100% OPEN SOURCE

EU GDPR COMPLIANT

PEN Test Passed

Powered by FIWARE

SNAP4CITY on EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE

Node-RED

SNAP4CITY

KM4CITY

SNAP4 Appliances and Dockers Installations



Be smart in a SNAP!

LIVING LAB

July 2022
Overview Platform

A Framework for rapid implementation of
- Sustainable Smart Solutions
- Decision Support Systems
as a no-coding, low-coding



SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DEPARTMENT OF INFORMATION ENGINEERING | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

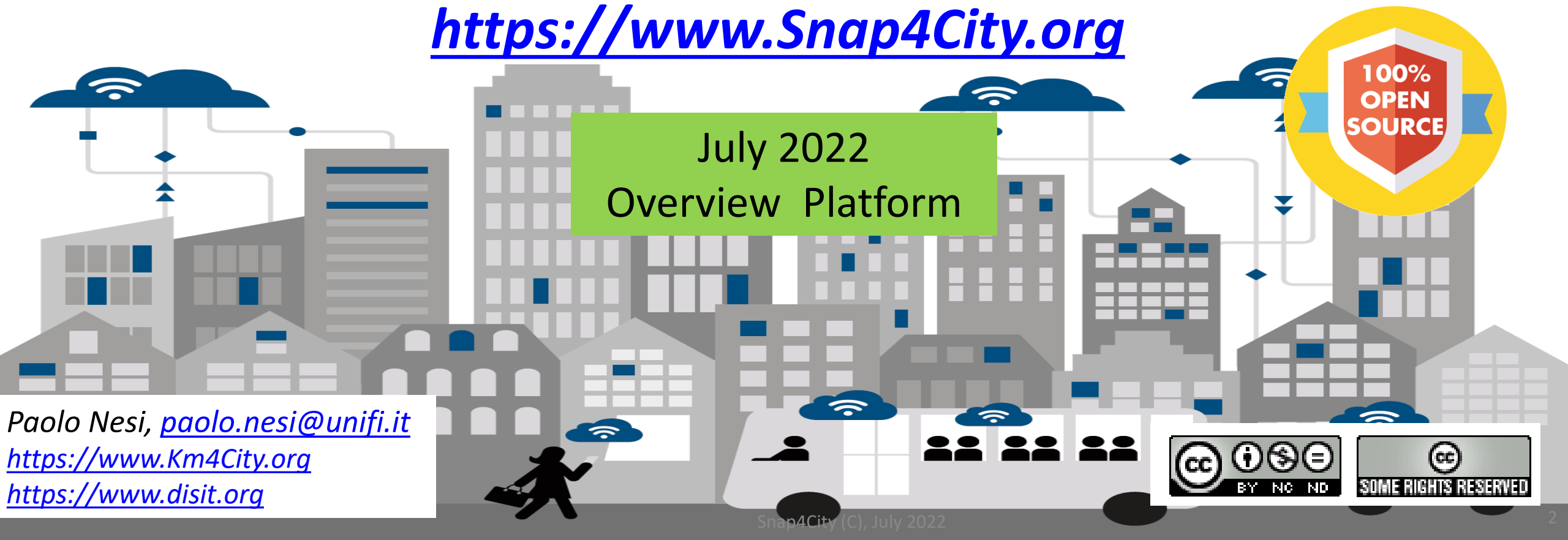
UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

SNAP4CITY

Powered by KM4CITY

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

https://www.Snap4City.org



July 2022
Overview Platform

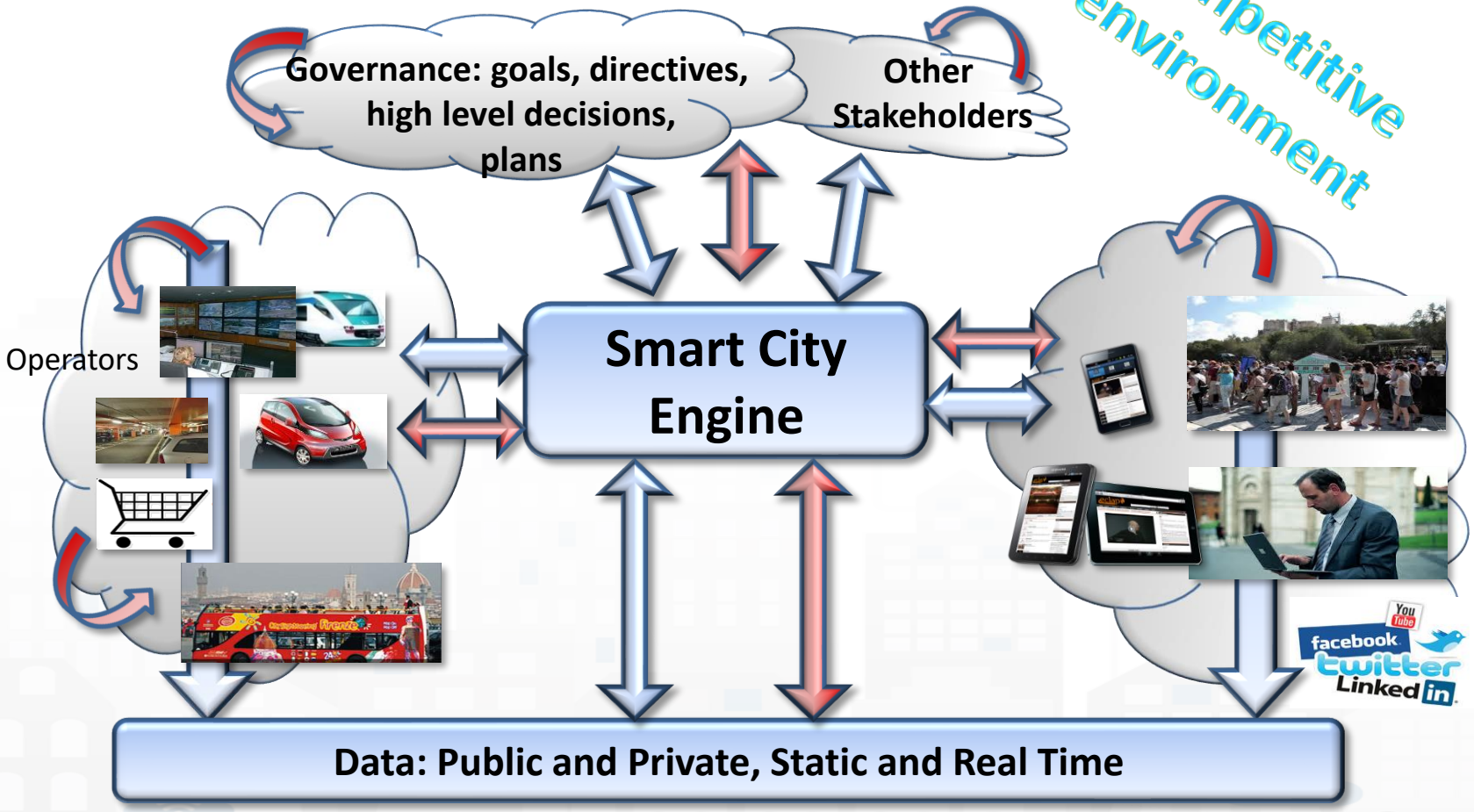
Paolo Nesi, paolo.nesi@unifi.it
https://www.Km4City.org
https://www.disit.org

BY NC ND
SOME RIGHTS RESERVED


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

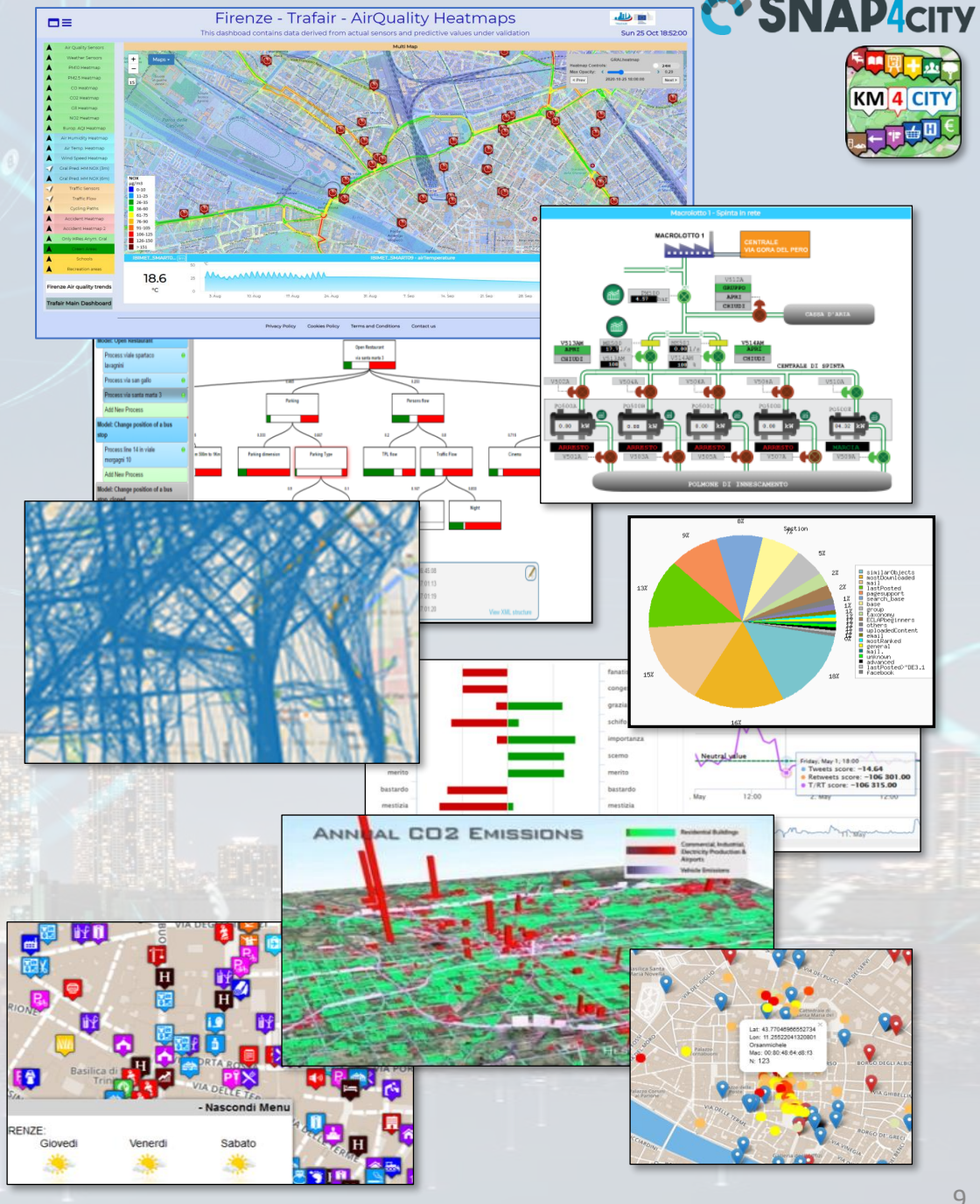
From Strategies to (re-)Actions

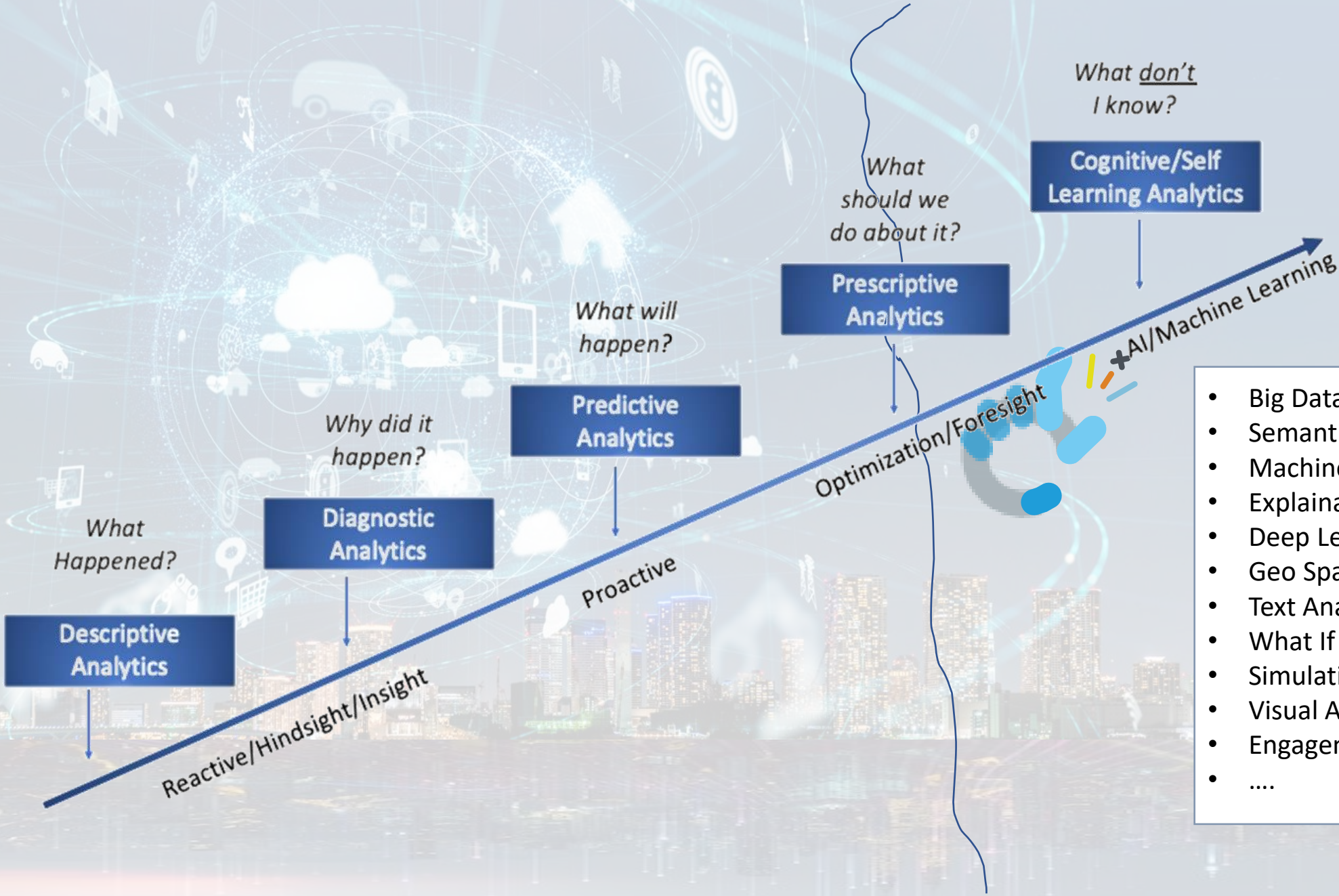
- Analyze
- Alerting, Early Warning
- Support Decision makers
- Plans
- Prescriptions
- Inform
- Suggest
- Engage
- Research



Data Driven Decision Support

- Decision Support system
- Assessment / Strategies
- Data Rendering, visual analytics
- Data Processing
- Data aggregation, Storage, indexing
- Data Ingestion



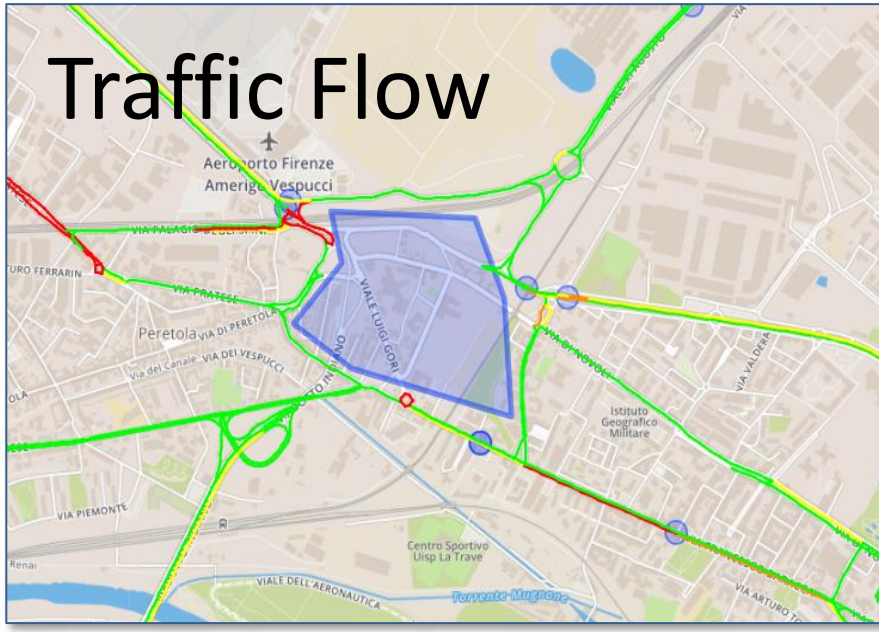


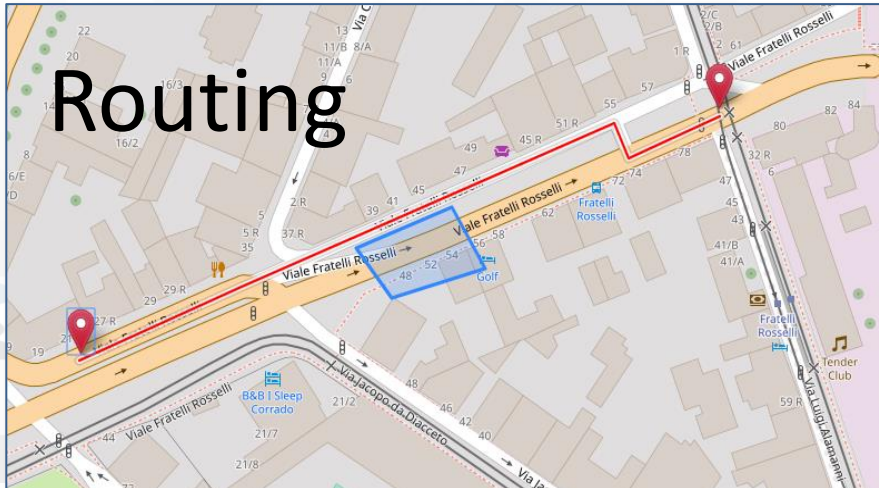
Sentient and active processes

- Big Data Analytics
- Semantic Computing
- Machine Learning
- Explainable Artificial Intelligence
- Deep Learning
- Geo Spatial Reasoning
- Text Analysis, Sentiment Analysis
- What If Analysis
- Simulations
- Visual Analytics
- Engagement Analysis
- ….

Decision Support Systems, What-if

- **Event planning, via what-if analysis**
  - Change in the graph structure of the city
  - Impact on the flow of people and vehicles
  - Adaptation: public transport, traffic, pedestrian management, etc.
- **Immediate reaction to natural events or not**
  - Everything is ready and updated in real time
  - Each view is contextualized in terms of data: descriptive and prescriptive
- **Digital Twin**
  - More detail in the context integrated data
  - Greater realism in deductions and representations
  - Less fragmentation and non-uniformity in the views to support decisions





SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

TOP



100% OPEN SOURCE

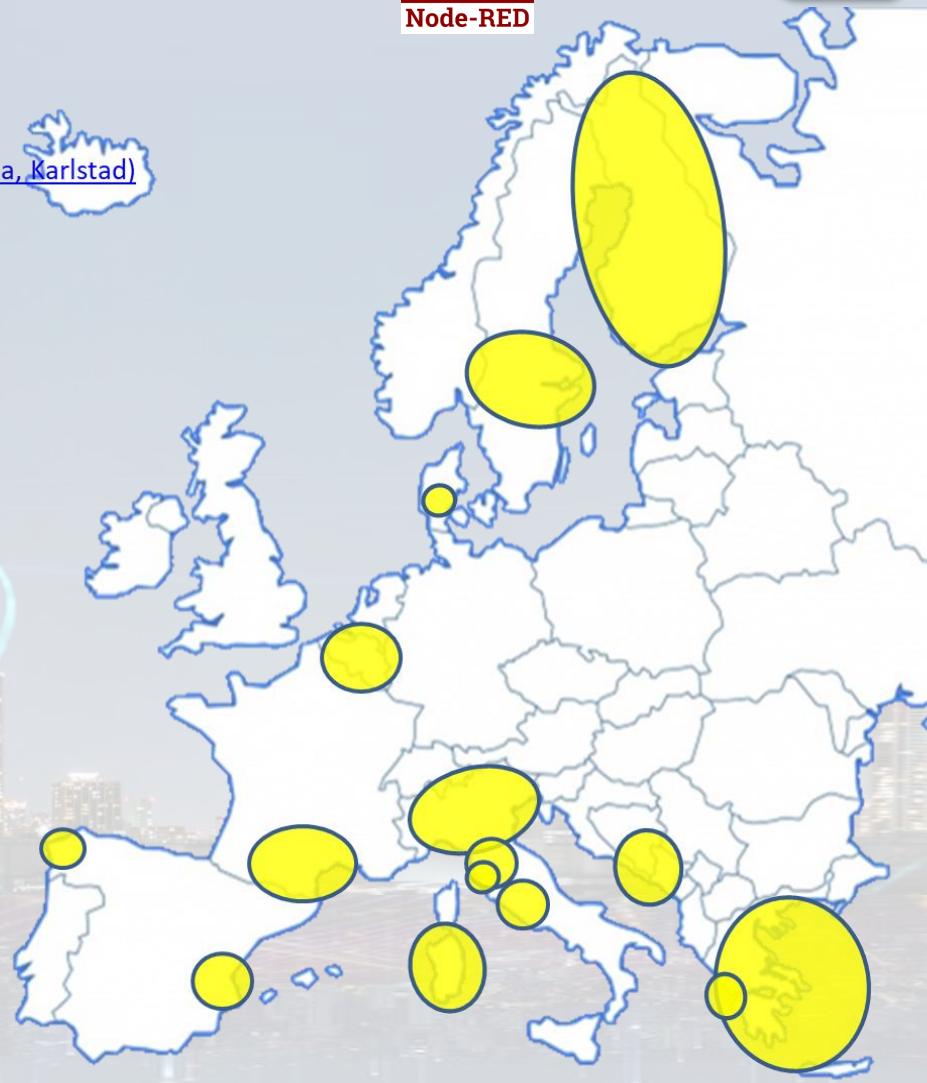
SNAP4 Appliances and Dockers **Installations**

https://www.Snap4City.org

- > 7 running installations
  - Toscana, Pisa, Sweden, ISPRA, Snap4.eu,
  - Altair, Italmatic, ….
- 13 projects, 12 pilots on 10 Countries
  - >40 cities/area
- **Wide MULTI-tenant deploy, e.g.,**
  - 18 Organizations / tenant
  - > 7400 users on
  - > 1400 Dashboards
  - > 16 mobile Apps
  - **> 2 Million of structured data per day**
  - > 520 IoT Applications/node-RED
  - > 700 web pages with training
  - > 60 videos, training videos

Main Organizations/areas

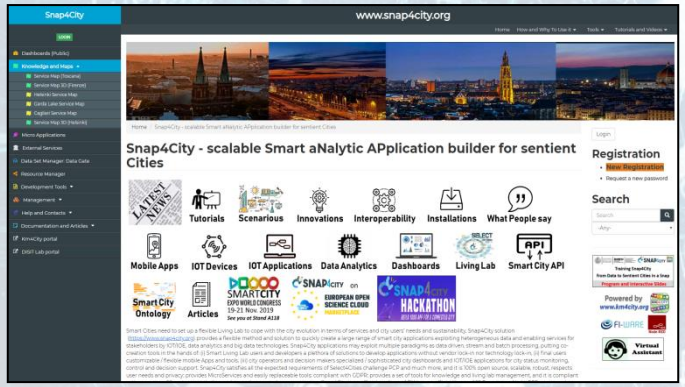
- Antwerp area (Be)
- Bologna (I)
- Capelon (Sweden: Västerås, Eskilstuna, Karlstad)
- DISIT demo (multiple)
- Dubrovnik, Croatia
- Firenze area (I)
- Garda Lake area (I)
- Greece (Gr)
- Helsinki area (Fin)
- Livorno area (I)
- Lonato del Garda (I)
- Modena (I)
- Mostar, Bosnia-Herzegovina
- Oslo & Padova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



- **Trials in Israel, Brasile, Australia, India, etc……**

How to adopt Snap4City

Https://www.snap4city.org



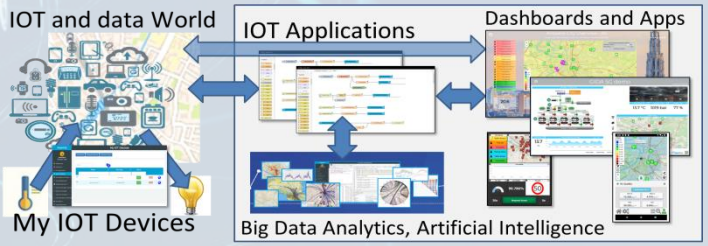
Smart City as a Service

- Supporting Org
- 100% Open Source Platform: Github
- Further developments
- Publishing Appliances and Dockers
- Training courses, docs
- Consulting
- Forums
- Etc.

SNAP4CITY on EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE

Download and deploy

On your premise





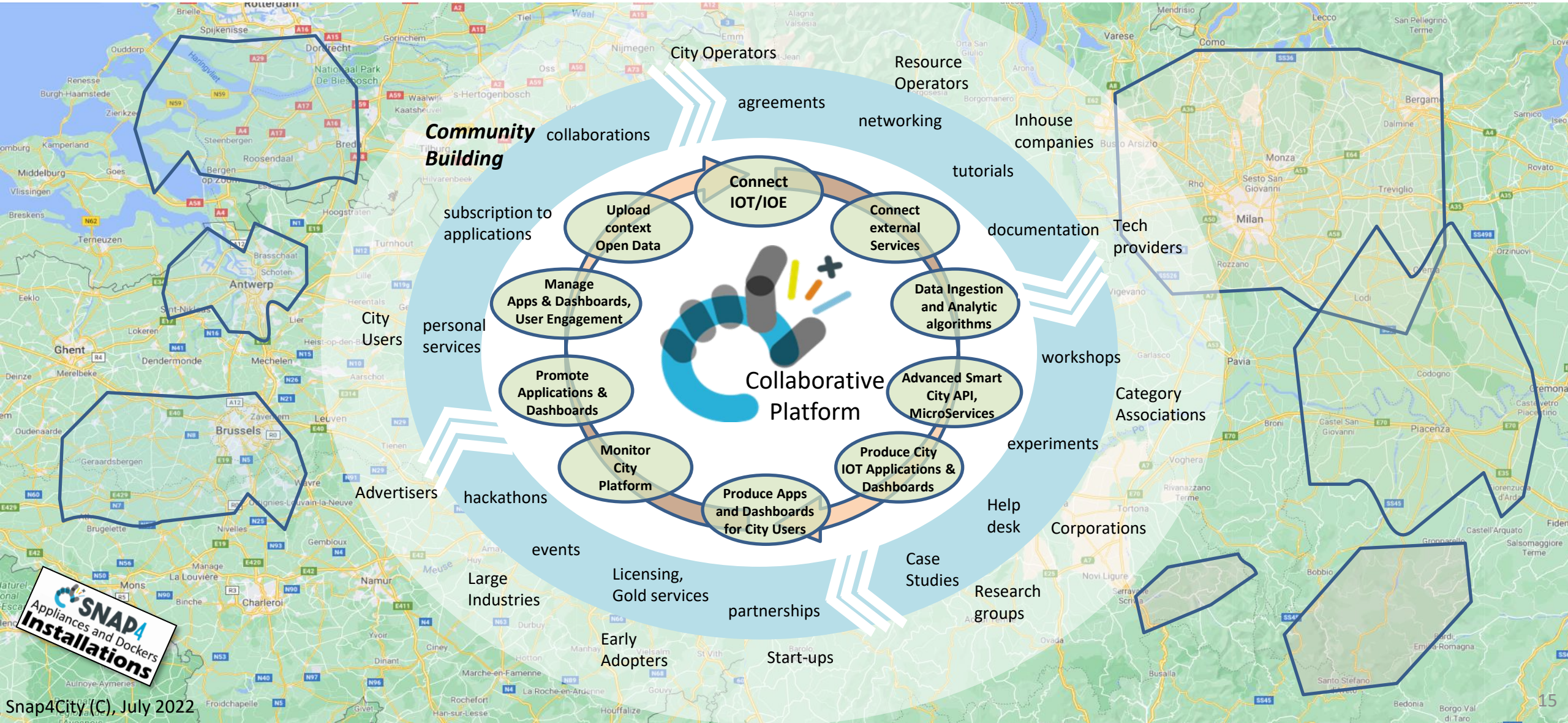
Installation on your premise

- **Virtual Machines or Dockers**
- Different configurations
  - From small to scalable
  - Exploiting your legacy tools
  - Interoperable with any tool
- No vendor lock-in, No tech lock-in

Mixed solutions! For example:

- Start on Cloud as Smart City as a Service
  - Migrate on premise on the fly
- Start on Cloud into a sand box
  - Pass to install on premise what you need

One Snap4City Platform may serve Multiple Cities



SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

TOP

FROM CITY DASHBOARD TO APPLICATIONS

DATA GATHERING AND CITY DATA KNOWLEDGE MANAGEMENT

FORGING & MANAGING OPEN AND FLEXIBLE WEB AND MOBILE APPS

IOT/IOE DEVICES AND NETWORKS

IOT APPLICATIONS VS IOT EDGE DEVICES

IOT APPLICATIONS, THE LOGIC AND THE SMARTNESS

ADVANCED SMART CITY API, MICROSERVICES, SNAP4CITY API

SNAP4CITY LIVING LAB FOR COLLABORATIVE WORK

SNAP4CITY FOR BEGINNERS

DATA ANALYTICS, BUSINESS INTELLIGENCE, WHAT-IF AND SIMULATION

SNAP4CITY ARCHITECTURE AND ECOSYSTEM. OPENED TO DEVELOPERS AND STAKEHOLDERS

DECISION SUPPORT SYSTEM AND CITY RESILIENCE

TWITTER VIGILANCE: SOCIAL MEDIA ANALYSIS

HOW TO ADOPT SNAP4CITY, AND OUR ROADMAP

SNAP4CITY AND KM4CITY PROJECTS

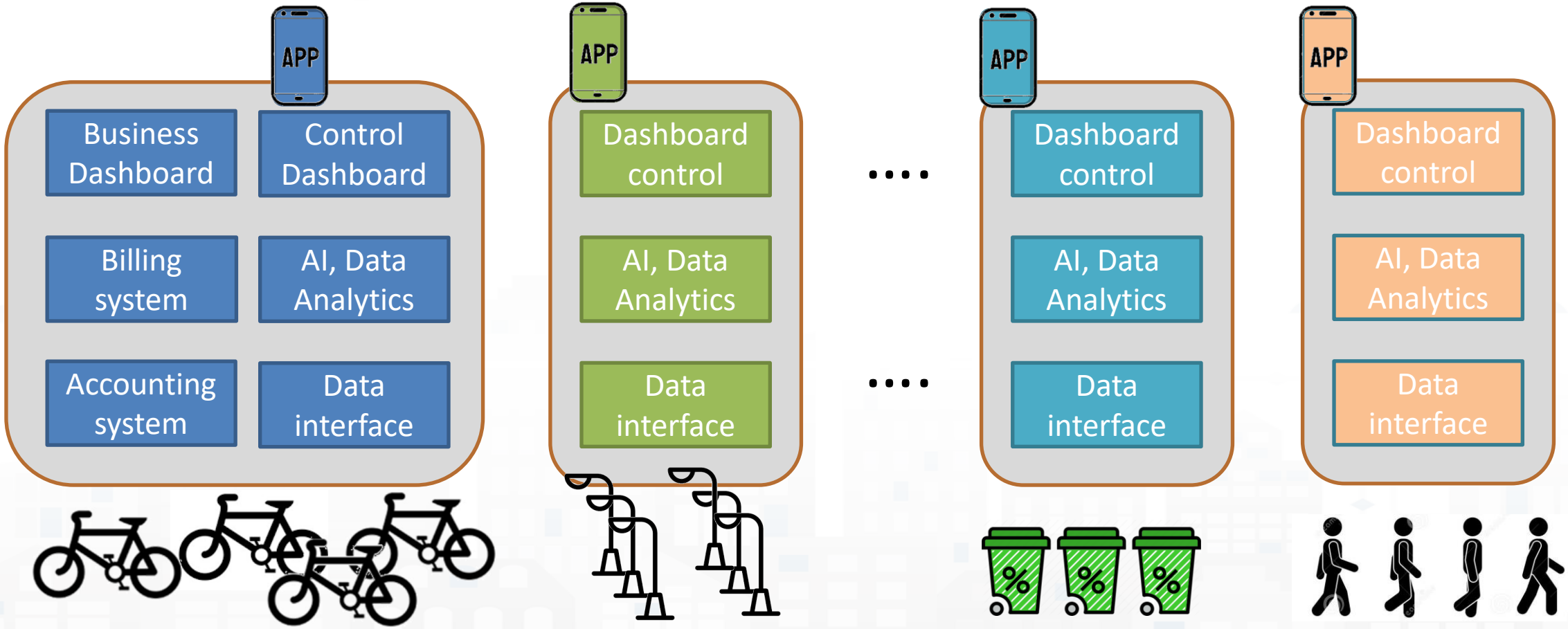
SNAP4CITY THE VIEW OF THE ADMINISTRATORS

how

100% OPEN SOURCE

SNAP4 Appliances and Dockers **Installations**

Avoiding to have a collection of verticals



Simplifying the development and integration of verticals

Tools for rapid implementation of sustainable Smart Solutions and Decision Support Systems

www.snap4city.org

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FREE TRIAL

PEN Test Passed

EU GDPR COMPLIANT

SNAP4 Appliances and Dockers Installations

EUROPEAN OPEN SCIENCE CLOUD

Node-RED

JS Foundation

E015 digital ecosystem

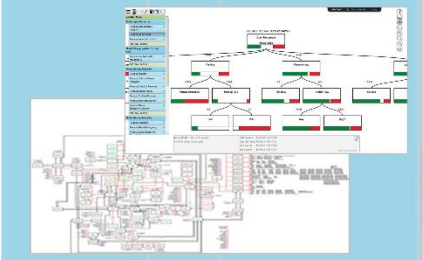
NVIDIA



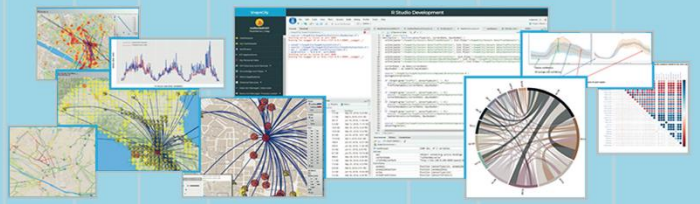


DASHBOARDS AND APPS - CONTROL ROOMS - DECISION SUPPORT SYSTEMS - WHAT-IF ANALYSIS - VISUAL ANALYTICS

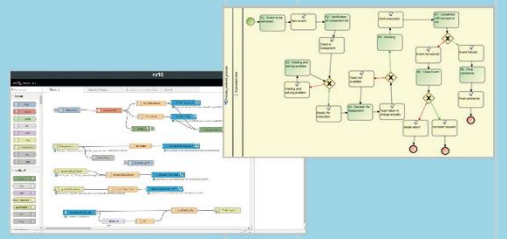
PREDICTION - ANOMALY DETECTION - ENVIRONMENTAL MODEL - 3D MODEL
KPI - SIMULATION - EARLY WARNING - SYNOPTIC - DIGITAL TWIN - VIRTUAL REALITY



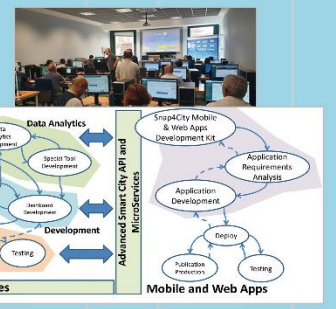
EXPERT SYSTEM
KNOWLEDGE BASE
STORAGE



BIG DATA ANALYTICS
EXPLAINABLE ARTIFICIAL INTELLIGENCE
BUSINESS INTELLIGENCE
MACHINE LEARNING



DATA FLOWS, DATA DRIVEN
WORKFLOWS, MICROSERVICES
PARALLEL DISTRIBUTED PROCESSING

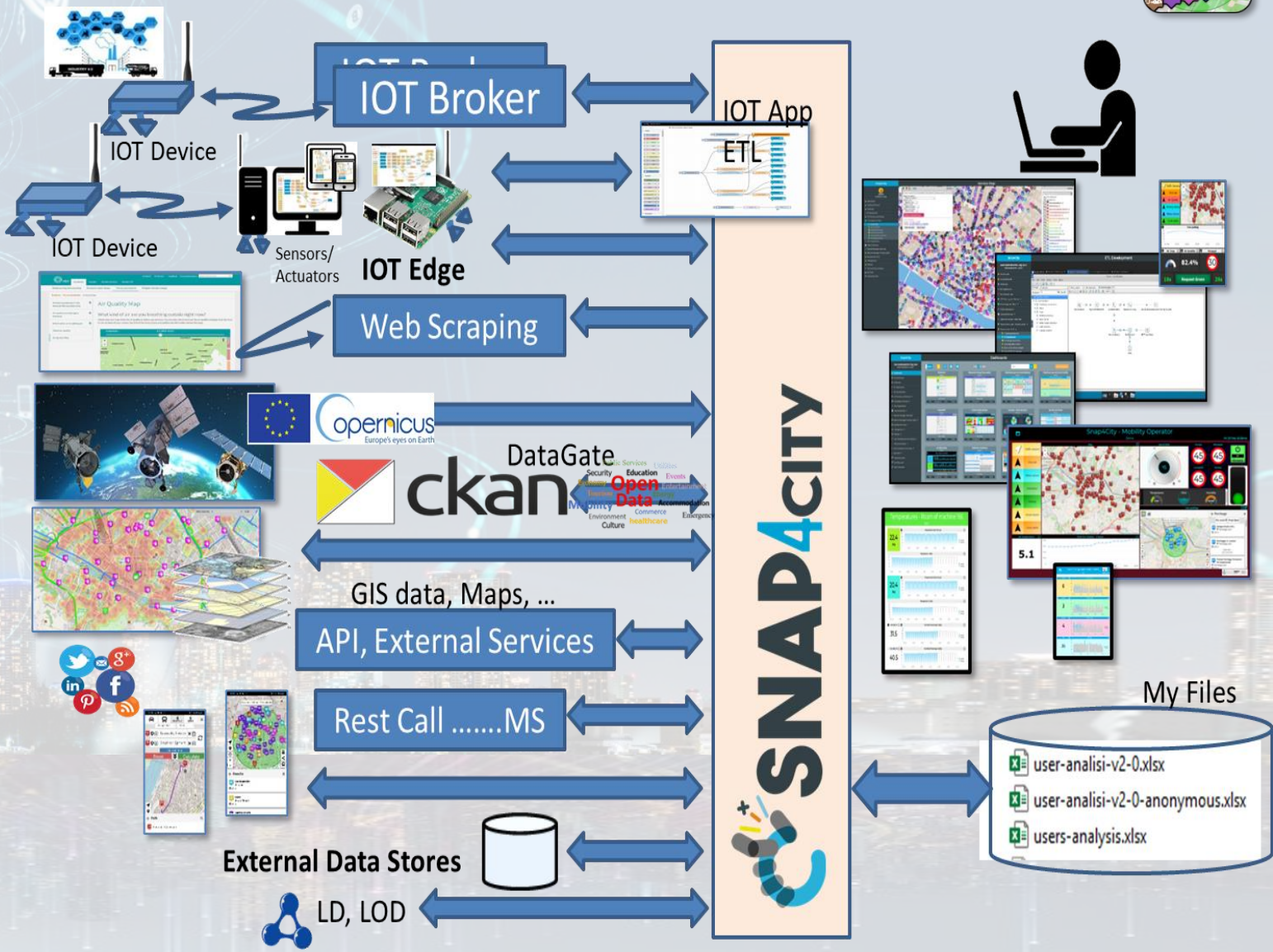


METHODOLOGIES
LIVING LABS
COURSES AND COMMUNITY
DEVELOPMENT TOOLS



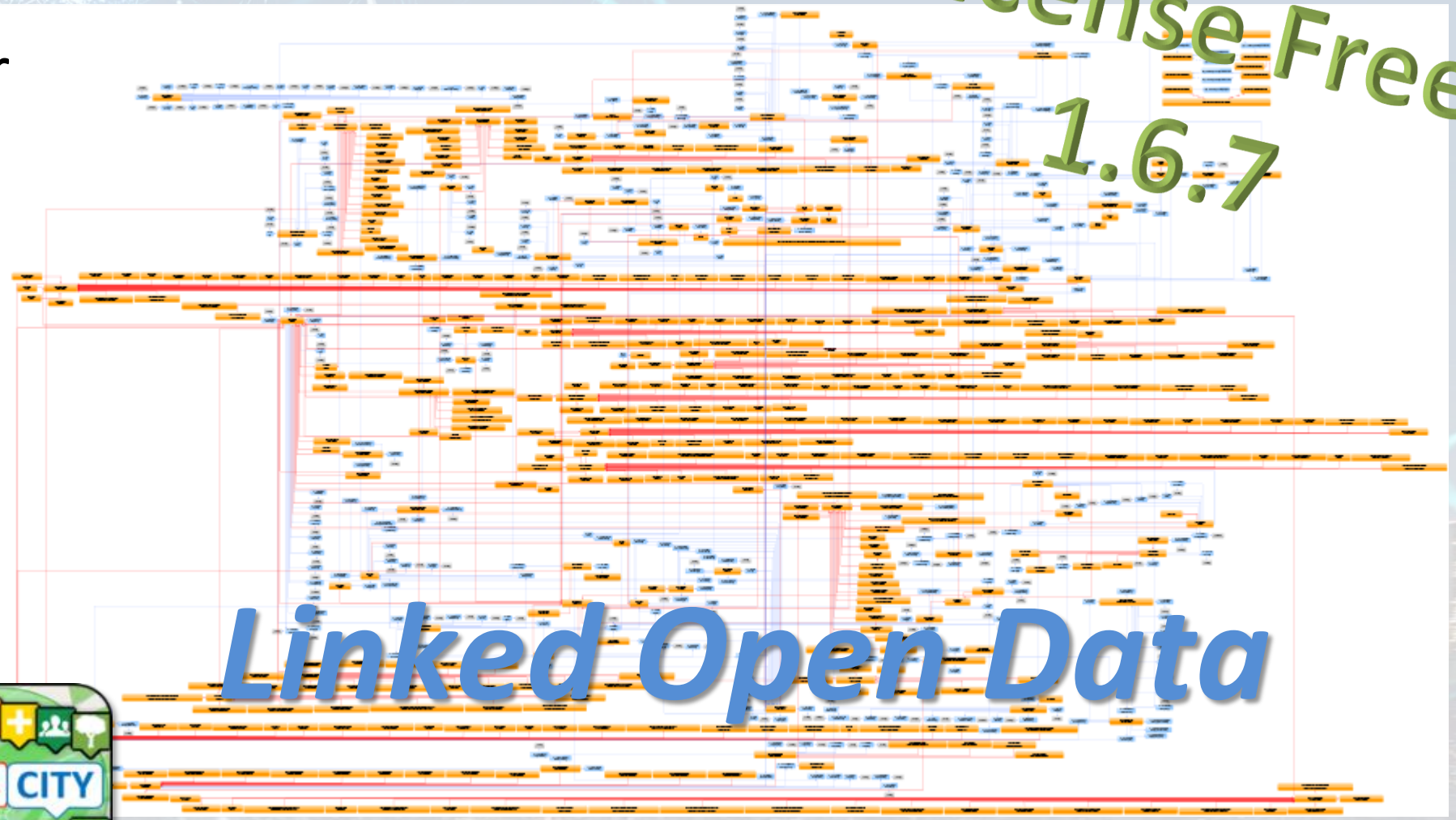
Ingestion, agg. → exploitation

- **Snap4City efficient tools for**
  - Bidirectional data channels
  - Any format, any channel, any data, any broker, any protocol, …
  - **Km4City** Knowledge base Ontology reasoning on geo, space, time, relationships



Expert System semantic queries

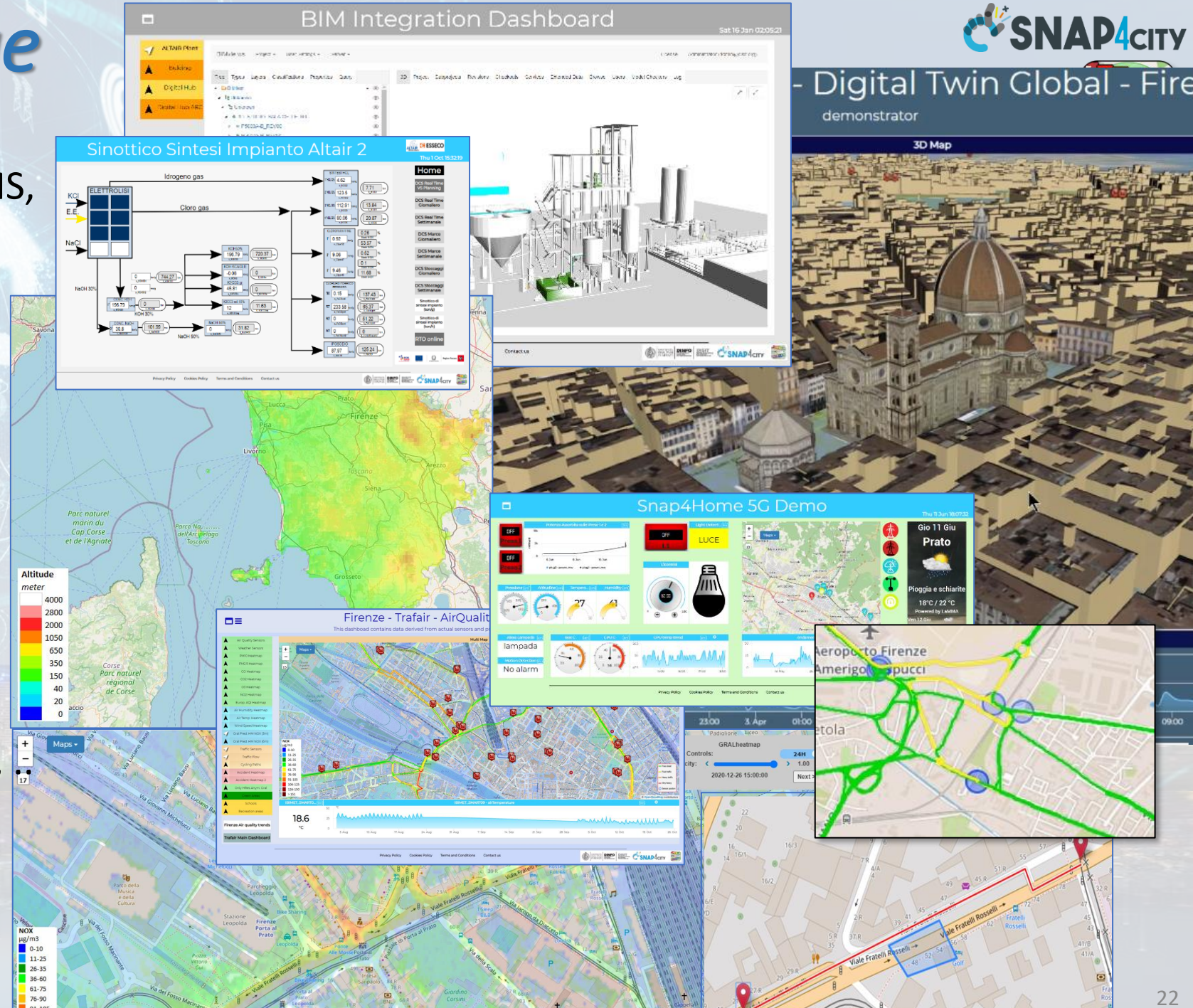
- **via**:
- **Smart City API** for Apps and third party
- **MicroServices** data driven develop via visual language Node-RED



https://www.snap4city.org/19

Data Type Coverage

- POI, IOT Devices, shapes,..
- GIS, maps, orthomaps, WFS/WMS, GeoTiff, calibrated heatmaps, ..
- Satellite data, ..
- traffic flow, typical trends, ..
- trajectories, events, Workflow, ..
- 3D, BIM, ..
- Dynamic icons/pins, ..
- OD Matrices of several kinds, ..
- Synoptics, animations, ..
- KPI, personal KPI,..
- social media data,
- routing, multimodal, constraints,
- decision scenarios, ….
- prediction models, ….
- etc.



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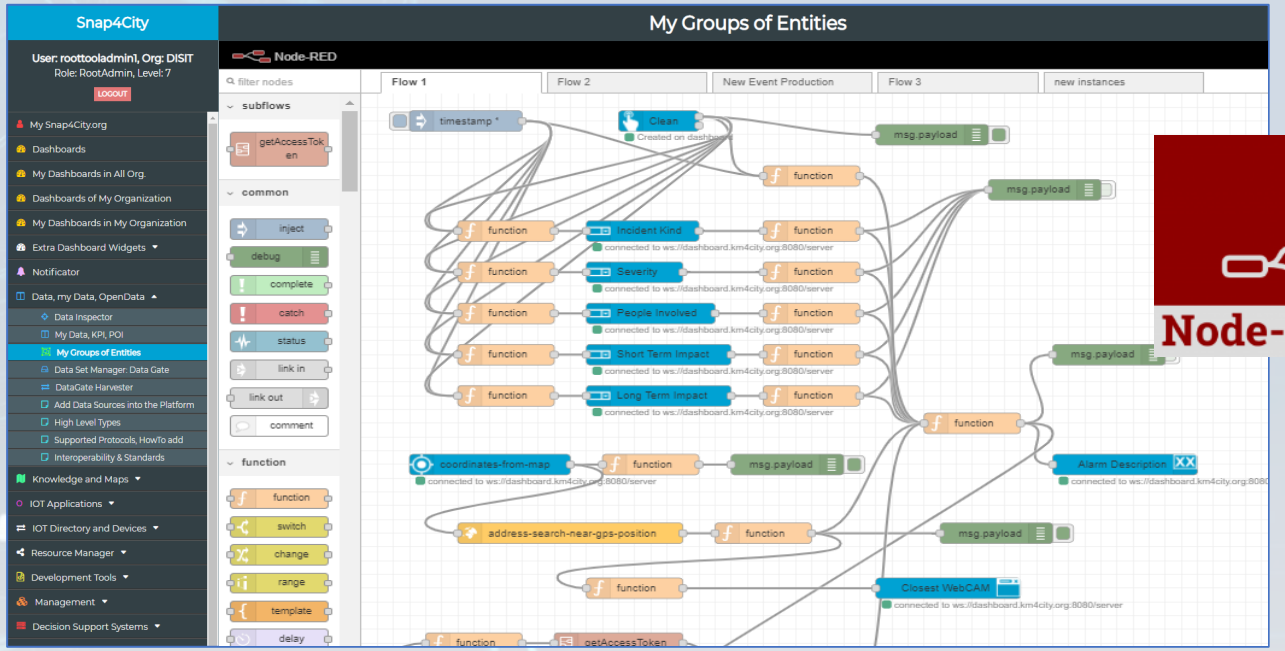
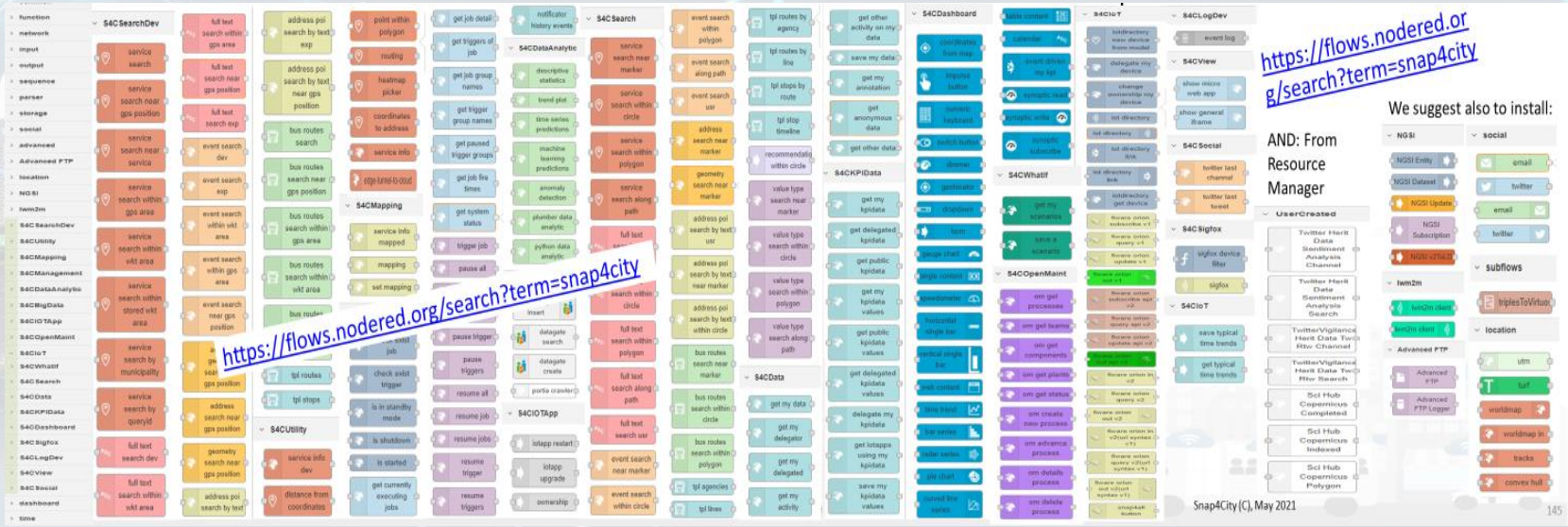
Ingestion, aggreg. → exploitation

- **IoT App Visual Programming, no coding**
  - **Data transformation**
  - **Integration, Interoperab.**
  - **Scripting Data Analytics**
  - **Data ingestion**
  - **Business logic**
- **Edge and Cloud**
- **MicroServices** data driven develop via visual language Node-RED

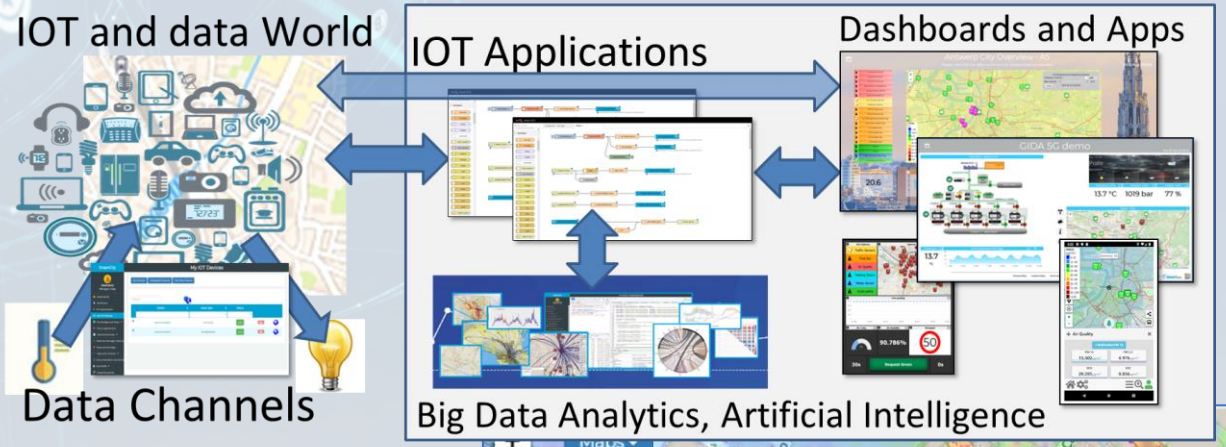


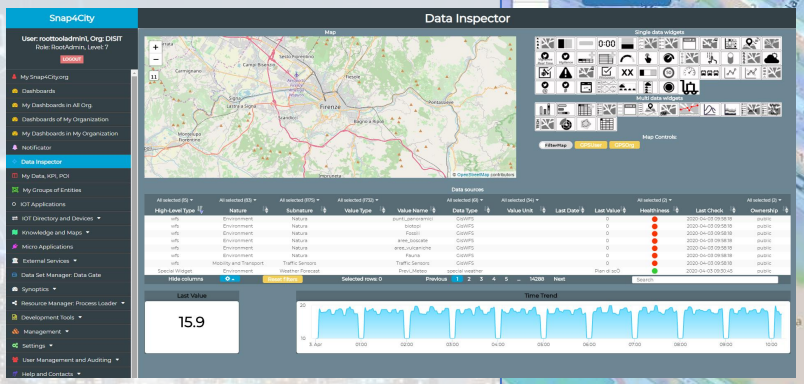


Solutions: reliable, secure and fast to realize

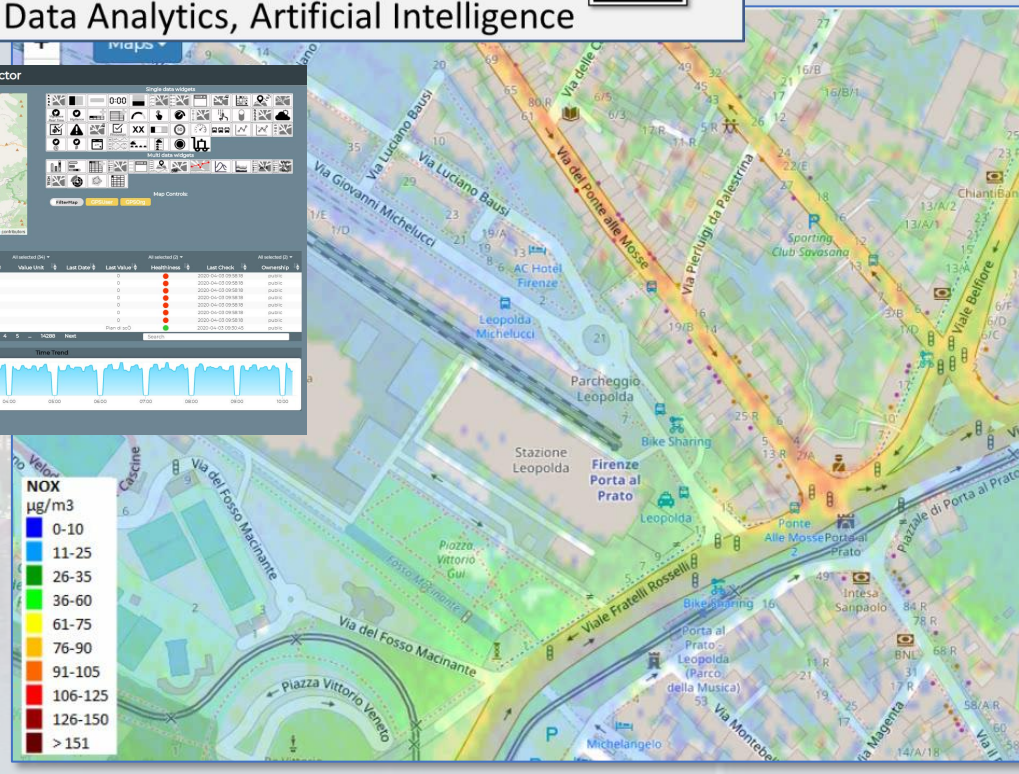
- **Via Snap4City tools**
  - **Dashboard Wizard**
  - **Dashboard Builder**
  - **Data/Visual Analytic**

- **Smart Solutions results to be**
  - **Real time data drive**
  - **Secure end-to-end**
  - **GDPR compliant**
  - **Reliable, interoperable**
  - **Auditable, marketable**









Data Analytics on Snap4City platform

Swagger







Ontology Schema



LOG.disit.org



Big Data Store Facility

Smart City API from Knowledge Base and other tools

TensorFlow

NVIDIA CUDA

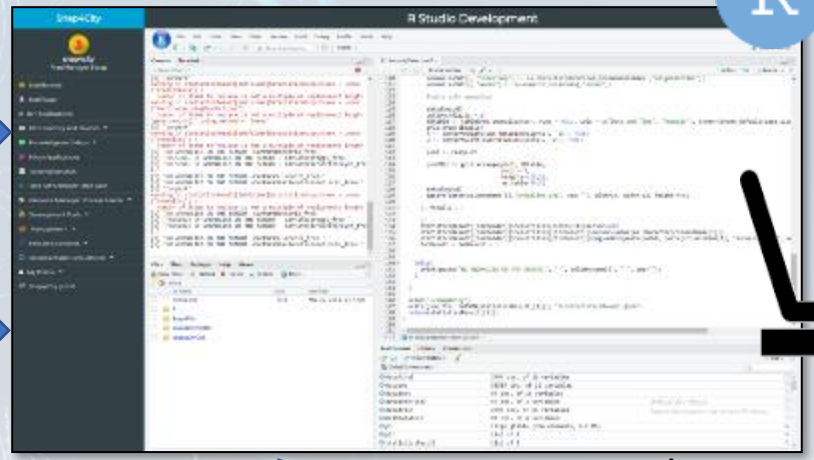
python

jupyter

R Studio

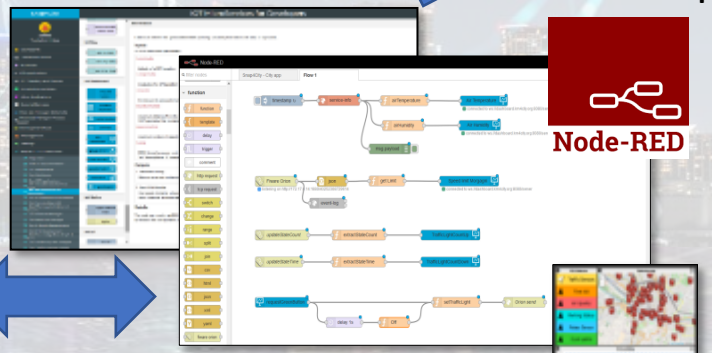
SNAP4CITY

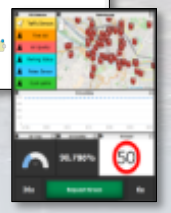
KM4CITY





Creating MicroServices





Using them into IOT Applications

Saving / Sharing reusing



Resource Manager Market Place



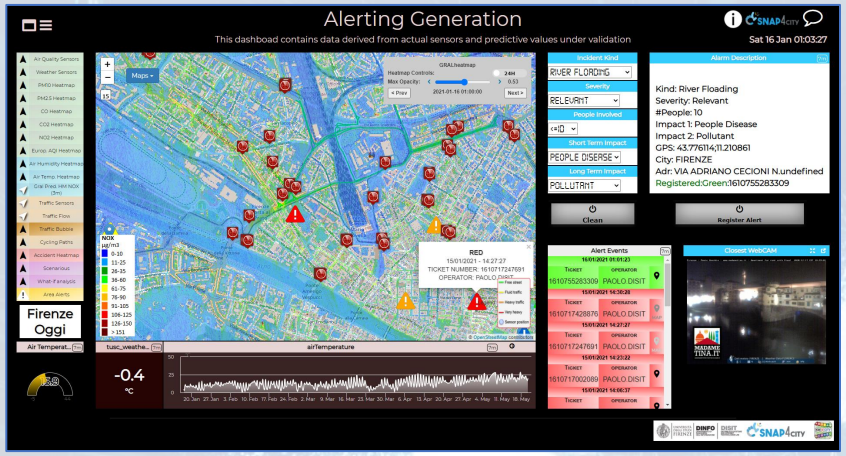
Big Data Analytics + Artificial Intelligence

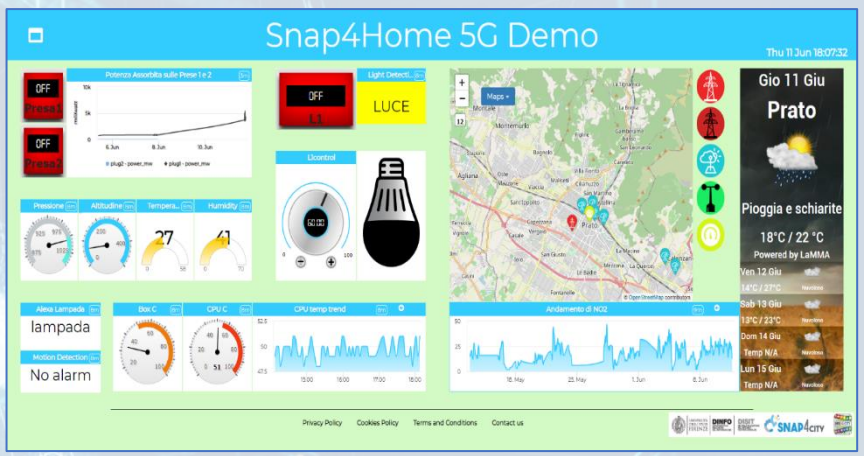
- **Short and Long terms predictive models on:**
  - traffic, parking, people flow, maintenance, land sliding, NO2
- **3D Flow prediction:** Pollutant (NOX, NO2, …)
- **Early warning, City Indexes, etc.**
- **AI & XAI:**
  - RF, XGBoost, BRNN, RNN, SVR, DNN, LSTM, CNN-LSTM, Autoencoders, …
  - Clustering: K-means, K-Medoid, …
  - XAI: Shap, variations, ..
- **Modelling, simulation, routing**
  - **Traffic Flow reconstruction**
  - **Constrained Routing**
- **What-IF analysis** (simulation + AI + data)
- **Based on several computational models**:
  - trajectories, OD matrices, Typical Time Trends, etc.

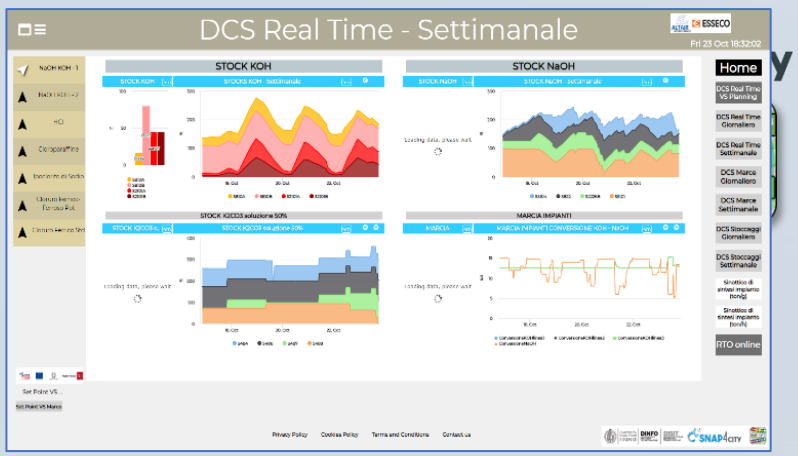
to cope with

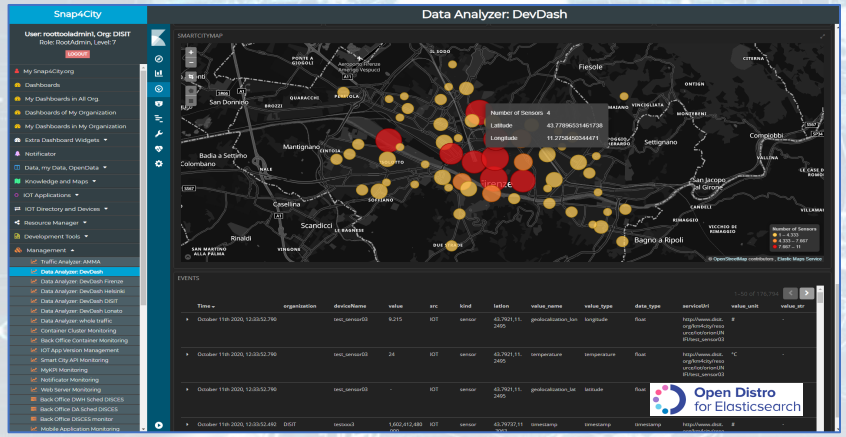
- *any data, format*
- *any channel, protocol*
- *any AI/ML*
- *any place*
- *online development*
- *multi-tenant*
- *Secure, PENTest*
- *GDPR, privacy*
- ***→ low costs***
- ***→ easy to evolve***

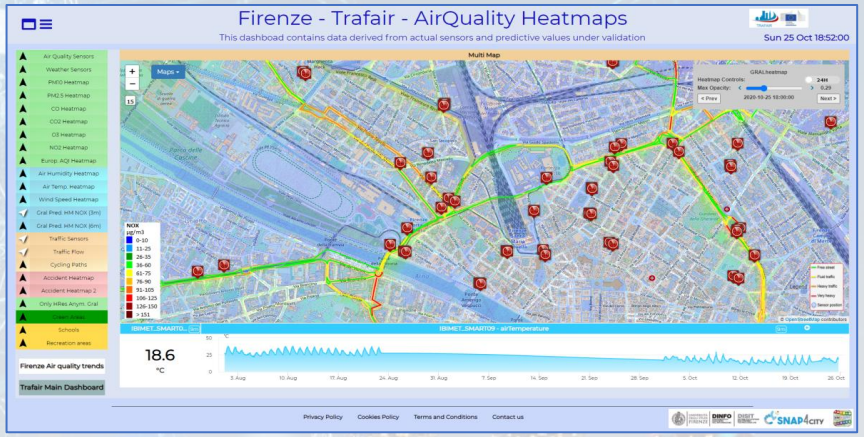
https://www.snap4city.org/download/video/course2020/da/Snap4City-4th-slot-Data-Analytic-v4-6.pdf

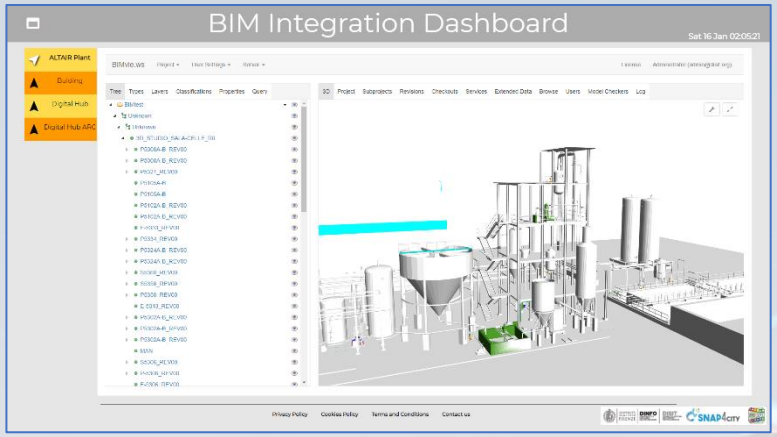

Alerting Generation
This dashboad contains data derived from actual sensors and predictive values under validation
Sat 16 Jan 01:03:27
Firenze Oggi
-0.4


Snap4Home 5G Demo
Thu 11 Jun 18:07:32
LUCE
lampada
No alarm
Gio 11 Giu
Prato
Pioggia e schiarite
18°C / 22 °C

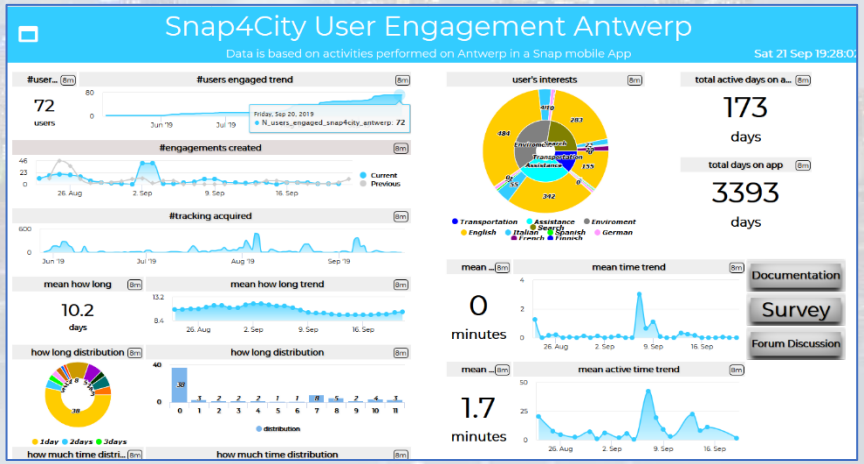

DCS Real Time - Settimanale
Fri 23 Oct 18:32:02
STOCK KOH
STOCK NaOH
Home

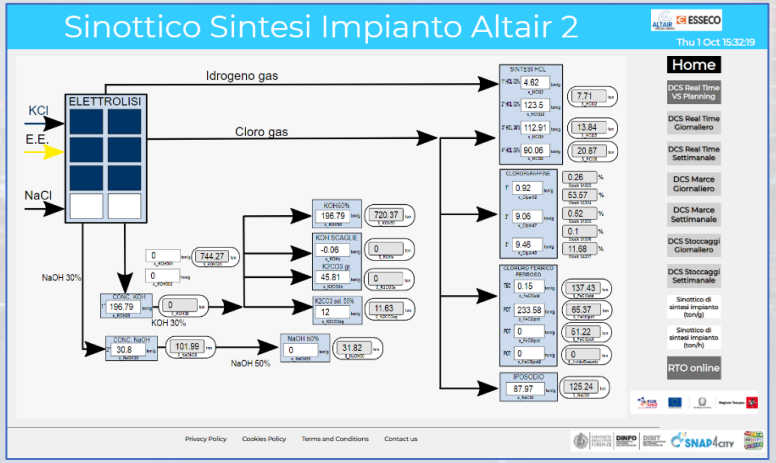

Snap4City
Data Analyzer: DevDash
Open Distro for Elasticsearch


Firenze - Trafair - AirQuality Heatmaps
This dashboad contains data derived from actual sensors and predictive values under validation
Sun 25 Oct 18:52:00
18.6


BIM Integration Dashboard
Sat 16 Jan 02:05:21

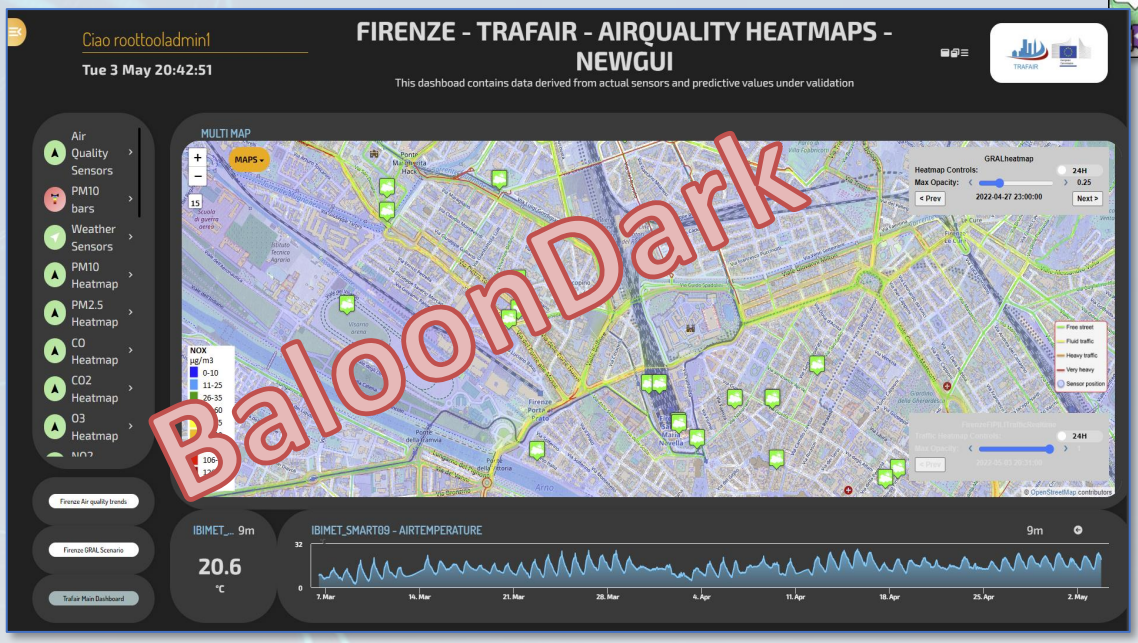

3D Multi Data Map - Digital Twin Global - Firenze
demonstrator
Sun 3 Apr 16:03:52
192

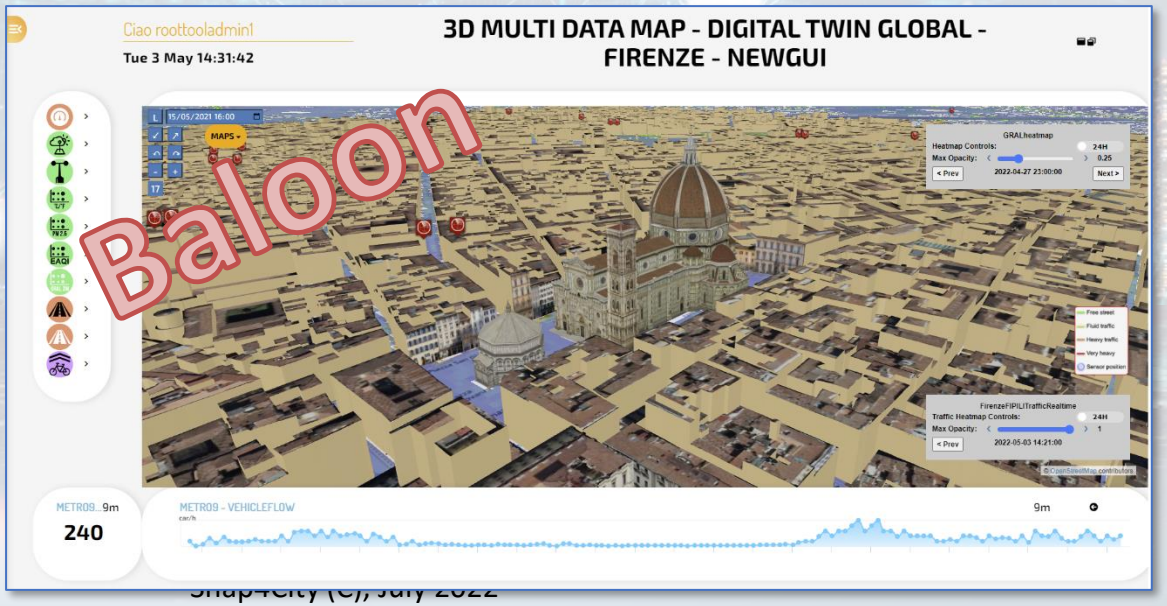

Snap4City User Engagement Antwerp
Data is based on activities performed on Antwerp in a Snap mobile App
Sat 21 Sep 19:28:0
72
users
173
days
3393
days
0
minutes
1.7
minutes
Documentation
Survey
Forum Discussion

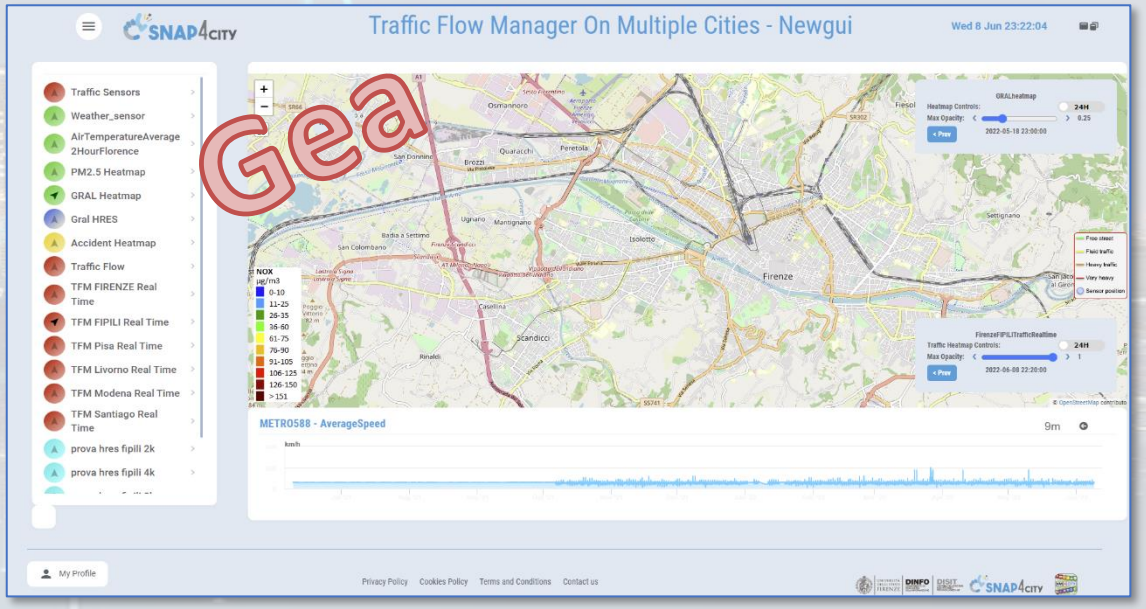

Sinottico Sintesi Impianto Altair 2
Thu 1 Oct 15:32:19
Home
Idrogeno gas
Cloro gas
ELETTROLISI
KCl
E.E.
NaCl
NaOH 30%
KOH 30%
NaOH 50%

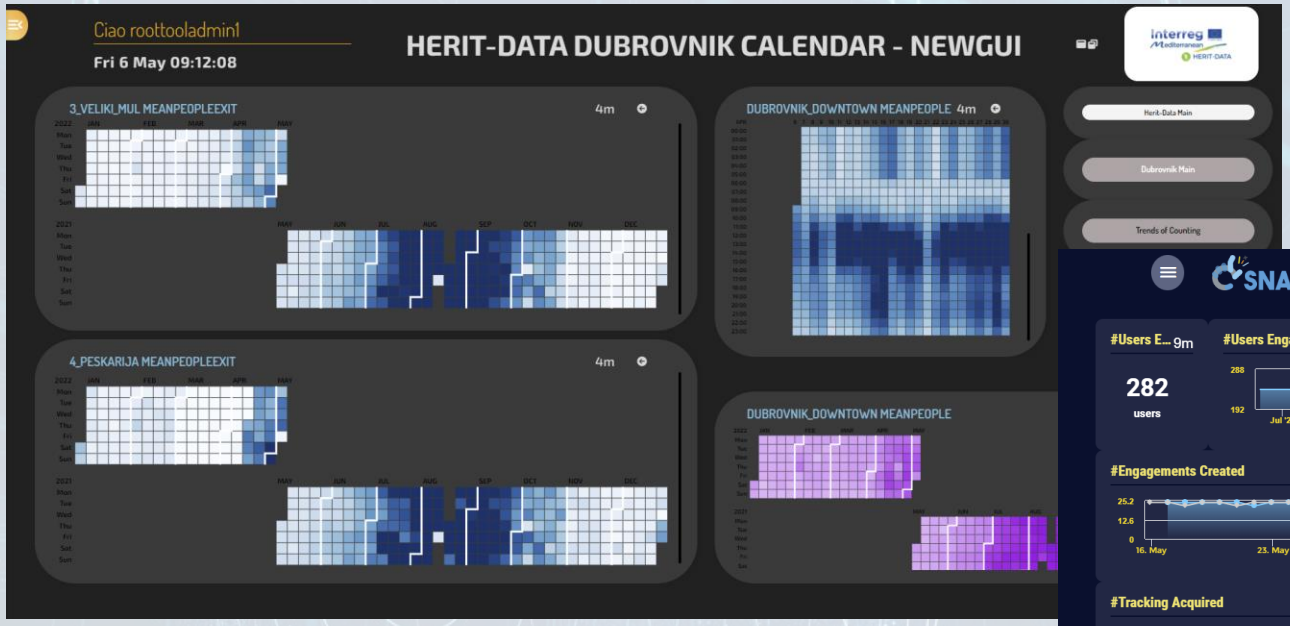
Different Themes

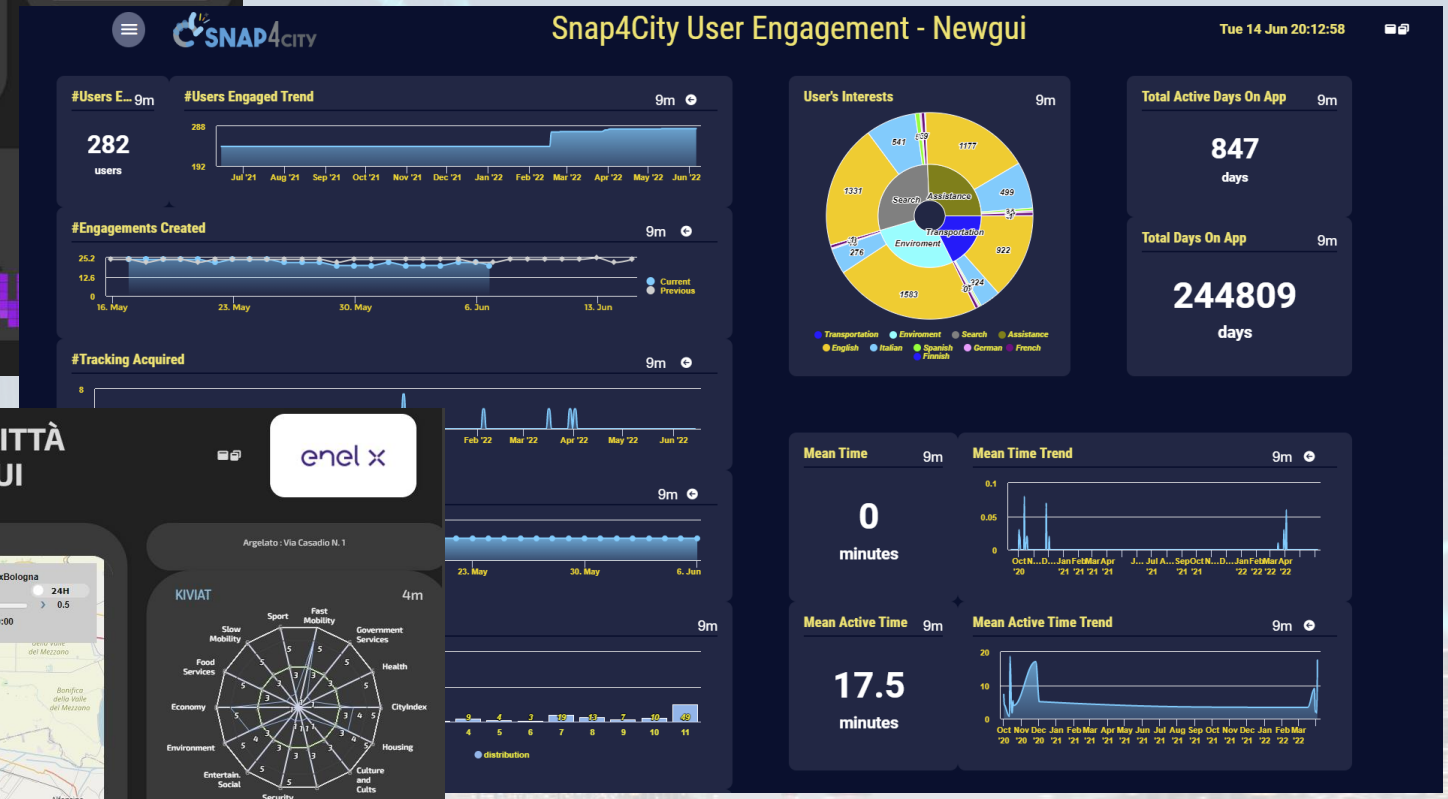


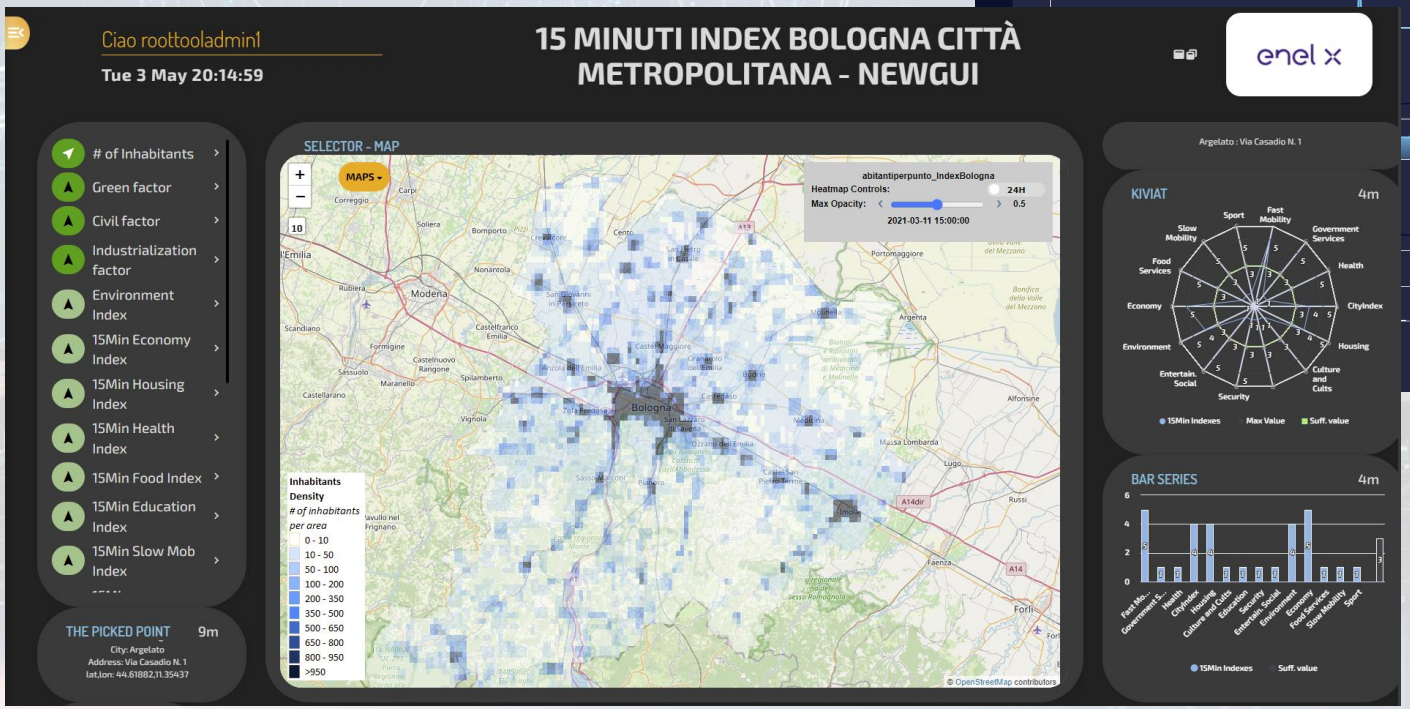




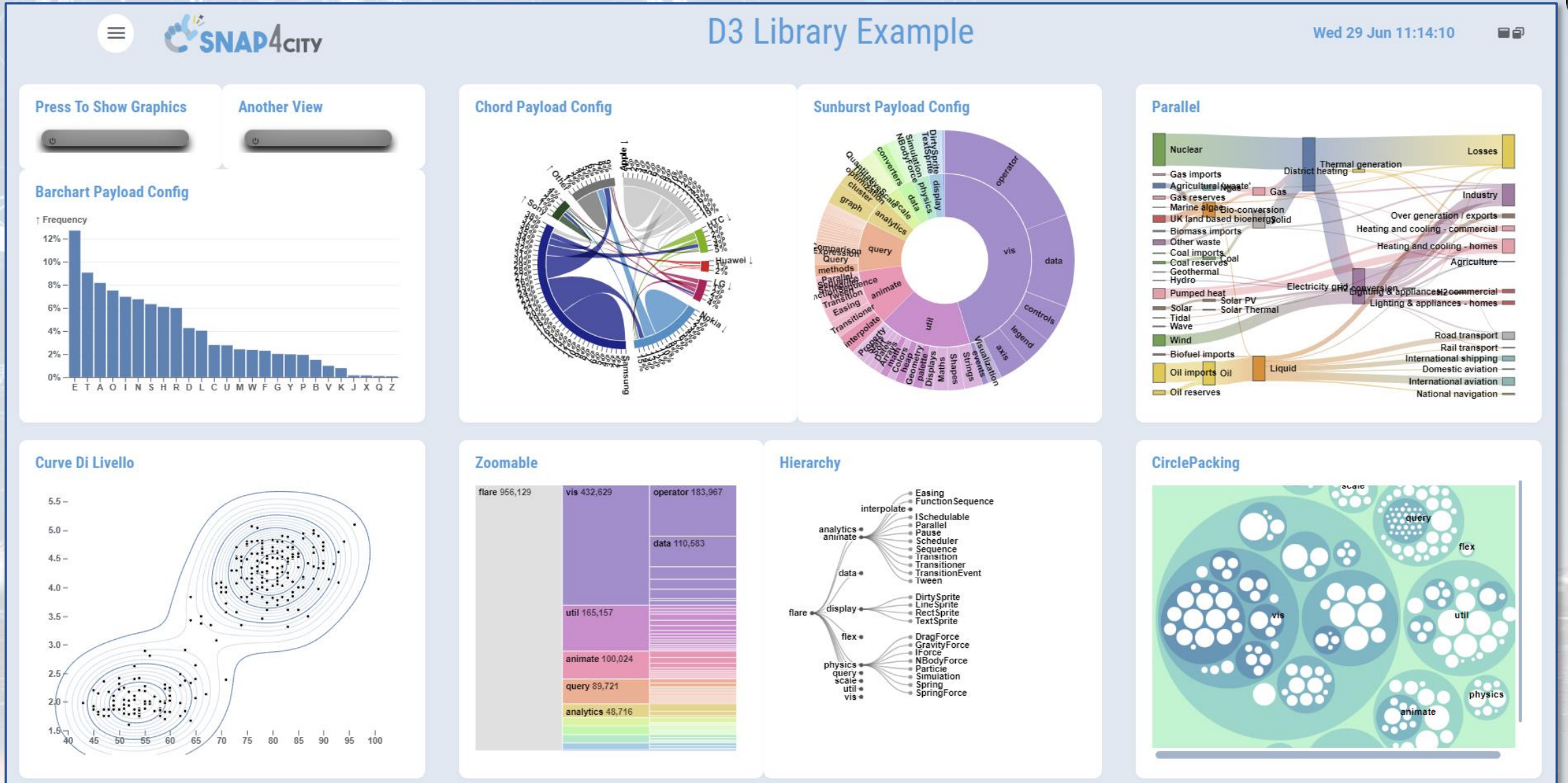



Ciao roottooladmin1
Fri 6 May 09:12:08
HERIT-DATA DUBROVNIK CALENDAR - NEWGUI
3_VELIKI_MUL MEANPEOPLEEXIT 4m
DUBROVNIK_DOWNTOWN MEANPEOPLE 4m
4_PESKARIJA MEANPEOPLEEXIT 4m
DUBROVNIK_DOWNTOWN MEANPEOPLE


Snap4City User Engagement - Newgui
Tue 14 Jun 20:12:58
#Users E... 9m
282
users
#Users Engaged Trend 9m
#Engagements Created 9m
#Tracking Acquired 9m
User's Interests 9m
Total Active Days On App 9m
847
days
Total Days On App 9m
244809
days
Mean Time 9m
0
minutes
Mean Time Trend 9m
Mean Active Time 9m
17.5
minutes
Mean Active Time Trend 9m

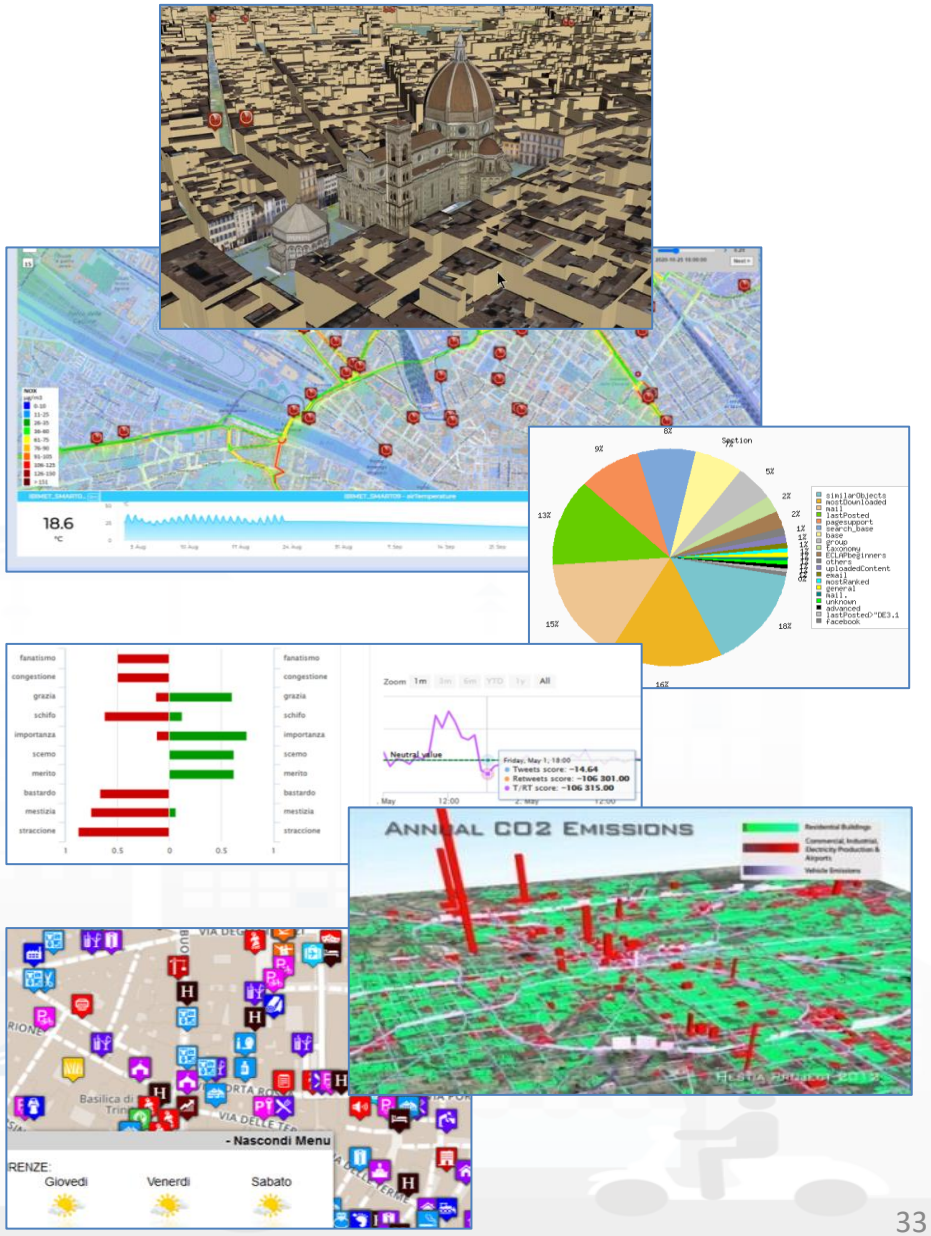

Ciao roottooladmin1
Tue 3 May 20:14:59
15 MINUTI INDEX BOLOGNA CITTÀ METROPOLITANA - NEWGUI
# of Inhabitants
Green factor
Civil factor
Industrialization factor
Environment Index
15Min Economy Index
15Min Housing Index
15Min Health Index
15Min Food Index
15Min Education Index
15Min Slow Mob Index
THE PICKED POINT 9m
City: Argelato
Address: Via Casadio N. 1
lat,lon: 44.61882,11.35437
SELECTOR - MAP
Inhabitants Density
# of inhabitants per area
KIVIAT 4m
BAR SERIES 4m

D3 Graph library capability



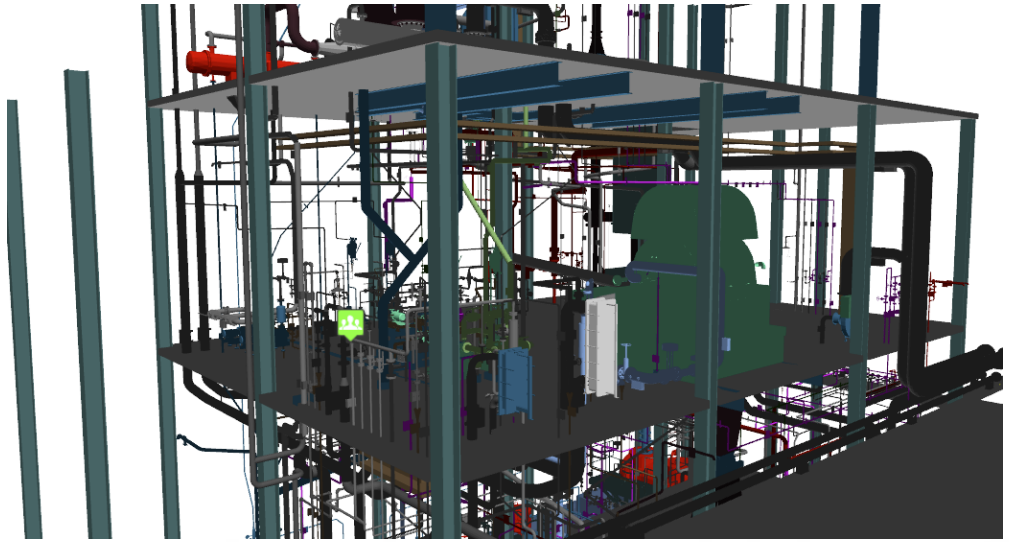
Digital Twin

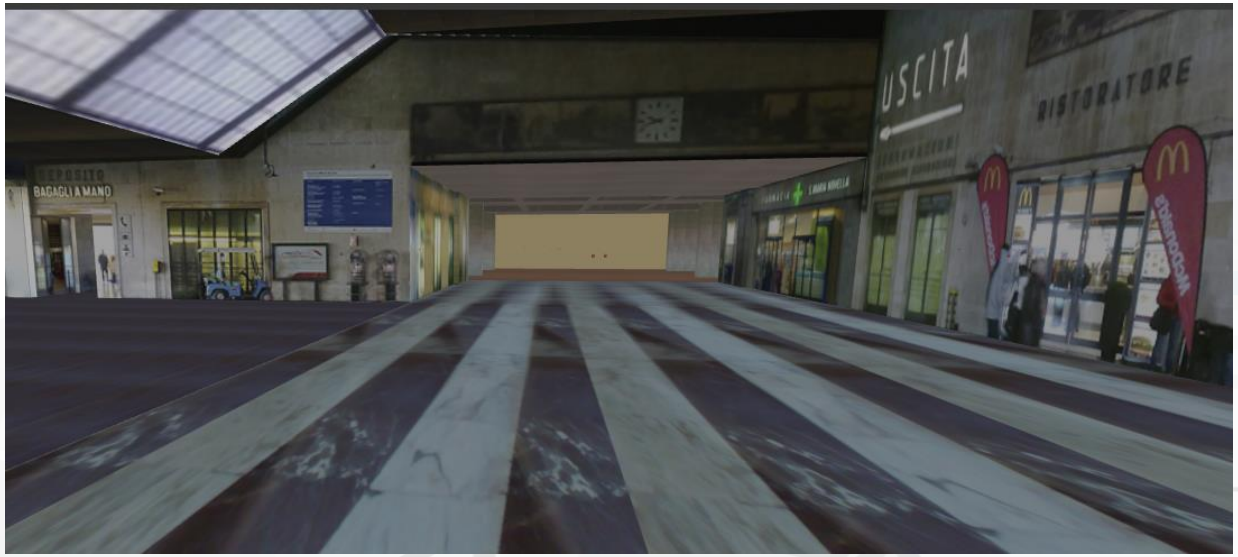
- **Digital Twin**
  - **Connected** with real physical systems
  - **Modelling aspects**: structural, visual, informative, real time data sensors (context), POI, functional, resource managements, etc.
  - **Integration of** AI/XAI techniques with simulations and modelling
- **Easier to understand the context, review from multiple points of view**
- **Useful to perform**
  - Discussion with city users
  - Support decision makers
  - By Case Experiments for analysing
    - New solutions, impact of disaster (natural and provoked)
    - Reduction of costs in the analysis, in reduction of mistakes

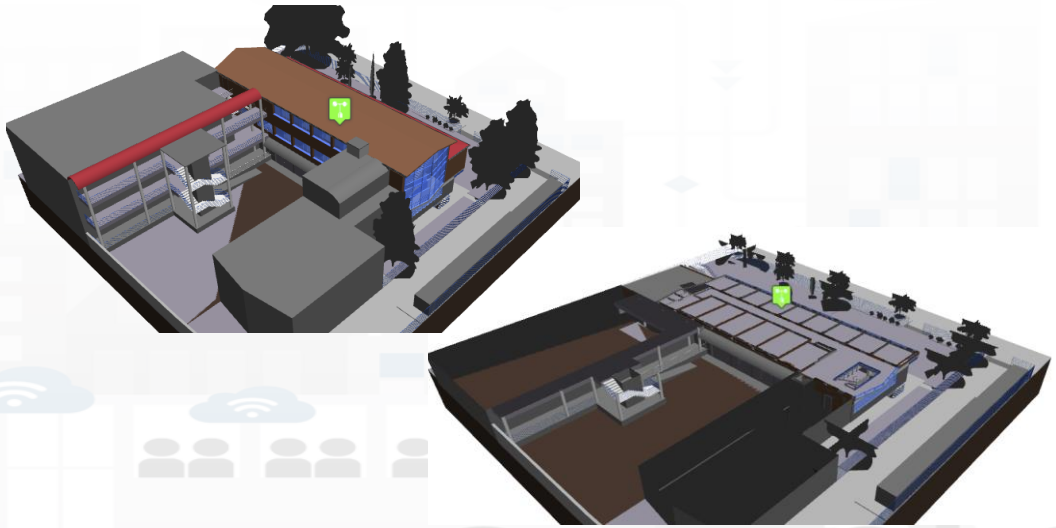


Digital Twin
Global vs Local





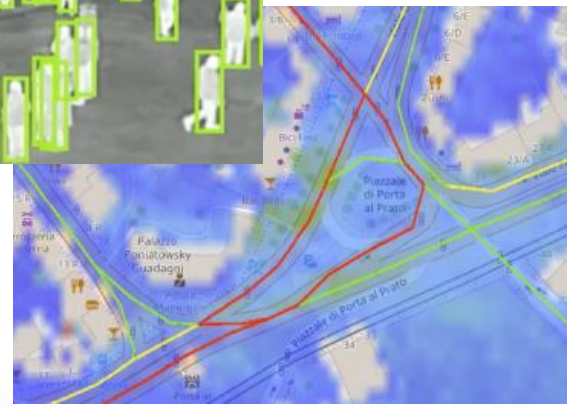


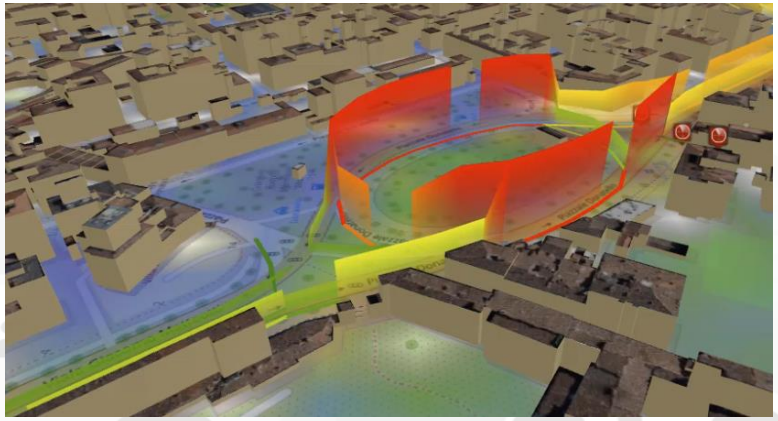


Awareness to manage and improve ….

- **Infrastructures** of the cultural cities:
  - **Security and Safety**: roads, buildings, squares
  - **Mobility and Transport**: traffic flow, parking, etc.
  - **Environment**: microclimate, predictions, assessment for acting
- **Services / events**: assessment and plan:
  - **Most of the cities provide diffuse cultural heritage as a wall**
    - Security, clean, public transport, environment, delivery, etc.
  - **Global and Local**: events vs actions
  - **Local Structures**: museums, events, shopping, attractions, ..
- **People and Transport Means (city users: citizens, tourists, etc.) :**
  - **Understand:**
    - flows, density, behaviour, classifications of user/means
    - reputation, appreciation Trip Advisor, Twitter, etc.
  - **Nagging, Suggest, Recommend, Engage, Guide..**
    - Context based

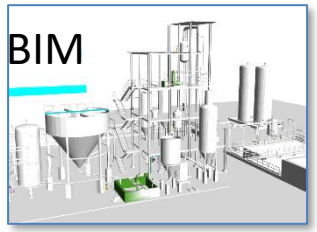






Concept

BIM

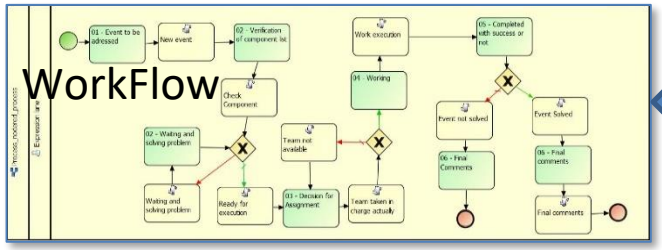


KPI, POI, MyKPI, …

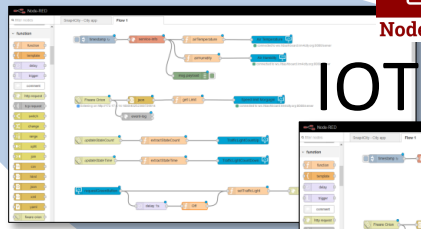
API, External Services

Web Scraping

WorkFlow







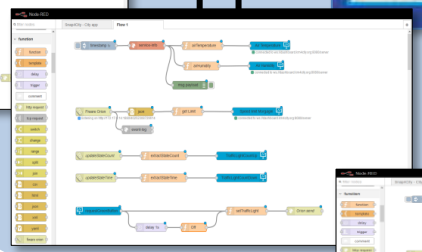
Node-RED

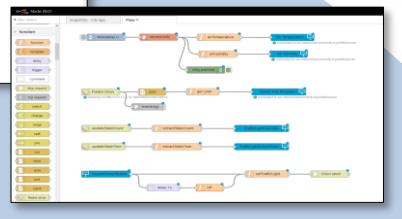
IOT Apps





opernicus
Europe's eyes on Earth





Data Analytics,
Artificial Intelligence

IOT Brokers

IOT Broker

IOT Broker



FIWARE



GIS

Big Data

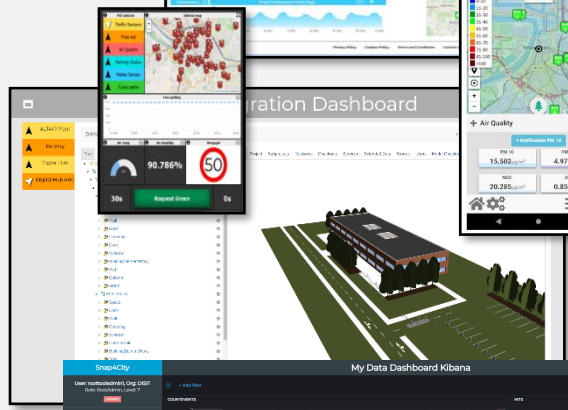
KB

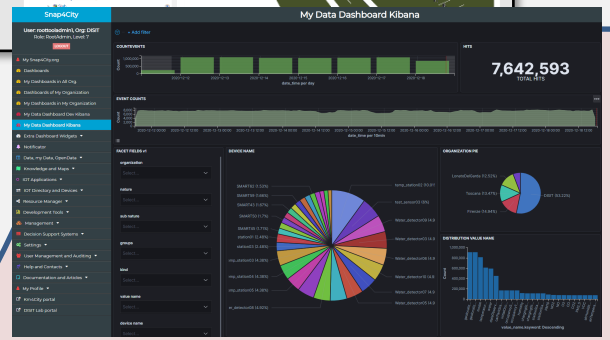
LD, LOD

ckan



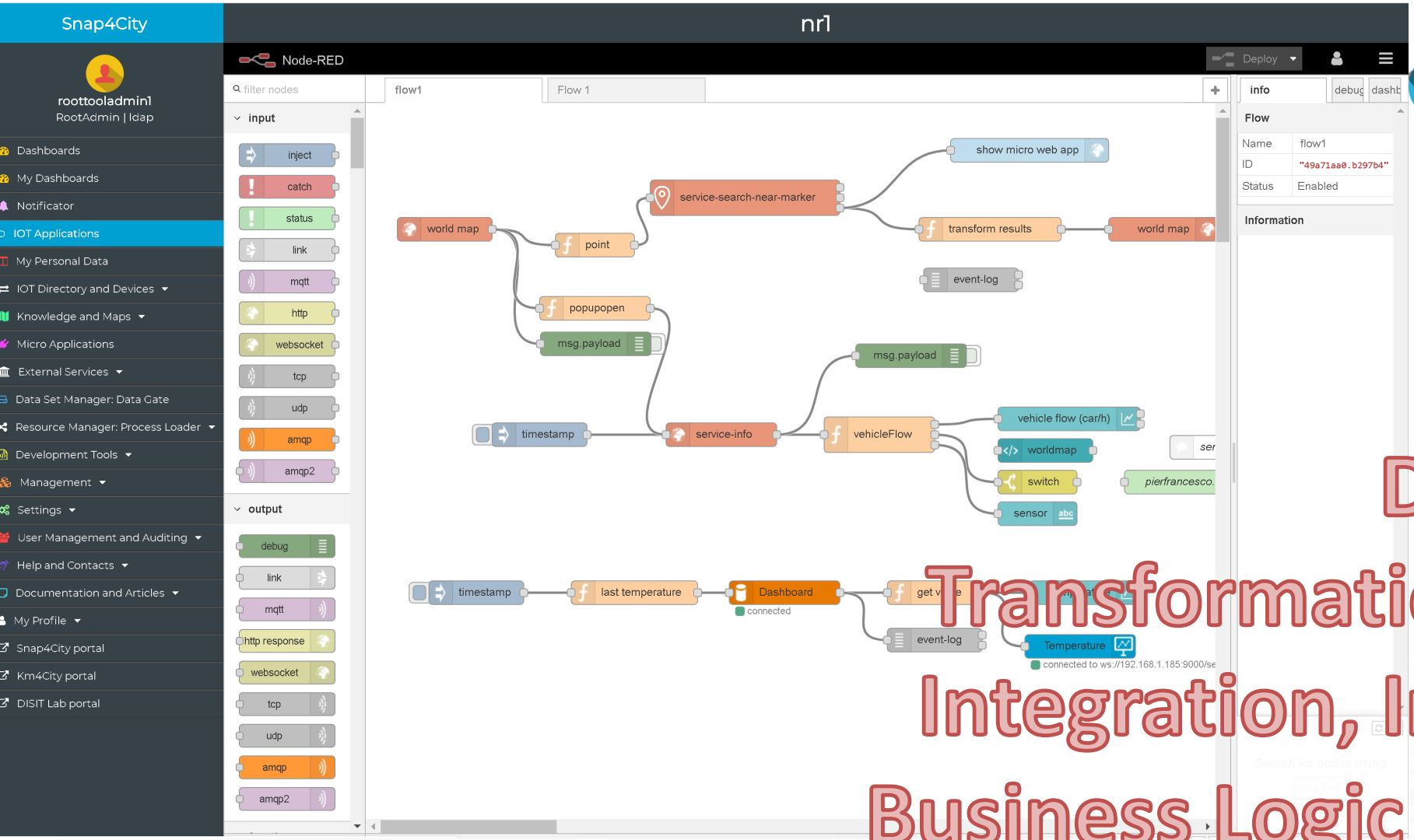






Dashboards and Apps

FI-WARE



Data Adapation Transformation, Conversion Integration, Interoperability Business Logic vs Dashboards Data Analytics control

Editing IOT Applications

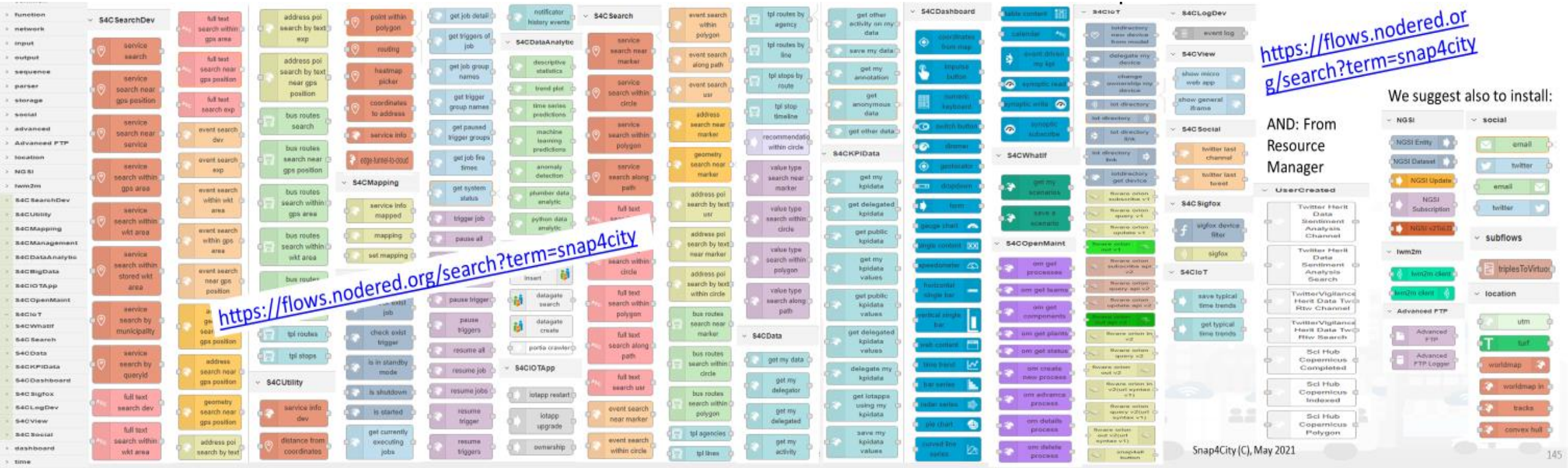
Everywhere: Cloud, on IoT Edge Devices

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

SNAP4CITY KM4CITY

Snap4City Libraries of MicroServices on Node-RED

Node-RED



Domain Coverage

- **Smart City**
  - **Mobility and transport:**
    - Public services, parking, sharing, …
    - Traffic flow reconstruction, comp. and show
    - Traffic predictions
    - What IF Analyses
    - Origin destination computing and show
    - Routing: modal and multimodal
    - Public service analysis, offer vs demand
    - Smart Parking, parking prediction
    - Smart bike sharing….
    - Fleet tracking
  - **Environment**
    - Any Pollutant and weather sensors
    - NOX, CO, NO2 predictions: short and long terms
  - **People Flow: counting and tracking**
    - PAX Counters, WI-FI tracking, classification
  - **Culture and Tourism**
    - POI, people flows
  - **GOV**
    - Any KPI: ISO, 15Min City Index
    - maintenance prediction and management
  - **Energy:** Smart light, recharge, data centers
  - **Security:** TV Cam management, detection, pax counting
  - **Health:** COVID-19, smart bed, smart ambulance
  - **Waste** status monitoring, best paths, etc.
- **Smart City & Industry 4.0 ←→ Urban Systems**
  - Control Room Management
    - Multiple monitor, multiple operator,
    - Situation room
    - Telecontrol
  - Decision Support Systems
    - Early warning, alarms
    - What-IF analysis
  - Mobile App API via ASCAPI
    - User engagement, bonus, scoring..
  - Telegram bot
- **Big Data Analytics**
  - Simulation / prediction
  - Explainable AI, real time analysis, event driven
  - Maintenance predictions
  - Optimization of production
  - Twitter Vigilance: volume and Sentiment
  - Value chain monitoring
- **On cloud / on IOT edge**

Standards and Interoperability (6/2022)

Compliant with:

- **IoT:** NGSI V2/LD, LoRa, LoRaWan, MQTT, AMQP, COAP, OneM2M, TheThingsNetwork, SigFOX, Libelium, IBIMET/IBE, Enocean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, BACnet, TALQ, Protocol Buffer, KNX, OBD2, ..
- **IoT model:** FIWARE Smart Data Model, Snap4City IoT Device Models
- **General**: HTTP, HTTPS, TLS, Rest Call, SMTP, TCP, UDP, SOAP, WSDL, FTP, FTPS, WebSocket, WebSocket Secure, GML, WFS, WMS, RTSP, ONVIF, AXIS TVCam, CISCO Meraki, OSM, Copernicus, The Weather Channel, Open Weather, OLAP, ….
- **Formats**: JSON, GeoJSON, XML, CSV, GeoTIFF, OWL, WKT, KML, SHP, db, XLS, XLSX, TXT, HTML, CSS, SVG, IFC, XPDL, OSM, Enfuser FMI, Lidar, glTF, GLB, DTM, GDAL, …
- **Database**: Open Search, MySQL, Mongo, HBASE, SOLR, SPARQL, ODBC, JDBC, Elastic Search, Phoenix, PostGres, MS Azure, ..
- **Industry**: OPC/OPC-UA, OLAP, ModBUS, RS485, RS232,..
- **Mobility**: DATEX, GTFS, Transmodel, ETSI, ..
- **Social**:Twitter, FaceBook, Telegram, ..
- **Events**: SMS, EMAIL, CAP, RSS Feed, ..
- **OS**: Linux, Windows, Android, Raspberry Pi, Local File System, ESP32, etc.

https://www.snap4city.org/65

Mobility and Transport

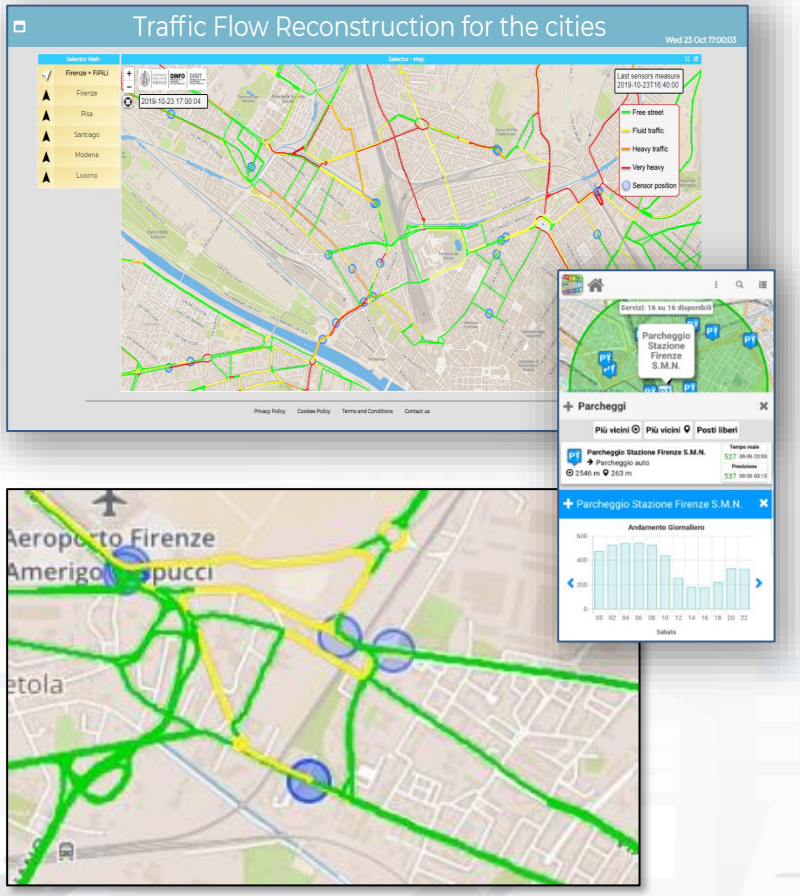
Traffic Flow reconstruction:
- fluidodynamic model plus stochastic relaxation

Prediction
- **Traffic Flow density, RF, LSTM, GBM, …**
- free slots for **parking…**
- **bike rack** status on bike sharing

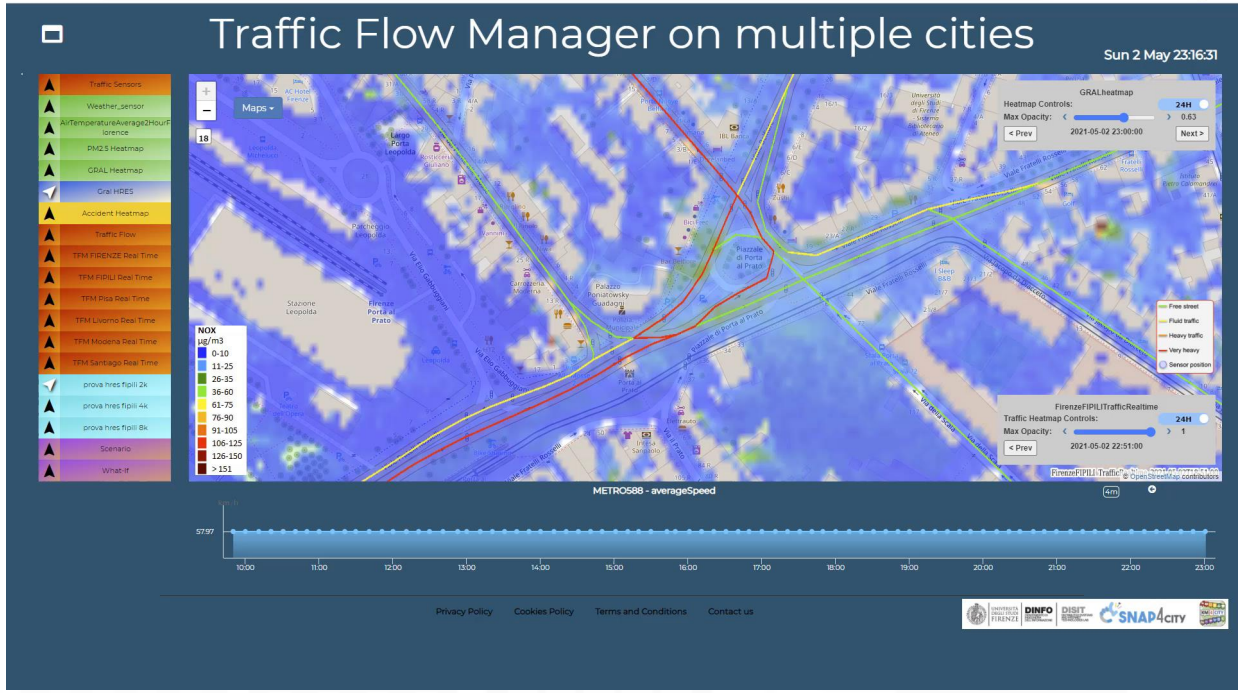
Classification of travel means of users via mobile data

IoT Data Anomaly Detection

Project:
- Sii-Mobility, SCN MIUR



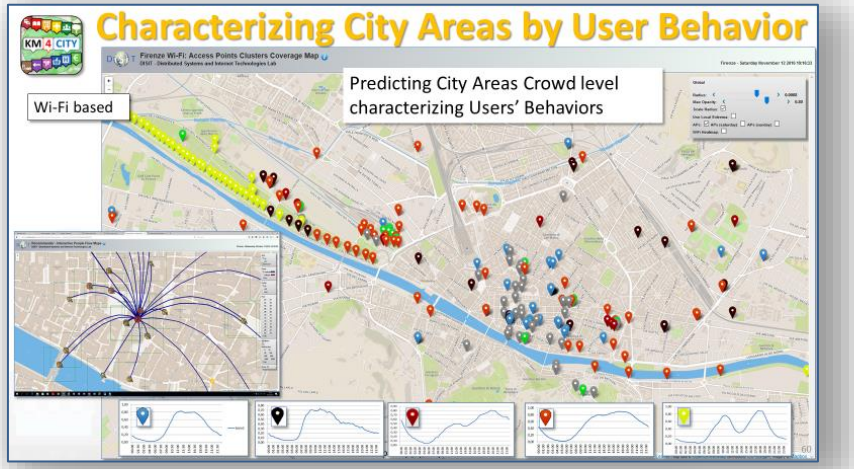
Environment

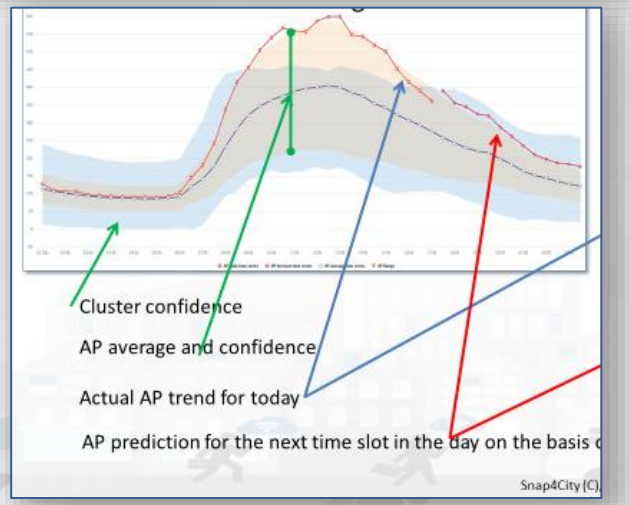


- **Prediction**
  - **NOX Pollutant** diffusion on the basis of Traffic Flow (prediction), weather and 3D structure
  - **NO2 progressive average** (Long term)
- **Project:**
  - **Trafair** CEF EC
  - Mixed solutions of Fluidinamics modeling and AI

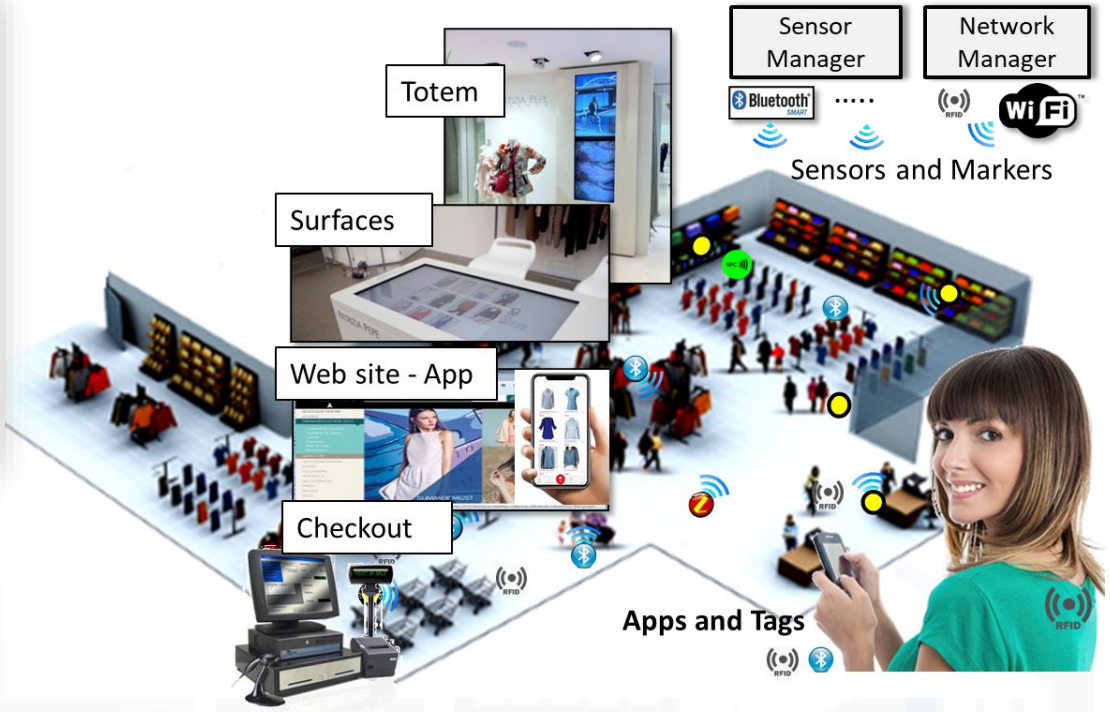
People Behaviour

- **Prediction of people flows** on the basis of Wi-Fi data
- **Anomaly** detection, early Warning
- **Classification** of city areas
- **Classification** of Trajectories
- **Project**
  - **Resolute** H2020



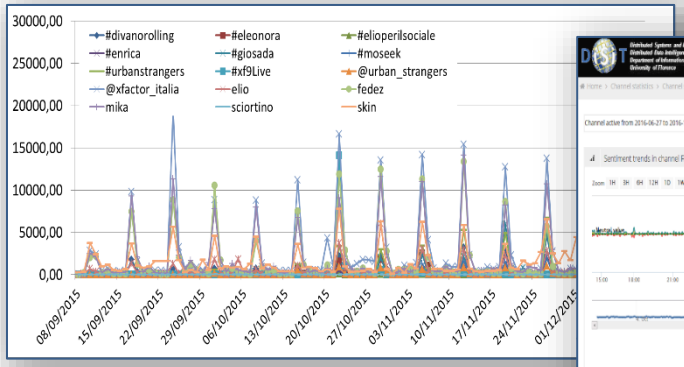


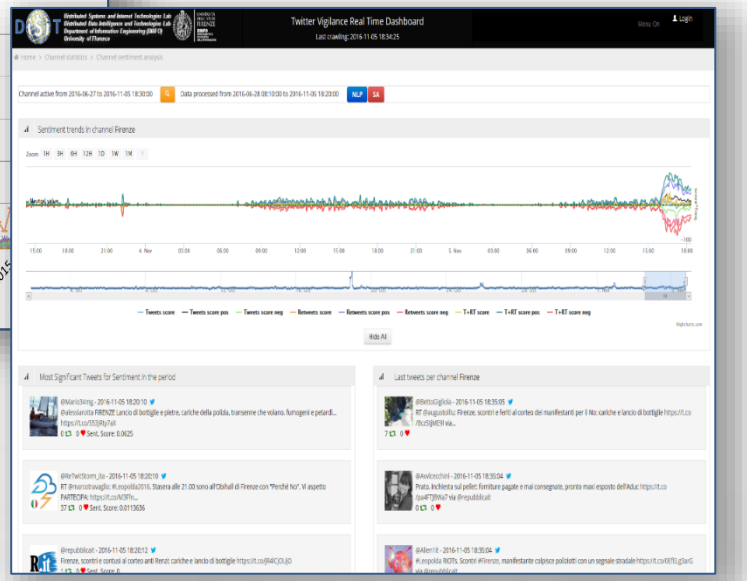
Smart Retail



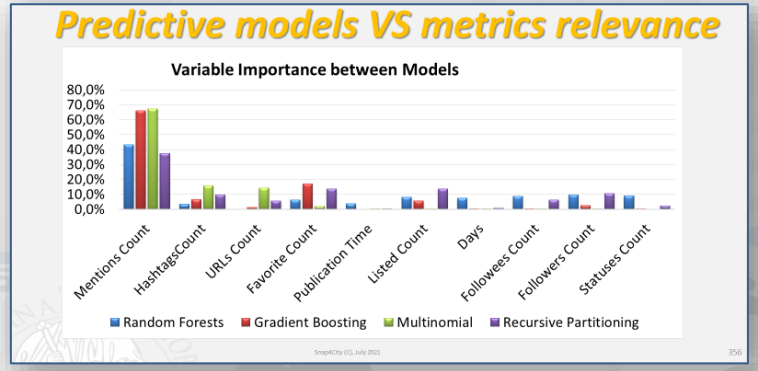
- **Recommendations**
  - User and Items Clustering
  - Prediction
  - User engagement
- **Project Feedback**

Social Media

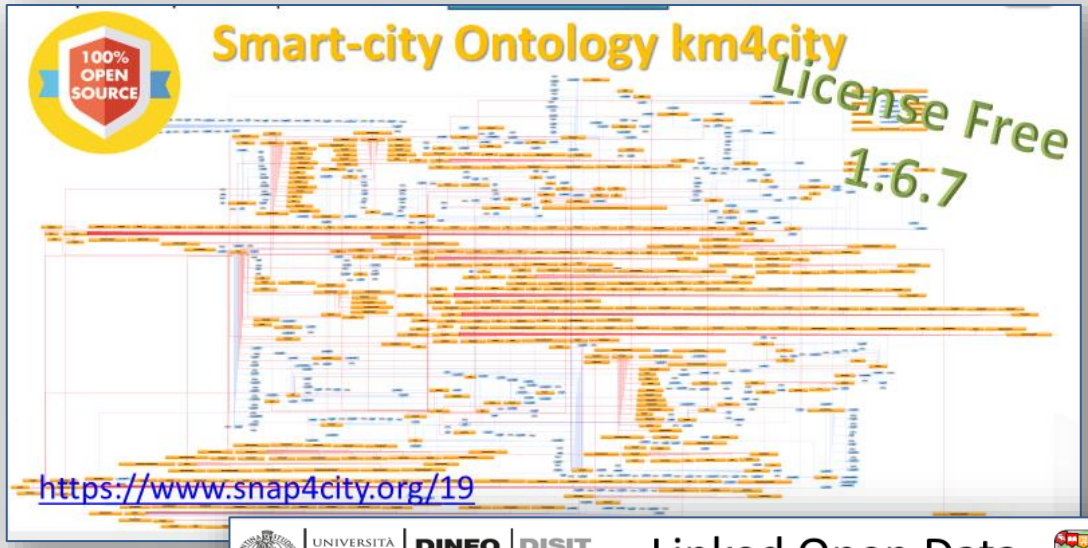


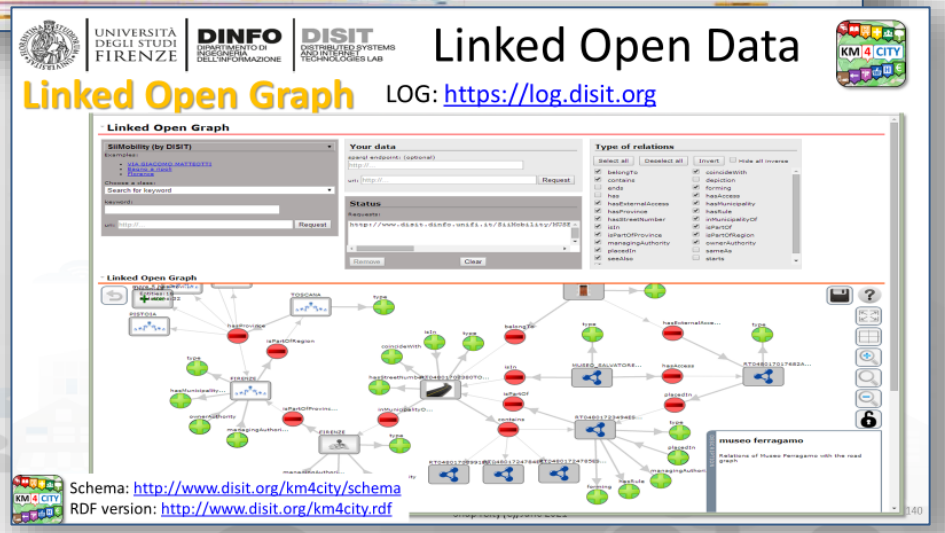


- **Prediction**
  - Audience on TV programme
  - retweet proneness
  - NLP, SA, AI
- **Projects**
  - TwitterVigilance

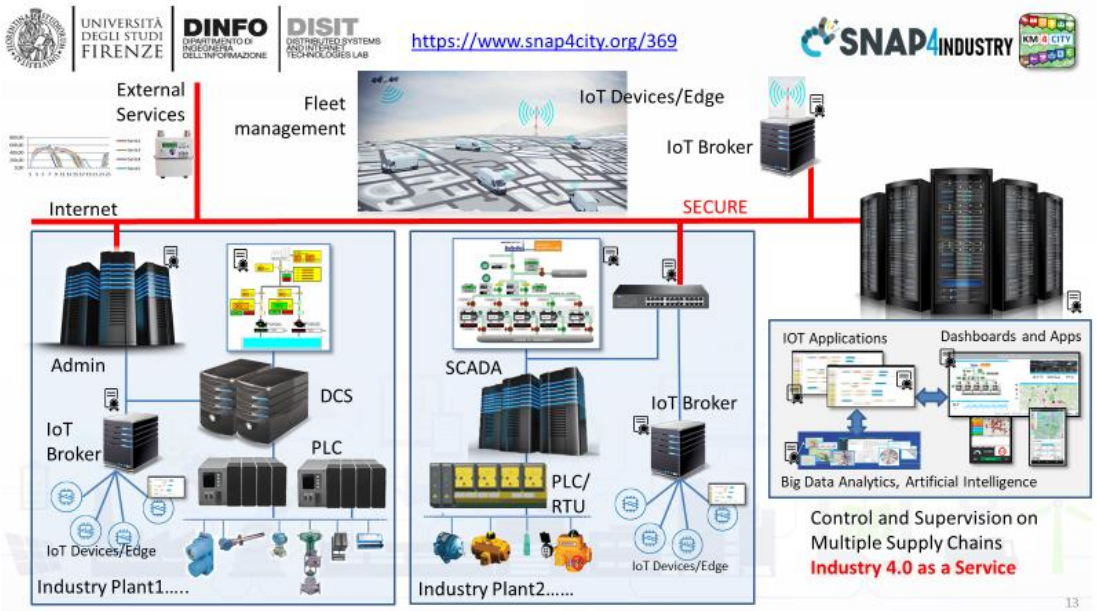


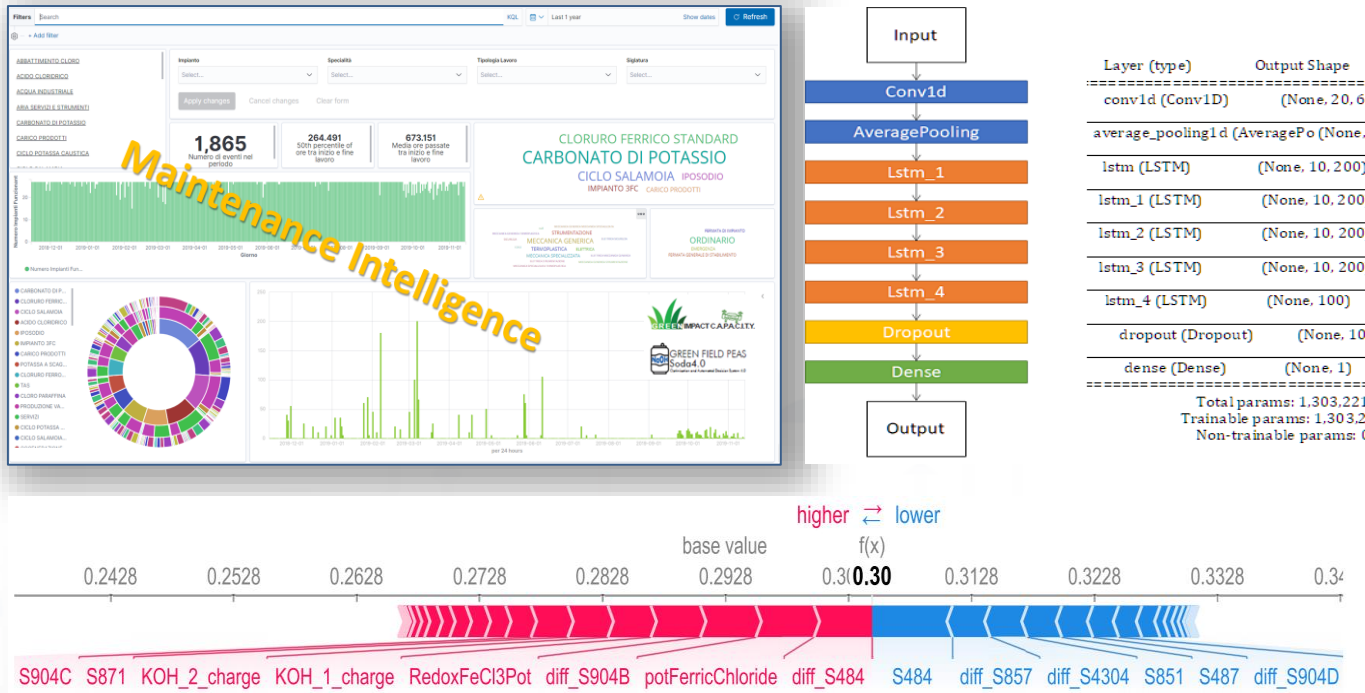
Knowledge Engineering





Industry 4.0 and Predictive Maintenance



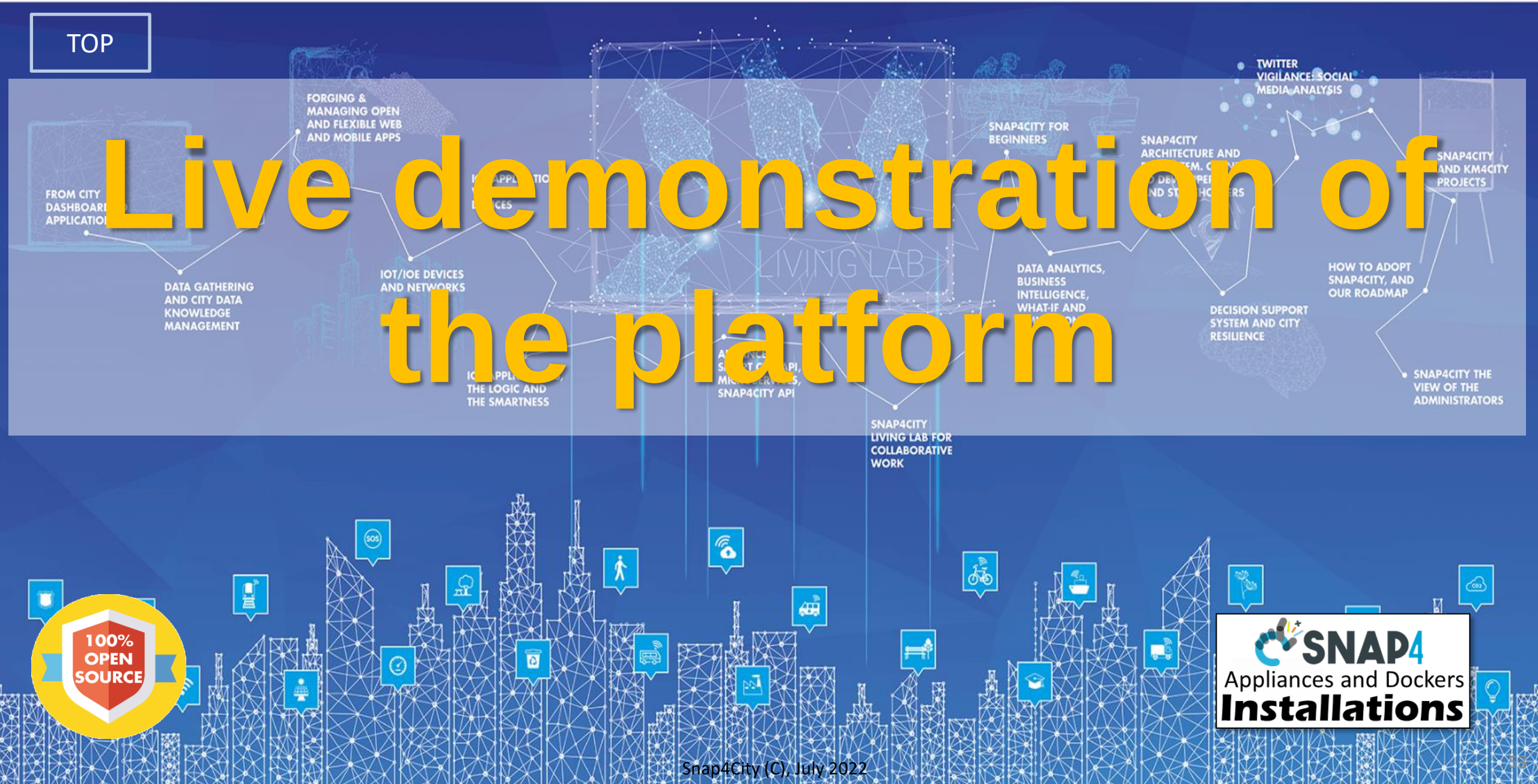


- **HyperAutomation**
- **Supervision and control**
- **TeleControl**
- **Factory integration**

- **Predictive** Maintenance
  - LSTM, CNN-LSTM
- **Maintenance** Intelligence
- Explainable AI

TOP

Live demonstration of the platform



•DEMO

Entering as AreaManager, Developer



- Dashboards
  - Firenze: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTQzOA==
  - Firenze traffic: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=OTg5
  - Firenze air quality: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjU0Mg==
  - 3D: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjM2MA==#
  - Metro: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjg3MA==
  - What-IF: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjE5MA==
  - Alert: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA0OQ==
  - Capelon: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA2Mg==
  - Lonato: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjM0Nw==
  - Svg: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjk4Ng==
  - Svg: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjk0NQ==
  - Roma: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjcyNg==

TOP

Some complete Use Cases



100% OPEN SOURCE

SNAP4 Appliances and Dockers **Installations**

Florence



Smart City Control Room
Florence Metropolitan City

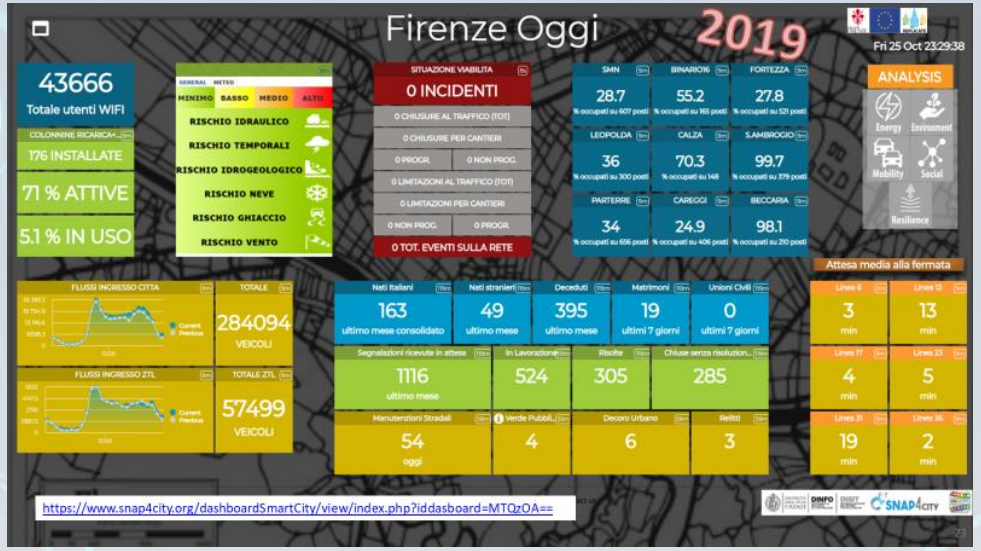
COMUNE DI FIRENZE

reference

SNAP4CITY

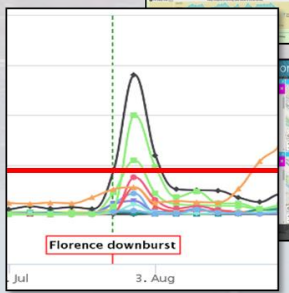
KM 4 CITY

- **Multiple Domain Data**
  - Thousands of Open/Private data, POI, IOT, etc.
  - ***mobility and transport***: accidents, public transport, parking, traffic flow, Traffic Reconstruction, KPI, …
  - ***AND***: environment, civil protection, gov KPI, covid-19, social & social media, people flow, tourism, energy, culture, …
- **Multiple dash/tool Levels & Decision Makers**
  - Real Time monitoring, Alerting, quality assess.
  - Predictions, KPI, DSS, what-if analysis
- **Historical and Real Time data**
  - Billions of Data
- **Services Exploited on:**
  - Multiple Levels, Mobile Apps, API
- **Since 2017**











https://www.snap4city.org/747


Snap4City
Dashboard Management Syst
Dashboard Management Syst
Nuova scheda
snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTQzOA==
Ospite
Firenze Oggi
Mon 16 May 12:59:27
20991
COLONNINE
SITUAZIONE VIABILI
0 INCIDENTI
0 CHIUSURE AL TRAFFICO (TOT)
0 CHIUSURE PER CANTIERI
0 PROGR.
0 NON PROG.
0 LIMITAZIONI AL TRAFFICO (TOT)
0 LIMITAZIONI PER CANTIERI
0 NON PROG.
0 PROGR.
0 TOT. EVENTI SULLA RETE
SMN
42.2
BINA...
54.5
FORT...
23.2
LEOP...
37.3
CALZA...
48
S.AM...
58.6
PART...
55
CARE...
13.8
BECC...
77.6
ANALYSIS
Energy
Environment
Mobility
Social
Resilience
FLUSSI INGRESSO CIT
TOTA...
92207
FLUSSI INGRESSO ZTL
TOTA...
15964
Nati italiani
175
Nati s...
48
Dece...
499
Matri...
72
Unio...
2
Manutenzioni Strad...
19
Verde
18
Decoro Urba...
3
Reiti...
5
Indicatore Rt per la provincia di
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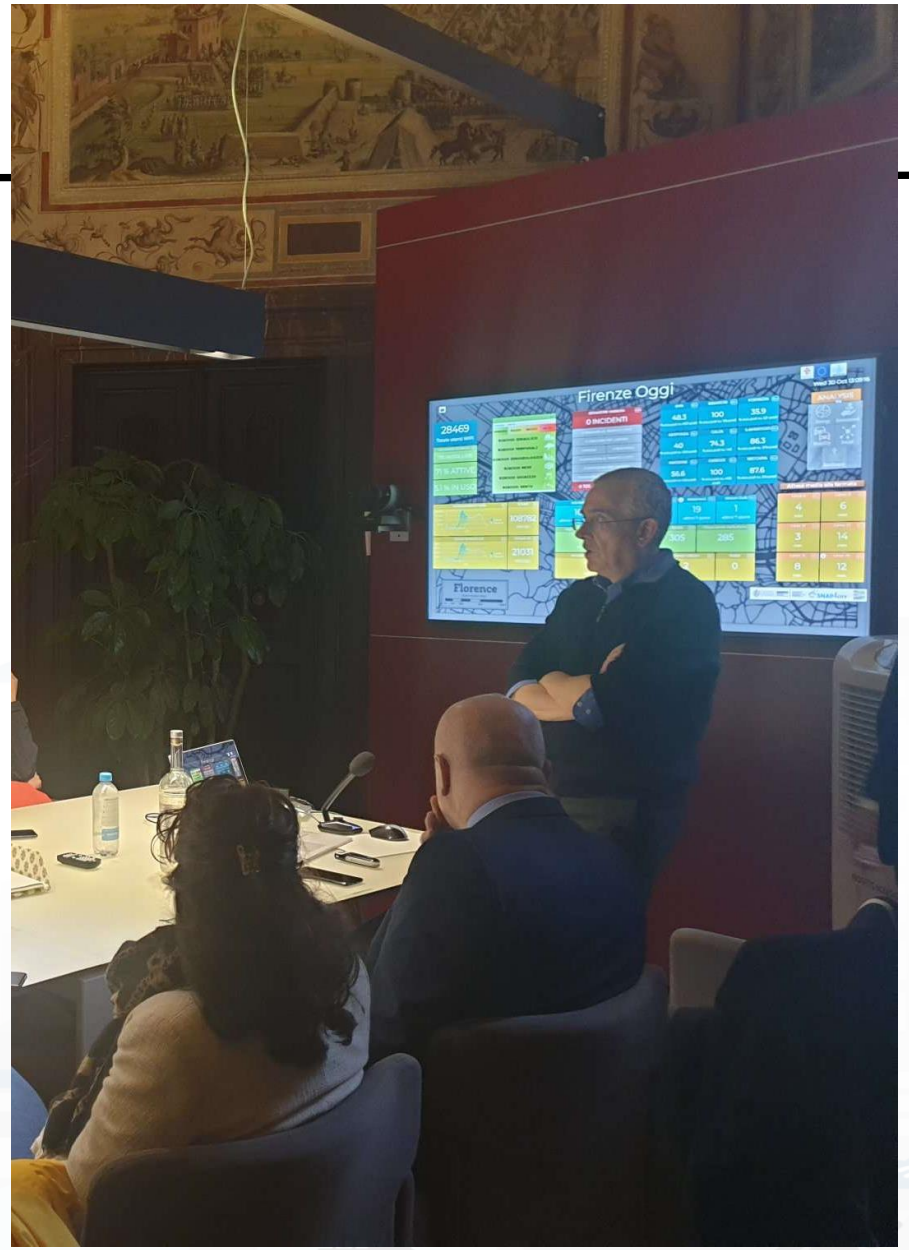
Linea...
Linea...
Linea...
The European House
Ambrosetti





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2020
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FIRENZE
CITTÀ FARO

Replicate Project @ReplicateEU · Oct 30

Last stop allowed to see the #smartcity #controlcenter an exciting experience and impressive



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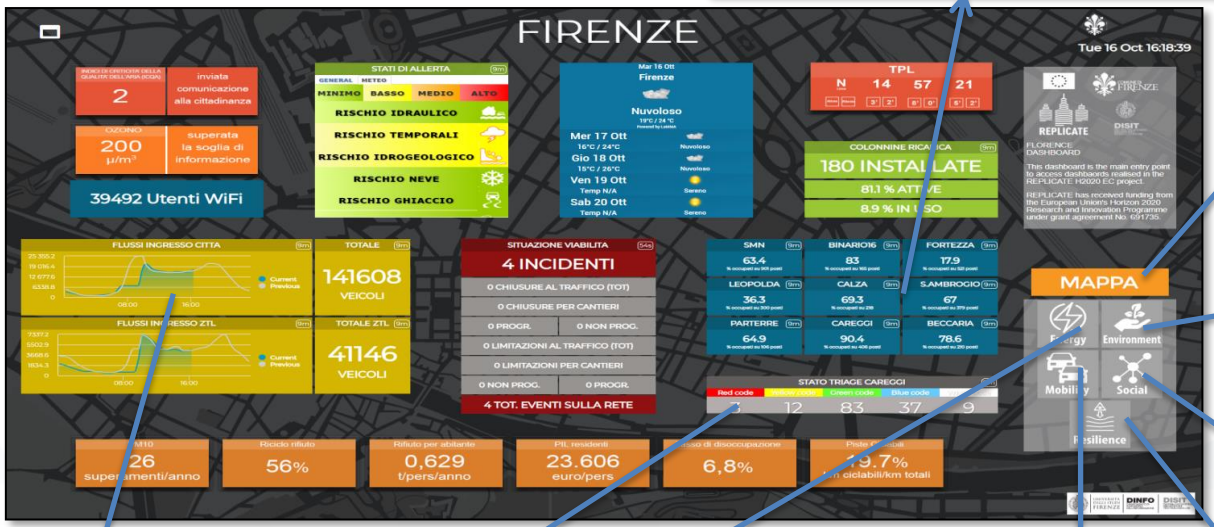
DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

REPLICATE

KM4CITY

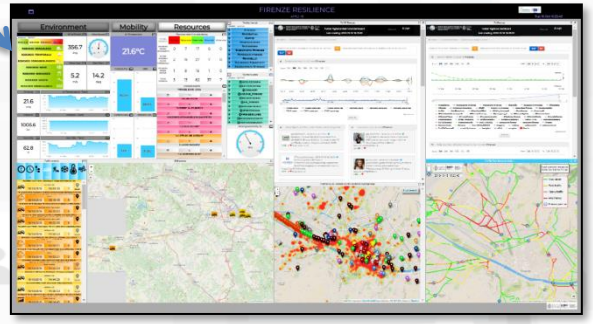


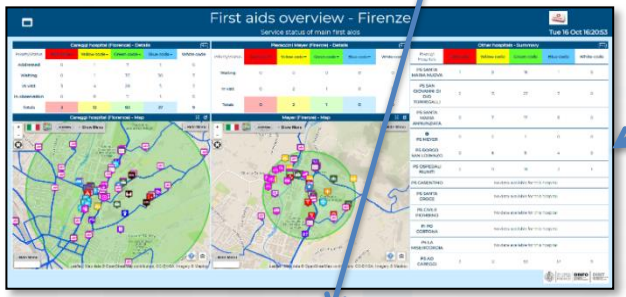




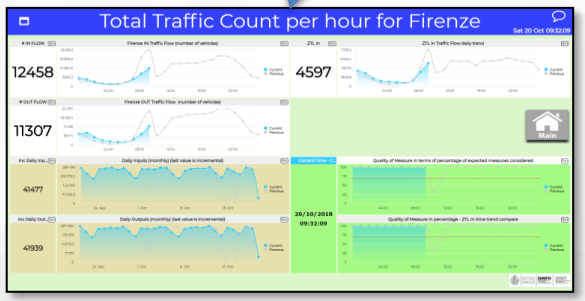








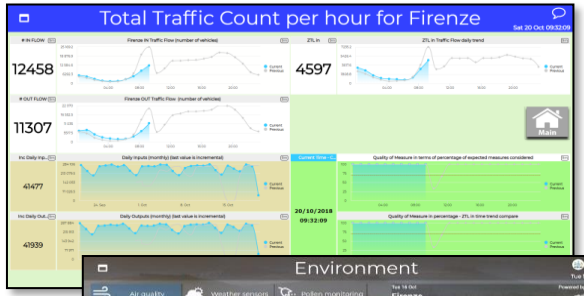






Florence Case

- **Smart City Control Room**
- **Dashboards and Services**
- **Mobile App:** Firenze Where What







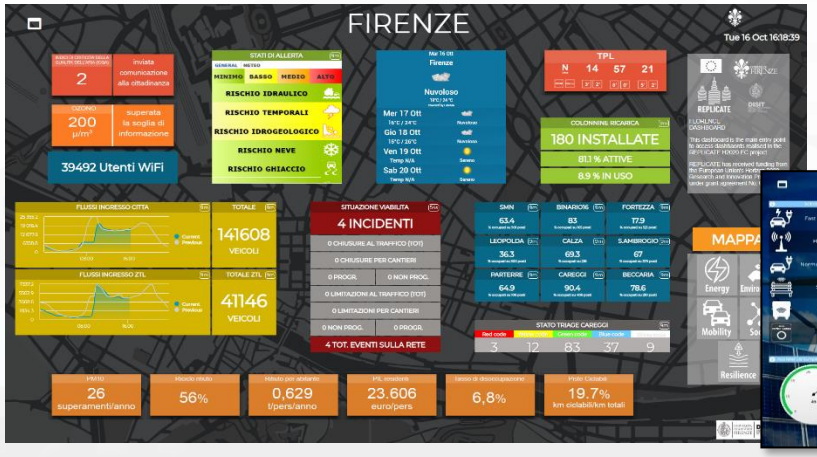
- **Mobility**:
  - quality of public transportation service (mean delay on bus-stops)
  - public transport operators schedule and paths, routing, multimodal routing
  - traffic flow reconstruction
  - Smart parking: predictions
  - Accidents and events, Log, heatmaps
- **Environment**:
  - smart irrigators
  - smart waste
  - Sensors: PM10. PM2.5,…..
  - Heatmaps: PM10, PM2.5, ….
  - NOX predictions
- **Energy**:
  - recharging stations (fast and reg.)
  - consumption meters (smart info)
  - smart light, street lights
- **Weather**
  - Forecast and actual



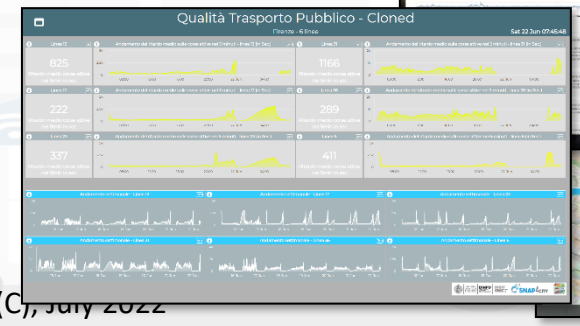
- **Social**:
  - smart benches
  - Twitter monitoring, Sentiment analysis, NLP text
  - TV camera streams
- **People Flows**:
  - Wi-Fi, people flow
  - Origin destination matrices
- **Governmental and Communications**:
  - KPI of the City
  - Digital Signage
  - Civil protection, Resilience (Resolute)
- **Tourism and Culture:**
  - POI, etc.

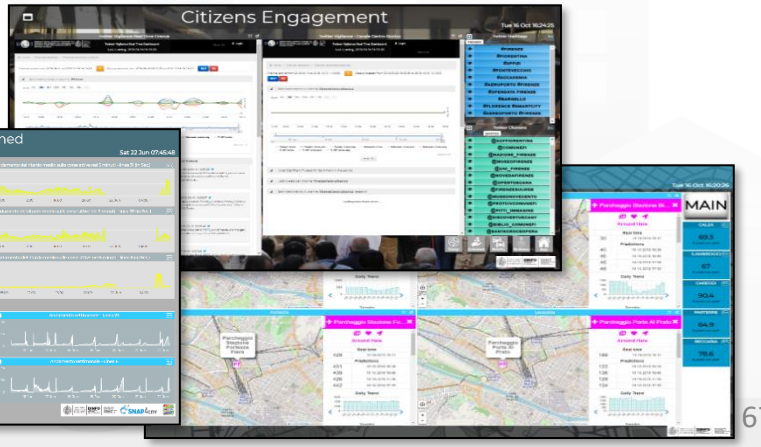
Analysis:

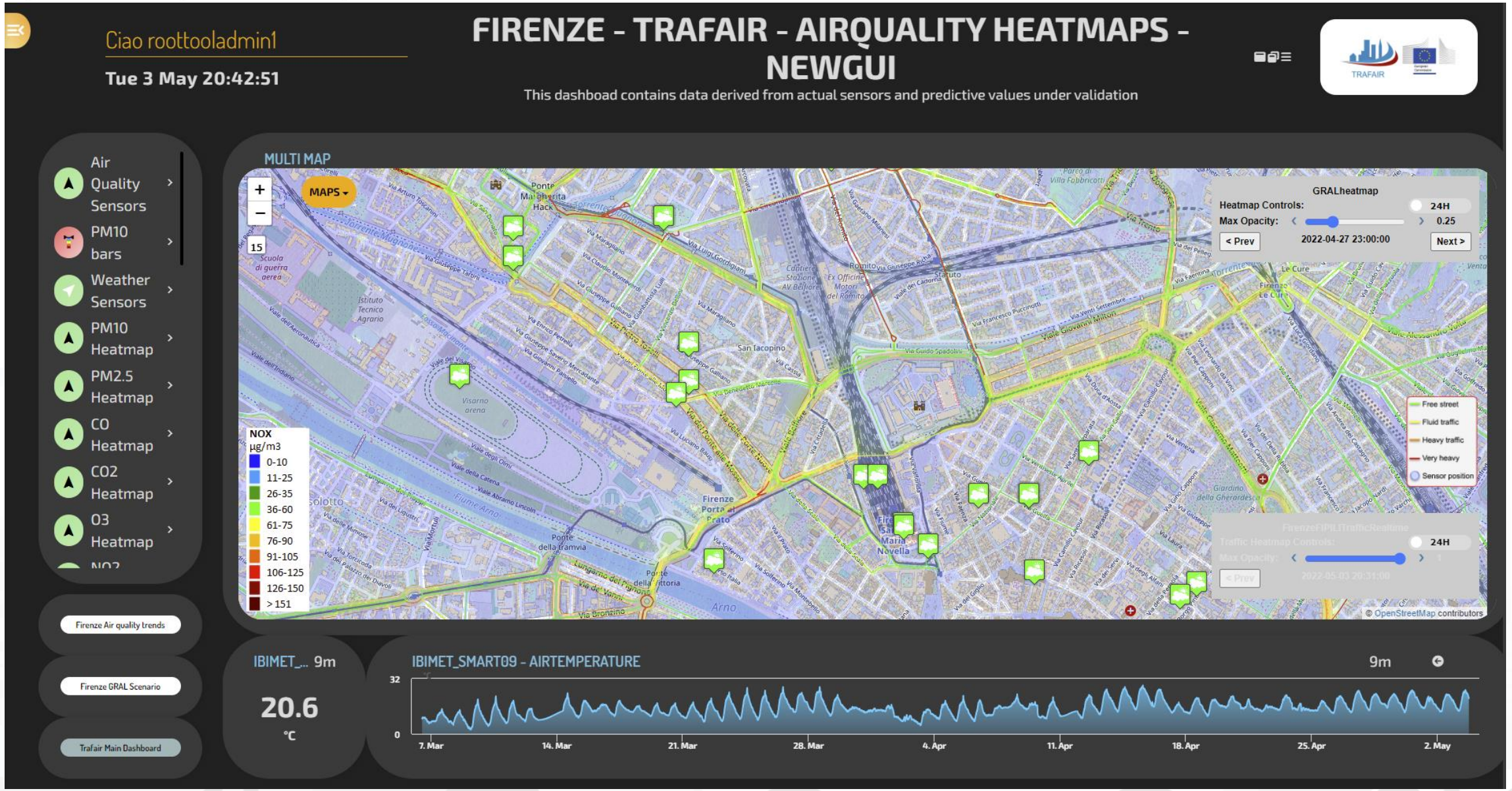
- **what-if routing, scenarios,**
- **traffic flow, environmental predictions**











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3D views



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

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SNAP4CITY KM4CITY

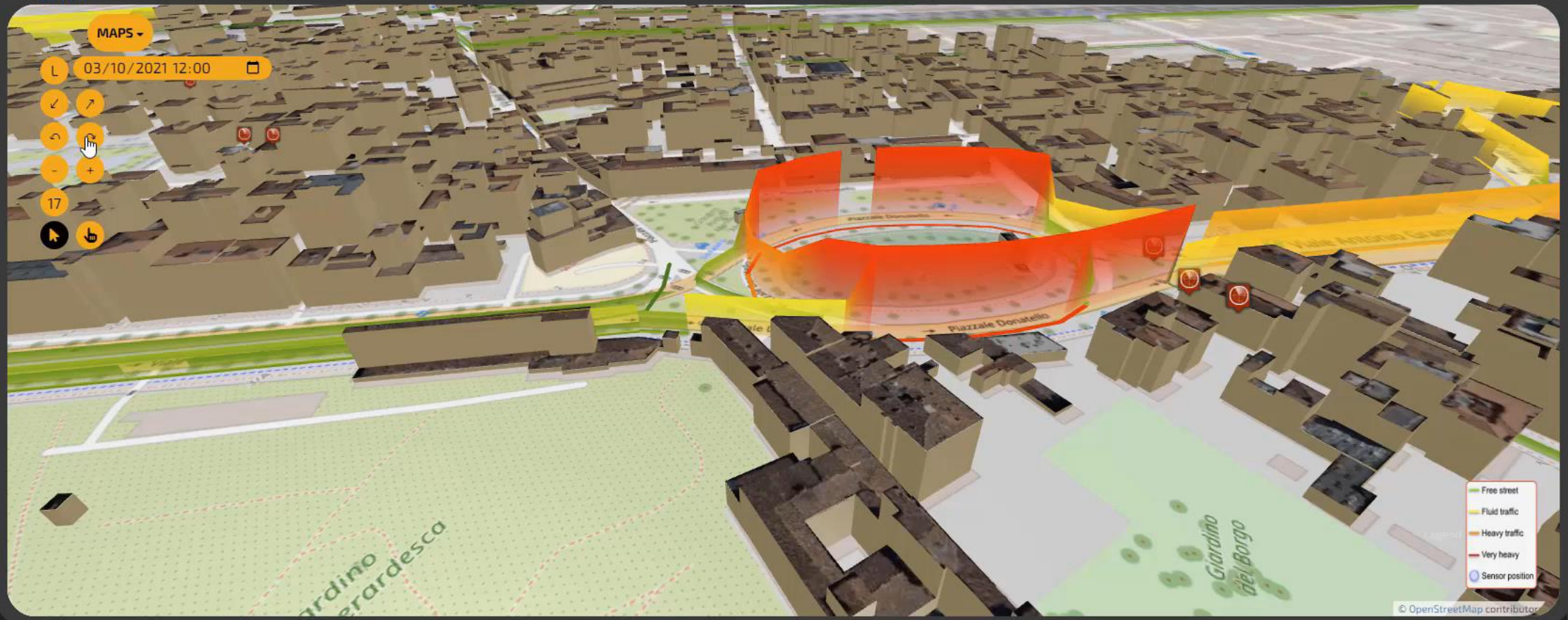
Ciao roottooladmin1

Thu 16 Jun 15:15:03

3D MAP DECK TEST-NEWGUI

demonstrator

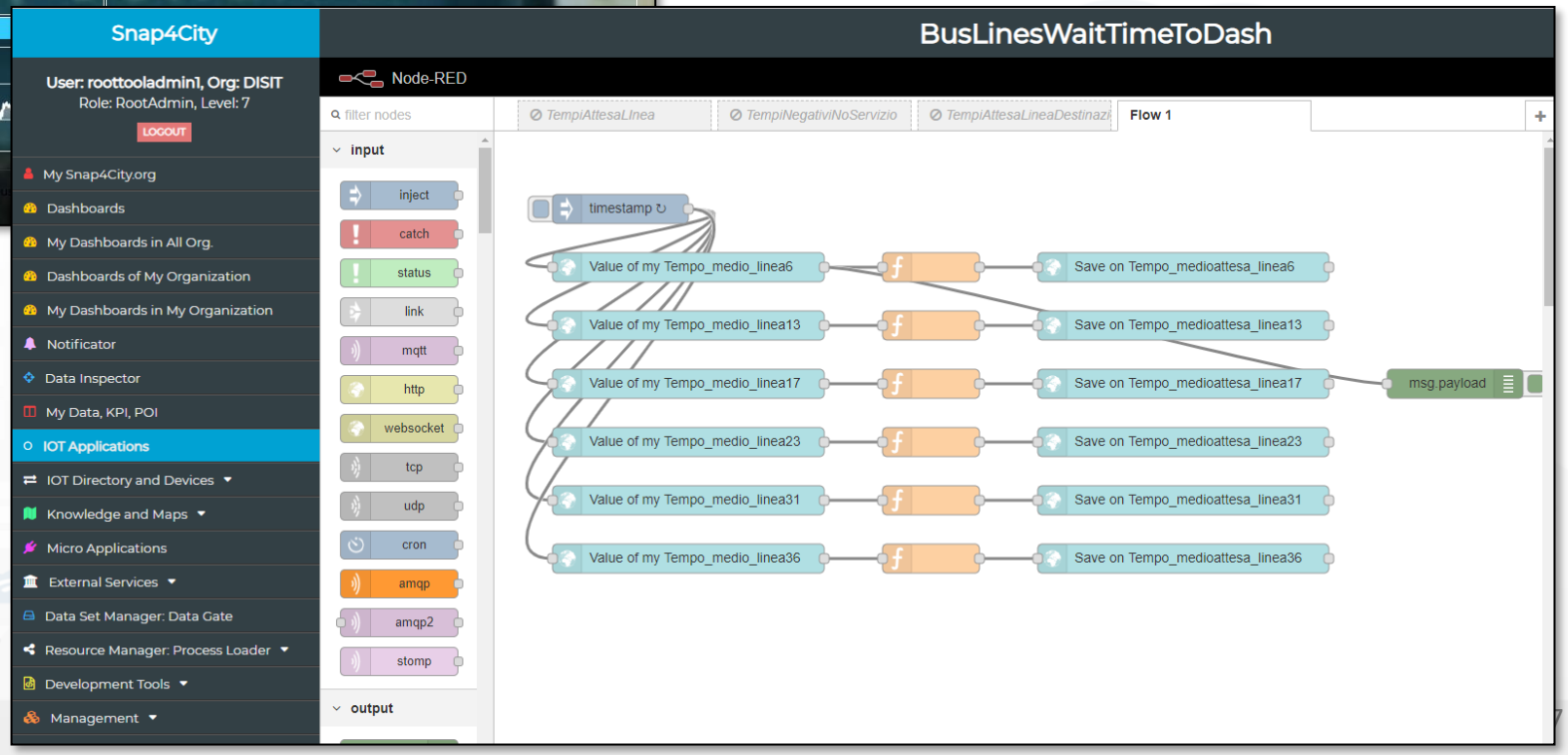
3D MAP

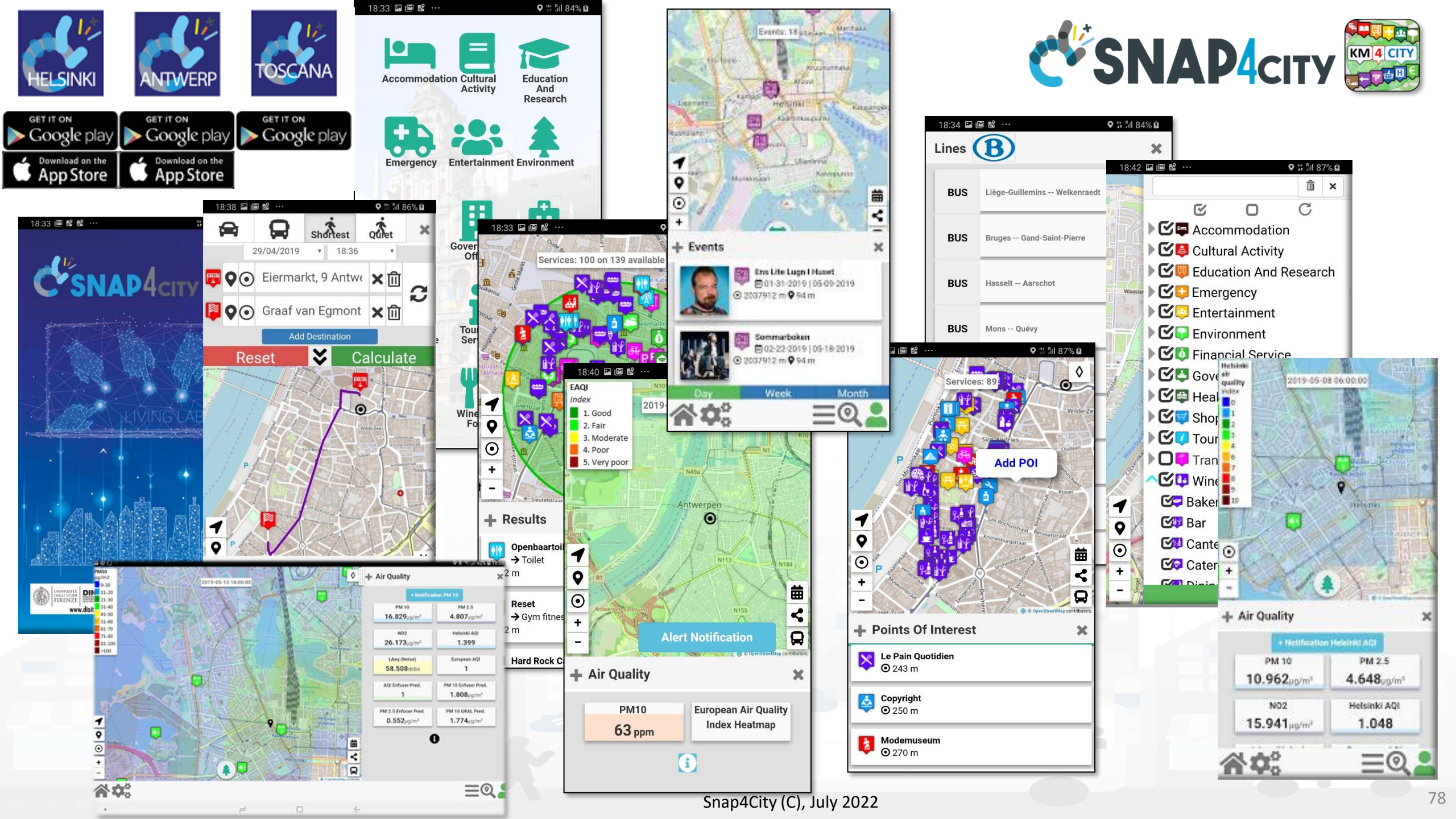


Estimation of the mean waiting time at bus stops





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TOSCANA
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KM 4 CITY
Accommodation
Cultural Activity
Education And Research
Emergency
Entertainment
Environment
Shortest
Quiet
Add Destination
Reset
Calculate
Events
Day
Week
Month
Services: 100 on 139 available
EAQI Index
1. Good
2. Fair
3. Moderate
4. Poor
5. Very poor
Results
Antwerpen
Alert Notification
Air Quality
PM10
63 ppm
European Air Quality Index Heatmap
Lines
BUS
Liège-Guillemins -- Welkenraedt
Bruges -- Gand-Saint-Pierre
Hasselt -- Aarschot
Mons -- Quévy
Services: 89
Add POI
Points Of Interest
Le Pain Quotidien
243 m
Copyright
250 m
Modemuseum
270 m
Air Quality
PM 10
10.962
PM 2.5
4.648
NO2
15.941
Helsinki AQI
1.048

Tuscany Region

https://www.snap4city.org/760

Firenze, Pisa, Livorno, Prato, etc.





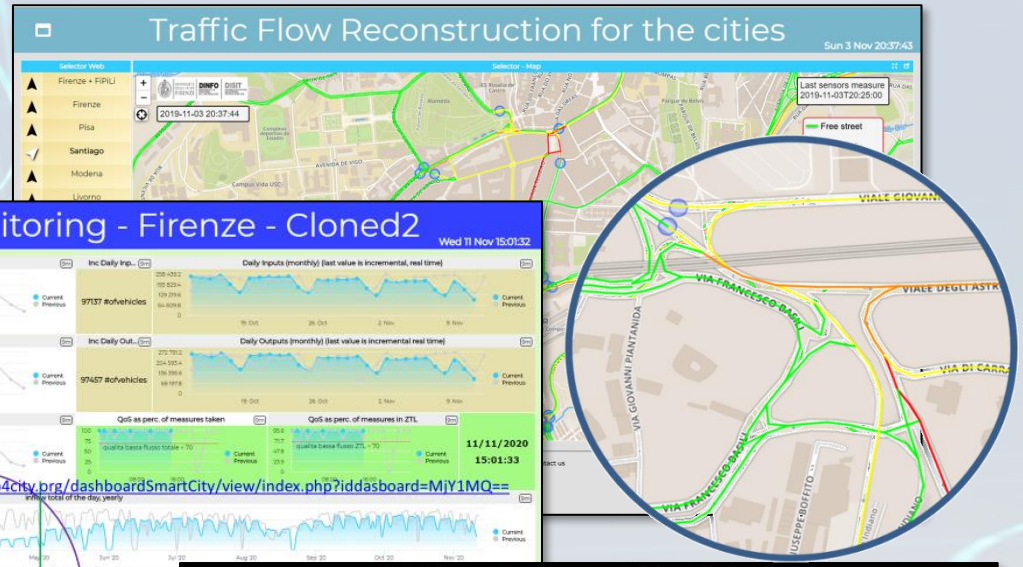


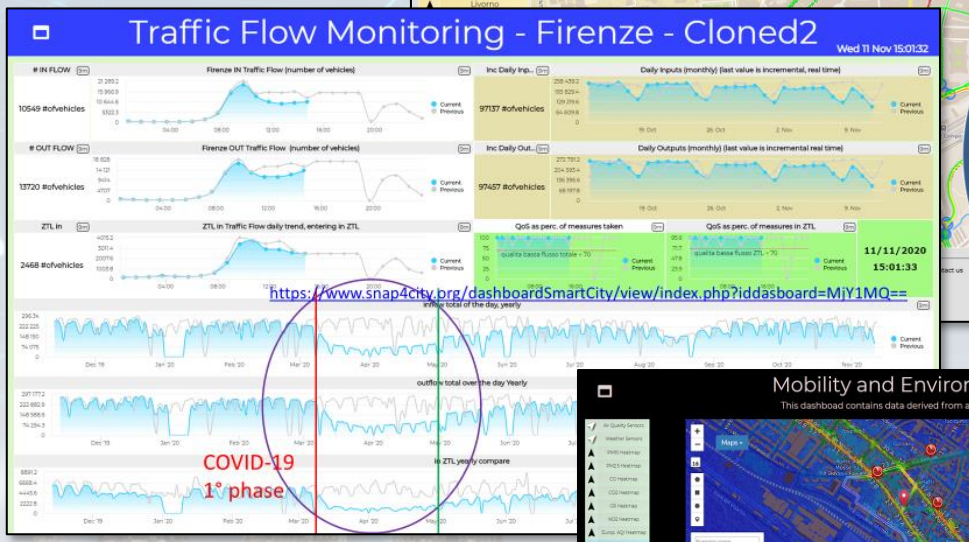
Mobility and Transport Traffic Flow Analysis

Cities: Firenze, Pisa, Livorno, Modena, Santiago di Compostela

reference

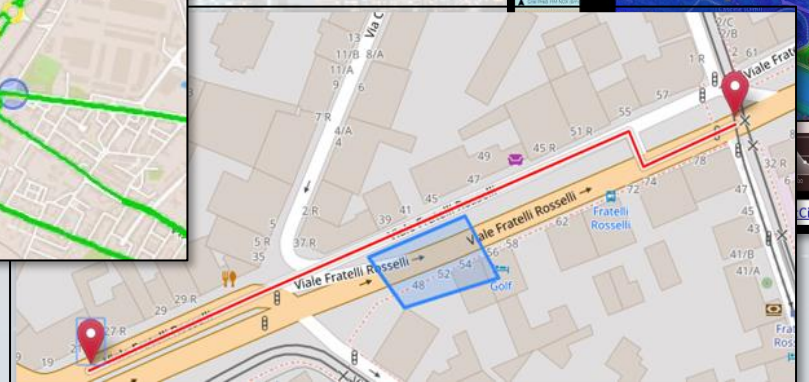
- **Multiple Domain Data**
  - Traffic Flow sensors, city structure, weather
- **Decision Makers Multiple Locations**
  - Real time Monitoring, predictions
  - Traffic Flow Predictions,
  - Traffic Reconstructions, routing
  - Dashboards, What-IF analysis
  - Mobile App, people flows
- **Historical and Real Time data**
- **Services Exploited on:**
  - Dashboards, Mobile App
- **Since 2017, 2019**



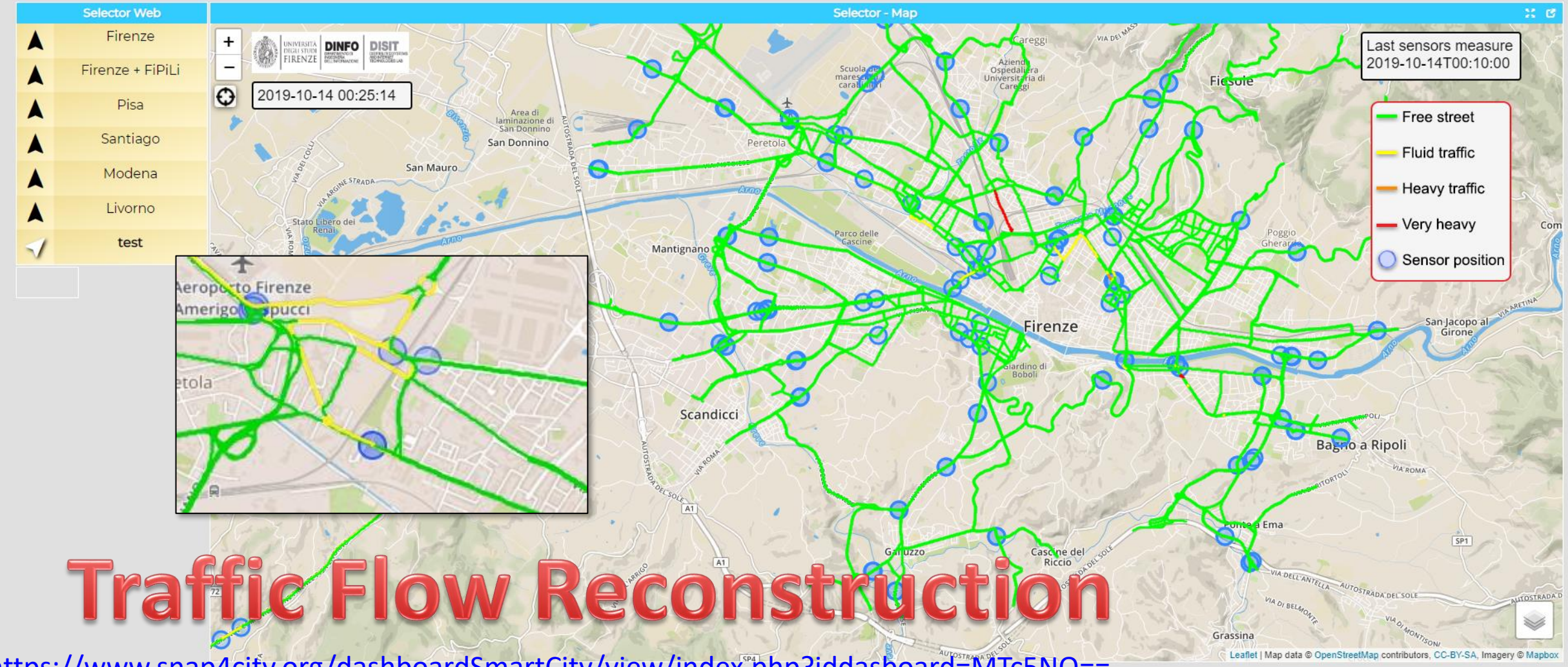








Traffic Flow Reconstruction for the cities



Traffic Flow Reconstruction

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc5NQ==

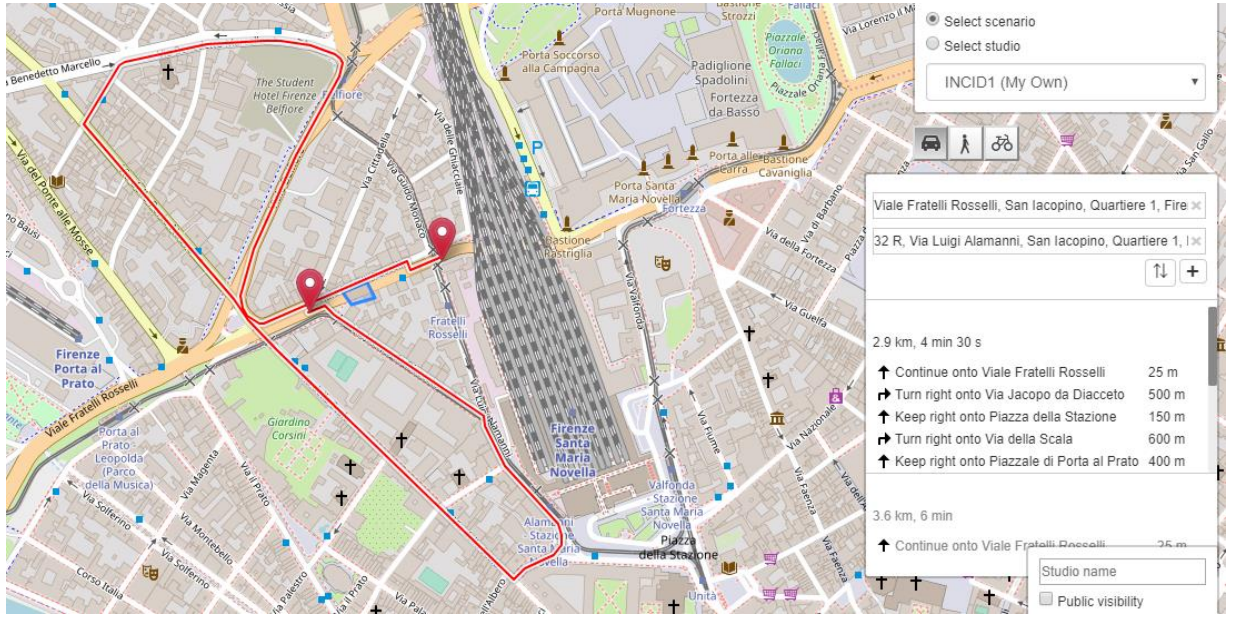
What-If Analysis

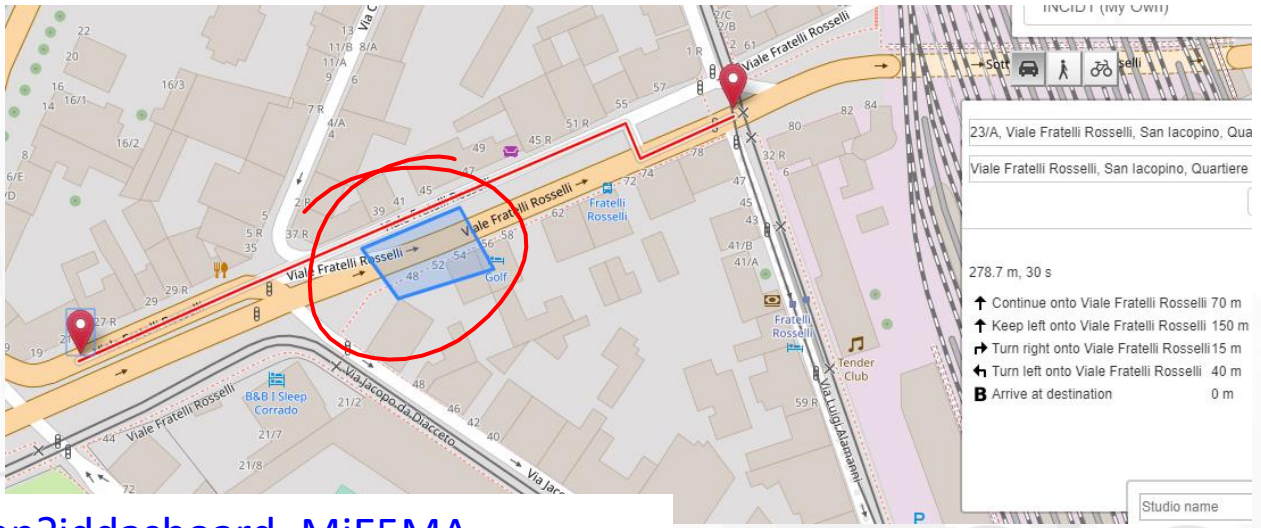
Accidents and elements blocking Points and Shapes taken into account for:

- Routing
- Traffic Flow reconstruction
- Evacuation paths
- Rescue team paths

Assessment on the basis of changes:

- Mobility demand assessment
- Mobility Offer assessment





https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjE5MA==

Mobility and Environment What-IF Analysis

This dashboad contains data derived from actual sensors and predictive values under validation

Mon 14 Oct 00:48:17

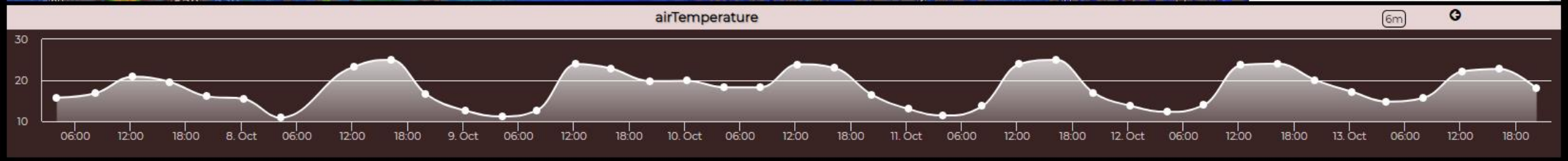
- Air Quality Sensors
- Weather Sensors
- PM10 Heatmap
- PM2.5 Heatmap
- CO Heatmap
- CO2 Heatmap
- O3 Heatmap
- NO2 Heatmap
- Europ. AQI Heatmap
- Air Humidity Heatmap
- Air Temp. Heatmap
- Wind Speed Heatmap
- Gral Pred. HM NOX (3m)
- Gral Pred. HM NOX (6m)
- Traffic Sensors
- Traffic Flow
- Cycling Paths
- Accident Heatmap
- Only HRes Anym. Gral
- Scenarious
- What-if analysis

Firenze Oggi

Air Temperat... 6m







https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjE5MA==

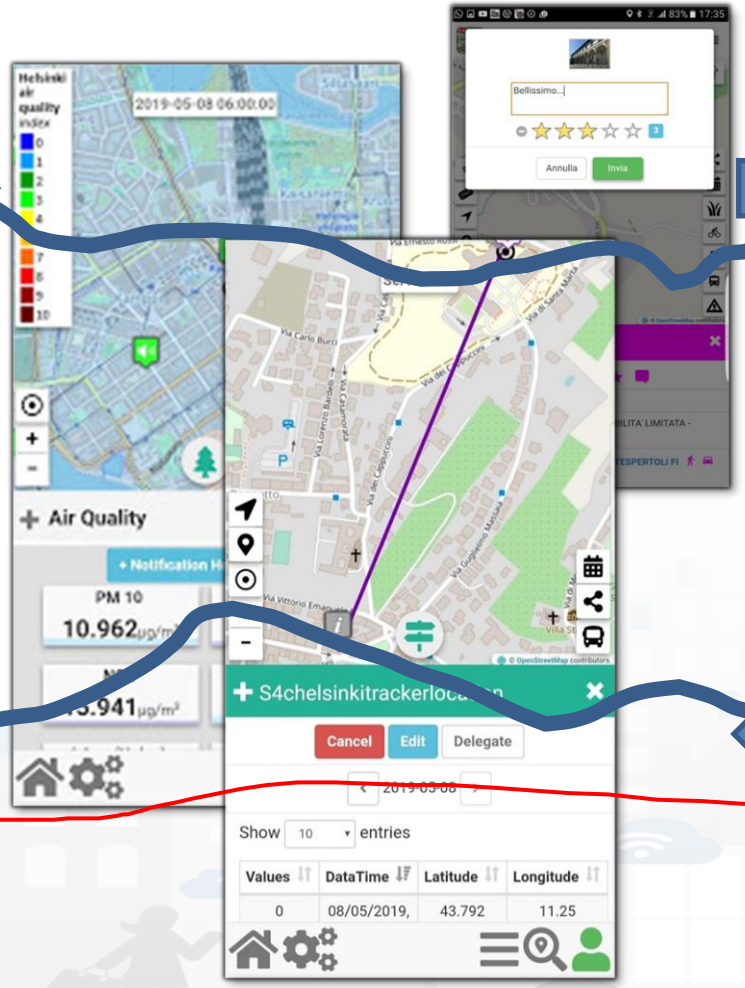
The App is a Bidirectional Device

- GPS Positions
- Selections on menus
- Views of POI
- Access to Dashboards
- searched information
- Routing
- Ranks, votes
- Comments
- Images
- Subscriptions to notifications
- ….

Produced information

- Viewed ?
- Accepted ?
- Performed ?
- …

Users



Derived information

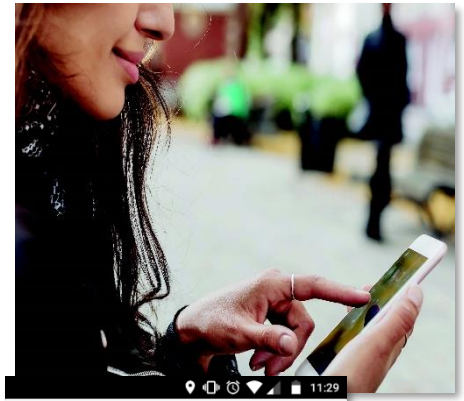
- Trajectories
- Hot Places by click and by move
- Origin destination matrices
- Most interested topics
- Most interested POI
- Delegation and relationships
- Accesses to Dashboards
- **Cumulated Scores from Actions**
- Requested information
- Routing performed
- …..

Produced information

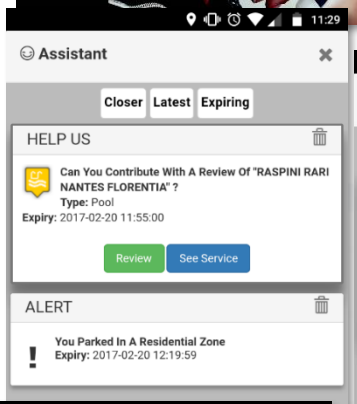
- Suggestions
- Engagements
- Notifications
- …

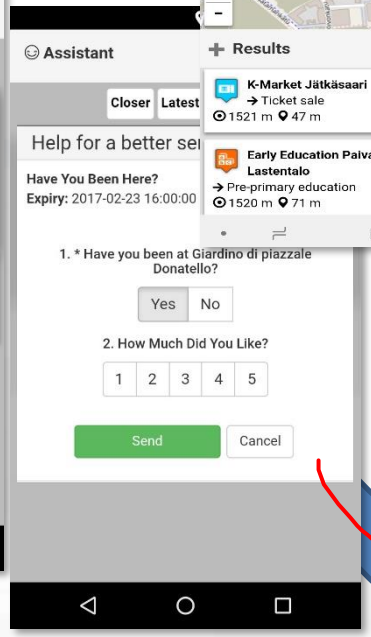
System

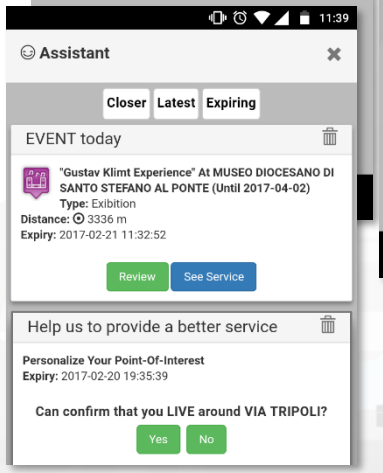
Users' Engagement

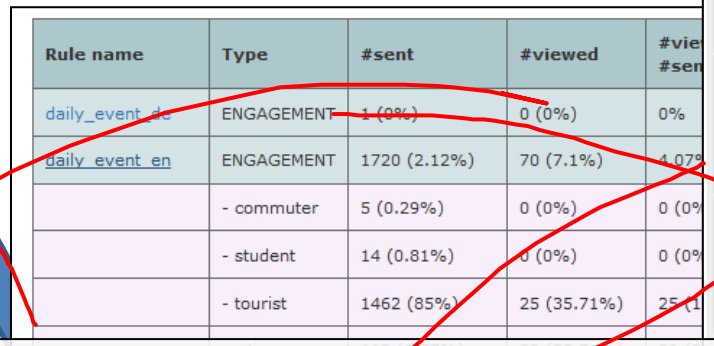




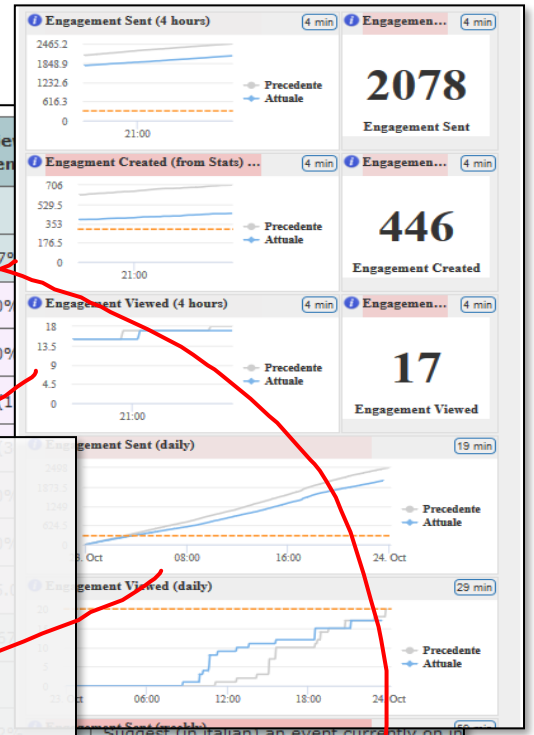


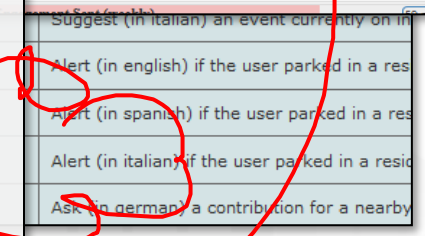






Rule name	Type	#sent	#viewed	#vie #sen
daily_event_de	ENGAGEMENT	1 (0%)	0 (0%)	0%
daily_event_en	ENGAGEMENT	1720 (2.12%)	70 (7.1%)	4.07%
	- commuter	5 (0.29%)	0 (0%)	0 (0%
	- student	14 (0.81%)	0 (0%)	0 (0%
	- tourist	1462 (85%)	25 (35.71%)	25 (1





Inform
- Air Quality forecast is not very nice
- You have parked out of your residential parking zone
- The Road cleaning is this night
- The waste in S.Andreas Road is full

Engage
- Provide a comment, a score, etc.

Stimulate / recommend
- Events in the city, services you may be interested, etc..

Provide Bonus, rewards if needed
- you get a bonus since you parked here
- We suggest: leave the car out of the city, this bonus can be used to buy a bus ticket

Rules

User context

City context



Campaing on Sustainable Mobility

Sii smart.
Sii-Mobility!
Scarica, viaggia, vinci!



Dal 15 aprile al 15 luglio scegliere il trasporto pubblico ti premia!
Scarica l'app "Toscana dove, cosa", guadagna punti viaggiando in autobus e vinci tanti fantastici premi.
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DINFO
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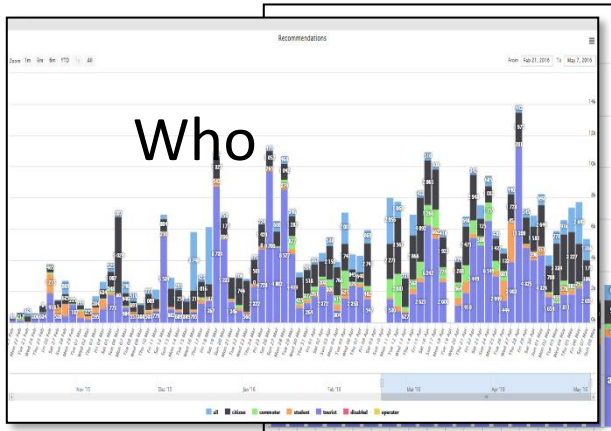
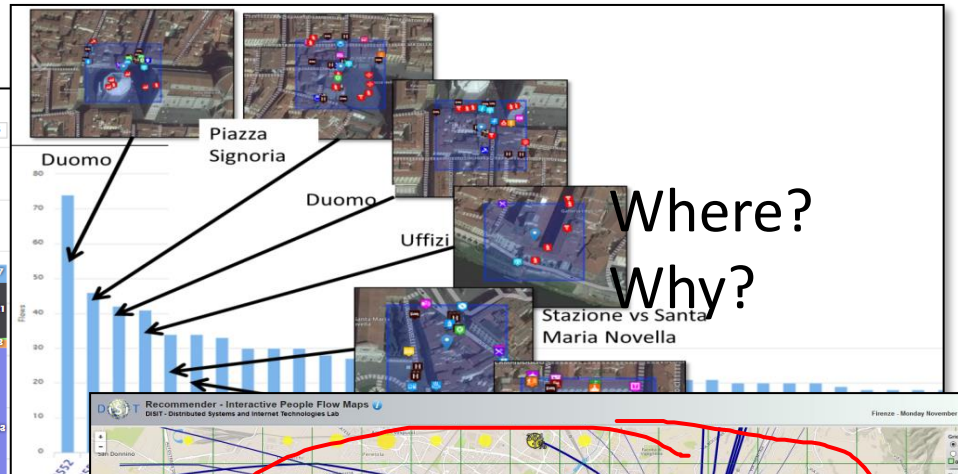
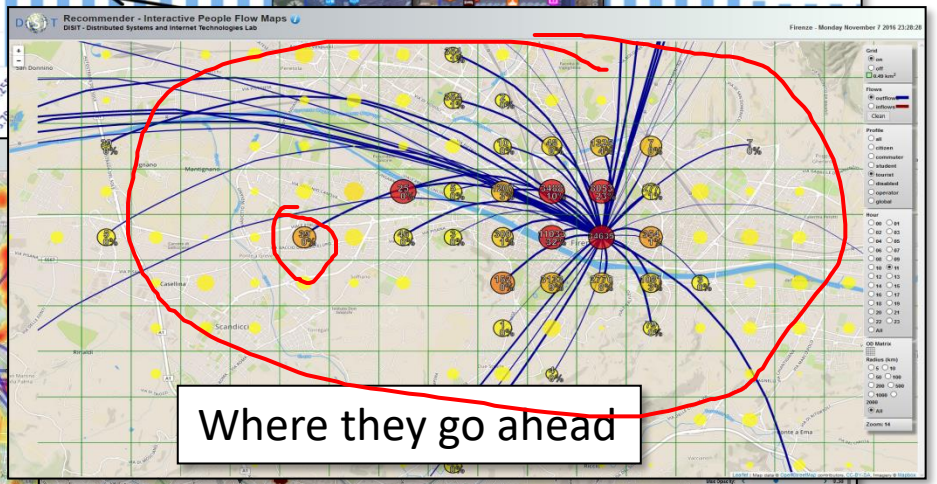
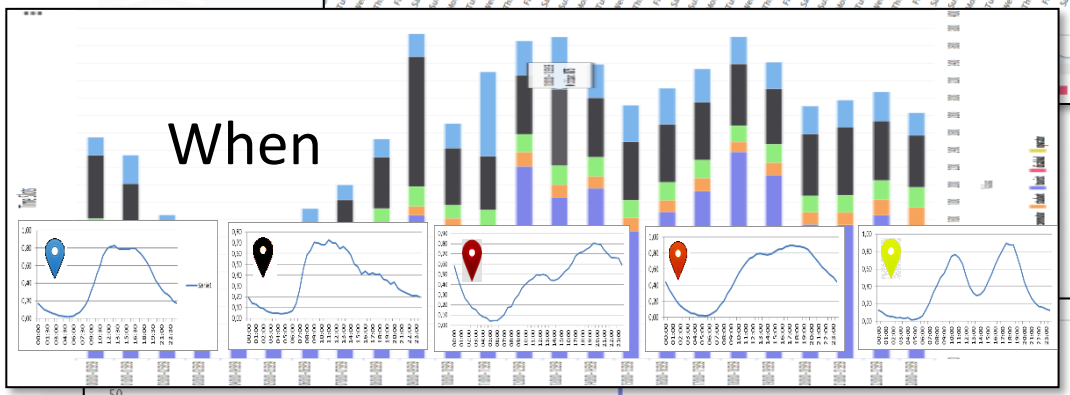
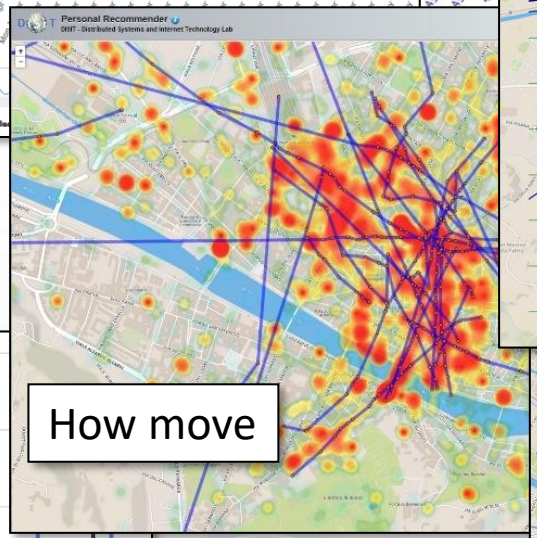
User Behavior Analyser for Collective Profiling

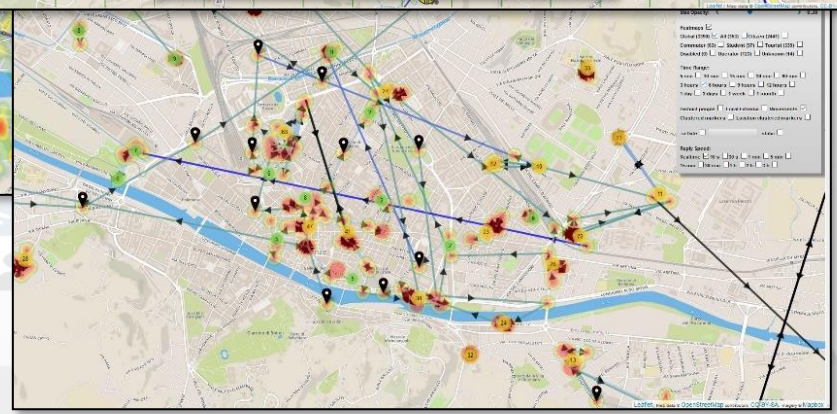


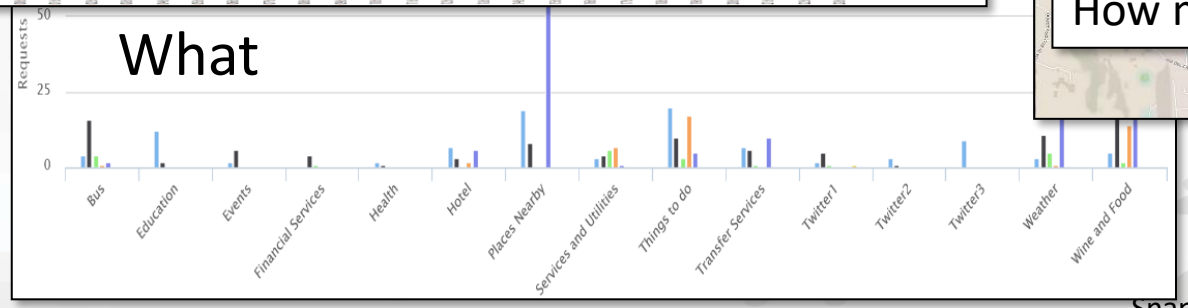












15MinCityIndex

What would support my neighborhood to become a 15-Minute City?

Using the Open Data:
We developed a data analytic tool based on municipal and national open data to assess services adequacy for people living in each 15 minutes areas of the city.

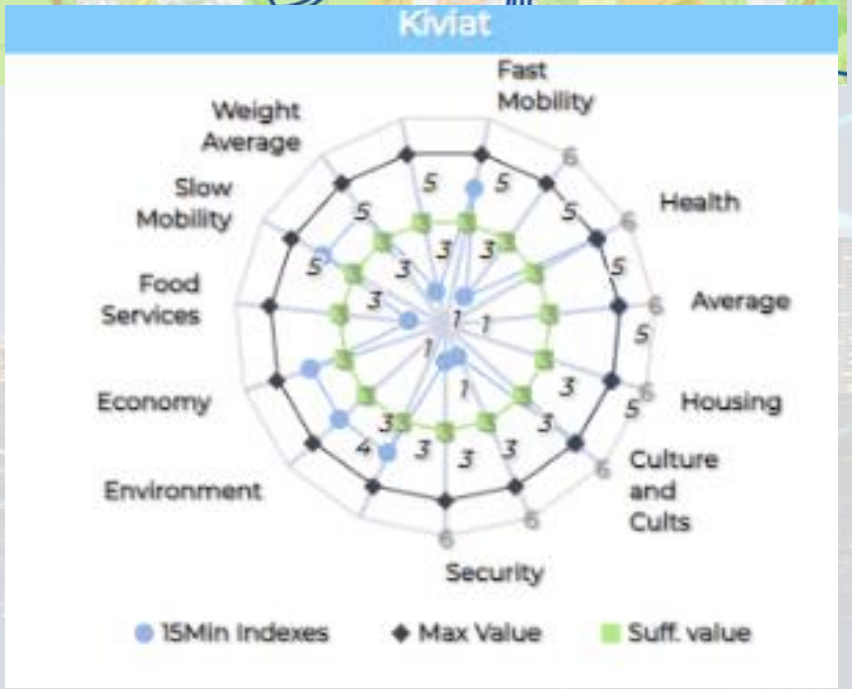


Good public transport services: bus, new tram line, train stations, cycle paths.



The tool supports the becoming of a 15-Minute city evaluating the service level in various domains.





Careggi/Rifredi is a relevant district in Florence because of hosting the main Florence/Tuscany hospitals Careggi and Meyer, but also university headquarters and many other workplaces.

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

Florence

https://www.snap4city.org/747

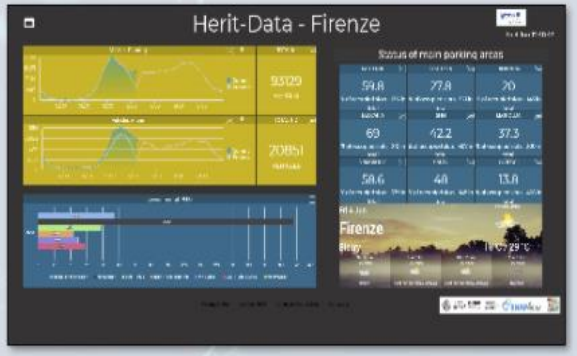


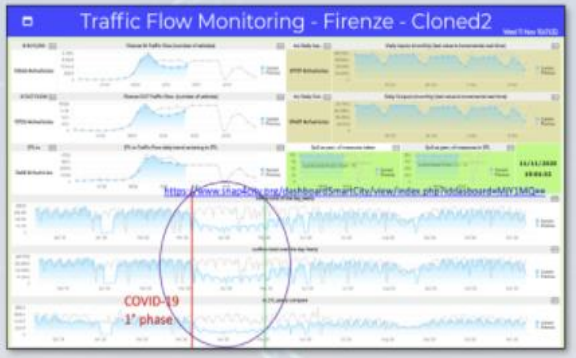
Herit-Data - Florence Main

Tue 21 Dec 23:38:03

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzE0NA==

- **Multiple Domains Data**
  - Traffic, environment, People, parking, stock options, Twitter, tc.
- **Decision Makers Multiple Locations**
  - NO2 long term predictions
  - Twitter analysis
- **Historical and Real Time data**
- **Services Exploited on:**
  - Dashboards
  - Social media,
  - Sentiment Analysis
- **Since 2019, 2020**









Interreg Mediterranean HERIT-DATA

Main
Herit-Data Main

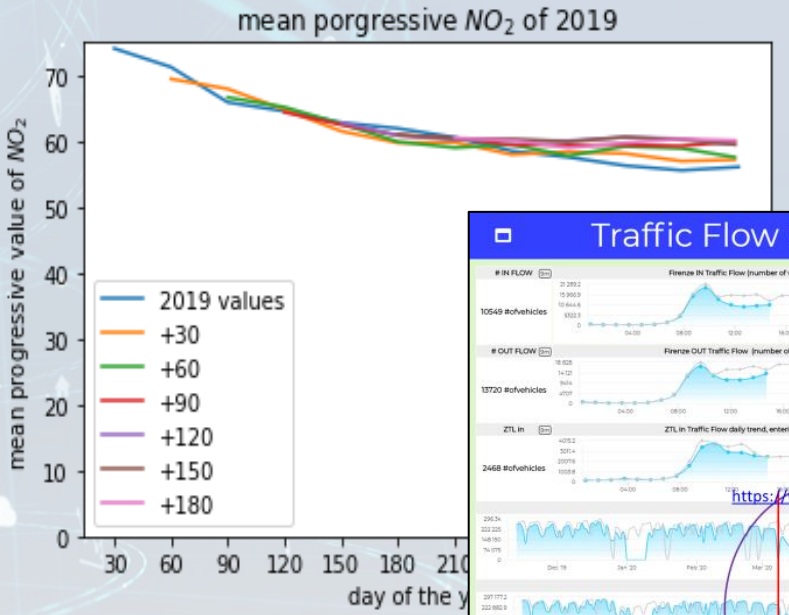
Regione Toscana

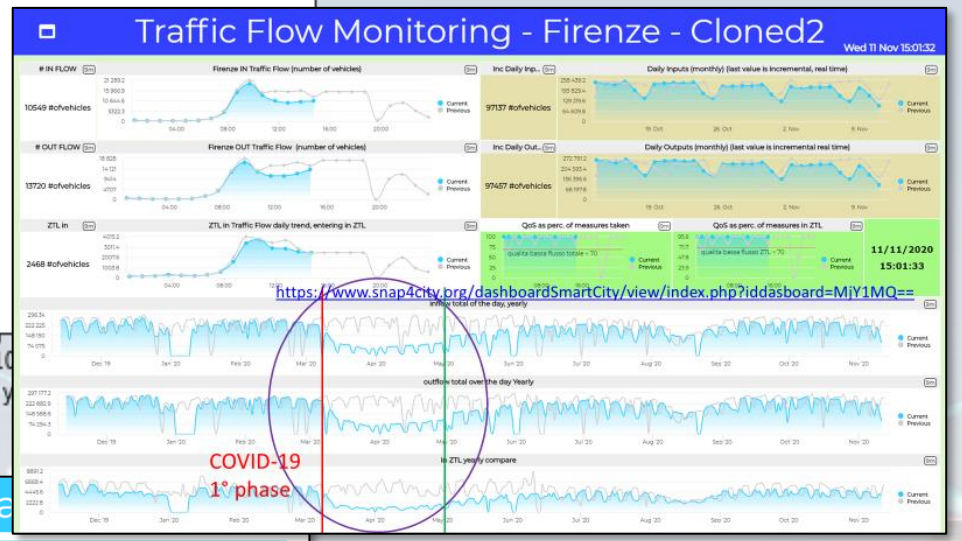
Università degli Studi Firenze | DINFO | DISIT | SNAP4CITY | KM4CITY

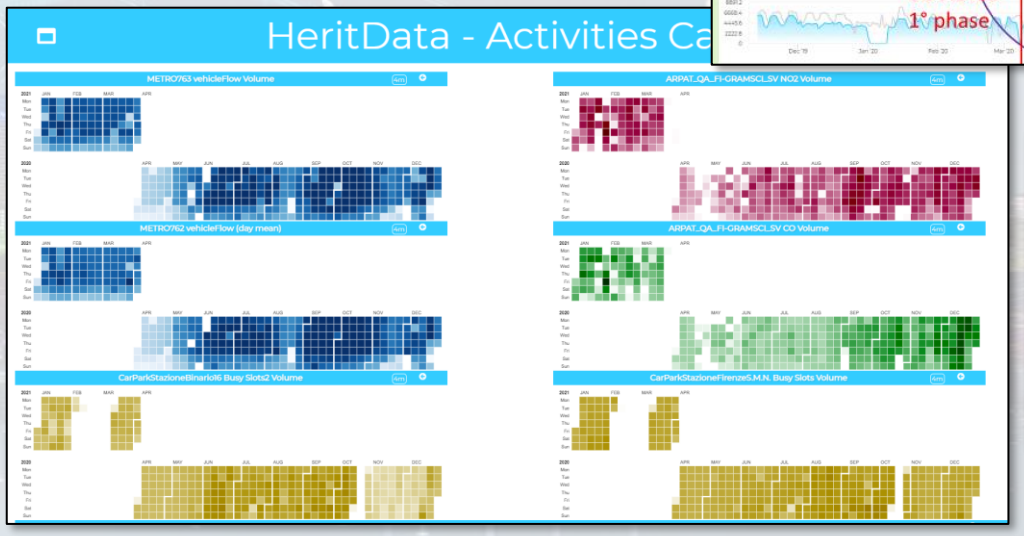
Impact of COVID-19

Cities: Firenze, Pisa, Livorno, Toscana

- **Multiple Domains Data**
  - Traffic, environment, People, parking, stock options, Twitter, tc.
- **Decision Makers Multiple Locations**
  - NO2 long term predictions
  - Twitter analysis
- **Historical and Real Time data**
- **Services Exploited on:**
  - Dashboards
  - Social media,
  - Sentiment Analysis
- **Since 2019, 2020**







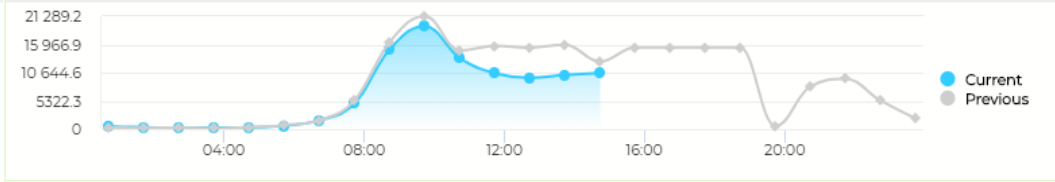
metric	model30	model60	model90	model120	model150	model180
MAE	1.21	1.31	1.52	2.04	2.31	2.37
RMSE	2.16	2.61	4.18	6.77	7.83	7.93
MAPE	1.99	2.20	2.65	3.57	4.07	4.18
R2	0.91	0.83	0.80	0.54	0.45	0.14

Table 4. Assessment of the predictive models with respect to the actual values of the 2019.

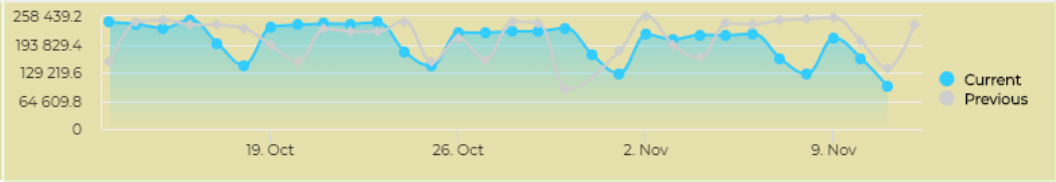
Traffic Flow Monitoring - Firenze - Cloned2

Wed 11 Nov 15:01:32

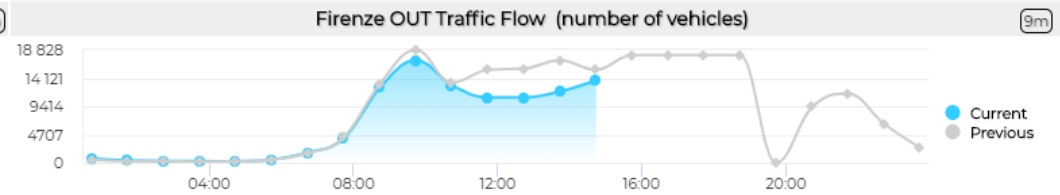
 # IN FLOW — 10549 #ofvehicles



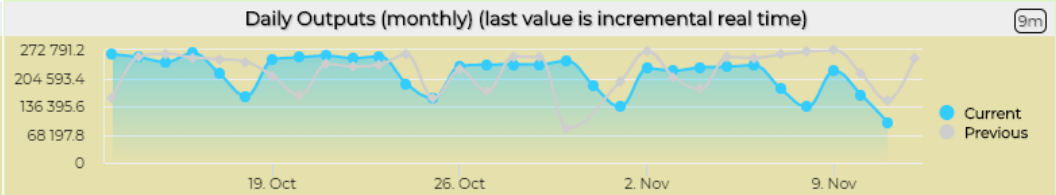
Inc Daily Inp... — 97137 #ofvehicles



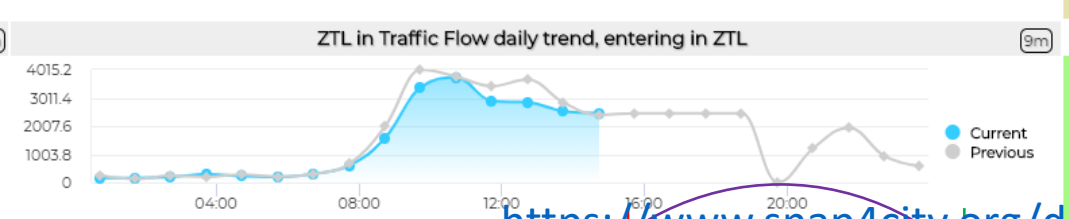
 # OUT FLOW — 13720 #ofvehicles

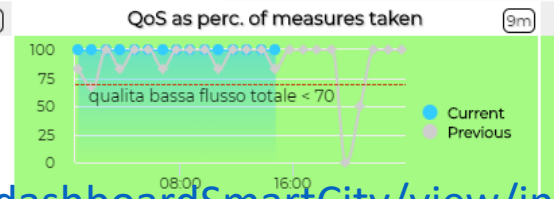


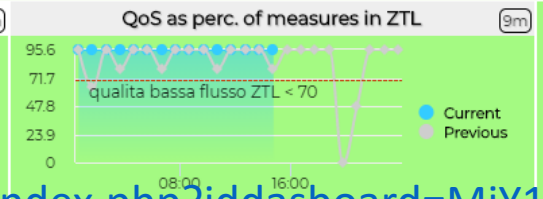
Inc Daily Out... — 97457 #ofvehicles



ZTL in — 2468 #ofvehicles

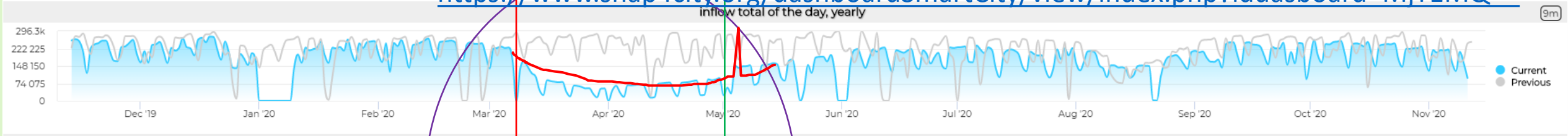


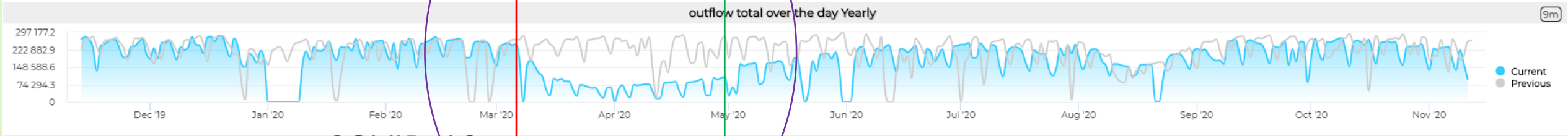


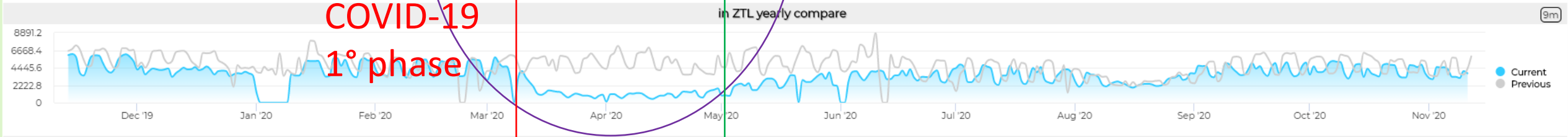


11/11/2020
15:01:33

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjY1MQ==



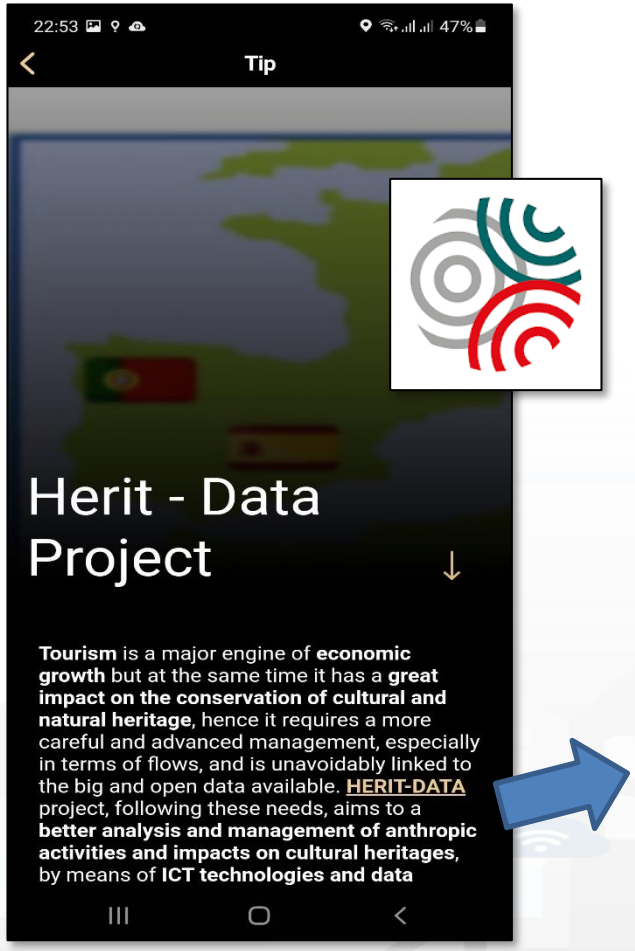




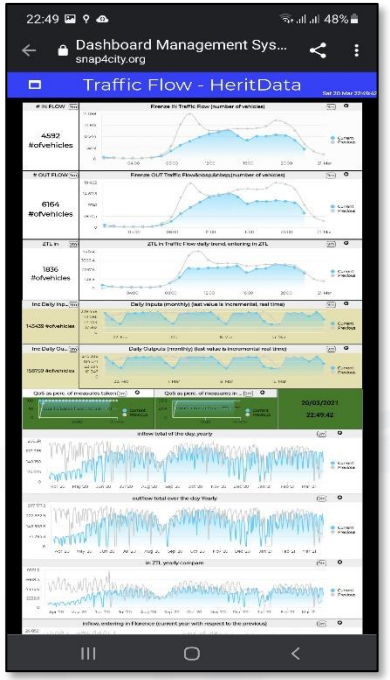
COVID-19
1° phase

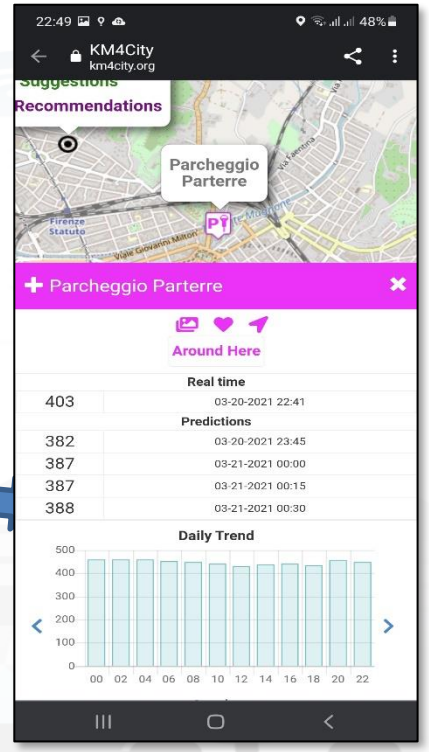
Florence Dashboard

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

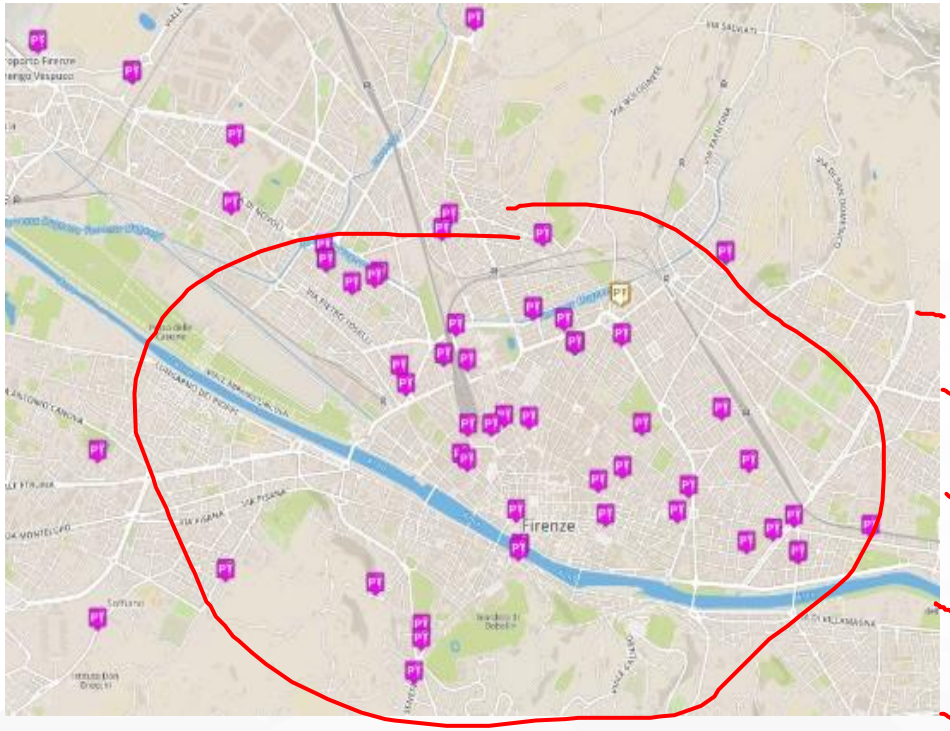








Different Reduction of parking for Covid



main Purpose	% of reduction in Lockdown	Recover in July 2020
Hospitals	55,9	31%
railway stations	84,2	60%
social hubs	85,8	72%
markets	45,1	25%
justice	96,1	82%

2020

Impact on Pollutant on LockDown 2020

	CO2	CO	NO2	PM10
Percentage at which the average value of the pollutant has been reduced (February wrt April, 2020)	41,06	47,54	38,84	61,99
Percentage at which the MAX value of the pollutant has been reduced (February wrt April 2020)	38,89	34,62	63,02	60,21

Event: clashes between police and demonstrators in Florence, during an unauthorized demonstration against the restrictions of Covid-19 government measures (on 30th October 2020 night).

Italy: Protests flare in Florence over restrictions

31 Oct, 2020

Facebook | Twitter | Mi piace 655 | Tweet



Florence mayor condemns violence and vandalism in historic centre in "surreal, terrible and painful night" for Tuscan city.

Protesters clashed with police in central Florence last night during an unauthorised protest over Italy's latest restrictions aimed at curbing the spread of covid-19.

In partnership with la Repubblica FIRENZE.it

Oct. 30 Protest Devastates Florence

10/31/2020



During the unauthorized evening demonstration against recent social lockdown pandemic measures lasting four hours in downtown Florence on the evening of October 30 saw

TOP NEWS STORIES

Oct. 30 Protest Devastates Florence
During the unauthorized evening demonstration against recent social lockdown pandemic measures lasting four hours in downtown Florence [...]

COVID Demonstrations Hit Florence
Unlike the U.S. protesters in Italy reserve public space for peaceful demonstrations which are organized to communicate a [...]

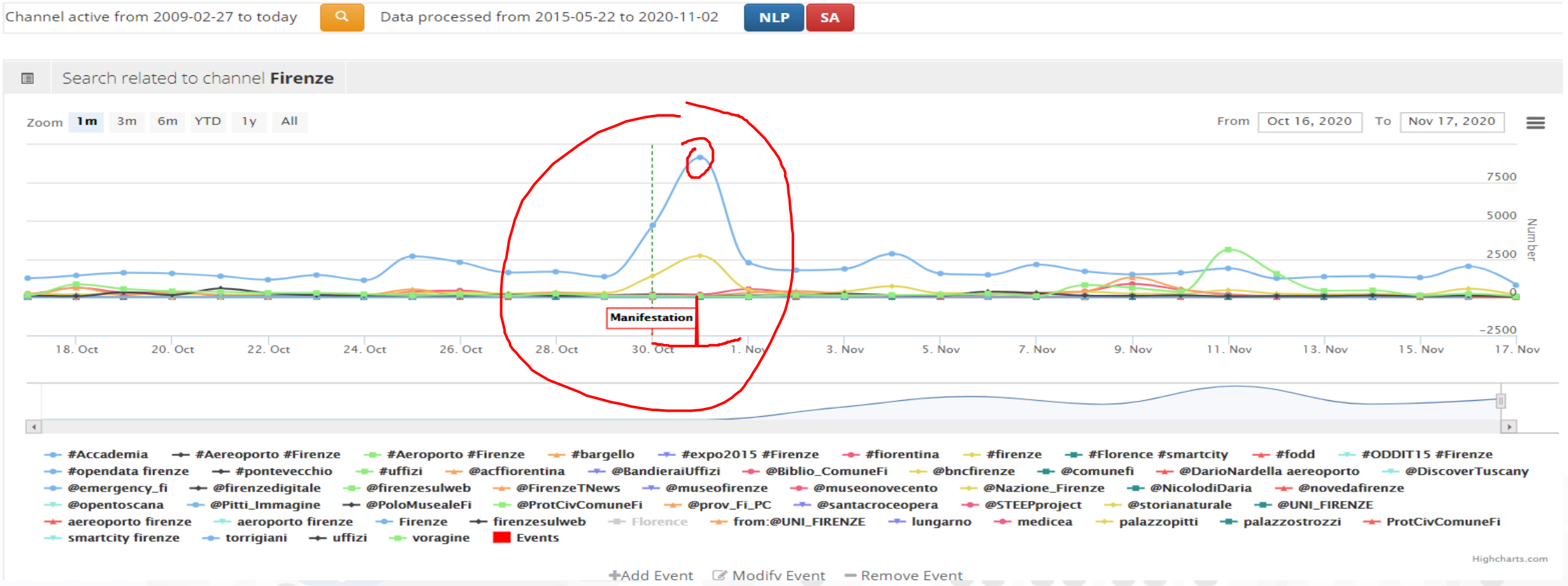
New Anti-Covid Regulations: Dos & Dont's
Given the upswing in Coronavirus infections and consequent hospital admissions since the beginning of October, Italian Prime Minister [...]

New Pandemic Regulations in Italy
In the face of the rise of Coronavirus infections, the Italian government has extended the national state [...]

LA COMPAGNIA
Original Language Movies
International Film Festivals

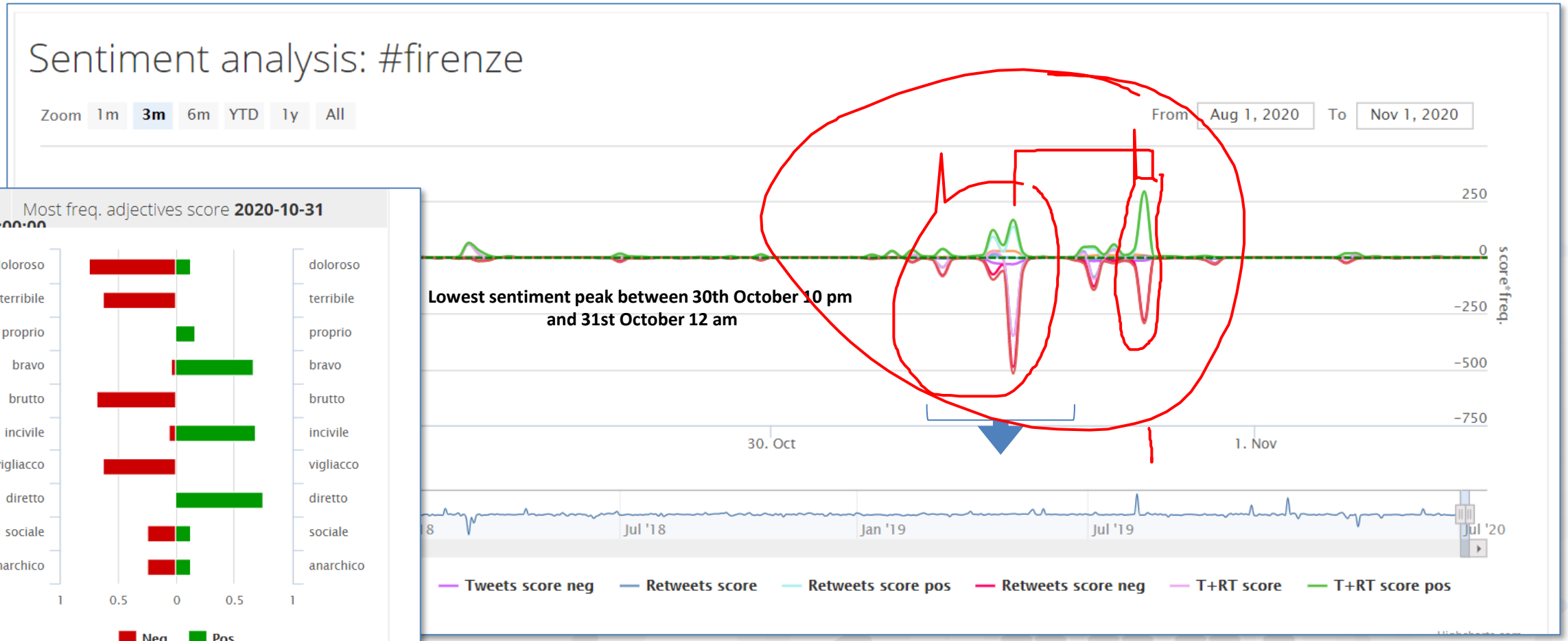
ORCHESTRA DELLA TOSCANA

30 October Manifestation



Twitter Vigilance

Sentiment Analysis for search «Firenze»



http://disit.org/tv/index.php?p=sa_ricerche&ricerca=436

Twitter Vigilance

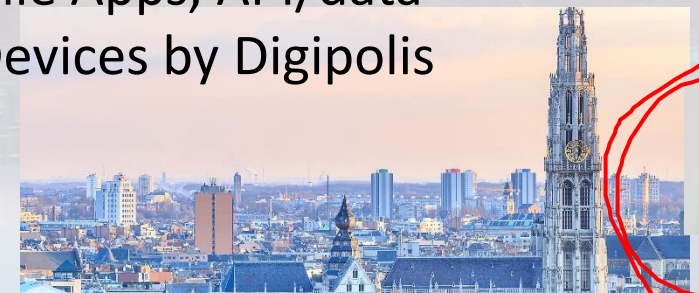
Antwerp, Belgium

https://www.snap4city.org/526



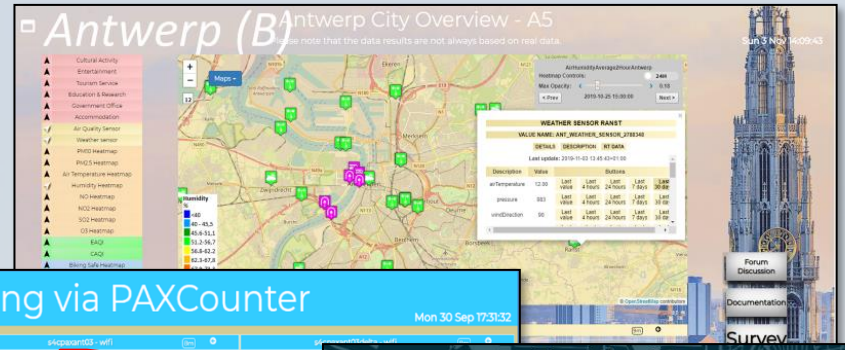
People Monitoring on Pub Services
DIGIPOLIS Antwerp

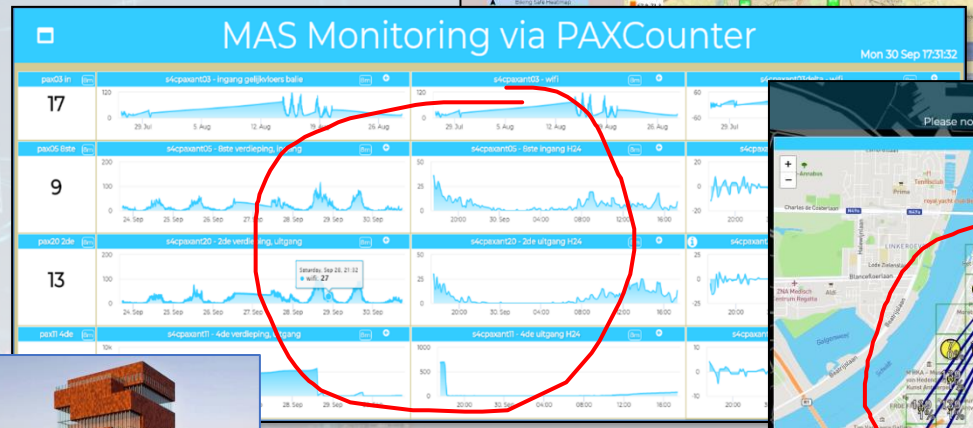
- **Multiple Domain Data**
  - PAX Counters: museum, pub services, COVID-19
- **Multiple Levels & Decision Makers**
  - Business Intelligence Dashboards
  - People flow, OD flows
  - Detection of critical conditions
- **Historical and Real Time data**
  - 20 fixed PaxCounters
  - 2 Mobile PaxCounters
- **Services Exploited on:**
  - Dashboards, Mobile Apps, API/data
  - Fully Controlled Devices by Digipolis
- **Since 2019**

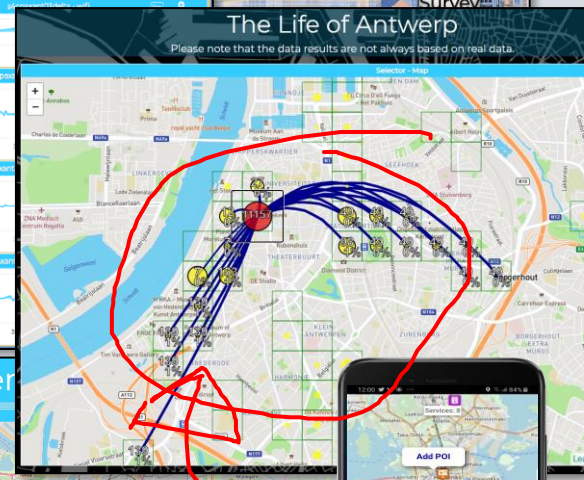


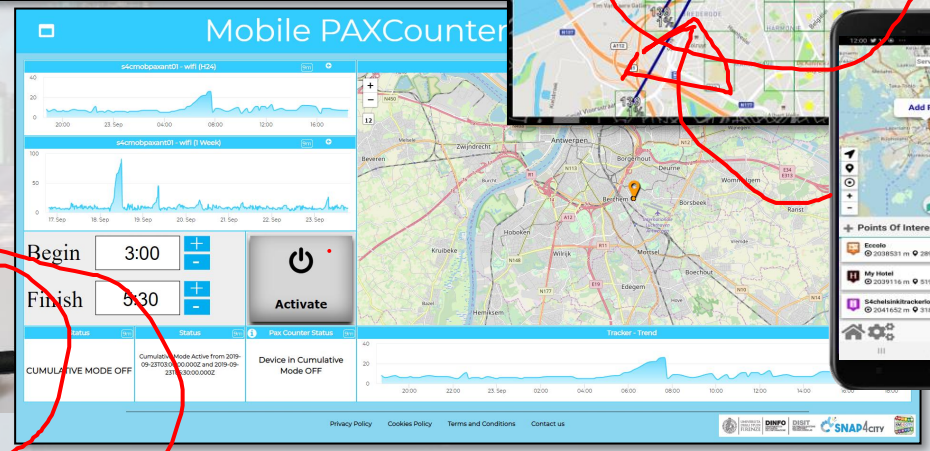


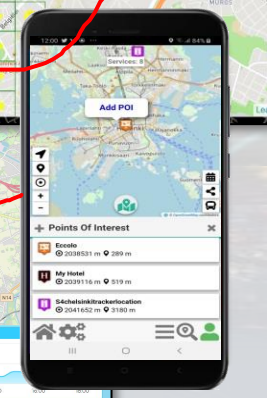


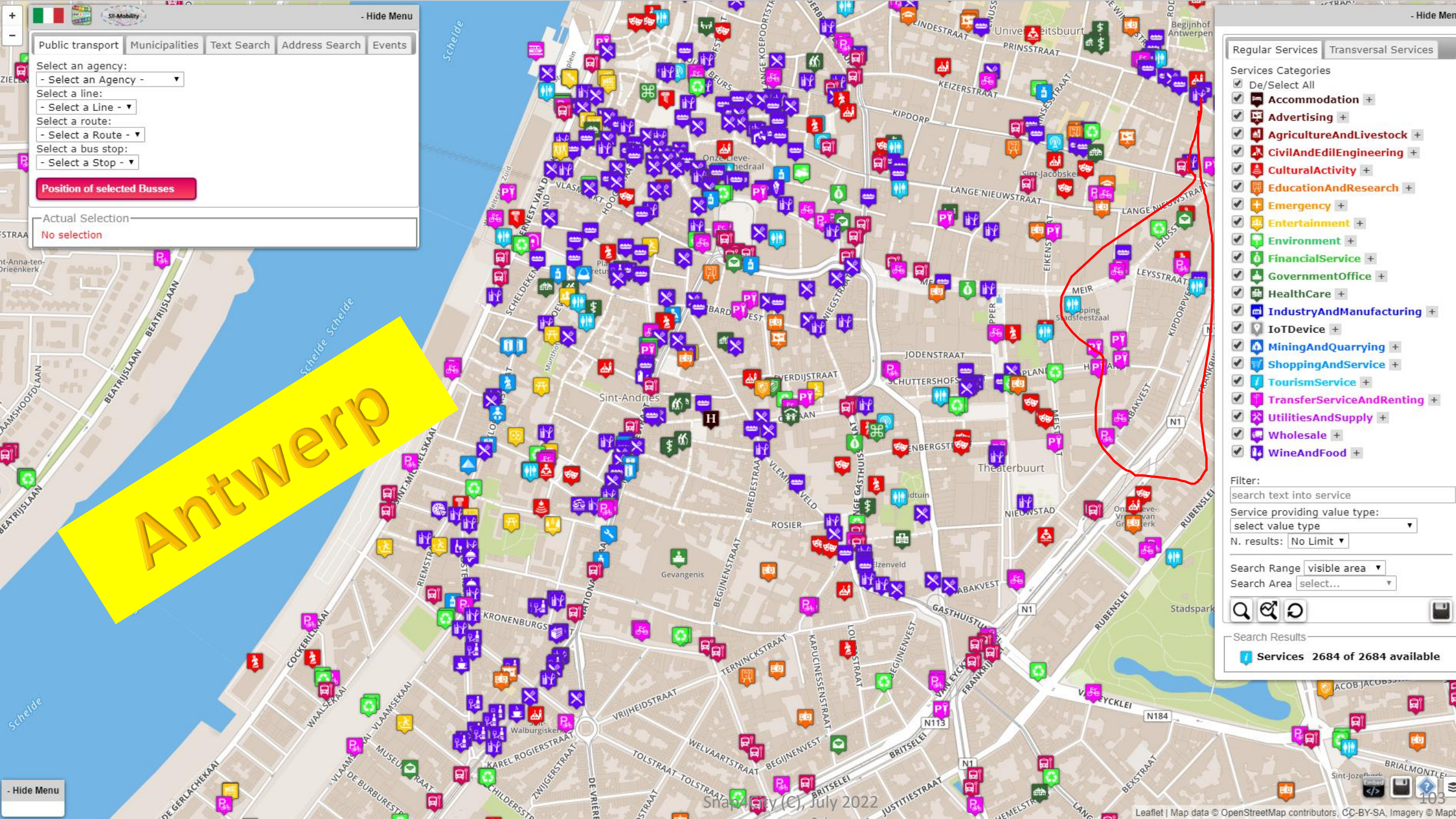








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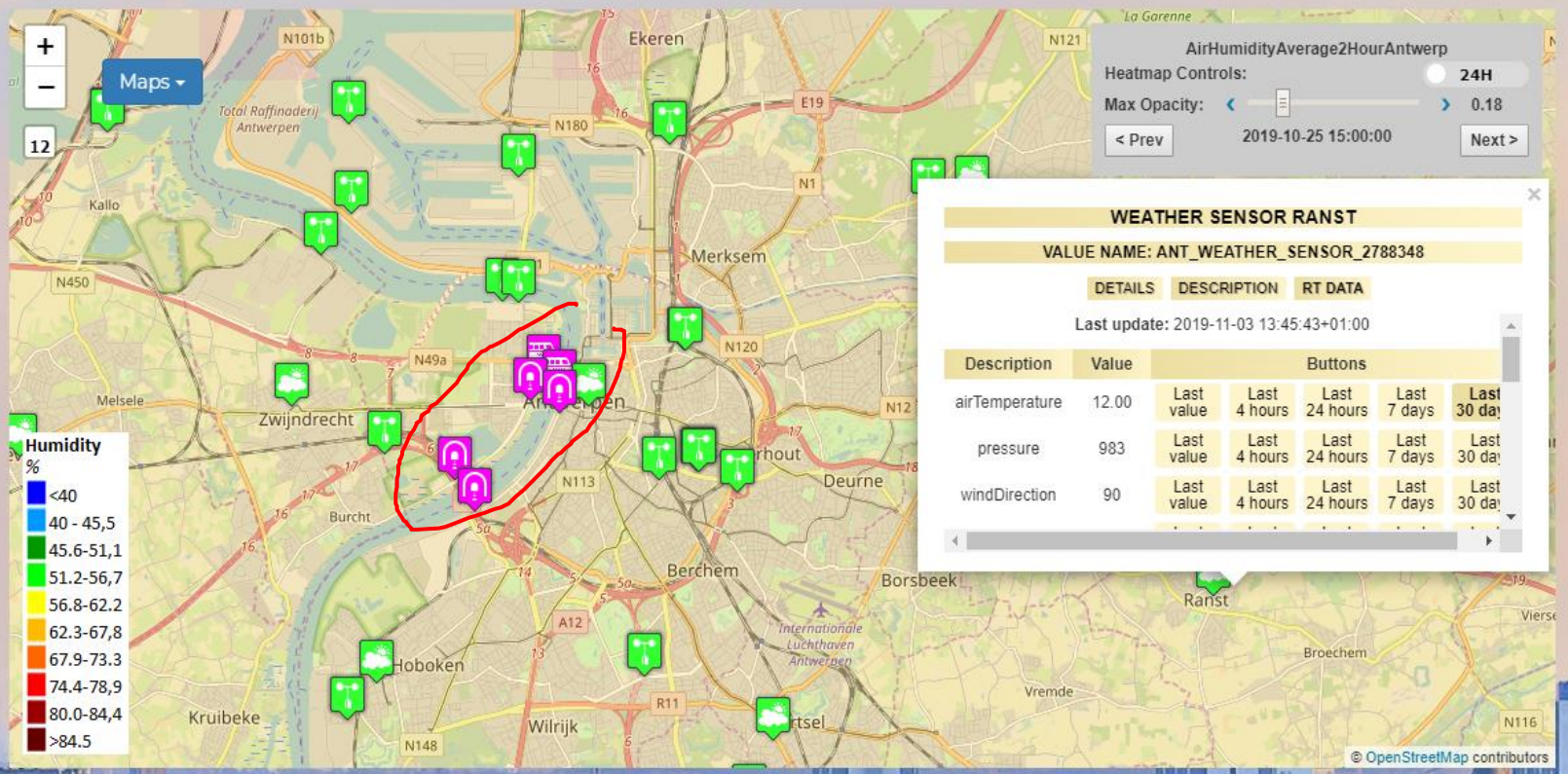
Public transport
Municipalities
Text Search
Address Search
Events
Select an agency:
- Select an Agency -
Select a line:
- Select a Line -
Select a route:
- Select a Route -
Select a bus stop:
- Select a Stop -
Position of selected Busses
Actual Selection
No selection
Antwerp
Regular Services
Transversal Services
Services Categories
De/Select All
Accommodation
Advertising
AgricultureAndLivestock
CivilAndEdilEngineering
CulturalActivity
EducationAndResearch
Emergency
Entertainment
Environment
FinancialService
GovernmentOffice
HealthCare
IndustryAndManufacturing
IoTDevice
MiningAndQuarrying
ShoppingAndService
TourismService
TransferServiceAndRenting
UtilitiesAndSupply
Wholesale
WineAndFood
Filter:
search text into service
Service providing value type:
select value type
N. results:
No Limit
Search Range
visible area
Search Area
select...
Search Results
Services 2684 of 2684 available
- Hide Menu
Schelde
Sint-Andries
Gevangenis
Theaterbuurt
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapb

Antwerp City Overview - A5

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

Sun 3 Nov 14:09:43

- Cultural Activity
- Entertainment
- Tourism Service
- Education & Research
- Government Office
- Accommodation
- Air Quality Sensor
- Weather sensor
- PM10 Heatmap
- PM2.5 Heatmap
- Air Temperature Heatmap
- Humidity Heatmap
- NO Heatmap
- NO2 Heatmap
- SO2 Heatmap
- O3 Heatmap
- EAQI
- CAQI
- Biking Safe Heatmap
- Tunnels and Ferry
- Routing Scenario
- What-IF Routing



Weather sensor Zwijndr... 8m

11.9



Forum Discussion

Documentation

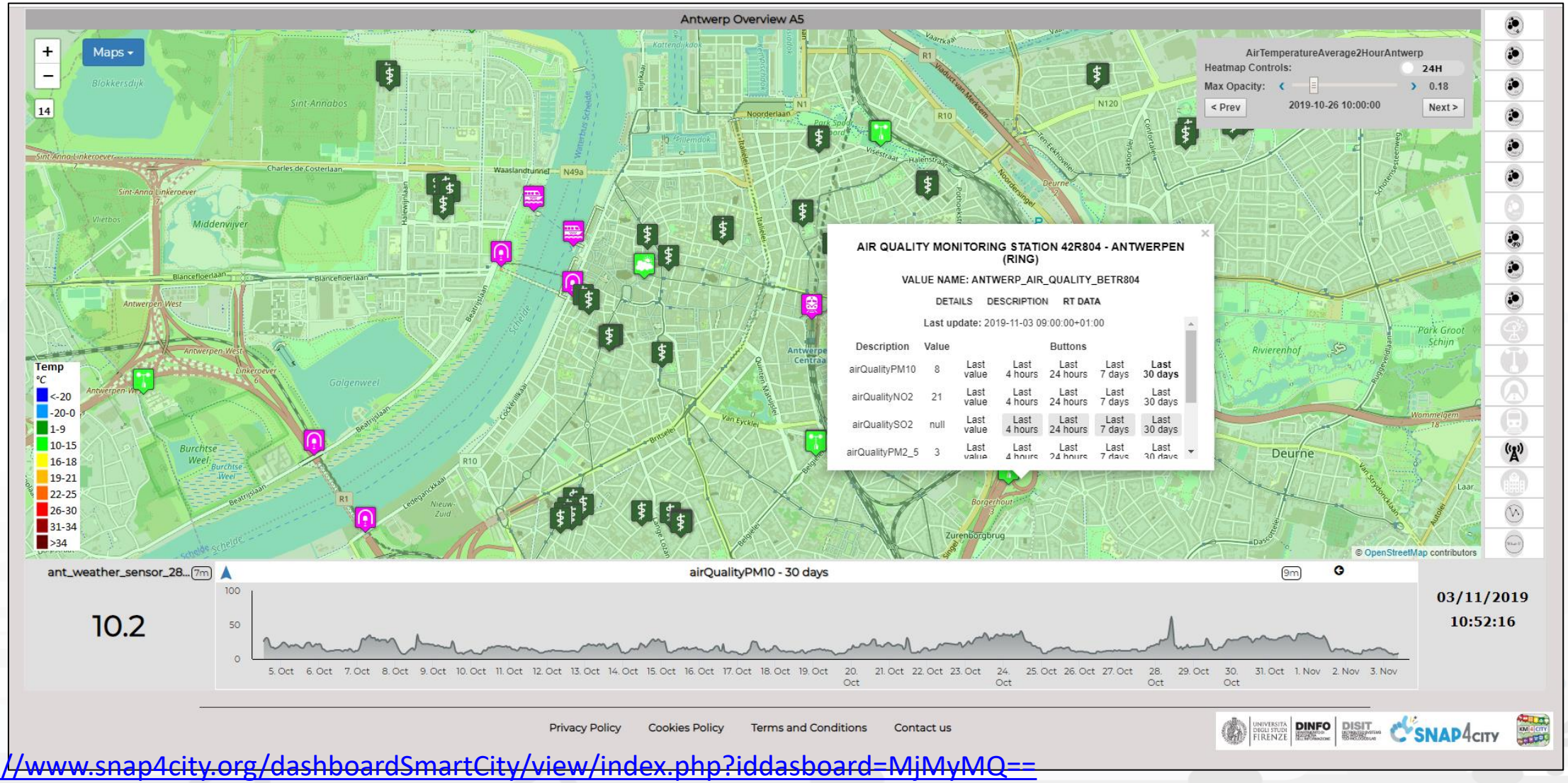
Survey

The Life of Antwerp

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

Antwerp

Unique Dashboard builder Multiple Styles



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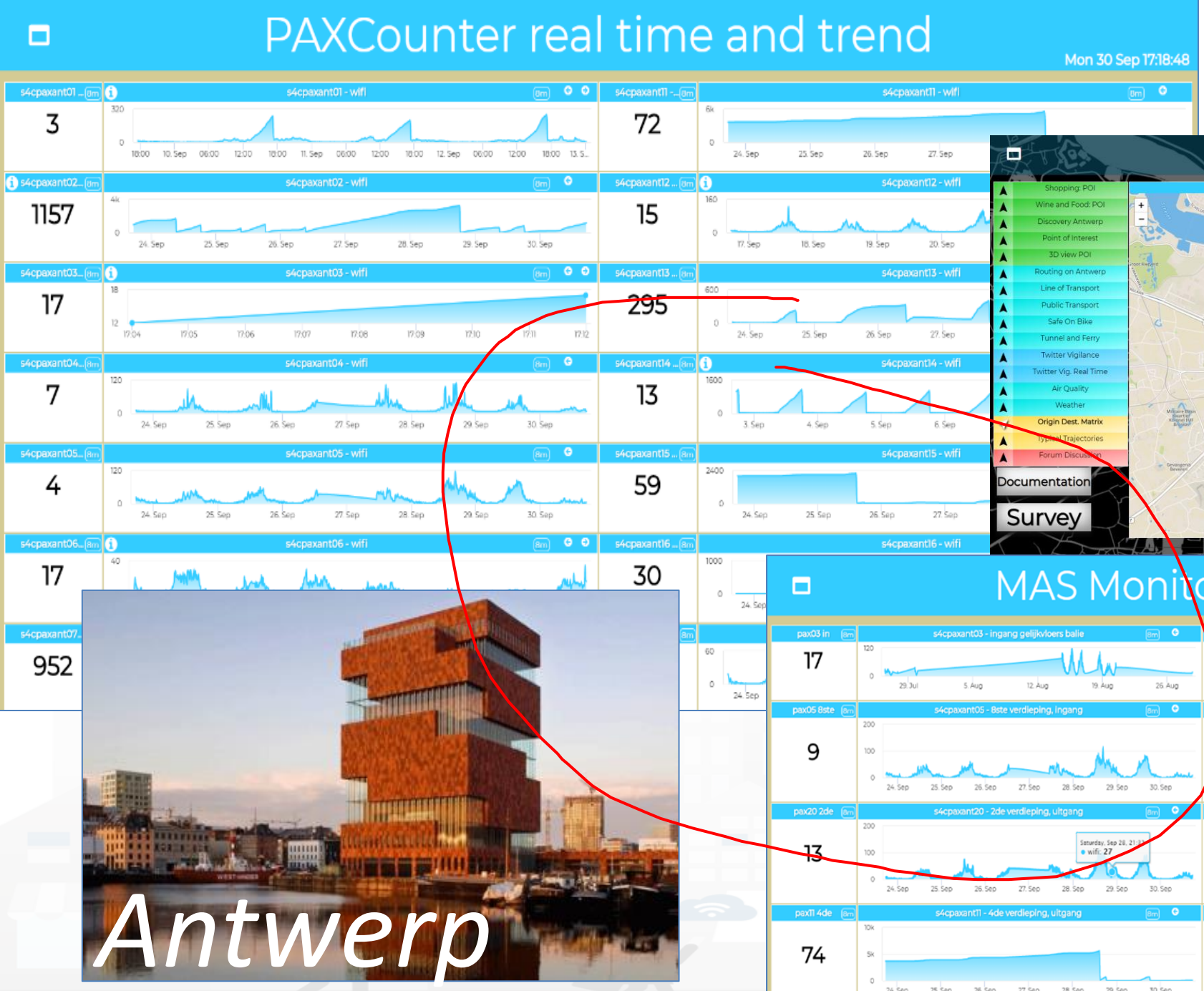
PAXCounter real time and trend
Mon 30 Sep 17:18:48
s4cpaxant01 - wifi
s4cpaxant11 - wifi
s4cpaxant02 - wifi
s4cpaxant12 - wifi
s4cpaxant03 - wifi
s4cpaxant13 - wifi
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s4cpaxant14 - wifi
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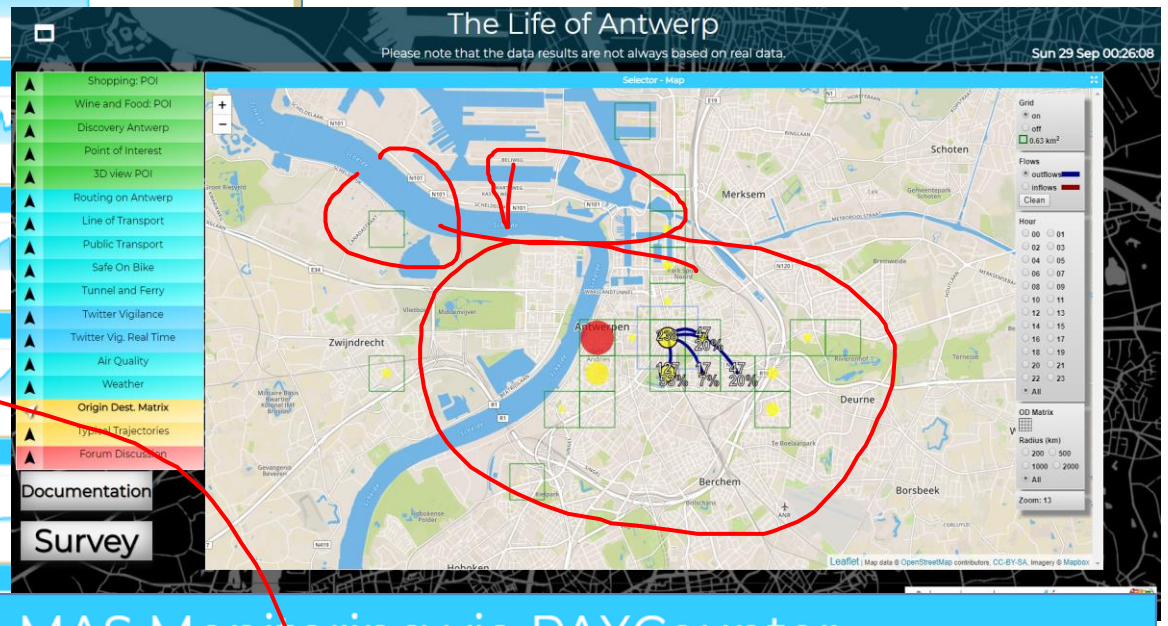
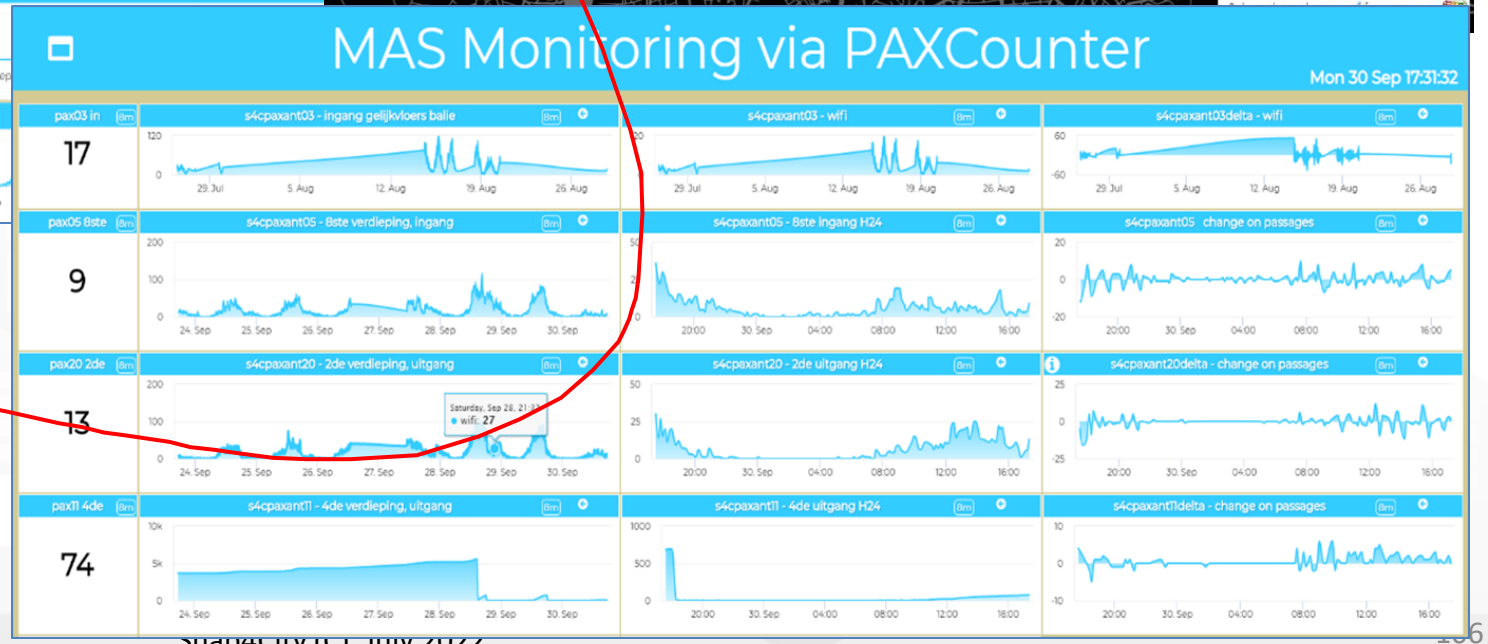

The Life of Antwerp
Please note that the data results are not always based on real data.
Sun 29 Sep 00:26:08
Shopping: POI
Wine and Food: POI
Discovery Antwerp
Point of Interest
3D view POI
Routing on Antwerp
Line of Transport
Public Transport
Safe On Bike
Tunnel and Ferry
Twitter Vigilance
Twitter Vig.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

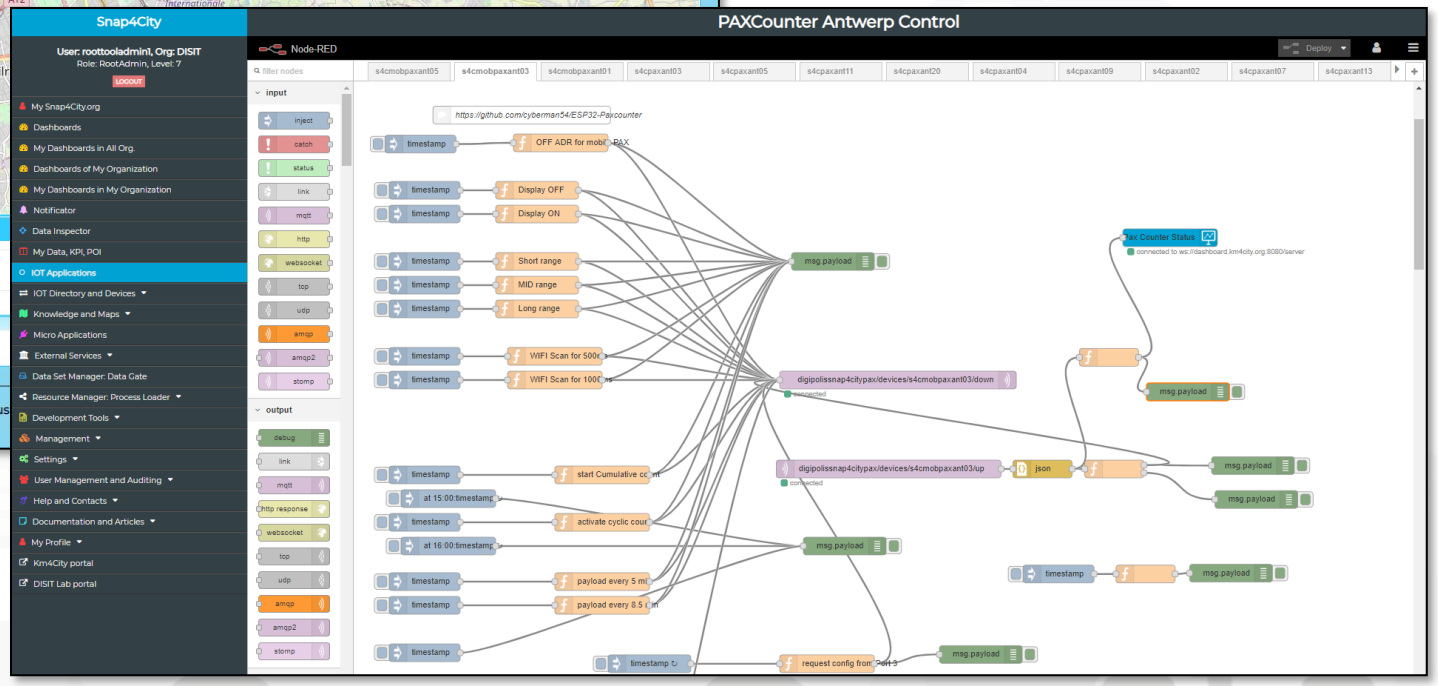
Antwerp


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

Programmable PAX counting





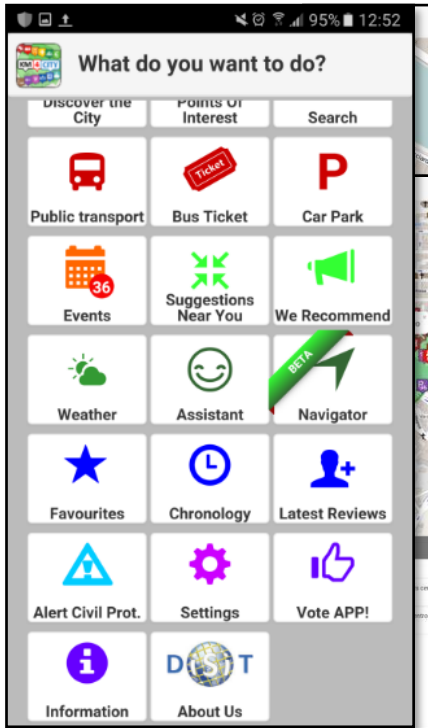


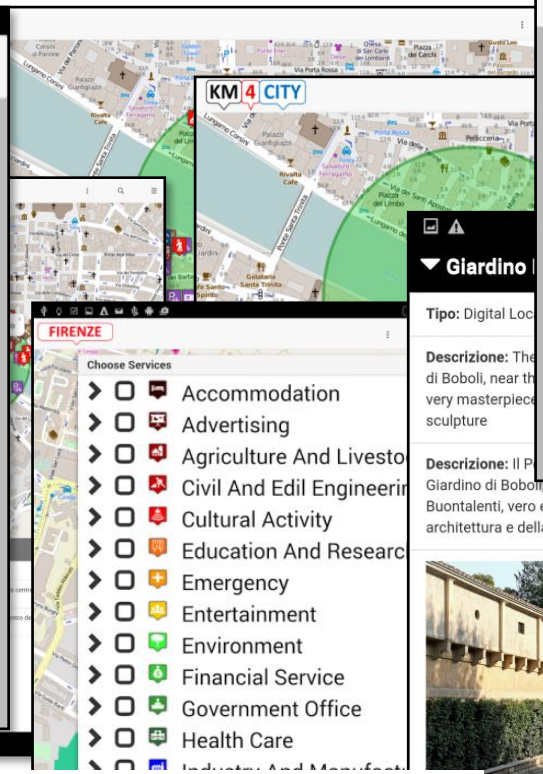
Antwerp

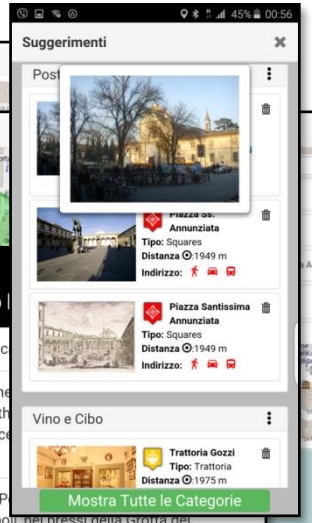
UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

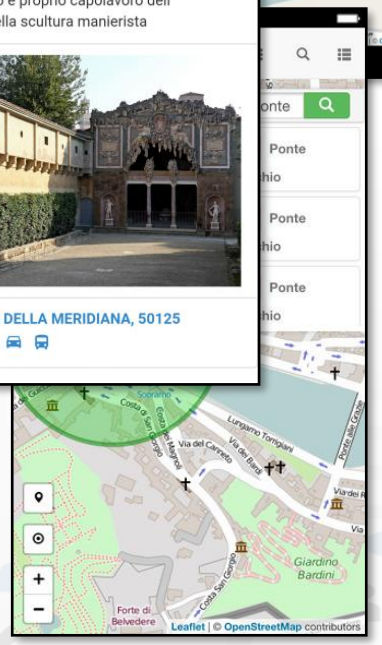
Mobile Apps

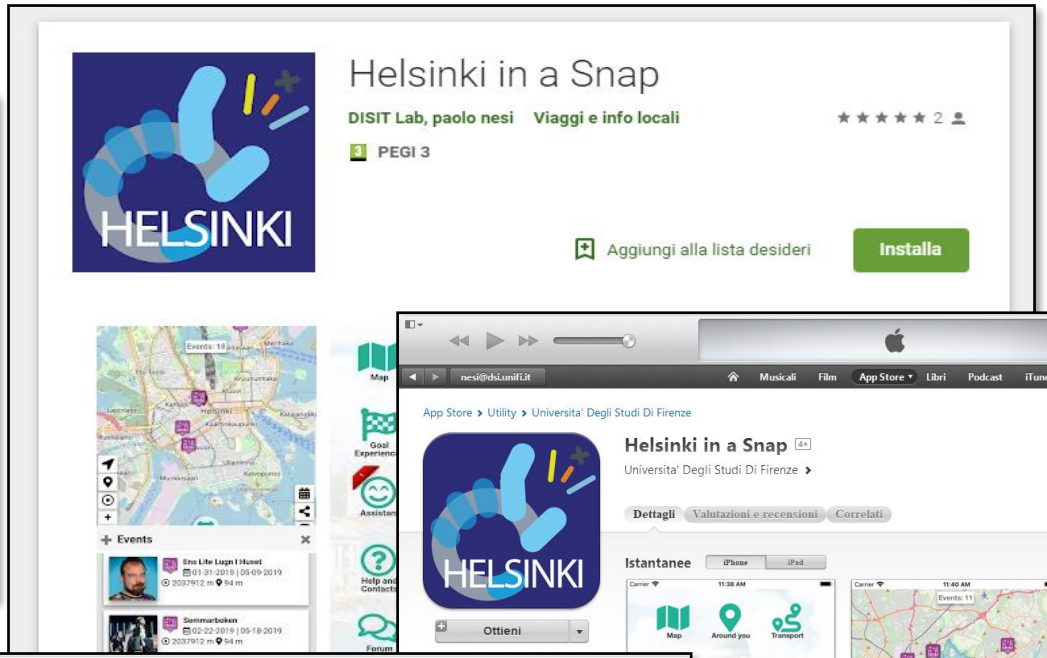
SNAP4CITY KM 4 CITY













DISPONIBILE SU Google play

Scarica da App Store

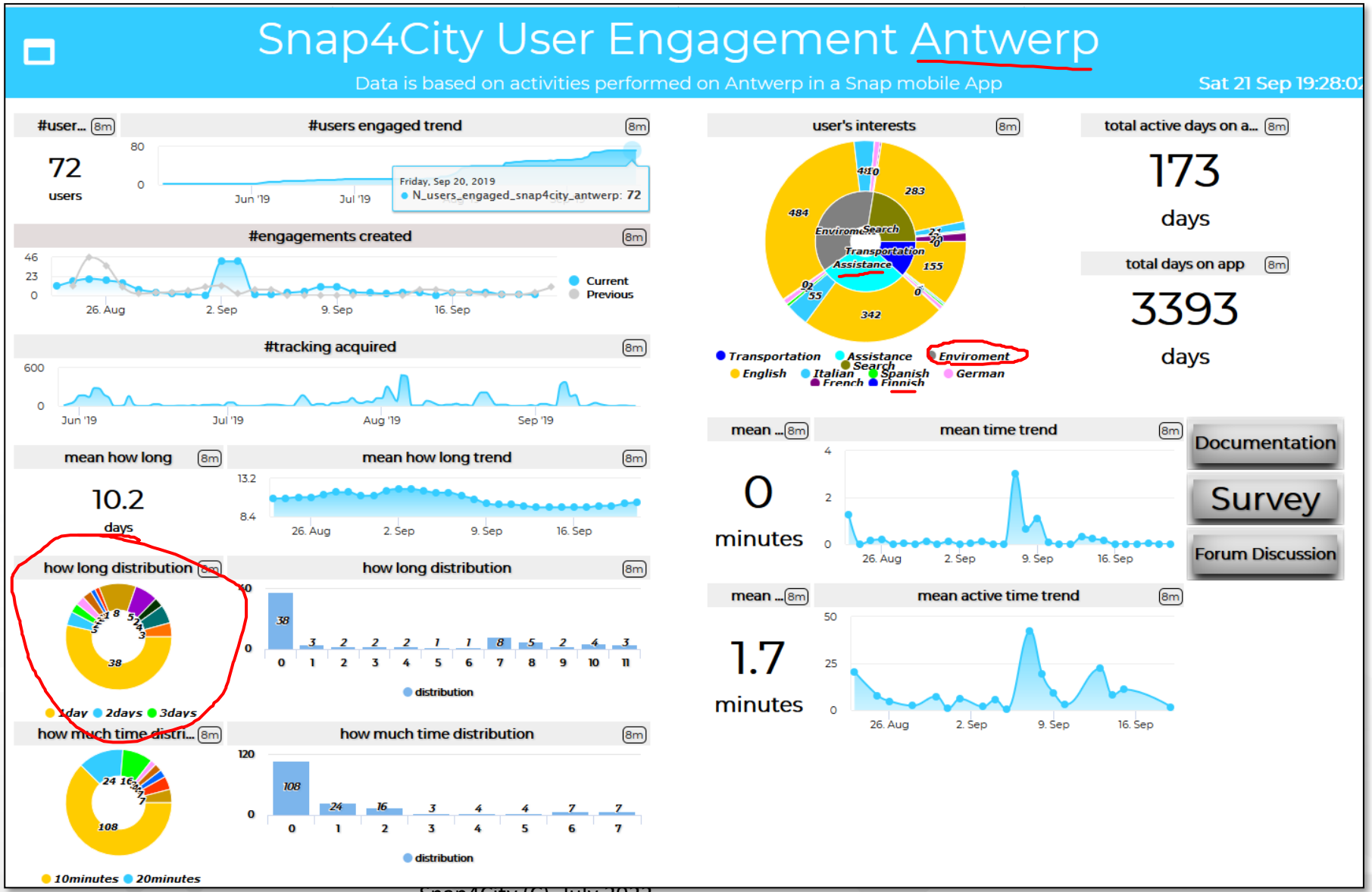
Scarica da Windows Store

SNAP4CITY

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc1OQ==

Dashboard monitoring the Mobile App:

- Collecting the clicks
- Describing the community of users in terms of the profile aspects
- Measuring the time spend, and topics of interest of the users, etc.



Antwerp



Altair Chemical (Italy, Saline di Volterra)

Industry Plant Supervision and Maintenance



Aims

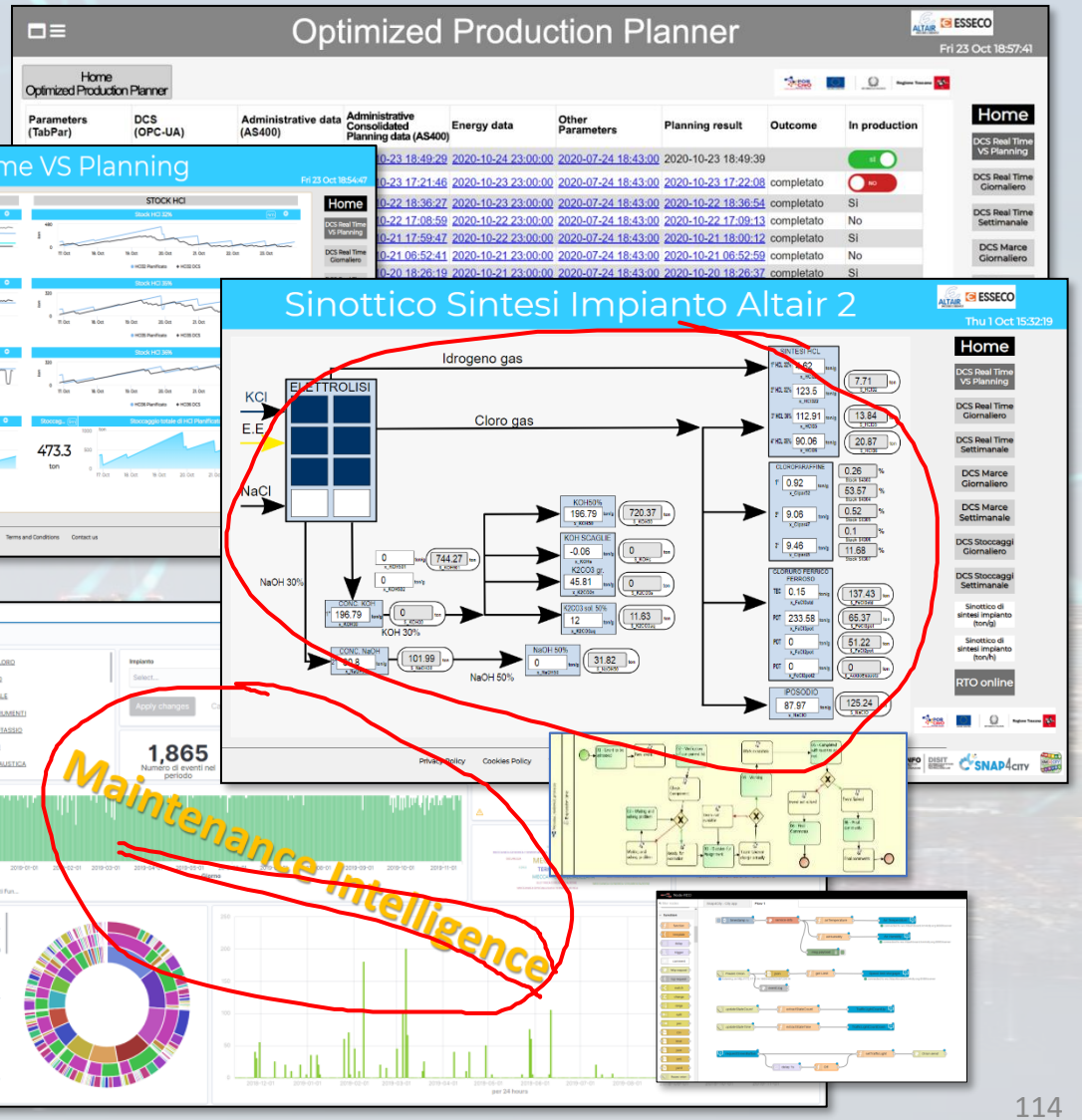
- **Control Room**: Higher level supervision and monitoring (since 2020)
  - Management of Production Plan *Optimization*
  - Control of Perimeter with drone and sensors
- **Maintenance ticketing** (since 2017)
  - *predictive* (in development)
  - 3D Digital Twin (in development)

Snap4Altair Decision Support supervision and control, Industry 4.0

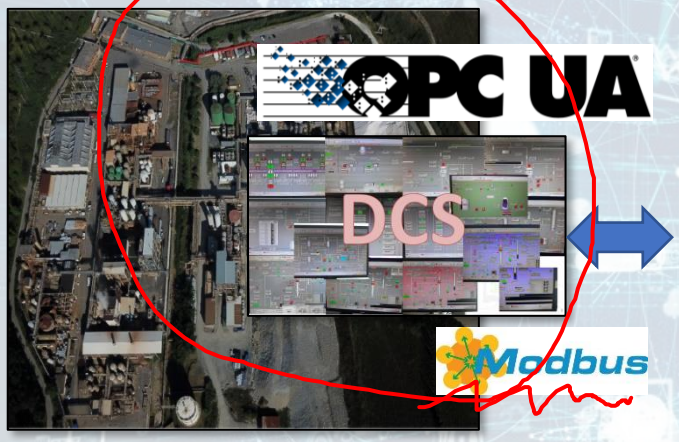
reference

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





MicroService Architecture





ADM

Energy Service



Data Connections and Transformation

IoT App/DA: Real Time & Stream Processing

- Predictive Maintenance
- Prod. Plan Optimization

API/MicroServices

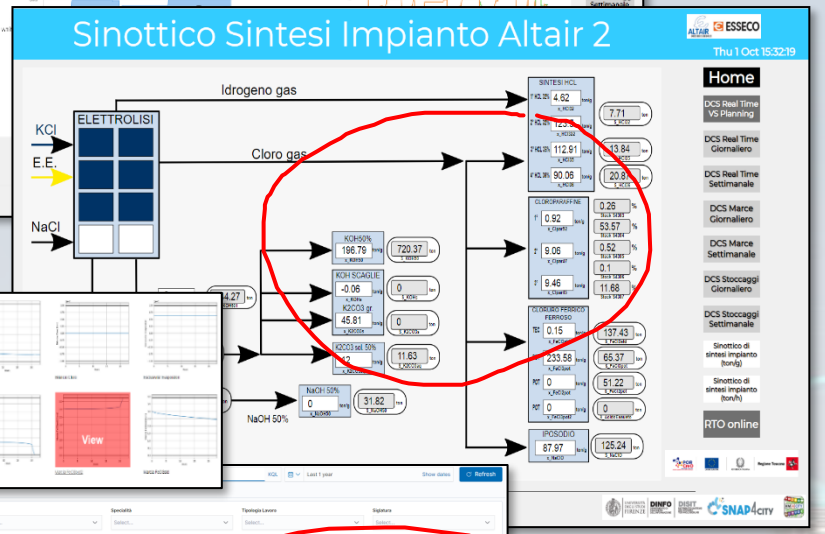
- Maintenance Intelligence
- Digital Twin Local / BIM
- ……

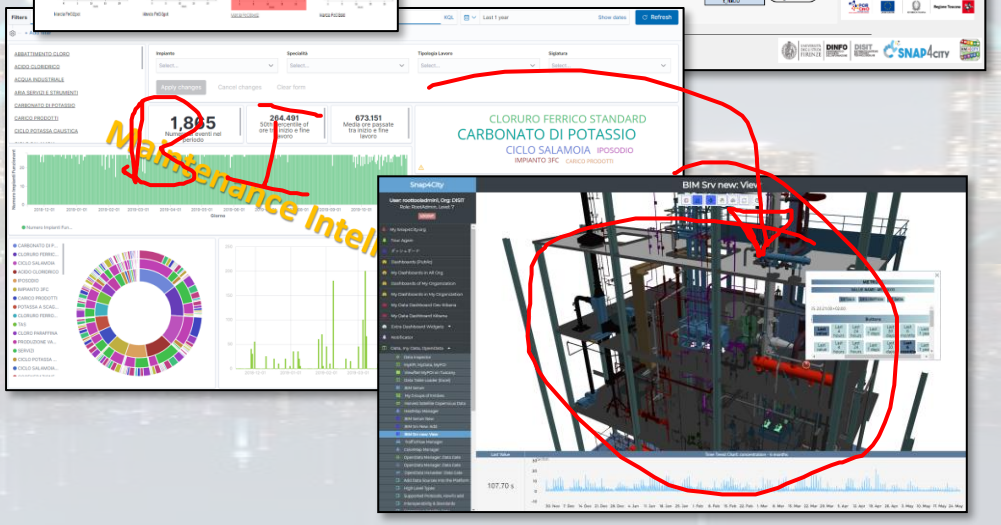
Data Storage

Management, Auth./Autoriz.

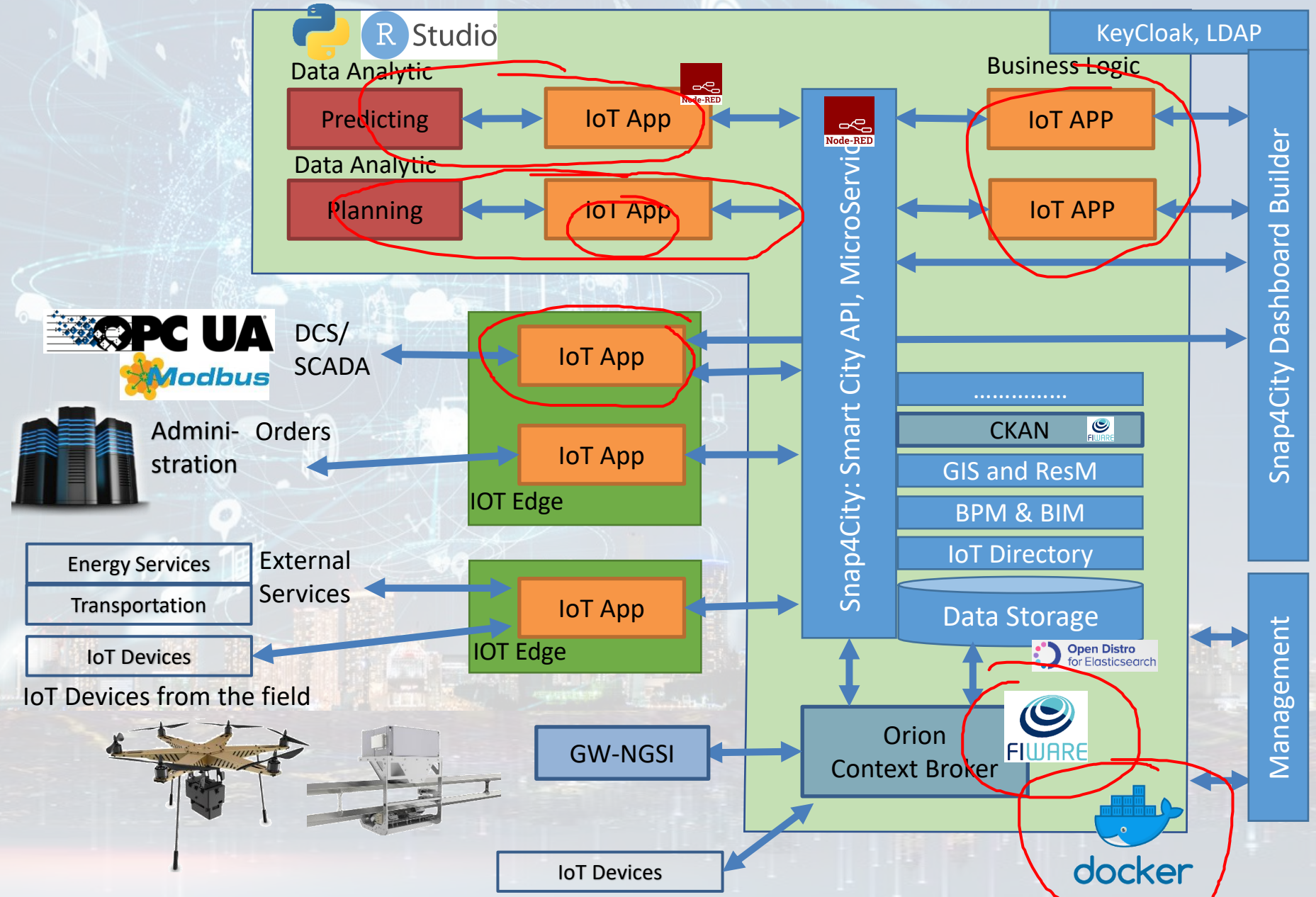
Snap4City Dashboard Builder







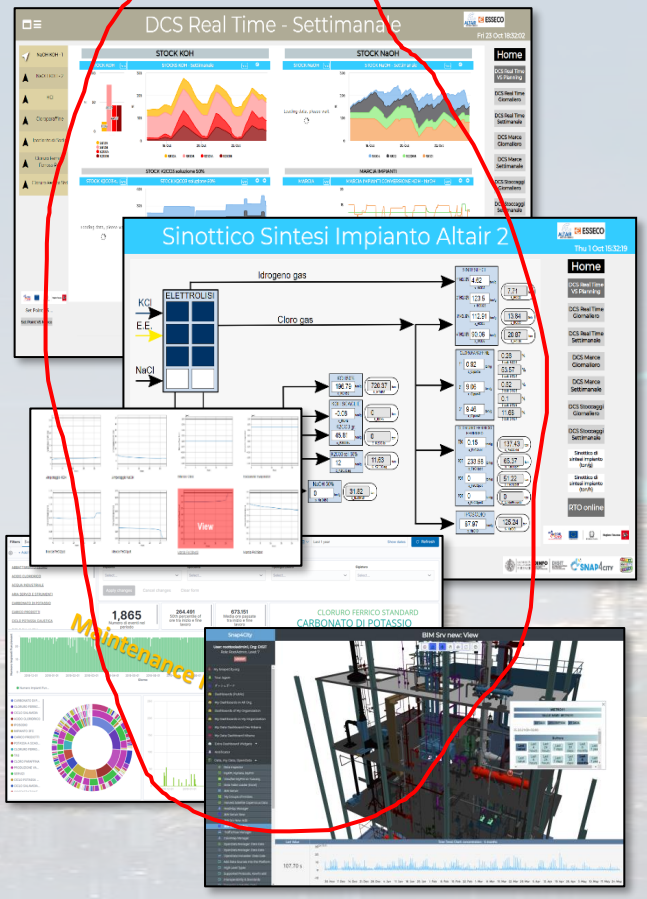
Snap4City/Industry Detailed Architecture

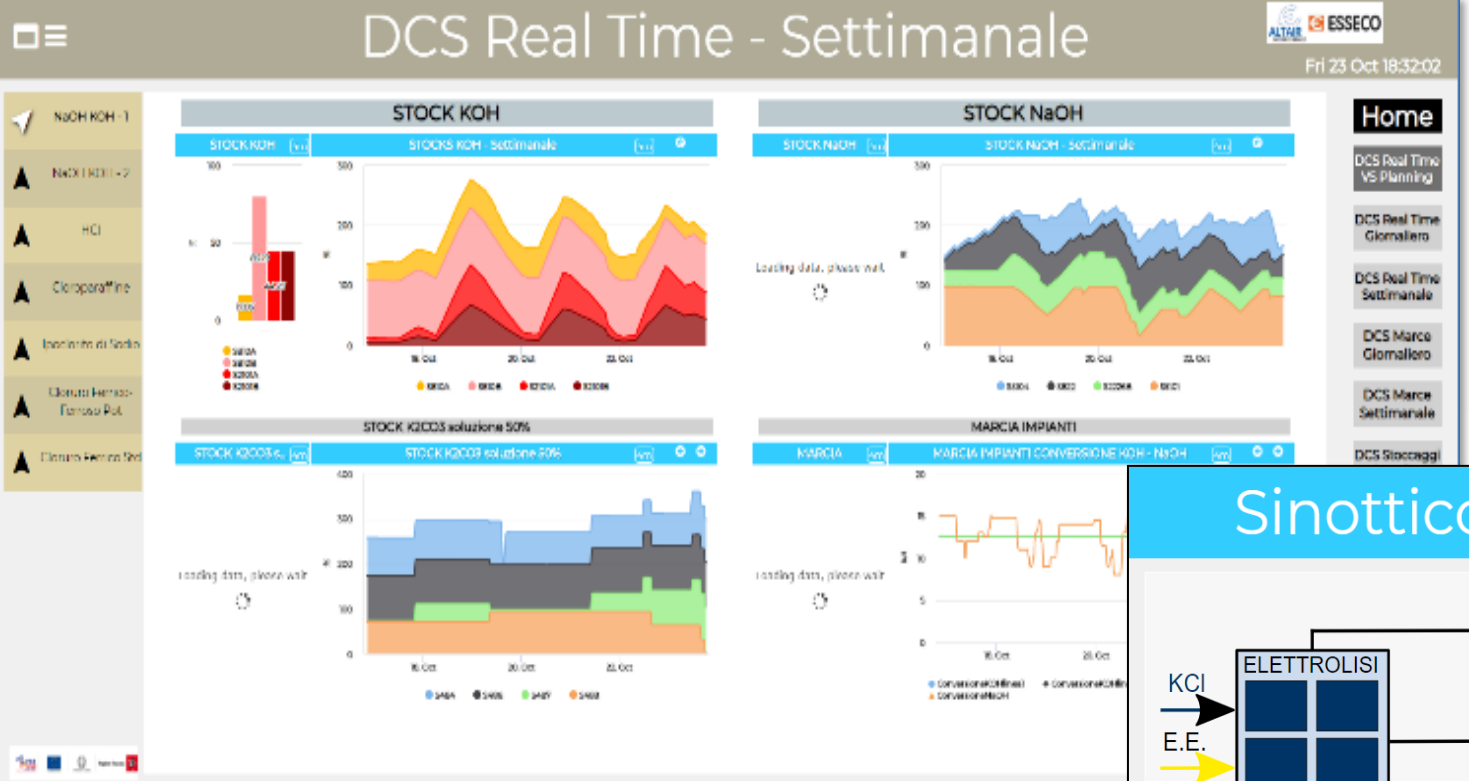


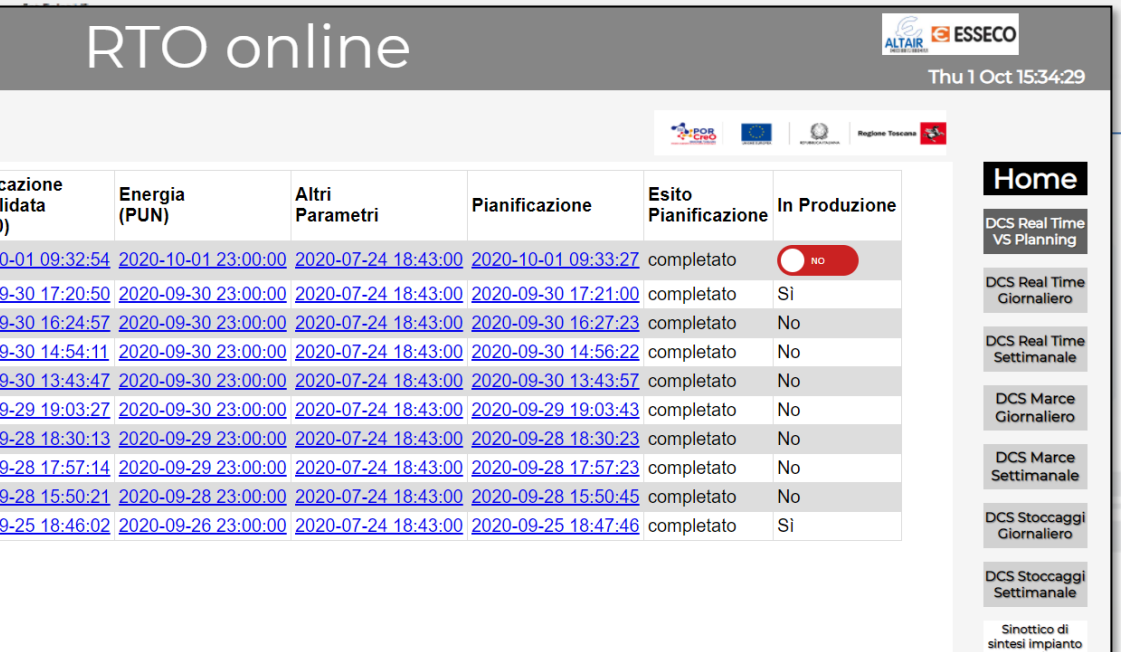


Production Parameters

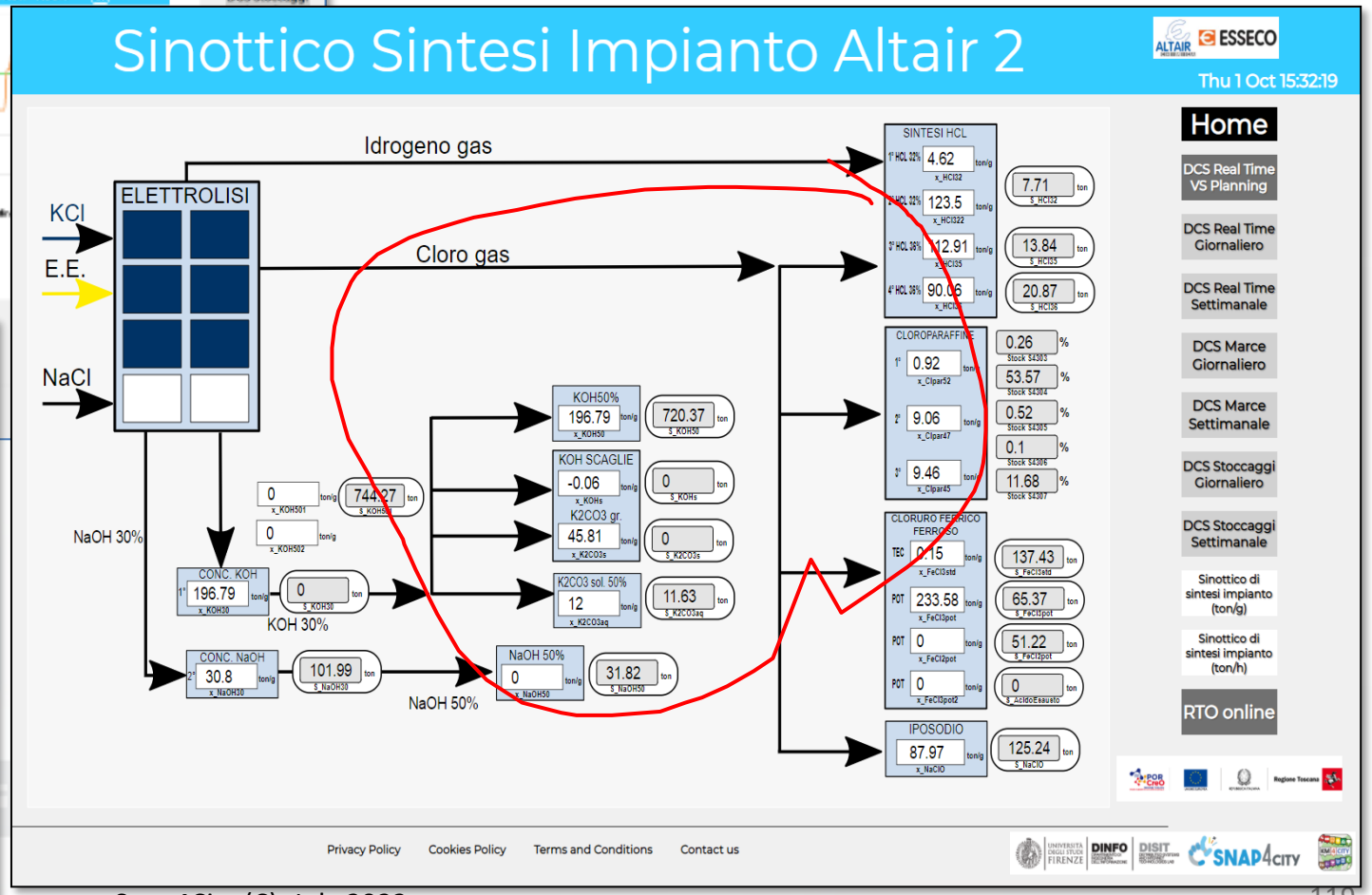
Dashboards, Visual Analytics, Synoptics, 3D, Maps



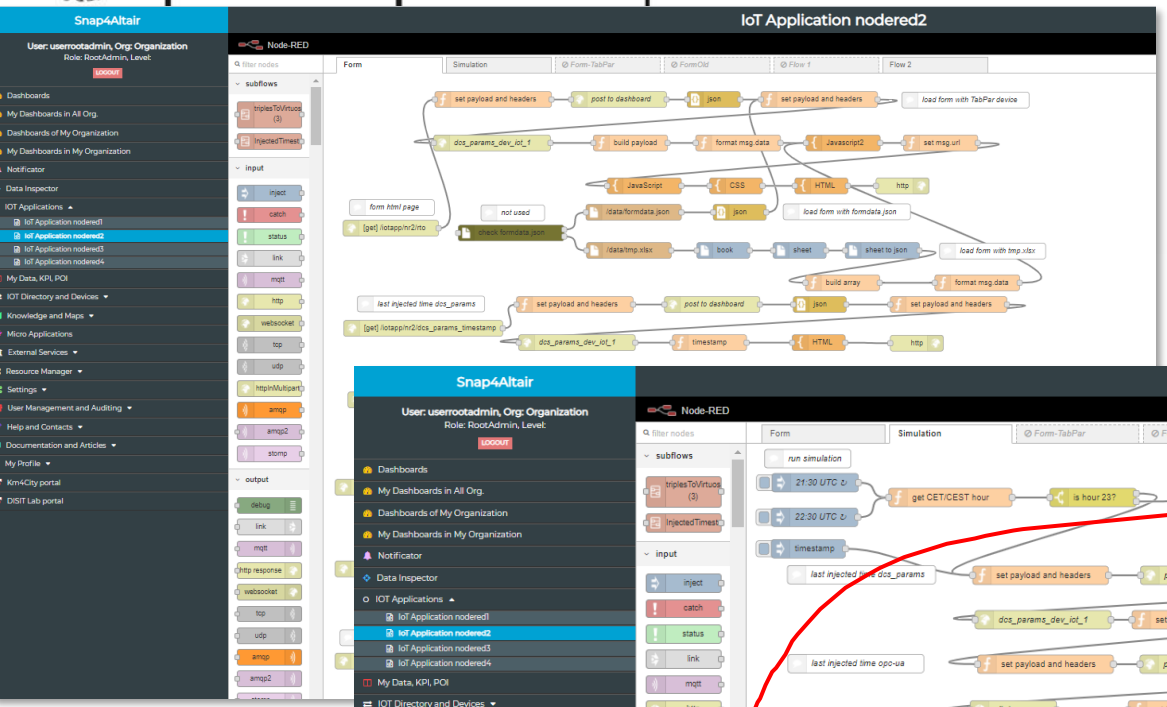


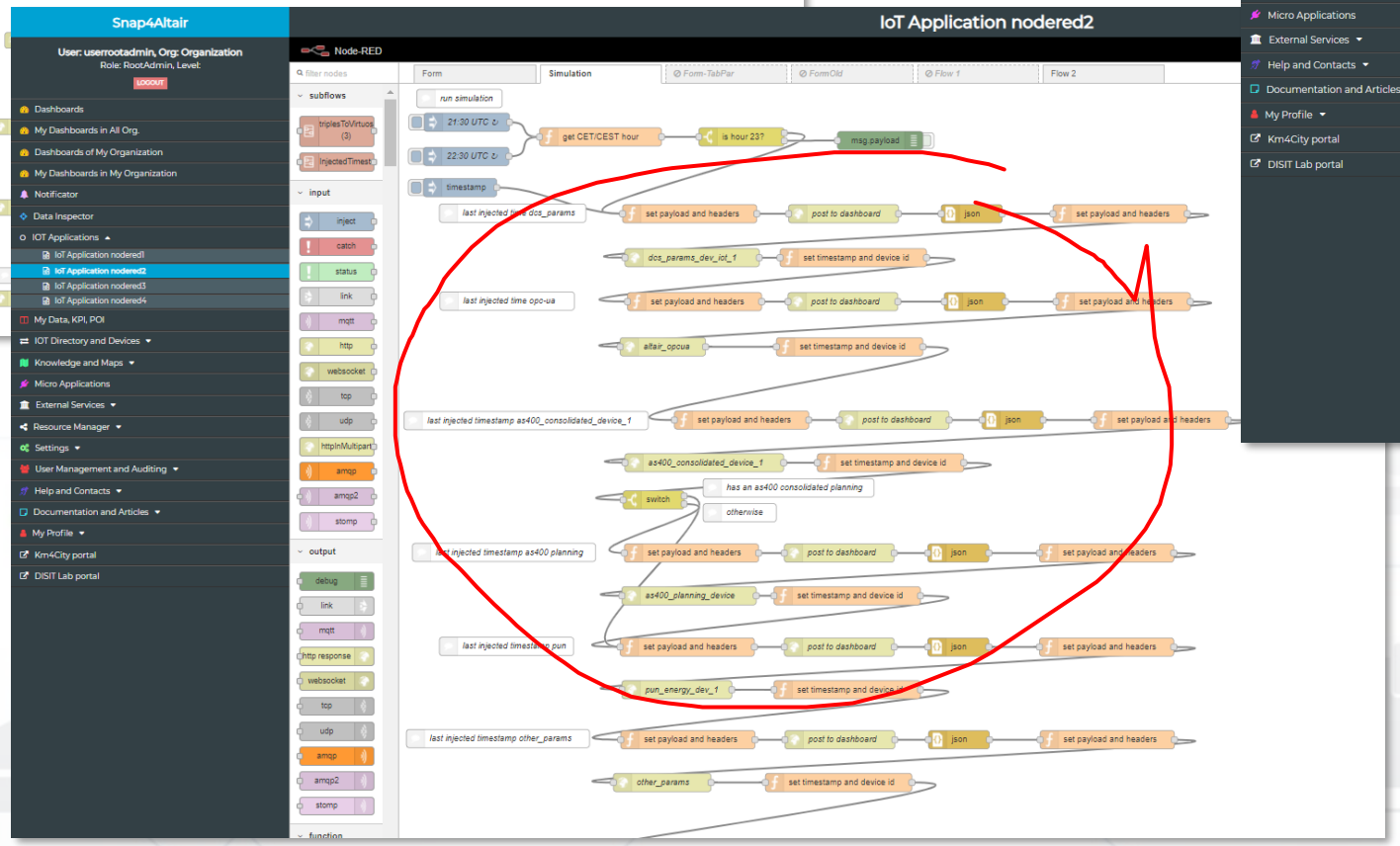


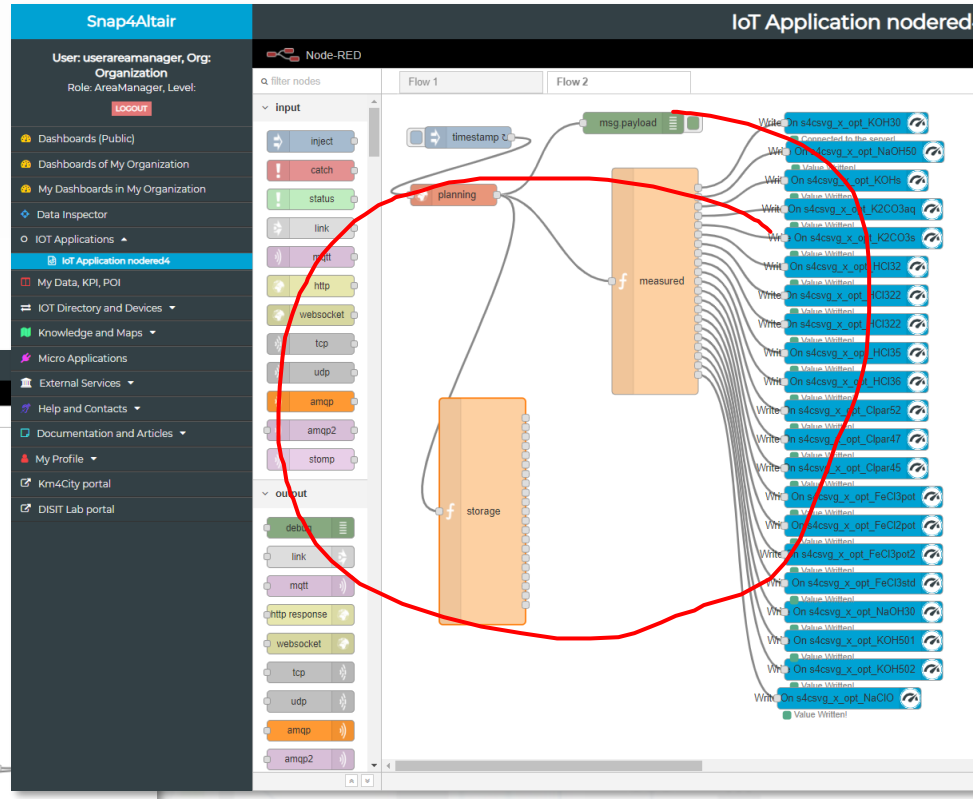
cazione lidata)	Energia (PUN)	Altri Parametri	Pianificazione	Esito Pianificazione	In Produzione
0-01 09:32:54	2020-10-01 23:00:00	2020-07-24 18:43:00	2020-10-01 09:33:27	completato	NO
9-30 17:20:50	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-30 17:21:00	completato	Sì
9-30 16:24:57	2020-09-30 23:00:00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



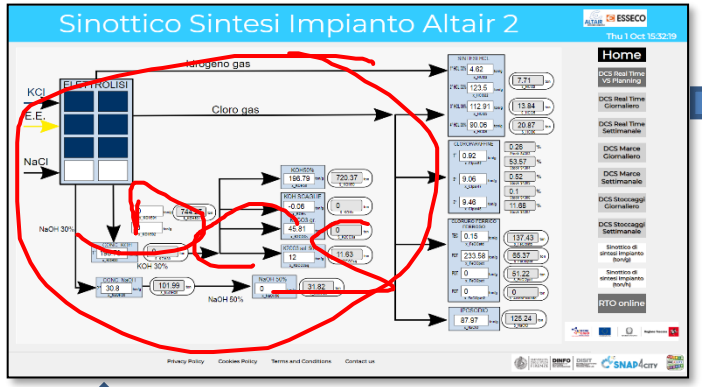
Some Altair Flows



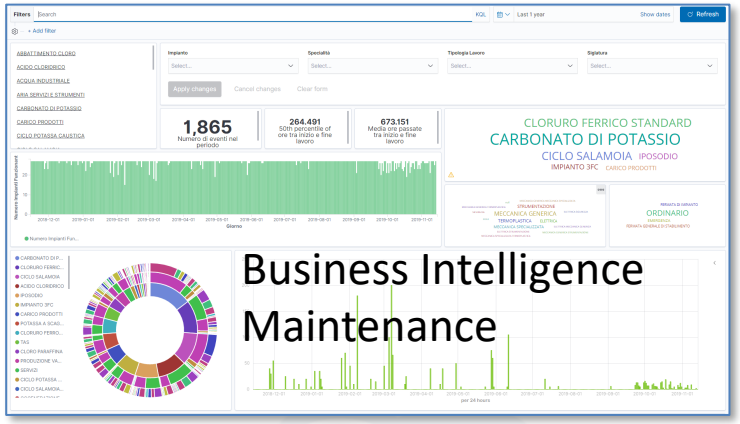




Workflow for Ticket management



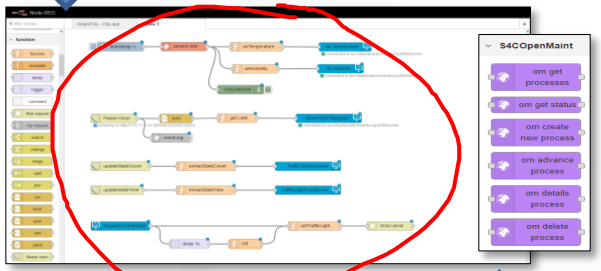
Consumptions/productions

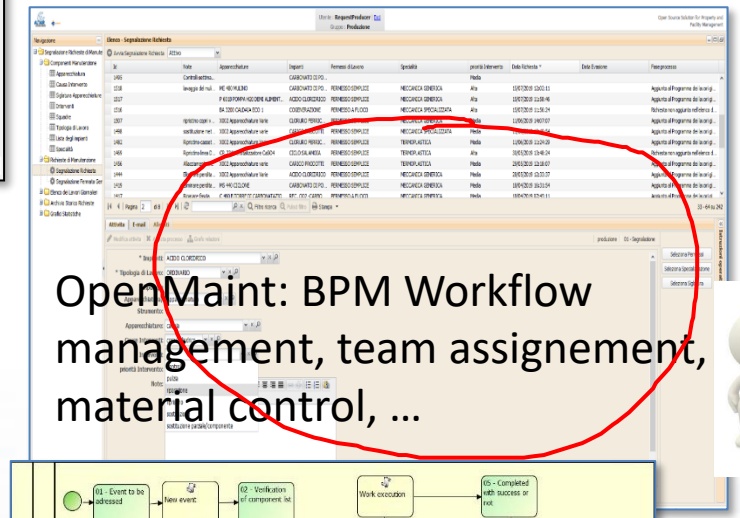


Events/actions

Business Intelligence
Maintenance

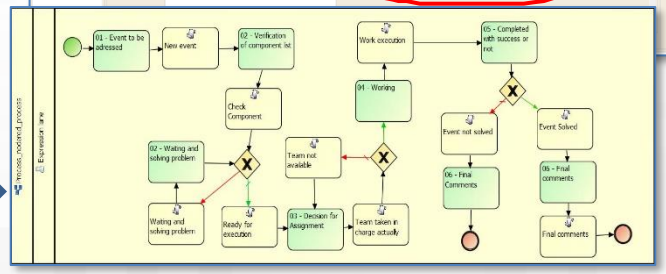
Dashboards and actions

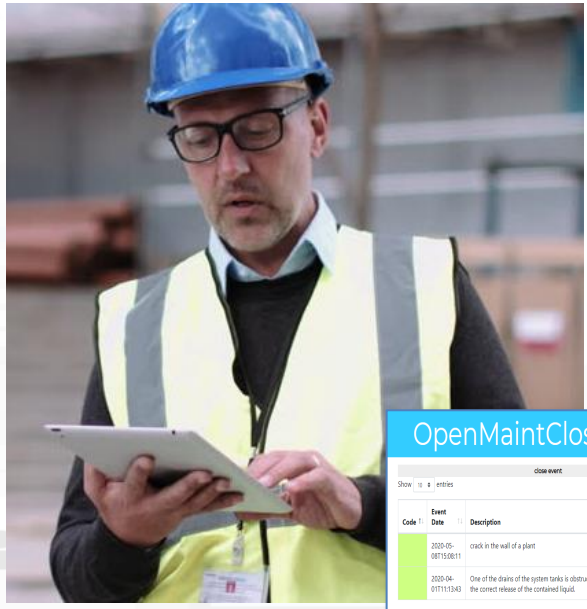




OpenMaint: BPM Workflow management, team assignement, material control, …







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

Filters | Search | KQL | Last 1 year | Show dates | Refresh

+ Add filter

- ABBATTIMENTO CLORO
- ACIDO CLORIDRICO
- ACQUA INDUSTRIALE
- ARIA SERVIZI E STRUMENTI
- CARBONATO DI POTASSIO
- CARICO PRODOTTI
- CICLO POTASSA CAUSTICA

Impianto: Select...

Specialità: Select...

Tipologia Lavoro: Select...

Siglatura: Select...

Apply changes | Cancel changes | Clear form

1,865
Numero di eventi nel periodo

264.491
50th percentile of ore tra inizio e fine lavoro

673.151
Media ore passate tra inizio e fine lavoro

CLORURO FERRICO STANDARD
CARBONATO DI POTASSIO
CICLO SALAMOIA
IPOSODIO
IMPIANTO 3FC
CARICO PRODOTTI

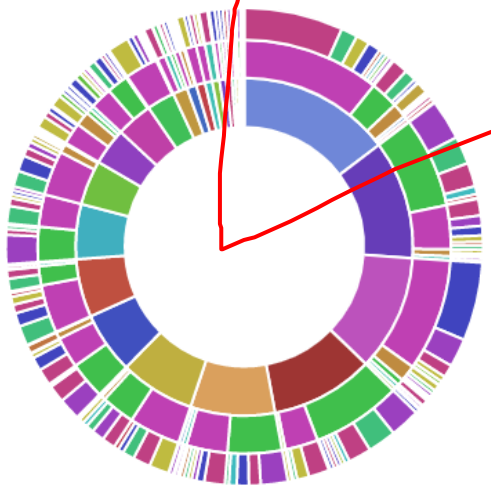
Maintenance Intelligence

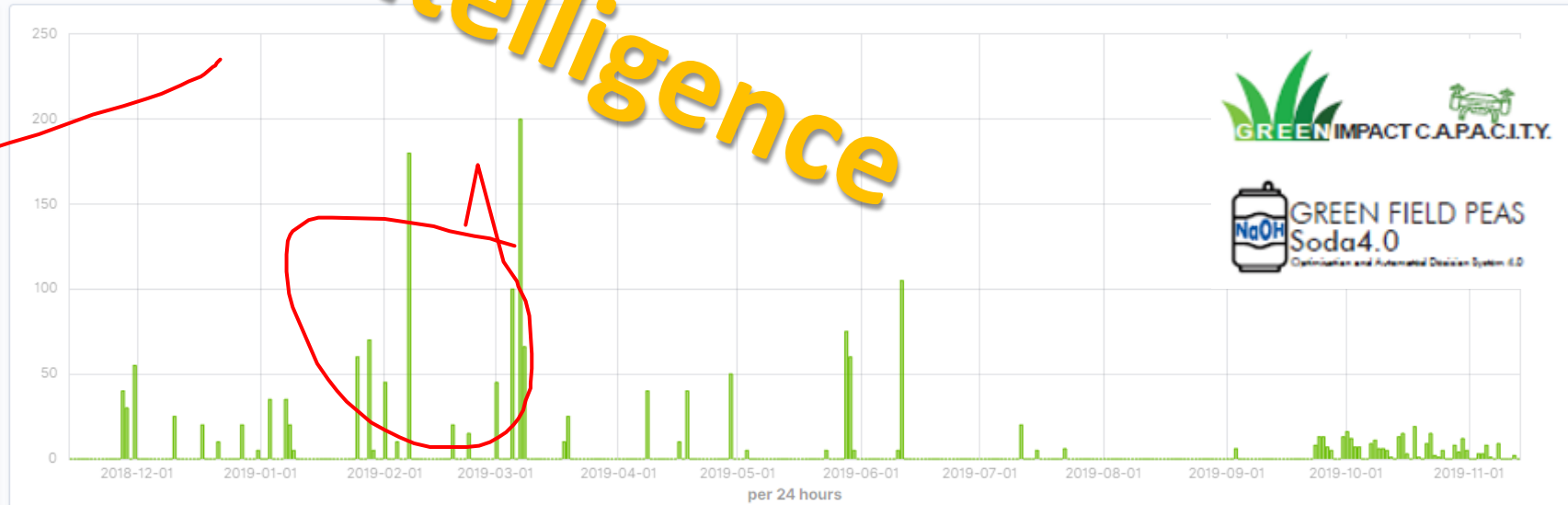






- CARBONATO DI P...
- CLORURO FERRIC...
- CICLO SALAMOIA
- ACIDO CLORIDRICO
- IPOSODIO
- IMPIANTO 3FC
- CARICO PRODOTTI
- POTASSA A SCAG...
- CLORURO FERRO...
- TAS
- CLORO PARAFFINA
- PRODUZIONE VA...
- SERVIZI
- CICLO POTASSA ...
- CICLO SALAMOIA...

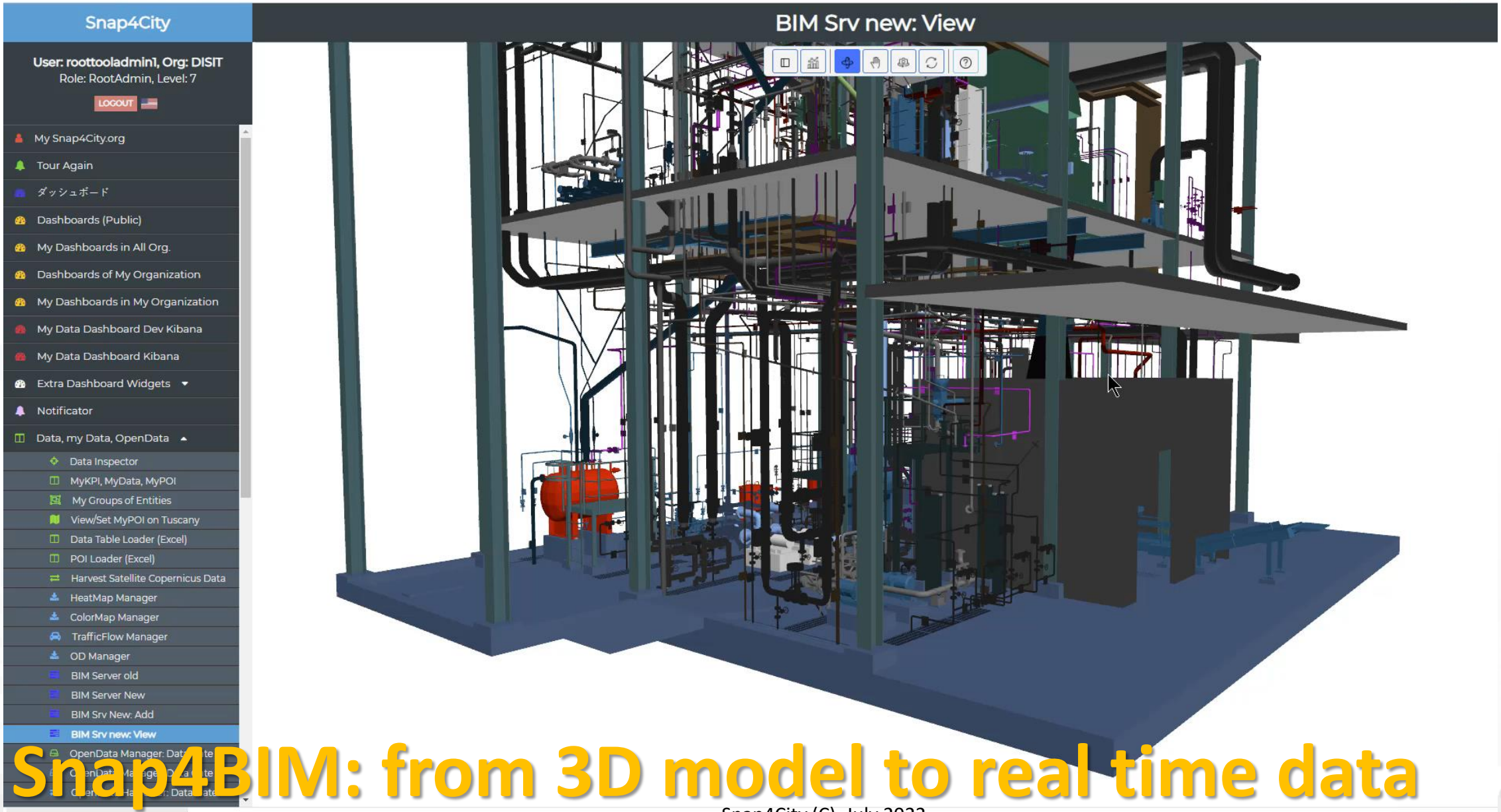




GREEN IMPACT C.A.P.A.C.I.T.Y.

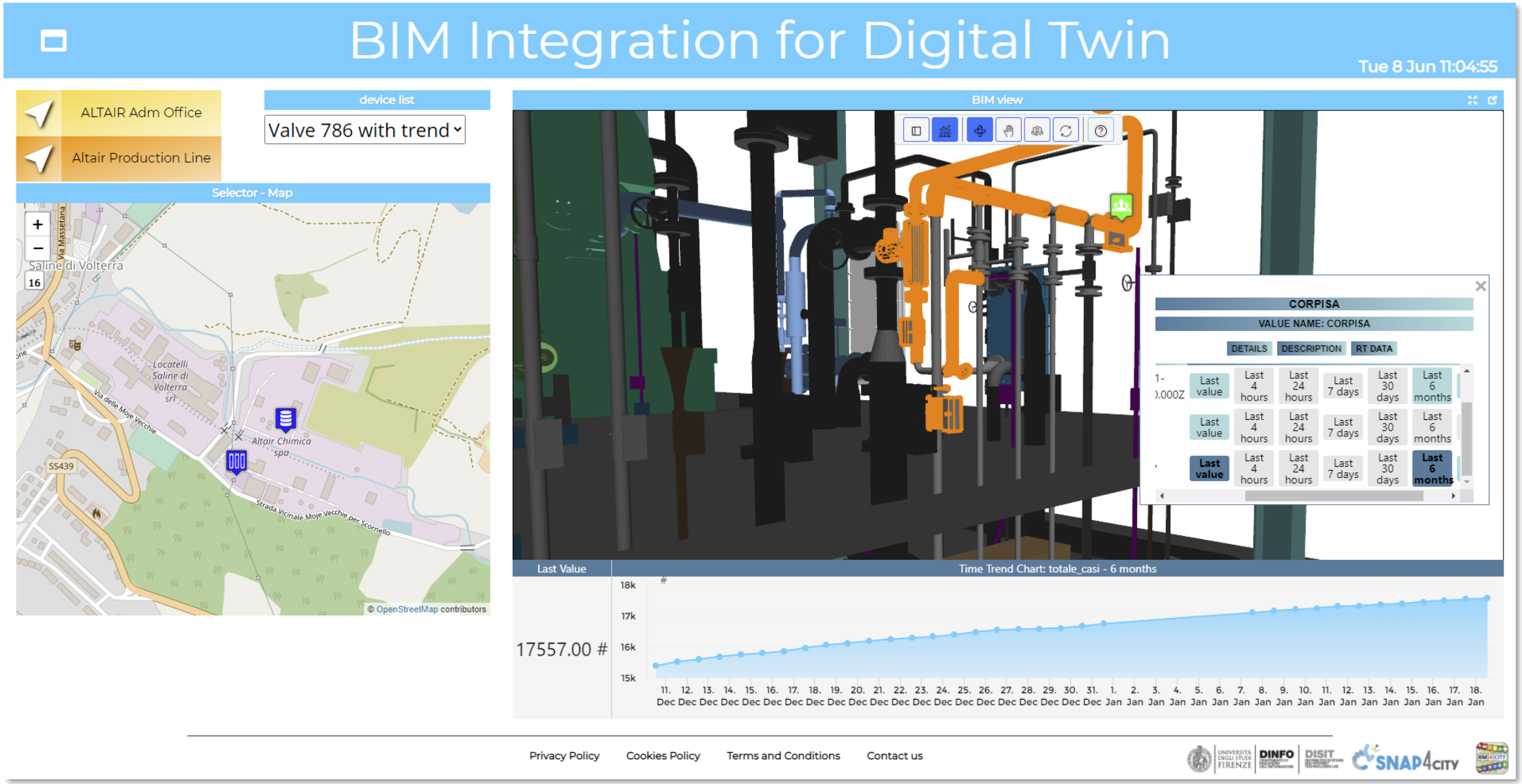
GREEN FIELD PEAS
Soda4.0

Digital Twin Local



Snap4BIM: from 3D model to real time data

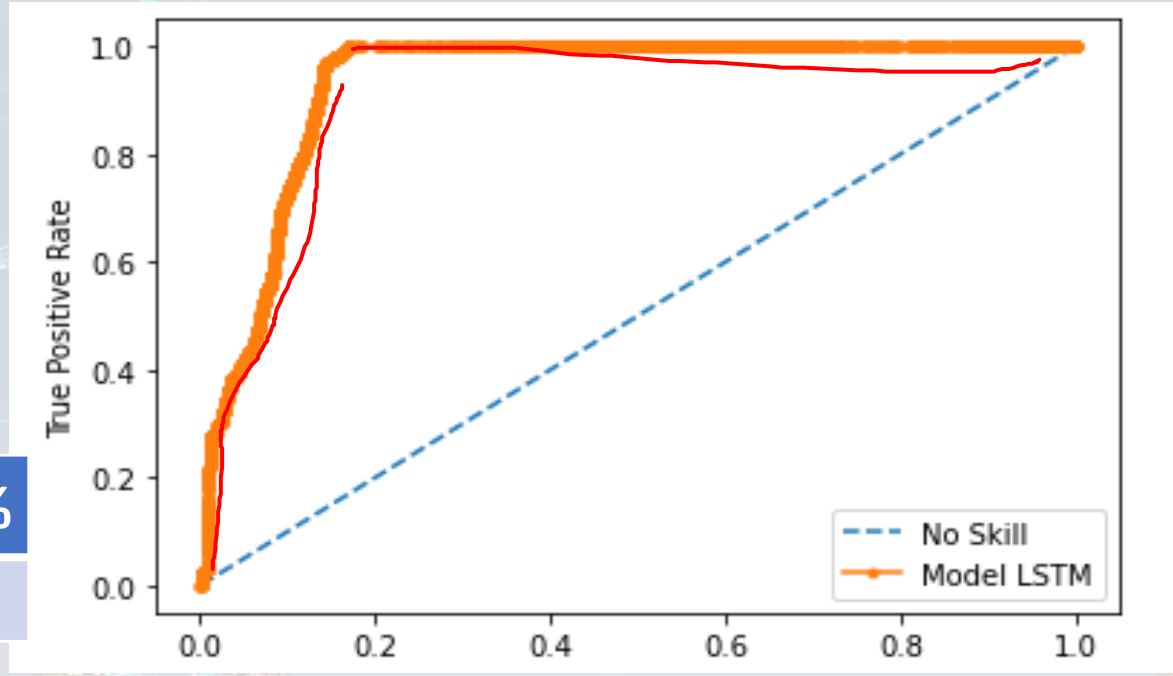
Digital Twin Local, 3D vs Real Time Data

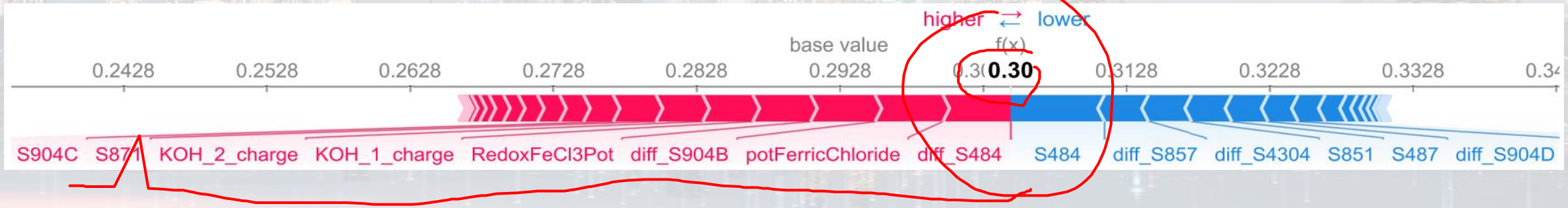


Preditive capabilities

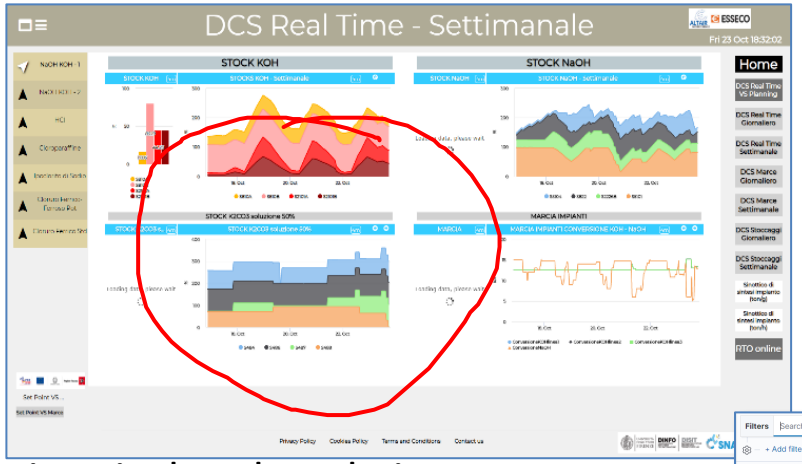
- Deep Learning: LSTM, CNN-LSTM approached
- Explainable AI: Identification of possible causes of fault

	Precision %	Recall %	F_1 score %
weighted avg	0.90	0.92	0.90



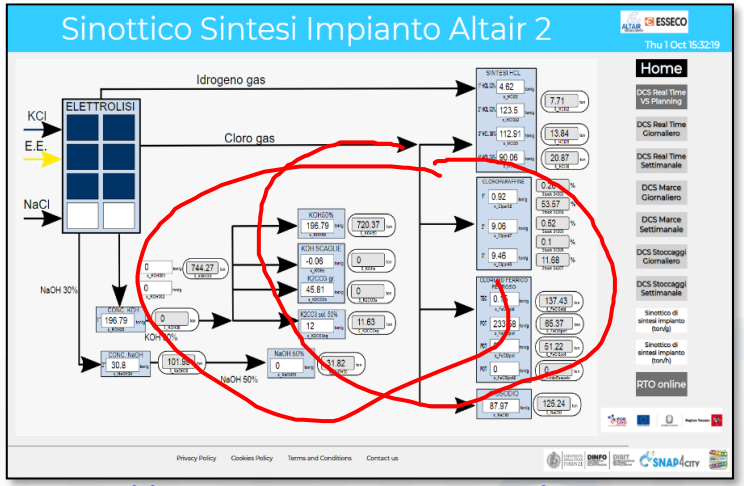


Closing the loop



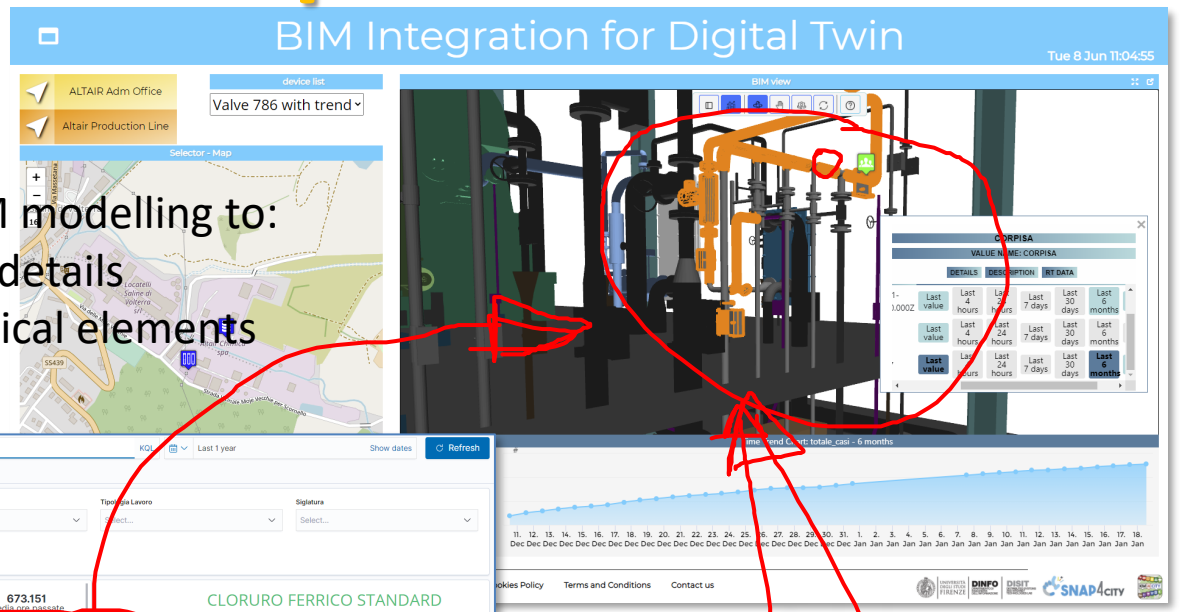
Historical and Real Time Data

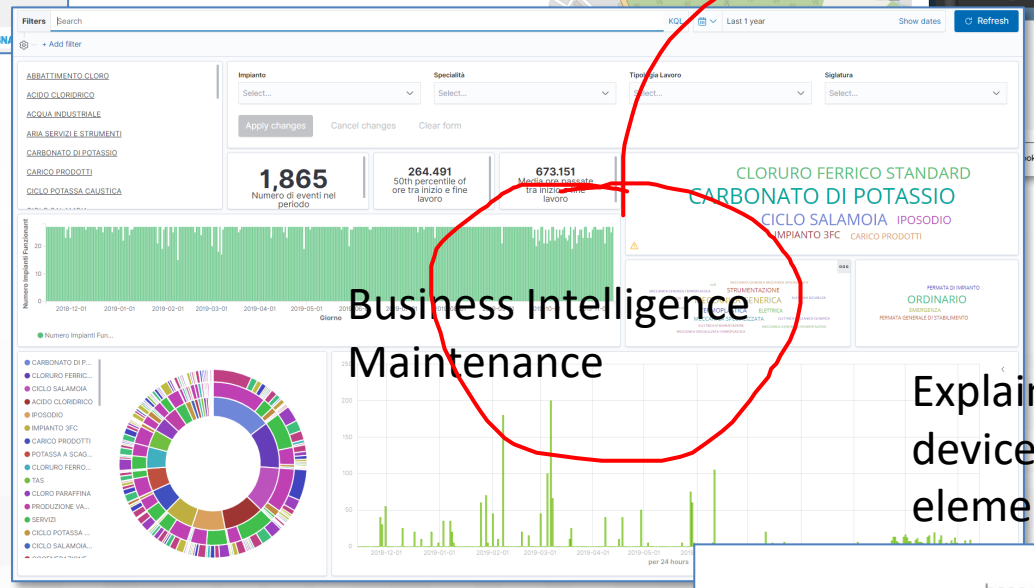
Synoptics for real time monitoring



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

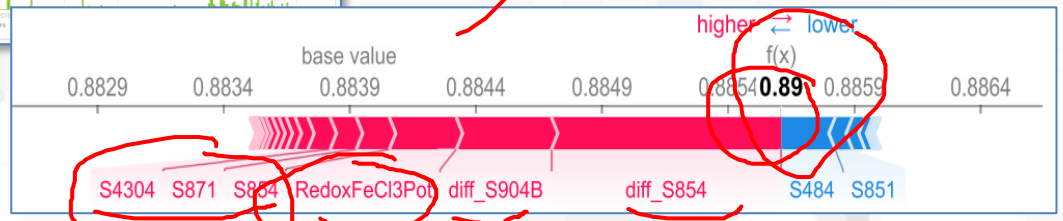
Map and 3D BIM modelling to:
-- represent the details
-- associate physical elements with data





Business Intelligence Maintenance

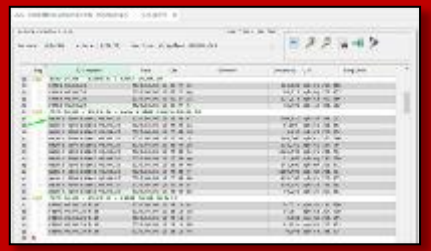
Explainable AI to map critical values of devices and detection to physical elements in the plant



GeNotiLab Architecture for ALTAIR

Analytical Data from the product quality Lab(LIMS/SAM)





AS400

IOT App



Users

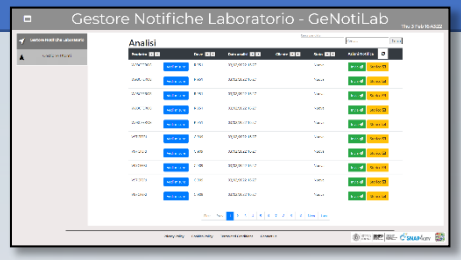
Analysis

Notifications



IOT App Analytics

Dashboards



IOT App Management



Tools:
-- List of Chemical Analyses
-- List of Notifications
-- Define notifications
-- Program, send notifications
-- see notification status



IOT App Vs Telegram

Telegram Bot



Tuscany Region

https://www.snap4city.org/760

Firenze, Pisa, Livorno, Prato, Siena, Arezzo, etc.

https://www.snap4city.org/746



https://www.snap4city.org/758

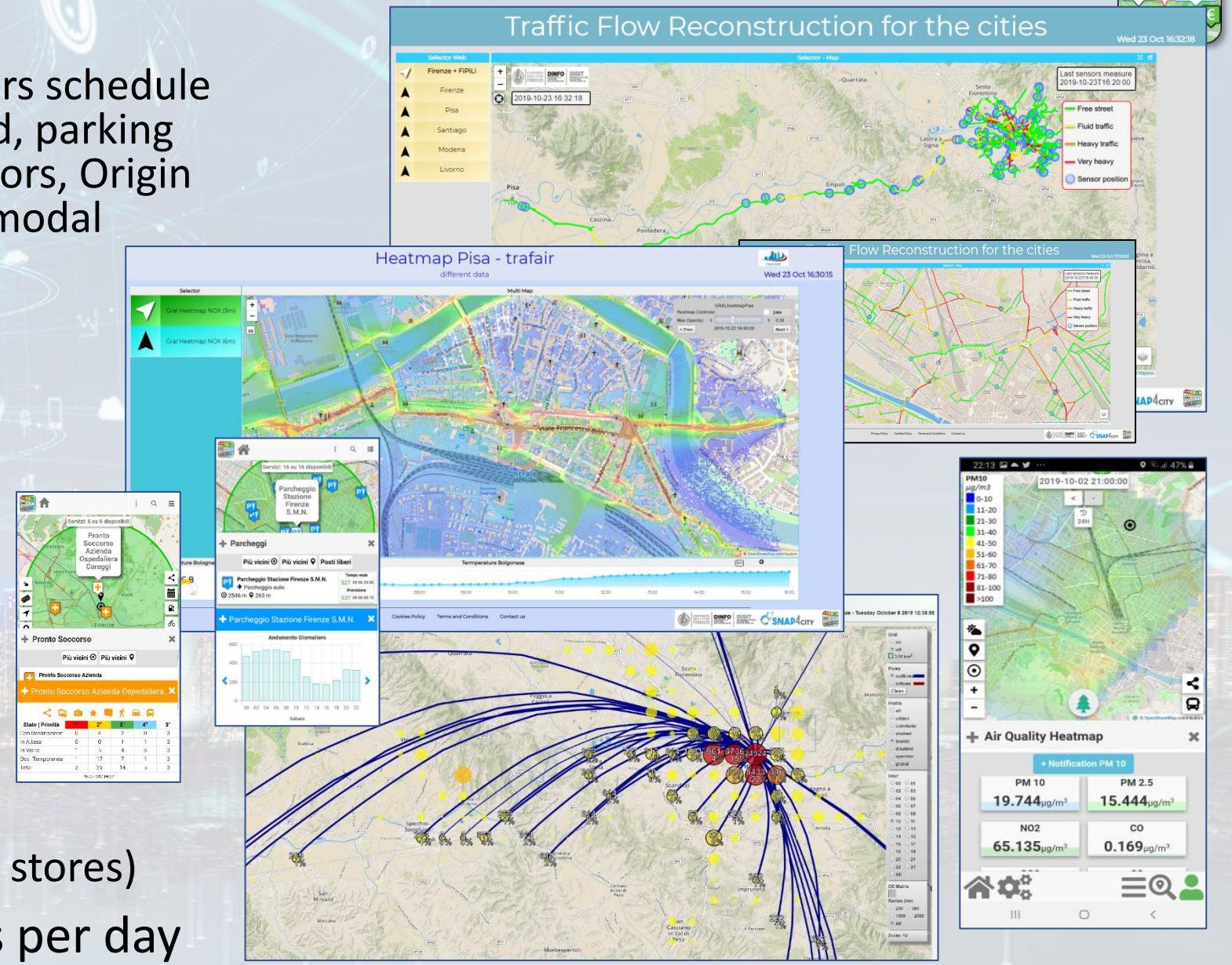


https://www.snap4city.org/751



Tuscany Region

- **Dashboards & Services**:
  - **Mobility**: public transport operators schedule and paths, traffic Fi-Pi-Li main road, parking status and predictions, traffic sensors, Origin Destination matrix, routing, multimodal routing, etc.
  - **Social**: Hospitals and triage, etc.
  - **Environment**: sensors, heatmaps,
  - alerting,
    - **Pollution** Forecast: NOX, NO2
    - **Weather** Forecast,
  - **Culture** and **Tourisms**
  - Etc.
- **Mobile App and MicroApplications:**
  - Tuscany in a Snap (all stores)
  - Tuscany where what… km4city (all stores)
- **Numbers**: 1.5 M complex events per day

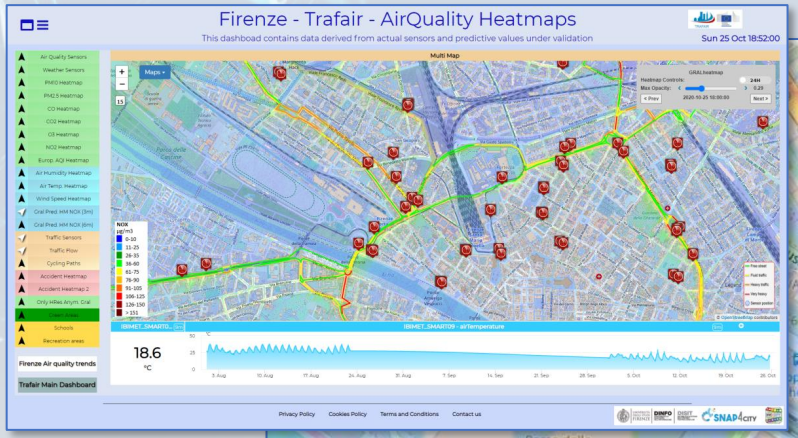


Environment and Quality of Life
Air Quality Predictions

Cities of: Firenze, Pisa, Livorno

reference

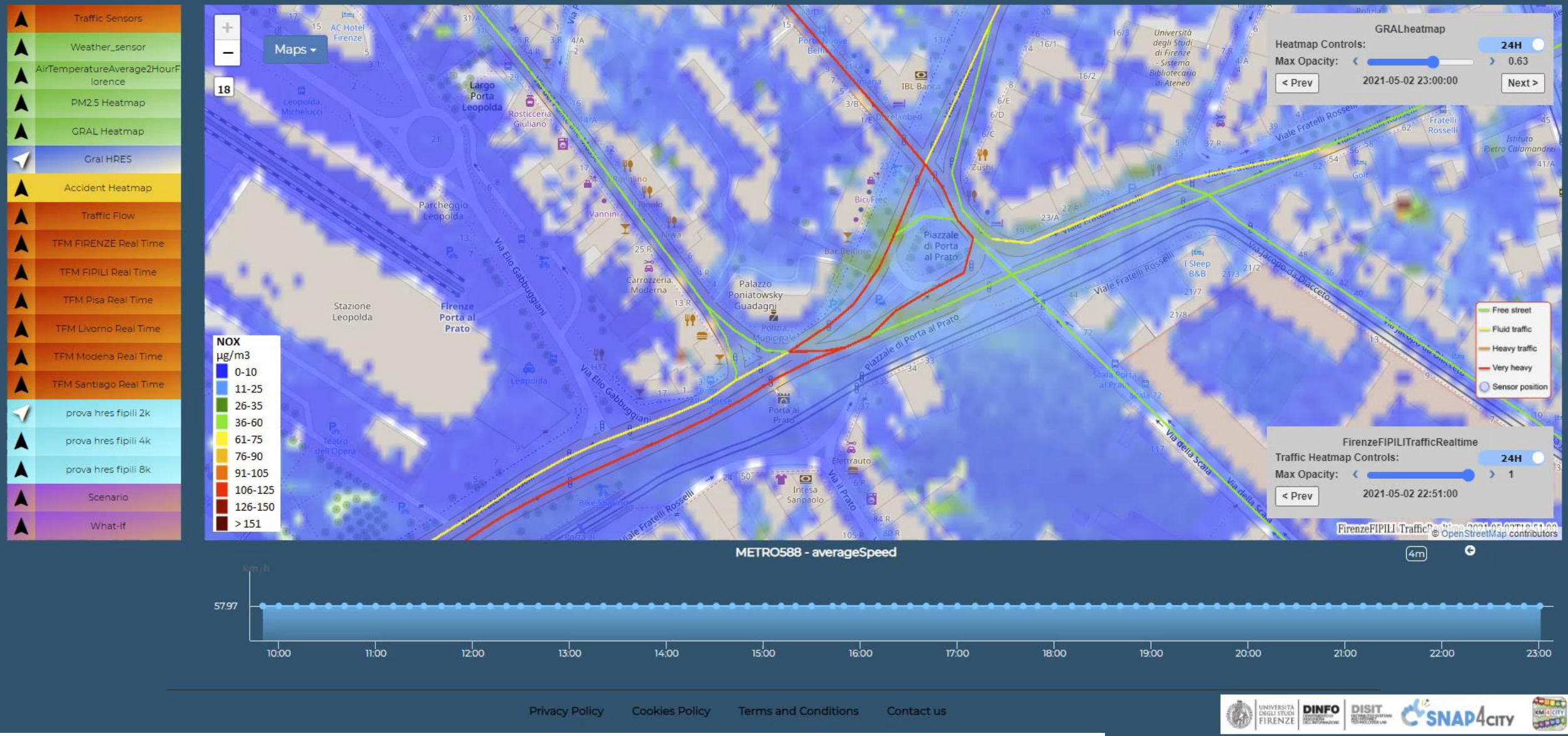
- **Multiple Domain Data**
  - Traffic Flow data, Pollutant: NOX, CO2, PM10, PM2.5, O3, ….
  - 3D City structure, weather, …
- **Multiple Decision Makers**
  - Pollutant Predictions: NOX, NO2, ..
  - City officers, energy industries
  - Dashboards, What-IF analysis
  - Traffic Flow Reconstruction
- **Historical and Real Time data**
  - Billions of Data
- **Services Exploited on:**
  - Dashboards, Mobile App
- **Since 2020**



Pollutant	Averaging period	Air Quality Directive: Objective and legal nature and concentration	Air Quality Directive: Comments	WHO guidelines: Concentration	WHO guidelines: Comments
$PM_{2.5}$	One day			25 µg/m³ (*)	99th percentile (3 days/year)
$PM_{2.5}$	Calendar year	Target value, 25 µg/m³	The target [illegible] become a limit value [illegible] January 2015	10 µg/m³	
PM_{10}	One day	Limit [illegible], 50 µg [illegible] to be exceeded on more than 35 days per year.		50 µg/m³ (*)	99th percentile (3 days/year)
PM_{10}	Calend[illegible]	[illegible] va[illegible] 40 µg/m³ (*)		20 µg/m³	
O_3	Maximum [illegible]ily 8-hour mean	Target value, 120 µg/m³	Not to be exceeded on more than 25 days per year, averaged over three years	100 µg/m³	
NO_2	One hour	Limit value, 200 µg/m³ (*)	Not to be exceeded more than 18 times a calendar year	200 µg/m³ (*)	
NO_2	Calendar year	Limit value, 40 µg/m³		40 µg/m³	

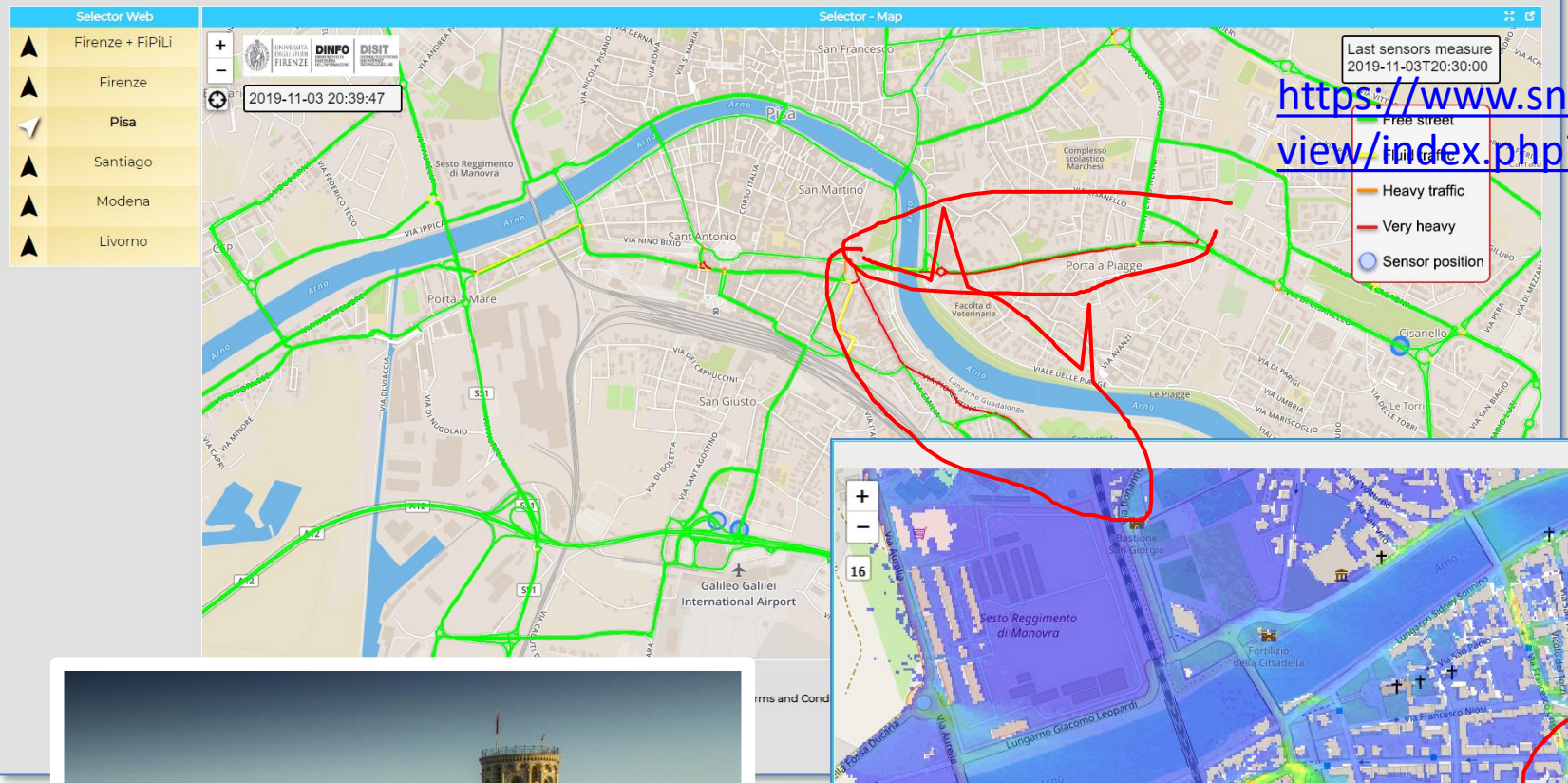
KPI of EC

Traffic Flow Manager on multiple cities



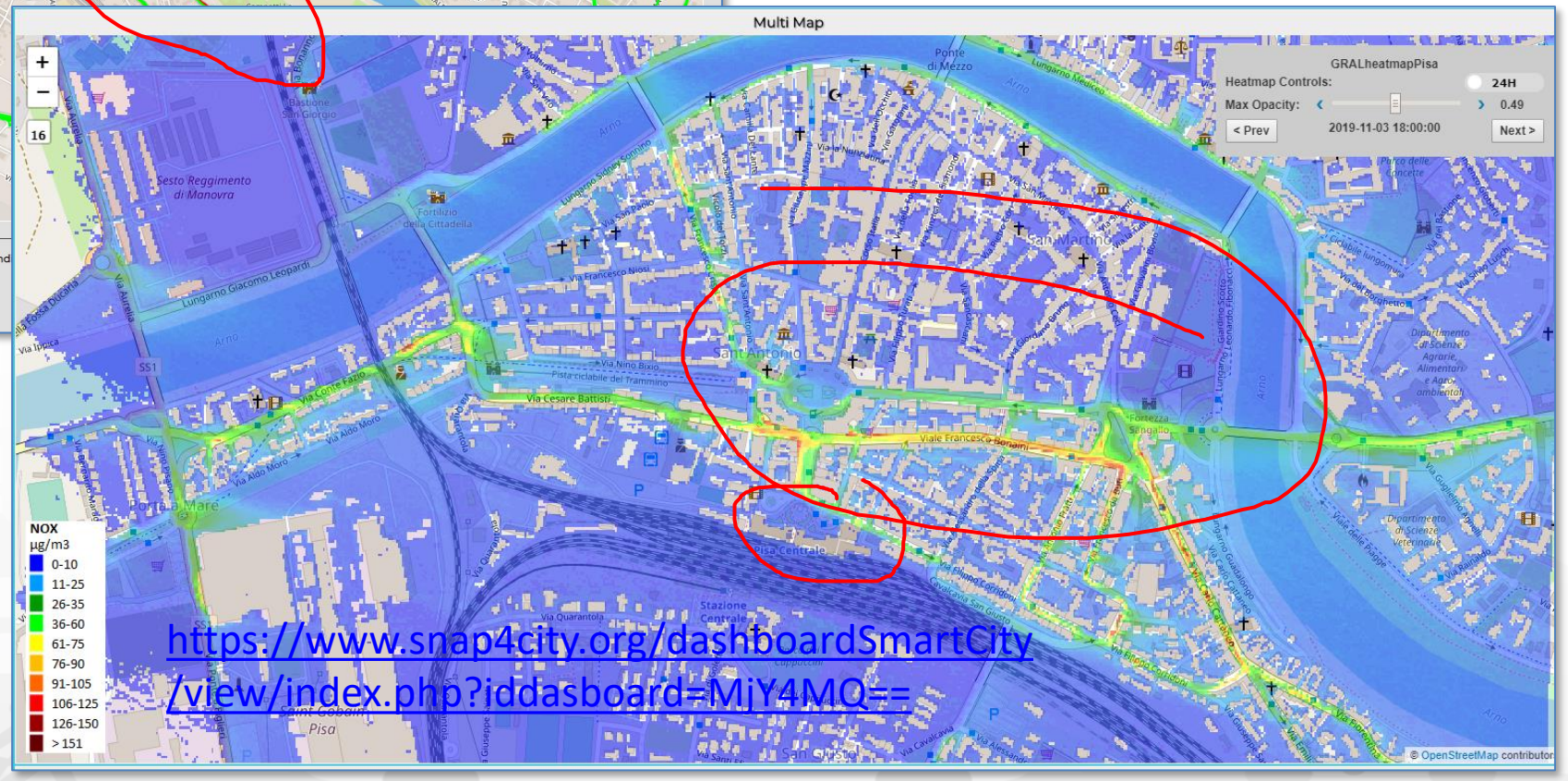
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzEyNg==

Traffic Flow Reconstruction for the cities



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjY3OA==





https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjY4MQ==



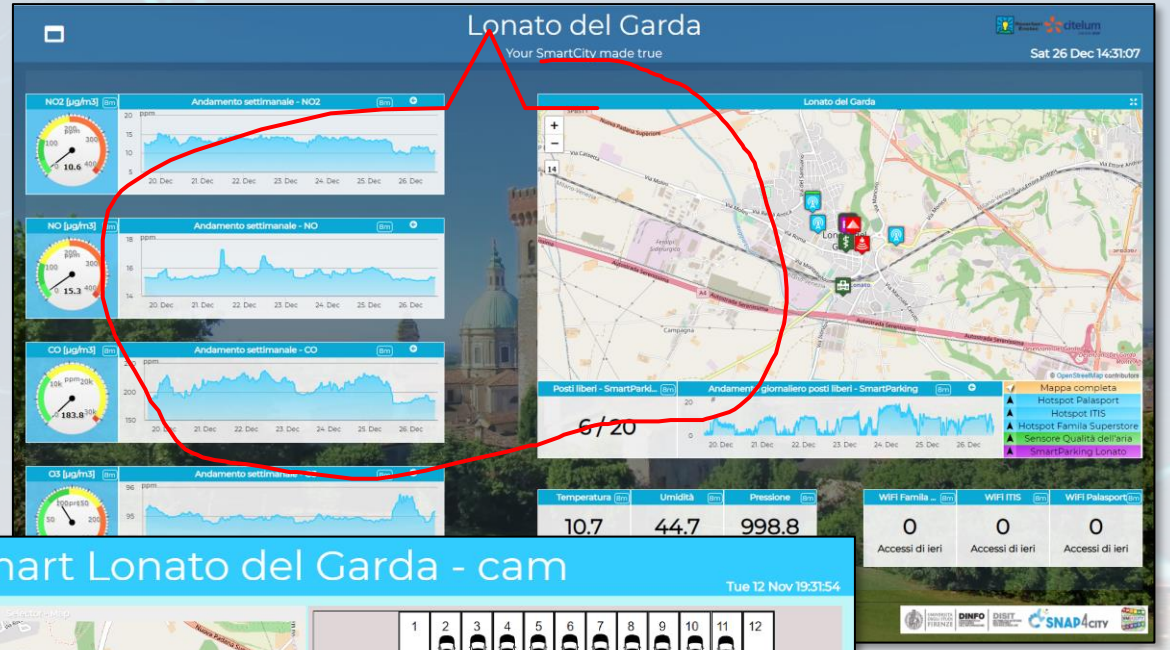
https://www.snap4city.org/712

Lonato del Garda, Italy

Smart City / Smart Parking + Environment Reverberi, Lonato del Garda

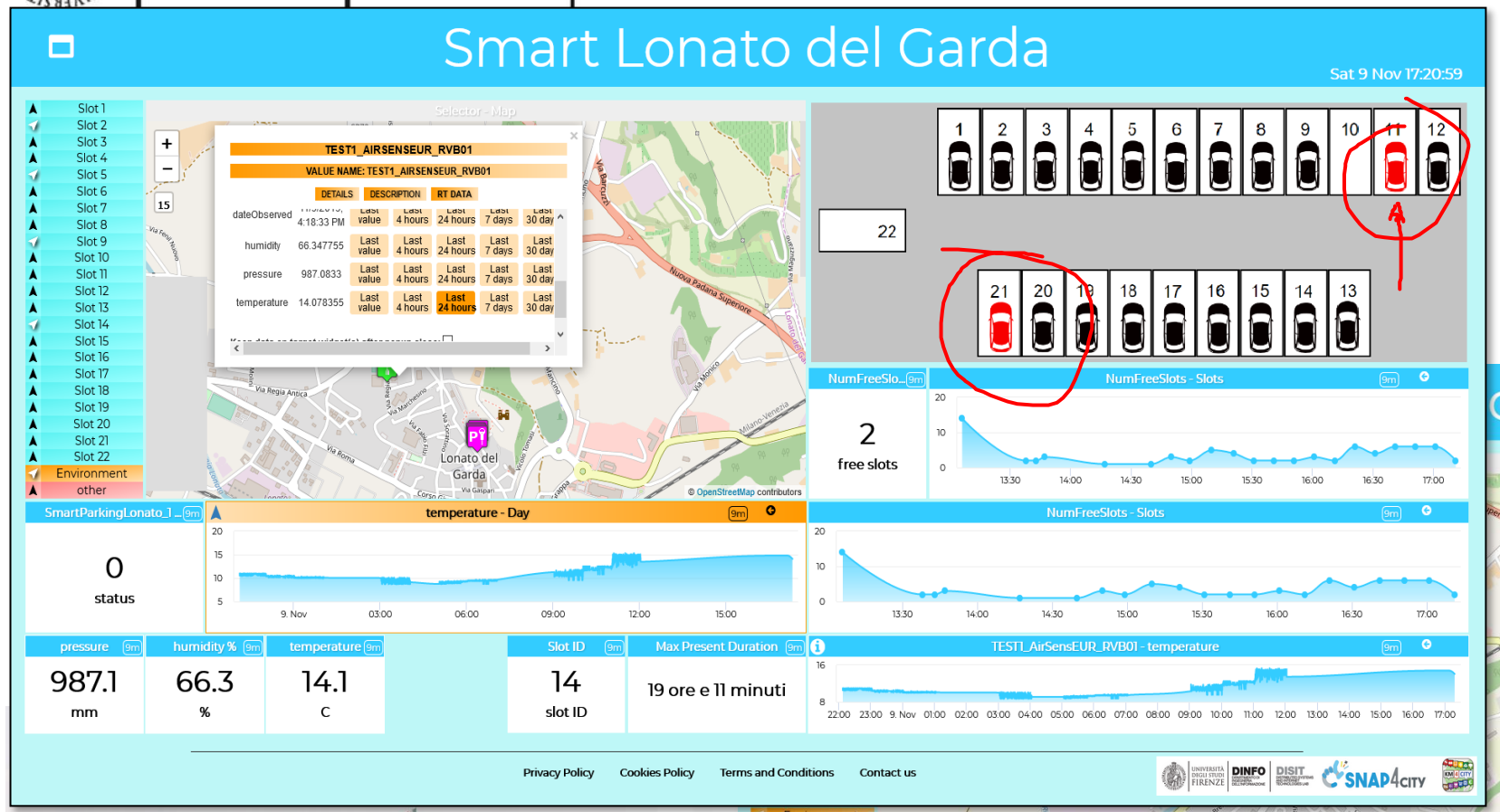
reference

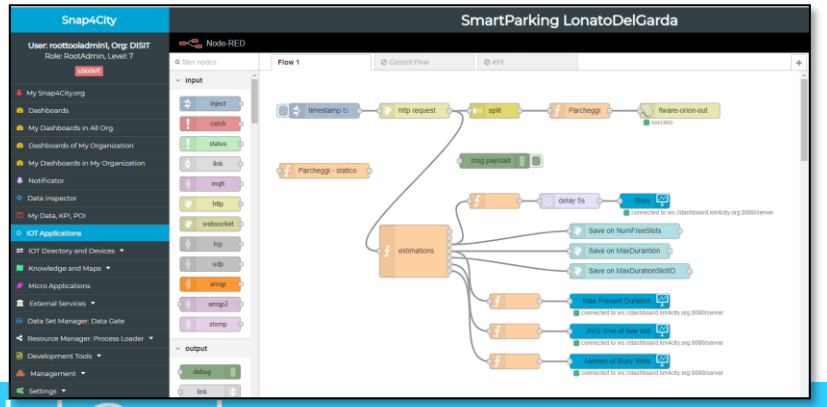
- **Multiple Domain Data**
  - Smart Parking, Environment, Wi-Fi
- **Multiple Decision Makers**
  - City Officer, operators
  - Data monitoring, alerting
  - analytics
- **Historical and Real Time data**
  - Dashboards
- **Services Exploited on:**
  - Dashboards, API
- **Since 2019**





Smart Parking Monitoring







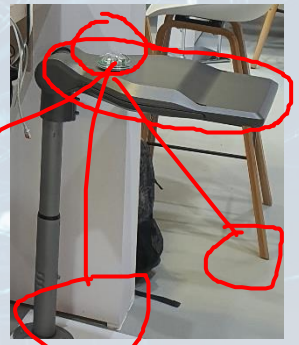


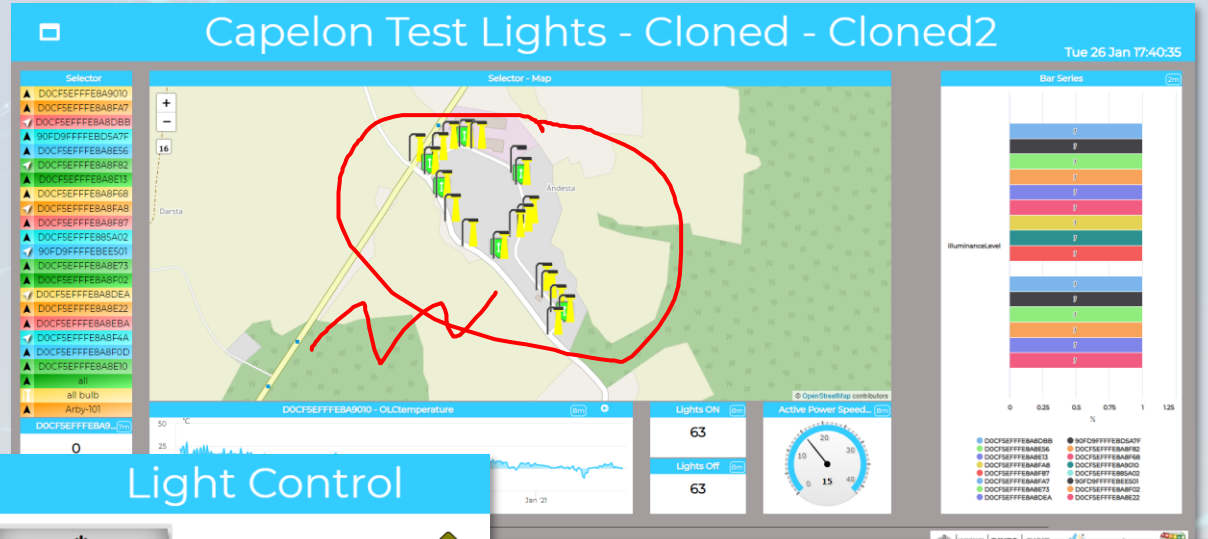
Västerås, Sweden

Smart Light Control of CAPELON

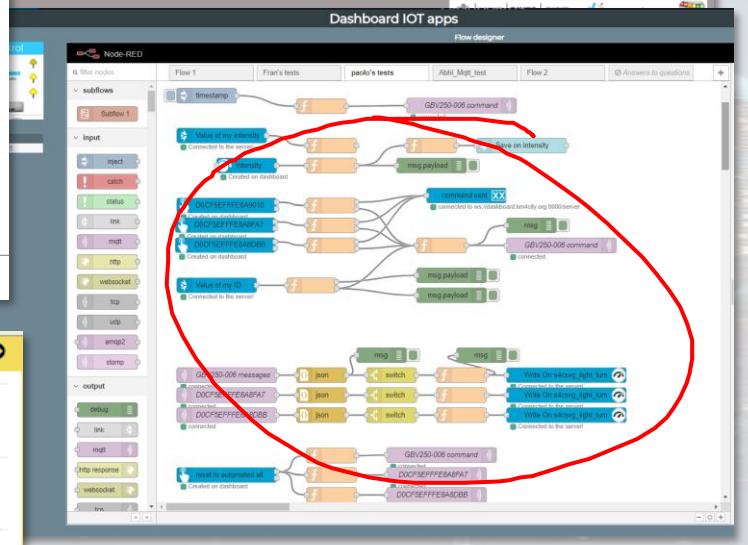
reference

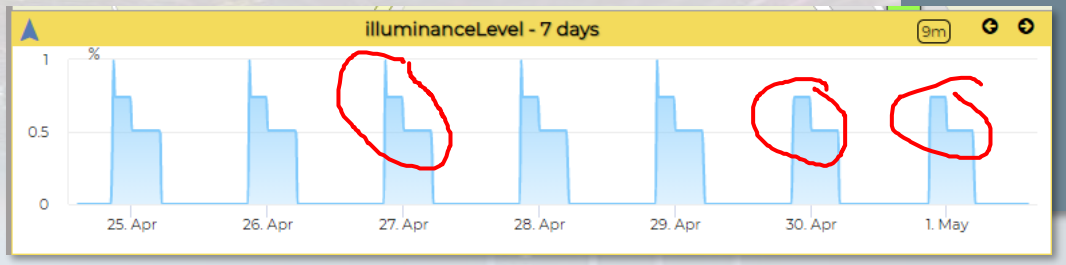
- **Energy Domain**
  - Smart Light, MQTT, ….
  - IoT Orion Broker FIWARE
- **Dashboards**
  - Map coverage on Sweden
  - Monitoring and real time control
  - Energy control, analytics
  - Direct control
- **Historical and Real Time data**
- **Services Exploited on:**
  - Multiple Levels, API
  - Dashboards
- **Since 2020**



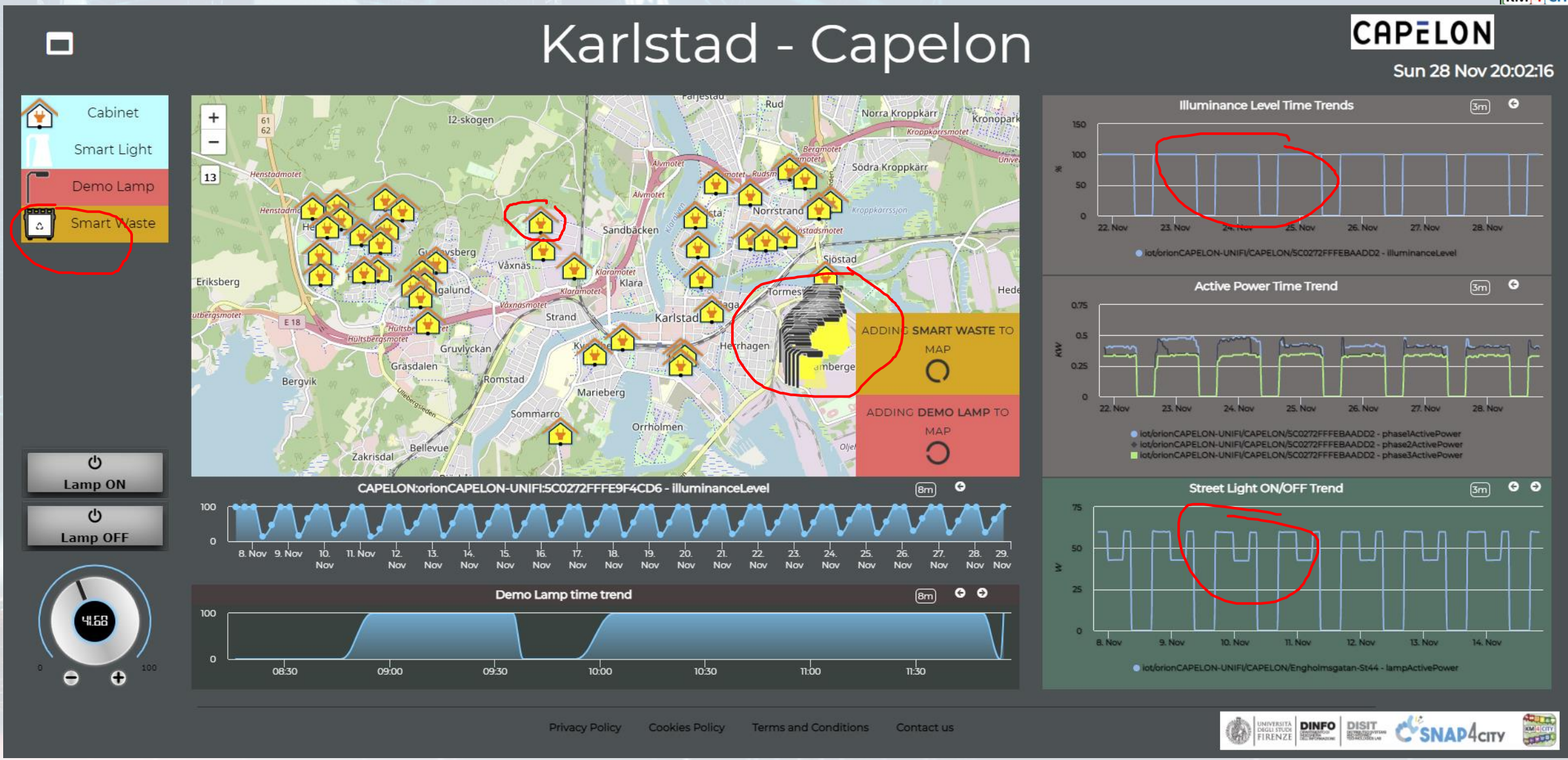






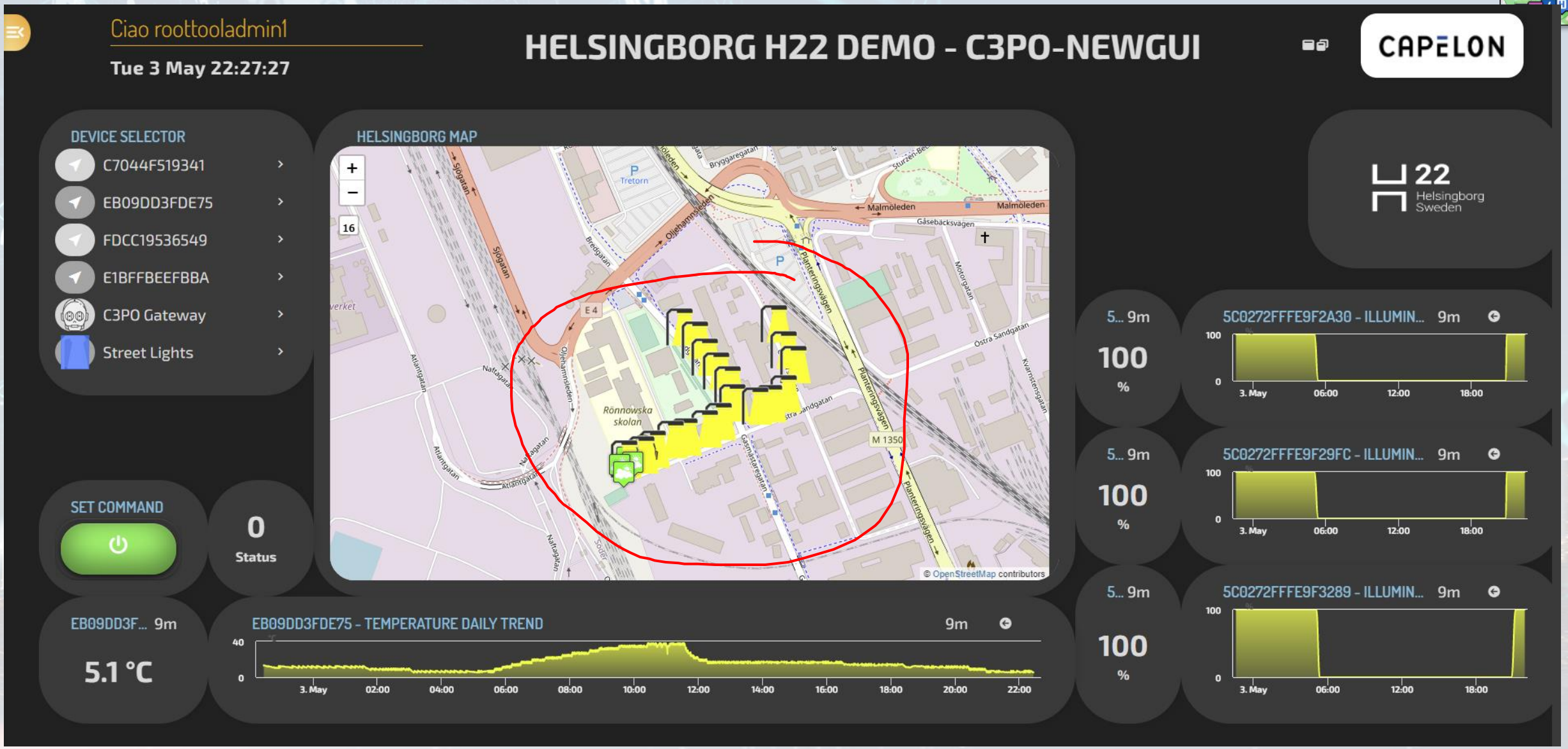


Karlstad Street Lights



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzI5NQ==

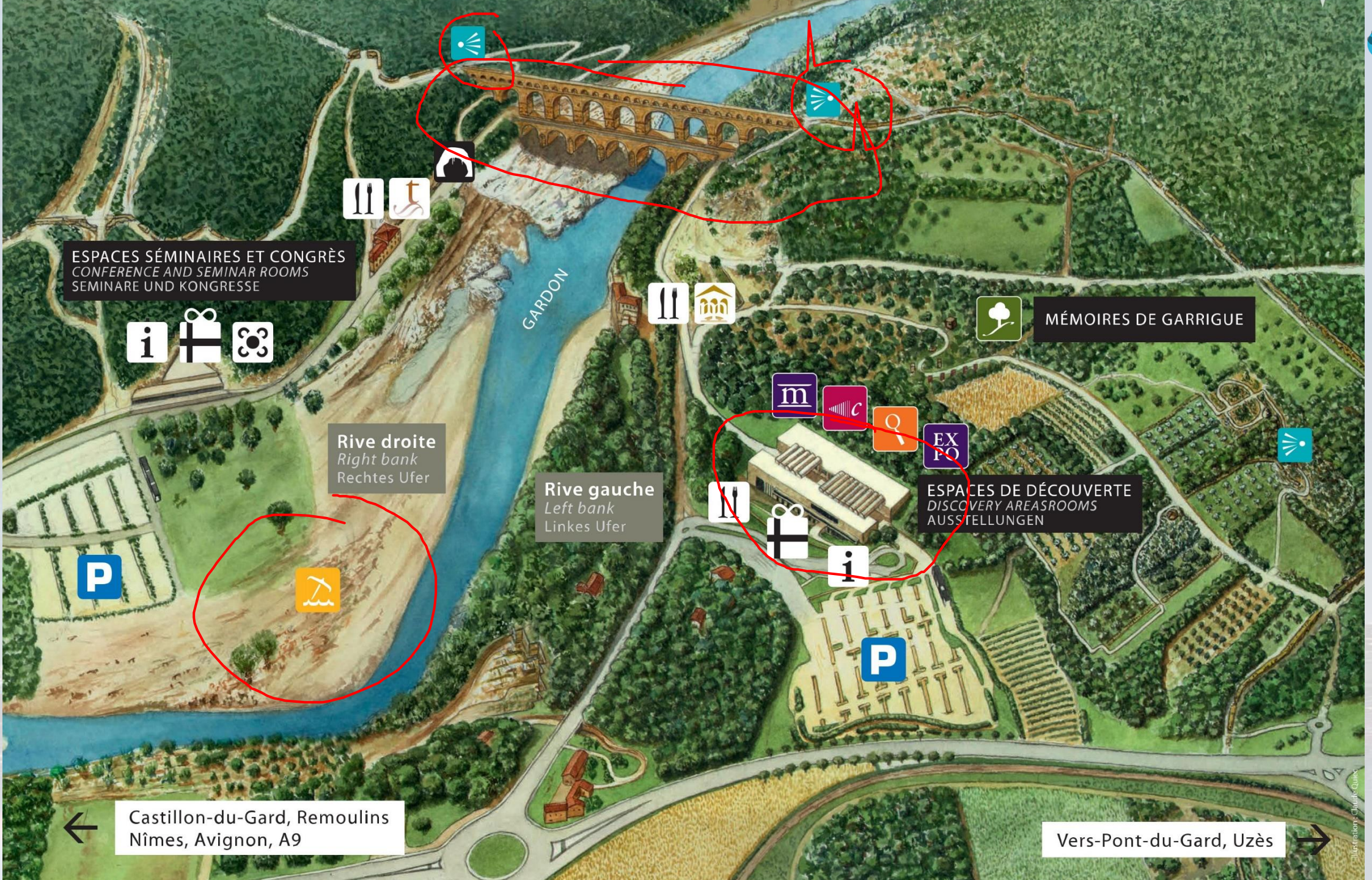
C3PO Street Lights



Pont du Gard, France

https://www.snap4city.org/740

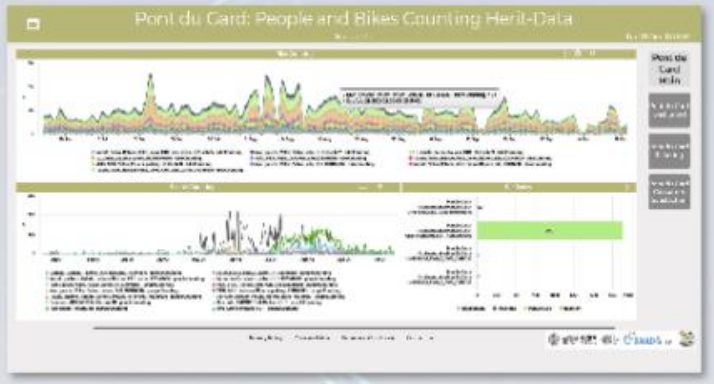


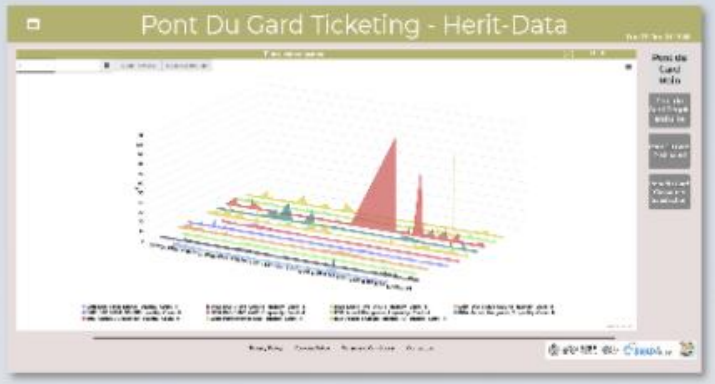

ESPACES SÉMINAIRES ET CONGRÈS
CONFERENCE AND SEMINAR ROOMS
SEMINARE UND KONGRESSE
GARDON
MÉMOIRES DE GARRIGUE
Rive droite
Right bank
Rechtes Ufer
Rive gauche
Left bank
Linkes Ufer
ESPACES DE DÉCOUVERTE
DISCOVERY AREASROOMS
AUSSTELLUNGEN
Castillon-du-Gard, Remoulins
Nîmes, Avignon, A9
Vers-Pont-du-Gard, Uzès

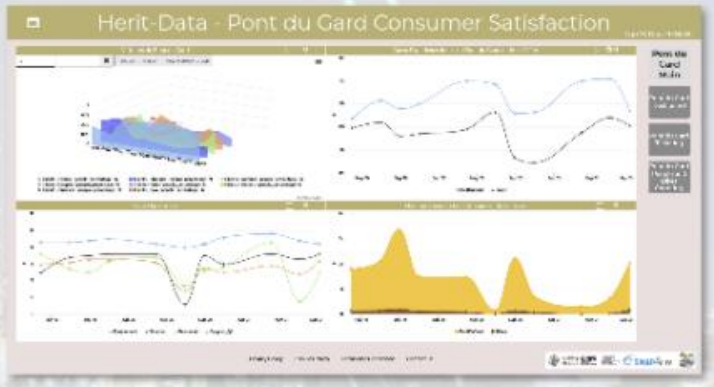
Pont du Gard

- **Tourism Domain**
  - KPIs
  - Social Media
  - People Flows
  - Bike Flows
- **Dashboards**
  - Monitoring KPI
  - People and bikes flows
  - Twitter Vigilance
- **Historical and updated data**
- **Services Exploited on:**
  - Dashboard
- **Since 2020**











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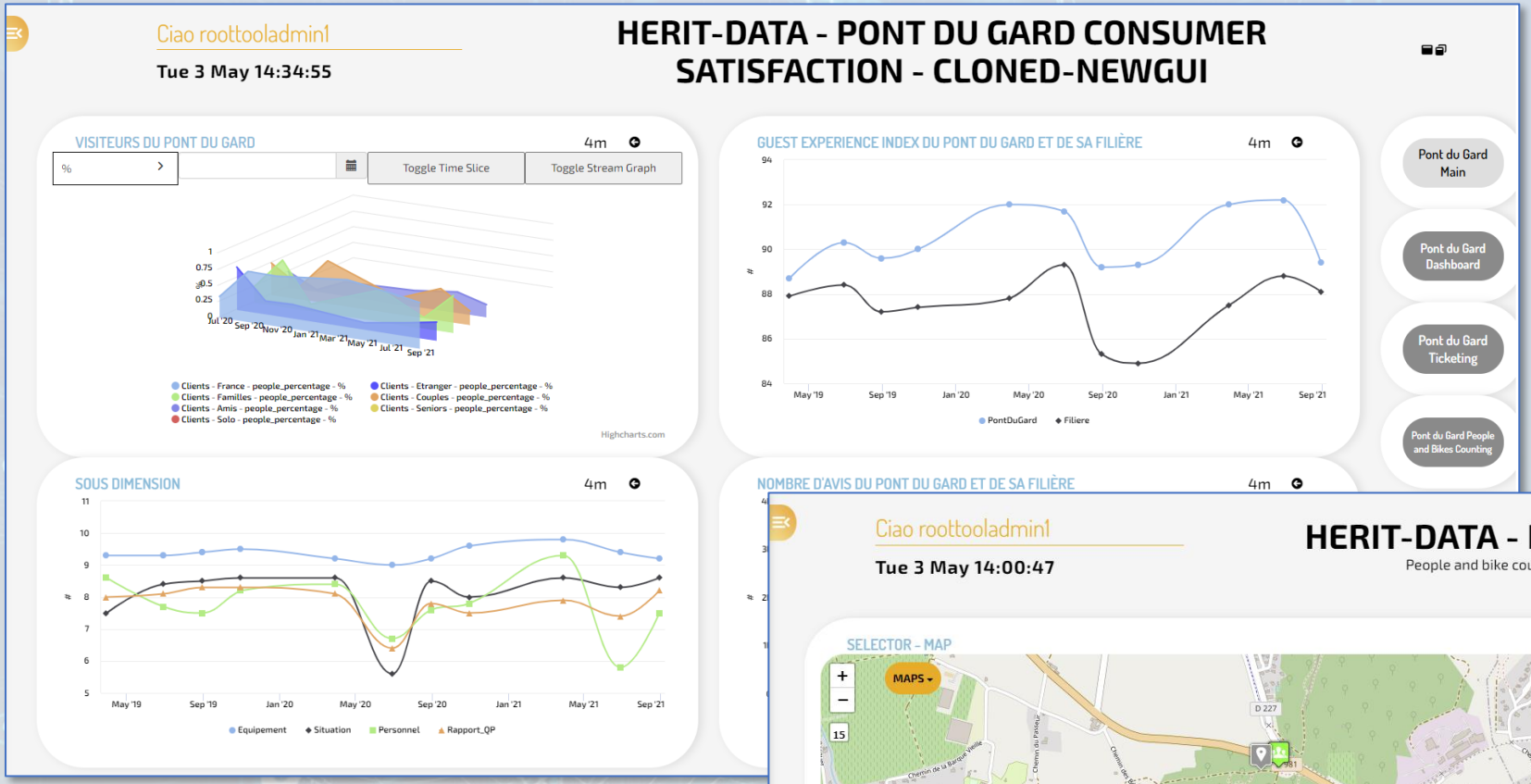
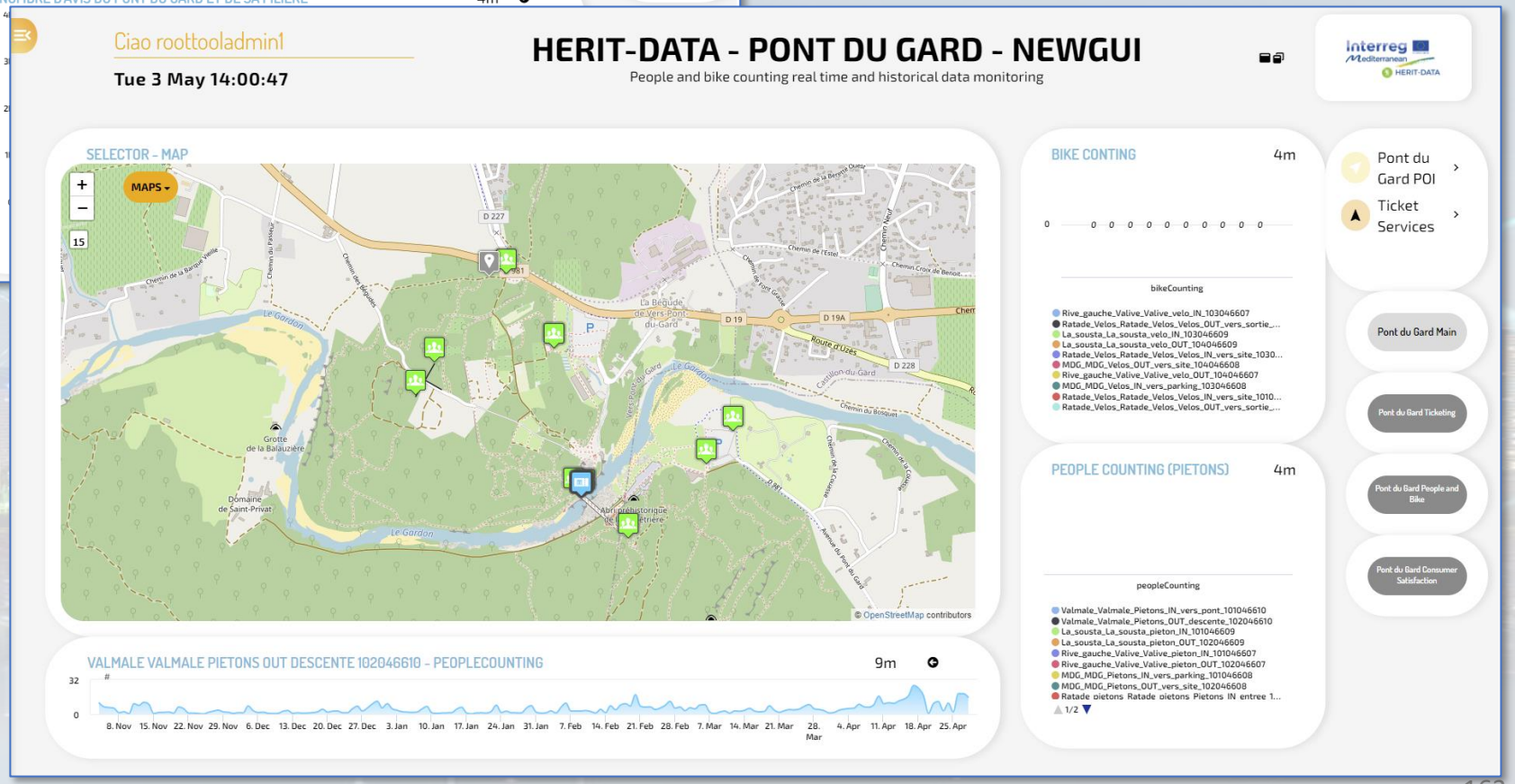

Ciao roottooladmin1
Tue 3 May 14:34:55
HERIT-DATA - PONT DU GARD CONSUMER SATISFACTION - CLONED-NEWGUI
VISITEURS DU PONT DU GARD
4m
Toggle Time Slice
Toggle Stream Graph
Clients - France - people_percentage - %
Clients - Familles - people_percentage - %
Clients - Amis - people_percentage - %
Clients - Solo - people_percentage - %
Clients - Etranger - people_percentage - %
Clients - Couples - people_percentage - %
Clients - Seniors - people_percentage - %
Highcharts.com
GUEST EXPERIENCE INDEX DU PONT DU GARD ET DE SA FILIÈRE
4m
PontDuGard
Filiere
SOUS DIMENSION
4m
Equipement
Situation
Personnel
Rapport_QP
NOMBRE D'AVIS DU PONT DU GARD ET DE SA FILIÈRE
4m
Pont du Gard Main
Pont du Gard Dashboard
Pont du Gard Ticketing
Pont du Gard People and Bikes Counting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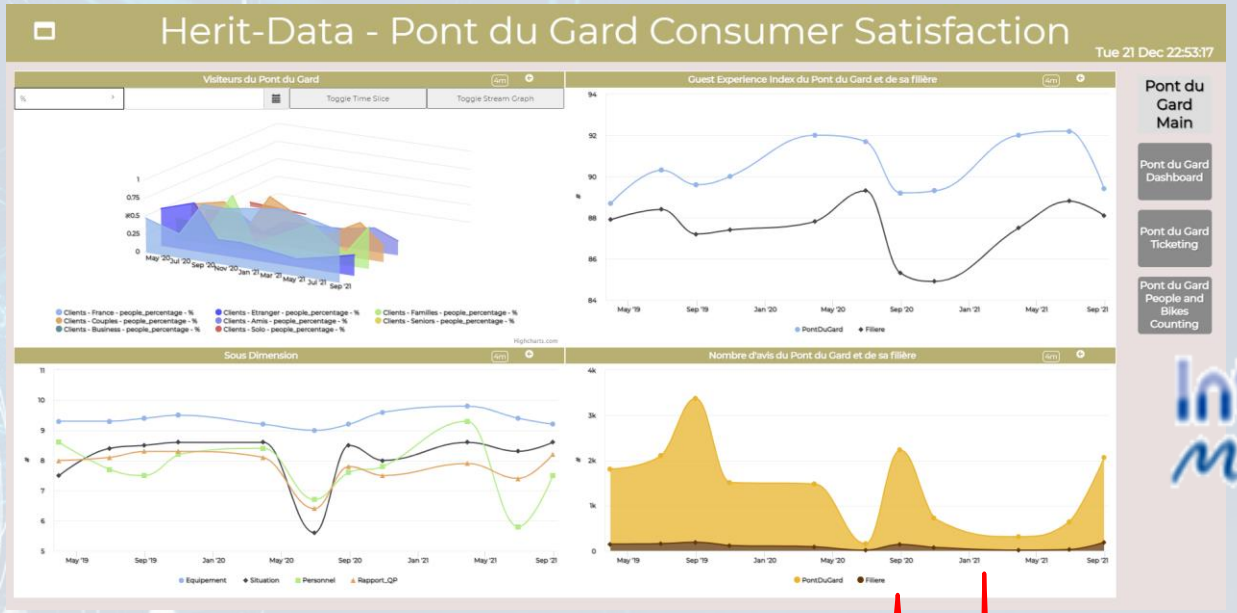
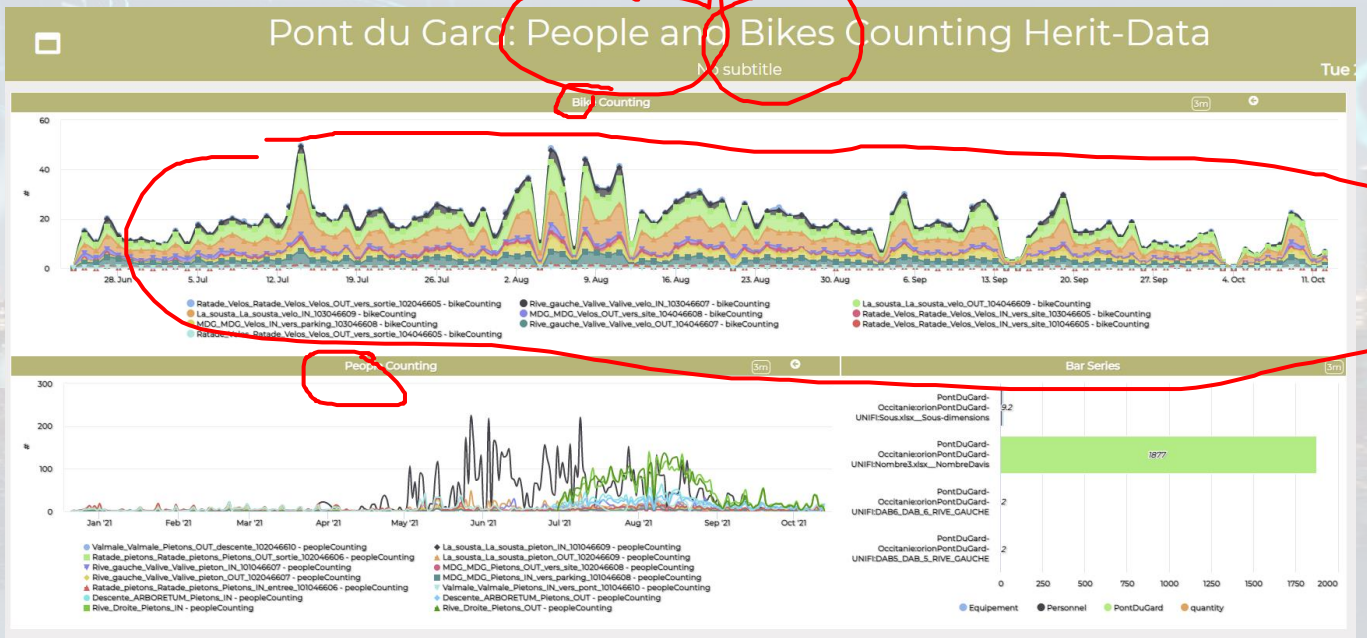
HERIT-DATA - PONT DU GARD - NEWGUI
People and bike counting real time and historical data monitoring
SELECTOR - MAP
MAPS
BIKE CONTING
4m
bikeCounting
PEOPLE COUNTING (PIETONS)
4m
peopleCounting
VALMALE VALMALE PIETONS OUT DESCENTE 102046610 - PEOPLECOUNTING
9m
Pont du Gard POI
Ticket Services
Pont du Gard Main
Pont du Gard Ticketing
Pont du Gard People and Bike
Pont du Gard Consumer Satisfaction

Pont du Gard

Pont du Gard

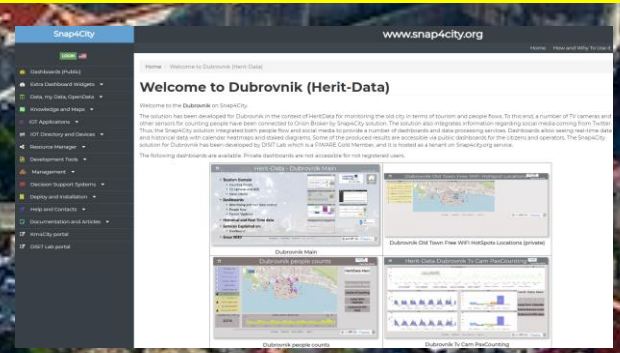
- **KPI:**
  - Consumer Satisfaction
  - Selling Tickets over time and locations
  - Business on Tourims
- **Real Time Data**
  - People Counting
  - Bike Counting
- **Social Media, Real Time**
  - A Set of Key: keywords, Hashtags, Citations
  - Volume of Tweets per Key and total
  - Sentiment Volume per Key and total





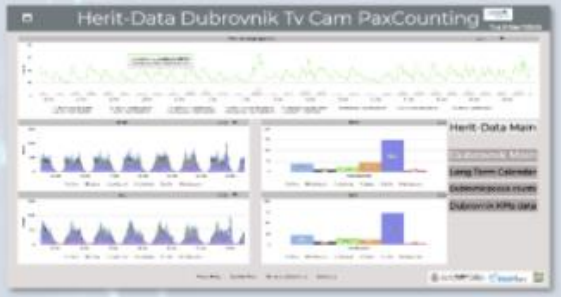
Dubrovnik, Croatia

https://www.snap4city.org/741

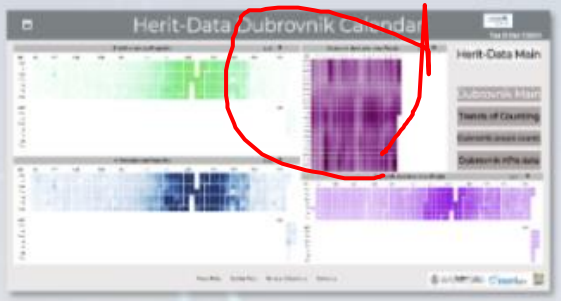


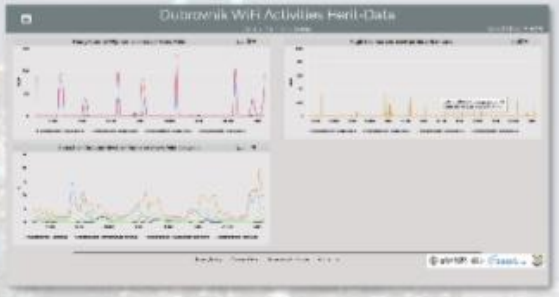
Dubrovnik

- **Tourism Domain**
  - Counting People
  - TV Cameras and WiFi
  - Social Media
- **Dashboards**
  - Monitoring and real time control
  - People flow
  - Twitter Vigilance
- **Historical and Real Time data**
- **Services Exploited on:**
  - Dashboard
- **Since 2020**

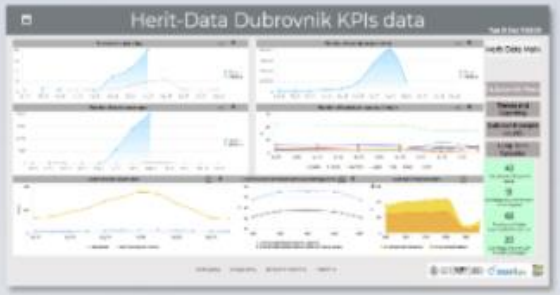








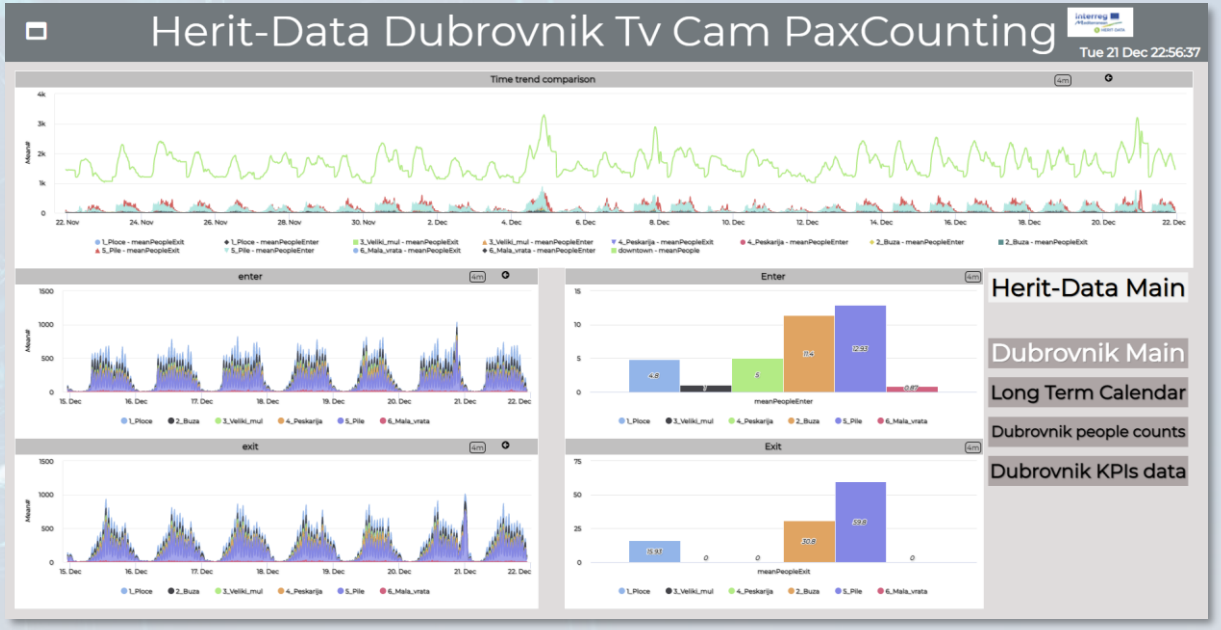


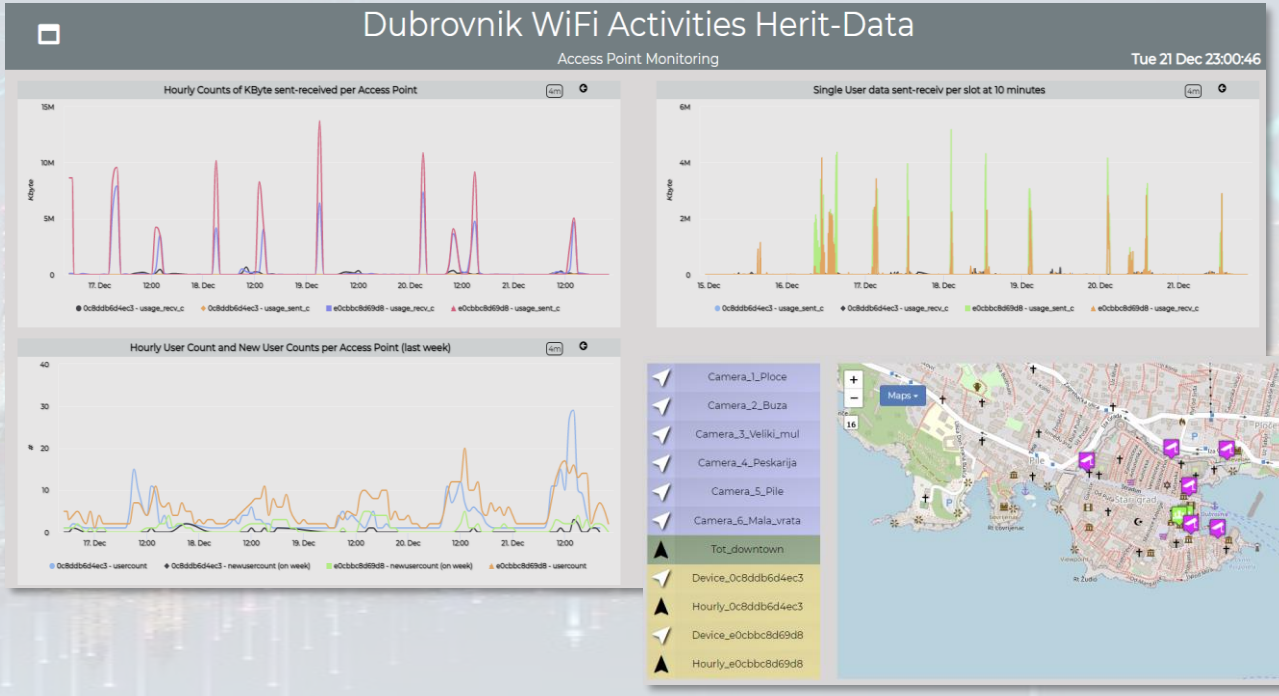


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzE0Ng==

Dubrovnik

- **KPI**
  - #overnights
  - #Cruise Passengers vs time
  - Environmental data
  - Tourists per Countries
  - Employers of the sector vs time
- **Real Time data**
  - PAX Counting via TV Cam
  - Pax Counting via Wi-Fi
  - Volume of Citizens vs Tourists
- **Social Media, Real Time**
  - A Set of Key: keywords, Hashtags, Citations
  - Volume of Tweets per Key and total
  - Sentiment Volume per Key and total

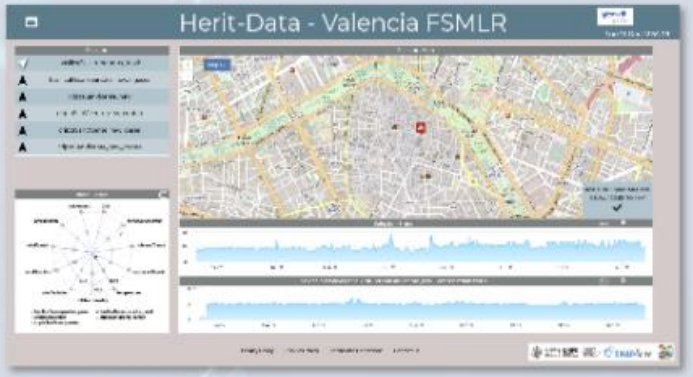


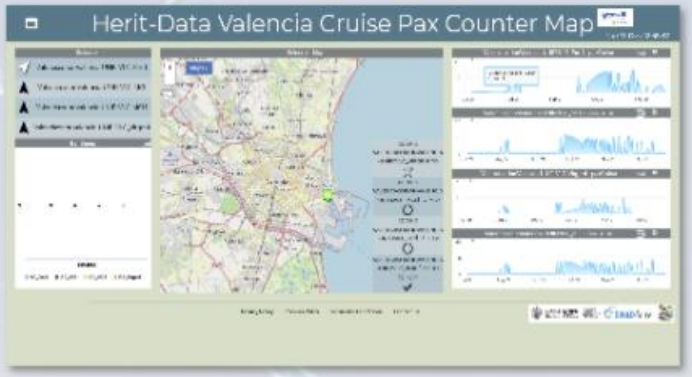



Interreg
MedRerranean
HERIT-DATA
Valencia, Spain
https://www.snap4city.org/742

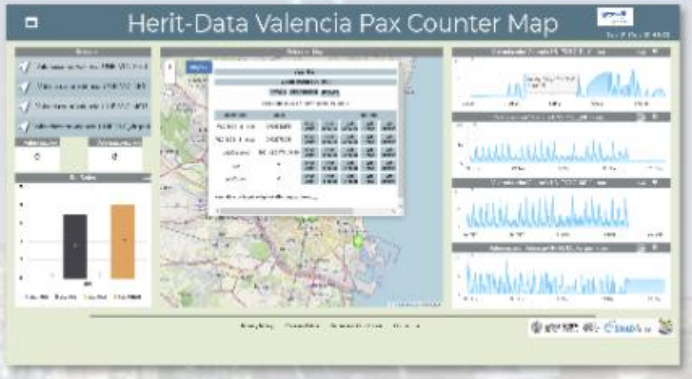
Valencia, FSMLR

- **Tourism Domain**
  - Counting People
  - Environmental data
  - Social Media
- **Dashboards**
  - Monitoring and real time control
  - People flow
  - Twitter Vigilance
- **Historical and Real Time data**
- **Services Exploited on:**
  - Dashboard
- **Since 2020**







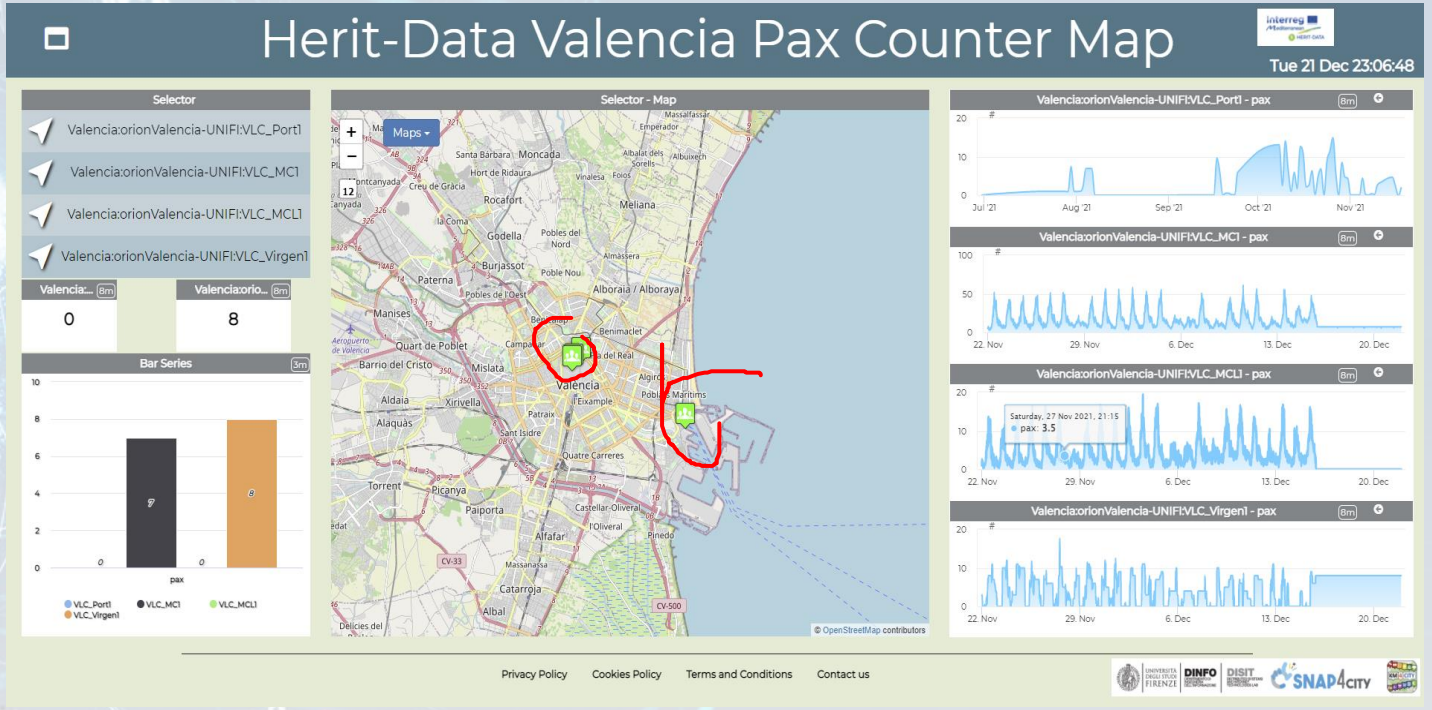


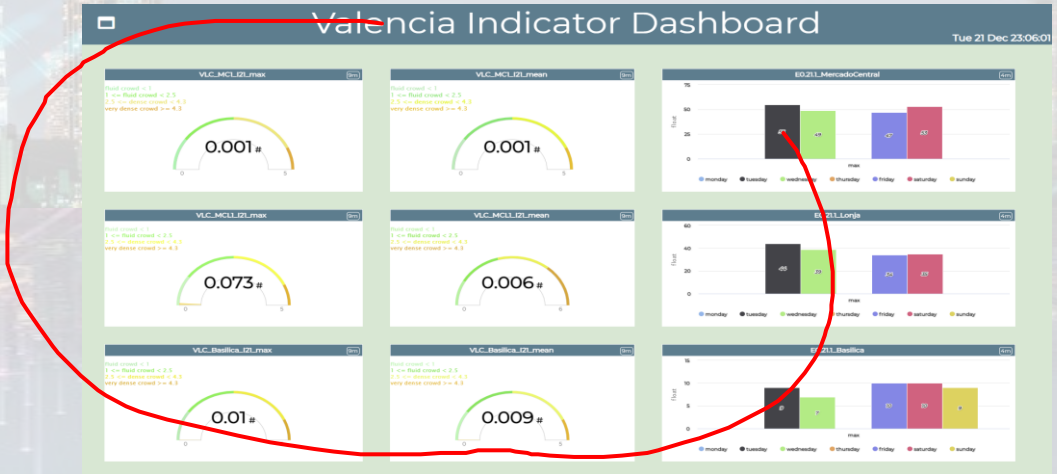


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzE1MA==

Valencia, FSMLR

- **KPI**
  - People
  - Environmental Data
- **Real Time**
  - PAX Counters
  - Environmental Data
- **Social Media, Real Time**
  - A Set of Key: keywords, Hashtags, Citations
  - Volume of Tweets per Key and total
  - Sentiment Volume per Key and total





Valencia, FSMLR

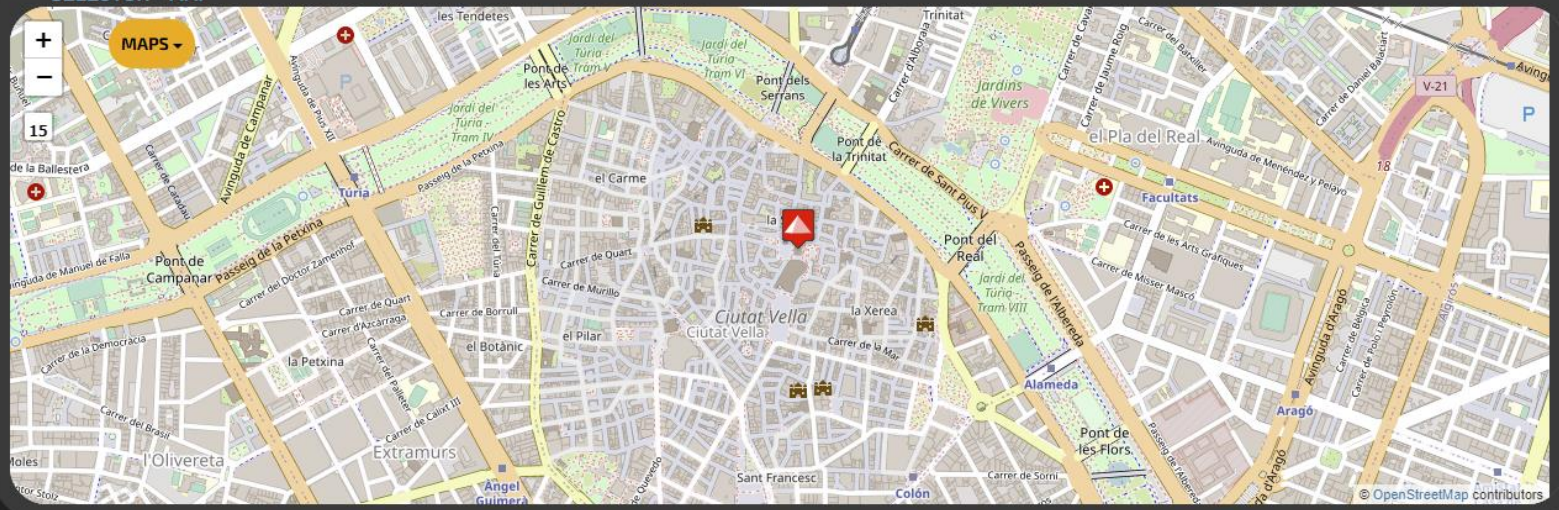
Ciao roottooladmin1

Tue 3 May 14:07:17

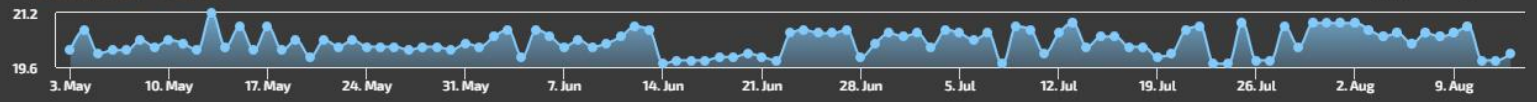
HERIT-DATA - VALENCIA FSMLR - NEWGUI

- basilicaDesamparados_new2
- basilicaDesamparados_new2_gases
- criptaSanVicente_new
- criptaSanVicente_new_conteo
- criptaSanVicente_new_gases
- criptaSanVicente_new_meteo

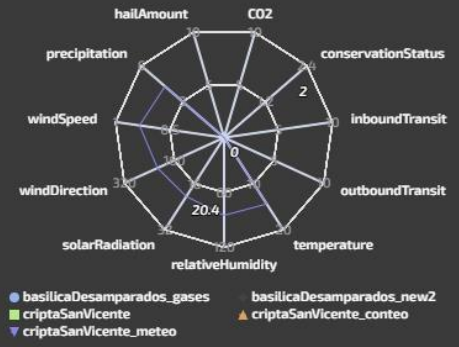
SELECTOR - MAP



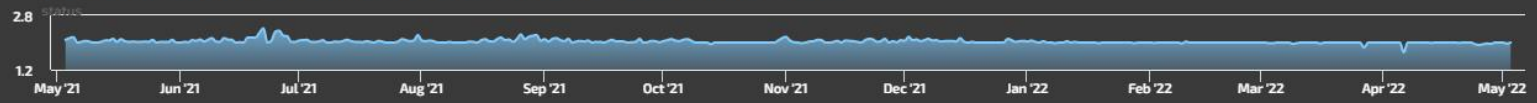
SELECTOR - TREND 9m



RADAR SERIES 4m



VALENCIA:ORIONVALENCIA-UNIFI:CRIPTASANVICENTE_NEW - CONSERVATIONSTATUS 9m



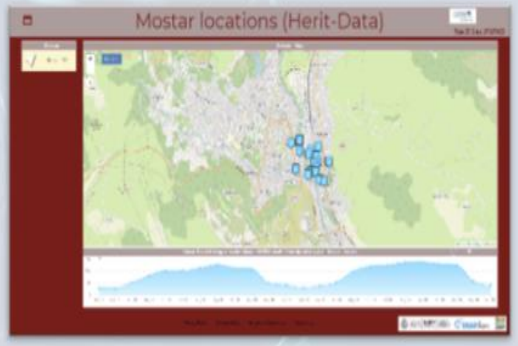
Mostar, Bosnia-Herzegovina

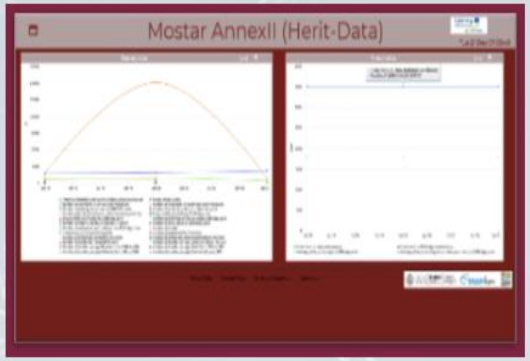
https://www.snap4city.org/744

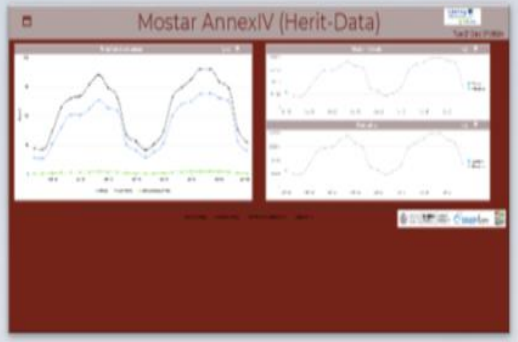


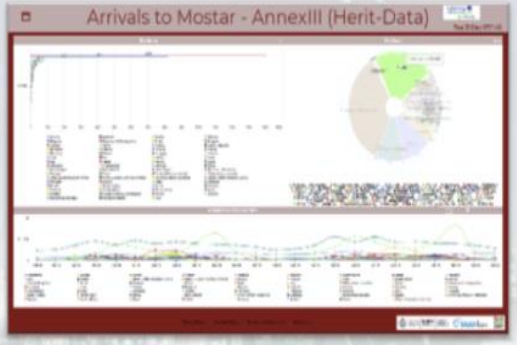
Mostar, Bosnia Herzegovina

- **Tourism Domain**
  - KPI: business, house prices, investments, stay duration, etc.
  - Profiled POI, Point of Interests
  - People flows: arrivals, overhights
- **Dashboards**
  - Monitoring KPI
  - POI, flows
- **Historical and updated data**
- **Services Exploited on:**
  - Dashboard
- **Since 2020**





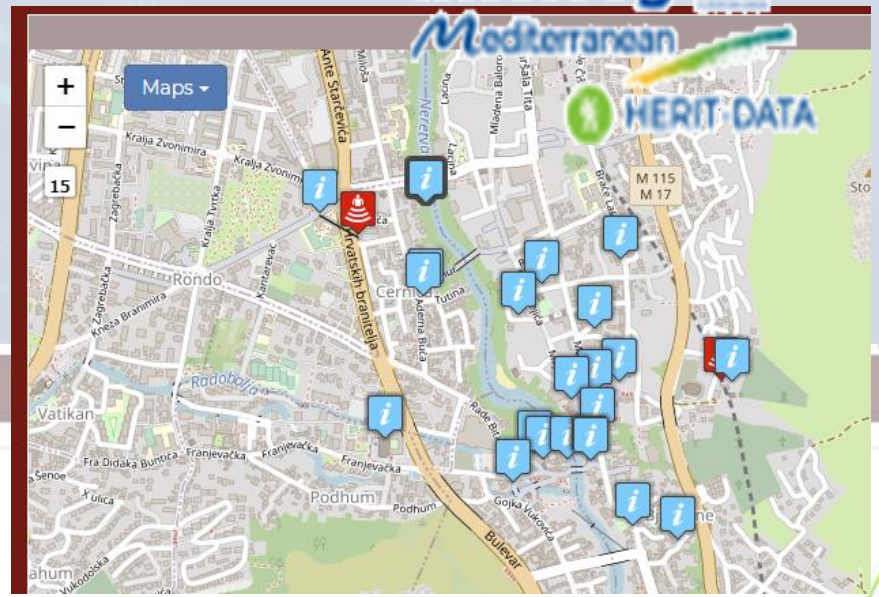


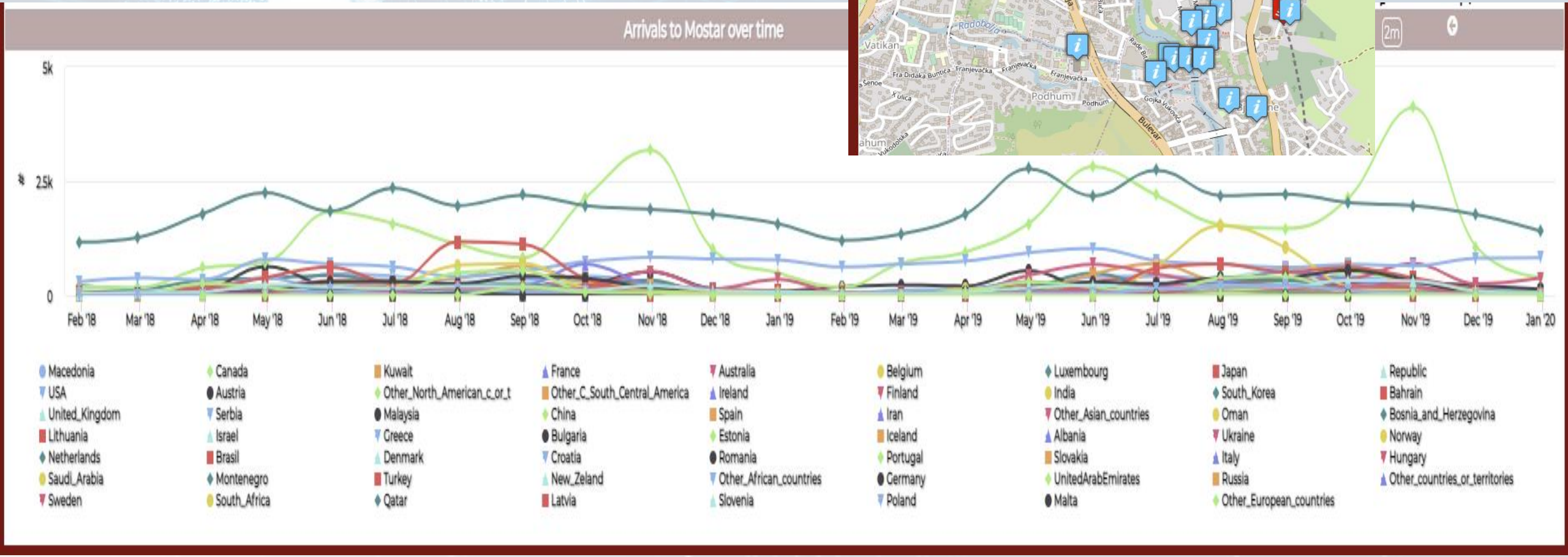


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzE0OQ==

Mostar, Bosnia Herzegovina

- Arrivals per Country Since 2018





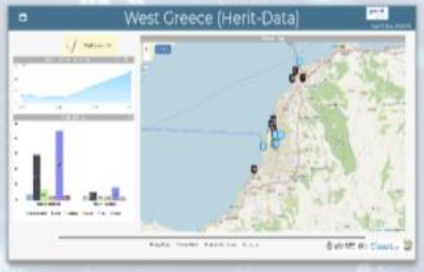


West Greece (Patra)

https://www.snap4city.org/743

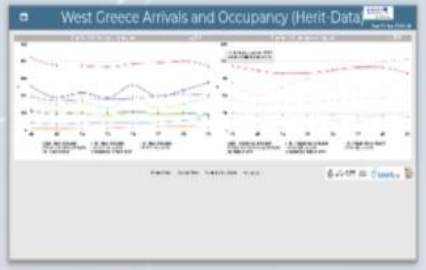
West Greece

- **Tourism Domain**
  - KPIs: ODM, Flows, …
  - Social Media
  - People Flows
- **Dashboards**
  - Monitoring KPI
  - People flows
  - Twitter Vigilance
- **Historical and updated data**
- **Services Exploited on:**
  - Dashboard
- **Since 2020**

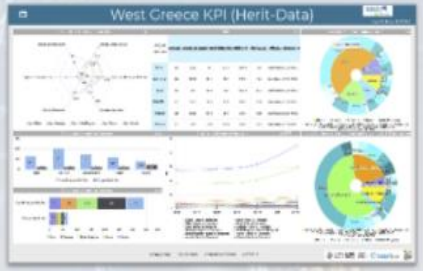


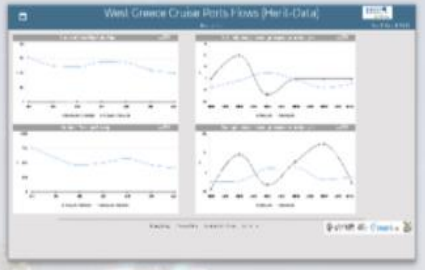


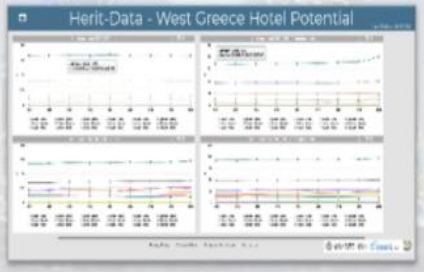










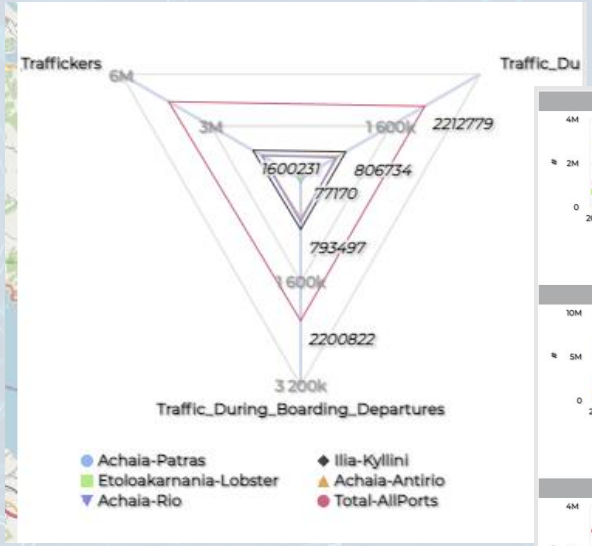


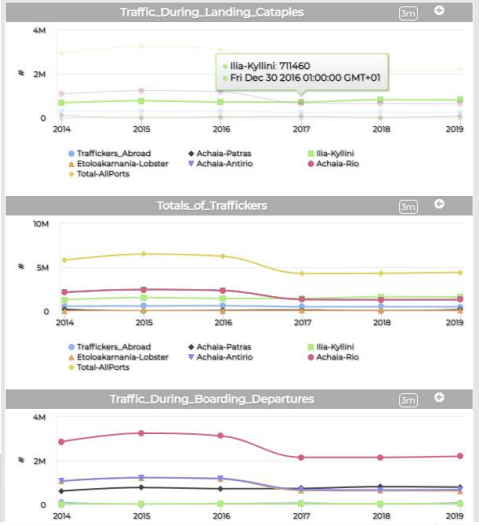


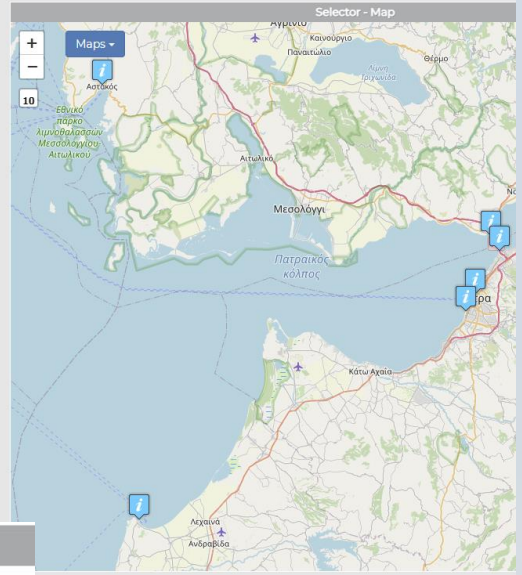
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzE1NA==

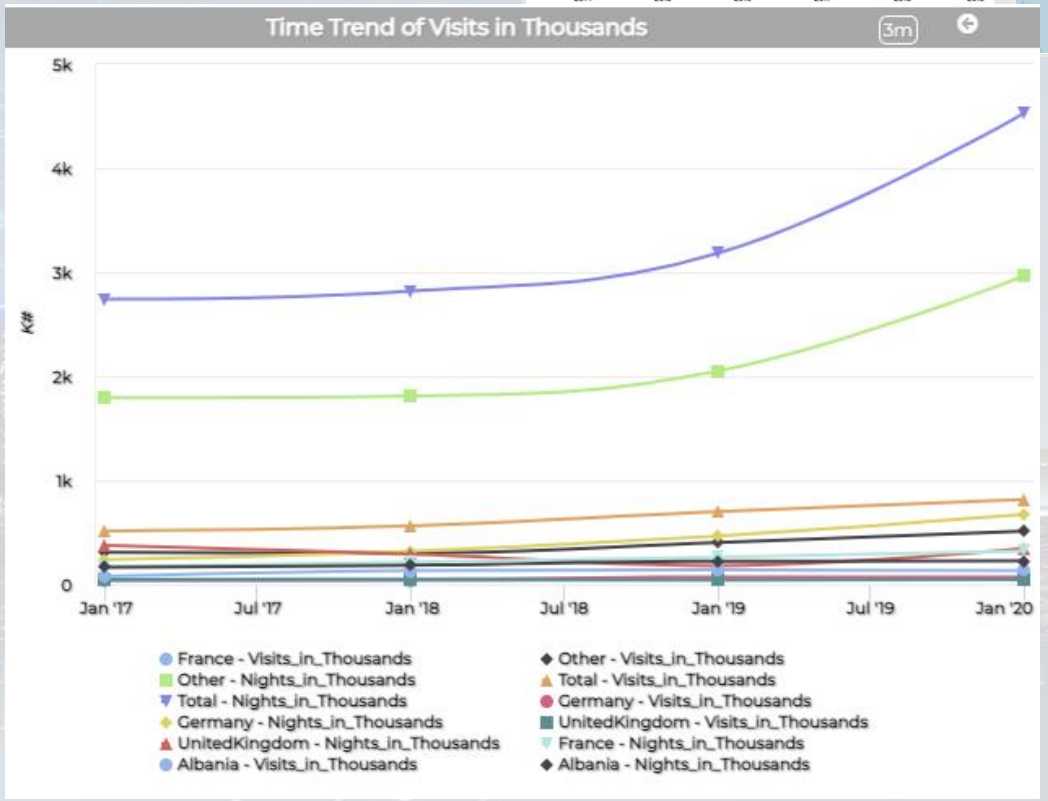
West Greece

- **KPI**
  - People arriving from locations
  - Expenditure per country per year
  - Tourists per Countries
  - Expenditure & cost per night per countries
- **Social Media, Real Time**
  - A Set of Key: keywords, Hashtags, Citations
  - Volume of Tweets per Key and total
  - Sentiment Volume per Key and total



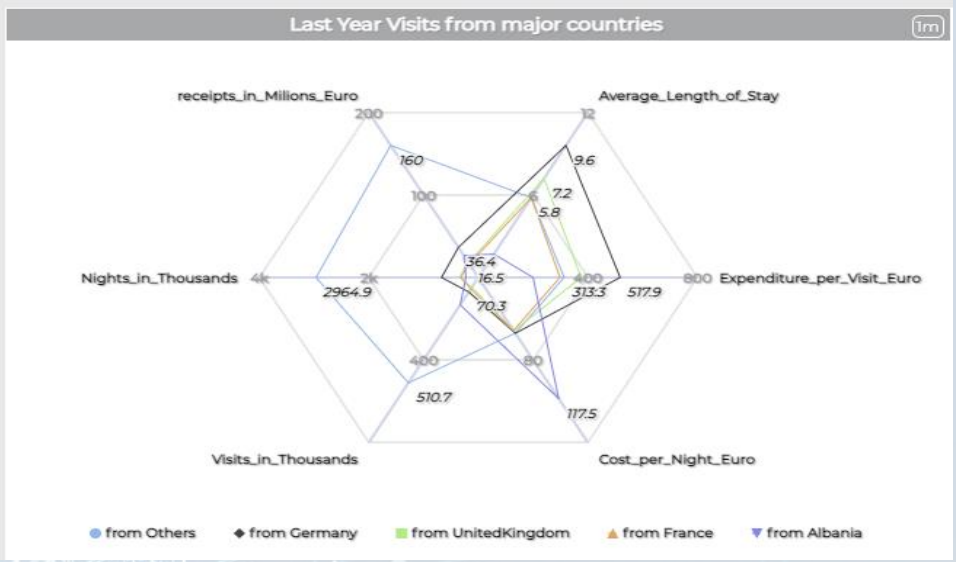


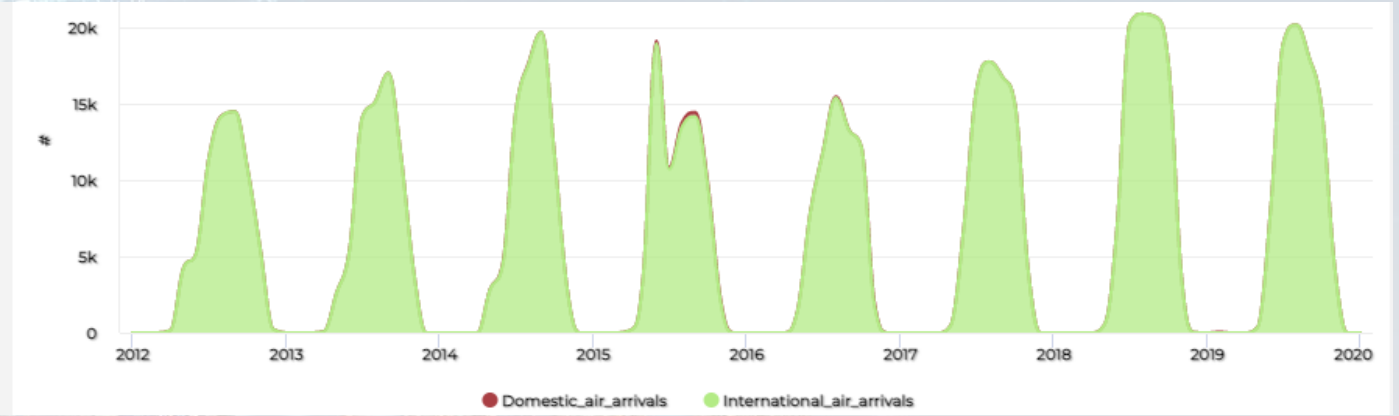




West Greece

- Profiling major Tourists per Countr
  - Visits
  - Receipts
  - Nights
  - Stay length
  - Night cost
  - Expenditure
- Arrivals and depatures
- Vistors on Archeological sites









Santiago di Compostela, Spain

Traffic Flow Reconstruction for the cities

Sun 3 Nov 20:37:43



Santiago di Compostela

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https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc5NQ==

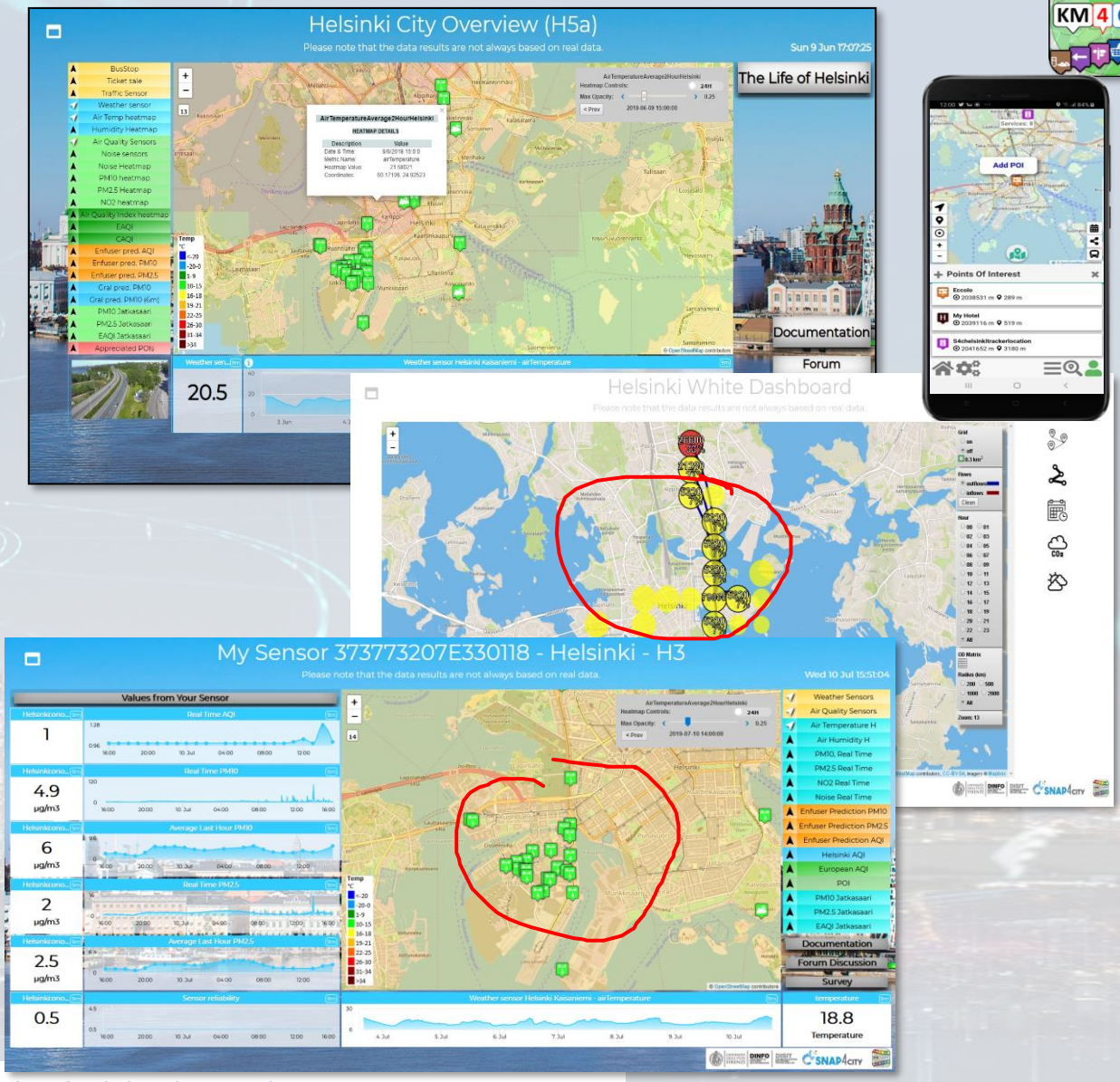
Helsinki, Finland

https://www.snap4city.org/528



Helsinki, Finland

- **Dashboards & Services**:
  - **Environment** & **Weather**, PM10, PM2.5,NO, SO2, CO, noise, etc.
    - Sensors values, Heatmap & **Alerts** on critical
    - FMI Enfuser prediction: PM10, PM2.5, ..
    - GRAL predictions PM10, validations
    - Private sensors in Jätkäsaari area (personal dashboards)
  - **Mobility**: Traffic Sensors, Operators, routing, multimodal routing, whatif
  - **Social**: Twitter Vigilance, early warning
  - **Life in Helsinki**: OD matrix people flow, Twitter Vigilance SA, hot places, etc.
  - **Tourism and Culture**
- **Mobile App and MicroApplications:**
  - Helsinki in a Snap (all stores)



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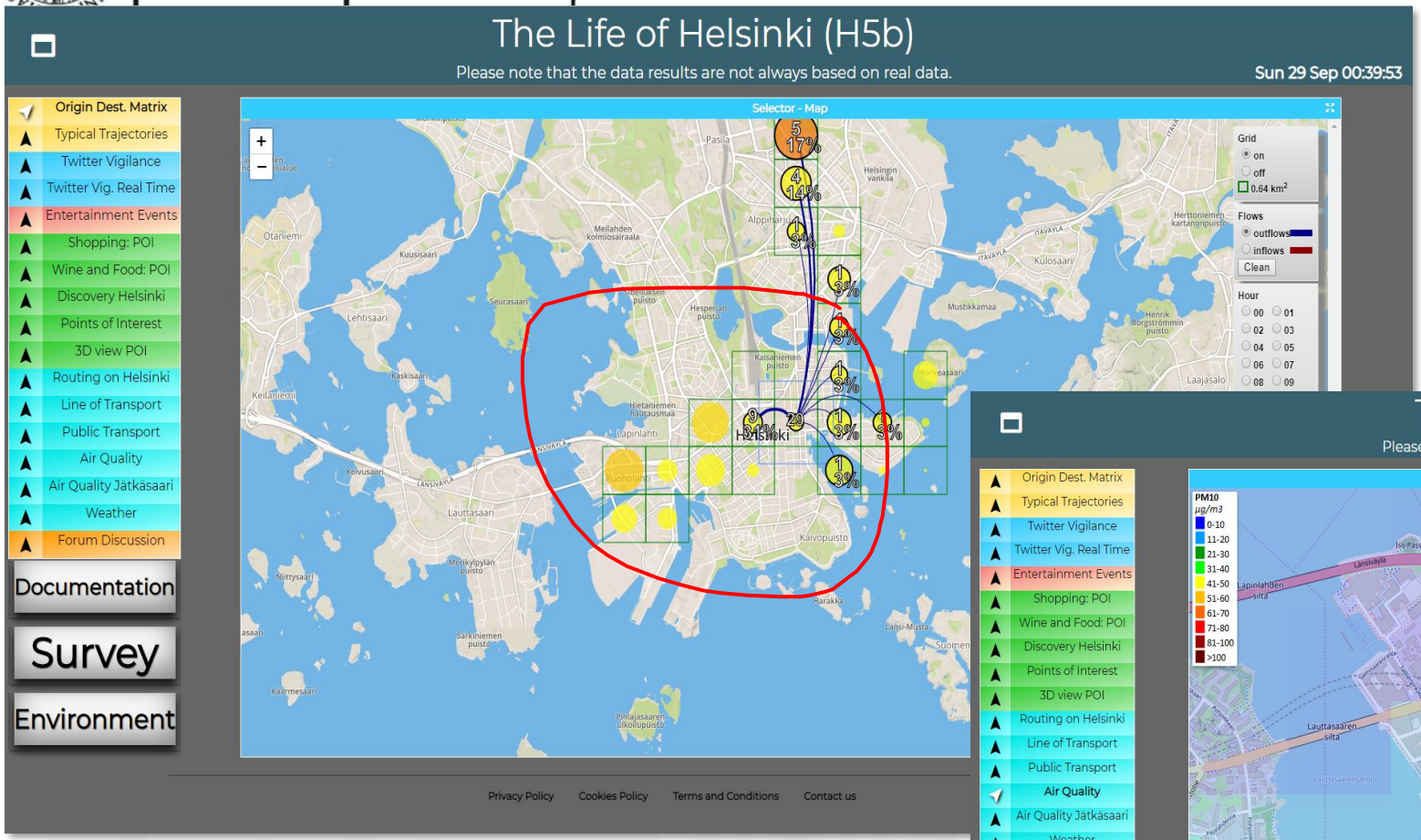
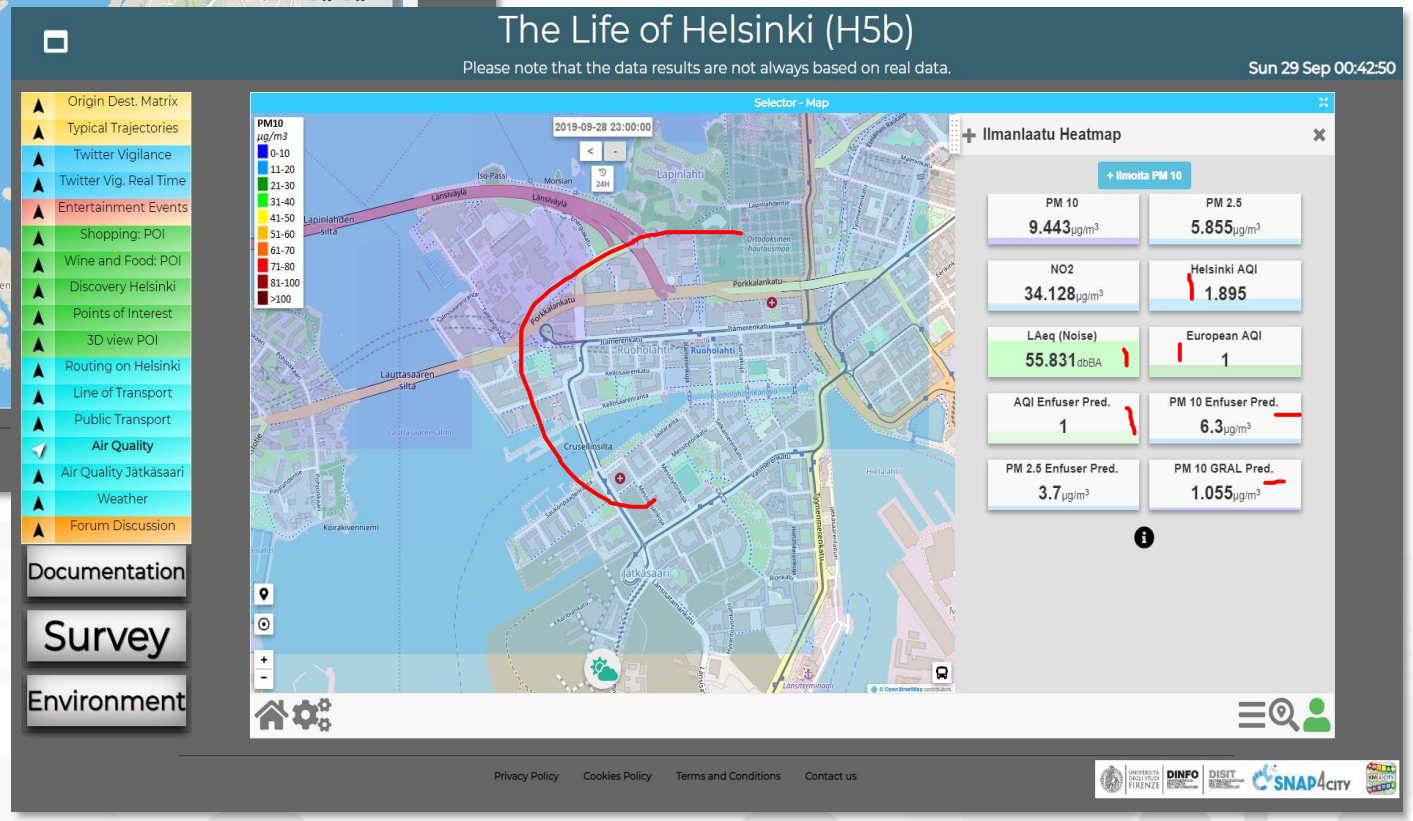
Helsinki





https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc1Mg==

Helsinki

Environmental Data Predictions: GRAL

- **GRAL predictions: PM10, NOX, ….**
  - **Comparison wrt real time values in actual value of Sensors**
  - Graz Lagrangian Model.
- GRAL model takes into account:
  - pollution sources (for example the vehicles, their distribution on the streets, the about of pollution they produce according to their distribution over time and space, etc.),
  - structure of the city (streets and shape 3D of the buildings),
  - weather forecast (wind intensity and direction), etc.
- GRAL can be applied on NOX, PM10, PM2.5, … or any other particles

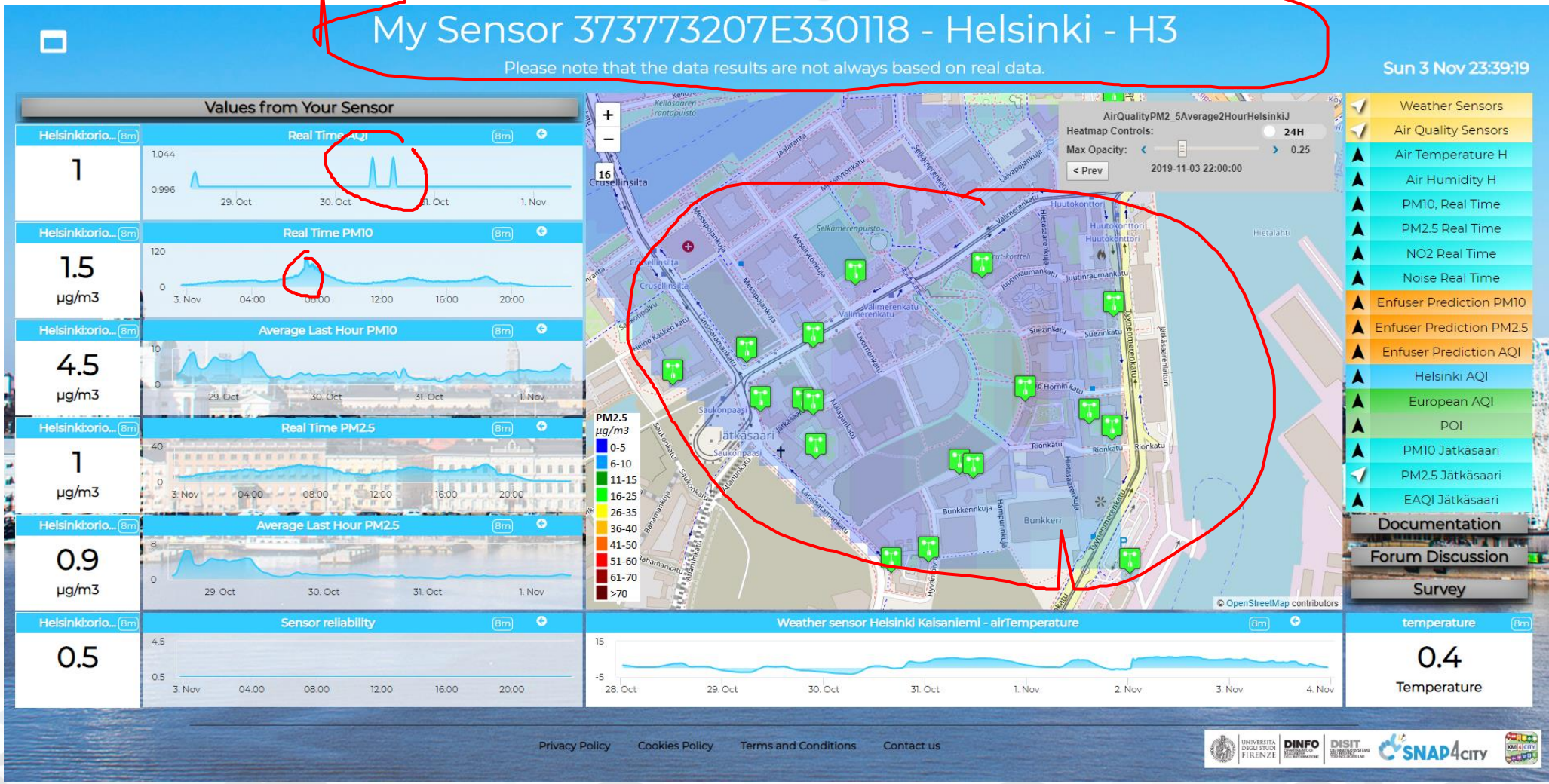


TRAFAIR

Environmental Devices hosted by Citizens









Prato https://www.snap4city.org/758

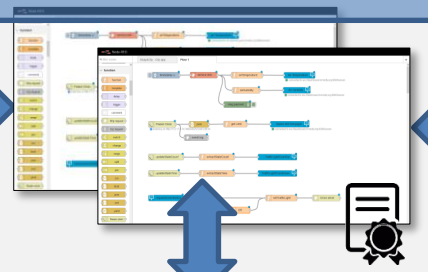
Smart City vs Industry 4.0

GIDA set up

Smart City data from many sources



IOT Applications

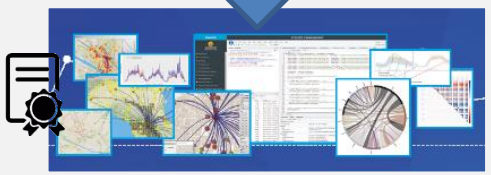


Dashboards and Apps





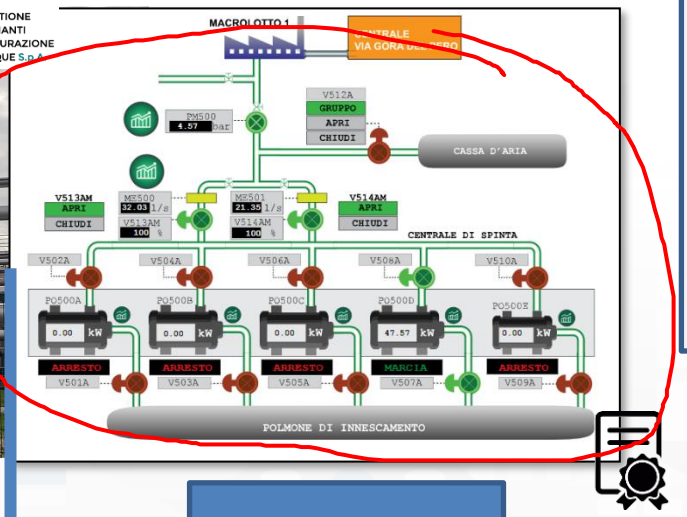




IOT Data Shadow Snap4City

Big Data Analytics, Artificial Intelligence





Modbus

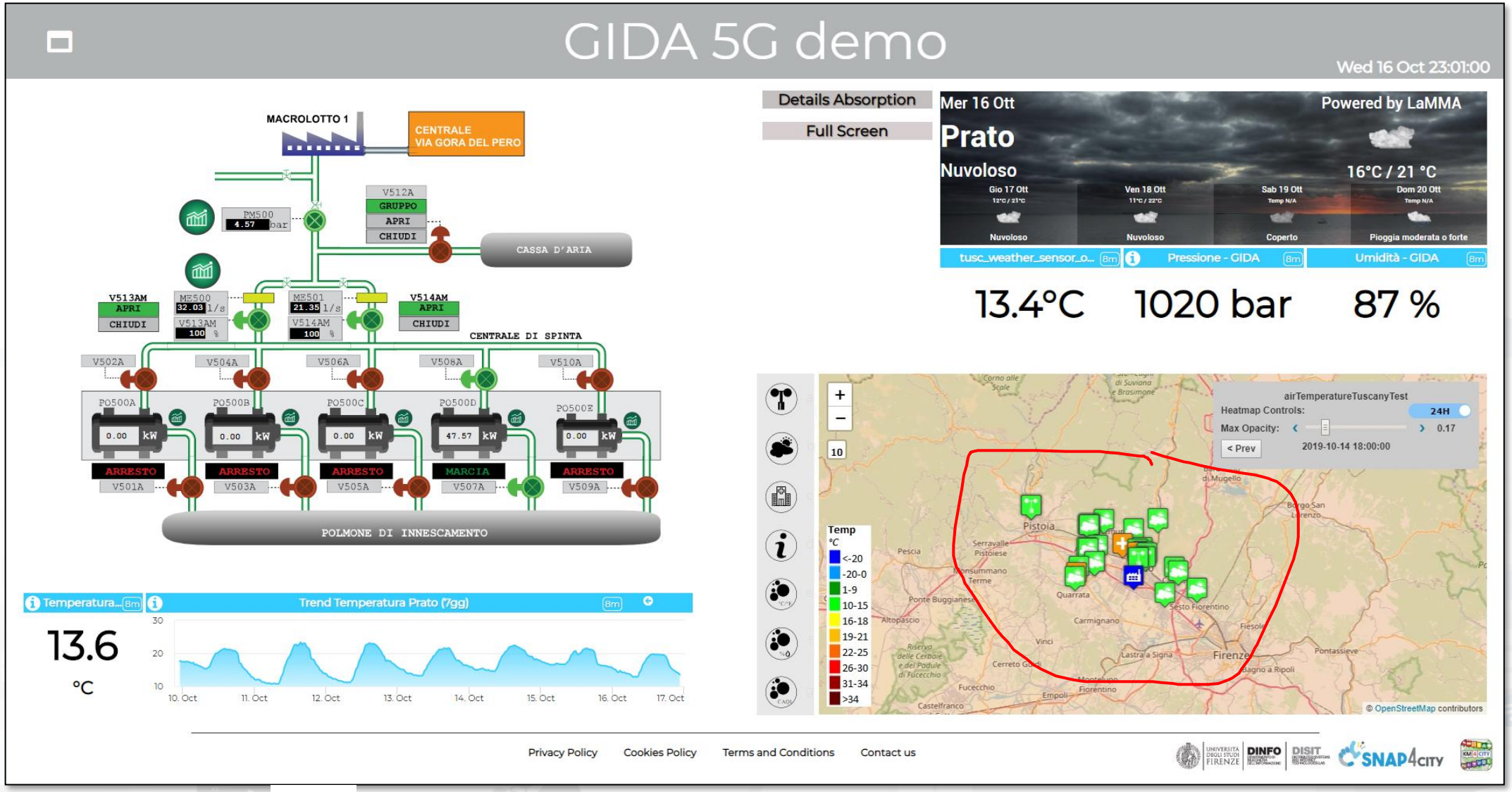
ModBus to Snap4City Gateway Edge

5G network devices

ZTE

Telemonitoring Telecontrol

Dashboards & Services:



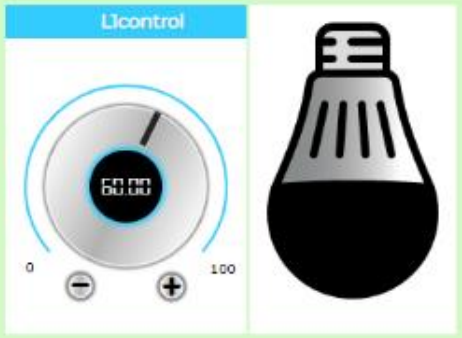
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjIyNg==

Snap4Home 5G Demo

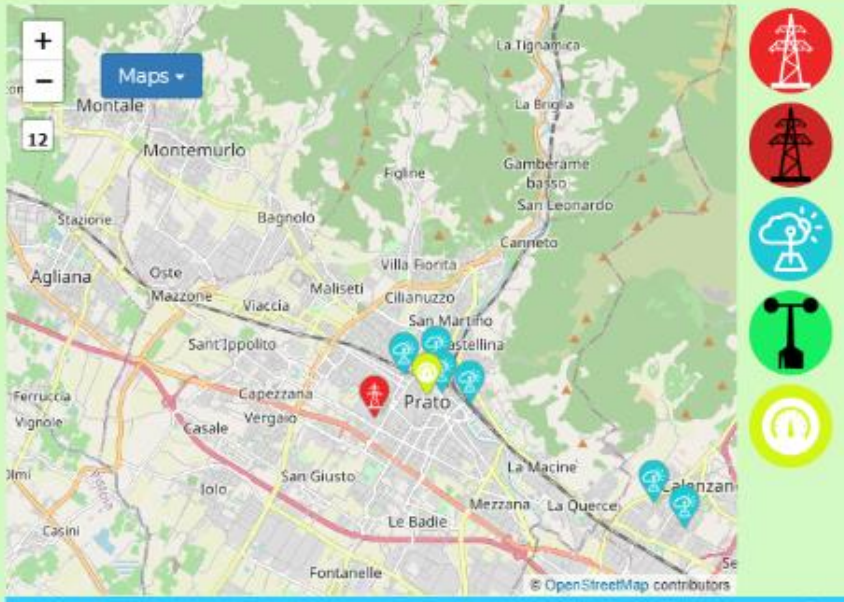
Thu 11 Jun 18:07:32





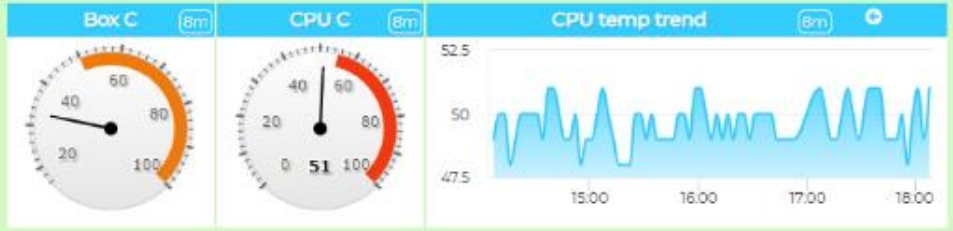












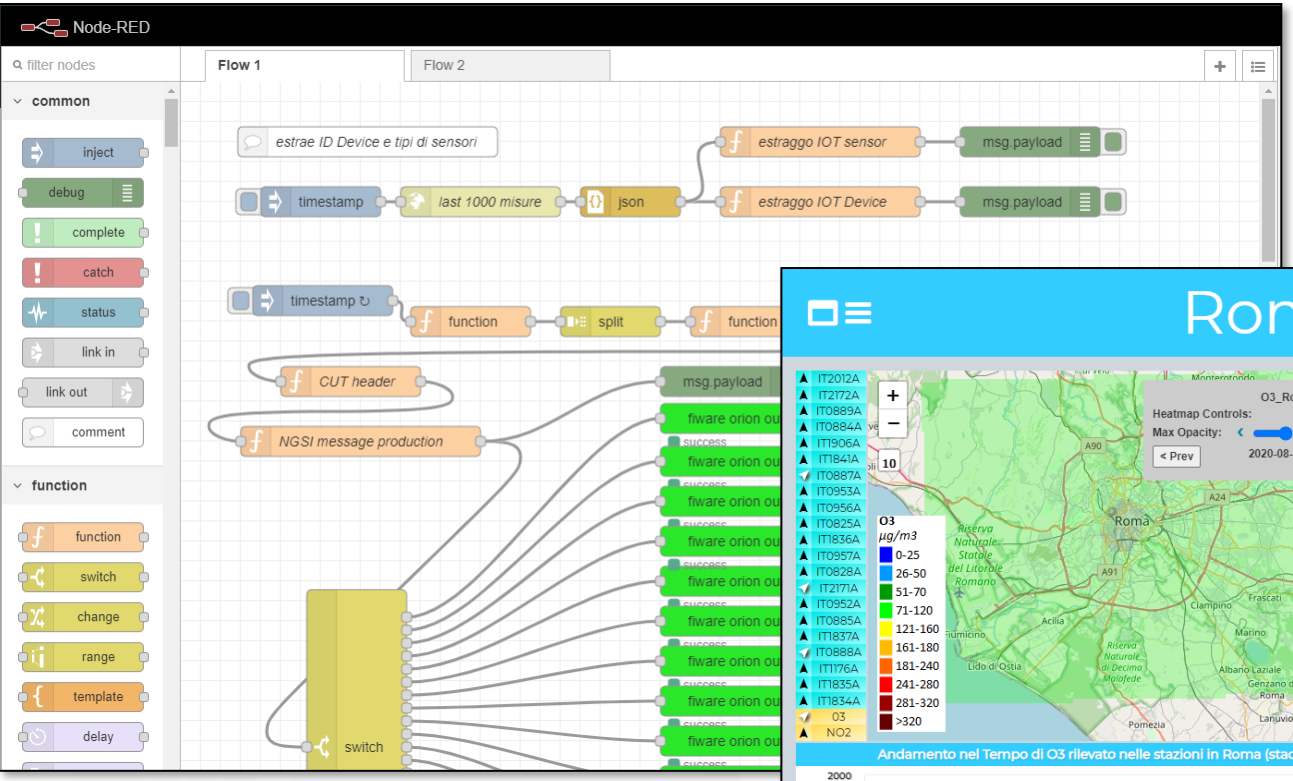


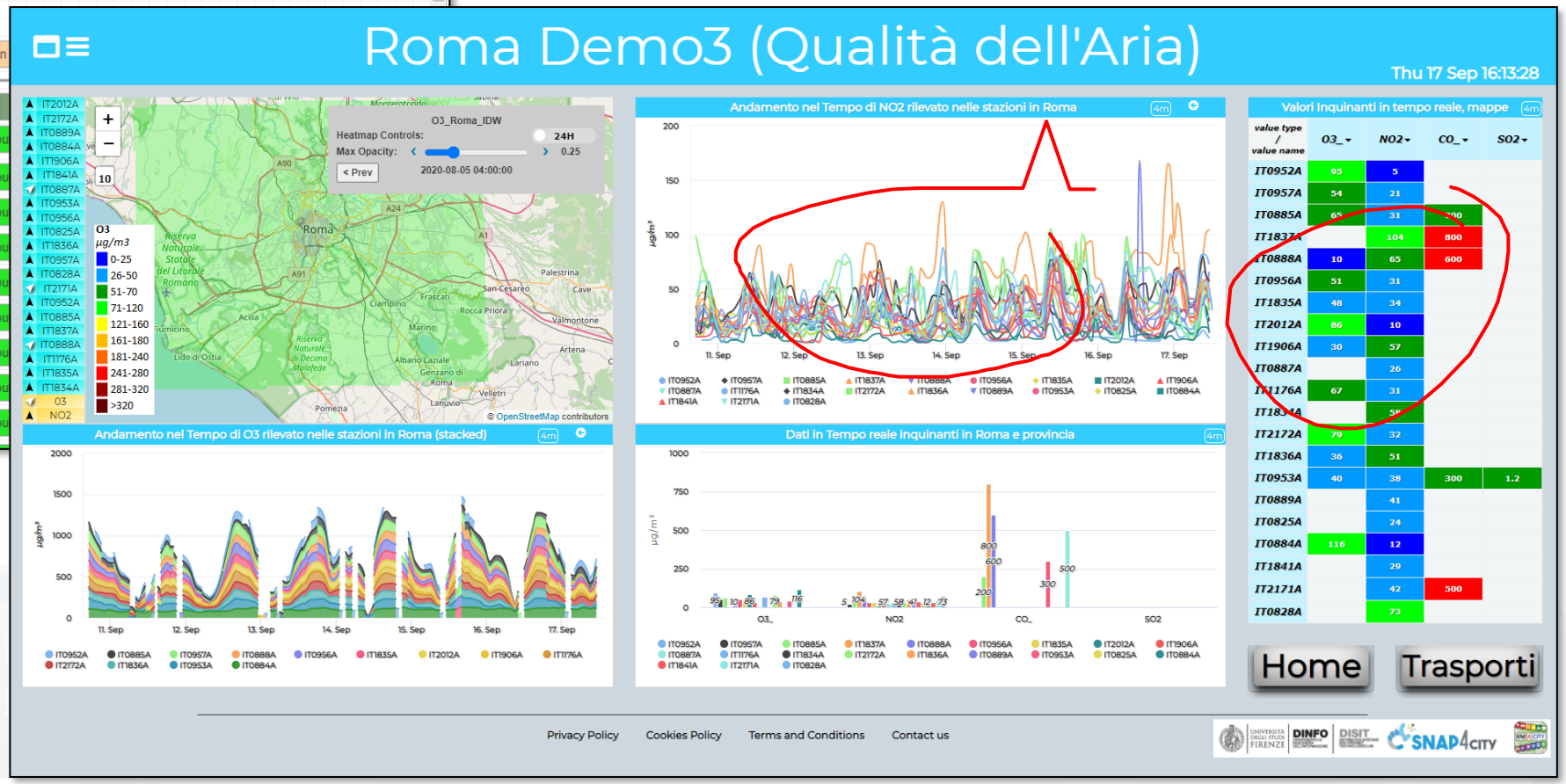
open fiber WIND 3 ZTE estra



Roma (I)

https://www.snap4city.org/753





Roma (I)

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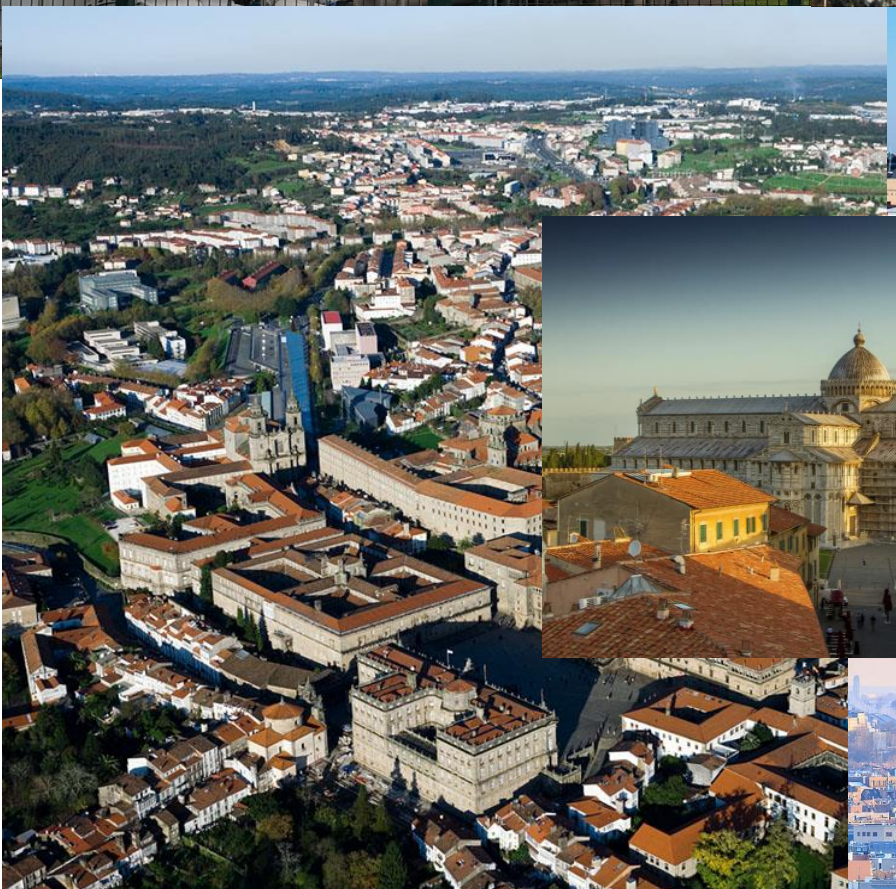
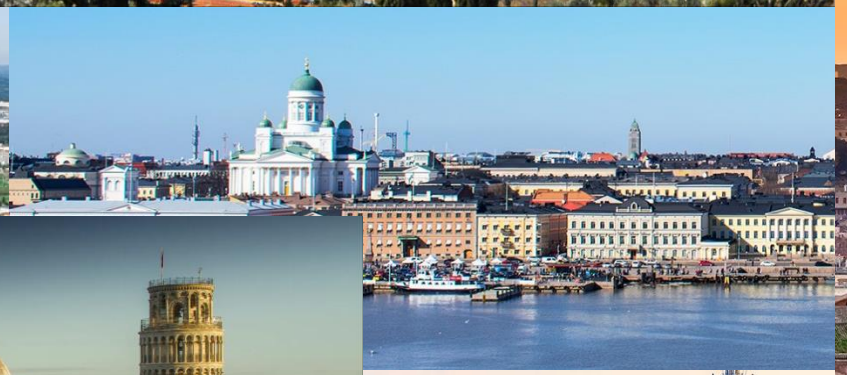
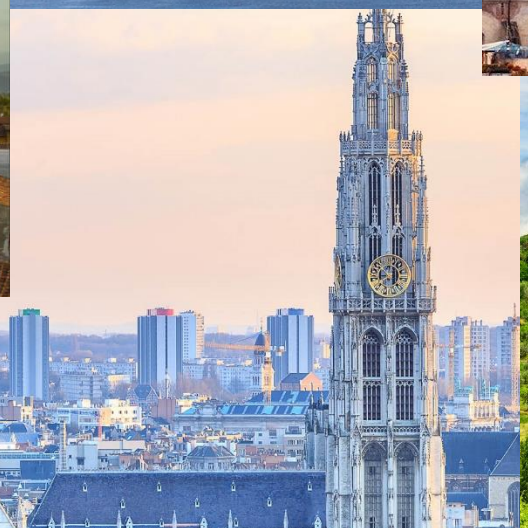
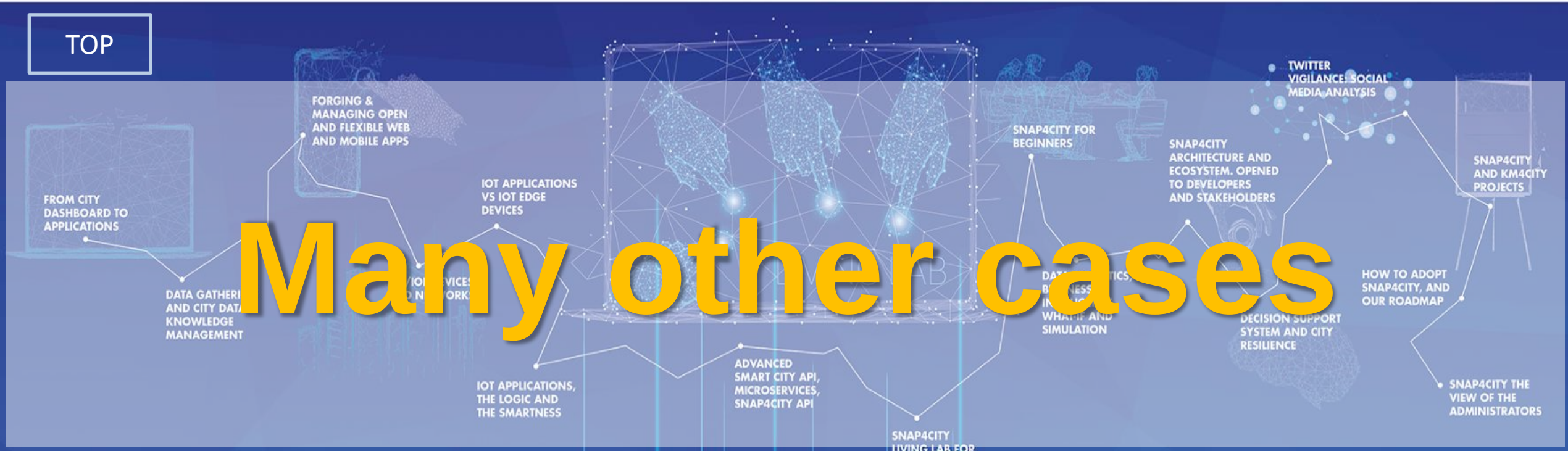





SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

TOP



Many other cases

100% OPEN SOURCE

SNAP4 Appliances and Dockers **Installations**

https://www.snap4city.org/4



Scenarious

- Scenario: SnapBot: Real Time Smart City services via Telegram
- Scenario: Copernicus Satellite Data
- Scenario: SmartBed, Materasso Intelligente
- MicroServices Suite for Smart City Applications
- Scenario: MODBUS for Snap4Industry Snap4City Applications
- Scenario: MOBIMART Interreg: MOBilità Intelligente MARe Terra
- Scenario: City of Roma case, mobility and environmental data
- Scenario: Herit-Data video and aims
- Scenario: Control Room vs Video Wall
- Scenario: Snap4Home the case of: Alexa, Philips, Sonoff, TP-link, etc. (Italiano)
- Scenario: how to manage maintenance and accidents workflows
- Scenario: Snap4Home, how to exploit Snap4City solution on home automation
- Scenario: Energy Monitoring
- Scenario: Multipurpose User Engagement Tools
- Scenario: 5G Enabled Water Cleaning Control (smart city, industry 4.0)
- Scenario: High Level Control of Industrial Plant (industry 4.0)
- Scenario: Vehicle Monitoring via OBD2
- Scenario: Events and Museums Monitoring in Antwerp
- Scenario: High Resolution Prediction of Environmental Data
- Scenario: Mobility and Transport Analyses in multiple cities
- Scenario: People Flow Analysis via Wi-Fi
- Scenario: Antwerp Pilot on Environmental Data
- Scenario: Helsinki Pilot on Environmental Data
- Scenario: Firenze Smart City Control Room
- Scenario: Mobile & Web App: Toscana Where What … Km4City, Toscana in a Snap
- Scenario: Helsinki Pilot on User Behaviour
- Scenario: Antwerp Pilot on User Behaviour

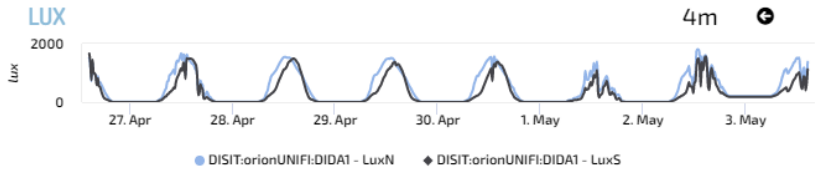
- Data Analytic: Origin Destination Matrices, Algorithms and tools
- Data Analytic: Traffic Flow Reconstruction
- Data Analytic: in general, and the cases of Antwerp and Helsinki
- Data Analytic: Predicting Air Quality
- Data Analytic: Analyzing Public Transportation Offer wrt Mobility Demand

Smart Building

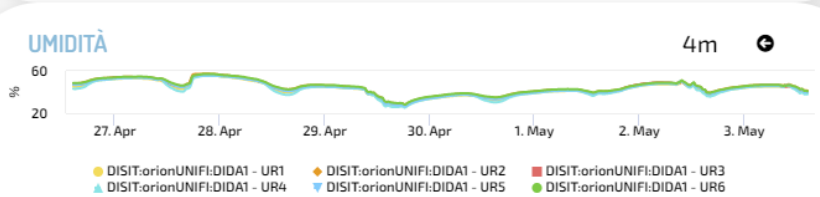
Ciao roottooladmin1

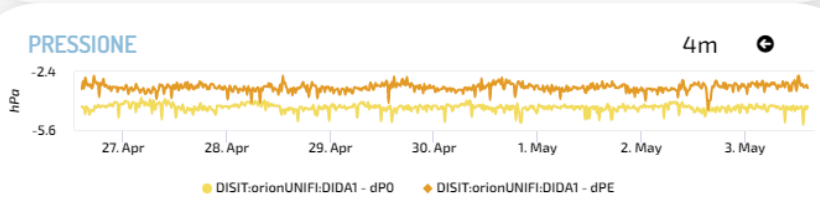
Tue 3 May 14:37:14

DIDA DATA 2 - NEWGUI



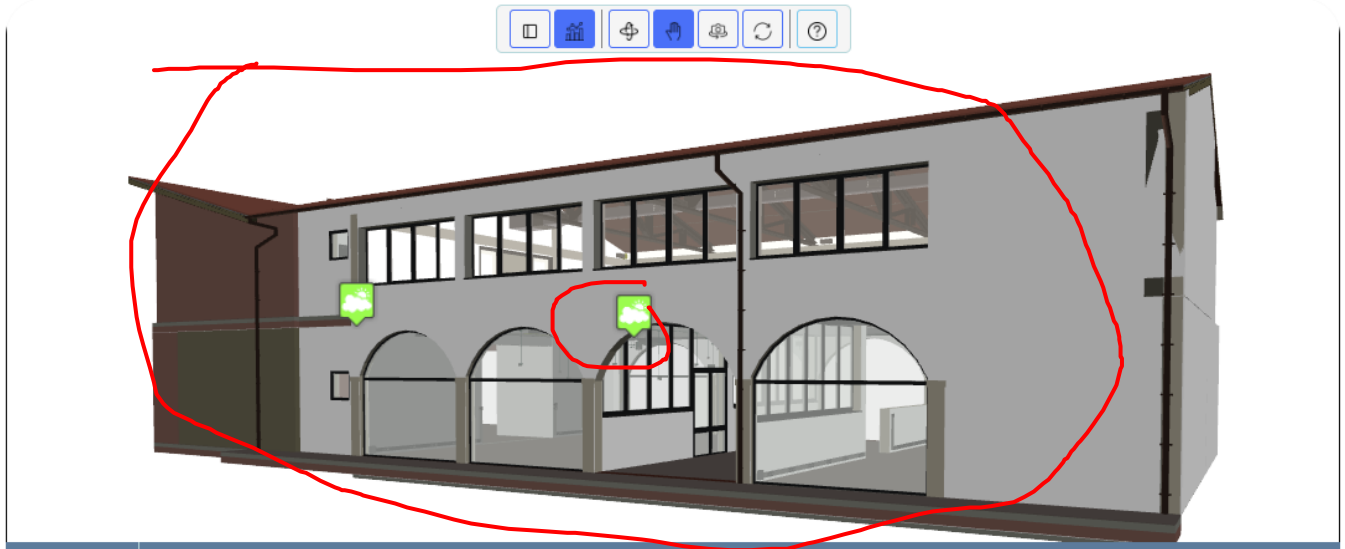






to see BIM log as user: info@disit.org, passwd: guest

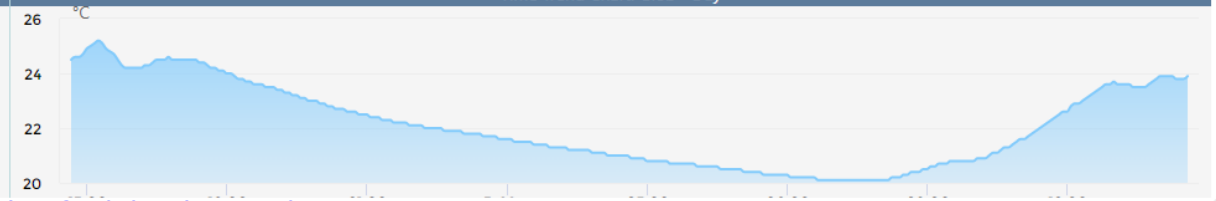
BIM SANTA VERDIANA



Last Value

No data

Time Trend Chart: Glob - Day



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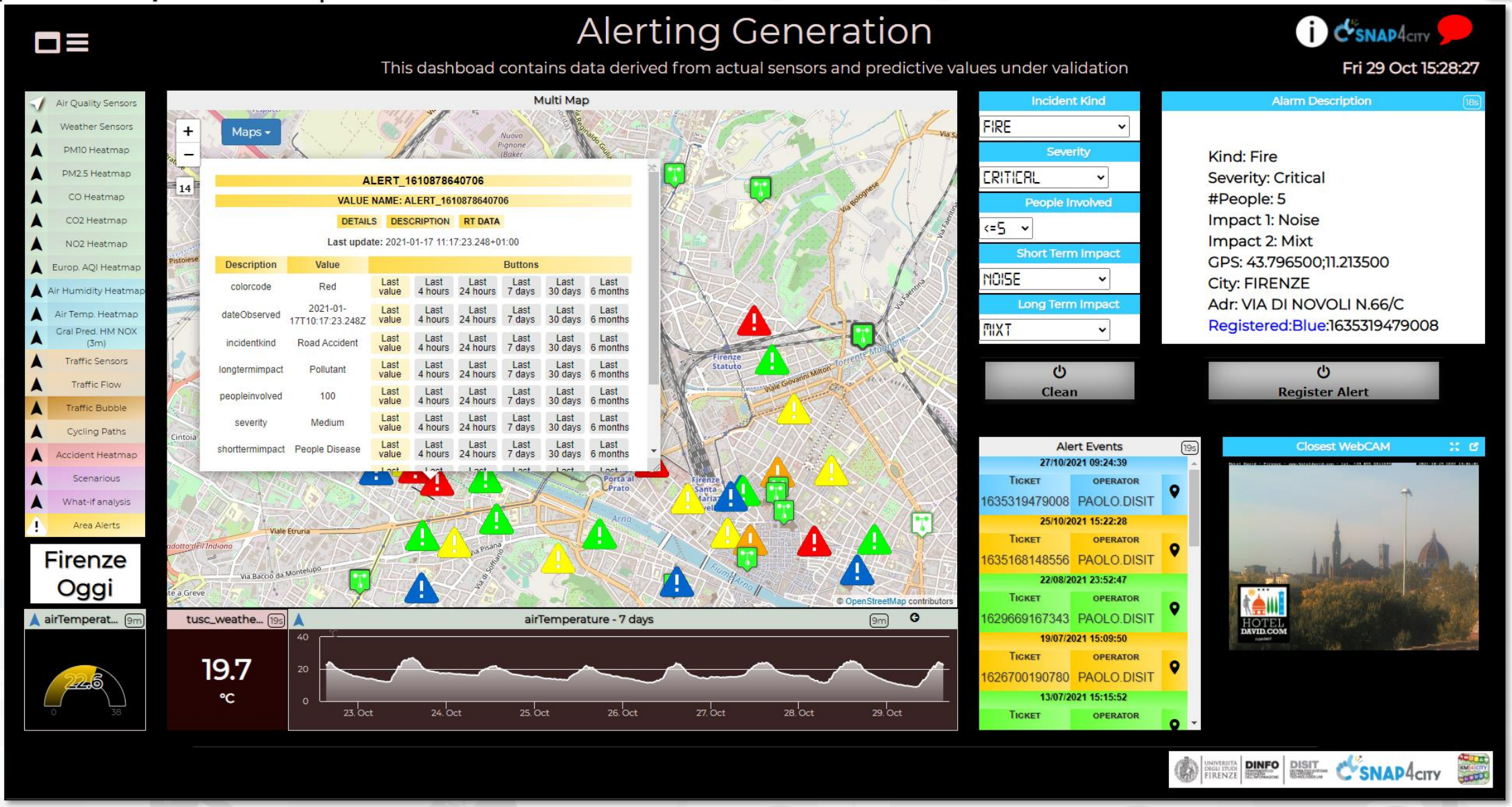
Alerting Mng



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

IoT Health Scenarios

- **1) Smart Ambulance:**
  Collecting and managing local data from tools and sensors inside the ambulance, IoT Devices, Tablets, Drones etc.



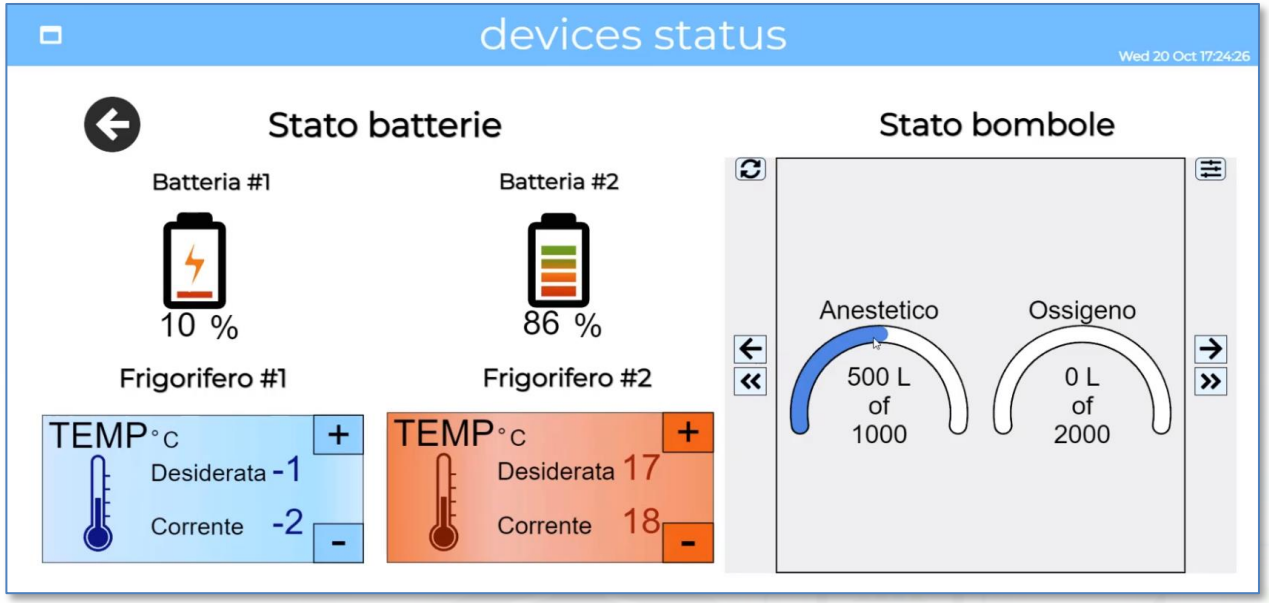
- **2) Personal Health devices:**
  e.g.: glucometers, etc.



- **3) Smart Bed:**
  Collecting and managing data from smart bed sensors, monitoring parameters in real-time



Smart Ambulance



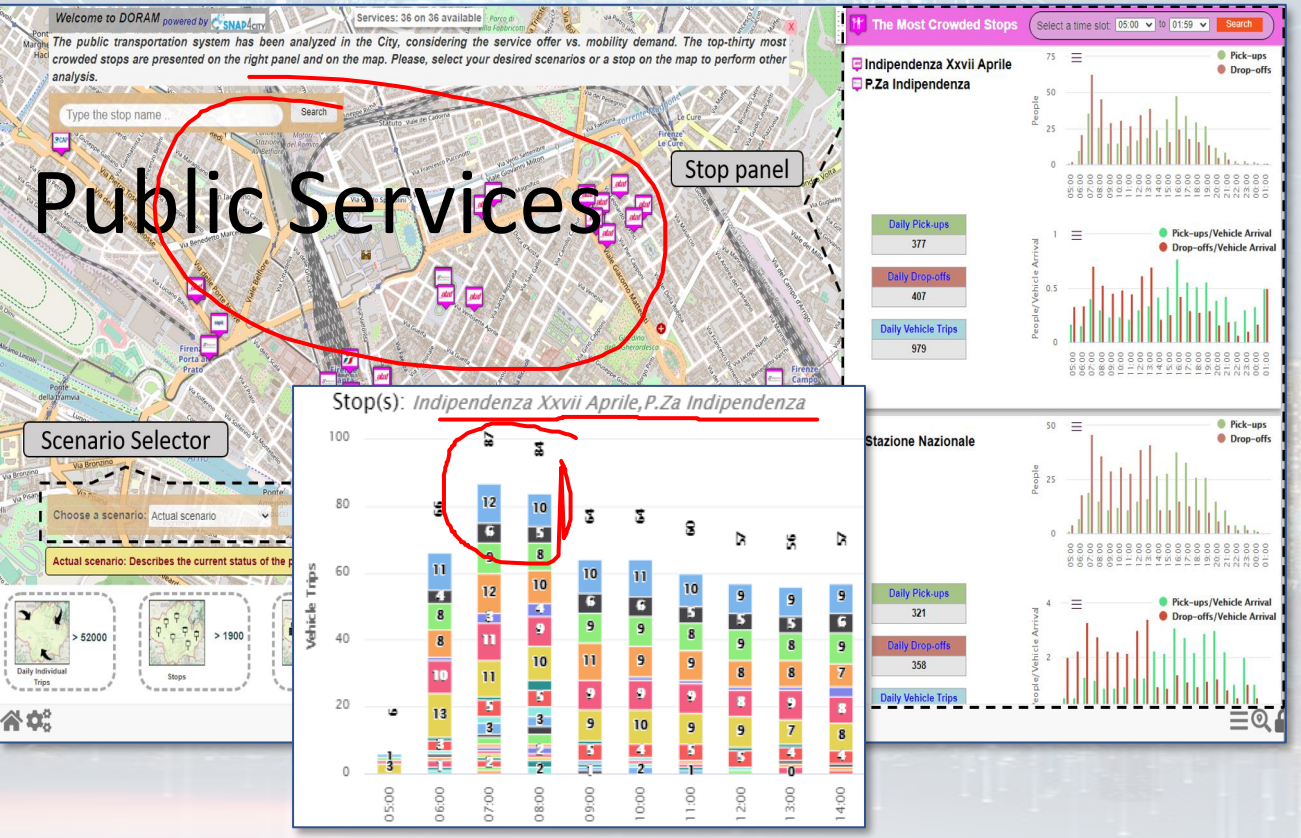


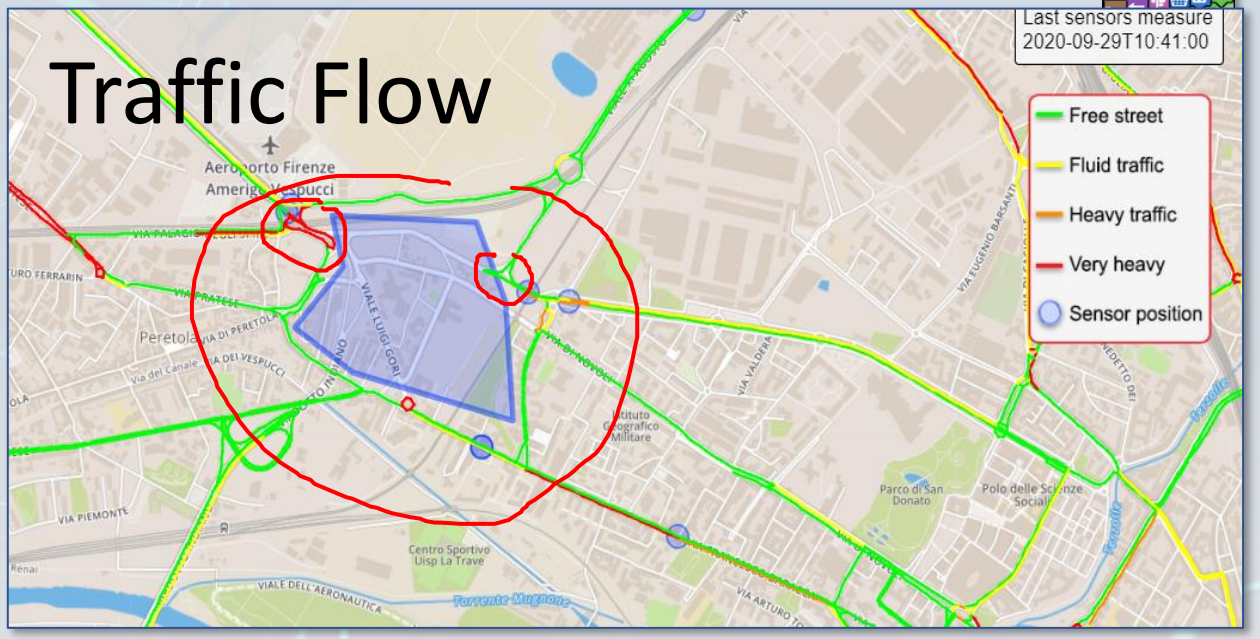


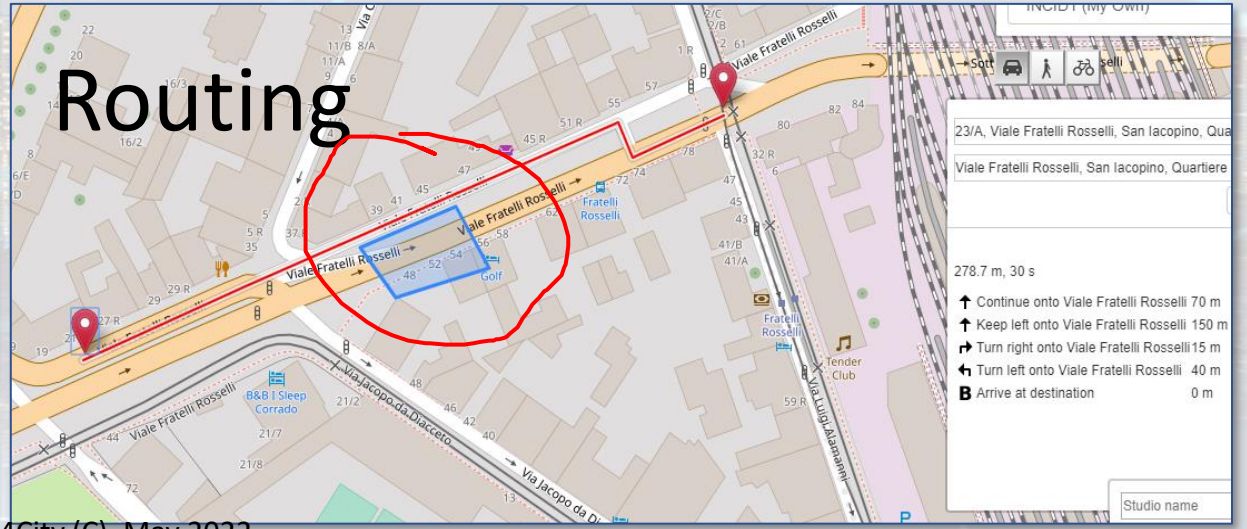


What-if Analysis

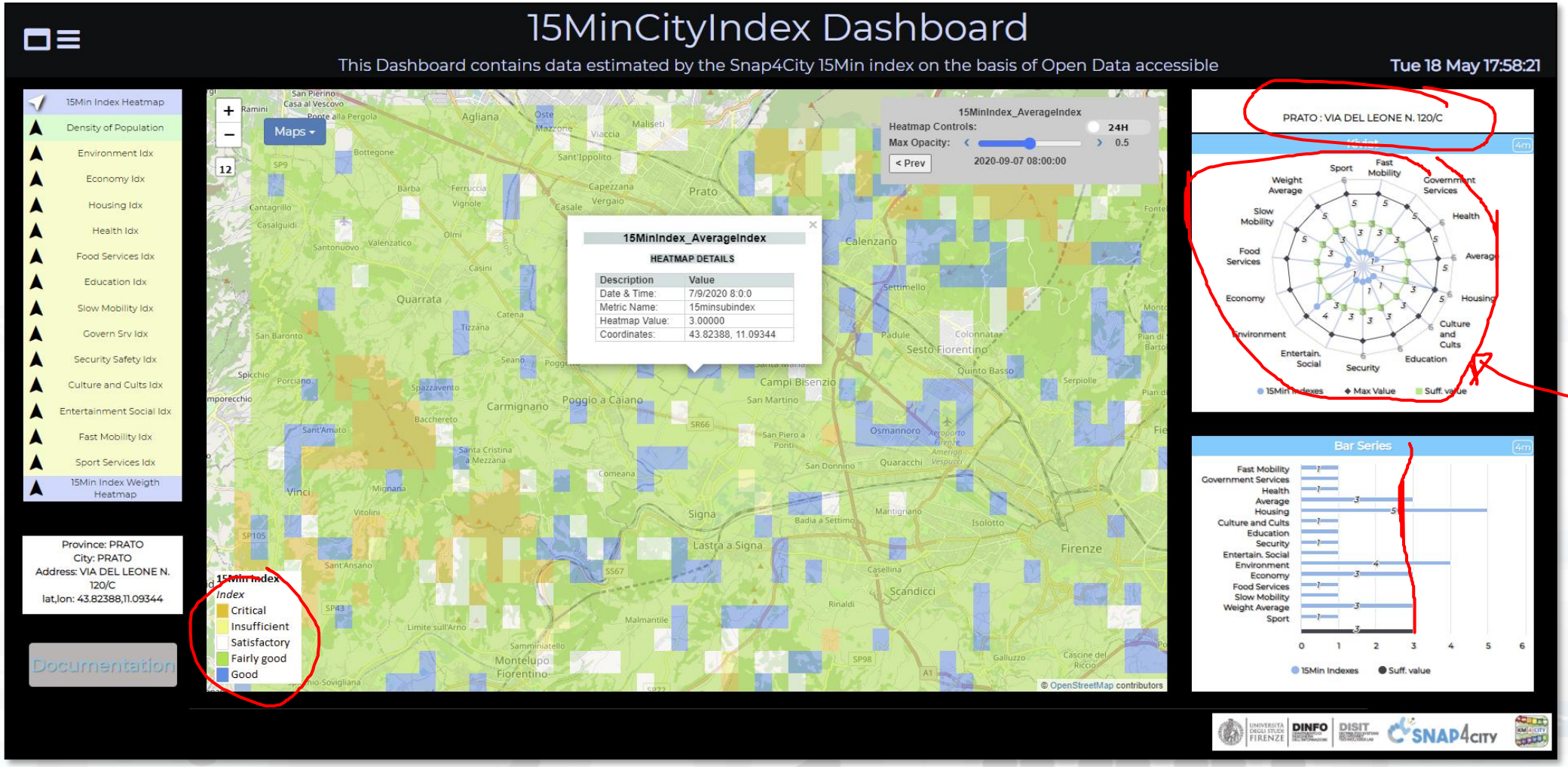
- Definition of scenarious impact on
  - Traffic, Pollutant, parking, public transport, private flows, etc.
  - KPI analysis





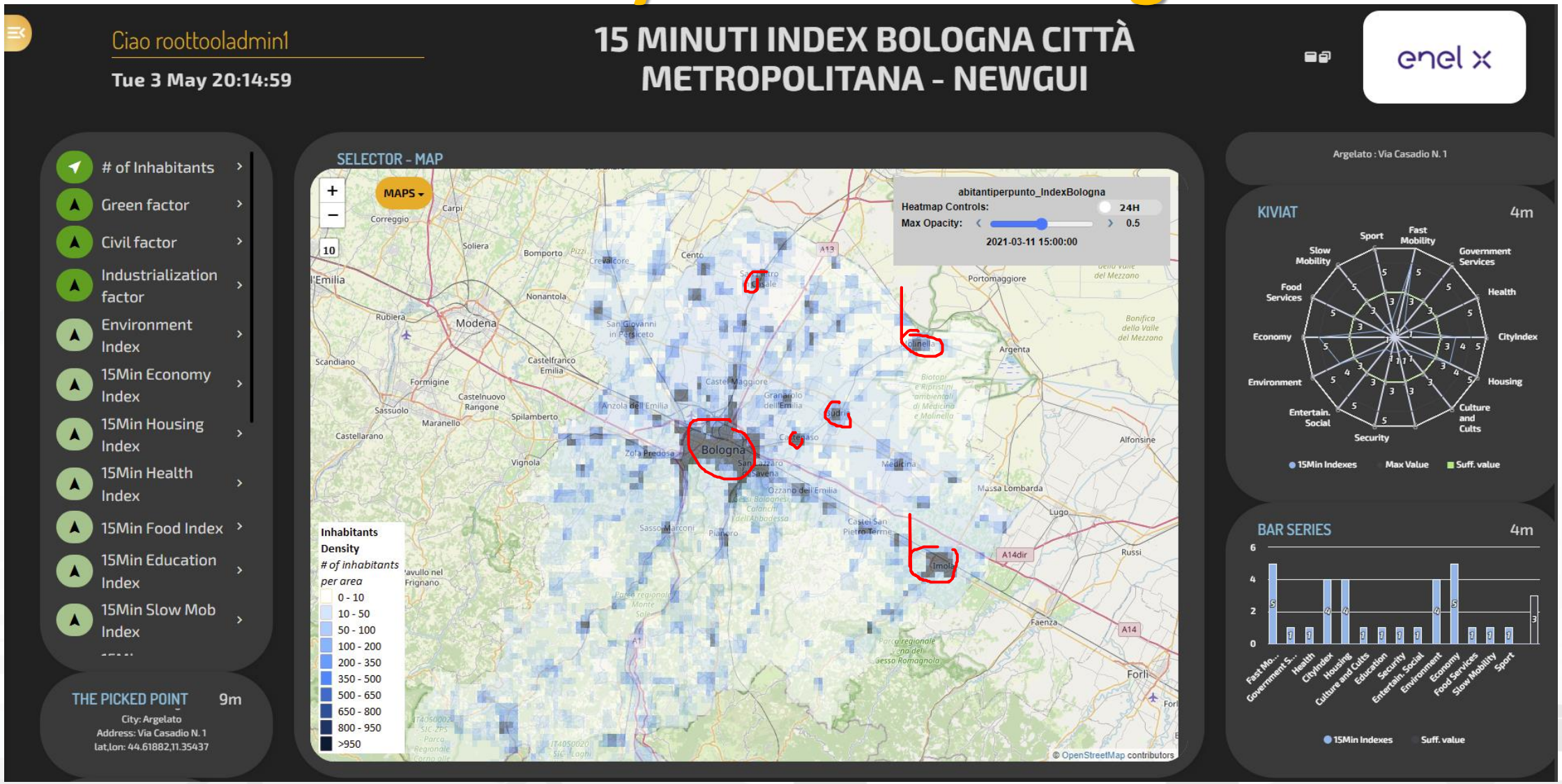


15MinCityIndex Firenze



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

15MinCityIndex on Bologna



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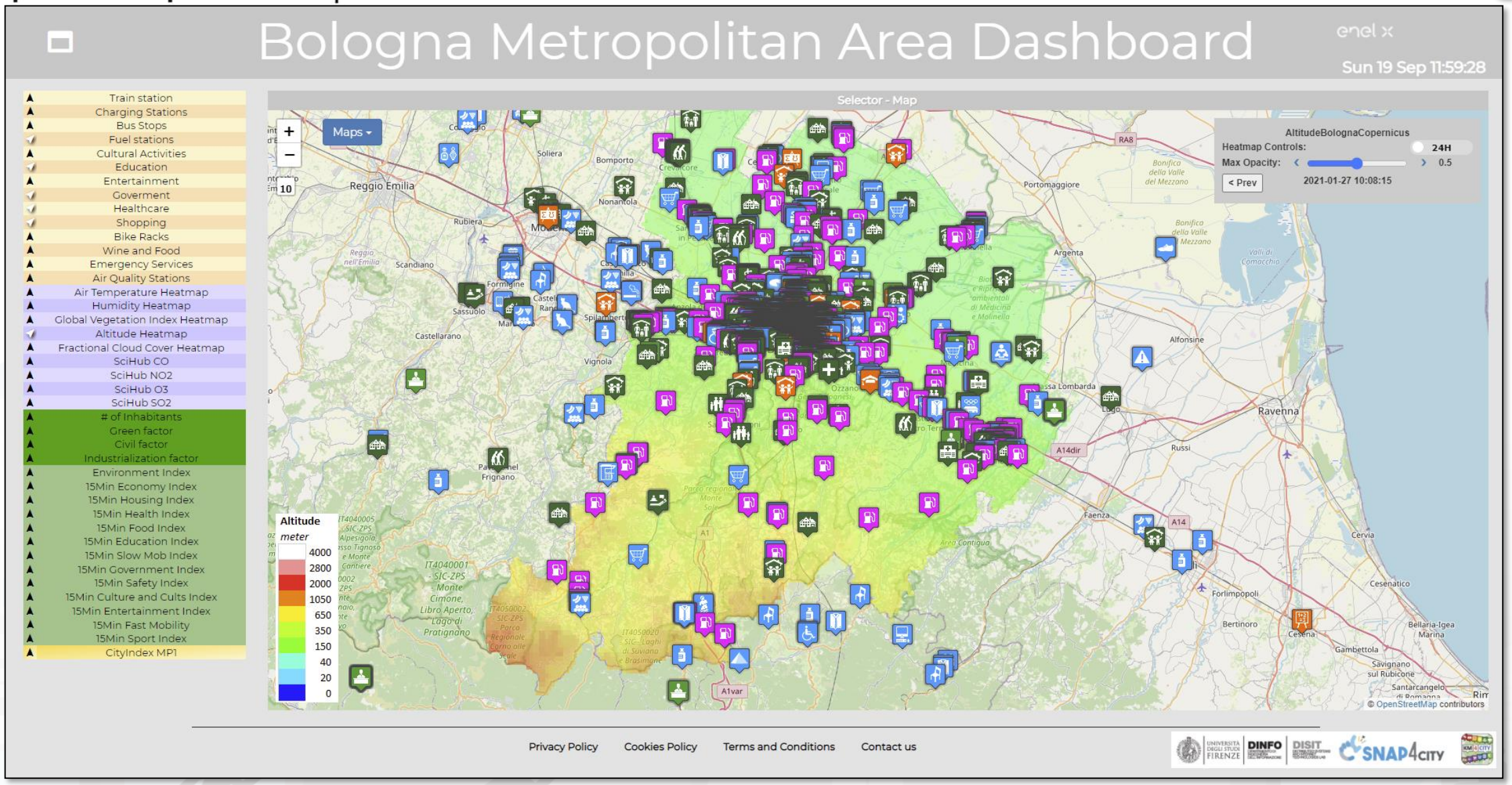
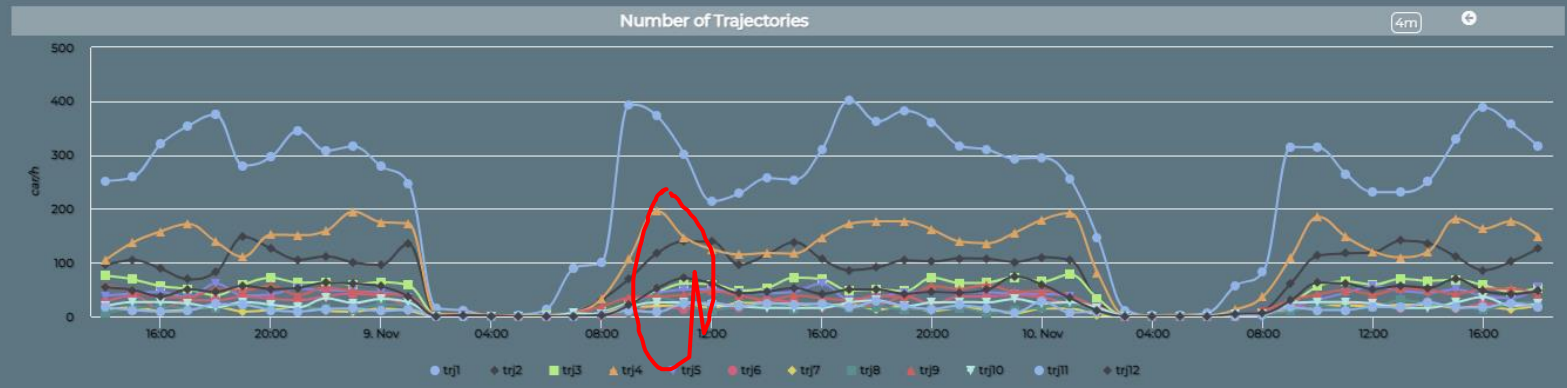


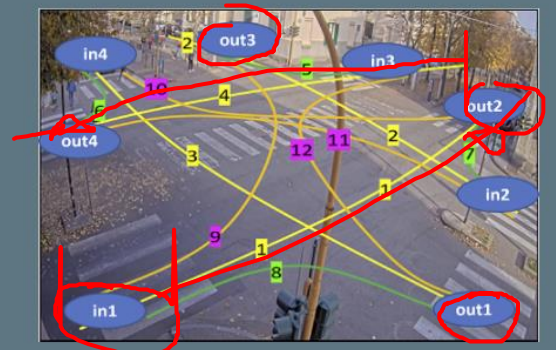
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA1OA==

Venaria Reale

Monitoring Cross Road Venaria - (AXIS Camera)

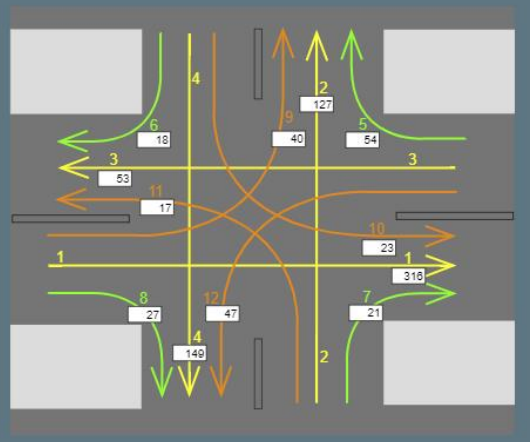
Wed 10 Nov 18:50:53





Venaria Street Cross - Synoptic





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https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzI5Ng==

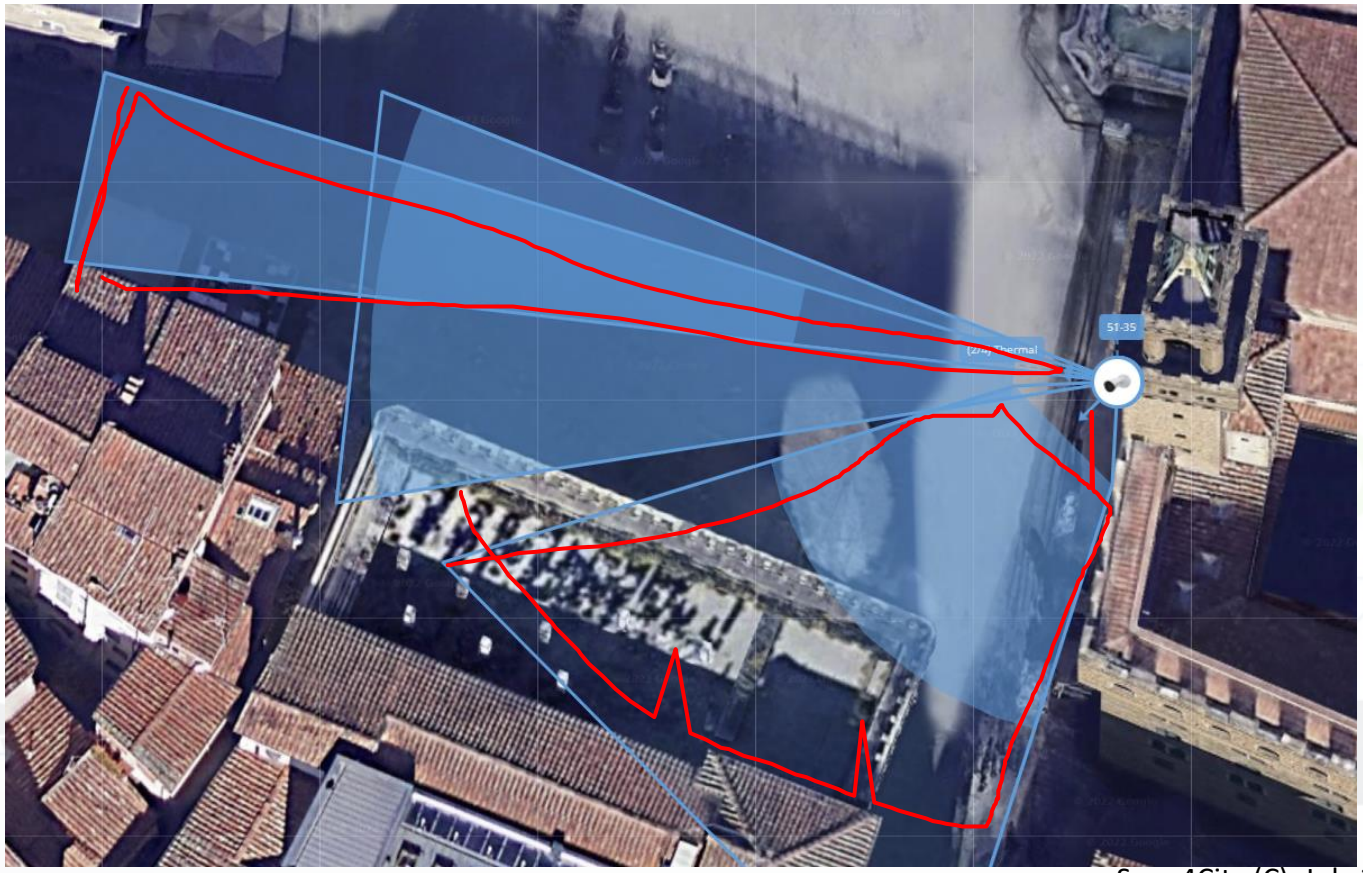
Venaria Reale

- **AXIS camera as IOT Edge**
  - **Color, Thermal and Radar: security, transport, etc.**
  - Node-RED on board
  - Snap4City Library installed
  - Image processing for trajectories
  - Sending data stream on Snap4City.org
- **Snap4City infrastructure**
  - Collecting data in real time
  - Pre-processing, clustering in real time
  - **Counting in real time**: 12 trajectories, 8 in/out flows
  - Presenting data on dashboard



One Camera
Many results

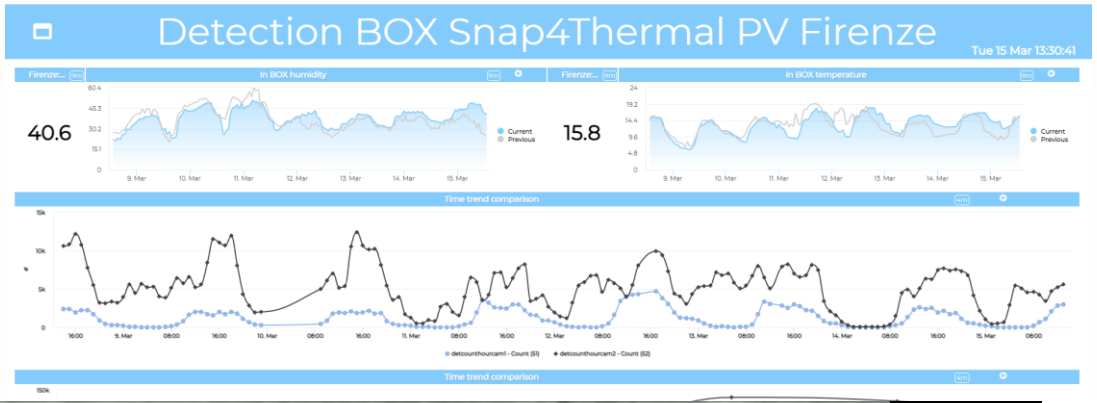
Tracking People
AXIS Camera with Snap4City

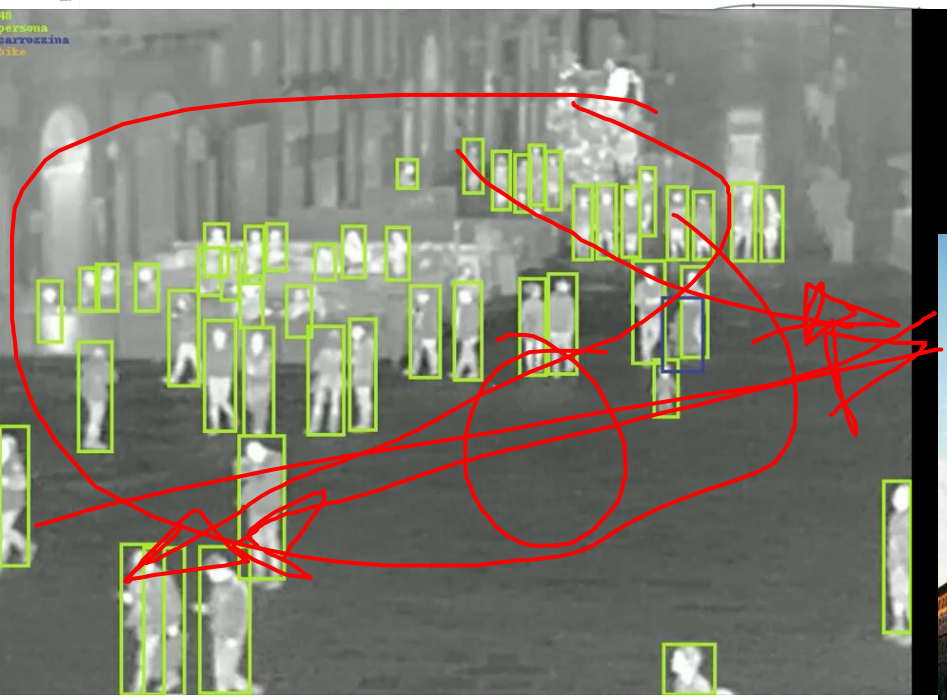


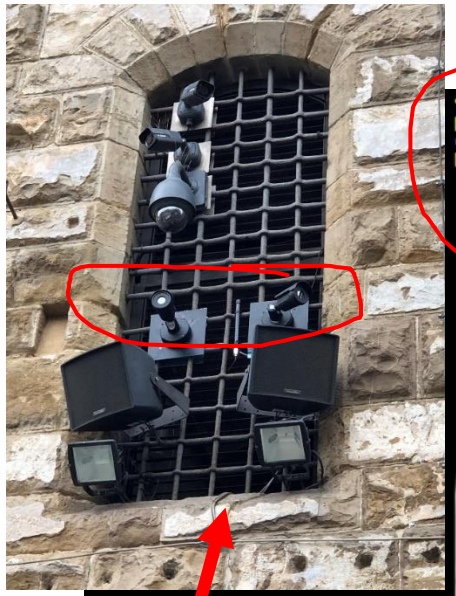




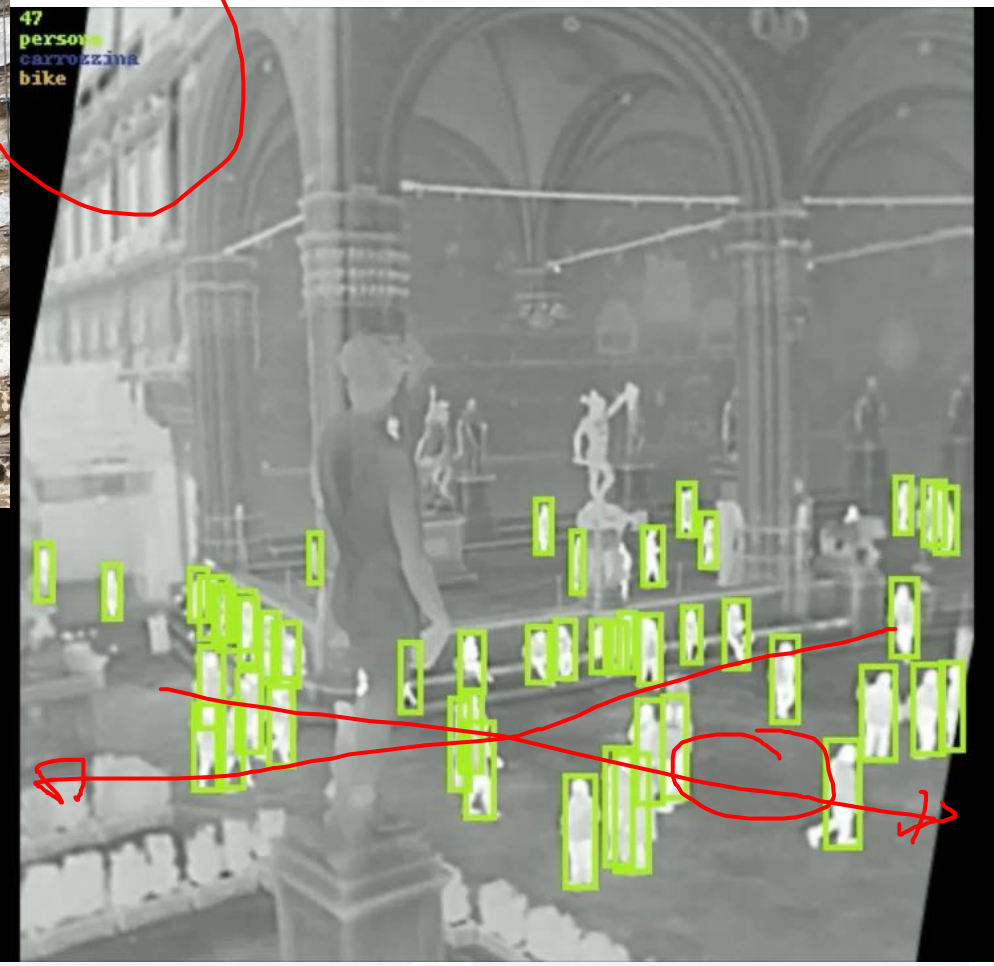
A view and data from the Thermal Camera









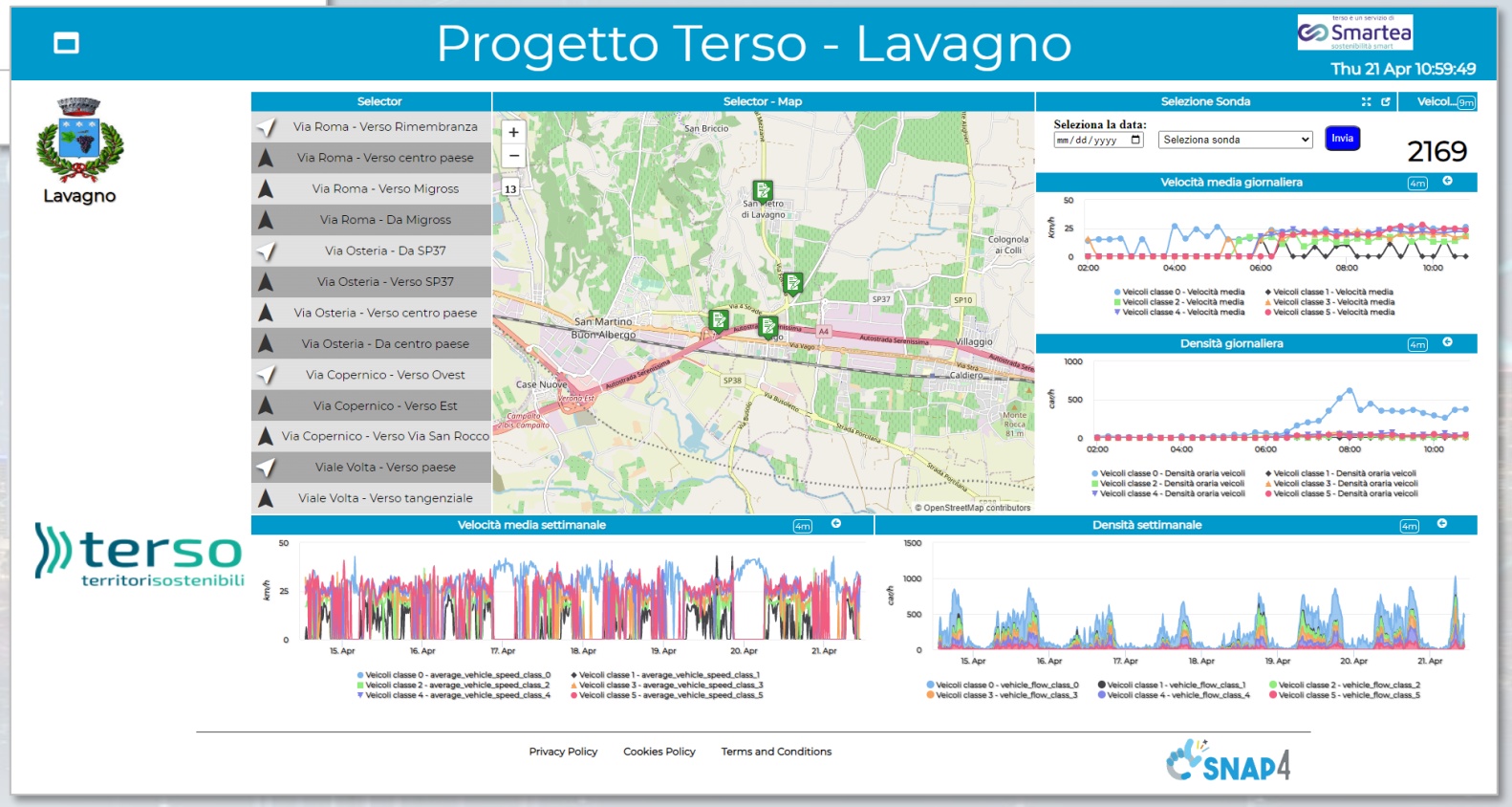




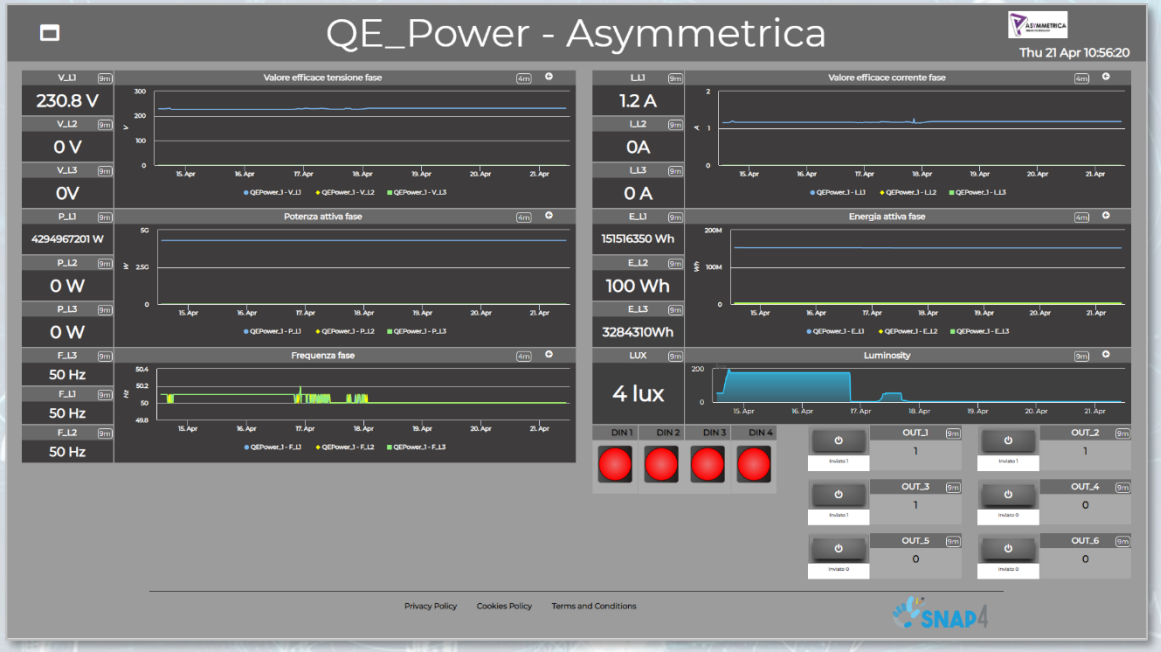


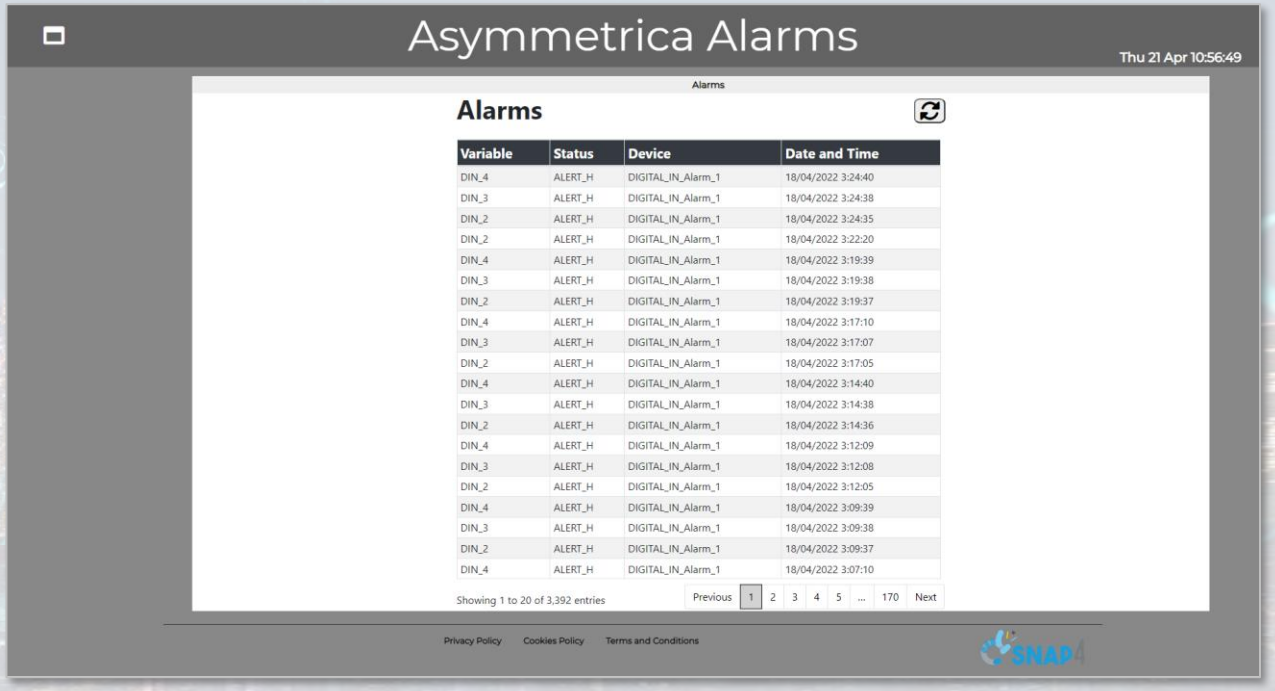
Smartea
sostenibilità smart

SNAP4



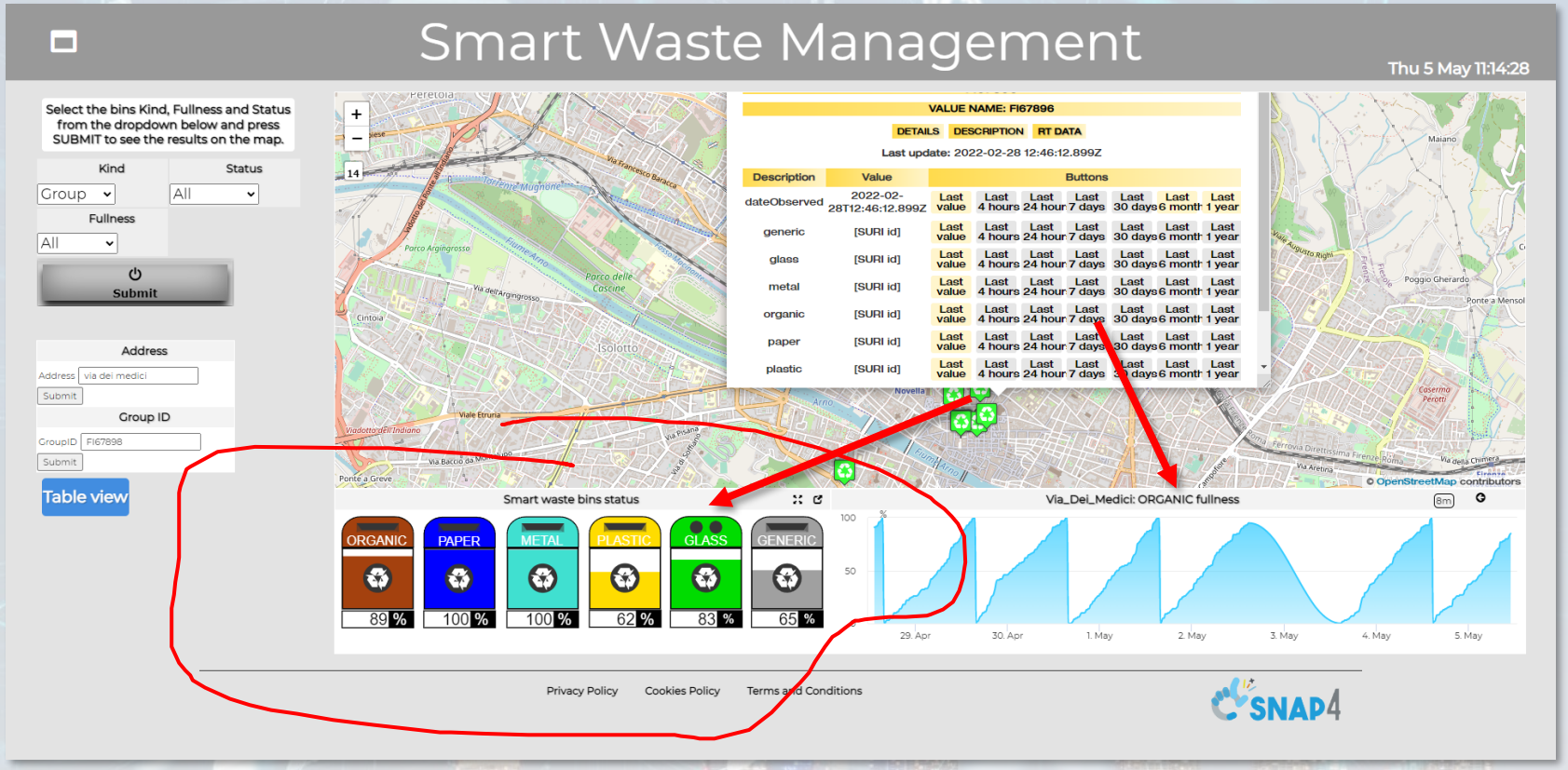
- Traffic Data
- Environmental Data
- People counting (pedestrian)





- Environmental data
- Power meter Data
- Smart Light data are coming (in collaboration with a multinational company)

Smart Waste – Map view

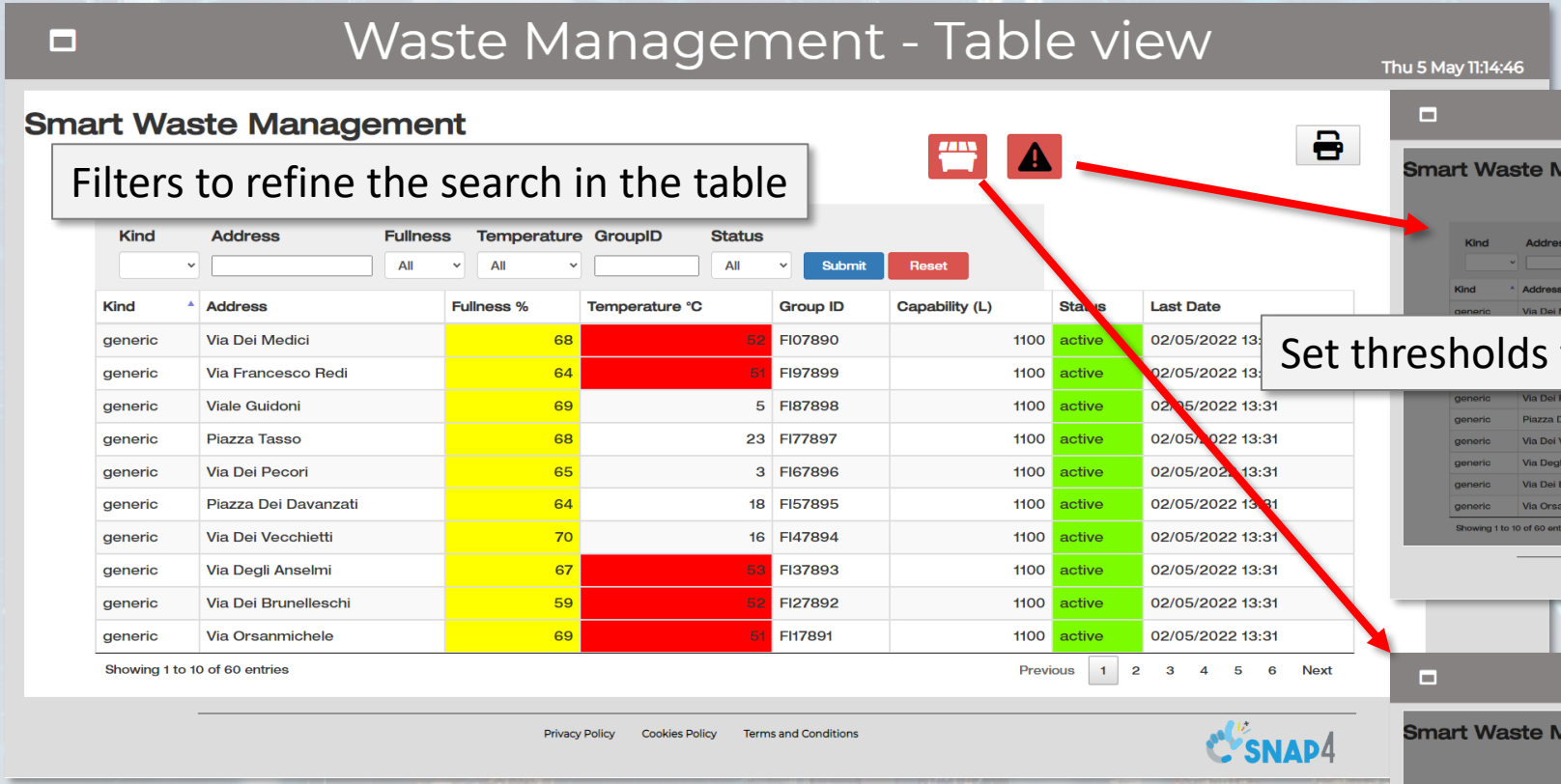


Search bins on map by filtering per:

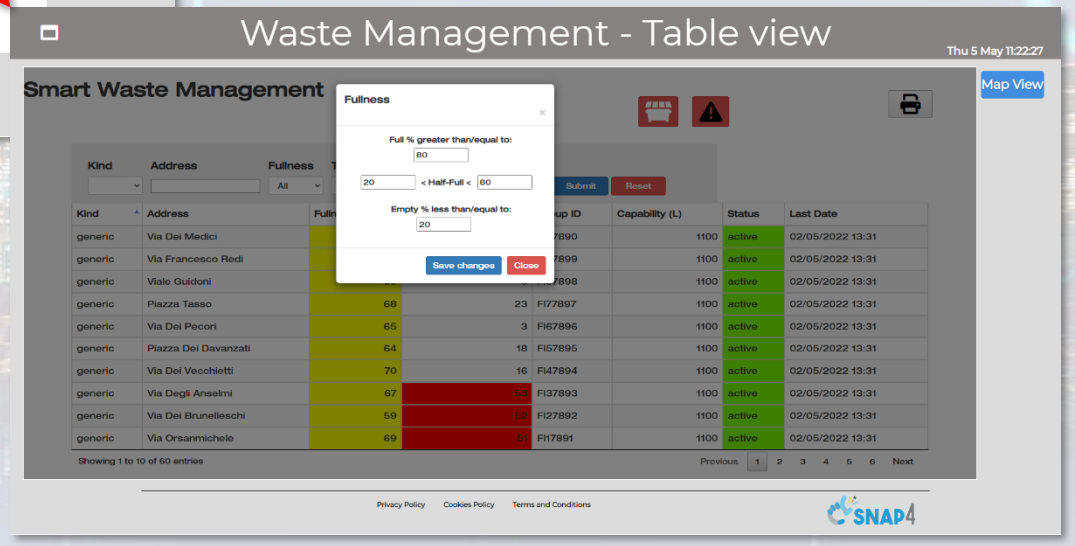
- **Kind** (All, generic, plastic, paper, glass, metal, organic)
- **Status** (Active, Not Active)
- **Fullness** (Full, Half-full, Empty)
- **Address**
- **Group of bins** (by GroupID)

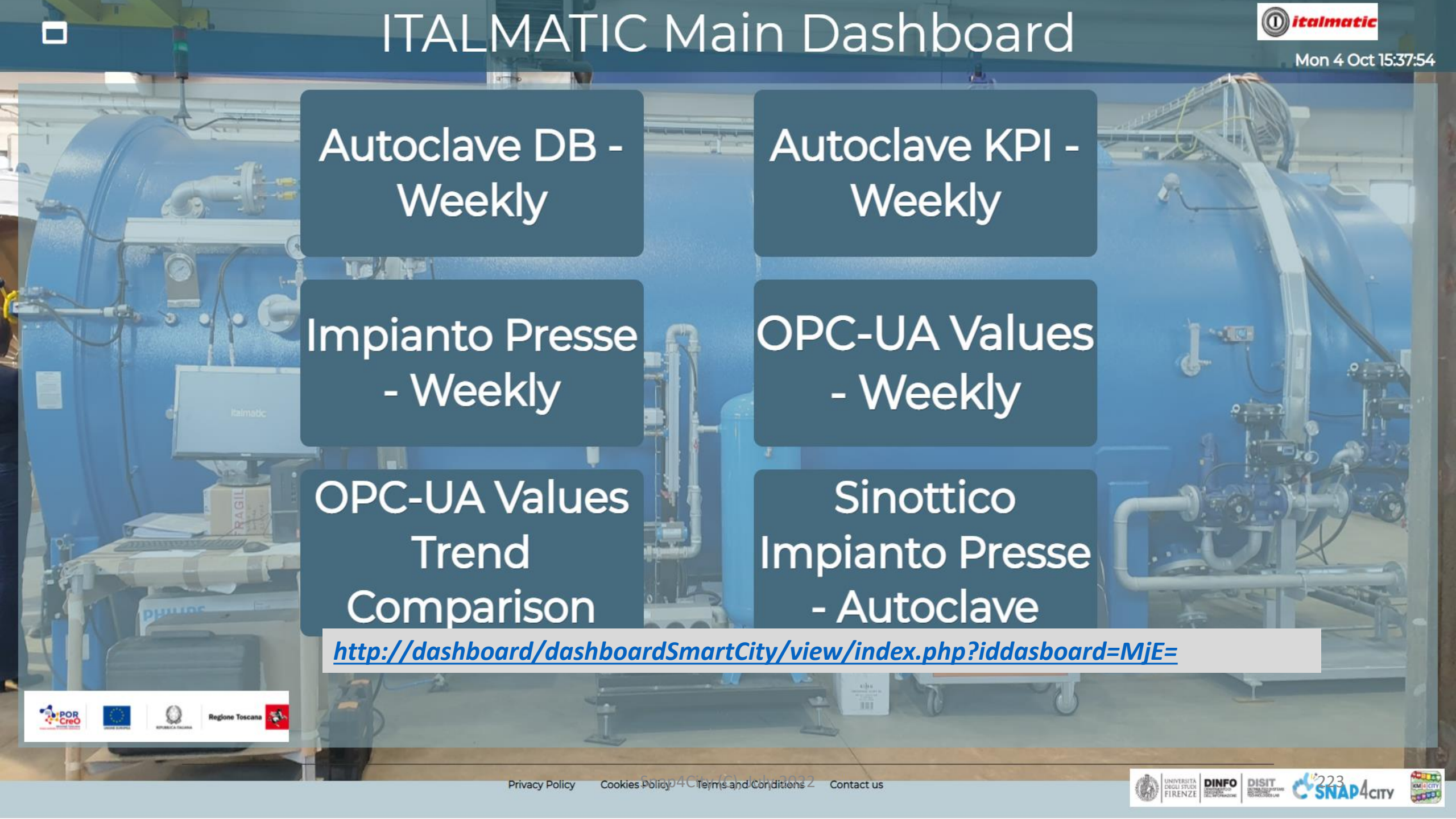
- Refine a search by using the filters on the left side
- Click on a waste bin pin on the map:
- A popup with real time data is shown
- The fullness status of the selected group of bins is shown in the synoptic below the map
- Specific fullness weekly trends are shown below the map
- Chick on the «Table view» button to access the other dashboard

Smart Waste – Table view








ITALMATIC Main Dashboard
italmatic
Mon 4 Oct 15:37:54
Autoclave DB - Weekly
Autoclave KPI - Weekly
Impianto Presse - Weekly
OPC-UA Values - Weekly
OPC-UA Values Trend Comparison
Sinottico Impianto Presse - Autoclave
http://dashboard/dashboardSmartCity/view/index.php?iddasboard=MjE=
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Snap4City (C) July 2022
223
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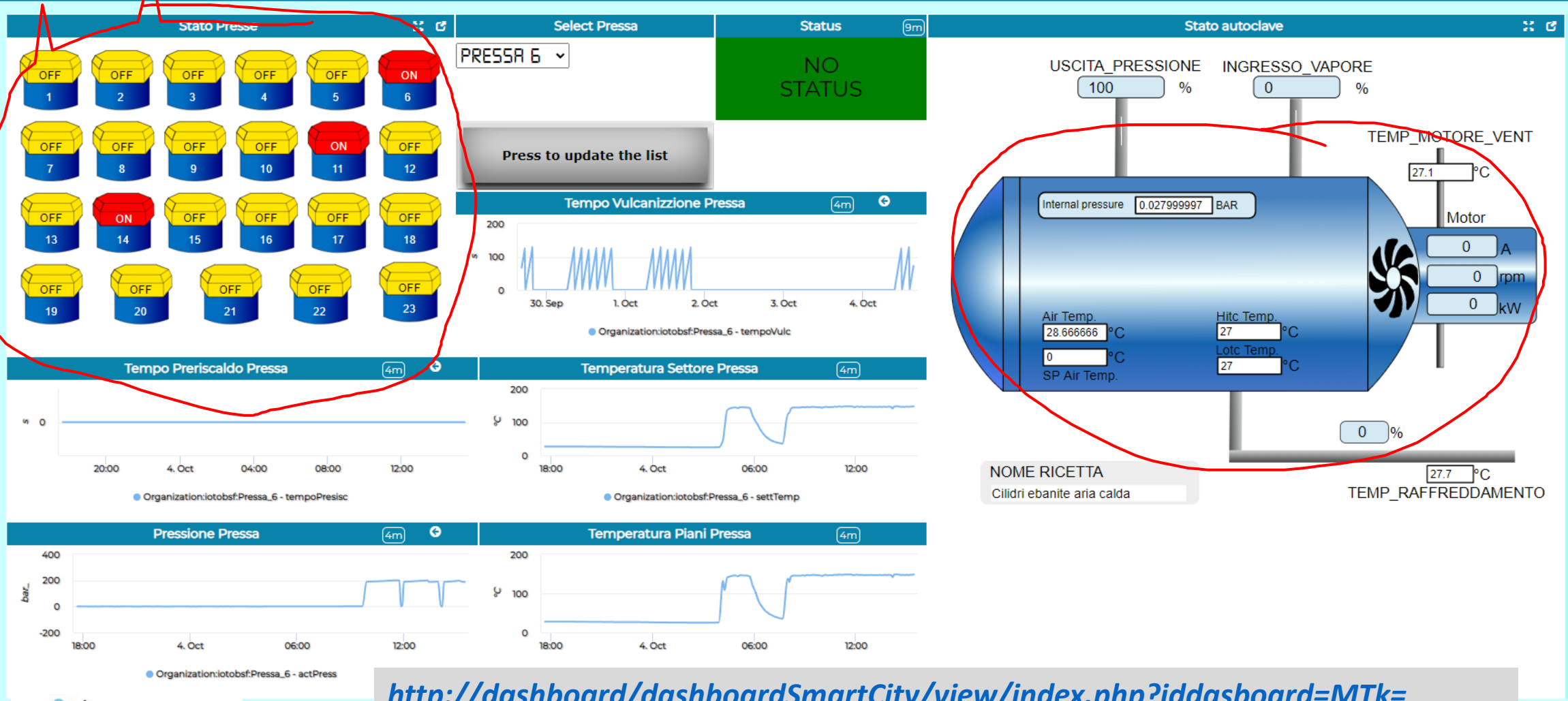
DISIT
SNAP4CITY

Sinottico Impianto

Sinottico Impianto Presse - Autoclave

Mon 4 Oct 15:34:59



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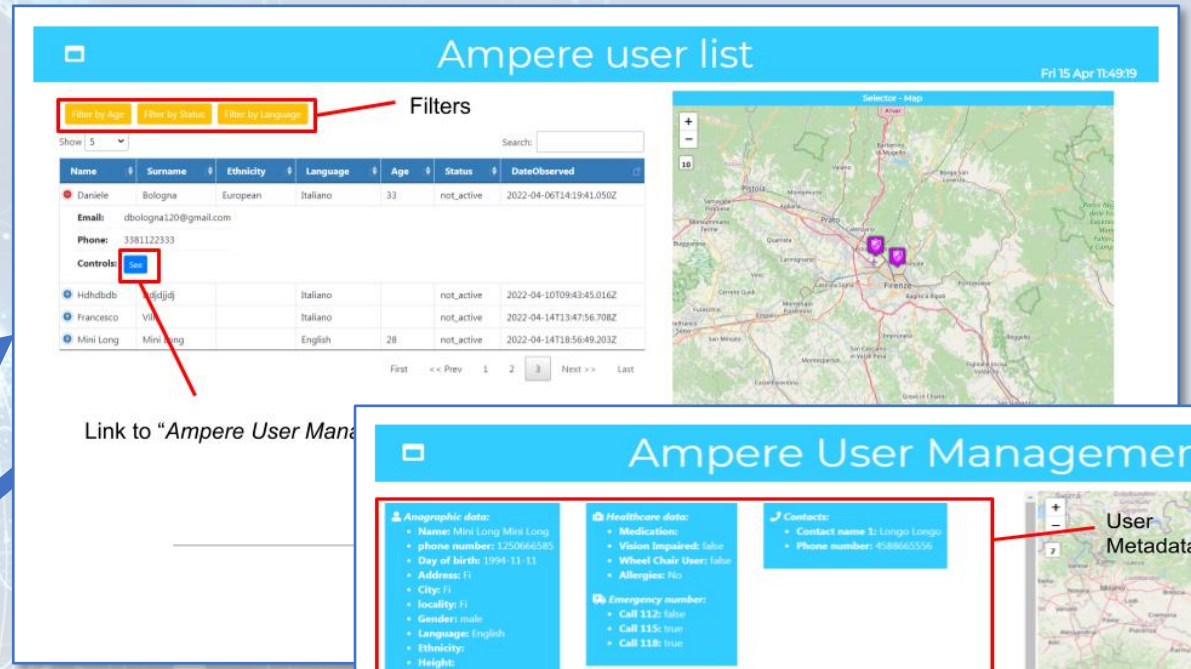
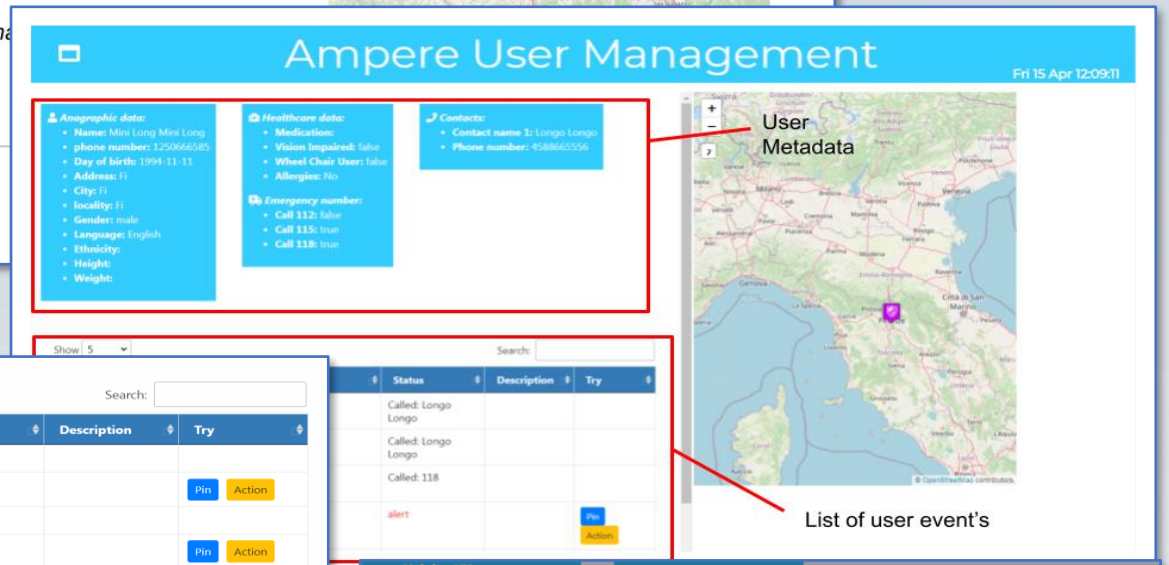
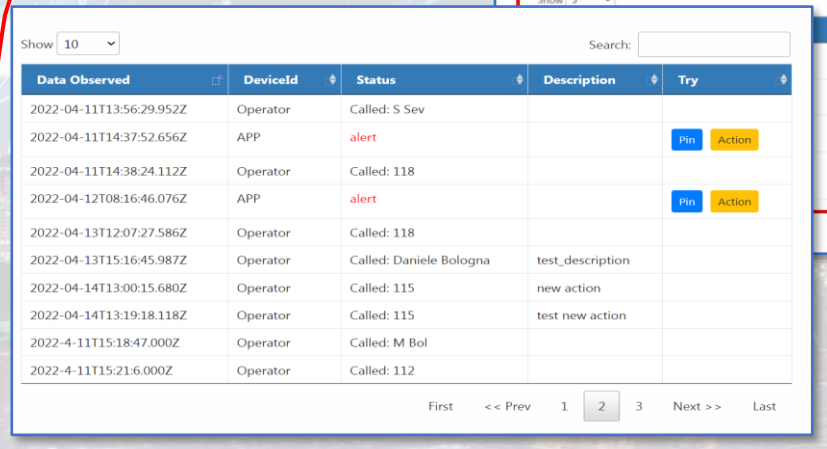
Snap4City (C), July 2022

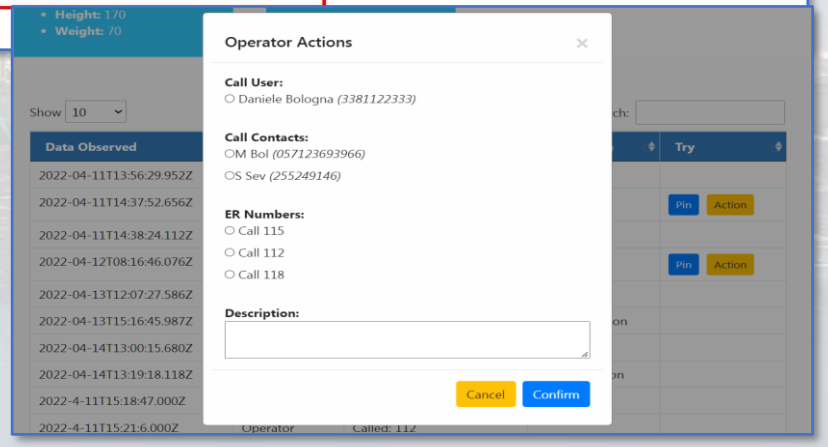
Jewel Alarms AMPERE











Energy monitoring and business intelligence

Green and Data Driven District @ MIND

Aggregated KPI | JuicePark | SmartPole | CityAnalytics

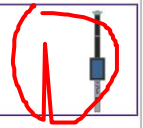
enel x

Energy produced to date		CityAnalytics insight		Videoanalysis – KPI to date	
JuicePark	0 kWh	Average daily people	9845.3	People counted	0
SmartPole	27.341 kWh	Average Milan resident over tourist ratio	1.57	Vehicle counted	520
				People aggregation	0
WiFi sessions daily peak		**SOS events to date**		**Vehicle charging sessions to date**	
Max connected devices	0	SmartPole requests	0	EV car	0
		JuicePark requests	0		
		AED requests	0		

Juice Park
Detailed KPIs



Smart Pole
Detailed KPIs



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enel-x juice park

enel x
Thu 21 Apr 10:48:31

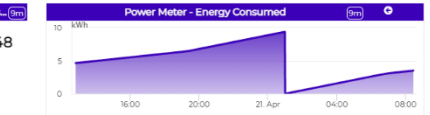
main
smart pole

Charging Station

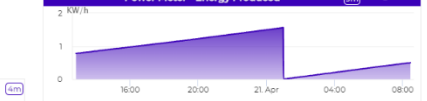
Number of Daily Ses...	Daily Energy Consumpti...
0 #	0 kWh
Number of Total Ses...	Total Energy Consumed
10 #	15 kWh

SOS - Number of Pushes	SOS - Last button us...
7 #	29/03/2022 11:48
SOS - Daily Number of Button Pus...	
0 #	

Power Meter - Energy Consumed



Power Meter - Energy Produced

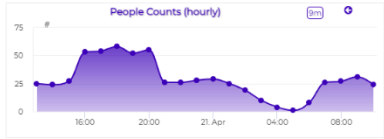


WiFi - Connections per Day

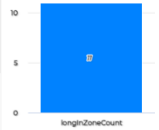


Video Analysis

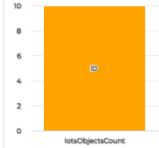
People Counts (hourly)



People in Forbidden Area



People Aggregation



Last Event	Last Event
21/04/2022 10:48	21/04/2022 10:47

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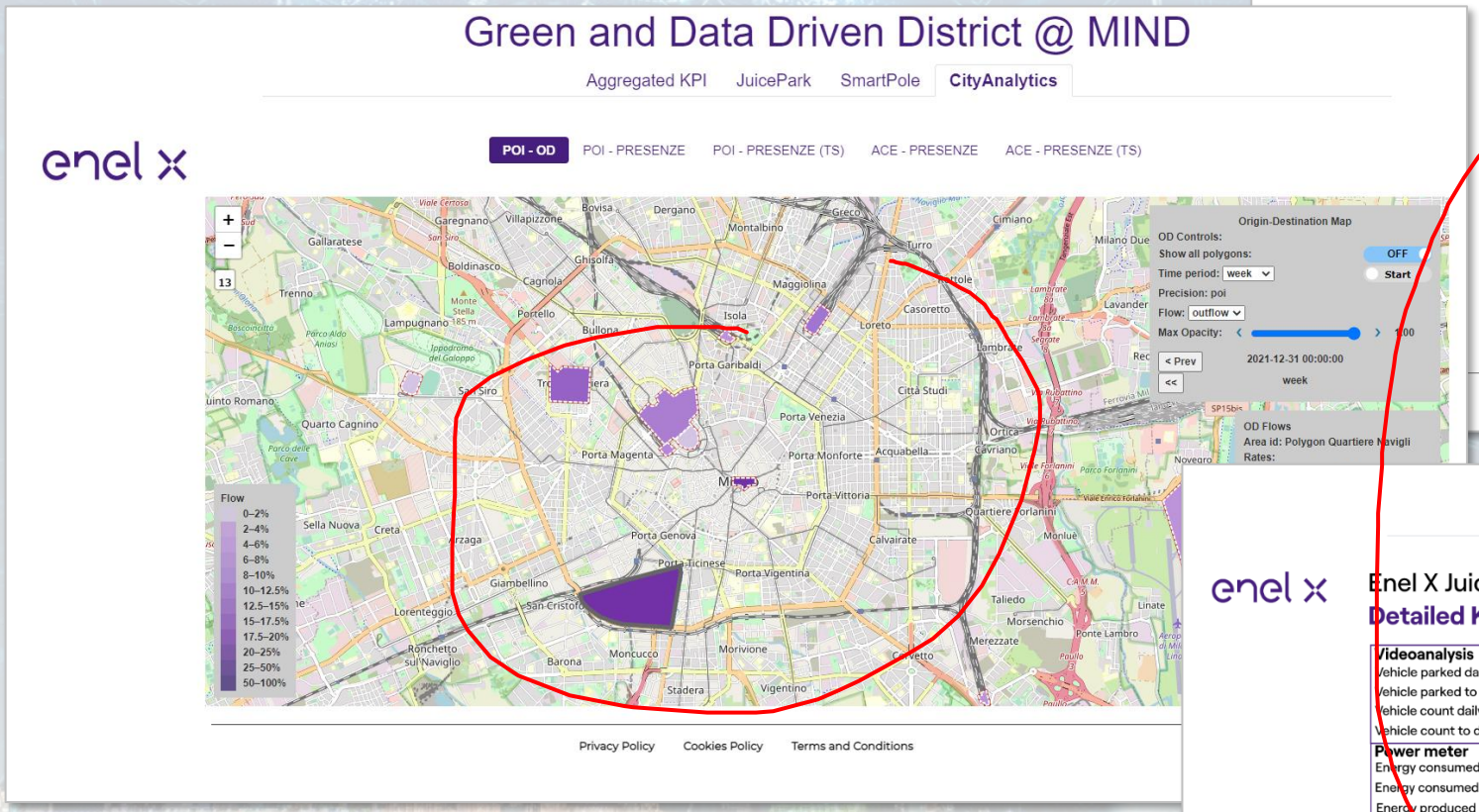
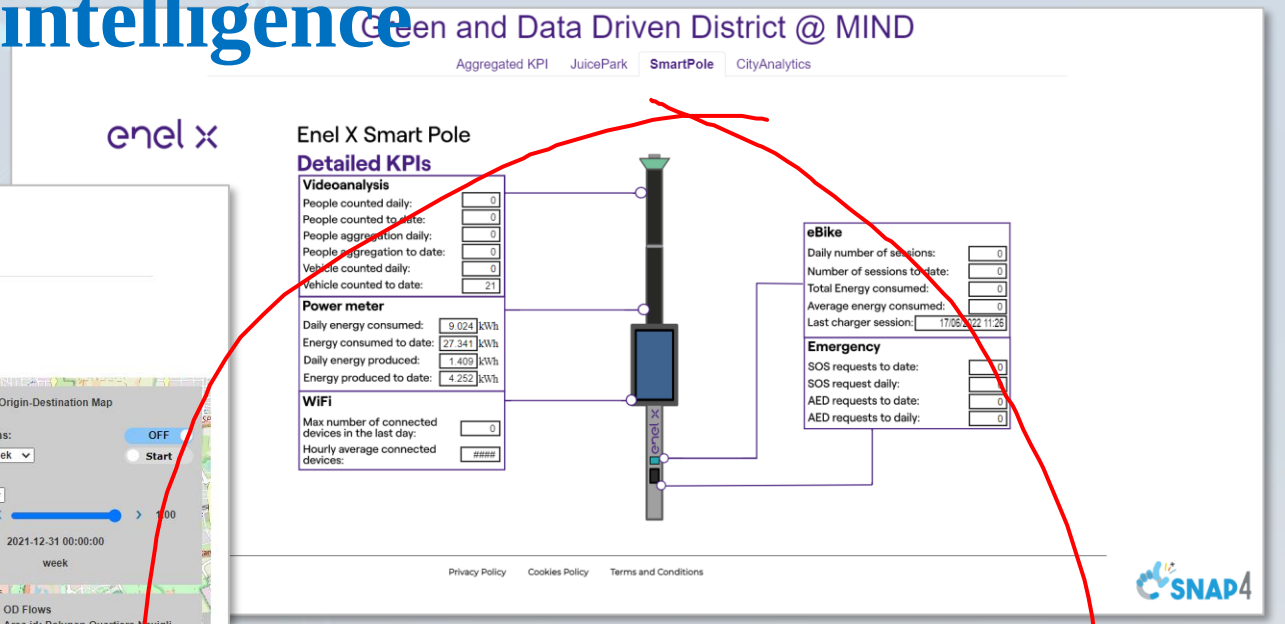
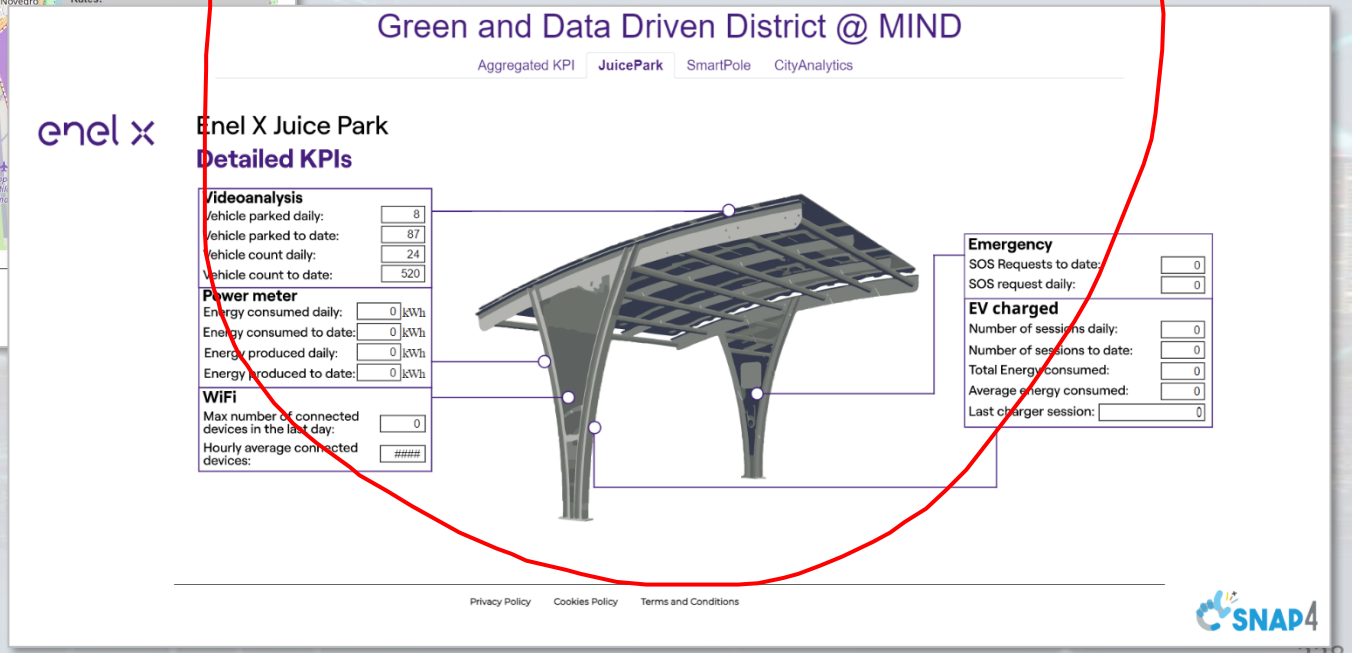
SNAP4

enel x

Energy monitoring and business intelligence







PaD

Predictive Analytics Dashboard

Mon 17 Jan 17:31:13

Piano Linea 2

Dettaglio Linea 2 | Vista Complessiva

Sintesi Linea 2 | Allocazione Squadre Linea 2 | Simulazione Allocazione Linea 2

	Data partenza in stima	Data fine in stima	Durata stimata	Data effettiva partenza	Data effettiva fine	Durata
Progetto di base	02/06/2022	31/08/2022	90	02/06/2022	31/08/2022	
Progetto esecutivo	31/08/2022	29/11/2022	90	31/08/2022	29/11/2022	
Vr_ODI PE	29/11/2022	28/01/2023	60	29/11/2022	28/01/2023	
Realizzazione	28/01/2023	20/09/2025	966	28/01/2023	20/09/2025	
Prove	20/09/2025	19/12/2025	90	20/09/2025	19/12/2025	
CVT e ANSFISA	19/12/2025	18/05/2026	150	19/12/2025	18/05/2026	
Totale	**02/06/2022**	**18/05/2026**	**1446**	**02/06/2022**	**18/05/2026**	

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PAD

Predictive Analytics Dashboard

Powered by

ITALFERR

GRUPPO FERROVIE DELLO STATO ITALIANE

SNAP4

PAD - ITALFERR

Mon 17 Jan 17:29:30

Predictive Analytics Dashboard

Simulazione Allocazione

Simulazione Allocazione

Sat 22 Jan 09:22:18

squadre

Pianificazione Stimata

MaxSquadre

Schedula effettiva

Predictive Analytics Dashboard | Sintesi Linea 2 | Allocazione Squadre Linea 2

MaxGiorni

GG 520

Submit

msg

Infattibile

Multi Time trends

Totali Eff

Max Pers...

126

Durata

886

Totali

Max Persone ...

126

Durata Eff

1123

Multi Time trends Eff

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Herit-Data Twitter Vigilance



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

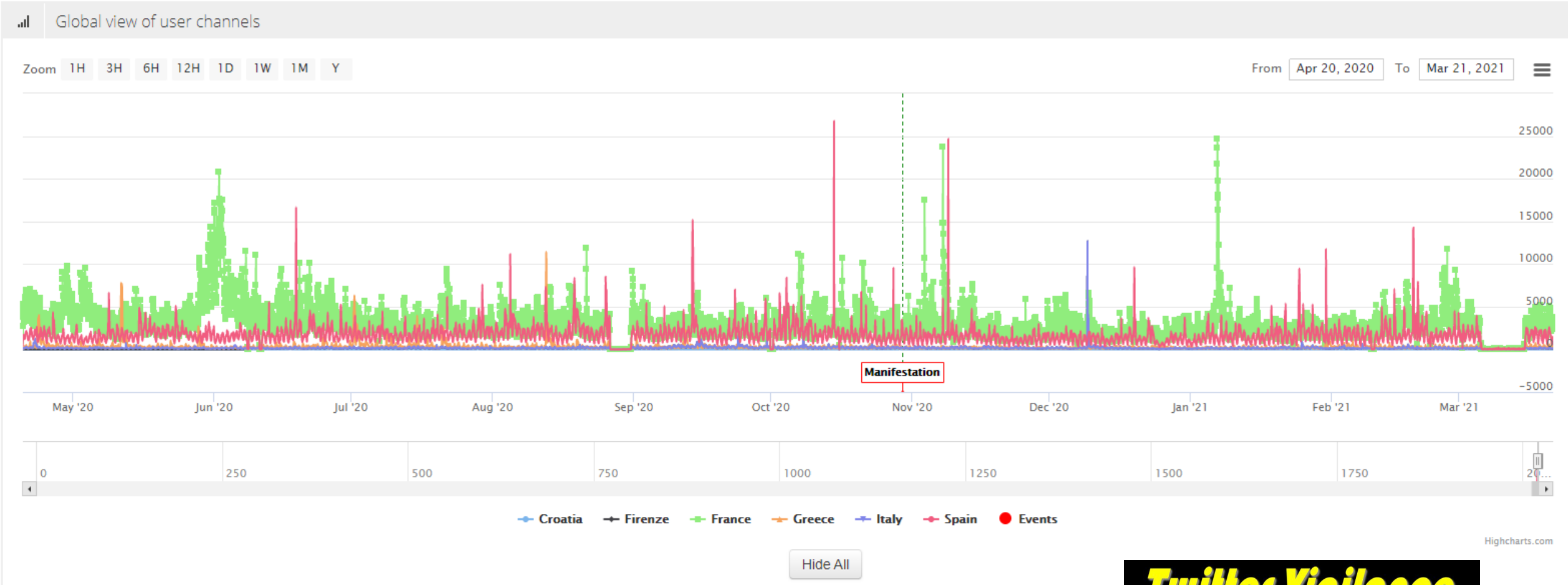
Twitter Vigilance Herit-Data: *Some Numbers*

Channel Name	Total Number of Collected TW+RTW	Number of Collected Tweets	Number of Collected Retweets	Twitter Volume Processing Time Range	NLP & Sentiment Analysis Processing Time Range	NLP & Sentiment Analysis Languages
Spain	113.7 Millions	40.99 Millions	72.49 Millions	From 30-01-2020 to current datetime	From 01-02-2020 to current datetime	English, Spanish
France	50,1 Millions	16.0 Millions	34.1 Millions	From 30-01-2020 to current datetime	From 01-02-2020 to current datetime	Italian, English, French
Greece	12.3 Millions	4.2 Millions	8.1 Millions	From 30-01-2020 to current datetime	From 01-02-2020 to current datetime	English
Italy	2.97 Millions	1.0 Million	1.9 Millions	From 30-01-2020 to current datetime	From 01-02-2020 to current datetime	Italian, English
Croatia	35.8 Thousands	15.5 Thousands	19,8 Thousands	From 30-01-2020 to current datetime	From 01-02-2020 to current datetime	English

Updated: Dec. 2021

Twitter Vigilance

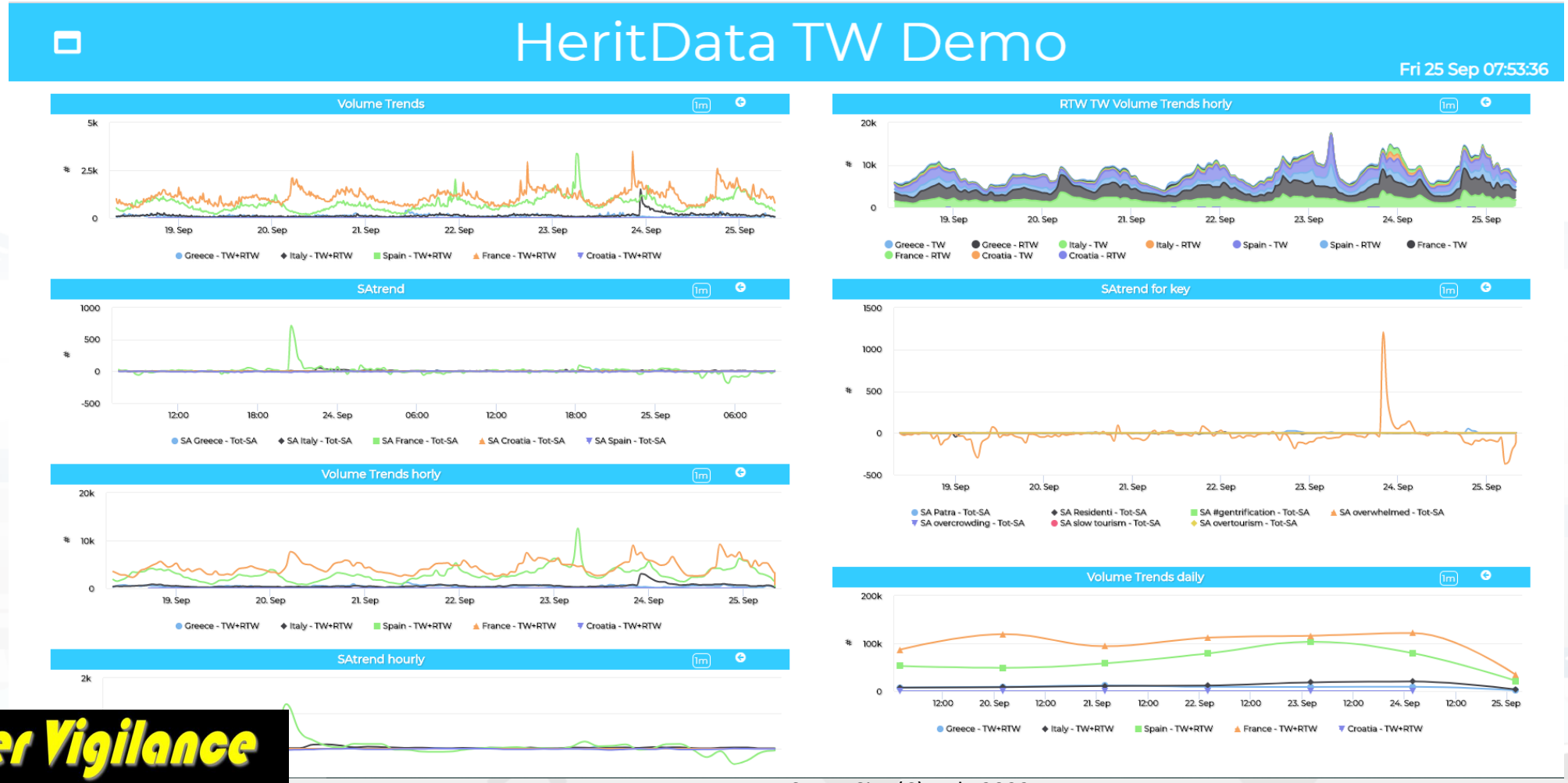
Overview on the last 12 months



Twitter Vigilance

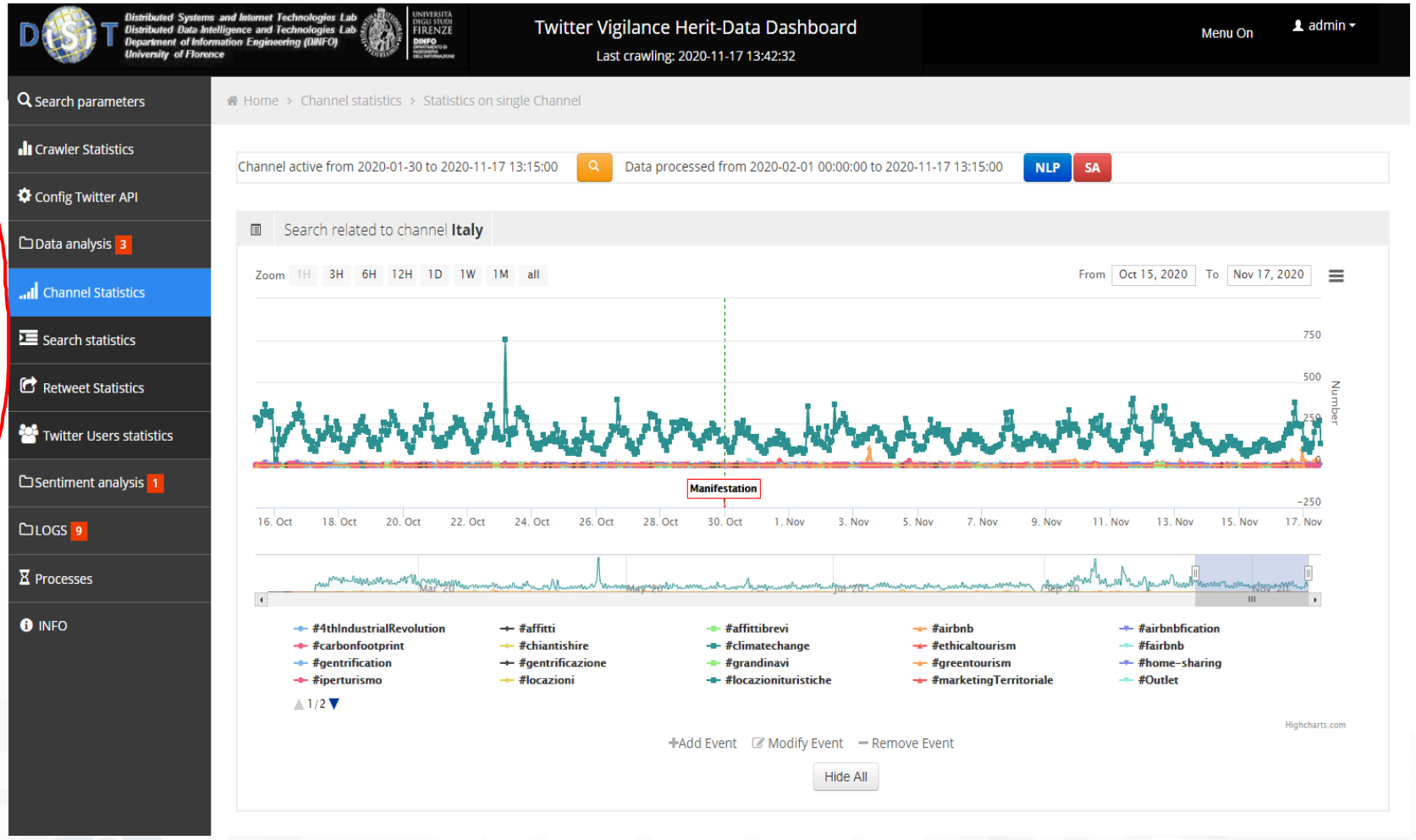
Twitter Vigilance Data on Dashboards trought IoT-App

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



TV on Florence

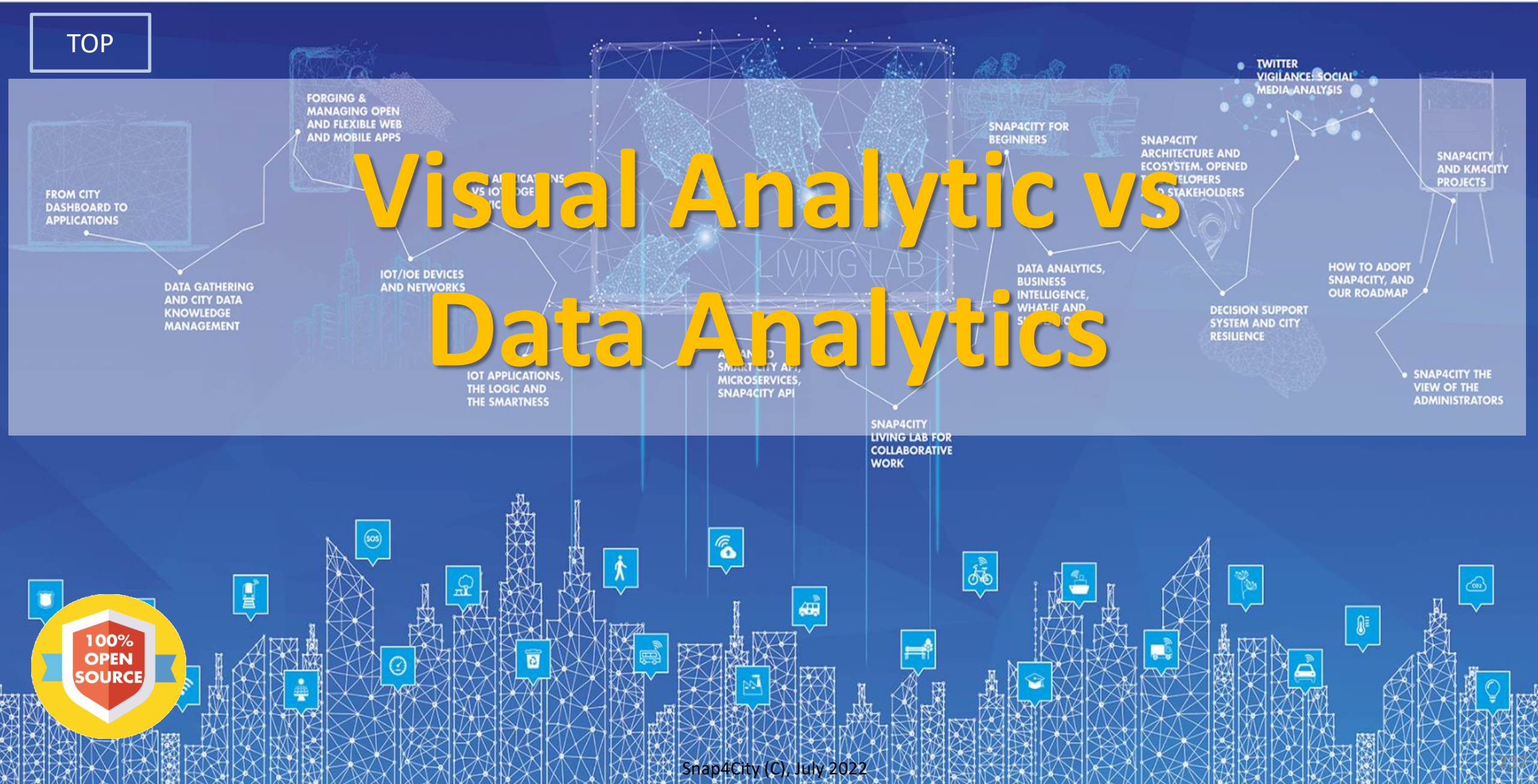
#4thIndustrialRevolution #affitti #affittibrevi #airbnb
#airbnbfication #carbonfootprint #chiantishire #climatechange
#ethicaltourism #fairbnb #gentrification #gentrificazione
#grandinavi #greentourism #home-sharing #iperturismo
#locazioni #locazionituristiche #marketingTerritoriale #Outlet
#overtourism #responsibletravel #sharingEconomy
#socialtourism #SustainableDevelopmentGoals
#sustainabletourism #Tourism4SDGs #turismoEnogastronomico
#turismoEsperenziale #turismoetico #turismoSmart
#turismosostenibile #turismoverde #voluntourism



Twitter Vigilance

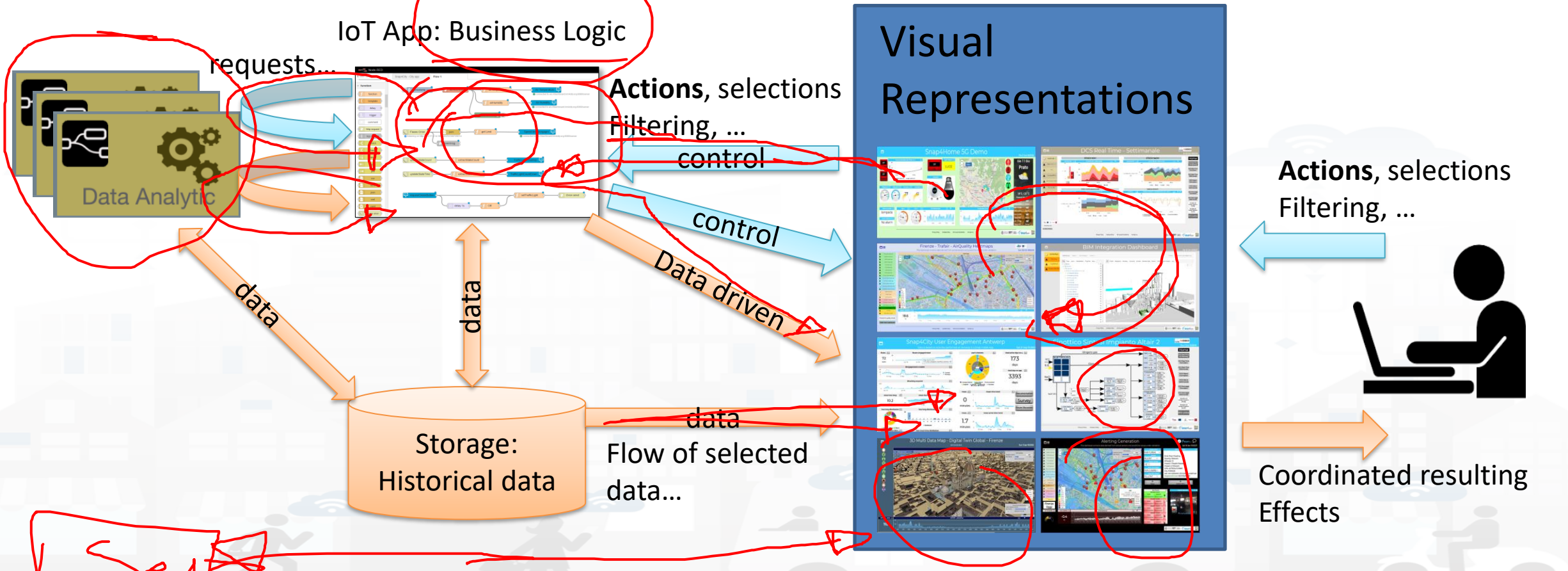
TOP

Visual Analytic vs Data Analytics



Visual Analytics

- implementing sophisticated ***Business Intelligence Tools***
- Open to receive a range of possible Actions, to produce a large combination of results in terms of data and representations.



Examples of Visual Analytics

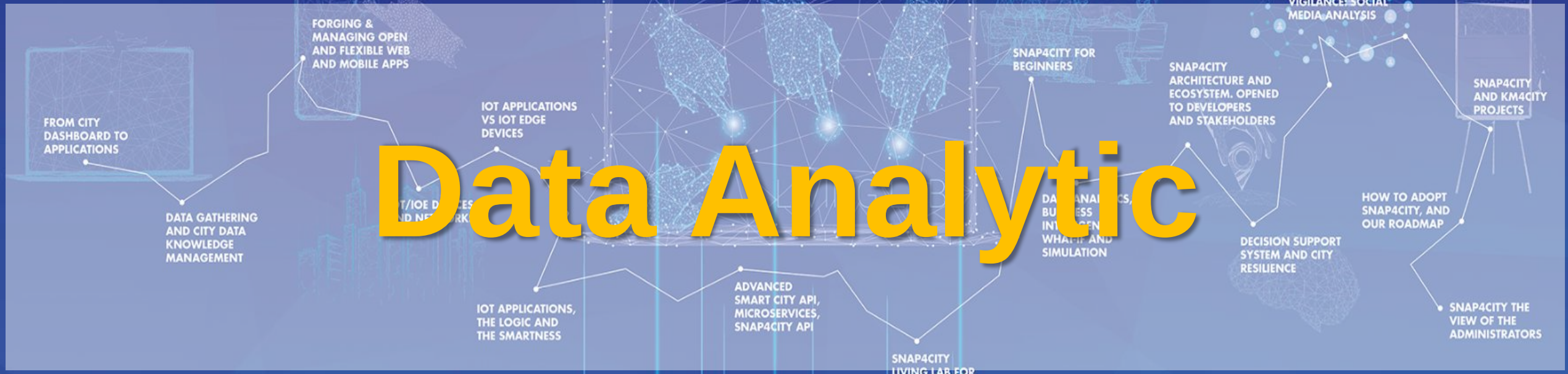
- **Selection of a number of filters →**
  - representation of the resulting data filtered in different manner: barseries, maps, tables, etc.
  - *Event driven change of the graphic representation of results*
- **Definition of blocked segment of road, starting and end points →**
  - calculation of the routing taking into account of the block
  - *Event driven change of the graphic representation of results*
- **Click on two points on the map and to request a comparison →**
  - computing the comparison and rendering it as a result.
  - *Event driven change of the graphic representation of results*

The implementation of Business Logic for Visual Analytic is reported into

- https://www.snap4city.org/download/video/course2020/das/ Creation of Dashboards
- https://www.snap4city.org/download/video/course2020/iot/ IoT Apps Creation

TOP

Data Analytic



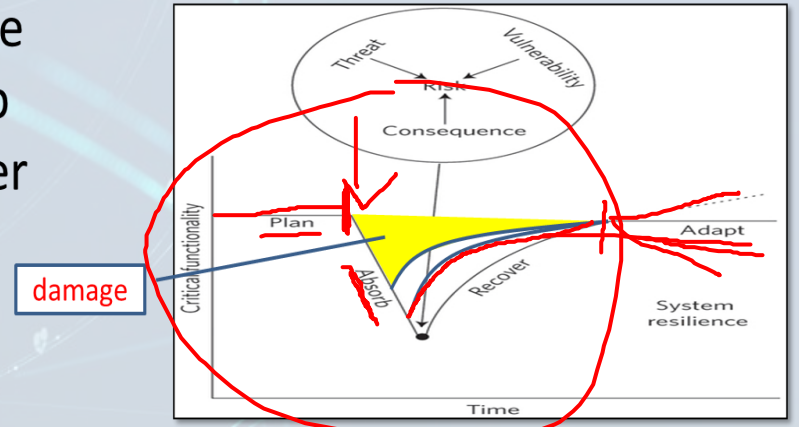
100% OPEN SOURCE

SNAP4 Appliances and Dockers **Installations**

Objectives

- Decision support systems
- Improvement of life quality
- Sustainable Solutions
- Reduction of costs
- Resilience

Prepare
Absorb
Recover
Adapt



Data Analytics

System Modeling and Simulation

Knowledge Models

Scenarious

Short Term Predictions, Anomaly Detections

Long Term Predictions, Anomaly Analysis

Recommendations & Prescriptions

What-if Analysis

Early Warning

Disaster Recovery

Strategies and Plans

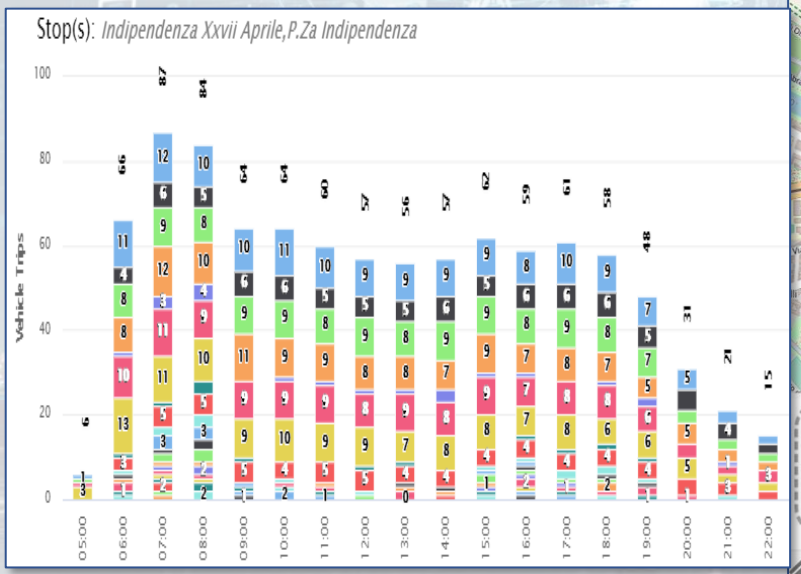
Partial graph

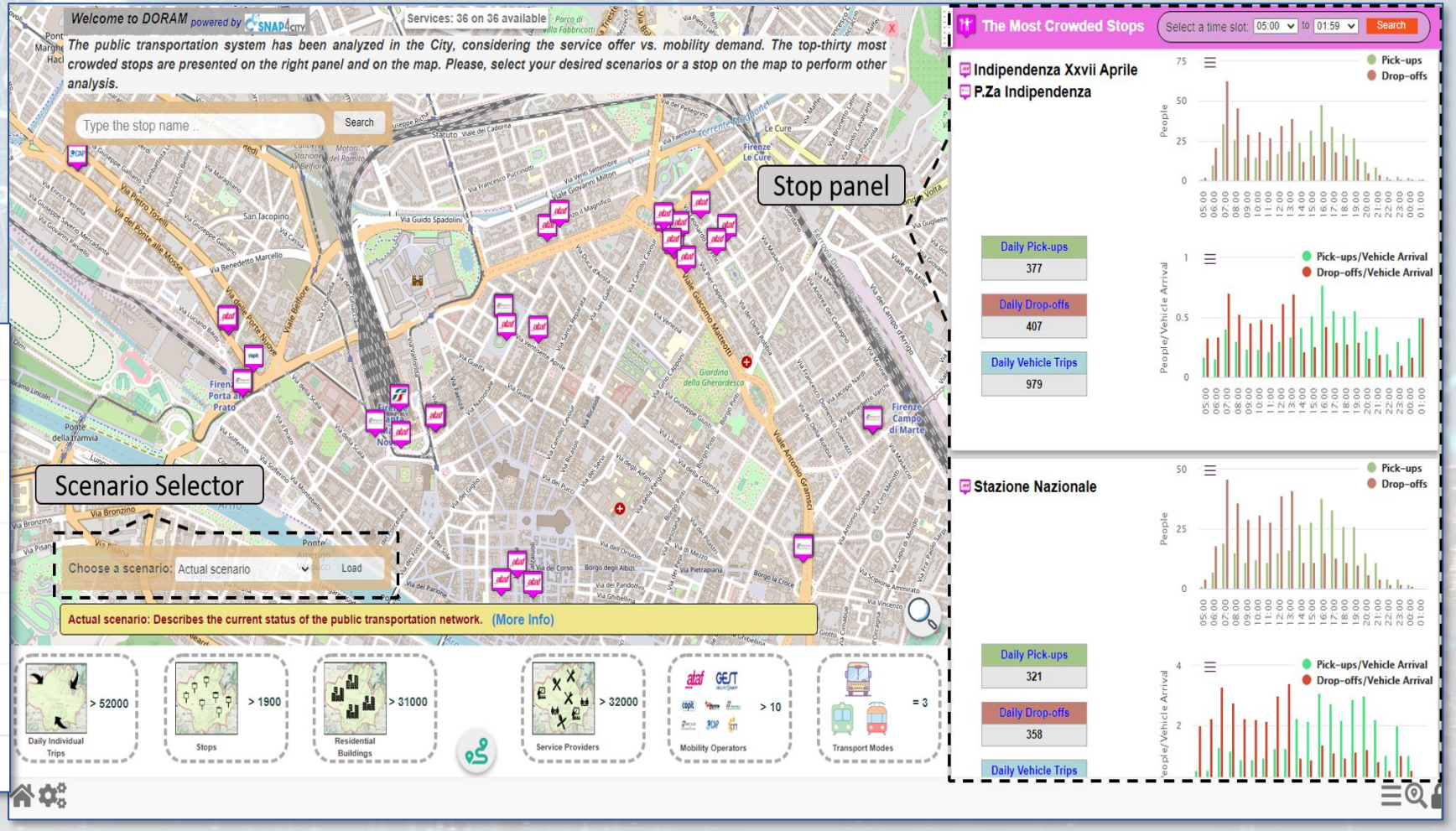
Quality of Life

What-if Analysis on Pub Transport

- Definition of scenarious impact on
  - Traffic, Pollutant, parking, public transport, private flows, etc.
  - KPI analysis

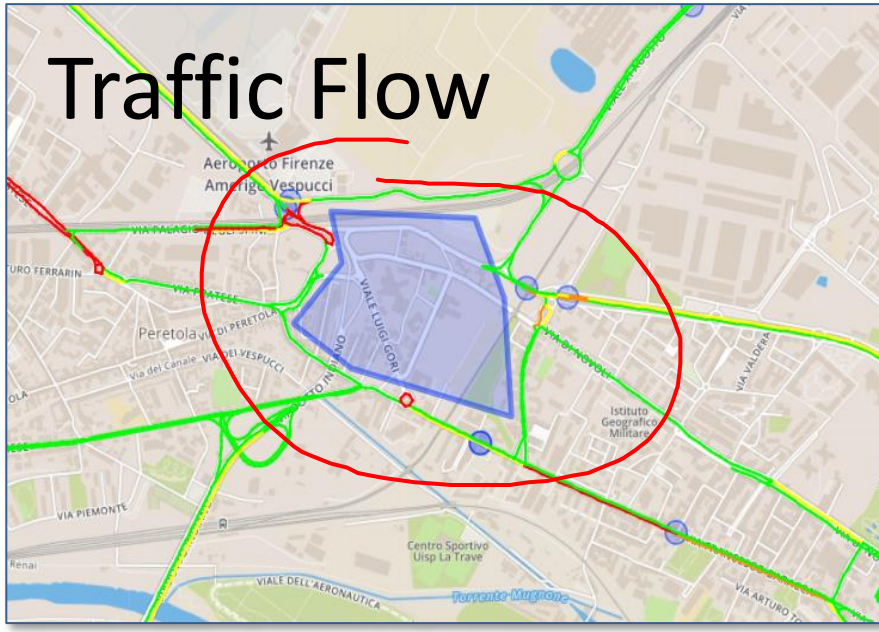
Public Services

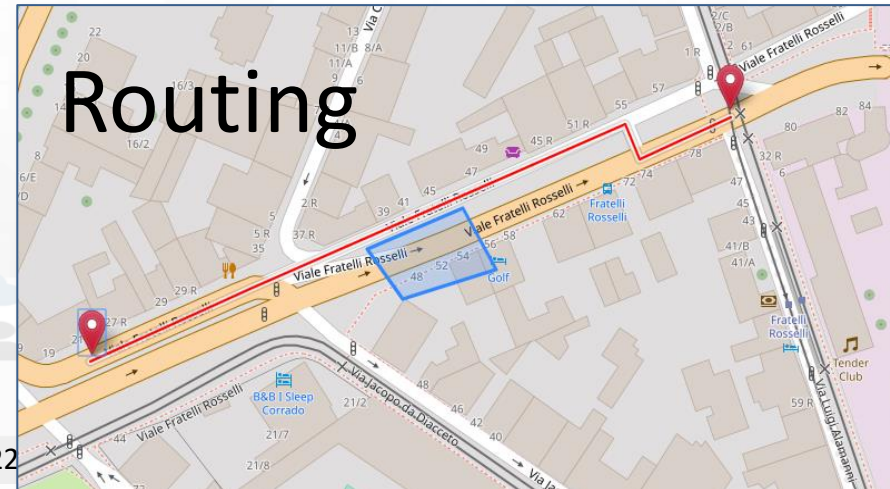




Decision Support Systems, What-if

- **Event planning, via what-if analysis**
  - Change in the graph structure of the city
  - Impact on the flow of people and vehicles
  - Adaptation: public transport, traffic, pedestrian management, etc.
- **Immediate reaction to natural events or not**
  - Everything is ready and updated in real time
  - Each view is contextualized in terms of data: descriptive and prescriptive
- **Digital Twin**
  - More detail in the context integrated data
  - Greater realism in deductions and representations
  - Less fragmentation and non-uniformity in the views to support decisions





Available Data Analytics

- Mobility and Transport
- City Users and Social
- Environment and Weather
- Time Series
- Semantic Reasoning
- Matrices, Images, Maps and 3D Digital Models
- Management and strategies
- Resilience and Risks Analysis

https://www.snap4city.org/download/video/course2020/da/



- ***15 Minute City Index:***
  - 13 differente subindexes



- Monitoring and Prediction of energy consumption
- Stimulating: Bike sharing, e-bikes, car charge, etc.



- Industry 4.0 integrated solutions
- Decisions Support Systems
- Process optimization
- Predictive maintenance



- Smart City infrastructure: monitoring and resilience
- Effective and Low cost smart solutions
- What-if analysis, Simulations



- Monitoring resource consuption,
- business intelligence tools for decision makers,
- Reduction production costs





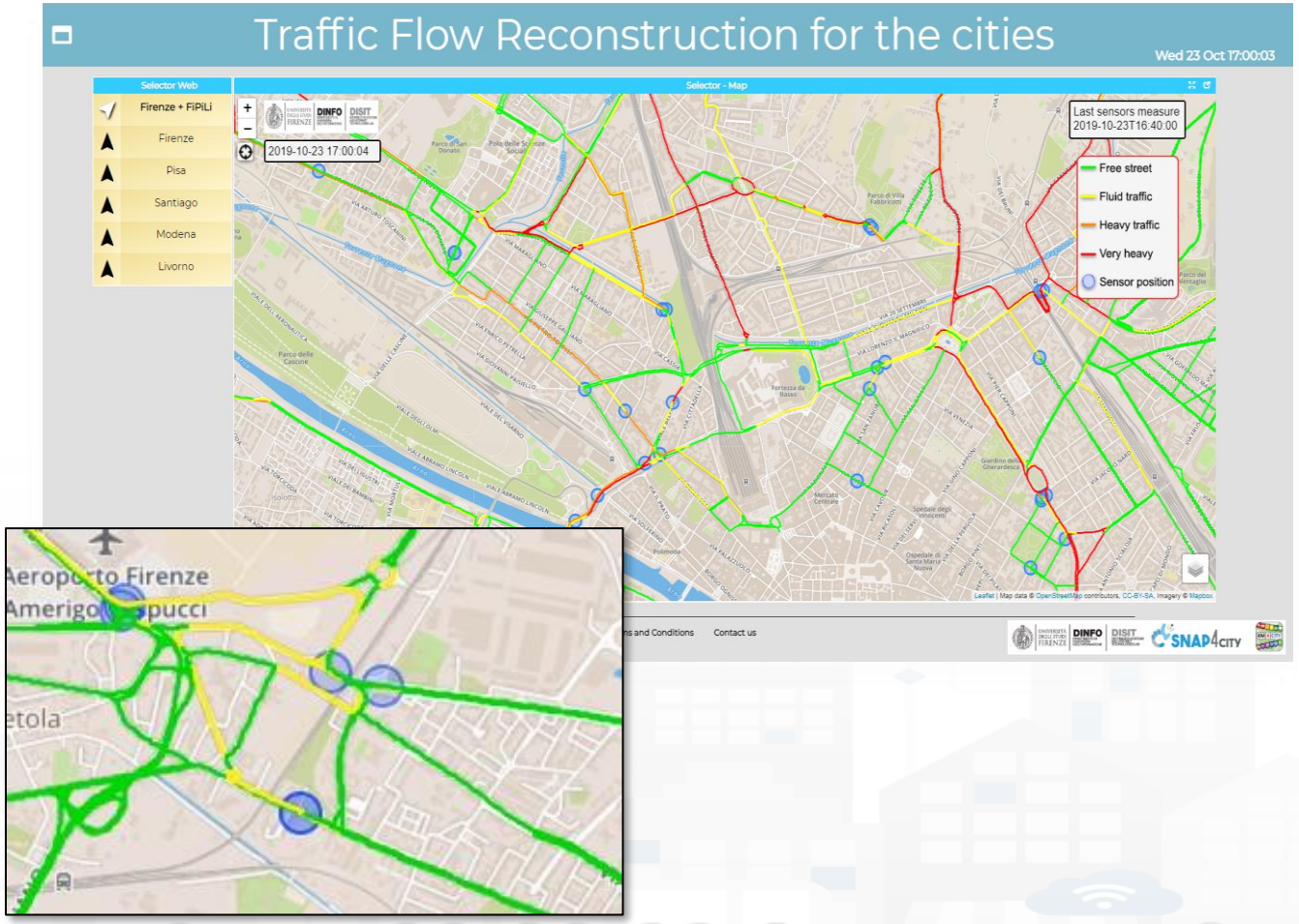
- Monitoring and Predictions for
  - NO2, NOX, CO2, Traffic flow, pollutant, landslide, etc.
  - Traffic flow reconstruction



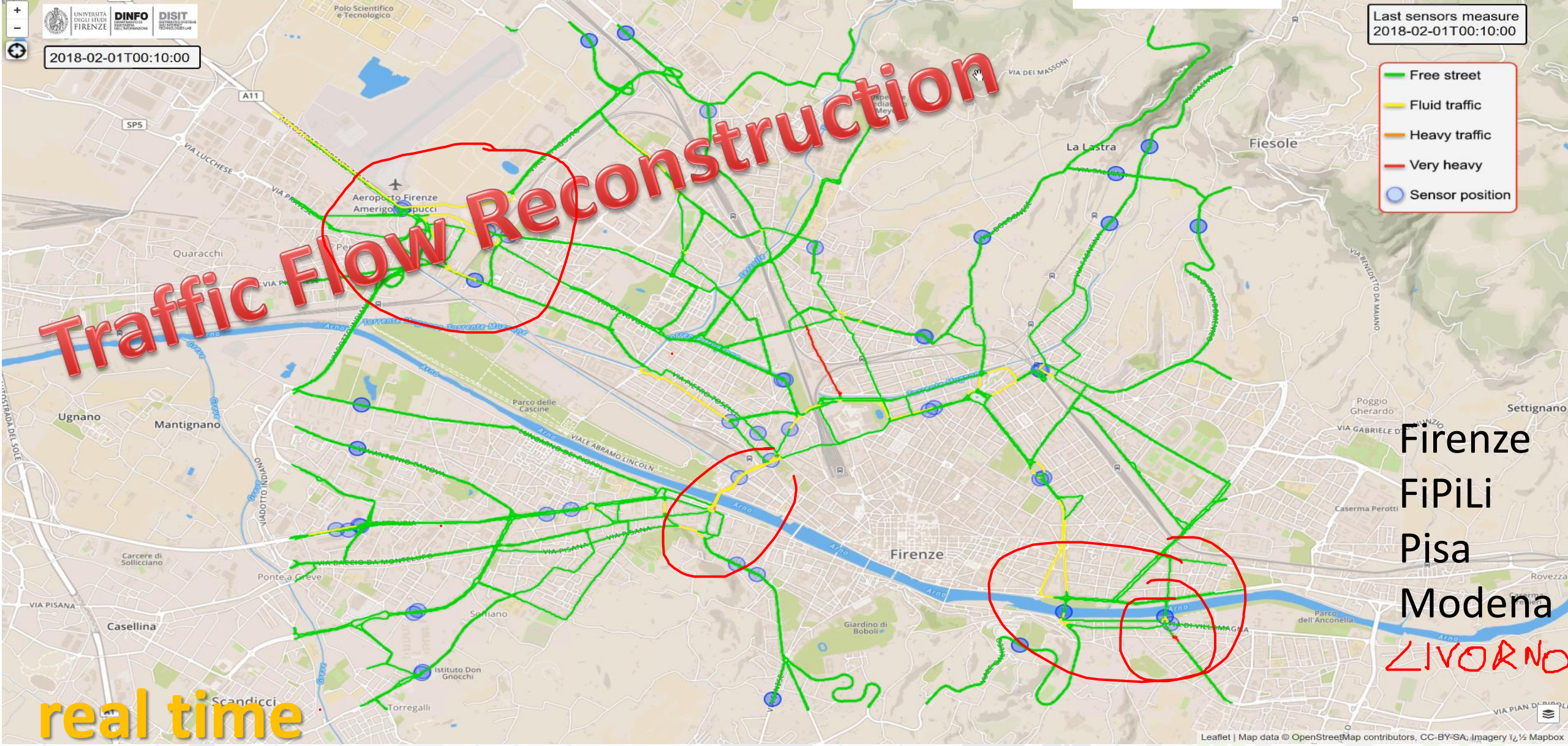
- Shortening justice time
- Predictiction of mediation proneness
- Ethical Explainable Artificial Intelligence

Why Dense Traffic Flow Reconstruction ?

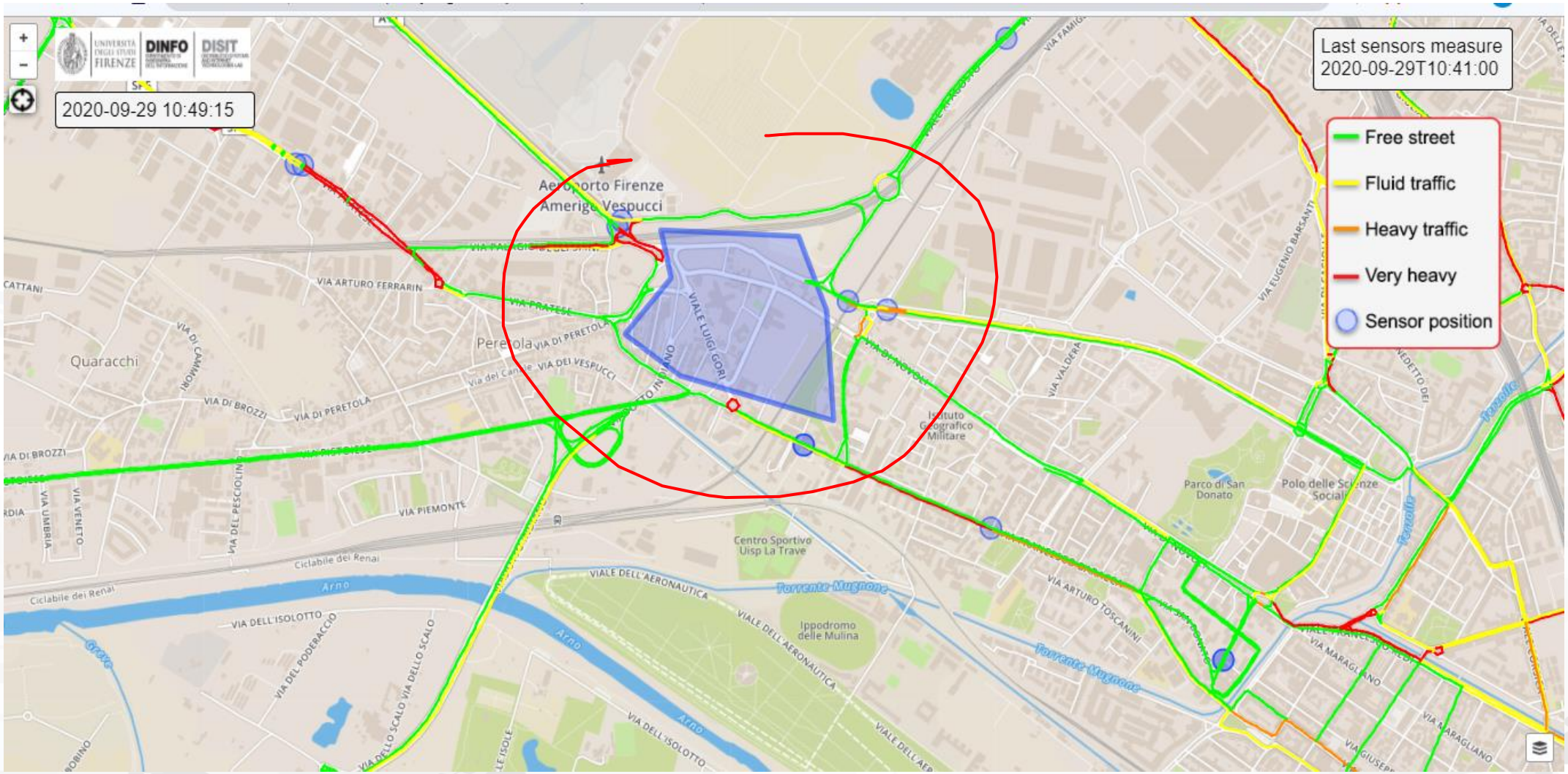
- Making decision on mobility and transport solutions → what if analysis
- Controlling pollution
- Dynamic Routing for Firebrigade, Ambulances, general public
- Planning Public Transportation routing



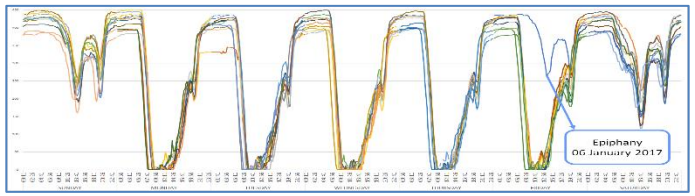
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc5NQ==


Traffic Flow Reconstruction
2018-02-01T00:10:00
Last sensors measure
2018-02-01T00:10:00
Free street
Fluid traffic
Heavy traffic
Very heavy
Sensor position
Firenze
FiPiLi
Pisa
Modena
LIVORNO
real time
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery ©¿½ Mapbox

Computation of Traffic Flow Evolution



I would arrive to surely Park in 45 Minutes??

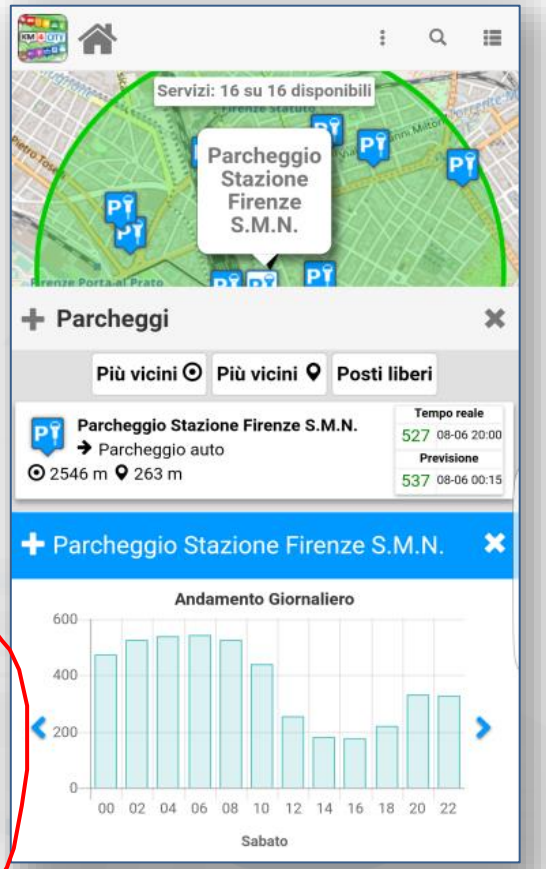


Category	Features	Description of features variable
Baseline features of free slot data	Free parking slots	Real number of available slots recorded every 15 minutes
	Time	Hours and minutes
	Month	Month of the year (1-12)
	Day	Day of the month (1-31)
	Day week	Day of the week (0-6)
	Weekend	0 for working days, 1 else
	Previous observation's difference (POD)	Difference between the number of free spaces at time i and number of free spaces at time (i − 15 minutes) recorded in the previous week
	Subsequent observation's difference (SOD)	Difference between the number of free spaces at time i, and the number of free spaces at time (i + 15 minutes) recorded in the previous week
Weather features	Temperature	City temperature measured one hour earlier than Time (°C)
	Humidity	City humidity measured one hour earlier than Time (%)
	Rainfall	City rainfall measured one hour earlier than Time (mm)
Traffic Sensors features	Average Vehicle Speed	Average speed of vehicles on the road being closest to the parking, over one-hour period (km/h)
	Vehicle Flow	Number of vehicles passing by closest to the parking, over one-hour period
	Average Vehicle Time	Average of distance between vehicles, over one-hour period
	Vehicle Concentration	Number of vehicles per kilometer, over one-hour period



Artificial Intelligence Predictions

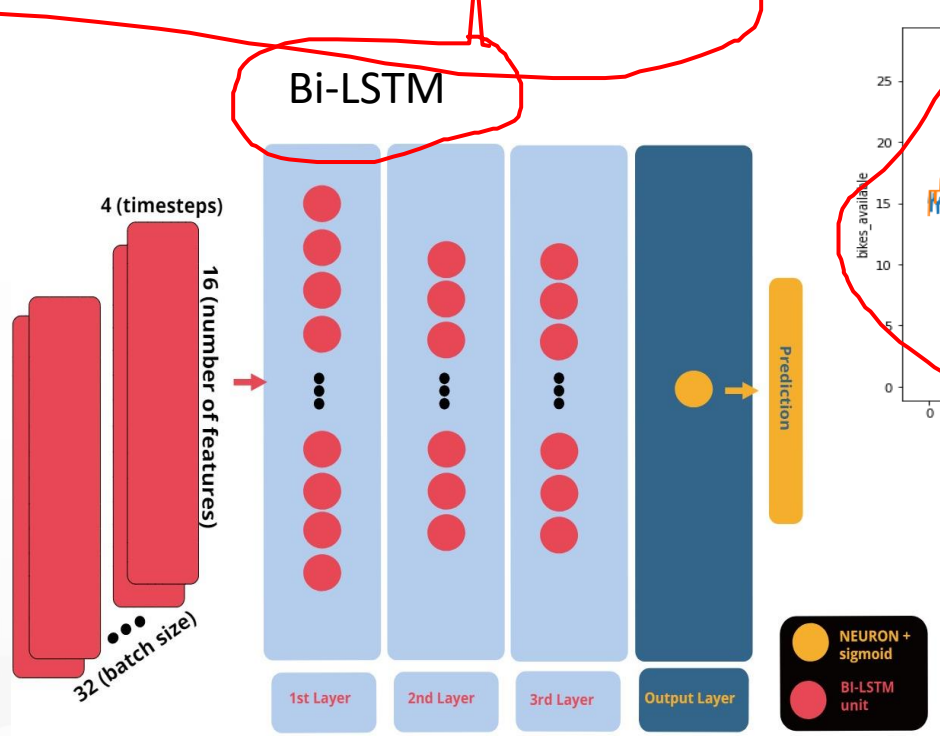
97% of precision

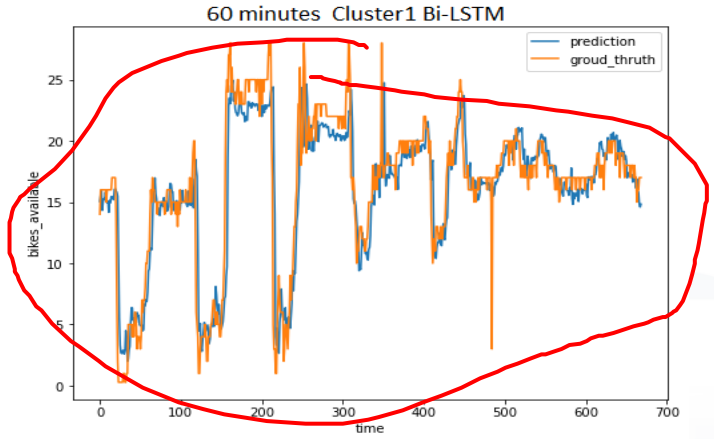


Deep Learning for Short-Term Prediction of Available Bikes on Bike-Sharing Stations







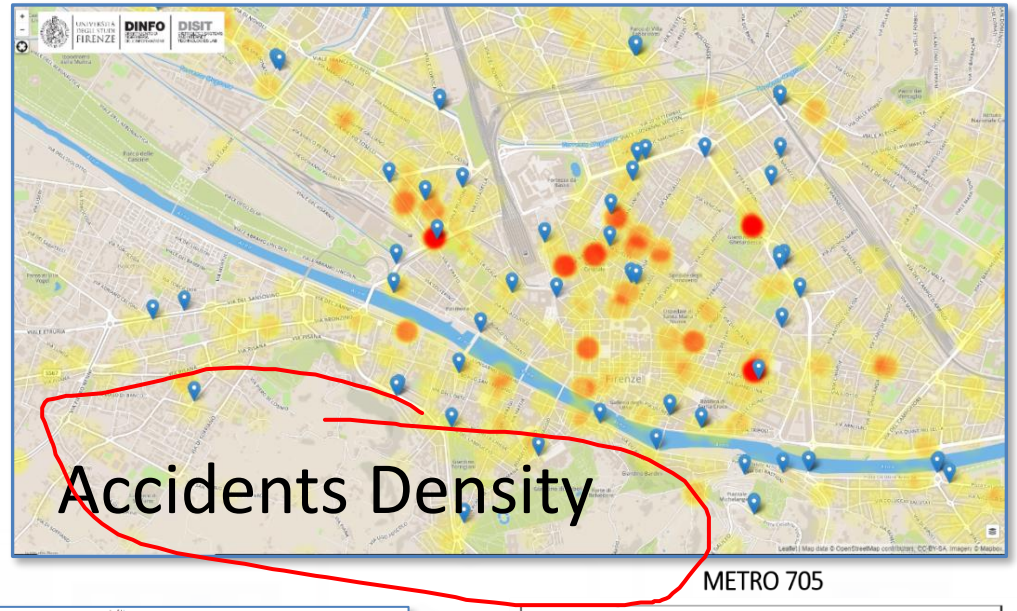


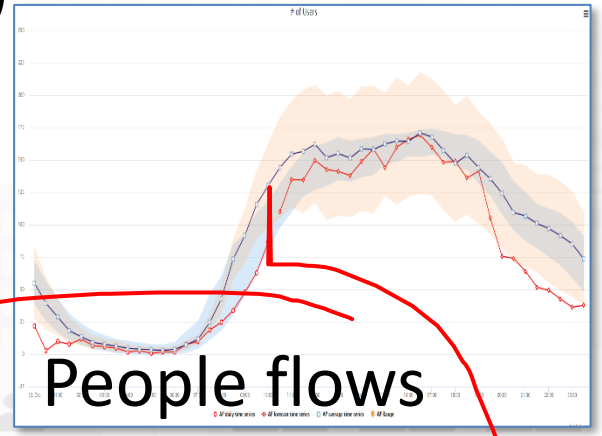


E. Collini, P. Nesi and G. Pantaleo, "Deep Learning for Short-Term Prediction of Available Bikes on Bike-Sharing Stations," in *IEEE Access*, vol. 9, pp. 124337-124347, 2021, doi: 10.1109/ACCESS.2021.3110794.
https://ieeexplore.ieee.org/abstract/document/9530580

Anomaly Detections

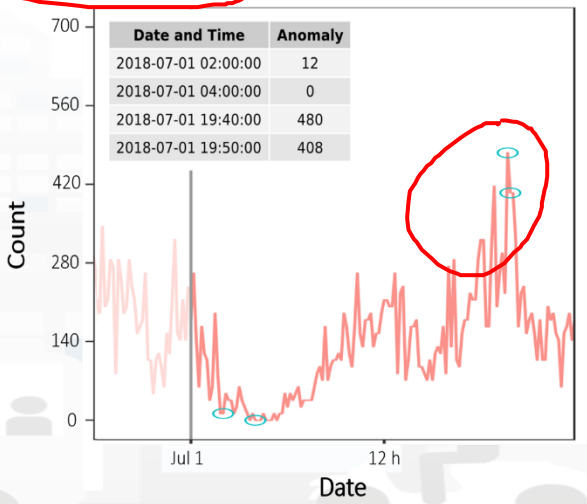
- About the IoT Devices status
  - Eventual problems on IoT Devices, connections, etc.
- About People Flows and Density
  - Early warning of the ineption of critical events
- About traffic flow
  - Early warning on eventual incidents, or on the inception of critical conditions on the traffic (e.g., a reduction in viability, a broken bus, ..)
- About….
  - Early warning, early detection of problems,
- Recurrence analysis
- Causal Analysis





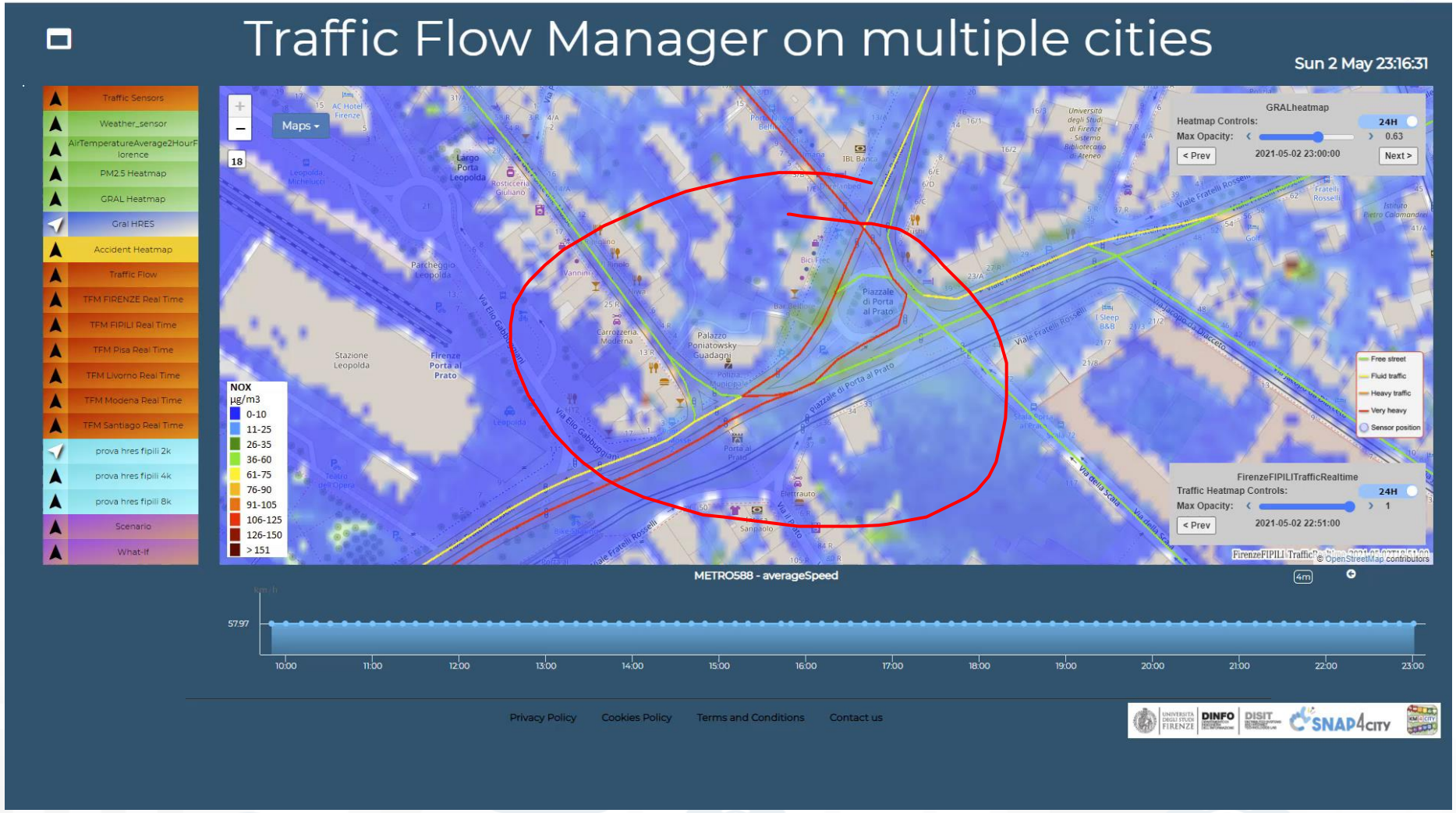
METRO 705

Date and Time	Anomaly
2018-07-01 02:00:00	12
2018-07-01 04:00:00	0
2018-07-01 19:40:00	480
2018-07-01 19:50:00	408

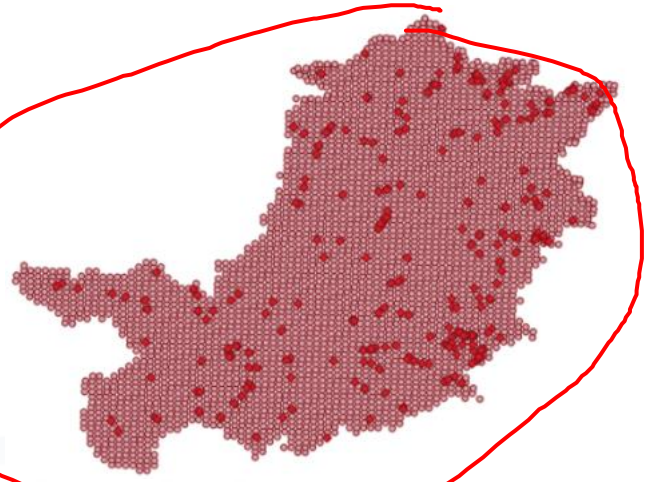


Environment

- **Prediction**
  - **NOX Pollutant** diffusion on the basis of Traffic Flow (prediction), weather and 3D structure
  - **NO2 progressive average** (Long term)
- **Project:**
  - **Trafair** CEF EC
  - Mixed solutions of Fluidinamics modeling and AI



Predicting Land slides



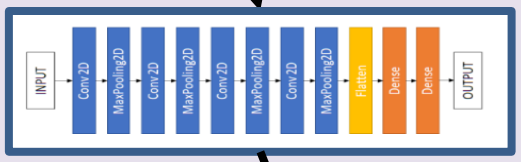
Dataset Construction

Dataset Construction

Previsional Model

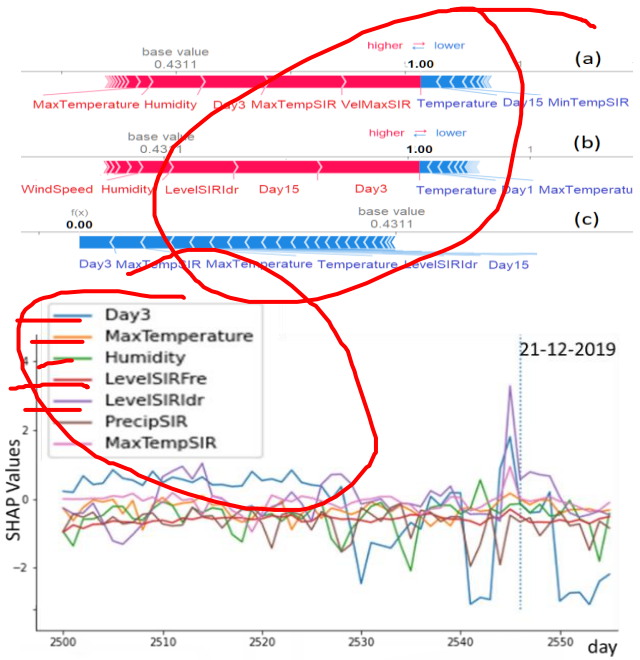
Model training And validation

Model



Data

SNAP4City Advanced APIs



landslide DB

Real Time data from Field: rain, weather, etc.

Processes

Ingestion

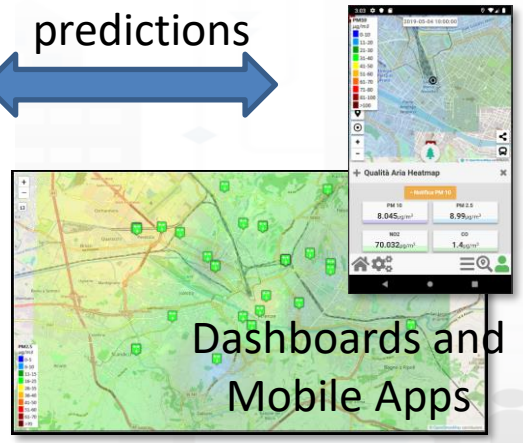
Big Data Storage and KB

Predictions

Model execution Shap Assessment

Data Analytics IOT App Management

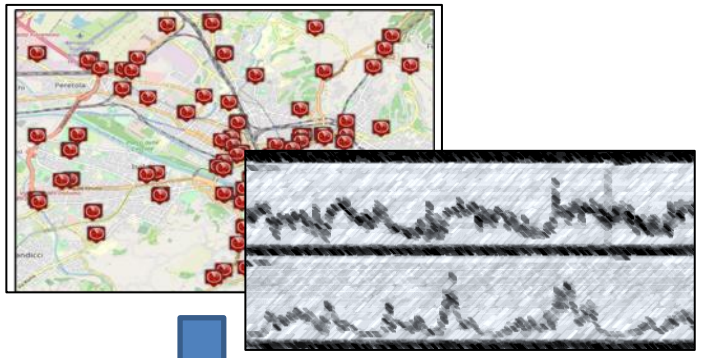
predictions



Snap4City Servers and Tools: Dashboard manager, Heatmap manager, GeoServer, Smart City API.

E. Collini, L. A. I. Palesi, P. Nesi, G. Pantaleo, N. Nocentini and A. Rosi, "Predicting and Understanding Landslide Events with Explainable AI," in *IEEE Access*, doi: 10.1109/ACCESS.2022.3158328.
https://ieeexplore.ieee.org/abstract/document/9732490

Estimating City Local CO2 from Traffic Flow Data



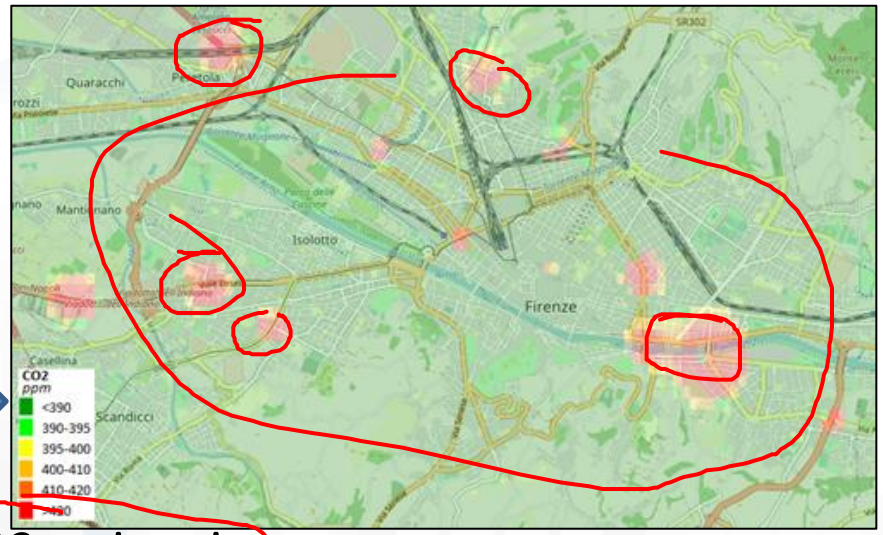
Computing Traffic Flow into CO2 sensor area



Traffic Flow data

- Traffic Flow is one the main source of CO2
- **Dense estimation of CO2 into the city** is very useful to know to target EC's KPIs

Computing CO2 on the basis of traffic flow data

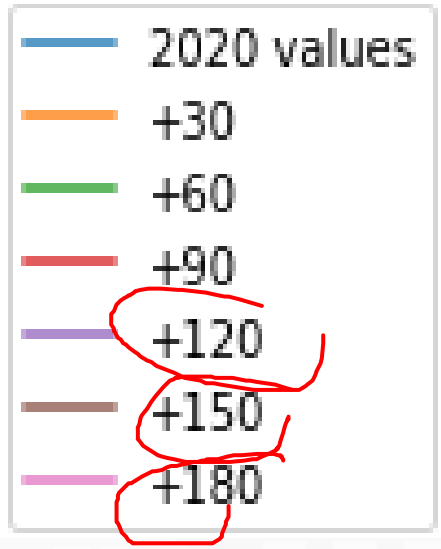


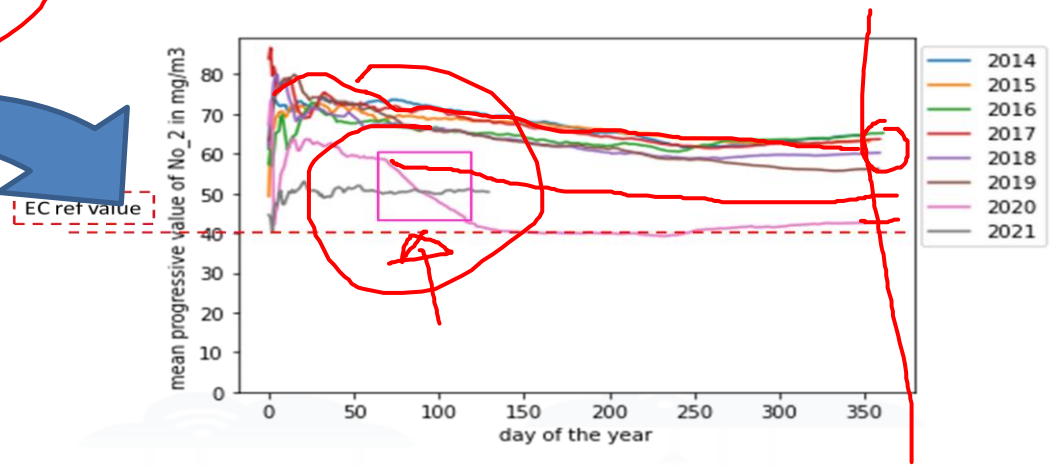
CO2 estimation

S. Bilotta, P. Nesi, "Estimating CO2 Emissions from IoT Traffic Flow Sensors and Reconstruction", Sensors, MDPI, 2022. https://www.mdpi.com/1424-8220/22/9/3382/

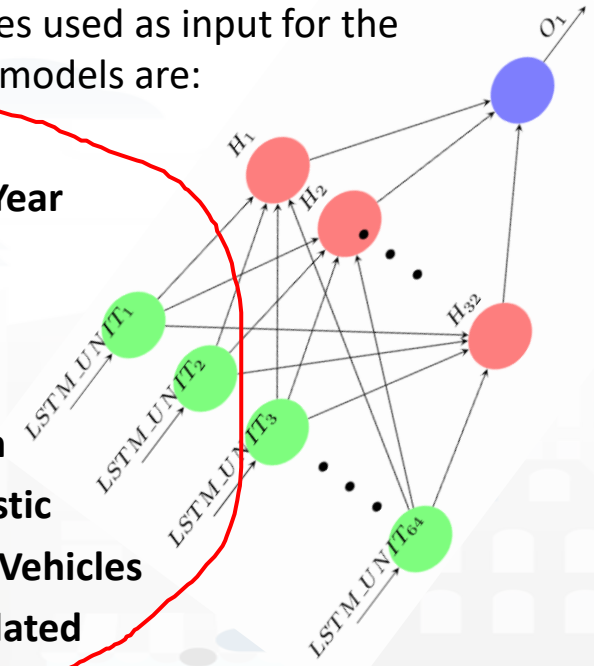
Predicting EC's KPI on NO2 months in advance

Deep Learning Long Terms Predictions of NO2 mean values, From 30 to 180 days in advance



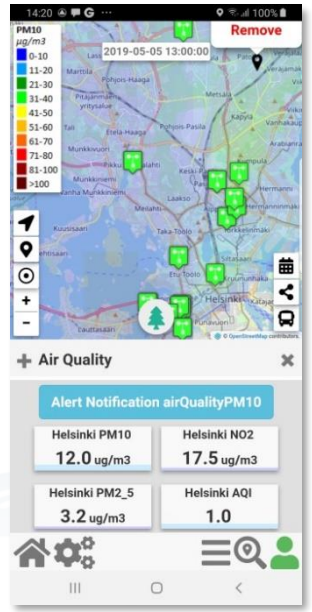


- The features used as input for the predictive models are:
  - **Month**
  - **dayOfTheYear**
  - **NO2**
  - **Tmean**
  - **Humidity**
  - **windMean**
  - **NoxDomestic**
  - **numberOfVehicles**
  - **NO2cumulated**
  - **NO2progresseveMean**
  - **numberOfVehiclesCumulated**



	Air Quality Directive			WHO guidelines	
Pollutant	Averaging period	Objective and legal nature and concentration	Comments	Concentration	Comments
$PM_{2.5}$	One day			25 µg/m³ (*)	99th percentile (3 days/year)
$PM_{2.5}$	Calendar year	Target value, 25 µg/m³	The target value has become a limit value since 1 January 2015	10 µg/m³	
PM_{10}	One day	Limit value, 50 µg/m³	Not to be exceeded on more than 35 days per year.	50 µg/m³ (*)	99th percentile (3 days/year)
PM_{10}	Calendar year	Limit value, 40 µg/m³ (*)		20 µg/m³	
O_3	Maximum daily 8-hour mean	Target value, 120 µg/m³	Not to be exceeded on more than 25 days per year, averaged over three years	100 µg/m³	
NO_2	One hour	Limit value, 200 µg/m³ (*)	Not to be exceeded more than 18 times a calendar year	200 µg/m³ (*)	
NO_2	Calendar year	Limit value, 40 µg/m³		40 µg/m³	

Environmental Heatmaps

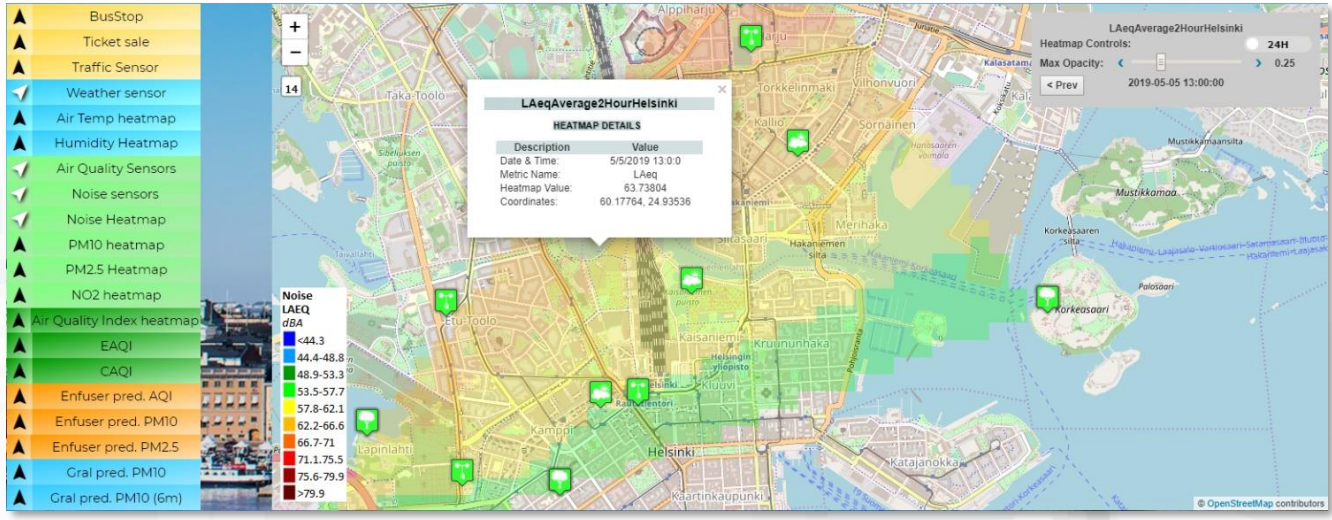


Why ?

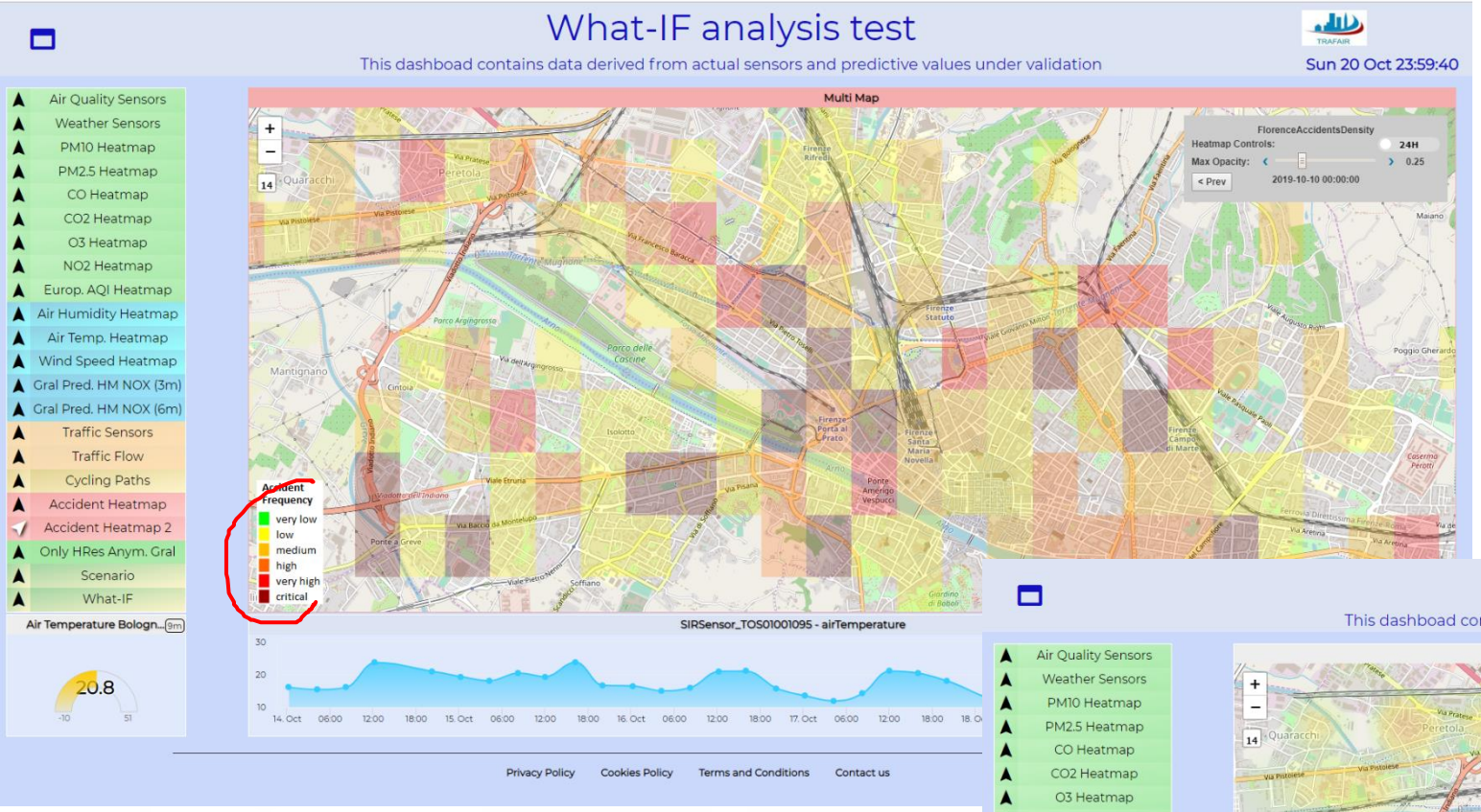
- Knowing the Pollutant level an its prediction may increase quality of life
- Making decision about the time slot to walk, run and bring baby at the park
- Be timely informed about the inception of eventual critical conditions
- Deciding where to get an apartment
- …

Calibrated heatmaps based on Interpolated data:

- **Real time** measures (PM_{10}, $PM_{2,5}$, NO_2, SO_2, Noise, NO, O_3, AQI,..)
- **Predictive** measures (ENFUSER, GRAL)
- From **200x200** to **4x4** m
- Hourly concentration
- Any programmed Color map
- Animations over H24
- Picking values in any place
- On Web and Mobile App



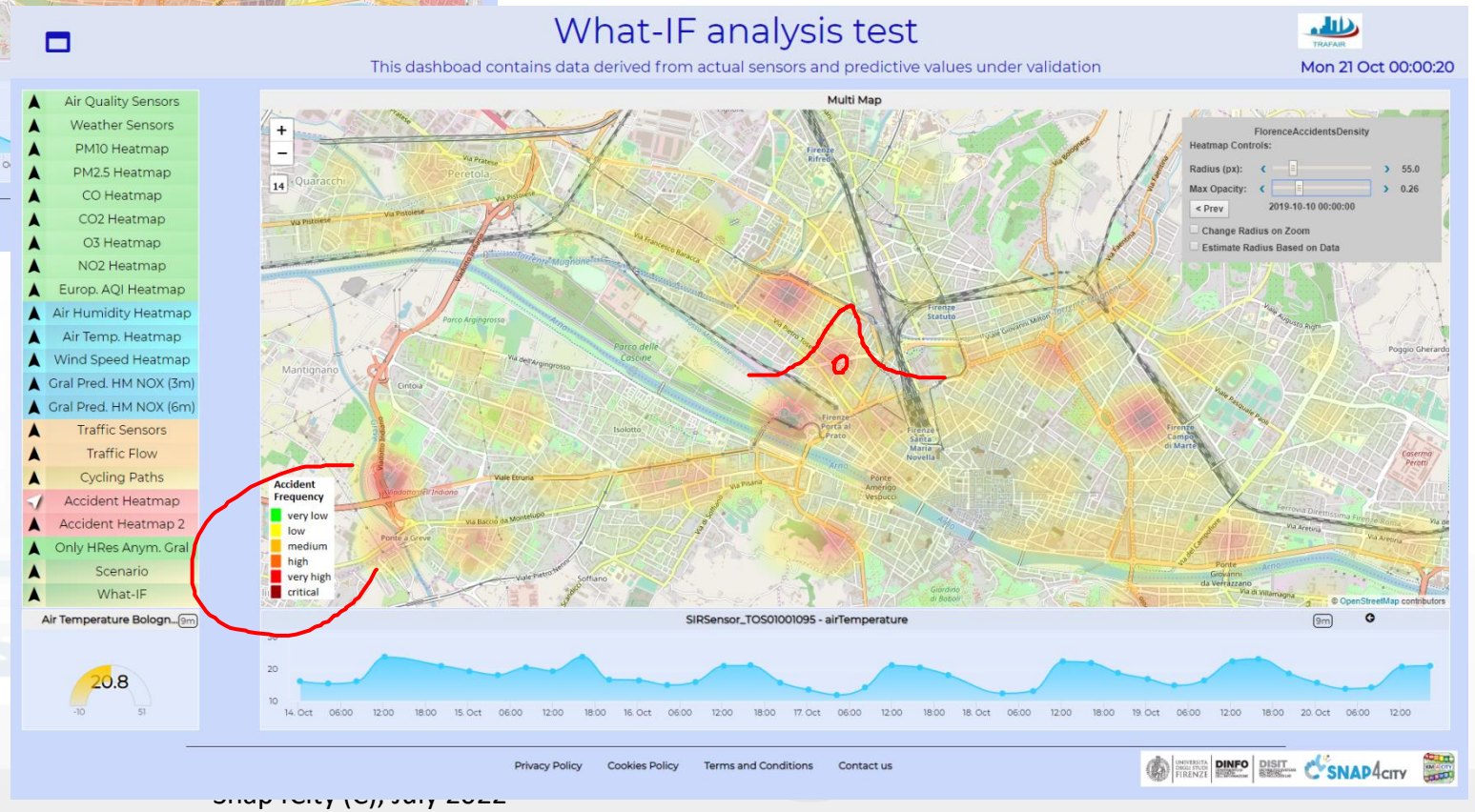
https://www.snap4city.org/snap4cityWebAppHelsinki/



Florence

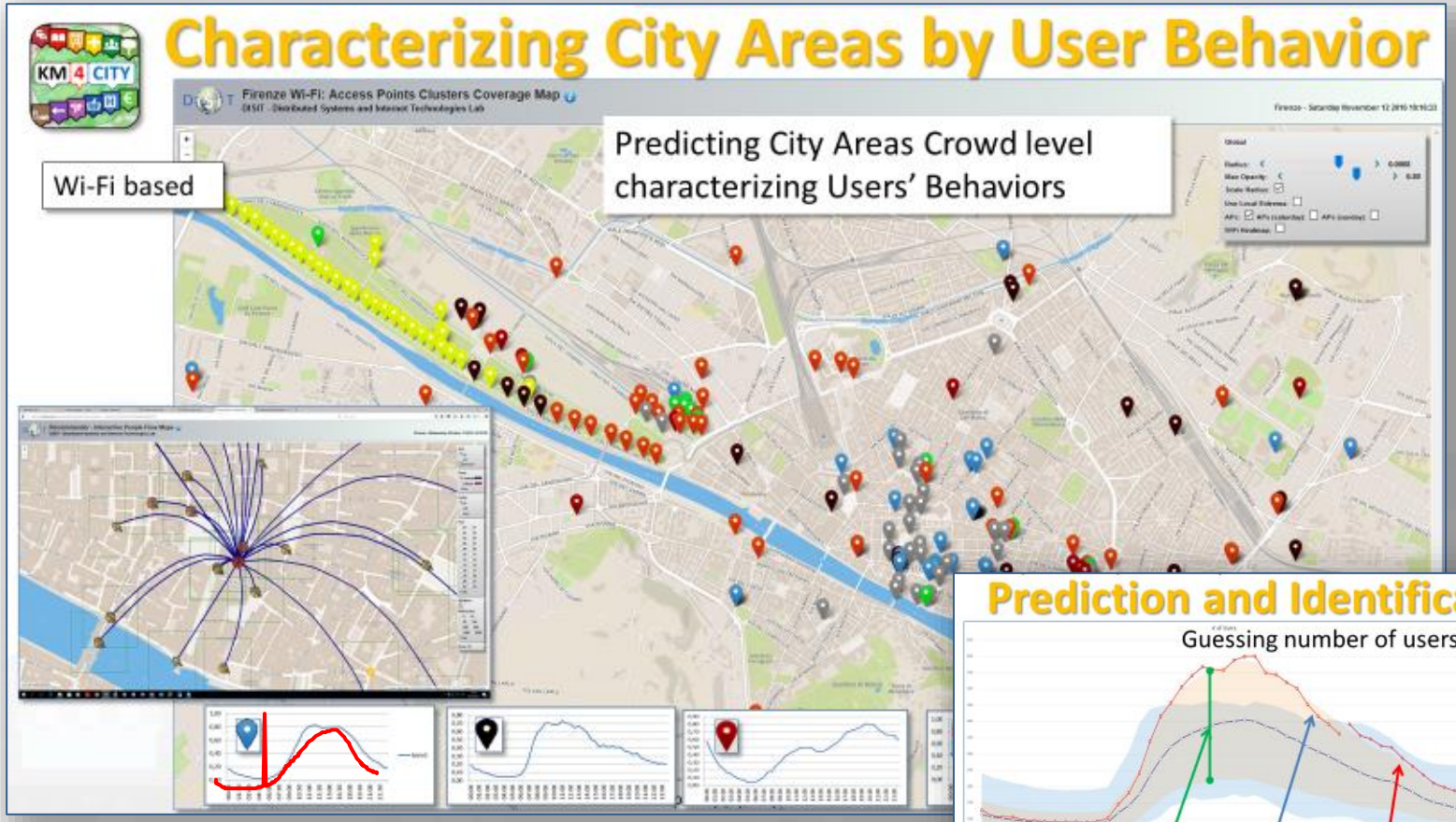
Accidents Density

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjE4Nw==

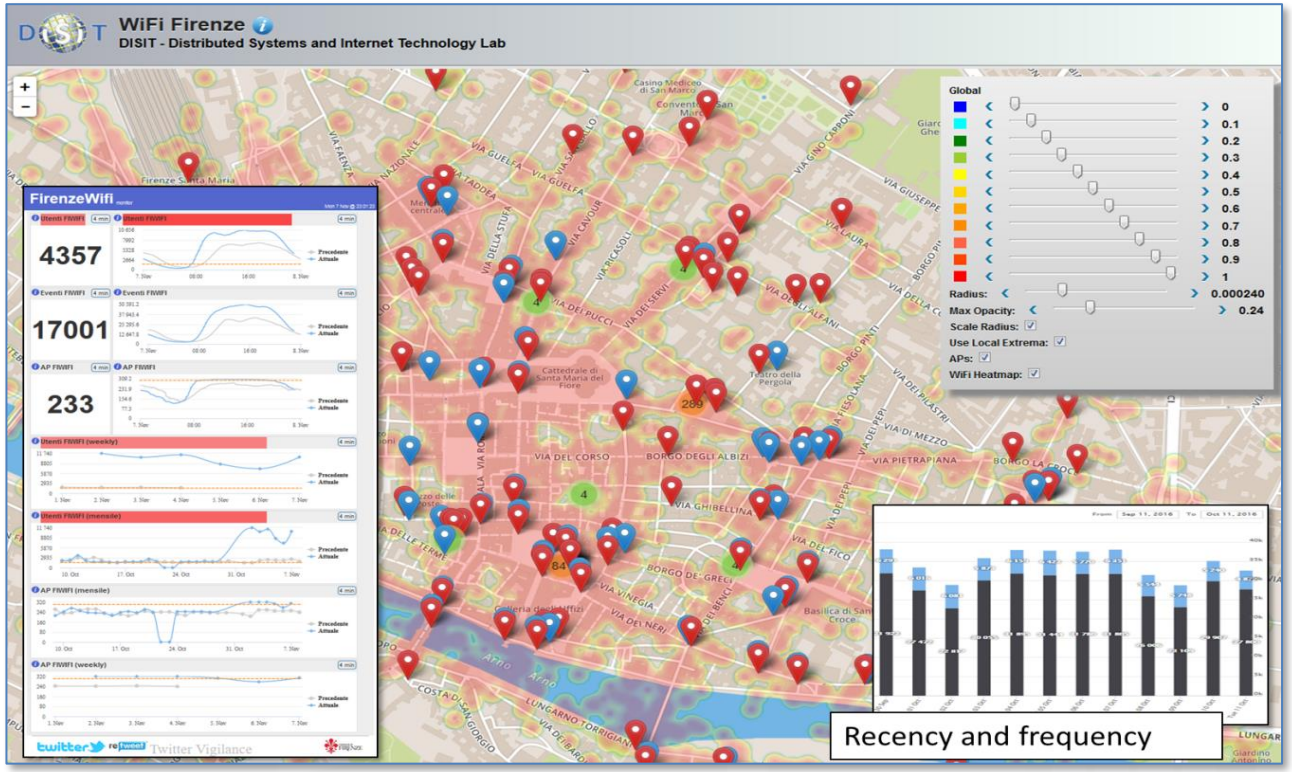


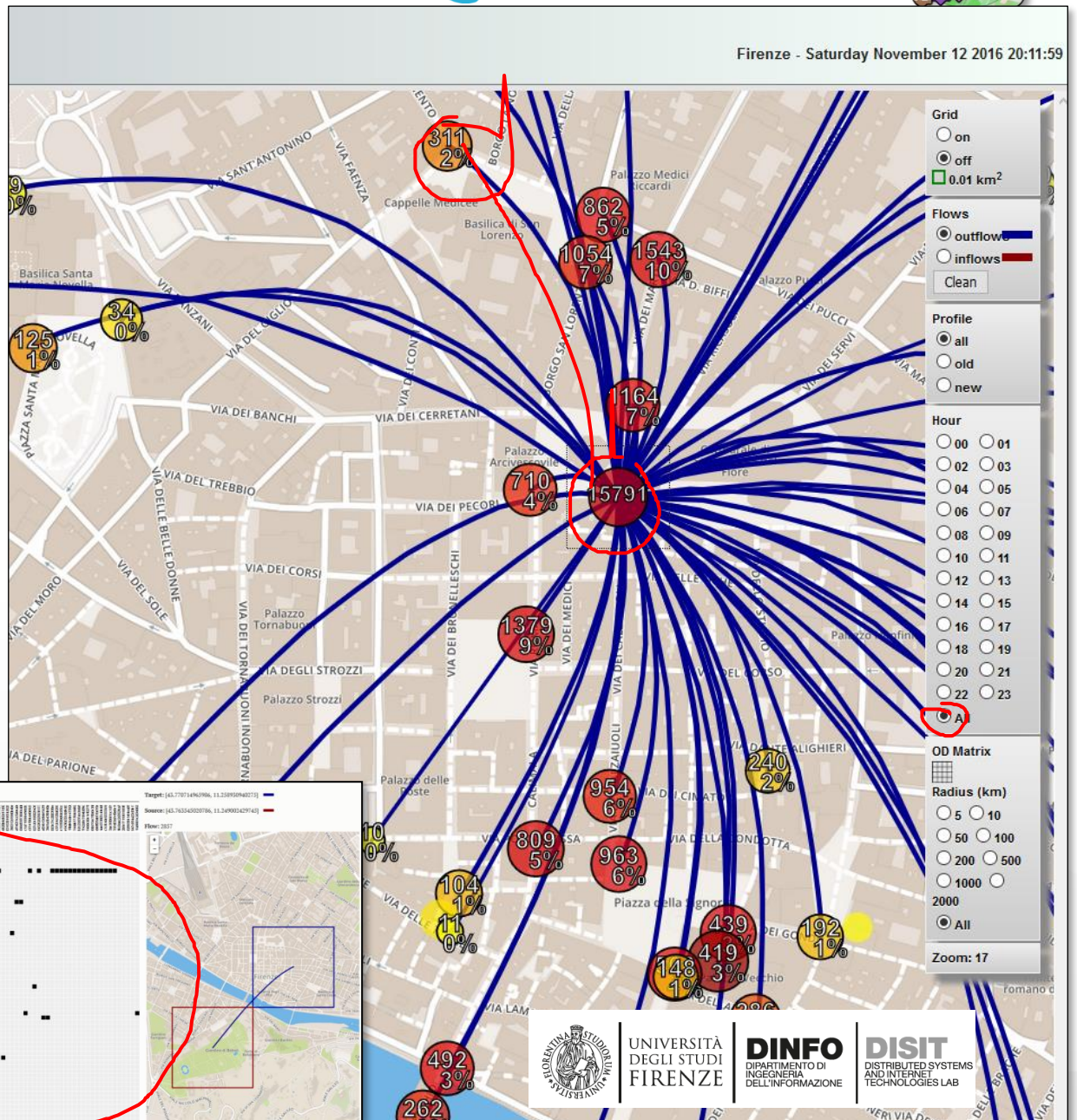
People Flows

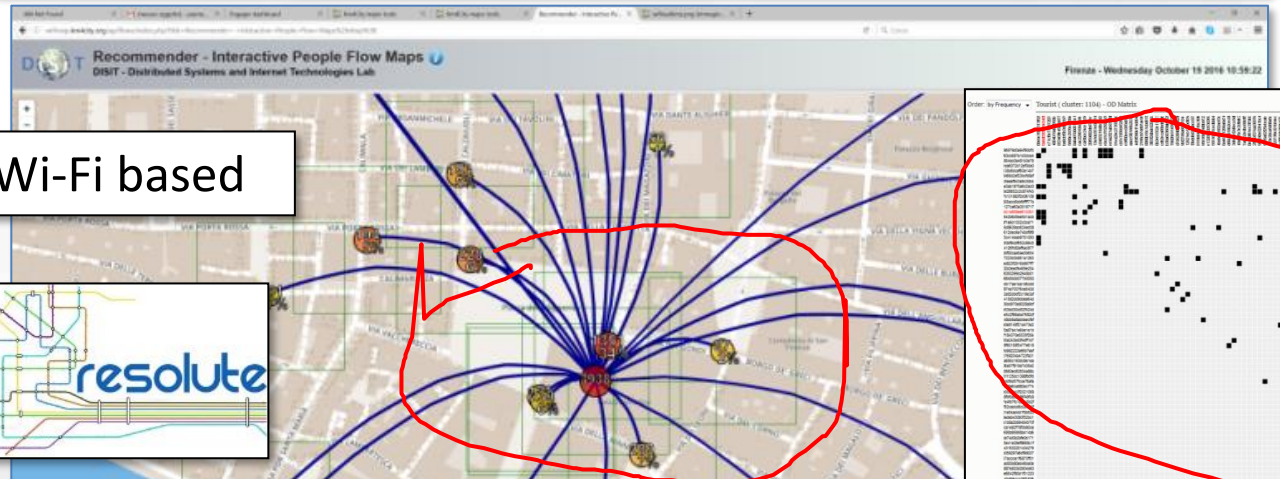
- **Prediction of people flows** on the basis of Wi-Fi data
- **Anomaly** detection
- **Resolute** H2020
- Classification of city areas



Origin Destination Matrix Estimation



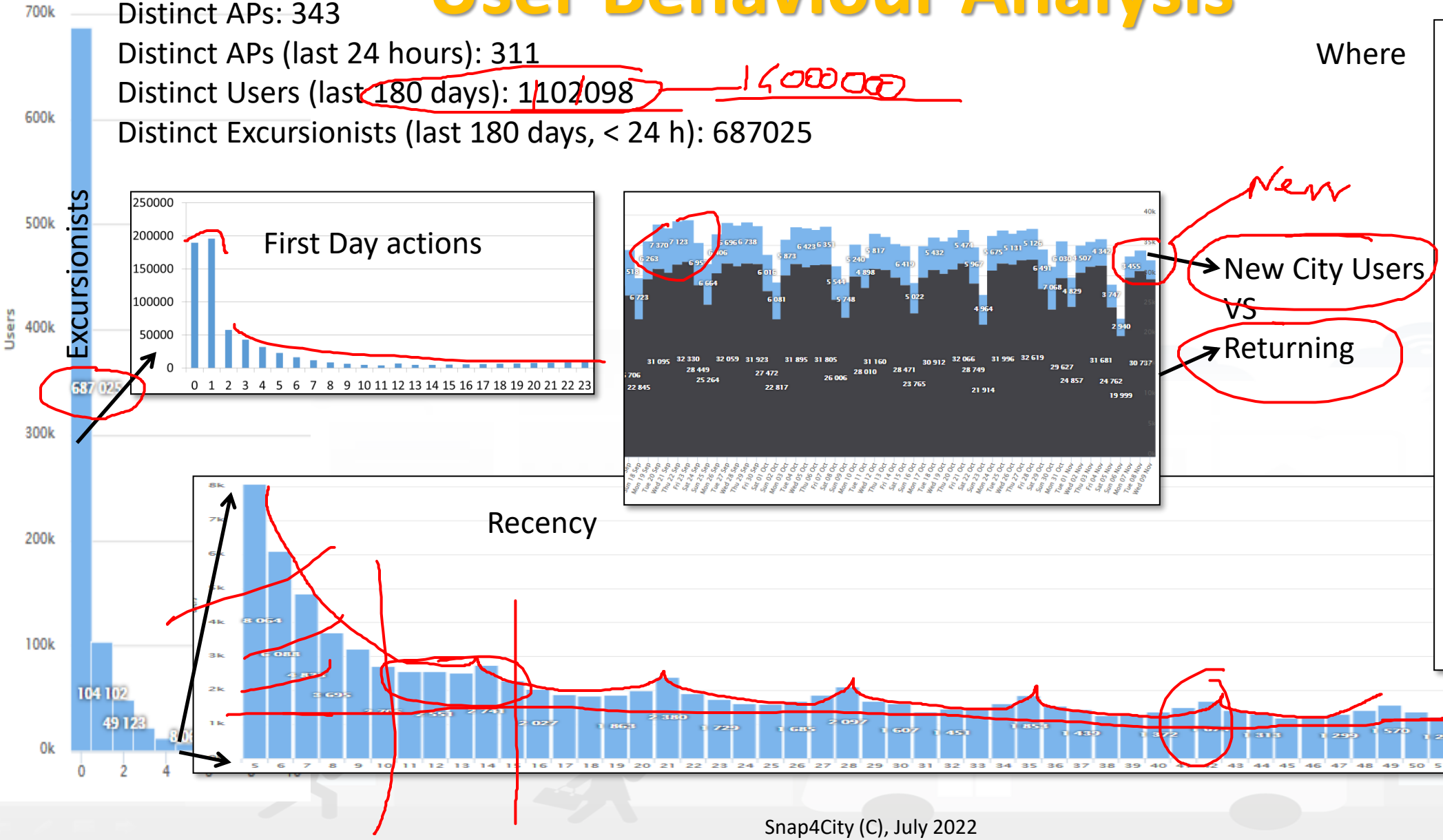




Wi-Fi based

User Behaviour Analysis

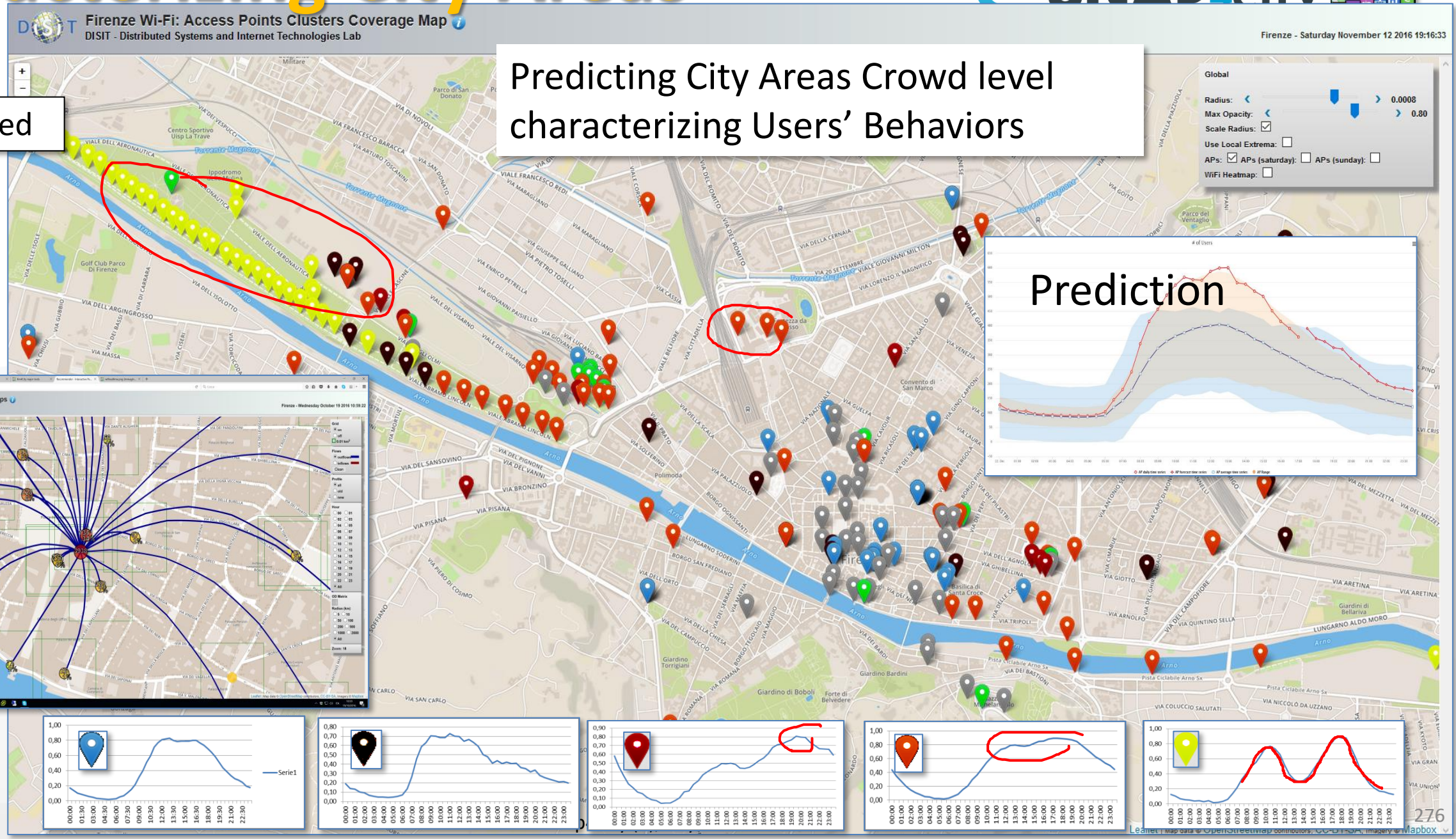
Distinct APs: 343
Distinct APs (last 24 hours): 311
Distinct Users (last 180 days): 1102098
Distinct Excursionists (last 180 days, < 24 h): 687025



Characterizing City Areas

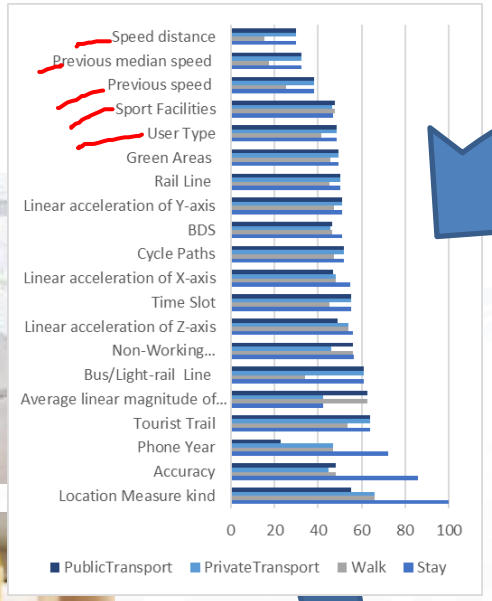
Wi-Fi based

Predicting City Areas Crowd level characterizing Users' Behaviors



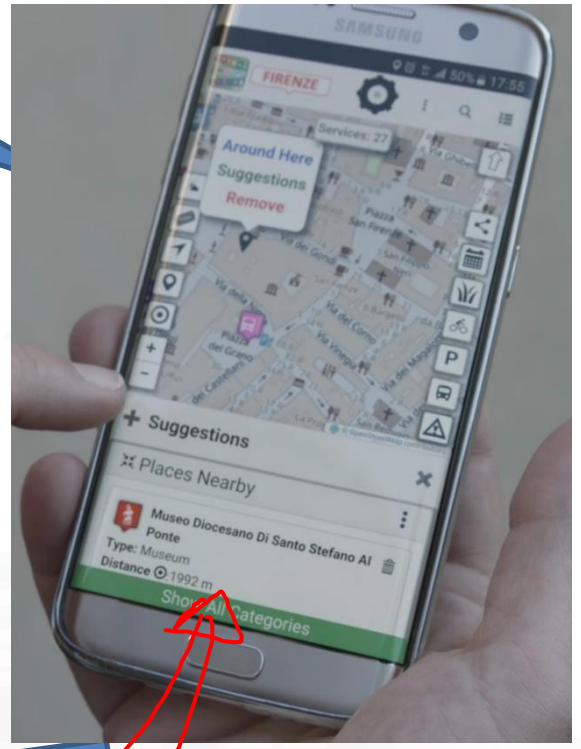
To propose suggestions and Engage city user
I need to know how they are moving





Artificial Intelligence
Classification

Suggestions



DORAM

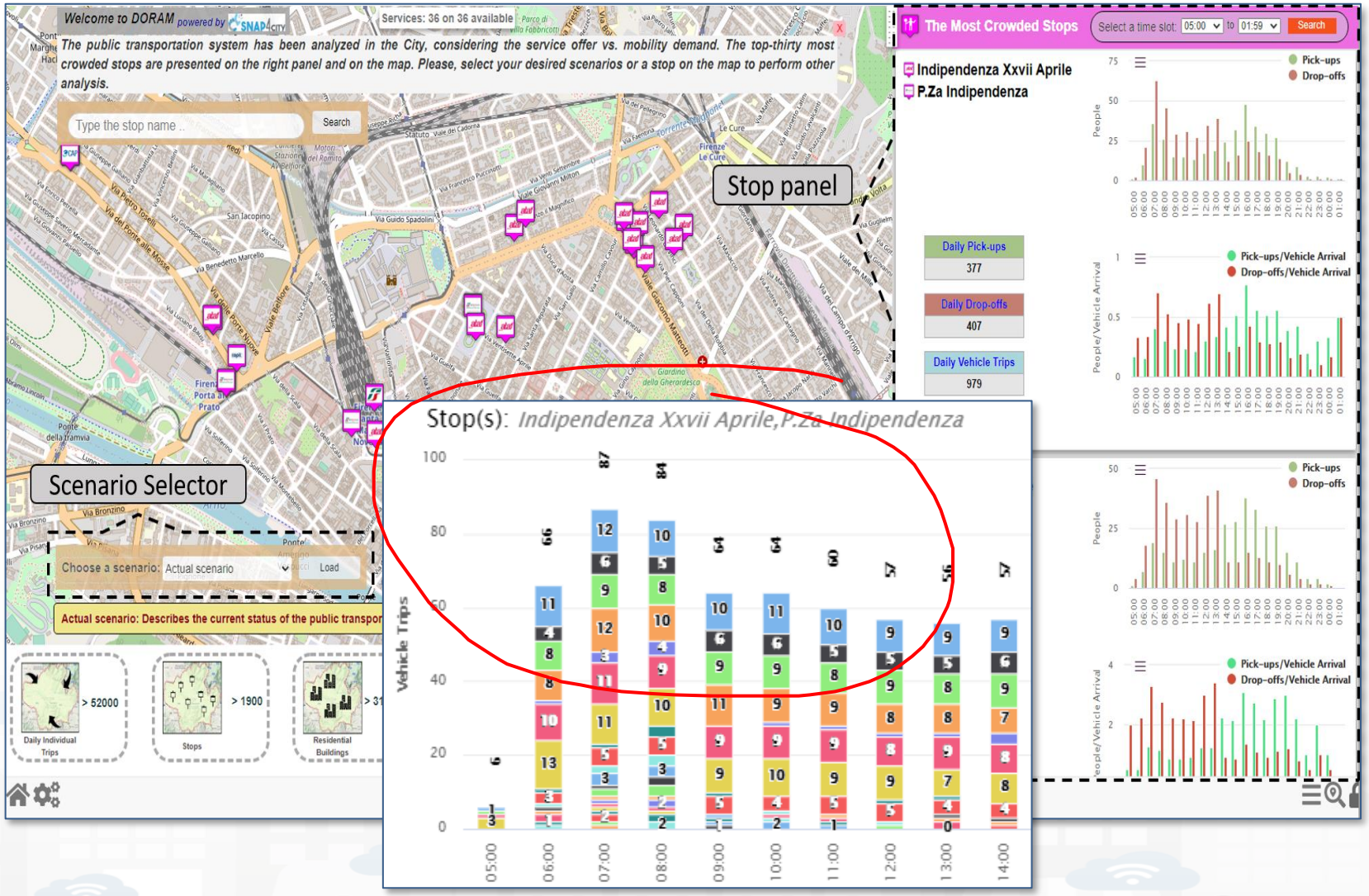
Analysis of

- **Demand** of Mobility
  - Via OD matrices
  - POI, city structure, etc.

With respect to

- **Offert** of Transportation:
  - Public services
  - Private services
  - Multiple agencies
  - GTFS

Critical Busses, busstops, paths, rides, etc.

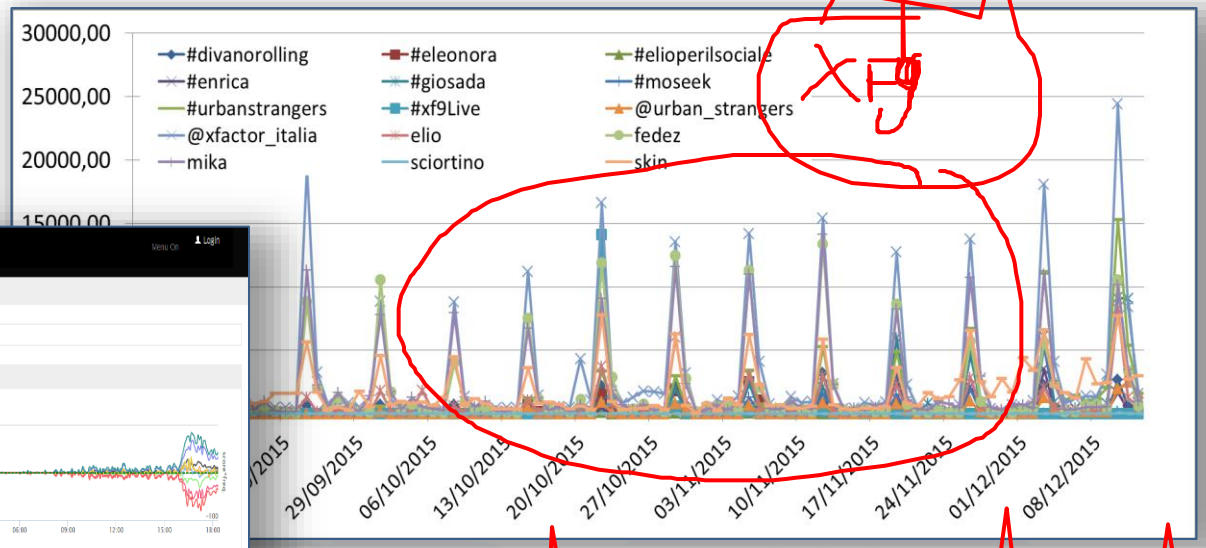


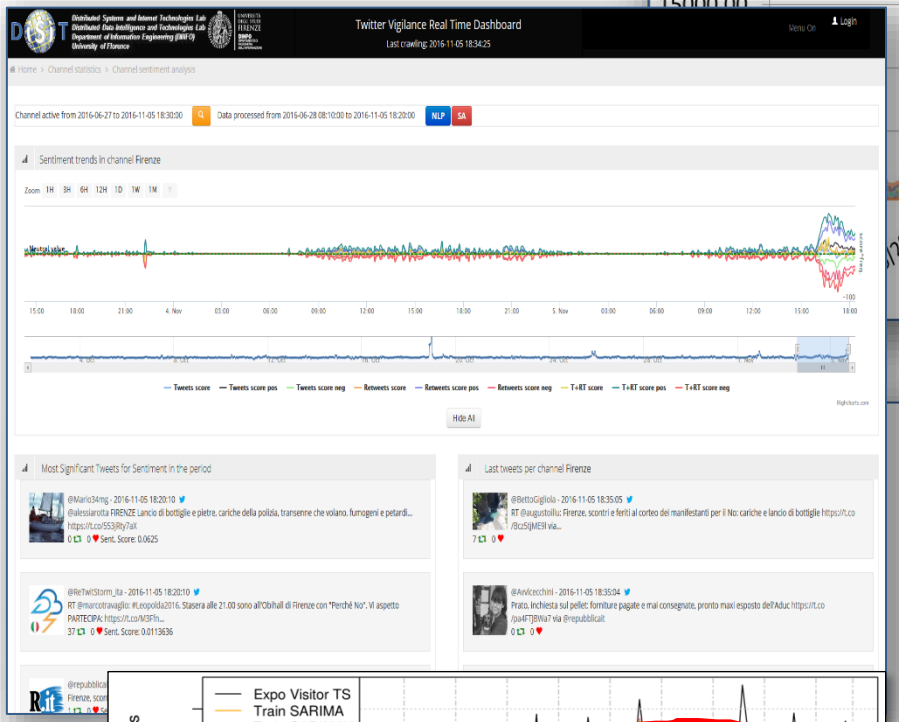
https://www.snap4city.org/odanalyzer/#b

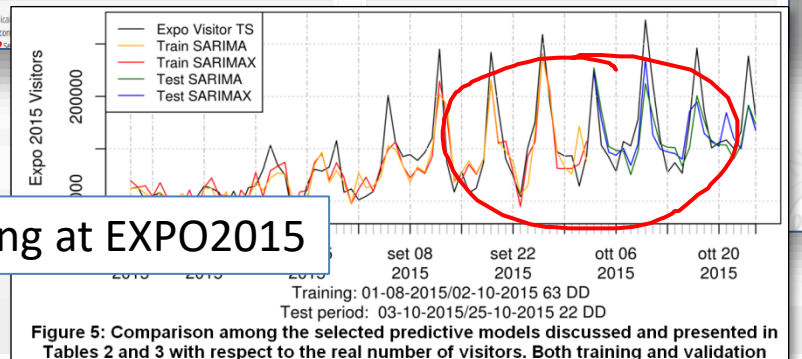
Social Media

Twitter Vigilance

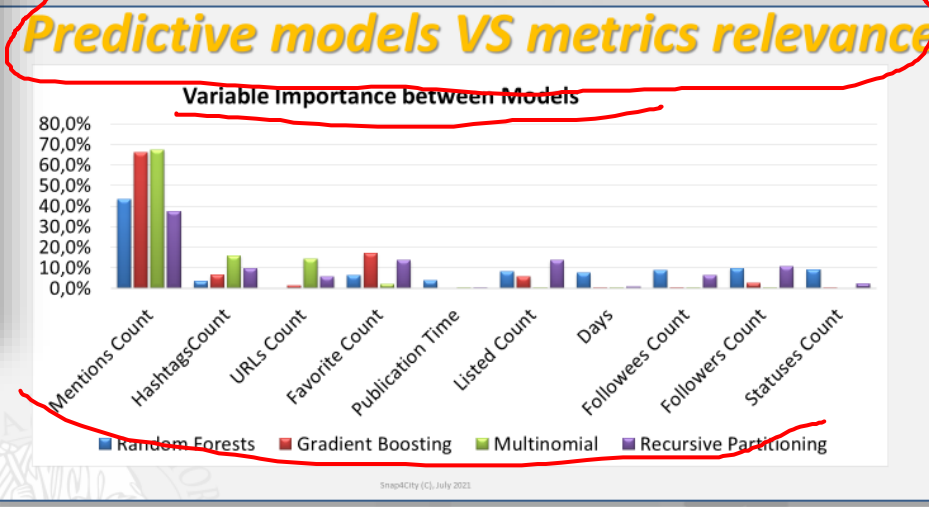
- **Prediction** of Audience on TV programme
- **Prediction** of retweet proneness: RF, GBM, ..
- **Project**
  - TwitterVigilance
  - +NLP, SA





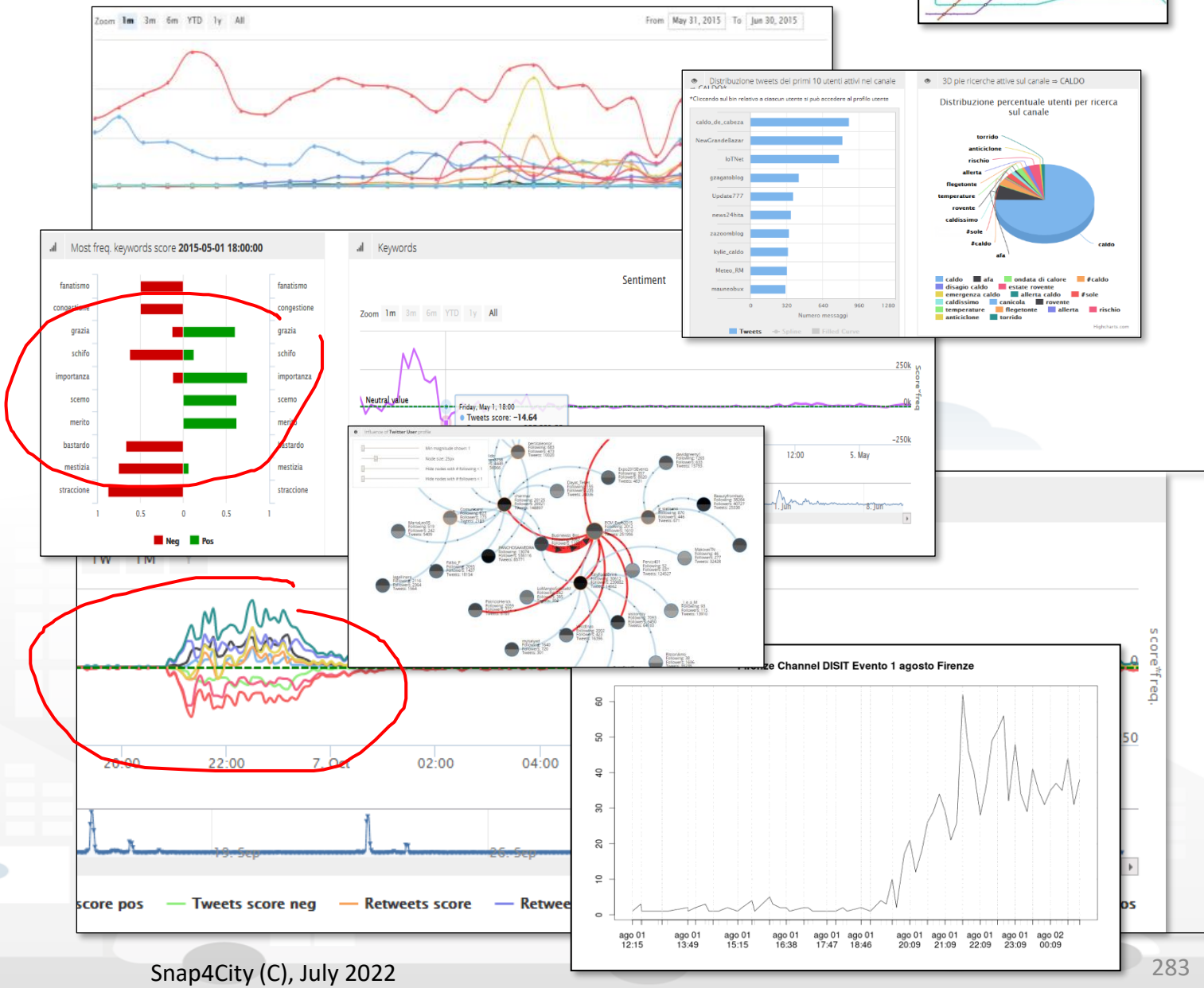


Predicting at EXPO2015



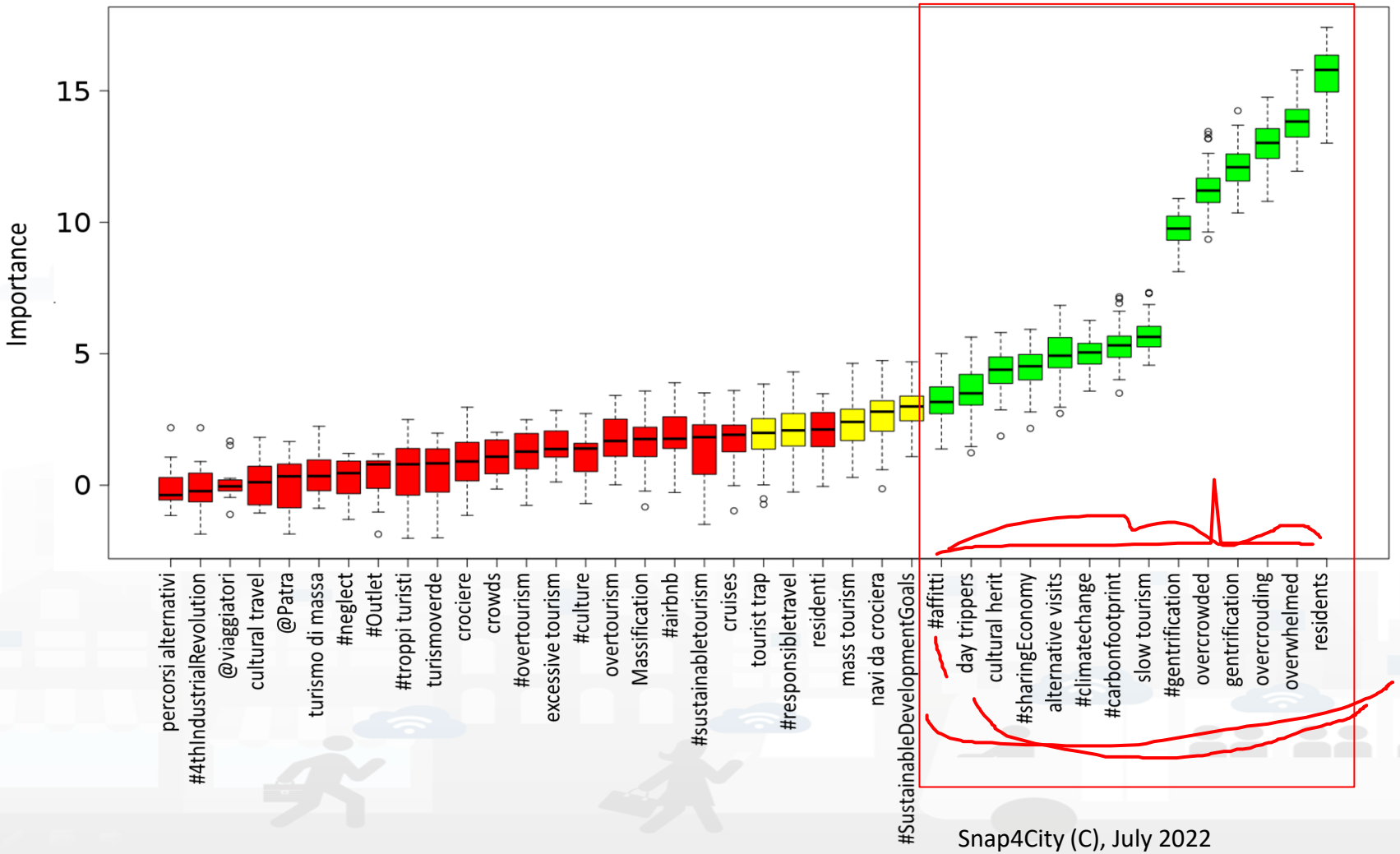
Twitter Vigilance

- http://www.disit.org/tv
- http://www.disit.org/rttv
- Citizens as sensors to
  - Assess sentiment on services, events, …
  - Response of consumers wrt, …
  - Early detection of critical conditions
  - Information channel
  - Opinion leaders
  - Communities
  - Formation
  - Predicting volume of visitors for tuning the services



Twitter Vigilance

Relevant Feature Selection - Italy



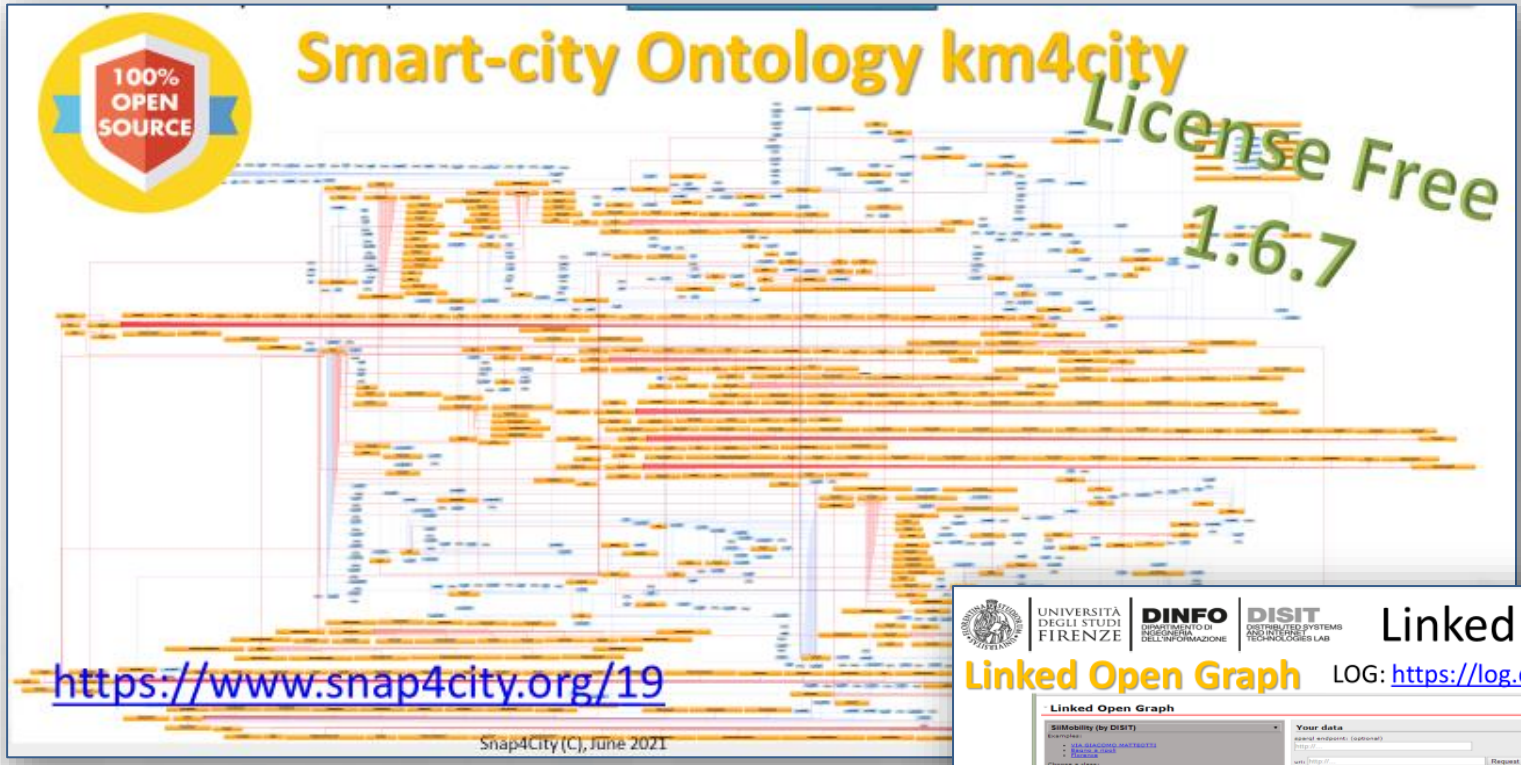
Random Forest Model Results expoiting the *confirmed* keys:

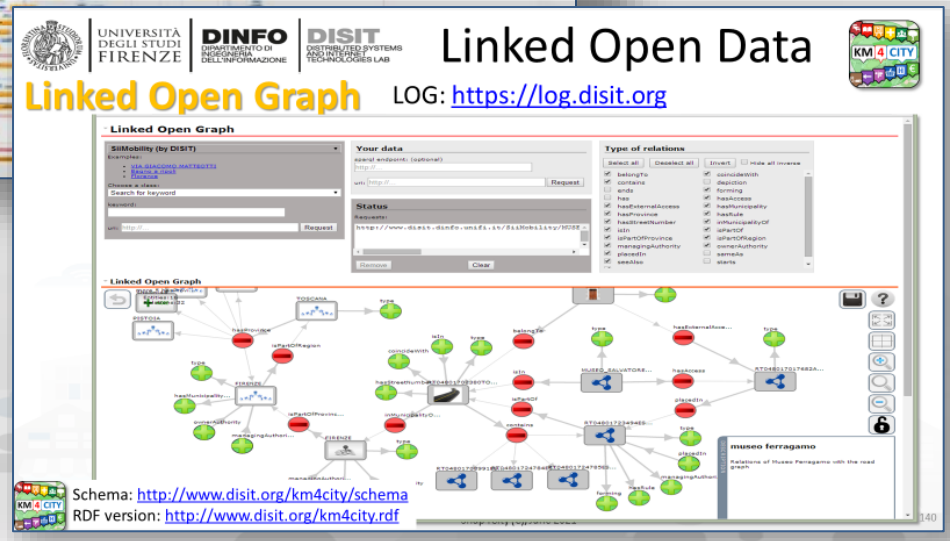
- Accuracy = 0.90
- Kappa index = 0.81

Twitter Vigilance

Knowledge engineering

- Ontologies + Inf. Reasoners
- Expert Systems
- PAVAL Virtual Assistant
- **Projects**
  - Icaro: Cloud Ontology
  - Km4City Ontology and tools
  - Linked Open Graph

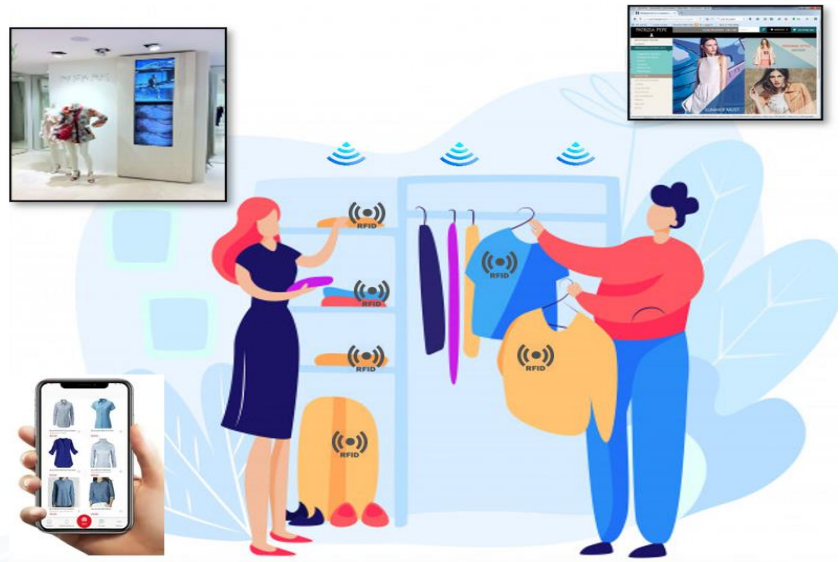




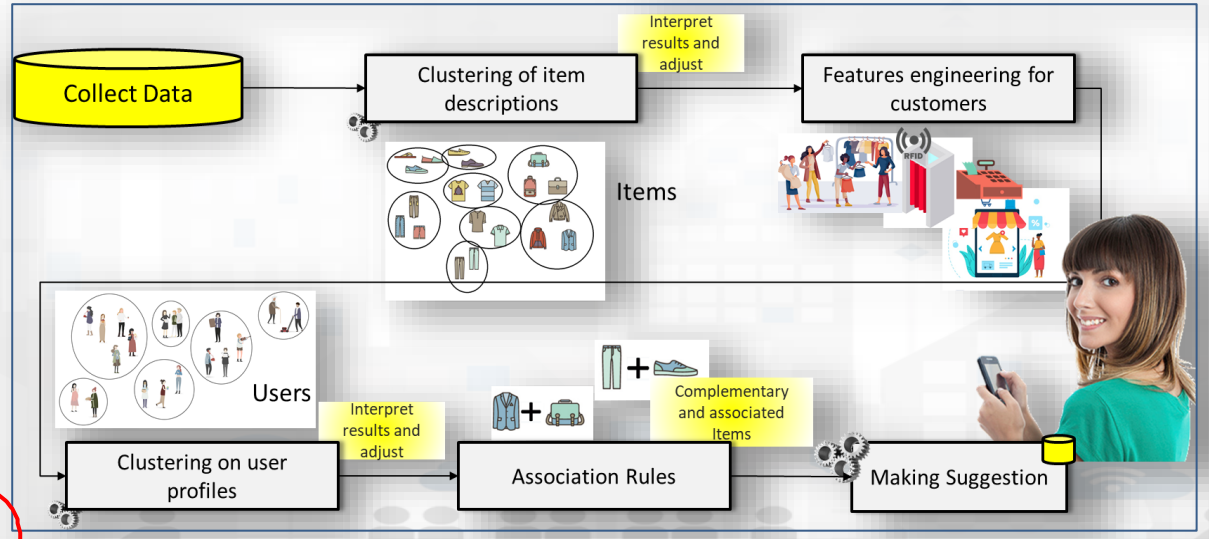
Smart Retail

- **Recommendations**
  - adaptive user engagement, customer experience
  - Advanced user profiling, user behaviour analysis
  - IOT and instrumentation
  - Predictive models for engagement
  - Integrated in city customer experience

Techniques
- Multiple clustering
- Prediction models



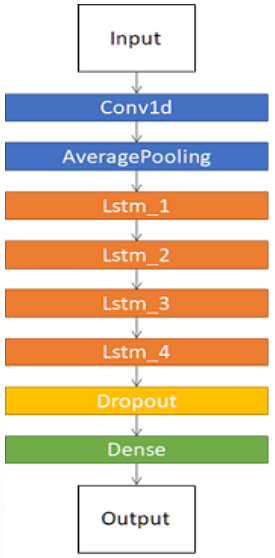
- **Feedback:**
  - Flexible Advanced Engagement Exploiting User Profiles and Product/Production Knowledge
  - Keywords: retail, GDO, …



feedback

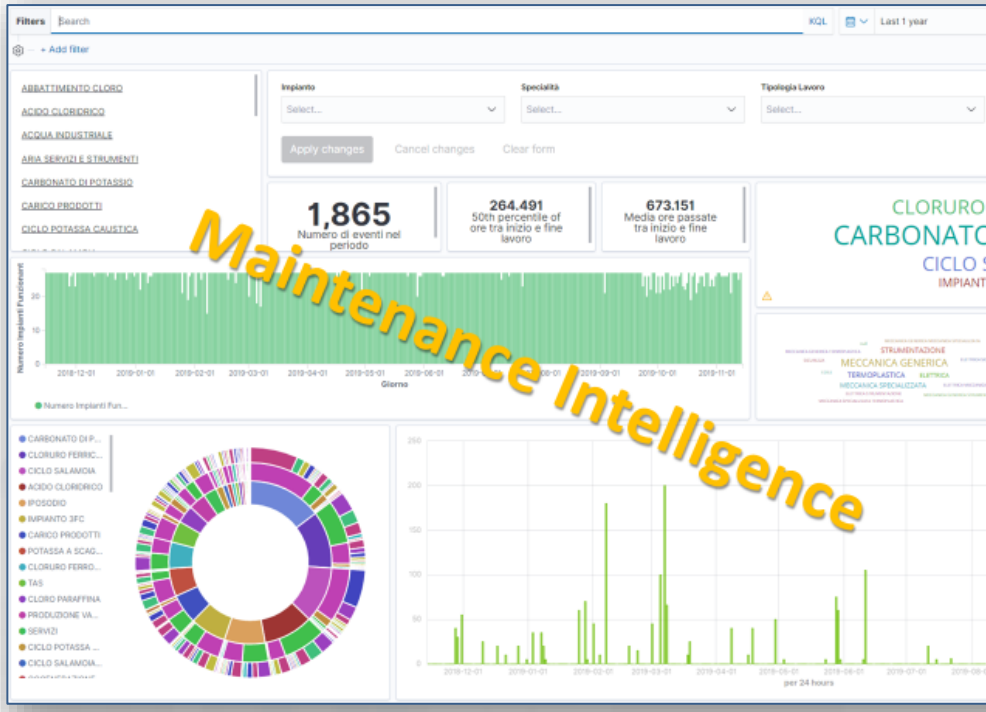
Predictive Maintenance

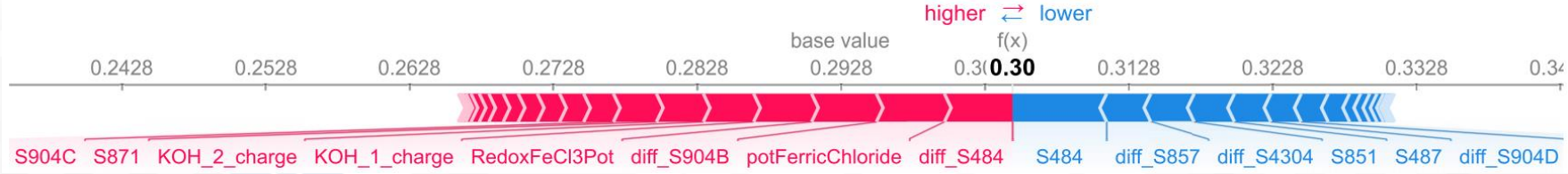
- **Predictive** Maintenance
  - LSTM
  - CNN-LSTM
- **Maintenance** Intelligence
- Explainable AI: SHAP, …



Layer (type)	Output Shape	Param #
conv1d (Conv1D)	(None, 20, 64)	8320
average_pooling1d (AveragePo	(None, 10, 64)	0
lstm (LSTM)	(None, 10, 200)	212000
lstm_1 (LSTM)	(None, 10, 200)	320800
lstm_2 (LSTM)	(None, 10, 200)	320800
lstm_3 (LSTM)	(None, 10, 200)	320800
lstm_4 (LSTM)	(None, 100)	120400
dropout (Dropout)	(None, 100)	0
dense (Dense)	(None, 1)	101

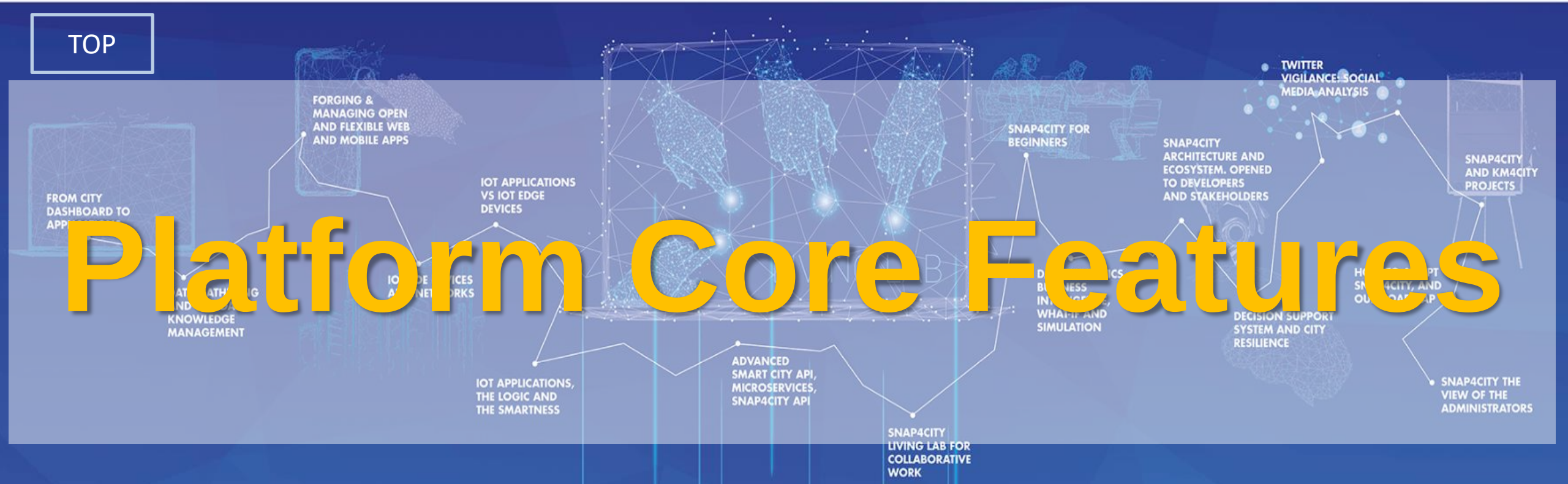
Total params: 1,303,221
Trainable params: 1,303,221
Non-trainable params: 0





TOP

Platform Core Features



100% OPEN SOURCE

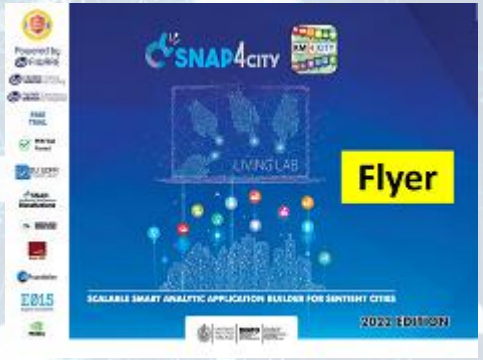
SNAP4 Appliances and Dockers **Installations**

Core Features

- **Fast and no-Coding Development of Applications/Solutions**
  - **Data Ingestion**: IoT Directory, Data Table Loader, POI Loader, data ingestion process, data integration, open data, GIS, satellite, Knowledge map, GeoTIFF; WMS, WFS, etc.
  - **Dashboard Production**
    - Data discovery/federation
  - **IoT App Development (Node-RED)**: integration, connectors, adapters, Data Analytics Management, business logic, etc.
  - **Data Analytics: R Studio, Python, etc.**
  - **Mobile App Development**
- **Platform Administration**
  - Setting, container, VM Appliance, ..
  - User Management, Auditing (user data, accesses, GDPR, etc.)
  - Assessment, accounting (the basis for billing), monitoring, reporting, etc.
- **Data Modeling and Ingestion:**
  - POI and IoT Device Model fast ingestion, manual ingestion, etc.
  - Knowledge Base data modeling

2022 booklets

- Snap4City



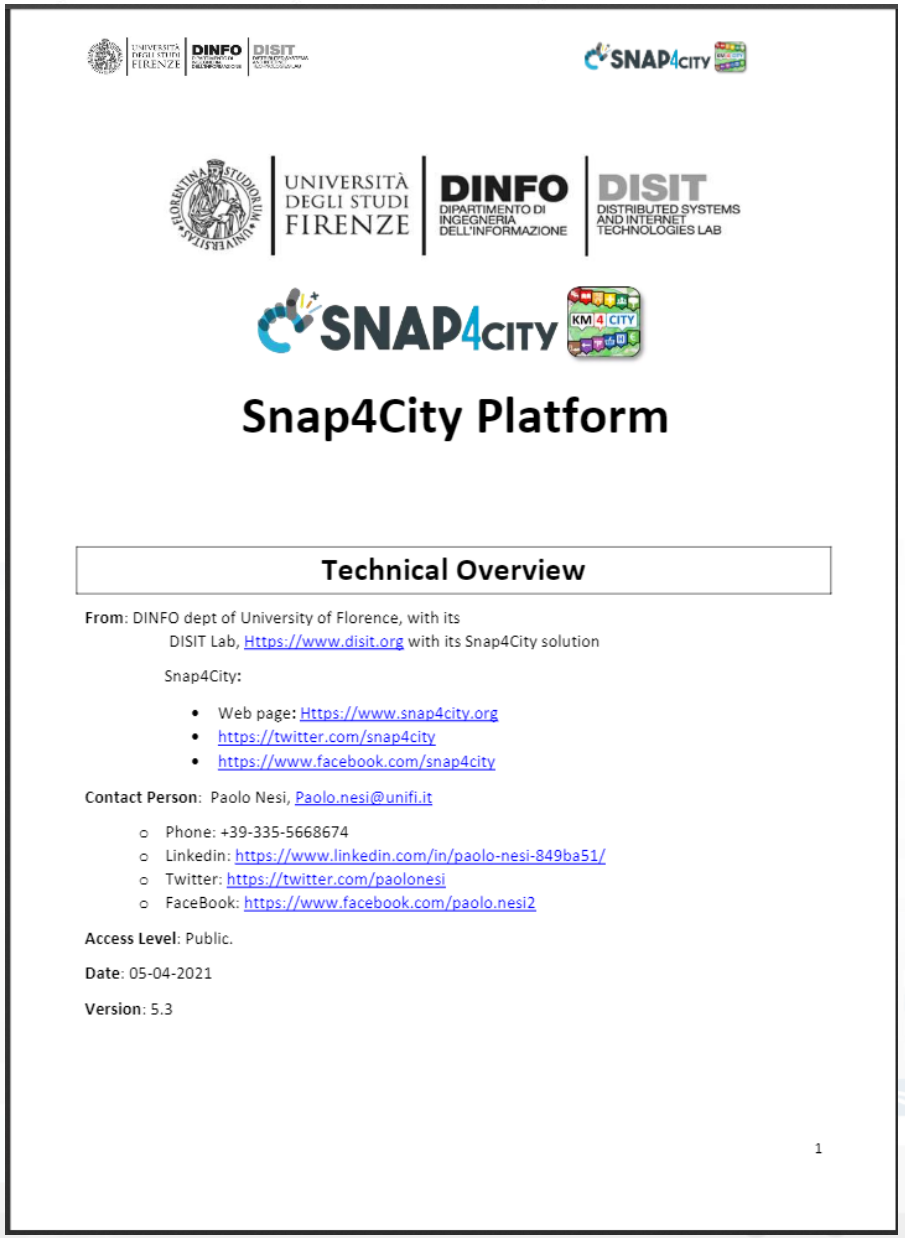
https://www.snap4city.org/download/video/DPL_SNAP4CITY_2022-v02.pdf

- Snap4Industry



https://www.snap4city.org/download/video/DPL_SNAP4INDUSTRY_2022-v03.pdf

Overview



Snap4City Platform

Technical Overview

From: DINFO dept of University of Florence, with its
DISIT Lab, Https://www.disit.org with its Snap4City solution

Snap4City:

- Web page: Https://www.snap4city.org
- https://twitter.com/snap4city
- https://www.facebook.com/snap4city

Contact Person: Paolo Nesi, Paolo.nesi@unifi.it

- Phone: +39-335-5668674
- Linkedin: https://www.linkedin.com/in/paolo-nesi-849ba51/
- Twitter: https://twitter.com/paolonesi
- FaceBook: https://www.facebook.com/paolo.nesi2

Access Level: Public.

Date: 05-04-2021

Version: 5.3

1

- https://www.snap4city.org/drupal/sites/default/files/files/Snap4City-PlatformOverview.pdf

Overview



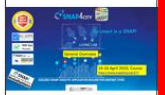
- https://fiware-foundation.medium.com/snap4city-fiware-powered-smart-app-builder-for-sentient-cities-acfe24df49d5
- https://www.snap4city.org/drupal/sites/default/files/files/FF_ImpactStories_Snap4City.pdf

TOP

Development of Solutions

FROM CITY DASHBOARD TO APPLICATIONS
DATA GATHERING AND CITY DATA KNOWLEDGE MANAGEMENT
FORGING & MANAGING OPEN AND FLEXIBLE WEB AND MOBILE APPS
IOT/IOE DEVICES AND NETWORKS
SNAP4CITY FOR BEGINNERS
DATA ANALYTICS, BUSINESS INTELLIGENCE, WHAT-IF AND
TWITTER VIGILANCE: SOCIAL MEDIA ANALYSIS
DECISION SUPPORT SYSTEM AND CITY RESILIENCE
HOW TO ADOPT SNAP4CITY, AND OUR ROADMAP
SNAP4CITY AND KM4CITY PROJECTS
SNAP4CITY THE VIEW OF THE ADMINISTRATORS

On Line Training Mate al (free of charge)

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



SNAP4 Appliances and Dockers **Installations**

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

- My Snap4City.org
- Tour Again
- Dashboards (Public)
- Dashboards of My Organization
- My Dashboards in My Organization
- My Data Dashboard Dev Kibana
- Extra Dashboard Widgets
- Data, my Data, OpenData
- Knowledge and Maps
- IOT Applications
- IOT Directory and Devices
- Resource Manager
- Development Tools
- Management
- Decision Support Systems
- Deploy and Installation
- Help and Contacts
- Documentation and Articles
- My Profile
- Km4City portal
- DISIT Lab portal

Home / Tutorials and Videos / Welcome: how to start using Snap4City for beginners

Welcome: how to start using Snap4City for beginners

Role: AreaManager

We suggest you:

Congratulations! You have really contributed to Snap4City and successfully passed all first levels!

You have reached a level in which you can contribute with competence to the city improvement and smartness. We hope you interested in helping other users in conquering higher levels on the city smartness ranking, and provising of smart services to all city users!
So that we could be interested in engaging and elevating your role in the Snap4City community, as coordinator of thematic groups, for example on **Mobile APP development**, **Dashboard** on Mobility, **IOT Application** Development, etc., according to your preferences.

Please contact **paonesi@gmail.com** !

Share Save ... Add to your favorites



Please start a fully guided training cases:

- HOW TO: create a Dashboard in Snap4City
- HOW TO: add a device to the Snap4City Platform
- HOW TO: add data sources to the Snap4City Platform
- HOW TO: define privacy rules for personal data, produced by the end-users own device
- HOW TO: Develop Smart Applications, Snap4City development Life Cycle
- HOW TO: HLT vs Ingestion, and HLT vs Widgets
- HOW TO: Develop an IOT Application for Data Ingestion

Username: paolo.disit

Search

Search

-Any-



Powered by www.km4city.org

FIWARE Node-RED

Organization Groups

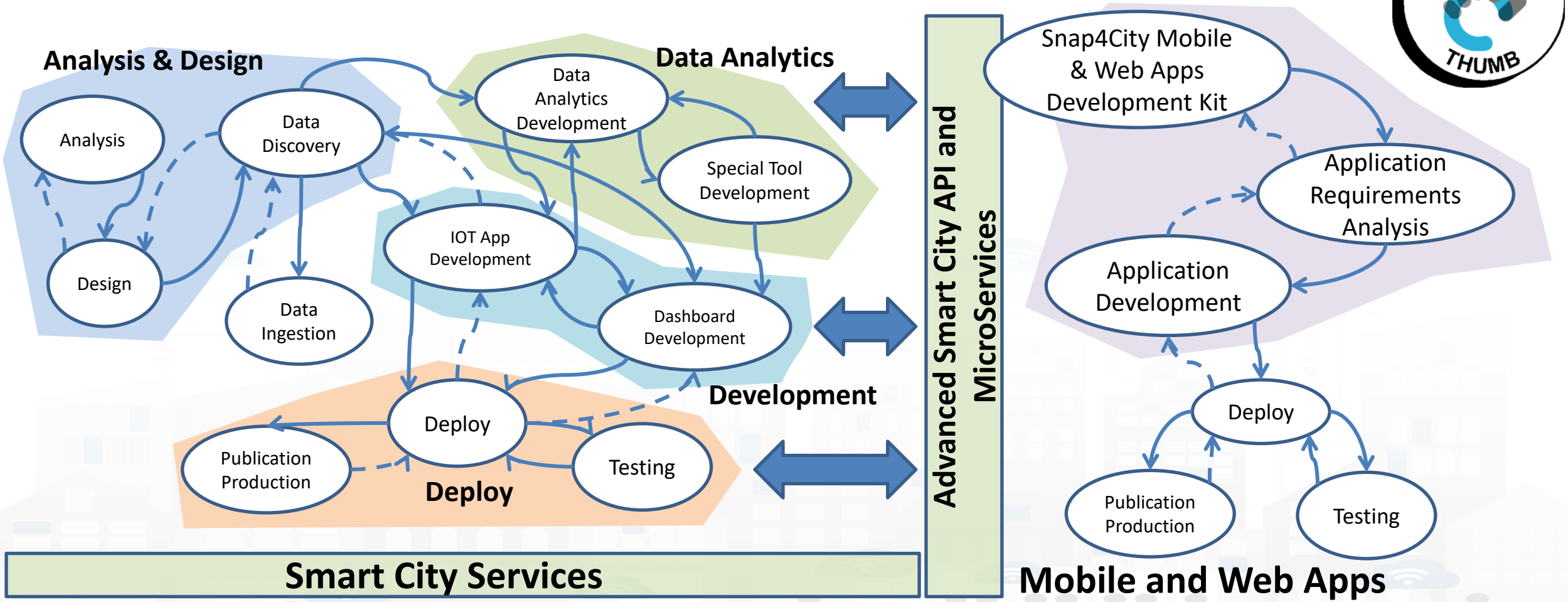
DISIT
- Developer
- Operativo

Updates on Tools

News from Snap4City & slides, Where to Meet Snap4City experts
updated
roottooladmin1

HOWTO: FIWARE Orion

Develop Mobile & Web Applications Exploiting Snap4City Smart City Services



https://www.snap4city.org/577

On Line Training Material (free of charge)

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

General Overview of the full Course 2021

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

A number of the training sections include exercitations

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

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


SNAP4city
Be smart in a SNAP!
LIVING LAB
9 July 2019, 2° Training day of 3 Florence
Coll@bora
Welcome: how to start using Snap4City for beginners
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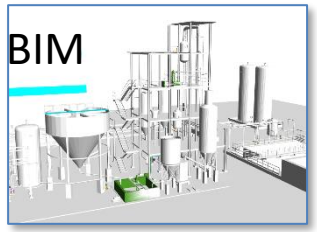
UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

SNAP4CITY | KM4CITY



Concept

BIM

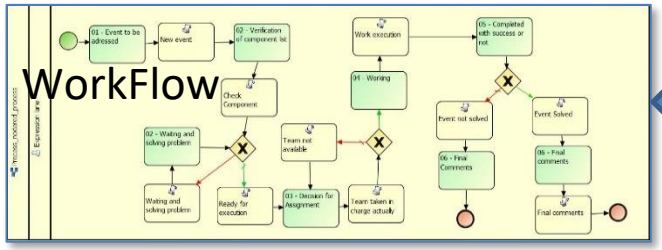


KPI, POI, MyKPI, …

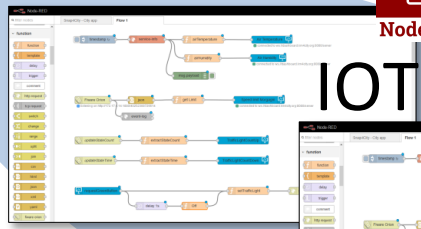
API, External Services

Web Scraping

WorkFlow







Node-RED

IOT Apps





Data Analytics,
Artificial Intelligence

IOT Brokers

IOT Broker

IOT Broker



FIWARE



GIS

Big Data

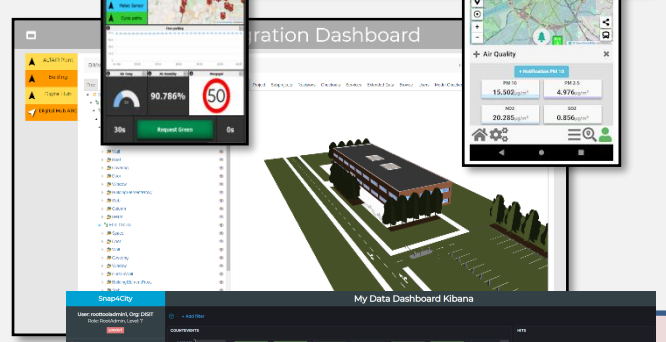
KB

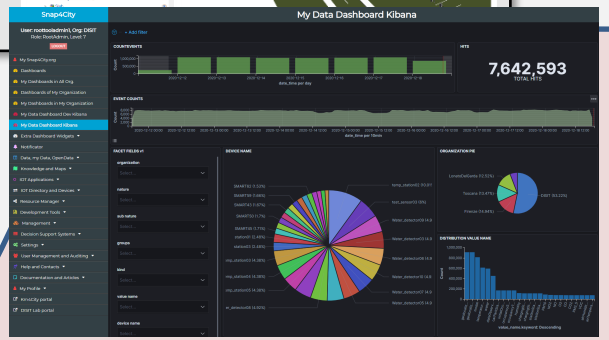
LD, LOD

ckan









Dashboards and Apps

FI-WARE

Dashboard and tools Development

On Line Training Material (free of charge)

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



Two Main Lines for Dashboarding

- **Kibana (DevDash, My Dashboard (Dev) Kibana)**

Ready to use

You can customize

Limited details



- **Dashboard Builder of Snap4City**

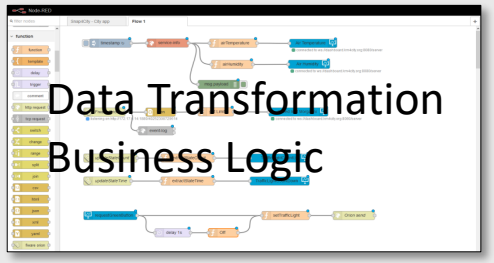
You need to create / customize

Full Control

Professional details



Dashboard Builder: Development



Data Transformation
Business Logic

IOT Applications



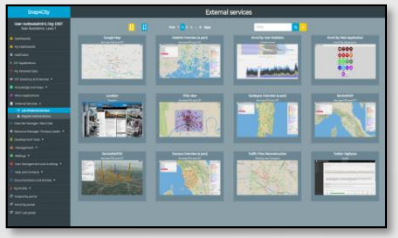
Knowledge and Storage
Data from the Field and
City + MyKPI ++

Widget Collection





Micro
Applicat
ions

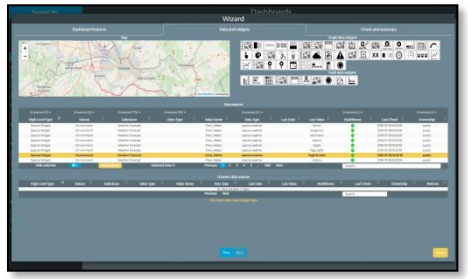


External
Services



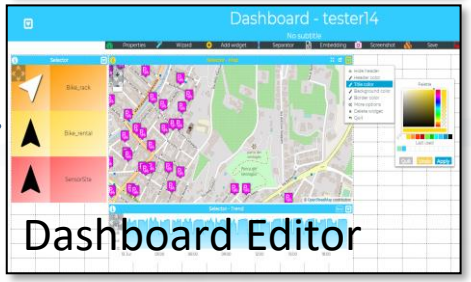
Custom
Widgets/
Synoptics

Dashboard Wizard



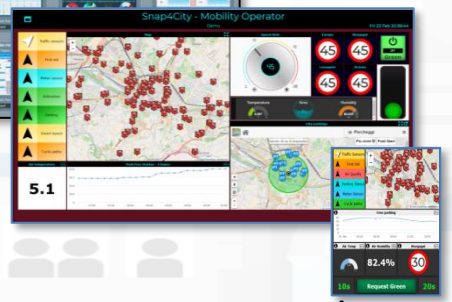
Create, save, load,
delegate, grant access,
change ownerhip





Dashboard Editor



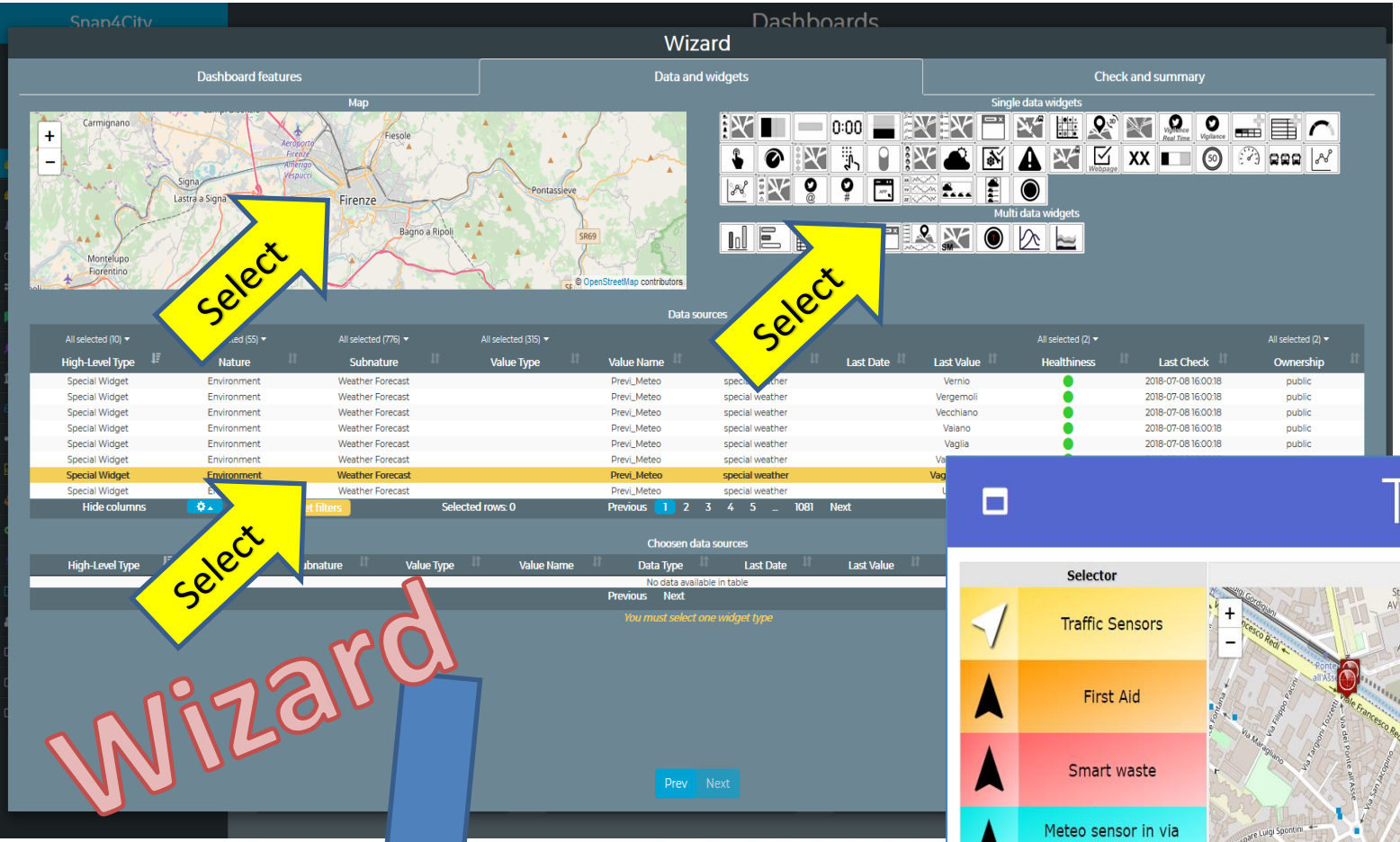


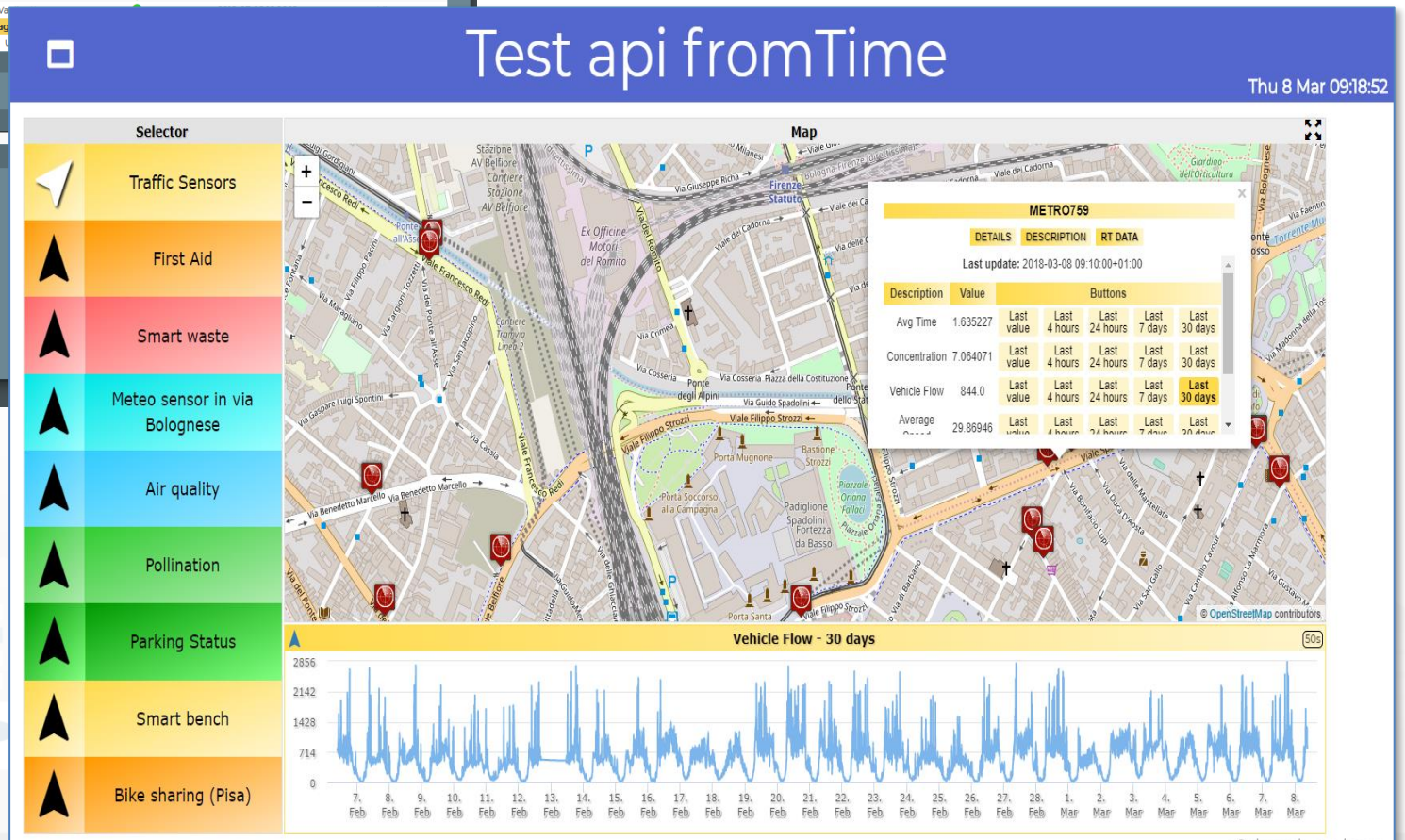
Public
Dashboard
Collection



My Own Dash/App

Dashboard Wizard



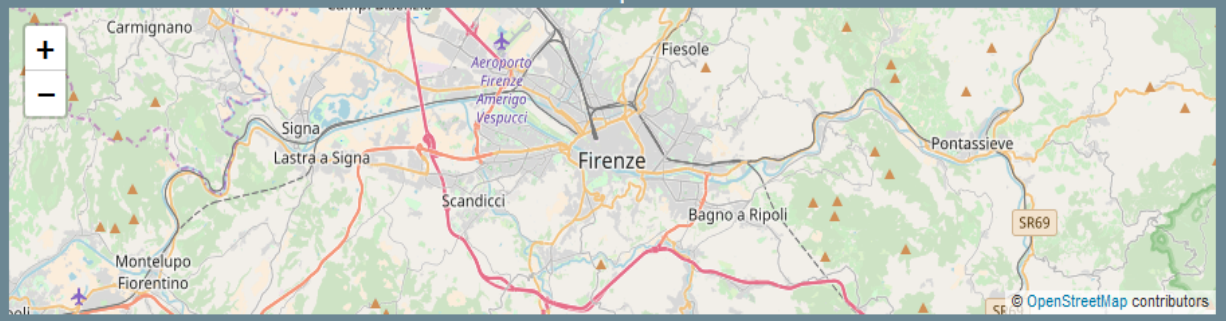


The Wizard help you in selecting only possible combination of data vs graphic representation

Wizard

Dashboard features | Data and widgets | Check and summary

Map



Single data widgets



Multi data widgets



Data sources

High-Level Type	Nature	Subnature	Value Type	Value Name	Data Type	Last Date	Last Value	Healthiness	Last Check	Ownership
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	**Environment**	**Weather Forecast**		**Previ_Meteo**	**special weather**		**Vagli di sotto**		**2018-07-08 16:00:18**	**public**
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather		Uzzano		2018-07-08 16:00:18	public

Hide columns | Selected rows: 0 | Previous 1 2 3 4 5 ... 1081 Next | Search

Choosen data sources

High-Level Type	Nature	Subnature	Value Type	Value Name	Data Type	Last Date	Last Value	Healthiness	Last Check	Ownership	Remove

Previous Next | Search

Close

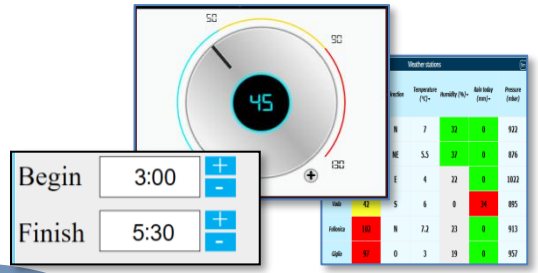
SNAP4CITY

Wizard

- Select the area of your interest: panning and zooming
- Select the
  - graphic aspect of your interest, or
  - High Level Type of your interest, or
  - Make a search if you a have a precise idea or
  - Act on filters: nature, subnature, type, name, value, date, health, owner, …
  - Combine them as you like
- Select the lines of your interest
- Then click on Next and get the Dashboard by wizard

Dashboard Widgets: List and Editor





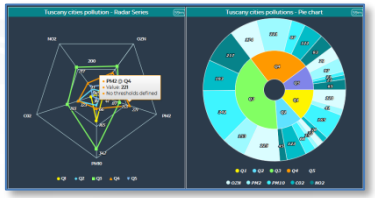


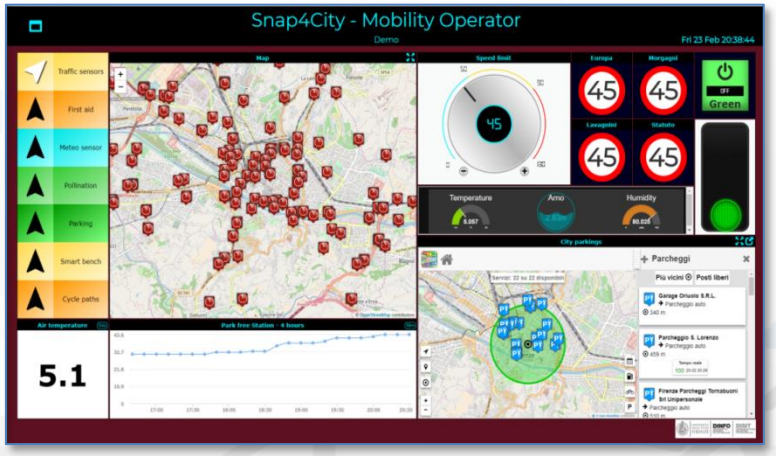


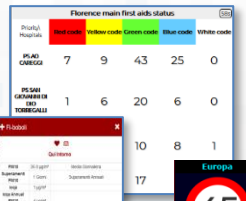


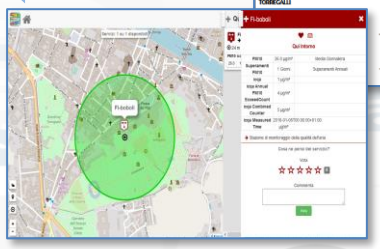




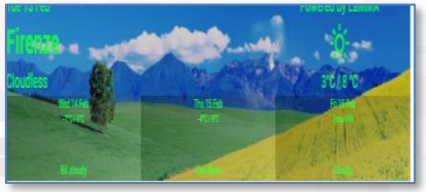


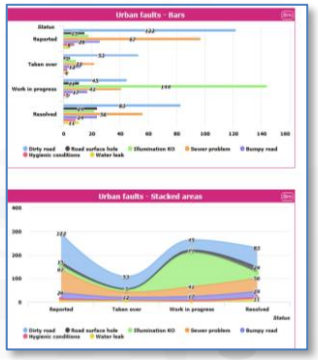






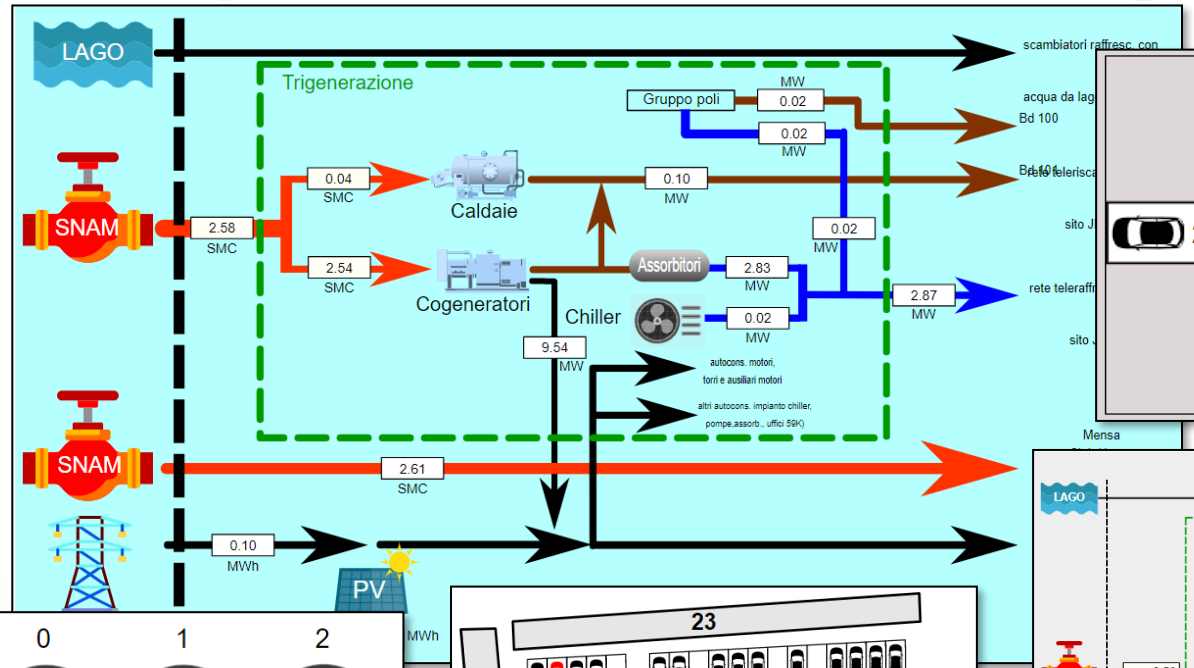


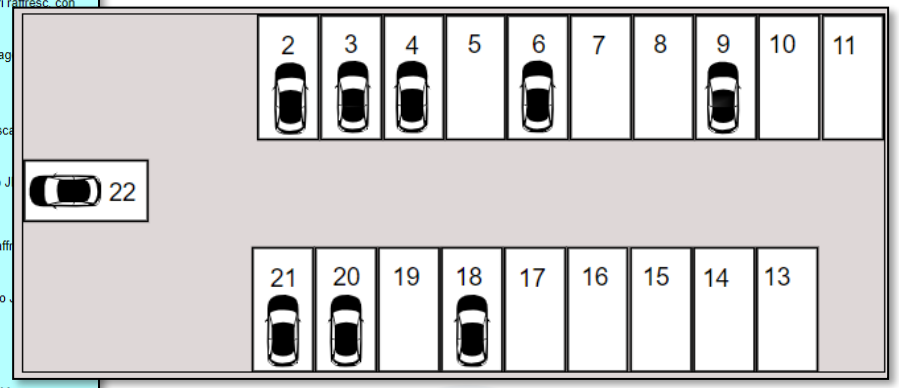


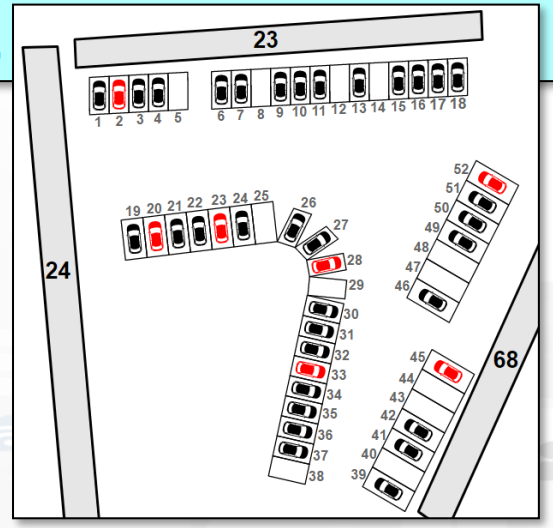


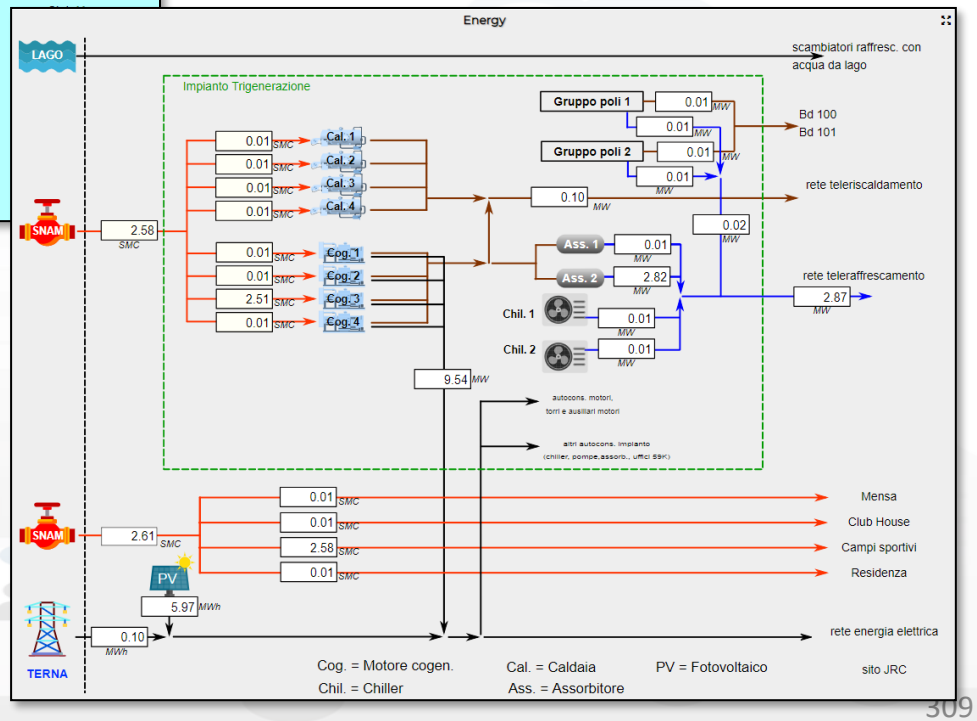
Special Custom Widgets

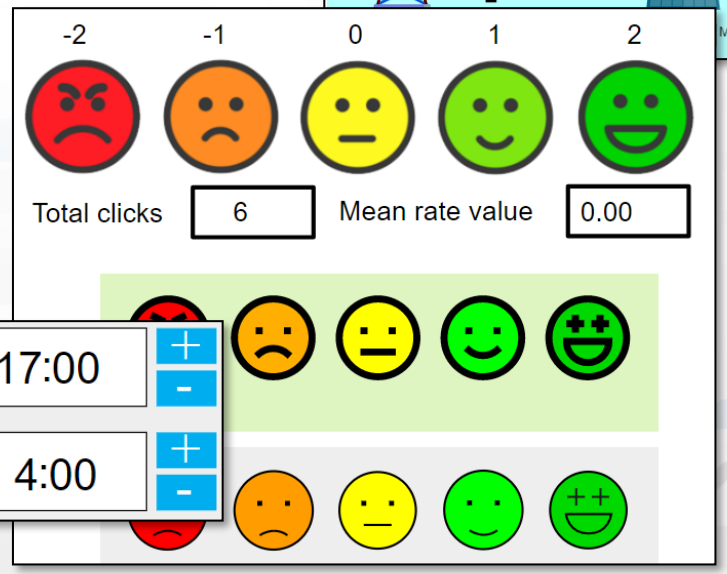
- Smart parking
- Smart Energy
- Smart Light
- Smart ….
- Energy View
- Custom Controls

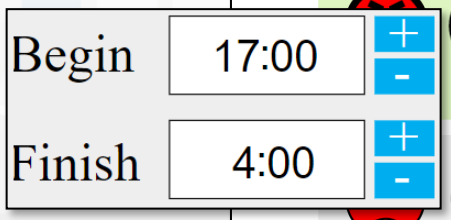




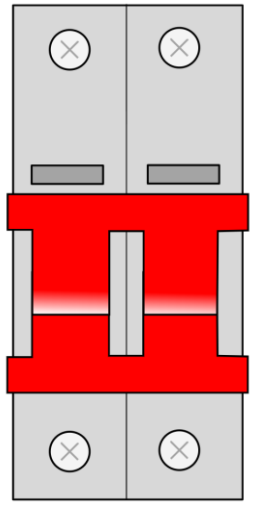






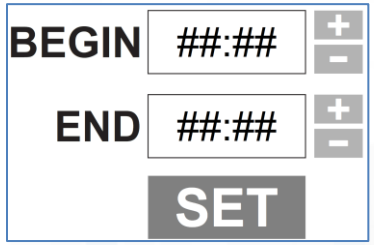


Other examples

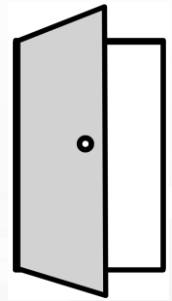


- **Virtual Actuators (sensor-actuator)**
  - From: Dashboard
  - To: IOT App, MyKPI, other Synoptics











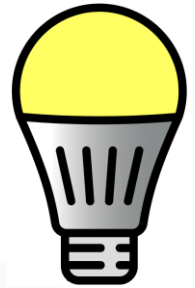




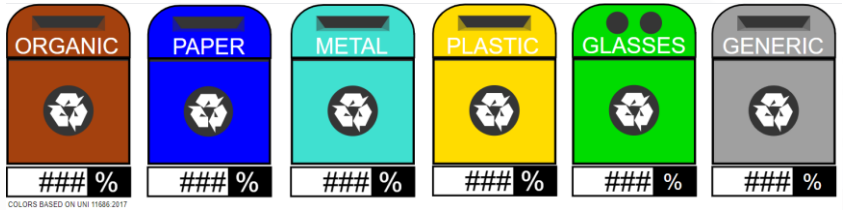
- **Virtual Sensors**
  - From: MyKPI, Sensors, IOT App, other Synoptics
  - To: Dashboards

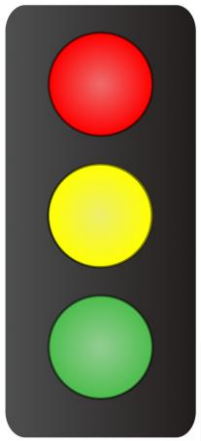


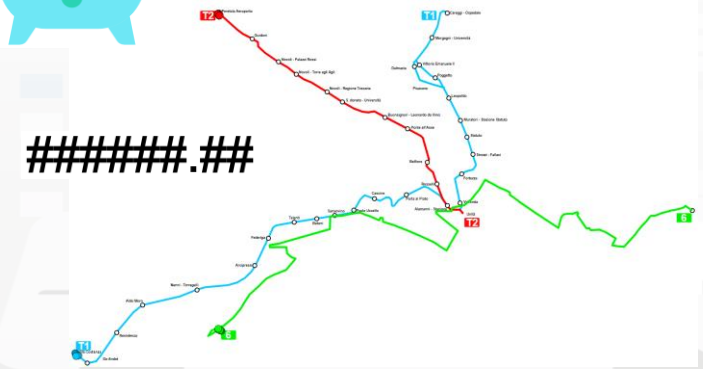


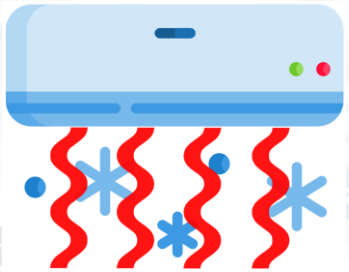








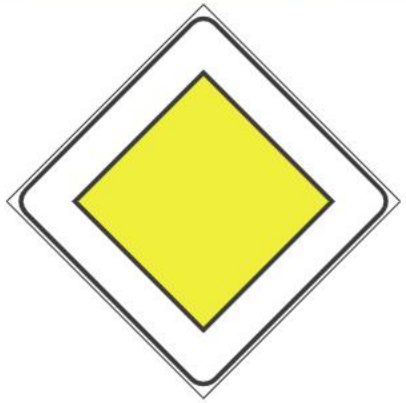




SVG Custom Widgets Examples

Sat 16 Jan 01:07:39

Precedence Italians Road signals



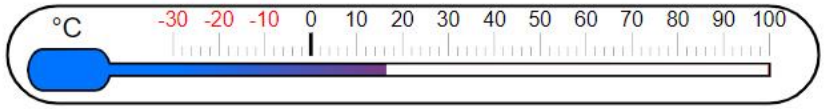
Select a code from 0 to 11 to change the road sign

New		Last confirmed: None
7	8	9
4	5	6
1	2	3
0	.	Canc
Confirm		

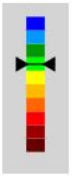
s... Smart Light Luminosity



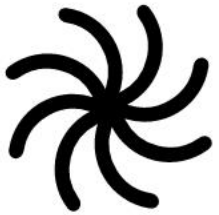
Air Temperature in Florence



PM10 level - Bologna



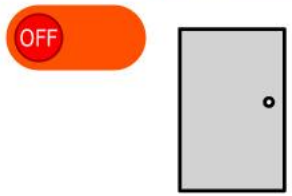
fan Fan velocity





Symbols Legenda

open/... M...



Dynamic Prohibition...



Prohibition Traffic Signs Co...

New		Last confirmed: None
7	8	9
4	5	6
1	2	3
0	.	Canc
Confirm		



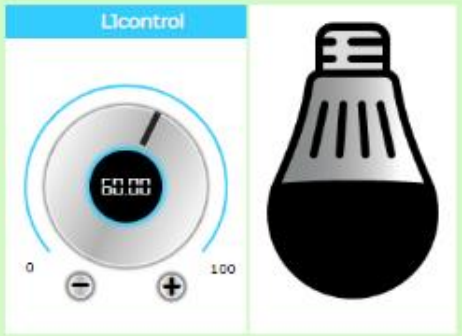
Prohibition Traffic Signs Legenda

Snap4Home 5G Demo

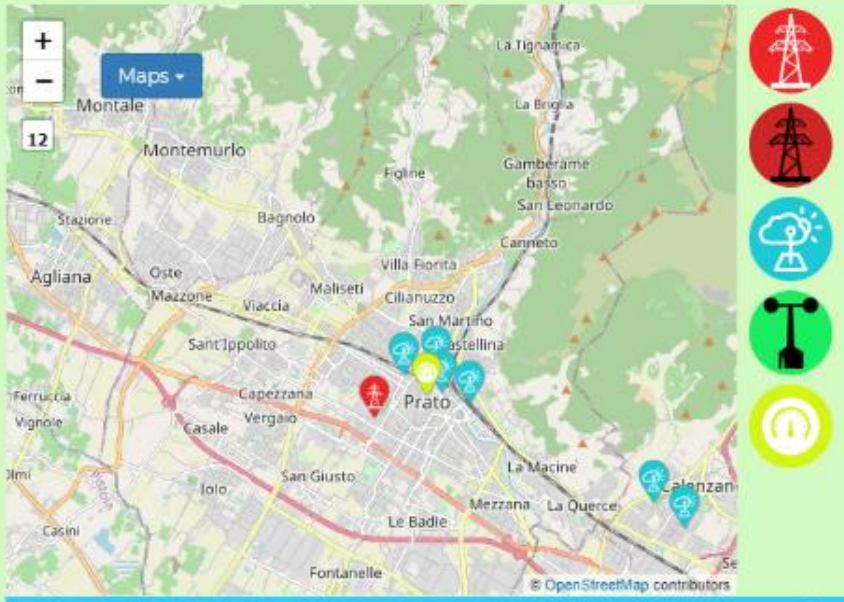
Thu 11 Jun 18:07:32





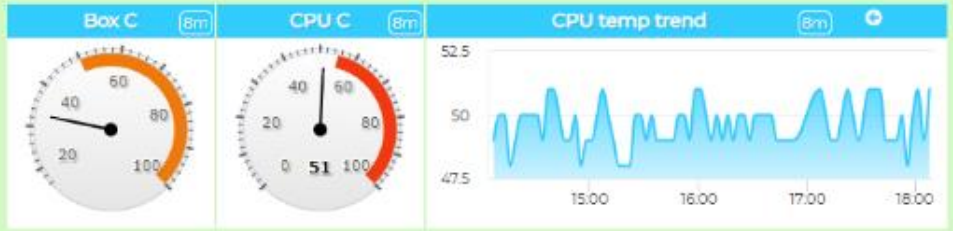








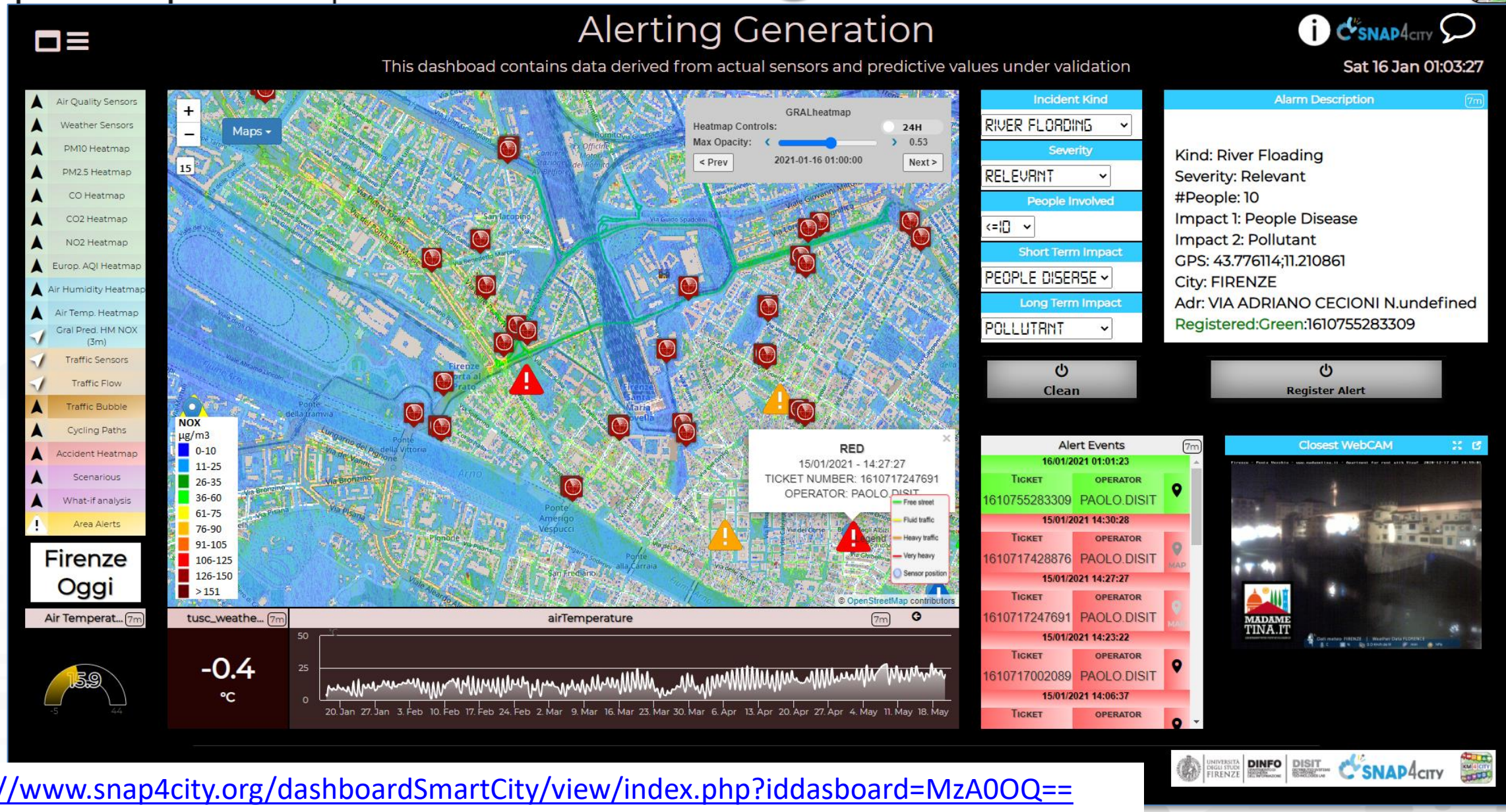






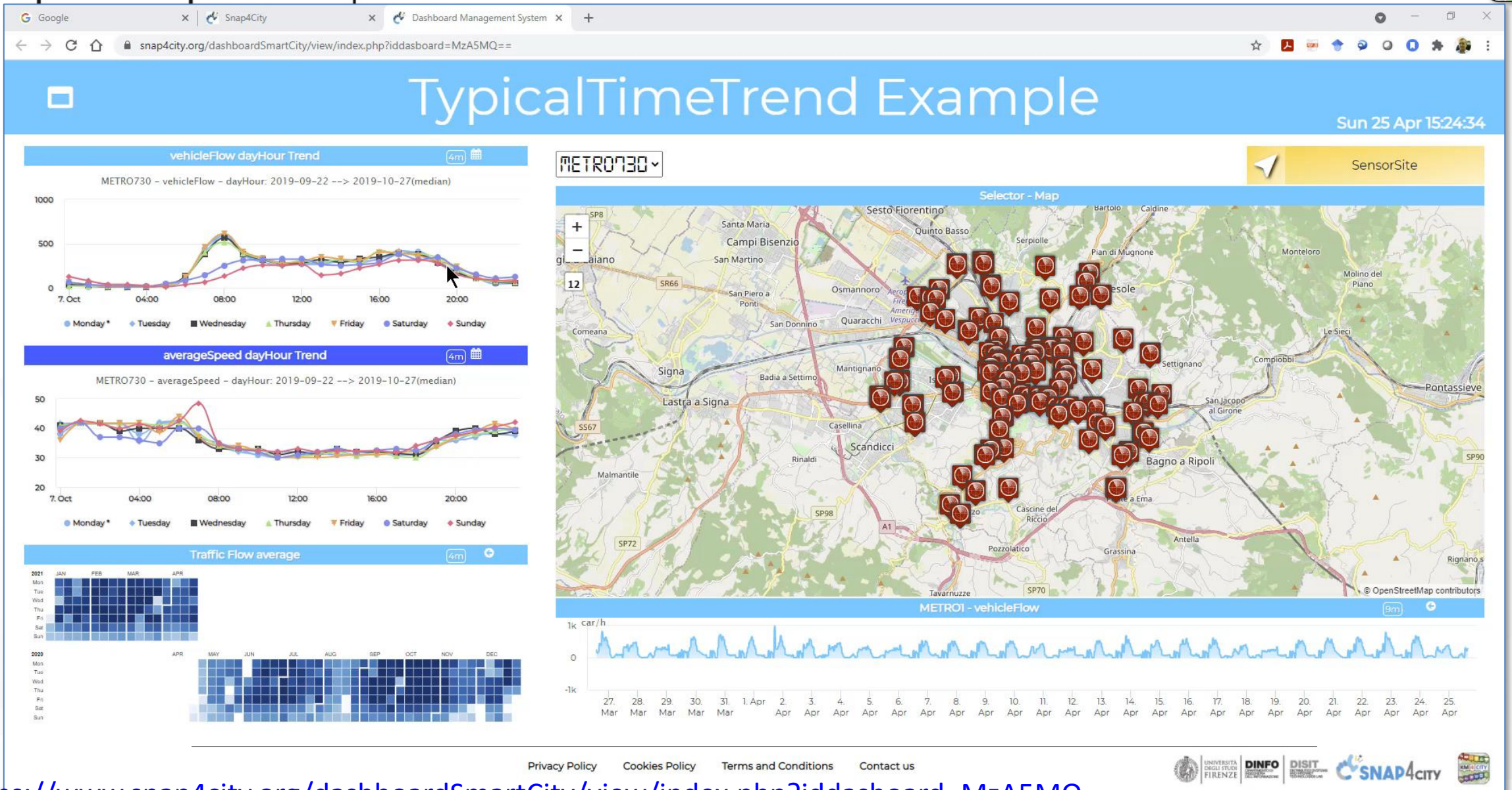
open fiber | WIND | ZTE | estra

Alert Registration



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

Typical Time Trends



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA5MQ==

How the Dashboards exchange data

Snap4City BigData Storage and KB

IOT Broker Orion Quantum Leap

ServiceMap Super ServiceMap

- Req. ServiceURI

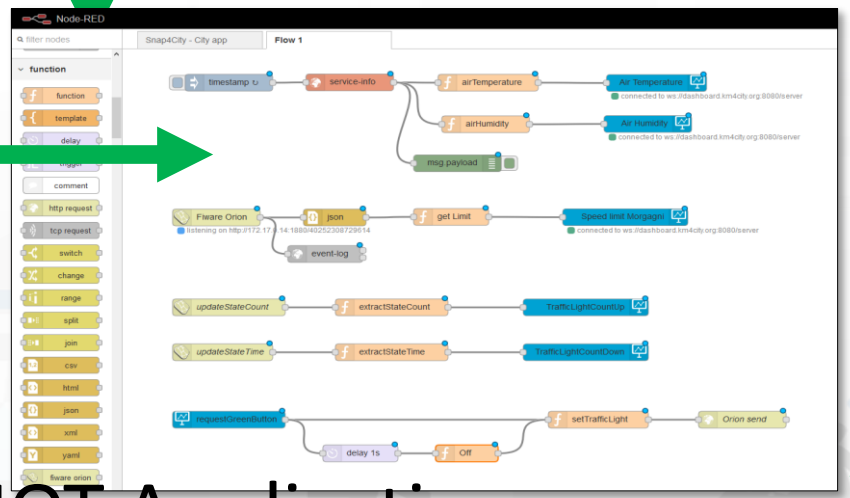
Metric, KPI

MyKPI, MyPOI, …

- Req. KPI, Metric ID
- Req. MyKPI ID

API, External Services, MicroApp

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

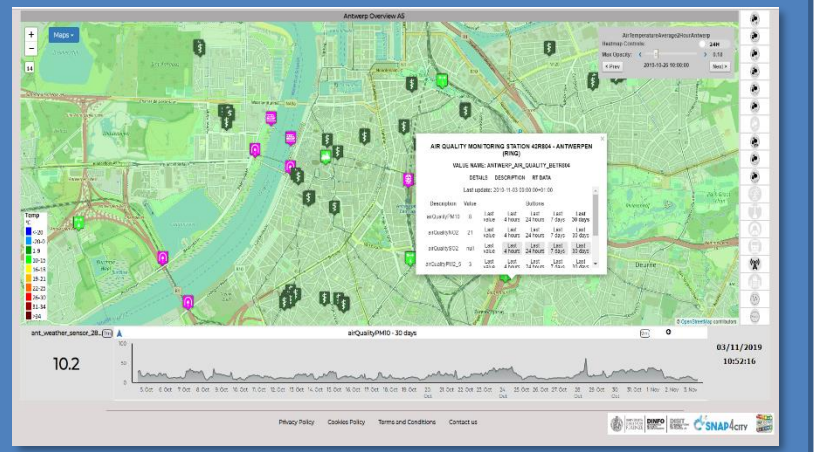


IOT Application

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

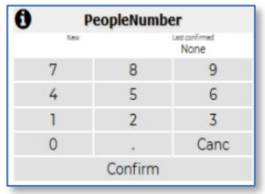
- Rx. Dynamic Data
- Event Driven Synoptics
- Actions, Show

Dashboards





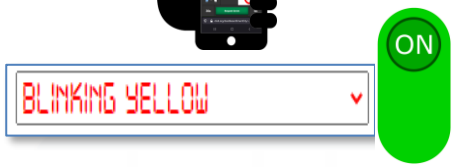
Business Logic on Dashboards

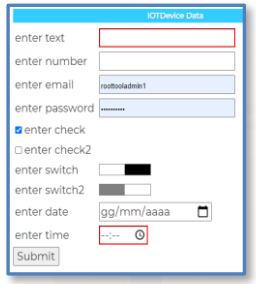


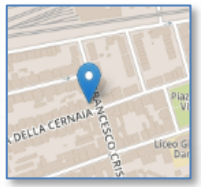


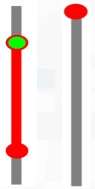




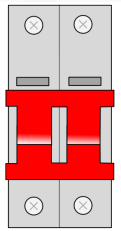




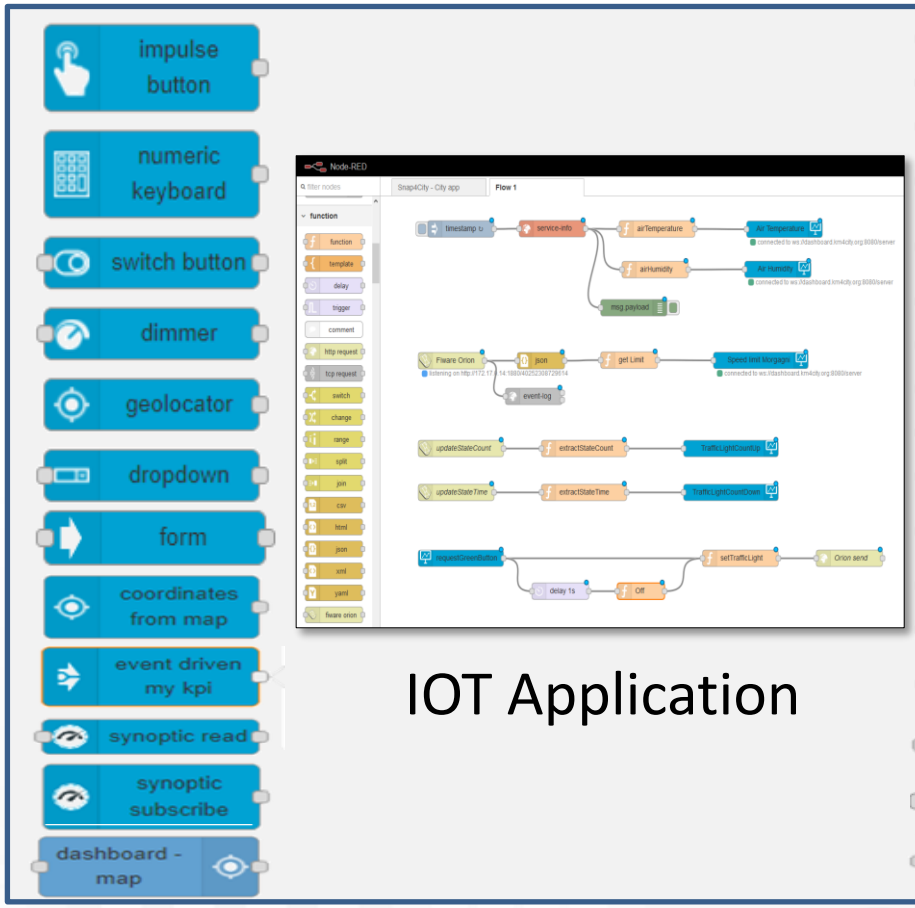




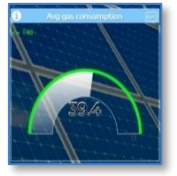




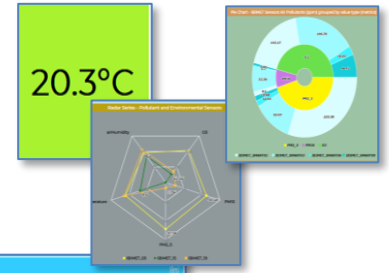




IOT Application

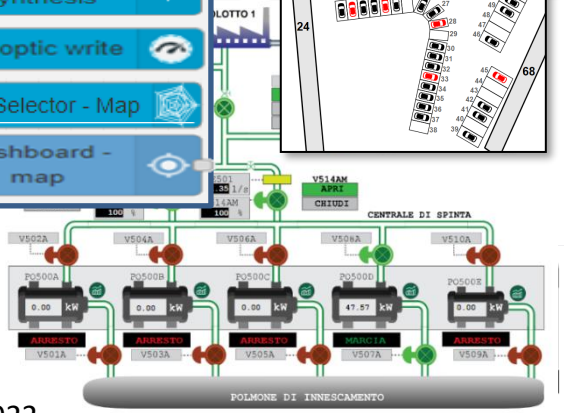


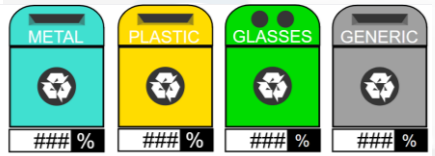










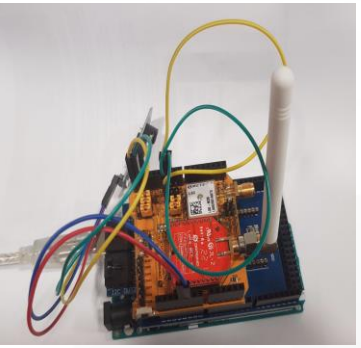


IOT Devices

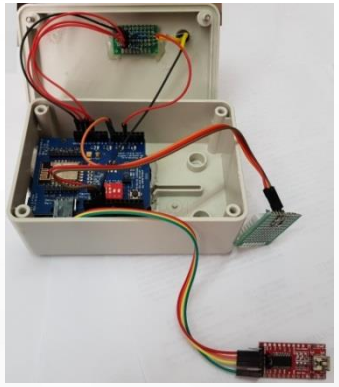
Sensors/
Actuators

IOT Edge Devices

LoraWAN +
Arduino +
I2C, NGSI



Arduino,
Wi-Fi, NGSI



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



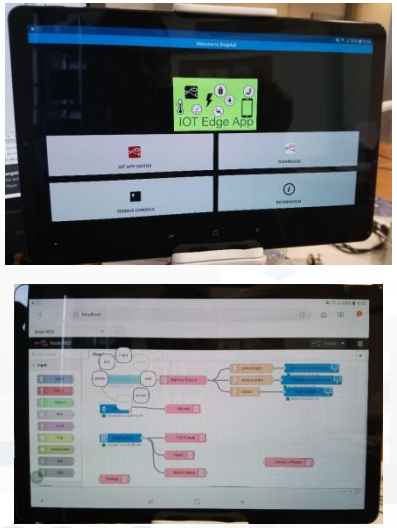
Snap4All PAX
Counter
LoraWAN
WIFI, NGSI,
GPS



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



IOT Edge
NodeRED:
Android, LINUX,
Windows, …



LoraWan
Gateway:
Node-RED
IOT Edge, NGSI,
WIFI, RJ45, GPS



Any Sensor / Actuator
Open to other protocols

IoT Application Development smartening the solutions

On Line Training Material (free of charg

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



IOT Applications

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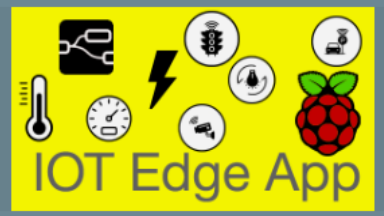

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Management

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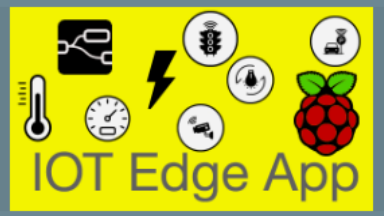

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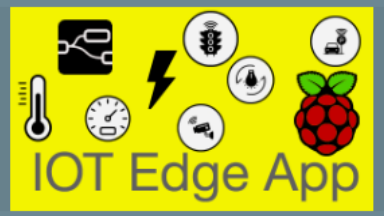

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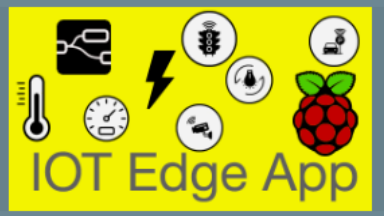

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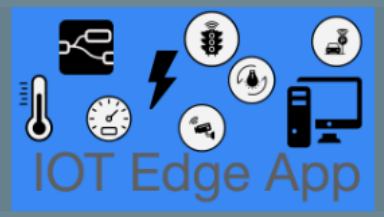
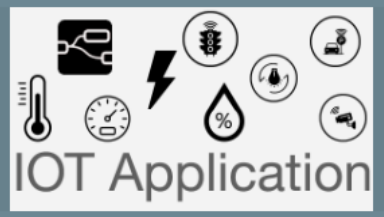
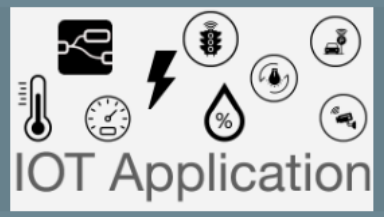
Management

2018-10-22T11:57


owner: semolarudy
Management

application


owner: tester5
Management

Bib APP


owner: semolarudy
Management

ChargingStations


owner: comunedashres
Management

Deprecated - SiiMobilityControlRoom


owner: badii
Management

SamsungGalaxyS4BarCode

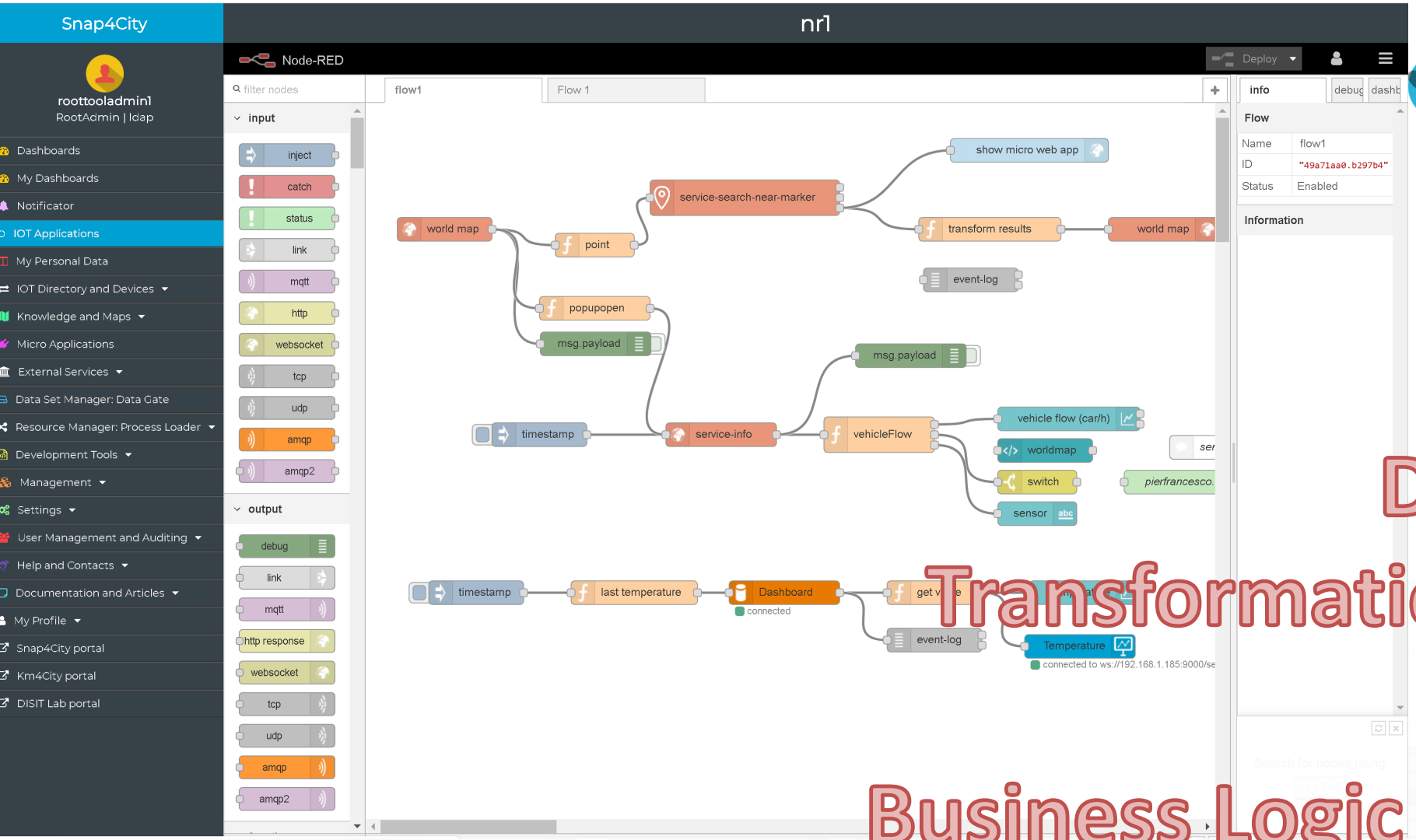

owner: badii
Management

esercitazione


owner: tester2
Management

Iot-App


owner: tester14
Management



Data Adapation
Transformation, Conversion
Integration
Business Logic vs Dashboards
Editing IOT Applications
Data Analytics control
Everywhere: Cloud, on IoT Edge Devices

IoT Applications

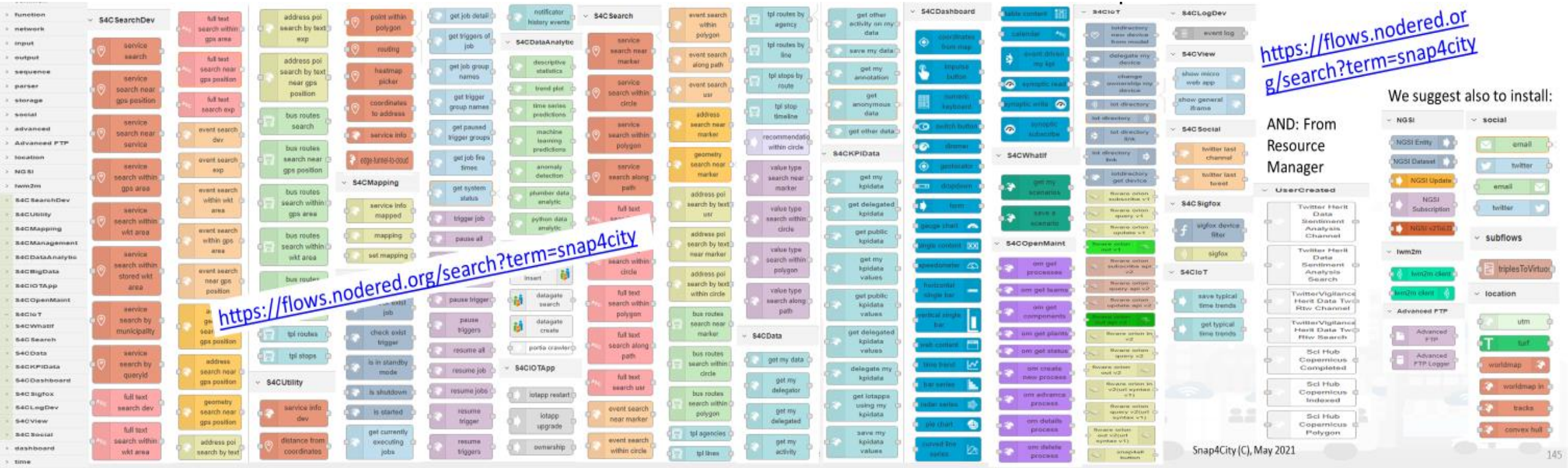
- **Data ingestion**: more than 70 protocols IOT and Industry 4.0, web Scraping, external services, any protocol database, etc.
- **Data access**: save/retrieve data, query search on expert system, georeverse solution, search on expert system Km4City ontology, etc.
- **Data Transformation/transcoding:** binary, hexadecimal, XML, JSON, String, any format
- **Integration**: CKAN, Web Scraping, FTP, Copernicus satellite, Twitter Vigilance, Workflow OpenMaint, Digital Twin BIMServer, any external service REST Call, etc.
- **Manipulation of complex data**: heatmaps, scenarios, typical time trend, multi series, calendar, maps, etc.
- **Access to Smart City Entities and exploitation of Smart City Services**: transport, parking, POI, KPI, personal data, scenarios, etc.
- **Data Analytic**: managing Python native, calling and scheduling Python/Rstudio containers as snap4city microservices (predictions, anomaly detection, statistics, etc.)
- **User interaction on Dashboard**: get data and message from the user interface, providing messages to the user (form, buttons, switches, animations, selector, maps, etc.), business logic on IOT Applications.
- **Custom Widgets**: SVG, synoptics, animations, dynamic pins on maps, etc
- **Event management**: Telegram, Twitter, Facebook, SMS, WhatsApp, CAP, etc.
- **Hardware Specific Devices**: Raspberry Pi, Android, Philips, video wall management, etc.

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

SNAP4CITY KM4CITY

Snap4City Libraries of MicroServices on Node-RED

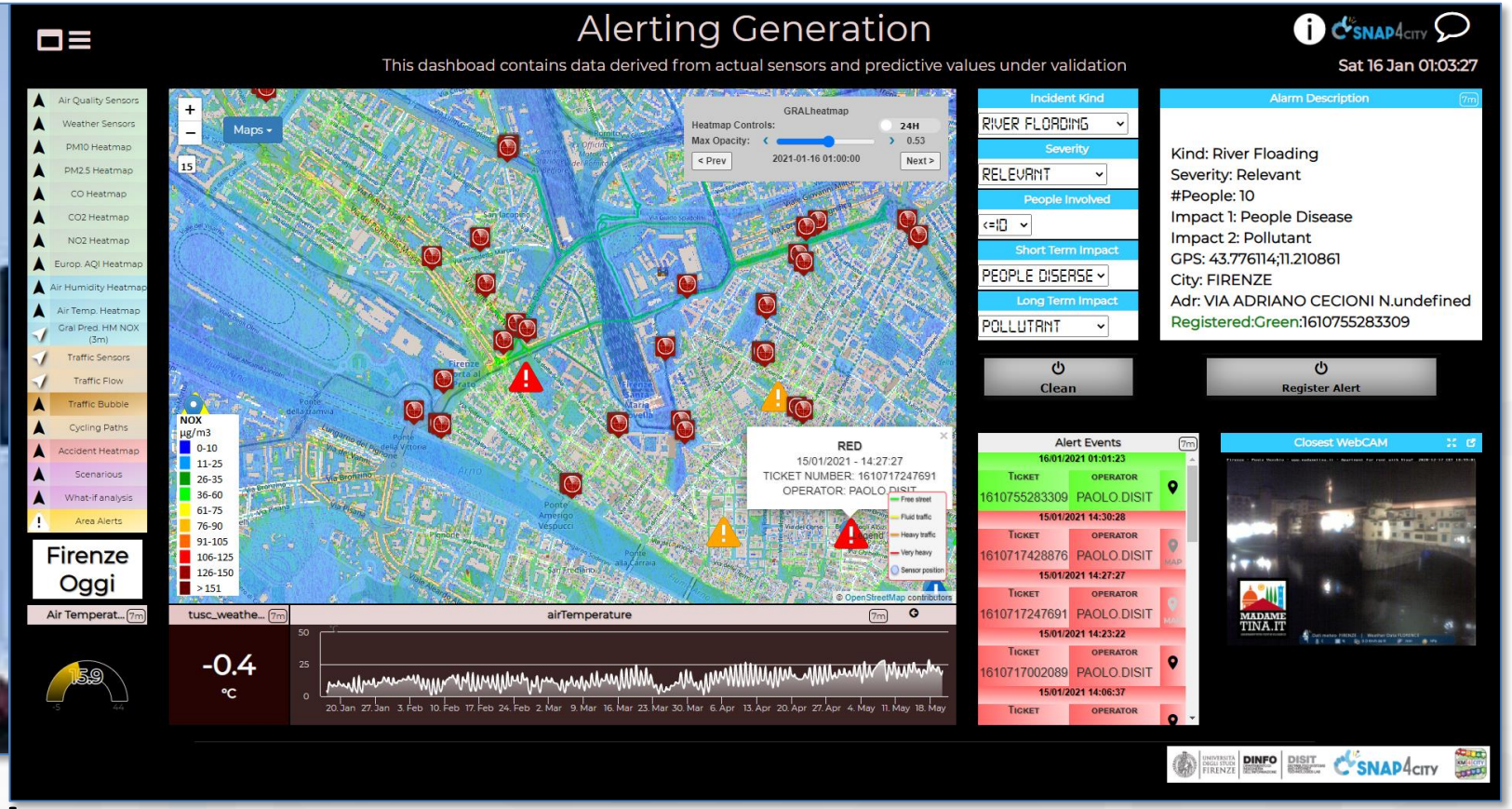
Node-RED

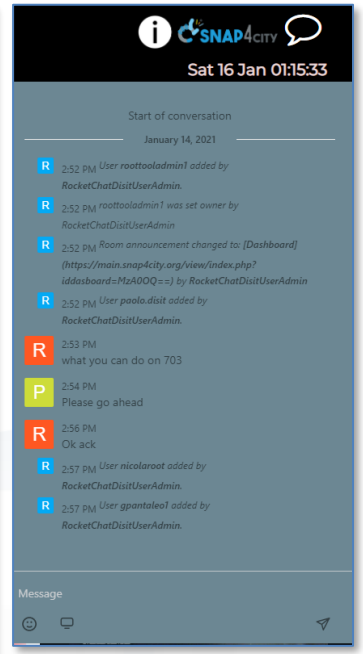


SNAP4CITY KM4CITY

Registering Alerting events







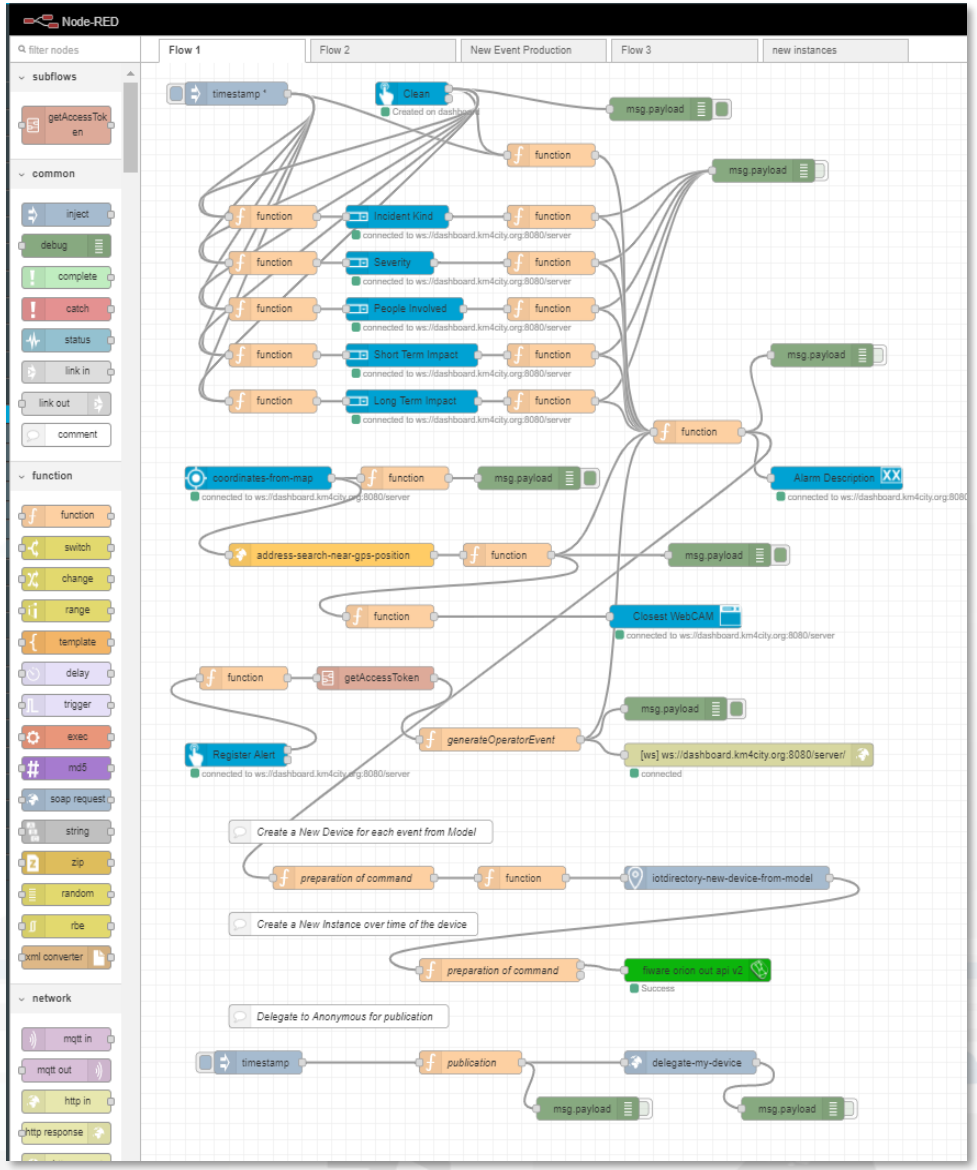
Private specific Chat

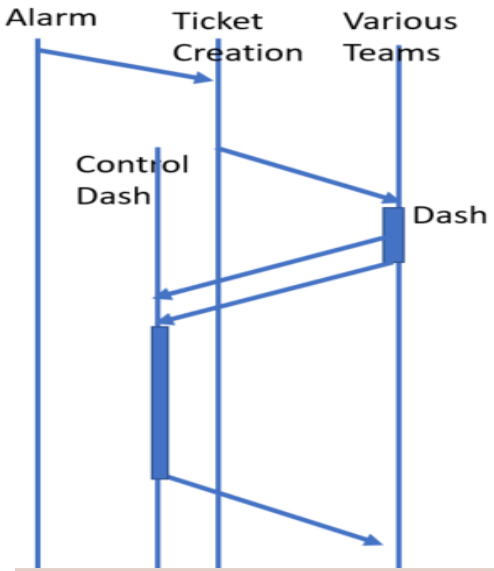
Control Room Operator

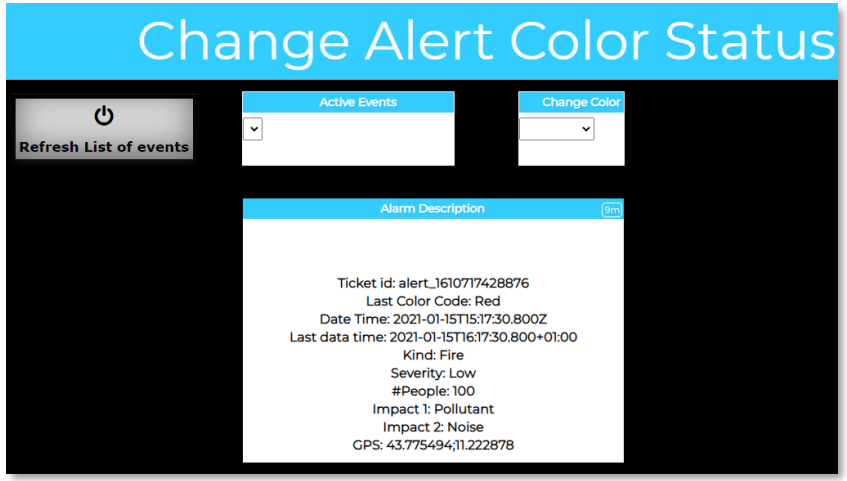
- **Monitor** traffic flow, Environment, Car parking, Cycling, First aid, temp., …
- **Registering Events: classification**
- **Changing status**
- **Acting**

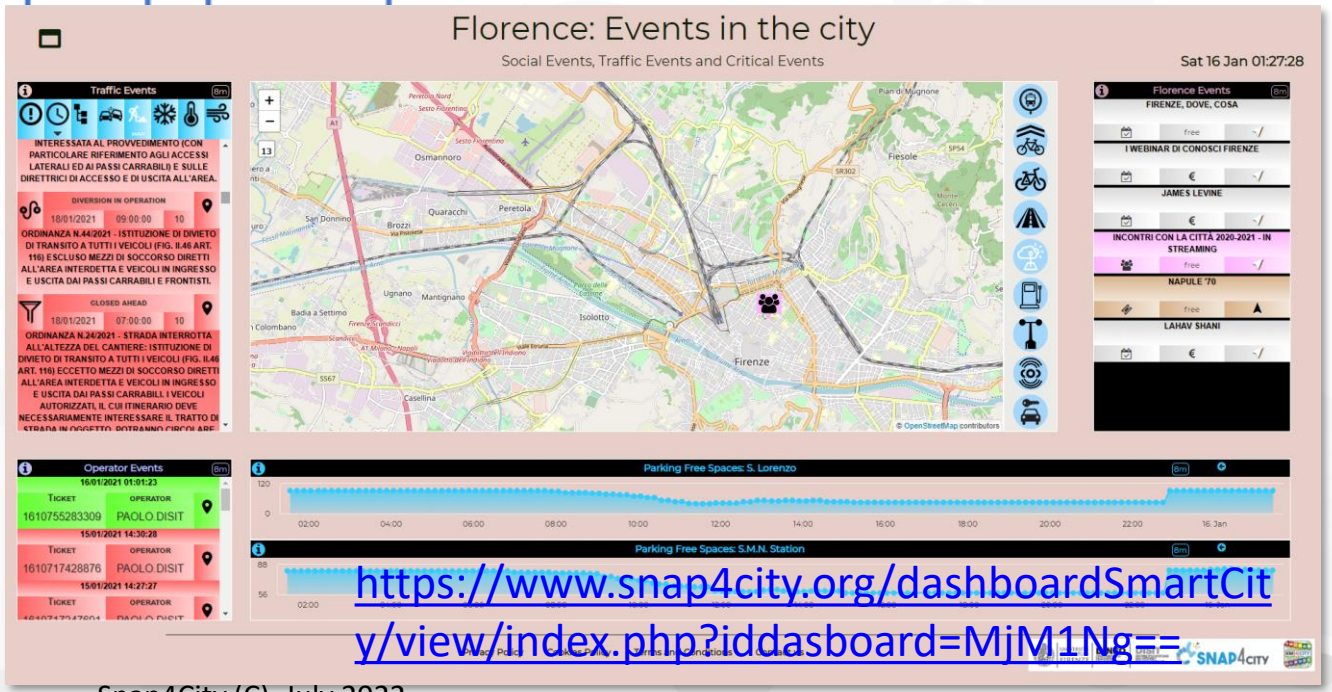
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA0OQ==

Flow Mng



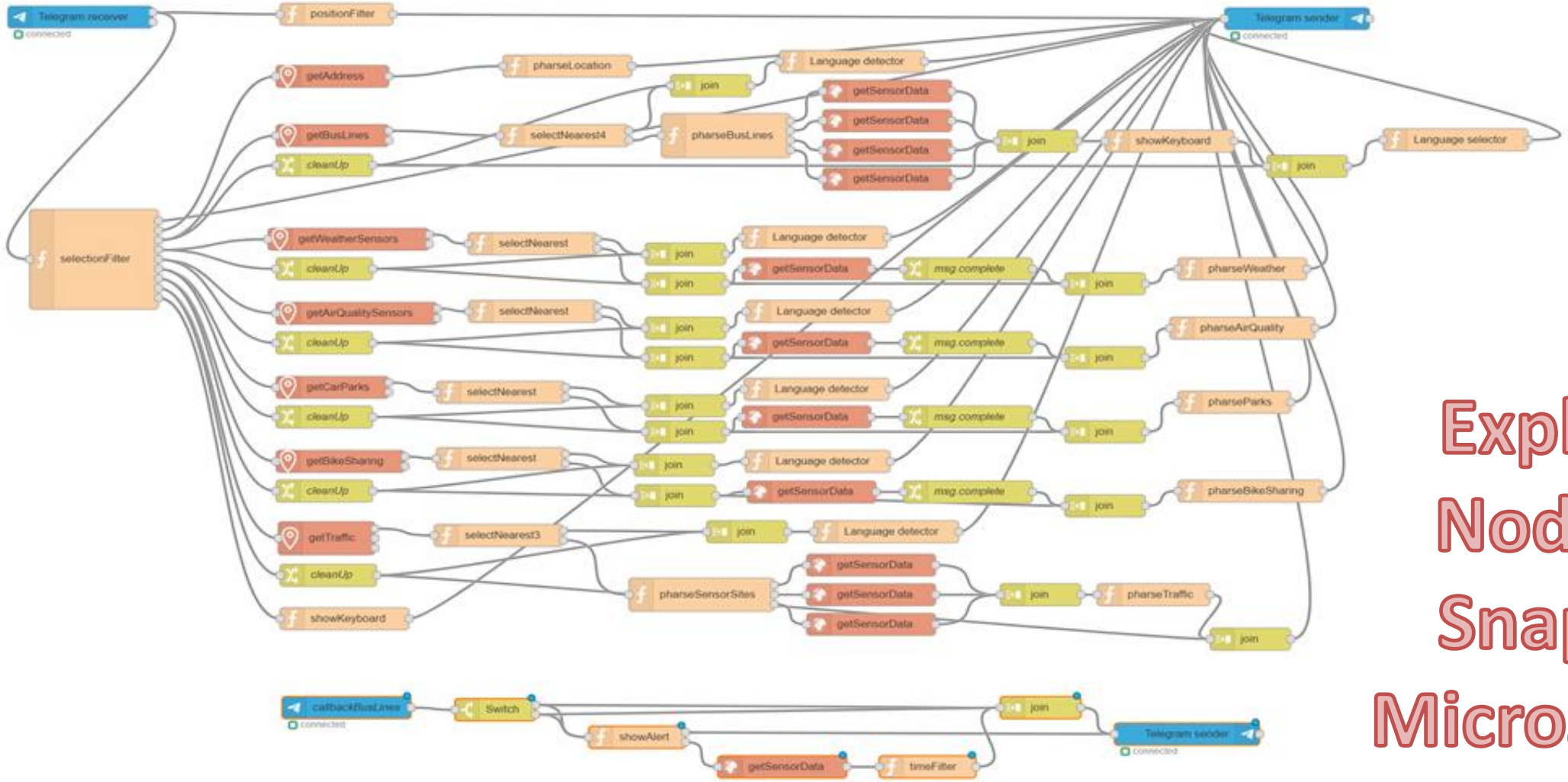






https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjM1Ng==

IOT App of SnapBot: OneShot Services



Exploiting Node-RED Snap4City MicroServices

Development of Data Analytics

On Line Training Material (free of charge)

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



Data Analytics on Snap4City platform

Swagger







Ontology Schema



LOG.disit.org

Knowledge Base, Km4City



Big Data Store Facility

Smart City API from Knowledge Base and other tools

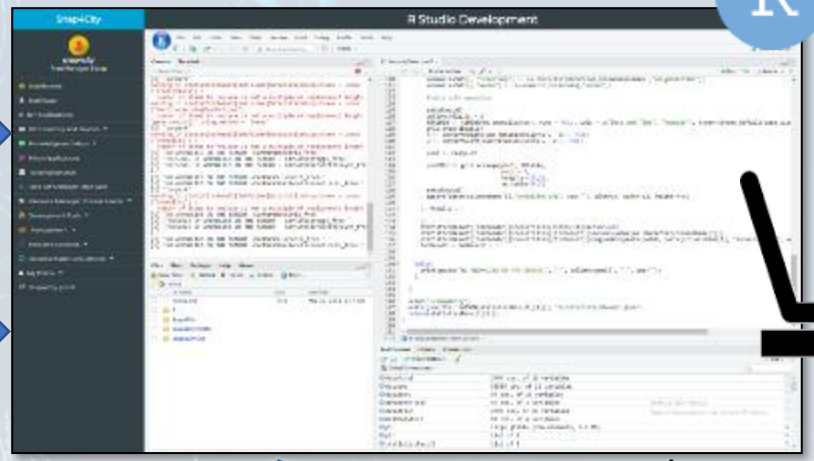
TensorFlow

NVIDIA CUDA

python

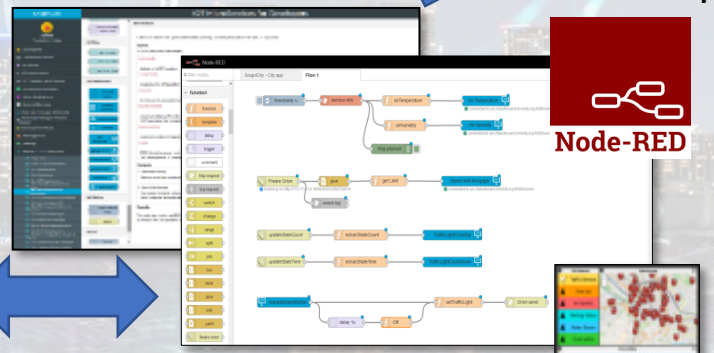
jupyter

R Studio





Creating MicroServices



Using them into IOT Applications

Saving / Sharing reusing

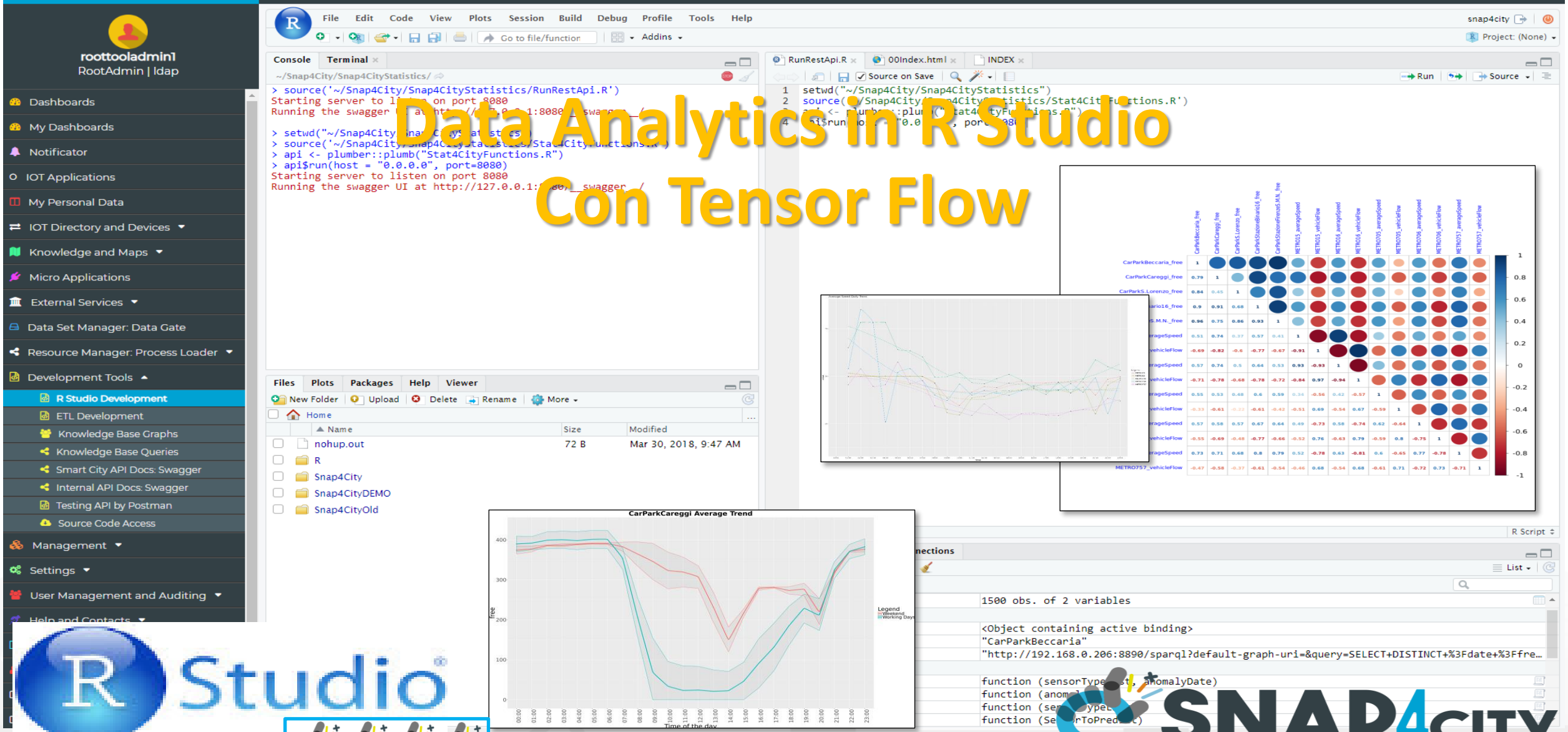


Resource Manager

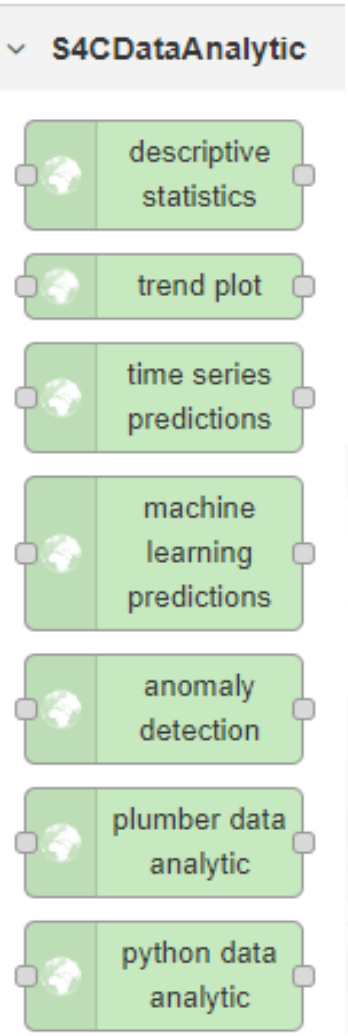


R Studio Development

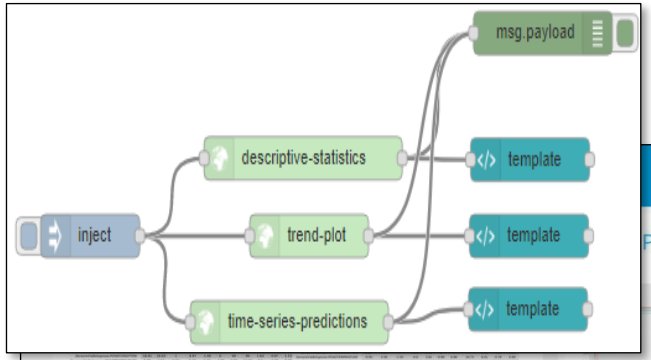
Data Analytics in R Studio Con Tensor Flow



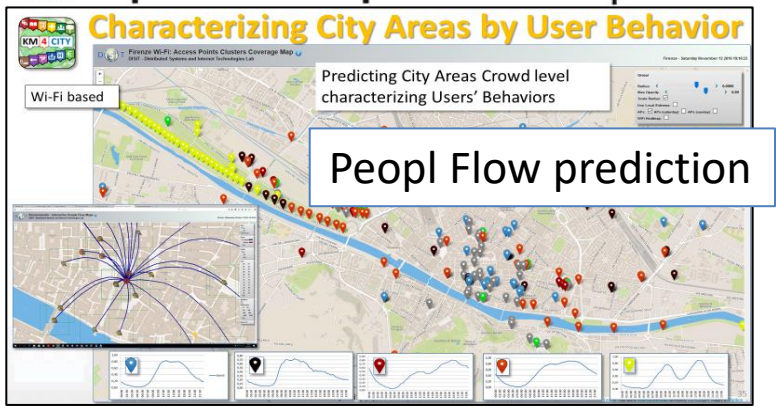
Data Analytics to MicroServices

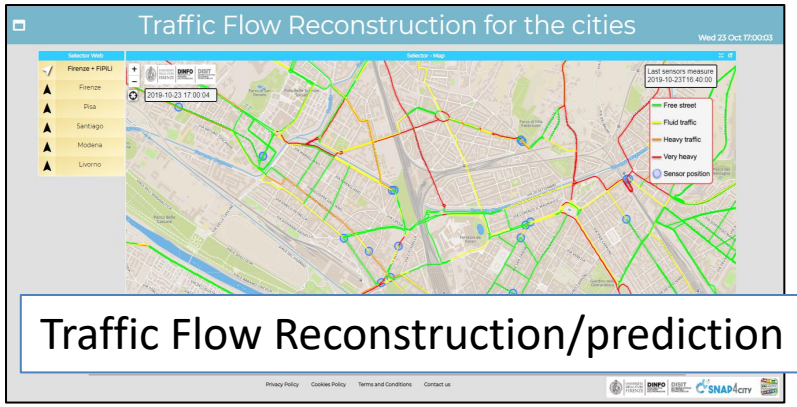


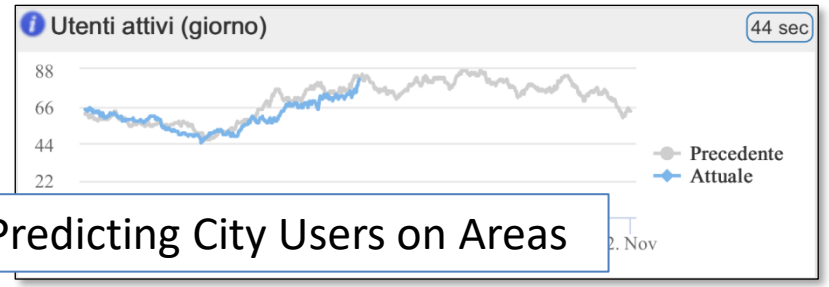
R Studio and Python algorithms are **automatically** transformed into **MicroServices** for your IOT Applications

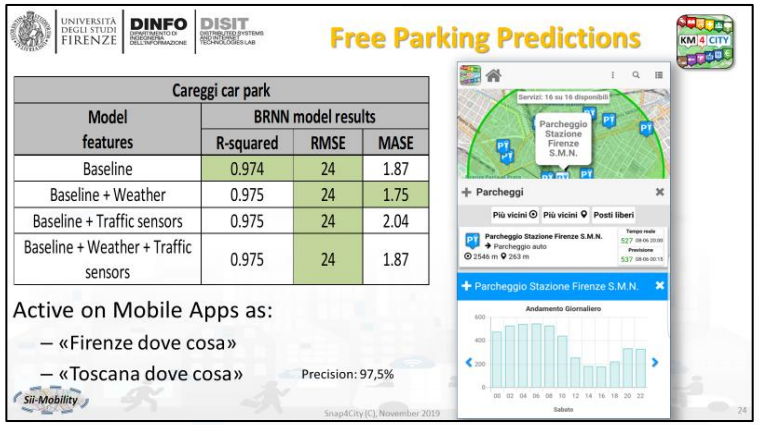


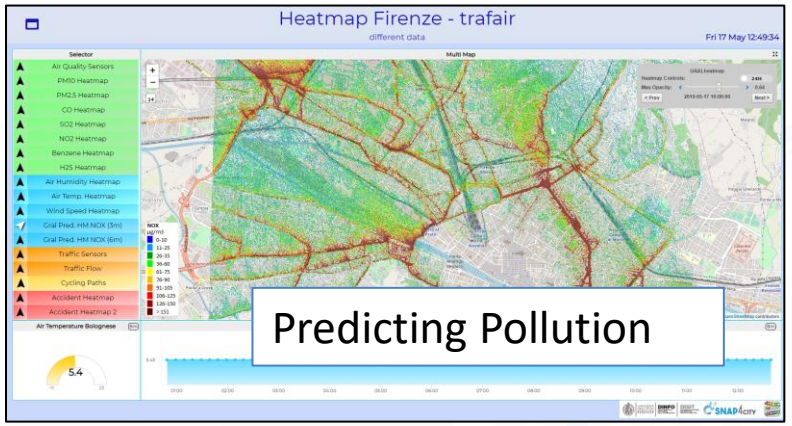
Data Analytics

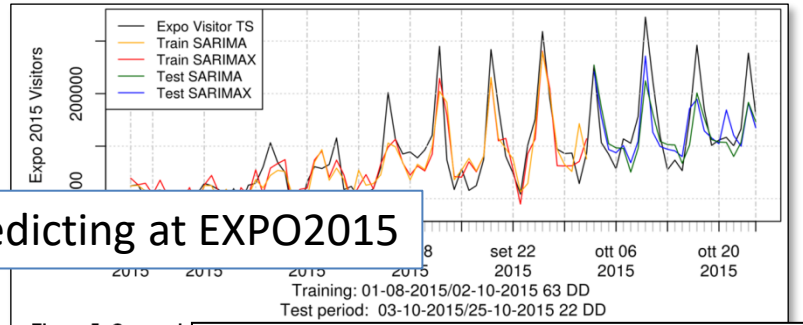


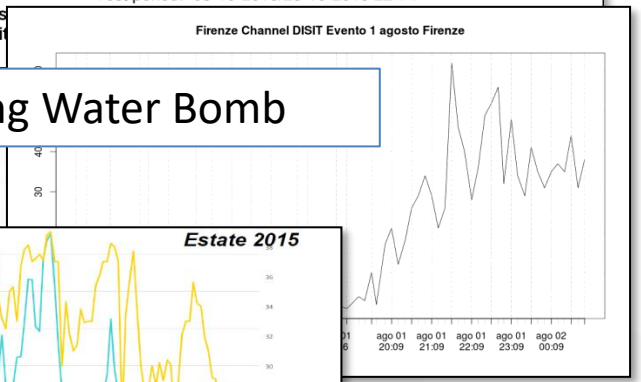


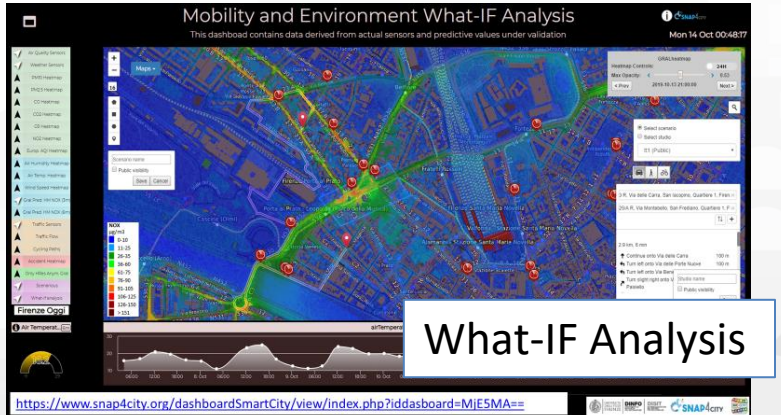


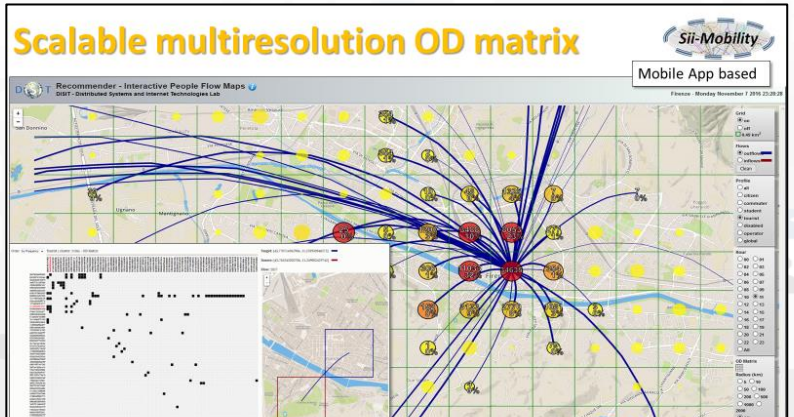


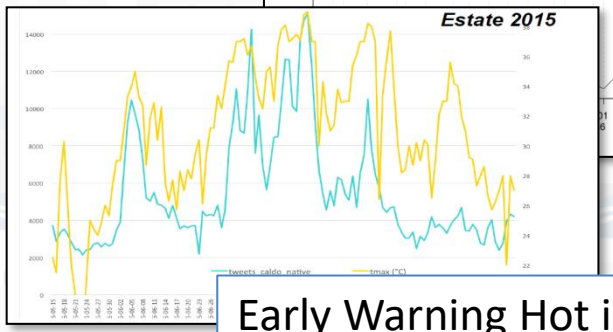












Disappearing Data Analytics

	Antwerp					Helsinki								Where				
SNAP4CITY	City official	ICT official	Developer	Citizen, tourist, visitor	Business owner	City officials	City officials Domain experts	City officials City developers	Third party developers	Citizen	Citizens with respiratory problems	Tourists	Business owners	Mobile	MIcroApplication	Tool, via Portal (ICT Developers)	Dashboards	RULE OF THUMB Main Data Sources
Discovery near to me	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			POI, OSM
Discovery along a path	x	x	x	x		x		x	x	x	x	x		x	x			POI, OSM
Discovery in an area, shape	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		POI, OSM
browsing Public Transport	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			OSM, GTFS
Full Text search	x	x	x	x	x	x		x	x	x	x	x	x	x		x		POI, OSM
Routing: pedestrian				x	x			x	x	x	x	x	x	x	x			OSM
Routing: pedestrian quite				x	x			x	x	x	x	x	x	x	x			OSM
Routing: private vehicles	x		x	x		x		x	x	x	x	x		x	x			OSM
Routing: Multimodal Public Transport				x					x	x	x	x		x	x	x		OSM, GTFS
heatmaps: weather (Temp, Humidity)	x	x		x	x	x	x		x	x	x	x	x	x			x	Sensors data, OSM
heatmaps: environmental variables, PM10, PM2.5, NO2, EAQI	x	x		x	x	x	x		x	x	x	x	x	x			x	Sensors data, OSM
heatmaps: environmental variables, Noise						x	x		x	x	x	x	x	x			x	Sensors data, OSM
heatmaps: safe on bike (Antwerp)	x	x		x	x									x			x	Spec. Portal
heatmaps: Enfuser prediction, PM10, PM2.5, AQI						x	x		x	x	x	x	x	x			x	Enfuser data
heatmaps piking values any place	x	x			x	x	x	x	x				x				x	Computed Heatmps
heatmaps: GRAL prediction, PM10						x	x		x	x	x	x	x	x			x	OSM, Traffic, Weather
Comparsison: Enfuser, Gral, Real Time						x	x										x	Enfuser, Sensors, GRAL
Sensors Data Time Trends, & drill down	x	x	x		x	x	x	x					x			x	x	Sensors data, OSM
Weather Forecast	x	x		x	x	x	x		x	x	x	x	x	x			x	Forecast Service
Origin Destination Matrices	x	x	x		x	x	x	x	x				x				x	Snap4City Mobile App
Typical trajectories	x	x	x	x	x	x	x	x	x				x			x	x	Snap4City Mobile App
Hot Area in the city	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	Snap4City Mobile App
Hot Places in Smart Zone	x	x	x	x	x									x		x	x	Snap4City PAXcounters
Services Suggestions on mobiles				x						x	x	x		x	x			Snap4City Mobile App
Alerts on critical cases: several variables	x			x	x	x	x			x	x		x	x				Sensors data, OSM
The most used services		x		x	x		x			x	x	x	x				x	Snap4City Mobile App
Twitter Trends Daily	x	x	x		x	x	x	x	x				x			x	x	Twitter Vigilance
The auditing of user and living lab		x				x		x								x		Snap4City Portal
Self assessment	x	x	x	x	x	x	x	x	x	x	x	x	x			x		Snap4City Portal
Trajectories reg from mobile PAX Counters	x	x	x			x	x	x							x		x	PAX Counters
Engagement real time assessment	x	x	x			x	x	x									x	Snap4City Mobile App

Mobile App Development
Smart City API and Federation

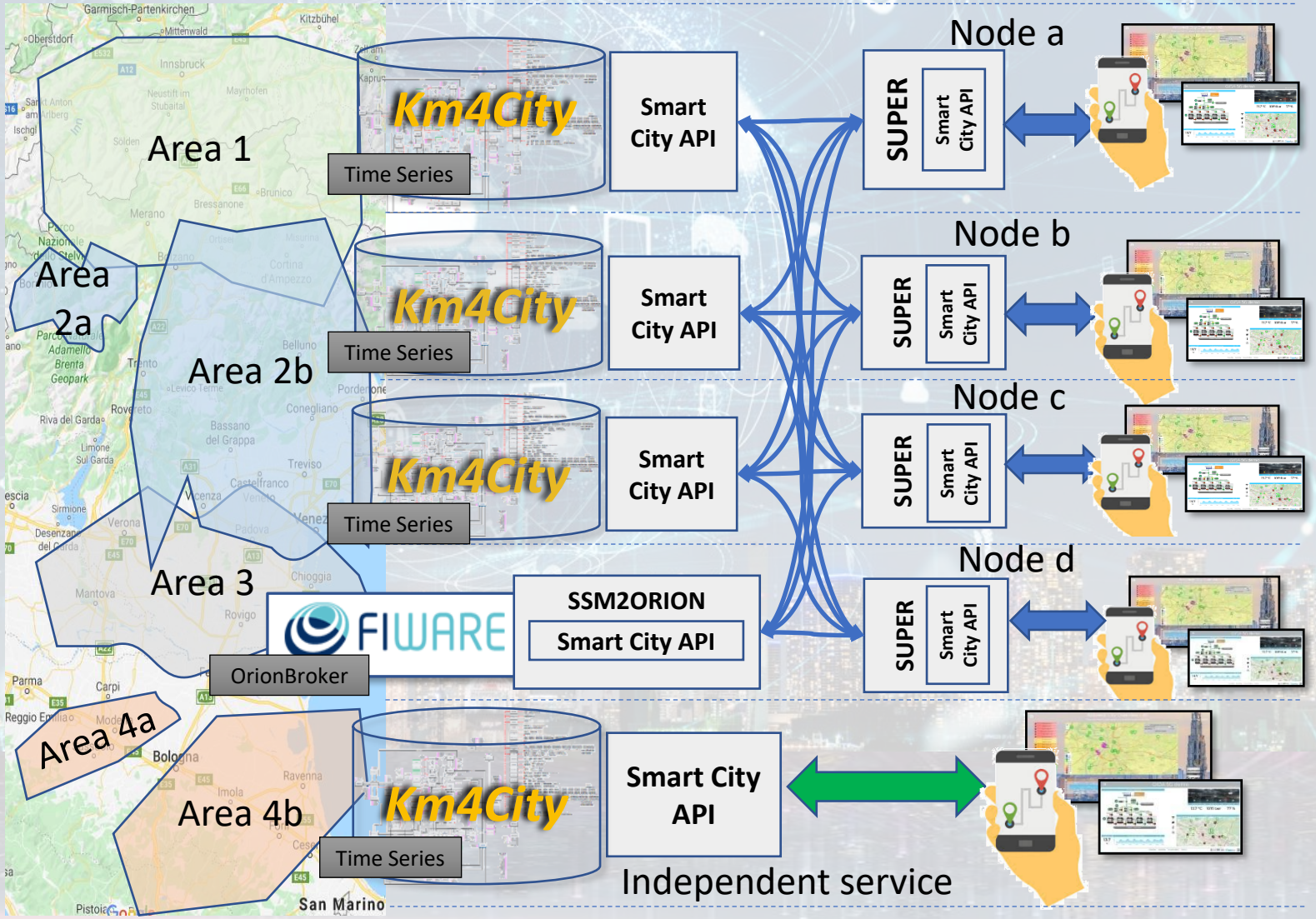
On Line Training Material (free of charge)

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



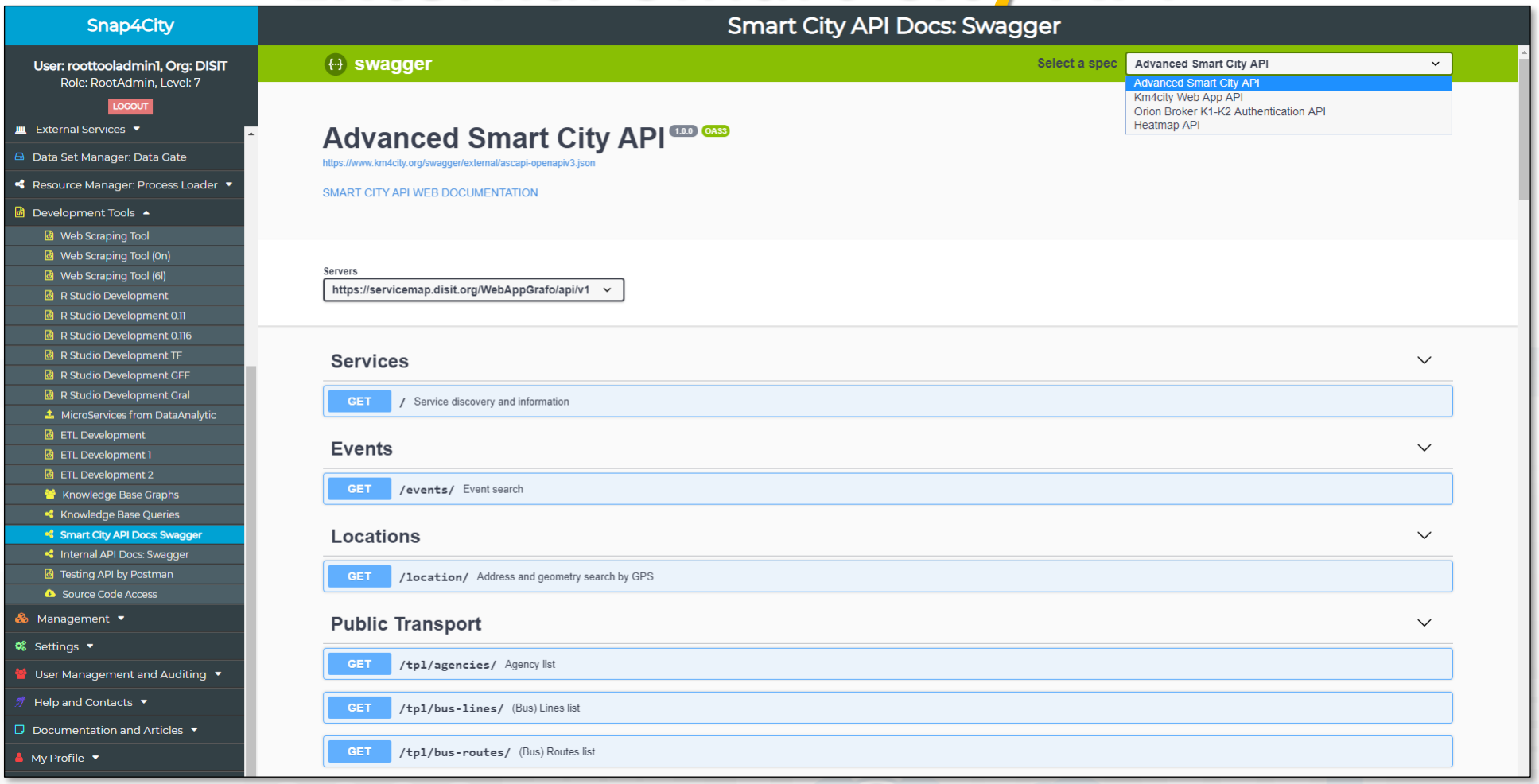
Federation of Smart City Services

Knowledge Base
Semantic Reasoners



- Km4City **Semantic Reasoner**
- **ServiceMap** interoperability
- **Seamless for multiple Mobile Apps**
- **Smart City API**
- **Super**:
  - distributed access and sharing services
  - Each city control its own data
  - Final user can pass from one city / area to another in seamless manner: without changing the mobile Apps

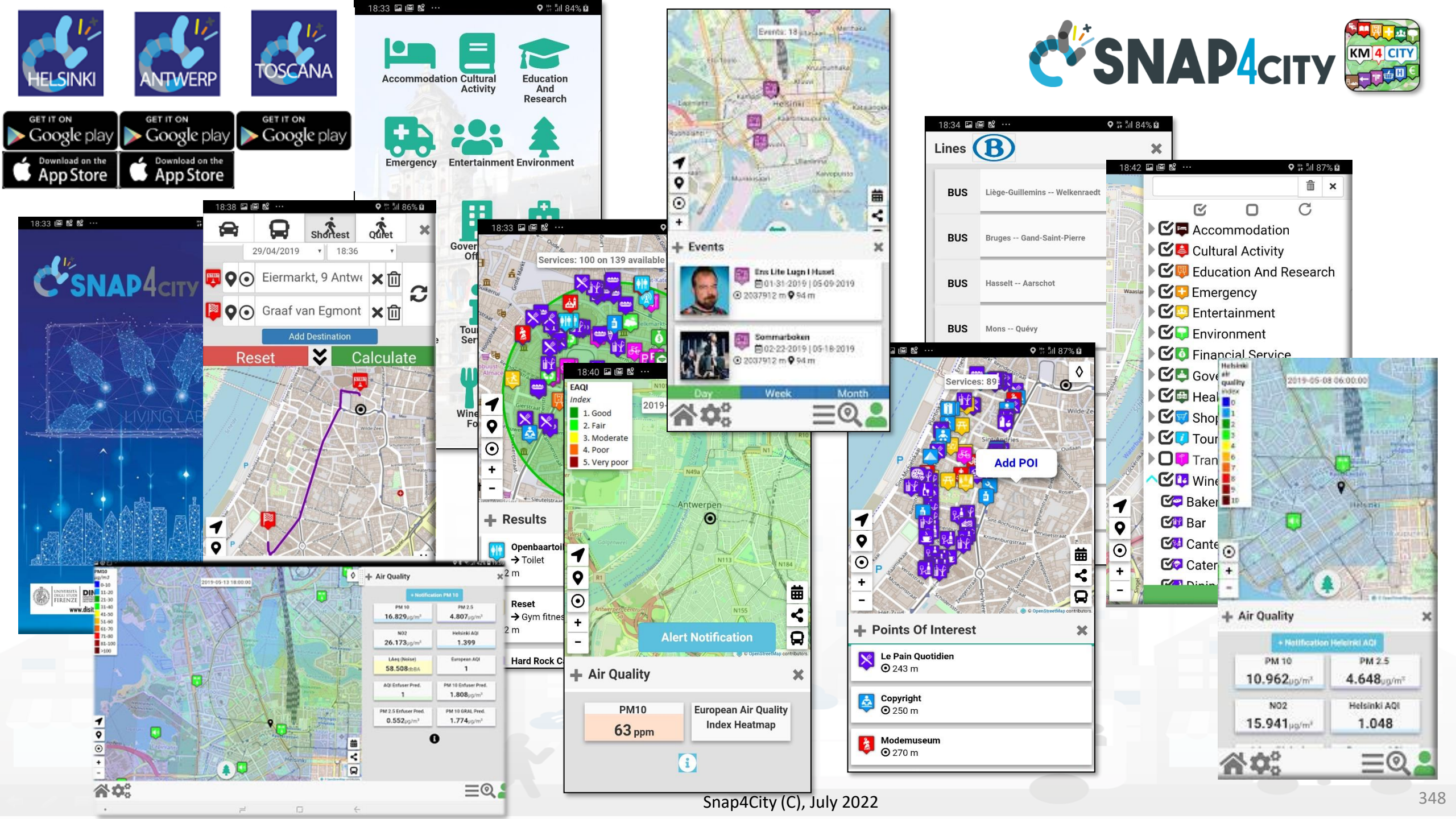
External Smart City API



https://www.km4city.org/swagger/external/index.html

External Smart City API

- **Advanced Smart City API**
  - To access the Service Map resources and query
- **Km4city Web App API**
  - To exploit MicroApplications created as tools for Dashboards, totem, web Apps, etc.
- **Orion Broker K1-K2 Authentication**
  - To communicate with IOT Orion Brokers exploiting the Secure Filter of Snap4City.
- **Heatmap**
  - To save and access to HeatMaps of the Heatmap server

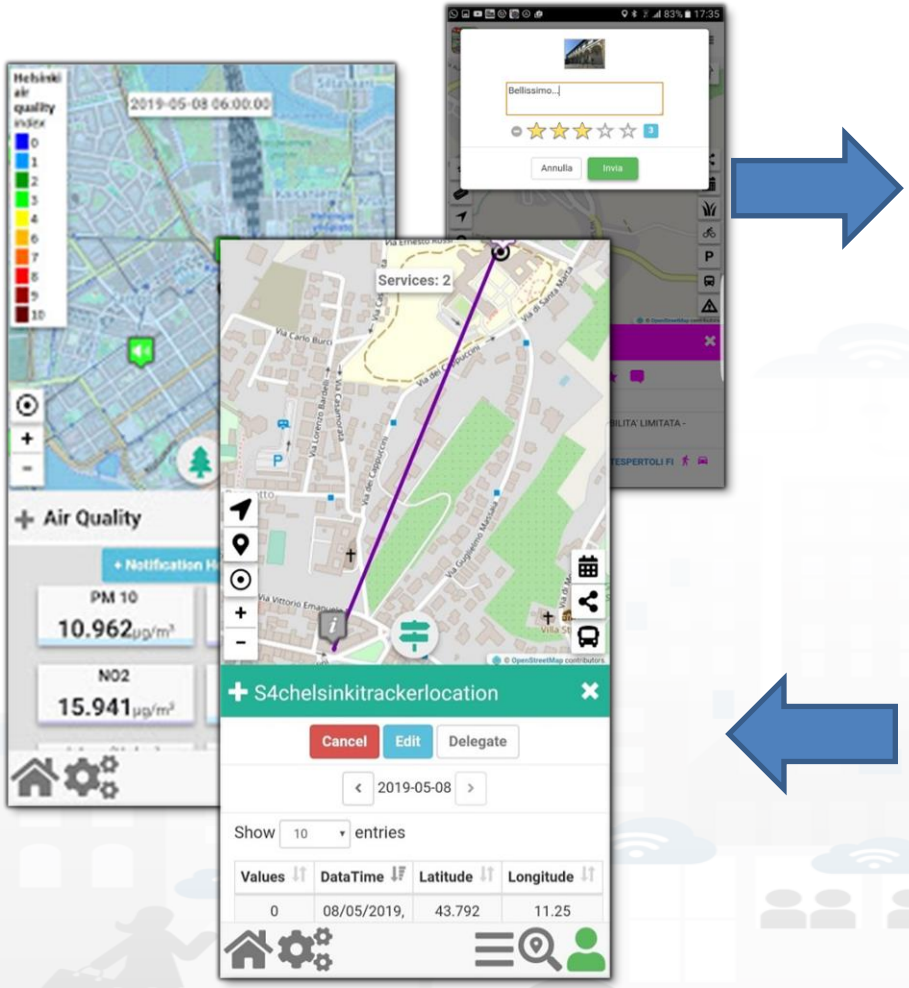

HELSINKI
ANTWERP
TOSCANA
GET IT ON Google play
Download on the App Store
SNAP4CITY
KM 4 CITY
Accommodation
Cultural Activity
Education And Research
Emergency
Entertainment
Environment
Shortest
Quiet
Add Destination
Reset
Calculate
Events
Day
Week
Month
Lines
BUS
Liège-Guillemins -- Welkenraedt
Bruges -- Gand-Saint-Pierre
Hasselt -- Aarschot
Mons -- Quévy
Services: 100 on 139 available
EAQI
Index
1. Good
2. Fair
3. Moderate
4. Poor
5. Very poor
Results
Alert Notification
Air Quality
PM10
63 ppm
European Air Quality Index Heatmap
Add POI
Points Of Interest
Le Pain Quotidien
243 m
Copyright
250 m
Modemuseum
270 m
Air Quality
PM 10
10.962
PM 2.5
4.648
NO2
15.941
Helsinki AQI
1.048

The App is a Bidirectional Device

- GPS Positions
- Selections on menus
- Views of POI
- Access to Dashboards
- searched information
- Routing
- Ranks, votes
- Comments
- Images
- Subscriptions to notifications
- ….

Produced information

- Accepted ?
- Performed ?
- …



Derived information

- Trajectories
- Hot Places by click and by move
- Origin destination matrices
- Most interested topics
- Most interested POI
- Delegation and relationships
- Accesses to Dashboards
- **Cumulated Scores from Actions**
- Requested information
- Routing performed
- …..

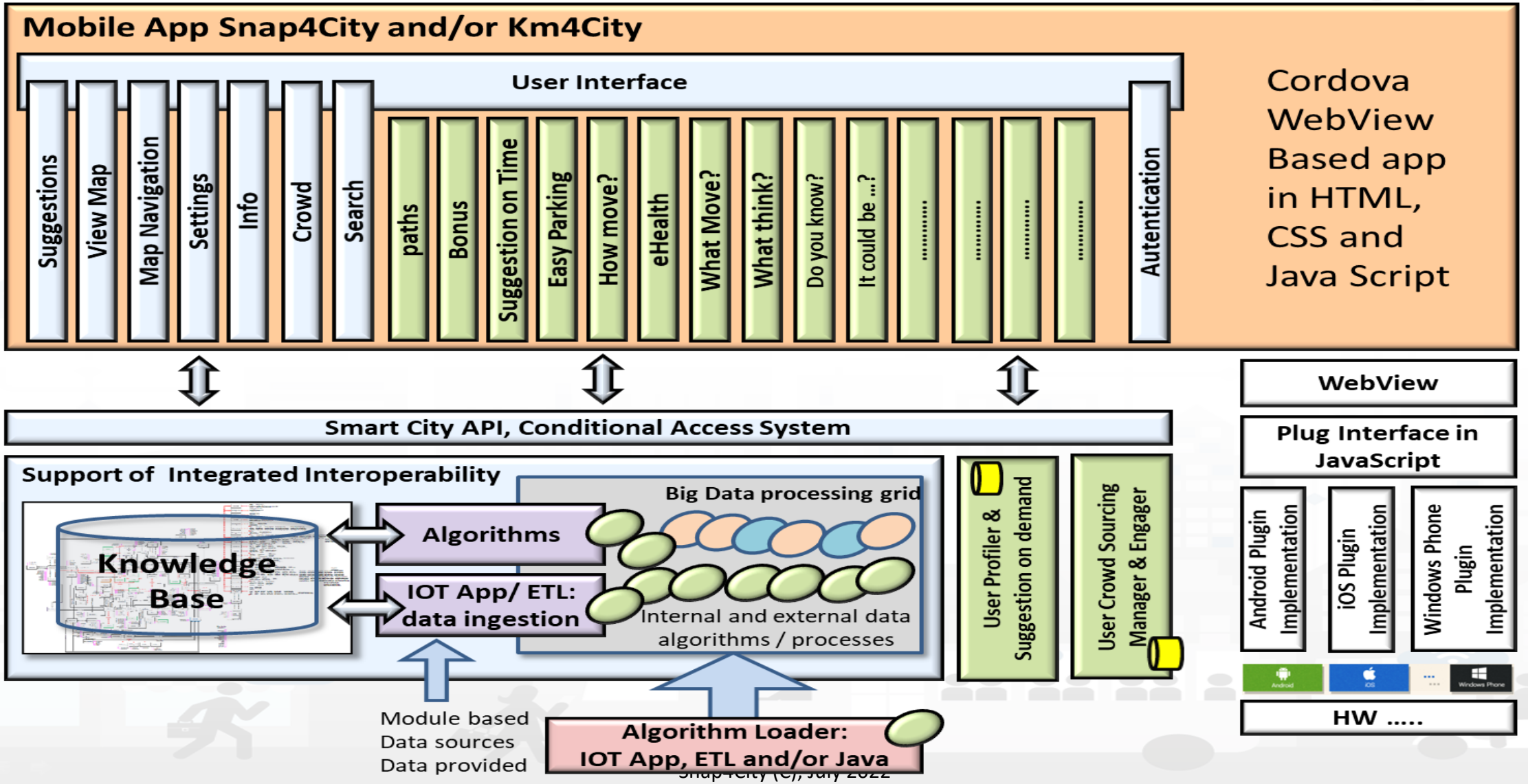
Produced information

- Suggestions
- Engagements
- Notifications
- …

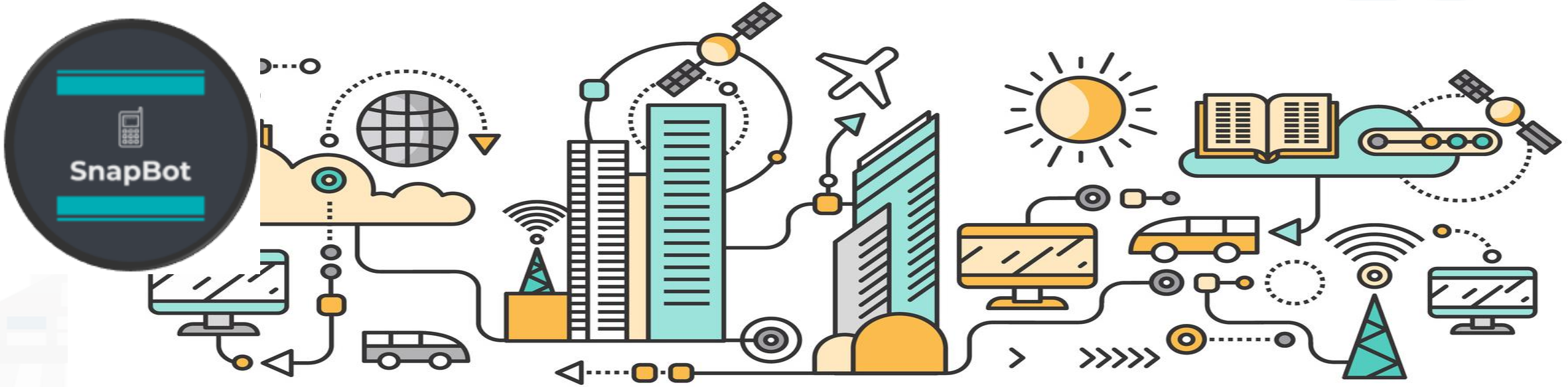
Users

System

General architecture of Mobile / Web App

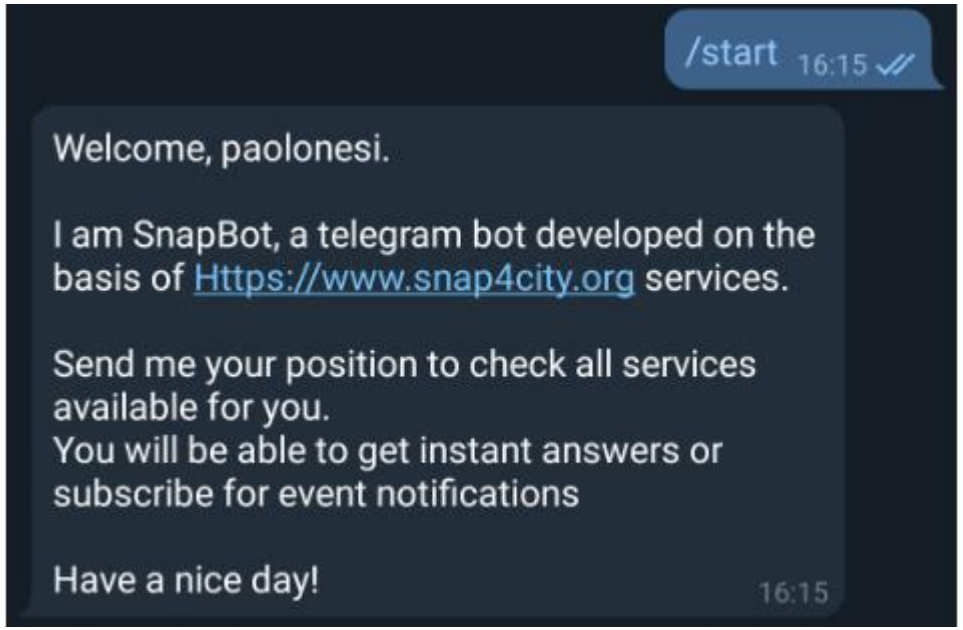


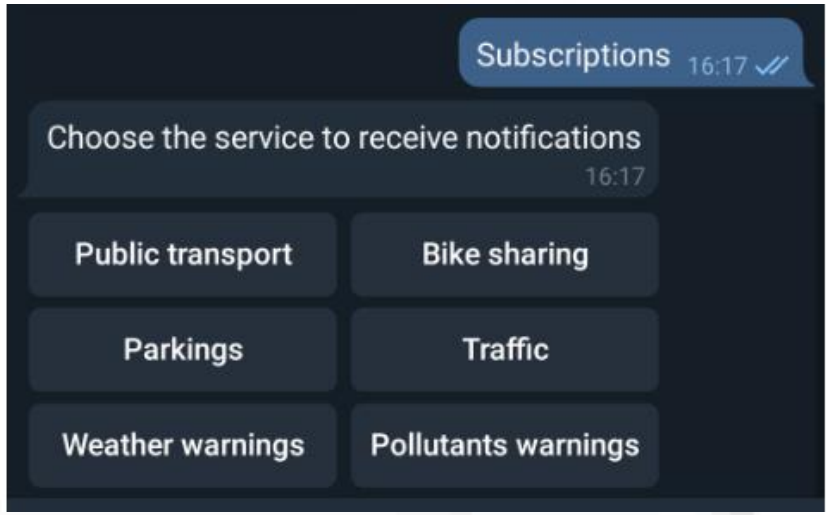
Integration with Telegram: SnapBot solution



SnapBot

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

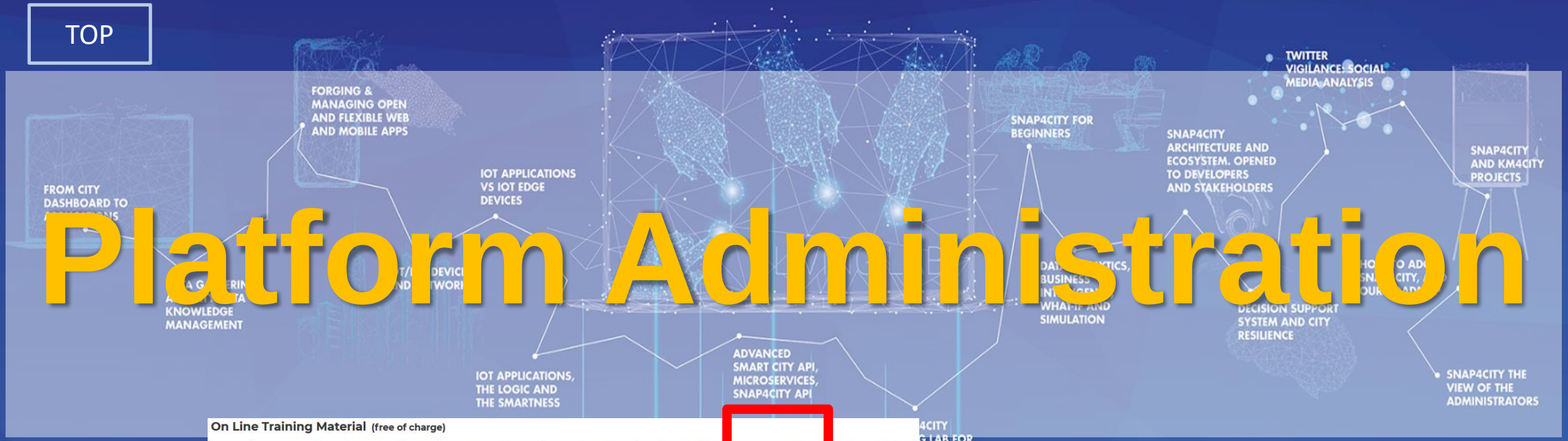






TOP

Platform Administration



On Line Training Material (free of charge)

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

100% OPEN SOURCE

SNAP4 Appliances and Dockers **Installations**

Smart City Functional Architecture

Transport systems
Mobility, parking



Public Services,
Govern, events, …



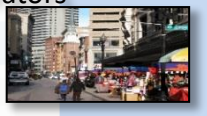
Sensors, IOT Cameras,
Wi-Fi



Environment, Water,
energy



Shops, services,
operators

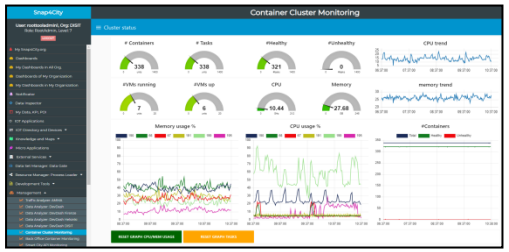


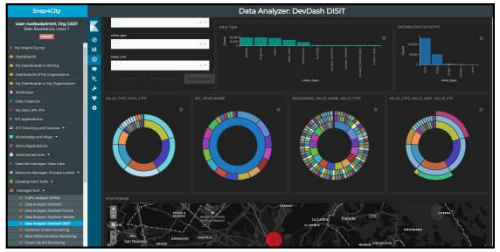
Social Media

Social Media Crawler and Manager

Back office tool







Back-End ⟵ ⟶ Front-End

Data Sources, External Services *PULL Data*

Data Sources, Brokers, External Services *Data Driven, Real Time*

Data and channel interface interoperability

Big Data Storage and Indexing

Federation

Search and Query, Smart City API, Web Socket Server, GIS, Facet, semantic

Data Analytics, Simulations, Special Tools
R Studio, Tensor Flow, Python, ….

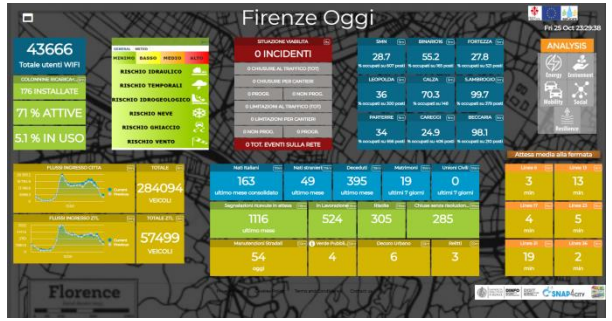
IOT Applications, Business Logic
Node-RED + Snap4City MicroServices

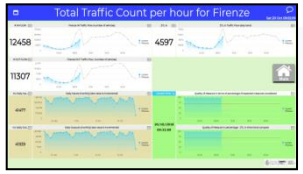
Inform, announce, Act!, warning, alarms, What-IF

thorization, Platform & Processes Management, Data Inspector, Digit

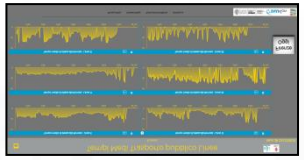
Dashboard, BIM, Synoptics, Visual Analytic, mapping, etc.

Dashboards, visual tools,
Web and Mobile Apps



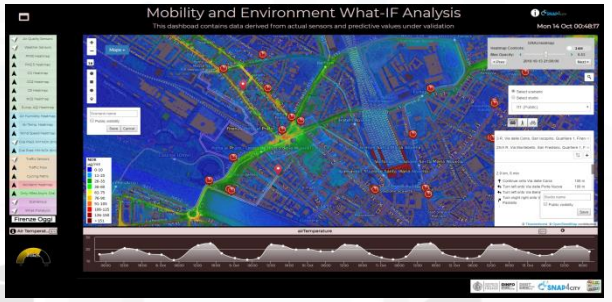












Smart City Functional Architecture

Transport systems
Mobility, parking



Public Services,
Govern, events, …



Sensors, IOT Cameras,
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Environment, Water,
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Shops, services,
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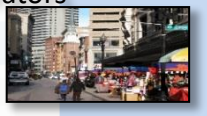

Social Media

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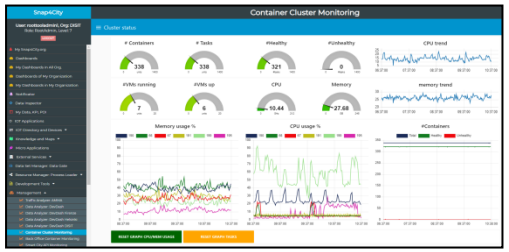
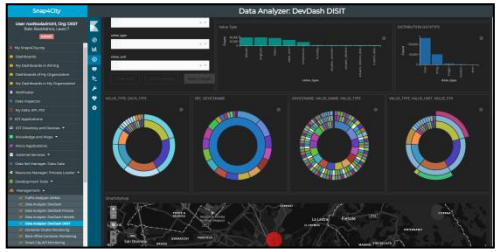
Back office tool







Back-End ← → Front-End

Data Sources, External Services *PULL Data*

Data Sources, Brokers, External Services *Data Driven, Real Time*

Data Ingestion, aggregation, regularizatio n, reconcile: IOT Directory, NIFI, special tools

Knowledge base Semantic Reasoners

Indexing and aggregating NiFi, OpenSearch

Federation

Search and Query, Smart City API, Web Socket Server, GIS, Facet, semantic

Data Analytics, Simulations, Special Tools R Studio, Tensor Flow, Python, ….

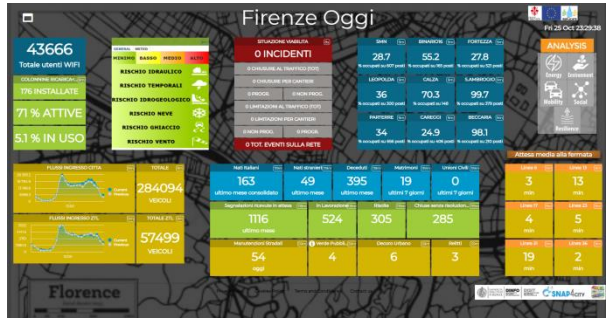
IOT Applications, Business Logic Node-RED + Snap4City MicroServices

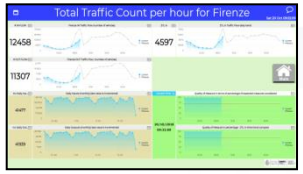
Rendering Acting, Widgets, Synoptics, MicroApps User interface, Drill down, maps, heatmaps

Inform, announce, Act!, warning, alarms, What-IF, ..

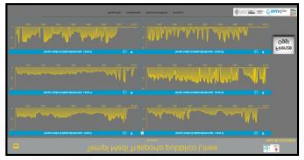
Authentication, Authorization, Platform & Processes Management, Data Inspector, Digital Twin, …

Dashboards, visual tools,
Web and Mobile Apps



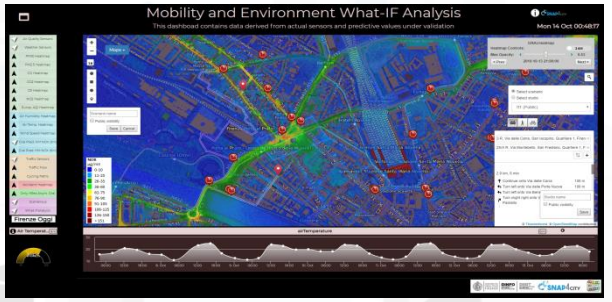












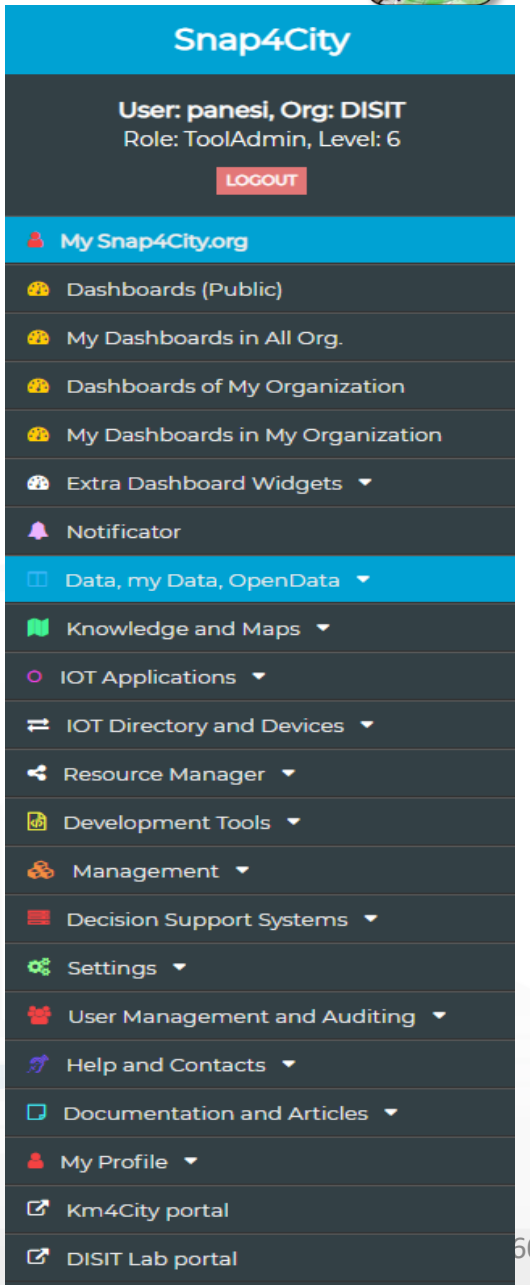
Roles in Snap4City/Industry solutions

- **RootAdmin**
  - The gods of the specific installation, access to all tools for all Organizations
- **ToolAdmin**
  - The administrators of an Organization with some capabilities on single tools
- **AreaManager (developers)**
  - access to development tools, access to a wider number of resources, IOT with both basic and advanced, IOT Models, etc.
- **Manager (final users)**
  - limited access to development, IOT App development with Basic library.

- **Users of any Role** have full control on their own resources: data, devices, dashboards, IOT App, etc., which may control according to GDPR rules,
  - providing access, revoking, etc.
- **All users start as Manager roles**
  - All users have also a Level (numeric). A score about what they have exploited in the platform. Higher scores correspond to wider exploitation of capabilities.
- **RootAdmin users may**
  - pass Users to higher roles. Ask to snap4city@disit.org to become an AreaManager for testing
  - Provide/grant specific authorizations to data access on Tool usage
- In the Installation onPremise, you become the RootAdmin of it, you decide ALL.

Management by Organization

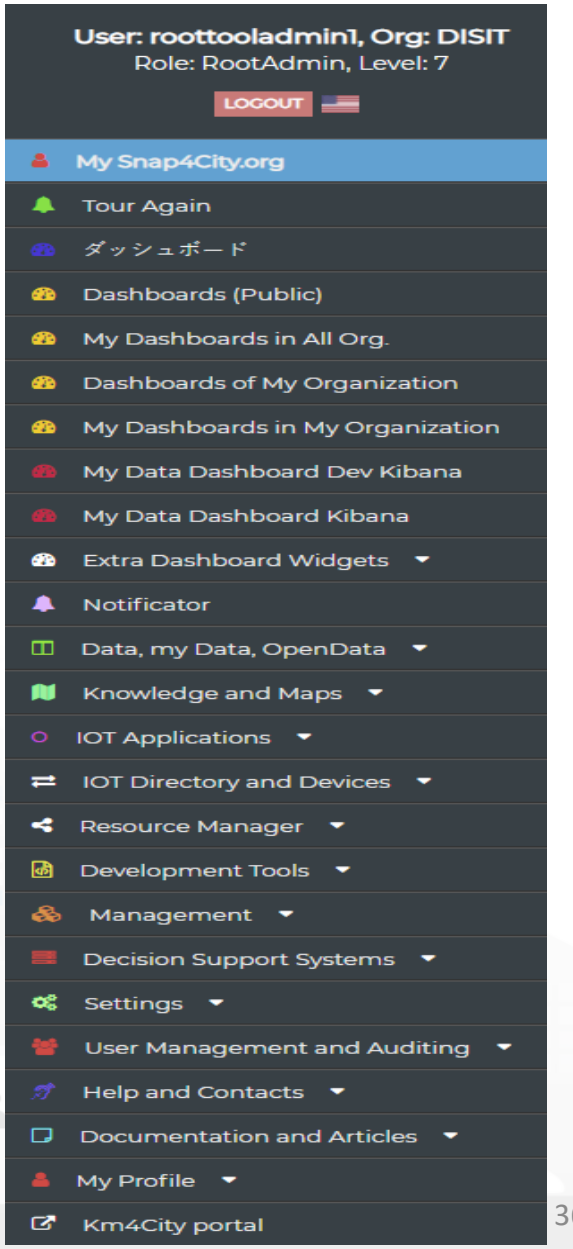
- **Organizations** /Tenant may have
  - name, ID, GPS center, a number of Groups on Snap4City.org (living lab support Drupal)
  - users of different kinds and may impose early bounds on the resourced used by users (IOT Dev, IOT App, Dash)
  - on cloud user kinds up to level of Tool Administrator
  - One or more ServiceMap and boundaries for the federation
- **ToolAdmin** users (requested by Organizations) may
  - control processes, consumption of resources, healthiness, etc.
  - manage tools exploited in your configuration
- **24H/7D Help Desk and Assistance**



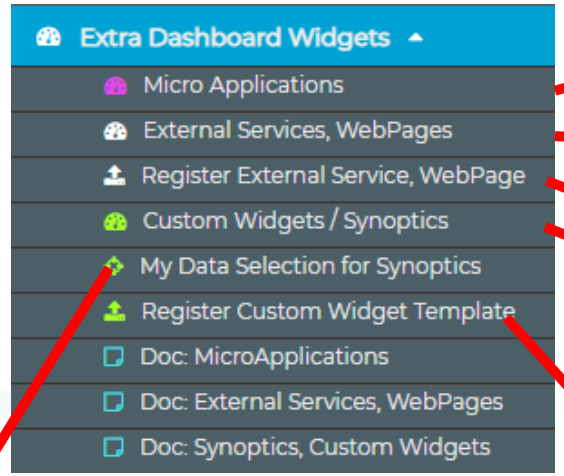
RootAdmin

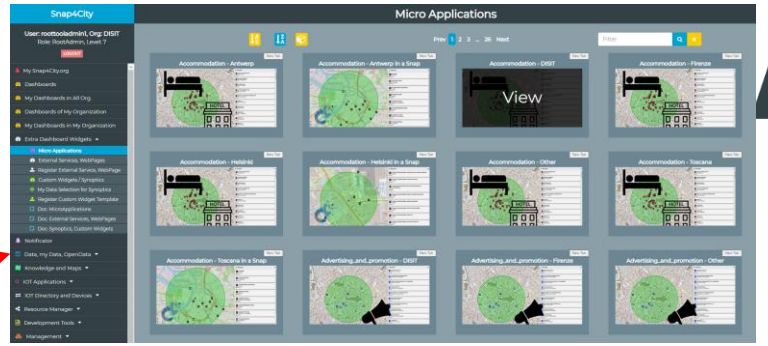
- RootAdmin on Snap4City.org has a very large set of tools
  - My Snap4City, ….Tour, etc.
  - Dashboards
  - **My Data Dashboard (Kibana)**
  - **Extra Dashboard Widgets**
  - Notificator
  - **Data, My Data, OpenData**
  - **Knowledge and Maps**
  - **IOT Applications**
  - **IOT Directory and Devices**
  - **Resource Manager**
  - **Development Tools**
  - **Management**
  - **Decision Support Systems**
  - **Settings**
  - **User Management and Auditing**
  - Help and Contacts
  - Documentation and Articles
  - …….

In this section of the slides, those market in bold are presented.



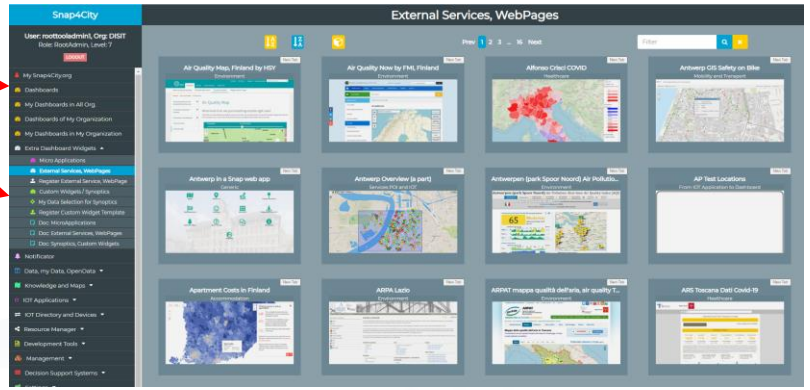
Extra Dashboard Widgets



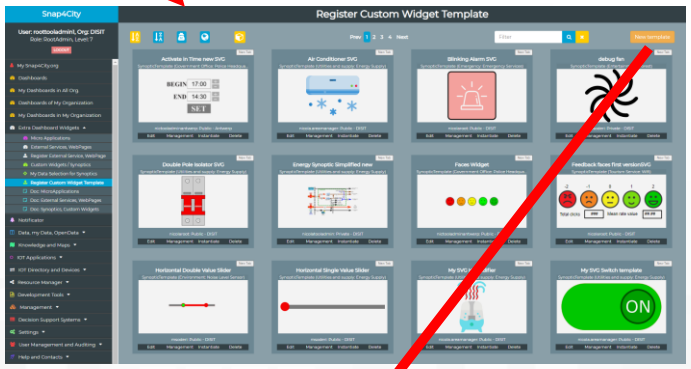


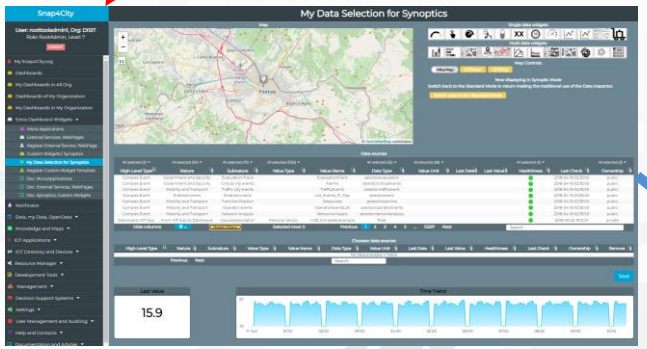
MicroApplic.



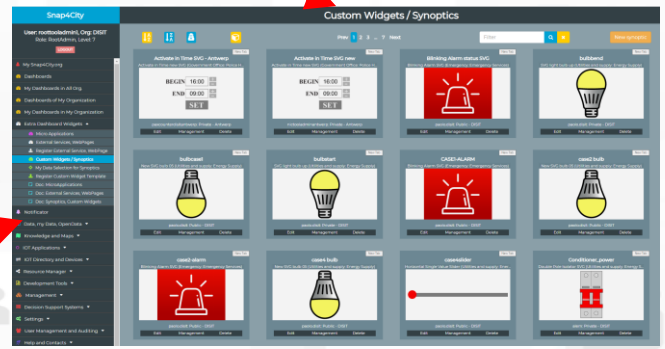


External Services



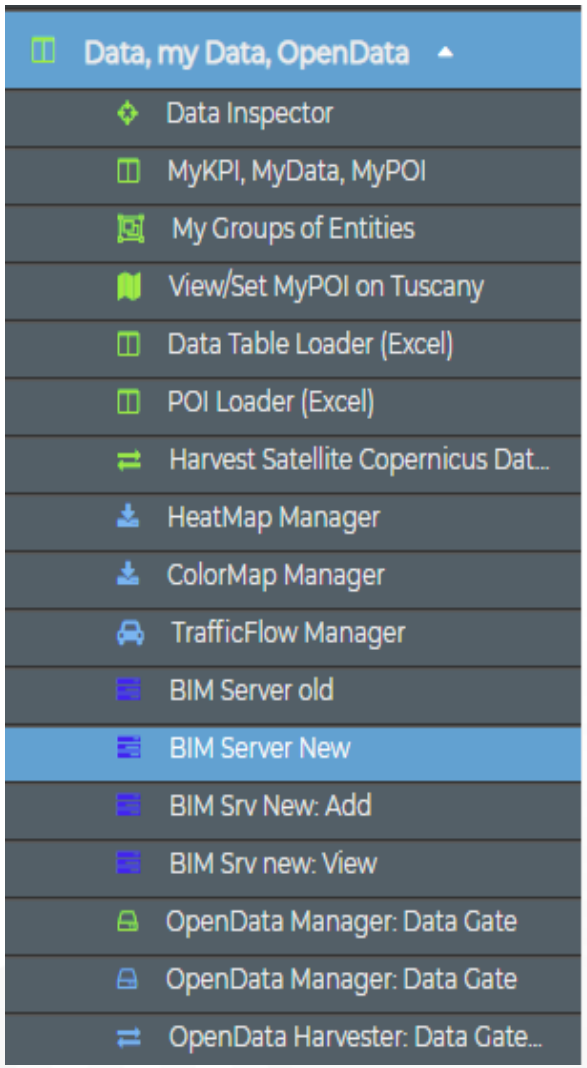






Synoptics, Custom

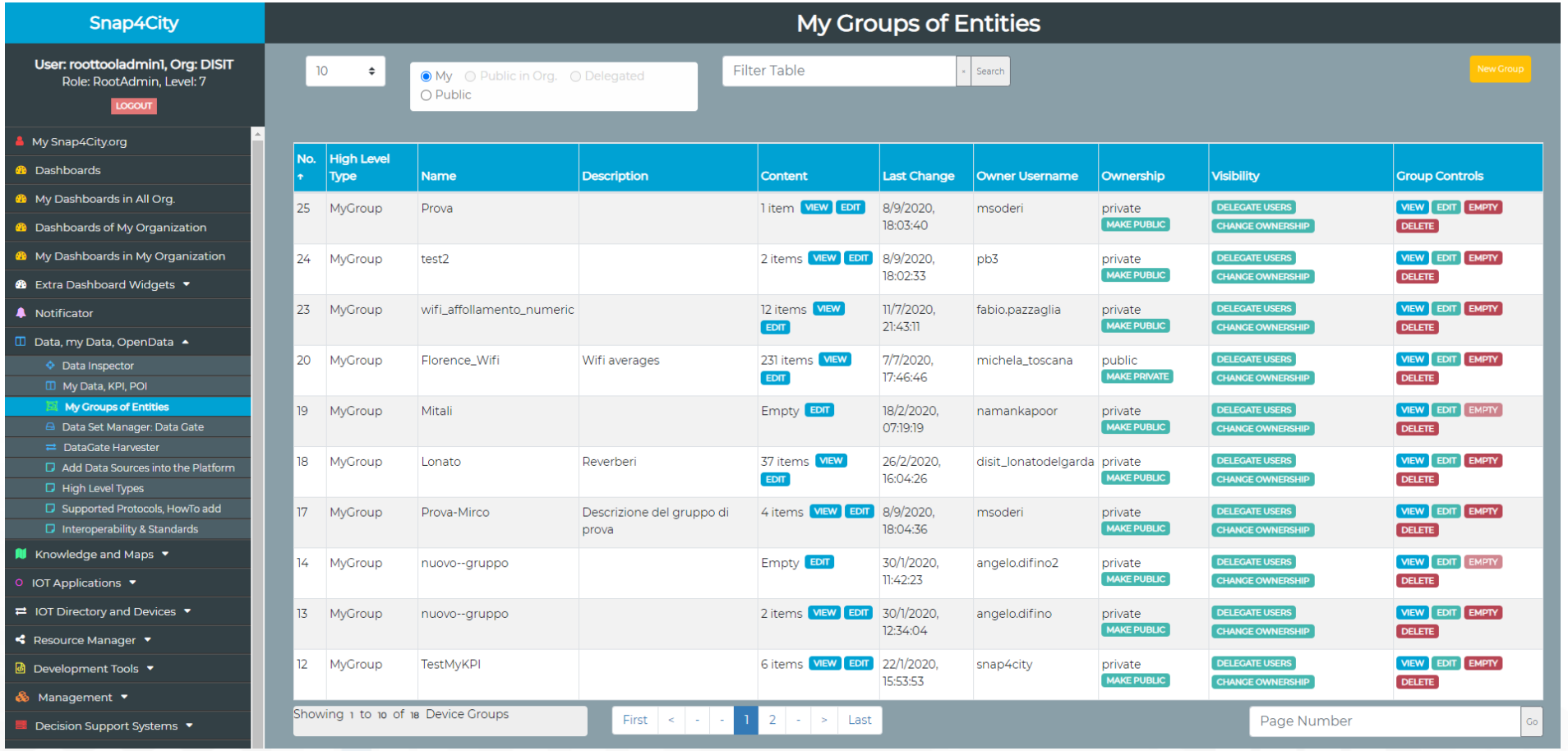
Data My data



- **Data Inspector**: to understant and see Digital Twin details of data
- **MyKPI, MyData, MyPOI**: to model and save your personal data
- **My Groups** of Entities: to create an aggegregation of Snap4City artects, entities to manage them in one shot
- **Data Table Loader**: fast load excel File as IOT Devices, IOT Device Model and instances
- **POI Loder**: fast load of Excel file with POI
- **Harvesting** satellite: to request data from Satellite services and make from them heatmaps
- **Heatmap Manager**: management of GeoTiff heatmaps as sequence of complex data
- **Traffic Flow Manager**: management of Traffic Flows as sequence of complex data
- **Color Map**: to code rendering colors of other Managers
- **BIM**: support 3D for the Digital Twin Local
- **Open Data, CKAN**: harvesting and publishing open data

Managing Groups

- **My Groups of Entities**
  - **Licensing group of Entities in One Click**

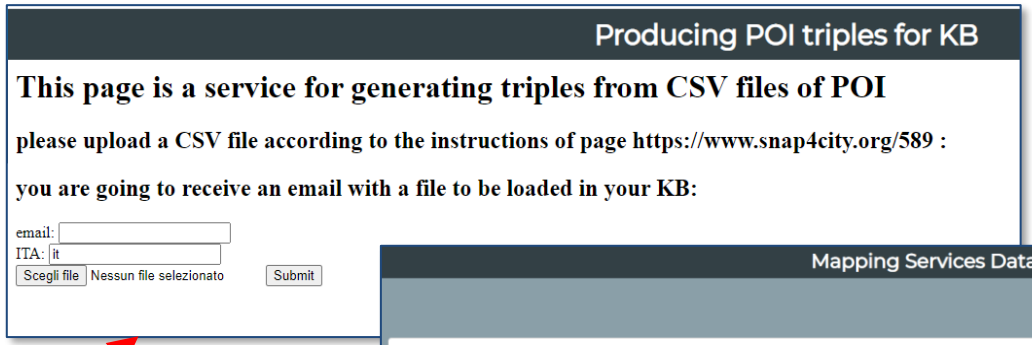


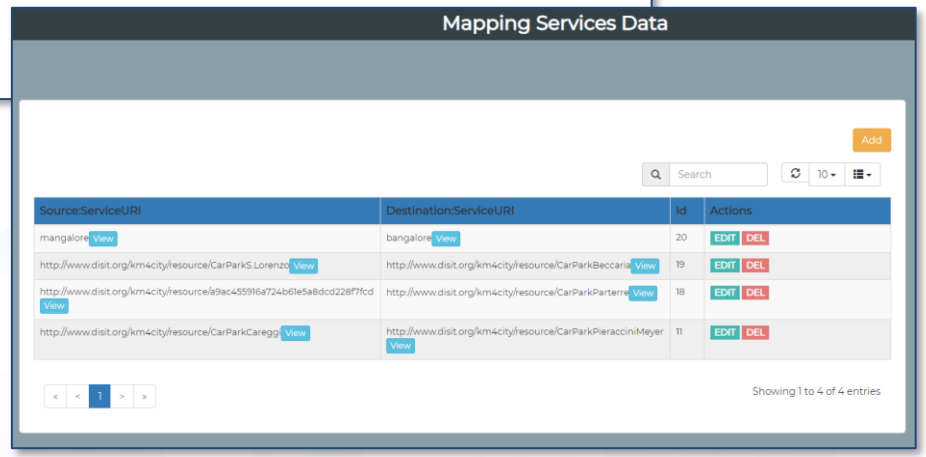
- For non admin tools see other Training parts: https://www.snap4city.org/577

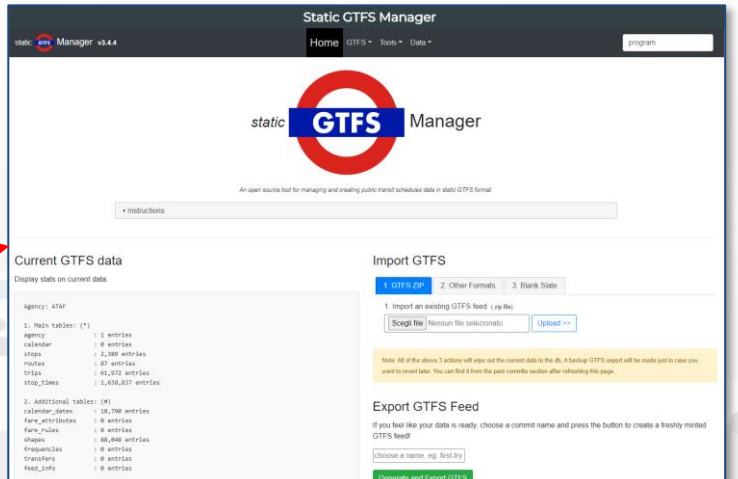
Knowledge and Maps

Knowledge and Maps
Service Map (Toscana)
Service Map 3D (Firenze)
Helsinki Service Map
Antwerp Service Map
Garda Lake Service Map
Cagliari Service Map
Lonato Del Garda Service Map
Valencia Service Map
Pont Du Gard Service Map
Dubrovnik Service Map
WestGreece Service Map
Mostar-Bosnia Service Map
Svealand Service Map
Roma Service Map
Pisa Service Map
Creating WKT
Service Map 3D (Antwerp)
Service Map 3D (Helsinki)
Producing POI triples for KB
Load WKT on ServiceMap (Helsinki)
Load WKT on ServiceMap (Toscana)
Load WKT on ServiceMap (Antwerp)
My Annotation on Services/Data
Mapping Services Data
ArcGIS DISIT Service
Static GTFS Manager

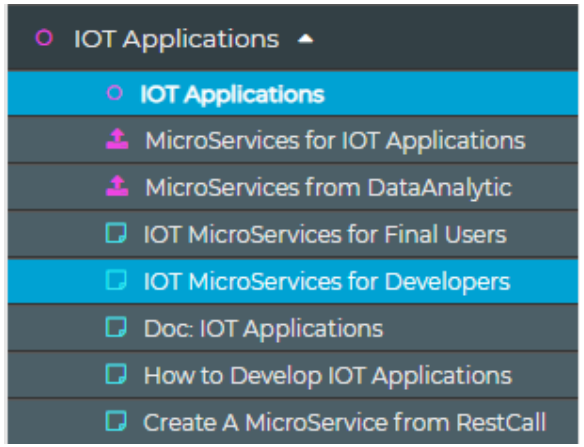
- A number of ServiceMaps, Knowledge bases, KB
- Tools for creating WKT, shapes
- Access to ServiceMap 3D, if any
- Service for Loading triples on KB
- My Annotations (deprecated)
- Mapping Tool (partial)
- GIS servers, if any
- Static GTFS editor and manager (if any)

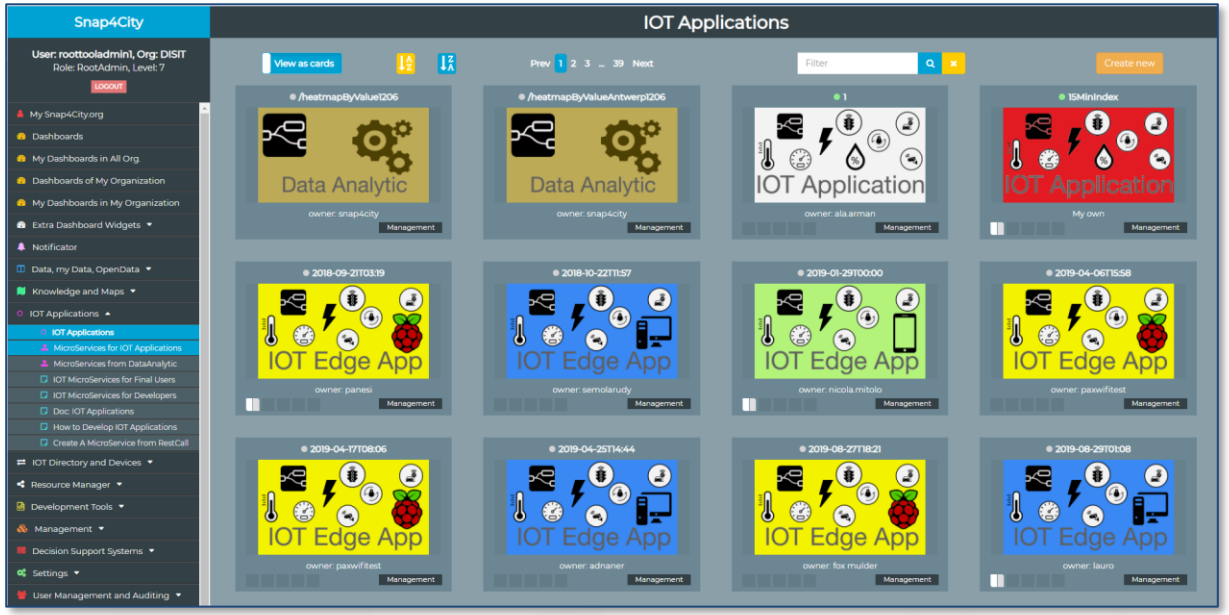






IOT Applications

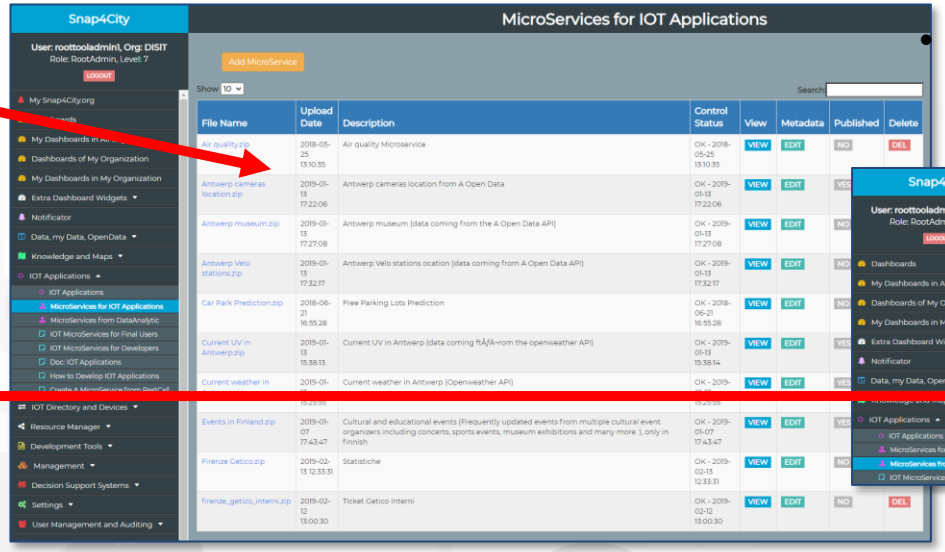


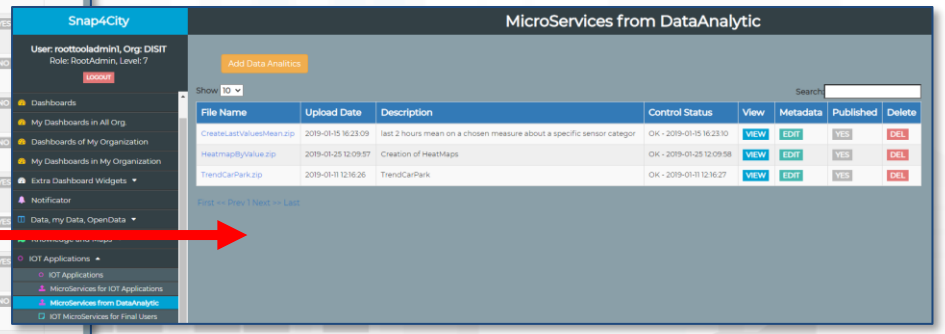


- **IOT Applications**: a view to manage Containers / IOT Edge Apps: IOT Apps, Data Analytics (R and Python), WebScraping, IOT edge, etc.

Managing also

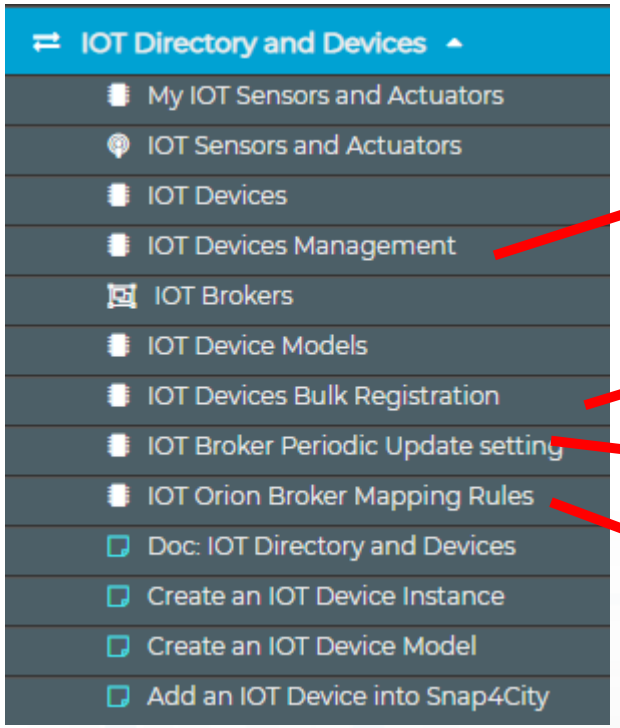
- **MicroServices for IOT App exploiting REST Call**
- **MicroServices from DataAnalytics**

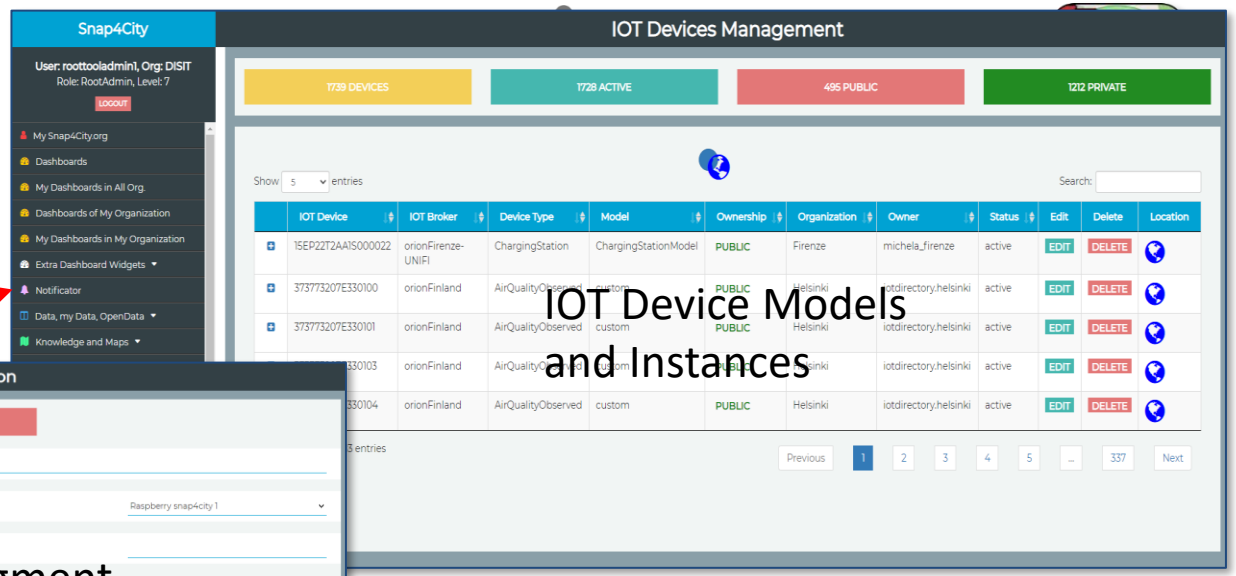




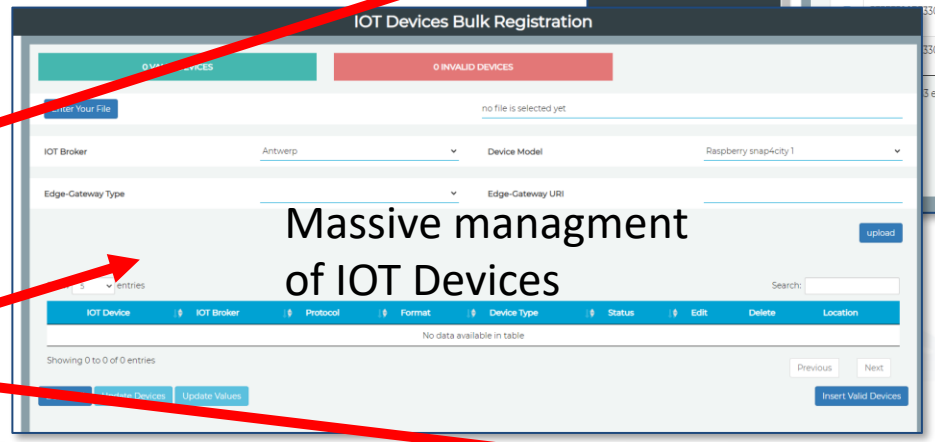
For non admin tools see Training parts 3 and 5: https://www.snap4city.org/577

IOT Directory and Devices

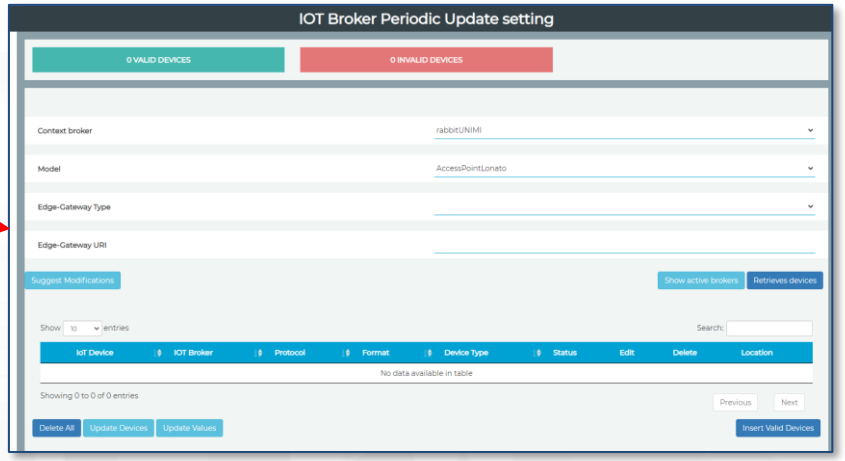


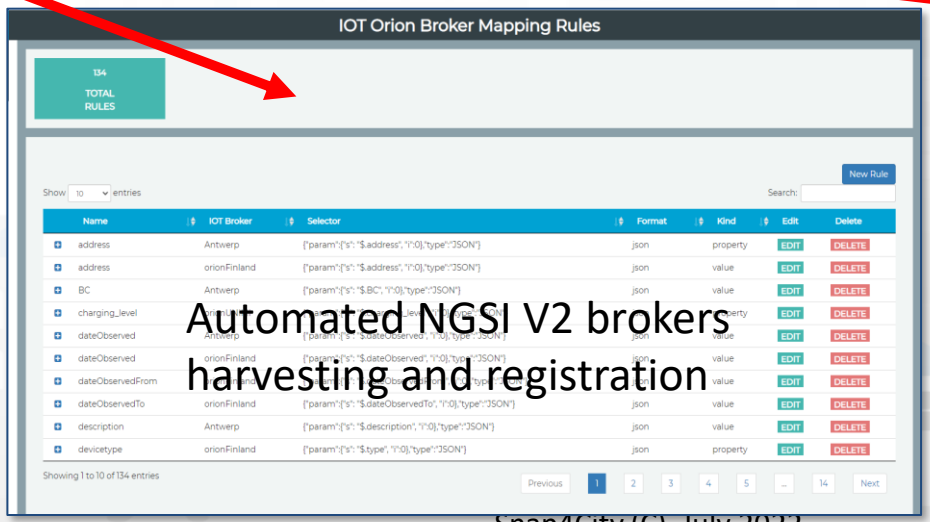


IOT Device Models and Instances



Massive managment of IOT Devices



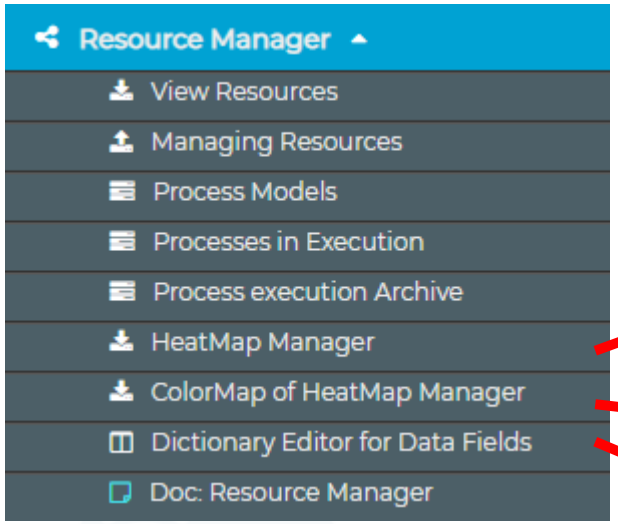


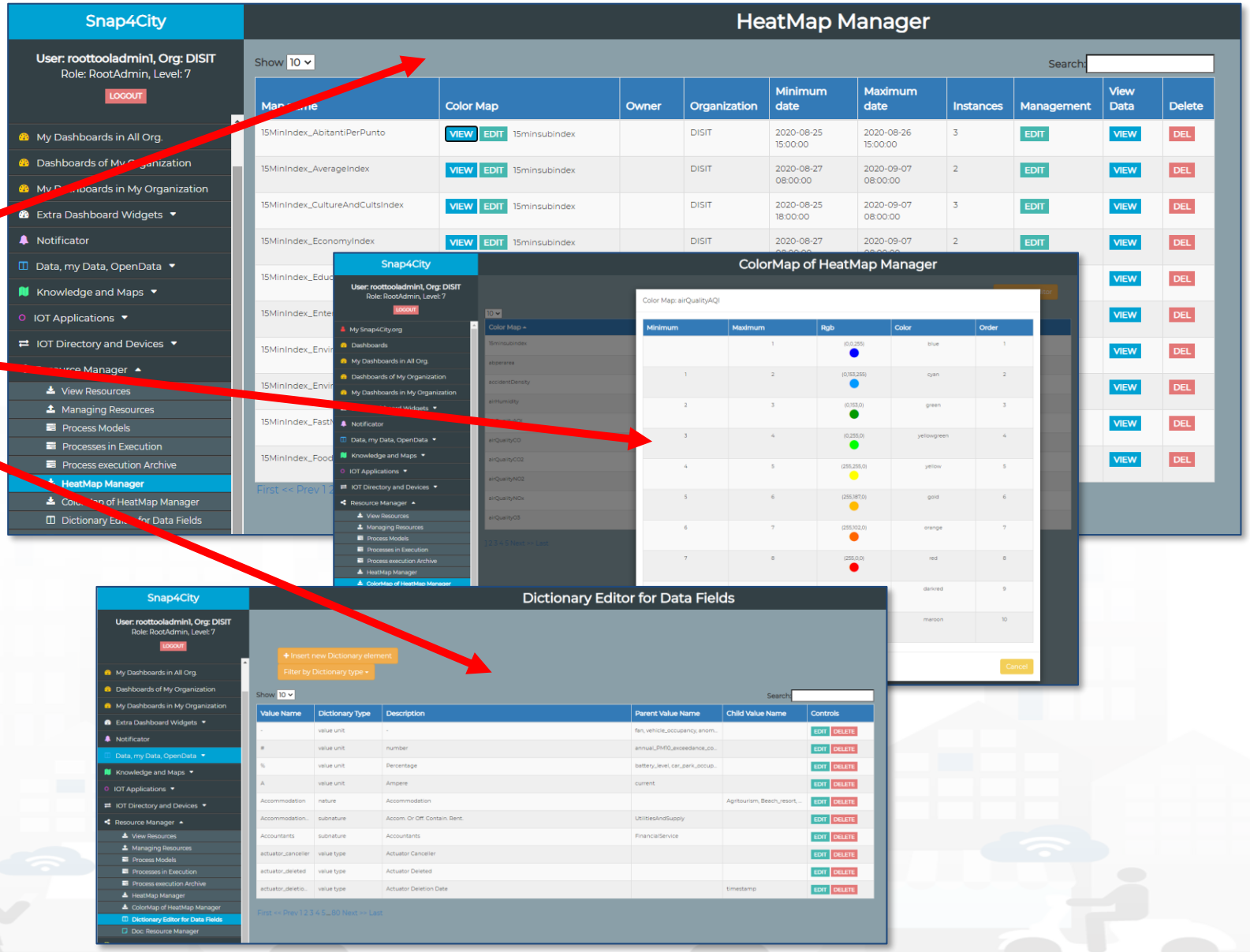
Automated NGSI V2 brokers harvesting and registration

IOT Directory manages multiple internal and external IoT Context Brokers

- For non admin tools see Training parts 3 and 5: https://www.snap4city.org/577

Resource Manager

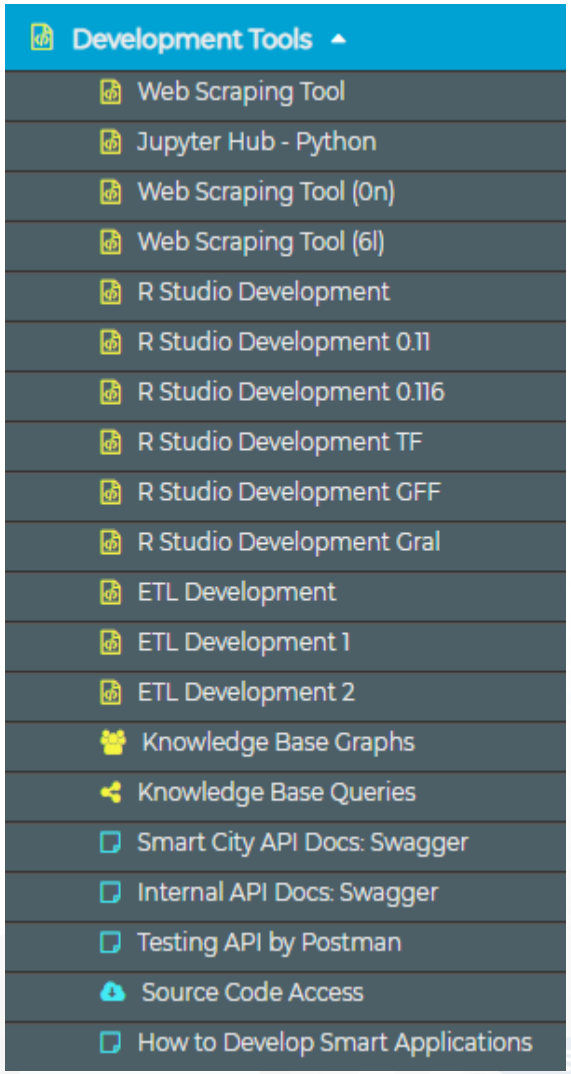




- Tools for managing shared resources among Organizations and Users

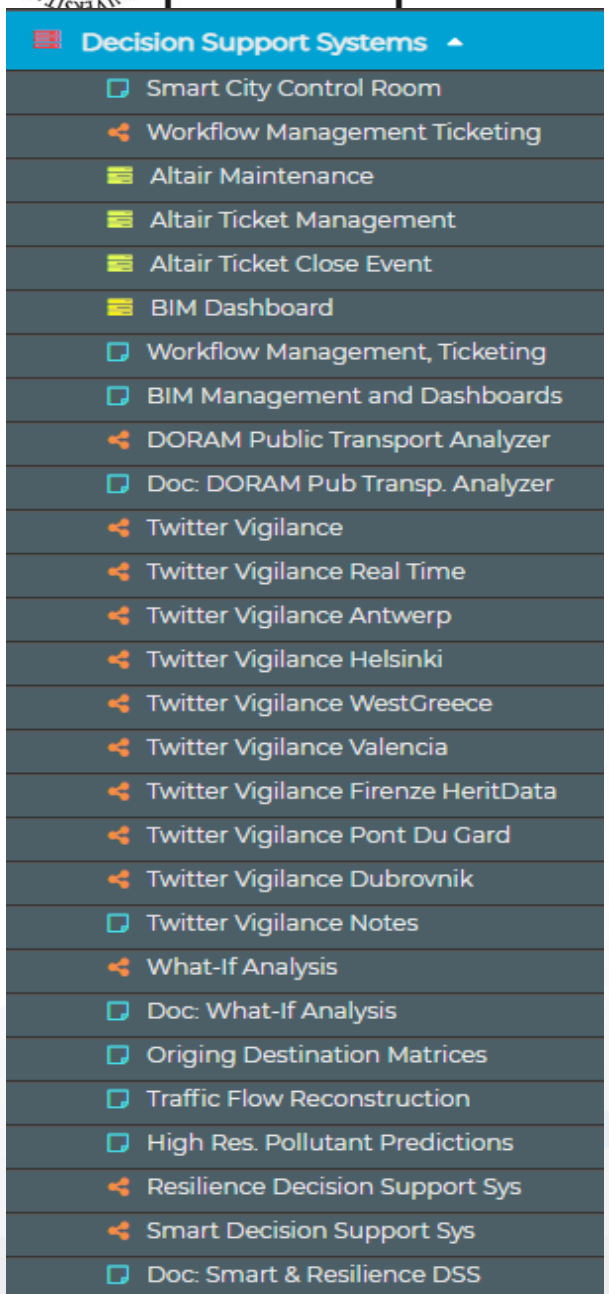
- For non admin tools see Training parts: https://www.snap4city.org/577

Development Tools



- *All these tools are well described into Training parts: https://www.snap4city.org/577*
- *The Administrators may*
  - *access to all instances of them*
  - *Grant access to them at specific AreaManager users*

- **API and Swagger documentation**
- **Model Knowledge Base Graphs (LOG.disit.org)**
- **Python online dev. Environment**
- **R Studio Online dev. Environment**
- WebScraping tool
- SPARQL Editor and tools (custom FLINT)
- ETL OnLine dev. Environment (deprecated)



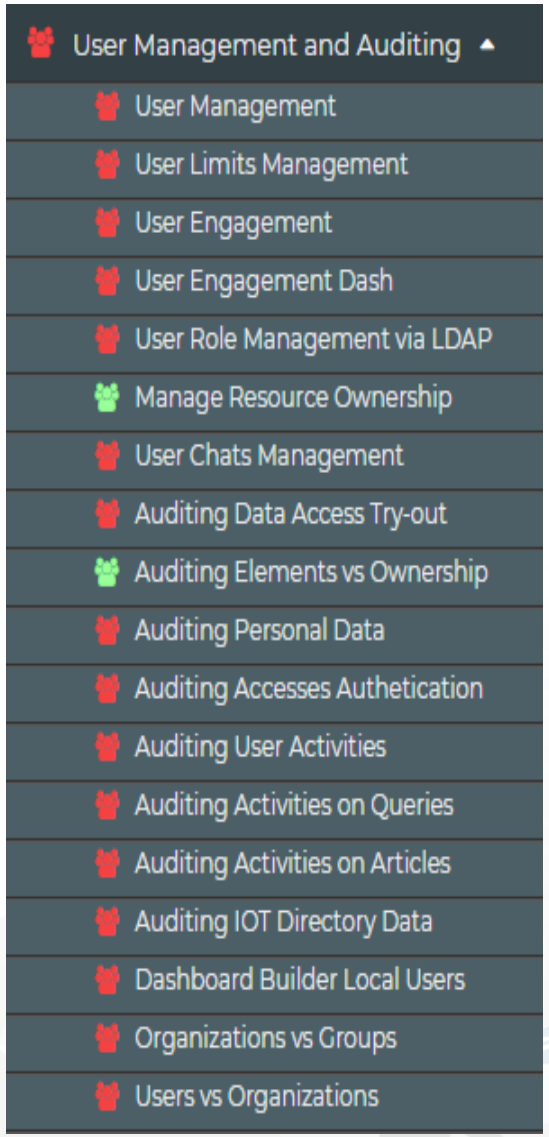
Decision Support Systems

- All these tools are well described into Training parts: https://www.snap4city.org/577
- Some of these tools need special VM / appliances, services to be activated
- Most of them are accessible to the public at least with guest account
- The Administrators may
  - access to all instances of them
  - Grant access to them at specific AreaManager users
- DSS: SmartDS, ResilienceDS, …

User Management

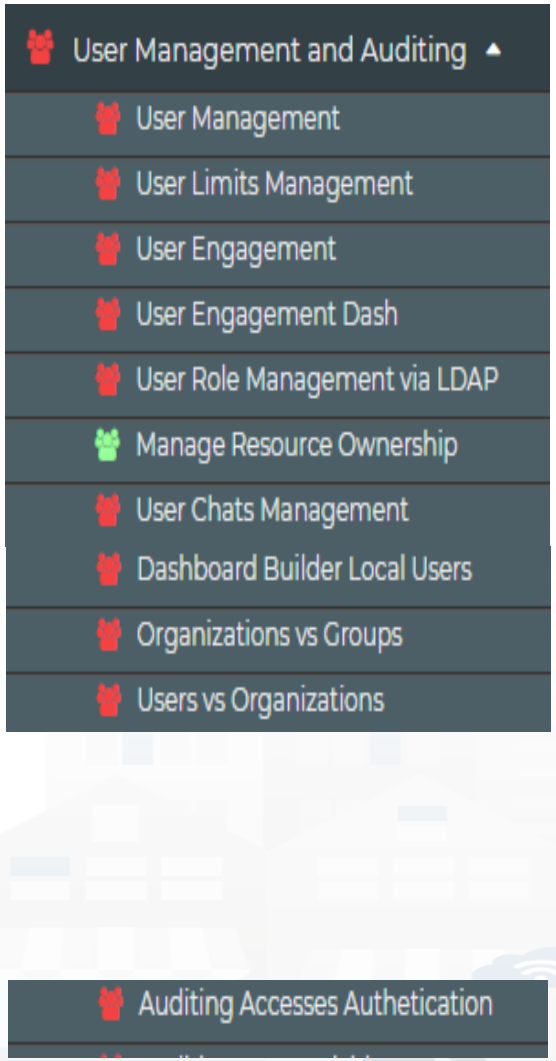


User Management and Auditing



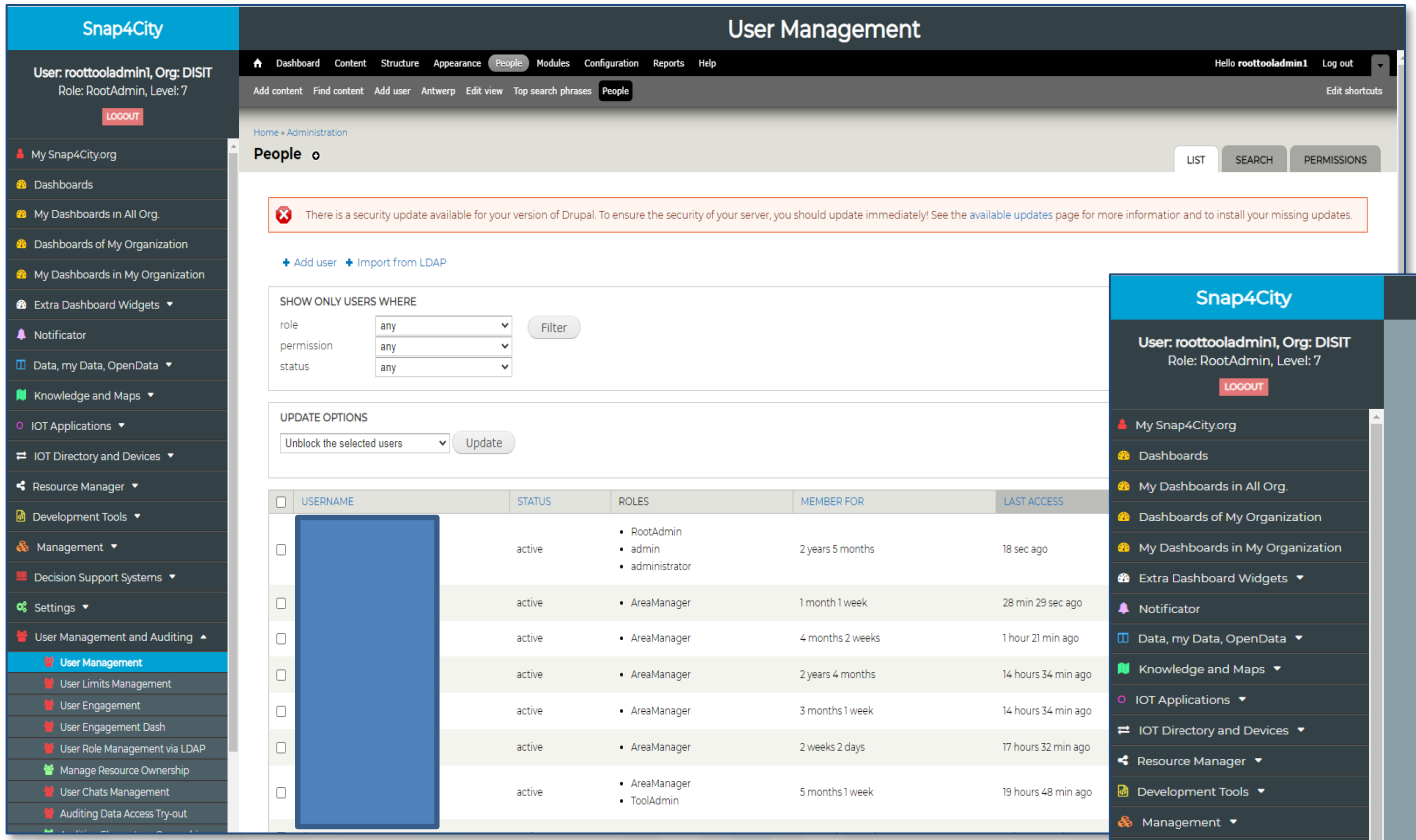
- All that the RootAdmin needs to manage:
  - **User Management: for managing**
    - accounts and profiles
    - limits of the users in exploiting resources
    - Accesses and providing special authorization
    - Organization vs Groups of users
    - Users vs Organizations
  - **Users vs Web and Mobile Applications**
    - Engaging and monitoring users on platform and devices
  - **Users on Chats room of Dashboards**
    - Managing Users on Chats of Dashboards
  - **Auditing of the data and resource accesses**
    - Auditing all the activities on the platform (see next section)
    - Personal auditing

User Management



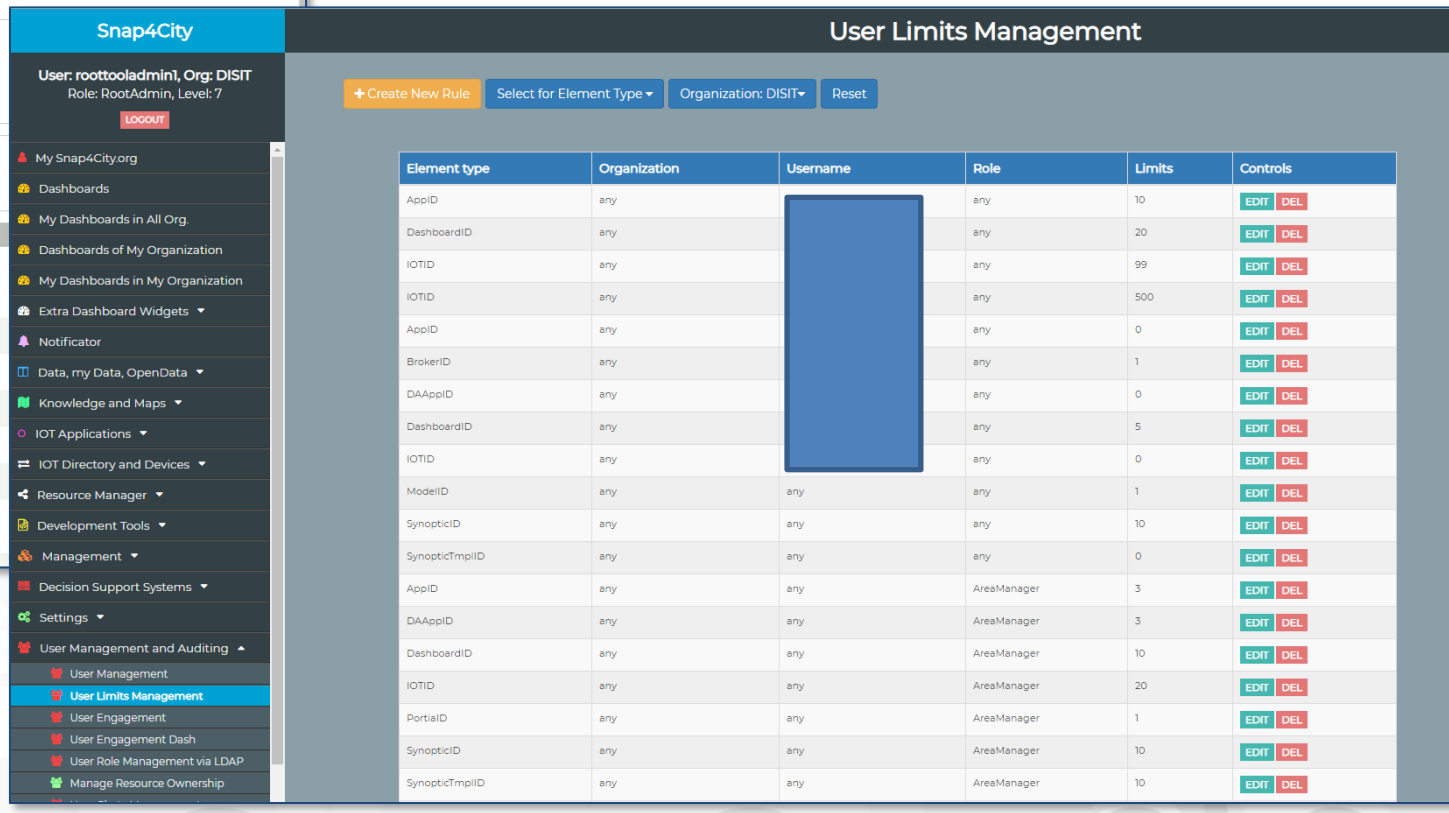
- User Management via Drupal or Local Users Management without CRM.
- User Limits con controlling resource consumption
- User Engagement: see mobile App training part
- Roles and LDAP management
- Managing Resources vs Users' Ownerships and granted accesses to the resources
- Organizations and their Groups of users
- Users vs Organizations
- ..
- AND User Access Authentication via KeyCloak

User Management and Users' Limits



Managing roles and authorizations

Controlling exploitation of resources

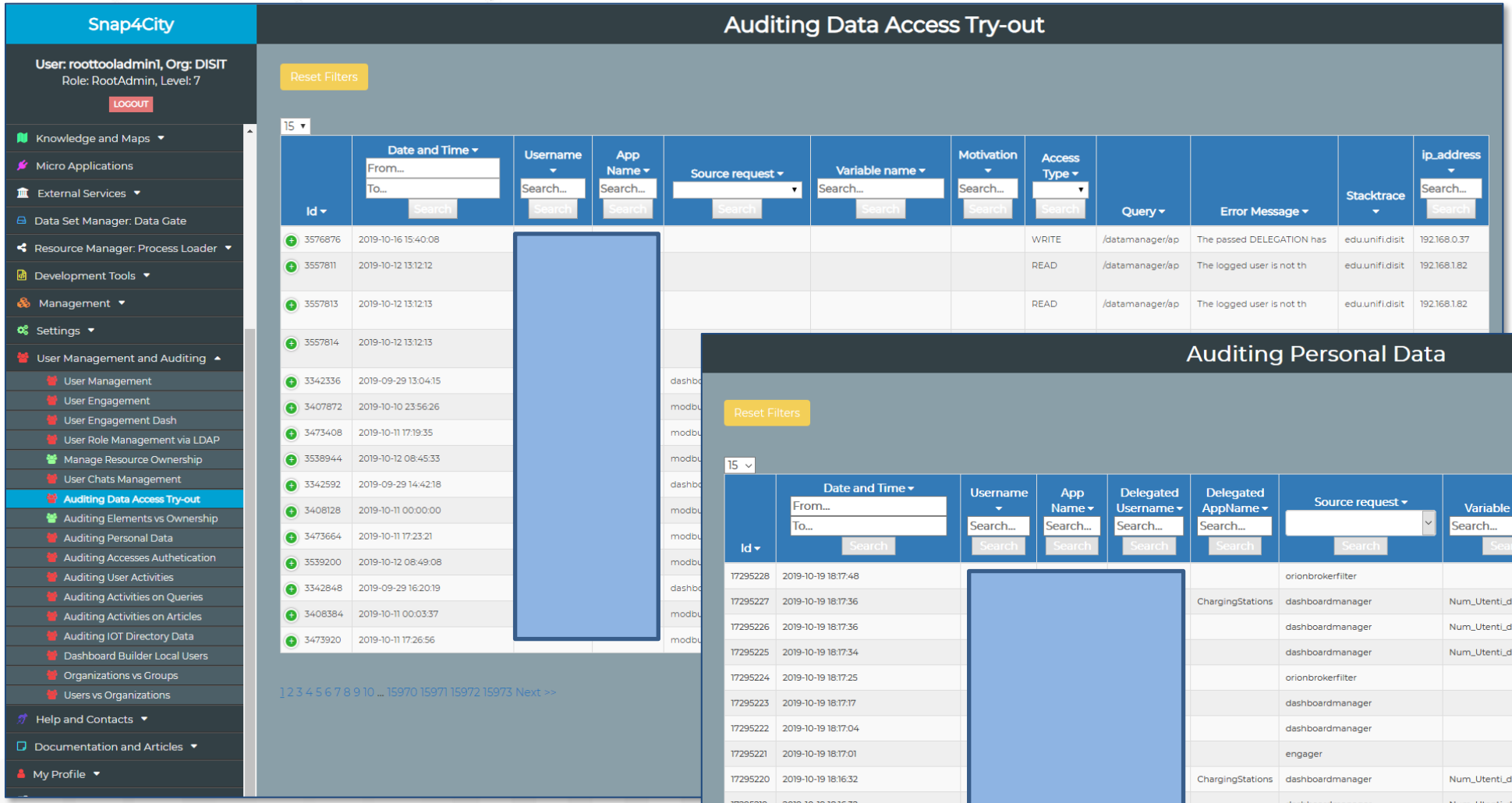


Auditing Activities

- Auditing Data Access Try-out
- Auditing Elements vs Ownership
- Auditing Personal Data
- Auditing Accesses Authetication
- Auditing User Activities
- Auditing Activities on Queries
- Auditing Activities on Articles
- Auditing IOT Directory Data



Auditing Activities

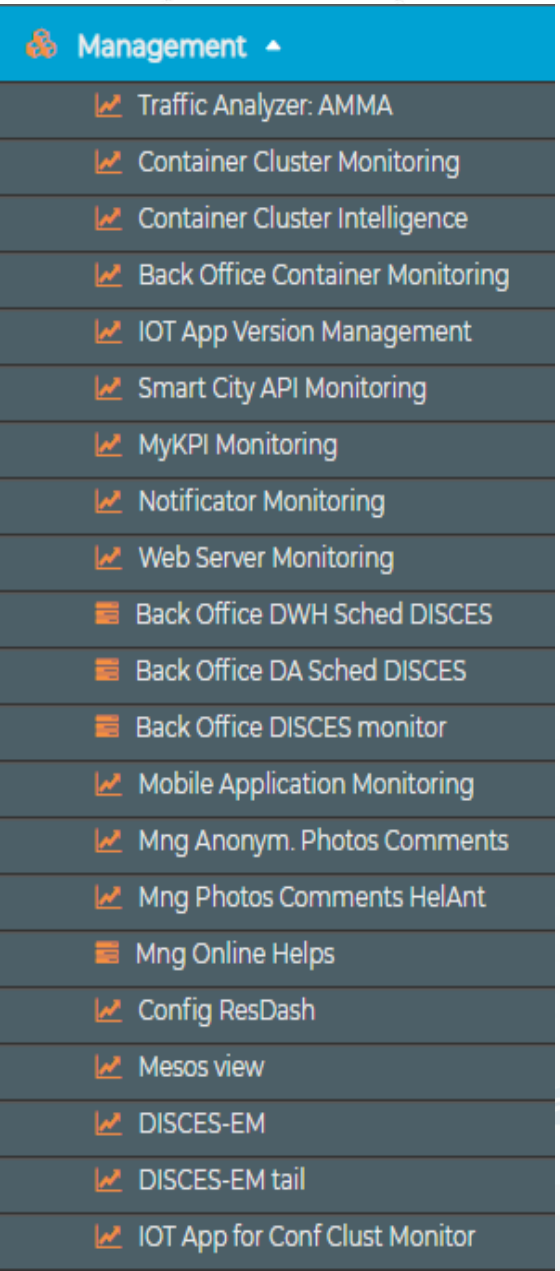


- Management
  - Traffic Analyzer: AMMA
  - Container Cluster Monitoring
  - Container Cluster Intelligence
  - Back Office Container Monitoring
  - IOT App Version Management
  - Smart City API Monitoring
  - MyKPI Monitoring
  - Notificator Monitoring
  - Web Server Monitoring
  - Back Office DWH Sched DISCES
  - Back Office DA Sched DISCES
  - Back Office DISCES monitor
  - Mobile Application Monitoring
  - Mng Anonym. Photos Comments
  - Mng Photos Comments HelAnt
  - Mng Online Helps
  - Config ResDash
  - Mesos view
  - DISCES-EM
  - DISCES-EM tail
  - IOT App for Conf Clust Monitor

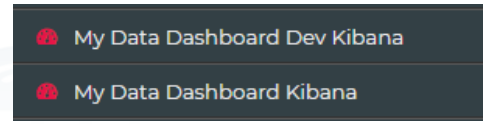
Platform Management



Management



- **Tools for Platform Management.**
  - Most of them only accessible for RootAdmin and OnPremise
- Tools can be **grouped in the following families**
  - AMMA Traffic Analyzer (Open Distro (Elastic Search, Kibana))
  - DataAnalyzer (DevDash): monitoring and browsing data ingested into Open Distro (Elastic Search, Kibana) (see on top as My Data ..)
  - Container Monitoring and Management
  - IOT App Version Management of Snap4City tools
  - Smart City API traffic monitoring
  - MyKPI Monitoring
  - DISCES schedulers monitoring and management (V1 infrastructure versions)
  - Mobile Applications Monitoring
  - Management of Images and Comments from Smart City API, Mobile and Web Apps
  - Management of OnLine Helps (not active)



Back office Platform Scalability
Containers Management and Monitoring



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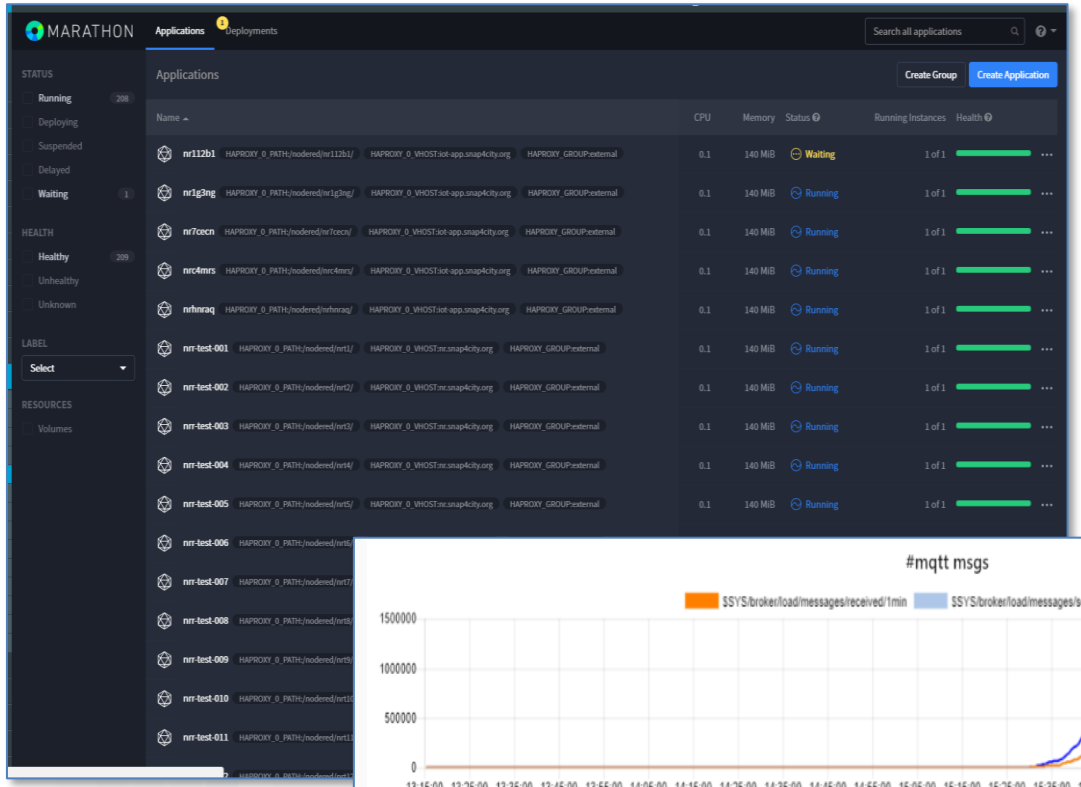
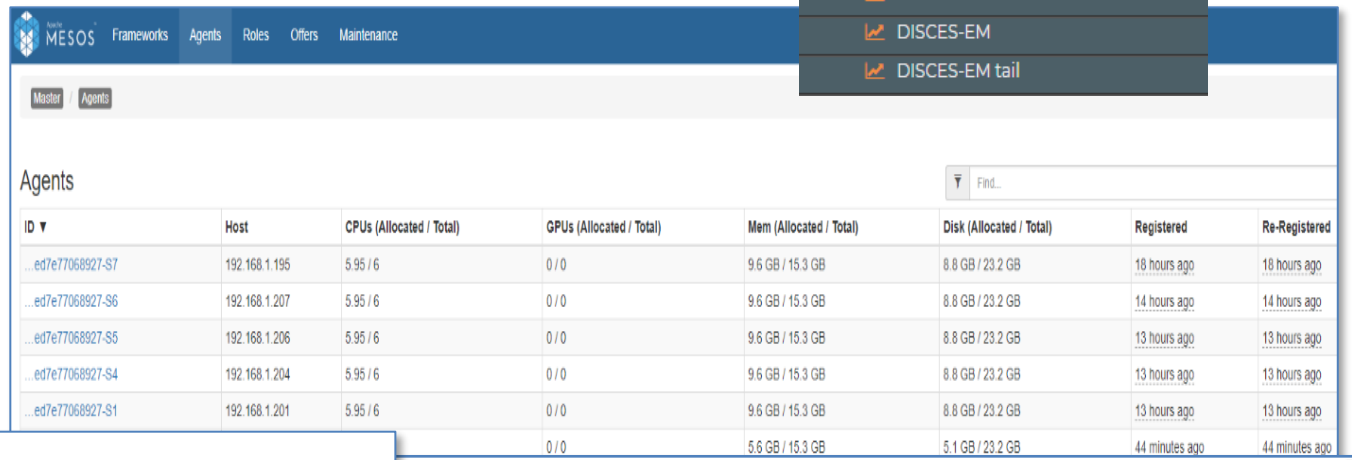
SNAP4CITY KM4CITY

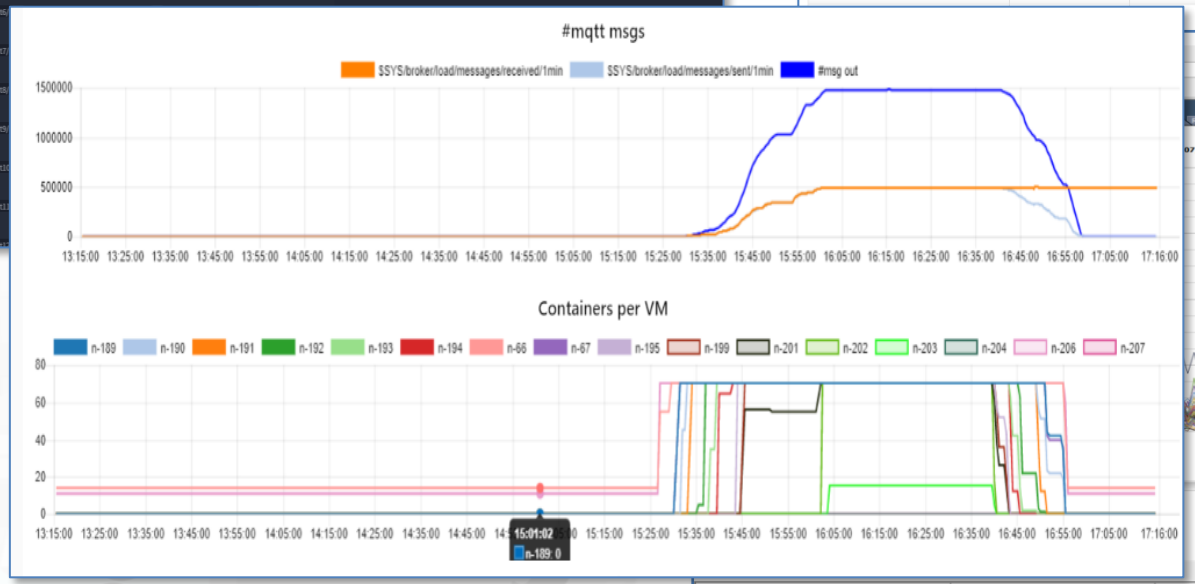
Container

- Container Cluster Monitoring
- Back Office Container Monitoring
- Mesos view
- DISCES-EM
- DISCES-EM tail

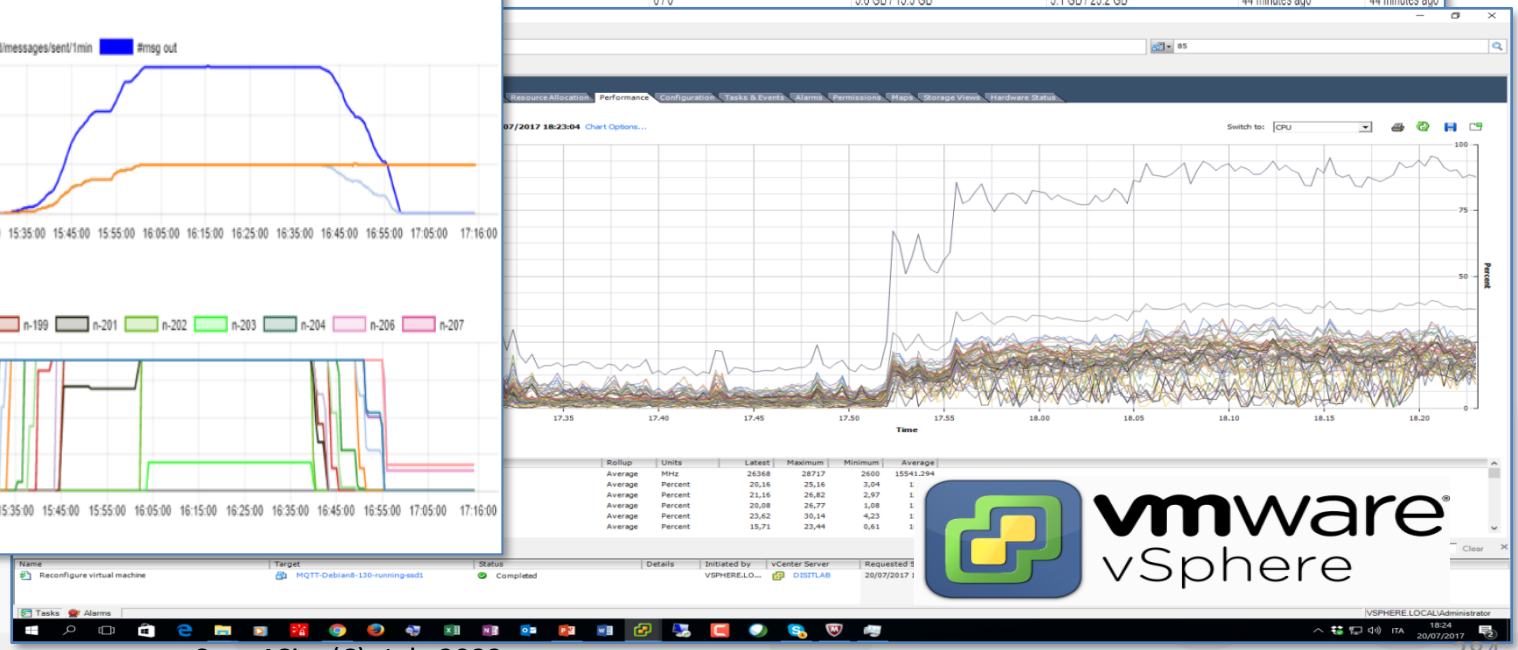




ID	Host	CPUs (Allocated / Total)	GPUs (Allocated / Total)	Mem (Allocated / Total)	Disk (Allocated / Total)	Registered	Re-Registered
...ed7e77068927-S7	192.168.1.195	5.95 / 6	0 / 0	9.6 GB / 15.3 GB	8.8 GB / 23.2 GB	18 hours ago	18 hours ago
...ed7e77068927-S6	192.168.1.207	5.95 / 6	0 / 0	9.6 GB / 15.3 GB	8.8 GB / 23.2 GB	14 hours ago	14 hours ago
...ed7e77068927-S5	192.168.1.206	5.95 / 6	0 / 0	9.6 GB / 15.3 GB	8.8 GB / 23.2 GB	13 hours ago	13 hours ago
...ed7e77068927-S4	192.168.1.204	5.95 / 6	0 / 0	9.6 GB / 15.3 GB	8.8 GB / 23.2 GB	13 hours ago	13 hours ago
...ed7e77068927-S1	192.168.1.201	5.95 / 6	0 / 0	9.6 GB / 15.3 GB	8.8 GB / 23.2 GB	13 hours ago	13 hours ago
			0 / 0	5.6 GB / 15.3 GB	5.1 GB / 23.2 GB	44 minutes ago	44 minutes ago







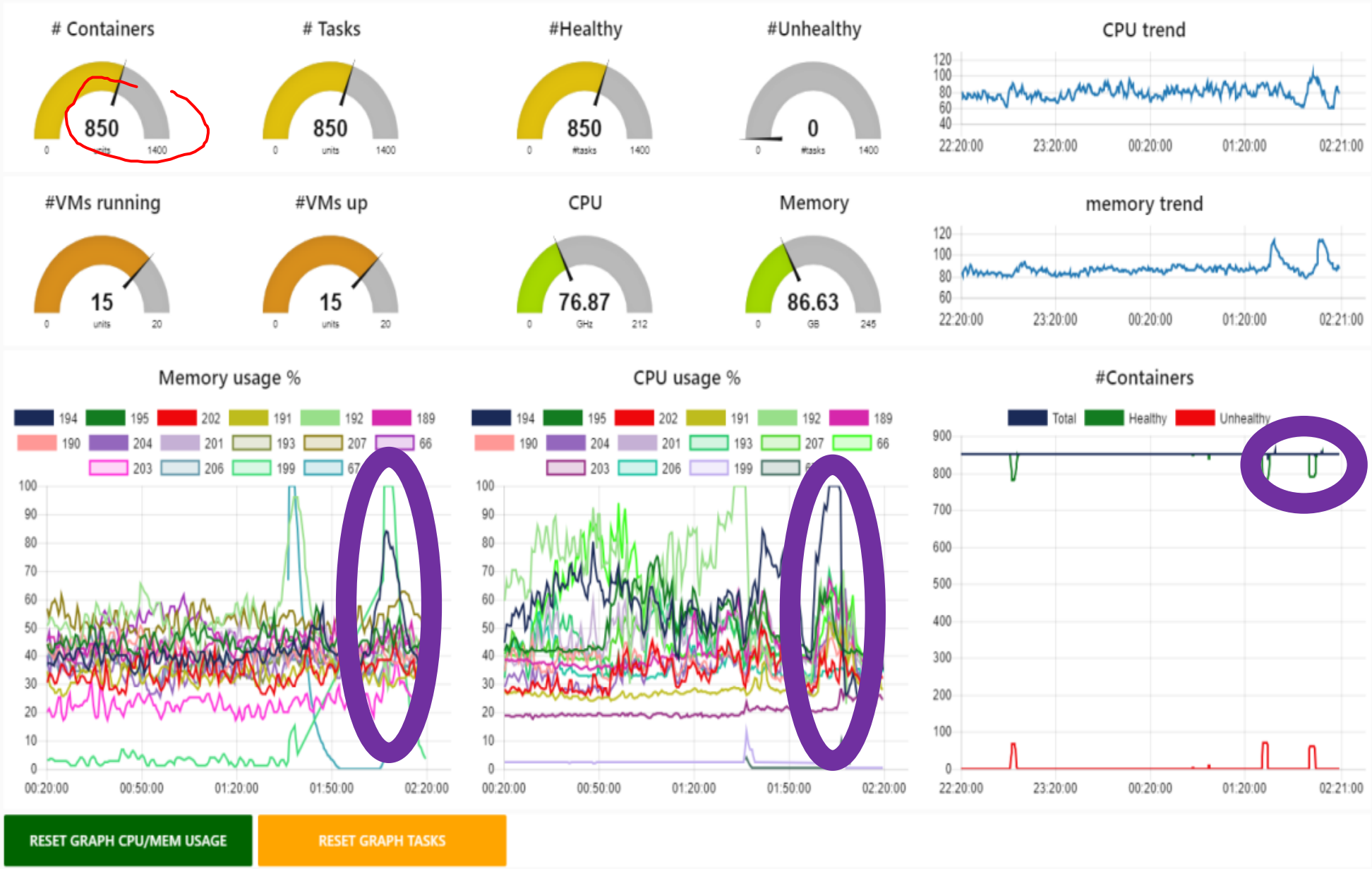
Snap4City

Container Cluster Monitoring

panesi
ToolAdmin | ldap

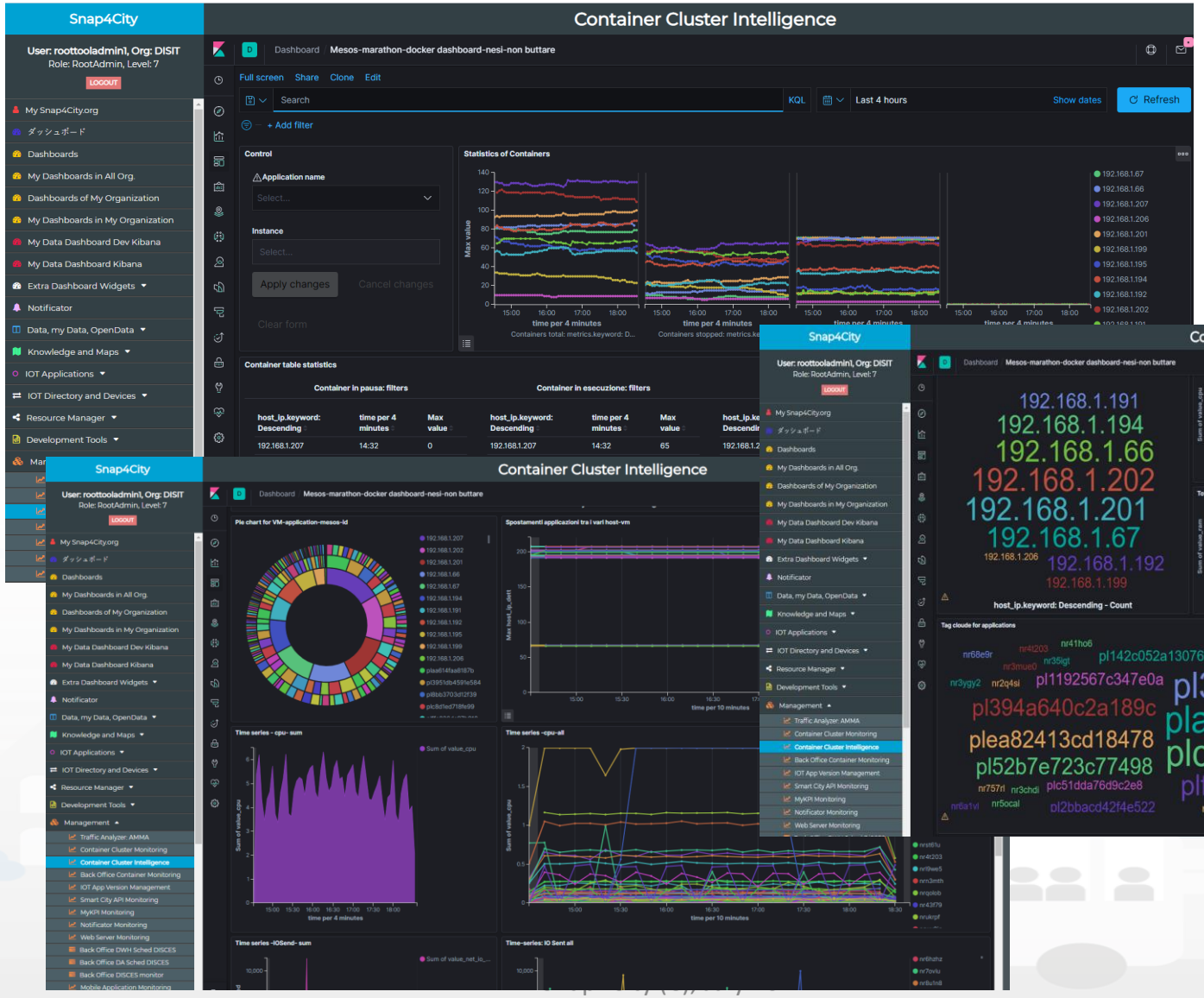
- Dashboards
- Notificator
- IOT Applications
- IOT Directory and Devices
- Knowledge and Maps
- Micro Applications
- External Services
- Data Set Manager: Data Gate
- Resource Manager: Process Loader
- Development Tools
- Management
  - Traffic Analyzer: AMMA
  - Data Analyzer: DevDash
  - Back Office Res. Analyzer: ResDash
  - Container Cluster Monitoring
  - Back Office Container Monitoring
  - Smart City API Monitoring
  - Notificator Monitoring
  - Web Server Monitoring
  - Back Office Scheduler DISCES
  - Mobile Application Monitoring
  - Auditing Elements vs Ownership
  - Auditing Personal Data
  - Auditing Data Access Try-out
  - Auditing Accesses
- Settings

Cluster status



Container Cluster Intelligence via Zabbix

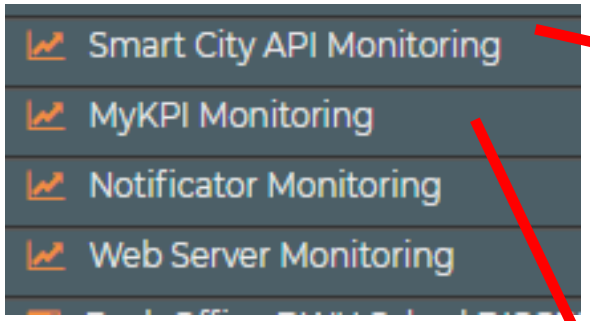
- Via ZABBIX
  - Open Distro
    - Elastic Search
    - Kibana
- By VM/Host
- By Container
- By CPU, MEM, I/O
- Over time



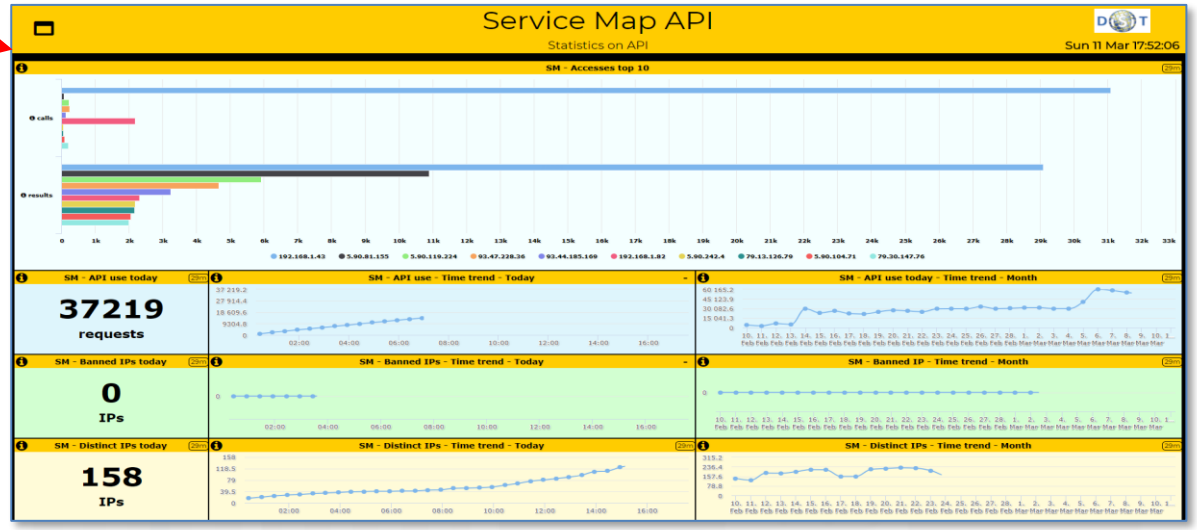
Monitoring Resources and API Traffic

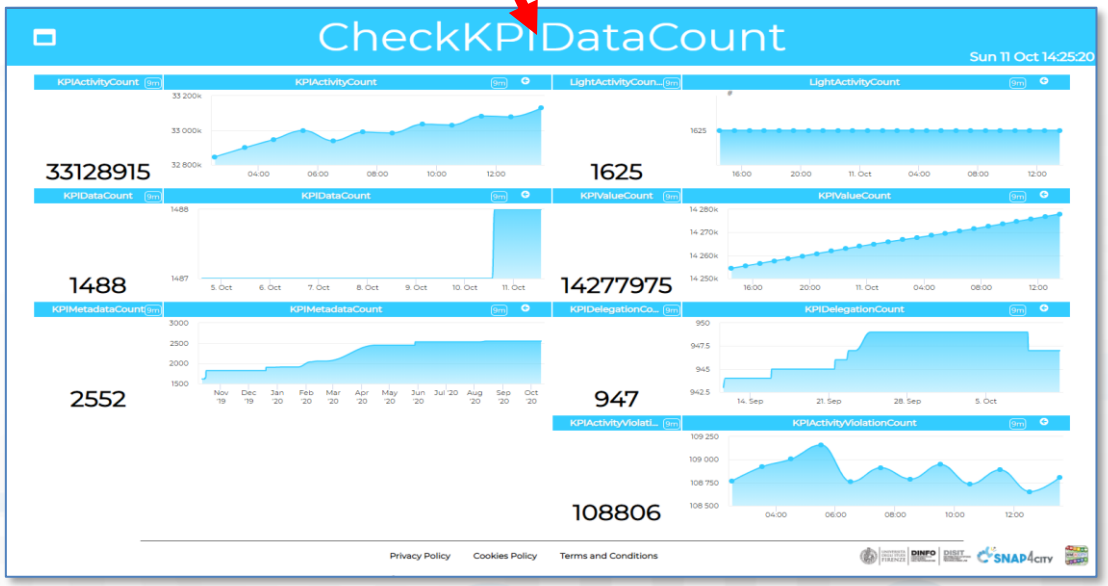


Monitoring Smart City API Usage



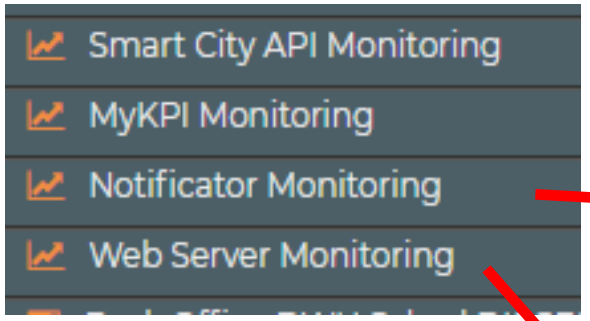
http://www.disit.org/dashboardSmartCity/view/index.php?iddasboard=MTkw



- 

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTY0NA==

Monitoring Resources and Traffic



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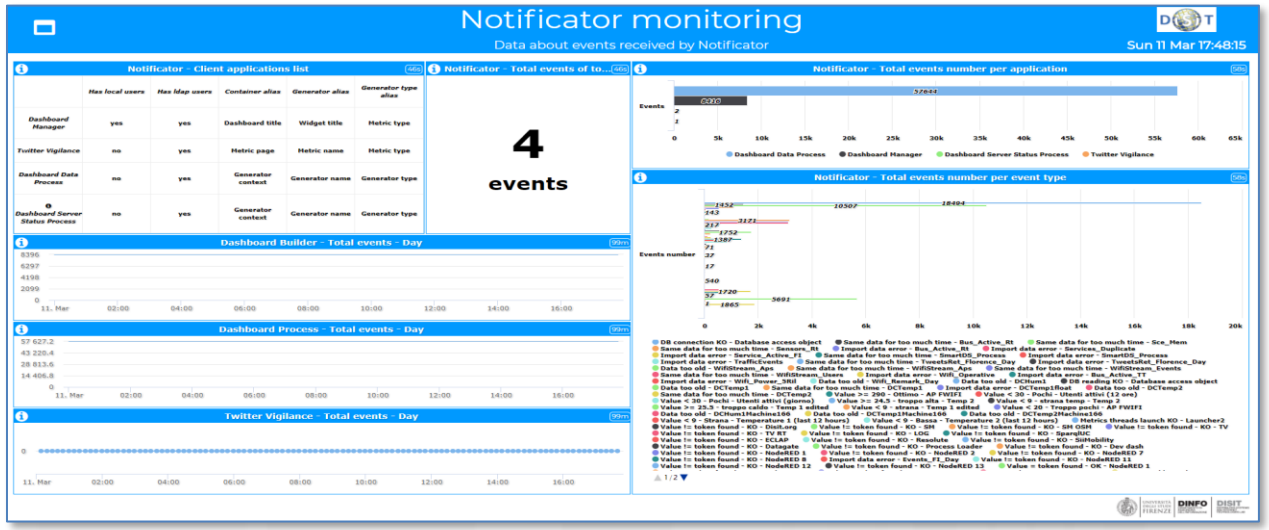
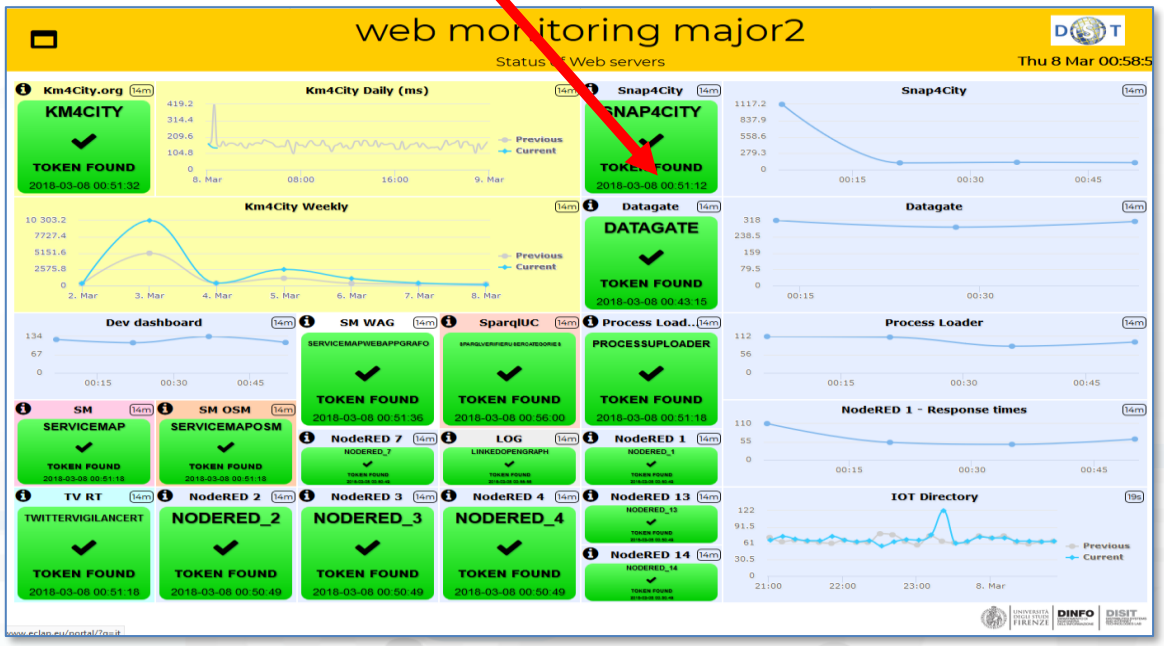


- 

http://www.disit.org/dashboardSmartCity/view/index.php?iddasboard=MjQ5

Managing Photos and Comments from Web and Mobile Apps

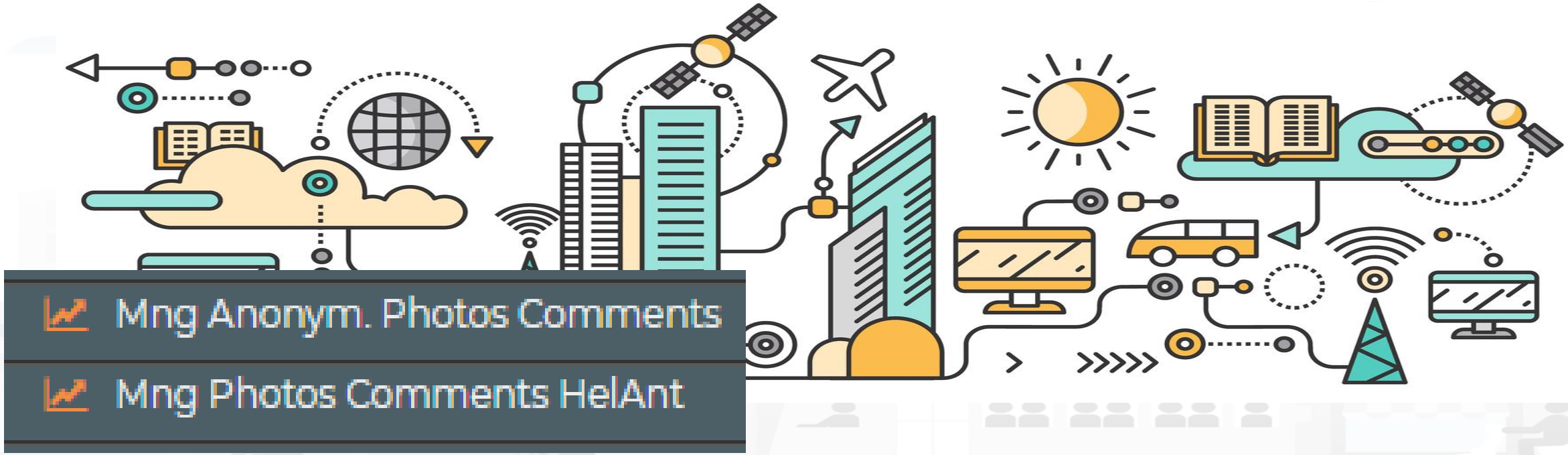
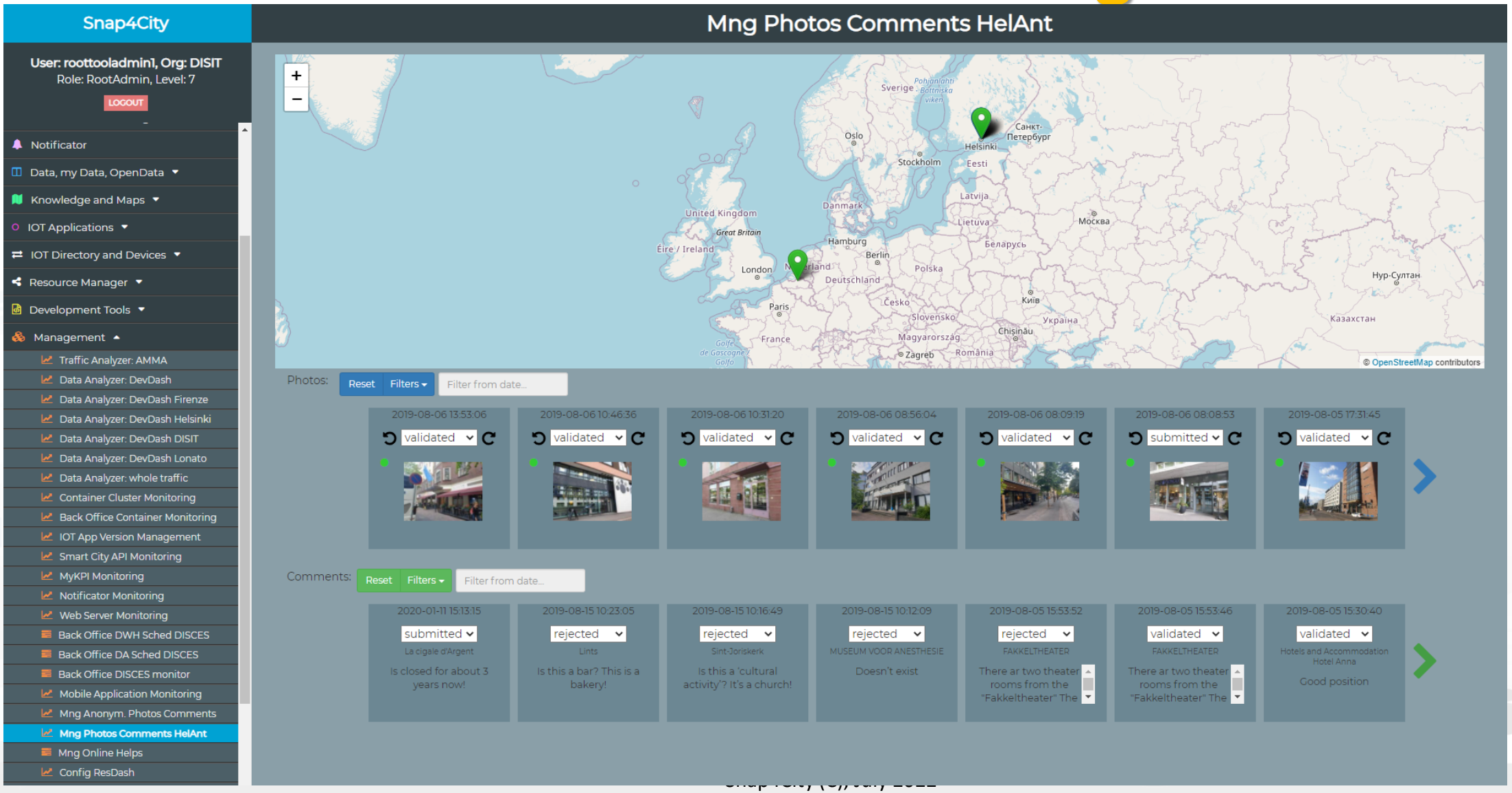
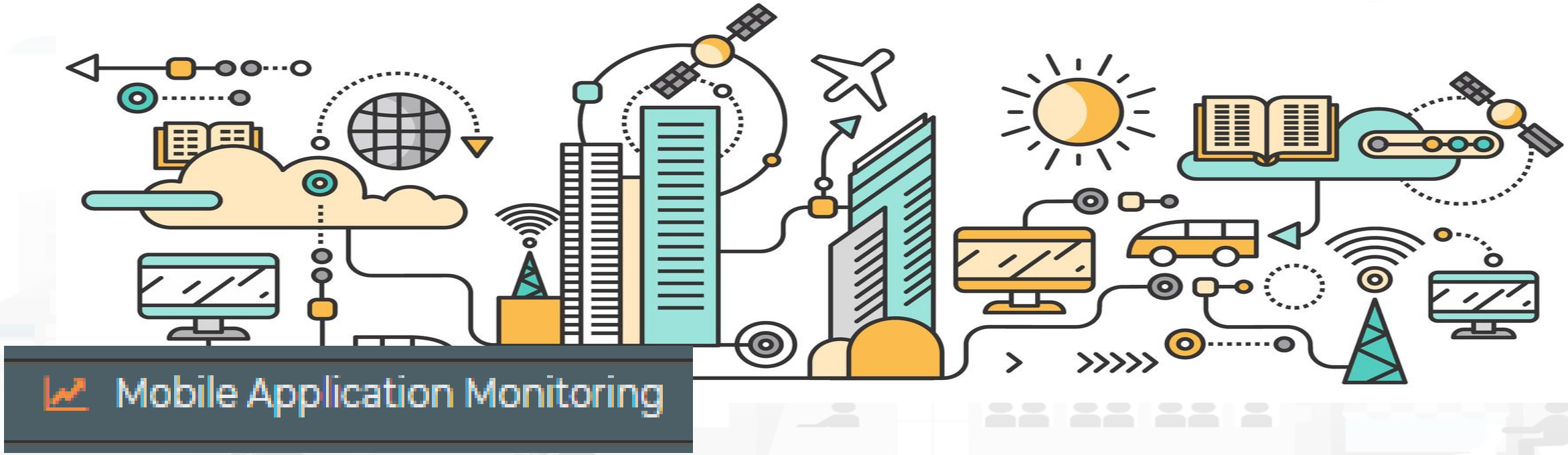


Photo and Comments Management



Mobile App Monitoring and Management



Mobile App Monitoring and Management

Snap4City

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

- IOT Applications
- IOT Directory and Devices
- Resource Manager
- Development Tools
- Management
  - Traffic Analyzer: AMMA
  - Data Analyzer: DevDash
  - Data Analyzer: DevDash Firenze
  - Data Analyzer: DevDash Helsinki
  - Data Analyzer: DevDash DISIT
  - Data Analyzer: DevDash Lonato
  - Data Analyzer: whole traffic
  - Container Cluster Monitoring
  - Back Office Container Monitoring
  - IOT App Version Management
  - Smart City API Monitoring
  - MyKPI Monitoring
  - Notificator Monitoring
  - Web Server Monitoring
  - Back Office DWH Sched DISCES
  - Back Office DA Sched DISCES
  - Back Office DISCES monitor
  - **Mobile Application Monitoring**
  - Mng Anonym. Photos Comments
  - Mng Photos Comments HelAnt
  - Mng Online Helps
  - Config ResDash

Mobile Application Monitoring

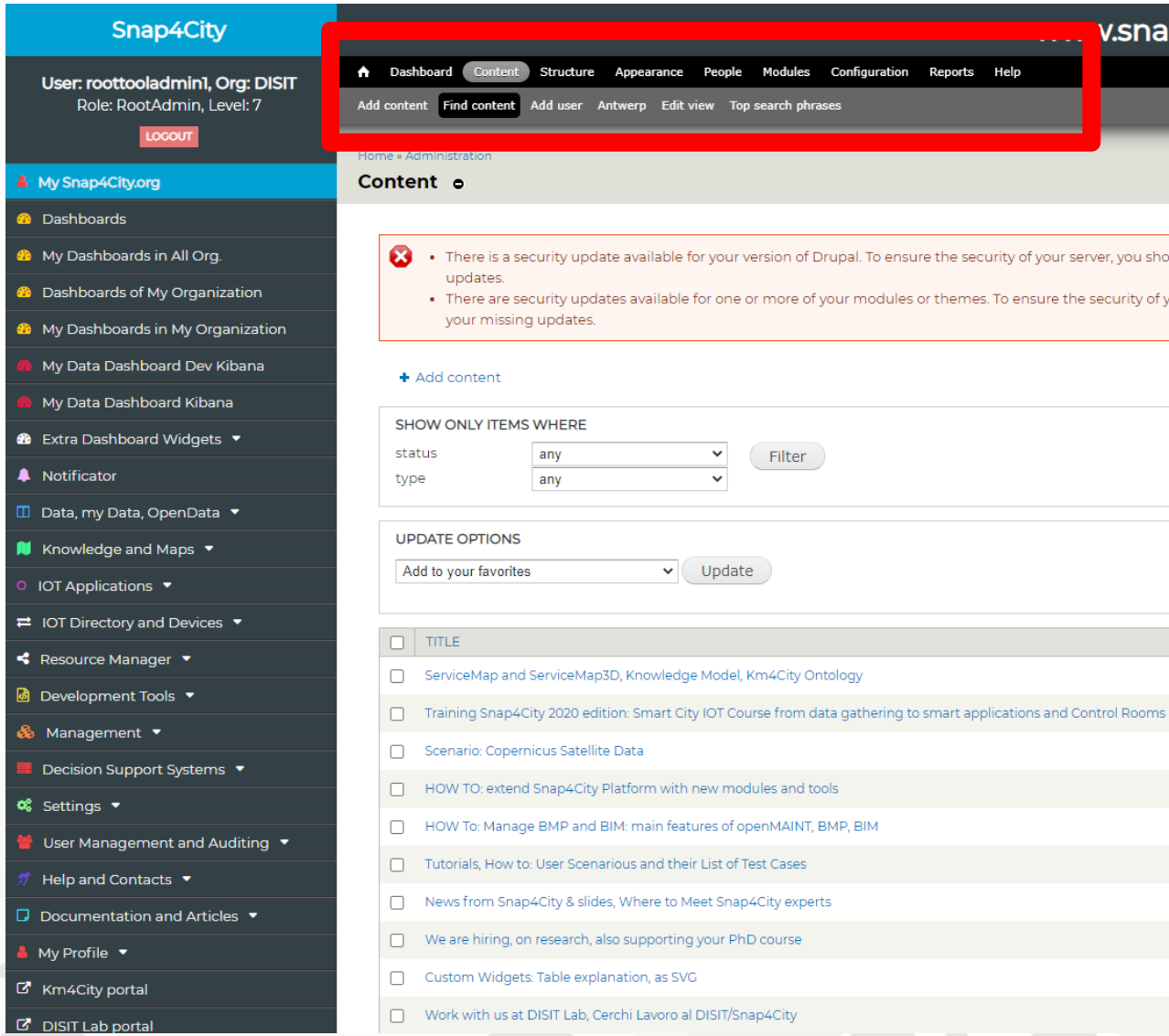
- City Users and Stats
- Recommendations Log
- General Settings
- Social Media Group Recommendations Settings
- Groups Recommendations Priorities
- Class Scores
- City Users
- List of Trajectories Clusters
- Heatmap and Trajectories Clusters (User Profile: All)
- Heatmap and Trajectories Clusters (User Profile: Citizen)
- Heatmap and Trajectories Clusters (User Profile: Commuter)
- Heatmap and Trajectories Clusters (User Profile: Student)
- Heatmap and Trajectories Clusters (User Profile: Tourist)
- Heatmap and Trajectories Clusters (User Profile: Disabled)
- Heatmap and Trajectories Clusters (User Profile: Operator)
- Heatmap and Trajectories Clusters of City Users Together
- Real Time City Users: positions and movements
- General Stats
- Statistics for City Users Types
- Interactive People Flow Maps

Customer Relationship Manager Integration and Living Lab basic

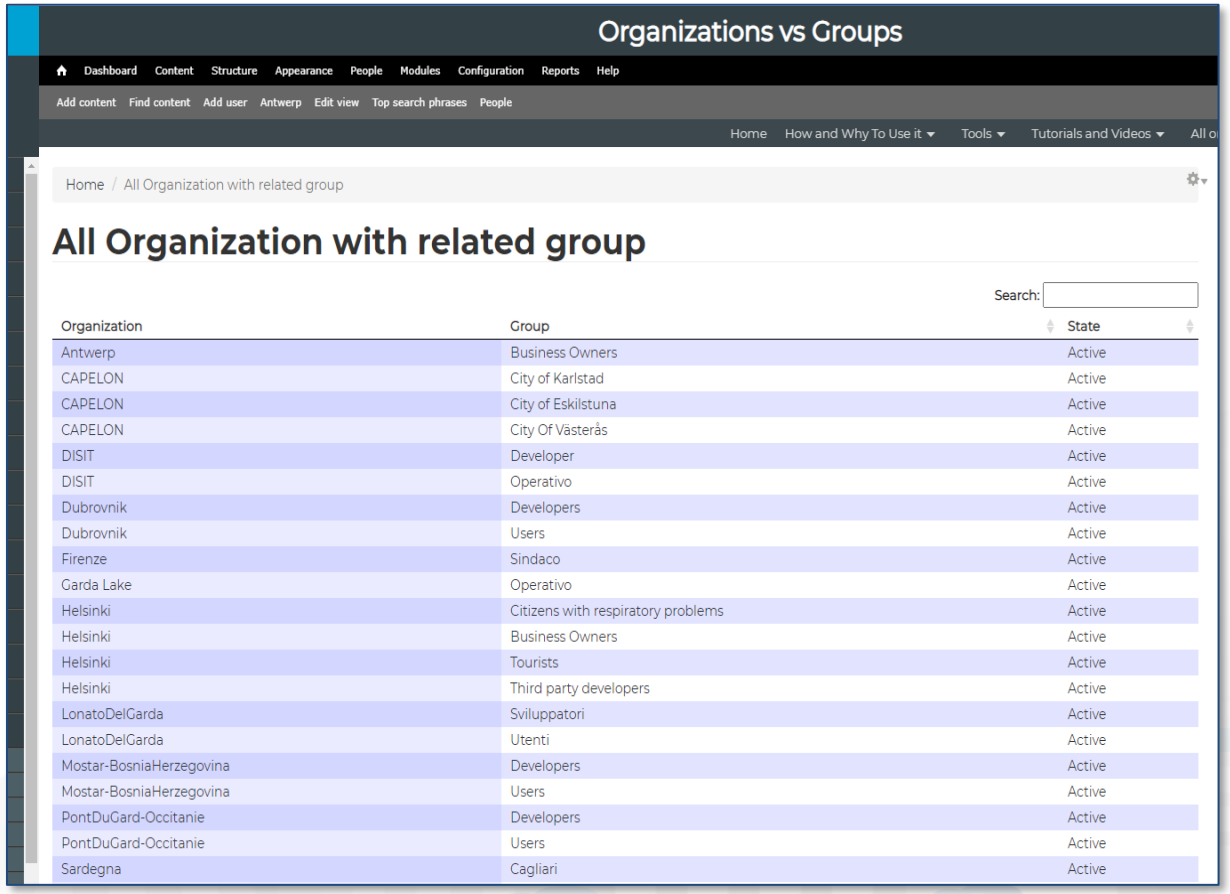


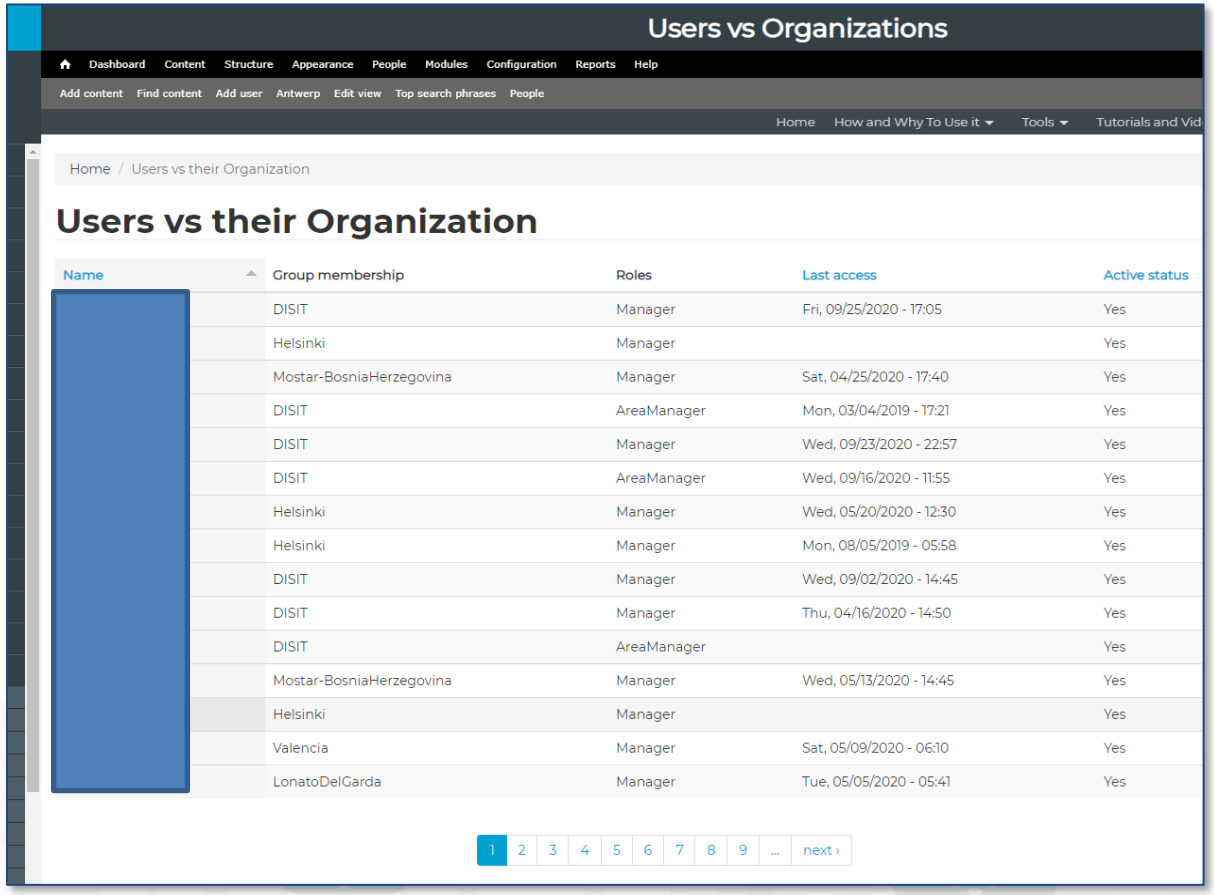
Living Lab vs DRUPAL

- **Based on Drupal 7 and only**
  - A Few Custom modules have been adapted and are distribution on GITHUB/DISIT
  - Full Customizable by adding Drupal modules as usual
- **User Management r**egistration and mailing
  - LDAP connection for role management
  - KeyCloak connection for SS0 / Authentication (OpenID Connect)
  - Management of user profile
  - Authorization to access at the web pages..
  - User profile management for Role and Details + statistics
- **Content management** for Organizations and Groups
  - Indexing of all content and search
  - Content Distribution: web pages, newsletters, articles, comments, Video, technical notes, training
    - Statistics on their usage
  - Reports and views regarding living lab usage, and web pages
  - Organizations vs Users
  - Organizations vs Groups
  - Tracking and monitoring
  - Production and distribution of NewsLetters
- **Open to full contributions and comments**
  - Comments on web pages, …
- Etc.



Organizations vs Groups vs Users





TOP

Data Model, Ingestion and Management

On Line Training Material (free of charge)

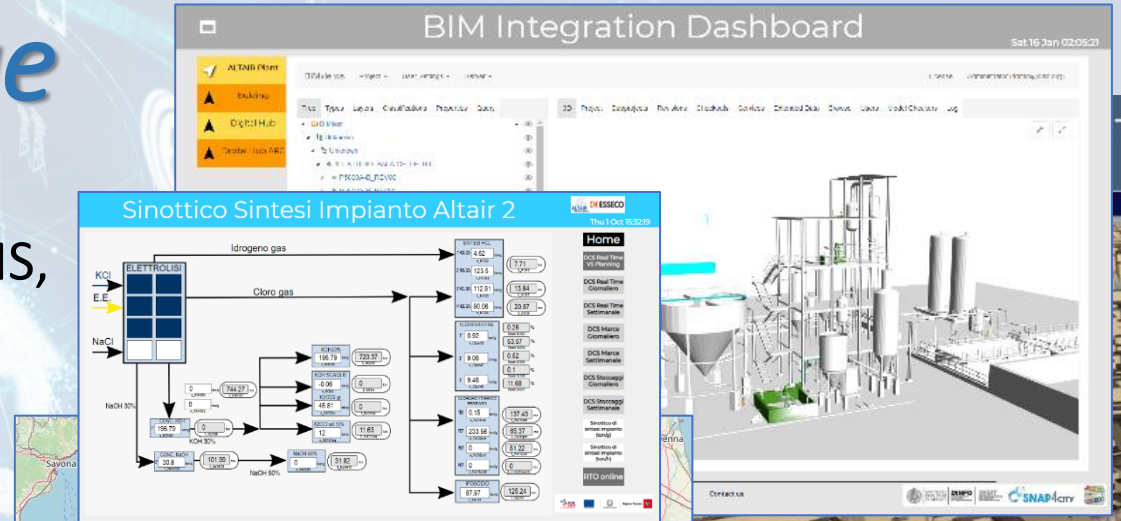
	1st part (*)	2nd part (*)	3rd part (*)	4th part (*)	5th part (*)	6th part (*)	7th part (*)
what	General	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	ystem and Deploy Install	Smart City API: Web & Mob. App
PDF							
Inter active							
Video1							
Video2							
Video3			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

100% OPEN SOURCE

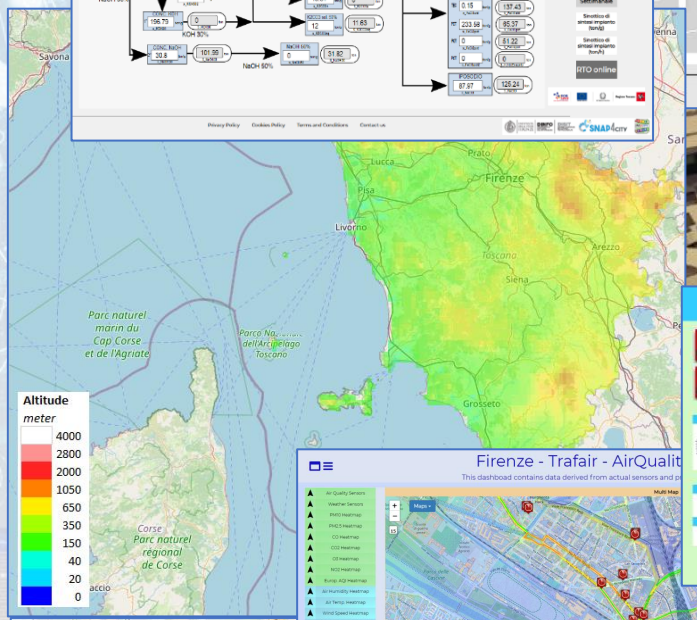
SNAP4 Appliances and Dockers **Installations**

Data Type Coverage

- POI, IOT Devices, shapes,..
- GIS, maps, orthomaps, WFS/WMS, GeoTiff, calibrated heatmaps, ..
- Satellite data, ..
- traffic flow, typical trends, ..
- trajectories, events, Workflow, ..
- 3D, BIM, ..
- Dynamic icons/pins, ..
- OD Matrices of several kinds, ..
- Synoptics, animations, ..
- KPI, personal KPI,..
- social media data,
- routing, multimodal, constraints,
- decision scenarios, ….
- prediction models, ….
- etc.

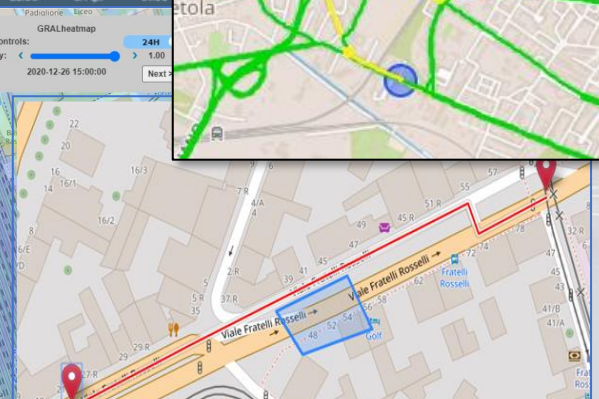












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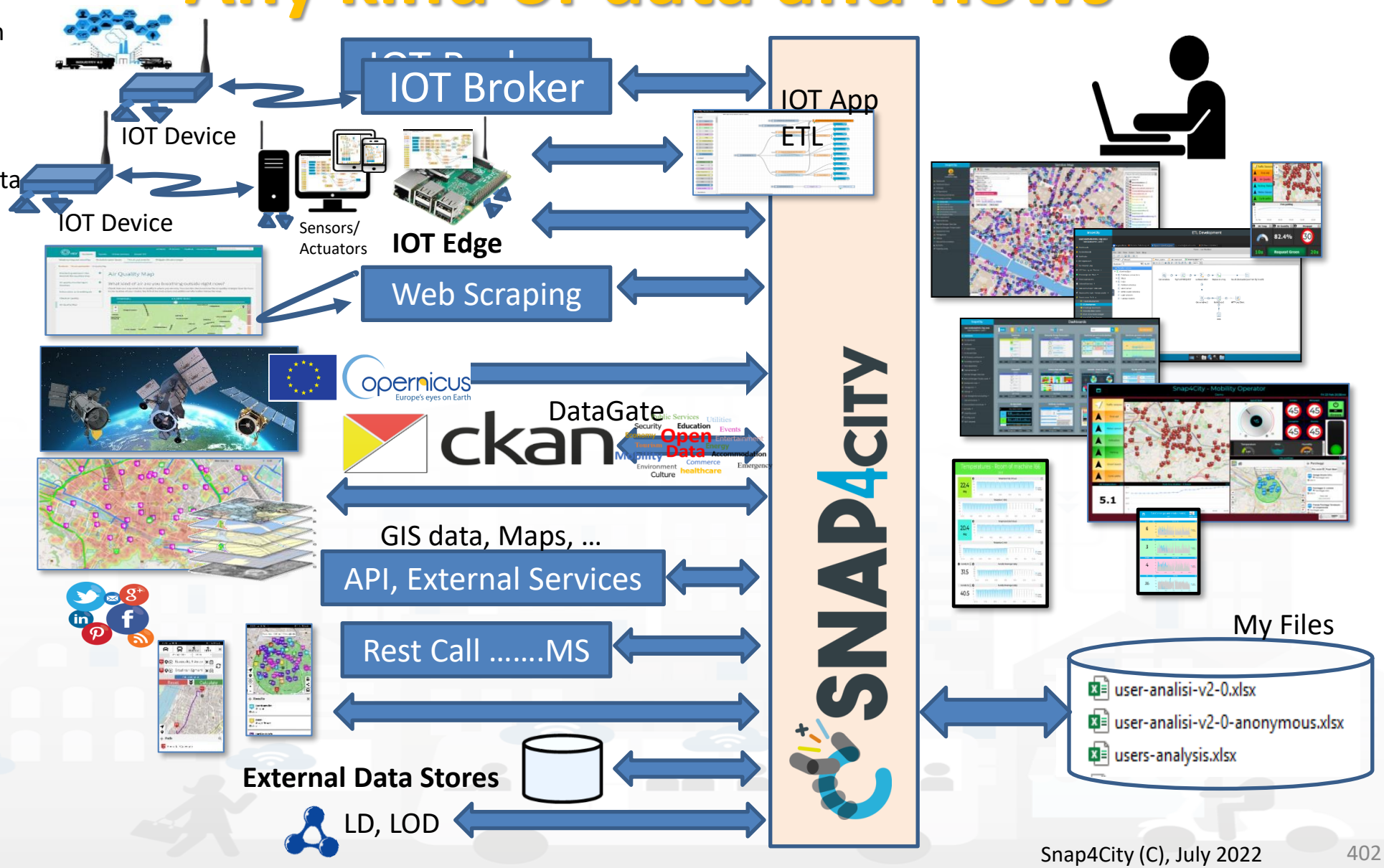
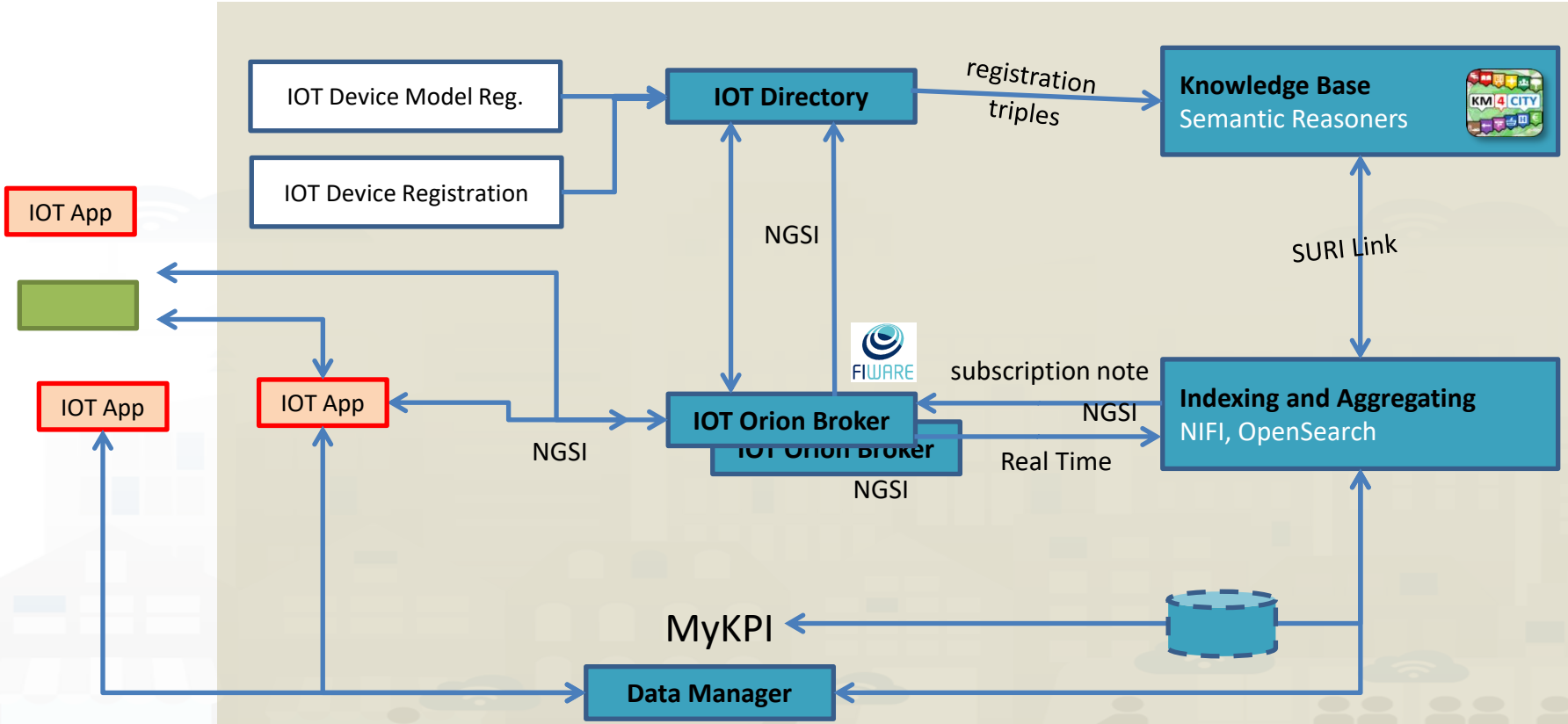
Any kind of data and flows

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



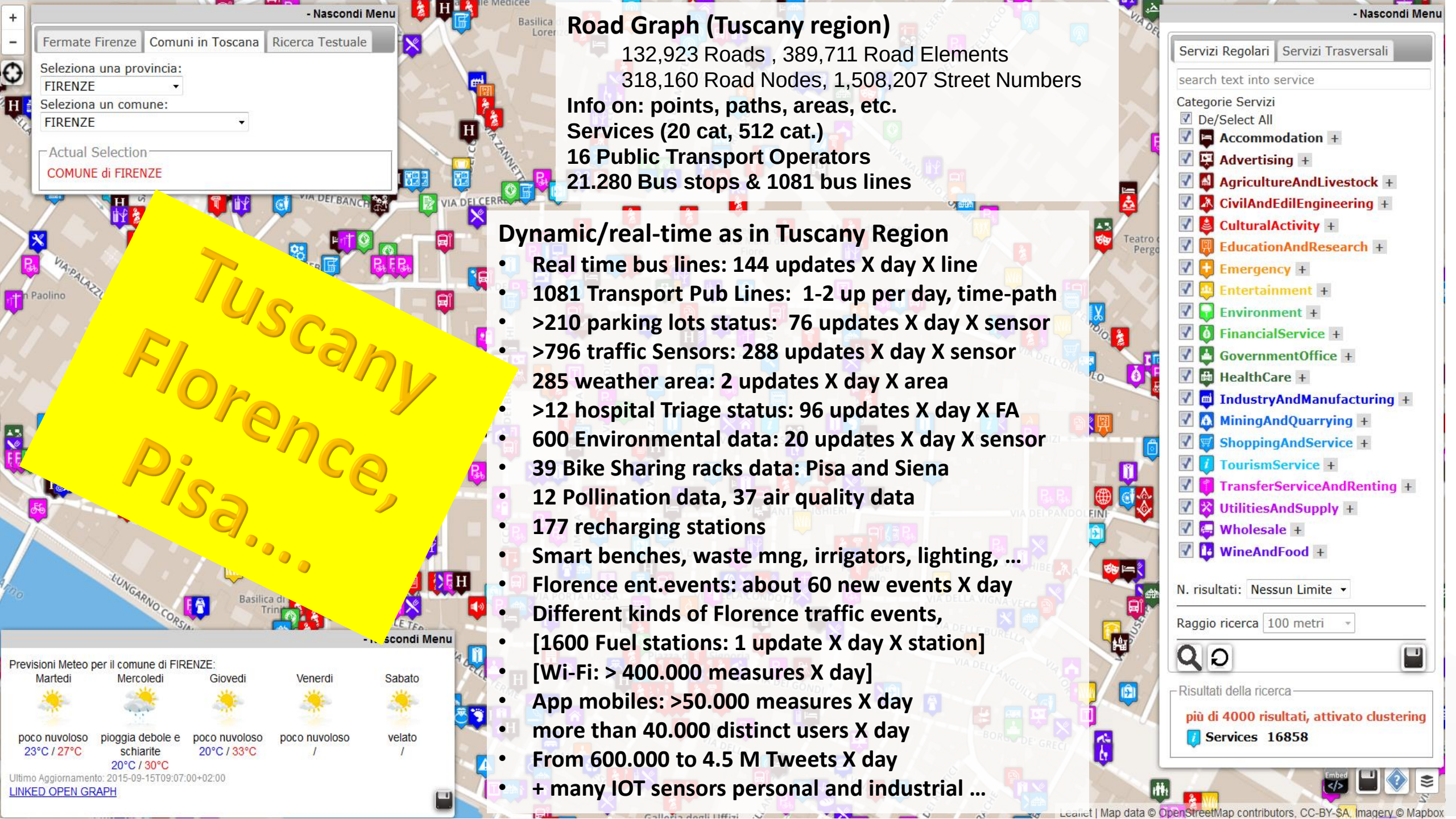
Main IoT Data In/Out flows





Data Modeling




- Nascondi Menu
Fermate Firenze
Comuni in Toscana
Ricerca Testuale
Seleziona una provincia:
FIRENZE
Seleziona un comune:
FIRENZE
Actual Selection
COMUNE di FIRENZE
Tuscany
Florence,
Pisa....
Road Graph (Tuscany region)
132,923 Roads , 389,711 Road Elements
318,160 Road Nodes, 1,508,207 Street Numbers
Info on: points, paths, areas, etc.
Services (20 cat, 512 cat.)
16 Public Transport Operators
21.280 Bus stops & 1081 bus lines
Dynamic/real-time as in Tuscany Region
• Real time bus lines: 144 updates X day X line
• 1081 Transport Pub Lines: 1-2 up per day, time-path
• >210 parking lots status: 76 updates X day X sensor
• >796 traffic Sensors: 288 updates X day X sensor
285 weather area: 2 updates X day X area
• >12 hospital Triage status: 96 updates X day X FA
• 600 Environmental data: 20 updates X day X sensor
• 39 Bike Sharing racks data: Pisa and Siena
• 12 Pollination data, 37 air quality data
• 177 recharging stations
• Smart benches, waste mng, irrigators, lighting, …
• Florence ent.events: about 60 new events X day
• Different kinds of Florence traffic events,
• [1600 Fuel stations: 1 update X day X station]
• [Wi-Fi: > 400.000 measures X day]
• App mobiles: >50.000 measures X day
• more than 40.000 distinct users X day
• From 600.000 to 4.5 M Tweets X day
• + many IOT sensors personal and industrial …
- Nascondi Menu
Servizi Regolari
Servizi Trasversali
search text into service
Categorie Servizi
De/Select All
Accommodation
Advertising
AgricultureAndLivestock
CivilAndEdilEngineering
CulturalActivity
EducationAndResearch
Emergency
Entertainment
Environment
FinancialService
GovernmentOffice
HealthCare
IndustryAndManufacturing
MiningAndQuarrying
ShoppingAndService
TourismService
TransferServiceAndRenting
UtilitiesAndSupply
Wholesale
WineAndFood
N. risultati: Nessun Limite
Raggio ricerca 100 metri
Risultati della ricerca
più di 4000 risultati, attivato clustering
Services 16858
- Nascondi Menu
Previsioni Meteo per il comune di FIRENZE:
Martedi
poco nuvoloso
23°C / 27°C
Mercoledi
pioggia debole e schiarite
20°C / 30°C
Giovedi
poco nuvoloso
20°C / 33°C
Venerdi
poco nuvoloso
/
Sabato
velato
/
Ultimo Aggiornamento: 2015-09-15T09:07:00+02:00
LINKED OPEN GRAPH
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

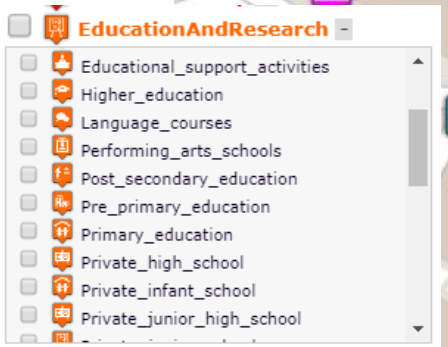
POI: Point of Interest vs Classification

- A POI is defined as an **element of a set (collection)** and with general info:
  - **Nature**: ……..
  - **Subnature**: ….
- Specific infor for each POI
  - **Location**: lat, lon
  - A set of **Attributes**
    - www, email, opening time, phone, cap, address, city, etc.
  - Eventually a link to data

Nature

- Accommodation
- Advertising
- AgricultureAndLivestock
- CivilAndEdilEngineering
- CulturalActivity
- EducationAndResearch
- Emergency
- Entertainment
- Environment
- FinancialService
- GovernmentOffice
- HealthCare
- IndustryAndManufacturing
- IoTDevice
- MiningAndQuarrying
- ShoppingAndService
- TourismService
- TransferServiceAndRenting
- UtilitiesAndSupply
- Wholesale
- WineAndFood

SubNature



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

Knowledge Base
Semantic Reasoners

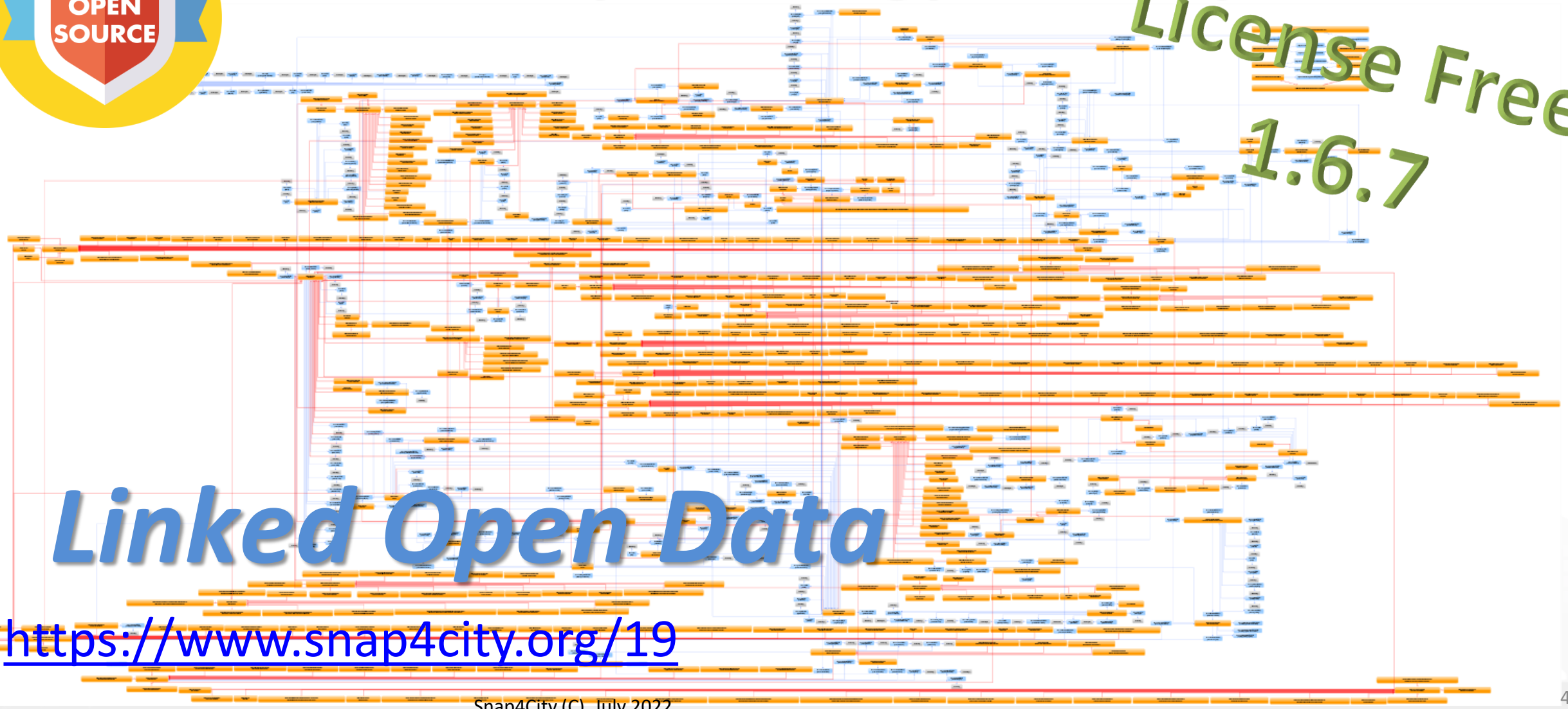
SNAP4CITY KM4CITY

100% OPEN SOURCE

Smart-city Ontology km4city

License Free

1.6.7



Linked Open Data

https://www.snap4city.org/19

Km4City Ontology elements 1.6.7

- **Km4C**: Km4City 1.6.7
- Using
  - **OTN**: Ontology of Transportation Networks
  - **SSN**: Semantic Sensor Network Ontology (see https://www.w3.org/TR/vocab-ssn/
  - **SAREF** Smart Appliances REFerence extension for building devices available at https://saref.etsi.org/saref4bldg/
  - **iot-lite**: IOT Vocabulary
  - **FOAF**: friends of a friends
  - **DCTERMS**: for metadata Dublin Core Metadata Initiative
  - **Schema.org** for people and organizations
  - **WGS84** Datum of Geo-Objects
  - **OWL-Time**: time reasoning
  - **Good Relation**: entities relationships

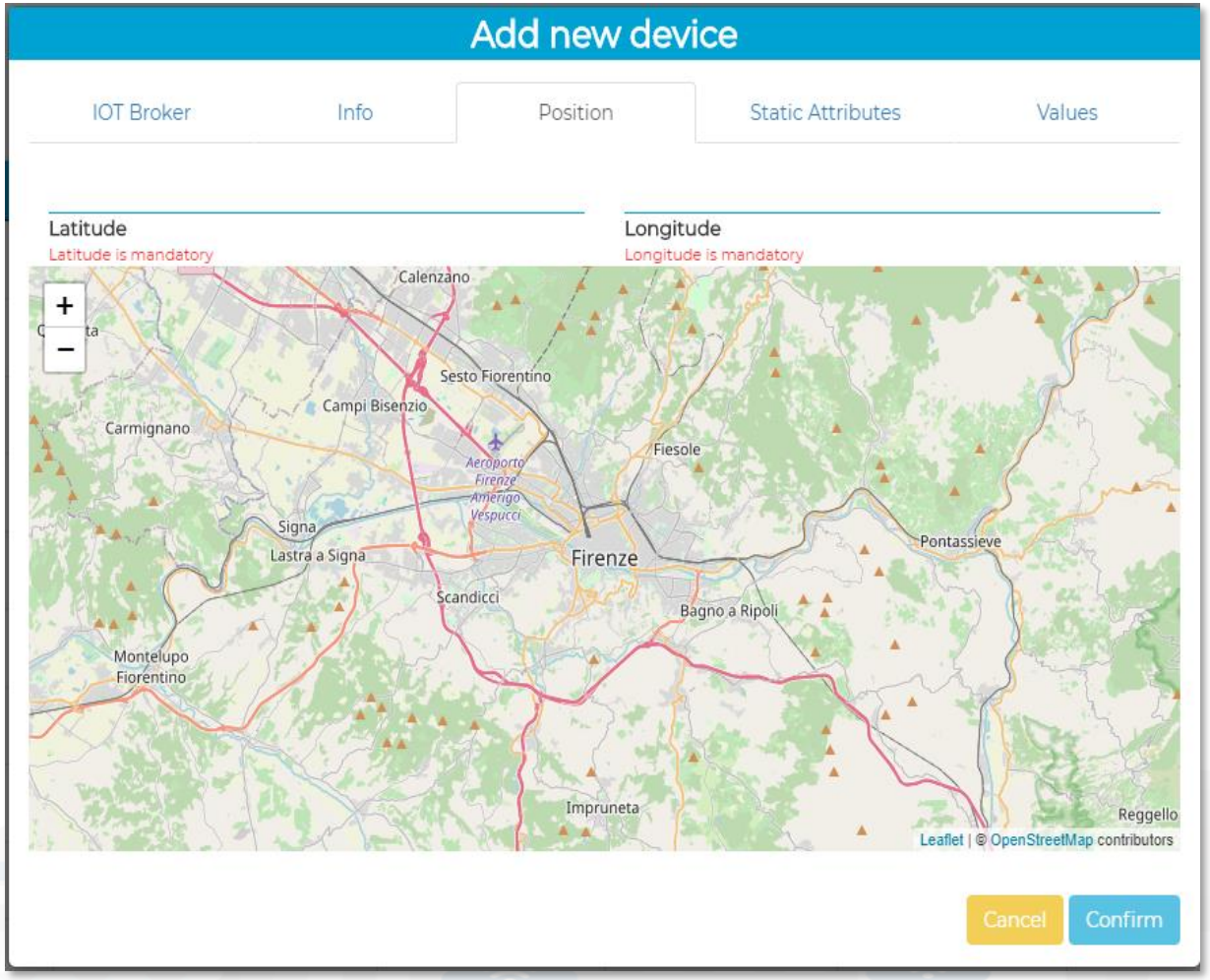
IOT Device Model

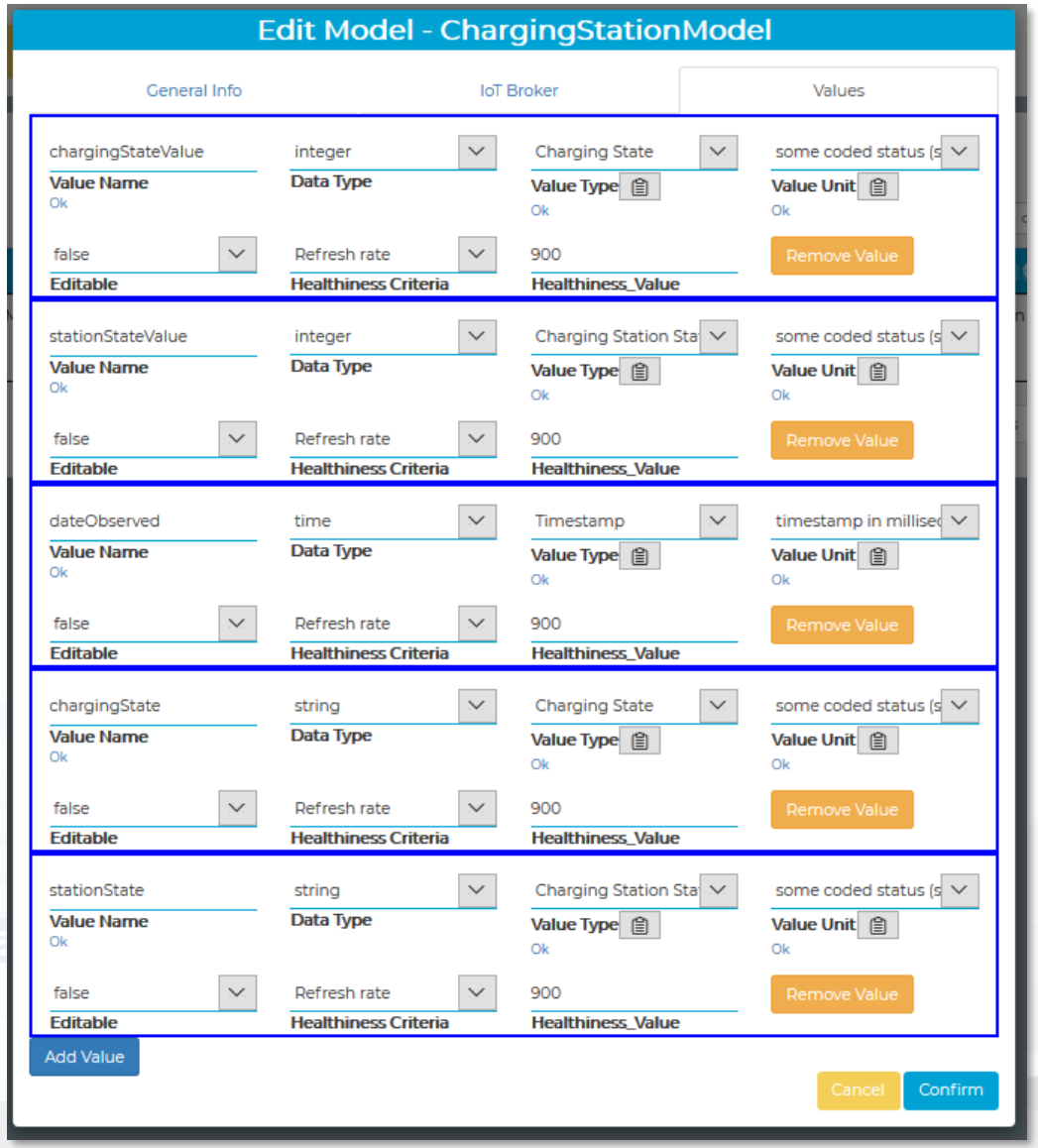


IOT Device Data Model (3): Attributes

Where	IOT Device Model	IOT Device	A Temporal Instance
IOT Broker	**Broker: OrionUNIFI**		
IOT Broker	**Protocol: NGSI**		
Info	**ID: string**	ID: "park45"	**park45**
Position	**GPS: lat, long**	GSP Position: 43.12, 11.34	GSP Position: 44.12, 11.12
Static attribute	**Description: string**	Description: "parking massaia"	
Static attribute	**Location: string**	Location: "Via Massaia"	
Static attribute	**Civic Number: string**	Civic Number: 3	
Static attribute	**MaxCapacity: number, cars**	MaxCapacity: 456	
Values	**dateObserved: Timestamp**		23-12-2019T20:13:12…
Values	**FreeSlots: Integer, #**		345
Values	**Humidity: float, %**		25,5
Values	**Temperature: float, celsius**		34

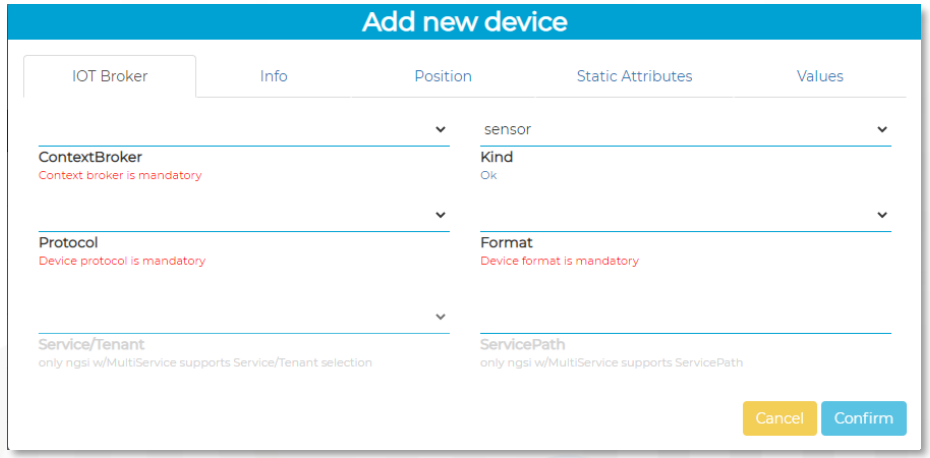
IOT Device Data Model (2)



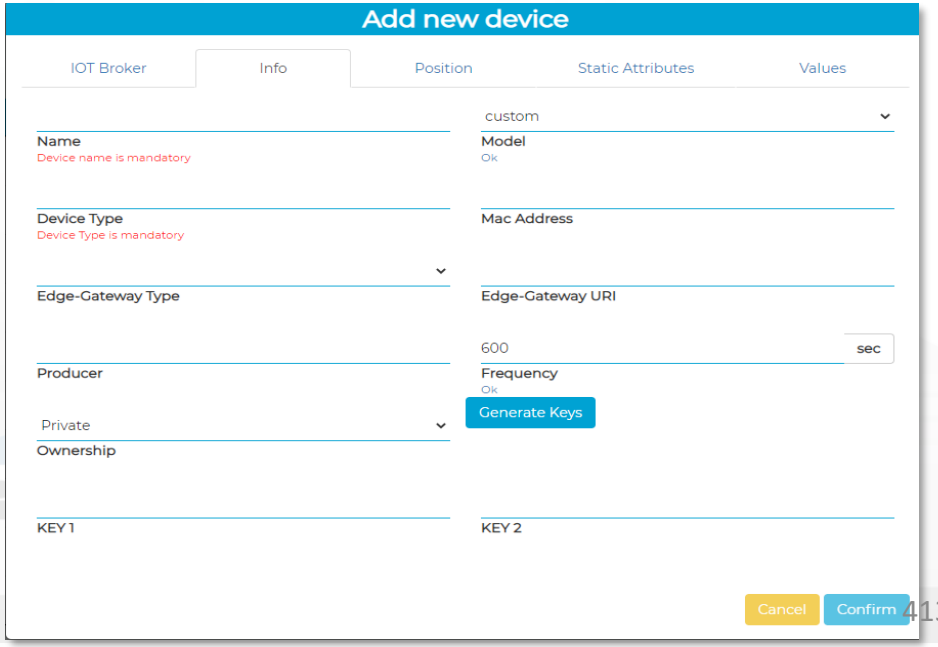


IOT Device Data Model (1)

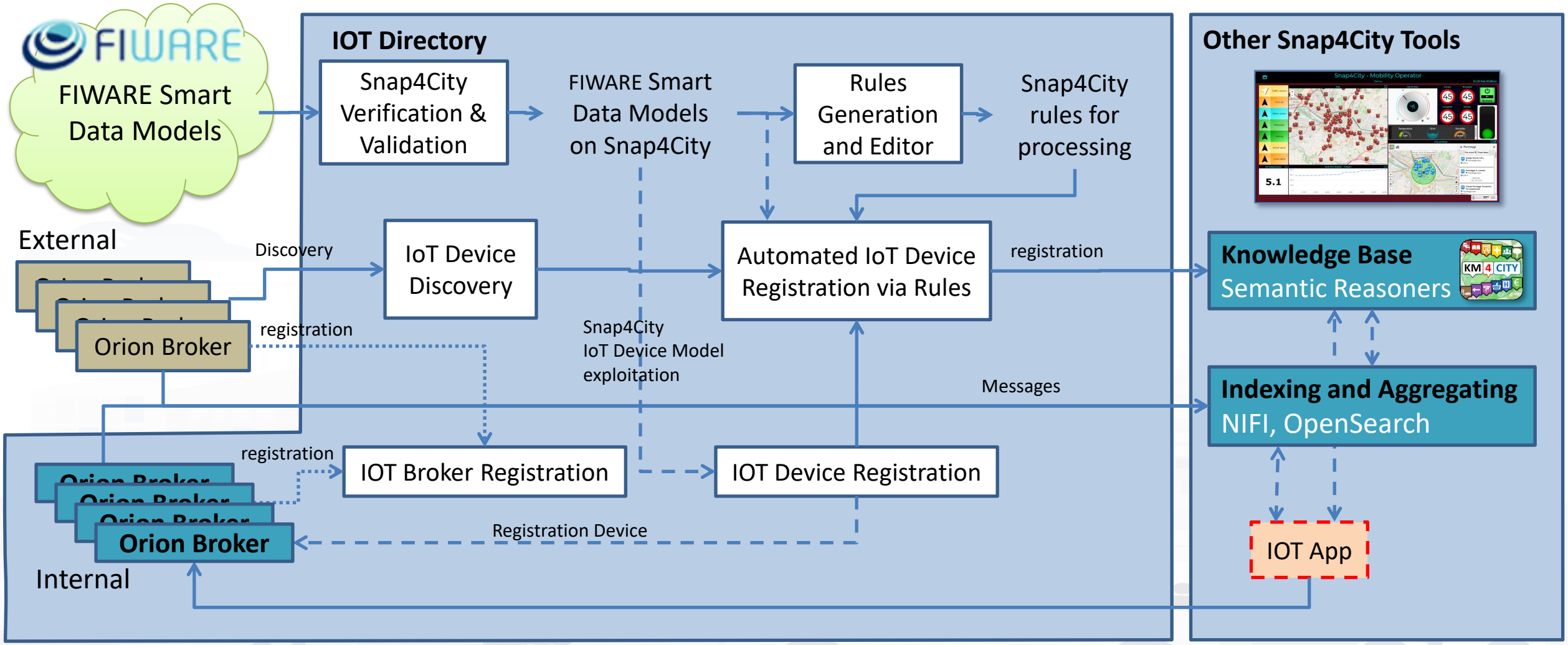
- IOT Broker
  - Name of the Brokers: among those registered
  - Protocol: NGSI, AMQP, MQTT, etc..
  - Format: CSV, JSON, XML.
  - Service/Tenant:…….
  - ServicePath:……



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



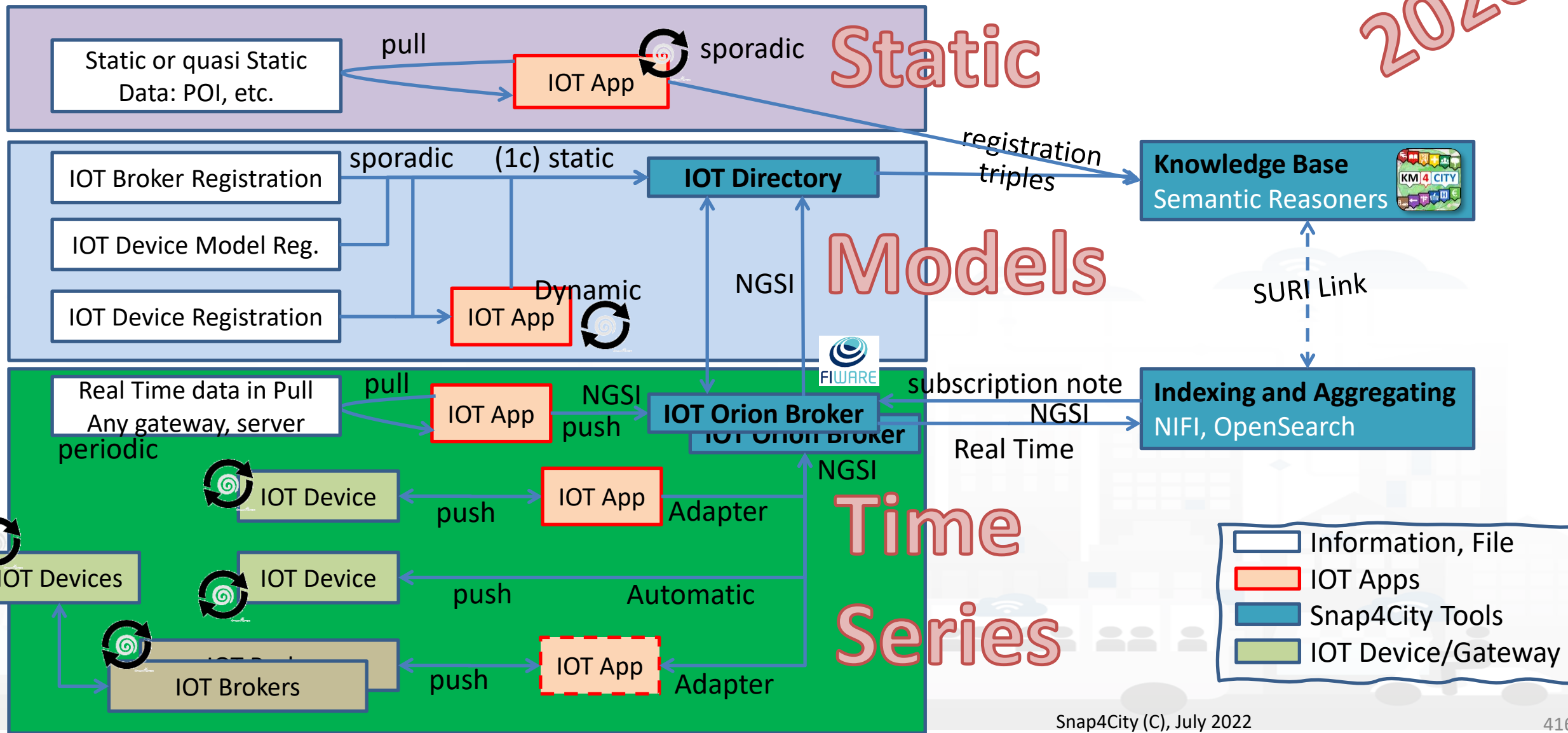
Exploiting FIWARE Smart Data Models



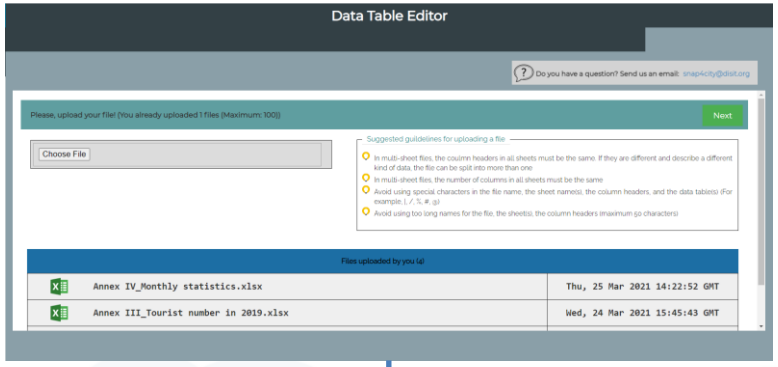
Data Ingestion and Management

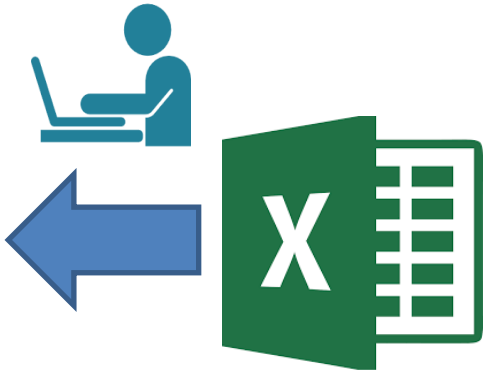


Snap4city Data Ingestion Flow Diagram

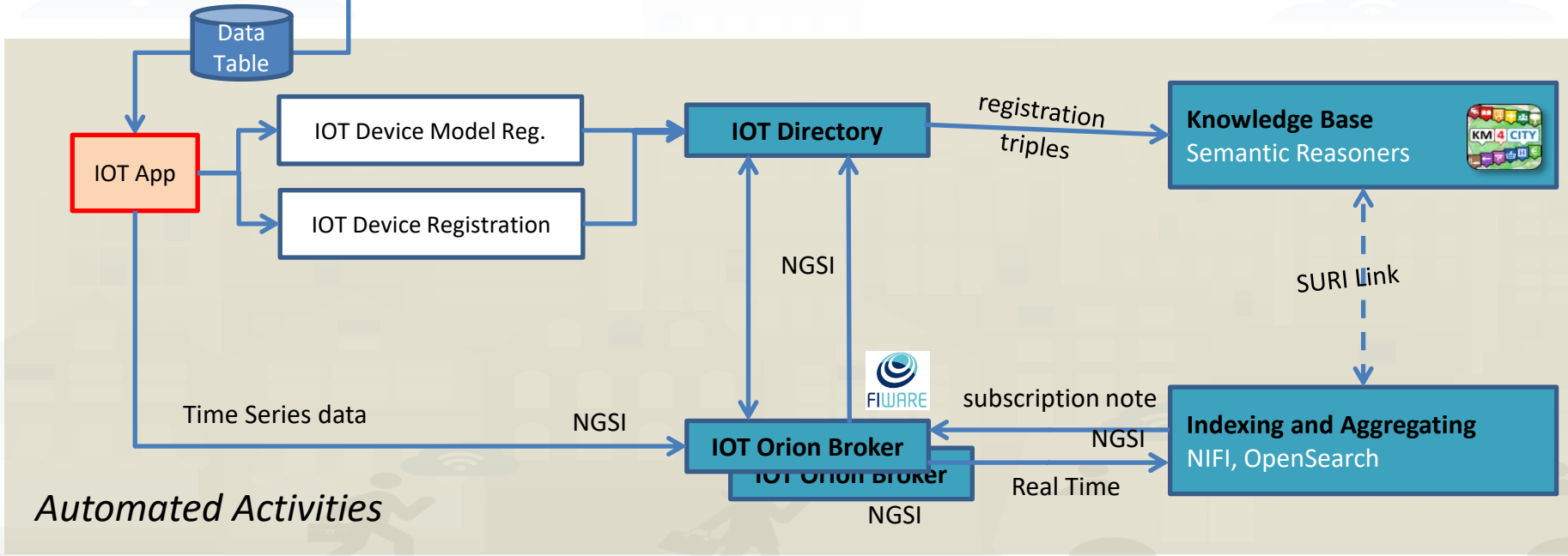


Short cut Data Ingestion from Excel file





1) Upload the file on **Data Table Loader**
2) Follows the instructions and guidelines
   -- the dirty work will be done in a Snap
   -- wait! –
3) See data on your Data Inspector ☺
4) Use Data Into Dashboards ☺

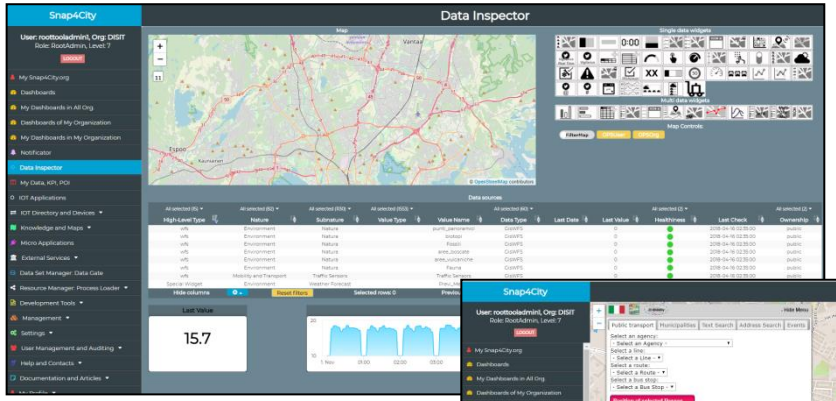




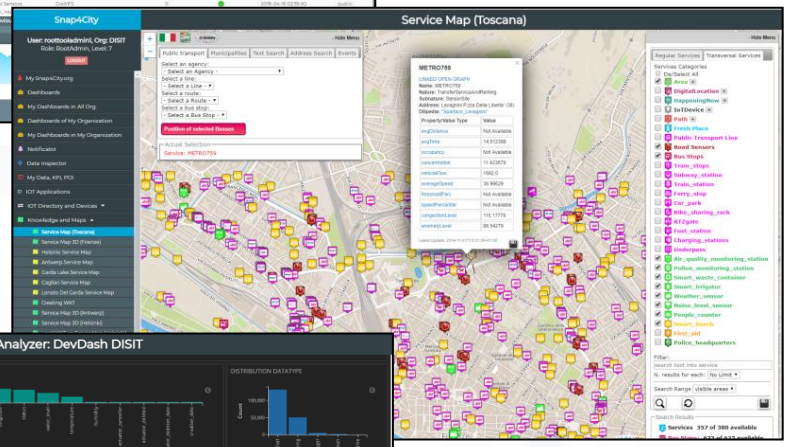
Checking data ingestion results

Knowledge base
Semantic reasoners

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



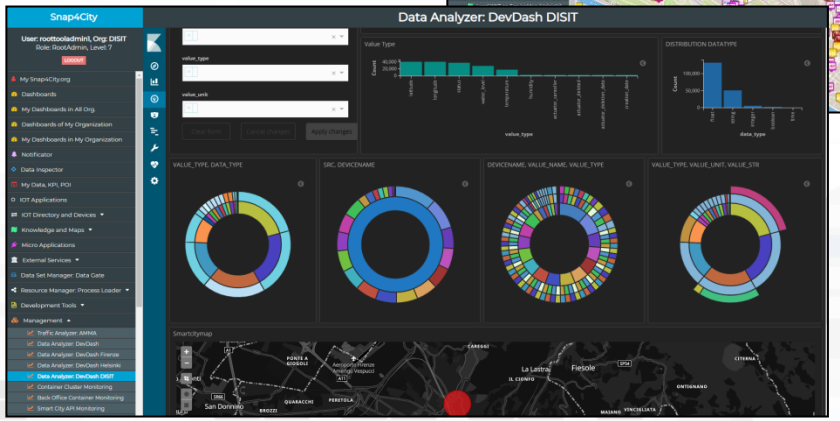
Data Inspector
Digital Twin view



ServiceMap

Indexing and aggregating
NIFI, OpenSearch

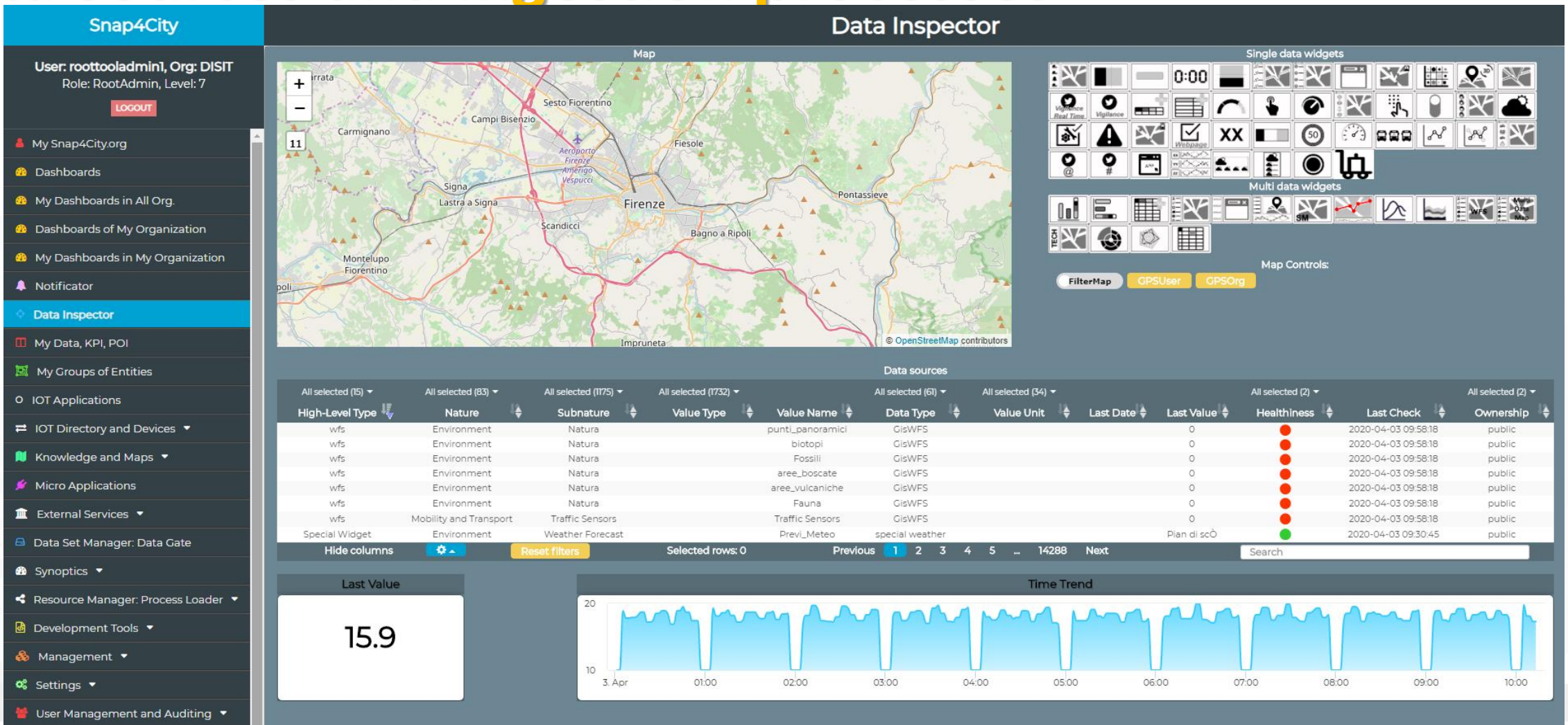
- **Data Inspector**
- **ServiceMap**, SCAPI
- **My Data Dashboard** (Kibana), DevDash
- Open Distro (ElasticSearch)



My Data Dashboard
DevDash

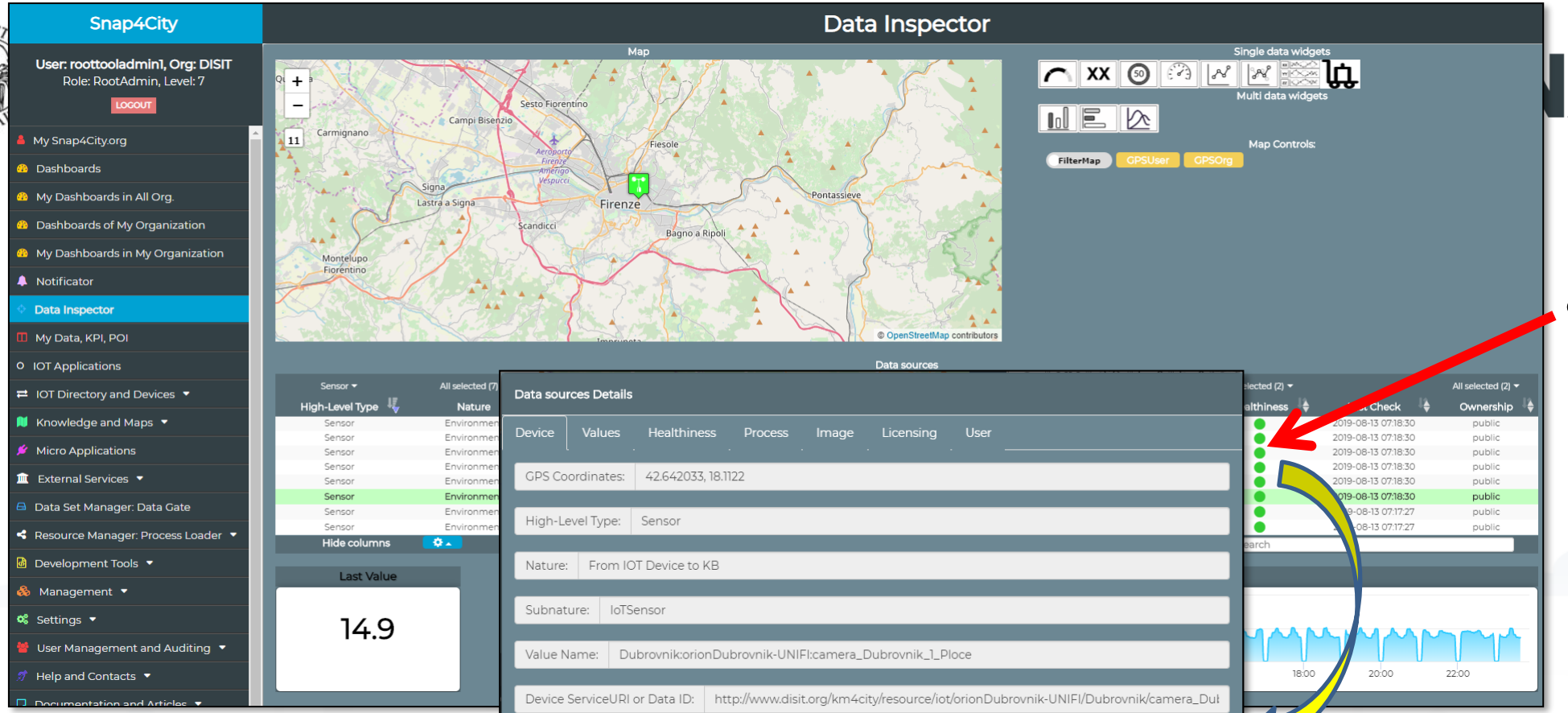
Some functionalities are limited to certain roles

Data Inspector: all you need to know about data, data sources and ingestion processes



Data Inspector (Digital Twin info) Major Submodels

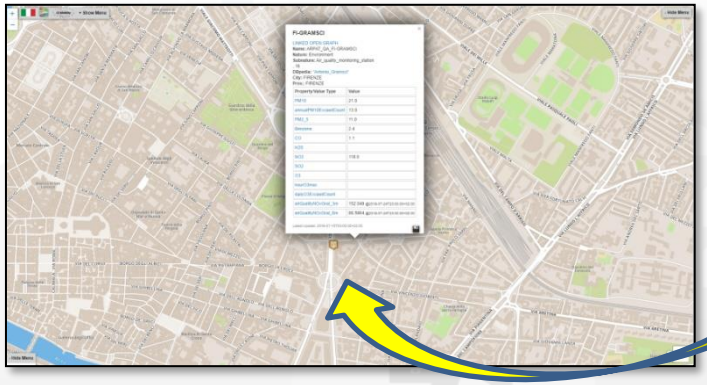
- **Digital Twin**
  - Device and sensors data
  - Values
  - Healthiness criteria and values
    - Machine learning tools
  - Images and physical world
  - Licensing
  - Users
- **Users**
  - Defined the Data and Devices
  - Defined the processes
  - Create dashboards
  - Etc.
- **Process Views**
  - Device Management tool
  - Data ingestion processes
    - ETL, IOT Apps
  - Data storage access views
    - Index views
    - Relationships view
  - Data Analytics and Transformation
    - IOT App, R Studio, Python
  - Data Rendering Dashboards
    - Synoptics
  - Processes' Developers

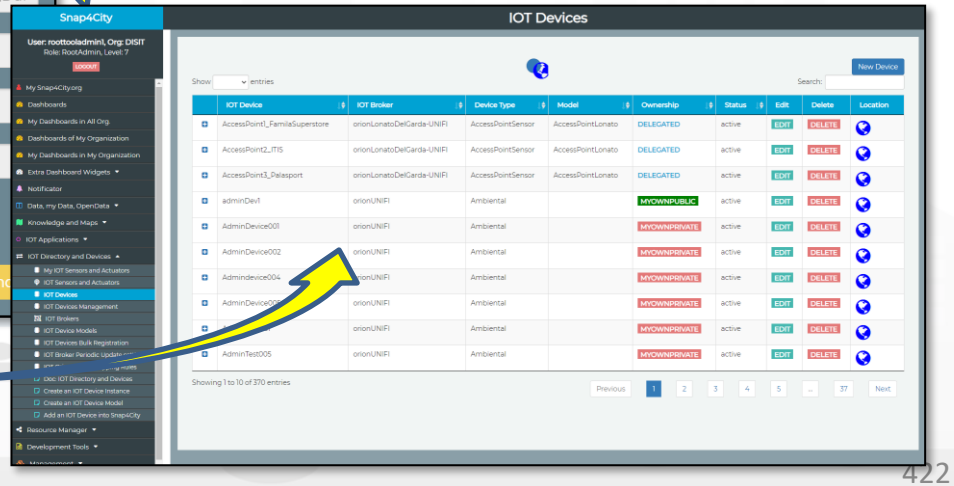


Knowledge Base view

- Click with the mouse on it

HLT: Sensor





Some functionalities are limited to certain roles

HLT: Sensor

Data sources Details

Device | Values | Healthiness | Process | Image | Licensing | User

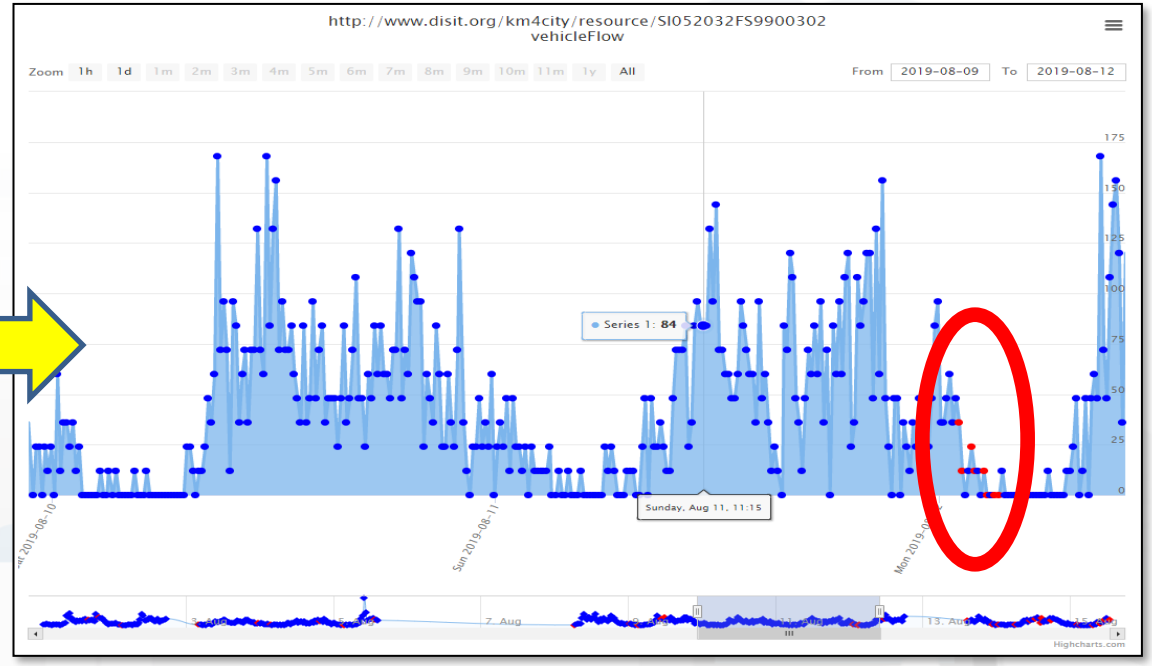
Last Date: 2020-07-21 19:00:00

Last Value:

Value Type	Healthy	Delay (s)	Reason	Healthiness Criteria	Refresh Rate (s)	Data type	Unit	Value	Time Trend
dateObserved	●	61890	undefined	undefined	300	time	timestamp	2020-07-21T17:00:00.000Z	VIEW
deceduti	●	61890	undefined	undefined	300	integer	#	16797	VIEW
dimessi_guariti	●	61890	undefined	undefined	300	integer	#	71775	VIEW
isolamento_domiciliare	●	61890	undefined	undefined	300	integer	#	6838	VIEW
nuovi_attualmente_positivi	●	61890	undefined	undefined	300	integer	#	-131	VIEW
ricoverati_con_sintomi	●	61890	undefined	undefined	300	integer	#	151	VIEW
stato	●	61890	undefined	undefined	300	string	#	ITA	VIEW
tamponi	●	61890	undefined	undefined	300	integer	#	1212468	VIEW
terapia_intensiva	●	61890	undefined	undefined	300	integer	#	21	VIEW
totale_attualmente_positivi	●	61890	undefined	undefined	300	integer	#	7010	VIEW
totale_casi	●	61890	undefined	undefined	300	integer	#	95582	VIEW
totale_ospedalizzati	●	61890	undefined	undefined	300	integer	#	172	VIEW
codice_regione	●	61890	missing value	undefined	300	integer	status		VIEW
denominazione_regione	●	61890	missing value	undefined	300	string	status		VIEW

Cancel

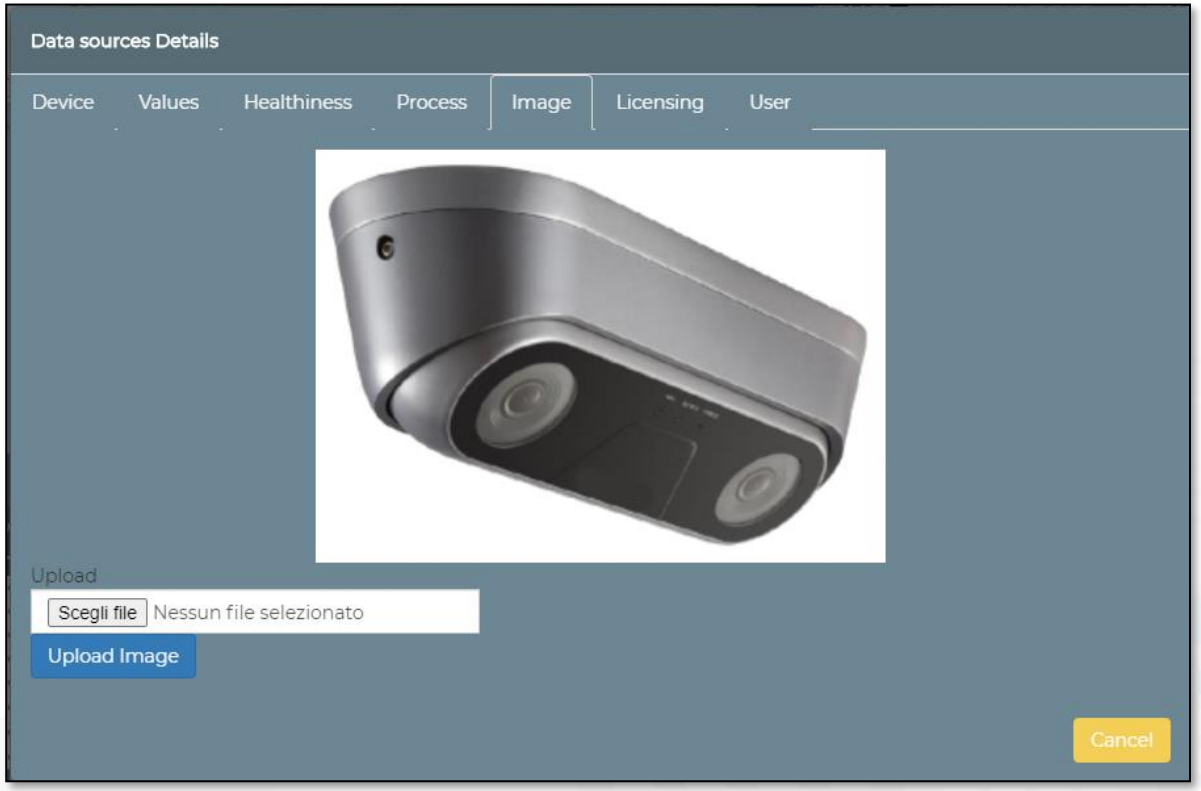
- Specific values of selected
- Information of the values of the other sensors on the same device
- View Trends, marking problems, healthiness by point according to a Fuzzy model
- Marking problems for future machine learning processes (separate tool)

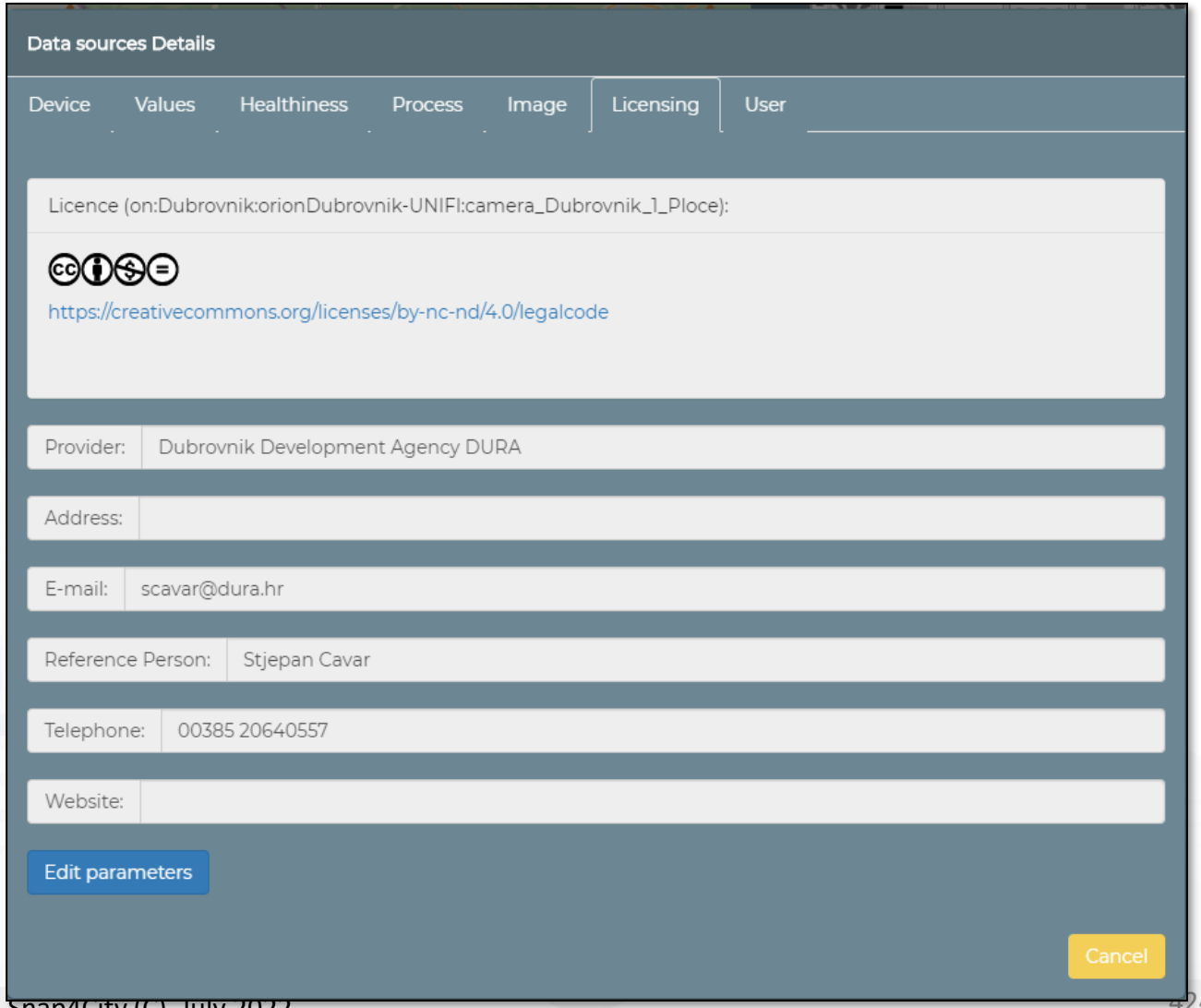


Some functionalities are limited to certain roles

HLT: Sensor

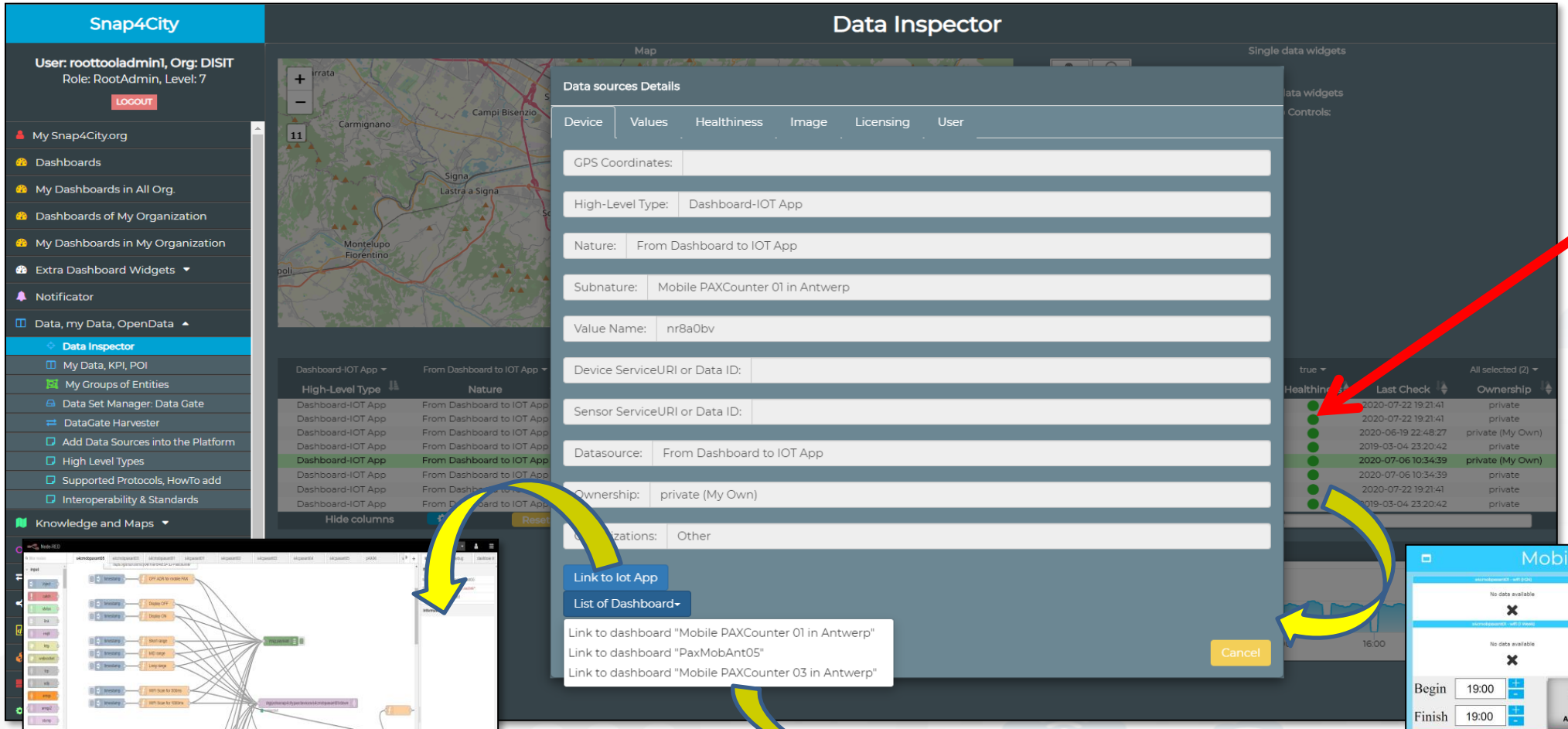
Image of the Devices and Licensing



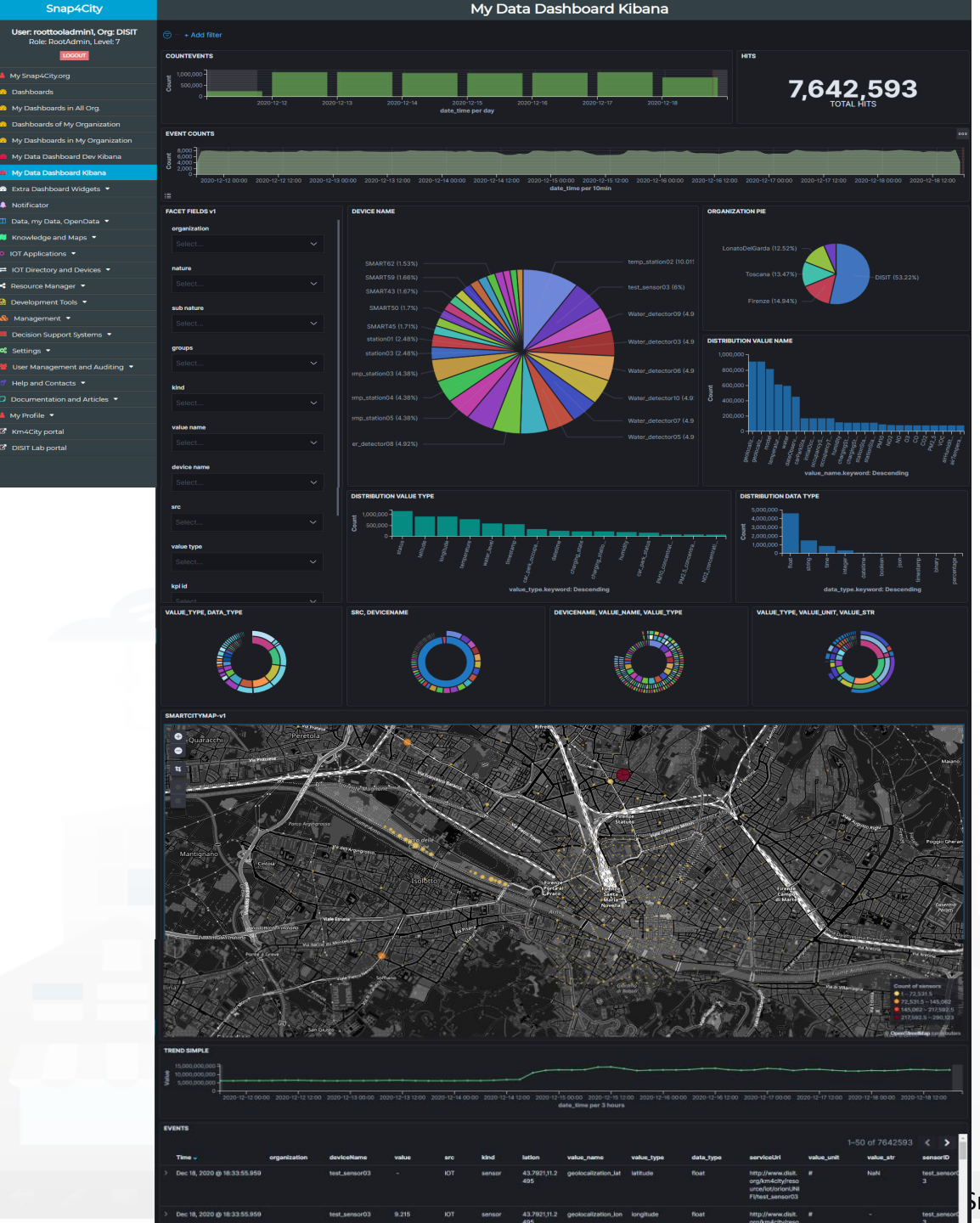


Some functionalities are limited to certain roles

HLT: From Dashboard to IOT APP



- Click with the mouse on it

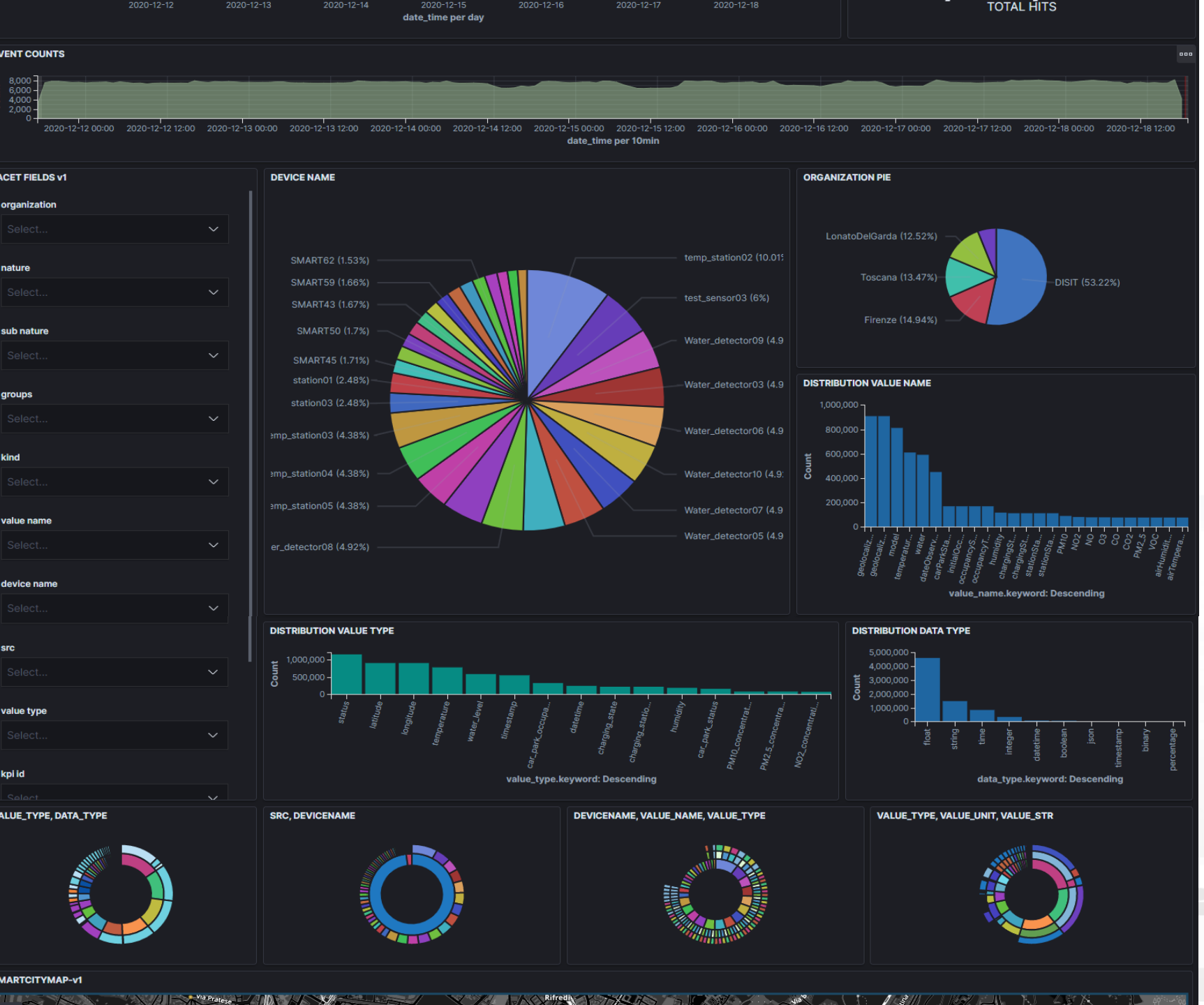


kibana

SNAP4CITY

Business Analysis Dashboards For all kind of users: DevDash

- Dynamic Filtering, Adaptable, …
- Full data details, drill down,…
- Synergic with **Data Inspector** which addresses data relationships, processing and information
- **Only Your Data for**
  - Manager and Area Managers
- **All Accessible Data for**
  - ToolAdmin and RootAdmin



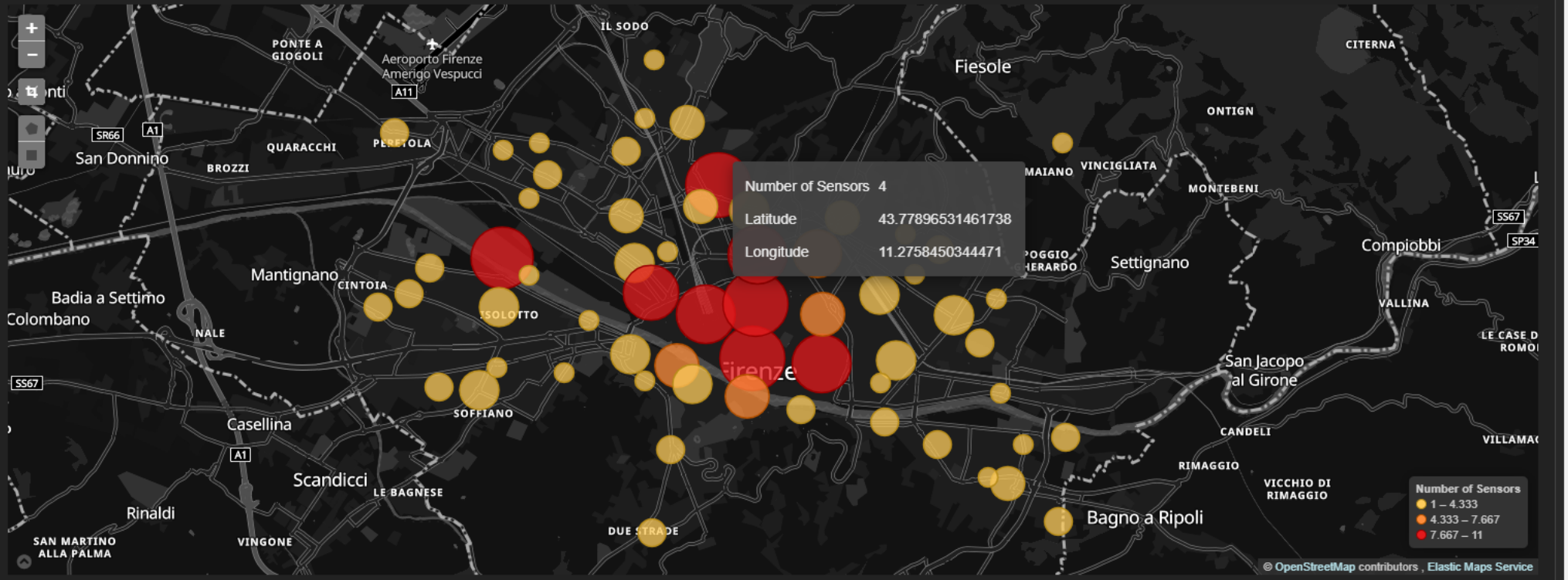
- Multi faceted Search by
  - Devices
  - Organization
  - Drill on Time
  - Drill on Map
  - Value Types
  - Data Type
  - Value name
  - Data table
  - Etc.
- Respect Privacy and GDPR

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

LOGOUT

My Snap4City.org
Dashboards
My Dashboards in All Org.
Dashboards of My Organization
My Dashboards in My Organization
Extra Dashboard Widgets
Notificator
Data, my Data, OpenData
Knowledge and Maps
IOT Applications
IOT Directory and Devices
Resource Manager
Development Tools
Management
Traffic Analyzer: AMMA
Data Analyzer: DevDash
Data Analyzer: DevDash Firenze
Data Analyzer: DevDash Helsinki
Data Analyzer: DevDash DISIT
Data Analyzer: DevDash Lonato
Data Analyzer: whole traffic
Container Cluster Monitoring
Back Office Container Monitoring
IOT App Version Management
Smart City API Monitoring
MyKPI Monitoring
Notificator Monitoring
Web Server Monitoring
Back Office DWH Sched DISCES
Back Office DA Sched DISCES
Back Office DISCES monitor
Mobile Application Monitoring

SMARTCITYMAP



EVENTS

1–50 of 176,794

Time	organization	deviceName	value	src	kind	latlon	value_name	value_type	data_type	serviceUri	value_unit	value_str
October 11th 2020, 12:33:52.790		test_sensor03	9.215	IOT	sensor	43.7921,11.2495	geolocalization_lon	longitude	float	http://www.disit.org/km4city/resource/iot/orionUNIFI/test_sensor03	#	-
October 11th 2020, 12:33:52.790		test_sensor03	24	IOT	sensor	43.7921,11.2495	temperature	temperature	float	http://www.disit.org/km4city/resource/iot/orionUNIFI/test_sensor03	°C	-
October 11th 2020, 12:33:52.790		test_sensor03	-	IOT	sensor	43.7921,11.2495	geolocalization_lat	latitude	float	http://www.disit.org/km4city/resource/iot/orionUNIFI/test_sensor03	#	NaN
October 11th 2020, 12:33:52.492	DISIT	testxxx3	1,602,412,480,000	IOT	sensor	43.79737,11.3063	timestamp	timestamp	timestamp	http://www.disit.org/km4city/reso	#	-

TOP

Platform Integration Capabilities



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

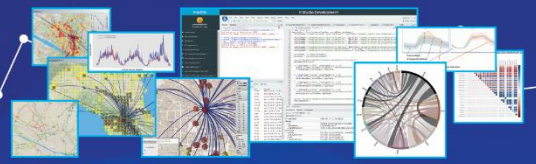
MICROSERVICES & ADVANCED SMART CITY API

LIVING LAB - DEV TOOLS - COWORKING

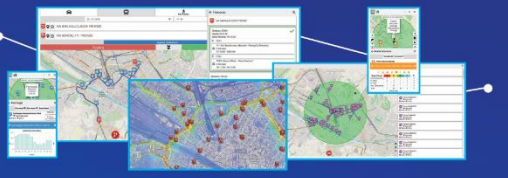


IOT DIRECTORY • SERVICE MAP • RESOURCE MANAGER • DATA GATE • R STUDIO • ETL

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



Smart City Functional Architecture

Transport systems
Mobility, parking



Public Services,
Govern, events, …



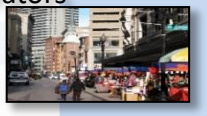
Sensors, IOT Cameras,
Wi-Fi



Environment, Water,
energy



Shops, services,
operators

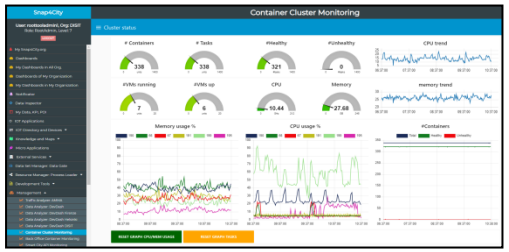


Social Media

Social Media Crawler and Manager

Back office tool







Back-End ← → Front-End

Data Sources, External Services *PULL Data*

Data Sources, Brokers, External Services *Data Driven, Real Time*

Data Ingestion, aggregation, regularizatio n, reconcile: IOT Directory, NIFI, special tools

Knowledge base
Semantic Reasoners

Indexing and aggregating
NiFi, OpenSearch

Federation

Search and Query, Smart City API, Web Socket Server, GIS, Facet, semantic

Data Analytics, Simulations, Special Tools
R Studio, Tensor Flow, Python, ….

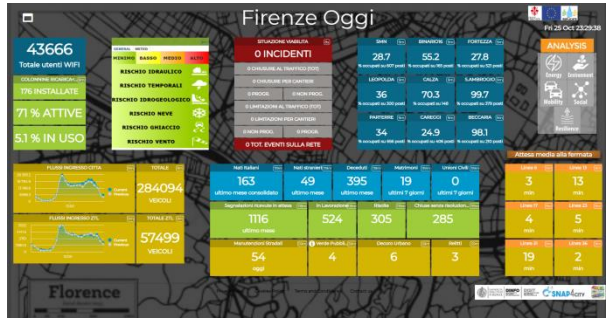
IOT Applications, Business Logic
Node-RED + Snap4City MicroServices

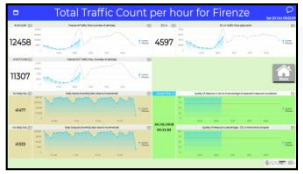
Rendering Acting, Widgets, Synoptics, MicroApps User interface, Drill down, maps, heatmaps

Inform, announce, Act!, warning, alarms, What-IF, ..

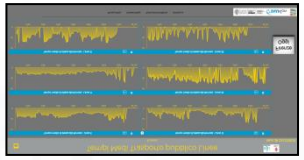
Authentication, Authorization, Platform & Processes Management, Data Inspector, Digital Twin, …

Dashboards, visual tools,
Web and Mobile Apps



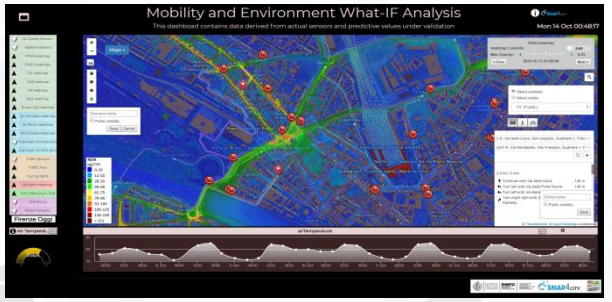




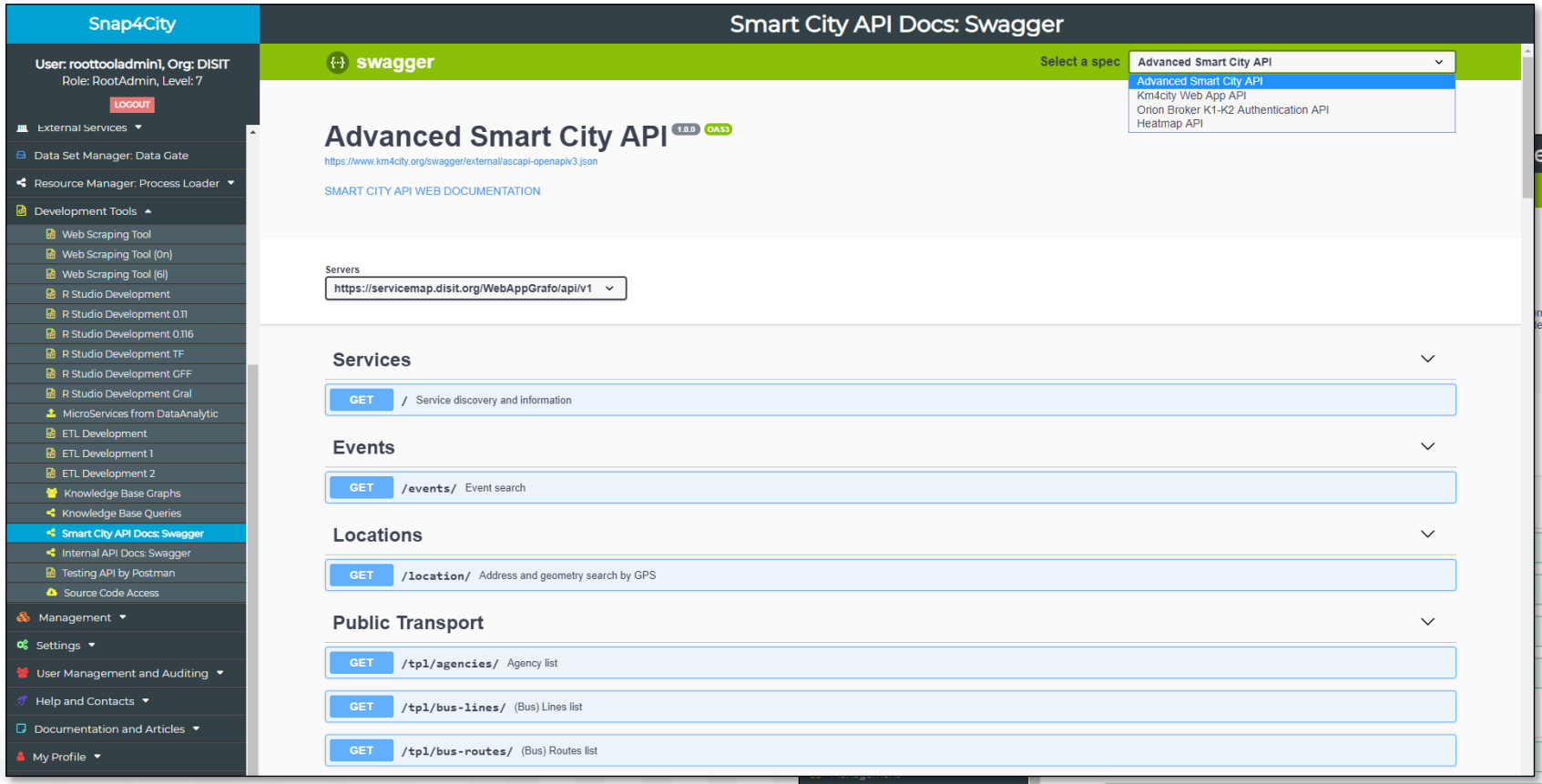


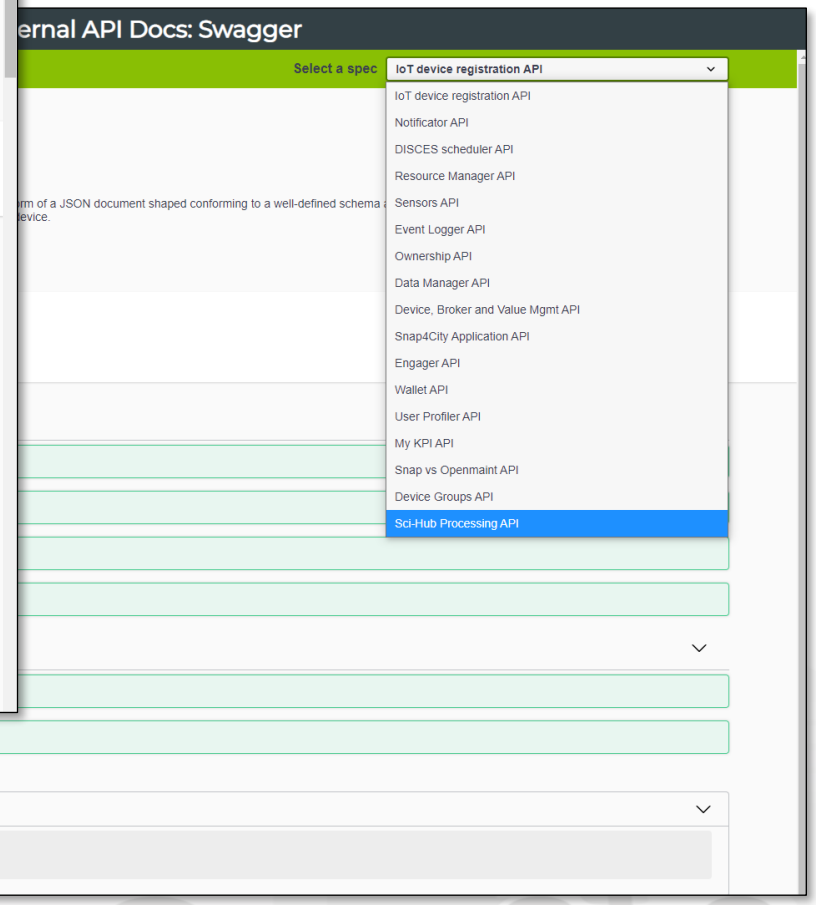






Internal and External Smart City API



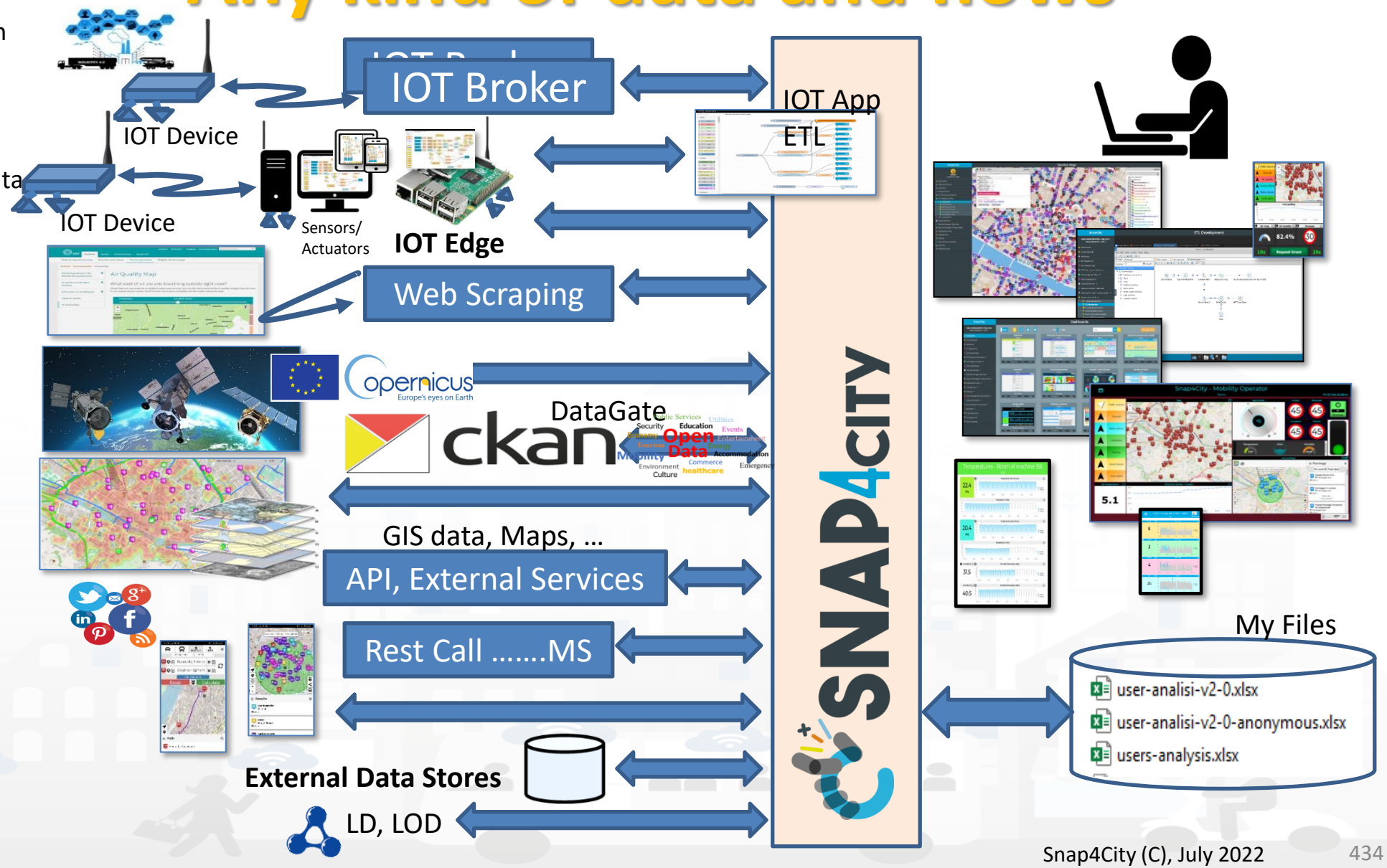


https://www.km4city.org/swagger/external/index.html

https://www.km4city.org/swagger/internal/index.html

Any kind of data and flows

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



Standards and Interoperability (6/2022)

Compliant with:

- **IoT:** NGSI V2/LD, LoRa, LoRaWan, MQTT, AMQP, COAP, OneM2M, TheThingsNetwork, SigFOX, Libelium, IBIMET/IBE, Enocean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, BACnet, TALQ, Protocol Buffer, KNX, OBD2, ..
- **IoT model:** FIWARE Smart Data Model, Snap4City IoT Device Models
- **General**: HTTP, HTTPS, TLS, Rest Call, SMTP, TCP, UDP, SOAP, WSDL, FTP, FTPS, WebSocket, WebSocket Secure, GML, WFS, WMS, RTSP, ONVIF, AXIS TVCam, CISCO Meraki, OSM, Copernicus, The Weather Channel, Open Weather, OLAP, ….
- **Formats**: JSON, GeoJSON, XML, CSV, GeoTIFF, OWL, WKT, KML, SHP, db, XLS, XLSX, TXT, HTML, CSS, SVG, IFC, XPDL, OSM, Enfuser FMI, Lidar, glTF, GLB, DTM, GDAL, …
- **Database**: Open Search, MySQL, Mongo, HBASE, SOLR, SPARQL, ODBC, JDBC, Elastic Search, Phoenix, PostGres, MS Azure, ..
- **Industry**: OPC/OPC-UA, OLAP, ModBUS, RS485, RS232,..
- **Mobility**: DATEX, GTFS, Transmodel, ETSI, ..
- **Social**:Twitter, FaceBook, Telegram, ..
- **Events**: SMS, EMAIL, CAP, RSS Feed, ..
- **OS**: Linux, Windows, Android, Raspberry Pi, Local File System, ESP32, etc.

https://www.snap4city.org/65

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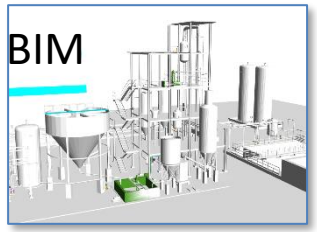
Concept

SNAP4CITY | KM4CITY

BIM

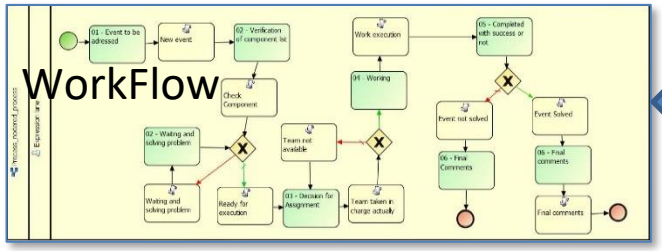


KPI, POI, MyKPI, …

API, External Services

Web Scraping

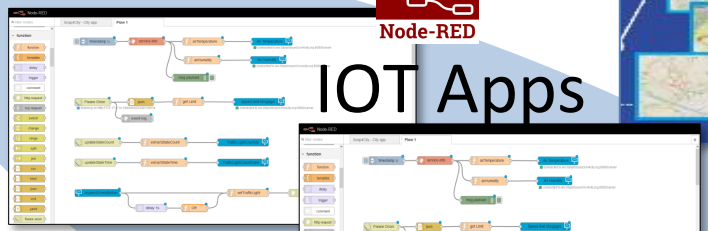
WorkFlow





Node-RED

IOT Apps





Data Analytics, Artificial Intelligence



opernicus Europe's eyes on Earth

IOT Brokers

IOT Broker

IOT Broker



FIWARE

ckan



GIS

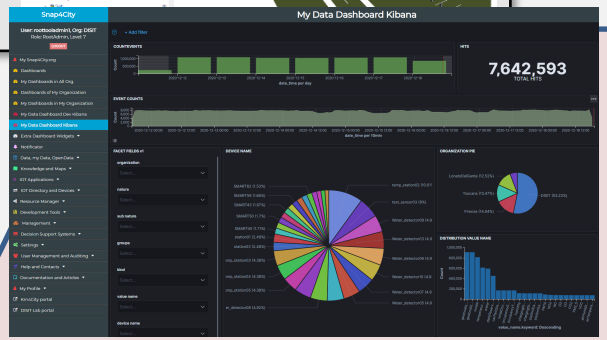
Big Data

KB

LD, LOD







Dashboards and Apps

FI-WARE

IOT Network Interoperability



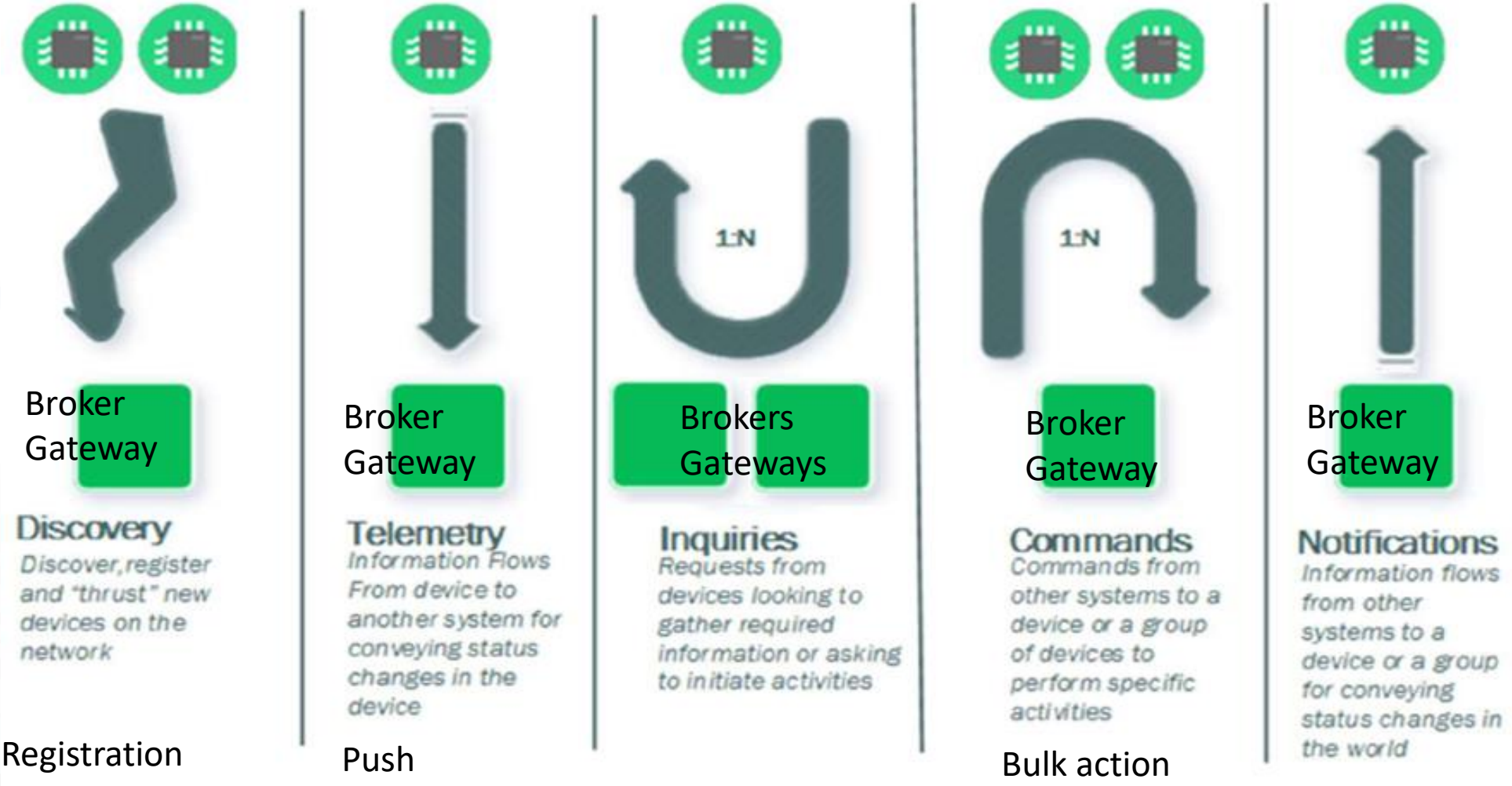
IOT Interoperability

Compliant with: AMQP, COAP, MQTT, OneM2M, HTTP, HTTPS, TLS, Rest Call, SMTP, TCP, UDP, NGSI, LoRa, LoRaWan, TheThingsNetwork, SigFOX, DATEX II, Telegram, SMS, WebSocket, WebSocket Secure, ModBUS, OPC, GML, RS485, RS232, XML, JSON, CSV, GeoJSON, ESP32, Libelium, IBIMET/IBE, OBD2, XLS, XLSX, KNX, Enocean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, BACnet, TALQ, Protocol Buffer, etc.

Node-RED
JS Foundation
FIWARE Open APIs for Open Minds
E015 digital ecosystem
bee smart city
sigfox partner network
ckan
GJL
LABGEO
esri Italia THE SCIENCE OF WHERE
EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE

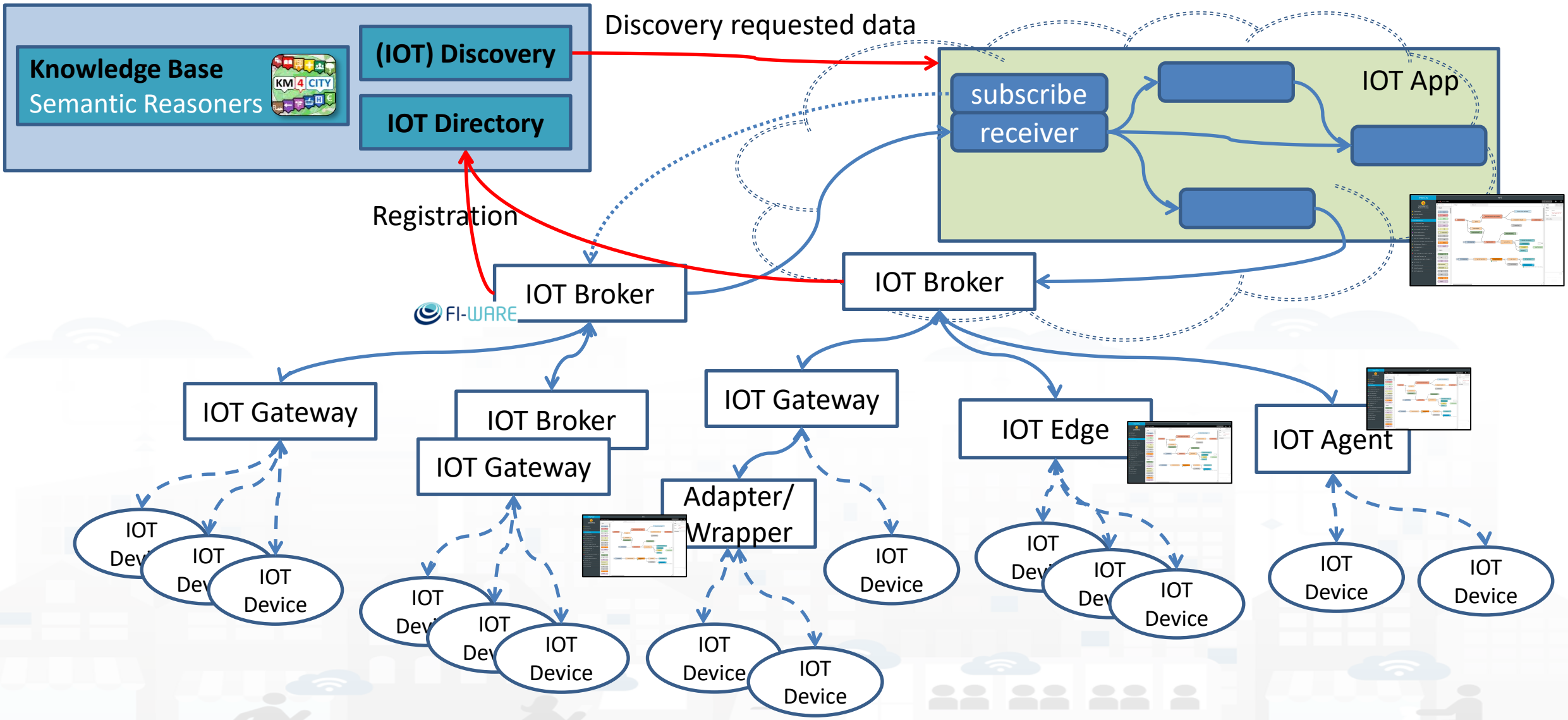
IOT/IOE Protocols

Communication Patterns



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

IoT Network


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

IOT Network Manager vs Final User

Network of IOT Brokers

IOT Broker

External

Internal

IOT Directory

IOT Network Manager

My IOT Device

Register

Registering

Discovering

Knowledge Base, Km4City

Knowledge and Storage Data from the Field and City

Browsing

ServiceMap Knowledge Base

Discovering

IOT Application

Final user Manager

Dashboard Wizard

Prepare Deep Manage

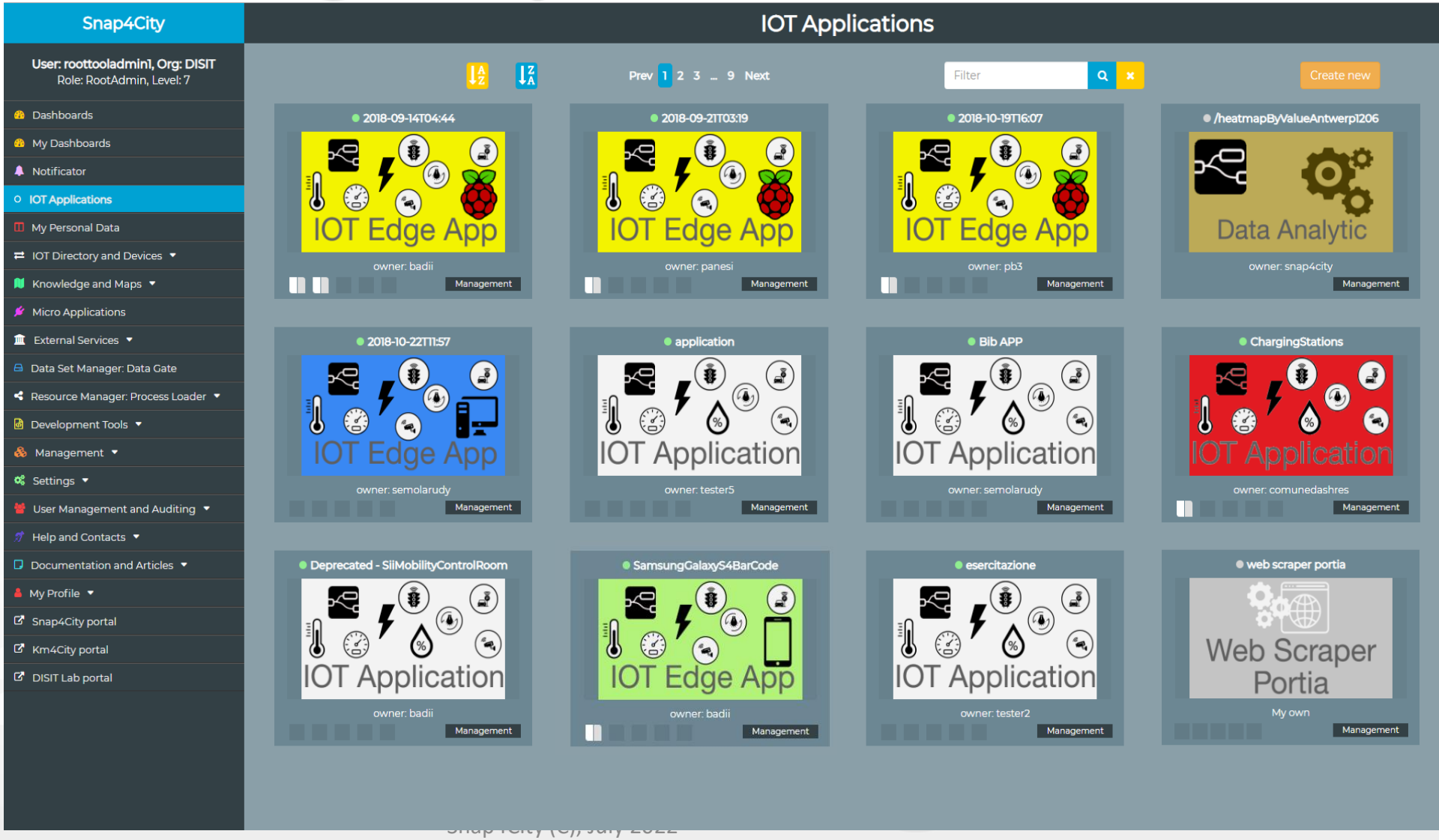
Exploit

Integration via IoT Apps and processes

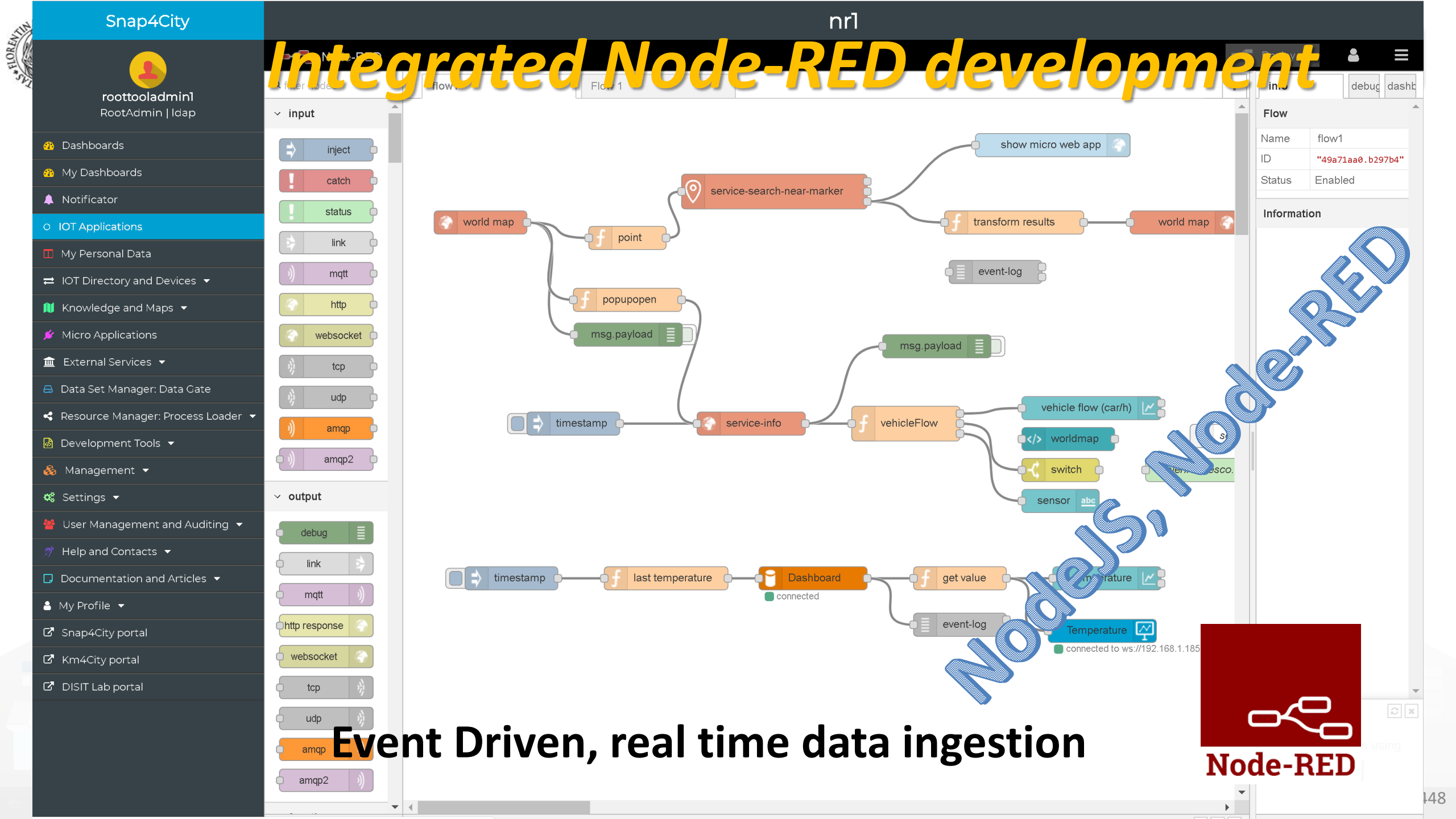


IOT Application Listing, they can be

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



Integrated Node-RED development



Event Driven, real time data ingestion

IoT Applications

- **Data ingestion**: more than 70 protocols IOT and Industry 4.0, web Scraping, external services, any protocol database, etc.
- **Data access**: save/retrieve data, query search on expert system, georeverse solution, search on expert system Km4City ontology, etc.
- **Data Transformation/transcoding:** binary, hexadecimal, XML, JSON, String, any format
- **Integration**: CKAN, Web Scraping, FTP, Copernicus satellite, Twitter Vigilance, Workflow OpenMaint, Digital Twin BIMServer, any external service REST Call, etc.
- **Manipulation of complex data**: heatmaps, scenarios, typical time trend, multi series, calendar, maps, etc.
- **Access to Smart City Entities and exploitation of Smart City Services**: transport, parking, POI, KPI, personal data, scenarios, etc.
- **Data Analytic**: managing Python native, calling and scheduling Python/Rstudio containers as snap4city microservices (predictions, anomaly detection, statistics, etc.)
- **User interaction on Dashboard**: get data and message from the user interface, providing messages to the user (form, buttons, switches, animations, selector, maps, etc.)
- **Custom Widgets**: SVG, synoptics, animations, dynamic pins on maps, etc
- **Event management**: Telegram, Twitter, Facebook, SMS, WhatsApp, CAP, etc.
- **Hardware Specific Devices**: Raspberry Pi, Android, Philips, video wall management, etc.

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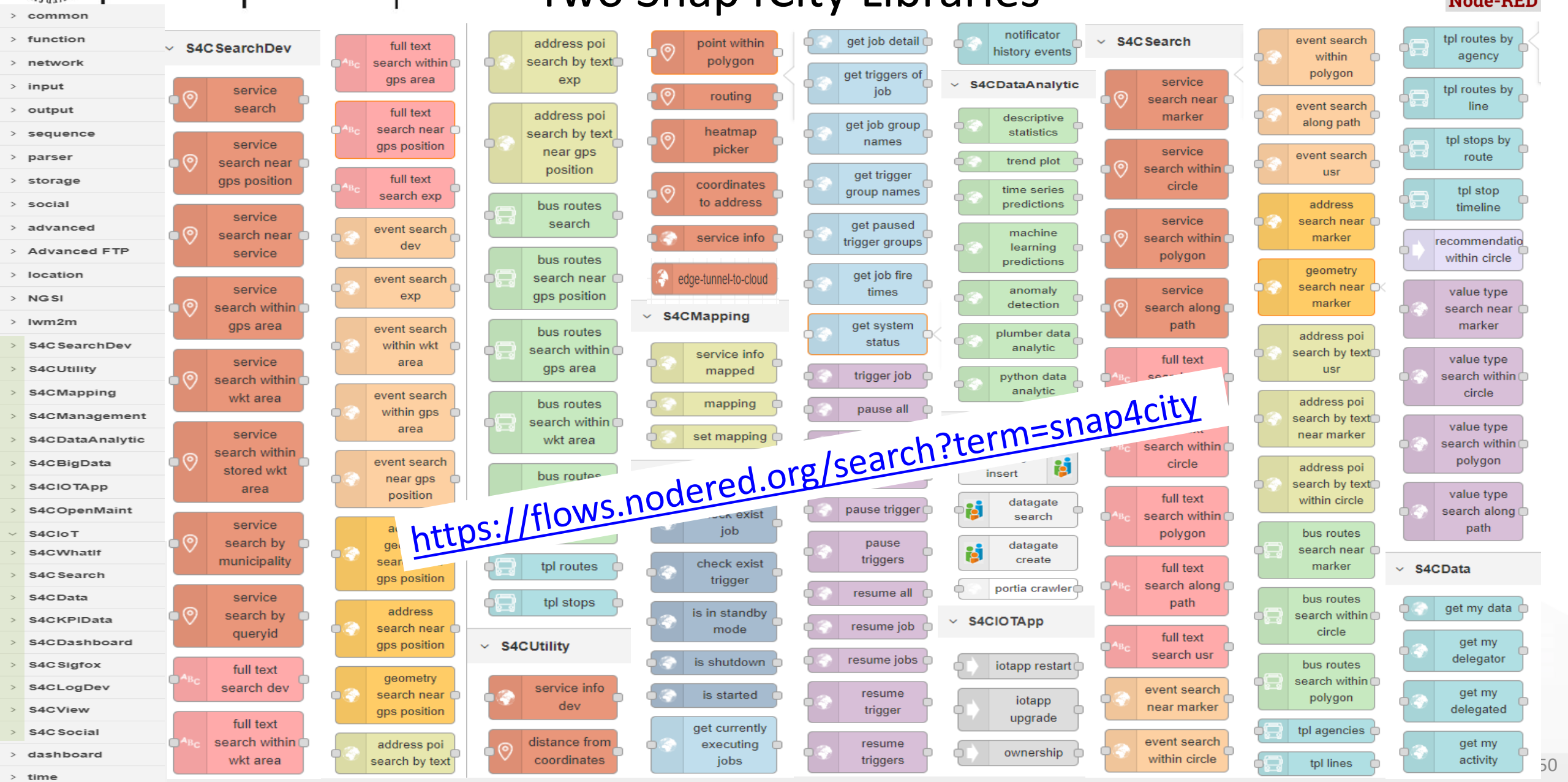
June 2022 collection

Two Snap4City Libraries

SNAP4CITY | Node-RED



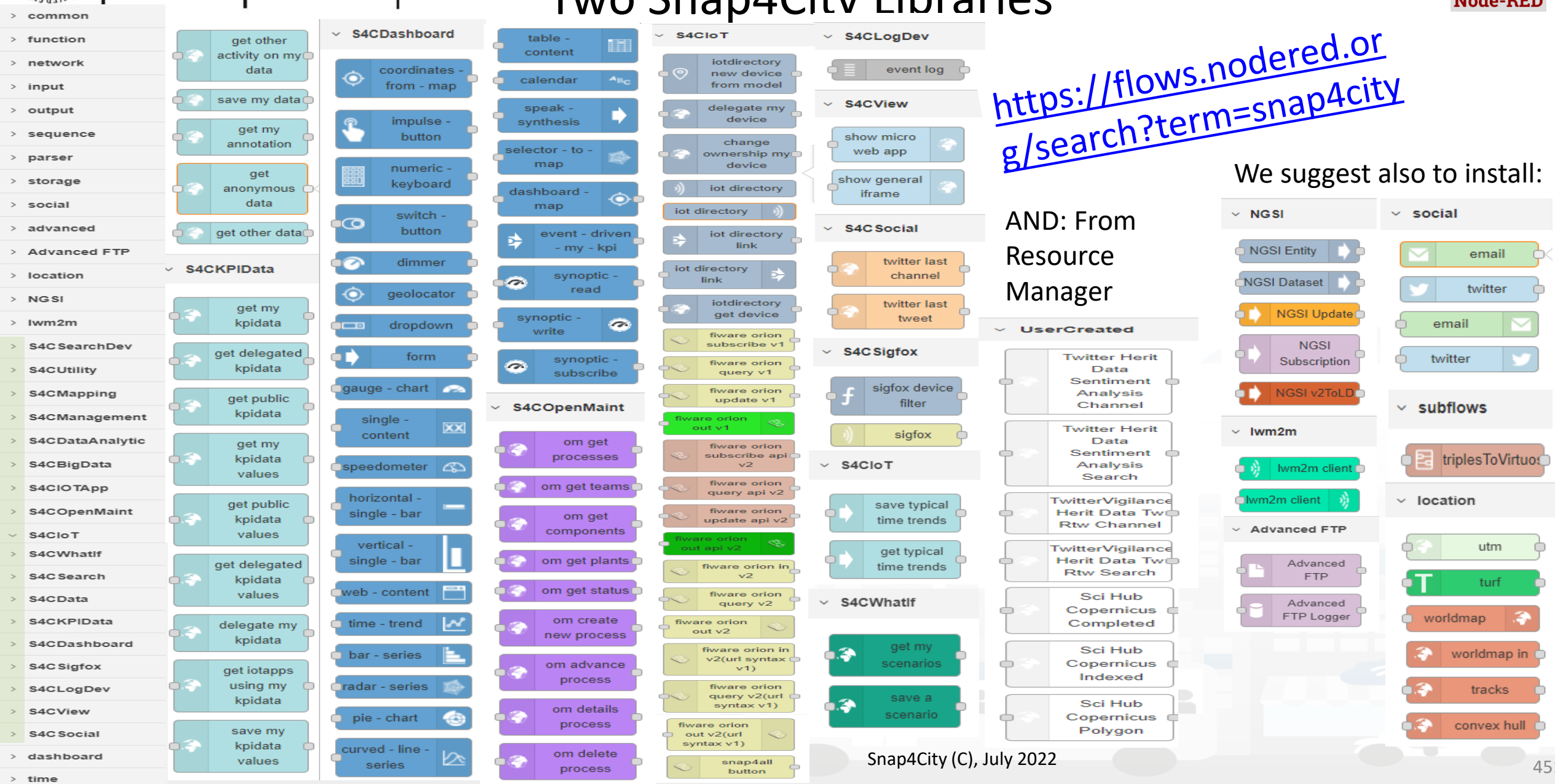
https://flows.nodered.org/search?term=snap4city

June 2022 collection

Two Snap4Citv Libraries

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

We suggest also to install:



AND: From Resource Manager

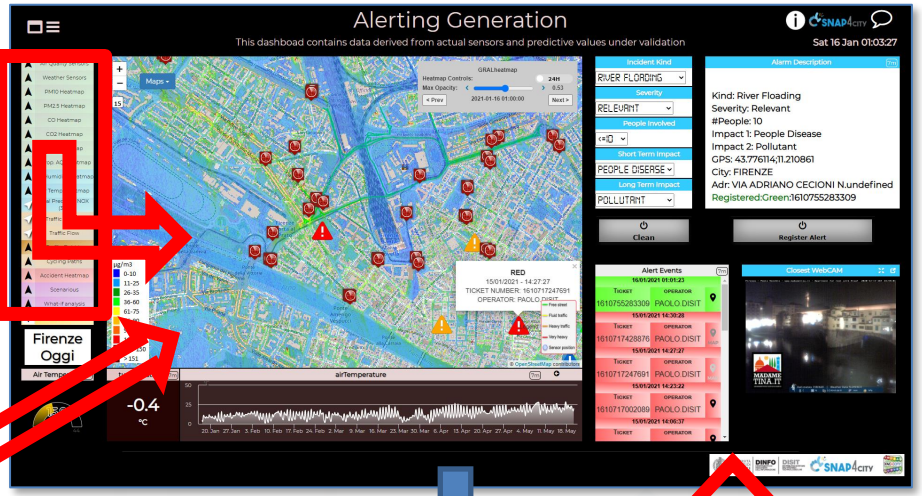
Maps Business Logic vs IOT Apps

Any Snap4City data and sources: IoT Devices, Variables, Heatmaps, traffic, tools, KPI, etc.

data

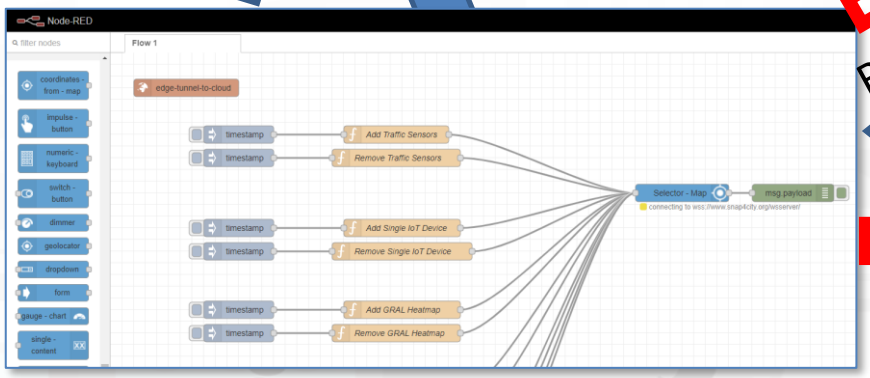
data

Selector



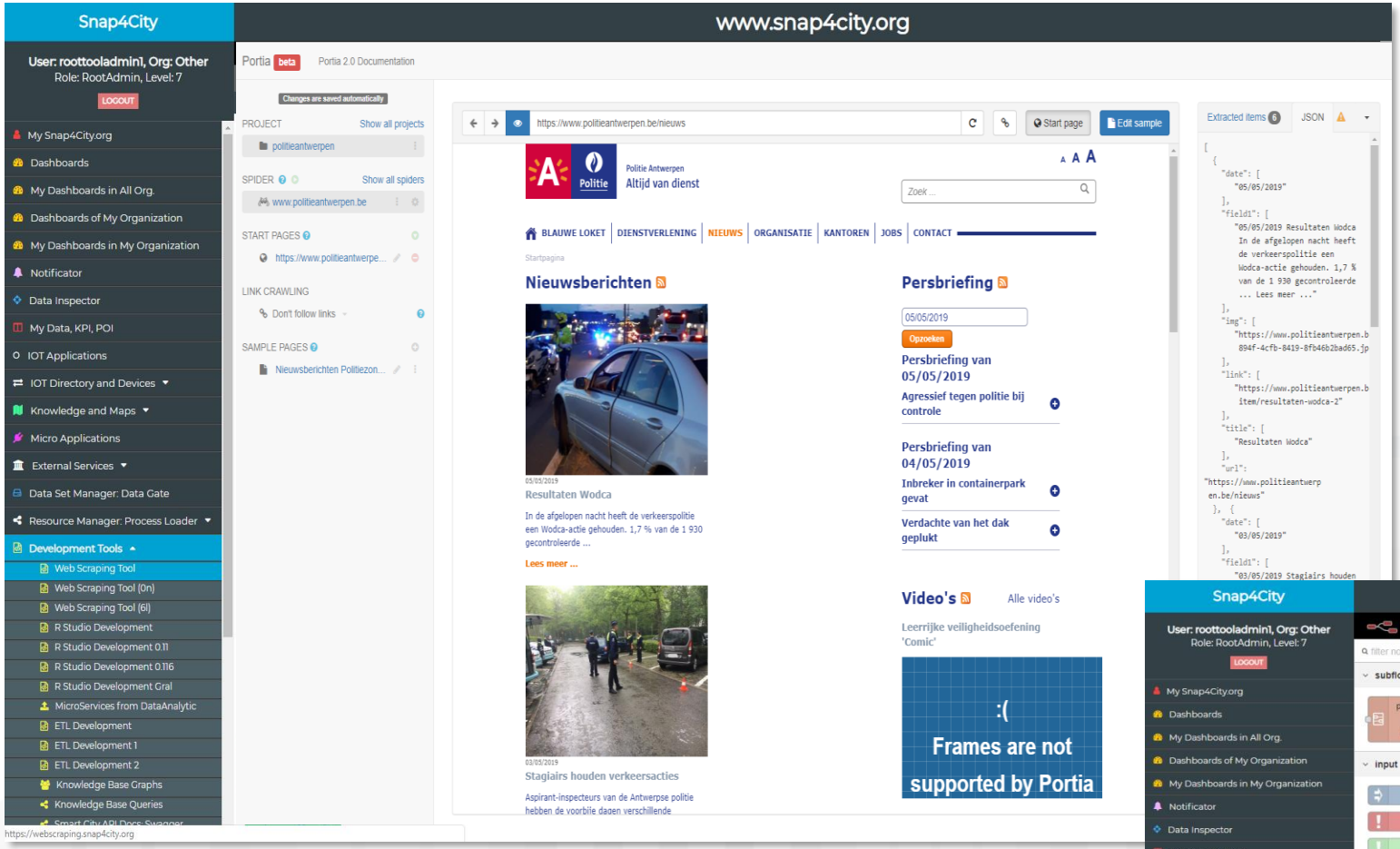
Data, changed data

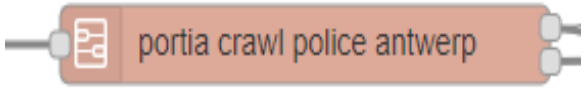
References, commands, selections

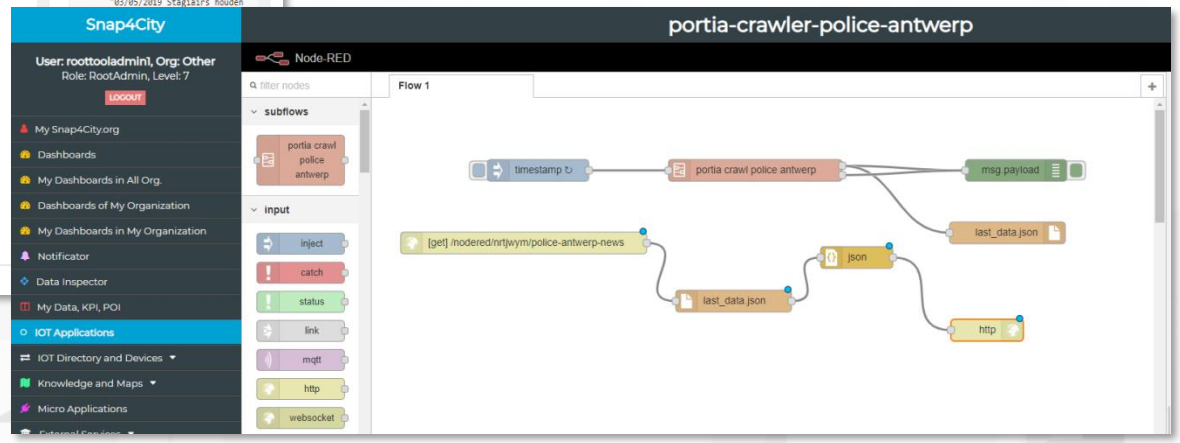


selections, positions, ServiceURI

Web Scraping



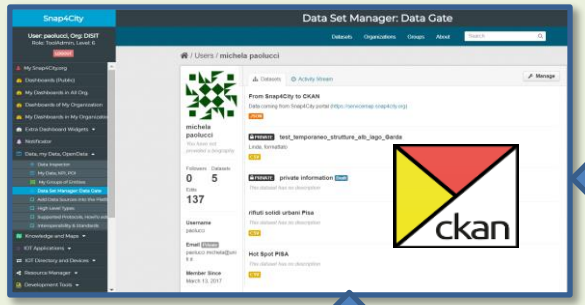




Snap4City vs CKAN

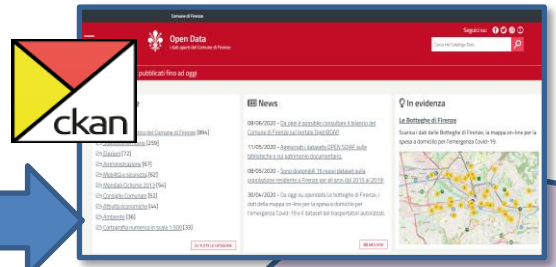
Snap4City Portal and Integrated tools

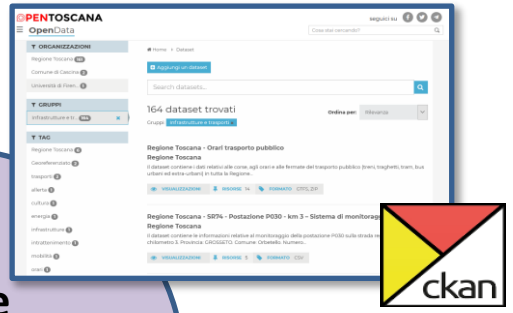
Datagate



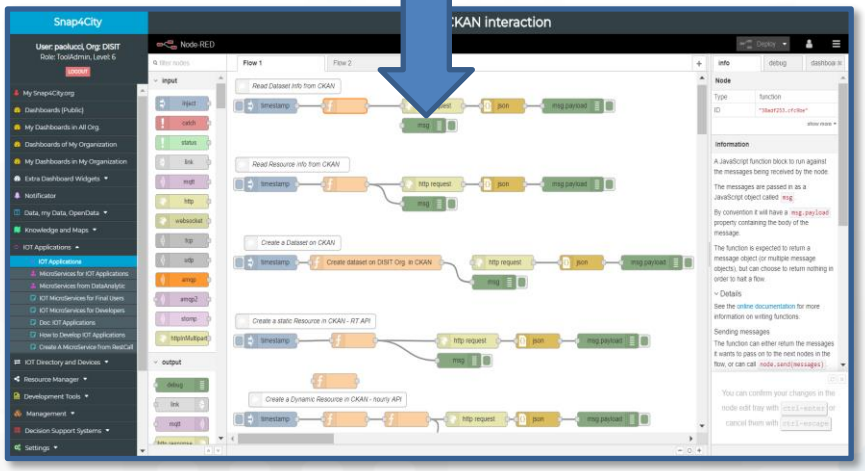
Advanced Snap4City APIs and Micro Services

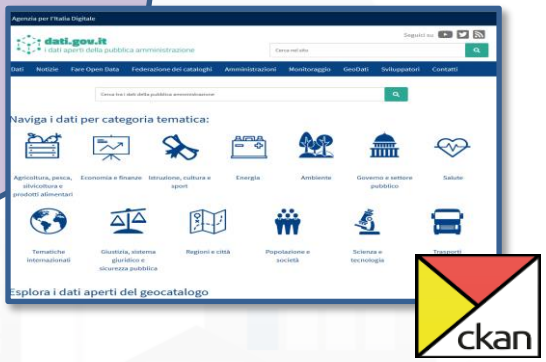
Harvesting and Publishing





Open or Private External CKAN Data Portals

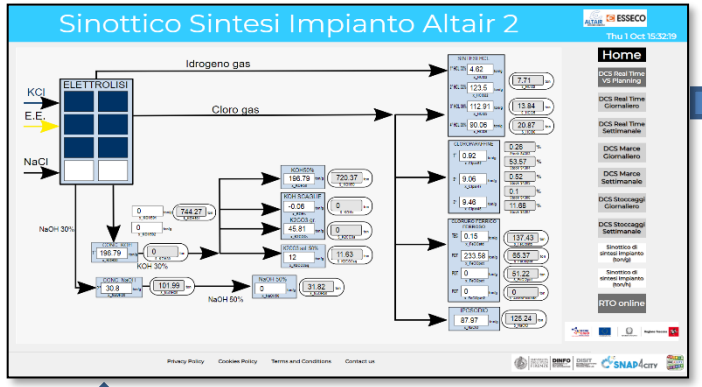




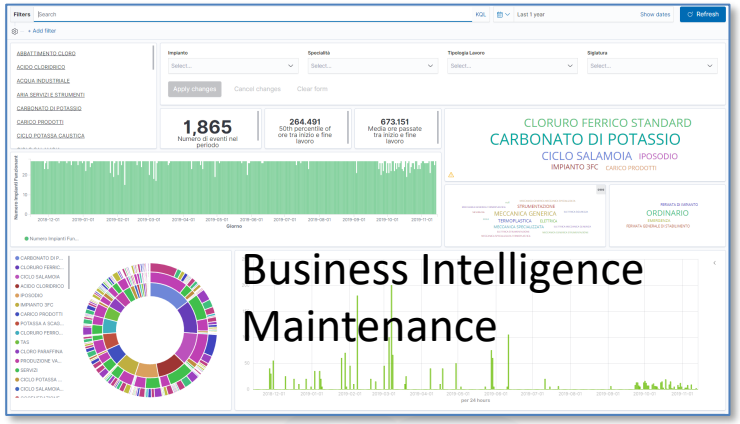
Automatize:

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

Example of Integrated workflow

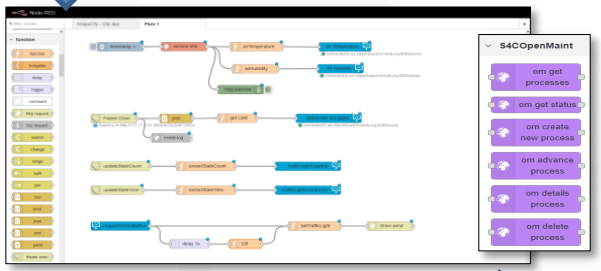


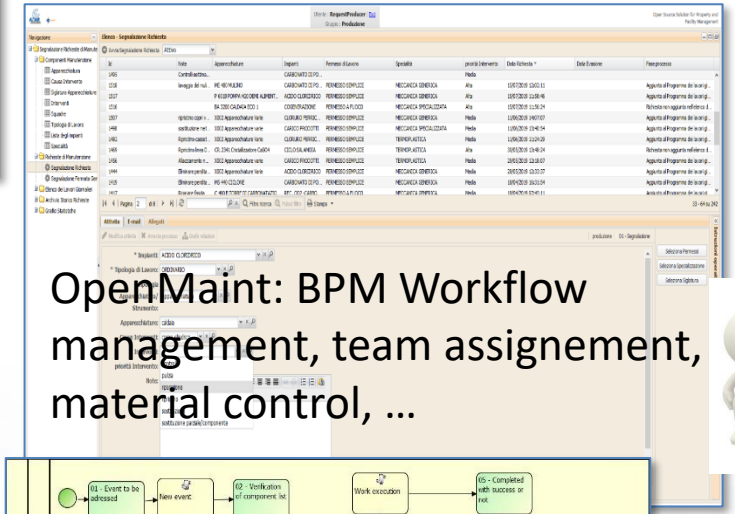
Consumptions/productions



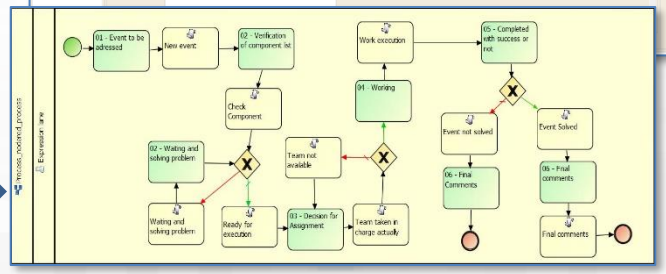
Events/actions

Dashboards and actions

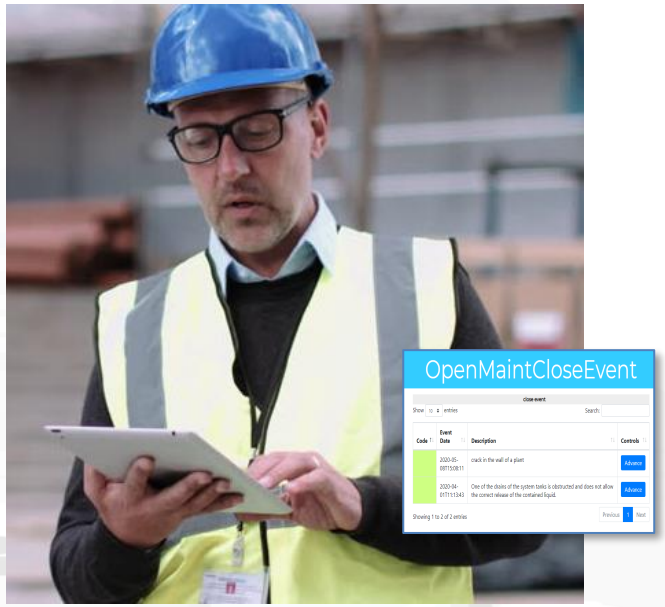




OpenMaint: BPM Workflow management, team assignement, material control, …

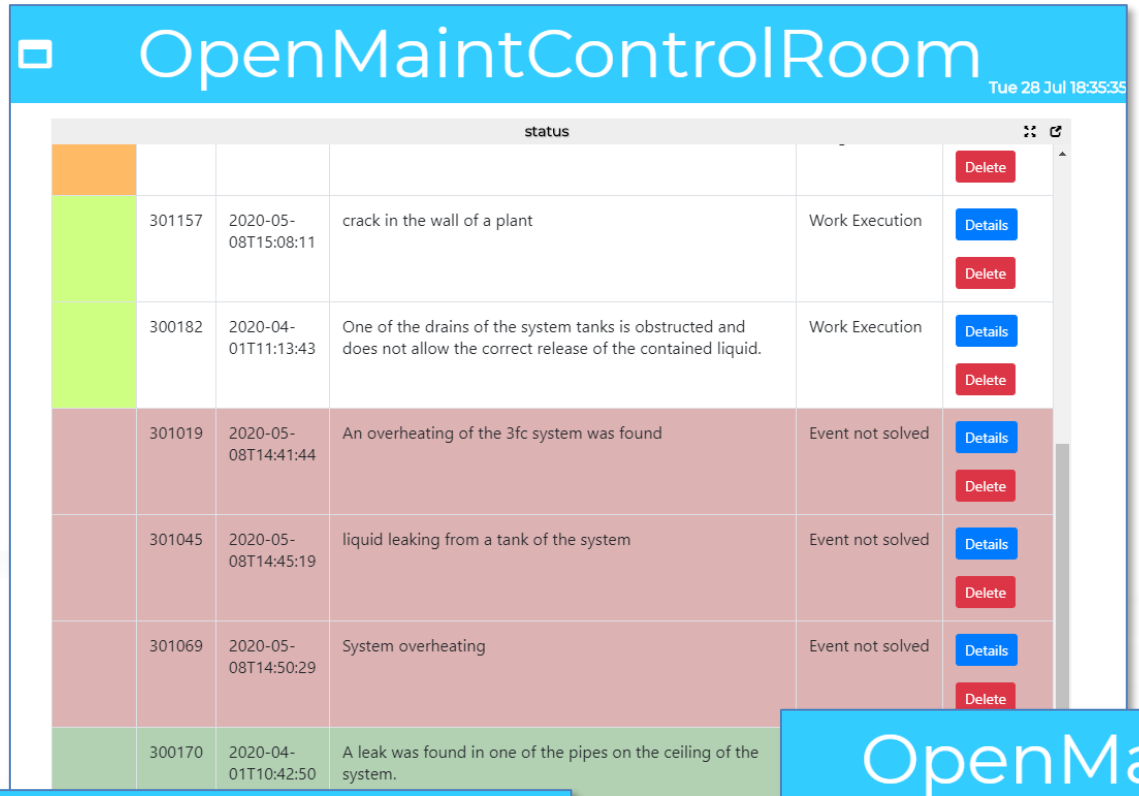


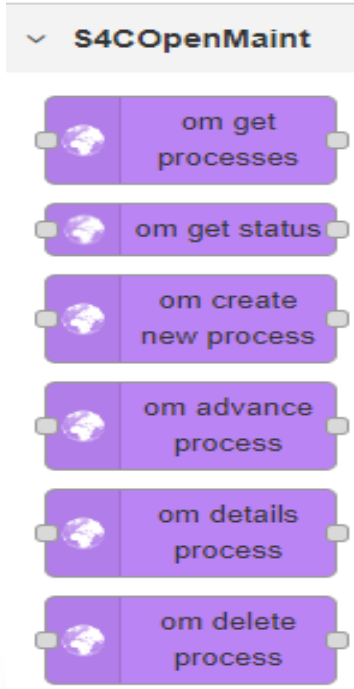


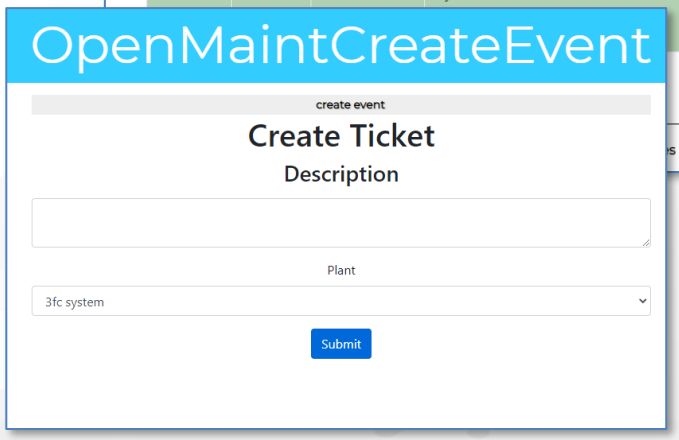


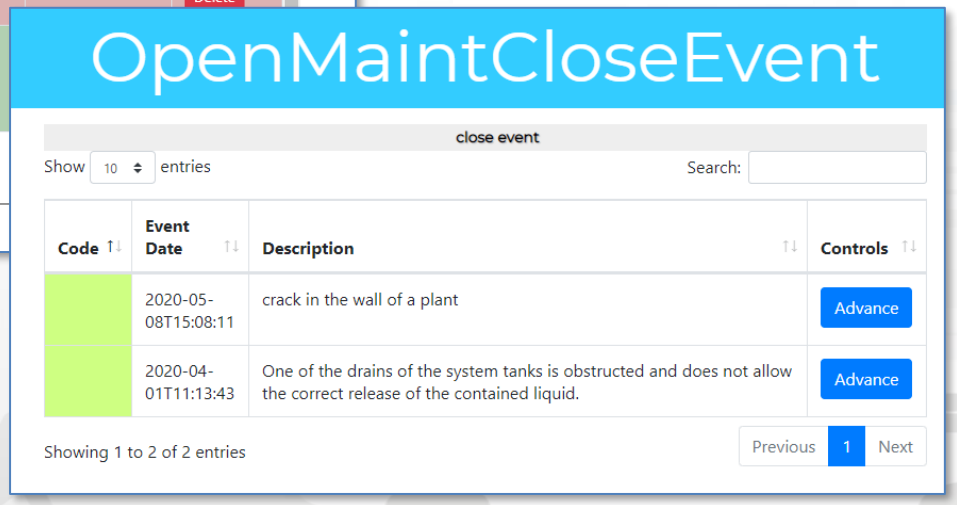
IOT App, Data event firing, event detection and firing Critical event management

Dashboards





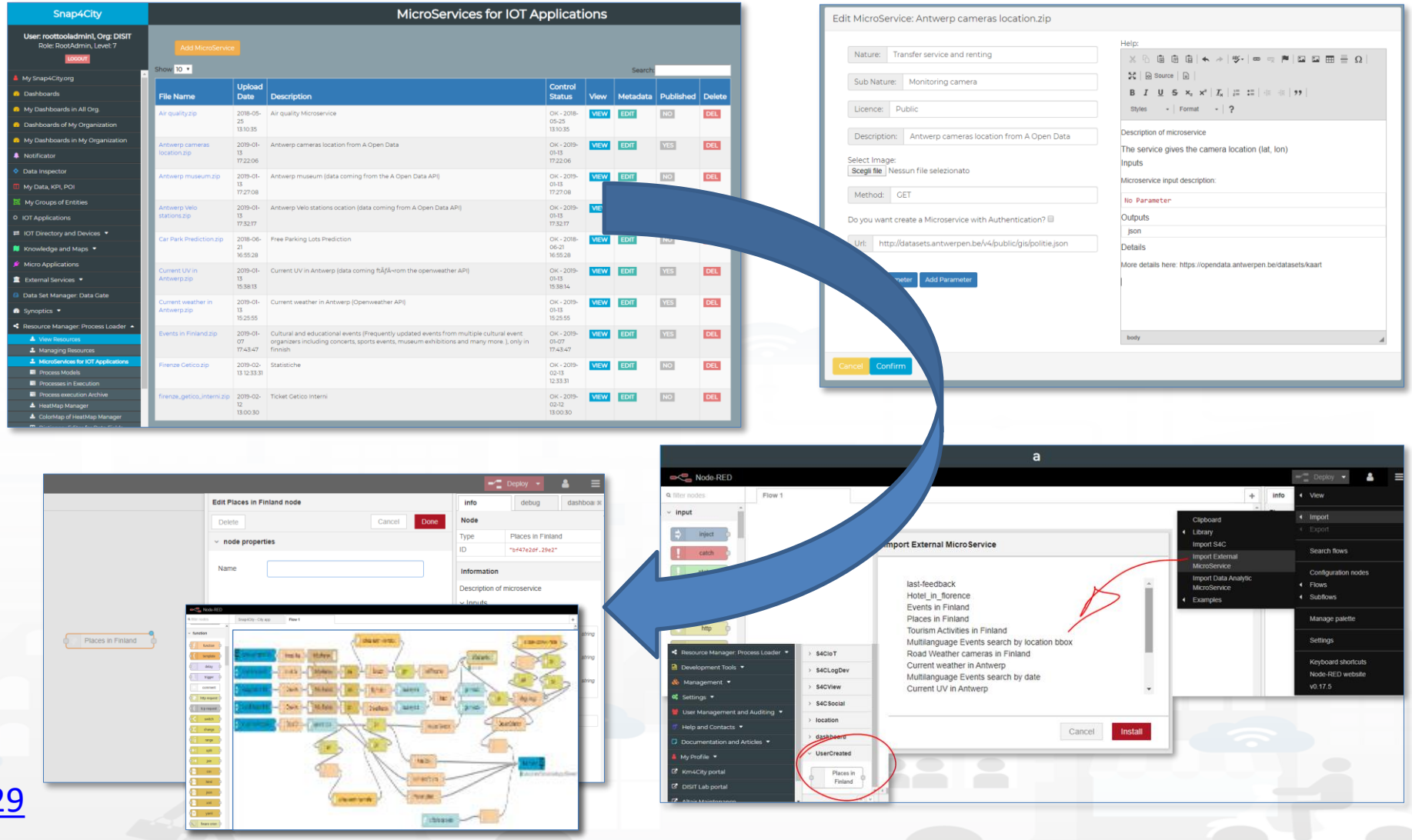




- **Snap4City can**
  - Create new tickets
  - Manage steps, workflow
  - Collecting feedbacks and results from teams
  - Manage all phases of the workflow on the fields via IOT Apps and logics
  - The integration if via API and MicroServices into IOT App.

External REST Call API vs MicroServices

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



https://www.snap4city.org/129

Integration via IoT Apps on IoT Edge



https://www.snap4city.org/369

Measuring any kind of sensors values

Controlling Energy Power

Measuring
Energy Consumption

Any kind of notification channel

IOT Edge:
Node-RED
+
Snap4City

Local Control

Contextual (smart city/home) data, Data Analytics
Historical Data, Remote Control, Mobile App

DCS

Administrative Servers

Alexa: Voice Commands

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Snap4Home

SNAP4CITY | KM 4 CITY

Sonoff: Controlling Energy Power



Philips Hue: Controlling Lights





Hue: Motion Control / Alarm



Measuring Energy Consumption



TP Link: Controlling / Measuring Energy Plugs

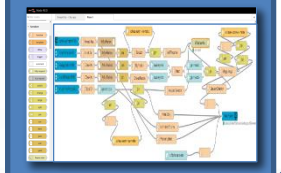


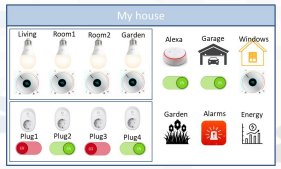
Alexa: Voice Control



IOT Edge:

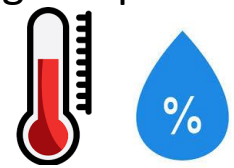
Raspberry pi: Node-RED + Snap4City





Local Control

Measuring Temperature and Humidity



Garage Door

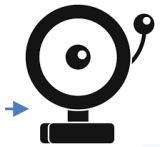


Window Roller Shutters



Controlling Motors

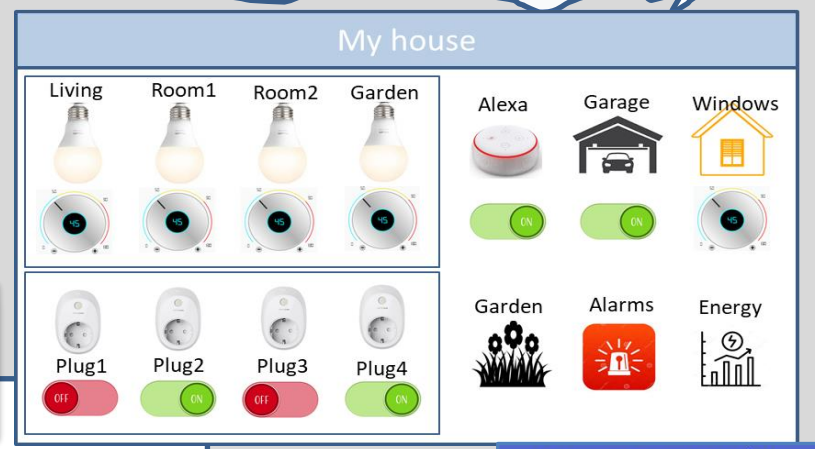


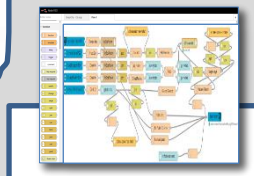


Alarm sound and light

Controlling Irrigators







SNAP4CITY



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

https://www.snap4city.org/620

IOT Edge Device

Other Local Connections

IOT Brokers

IOT Brokers

HTTPS

HTTPS

WiFi

Modbus

OPC UA

IOT Edge:
Node-RED + Snap4City

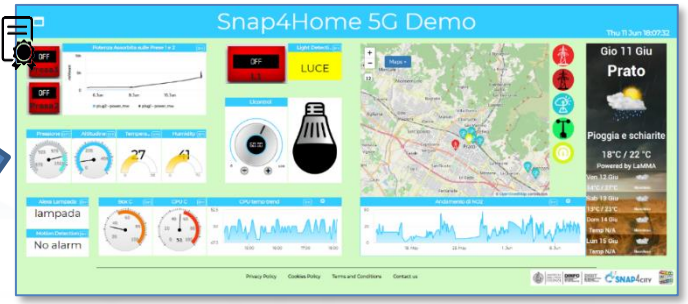
edge-tunnel-to-cloud

Search and Query, Smart City API
Facet, semantic search

Knowledge base
Semantic reasoners

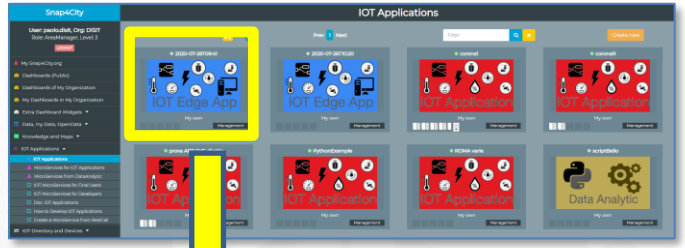
Indexing and aggregating
Elastic search

SNAP4CITY



WSs

Firewall
Gateway
Towards internet

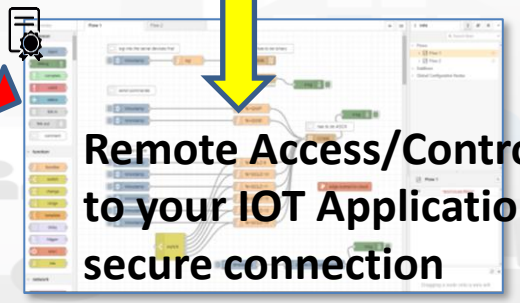


HTTPS



IOT Devices

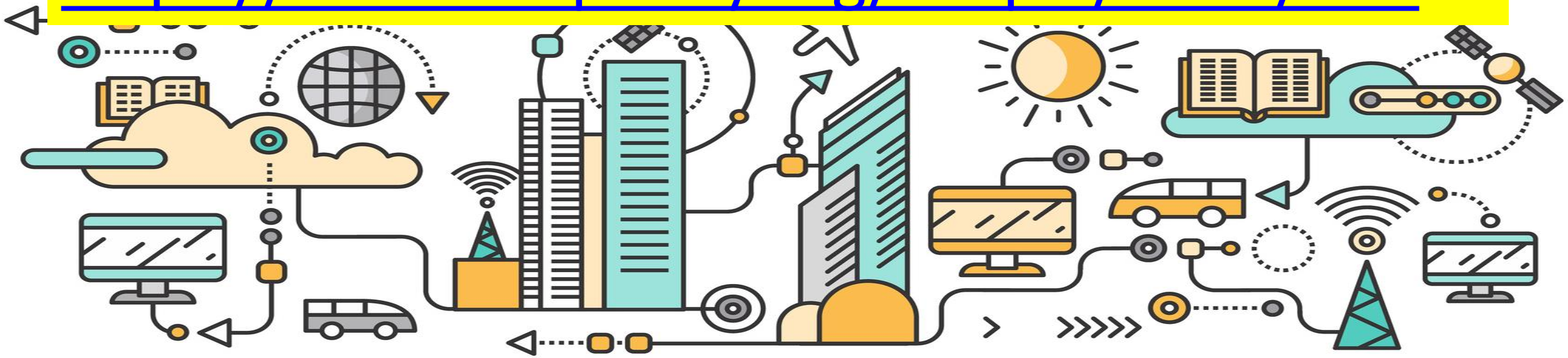
Access to IoT Edge Maintenance



Remote Access/Control/program to your IOT Applications via secure connection

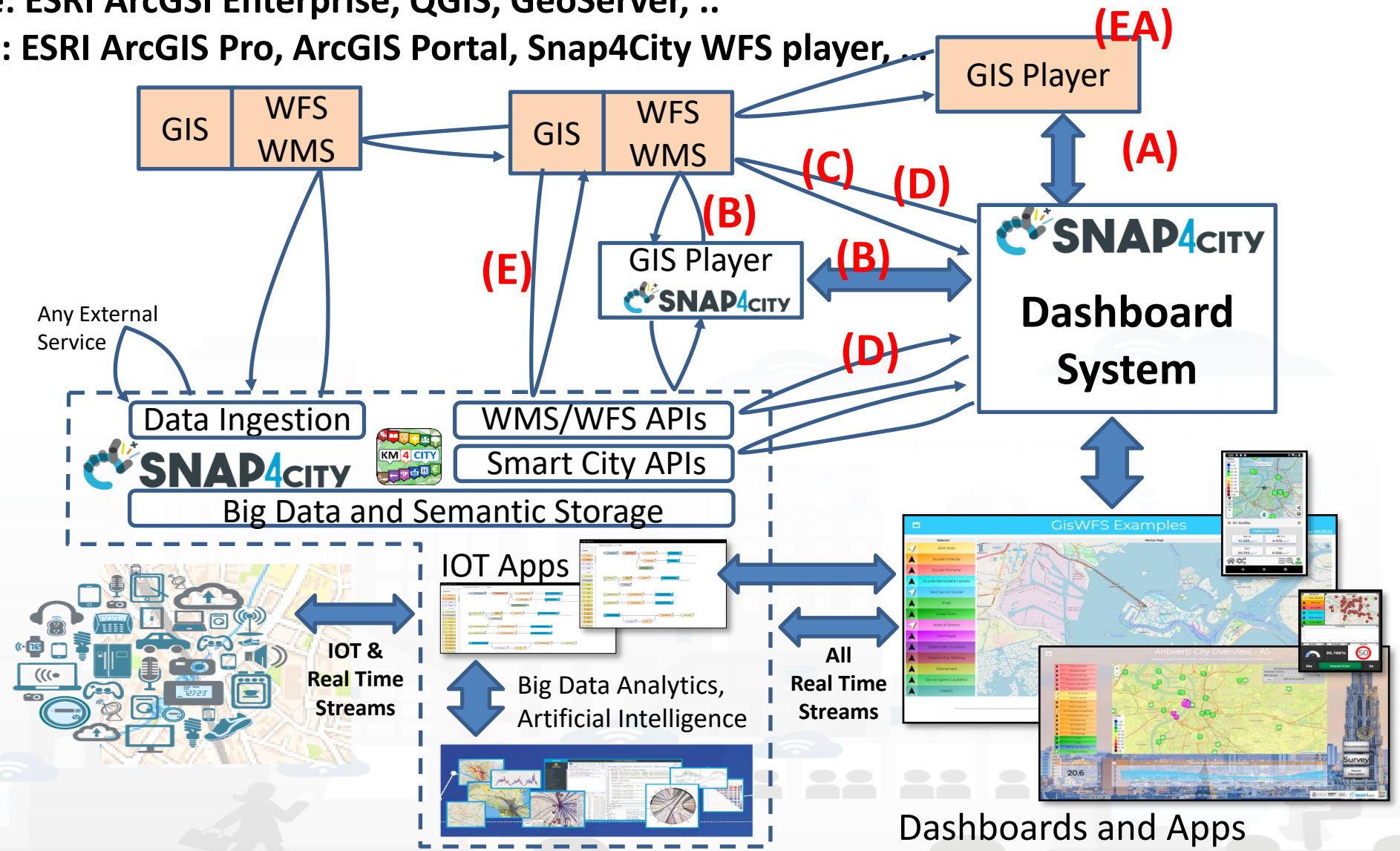
Integration with GIS and ArcGIS

https://www.snap4city.org/drupal/node/368



GIS vs Sna4City

GIS Server can be: ESRI ArcGSI Enterprise, QGIS, GeoServer, ..
GIS Player can be: ESRI ArcGIS Pro, ArcGIS Portal, Snap4City WFS player, ...

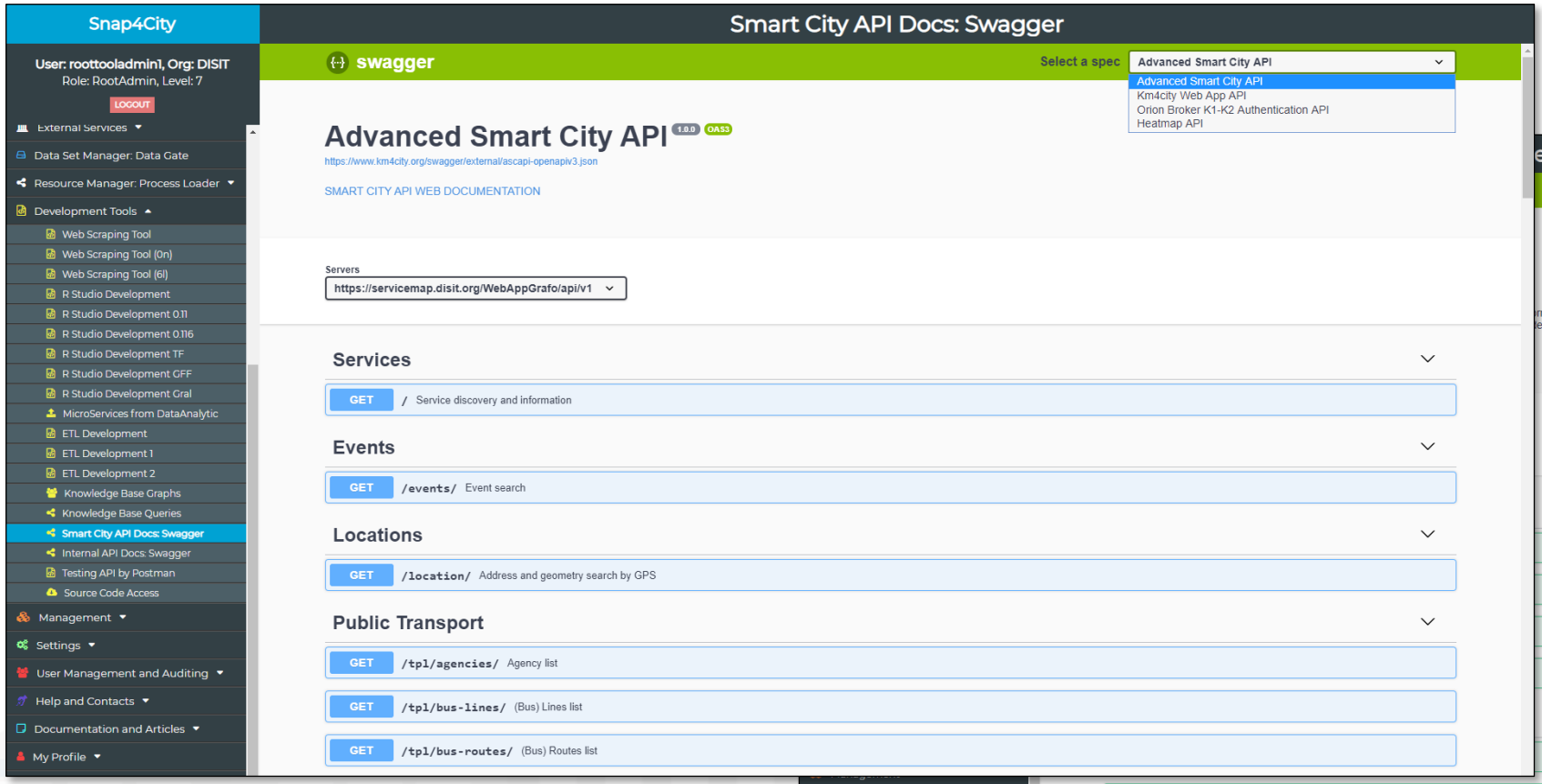


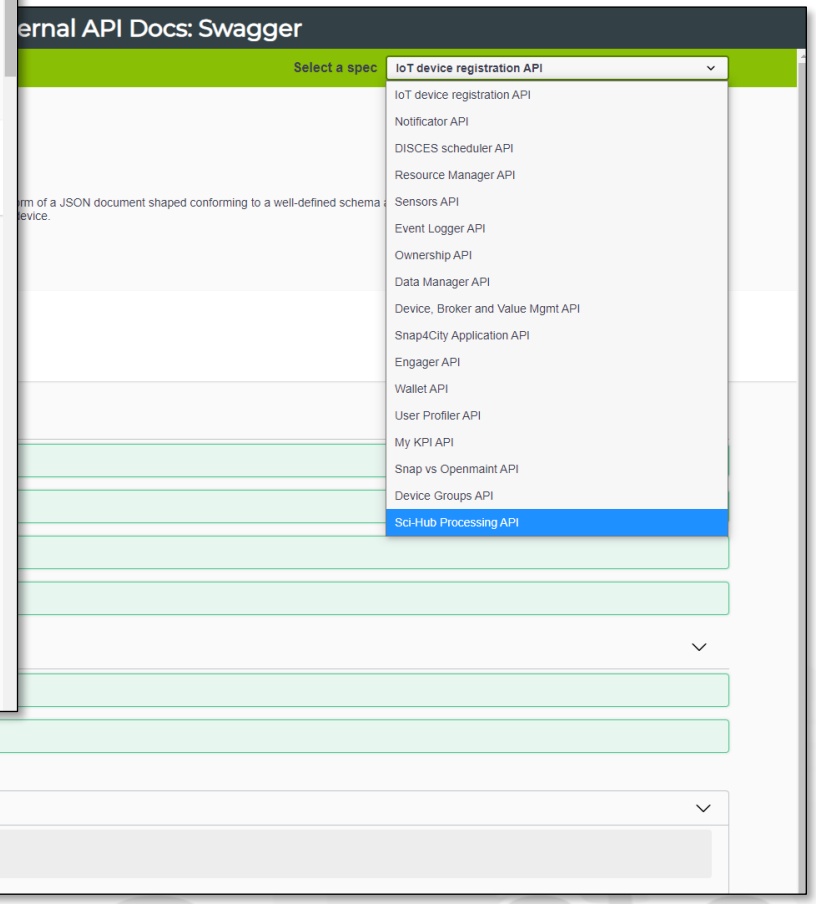
- **GIS:**
  - Geographic Information System
- **WMS:**
  - Web Map Service
- **WFS:**
  - Web Feature Services

API, and Federation of Smart Cities via API



Internal and External Smart City API



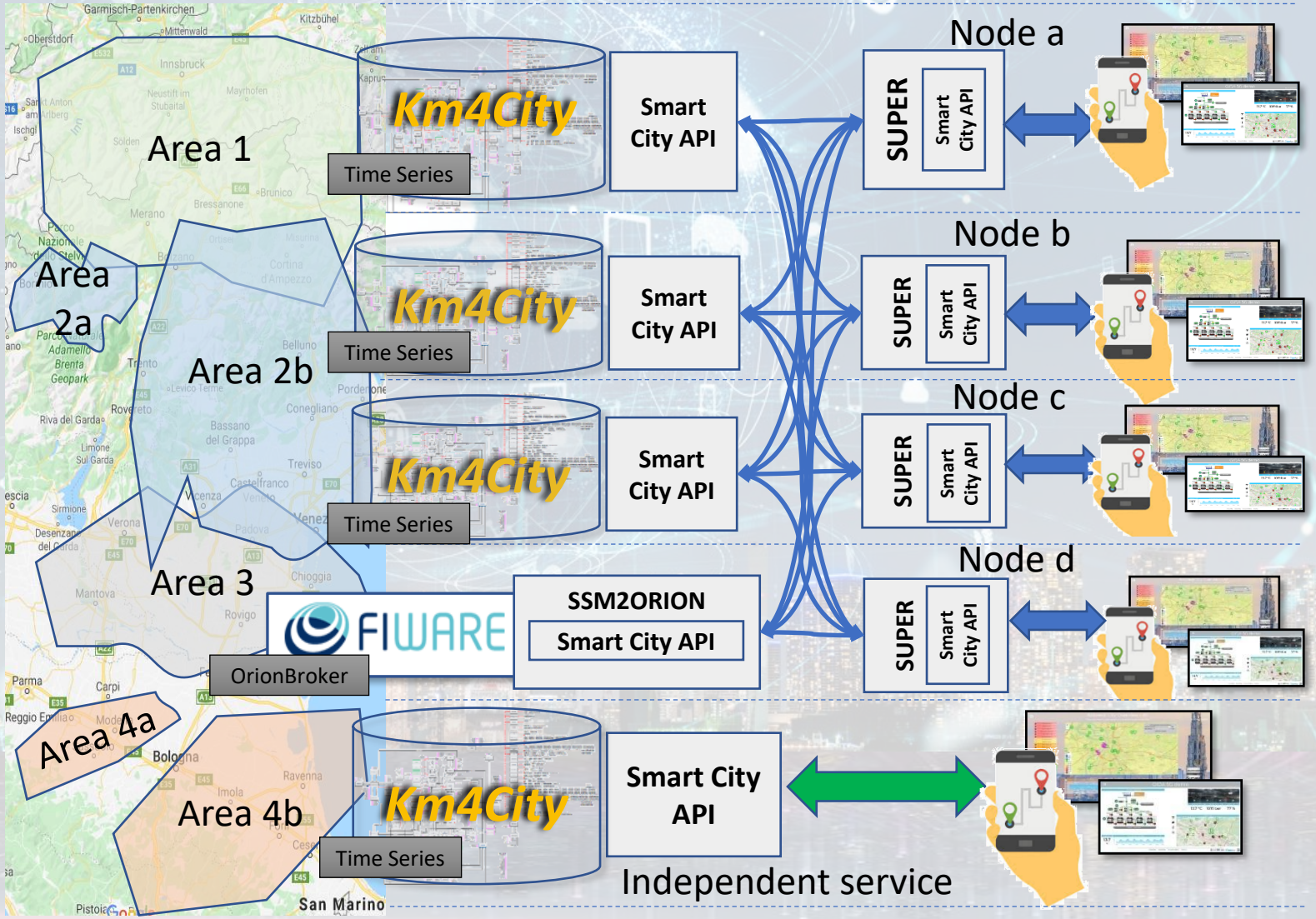


https://www.km4city.org/swagger/external/index.html

https://www.km4city.org/swagger/internal/index.html

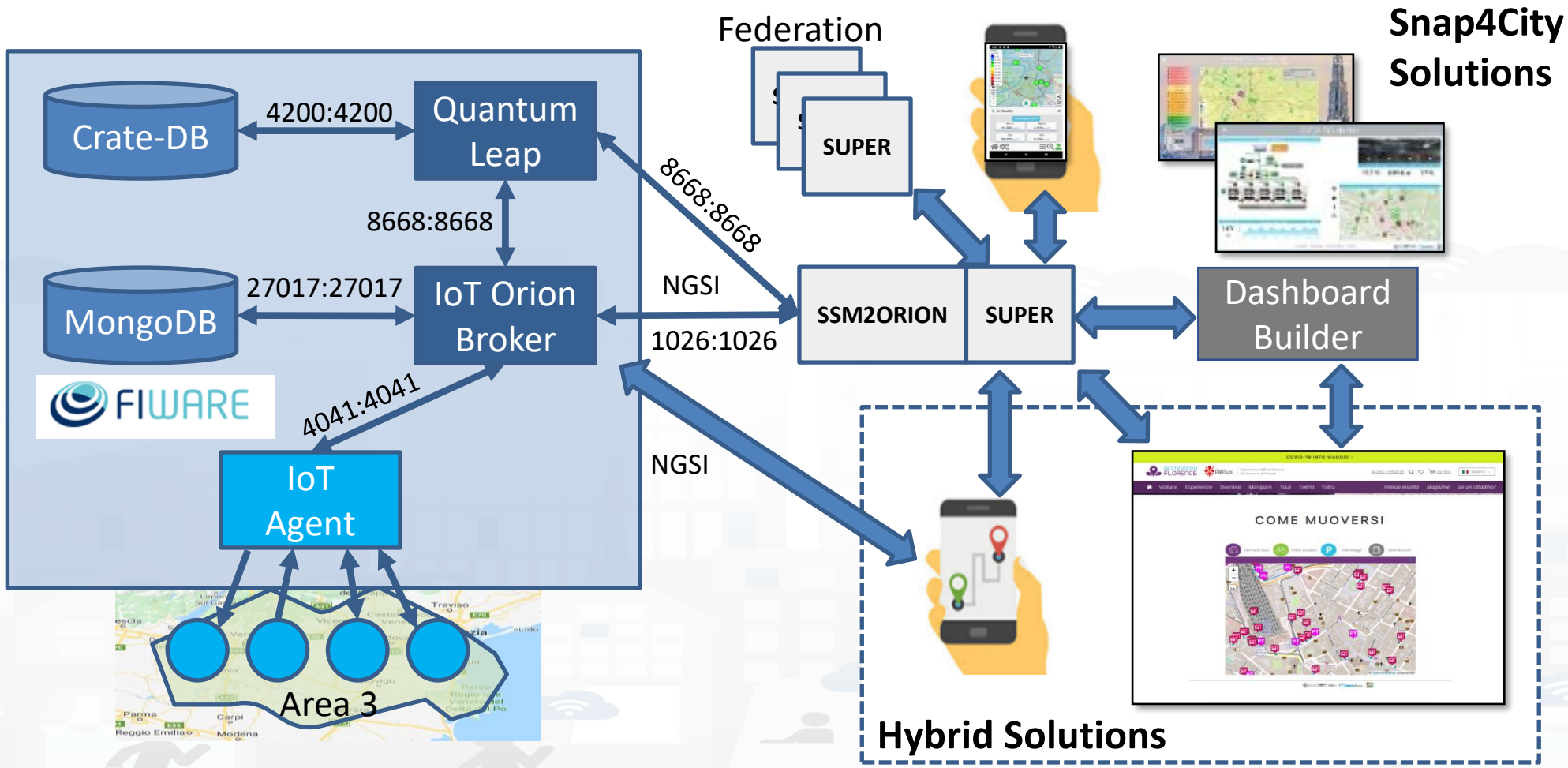
Federation of Smart City Services

Knowledge Base
Semantic Reasoners



- Km4City **Semantic Reasoner**
- **ServiceMap** interoperability
- **Seamless for multiple Mobile Apps**
- **Smart City API**
- **Super**:
  - distributed access and sharing services
  - Each city control its own data
  - Final user can pass from one city / area to another in seamless manner: without changing the mobile Apps

Federation of Snap4City vs IOT ORION Broker



Linked Open Data

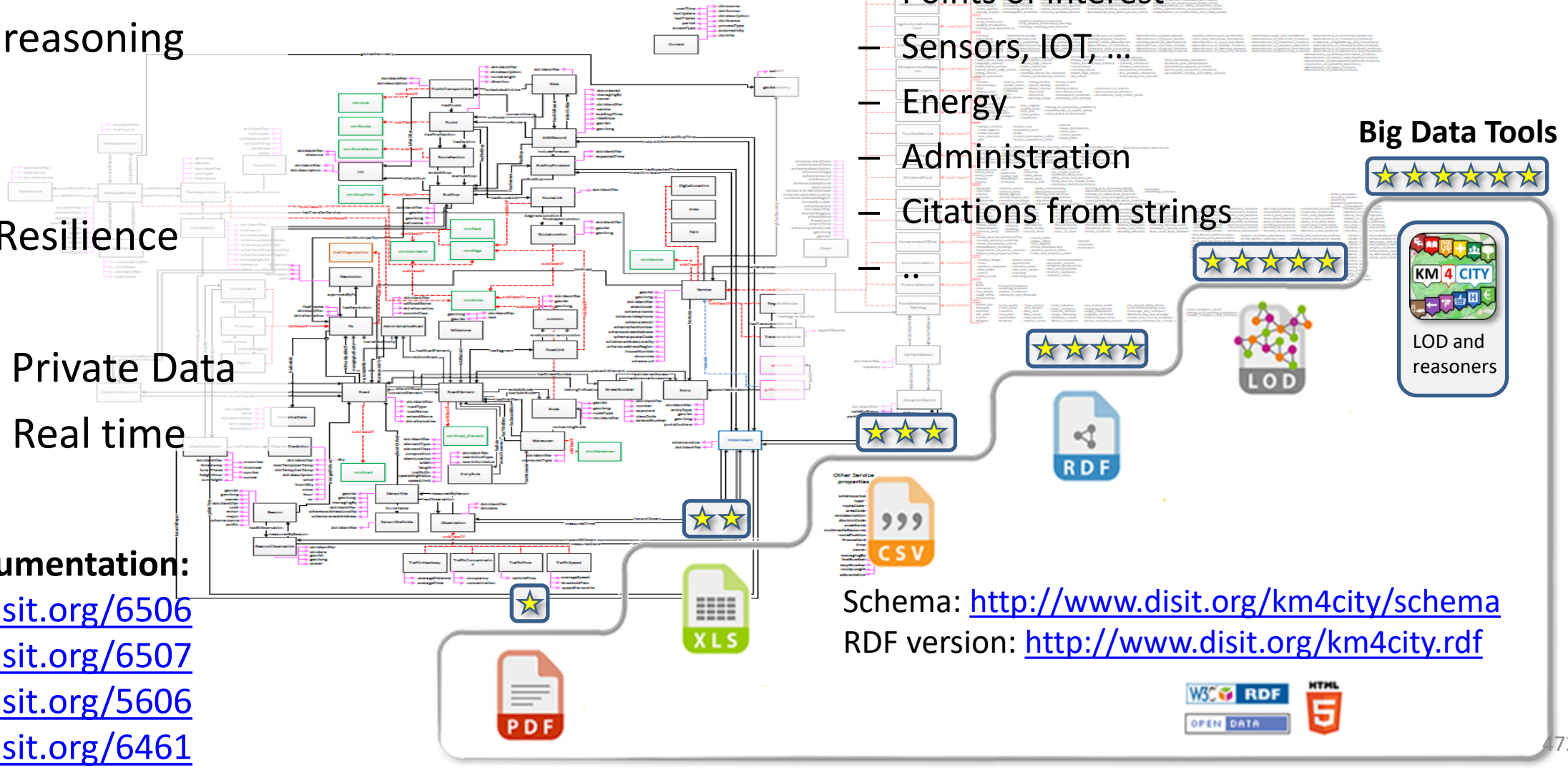


Km4City: Knowledge Base

- **Multiple DOMAINS**
- Geospatial reasoning
- Temporal reasoning
- Metadata
- Statistics
- Risk and Resilience
- Licensing
- Open and Private Data
- Static and Real time
- IOT/IOE

Ontology Documentation:
http://www.disit.org/6506
http://www.disit.org/6507
http://www.disit.org/5606
http://www.disit.org/6461

- Street-Guide
- Mobility and transport
- Points of interest
- Sensors, IOT, …
- Energy
- Administration
- Citations from strings
- ..



Schema: http://www.disit.org/km4city/schema
RDF version: http://www.disit.org/km4city.rdf

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Knowledge Base
Semantic Reasoners

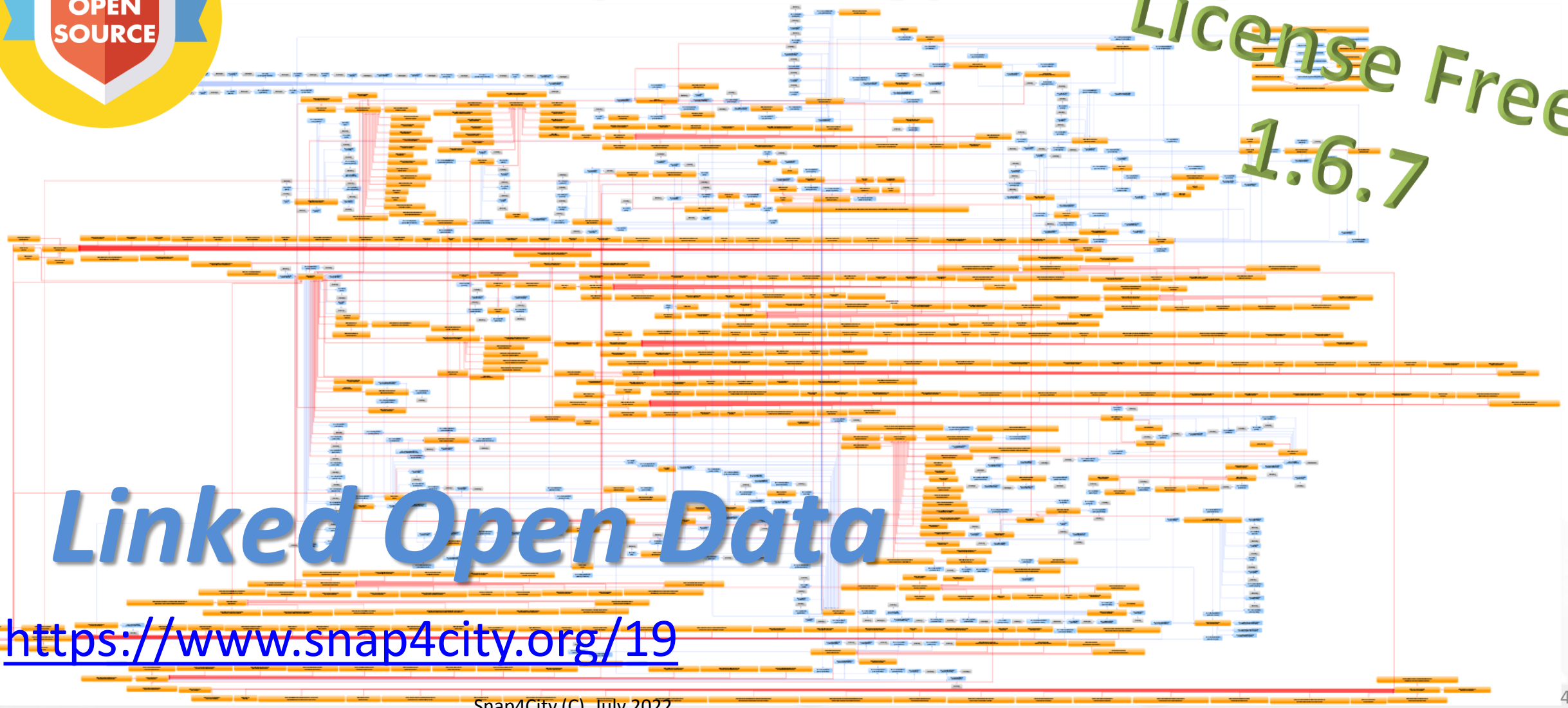
SNAP4CITY

100% OPEN SOURCE

Smart-city Ontology km4city

License Free

1.6.7

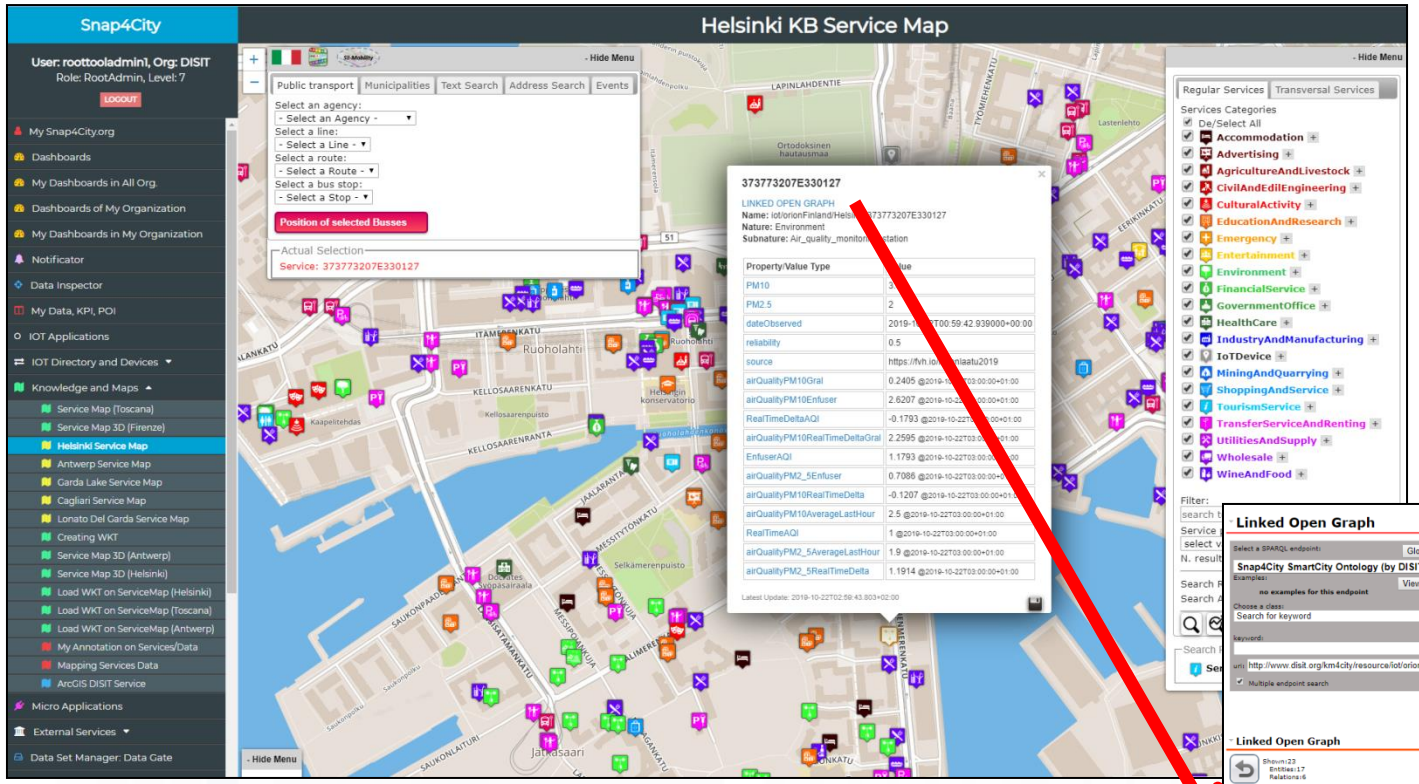


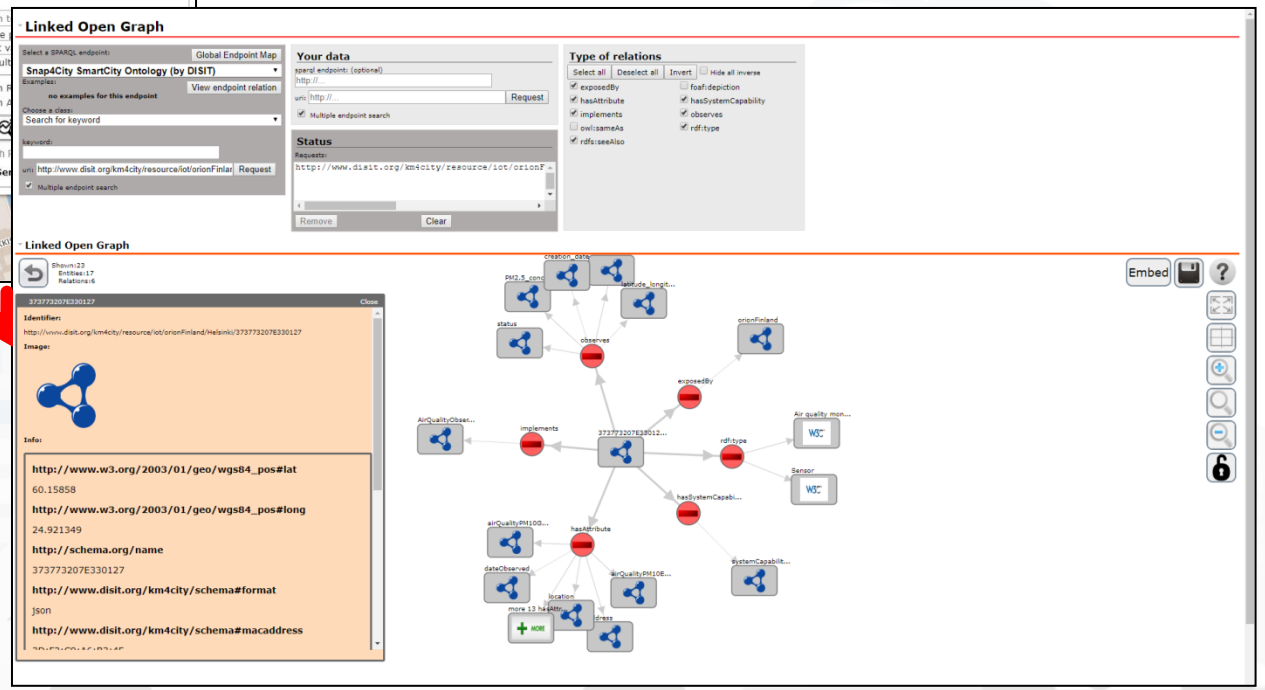
Linked Open Data

https://www.snap4city.org/19

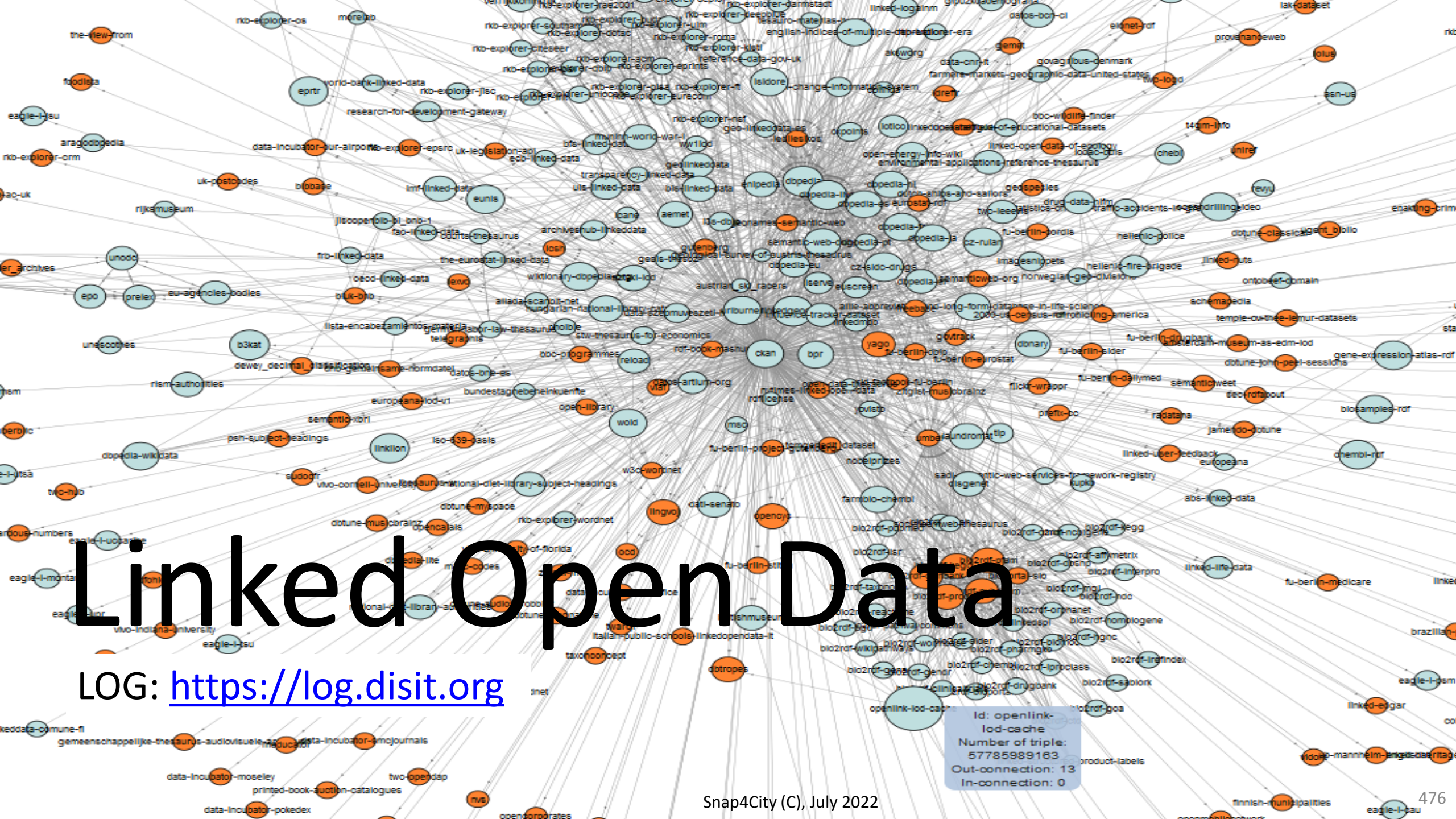
Views of the Knowledge Base

Knowledge Base
Semantic Reasoners



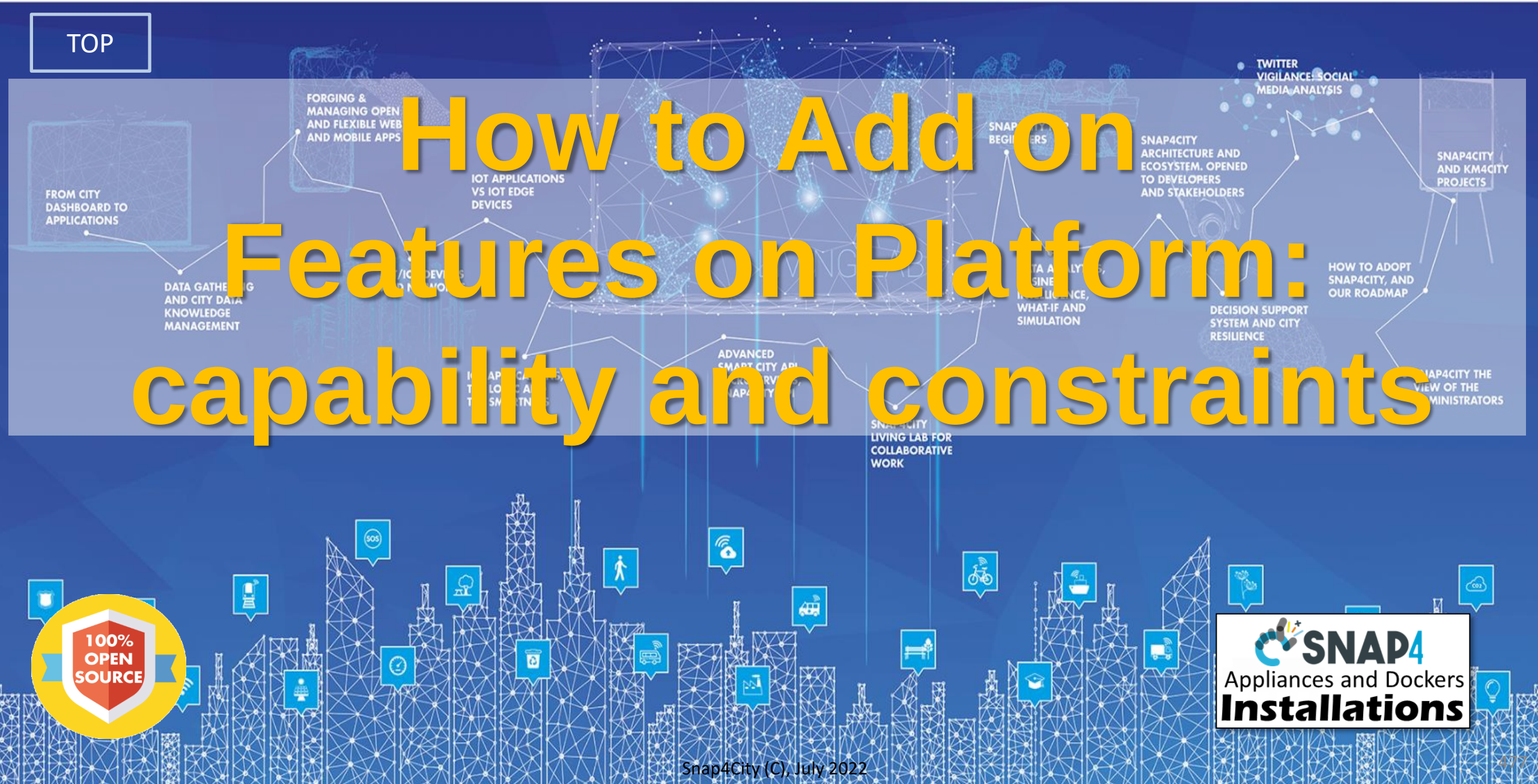


- How pass from ServiceMap to Linked Open Graph, Linket Data view tool


Linked Open Data
LOG: https://log.disit.org
Id: openlink-lod-cache
Number of triple: 57785989163
Out-connection: 13
In-connection: 0

TOP

How to Add on Features on Platform: capability and constraints



Adding new Features

- **Dashboard Features** --> Custom Widgets, Widgets
- **Connectors, adapters, IoT protocols, data transformations,** etc. --> by creating new MicroServices, new flows or new IoT Apps ...
- **Applications, Modules** --> for management, for verticals, in the core by using
- **IoT Devices** --> for collecting new data kind or acting on the field
- **Processes** --> Data Analytic of any kind, also exploiting machine learning, gpu, etc.
- **Web and Mobile Apps** --> new end-users services
- **Dashboards**
- **IoT Applications**
- **Data ingestion process**, integration, etc.
- **External Services** to be exploited on Dashboards
- etc. etc.

Adding new Features

https://www.snap4city.org/692

- **Dashboard Features** --> Custom Widgets, Widgets
  - they can be created by using the Custom Widget SVG approach
    - TC1.22a: Create and configure a Snap4City SVG Custom Widget for real-time interaction
    - TC1.22b: Create and configure a Snap4City SVG Custom Widget for real-time interaction
    - Custom Widgets: Table explanation, as SVG
    - TC1.26: Use customised SVG pins in a map
    - TC9.19: Custom Widgets / Synoptics controlled by IOT Applications
  - they can be created by developing new elements programming in PHP, JavaScript, Angular, D3, etc..
    - Custom Synoptics and Widgets for Dashboards
- **connectors, adapters, IoT protocols, data transformations,** etc. --> by creating new MicroServices, new flows or new IoT Apps ...
  - https://www.snap4city.org/download/video/course2020/di/
  - HOW TO: Develop an IOT Application for Data Ingestion
  - they have to be in Node.JS, JavaScript according to Node-RED
    - Snap4City Supported Protocols, adding new protocols
    - how to create a flow and nodes in Node-red: https://nodered.org/docs/creating-nodes/first-node
  - They can be automatically created from API rest call
    - TC2.25. Registering external MicroService calling RestCall services, using it on IOT applications
  - business logic behind a dashboard
    - TC9.19: Custom Widgets / Synoptics controlled by IOT Applications

Adding new Features

- **Applications, Modules** --> for management, for verticals, in the core by using
  - any language you prefer, preferably exposing API for integration with other modules
    - https://www.km4city.org/swagger/external/index.html
    - https://www.km4city.org/swagger/internal/index.html
  - See Tutorial on how to transform any REST API in a MicroService
    - TC2.25. Registering external MicroService calling RestCall services, using it on IOT applications
- **IoT Devices** --> for collecting new data kind or acting on the field
  - HOW TO: add a device to the Platform
  - HOW TO: Manage IOT Network Components on Snap4City
  - you can add to the platform any kind of IoT Device, with any kind of IoT Protocol
  - You can exploit the open source for Android and raspberry for creating your safely connected IoT device with Snap4City using NGSI V1, V2 and exploiting our secure communication approach

https://www.snap4city.org/692

Adding new Features

https://www.snap4city.org/692

- **Processes --> Data Analytic** of any kind, also exploiting machine learning, gpu, etc.
  - see tutorial on Data Analytics
  - https://www.snap4city.org/download/video/course2020/da/
- **Web and Mobile Apps** --> new end-users services
  - https://www.snap4city.org/download/video/course2020/app/
- **Dashboards: Dashboard Builder and Kibana**
  - https://www.snap4city.org/download/video/course2020/das/
- **IoT Applications in Node-RED**
  - https://www.snap4city.org/download/video/course2020/iot/
- **data ingestion process, integration, etc.**
  - https://www.snap4city.org/download/video/course2020/di/
- **External Services to be exploited on Dashboard**s
  - by simply registering their URLs on the portal
  - https://www.snap4city.org/55
- **Workflows**: via OpenMaint
  - TC 1.24 – Integrated Ticketing and Facility Management system
- **BIM models** via Bim Editor for IFC production → Bim Server
  - HOW To: Manage BMP and BIM: main features of openMAINT, BMP, BIM
- etc. etc.

Constraints

https://www.snap4city.org/692

- **new version modules**
  - **to be integrated in the main version,** have to be tested and validated by DISIT Lab. They have to:
    - be in Affero GPL
    - do not affect the functionalities of other modules in negative manner
    - provide the needed quality, in terms of test cases, documentation, etc.
  - **If they are not part of the core**,
    - can be based on proprietary model, and exploit the Snap4City tools via APIs
      - **no constraints**
    - **but forked, they need to te** published version on Internet and linked to main according to **Affero GPL.**
- **Snap4City modules are mainly in Affero GPL**
  - **platform rebranding is not allowed**

TOP

Integrated command and control center



Command and Control

- **Multiple dashboards**, different features and tools for different users and contexts:
  - decision makers, operators, tablet for operators, mobile phones,…
  - **situation room** with touch screen,
  - **Chat room** for each dashboard, network of dashboards, etc.
  - **Interactive and animated widgets**: custom widgets, dynamic pins,
- **Unique Visual Prog. IoT App**: Business Logic, Integration, Connectors, Data Transform, ….
- **Large range of data, beyond GIS and IoT, also derived data**
  - historical and real time even driven
  - rendering data and acting on the field, actuators, agents, final users, operators..
- **Easy to Reshape, adapt, evolve:** according to the City's Needs
- **Easy to Add Features:** data analytics, custom modules, integration, interoperable, ….
- **Controlling Control Room, video walls**:
  - automated reconfiguration on the basis of the events
  - passing from operators to wall, etc..
  - Multiple operators stations with multiple monitors


MAPPA FIRENZE
Fri 19 Oct 17:24:39
Colonnine Ricarica
Colonnine ricarica Fast
Pannelli a Messaggio Variabile
Parcheggi
Piste Ciclabili
Sensori del Traffico
Stazioni ambientali
Stazioni meteo
Traffico Real Time
Varchi ZTL
Wi-Fi
Eventi Traffico a Firenze
Concentration - 7 days
Main





Chemical Plant Dashboard Green Impact Capacity (GIC)

Altair Control room

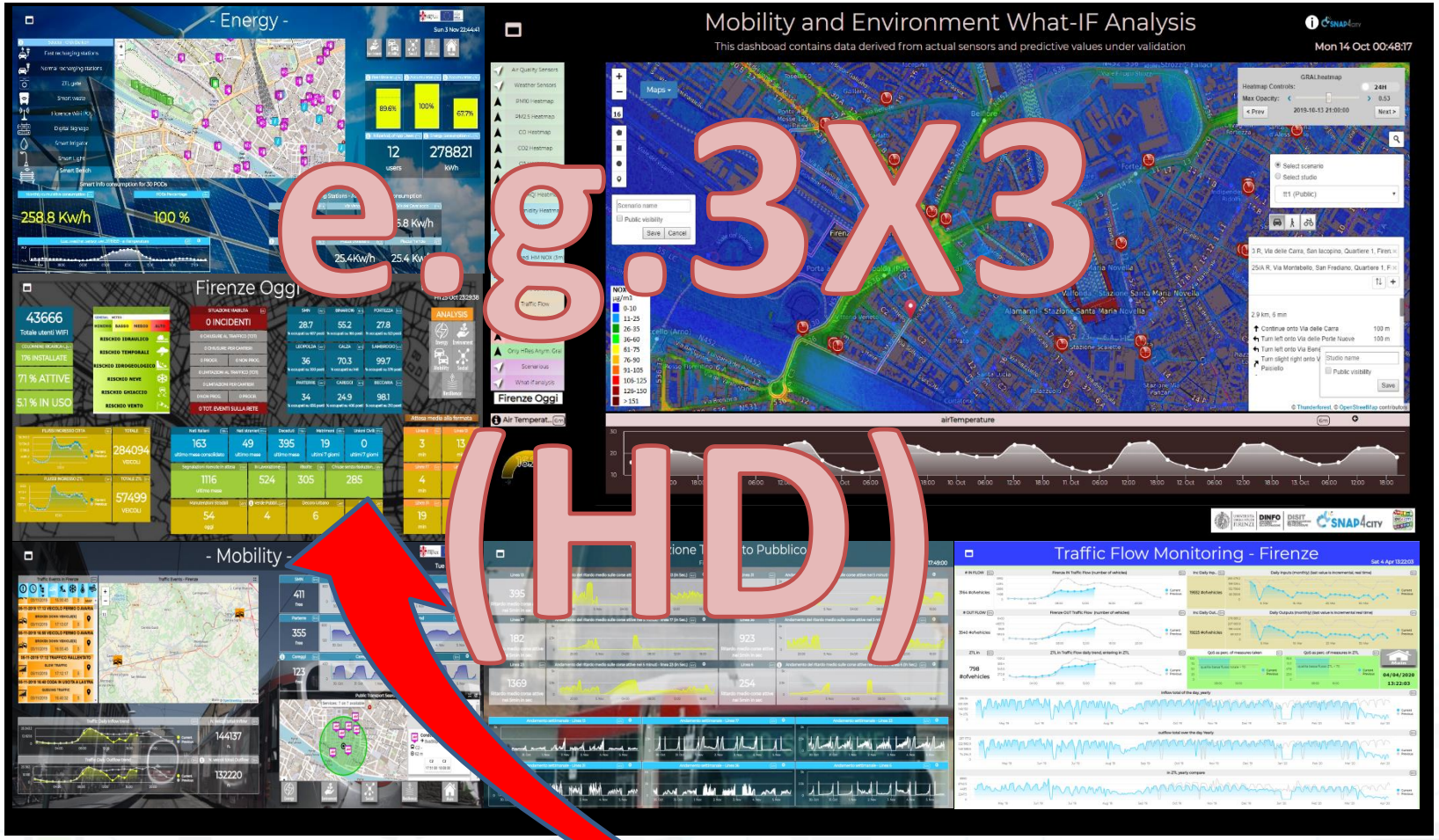


Control Room

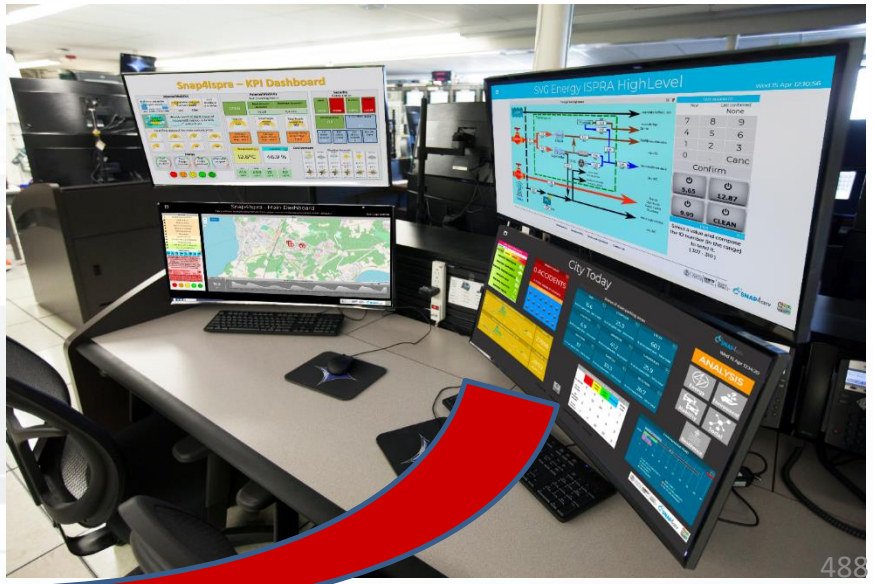




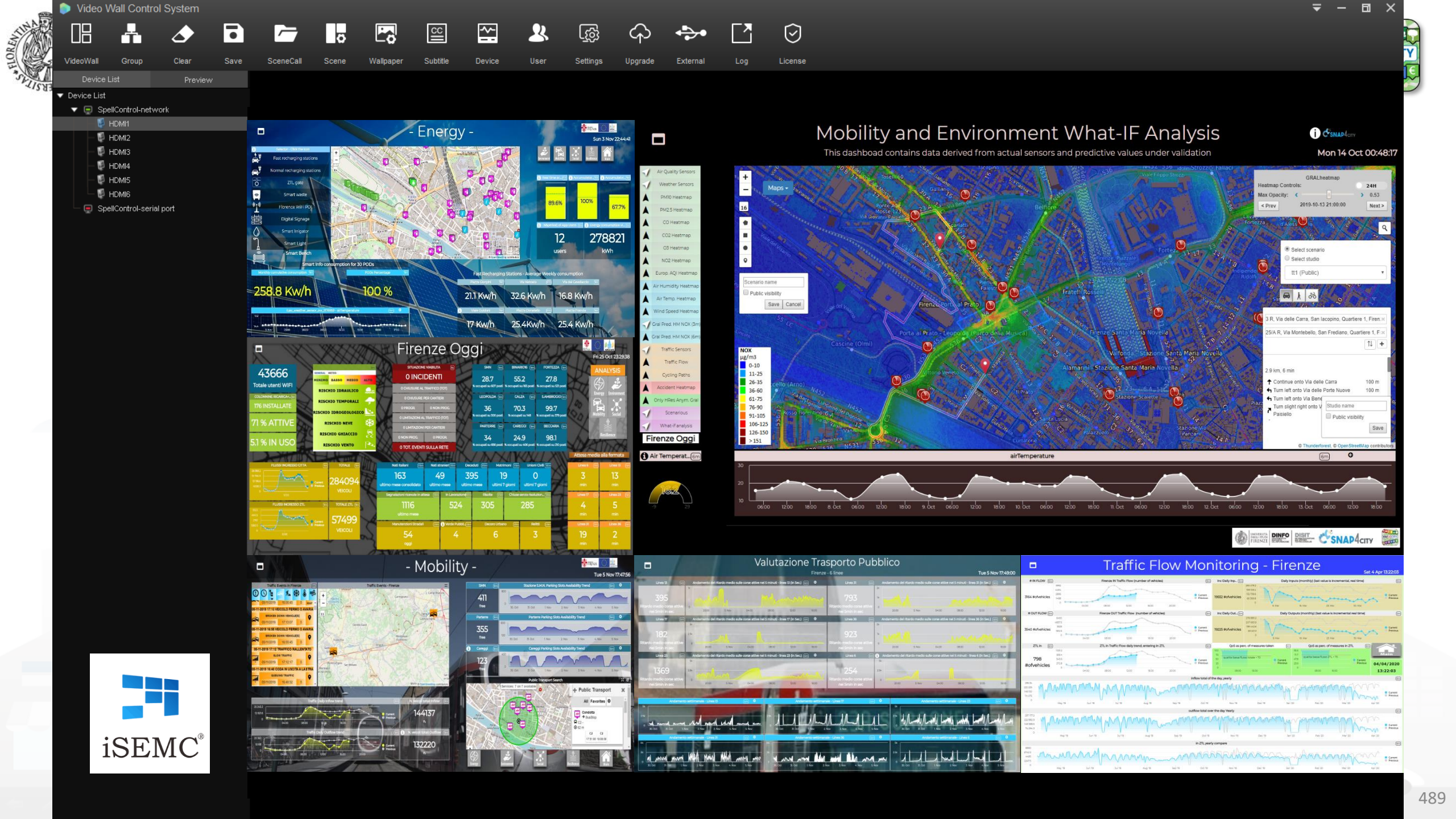
Video Wall







From Consolle Operator to the Video Wall


Video Wall Control System
VideoWall
Group
Clear
Save
SceneCall
Scene
Wallpaper
Subtitle
Device
User
Settings
Upgrade
External
Log
License
Device List
Preview
Device List
SpellControl-network
HDMI1
HDMI2
HDMI3
HDMI4
HDMI5
HDMI6
SpellControl-serial port
- Energy -
Fast recharging stations
Normal recharging stations
ZTL gate
Smart waste
Florence WiFi PO
Digital Signage
Smart Irrigator
Smart Light
Smart Bench
89.6%
100%
67.7%
12
users
278821
kWh
Smart Info consumption for 30 PODs
258.8 Kw/h
100 %
Fast Recharging Stations - Average Weekly consumption
21.1 Kw/h
32.6 Kw/h
16.8 Kw/h
17 Kw/h
25.4Kw/h
25.4 Kw/h
Firenze Oggi
43666
Totale utenti WIFI
176 INSTALLATE
71 % ATTIVE
5.1 % IN USO
RISCHIO IDRAULICO
RISCHIO TEMPORALI
RISCHIO IDROGEOLOGICO
RISCHIO NEVE
RISCHIO GHIACCIO
RISCHIO VENTO
0 INCIDENTI
ANALYSIS
284094
VEICOLI
57499
VEICOLI
Mobility and Environment What-IF Analysis
This dashboad contains data derived from actual sensors and predictive values under validation
Mon 14 Oct 00:48:17
Air Quality Sensors
Weather Sensors
PM10 Heatmap
PM2.5 Heatmap
CO Heatmap
CO2 Heatmap
O3 Heatmap
NO2 Heatmap
Europ. AQI Heatmap
Air Humidity Heatmap
Air Temp. Heatmap
Wind Speed Heatmap
Traffic Sensors
Traffic Flow
Cycling Paths
Accident Heatmap
Only HRes Anym. Grid
Scenarious
What-if analysis
Firenze Oggi
Maps
NOX µg/m3
0-10
11-25
26-35
36-60
61-75
76-90
91-105
106-125
126-150
> 151
airTemperature
- Mobility -
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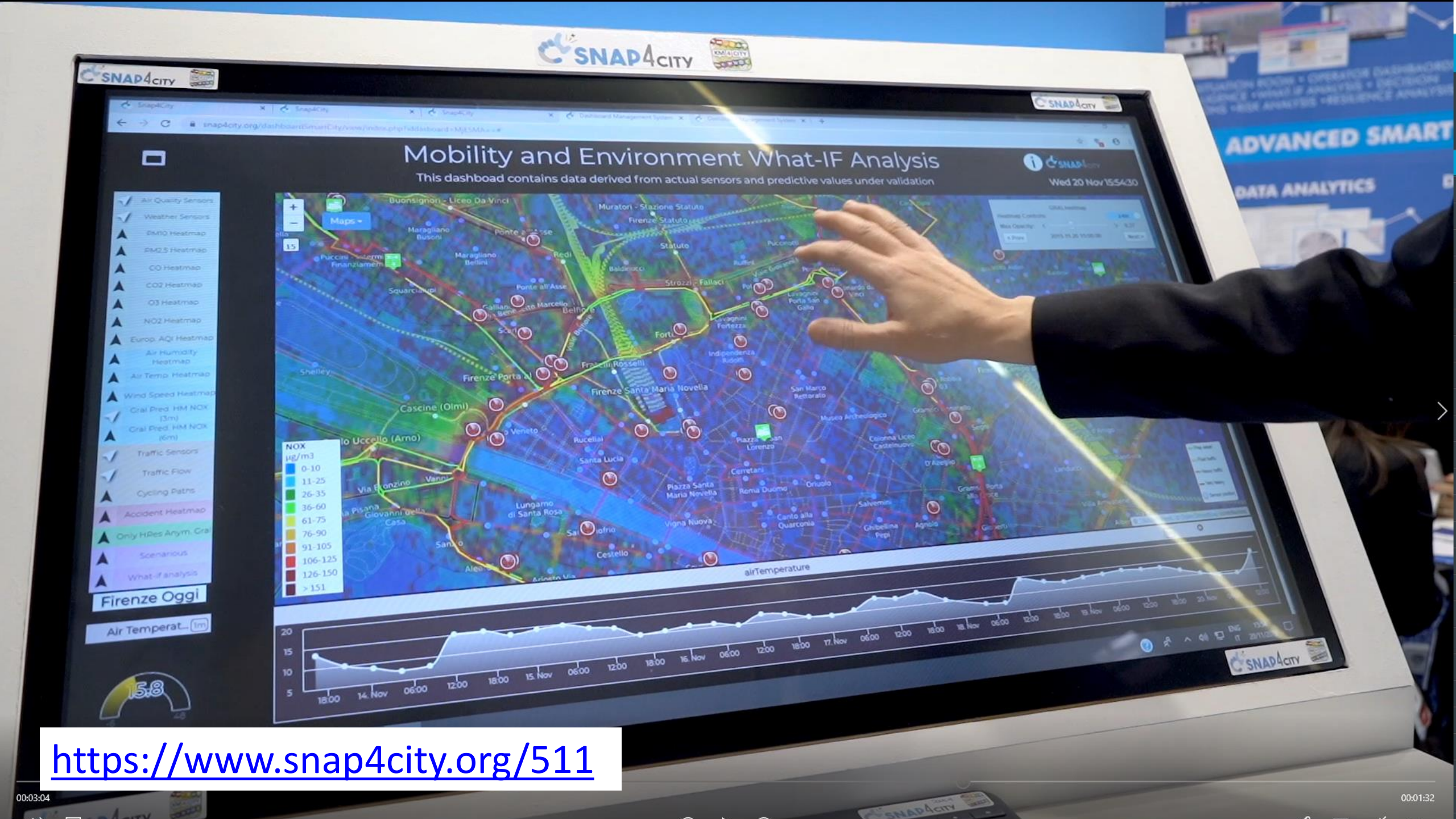
132220
Valutazione Trasporto Pubblico
Traffic Flow Monitoring - Firenze
iSEMC®



https://www.snap4city.org/511

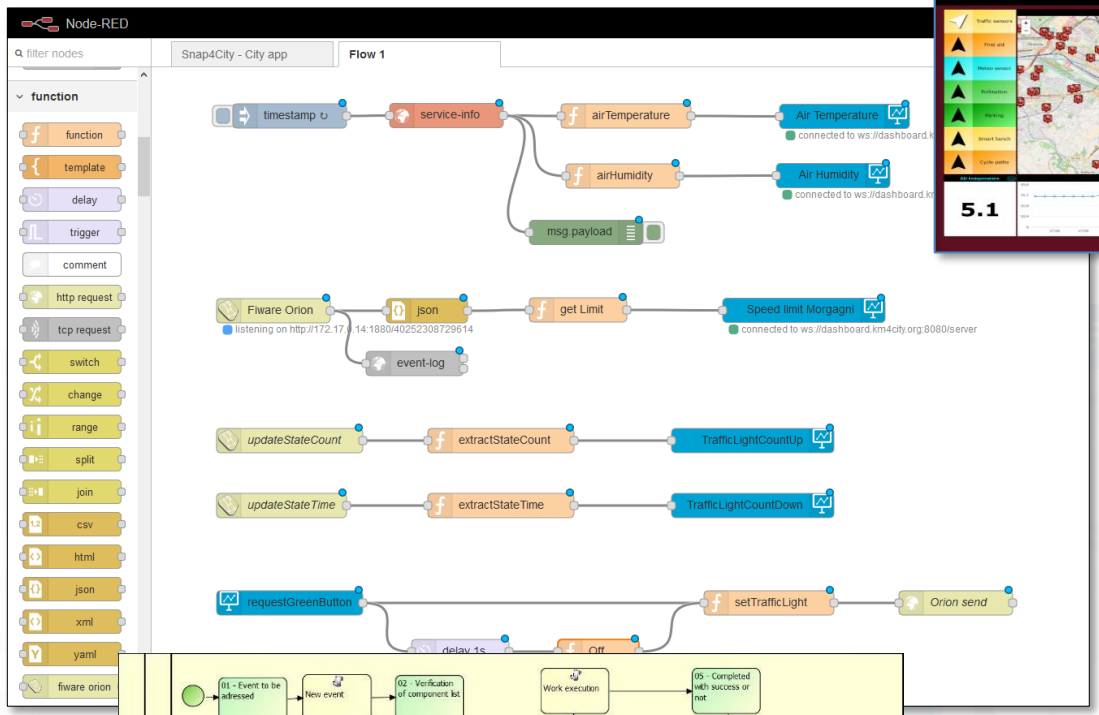
00:03:04

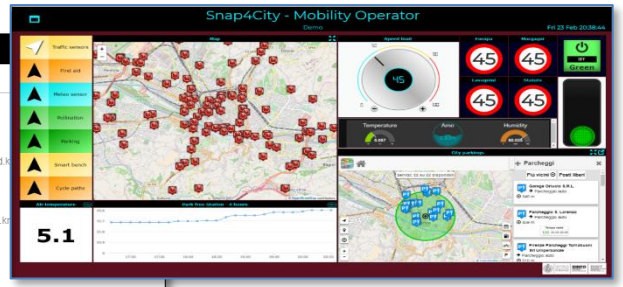
00:01:32

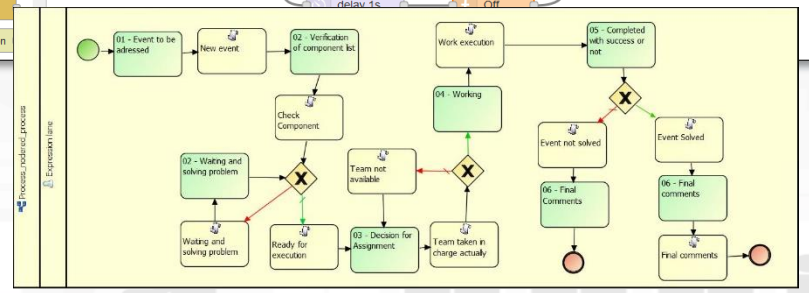
Smart City Monitoring: notifications, alerting

Notification with IOT App may

- Fire on any kind of condition exploiting on IOT App logic
- produce messages/events on
  - **Facebook, Telegram,**
  - **SMS, MMS, IOT Devices, ..**
  - **email, LOGS, FTP, ..**
  - **dashboards**, mobiles, …
  - **Workflow/incident** management system for **ticketing**
  - **video wall** management,
  - etc. etc.











facebook

Map Representing



Maps Representing

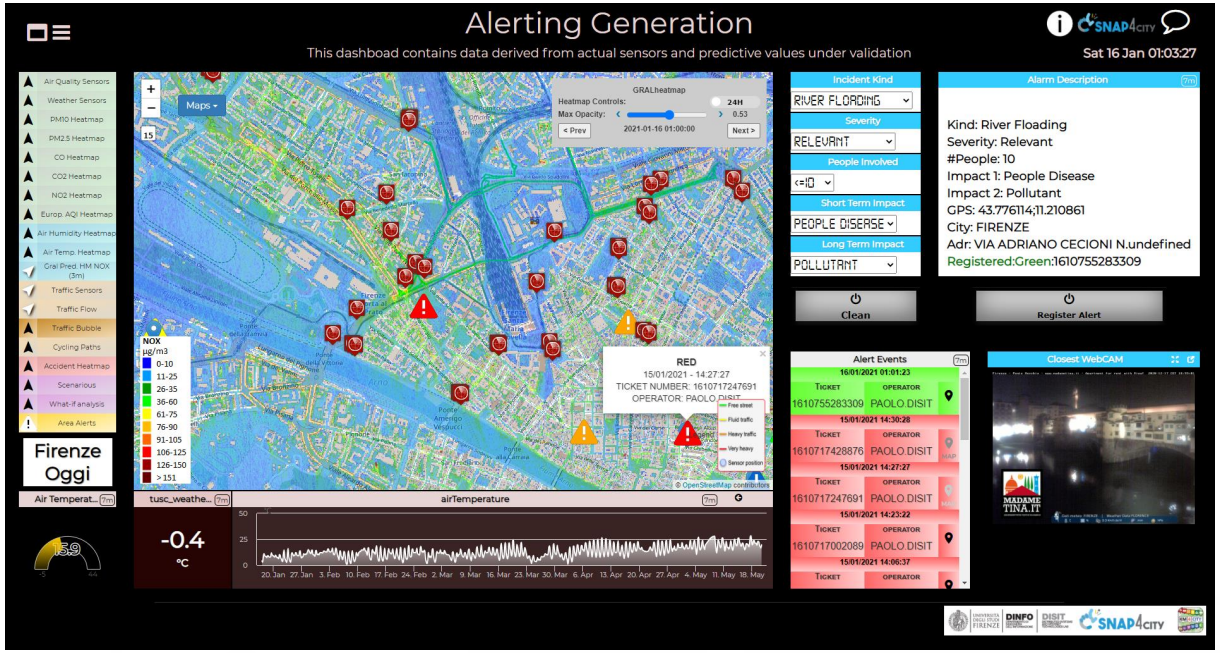
- **Dashboards, ServiceMap, Kibana DevDash, MicroApplications**
  - **All entities are classified according to Nature/subnature/type,...**
  - City structure (routable), neighbourhoods, streets, roads, preferences, etc.
  - public transportation paths (GTFS), cycling paths, gardens, shapes, RTZ, etc.
  - POI, IoT Devices (sensors and actuators), MyKPI, etc.
  - Heatmaps, routing, traffic flows, scenarios, events, Typical Time Trend, routing Trajectories, Typical Trajectories, etc.
  - 3D buildings shapes, weather forecast, alerting events, ..
- **BIM for managing and representing**
  - 3D: building with floors, structures and tiny details
  - public service facilities including governmental & commercial buildings.

ServiceMap

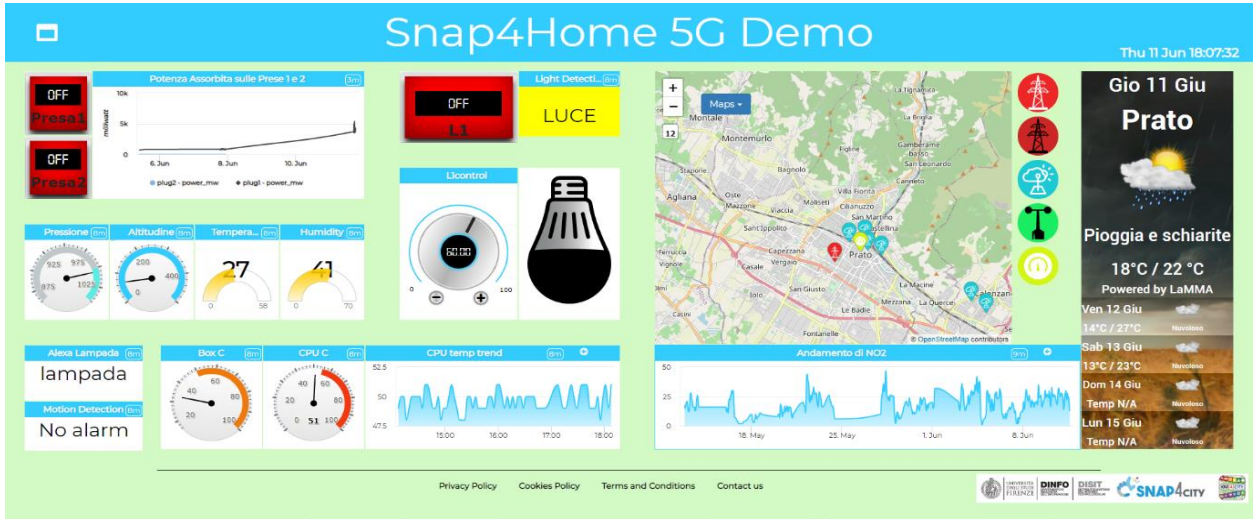


Snap4City
Service Map (Toscana)
User: roottooladmin1, Org: DISIT
Role: RootAdmin, Level: 7
LOGOUT
My Snap4City.org
Dashboards
My Dashboards in All Org.
Dashboards of My Organization
My Dashboards in My Organization
My Data Dashboard Dev Kibana
My Data Dashboard Kibana
Extra Dashboard Widgets
Notificator
Data, my Data, OpenData
Knowledge and Maps
Service Map (Toscana)
Service Map 3D (Firenze)
Helsinki Service Map
Antwerp Service Map
Garda Lake Service Map
Cagliari Service Map
Lonato Del Garda Service Map
Valencia Service Map
Pont Du Gard Service Map
Dubrovnik Service Map
WestGreece Service Map
Mostar-Bosnia Service Map
Svealand Service Map
Roma Service Map
Pisa Service Map
Creating WKT
Service Map 3D (Antwerp)
Service Map 3D (Helsinki)
Producing POI triples for KB
Load WKT on ServiceMap (Helsinki)
Load WKT on ServiceMap (Toscana)
Load WKT on ServiceMap (Antwerp)
- Hide Menu
Public transport
Municipalities
Text Search
Address Search
Events
Select an agency:
- Select an Agency -
Select a line:
- Select a Line -
Select a route:
- Select a Route -
Select a bus stop:
- Select a Bus Stop -
Position of selected Busses
Actual Selection
Service: METRO758
Serviceuri: http://www.disit.org/km4city/resource/METRO758
Name: METRO758
Nature: TransferServiceAndRenting
Subnature: SensorSite
Address: Lavagnini dir. Viale Strozzi (38)
DBpedia: "Spartaco_Lavagnini"
Property/Value Type | Value
avgDistance | Not Available
avgTime | 14.291604
occupancy | Not Available
concentration | 8.25
vehicleFlow | 1344.0
averageSpeed | 29.613344
thresholdPerc | Not Available
speedPercentile | Not Available
congestionLevel | 119.0967
anomalyLevel | 101.56058
Latest Update: 2021-01-16T17:10:00+01:00
Regular Services
Transversal Services
Services Categories
De/Select All
Accommodation
Advertising
AgricultureAndLivestock
CivilAndEdilEngineering
CulturalActivity
EducationAndResearch
Emergency
Carabinieri
Civil_protection
Coast_guard_harbormaster
Commissariat_of_public_safety
Corps_of_forest_rangers
Emergency_medical_care
Emergency_services
Fire_brigade
First_aid
Italian_finance_police
Entertainment
Environment
FinancialService
GovernmentOffice
HealthCare
IndustryAndManufacturing
IoTDevice
MiningAndQuarrying
ShoppingAndService
TourismService
TransferServiceAndRenting
UtilitiesAndSupply
Wholesale
WineAndFood
Filter:
search text into service
Service providing value type:
select value type
N. results: 500
Search Range 2 km
Search Area
select...
- Hide Menu
Weather Forecast for Mucipality of : FIRENZE
Saturday
Sunday
Monday
Tuesday
Wednesday
bit cloudy -2°C / 7°C
overcast -2°C / 6°C
cloudless -3°C / 7°C
cloudy -3°C / 6°C
overcast 5°C / 10°C
Latest Update: 2021-01-16T07:57:00+01:00
http://www.disit.org/km4city/resource/Firenze1610780220000

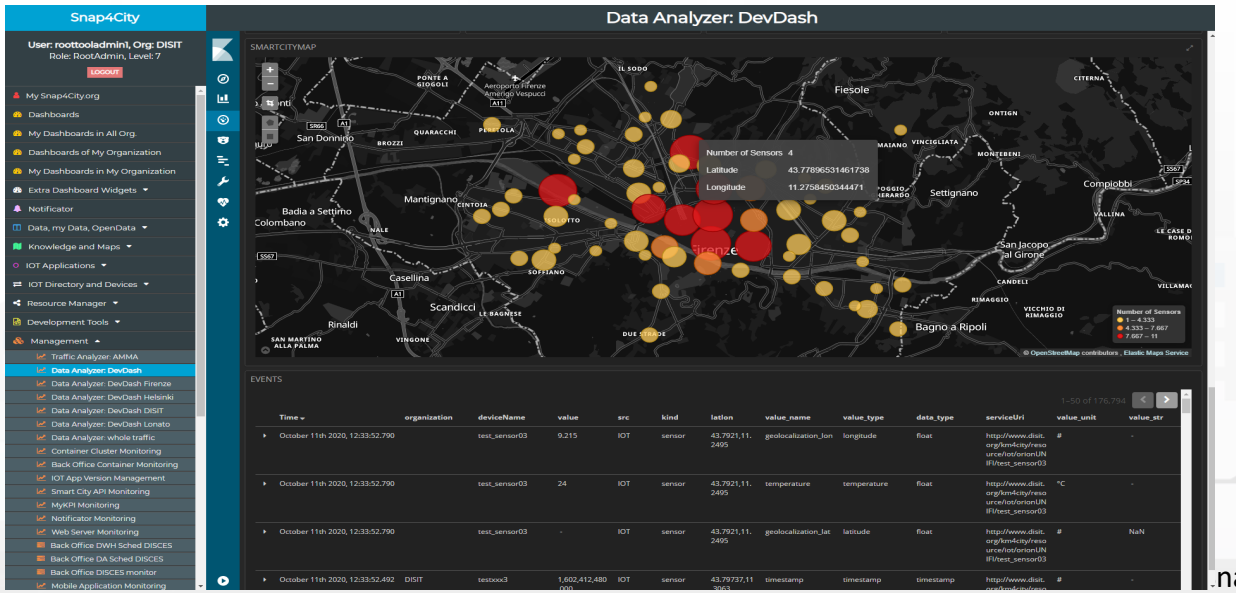
Dashboards



Alerting Generation
This dashboad contains data derived from actual sensors and predictive values under validation
Sat 16 Jan 01:03:27
Incident Kind
RIVER FLOADING
Severity
RELEVANT
People Involved
Short Term Impact
PEOPLE DISEASE
Long Term Impact
POLLUTANT
Alarm Description
Kind: River Floading
Severity: Relevant
#People: 10
Impact 1: People Disease
Impact 2: Pollutant
GPS: 43.776114;11.210861
City: FIRENZE
Adr: VIA ADRIANO CECIONI N.undefined
Registered:Green:1610755283309
Clean
Register Alert
Alert Events
Closest WebCAM
Firenze Oggi
airTemperature
-0.4



Snap4Home 5G Demo
Thu 11 Jun 18:07:32
Potenza Assorbita sulle Prese 1 e 2
LUCE
Gio 11 Giu
Prato
Pioggia e schiarite
18°C / 22 °C
Powered by LaMMA
Alexa Lampada
lampada
Motion Detection
No alarm
Box C
CPU C
CPU temp trend
Andamento di NO2
Privacy Policy
Cookies Policy
Terms and Conditions
Contact us



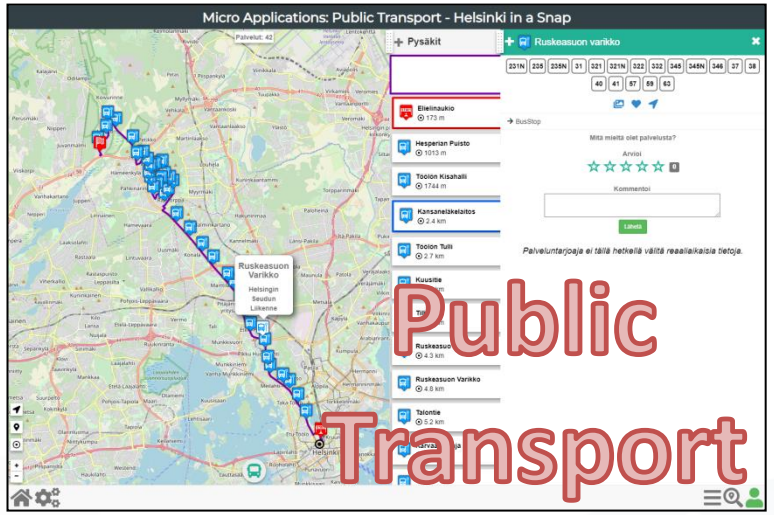
Snap4City
Data Analyzer: DevDash
SMARTCITYMAP
EVENTS

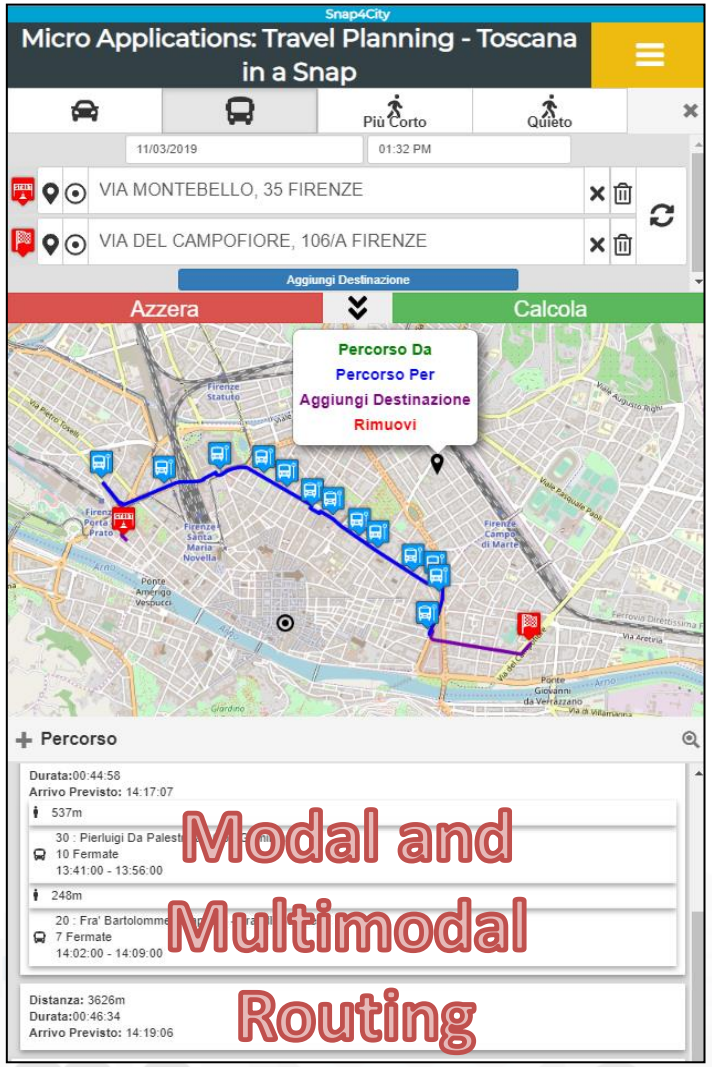


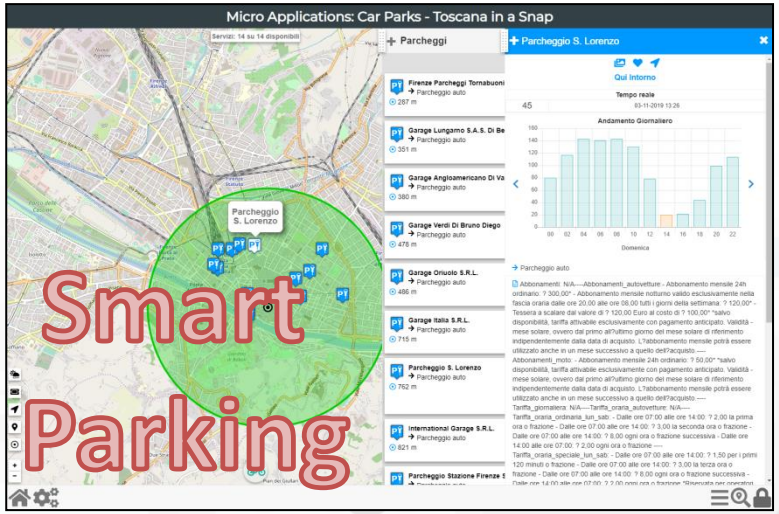
3D Multi Data Map - Digital Twin Global - Firenze
demonstrator
Mon 28 Mar 23:41:27
3D Map
METRO9 - vehicleFlow
45.2
Privacy Policy
Cookies Policy
Terms and Conditions
Contact us

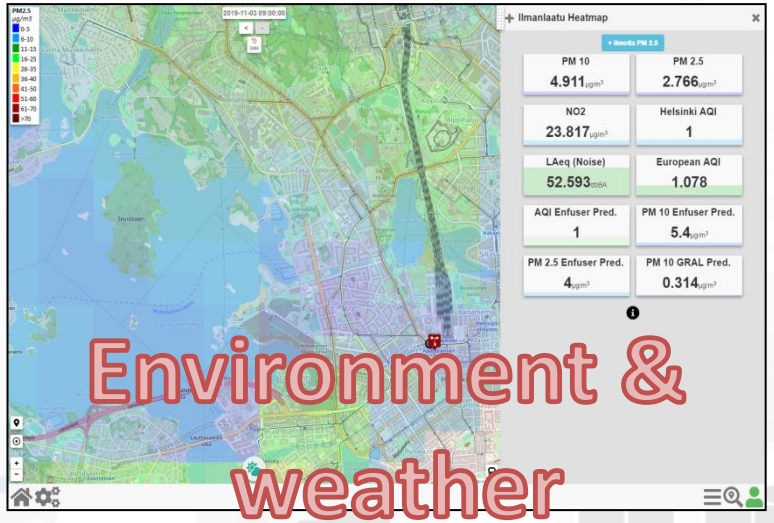
MIcroApplications



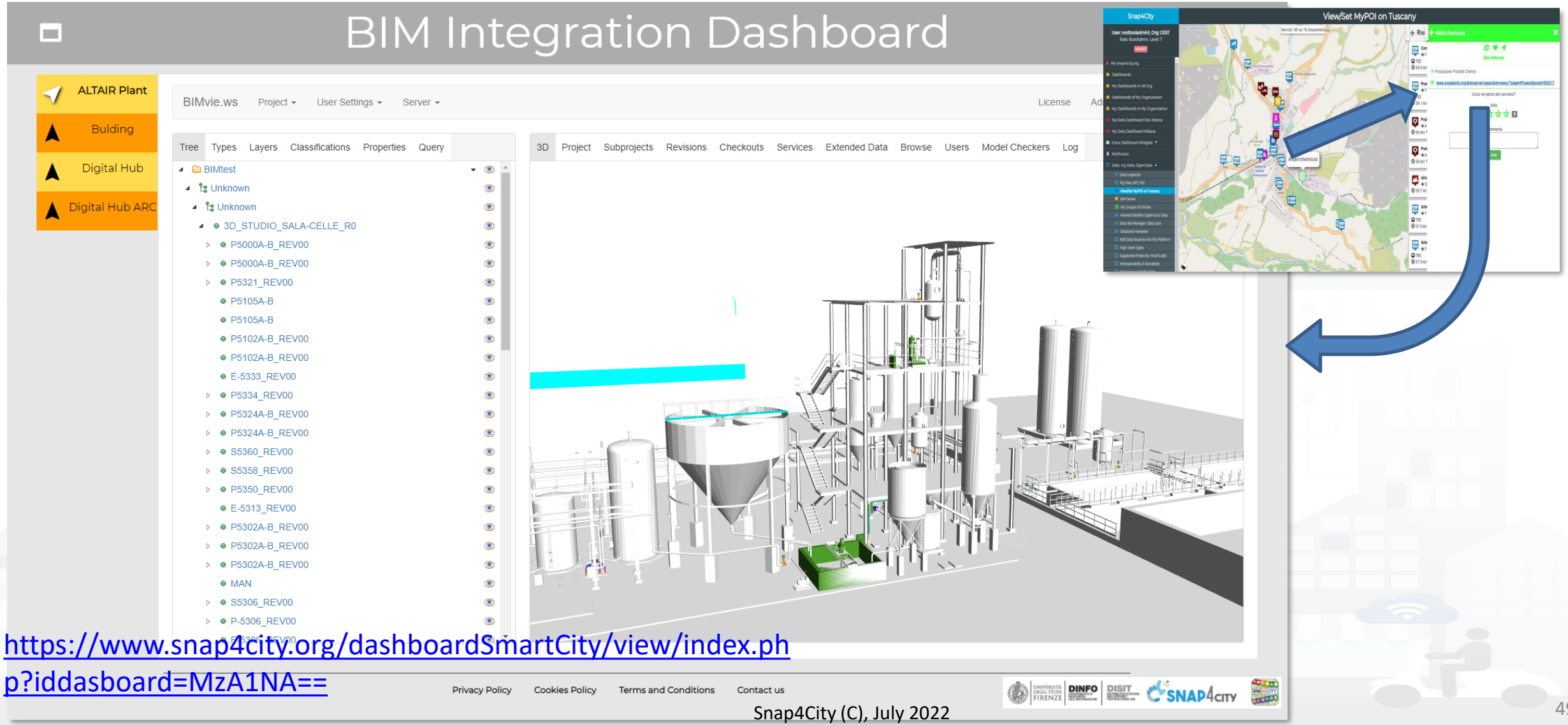








BIM view of the Altair Chemical Plant



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

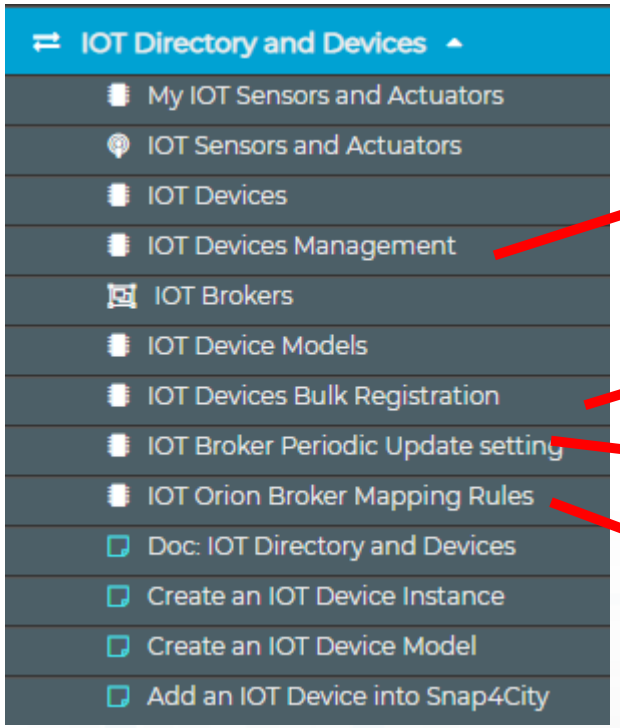
Working on IoT Devices

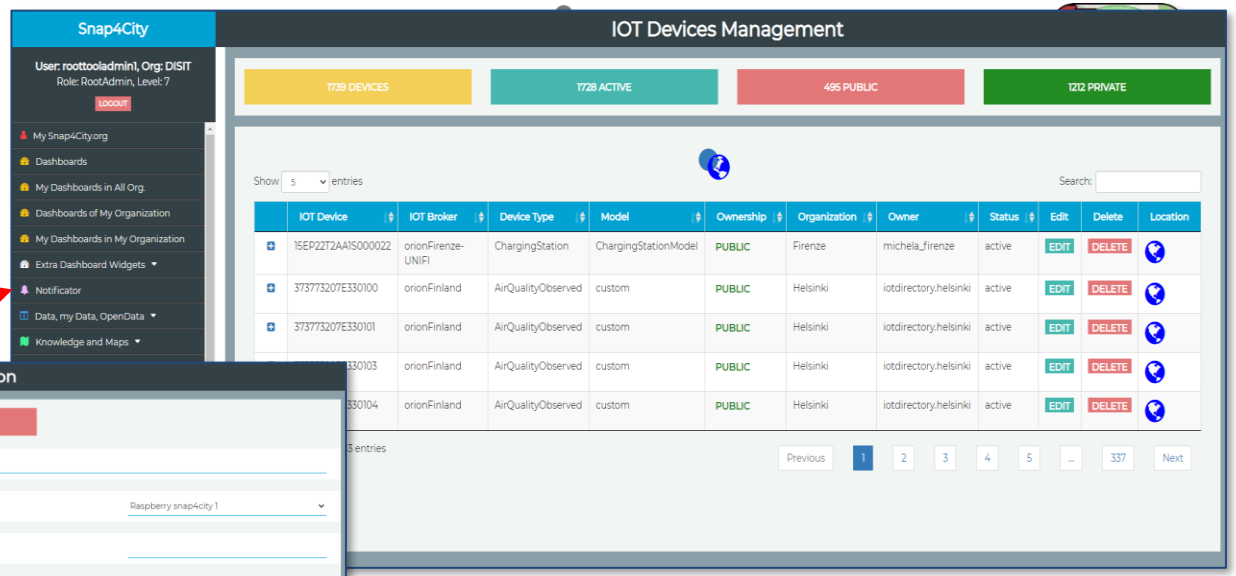


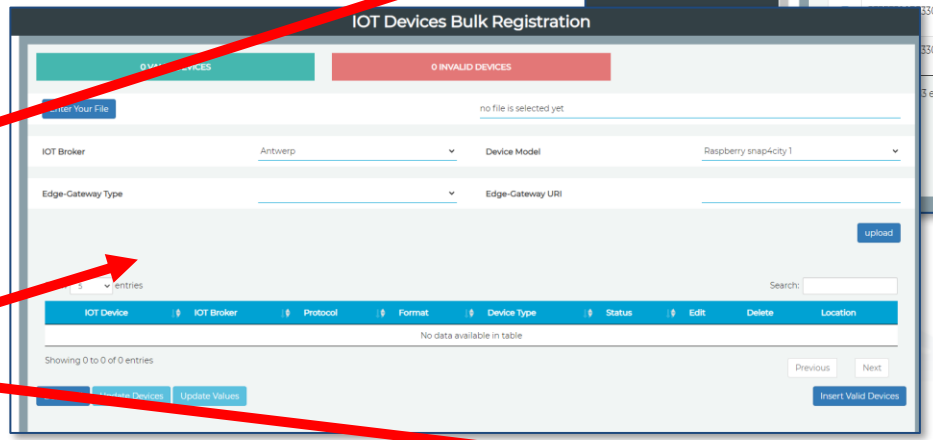
Working on IoT Devices

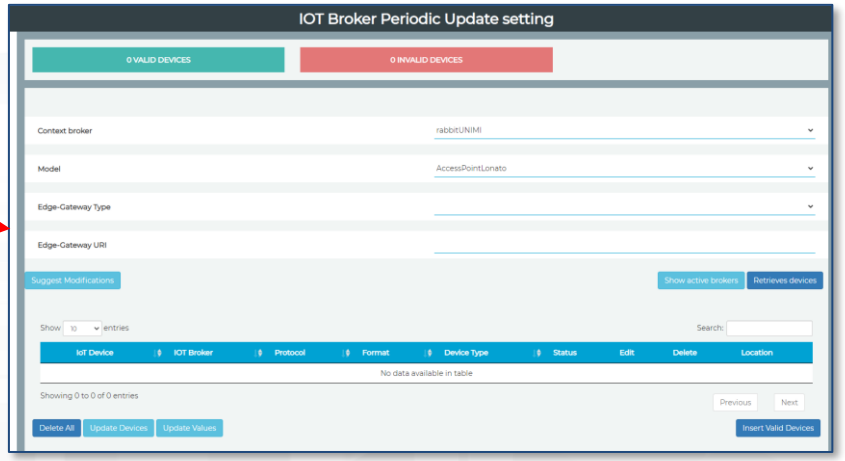
- **Internet of Everything** since devices can be entities of
  - Industry 4.0, Home, mobile devices, cars, KPI, etc.
- **Unified Modelling** via HTL ……
  - **Any Data, Any Device, Any Protocol and Format**
    - Push and Pull protocols, real time event driven
    - Sensors and Actuators
  - **Classification and Discovery**: Device Models, Ontological Model
    - Any other data model as described before
- **End-to-End Secure** connection from Devices to Dashboards
- **Virtual Devices** on Dashboards, Sensors and Actuators

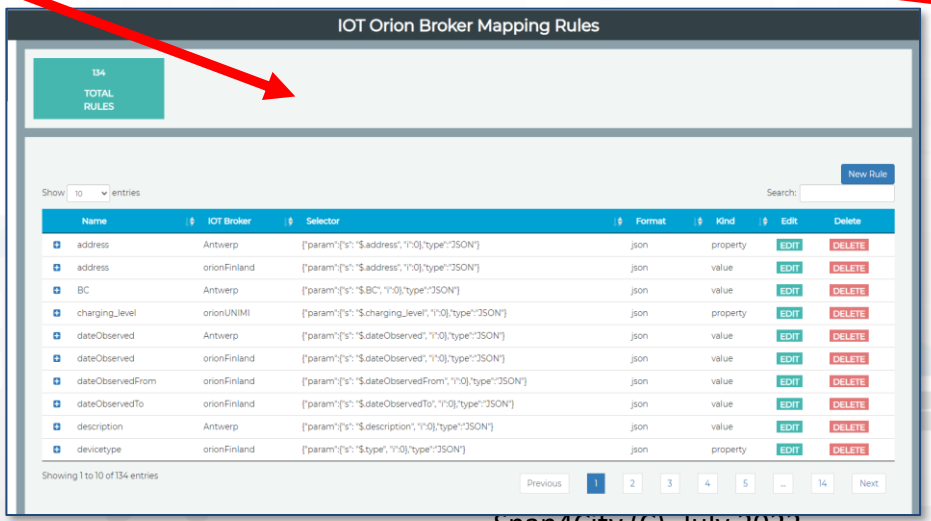
IOT Directory and Devices







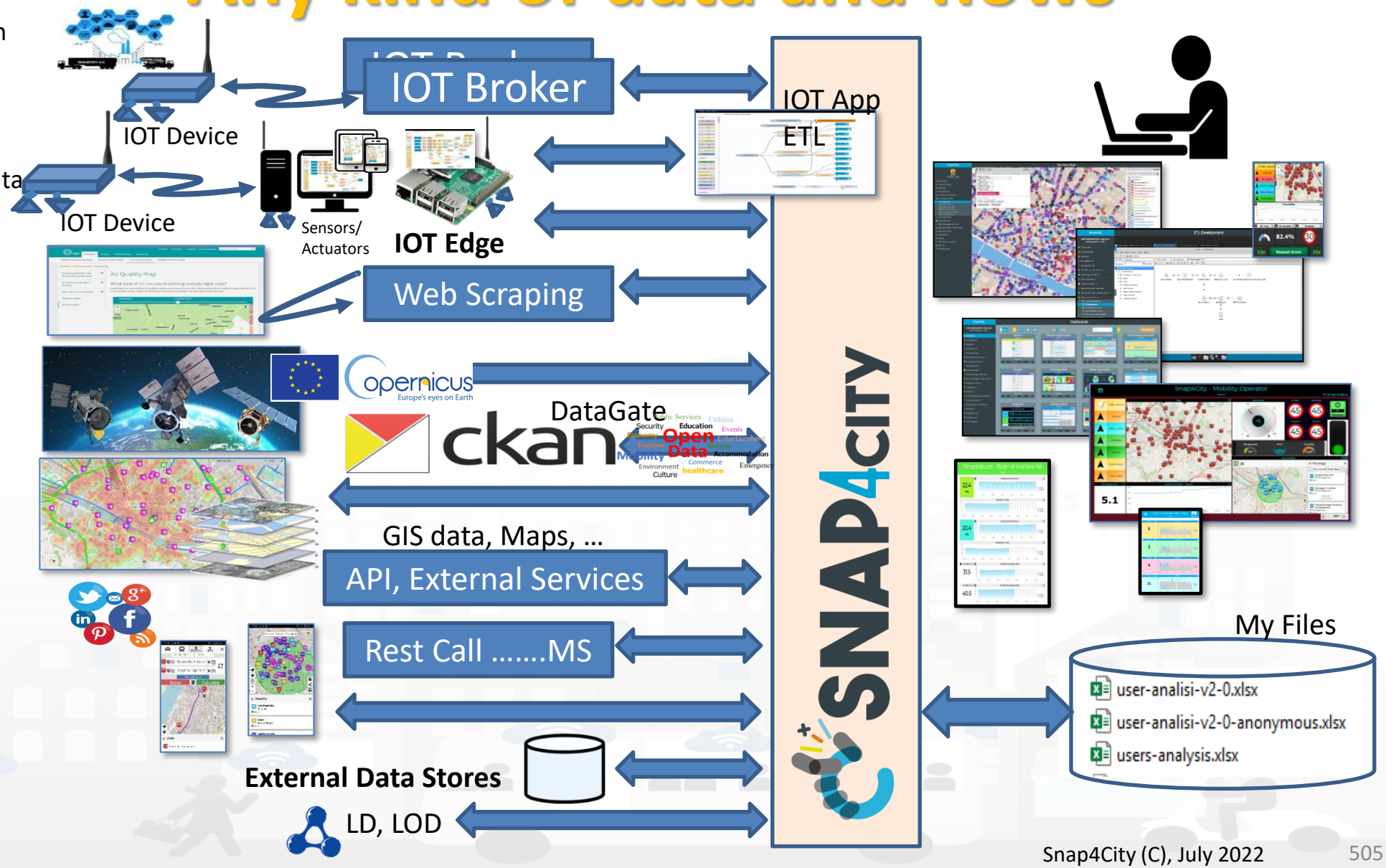




- For non admin tools see Training parts 3 and 5: https://www.snap4city.org/577

Any kind of data and flows

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



From-To Custom Widgets / Synoptics to Storage in WS

MyKPI

Sensors

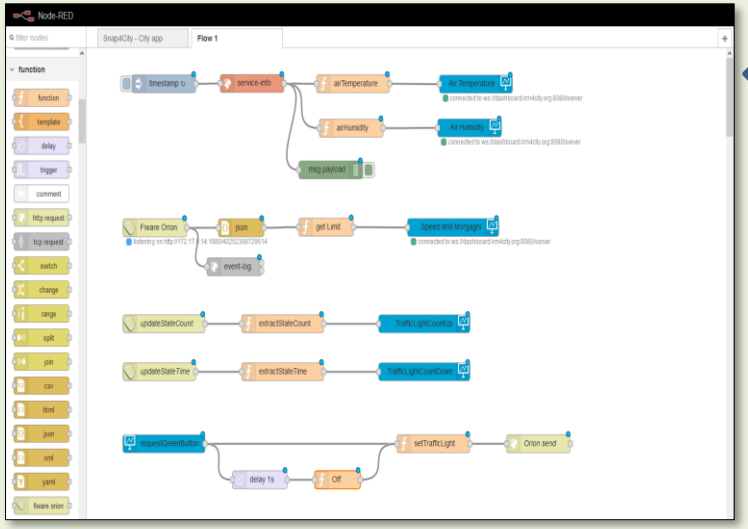
MyKPI

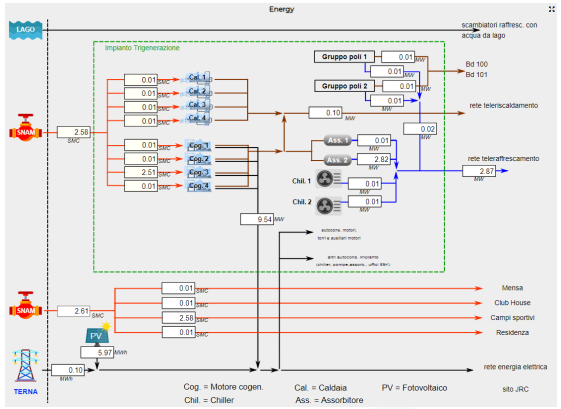
Sensor

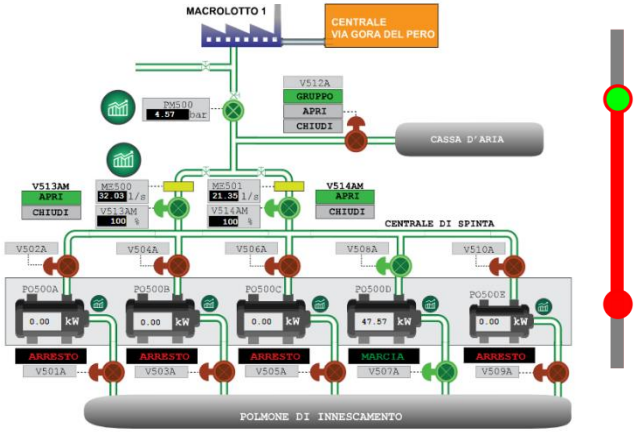
[ ]

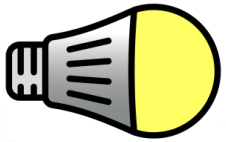
New Shared Variables

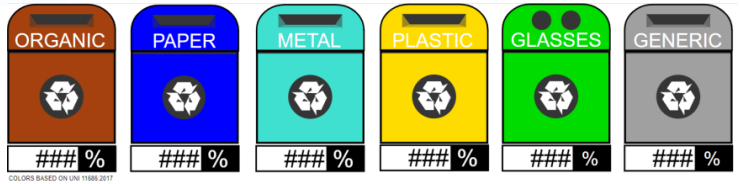
Constant Values

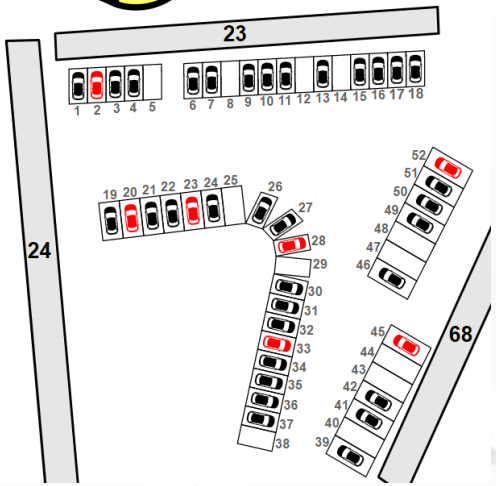






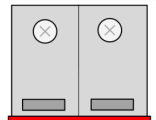


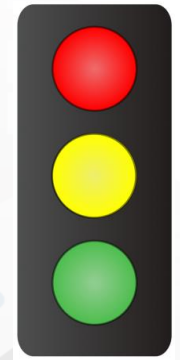






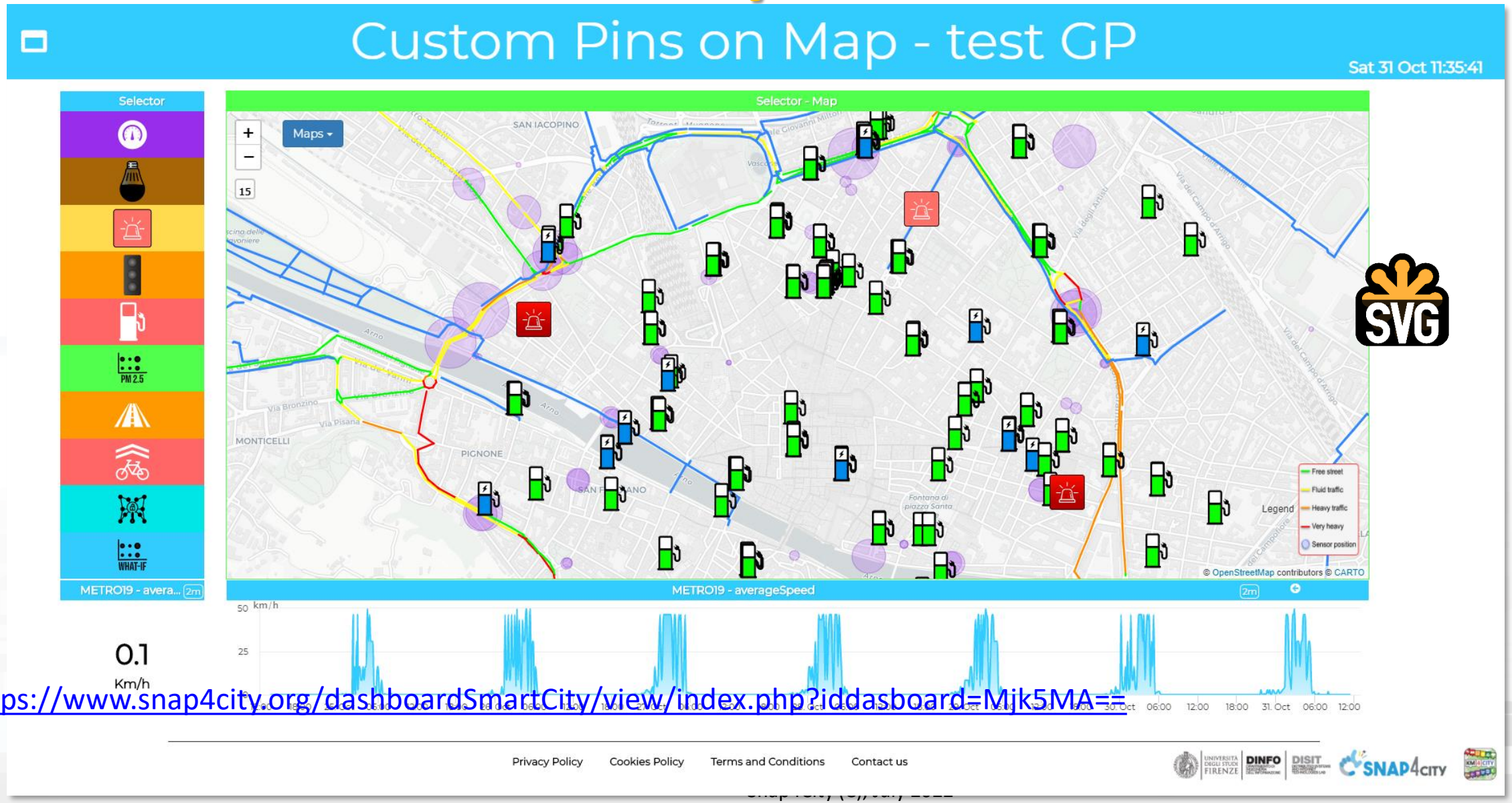






Web Socket Secure

Custom Dynamic Pins



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

Multi-Widget Map

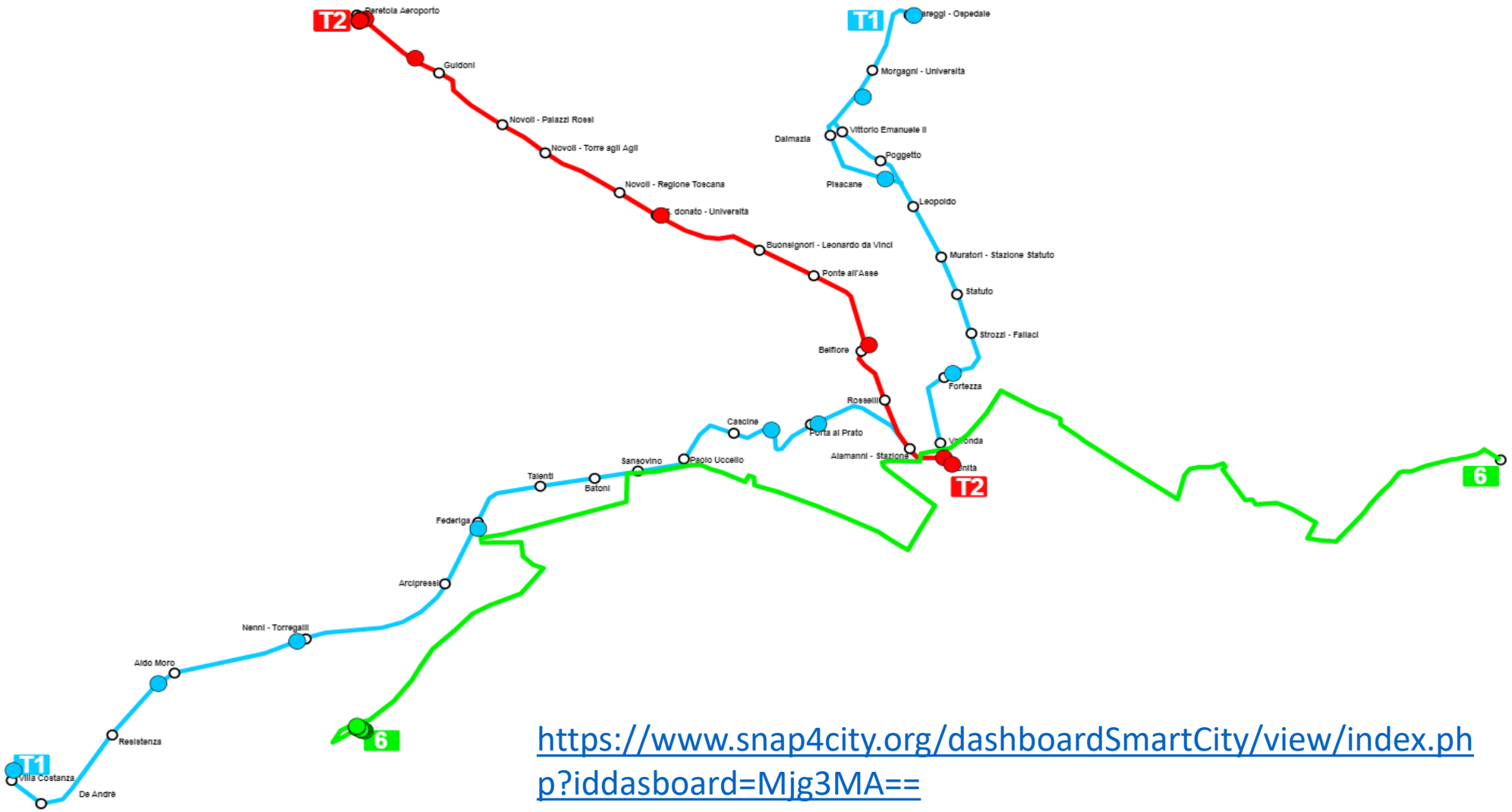


https://main.snap4city.org/view/index.php?iddasboard=OTc2

Firenze SVG Tramline Multi rides

Fri 17 Jul 18:29:50

Tramline

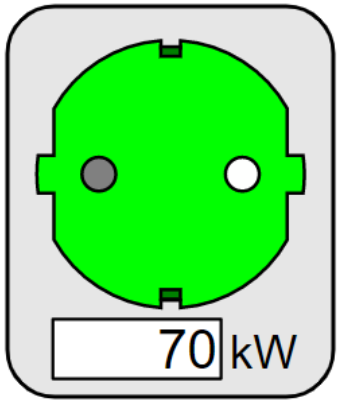


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjg3MA==

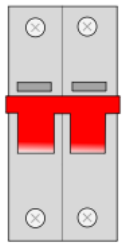
SVG Custom Widgets Examples 2

Tue 17 Nov 18:46:47

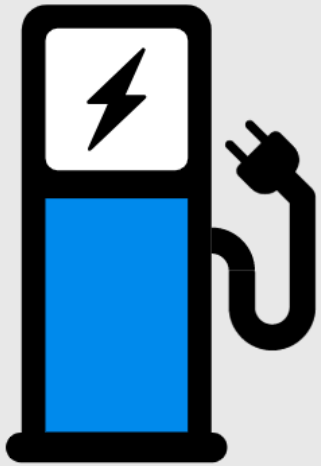
SVG shucko plug



Schuko switch



Charging Station Status



Legenda

Charging Station Status

Set on the keypad one of the following values

0 = ERROR (RED)

1 = AVAIBLE (GREEN)

2 = BOOKED (YELLOW)

3 = CHARGING

9999 = white icon

Charging Station status

New | Last confirmed: None

7	8	9
4	5	6
1	2	3
0	.	Canc
Confirm		

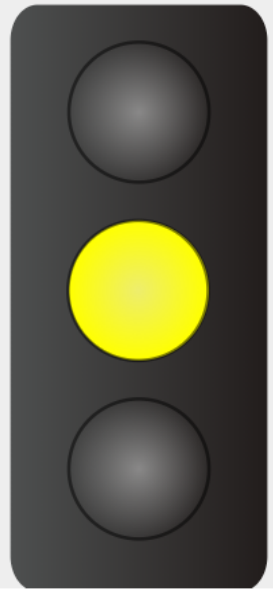
Underpass



Set tunnel st...



Traffic Light



Traffic Light status set

YELLOW LIGHT

Speed Limit Set

New | Last confirmed: None

7	8	9
4	5	6
1	2	3
0	.	Canc
Confirm		

Dynamic Speed Limit Sign



Speed Limit Explaination

Speed Limit Custom Widget example

Write the speed limit by using the keypad and click CONFIRM.

9999 = white sign.

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjk4Ng==

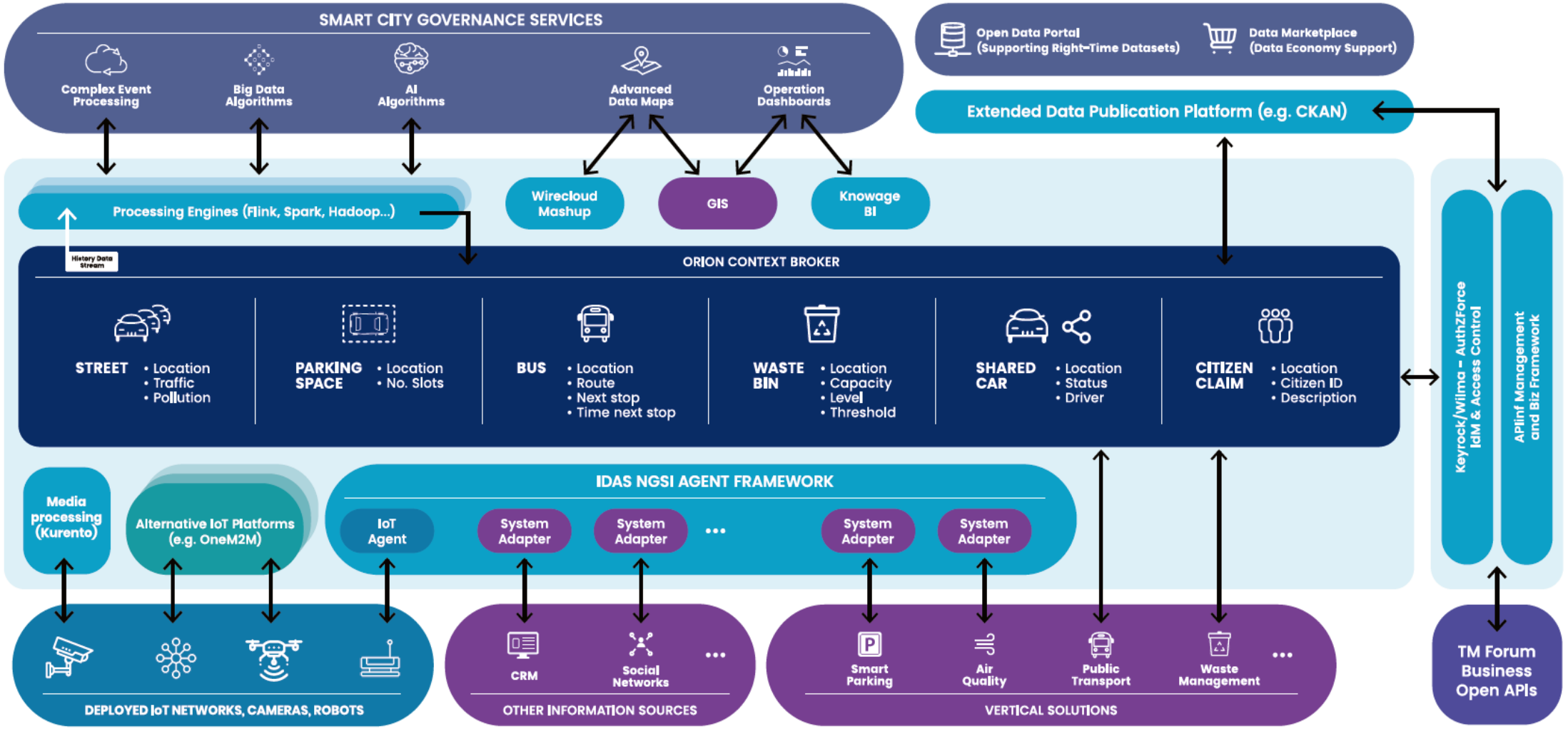
TOP



FIWARE & Snap4City

Powered by FIWARE

THE FIWARE SMART CITIES REFERENCE ARCHITECTURE



- Snap4City - Powered by FIWARE Solution & Platform:
  - https://marketplace.fiware.org/pages/solutions/b8905e91973b420189cce972
  - https://marketplace.fiware.org/pages/solutions/d68534ec827500f1bde8720f
  - NGSI V1, V2 The IOT Orion Broker
  - IOT Orion Broker can connect JSON, MQTT, Lightweight M2M, LoraWAN, OPC, SigFOX, etc. see FiWare Https://www.fiware.org
- Snap4City - FIWARE Training Services:
  - https://marketplace.fiware.org/pages/solutions/03bccd83a0e1b0398ba7a0bf
- Snap4City - FIWARE Consultancy Services:
  - https://marketplace.fiware.org/pages/solutions/907f5ecc63927f643dd8421b
- **Snap4City is compatible** with all the above protocols
  - via IOT Orion Broker,
  - via IOT Applications.
  - via direct connection on ETL processes on their corresponding IOT brokers, and/or
- **Snap4City is also compatible** with many other protocols, see the table reported in page: https://www.snap4city.org/65

Powered by FIWARE

Overview



- https://fiware-foundation.medium.com/snap4city-fiware-powered-smart-app-builder-for-sentient-cities-acfe24df49d5
- https://www.snap4city.org/drupal/sites/default/files/files/FF_ImpactStories_Snap4City.pdf

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

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

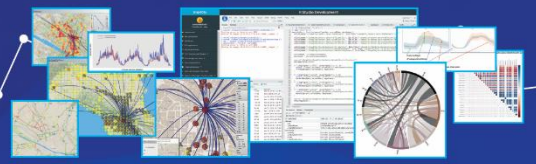
MICROSERVICES & ADVANCED SMART CITY API

LIVING LAB - DEV TOOLS - COWORKING

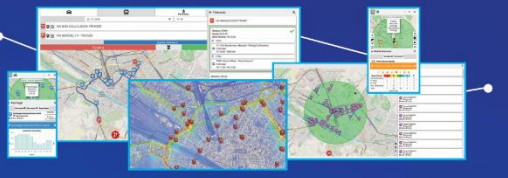


IOT DIRECTORY • SERVICE MAP • RESOURCE MANAGER • DATA GATE • R STUDIO • ETL

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

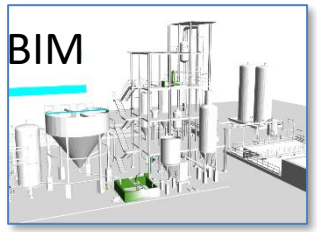
IOT MNG - DATA MNG - DATA INSPECTOR – PROCESS MNG – USER ENGAGEMENT – GDPR MNG ...

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



Concept

BIM

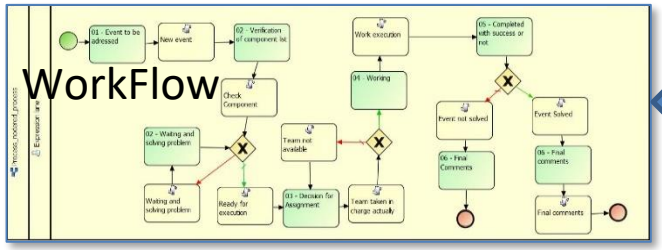


KPI, POI, MyKPI, …

API, External Services

Web Scraping

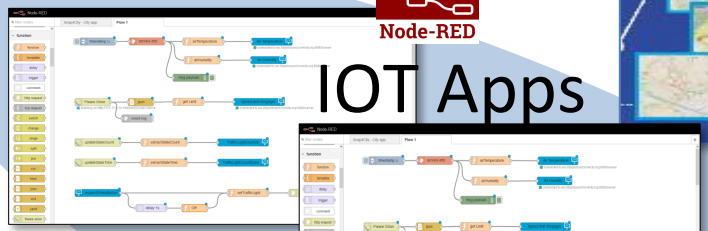
WorkFlow





Node-RED

IOT Apps





Data Analytics,
Artificial Intelligence



IOT Brokers

IOT Broker

IOT Broker



FIWARE



GIS

Big Data

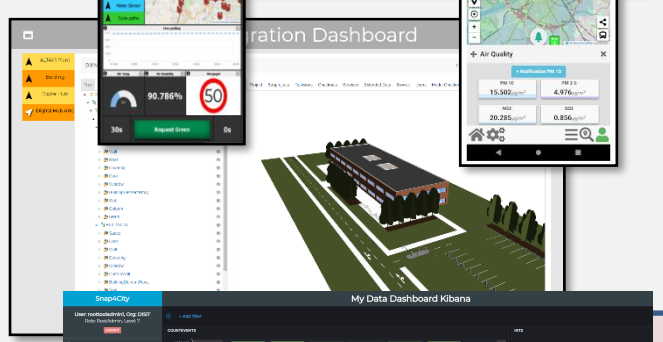
KB

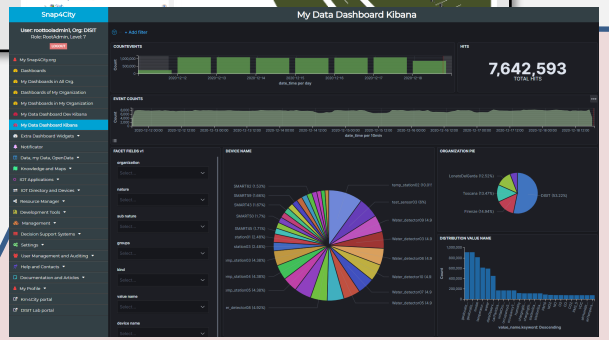
LD, LOD

ckan









Dashboards and Apps

FI-WARE

Functional: FIWARE ref arc wrt Snap4City solutions

	FIWARE ref arc smart city	Snap4City
Multiple Protocols: IoT, Databases, etc..	10 on IOT, Limited on databases, etc.	More than 200, very very wide
Large set of high level types: maps, trends, heatmaps, traffic, trajectories, scenarios,…	No	Yes:
Integration with workflows, BPM	Not Supported	Yes: bidirectional
Integration and Modeling Digital Twin BIM	Not Supported	Yes: bidirectional
Integration with GIS: WFS, WMS	Not fully supported	Yes: bidirectional
Integration with Heatmaps and Satellite	Partially, not caòibrated	Yes: fully; calibarate and multiple versions, animations
Integration with Satellite	not supported	Yes: fully
Smart City API	no	Yes
Open Data Management	Partial with CKAN	Yes, Fully automated with CKAN
Federation of platforms	Partial on brokers	Full on Brokers and Knowledge base and API
Semantic model and queries	No, probably with NGSI-LD in the future	Yes since 2013
Multiple kinds of IoT Brokers	No, only agents	Yes: NGSI, COAP, AMQP, MQTT, SigFOX, etc.

Interoperability
Openess

Functional: FIWARE refarc wrt Snap4City solutions

	FIWARE ref arc smart city	Snap4City
Data Transformation	Coding	Yes: IOT App, Node.JS, Visual Programming, scalable
Data Analytics	No	Yes
on line development	No, limited	Yes: Rstudio, Python, Tensor Flow, MapReduce, etc.
Dashboard on data	Grafana no LDAP	Yes: Dashboard Builder, Kibana with GDPR, LDA (Open Distro)
Dashboard Widgets	Limited, no custom, coding needed	Yes: A wide range including custom widgets, secure compliant, animations, configuration, also open to new development
Real Time end-to-end from Dashboards to any other channel, event driven	No, very limited	Yes, fully supported
Multi Data Map	Limited with non OS	Very extensive, with multiple widgets and sync
MicroApplications	No	Yes
Auditing, Assessment, accounting	No, no, no	Yes, Yes, Yes
Multitenacy on data management	No only on broker	Yes: on Broker, on data management, on dashboards, etc..
Living Lab for creating/managing communities/groups	Not supported	Yes: provided in the open source
Report generation/management	No	Yes

Process Graphics Manag.

FI-WARE

SMART CITIES REFERENCE ARCHITECTURE

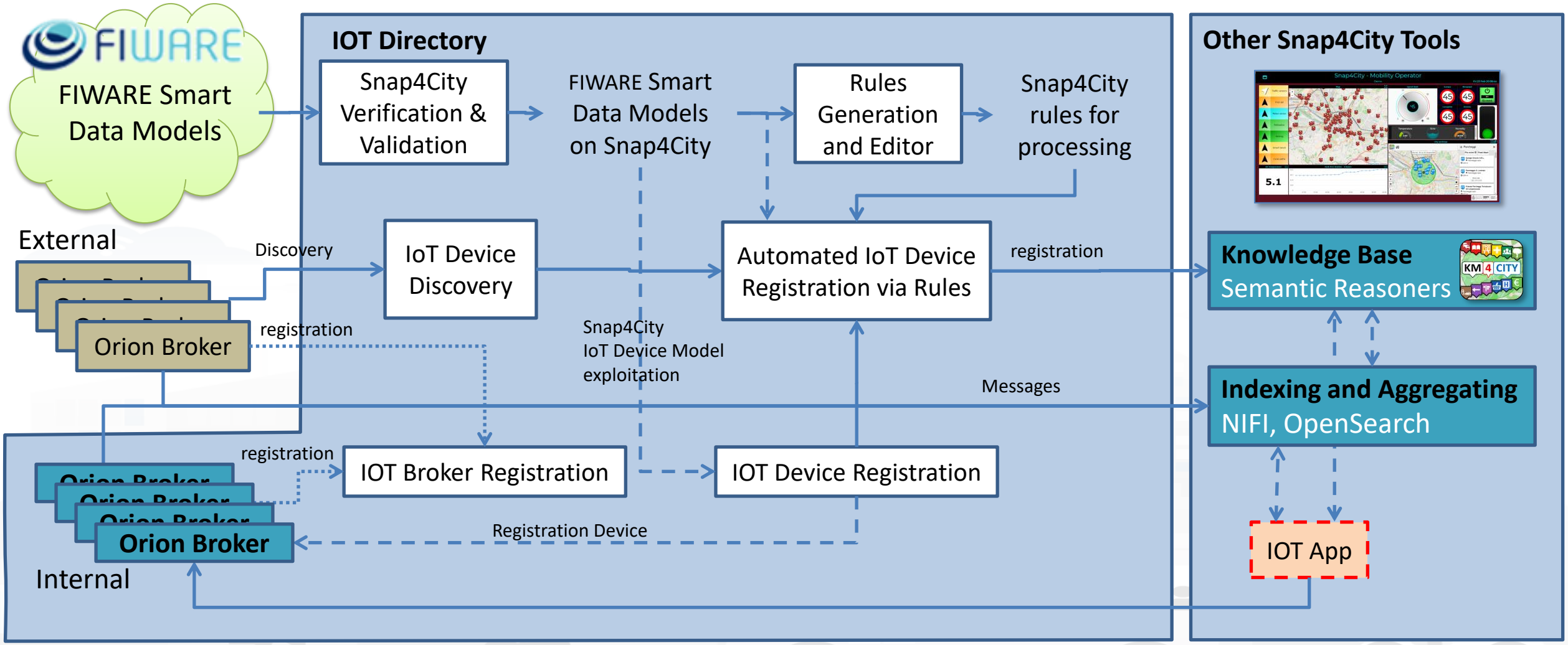
- Is open to the Development of Applications leaving large space to developers
- Is centered on the Orion Broker that results central in the architecture: any Broker or data source is sending data to the Orion
- Data shadow for historical data with external data base as CrateDB on which you can attach Kibana
- **Security level** is based on TLS. User management partially demanded to developers
- Visual Flexible IOT processing is not clearly provided
- **Limited API** for smart city, API IOT data access mainly
- Limited data modelling for smart city, powerful on IoT
- **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 applicative parts

VS

SNAP4CITY

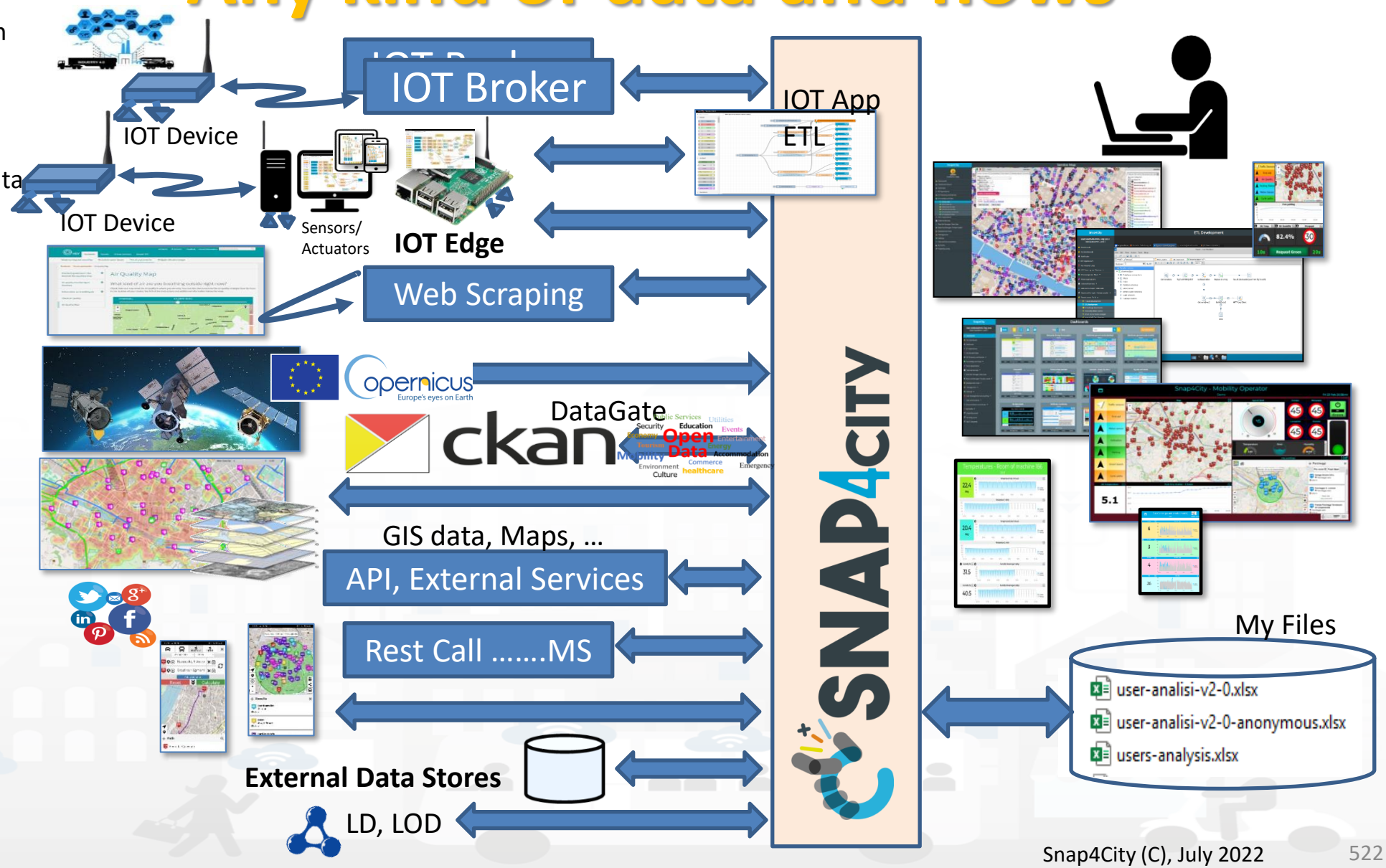
- Is open to the Development of Applications leaving large space and providing a **large set of ready to use applicative tools** and solutions to build their solutions on top or aside.
- Is fully distributed, **any kind of data source** can be ingested, automatically to form the Data Shadow.
- **Orion 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 IOT App that is Node-RED plus 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
- **Storage** based on OpenDistro (Elastic Search + Kibana) or HBase/Phoenix, or Elastic Search + Kibana (with some limitations)
- **Market Place** for promoting, publishing and sharing Open Data, tools, processes, experiences
- Passed PEN test, GDPR compliant, **published security** on IEEE Access
- **Interoperable** with huge number of protocols and formats
- Full Support for **Living Lab** of the city, coworking, tutorials
- Fully support for **Multi-tenancy**
- Fully support **federation of smart cities, smart factories**
- Deployed as VM and Dockers, on cloud and on premise
- 100% open Source, including the management and applicative aspects

Exploiting FIWARE Smart Data Models



Any kind of data and flows

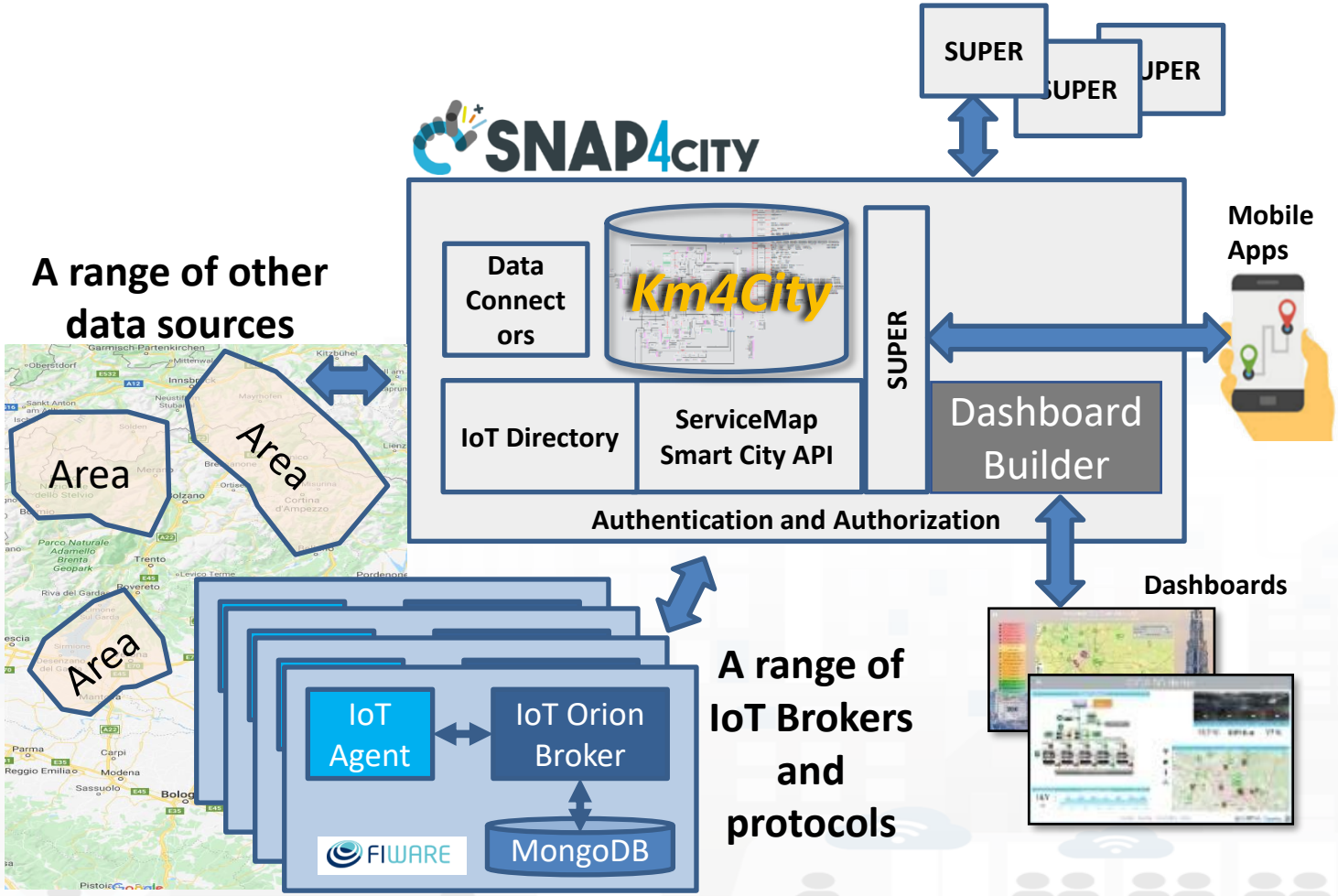
- **Open Data:**
  - Data gate, federation of Open Data Portals
  - IOT App, ETL proc(PULL)
- **IOT Networks:**
  - IOT Application processes, data driven or PULL
  - IOT Brokers (Push) → IOT Shadow
- **Web Pages:**
  - Web scraping, crawling processes
- **Satellite data**
- **Social media: Twitter,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



Snap4City and FiWare integration

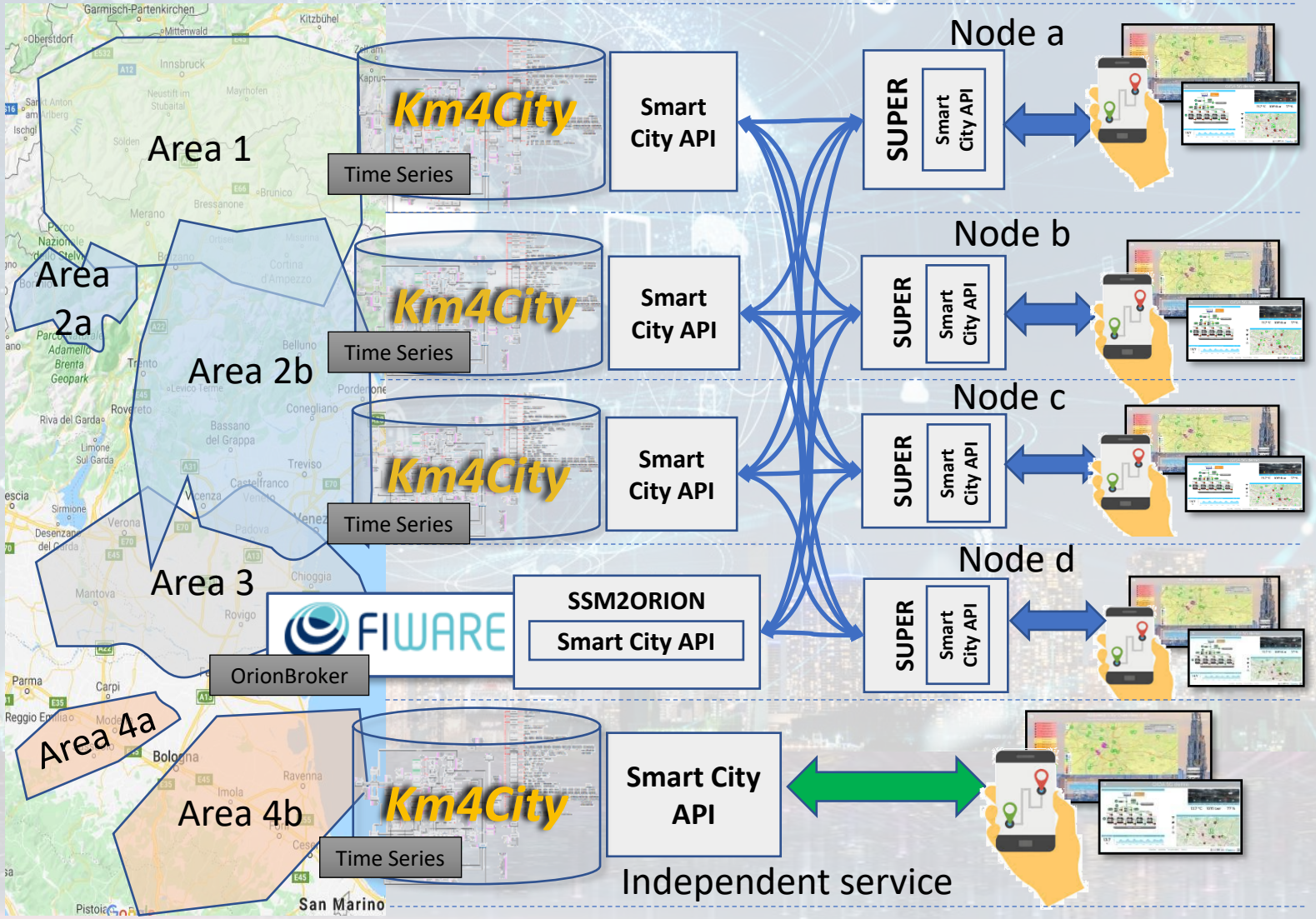
- **A) IoT Orion Broker as an External Broker** of a Snap4City platform
  - Devices are mainly managed by Orion Broker only
  - IoT Directory can harvest devices on Broker to registered them
- **B) IoT Orion Broker is an Internal Broker** of a Snap4City platform
  - This implies that Snap4City facilities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

Snap4City IoT Registration and Access



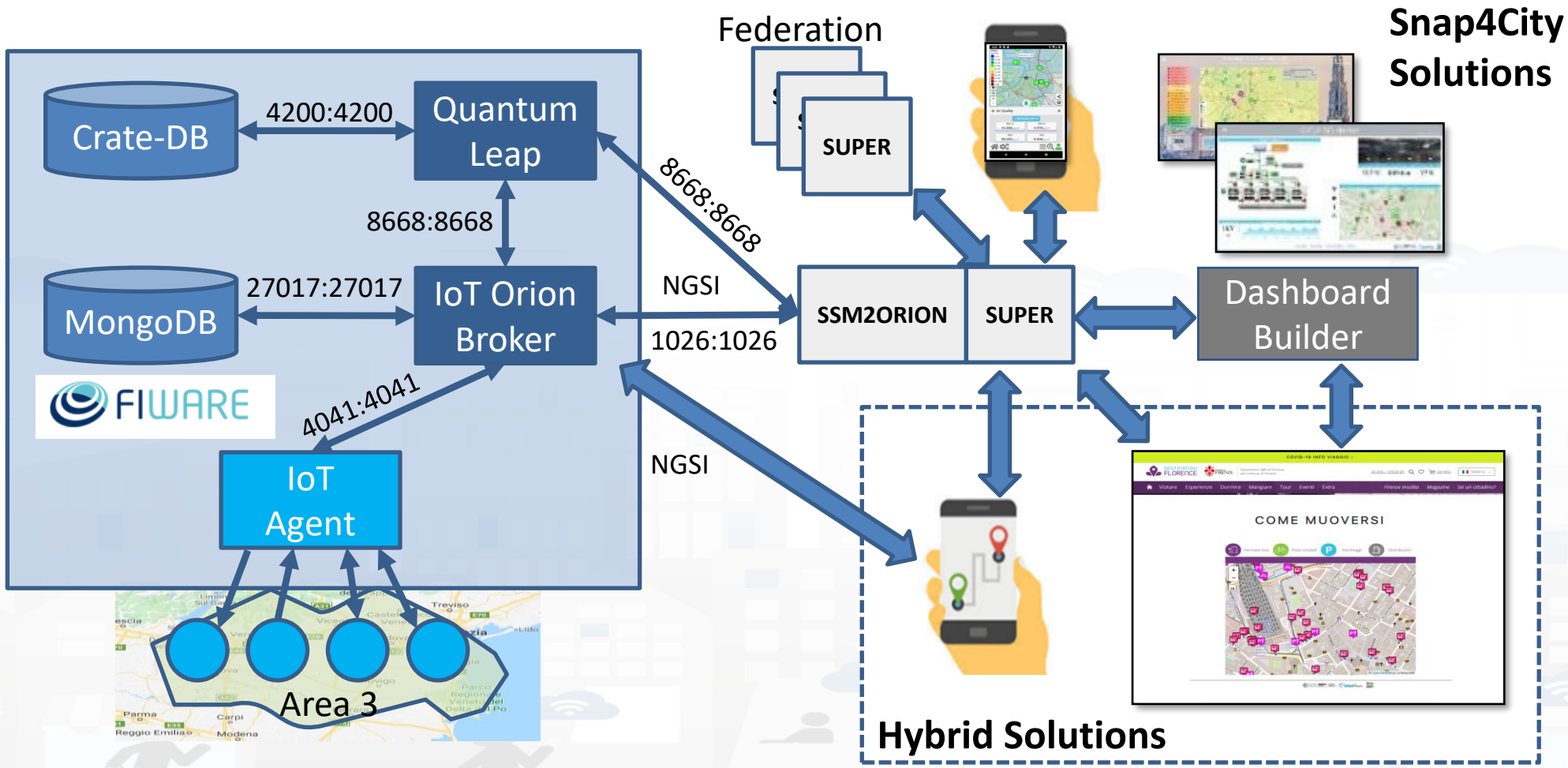
Federation of Smart City Services

Knowledge Base
Semantic Reasoners



- Km4City **Semantic Reasoner**
- **ServiceMap** interoperability
- **Seamless for multiple Mobile Apps**
- **Smart City API**
- **Super**:
  - distributed access and sharing services
  - Each city control its own data
  - Final user can pass from one city / area to another in seamless manner: without changing the mobile Apps

Federation of Snap4City vs IOT ORION Broker



Non Functional

FiWare OS Solutions wrt Snap4City solutions

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

TOP

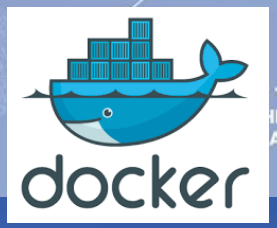


Installing Snap4City

SNAP4 Appliances and Dockers **Installations**



Installations

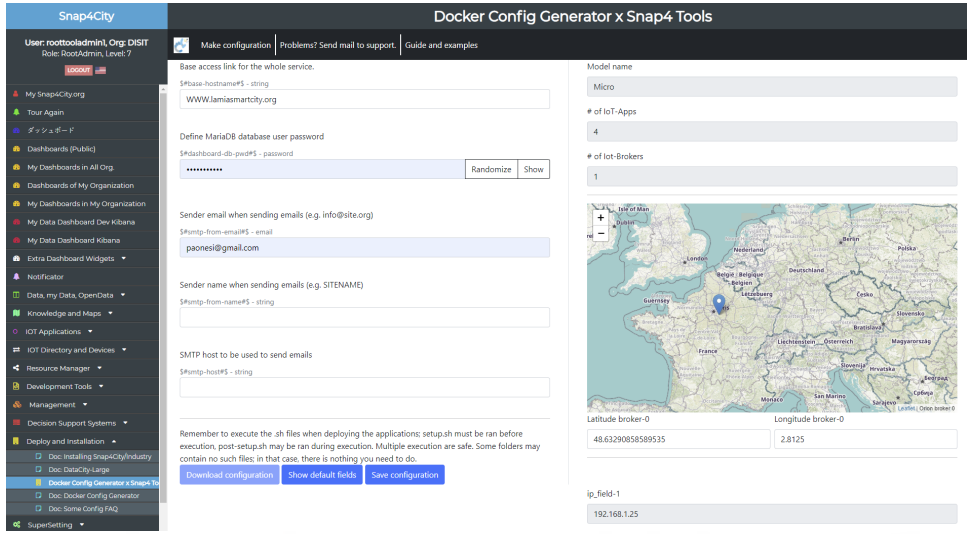


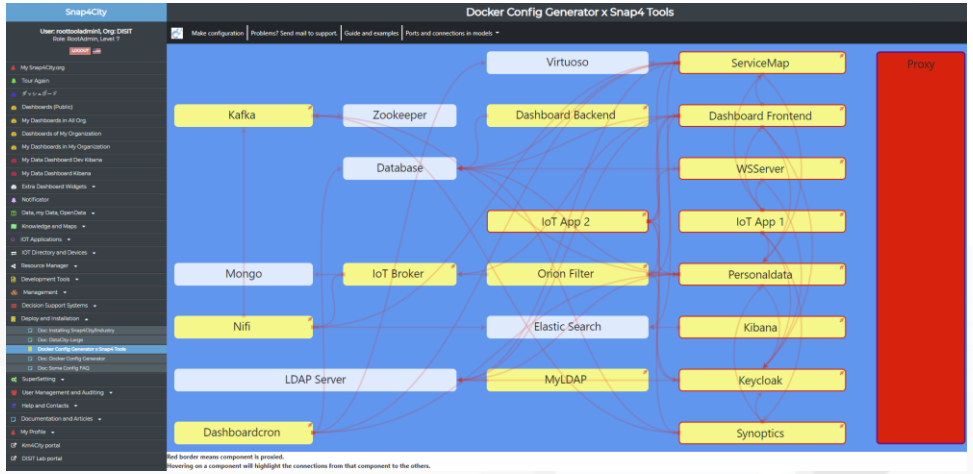
https://www.snap4city.org/471

To get an updated version read it!

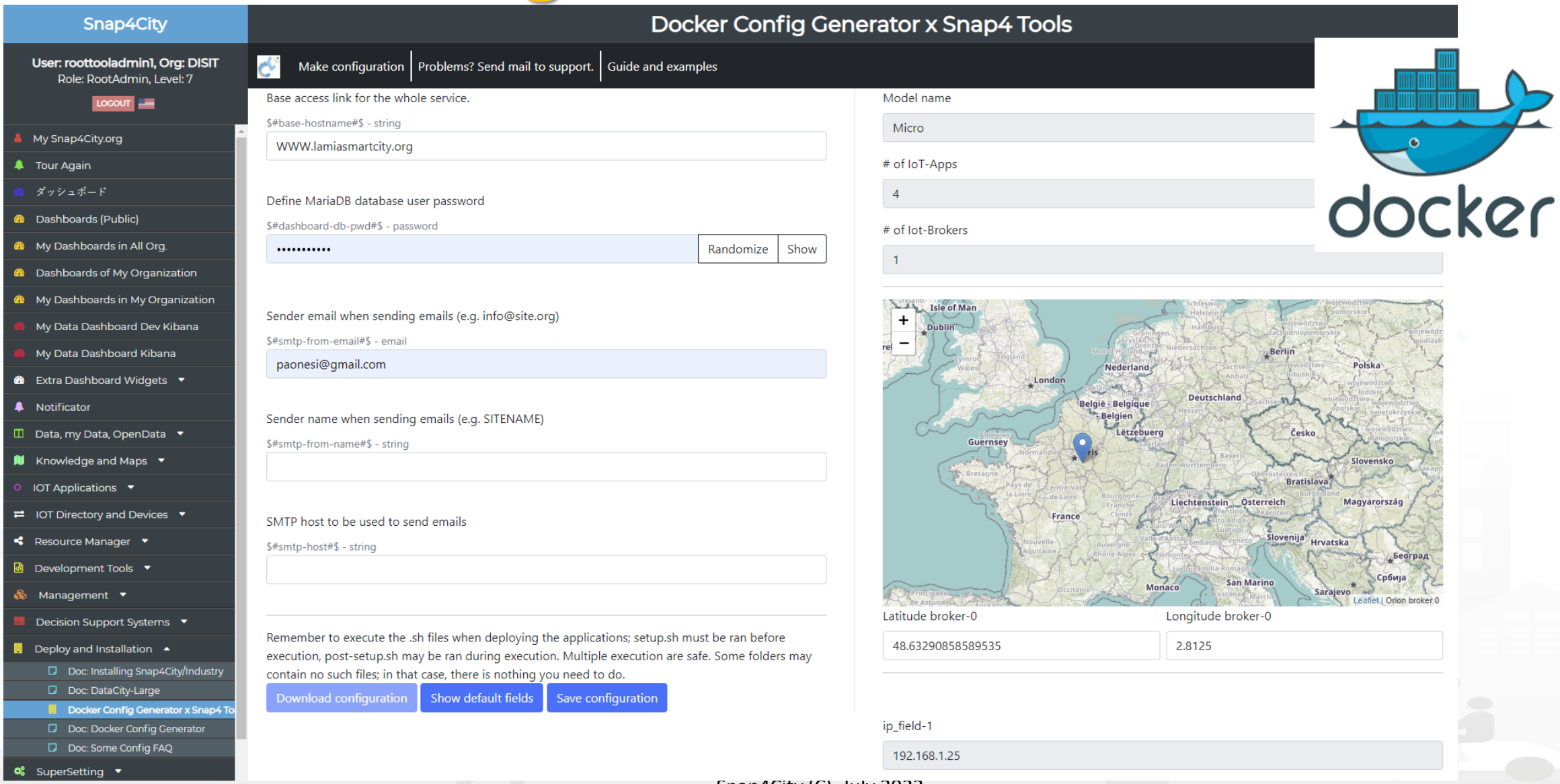
Installations, different models a TOOL to get them

- Micro X:
  - 1 VM of dockers
- Normal X,Y:
  - 2 VM of dockers
- Small X,Y: scalable
  - 4 VM of dockers
- DataCitySmall X,Y,Z: scalable
  - 6 VM of dockers
- DataCityMid X,Y,Z,T: scalable
  - # VM + X/70 VM + Y/3 VM + Z VM + T VM of dockers
- DataCityLarge: scalable
  - depending on your needs

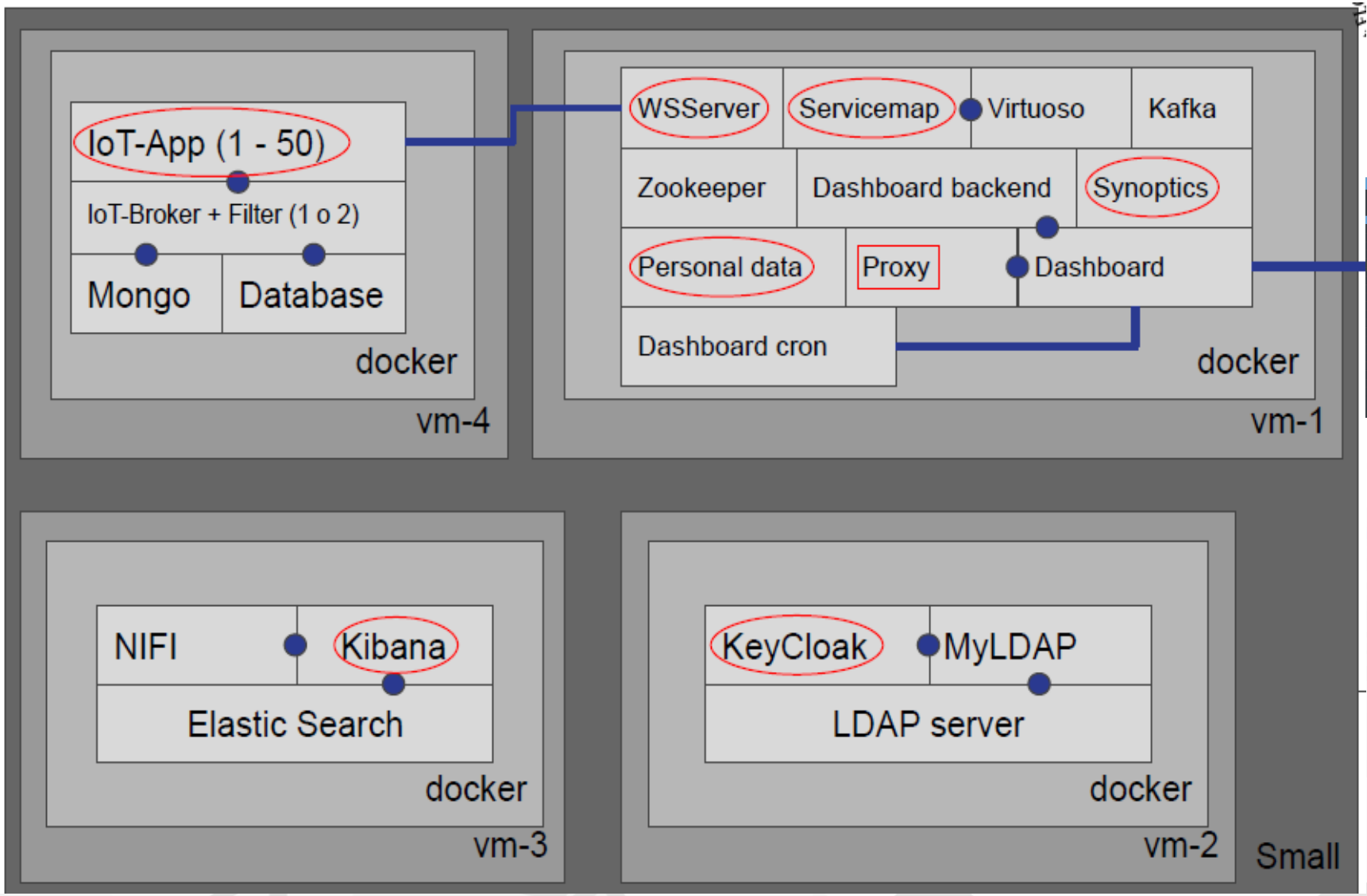




Config Generator Tools

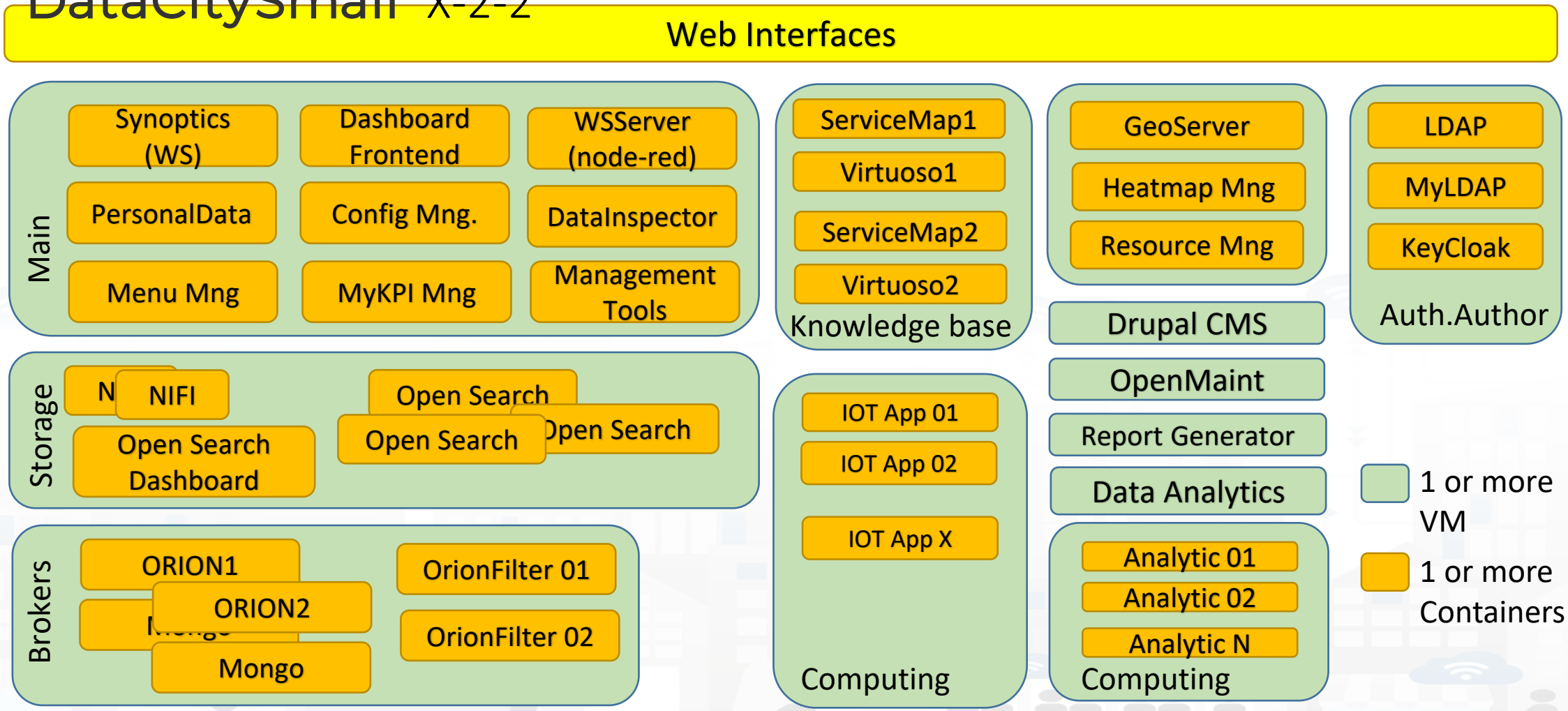


Deployed Small X, Y





DataCitySmall X-2-2



Support

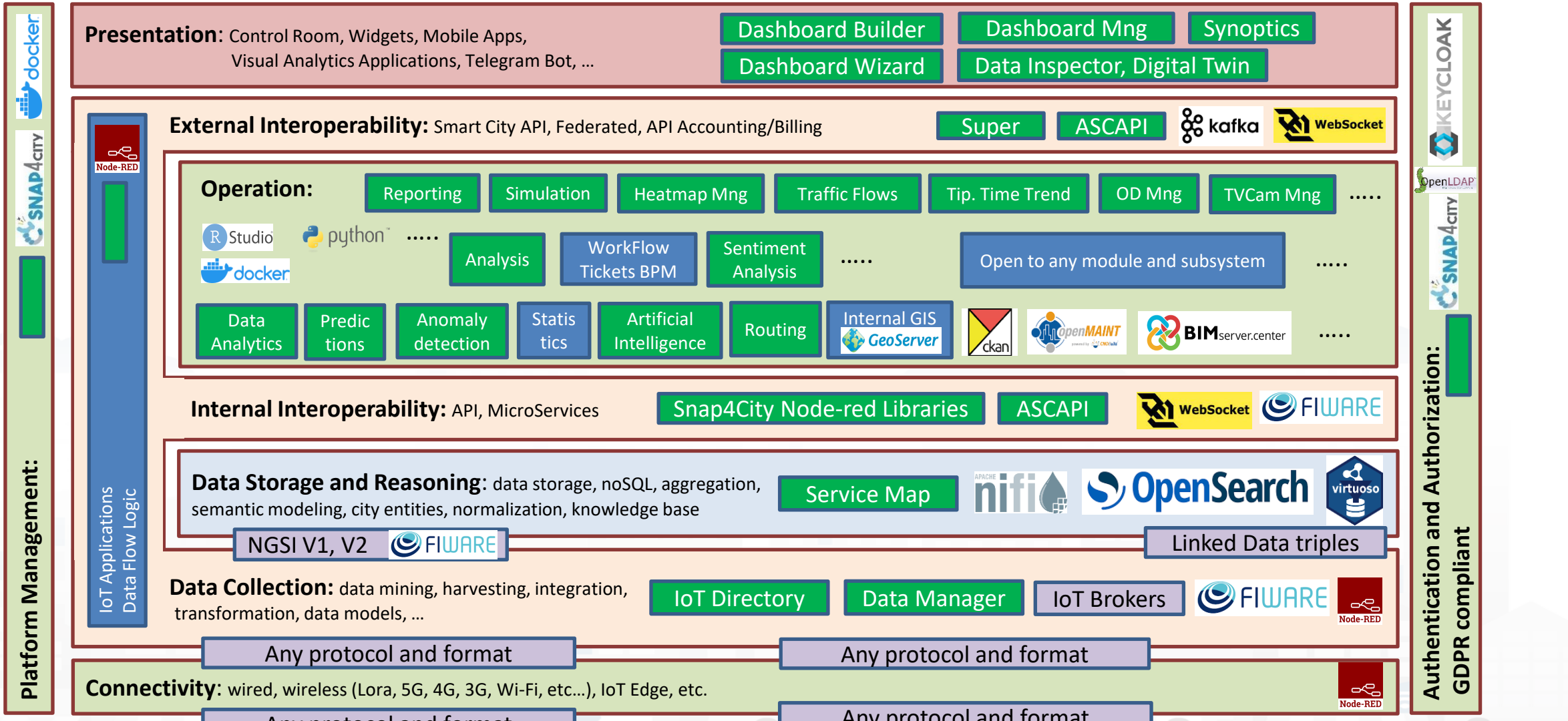
- **SLA:**
  - Including: Direct Contact, POC; Help Desk
    - may be an Organization on our cloud to test new tools, and work with the community, this is typically 5-12Keuro first 2years and 1-2keuro for each successive year depending on the feature and number of users you are placing.
  - Similar to: https://www.snap4city.org/497 with some adaptation on the basis of your deploy and critical conditions, if any
    - Updates, help desk, etc.
- **Our support can be valued on:**
  - The basis of the complexity of your solution: 10% of the cost
    - Or
  - Block of: 16 hours, for 3000 euro / 50 hours, for 6000 euro
    - larger packages can be negotiated
- **Support can be provided by:** Snap4, DISIT Lab, and other companies
- **Customizations can be assessed separately**

Costs

- **The solution is 100% open source**
  - Licensing cost is 0 (zero) euro
- **Recurrent costs are**
  - **HighCharts**
    - Proprietary for commercial, Free of use for non-profit organizations.
    - Perpetual licence is about 5350Euro for 10 developer, then 171 euro for each developer for the successive hears.
  - **Eventual SLA with us for**
    - Corrective maintenance
    - Updates when performed by US

UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB | SNAP4CITY | legenda

SNAP4CITY | KM 4 CITY



DCL: DataCity-Large (2020 edition)

Opt. Services
- Chat Manager
- Routing Server
- Engager Server
- …… Server
- ……. Server

External Services
Energy, Mobility, GIS, Waste, …
Digital Signage, Security, Environment, Weather

Servers
- R Studio Server
- Python Server
- OpenMaint
- CKAN DataGate

MCLSCont
IOT Application, Data Analytic

IOTOBSFs
FIWARE
- IOT Broker
- IOT Orion Broker
- IOT Context Broker
- ProxyFilter Security

IOTDSES
Balancer
APACHE nifi

ESSTORE
kibana
elasticsearch

Other Brokers
Other Brokers

FIWARE
- IOT ORION Broker
- Quantum Leap

SSM2ORION

Snap4CityMAIN
Dashboard Builder, Wizard, Widgets, IOT App1 Notificator, WS Server, Data Inspector, User Stats, ExternalSrv, Resource Manager, MicroApps, Authorization/Authentic, MyKPI, MyPOI, Synoptic, IOT Directory

SuperServiceMap
SuperServiceMap, ASCAPI, KB/ServiceMap, LOG/FLINT, Virtuoso
KBSSM

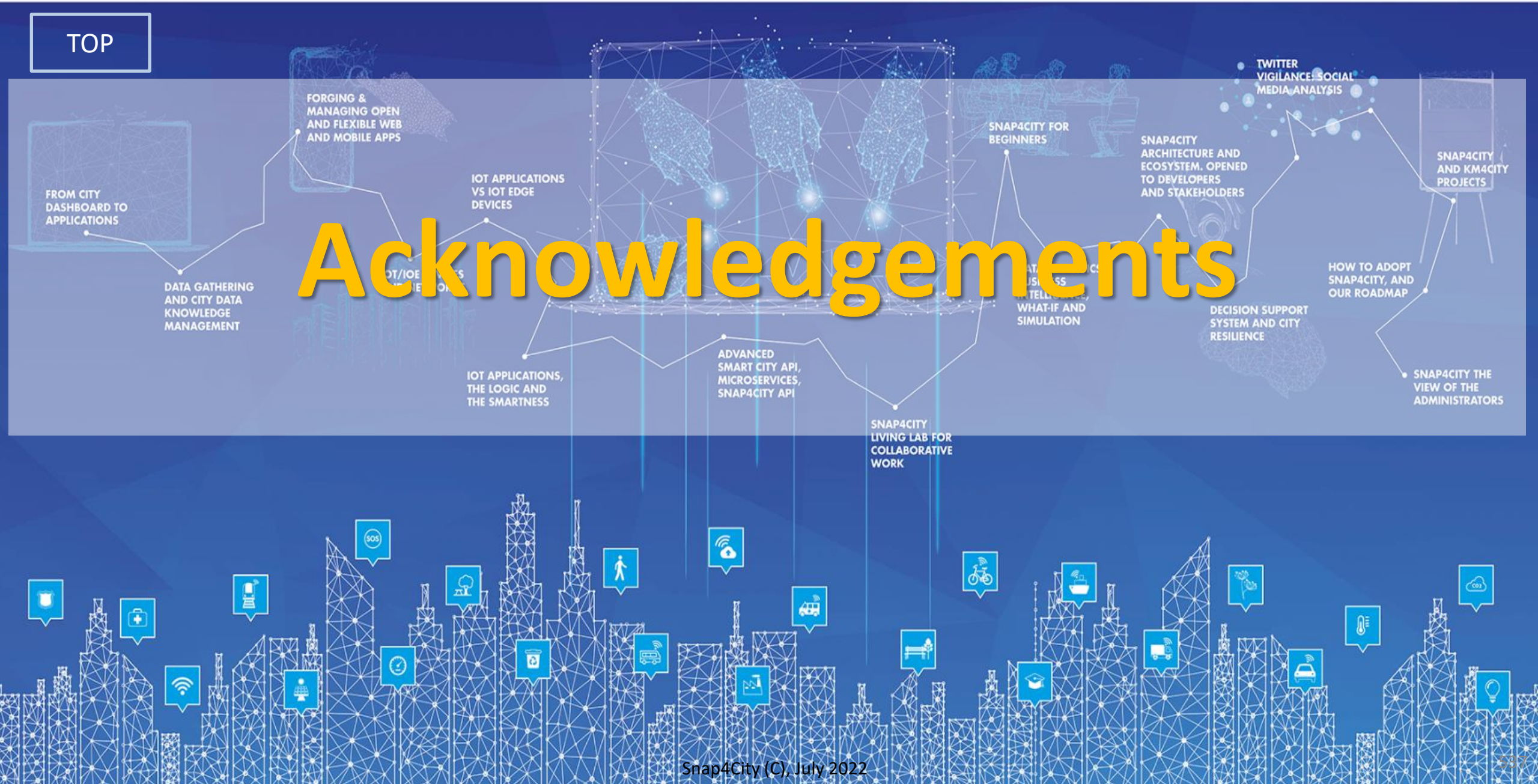
HeatMap Server
Manager [GeoServer]

Living Lab support
Drupal, CRM

Balancers



TOP



Acknowledgements

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
- LOD

- Twitter Vigilance
- Social Media Analytics, Sentiment Analysis

Km4City 1.4

2015
Km4City 1.5

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

ckan, resolute, H2020 (2015-18)

2016
(2016-21) H2020 REPLICATE

Km4City 1.6.4

- Smart Energy
- Sustainable Mobility
- Control Room
- Dashboard

Km4City 1.6.2

Sii-Mobility (2016-21) MIUR
SII-MOBILITY SCN

- Infomobility
- Mobile App
- Routing
- Multimodality

FIWARE

Km4City 1.5

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

2017
Sii-Mobility

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

E015 digital ecosystem (Powered by EXPO MILANO 2015)

(2016-19) MIUR
GHOST SIR

- Sardinia Region Smart City Strategies and plan

GREEN IMPACT C.A.P.A.C.I.T.Y.
GREEN IMPACT
POR FESR 2014-2020

- Industry 4.0
- Critical Plant
- Monitoring

- IOT/IOE, IOT App
- Living Lab
- Maker Support
- IOT Edge
- Smart City IOT
- GDPR,
- Privacy & Security

life weee (2017-20)

- Smart Waste

2018
MOSAiC Mobility 4.0 for SmArt (i) City (POR CreO, Regione Toscana)
(2018-20)

- Mobility Demand / Offer Analytics and Strategy

Sii-Mobility

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

IOT/IOE

Km4City 1.6.6

Node-RED

SNAP4CITY SELECT for Cities H2020 (2017-19)

2019
5G (2018-21)

- 5G tech
- Energy
- Industry 4.0
- Synoptics

TRAFAIR
CEF (2018-21)

- Traffic and Mobility Impact on Pollution
- NOX predictions

EUROPEAN OPEN SCIENCE CLOUD

SIRIUS

LAID Smart Bed (POR CreO, Regione Toscana)

- Smart Health

GREEN FIELD PEAS Soda4.0 Optimization and Automated Decision System 4.0 (POR CreO, Regione Toscana)

- Industry 4.0

bee smart city

- Smart Lonato

Reverberi Enetec Gruppo MPES

SNAP4CITY KM4CITY

Winner of Select4Cities PCP



SNAP4CITY roadmap

SODA

2020

JRC EUROPEAN COMMISSION

Interreg Mediterranean HERIT-DATA
- Smart Tourism
- 6 Pilots
- Data Analytics
- Extended platform

Interreg MARITTIMO-IT FR-MARITIME MOBI MART
- Smart Mobility
- PISA, PUMS
- Living lab

2021

JRC EUROPEAN COMMISSION

PC4City (2020-21)
Monitoring Terrain

Winner of Open Data Challenge of enel x

CAPELON
- Smart Light
- Sweden

Km4City 1.6.7

enel x
Contract

Smart Ambulance (2021-22)

Enterprise (2021-22)
Industry 4.0

Almafluida
Industry 4.0
(2021-22)

AMPERE (2021-22)
Industry 4.0

SYN-RG-AI
SmartCity

Smartea

IMPETUS
Security and Risk

ITALFERR GRUPPO FERROVIE DELLO STATO ITALIANE
Smart City

ASYMMETRICA URBAN TECHNOLOGY
Smart City

2022

AXIS COMMUNICATIONS
SmartCity

uni.systems
SmartCity

GRUPPO PRETTO
Industry 4.0

enel x
Contract

Filippi
Contract

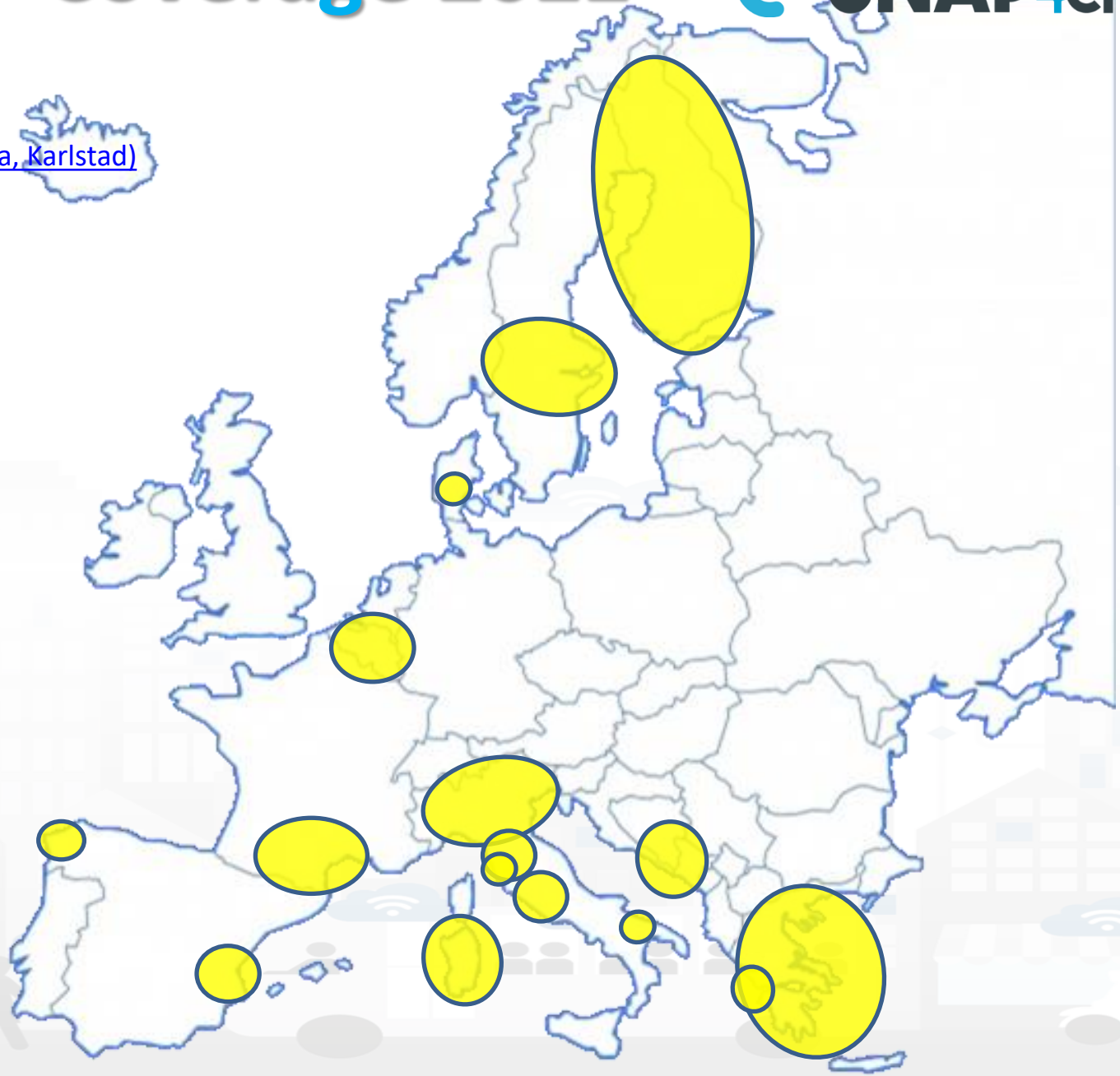
ART-ER ATTRATTIVITÀ RICERCA TERRITORIO
Contract

Some agreements

Coverage 2022

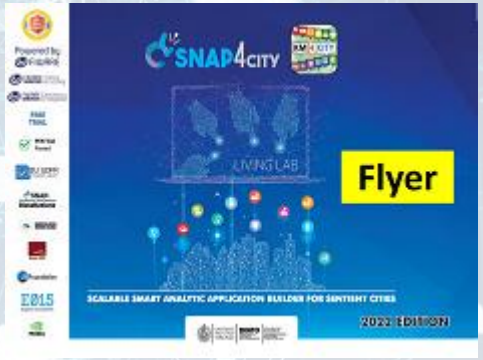
Main Organizations/areas

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



2022 booklets

- Snap4City



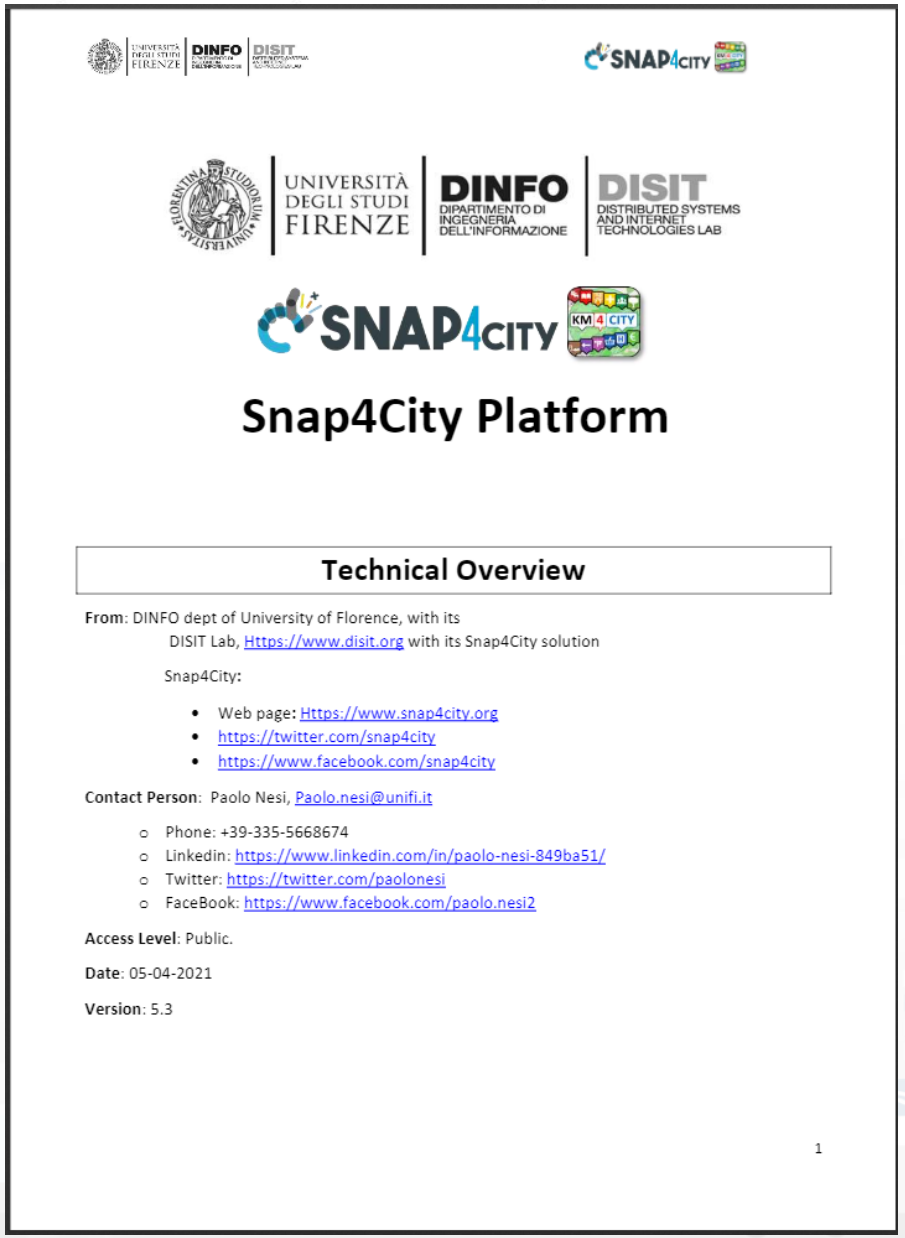
https://www.snap4city.org/download/video/DPL_SNAP4CITY_2022-v02.pdf

- Snap4Industry



https://www.snap4city.org/download/video/DPL_SNAP4INDUSTRY_2022-v03.pdf

Overview



Snap4City Platform

Technical Overview

From: DINFO dept of University of Florence, with its
DISIT Lab, Https://www.disit.org with its Snap4City solution

Snap4City:

- Web page: Https://www.snap4city.org
- https://twitter.com/snap4city
- https://www.facebook.com/snap4city

Contact Person: Paolo Nesi, Paolo.nesi@unifi.it

- Phone: +39-335-5668674
- Linkedin: https://www.linkedin.com/in/paolo-nesi-849ba51/
- Twitter: https://twitter.com/paolonesi
- FaceBook: https://www.facebook.com/paolo.nesi2

Access Level: Public.

Date: 05-04-2021

Version: 5.3

1

- https://www.snap4city.org/drupal/sites/default/files/files/Snap4City-PlatformOverview.pdf

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Main running instances (01/22)

- Sii-Mobility → mobility and transport, sustainability
- REPLICATE → ICT, smart City Control room, Energy, IOT
- RESOLUTE → Resilience, ICT, Big Data
- GHOST → Strategies, smart city
- TRAFAIR → Environment & transport
- MOSAIC → mobility and transport
- WEEE Life → Smart waste, environment
- Smart Garda Lake → Castelnuovo del Garda, SMARTEA
- 5G → Industry 4.0 vs SmartCity
- Green Impact → Industry 4.0, Chemical Plant, control and plan
- SmartBed (Laid) → smart health
- Green Field Peas (Soda) → Industry 4.0, Chemical plant
- MobiMart and PISA Agreement → data aggregation, mobility and transport, Living Lab
- Lonato del Garda → smart parking, environment
- Herit Data → tourism, culture and management
- ISPRA JRC → site management and services
- Capelon (Sweden) → smart light solutions
- PC4City → land slide monitoring and predictions
- Italmatic → industry 4.0 production control

Acknowledgements

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TOP

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