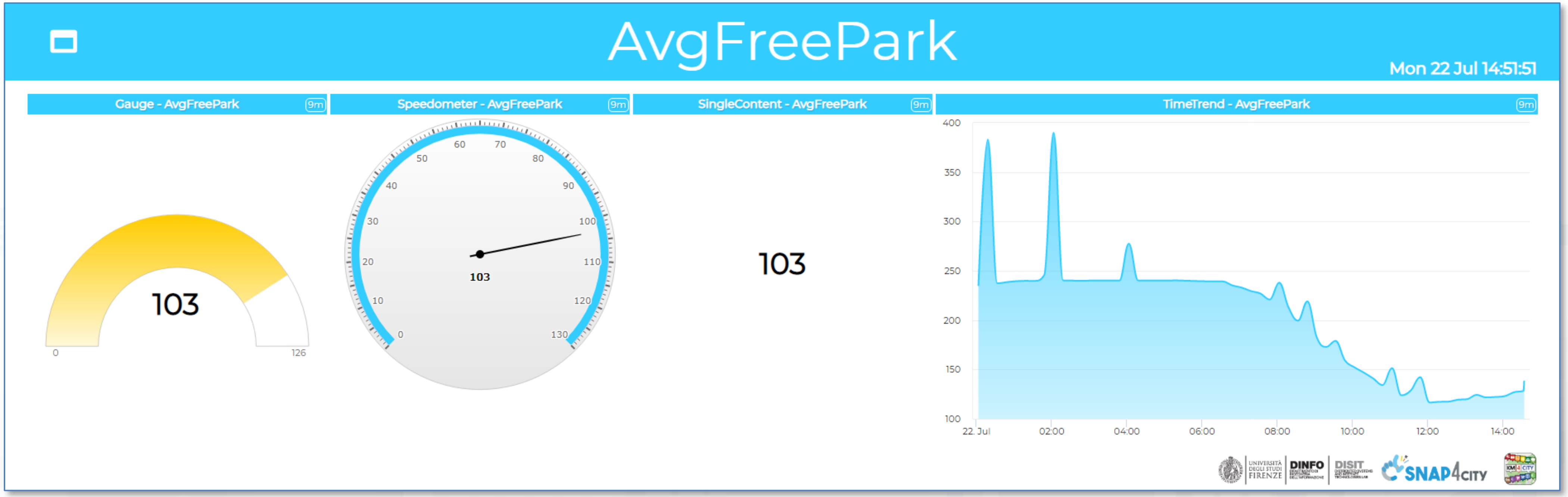
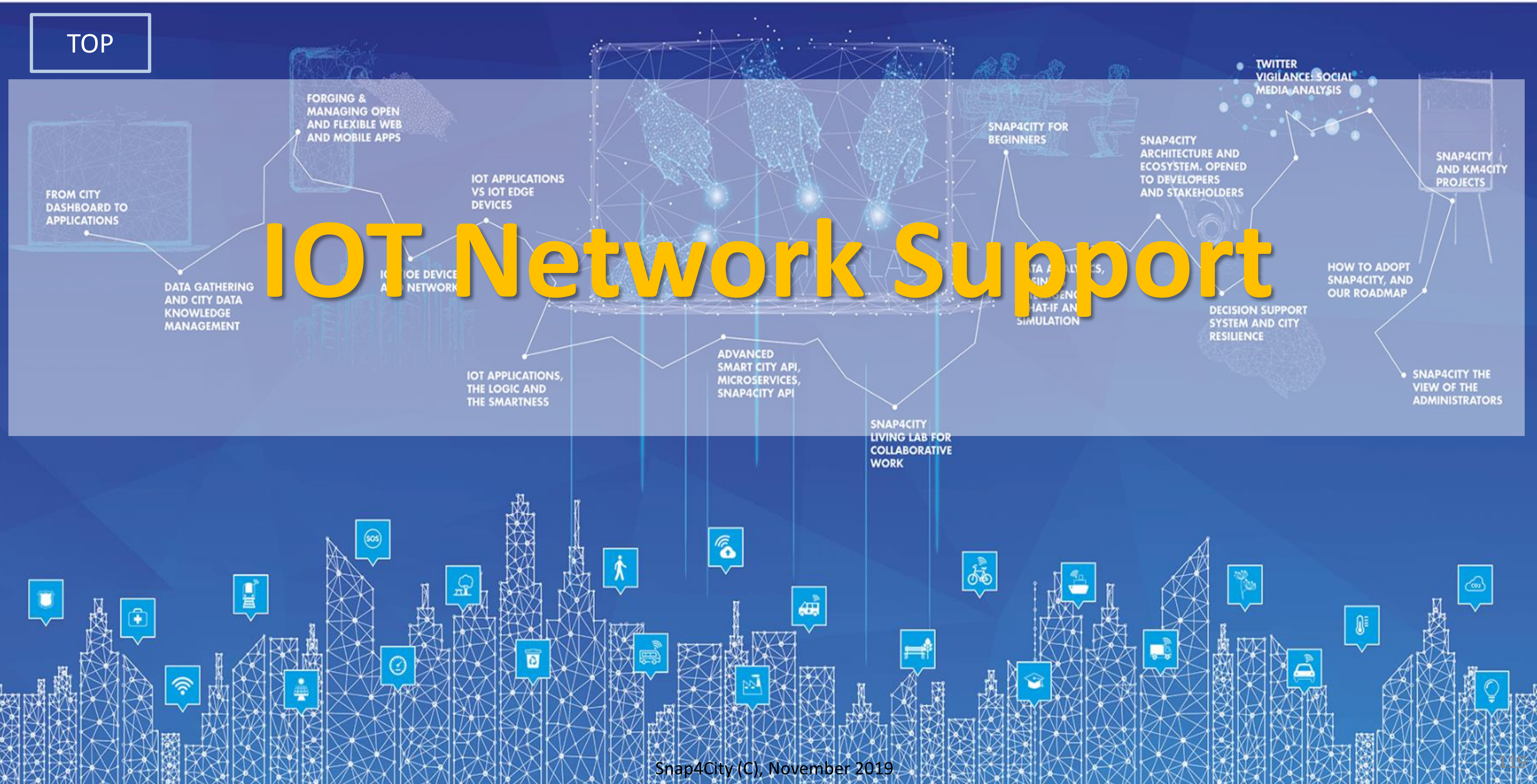
Resulting Dashboard



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

TOP

IOT Network Support


FROM CITY DASHBOARD TO APPLICATIONS
DATA GATHERING AND CITY DATA KNOWLEDGE MANAGEMENT
FORGING & MANAGING OPEN AND FLEXIBLE WEB AND MOBILE APPS
IOT APPLICATIONS VS IOT EDGE DEVICES
IOE DEVICE
NETWORK
IOT APPLICATIONS, THE LOGIC AND THE SMARTNESS
ADVANCED SMART CITY API, MICROSERVICES, SNAP4CITY API
SNAP4CITY LIVING LAB FOR COLLABORATIVE WORK
SNAP4CITY FOR BEGINNERS
HAT-IF AN
SIMULATION
SNAP4CITY ARCHITECTURE AND ECOSYSTEM. OPENED TO DEVELOPERS AND STAKEHOLDERS
TWITTER VIGILANCE: SOCIAL MEDIA ANALYSIS
DECISION SUPPORT SYSTEM AND CITY RESILIENCE
SNAP4CITY AND KM4CITY PROJECTS
HOW TO ADOPT SNAP4CITY, AND OUR ROADMAP
SNAP4CITY THE VIEW OF THE ADMINISTRATORS

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

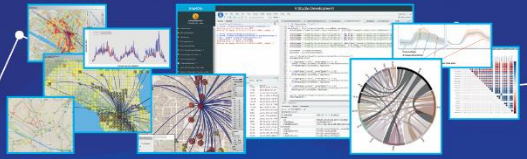
DEVELOPMENT KIT • SUGGESTIONS • MOBILE APPS • MONITORING PANELS • PLATFORM UTILITIES • READY TO USE SMART APPLICATIONS

MICROSERVICES & ADVANCED SMART CITY API

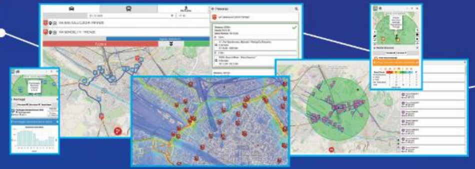
LIVING LAB - DEV TOOLS - COWORKING

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 ...

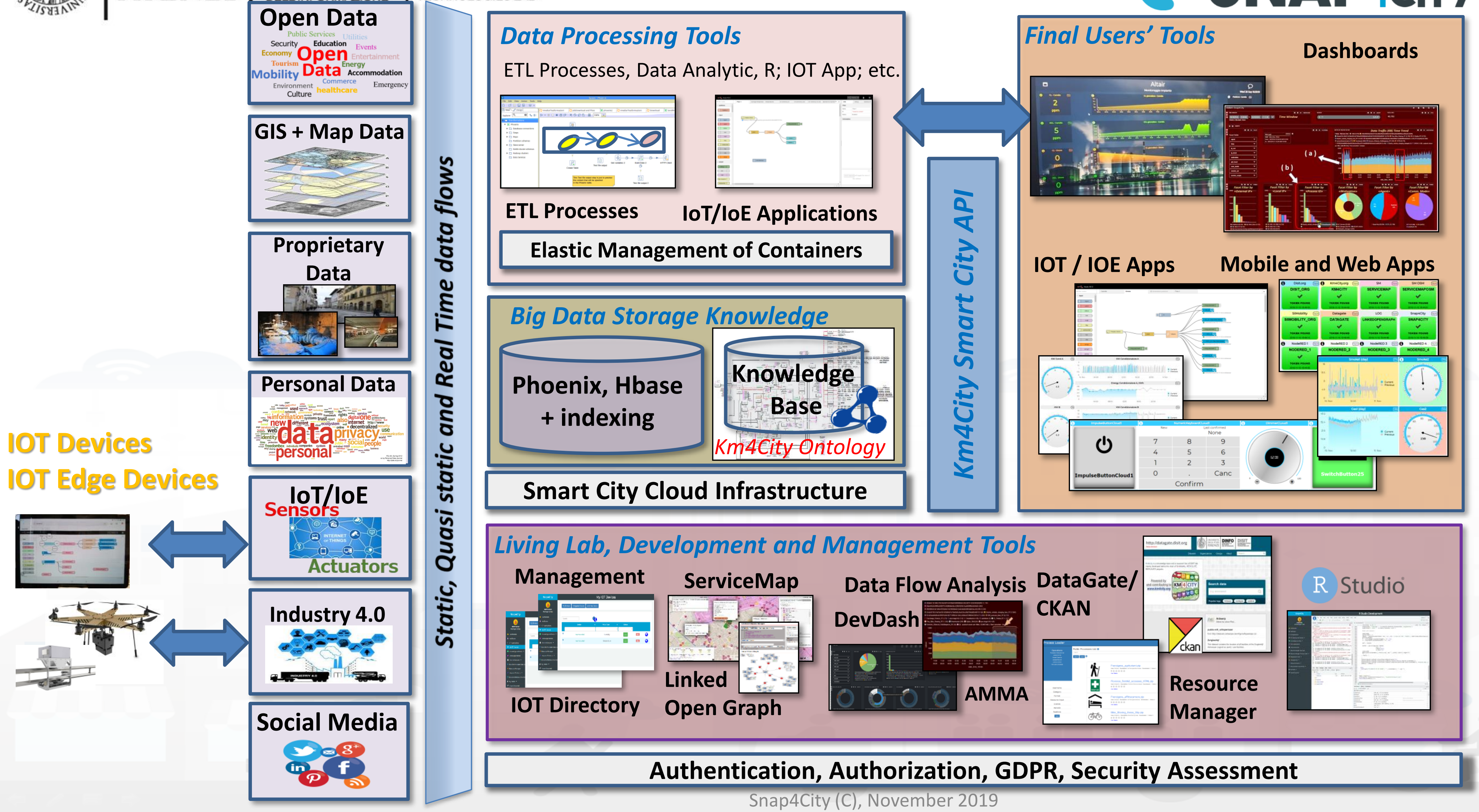
GIS | CITY UTILITIES | OPEN DATA | LEGACY & EXTERNAL SERVICES | PERSONAL DATA | IOT / IOE | BROKERS | KPI | INDUSTRY 4.0 | SOCIAL MEDIA

UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

SNAP4CITY



Open Data

GIS + Map Data

Proprietary Data

Personal Data

IoT/IoE Sensors Actuators

Industry 4.0

Social Media

IOT Devices

IOT Edge Devices

Static, Quasi static and Real Time data flows

Data Processing Tools

ETL Processes, Data Analytic, R; IOT App; etc.

ETL Processes

IoT/IoE Applications

Elastic Management of Containers

Big Data Storage Knowledge

Phoenix, Hbase + indexing

Knowledge Base

Km4City Ontology

Smart City Cloud Infrastructure

Km4City Smart City API

Final Users' Tools

Dashboards

IOT / IOE Apps

Mobile and Web Apps

Living Lab, Development and Management Tools

Management

IOT Directory

ServiceMap

Linked Open Graph

Data Flow Analysis

DevDash

AMMA

DataGate/ CKAN

Resource Manager

R Studio

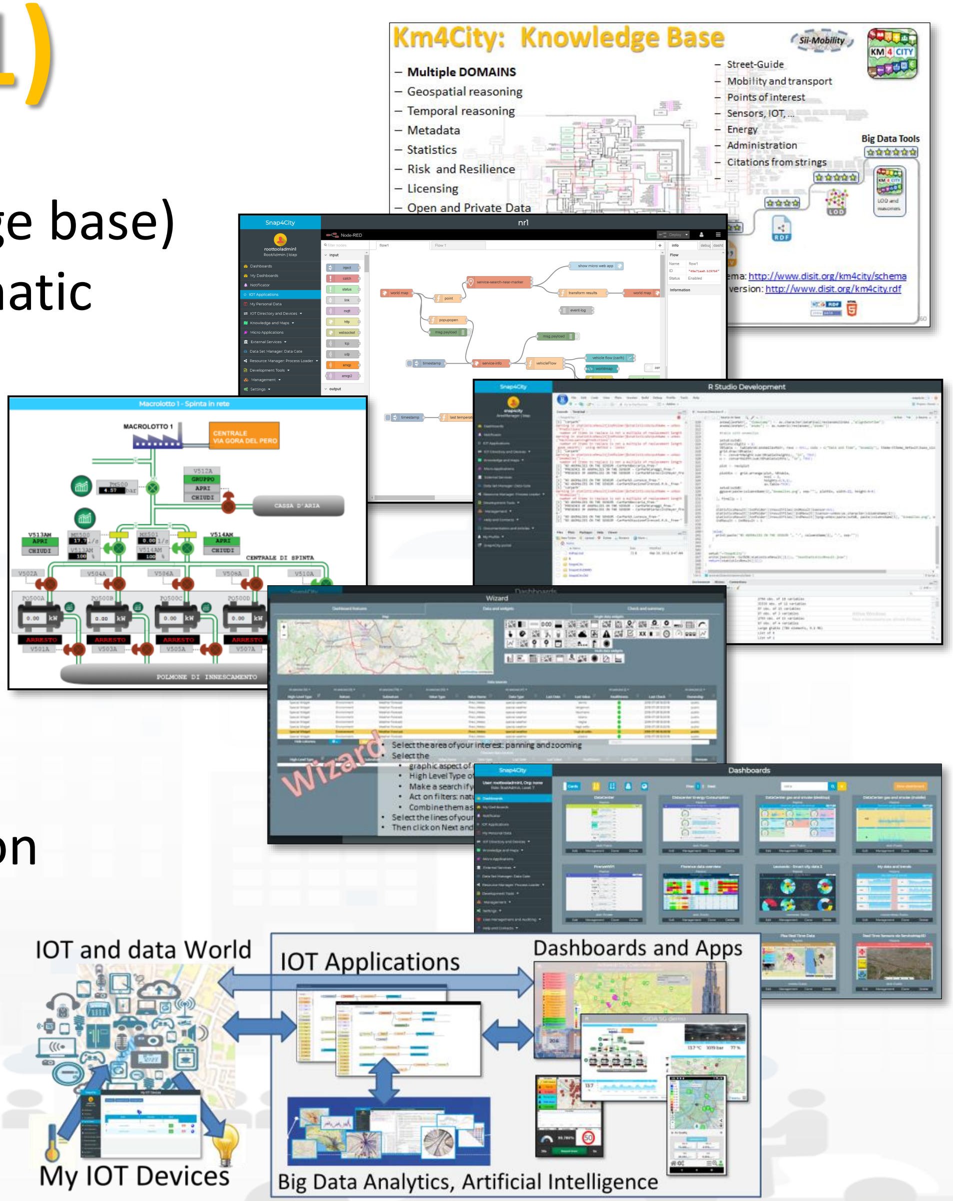
Authentication, Authorization, GDPR, Security Assessment

Market Solutions

	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

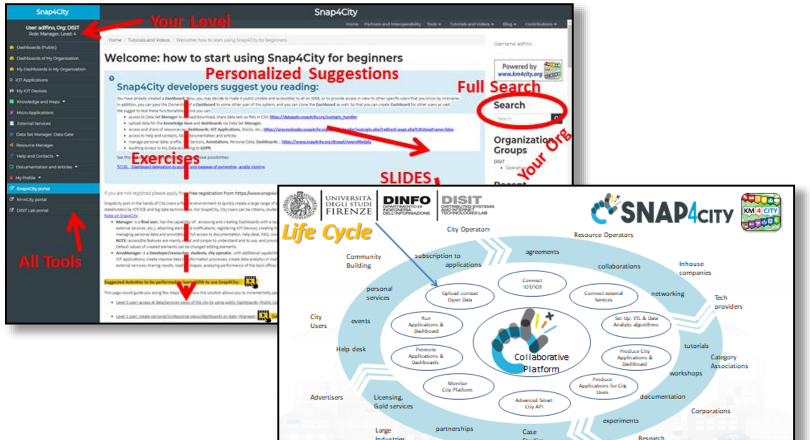
Unique of Snap4City Platform (1)

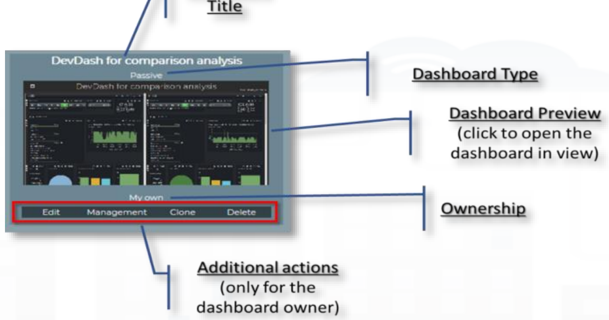
- Data ingestion and model
  - **Unified data model** (exploited in the Wizard and Knowledge base)
  - **Semantic Reasoner** modelling city entities, supporting sematic search, expert system, digital Twin, etc.
  - **IOT Directory abstracting complexity of IOT Devices, Edge, Brokers**, protocols and data formats
- 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 data vs graphics representation
  - **Dashboards specialized** multidomain for Smart Cities
  - **Custom Widgets and Synoptics**
  - **Ready to use Mobile App, instant App, MicroApplication**
  - **Strategies** formalization supports

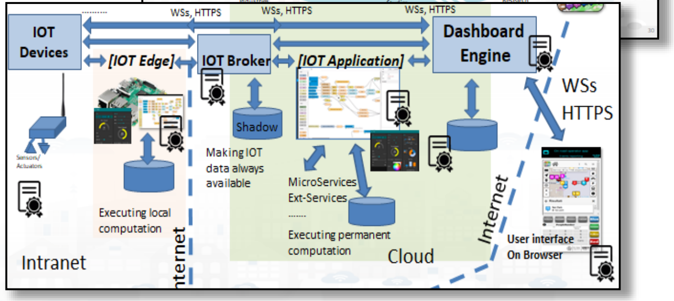


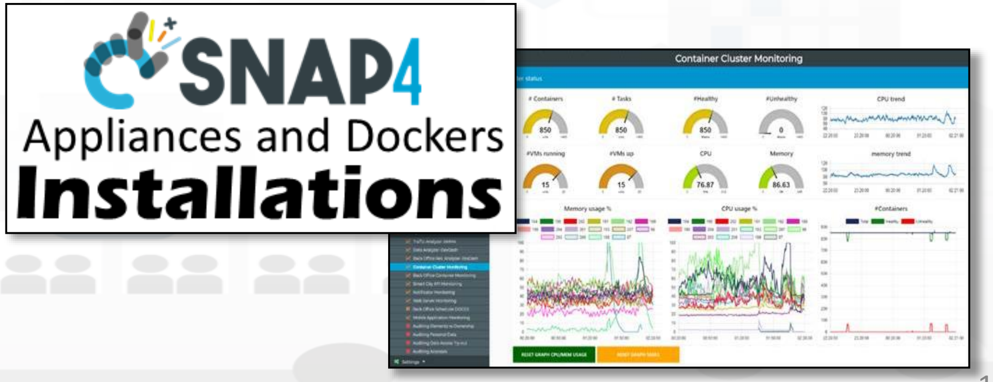
Unique of Snap4City Platform (2)

- Openness to any developers
  - **Living Lab support for coworking, sharing, and delegating**
  - **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**



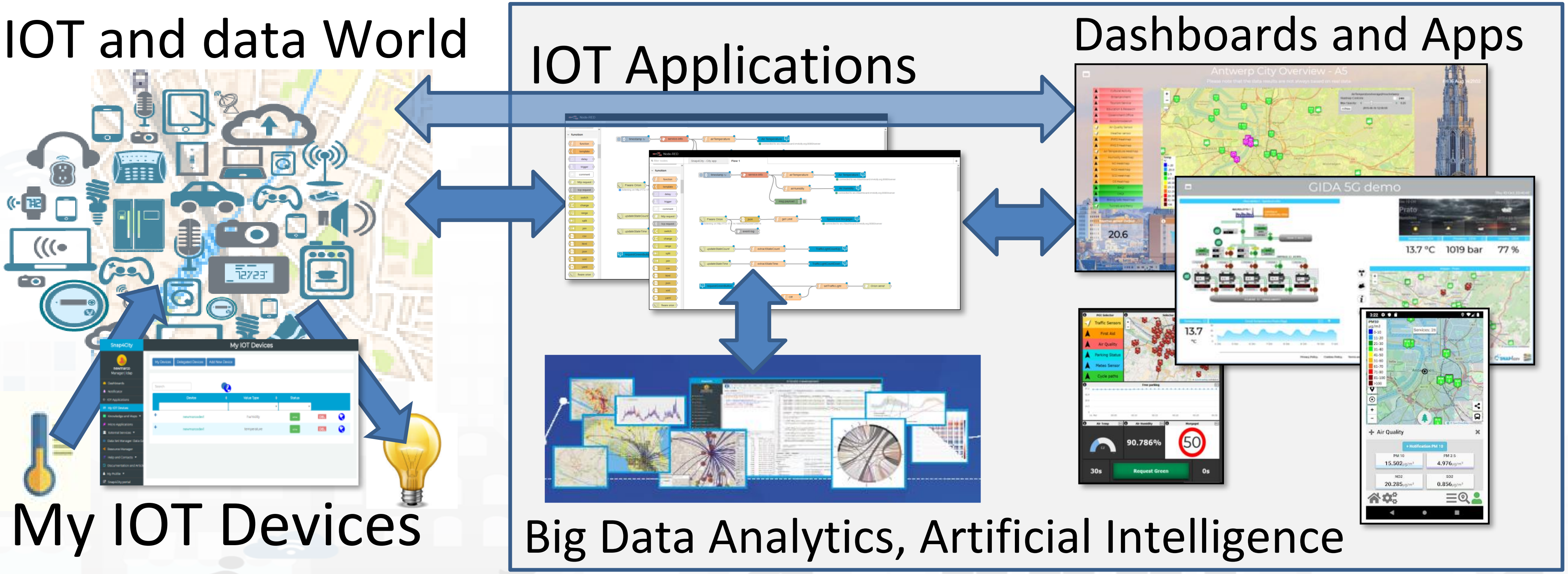

Dashboard Title
DevDash for comparison analysis
Passive
Dashboard Type
Dashboard Preview (click to open the dashboard in view)
My own
Edit
Management
Clone
Delete
Ownership
Additional actions (only for the dashboard owner)


IOT Devices
WSs, HTTPS
[IOT Edge]
IOT Broker
[IOT Application]
Dashboard Engine
WSs HTTPS
Shadow
Making IOT data always available
MicroServices Ext-Services
Executing local computation
Executing permanent computation
Sensors/Actuators
Intranet
Internet
Cloud
User interface On Browser



Snap4City: Builder of Sentient Cities Solutions

Dashboards with data driven IOT Applications enforcing intelligence



IOT and data World

IOT Applications

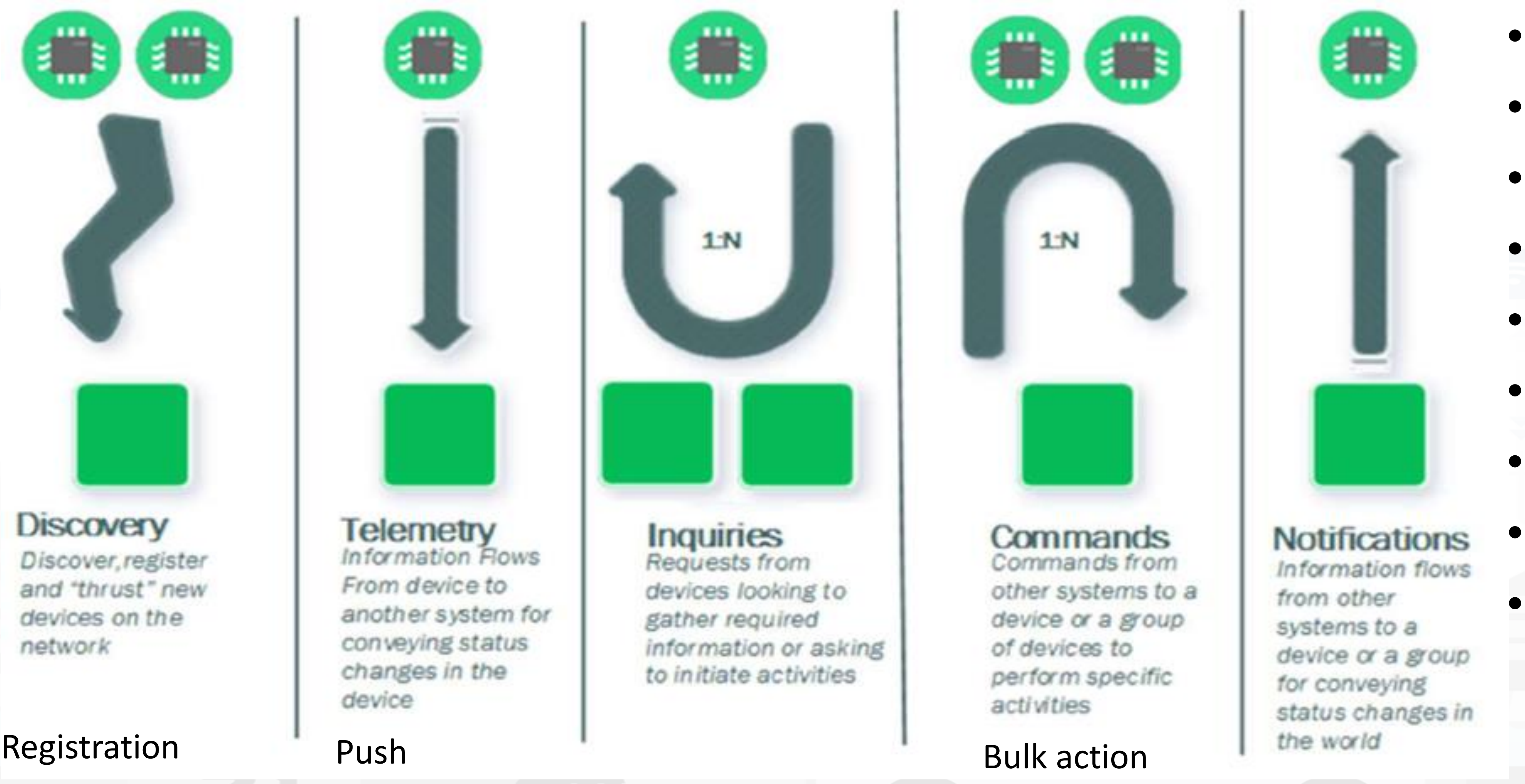
Dashboards and Apps

My IOT Devices

Big Data Analytics, Artificial Intelligence

IOT/IOE Protocols

Communication Patterns



Discovery
Discover,register and "thrust" new devices on the network

Registration

Telemetry
Information Flows From device to another system for conveying status changes in the device

Push

Inquiries
Requests from devices looking to gather required information or asking to initiate activities

Commands
Commands from other systems to a device or a group of devices to perform specific activities

Bulk action

Notifications
Information flows from other systems to a device or a group for conveying status changes in the world

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

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, WFS, WMS, ODBC, JDBC, Elastic Search, Phoenix, XML, JSON, CSV, db, GeoJSON, Enfuser FMI, Android, Raspberry Pi, Local File System, ESP32, Libelium, IBIMET, OBD2, SVG, XLS, XLSX, TXT, HTML, CSS, etc.

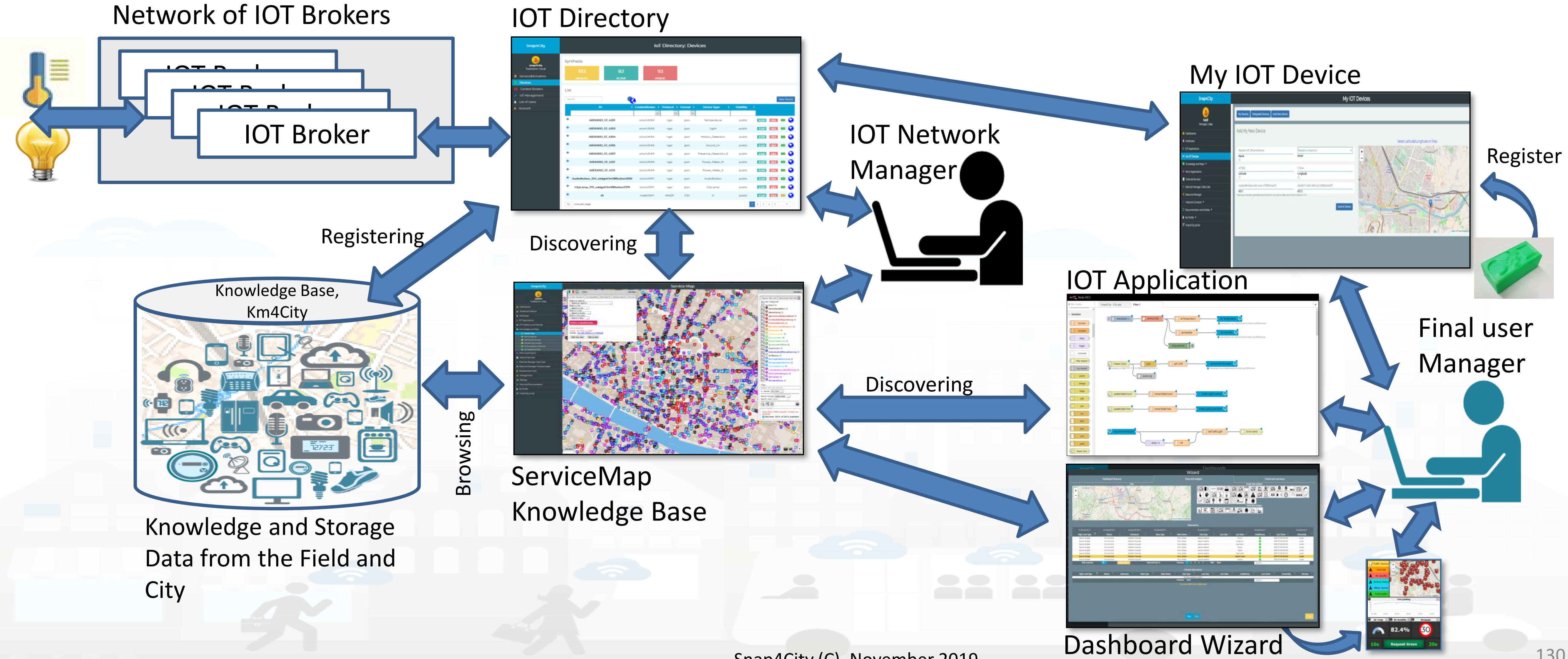
Node-RED | JS Foundation | FI-WARE | E015 digital ecosystem | bee smart city

sigfox partner network | ckan | GJL | LABGEO | esri Italia | EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE

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



Network of IOT Brokers

IOT Broker

IOT Directory

My IOT Device

Register

IOT Network Manager

Registering

Discovering

Knowledge Base, Km4City

Knowledge and Storage Data from the Field and City

Browsing

ServiceMap Knowledge Base

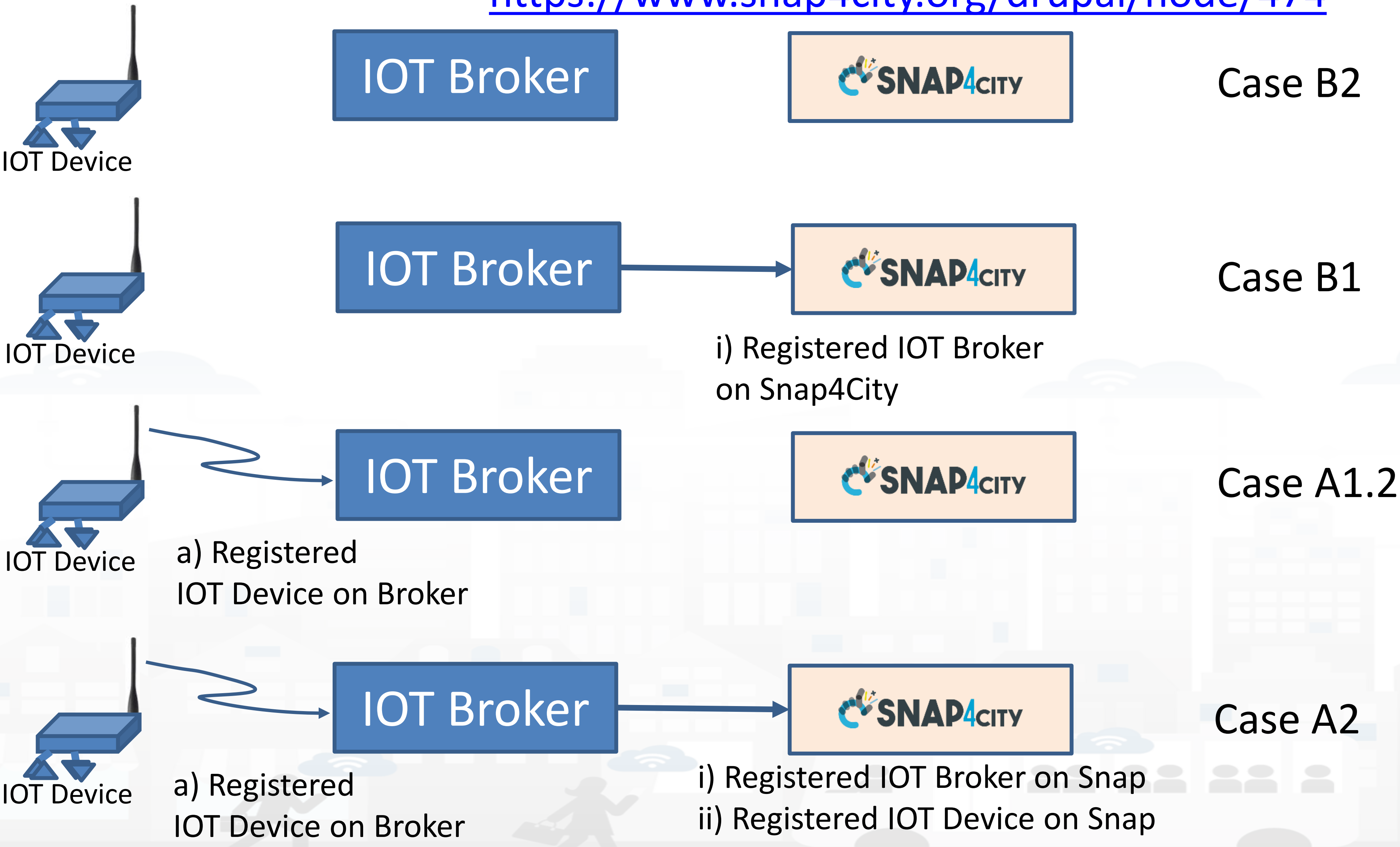
IOT Application

Final user Manager

Discovering

Dashboard Wizard

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



i) Registered IOT Broker on Snap4City

a) Registered IOT Device on Broker

a) Registered IOT Device on Broker

i) Registered IOT Broker on Snap
ii) Registered IOT Device on Snap

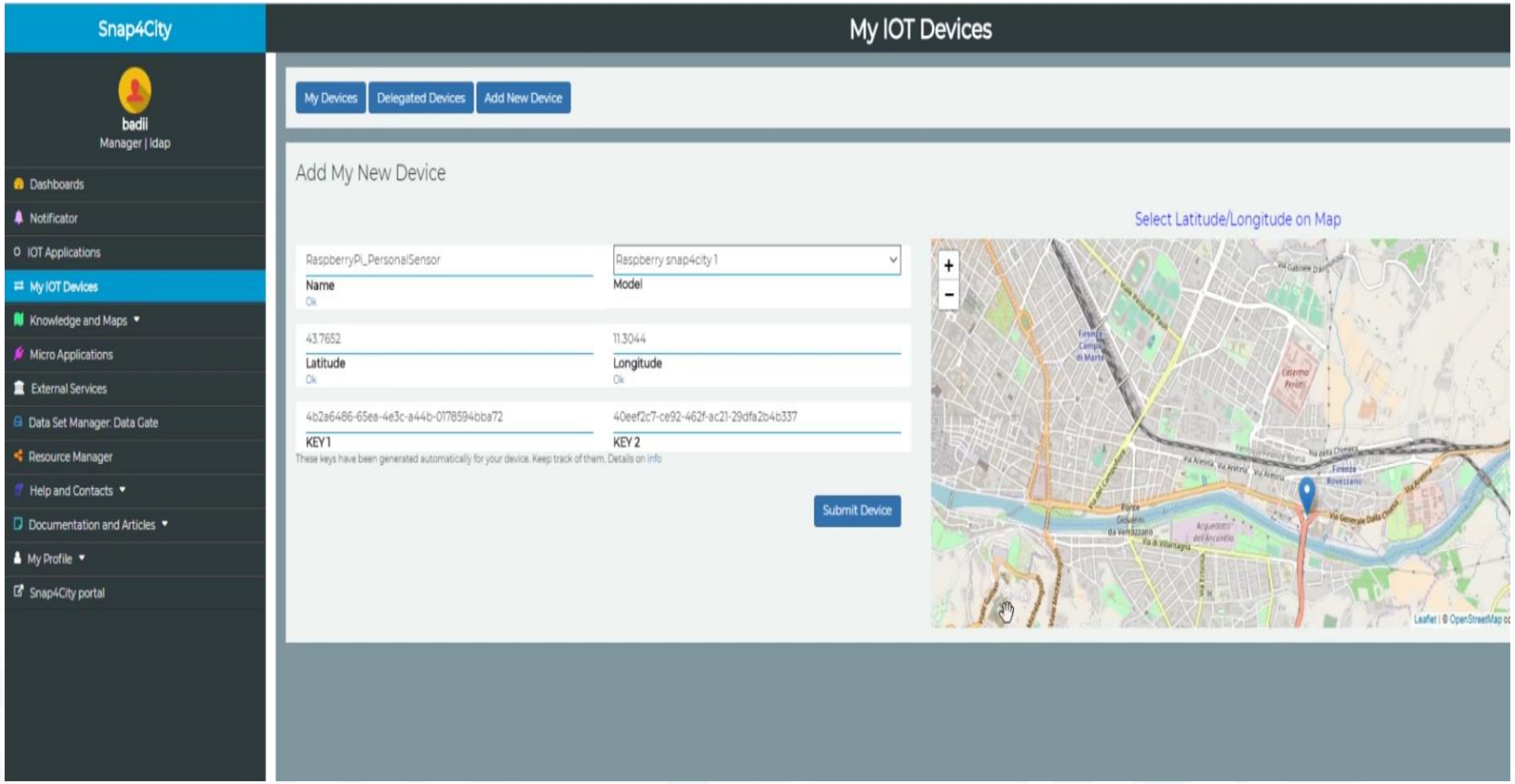
Add IOT/IOE Devices

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.



My IOT Devices

Add My New Device

Name: RaspberryPi_PersonalSensor (Ok)	Model: Raspberry snap4city 1
Latitude: 43.7652 (Ok)	Longitude: 11.3044 (Ok)
KEY 1: 4b2a6486-65ea-4e3c-a44b-0178594bba72	KEY 2: 40eef2c7-ce92-462f-ac21-29dfa2b4b337

These keys have been generated automatically for your device. Keep track of them. Details on info

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

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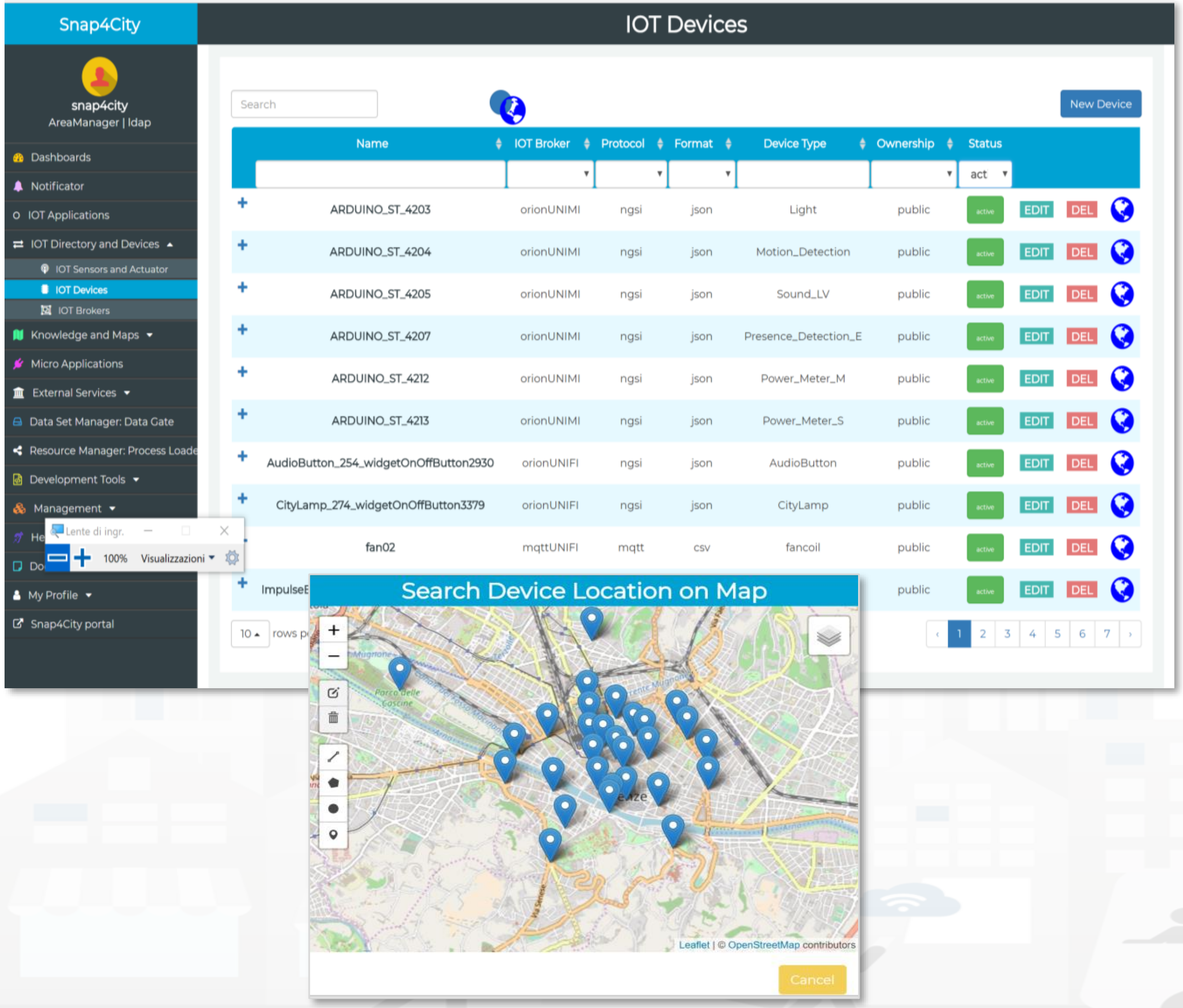
IOT Directory



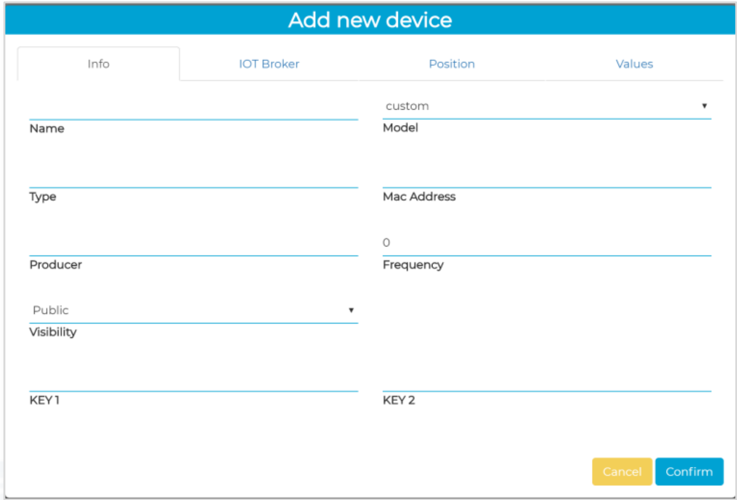
IOT Devices

Name	IOT Broker	Protocol	Format	Device Type	Ownership	Status	
						act	
ARDUINO_ST_4203	orionUNIMI	ngsi	json	Light	public	active	EDIT DEL
ARDUINO_ST_4204	orionUNIMI	ngsi	json	Motion_Detection	public	active	EDIT DEL
ARDUINO_ST_4205	orionUNIMI	ngsi	json	Sound_LV	public	active	EDIT DEL
ARDUINO_ST_4207	orionUNIMI	ngsi	json	Presence_Detection_E	public	active	EDIT DEL
ARDUINO_ST_4212	orionUNIMI	ngsi	json	Power_Meter_M	public	active	EDIT DEL
ARDUINO_ST_4213	orionUNIMI	ngsi	json	Power_Meter_S	public	active	EDIT DEL
AudioButton_254_widgetOnOffButton2930	orionUNIFI	ngsi	json	AudioButton	public	active	EDIT DEL
CityLamp_274_widgetOnOffButton3379	orionUNIFI	ngsi	json	CityLamp	public	active	EDIT DEL
fan02	mqttUNIFI	mqtt	csv	fancoil	public	active	EDIT DEL
ImpulseE					public	active	EDIT DEL

10 rows p

‹ 1 2 3 4 5 6 7 ›

Search Device Location on Map

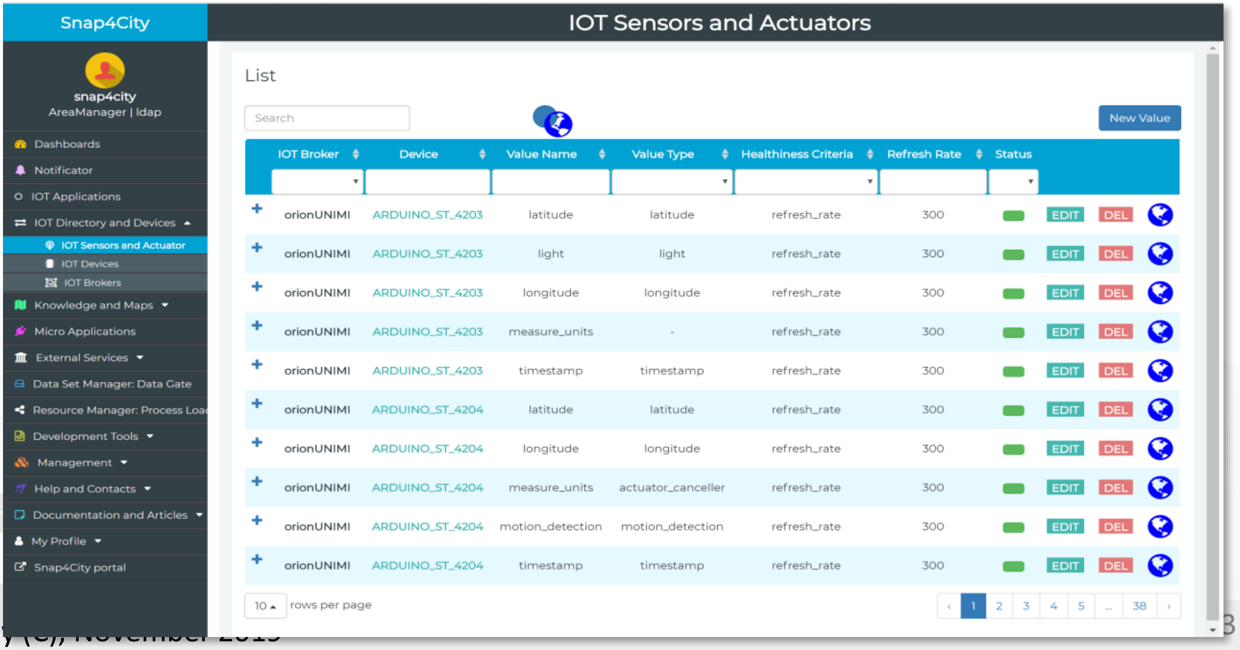


Add new device

Info | IOT Broker | Position | Values

Name:	Model: custom
Type:	Mac Address:
Producer:	Frequency: 0
Visibility: Public	
KEY 1:	KEY 2:

Cancel | Confirm



IOT Sensors and Actuators

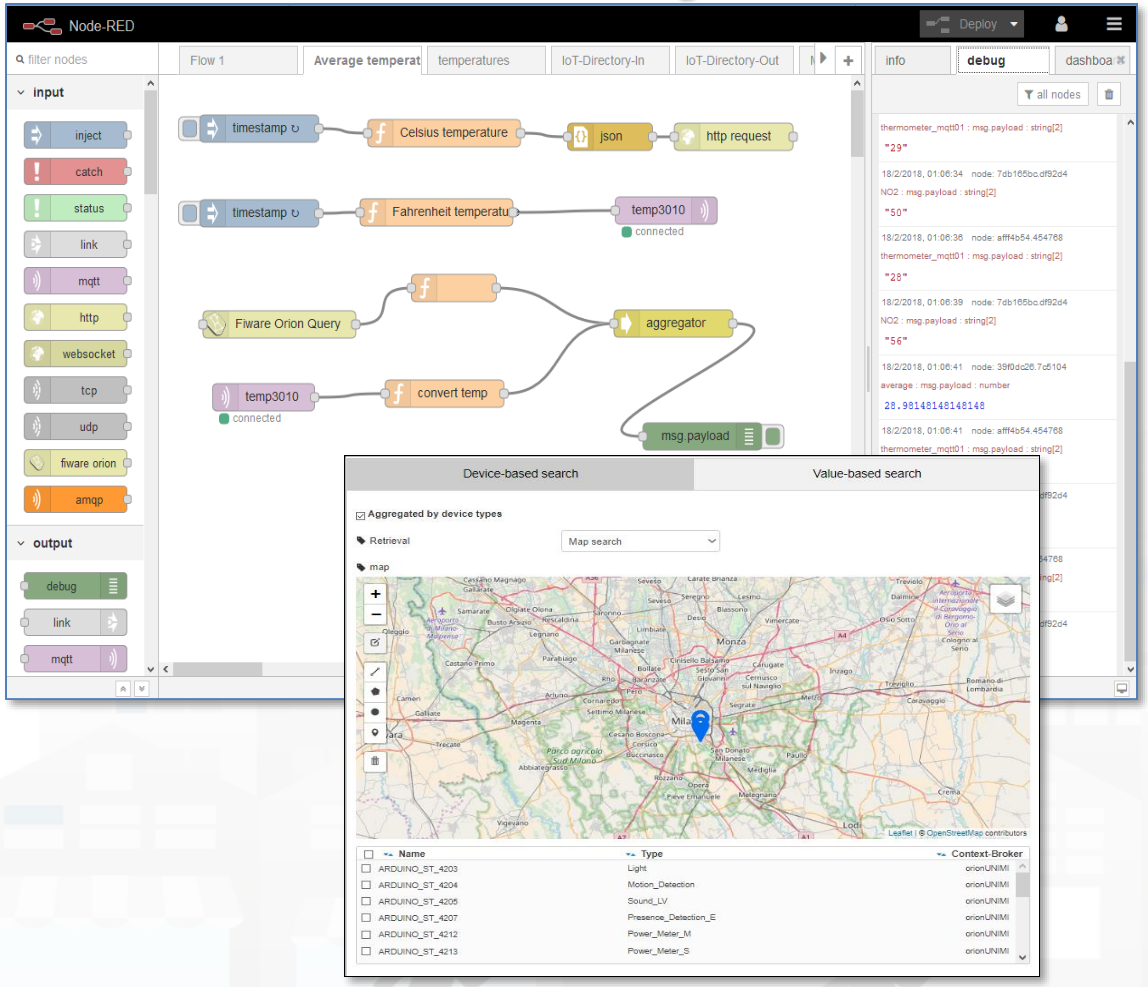
List

IOT Broker	Device	Value Name	Value Type	Healthiness Criteria	Refresh Rate	Status	
orionUNIMI	ARDUINO_ST_4203	latitude	latitude	refresh_rate	300	🟩	EDIT DEL
orionUNIMI	ARDUINO_ST_4203	light	light	refresh_rate	300	🟩	EDIT DEL
orionUNIMI	ARDUINO_ST_4203	longitude	longitude	refresh_rate	300	🟩	EDIT DEL
orionUNIMI	ARDUINO_ST_4203	measure_units	-	refresh_rate	300	🟩	EDIT DEL
orionUNIMI	ARDUINO_ST_4203	timestamp	timestamp	refresh_rate	300	🟩	EDIT DEL
orionUNIMI	ARDUINO_ST_4204	latitude	latitude	refresh_rate	300	🟩	EDIT DEL
orionUNIMI	ARDUINO_ST_4204	longitude	longitude	refresh_rate	300	🟩	EDIT DEL
orionUNIMI	ARDUINO_ST_4204	measure_units	actuator_canceller	refresh_rate	300	🟩	EDIT DEL
orionUNIMI	ARDUINO_ST_4204	motion_detection	motion_detection	refresh_rate	300	🟩	EDIT DEL
orionUNIMI	ARDUINO_ST_4204	timestamp	timestamp	refresh_rate	300	🟩	EDIT DEL

10 rows per page

‹ 1 2 3 4 5 ... 38 ›

IOT Discovery on IOT Application Development



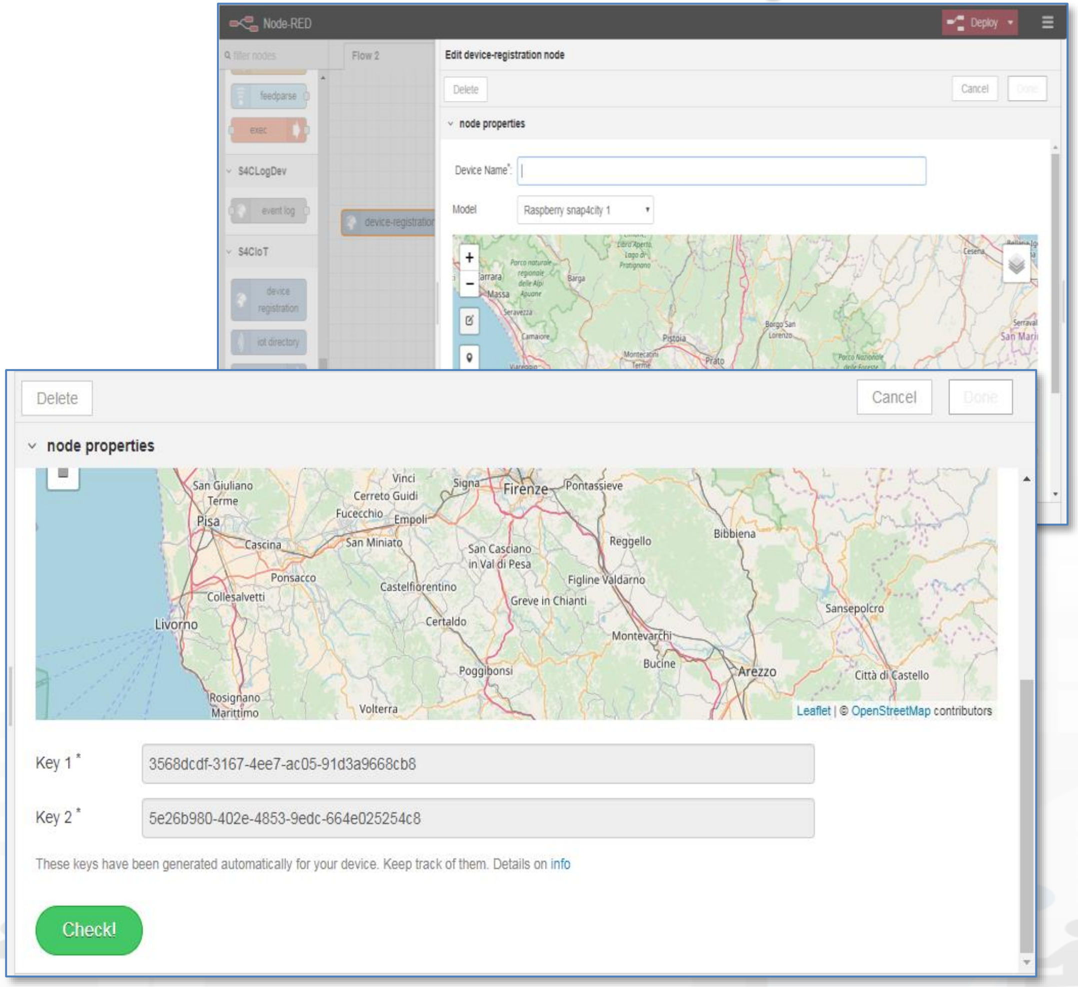
```
thermometer_mqtt01 : msg.payload : string[2]
 "29"
18/2/2018, 01:06:34   node: 7db165bc.df92d4
NO2 : msg.payload : string[2]
 "50"
18/2/2018, 01:06:36   node: afff4b54.454768
thermometer_mqtt01 : msg.payload : string[2]
 "28"
18/2/2018, 01:06:39   node: 7db165bc.df92d4
NO2 : msg.payload : string[2]
 "56"
18/2/2018, 01:06:41   node: 39f0dc26.7c5104
average : msg.payload : number
 28.98148148148148
18/2/2018, 01:06:41   node: afff4b54.454768
thermometer_mqtt01 : msg.payload : string[2]
```

☑ Aggregated by device types

Retrieval: Map search

map

□	Name	Type	Context-Broker
□	ARDUINO_ST_4203	Light	orionUNIMI
□	ARDUINO_ST_4204	Motion_Detection	orionUNIMI
□	ARDUINO_ST_4205	Sound_LV	orionUNIMI
□	ARDUINO_ST_4207	Presence_Detection_E	orionUNIMI
□	ARDUINO_ST_4212	Power_Meter_M	orionUNIMI
□	ARDUINO_ST_4213	Power_Meter_S	orionUNIMI



Edit device-registration node

Device Name*:

Model: Raspberry snap4city 1

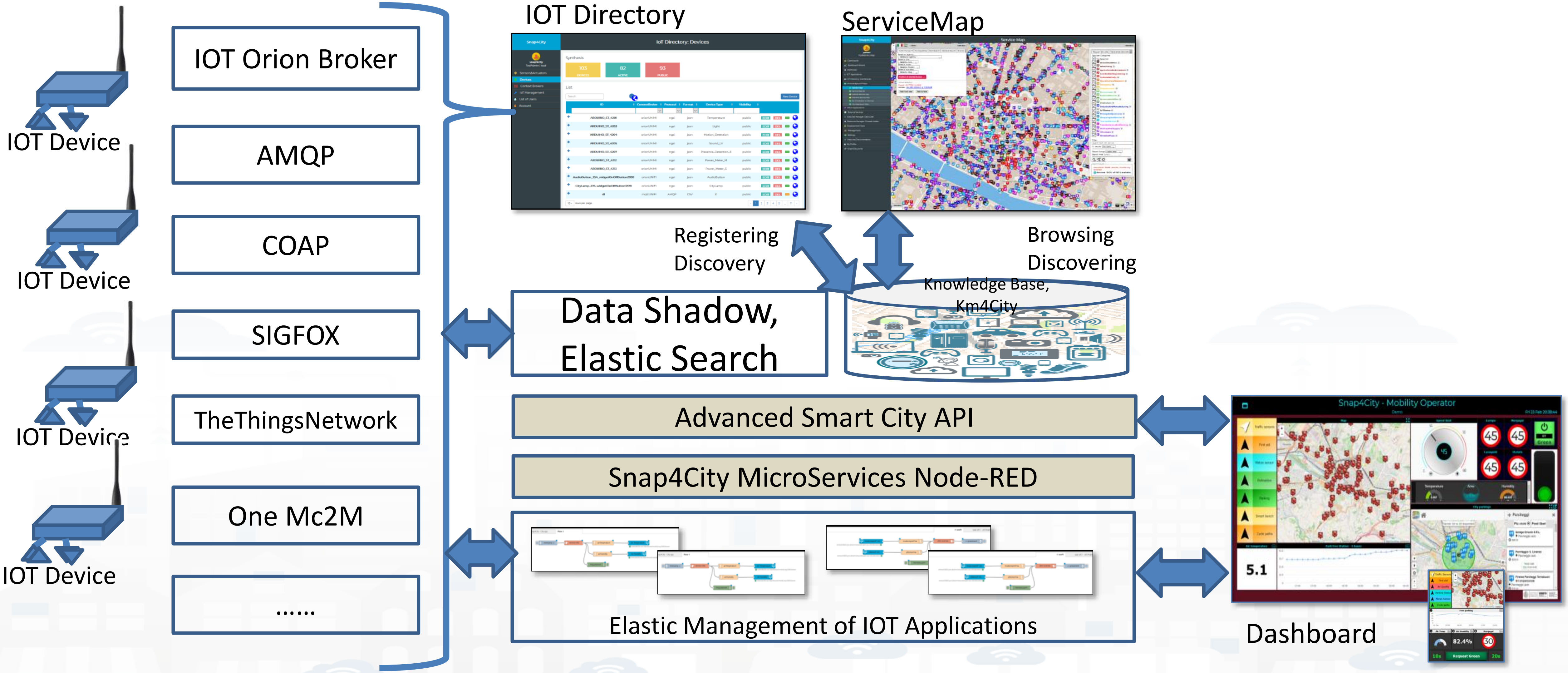
Key 1 *: 3568dcdf-3167-4ee7-ac05-91d3a9668cb8

Key 2 *: 5e26b980-402e-4853-9edc-664e025254c8

These keys have been generated automatically for your device. Keep track of them. Details on info

Snap4City (C), November 2019

IOT Architecture



IOT Device

IOT Device

IOT Device

IOT Device

IOT Orion Broker

AMQP

COAP

SIGFOX

TheThingsNetwork

One Mc2M

……

IOT Directory

ServiceMap

Registering
Discovery

Browsing
Discovering

Knowledge Base,
Km4City

Data Shadow,
Elastic Search

Advanced Smart City API

Snap4City MicroServices Node-RED

Elastic Management of IOT Applications

Dashboard

FI-WARE VS SNAP4CITY

SMART CITIES REFERENCE ARCHITECTURE

- Is open to the Development of Applications leaving large space to developers
- Is cantered on the Orion Broker that result central in the architecture: any Broker or data source is sending data to Orion
- Security level is not clear, partially demanded to developers
- Visual Flexible IOT processing is not clearly provided
- **Limited API** for IOT data access
- **Knowage BI** presents several limitations in showing Smart City Data
- Market place on Open Data
- Support of Developers via Fi-Ware
- Deployed as VM and Dockers
- open source, not the application parts

- Is open to the Development of Applications leaving large space and providing a **large set of ready to use applicative tools** and solutions to build their solutions on top or aside.
- Is fully distributed, **any kind of data source** can be ingested, automatically.
- **Orion Broker is only one of the Brokers** that can be used. It can be also protected by Snap4City tech, with Mutual Authentication
- **Visual Flexible IOT processing is provided** as Node-RED and Snap4City MicroServices suites
- **Advanced Smart City API** are provided on top of Knowledge Base
- **Dashboard Builder** has been designed for Smart City Data and automated dashboards’ production
- **Market Place** on Open Data, tools, processes, experiences
- Full Support for Living Lab of the city, coworking, tutorials
- Deployed as VM and Dockers
- 100% open Source

FI-WARE vs SNAP4CITY

- **Snap4City is an official Fi-Ware Solution via**
  - NGSI V1, V2 The IOT Orion Broker
  - IOT Orion Broker can connect JSON, MQTT, Lightweight M2M, LoraWAN, OPC, SigFOX, etc. see Fi-Ware Https://www.fiware.org
- **Snap4City is compatible** with all the above protocols
  - via IOT Orion Broker,
  - via direct connection on ETL processes on their corresponding IOT brokers, and/or
  - via IOT Applications.
- **Snap4City is also compatible** with many other protocols, see the table reported in page: https://www.snap4city.org/65

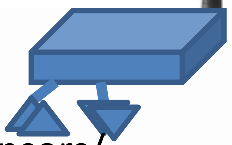
FI-WARE vs SNAP4CITY

- In Snap4City you can chose to connect your devices at Snap4City Platform in different manners:
  - (a) directly to Snap4City, or
  - (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.

IOT Devices Registration (self training)

- IOT device registration can be performed by all kind of users.
- Higher level users can register large sets of IOT devices, reg. in Bulk
- Suggested training:
  - **HOW TO: add a device to the Snap4City Platform**
  - **Snap4City IOT Devices Registration**
  - **TC2.15 - IOT device registration**
  - **TC2.11 - Search on IOT Directory for Devices and Sensors, IOT Device Registration**
  - **TC2.30 - Bulk Load for IoT Devices Registration**
  - **TC10.9 - IOT Directory and Multiple Brokers**

Proprietary IOT Devices as well as Open Hardware / Open Software

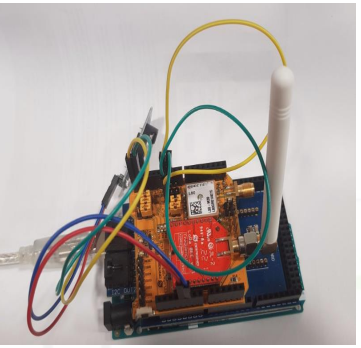


Sensors/
Actuators

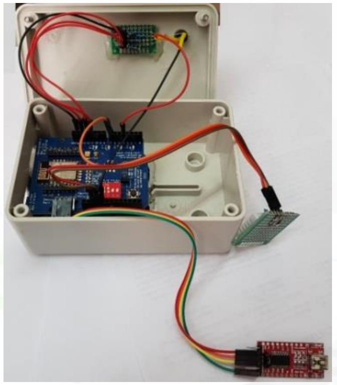
IOT Devices

IOT Edge Devices

LoraWAN + Arduino + I2C, NGSI



Arduino, Wi-Fi, NGSI

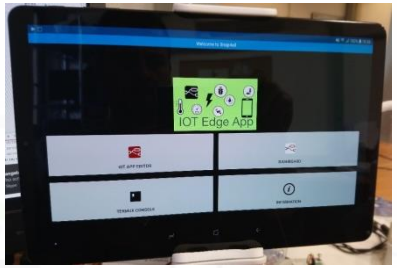


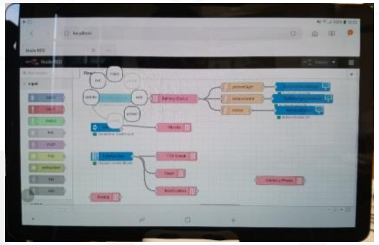
Snap4All IOT Button ESP, NGSI, Wi-FI, BT

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

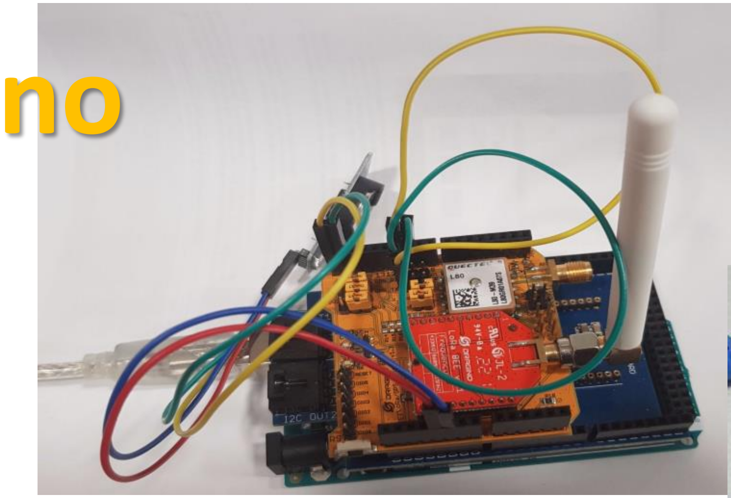
Any Sensor / Actuator
Open to other protocols

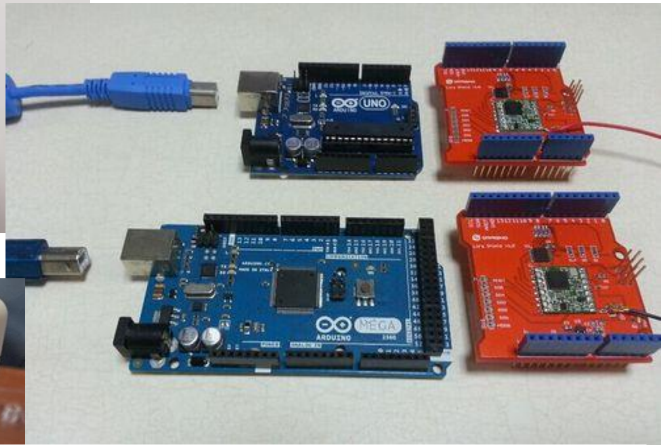
IOT Dev Management: activities

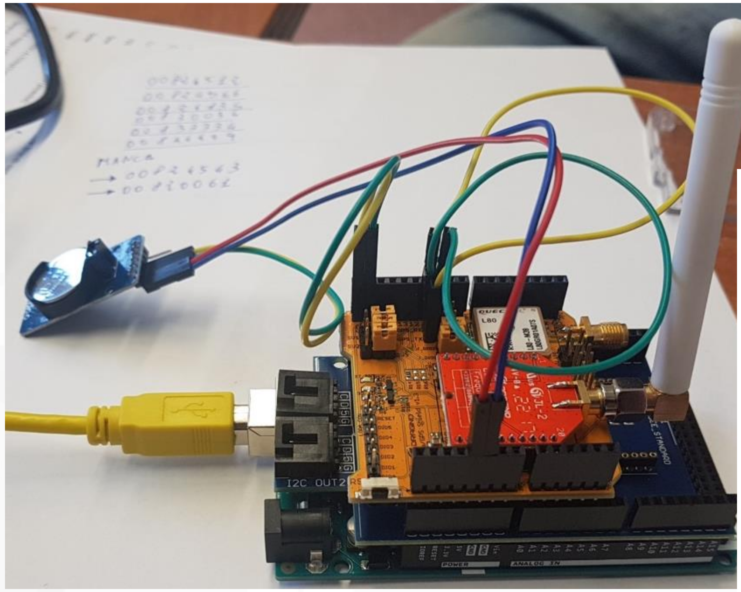
- **IOT Devices can be open or proprietary**
- **IOT Devices**: a large range of protocols, formats and kind
  - IOT Devices (single or in bulk) are **registered** on IOT Directory and thus according to Knowledge base are registered to be used in IOT Applications, Dashboards, etc. with Shadow values, etc.
  - IOT Models are saved on IOT Directory for shortening the registration process
  - IOT Device healthiness is monitored automatically
- **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

Lora IOT Device, Arduino

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



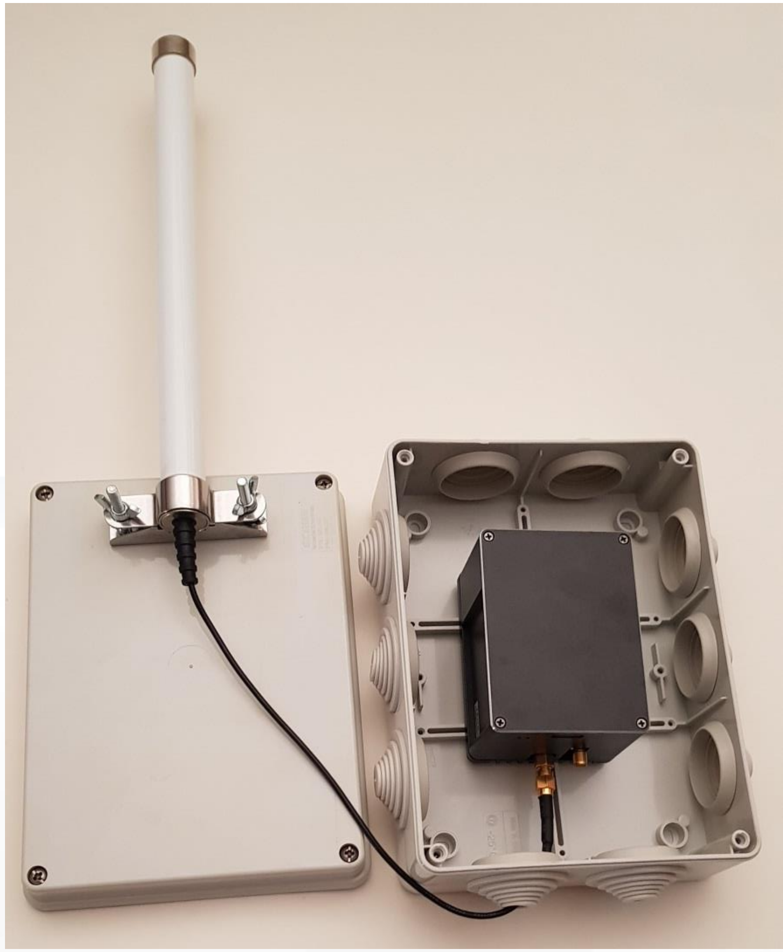




https://www.snap4city.org/drupal/node/216

LoraWan Gateway out of the Box

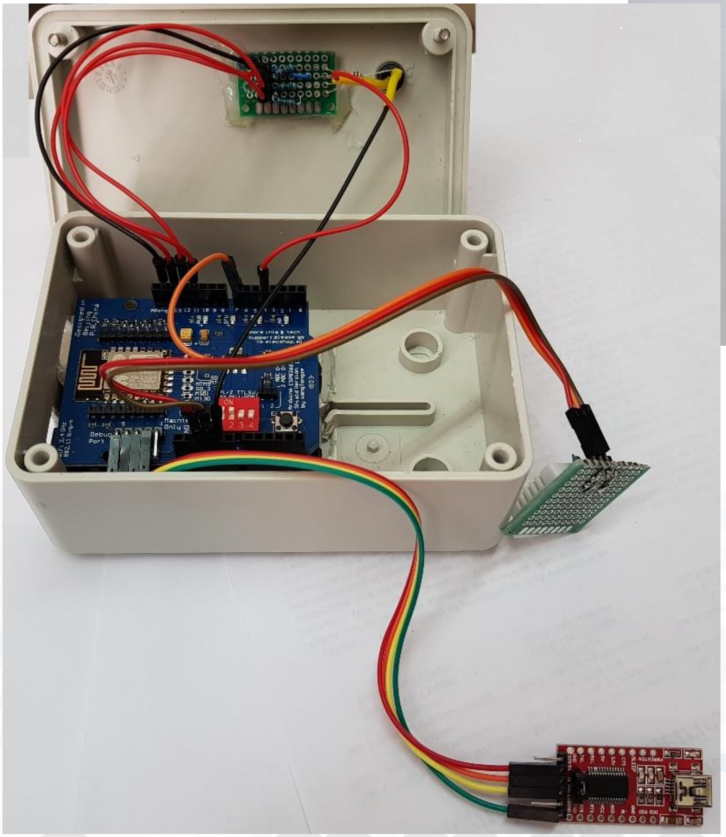
- Raspberry Pi Based LoraWan Gateway
- Physical UpLink as: Wi-Fi, RJ45
- Logical UpLink: LoraWAN TheThingsNetwork, NGSI V2 (mutual authenticated Snap4City)
- Powered 5V
- GeoLocated GPS Antenna
- IOT Edge Snap4City Included if needed

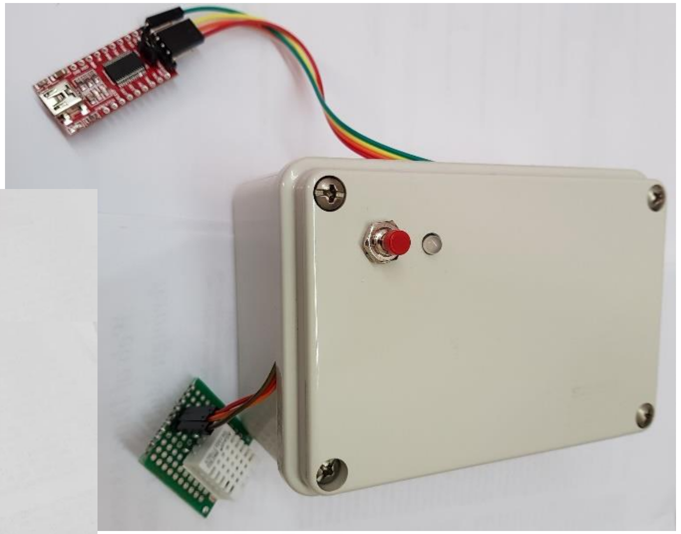


FIWARE LoRa WiFi

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



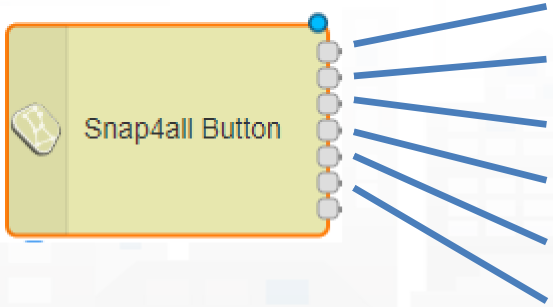


FIWARE Wi Fi

Snap4All IOT Button

- Multi Wi-Fi
- Ready to use BLE Bluetooth
- ESP 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

version: 3

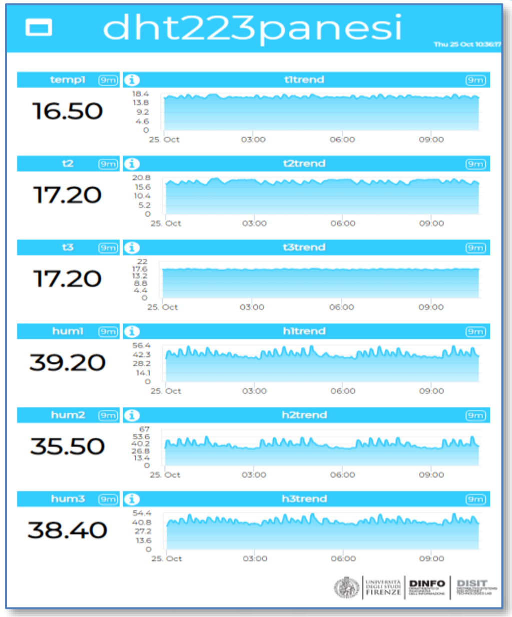


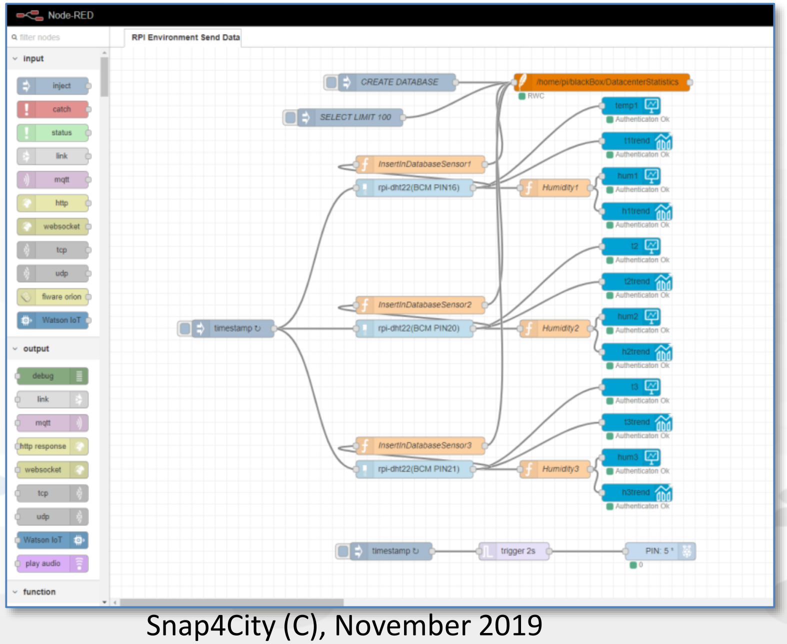
Squared Short
Squared Double
Squared Long
Round Short
Round Double
Round Long

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

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**



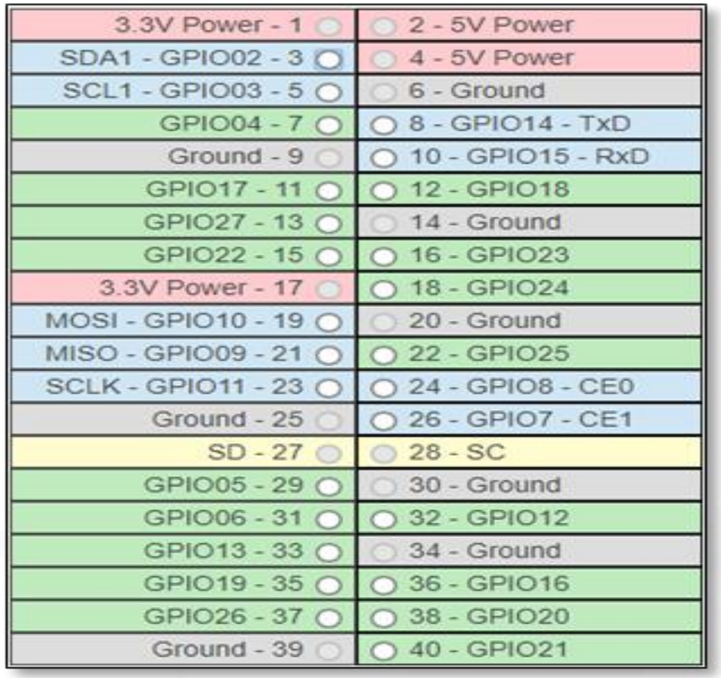


MicroServices:
- DHT
- ModBus
- any shield
- etc….

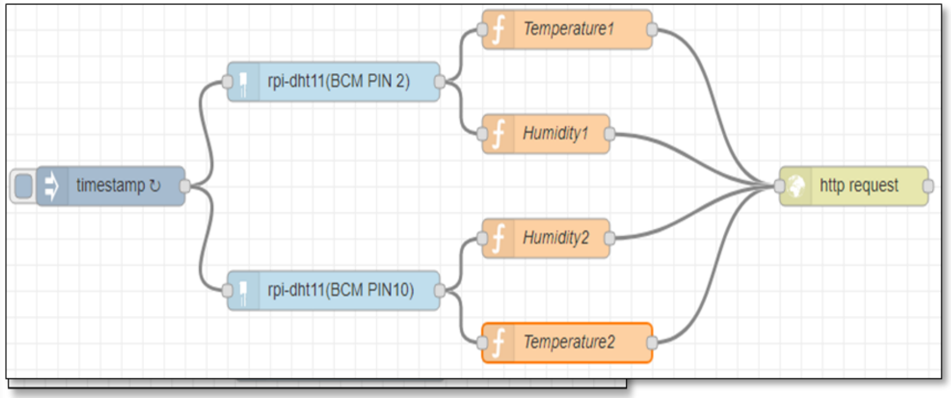
FIWARE

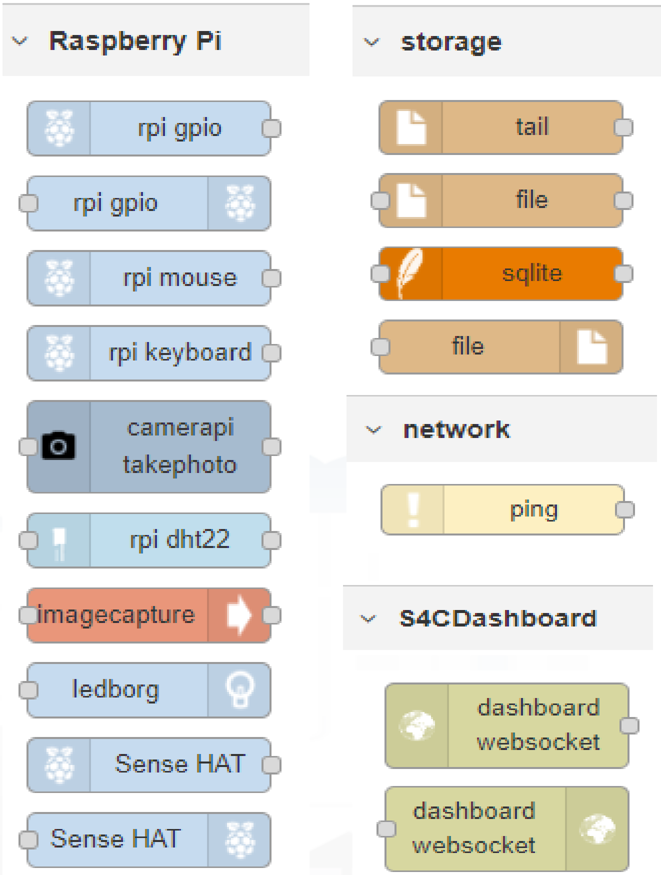
Wi Fi

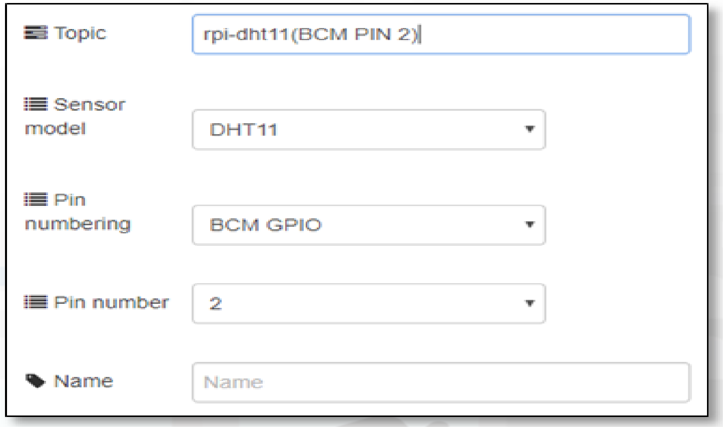
Snap4City on Raspberry Pi, IOT edge



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







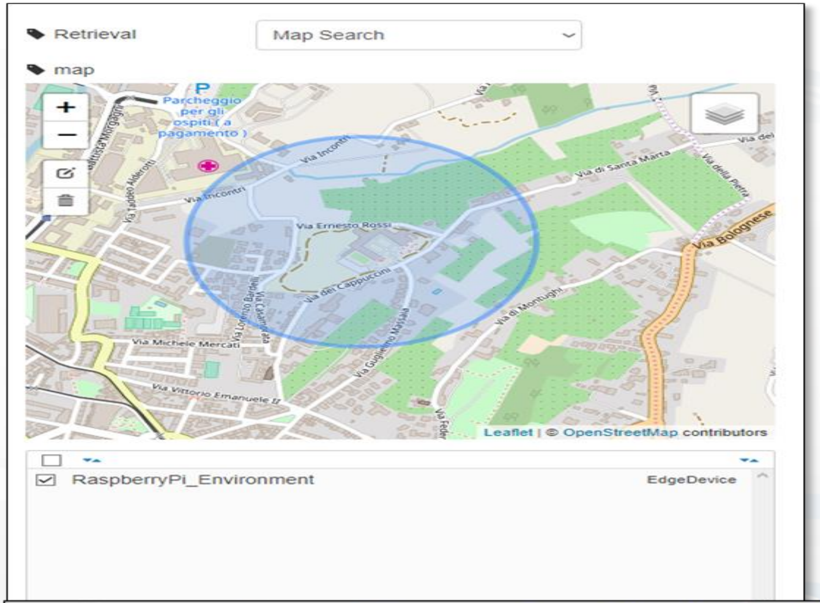
Topic: rpi-dht11(BCM PIN 2)

Sensor model: DHT11

Pin numbering: BCM GPIO

Pin number: 2

Name: Name



Retrieval: Map Search

map

☑ RaspberryPi_Environment EdgeDevice

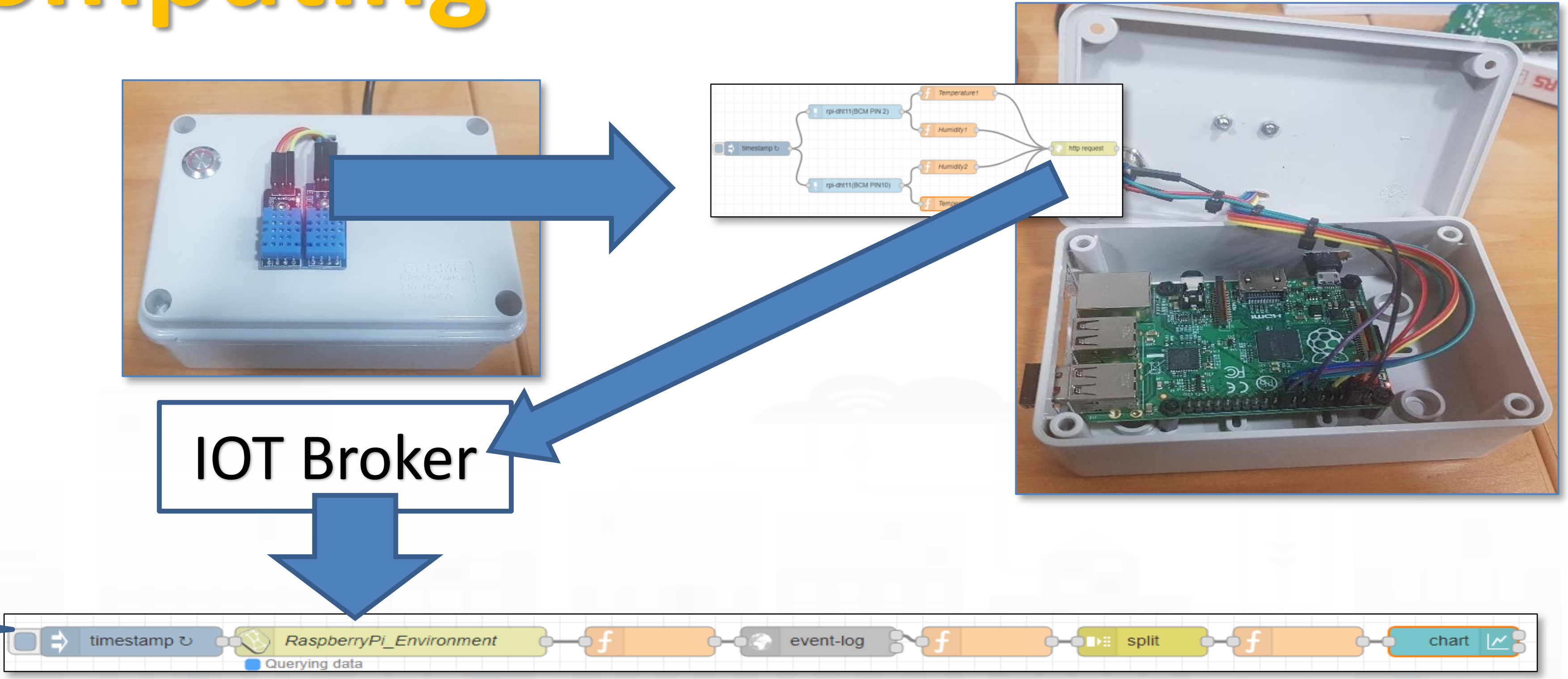
```
msg.payload={"temperature1":{"value":msg.payload , "type":"Float"}};
return msg;
```

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**

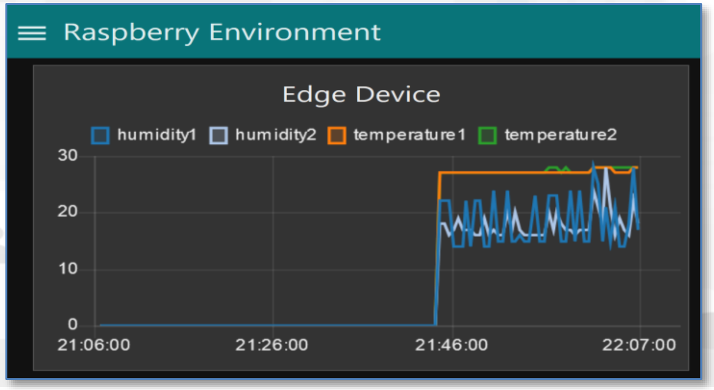


IOT Broker

Click here

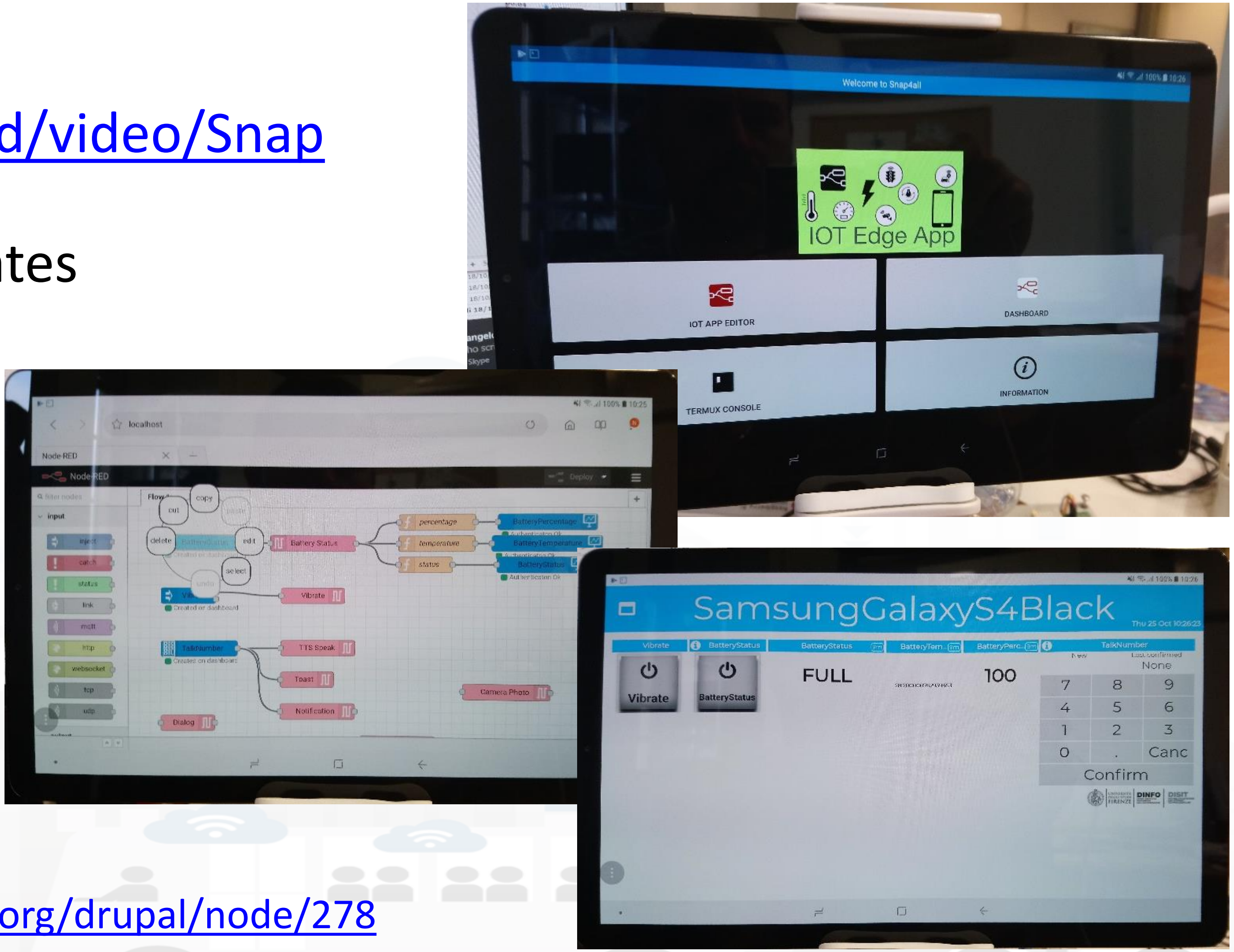
Steps:

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**



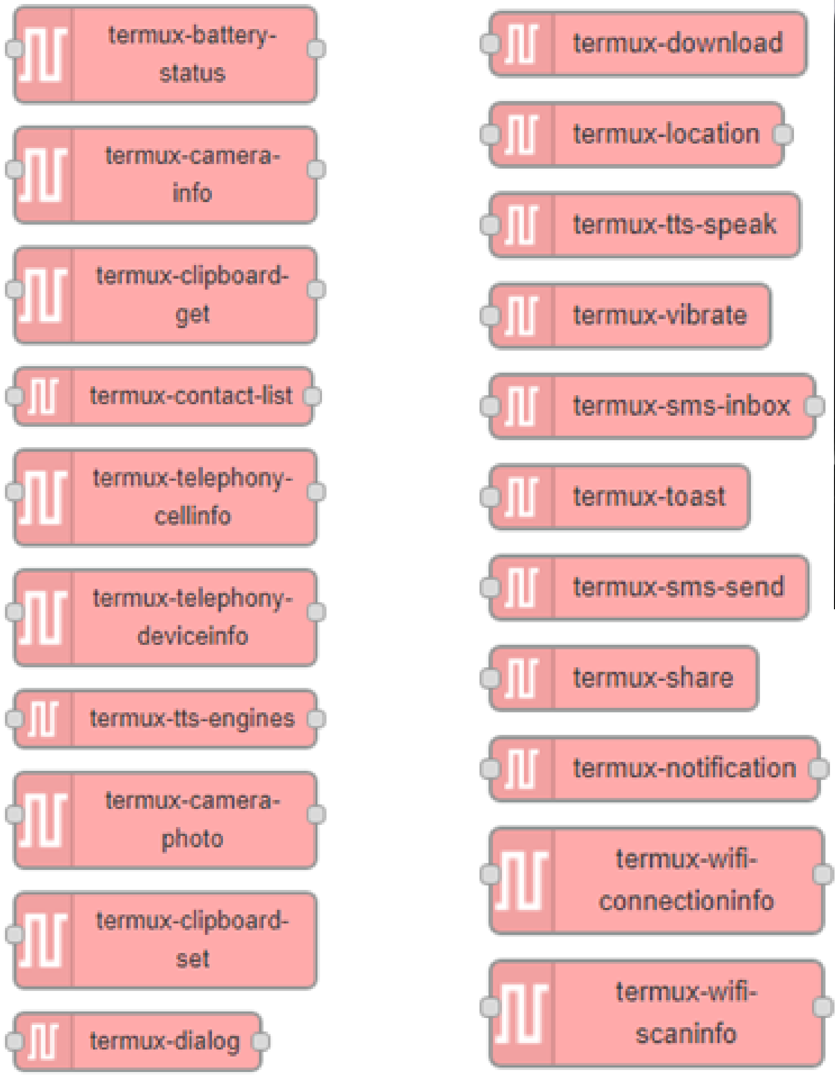
IOT Edge Snap4All App for Android

- **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



termux-battery-status

termux-camera-info

termux-clipboard-get

termux-contact-list

termux-telephony-cellinfo

termux-telephony-deviceinfo

termux-tts-engines

termux-camera-photo

termux-clipboard-set

termux-dialog

termux-download

termux-location

termux-tts-speak

termux-vibrate

termux-sms-inbox

termux-toast

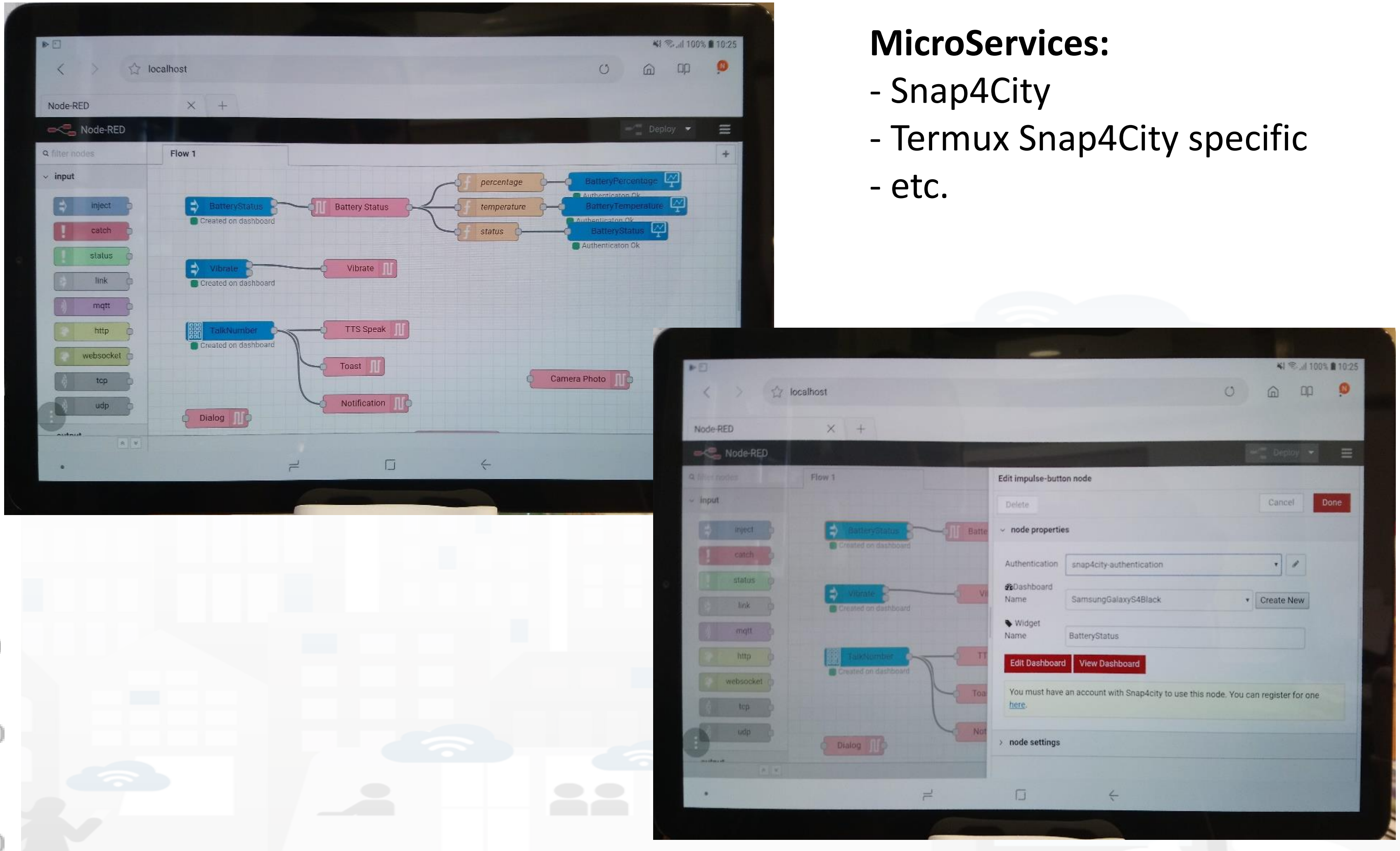
termux-sms-send

termux-share

termux-notification

termux-wifi-connectioninfo

termux-wifi-scaninfo



Edit impulse-button node

Delete | Cancel | Done

node properties

Authentication: snap4city-authentication

Dashboard Name: SamsungGalaxyS4Black | Create New

Widget Name: BatteryStatus

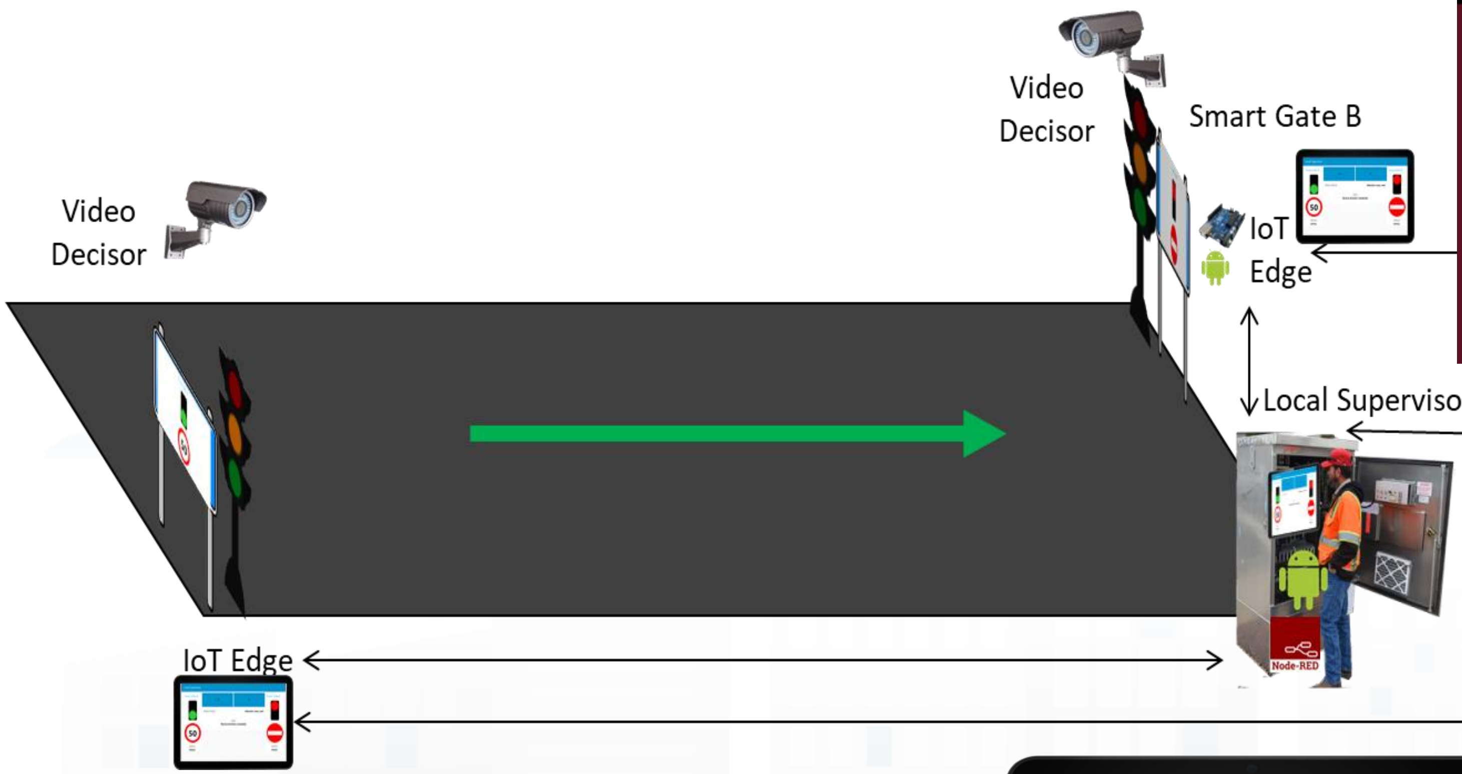
Edit Dashboard | View Dashboard

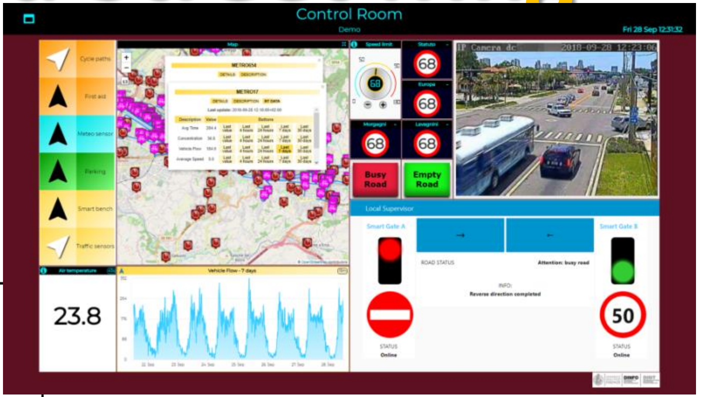
You must have an account with Snap4city to use this node. You can register for one here.

node settings

MicroServices:
- Snap4City
- Termux Snap4City specific
- etc.

Sii-Mobility: Dynamic Signage and Street Mng




Control Room

Demo

Fri 28 Sep 12:31:32

Local Supervisor

Smart Gate A → ← Smart Gate B

ROAD STATUS Attention: busy road

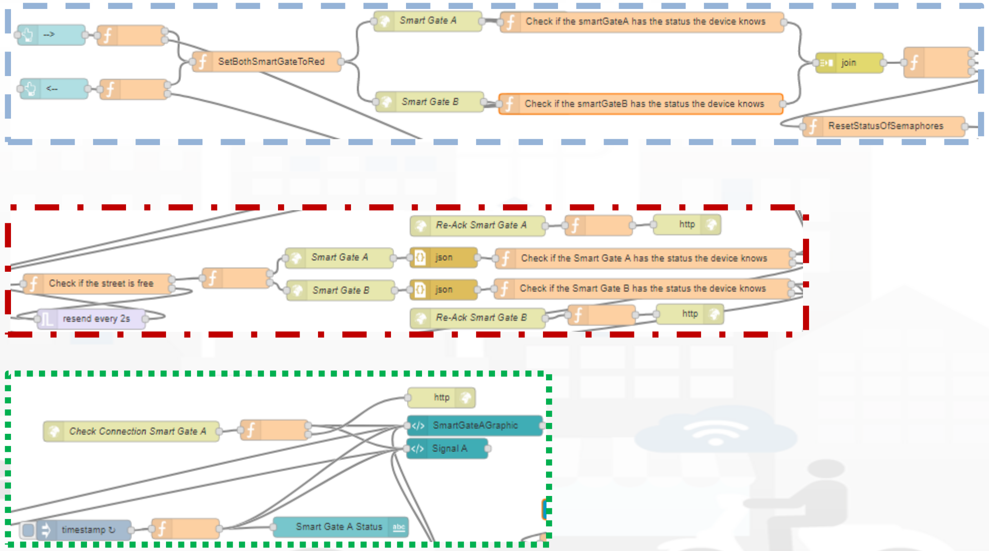
INFO:
Reverse direction completed

50

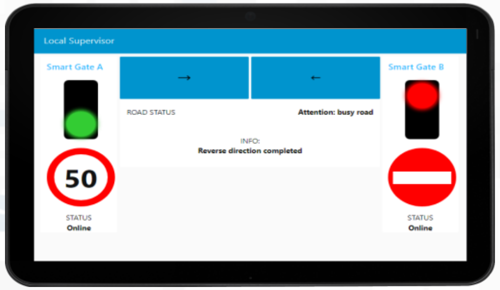
STATUS Online

STATUS Online

Control Room


SetBothSmartGateToRed
Smart Gate A
Check if the smartGateA has the status the device knows
Smart Gate B
Check if the smartGateB has the status the device knows
join
ResetStatusOfSemaphores
Re-Ack Smart Gate A
http
Smart Gate A
json
Check if the Smart Gate A has the status the device knows
Check if the street is free
Smart Gate B
json
Check if the Smart Gate B has the status the device knows
resend every 2s
Re-Ack Smart Gate B
http
http
Check Connection Smart Gate A
SmartGateAGraphic
Signal A
timestamp
Smart Gate A Status

Local Control Dashboard


Local Supervisor

Smart Gate A → ← Smart Gate B

ROAD STATUS Attention: busy road

INFO:
Reverse direction completed

50

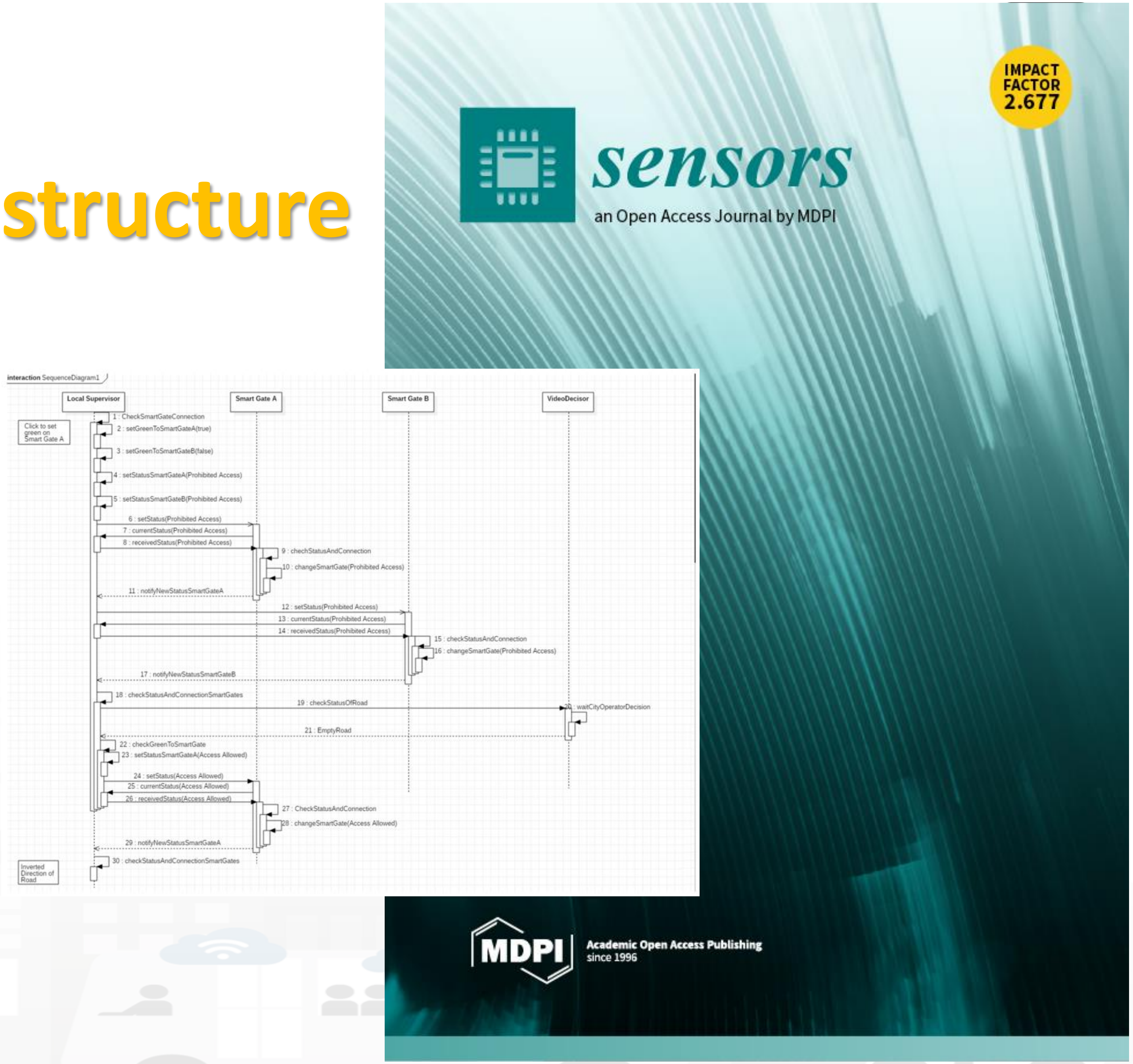
STATUS Online

STATUS Online

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


IMPACT FACTOR 2.677
sensors
an Open Access Journal by MDPI
interaction SequenceDiagram1
Local Supervisor
Smart Gate A
Smart Gate B
VideoDecisor
Click to set green on Smart Gate A
1 : CheckSmartGateConnection
2 : setGreenToSmartGateA(true)
3 : setGreenToSmartGateB(false)
4 : setStatusSmartGateA(Prohibited Access)
5 : setStatusSmartGateB(Prohibited Access)
6 : setStatus(Prohibited Access)
7 : currentStatus(Prohibited Access)
8 : receivedStatus(Prohibited Access)
9 : chechStatusAndConnection
10 : changeSmartGate(Prohibited Access)
11 : notifyNewStatusSmartGateA
12 : setStatus(Prohibited Access)
13 : currentStatus(Prohibited Access)
14 : receivedStatus(Prohibited Access)
15 : checkStatusAndConnection
16 : changeSmartGate(Prohibited Access)
17 : notifyNewStatusSmartGateB
18 : checkStatusAndConnectionSmartGates
19 : checkStatusOfRoad
20 : waitCityOperatorDecision
21 : EmptyRoad
22 : checkGreenToSmartGate
23 : setStatusSmartGateA(Access Allowed)
24 : setStatus(Access Allowed)
25 : currentStatus(Access Allowed)
26 : receivedStatus(Access Allowed)
27 : CheckStatusAndConnection
28 : changeSmartGate(Access Allowed)
29 : notifyNewStatusSmartGateA
30 : checkStatusAndConnectionSmartGates
Inverted Direction of Road
MDPI
Academic Open Access Publishing since 1996

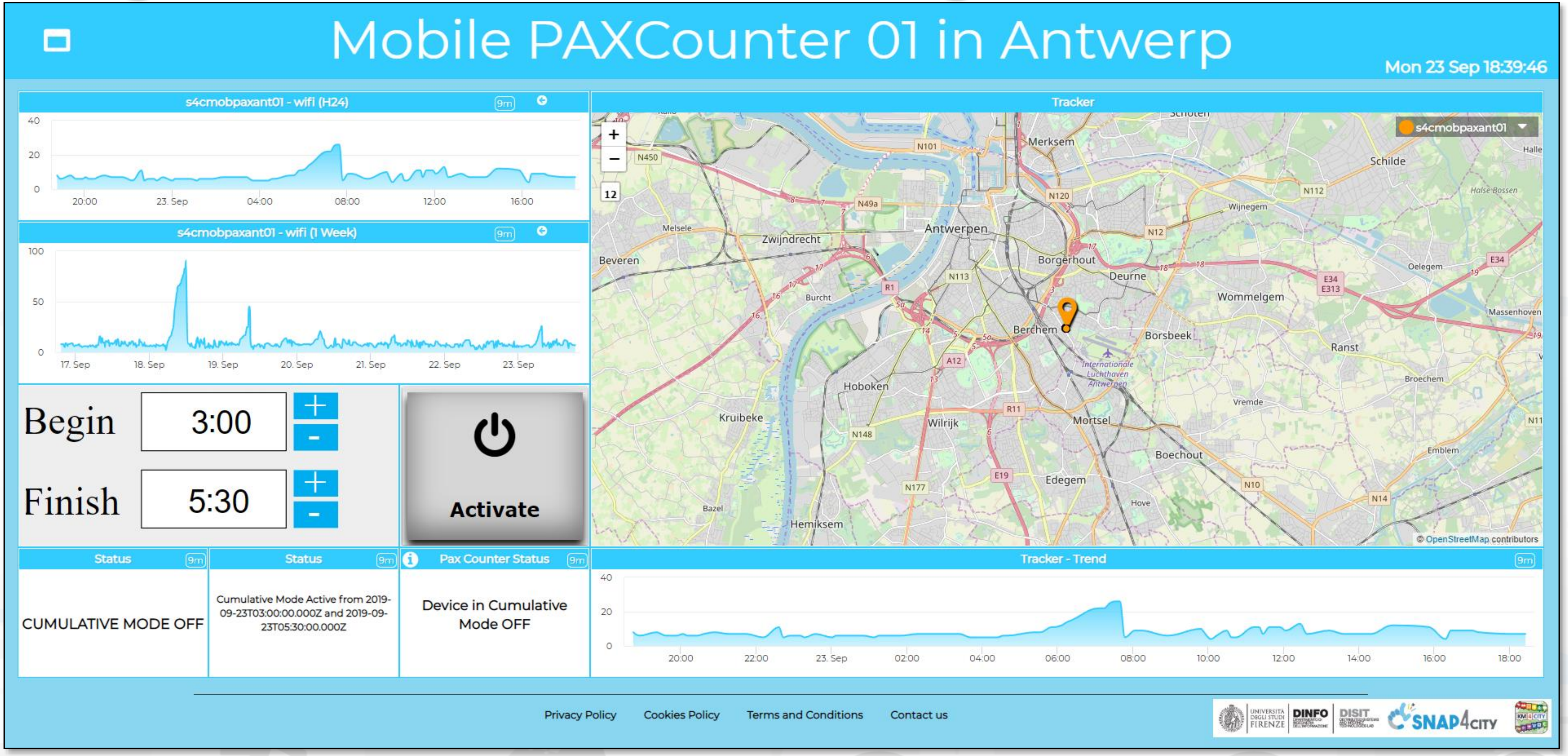
PaxCounter devices

- Fixed PaxCounter LoraWan
  – Based on Wi-Fi- Bluetooth
- Mobile PaxCounter LoraWan
  - Based on Wi-Fi- Bluetooth
- Fixed PaxCounter(LoraWan+Wifi out)
  – Based on Wi-Fi- Bluetooth

LoRa® Wi Fi Bluetooth™

https://www.snap4city.org/drupal/node/456

Programmable PAX counting



Mobile PAXCounter 01 in Antwerp

Mon 23 Sep 18:39:46

Begin 3:00

Finish 5:30

Activate

Status: CUMULATIVE MODE OFF

Status: Cumulative Mode Active from 2019-09-23T03:00:00.000Z and 2019-09-23T05:30:00.000Z

Pax Counter Status: Device in Cumulative Mode OFF

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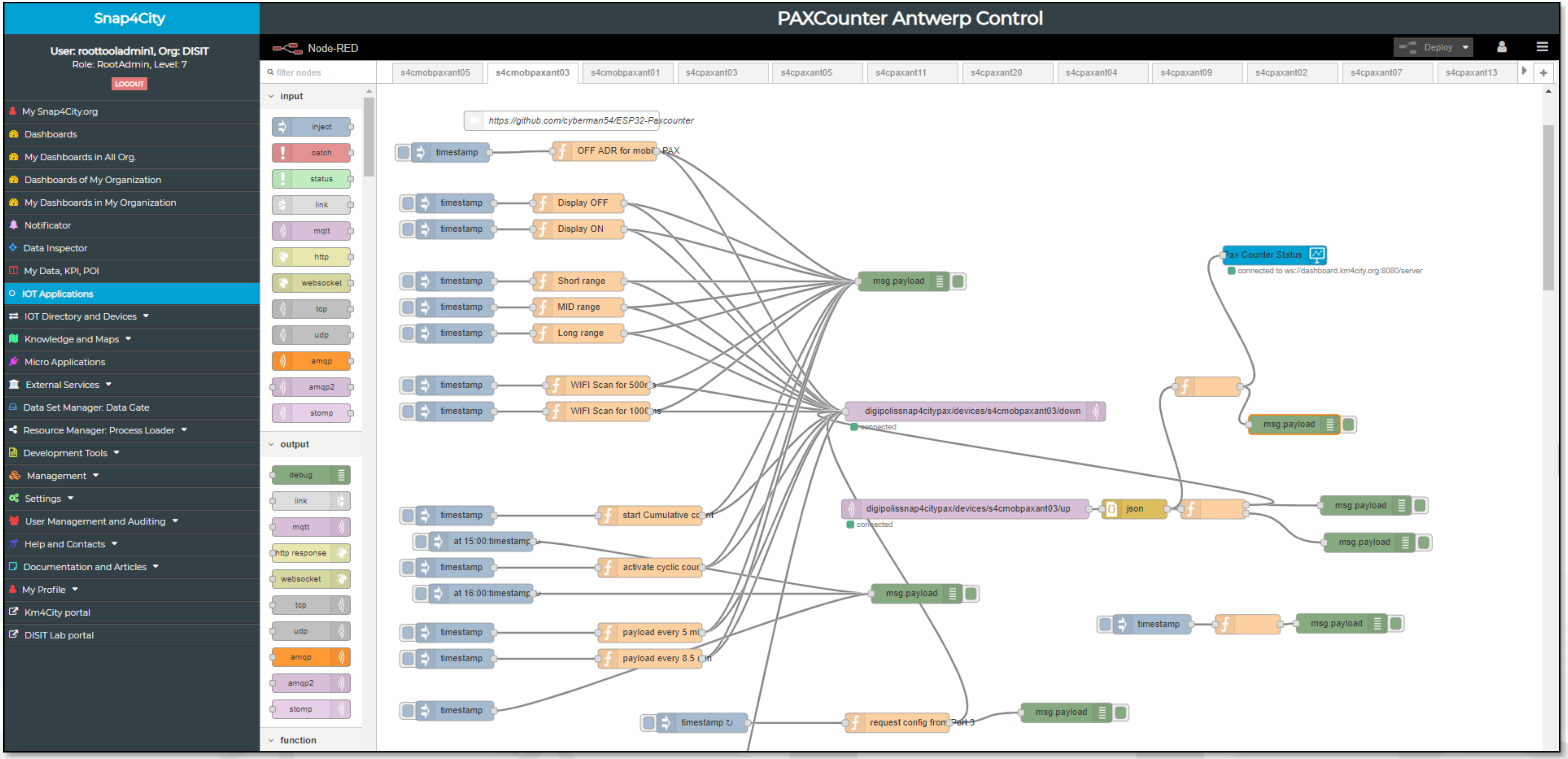
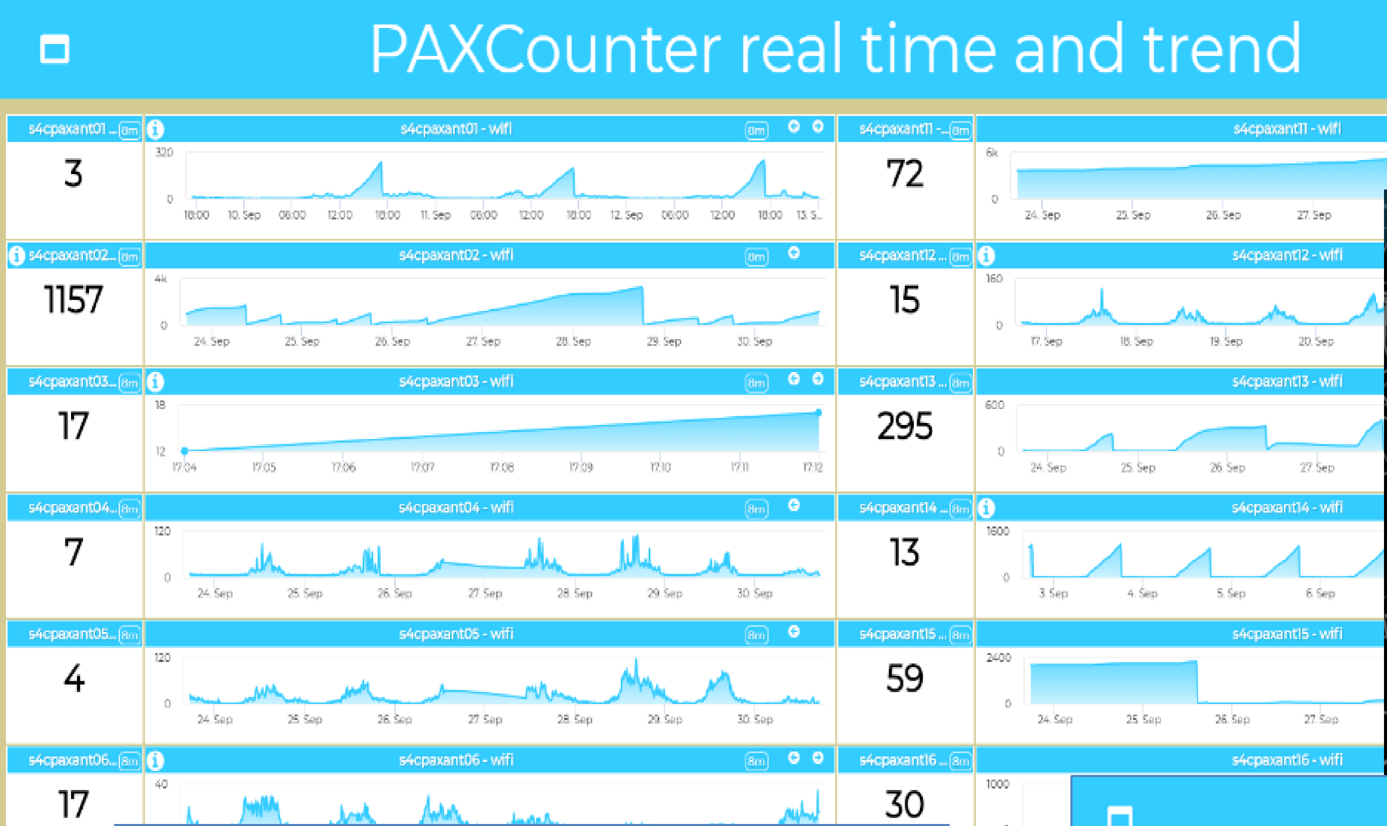
IOT App behind

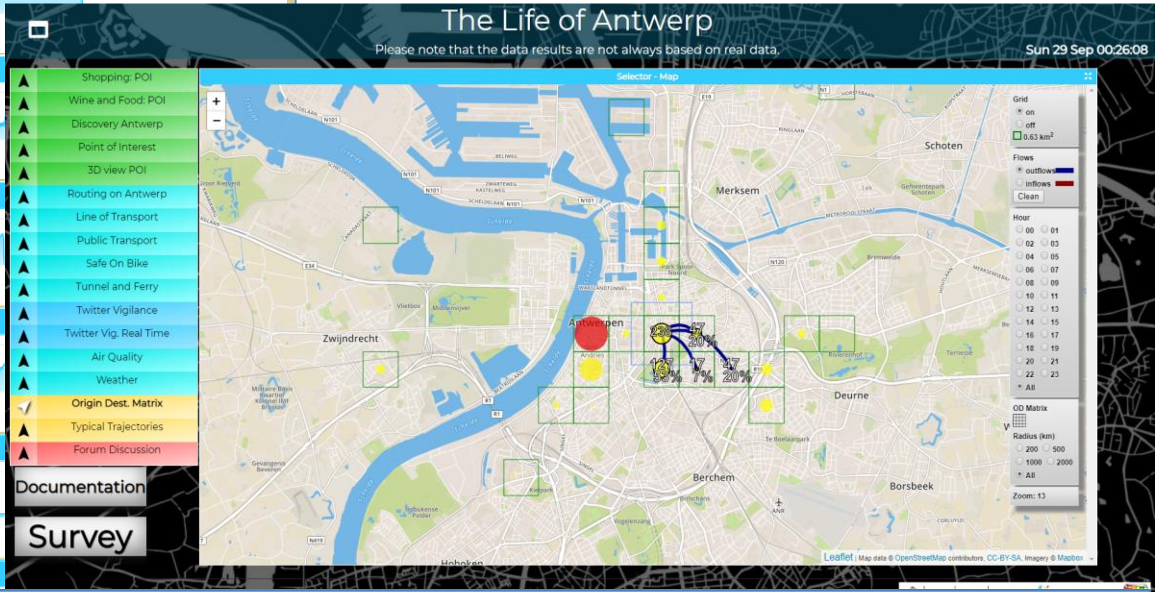




PAXCounter real time and trend

Mon 30 Sep 17:18:48

Sensor	Value	Chart
s4cpaxant01 ...	3	s4cpaxant01 - wifi
s4cpaxant02...	1157	s4cpaxant02 - wifi
s4cpaxant03...	17	s4cpaxant03 - wifi
s4cpaxant04...	7	s4cpaxant04 - wifi
s4cpaxant05...	4	s4cpaxant05 - wifi
s4cpaxant06...	17	s4cpaxant06 - wifi
s4cpaxant07...	952	
s4cpaxant11 -...	72	s4cpaxant11 - wifi
s4cpaxant12 ...	15	s4cpaxant12 - wifi
s4cpaxant13 ...	295	s4cpaxant13 - wifi
s4cpaxant14 ...	13	s4cpaxant14 - wifi
s4cpaxant15 ...	59	s4cpaxant15 - wifi
s4cpaxant16 ...	30	s4cpaxant16 - wifi



The Life of Antwerp

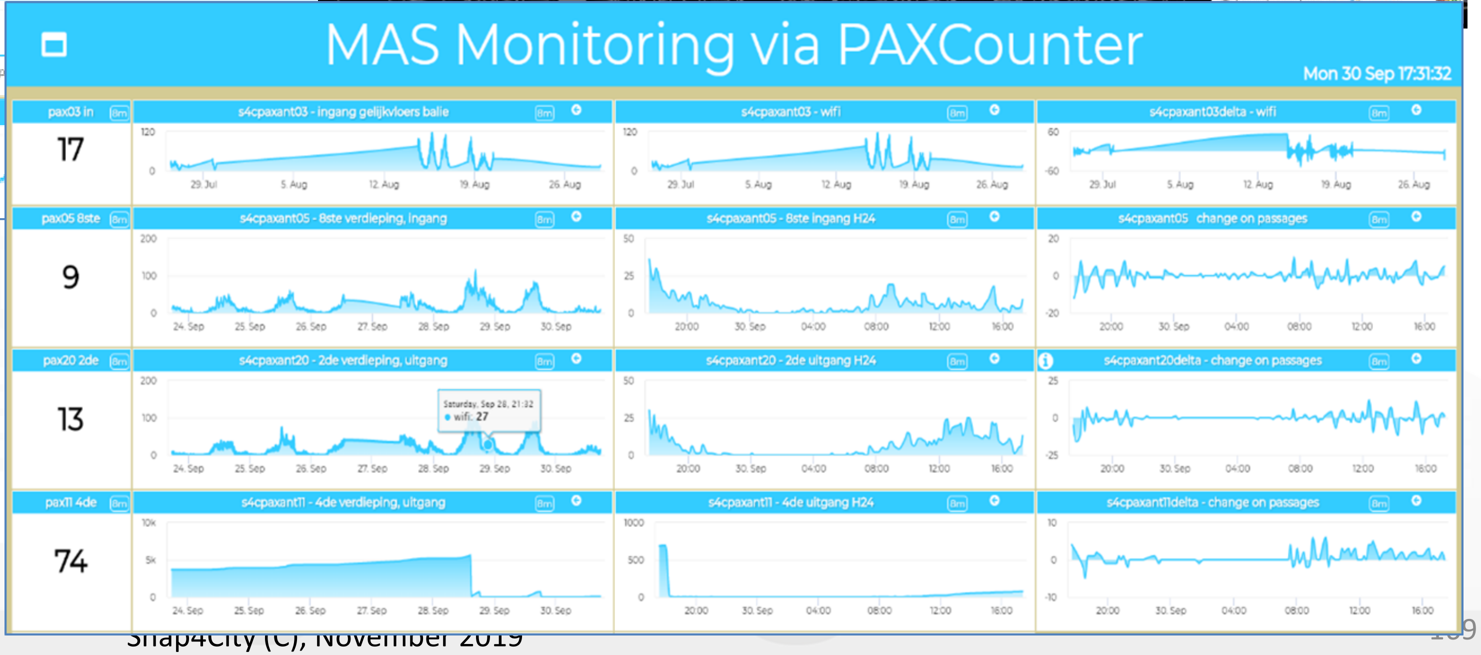
Please note that the data results are not always based on real data.

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

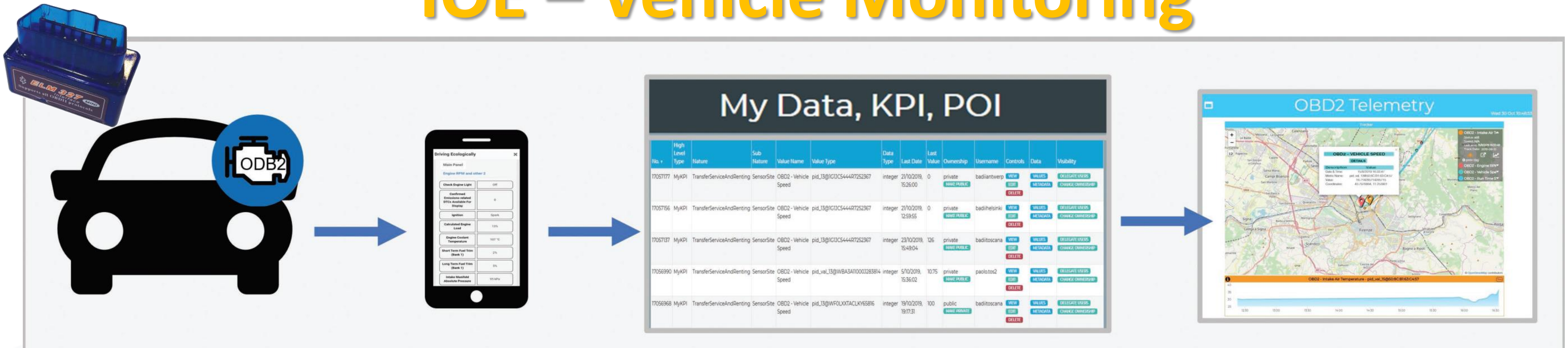


MAS Monitoring via PAXCounter

Mon 30 Sep 17:31:32

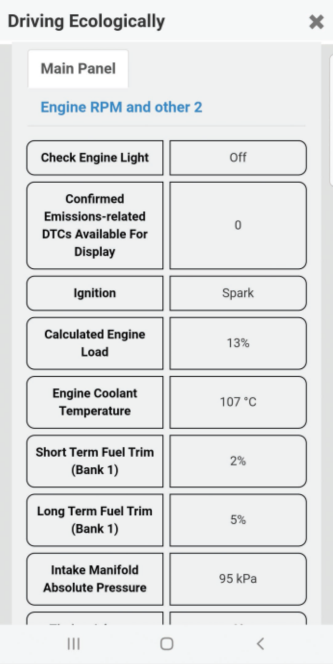
Sensor	Value	Chart	Chart	Chart
pax03 in	17	s4cpaxant03 - ingang gelijkvloers balie	s4cpaxant03 - wifi	s4cpaxant03delta - wifi
pax05 8ste	9	s4cpaxant05 - 8ste verdieping, ingang	s4cpaxant05 - 8ste ingang H24	s4cpaxant05 change on passages
pax20 2de	13	s4cpaxant20 - 2de verdieping, uitgang	s4cpaxant20 - 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



My Data, KPI, POI

No.	High Level Type	Nature	Sub Nature	Value Name	Value Type	Data Type	Last Date	Last Value	Ownership	Username	Controls	Data	Visibility
17057177	MyKPI	TransferServiceAndRenting	SensorSite	OBD2 - Vehicle Speed	pid_13@1G1JC5444R7252367	integer	21/10/2019, 15:26:00	0	private MAKE PUBLIC	badiiantwerp	VIEW EDIT DELETE	VALUES METADATA	DELEGATE USERS CHANGE OWNERSHIP
17057156	MyKPI	TransferServiceAndRenting	SensorSite	OBD2 - Vehicle Speed	pid_13@1G1JC5444R7252367	integer	21/10/2019, 12:59:55	0	private MAKE PUBLIC	badiihelsinki	VIEW EDIT DELETE	VALUES METADATA	DELEGATE USERS CHANGE OWNERSHIP
17057137	MyKPI	TransferServiceAndRenting	SensorSite	OBD2 - Vehicle Speed	pid_13@1G1JC5444R7252367	integer	23/10/2019, 15:49:04	126	private MAKE PUBLIC	badiitoscana	VIEW EDIT DELETE	VALUES METADATA	DELEGATE USERS CHANGE OWNERSHIP
17056990	MyKPI	TransferServiceAndRenting	SensorSite	OBD2 - Vehicle Speed	pid_val_13@WBA3A11000J283814	integer	5/10/2019, 15:36:02	10.75	private MAKE PUBLIC	paolo.tos2	VIEW EDIT DELETE	VALUES METADATA	DELEGATE USERS CHANGE OWNERSHIP
17056968	MyKPI	TransferServiceAndRenting	SensorSite	OBD2 - Vehicle Speed	pid_13@WF0LXXTACLKY65816	integer	19/10/2019, 19:17:31	100	public MAKE PRIVATE	badiitoscana	VIEW EDIT DELETE	VALUES METADATA	DELEGATE USERS CHANGE OWNERSHIP

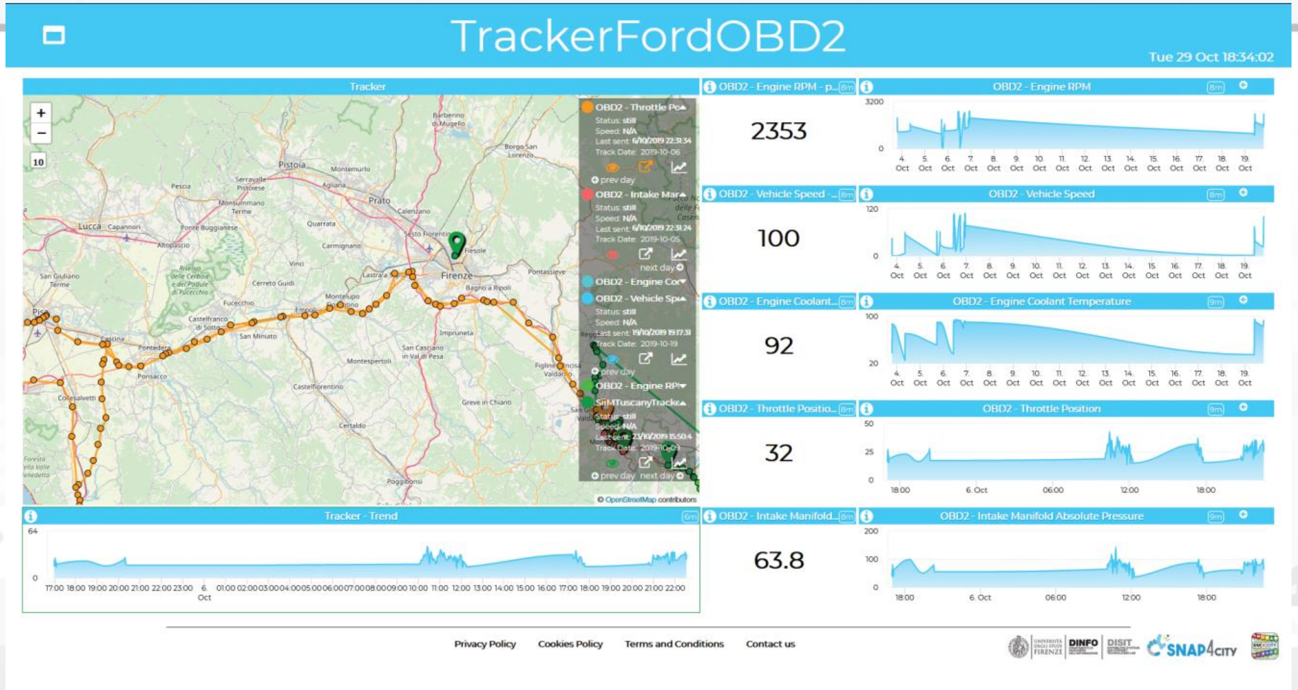


Driving Ecologically

Main Panel

Engine RPM and other 2

Check Engine Light	Off
Confirmed Emissions-related DTCs Available For Display	0
Ignition	Spark
Calculated Engine Load	13%
Engine Coolant Temperature	107 °C
Short Term Fuel Trim (Bank 1)	2%
Long Term Fuel Trim (Bank 1)	5%
Intake Manifold Absolute Pressure	95 kPa



TrackerFordOBD2

Tue 29 Oct 18:34:02

Tracker

OBD2 - Engine RPM - p... 2353

OBD2 - Vehicle Speed -... 100

OBD2 - Engine Coolant... 92

OBD2 - Throttle Positio... 32

OBD2 - Intake Manifold... 63.8

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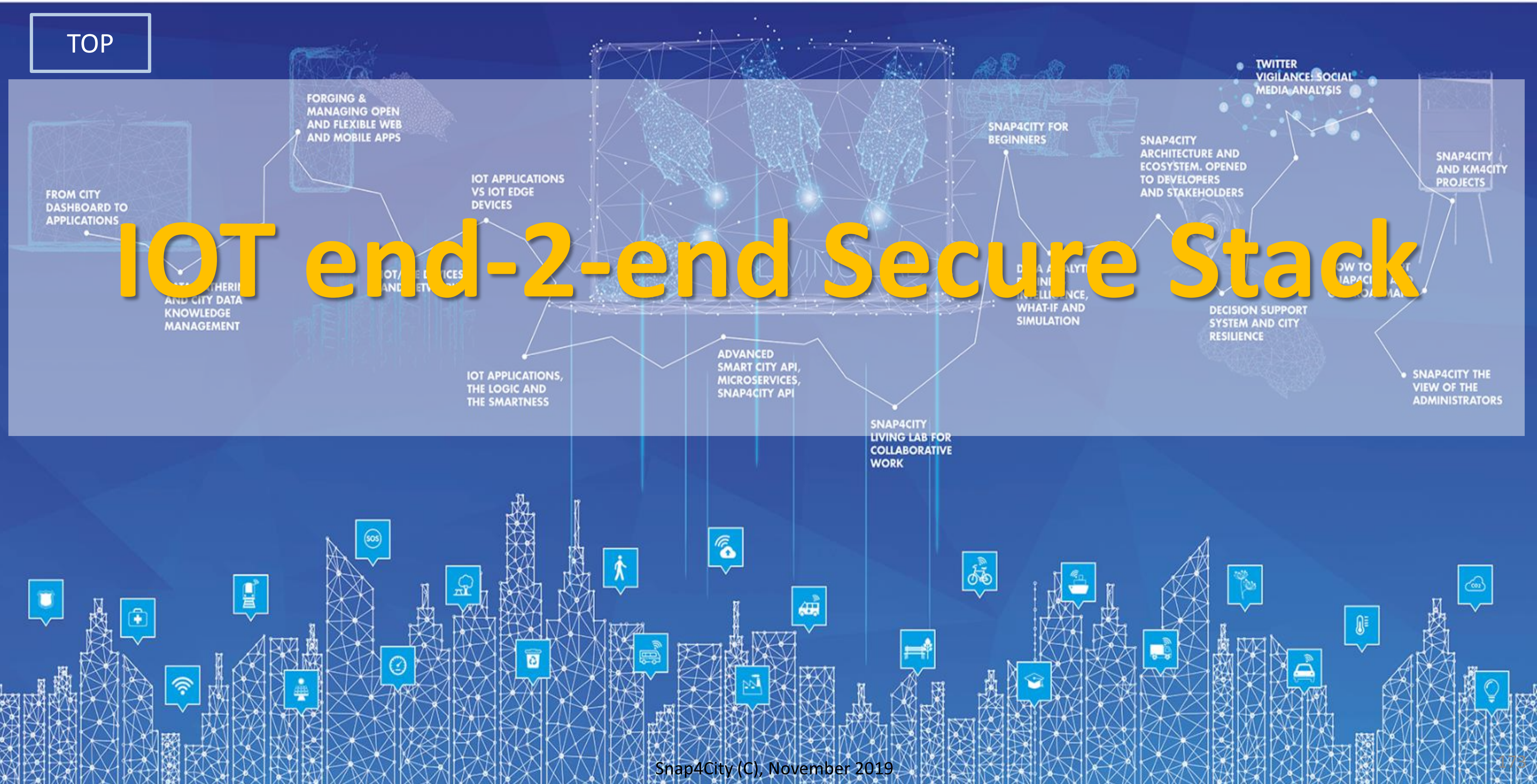
IOT Devices and IOT Edge (Self Training)

- **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**

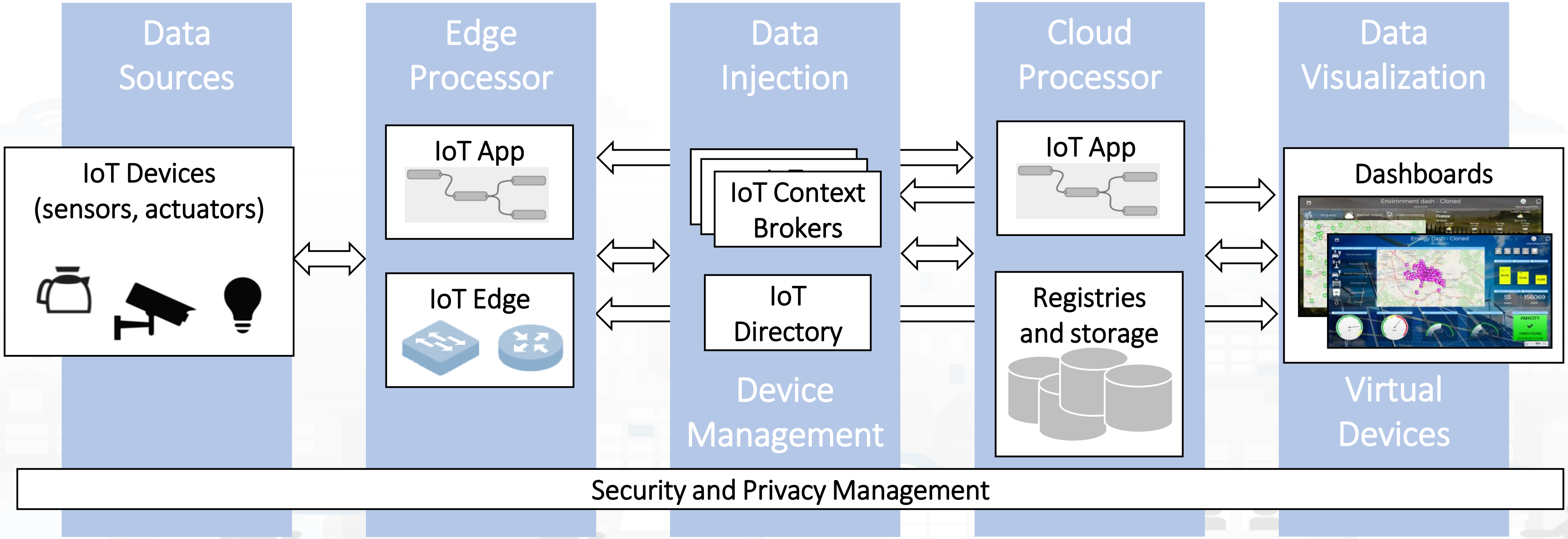
TOP

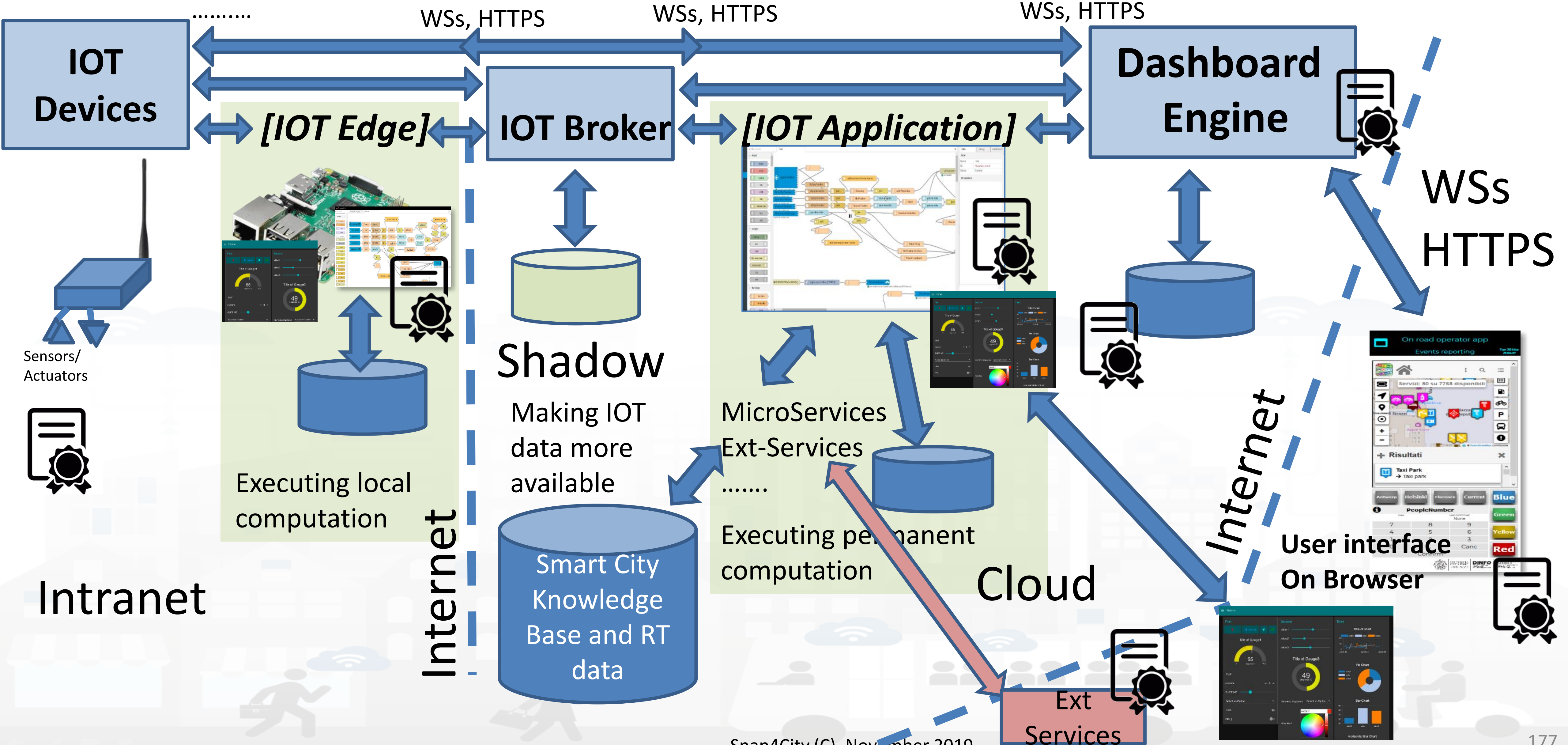
IOT end-2-end Secure Stack


FROM CITY DASHBOARD TO APPLICATIONS
FORGING & MANAGING OPEN AND FLEXIBLE WEB AND MOBILE APPS
IOT APPLICATIONS VS IOT EDGE DEVICES
SNAP4CITY FOR BEGINNERS
TWITTER VIGILANCE: SOCIAL MEDIA ANALYSIS
SNAP4CITY ARCHITECTURE AND ECOSYSTEM. OPENED TO DEVELOPERS AND STAKEHOLDERS
SNAP4CITY AND KM4CITY PROJECTS
AND CITY DATA KNOWLEDGE MANAGEMENT
WHAT-IF AND SIMULATION
DECISION SUPPORT SYSTEM AND CITY RESILIENCE
IOT APPLICATIONS, THE LOGIC AND THE SMARTNESS
ADVANCED SMART CITY API, MICROSERVICES, SNAP4CITY API
SNAP4CITY LIVING LAB FOR COLLABORATIVE WORK
SNAP4CITY THE VIEW OF THE ADMINISTRATORS

Complexity in Smart City IOT Platforms

- End to End security
  - From IOT Devices to Dashboard (user interface)





……….

WSs, HTTPS

WSs, HTTPS

WSs, HTTPS

IOT Devices

[IOT Edge]

IOT Broker

[IOT Application]

Dashboard Engine

Sensors/ Actuators

Executing local computation

Shadow

Making IOT data more available

Smart City Knowledge Base and RT data

MicroServices
Ext-Services
…….

Executing permanent computation

WSs HTTPS

Internet

Internet

Intranet

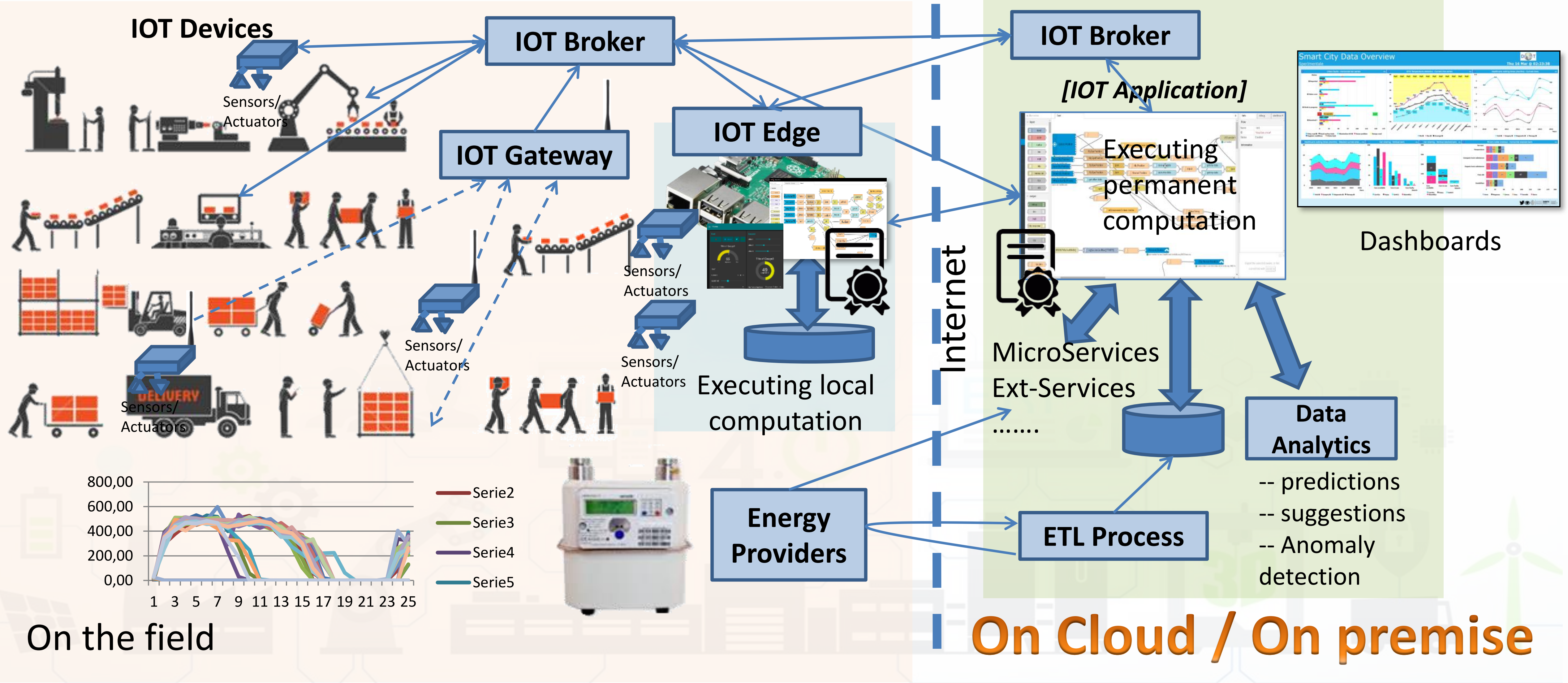
Cloud

User interface On Browser

Ext Services

Industry 4.0 Application

SNAP4APPLIANCE
Virtual Machines ready to use for Smart City and IOT Applications
DOWNLOAD



IOT Devices

IOT Broker

IOT Gateway

IOT Edge

Executing local computation

Internet

IOT Broker

[IOT Application]

Executing permanent computation

Dashboards

MicroServices
Ext-Services
…….

Data Analytics
-- predictions
-- suggestions
-- Anomaly detection

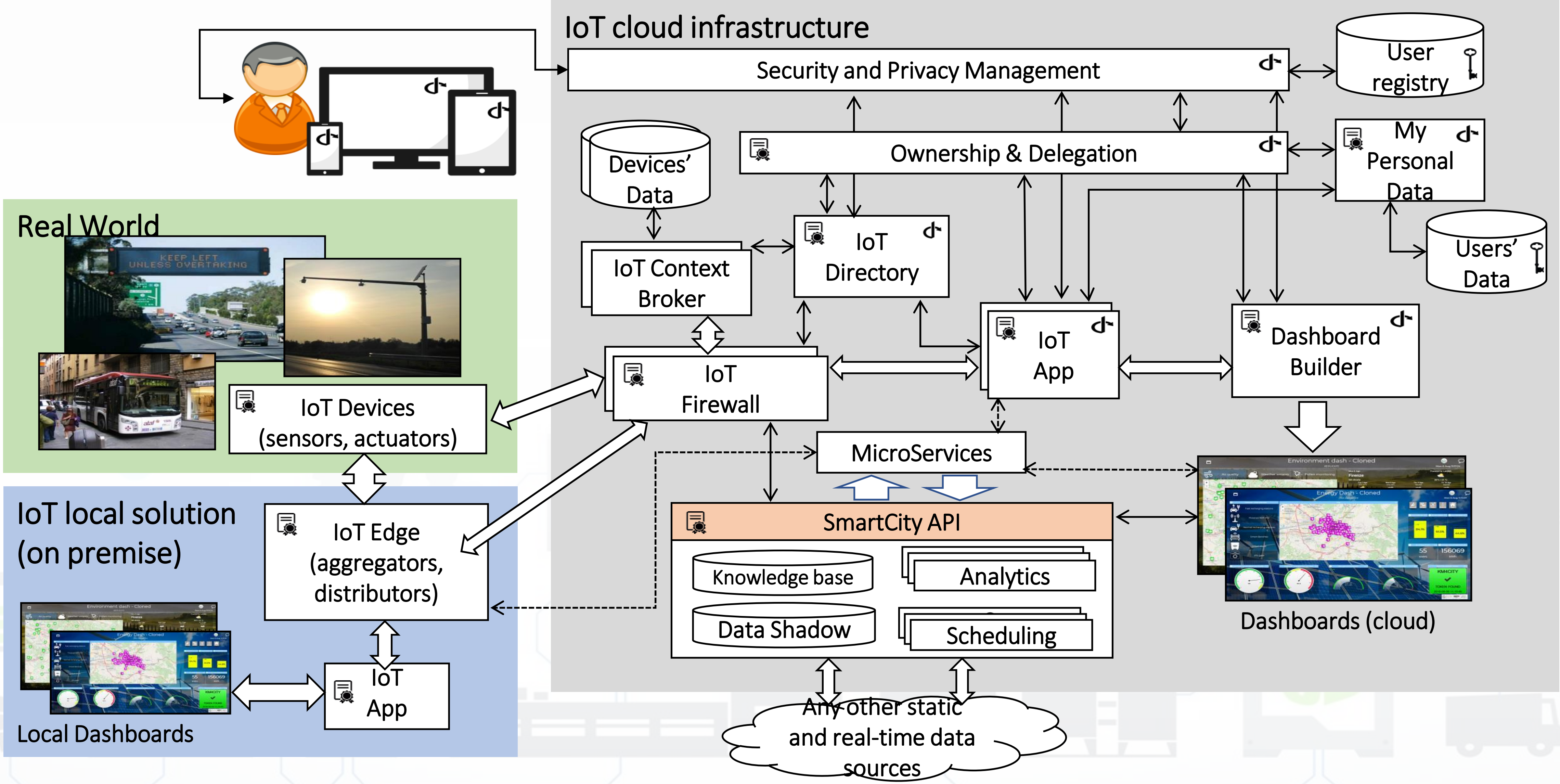
Energy Providers

ETL Process

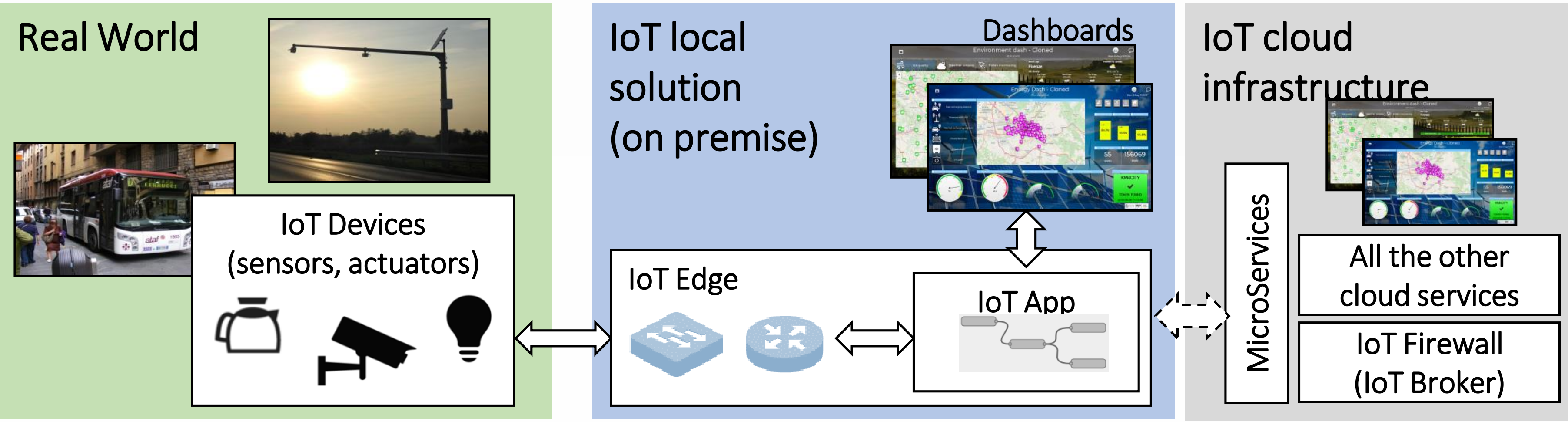
On the field

On Cloud / On premise

Secure Architecture



OnPremise vs Cloud



Real World

IoT Devices
(sensors, actuators)

IoT local
solution
(on premise)

Dashboards

IoT Edge

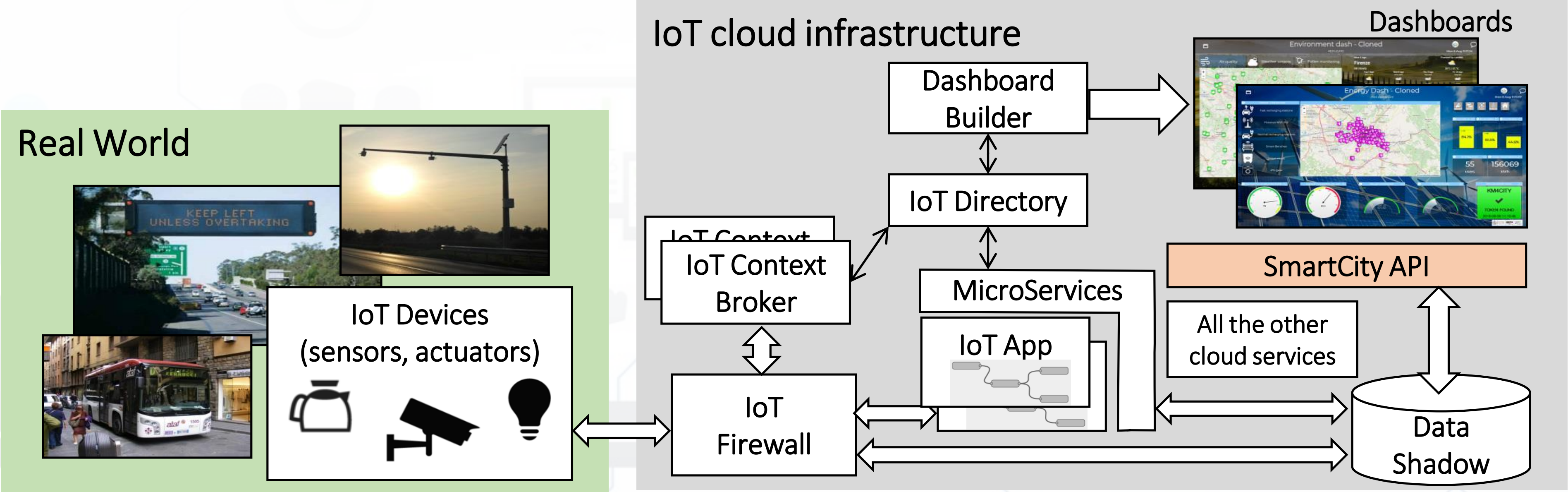
IoT App

IoT cloud
infrastructure

MicroServices

All the other
cloud services

IoT Firewall
(IoT Broker)



IoT cloud infrastructure

Dashboards

Dashboard
Builder

IoT Directory

IoT Context
Broker

MicroServices

IoT App

SmartCity API

All the other
cloud services

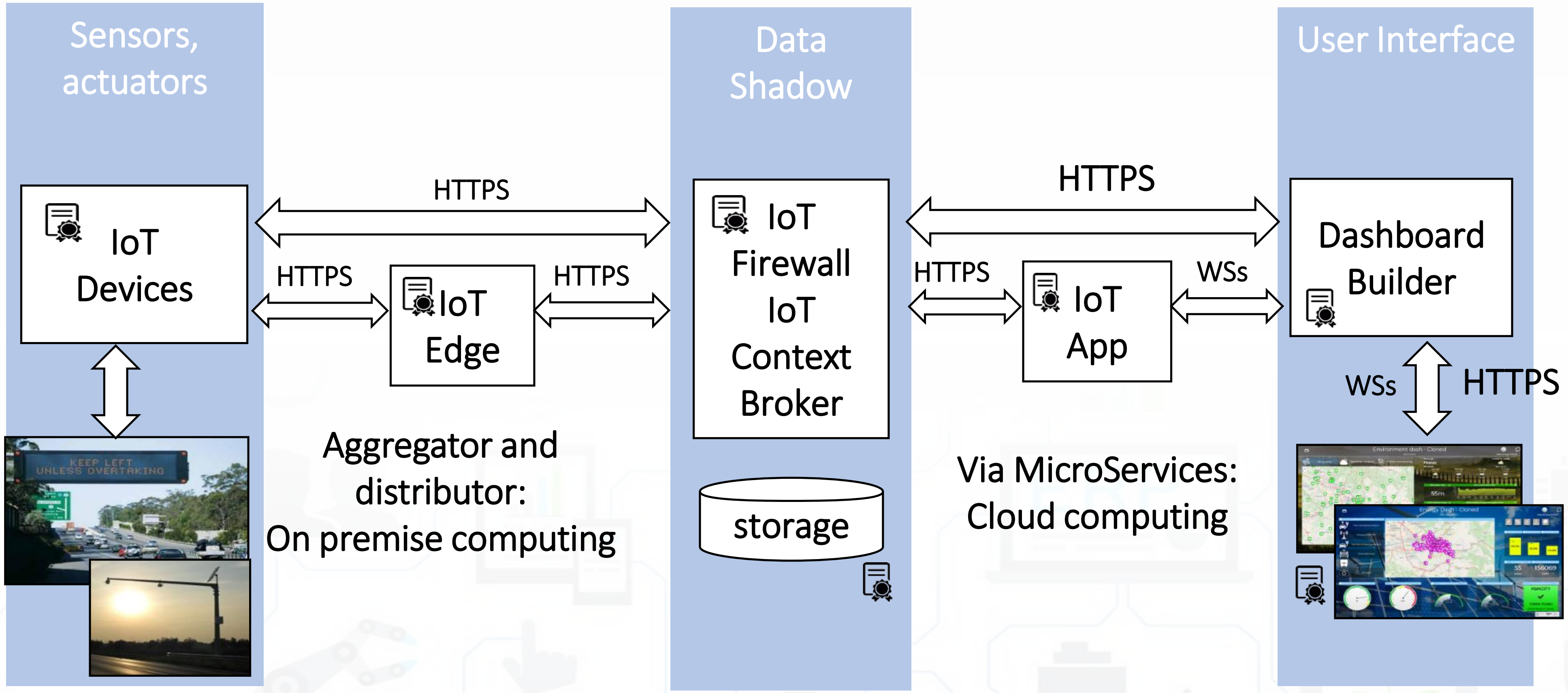
Real World

IoT Devices
(sensors, actuators)

IoT
Firewall

Data
Shadow

The secure stack



Sensors, actuators

IoT Devices

Data Shadow

IoT Firewall IoT Context Broker

storage

User Interface

Dashboard Builder

HTTPS

HTTPS

IoT Edge

HTTPS

Aggregator and distributor: On premise computing

HTTPS

HTTPS

IoT App

WSs

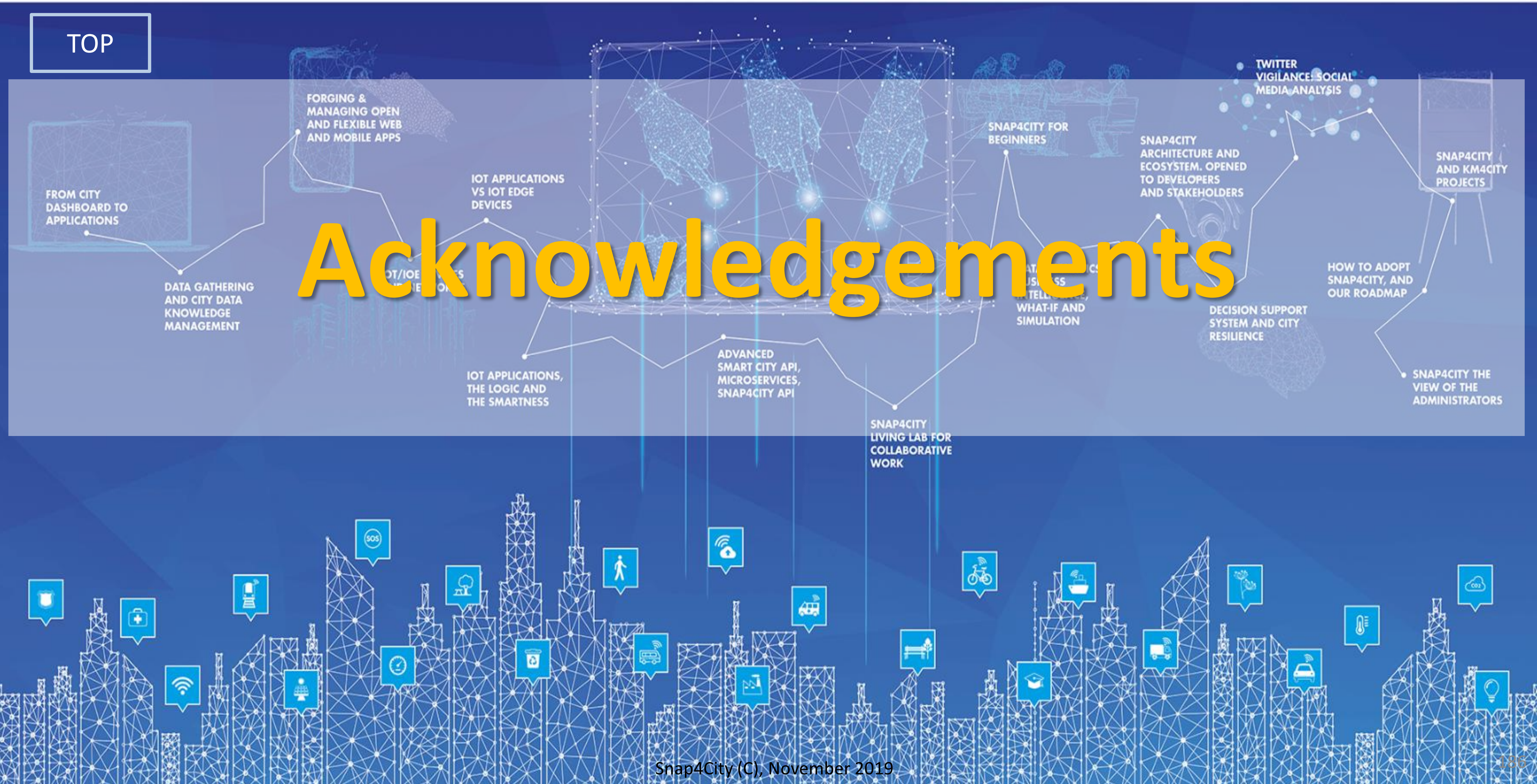
Via MicroServices: Cloud computing

WSs

HTTPS

TOP

Acknowledgements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Acknowledgements

- Thanks to the European Commission for founding. All slides reporting logo of **Snap4City** https://www.snap4city.org **of Select4Cities H2020** are representing tools and research founded by European Commission for the **Select4Cities** project. **Select4Cities** has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation Programme (grant agreement n° 688196)
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- **Km4City** *is an open technology and research line of DISIT Lab exploited by a number of projects. Some of the innovative solutions and research issues developed into projects are also compliant and contributing to the Km4City approach and thus are released as open sources and are interoperable, scalable, modular, standard compliant, etc.*

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INEA CEF-TELECOM Project
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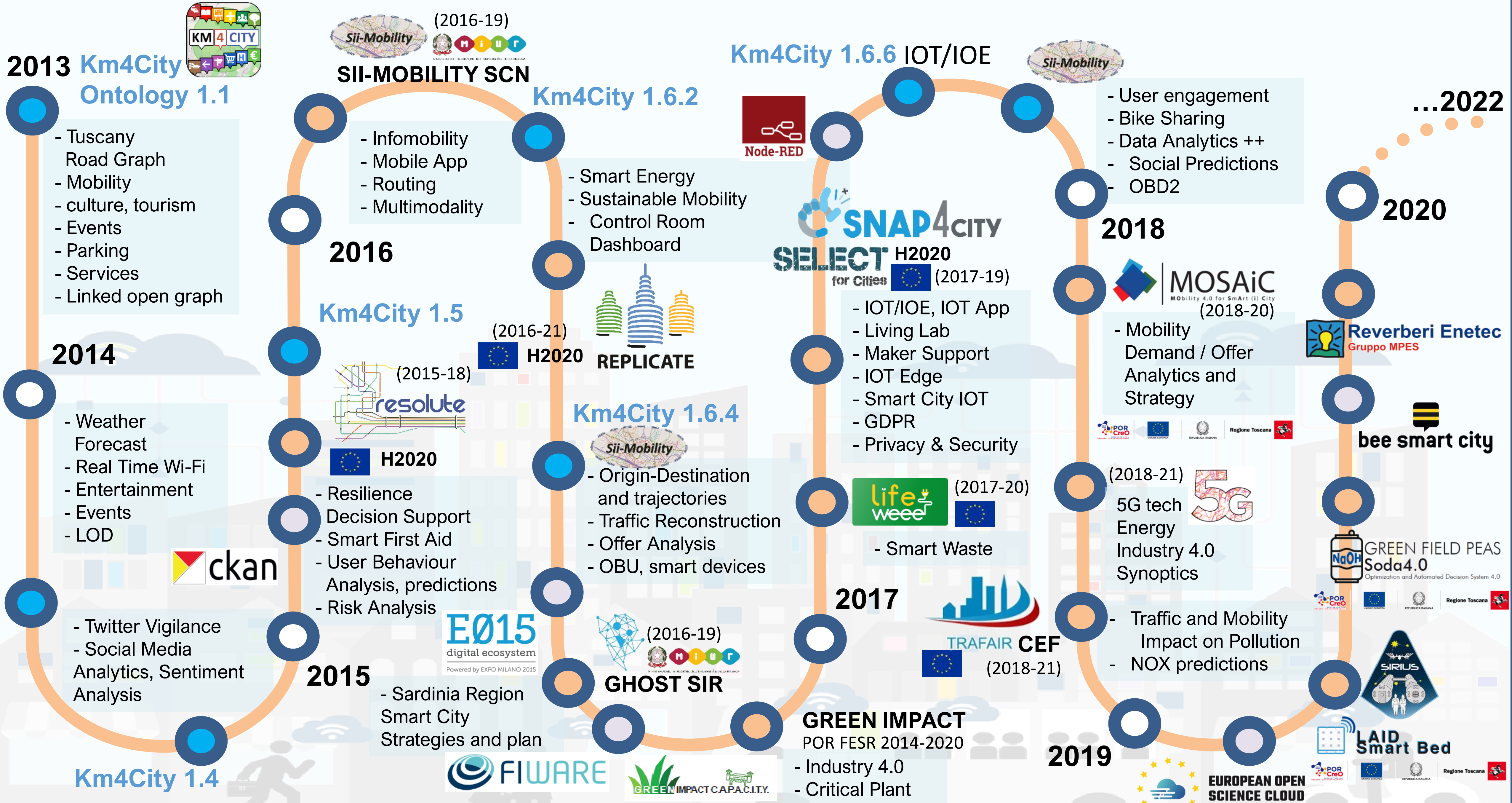
DISIT lab roadmap vs model and tools' usage



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
- Events
- LOD

ckan

- Twitter Vigilance
- Social Media Analytics, Sentiment Analysis

Km4City 1.4

2015

- Sardinia Region Smart City Strategies and plan

E015 digital ecosystem
Powered by EXPO MILANO 2015

FIWARE

GREEN IMPACT CAPACITY

Km4City 1.5

resolute (2015-18)
H2020

- Resilience Decision Support
- Smart First Aid
- User Behaviour Analysis, predictions
- Risk Analysis

2016

Sii-Mobility (2016-19)
SII-MOBILITY SCN

- Infomobility
- Mobile App
- Routing
- Multimodality

Km4City 1.6.2

- Smart Energy
- Sustainable Mobility
- Control Room Dashboard

(2016-21)
H2020 REPLICATE

Km4City 1.6.4

Sii-Mobility

- Origin-Destination and trajectories
- Traffic Reconstruction
- Offer Analysis
- OBU, smart devices

(2016-19)
GHOST SIR

GREEN IMPACT
POR FESR 2014-2020

- Industry 4.0
- Critical Plant
- Monitoring

2017

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

life weee (2017-20)

- Smart Waste

TRAFAIR CEF (2018-21)

Km4City 1.6.6 IOT/IOE

Sii-Mobility

- User engagement
- Bike Sharing
- Data Analytics ++
- Social Predictions
- OBD2

2018

MOSAiC Mobility 4.0 for SmArt (i) City (2018-20)

- Mobility Demand / Offer Analytics and Strategy

POR CreO · Regione Toscana

(2018-21)
5G tech
Energy
Industry 4.0
Synoptics

- Traffic and Mobility Impact on Pollution
- NOX predictions

2019

EUROPEAN OPEN SCIENCE CLOUD

2020

…2022

Reverberi Enetec
Gruppo MPES

bee smart city

GREEN FIELD PEAS
Soda4.0
Optimization and Automated Decision System 4.0

POR CreO · Regione Toscana

SIRIUS

LAID Smart Bed

POR CreO · Regione Toscana

TOP

SNAP4CITY

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CONTACT

DISIT Lab, DINFO: Department of Information Engineering
Università degli Studi di Firenze - School of Engineering

Via S. Marta, 3 - 50139 Firenze, ITALY
https://www.disit.org

www.snap4city.org

Email: snap4city@disit.org

Office: +39-055-2758-515 / 517
Cell: +39-335-566-86-74
Fax.: +39-055-2758570

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