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

December 2022
Overview Platform

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

SMARTCITY EXPO WORLD CONGRESS
15 - 17 NOV 2022
BARCELONA & ONLINE
Visit our stand:
Pavillon 2, stand B86

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

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

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

SNAP4CITY

Powered by KM4CITY

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

https://www.Snap4City.org

100% OPEN SOURCE

December 2022
Overview Platform

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

BY NC ND
SOME RIGHTS RESERVED

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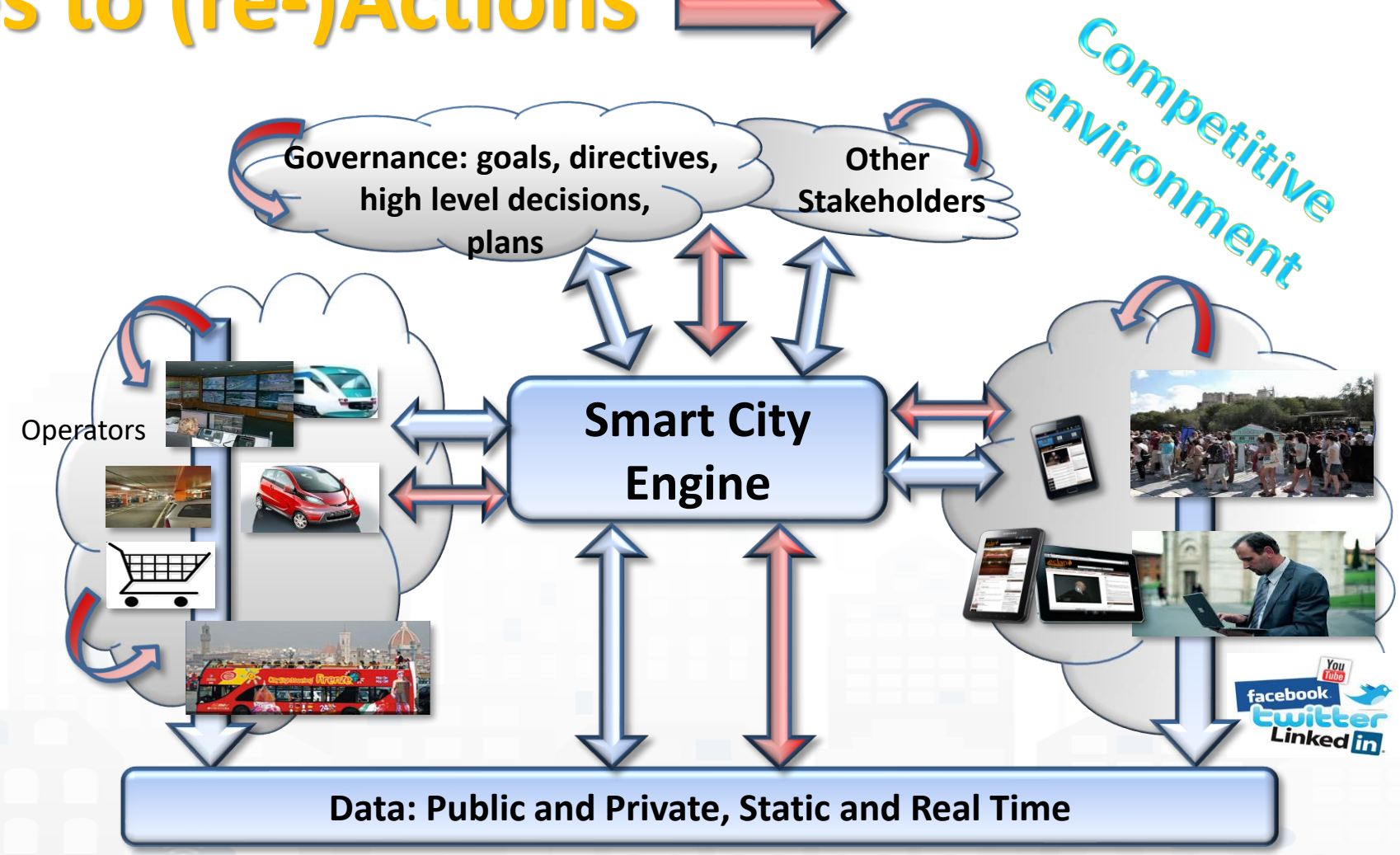
SNAP4CITY | KM4CITY

SUSTAINABLE DEVELOPMENT GOALS

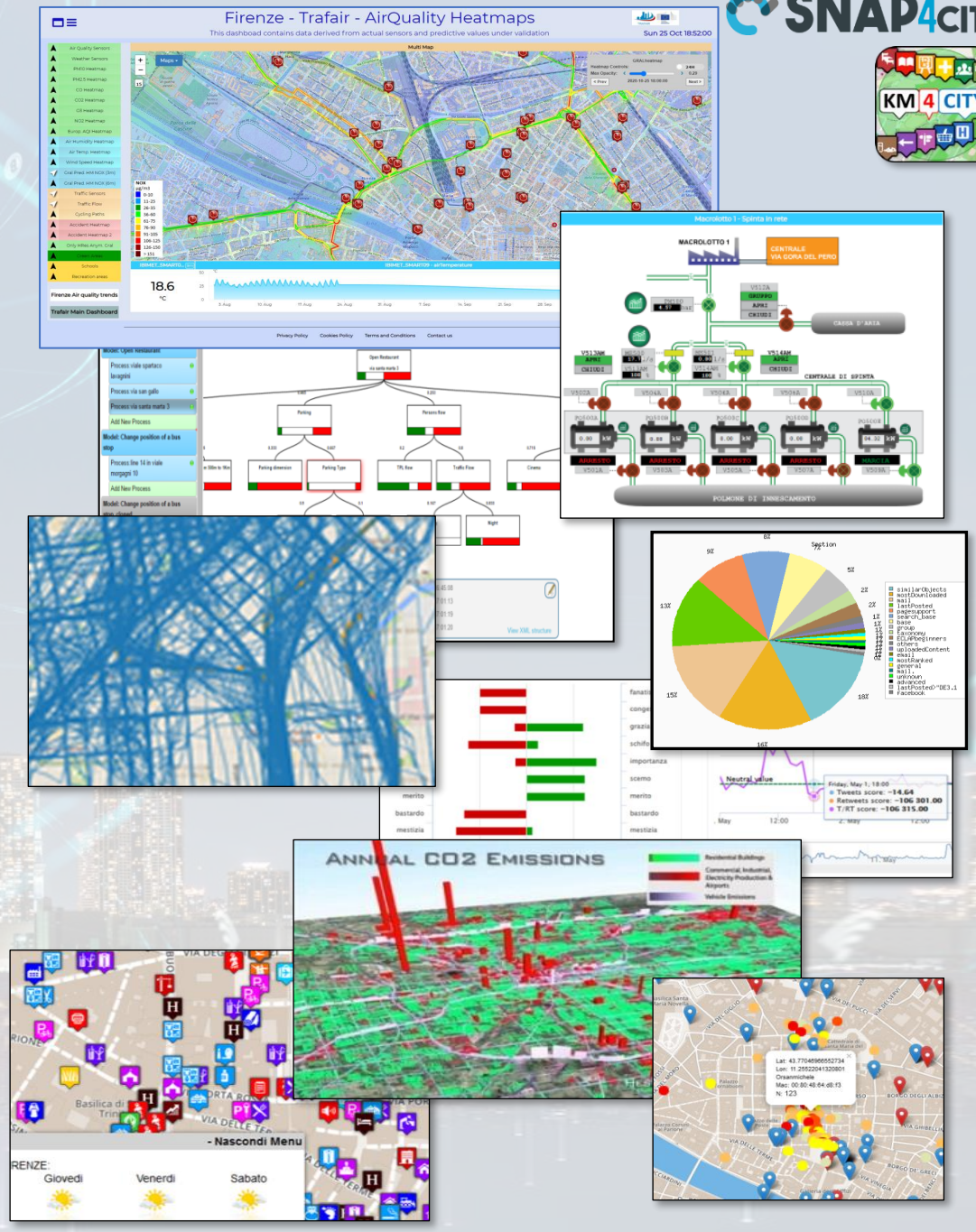
From Strategies to (re-)Actions

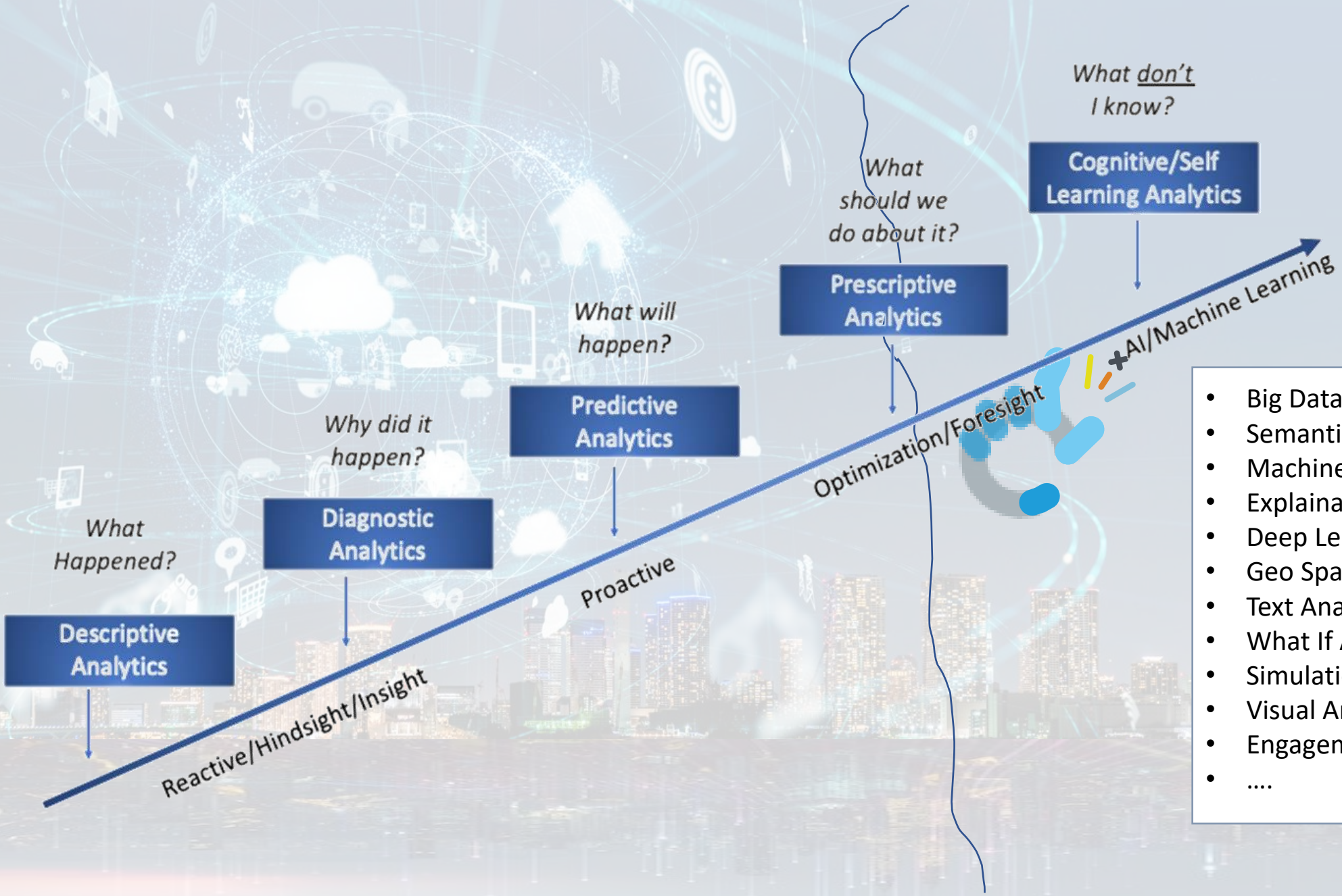
- Analyze
- Alerting, Early Warning
- Support Decision makers
- Plans
- Prescriptions
- Inform
- Suggest
- Engage
- Research



Data Driven Decision Support

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



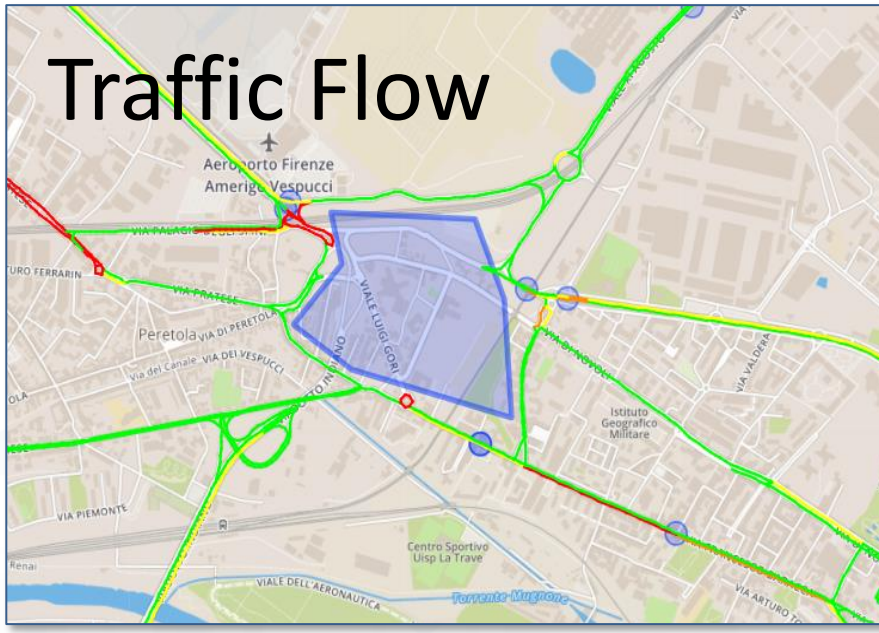


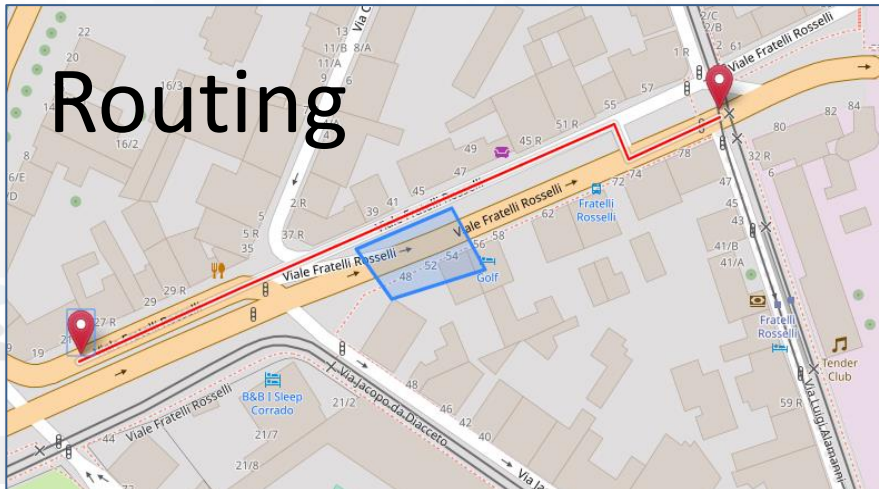
Sentient and active processes

- 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

https://www.Snap4City.org

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SNAP4CITY

Node-RED

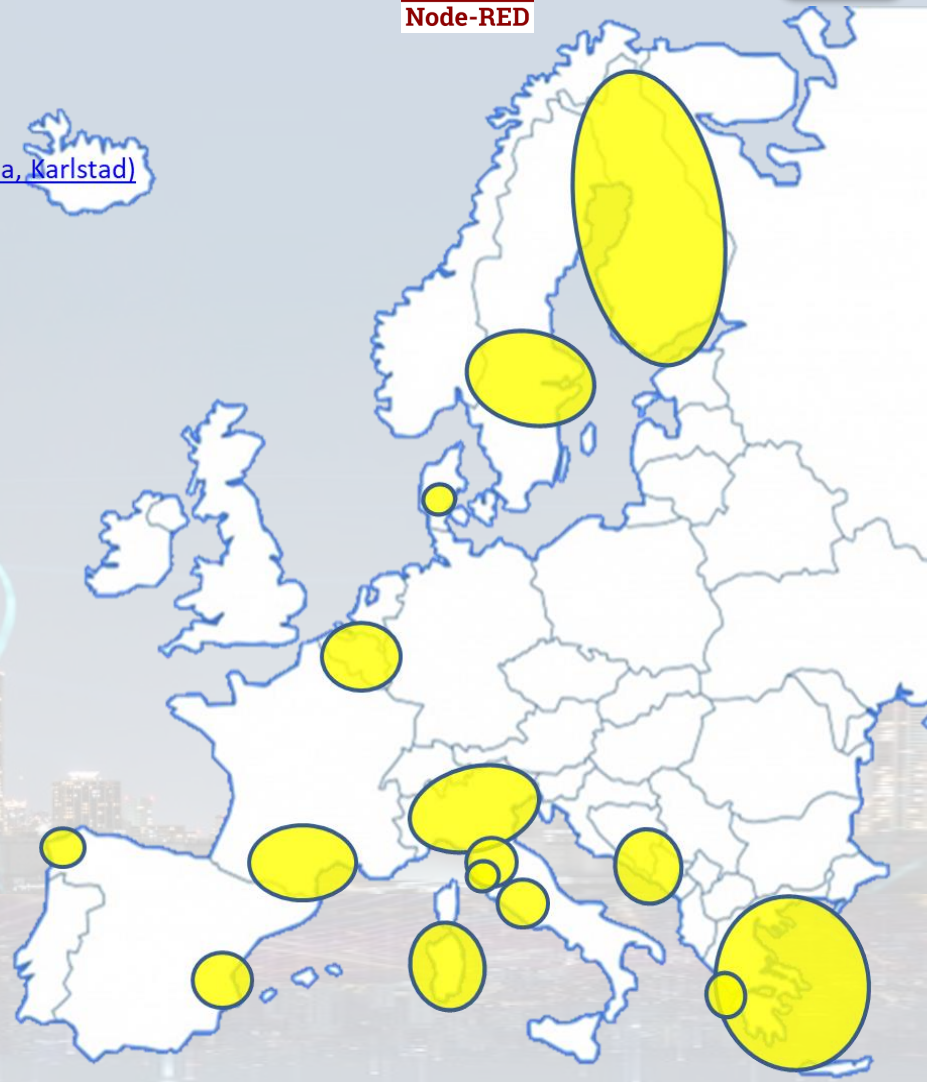
FIWARE

KM4CITY

- 8 running installations in Europe
  - Toscana, Pisa, Sweden, ISPRA, Snap4.eu,
  - Altair, Italmatic, Denmark, ….
- 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)

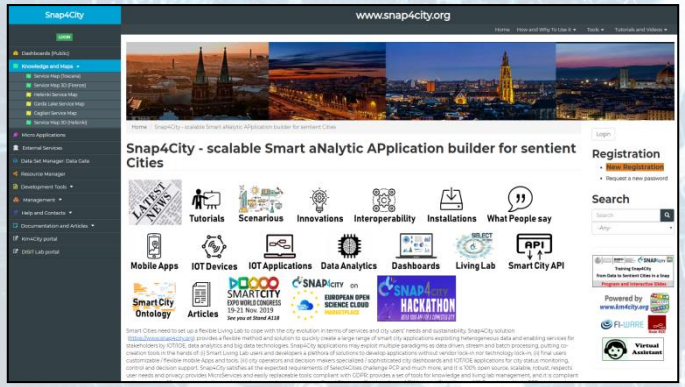


- **Trials in Israel, Colombia, Brasile, Australia, India, Romania, etc.**

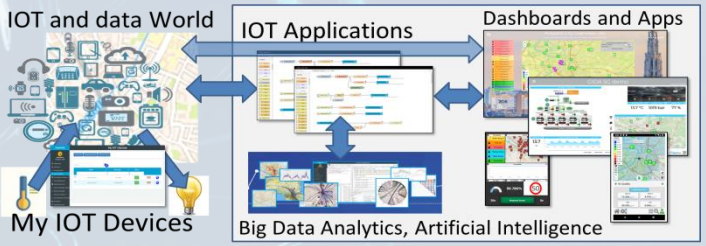
EUROPEAN OPEN SCIENCE CLOUD

How to adopt Snap4City

Https://www.snap4city.org



On your premise



Smart City as a Service

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

Download and deploy

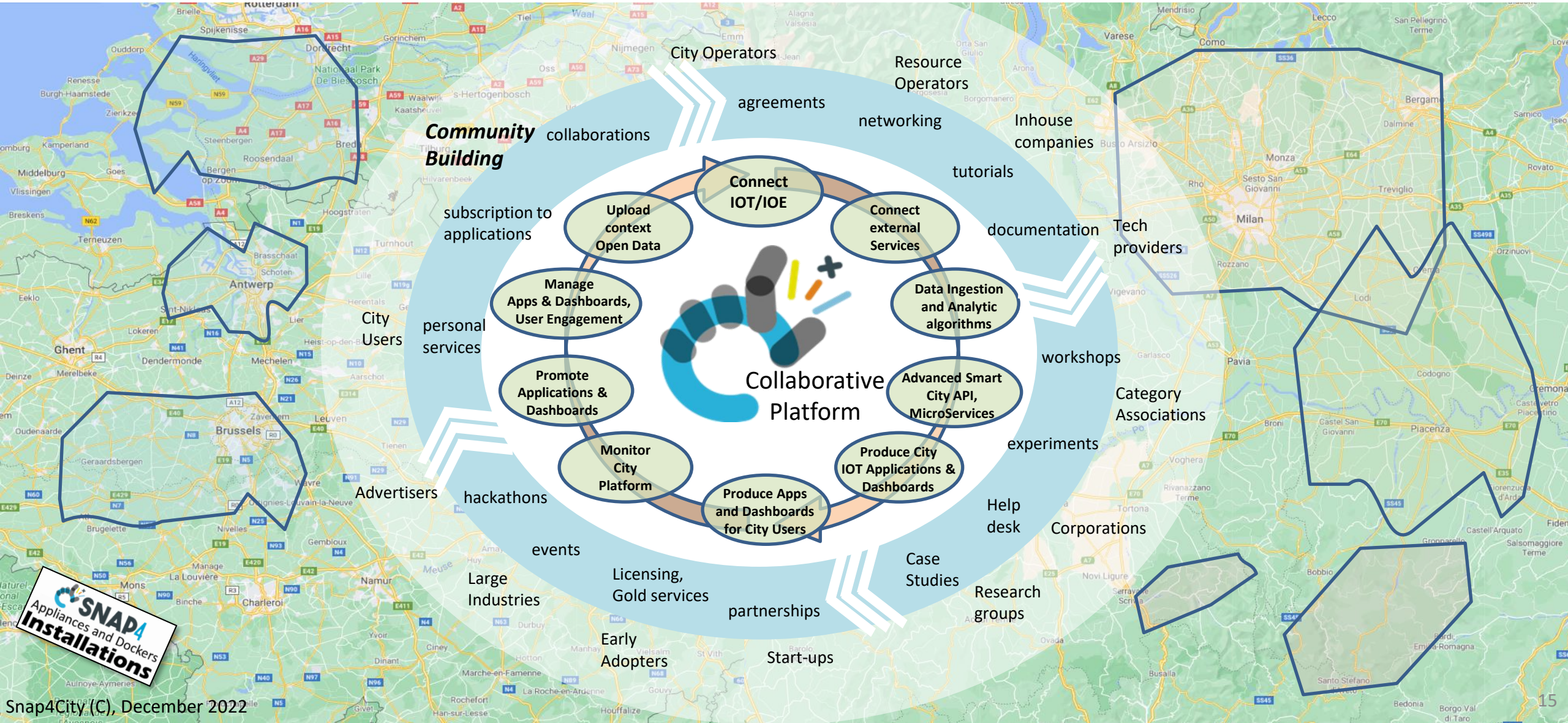
Installation on your premise

- **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:

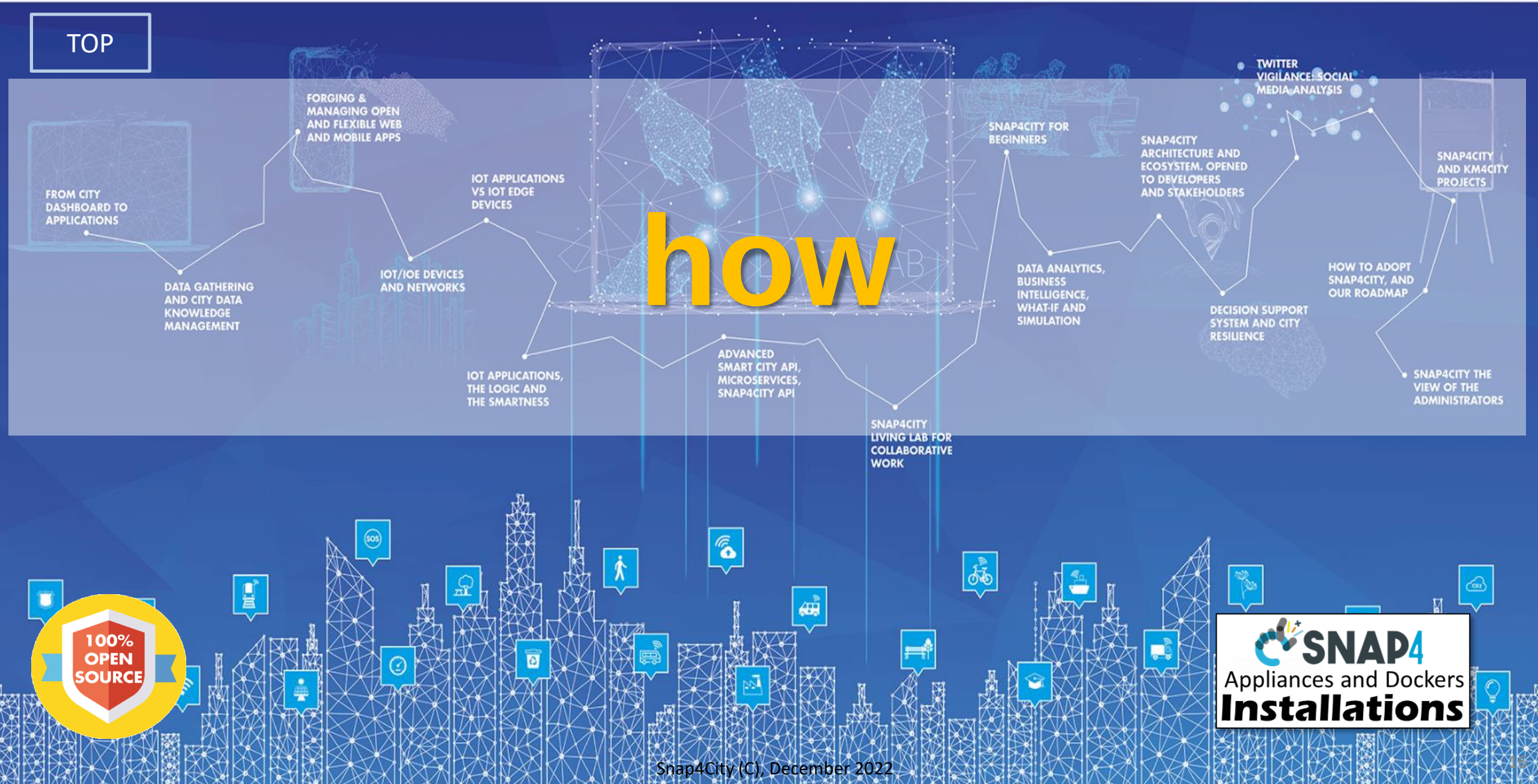
- Start on Cloud as Smart City as a Service
  - Migrate on premise on the fly
- Start on Cloud into a sand box
  - Pass to install on premise what you need

One Snap4City Platform may serve Multiple Cities

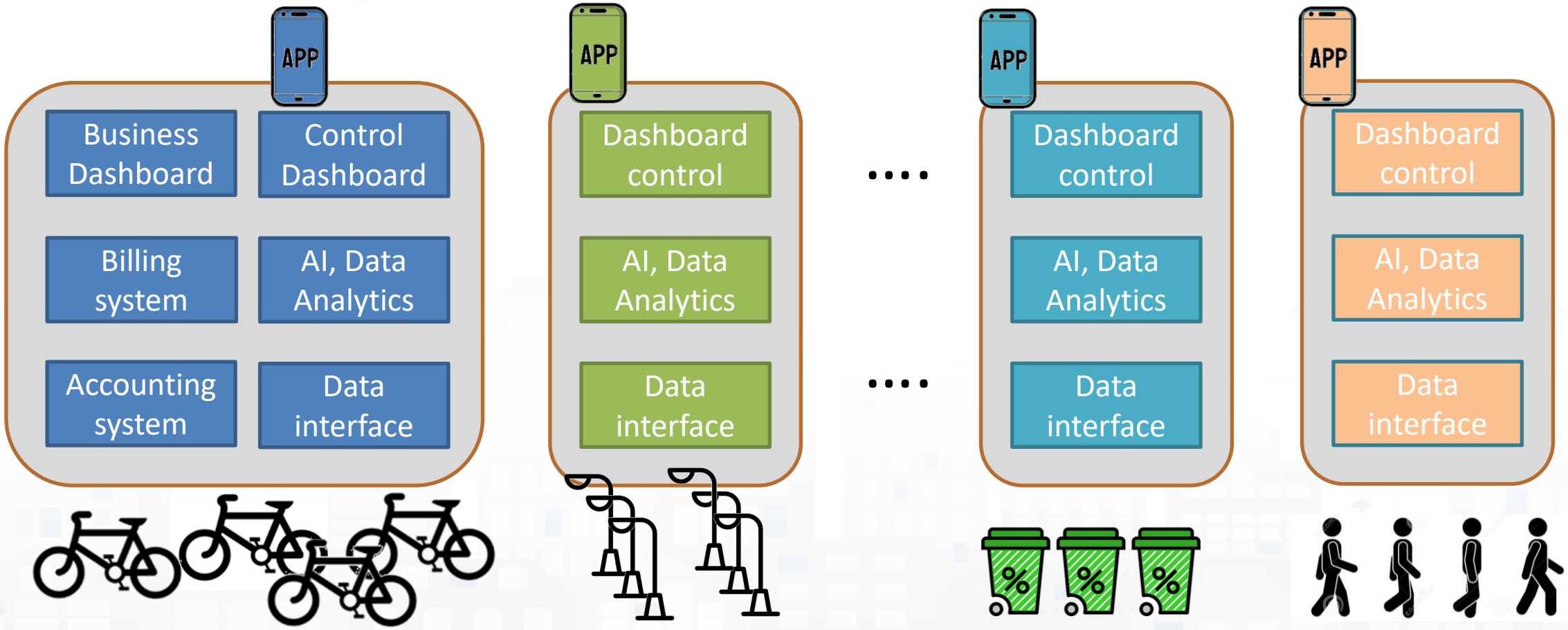


SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

TOP



Avoiding to have a collection of verticals



Simplifying the development and integration of verticals

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SNAP4 Appliances and Dockers Installations

EUROPEAN OPEN SCIENCE CLOUD

Node-RED

JS Foundation

E015 digital ecosystem

NVIDIA

SNAP4CITY KM4CITY

SMART SOLUTIONS AND DECISION SUPPORT SYSTEMS

CONTROL ROOMS - DECISION SUPPORT SYSTEMS - WHAT-IF ANALYSIS - BUSINESS INTELLIGENCE - SIMULATIONS - SMART APPLICATIONS

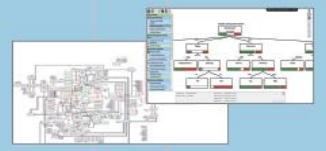
DASHBOARDS - VISUAL ANALYTICS - SYNOPTICS - DIGITAL TWIN - GRAPHICAL WIDGETS - ANALYTICS - GUI CUSTOM STYLES - VISUAL PROGRAMMING

DASHBOARDS, WIDGETS
TEMPLATES

PREDICTION - ANOMALY DETECTION - CLUSTERING - ROUTING - SENTIMENT NLP - TRAFFIC FLOW
PEOPLE FLOWS - SDG - 15 MIN CITY INDEX - KPI - HEATMAPS - ORIGIN DESTINATION - ETC...

API - MICROSERVICES - GIS - BPM
VIDEO - REPORTS - MAPS - 3D ...

ANY: DATA, BROKER, NETWORK AND VERTICAL



EXPERT SYSTEM, KNOWLEDGE BASE
SEMANTIC REASONING
SMART DATA MODEL
IOT DEVICE MODELS, STORAGE

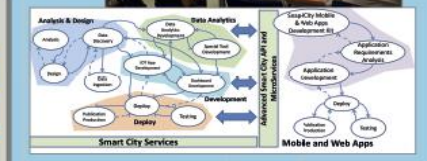
BIG DATA ANALYTICS, ARTIFICIAL INTELLIGENCE
EXPLAINABLE AI, MACHINE LEARNING
OPERATIVE RESEARCH, STATISTICS

VISUAL PROGRAMMING, ADAPTERS
DATA FLOWS, WORKFLOWS
PARALLEL DISTRIBUTED PROCESSING
DATA DRIVEN

Native and External Applications

- Smart Parking
- Smart Light
- Smart Waste
- Smart Energy
- Social Media Analysis

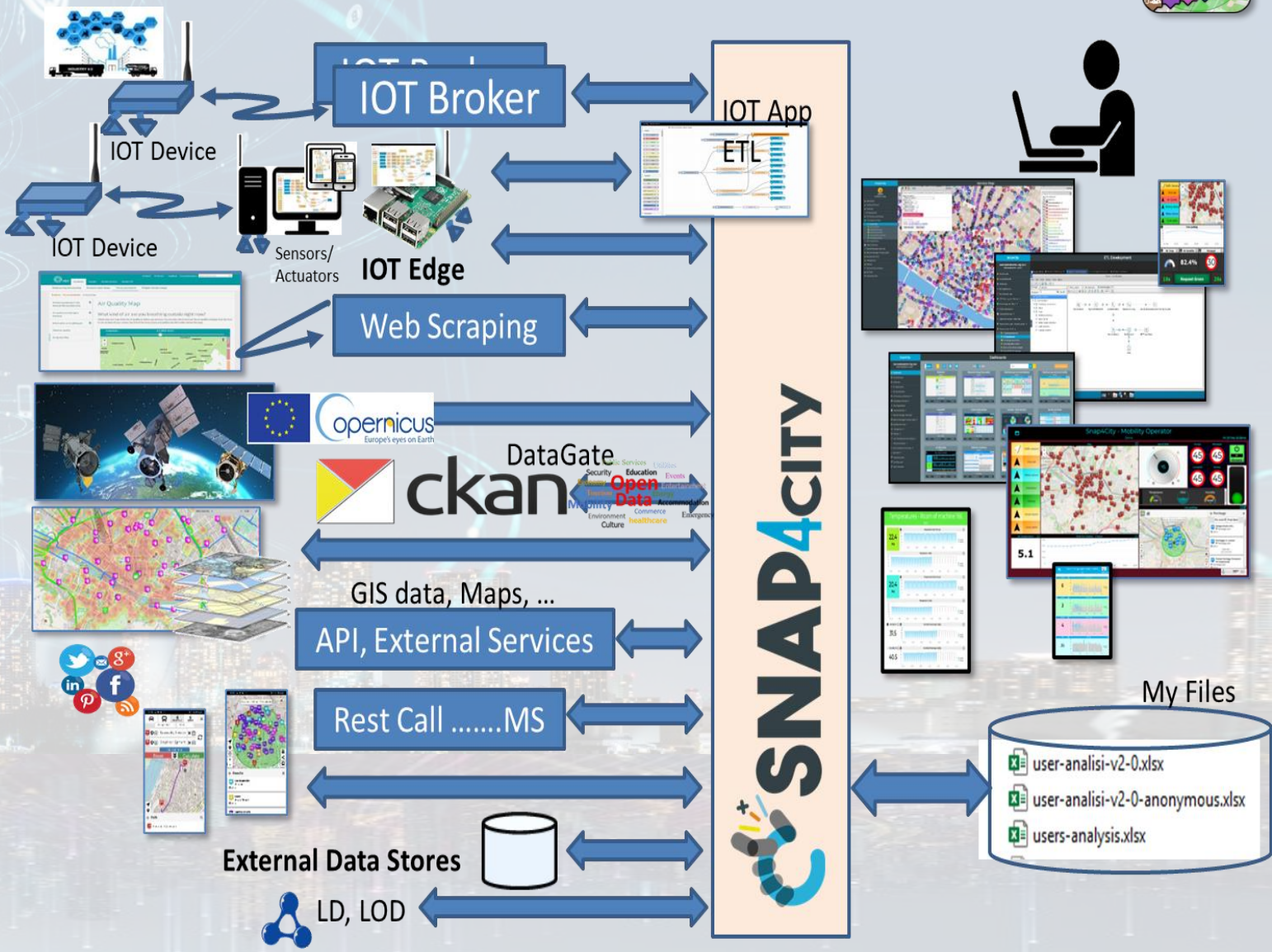
...



METHODOLOGIES
LIVING LABS
COURSES AND COMMUNITY
DEVELOPMENT TOOLS

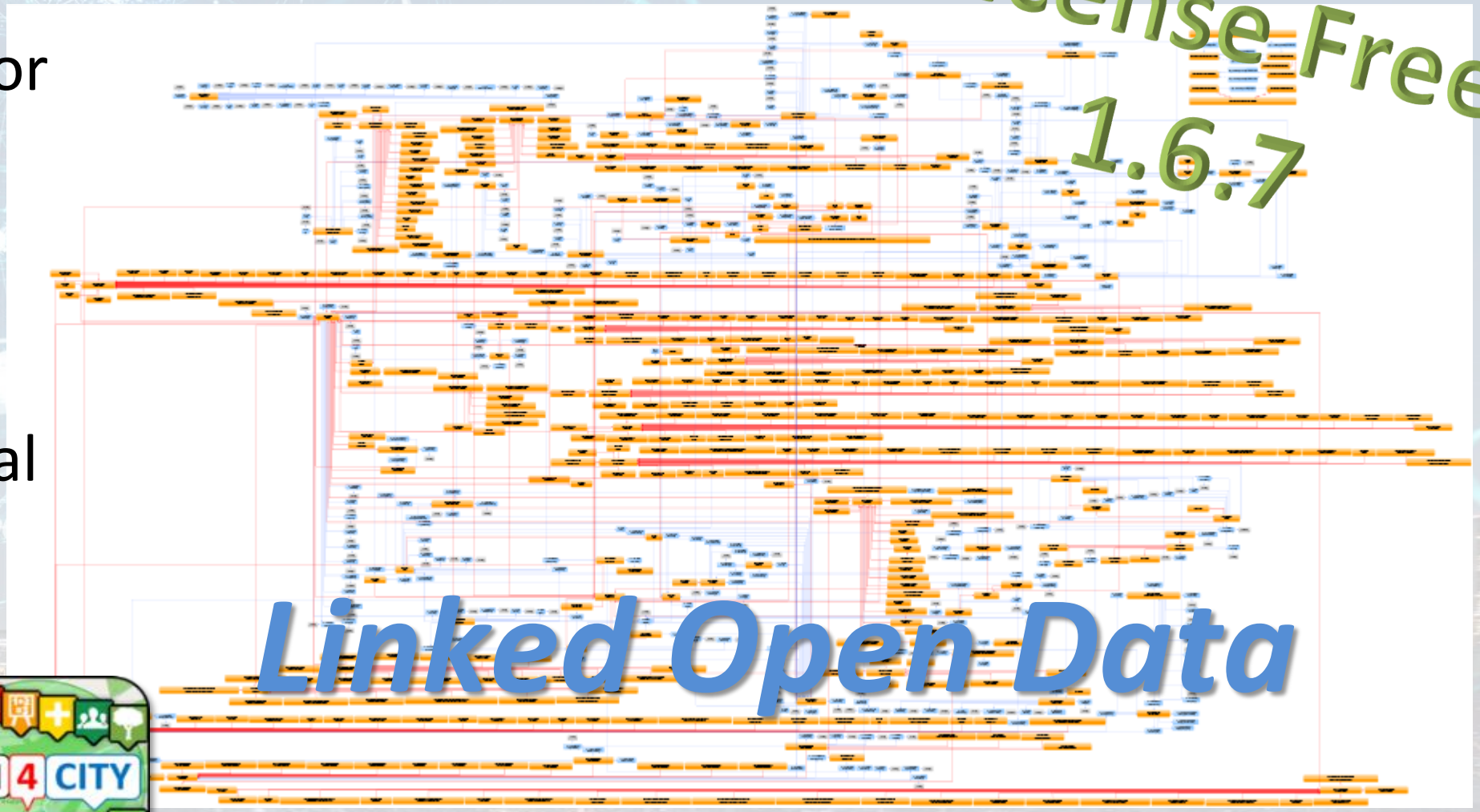
Ingestion, agg. → exploitation

- **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

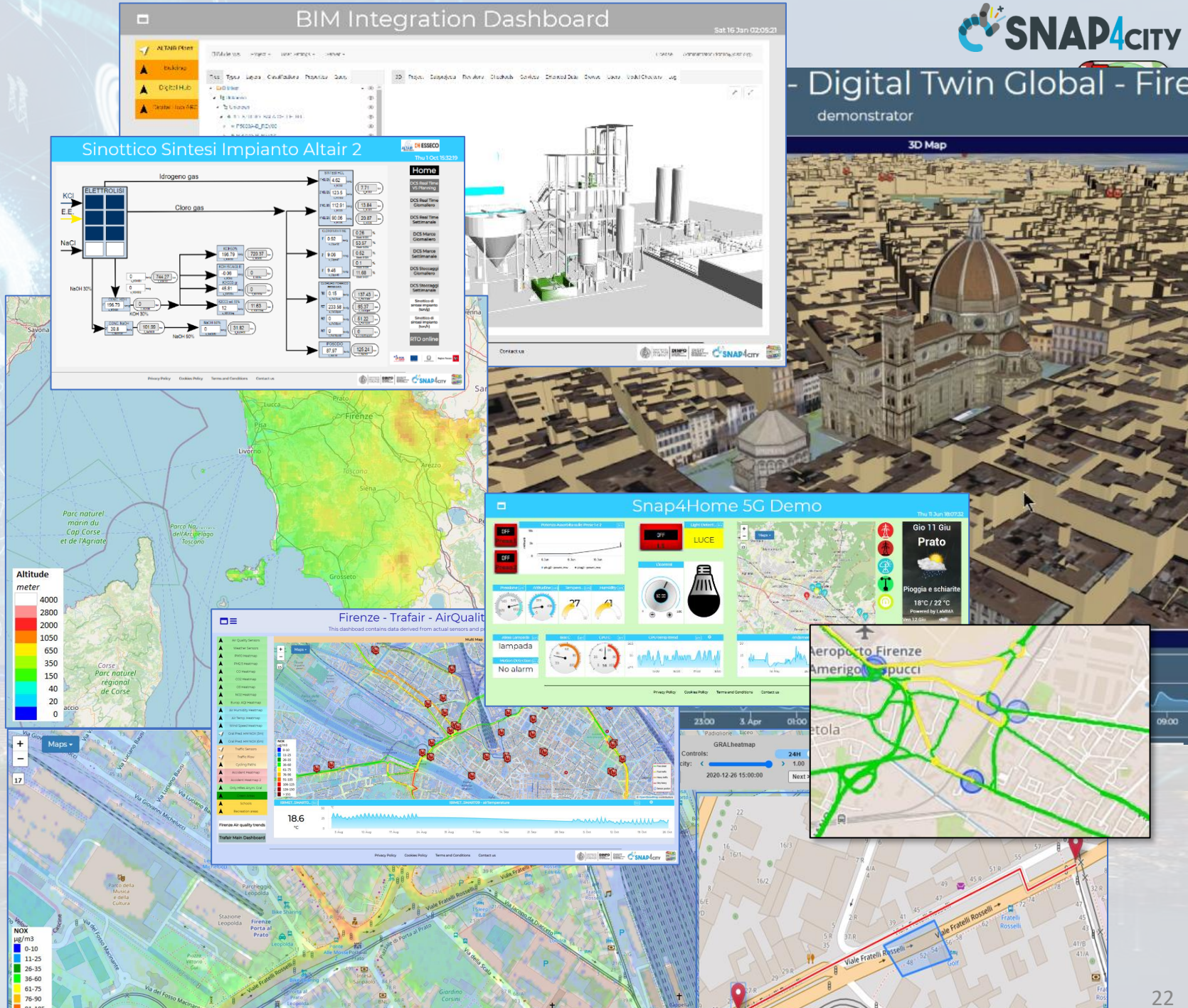
- **via**:
- **Smart City API** for Apps and third party
- **MicroServices** data driven develop via visual language Node-RED



https://www.snap4city.org/19

High Level Types

- POI, IOT Devices, shapes,..
- FIWARE Smart Data Models,
- IoT Device Models
- GIS, maps, orthomaps, WFS/WMS, GeoTiff, calibrated heatmaps, ..
- Satellite data, ..
- traffic flow, typical trends, ..
- trajectories, events, Workflow, ..
- 3D Models, BIM, Digital Twins, ..
- OD Matrices of several kinds, ..
- Dynamic icons/pins, ..
- Synoptics, animations, ..
- KPI, personal KPI,..
- social media data, TV Stream,
- routing, multimodal, constraints, ..
- decision scenarios, ...
- etc.



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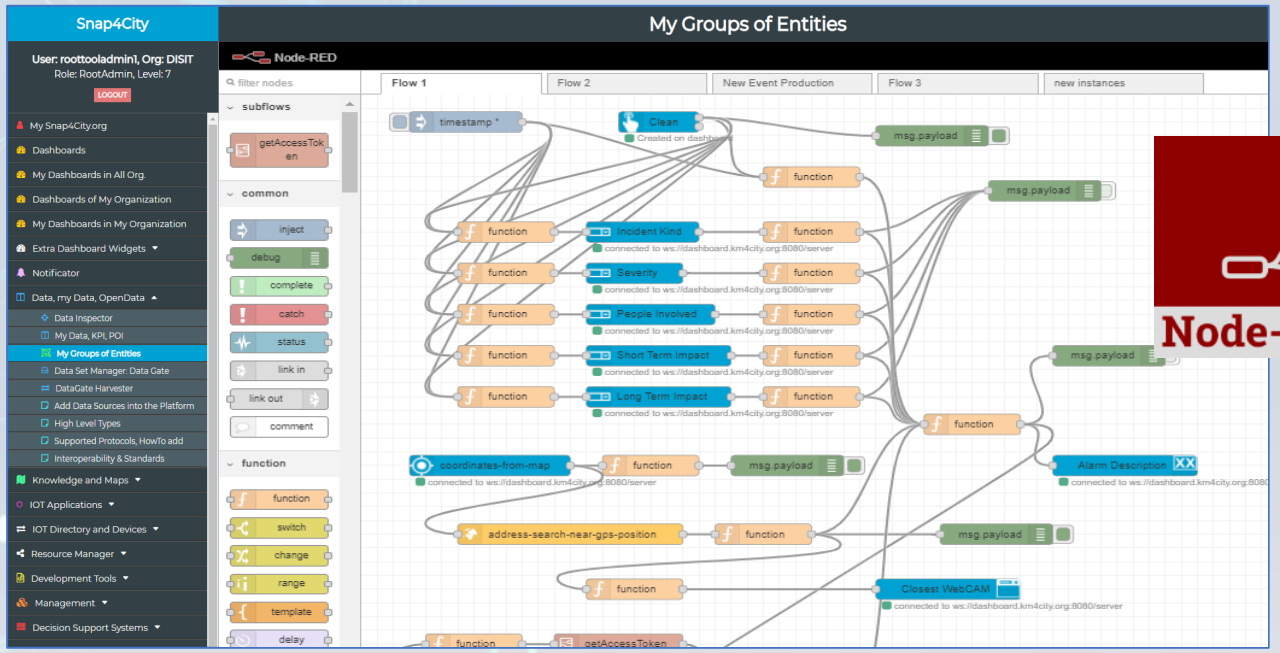
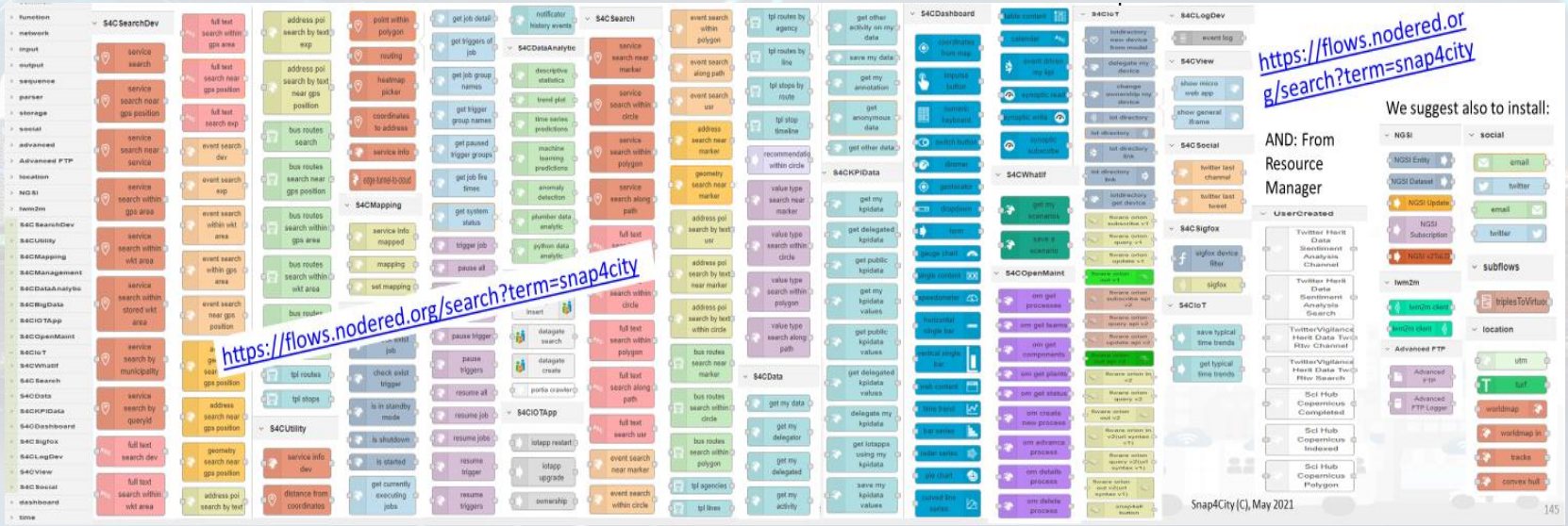
Ingestion, aggreg. → exploitation

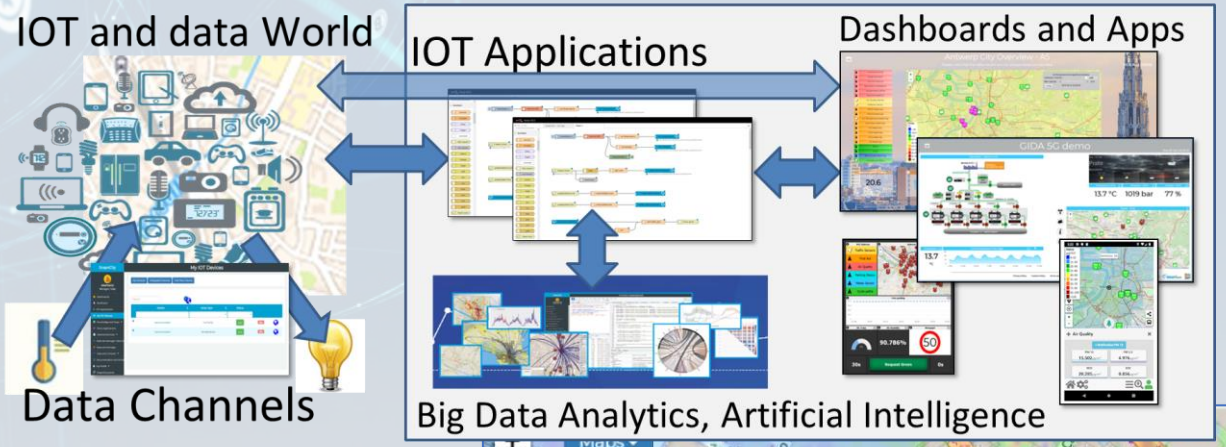
- **IoT App Visual Programming, no coding**
  - **Data transformation**
  - **Integration, Interoperab.**
  - **Scripting Data Analytics**
  - **Data ingestion**
  - **Business logic**
- **Edge and Cloud**
- **MicroServices** data driven develop via visual language Node-RED



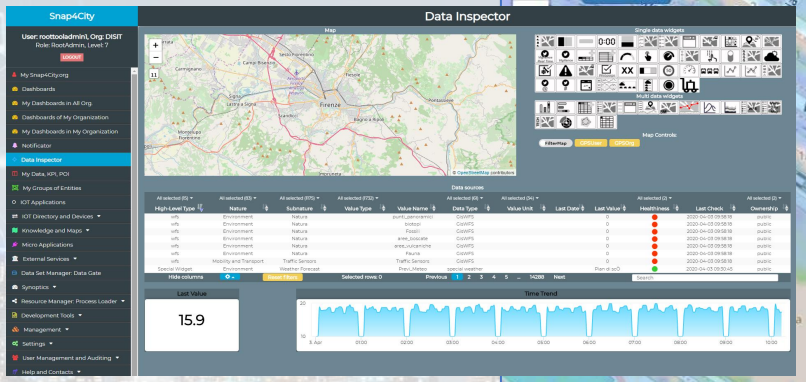


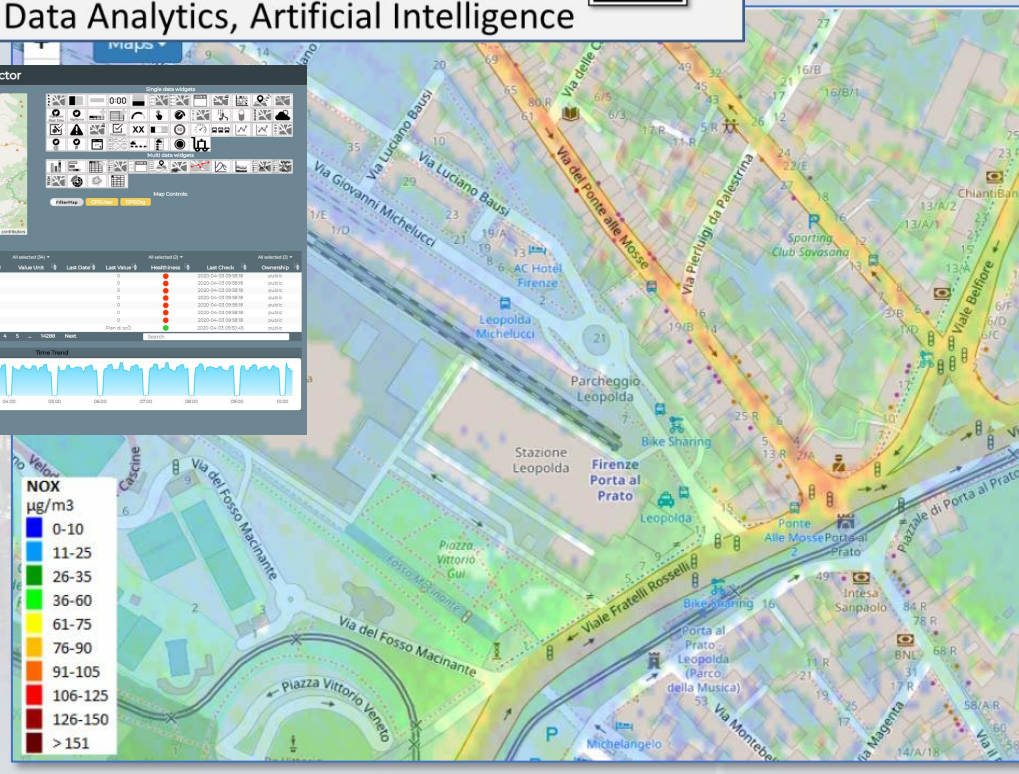
Solutions: reliable, secure and fast to realize

- **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

python jupyter TensorFlow NVIDIA CUDA R Studio

Swagger

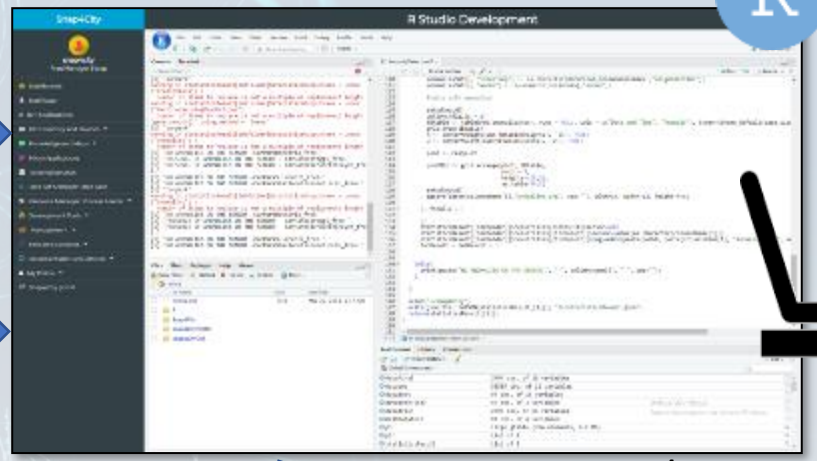
Ontology Schema

LOG.disit.org

Knowledge Base, Km4City

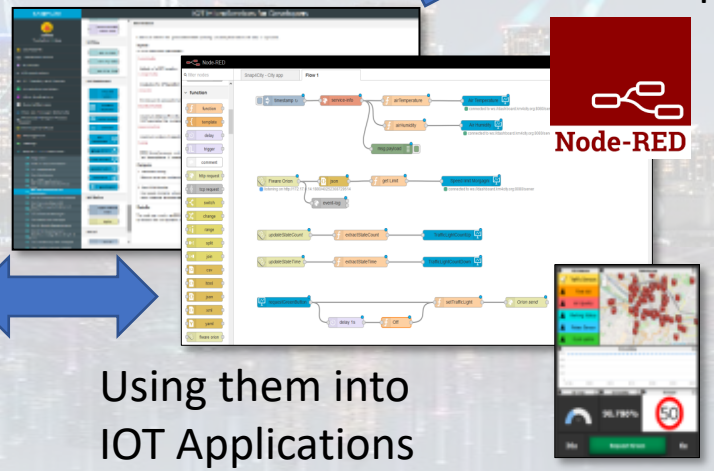
Big Data Store Facility

Smart City API from Knowledge Base and other tools



Creating MicroServices

Saving / Sharing reusing



Node-RED

Using them into IOT Applications

Resource Manager Market Place

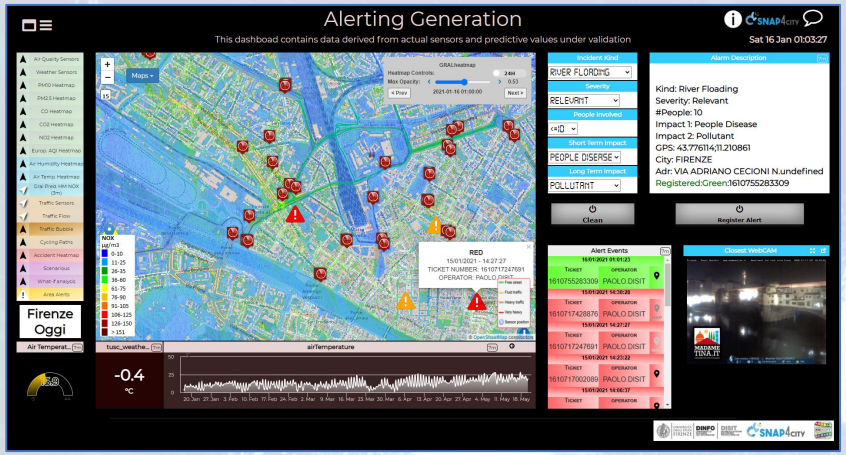
Big Data Analytics + Artificial Intelligence

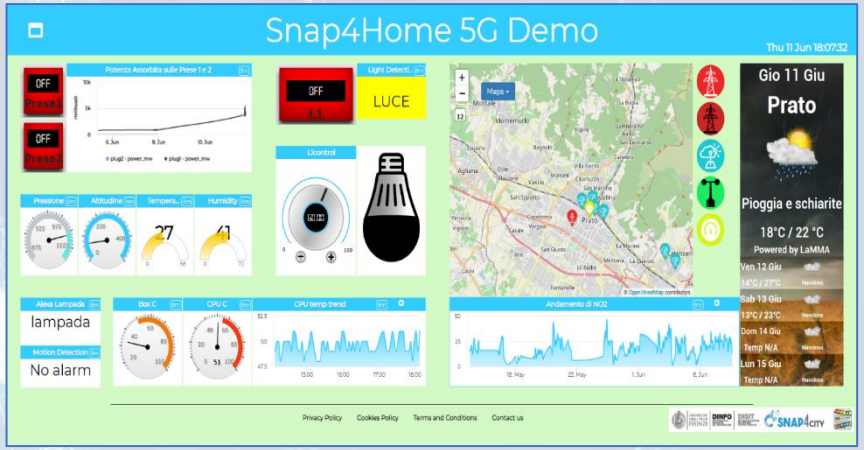
- **Short and Long terms predictive models on:**
  - traffic, parking, people flow, maintenance, land sliding, NO2
- **3D Flow prediction:** Pollutant (NOX, NO2, …)
- **Early warning, City Indexes, etc.**
- **AI & XAI:**
  - RF, XGBoost, BRNN, RNN, SVR, DNN, LSTM, CNN-LSTM, Autoencoders, …
  - Clustering: 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.

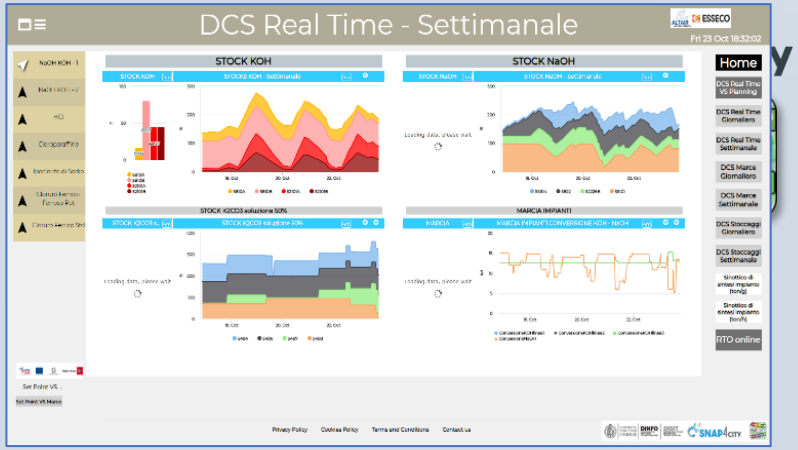
to cope with

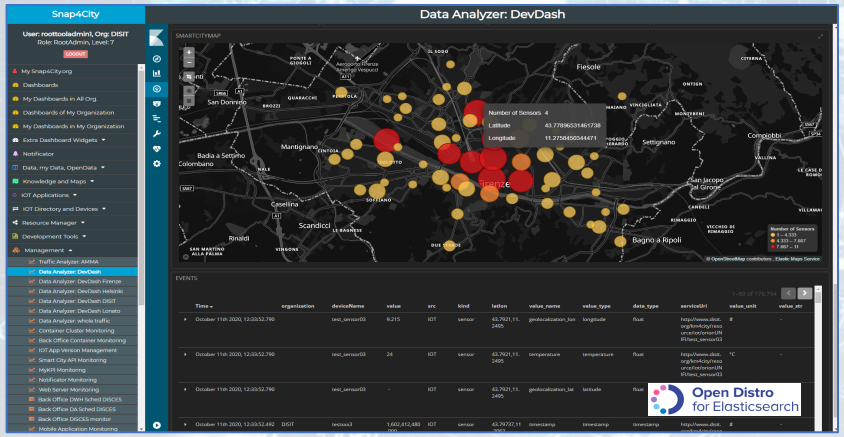
- *any data, format*
- *any channel, protocol*
- *any AI/ML*
- *any place*
- *online development*
- *multi-tenant*
- *Secure, PENTest*
- *GDPR, privacy*
- ***→ low costs***
- ***→ easy to evolve***

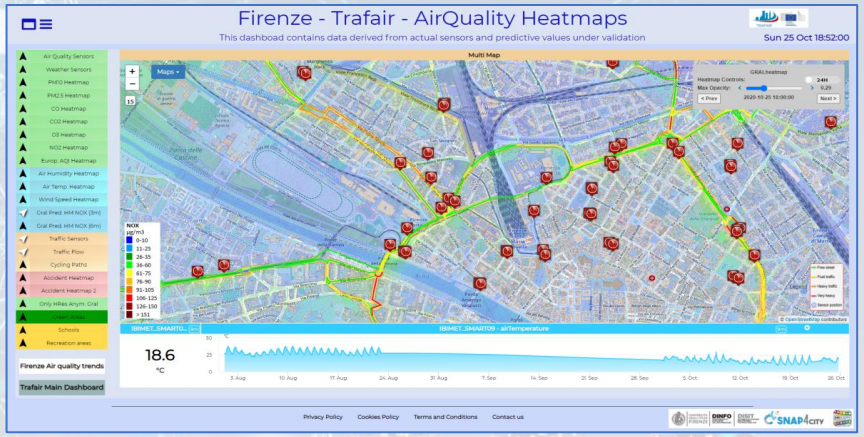
https://www.snap4city.org/download/video/course/da/

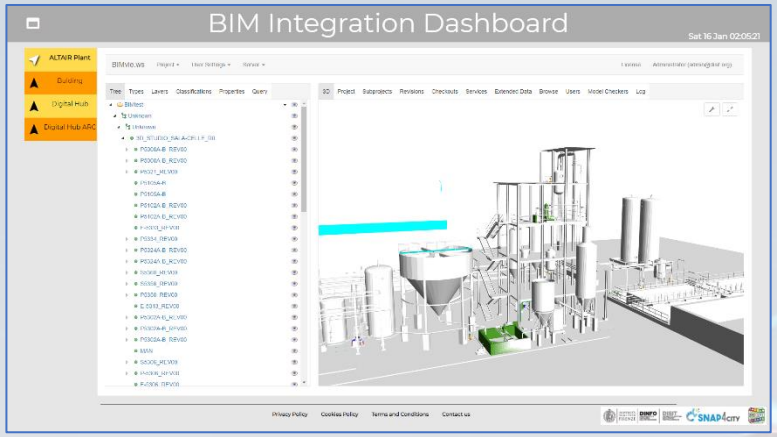

Alerting Generation
This dashboard contains data derived from actual sensors and predictive values under validation
Sat 16 Jan 01:03:27
Firenze Oggi
-0.4
°C
Kind: River Flooding
Severity: Relevant
#People: 10
Impact 1: People Disease
Impact 2: Pollutant
GPS: 43.776114,11.210861
City: FIRENZE
Adr: VIA ADRIANO CECIONI N.undefined
Registered:Green:1610755283309
Clean
Register Alert


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

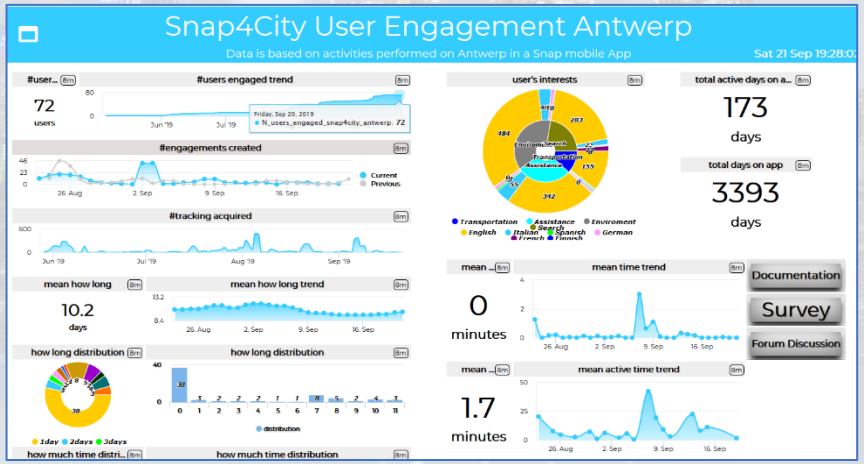

DCS Real Time - Settimanale
Fri 23 Oct 18:32:02
STOCK KOH
STOCK NaOH
Home

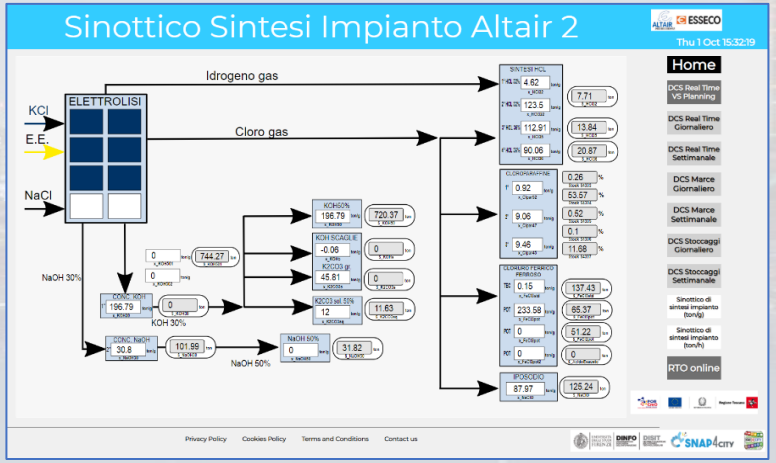

Data Analyzer: DevDash
Open Distro for Elasticsearch


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

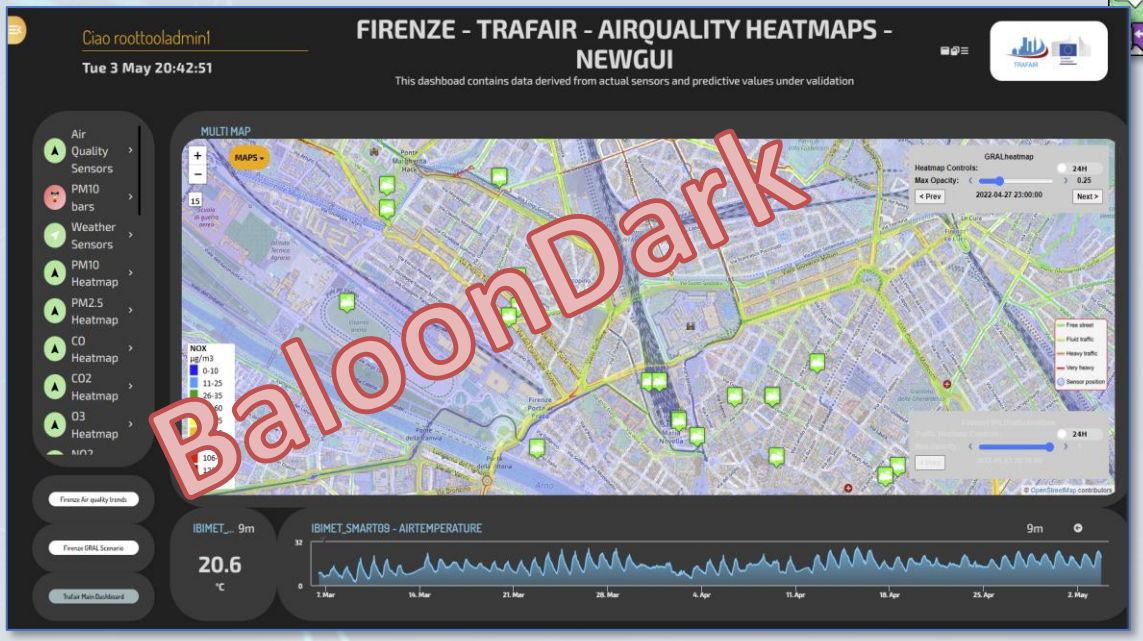

BIM Integration Dashboard
Sat 16 Jan 02:05:21

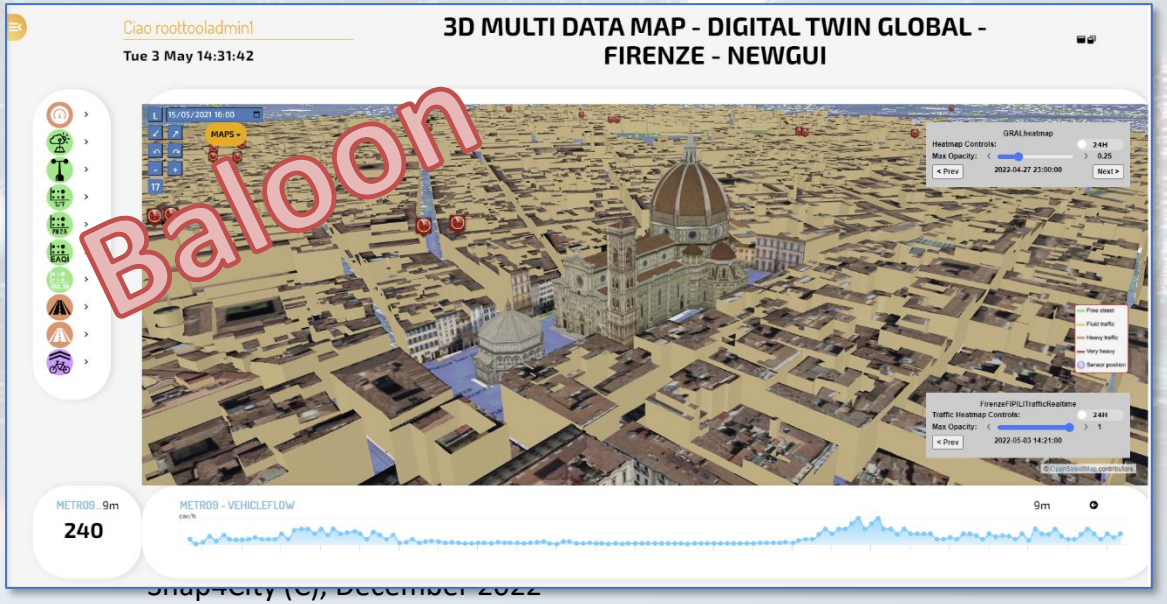
3D Multi Data Map - Digital Twin Global - Firenze
demonstrator
Sun 3 Apr 16:03:52
192

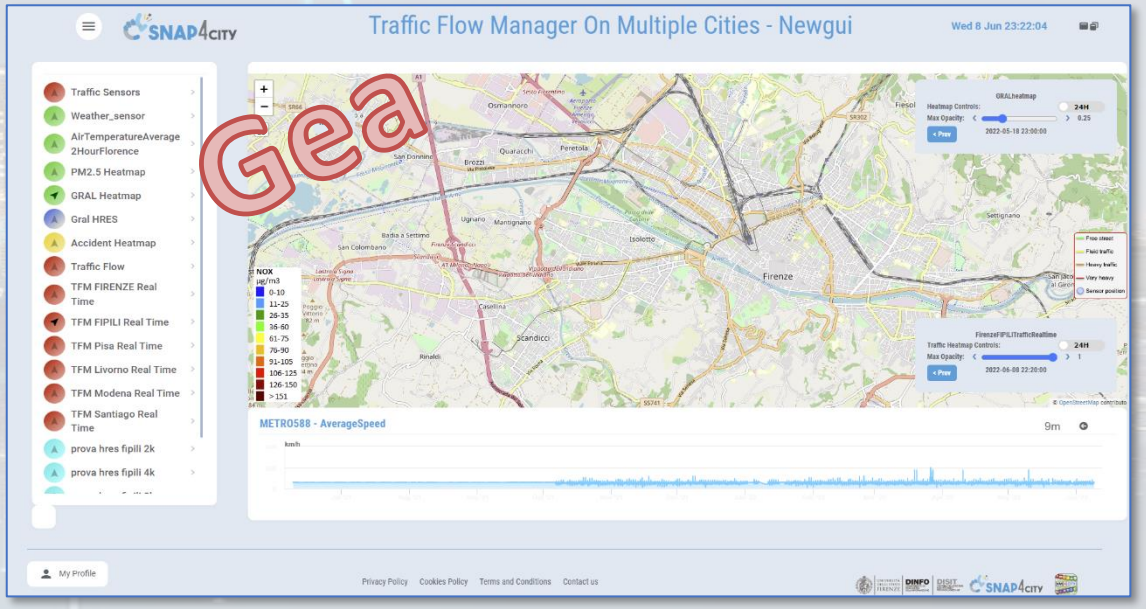

Snap4City User Engagement Antwerp
Data is based on activities performed on Antwerp in a Snap mobile App
Sat 21 Sep 19:28:07
72
users
10.2
days
173
days
3393
days
0
minutes
1.7
minutes
Documentation
Survey
Forum Discussion


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

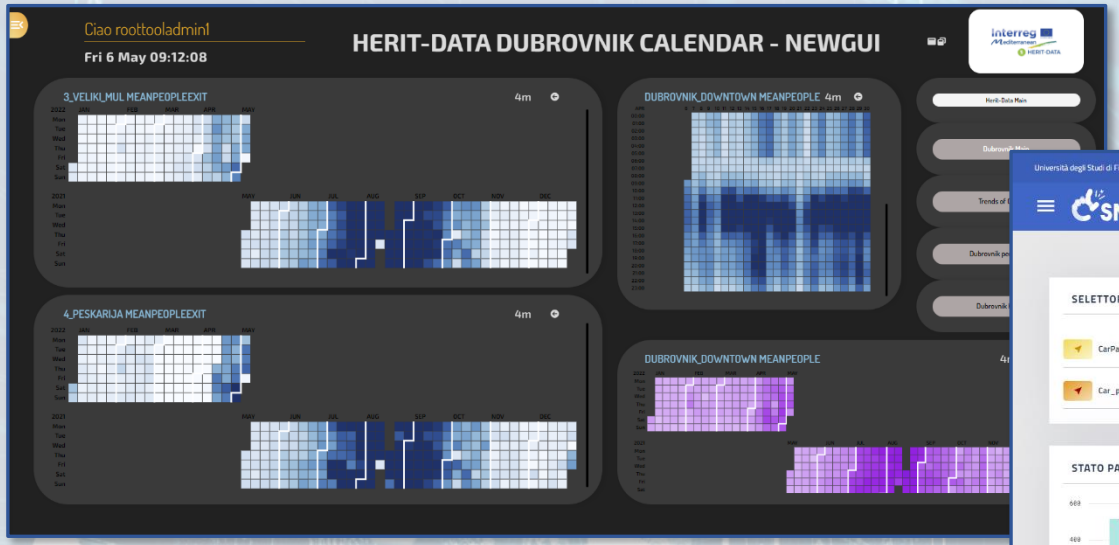
Different Themes

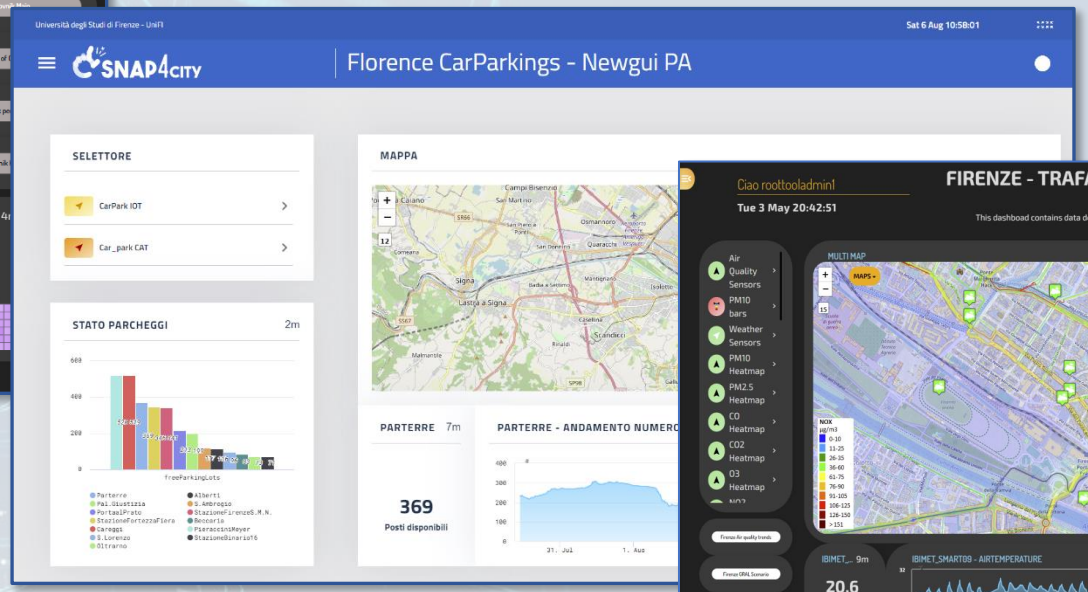


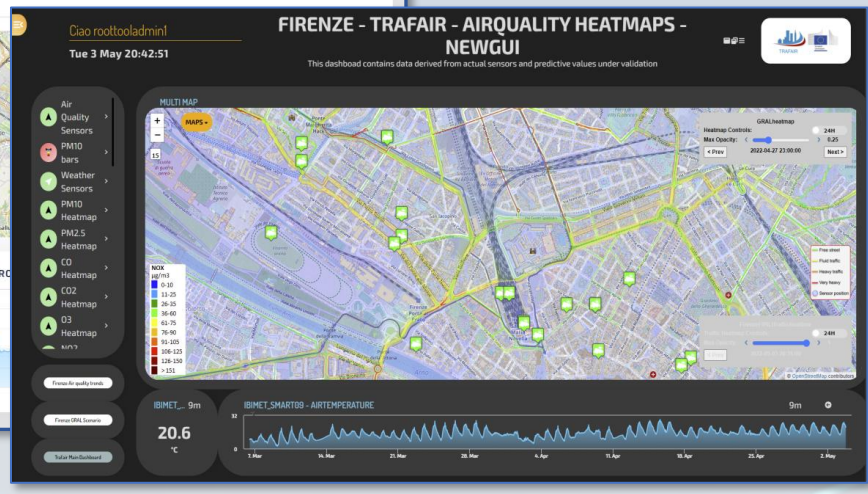


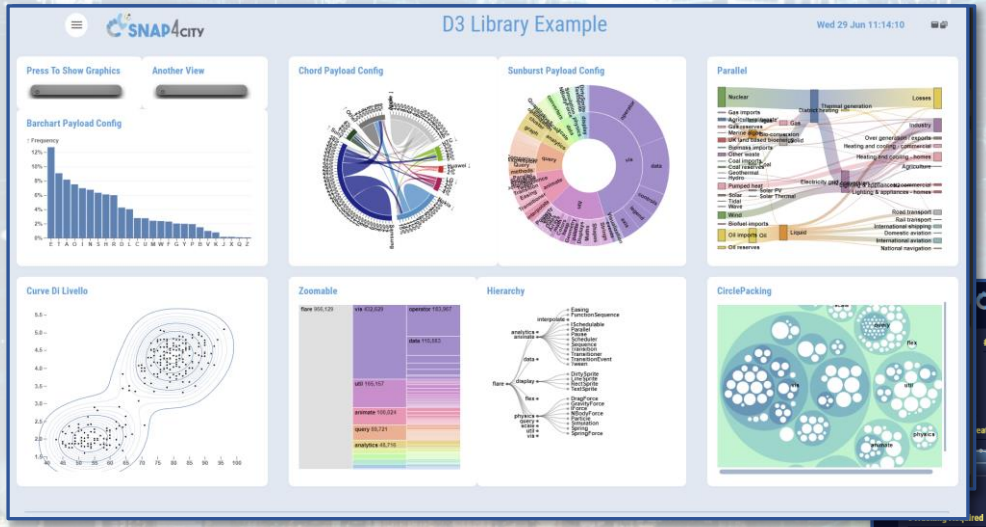


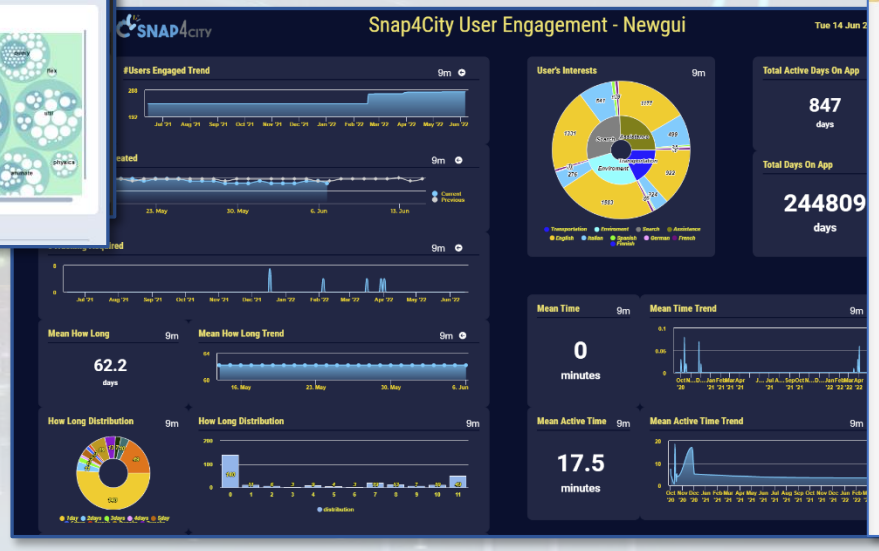
Different Themes

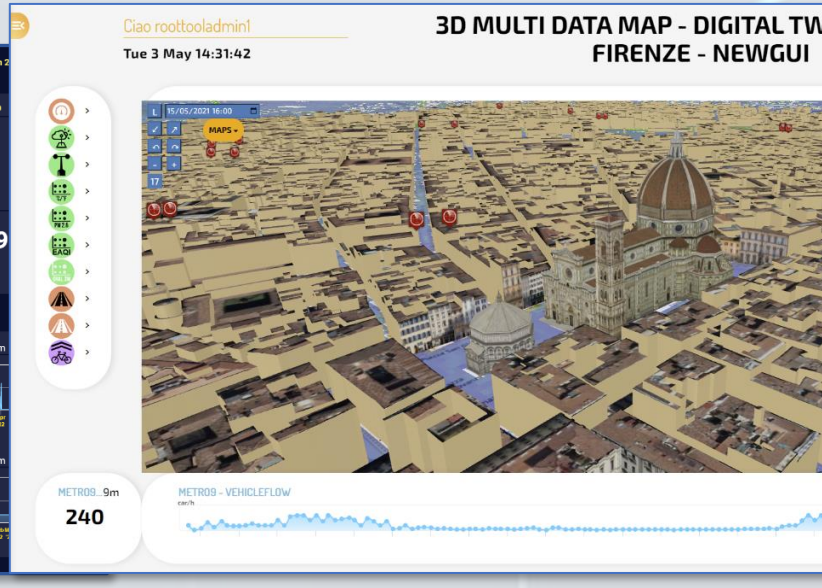










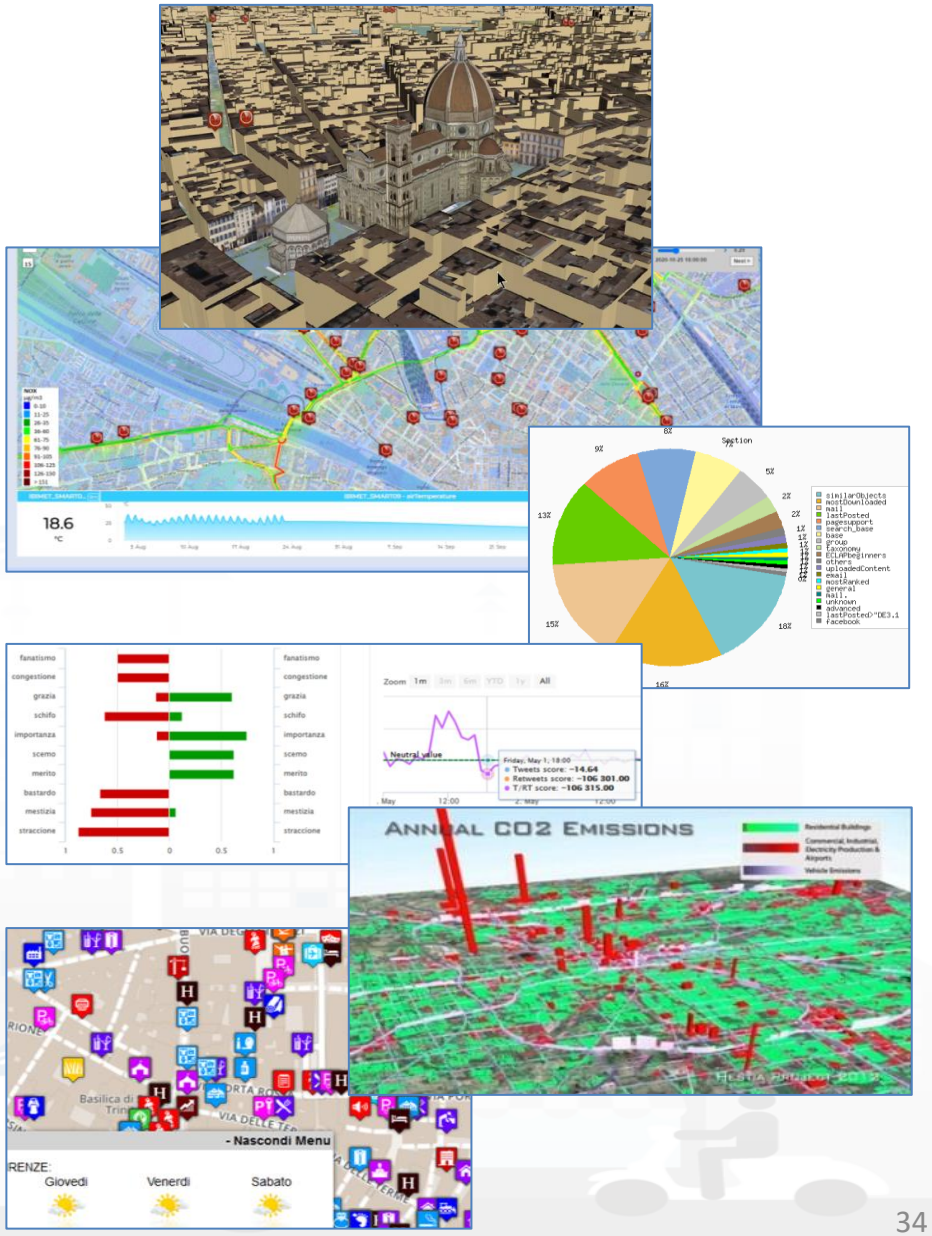


New styles/themes can be developed by specializing a few files from open source

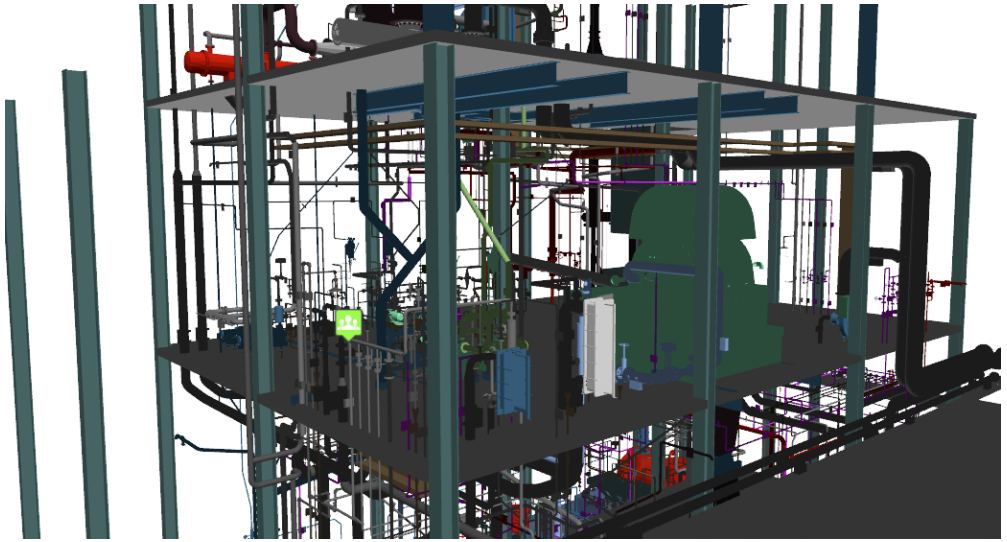
https://www.snap4city.org/793

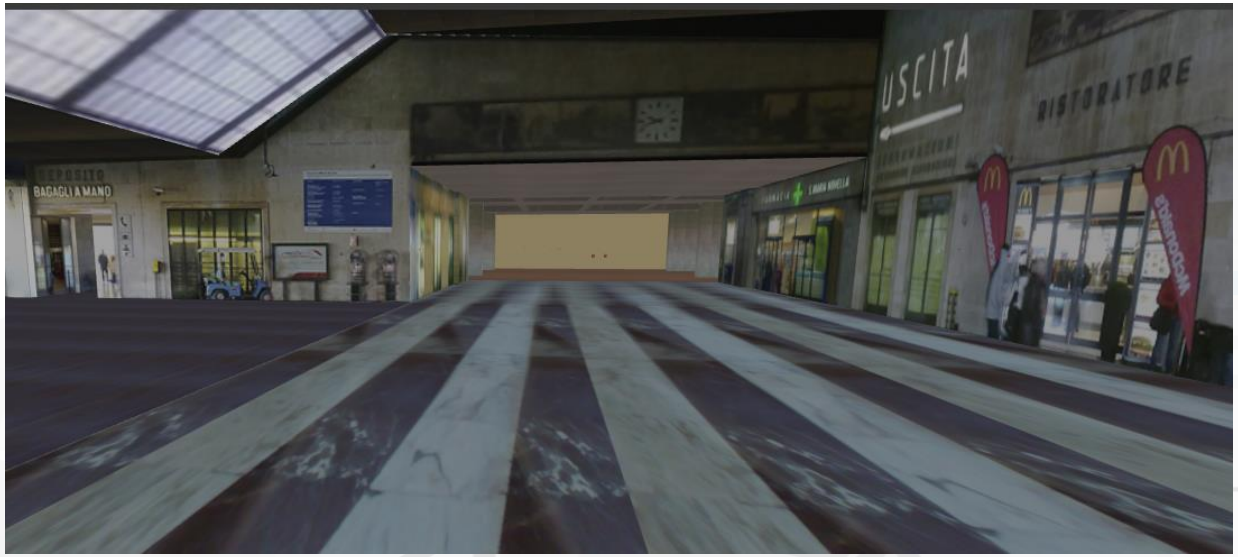
Digital Twin

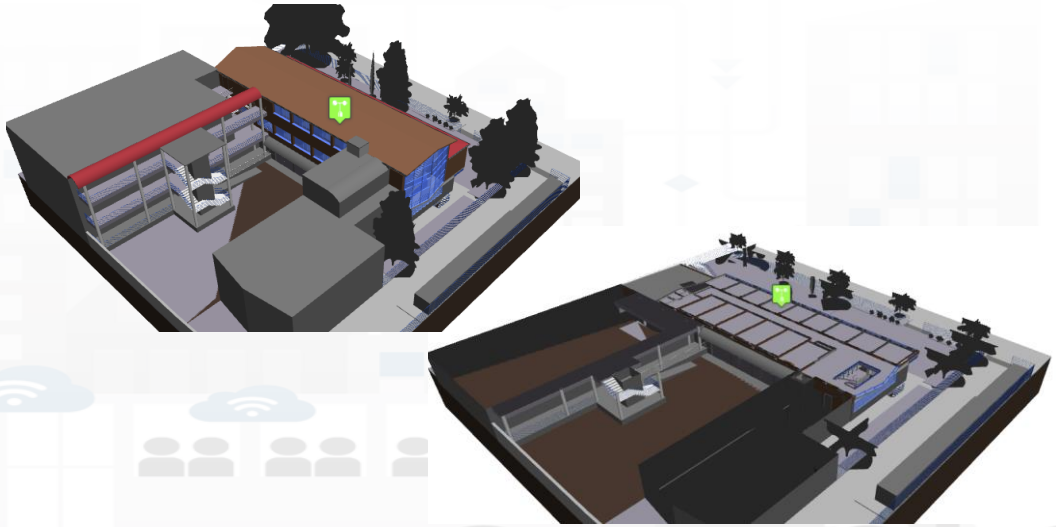
- **Digital Twin**
  - **Connected** with real physical systems
  - **Modelling aspects**: structural, visual, informative, real time data sensors (context), POI, functional, resource managements, etc.
  - **Integration of** AI/XAI techniques with simulations and modelling
- **Easier to understand the 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

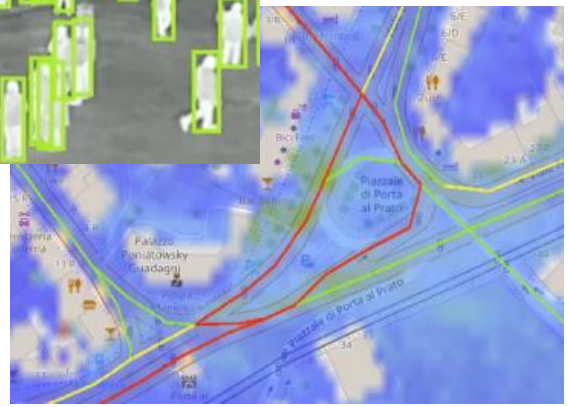


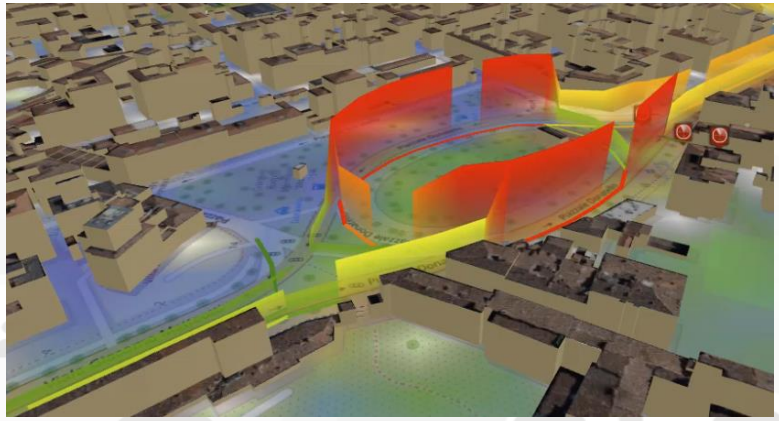




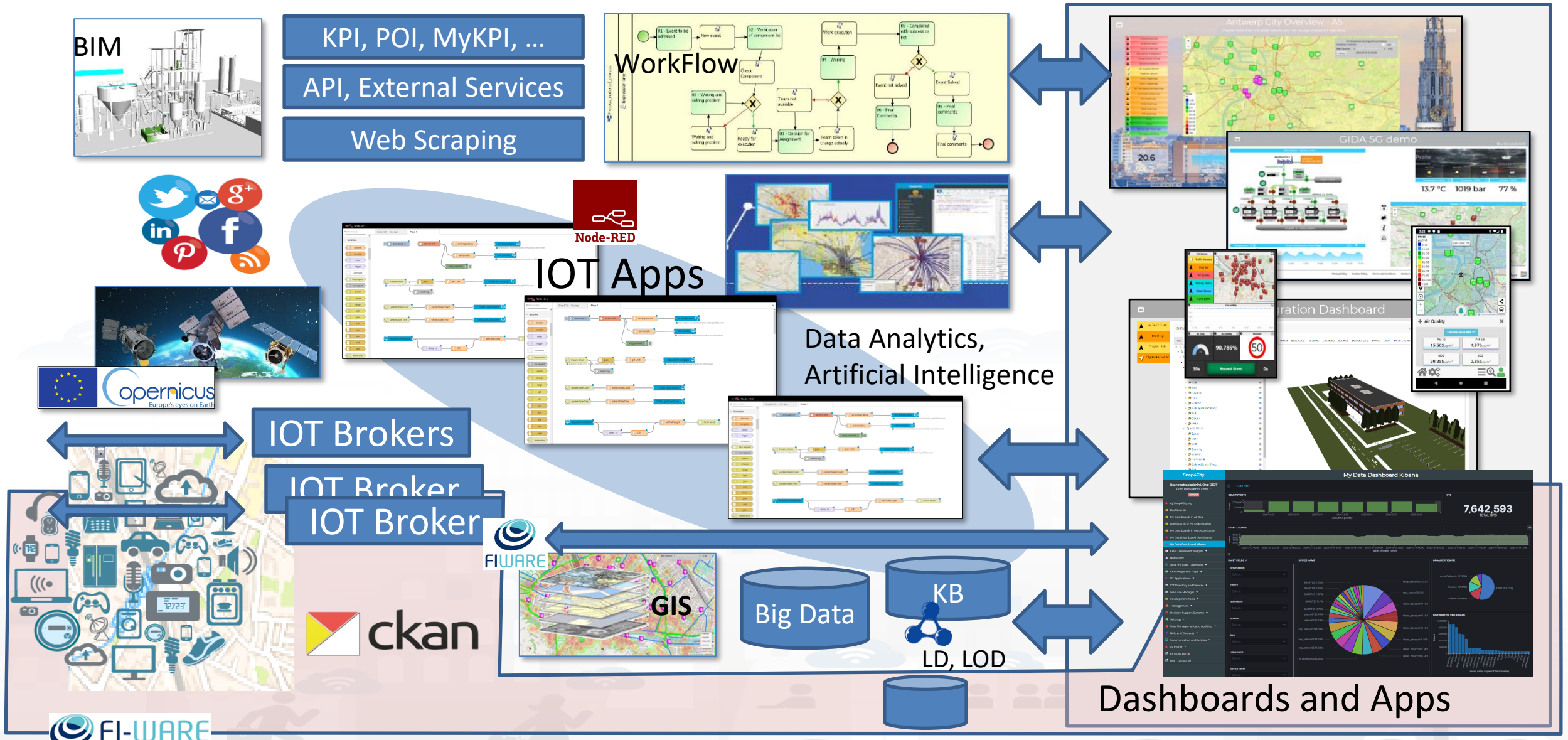
Awareness to manage and improve ….

- **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.
  - **Suggest, Recommend, Engage, Guide..**
    - Context based

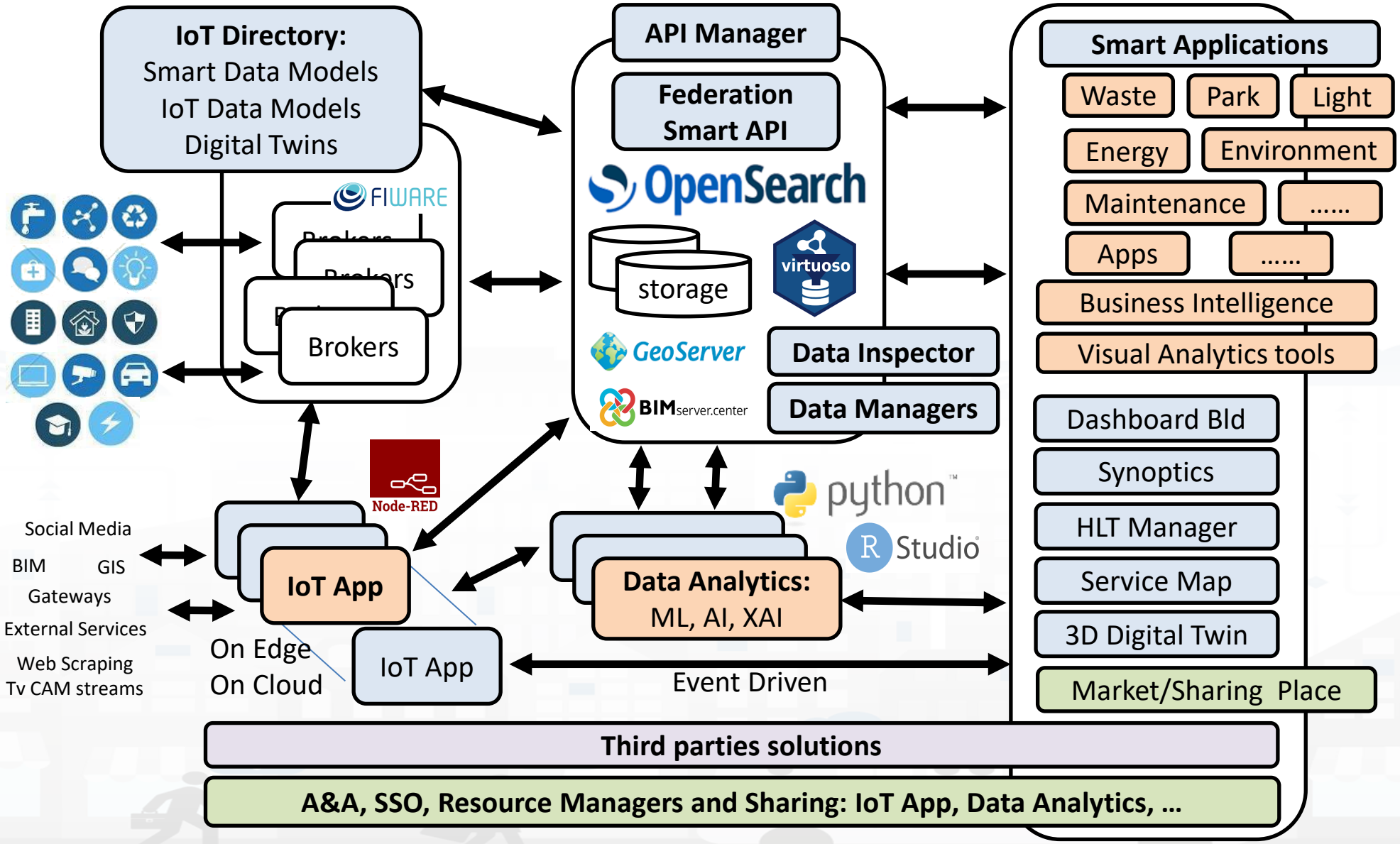


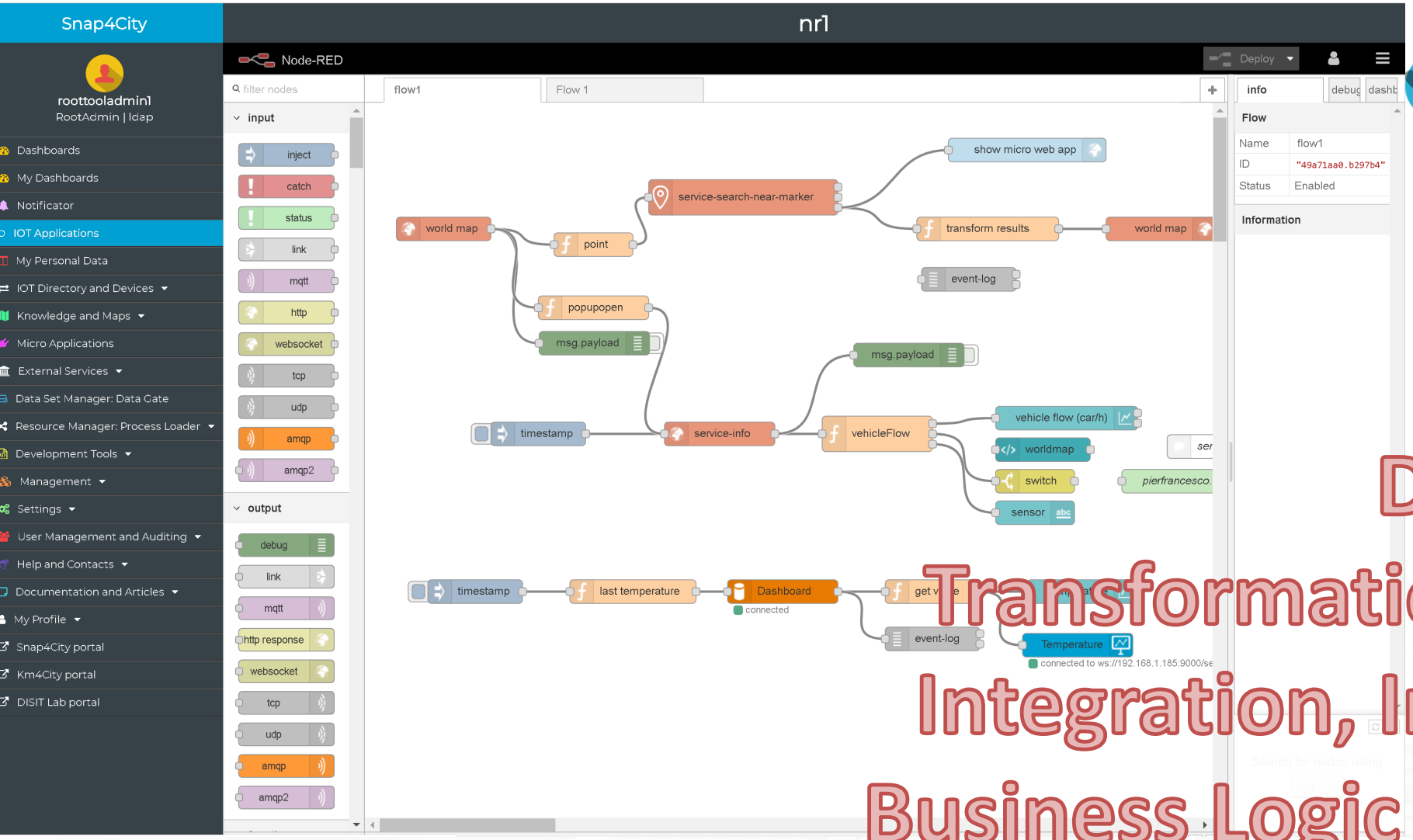


Concept


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
ckan
GIS
Big Data
KB
LD, LOD
Dashboards and Apps
FI-WARE

Tech Arch - 2023





Data Adapation

Transformation, Conversion

Integration, Interoperability

Business Logic vs Dashboards

Editing IOT Applications

Data Analytics control

Everywhere: Cloud, on IoT Edge Devices

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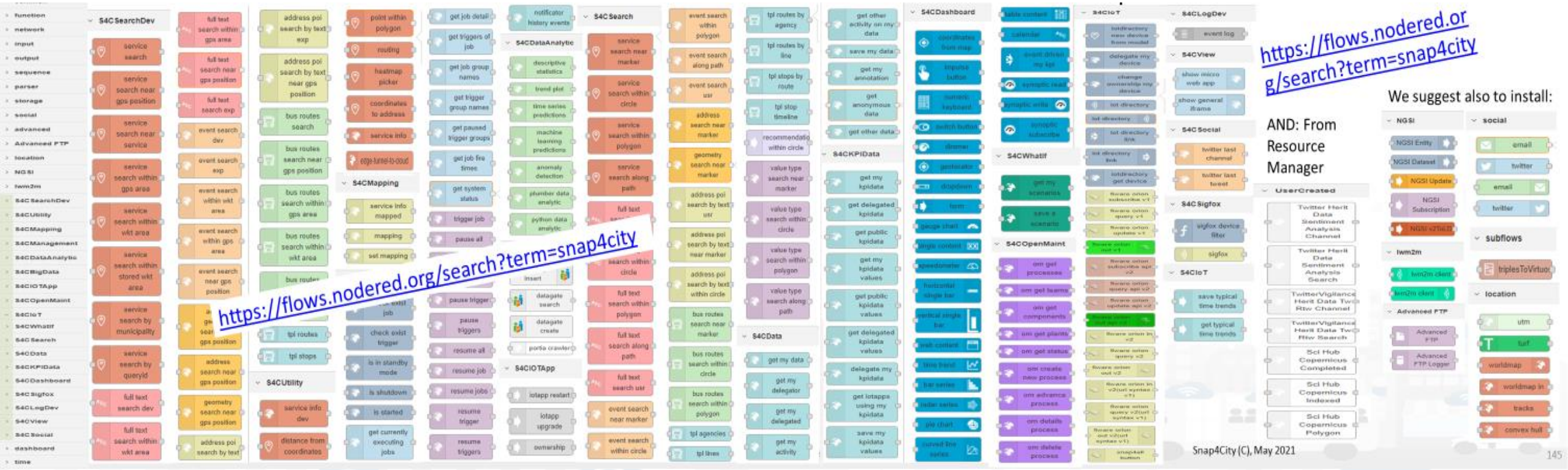
SNAP4CITY

Snap4City Libraries of MicroServices on Node-RED

Node-RED



SNAP4CITY

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 (9/2022)

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, Proximus, ..
- **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, Satellite, D3 JSON, …
- **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, AXIS, ESP32, etc.

https://www.snap4city.org/65

Mobility and Transport

Traffic Flow reconstruction:

- fluidodynamic model plus stochastic relaxation

Prediction

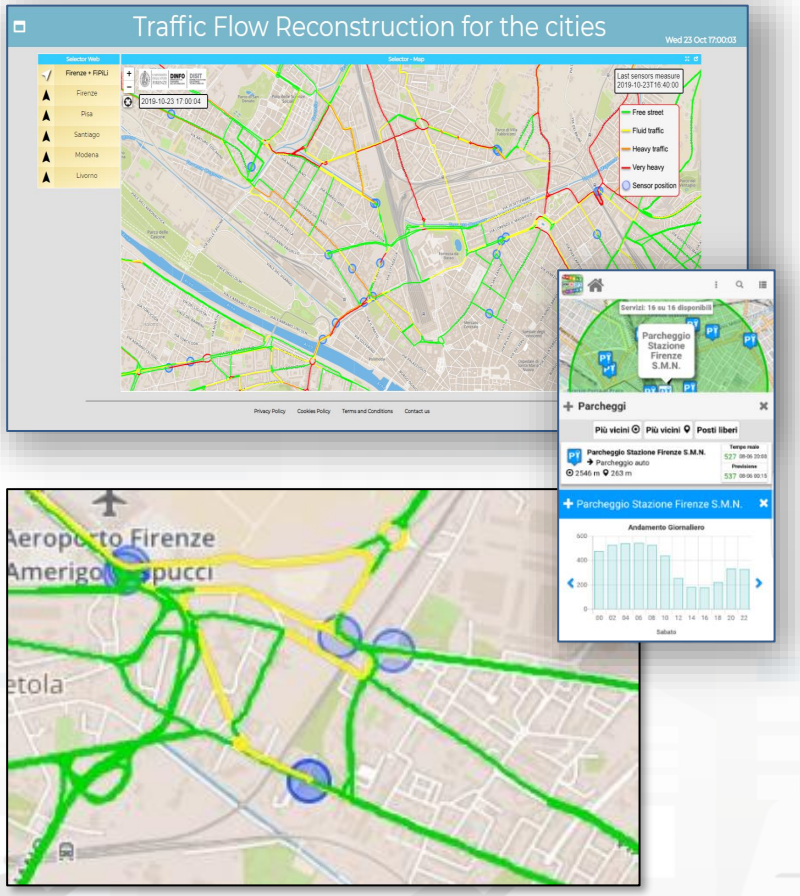
- **Traffic Flow density, RF, LSTM, GBM, …**
- free slots for **parking…**
- **bike rack** status on bike sharing

Classification of travel means of users via mobile data

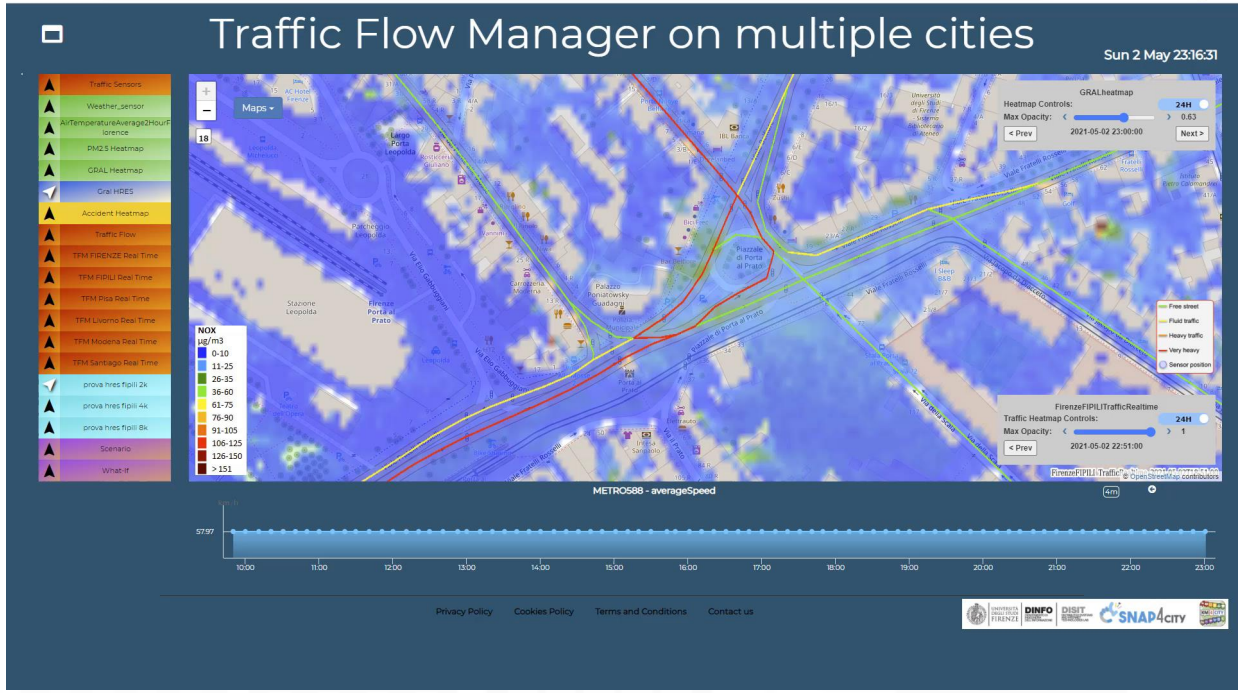
IoT Data Anomaly Detection

Project:

- Sii-Mobility, SCN MIUR



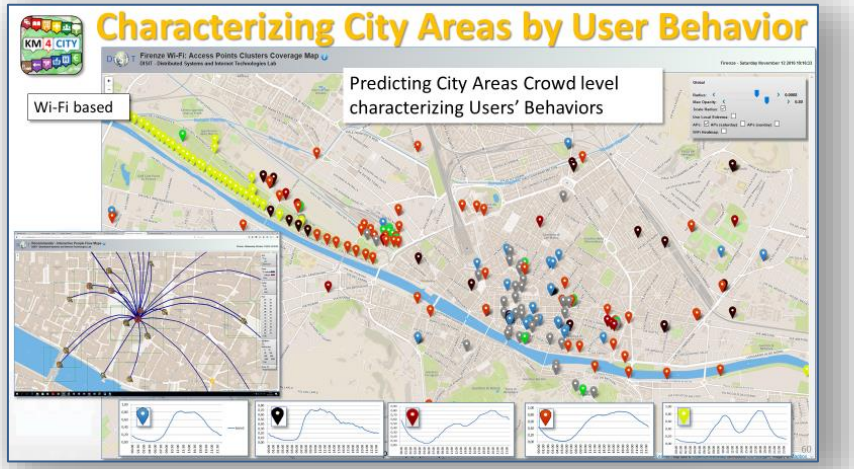
Environment

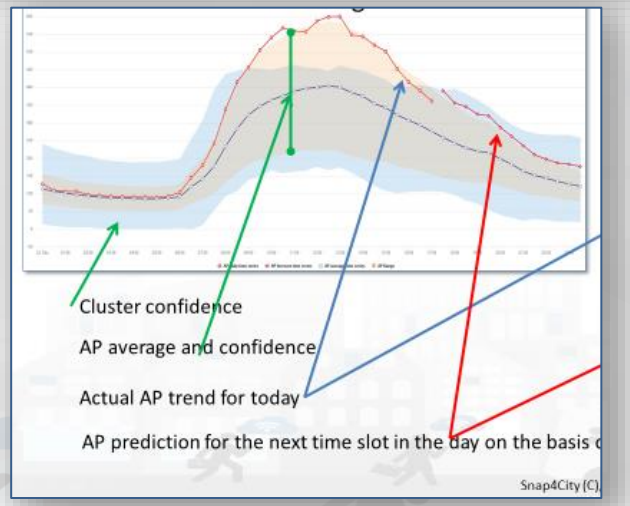


- **Prediction**
  - **NOX Pollutant** diffusion on the basis of Traffic Flow (prediction), weather and 3D structure
  - **NO2 progressive average** (Long term)
- **Project:**
  - **Trafair** CEF EC
  - Mixed solutions of Fluidinamics modeling and AI

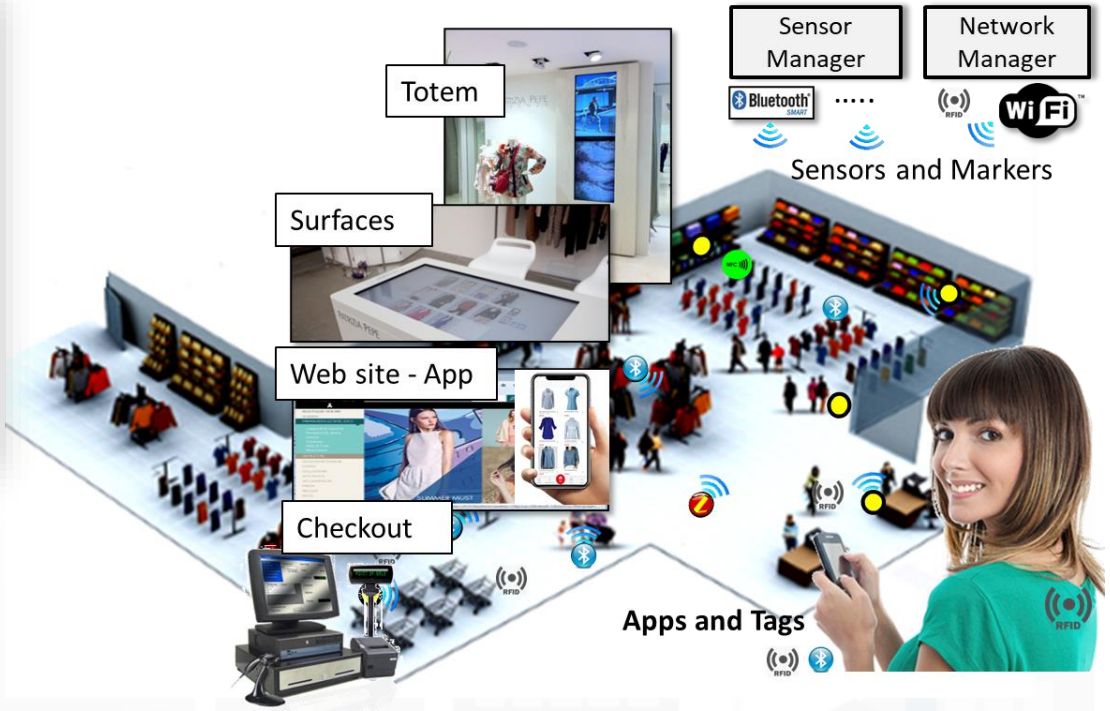
People Behaviour

- **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



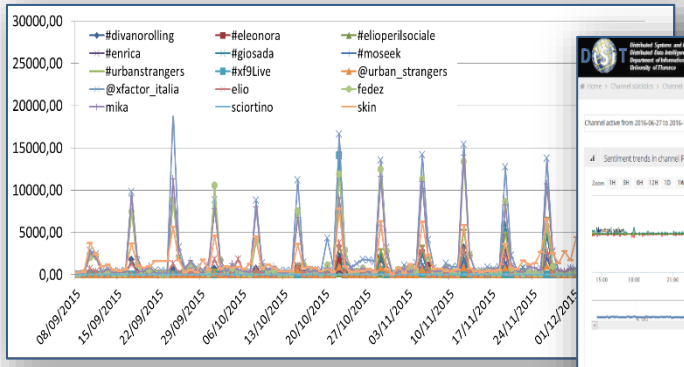


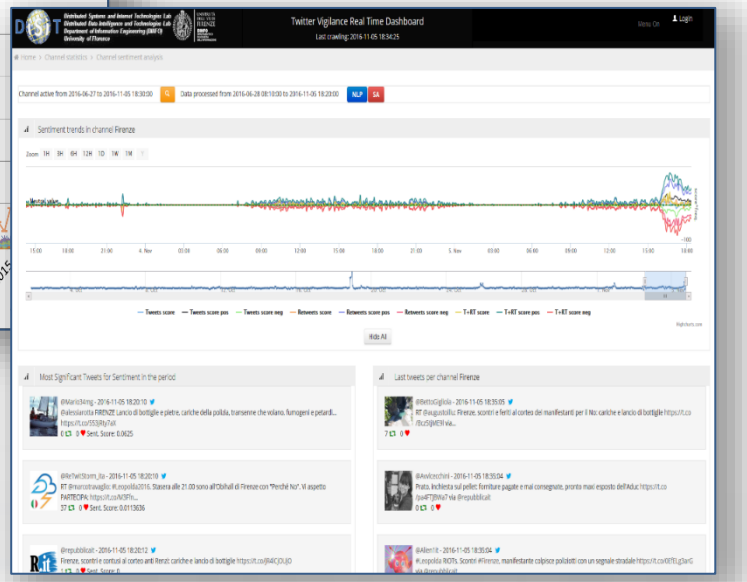
Smart Retail



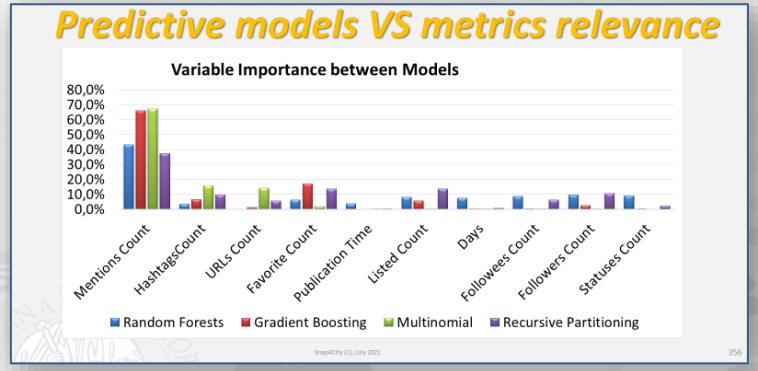
- **Recommendations**
  - User and Items Clustering
  - Prediction
  - User engagement
- **Project Feedback**

Social Media

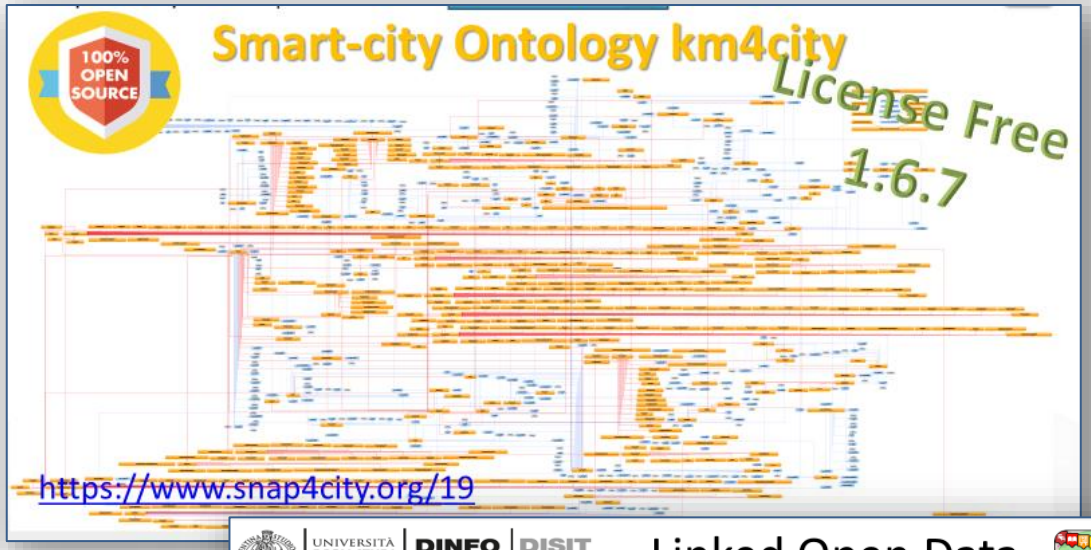


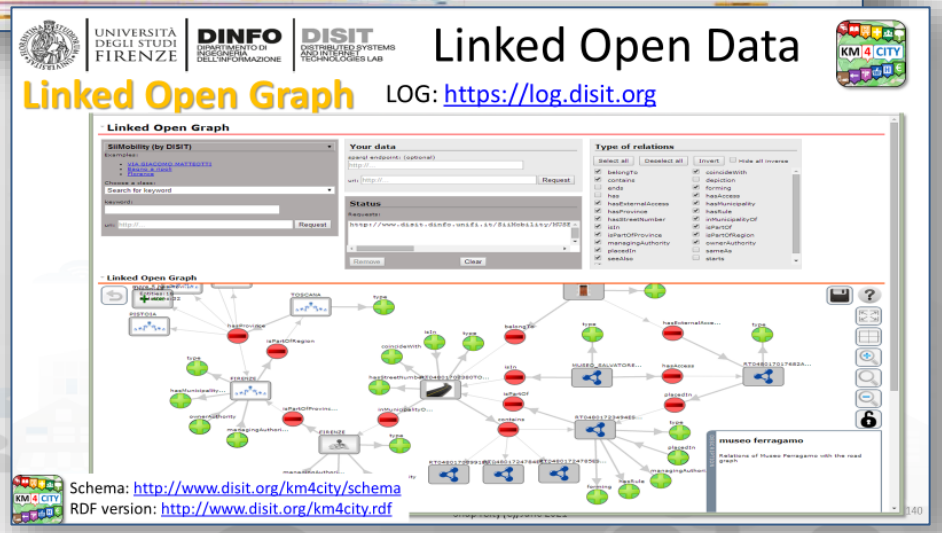


- **Prediction**
  - Audience on TV programme
  - retweet proneness
  - NLP, SA, AI
- **Projects**
  - TwitterVigilance

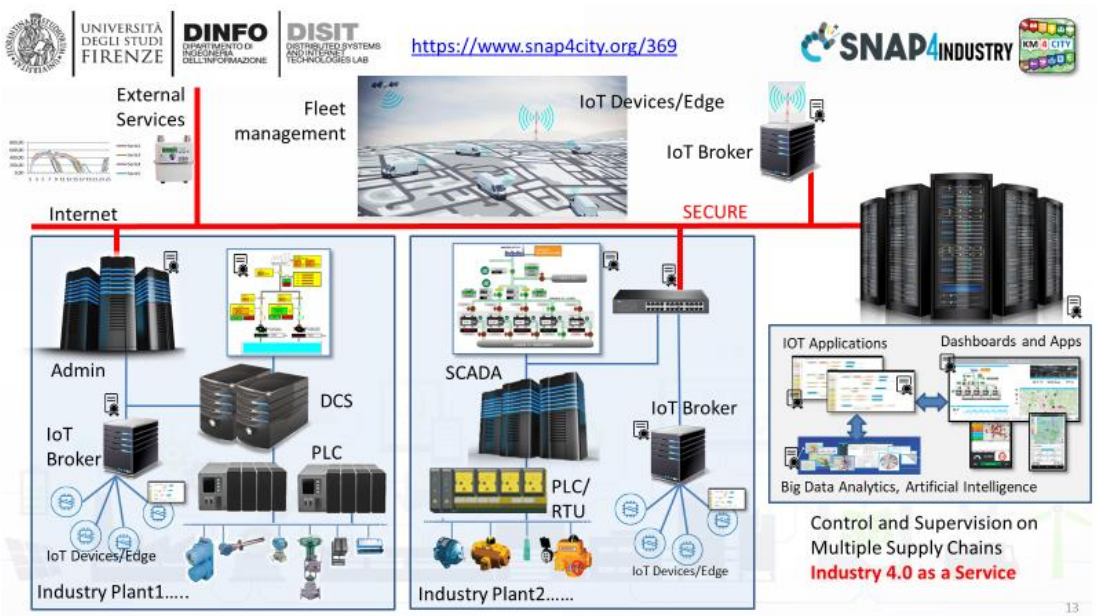


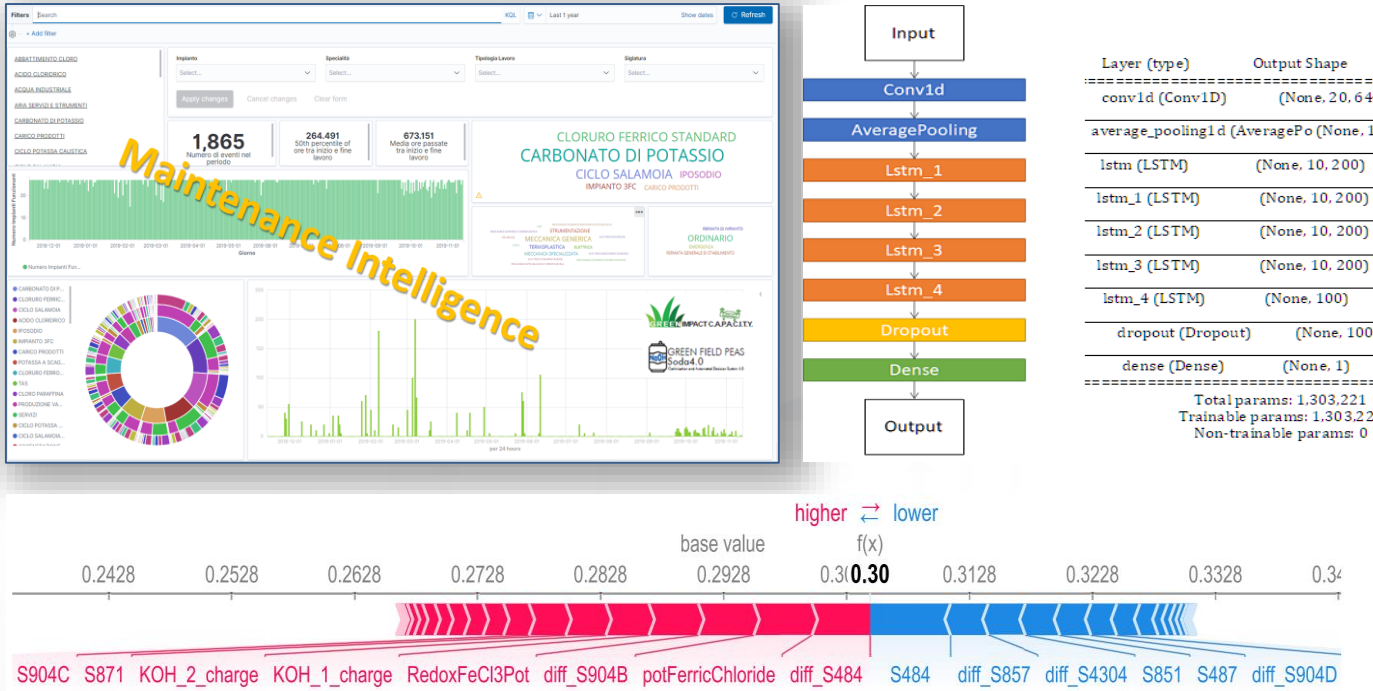
Knowledge Engineering





Industry 4.0 and Predictive Maintenance



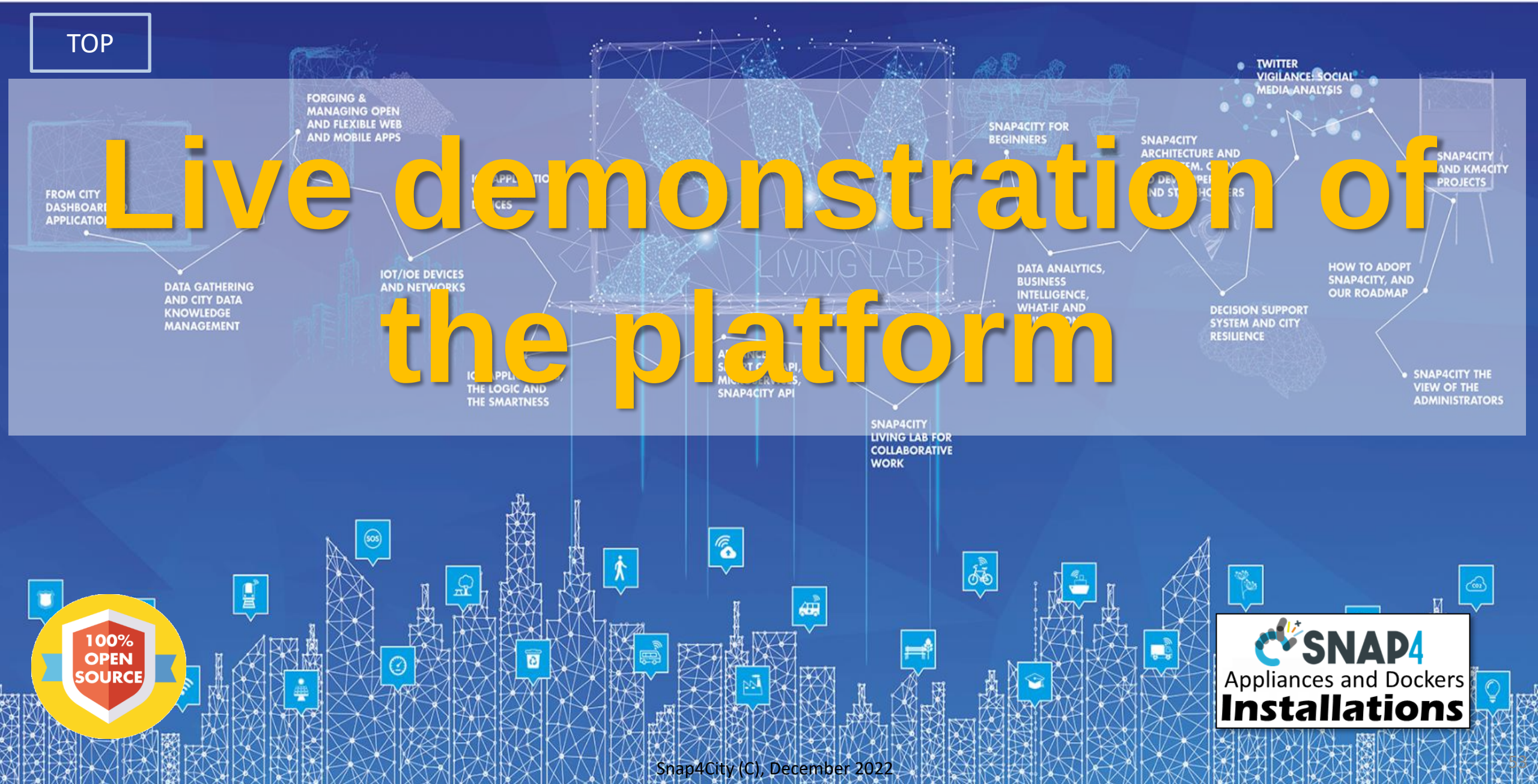


- **HyperAutomation**
- **Supervision and control**
- **TeleControl**
- **Factory integration**

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

TOP

Live demonstration of the platform



•DEMO

Entering as AreaManager, Developer

Snap4City

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

- My Snap4City.org
- Dashboards (Public)
- Dashboards of My Organization
- My Dashboards in My Organization
- 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
- Help and Contacts
- Documentation and Articles
- My Profile
- Km4City portal
- DISIT Lab portal

Snap4City

Home | How and Why To Use it | Tools | Tutorials and Videos

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

Welcome: how to start using Snap4City for beginners

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** !

Add to your favorites

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IOT Devices | IOT Applications | Data Analytics | Dashboards | Living Lab | Smart City API | Smart City Ontology | Work with Us | Articles | SMARTCITY EXPO WORLD CONGRESS 19-21 Nov. 2019 See you at Stand A118 | Booklet/Flyer 2019

SNAP4CITY on EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE | SNAP4CITY HACKATHON BUILD YOUR APP FOR A CONNECTED CITY | INDUSTRY 4.0 Snap4Industry | Snap4Home

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

Username: paolo.disit

Search

Search
-Any-

Snap4City Training Course 2020

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FI-WARE | Node-RED

Organization Groups

DISIT
- Developer
- Operativo

Updates on Tools

Custom Widgets: Table explanation, as SVG drupaladmin

Work with us at DISIT Lab, Cerchi Lavoro al

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

TOP

Some complete Use Cases

Florence

1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
7 AFFORDABLE AND CLEAN ENERGY
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
15 LIFE ON LAND

Smart City Control Room
Florence Metropolitan City

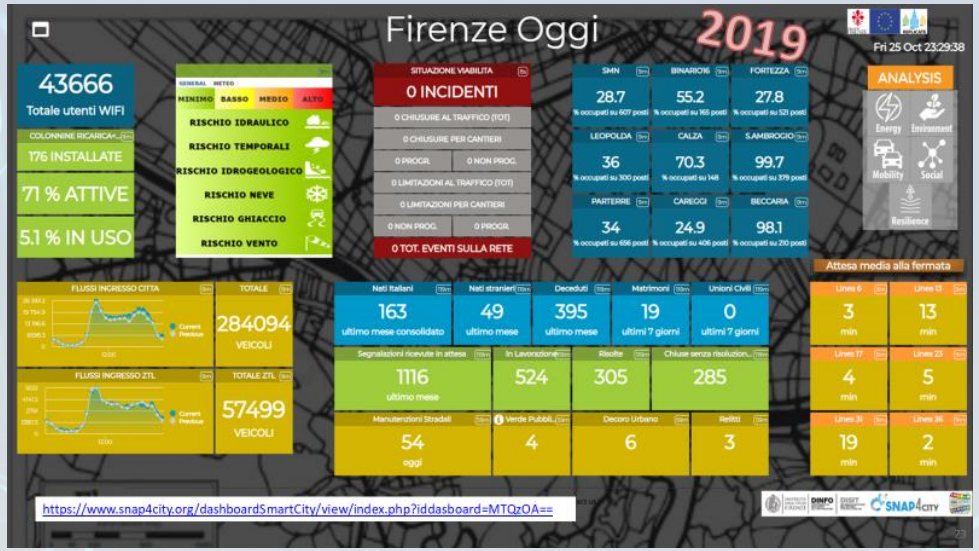
COMUNE DI FIRENZE

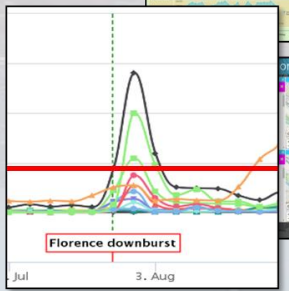
reference

SNAP4CITY

KM4CITY

- **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

Firenze Oggi
Mon 16 May 12:59:27
20991
COLONNINE
SITUAZIONE VIABILI
0 INCIDENTI
0 CHIUSURE AL TRAFFICO
0 CHIUSURE PER CANTIERI
0 PROGR.
0 NON PROG.
0 LIMITAZIONI AL TRAFFICO
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
Rt
0.94
Linea
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The European House Ambrosetti
The European House Ambrosetti
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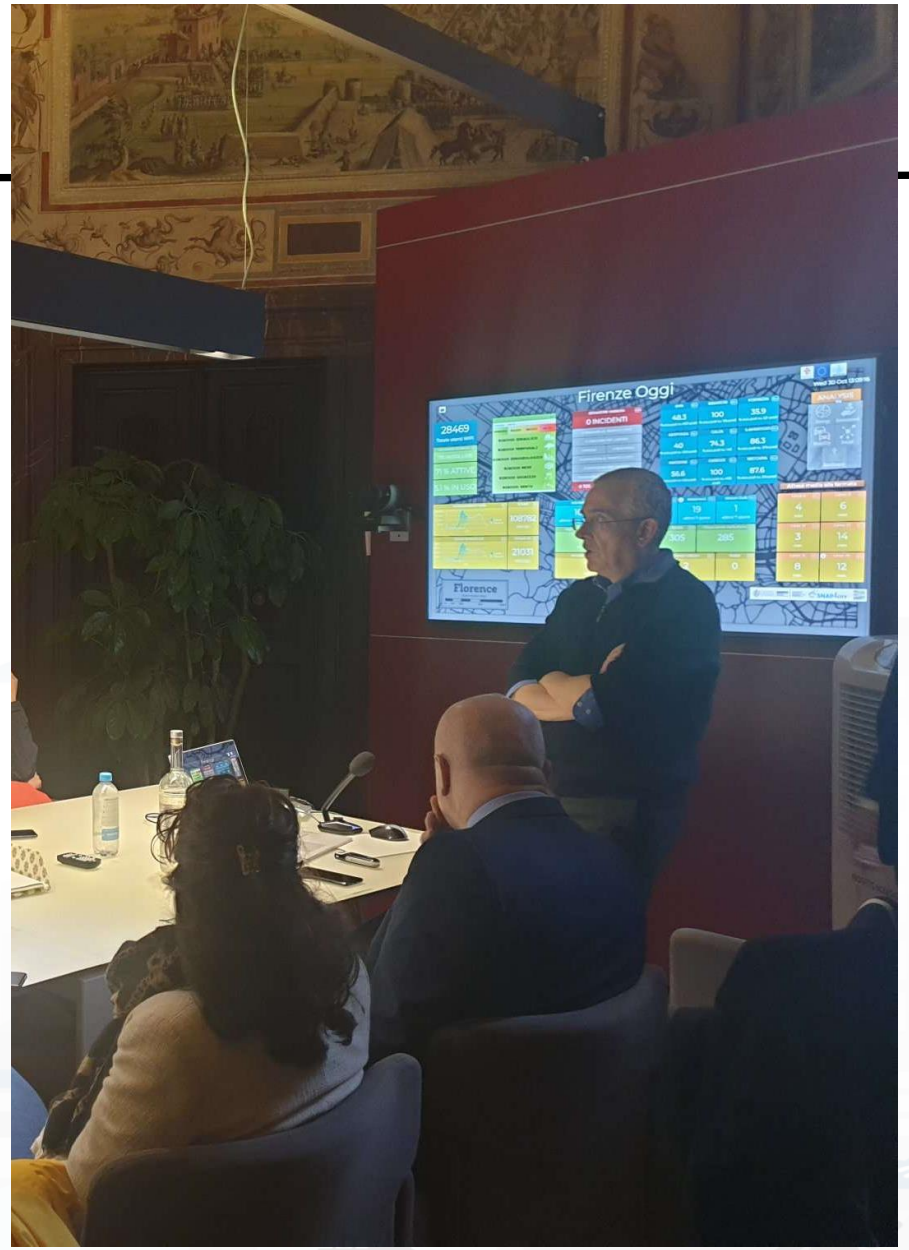
The European House Ambrosetti



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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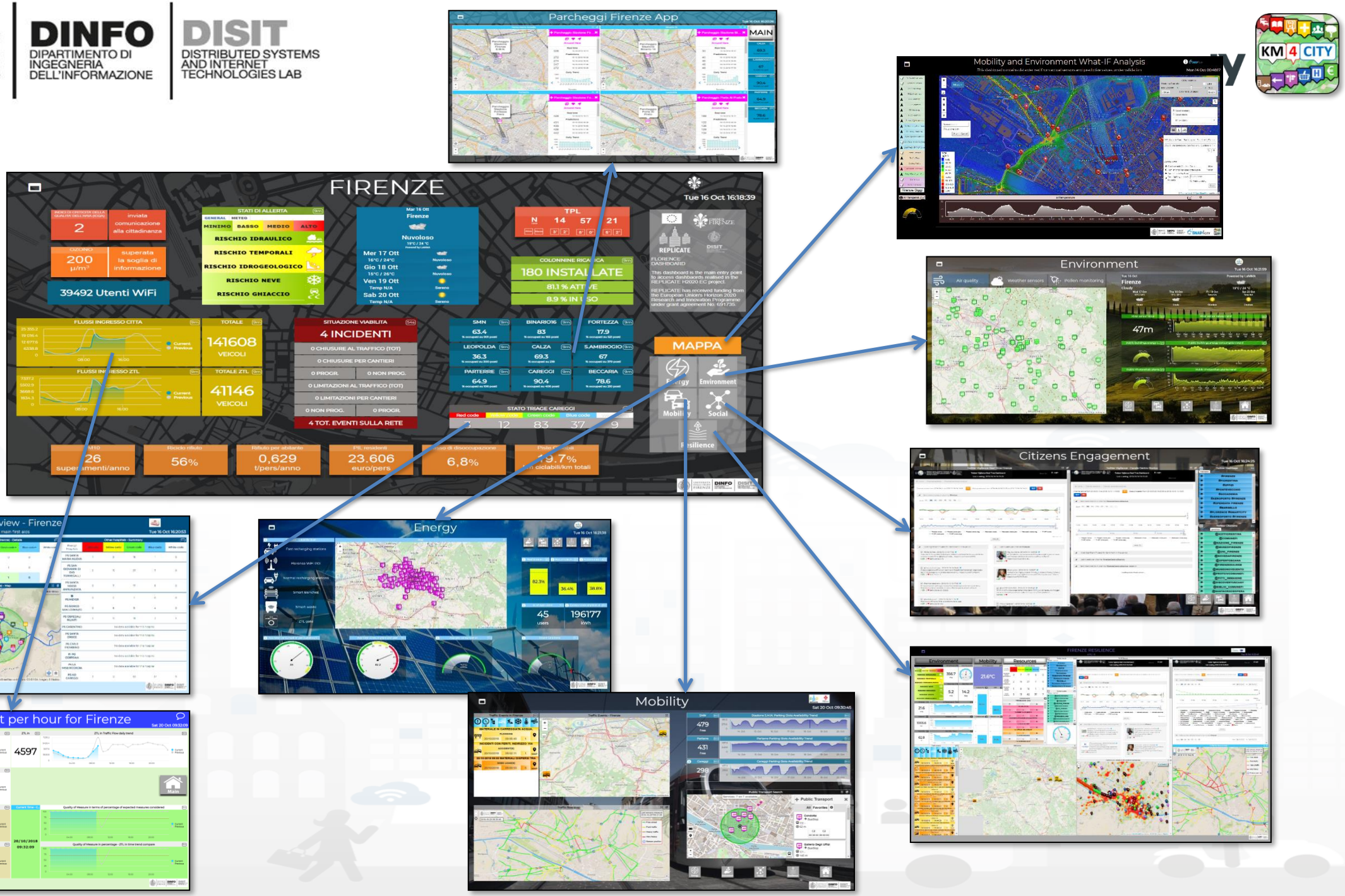
DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

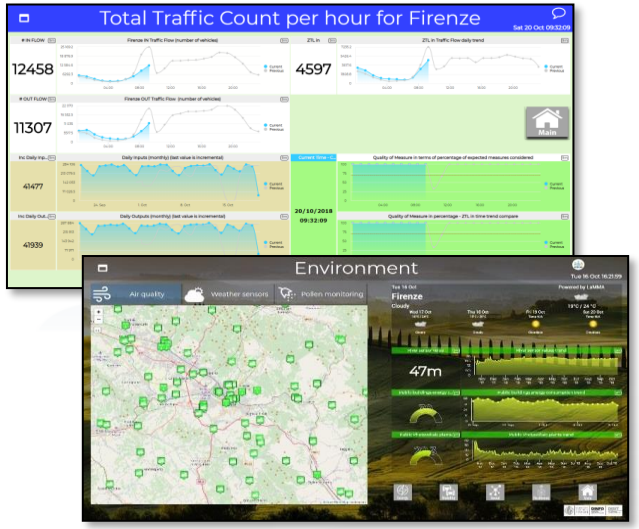
REPLICATE

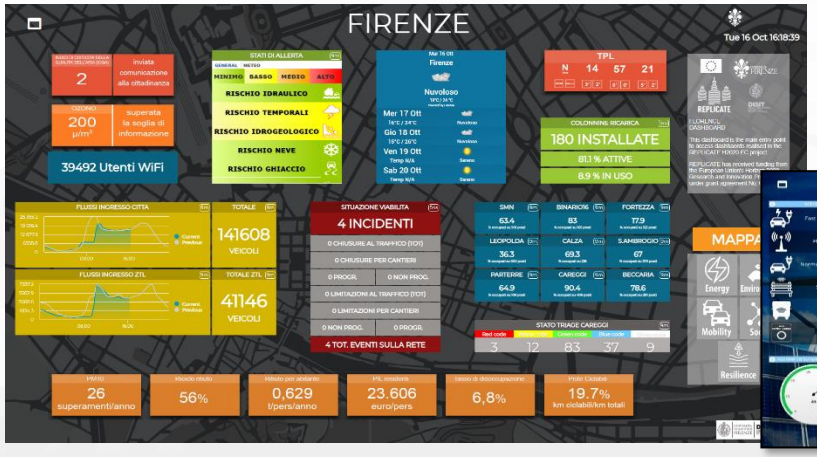
KM4CITY



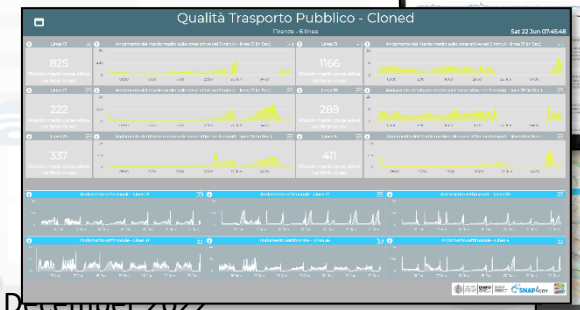
Florence Case

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





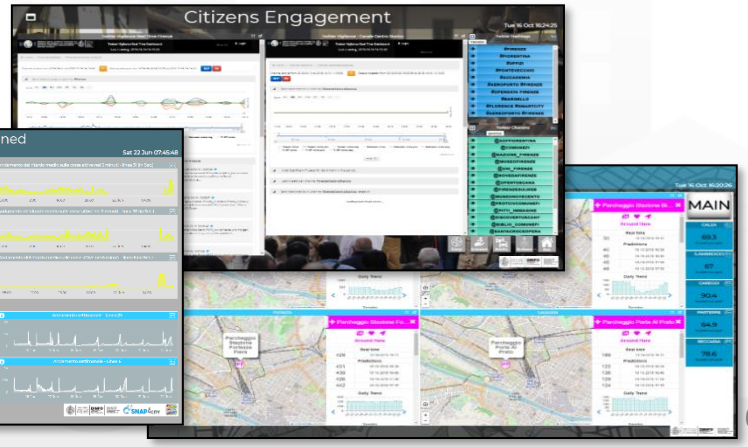
- **Mobility**:
  - quality of public transportation service (mean delay on bus-stops)
  - public transport operators schedule and paths, routing, multimodal routing
  - traffic flow reconstruction
  - Smart parking: predictions
  - Accidents and events, Log, heatmaps
- **Environment**:
  - smart irrigators
  - 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



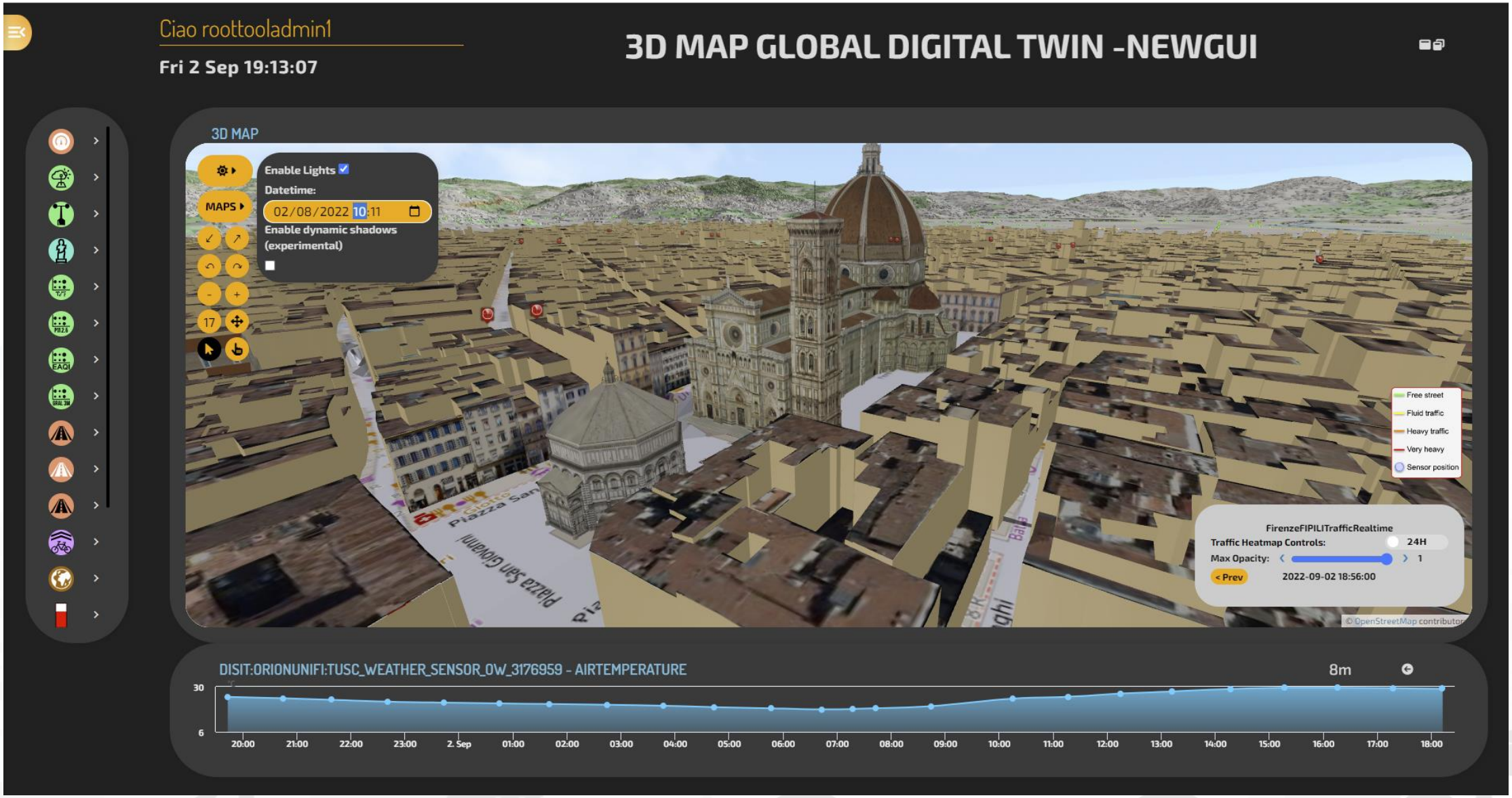
- **Social**:
  - smart benches
  - Twitter monitoring, Sentiment analysis, NLP text
  - TV camera streams
- **People Flows**:
  - Wi-Fi, people flow
  - Origin destination matrices
- **Governmental and Communications**:
  - KPI of the City
  - Digital Signage
  - Civil protection, Resilience (Resolute)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

Analysis:

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



3D View


Ciao roottooladmin1
Fri 2 Sep 19:13:07
3D MAP GLOBAL DIGITAL TWIN -NEWGUI
3D MAP
Enable Lights
Datetime:
02/08/2022 10:11
Enable dynamic shadows (experimental)
MAPS
Free street
Fluid traffic
Heavy traffic
Very heavy
Sensor position
FirenzeFIPILITrafficRealtime
Traffic Heatmap Controls:
24H
Max Opacity:
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© OpenStreetMap contributors
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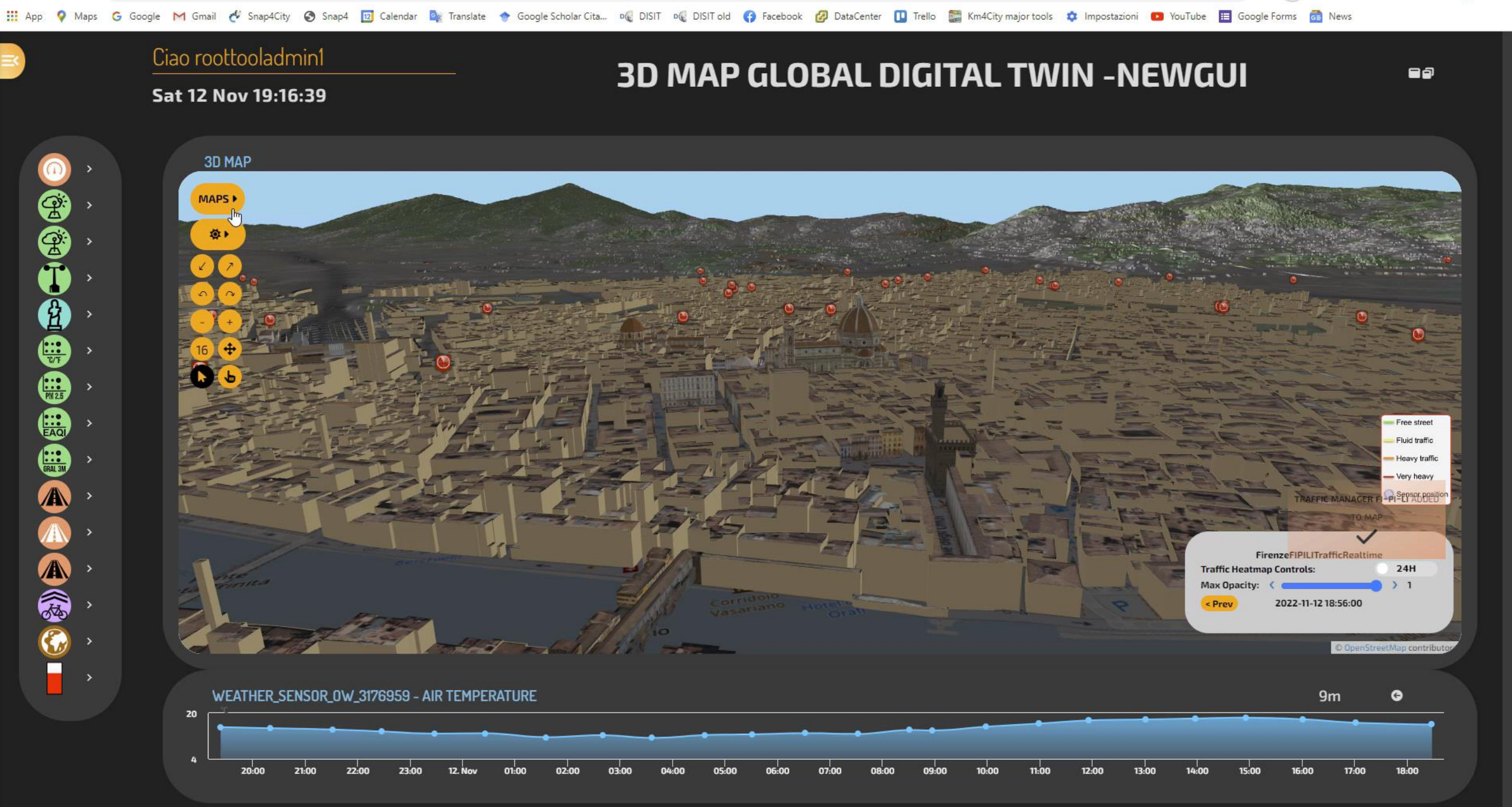
App Maps Google Gmail Snap4City Snap4 Calendar Translate Google Scholar Cita... DISIT DISIT old Facebook DataCenter Trello Km4City major tools Impostazioni YouTube Google Forms News
Ciao roottooladmin1
Sat 12 Nov 19:16:39
3D MAP GLOBAL DIGITAL TWIN -NEWGUI
3D MAP
MAPS
Free street
Fluid traffic
Heavy traffic
Very heavy
Sensor position
FirenzeFIPILITrafficRealtime
Traffic Heatmap Controls:
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Max Opacity:
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© OpenStreetMap contributors
WEATHER_SENSOR_OW_3176959 - AIR TEMPERATURE
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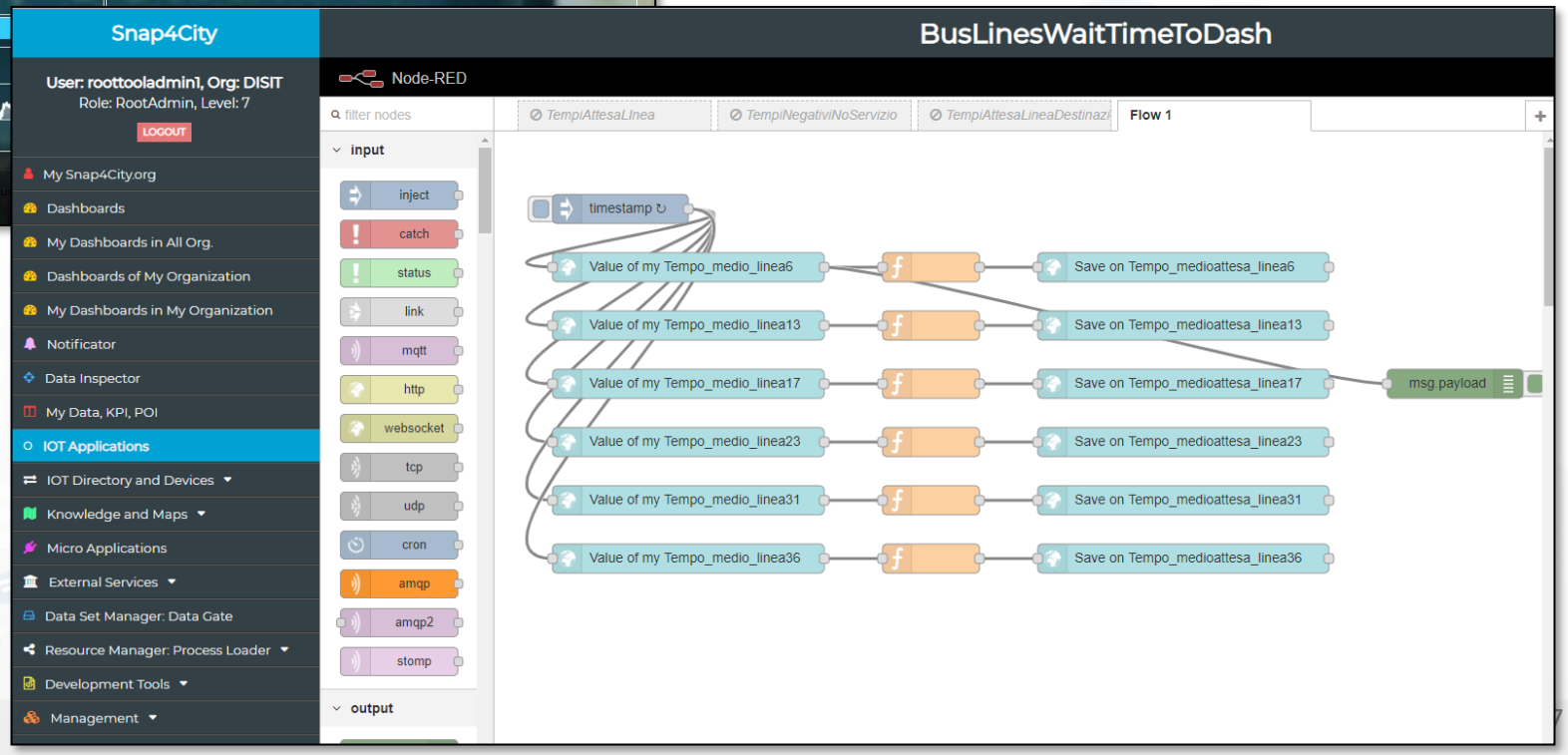
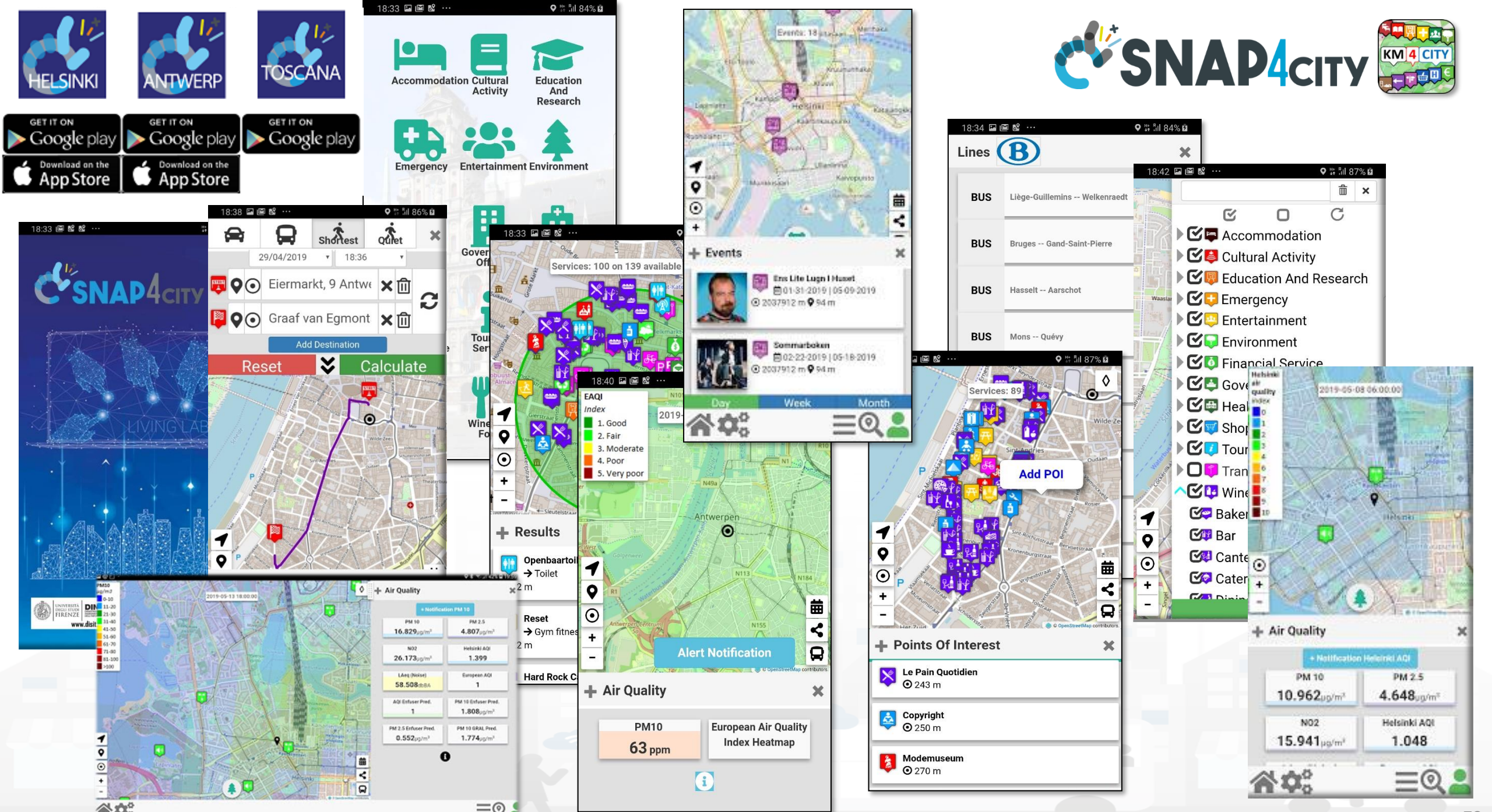
Estimation of the mean waiting time at bus stops




HELSINKI
ANTWERP
TOSCANA
GET IT ON Google play
Download on the App Store
SNAP4CITY
KM4CITY
Accommodation
Cultural Activity
Education And Research
Emergency
Entertainment
Environment
Shortest
Quiet
29/04/2019
18:36
Eiermarkt, 9 Antwe
Graaf van Egmont
Add Destination
Reset
Calculate
Services: 100 on 139 available
EAQI
Index
1. Good
2. Fair
3. Moderate
4. Poor
5. Very poor
Results
Openbaartoi
Toilet
Reset
Gym fitnes
Hard Rock C
Antwerpen
Alert Notification
Air Quality
PM10
63 ppm
European Air Quality Index Heatmap
Events
Lines
BUS
Liège-Guillemins -- Welkenraedt
Bruges -- Gand-Saint-Pierre
Hasselt -- Aarschot
Mons -- Quévy
Day
Week
Month
Services: 89
Add POI
Points Of Interest
Le Pain Quotidien
243 m
Copyright
250 m
Modemuseum
270 m
Accommodation
Cultural Activity
Education And Research
Emergency
Entertainment
Environment
Financial Service
Bar
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, Siena, Arezzo, etc.

https://www.snap4city.org/746

https://www.snap4city.org/758

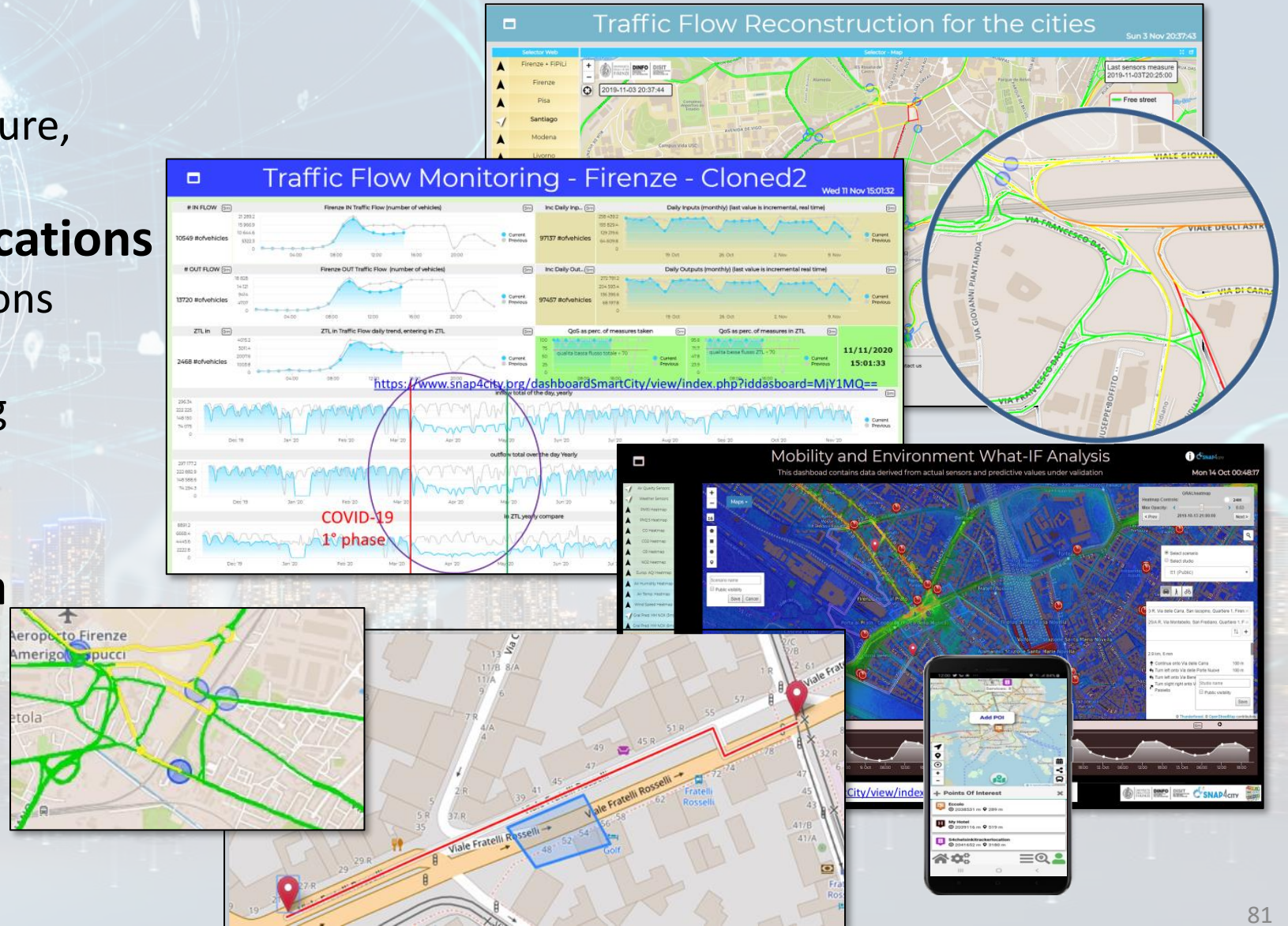
https://www.snap4city.org/751

Mobility and Transport Traffic Flow Analysis

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

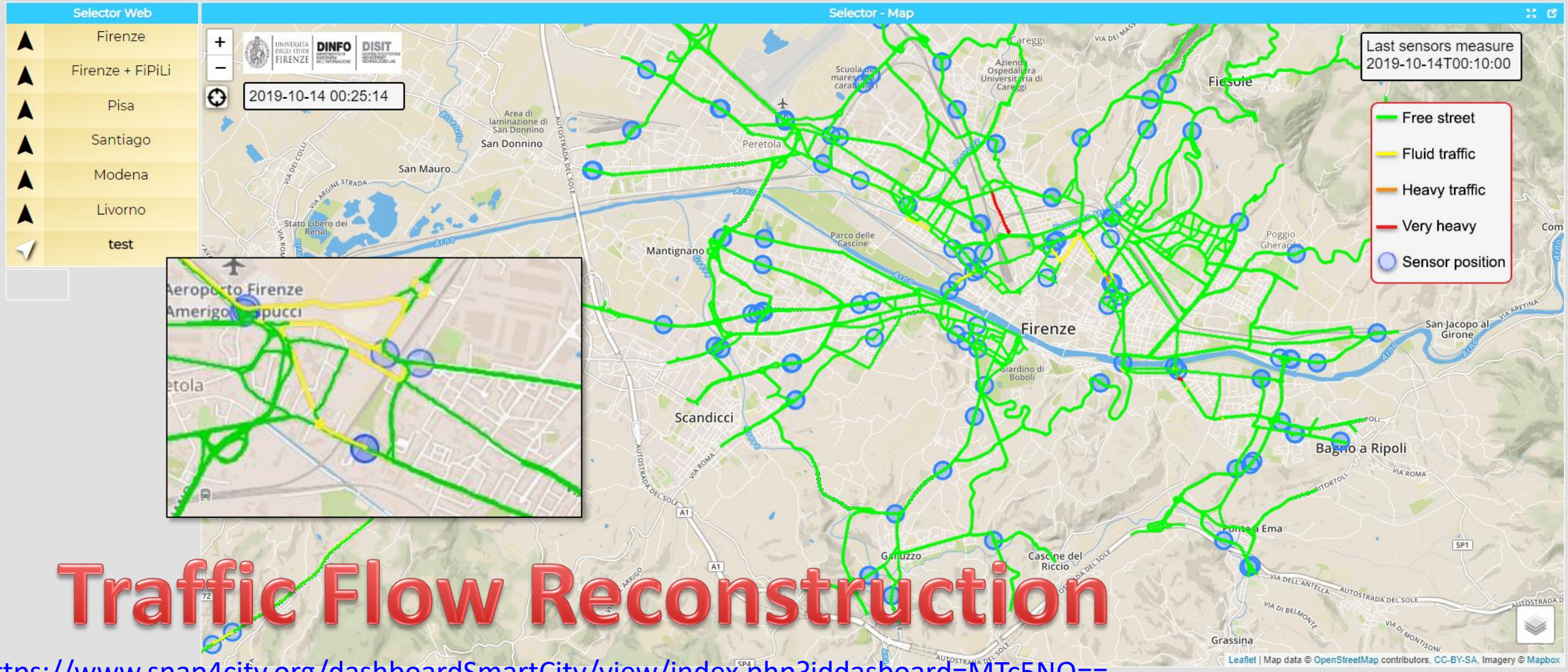
reference

- **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

Mon 14 Oct 00:25:15



Traffic Flow Reconstruction

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

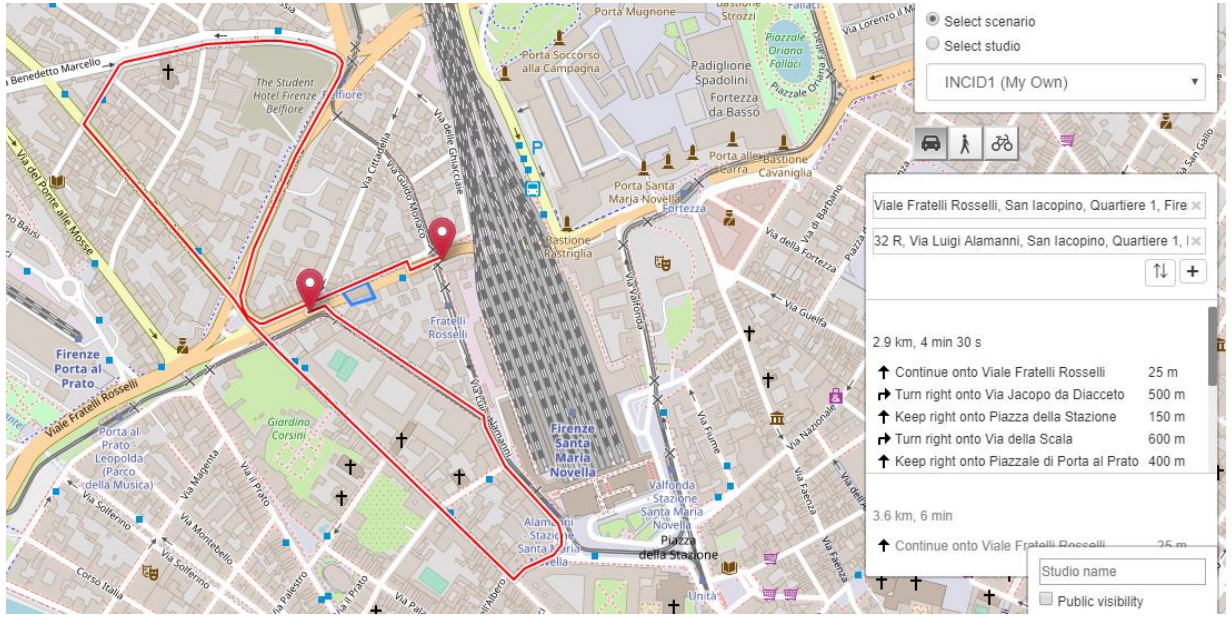
What-If Analysis

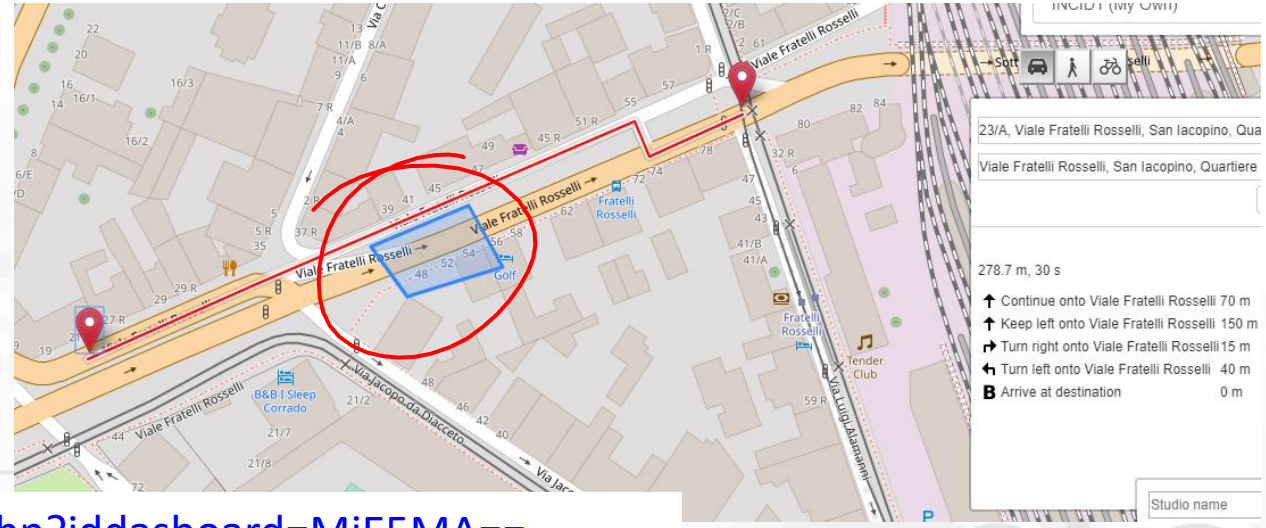
Accidents and elements blocking Points and Shapes taken into account for:

- 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==

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

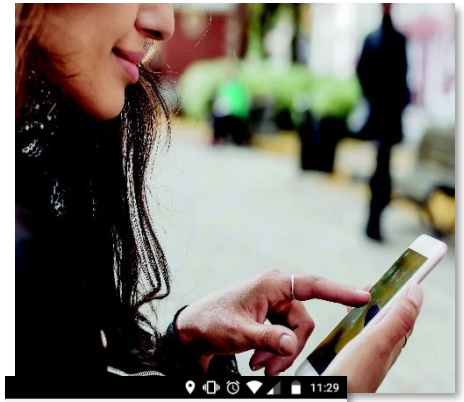
- Trajectories
- Hot Places by click and by move
- Origin destination matrices
- Most interested topics
- Most interested POI
- Delegation and relationships
- Accesses to Dashboards
- **Cumulated Scores from Actions**
- Requested information
- Routing performed
- .....

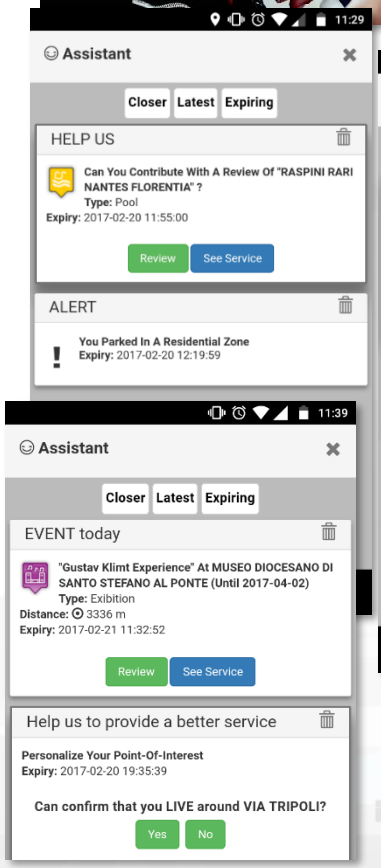
Produced information

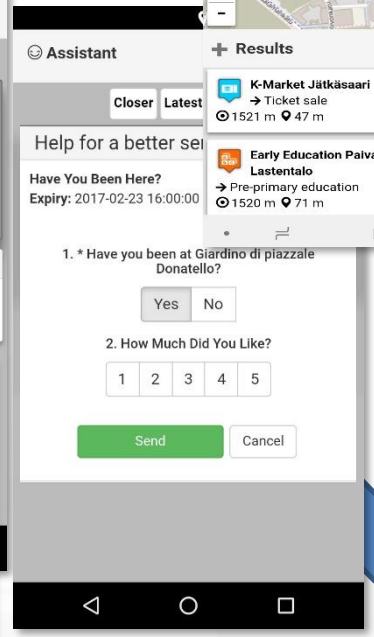
- Suggestions
- Engagements
- Notifications
- ...

System

Users' Engagement





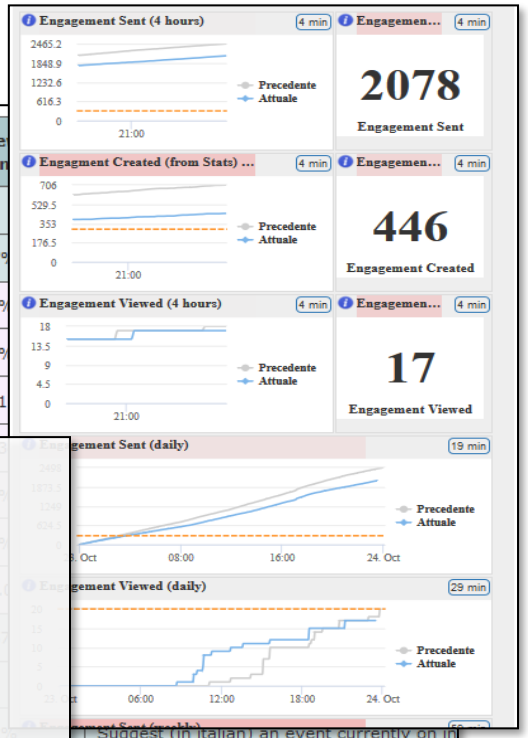


User context

Rules

City context

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..

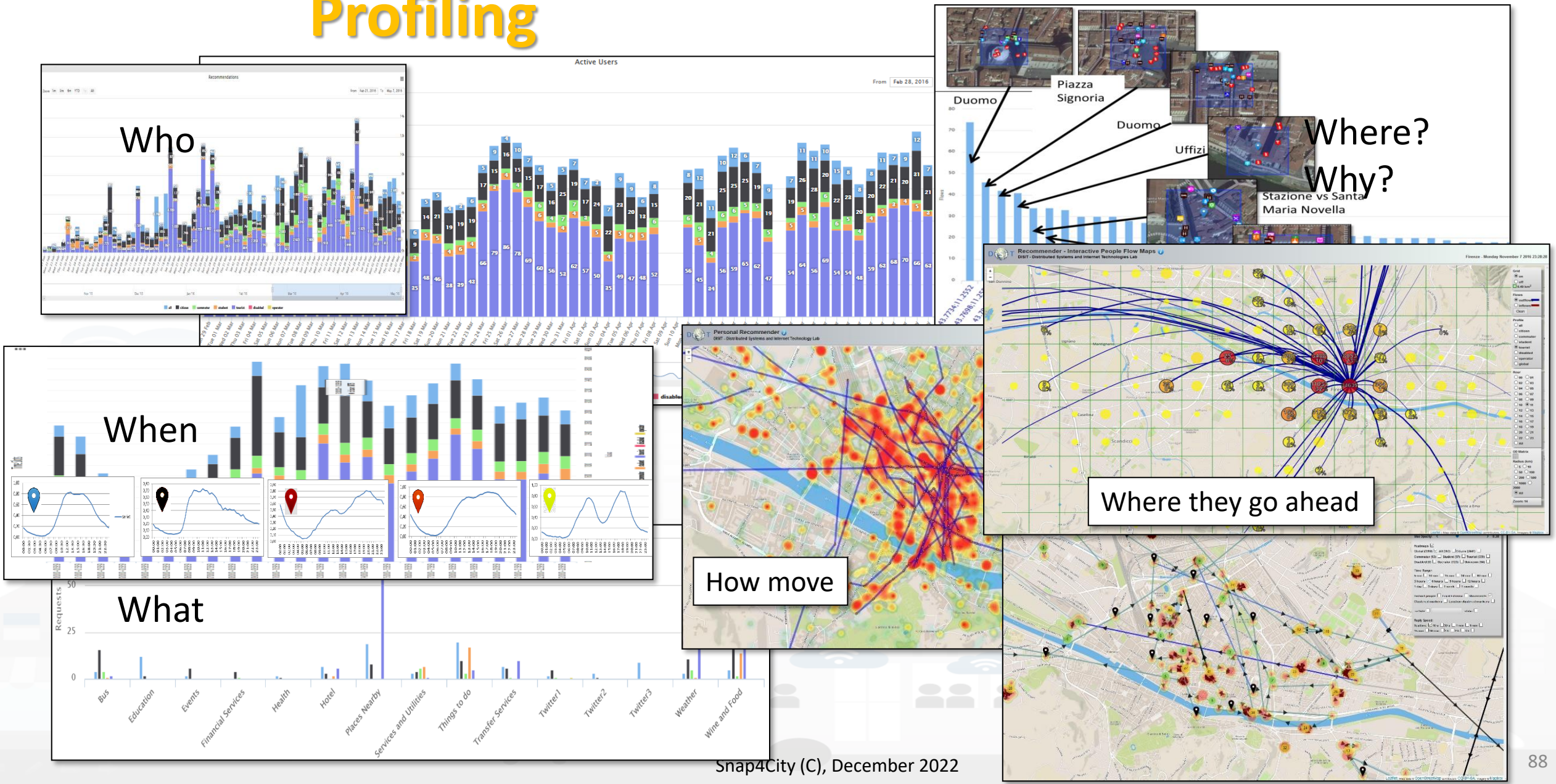
Provide Bonus, rewards if needed

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

Suggest (in italian) an event currently on in
Alert (in english) if the user parked in a res
Alert (in spanish) if the user parked in a res
Alert (in italian) if the user parked in a resid
Ask (in german) a contribution for a nearby

Campaing on Sustainable Mobility

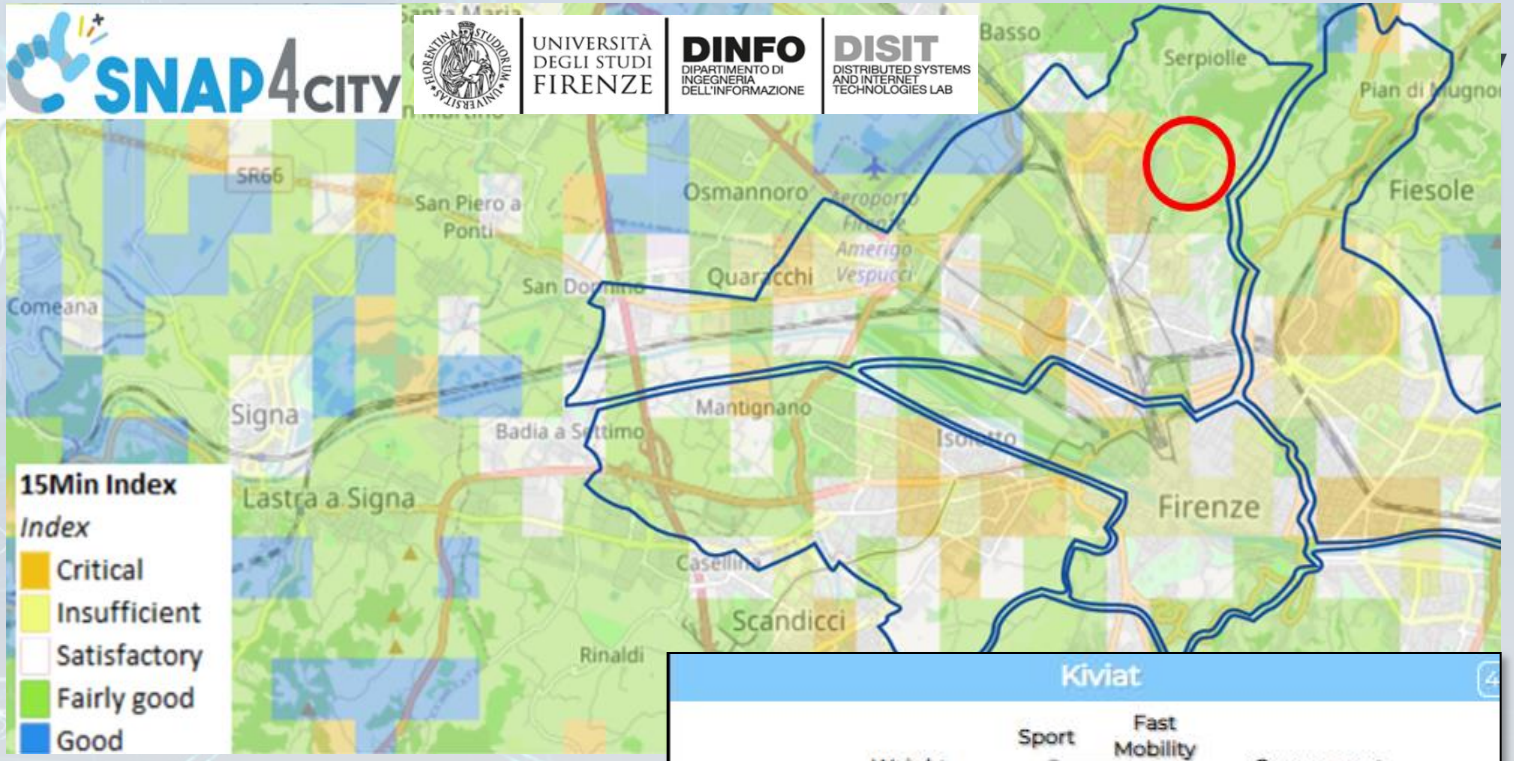
User Behavior Analyser for Collective Profiling



15MinCityIndex

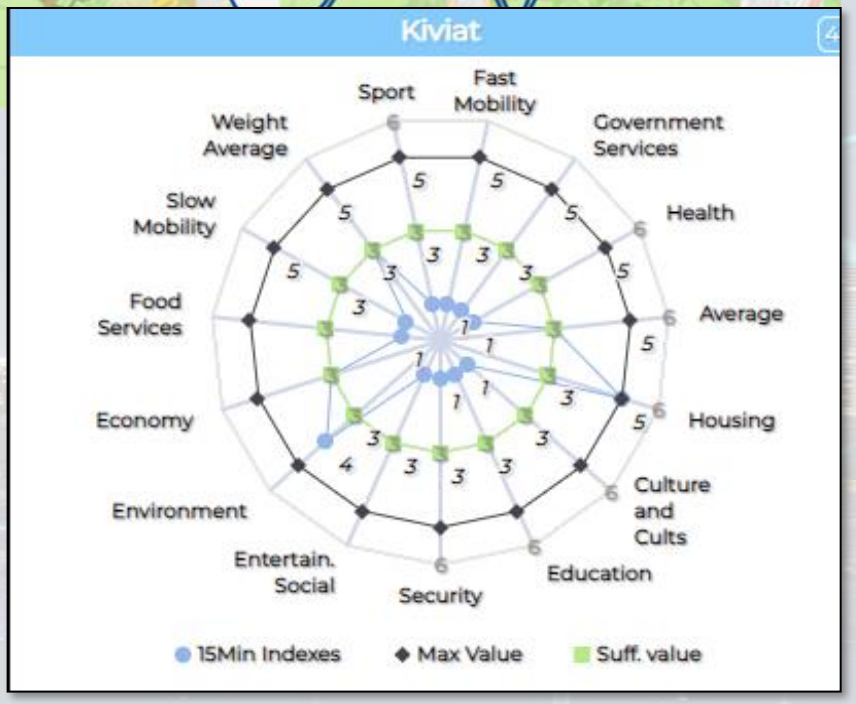
What would support my neighborhood to become a 15-Minute City?

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

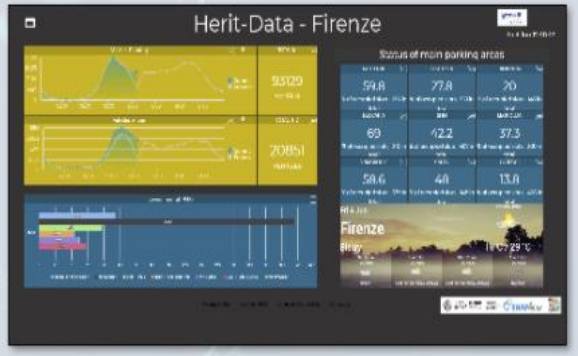
https://www.snap4city.org/747

Herit-Data - Florence Main

Tue 21 Dec 23:38:03

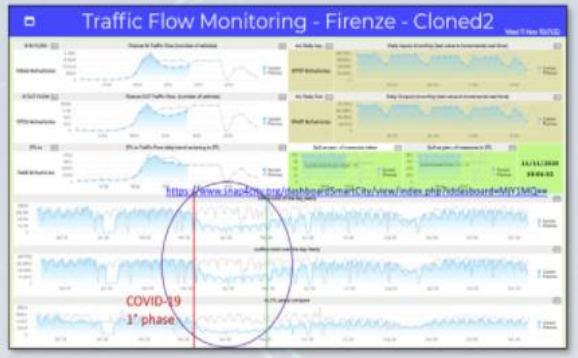
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzE0NA==

- **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

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
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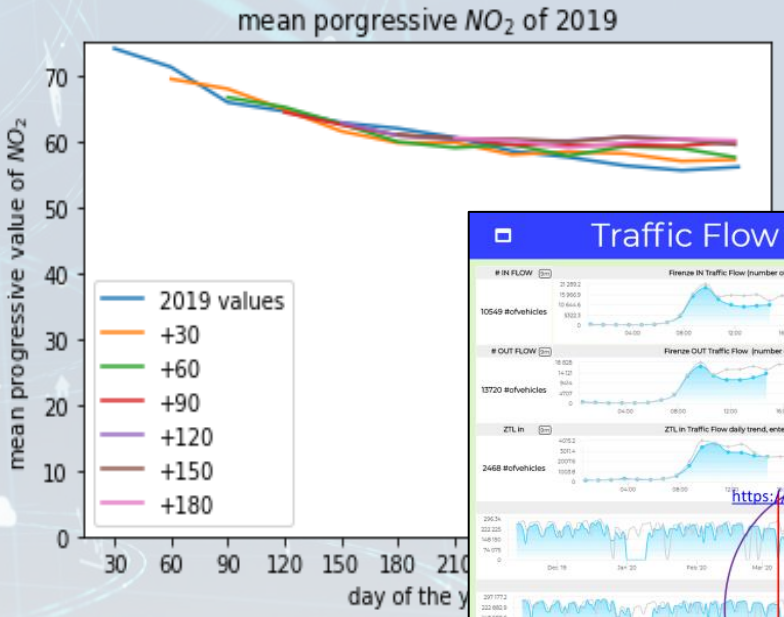
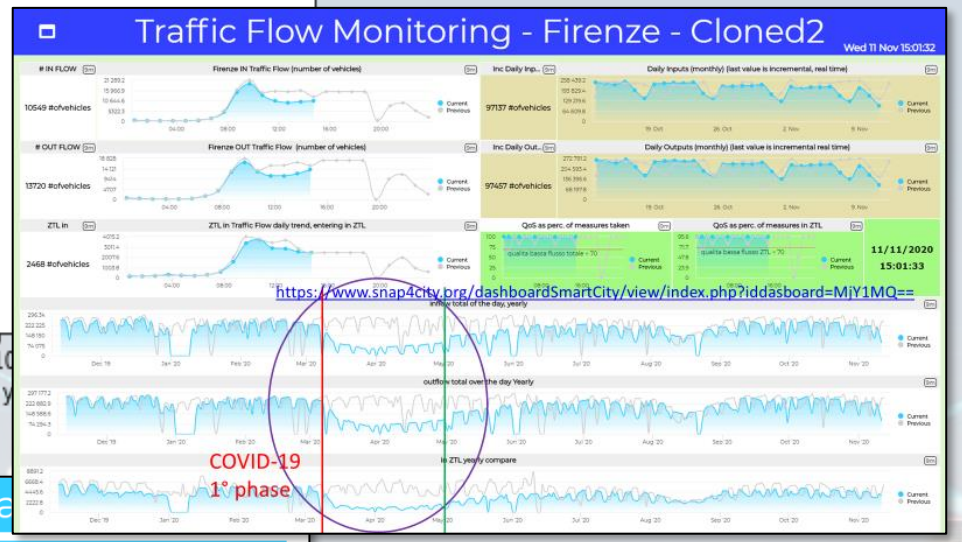
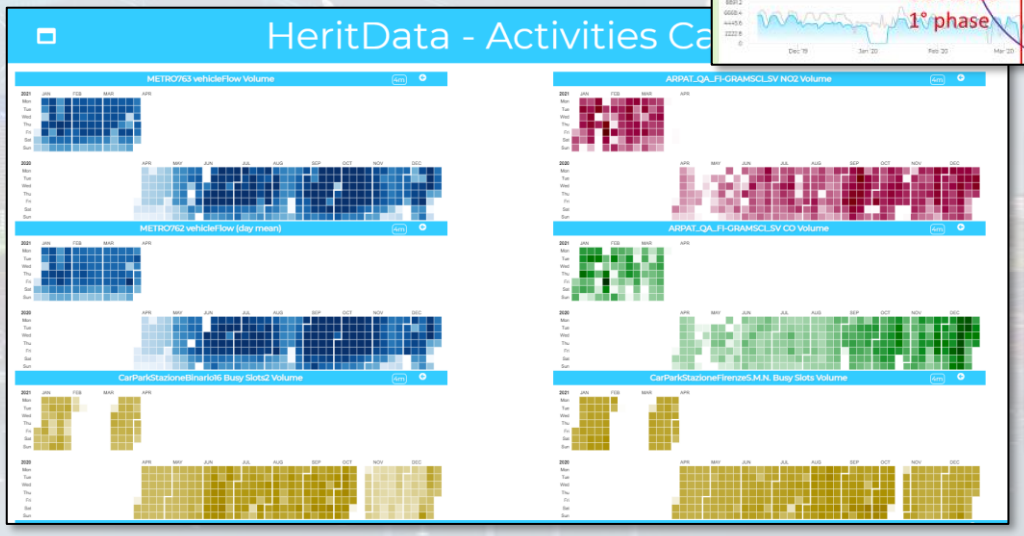
  - Sentiment Analysis
- **Since 2019, 2020**





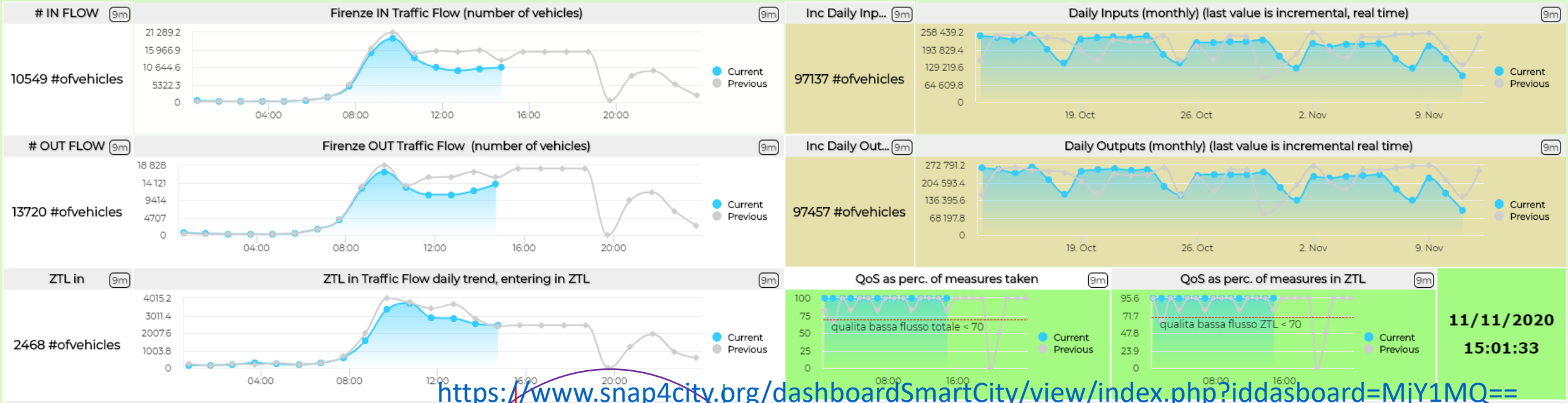


metric	model30	model60	model90	model120	model150	model180
MAE	1.21	1.31	1.52	2.04	2.31	2.37
RMSE	2.16	2.61	4.18	6.77	7.83	7.93
MAPE	1.99	2.20	2.65	3.57	4.07	4.18
R2	0.91	0.83	0.80	0.54	0.45	0.14

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

Traffic Flow Monitoring - Firenze - Cloned2

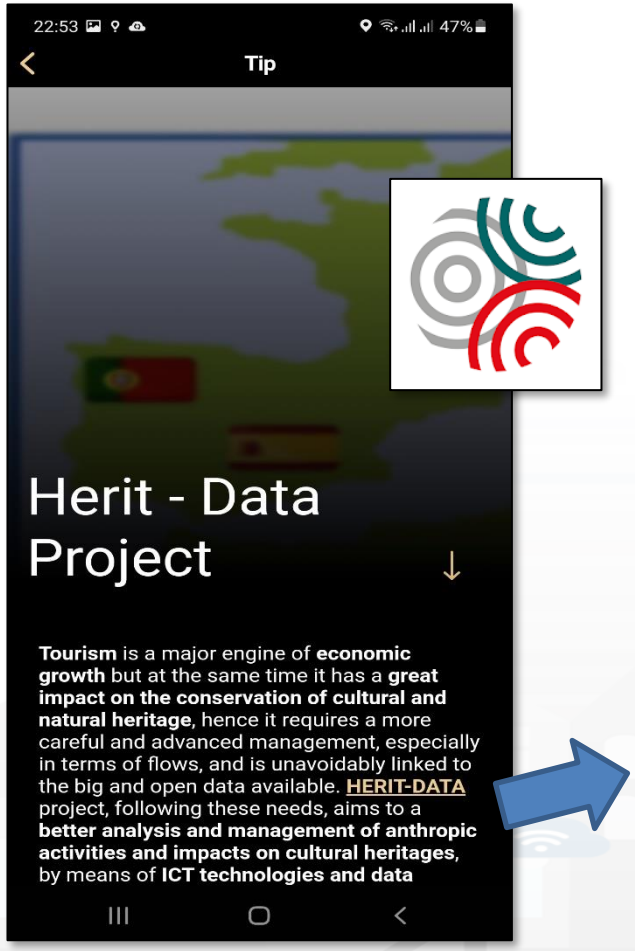
Wed 11 Nov 15:01:32

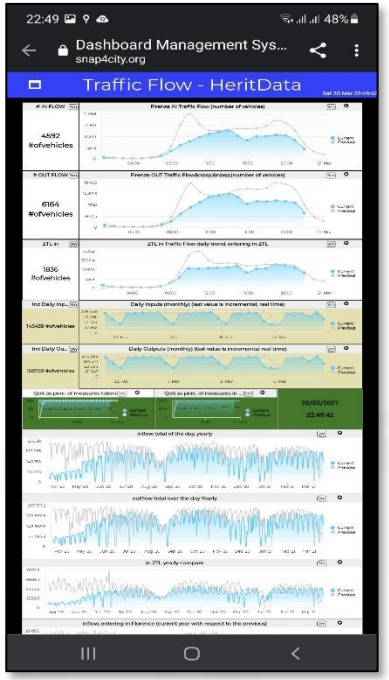


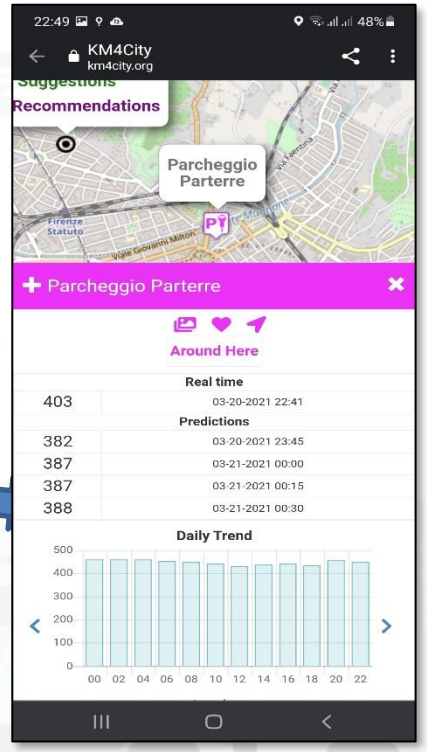
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjY1MQ==

Florence Dashboard

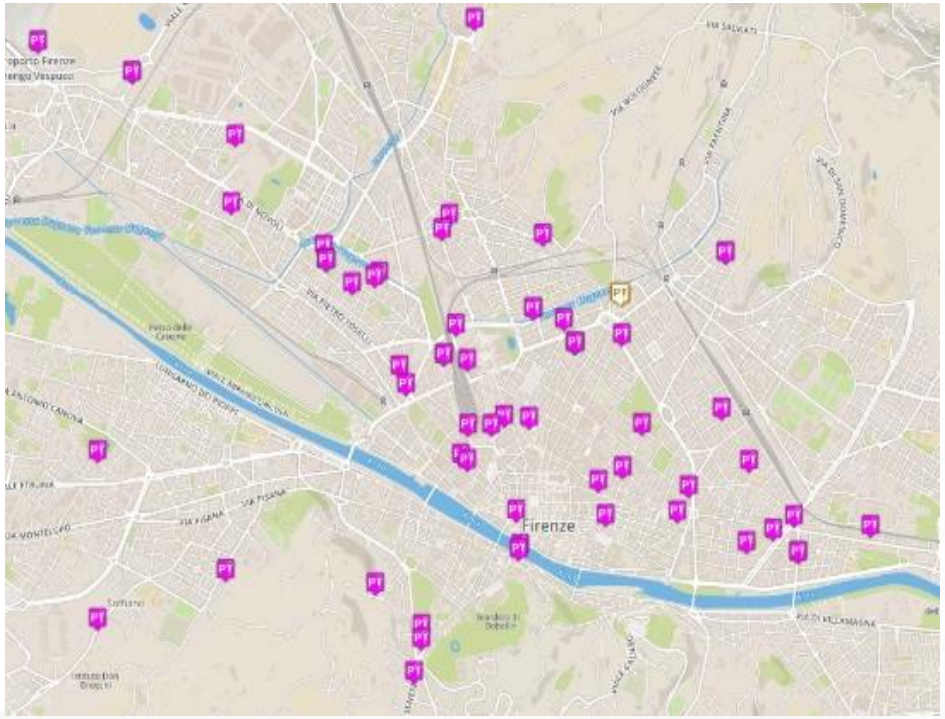
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzAwNA==







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

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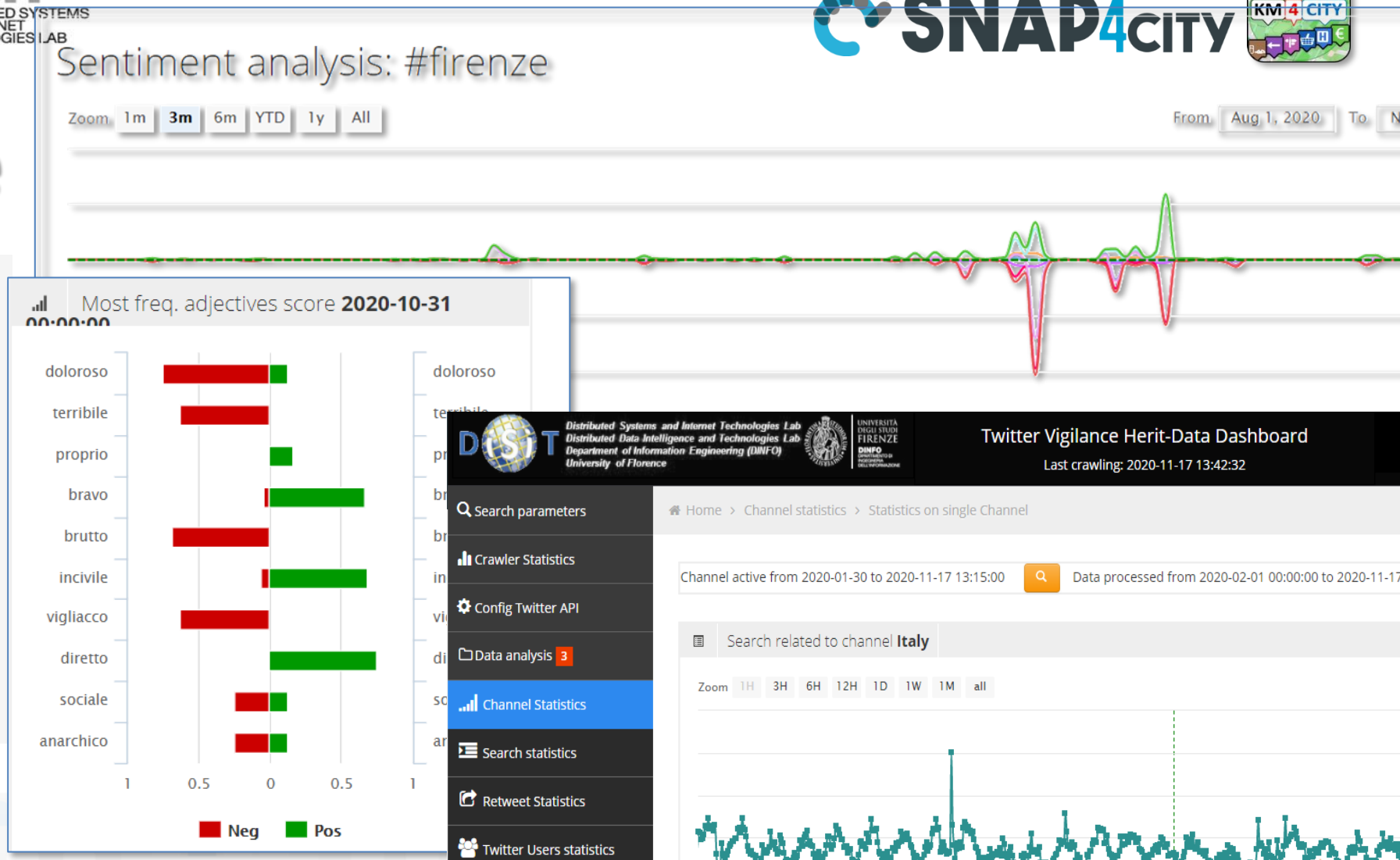
SNAP4CITY | KM4CITY

TV on Florence

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



Interreg Mediterranean

HERIT-DATA

Twitter Vigilance

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 participants throwing Molotov cocktails, smashing shop windows and squad car windshields

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 [...]

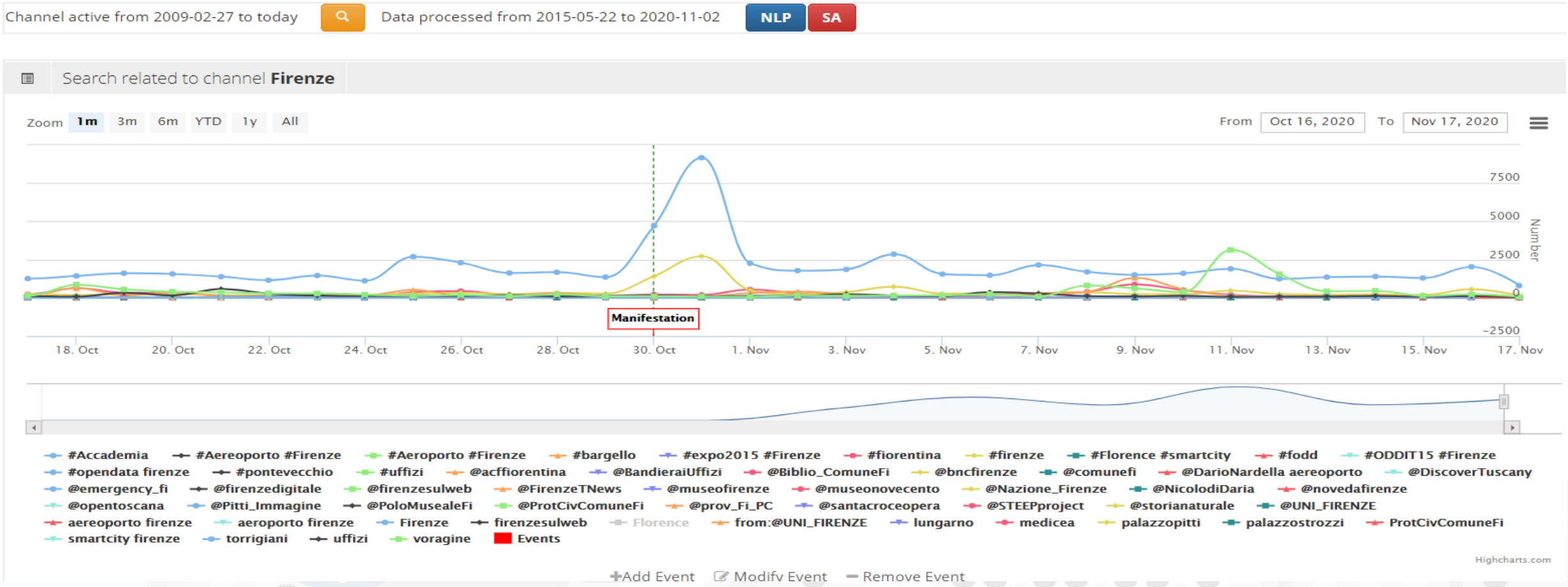
New Anti-Covid Regulations: Dos & Dont's
Given the upswing in Coronavirus infections and consequent hospital admissions since the beginning of October, Italian Prime Minister [...]

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

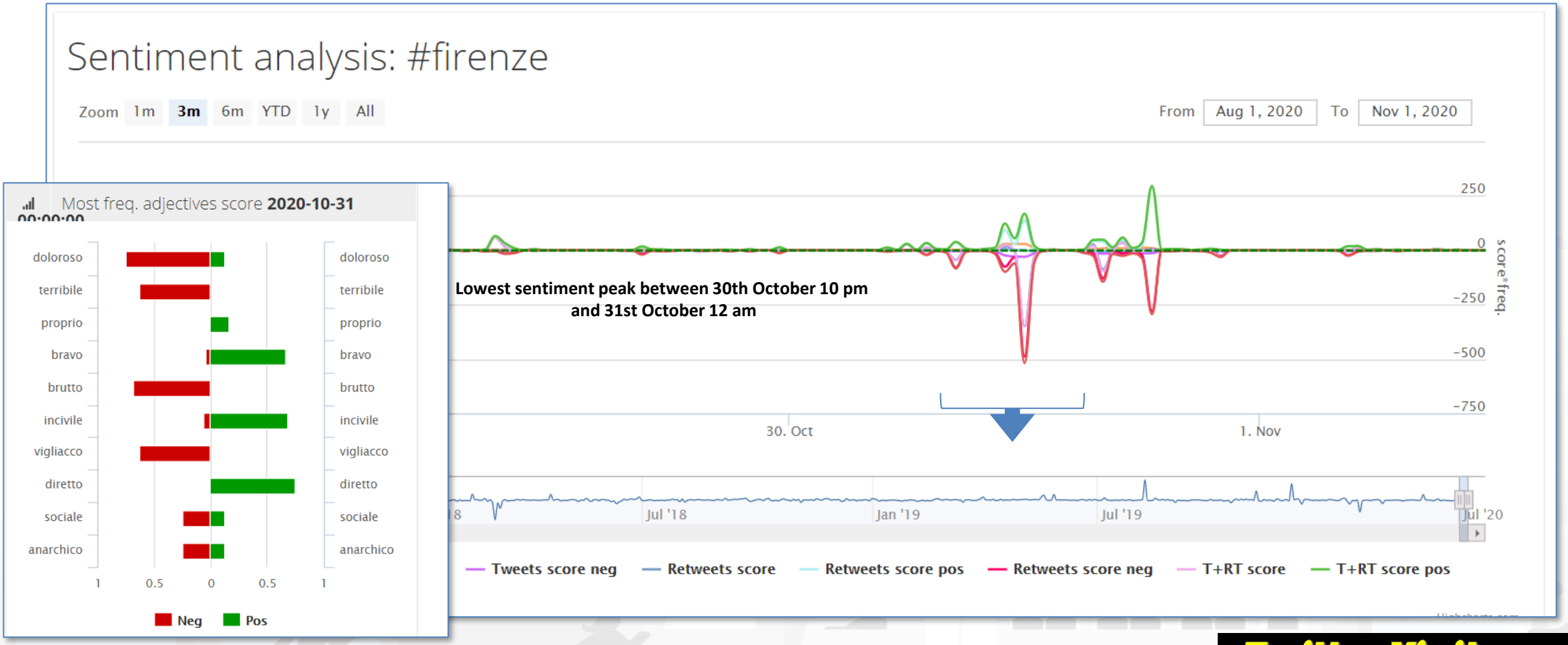
ORCHESTRA DELLA TOSCANA

30 October Manifestation



Twitter Vigilance

Sentiment Analysis for search «Firenze»

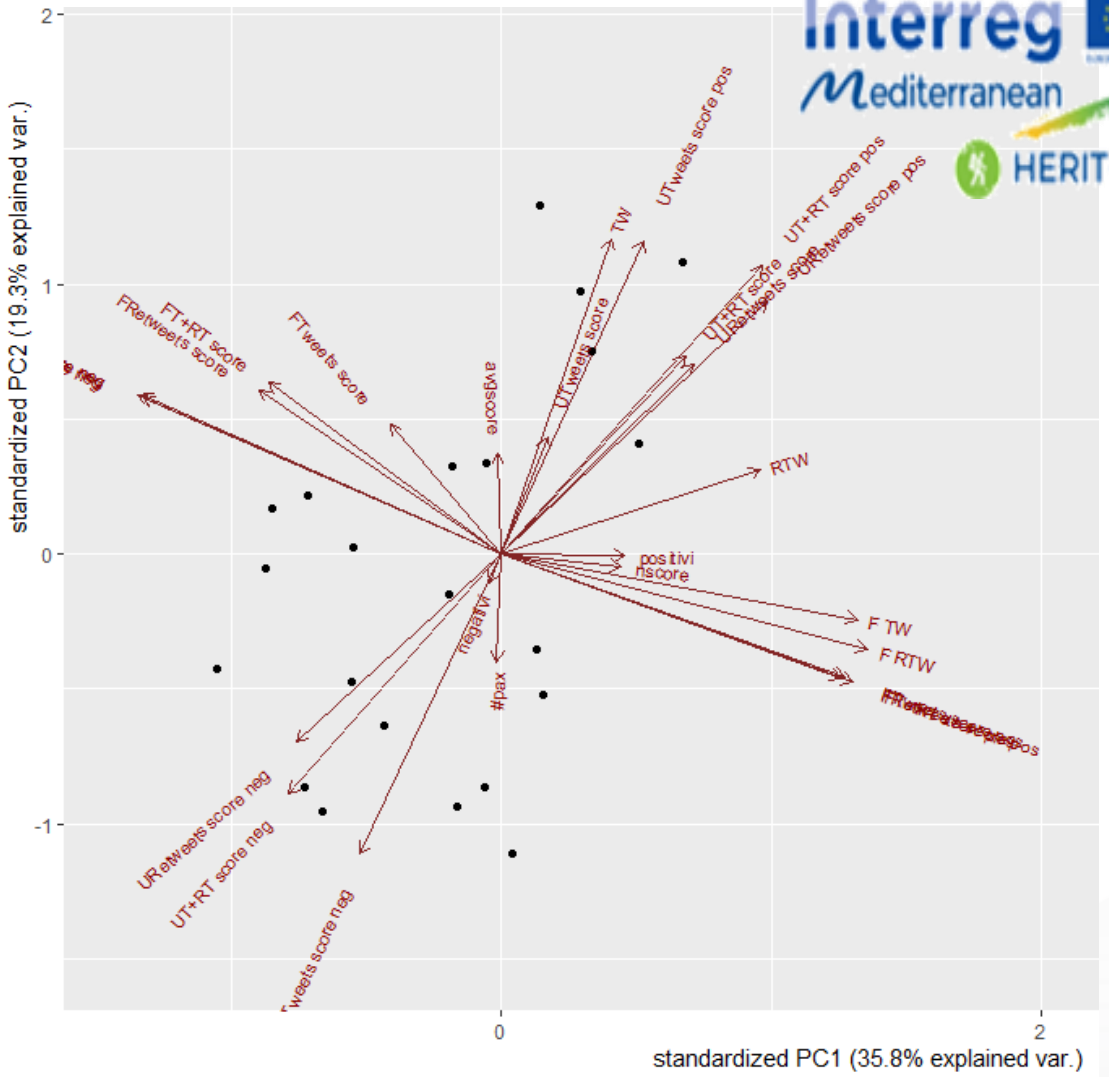


http://disit.org/tv/index.php?p=sa_ricerche&ricerca=436

Twitter Vigilance

Reputation

- Prediction/estimation of **Average Score of Trip Advisor** as a function of *Twitter Vigilance Metrics + other information*
- Prediction/estimation of **Negative Scores on specific Museum** or service as a function *of Twitter Vigilance Metrics + other information*



Twitter Vigilance

Antwerp, Belgium

https://www.snap4city.org/526

11 SUSTAINABLE CITIES AND COMMUNITIES

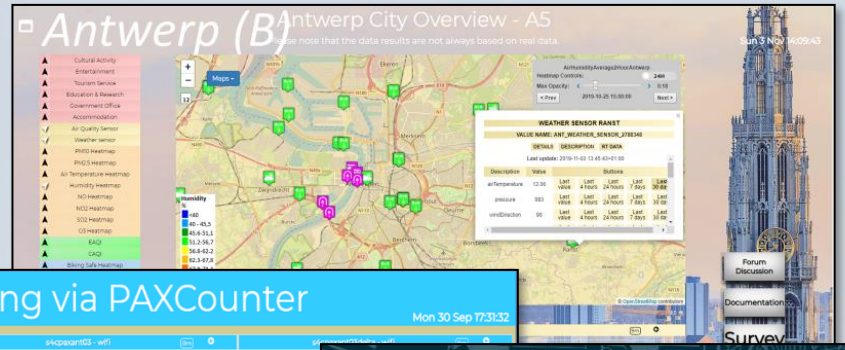
13 CLIMATE ACTION

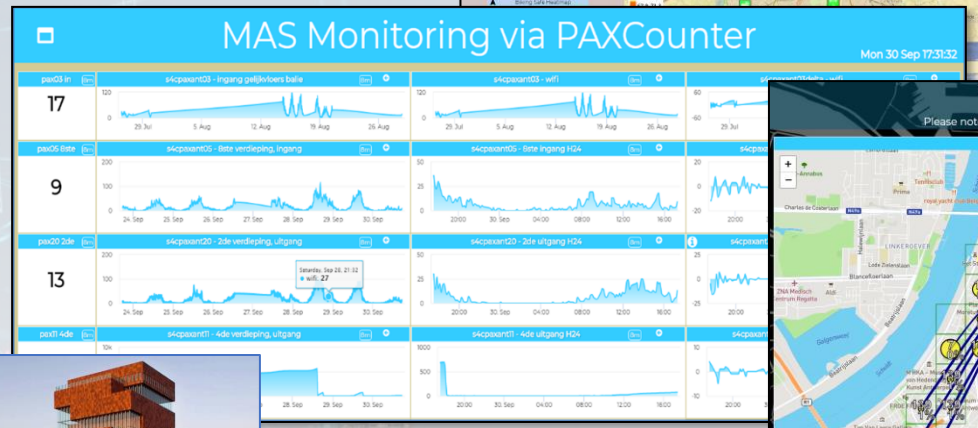
Snap4City (C), December 2022

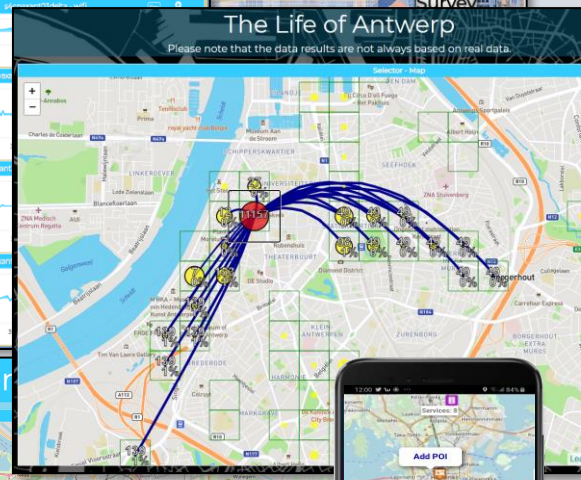
People Monitoring on Pub Services DIGIPOLIS Antwerp

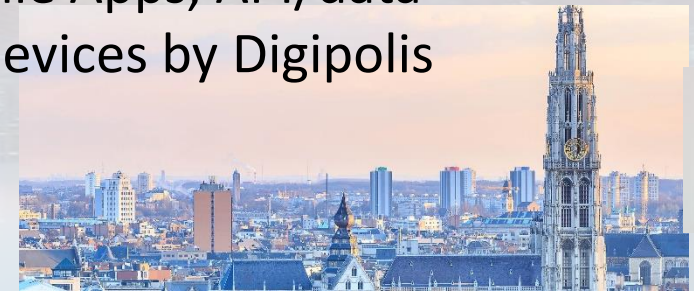
reference

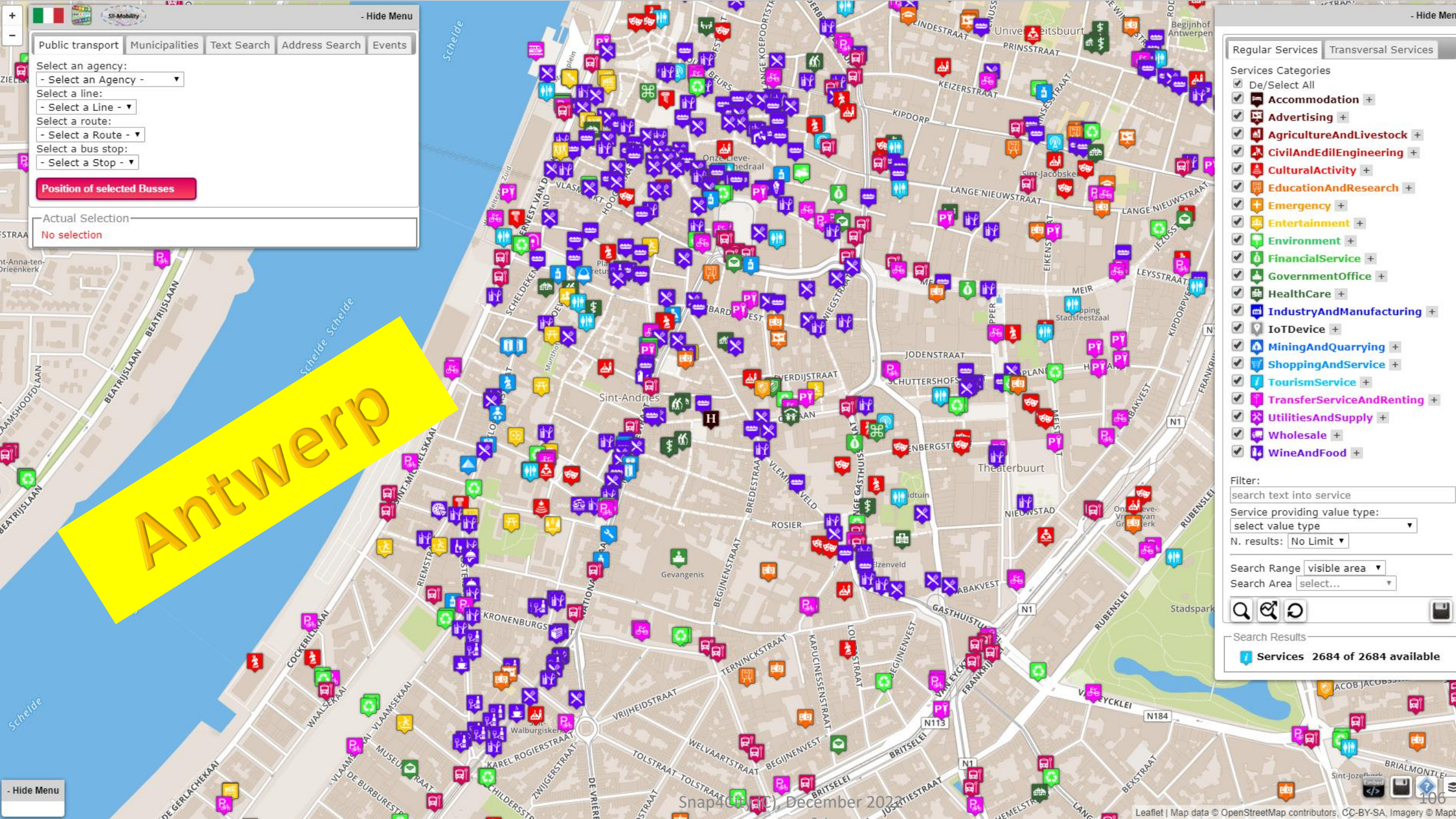
- **Multiple Domain Data**
  - PAX Counters: museum, pub services, COVID-19
- **Multiple Levels & Decision Makers**
  - Business Intelligence Dashboards
  - People flow, OD flows
  - Detection of critical conditions
- **Historical and Real Time data**
  - 20 fixed PaxCounters
  - 2 Mobile PaxCounters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









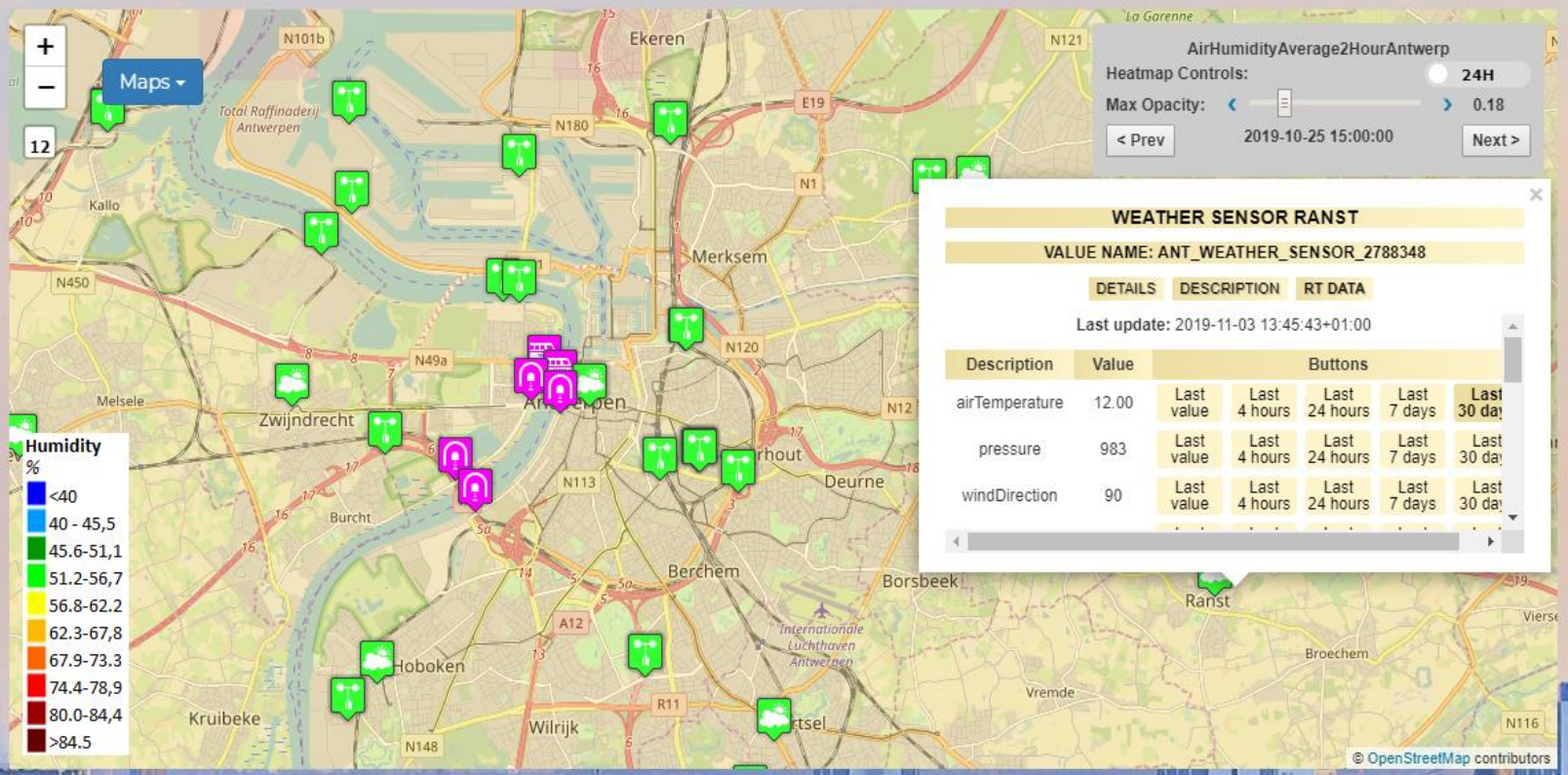

- Hide Menu
Public transport
Municipalities
Text Search
Address Search
Events
Select an agency:
- Select an Agency -
Select a line:
- Select a Line -
Select a route:
- Select a Route -
Select a bus stop:
- Select a Stop -
Position of selected Busses
Actual Selection
No selection
Antwerp
Regular Services
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
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

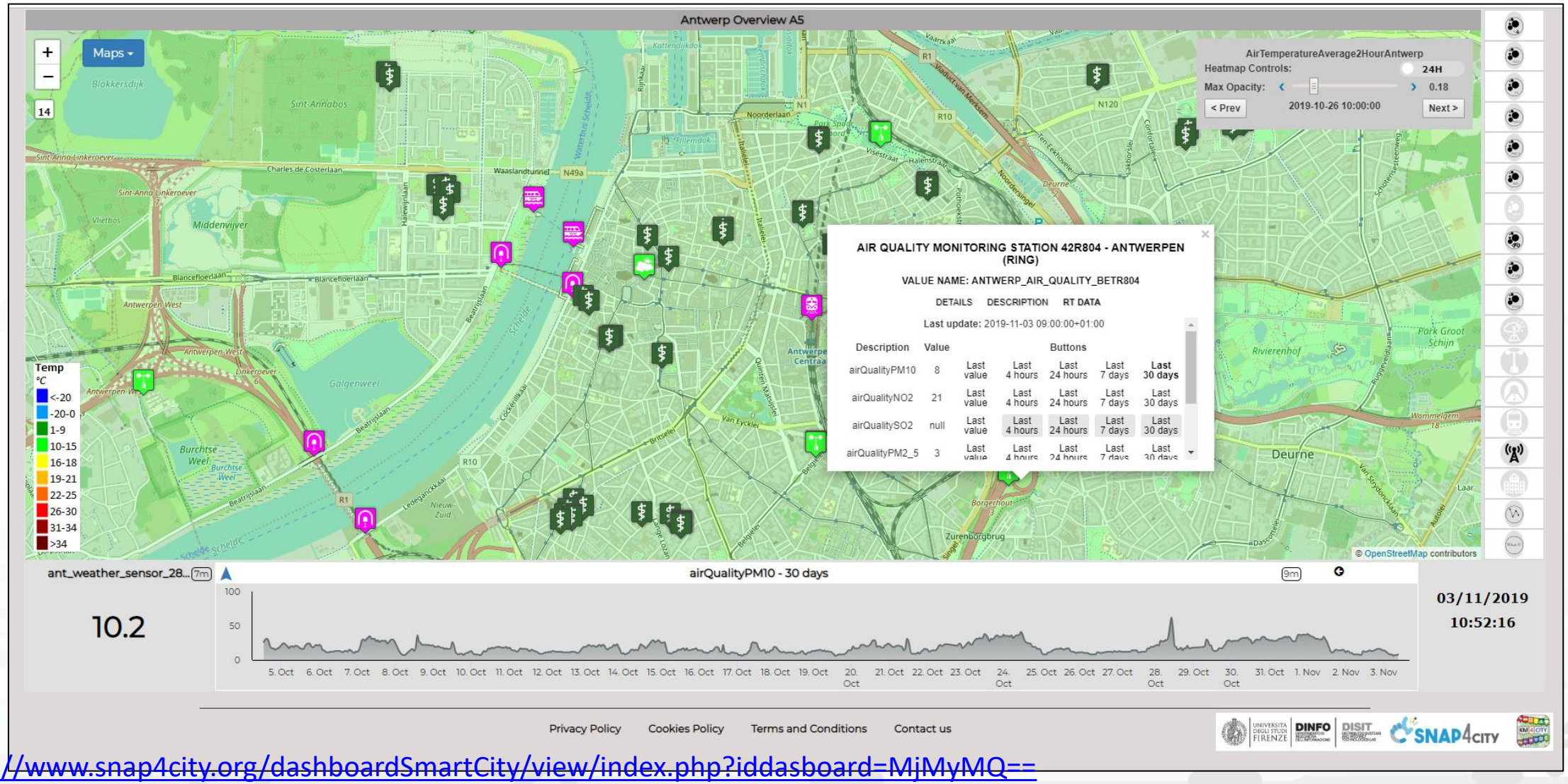
Survey

The Life of Antwerp

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

Antwerp

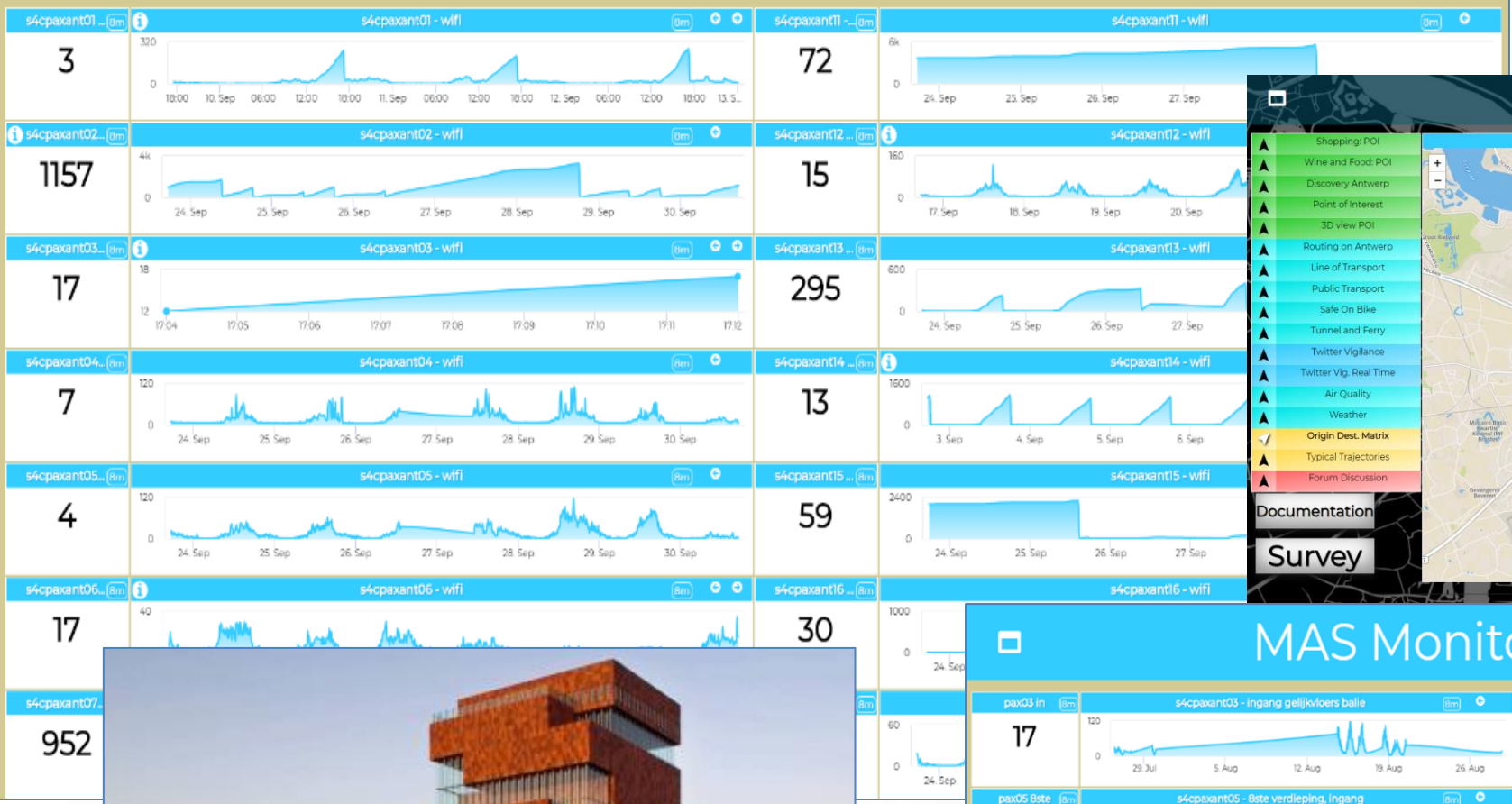
Unique Dashboard builder Multiple Styles

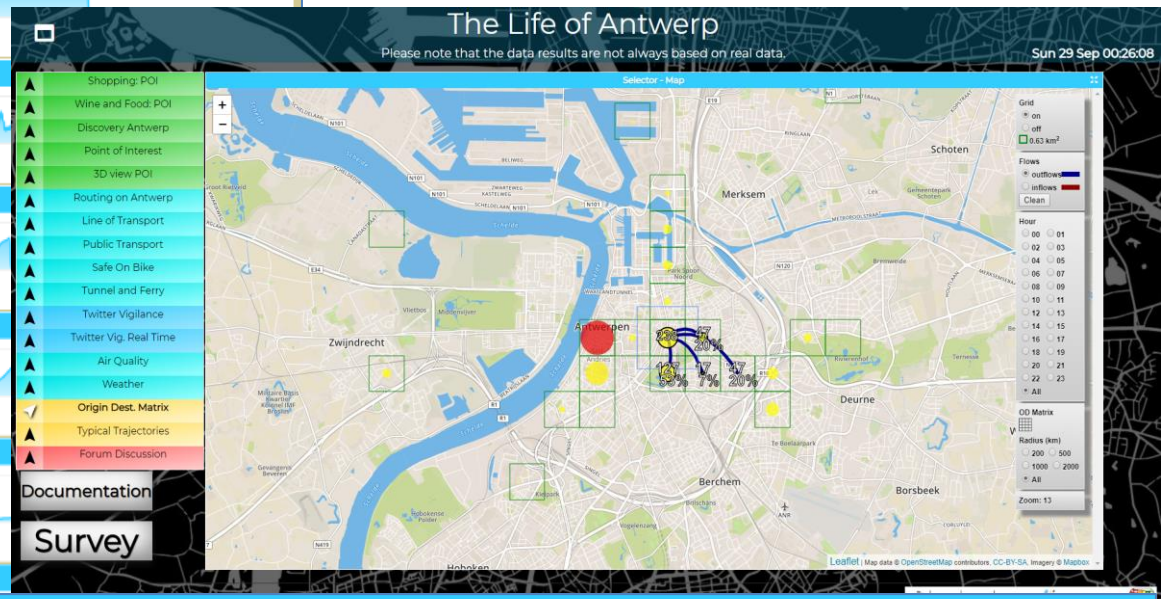


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjMyMQ==

PAXCounter real time and trend

Mon 30 Sep 17:18:48





MAS Monitoring via PAXCounter

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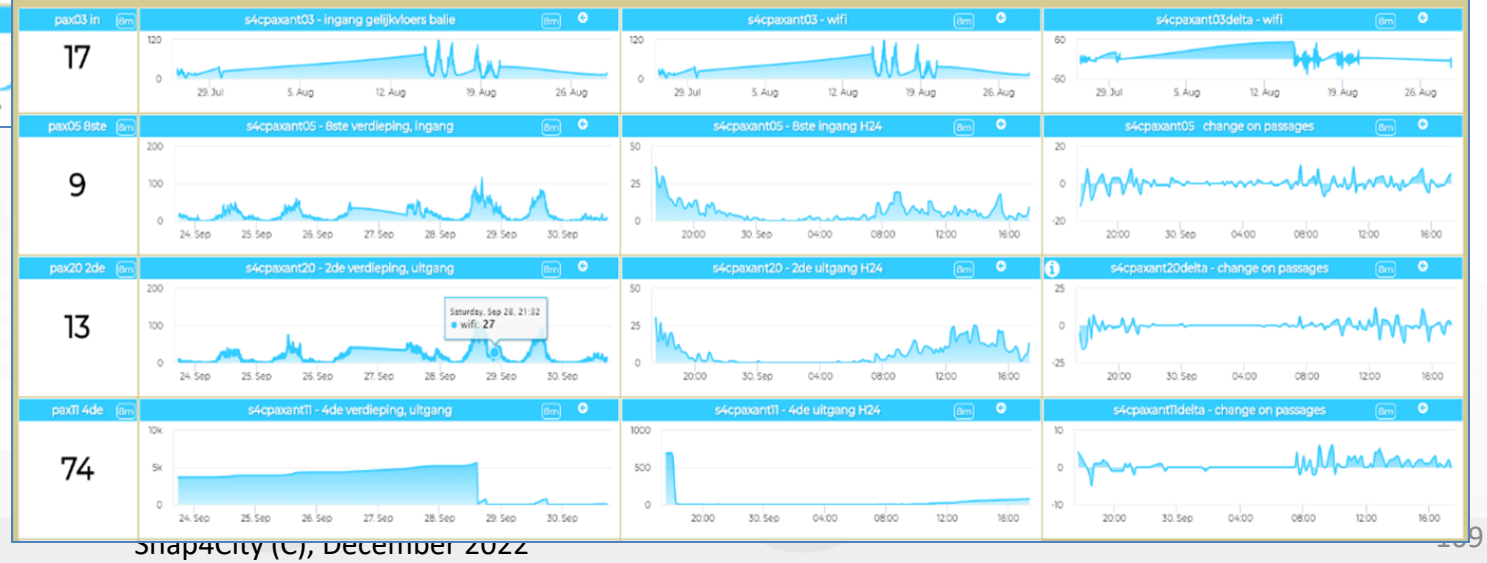
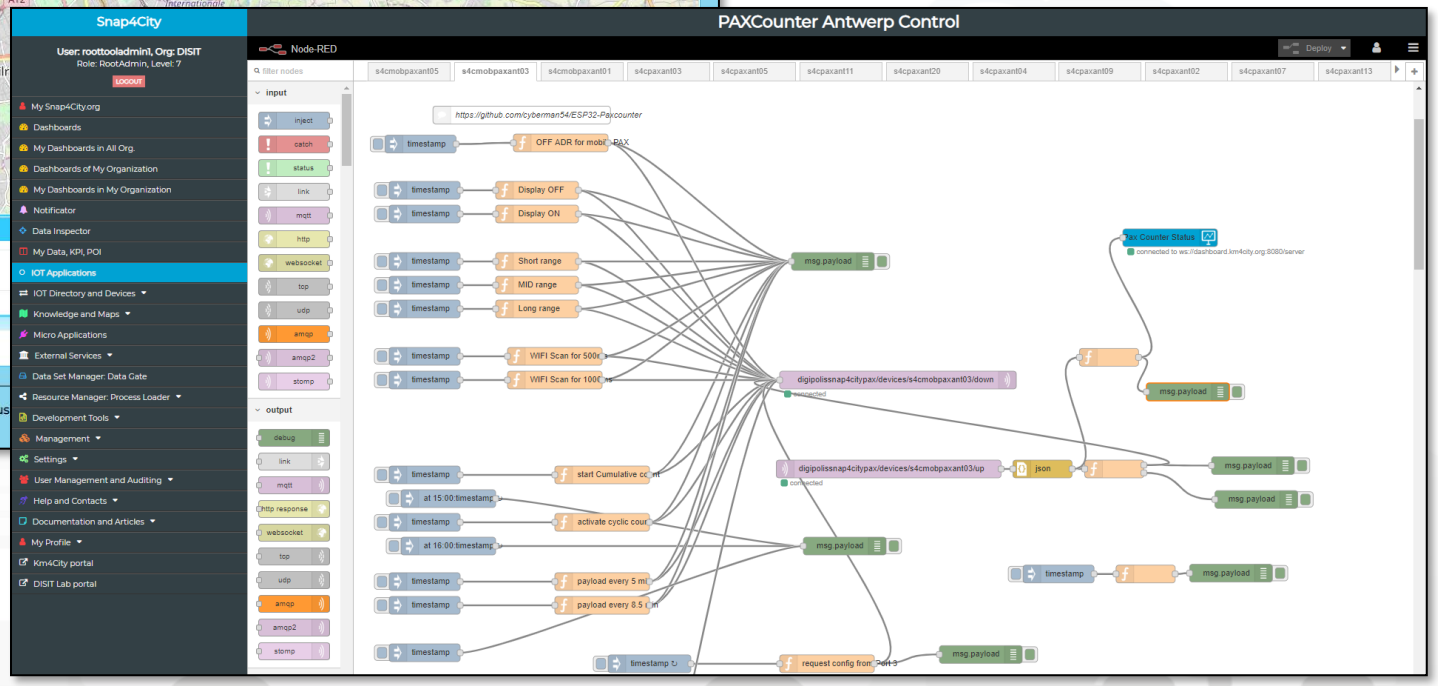


Programmable PAX counting



Antwerp

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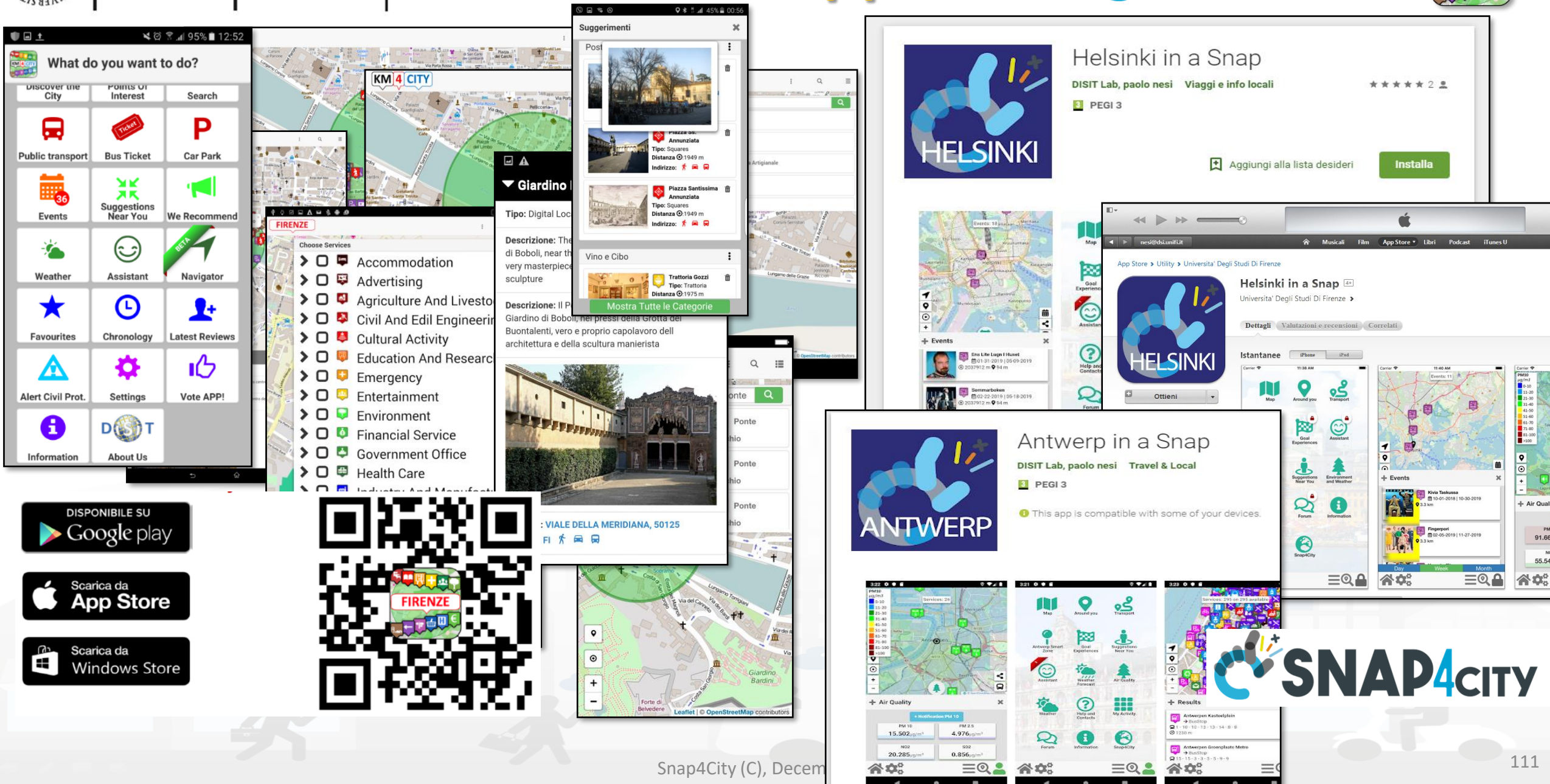
Mobile Apps

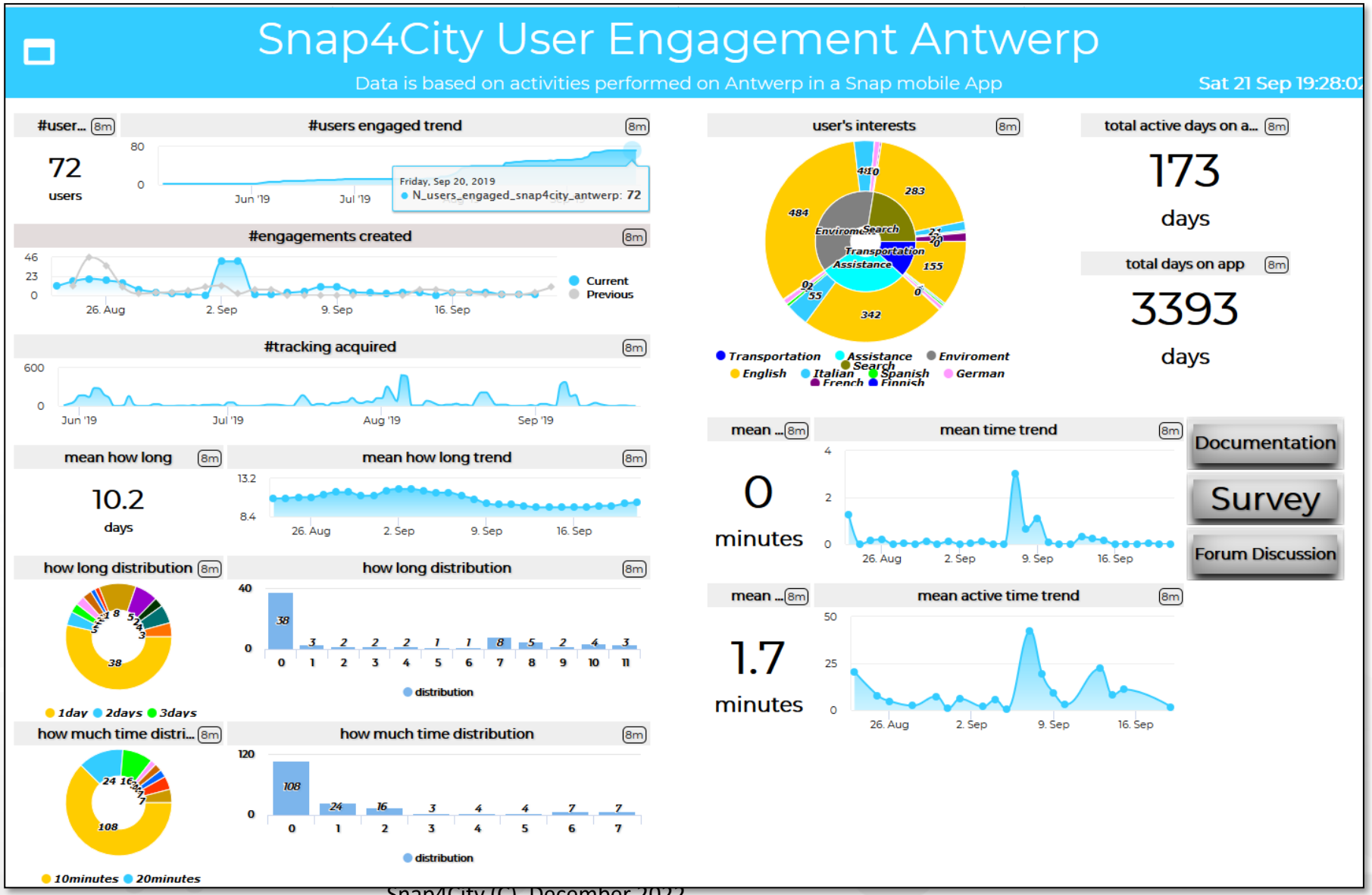
SNAP4CITY



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

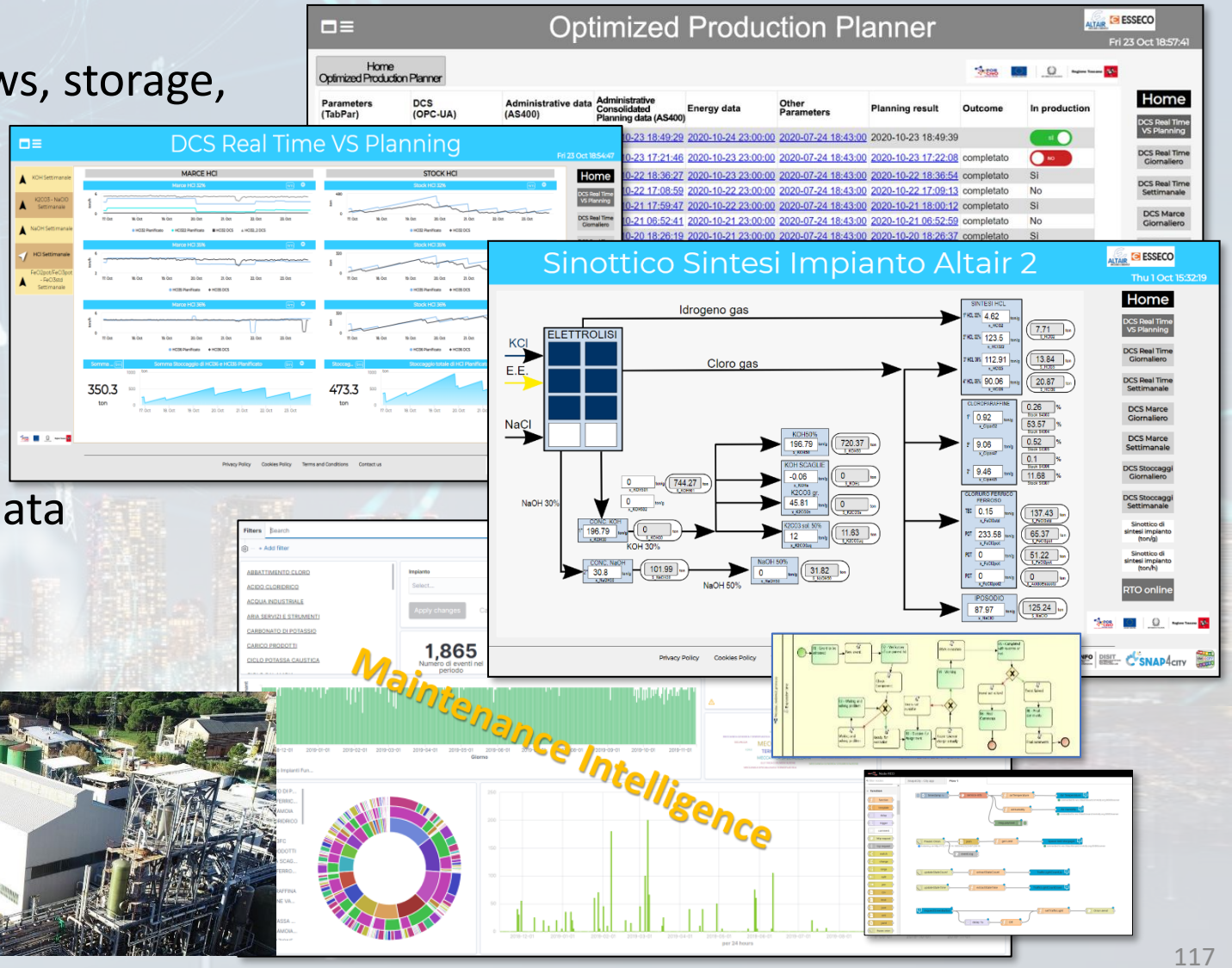
Aims

- **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

Energy Service

Data Connections and Transformation

IoT App/DA: Real Time & Stream Processing

Predictive Maintenance

Prod. Plan Optimization

API/MicroServices

Maintenance Intelligence

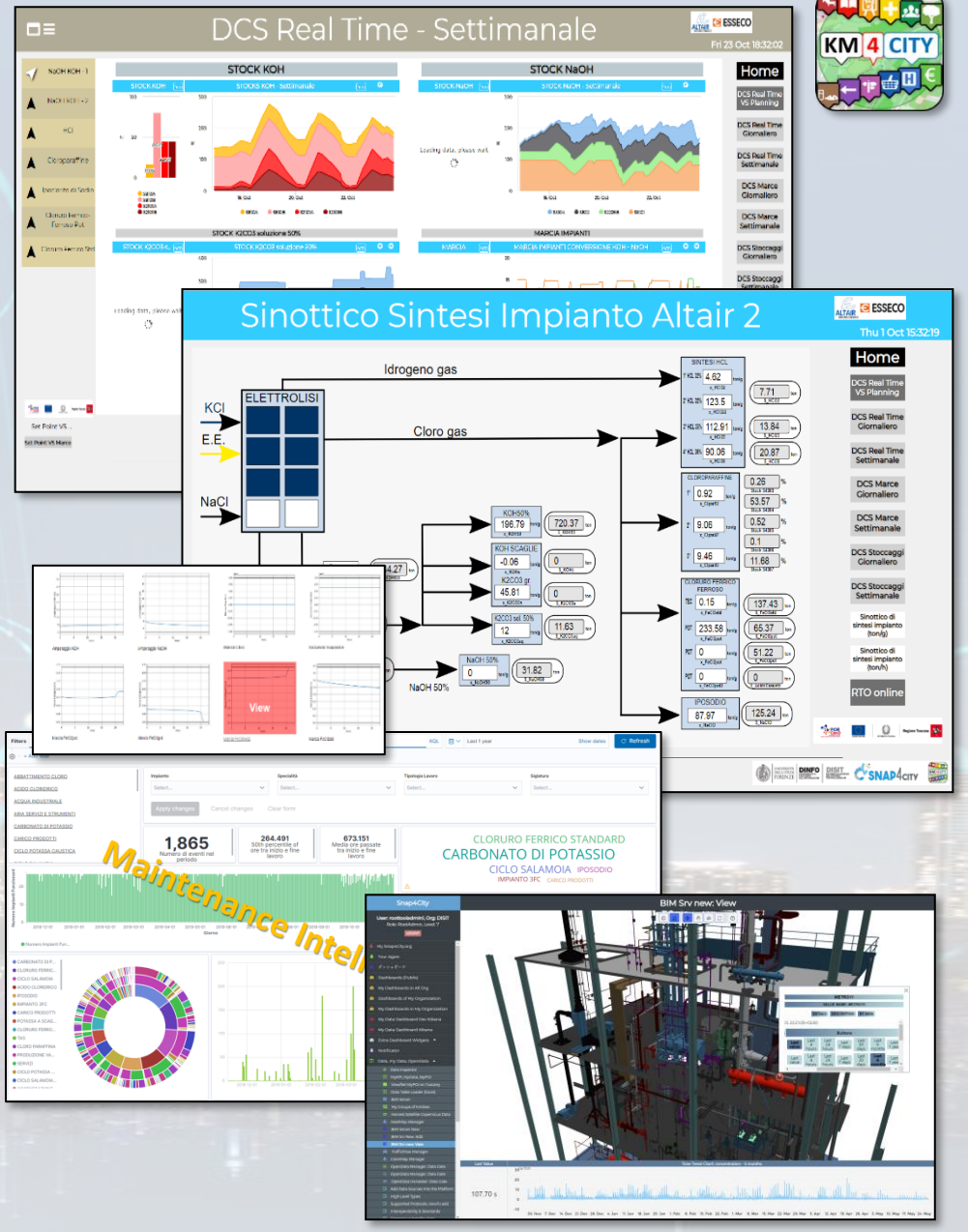
Digital Twin Local / BIM

……

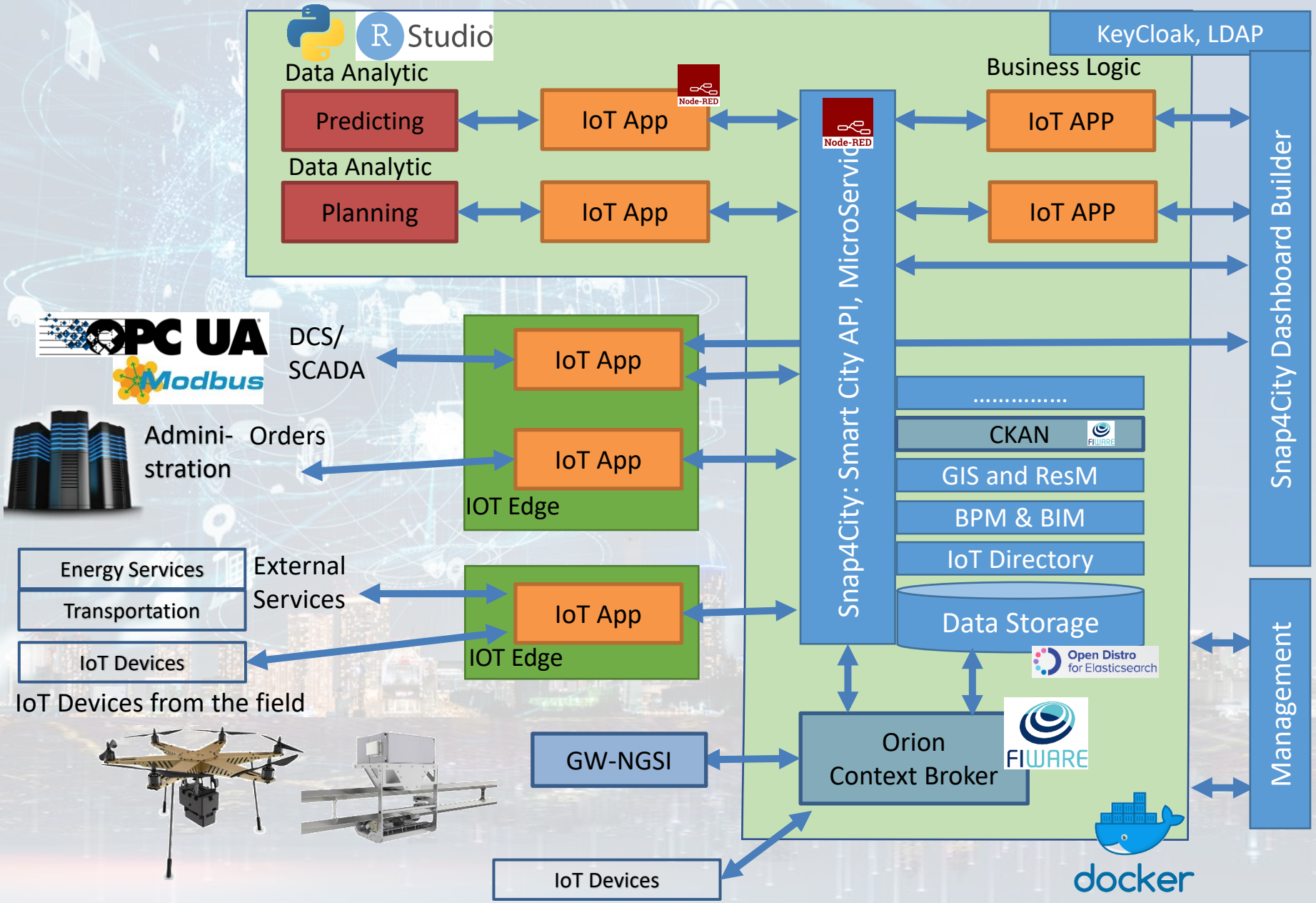
Data Storage

Management, Auth./Autoriz.

Snap4City Dashboard Builder

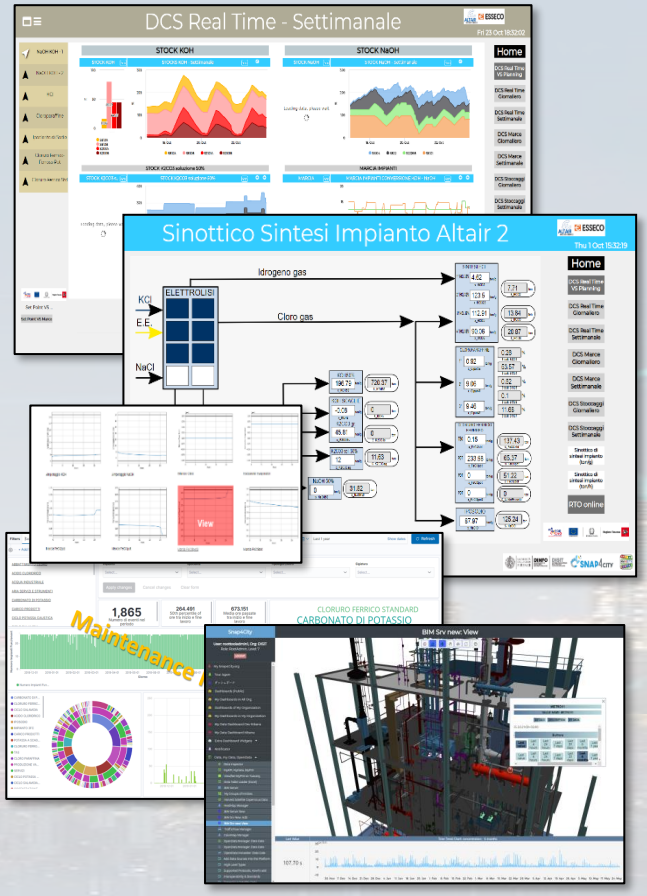


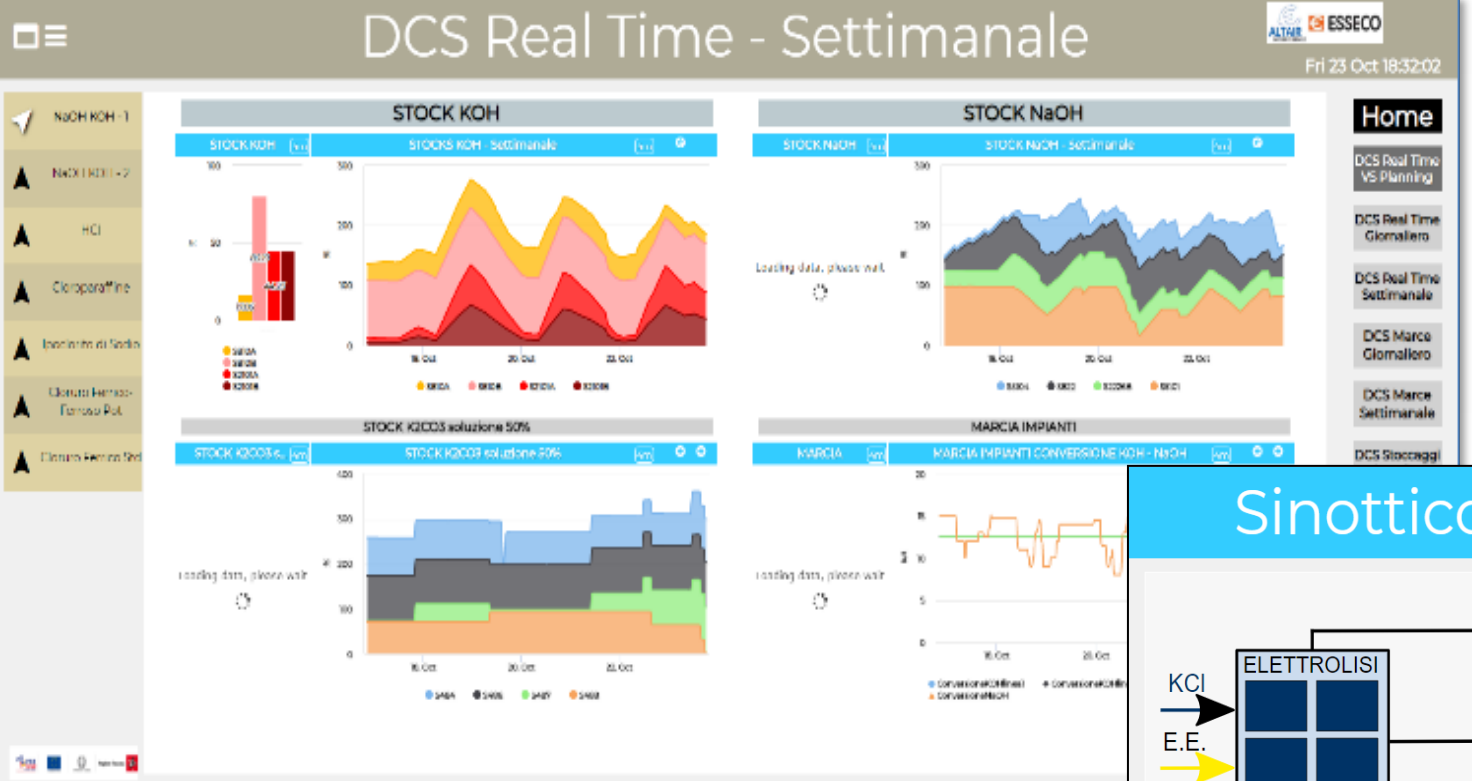
Snap4City/Industry Detailed Architecture

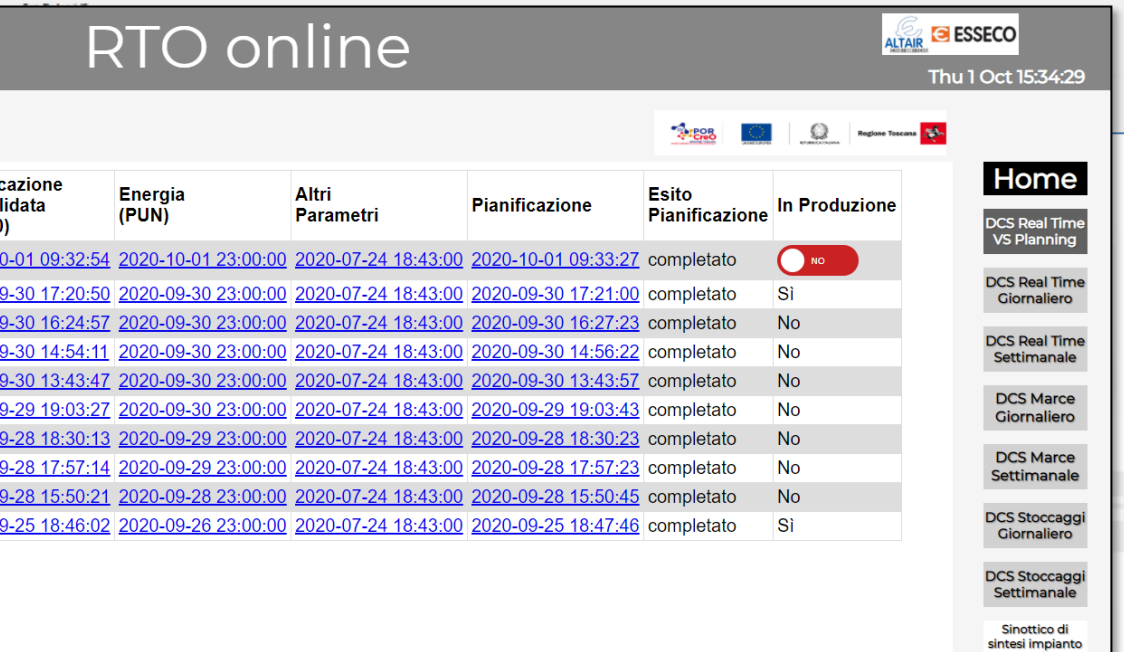


Production Parameters

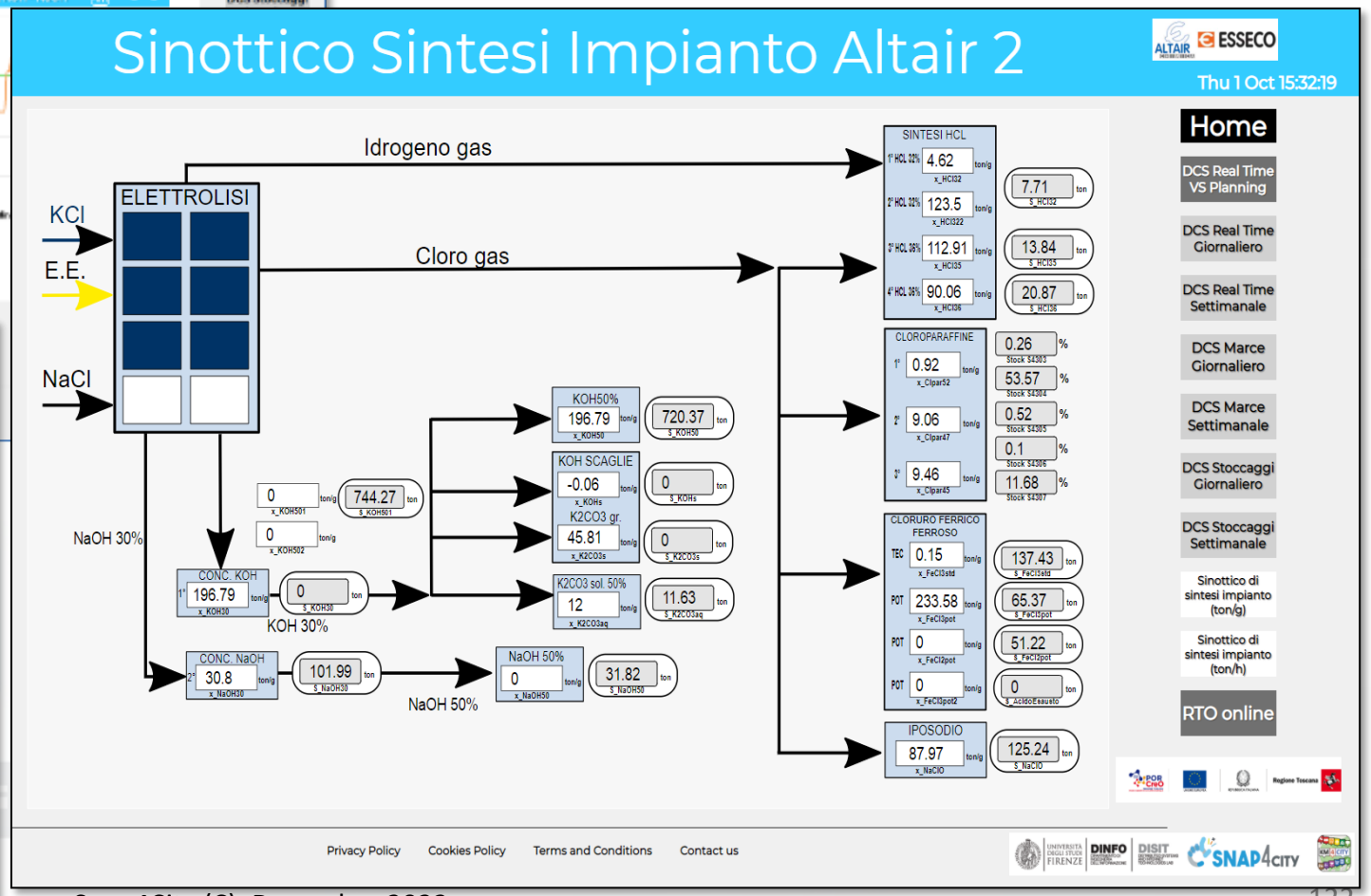
Dashboards, Visual Analytics, Synoptics, 3D, Maps



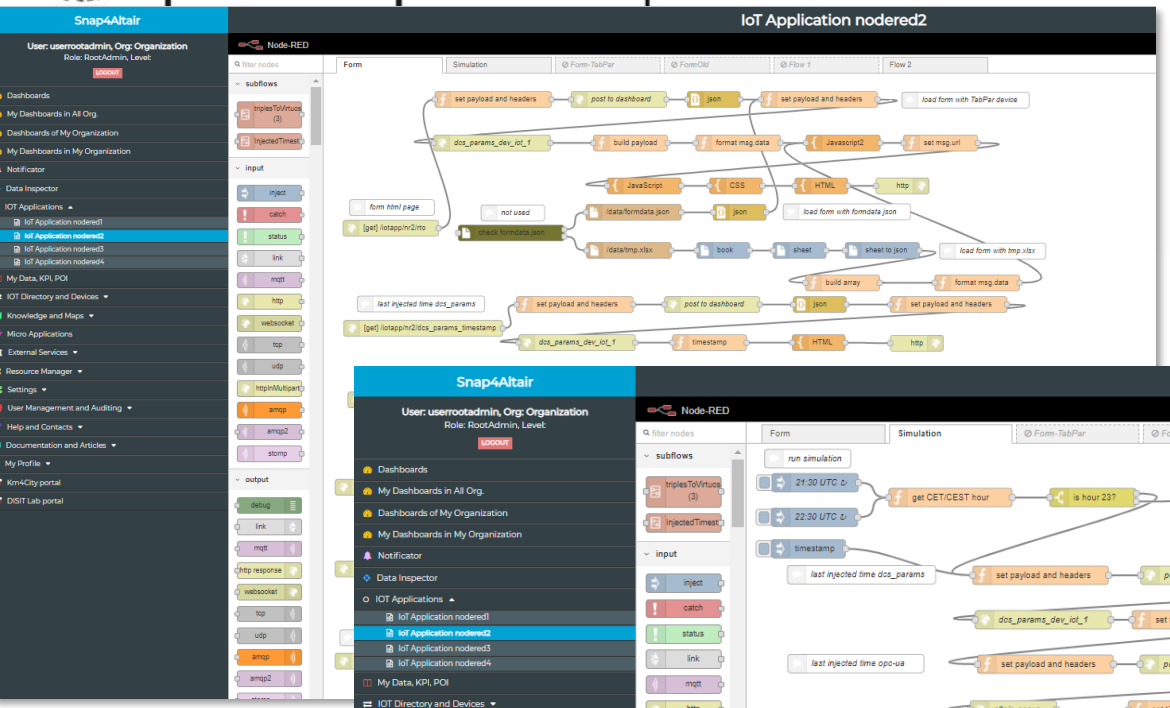


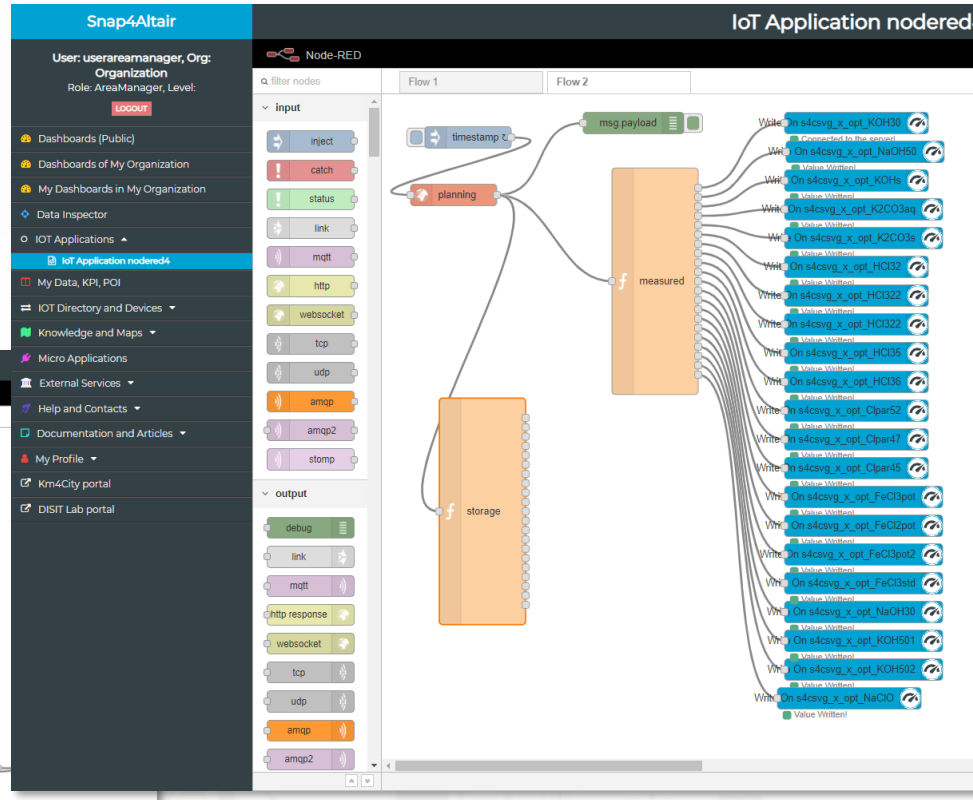


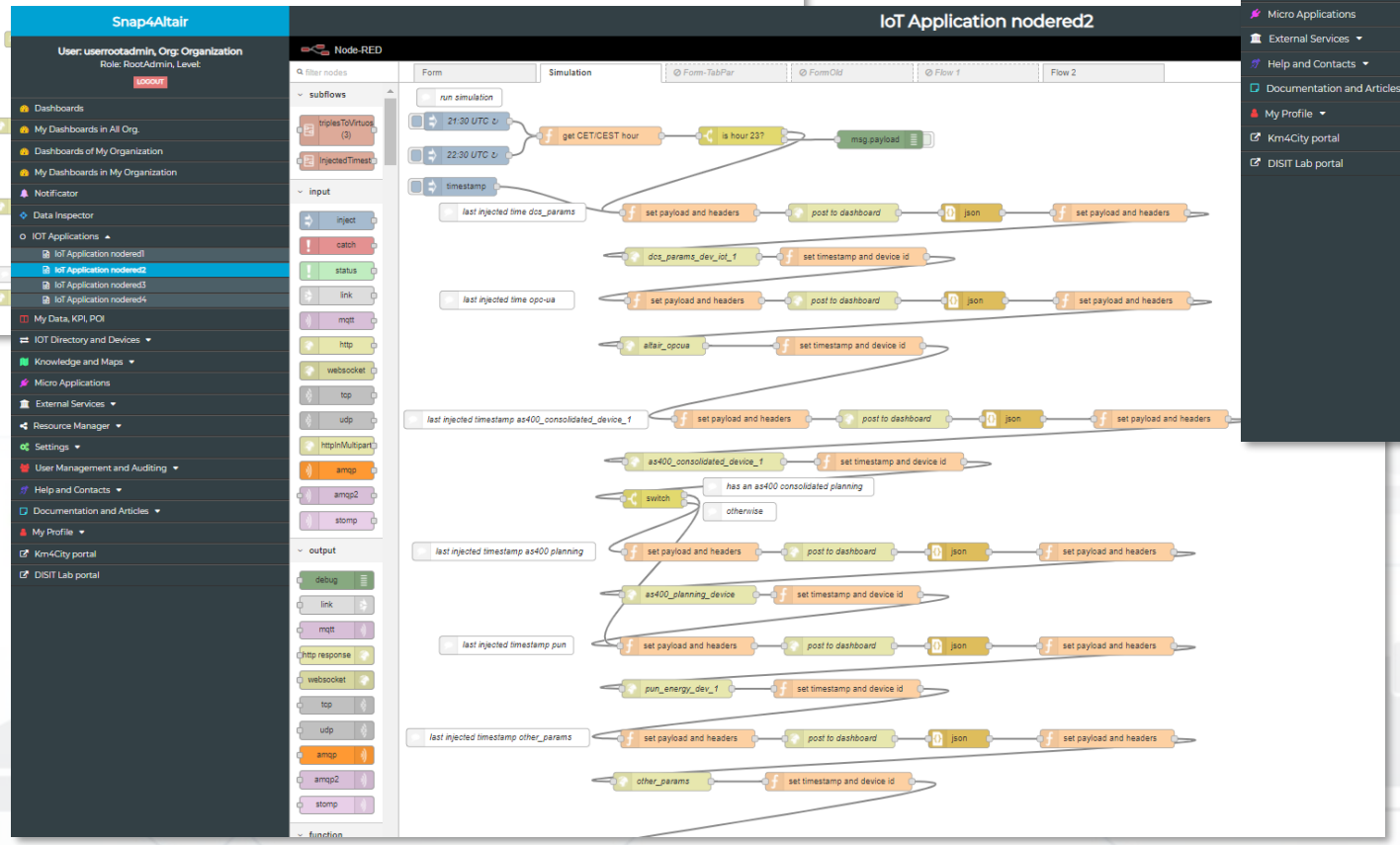
cazione lidata)	Energia (PUN)	Altri Parametri	Pianificazione	Esito Pianificazione	In Produzione
0-01 09:32:54	2020-10-01 23:00:00	2020-07-24 18:43:00	2020-10-01 09:33:27	completato	NO
9-30 17:20:50	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-30 17:21:00	completato	Sì
9-30 16:24:57	2020-09-30 23:00:00	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



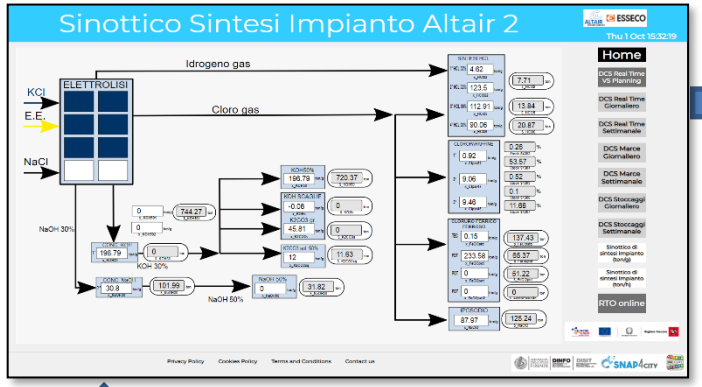
Some Altair Flows



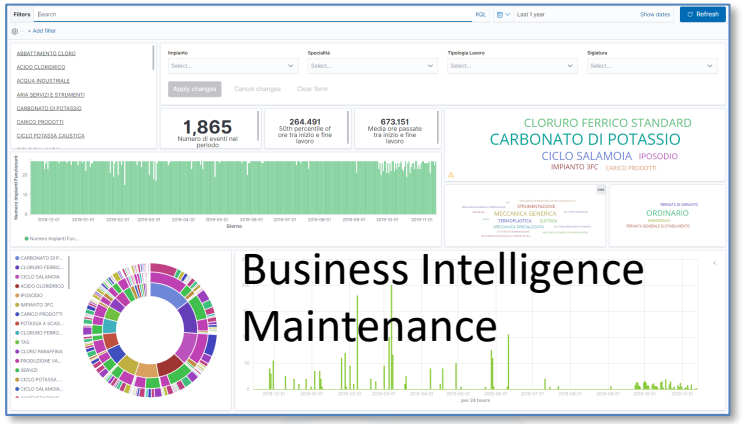




Workflow for Ticket management

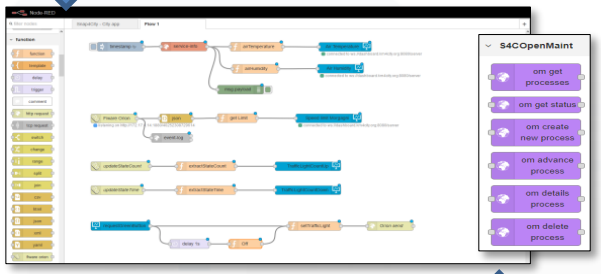


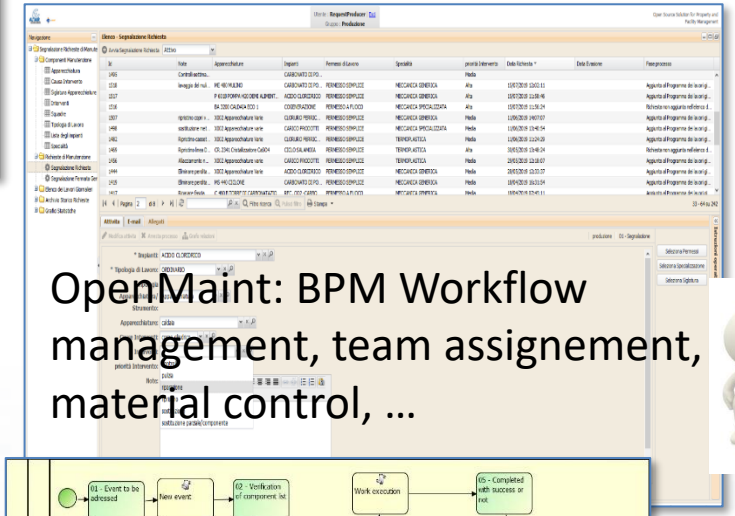
Consumptions/productions



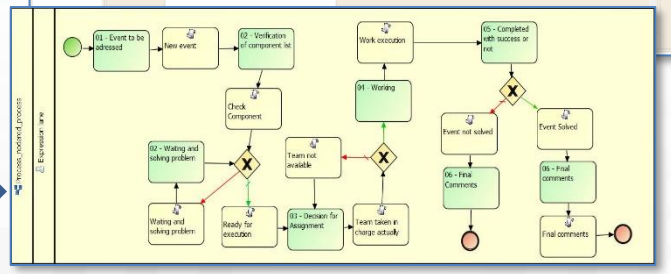
Events/actions

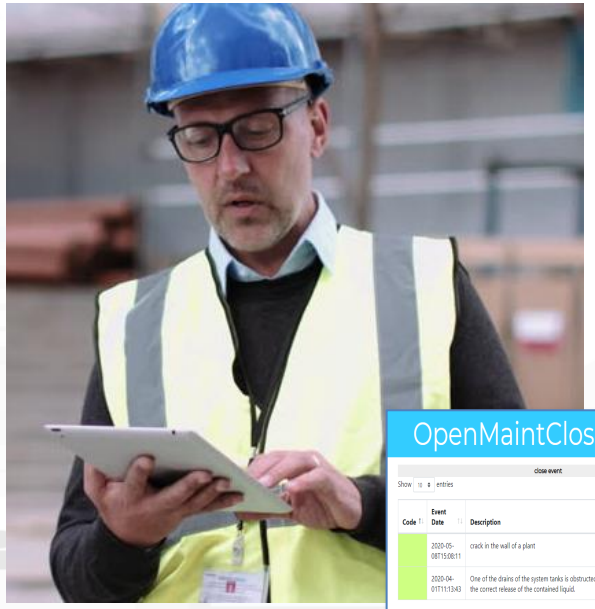
Dashboards and actions

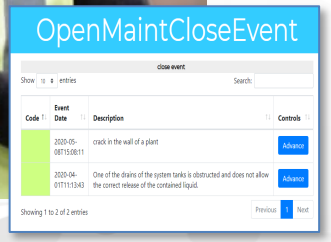




OpenMaint: BPM Workflow management, team assignement, material control, …







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...

Apply changes | Cancel changes | Clear form

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Maintenance Intelligence

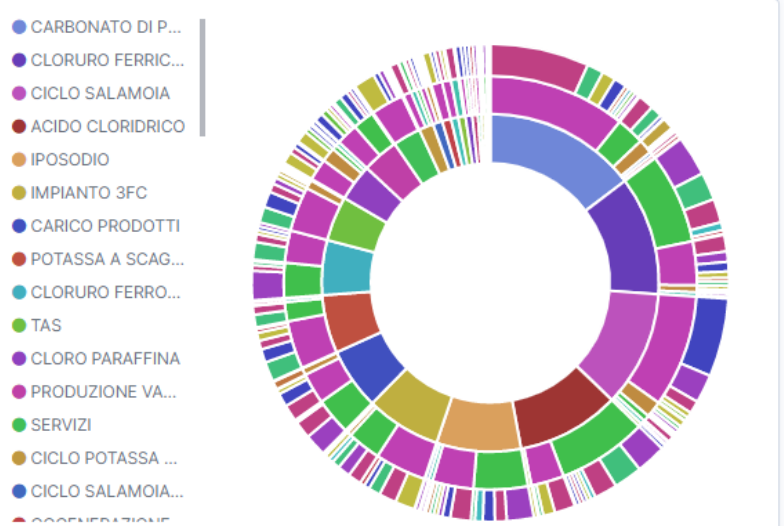
1,865
Numero di eventi nel periodo

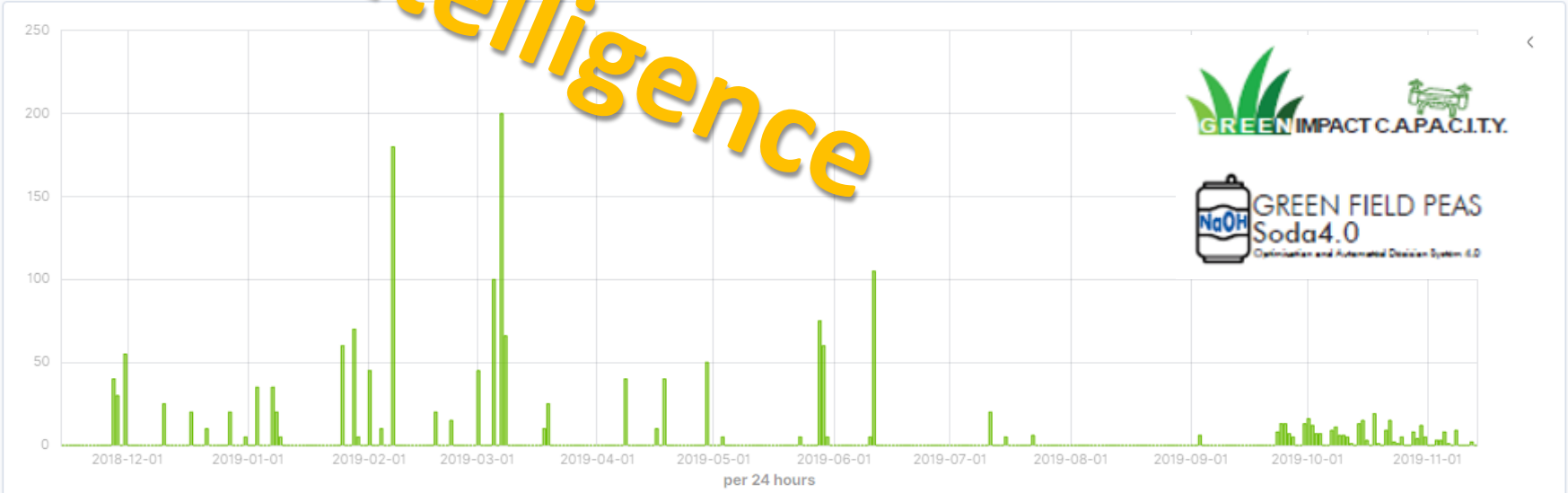
264.491
50th percentile of ore tra inizio e fine lavoro

673.151
Media ore passate tra inizio e fine lavoro

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

FERMATA DI IMPIANTO
ORDINARIO
EMERGENZA
FERMATA GENERALE DI STABILIMENTO

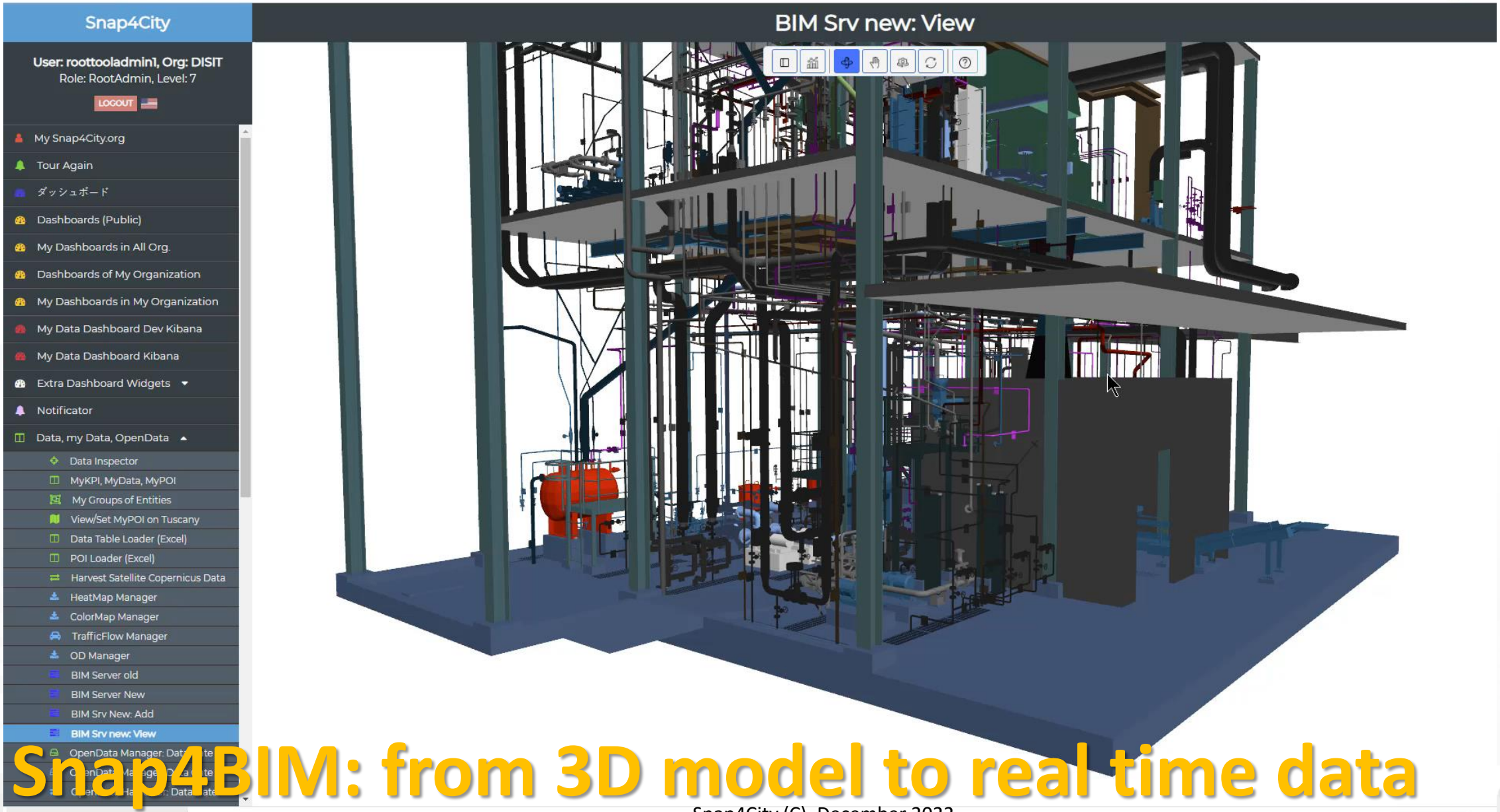




GREEN IMPACT C.A.P.A.C.I.T.Y.

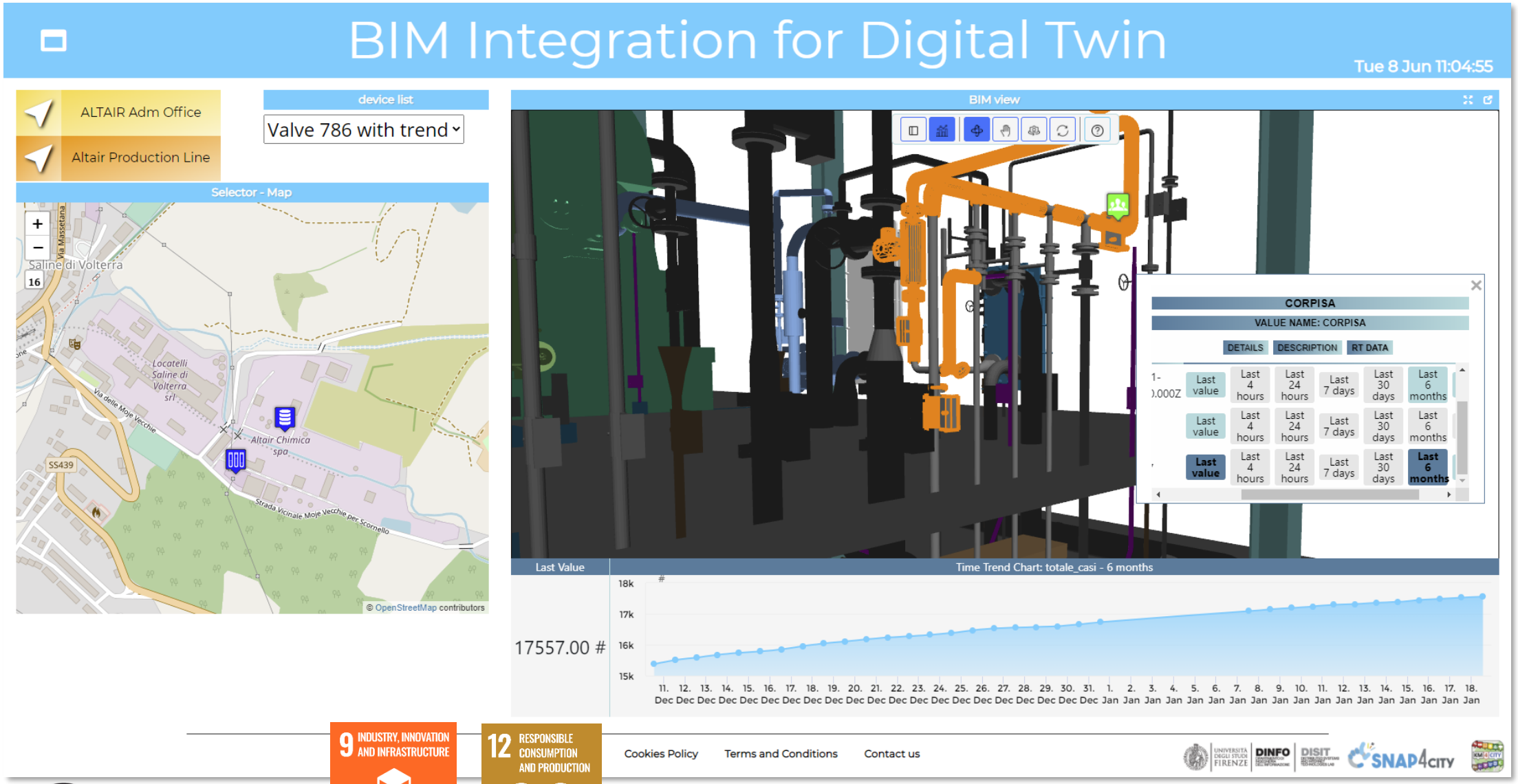
GREEN FIELD PEAS
Soda4.0

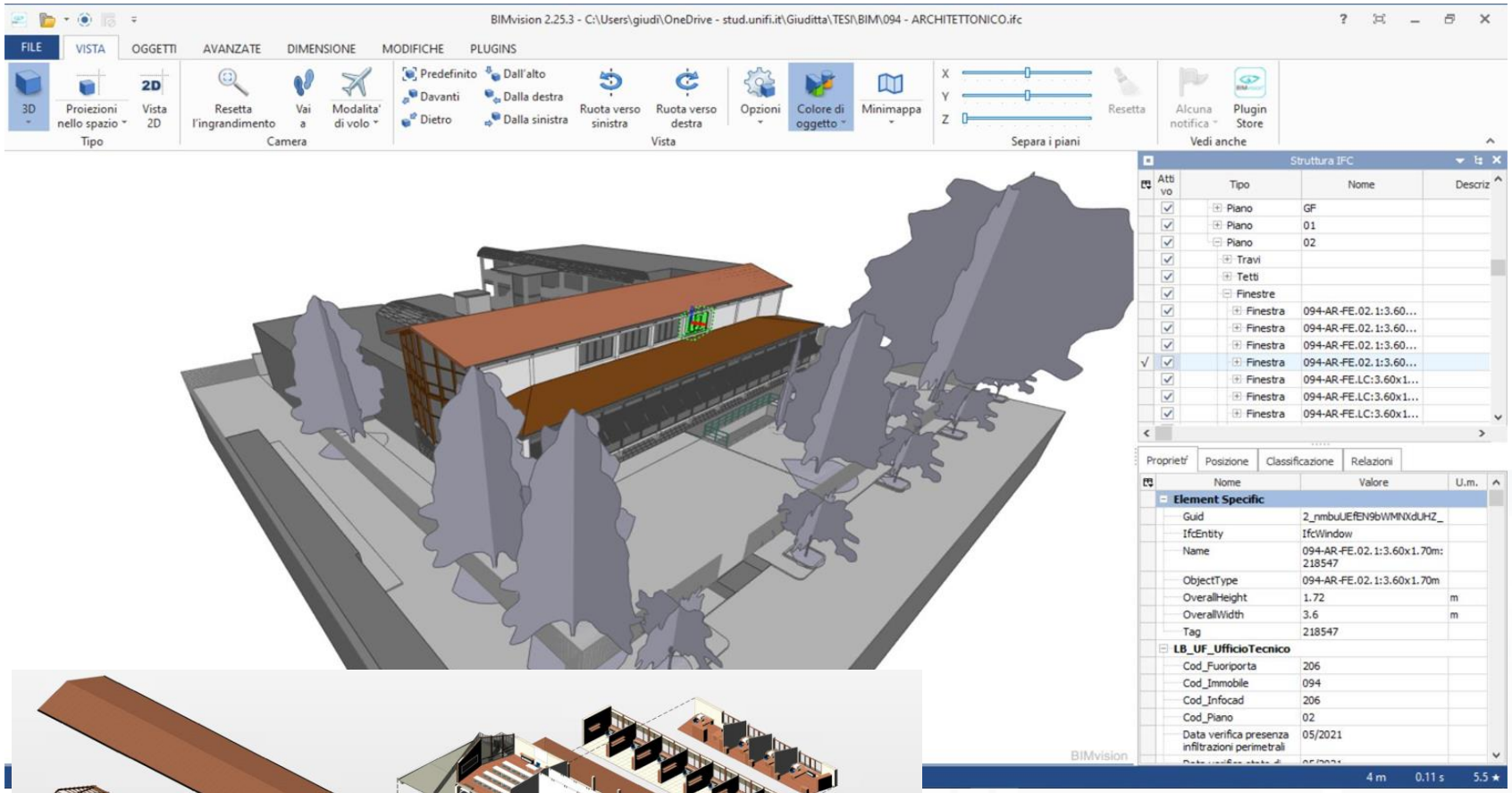
Digital Twin Local



Snap4BIM: from 3D model to real time data

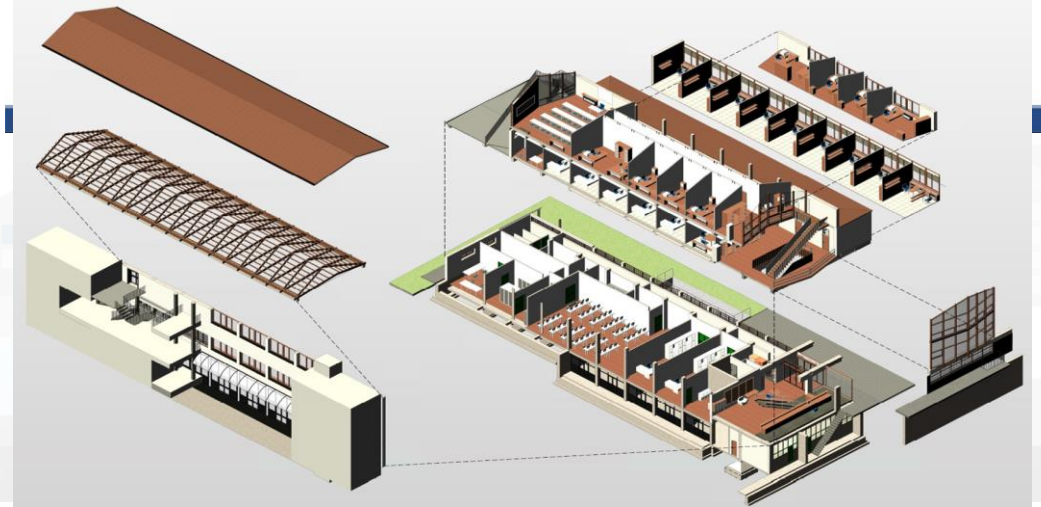
Digital Twin Local, 3D vs Real Time Data





.IFC

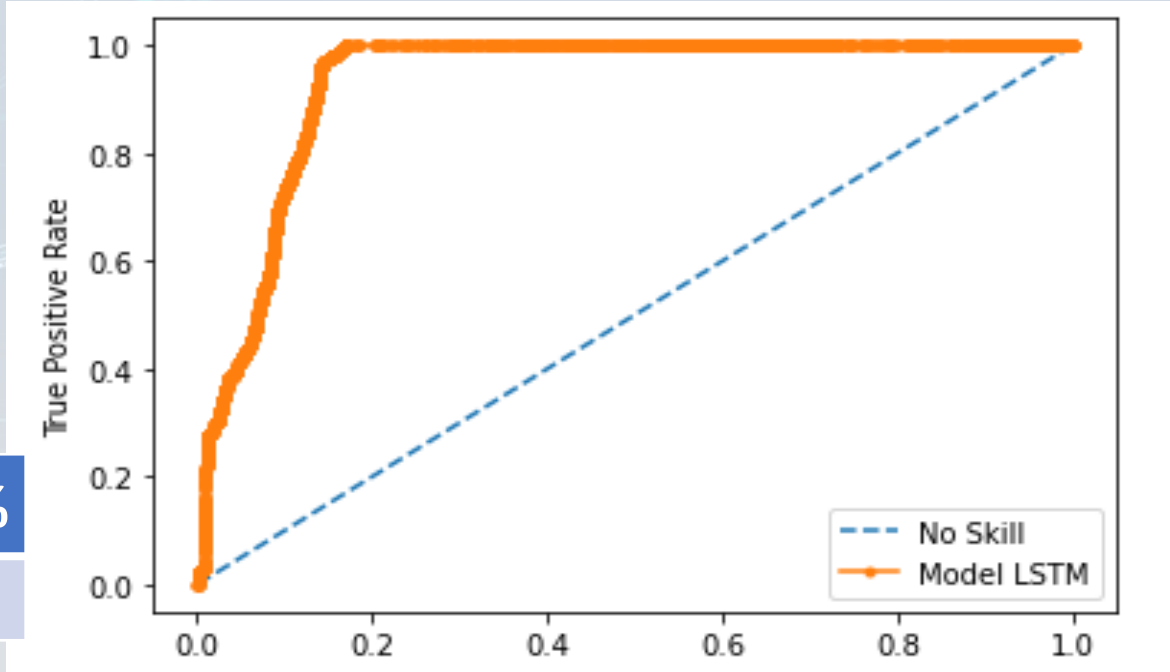
Nome	Valore	U.m.
LB_UF_UfficioTecnico		
Cod_Fuoriporta	122	
Cod_Immobile	094	
Cod_Infocad	122	
Cod_Piano	01	
Data verifica presenza infiltrazioni perimetrali	05/2021	
Data verifica stato di conservazione, fissaggio, funzionalità, stabilità e tenuta superfici vetrate	05/2021	
Descrizione	Facciata continua con telaio in legno, finestre apribili e avvolgibili	
Immagine	Immagine raster: IMG_7428.JPG	
Immagine tipo	Immagine raster: IMG_7428.JPG	
Periodicità verifica presenza infiltrazioni perimetrali	A chiamata	
Periodicità verifica stato di conservazione, fissaggio, funzionalità, stabilità e tenuta di superfici vetrate	A chiamata	
Verifica presenza infiltrazioni perimetrali	Si	
Verifica stato di conservazione, fissaggio, funzionalità, stabilità e tenuta di superfici vetrate	Si	



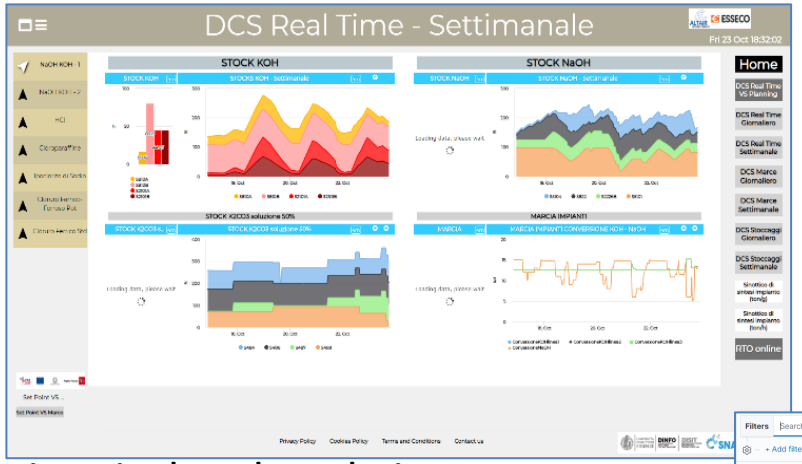
Preditive capabilities

- 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

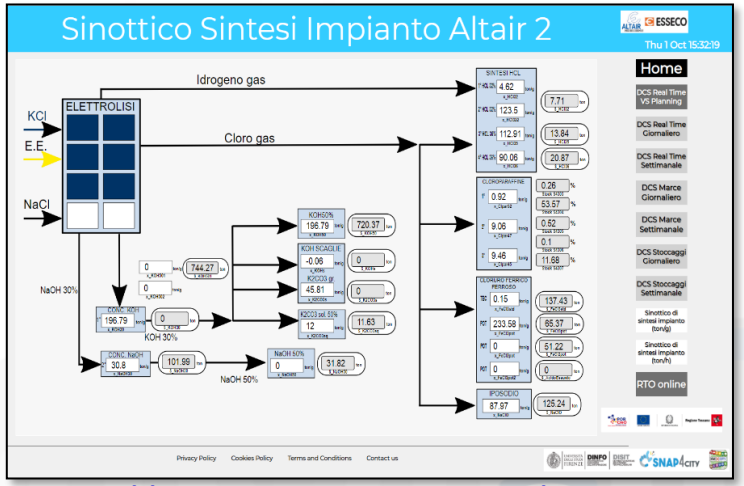


Closing the loop

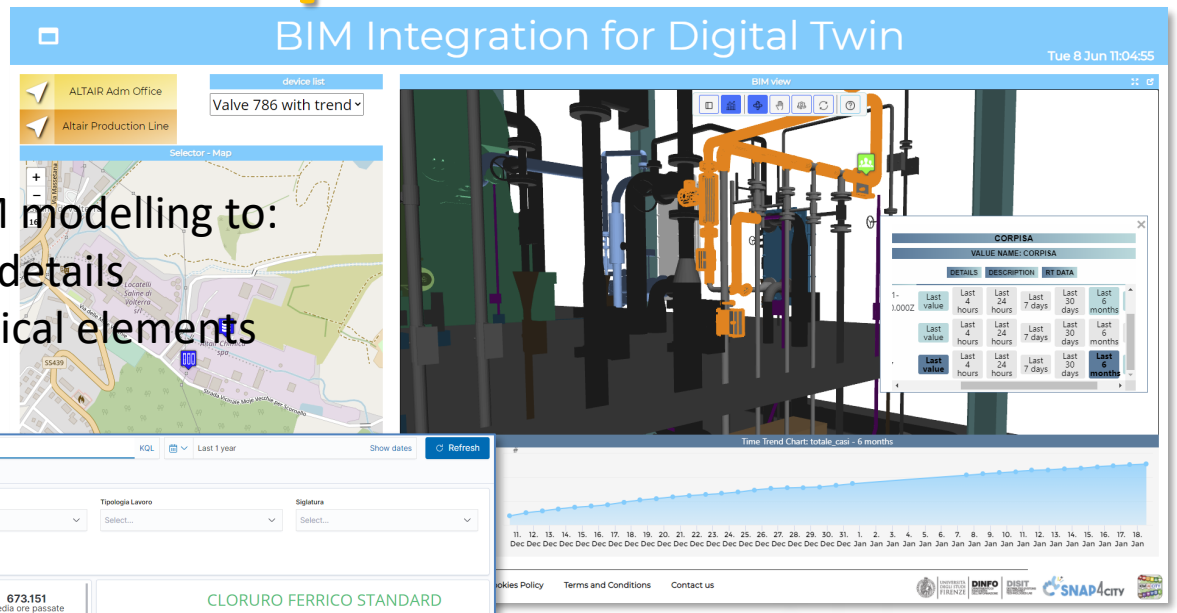


Historical and Real Time Data

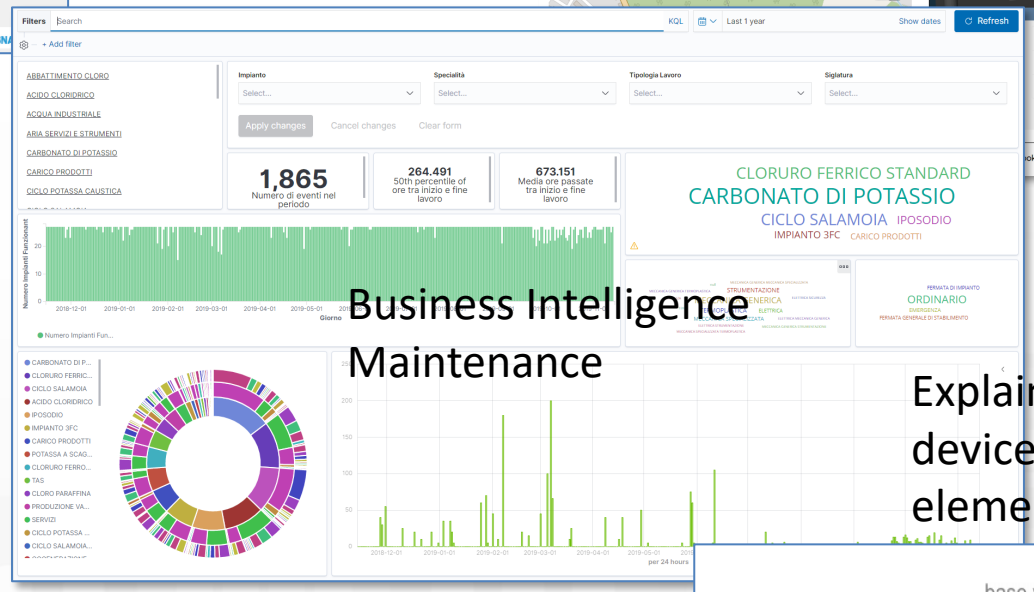
Synoptics for real time monitoring



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

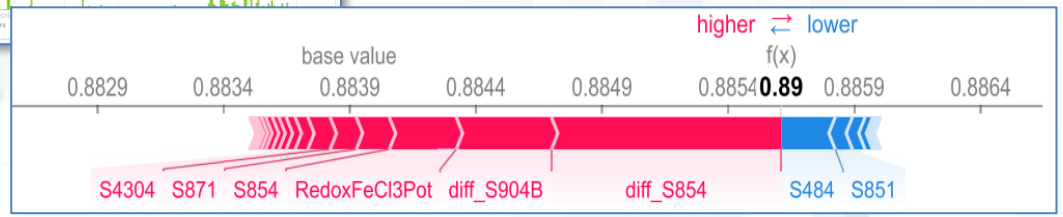


Map and 3D BIM modelling to:
-- represent the details
-- associate physical elements with data

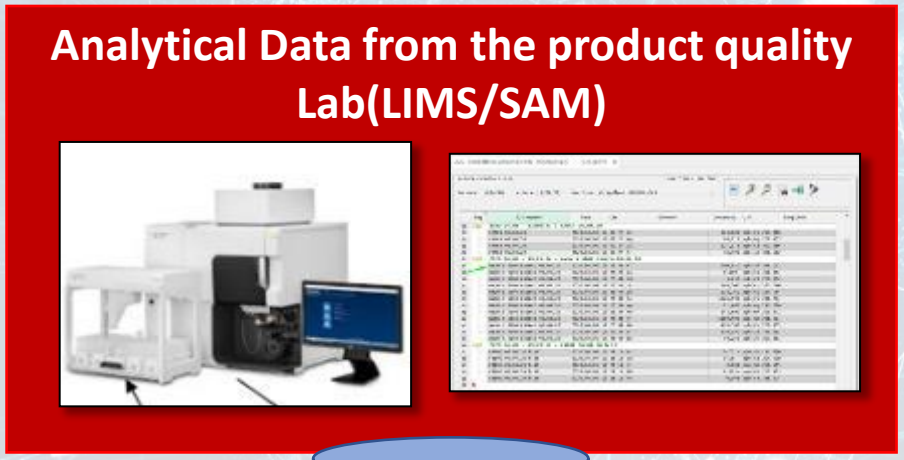


Business Intelligence
Maintenance

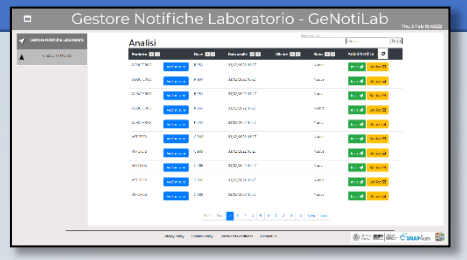
Explainable AI to map critical values of devices and detection to physical elements in the plant



GeNotiLab Architecture for ALTAIR



IOT App Analytics



Dashboards

AS400

IOT App

Users

Analysis

Notifications

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.

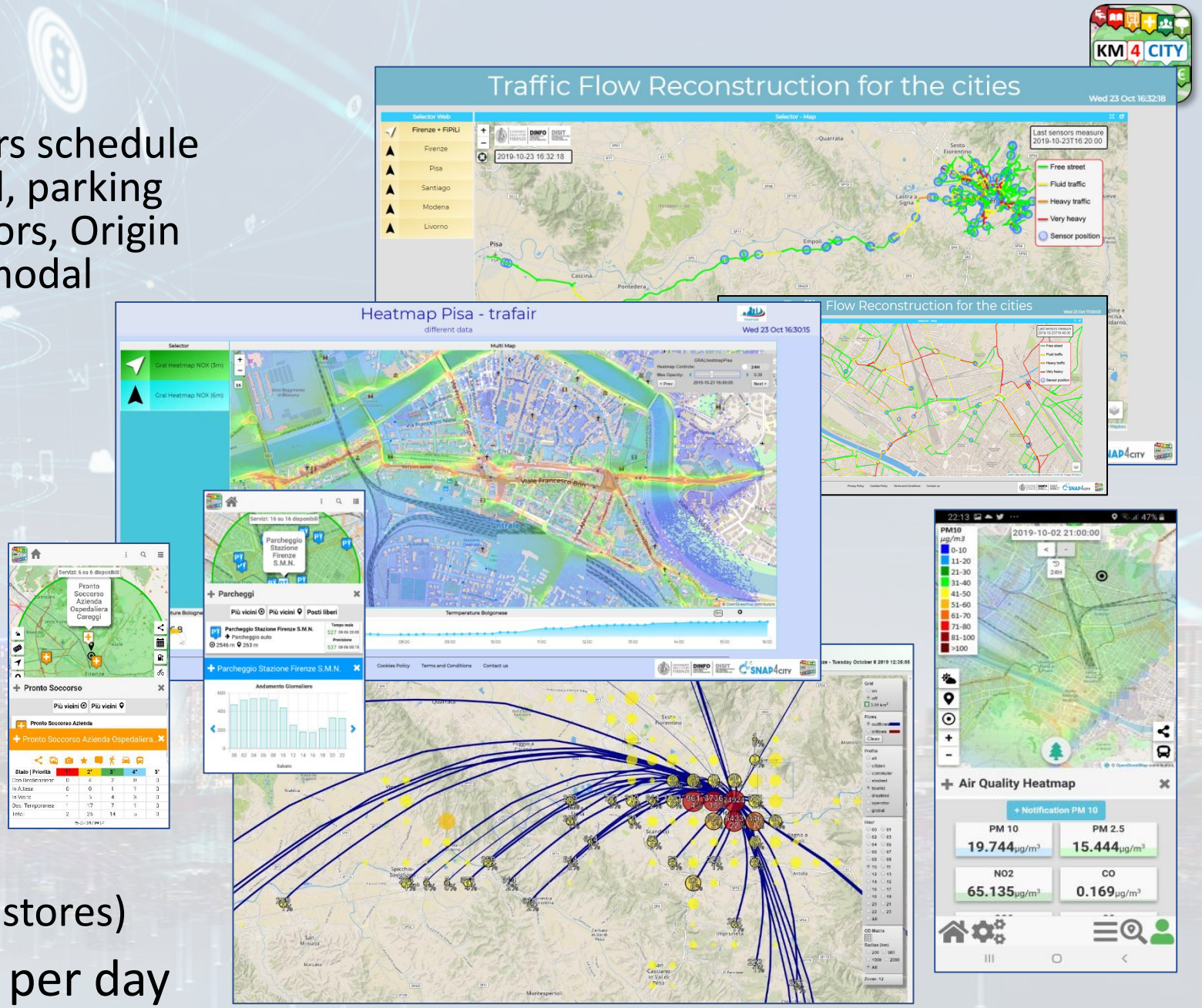
https://www.snap4city.org/746

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

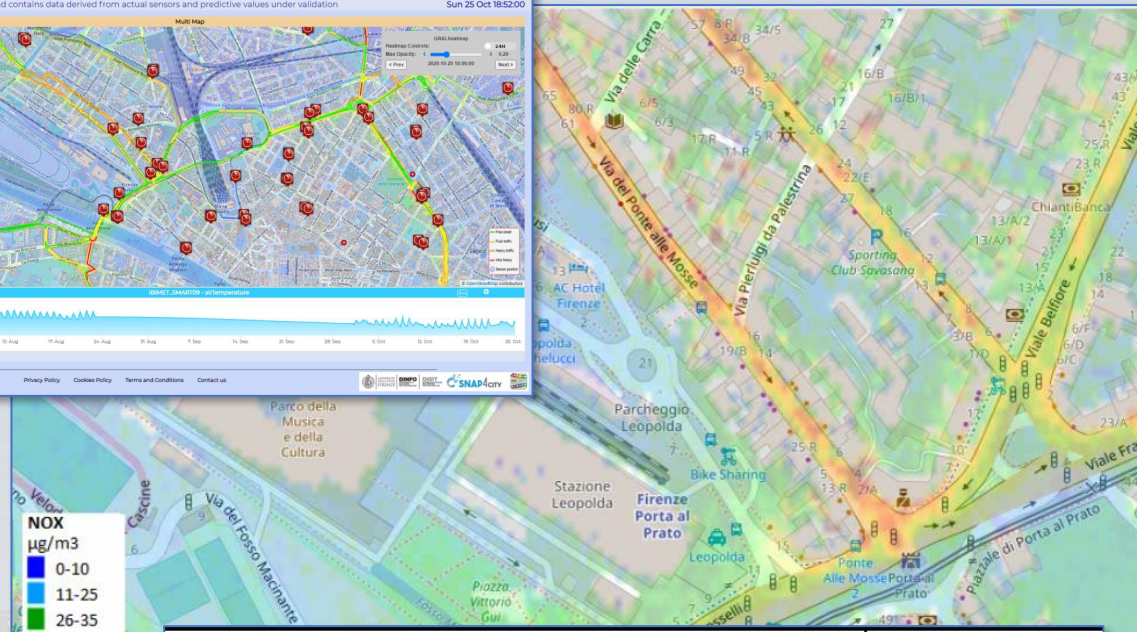


Environment and Quality of Life
Air Quality Predictions

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**

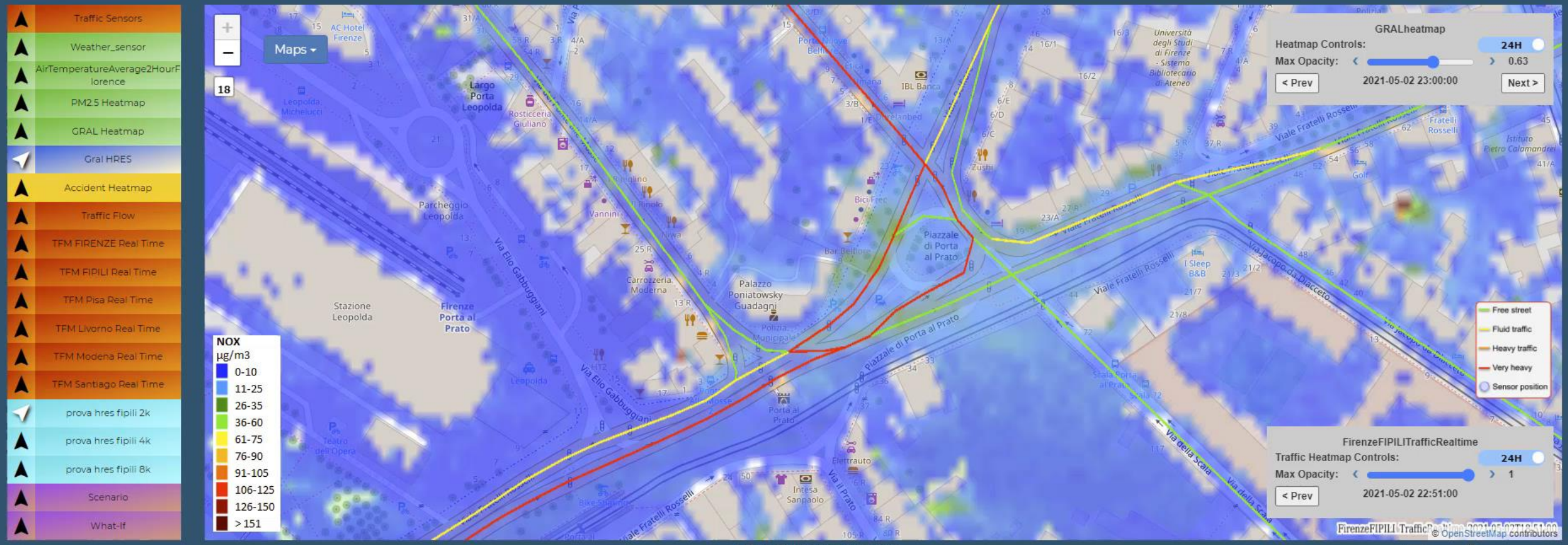


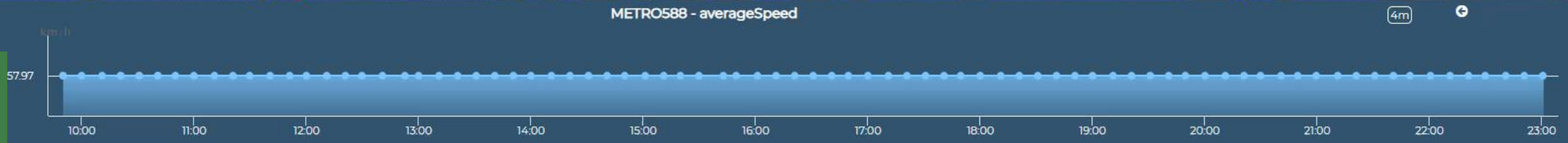
	Air Quality Directive			WHO guidelines	
Pollutant	Averaging period	Objective and legal nature and concentration	Comments	Concentration	Comments
$PM_{2.5}$	One day			25 µg/m³ (*)	99th percentile (3 days/year)
$PM_{2.5}$	Calendar year	Target value, 25 µg/m³	The targe[illegible] ha[illegible] become a [illegible] value [illegible] ry 2015	10 µg/m³	
PM_{10}	One day	Limit [illegible]e, 50 µ[illegible]	[illegible]t to be e[illegible]ed [illegible] on more [illegible]han 35 d[illegible]s per year.	50 µg/m³ (*)	99th percentile (3 days/year)
PM_{10}	Calend[illegible]	[illegible] va[illegible] 40 µg/m[illegible] (*)		20 µg/m³	
O_3	Maximum [illegible]ly 8-hour m[illegible]an	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

Sun 2 May 23:16:31





11 SUSTAINABLE CITIES AND COMMUNITIES

13 CLIMATE ACTION

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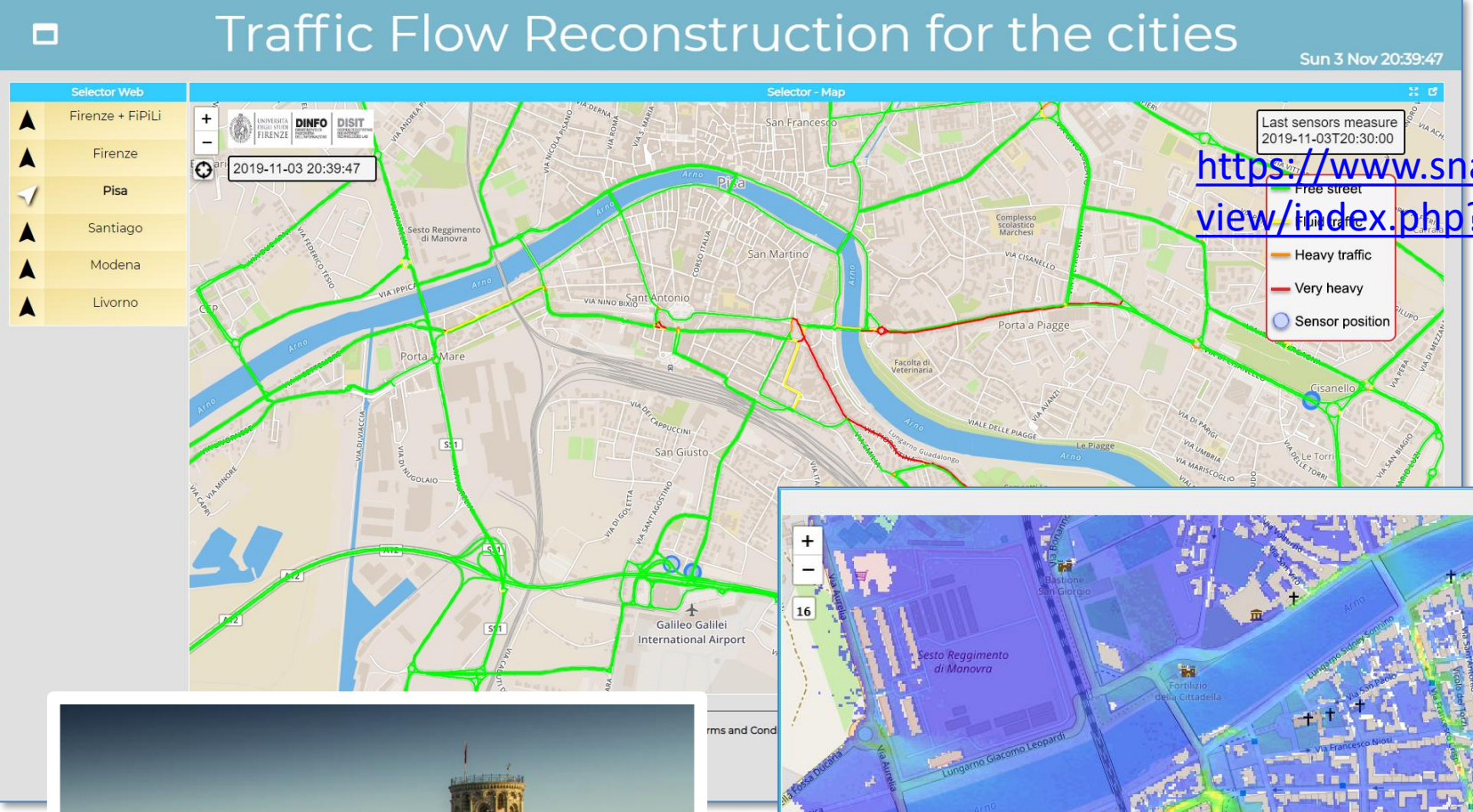
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzEyNg==

Traffic Flow Reconstruction for the cities



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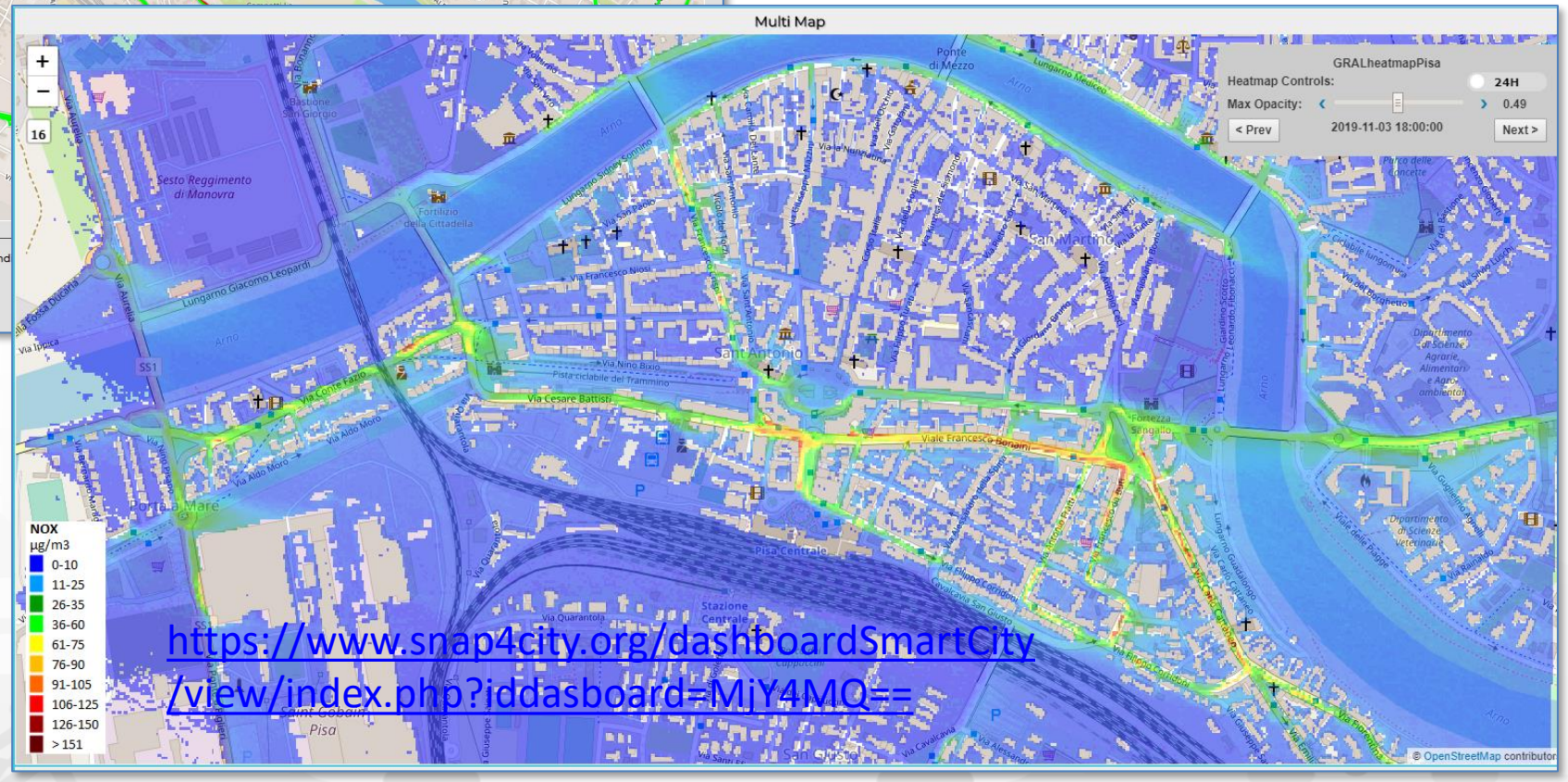


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjY4MQ==

https://www.snap4city.org/712

Lonato del Garda, Italy

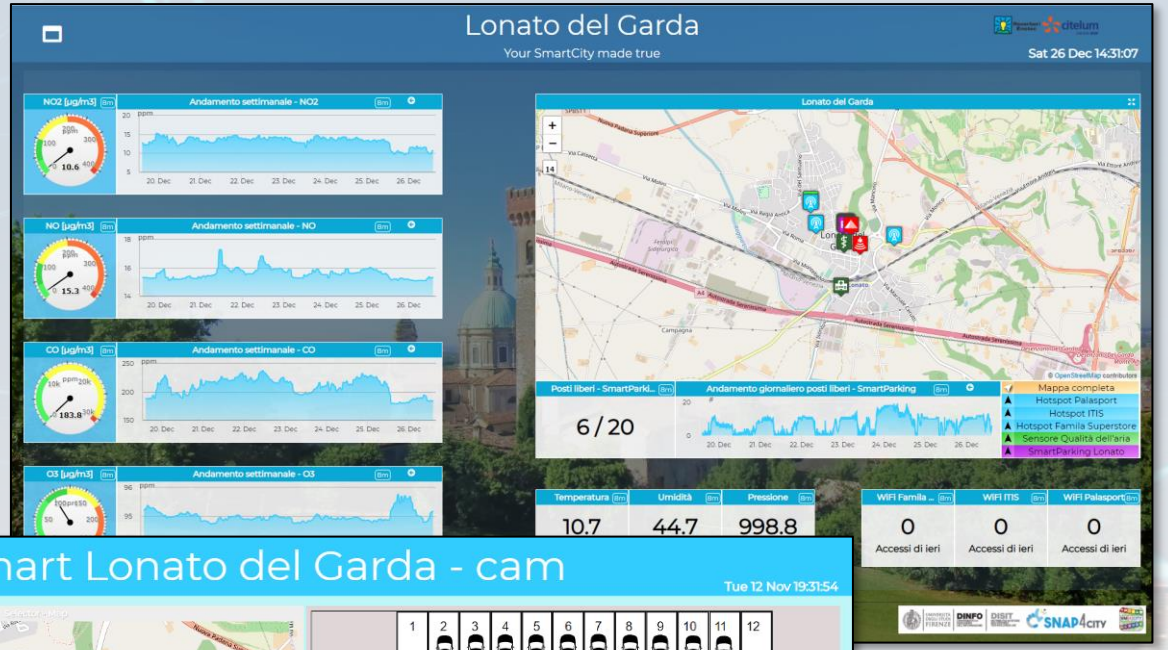
11 SUSTAINABLE CITIES AND COMMUNITIES

13 CLIMATE ACTION

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

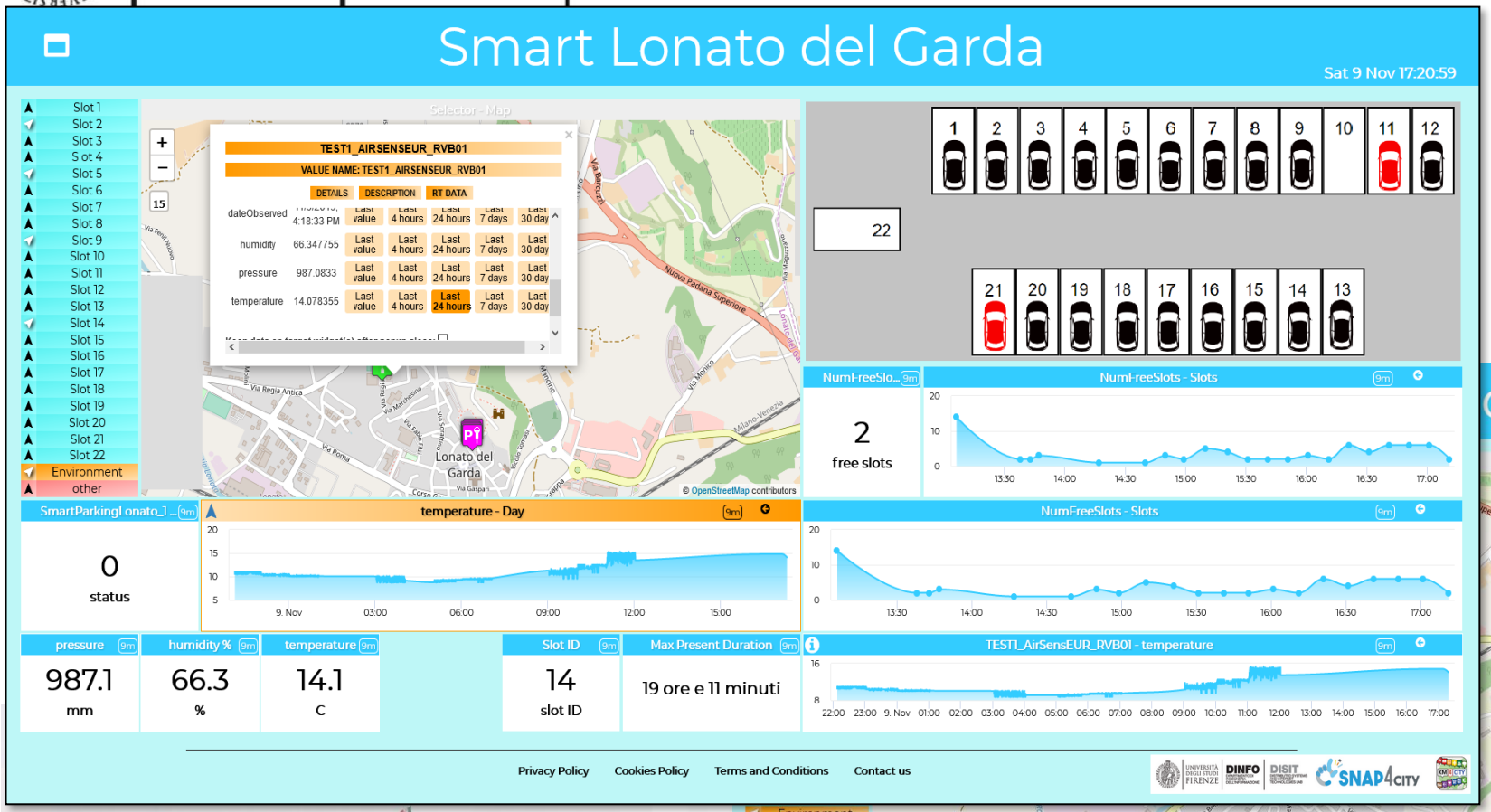
reference

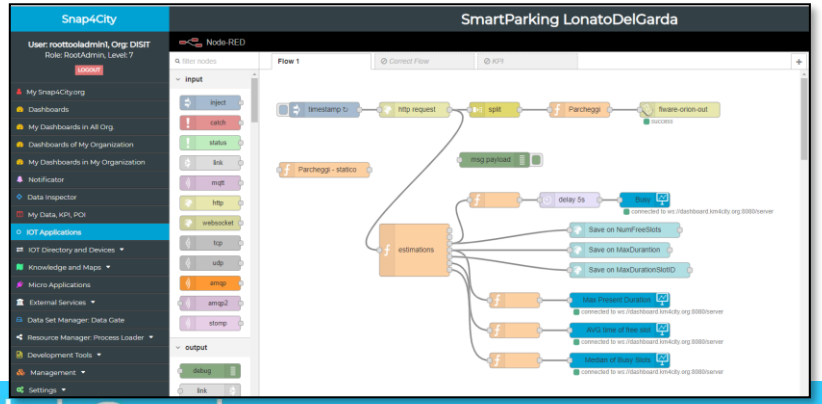
- **Multiple Domain Data**
  - Smart Parking, Environment, Wi-Fi
- **Multiple Decision Makers**
  - City Officer, operators
  - Data monitoring, alerting
  - analytics
- **Historical and Real Time data**
  - Dashboards
- **Services Exploited on:**
  - Dashboards, API
- **Since 2019**



11 SUSTAINABLE CITIES AND COMMUNITIES

Smart Parking Monitoring



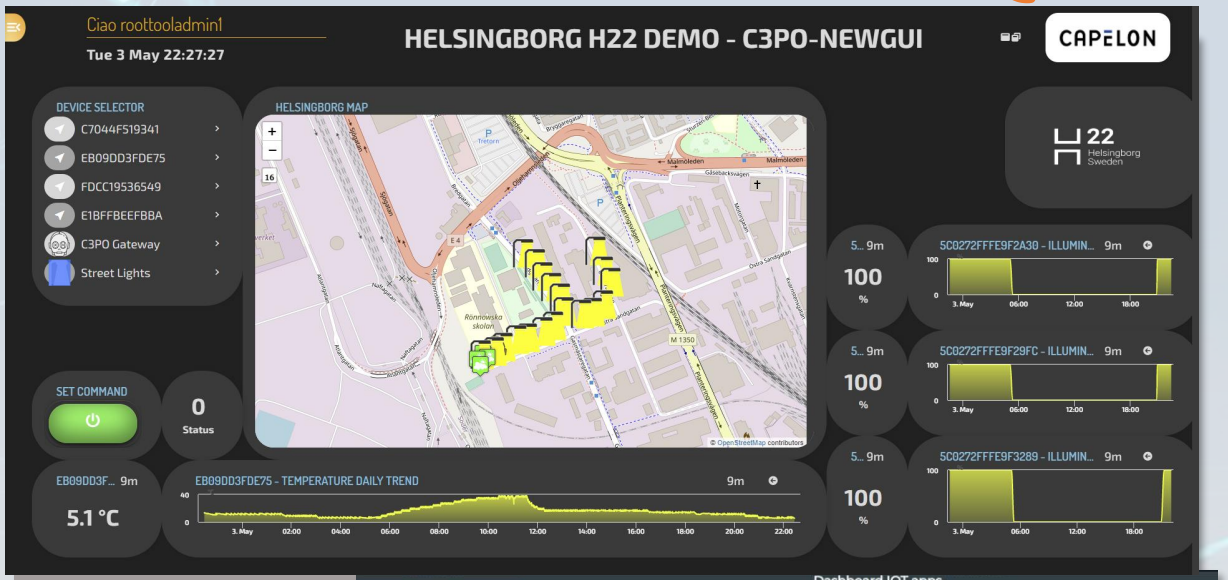


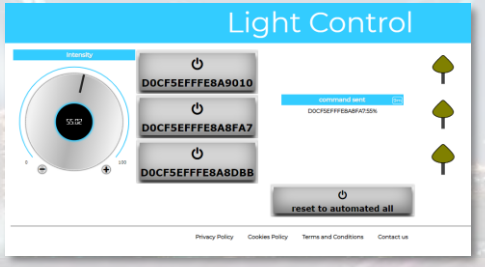
Västerås, Sweden

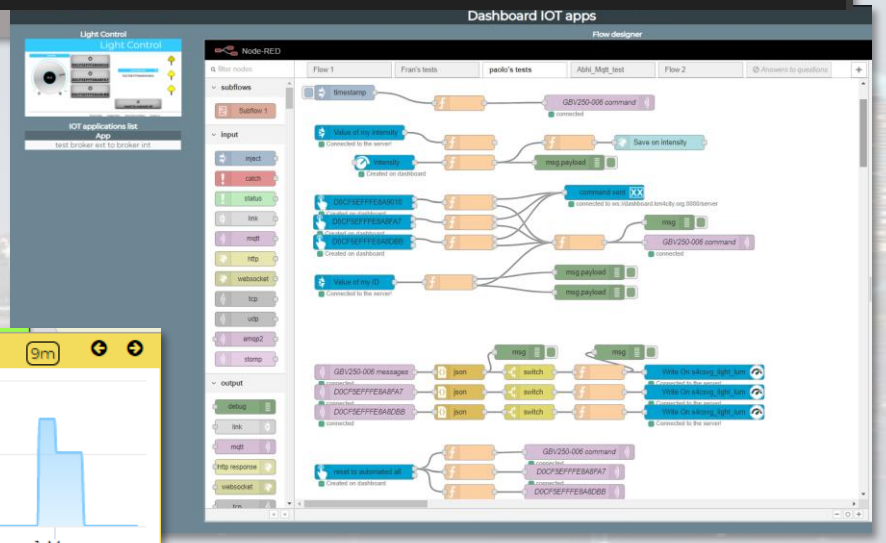
Smart Light Control of CAPELON

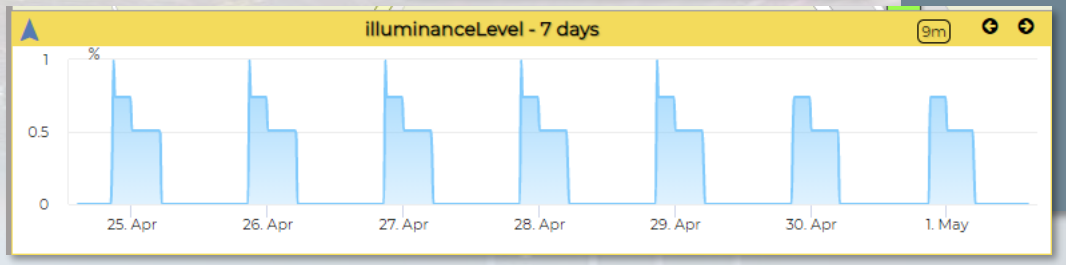
reference

- **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**

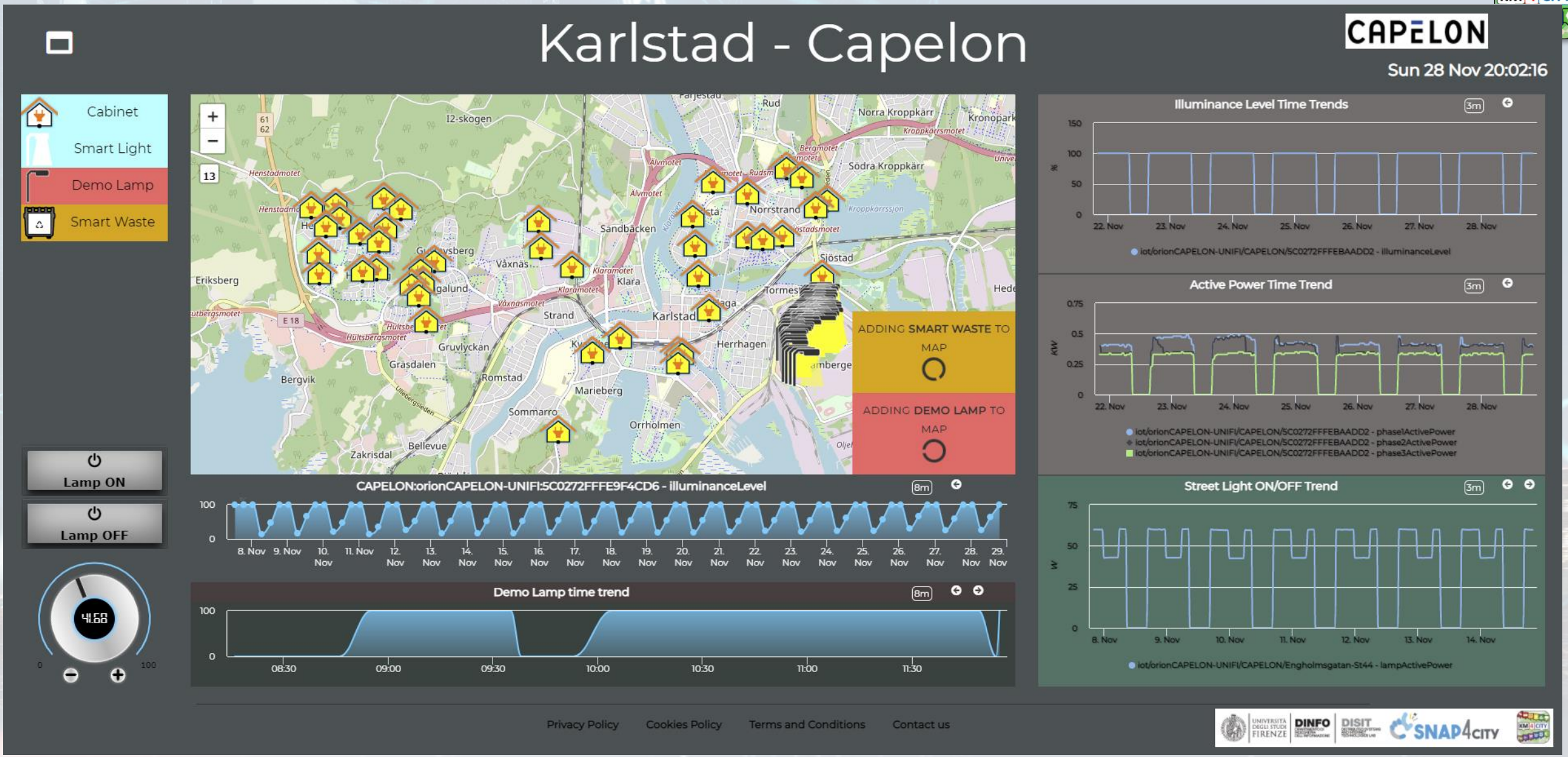






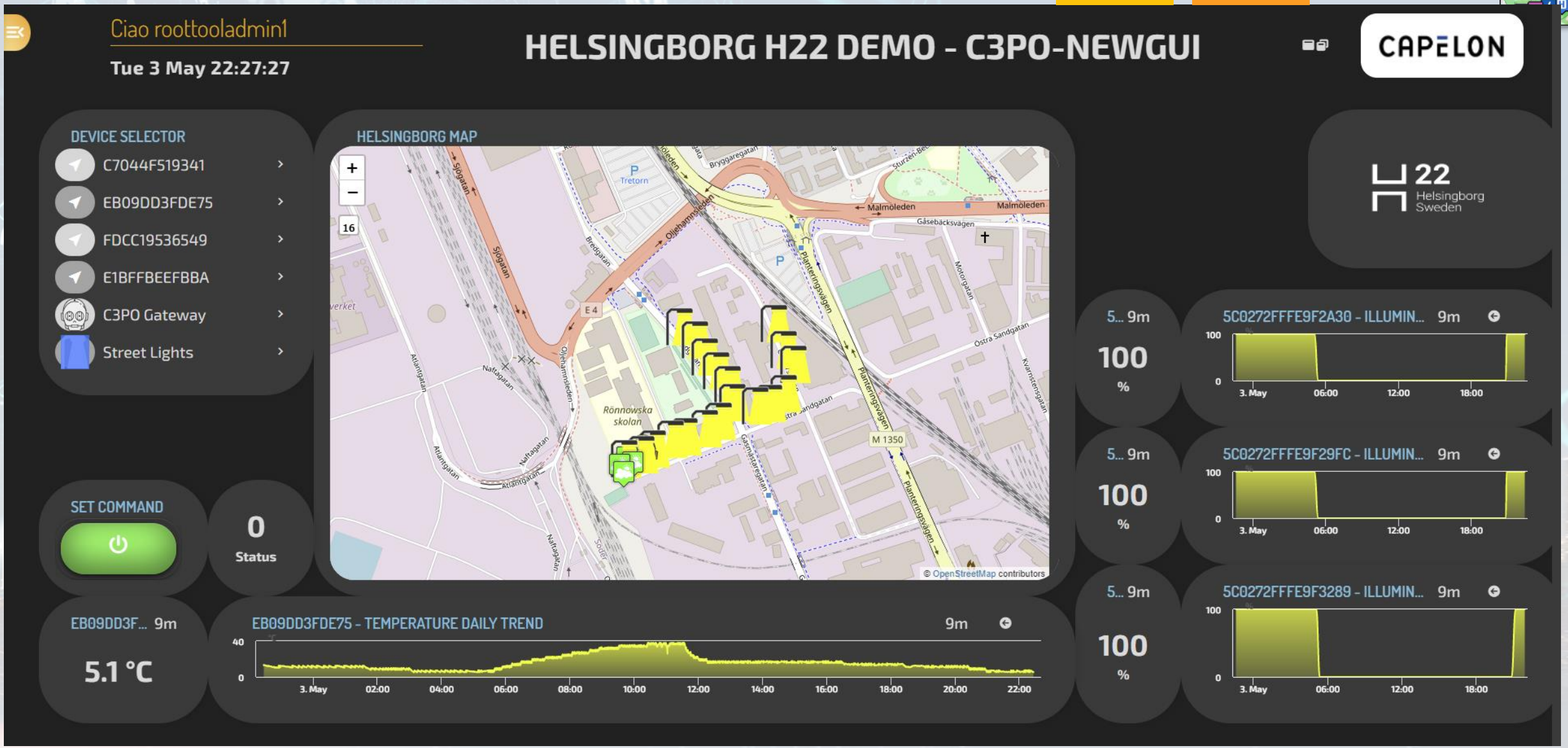


Karlstad Street Lights



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

C3PO Street Lights



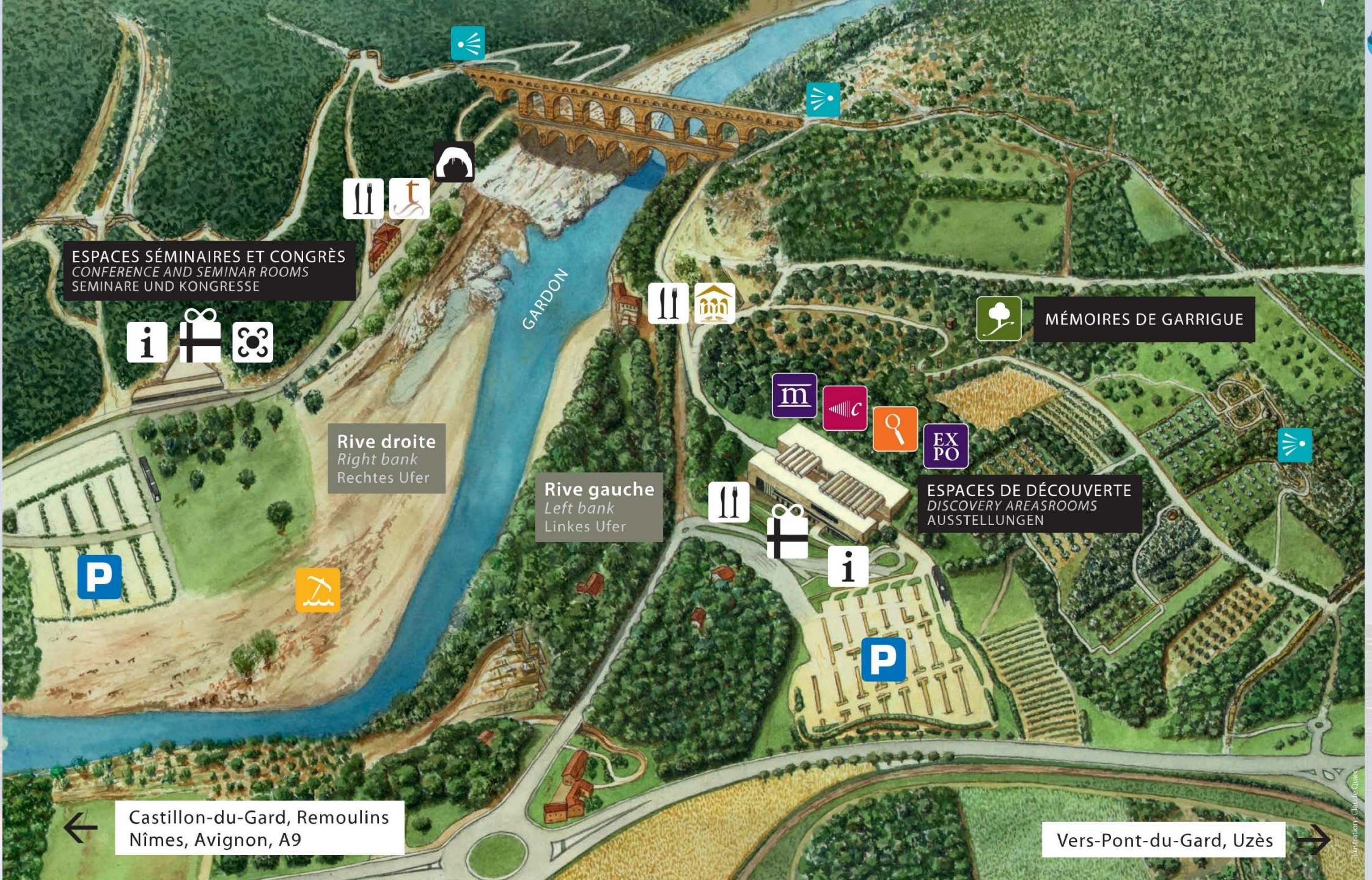
11 SUSTAINABLE CITIES AND COMMUNITIES

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

13 CLIMATE ACTION

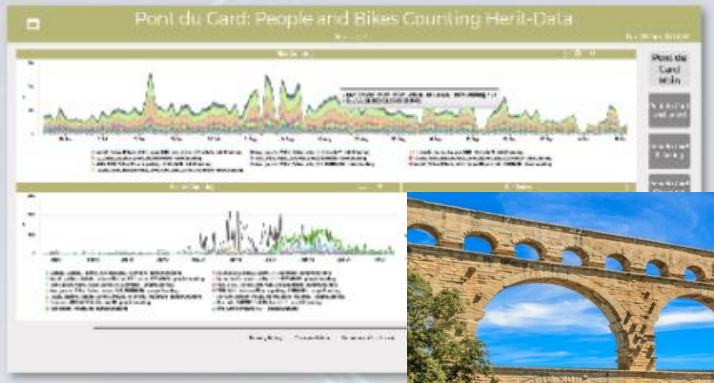
Pont du Gard, France

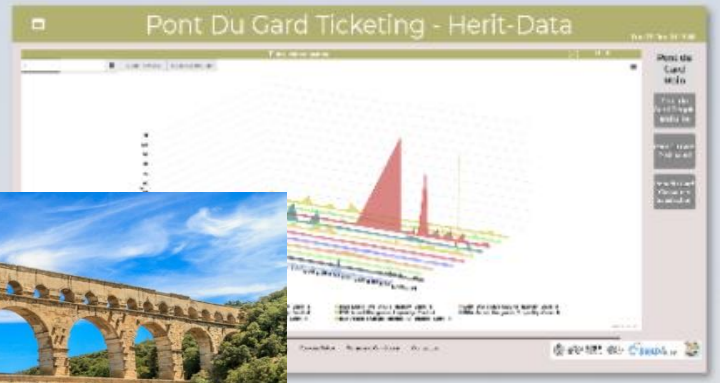
https://www.snap4city.org/740

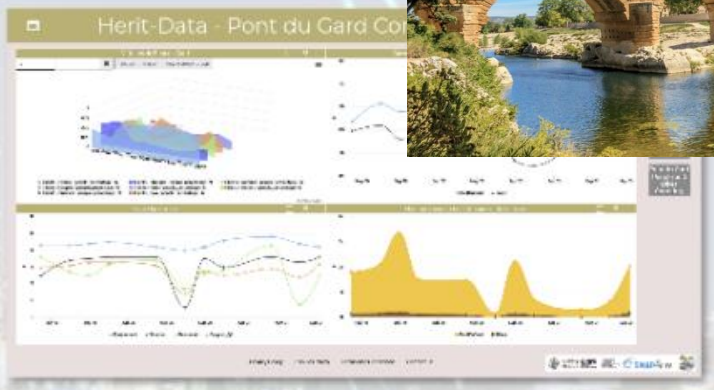

ESPACES SÉMINAIRES ET CONGRÈS
CONFERENCE AND SEMINAR ROOMS
SEMINARE UND KONGRESSE
GARDON
MÉMOIRES DE GARRIGUE
Rive droite
Right bank
Rechtes Ufer
Rive gauche
Left bank
Linkes Ufer
EXPO
ESPACES DE DÉCOUVERTE
DISCOVERY AREASROOMS
AUSSTELLUNGEN
Castillon-du-Gard, Remoulins
Nîmes, Avignon, A9
Vers-Pont-du-Gard,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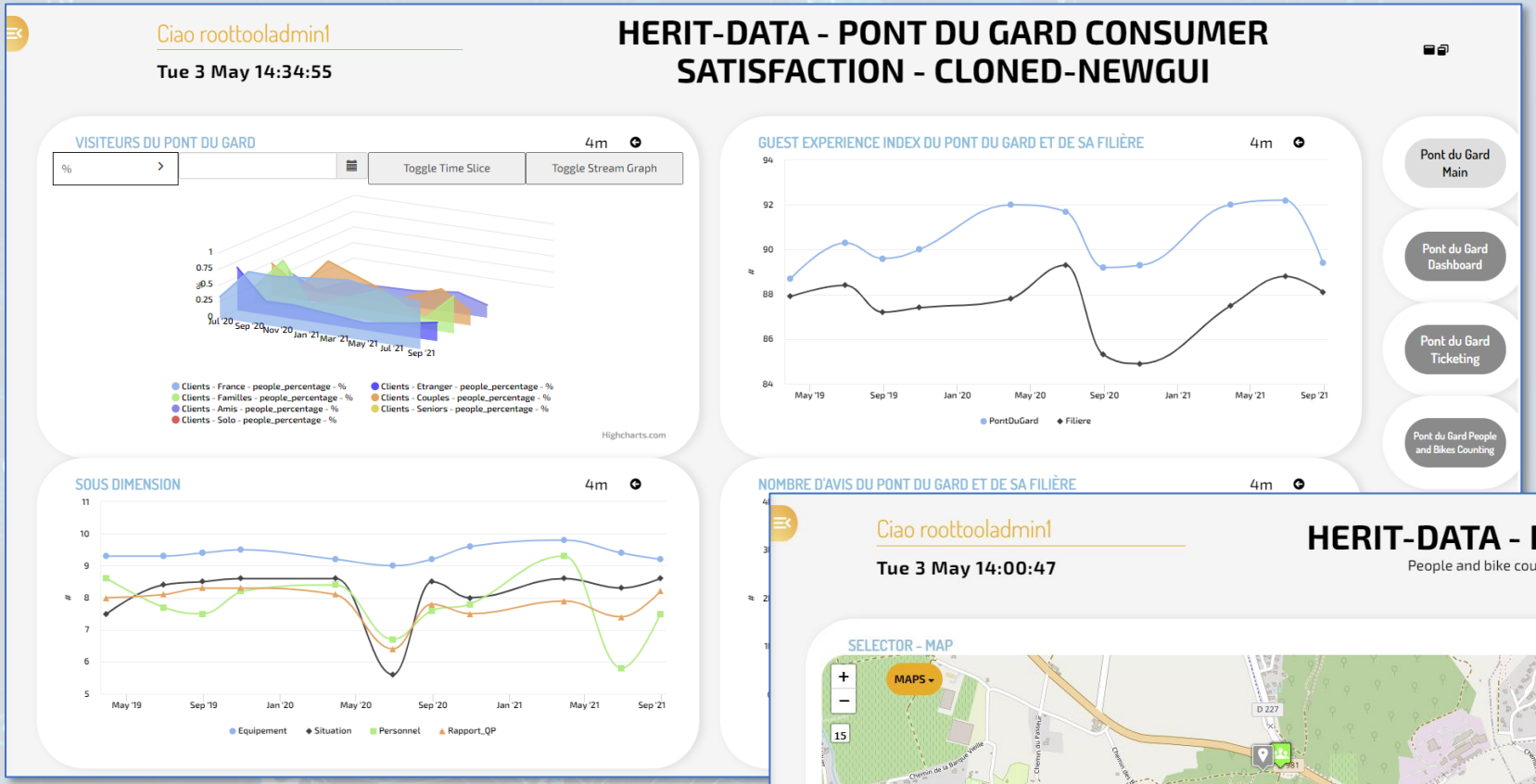
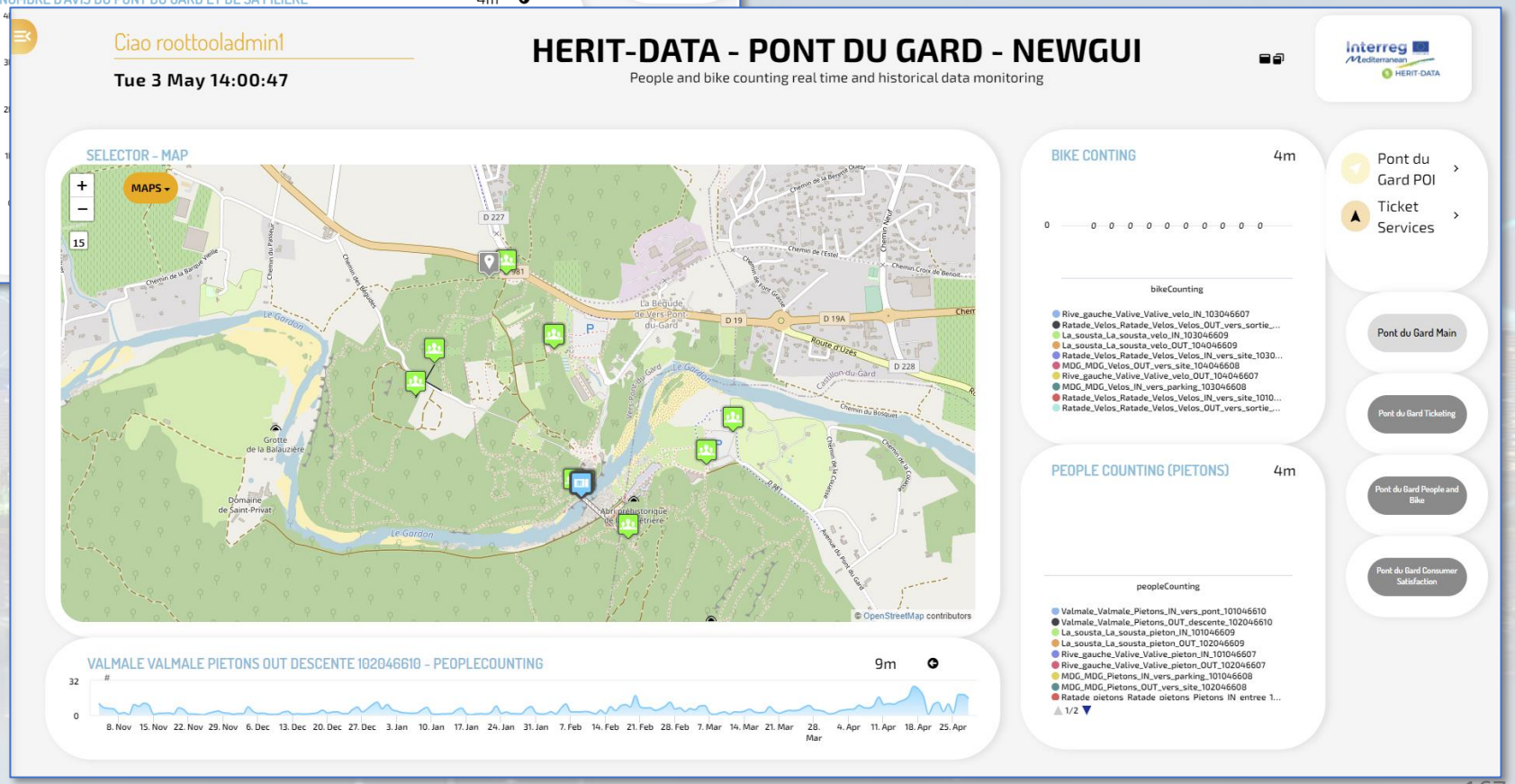
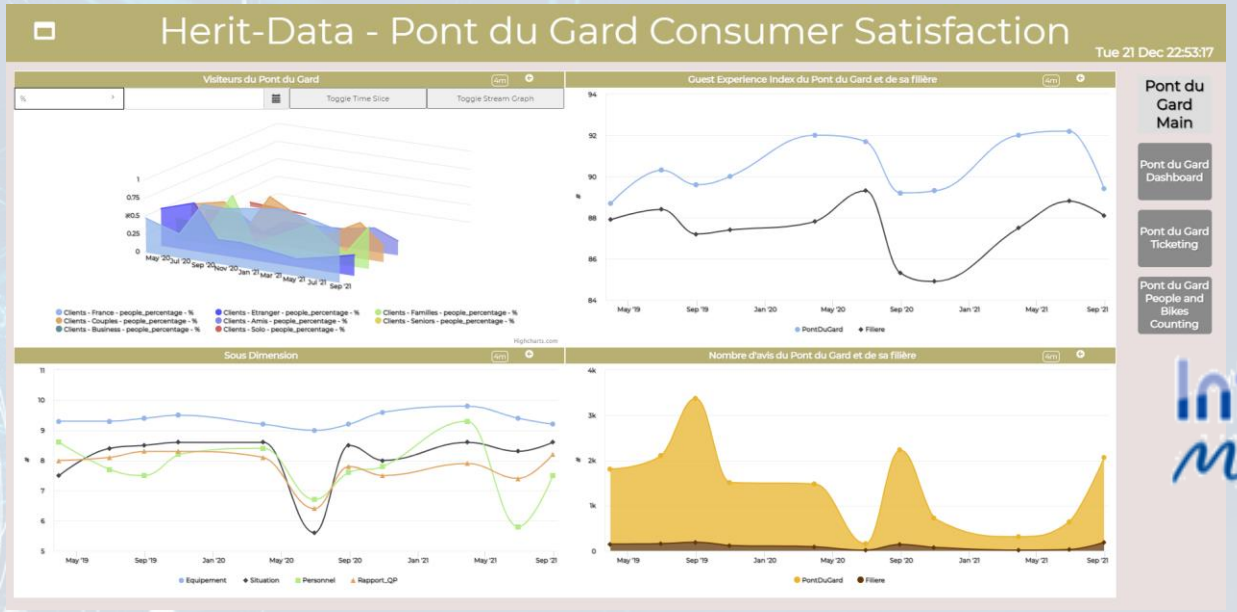
Pont du Gard

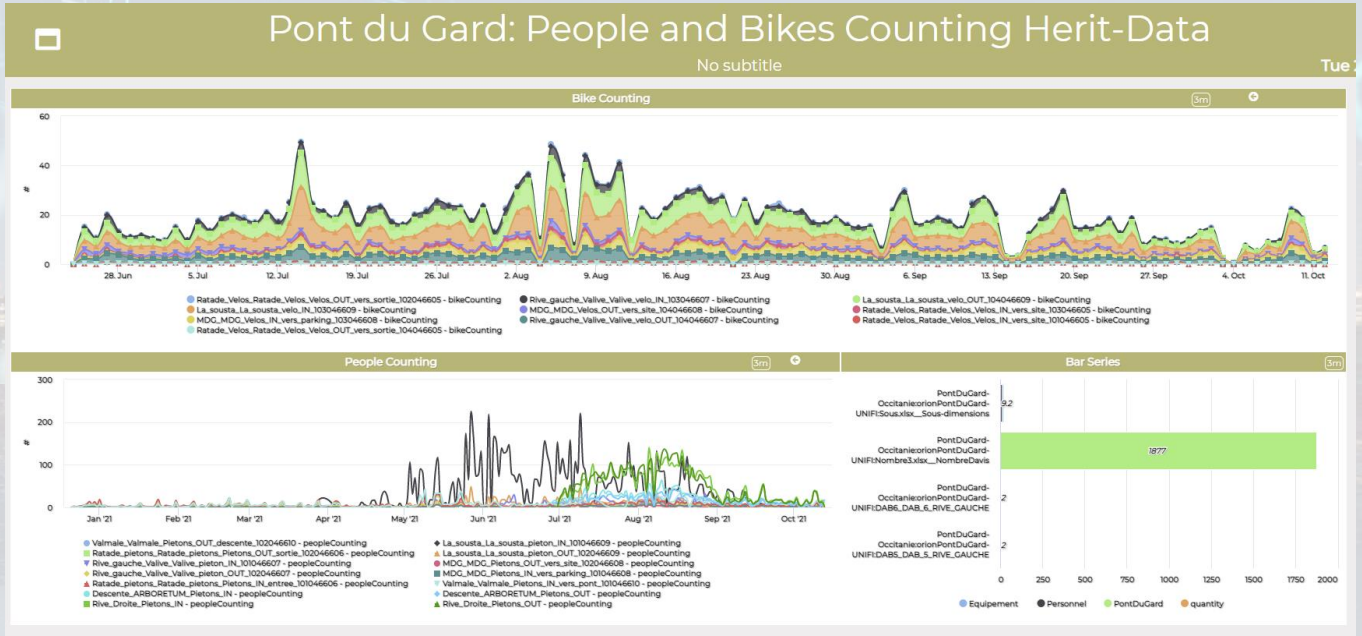

Ciao roottooladmin1
Tue 3 May 14:34:55
HERIT-DATA - PONT DU GARD CONSUMER SATISFACTION - CLONED-NEWGUI
VISITEURS DU PONT DU GARD
Toggle Time Slice
Toggle Stream Graph
GUEST EXPERIENCE INDEX DU PONT DU GARD ET DE SA FILIÈRE
PontDuGard
Filiere
SOUS DIMENSION
Equipement
Situation
Personnel
Rapport_QP
NOMBRE D'AVIS DU PONT DU GARD ET DE SA FILIÈRE
Pont du Gard Main
Pont du Gard Dashboard
Pont du Gard Ticketing
Pont du Gard People and Bikes Counting


Ciao roottooladmin1
Tue 3 May 14:00:47
HERIT-DATA - PONT DU GARD - NEWGUI
People and bike counting real time and historical data monitoring
SELECTOR - MAP
MAPS
BIKE CONTING
bikeCounting
PEOPLE COUNTING (PIETONS)
peopleCounting
VALMALE VALMALE PIETONS OUT DESCENTE 102046610 - PEOPLECOUNTING
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

- **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

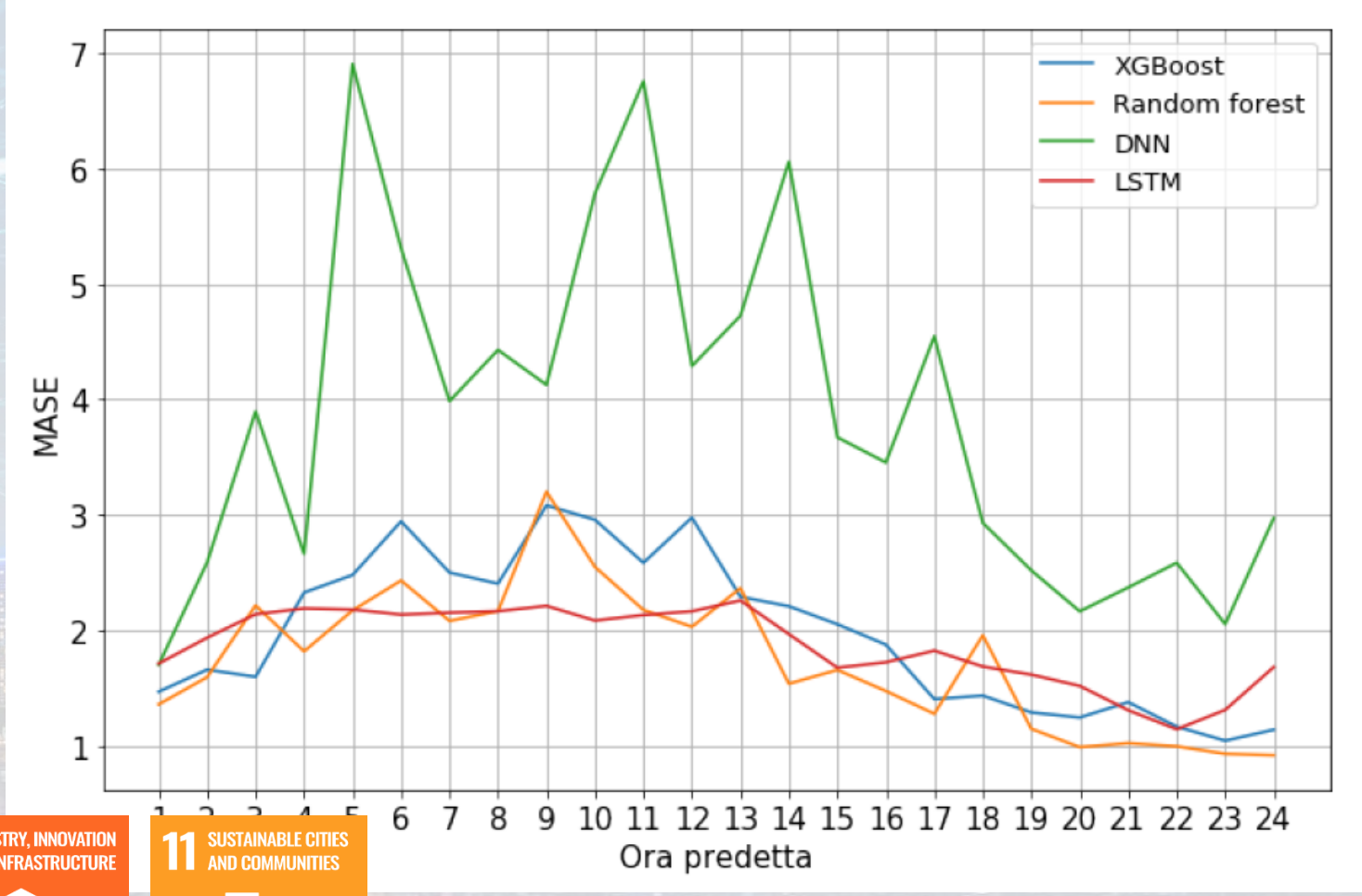




Pont du Gard: data analytics

- Prediction of the number of sold tickets 24 hours in advance

- Using:
  - Historical data
  - Weather conditions
  - Social Media



Twitter Vigilance

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

11 SUSTAINABLE CITIES AND COMMUNITIES

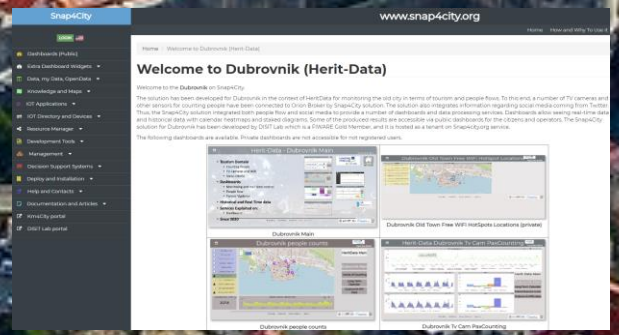
Dubrovnik, Croatia

https://www.snap4city.org/741

11 SUSTAINABLE CITIES AND COMMUNITIES

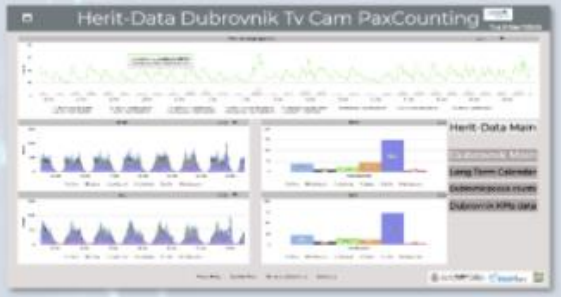
12 RESPONSIBLE CONSUMPTION AND PRODUCTION

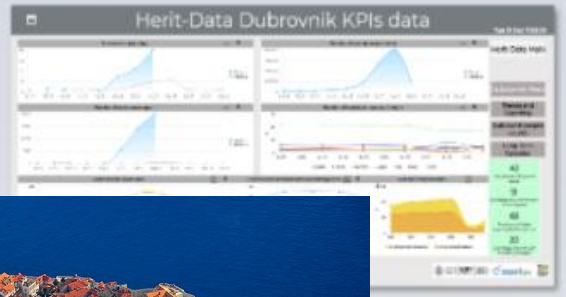
13 CLIMATE ACTION

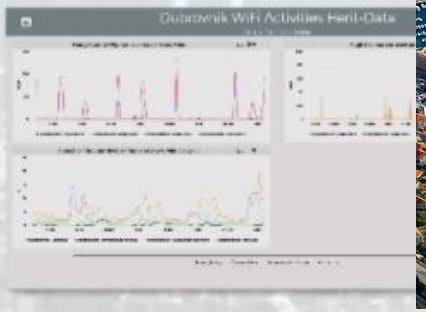


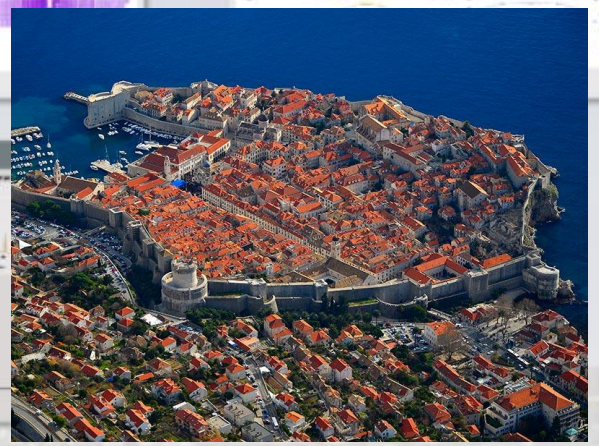
Dubrovnik

- **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**





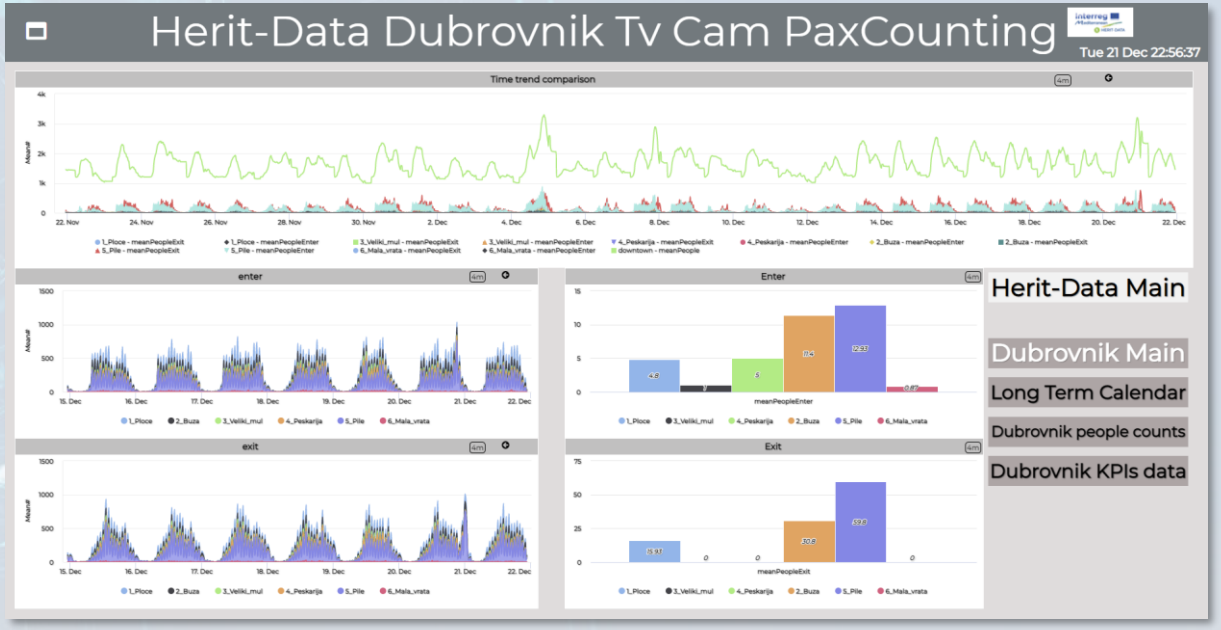


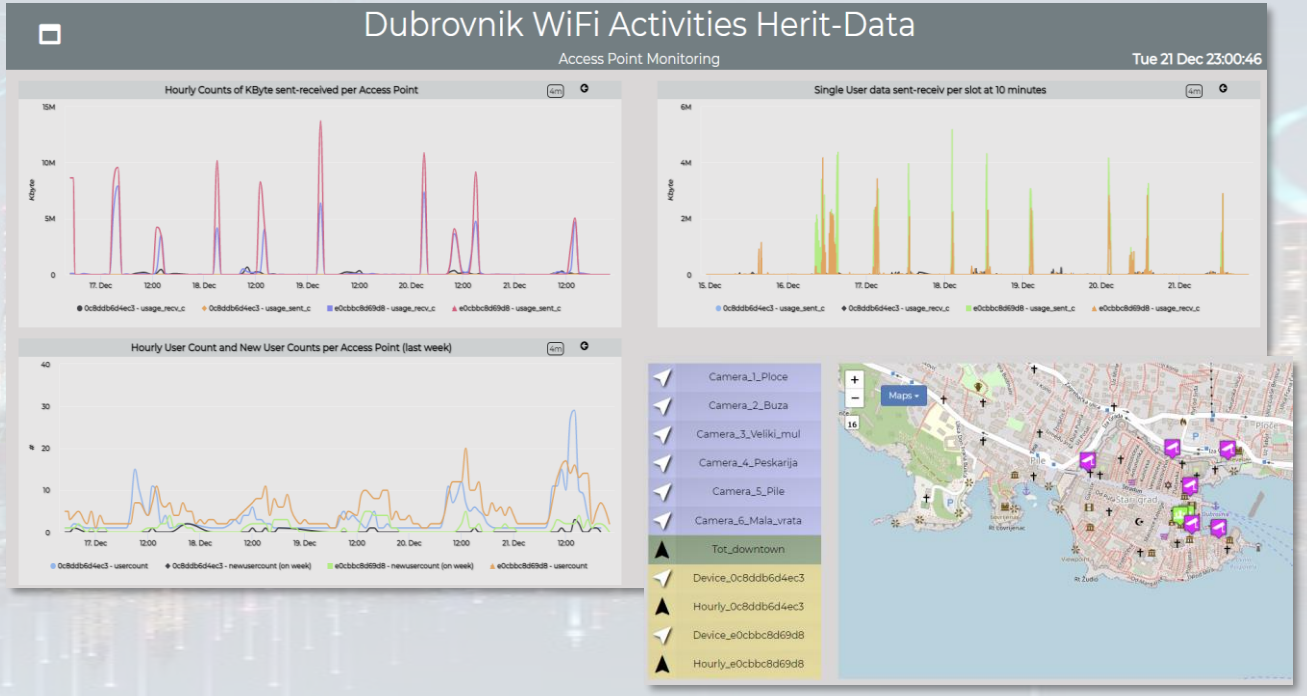


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzE0Ng==

Dubrovnik

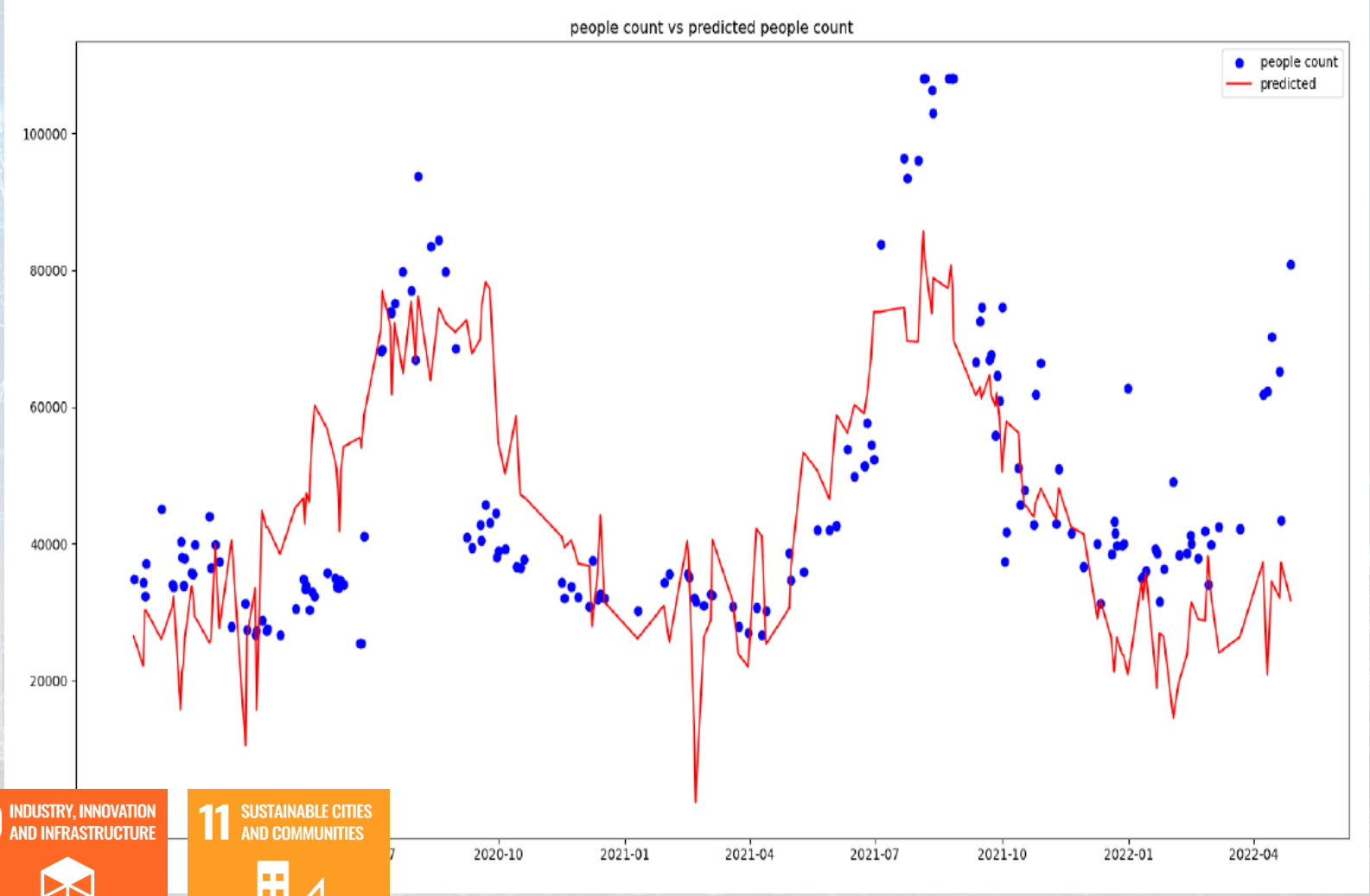
- **KPI**
  - #overnights
  - #Cruise Passengers vs time
  - Environmental data
  - Tourists per Countries
  - Employers of the sector vs time
- **Real Time data**
  - PAX Counting via TV Cam
  - Pax Counting via Wi-Fi
  - Volume of Citizens vs Tourists
- **Social Media, Real Time**
  - A Set of Key: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





Dubrovnik: Data Analytics

- Assessing impact of advertising
- Prediction of presences on the basis of
  - Social Media Twitter Vigilance
  - weather conditions
  - Historical data



Twitter Vigilance

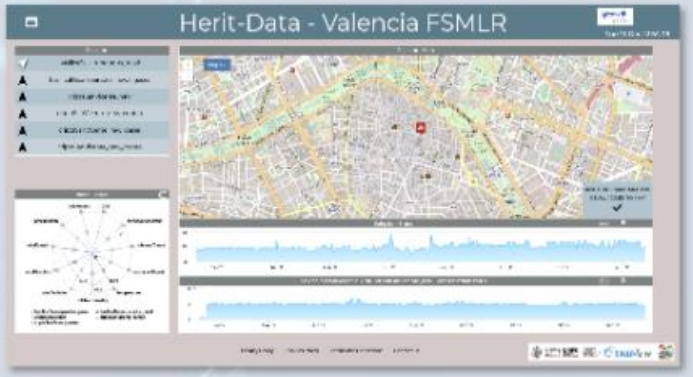
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

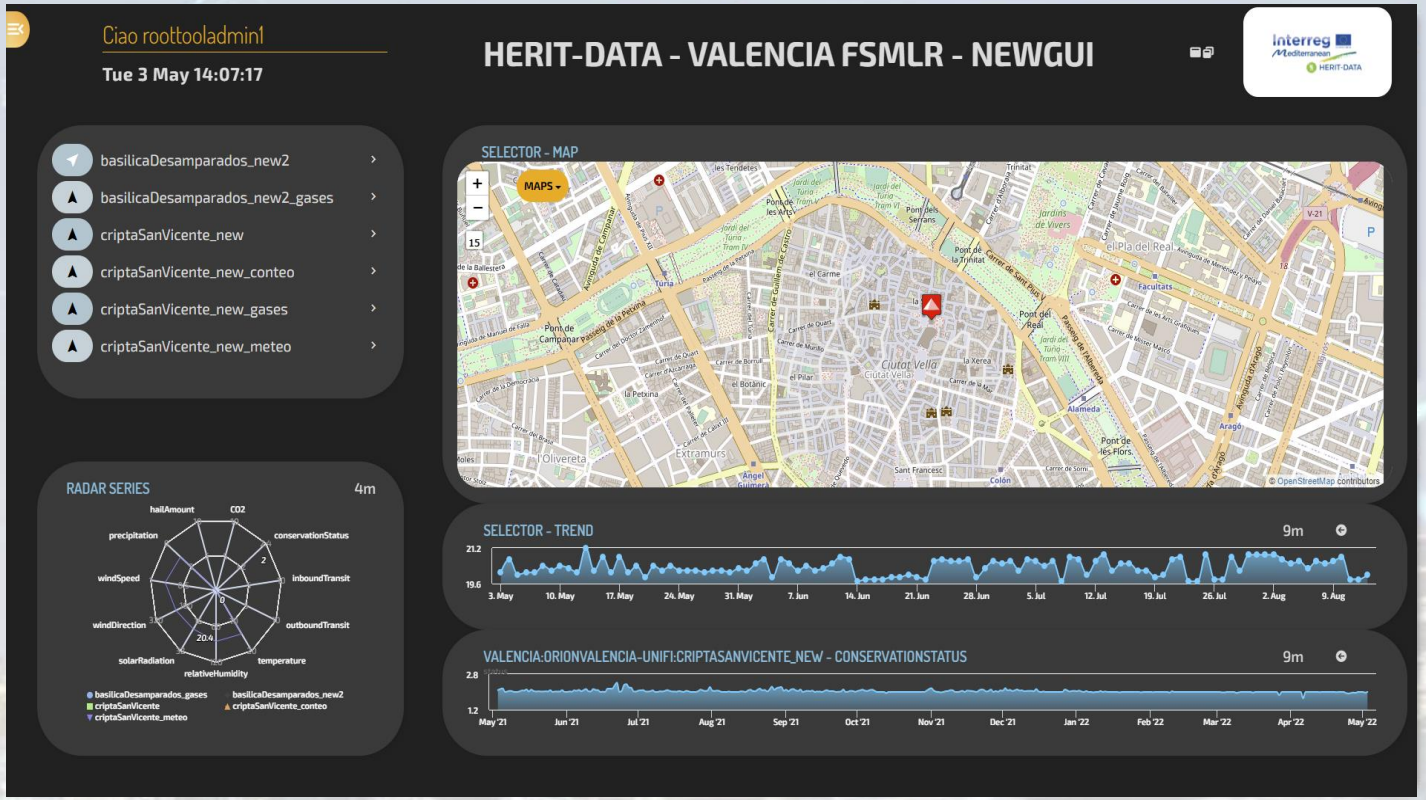
11 SUSTAINABLE CITIES AND COMMUNITIES

Interreg
Mediterranean
HERIT-DATA
Valencia, Spain
https://www.snap4city.org/742
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION

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**

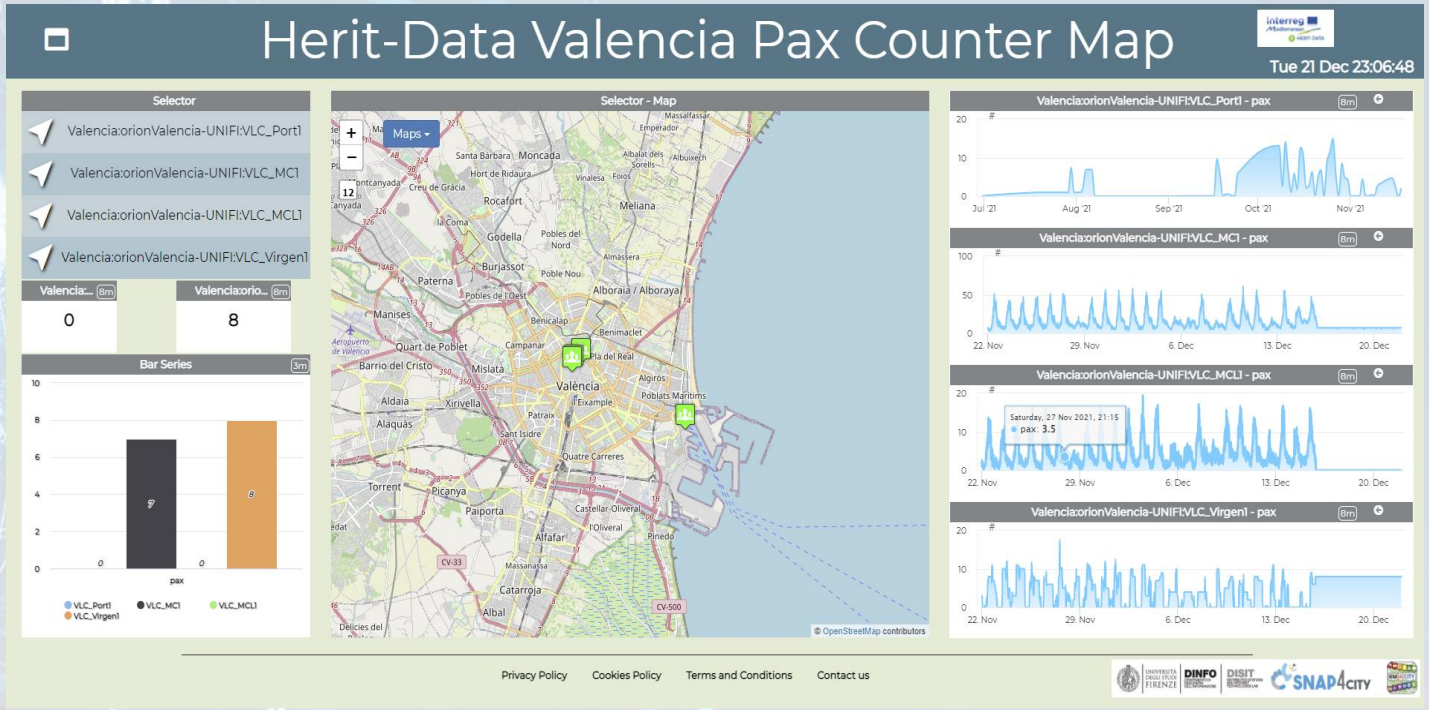


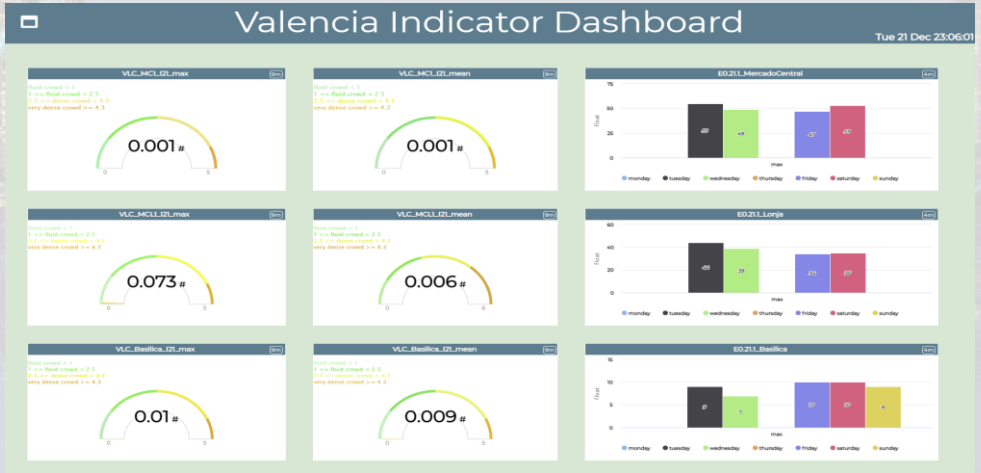


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzE1MA==

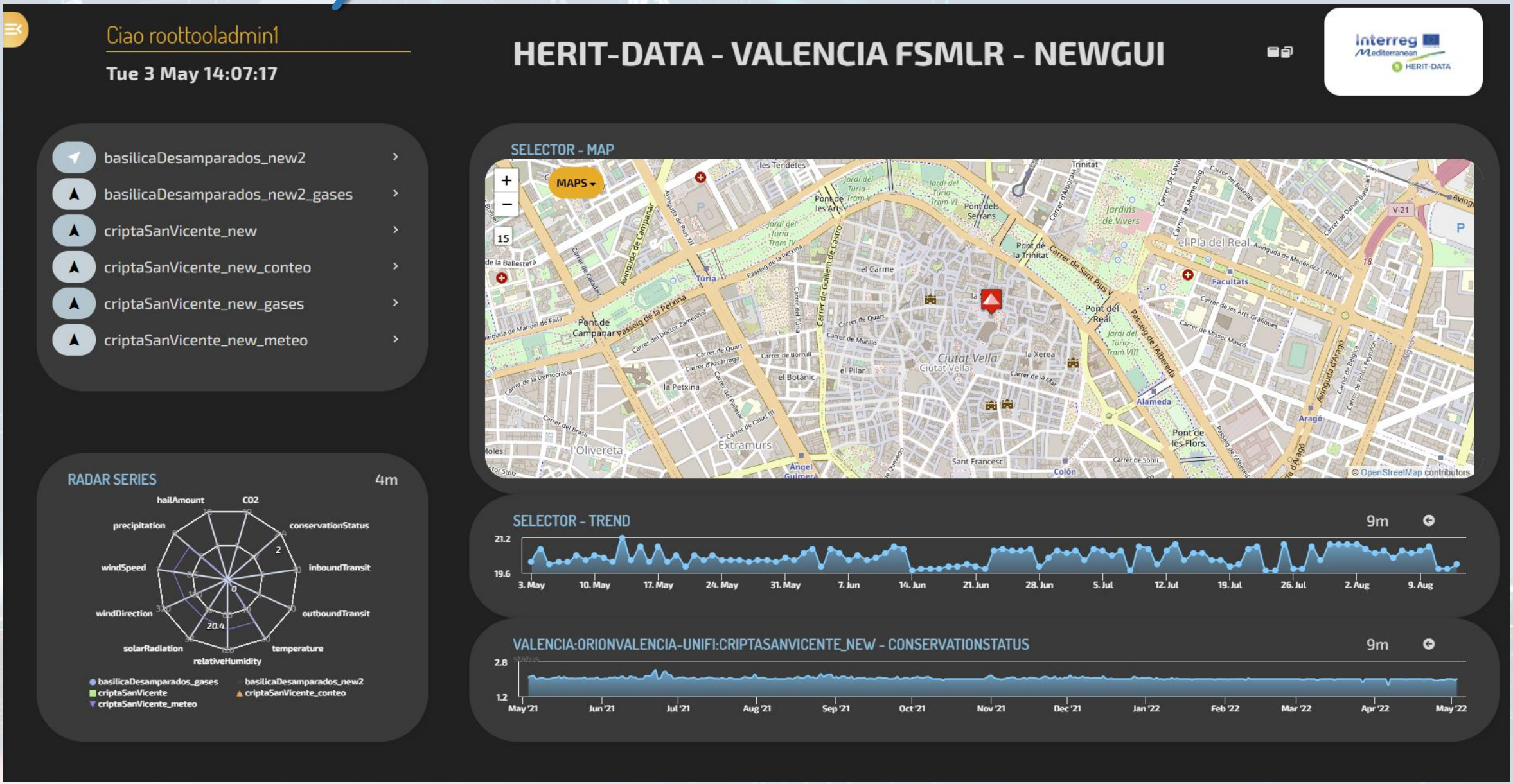
Valencia, FSMLR

- **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



Mostar, Bosnia-Herzegovina

https://www.snap4city.org/744

11 SUSTAINABLE CITIES AND COMMUNITIES

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

13 CLIMATE ACTION

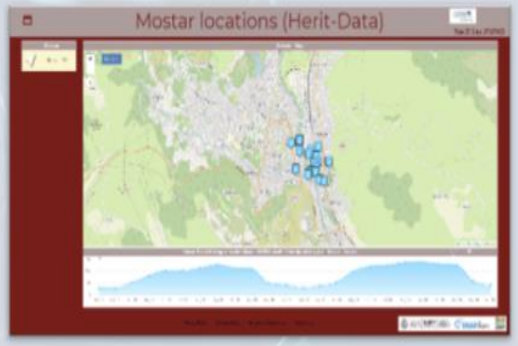
Interreg Mediterranean

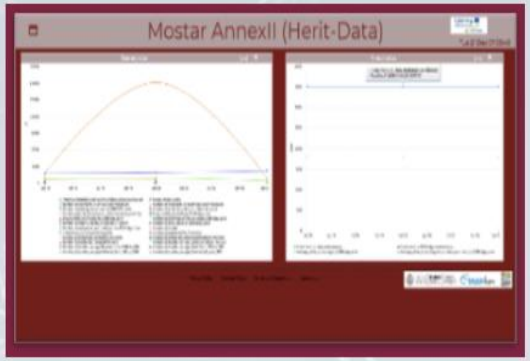
HERIT-DATA

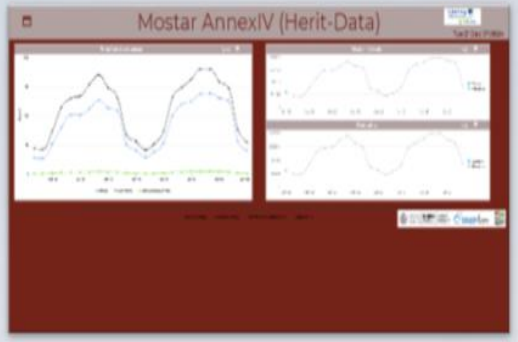
Mostar, Bosnia Herzegovina

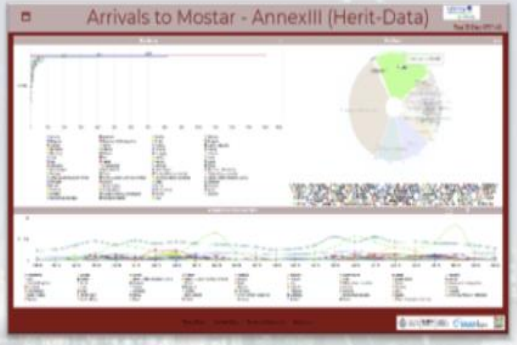
- **Tourism Domain**
  - KPI: business, house prices, investments, stay duration, etc.
  - Profiled POI, Point of Interests
  - People flows: arrivals, overhights
- **Dashboards**
  - Monitoring KPI
  - POI, flows
- **Historical and updated data**
- **Services Exploited on:**
  - Dashboard
- **Since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

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



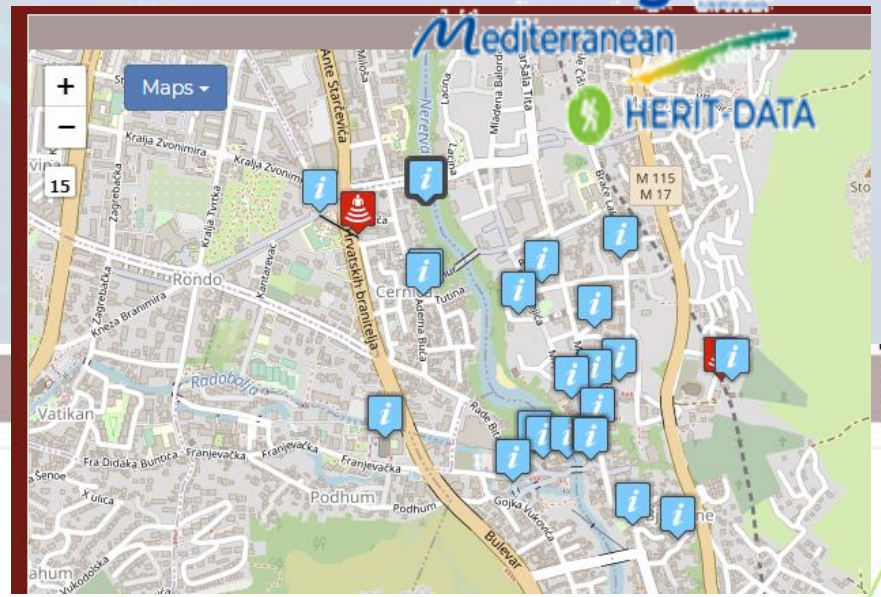


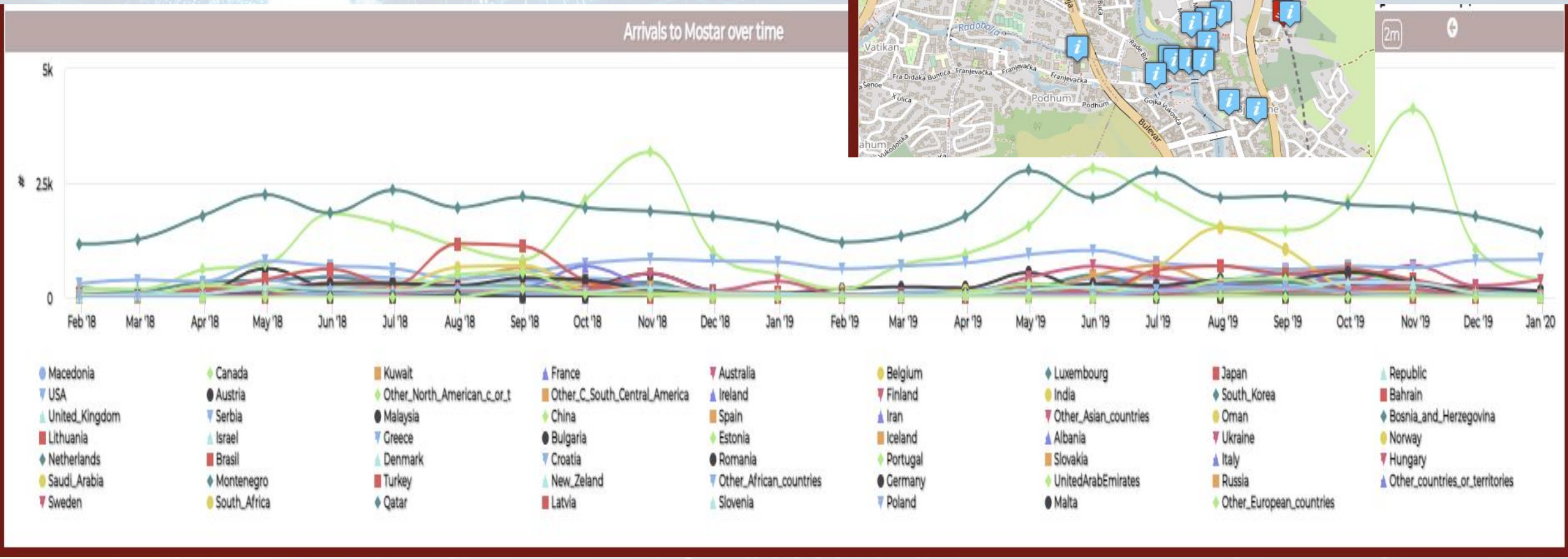




Mostar, Bosnia Herzegovina

- Arrivals per Country Since 2018



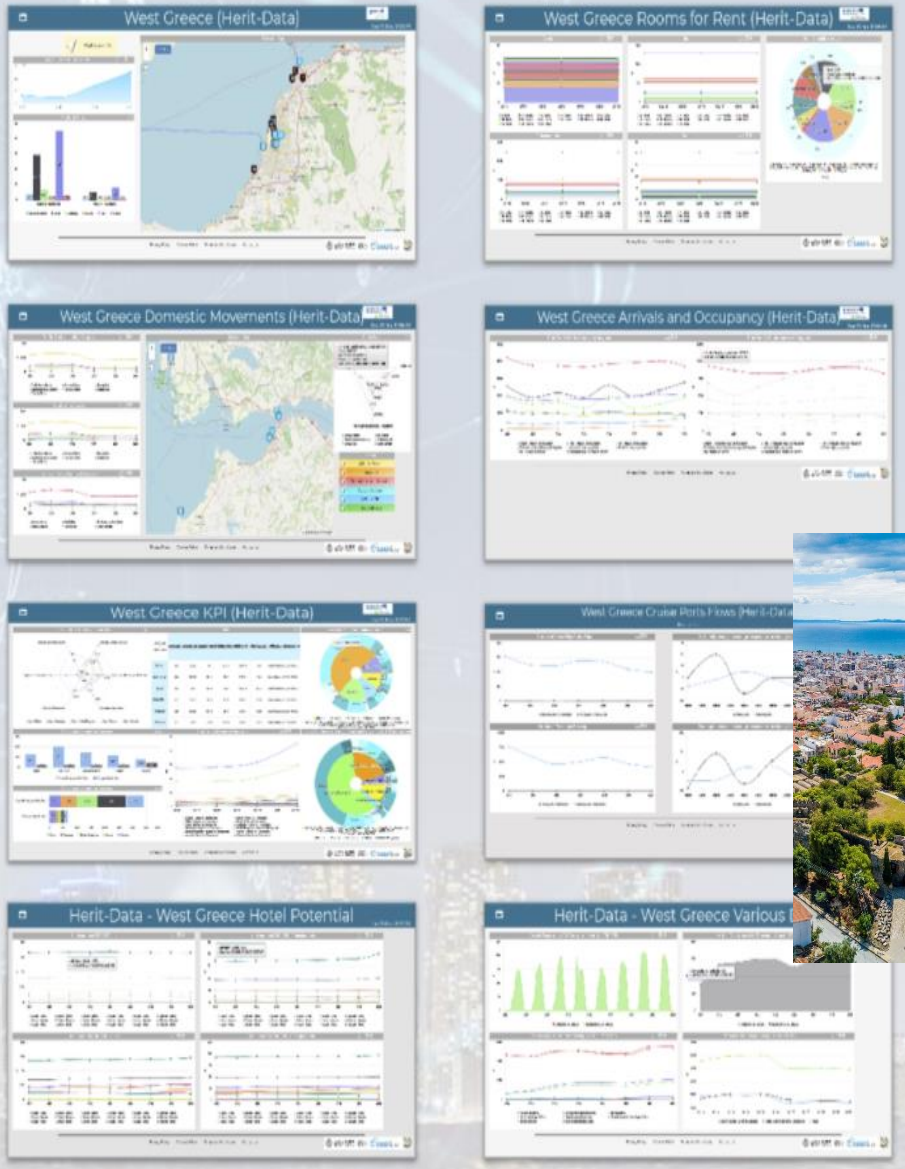


West Greece (Patra)

https://www.snap4city.org/743

West Greece

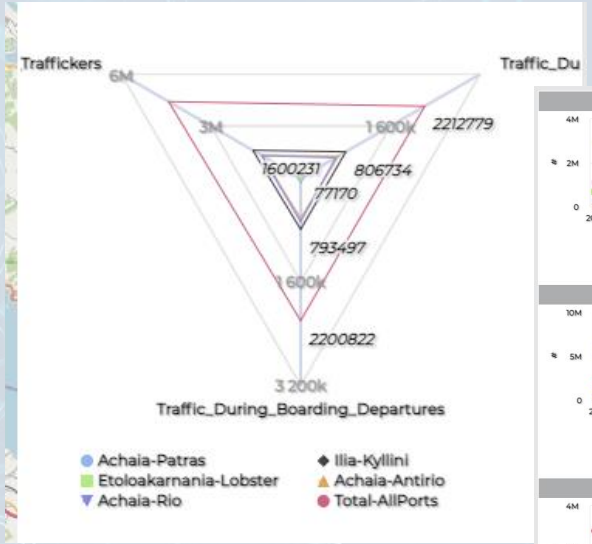
- **Tourism Domain**
  - KPIs: ODM, Flows, …
  - Social Media
  - People Flows
- **Dashboards**
  - Monitoring KPI
  - People flows
  - Twitter Vigilance
- **Historical and updated data**
- **Services Exploited on:**
  - Dashboard
- **Since 2020**

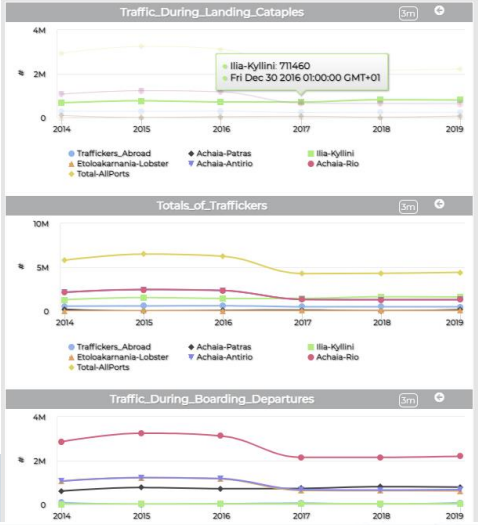


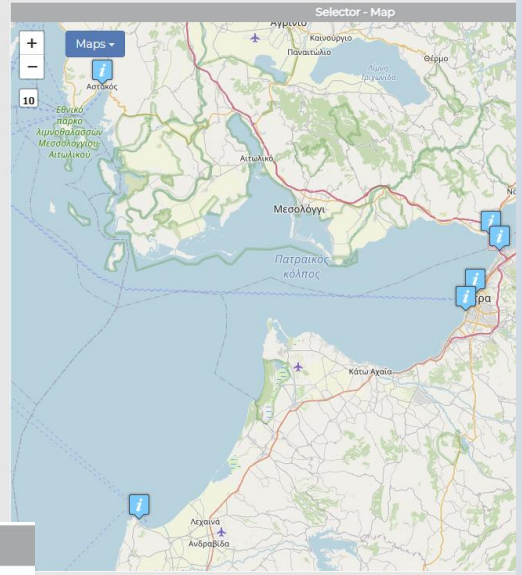
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzE1NA==

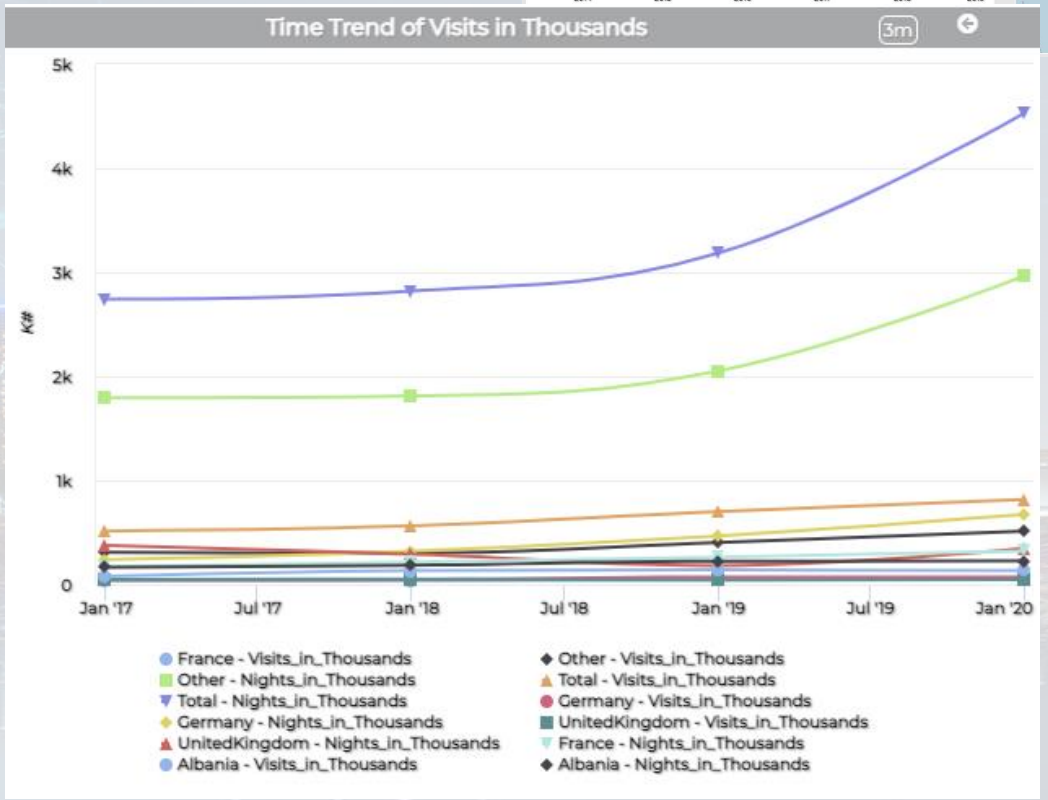
West Greece

- **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



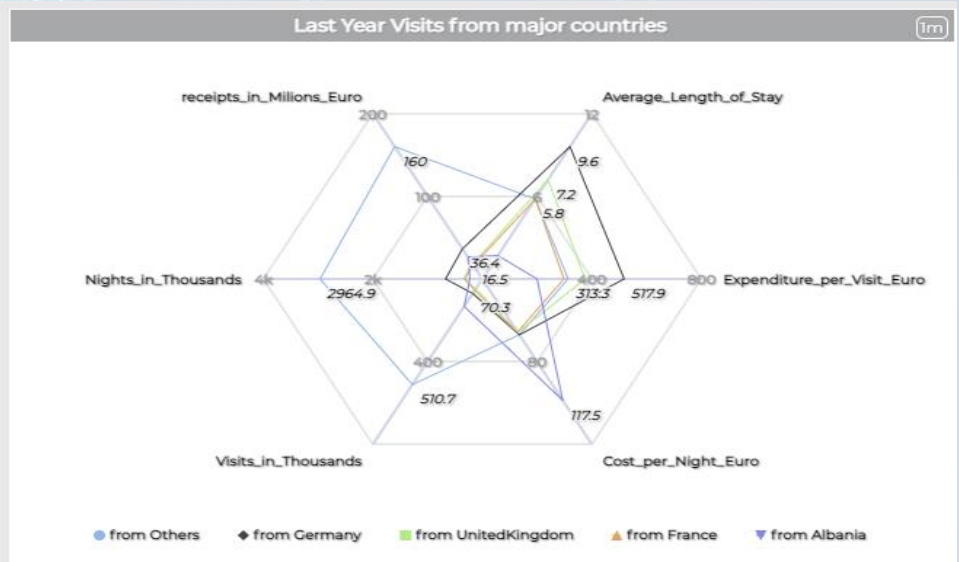


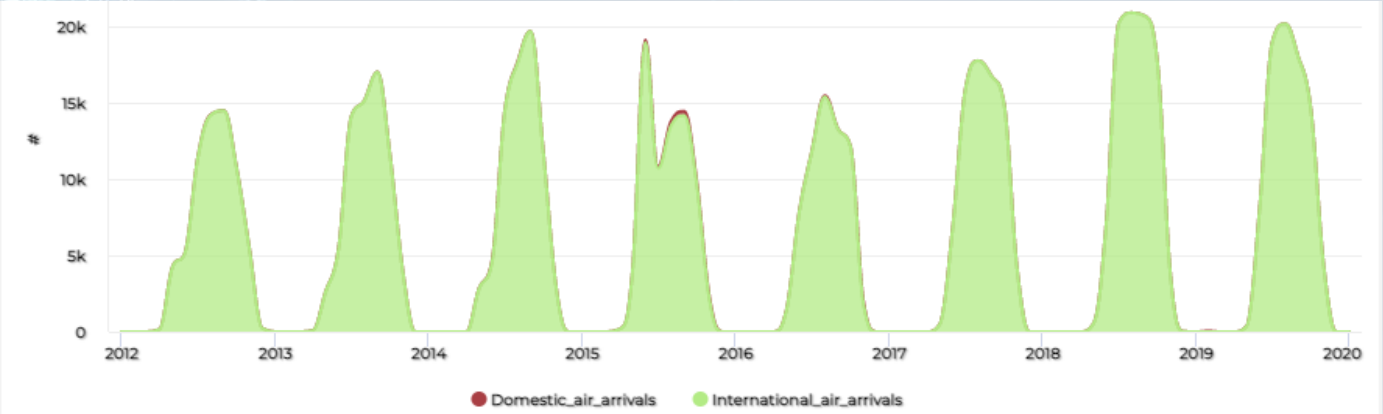




West Greece

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





Santiago di Compostela, Spain

11 SUSTAINABLE CITIES AND COMMUNITIES

Snap4City (C), December 2022

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

11 SUSTAINABLE CITIES AND COMMUNITIES

13 CLIMATE ACTION

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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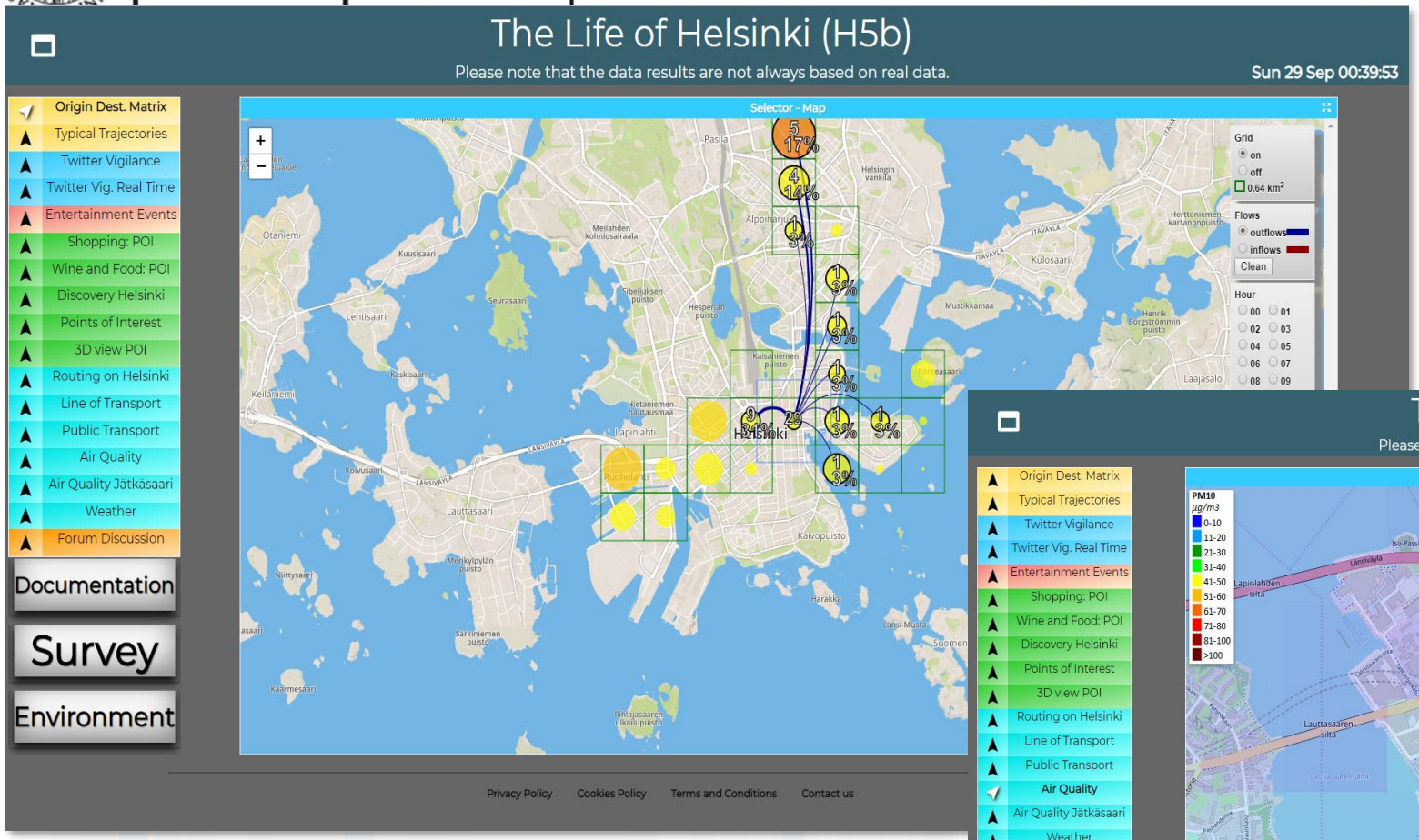
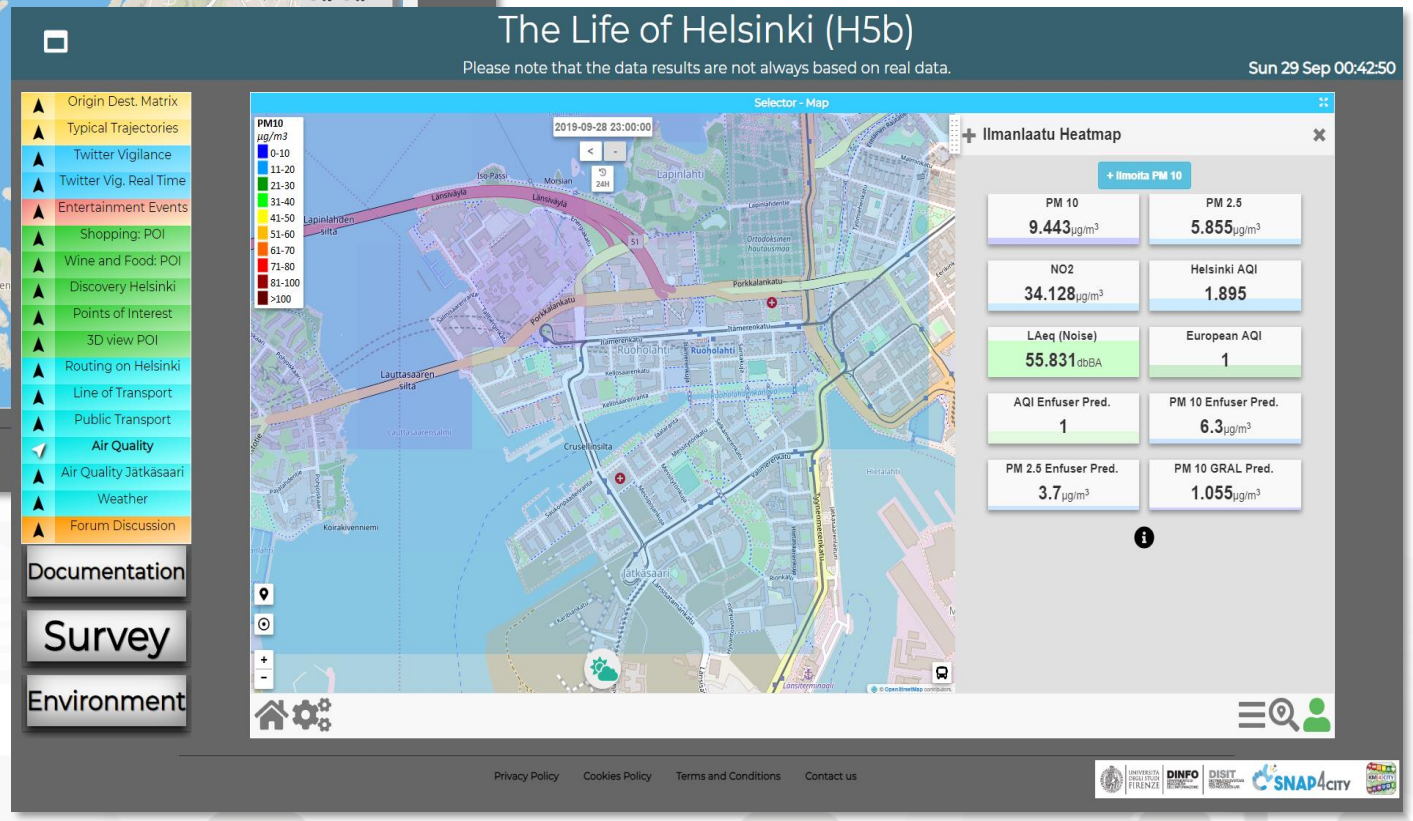
Helsinki





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

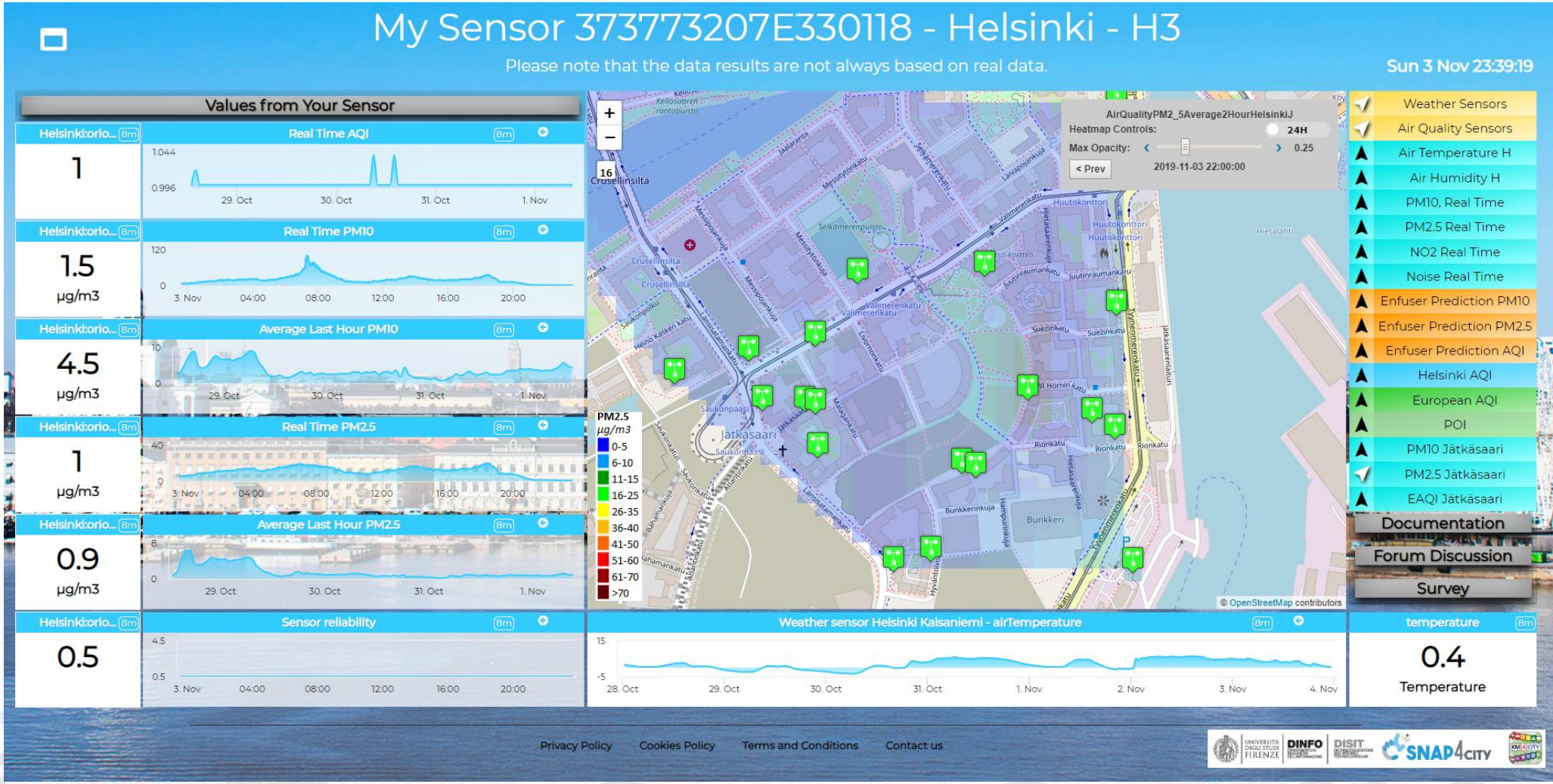
Helsinki

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

Helsinki

Environmental Devices hosted by Citizens



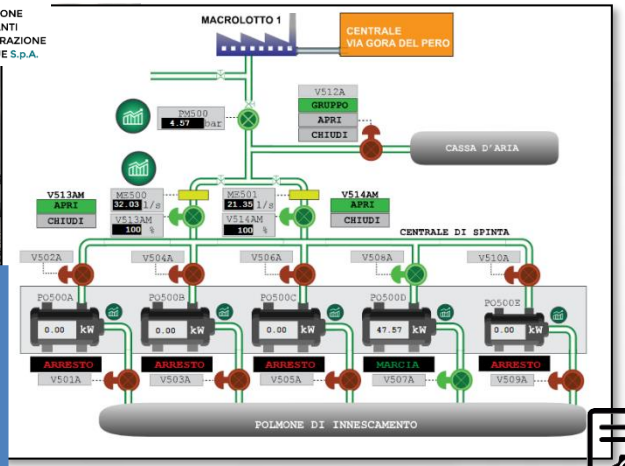
Prato

https://www.snap4city.org/758

Smart City vs Industry 4.0

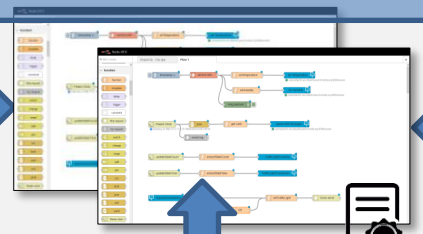
GIDA set up

Smart City data from many sources



IOT Applications

Dashboards and Apps



Big Data Analytics, Artificial Intelligence

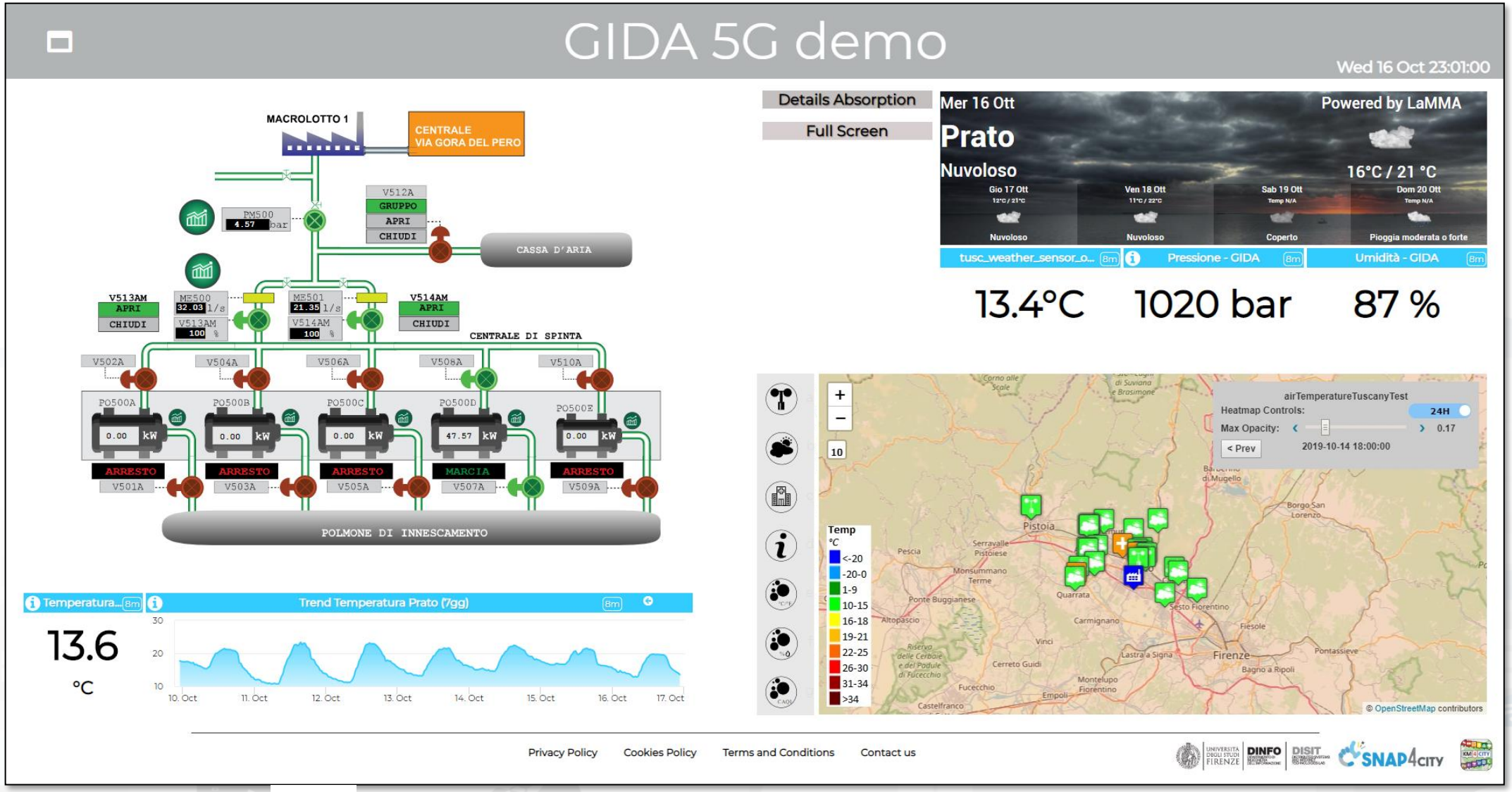
IOT Data Shadow Snap4City

ModBus to Snap4City Gateway Edge

5G network devices

Telemonitoring
Telecontrol

Dashboards & Services:



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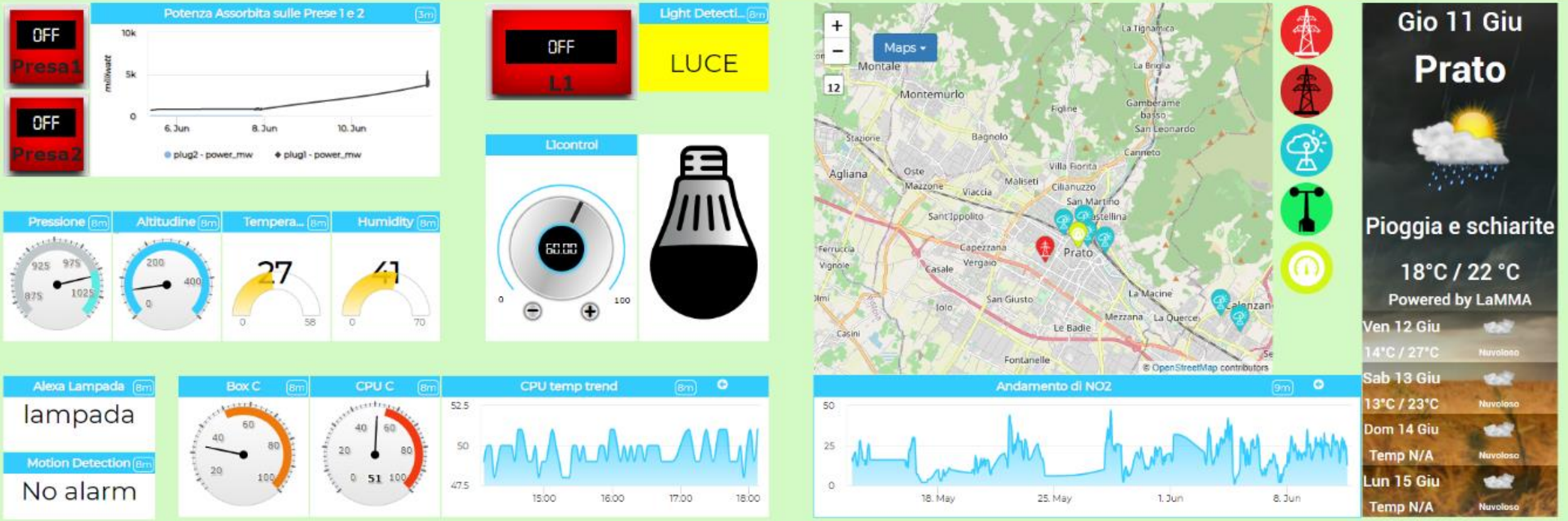
Snap4Home 5G Demo

Thu 11 Jun 18:07:32



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open fiber WIND 3 ZTE estra

Roma (I)

https://www.snap4city.org/753

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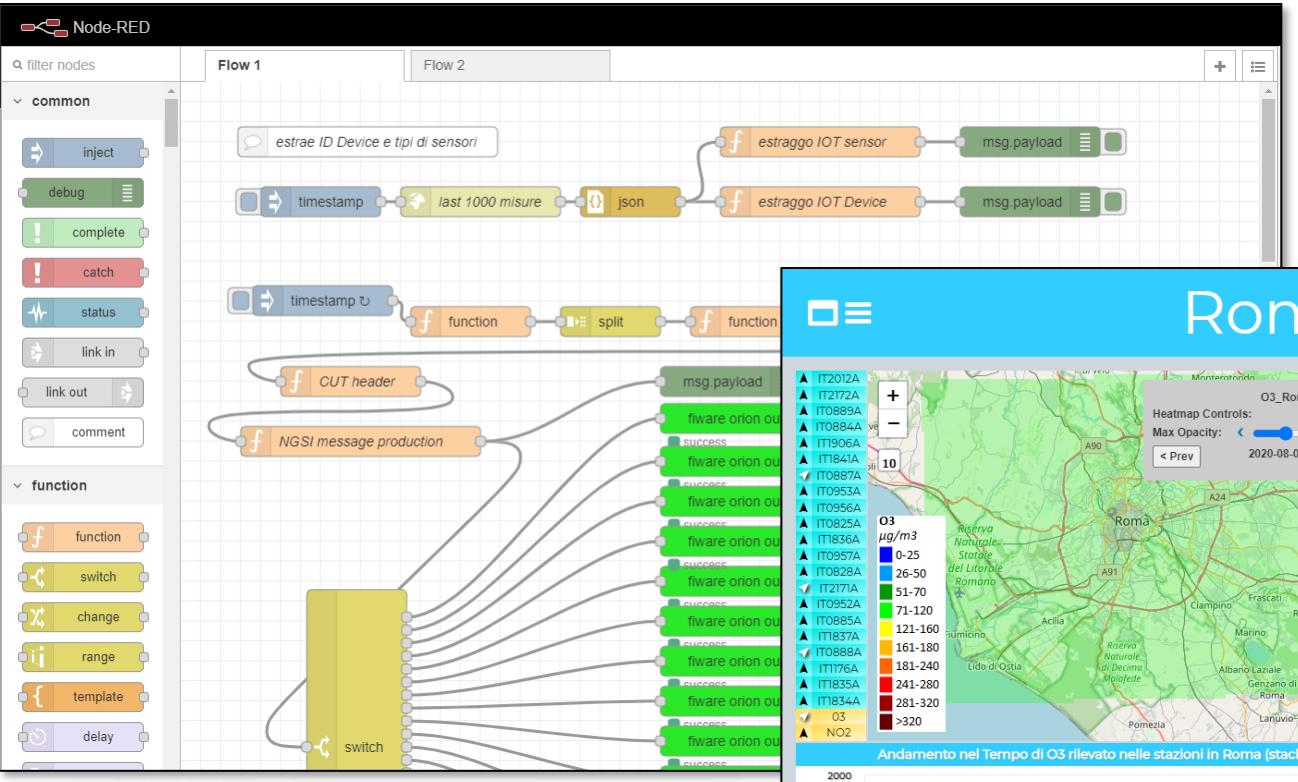
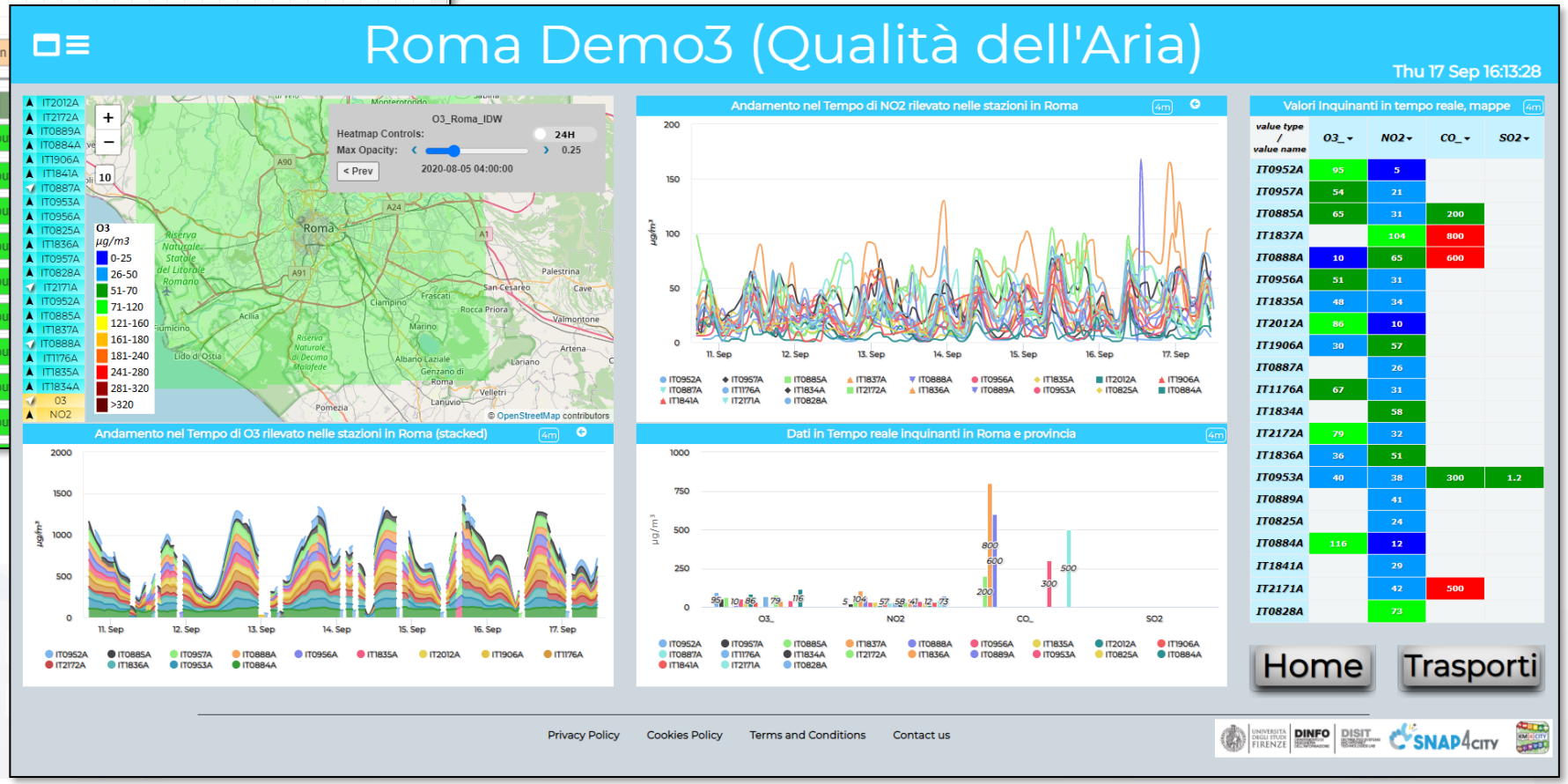
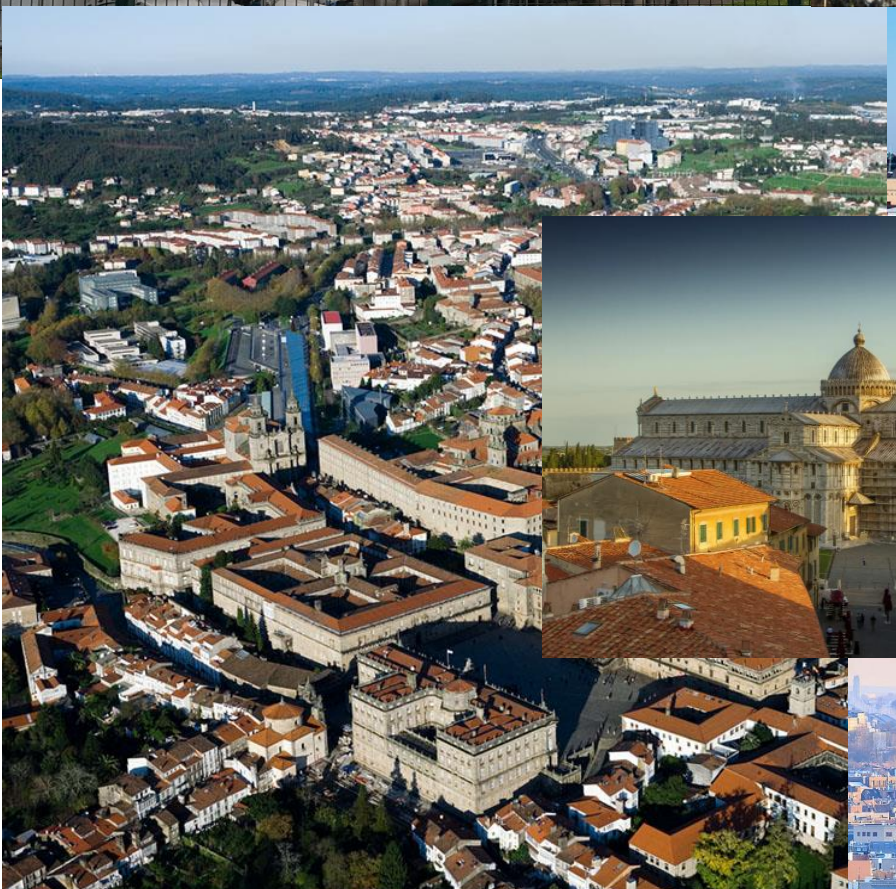
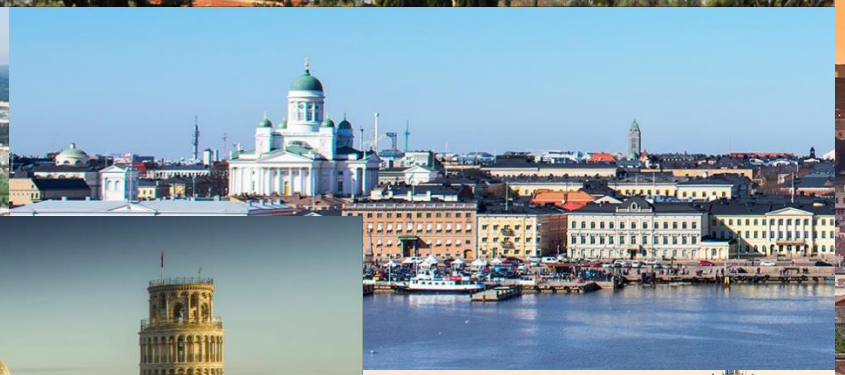
SNAP4CITY | KM4CITY





Roma (I)

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

TOP

Many other cases

FROM CITY DASHBOARD TO APPLICATIONS

DATA GATHERI AND CITY DAT KNOWLEDGE MANAGEMENT

FORGING & MANAGING OPEN AND FLEXIBLE WEB AND MOBILE APPS

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

SIMULATION

SNAP4CITY ARCHITECTURE AND ECOSYSTEM. OPENED TO DEVELOPERS AND STAKEHOLDERS

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

100% OPEN SOURCE

SNAP4 Appliances and Dockers **Installations**

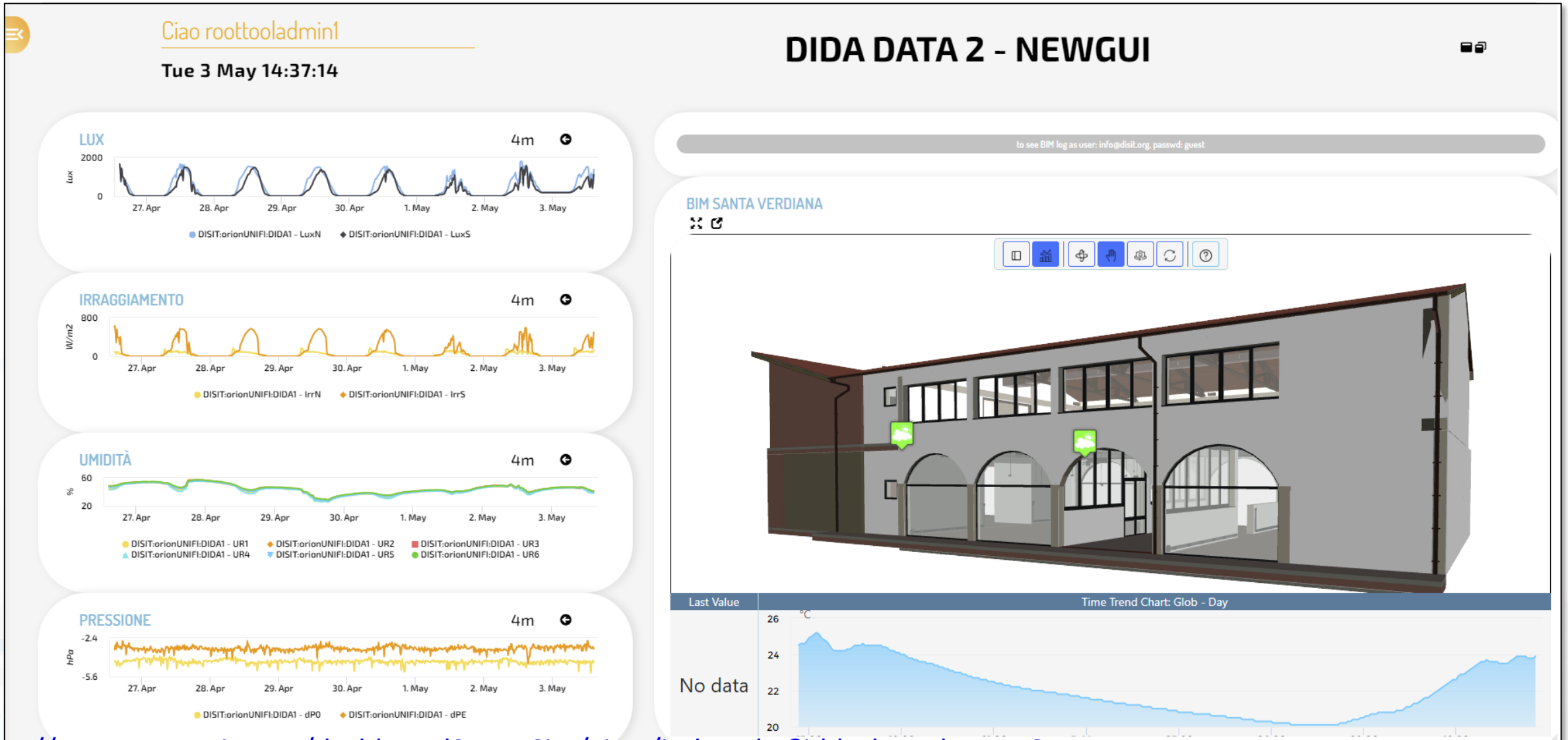
https://www.snap4city.org/4

- 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

Scenarious

- 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



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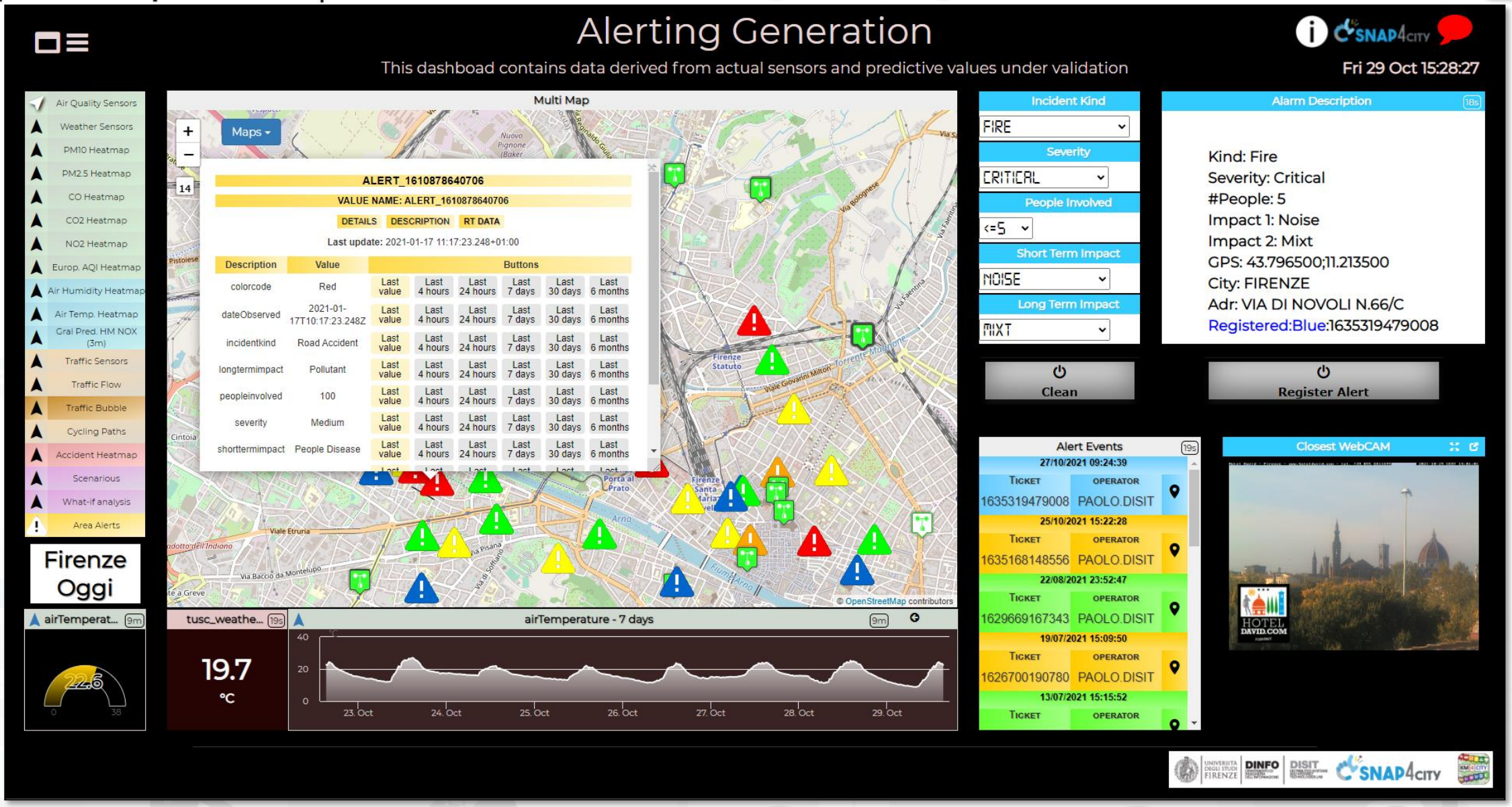
Alerting Mng



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

IoT Health Scenarios

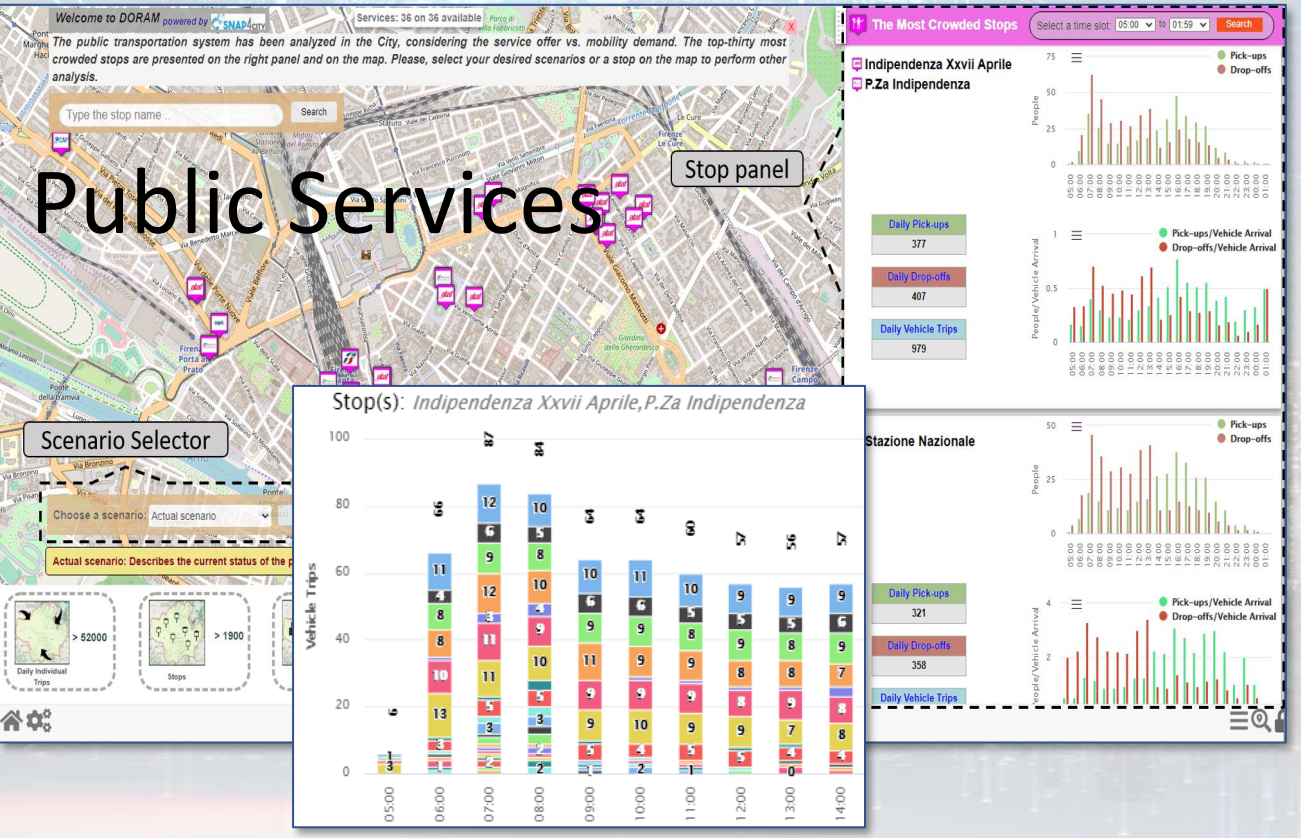
- **1) Smart Ambulance:**
  Collecting and managing local data from tools and sensors inside the ambulance, IoT Devices, Tablets, Drones etc.

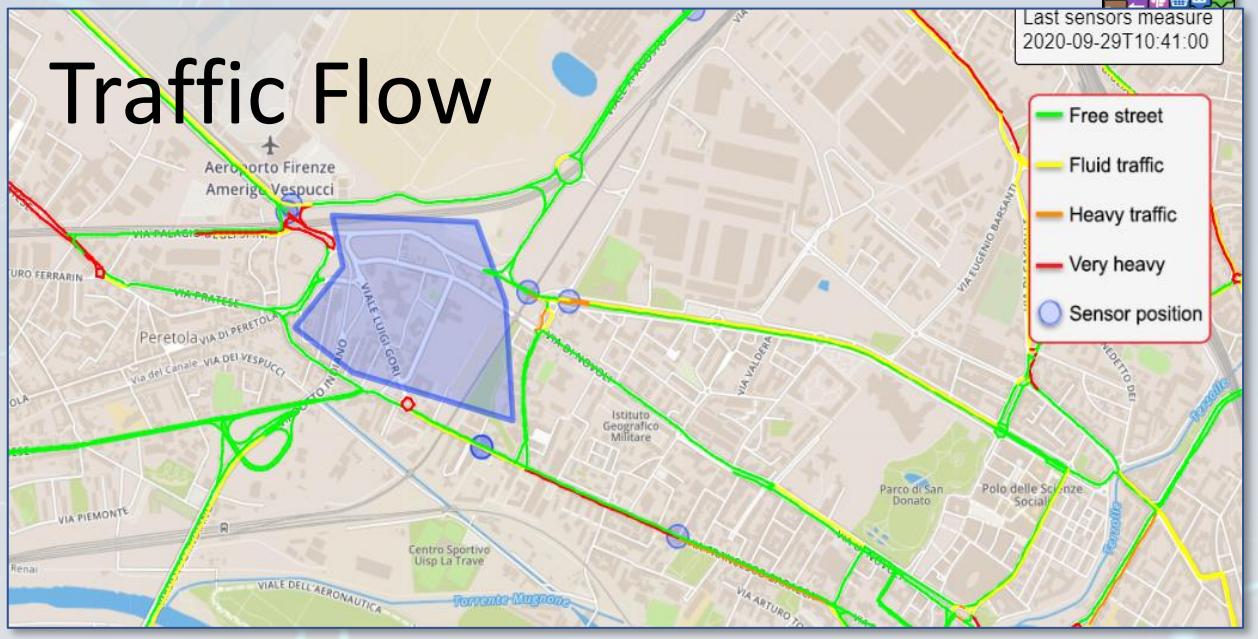
- **2) Personal Health devices:**
  e.g.: glucometers, etc.

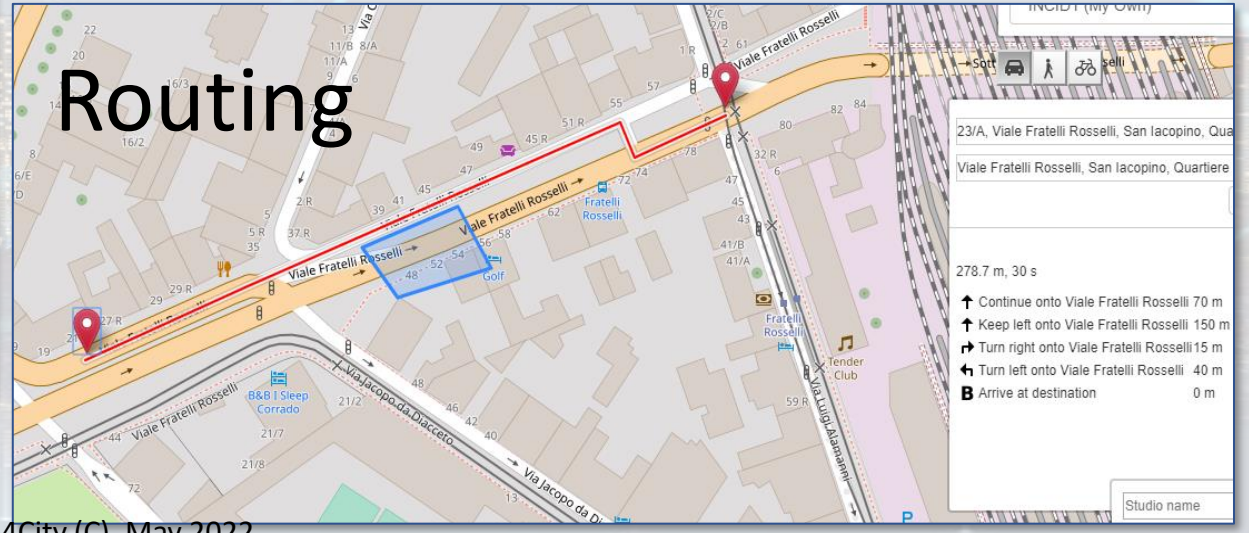
- **3) Smart Bed:**
  Collecting and managing data from smart bed sensors, monitoring parameters in real-time

What-if Analysis

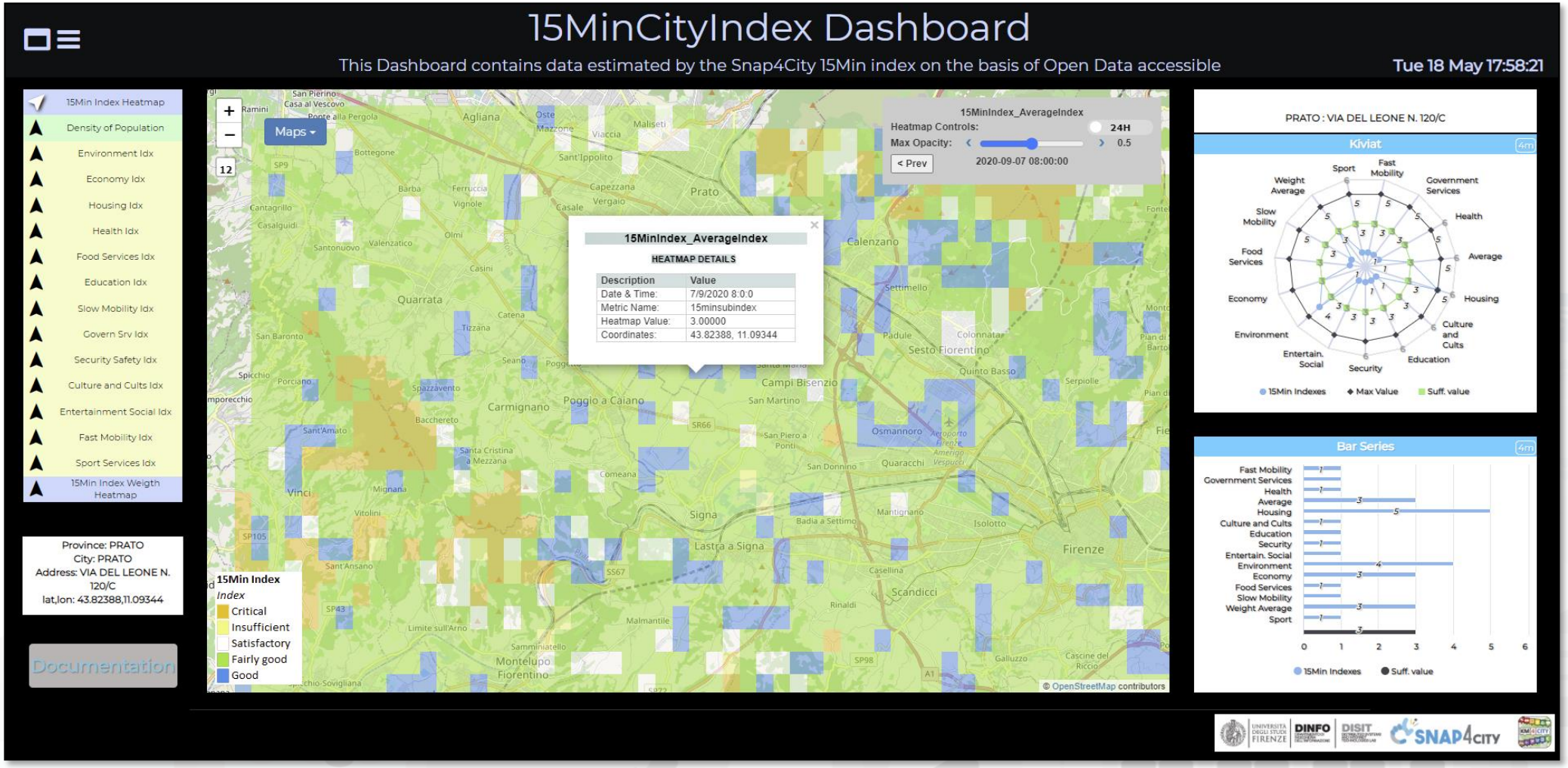
- Definition of scenarious impact on
  - Traffic, Pollutant, parking, public transport, private flows, etc.
  - KPI analysis





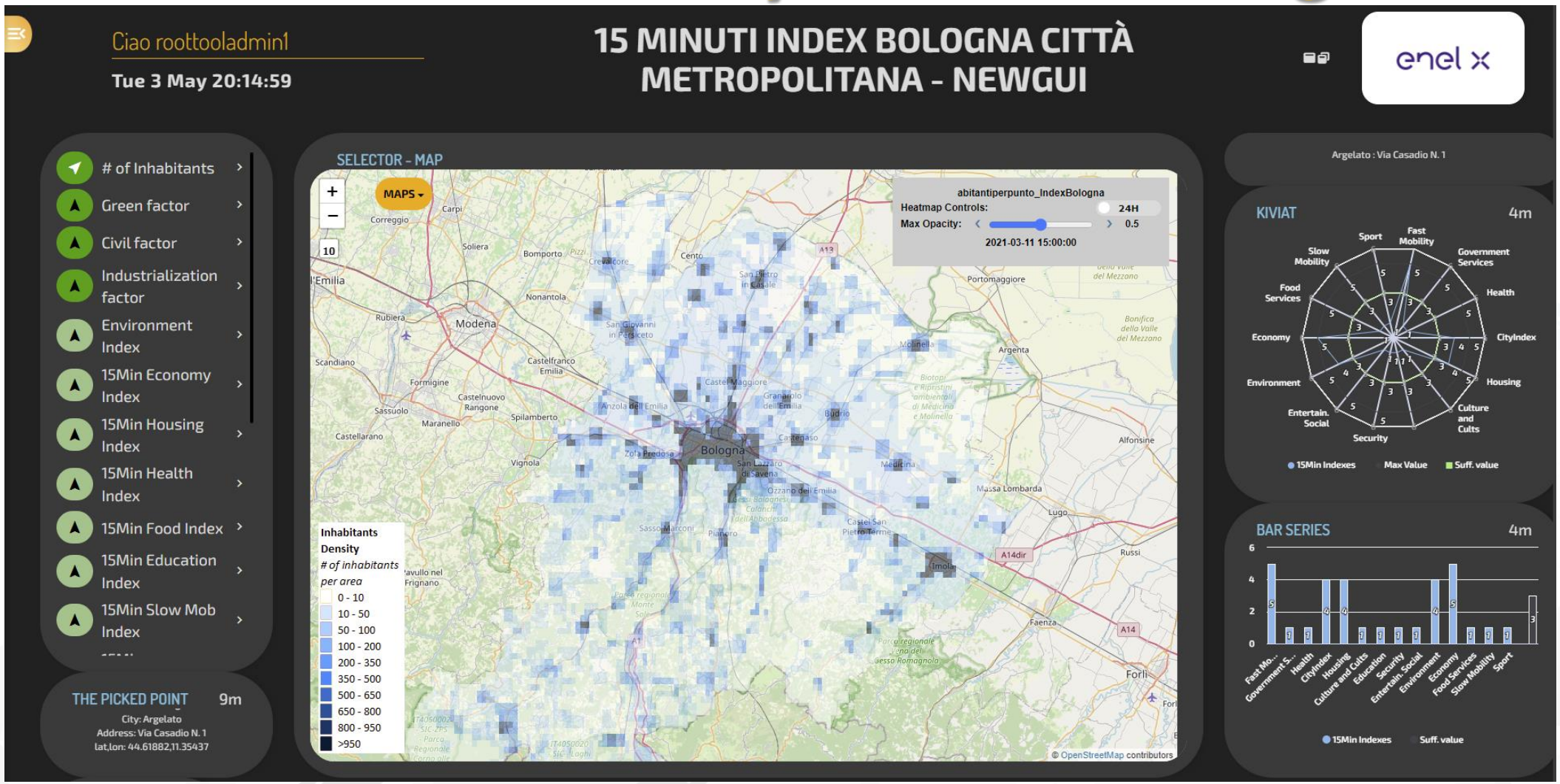


15MinCityIndex Firenze



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

15MinCityIndex on Bologna



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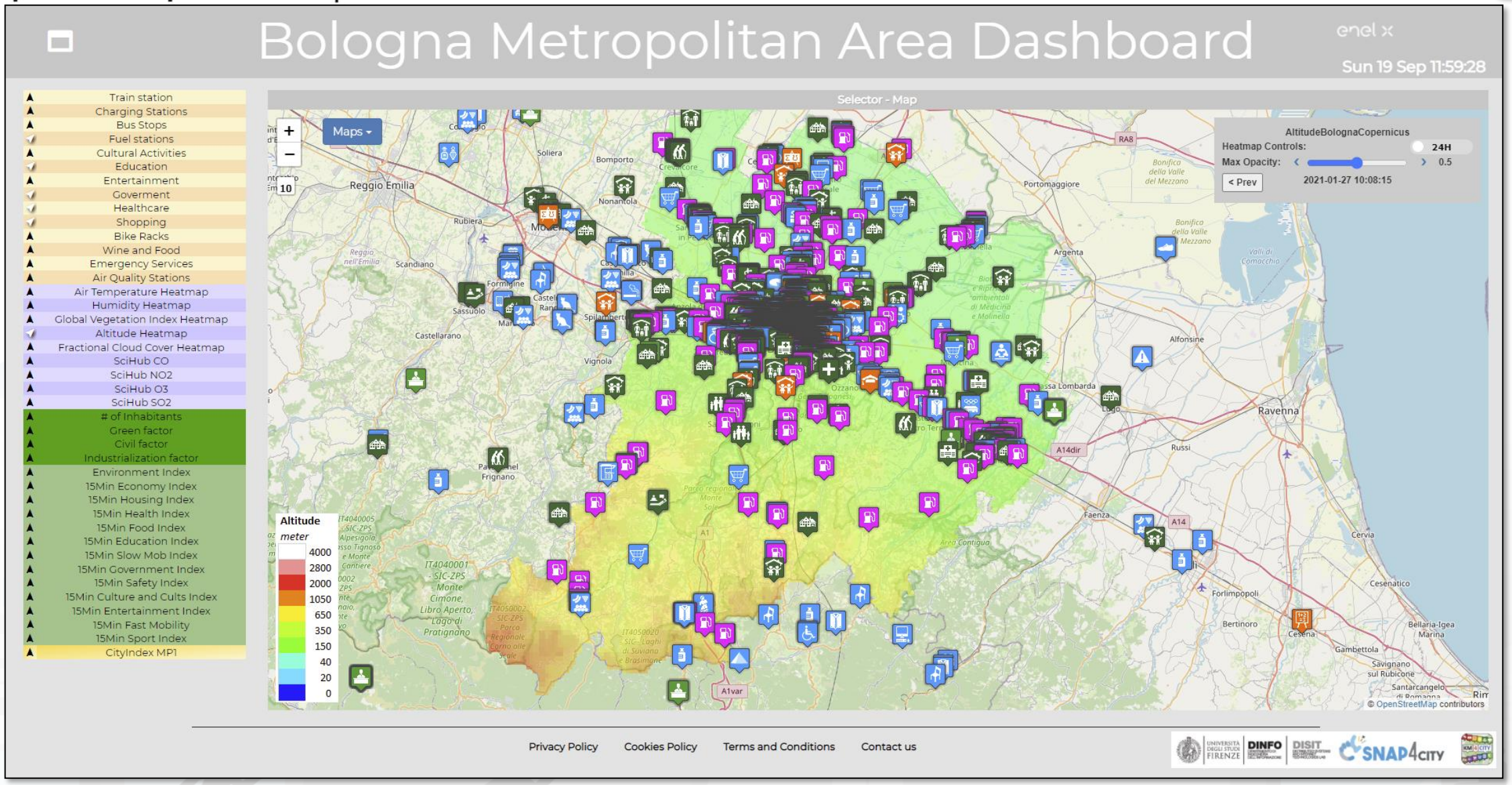

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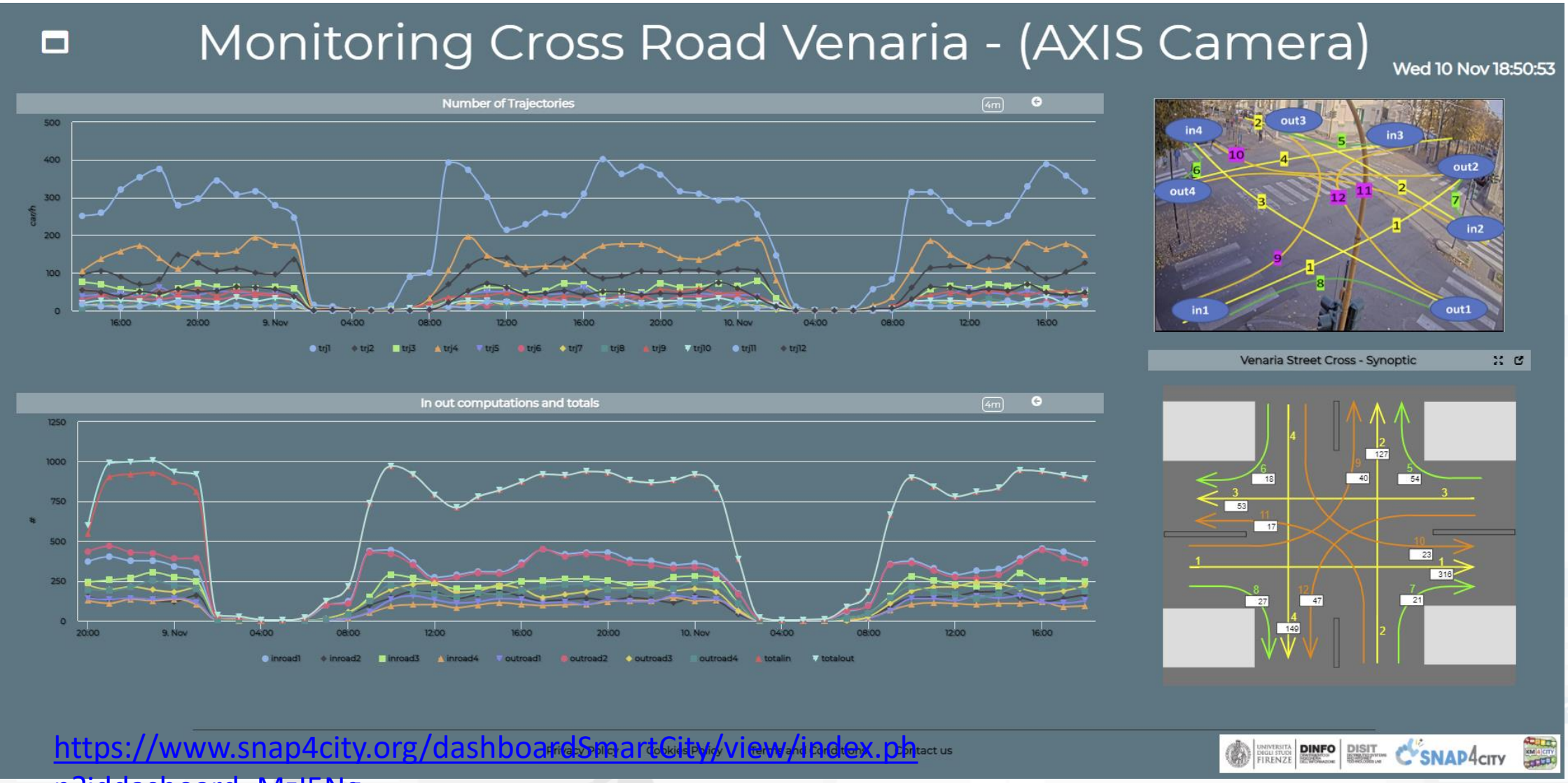
Venaria Reale



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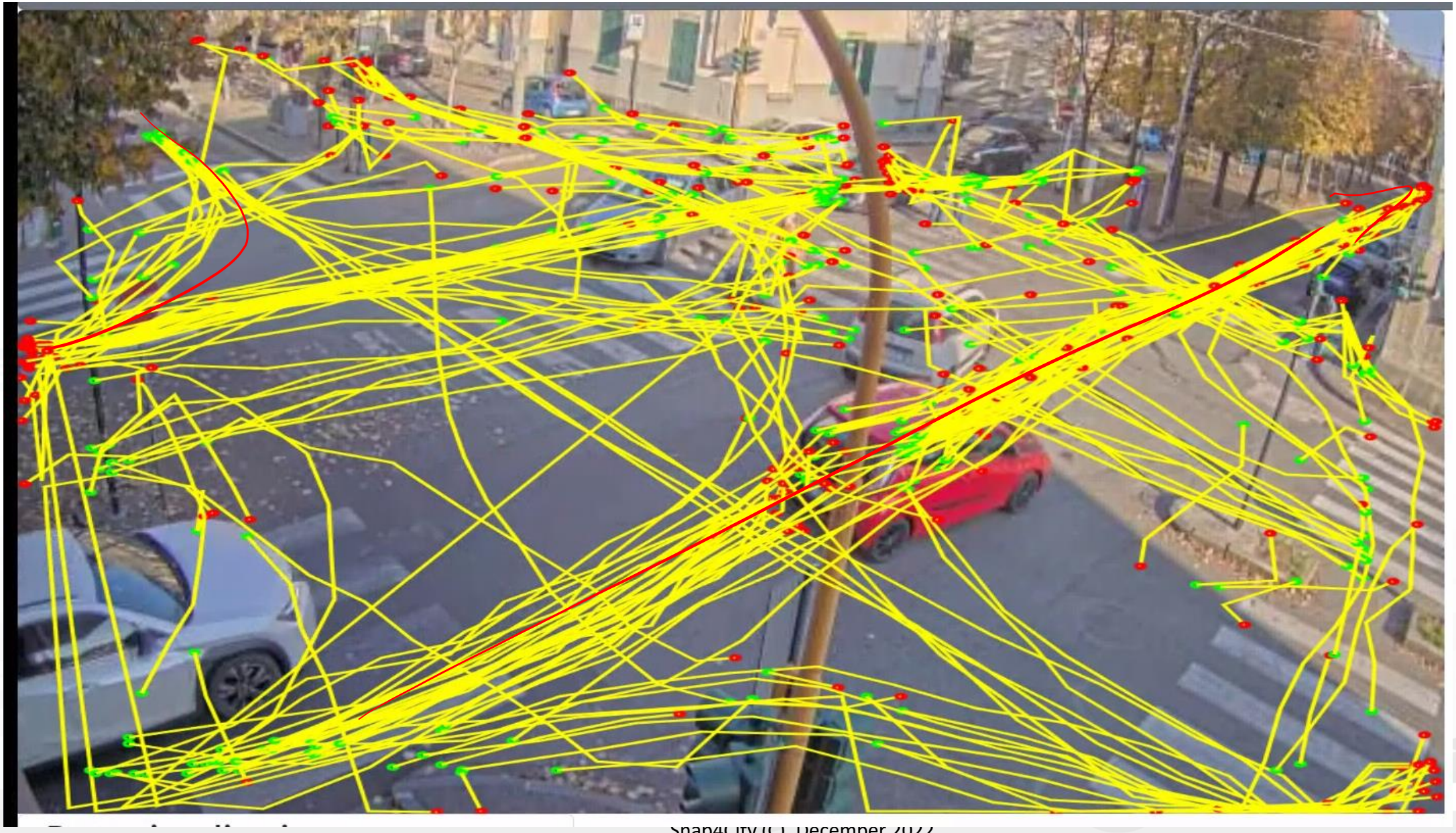
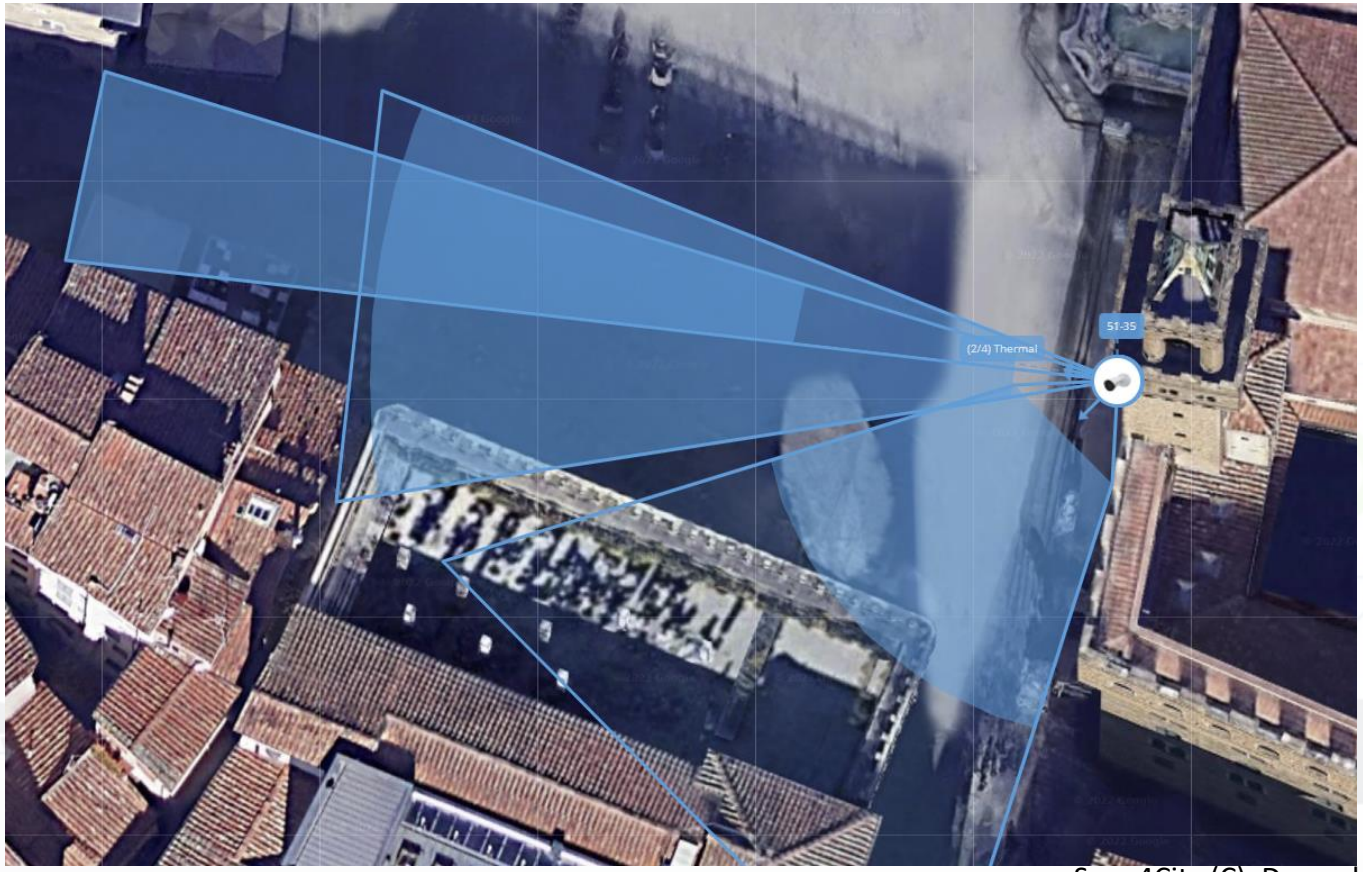


Venaria Reale

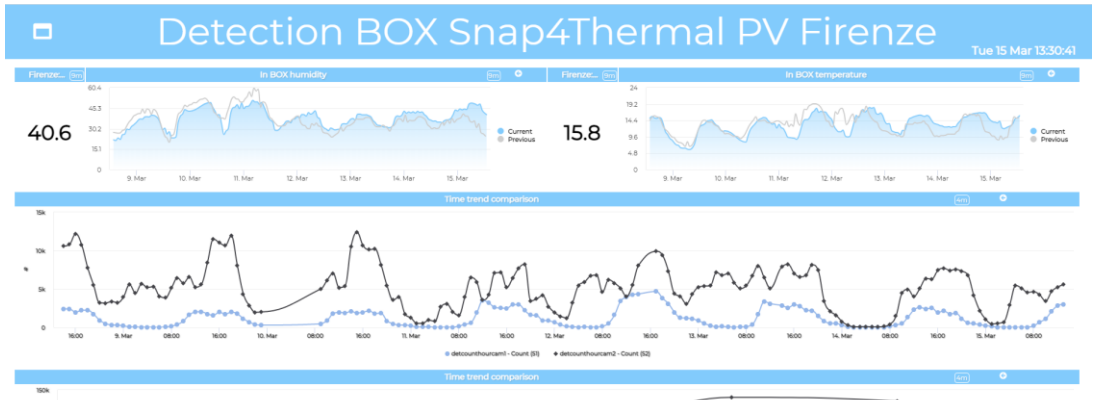
- **AXIS camera as IOT Edge**
  - **Color, Thermal and Radar: security, transport, etc.**
  - Node-RED on board
  - Snap4City Library installed
  - Image processing for trajectories
  - Sending data stream on Snap4City.org
- **Snap4City infrastructure**
  - Collecting data in real time
  - Pre-processing,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

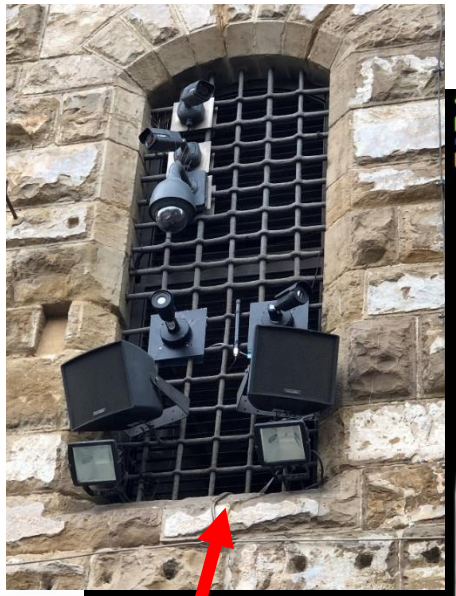
One Camera
Many results

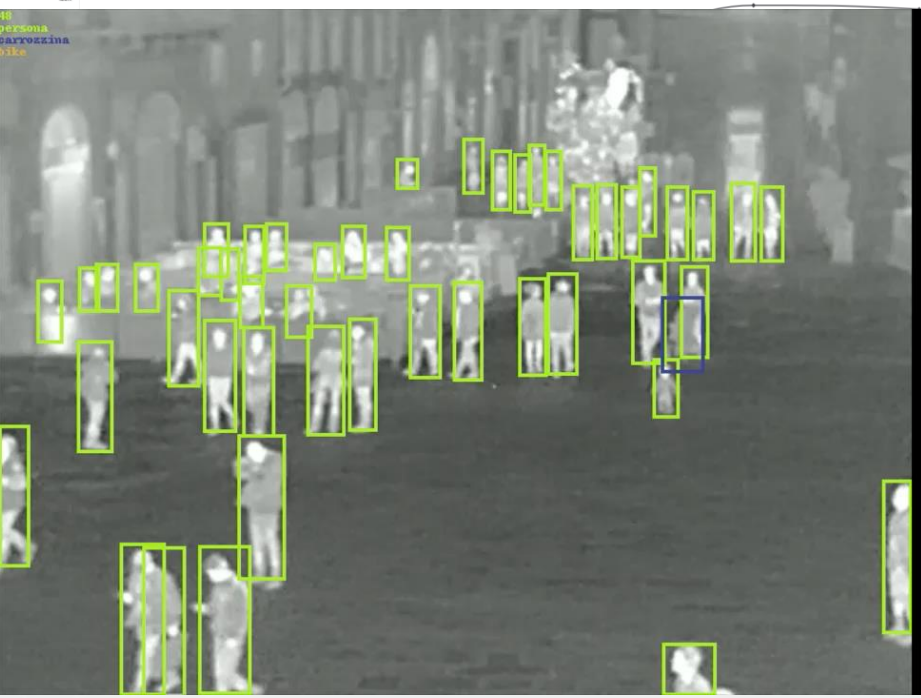
Tracking People
AXIS Camera with Snap4City



A view and data from the Thermal Camera







11 SUSTAINABLE CITIES AND COMMUNITIES

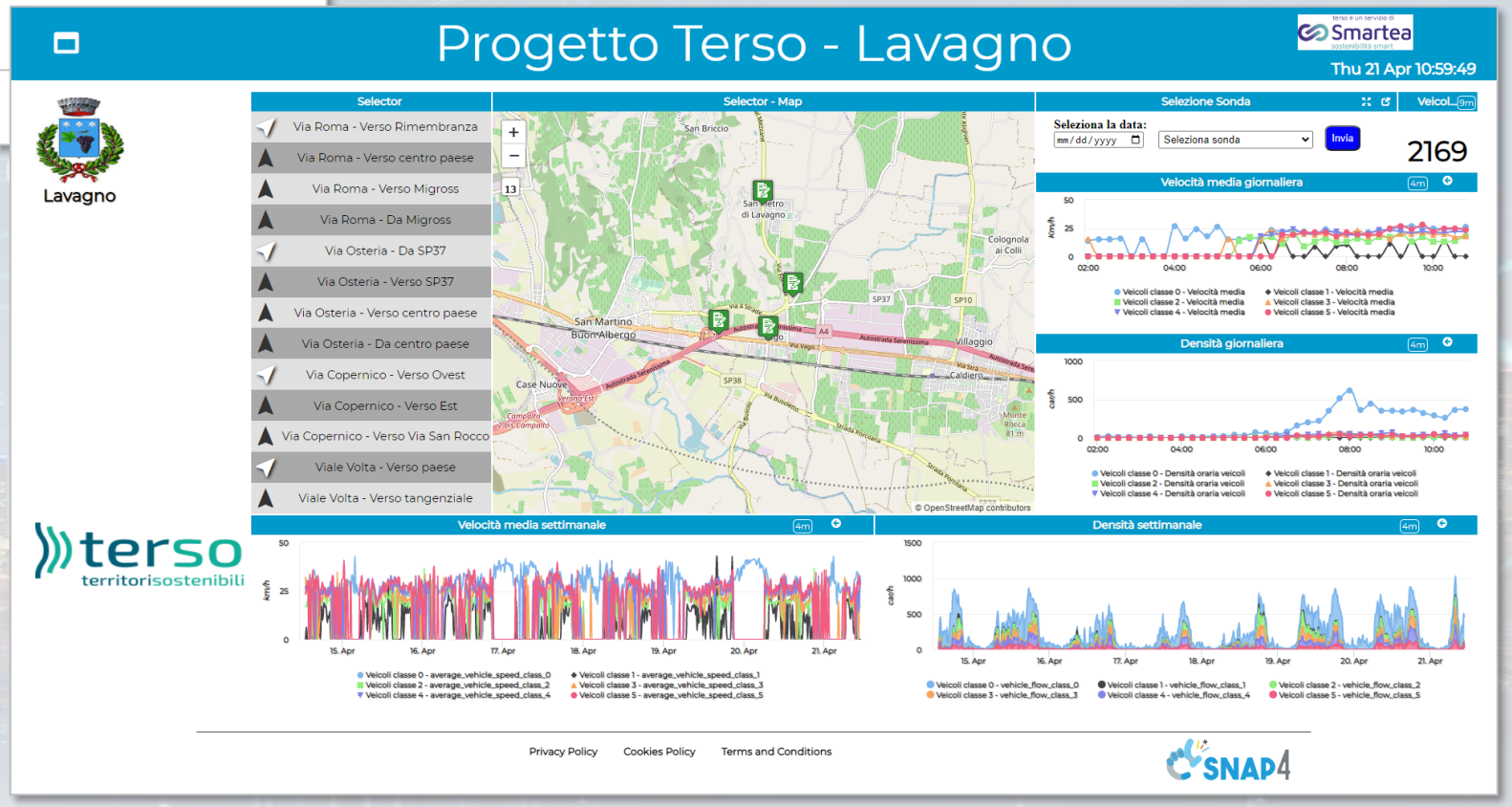
Smartea
sostenibilità smart

SNAP4

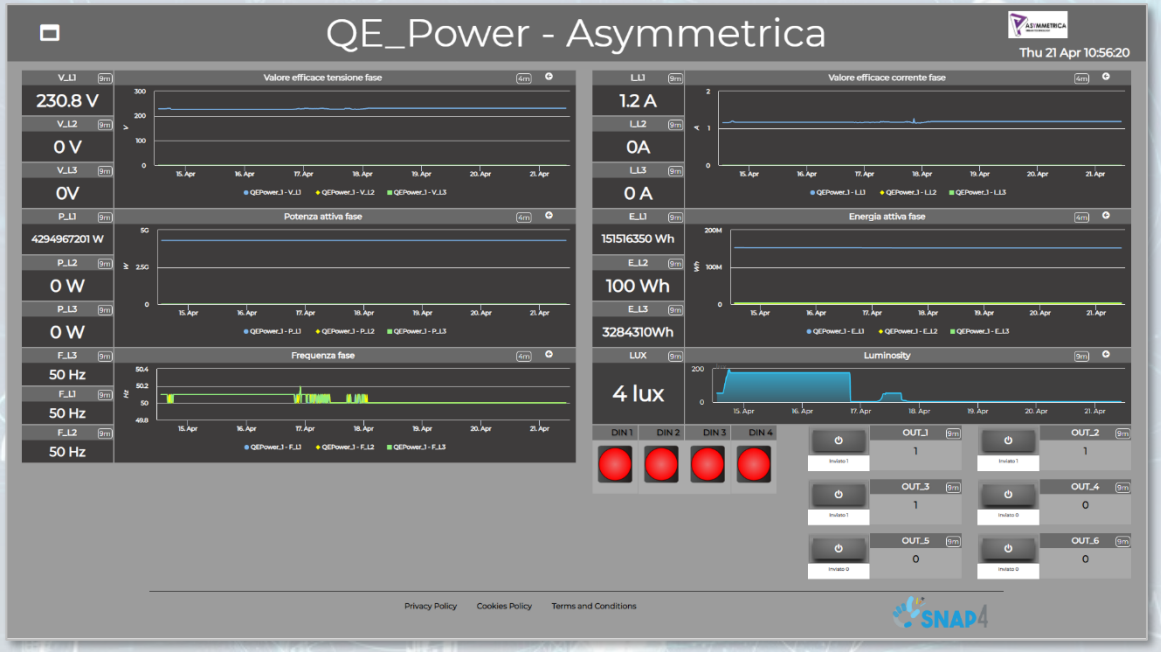
11 SUSTAINABLE CITIES AND COMMUNITIES

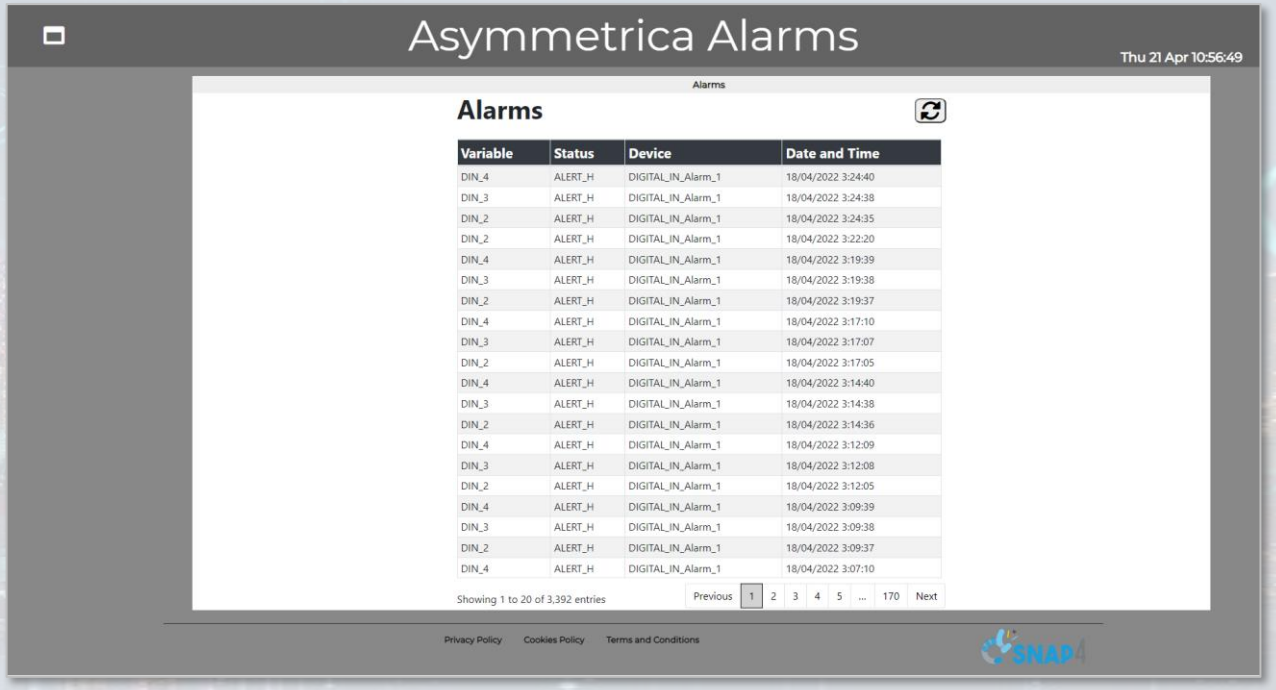
13 CLIMATE ACTION

15 LIFE ON LAND



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

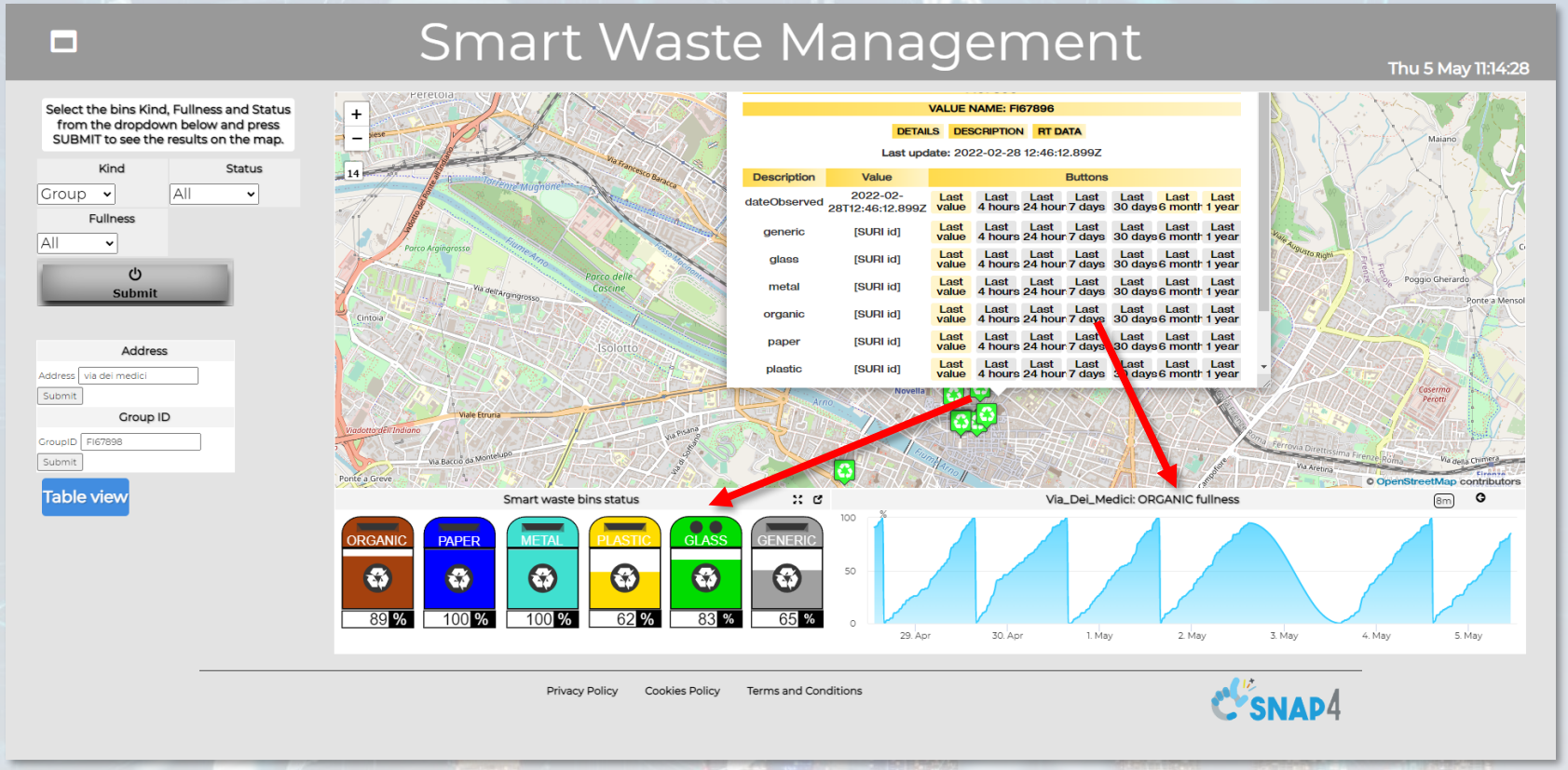




Variable	Status	Device	Date and Time
DIN_4	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:24:40
DIN_3	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:24:38
DIN_2	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:24:35
DIN_2	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:22:20
DIN_4	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:19:39
DIN_3	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:19:38
DIN_2	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:19:37
DIN_4	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:17:10
DIN_3	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:17:07
DIN_2	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:17:05
DIN_4	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:14:40
DIN_3	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:14:38
DIN_2	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:14:36
DIN_4	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:12:09
DIN_3	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:12:08
DIN_2	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:12:05
DIN_4	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:09:39
DIN_3	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:09:38
DIN_2	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:09:37
DIN_4	ALERT_H	DIGITAL_IN_Alarm_1	18/04/2022 3:07:10

- 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

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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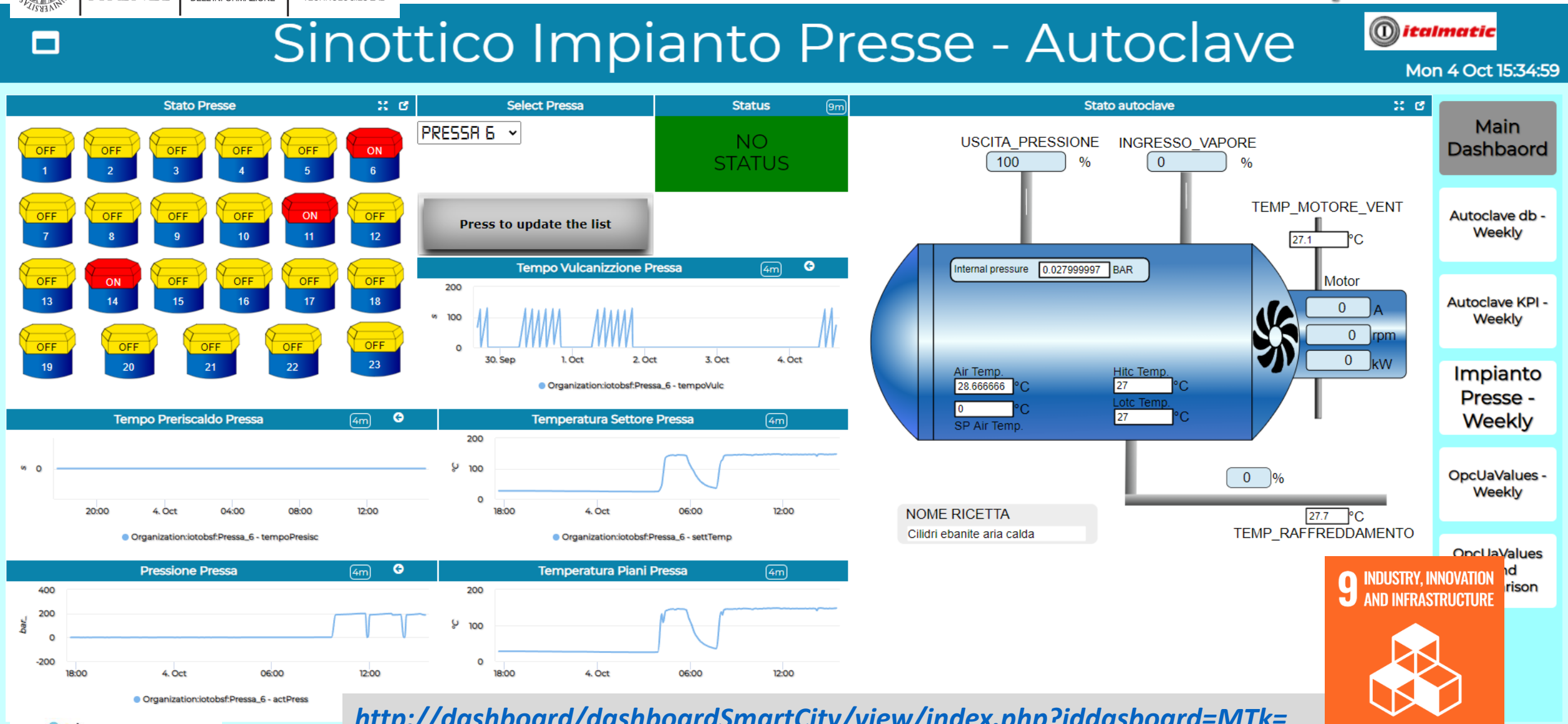
Sinottico Impianto



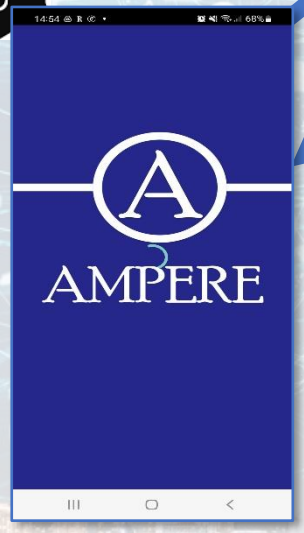
http://dashboard/dashboardSmartCity/view/index.php?iddasboard=MTk=

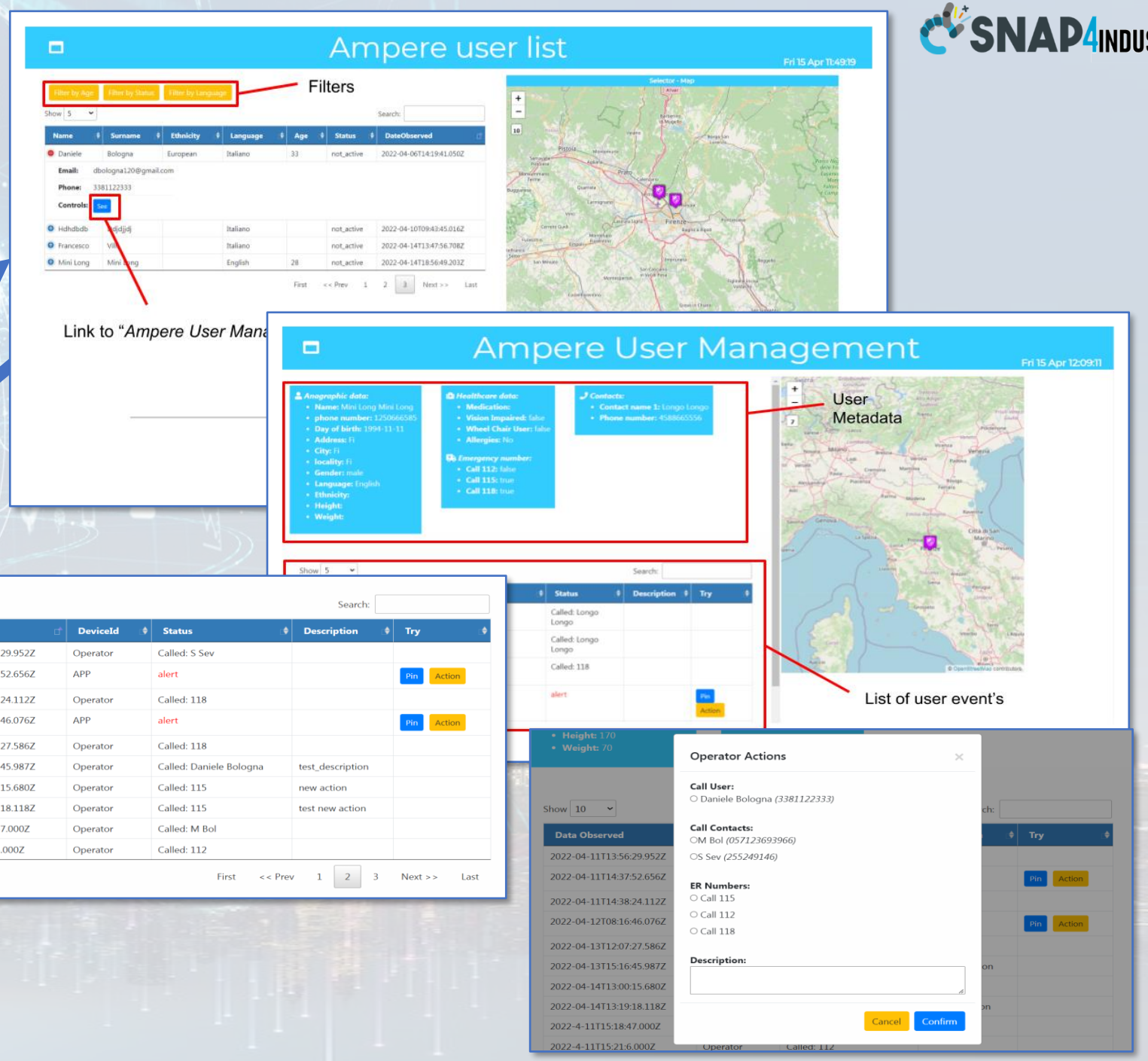
Jewel Alarms AMPERE

NFC

BLE

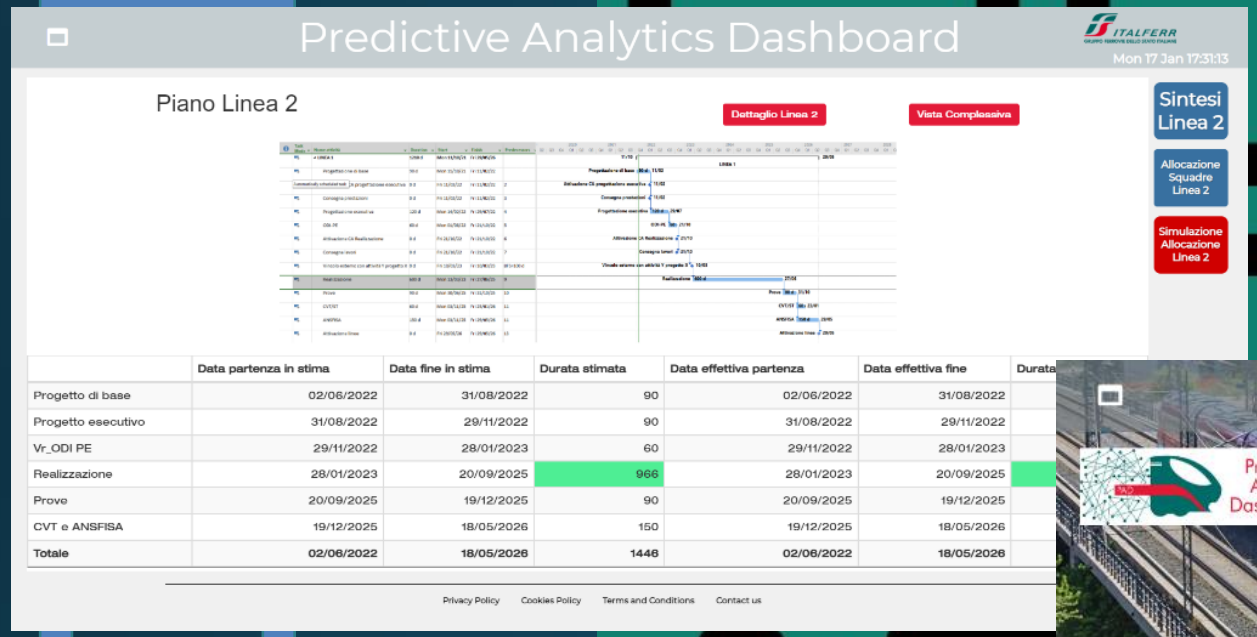
Click on Jewel



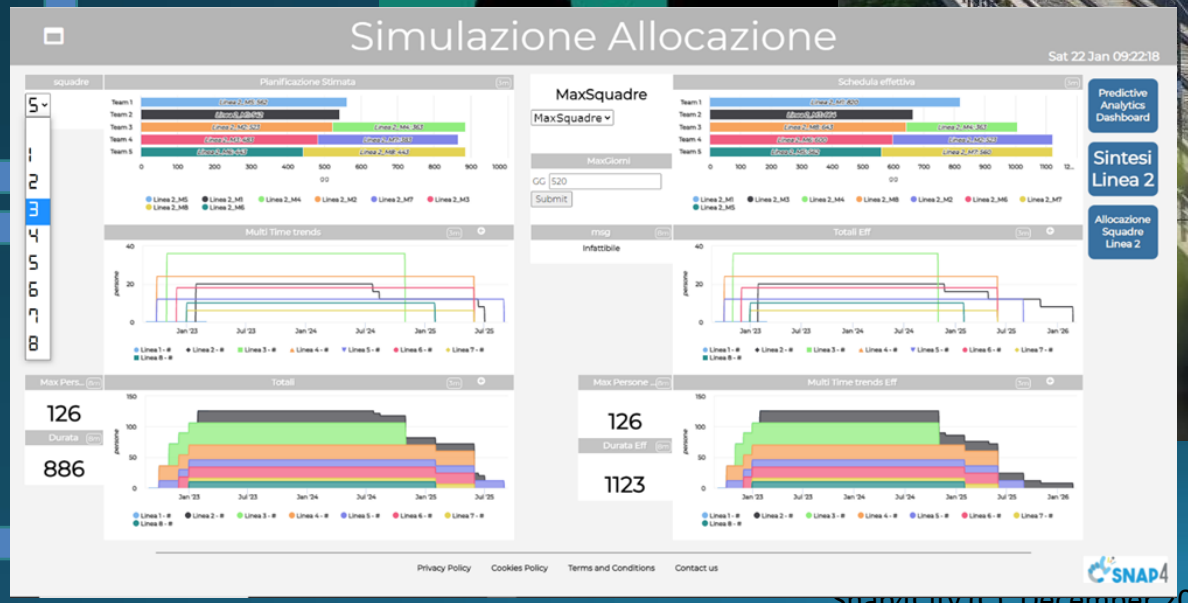


3 GOOD HEALTH AND WELL-BEING

PaD



	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**	



PAD
Predictive Analytics Dashboard
Powered by
ITALFERR
GRUPPO FERROVIE DELLO STATO ITALIANE
SNAP4

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Herit-Data Twitter Vigilance

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

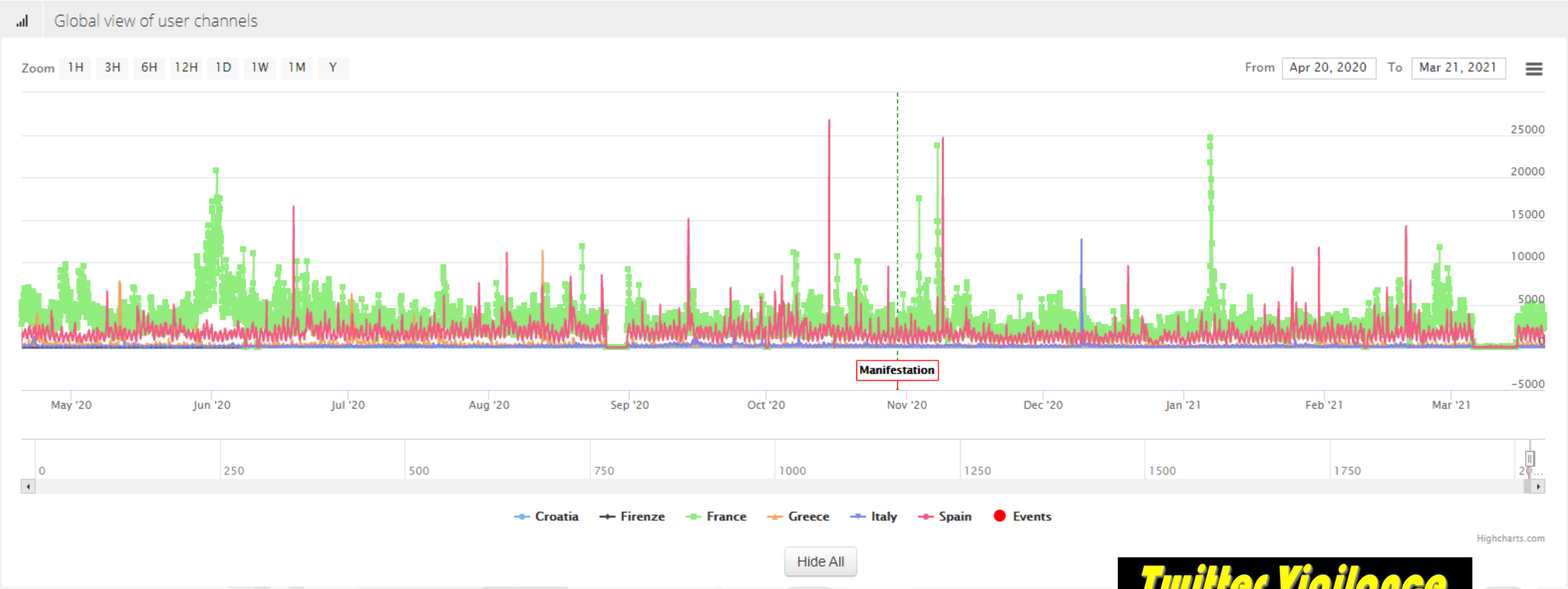
Twitter Vigilance Herit-Data: *Some Numbers*

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

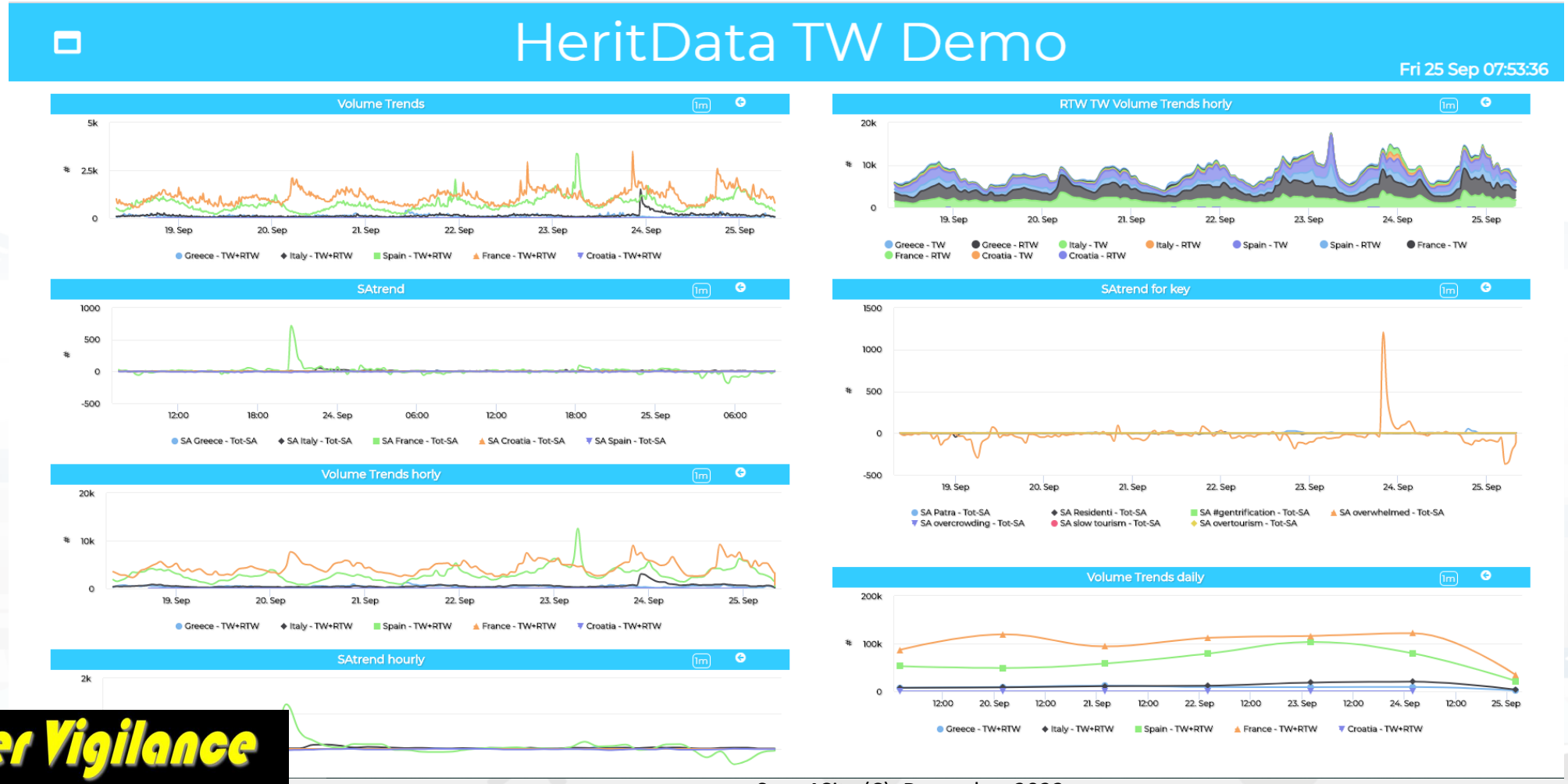
Overview on the last 12 months



Twitter Vigilance

Twitter Vigilance Data on Dashboards trought IoT-App

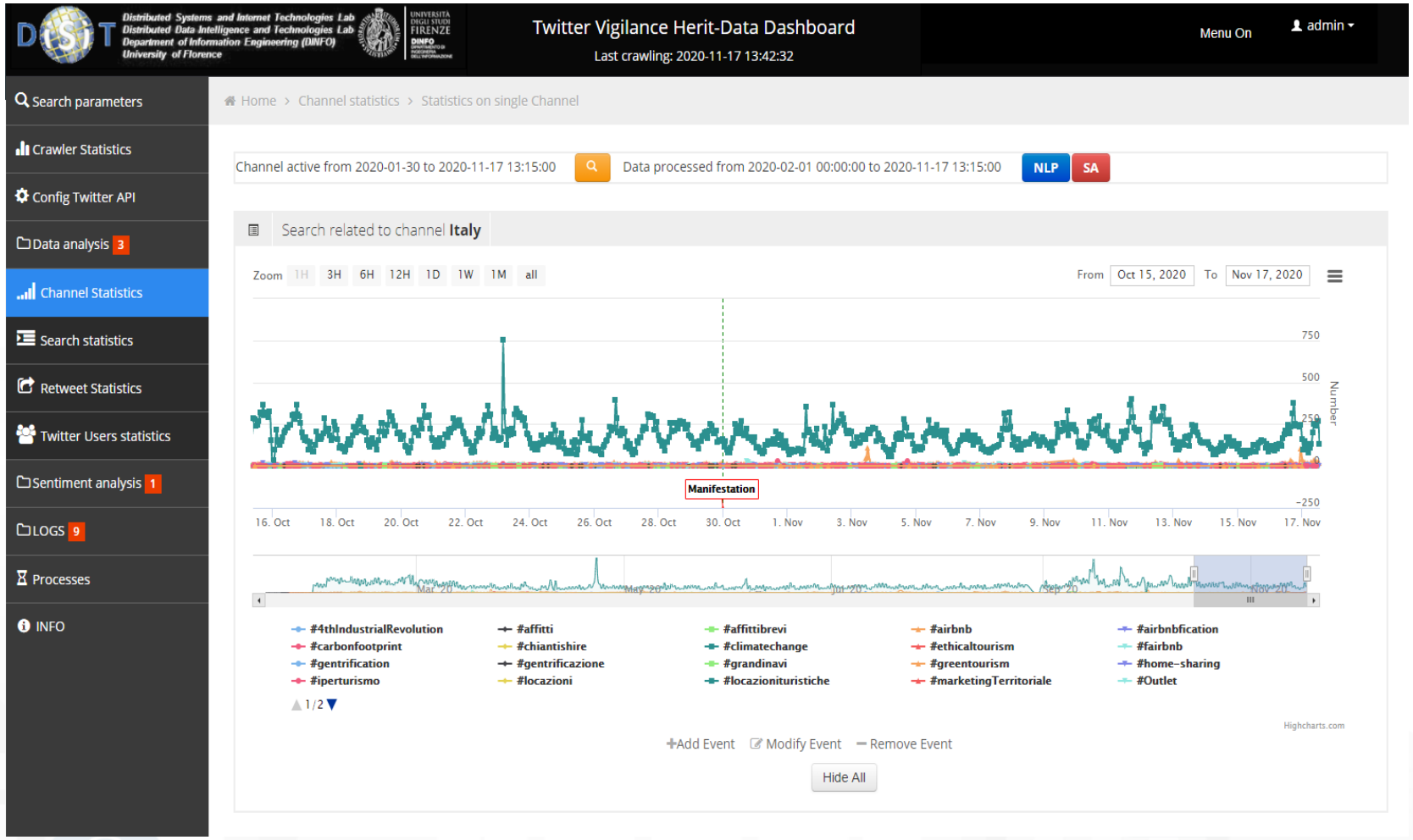
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjc3NQ==



Twitter Vigilance

TV on Florence

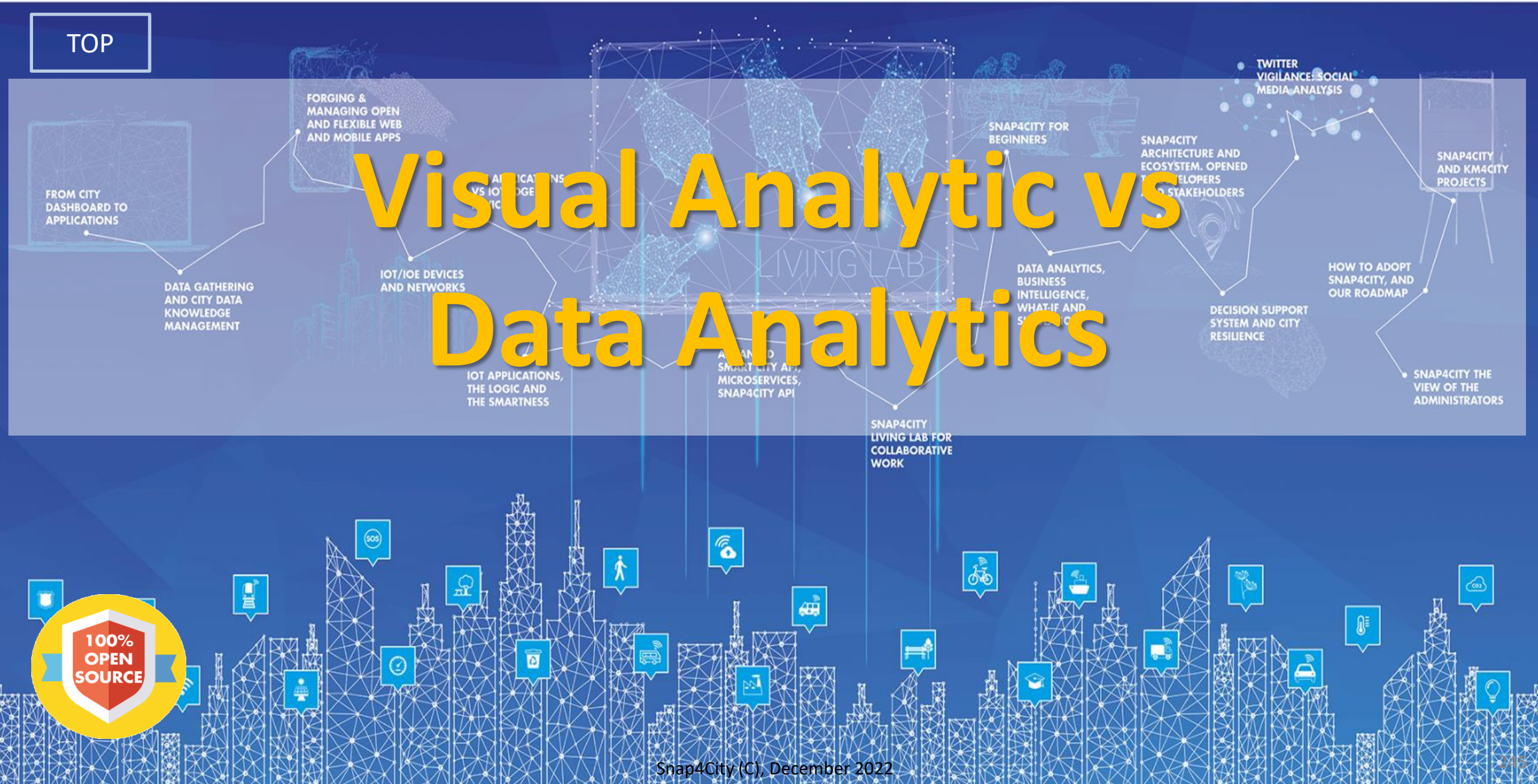
#4thIndustrialRevolution #affitti #affittibrevi #airbnb
#airbnbfication #carbonfootprint #chiantishire #climatechange
#ethicaltourism #fairbnb #gentrification #gentrificazione
#grandinavi #greentourism #home-sharing #iperturismo
#locazioni #locazionituristicheche #marketingTerritoriale #Outlet
#overtourism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



Twitter Vigilance

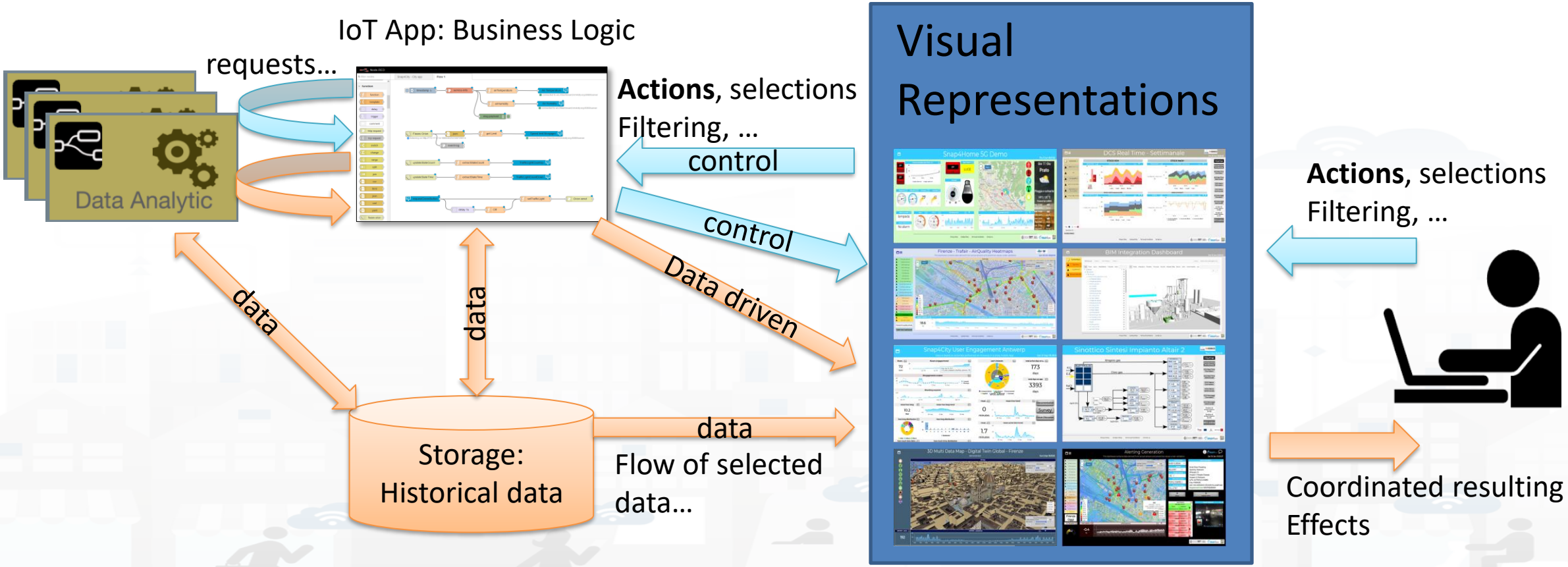
TOP

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

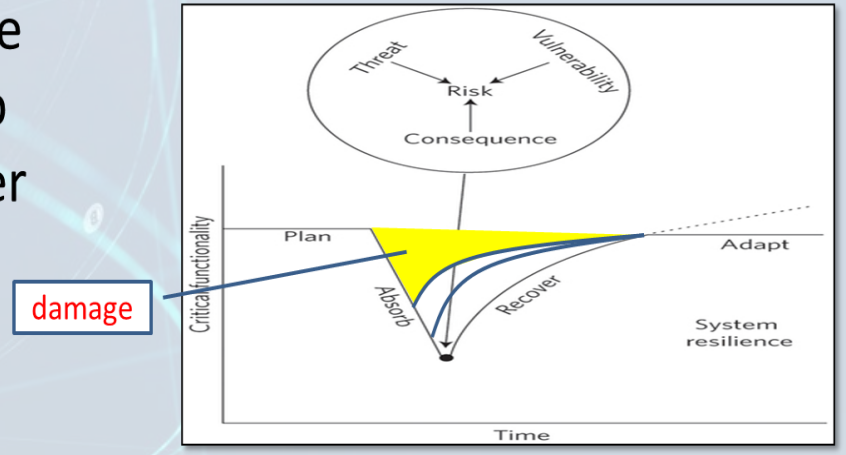
TOP

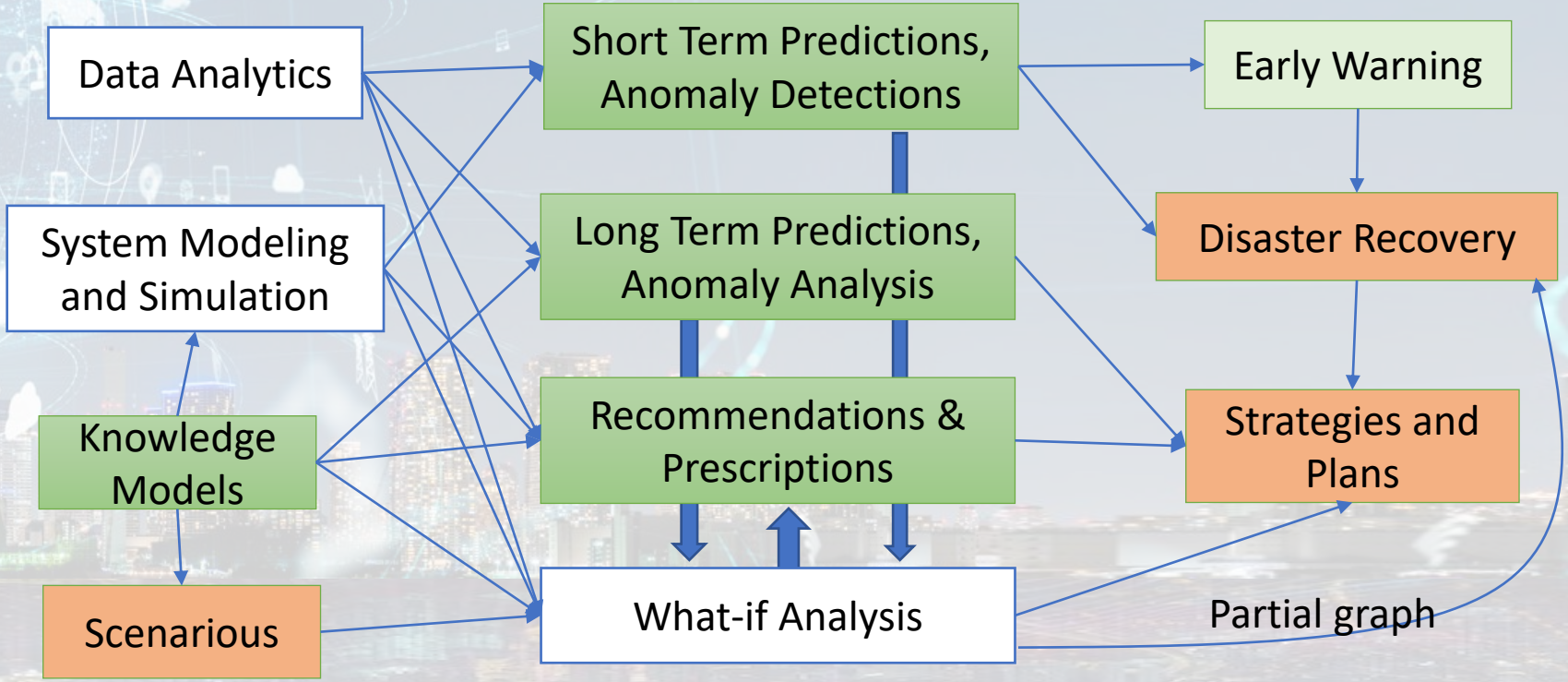
Data Analytic Artificial Intelligence, XAI, Machine and Deep Learning

Snap4City Analytics

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

Prepare
Absorb
Recover
Adapt





Decision Support System, targeting: Quality of Life, KPI, SDG, 15MinIndex,…

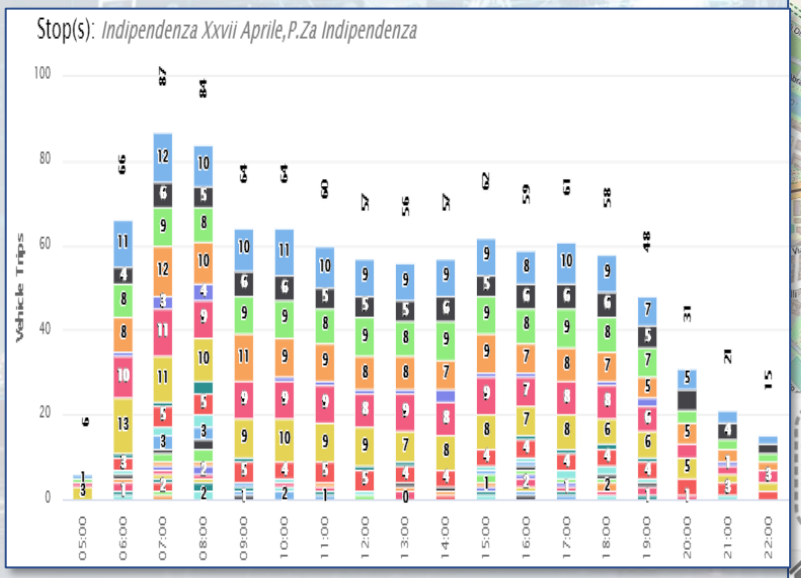
AI/XAI on: Management and strategies Resilience and Risks Analysis

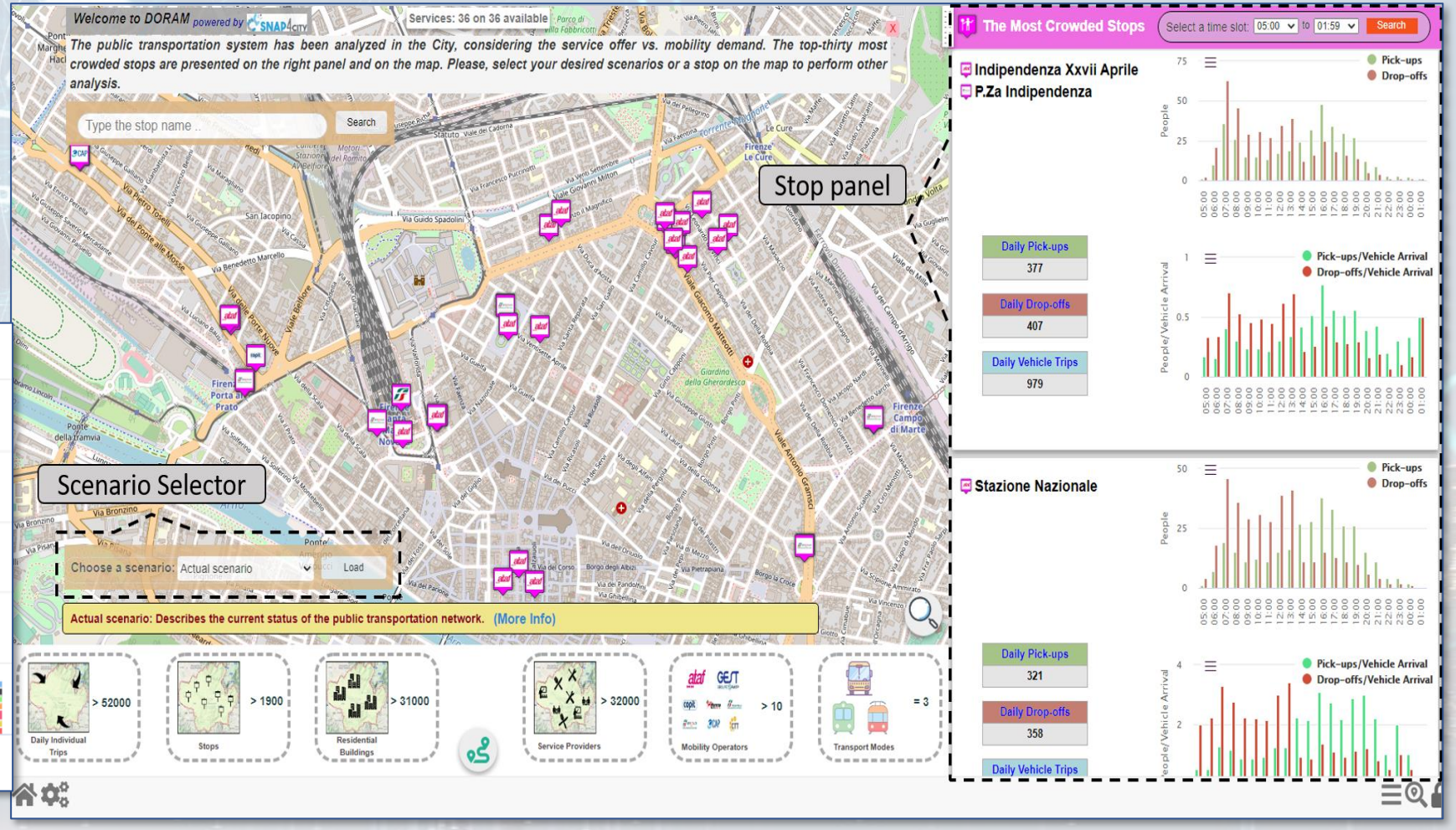
- **What-if analysis**, dynamic routing, origin destination matrices production from a large range of sources
- **Early warning** computation
- **Estimation of KPI** and local indexes for: quality of life (15MinCityIndex)
- **Production Optimization**
- **Planning and Monitoring** renovation works via objective KPIs
- **Managing Maintenance** and teams
- **Predictive Maintenance** and costs predictions: chemical plant, vehicles, boats
- **Resilience analysis** wrt European Guidelines on Resilience of critical infrastructure, and transport systems
- **Risk analysis:** natural and non natural disaster

What-if Analysis on Pub Transport

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

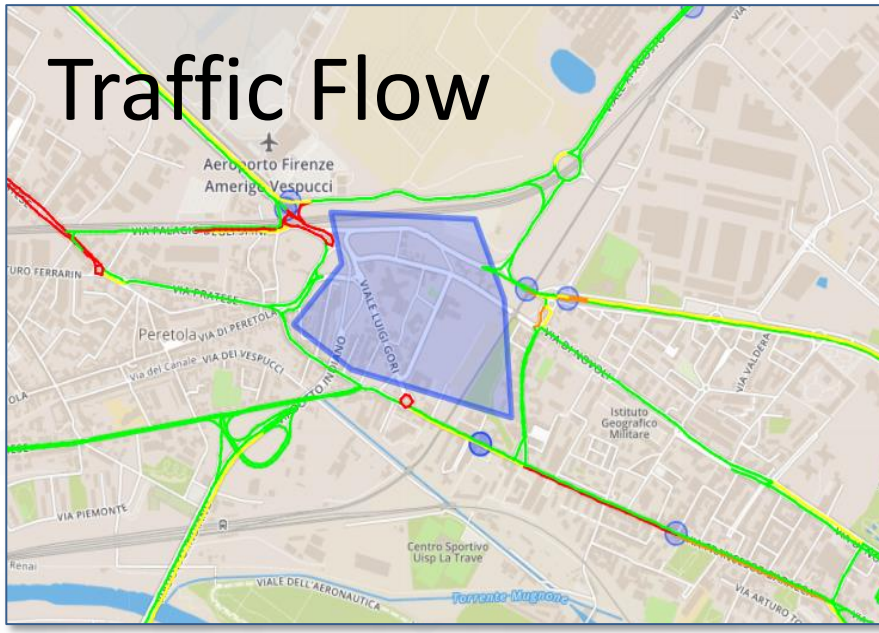
Public Services

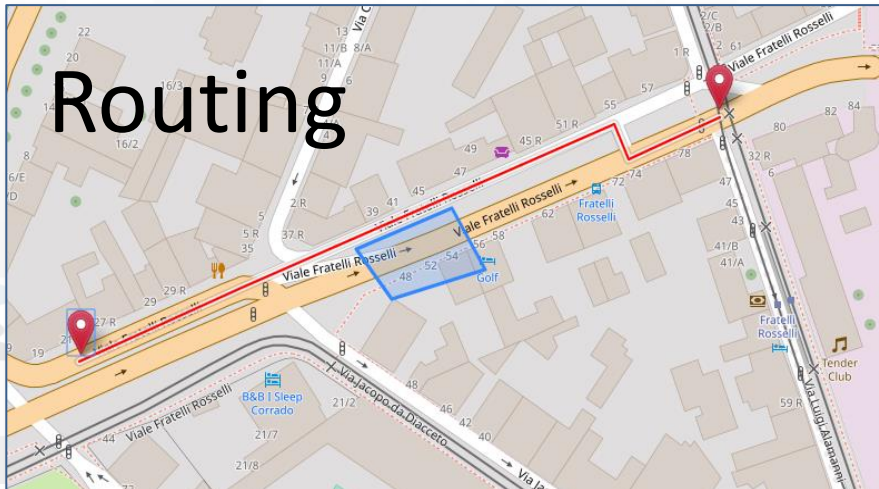




Decision Support Systems, What-if

- **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





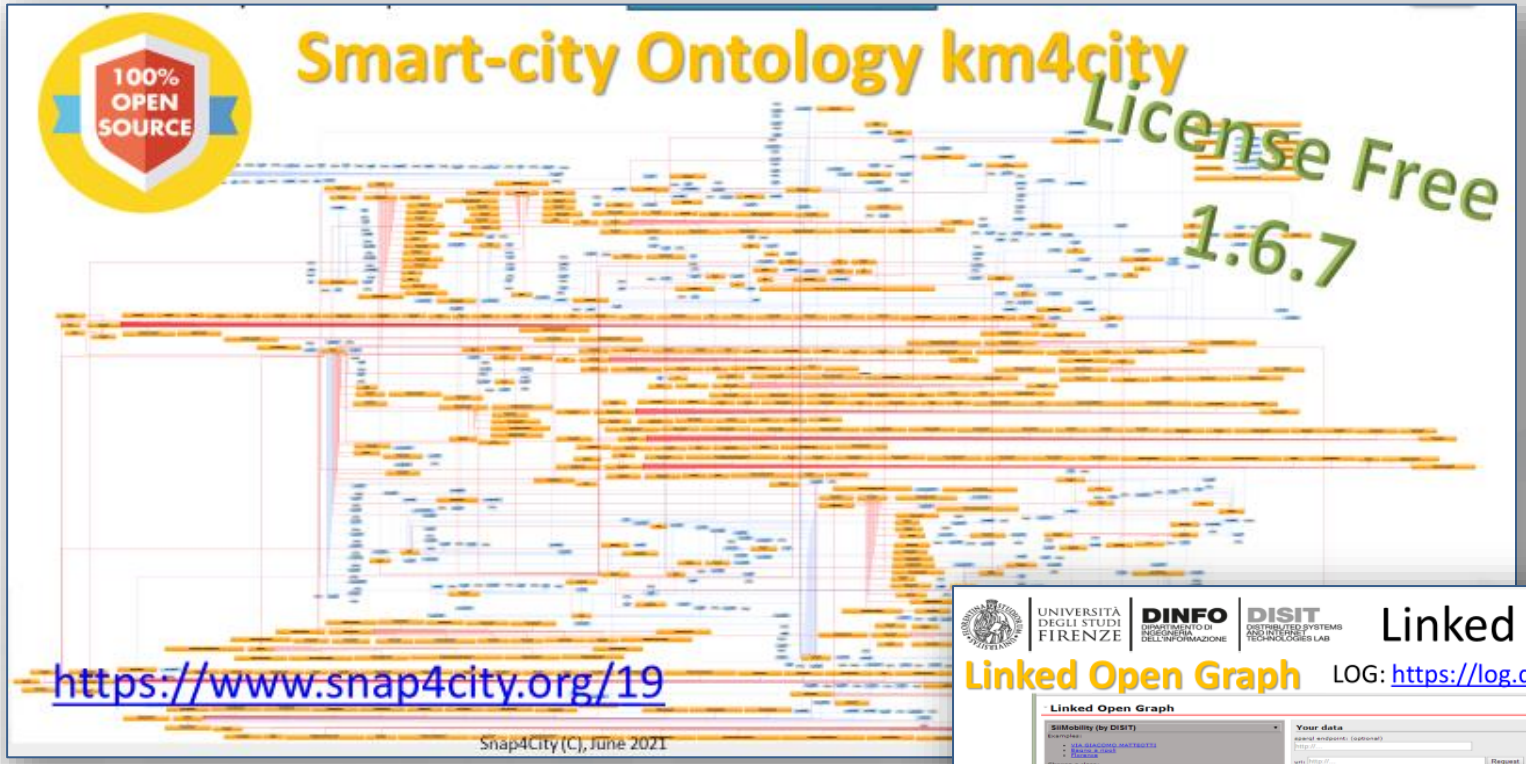
Available Data Analytics

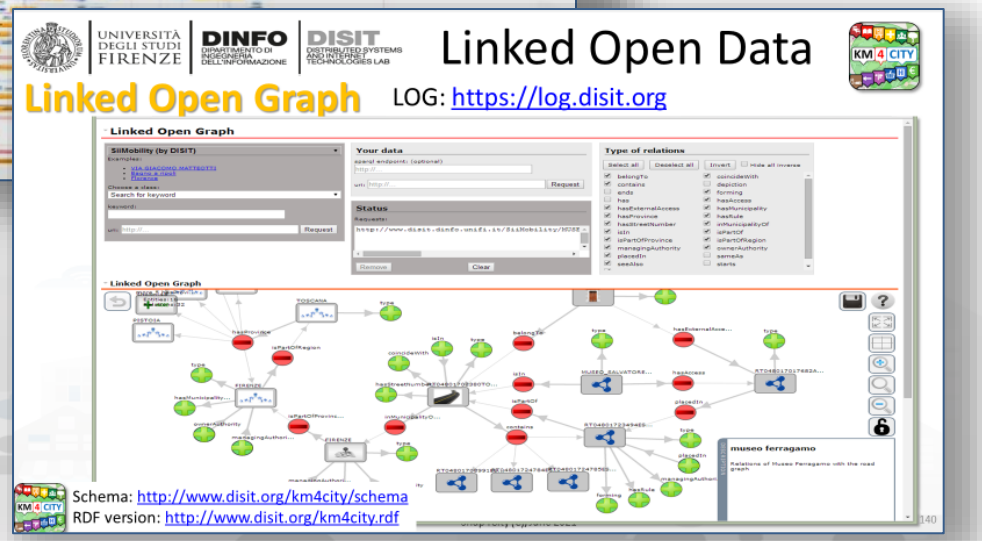
- Mobility and Transport
- City Users and Social
- Environment and Weather
- Time Series
- Semantic Reasoning
- Matrices, Images, Maps and 3D Digital Models
- Management and strategies
- Resilience and Risks Analysis

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

Knowledge engineering

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





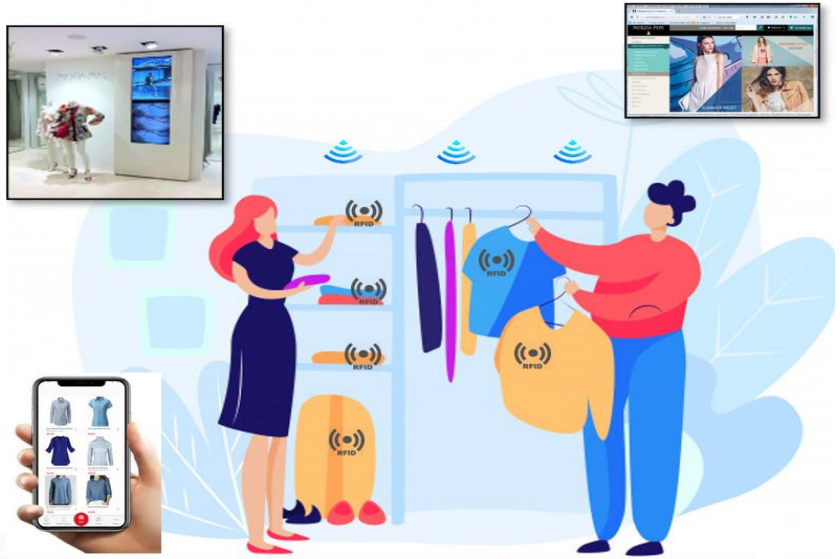
Smart Retail

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

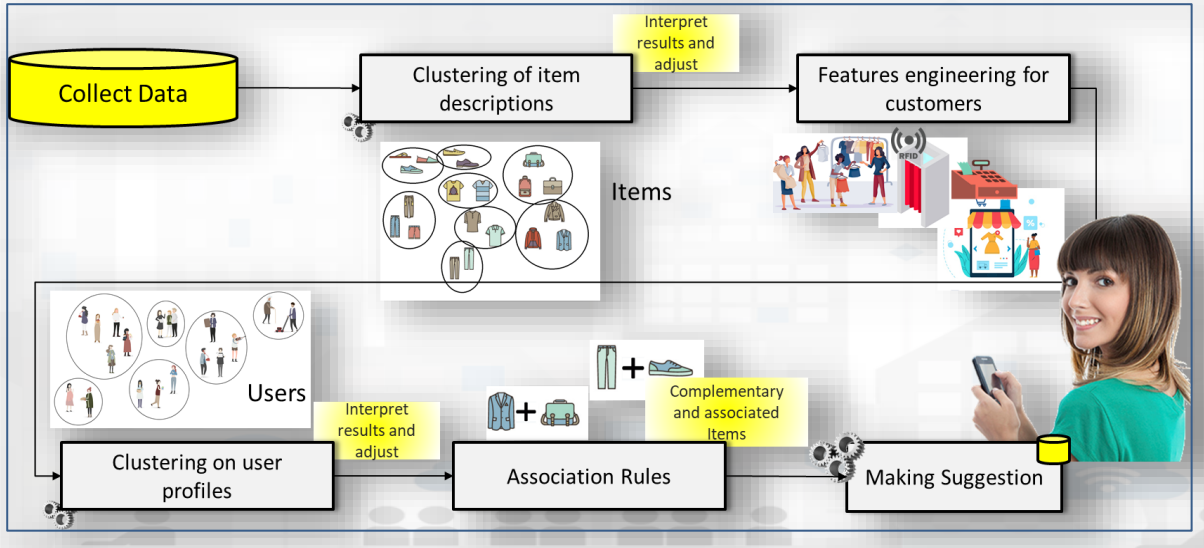
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Techniques

- Multiple clustering
- Prediction models



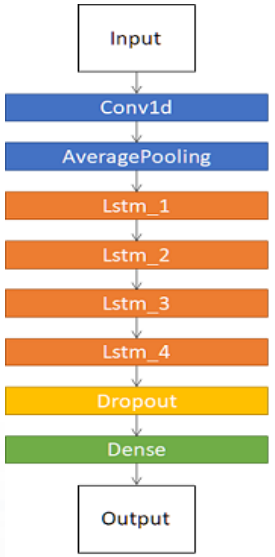
- **Feedback:**
  - Flexible Advanced Engagement Exploiting User Profiles and Product/Production Knowledge
  - Keywords: retail, GDO, …



feedback

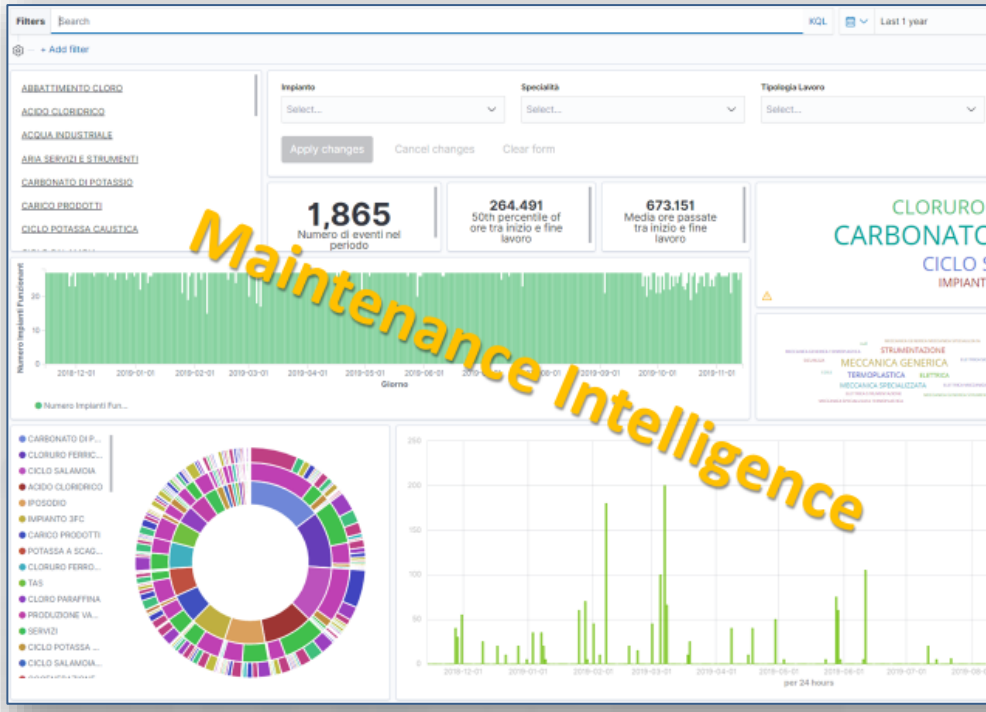
Predictive Maintenance

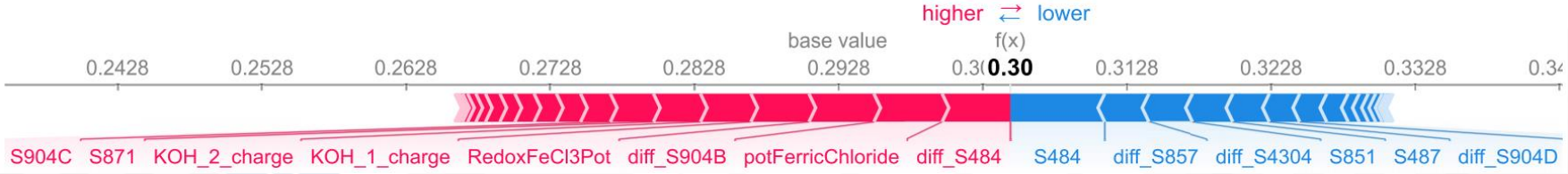
- **Predictive** Maintenance
  - LSTM
  - CNN-LSTM
- **Maintenance** Intelligence
- Explainable AI: SHAP, …



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





1 NO POVERTY | 2 ZERO HUNGER | 3 GOOD HEALTH AND WELL-BEING | 4 QUALITY EDUCATION

- ***15 Minute City Index:***
  - 13 subindexes: energy, slow mobility, fast mobility, housing, economy education, culture and cults, health, entertainment, gov, food, security…

7 AFFORDABLE AND CLEAN ENERGY

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

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

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

11 SUSTAINABLE CITIES AND COMMUNITIES

- Smart City infrastructure: monitoring and resilience, long terms predictions
- Effective and Low cost smart solutions
- What-if analysis, Simulations
- Origin Destination matrices computation

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

- business intelligence tools for decision makers
- Reduction production costs
- Monitoring resource consumption
- Optimization of Waste Collection

13 CLIMATE ACTION | 15 LIFE ON LAND

- Monitoring and Predicting: NO2, NOX, CO2, Traffic flow, pollutant, landslide, waste, etc.
- Traffic flow reconstruction
- Demand vs Offer of Mobility analysis

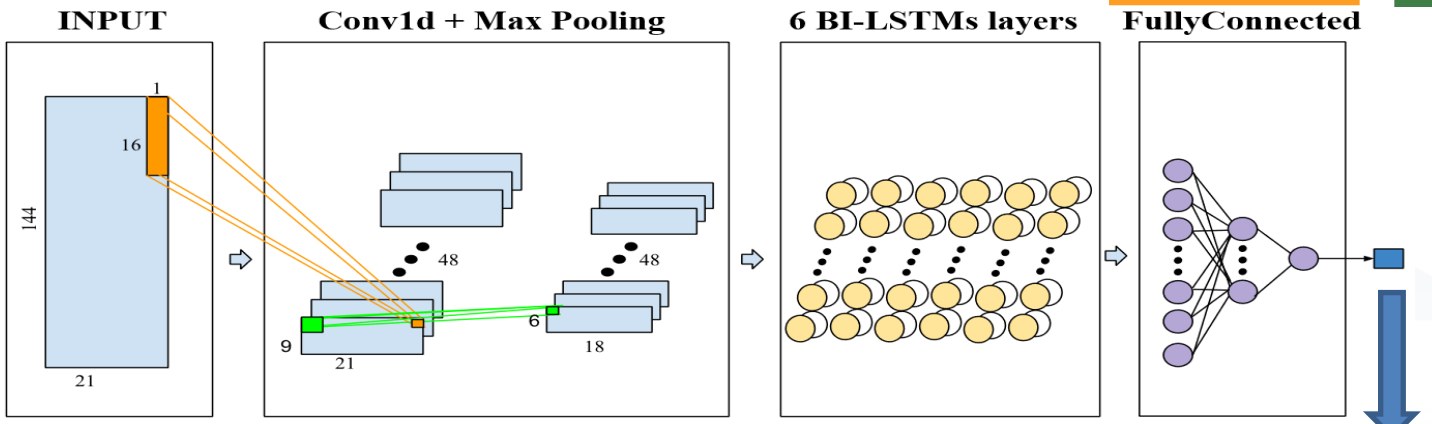
16 PEACE, JUSTICE AND STRONG INSTITUTIONS

- Shortening justice time
- Anonymization and indexing legal docs.
- Prediction of mediation proneness
- Ethical Explainable Artificial Intelligence

AI/XAI on: Mobility and Transport

- **What if analysis**: routing, traffic flow, demand vs offer, pollutant, etc. (Simulation + ML)
- **Traffic flow reconstruction** from sensors and other sources (simulation + ML)
- **Predictions** for: traffic flow, smart parking, smart bike sharing, people flows, etc. (ML, DL)
- **Public Transportation**: Ingestion and modelling of GTFS and Transmodel
  - Analysis of the **demand mobility vs offer transport** of according to public transportation and multiple data sources (Simulation)
  - Assessing **quality of public transportation** (analysis)
- **Accidents** heatmaps, anomaly detection (analysis, ML)
- **Tracking fleets**, people, via devices: OBU, OBD2, mobile apps, etc.
- **Routing** and multimodal routing (multistop travel planning), constrained routing, dynamic routing
- Computing **Origin Destination Matrices** from different kind of data (analysis)
- Computing **typical trajectories** on the basis of tracks (analysis, ML)
- Computing Messages for Connected drive
- Slow and Fast Mobility **15 Minute City Indexes** (analysis, ML)
- Computing and comparing traffic flow on devices and at the city border (analysis)
- **Typical time trends** for traffic flow and IoT Time series. (analysis, ML)
- **Impact of COVID-19** on mobility and transport

Short-Term Prediction of City Traffic Flow via Convolutional Deep Learning

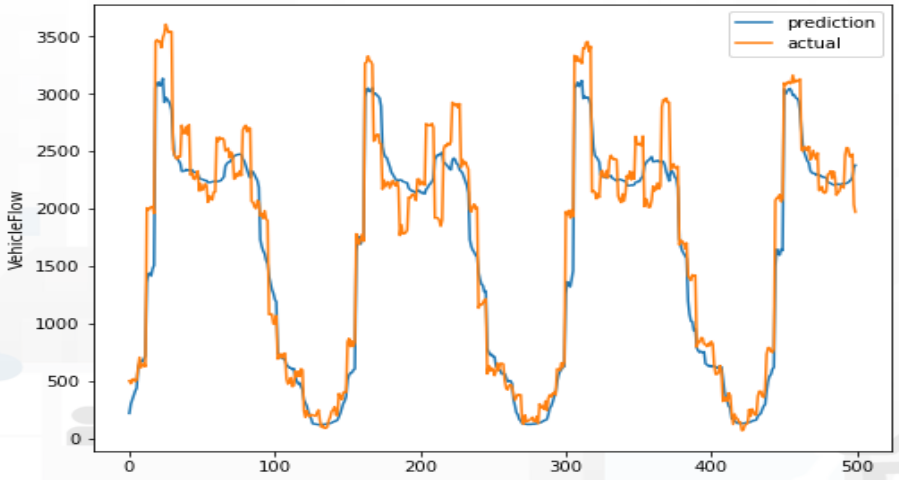


Urban data:

- Date-time
- Traffic
- Temporal
- Seasonality
- Pollution
- Weather

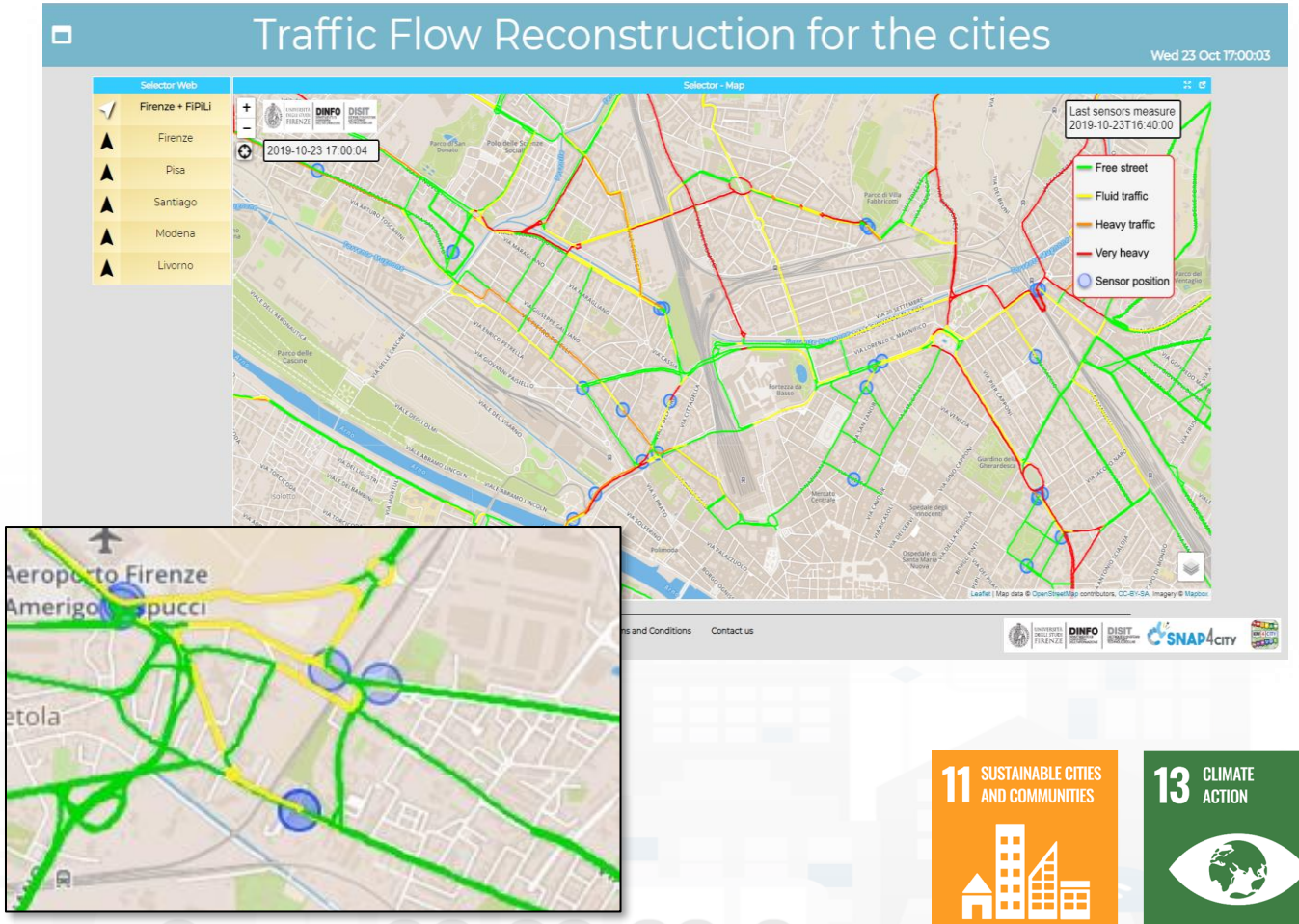
RF
XGBOOST
DNN
LSTM
BI-LSTM
Autoencoder BI-LSTM
Attention CONV-LSTM
CONV-BI-LSTM

CONV-BI-LSTM



Why Dense Traffic Flow Reconstruction ?

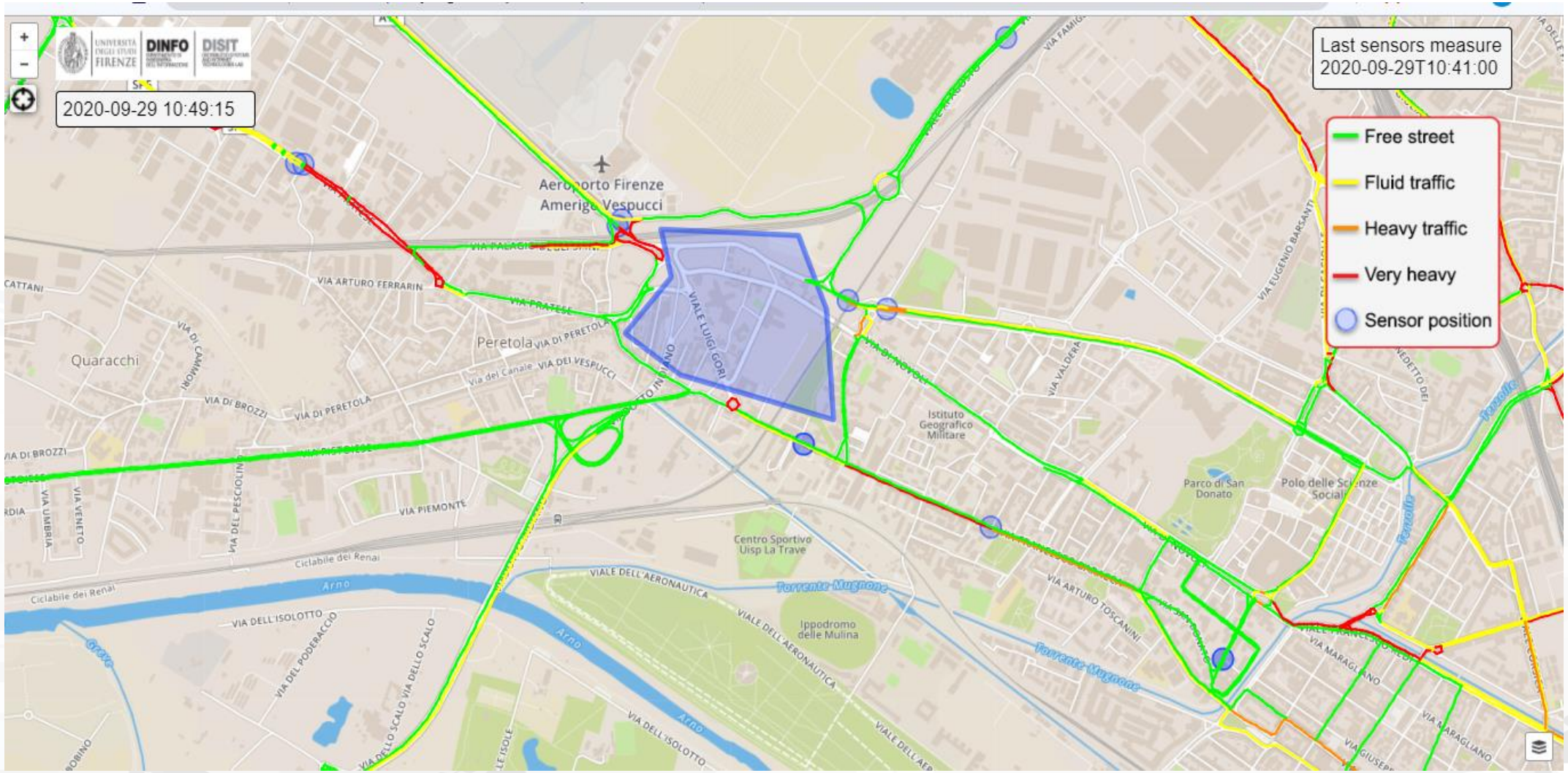
- Making decision on mobility and transport solutions → what if analysis
- Controlling pollution
- Dynamic Routing for Firebrigade, Ambulances, general public
- Planning Public Transportation routing



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

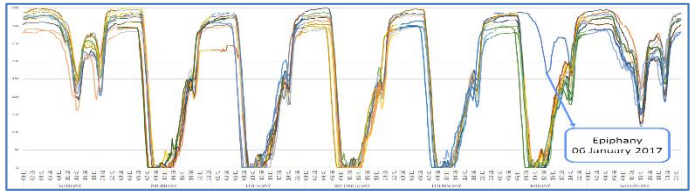
Traffic Flow Reconstruction
2018-02-01T00:10:00
Last sensors measure
2018-02-01T00:10:00
Free street
Fluid traffic
Heavy traffic
Very heavy
Sensor position
Firenze
FiPiLi
Pisa
Modena
real time
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery ¡¿½ Mapbox

Computation of Traffic Flow Evolution



Parking predictions

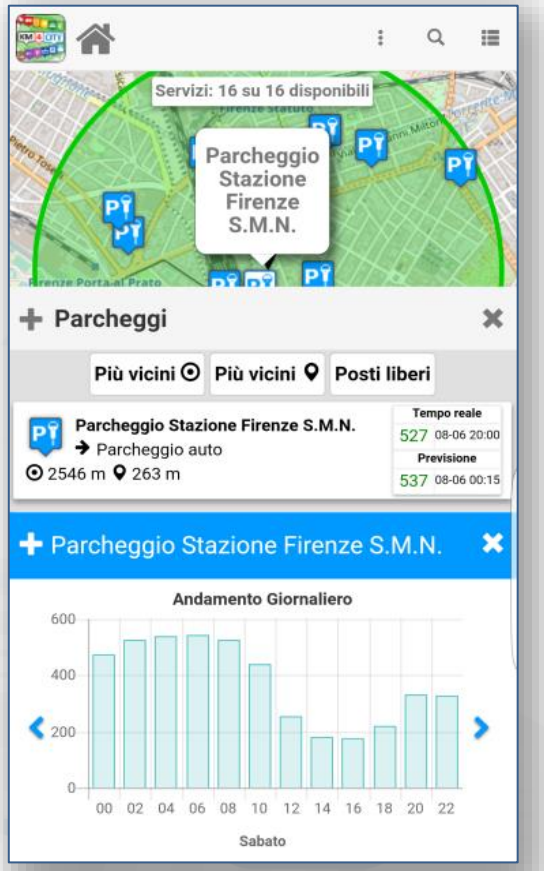
I would arrive to surely Park in 45 Minutes??



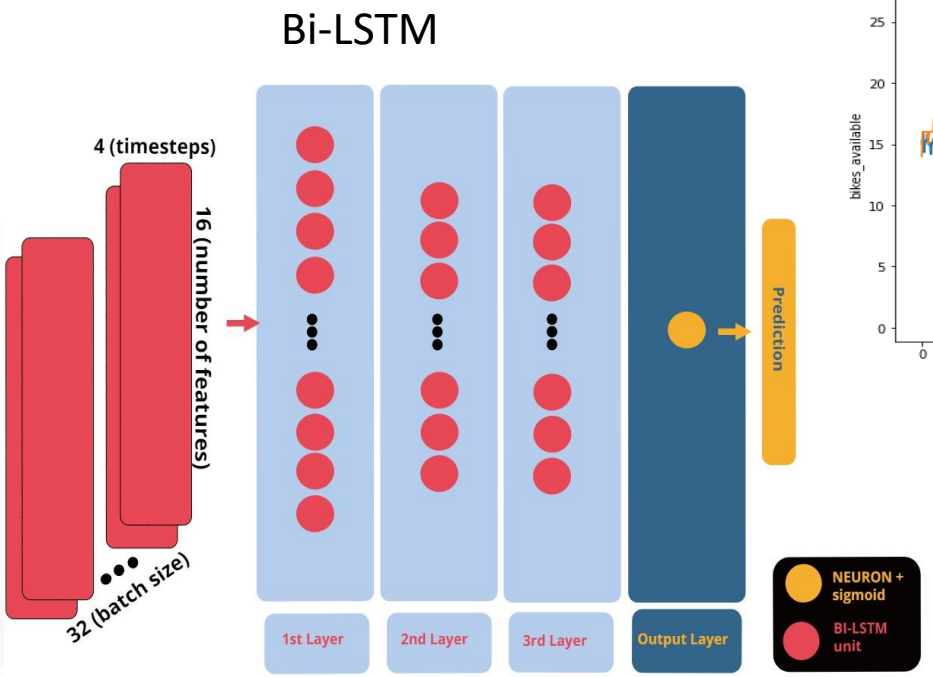
Category	Features	Description of features variable
Baseline features of free slot data	Free parking slots	Real number of available slots recorded every 15 minutes
	Time	Hours and minutes
	Month	Month of the year (1-12)
	Day	Day of the month (1-31)
	Day week	Day of the week (0-6)
	Weekend	0 for working 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

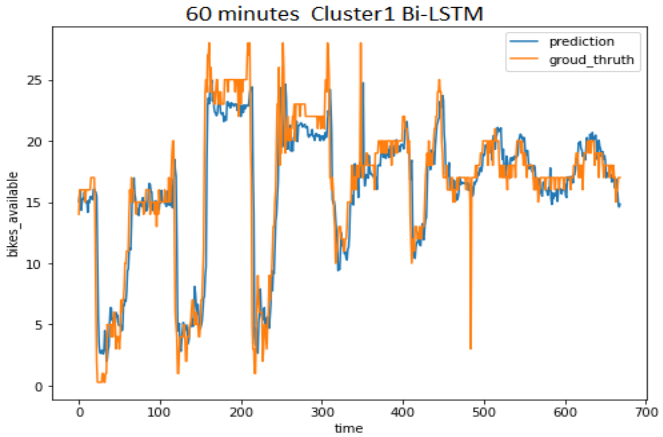
Artificial Intelligence Predictions

97% of precision



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

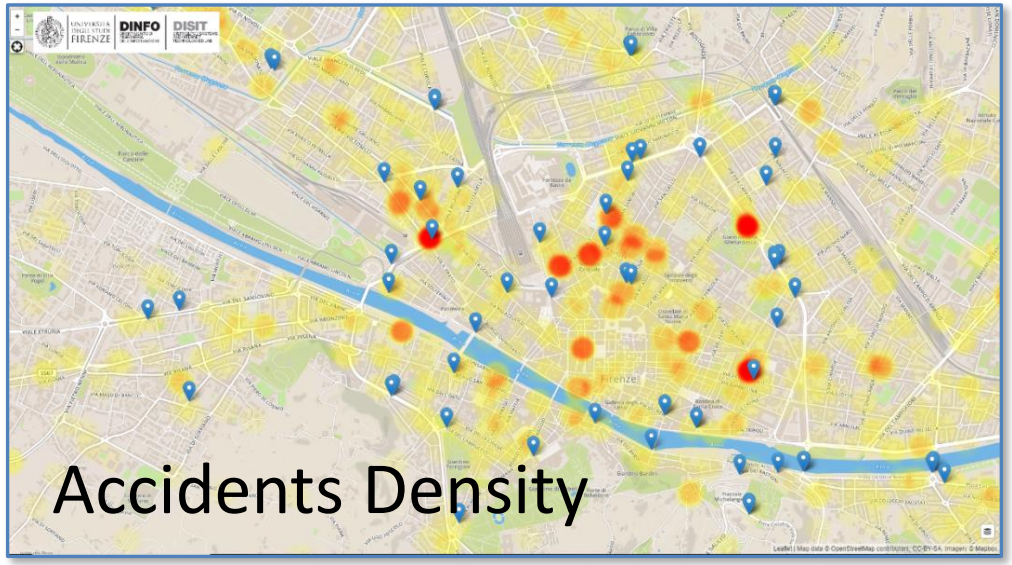


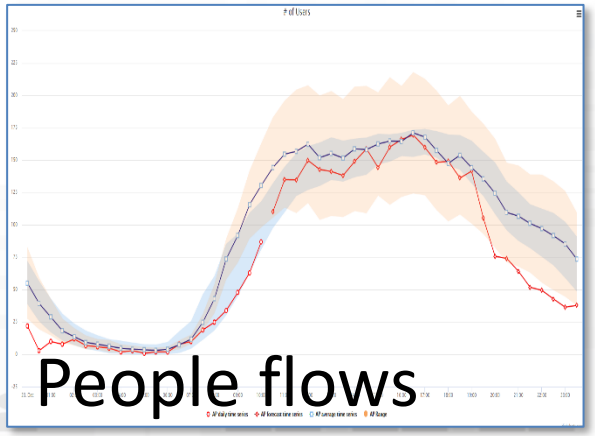


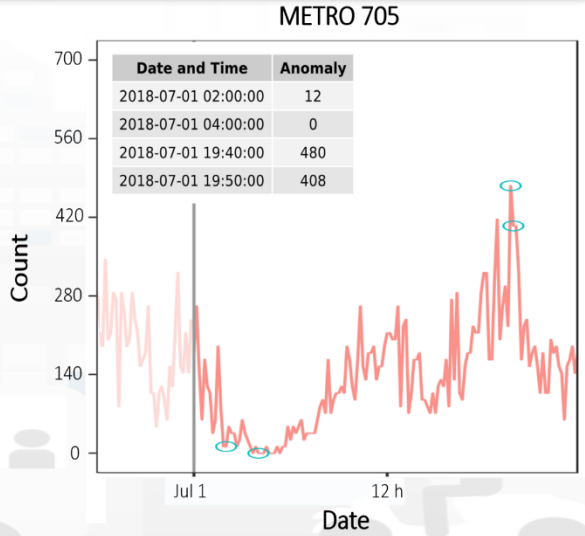
E. Collini, P. Nesi and G. Pantaleo, "Deep Learning for Short-Term Prediction of Available Bikes on Bike-Sharing Stations," in *IEEE Access*, vol. 9, pp. 124337-124347, 2021, doi: 10.1109/ACCESS.2021.3110794.
https://ieeexplore.ieee.org/abstract/document/9530580

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





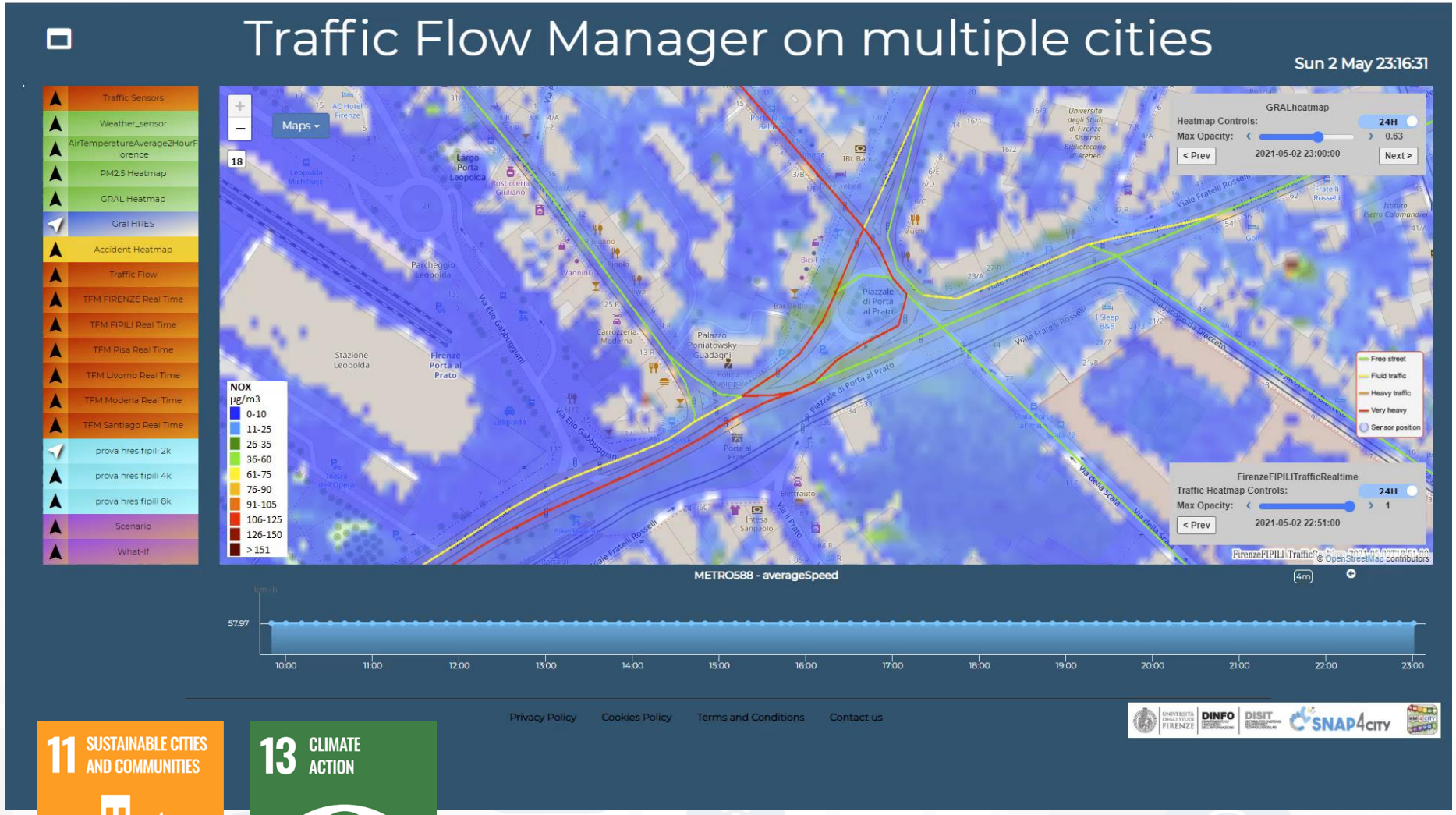


AI/XAI on: Environment and Weather

- **Predictions** of pollution conditions for diffusion NOX, PM10, PM2.5, on the basis of traffic flow, 48 hours
- **Long term predictions** of European Commission KPIs on
  - NO2 average value over the year
  - PM10 …….
- **Prediction of landslides**, 24 hours in advance
- **Computation of CO2** on the basis of traffic flows
  - each road for each time slot of the day
- **Heatmaps production**, dense data interpolation for
  - Weather conditions: temperature, humidity, wind, DEW
  - Pollutants and Aerosol: NO, NO2, CO2, PM10, PM2.5, etc.
- **Impact of COVID-19** on Environmental aspects

Environment

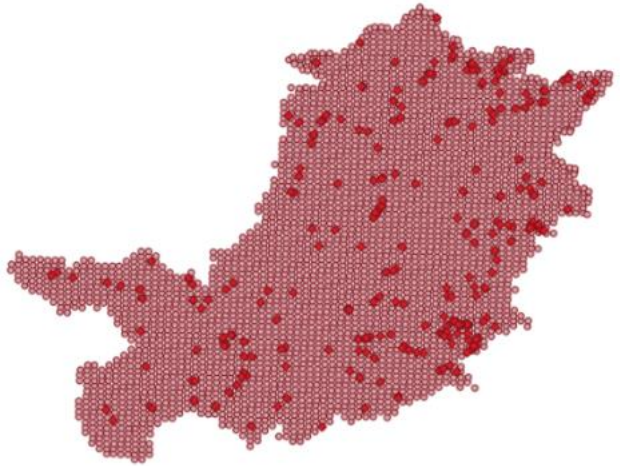
- **Prediction**
  - **NOX Pollutant** diffusion on the basis of Traffic Flow (prediction), weather and 3D structure
  - **NO2 progressive average** (Long term)
- **Project:**
  - **Trafair** CEF EC
  - Mixed solutions of Fluidinamics modeling and AI



11 SUSTAINABLE CITIES AND COMMUNITIES

13 CLIMATE ACTION

Predicting Land slides



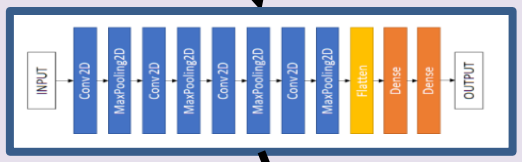
Dataset Construction

Dataset Construction

Previsional Model

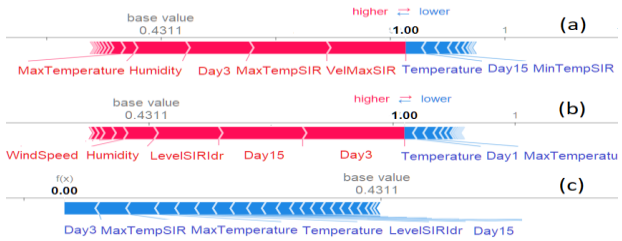
Model training And validation

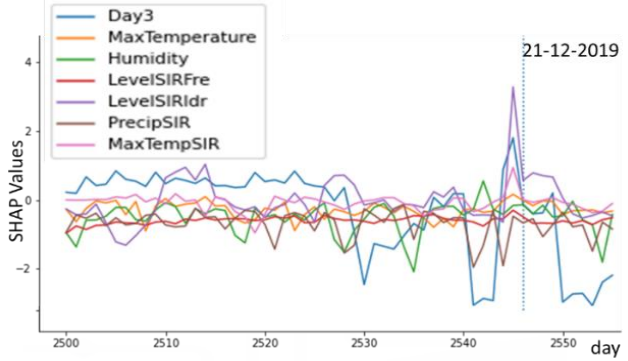
Model



Data

SNAP4City Advanced APIs





landslide DB

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

Processes

Ingestion

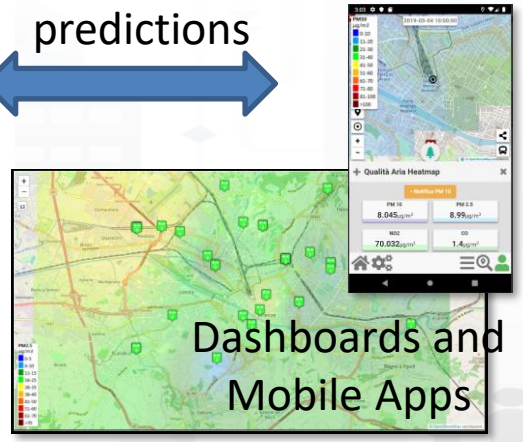
Big Data Storage and KB

Predictions

Model execution Shap Assessment

Data Analytics IOT App Management

predictions

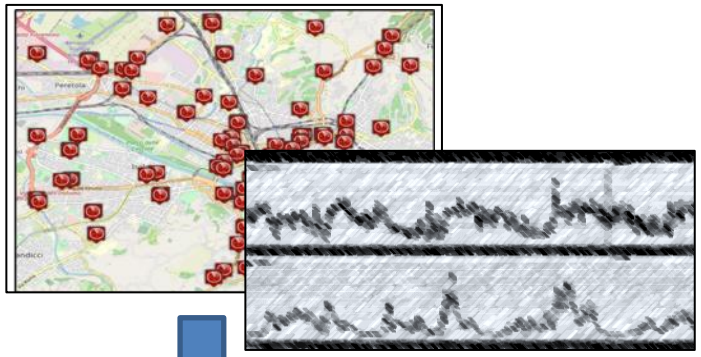


Dashboards and Mobile Apps

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

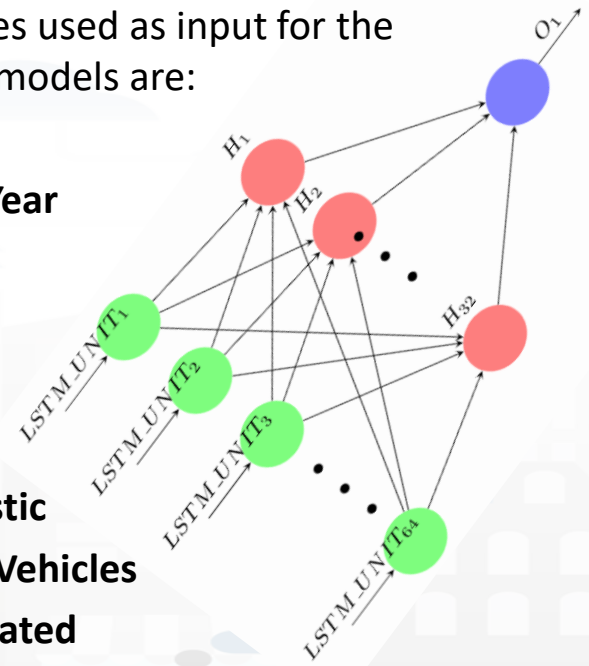
CO2 estimation

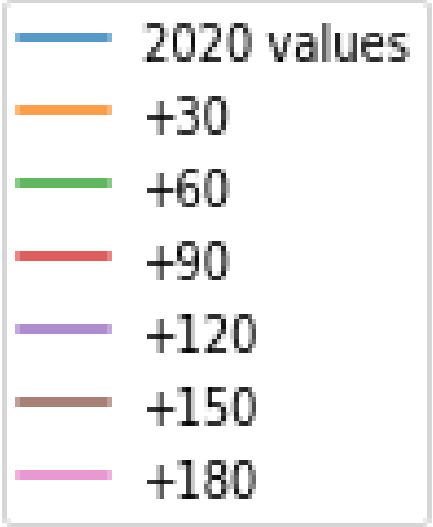
S. Bilotta, P. Nesi, "Estimating CO2 Emissions from IoT Traffic Flow Sensors and Reconstruction", Sensors, MDPI, 2022. https://www.mdpi.com/1424-8220/22/9/3382/

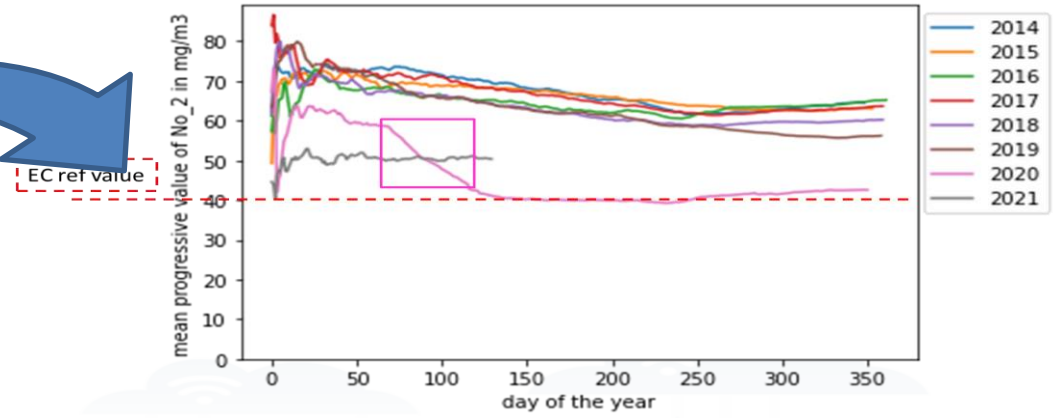
Predicting EC's KPI on NO2 months in advance

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**

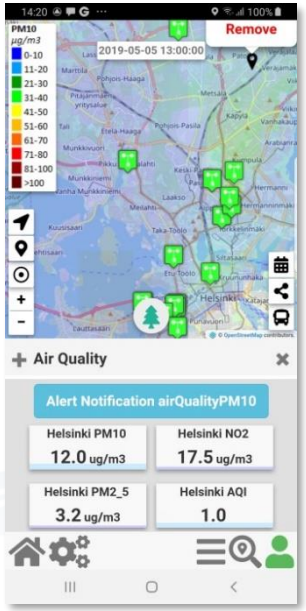






	Air Quality Directive			WHO guidelines	
Pollutant	**Averaging period**	**Objective and legal nature and concentration**	**Comments**	**Concentration**	**Comments**
$PM_{2.5}$	One day			25 µg/m³ (*)	99th percentile (3 days/year)
$PM_{2.5}$	Calendar year	Target value, 25 µg/m³	The target value has become 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

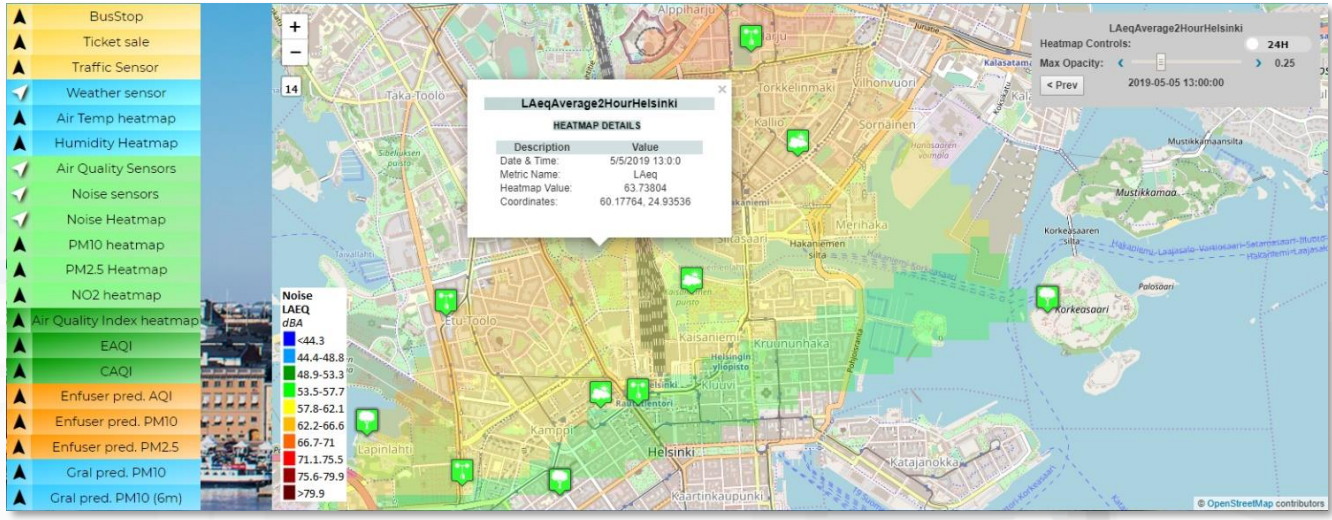


Why ?

- 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:

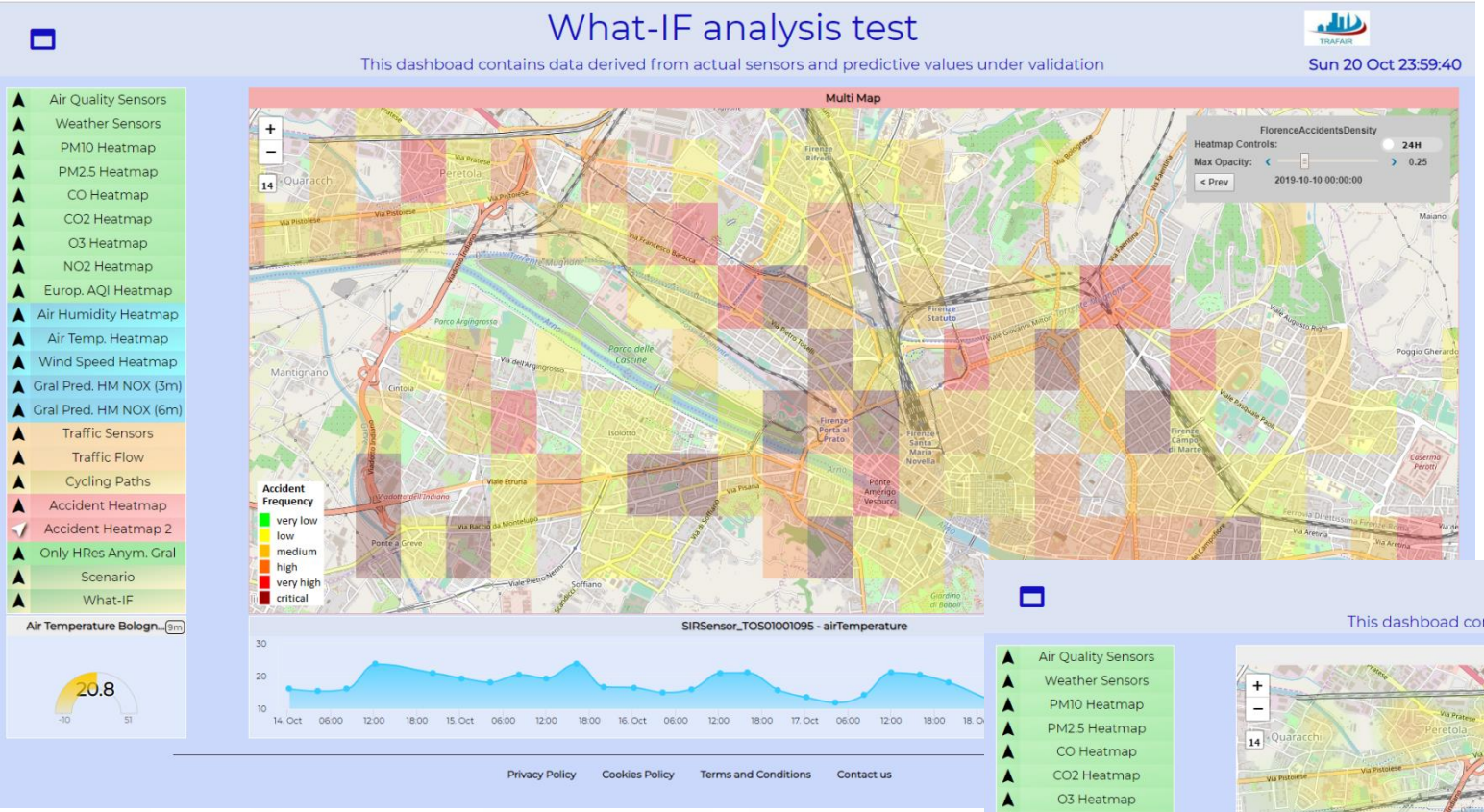
- **Real time** measures (PM_{10}, $PM_{2,5}$, NO_2, SO_2, Noise, NO, O_3, AQI,..)
- **Predictive** measures (ENFUSER, GRAL)
- From **200x200** to **4x4** m
- Hourly concentration
- Any programmed Color map
- Animations over H24
- Picking values in any place
- On Web and Mobile App

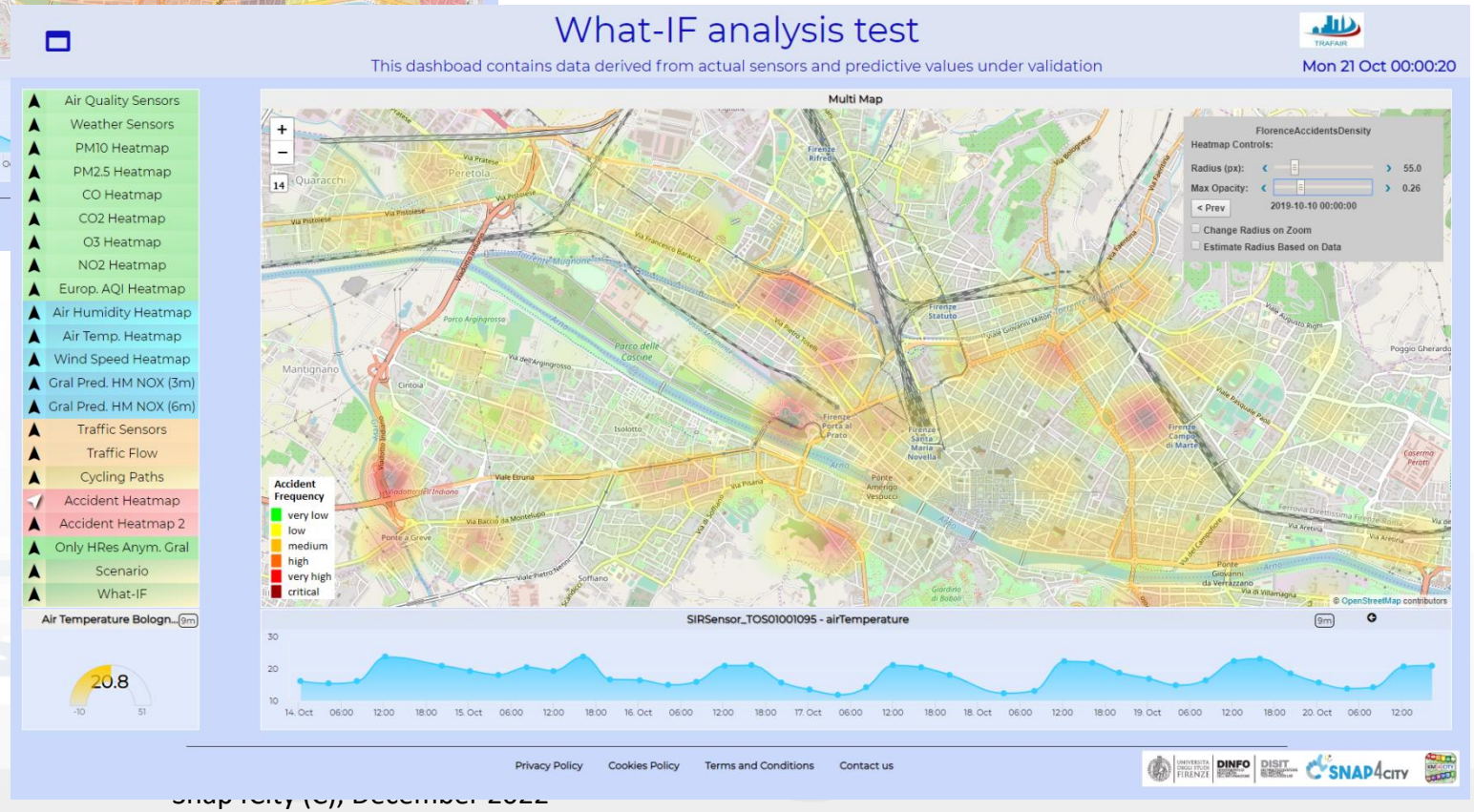


https://www.snap4city.org/snap4cityWebAppHelsinki/

Florence

Accidents Density





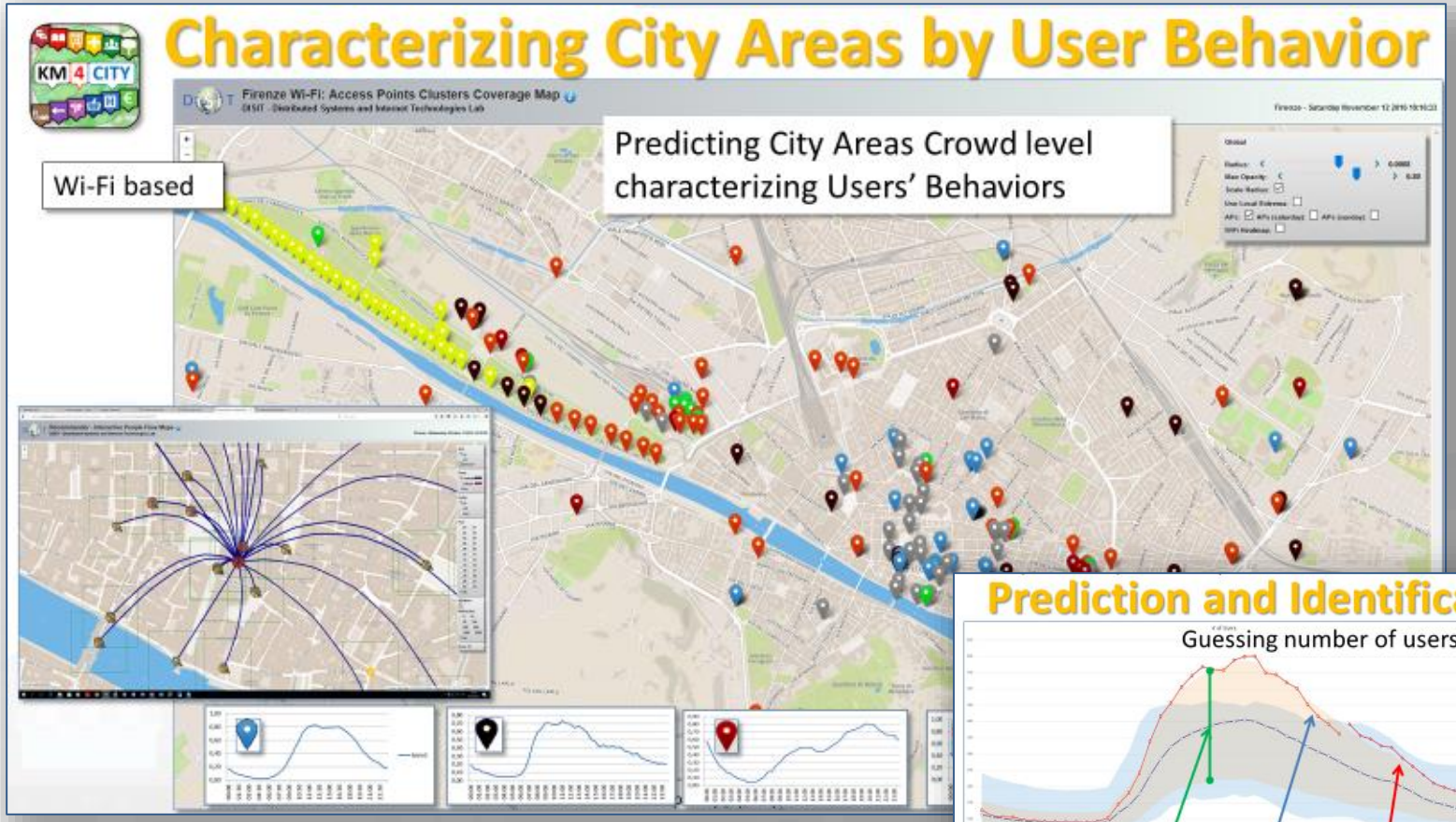
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjE4Nw==

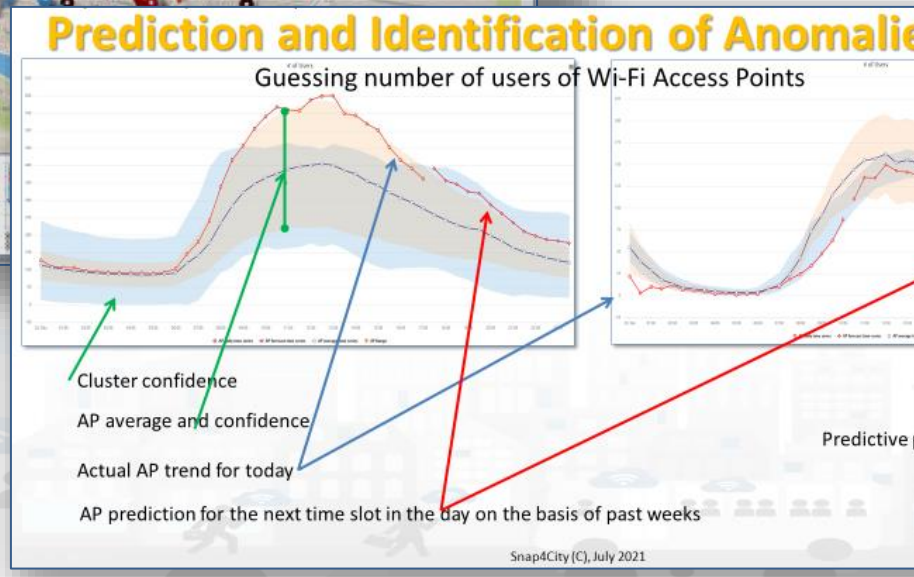
AI/XAI on: City Users and Social

- **People detection and classification**: persona, carts, bikes, etc. (ML, DL)
- **people counting** and tracking (via thermal cameras, ML, DL)
- **People prediction**: wifi, mobile, etc.
- **People counting** via head counting (via thermal cameras, ML, DL)
- **People flows prediction** and reconstruction, (ML, DL)
  - Wi-Fi data, mobile apps data, Mobile Data, etc.
- **User engagement and suggestions** for sustainable mobility (Rule Based, ML)
- **User's behaviour analysis**,
  - origin destination matrices, hot places, time schedule, Recency and frequency, permanence, typical trajectory, etc.
  - **People flow analysis** from PAX Counters and heterogenous data sources
- **15 Minute City Index** , etc. (modeling and computability)

People Flows

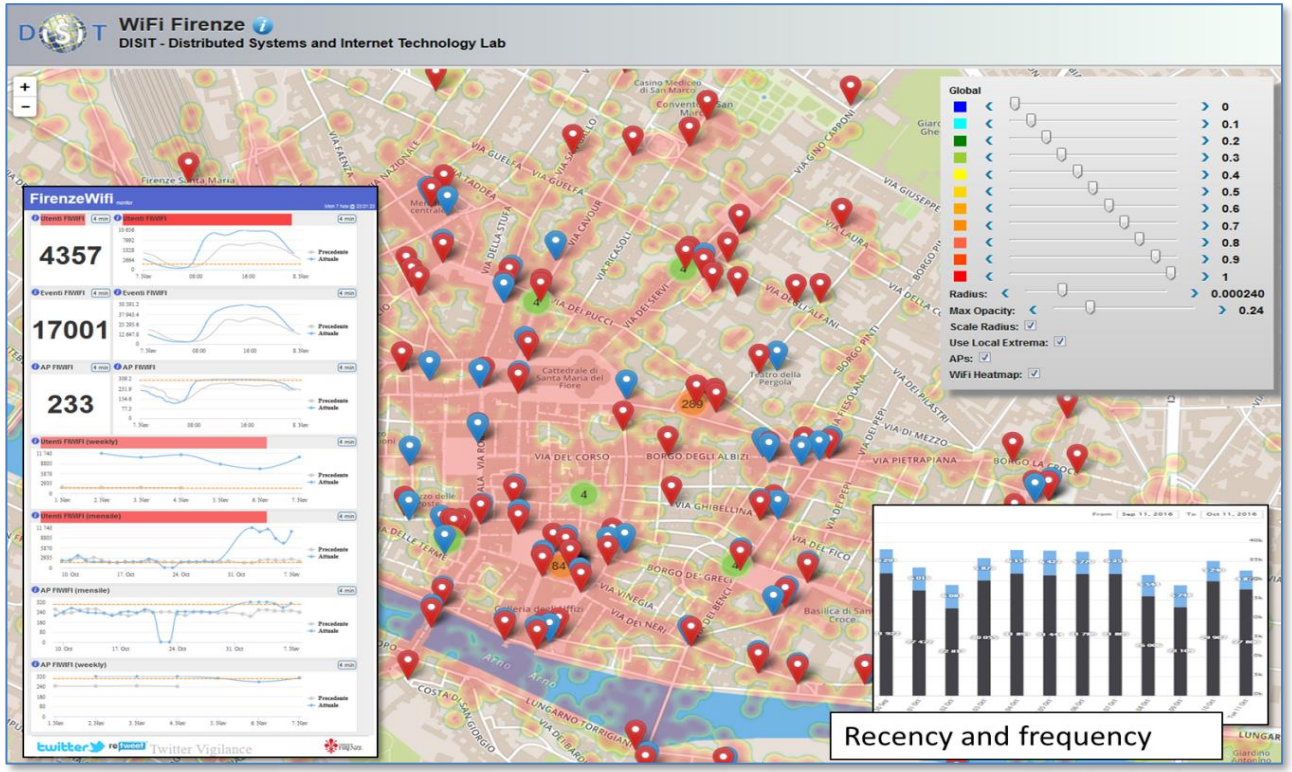
- **Prediction of people flows** on the basis of Wi-Fi data
- **Anomaly** detection
- **Resolute** H2020
- Classification of city areas

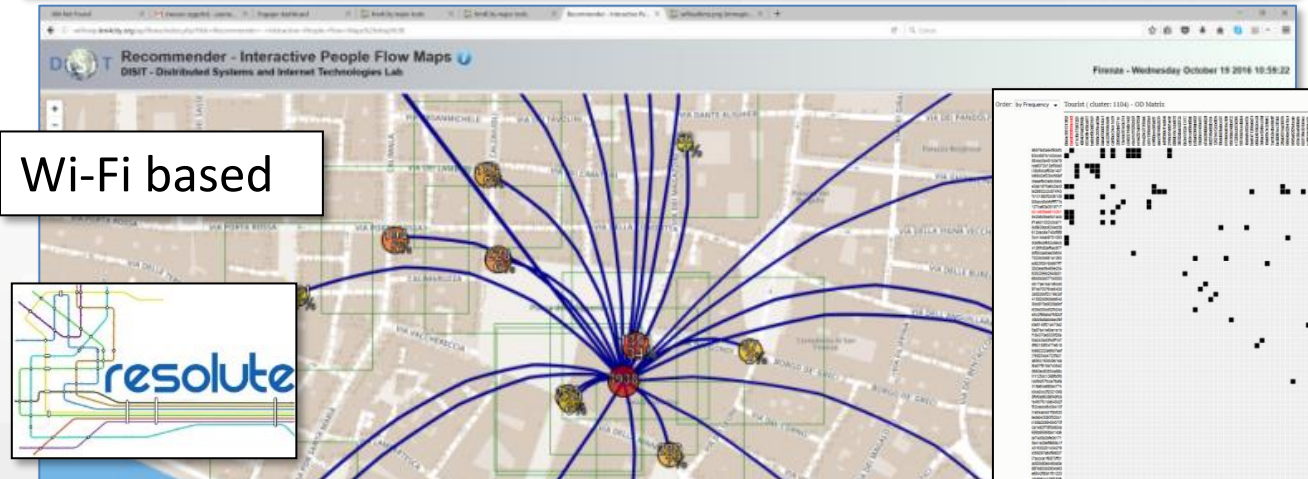


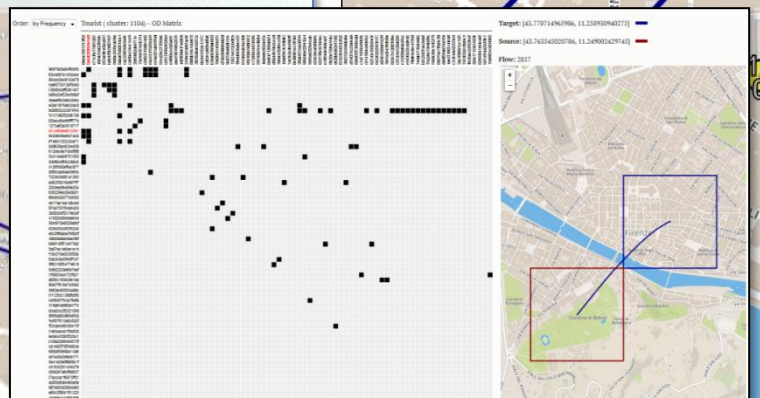


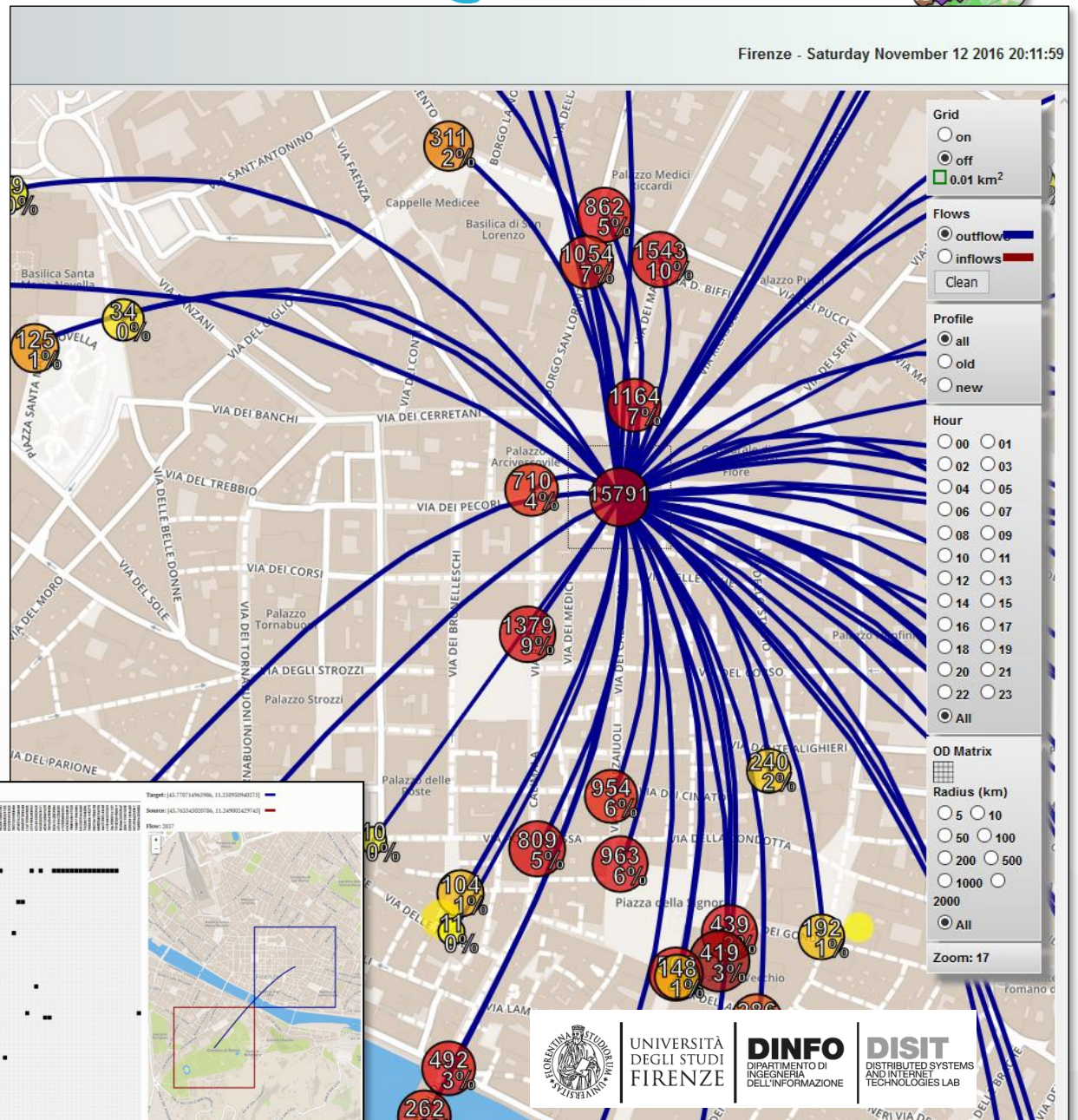
11 SUSTAINABLE CITIES AND COMMUNITIES

Origin Destination Matrix Estimation





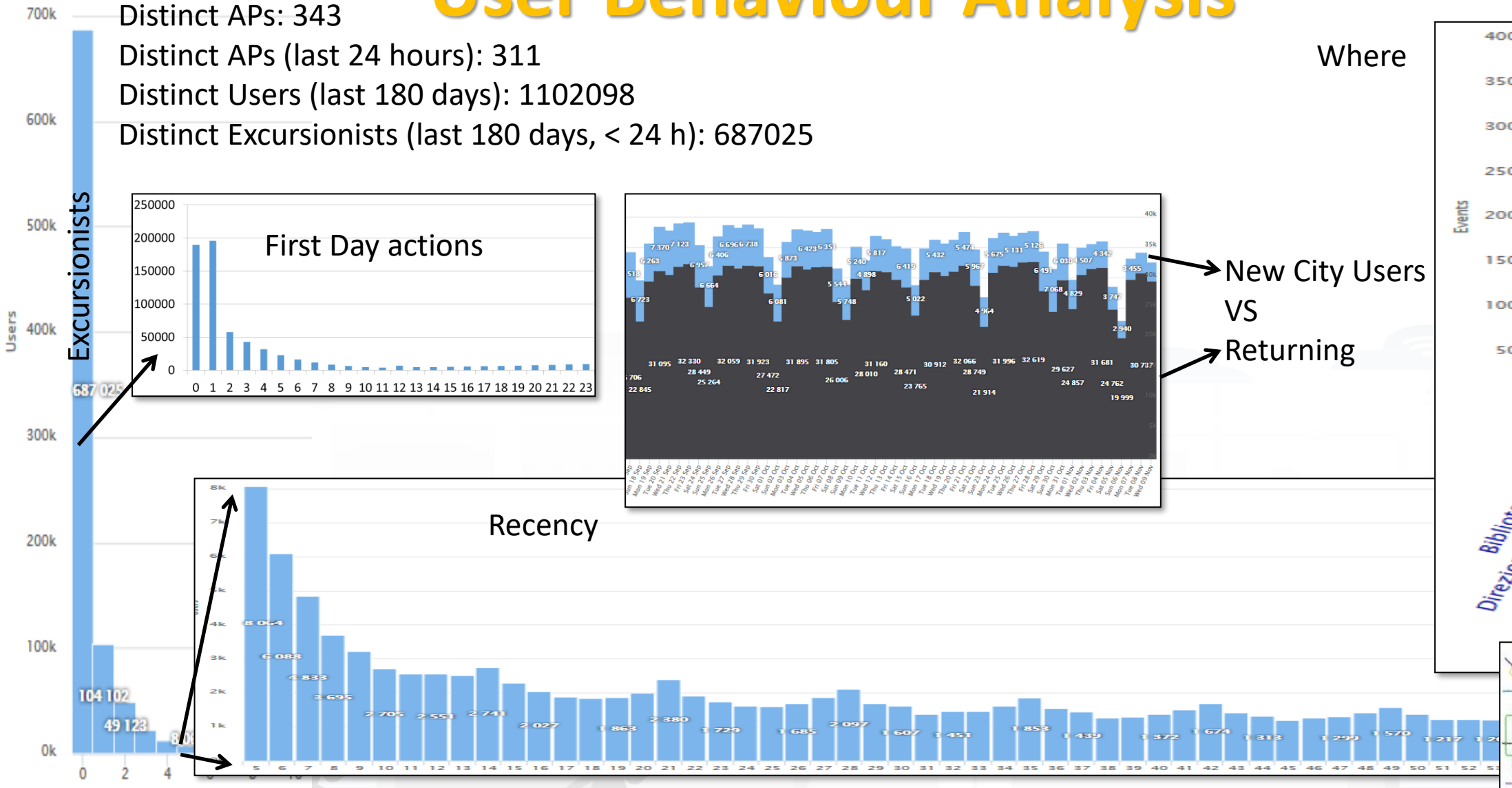




UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

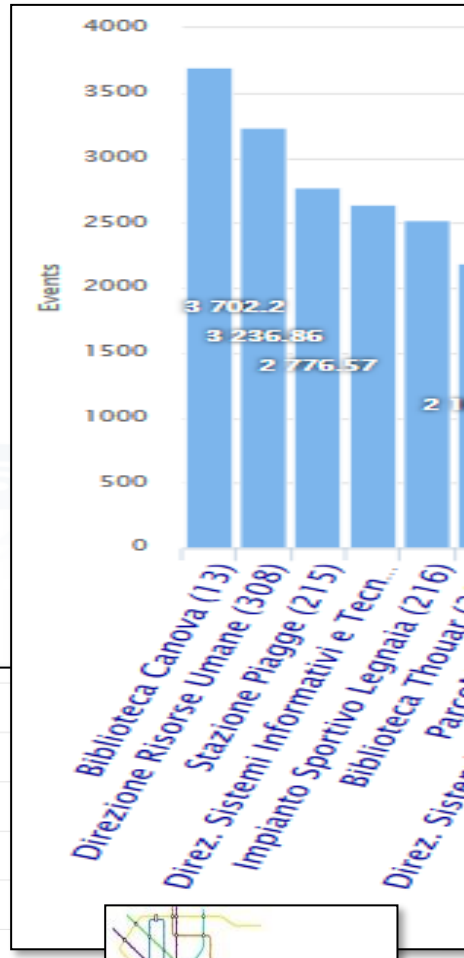
User Behaviour Analysis

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



New City Users
VS
Returning

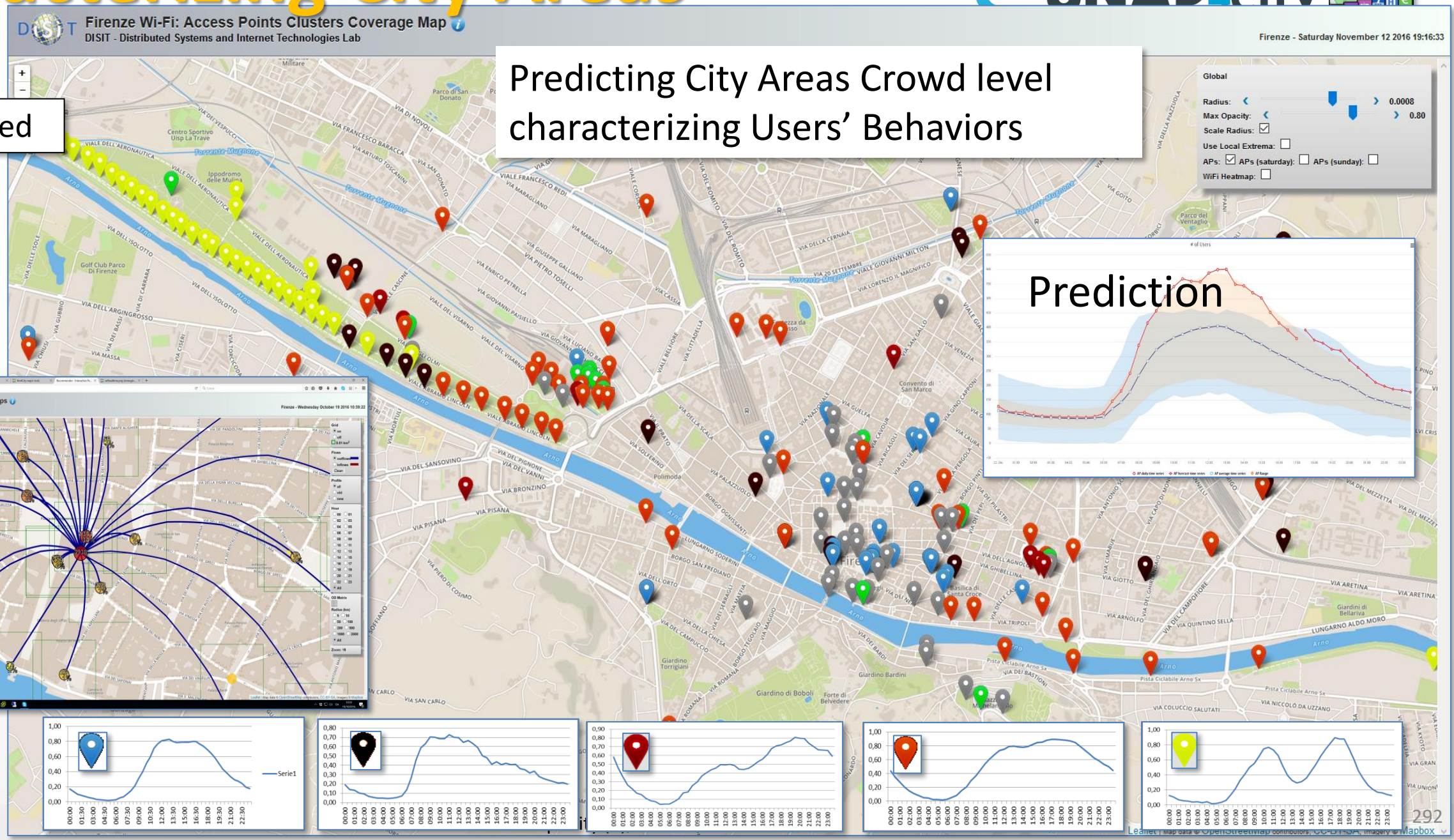
Where



Characterizing City Areas

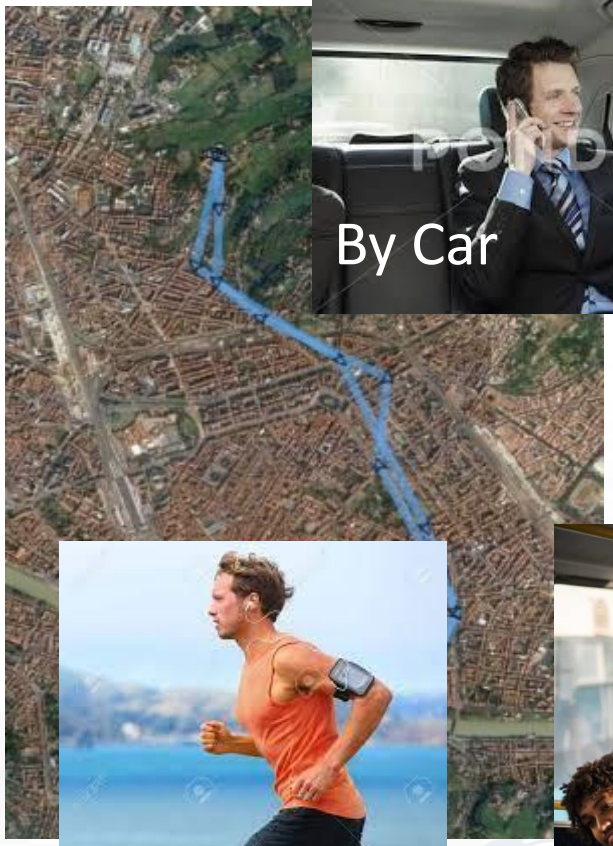
Wi-Fi based

Predicting City Areas Crowd level characterizing Users' Behaviors

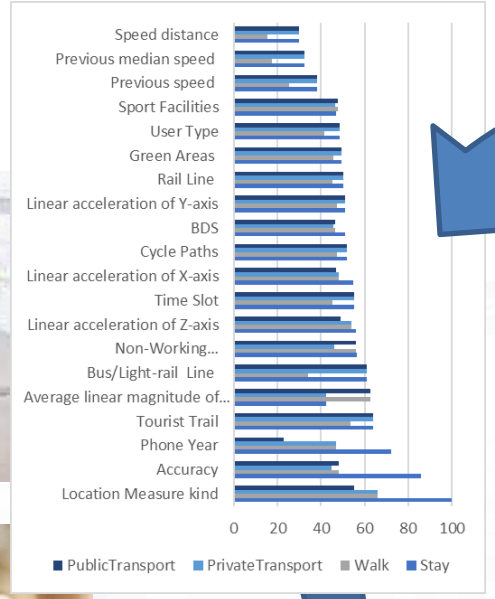


To propose suggestions and Engage city user

we need to know how they are moving

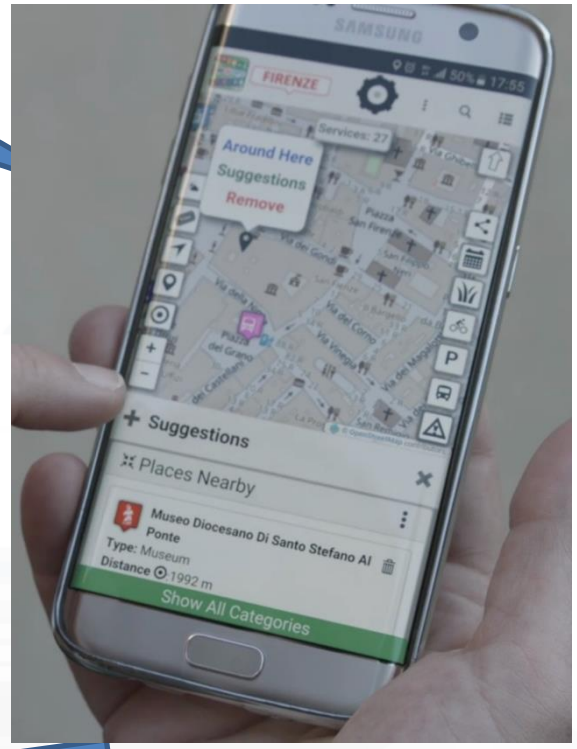


Walk



Artificial Intelligence Classification

Suggestions



DORAM

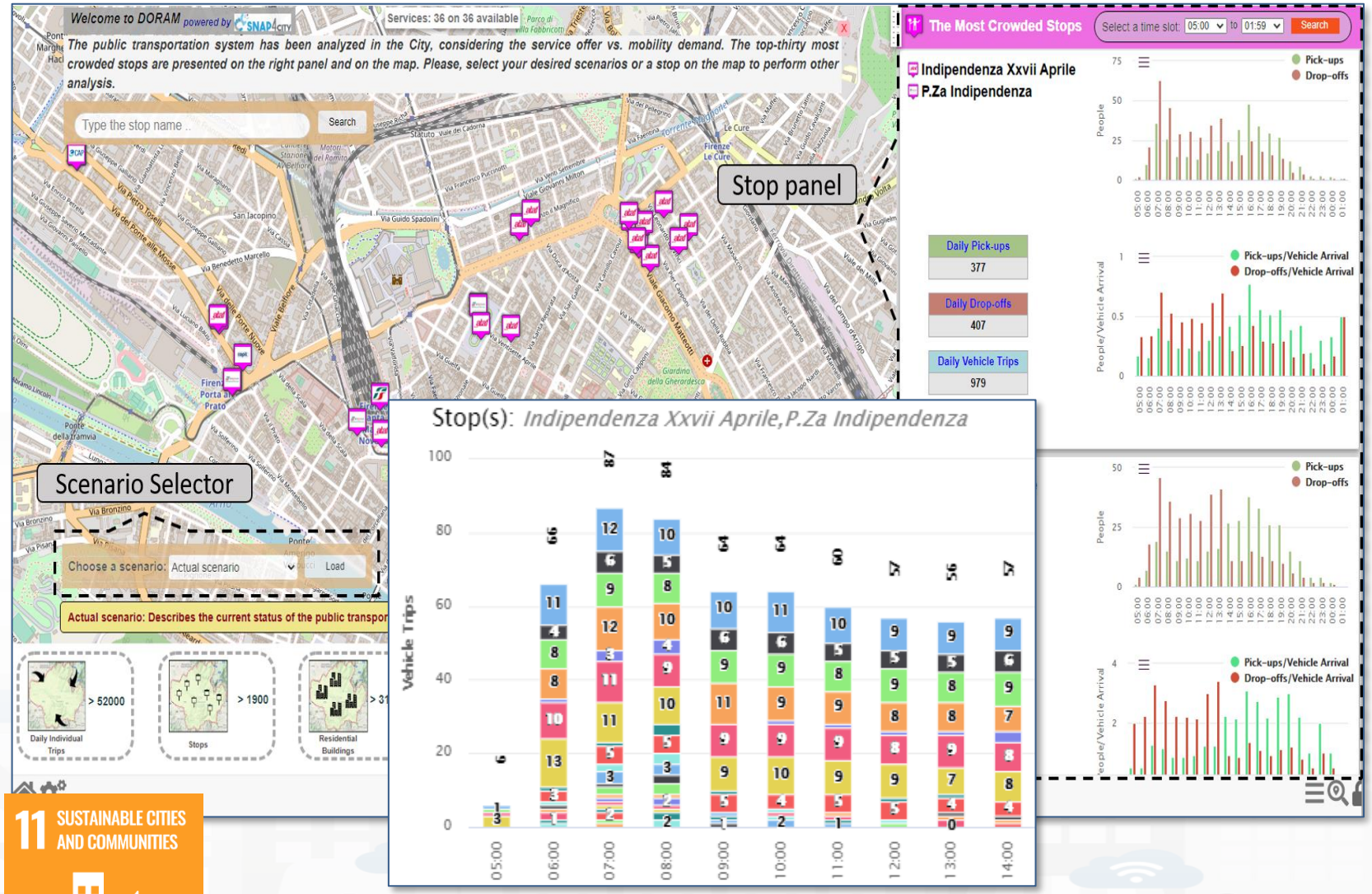
Analysis of

- **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.



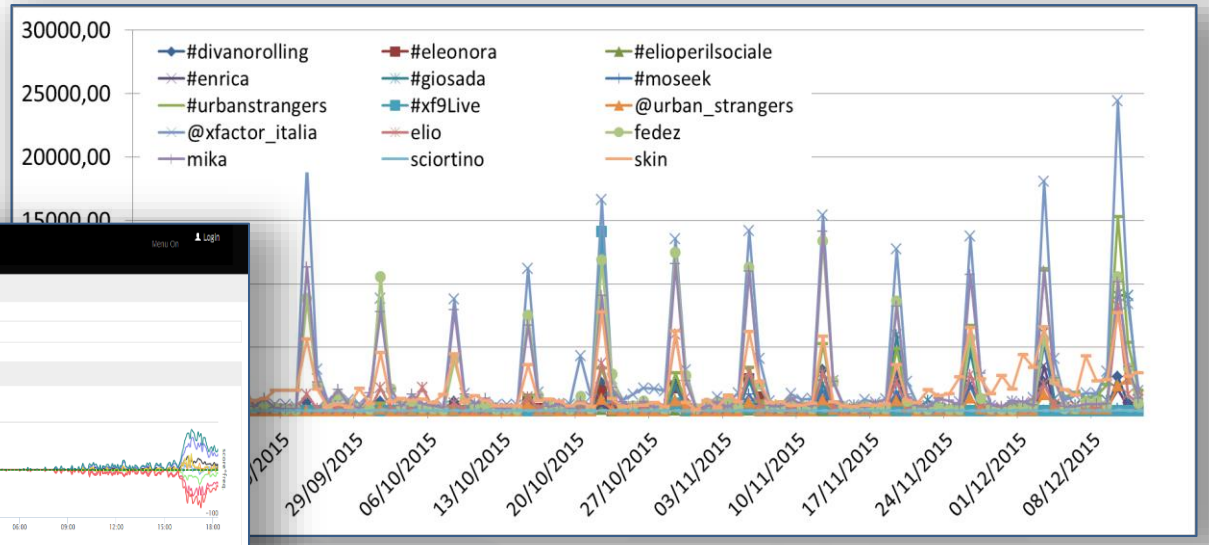
11 SUSTAINABLE CITIES AND COMMUNITIES

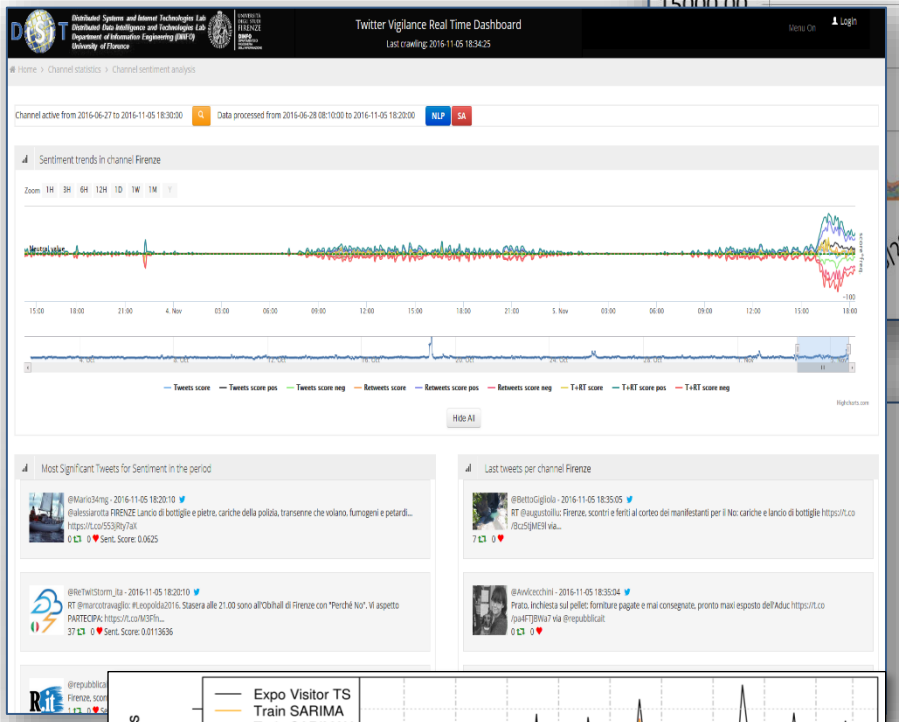
https://www.snap4city.org/odanalyzer/#b

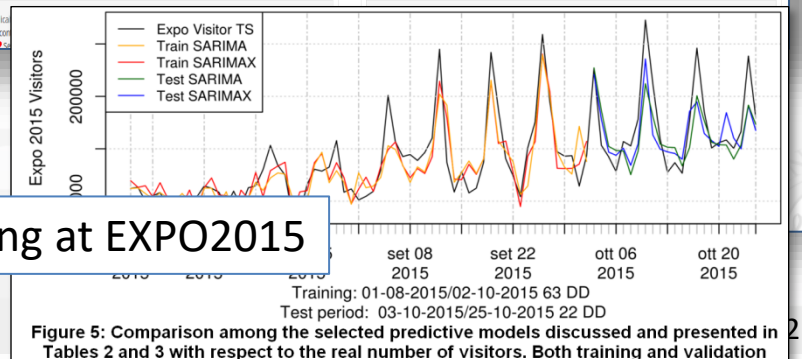
Social Media

Twitter Vigilance

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

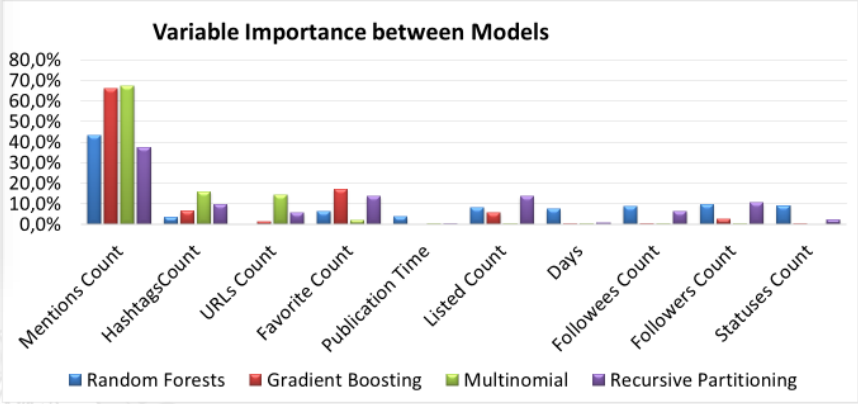






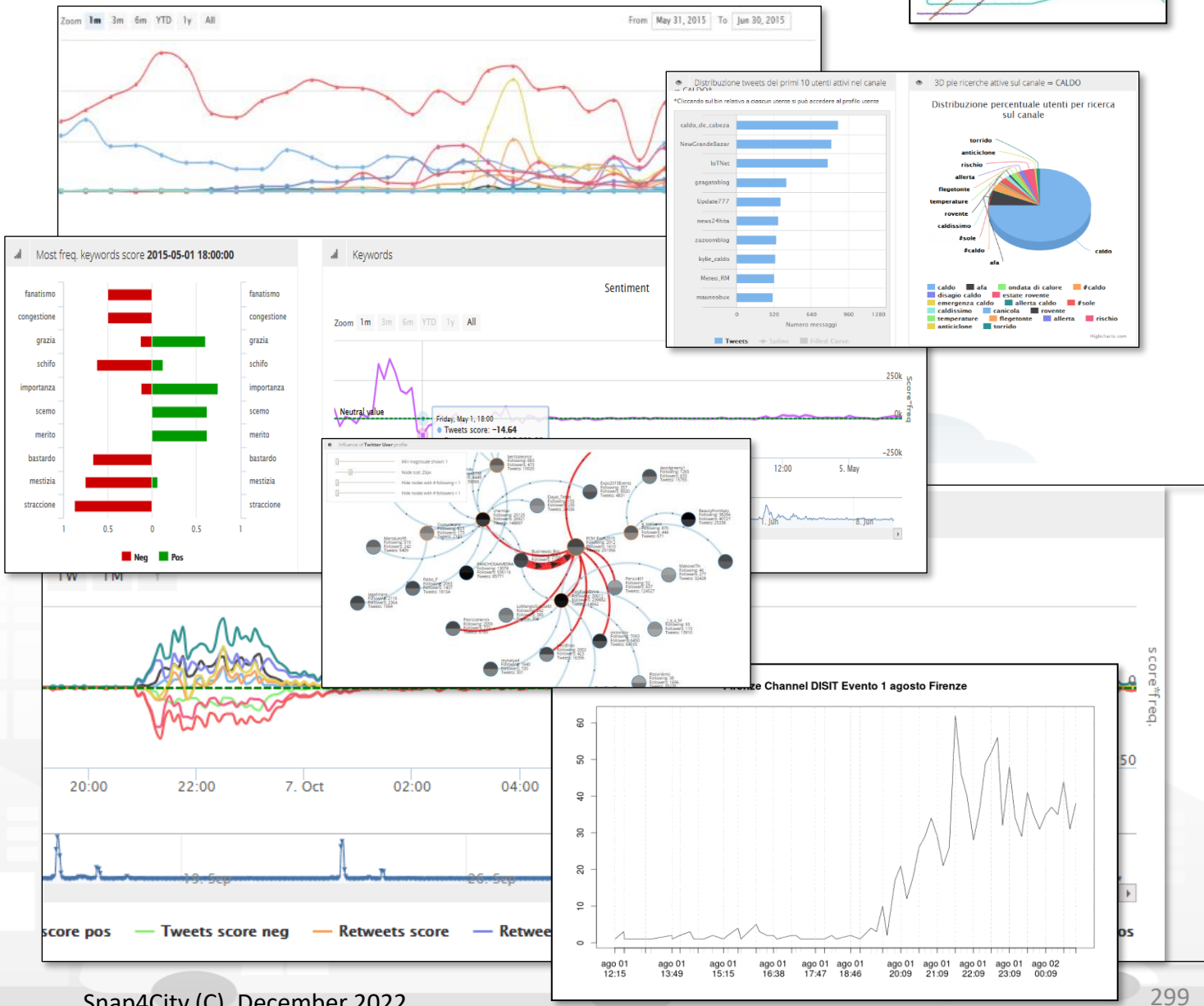
Predicting at EXPO2015

Predictive models VS metrics relevance



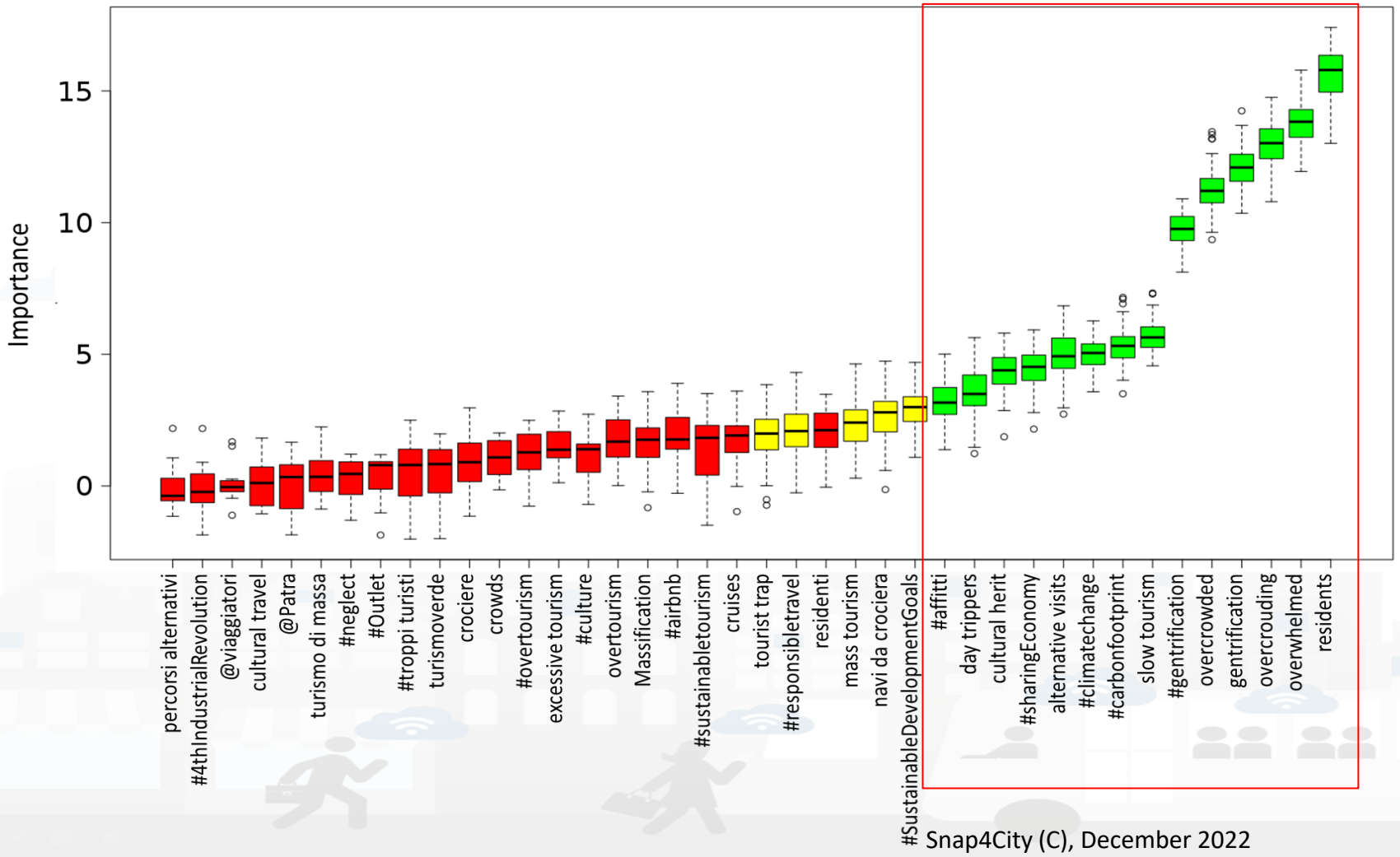
Twitter Vigilance

- 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



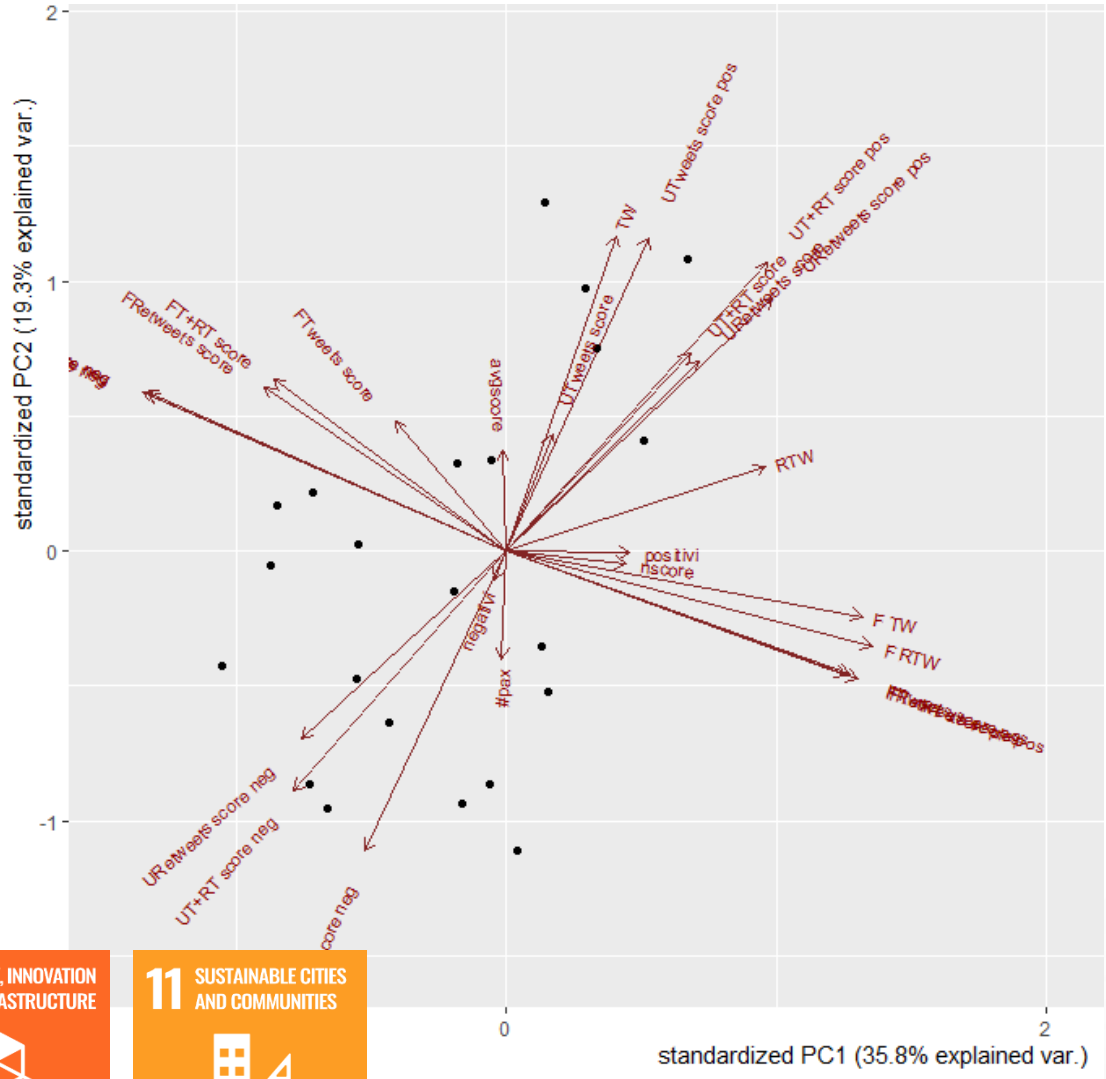
Random Forest Model Results expoiting the *confirmed* keys:

- Accuracy = 0.90
- Kappa index = 0.81

Twitter Vigilance

Reputation

- Prediction/estimation of **Average Score of Trip Advisor** as a function of *Twitter Vigilance Metrics + other information*
- Prediction/estimation of **Negative Scores on specific Museum** or service as a function *of Twitter Vigilance Metrics + other information*



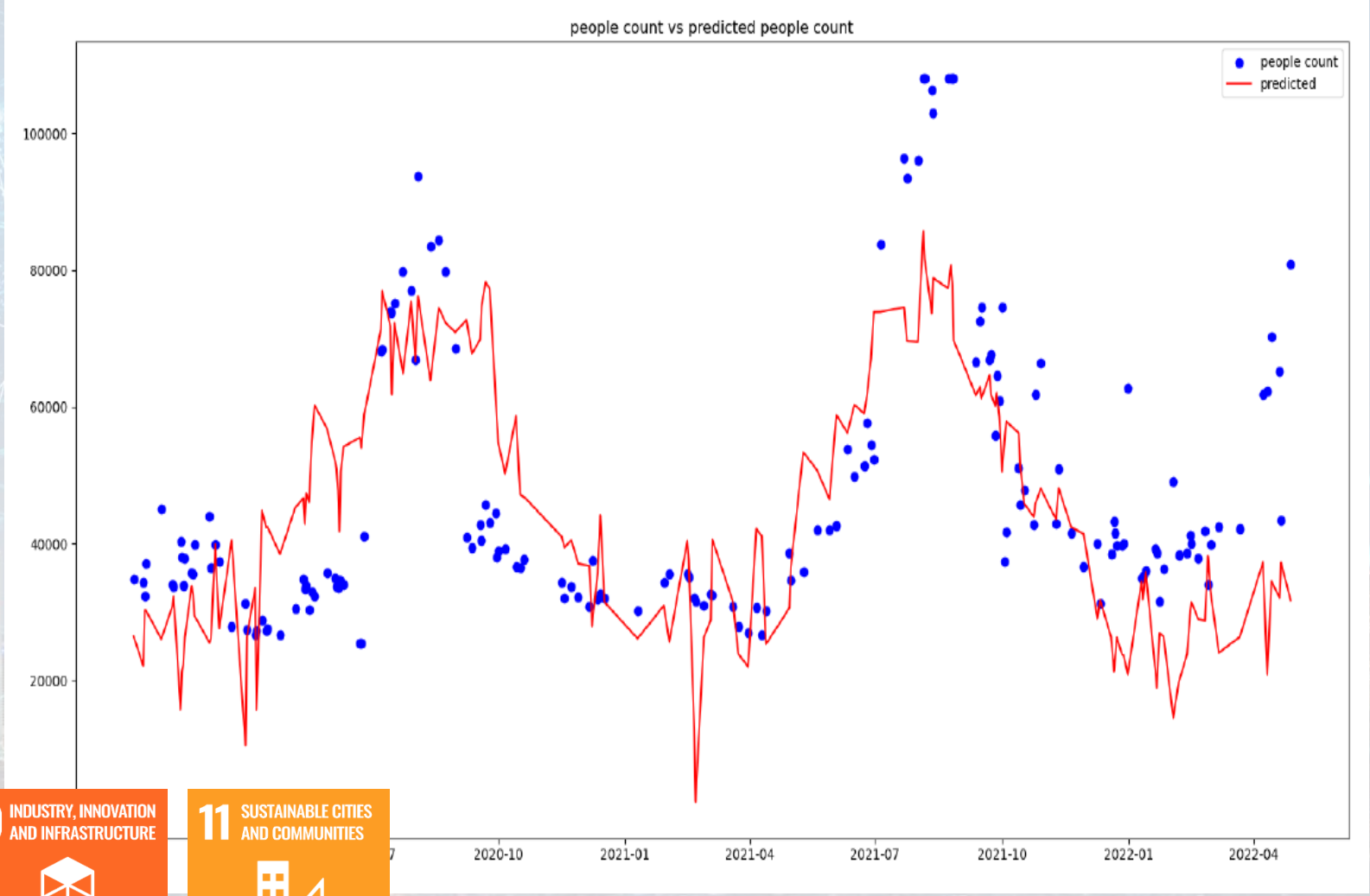
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

11 SUSTAINABLE CITIES AND COMMUNITIES

Twitter Vigilance

Dubrovnik: Data Analytics

- Assessing impact of advertising
- Prediction of presences on the basis of
  - Social Media Twitter Vigilance
  - weather conditions
  - Historical data



Twitter Vigilance

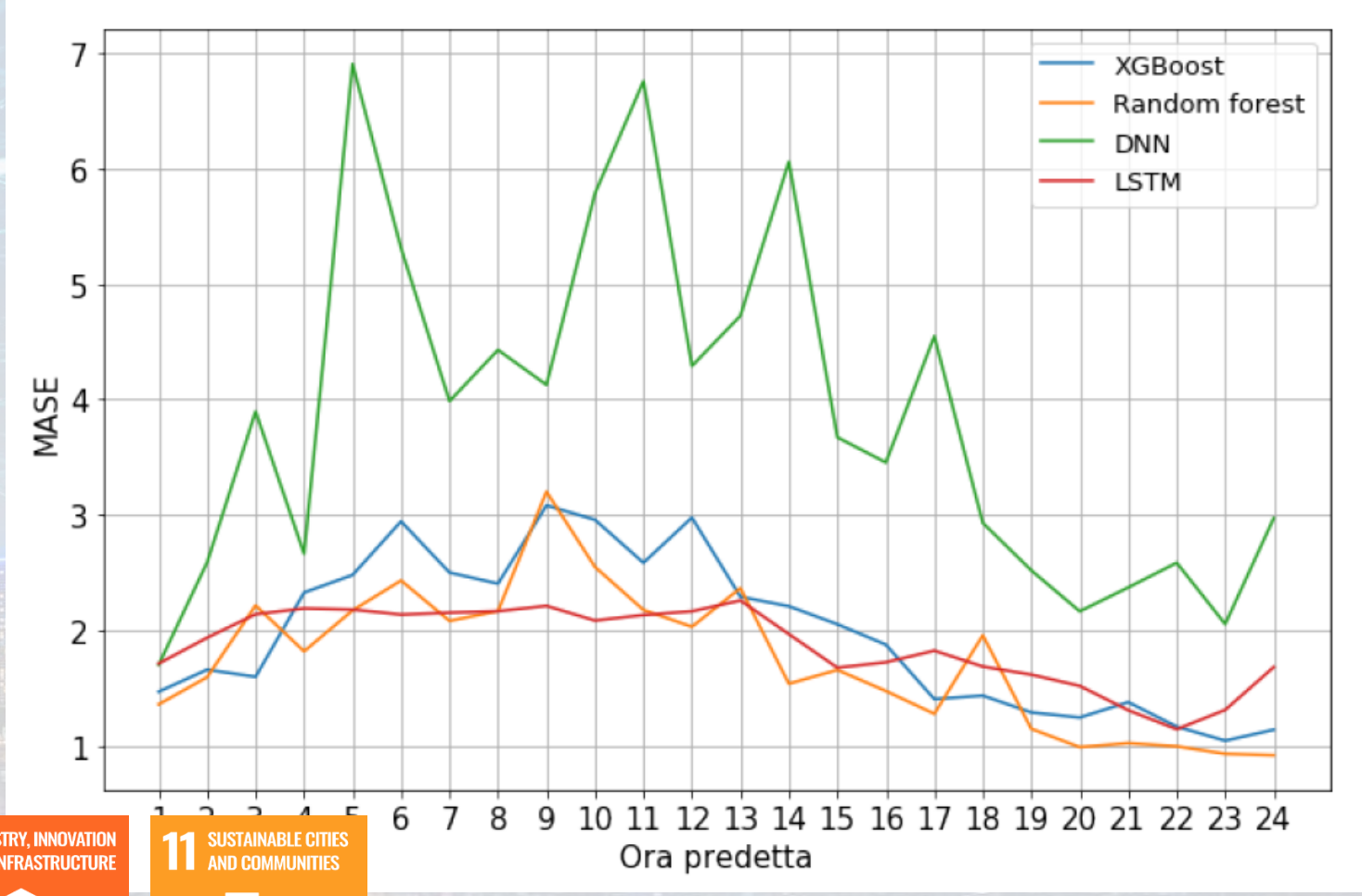
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

11 SUSTAINABLE CITIES AND COMMUNITIES

Pont du Gard: data analytics

- Prediction of the number of sold tickets 24 hours in advance

- Using:
  - Historical data
  - Weather conditions
  - Social Media



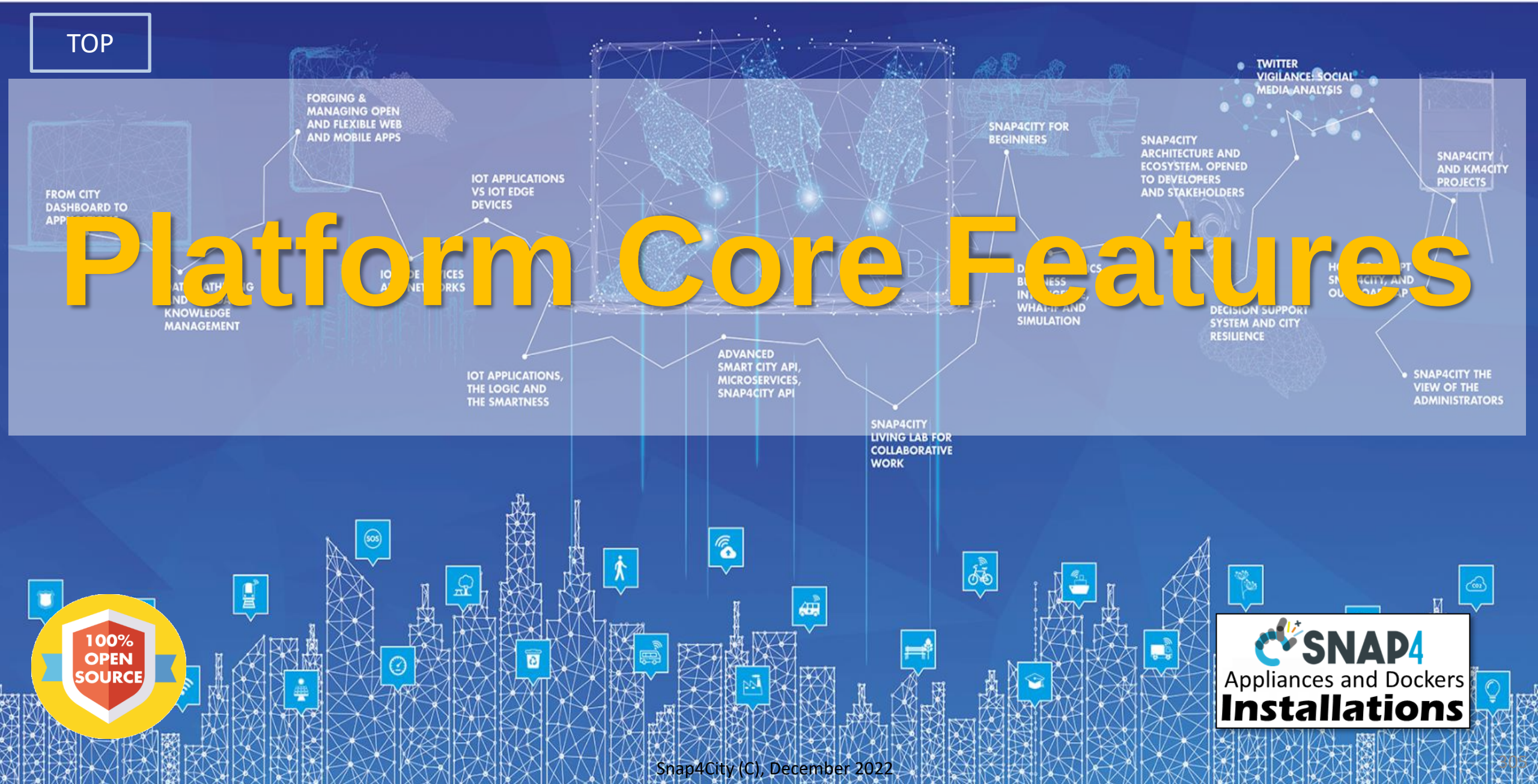
Twitter Vigilance

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

11 SUSTAINABLE CITIES AND COMMUNITIES

TOP

Platform Core Features

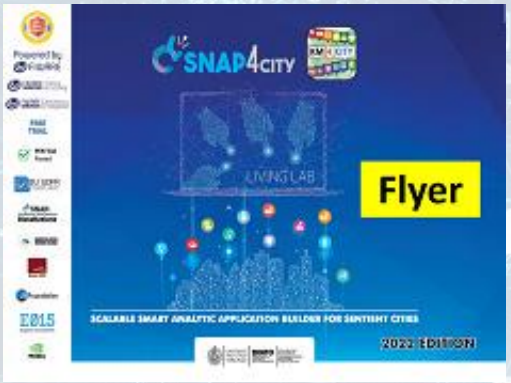


Core Features

- **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

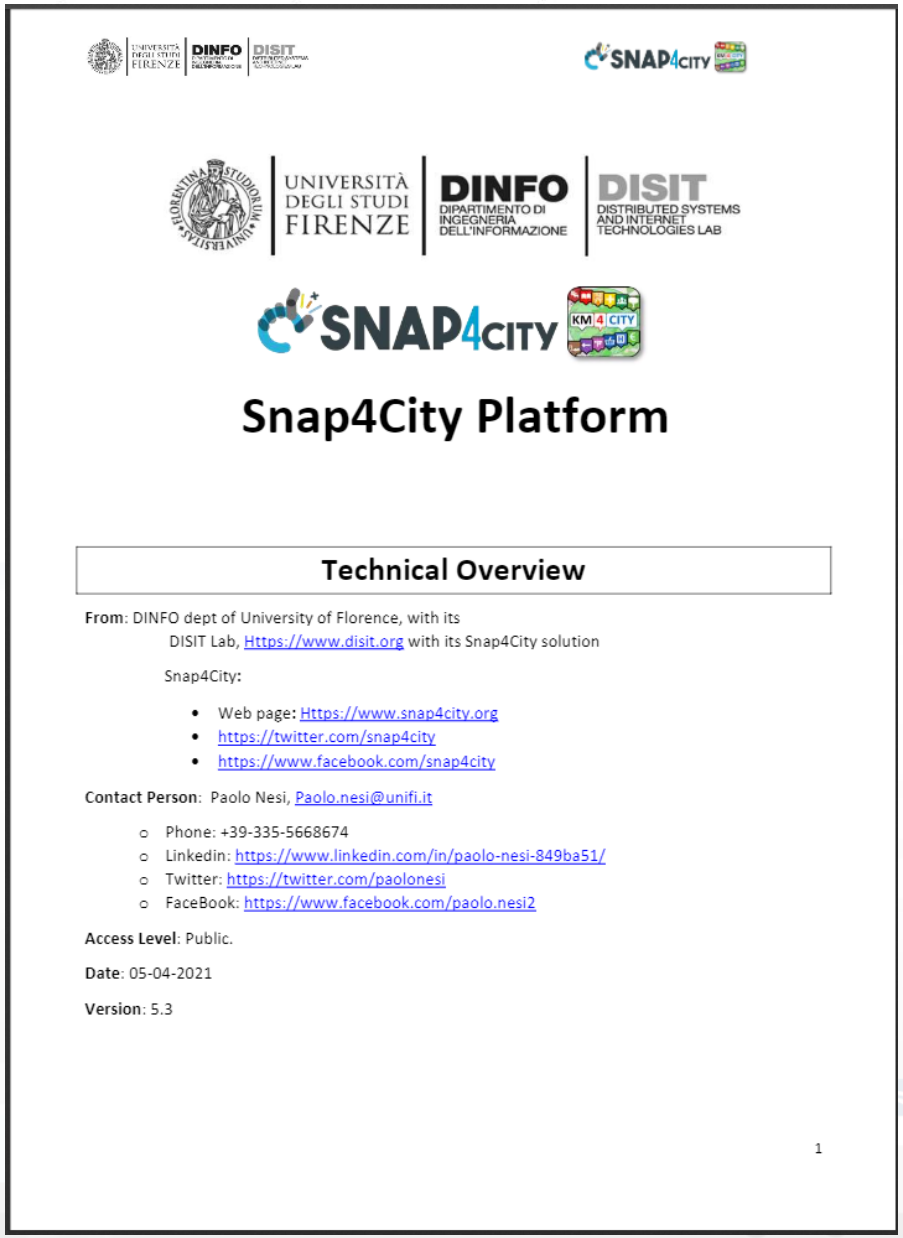
- Snap4Industry

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

- Solutions
- Data Analytics

https://www.snap4city.org/download/video/DPL_SNAP4SOLU.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

100% OPEN SOURCE

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

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, 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-

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FIWARE Node-RED

Organization Groups

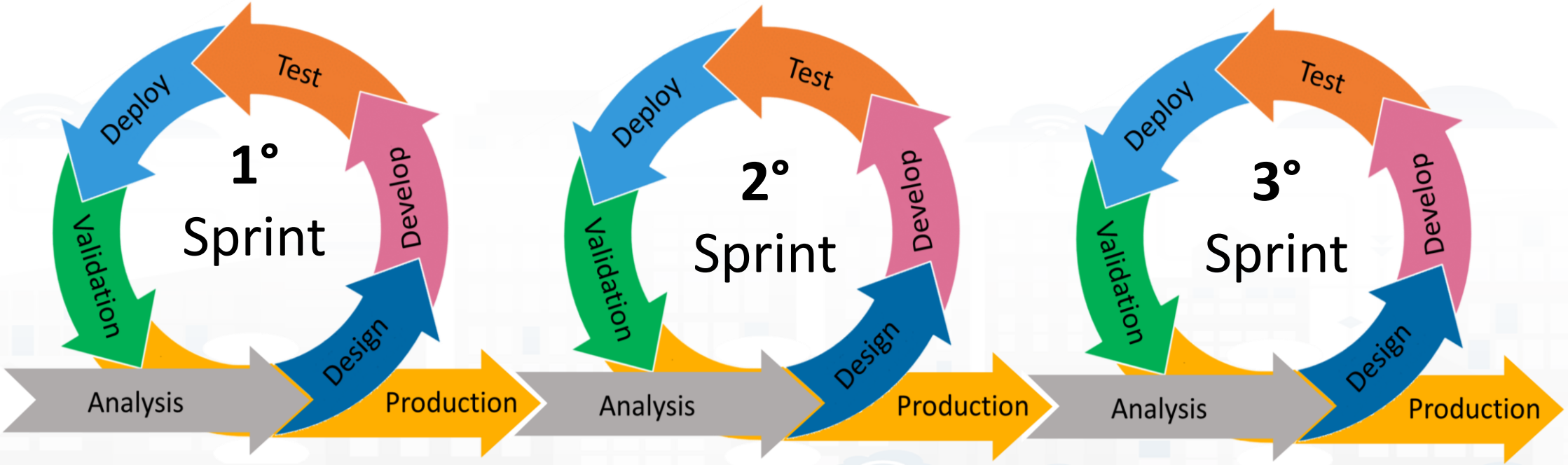
DISIT
- Developer
- Operativo

Updates on Tools

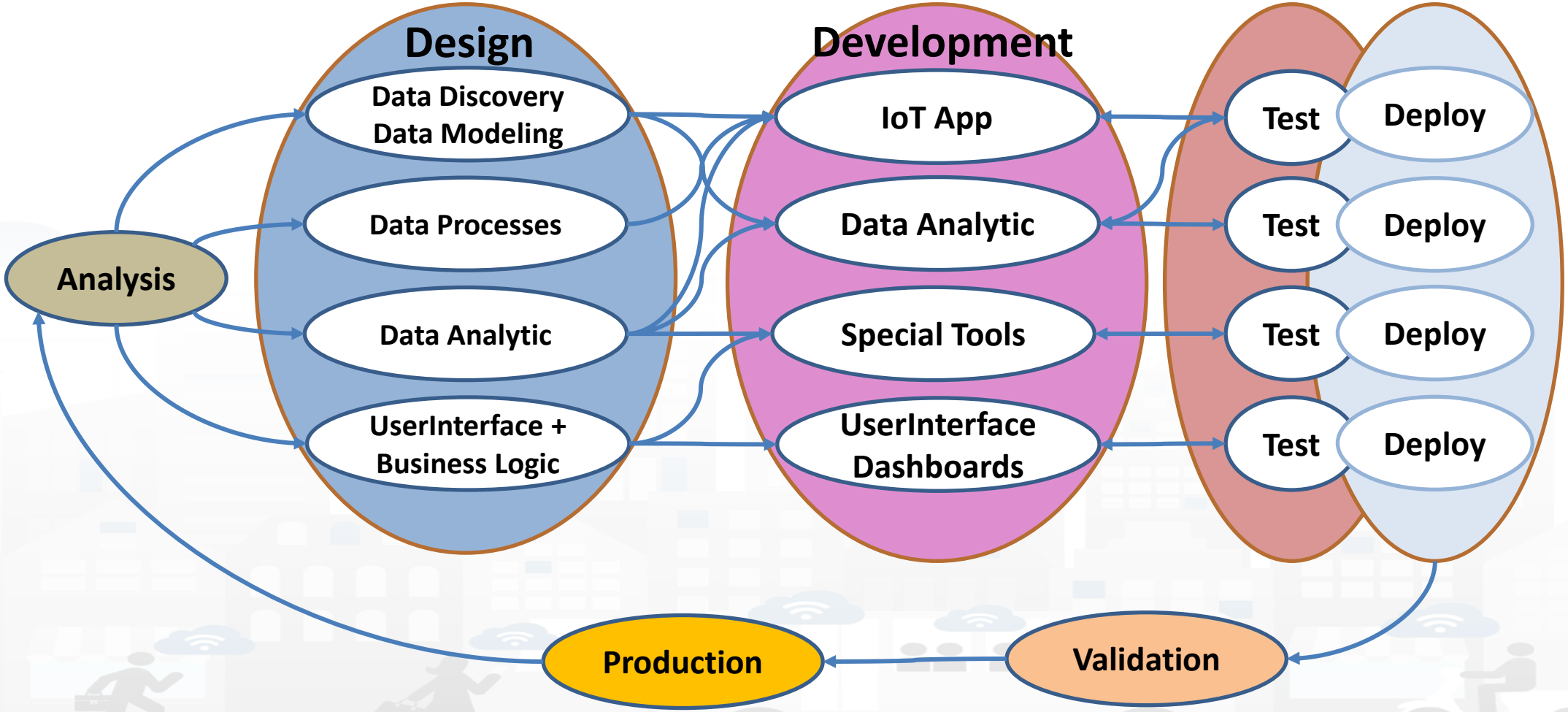
News from Snap4City & slides, Where to Meet Snap4City experts
updated
roottooladmin1

HOWTO: FIWARE Orion

Development Life Cycle
Smart Solutions

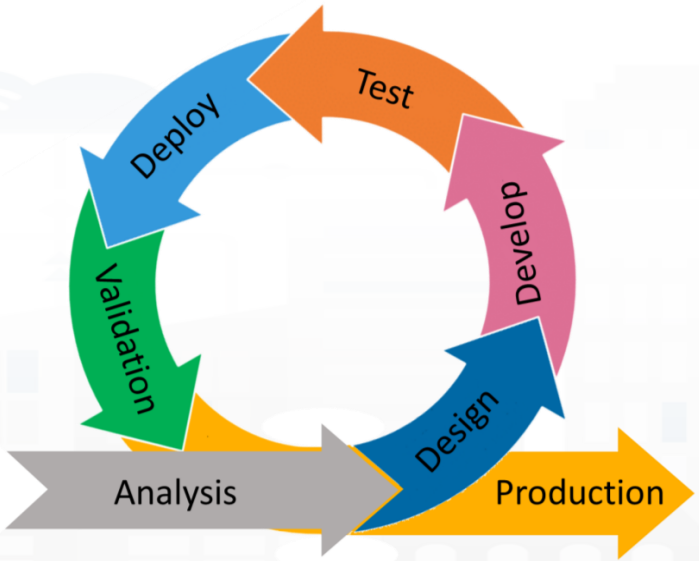


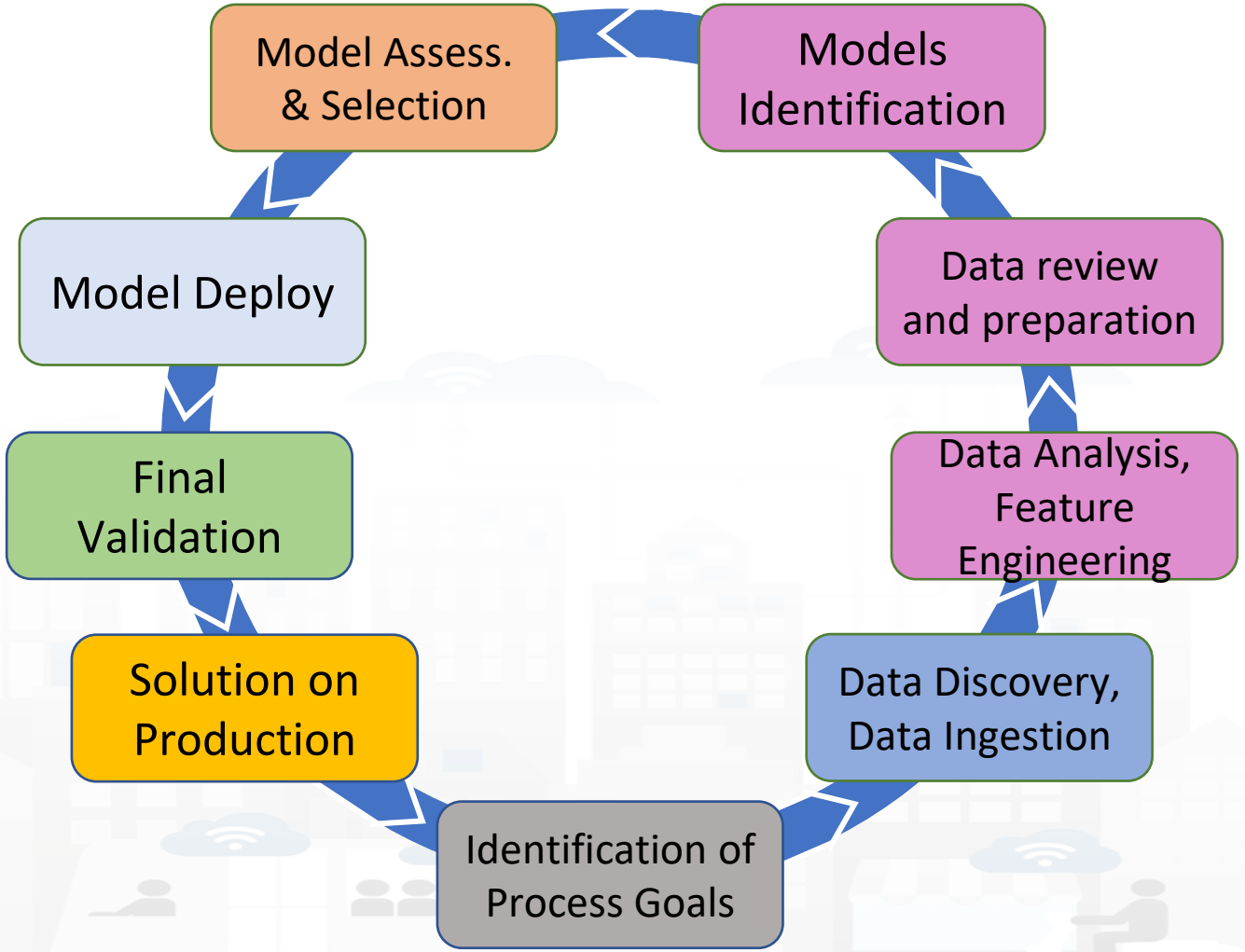
Development Life Cycle Smart Solutions



Data Analytics Development Life Cycle

- Detailed development process





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	8th
what	Overview	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App	Design and Develop Smart Solutions
PDF 2022								
Interactive (2022) with video and animations								

Video1	YouTube	YouTube	YouTube	YouTube	YouTube	YouTube	YouTube
Video2	YouTube	YouTube	YouTube	YouTube	YouTube	YouTube	YouTube
Video3	YouTube	YouTube	YouTube	YouTube	YouTube	YouTube	YouTube
Video4	YouTube	YouTube	YouTube	none	YouTube	none	none

General Overview of the full Course

1. *General Overview*
2. ***Dashboards** Creation and Management, **Business Intelligence***
3. ***IOT Applications** development, IOT Devices, IOT Networks*
4. ***Data Analytics**, in R Studio, in Python, how to Exploit and Manage Data Analytics in IOT Applications*
5. ***Data Ingestion**, Data Warehouse, Data Gate, IOT Device Data ingestion, IOT App for Data Ingestion, **Interoperability**, etc.*
6. *Snap4City **Installation, Extension, Administration***
7. ***Smart city API** (internal and external) **Web and Mobile App development** tool kit*
8. *How to **Design and Develop Smart Applications***

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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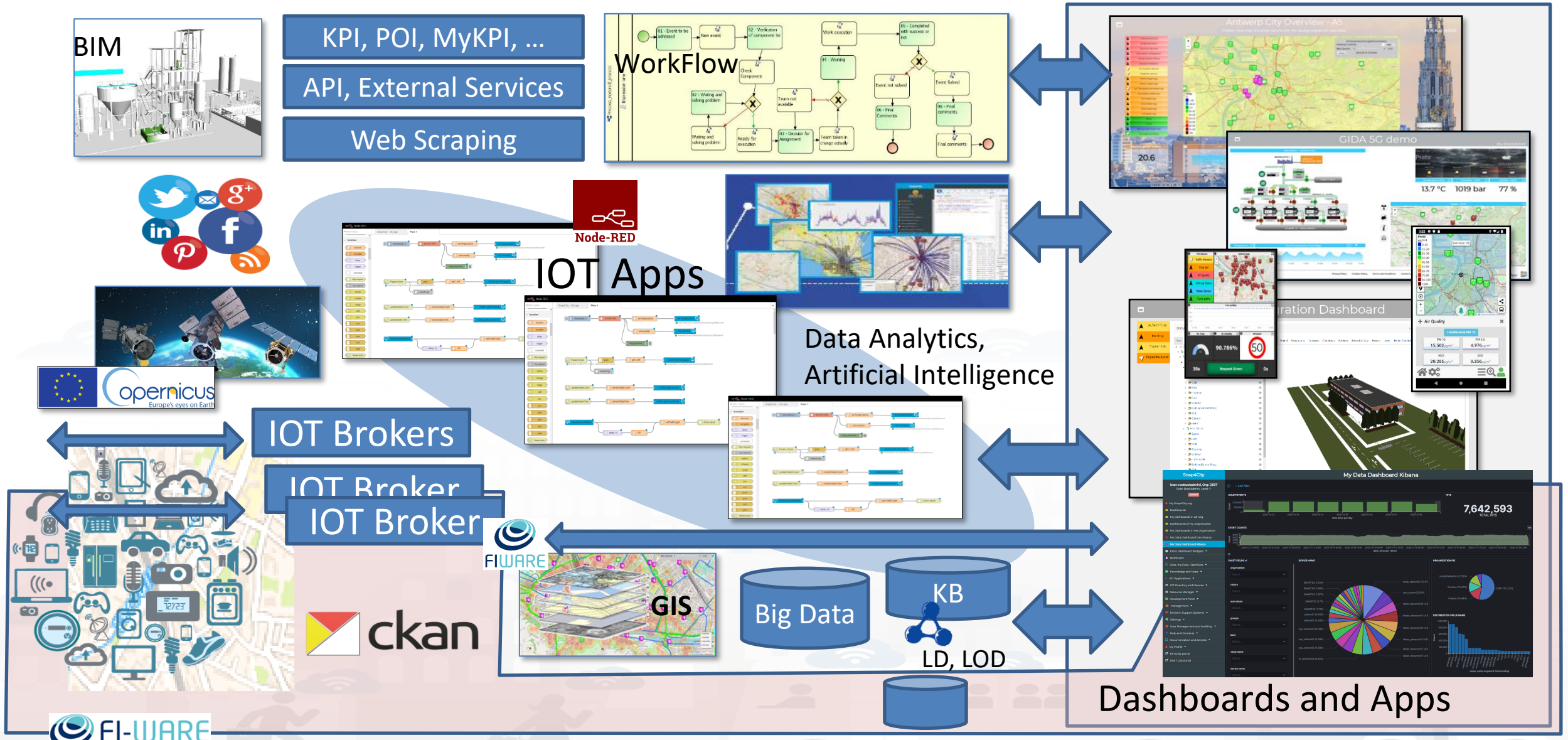
SNAP4CITY

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
ckan
GIS
Big Data
KB
LD, LOD
Dashboards and Apps
FI-WARE

TOP

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							
Inter active							
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

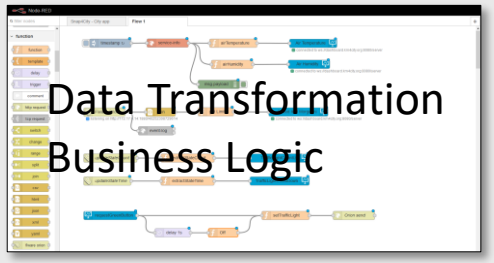
- **Dashboard Builder of Snap4City**

You need to create / customize

Full Control

Professional details

Dashboard Builder: Development



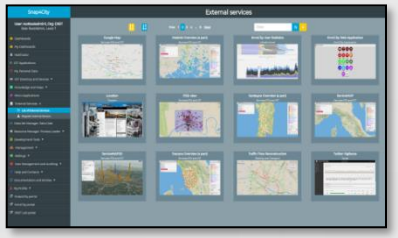
Data Transformation
Business Logic

IOT Applications

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

Widget Collection

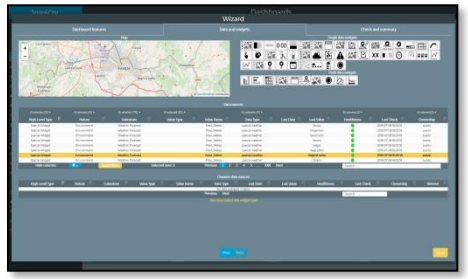
Micro
Applicat
ions



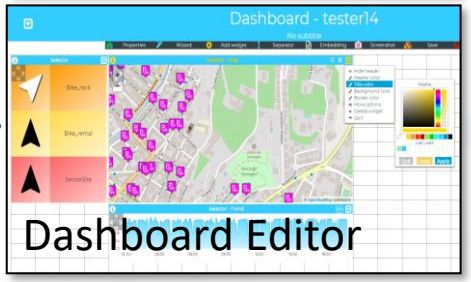
External
Services

Custom
Widgets/
Synoptics

Dashboard Wizard



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

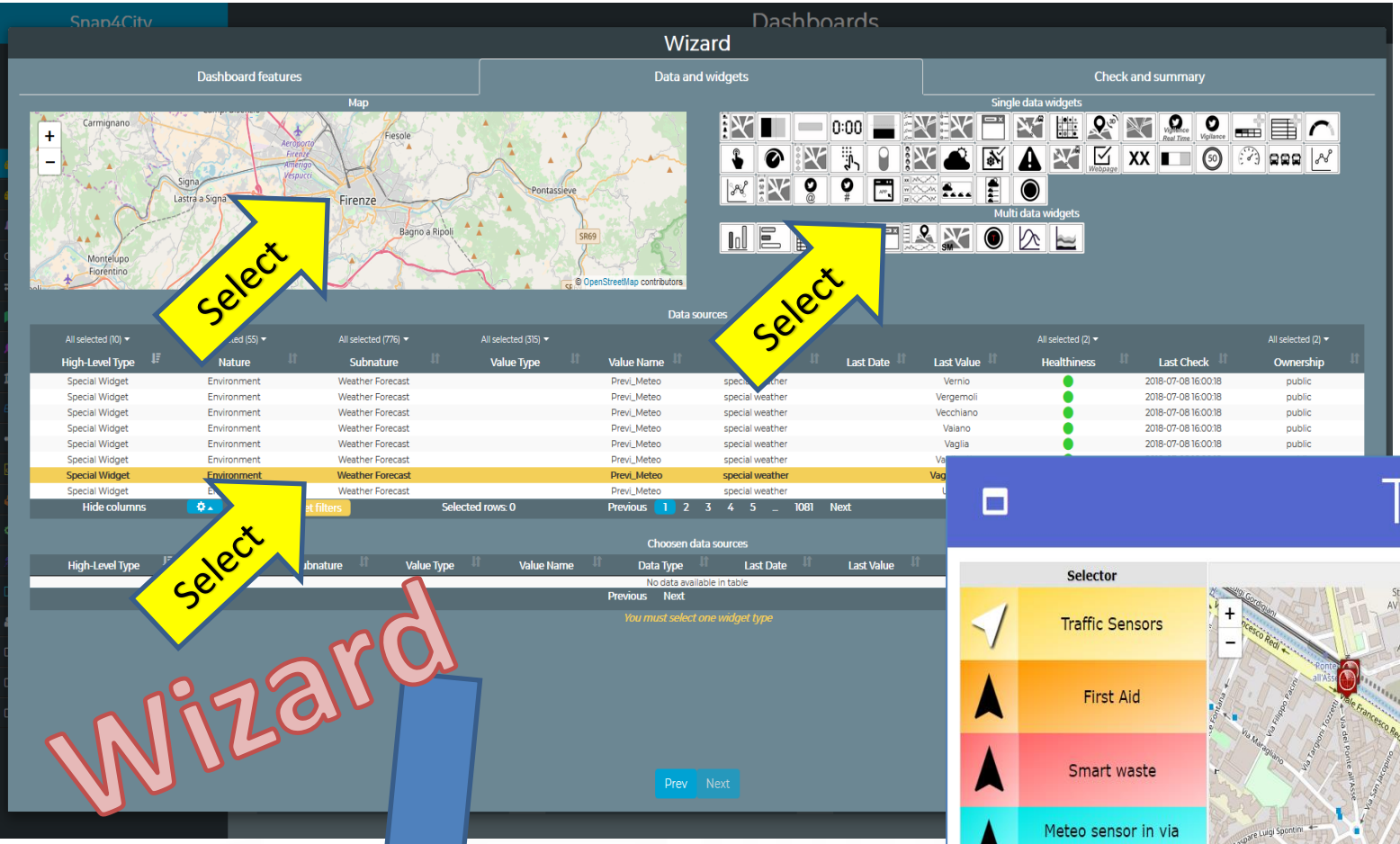


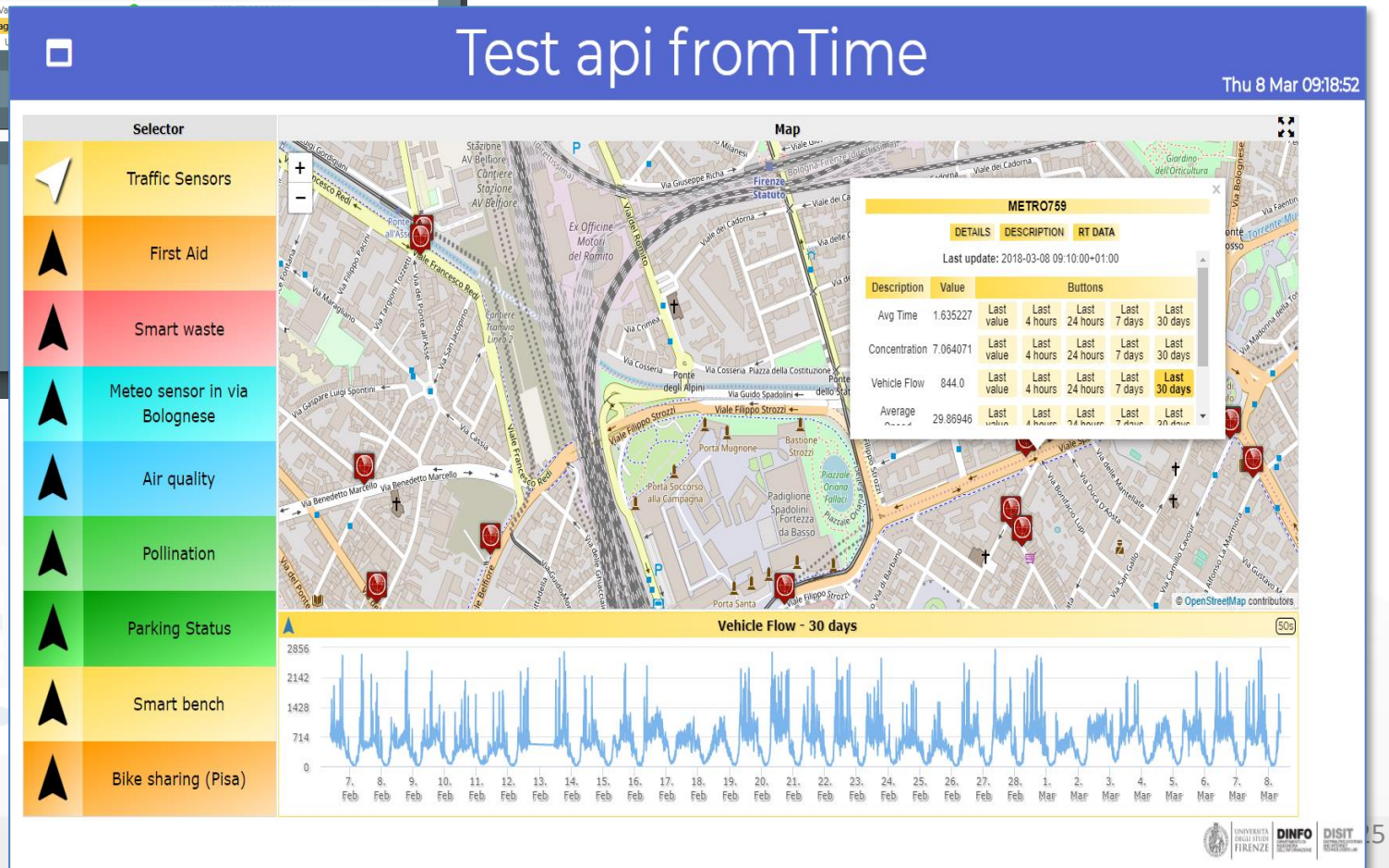
Dashboard Editor

Public
Dashboard
Collection

My Own Dash/App

Dashboard Wizard

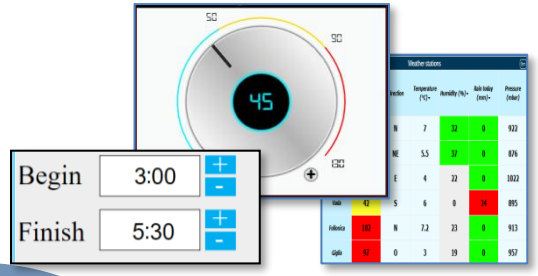


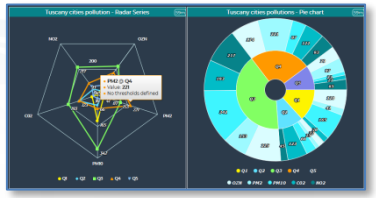


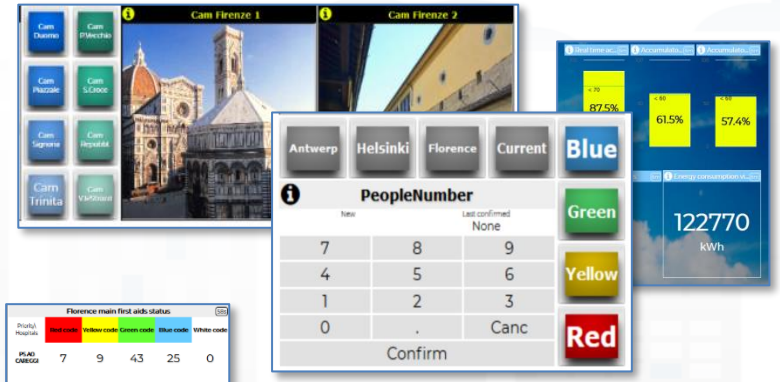
The Wizard help you in selecting only possible combination of data vs graphic representation

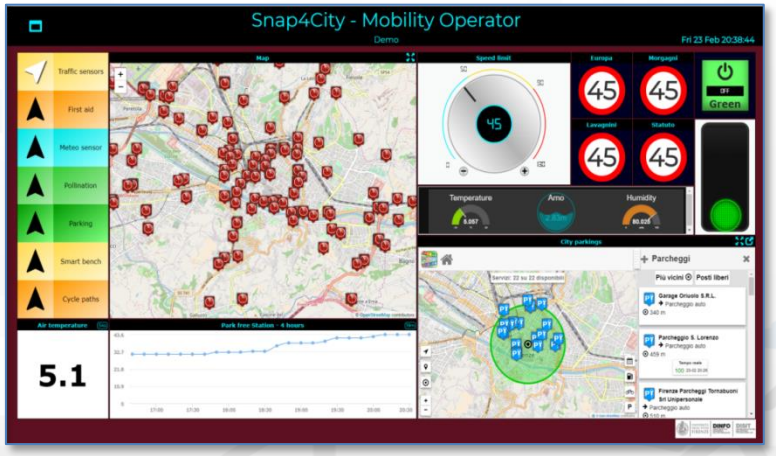
- Select the area of your interest: panning and zooming
- Select the
  - graphic aspect of your interest, or
  - High Level Type of your interest, or
  - Make a search if you a have a precise idea or
  - Act on filters: nature, subnature, type, name, value, date, health, owner, …
  - Combine them as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

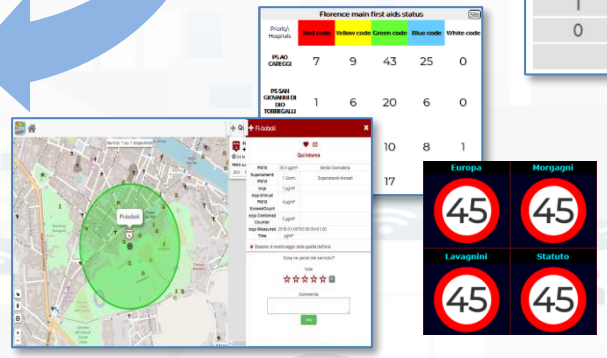
Dashboard Widgets: List and Editor

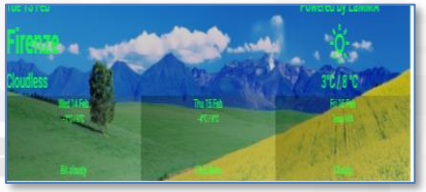


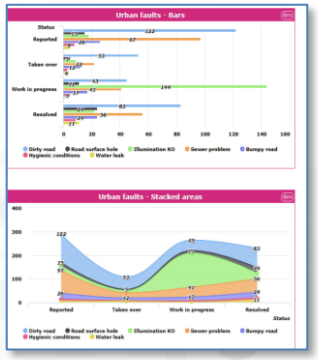






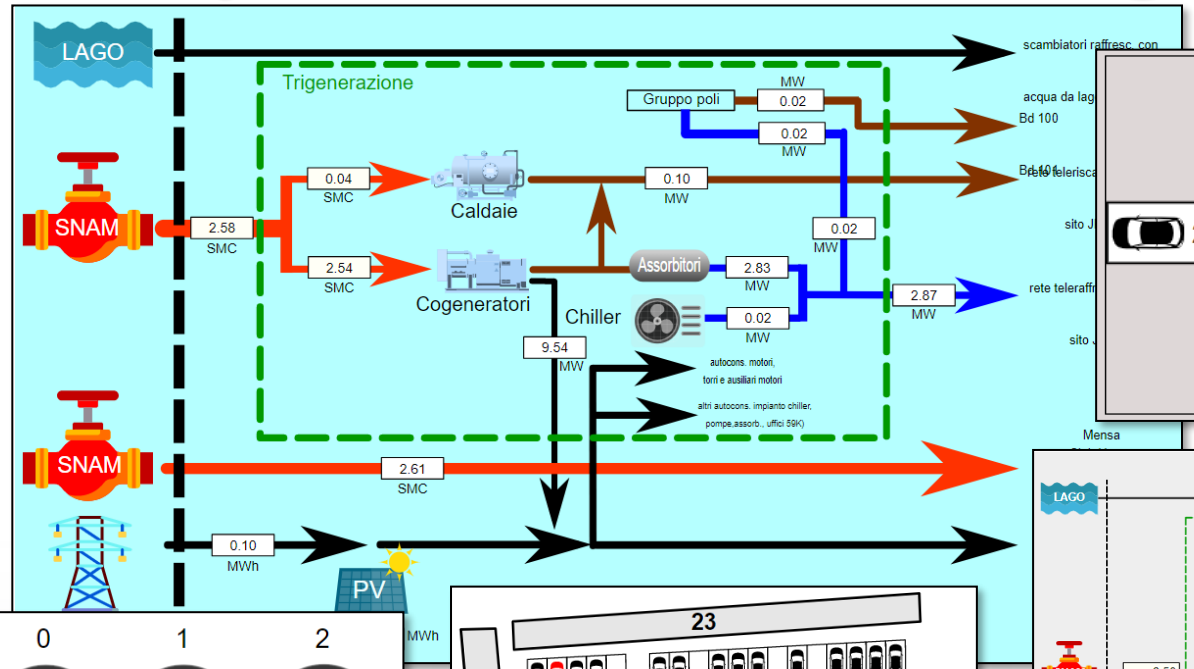


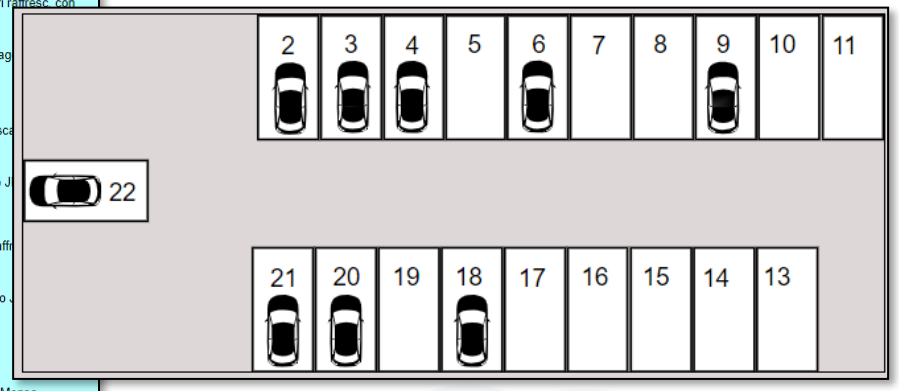


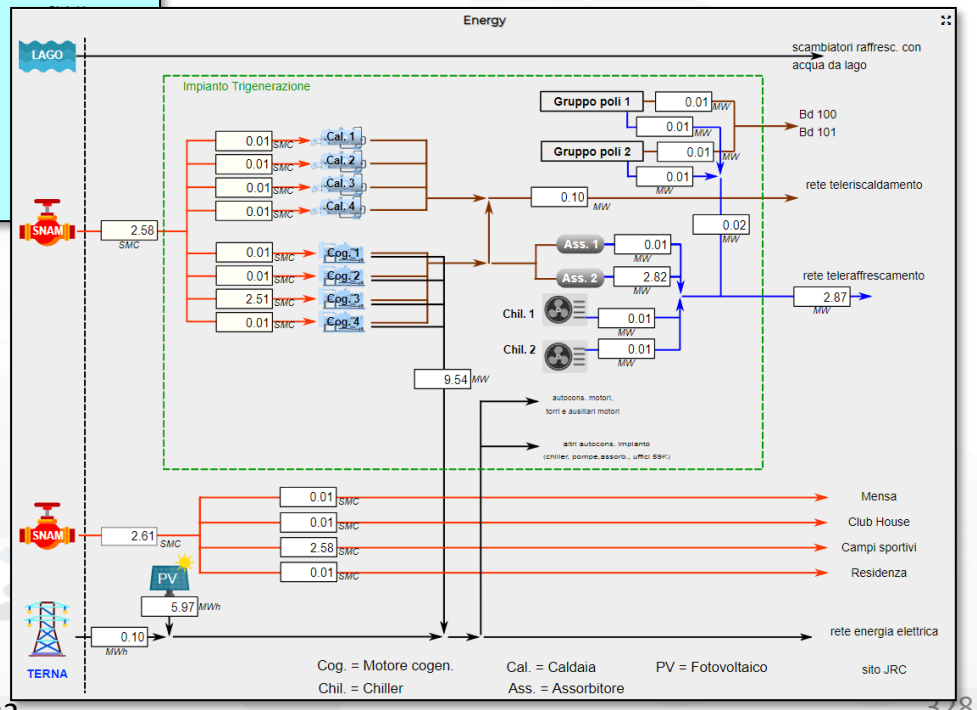


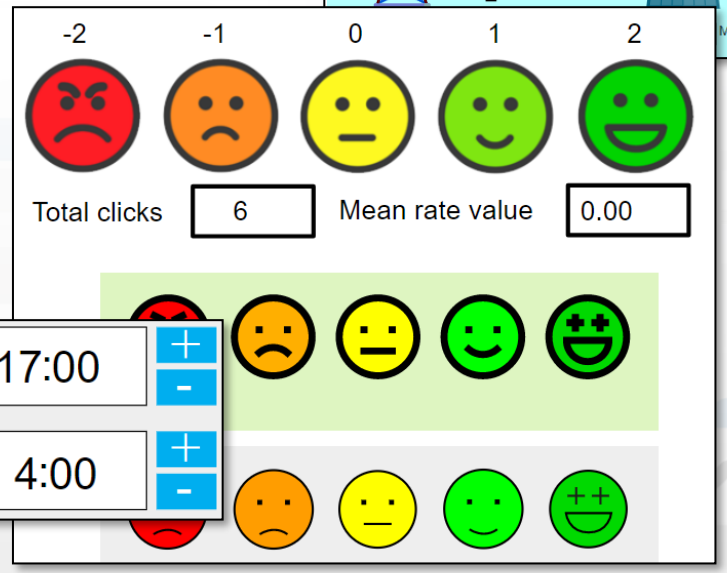
Special Custom Widgets

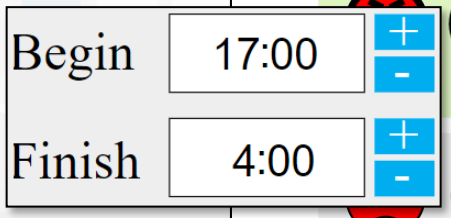
- Smart parking
- Smart Energy
- Smart Light
- Smart ….
- Energy View
- Custom Controls

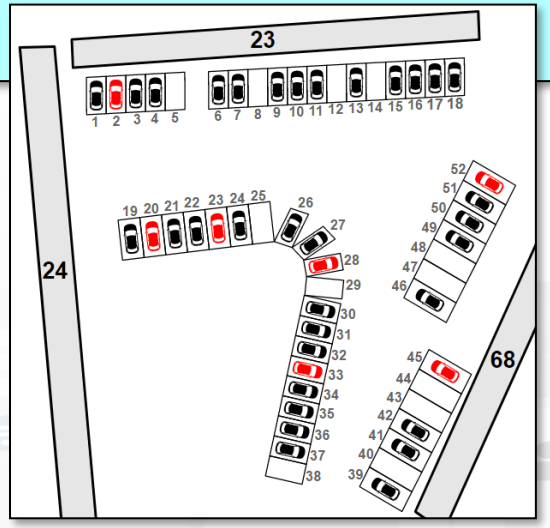




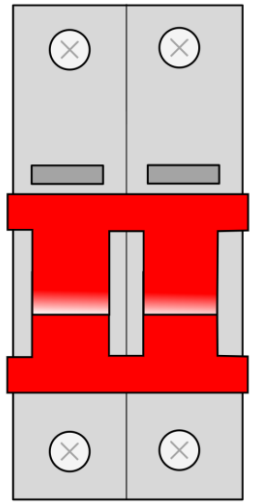




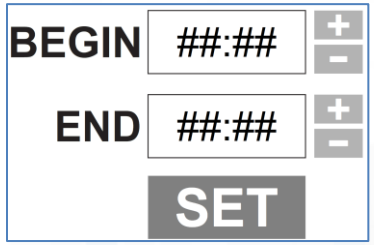


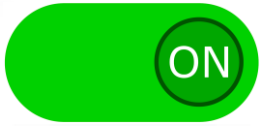


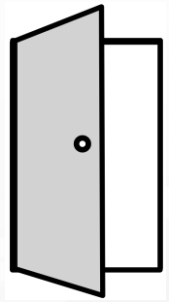
Other examples

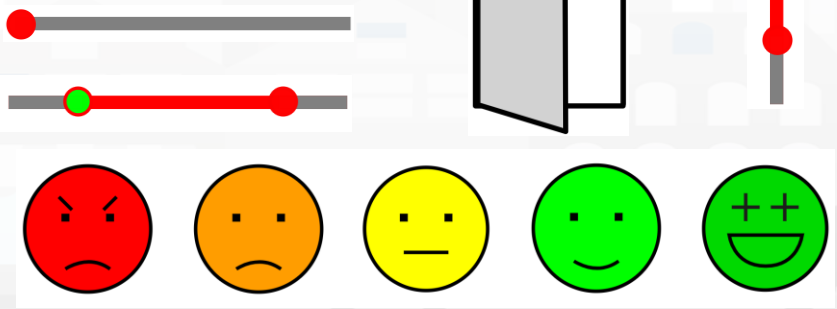


- **Virtual Actuators (sensor-actuator)**
  - From: Dashboard
  - To: IOT App, MyKPI, other Synoptics

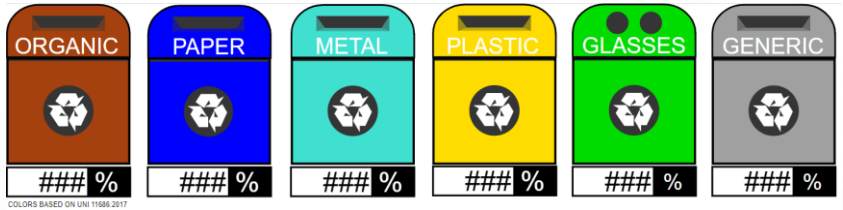


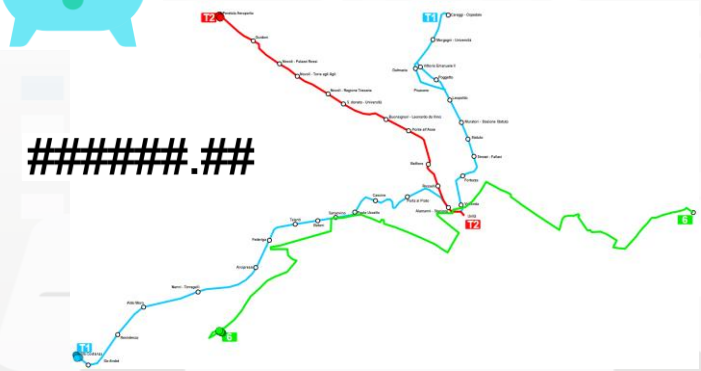


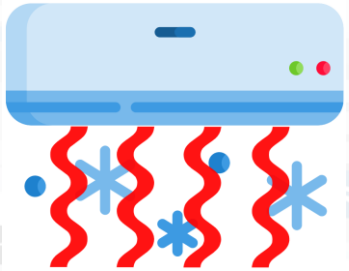




- **Virtual Sensors**
  - From: MyKPI, Sensors, IOT App, other Synoptics
  - To: Dashboards

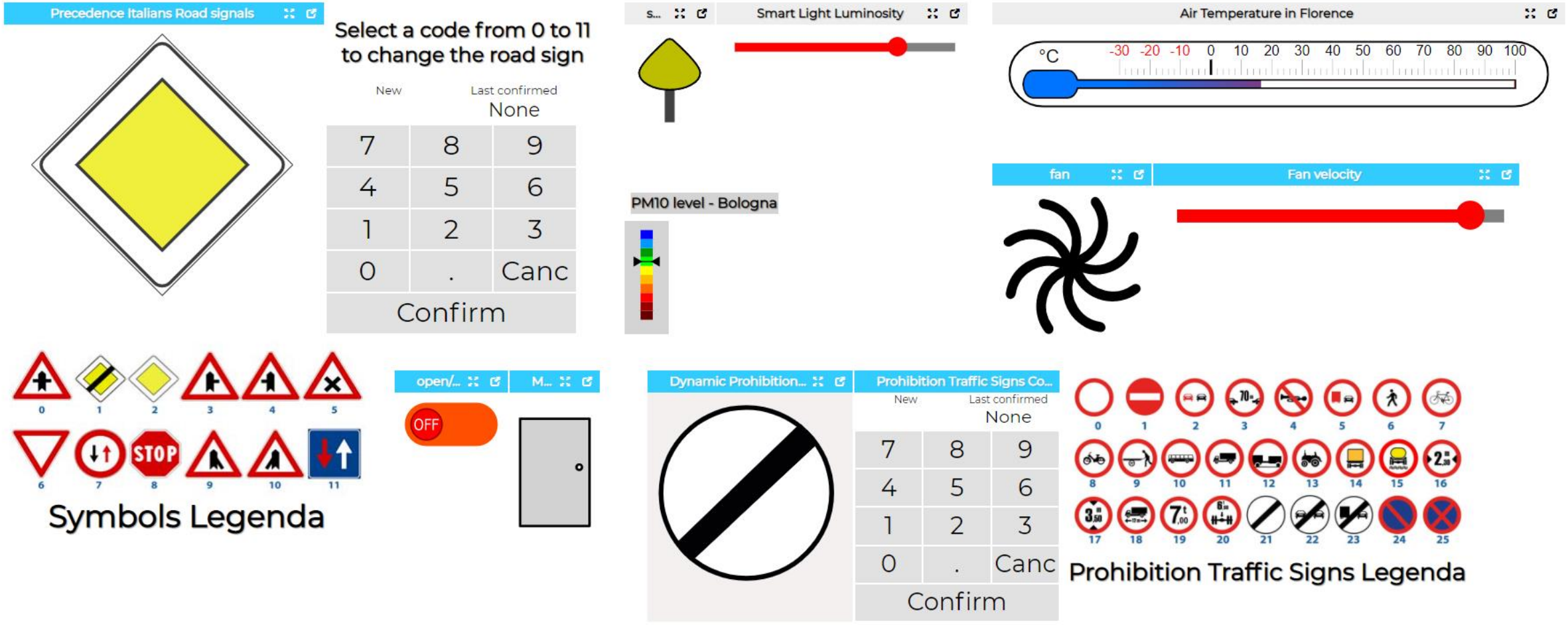






SVG Custom Widgets Examples

Sat 16 Jan 01:07:39



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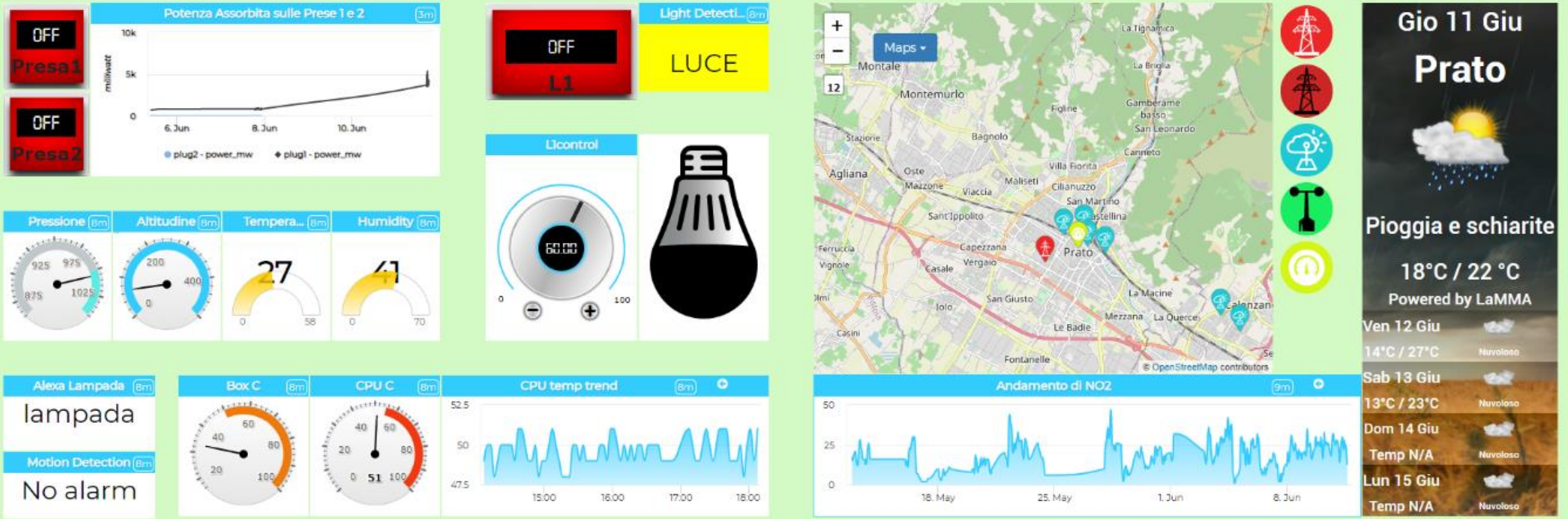
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjk0NQ==

Snap4Home 5G Demo

Thu 11 Jun 18:07:32



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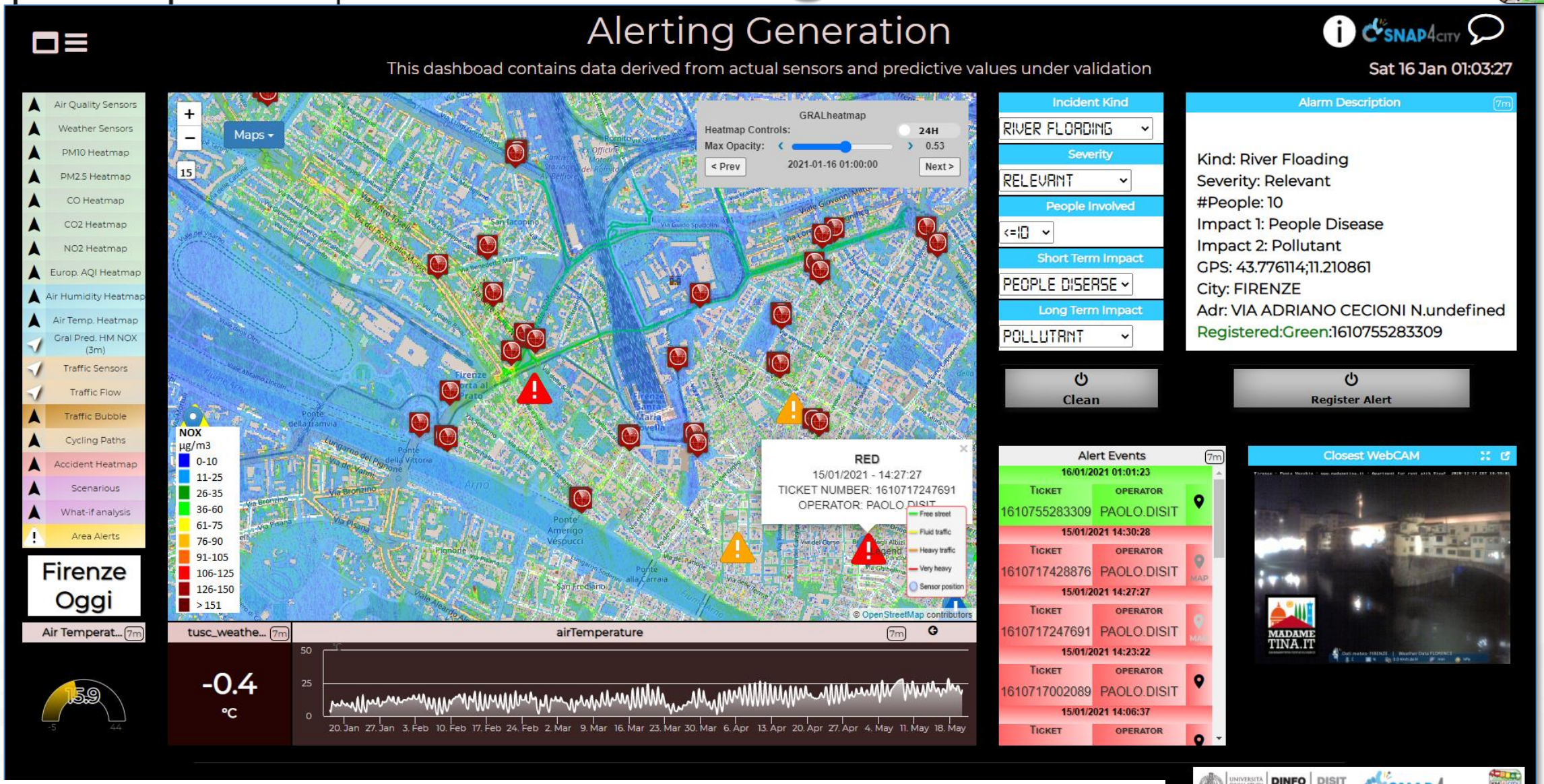
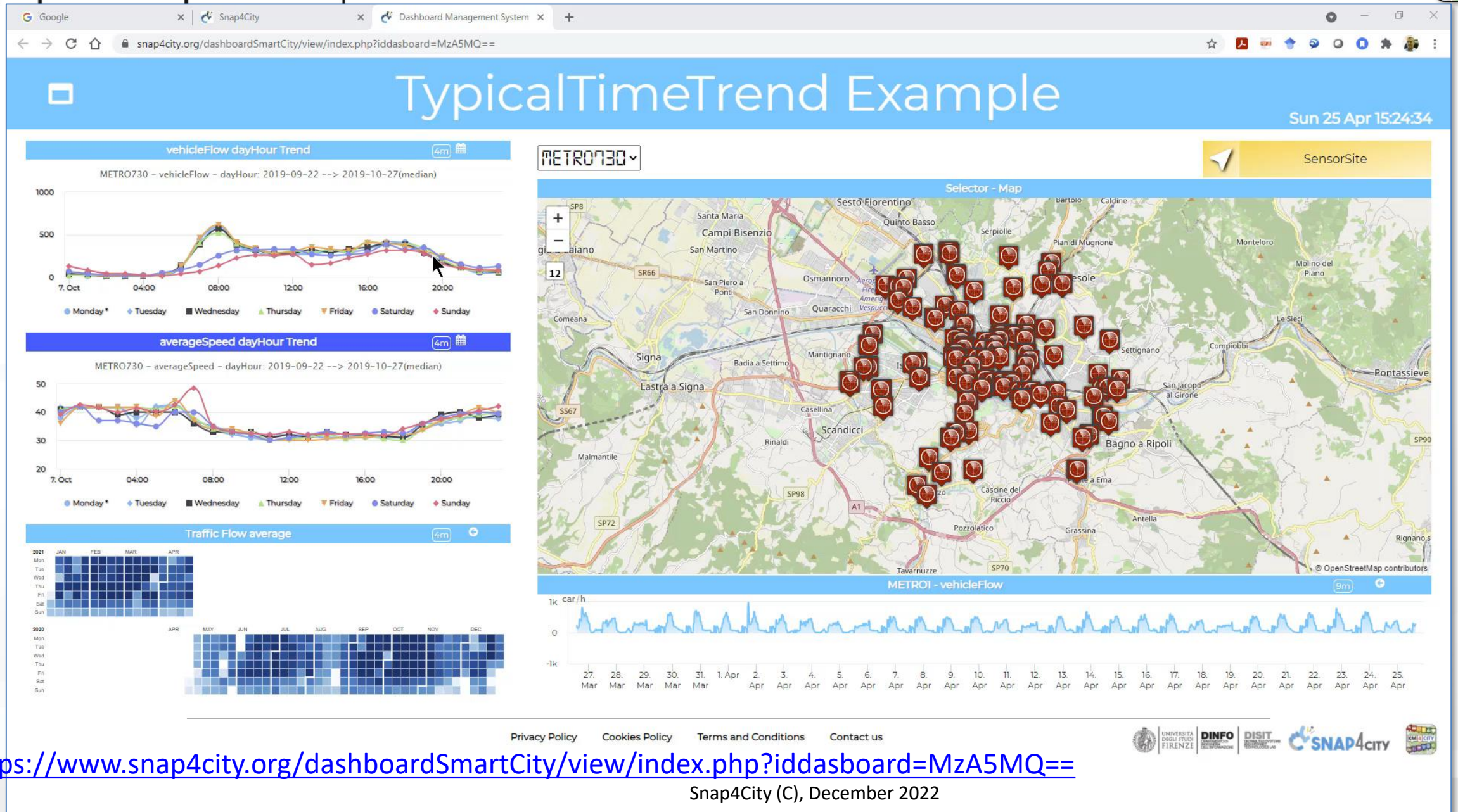
open fiber | WIND | 3 | ZTE | estra

Alert Registration



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

Typical Time Trends



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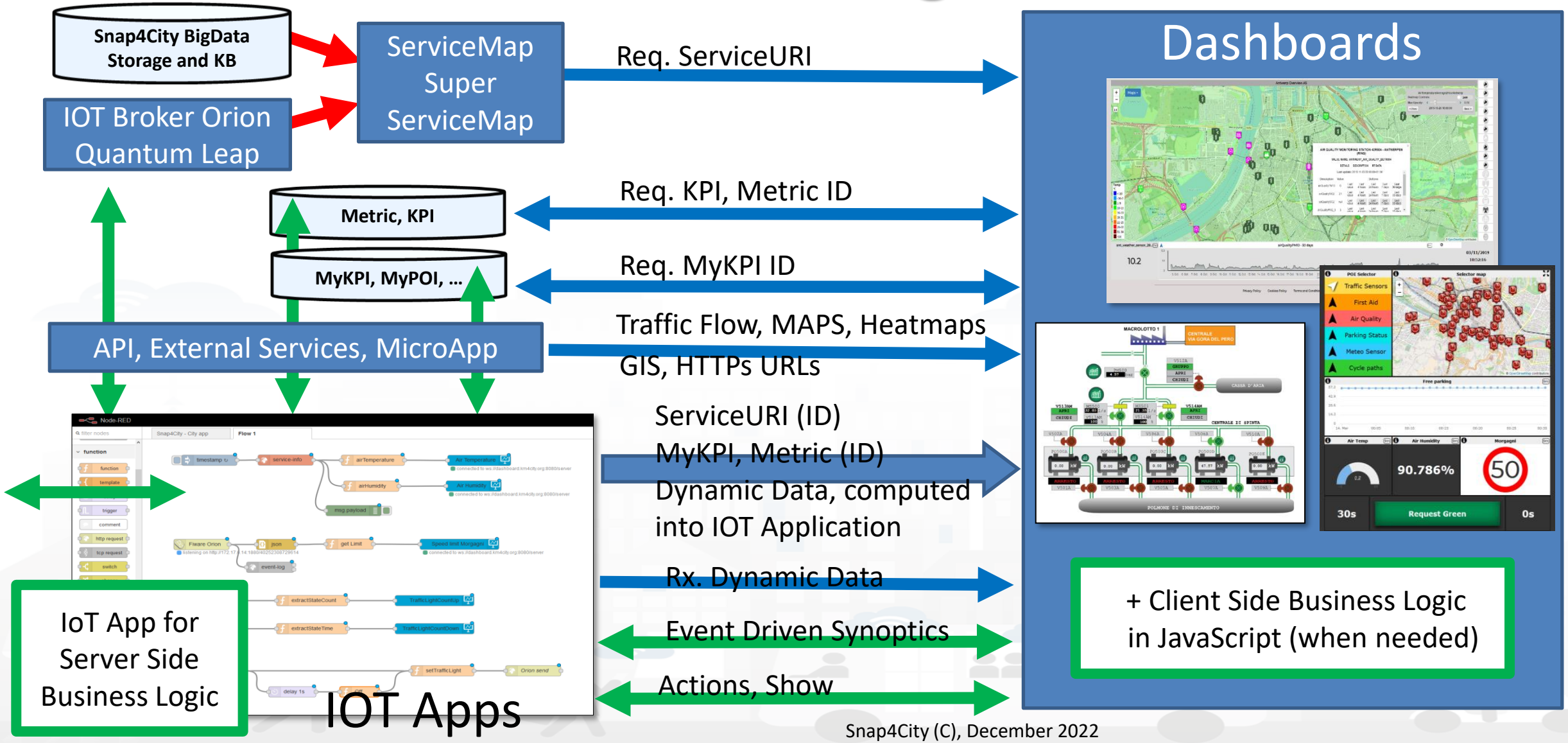
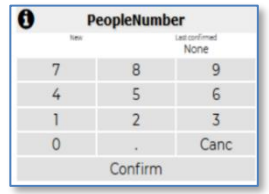
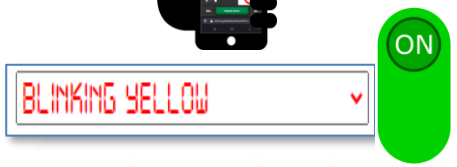
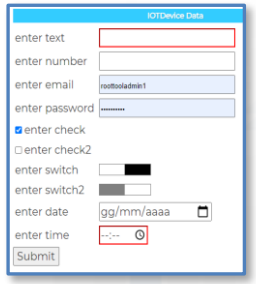
How the Dashboards exchange data

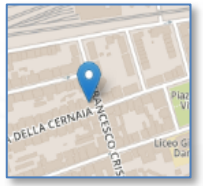


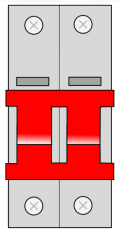
Business Logic on Dashboards

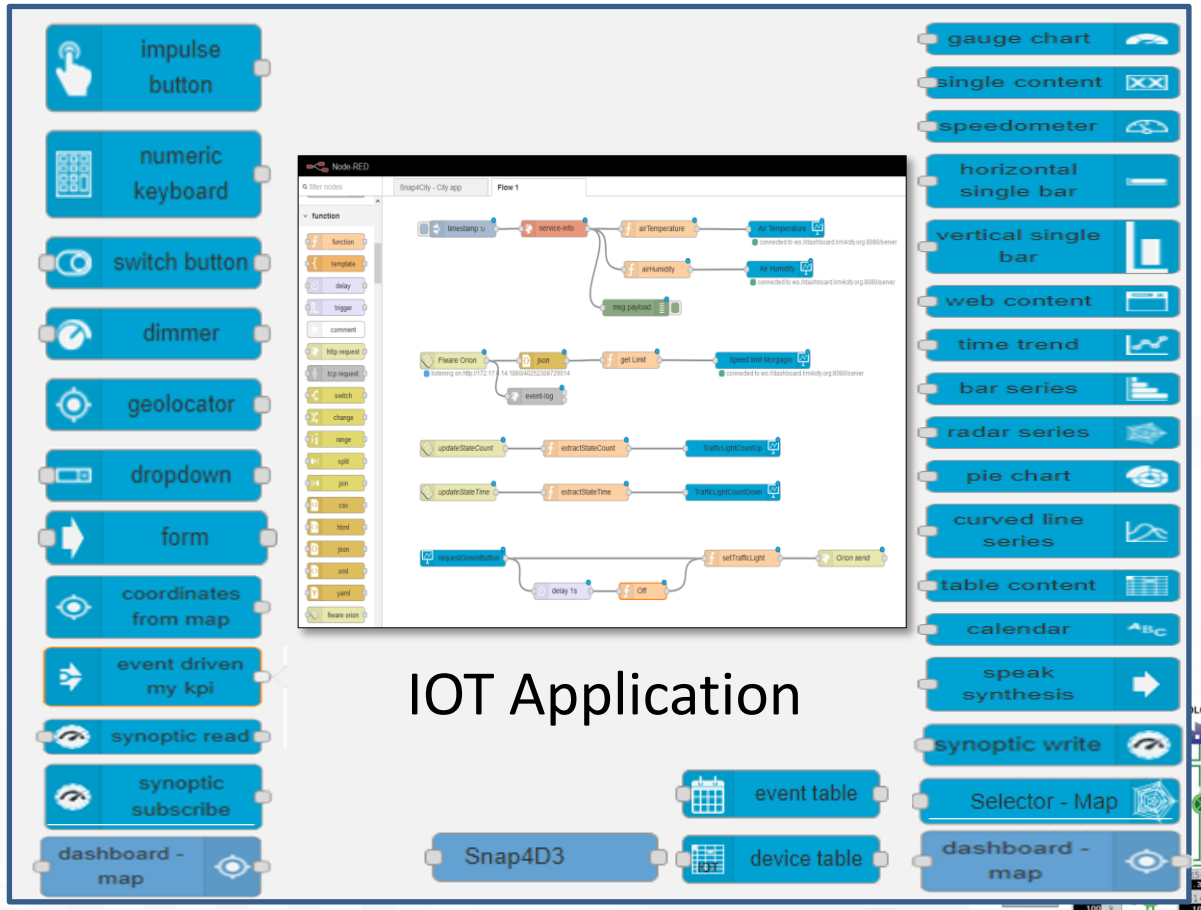


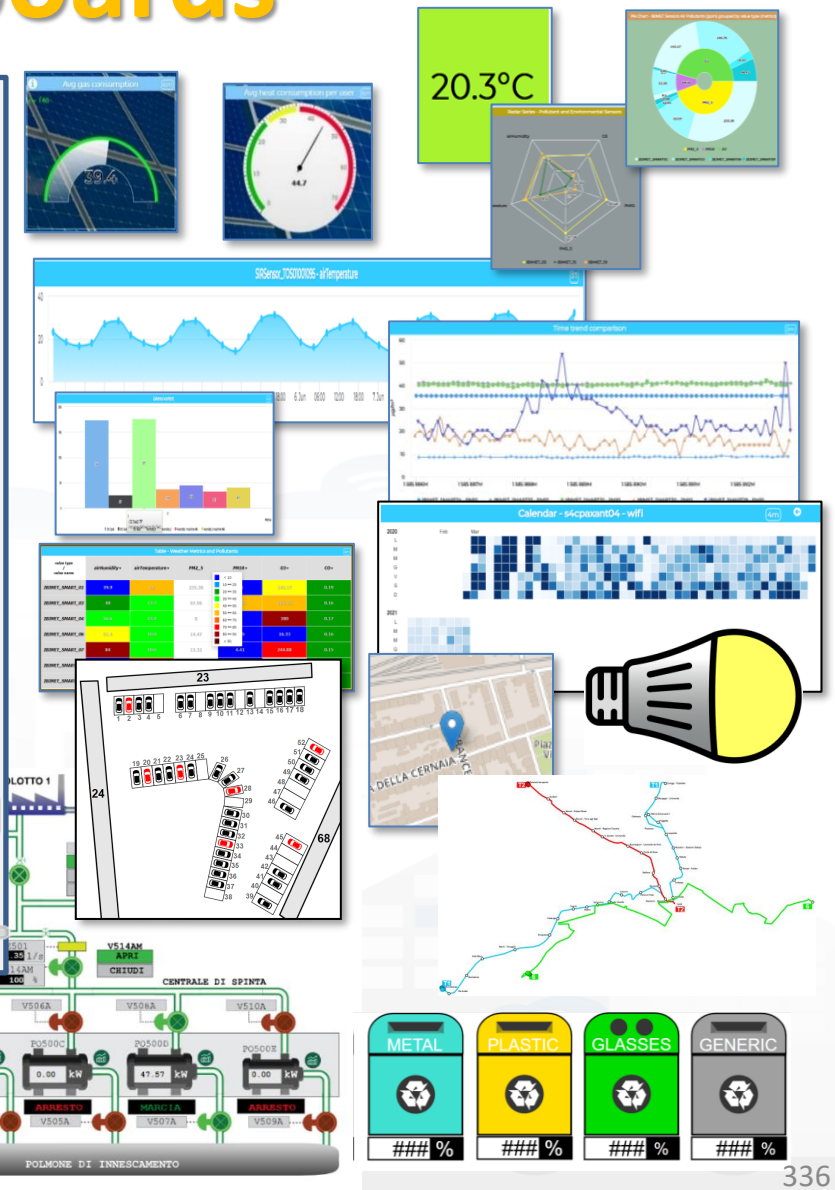












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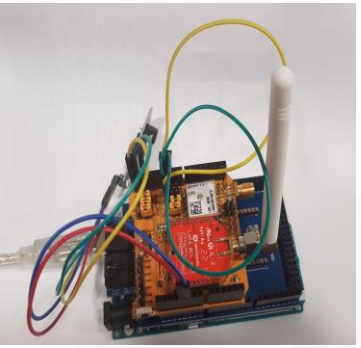
IOT Devices

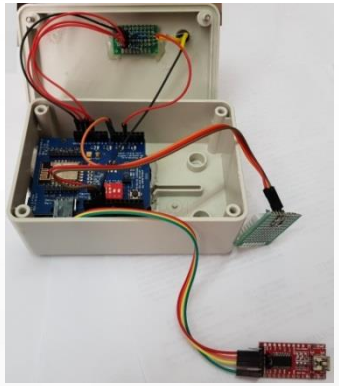
Sensors/
Actuators

IOT Edge Devices

LoraWAN + Arduino + I2C, NGSI



Arduino, Wi-Fi, NGSI

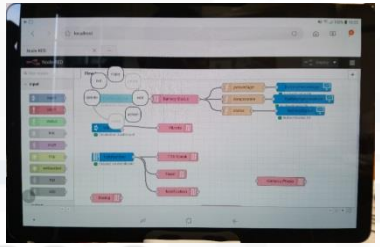


Snap4All IOT Button ESP, NGSI, Wi-FI, BT

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

TOP

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

Snap4City

IOT Applications

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

- Dashboards
- My Dashboards
- Notificator
- IOT Applications
- My Personal Data
- IOT Directory and Devices
- Knowledge and Maps
- Micro Applications
- External Services
- Data Set Manager: Data Gate
- Resource Manager: Process Loader
- Development Tools
- Management
- Settings
- User Management and Auditing
- Help and Contacts
- Documentation and Articles
- My Profile
- Snap4City portal
- Km4City portal
- DISIT Lab portal

Prev 1 2 3 ... 9 Next

Filter

Create new

2018-09-14T04:44
owner: badii
Management

2018-09-21T03:19
owner: panesi
Management

2018-10-19T16:07
owner: pb3
Management

2018-10-19T17:17
owner: pb3
Management

2018-10-22T11:57
owner: semolarudy
Management

application
owner: tester5
Management

Bib APP
owner: semolarudy
Management

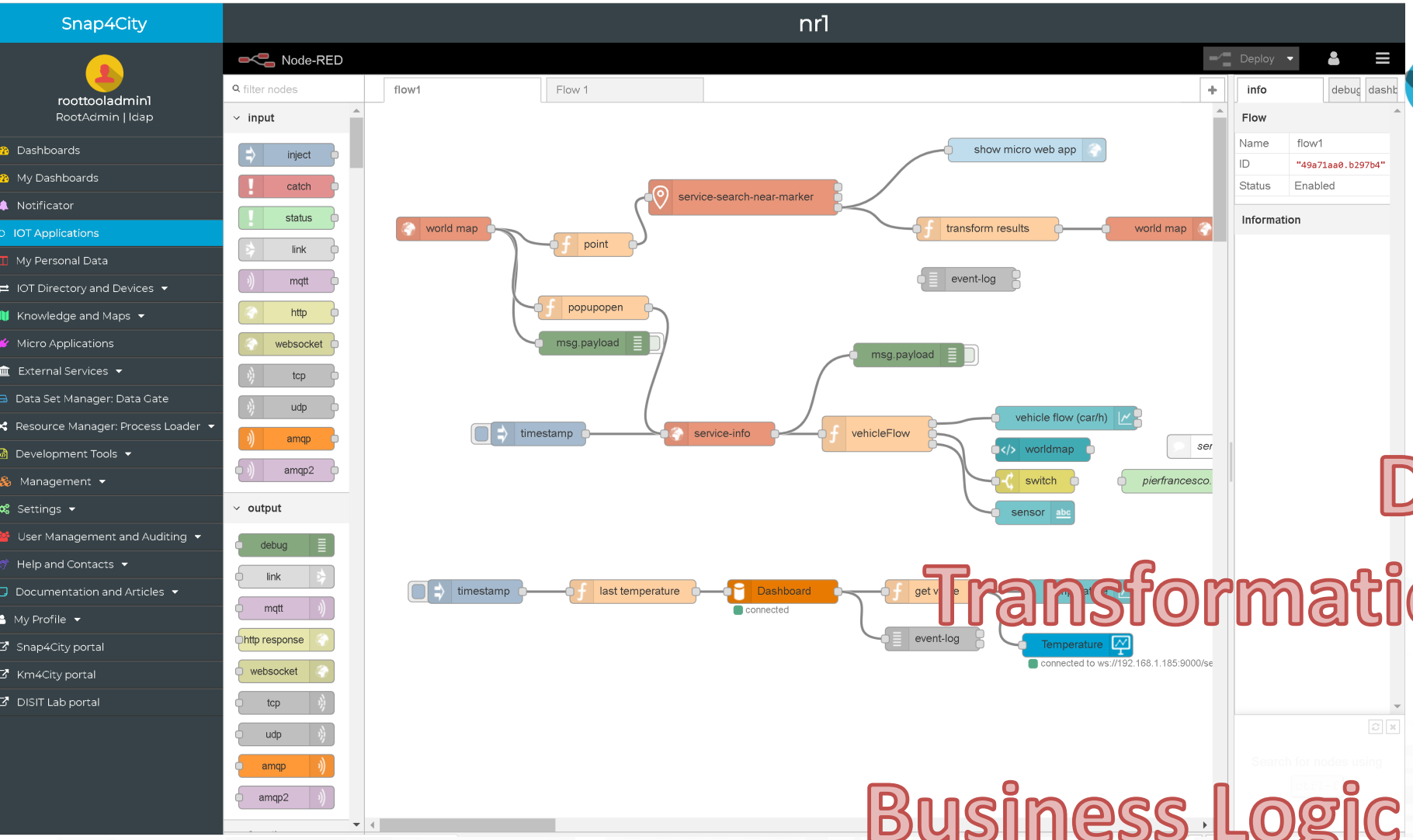
ChargingStations
owner: comunedashres
Management

Deprecated - SiiMobilityControlRoom
owner: badii
Management

SamsungGalaxyS4BarCode
owner: badii
Management

esercitazione
owner: tester2
Management

Iot-App
owner: tester14
Management



Editing IOT Applications

Data Adapation

Transformation, Conversion

Integration

Business Logic vs Dashboards

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.

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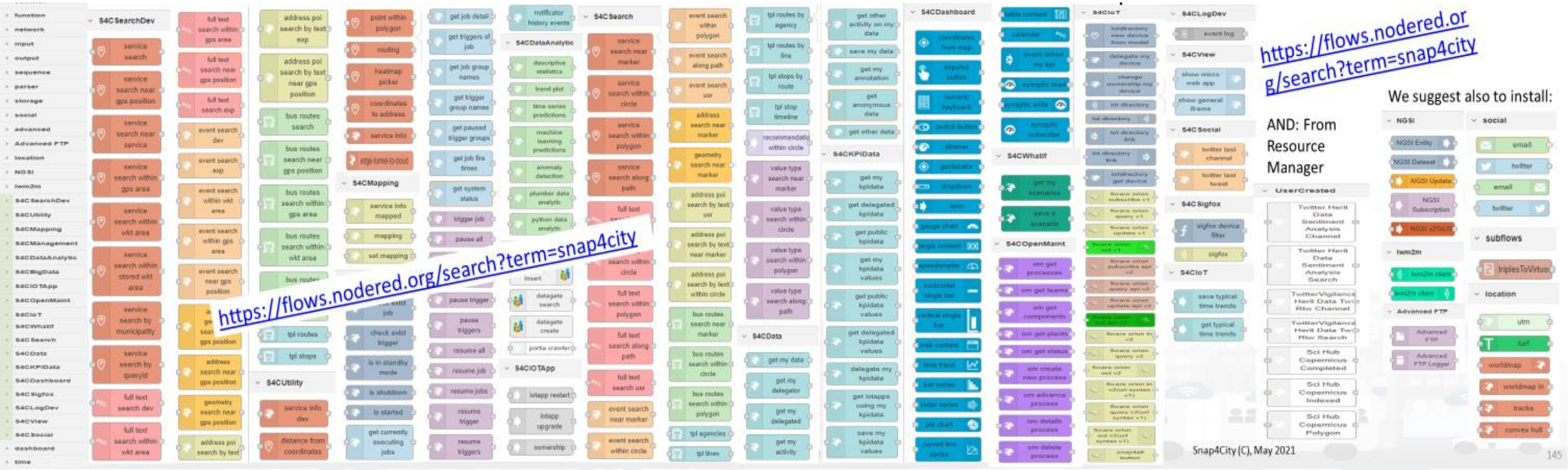
SNAP4CITY KM4CITY

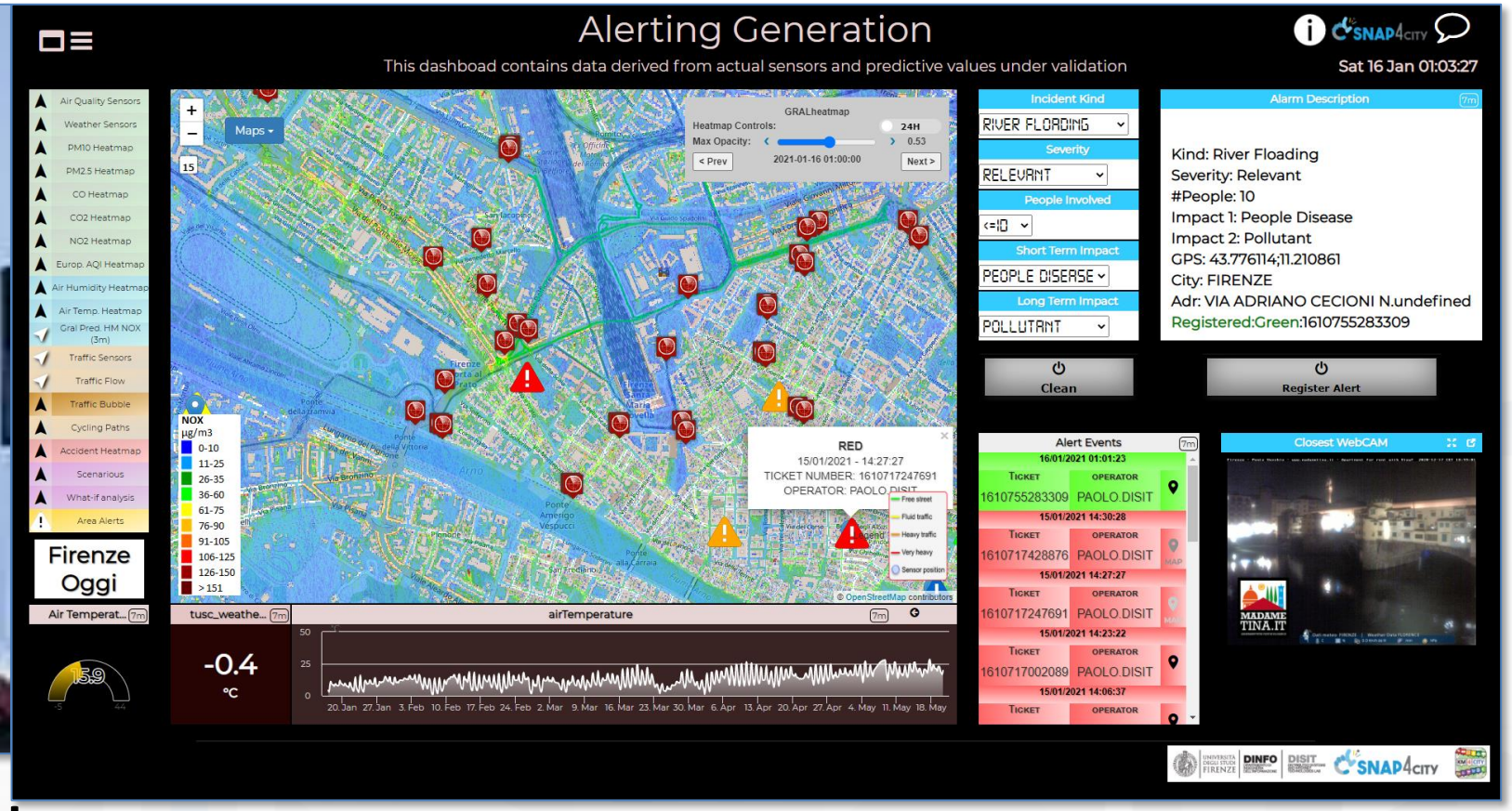
Snap4City Libraries of MicroServices on Node-RED

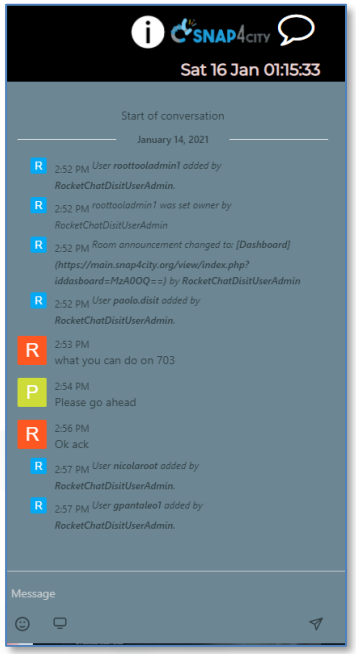
Node-RED



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==

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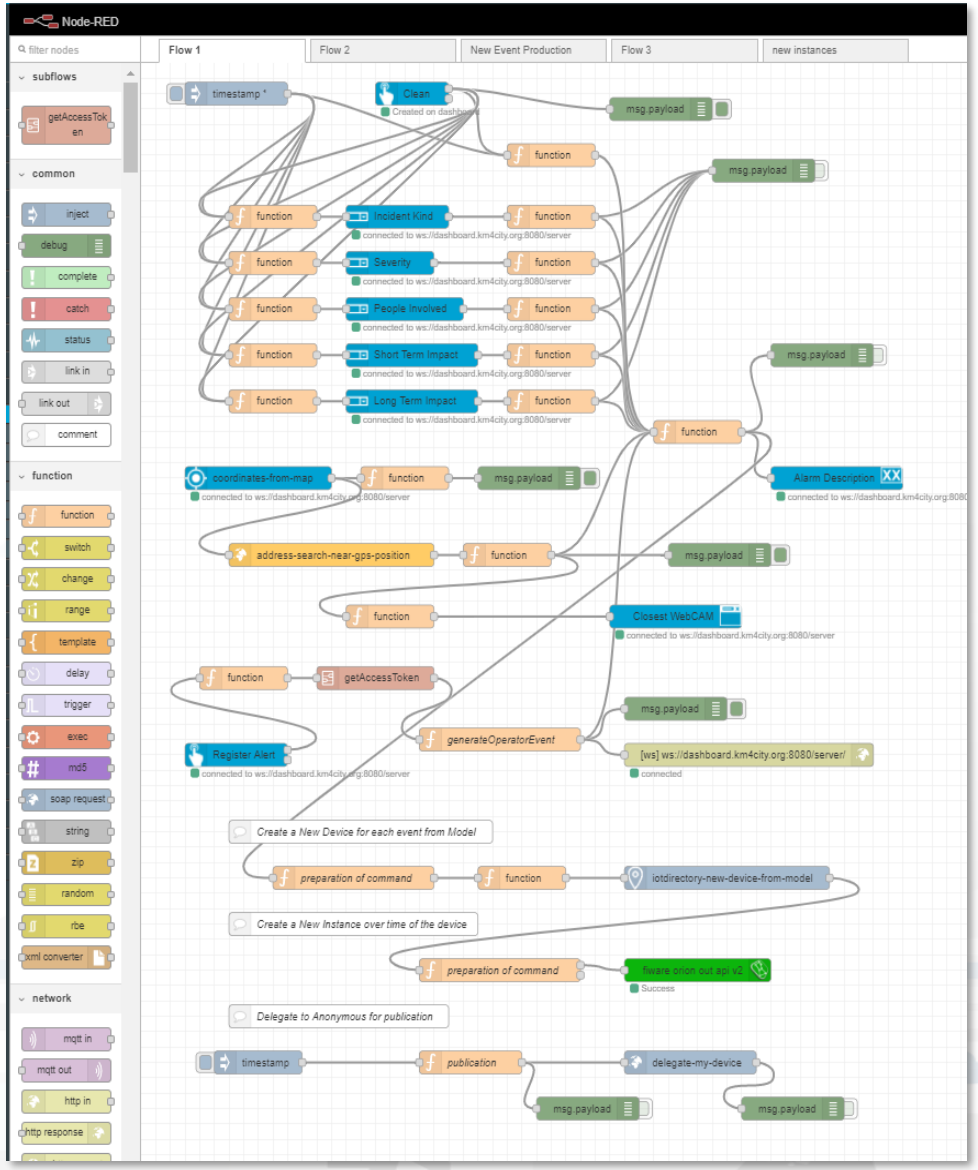
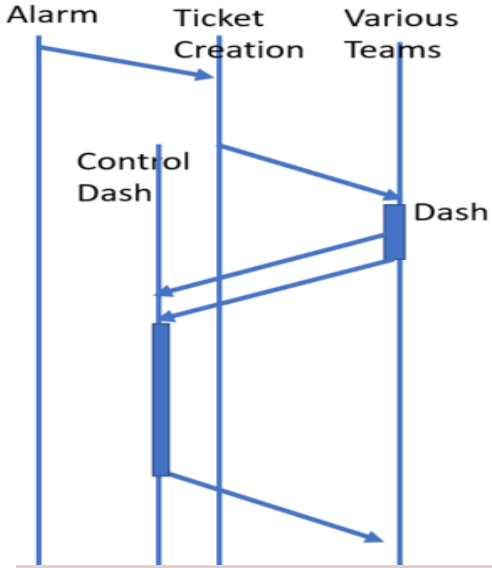
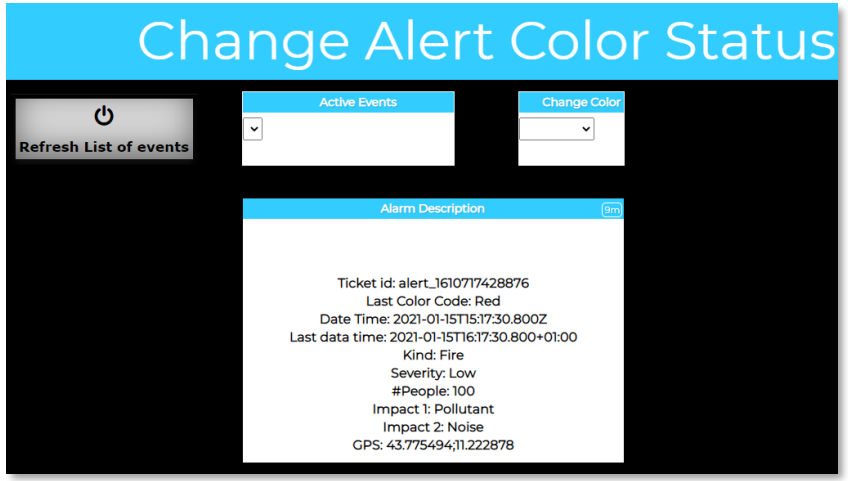
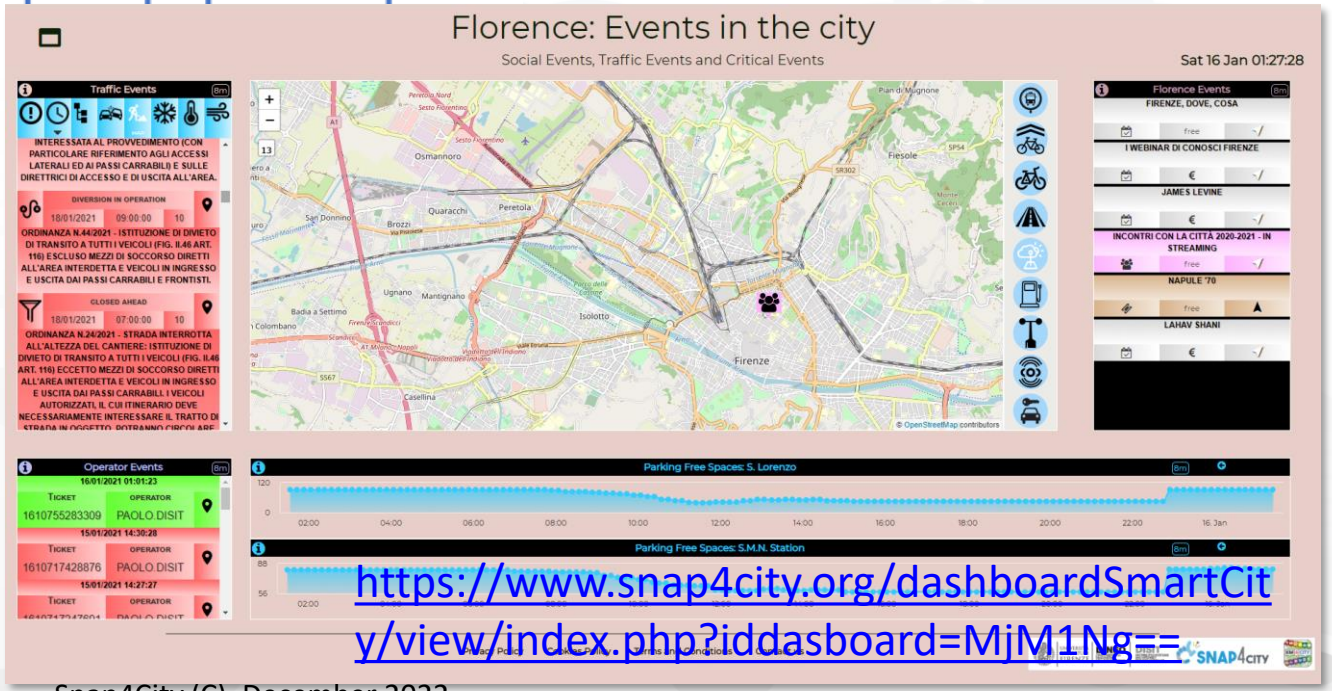
Flow Mng

SNAP4CITY | KM4CITY



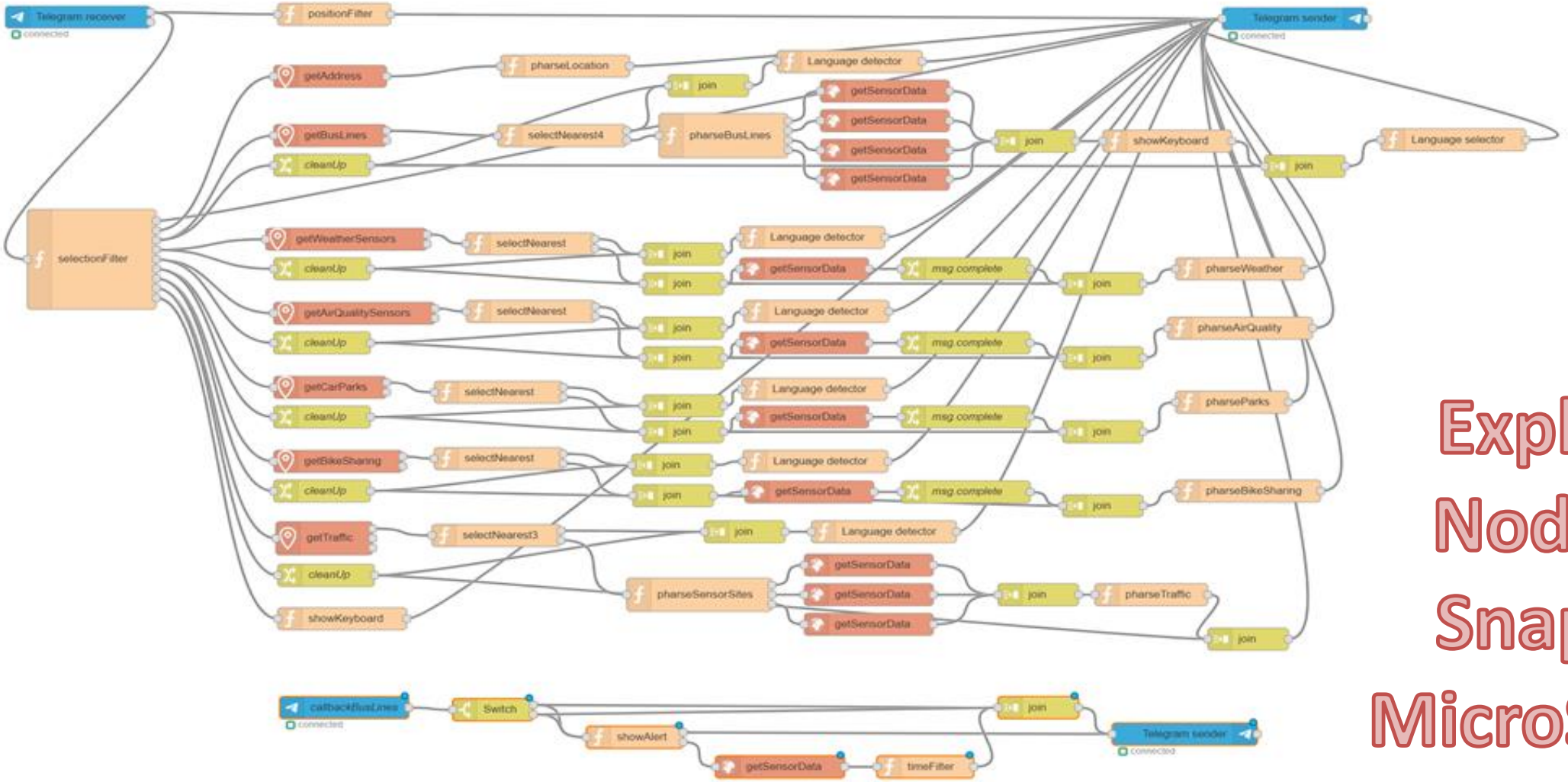


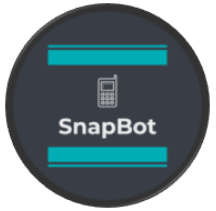




https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjM1Ng==

IOT App of SnapBot: OneShot Services





Exploiting Node-RED Snap4City MicroServices

TOP

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

Big Data Store Facility

Smart City API from Knowledge Base and other tools

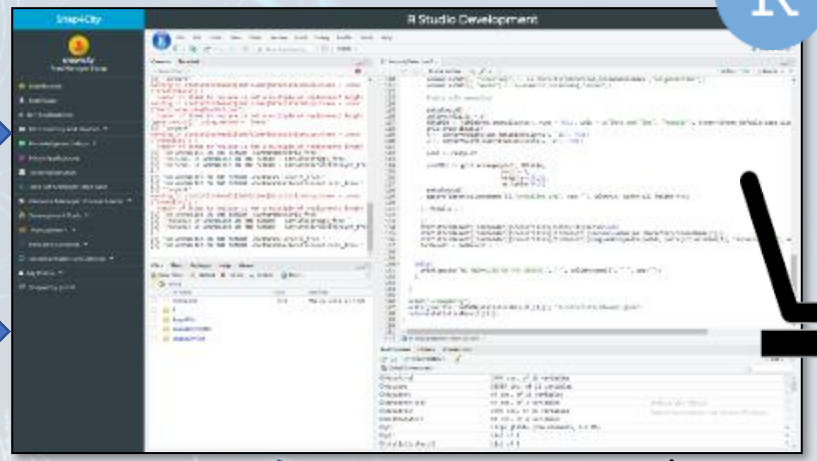
TensorFlow

NVIDIA CUDA

python

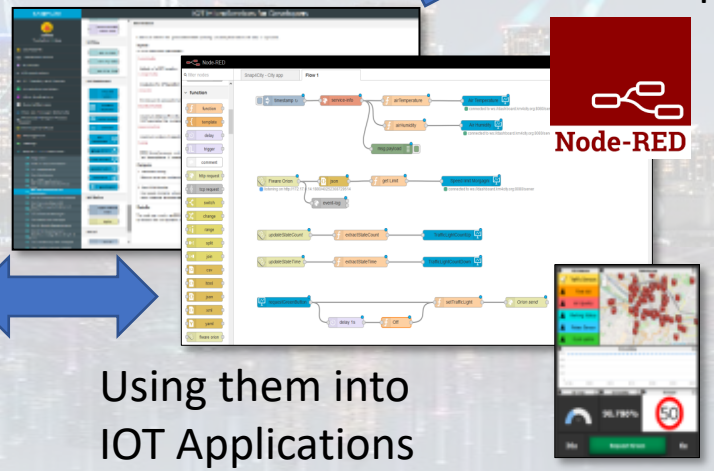
jupyter

R Studio



Creating MicroServices

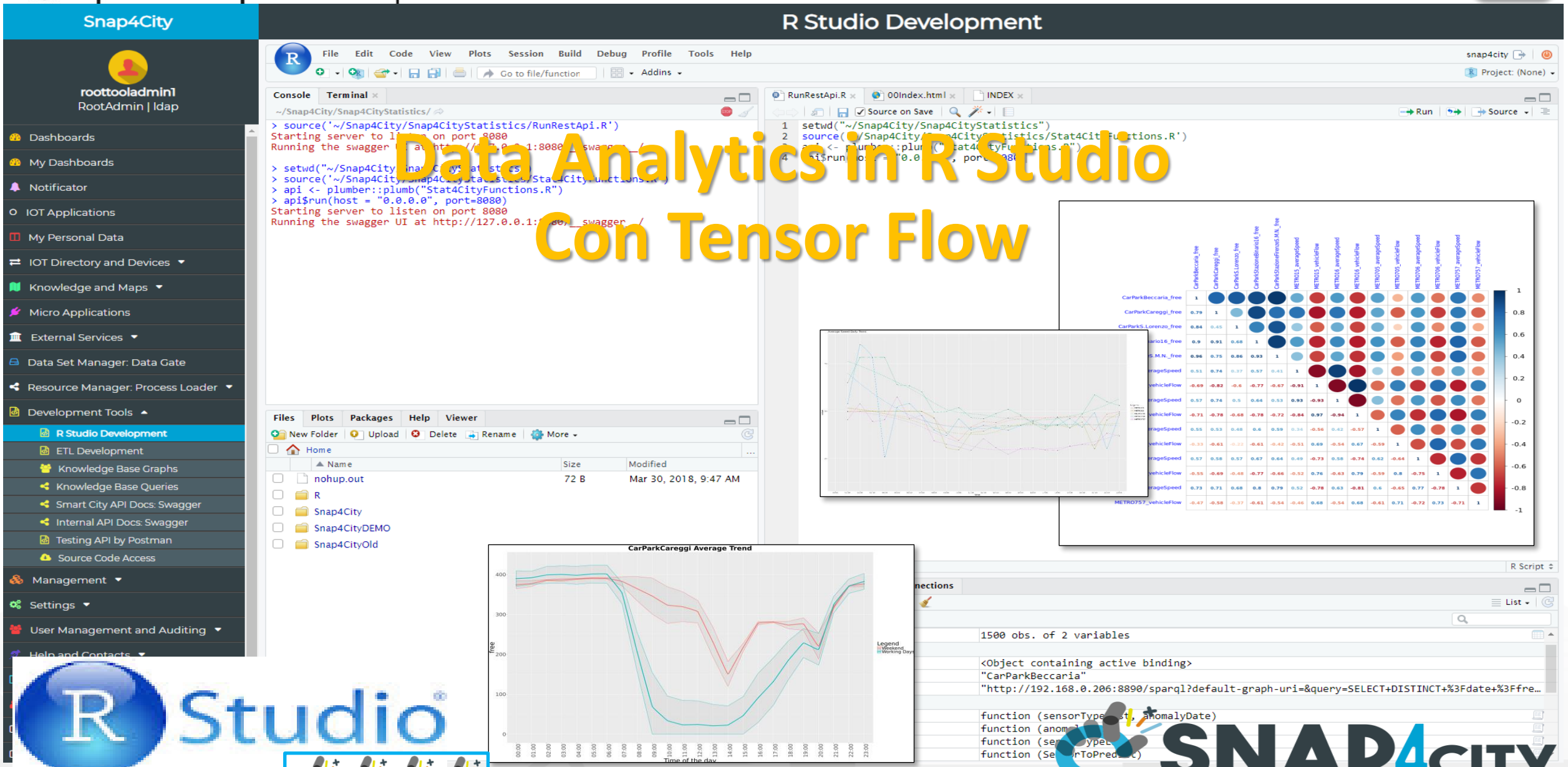
Saving / Sharing reusing



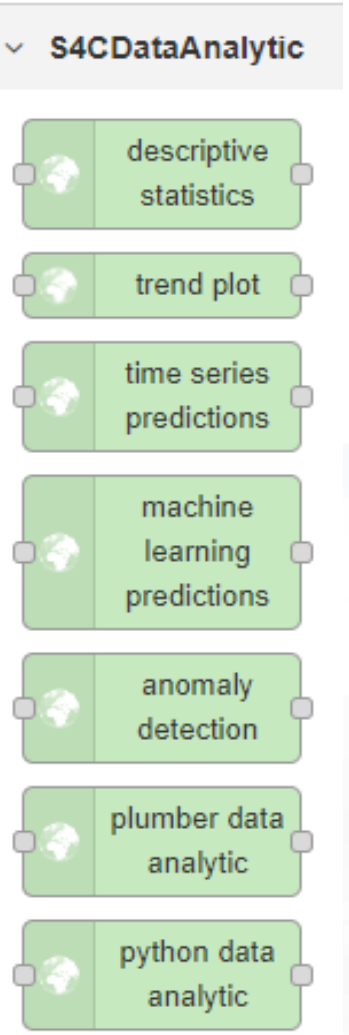
Using them into IOT Applications

Resource Manager

Data Analytics in R Studio Con Tensor Flow

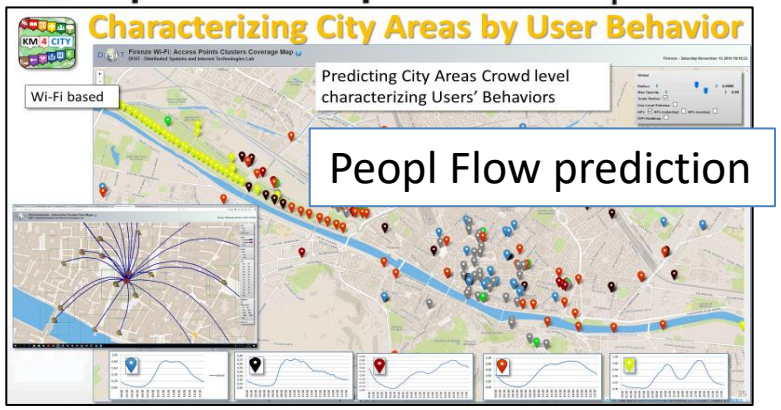


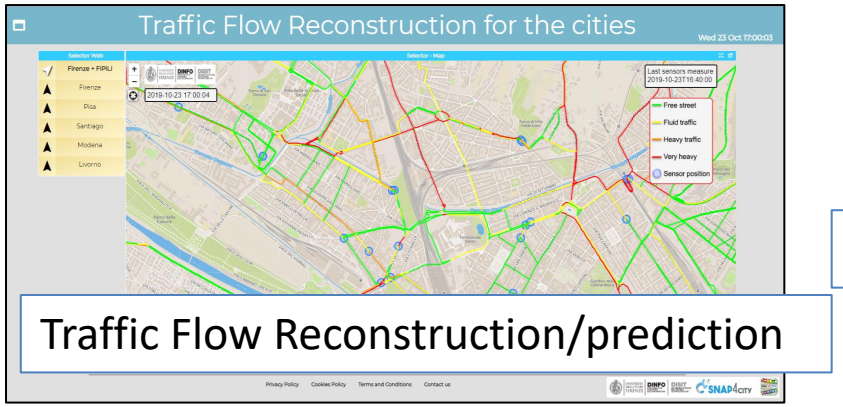
Data Analytics to MicroServices

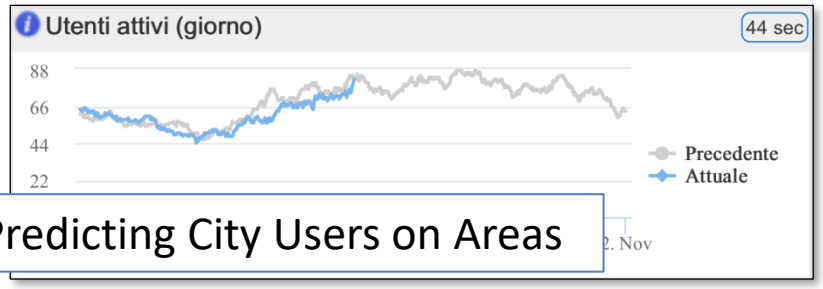


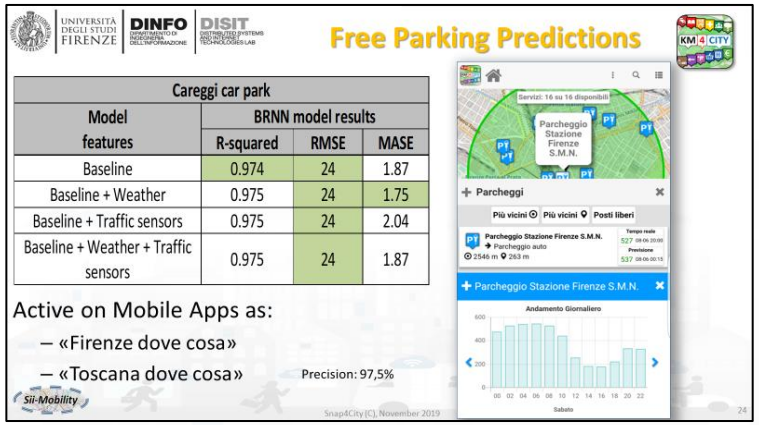
R Studio and Python algorithms are **automatically** transformed into **MicroServices** for your IOT Applications

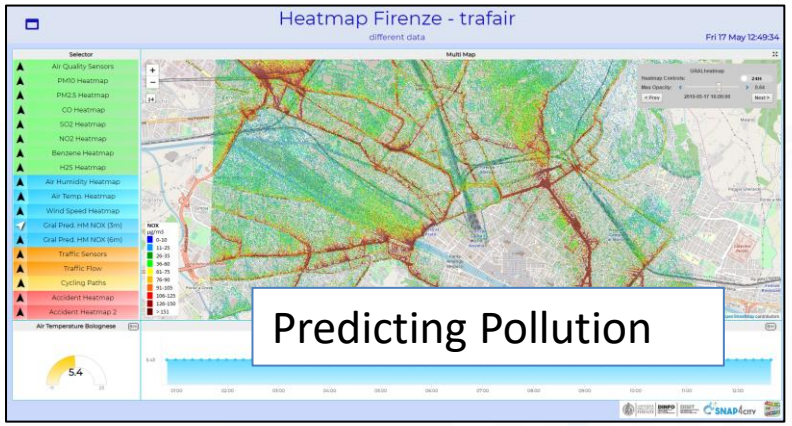
Data Analytics

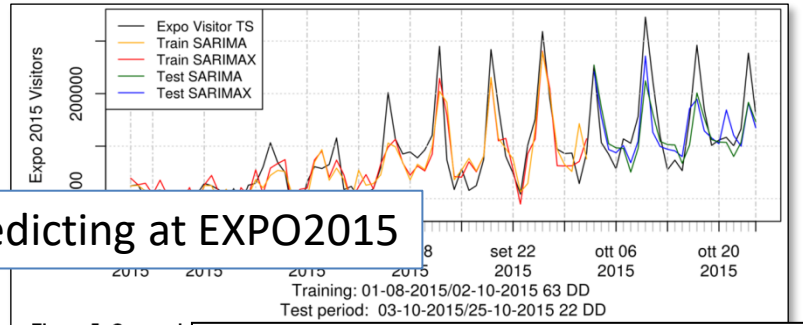


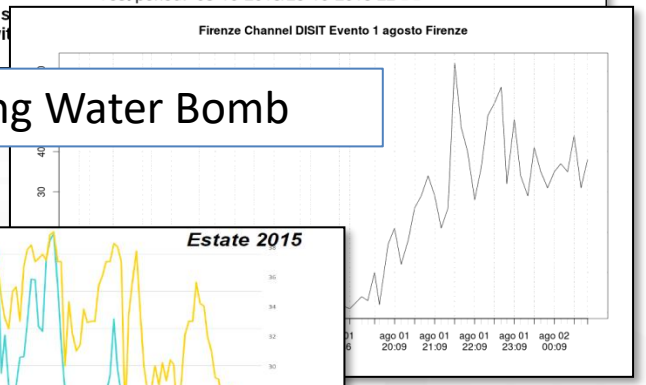


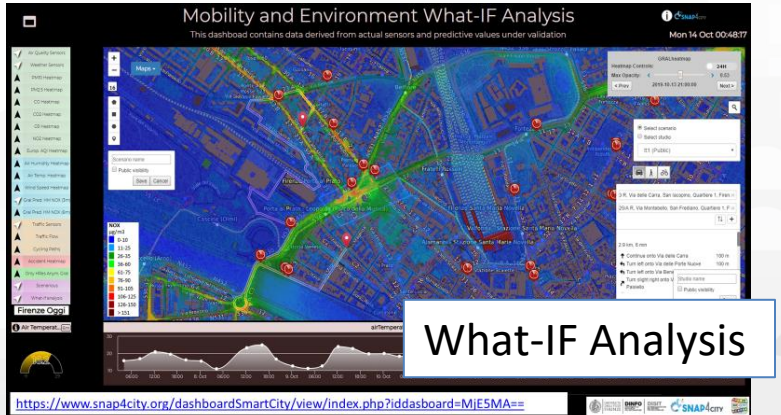


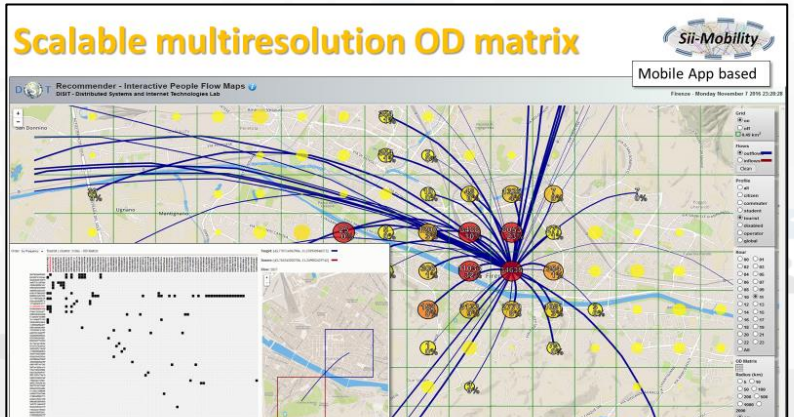


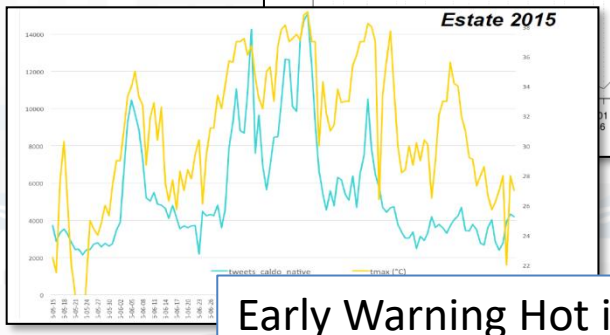












Disappearing Data Analytics

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

TOP

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							
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Video1							
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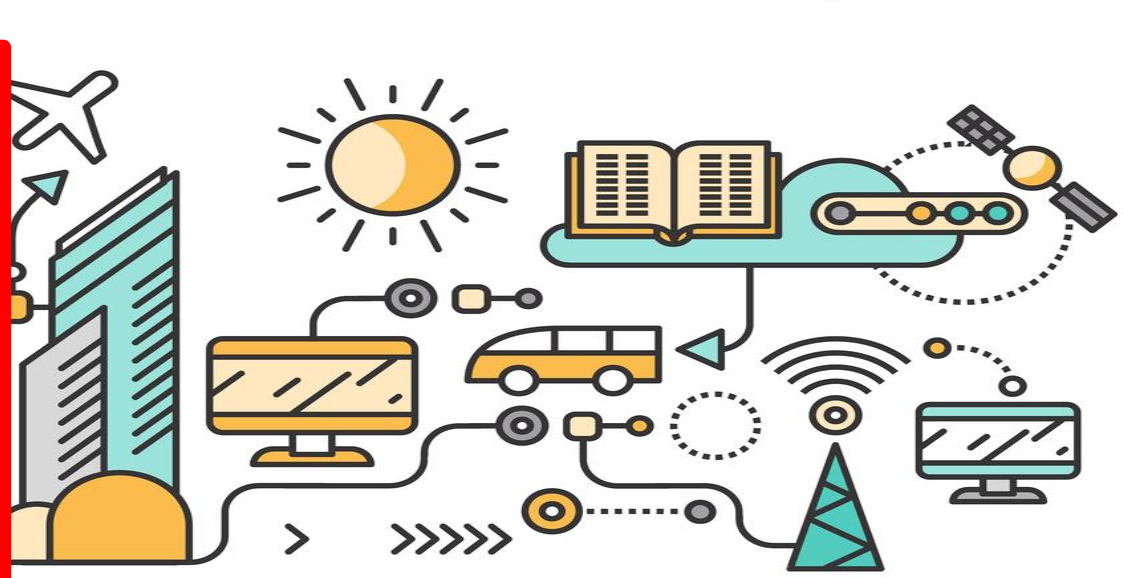
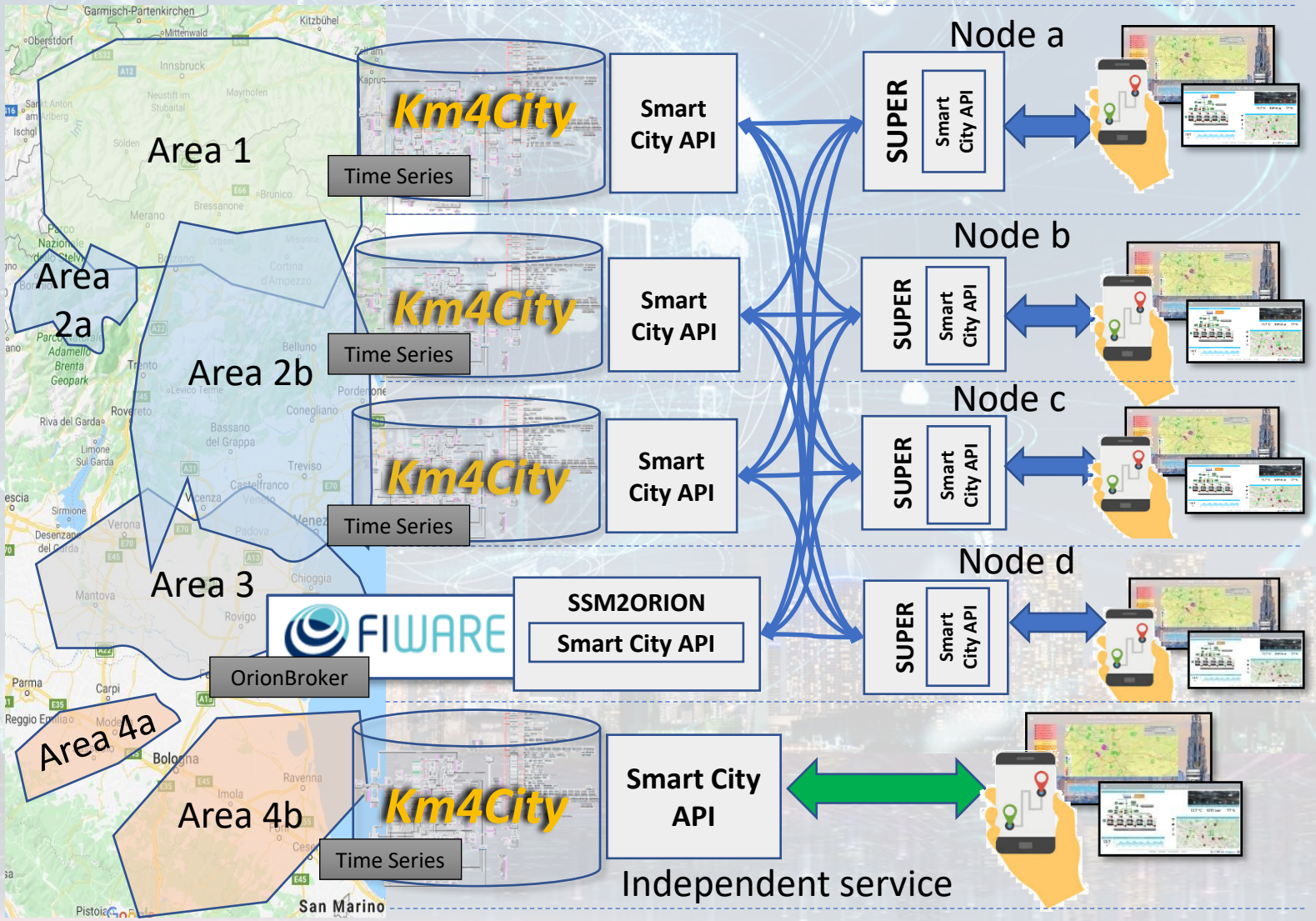


Federation of Smart City Services

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

Snap4City

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

- External Services
- Data Set Manager: Data Gate
- Resource Manager: Process Loader
- Development Tools
  - Web Scraping Tool
  - Web Scraping Tool (On)
  - Web Scraping Tool (6l)
  - R Studio Development
  - R Studio Development 0.11
  - R Studio Development 0.116
  - R Studio Development TF
  - R Studio Development GFF
  - R Studio Development Gral
  - MicroServices from DataAnalytic
  - ETL Development
  - ETL Development 1
  - ETL Development 2
  - Knowledge Base Graphs
  - Knowledge Base Queries
  - Smart City API Docs: Swagger
  - Internal API Docs: Swagger
  - Testing API by Postman
  - Source Code Access
- Management
- Settings
- User Management and Auditing
- Help and Contacts
- Documentation and Articles
- My Profile

Smart City API Docs: Swagger

swagger

Select a spec: Advanced Smart City API
- Advanced Smart City API
- Km4city Web App API
- Orion Broker K1-K2 Authentication API
- Heatmap API

Advanced Smart City API 1.0.0 OAS3

https://www.km4city.org/swagger/external/ascapi-openapiv3.json

SMART CITY API WEB DOCUMENTATION

Servers: https://servicemap.disit.org/WebAppGrafo/api/v1

Services

GET / Service discovery and information

Events

GET /events/ Event search

Locations

GET /location/ Address and geometry search by GPS

Public Transport

GET /tpl/agencies/ Agency list

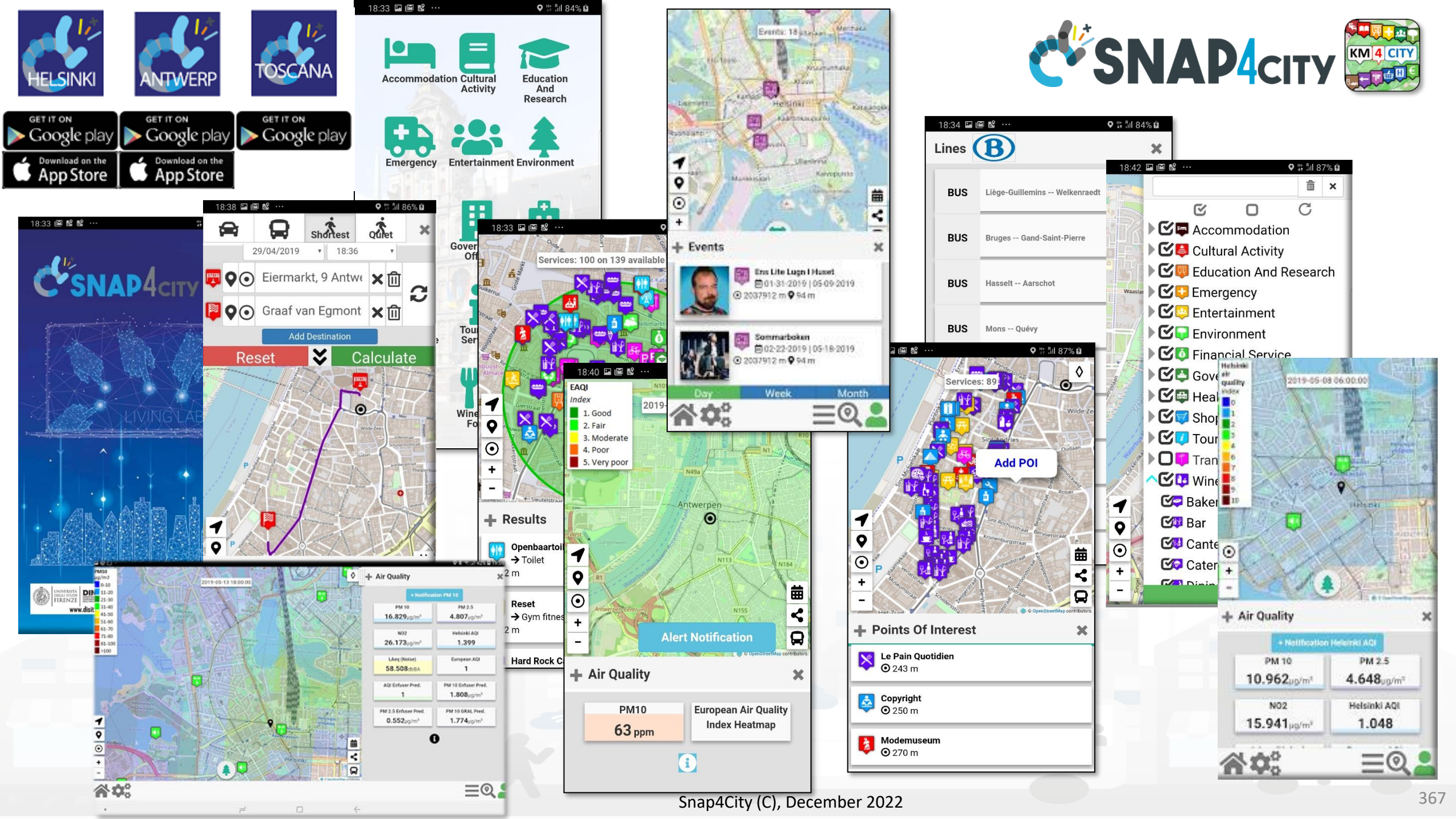
GET /tpl/bus-lines/ (Bus) Lines list

GET /tpl/bus-routes/ (Bus) Routes list

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
KM4CITY
Accommodation
Cultural Activity
Education And Research
Emergency
Entertainment
Environment
Shortest
Quiet
29/04/2019
18:36
Eiermarkt, 9 Antwe
Graaf van Egmont
Add Destination
Reset
Calculate
Services: 100 on 139 available
EAQI
Index
1. Good
2. Fair
3. Moderate
4. Poor
5. Very poor
Results
Openbaartoi
Toilet
Reset
Gym fitnes
Hard Rock C
Antwerpen
Alert Notification
Air Quality
PM10
63 ppm
European Air Quality Index Heatmap
Events
Lines
BUS
Liège-Guillemins -- Welkenraedt
Bruges -- Gand-Saint-Pierre
Hasselt -- Aarschot
Mons -- Quévy
Accommodation
Cultural Activity
Education And Research
Emergency
Entertainment
Environment
Financial Service
Bar
Services: 89
Add POI
Points Of Interest
Le Pain Quotidien
243 m
Copyright
250 m
Modemuseum
270 m
Air Quality
PM 10
16.829
PM 2.5
4.807
NO2
26.173
Helsinki AQI
1.399
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

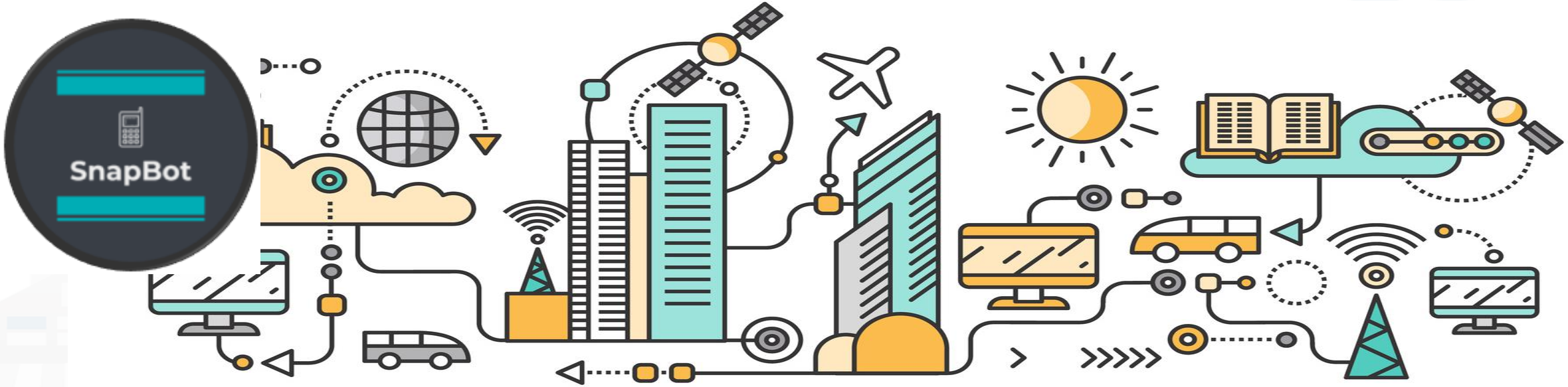
- Suggestions
- Engagements
- Notifications
- …

Users

System

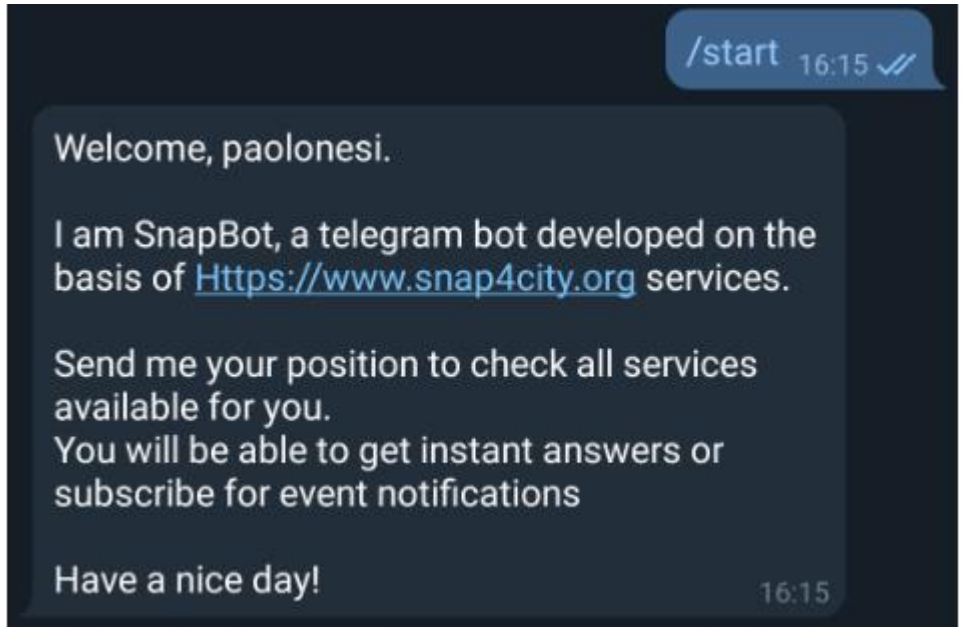
TOP

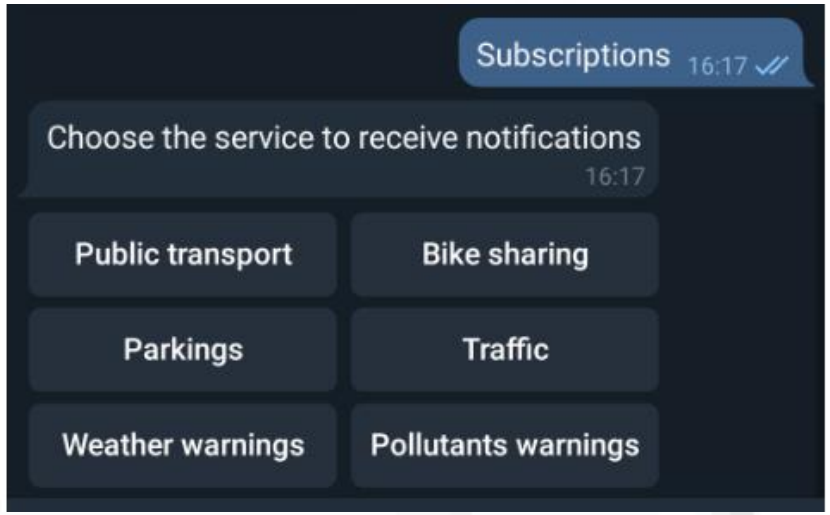
Integration with Telegram: SnapBot solution



SnapBot

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





TOP

Platform Administration

FORGING & MANAGING OPEN AND FLEXIBLE WEB AND MOBILE APPS

FROM CITY DASHBOARD TO

KNOWLEDGE MANAGEMENT

IOT APPLICATIONS VS IOT EDGE DEVICES

IOT APPLICATIONS, THE LOGIC AND THE SMARTNESS

ADVANCED SMART CITY API, MICROSERVICES, SNAP4CITY API

SNAP4CITY FOR BEGINNERS

SIMULATION

SNAP4CITY ARCHITECTURE AND ECOSYSTEM. OPENED TO DEVELOPERS AND STAKEHOLDERS

TWITTER VIGILANCE: SOCIAL MEDIA ANALYSIS

SNAP4CITY AND KM4CITY PROJECTS

DECISION SUPPORT SYSTEM AND CITY RESILIENCE

SNAP4CITY THE VIEW OF THE ADMINISTRATORS

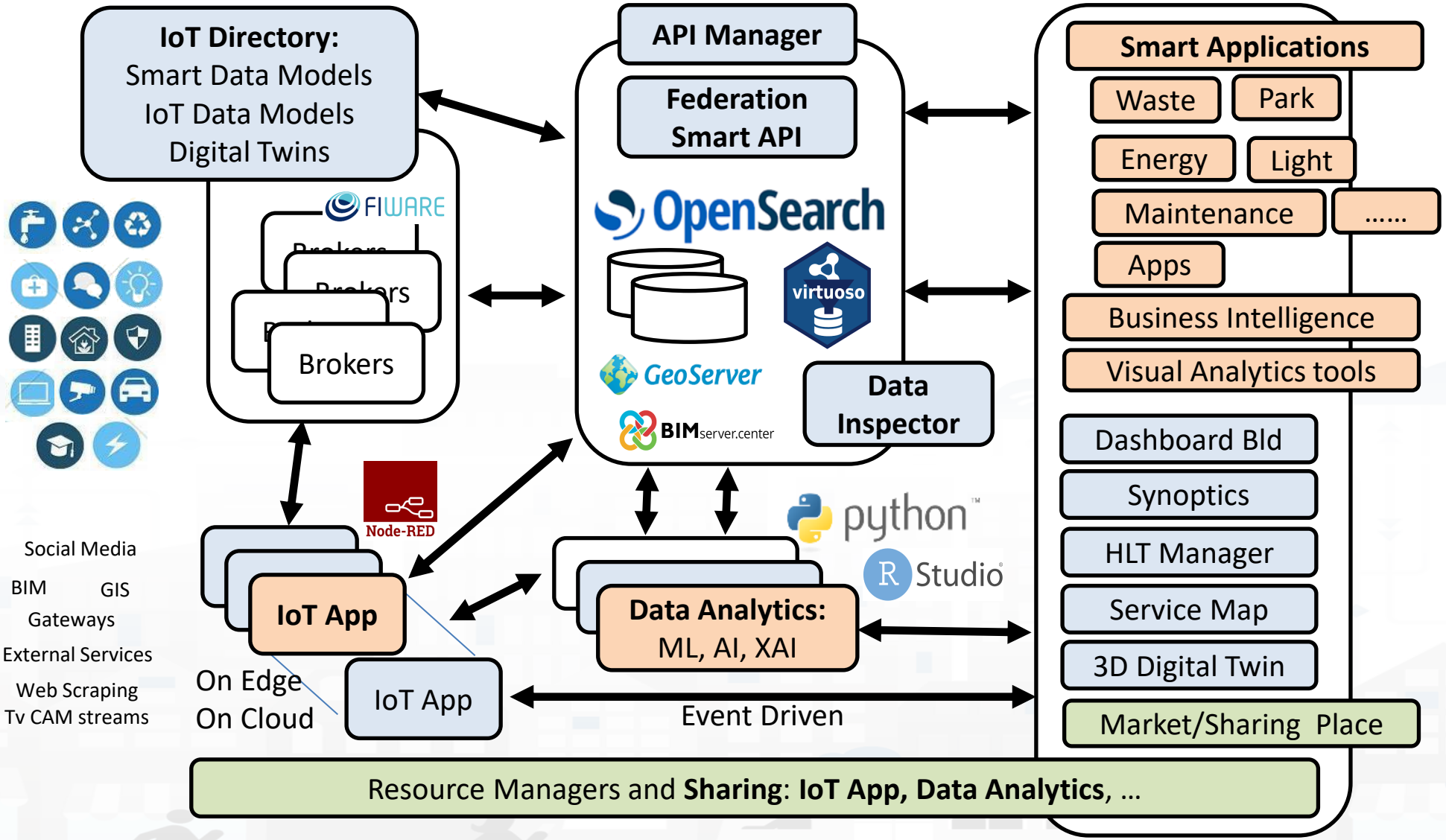
On Line Training Material (free of charge)

	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**

Tech Arch


IoT Directory:
Smart Data Models
IoT Data Models
Digital Twins
FIWARE
Brokers
Brokers
Brokers
API Manager
Federation
Smart API
OpenSearch
virtuoso
GeoServer
BIMserver.center
Data
Inspector
Smart Applications
Waste
Park
Energy
Light
Maintenance
……
Apps
Business Intelligence
Visual Analytics tools
Dashboard Bld
Synoptics
HLT Manager
Service Map
3D Digital Twin
Market/Sharing Place
Node-RED
python
R Studio
Social Media
BIM
GIS
Gateways
External Services
Web Scraping
Tv CAM streams
IoT App
IoT App
On Edge
On Cloud
Data Analytics:
ML, AI, XAI
Event Driven
Resource Managers and Sharing: IoT App, Data Analytics, …

Smart City Functional Architecture

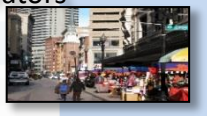
Transport systems
Mobility, parking

Public Services,
Govern, events, …

Sensors, IOT Cameras,
Wi-Fi

Environment, Water,
energy

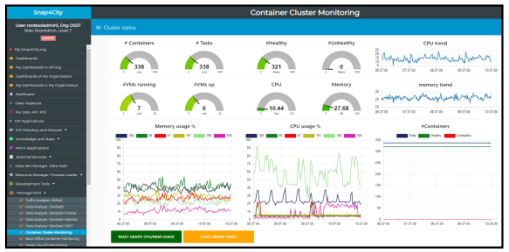
Shops, services,
operators

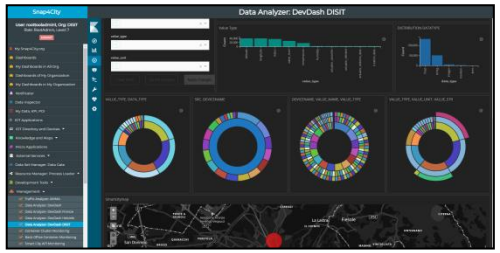


Social Media

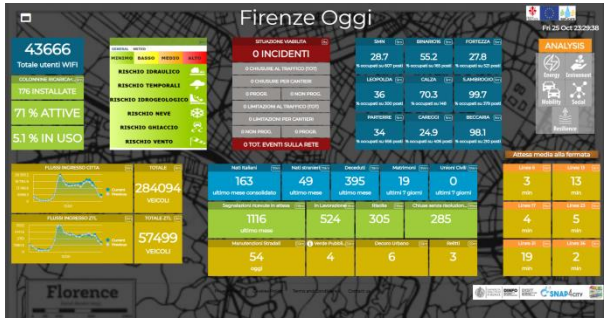
Social Media Crawler and Manager

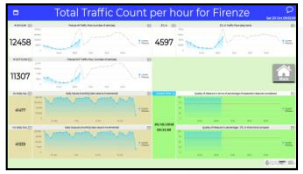
Back office tool

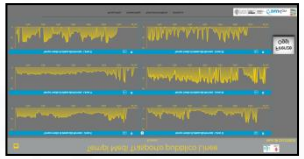


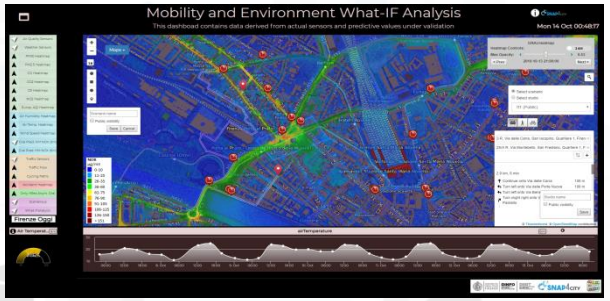


Dashboards, visual tools,
Web and Mobile Apps









Back-End → **Front-End**

Data Sources, External Services
PULL Data

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

Data Ingestion, aggregation, regularization, 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, …

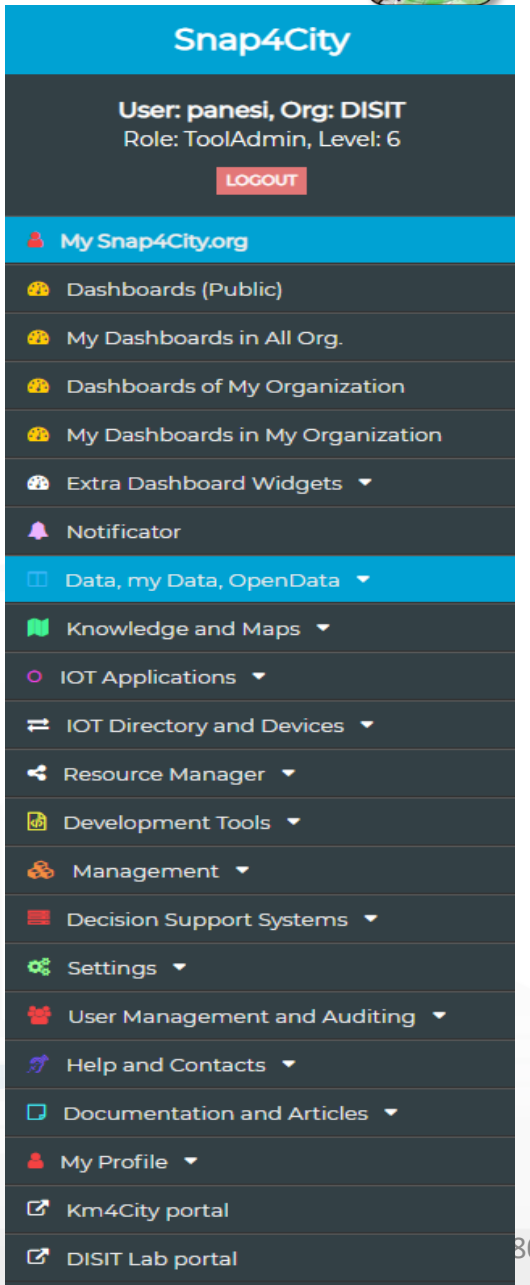
Roles in Snap4City/Industry solutions

- **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

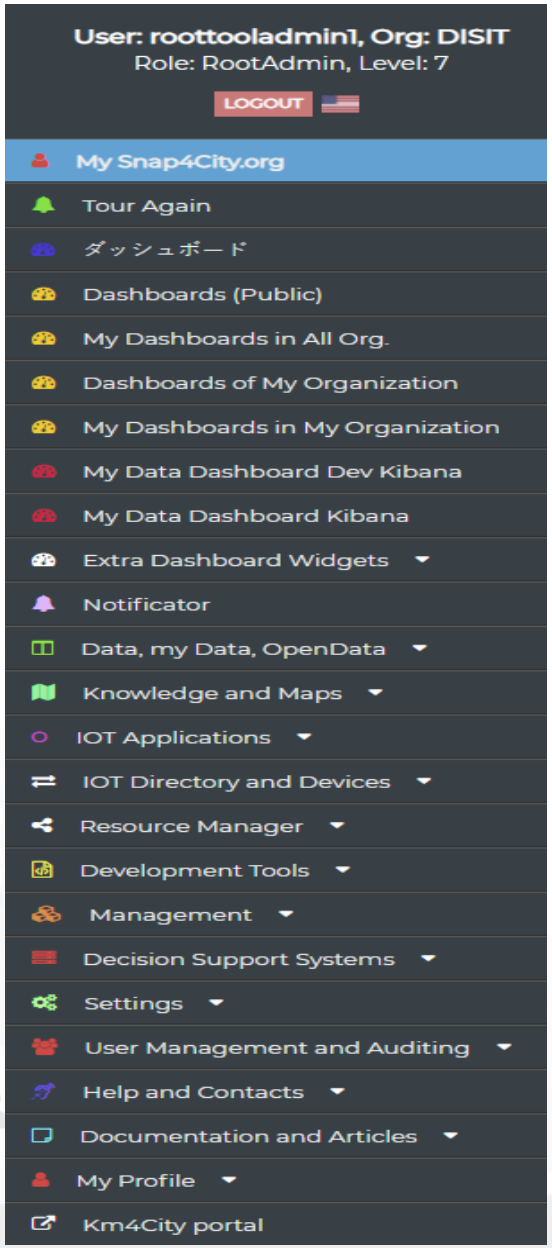
- **Organizations** /Tenant may have
  - name, ID, GPS center, a number of Groups on Snap4City.org (living lab support Drupal)
  - users of different kinds and may impose early bounds on the resourced used by users (IOT Dev, IOT App, Dash)
  - on cloud user kinds up to level of Tool Administrator
  - 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.



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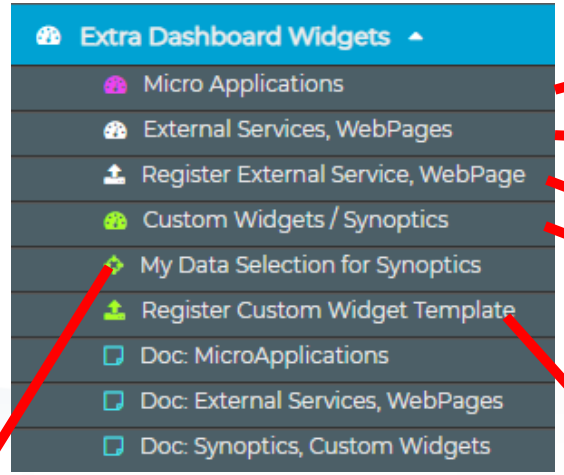
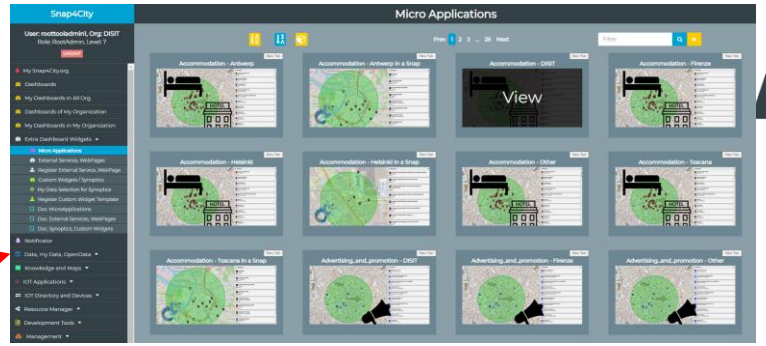
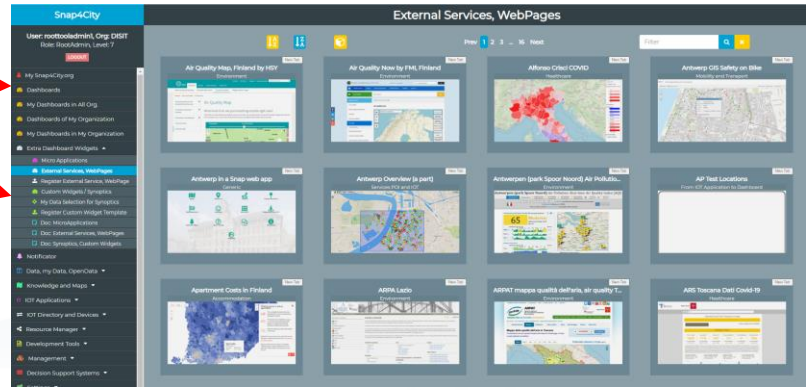
Extra Dashboard Widgets

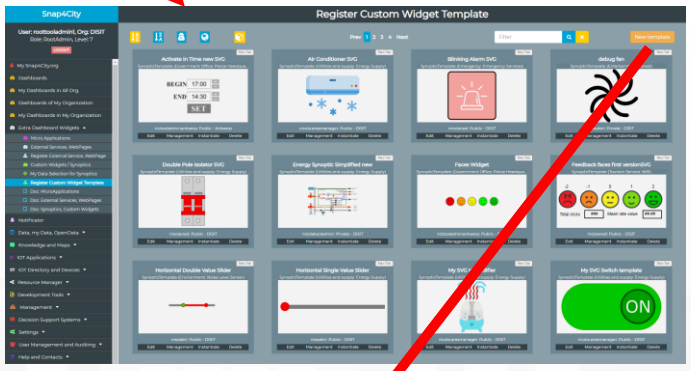


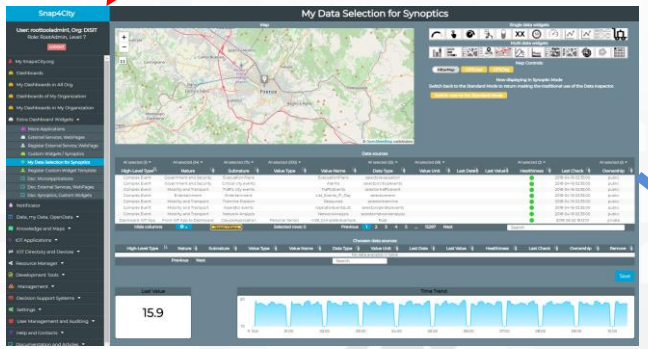


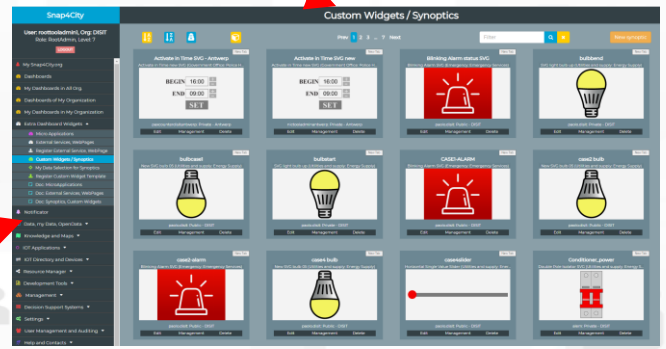
MicroApplic.



External Services

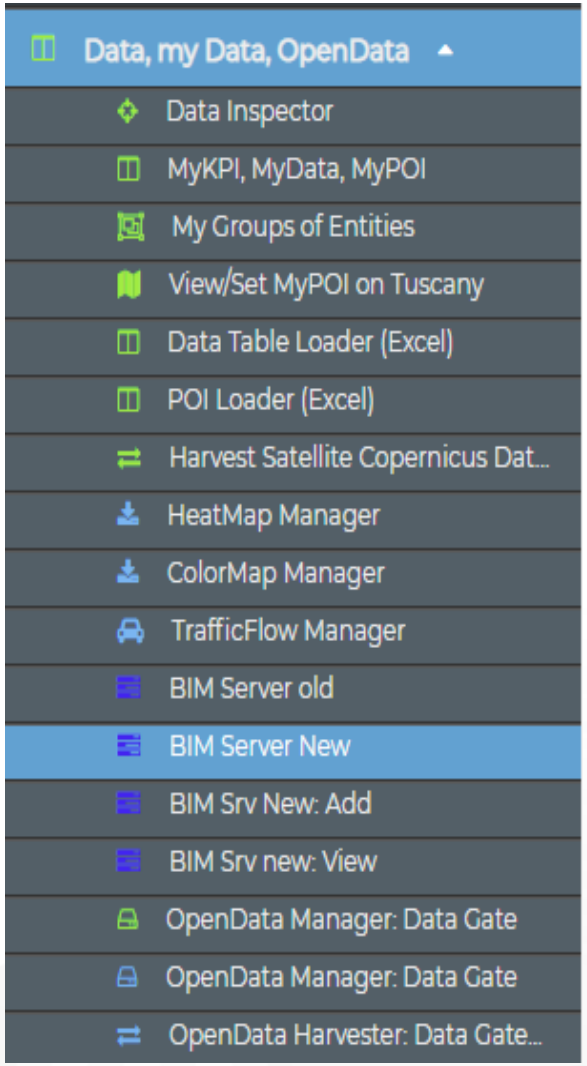






Synoptics, Custom

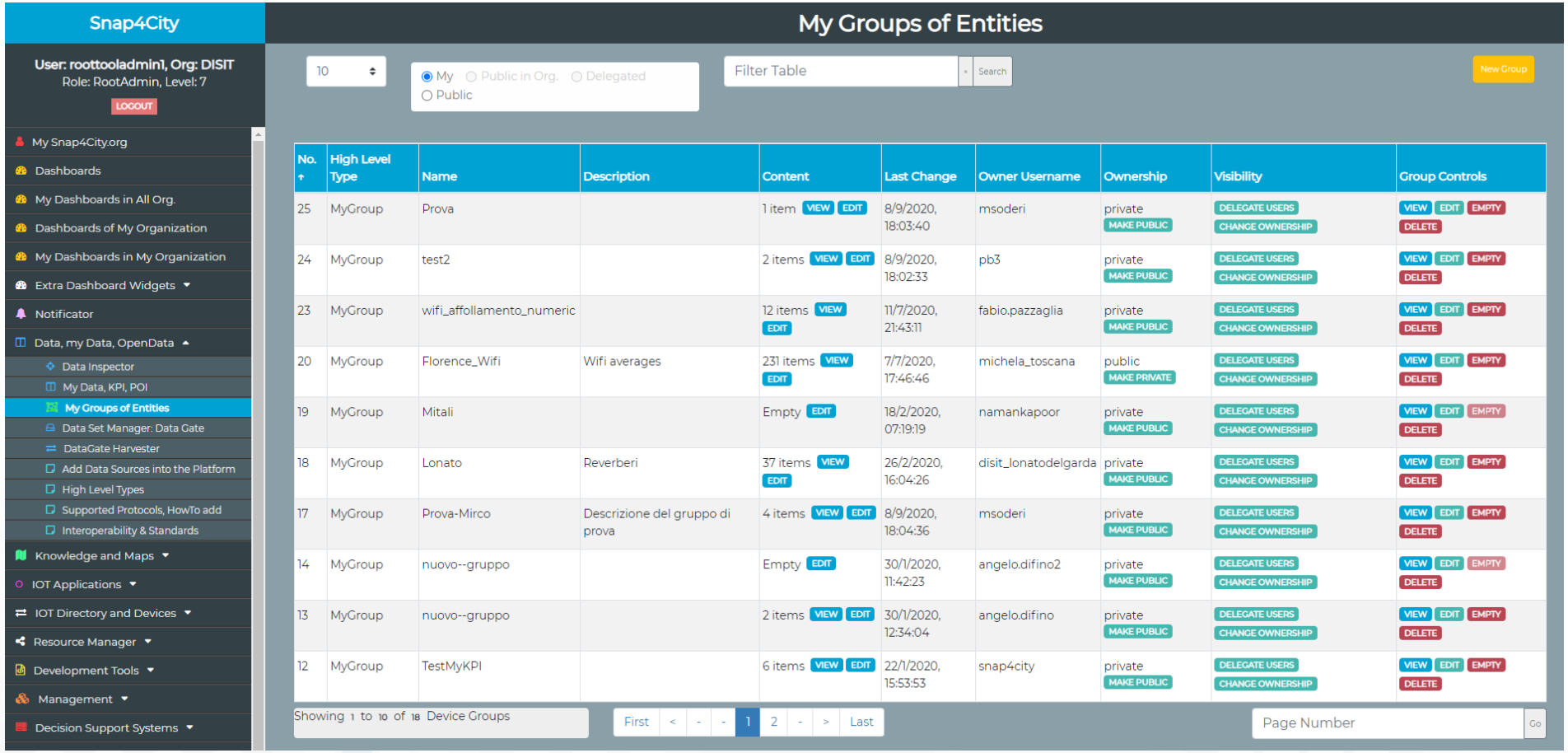
Data My data



- **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

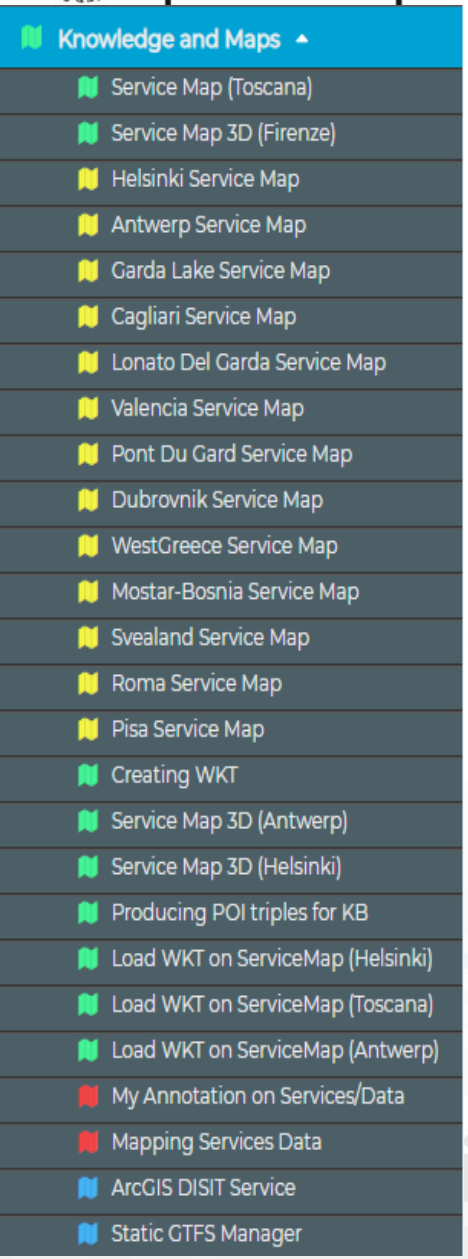
Managing Groups

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

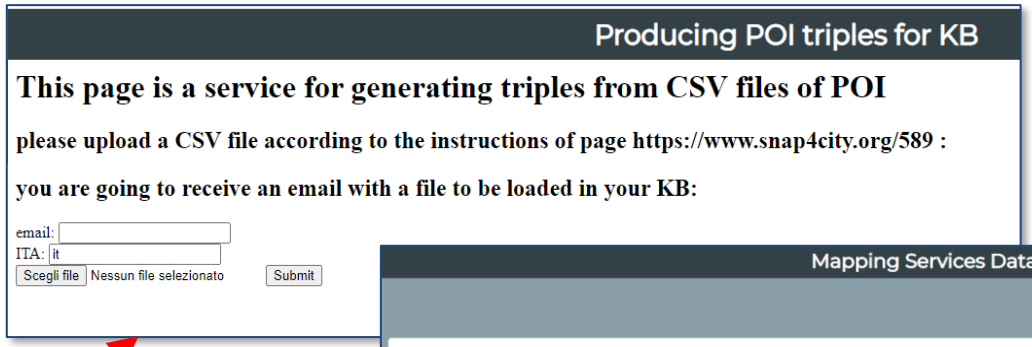


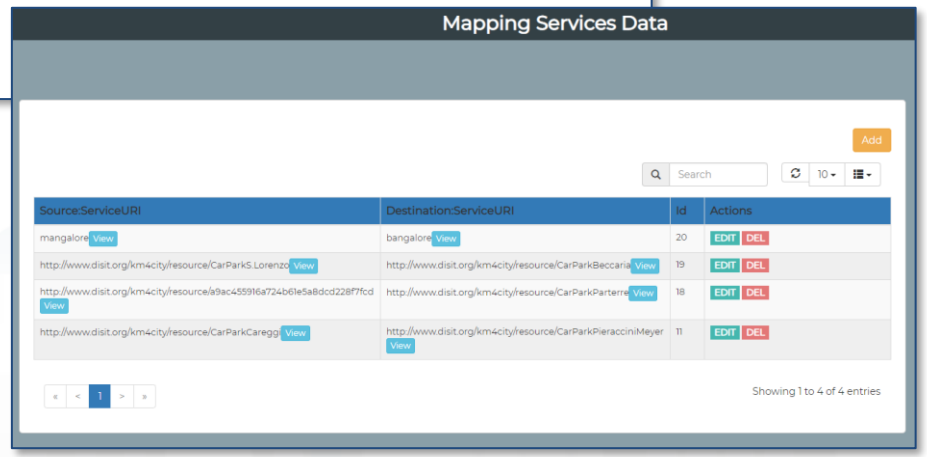
- For non admin tools see other Training parts: https://www.snap4city.org/577

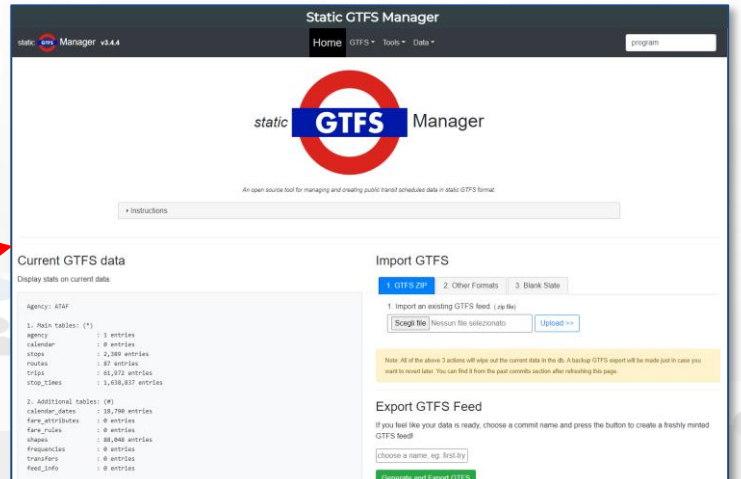
Knowledge and Maps



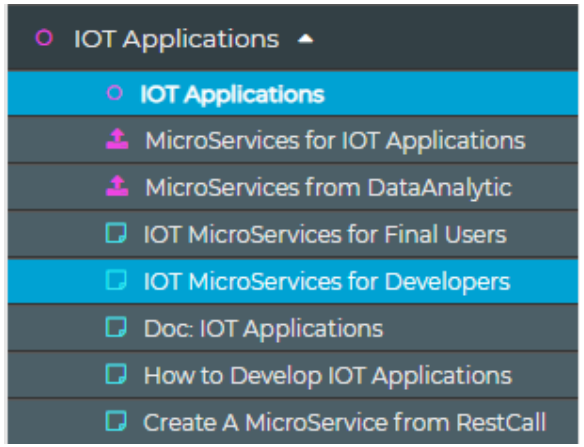
- A number of ServiceMaps, Knowledge bases, KB
- Tools for creating WKT, shapes
- Access to ServiceMap 3D, if any
- Service for Loading triples on KB
- My Annotations (deprecated)
- Mapping Tool (partial)
- GIS servers, if any
- Static GTFS editor and manager (if any)

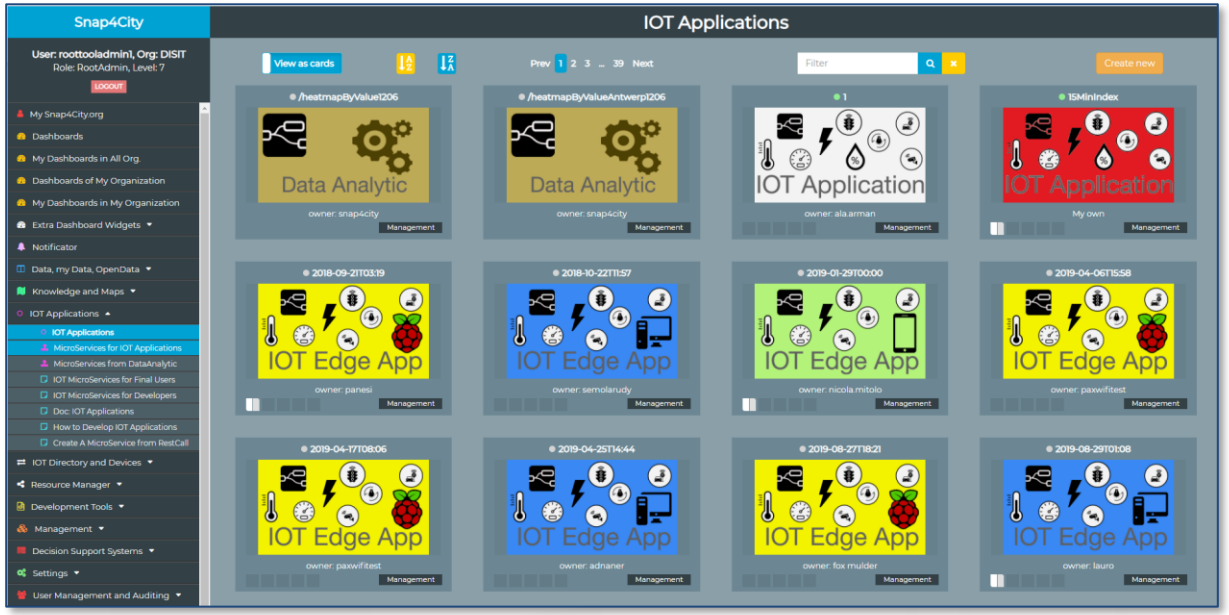






IOT Applications

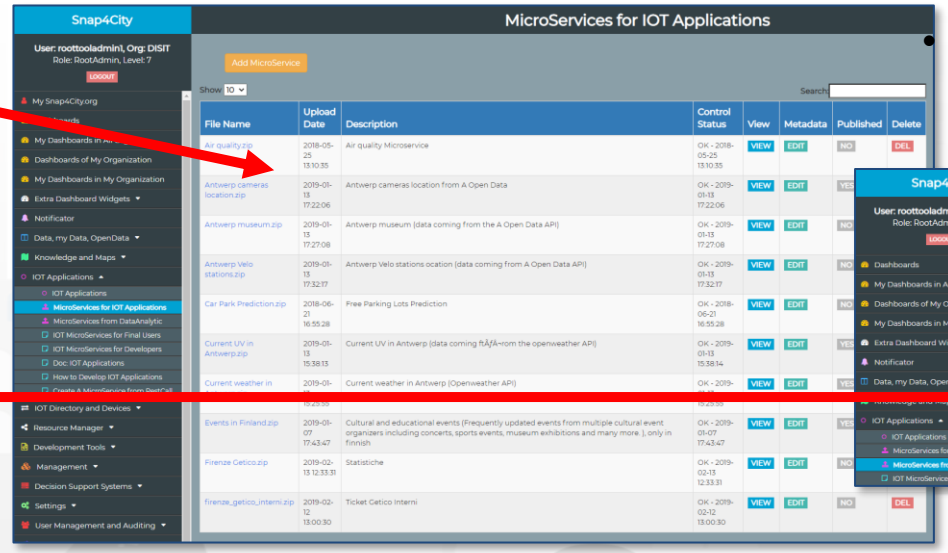


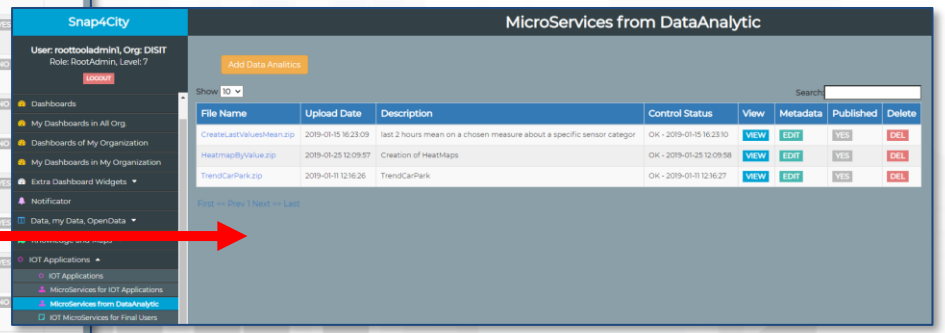


- **IOT Applications**: a view to manage Containers / IOT Edge Apps: IOT Apps, Data Analytics (R and Python), WebScraping, IOT edge, etc.

Managing also

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





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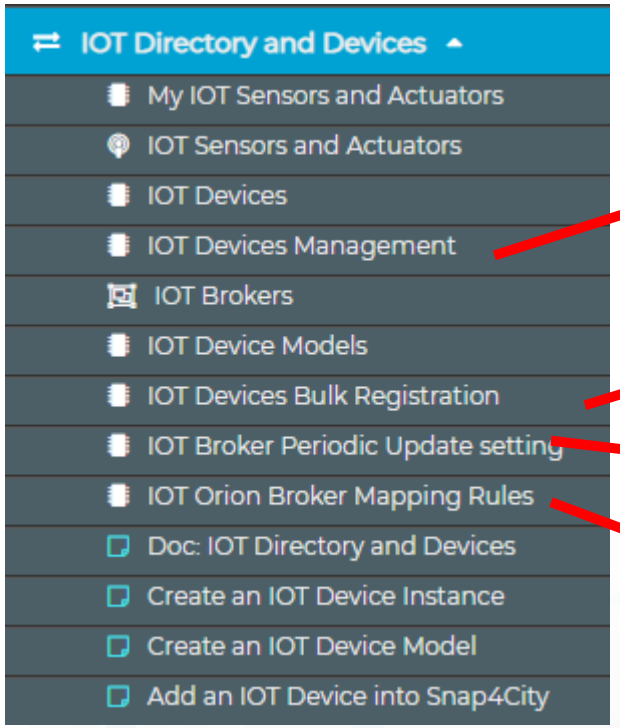
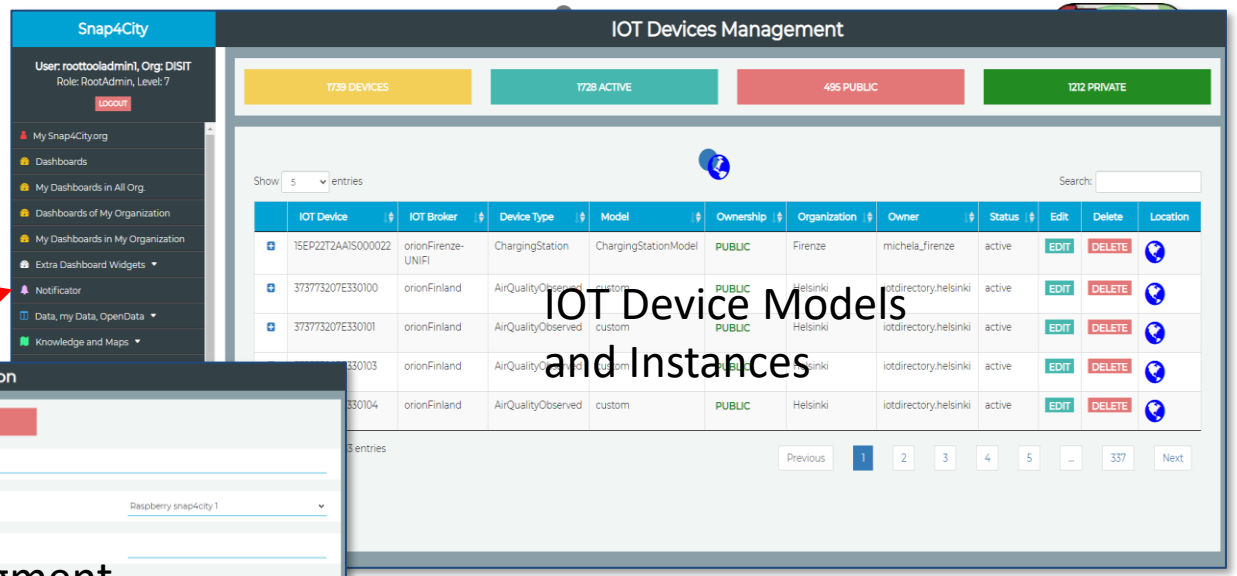
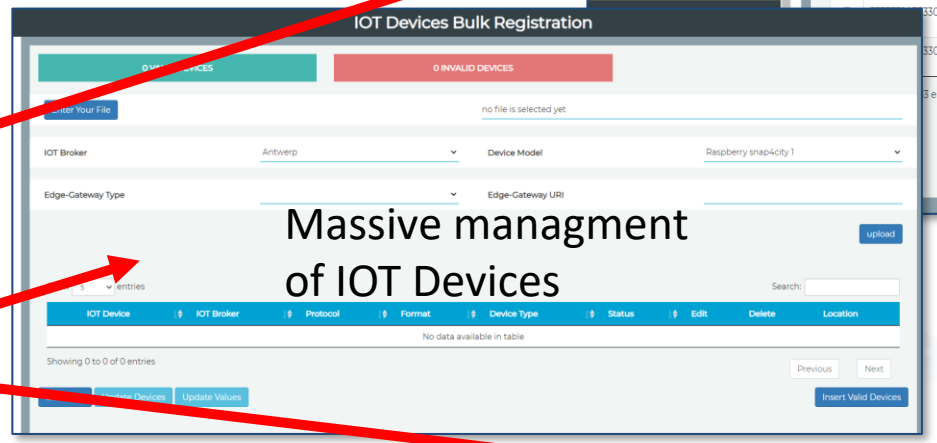
IOT Directory and Devices

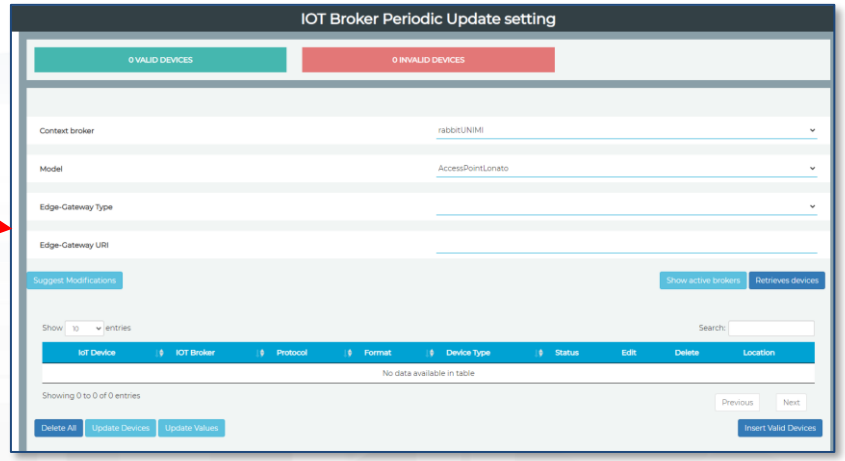


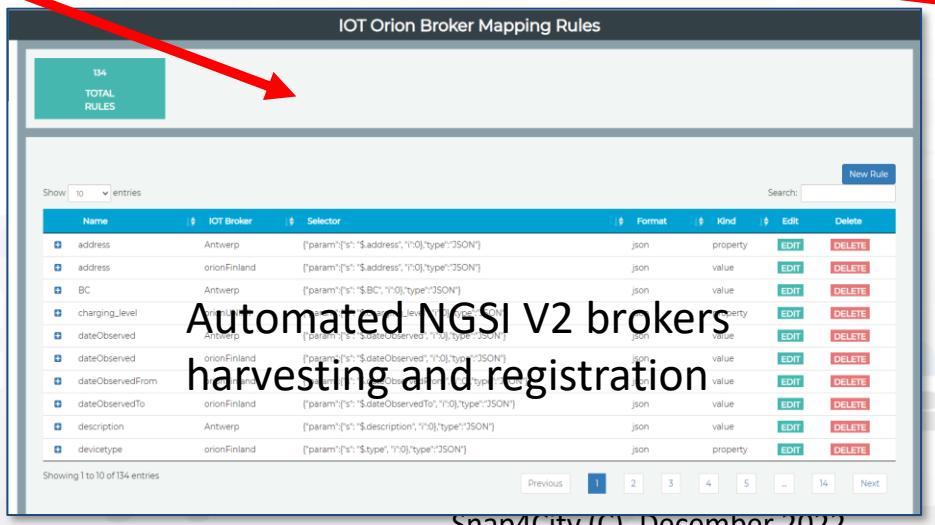


IOT Device Models and Instances



Massive managment of IOT Devices



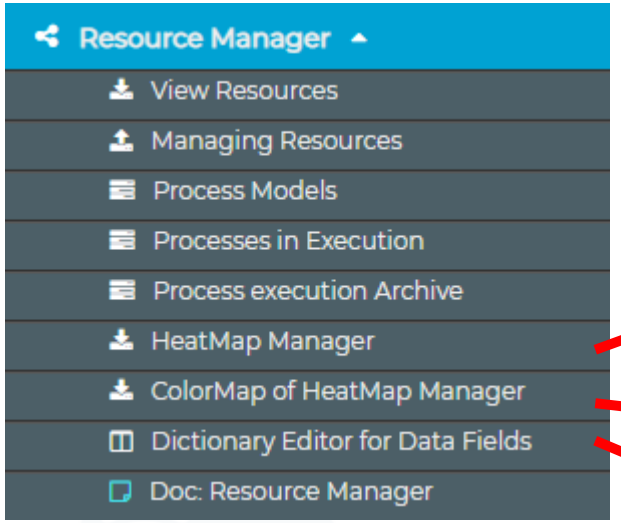


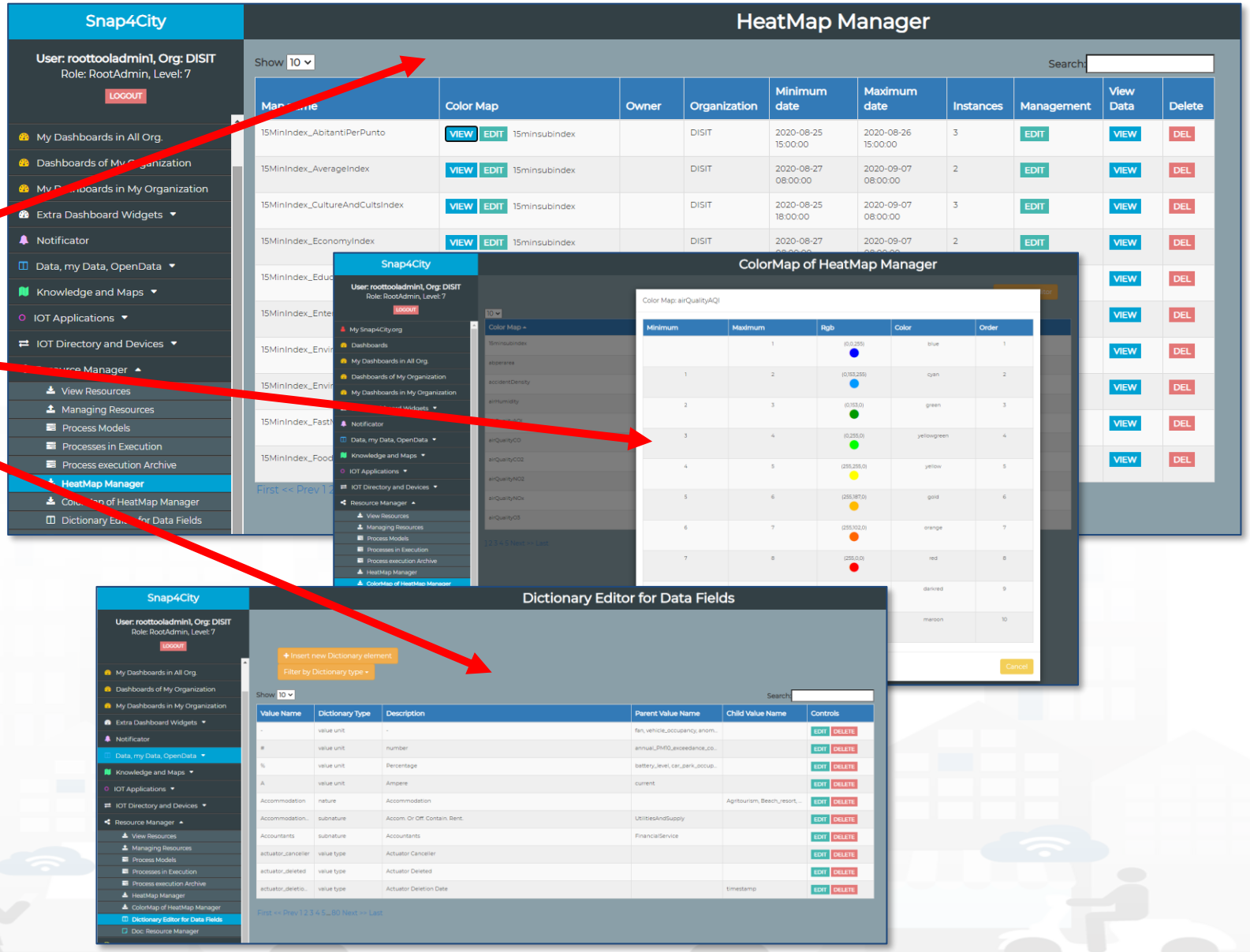
Automated NGSI V2 brokers harvesting and registration

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

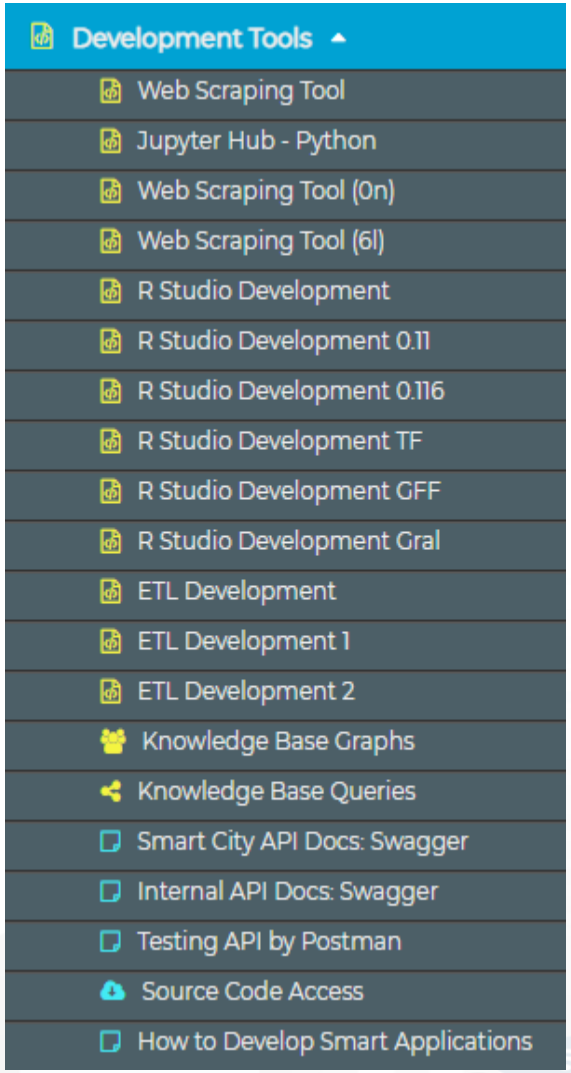




- Tools for managing shared resources among Organizations and Users

- 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
Smart City Control Room
Workflow Management Ticketing
Altair Maintenance
Altair Ticket Management
Altair Ticket Close Event
BIM Dashboard
Workflow Management, Ticketing
BIM Management and Dashboards
DORAM Public Transport Analyzer
Doc: DORAM Pub Transp. Analyzer
Twitter Vigilance
Twitter Vigilance Real Time
Twitter Vigilance Antwerp
Twitter Vigilance Helsinki
Twitter Vigilance WestGreece
Twitter Vigilance Valencia
Twitter Vigilance Firenze HeritData
Twitter Vigilance Pont Du Gard
Twitter Vigilance Dubrovnik
Twitter Vigilance Notes
What-If Analysis
Doc: What-If Analysis
Origing Destination Matrices
Traffic Flow Reconstruction
High Res. Pollutant Predictions
Resilience Decision Support Sys
Smart Decision Support Sys
Doc: Smart & Resilience DSS

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, …

TOP

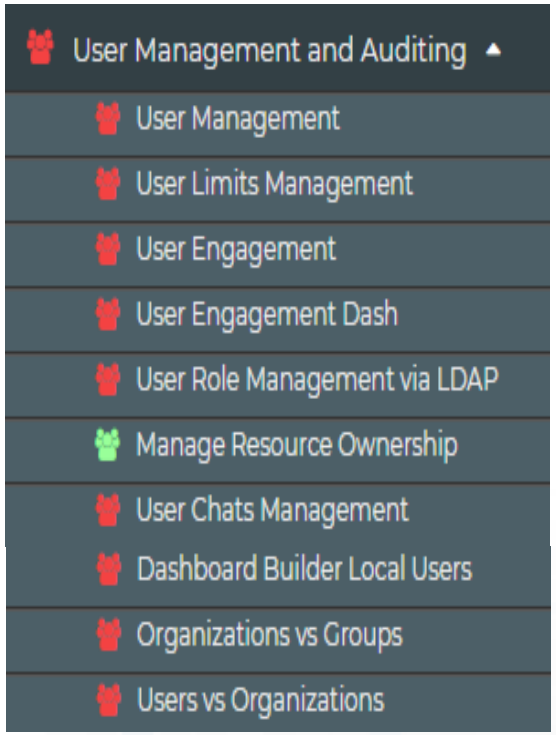
User Management

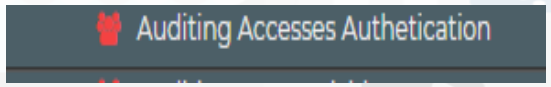
User Management and Auditing

- User Management and Auditing
  - User Management
  - User Limits Management
  - User Engagement
  - User Engagement Dash
  - User Role Management via LDAP
  - Manage Resource Ownership
  - User Chats Management
  - 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
  - Dashboard Builder Local Users
  - Organizations vs Groups
  - Users vs Organizations

- 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

Controlling exploitation of resources

Managing roles and authorizations

TOP

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

Snap4City

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

- Knowledge and Maps
- Micro Applications
- External Services
- Data Set Manager: Data Gate
- Resource Manager: Process Loader
- Development Tools
- Management
- Settings
- User Management and Auditing
  - User Management
  - User Engagement
  - User Engagement Dash
  - User Role Management via LDAP
  - Manage Resource Ownership
  - User Chats Management
  - 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
  - Dashboard Builder Local Users
  - Organizations vs Groups
  - Users vs Organizations
- Help and Contacts
- Documentation and Articles
- My Profile

Auditing Data Access Try-out

Reset Filters

15

Id	Date and Time (From... / To...)	Username	App Name	Source request	Variable name	Motivation	Access Type	Query	Error Message	Stacktrace	ip_address
3576876	2019-10-16 15:40:08						WRITE	/datamanager/ap	The passed DELEGATION has	edu.unifi.disit	192.168.0.37
3557811	2019-10-12 13:12:12						READ	/datamanager/ap	The logged user is not th	edu.unifi.disit	192.168.1.82
3557813	2019-10-12 13:12:13						READ	/datamanager/ap	The logged user is not th	edu.unifi.disit	192.168.1.82
3557814	2019-10-12 13:12:13										
3342336	2019-09-29 13:04:15			dashbo							
3407872	2019-10-10 23:56:26			modbu							
3473408	2019-10-11 17:19:35			modbu							
3538944	2019-10-12 08:45:33			modbu							
3342592	2019-09-29 14:42:18			dashbo							
3408128	2019-10-11 00:00:00			modbu							
3473664	2019-10-11 17:23:21			modbu							
3539200	2019-10-12 08:49:08			modbu							
3342848	2019-09-29 16:20:19			dashbo							
3408384	2019-10-11 00:03:37			modbu							
3473920	2019-10-11 17:26:56			modbu							

1 2 3 4 5 6 7 8 9 10 ... 15970 15971 15972 15973 Next >>

Auditing Personal Data

Reset Filters

15

Id	Date and Time (From... / To...)	Username	App Name	Delegated Username	Delegated AppName	Source request	Variable name	Motivation	Access Type	Domain
17295228	2019-10-19 18:17:48					orionbrokerfilter			READ	DELEGATION
17295227	2019-10-19 18:17:36				ChargingStations	dashboardmanager	Num_Utenti_distinti_globali		READ	DATA
17295226	2019-10-19 18:17:36					dashboardmanager	Num_Utenti_distinti_globali		READ	DATA
17295225	2019-10-19 18:17:34					dashboardmanager	Num_Utenti_distinti_globali		READ	DATA
17295224	2019-10-19 18:17:25					orionbrokerfilter			READ	DELEGATION
17295223	2019-10-19 18:17:17					dashboardmanager			READ	DELEGATION
17295222	2019-10-19 18:17:04					dashboardmanager			READ	DELEGATION
17295221	2019-10-19 18:17:01					engager		ASSISTANCE_ENABLED	READ	DATA
17295220	2019-10-19 18:16:32				ChargingStations	dashboardmanager	Num_Utenti_distinti_globali		READ	DATA
17295219	2019-10-19 18:16:32					dashboardmanager	Num_Utenti_distinti_globali		READ	DATA
17295218	2019-10-19 18:16:31					engager		ASSISTANCE_ENABLED	READ	DATA
17295217	2019-10-19 18:16:28					dashboardmanager			READ	DATA
17295216	2019-10-19 18:16:28					dashboardmanager			READ	DATA
17295215	2019-10-19 18:16:28					dashboardmanager			READ	DATA
17295214	2019-10-19 18:16:28					dashboardmanager			READ	DATA

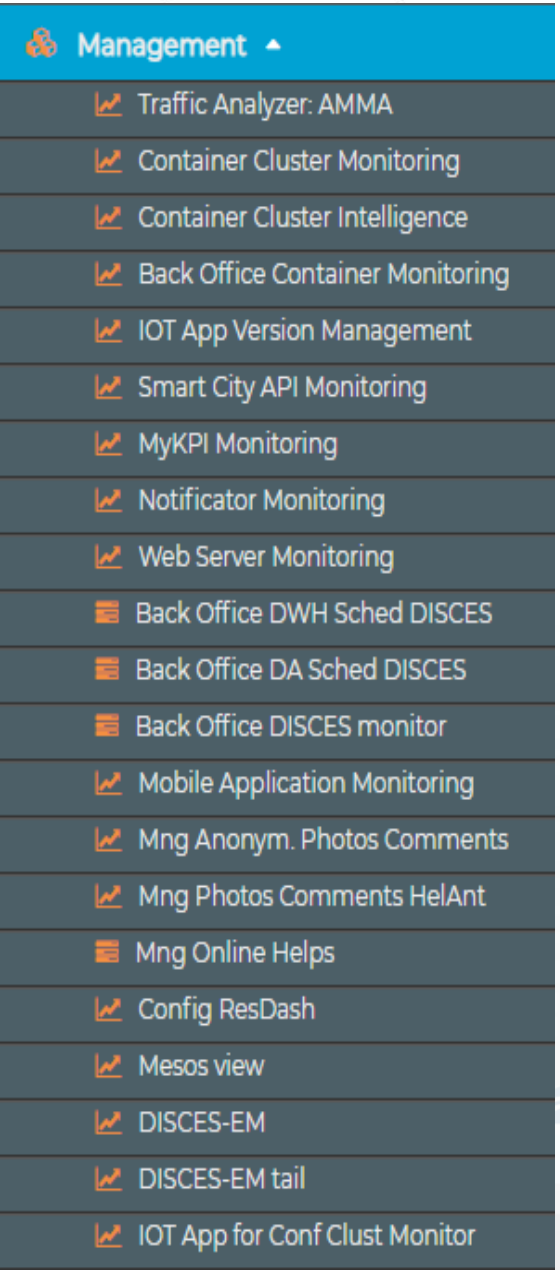
TOP

Management

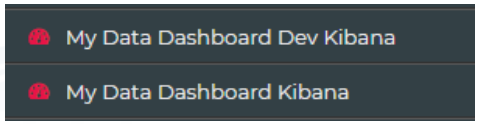
- Traffic Analyzer: AMMA
- Container Cluster Monitoring
- Container Cluster Intelligence
- Back Office Container Monitoring
- IOT App Version Management
- Smart City API Monitoring
- MyKPI Monitoring
- Notificator Monitoring
- Web Server Monitoring
- Back Office DWH Sched DISCES
- Back Office DA Sched 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)



TOP

Back office Platform Scalability
Containers Management and Monitoring

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DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

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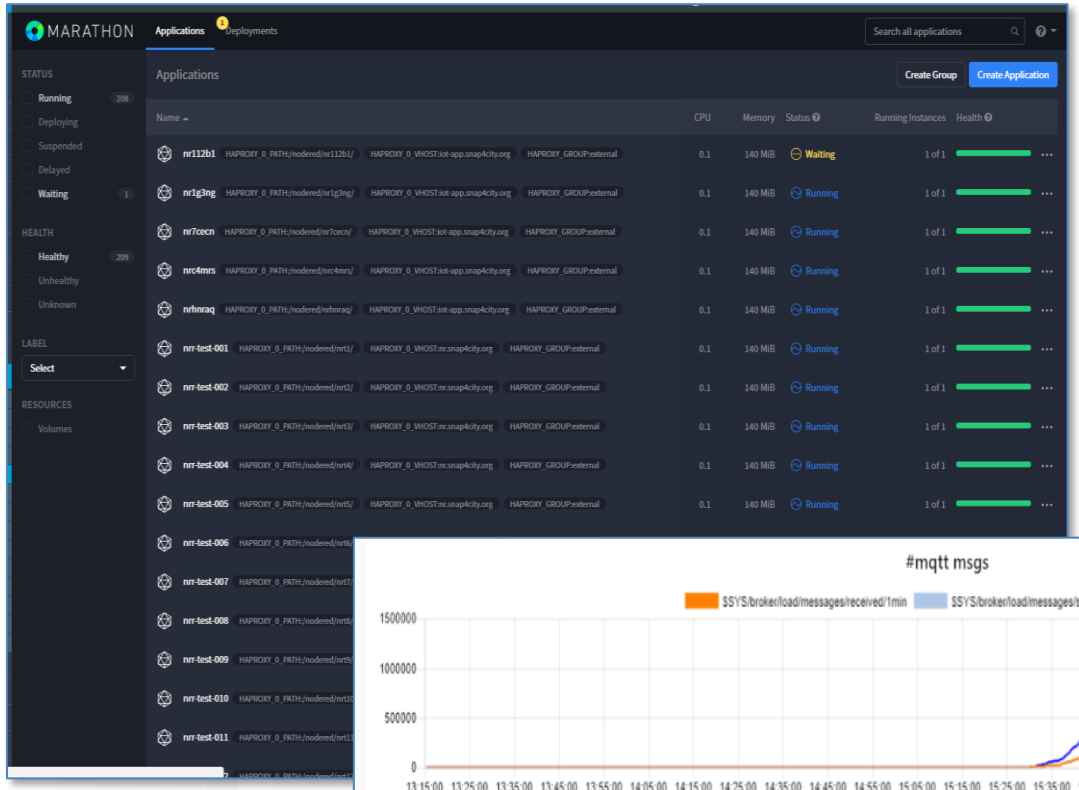
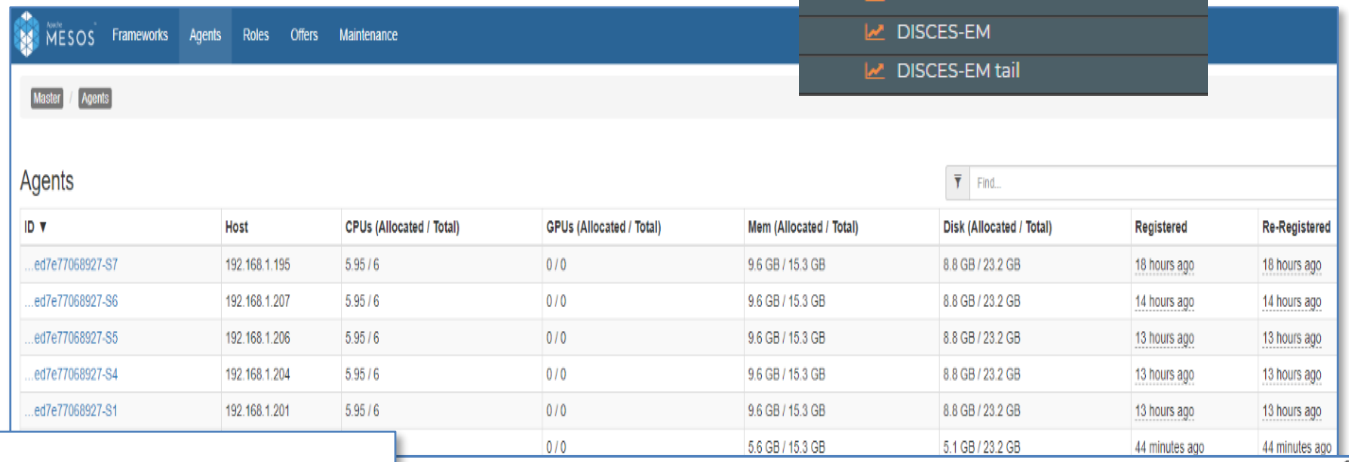
KM4CITY

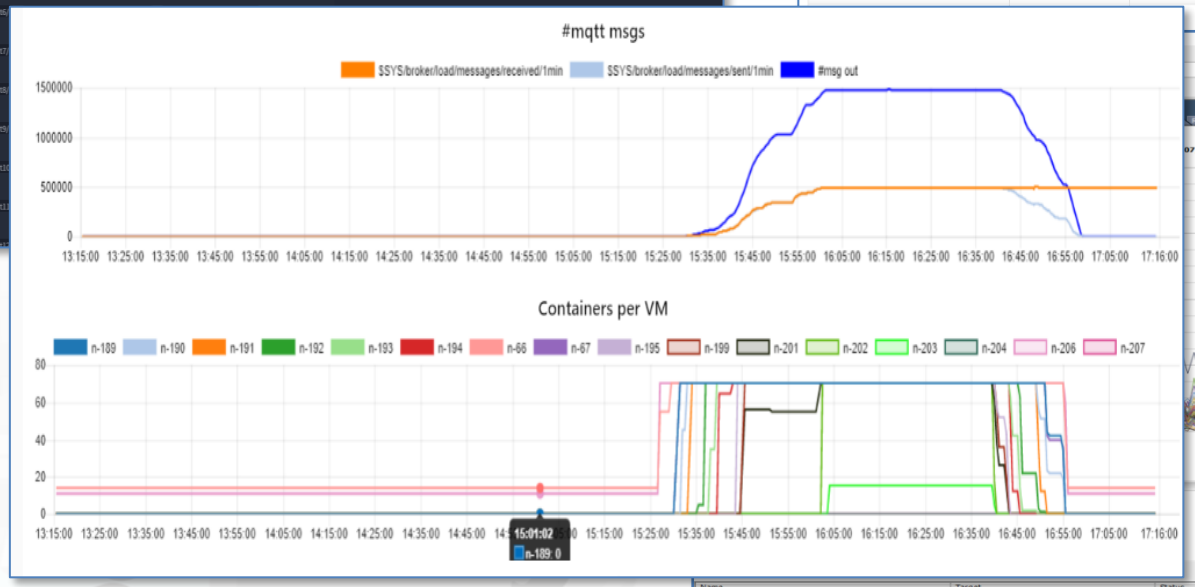
Container

- 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



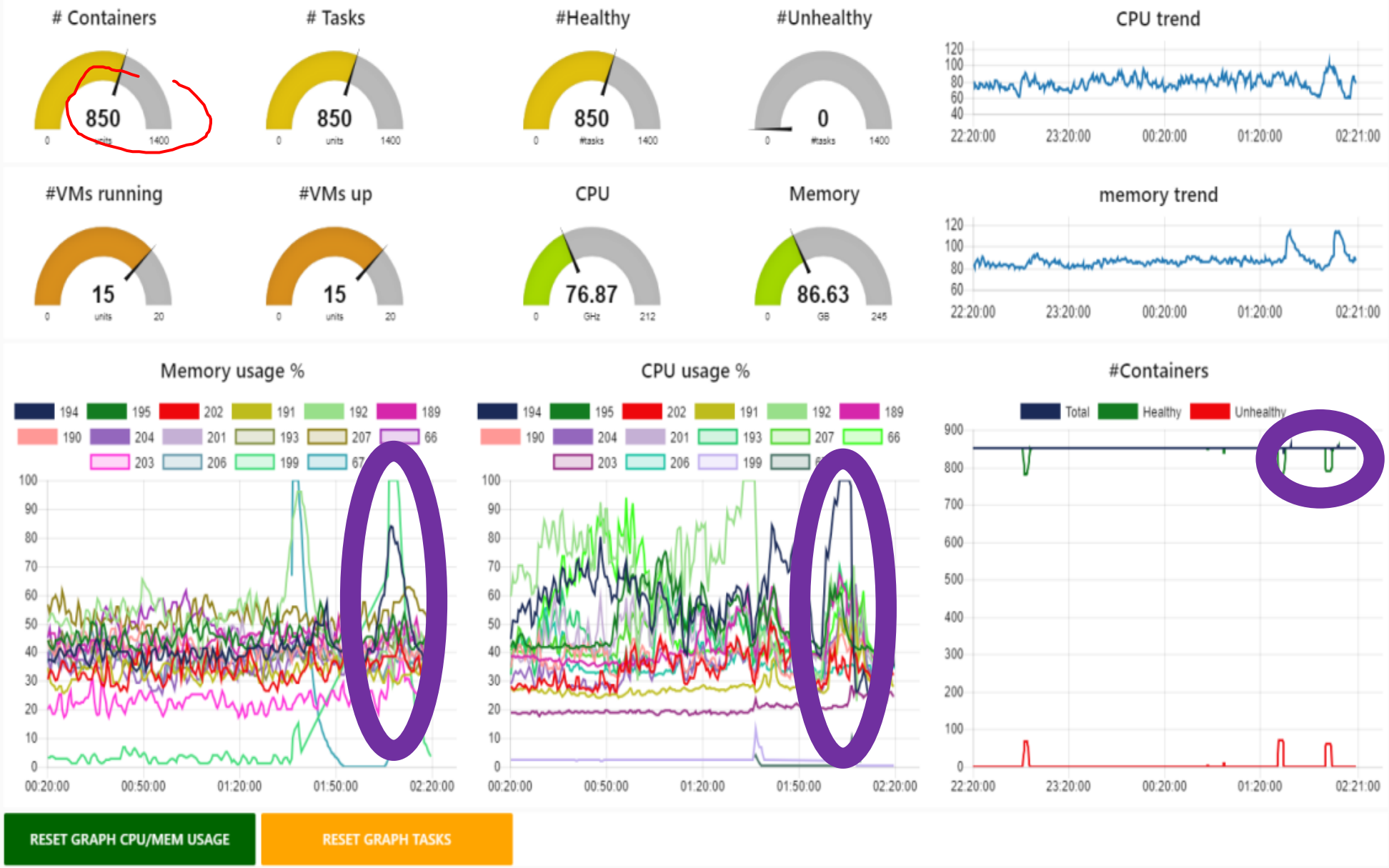
Snap4City

Container Cluster Monitoring

panesi
ToolAdmin | ldap

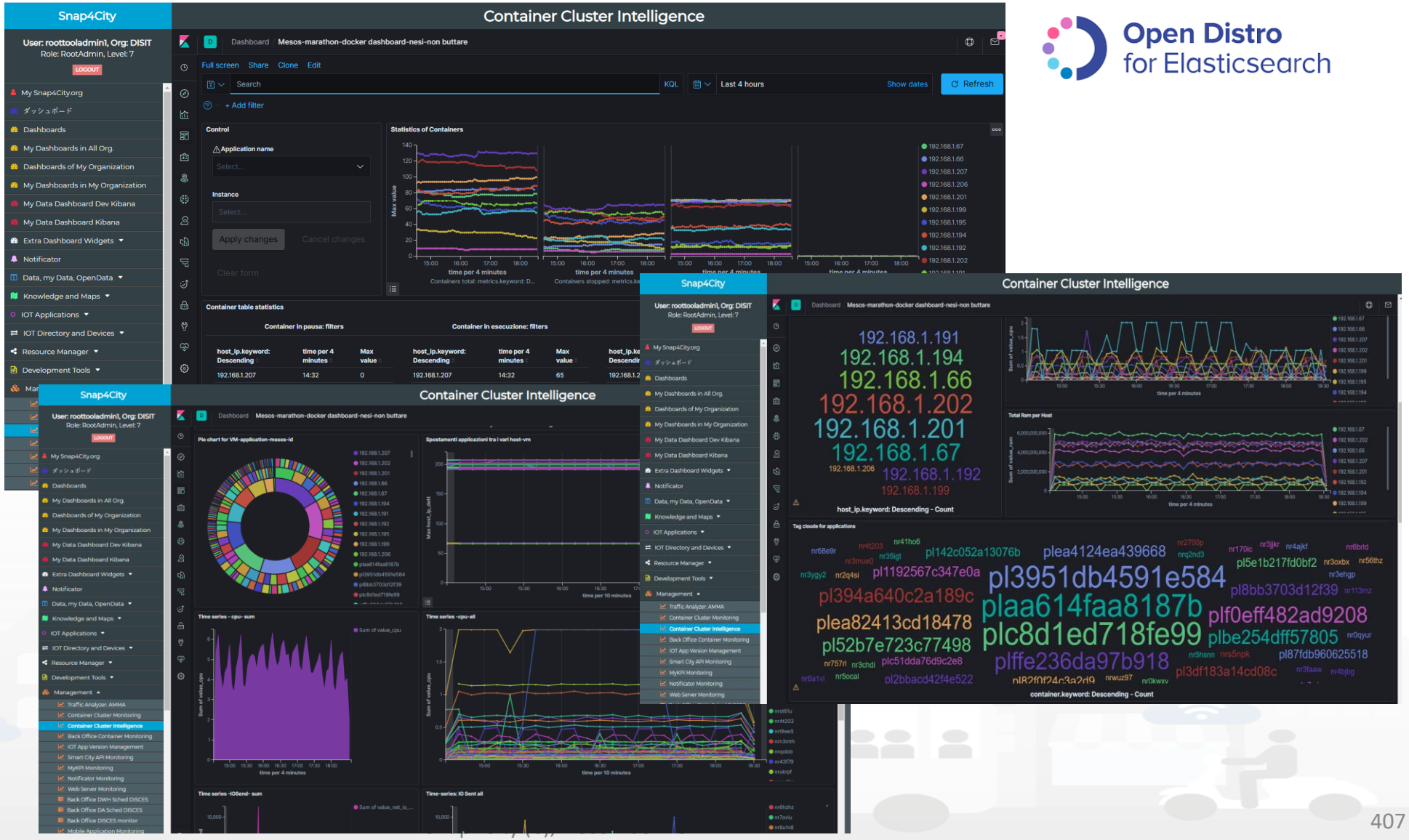
- Dashboards
- Notificator
- IOT Applications
- IOT Directory and Devices
- Knowledge and Maps
- Micro Applications
- External Services
- Data Set Manager: Data Gate
- Resource Manager: Process Loader
- Development Tools
- Management
  - Traffic Analyzer: AMMA
  - Data Analyzer: DevDash
  - Back Office 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

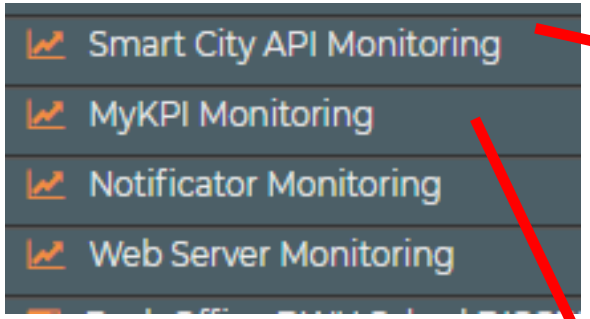
- Via ZABBIX
  - Open Distro
    - Elastic Search
    - Kibana
- By VM/Host
- By Container
- By CPU, MEM, I/O
- Over time



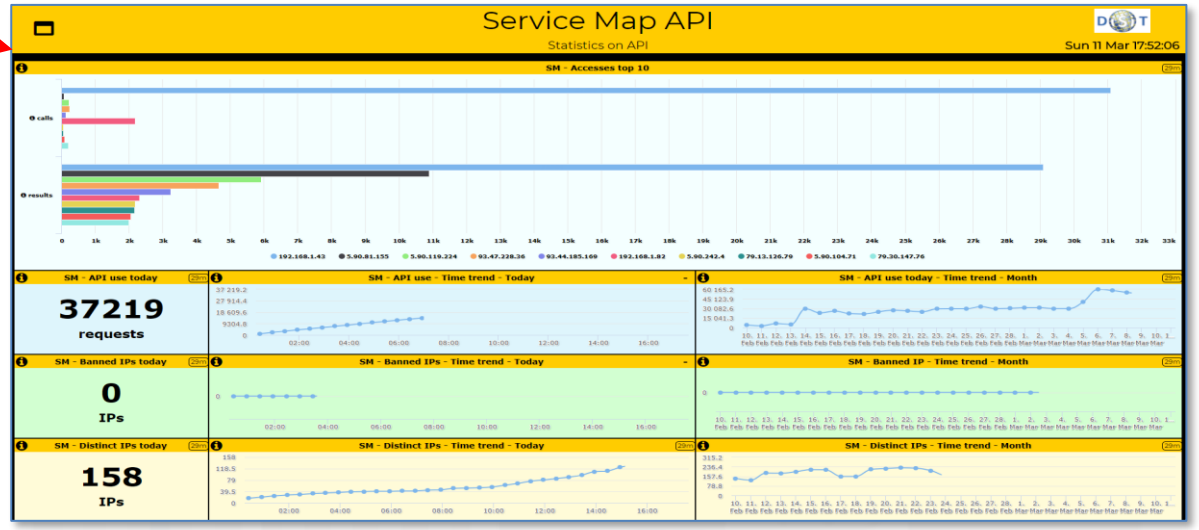
TOP

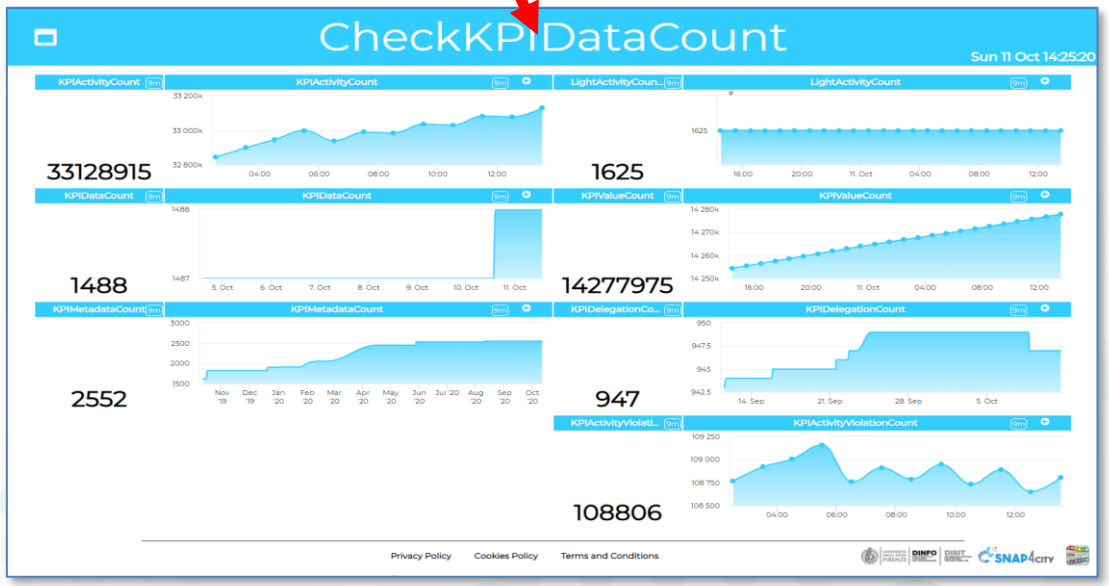
Monitoring Resources and API Traffic

Monitoring Smart City API Usage



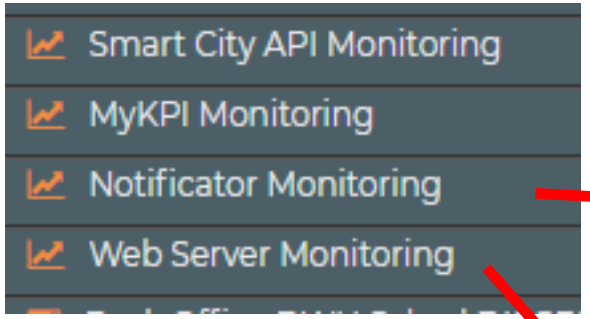
http://www.disit.org/dashboardSmartCity/view/index.php?iddasboard=MTkw



- 

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

Monitoring Resources and Traffic



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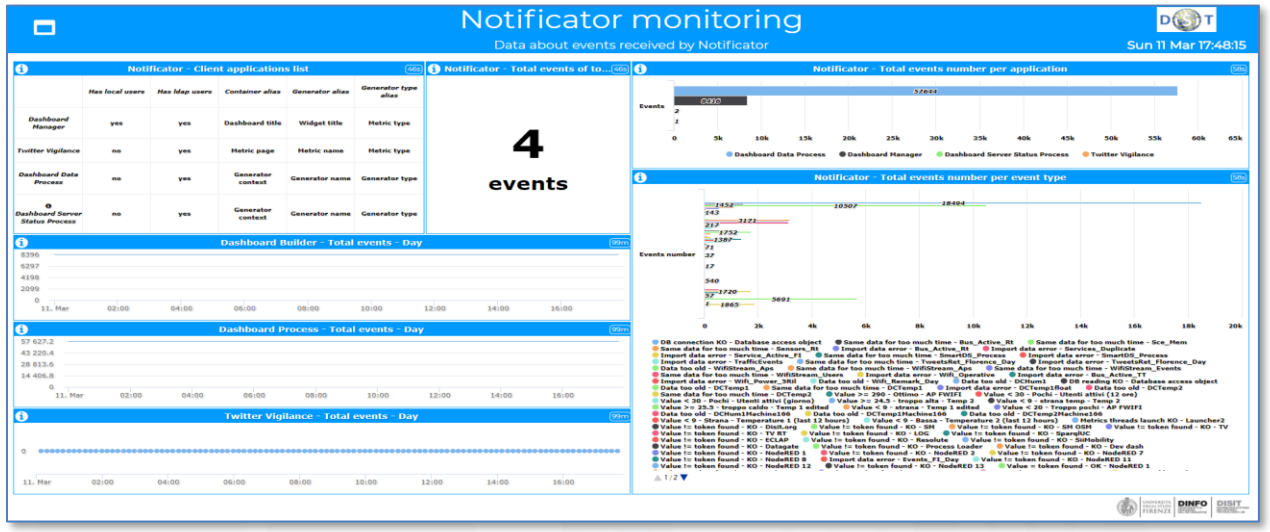

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http://www.disit.org/dashboardSmartCity/view/index.php?iddasboard=MjQ5

TOP

Managing Photos and Comments from Web and Mobile Apps

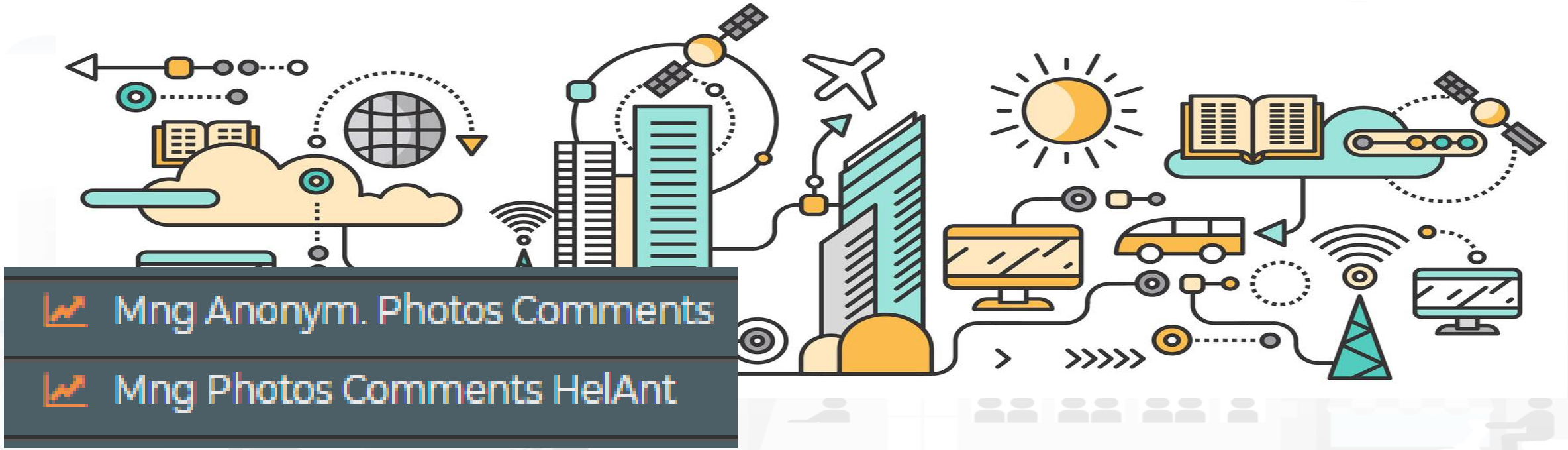
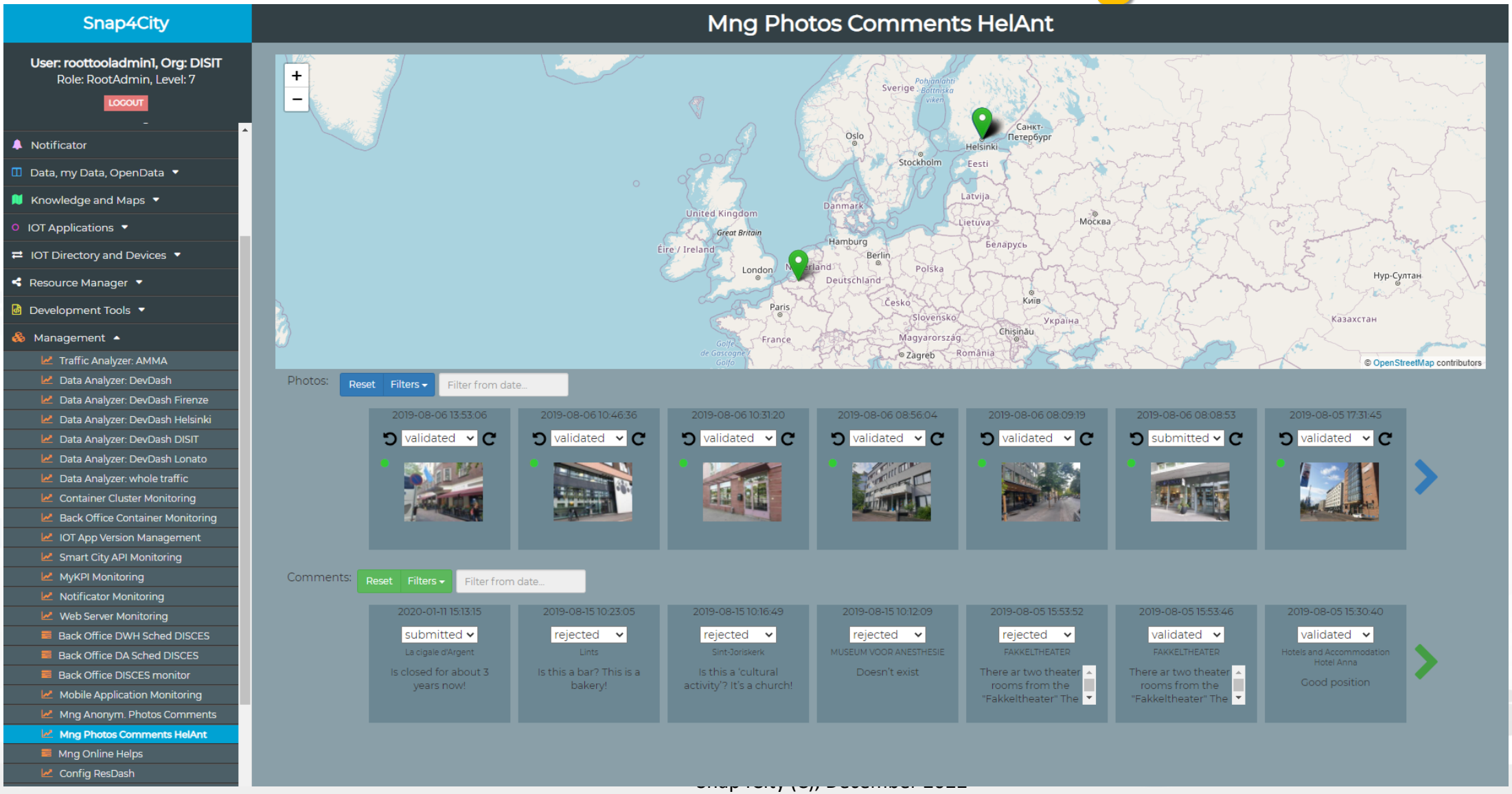
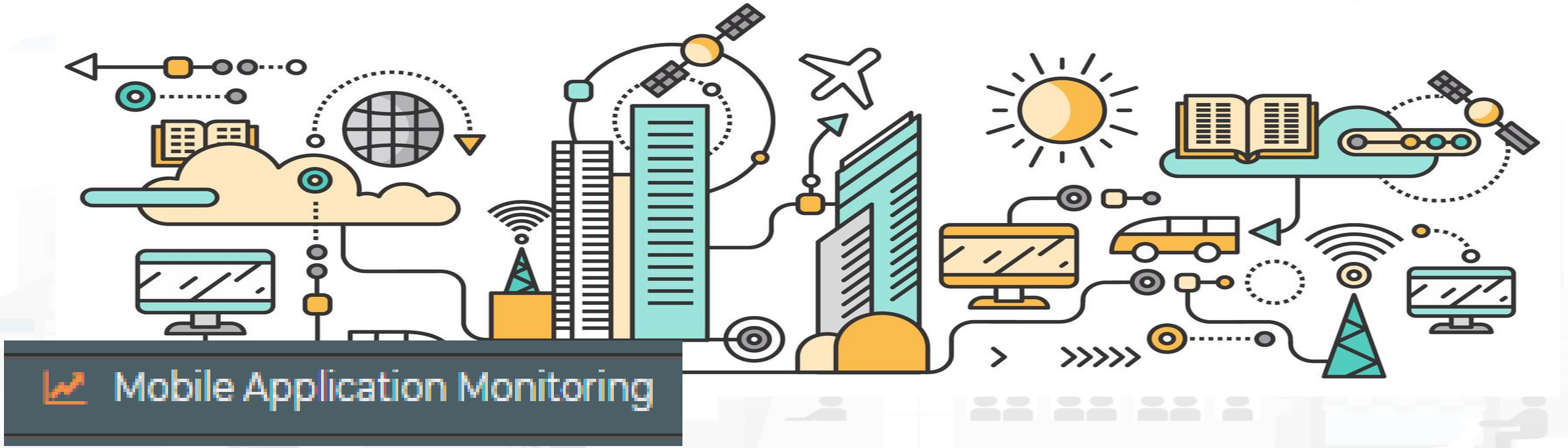


Photo and Comments Management



TOP

Mobile App Monitoring and Management



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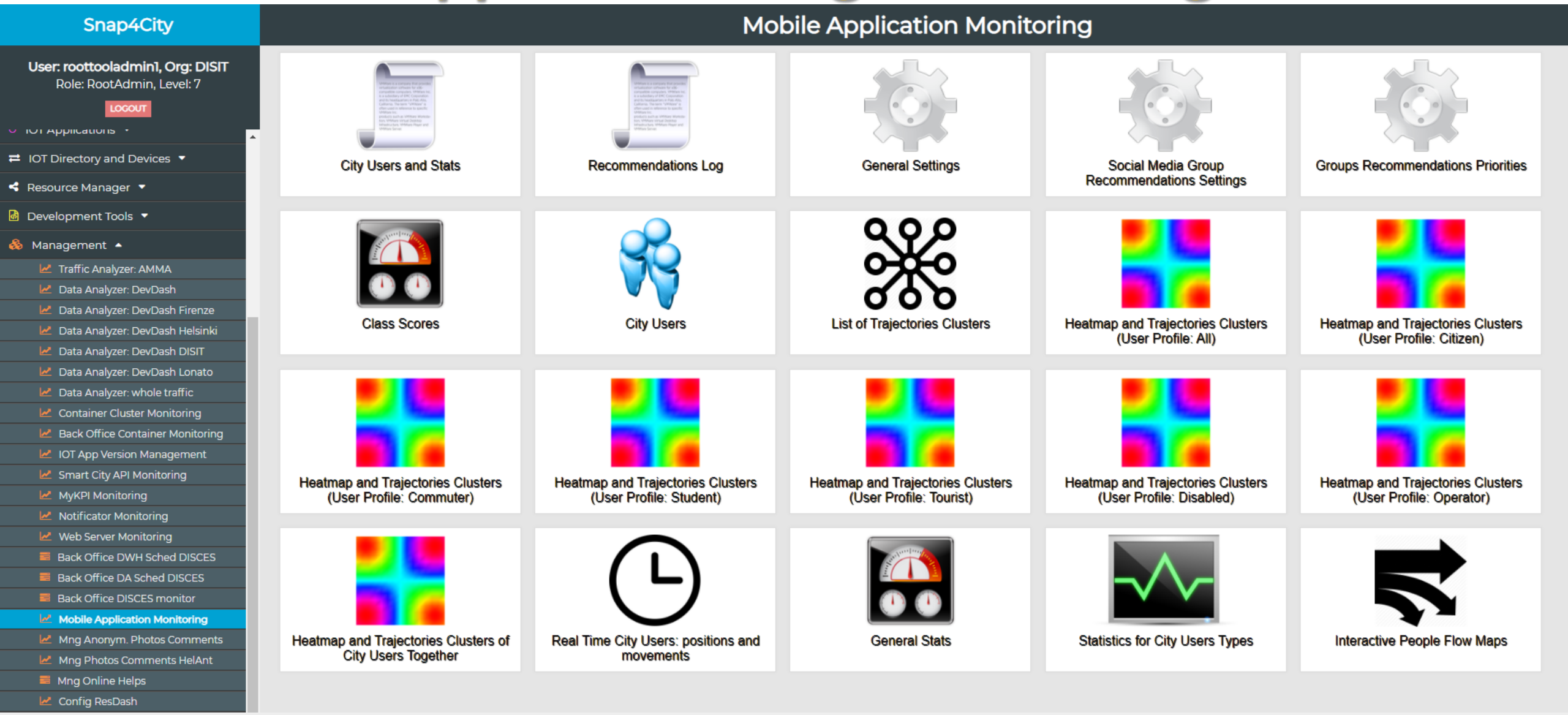
Mobile App Monitoring and Management

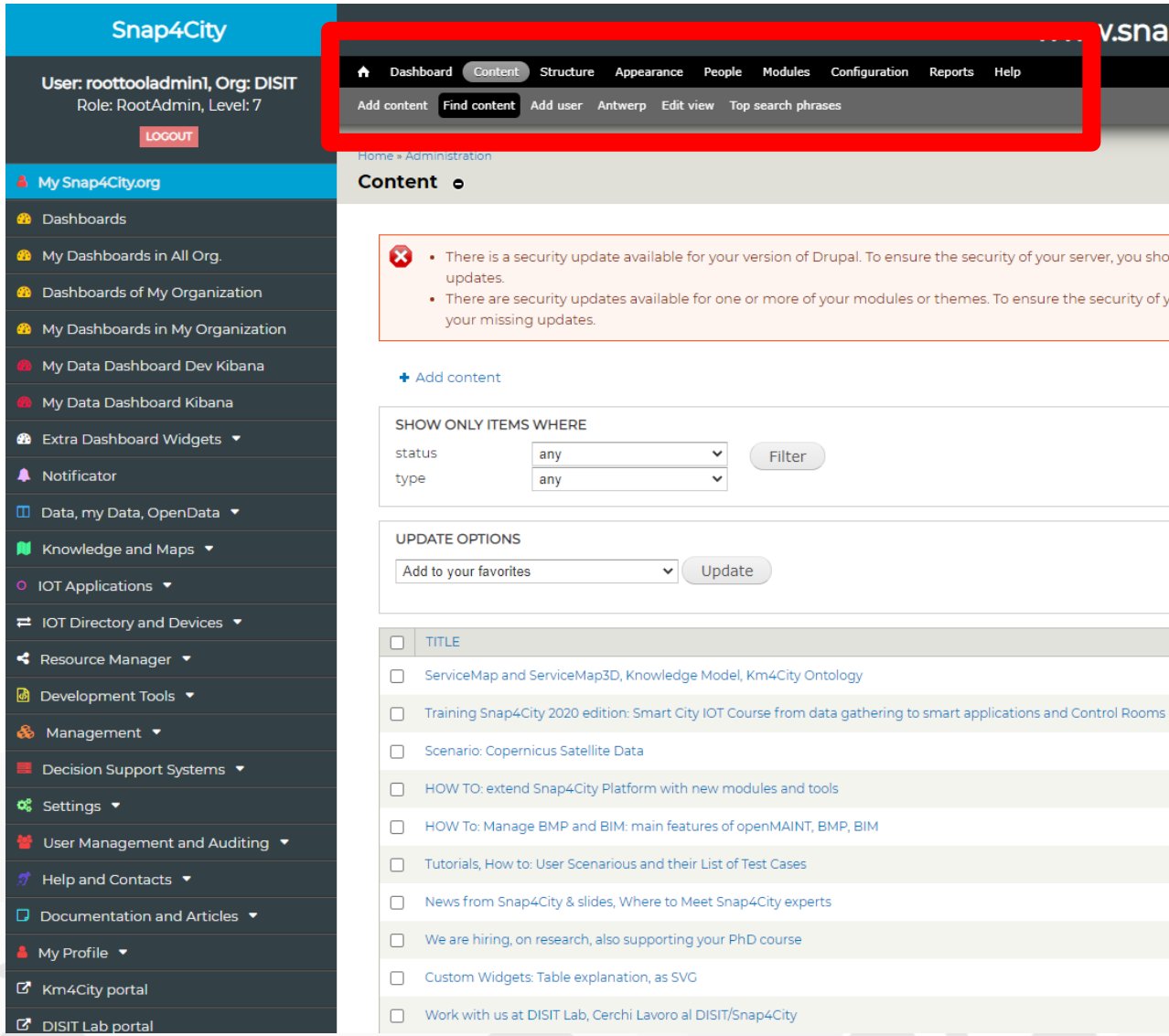


TOP

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** registration 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.



TOP

Data Model, Ingestion and Management

On Line Training Material (free of charge)

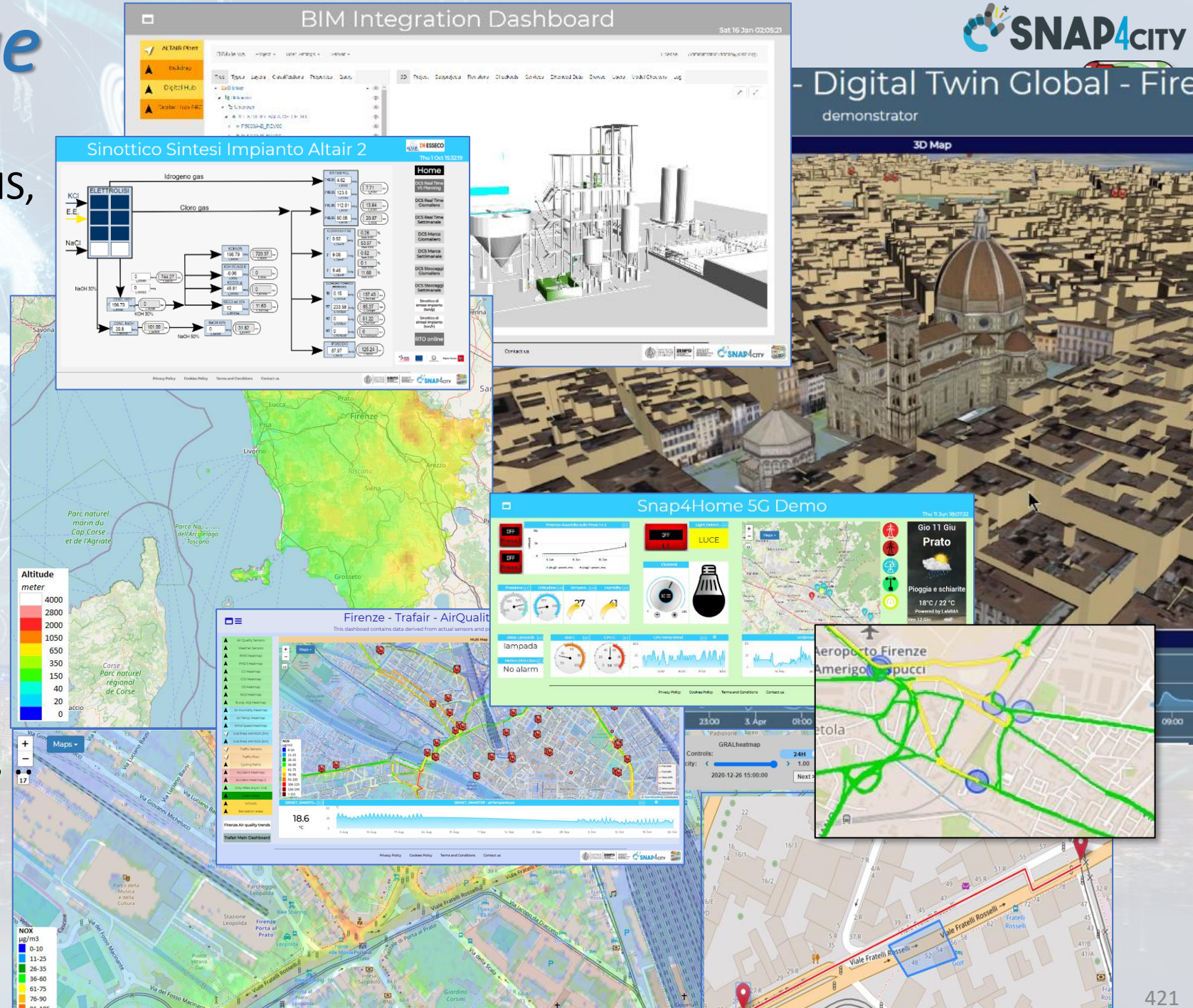
	1st part (*)	2nd part (*)	3rd part (*)	4th part (*)	5th part (*)	6th part (*)	7th part (*)
what	General	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	ystem and Deploy Install	Smart City API: Web & Mob. App
PDF							
Inter active							
Video1							
Video2							
Video3							
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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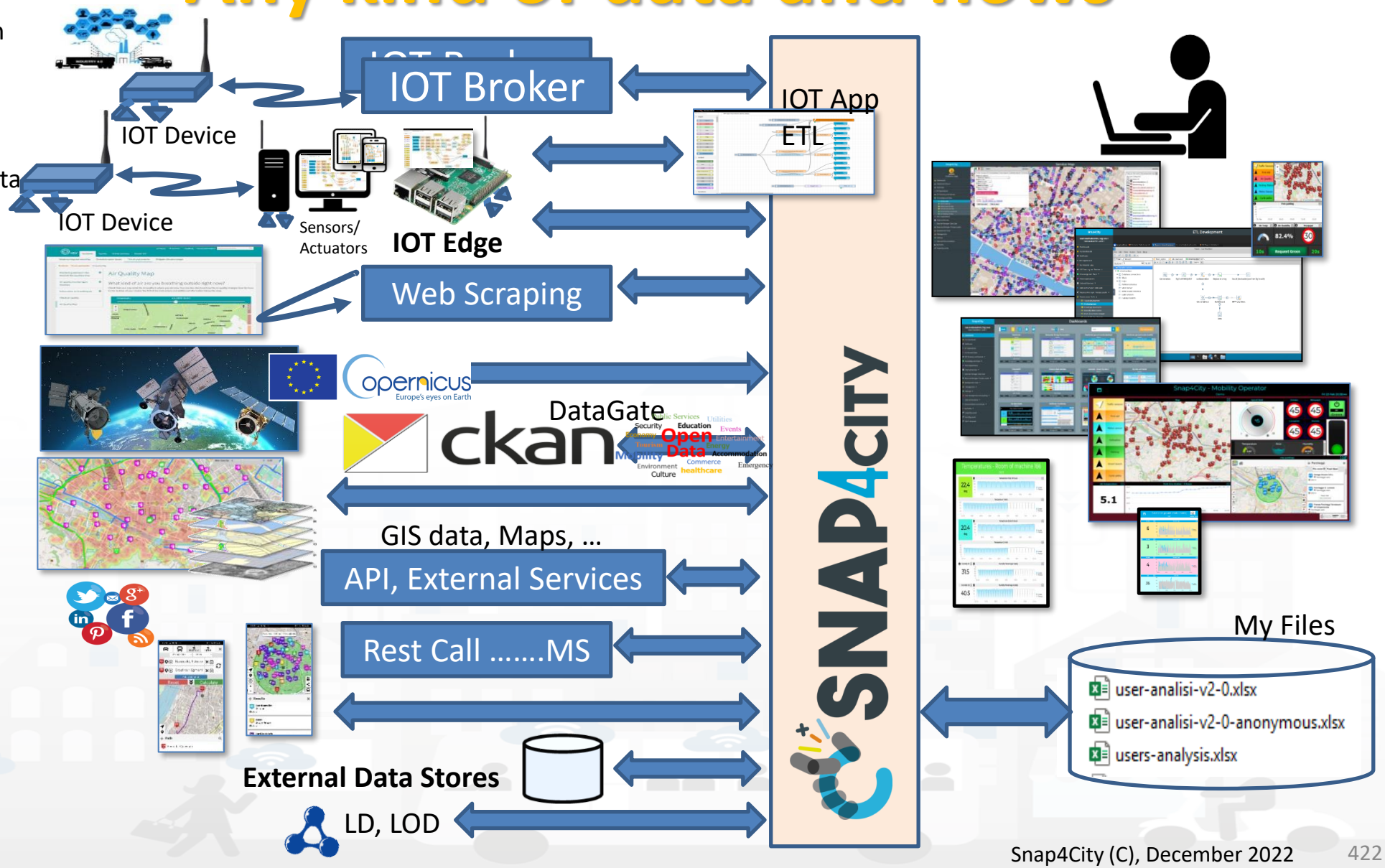
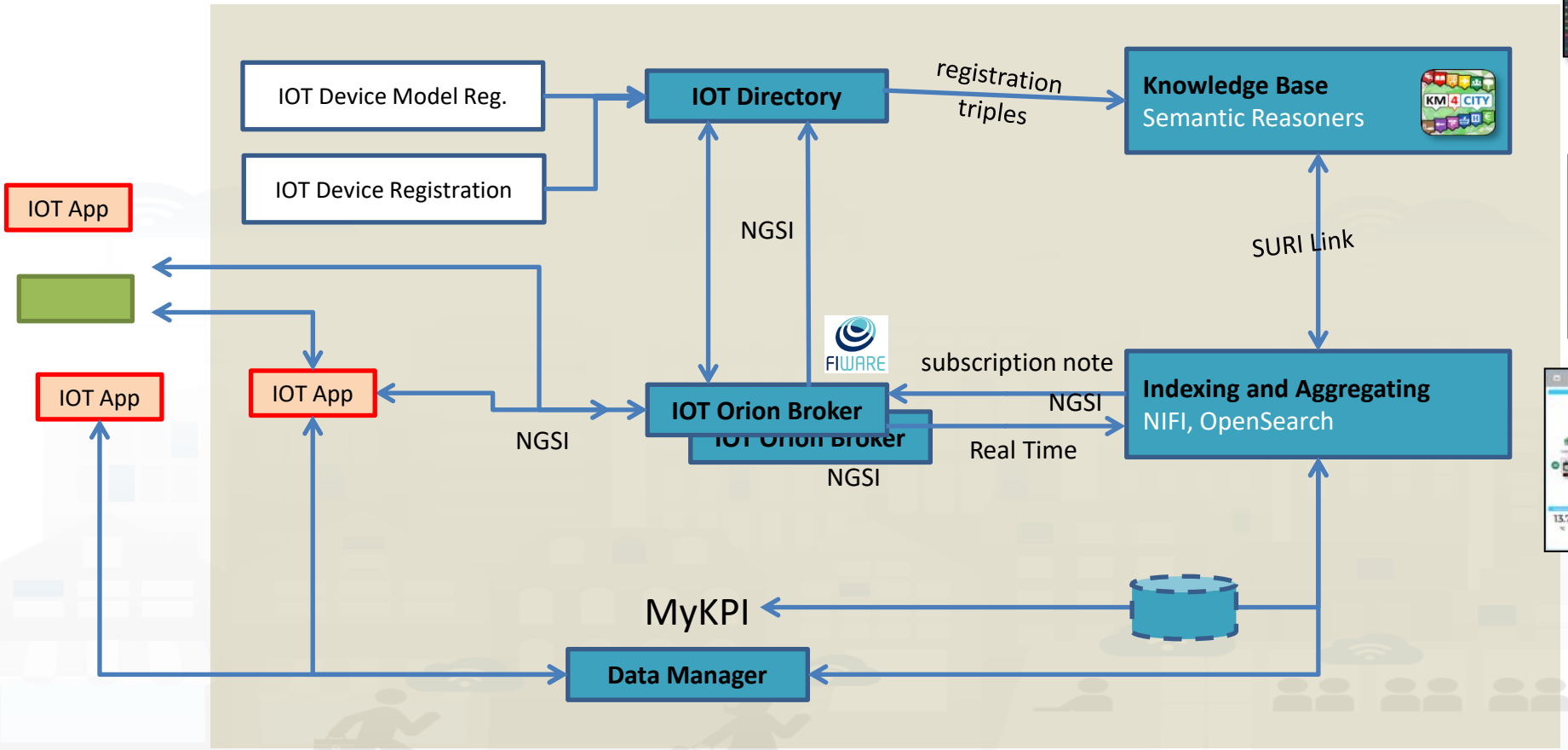
Any kind of data and flows

- **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

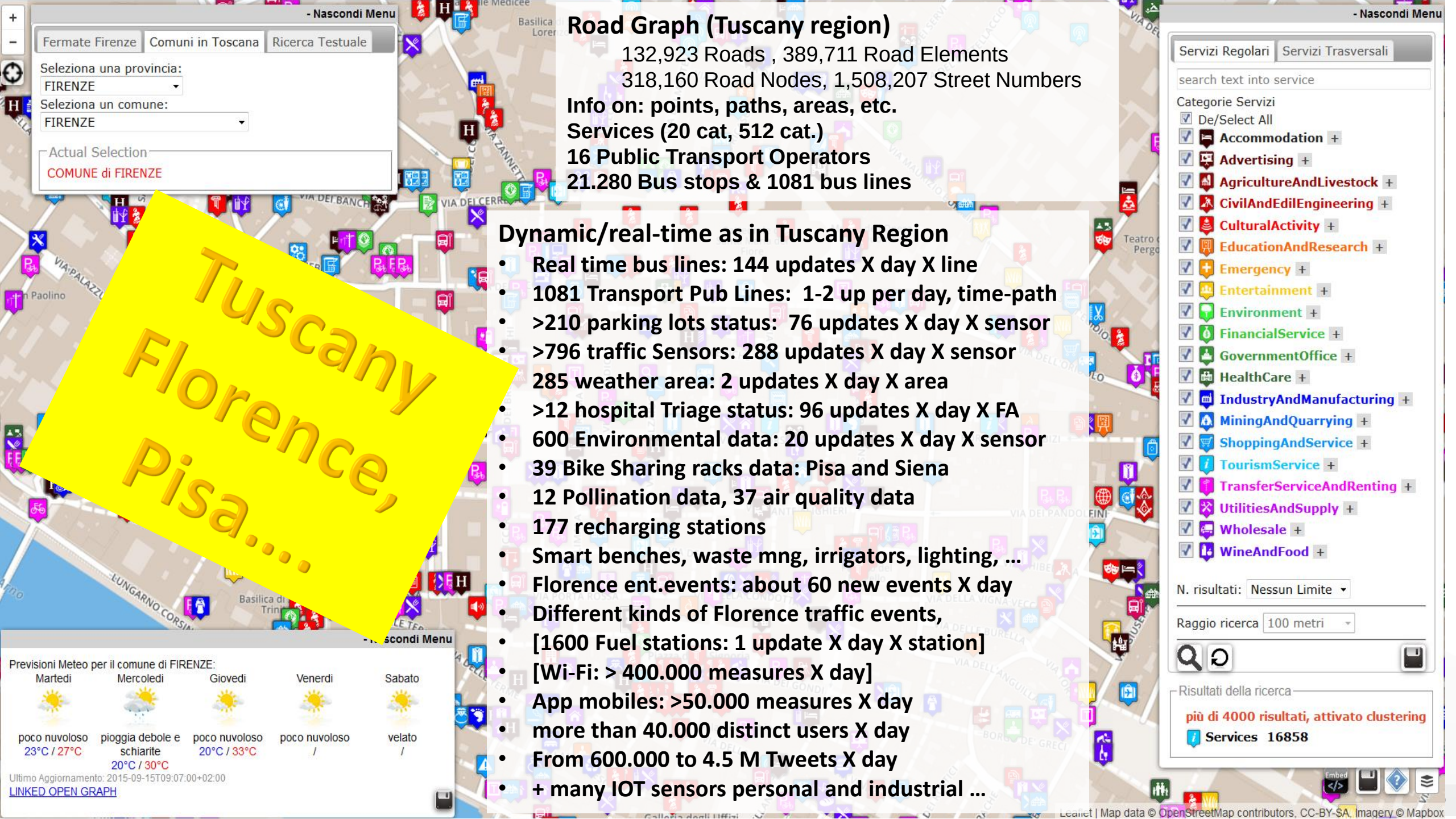


Main IoT Data In/Out flows



TOP

Data Modeling



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 …**

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

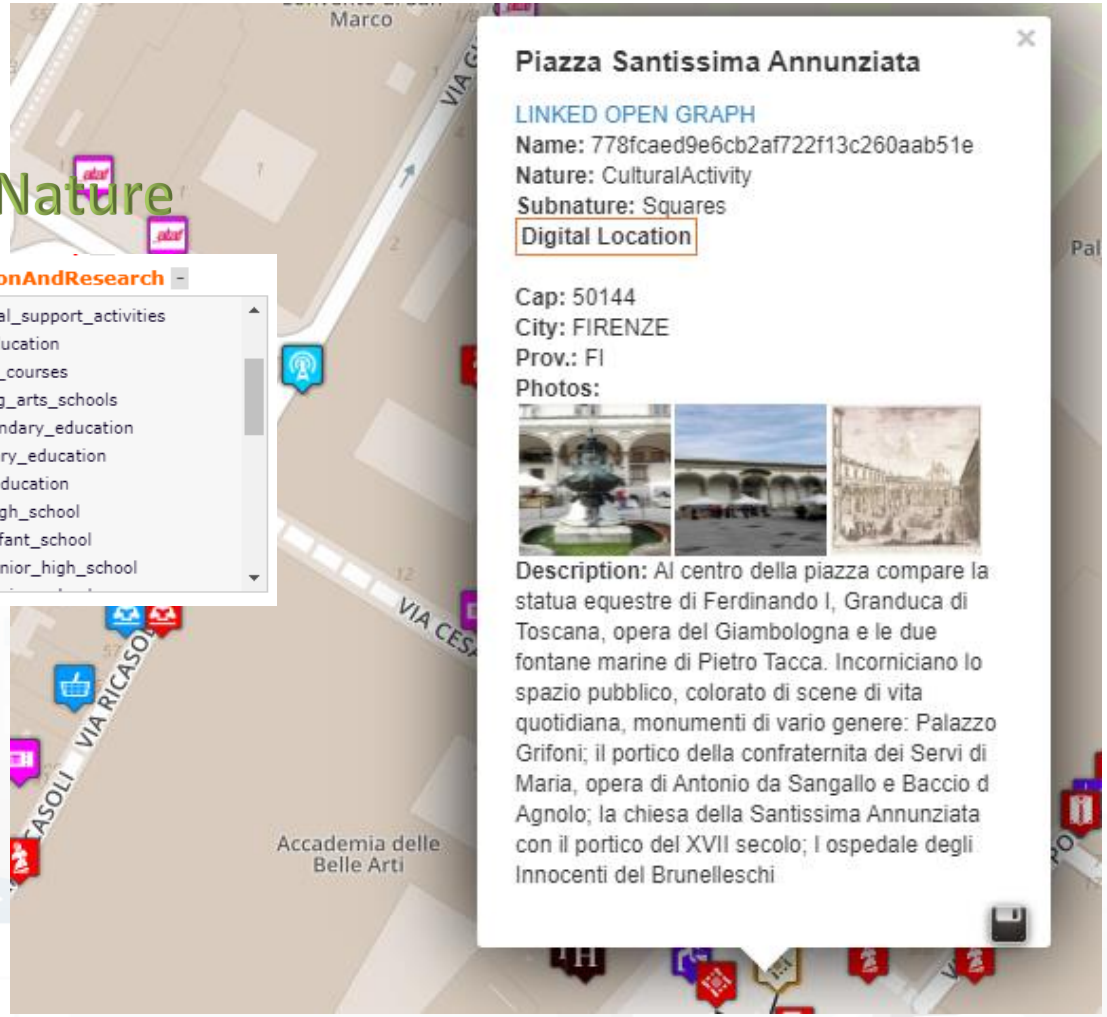
Nature

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

SubNature

EducationAndResearch -

- Educational_support_activities
- Higher_education
- Language_courses
- Performing_arts_schools
- Post_secondary_education
- Pre_primary_education
- Primary_education
- Private_high_school
- Private_infant_school
- Private_junior_high_school



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

Knowledge Base
Semantic Reasoners

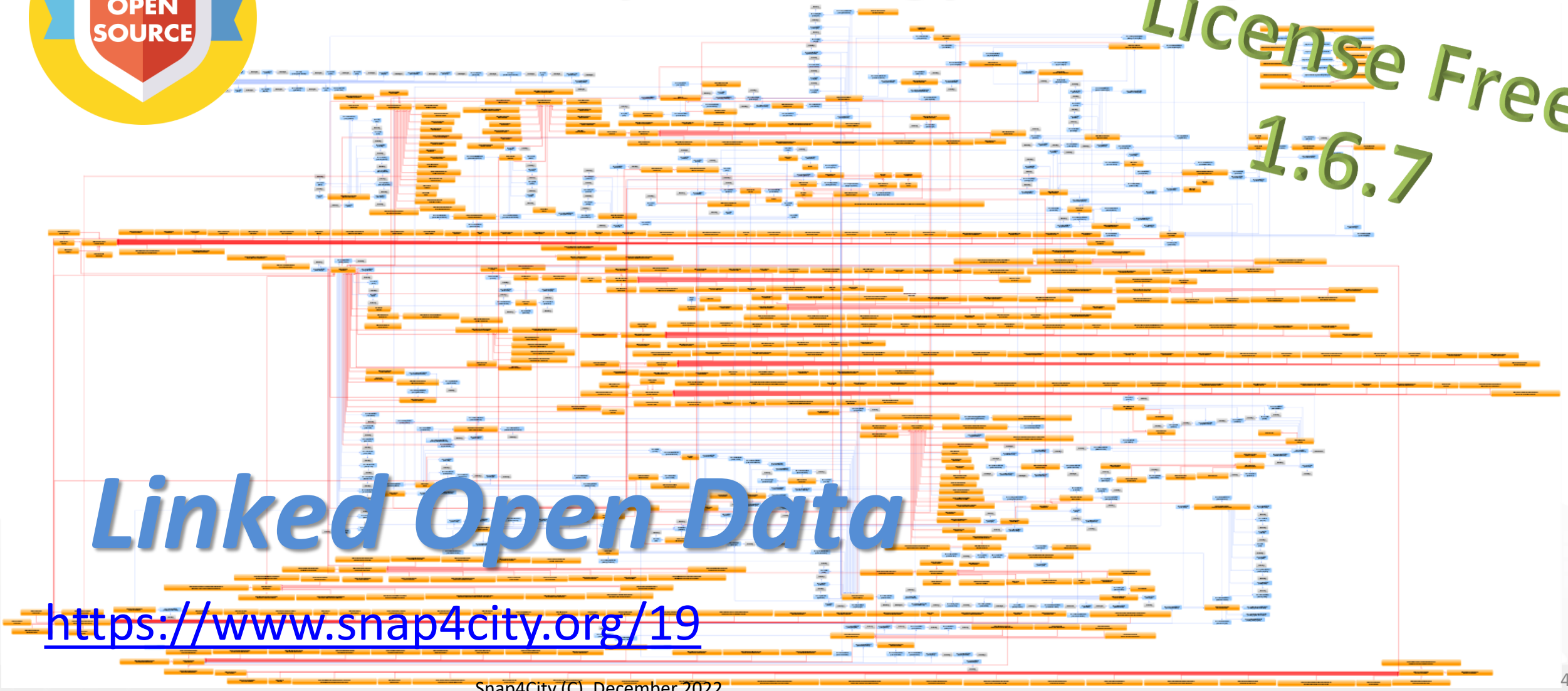
SNAP4CITY

100% OPEN SOURCE

Smart-city Ontology km4city

License Free

1.6.7



Linked Open Data

https://www.snap4city.org/19

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

TOP

Smart Data Models and Snap4City IoT Device Models

FIWARE Smart Data Models -- Library

Snap4City

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

LOGOUT

- Knowledge and Maps
- IOT Applications
- IOT Directory and Devices
  - My IOT Sensors and Actuators
  - IOT Sensors and Actuators
  - IOT Devices
  - IOT Devices Management
  - IOT Brokers
  - FIWARE Smart Data Models
  - IOT Device Models
  - IOT Devices Bulk Registration
  - Ext. MS Broker Devices Discovery
  - Ext. MS Broker Discovery
  - Ext. Broker Devs Periodic Update
  - Rules for Discovery
  - OLD IOT Orion Broker Mapping Rule
  - Doc: IOT Directory and Devices
  - Create an IOT Device Instance
  - Create an IOT Device Model
  - Add an IOT Device into Snap4City
- Resource Manager
- Development Tools

FIWIRE Smart Data Models Library

Show 10 entries Search:

Name	Subdomain	Domain	Version	Edit
Alert	Alert	CrossSector	0.0.2	EDIT
Anomaly	Alert	CrossSector	0.0.2	EDIT
Battery	Battery	CrossSector	0.0.2	EDIT
BatteryStatus	Battery	CrossSector	0.0.2	EDIT
StorageBatteryDevice	Battery	CrossSector	0.0.2	EDIT
StorageBatteryMeasurement	Battery	CrossSector	0.0.2	EDIT
CallUser	CallComplaints	CrossSector	0.0.1	EDIT
Complaint	CallComplaints	CrossSector	0.0.1	EDIT
ComplaintsCollection	CallComplaints	CrossSector	0.0.2	EDIT
ComplaintsOrganization	CallComplaints	CrossSector	0.0.2	EDIT

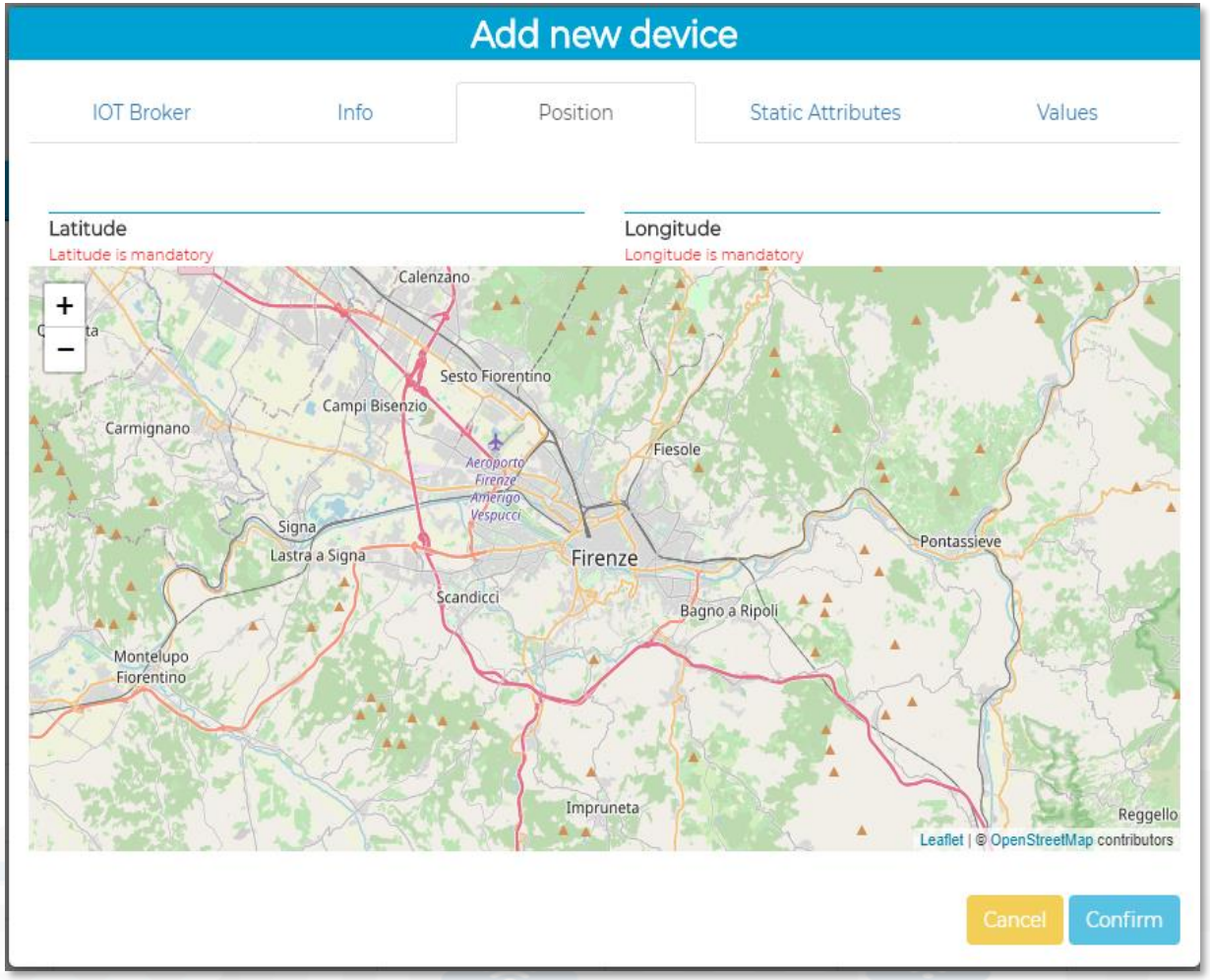
Showing 1 to 10 of 441 entries

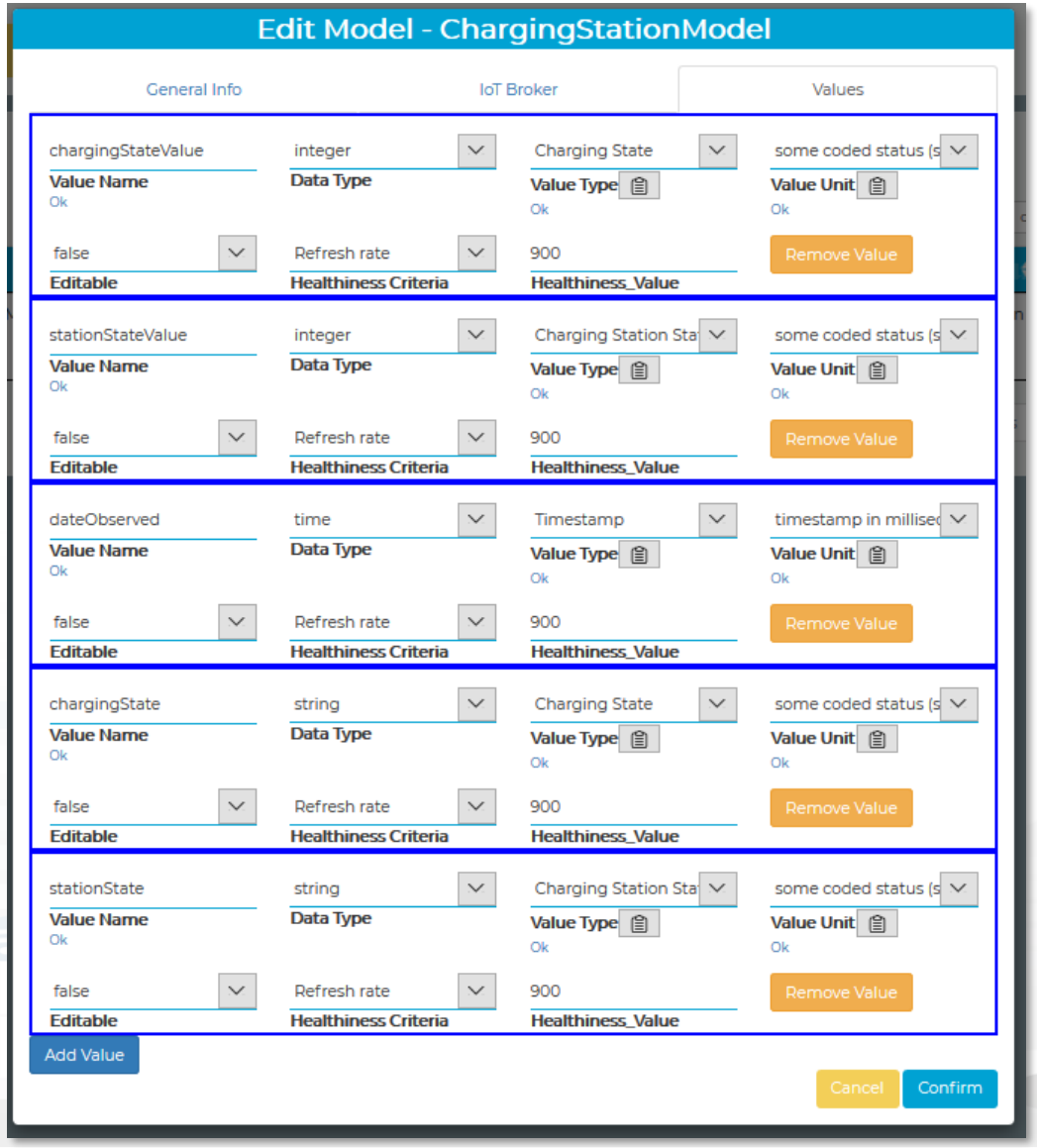
Previous 1 2 3 4 5 ... 45 Next

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

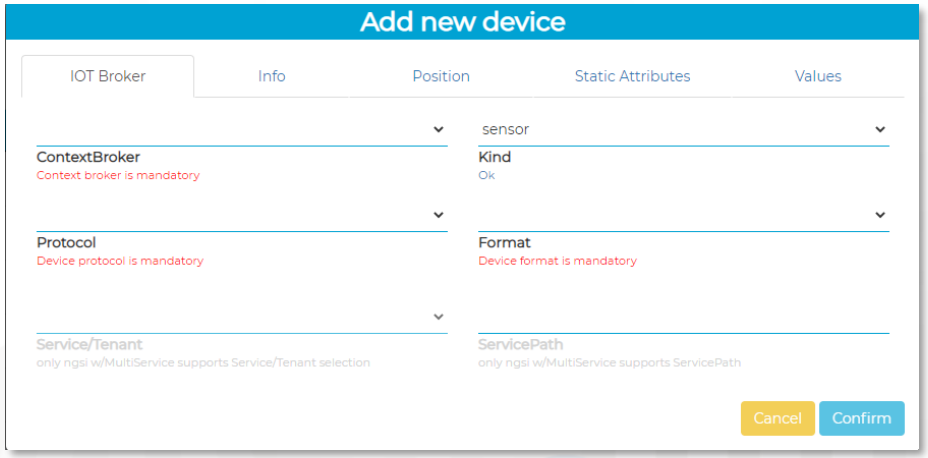
IOT Device Data Model (2)



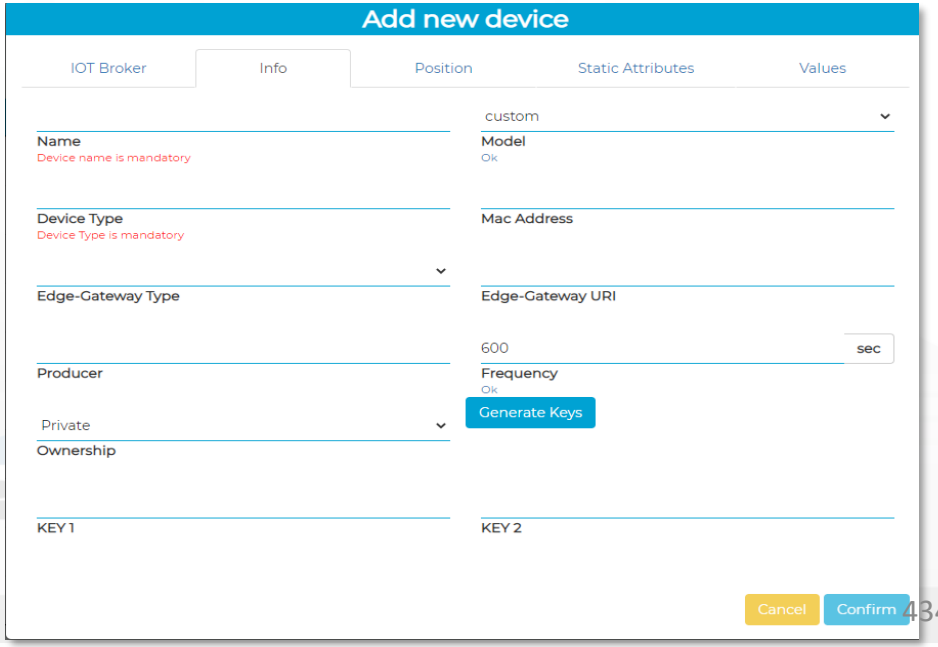


IOT Device Data Model (1)

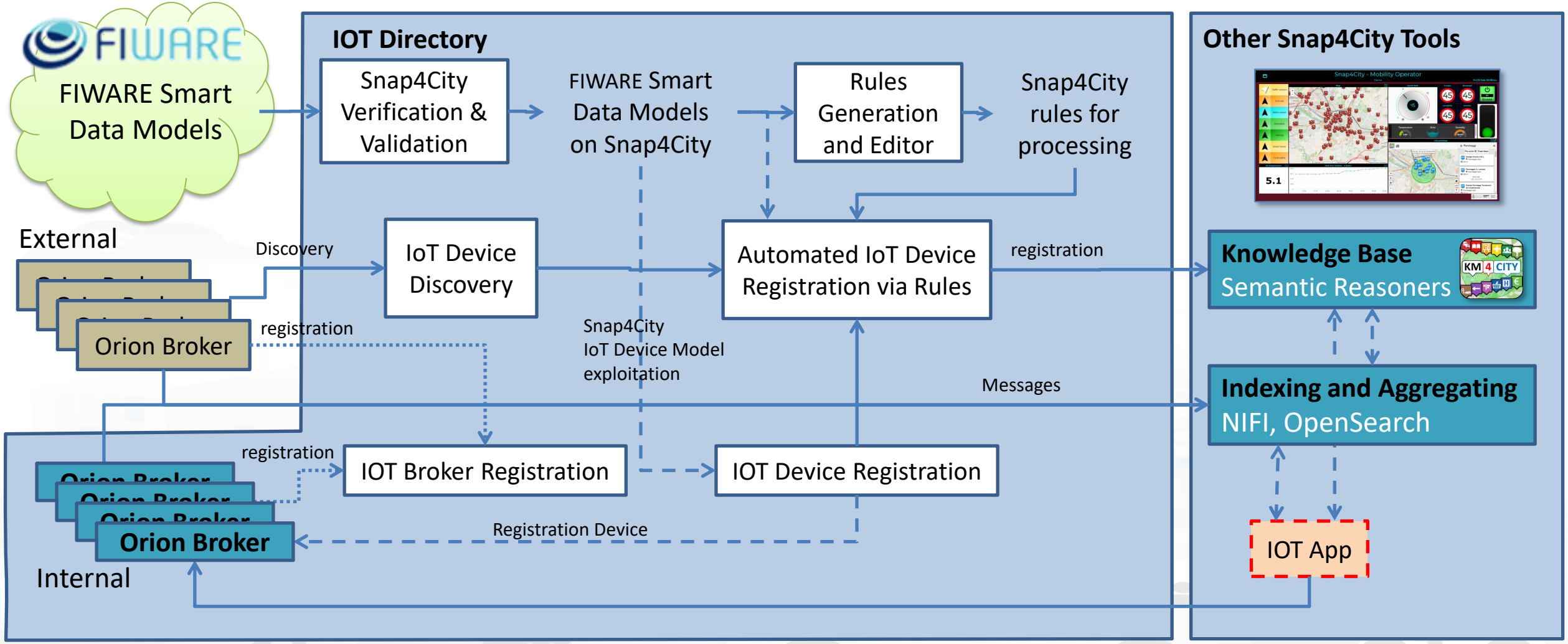
- IOT Broker
  - Name of the Brokers: among those registered
  - Protocol: NGSI, AMQP, MQTT, etc..
  - Format: CSV, JSON, XML.
  - Service/Tenant:…….
  - ServicePath:……



- 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



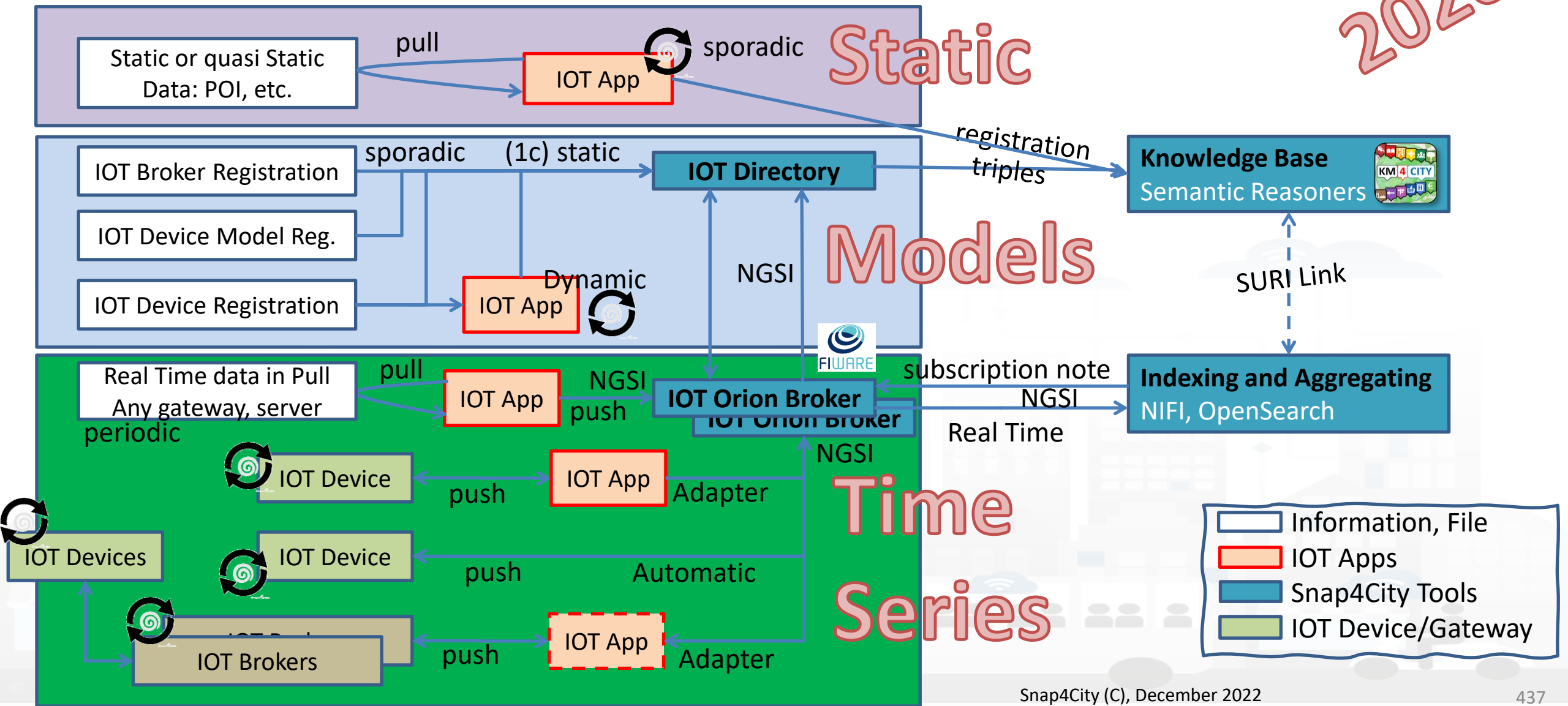
Exploiting FIWARE Smart Data Models



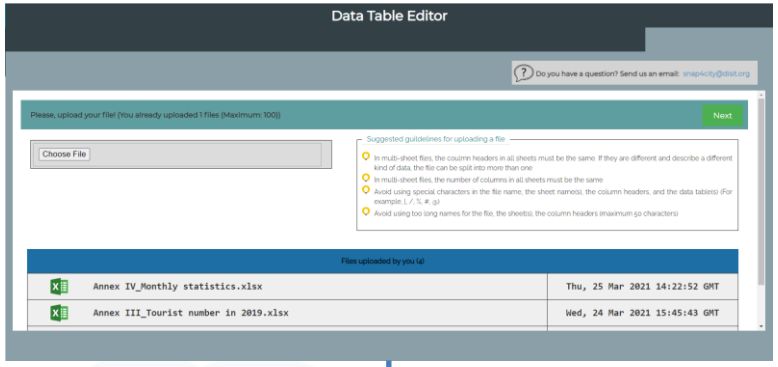
TOP

Data Ingestion and Management

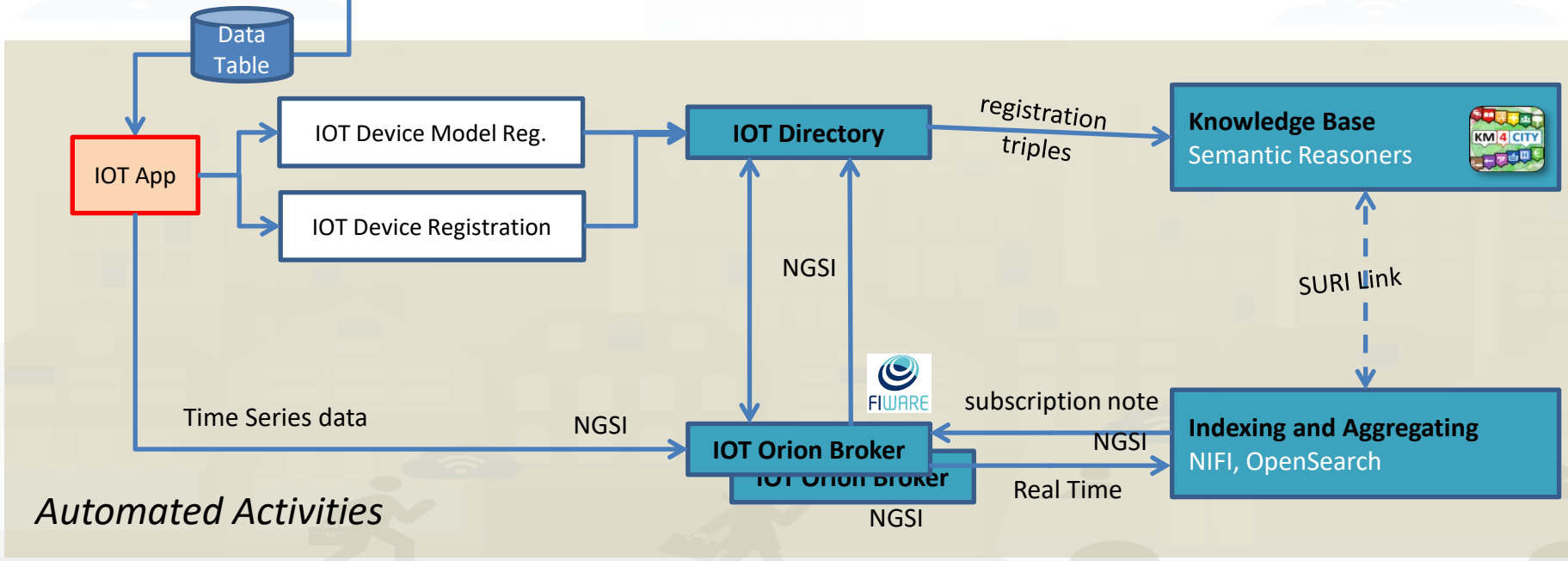
Snap4city Data Ingestion Flow Diagram



Short cut Data Ingestion from Excel file



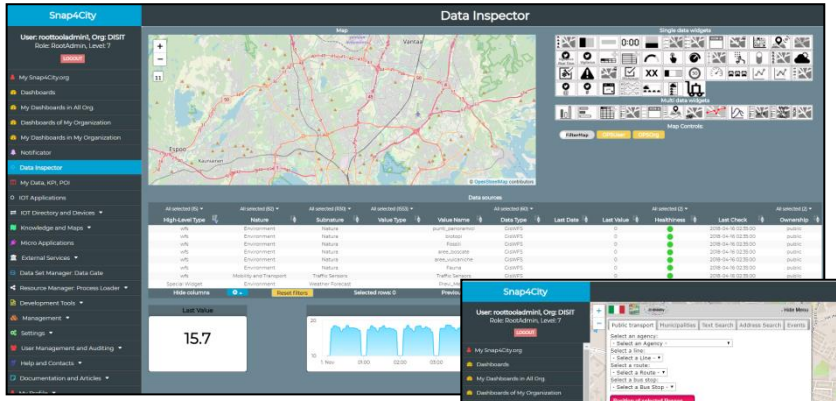
1) Upload the file on **Data Table Loader**
2) Follows the instructions and guidelines
   -- the dirty work will be done in a Snap
   -- wait! –
3) See data on your Data Inspector ☺
4) Use Data Into Dashboards ☺



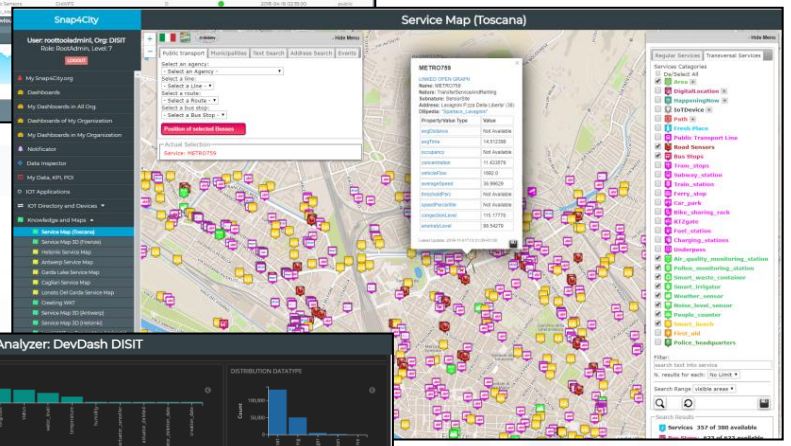
Checking data ingestion results

Knowledge base
Semantic reasoners

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



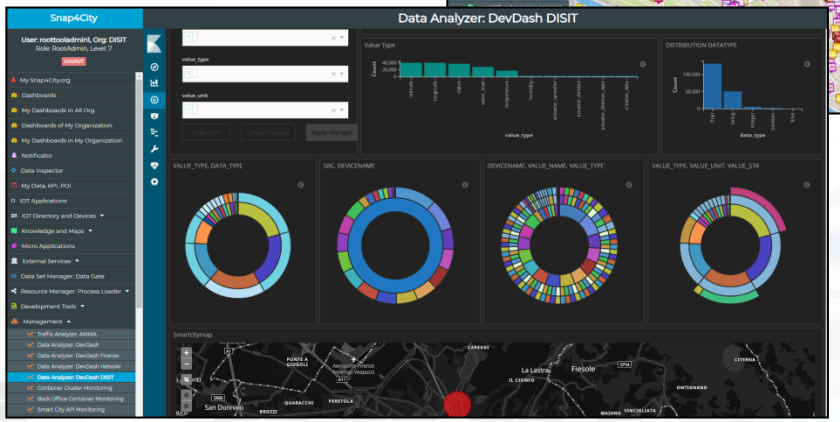
Data Inspector
Digital Twin view



ServiceMap

Indexing and aggregating
NIFI, OpenSearch

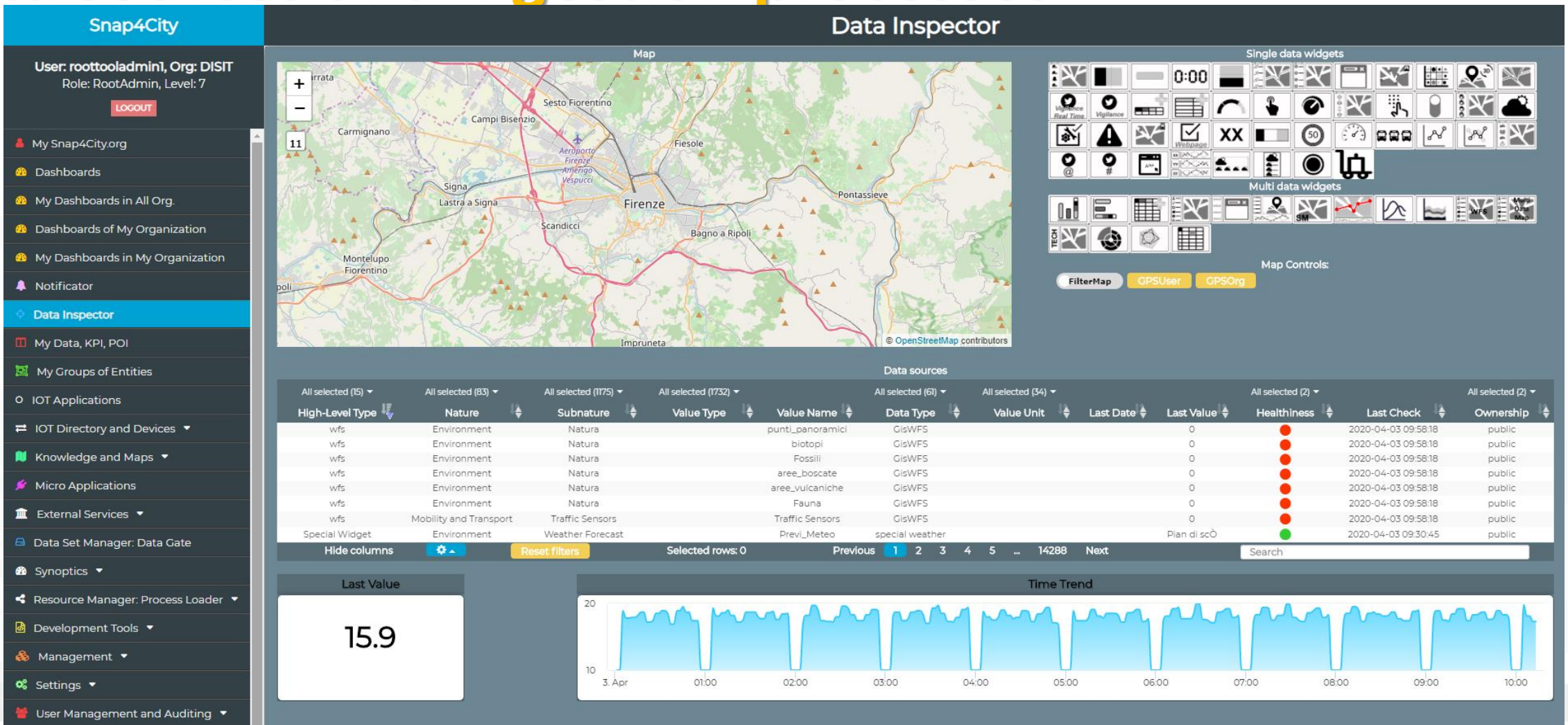
- **Data Inspector**
- **ServiceMap**, SCAPI
- **My Data Dashboard** (Kibana), DevDash
- Open Distro (ElasticSearch)



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

Data Inspector

Snap4City

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

- My Snap4City.org
- Dashboards
- My Dashboards in All Org.
- Dashboards of My Organization
- My Dashboards in My Organization
- Notificator
- Data Inspector
- My Data, KPI, POI
- 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
- Settings
- User Management and Auditing
- Help and Contacts

Map

Single data widgets

Multi data widgets

Map Controls:

FilterMap GPSUser GPSOrg

Data sources

Data sources Details

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

GPS Coordinates:	42.642033, 18.1122
High-Level Type:	Sensor
Nature:	From IOT Device to KB
Subnature:	IoTSensor
Value Name:	Dubrovnik:orionDubrovnik-UNIFI:camera_Dubrovnik_1_Ploce
Device ServiceURI or Data ID:	http://www.disit.org/km4city/resource/iot/orionDubrovnik-UNIFI/Dubrovnik/camera_Dul
Sensor ServiceURI or Data ID:	http://www.disit.org/km4city/resource/iot/orionDubrovnik-UNIFI/Dubrovnik/camera_Dul
Datasource:	IoT
Ownership:	private
Organizations:	Dubrovnik

Link to Service Map | Link to IoT Device

Last Value: 14.9

Knowledge Base view

- Click with the mouse on it

HLT: Sensor

IOT Devices

Some functionalities are limited to certain roles

HLT: Sensor

Data sources Details

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

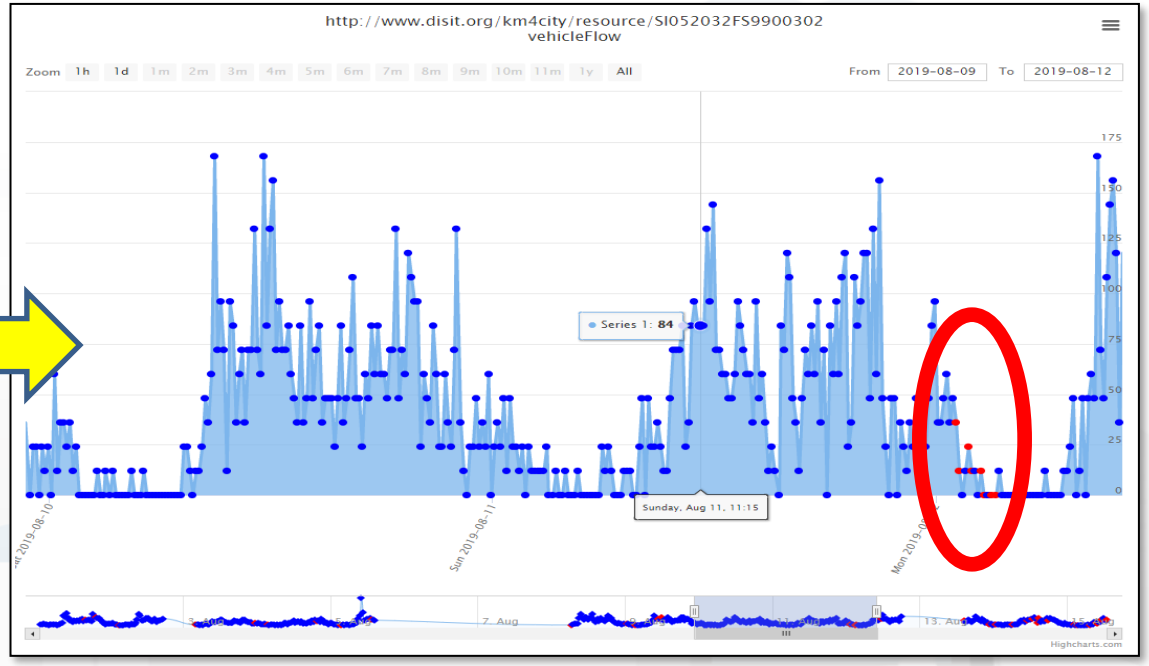
Last Date: 2020-07-21 19:00:00

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

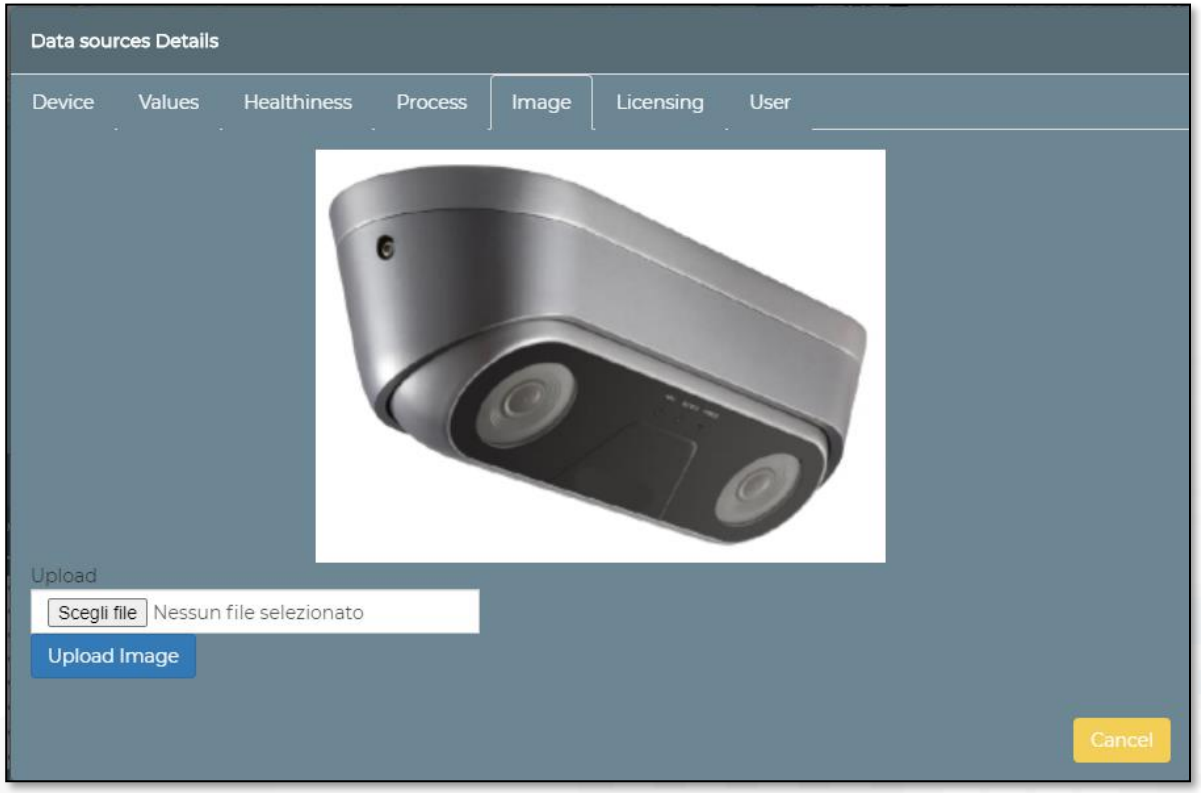
- Specific values of selected
- Information of the values of the other sensors on the same device
- View Trends, marking problems, healthiness by point according to a Fuzzy model
- Marking problems for future machine learning processes (separate tool)

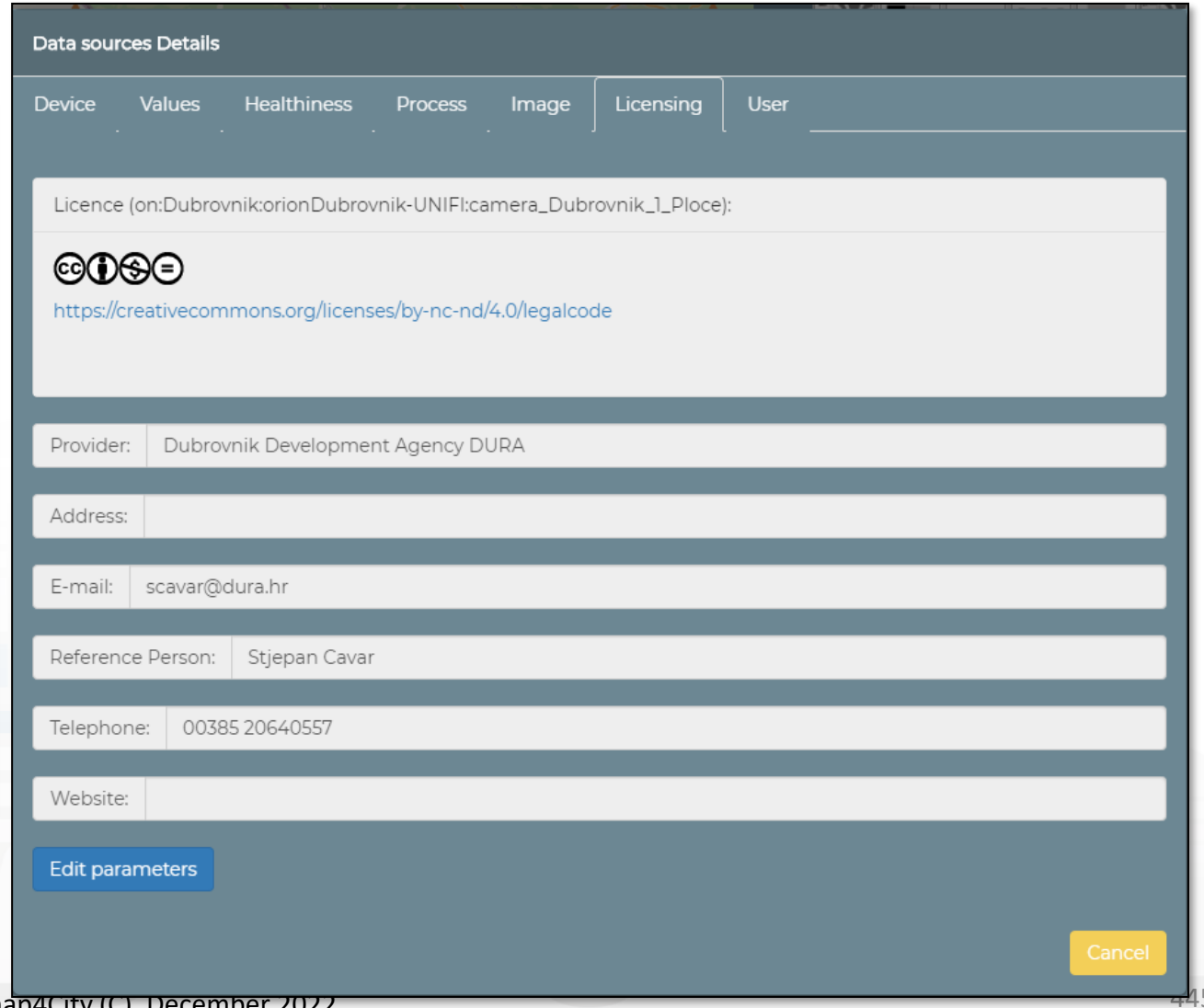


Some functionalities are limited to certain roles

HLT: Sensor

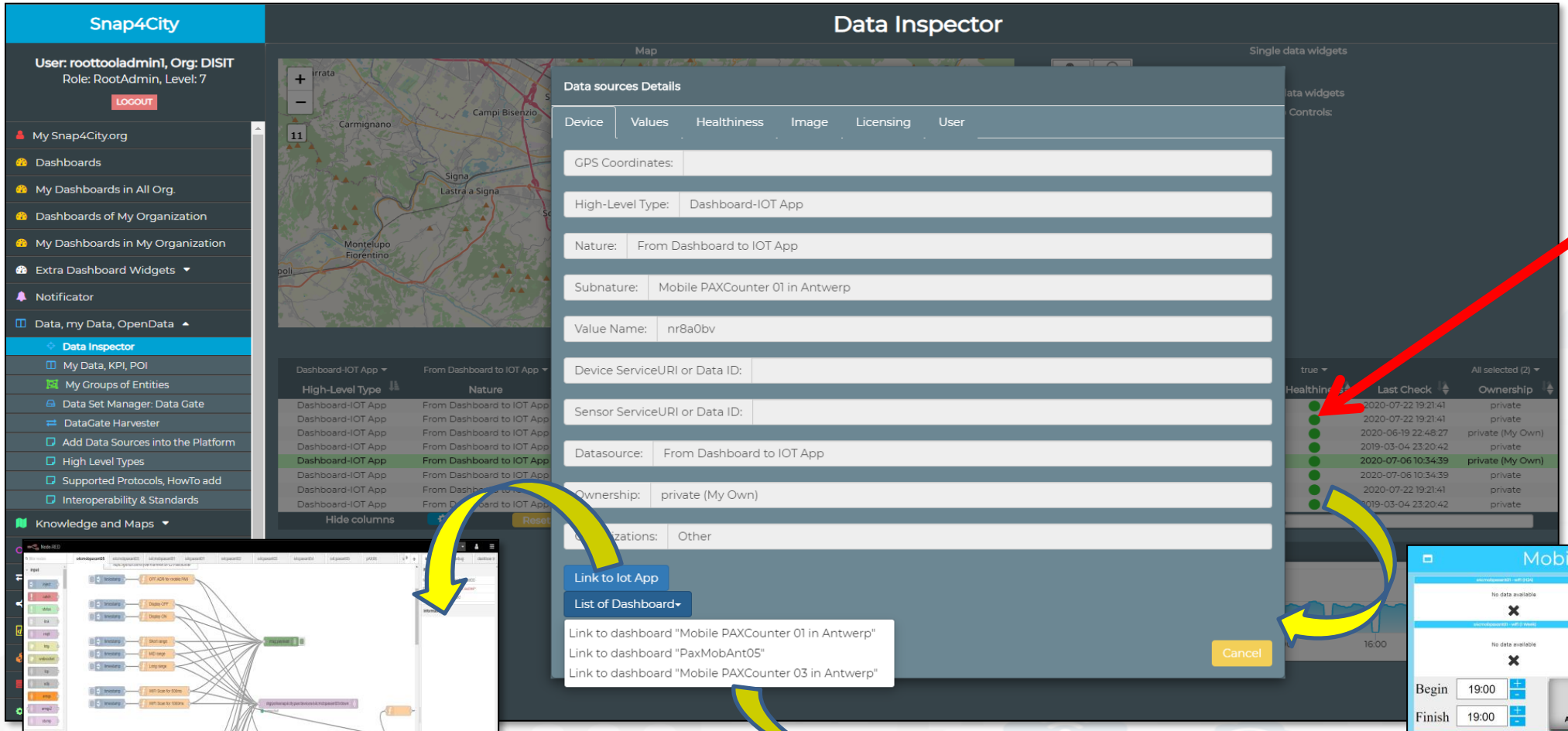
Image of the Devices and Licensing





Some functionalities are limited to certain roles

HLT: From Dashboard to IOT APP

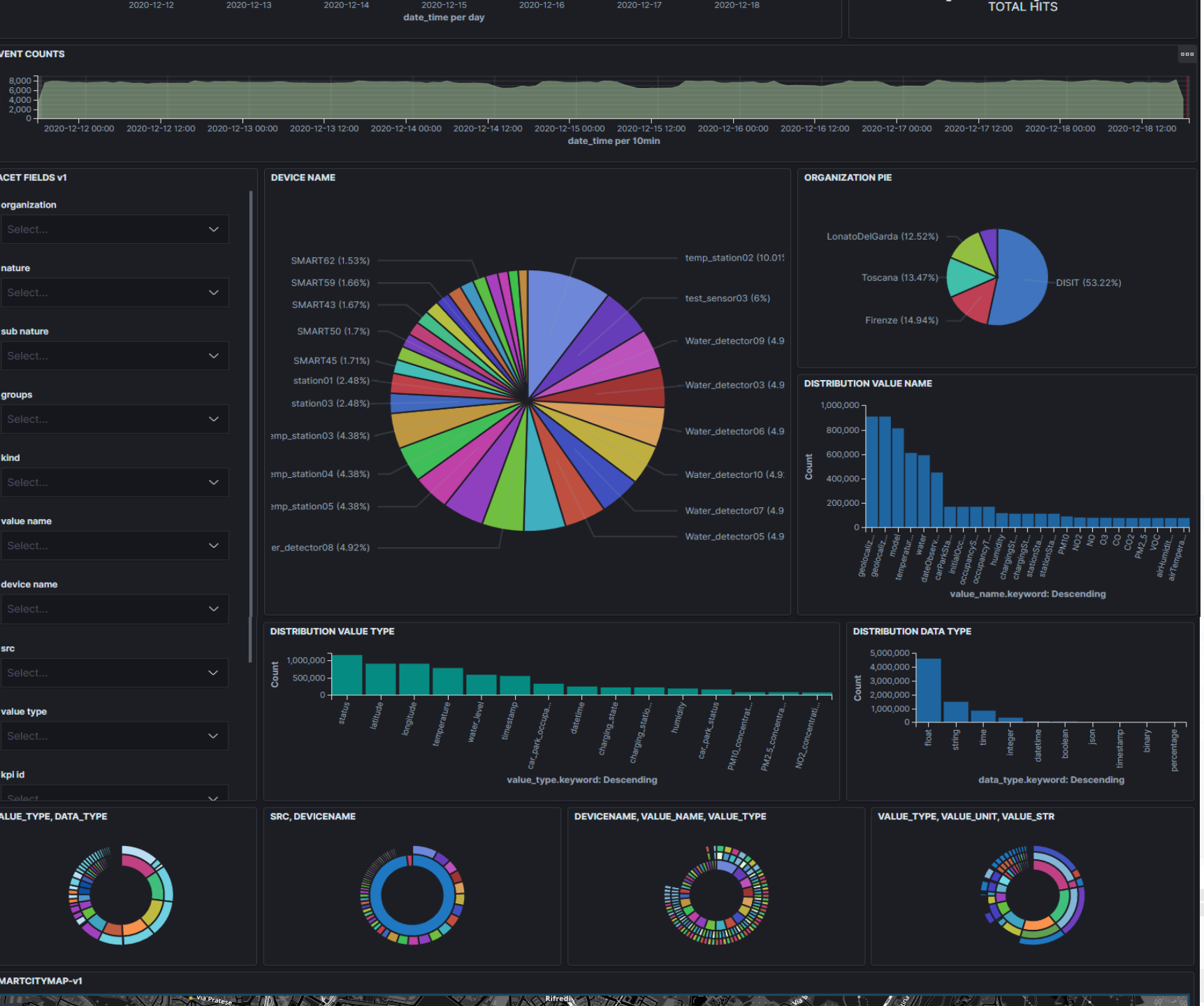


- Click with the mouse on it

kibana SNAP4CITY KM4CITY

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.

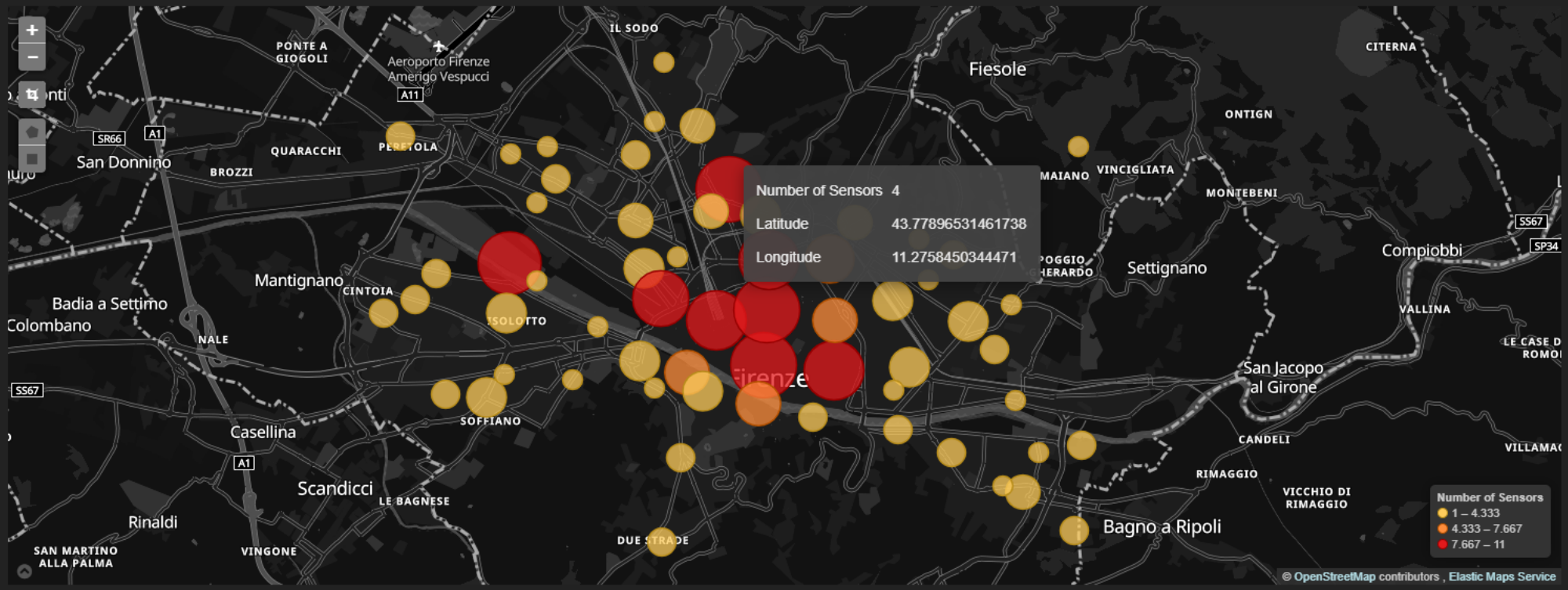
- Respect Privacy and GDPR

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

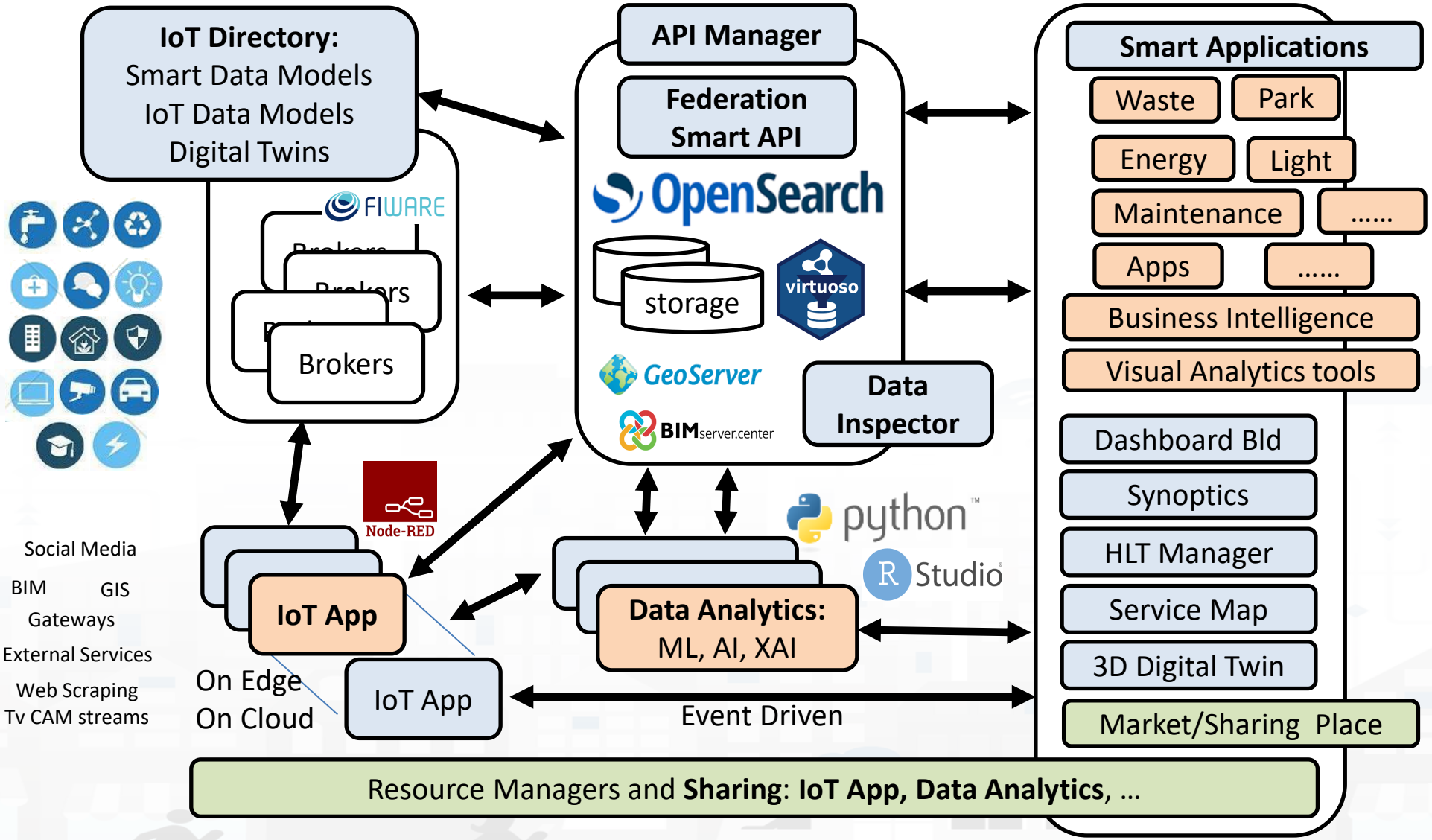
1–50 of 176,794

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	43.79737,113063	timestamp	timestamp	timestamp	http://www.disit.org/km4city/reso	#	-

TOP

Platform Integration Capabilities

Tech Arch


IoT Directory:
Smart Data Models
IoT Data Models
Digital Twins
FIWARE
Brokers
Brokers
Brokers
API Manager
Federation Smart API
OpenSearch
storage
virtuoso
GeoServer
BIMserver.center
Data Inspector
Node-RED
python
RStudio
Social Media
BIM
GIS
Gateways
External Services
Web Scraping
Tv CAM streams
IoT App
IoT App
On Edge
On Cloud
Data Analytics:
ML, AI, XAI
Event Driven
Smart Applications
Waste
Park
Energy
Light
Maintenance
.....
Apps
.....
Business Intelligence
Visual Analytics tools
Dashboard Bld
Synoptics
HLT Manager
Service Map
3D Digital Twin
Market/Sharing Place
Resource Managers and Sharing: IoT App, Data Analytics, ...

Internal and External Smart City API

Snap4City

Smart City API Docs: Swagger

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

LOGOUT

- External Services
- Data Set Manager: Data Gate
- Resource Manager: Process Loader
- Development Tools
  - Web Scraping Tool
  - Web Scraping Tool (On)
  - Web Scraping Tool (6l)
  - R Studio Development
  - R Studio Development 0.11
  - R Studio Development 0.116
  - R Studio Development TF
  - R Studio Development GFF
  - R Studio Development Gral
  - MicroServices from DataAnalytic
  - ETL Development
  - ETL Development 1
  - ETL Development 2
  - Knowledge Base Graphs
  - Knowledge Base Queries
  - Smart City API Docs: Swagger
  - Internal API Docs: Swagger
  - Testing API by Postman
  - Source Code Access
- Management
- Settings
- User Management and Auditing
- Help and Contacts
- Documentation and Articles
- My Profile

swagger

Select a spec: Advanced Smart City API

- Advanced Smart City API
- Km4city Web App API
- Orion Broker K1-K2 Authentication API
- Heatmap API

Advanced Smart City API 1.0.0 OAS3

https://www.km4city.org/swagger/external/ascapi-openapiv3.json

SMART CITY API WEB DOCUMENTATION

Servers: https://servicemap.disit.org/WebAppGrafo/api/v1

Services

GET / Service discovery and information

Events

GET /events/ Event search

Locations

GET /location/ Address and geometry search by GPS

Public Transport

GET /tpl/agencies/ Agency list

GET /tpl/bus-lines/ (Bus) Lines list

GET /tpl/bus-routes/ (Bus) Routes list

ernal API Docs: Swagger

Select a spec: IoT device registration API

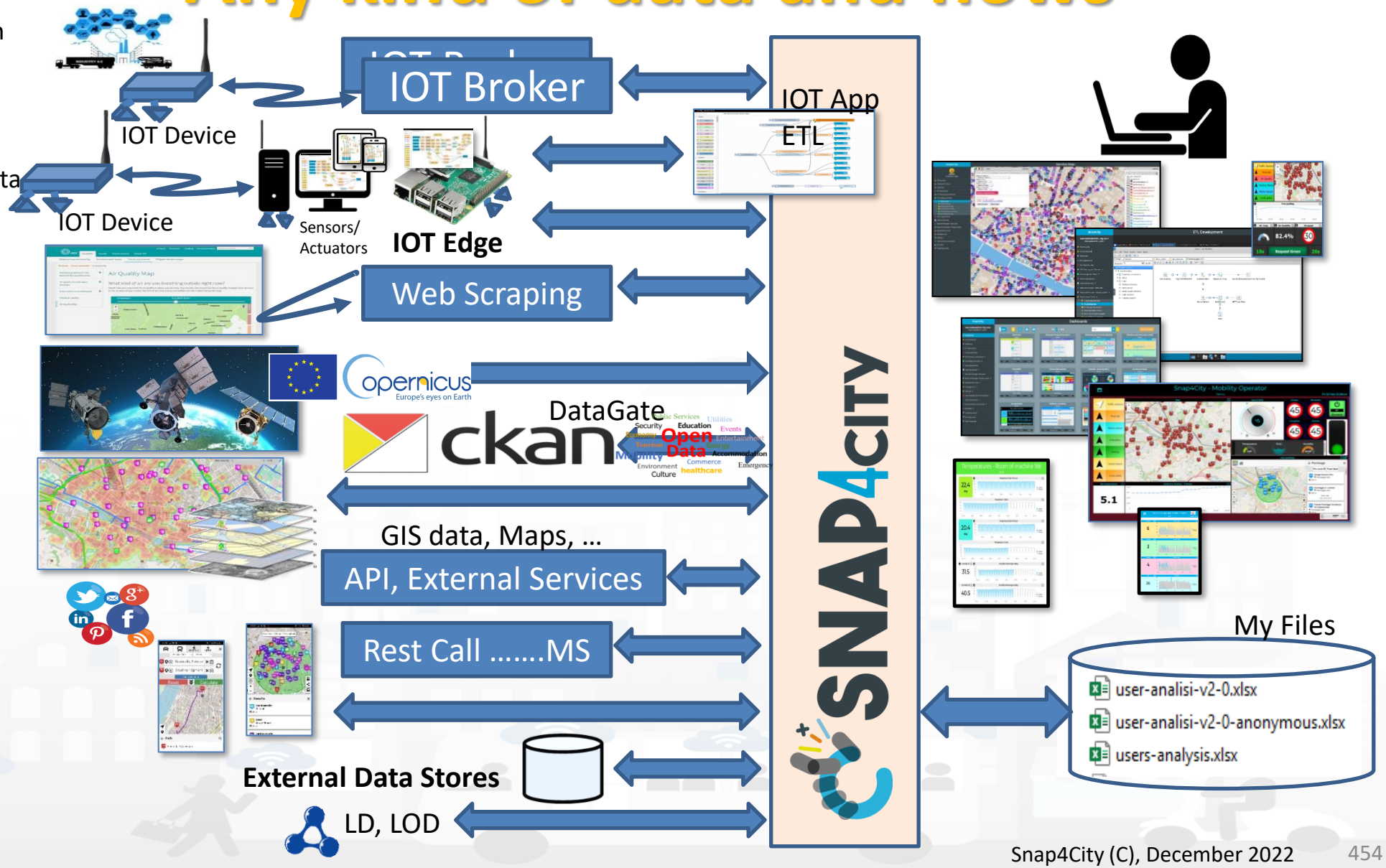
- IoT device registration API
- Notificator API
- DISCES scheduler API
- Resource Manager API
- Sensors API
- Event Logger API
- Ownership API
- Data Manager API
- Device, Broker and Value Mgmt API
- Snap4City Application API
- Engager API
- Wallet API
- User Profiler API
- My KPI API
- Snap vs Openmaint API
- Device Groups API
- Sci-Hub Processing 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 (9/2022)

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, Proximus, ..
- **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, Satellite, D3 JSON, …
- **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, AXIS, ESP32, etc.

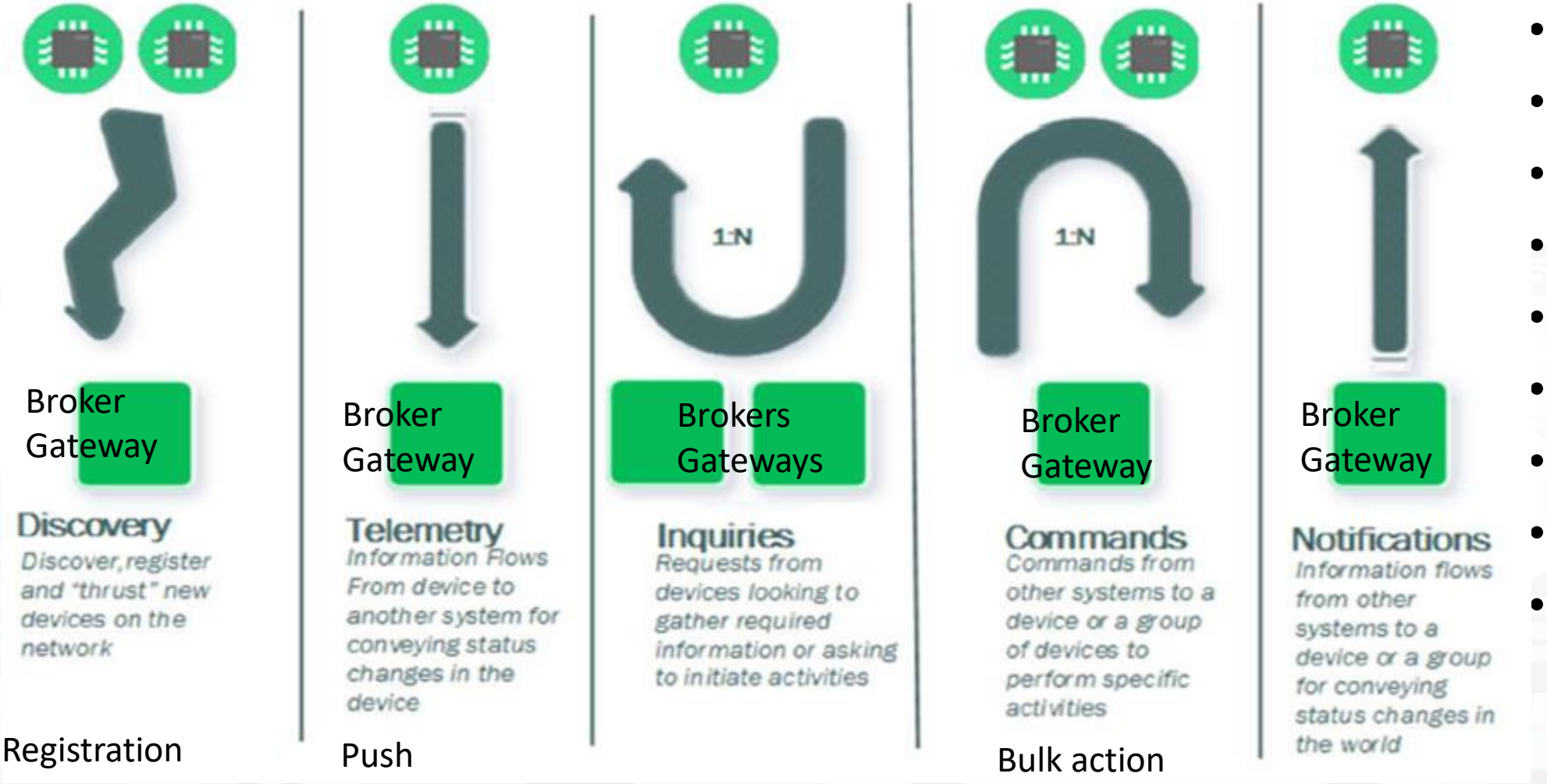
https://www.snap4city.org/65

TOP

IOT Network Interoperability

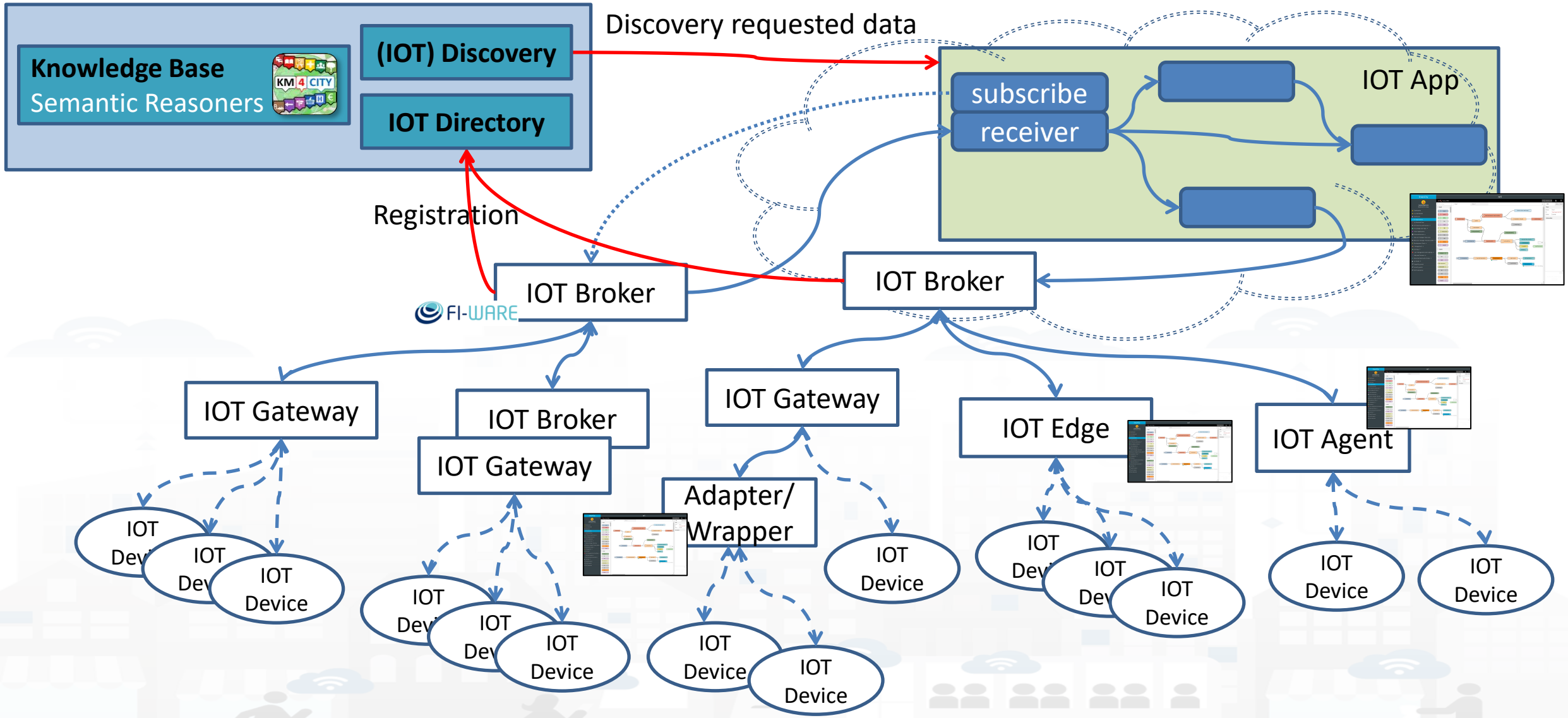
IOT/IOE Protocols

Communication Patterns

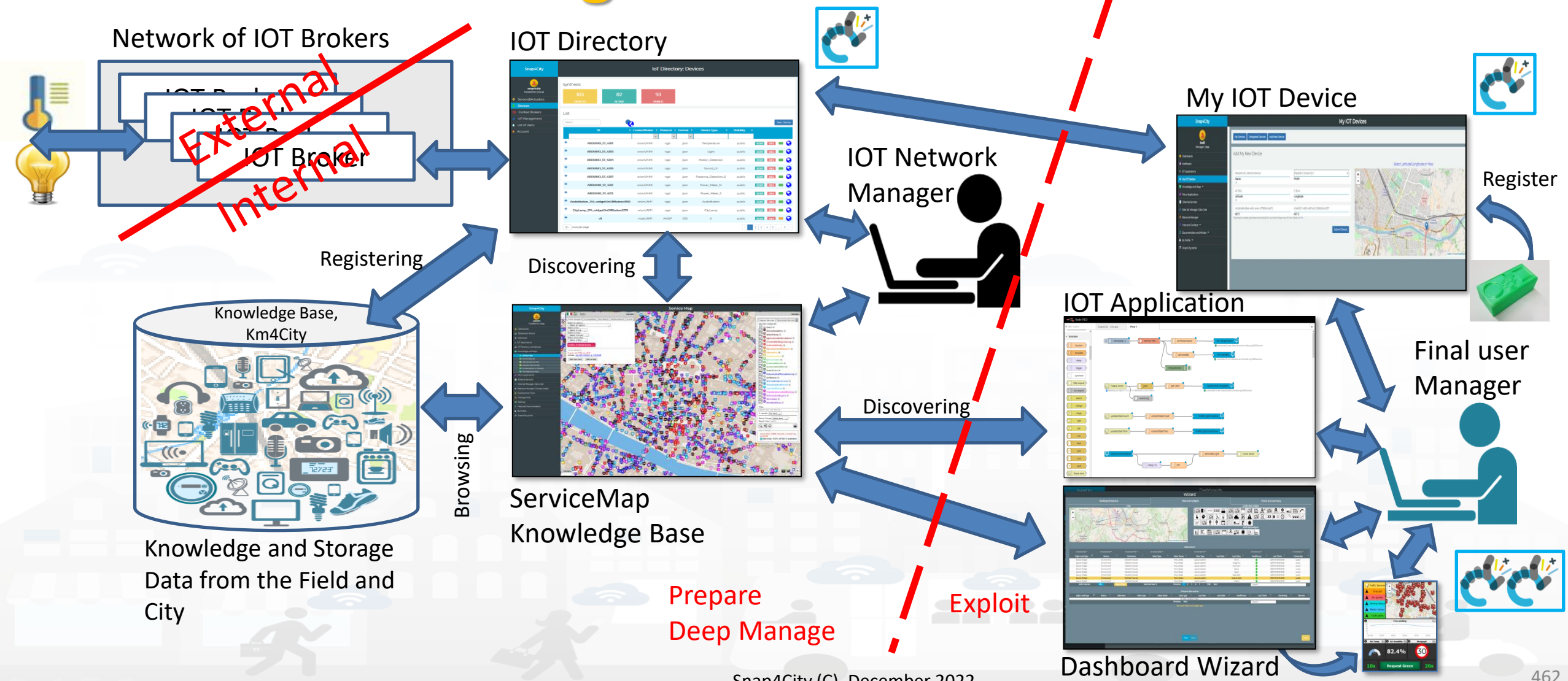


- MQTT
- HTTP(s)
- AMQP
- COAP
- NGSI
- OneM2M
- WebSockets
- ……..
- Etc.

IoT Network


Knowledge Base
Semantic Reasoners
(IOT) Discovery
IOT Directory
Discovery requested data
IOT App
subscribe
receiver
Registration
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

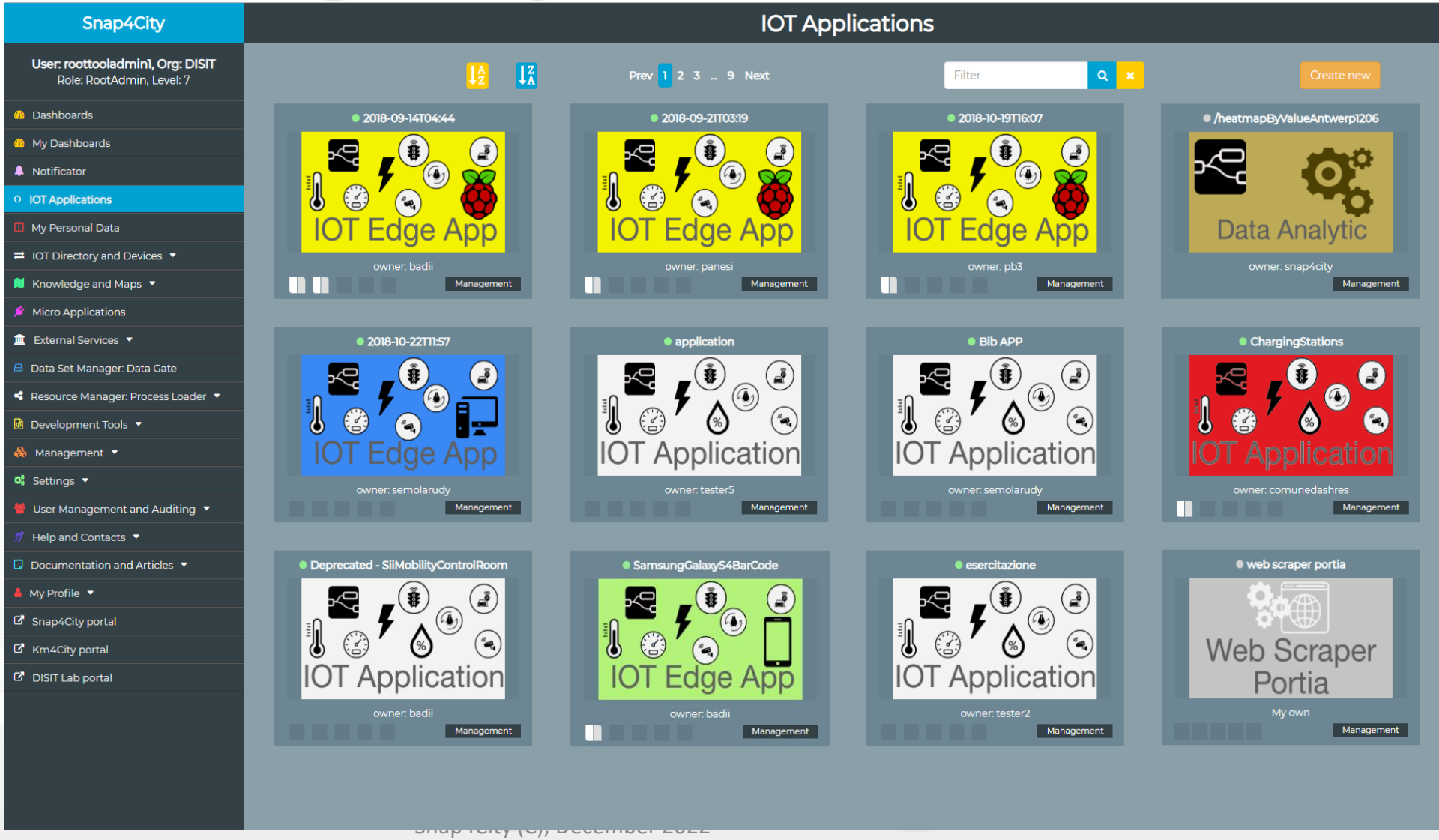


TOP

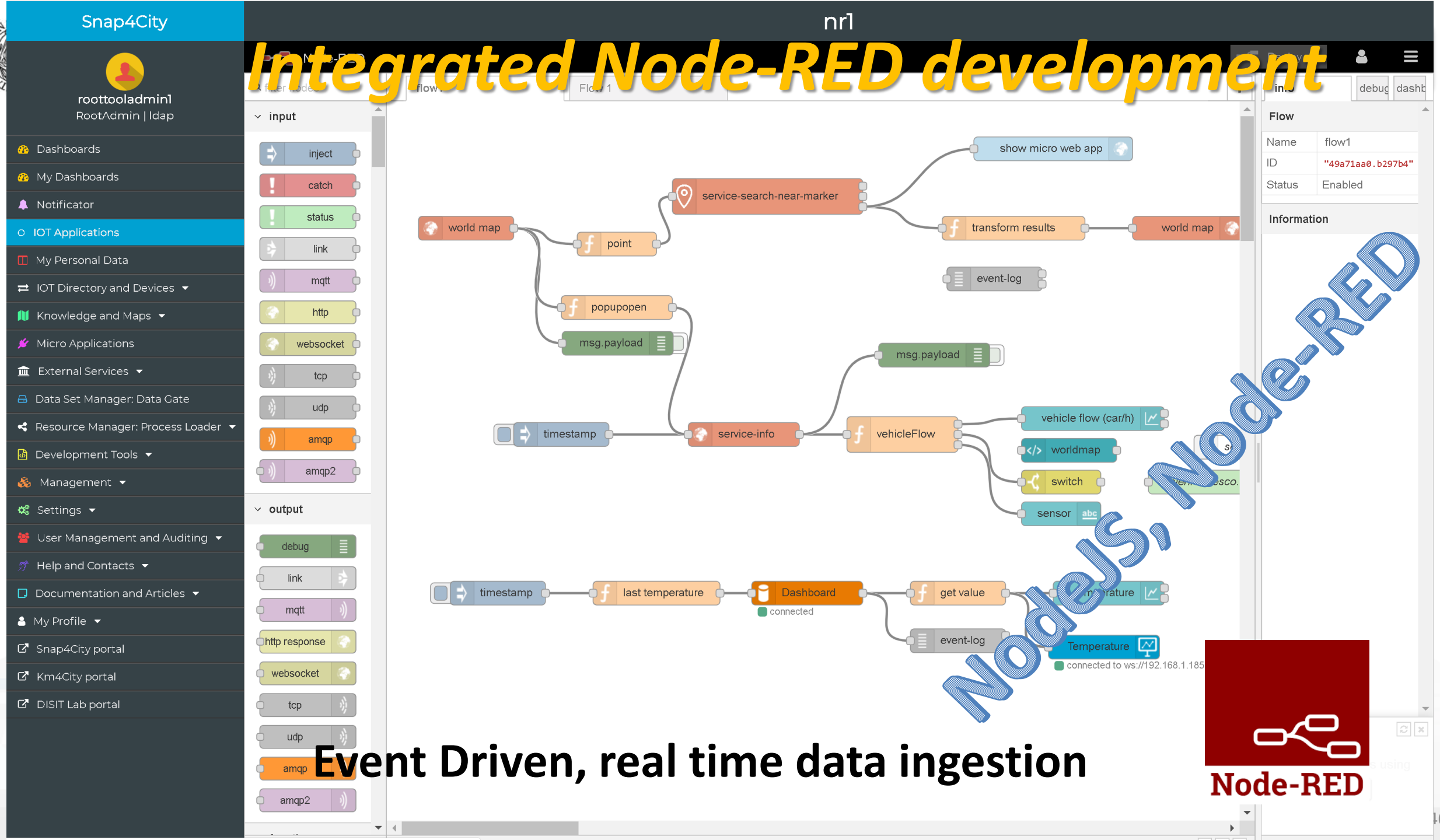
Integration via IoT Apps and processes

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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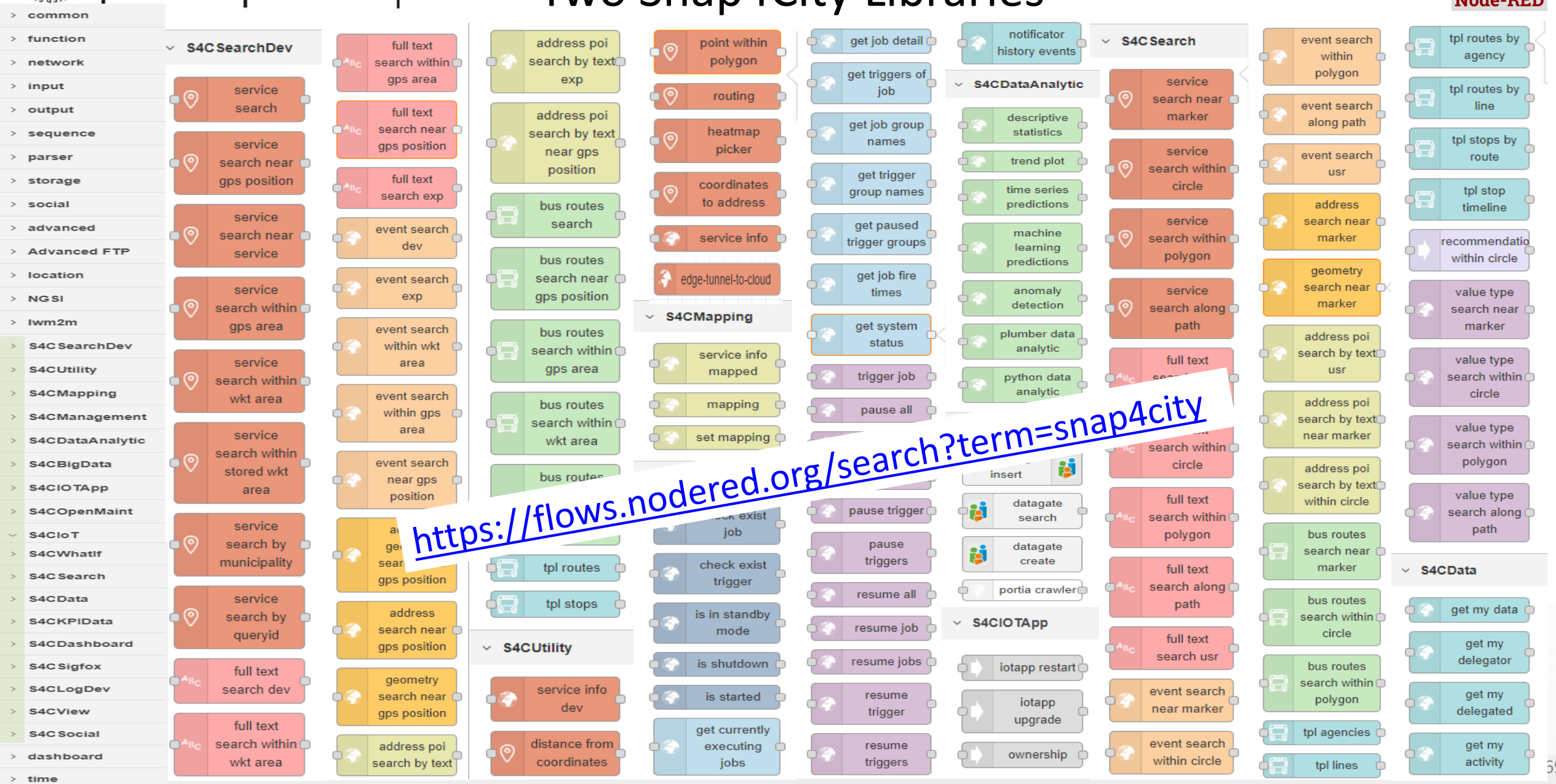
Sept 2022 collection

Two Snap4City Libraries

SNAP4CITY | Node-RED



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

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Sept 2022 collection

Two Snap4City Libraries

SNAP4CITY | Node-RED

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

common
function
network
input
output
sequence
parser
storage
social
advanced
Advanced FTP
location
NGSI
lwm2m
S4CSearchDev
S4CUtility
S4CMapping
S4CManagement
S4CDataAnalytic
S4CBigData
S4CIOTApp
S4COpenMaint
S4CIoT
S4CWhatIf
S4CSearch
S4CData
S4CKPIData
S4CDashboard
S4CSigfox
S4CLogDev
S4CView
S4CSocial
dashboard
time

get other activity on my data
save my data
get my annotation
get anonymous data
get other data

S4CKPIData

get my kpidata
get delegated kpidata
get public kpidata
get my kpidata values
get public kpidata values
get delegated kpidata values
delegate my kpidata
get iotapps using my kpidata
save my kpidata values

S4CDashboard

coordinates - from - map
impulse - button
numeric - keyboard
switch - button
dimmer
geolocator
dropdown
form
gauge - chart
single - content
speedometer
horizontal - single - bar
vertical - single - bar
web - content
time - trend
bar - series
radar - series
pie - chart
curved - line - series

table - content
calendar
speak - synthesis
selector - to - map
dashboard - map
event - driven - my - kpi
synoptic - read
synoptic - write
synoptic - subscribe

S4COpenMaint

om get processes
om get teams
om get components
om get plants
om get status
om create new process
om advance process
om details process
om delete process

S4CIoT

iotdirectory new device from model
delegate my device
change ownership my device
iot directory
iot directory
iot directory link
iot directory link
iotdirectory get device
fiware orion subscribe v1
fiware orion query v1
fiware orion update v1
fiware orion out v1
fiware orion subscribe api v2
fiware orion query api v2
fiware orion update api v2
fiware orion out api v2
fiware orion in v2
fiware orion query v2
fiware orion out v2
fiware orion in v2(url syntax v1)
fiware orion query v2(url syntax v1)
fiware orion out v2(url syntax v1)
snap4all button

S4CLogDev

event log

S4CView

show micro web app
show general iframe

S4CSocial

twitter last channel
twitter last tweet

S4CSigfox

sigfox device filter
sigfox

S4CIoT

save typical time trends
get typical time trends

S4CWhatIf

get my scenarios
save a scenario

AND: From Resource Manager

UserCreated

Twitter Herit Data Sentiment Analysis Channel
Twitter Herit Data Sentiment Analysis Search
TwitterVigilance Herit Data Tw Rtw Channel
TwitterVigilance Herit Data Tw Rtw Search
Sci Hub Copernicus Completed
Sci Hub Copernicus Indexed
Sci Hub Copernicus Polygon

We suggest also to install:

NGSI

NGSI Entity
NGSI Dataset
NGSI Update
NGSI Subscription
NGSI v2ToLD

lwm2m

lwm2m client
lwm2m client

Advanced FTP

Advanced FTP
Advanced FTP Logger

social

email
twitter
email
twitter

subflows

triplesToVirtuo

location

utm
turf
worldmap
worldmap in
tracks
convex hull

Maps Business Logic vs IOT Apps

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

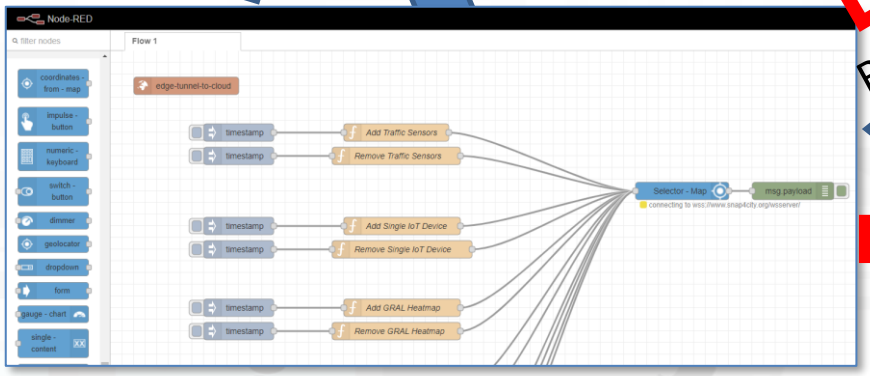
data

Selector

data

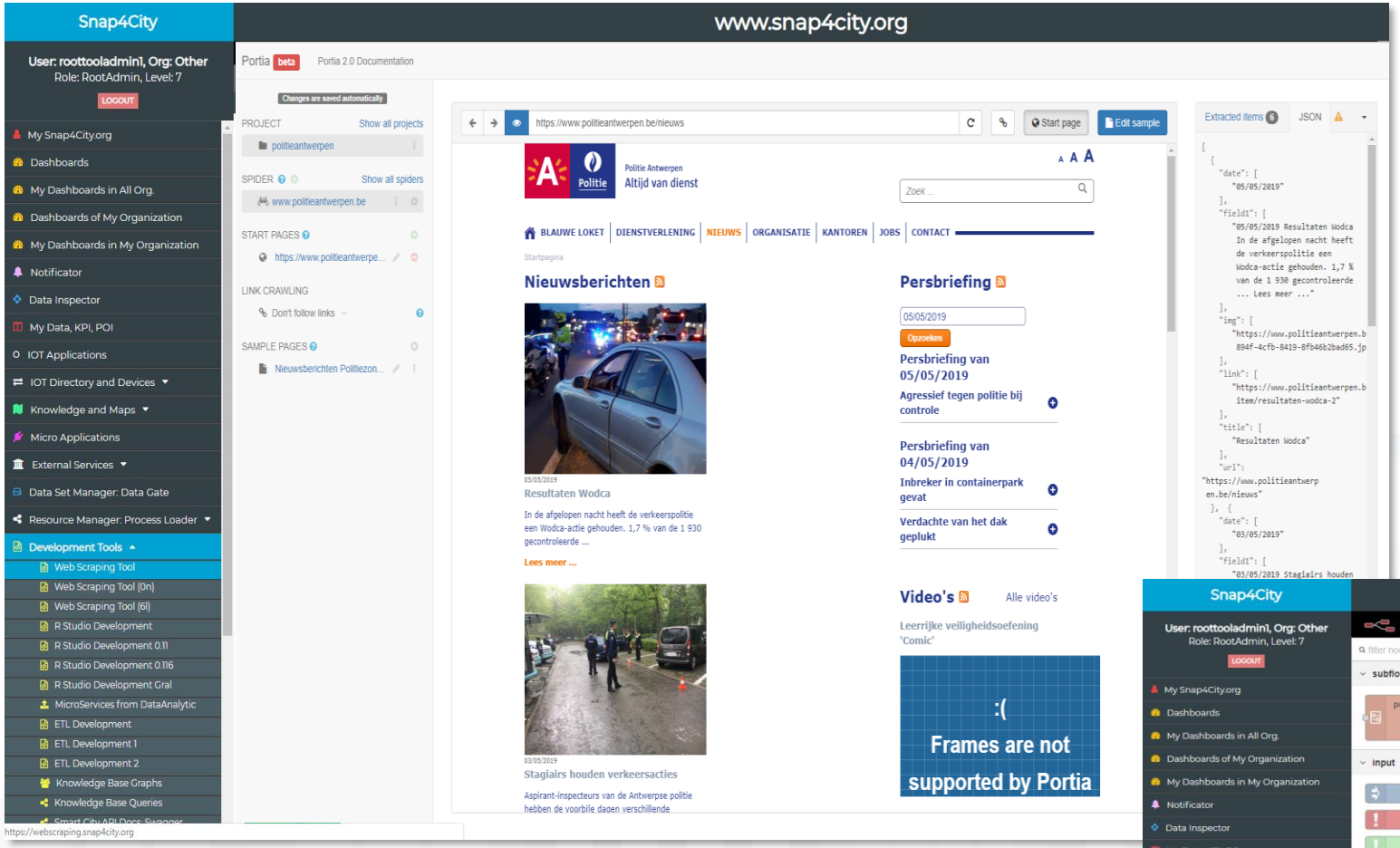
Data, changed data

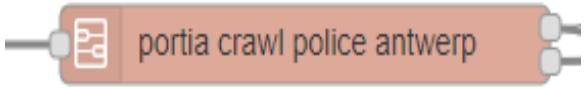
References, commands, selections

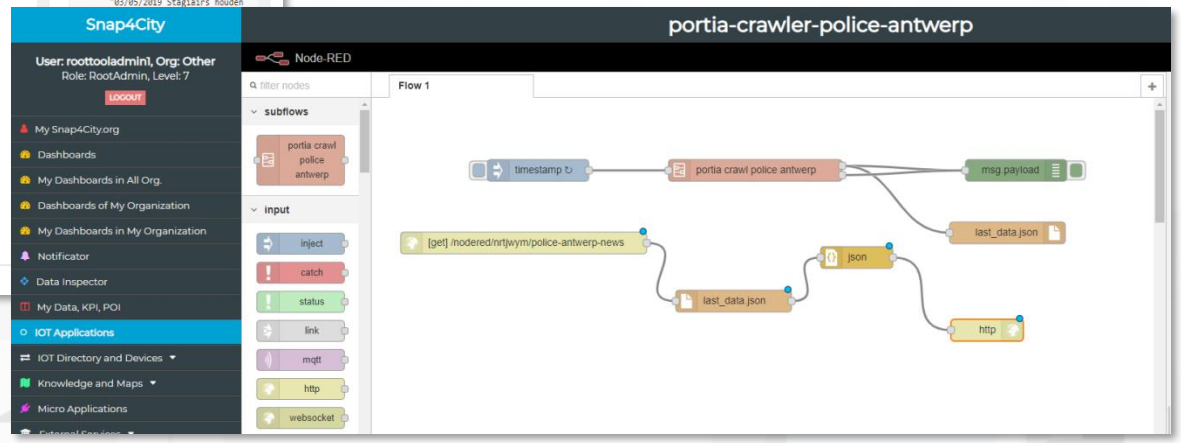


selections, positions, ServiceURI

Web Scraping



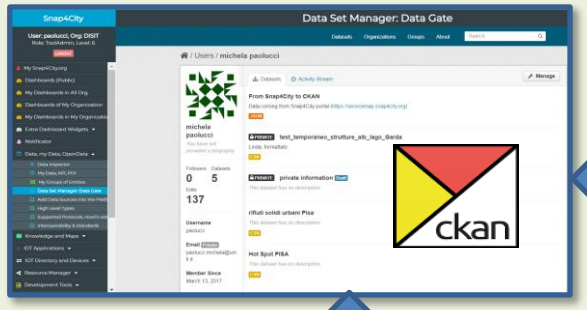




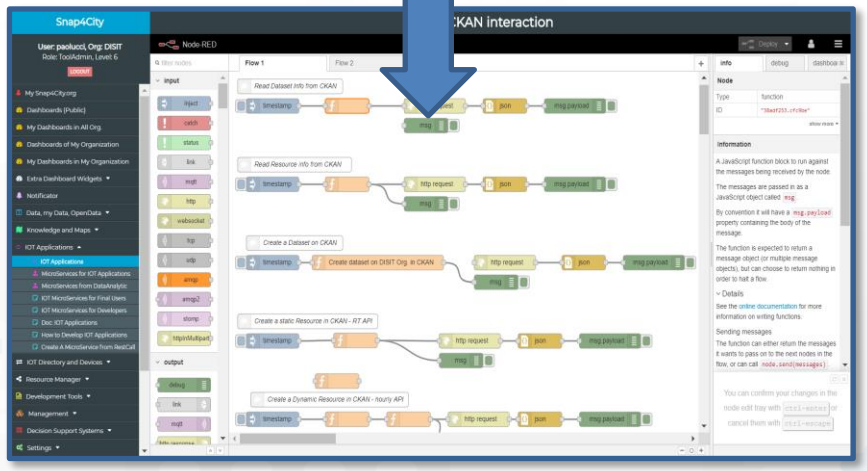
Snap4City vs CKAN

Snap4City Portal and Integrated tools

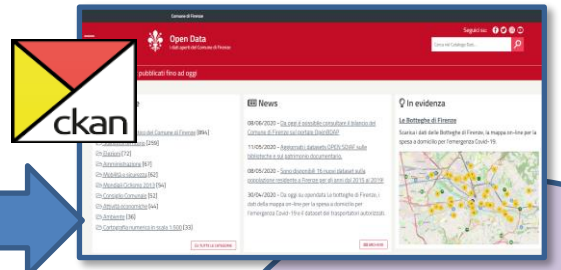
Datagate

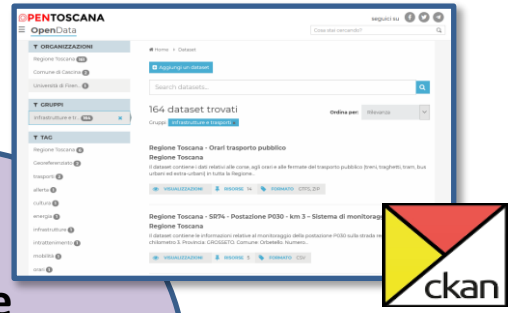


Advanced Snap4City APIs and MicroServices

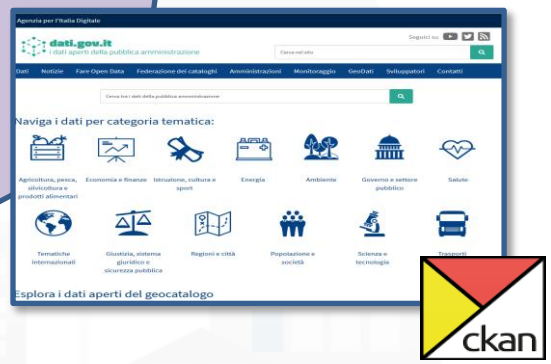


Harvesting and Publishing





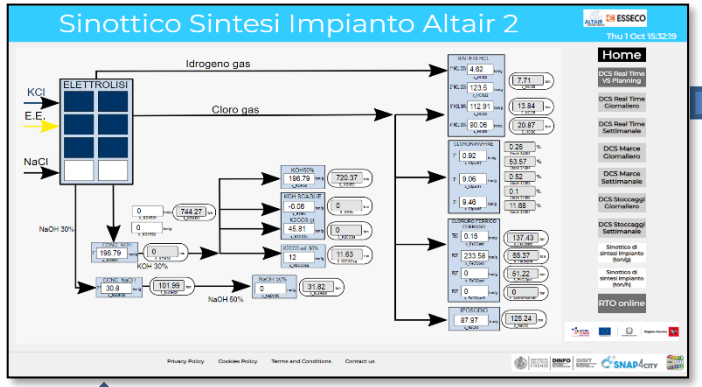
Open or Private External CKAN Data Portals



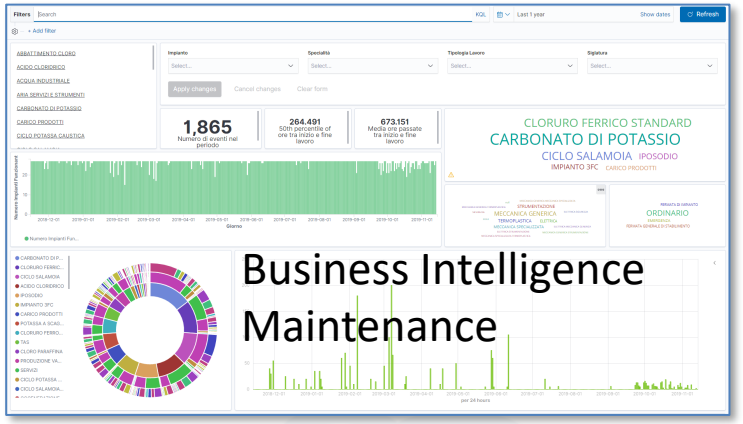
Automatize:

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

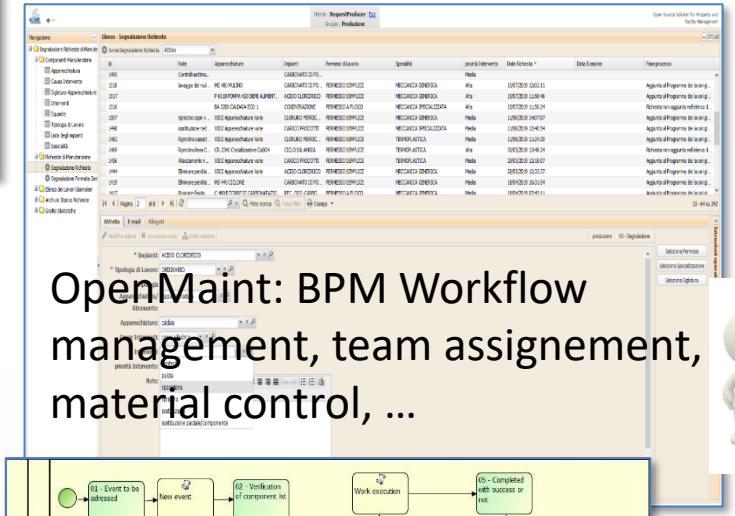
Example of Integrated workflow



Consumptions/productions

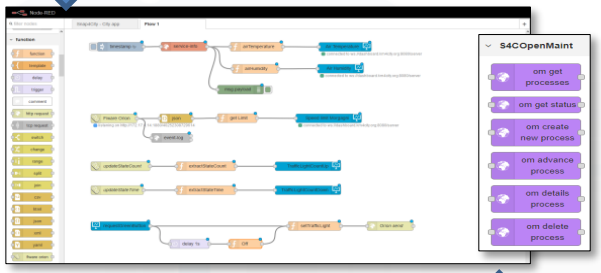


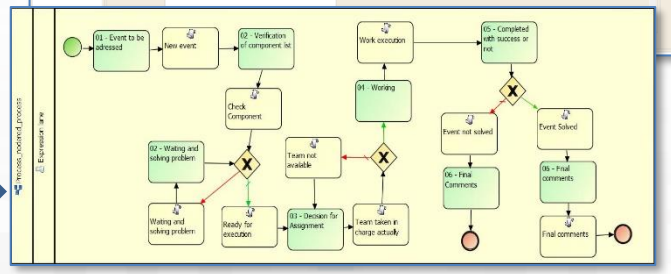
Events/actions

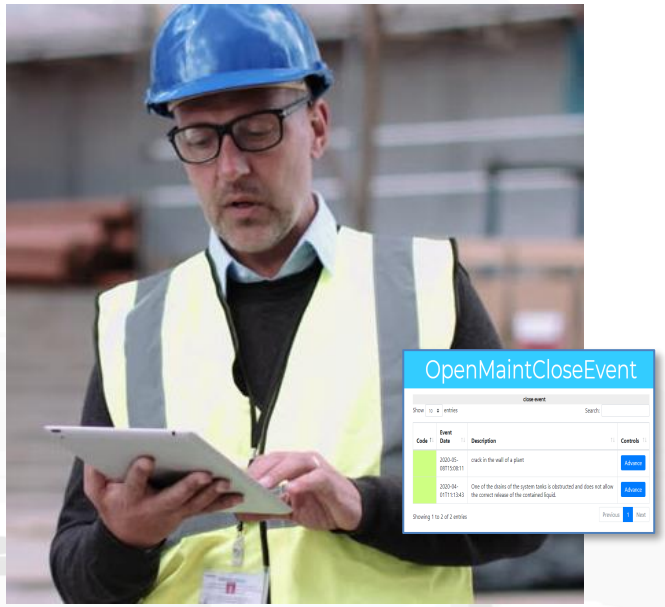


OpenMaint: BPM Workflow management, team assignement, material control, …

Dashboards and actions

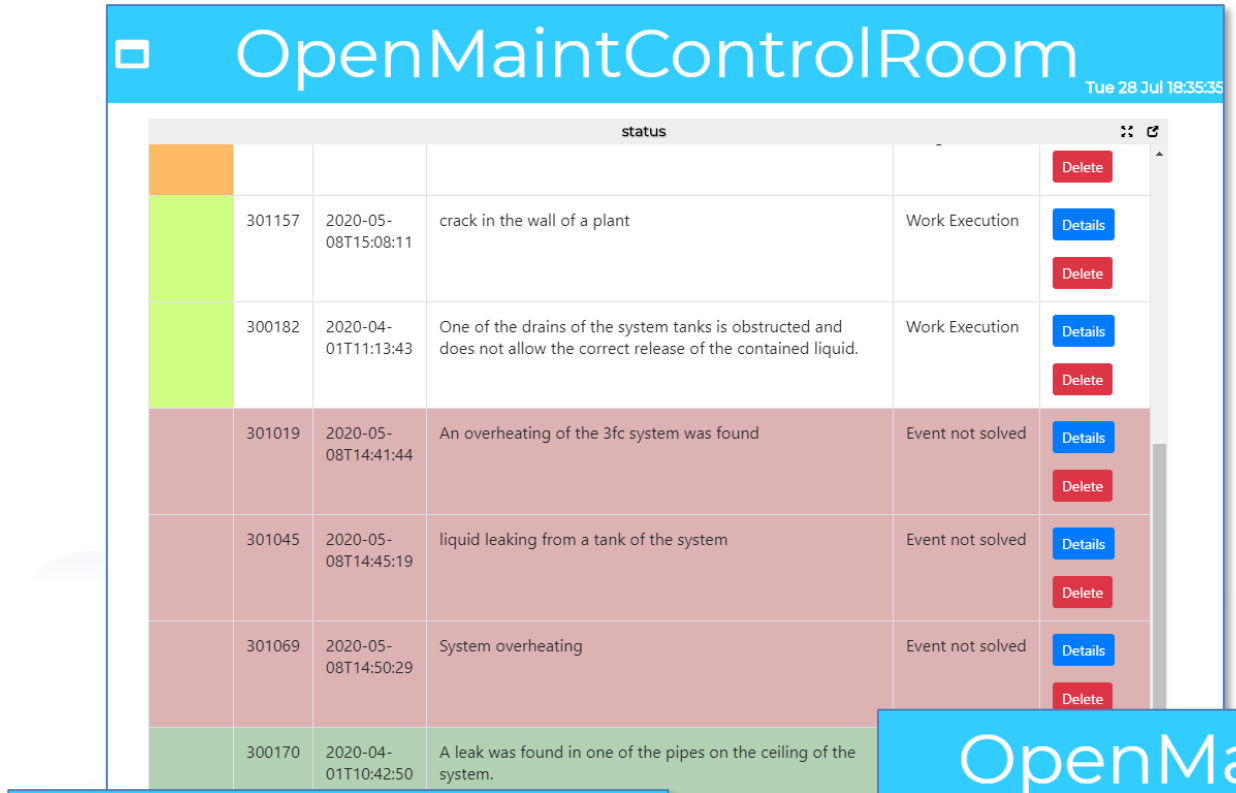


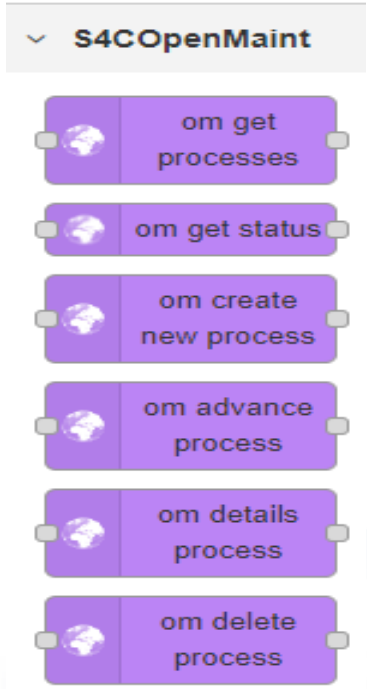


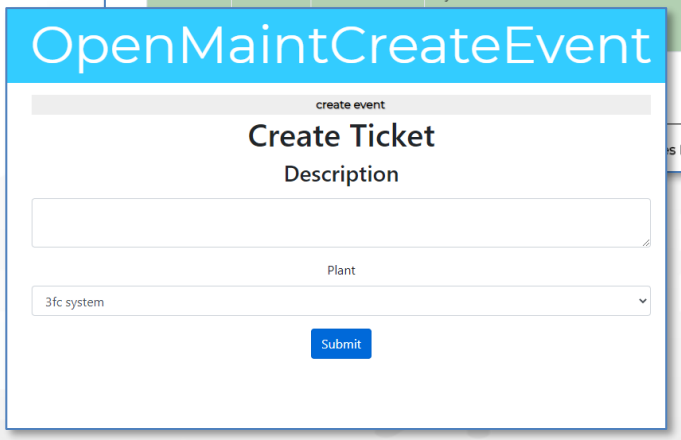


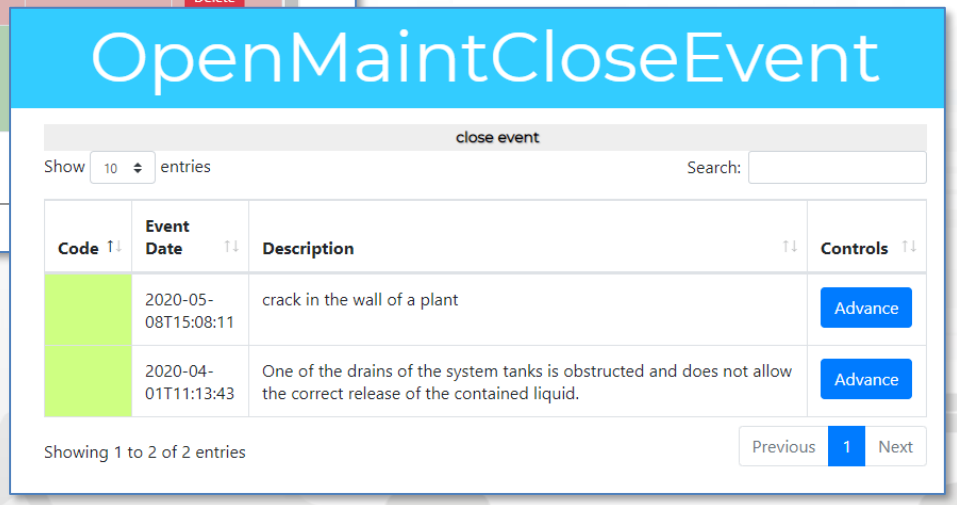
IOT App, Data event firing, event detection and firing
Critical event management

Dashboards





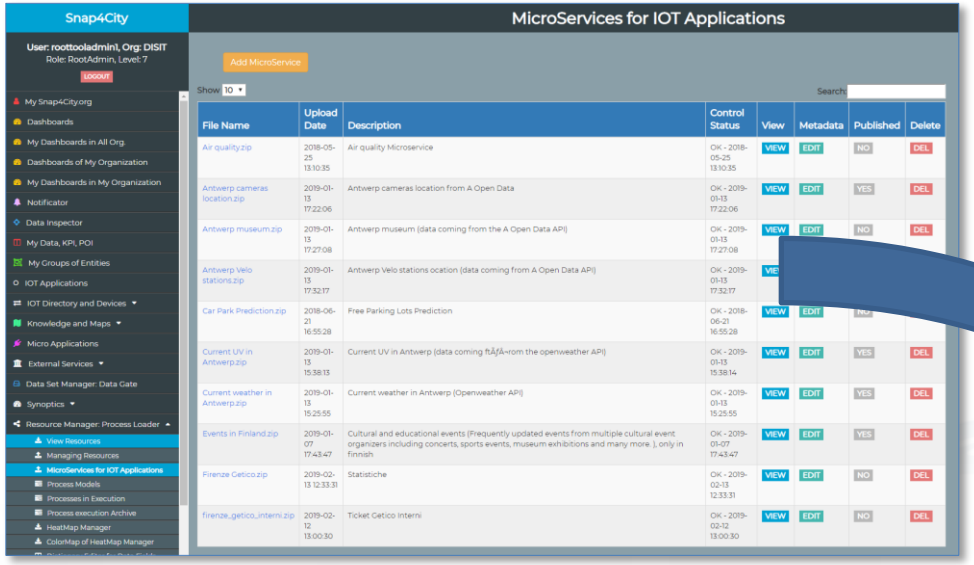


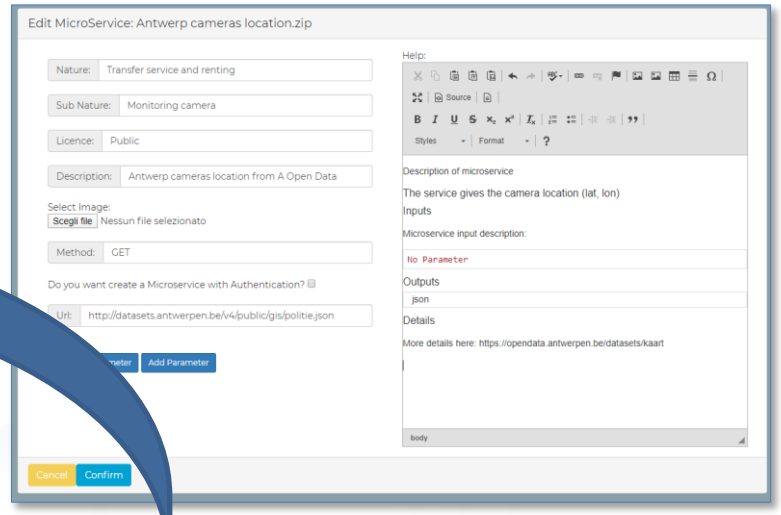


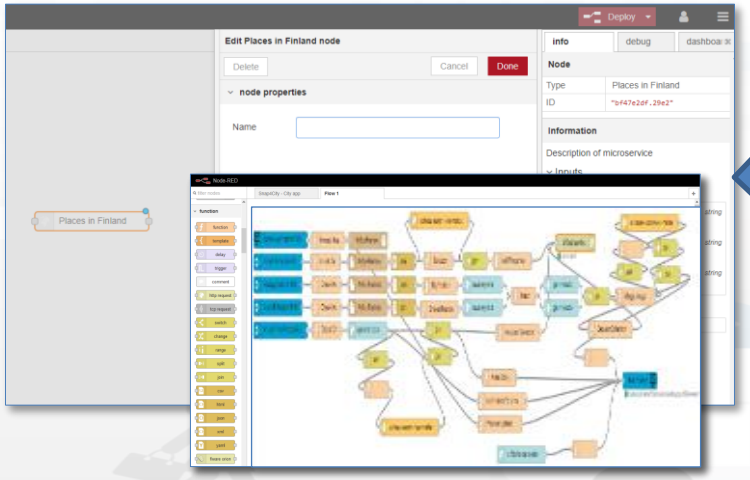
- **Snap4City can**
  - Create new tickets
  - Manage steps, workflow
  - Collecting feedbacks and results from teams
  - Manage all phases of the workflow on the fields via IOT Apps and logics
  - The integration if via API and MicroServices into IOT App.

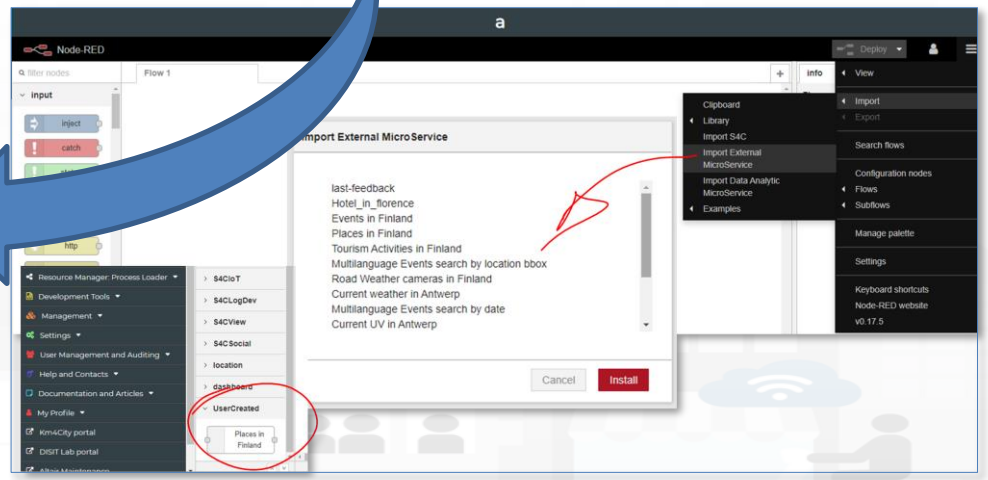
External REST Call API vs MicroServices

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









https://www.snap4city.org/129

TOP

Integration via IoT Apps on IoT Edge

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https://www.snap4city.org/369

SNAP4CITY

Measuring any kind of sensors values

Controlling Energy Power

Measuring Energy Consumption

Any kind of notification channel

IOT Edge: Node-RED + Snap4City

Local Control

Modbus

SCADA

OPC UA

DCS

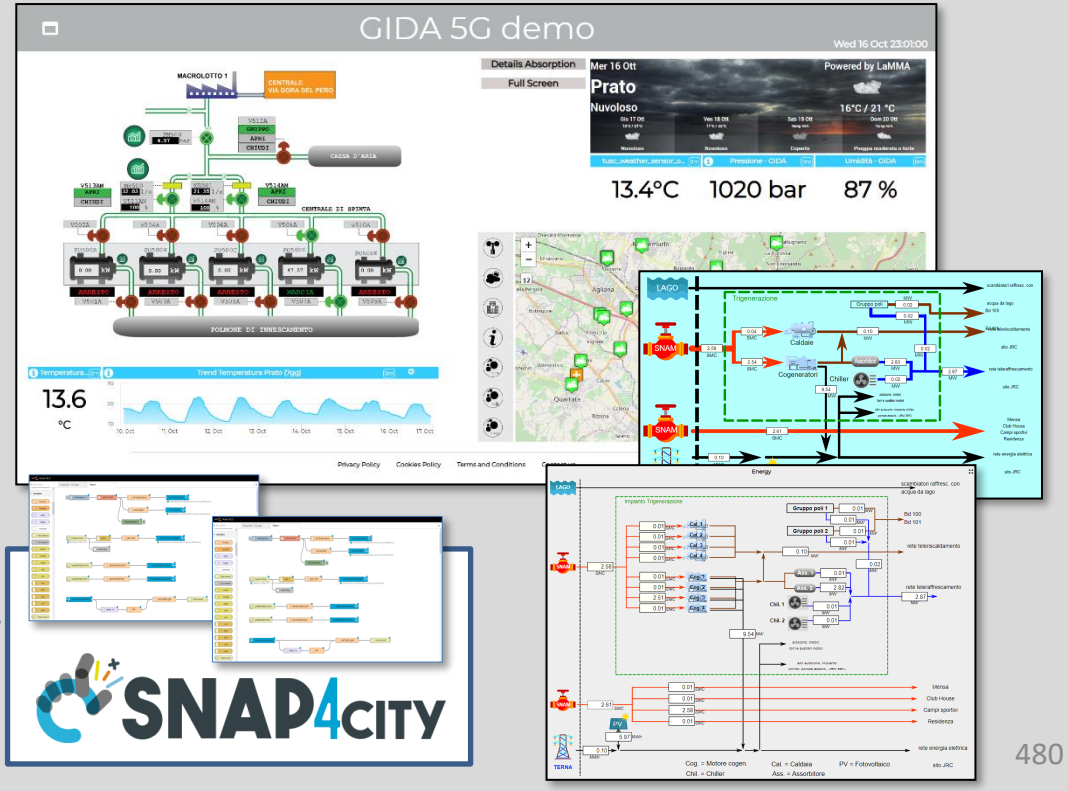
PLC

ODBC

Administrative Servers

Alexa: Voice Commands

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



Snap4Home

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SNAP4CITY | KM4CITY

Sonoff: Controlling Energy Power

Philips Hue: Controlling Lights

Hue: Motion Control / Alarm

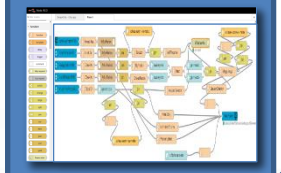
Measuring Energy Consumption

TP Link: Controlling / Measuring Energy Plugs

Alexa: Voice Control

IOT Edge:

Raspberry pi: Node-RED + Snap4City



Measuring Temperature and Humidity

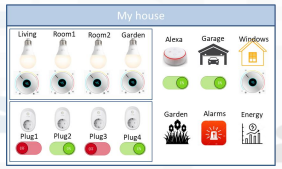
Garage Door

Window Roller Shutters

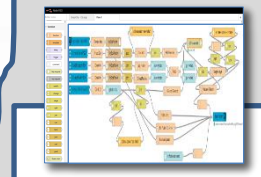
Controlling Motors

Alarm sound and light

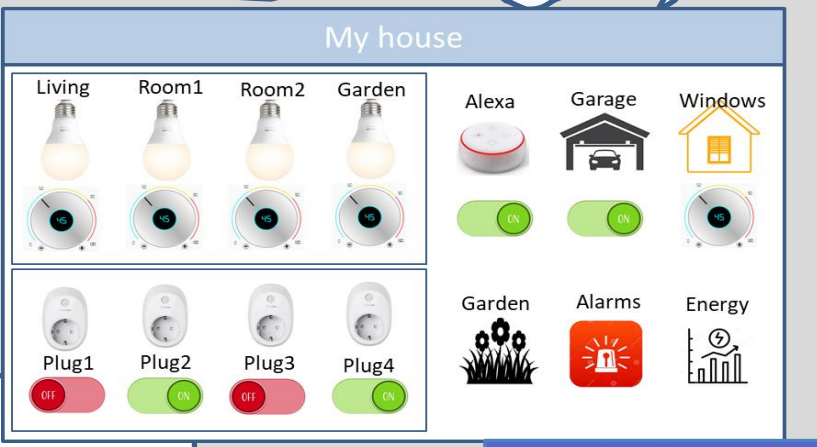
Controlling Irrigators



Local Control



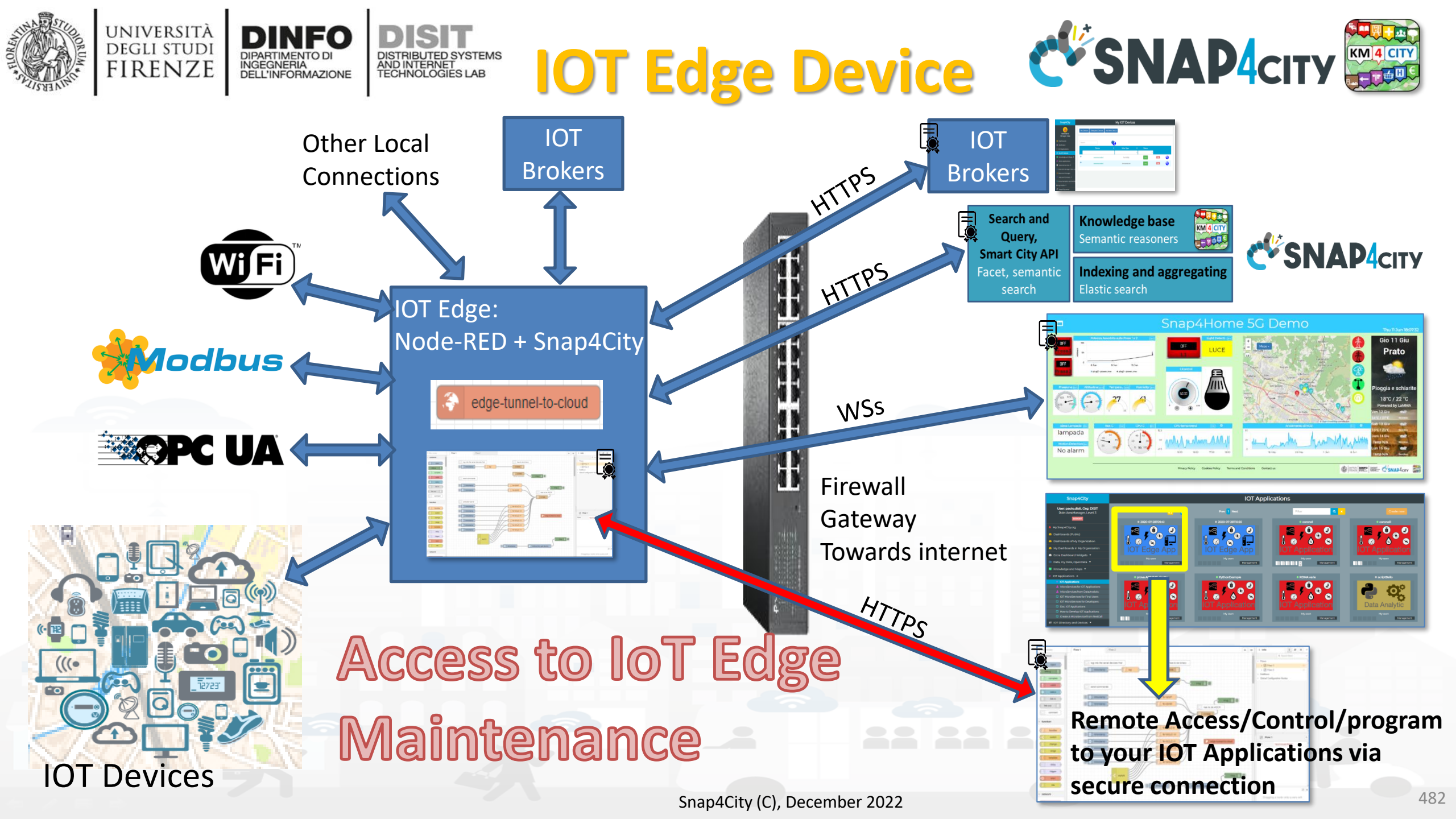
SNAP4CITY



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

https://www.snap4city.org/620

IOT Edge Device



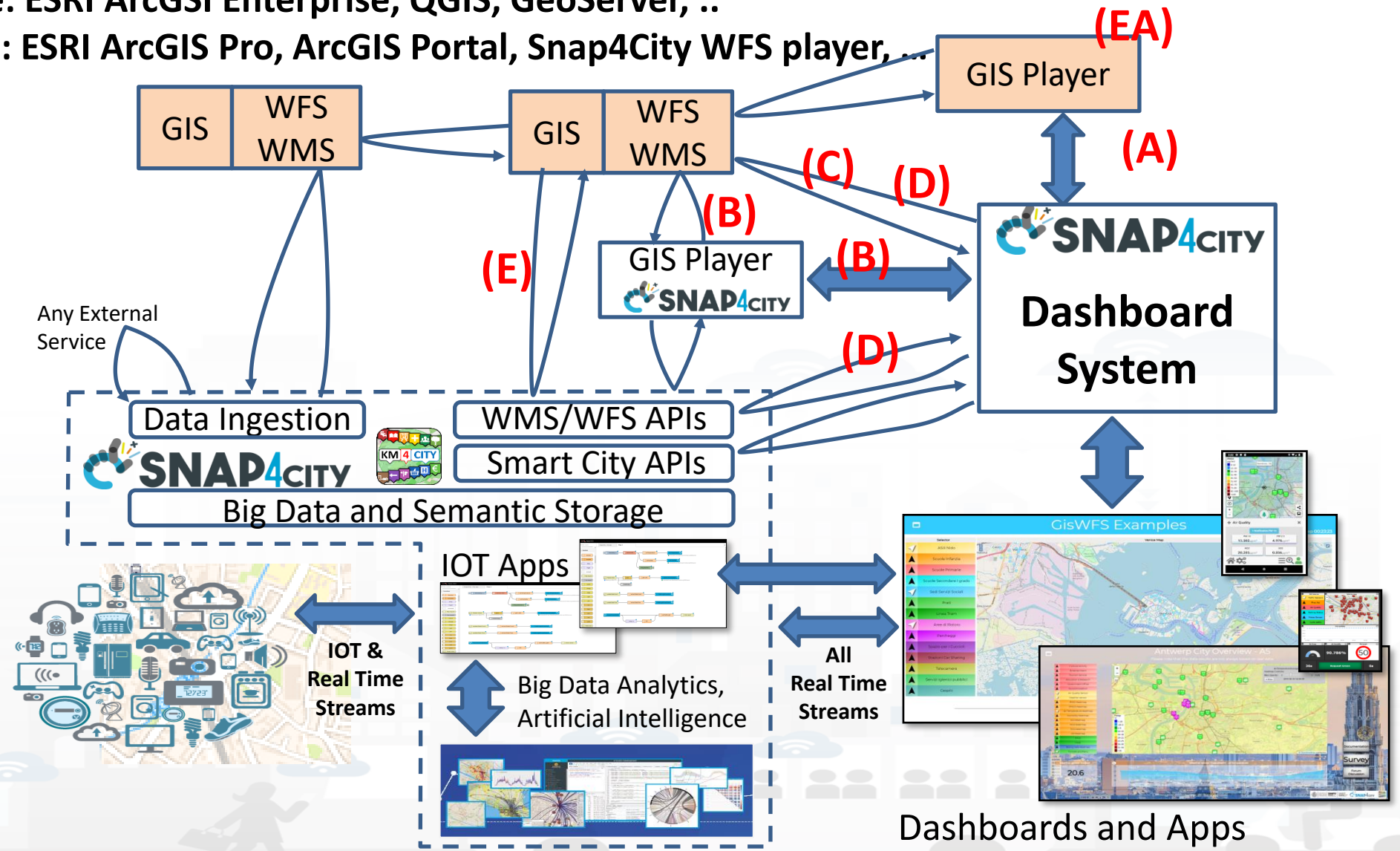
TOP

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

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TOP

API, and Federation of Smart Cities via API

Internal and External Smart City API

Snap4City

Smart City API Docs: Swagger

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

LOGOUT

- External Services
- Data Set Manager: Data Gate
- Resource Manager: Process Loader
- Development Tools
  - Web Scraping Tool
  - Web Scraping Tool (On)
  - Web Scraping Tool (6l)
  - R Studio Development
  - R Studio Development 0.11
  - R Studio Development 0.116
  - R Studio Development TF
  - R Studio Development GFF
  - R Studio Development Gral
  - MicroServices from DataAnalytic
  - ETL Development
  - ETL Development 1
  - ETL Development 2
  - Knowledge Base Graphs
  - Knowledge Base Queries
  - Smart City API Docs: Swagger
  - Internal API Docs: Swagger
  - Testing API by Postman
  - Source Code Access
- Management
- Settings
- User Management and Auditing
- Help and Contacts
- Documentation and Articles
- My Profile

swagger

Select a spec: Advanced Smart City API

- Advanced Smart City API
- Km4city Web App API
- Orion Broker K1-K2 Authentication API
- Heatmap API

Advanced Smart City API 1.0.0 OAS3

https://www.km4city.org/swagger/external/ascapi-openapiv3.json

SMART CITY API WEB DOCUMENTATION

Servers: https://servicemap.disit.org/WebAppGrafo/api/v1

Services

GET / Service discovery and information

Events

GET /events/ Event search

Locations

GET /location/ Address and geometry search by GPS

Public Transport

GET /tpl/agencies/ Agency list

GET /tpl/bus-lines/ (Bus) Lines list

GET /tpl/bus-routes/ (Bus) Routes list

ernal API Docs: Swagger

Select a spec: IoT device registration API

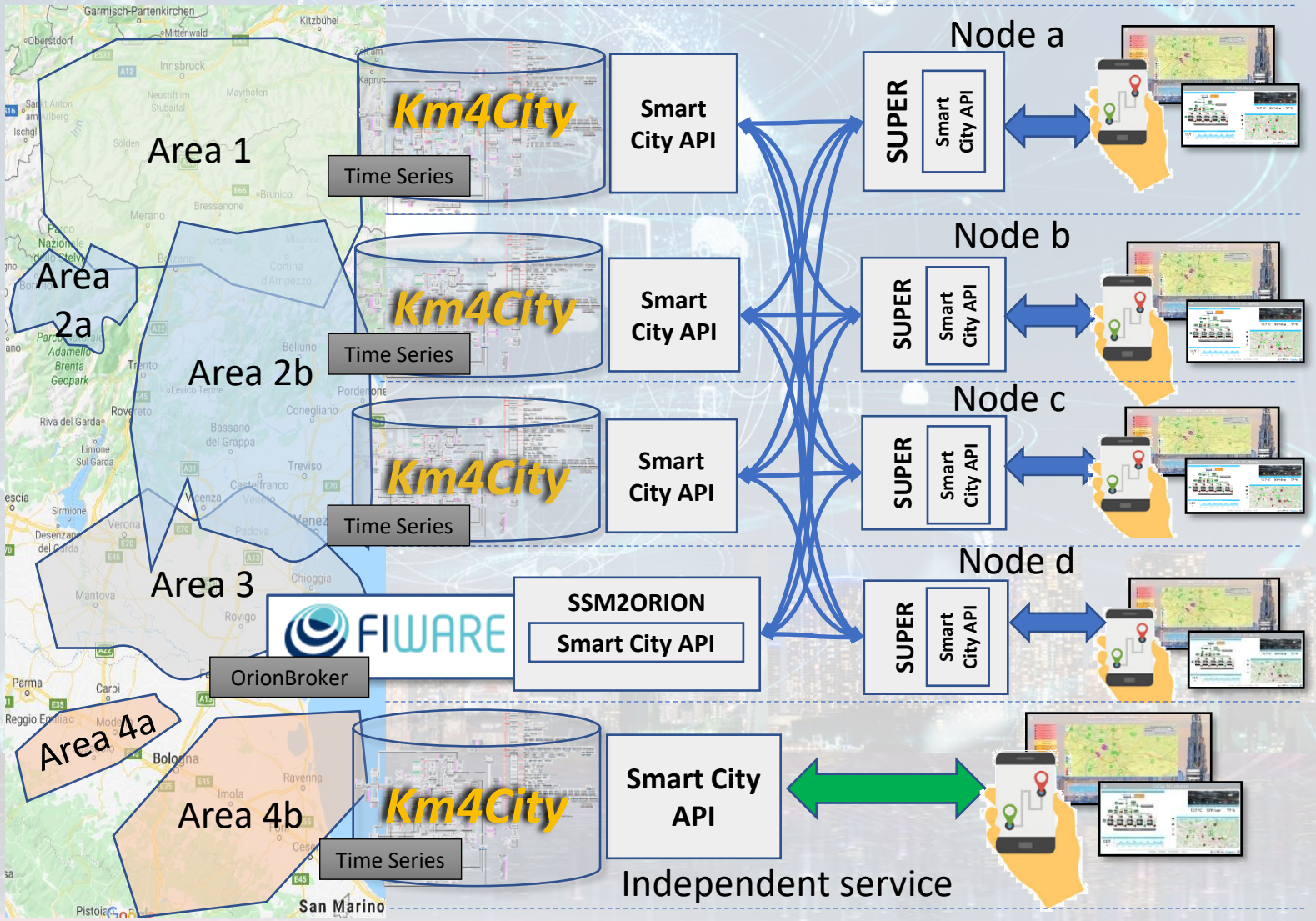
- IoT device registration API
- Notificator API
- DISCES scheduler API
- Resource Manager API
- Sensors API
- Event Logger API
- Ownership API
- Data Manager API
- Device, Broker and Value Mgmt API
- Snap4City Application API
- Engager API
- Wallet API
- User Profiler API
- My KPI API
- Snap vs Openmaint API
- Device Groups API
- Sci-Hub Processing API

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

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

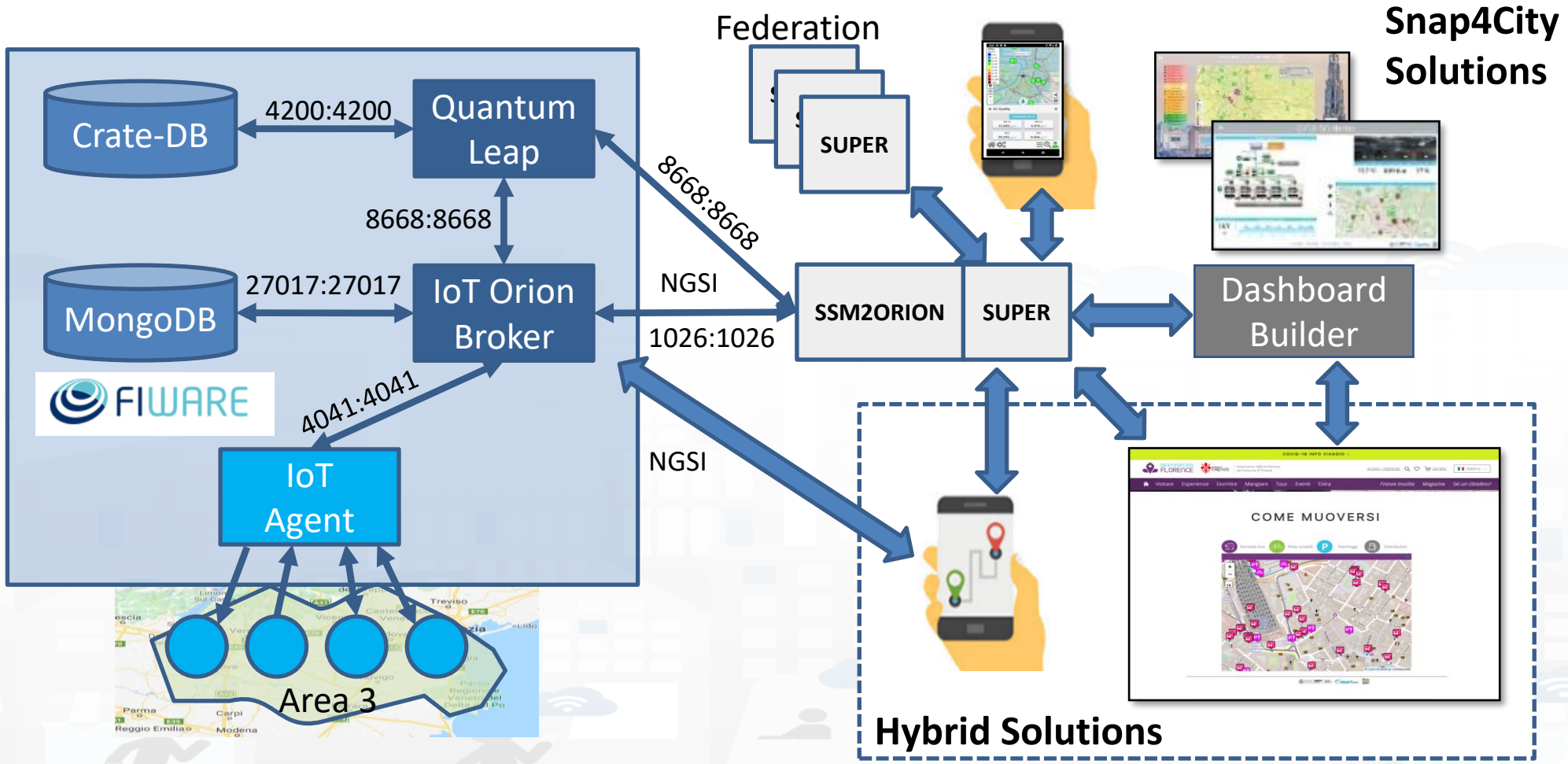
Federation of Smart City Services

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



TOP

Linked Open Data

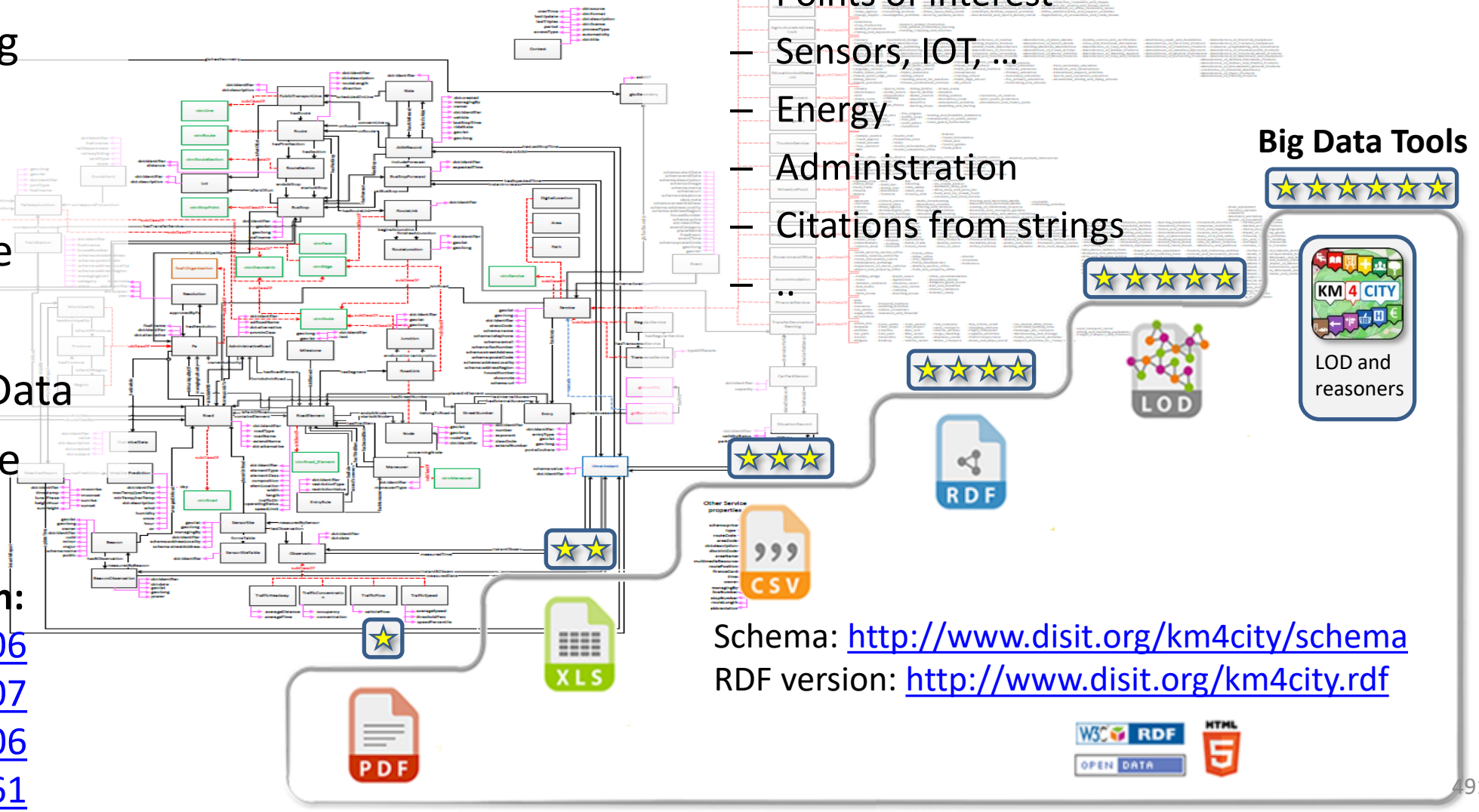
Km4City: Knowledge Base

- **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

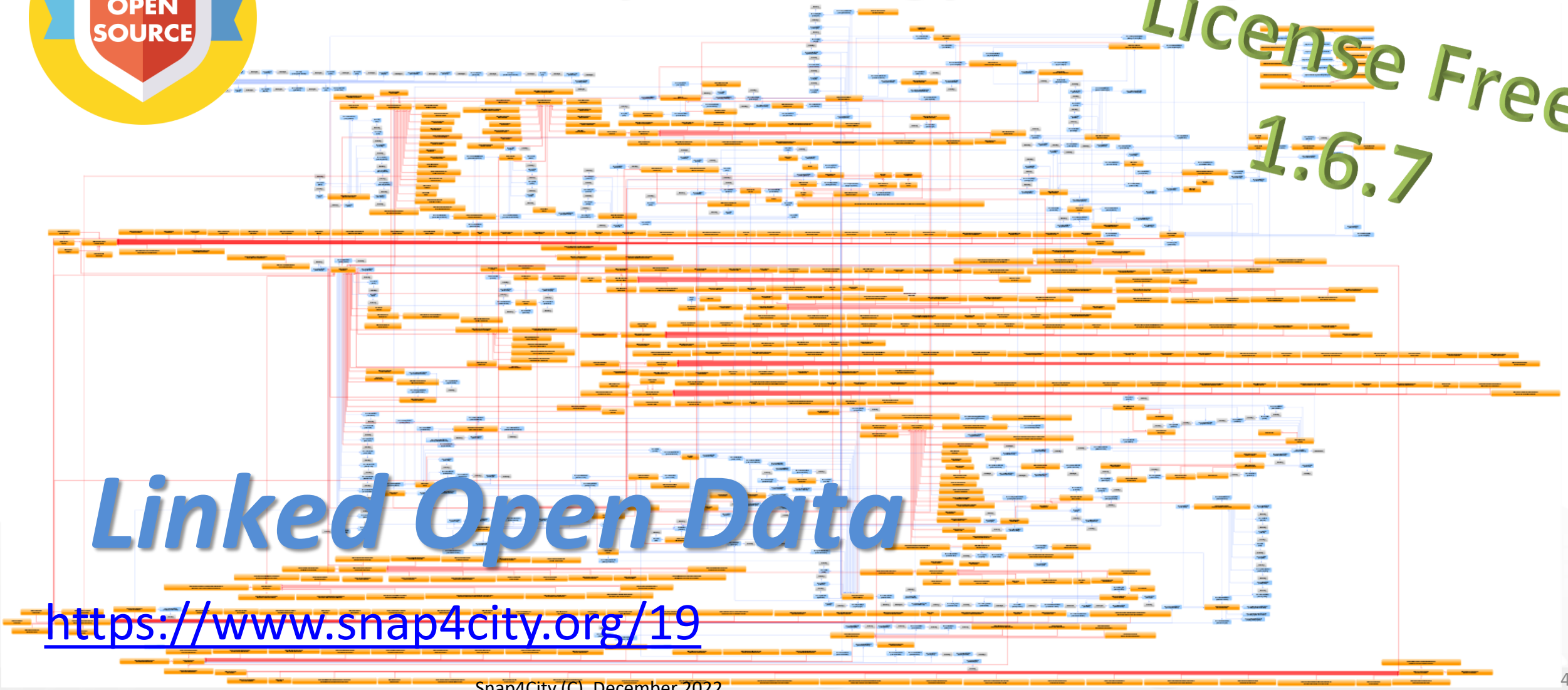
SNAP4CITY

100% OPEN SOURCE

Smart-city Ontology km4city

License Free

1.6.7

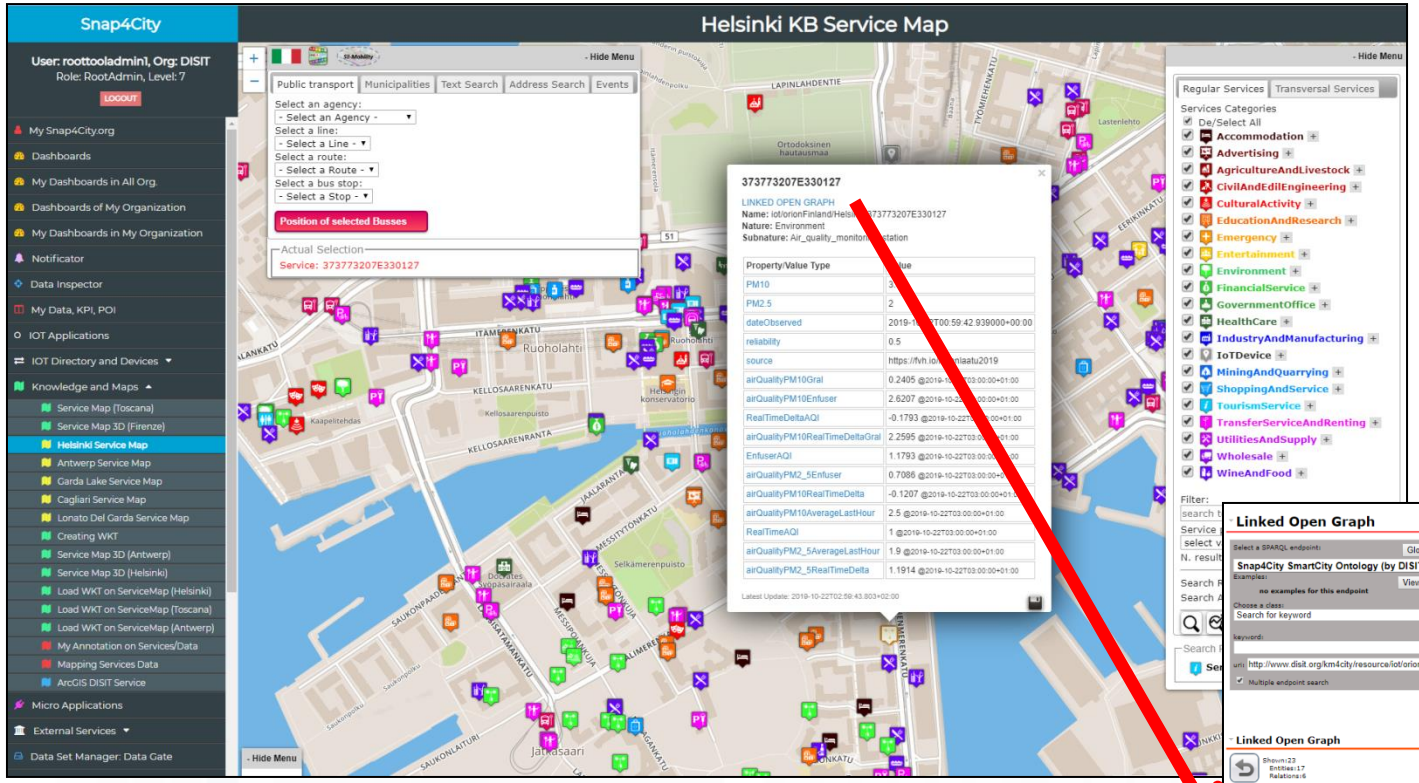


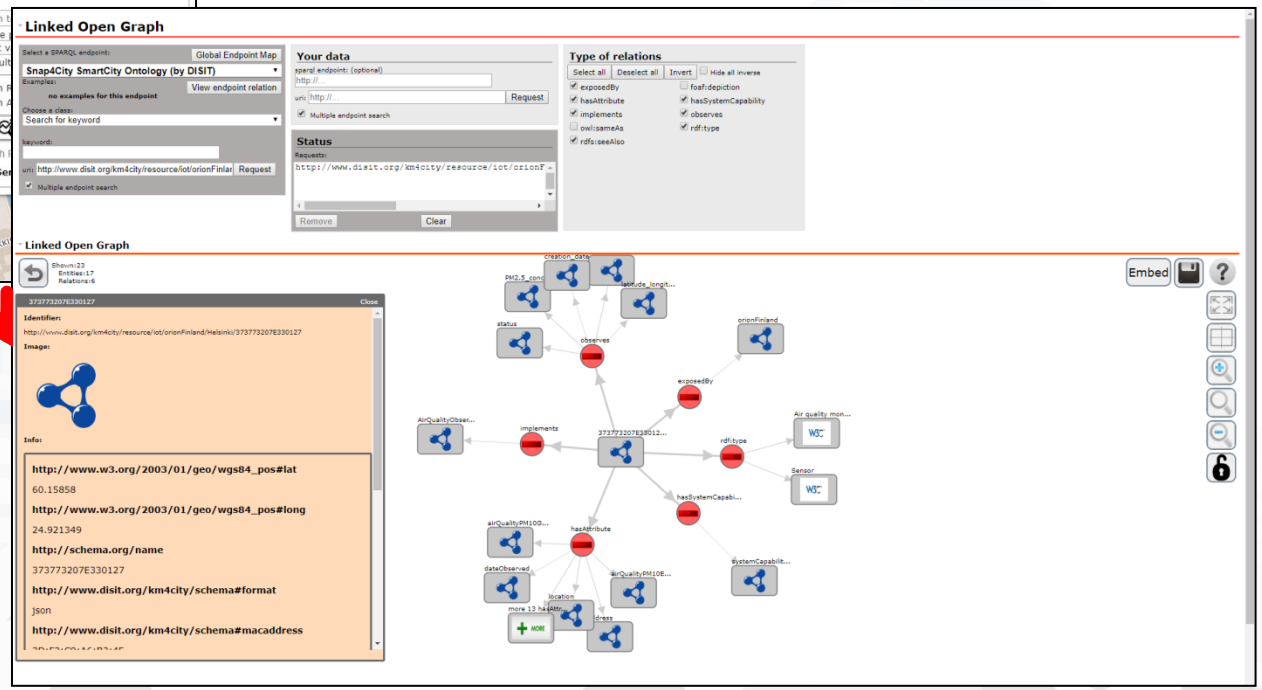
Linked Open Data

https://www.snap4city.org/19

Views of the Knowledge Base

Knowledge Base
Semantic Reasoners

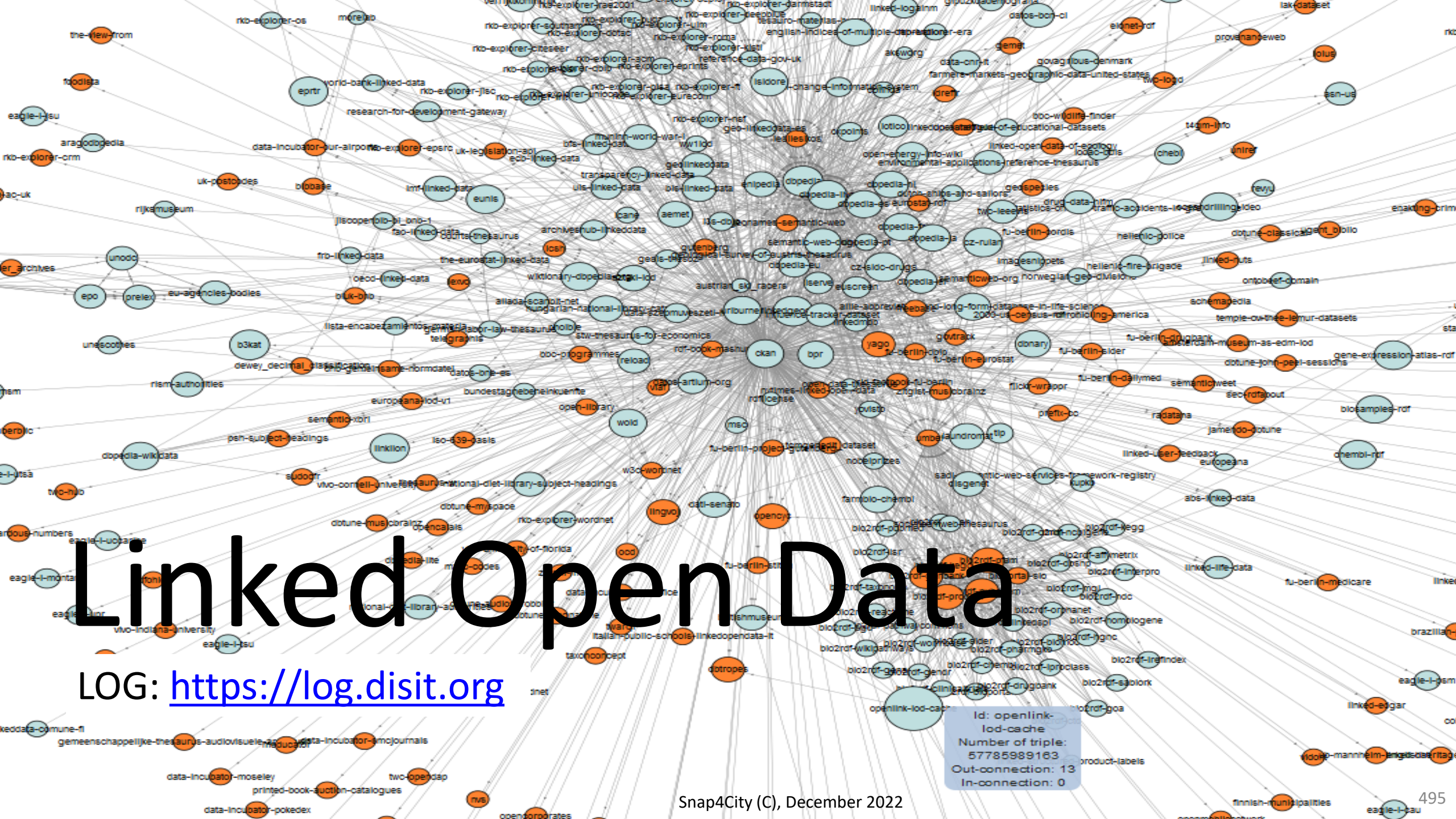




- How pass from ServiceMap to Linked Open Graph, Linket Data view tool

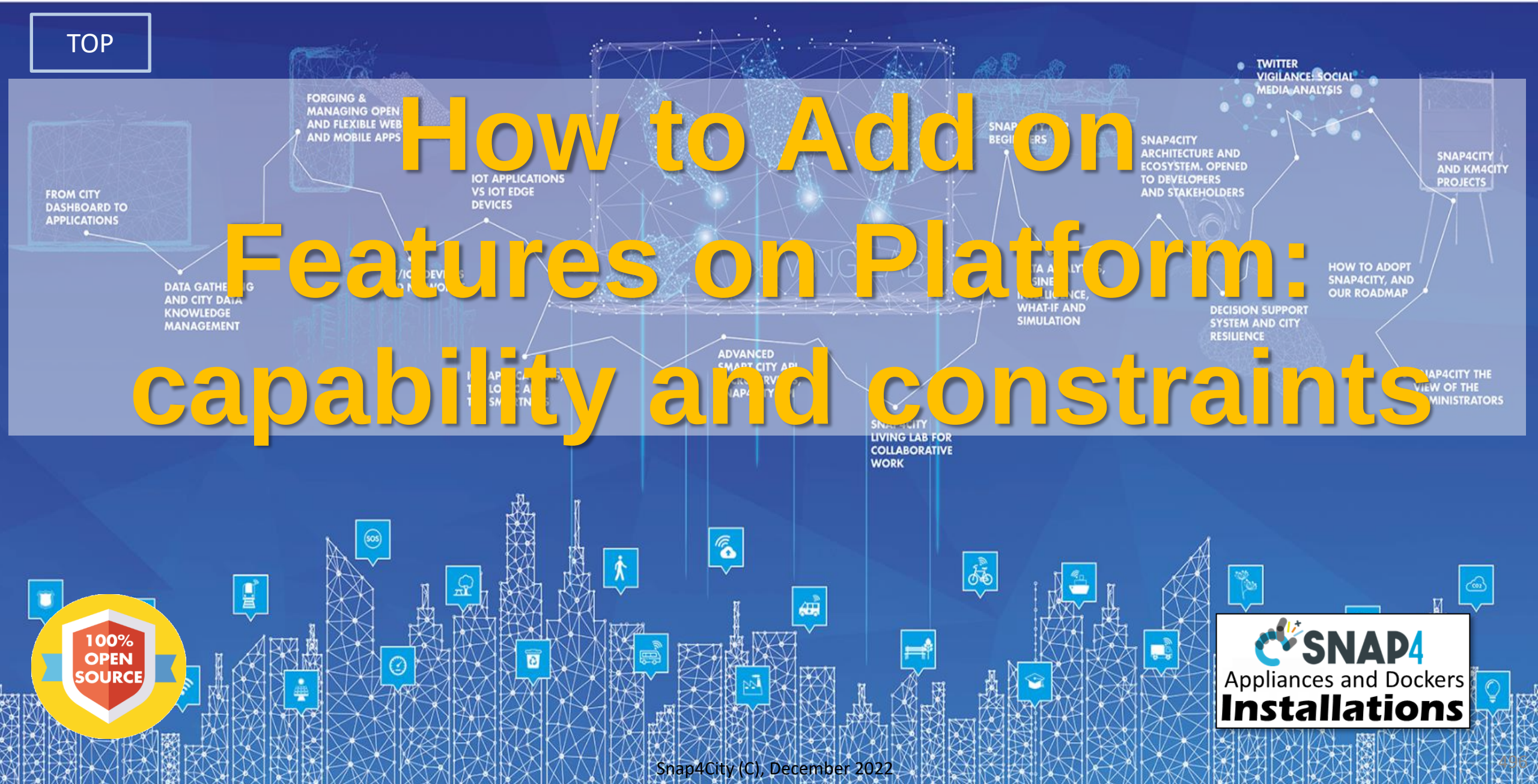
Linked Open Data

LOG: https://log.disit.org



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/course/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/course/da/
- **Web and Mobile Apps** --> new end-users services
  - https://www.snap4city.org/download/video/course/app/
- **Dashboards: Dashboard Builder and Kibana**
  - https://www.snap4city.org/download/video/course/das/
- **IoT Applications in Node-RED**
  - https://www.snap4city.org/download/video/course/iot/
- **data ingestion process, integration, etc.**
  - https://www.snap4city.org/download/video/course/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

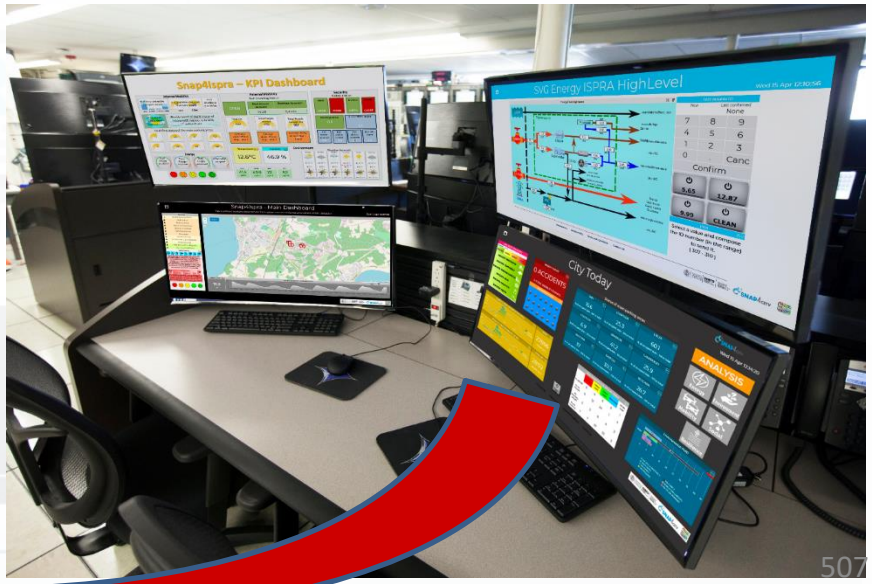
MAPPA FIRENZE
Fri 19 Oct 17:24:39
Colonnine Ricarica
Colonnine ricarica Fast
Pannelli a Messaggio Variabile
Parcheggi
Piste Ciclabili
Sensori del Traffico
Stazioni ambientali
Stazioni meteo
Traffico Reali Time
Varchi ZTL
Wi-Fi
Eventi Traffico a Firenze
Concentration - 7 days
Main

Chemical Plant Dashboard Green Impact Capacity (GIC)

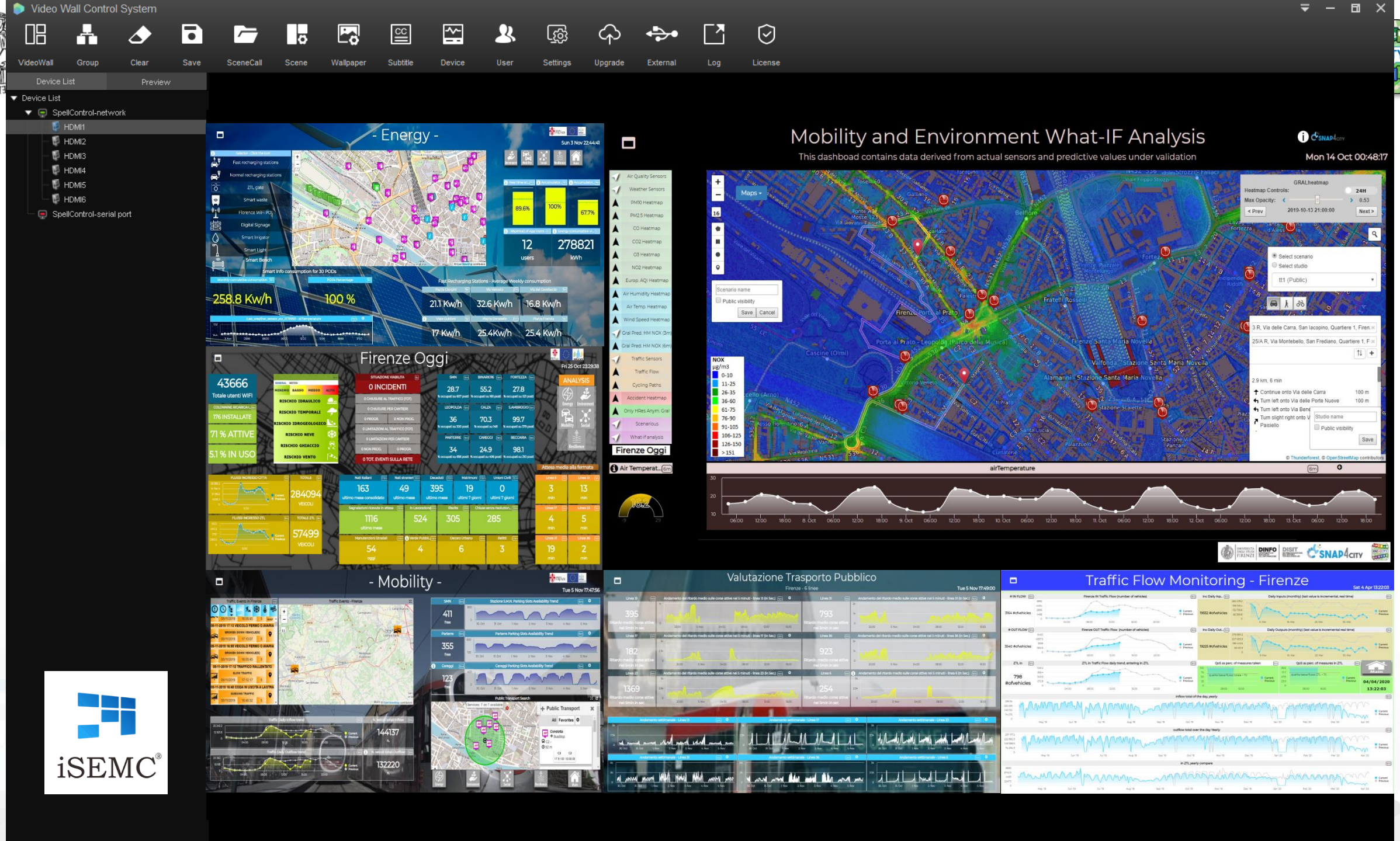
Altair Control room

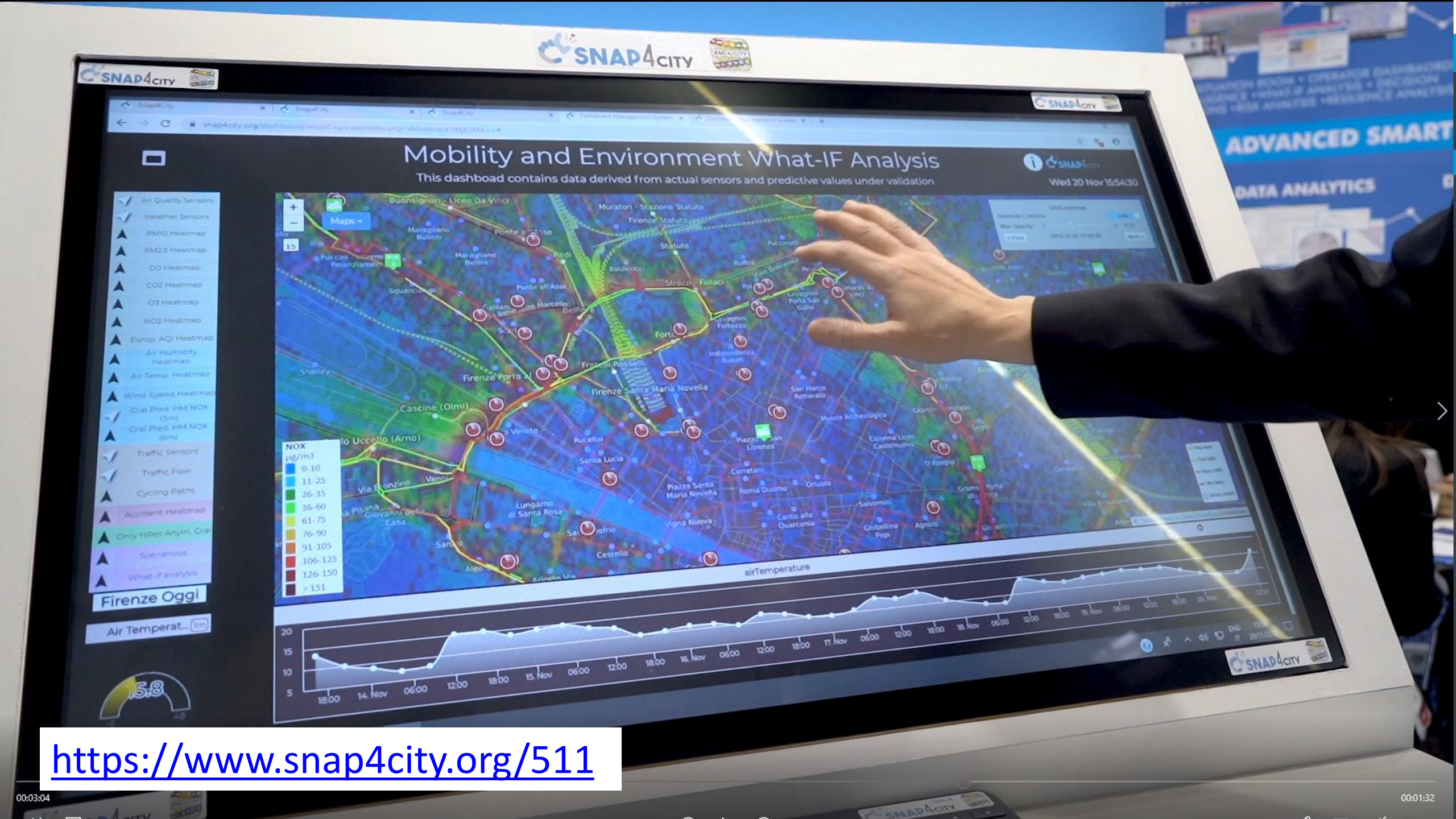
Control Room

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 -
258.8 Kw/h
100 %
12
users
278821
kWh
Firenze Oggi
43666
Totale utenti WIFI
176 INSTALLATE
71 % ATTIVE
5.1 % IN USO
0 INCIDENTI
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
airTemperature
- Mobility -
Valutazione Trasporto Pubblico
Traffic Flow Monitoring - Firenze
iSEMC



https://www.snap4city.org/511

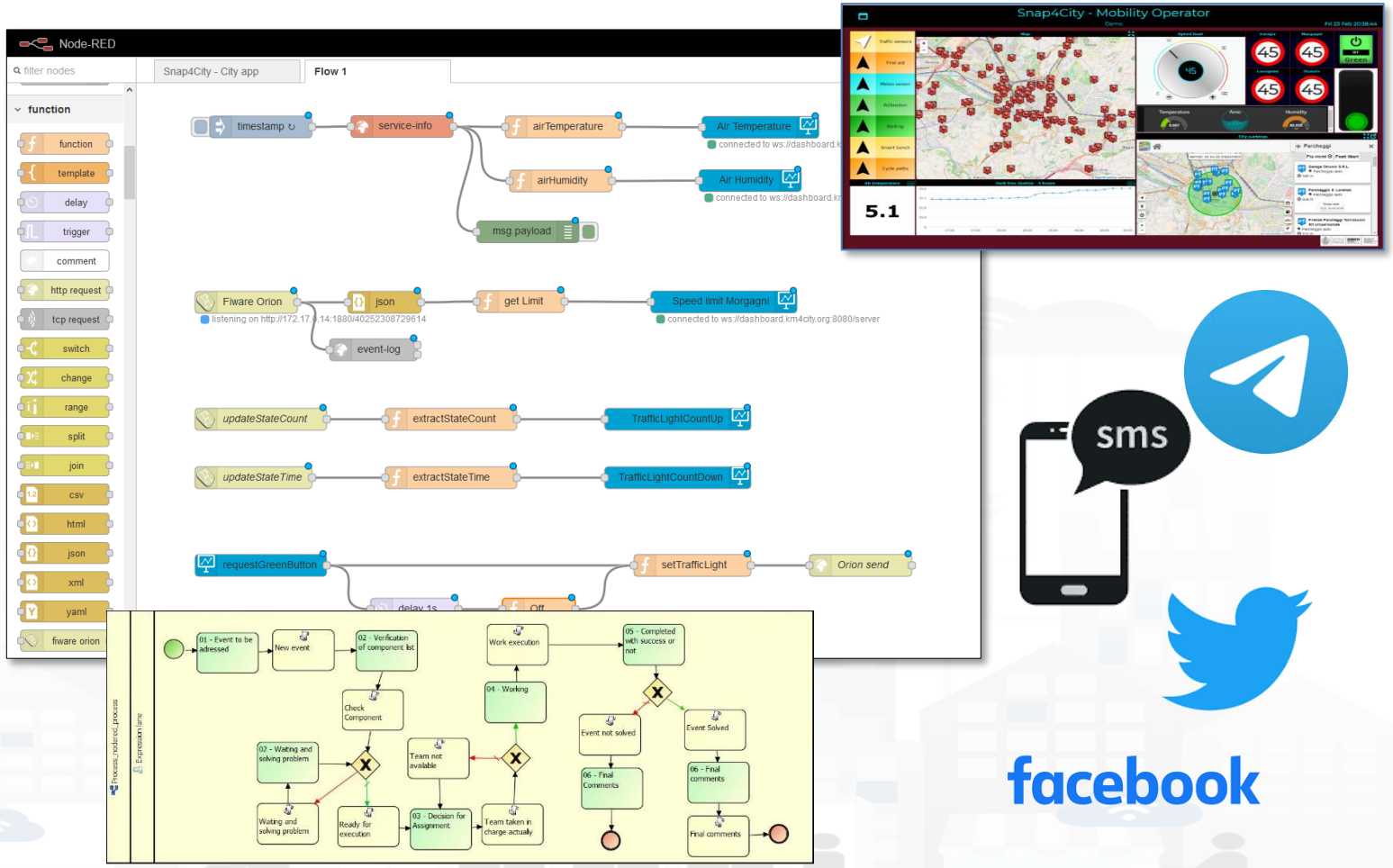
00:03:04

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.



TOP

Map Representing

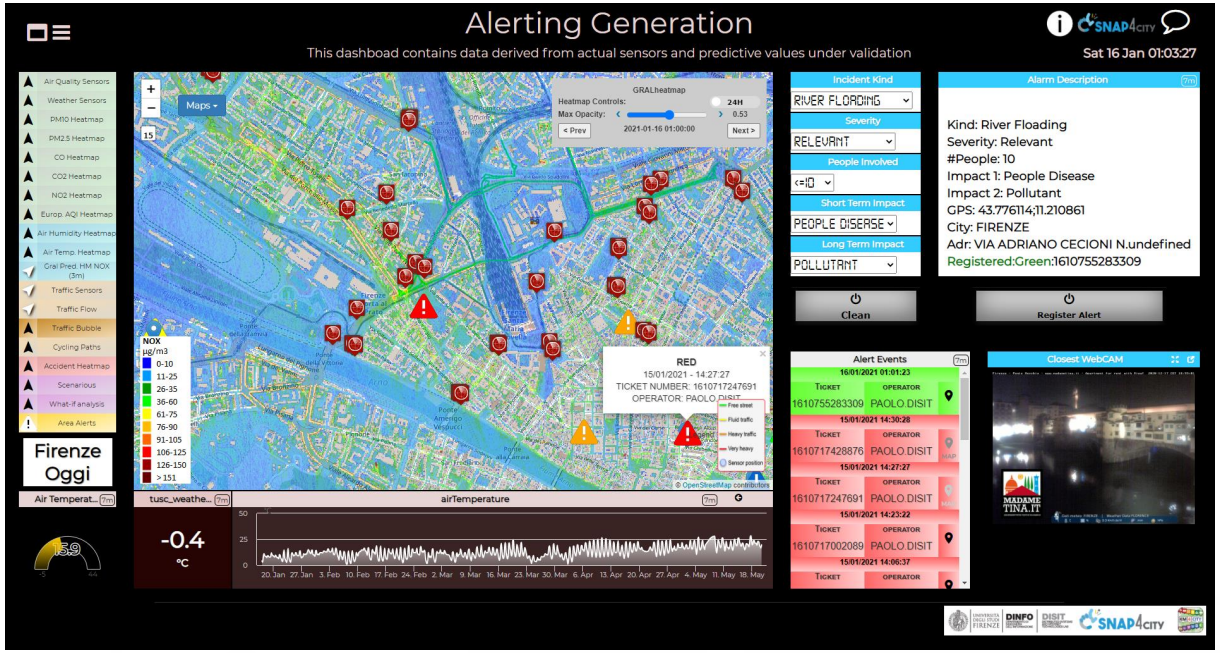
Maps Representing

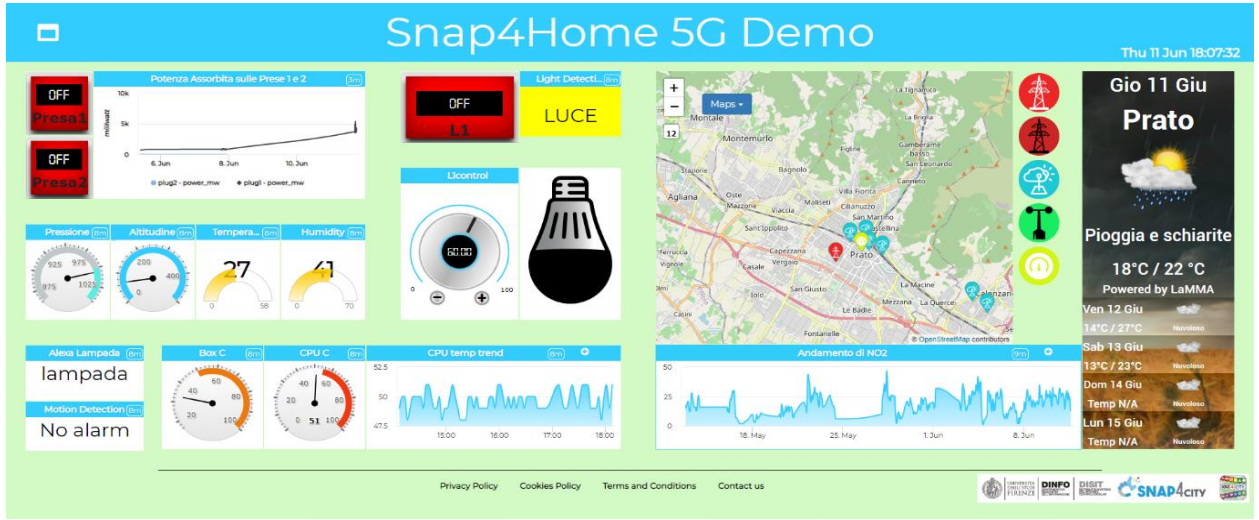
- **Dashboards, ServiceMap, Kibana DevDash, MicroApplications**
  - **All entities are classified according to Nature/subnature/type,...**
  - City structure (routable), neighbourhoods, streets, roads, preferences, etc.
  - public transportation paths (GTFS), cycling paths, gardens, shapes, RTZ, etc.
  - 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.

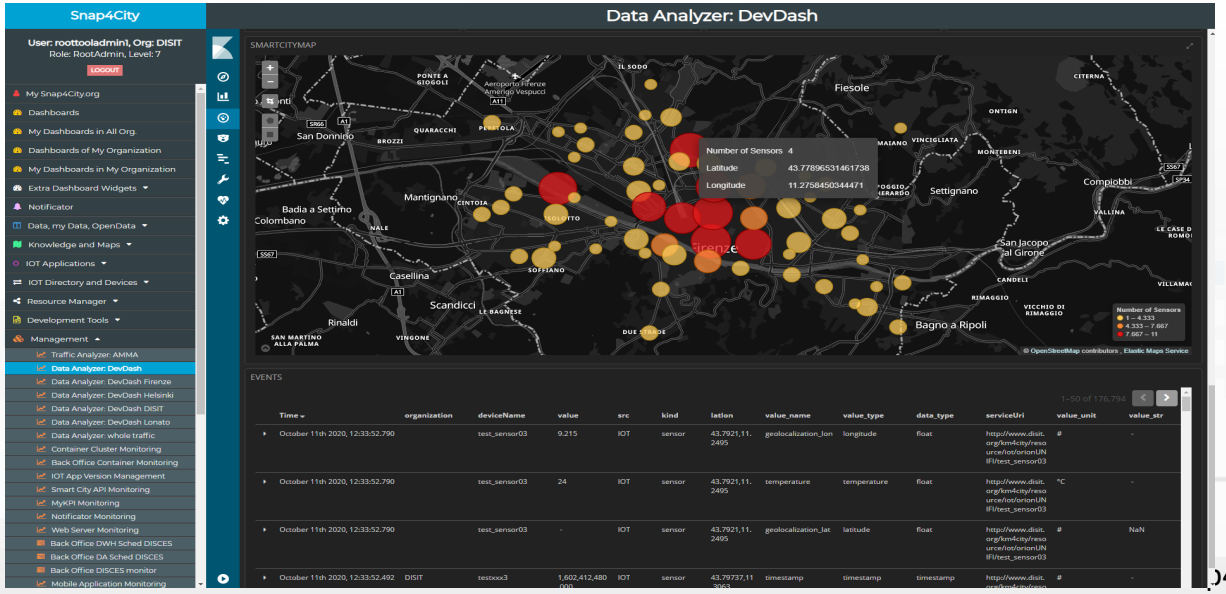
ServiceMap

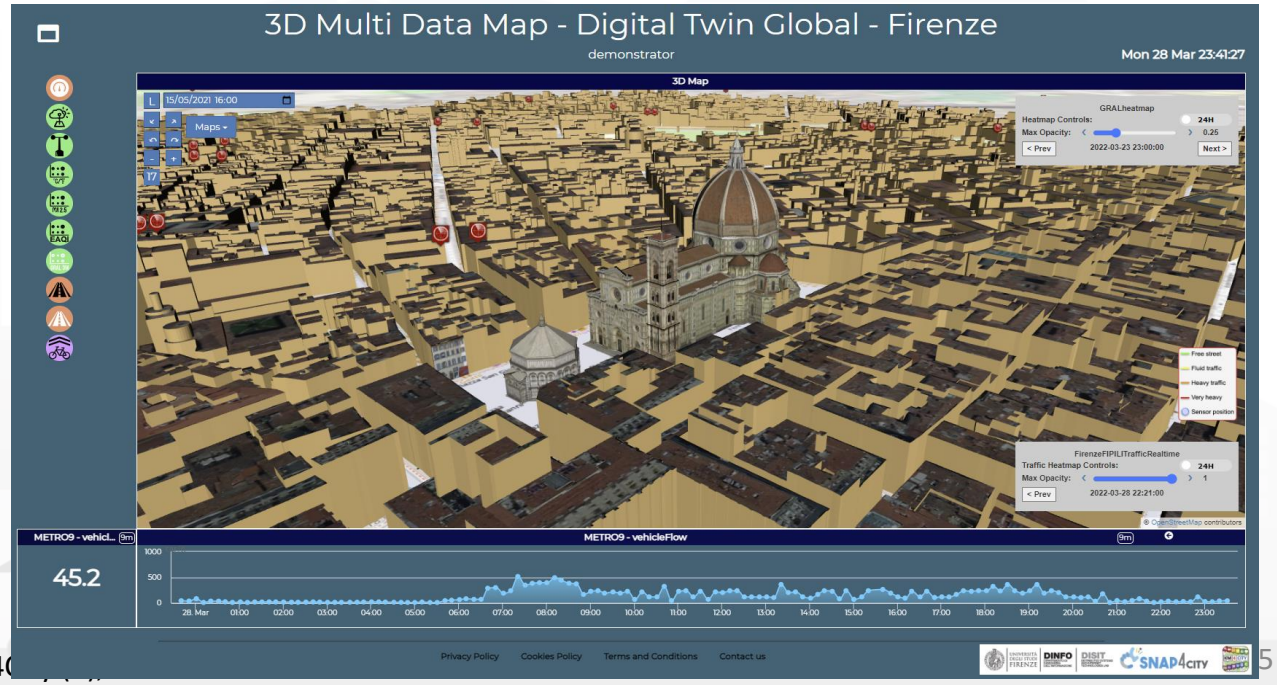
Snap4City
Service Map (Toscana)
User: roottooladmin1, Org: DISIT
Role: RootAdmin, Level: 7
LOGOUT
My Snap4City.org
Dashboards
My Dashboards in All Org.
Dashboards of My Organization
My Dashboards in My Organization
My Data Dashboard Dev Kibana
My Data Dashboard Kibana
Extra Dashboard Widgets
Notificator
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...
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
Via Venti Settembre
Viale Filippo Strozzi
Ponte degli Alpini
Porta Mugnone
Sala della Nazioni
Polveriera
Porta Soccorso alla Campagna
Padiglione Arsenale
Fortezza da Basso
Padiglione delle Ghiaie
Porta a Faenza
Porta Santa Maria Novella
Via Francesco Crispi
La Fortezza
Ufficio Imposte S. Caterina
Hotel Royal
Plus Hostel Florence
Chiesa di Nostra Signora del Sacro Cuore
Carrefour Express
Hotel Cimabue
Il Vegetariano
Malaspina
Casa dello Studente
Ospedale Santa Chiara
Hotel Piccadilly
Residenza la Rondini
Caffè Noir
Tourist House Liberty
Palazzo Le Monnier
San Giovannino dei Cavalieri
Via Zara
Via Bonifacio Lupi
Via San Zanobi

Dashboards

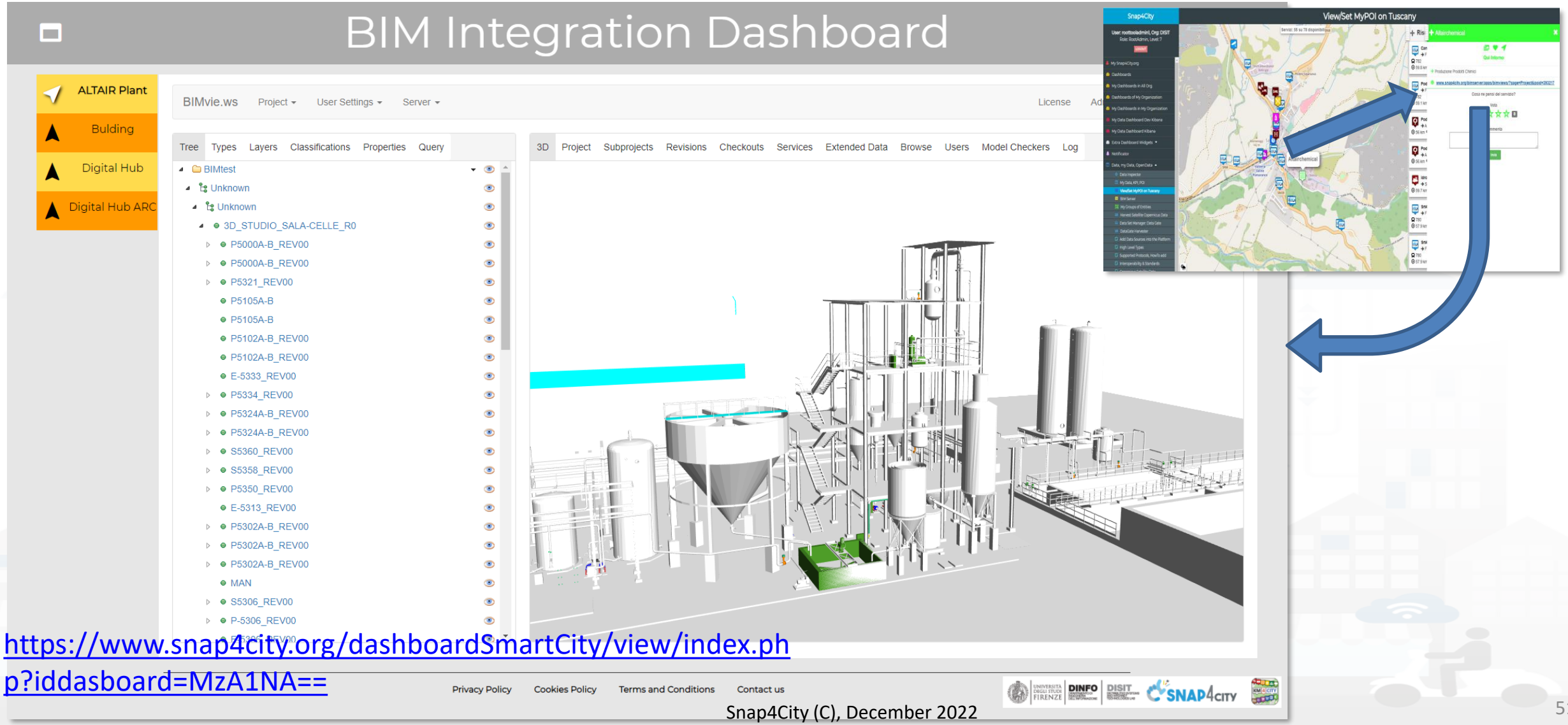

Alerting Generation
This dashboard contains data derived from actual sensors and predictive values under validation
Sat 16 Jan 01:03:27
Incident Kind
RIVER FLOODING
Severity
RELEVANT
People Involved
<=10
Short Term Impact
PEOPLE DISEASE
Long Term Impact
POLLUTANT
Alarm Description
Kind: River Floading
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
-0.4
°C
airTemperature


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


Snap4City
Data Analyzer: DevDash
SMARTCITYMAP
Number of Sensors 4
Latitude 43.77896531461738
Longitude 11.2758450344471
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

BIM view of the Altair Chemical Plant



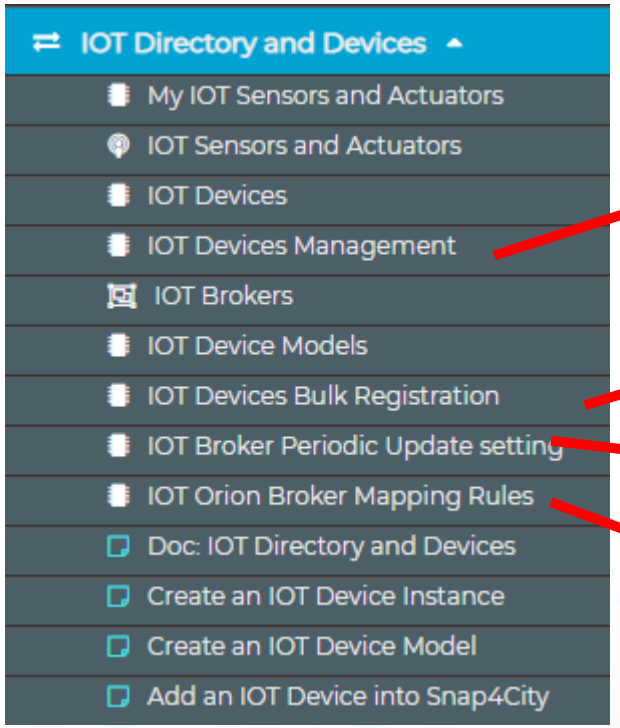
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA1NA==

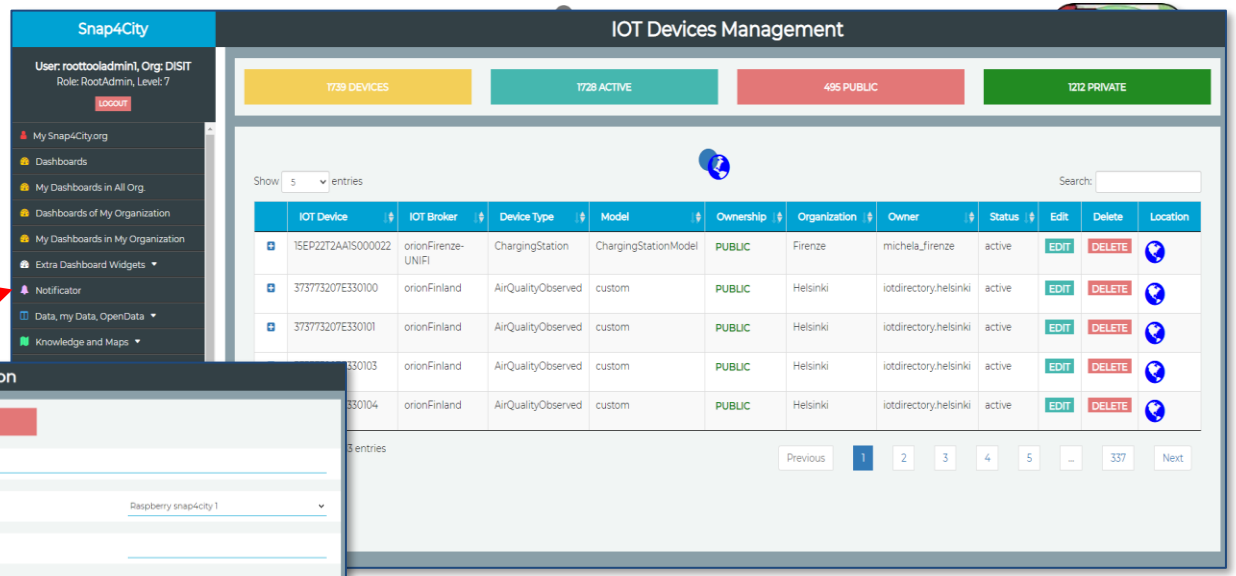
TOP

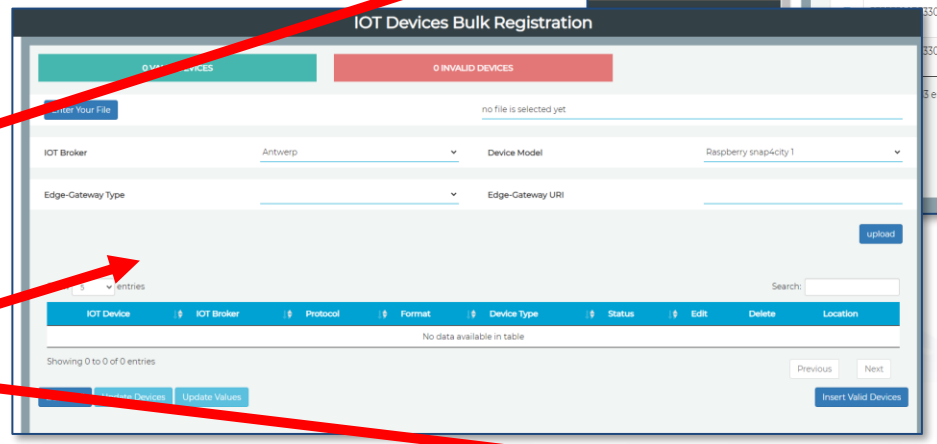
Working on IoT Devices

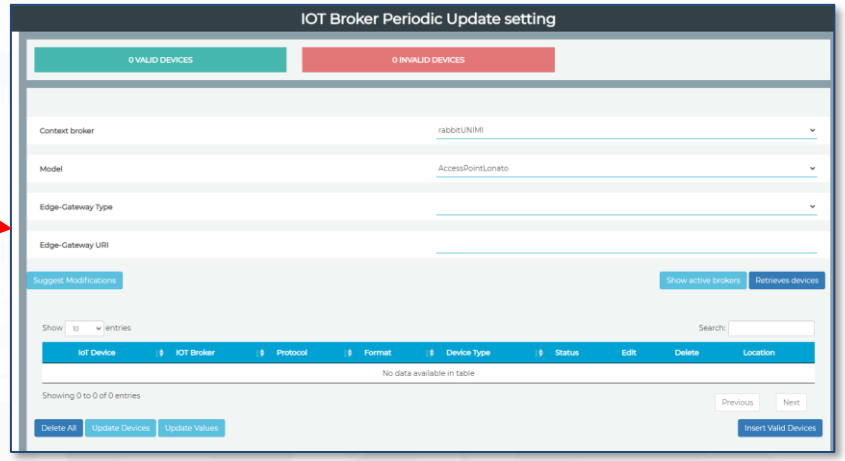
UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

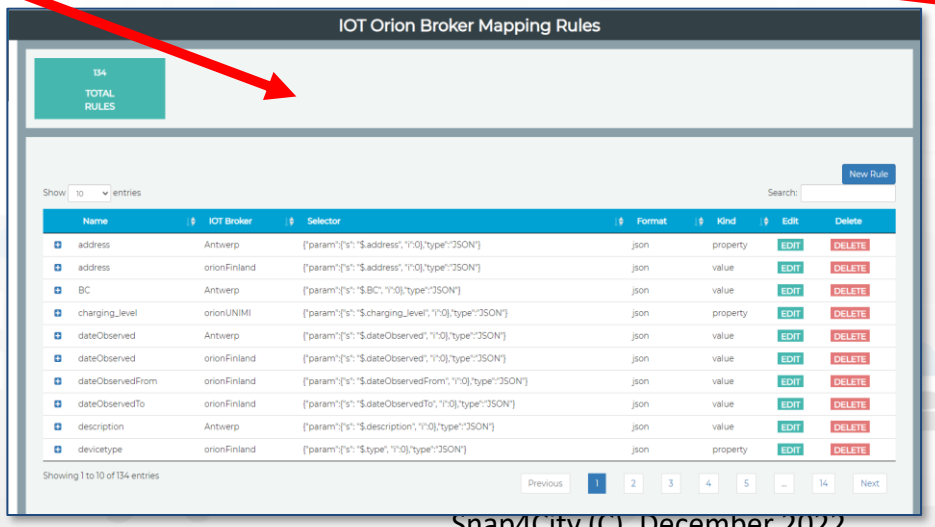
IOT Directory and Devices







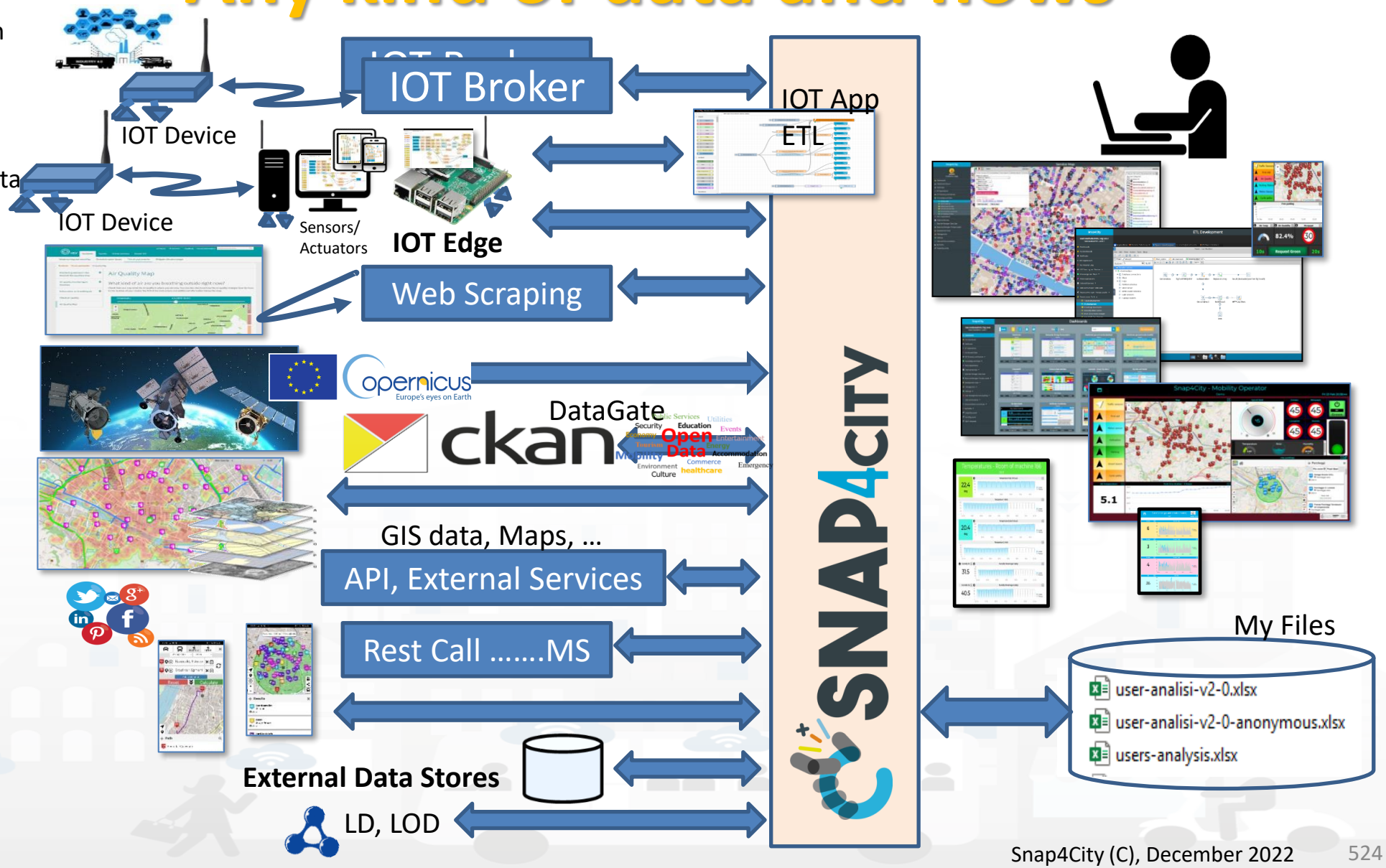




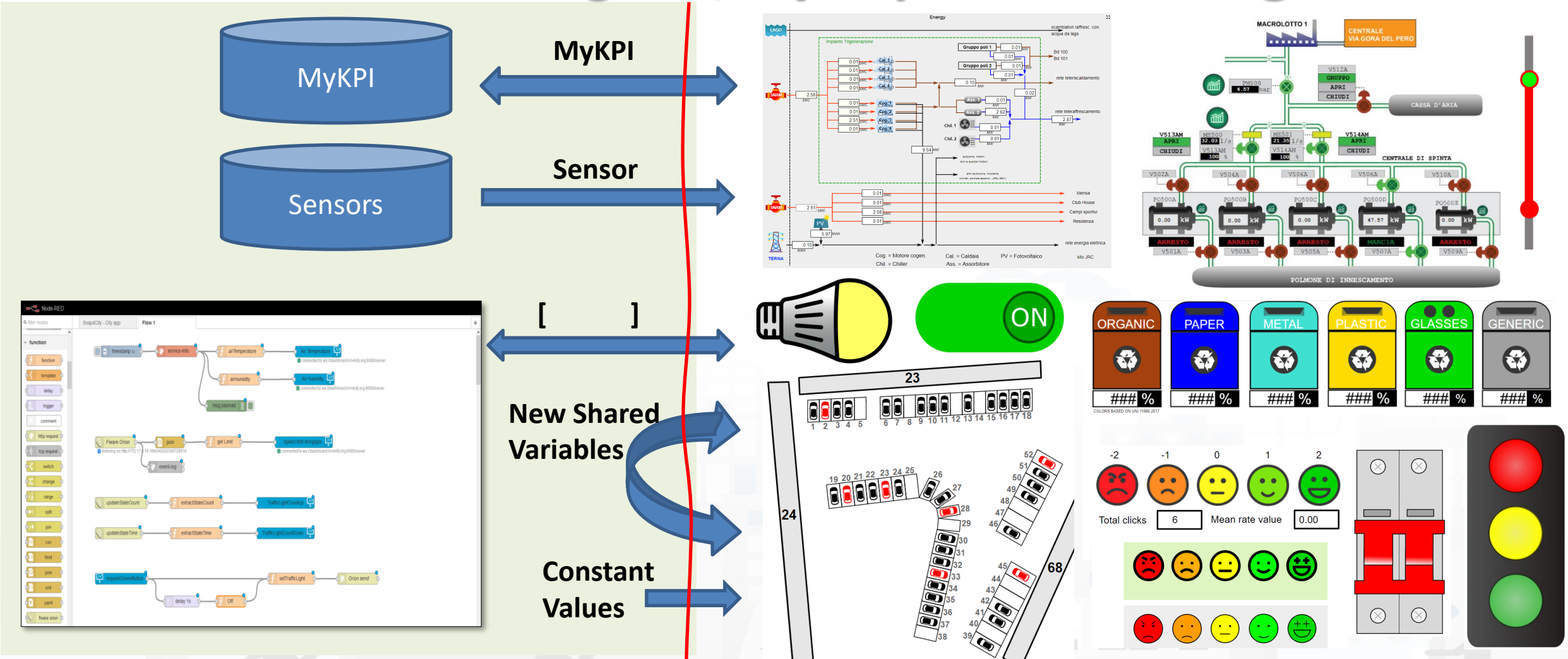
- For non admin tools see Training parts 3 and 5: https://www.snap4city.org/577

Any kind of data and flows

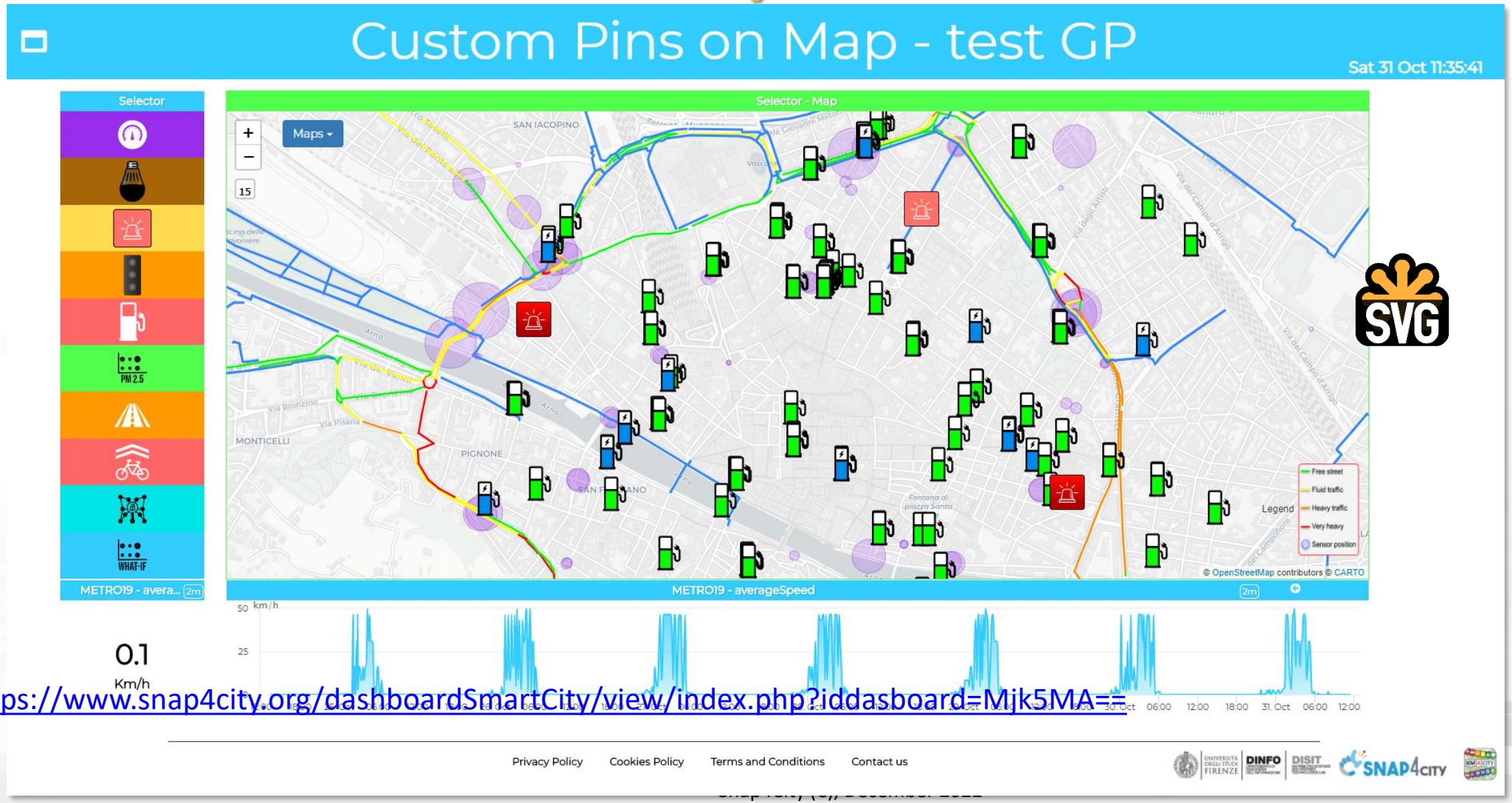
- **Open Data:**
  - Data gate, federation of Open Data Portals
  - IOT App, ETL proc(PULL)
- **IOT Networks:**
  - IOT Application processes, data driven or PULL
  - IOT Brokers (Push) → IOT Shadow
- **Web Pages:**
  - Web scraping, crawling processes
- **Satellite data**
- **Social media: Twitter, 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

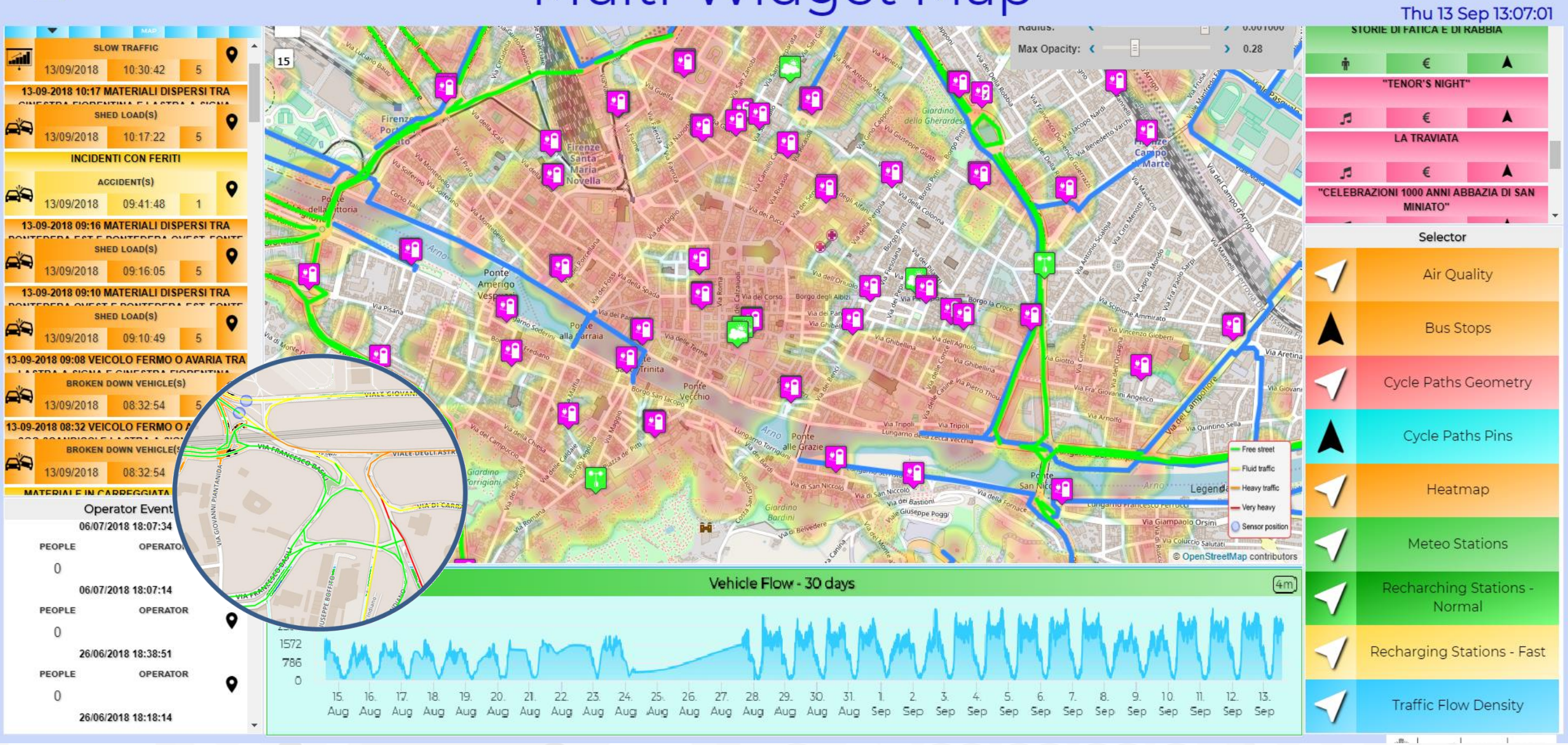


Custom Dynamic Pins



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

Multi-Widget Map

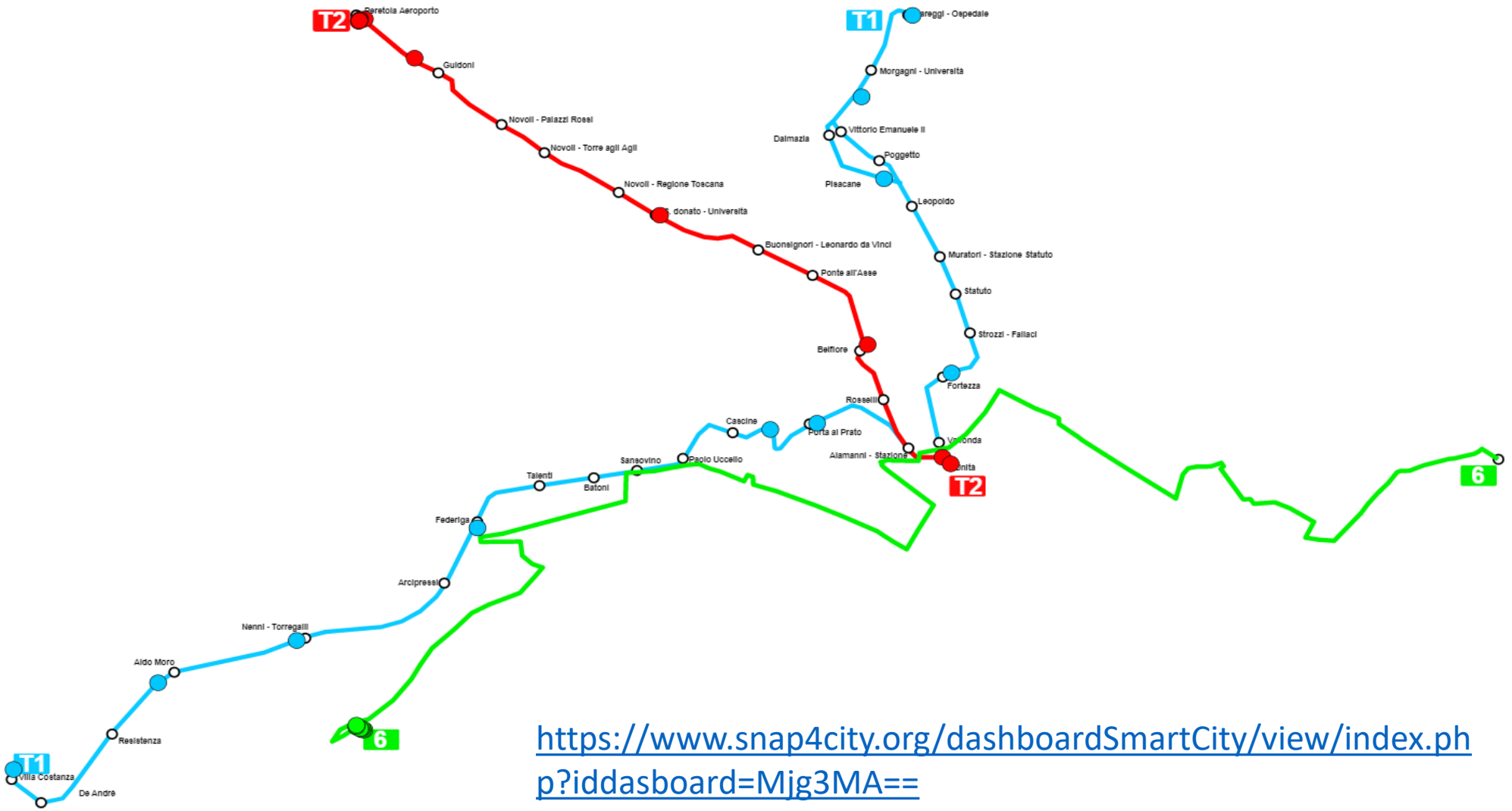


https://main.snap4city.org/view/index.php?iddasboard=OTc2

Firenze SVG Tramline Multi rides

Fri 17 Jul 18:29:50

Tramline

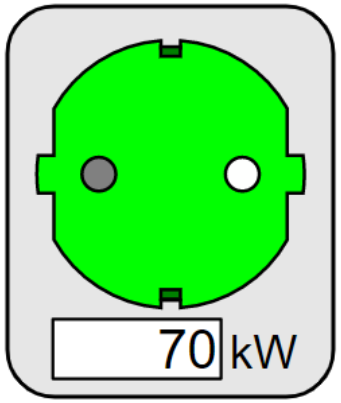


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjg3MA==

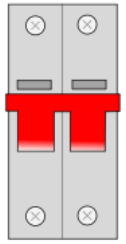
SVG Custom Widgets Examples 2

Tue 17 Nov 18:46:47

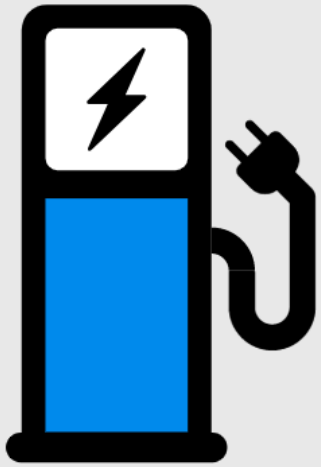
SVG shucko plug



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		

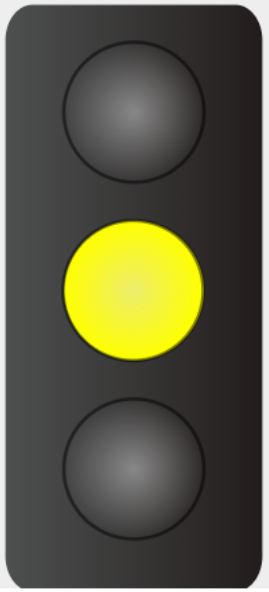
Underpass

Set tunnel st...

Traffic Light status set

YELLOW LIGHT

Traffic 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

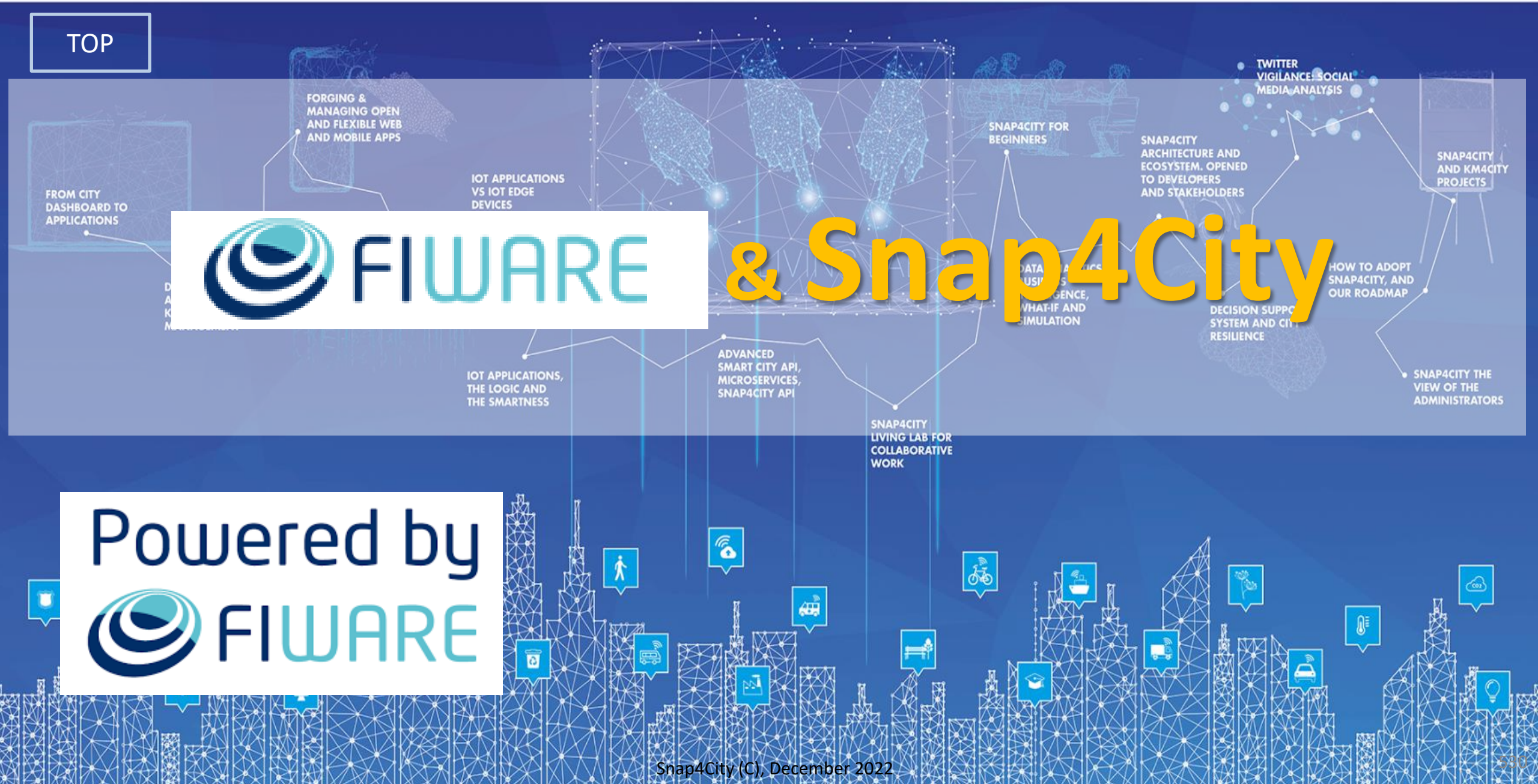
Speed Limit Custom Widget example

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

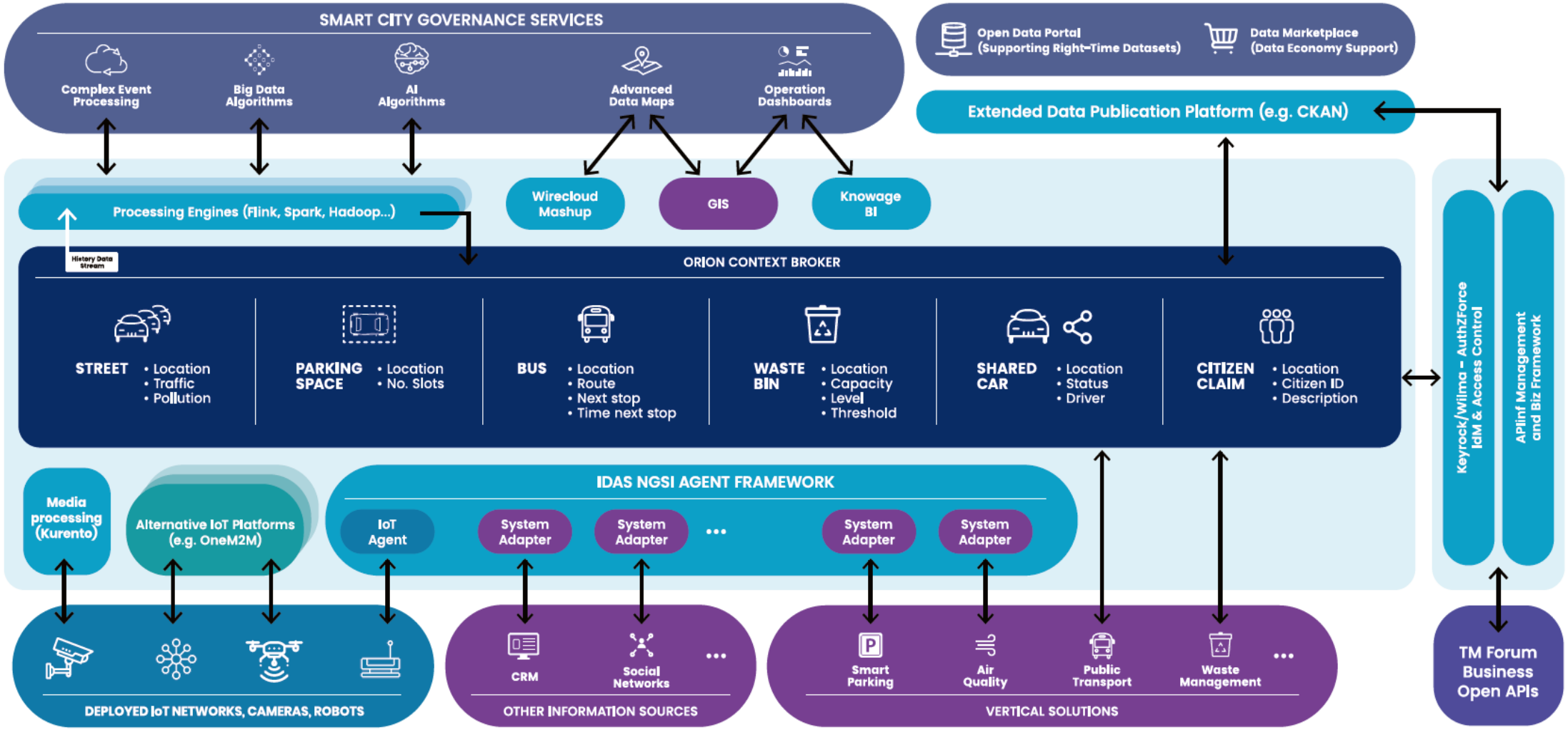
9999 = white sign.

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

TOP


FORGING & MANAGING OPEN AND FLEXIBLE WEB AND MOBILE APPS
FROM CITY DASHBOARD TO APPLICATIONS
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
SNAP4CITY ARCHITECTURE AND ECOSYSTEM. OPENED TO DEVELOPERS AND STAKEHOLDERS
TWITTER VIGILANCE: SOCIAL MEDIA ANALYSIS
SNAP4CITY AND KM4CITY PROJECTS
HOW TO ADOPT SNAP4CITY, AND OUR ROADMAP
SNAP4CITY THE VIEW OF THE ADMINISTRATORS
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

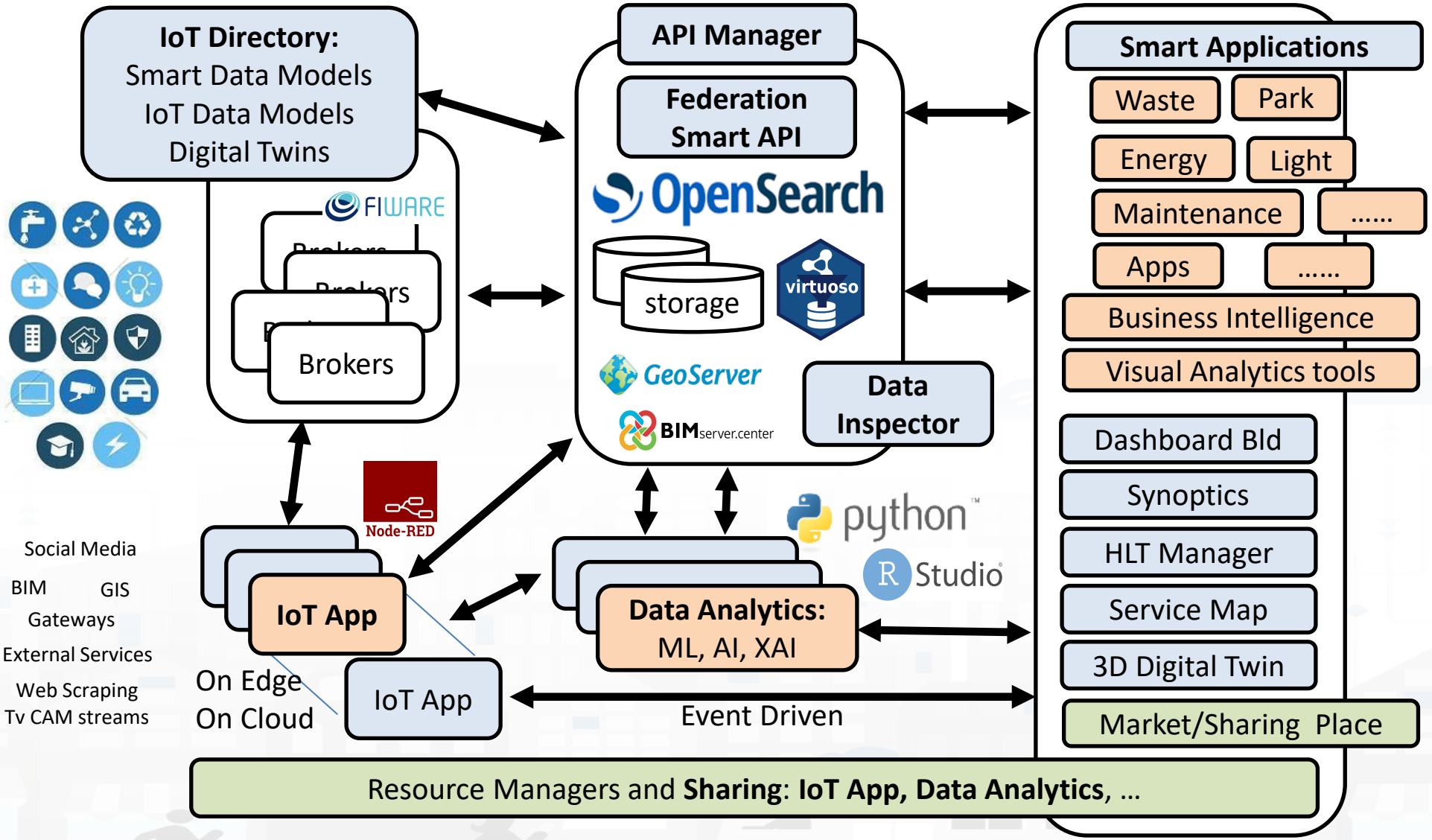
Powered by FIWARE

Overview

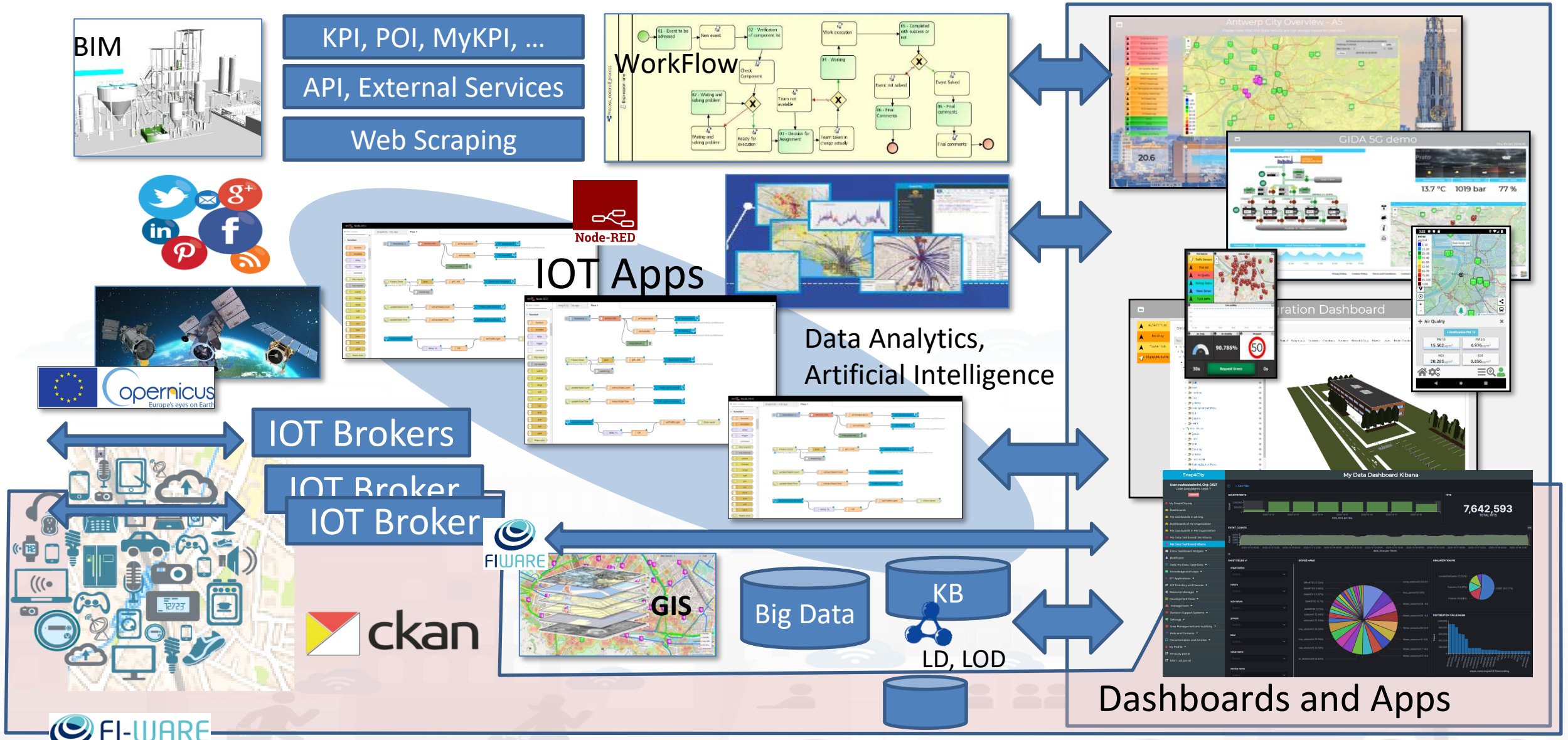
- https://fiware-foundation.medium.com/snap4city-fiware-powered-smart-app-builder-for-sentient-cities-acfe24df49d5
- https://www.snap4city.org/drupal/sites/default/files/files/FF_ImpactStories_Snap4City.pdf

- 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.

Tech Arch


IoT Directory:
Smart Data Models
IoT Data Models
Digital Twins
FIWARE
Brokers
Brokers
Brokers
API Manager
Federation
Smart API
OpenSearch
storage
virtuoso
GeoServer
BIMserver.center
Data
Inspector
Smart Applications
Waste
Park
Energy
Light
Maintenance
.....
Apps
.....
Business Intelligence
Visual Analytics tools
Dashboard Bld
Synoptics
HLT Manager
Service Map
3D Digital Twin
Market/Sharing Place
Node-RED
python
R Studio
Social Media
BIM
GIS
Gateways
External Services
Web Scraping
Tv CAM streams
IoT App
IoT App
On Edge
On Cloud
Data Analytics:
ML, AI, XAI
Event Driven
Resource Managers and Sharing: IoT App, Data Analytics, ...

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
ckan
GIS
Big Data
KB
LD, LOD
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

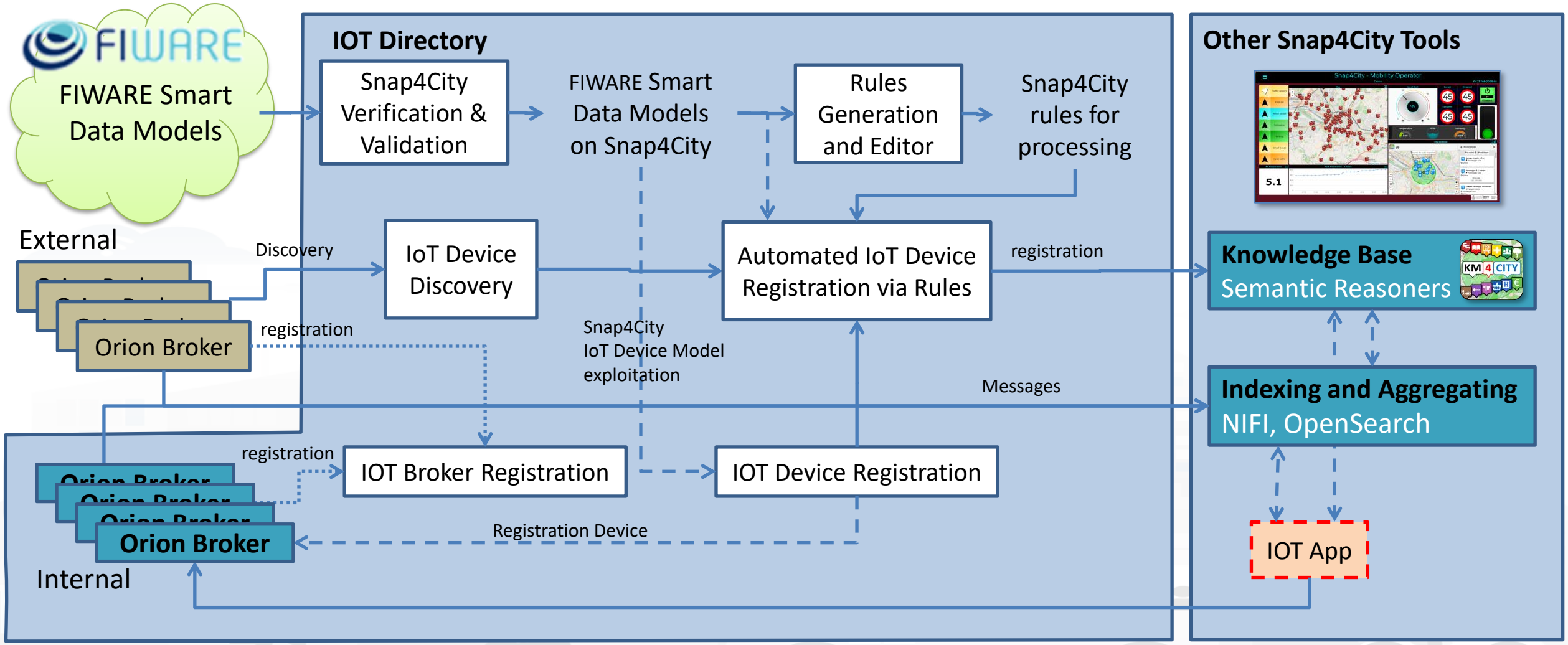
- Is open to the Development of Applications leaving large space to developers
- Is centered on the Orion Broker that results central in the architecture: any Broker or data source is sending data to the Orion
- Data shadow for historical data with external data base as CrateDB on which you can attach 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

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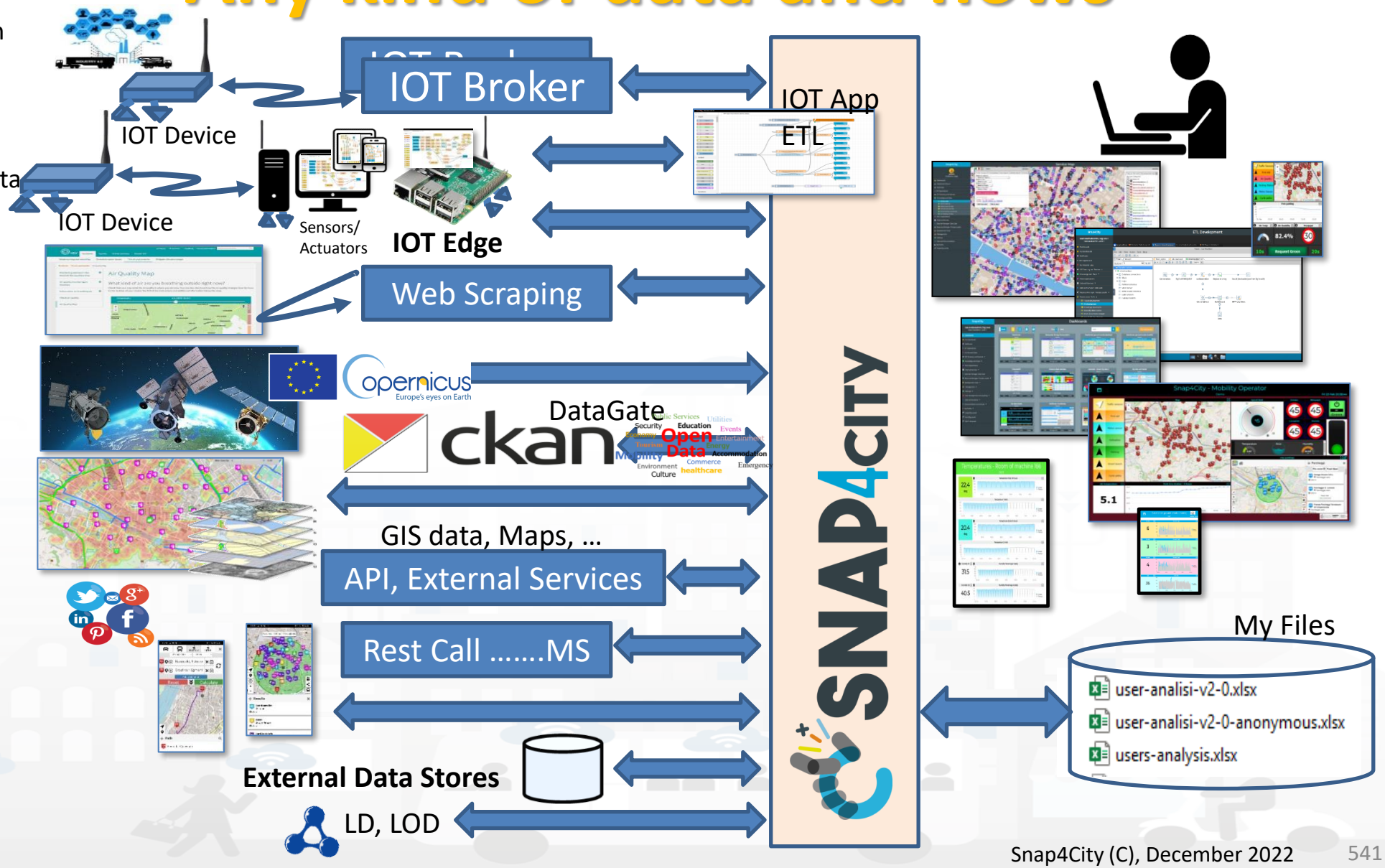
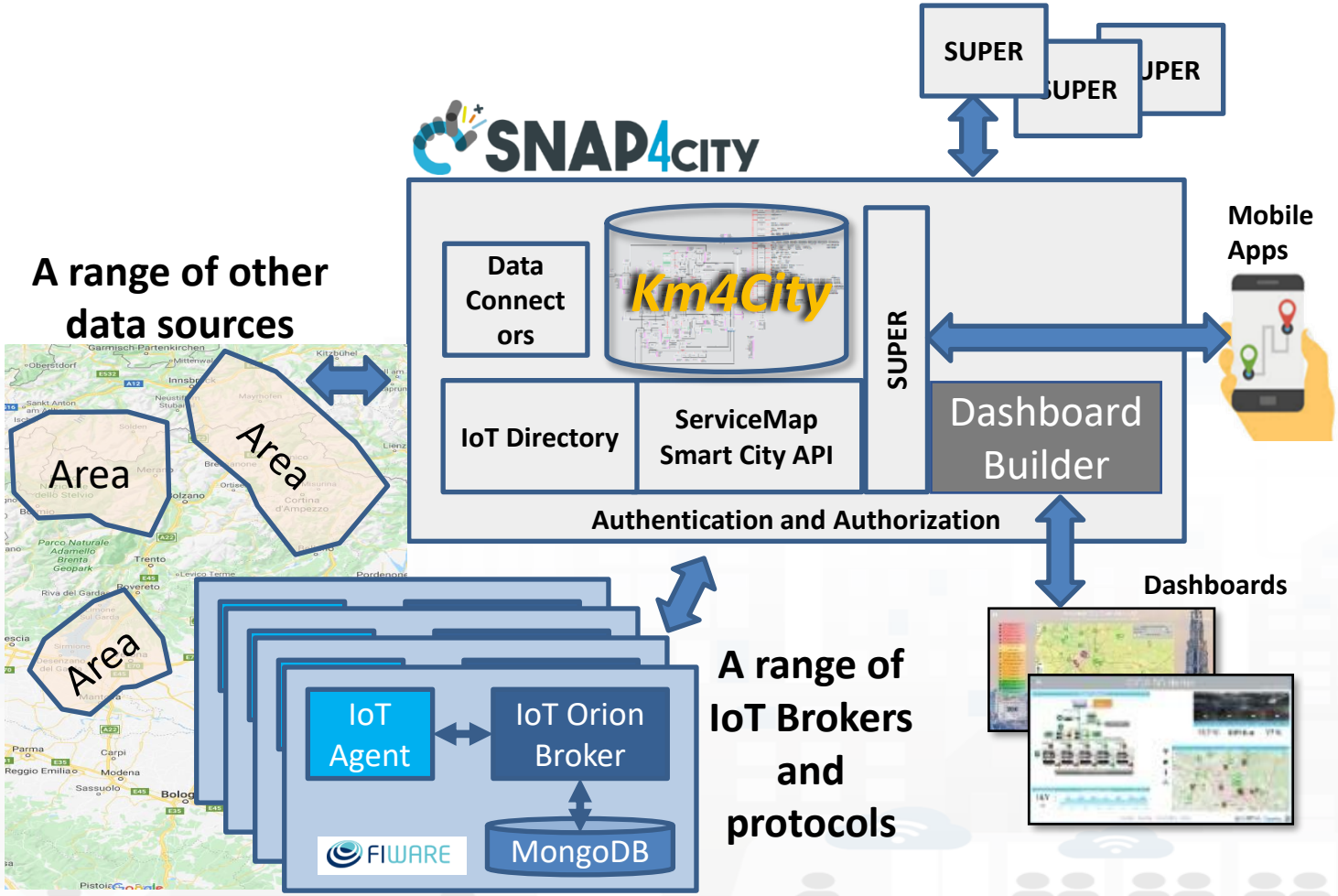
  - IOT Applications, ETL
- **Data base accesses**
  - GIS: WFS, WMS
  - ETL, IOT Application



Snap4City and FiWare integration

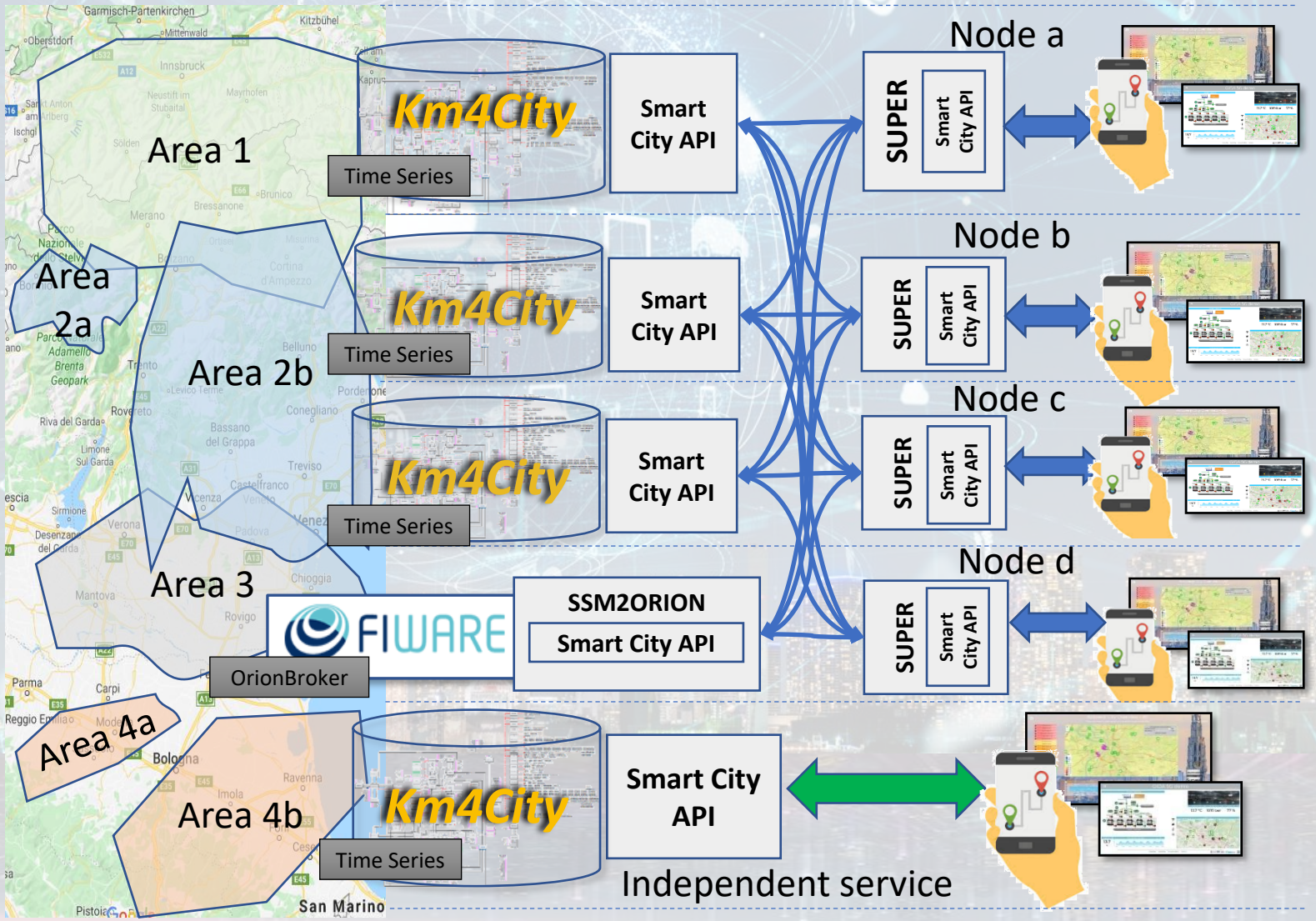
- **A) IoT Orion Broker as an External Broker** of a Snap4City platform
  - Devices are mainly managed by Orion Broker only
  - IoT Directory can harvest devices on Broker to registered them
- **B) IoT Orion Broker is an Internal Broker** of a Snap4City platform
  - This implies that Snap4City facilities 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



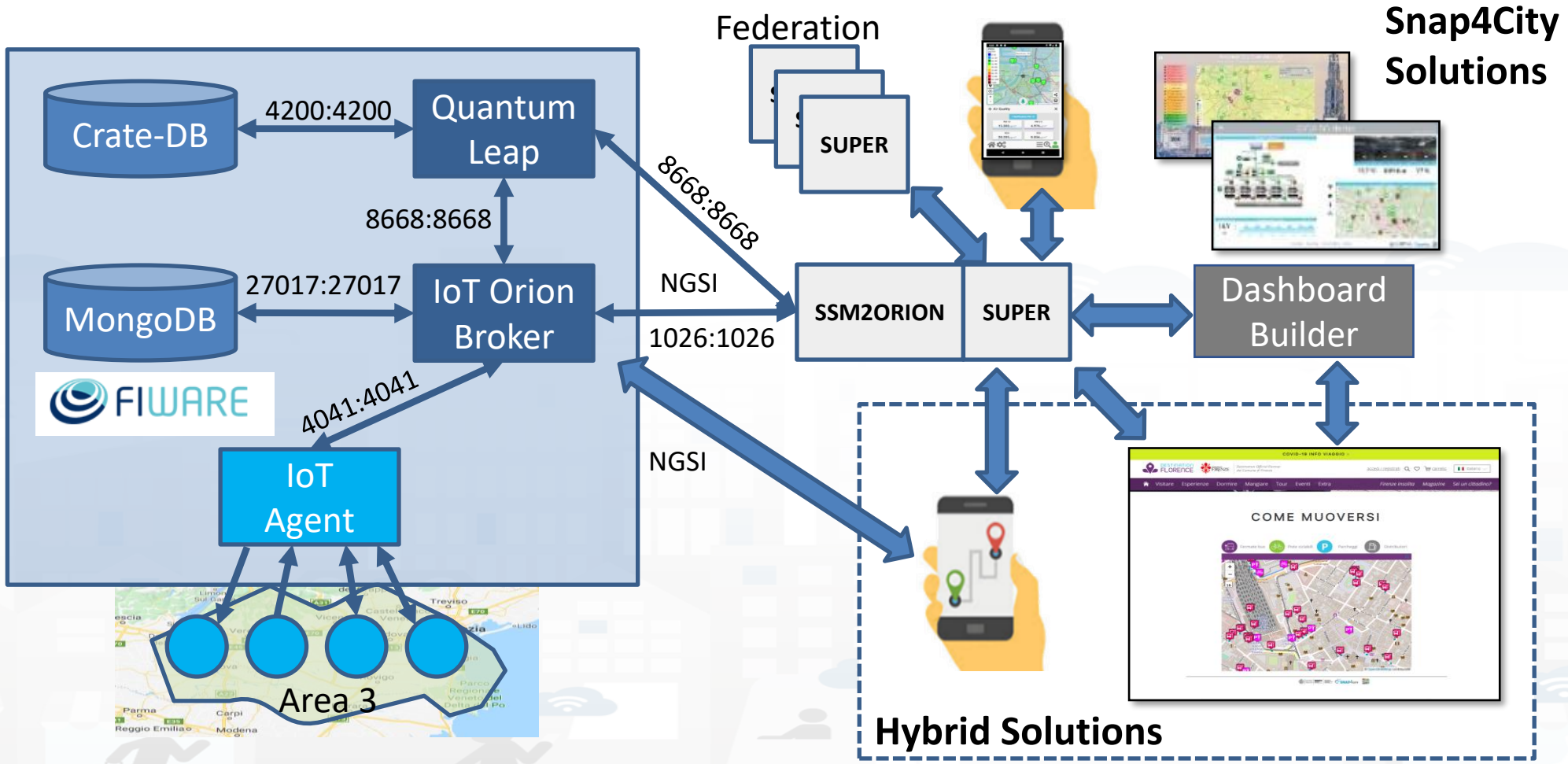
Federation of Smart City Services

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

100% OPEN SOURCE

Installing Snap4City

SNAP4 Appliances and Dockers **Installations**

Installations

docker

https://www.snap4city.org/471

To get an updated version read it!

Using from Cloud or Installing on Premise

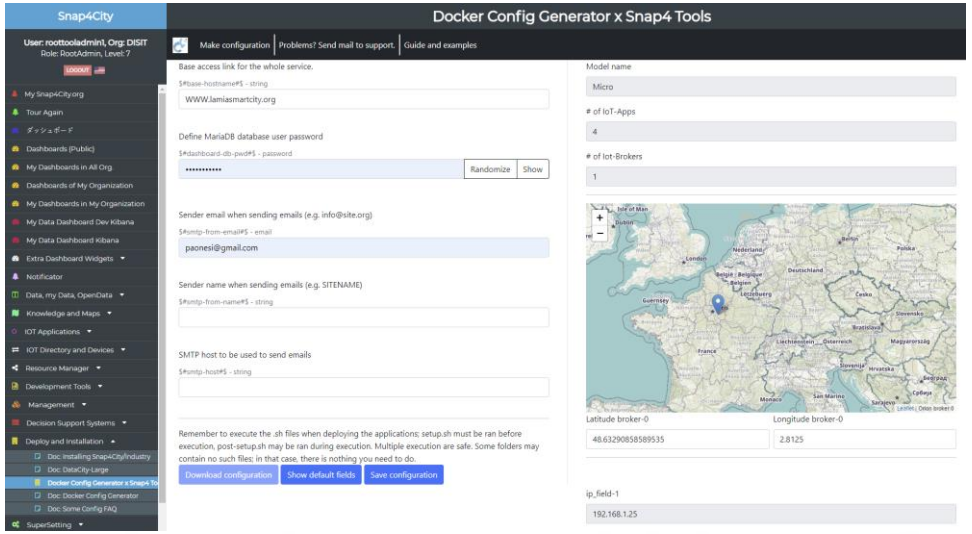
- **Cloud «as a service»:** a number of installations are in place
  - The largest https://www.snap4city.org
    - 20 tenants/organizations, Billions of data
    - 1 hour deploy new organization, devices, data, dashboards
- **Installations on public or private cloud, or on private servers**
  - A number of ready to use configurations from 1VM to multiple scalable solutions: https://www.snap4city.org/471
    - VM: Appliances ready to use
    - Docker compose, Tool for generating and downloading the docker compose files
      - Micro X version can be installed and tested in 4 hours.

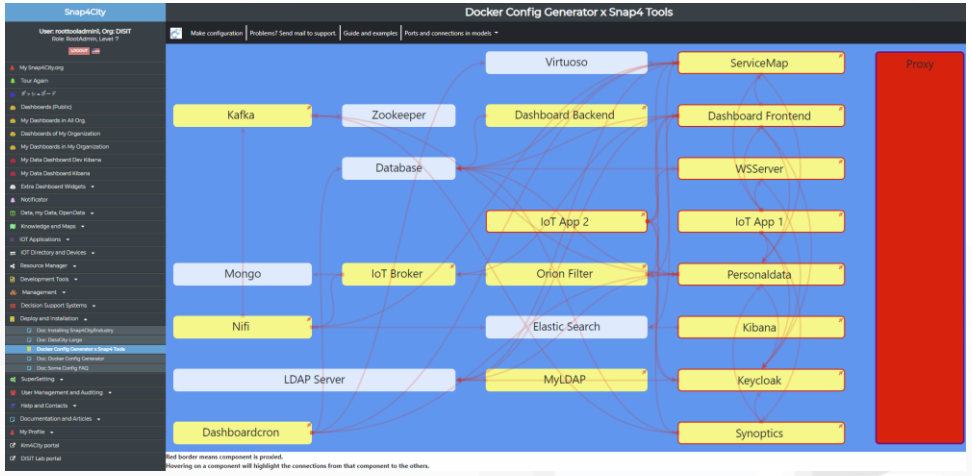
https://www.snap4city.org/docker-generator/selecting_model

SNAP4 Appliances and Dockers Installations

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

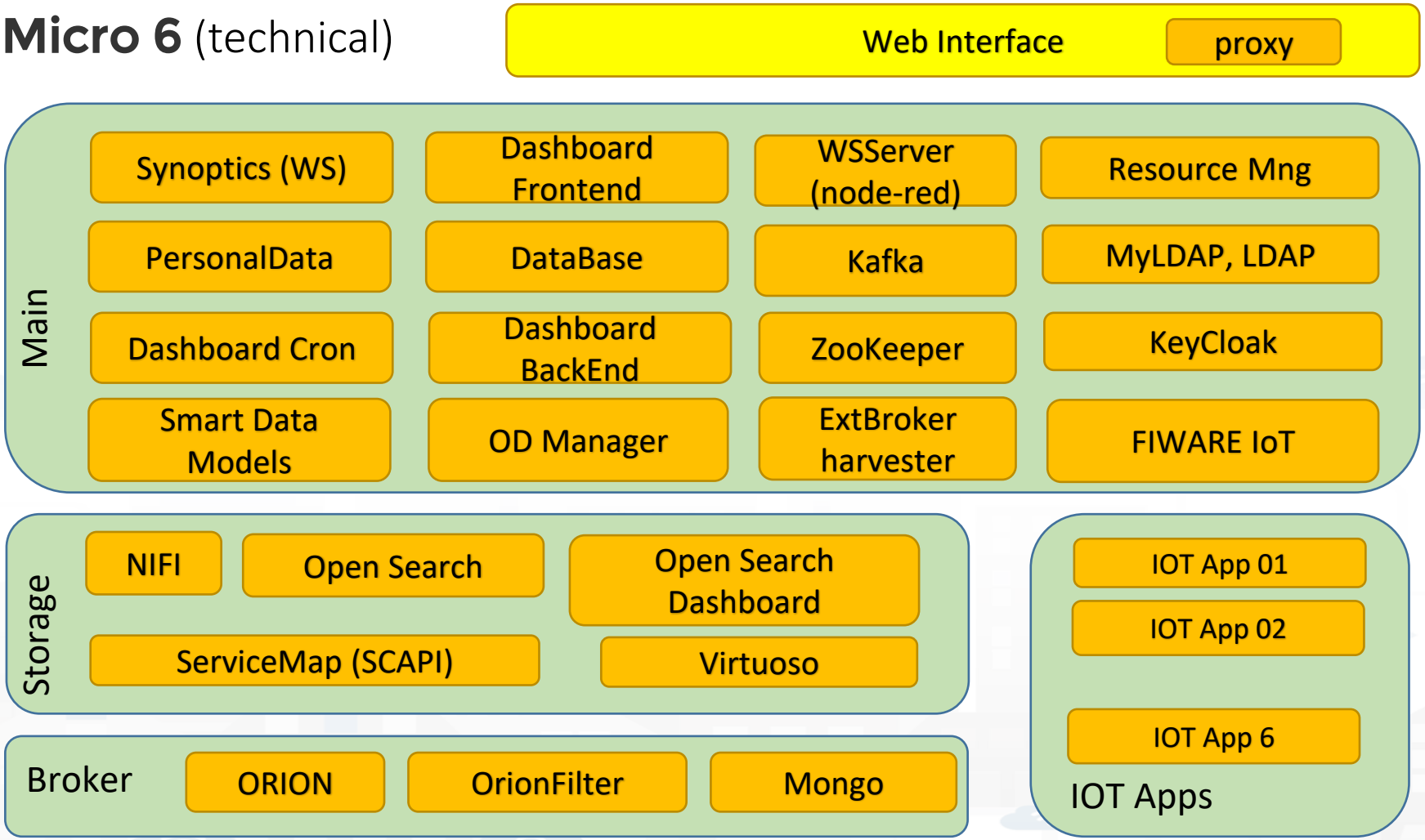




https://www.snap4city.org/docker-generator/selecting_model

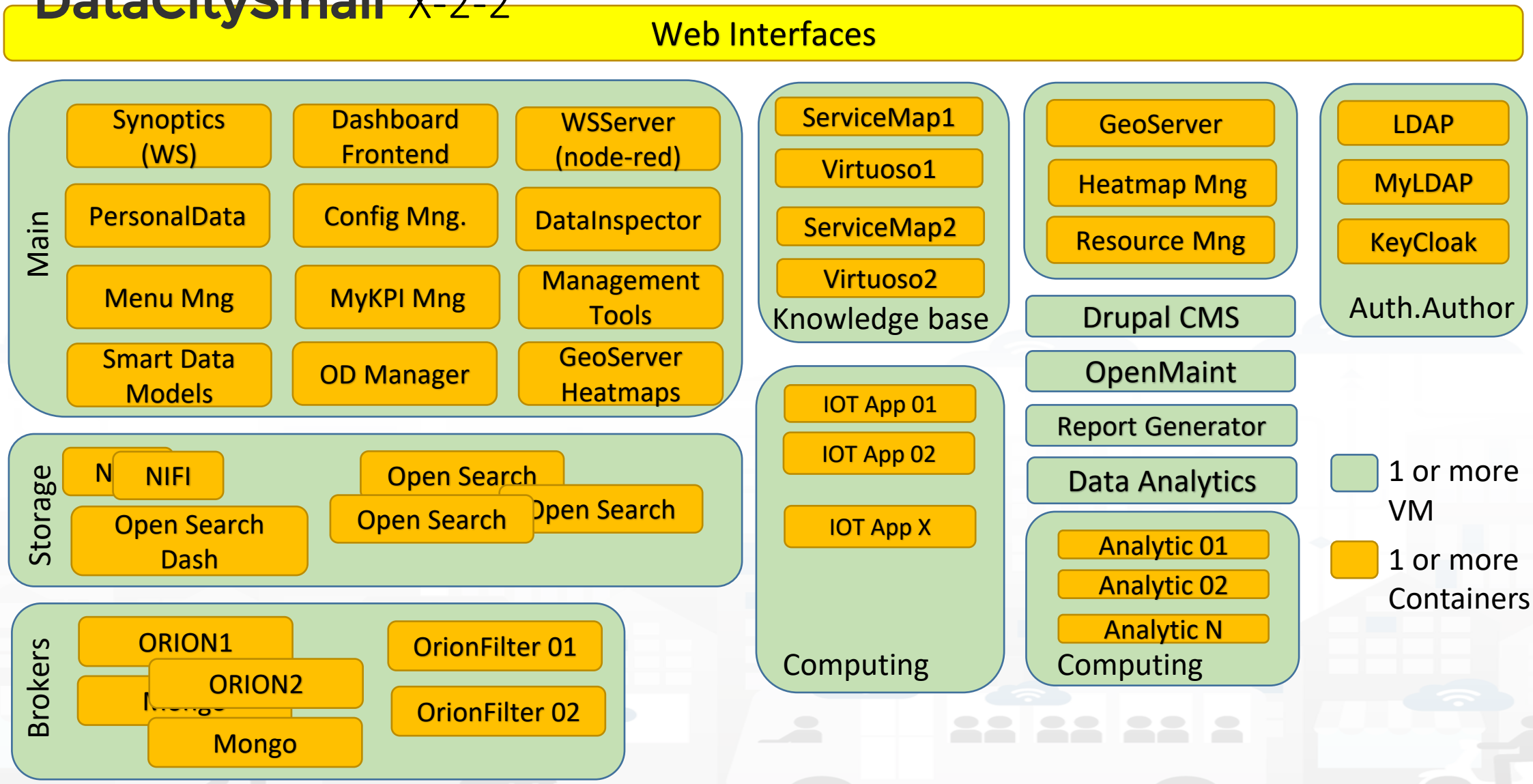
Micro 6 model

Micro 6 (technical)



1Hour installation and ready to use

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
- **Services**: customisation, development of data analytics, development of IoT Apps.

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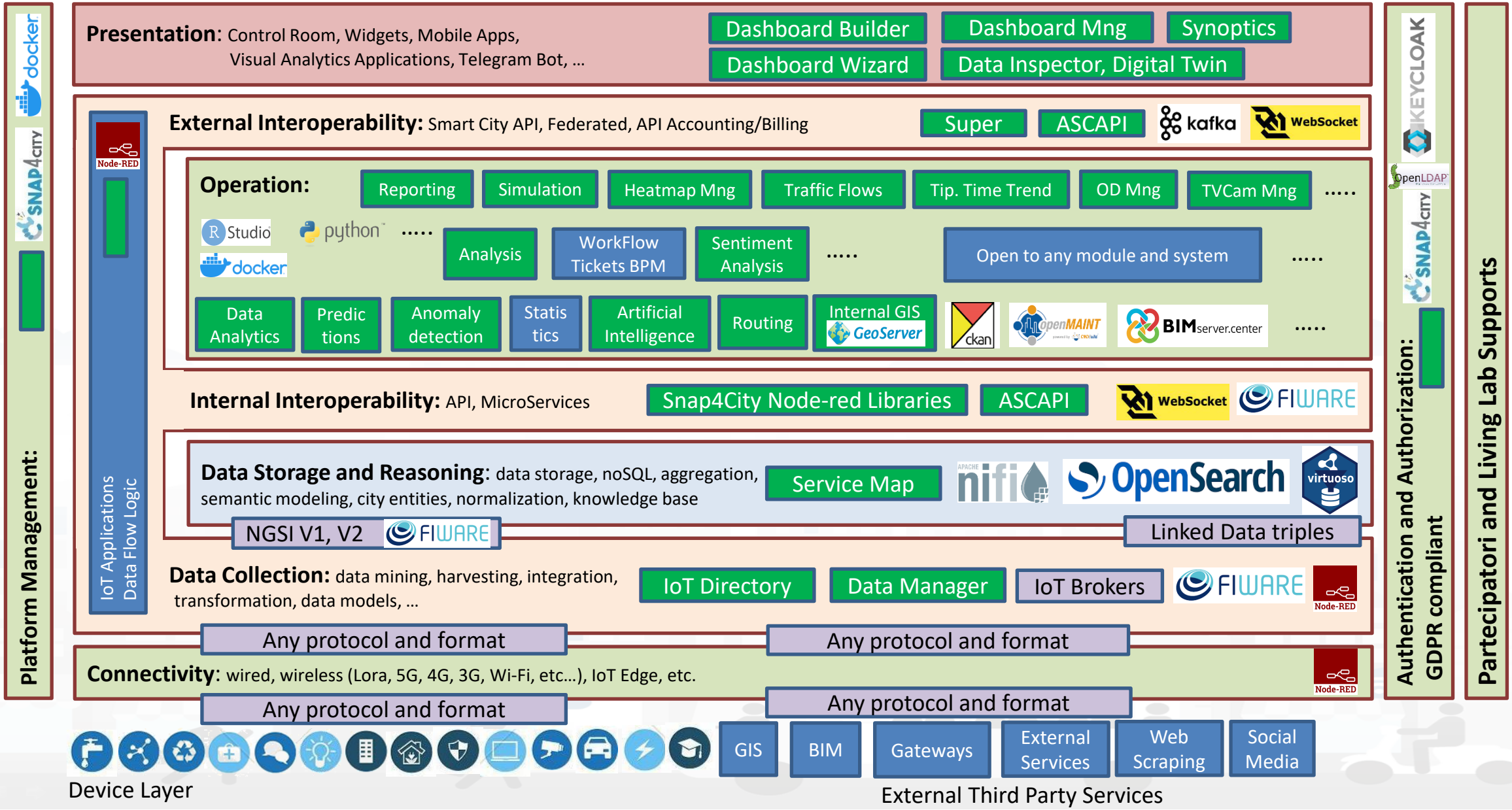
legenda



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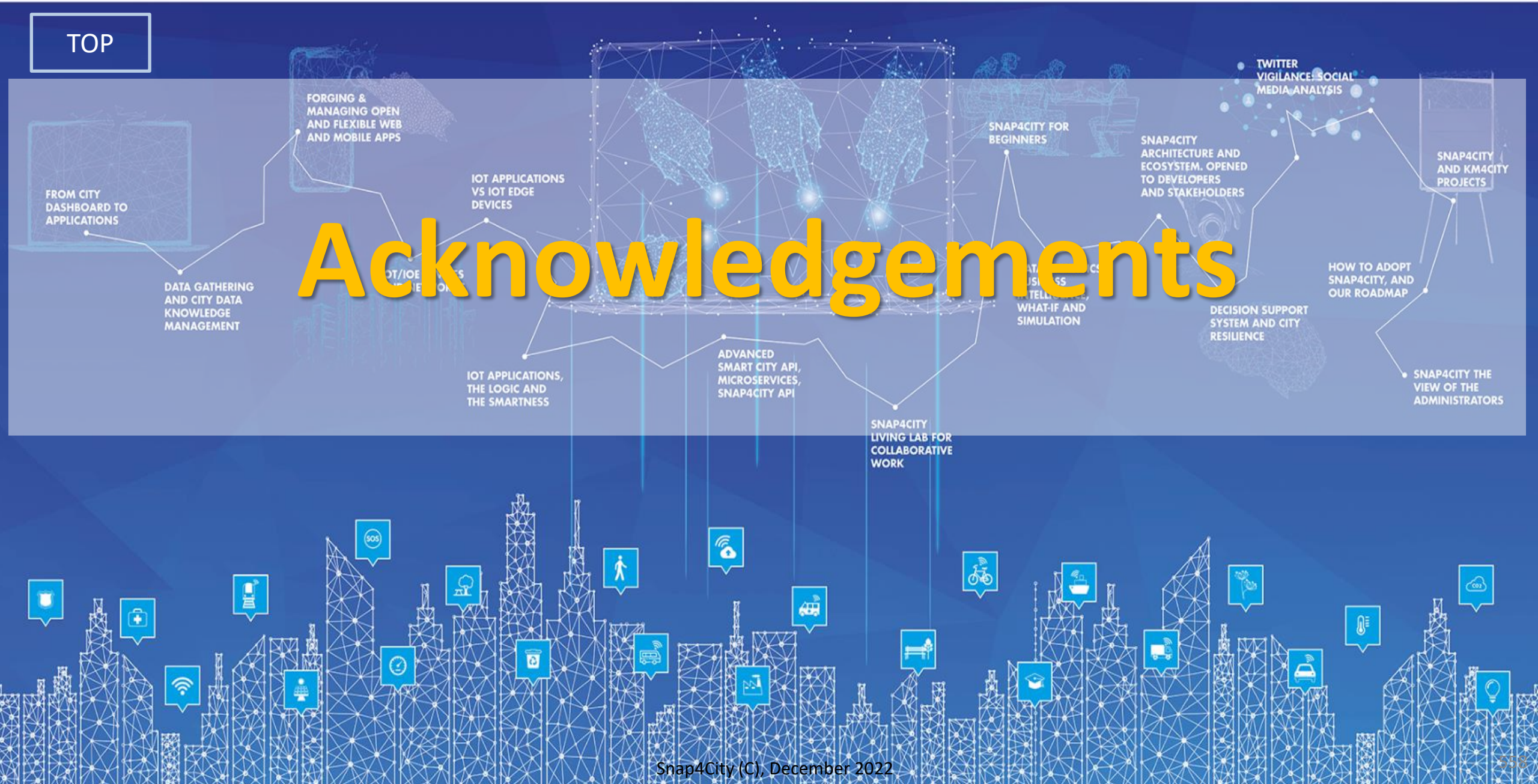
Acknowledgements



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 1.5

Km4City 1.4

2015

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

H2020 (2015-18)

(2016-21) H2020 REPLICATE

Km4City 1.6.2

- Smart Energy
- Sustainable Mobility
- Control Room
- Dashboard

(2016-21) SII-MOBILITY SCN

- Infomobility
- Mobile App
- Routing
- Multimodality

2016

FIWARE

Km4City 1.6.4

- Sardinia Region Smart City Strategies and plan

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

GREEN IMPACT
POR FESR 2014-2020

- Industry 4.0
- Critical Plant
- Monitoring

2017

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

E015 digital ecosystem

(2016-19) GHOST SIR

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

(2017-20)

- Smart Waste

2018

(2018-20)

- Mobility Demand / Offer Analytics and Strategy

(2018-21)

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

IOT/IOE

Km4City 1.6.6

Node-RED

SNAP4CITY SELECT for Cities H2020 (2017-19)

5G tech
Energy
Industry 4.0
Synoptics

TRAFAIR

CEF (2018-21)

- Traffic and Mobility Impact on Pollution
- NOX predictions

2019

EUROPEAN OPEN SCIENCE CLOUD

LAID Smart Bed

- Smart Health

GREEN FIELD PEAS Soda4.0

- Industry 4.0

Winner of Select4Cities PCP

- Smart Lonato

ckan resolute life weee SIRIUS bee smart city Reverberi Enetec Gruppo MPES

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

smartGARDAlake

2021

PC4City (2020-21)
Monitoring Terrain

Winner of Open Data Challenge of enel x

CAPELON

- Smart Light
- Sweden

Km4City 1.6.7

JRC EUROPEAN COMMISSION

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

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

IMPETUS
Security and Risk

enel x
Contract

Filippi
Contract

ART-ER ATTRATTIVITÀ RICERCA TERRITORIO
Contract

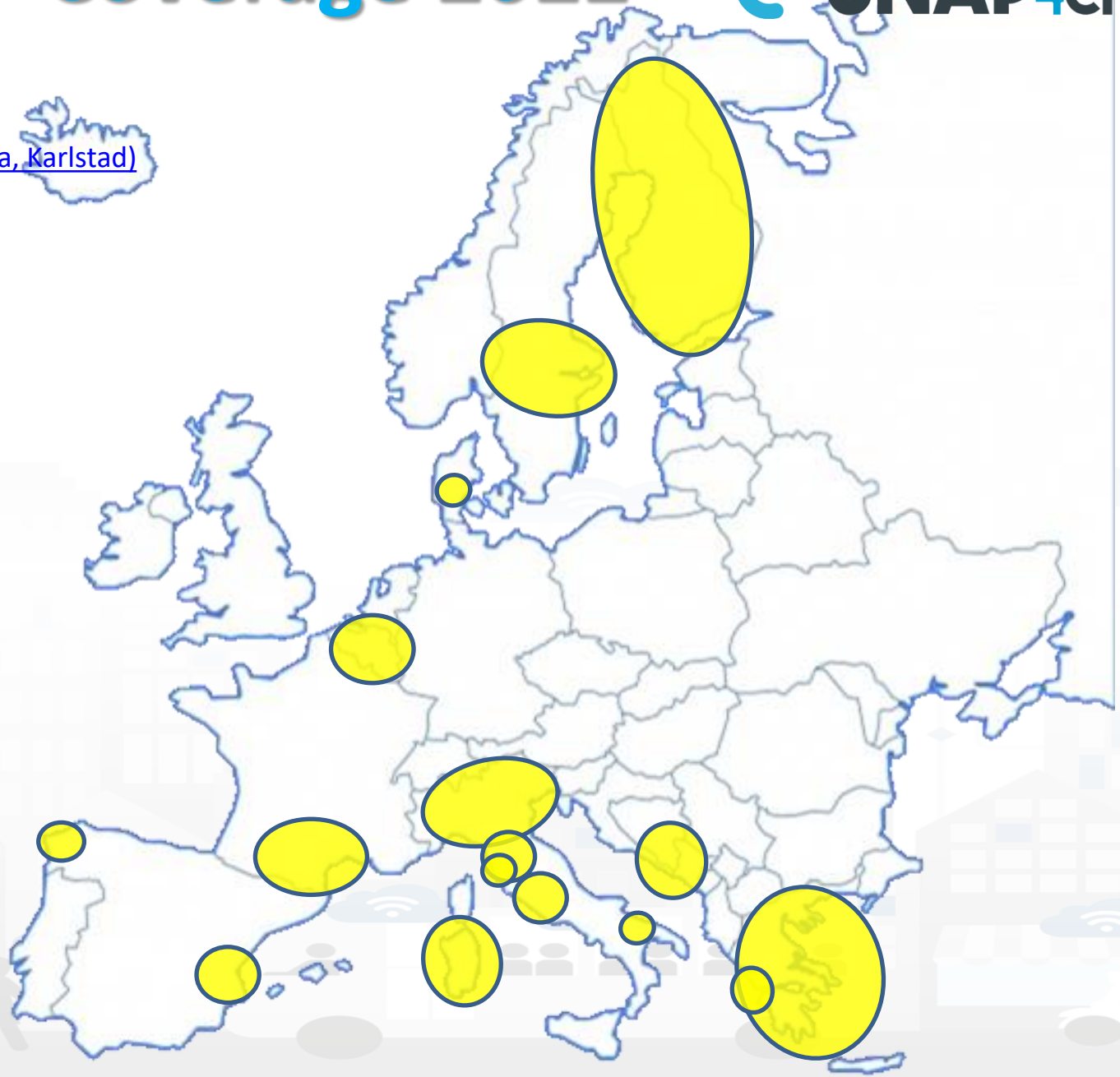
Some agreements

JRC EUROPEAN COMMISSION

Coverage 2022

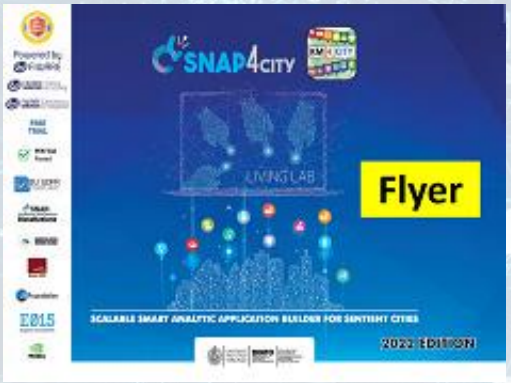
Main Organizations/areas

- 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

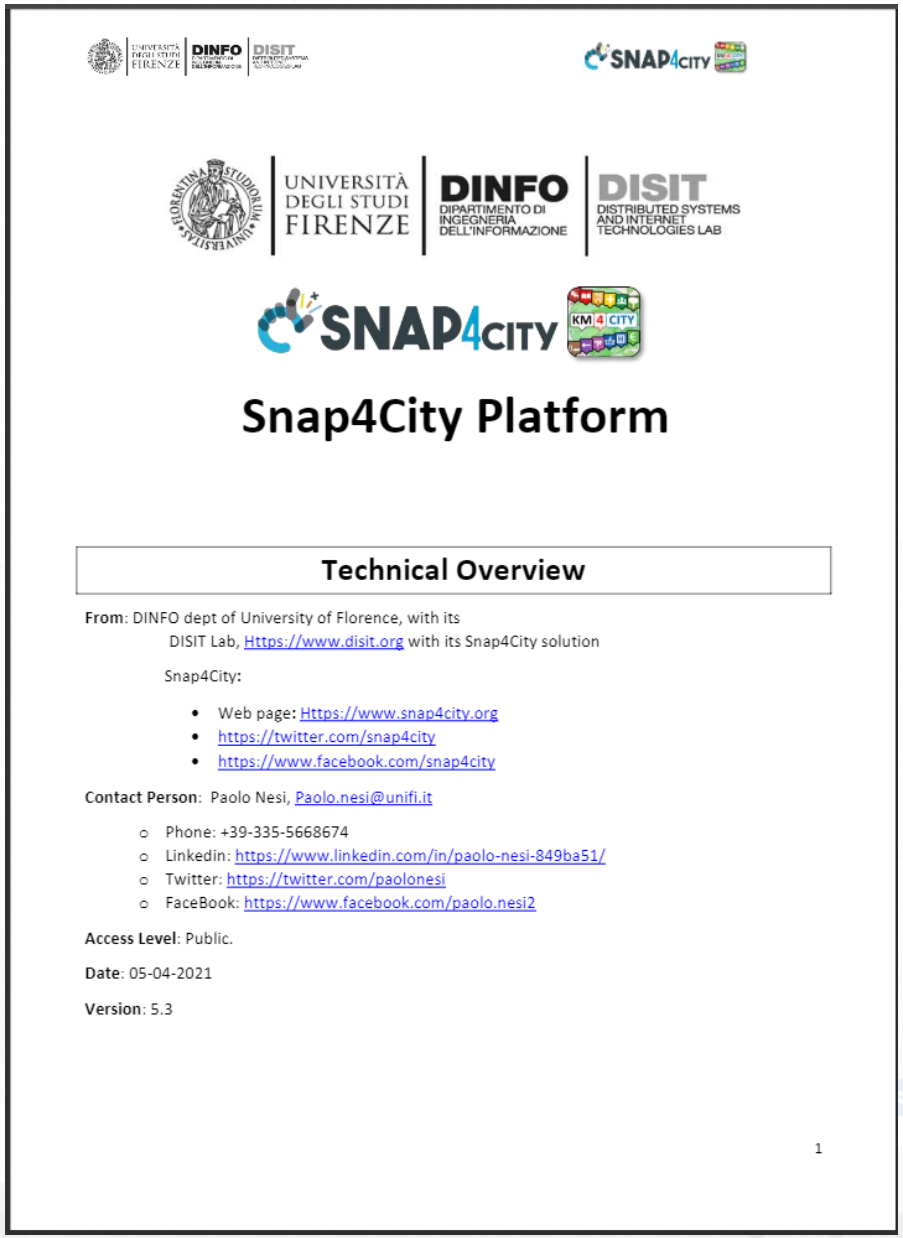
- Snap4Industry

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

- Solutions
- Data Analytics

https://www.snap4city.org/download/video/DPL_SNAP4SOLU.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

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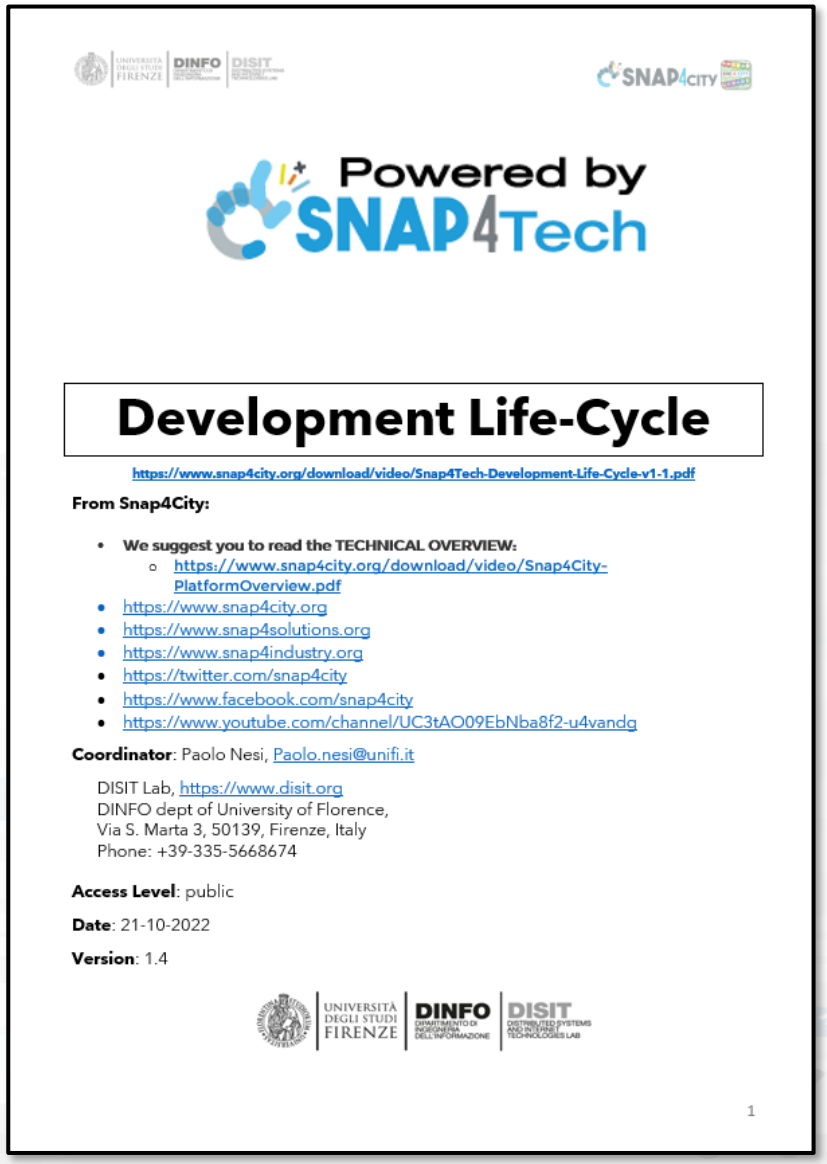
- https://www.snap4city.org/drupal/sites/default/files/files/Snap4City-PlatformOverview.pdf

Development



Powered by SNAP4Tech

Development Life-Cycle

https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle-v1-1.pdf

From Snap4City:

- **We suggest you to read the TECHNICAL OVERVIEW:**
  - https://www.snap4city.org/download/video/Snap4City-PlatformOverview.pdf
- https://www.snap4city.org
- https://www.snap4solutions.org
- https://www.snap4industry.org
- https://twitter.com/snap4city
- https://www.facebook.com/snap4city
- https://www.youtube.com/channel/UC3tAO09EbNba8f2-u4vandg

Coordinator: Paolo Nesi, Paolo.nesi@unifi.it

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Access Level: public

Date: 21-10-2022

Version: 1.4

1

https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf

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

- Thanks to the European Commission for founding. All slides reporting logo of **Snap4City** https://www.snap4city.org **of Select4Cities H2020** are representing tools and research founded by European Commission for the **Select4Cities** project. **Select4Cities** has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation Programme (grant agreement n° 688196)
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- Thanks to the European Commission for founding. All slides reporting logo of **REPLICATE H2020** are representing tools and research founded by European Commission for the REPLICATE project. **REPLICATE** has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation Programme (grant agreement n° 691735).
- Thanks to the European Commission for founding. All slides reporting logo of **RESOLUTE H2020** are representing tools and research founded by European Commission for the RESOLUTE project. **RESOLUTE** has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation Programme (grant agreement n° 653460).
- Thanks to the MIUR for co-founding and to the University of Florence and companies involved. All slides reporting logo of **Sii-Mobility** are representing tools and research founded by MIUR for the Sii-Mobility SCN MIUR project.
- **Km4City** *is an open technology and research line of DISIT Lab exploited by a number of projects. Some of the innovative solutions and research issues developed into projects are also compliant and contributing to the Km4City approach and thus are released as open sources and are interoperable, scalable, modular, standard compliant, etc.*

TOP

SNAP4CITY

KM4CITY

Be smart in a SNAP!

100% OPEN SOURCE

SNAP4 Appliances and Dockers **Installations**

www.snap4city.org

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