# SNAP4CITY

www.snap4city.org
www.snap4solutions.org

www.km4city.org


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DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB


#snap4city
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#disitlab
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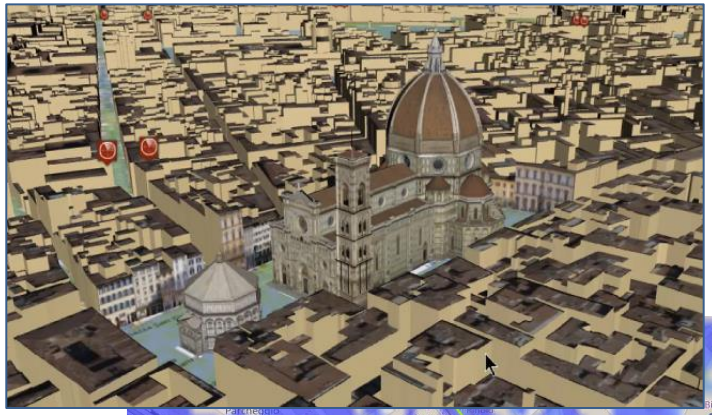
# Public Spaces as Critical Infrastructures

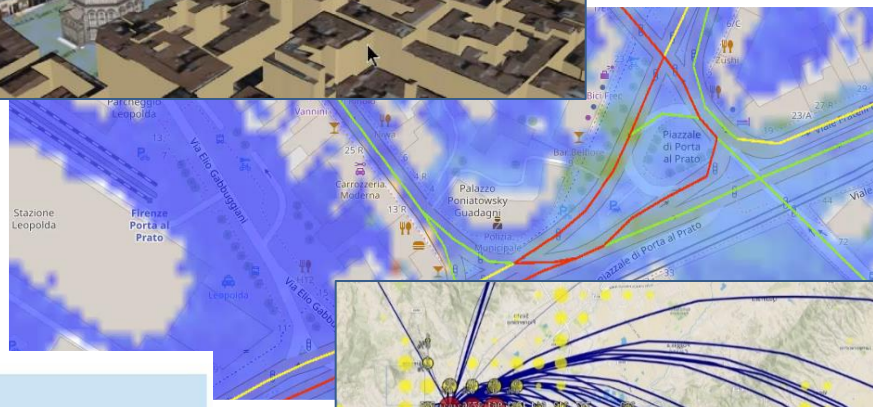
- The City is a system of systems for city users
  - Cascading effects
- **Transport** networks
  - Main means for rescue teams, food, water, etc.
- **Communication**, ICT infrastructure
  - TV cam, switches, cyber,
- **Energy** networks
  - power supply for health, cyber systems, etc.
- **Hospitals** networks
- Aggregation areas

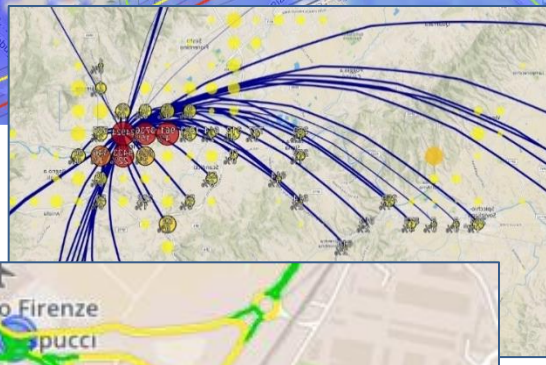

https://www.snap4city.org/download/video/DPL_SNAP4SOLU.pdf

# Main Tasks

- **Controlling Status: management, and operational**
  - Monitoring via KPI
  - Computing predictions data from the field and KPI
  - Anomaly detection
  - Early warning on critical conditions
- **Making plan: tactic and strategic, medium and long range**
  - Optimisation: Prescriptions, suggestions
  - Risk assessment
  - What-if analysis on scenarios
    - Simulation and predictions
  - Resilience
- **Be ready for Unexpected Unknows**





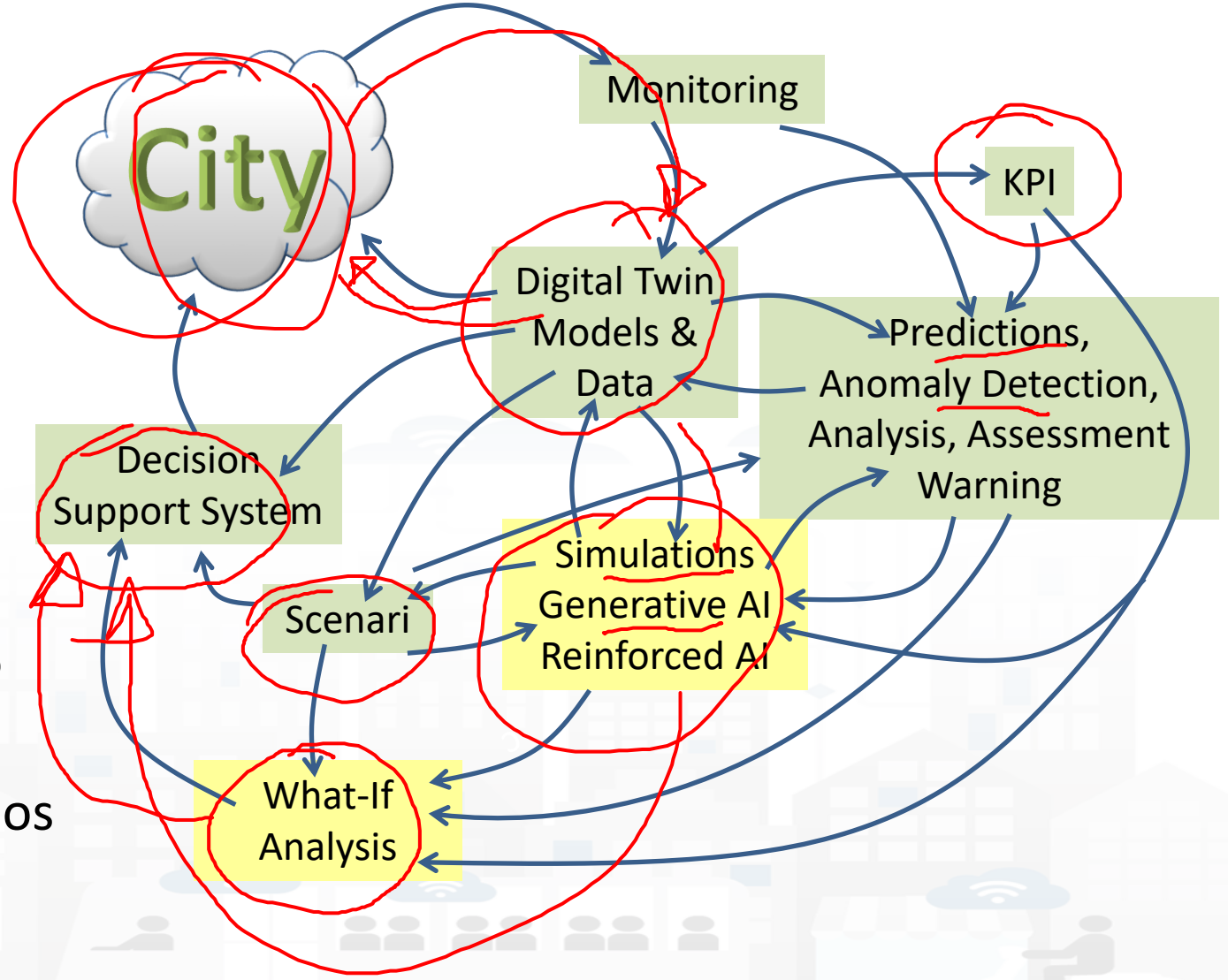


# Complex Smart Applications

- **Recent solutions**
  - Dynamic traffic light control and synchronizations
  - MaaS, sharing, evolution of info-mobility
  - Connected and Autonomous Vehicles/solutions
  - Integrated Energy & Environmental applications
  - Etc.
- **Most of them share the same modules, differently implemented and combined, but the same modules**
  - Real time data gathering and derived info distribution
  - Predictive and/or simulative models, on edge or cloud
  - Data gathering + monitoring + plan + rendering: dashboard, visual analytics, mobile apps

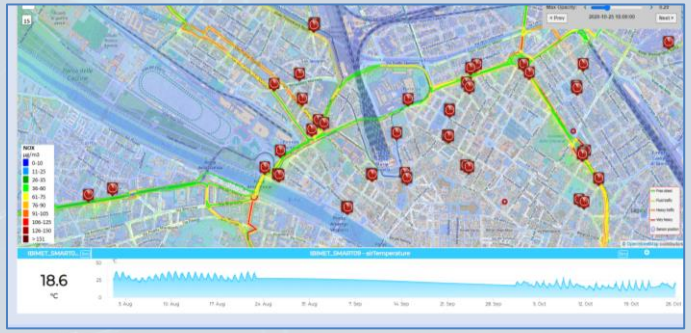
# Main tasks

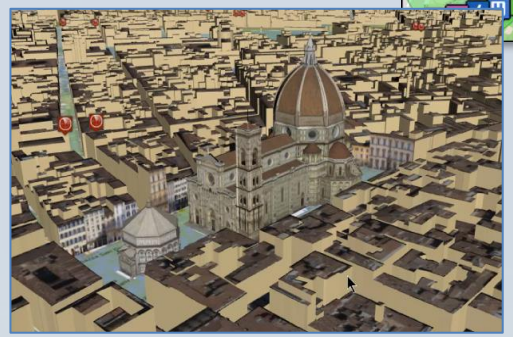
- **Controlling Status: management, and operational**
  - Monitoring via KPI
  - Computing predictions vs KPI
  - Anomaly detection
  - Neuro-Symbolic analysis
  - Risk assessment
  - Early warning on critical conditions
- **Making plan: tactic and strategic, medium and long range, micro/macro**
  - Simulation & predictions
  - Generative AI Prescriptions, scenarios
  - Resilience to Unexpected unknows
  - What-if analysis wrt scenarios

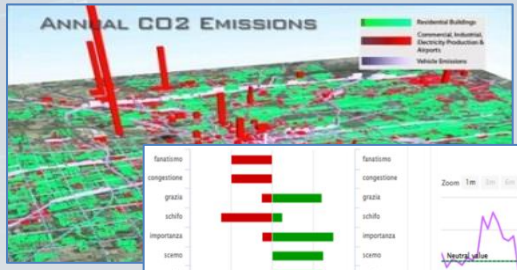


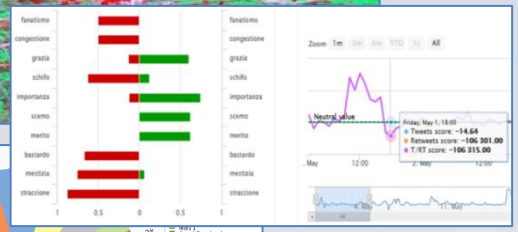
# Digital Twin

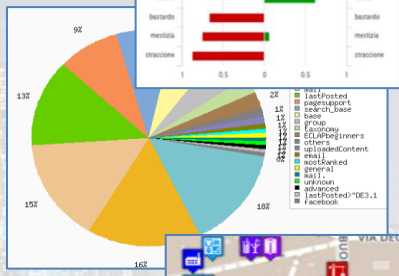
- **Digital Twin**
  - **Connected** with real systems
  - **Modelling** aspects: structural, visual, informative, real time data sensors (context), POI, functional, resources, etc.
  - **Analytics:** AI/XAI techniques, simulations, users' needs, etc.
- **Easier to understand the context, review from 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

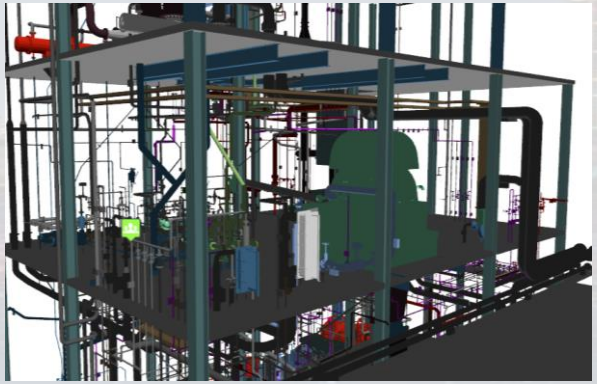






# Smart Solutions and Decision Support Systems

100% OPEN SOURCE

Powered by FIWARE

FREE TRIAL

PEN Test Passed

EU GDPR COMPLIANT

SNAP4 Appliances and Dockers Installations

EUROPEAN OPEN SCIENCE CLOUD

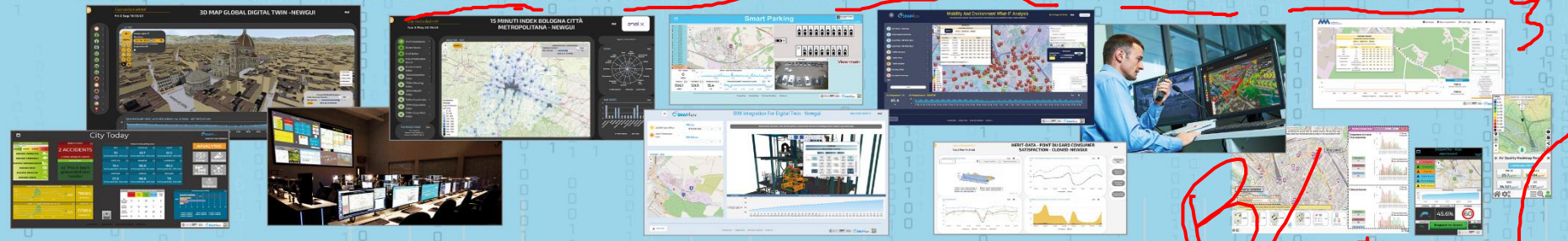
Node-RED

JS Foundation

EØ15 digital ecosystem

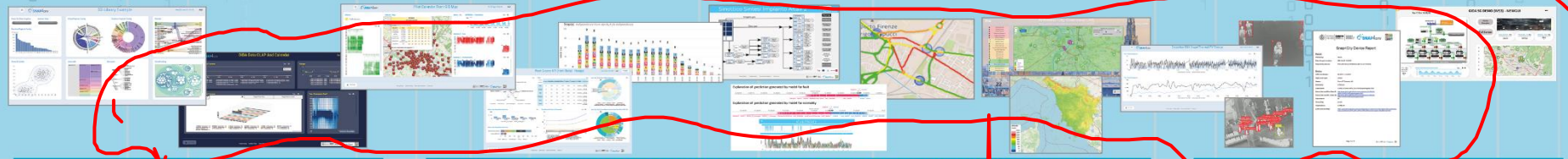
NVIDIA

## 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

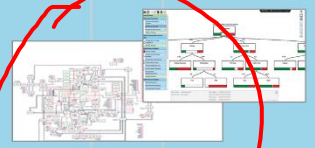


DASHBOARDS, WIDGETS
TEMPLATES

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

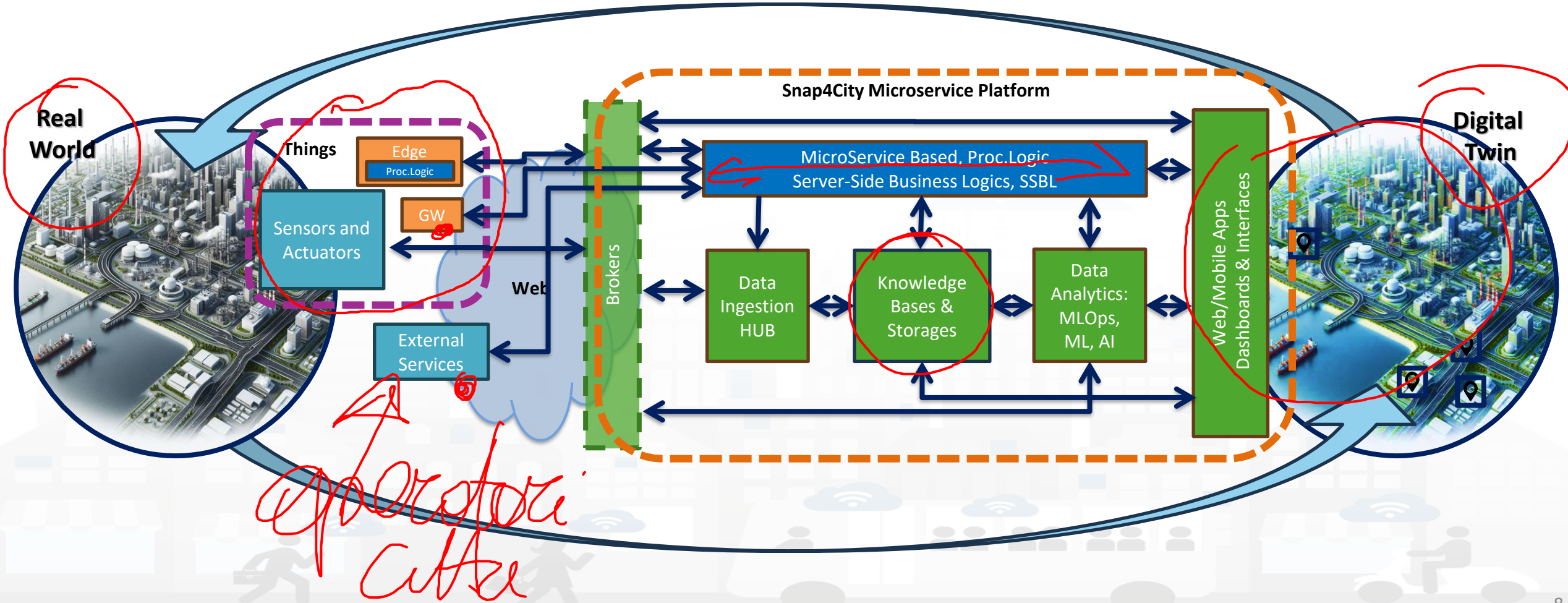
VISUAL PROGRAMMING, ADAPTERS
DATA FLOWS, WORKFLOWS
PARALLEL DISTRIBUTED PROCESSING
EVENT DRIVEN

**Native and External Smart Applications**

- Mobility & Transport
- Light & Energy
- Waste
- Environment
- Building
- Tourism
- Asset Management
- Security and Safety
- Social Media
- ...


METHODOLOGIES
LIVING LABS
COURSES AND COMMUNITY
DEVELOPMENT TOOLS

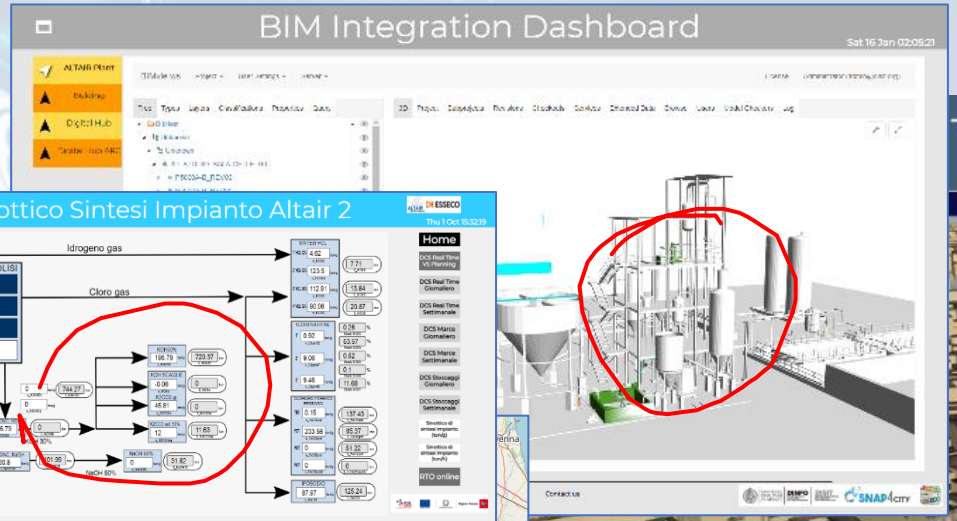

# Digital Twin Development Platform

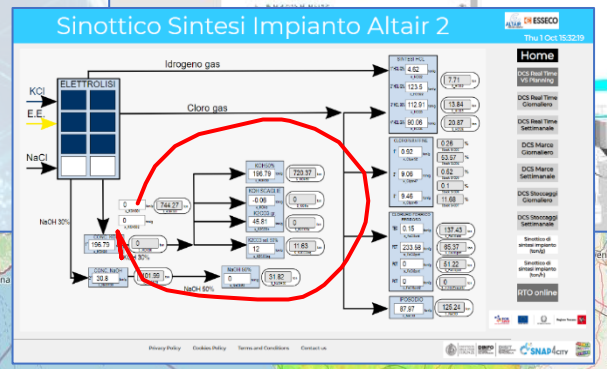


# High Level Types

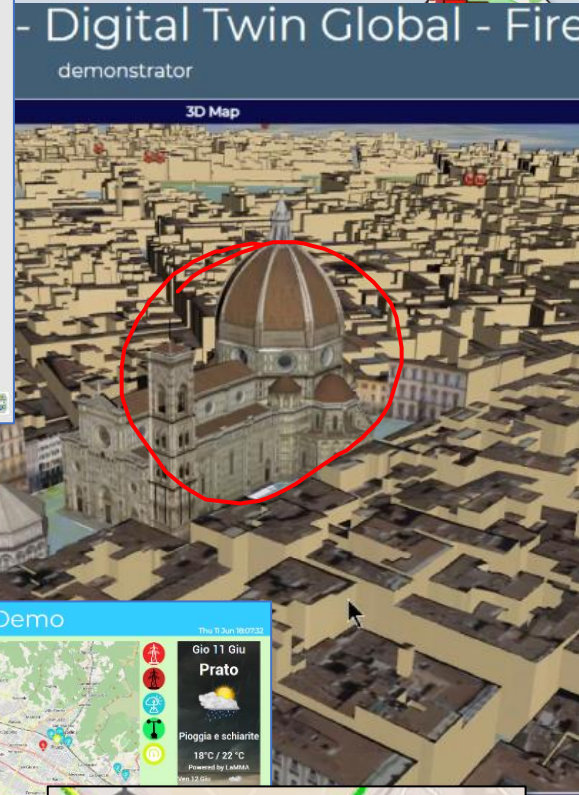
Snap4City (C), May 2024

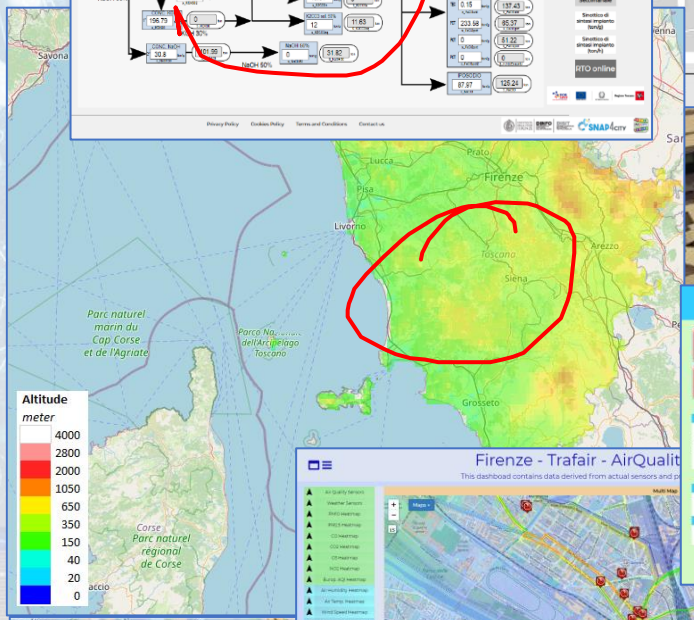
- POI, IOT Devices, shapes,..
  - FIWARE Smart Data Models,
  - IoT Device Models
- GIS, maps, orthomaps, WFS/WMS, GeoTiff, calibrated heatmaps, ..
- Satellite data, any kind..
- traffic flow, typical trends, ..
- trajectories, events, Workflow, ..
- 3D Models, BIM, Digital Twins, ..
- OD Matrices of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

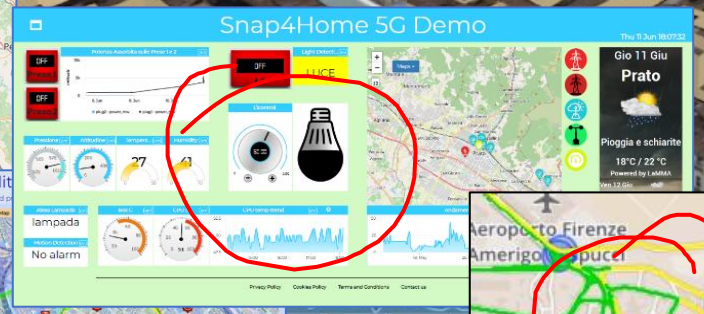


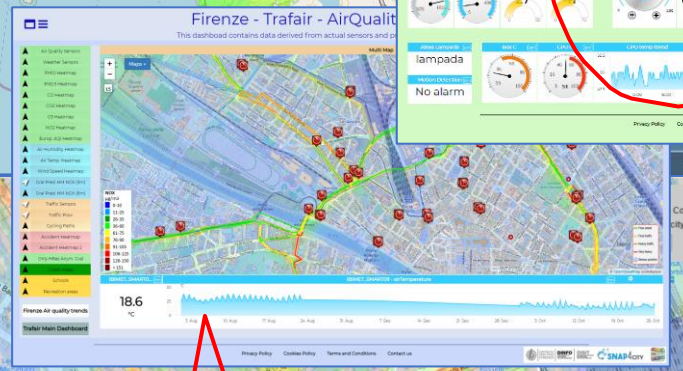



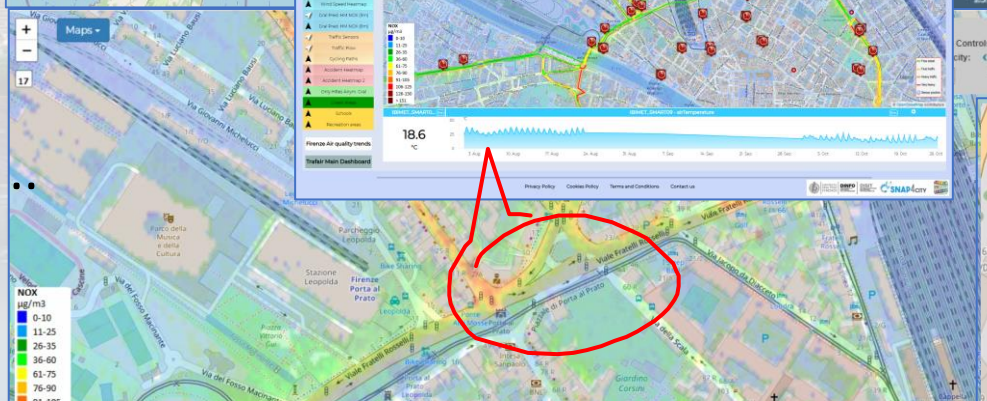



# Standards and Interoperability (6/2023)

SNAP4CITY

KM 4 CITY

**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, VMS, ….
- **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, NeTEx, ..
- **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

Node-RED

JS Foundation

FIWARE Open APIs for Open Minds

gaia-x

E015 digital ecosystem

bee smart city

sigfox partner network

ckan

GJL

LABGEO

esri Italia THE SCIENCE OF WHERE

EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE

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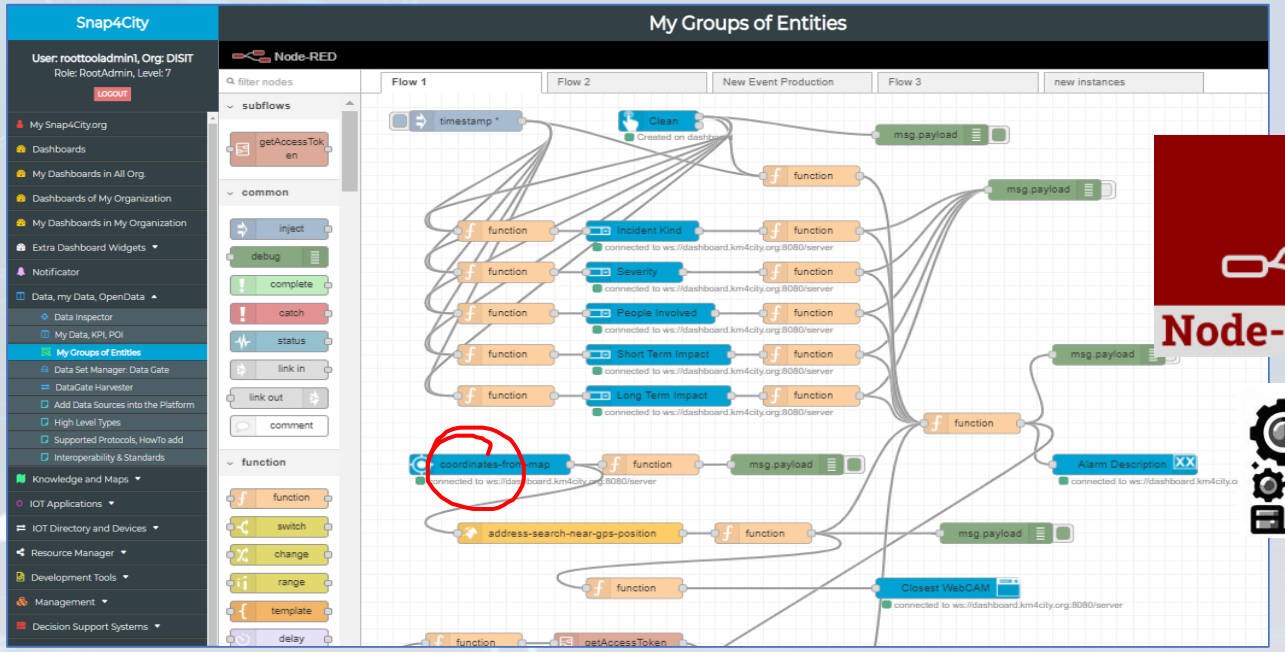
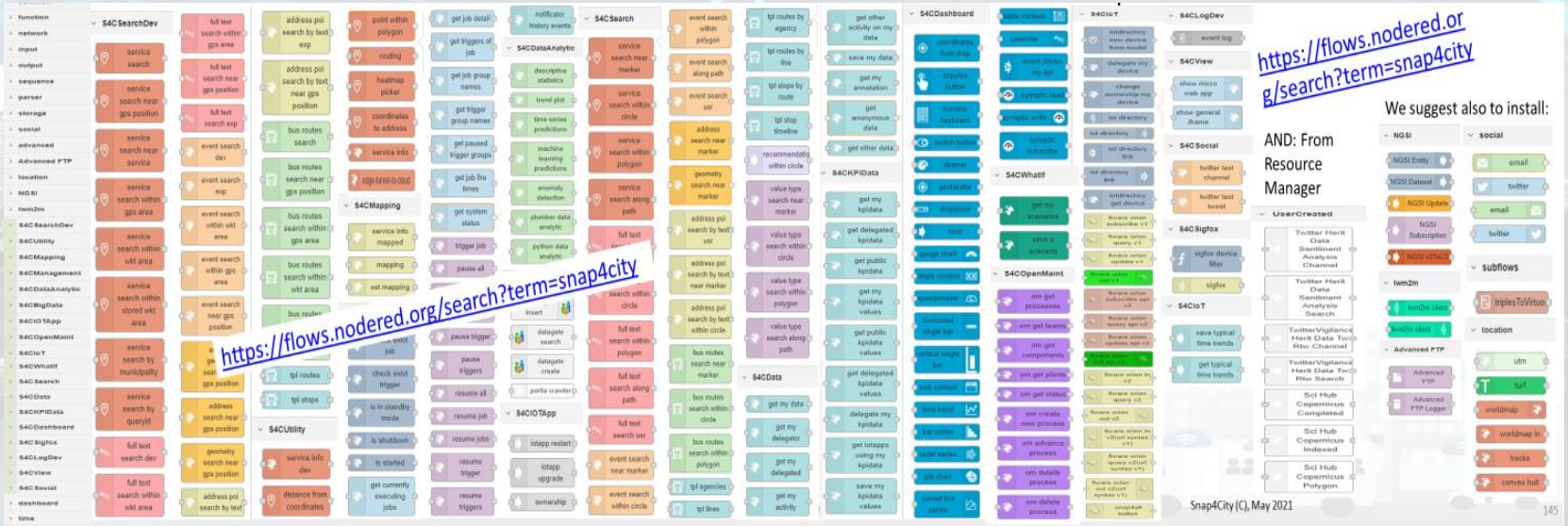
# Ingestion, aggreg. → exploitation

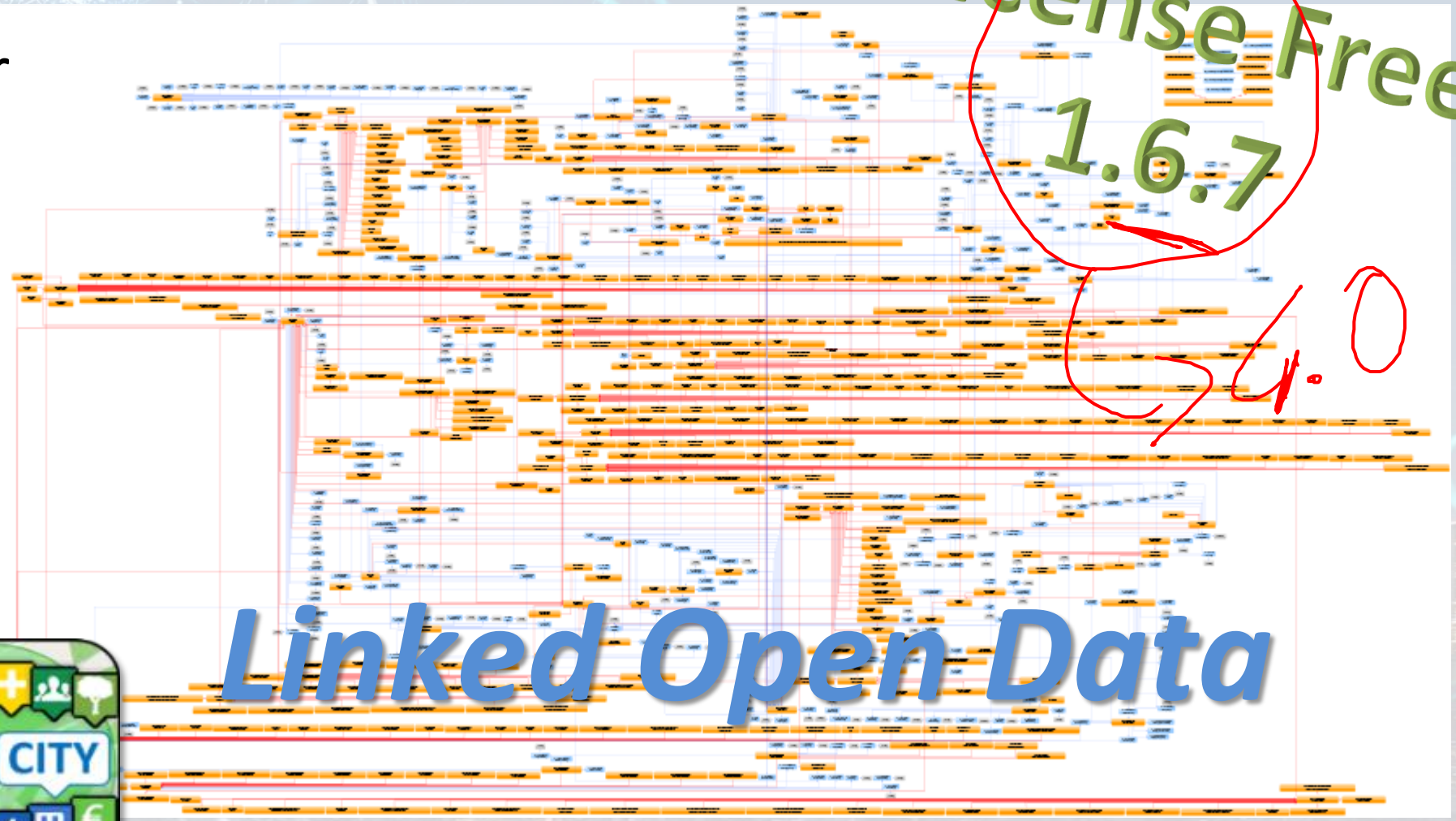
- **IoT App Visual Programming, no coding**
  - **Data transformation**
  - **Integration, Interoperab.**
  - **Scripting Data Analytics**
  - **Data ingestion**
  - **Business logic Server Side**
- **Edge and Cloud**
- **MicroServices** data event driven develop via visual language Node-RED



# Expert System semantic queries

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

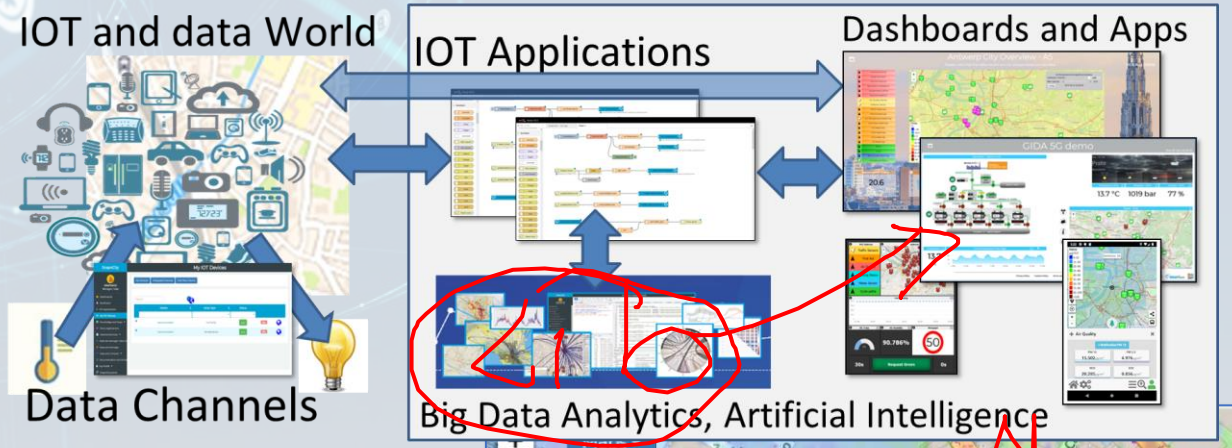


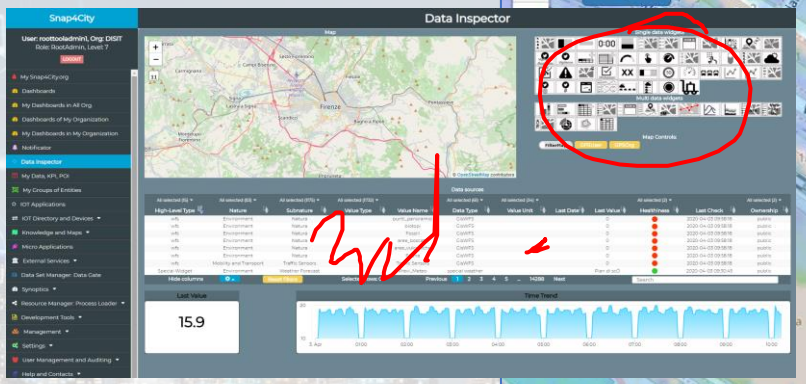

https://www.snap4city.org/19

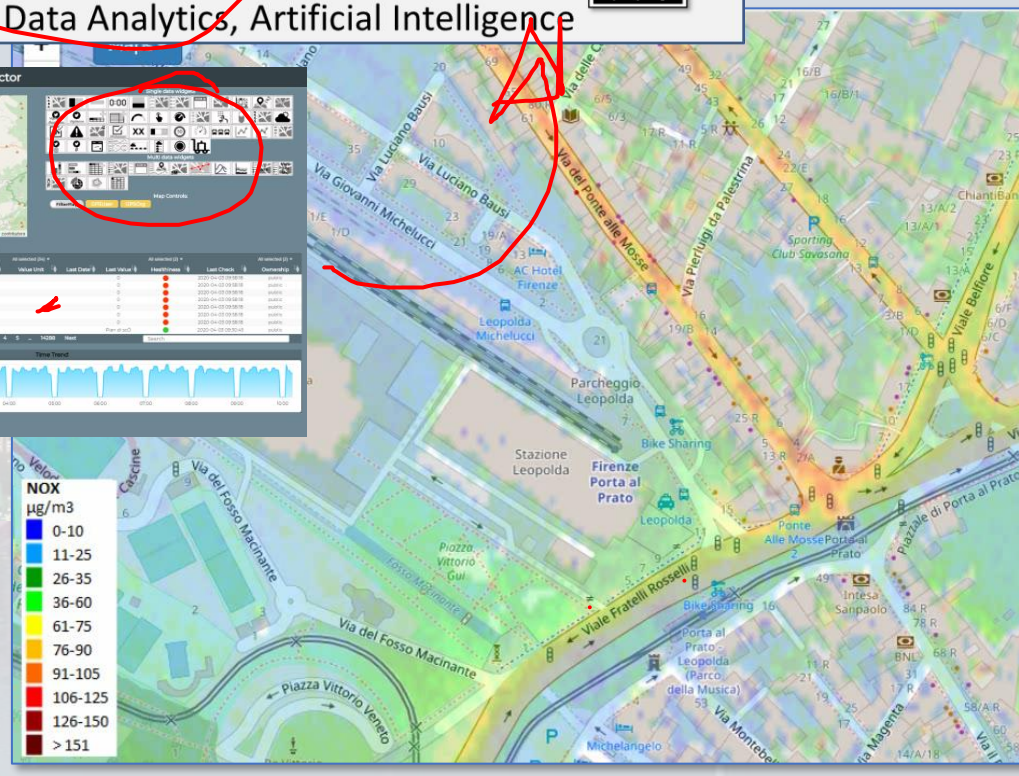
# Solutions: reliable, secure and fast to realize

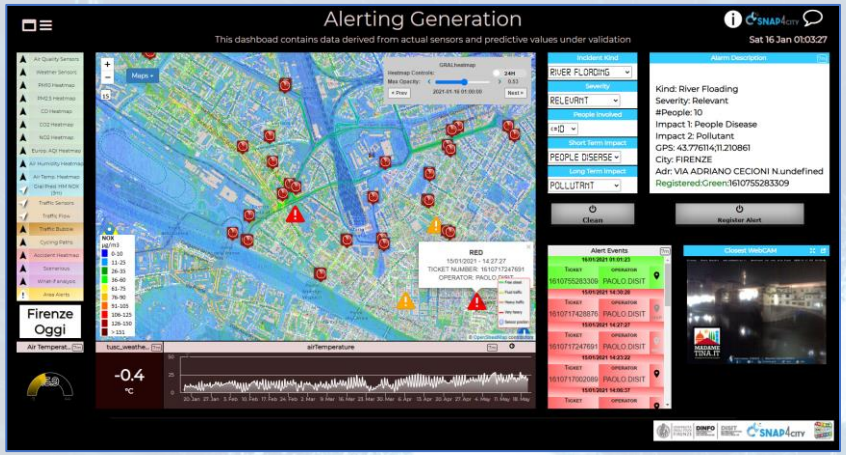
- **Via Snap4City tools**
  - **Dashboard Wizard**
  - **Dashboard Builder**
  - **Data/Visual Analytic**

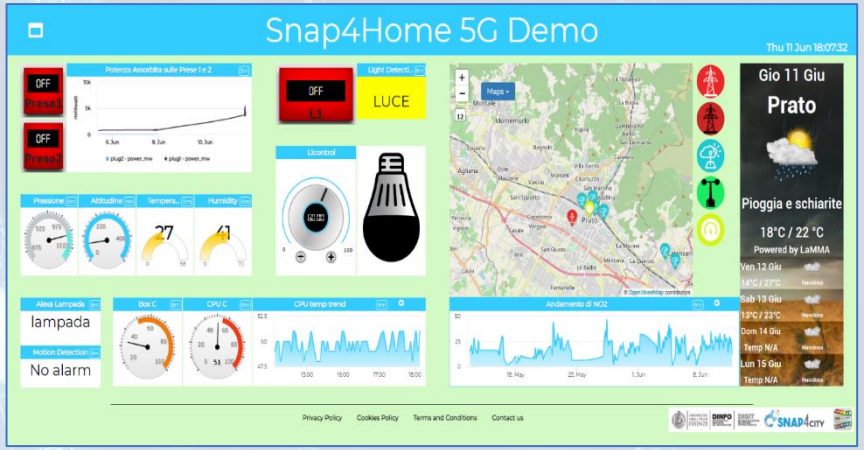
- **Smart Solutions results to be**
  - **Real time data drive**
  - **Secure end-to-end**
  - **GDPR compliant**
  - **Reliable, interoperable**
  - **Auditable, marketable**

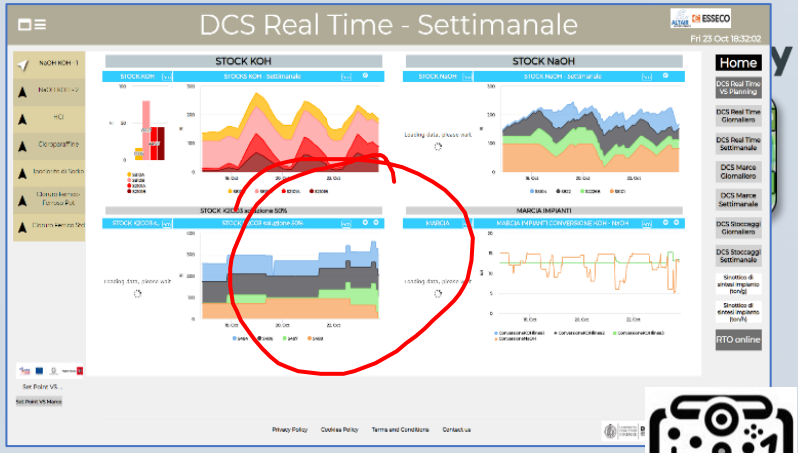


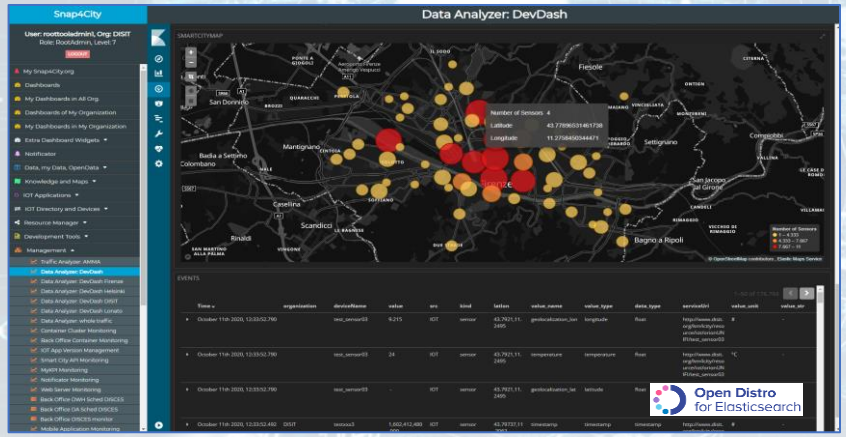



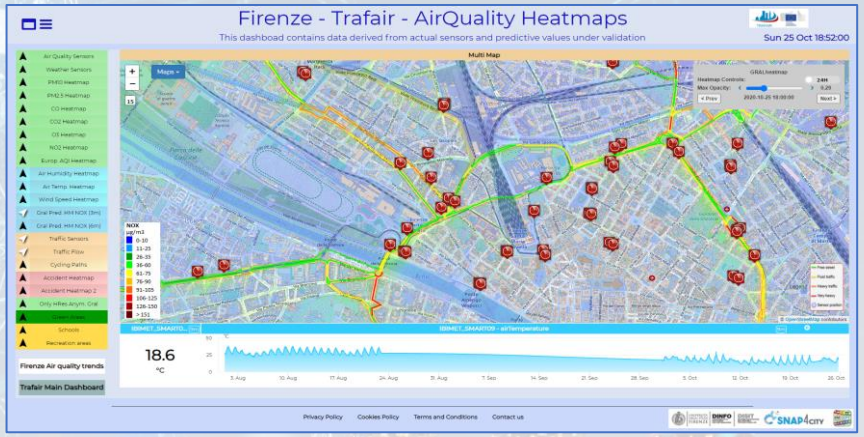



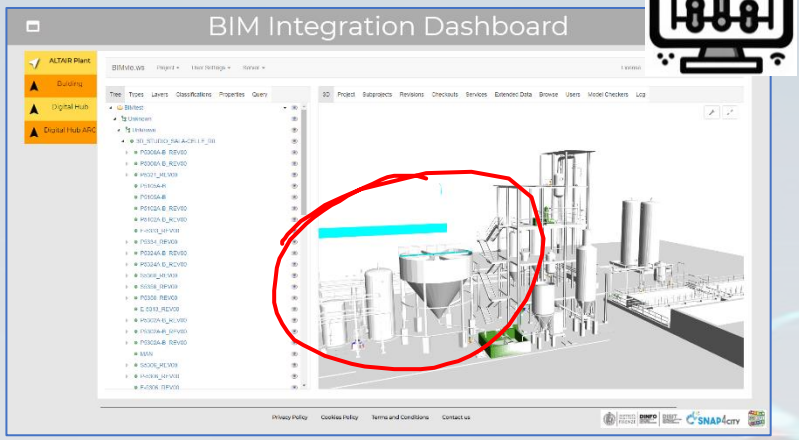

Alerting Generation
This dashboad contains data derived from actual sensors and predictive values under validation
Sat 16 Jan 01:03:27
Firenze Oggi
-0.4


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

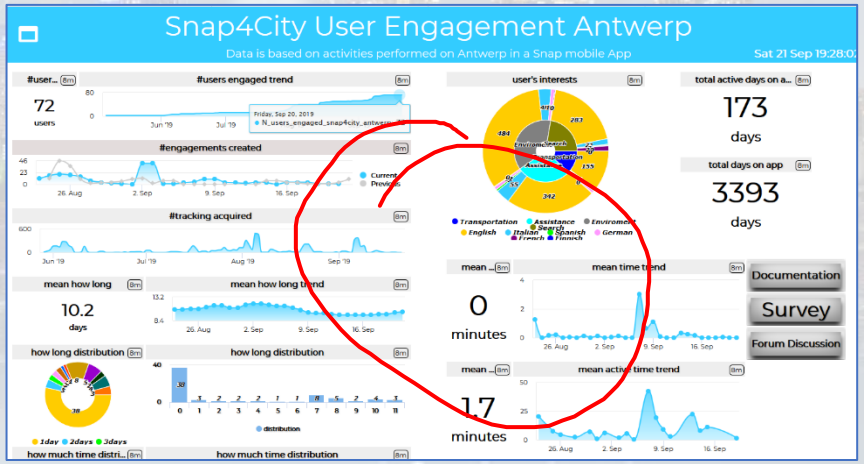

DCS Real Time - Settimanale
Fri 23 Oct 18:32:02
STOCK KOH
STOCK NaOH
Home

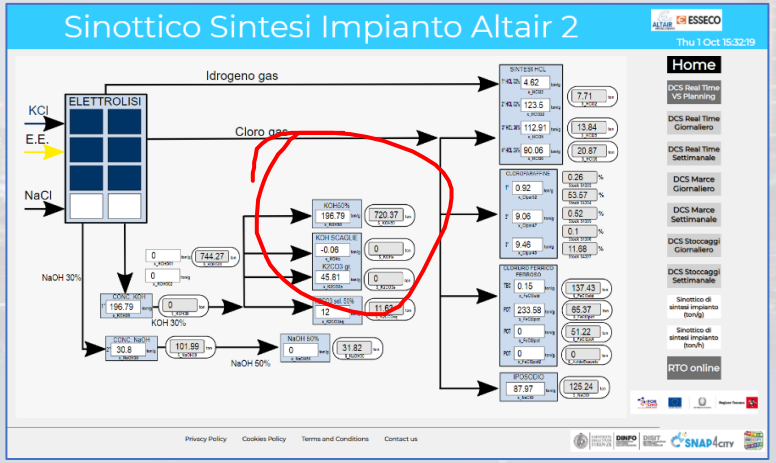

Data Analyzer: DevDash
Open Distro for Elasticsearch


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


BIM Integration Dashboard


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


Snap4City User Engagement Antwerp
Data is based on activities performed on Antwerp in a Snap mobile App
Sat 21 Sep 19:28:0
72
users
173
days
3393
days
10.2
days
0
minutes
17
minutes
Documentation
Survey
Forum Discussion


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

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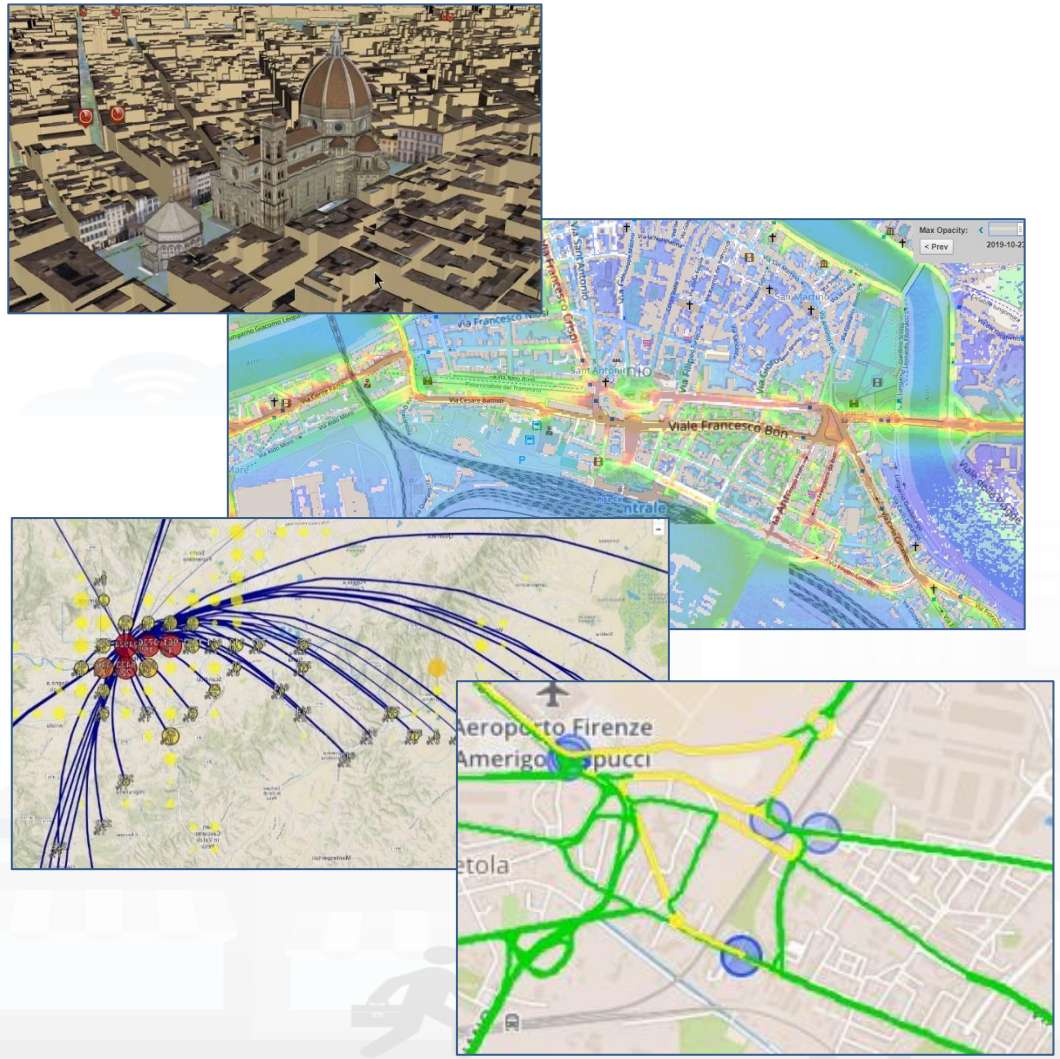
# Smart City Digital Twin



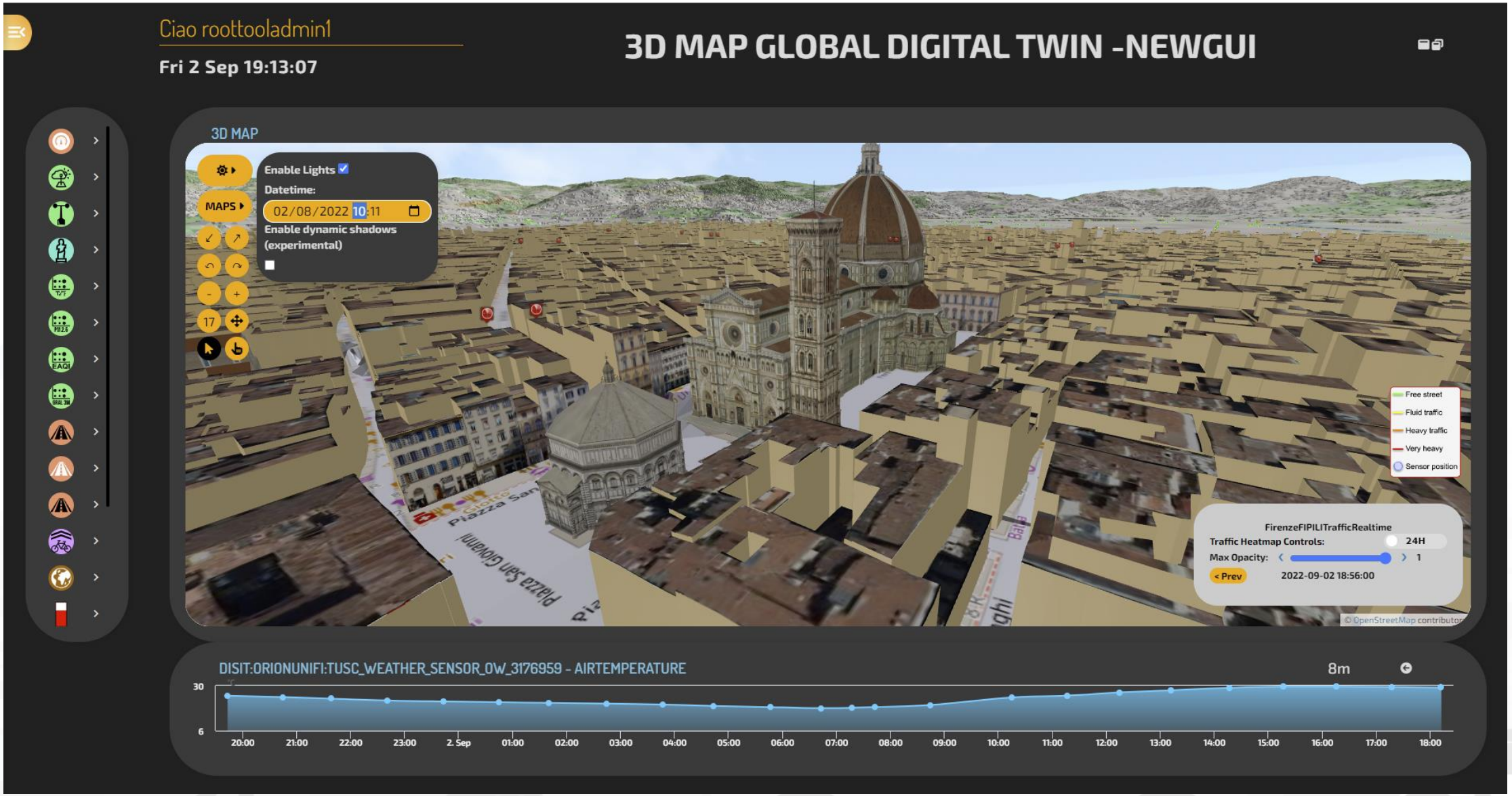

## City Digital Model with…

- Intuitive platform
- Any Data TYPE, any data source, any protocol
- Data storage seamless
- Data analytics → artificial intelligence, AI/XAI
- Data Ethics, AI Ethics, GDPR
- Data Representation, any kind
- Key Performance Indicators, any kind
- What-IF analysis – Simulation, prediction, 2D/3D
- Micro, Meso e macro scales
- Operation, planning tactic and strategic
- Collaborative and shared representation
- Sustainable, shared, open source 100%

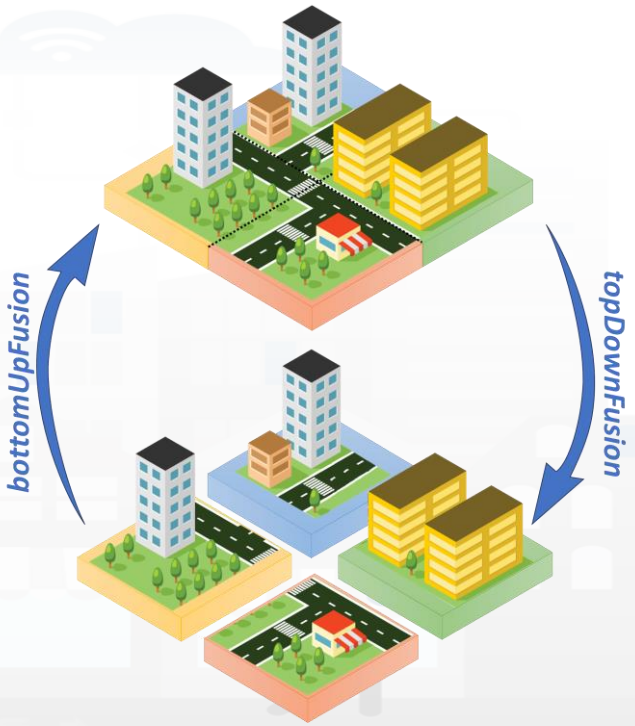
**Complex and heterogeneous information, interoperability**

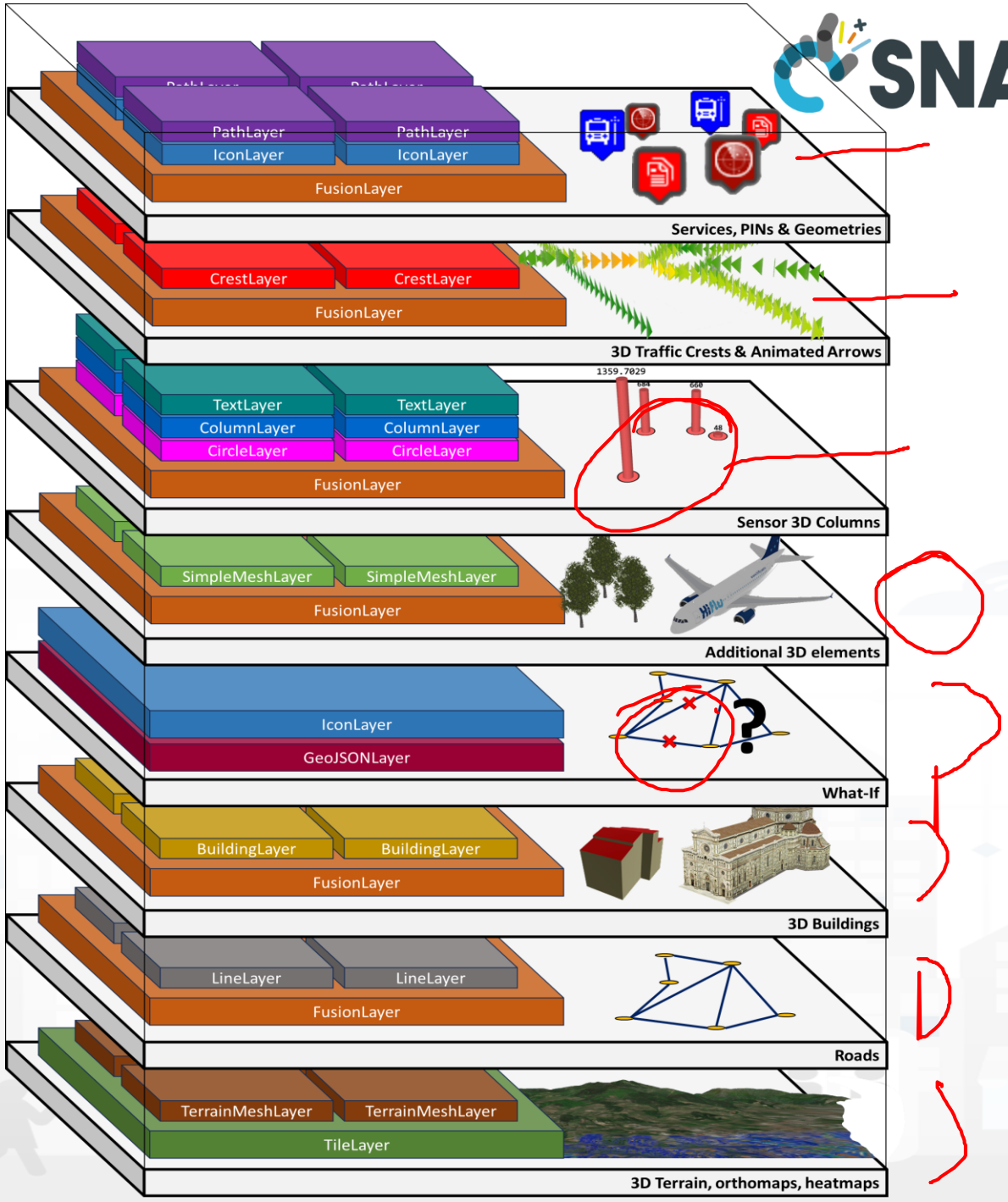
- GIS, ITS, AVM, IoT, BIM, CKAN, etc.
- Satellite services
- MaaS, last-mile delivery HUBs
- etc.

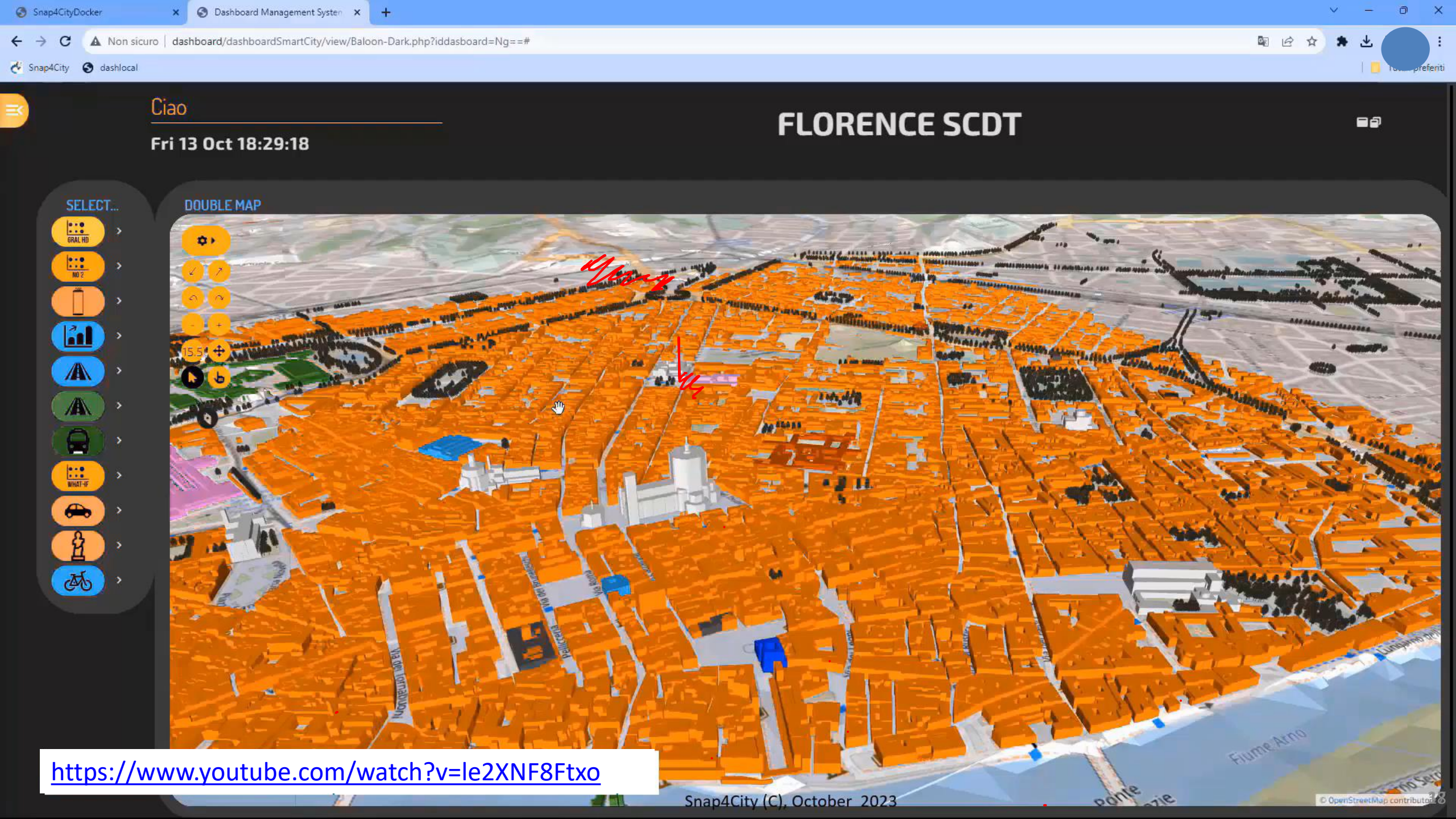
# 3D Digital Twin



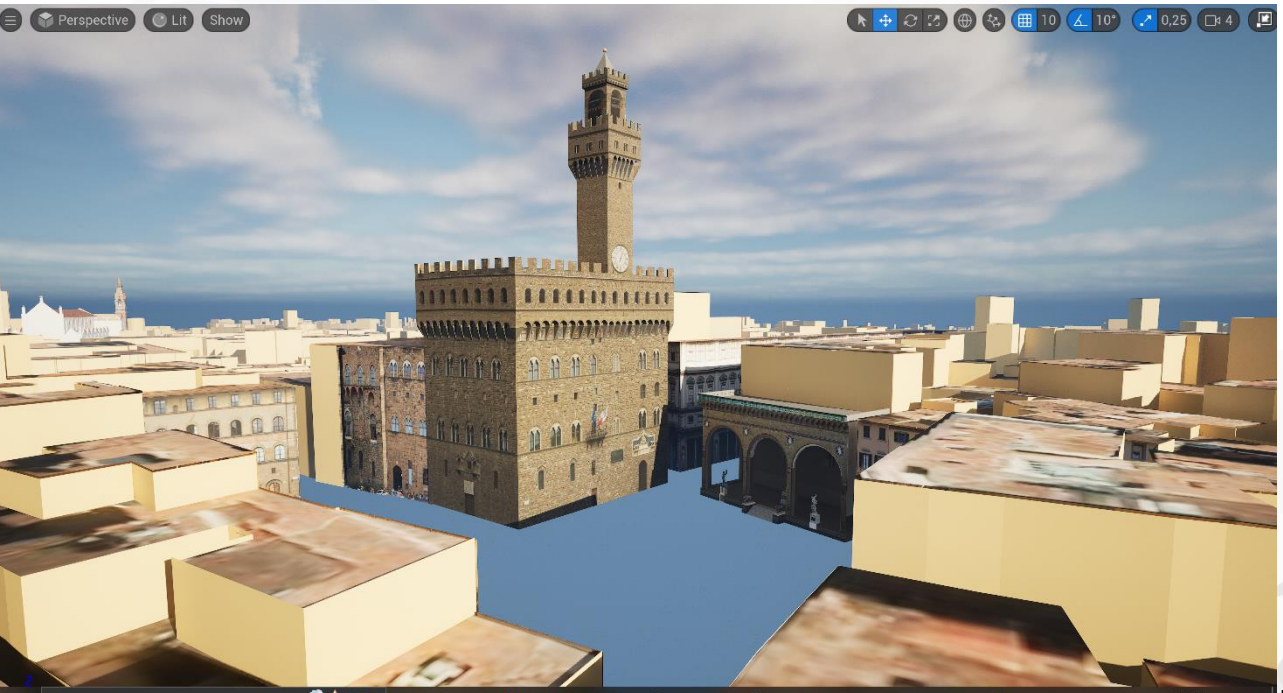
# Layers vs Fusion Layers




Snap4CityDocker
Dashboard Management Syste
Non sicuro
dashboard/dashboardSmartCity/view/Baloon-Dark.php?iddasboard=Ng==#
Snap4City
dashlocal
Ciao
Fri 13 Oct 18:29:18
FLORENCE SCDT
SELECT...
DOUBLE MAP
GRAL HD
NO 2
WHAT-IF
Fiume Arno
https://www.youtube.com/watch?v=le2XNF8Ftxo
Snap4City (C), October 2023
© OpenStreetMap contributors

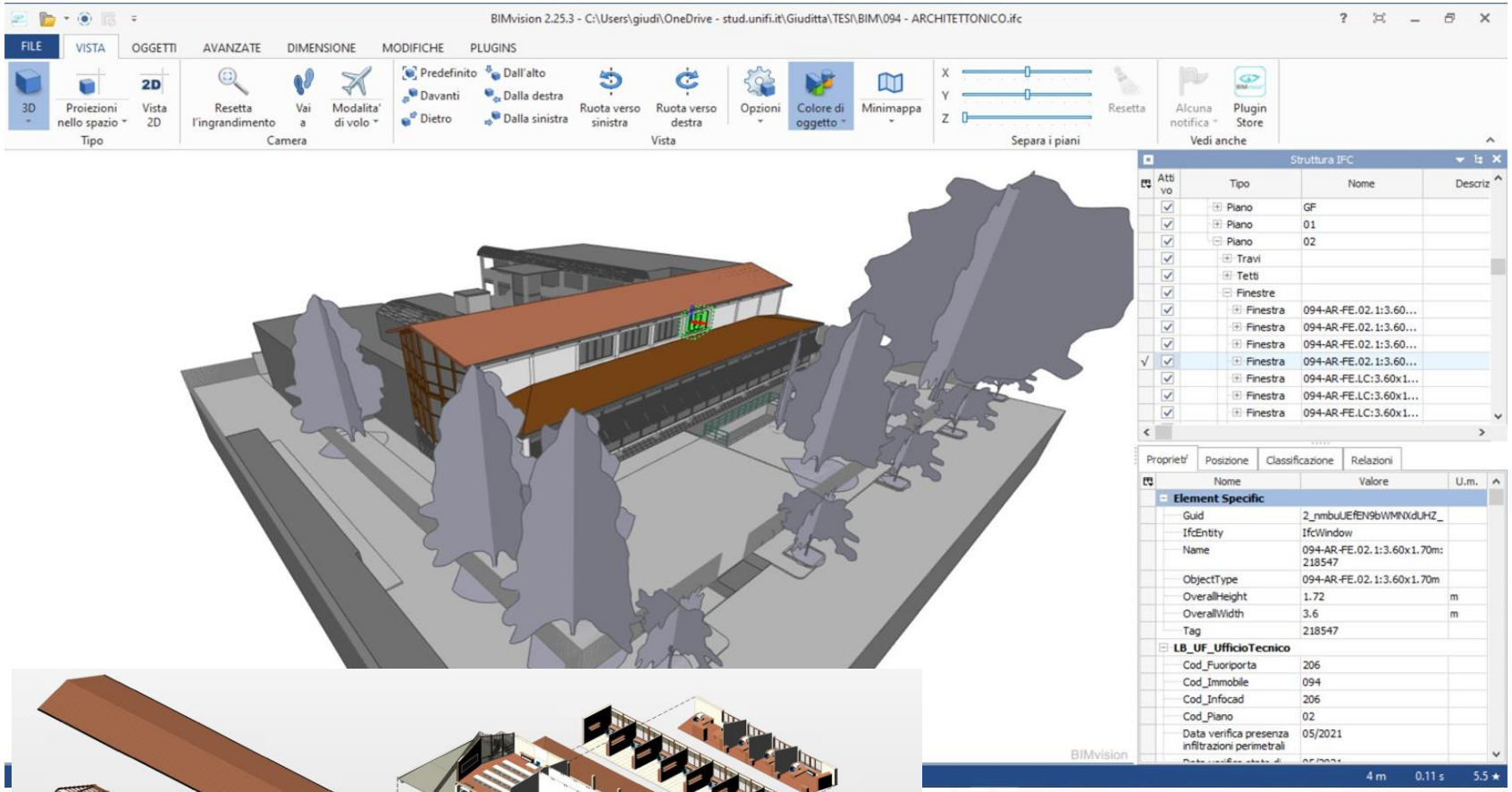
# OCULUS


Perspective
Lit
Show
Scrivi qui per eseguire la ricerca
6°C
19:09
30/11/2022

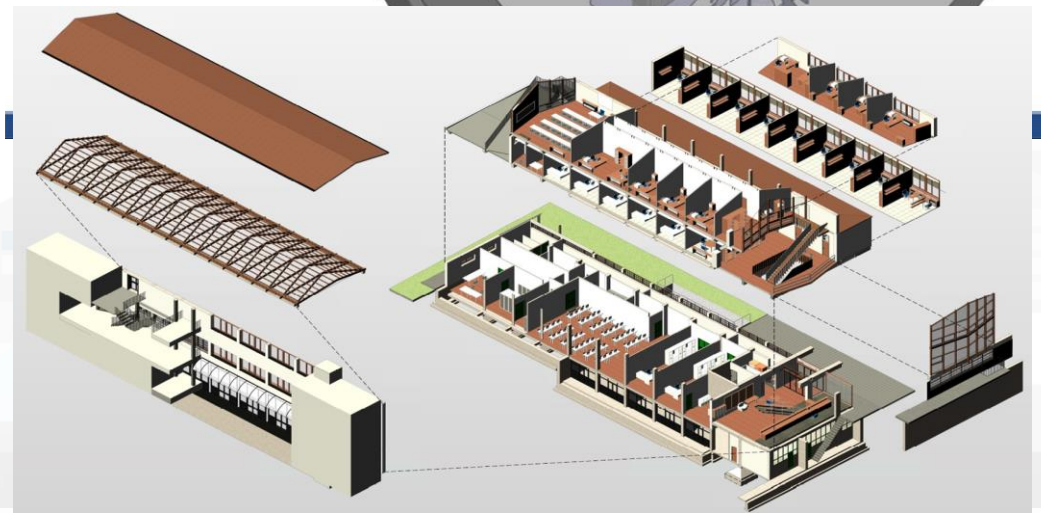

Perspective
Lit
Show

# OCULUS

.IFC

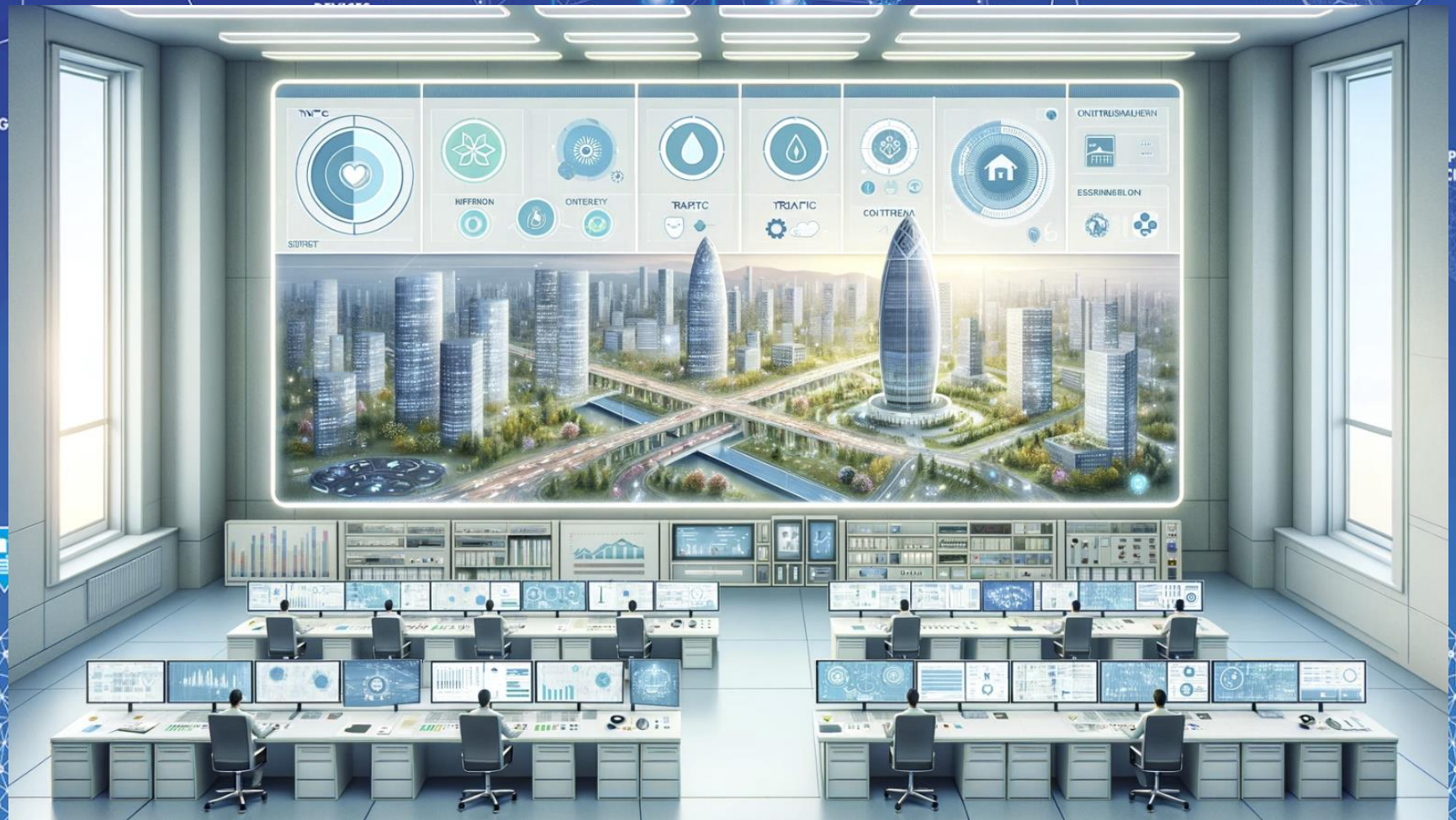



| Nome | Valore | U.m. |
|---|---|---|
| **LB_UF_UfficioTecnico** | | |
| Cod_Fuoriporta | 122 | |
| Cod_Immobile | 094 | |
| Cod_Infocad | 122 | |
| Cod_Piano | 01 | |
| Data verifica presenza infiltrazioni perimetrali | 05/2021 | |
| Data verifica stato di conservazione, fissaggio, funzionalità, stabilità 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 | |



TOP

# Monitoring and Control



FROM CITY DASHBOARD TO APPLICATIONS

DATA GATHERING AND CITY DATA KNOWLEDGE MANAGEMENT

FORGING & MANAGING OPEN

IOT APPLICATIONS VS IOT EDGE

TWITTER VIGILANCE: SOCIAL MEDIA ANALYSIS

TO DEVELOPERS AND STAKEHOLDERS

SNAP4CITY AND KM4CITY PROJECTS

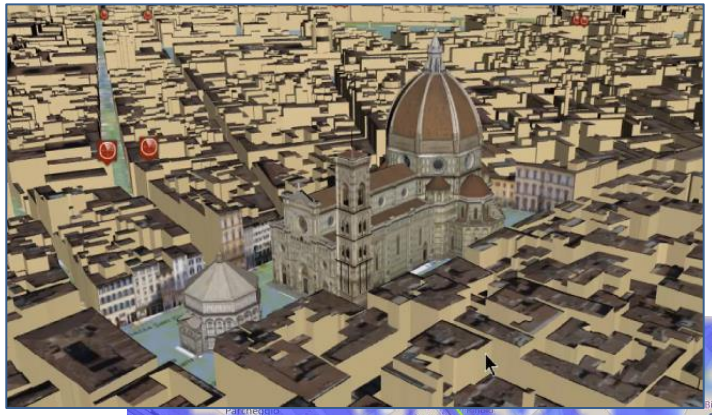
HOW TO ADOPT SNAP4CITY, AND OUR ROADMAP

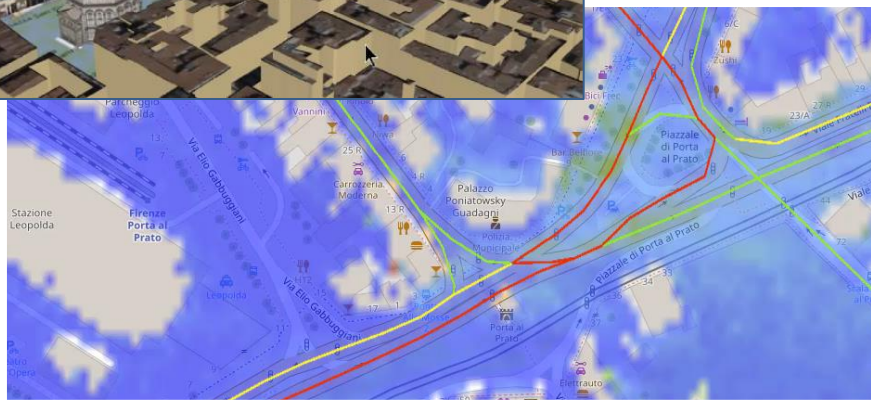
SNAP4CITY THE VIEW OF THE ADMINISTRATORS

100% OPEN SOURCE

# Monitoring

- **Controlling Status: management, and operational**
  - Monitoring via KPI
  - Computing predictions and KPI
  - Anomaly detection, Early warning
  - Control Rooms, situation rooms
- **Reacting: Computing in real time**
  - Changing semaphore maps
  - Changing Dynamic signage
  - Real time Info Mobility
  - User engagement via Mobile Apps
  - What-if analysis
  - etc.,






# Smart City Control Room
## Florence Metropolitan City

COMUNE DI FIRENZE

reference

SNAP4CITY

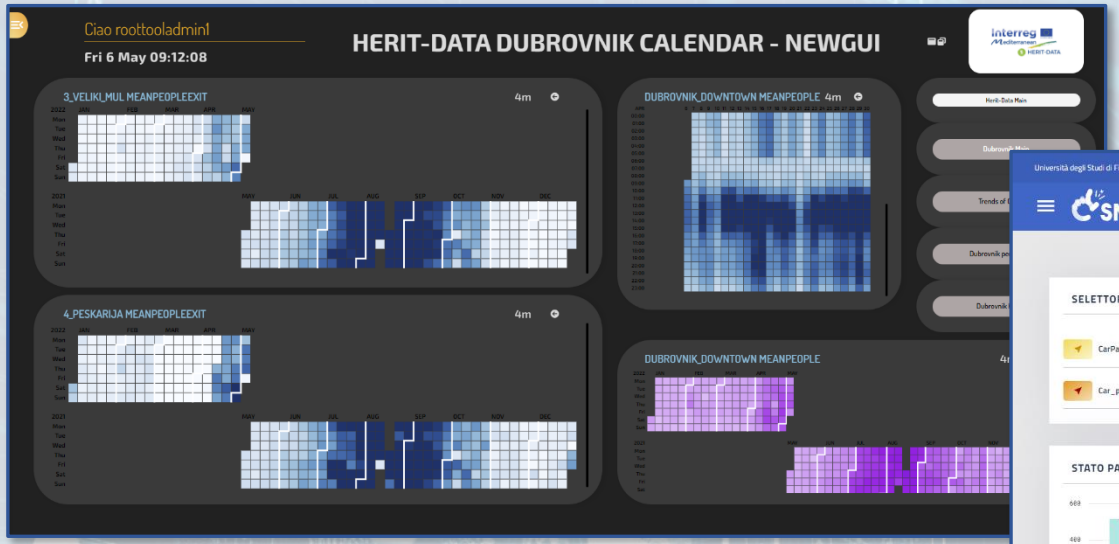
KM 4 CITY

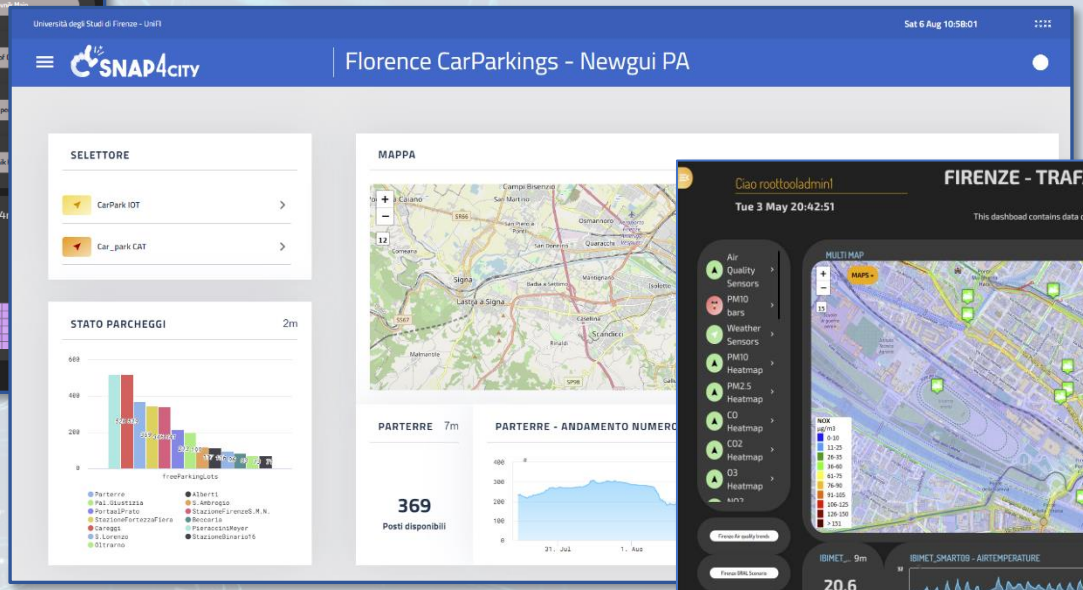
- **Multiple Domain Data**
  - Thousands of Open/Private data, POI, IOT, etc.
  - ***mobility and transport***: accidents, public transport, parking, traffic flow, Traffic Reconstruction, KPI, …
  - ***AND***: environment, civil protection, gov KPI, covid-19, social & social media, people flow, tourism,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

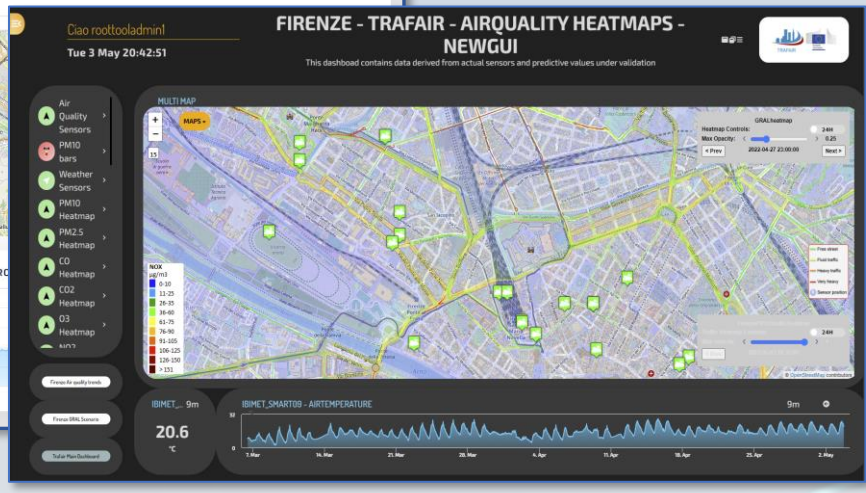


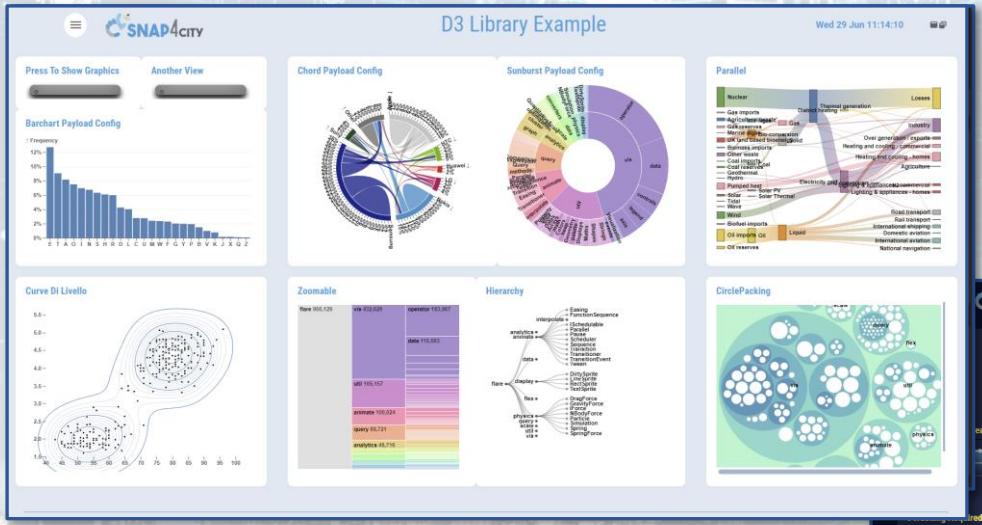
https://www.snap4city.org/747

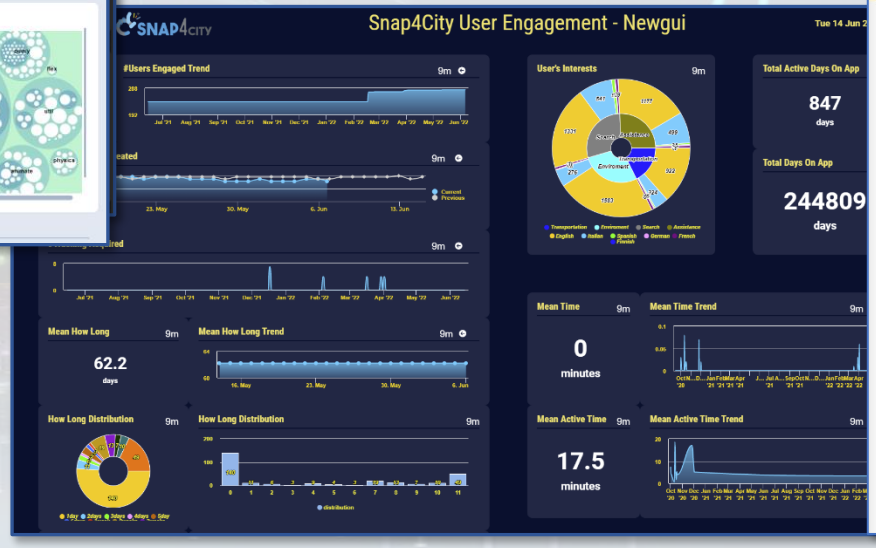
# Different Themes

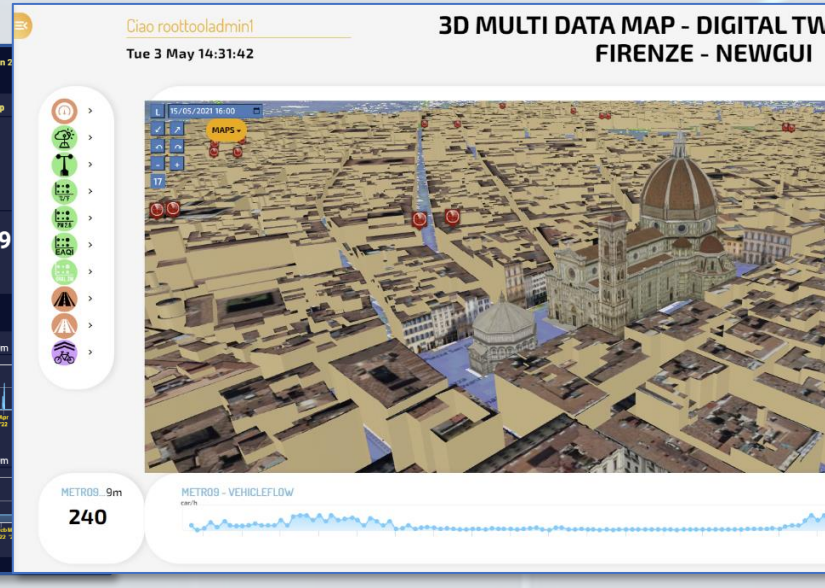



New styles/themes can be developed by specializing a few files from open source

https://www.snap4city.org/793

# Key Performance Indicators, KPI



| 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 | |

- **United Nations Sustainable Development Goals, SDGs** (for which cities can do more to achieve some of the 17 SDGs, https://sdgs.un.org/goals);
- **15 minutes cities** (where primary services must be accessible within 15 minutes on foot);
- **objectives of the European Commission** in terms of pollutant emissions for: NO2, PM10, PM2.5 (https://environment.ec.europa.eu/topics/air_en);
- **SUMI: mobility and transport vs env**
  - https://www.snap4city.org/951
- **SUMP/PUMS: mobility and transport vs env.**
- **ISO indicators:** city smartness, digitization, tech level.
- **Low Level/Real Time:** global traffic, quality of service, betweenness, centrality, queue, time to travel, etc.

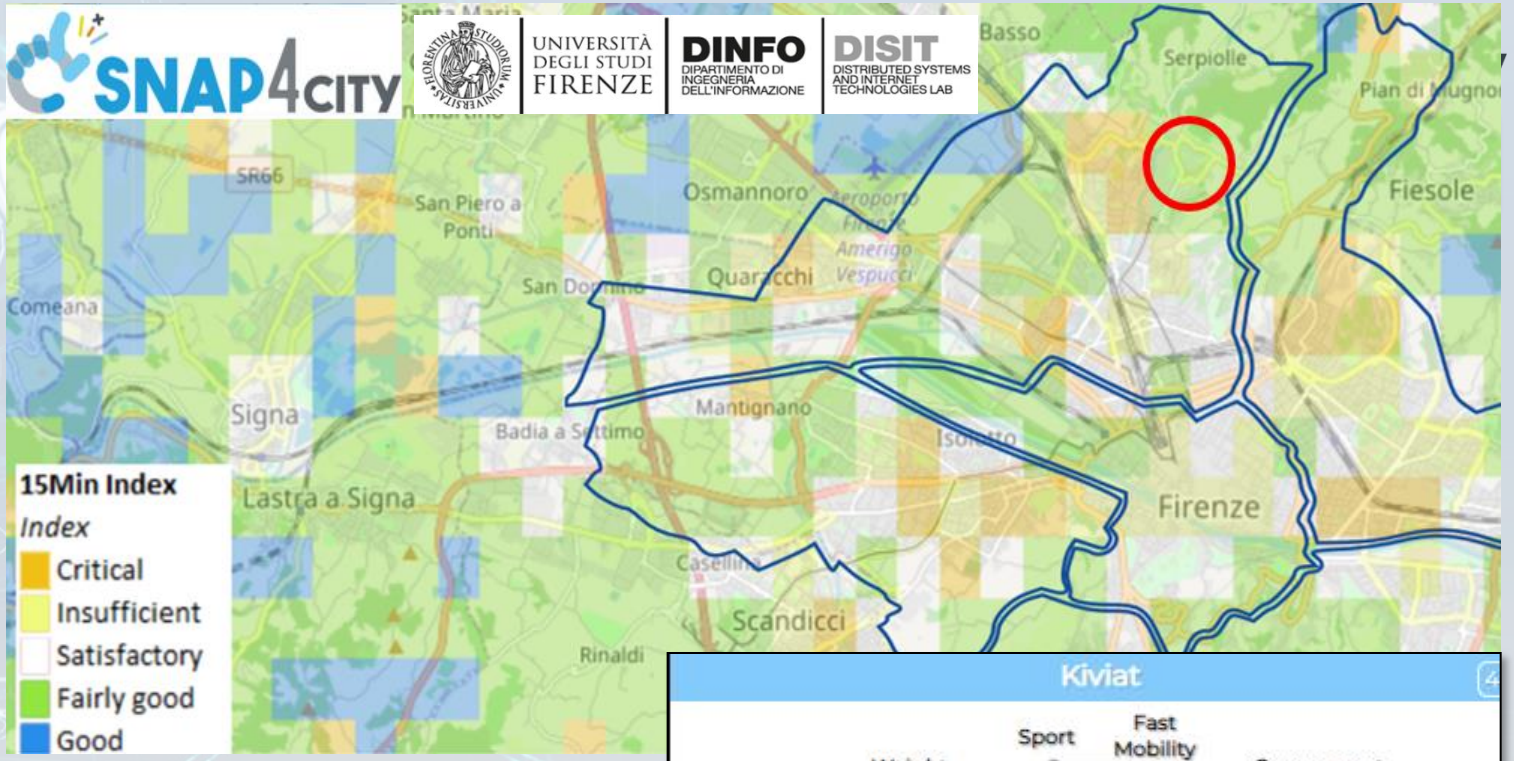
Global & Local

Periodic & Realtime

# 15MinCityIndex

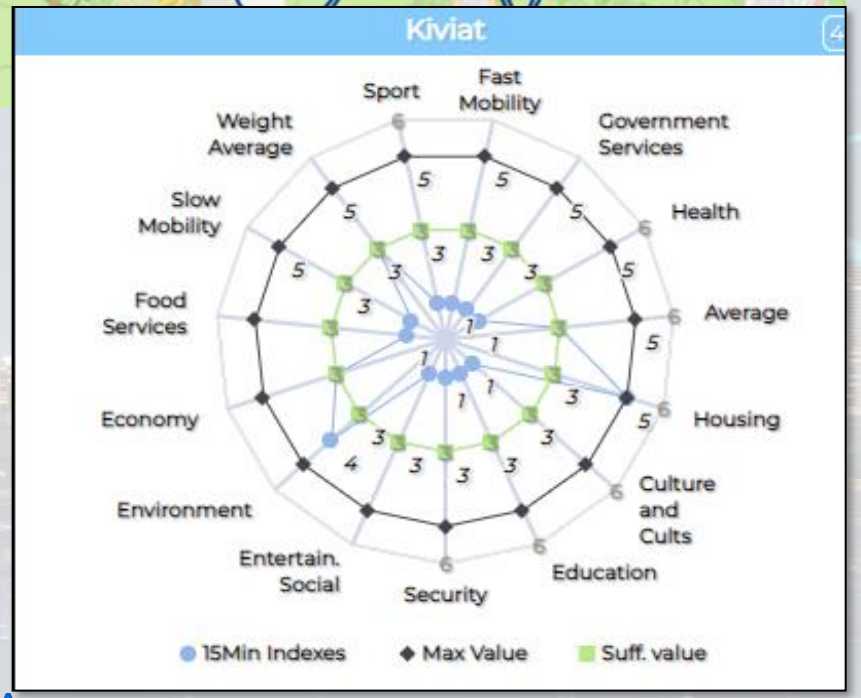
***What would support my neighborhood to become a 15-Minute City?***

**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.

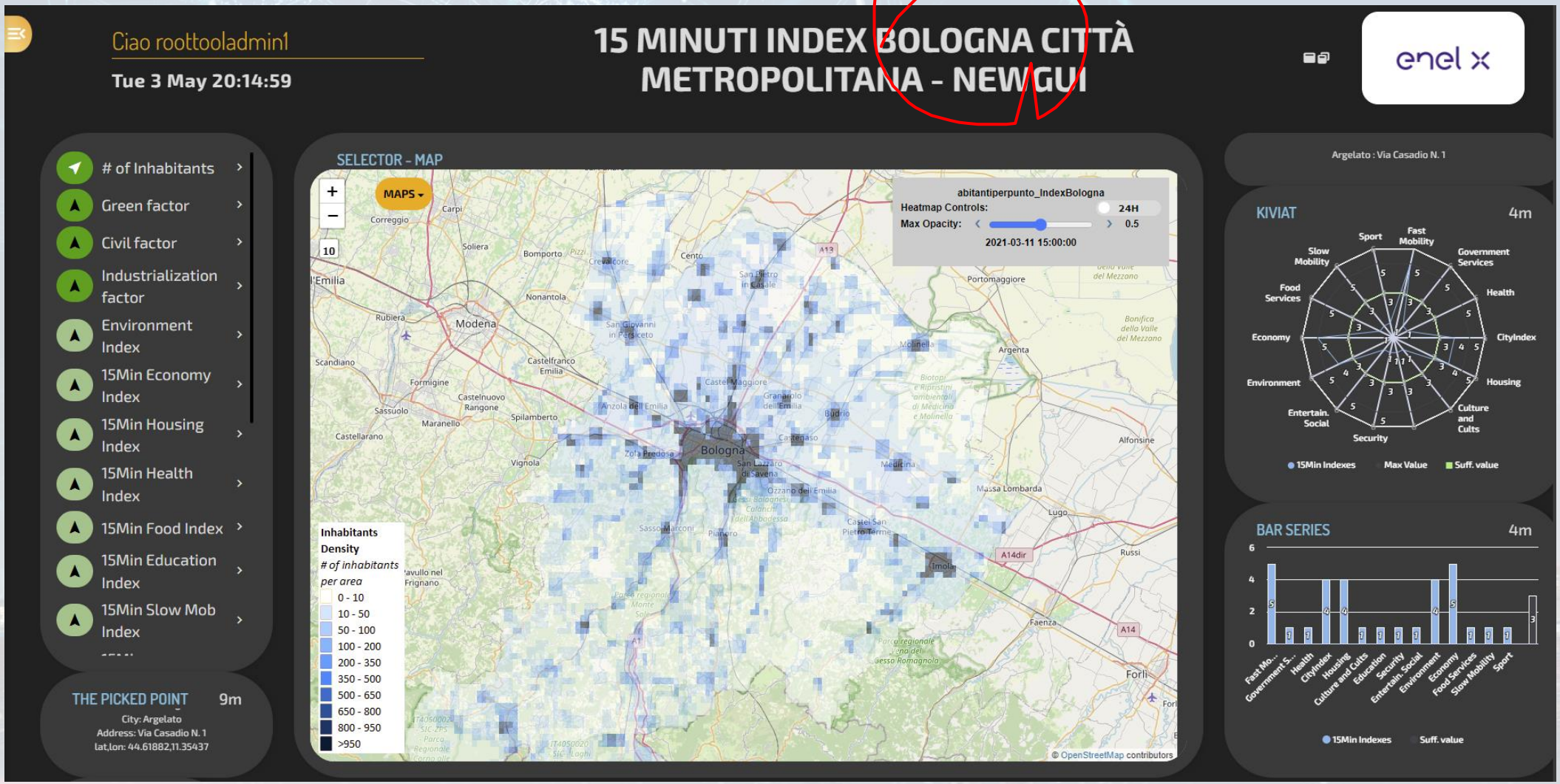
The tool supports the becoming of a 15-Minute city evaluating the service level in various domains.




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==

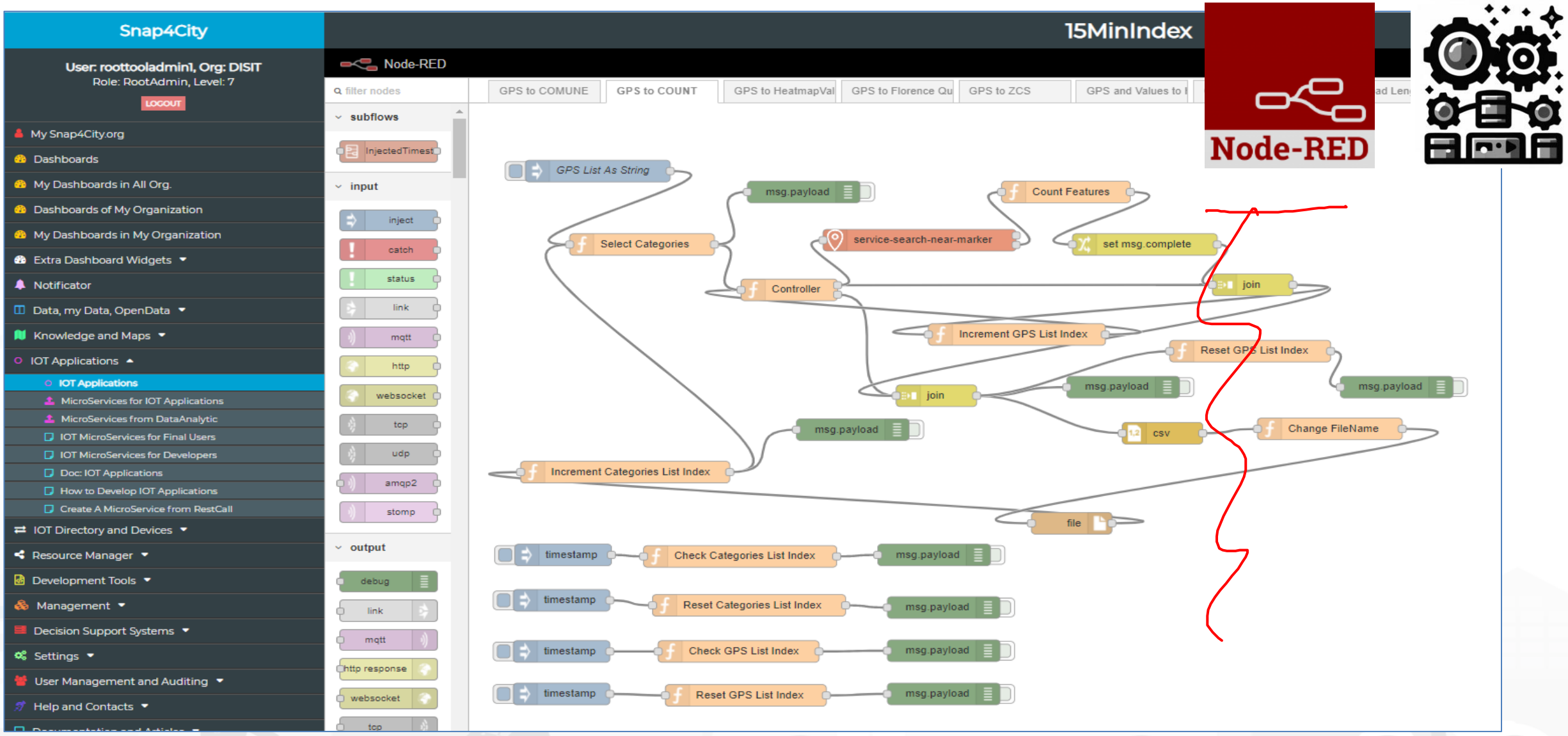
# 15MinCityIndex on Bologna



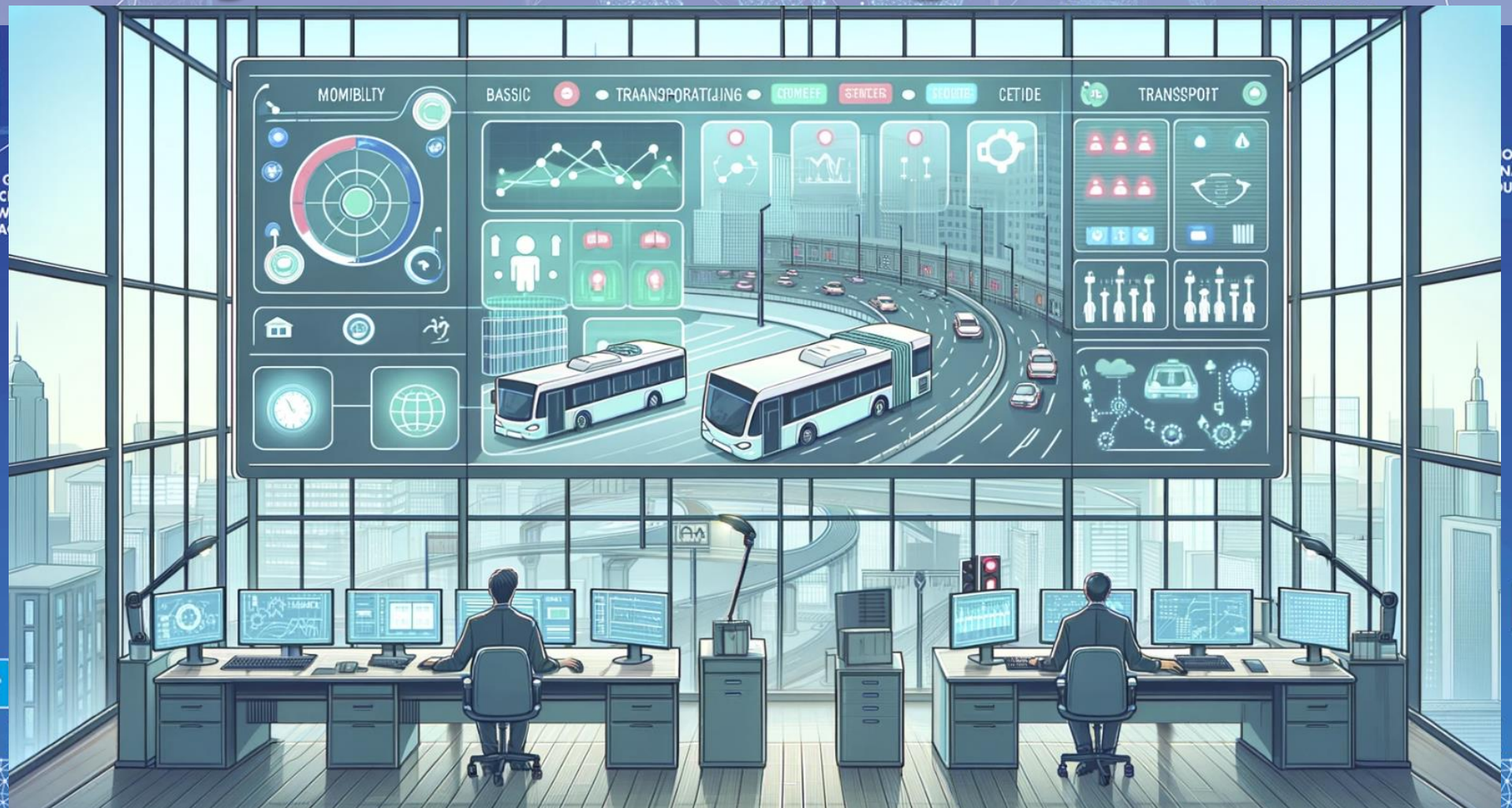


https://www.snap4city.org/dashboardSmartCity/view/Baloon-Dark.php?iddasboard=MzQxMg==

# IoT App....


Snap4City
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 Applications
MicroServices for IOT Applications
MicroServices from DataAnalytic
IOT MicroServices for Final Users
IOT MicroServices for Developers
Doc: IOT Applications
How to Develop IOT Applications
Create A MicroService from RestCall
IOT Directory and Devices
Resource Manager
Development Tools
Management
Decision Support Systems
Settings
User Management and Auditing
Help and Contacts
Node-RED
15MinIndex
filter nodes
subflows
InjectedTimest
input
inject
catch
status
link
mqtt
http
websocket
tcp
udp
amqp2
stomp
output
debug
link
mqtt
http response
websocket
tcp
GPS to COMUNE
GPS to COUNT
GPS to HeatmapVal
GPS to Florence Qu
GPS to ZCS
GPS and Values to
GPS List As String
msg.payload
Count Features
Select Categories
service-search-near-marker
set msg.complete
Controller
join
Increment GPS List Index
Reset GPS List Index
join
msg.payload
msg.payload
msg.payload
csv
Change FileName
Increment Categories List Index
file
timestamp
Check Categories List Index
msg.payload
timestamp
Reset Categories List Index
msg.payload
timestamp
Check GPS List Index
msg.payload
timestamp
Reset GPS List Index
msg.payload

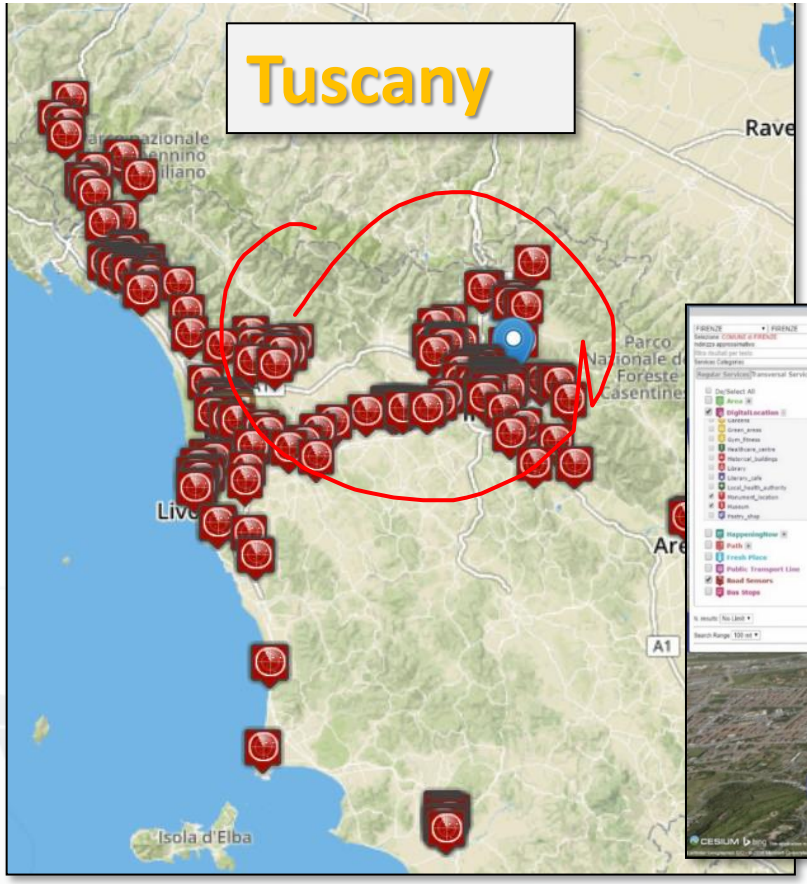
# Mobility Monitoring and Control

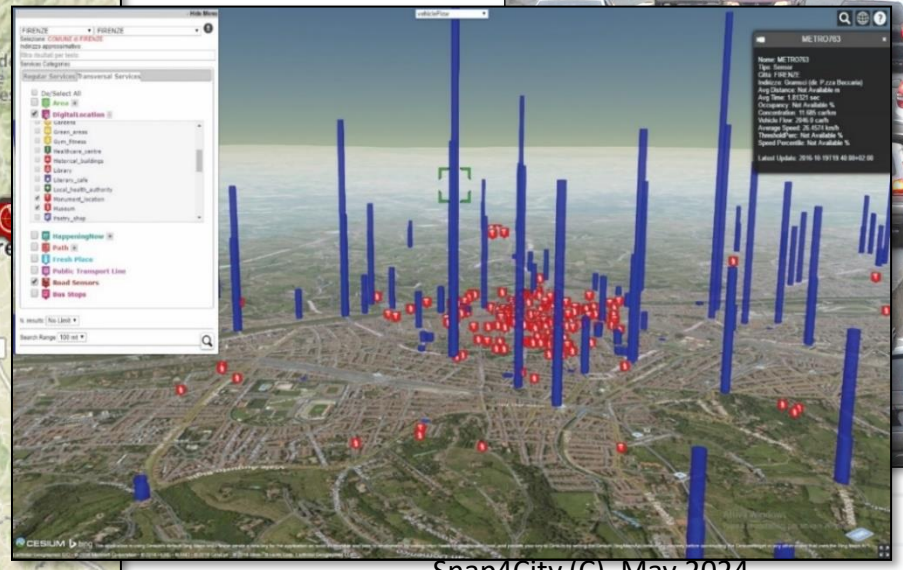


# Traffic Flow Tools

Spire and Virtual Spires (cameras), Bluetooth, …

Specifically located: along, around, on gates, on x…



# Firenze - Trafair - AirQuality Heatmaps

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

Mon 6 Apr 15:12:27

- Air Quality Sensors
- Weather Sensors
- PM10 Heatmap
- PM2.5 Heatmap
- CO Heatmap
- CO2 Heatmap
- O3 Heatmap
- NO2 Heatmap
- Europ. AQI Heatmap
- Air Humidity Heatmap
- Air Temp. Heatmap
- Wind Speed Heatmap
- Gral Pred. HM NOX (3m)
- Gral Pred. HM NOX (6m)
- Traffic Sensors
- Traffic Flow
- Cycling Paths
- Accident Heatmap
- Accident Heatmap 2
- Only HRes Anym. Gral
- Green Areas
- Schools

Air quality trends

Multi Map

Maps

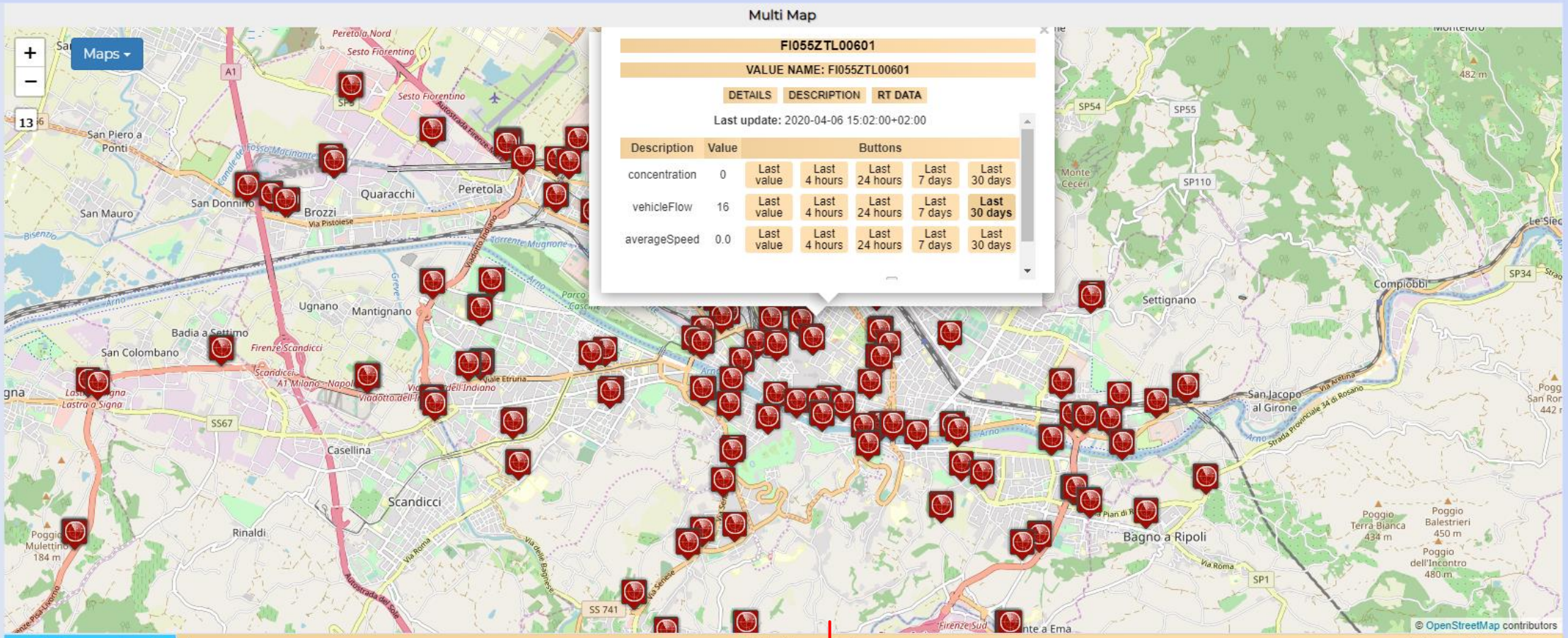
FI055ZTL00601

VALUE NAME: FI055ZTL00601

DETAILS | DESCRIPTION | RT DATA

Last update: 2020-04-06 15:02:00+02:00

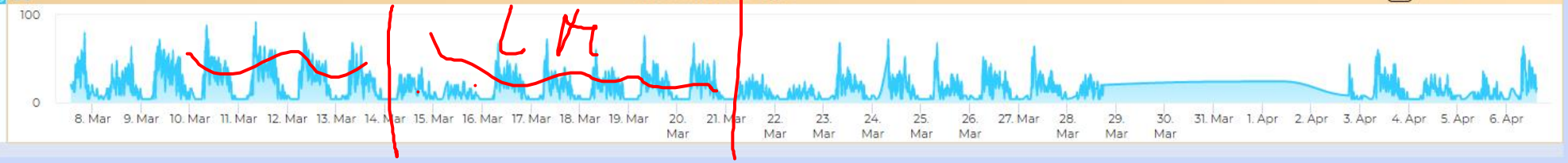
| Description | Value | Buttons | | | | |
|---|---|---|---|---|---|---|
| concentration | 0 | Last value | Last 4 hours | Last 24 hours | Last 7 days | Last 30 days |
| vehicleFlow | 16 | Last value | Last 4 hours | Last 24 hours | Last 7 days | **Last 30 days** |
| averageSpeed | 0.0 | Last value | Last 4 hours | Last 24 hours | Last 7 days | Last 30 days |




Air Temperature 9m

21.8 °C

vehicleFlow - 30 days 9m



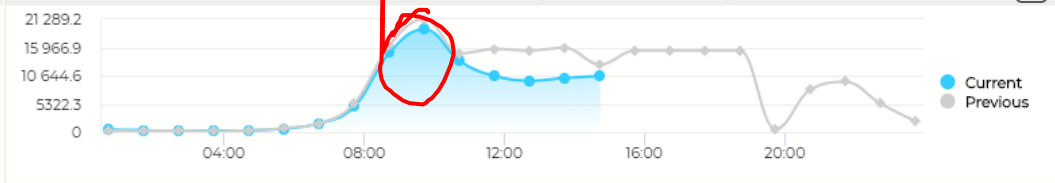
# Traffic Flow Monitoring - Firenze - Cloned2

Wed 11 Nov 15:01:32

**# IN FLOW** 9m

10549 #ofvehicles

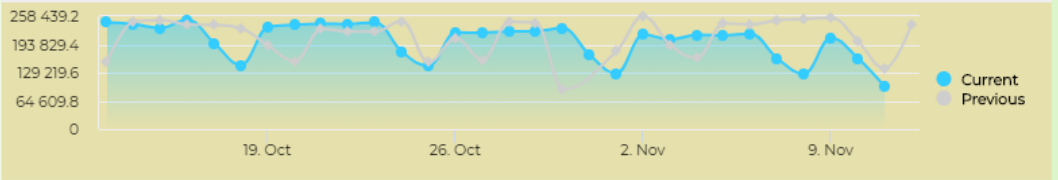
**Firenze IN Traffic Flow (number of vehicles)** 9m




**Inc Daily Inp...** 9m

97137 #ofvehicles

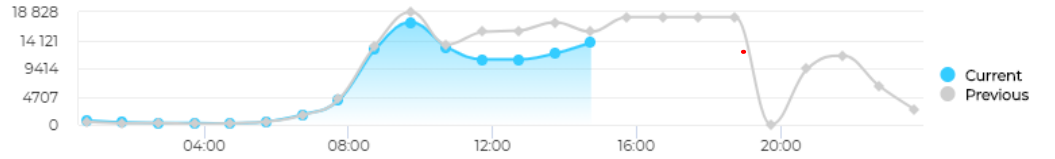
**Daily Inputs (monthly) (last value is incremental, real time)** 9m




**# OUT FLOW** 9m

13720 #ofvehicles

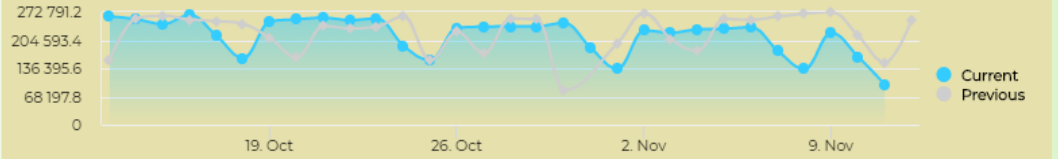
**Firenze OUT Traffic Flow (number of vehicles)** 9m




**Inc Daily Out...** 9m

97457 #ofvehicles

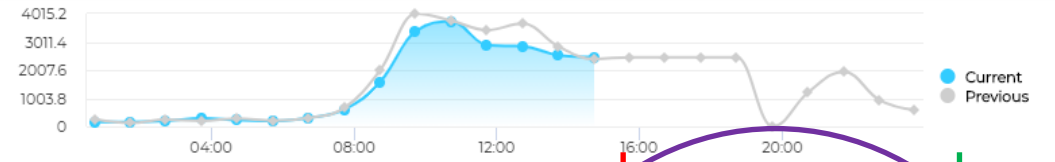
**Daily Outputs (monthly) (last value is incremental real time)** 9m



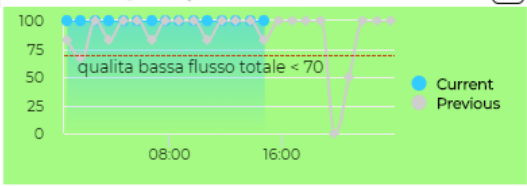

**ZTL in** 9m

2468 #ofvehicles

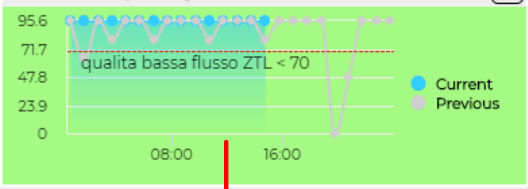
**ZTL in Traffic Flow daily trend, entering in ZTL** 9m




**QoS as perc. of measures taken** 9m



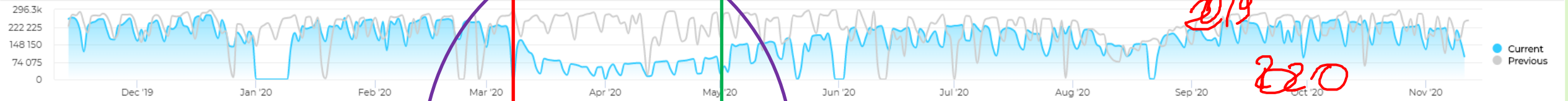

**QoS as perc. of measures in ZTL** 9m




**11/11/2020**

**15:01:33**

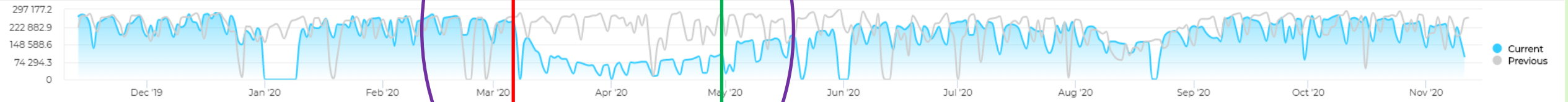
**inflow total of the day, yearly** 9m



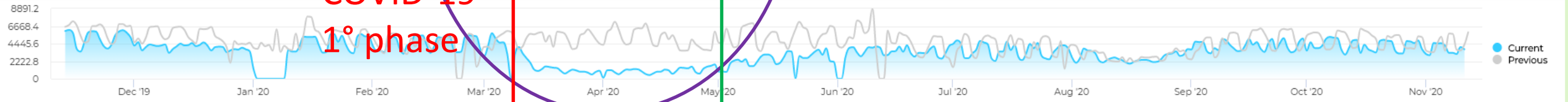

2019

2020

**outflow total over the day Yearly** 9m



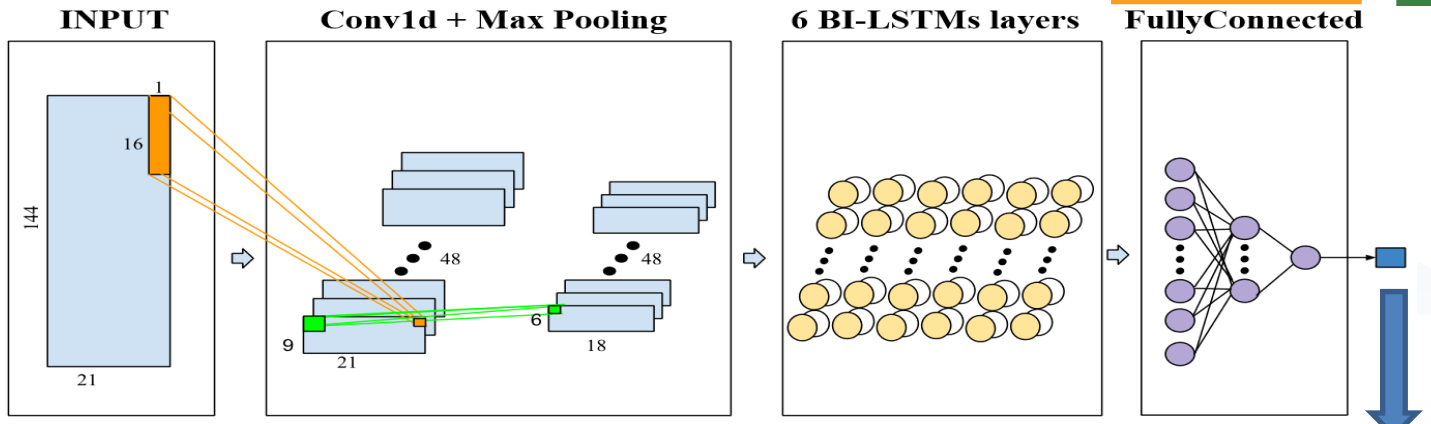

**in ZTL yearly compare** 9m




COVID-19

1° phase

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

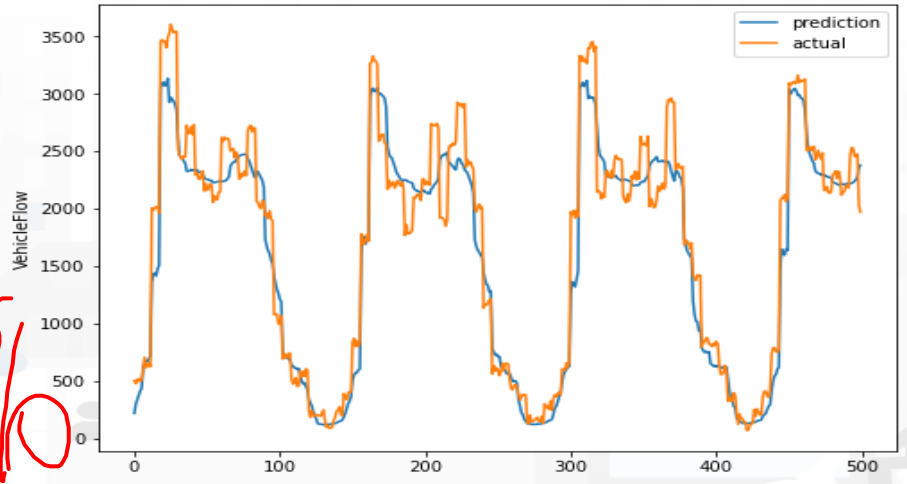


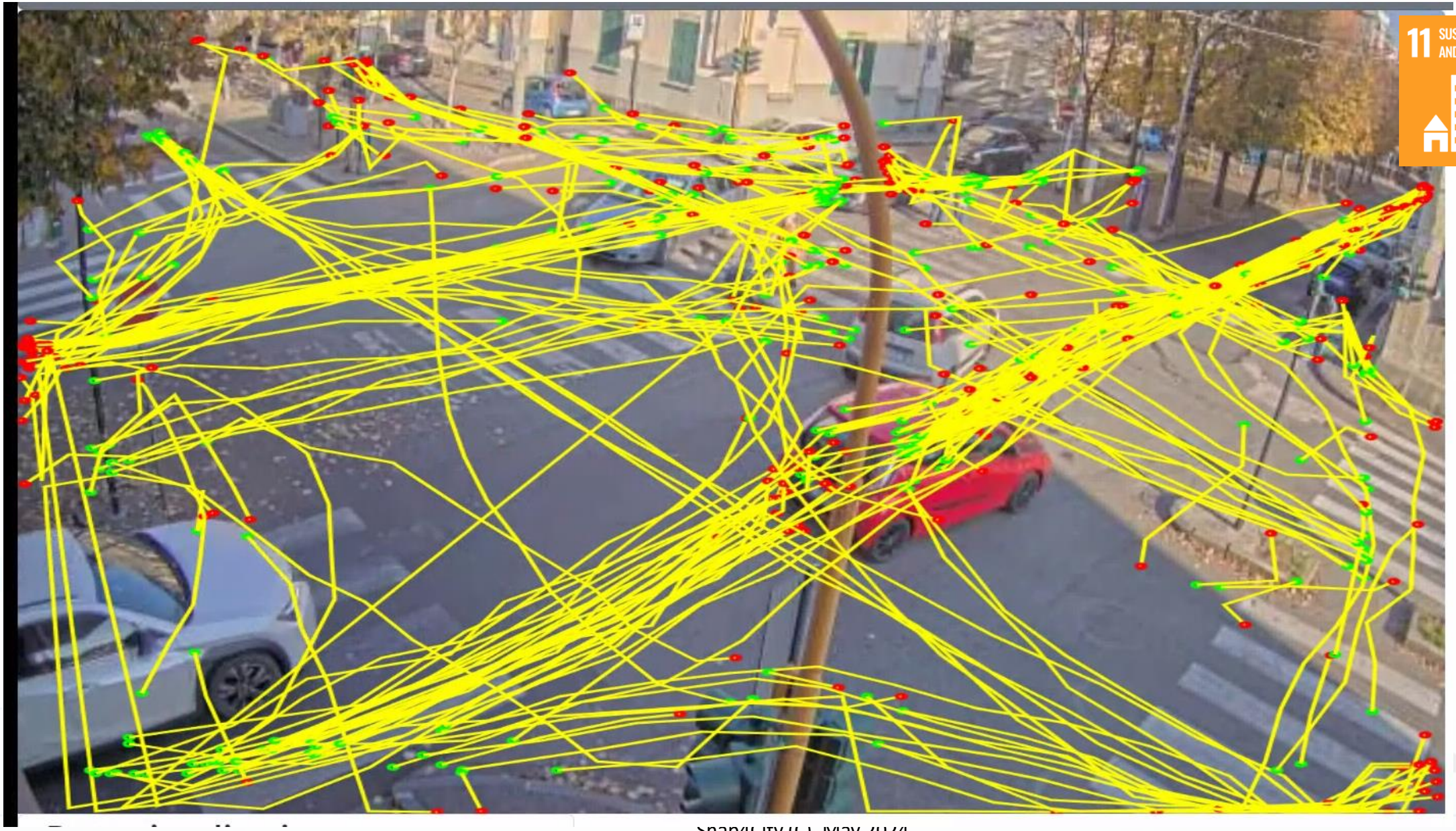

Urban data:

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

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

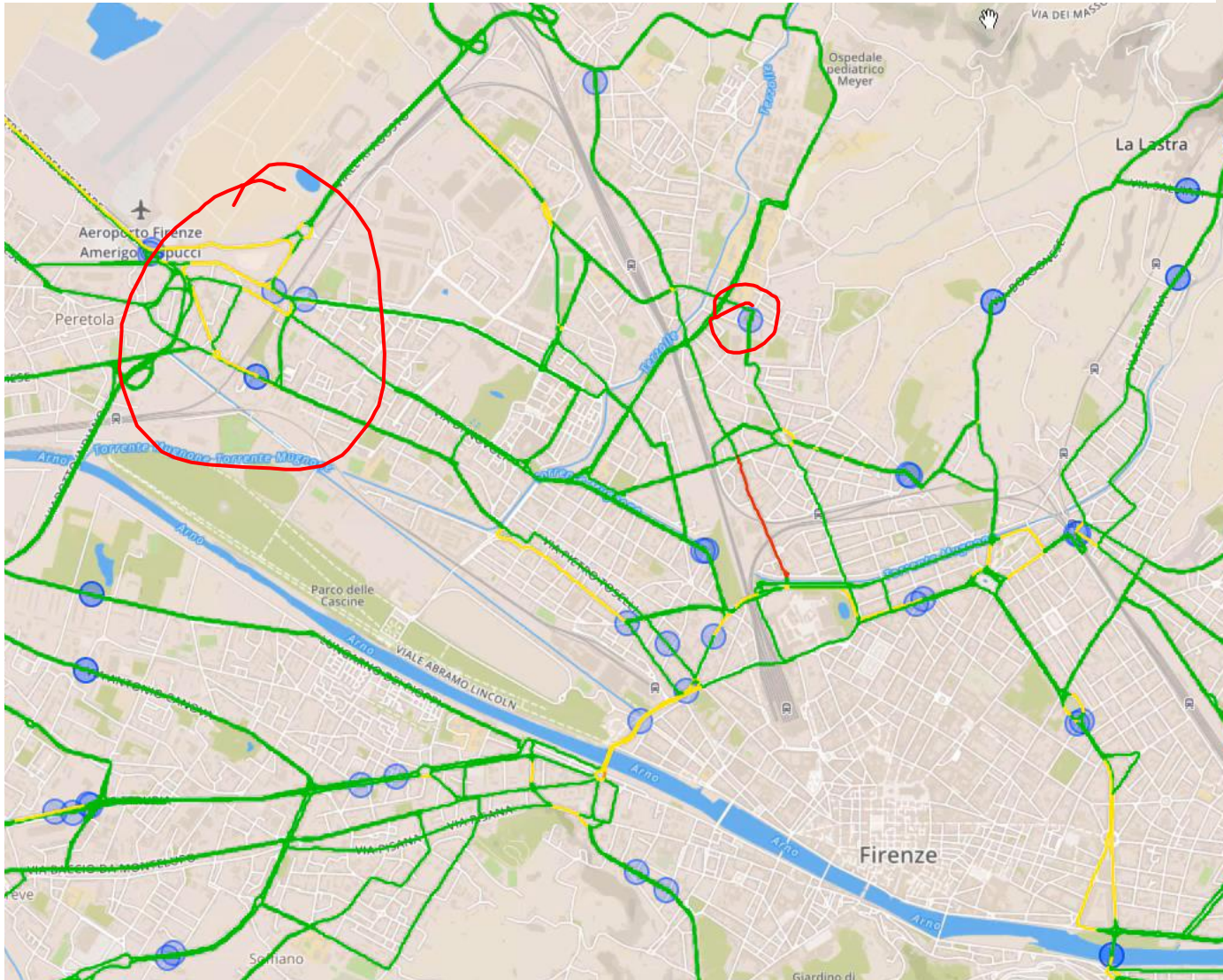
CONV-BI-LSTM





# 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



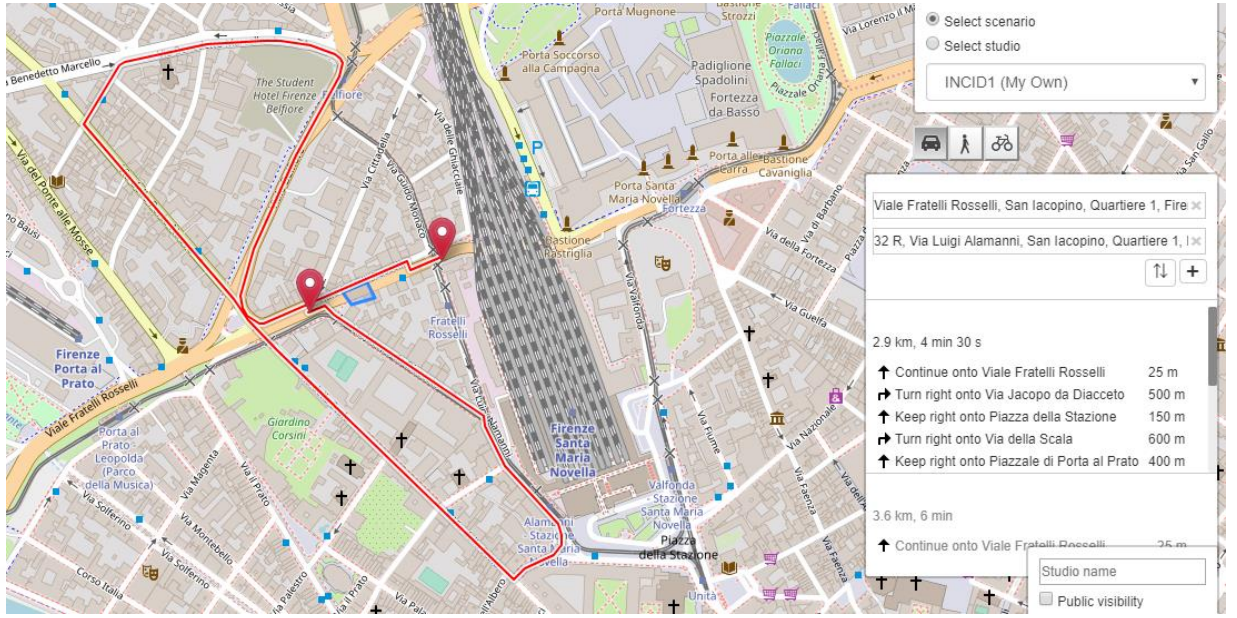
# What-If Analysis

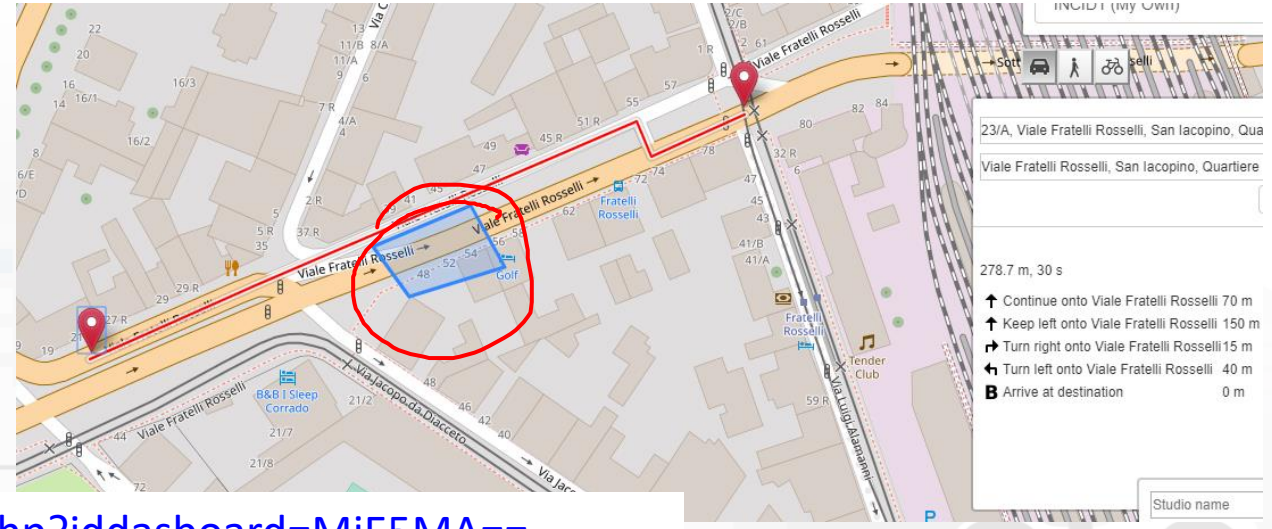
Accidents and elements blocking Points and Shapes taken into account for:

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

Assessment on the basis of changes:

- Mobility demand assessment
- Mobility Offer assessment

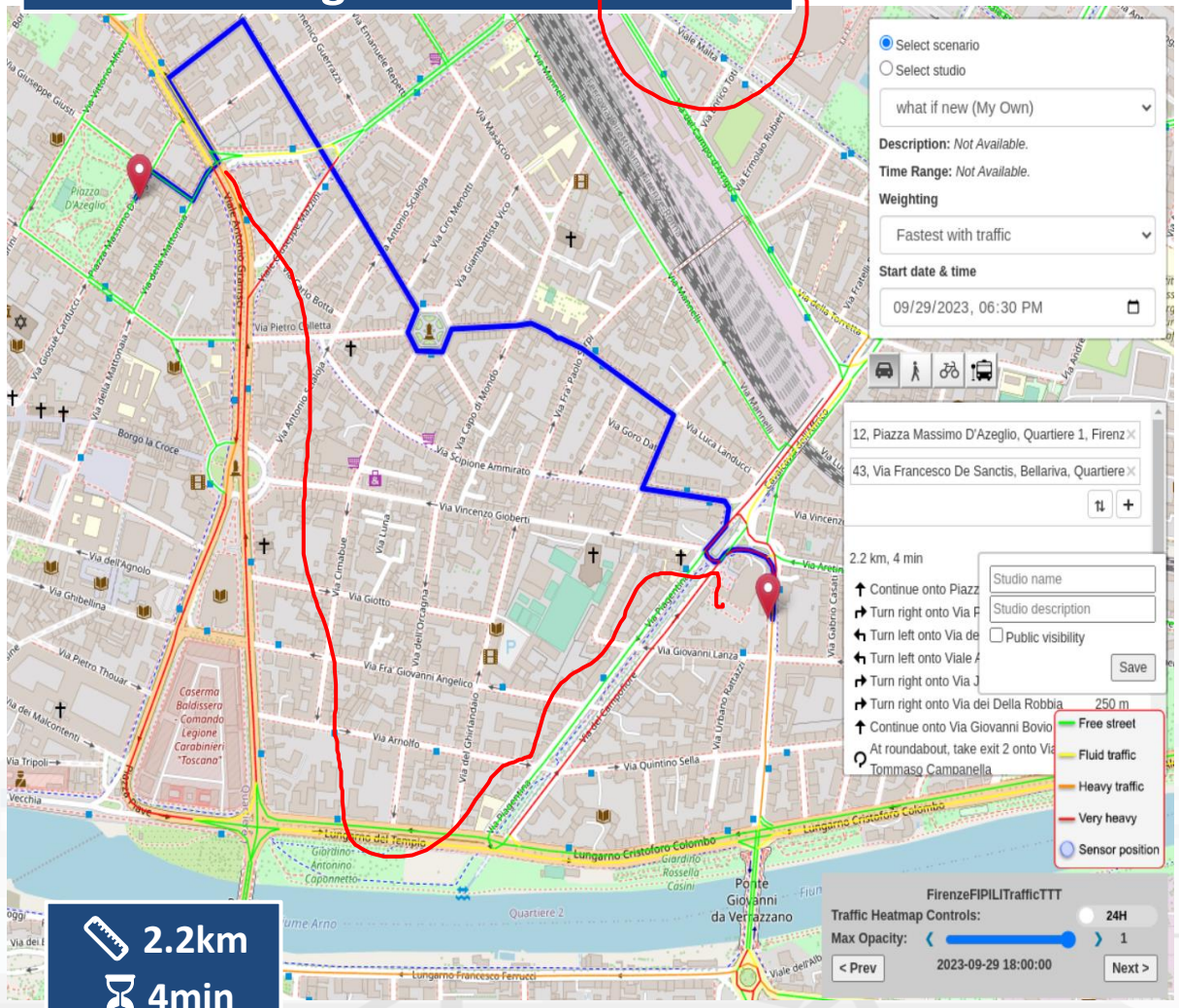



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjE5MA==

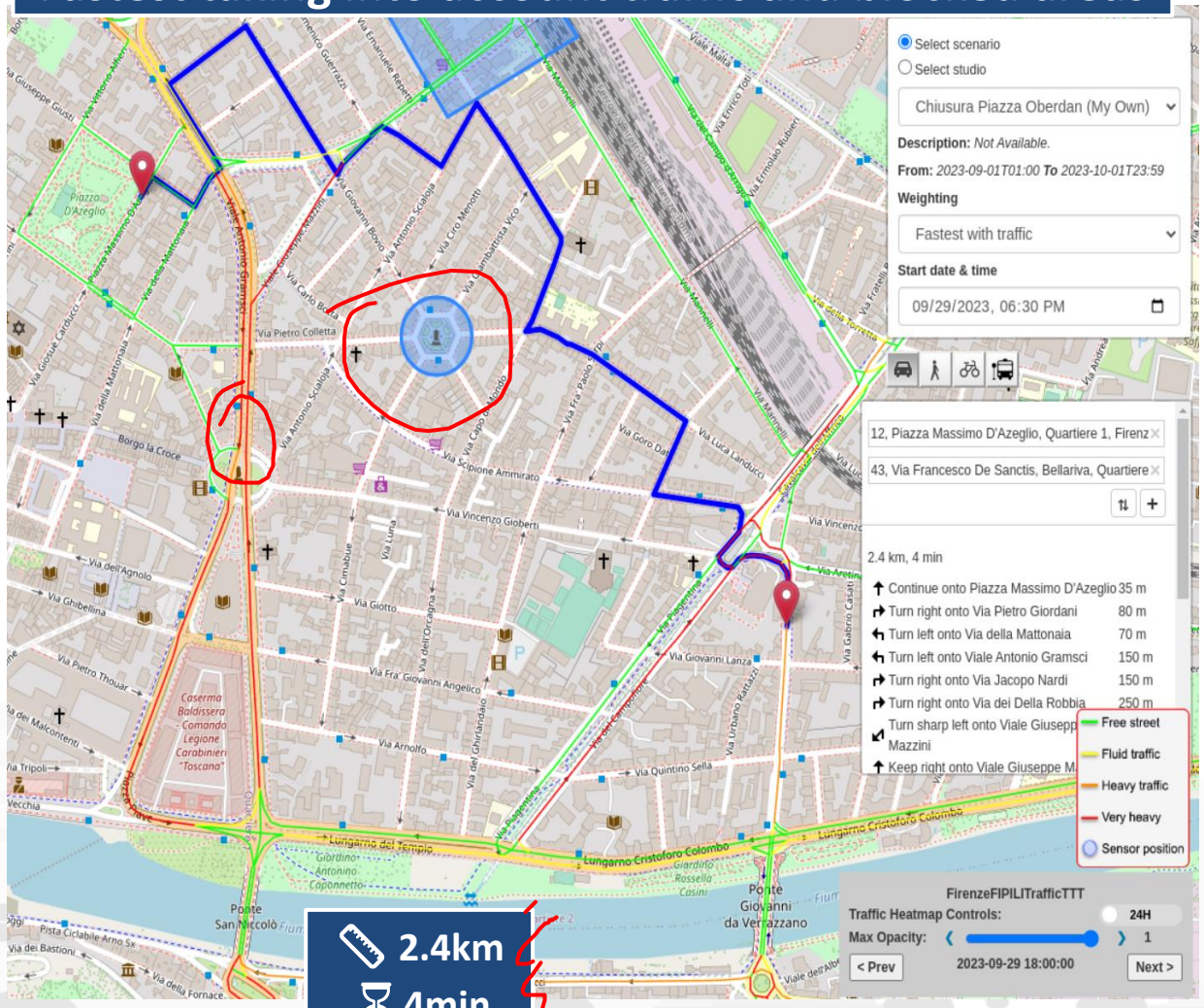
# Constrained Dynamic Routing: Traffic Flow

## Fastest taking into account traffic




2.2km
4min

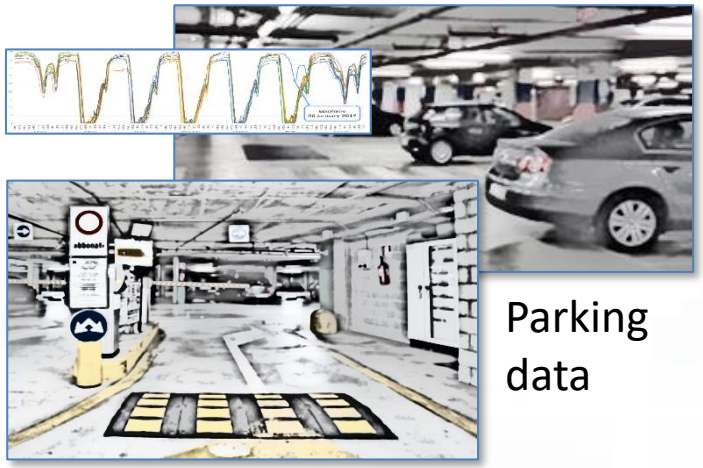
## Fastest taking into account traffic and blocked areas




2.4km
4min

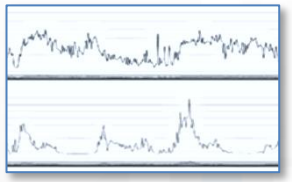

autostrada
FIESOLE
SIENA
AREZZO - FORLI'

# Deep Learning AI to surely Park!

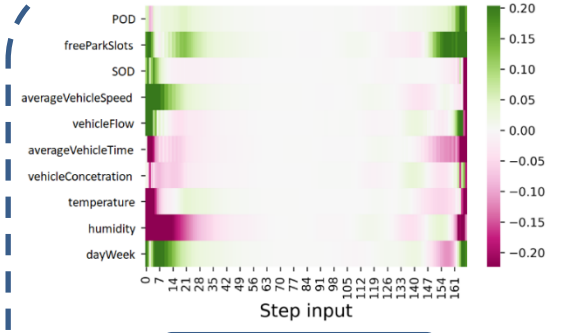


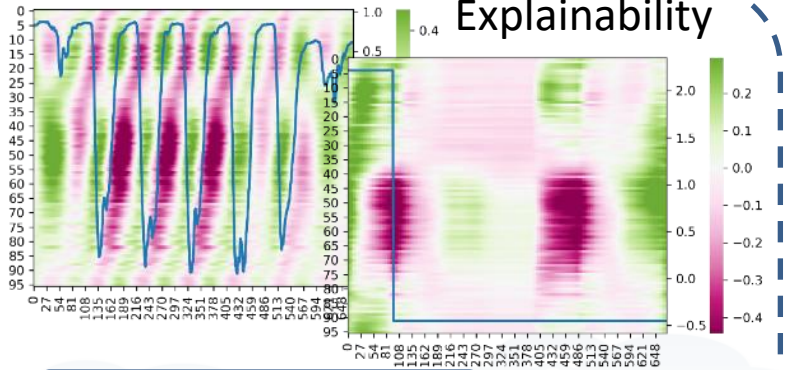
Parking data

Traffic sensors data



Weather Features

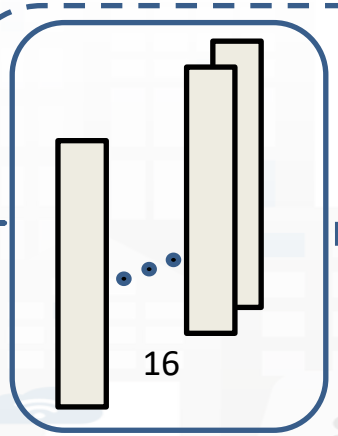


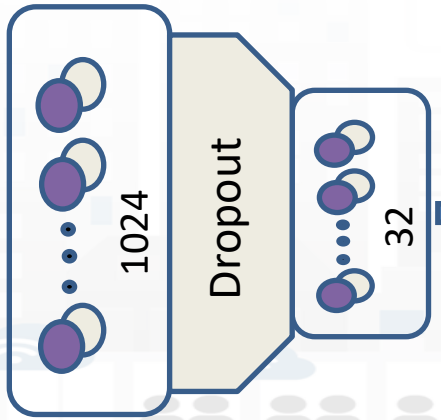



Explainability

Gradient

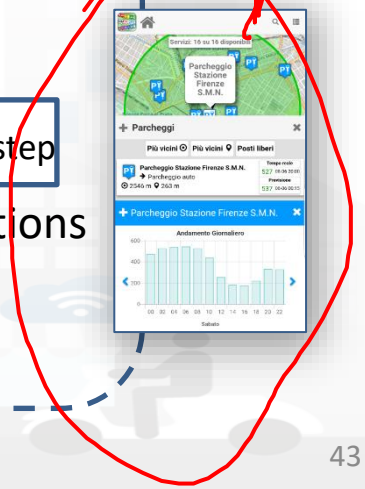
Integrated Gradient



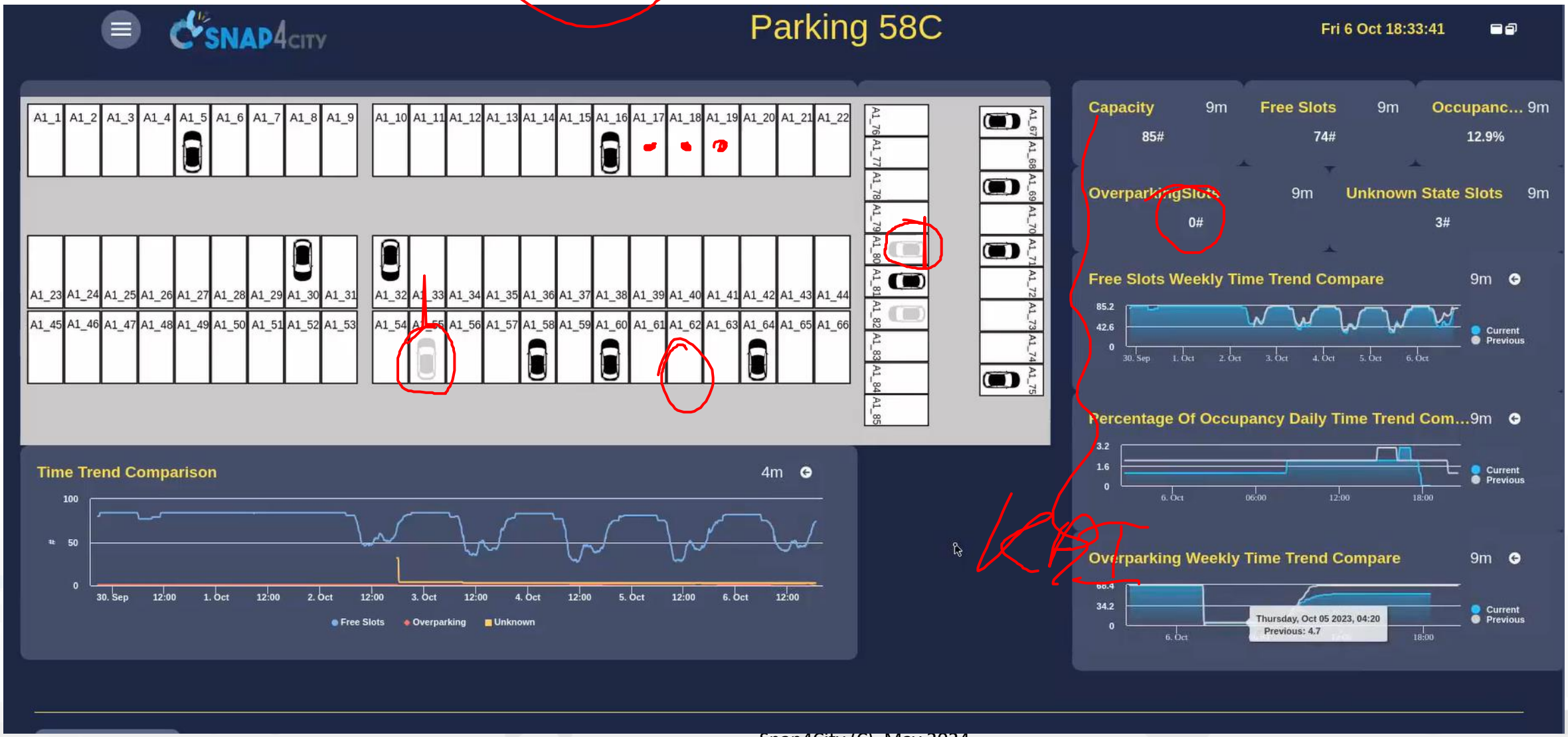




Conv1D+AvPooling1D BI-LSTM BI-LSTM Dense

Multi-step Predictions



# Snap4ISPRA Parking: ISPRA JRC



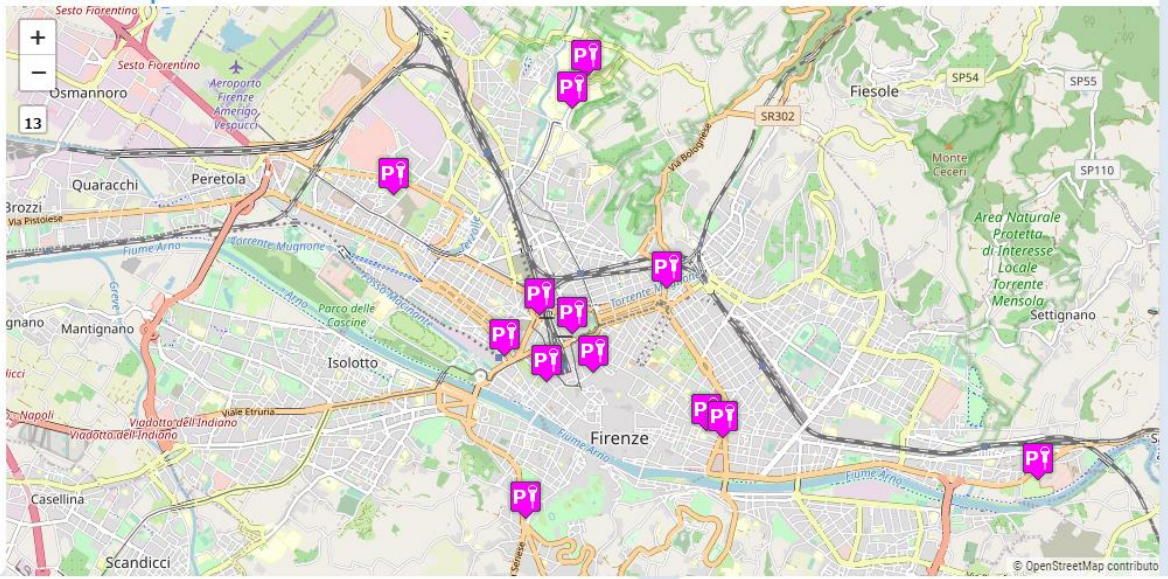
# Monitoraggio Parcheggi

Sat 13 May 23:26:20

## Selector

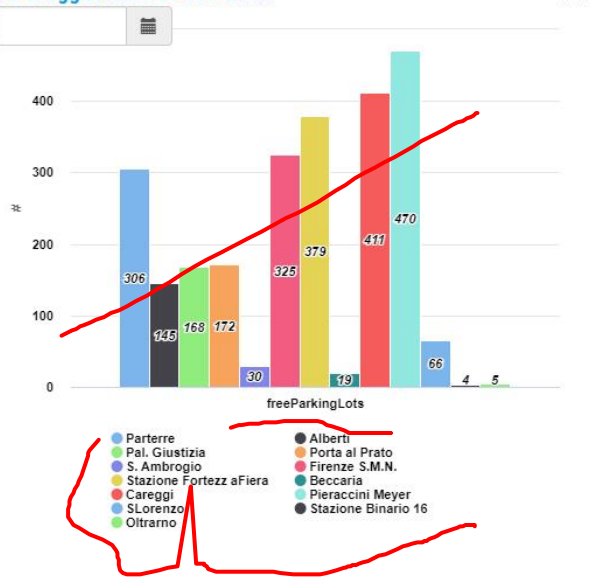
- Parterre
- Piazza Alberti
- Palazzo di.Giustizia
- Porta al Prato
- S. Ambrogio
- Stazione Firenze S.M.N.
- Stazione Fortezza Fiera
- Piazza Beccaria

## Selector - Map



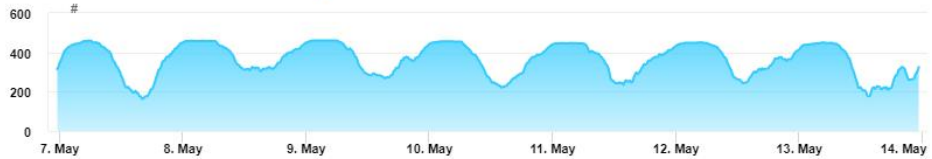

## Parcheggi: Numero Posti Liberi

4m




## StazioneFirenzeS.M.N. - FreeParkingLots

9m




## Andamento Posti Occupati

4m


My Profile

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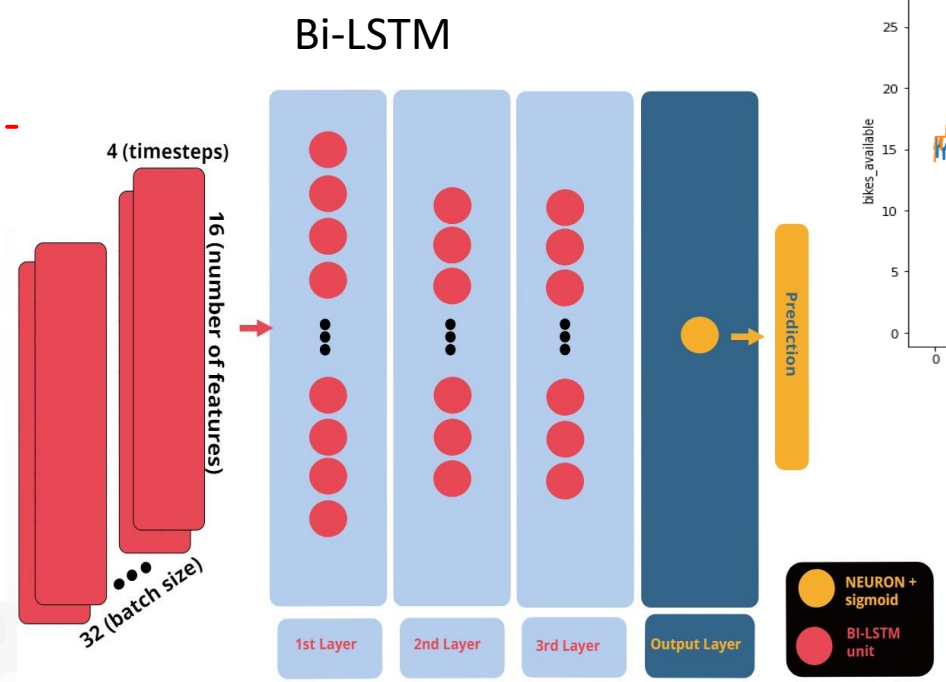
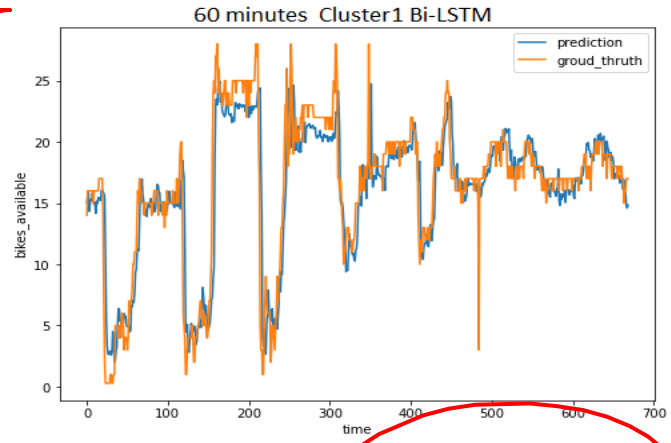
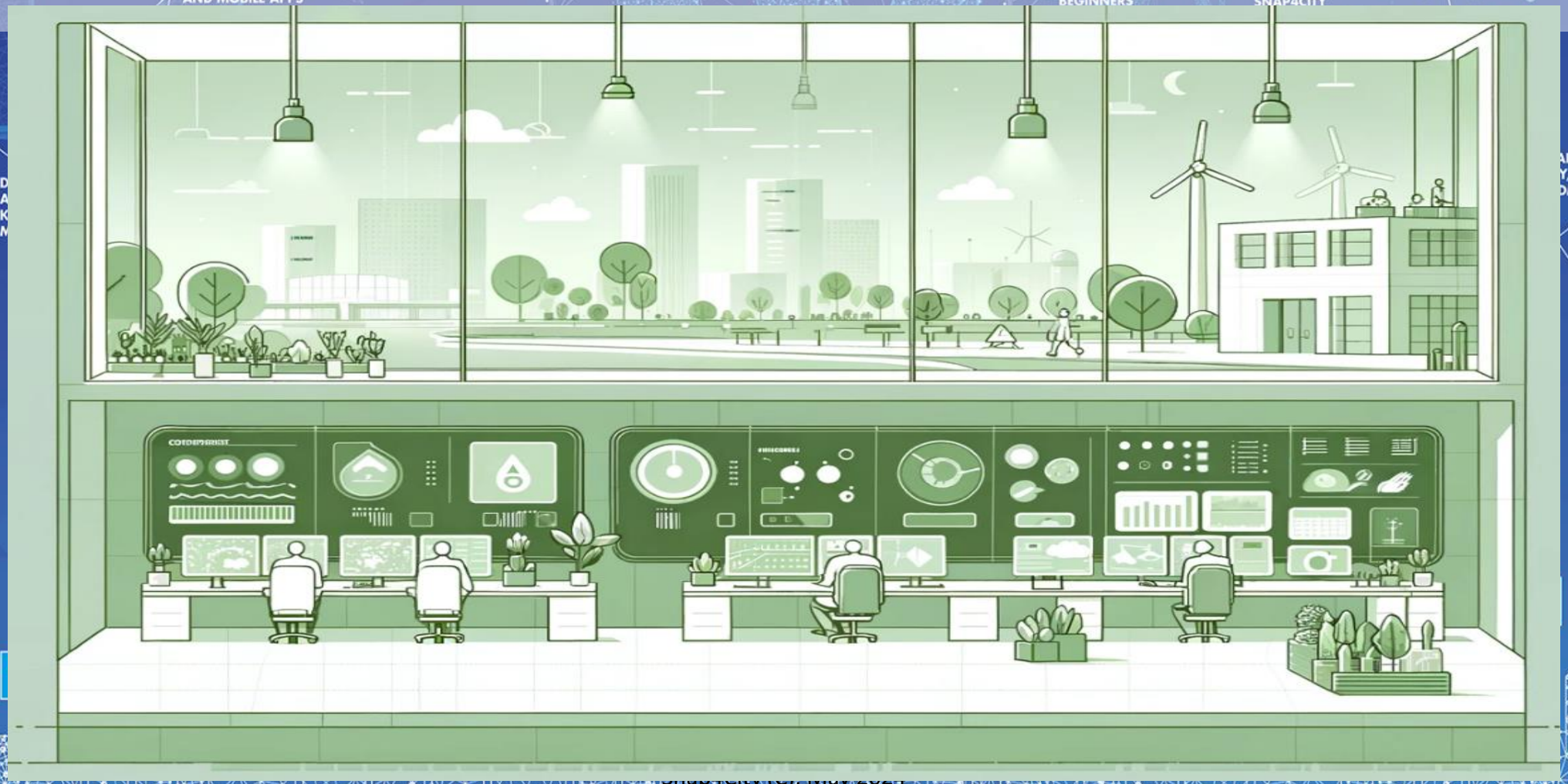
# Deep Learning for Short-Term Prediction of Available Bikes on Bike-Sharing Stations


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

# Environmental Monitoring and Control



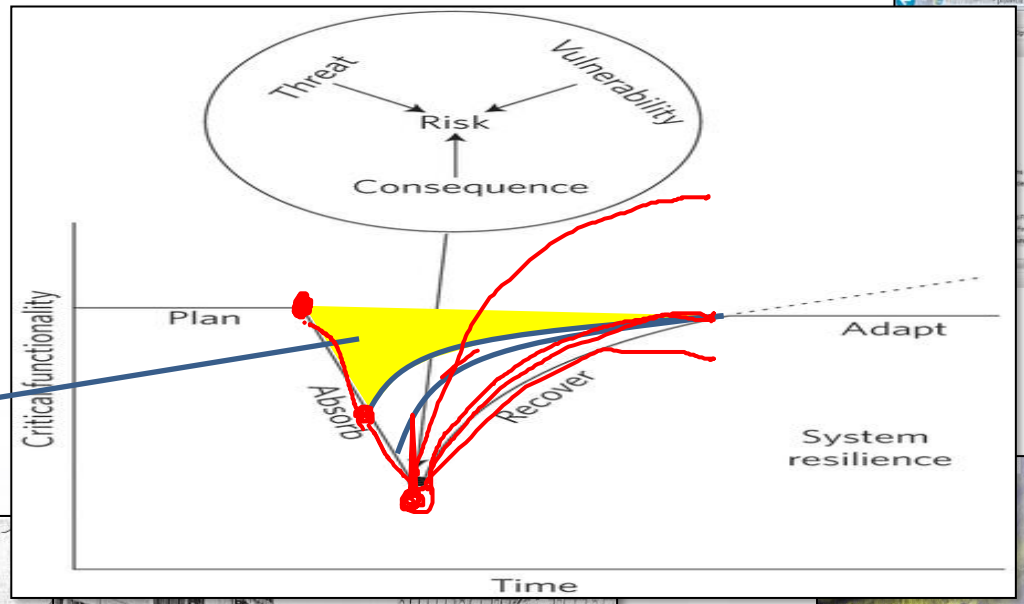
# City Resilience

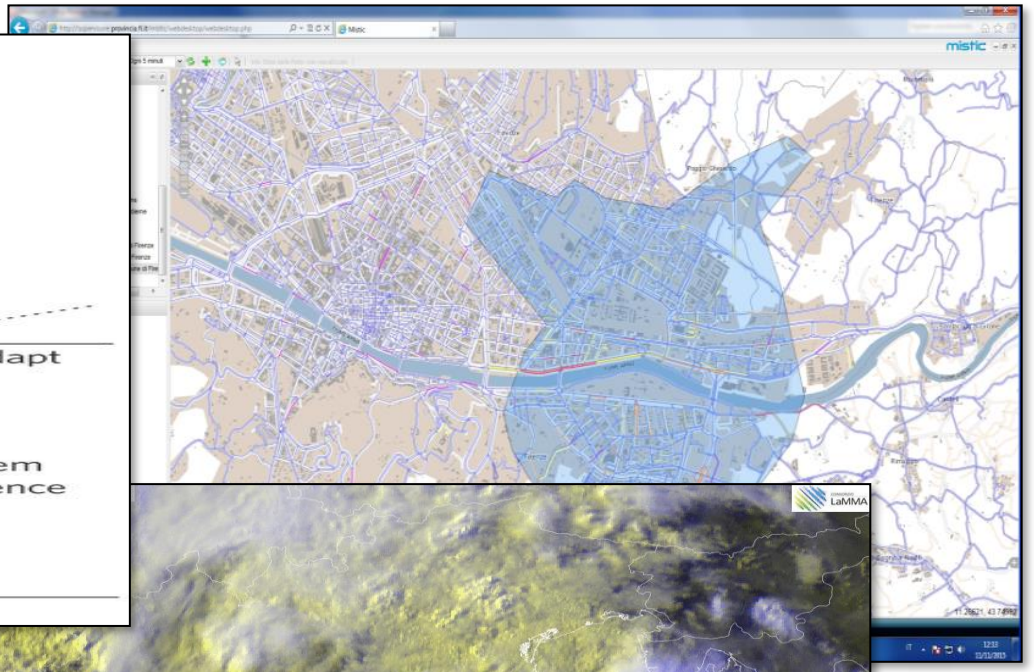


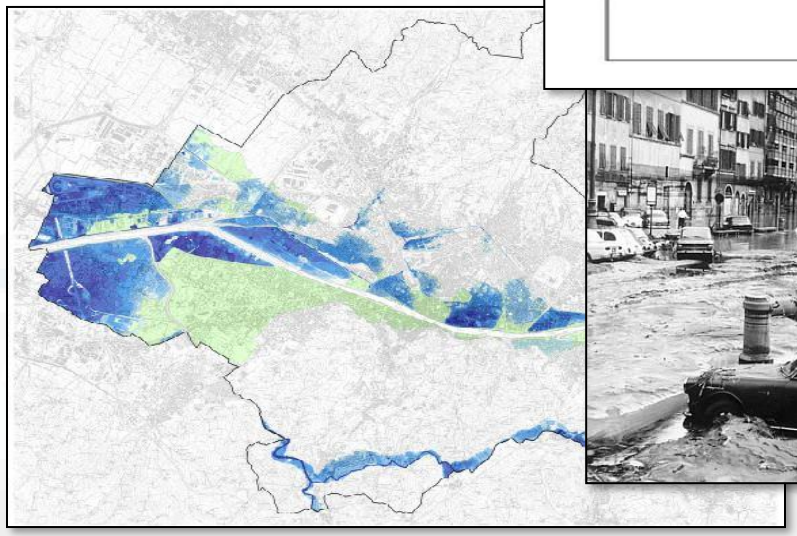
# *Early Warning, Detection*

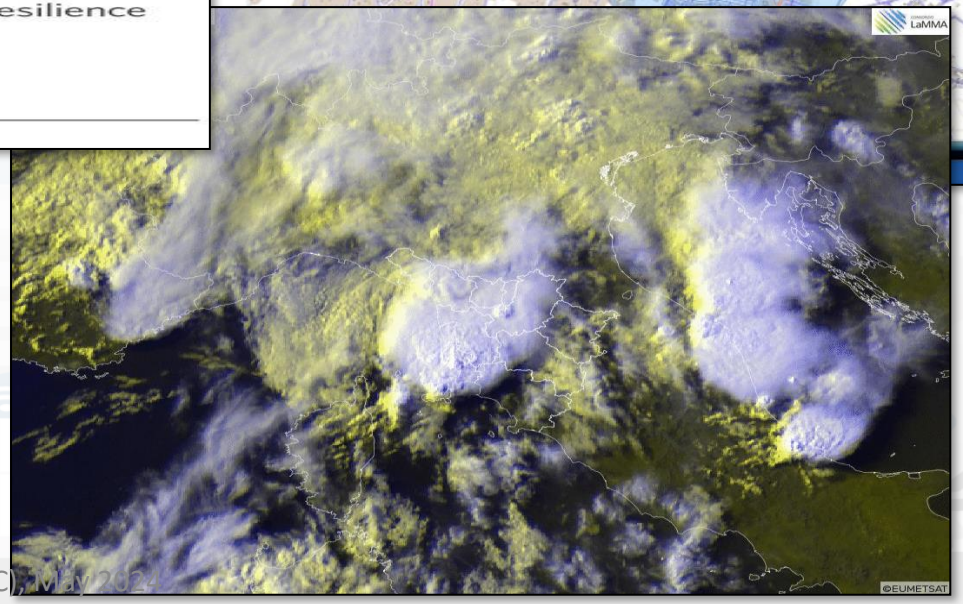
***P***repare
***A***bsorb
***R***ecover
***A***dapt

damage

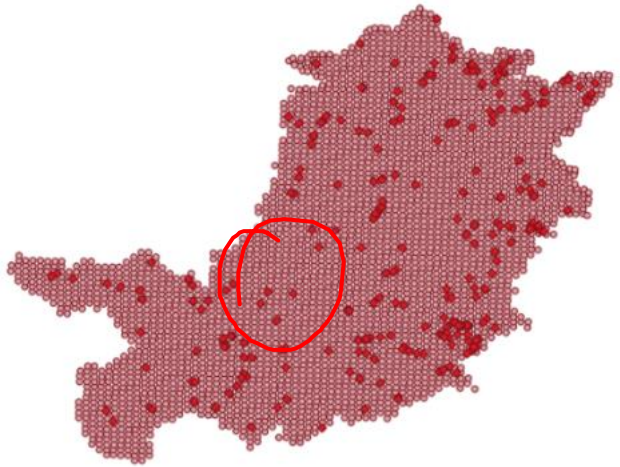


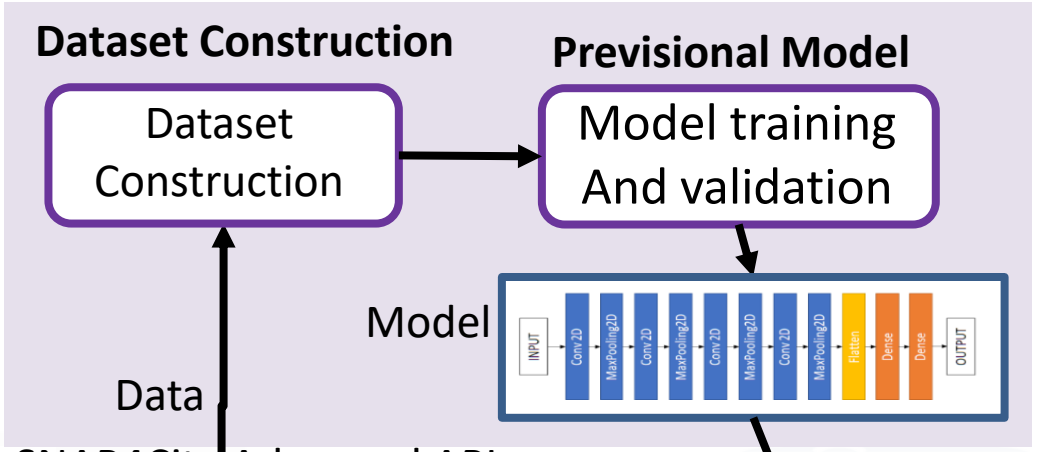



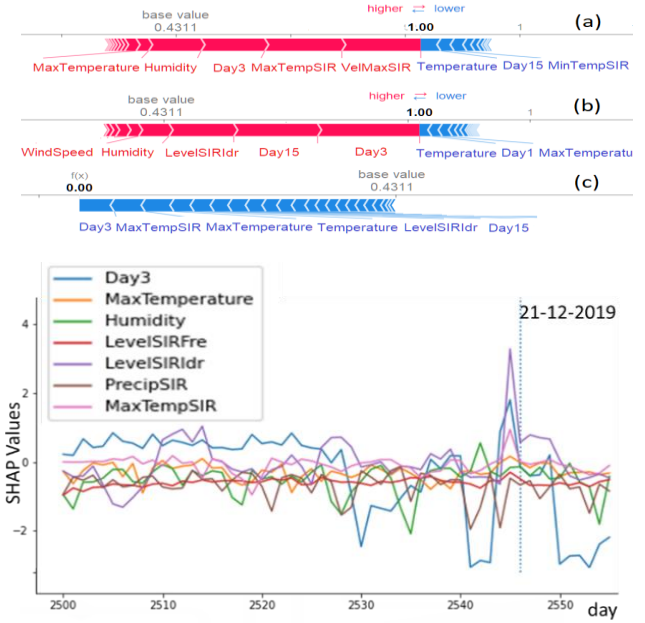




# Predicting Land slides






landslide DB

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

Processes

Ingestion

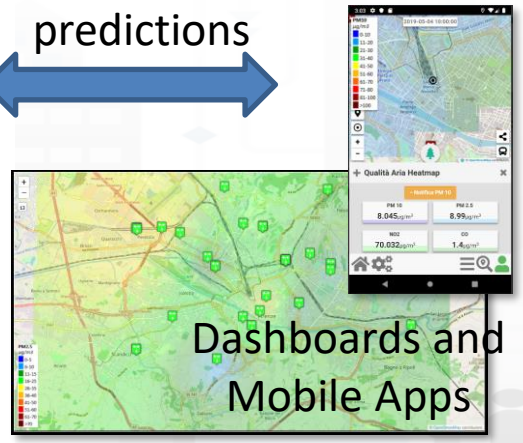
Big Data Storage and KB

Predictions

Model execution Shap Assessment

Data Analytics IOT App Management

predictions

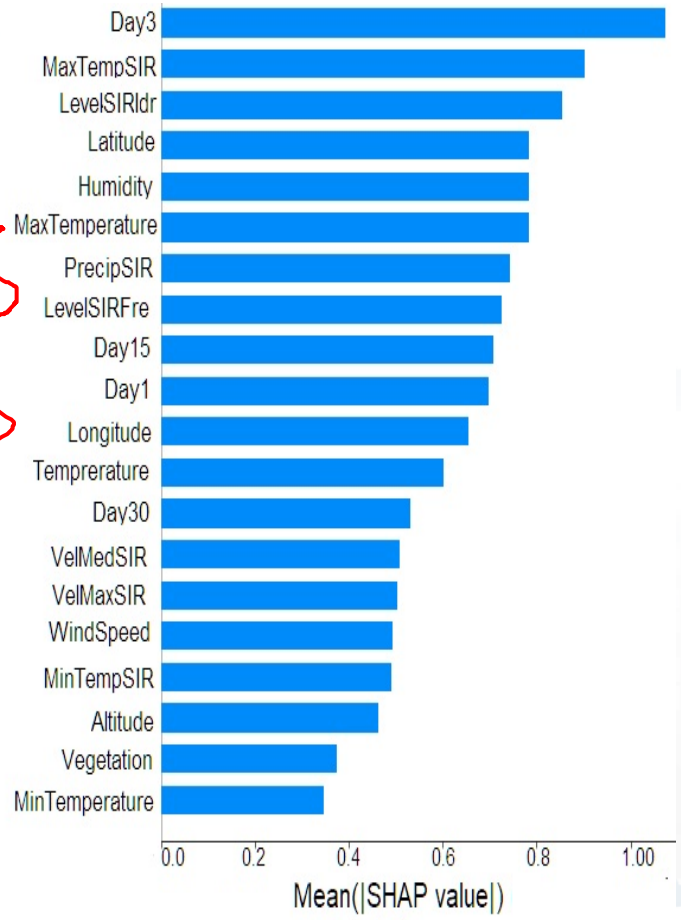


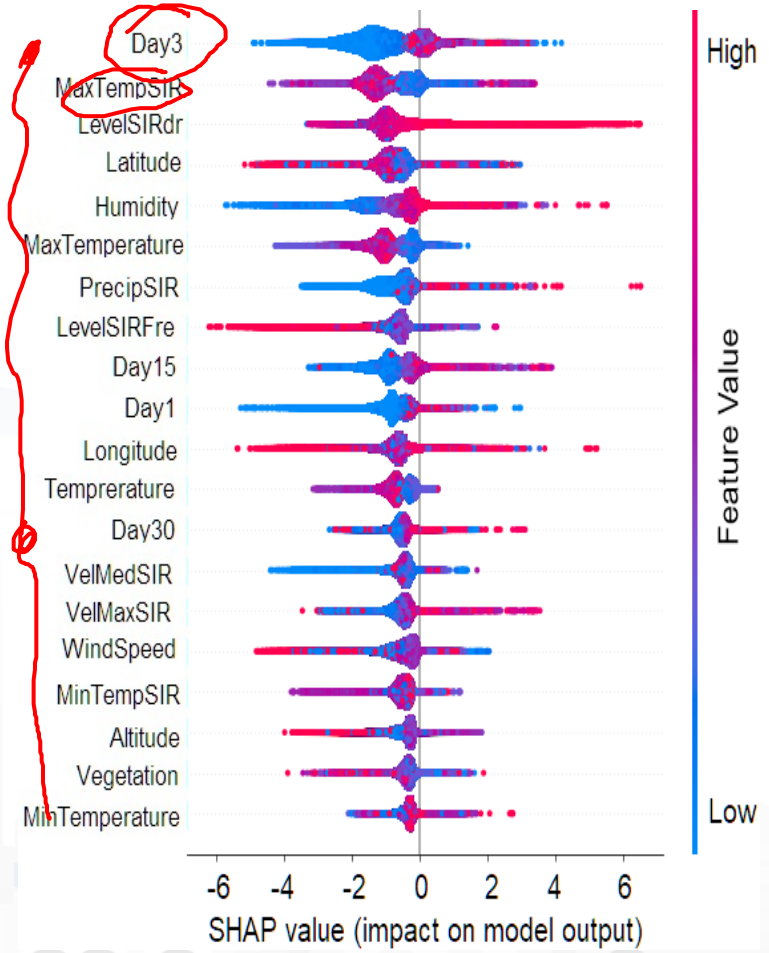

Snap4City Servers and Tools: Dashboard manager, Heatmap manager, GeoServer, Smart City API.

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

# Comparing Predictive Model/architectures

| Model | XGBoost | RF | CNN | Auto encoder | SIGMA |
|---|---|---|---|---|---|
| MAE | 0.000173 | 0.000334 | 0.000600 | 0.009218 | 0.004169 |
| MSE | 0.000173 | 0.000334 | 0.000259 | 0.009218 | 0.004169 |
| RMSE | 0.0131 | 0.0182 | 0.0160 | 0.0960 | 0.064572 |
| Accuracy | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 |
| Sensitivity | 0.79 | 0.36 | 0.24 | 0.19 | 0.06 |
| Specificity | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 |
| TSS | 0.78 | 0.35 | 0.23 | 0.18 | 0.05 |
| PfA | 0.01% | 0.02% | 0.01% | 0.11% | 0.39% |
| Precision | 0.63 | 0.35 | 0.33 | 0.64 | 0.003 |
| F1 score | 0.70 | 0.36 | 0.27 | 0.29 | 0.007 |
| MCC | 0.70 | 0.36 | 0.28 | 0.35 | 0.01 |
| OA | 2.40 | 1.72 | 1.55 | 1.64 | 1.02 |
| Kappa | 0.70 | 0.36 | 0.27 | 0.29 | 0.01 |
| AUC | 0.89 | 0.68 | 0.99 | 0.92 | 0.53 |




Global Explainable AI

- Feature relevance

- Red: positive, blue: negeative;
- vs intensity and impact

# Local Explainable AI - understanding the single event

- The local explanation puts in evidence the features which provided major contribution to the prediction
- For example considering Figure10a, the value of VelMaxSIR, MaxTempSIR, Day3 and Humidity contributed significantly to the classification of the observation as a l**andslide event**

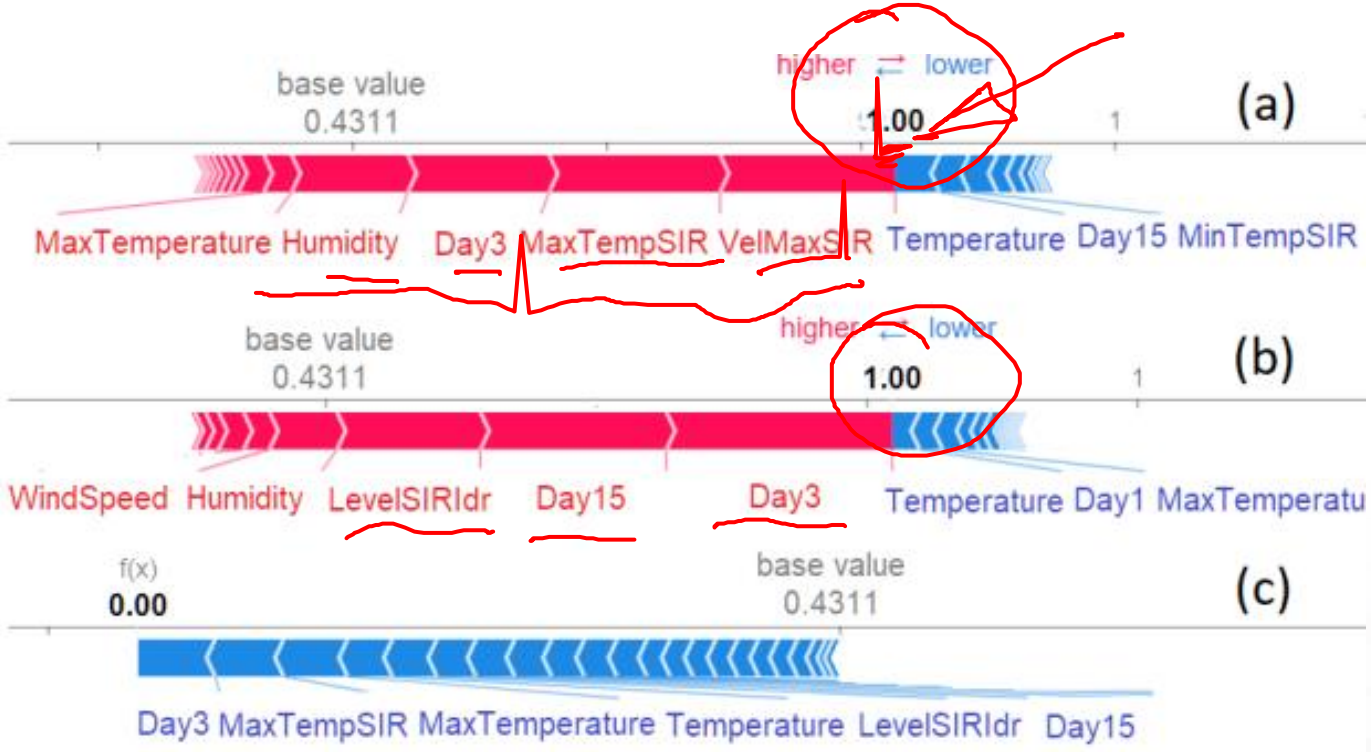



**FIGURE 10.** Local feature relevance via SHAP, as interpretation of events in terms of feature values: (a) and (b) are events with predictions of landslide, (c) a no landslide event.

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# Human Behavior Monitoring

# City Users Behaviour, Safety, Security and Social Analysis

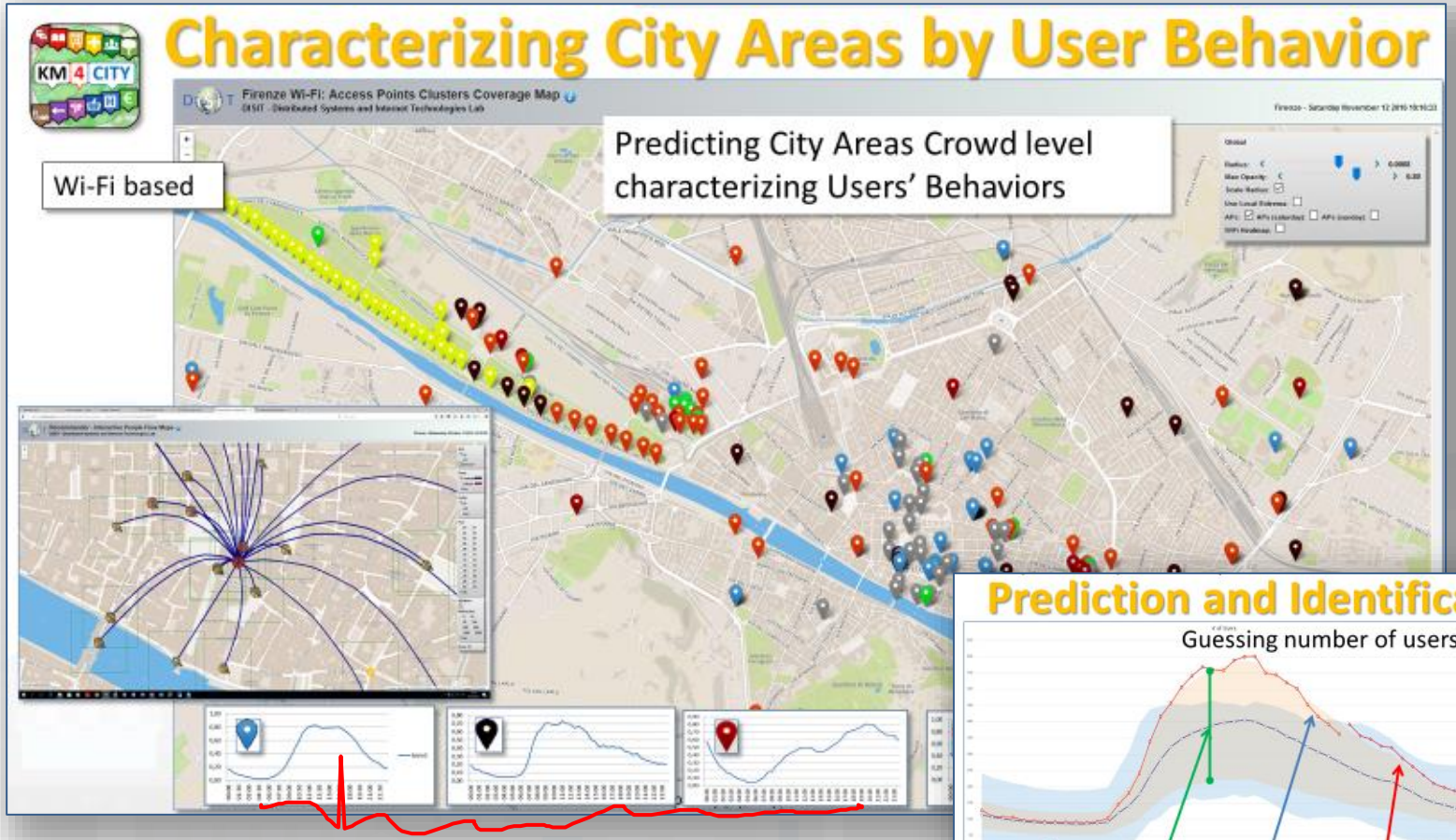
- **People detection and classification**: persona, strollers, bikes, etc. (ML, DL)
- **people counting and tracking**, head counting, people trajectories (via thermal cameras, ML, DL)
- **People flows prediction** and reconstruction, (ML, DL)
  - Wi-Fi data, mobile apps data, Mobile Data, etc.
- **User's behaviour analysis**, **People flow analysis** from PAX Counters and heterogenous data sources (ML, AI)
  - origin destination matrices, hot places, time schedule,
  - Recency and frequency, permanence, typical trajectory, etc.
- **Computing User engagement and suggestions** for sustainable mobility (Rule Based, ML)
- **Social media analysis** on specific channel, specific keywords: see Twitter Vigilance,
  - Reputation, service assessment: MultiLingual NLP and Sentiment Analysis, SA
  - Tweet proneness, retweet-ability of tweets, impact guessing
  - Audience predictions on TV channels and physical events, locations
  - Prediction of attendance of events and on attractions
- **Virtual Assistant construction, LLM, NLP, Sentiment Analysis (DL, NLP)**
- **Video management System integration for security**
- **15 Minute City Index** , etc. (modeling and computability)
- Computing **SDG**, etc., (DP)
- Etc.

# People Flows

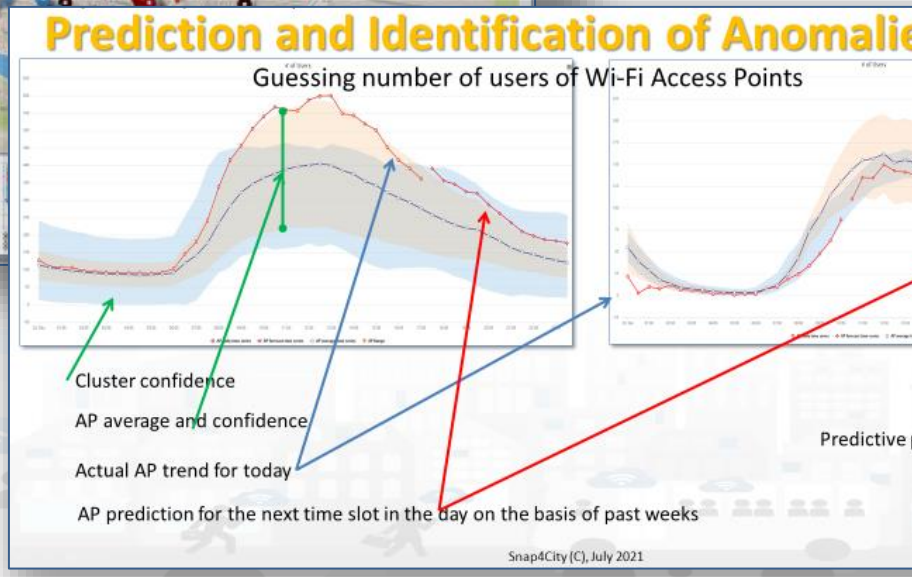


- **Prediction of people flows** on the basis of Wi-Fi data
- **Anomaly** detection
- **Resolute** H2020
- Classification of city areas

## Characterizing City Areas by User Behavior



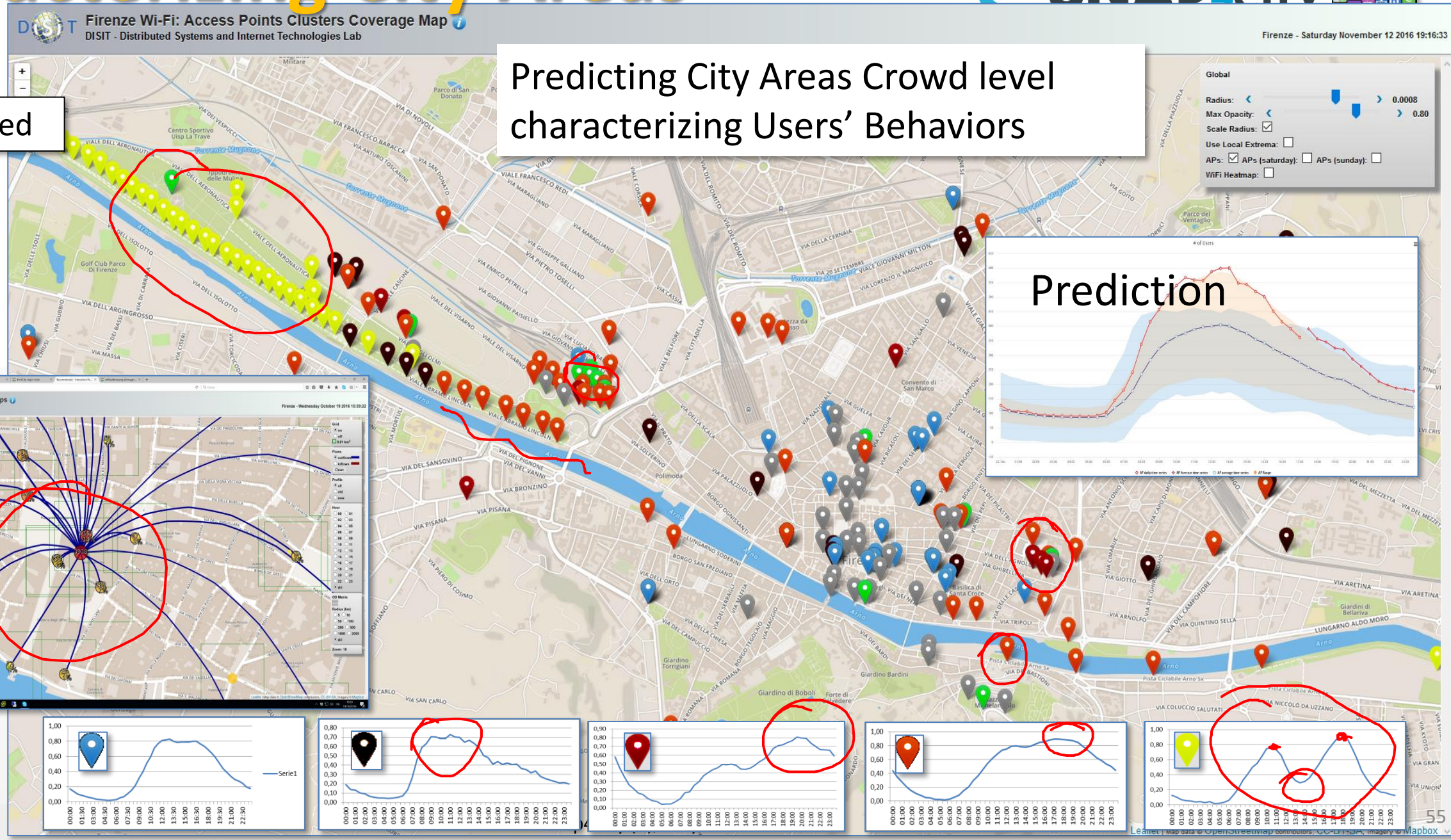

11 SUSTAINABLE CITIES AND COMMUNITIES



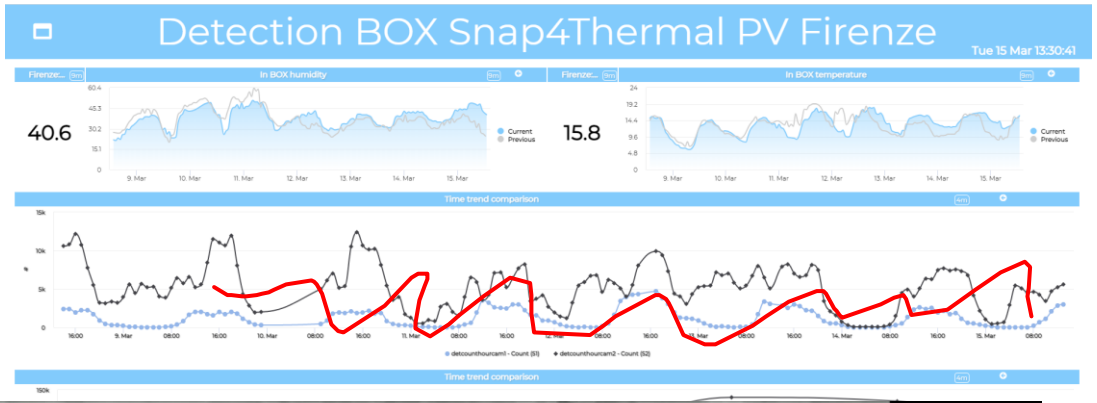
# Characterizing City Areas

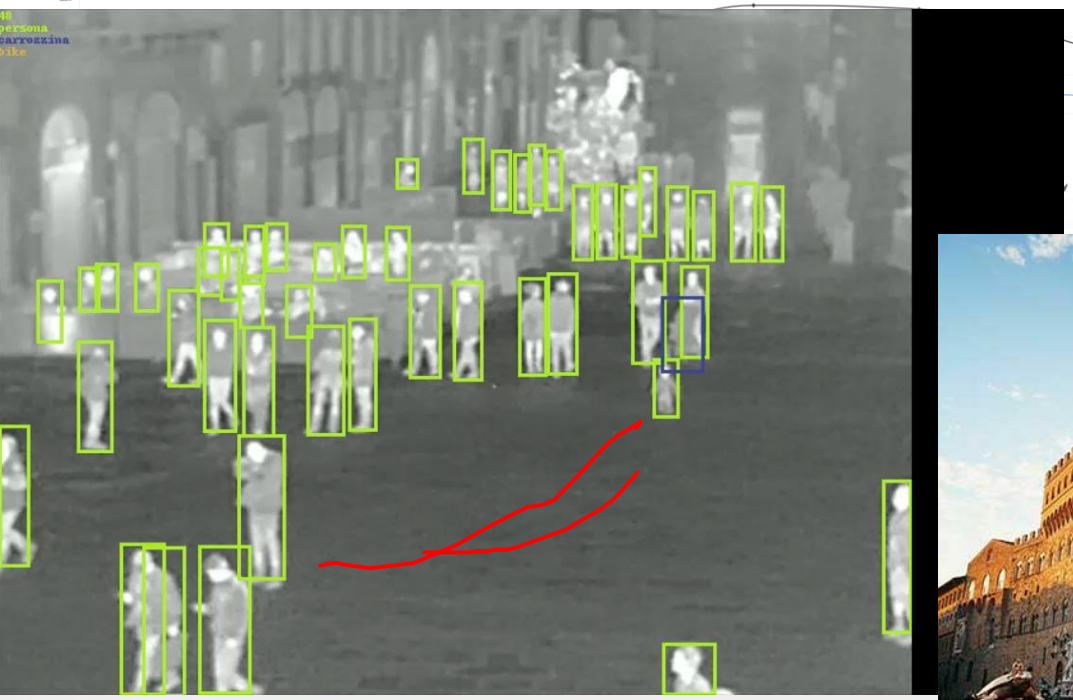
Wi-Fi based

Predicting City Areas Crowd level characterizing Users' Behaviors



# A view and data from the Thermal Camera

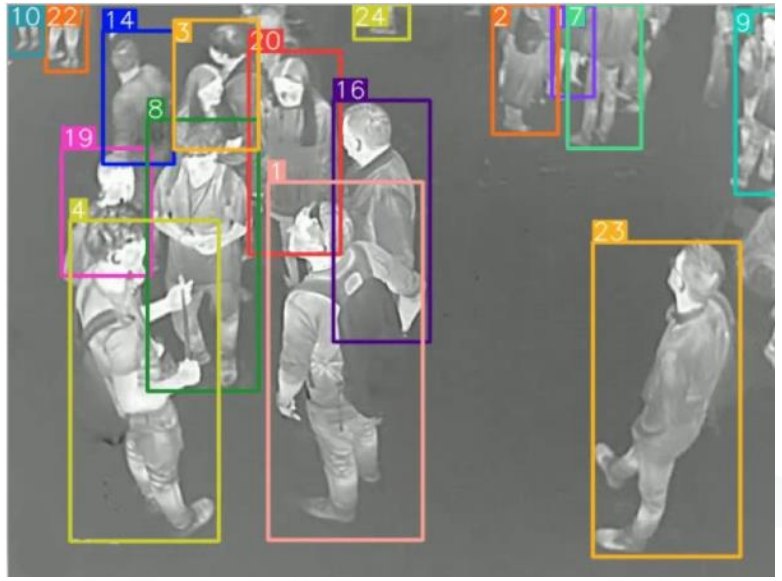


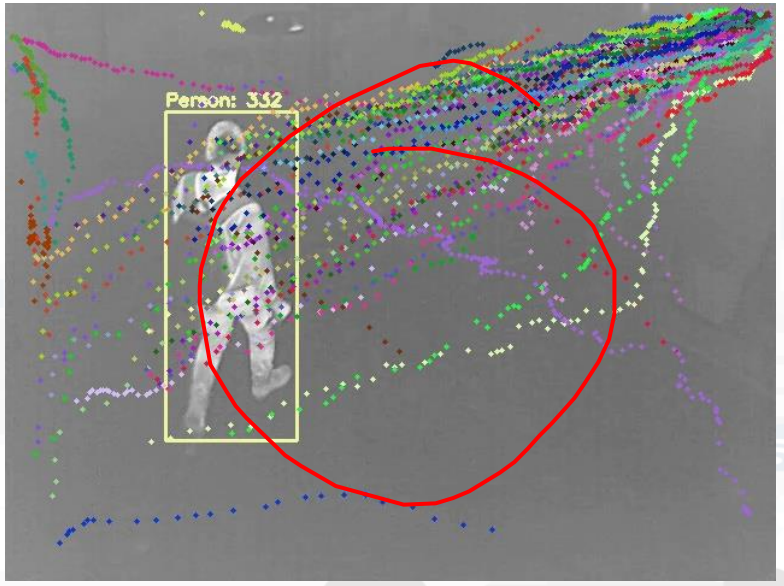





11 SUSTAINABLE CITIES AND COMMUNITIES

# People Counting and Tracking

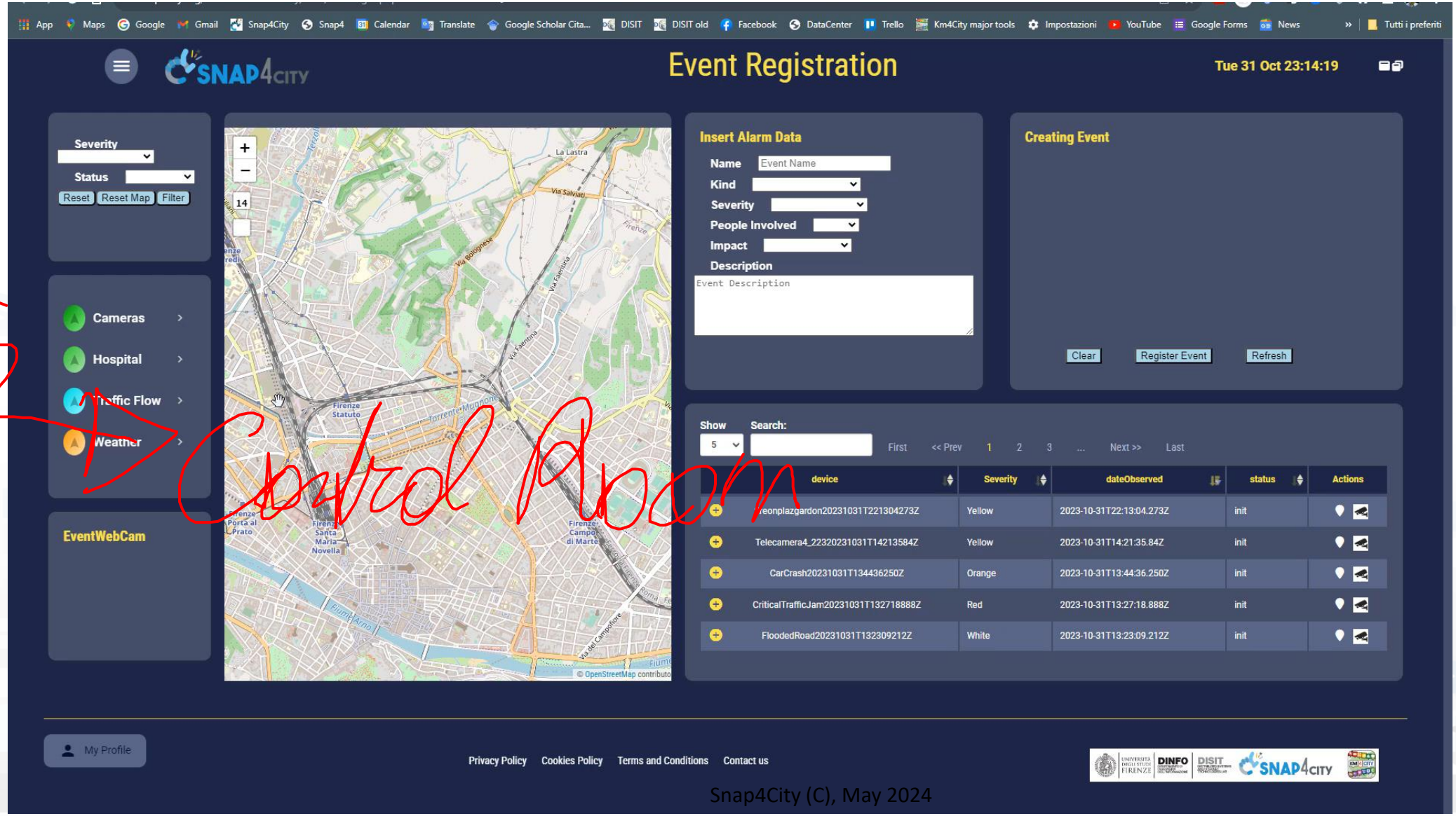



11 SUSTAINABLE CITIES AND COMMUNITIES

3X

# Event Management



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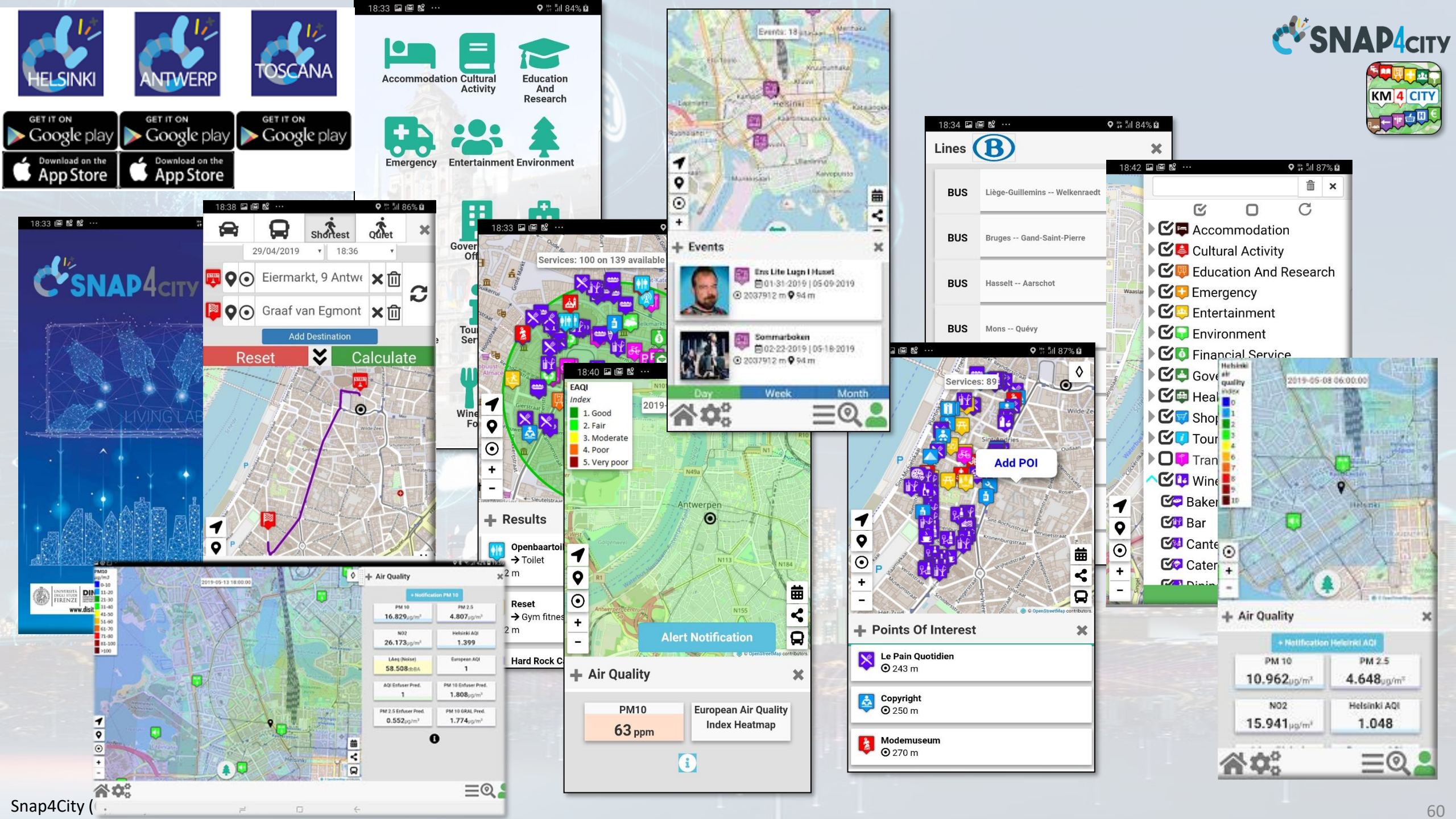
# Engaging via Mobile Apps


FROM CITY DASHBOARD TO APPLICATIONS

SNAP4CITY AND KM4CITY PROJECTS

SNAP4CITY THE VIEW OF THE ADMINISTRATORS

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

# Citizen Engagement via Mobile Apps

- 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**

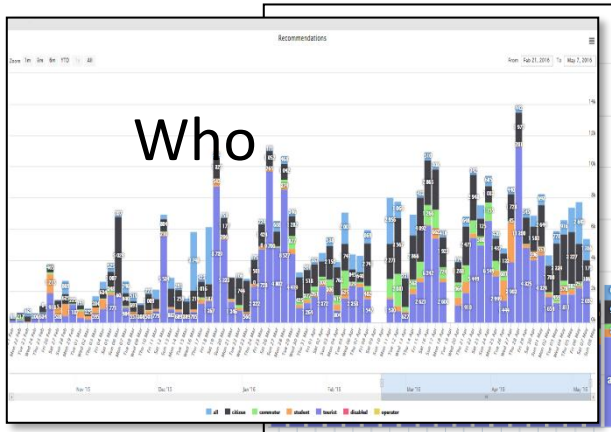
- Trajectories
- Hot Places by click and by move
- Origin destination matrices
- Most interested topics
- Most interested POI
- Delegation and relationships
- Accesses to Dashboards
- **Cumulated Scores from Actions**
- Requested information
- Routing performed
- …..

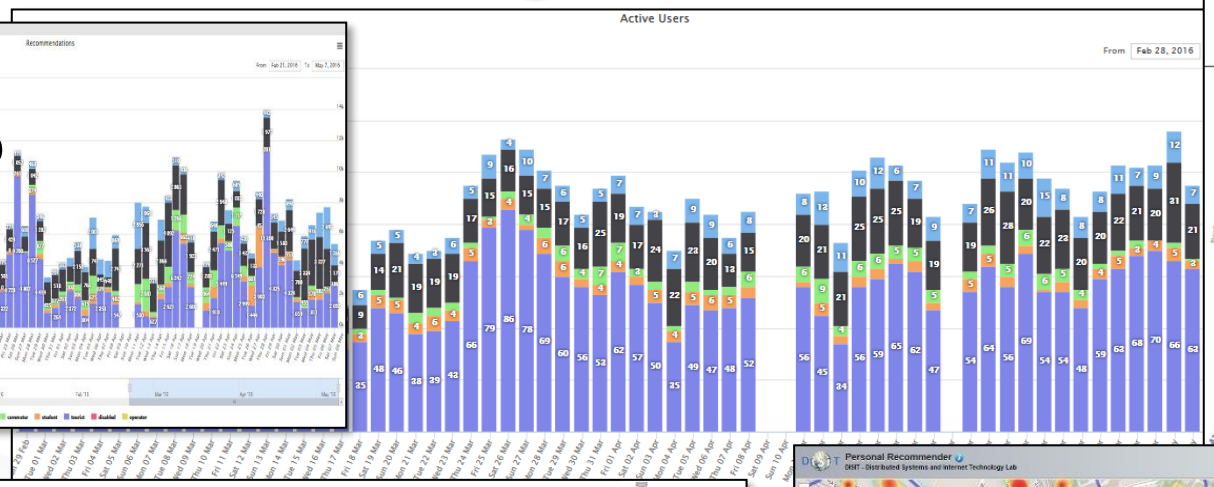
**Produced information**

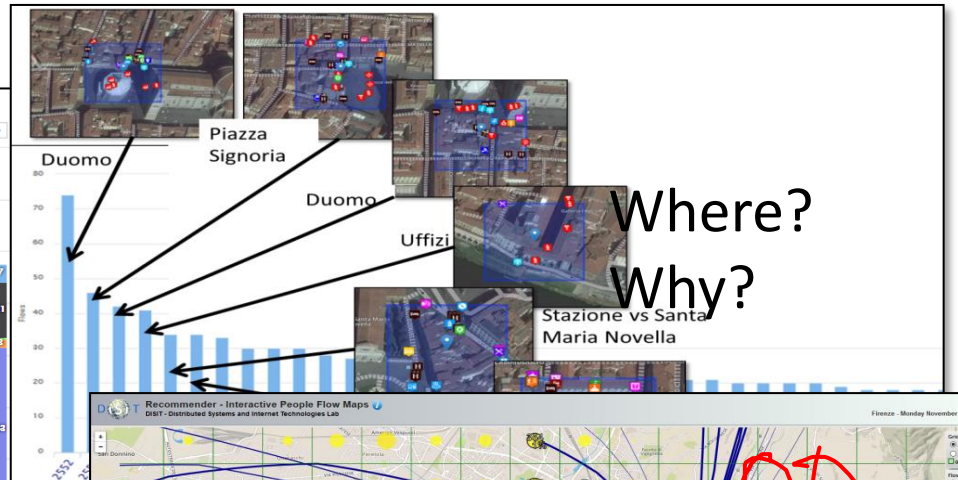
- Suggestions
- Engagements
- Notifications
- …

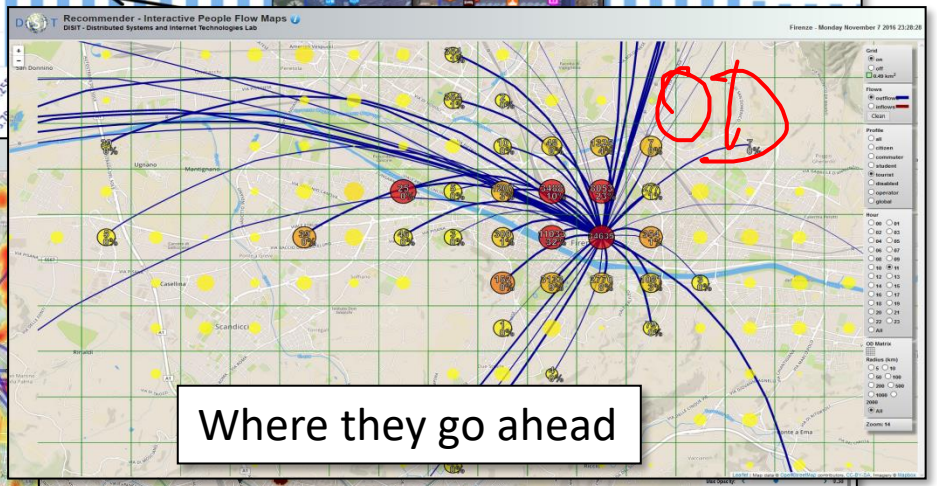
System

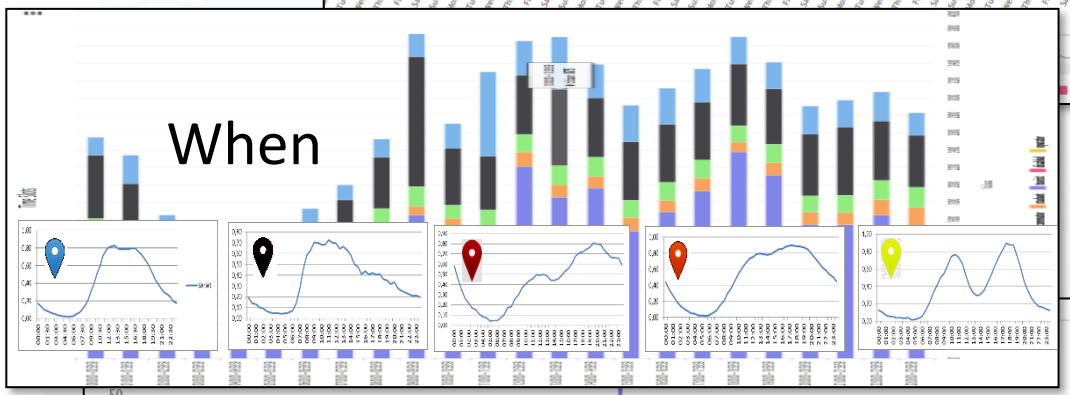
# User Behavior Analyser for Collective Profiling

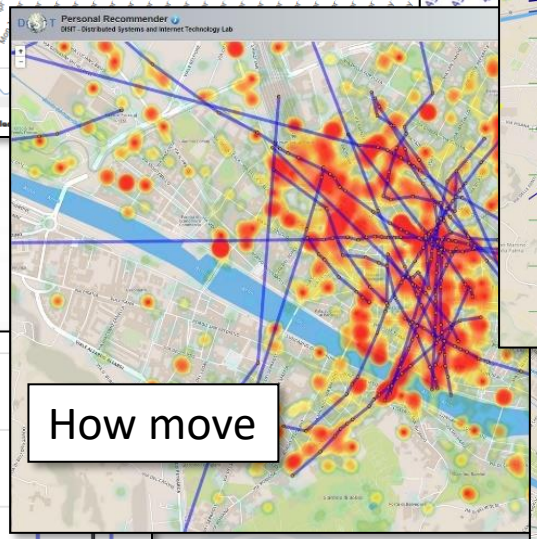


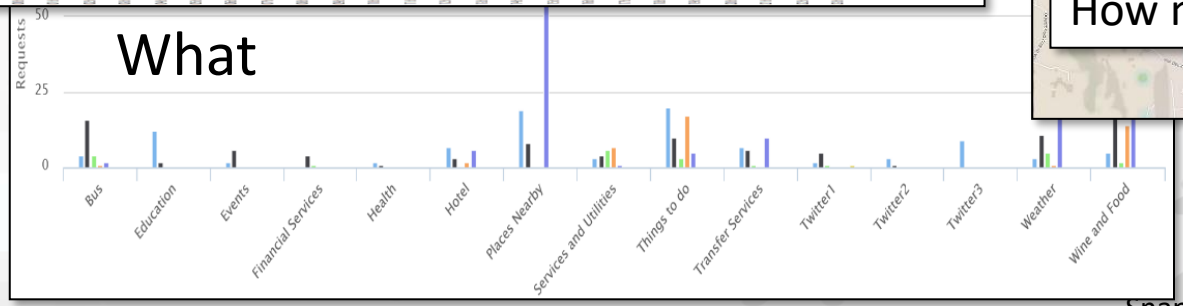



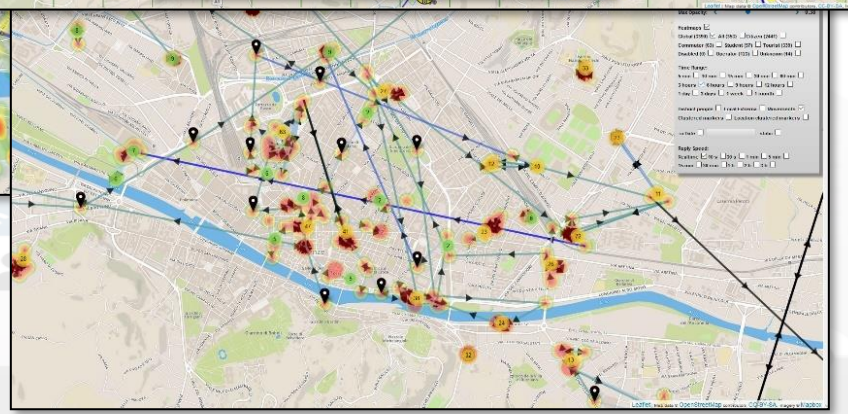



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DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB
DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

7 AFFORDABLE AND CLEAN ENERGY

11 SUSTAINABLE CITIES AND COMMUNITIES

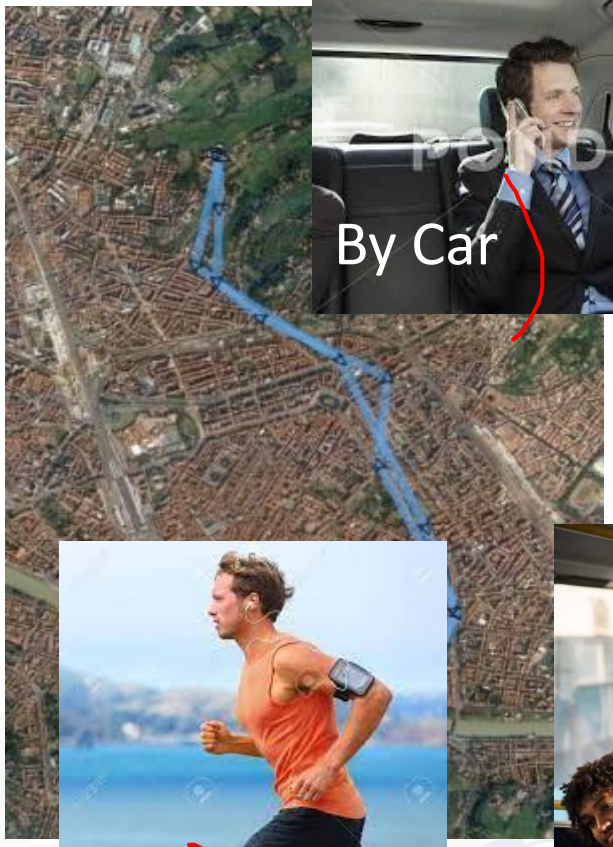
13 CLIMATE ACTION

SNAP4CITY

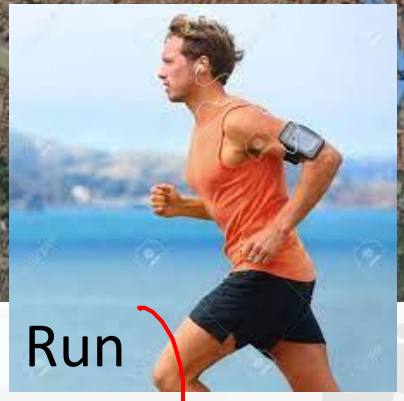
KM4CITY

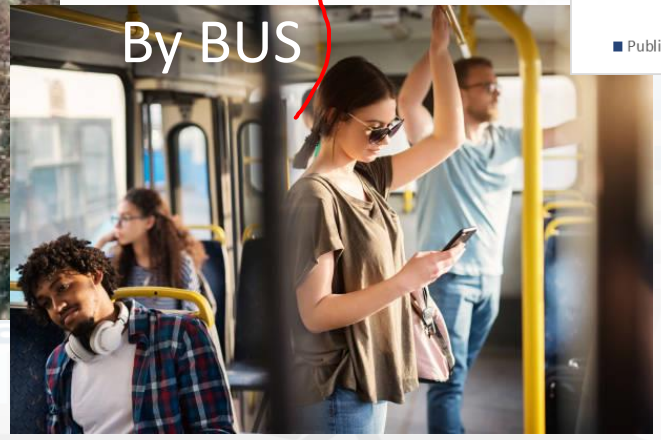
# To propose suggestions and Engage city user

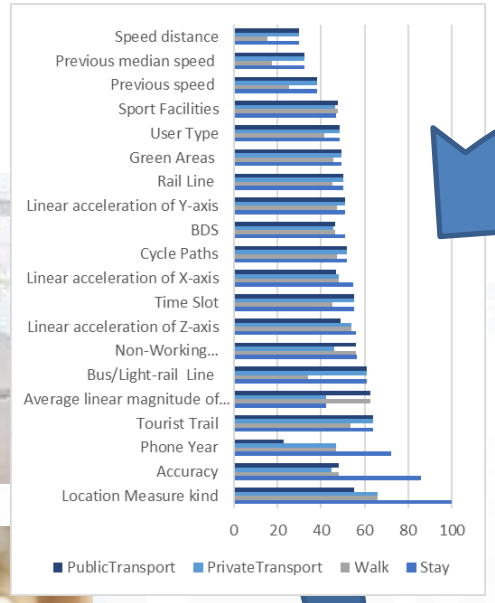
## *we need to know how they are moving*





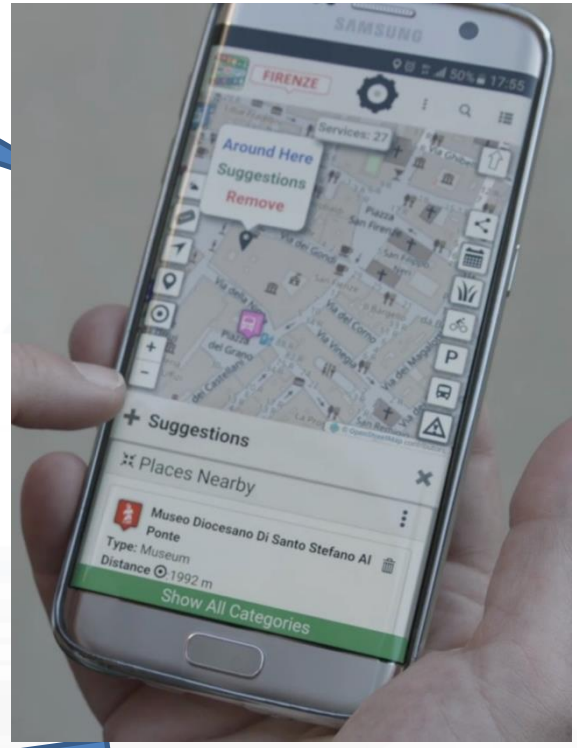


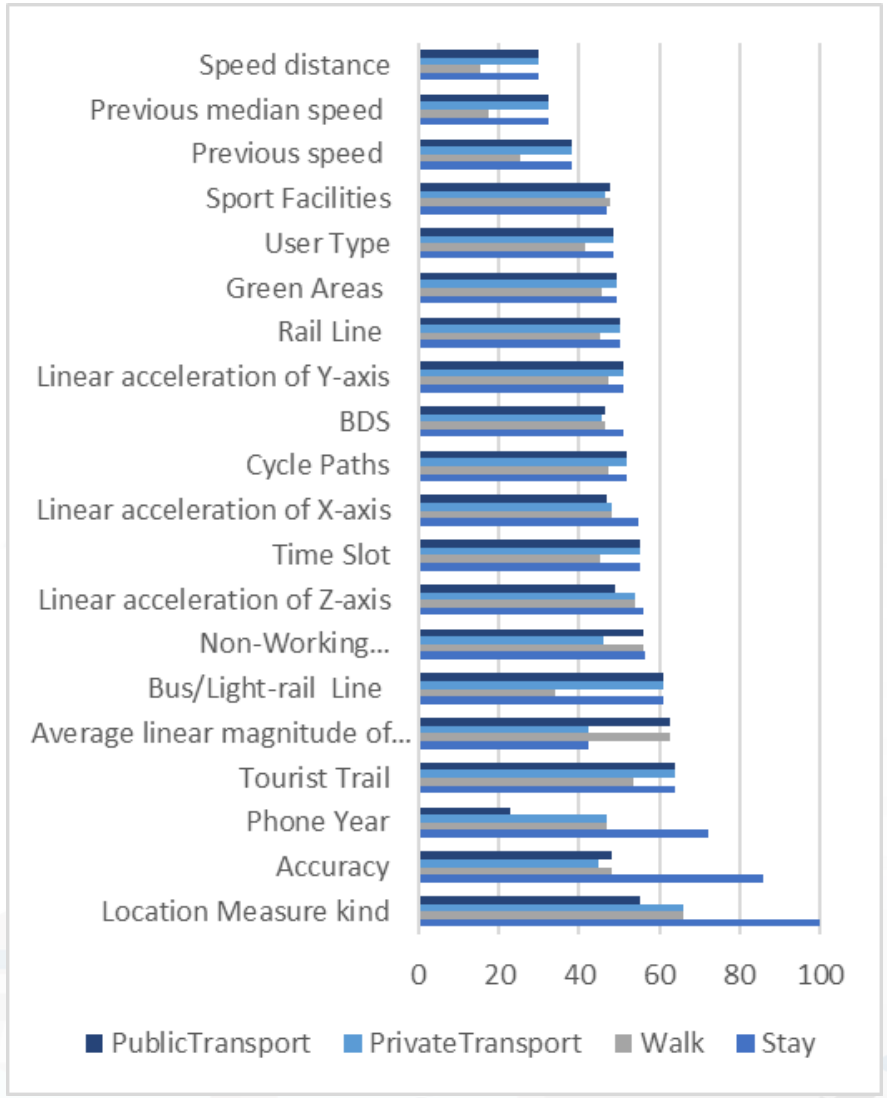




Artificial Intelligence Classification

Suggestions






# Feature relevance

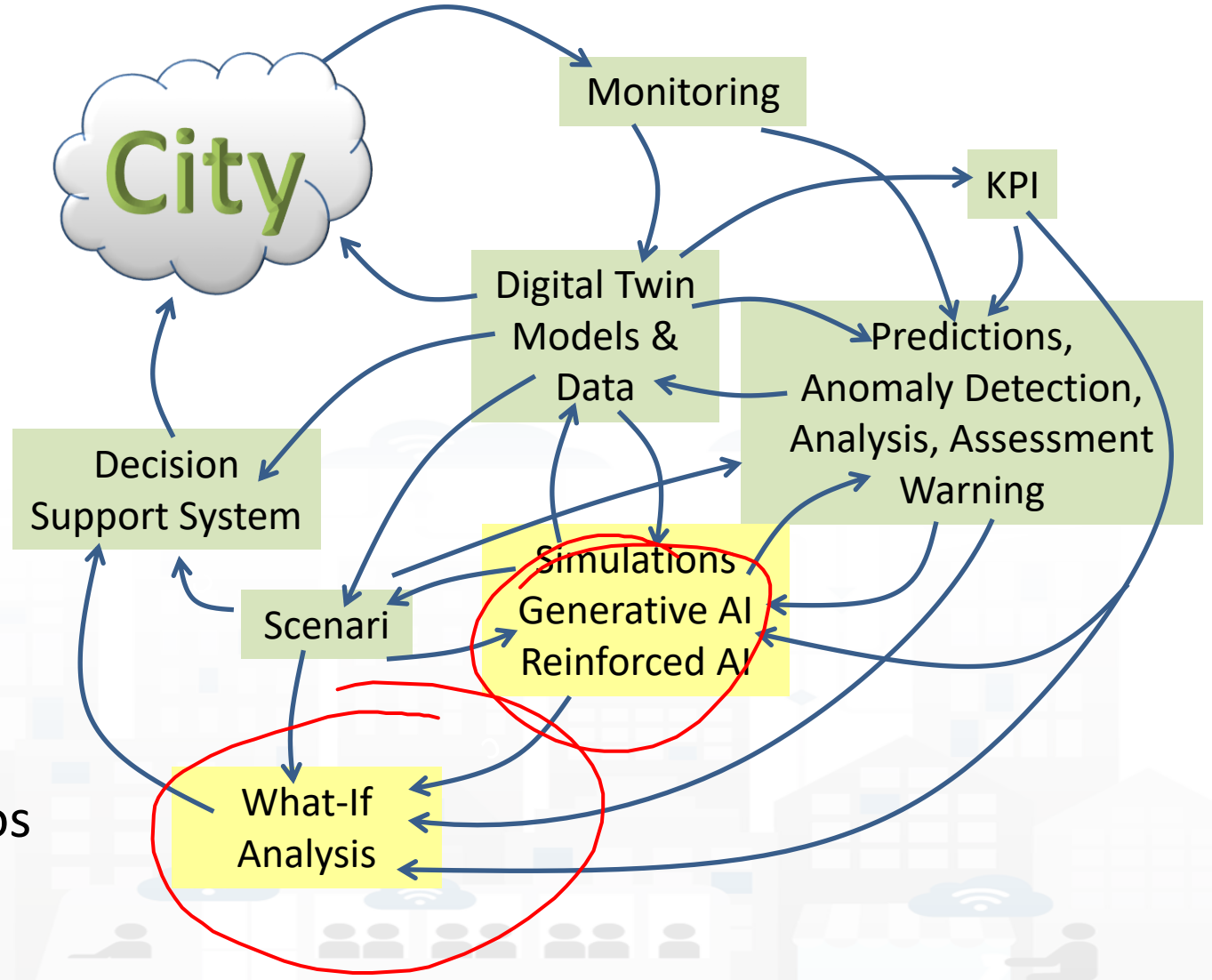
| Model features categories | Extra Tree Model results | | | |
|---|---|---|---|---|
| | Accuracy % | Precision % | Recall % | $F_1$ Score |
| Baseline and GPS | 91.0 | 68.2 | 75.1 | 0.714 |
| Baseline and GPS + proximity | 92.4 | 73.9 | 69.1 | 0.715 |
| Baseline and GPS + proximity + Accelerometer | 92.6 | 81.4 | 74.4 | 0.777 |
| Baseline and GPS + proximity + Temporal window | 94.9 | 80.5 | 78.7 | 0.787 |
| Baseline and GPS + proximity + Accelerometer + Temporal window | 95.3 | 82.7 | 86.9 | 0.847 |

# Decision Support System: Immediate response and Tactic and Strategic Plans, via What-if Analysis

TOP

# Main tasks

- **Controlling Status: management, and operational**
  - Monitoring via KPI
  - Computing predictions vs KPI
  - Anomaly detection
  - Neuro-Symbolic analysis
  - Risk assessment
  - Early warning on critical conditions
- **Making plan: tactic and strategic, medium and long range, micro/macro**
  - Simulation & predictions
  - Generative AI Prescriptions, scenarios
  - Resilience to Unexpected unknows
  - What-if analysis wrt scenarios



# Key Performance Indicators, KPI



| 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) |
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| $NO_2$ | 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 | |

- **United Nations Sustainable Development Goals, SDGs** (for which cities can do more to achieve some of the 17 SDGs, https://sdgs.un.org/goals);
- **15 minutes cities** (where primary services must be accessible within 15 minutes on foot);
- **objectives of the European Commission** in terms of pollutant emissions for: NO2, PM10, PM2.5 (https://environment.ec.europa.eu/topics/air_en);
- **SUMI: mobility and transport vs env**
  - https://www.snap4city.org/951
- **SUMP/PUMS: mobility and transport vs env.**
- **ISO indicators:** city smartness, digitization, tech level.
- **Low Level/Real Time:** global traffic, quality of service, betweenness, centrality, queue, time to travel, etc.

Global & Local

Periodic & Realtime

SUSTAINABLE DEVELOPMENT GOALS


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


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


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



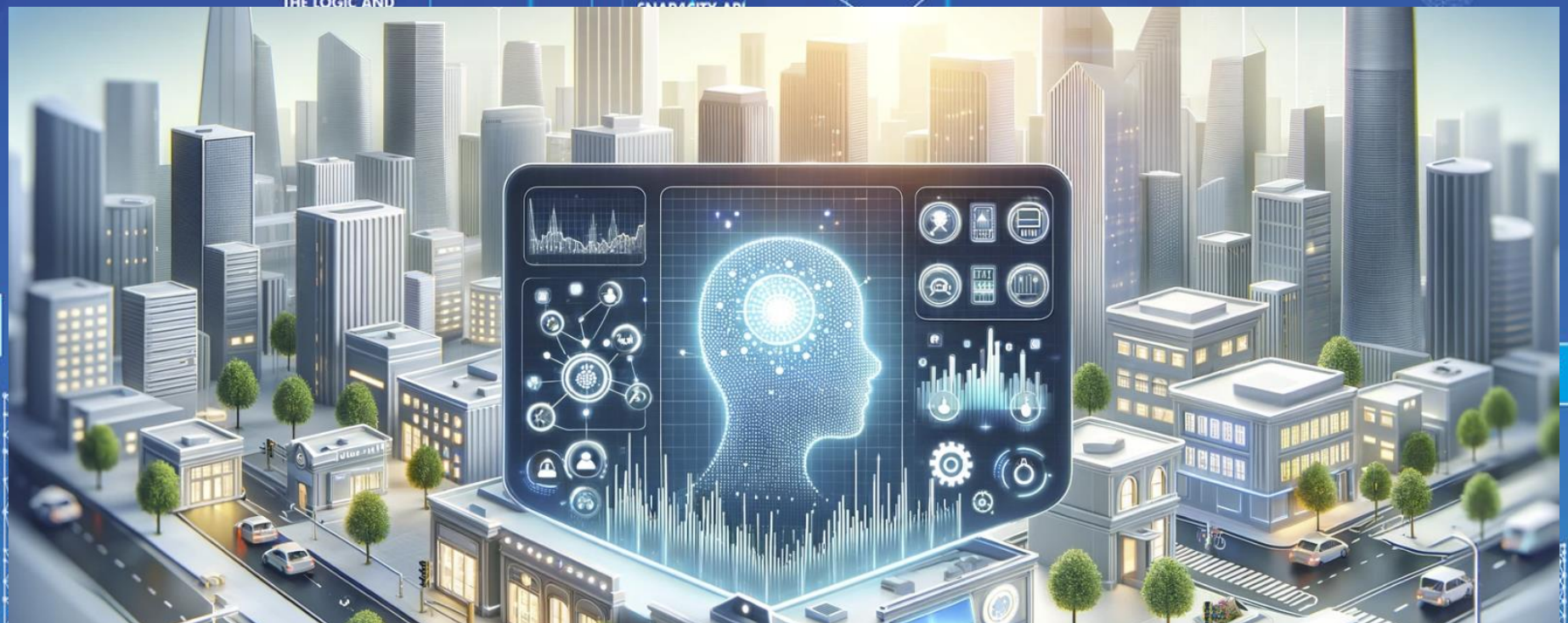
- Monitoring and Predicting: NO2, NOX, CO2, Traffic flow, pollutant, landslide, waste, etc.
- Traffic flow reconstruction
- Demand vs Offer of Mobility analysis


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


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


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

# Data Analytic Artificial Intelligence, XAI, Machine and Deep Learning



# Available AI Solutions on Snap4City

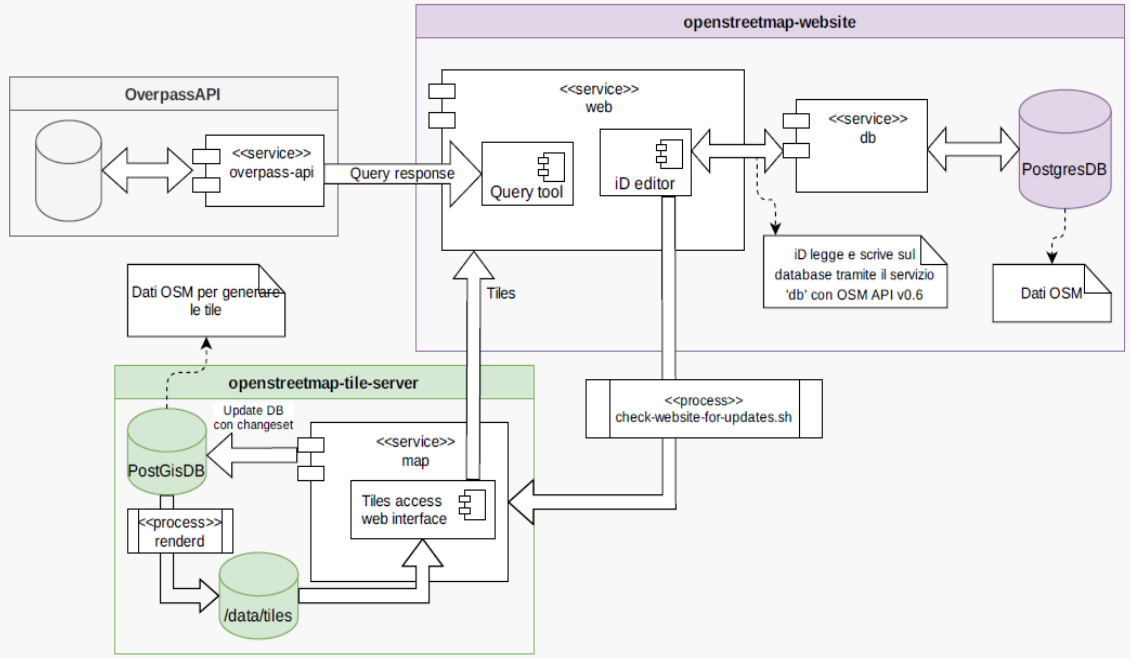
- Mobility and Transport
- Environment, Weather, Waste, Water
- City Users Behaviour and Social analysis
- Energy and Control, Security, …..
- Tourism and People
- Security and Safety
- High Level Decision Support Solutions
  - Asset management
  - Resilience and Risks Analysis
- Low level Techniques

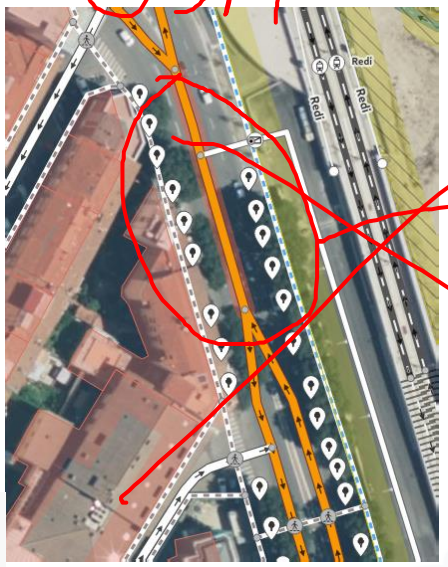

https://www.snap4city.org/download/video/DPL_SNAP4SOLU.pdf

https://www.snap4city.org/download/video/course/p4/

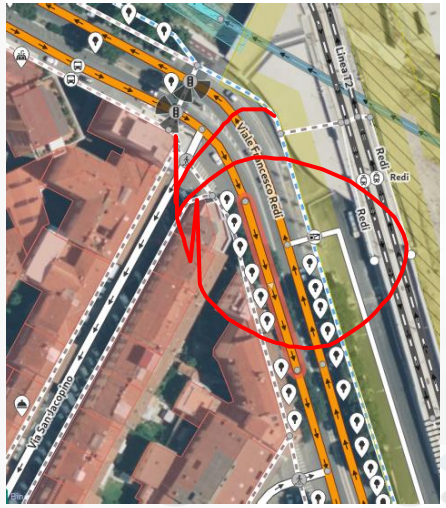
# Tactic and/or Strategic Planning

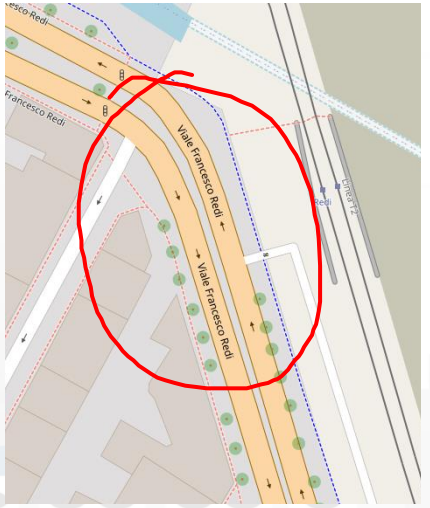
**Correction of road graphs which is present on OSM**




OSM data with non clear double bidirection lane on Viale Redi, Florence.
Editing OSM data and present Tiles






After Corretion of OSM data defining a clear double bidirection lane on Viale Redi, Florence.
Regeneration of the TILEs for the maps

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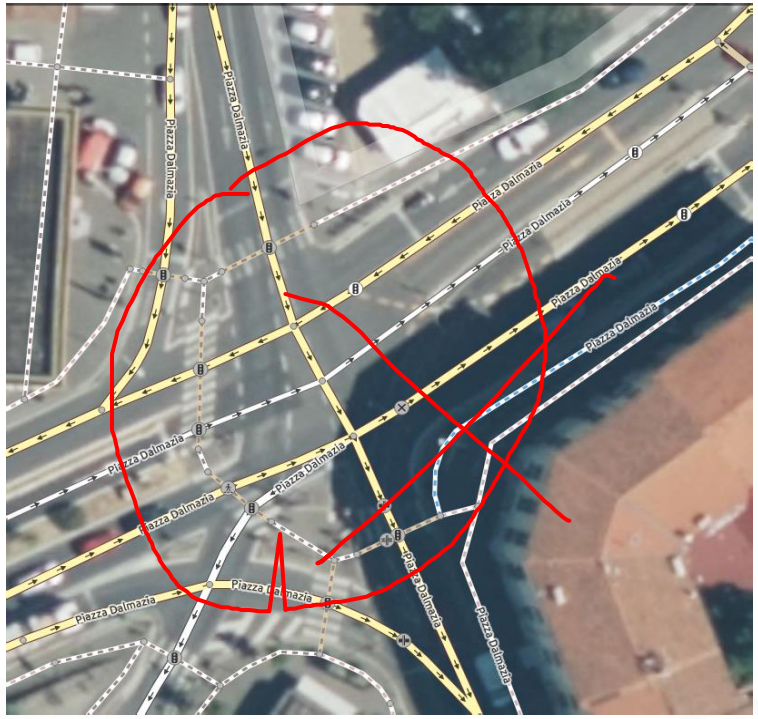
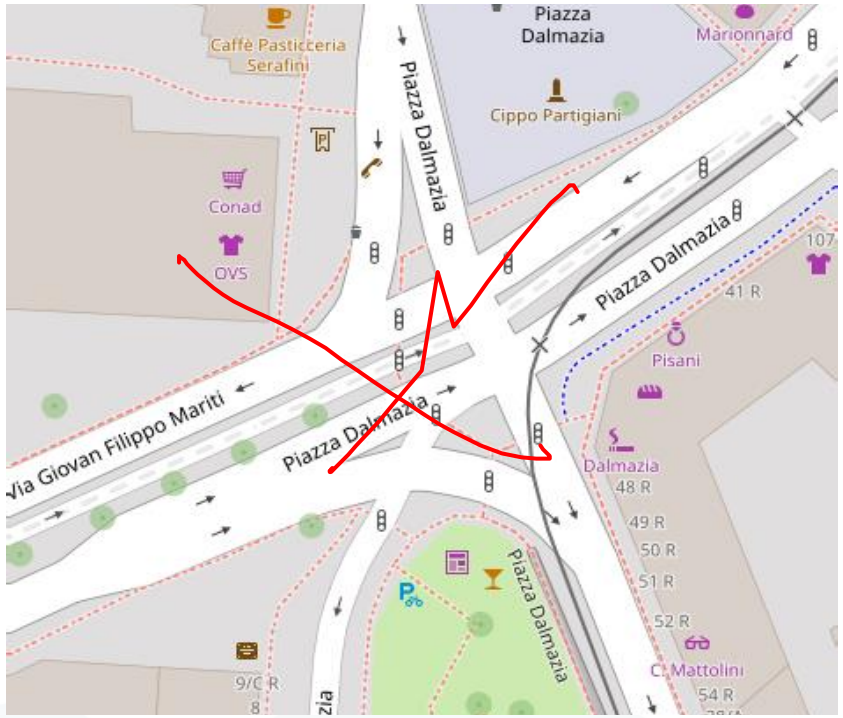
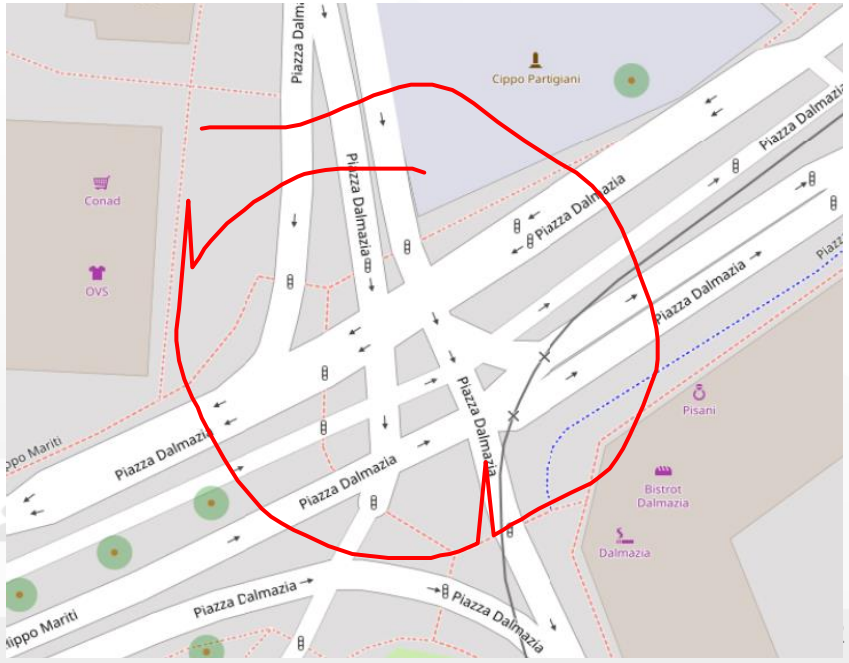
OSM data with non correct viability in Piazza Dalmazia, Firenze

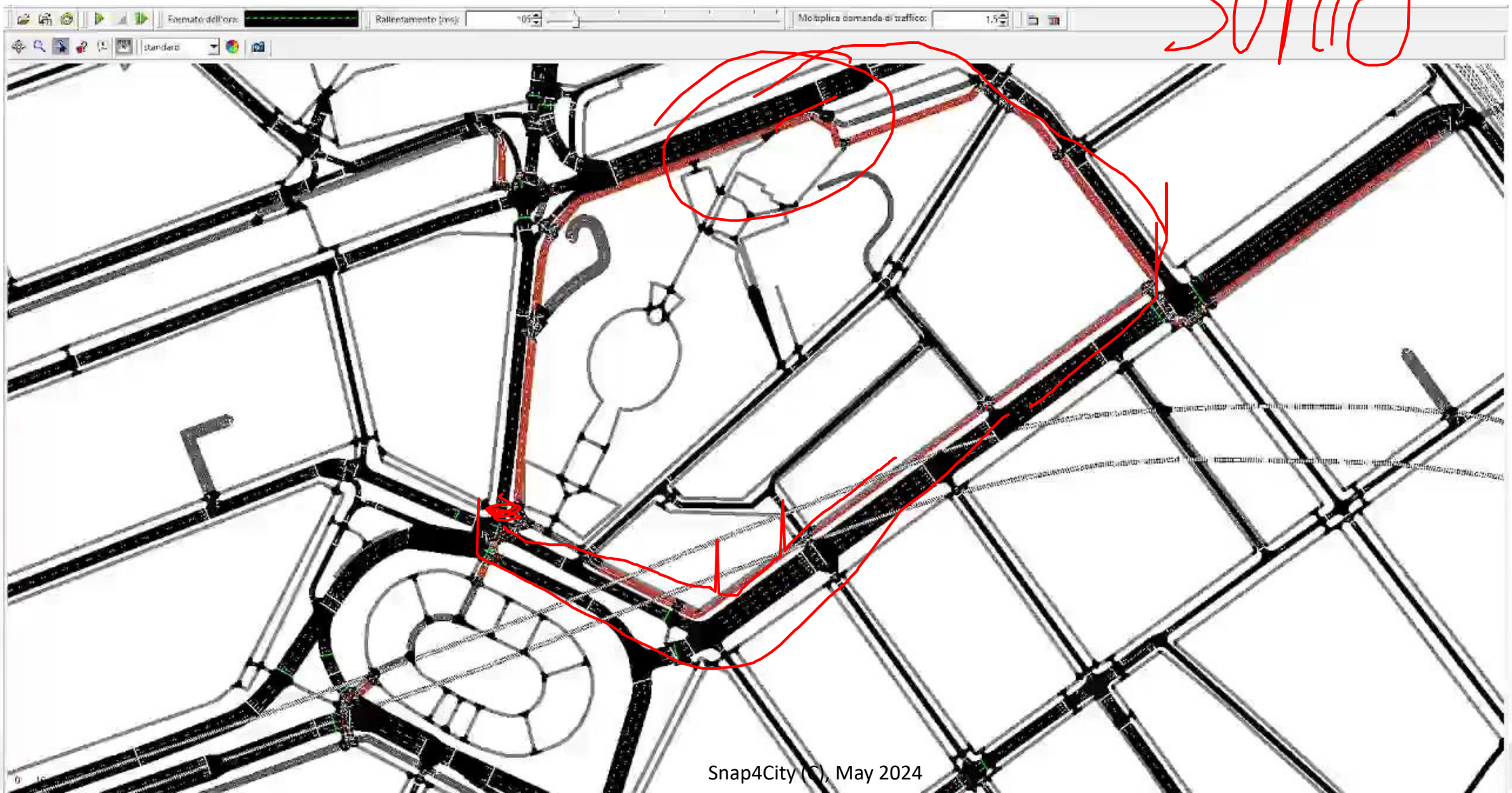





After Correction of OSM data defining a correct viability of Piazza Dalmazia, Florence. Regeneration of the TILEs for the maps



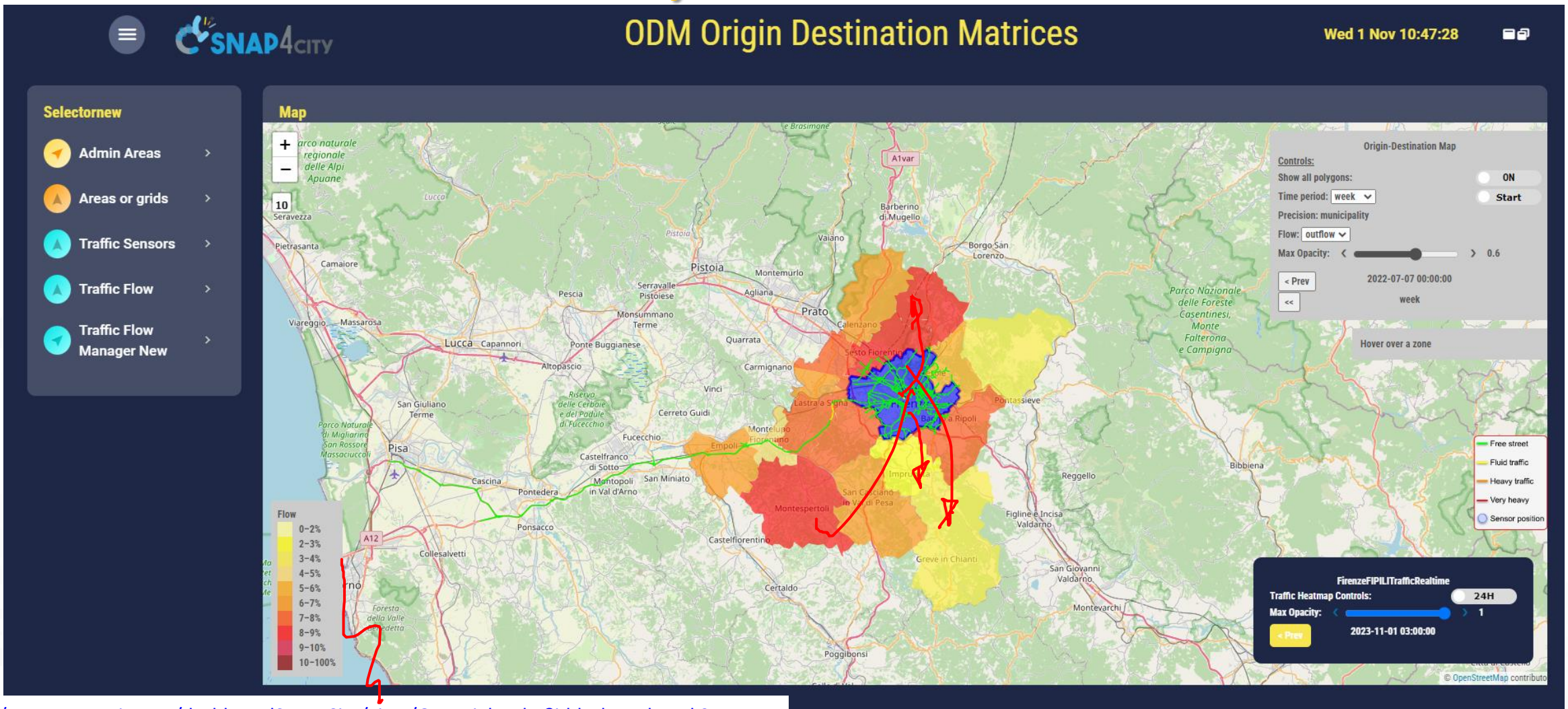
# Micro Simulation



# Mobility and Transport

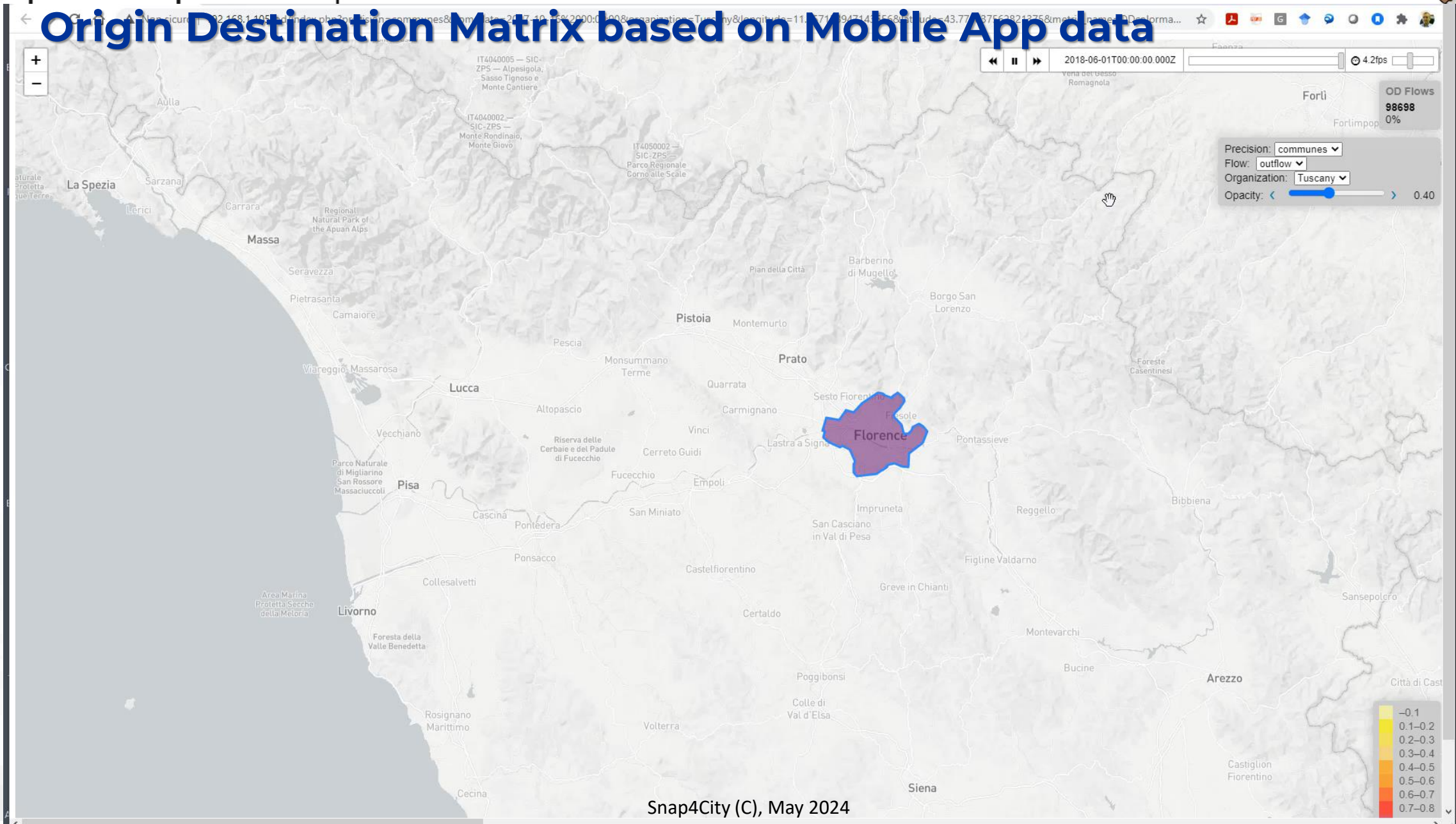
- **Predictions** for: traffic flow, smart parking, smart bike sharing, people flows, etc. (ML, DL)
- **What if analysis**: routing, traffic flow, demand vs offer, pollutant, etc. (Simulation + ML)
- **Traffic flow reconstruction** from sensors and other sources (simulation + ML)
- **Public Transportation**: Ingestion and modelling of GTFS, Transmodel, NeTEx, etc. (DP)
  - 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. (DP)
- **Routing** and multimodal routing (multistop travel planning), constrained routing, dynamic routing (DA)
- Computing **Origin Destination Matrices** from different kind of data (analysis, DP, DP)
- Computing **typical trajectories** on the basis of tracks (analysis, ML)
- Computing Messages for Connected drive (DP)
- Slow and Fast Mobility **15 Minute City Indexes** (analysis, DP, …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
- Computing **SUMI, PUMS**, etc. (mainly DP)
- **Definition of Scenarios:** traffic, road graph, conditions, etc.
- Etc.

# ODM, Traffic Flow



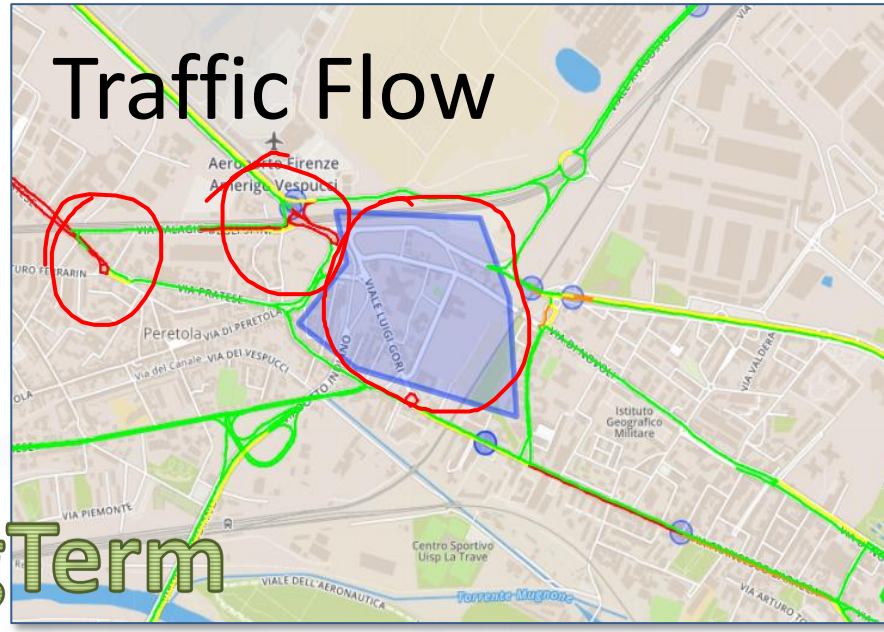

https://www.snap4city.org/dashboardSmartCity/view/Gea-Night.php?iddasboard=Mzk3Nw==

# Origin Destination Matrix based on Mobile App data



# Decision Support Systems, What-if

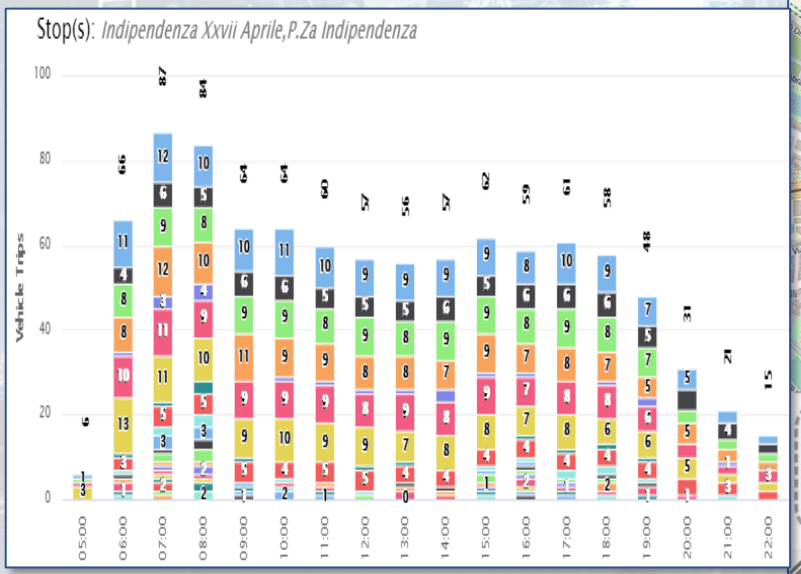
- **Event planning, via what-if analysis**
  - Change in the graph structure of the city
  - Impact on the flow of people and vehicles
  - Adaptation: public transport, traffic, pedestrian management, etc.
- **Immediate reaction to natural events or not**
  - Everything is ready and updated in real time
  - 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

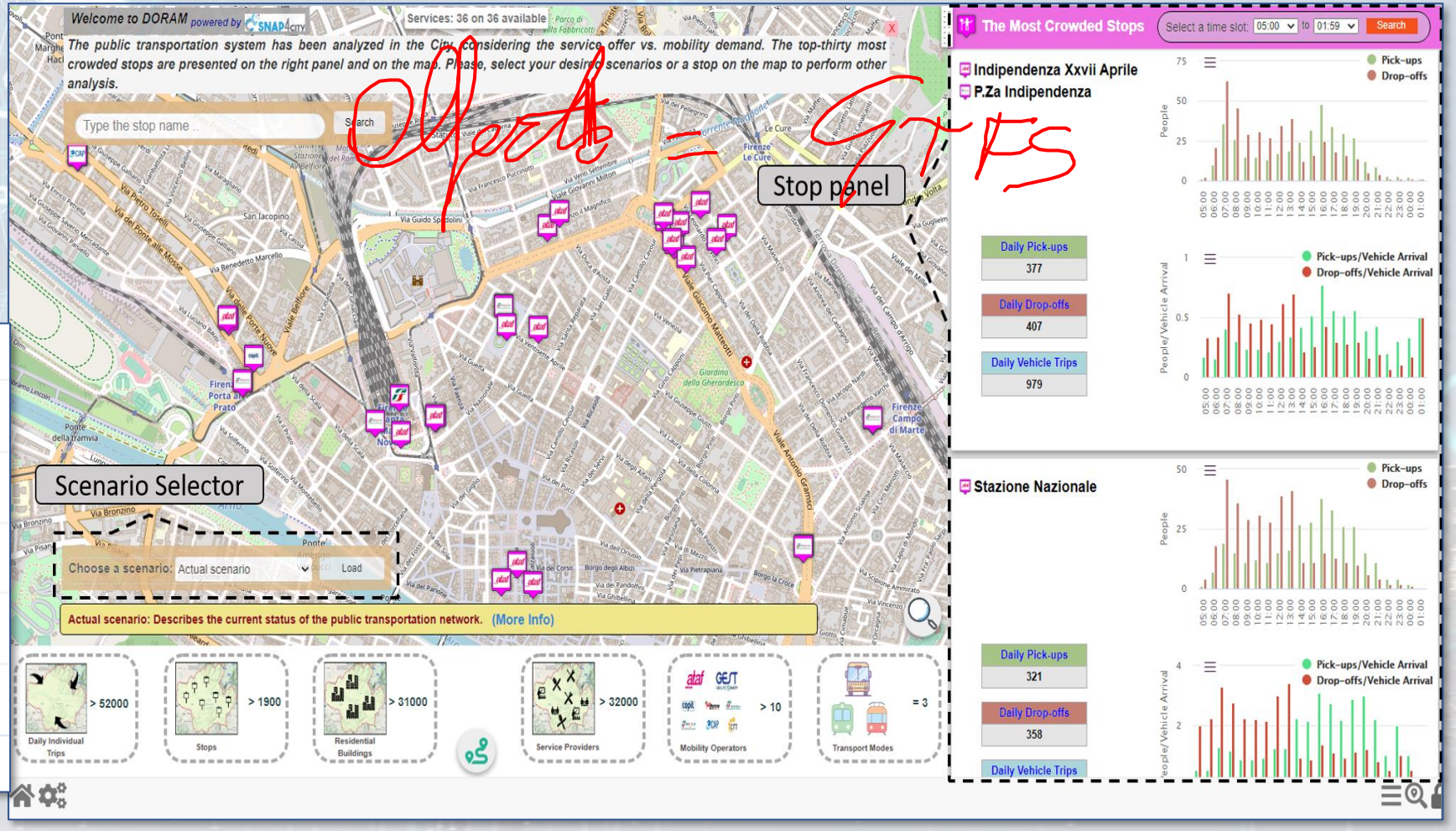



# What-if Analysis on Pub Transport

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

## Public Services



# Environment and Weather

- **Pollutant Predictions: short, long and very long term** European Commission KPIs
  - NOX, PM10 pollution on the basis of traffic flow, 48 hours (ML, AI, DL)
  - Cumulated NO2 average value over the year, ……. (ML, AI, DL)
- **Computation of CO2** on the basis of traffic flows (DP), computing emission factor (DA)
  - each road for each time slot of the day
- **Prediction of MicroClimate** conditions for diffusion (ML, AI)
  - NO2, PM10, PM2.5, etc.
- **Prediction of landslides**, 24 hours in advance (AI, DL)
- **Heatmaps production**, dense data interpolation (DP) for
  - Weather conditions: temperature, humidity, wind, DEW
  - Pollutants and Aerosol: NO, NO2, CO2, PM10, PM2.5, etc.
- **Impact of COVID-19** on Environmental aspects (DP)
- Optimisation of **waste collection** schedule and paths (DP, ML)
- Computing **SDG, SUMI, PUMS**, .. (mainly DP)
- Etc.

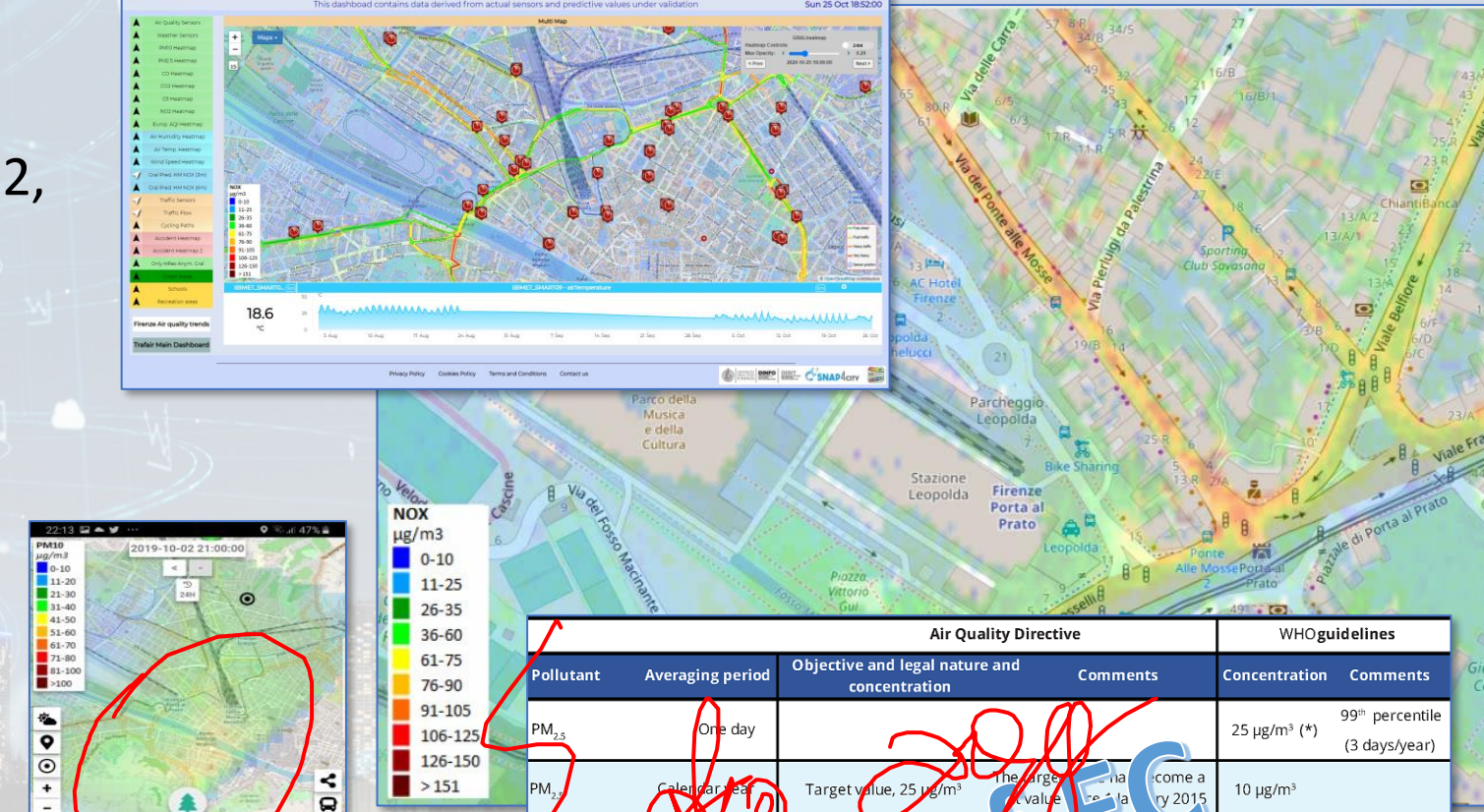
# Environment and Quality of Life
# Air Quality Predictions

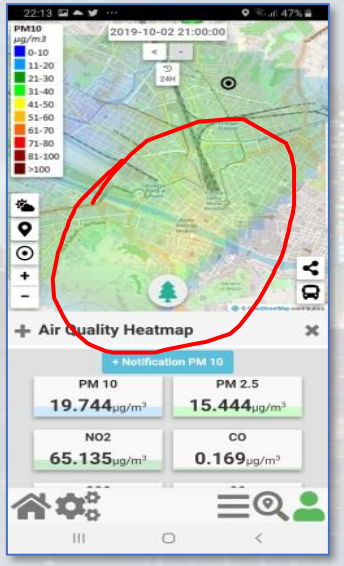
Cities of: Firenze, Pisa, Livorno

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) |
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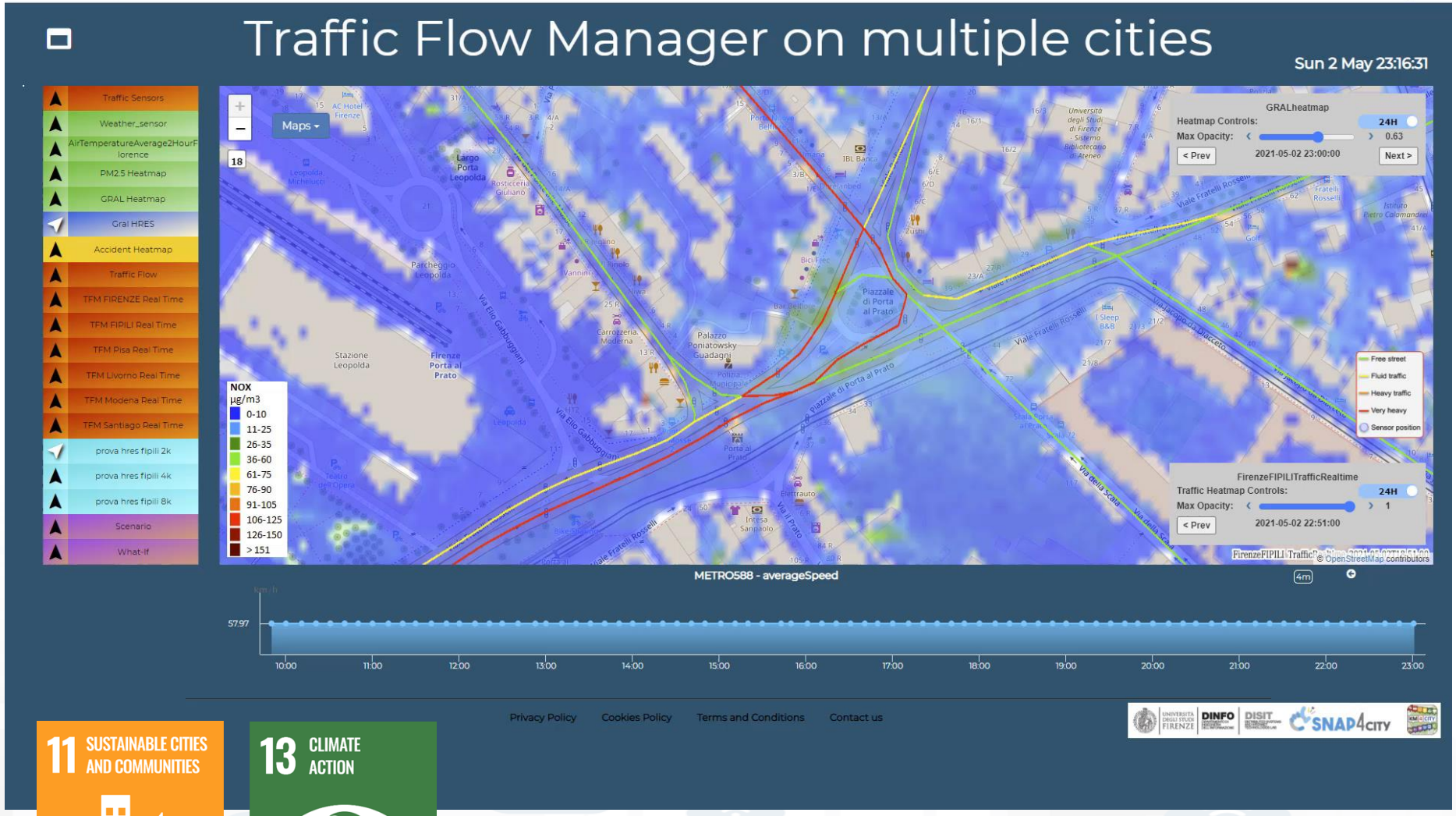
KPI of EC

# Environment



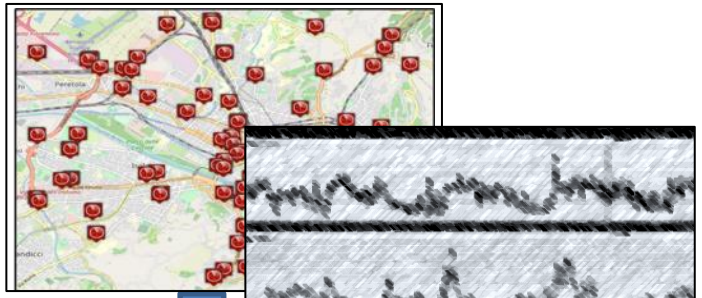
- **Prediction**
  - **NOX Pollutant** diffusion on the basis of Traffic Flow (prediction), weather and 3D structure
  - **NO2 progressive average** (Long term)
- **Project:**
  - **Trafair** CEF EC
  - Mixed solutions of Fluidinamics modeling and AI




11 SUSTAINABLE CITIES AND COMMUNITIES

13 CLIMATE ACTION

# Estimating City Local CO2 from Traffic Flow Data

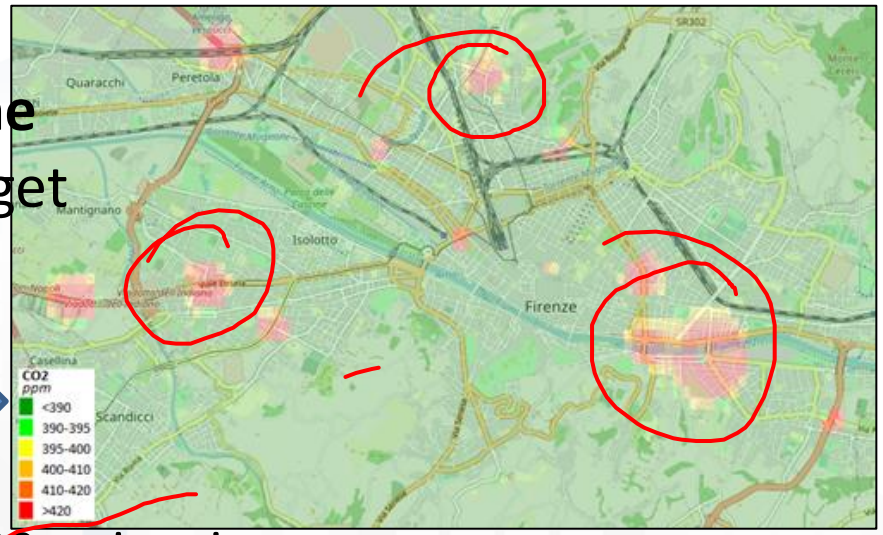


Computing Traffic Flow into CO2 sensor area

Traffic Flow data

- Traffic Flow is one the main source of CO2 **(ton of CO2 x Km x Vehicle)**
  - **K1: Fluid Flow**
  - **K2: Stop and Go**
- **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 Air Quality

- European Air Quality Directive
- Predicting critical days
  - PM10 with an accuracy of more than 90% and precision of 85%;
  - PM2.5 with an accuracy of 90% and precision greater than the 95%.
- Simulating Long terms values
  - For long terms predictions

| | | Air Quality Directive | | WHO guidelines | |
|---|---|---|---|---|---|
| **Pollutant** | **Averaging period** | **Objective and legal nature and concentration** | **Comments** | **Concentration** | **Comments** |
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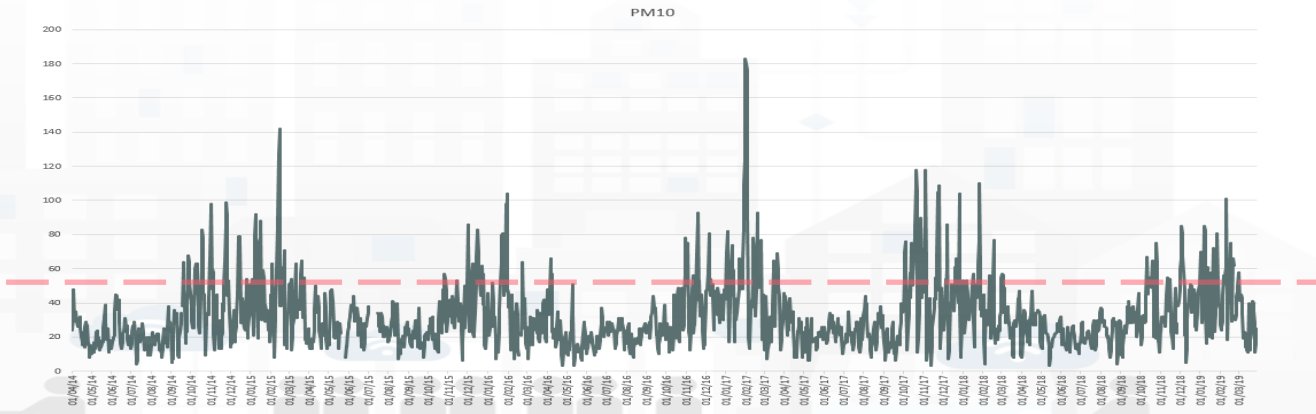
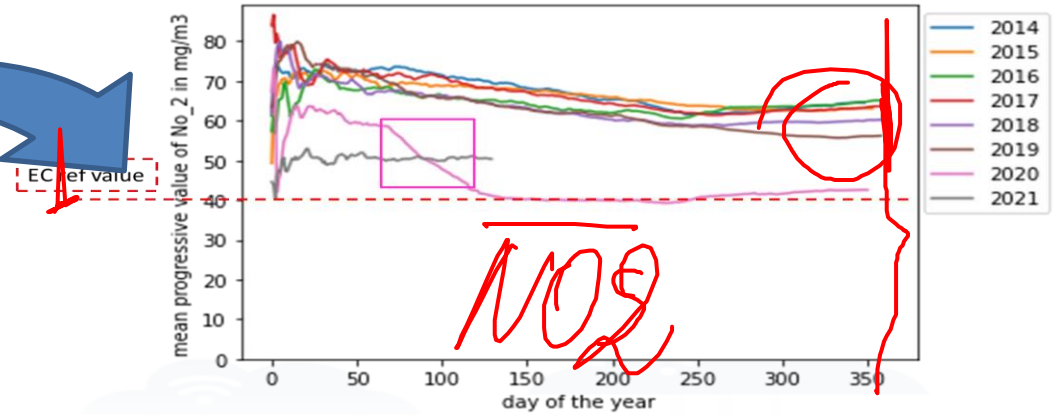
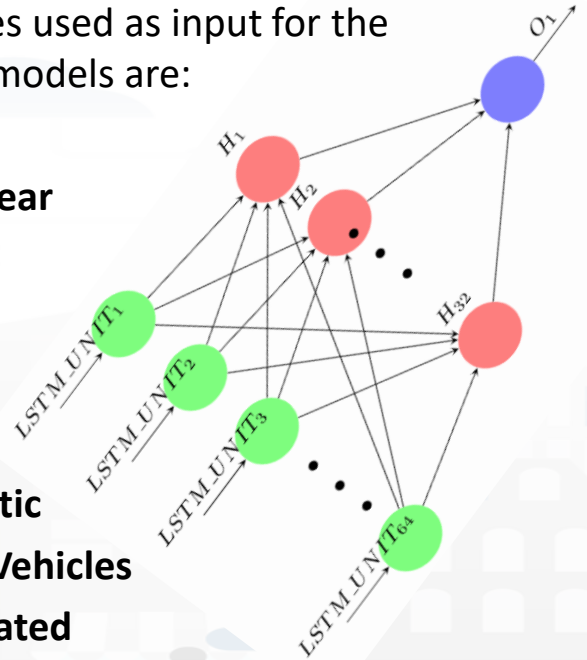


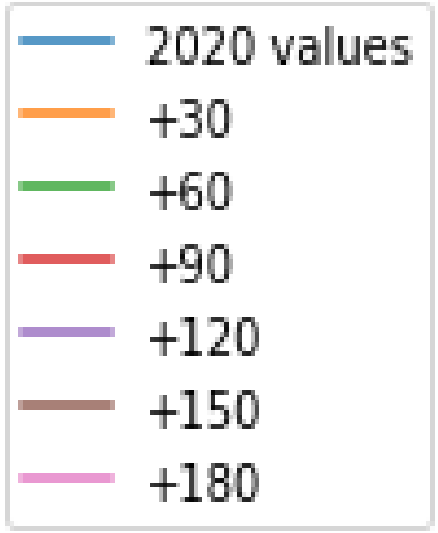
# Predicting EC's KPI on NO2 months in advance

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**



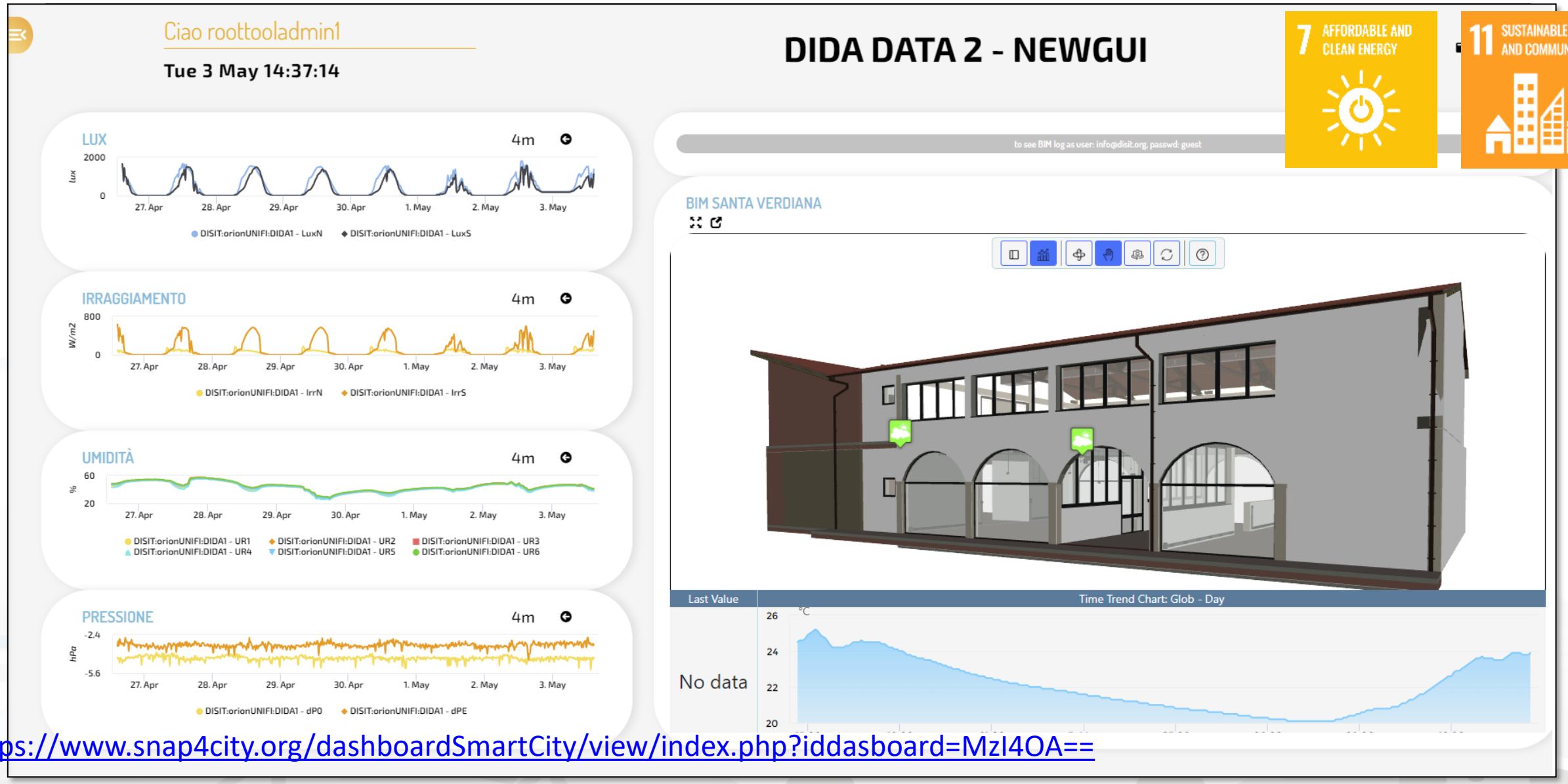

| | Air Quality Directive | | | WHO guidelines | |
|---|---|---|---|---|---|
| Pollutant | Averaging period | Objective and legal nature and concentration | Comments | Concentration | Comments |
| $PM_{2.5}$ | One day | | | 25 µg/m³ (*) | 99th percentile (3 days/year) |
| $PM_{2.5}$ | Calendar year |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

# Smart Buildings, Snap4Building

- **Digital Twin for monitor, control and manage distributed infrastructures**
  - 2D/3D representations of the whole set of buildings, BIM modeling
  - Entities (building, floors, rooms, parking, charging stations, gates, etc.) with their shapes and descriptors, and data monitoring the allocation to office, meeting, cafeteria, storage, stairs, elevator, etc.
- **Monitoring and computing KPI on real time for**
  - **energy** consumed or produced (hot/cold)**, parking, logistic, presences, cleaning, air quality, departments, subareas, maintenance, etc.**
  - **allocation/designation**, dispositions, heating, cooling, temperature, equipment, etc.
  - **grouped in Zones**

# Smart Building

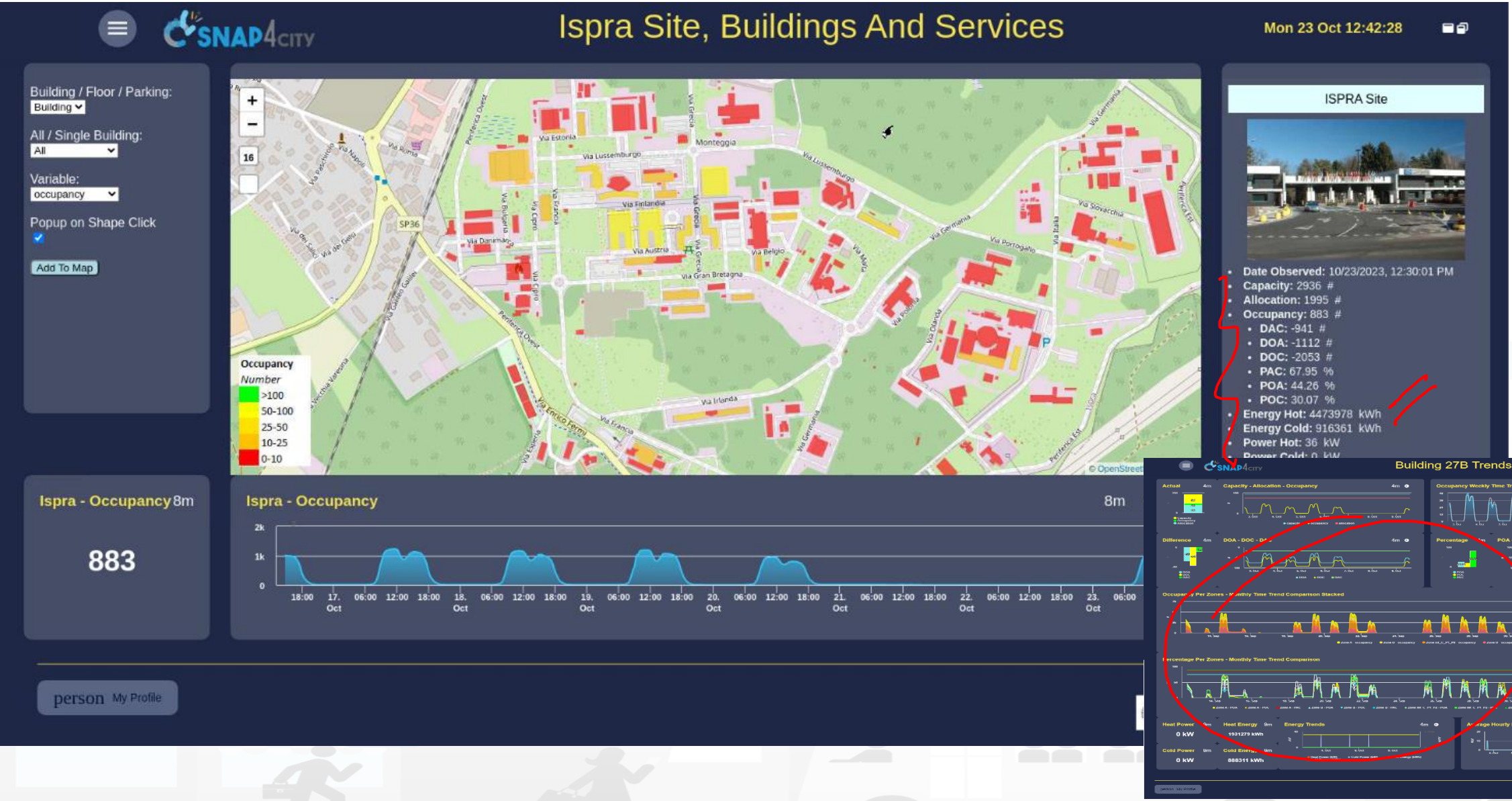





https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzI4OA==

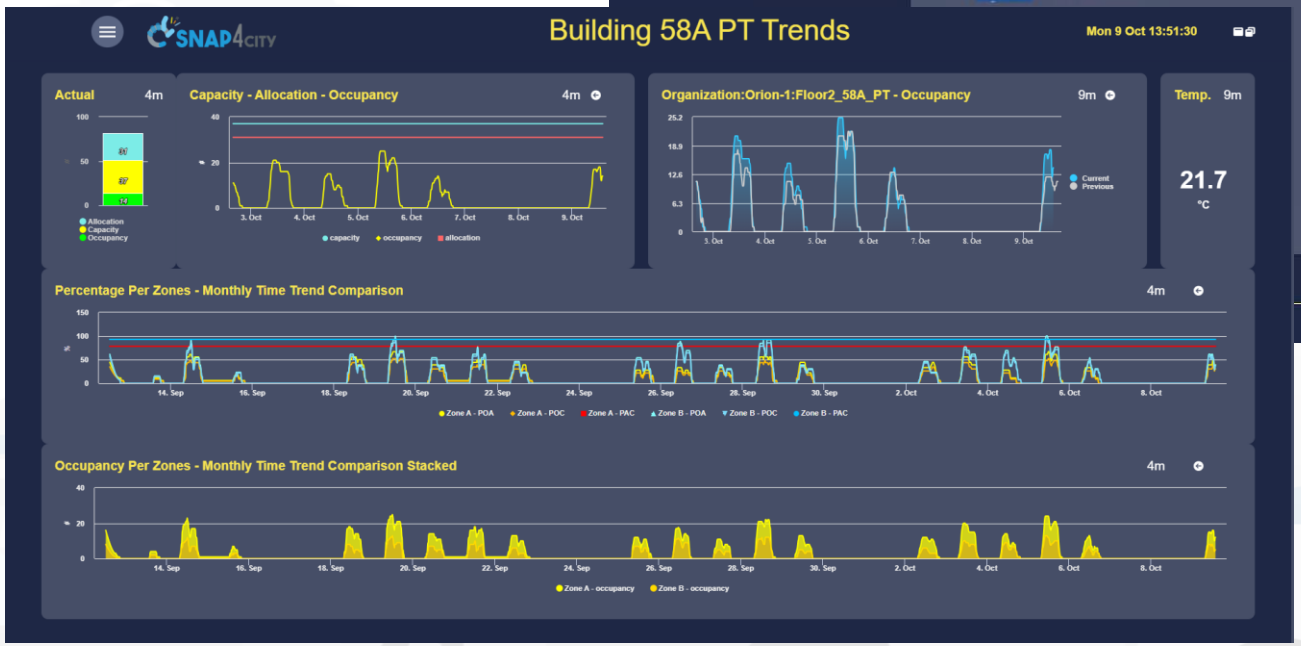
# ISPRA JRC Site





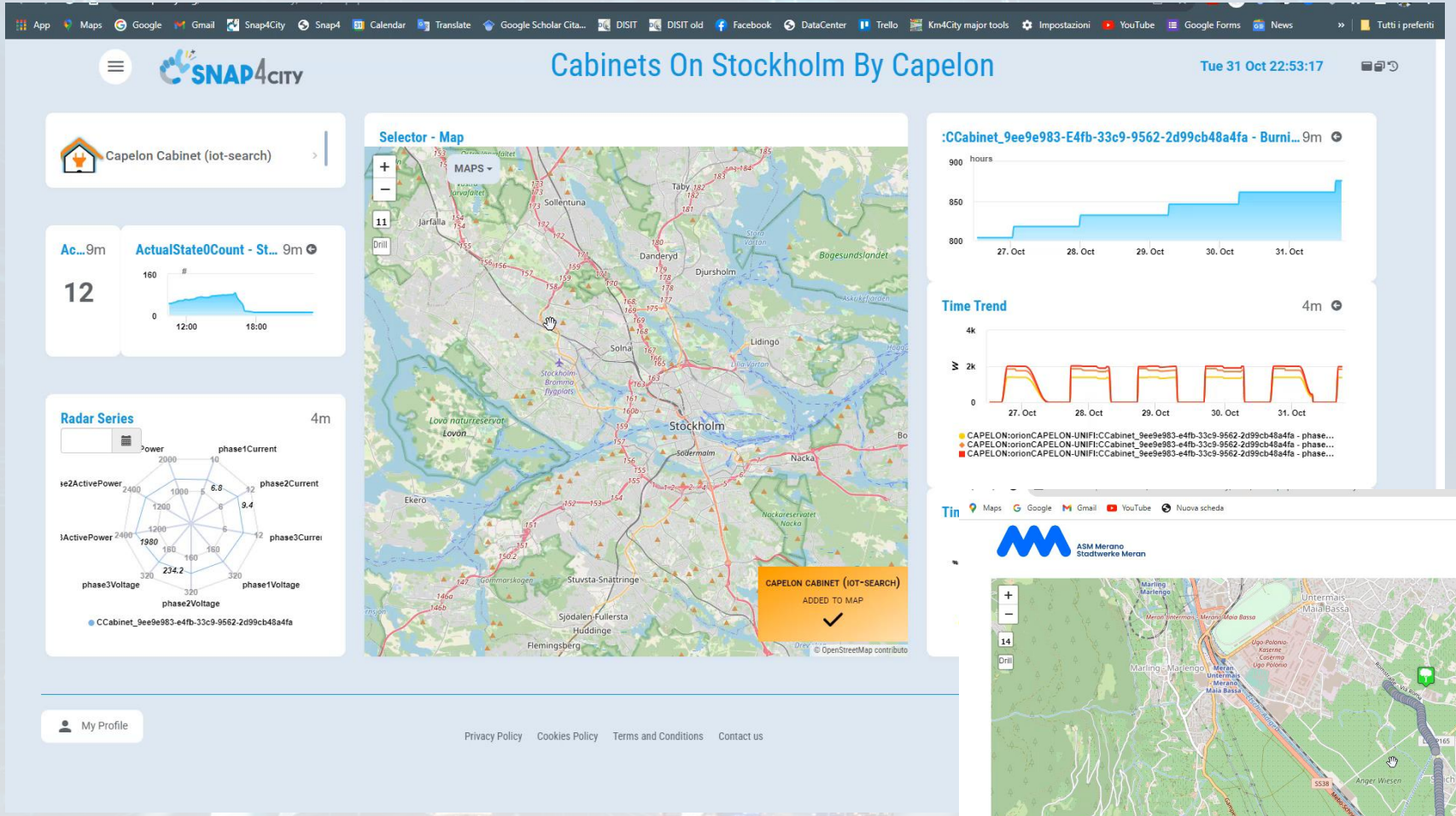

# Floor Details

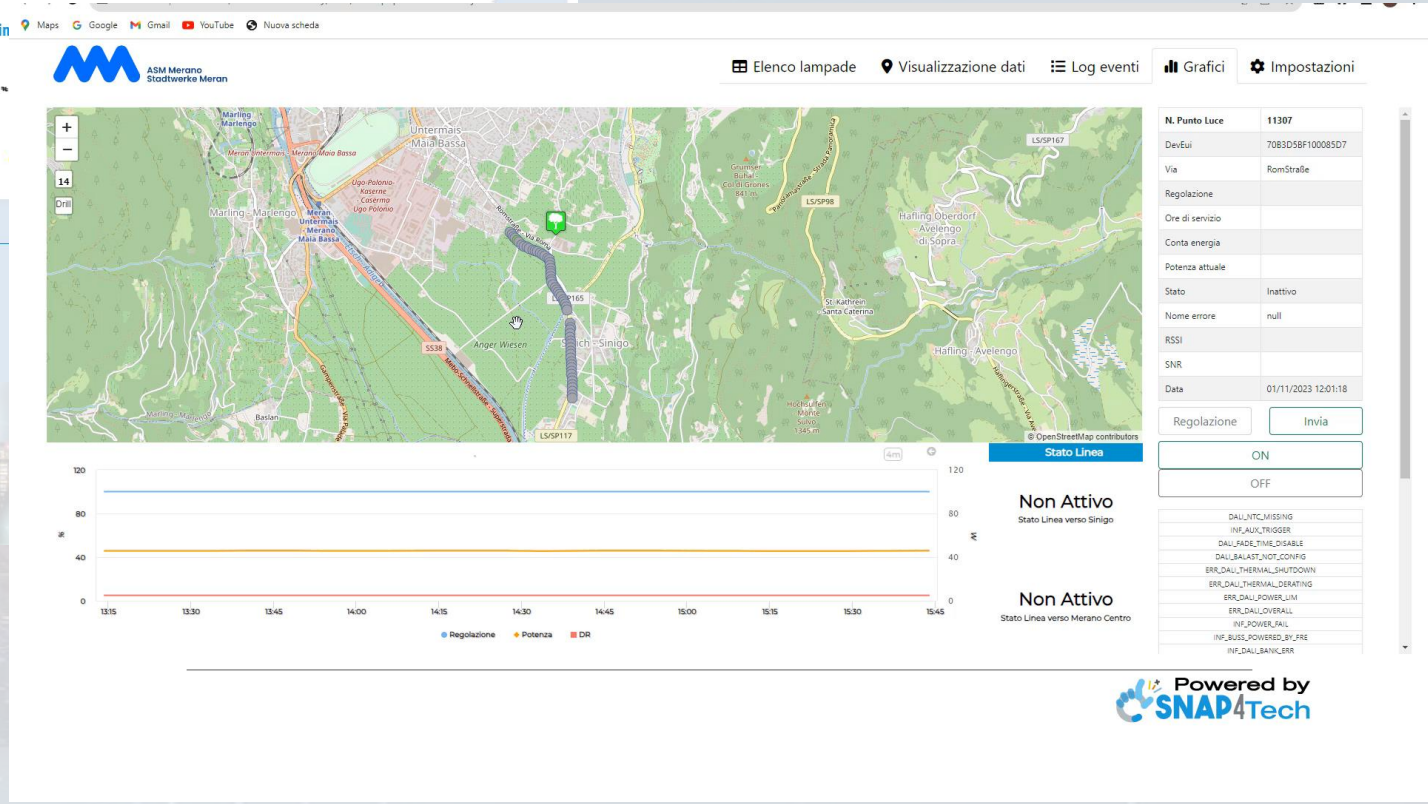
## *ISPRA JRC Site*

# Energy

- Monitoring Energy Consumption in single building, area and per zone
- Matching Energy consumption with respect to the actual usage
- Computing Roof orientation for Photovoltaic installations
- Simulation of Photovoltaicc installations to identify the best parameters of size and storage
- Smart Light management, unicast and multi cast management, smart light controlled by traffic flow data
- Collecting and managing Communities of Energy
- Monitoring Energy provisioning on recharging station
- Optimization of battery life
- Computing KPI
- Etc.



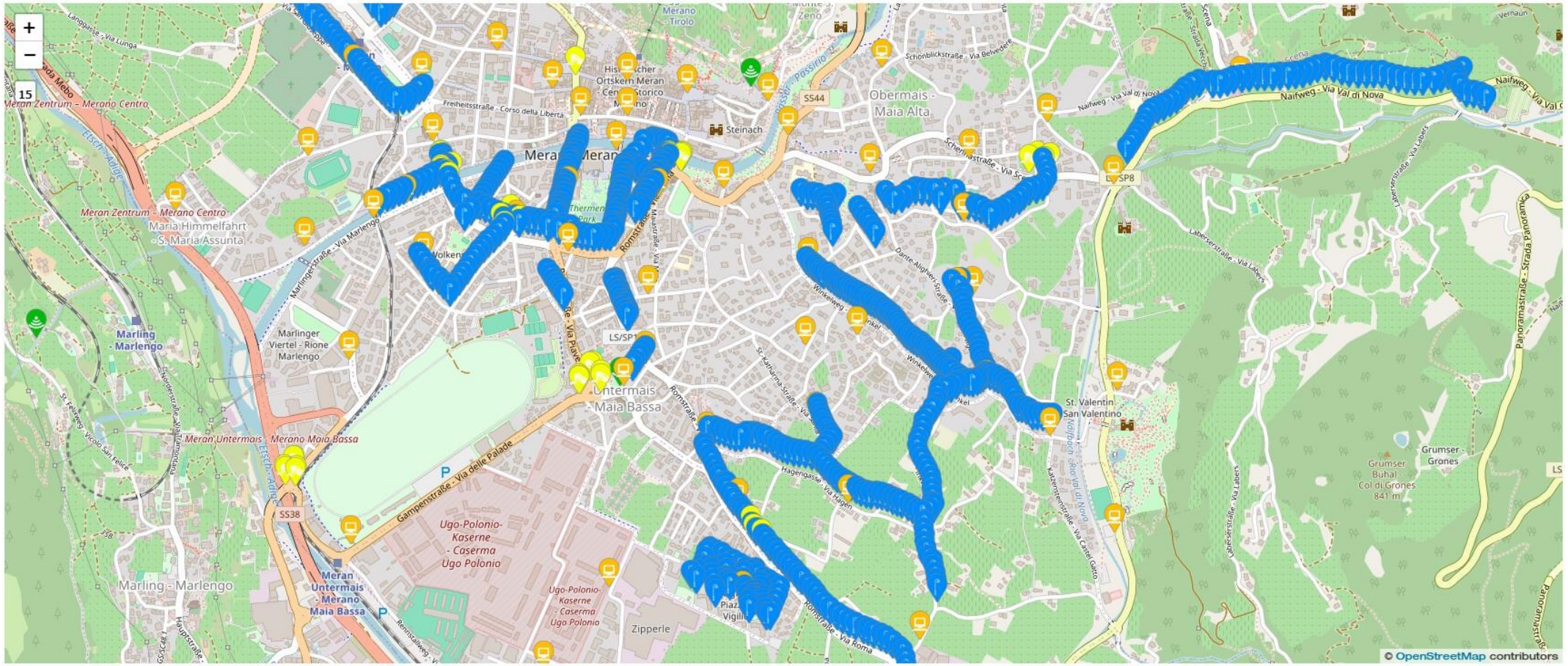

# Smart Light Management

# Smart Light in Merano

ASM Merano Stadtwerke Meran

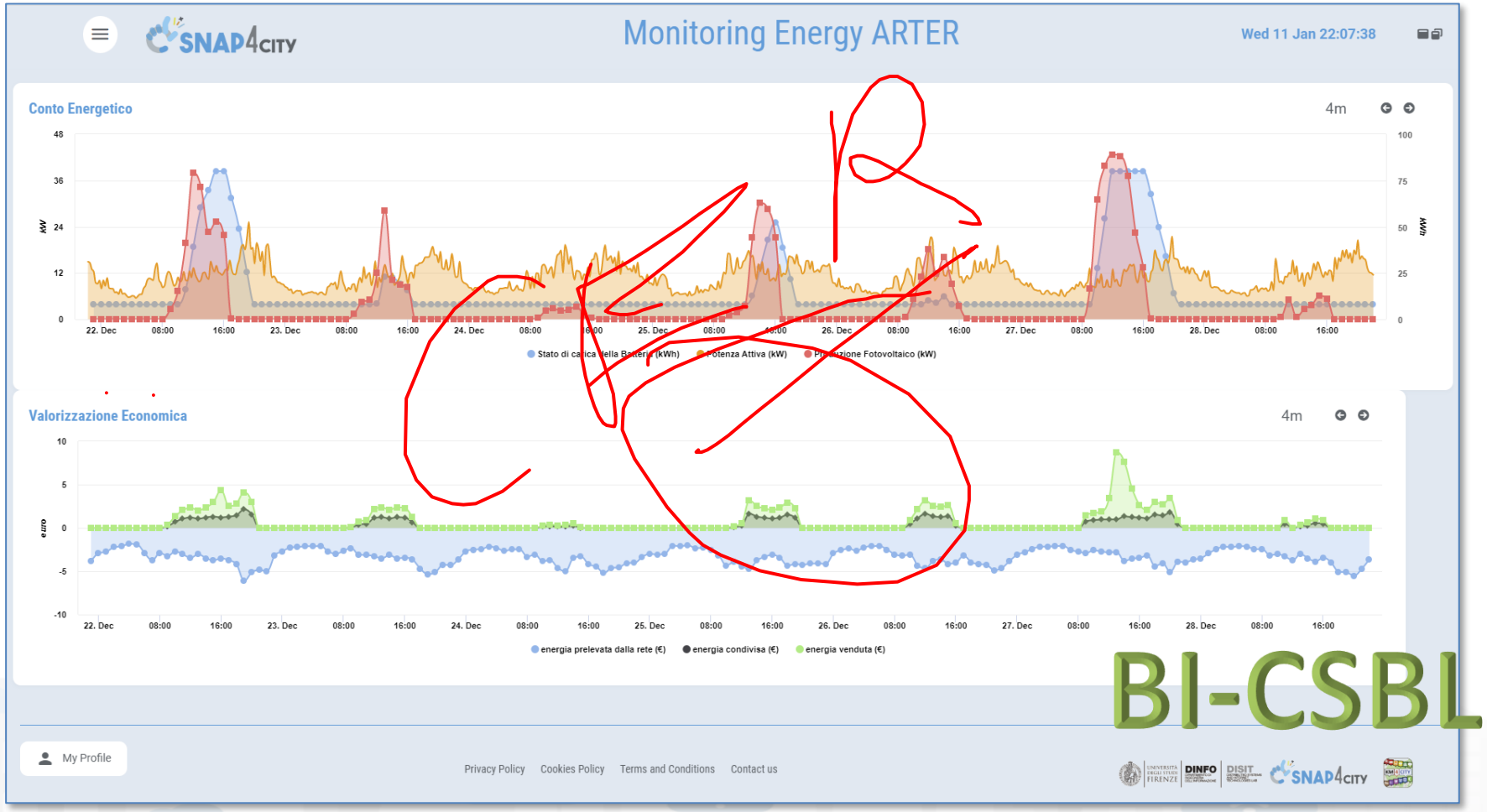
## Merano - tutti i servizi

Wed 13 Dec 15:34:57




Powered by SNAP4Tech

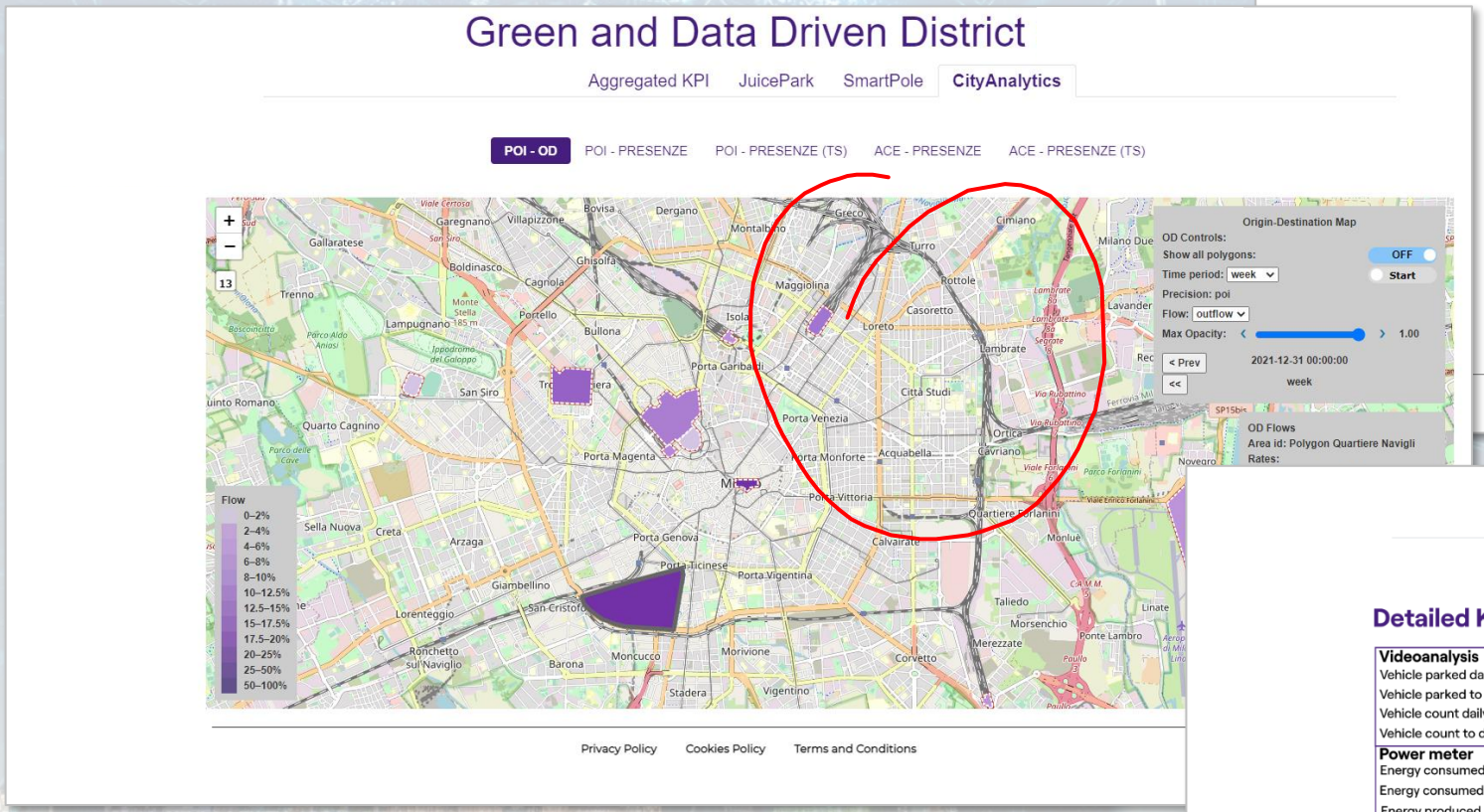
- **Field-tested energy community: the self-consumer condominium**
- The Self User project creates in the pilot condominium, through the collection and analysis of data, a model for calculating and enhancing the impact of an energy community on a community of people, with a view to actions to combat energy poverty

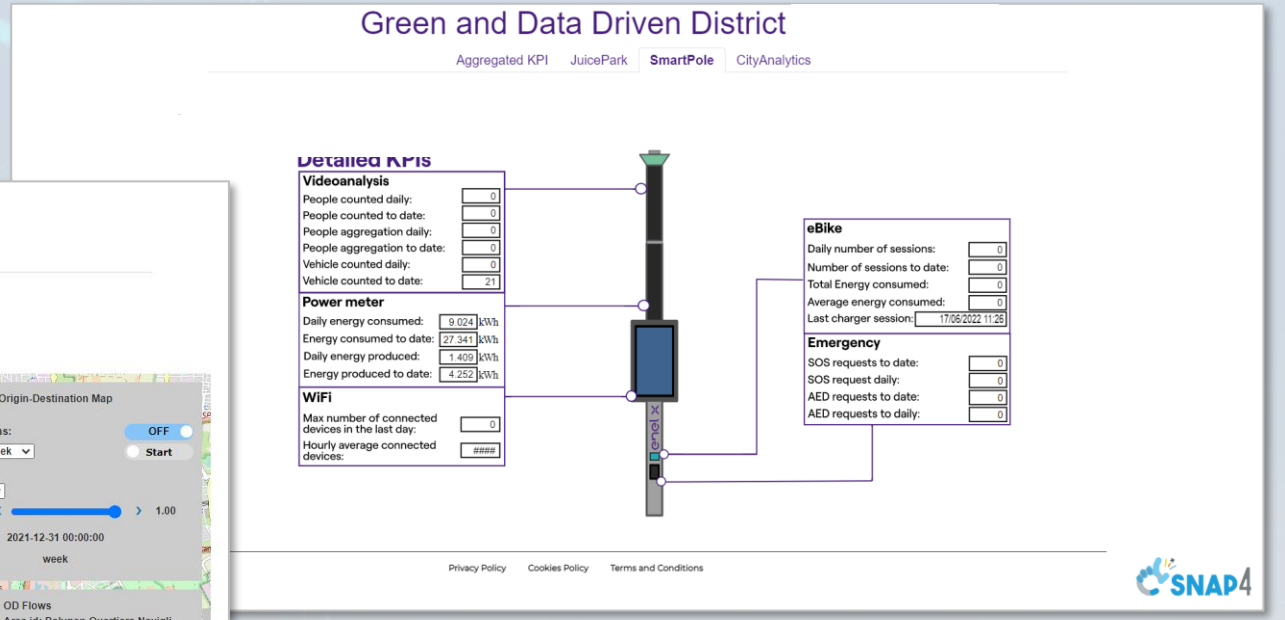


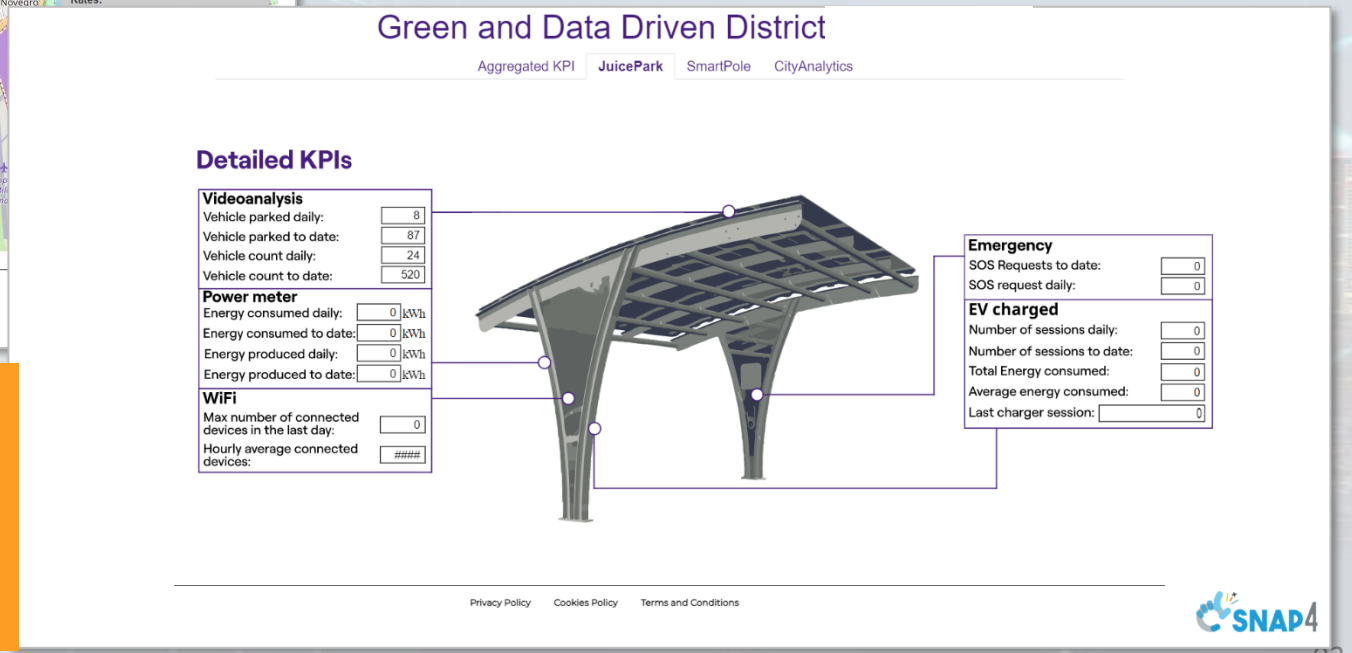

BI-CSBL

https://www.selfuser.it

# Energy monitoring and business intelligence




7 AFFORDABLE AND CLEAN ENERGY

11 SUSTAINABLE CITIES AND COMMUNITIES

https://www.snap4city.org/dashboardSmartCity/view/Baloon.php?iddasboard=MzczNg==

Ciao roottooladmin1

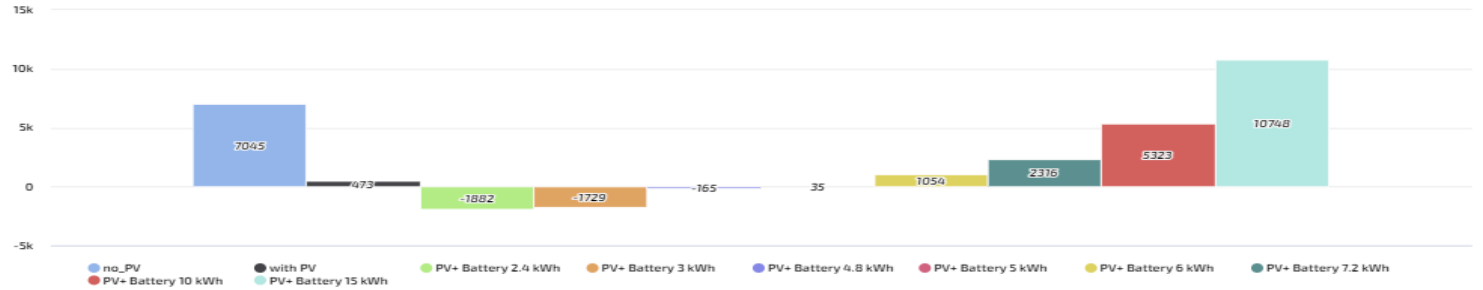
Sat 11 Nov 17:26:28

# ONLINE PHOTOVOLTAIC SYSTEM SIMULATOR

User Manual | Italian Version

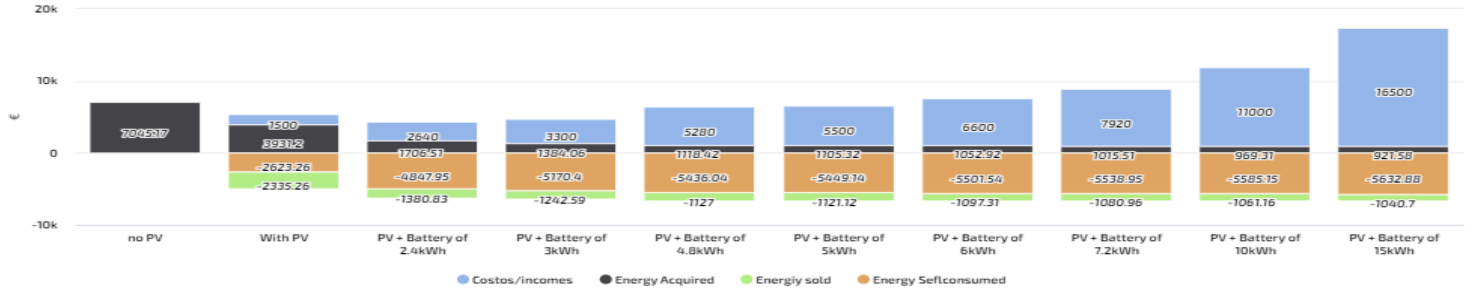
## TOTAL COSTS OVER THE INVESTMENT YEARS

599m



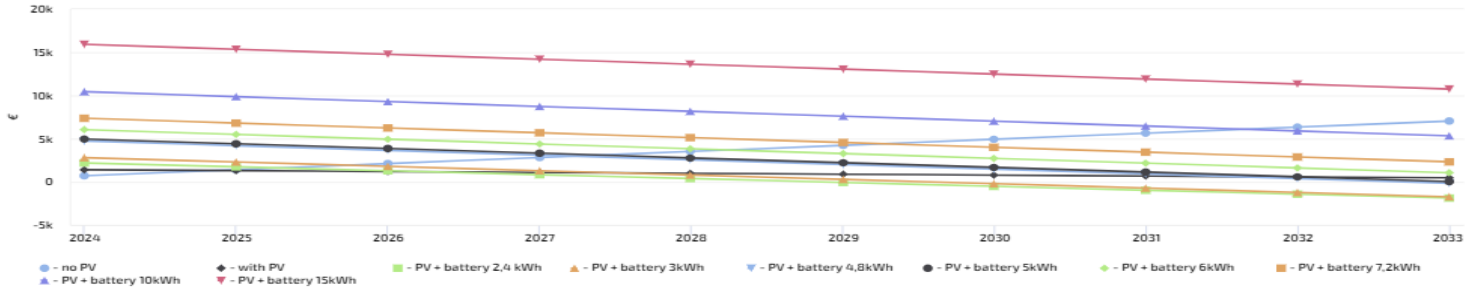

## TOTAL COSTS OVER YEARS DECOMPOSED IN COSTS AND INCOMES

599m




## BREAK EVEN TREND FOR THE DIFFERENT KIND OF PLANTS

599m




## PARAMETERS OF YOUR PV PLANT

**We suggest you PV plus battery of 2.4 kWh**

| | |
|---|---|
| Annual Consumption | 2000 kWh |
| Price of energy sold (€/kWh) | 0,15 |
| Price of Energy Acquired (€/kWh) | 0,35 |
| Years of Investiment | 10 |
| Months for typical trends | Gennaio |

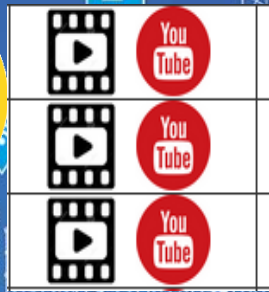
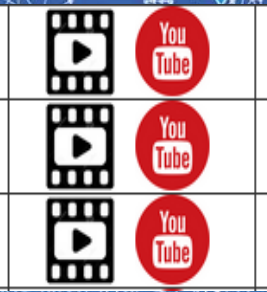
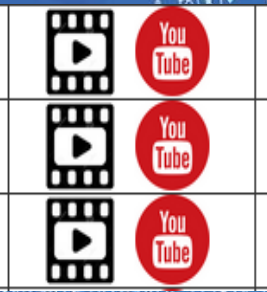
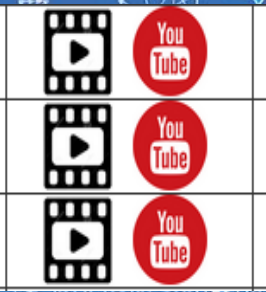
Compute

7 AFFORDABLE AND CLEAN ENERGY

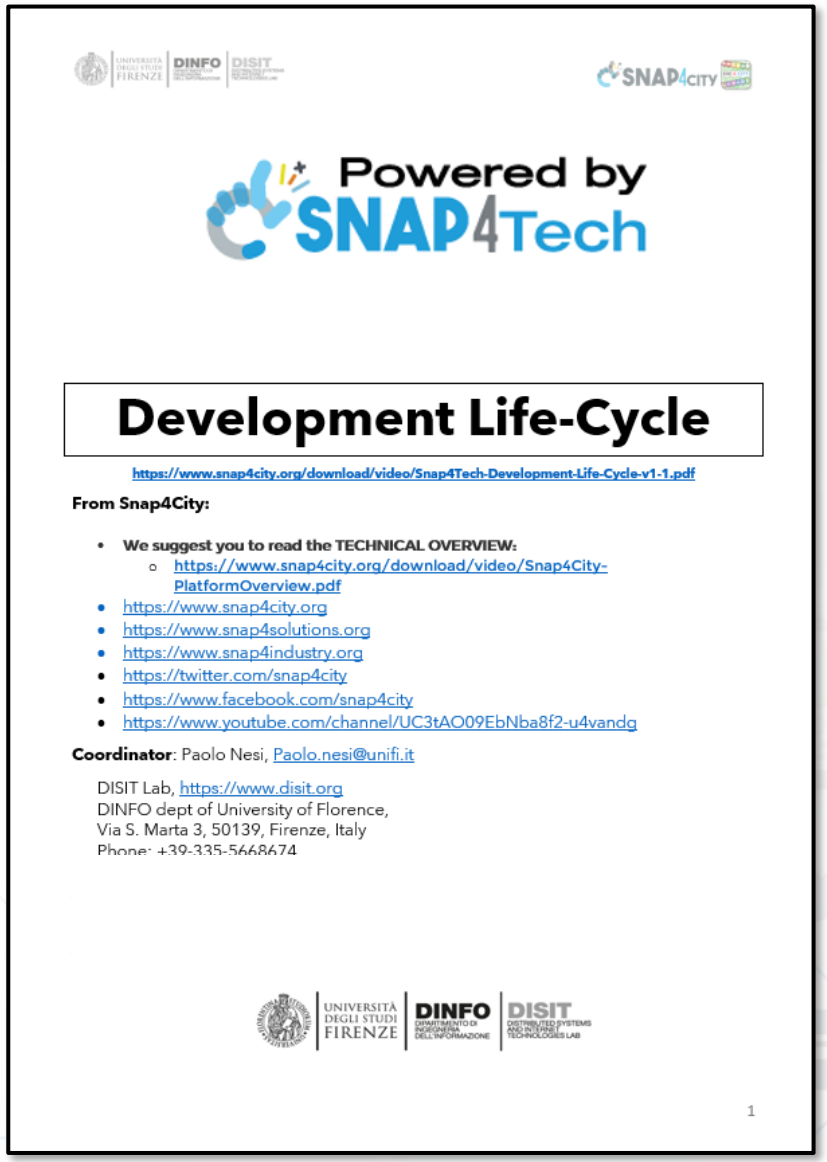
https://www.snap4city.org/944

# Developing on Snap4City

| 1st part | 2nd part | 3rd part | 4th part | 5th part | 6th part | 7th part | 8th |
|---|---|---|---|---|---|---|---|
| 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 |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |

# 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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1

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

# Technical Architecture (high level)

**Data Ingestion**
**Interoperability**
**Entity Directory:**
Smart Data Models
IoT Data Models
Digital Twins

**Event Driven**

**API Manager**
**Federation Smart City API**
Storage & ontologies
**EntityInspector**
**Data Managers**

Social Media
BIM GIS
Gateways, satellite
External Services
Web Scraping
Tv CAM streams

Node-RED

**Processing**
**Interoperability**
**IoT App, ProcLog.**
**On Edge / on Cloud**

**Data Analytics:**
ML, AI, XAI,
simulations, etc.

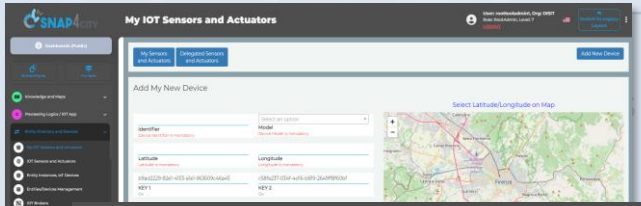
**Event Driven**

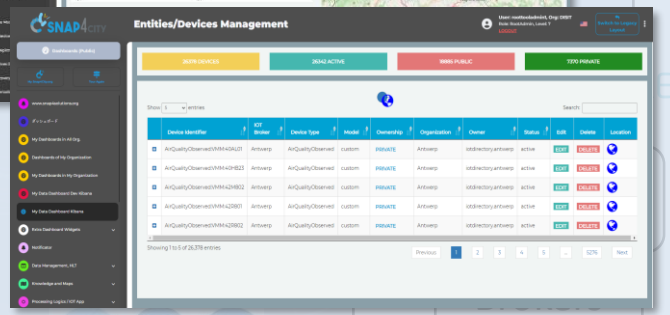
**Web and Mobile Apps**
**Smart Applications**
Waste | Park | Light
Energy | Environment
Maintenance | ……
Apps | Mobile App
Visual Analytics tools
Business Intelligence CSBL
Dashboard Bld & Mng
Service Map
HLT Manager
Synoptics
3D Digital Twin
Market/Sharing Place

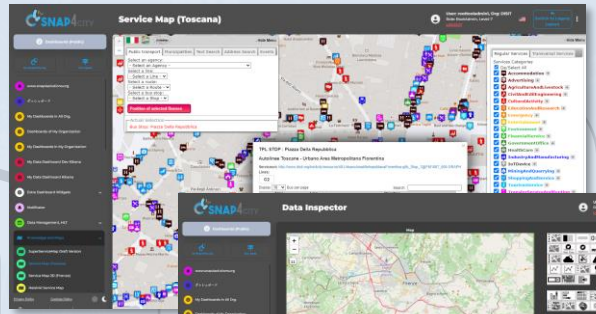
**Third parties' solutions**

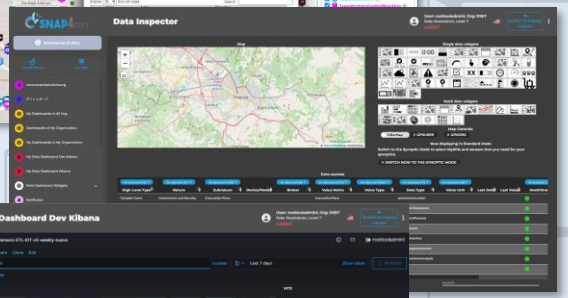
**A&A, SSO, Blockchain, Resource Managers and Sharing: IoT App, Data Analytics, …**

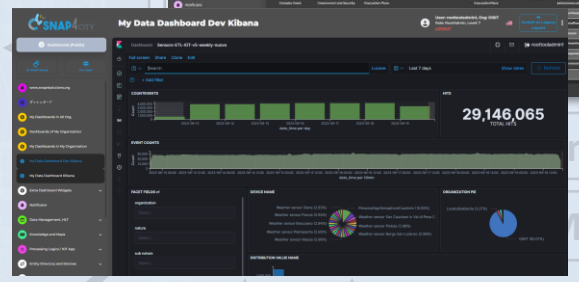
# Tools of Tech. Arch.

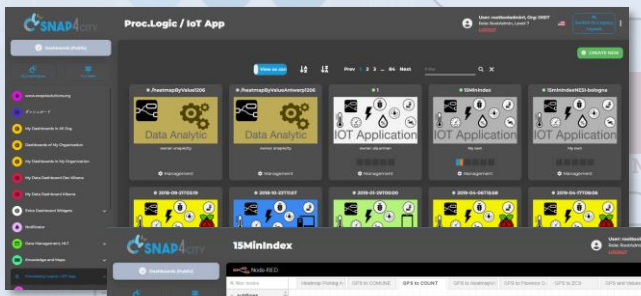


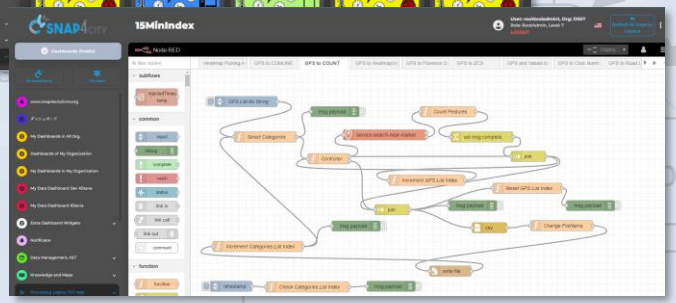



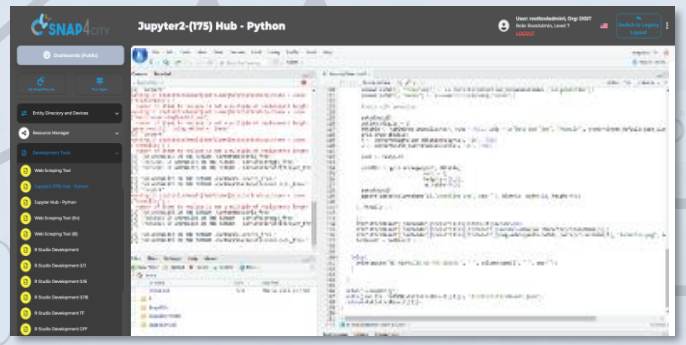



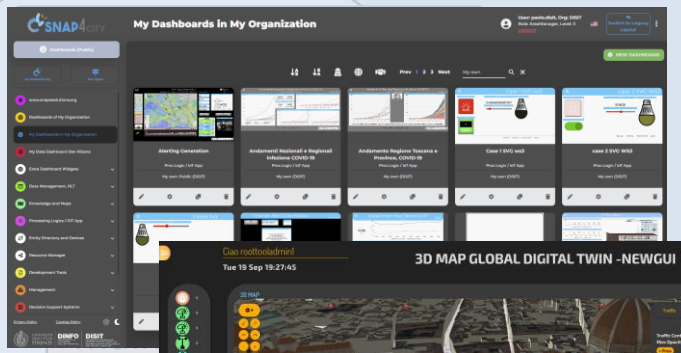



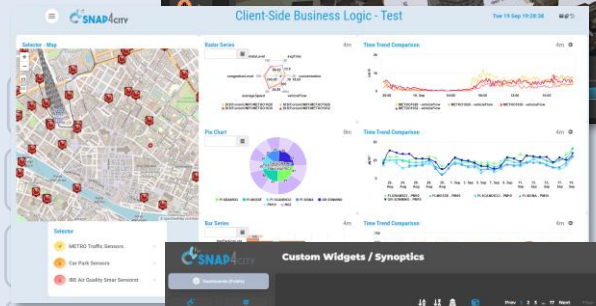





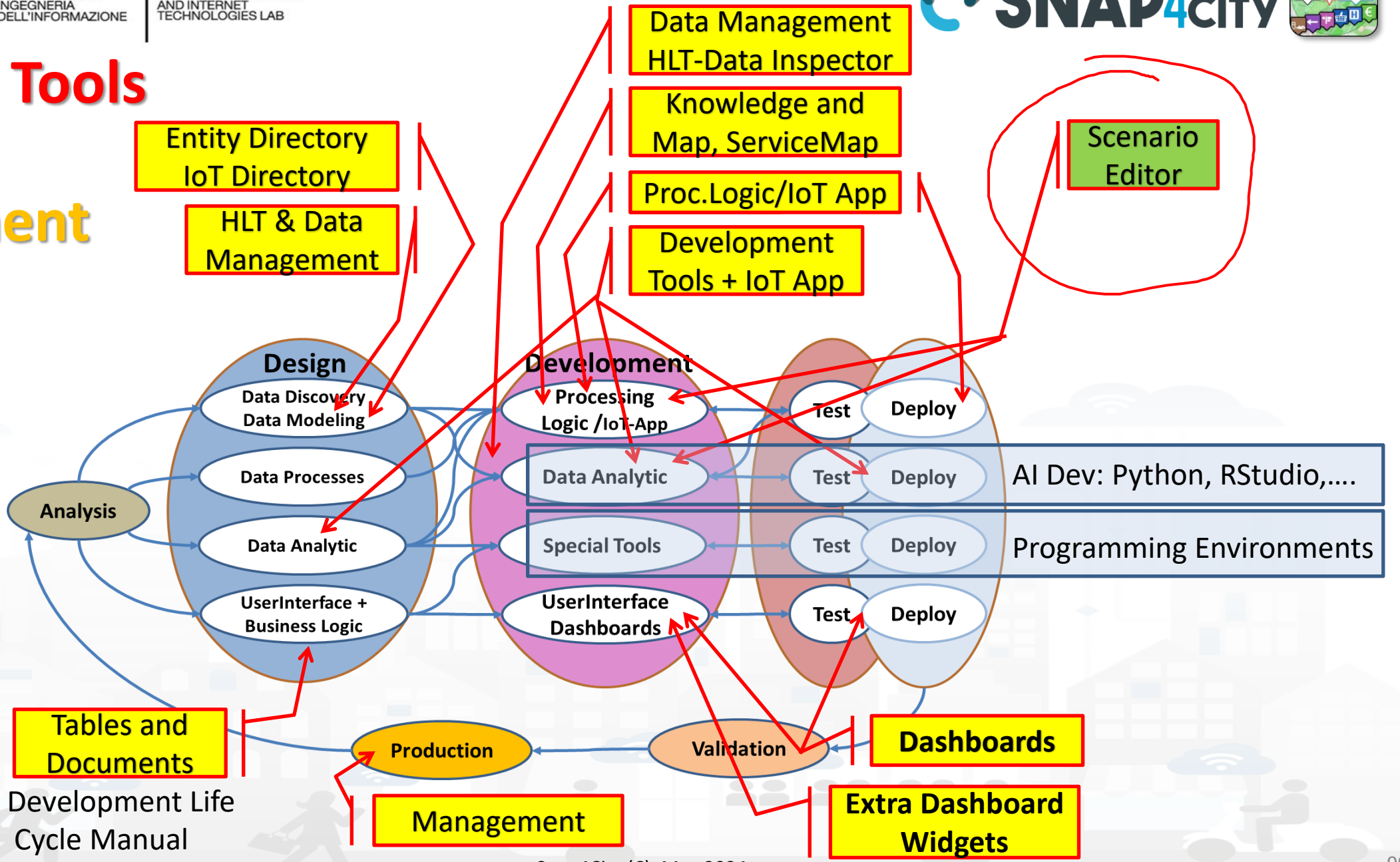




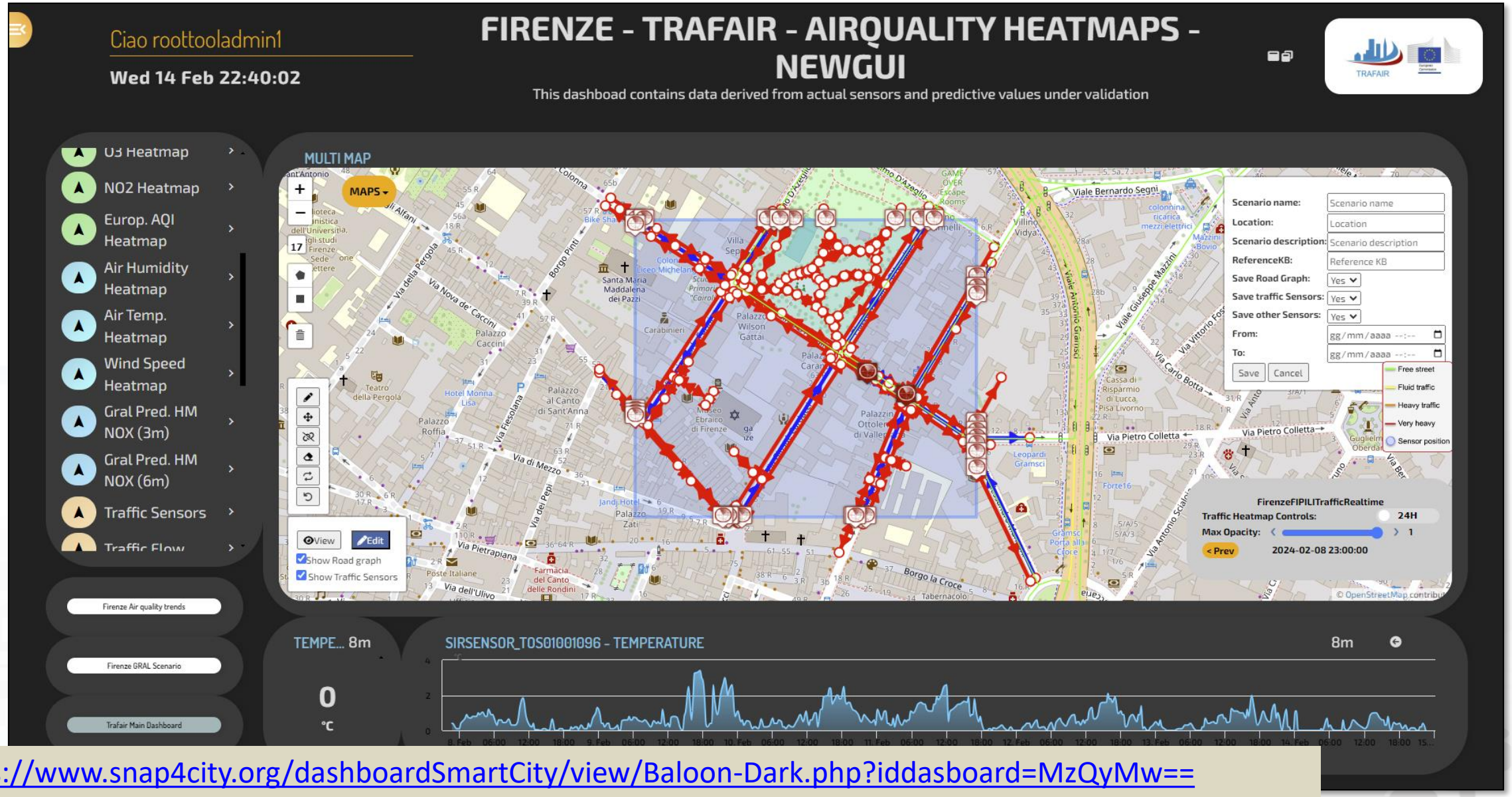
Third parties solutions

A&A, SSO, Blockchain, Resource Managers and Sharing: IoT App, Data Analytics, …

# Snap4City Tools vs Development Life Cycle



# Trial:




https://www.snap4city.org/dashboardSmartCity/view/Baloon-Dark.php?iddasboard=MzQyMw==

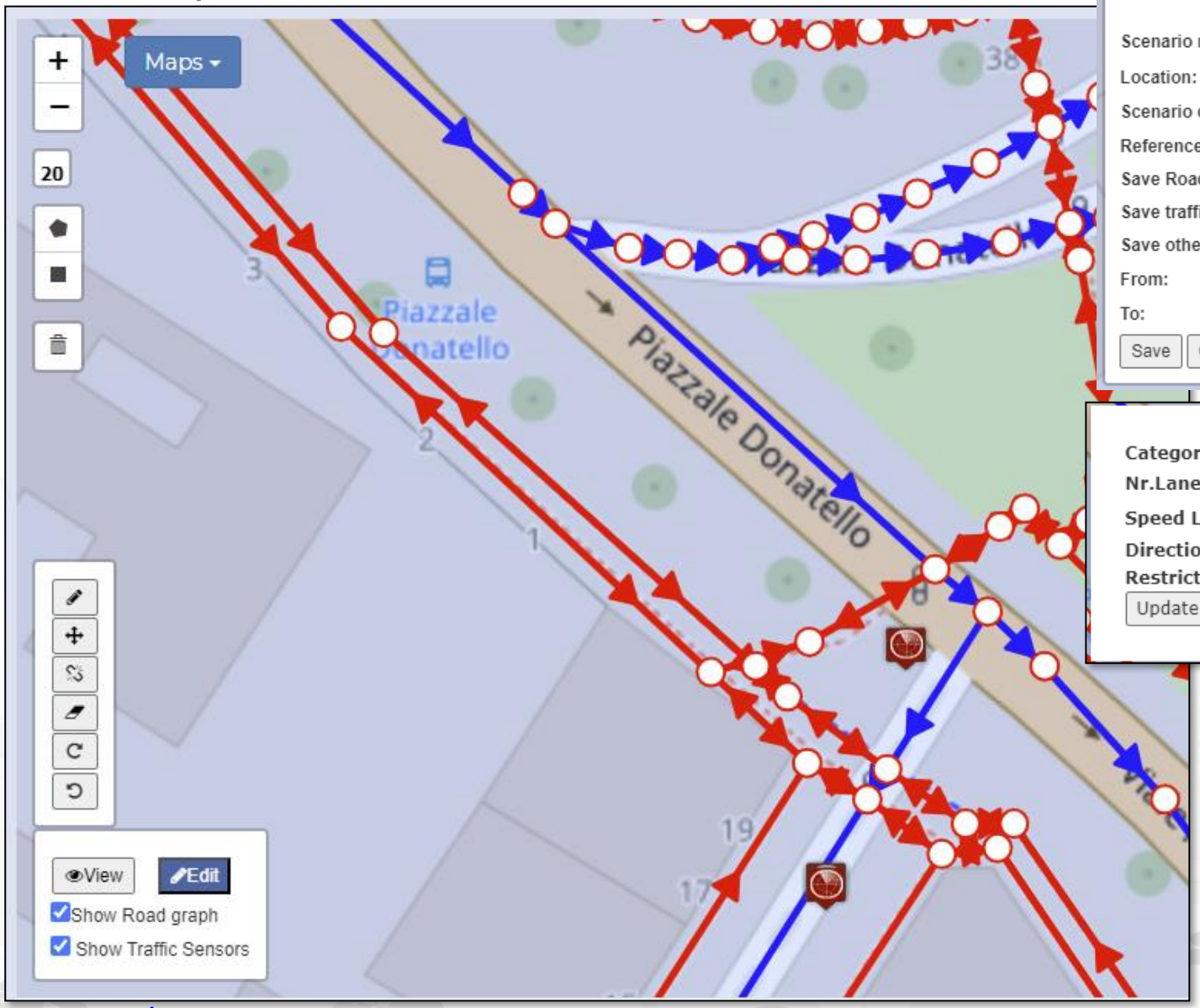
# For example:

Select map

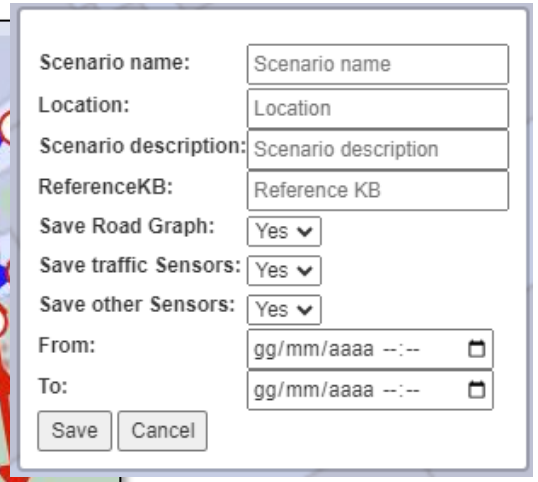
Zoom

New Scenario

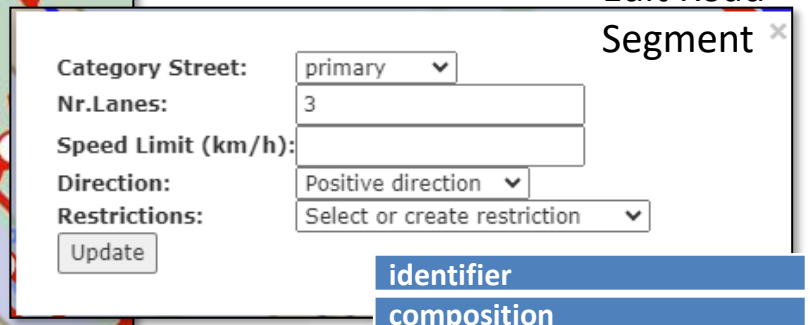
Editing
Drag & drop
Split & Join
Delete
Do and Undo




Save




Edit Road Segment

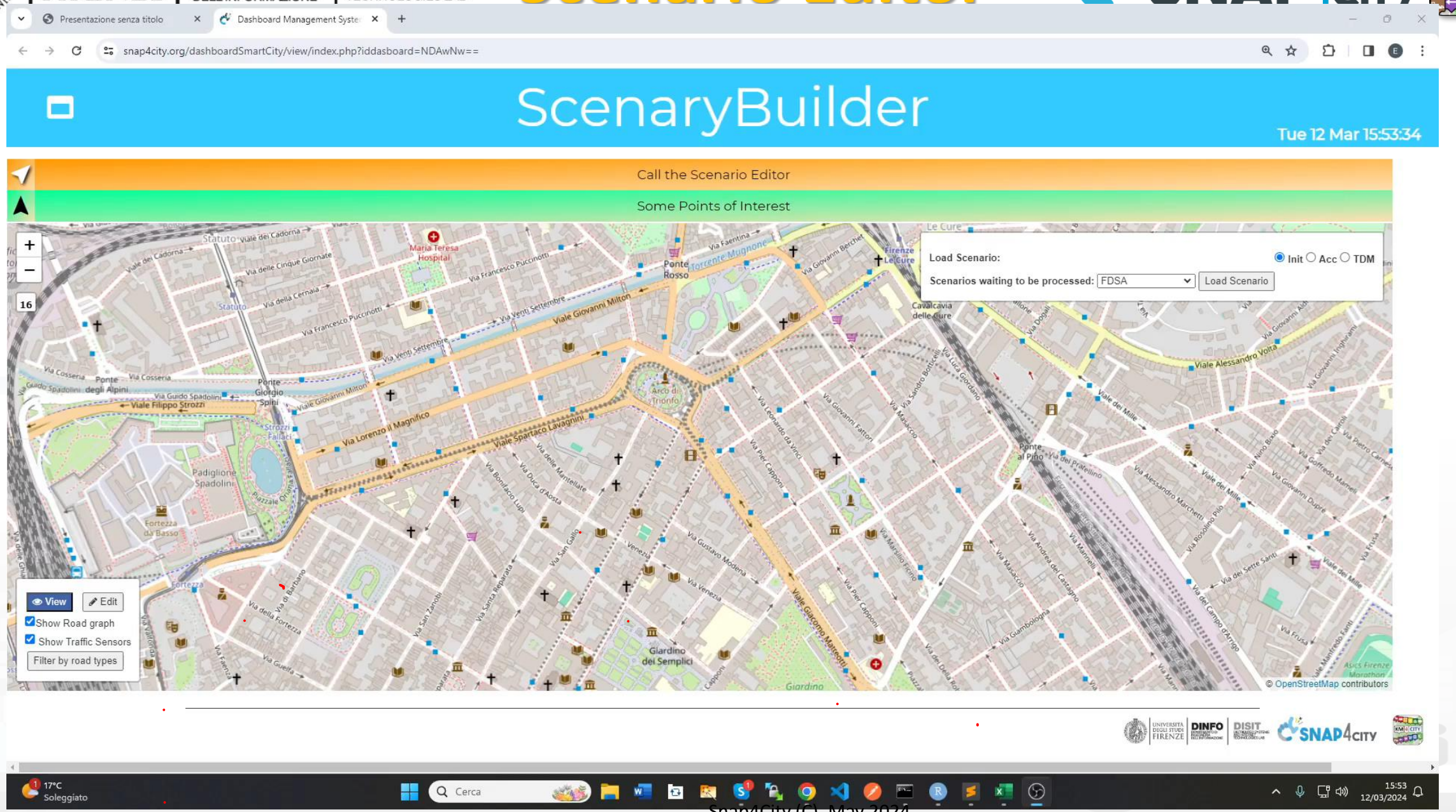



- identifier
- composition
- elemLocation
- elementClass
- elementType
- length
- operatingStatus
- speedLimit
- trafficDir
- width
- highwayType
- route

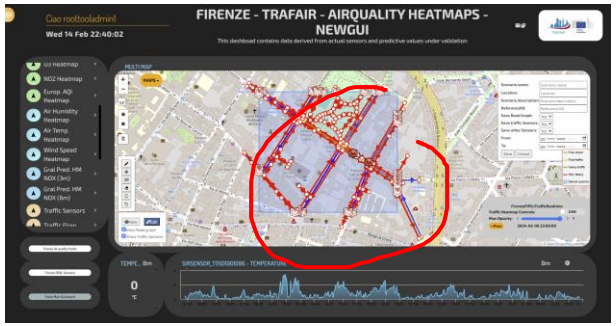
Properties of Road Elements

https://www.snap4city.org/976

# Scenario Editor



# The actual Scenario Exploitation

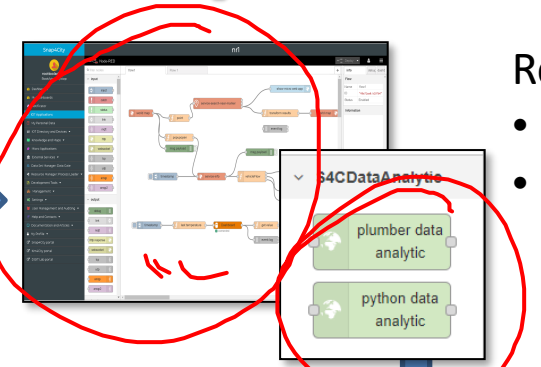



Defining Context via Editing Scenario:

- Select area and data
- Editing roads, POI, IoT entities, ..
- Save/load, share
- Change status


A Scenario includes:

- Metadata
- Status and versions, date time
- Period of validity
- Road graphs, cycling, pedestrian seg.
- List of data, sensors
- Etc.

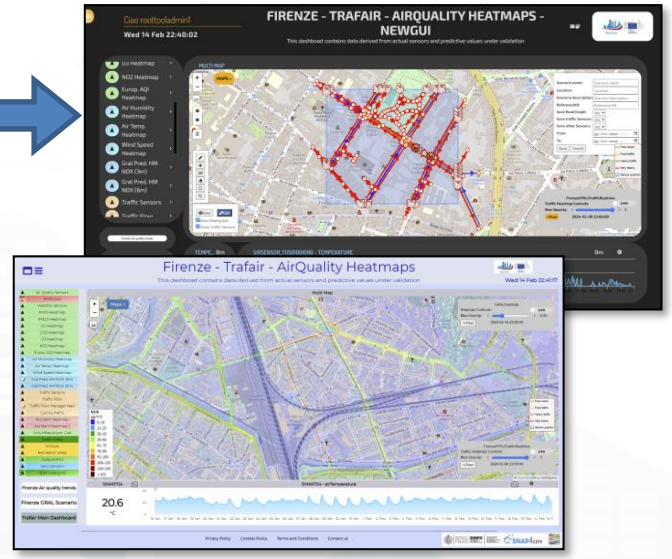



Computing in the Scenario Context as:

- KPI, Metrics, SUMI, SUMP, 15MinCity Index
- Heatmaps
- OD Matrices
- Traffic Flow reconstructions
- Predictions
- Routing, constrained routing
- Early Warnings
- Etc.

ReLoading Scenario in JavaScript

- Evolve Scenarios
- Use Scenario to context the Data Analytics: R Studio, Python for computing



# Part 2: Dashboard production and management

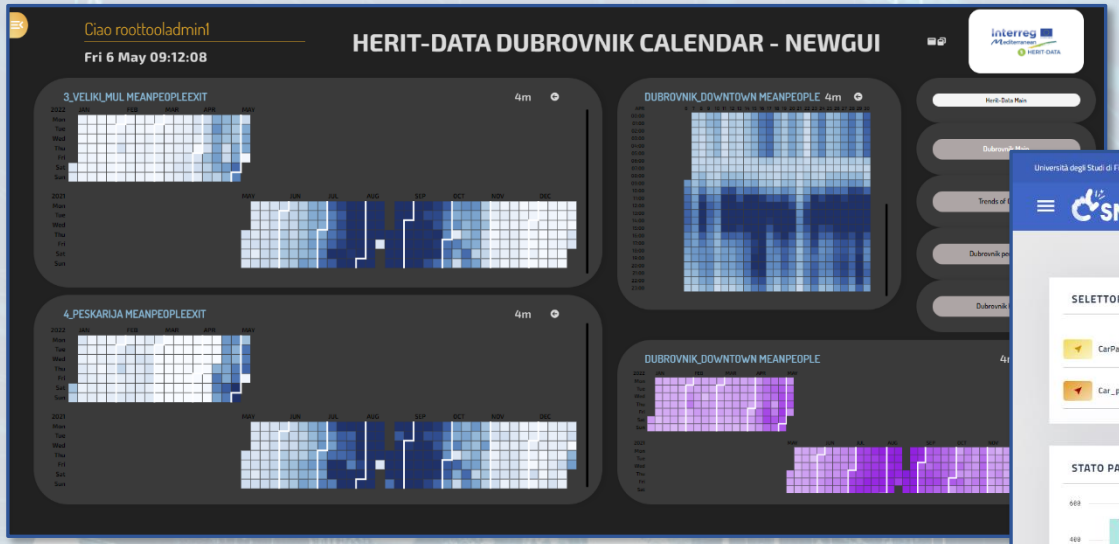
Part 2: Dashboards production and management

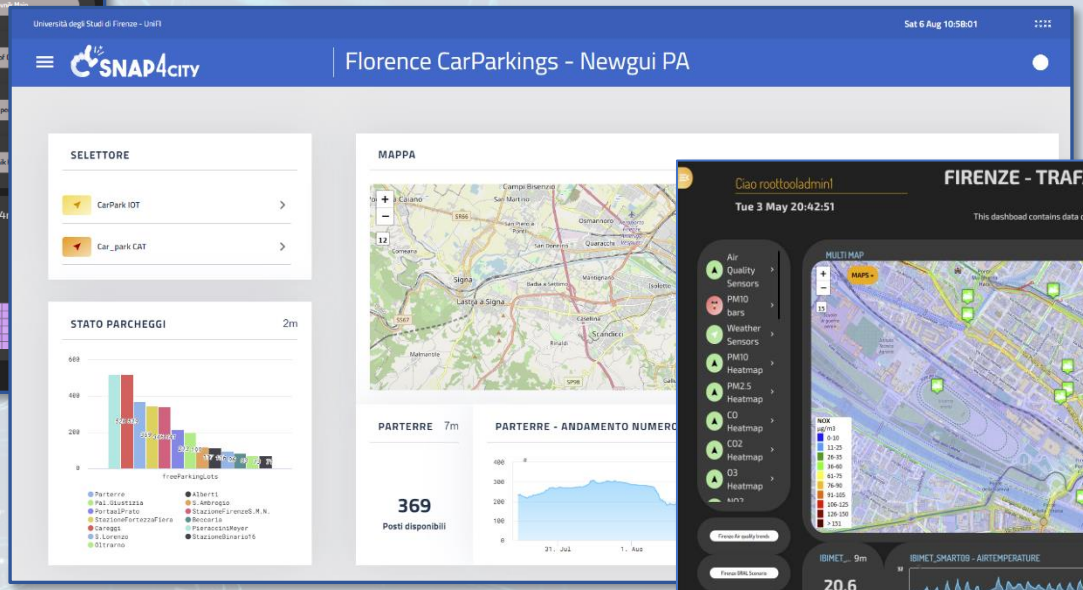
SLIDES

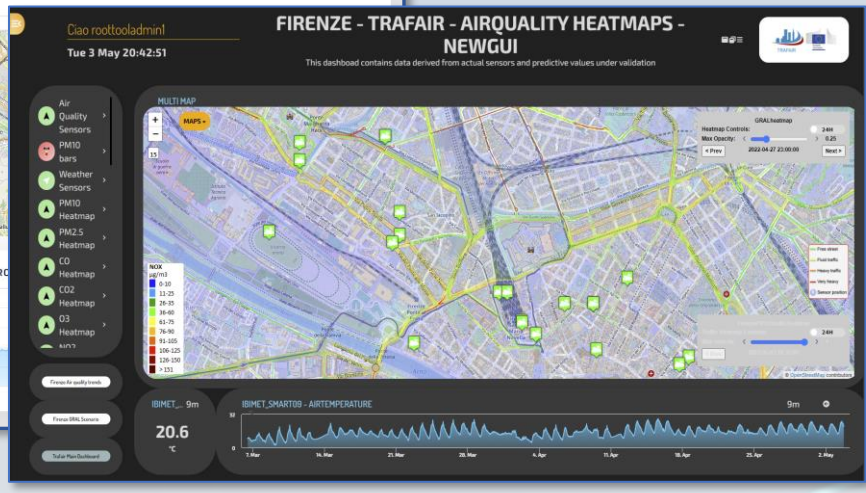
Interactive Slides

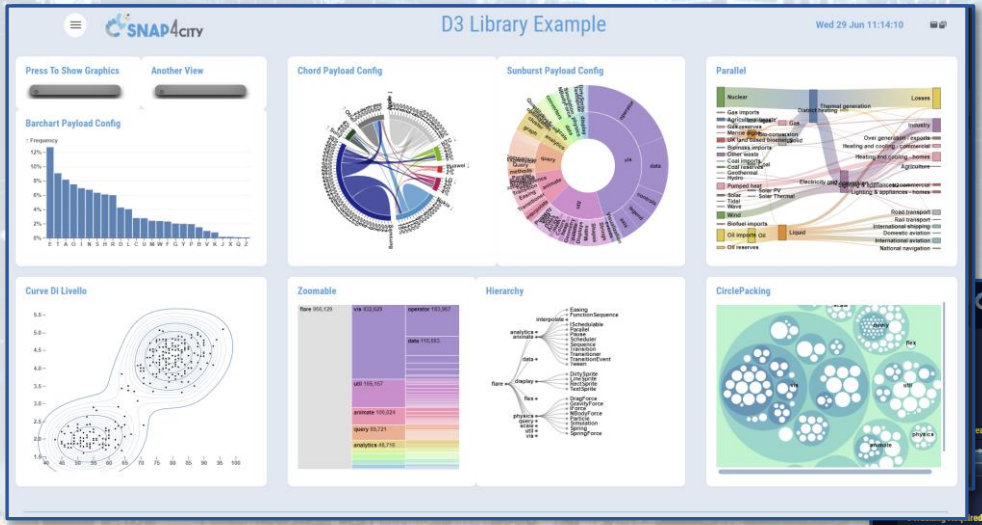

- Recall on Snap4City Architecture
- Dashboards Purposes and Uses
- Main Data Kinds: data vs representations
- Dashboards Main Concepts and simple Widgets
- Creating a Snap4City Dashboard, wizard
- Multi Data Map Widget
- High Level Types, video, external services, synoptics
- Selector for the Multi Data Map Widget
- Data Inspector vs Data Processes Details
- Dashboard Management

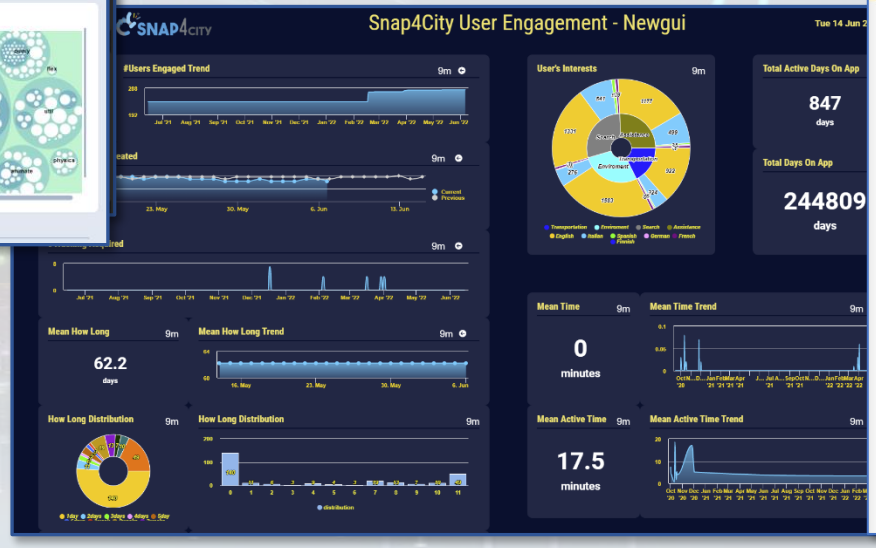
# Different Themes

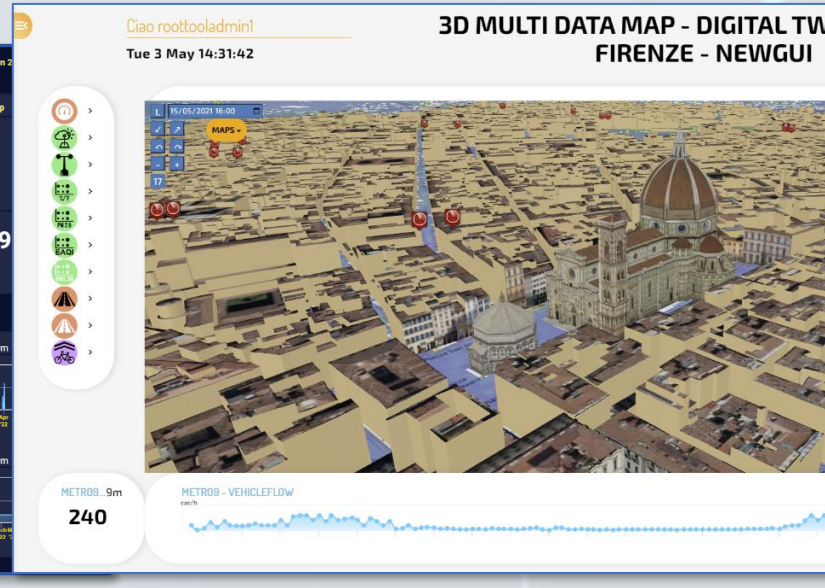


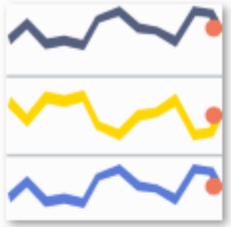




New styles/themes can be developed by specializing a few files from open source

https://www.snap4city.org/793

# Visual Representations


Sliderwith-multiple-steps-for-KPI


sparklines

kpi


histogram


heatmap


flow-maps


geo-maps

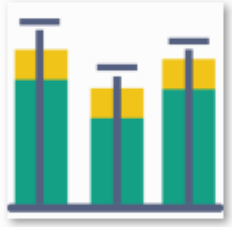

donut-chart

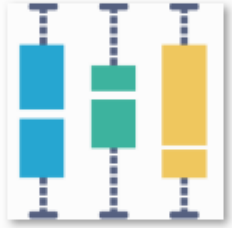

Data-grid


chord


Cone


Bubble-matrix-chart


Bullet


Box-plot


staked-area


Stacked-line-chart


Stacked-combinational-Chart


spider-maps


Sequence-Sunbur


Pivot


pie-chart-1


Pareto-chart


radar

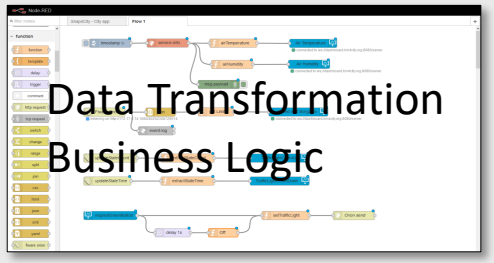

Bubble-maps


waterfall


Sunburst


Sankey

# Dashboard Builder: Development



Data Transformation
Business Logic

IOT Applications


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

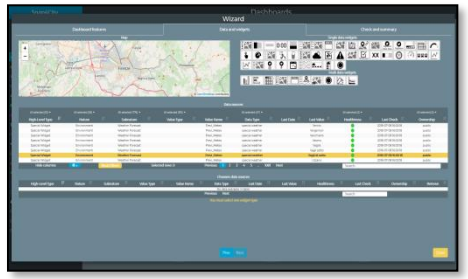
Widget Collection

Micro
Applicat
ions

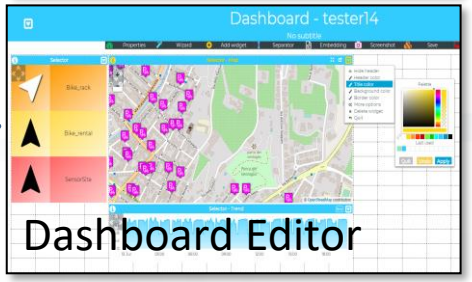
External
Services

Custom
Widgets/
Synoptics

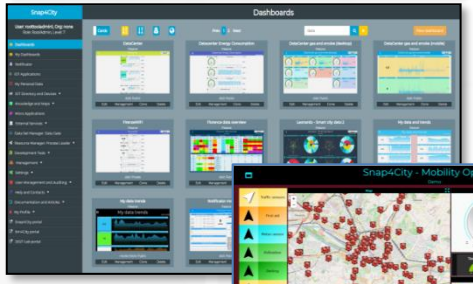
Dashboard Wizard

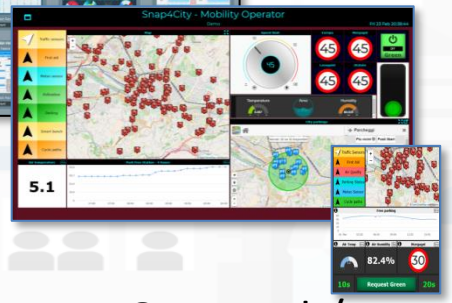


Create, save, load,
delegate, grant access,
change ownership




Dashboard Editor





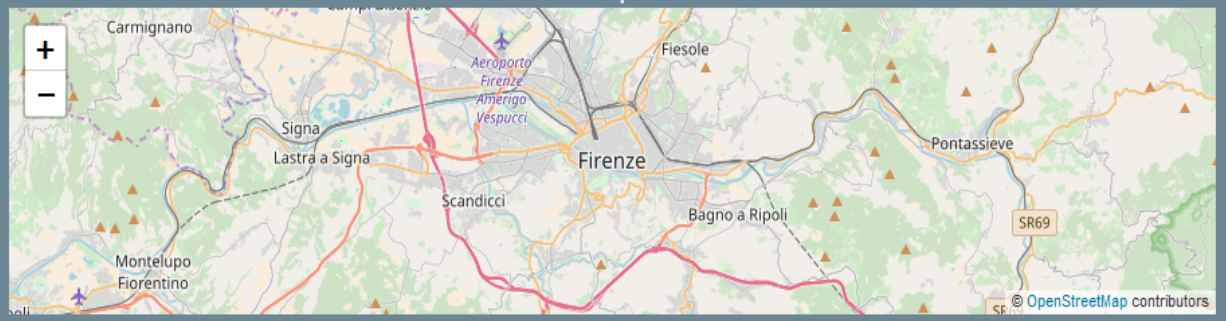

Public
Dashboard
Collection

My Own Dash/App

# Wizard

Dashboard features | Data and widgets | [illegible]

Map




Single data widgets

Multi data widgets

Data sources

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

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

Choosen data sources

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

Previous Next | Search

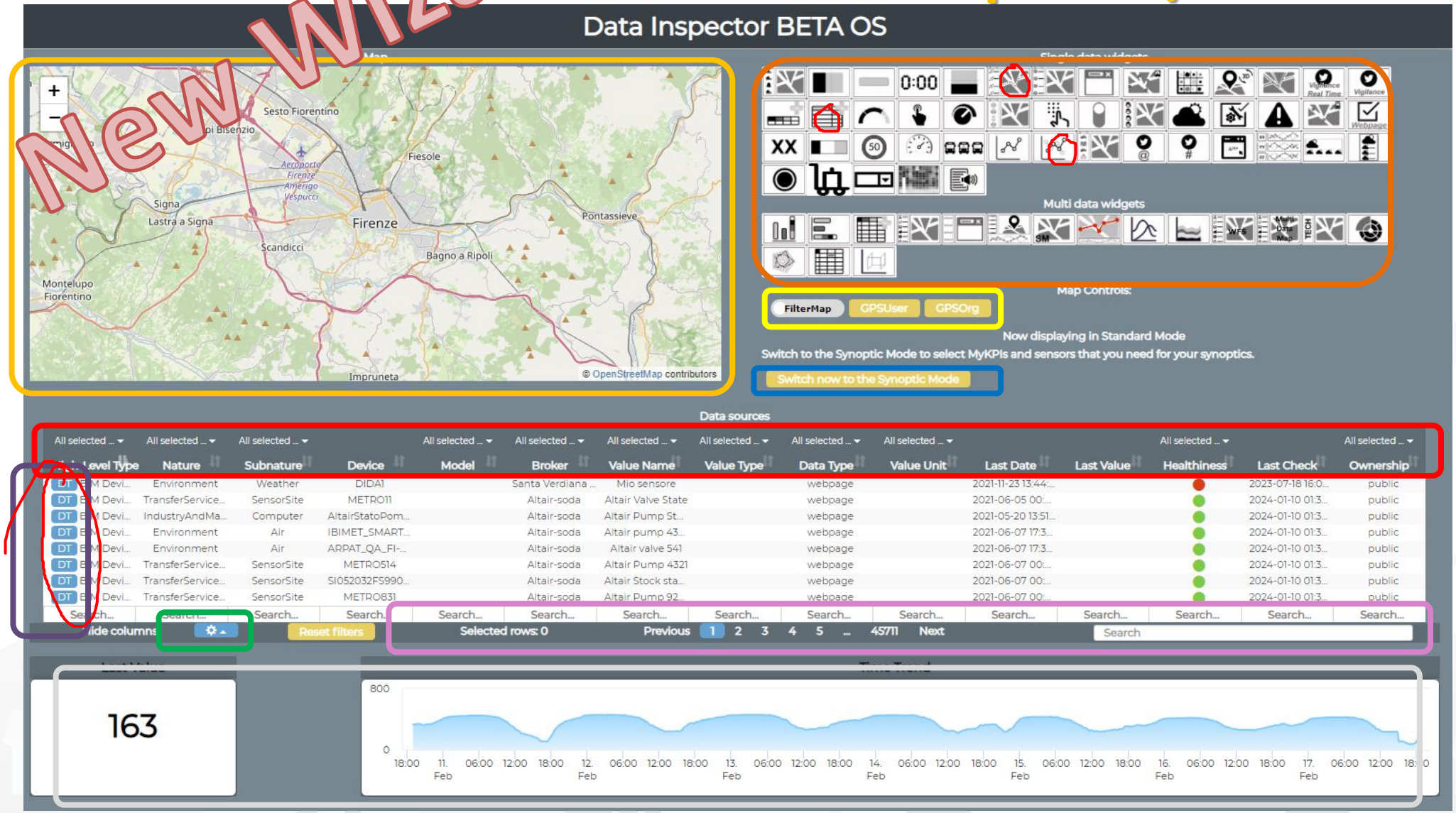
Close

Wizard

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

# New Data Inspector/Wizard

New Wizard




Filtering/Searching for individual fields (even for some fields not displayed as geographic coordinates)

Geographic Filtering

Text Search on all fields

Menu for choosing the fields to display in the table

View on Map(via PREVIEW)

Data and Trend visualization

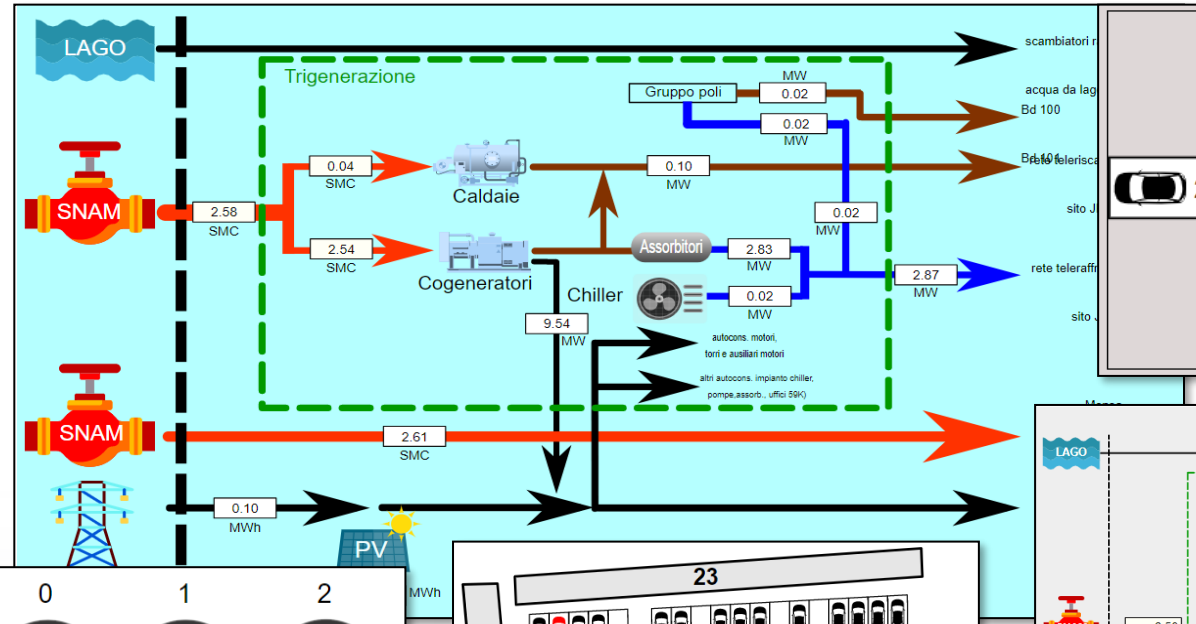
Opening Digital Twin

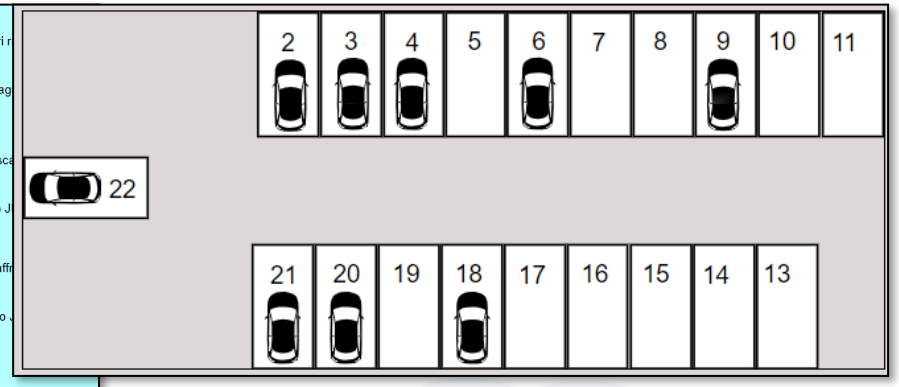
Pass to Synoptic mode

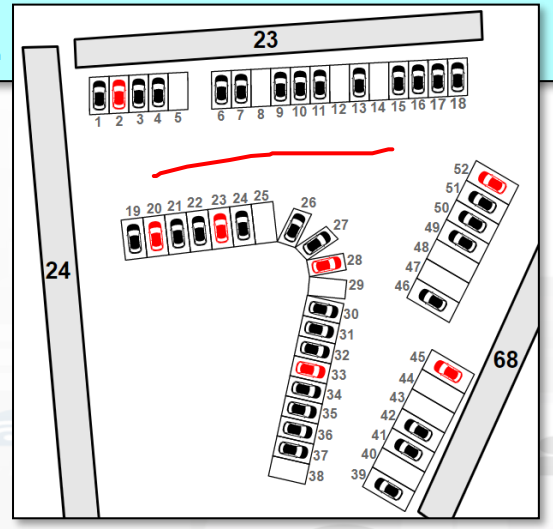
Select the graph representation

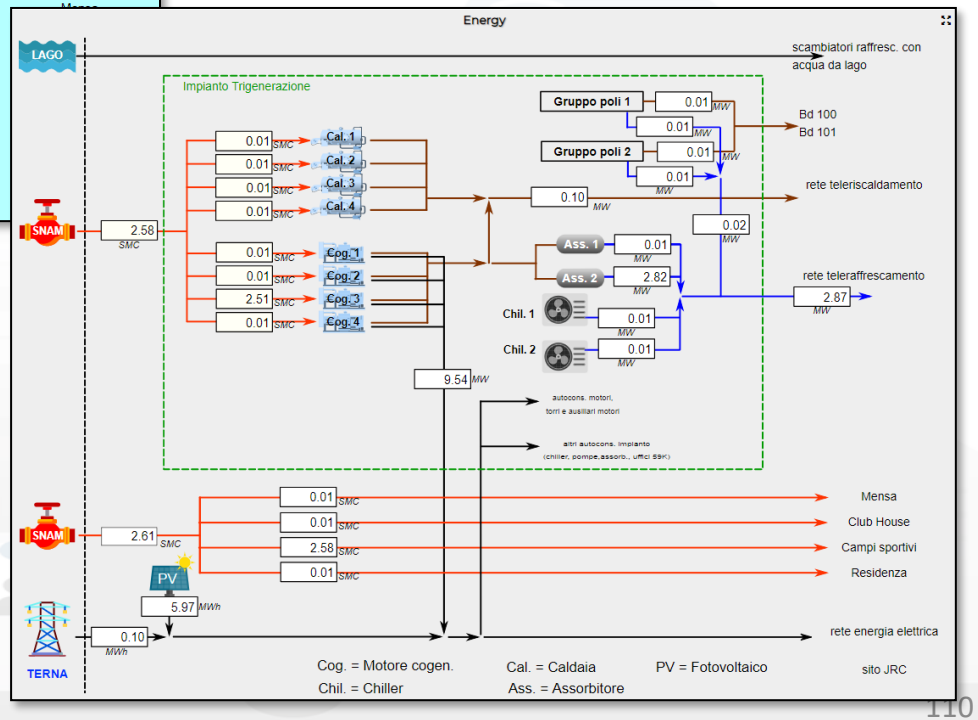
# Special Custom Widgets

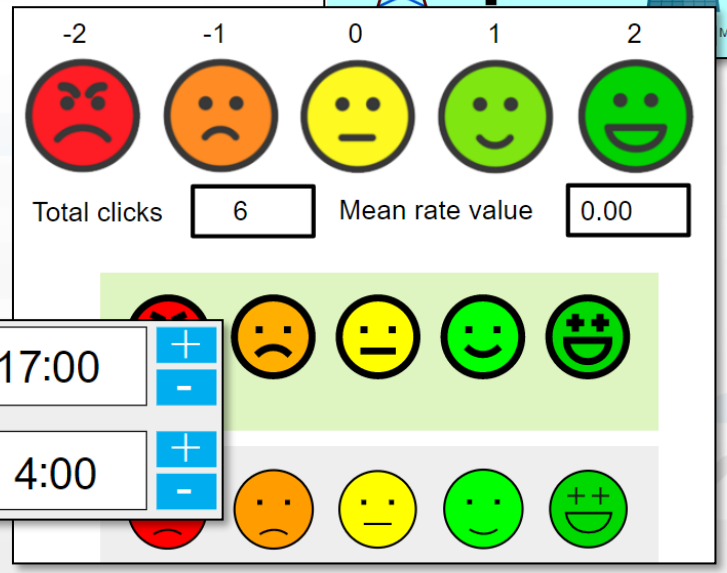
- Smart parking
- Smart Energy
- Smart Light
- Smart ….
- Energy View
- Custom Controls

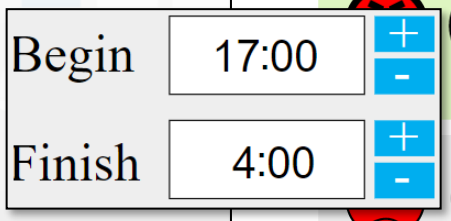


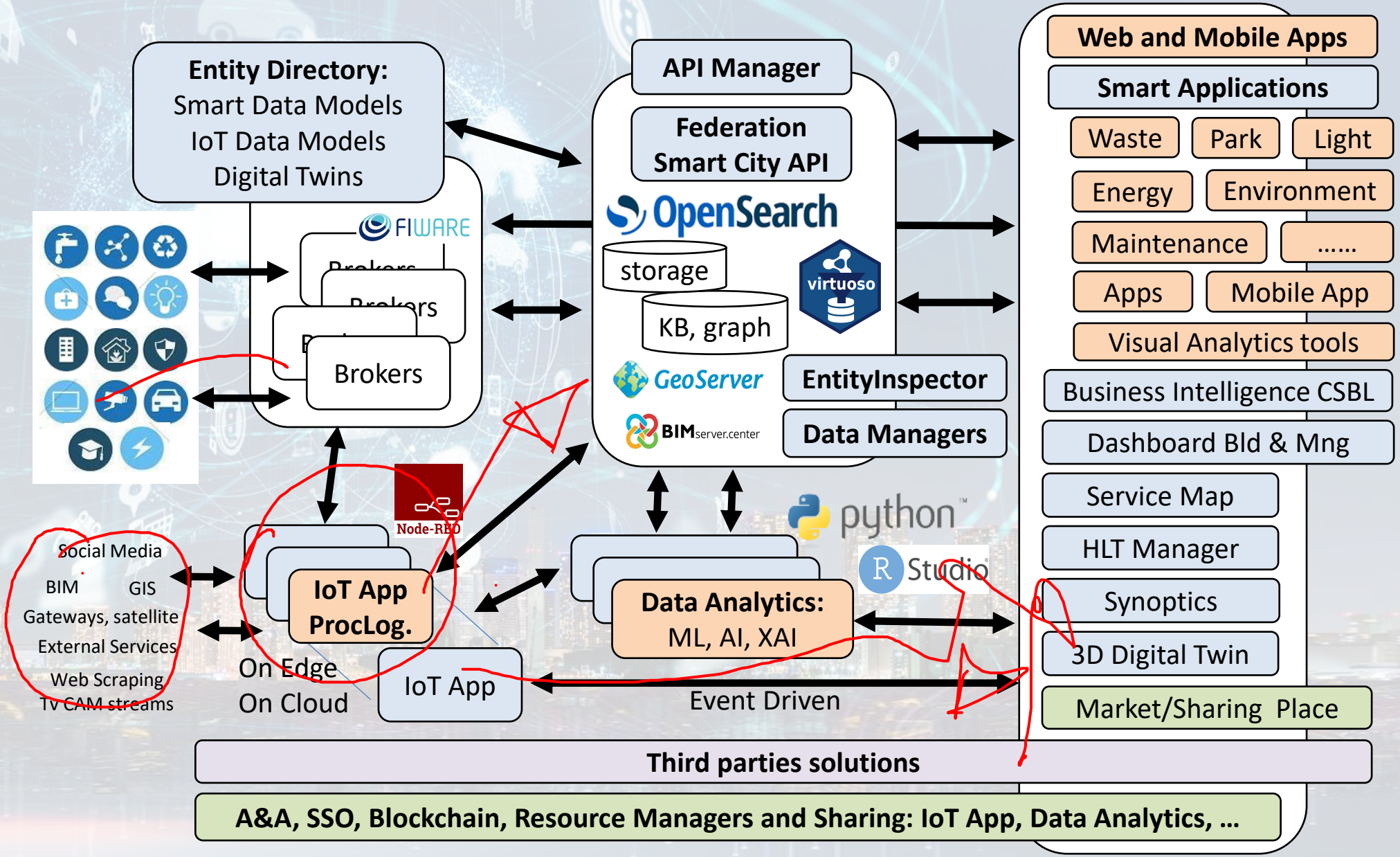



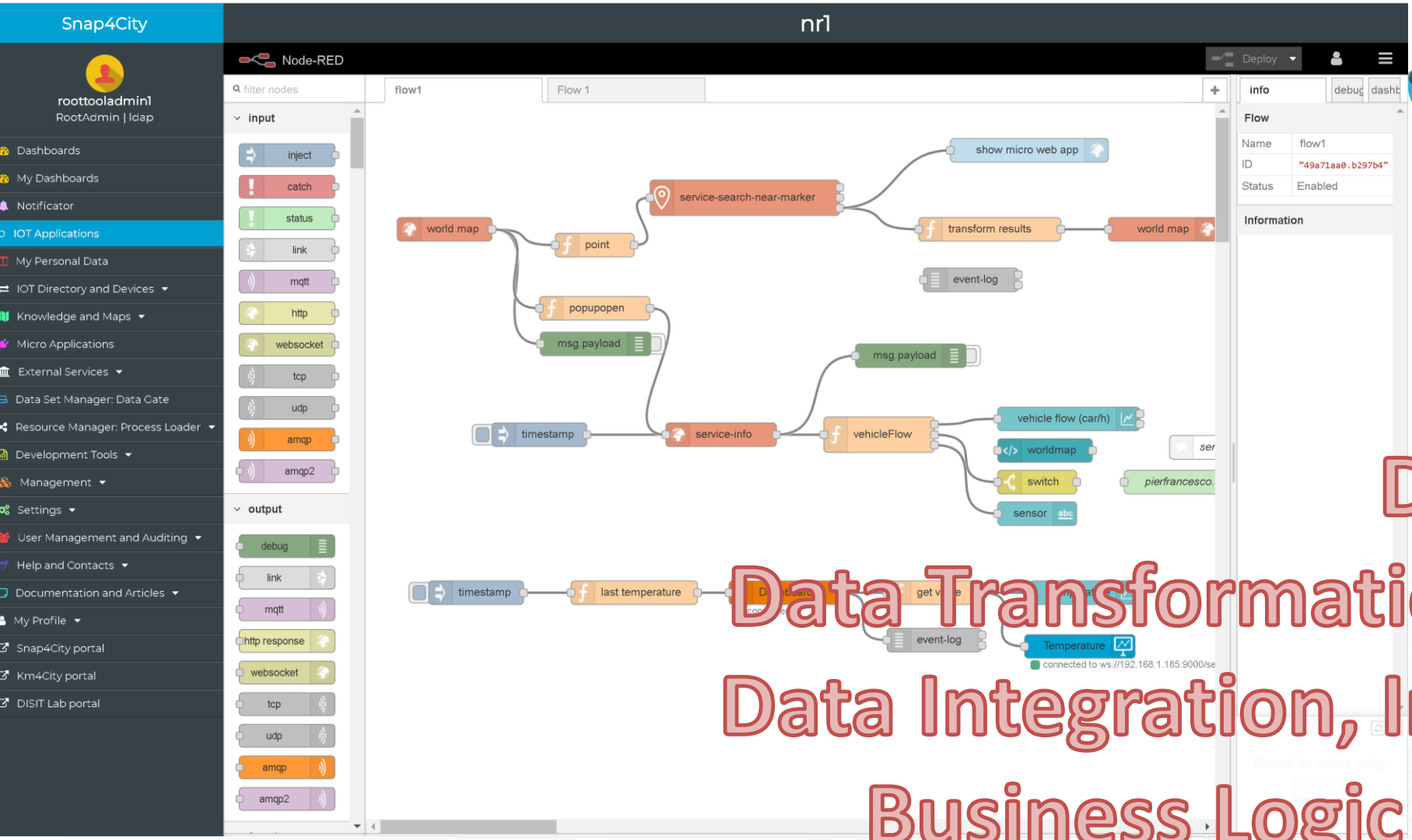



# Part 3: IoT App, process logic, server side BL


- Recall on Snap4City Architecture
- Node-RED
- IOT App = Node-RED + Snap4City
  - IoT App === Proc.Logic
- Examples of IOT App for Smartening Solutions
- Exploiting/Generating data by using: IoT App/Proc.Logic
- External Service <-> IoT App/Proc.Logic
- Dashboards <-> IoT App/Proc.Logic
  - Server Side Business Logic
- training material

# Technical Architecture






Data Adapation

Data Transformation, Conversion

Data Integration, Interoperability

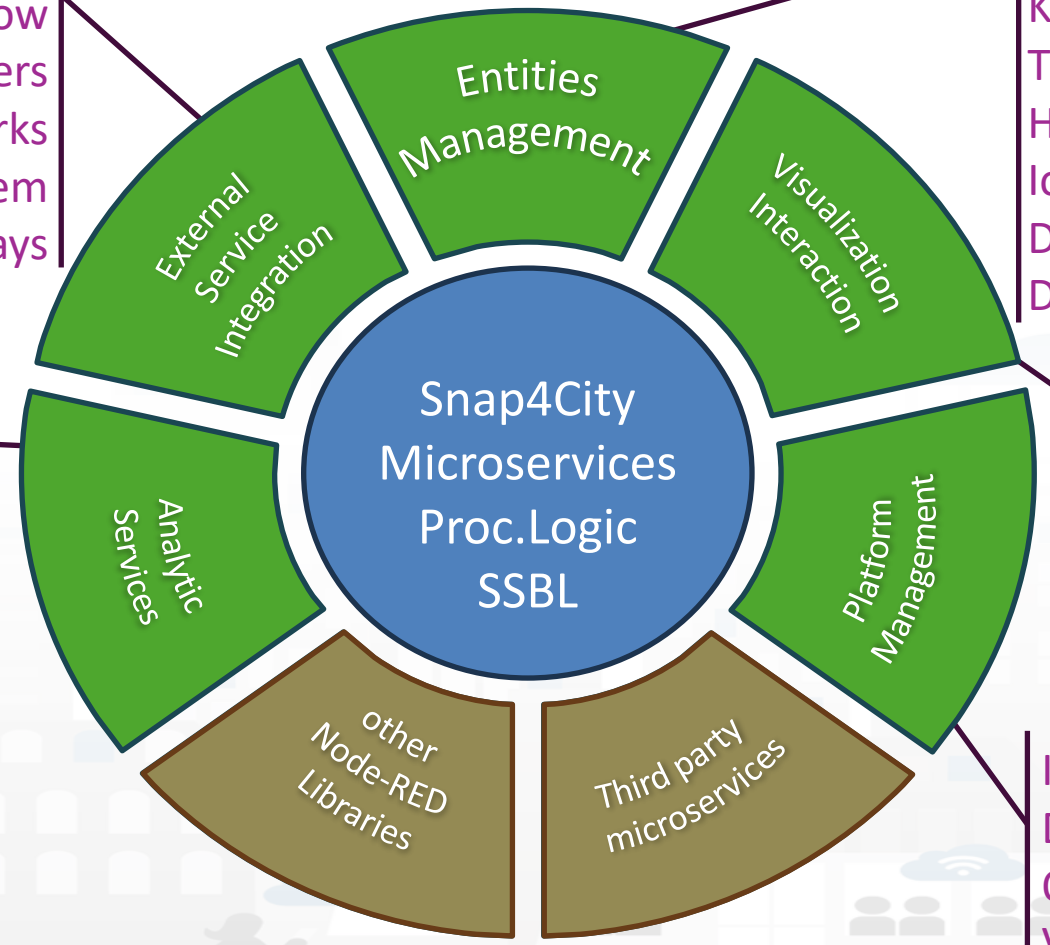
Business Logic vs Dashboards

Editing IOT Applications

Data Analytics control

Everywhere: Cloud, on IoT Edge Devices

# MicroServices Areas




Open Data CKAN
Ticket Management, workflow
BIM Servers
Social Networks
Video Management system
Gateways

Data Load / Search / Retrieval
KPI, POI, GIS Data, Scenarios
Time Series, Public transport
High Level Types: heatmaps, ODM,…
IoT / Entity Discovery
Delegation Management
Data Mapping

Data Analytics
Statistic, Optimization
Simulation
Artificial Intelligence
What-if Analysis Support
Geo Utilities Support
Routing & Traffic Flow
MLOps support
Python support
R Studio Support

Dashboards
Widgets: Graphic Libraries
Interactive Widgets
Maps, 3D representations
Synoptics, External Content
Micro Web App

IoTApp Management
Data Logs, A&A, Security
Ownership Management
VPN remote access

Node-RED

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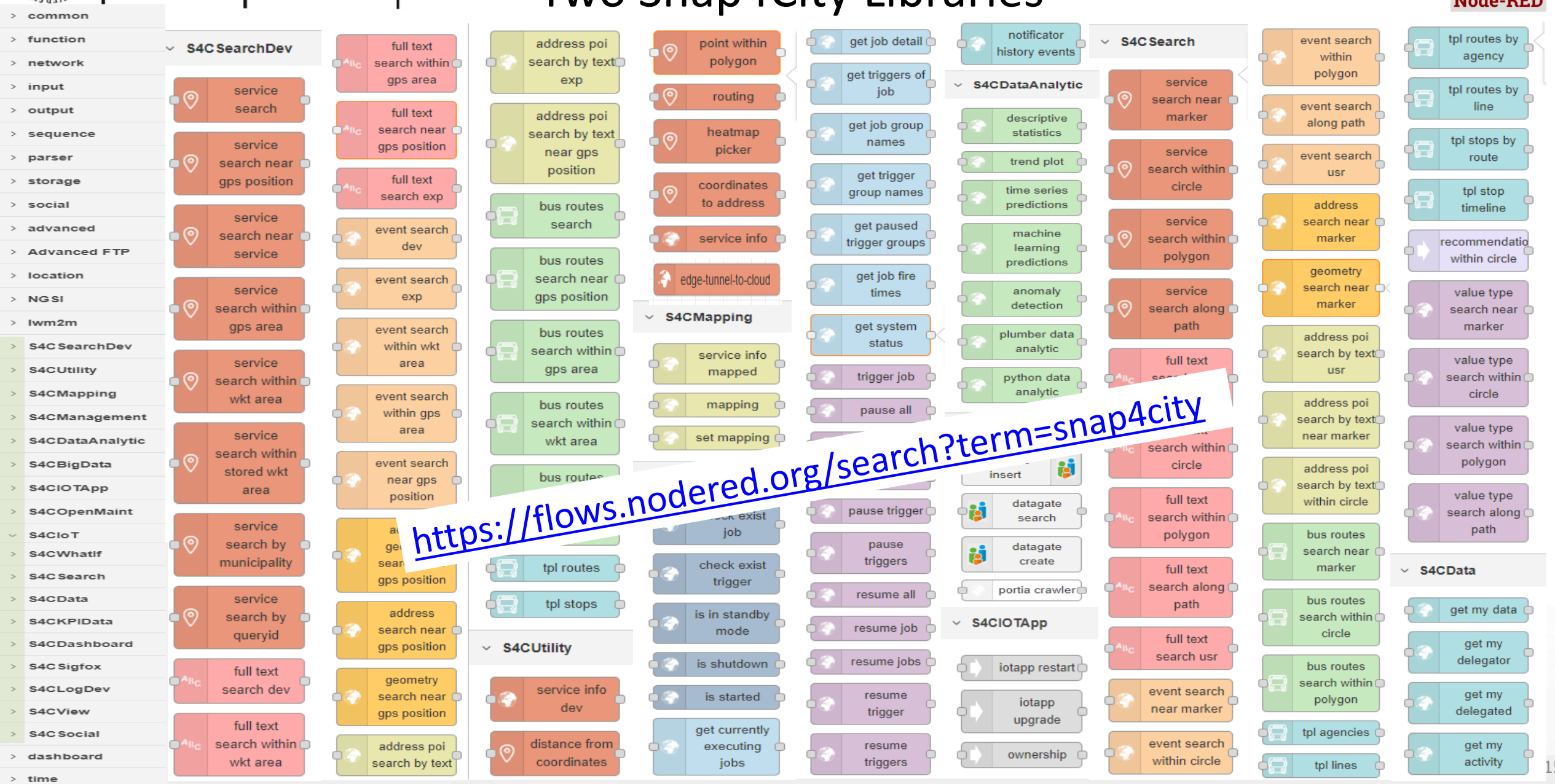
# Sept 2023 collection

## Two Snap4City Libraries

SNAP4CITY | Node-RED




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

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# Sept 2023 collection

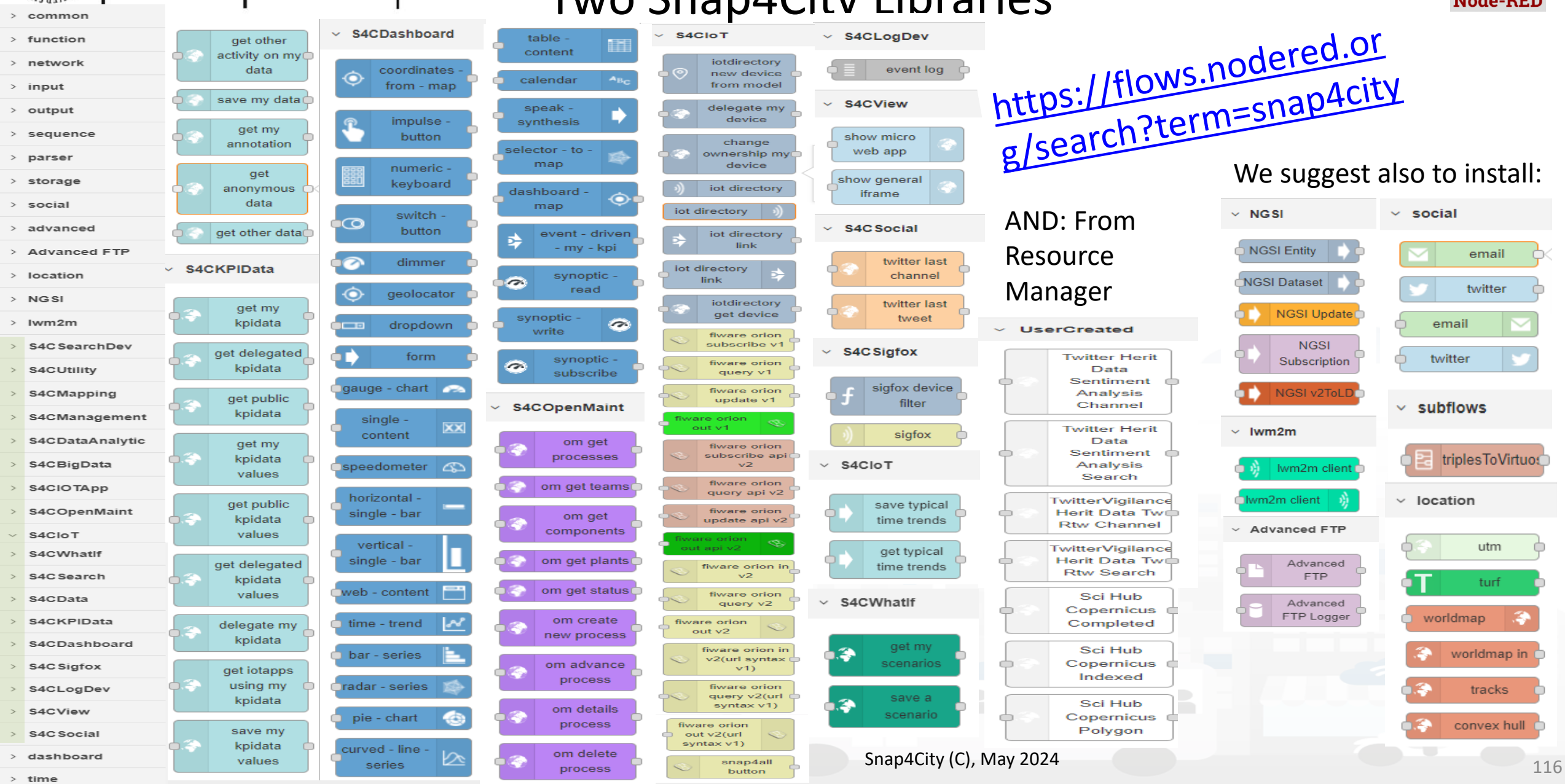
## Two Snap4Citv Libraries

SNAP4CITY | Node-RED

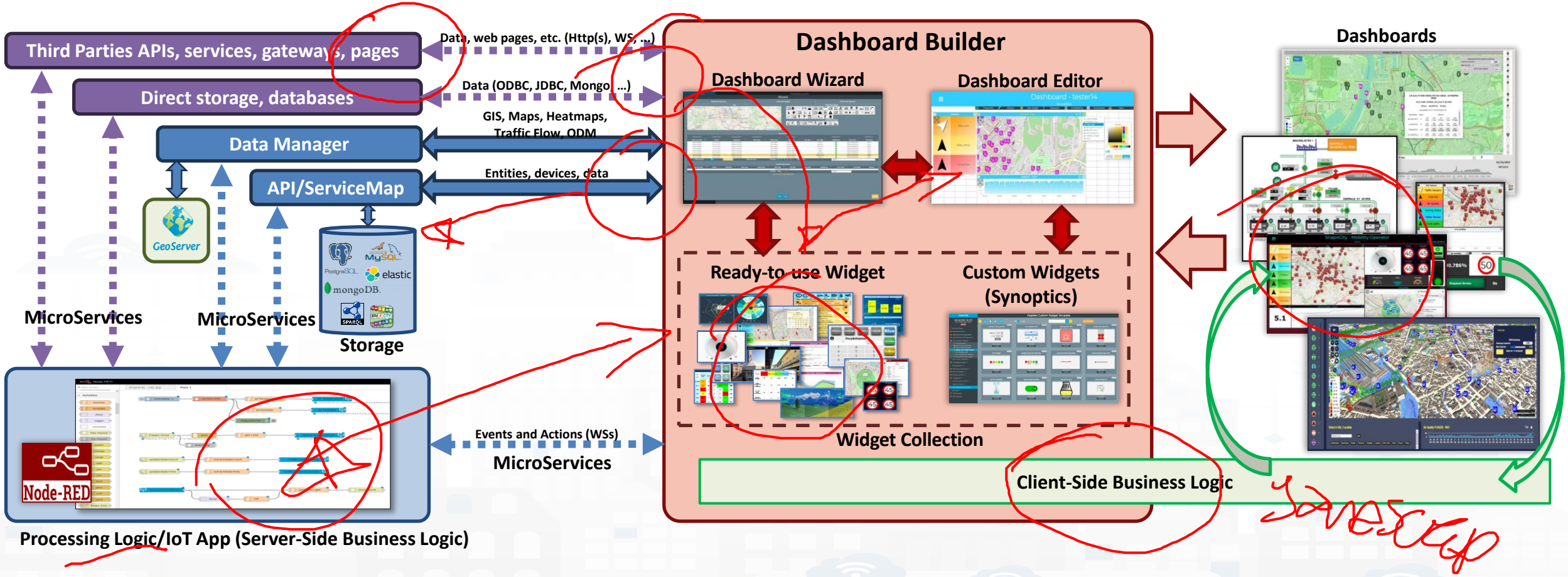
https://flows.nodered.org/search?term=snap4city

We suggest also to install:

AND: From Resource Manager

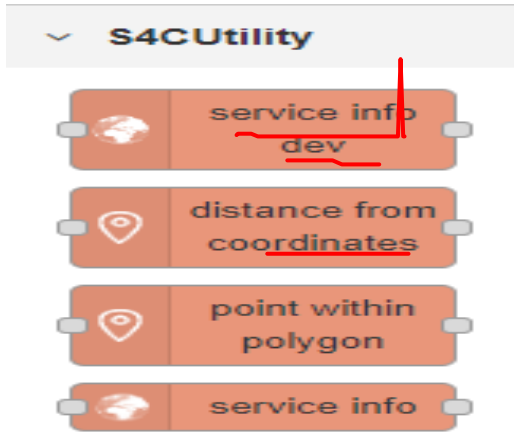


# How the Dashboards exchange data

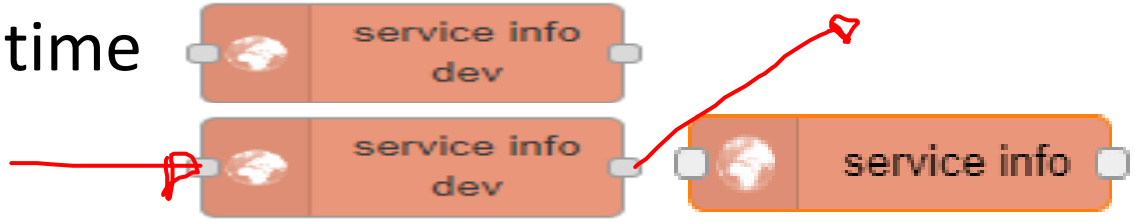


# S4CSearch

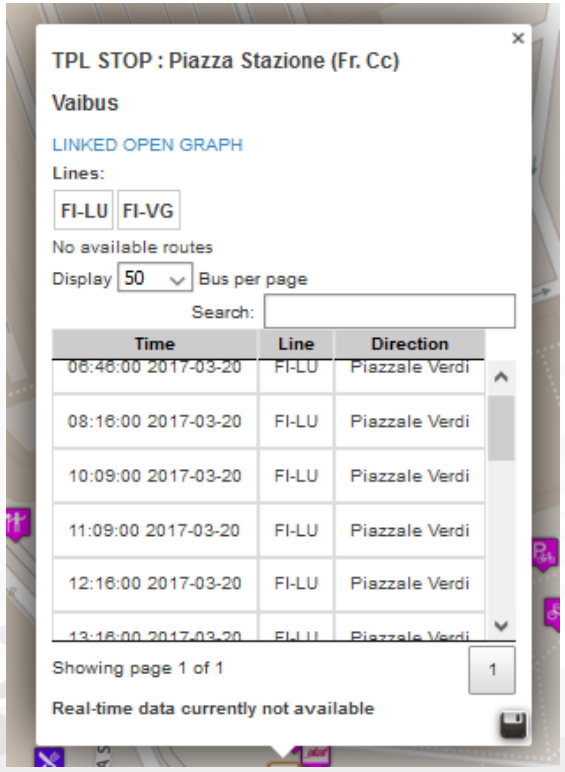


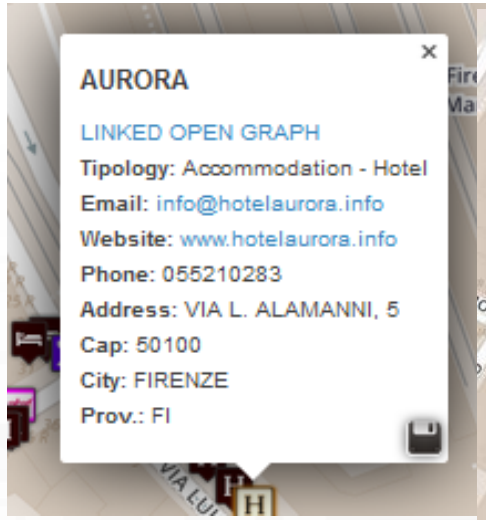


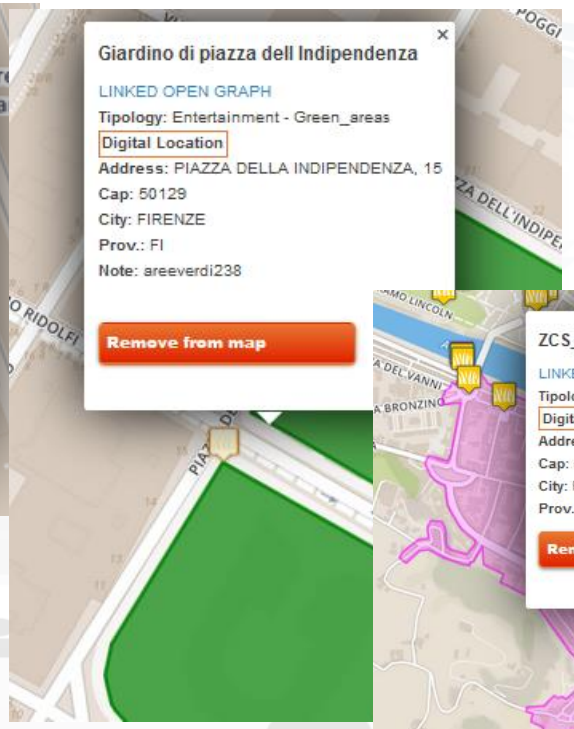

- ANY kind of sensors
- **To Get DATA of a Service / POI /sensor**
  - Historical and real time
  - Real Time

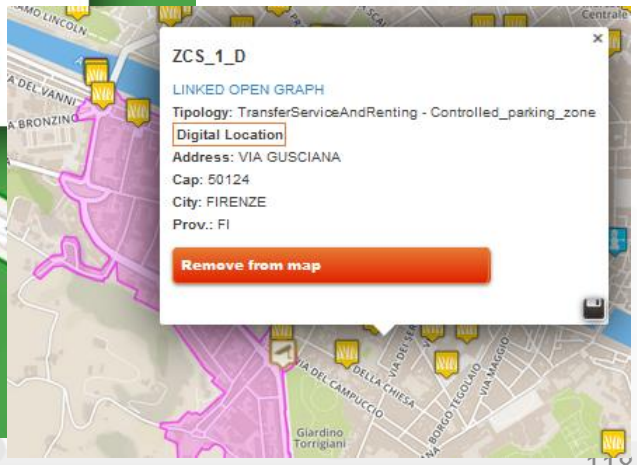




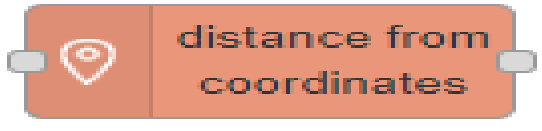


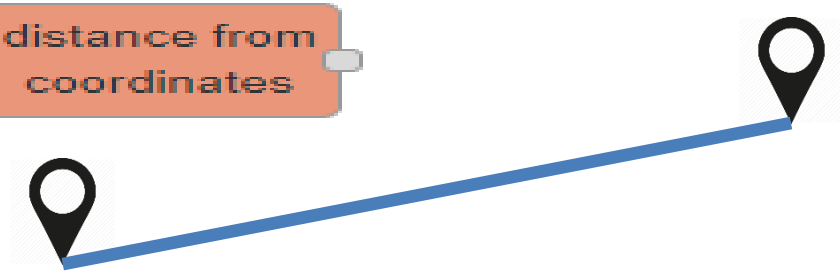



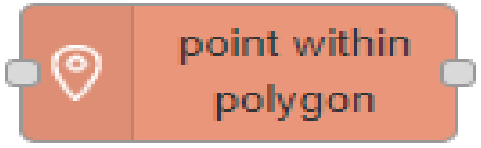



- **Distance from GPS point**



- **Point is in Polygon ?**
  - **Polyline as WKT**



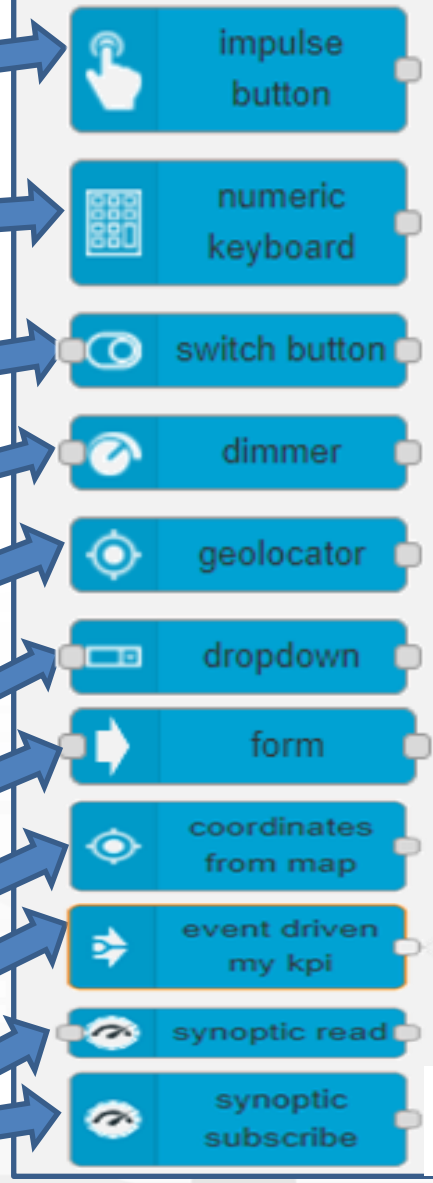

# Dashboard-IoT App



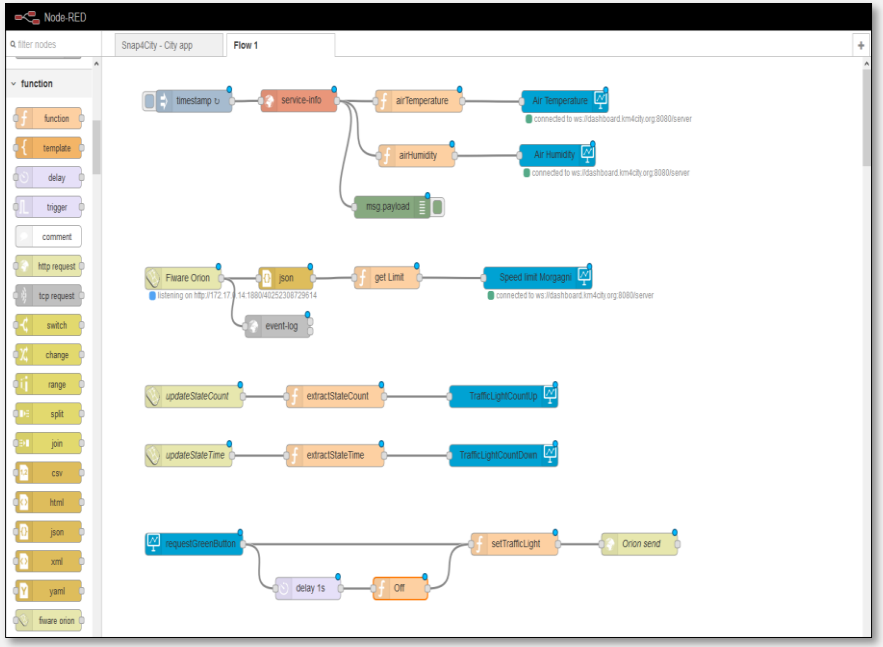
MapClick

MyKPI variable onchange

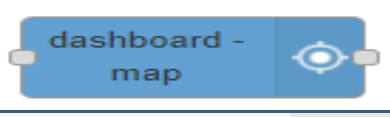
Synoptics




## From Dashboard to IOT App




IOT Application



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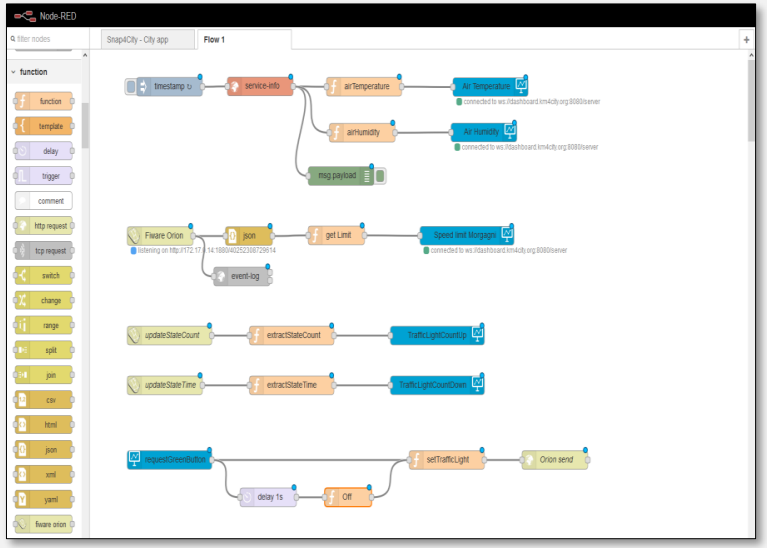
# Nature

SNAP4CITY | Node-RED

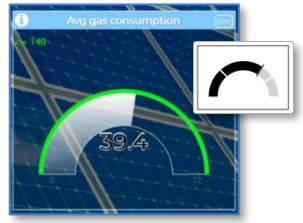
# Dashboard-IOT App

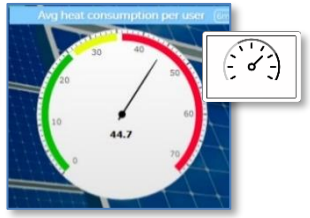
## From IoT App to Dashboard

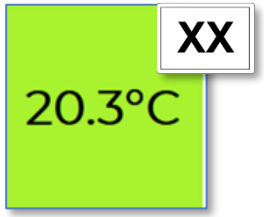


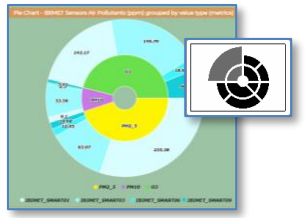

IOT Application

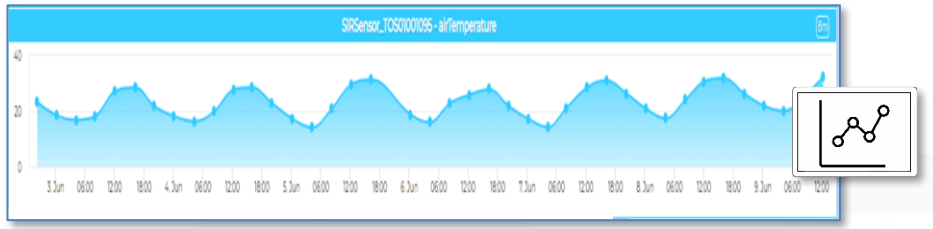
- gauge chart
- single content
- speedometer
- horizontal single bar
- vertical single bar
- web content
- time trend
- bar series
- radar series
- pie chart
- curved line series
- table content
- calendar
- speak synthesis
- synoptic write
- Selector - Map
- Snap4D3
- dashboard - map
- event table
- device table

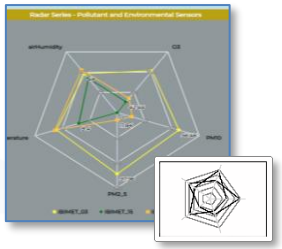


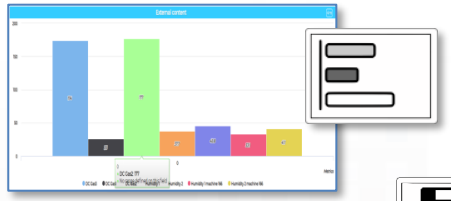



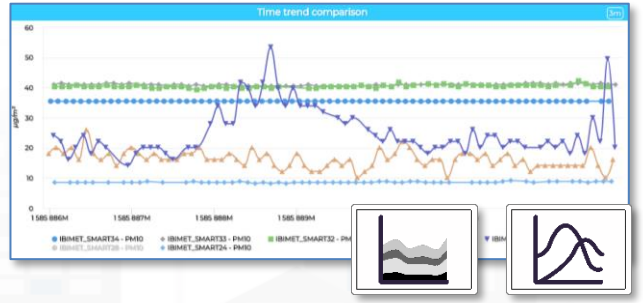



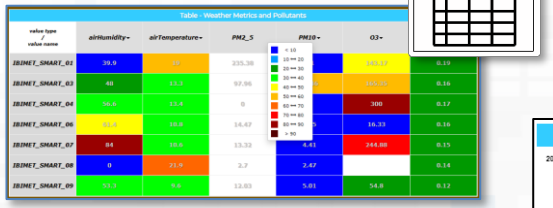



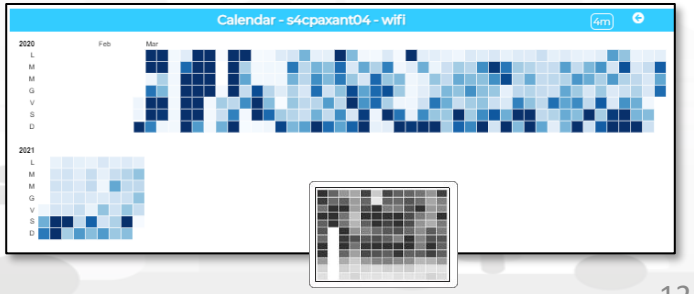






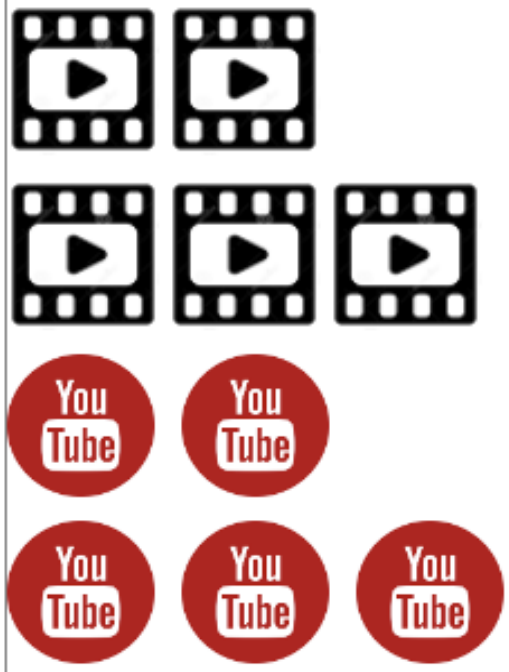



# Part 5: Data Ingestion and Interoperability

Part 5: Data Ingestion and Interoperability

SLIDES

Interactive Slides

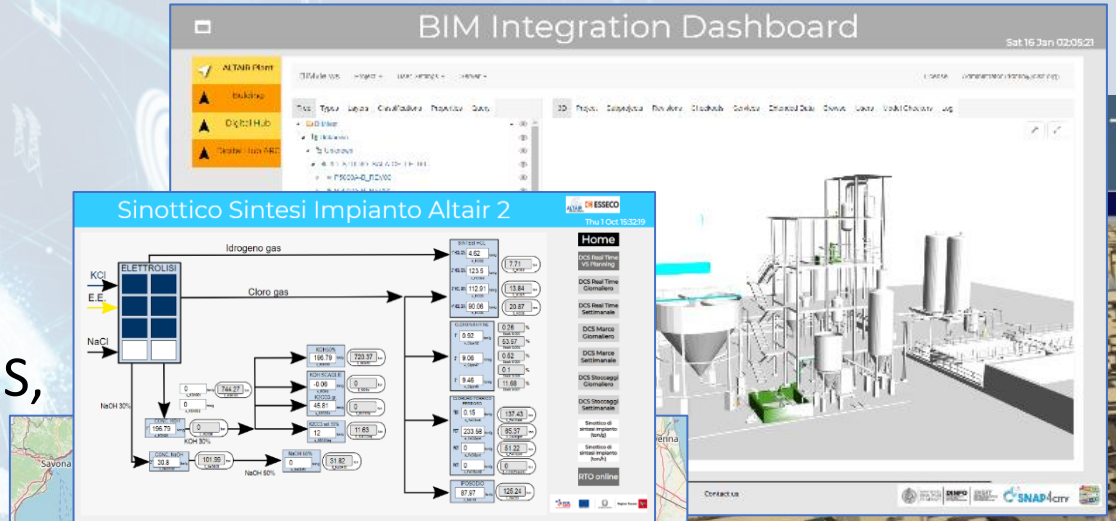


- When Solutions and tools for Data Ingestion and Interoperability are needed
- Overview of Snap4City Data Storage and Stack
- Knowledge Base: Modelling and Setting Up
- High Level Types vs Ingestion Process
- Data Ingestion Strategy and Orientation
- Ingestion of Points of Interest with POI Loader
- Models vs Devices/Entities and Registration
- Verification of Data Ingestion
  - Digital Twin Data Inspector vs Data Processes Details
  - My Data Dashboard Dev to assess data on Open Search Storage
- An Integrated Example for Time Series
- Entities Ingestion with Data Table Loader
- High Performance Ingestion via Python
- FIWARE Smart Data Models on Snap4City
- Ingestion of MyKPI with Proc.Logic / IoT App

# High Level Types

Snap4City (C), May 2024

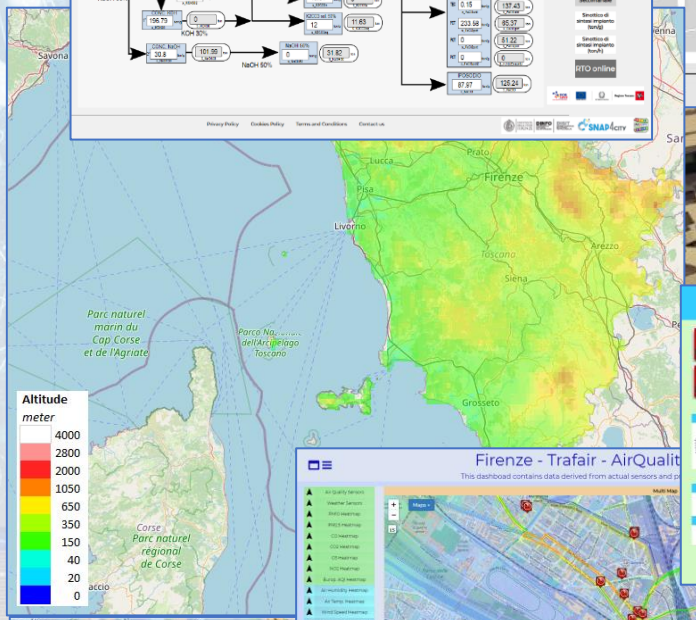
- POI, IOT Devices, shapes,..
  - FIWARE Smart Data Models,
  - IoT Device Models
- GIS, maps, orthomaps, WFS/WMS, GeoTiff, calibrated heatmaps, ..
- Satellite data, ..
- traffic flow, typical trends, ..
- trajectories, events, Workflow, ..
- 3D Models, BIM, Digital Twins, ..
- OD Matrices of several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



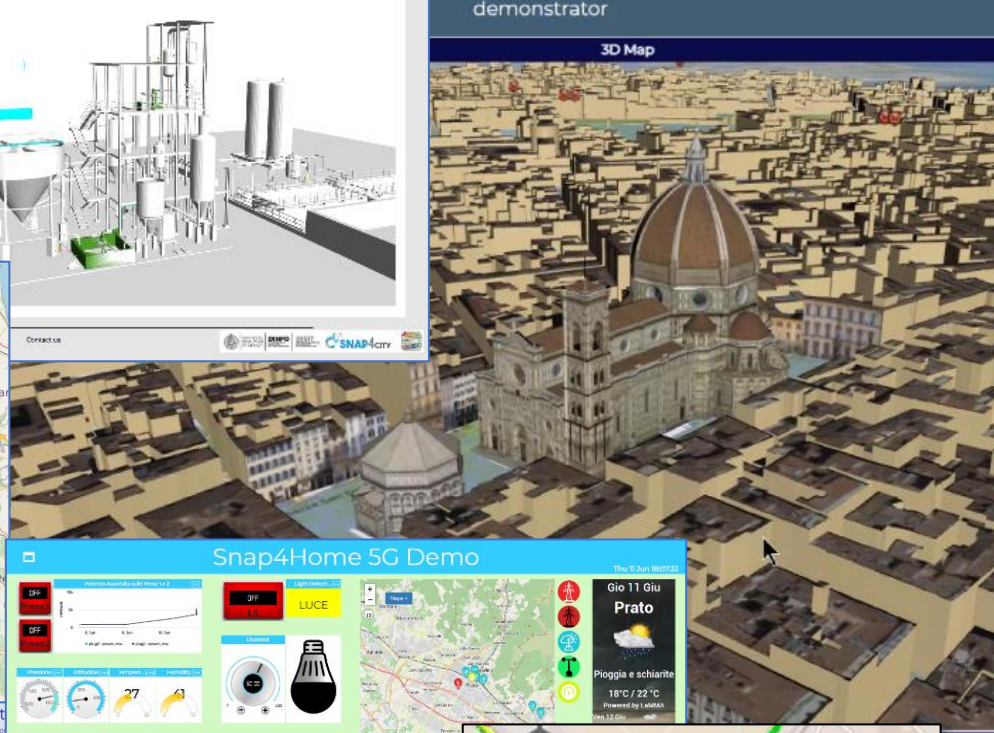


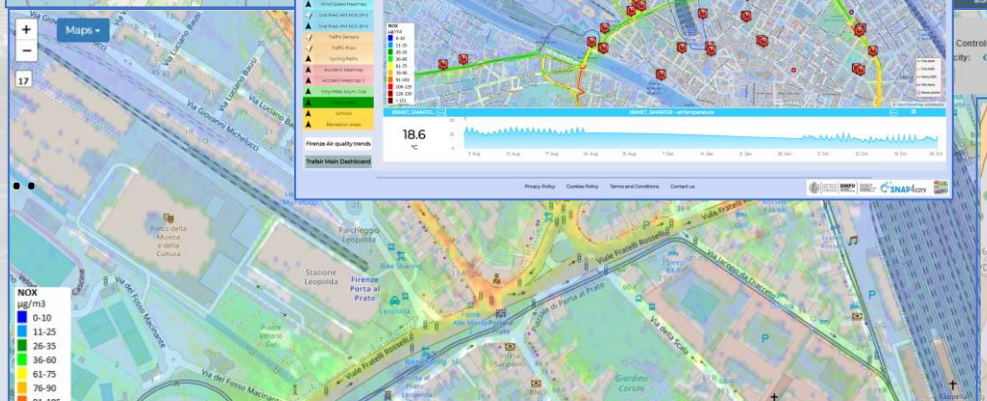









# Entity Instances, IoT Devices

Snap4City

Switch To New Layout (Beta)

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

LOGOUT

- My Snap4City.org
- Tour Again
- www.snap4solutions.org
- Dashboards (Public)
- Dashboards of My Organization
- My Dashboards in My Organization
- My Data Dashboard Dev Kibana
- Extra Dashboard Widgets
- Data Management, HLT
- Knowledge and Maps
- Processing Logics / IOT App
- Entity Directory and Devices
  - My IOT Sensors and Actuators
  - IOT Sensors and Actuators
  - Entity Instances, IoT Devices
  - IOT Brokers
  - FIWARE Smart Data Models
  - Entity Models/IoT Devices
  - IOT Devices Bulk Registration
  - Doc: IOT Directory and Devices
  - Create an IOT Device Instance
  - Create an IOT Device Model

Show delegated dev. | Show public dev. | Show my dev. | Show all dev

Add new device

Show entries

Search:

| | Device Identifier | IOT Broker | Device Type | Model | Ownership | Status | Edit | Delete | Location | View |
|---|---|---|---|---|---|---|---|---|---|---|
| + | 1dd79caa95f6771afad4fd38e699c8542022-12-05T18:54:13.000Z | orionUNIFI | File | fileModel | MYOWNPUBLIC | active | EDIT | DELETE | | VIEW |
| + | alert_1610543238306 | orionUNIFI | event | AlertGeneric | MYOWNPRIVATE | active | EDIT | DELETE | | VIEW |
| + | alert_1610548534047 | orionUNIFI | event | AlertGeneric | MYOWNPRIVATE | active | EDIT | DELETE | | VIEW |
| + | alert_1610613189703 | orionUNIFI | event | AlertGeneric | MYOWNPRIVATE | active | EDIT | DELETE | | VIEW |
| + | alert_1610629197473 | orionUNIFI | event | AlertGeneric | MYOWNPRIVATE | active | EDIT | DELETE | | VIEW |
| | | orionUNIFI | event | AlertGeneric | MYOWNPRIVATE | active | EDIT | DELETE | | VIEW |
| | | orionUNIFI | event | AlertGeneric | MYOWNPRIVATE | active | EDIT | DELETE | | VIEW |
| | | orionUNIFI | event | AlertGeneric | MYOWNPRIVATE | active | EDIT | DELETE | | VIEW |
| | | orionUNIFI | event | AlertGeneric | MYOWNPRIVATE | active | EDIT | DELETE | | VIEW |
| | | orionUNIFI | event | AlertGeneric | MYOWNPRIVATE | active | EDIT | DELETE | | VIEW |

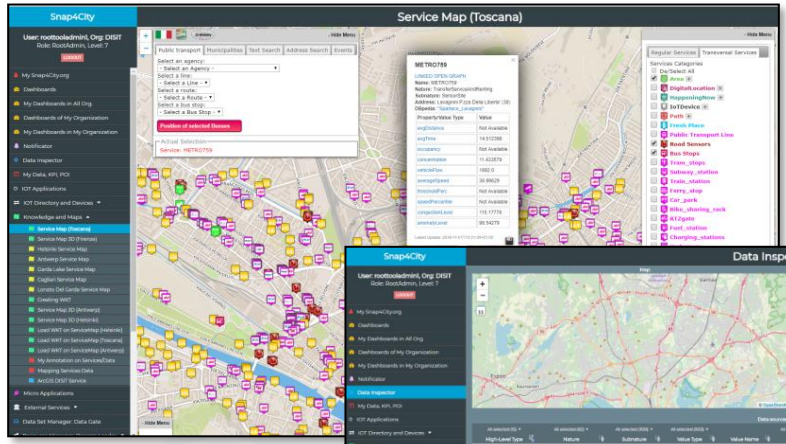
Previous 1 2 3 4 5 ... 12 Next

# Checking data/Entity ingestion results

**Knowledge base**
Semantic reasoners

- All searches
- Metata
- Structure
- Last values of IoT Dev
- GTFS
- Only public IoT Dev

- **ServiceMap**, SCAPI, **SuperSM**
  - LOG / LOD viewer
  - Super Service Map
  - SCAPI: Swagger
  - Last data
- **Data Inspector (last data)**
- IoT/Entity Directory
  - IoT Brokers



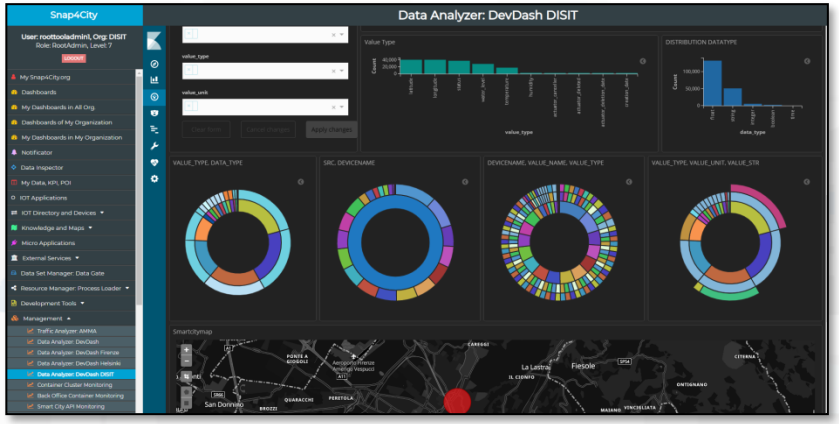

ServiceMap or
Super ServiceMap

Data Inspector
Digital Twin view

**Indexing and aggregating**
NIFI, OpenSearch

- Faceted search
- Geo search
- Time Series
- Private and Public

- **ServiceMap**, SCAPI (last data), **SuperSM**
- **My Data Dashboard,** OpenSearchDash
- **Data Inspector (last data)**

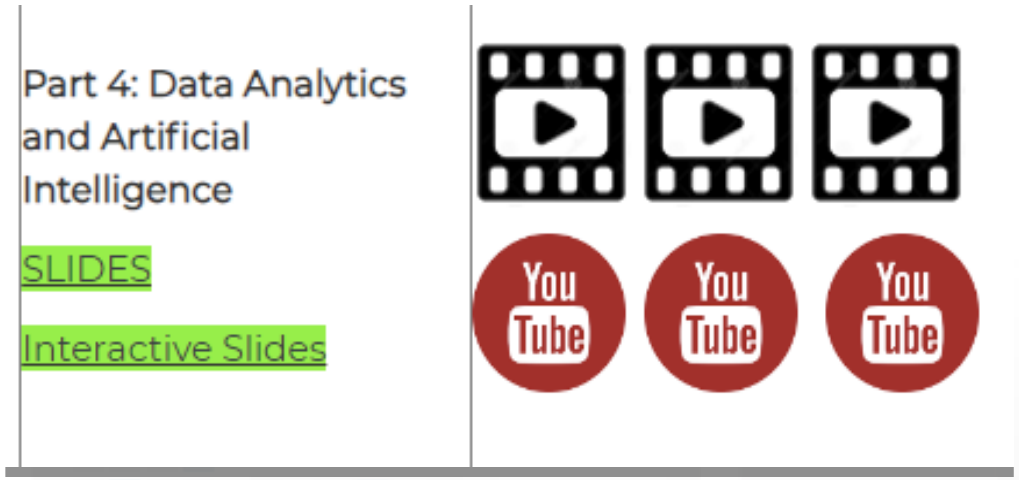



My Data Dashboard

DevDash

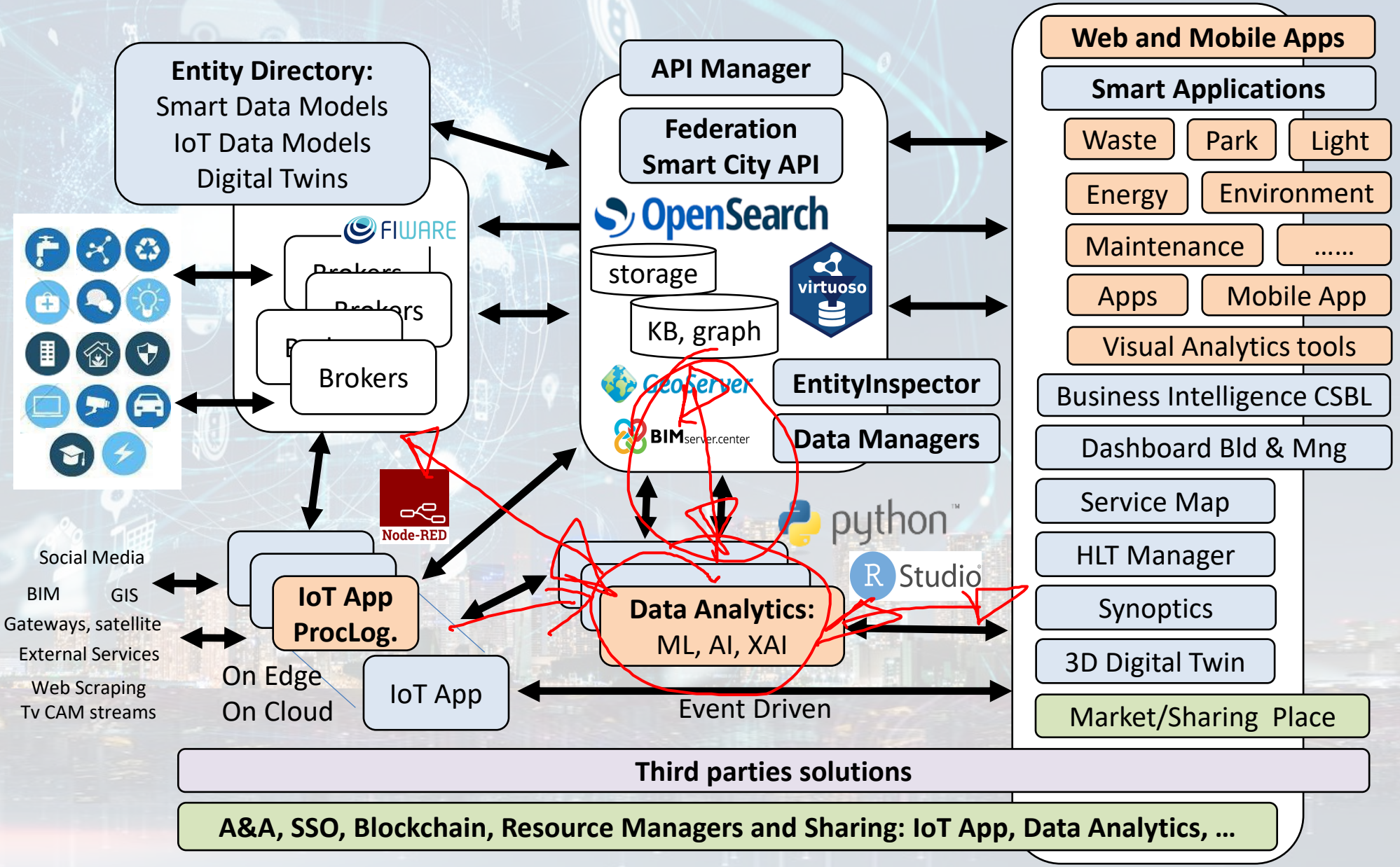
*Some functionalities are limited to certain roles*

# Part 4: Data Analytics



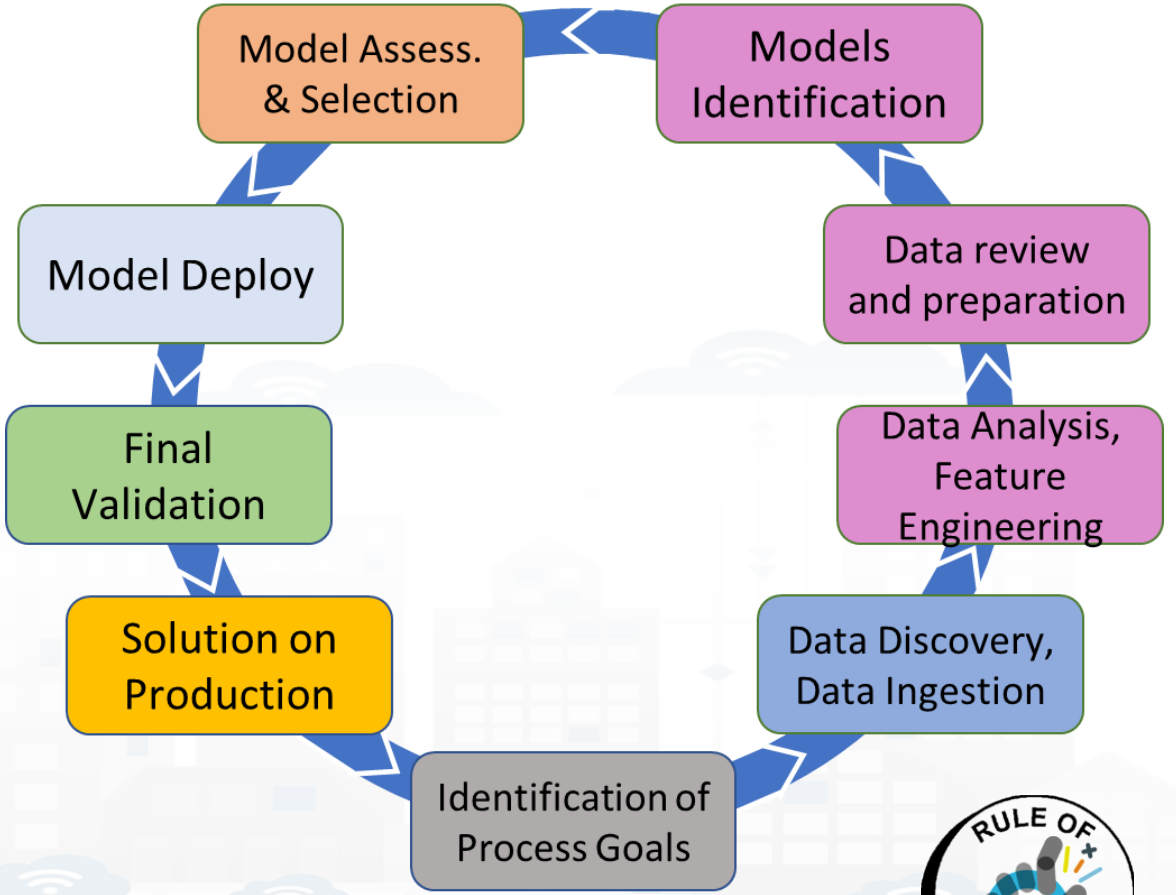

- Why and Where use DA, AI and XAI --> General Life Cycle
- Data Processing
- What is Data Analytics, DA and Artificial Intelligence, AI
- List of the most relevant available DA and AI Solutions
- Predictions and Anomaly detections
- Computing: Higher Level Types Data and their representations
- How AI/XAI, and  Life Cycle
- Using DA, AI, XAI in Snap4City infrastructure
  - Data Analytics <--> IoT App / Proc.Logic
- Decision Support Systems and What-If Analysis
- Routing, Multimodal Routing, Dynamic Routing
- Business Intelligence and Visual Analytics

# Technical Architecture



# Model/Technique Development/testing

- **Identification of Process goals and Planning (problem definition)**
  - Which goals
  - How to compute, which language
  - Which environment, which libraries
- **Data Discovery and Ingestion (from the general life cycle)**
  - Data Collection, Data Preprocessing if needed
- **Data Analysis: feature engineering, feature selection**
  - Data ethics assessment
- **Data review and preparation for the model, splitting, encoding**
- **Model Identification and building: ML, AI, etc….**
  - Model Training
  - Tuning hyperparameters when possible
- **Model Assessment and Selection (Evaluation)**
  - Validation in testing
  - Assessment on a set of metrics depending on the goals: global relevant and feature assessment
  - Assessing computational costs
  - Impact Assessment, Ethic Assessment and incidental findings
  - Global and Local Explanation via Explainable AI techniques
- **Model Deploy and Final Validation**
  - Optimisation of computation cost for features, if needed reiterate
  - Solution on Production (security, scalability, etc.)
- **Monitoring and Maintenance on production**
- **Documentation, incremental documentation**



# Data Analytics on Snap4City platform

Swagger

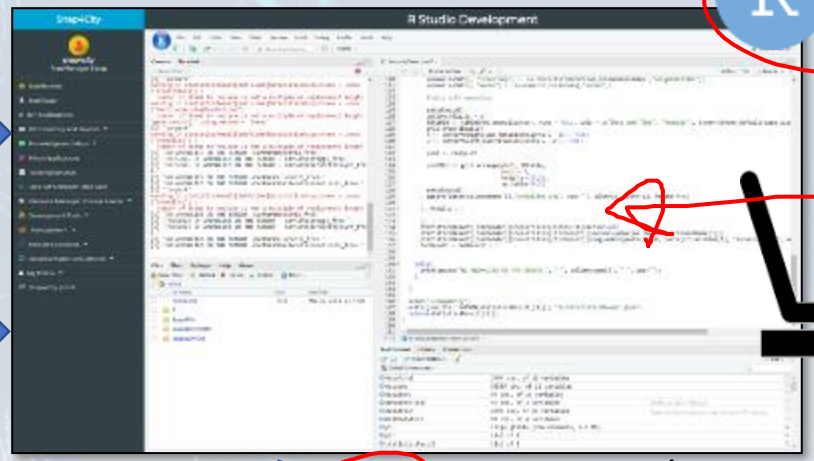
Ontology Schema

LOG.disit.org

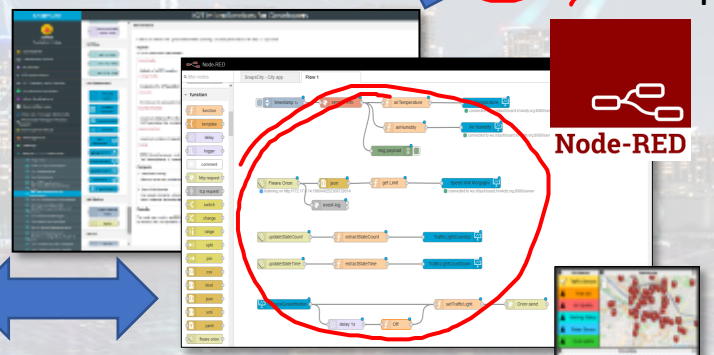
Knowledge Base, Km4City

**Big Data Store Facility**

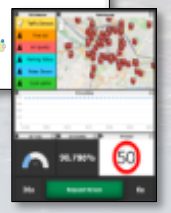
Smart City API from Knowledge Base and other tools



Creating MicroServices



Node-RED



Using them into IOT Applications

Saving / Sharing reusing

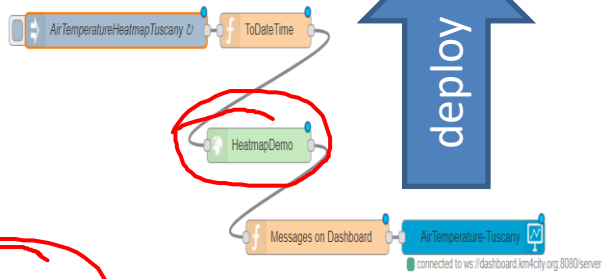
Resource Manager

# Development

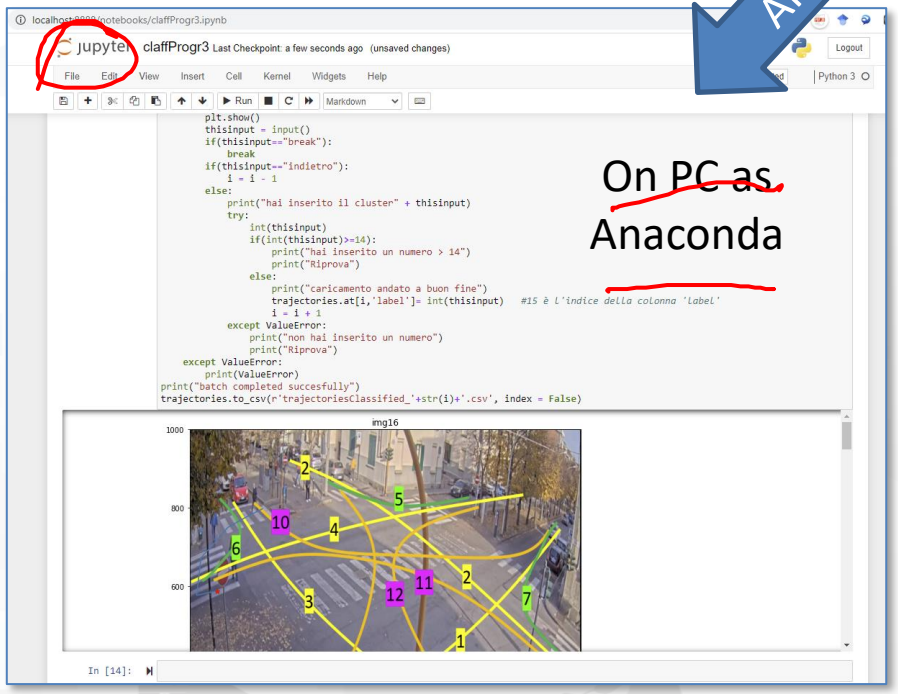
API


API


deploy




On Server
Or
On PC

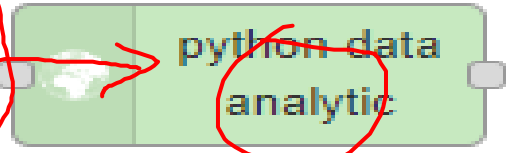



Once finalized

File.py
AI Model
Mapping
Data..

ZIP

Load
File.py
or .zip



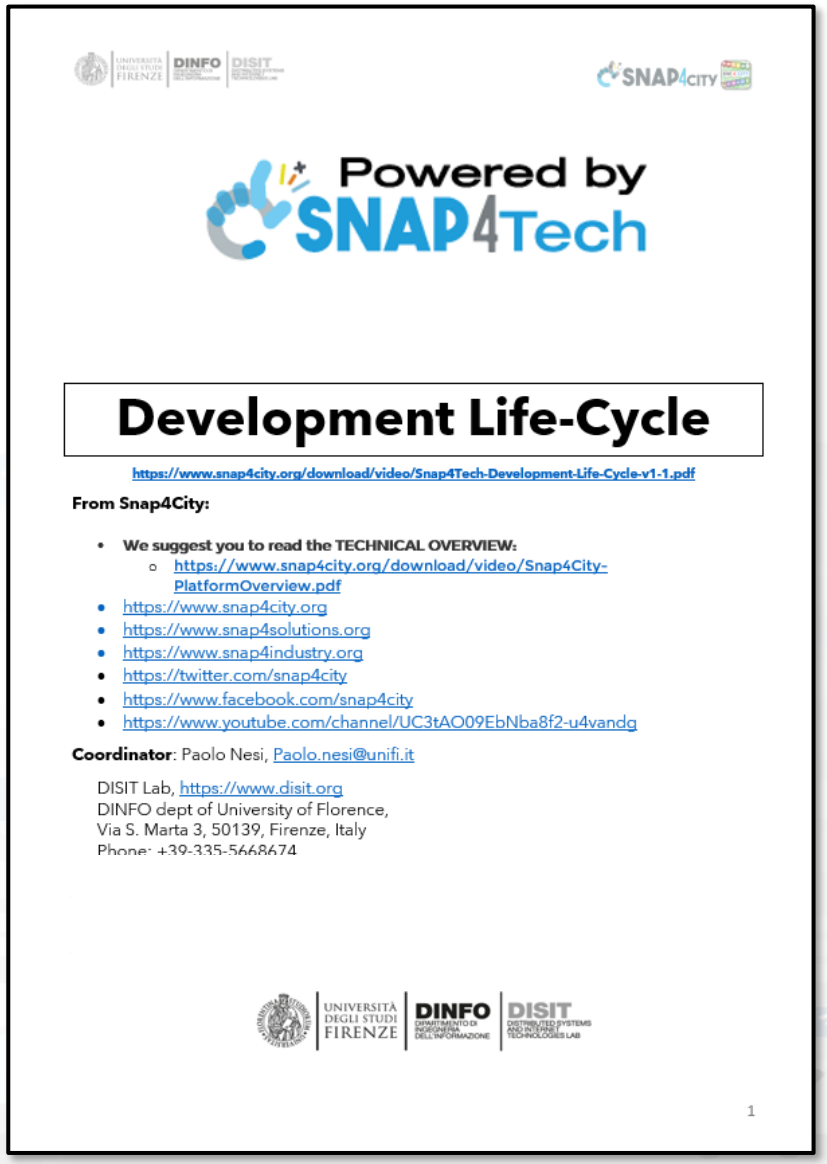

To make the .PY usable as MicroService you need to adapt it to get and send data in/out with Node-RED from a Container.
**If you provide a .zip file the main .py inside has to be called doScript.py**

# Parts 7 & 8: API, Mobil, Business Intelligence

| | |
|---|---|
| Part 7: Exploiting Snap4City API, and Web/Mobile Applications SDK<br>SLIDES<br>Interactive Slides |  |
| Part 8: Developing Smart Applications & Business Intelligence Solutions<br>SLIDES<br>Interactive Slides |  |

- Smart City API: Internal and External
- Concepts and tools for using Knowledge Base, ServiceMap, API
- Federated Knowledge Bases and Smart City APIs
- Advanced Smart City API
- Access to Protected data
- Forging and managing: Mobile and Web Apps, MicroApplications
- Web and Mobile App Development Kit
- ----------
- Developing in the smart city IoT/WoT context
- Smart Solutions Development Life Cycle
- Analysis for Innovation (Co-Creation and Co-Working)
- Design: Data, Data Models, Data Relationships
- Design & Develop: Data Processes Proc.Logic / IoT App
- Design & Develop of Data Analytics
- Design & Develop: user interfaces, visual tools
- Visual Analytic vs Data Analytics: Client Side Business Logic Intelligence
- Design and Control of Smart Applications

# 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

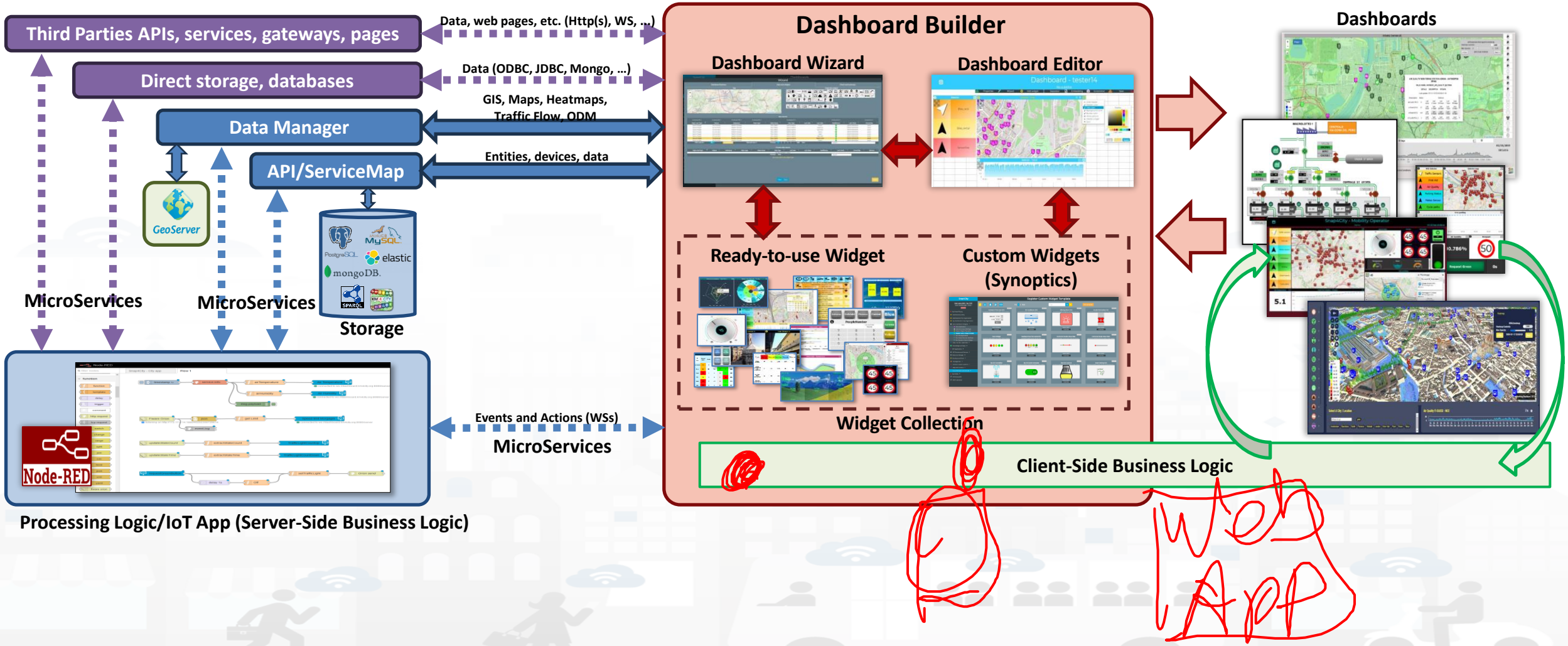
DISIT Lab, https://www.disit.org
DINFO dept of University of Florence,
Via S. Marta 3, 50139, Firenze, Italy
Phone: +39-335-5668674

UNIVERSITÀ DEGLI STUDI FIRENZE DINFO DISIT

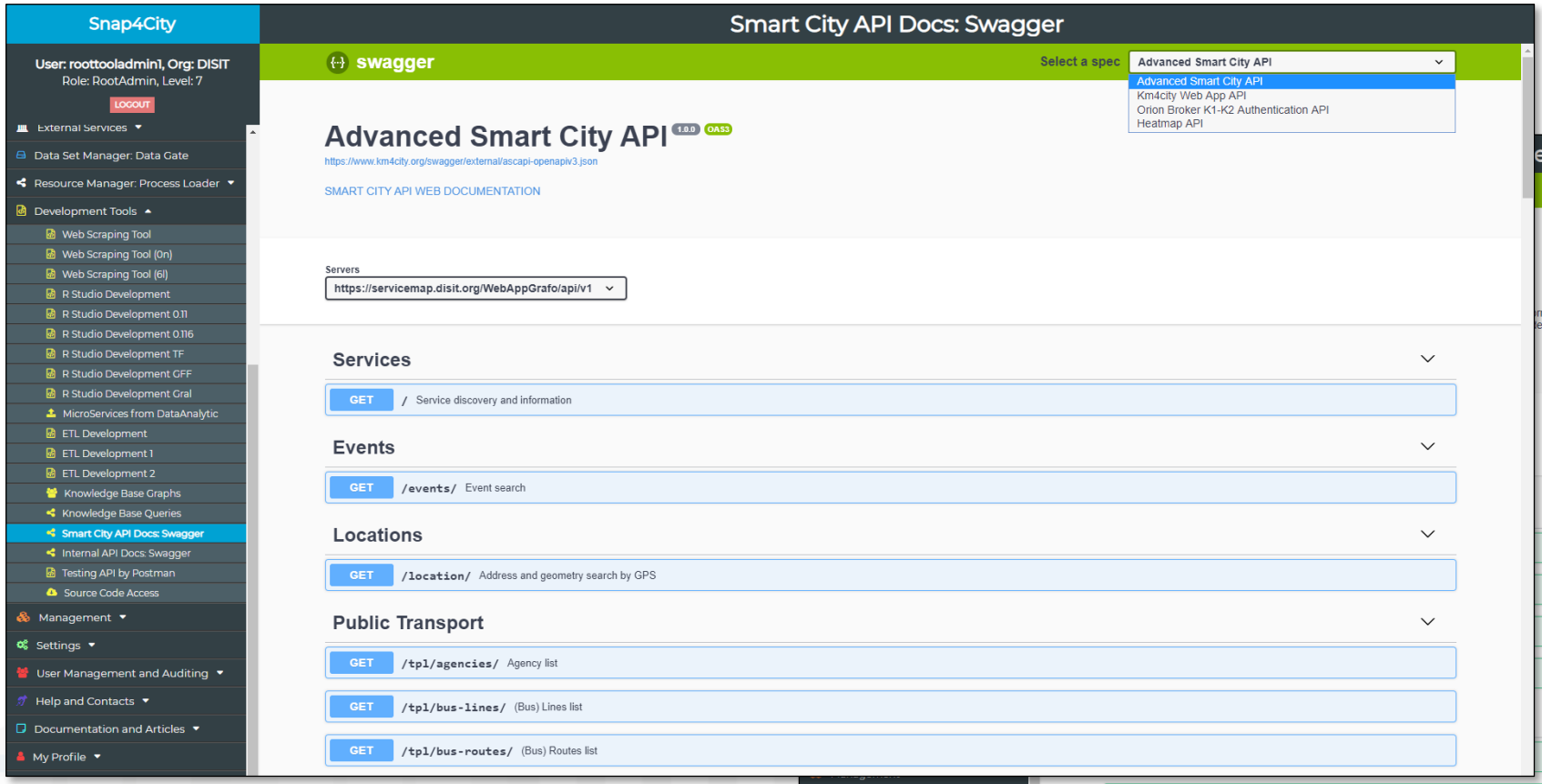
1

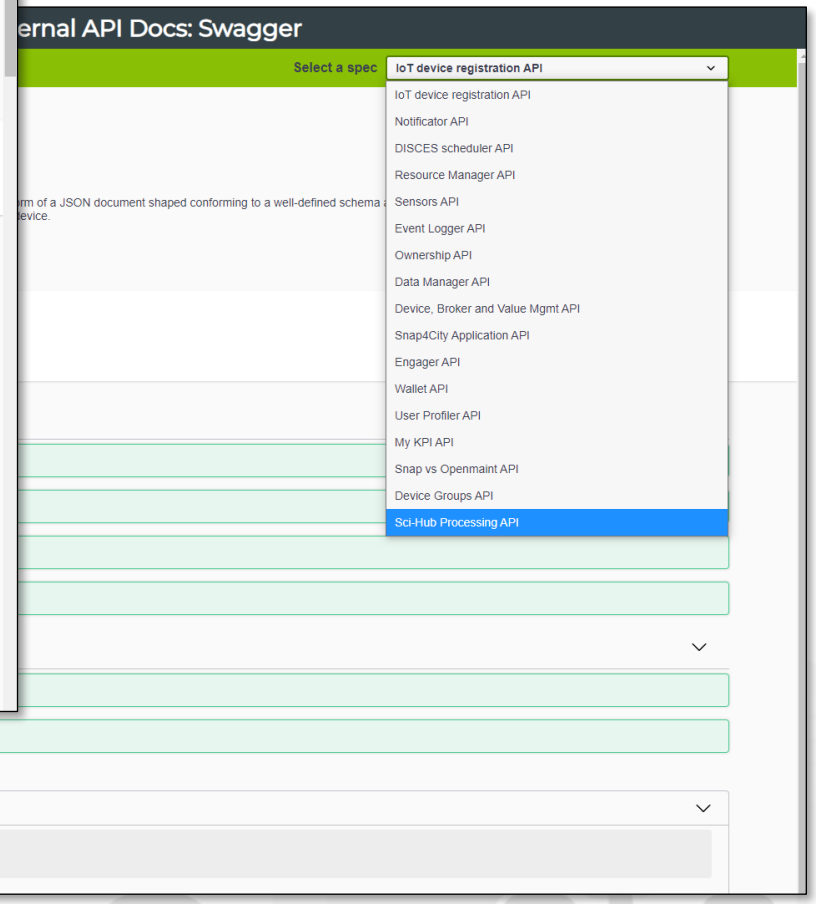
https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf

# How the Dashboards exchange data



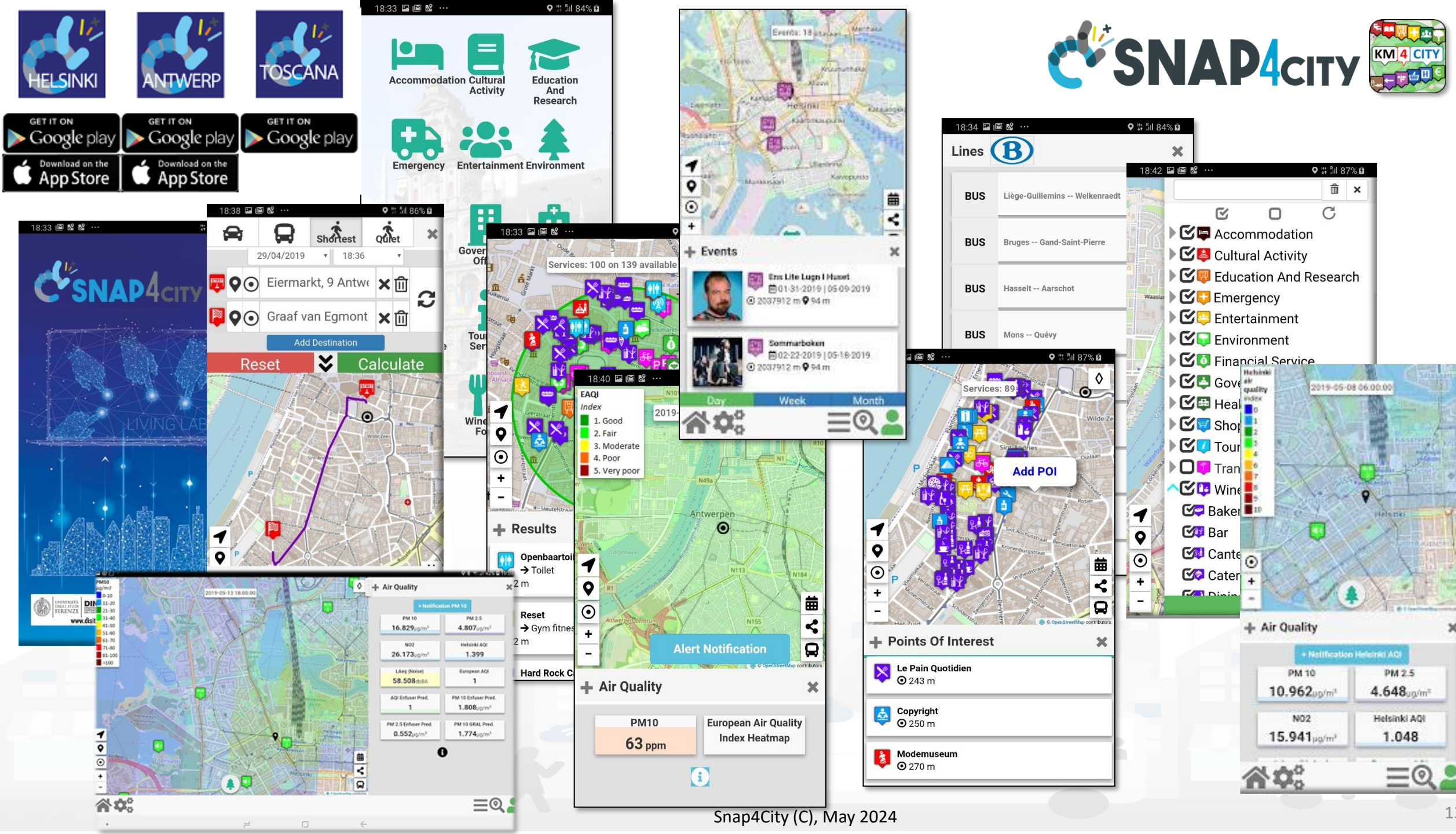
# Internal and External Smart City API



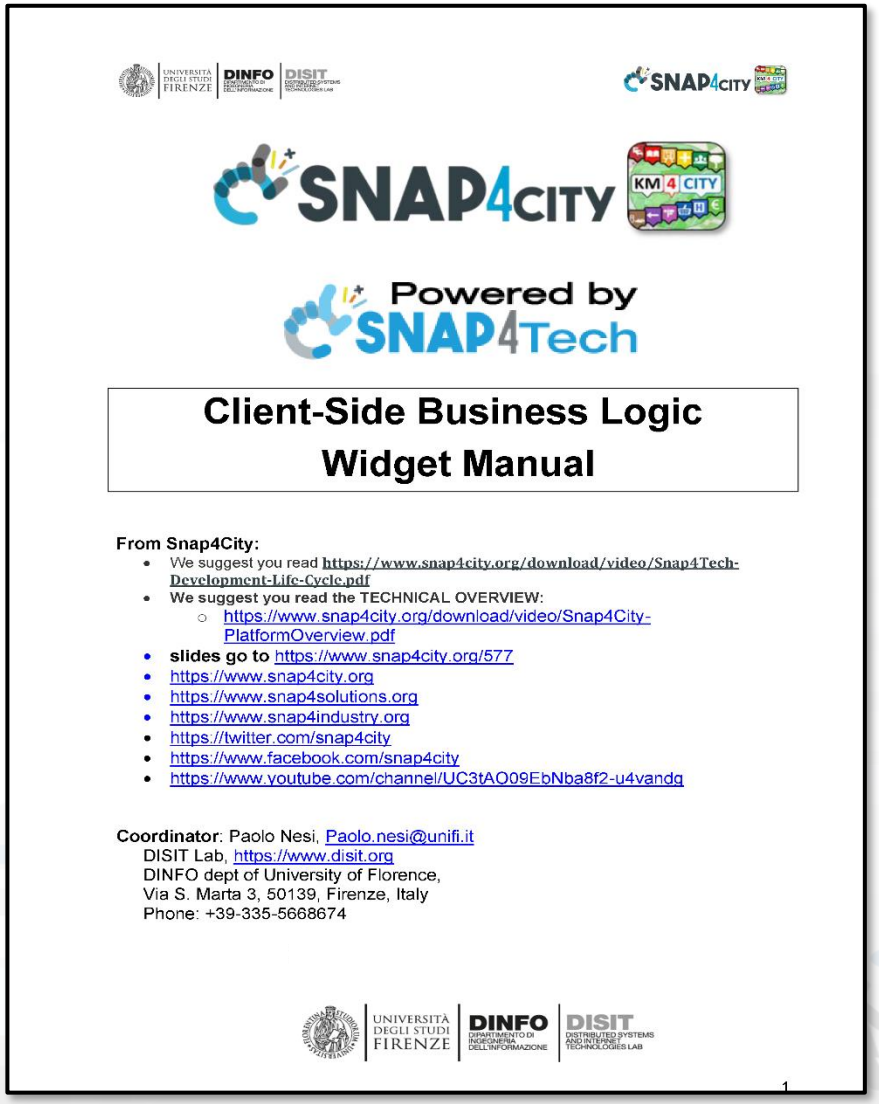

https://www.km4city.org/swagger/external/index.html

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


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

# CSBL

# Client Side Business Logic



Powered by SNAP4Tech

**Client-Side Business Logic Widget Manual**

**From Snap4City:**

- We suggest you read **https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf**
- **We suggest you read the TECHNICAL OVERVIEW:**
  - https://www.snap4city.org/download/video/Snap4City-PlatformOverview.pdf
- **slides go to** https://www.snap4city.org/577
- 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/UC3tAQ09EbNba8f2-u4vandg

**Coordinator**: Paolo Nesi, Paolo.nesi@unifi.it
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DINFO dept of University of Florence,
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Phone: +39-335-5668674

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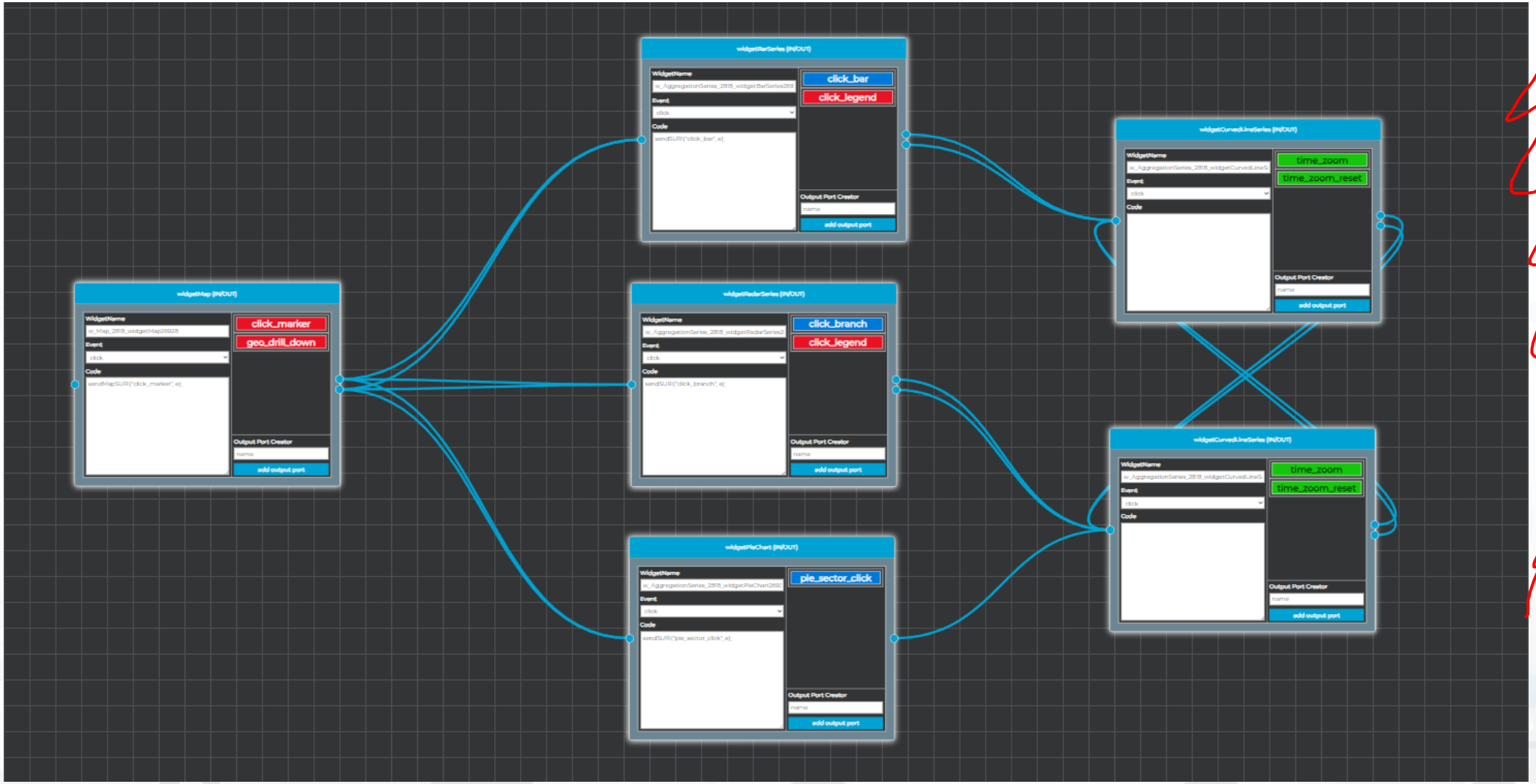
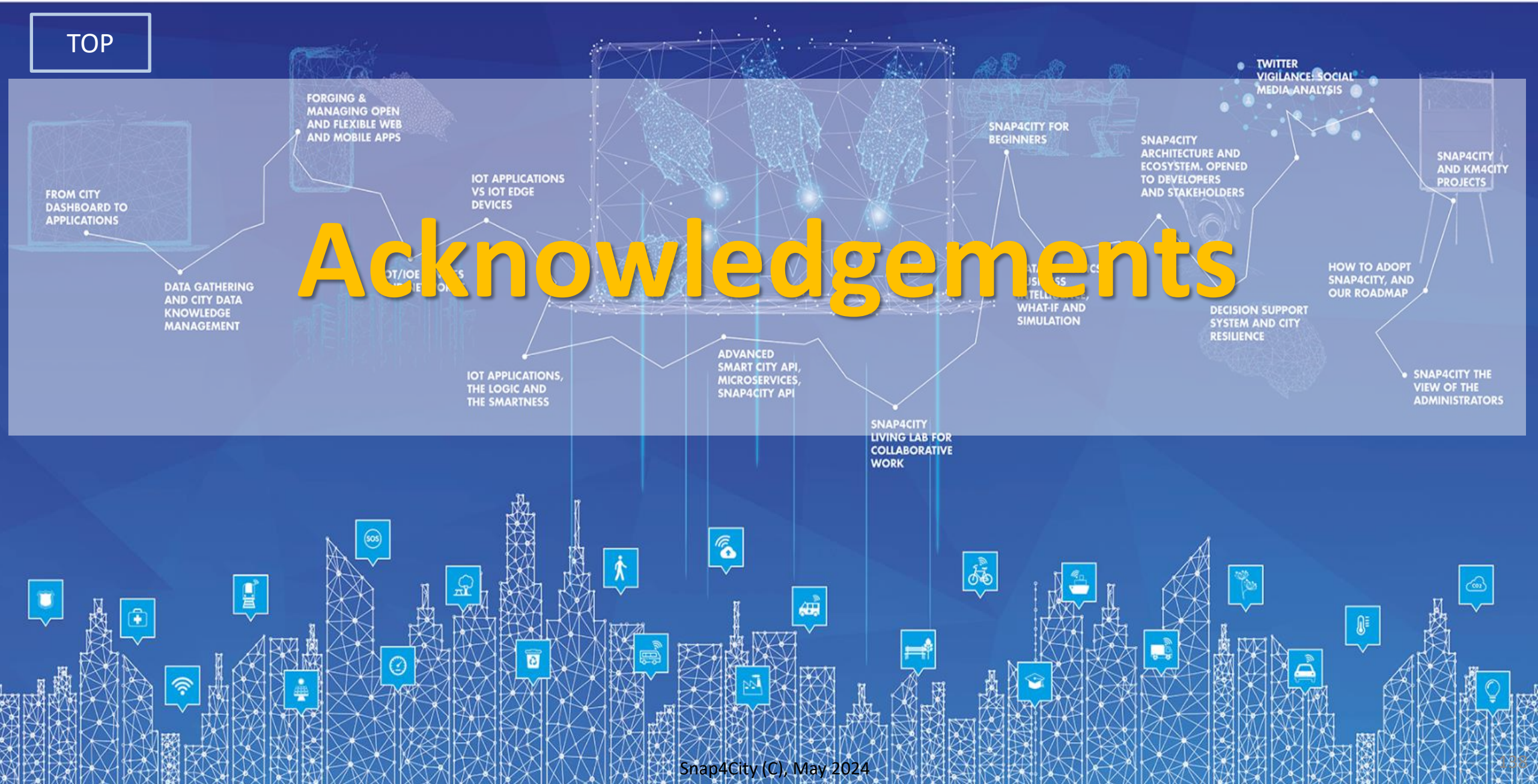
https://www.snap4city.org/download/video/ClientSideBusinessLogic-WidgetManual.pdf

CSBL Edition

# Visual programming for CSBL is coming soon



TOP




# Acknowledgements

# 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

# 2023 booklets

- Smart City


https://www.snap4city.org/download/video/DPL_SNAP4CITY.pdf

- Industry


https://www.snap4city.org/download/video/DPL_SNAP4INDUSTRY.pdf

- Artificial Intelligence


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

# https://www.snap4city.org/4

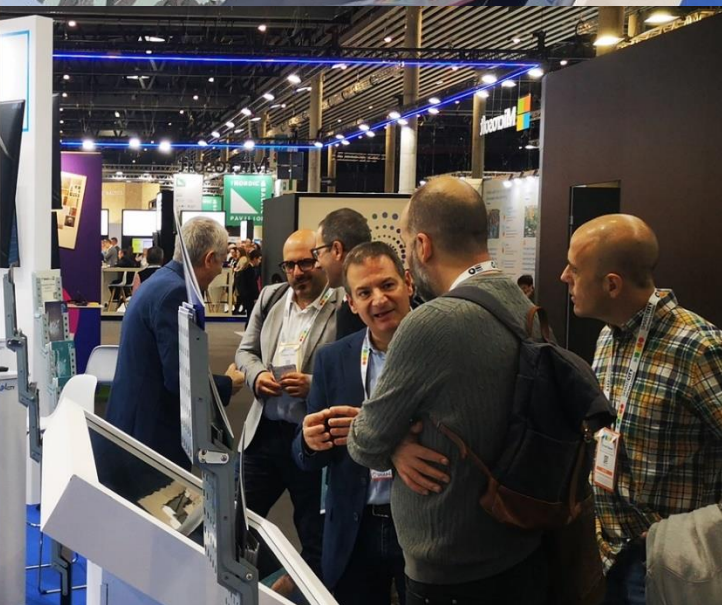
## Scenarious

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

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





# SMARTCITY

EXPO WORLD CONGRESS

7 - 9 NOVEMBER 2023

PAVILLON 1 - STAND D 100

# DISIT lab roadmap vs model and tools' usage

## 2013
Km4City Ontology 1.1

- Tuscany, Road Graph
- Mobility
- culture, tourism
- Events
- Parking
- Services
- Linked open graph

## 2014
- Weather Forecast
- Real Time Wi-Fi
- Entertainment
- LOD

- Twitter Vigilance
- Social Media Analytics, Sentiment Analysis

Km4City 1.4

## 2015
Km4City 1.5

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

ckan, resolute, H2020 (2015-18)

## 2016
(2016-21) H2020 REPLICATE

Km4City 1.6.4

- Smart Energy
- Sustainable Mobility
- Control Room
- Dashboard

Km4City 1.6.2

Sii-Mobility (2016-21) MIUR

SII-MOBILITY SCN

- Infomobility
- Mobile App
- Routing
- Multimodality

FIWARE

Km4City 1.5

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

## 2017
Sii-Mobility

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

E0l5 digital ecosystem (Powered by EXPO MILANO 2015)

(2016-19) MIUR GHOST SIR

- Sardinia Region Smart City Strategies and plan

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

GREEN IMPACT
POR FESR 2014-2020

- Industry 4.0
- Critical Plant
- Monitoring

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

life weee (2017-20)

- Smart Waste

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

- Mobility Demand / Offer Analytics and Strategy

5G (2018-21)

- 5G tech
- Energy
- Industry 4.0
- Synoptics

Sii-Mobility

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

IOT/IOE

Km4City 1.6.6

Node-RED

SNAP4CITY SELECT for Cities H2020 (2017-19)

SIRIUS

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 Optimization and Automated Decision System 4.0

- Industry 4.0

bee smart city

- Smart Lonato

Reverberi Enetec Gruppo MPES

Winner of Select4Cities PCP

SNAP4CITY

# roadmap

SODA

## 2020

Sii-Mobility

JRC EUROPEAN COMMISSION Contract

Interreg Mediterranean HERIT-DATA

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

Interreg MARITTIMO-IT FR-MARITIME MOBI MART

- Smart Mobility
- PISA, PUMS
- Living lab

smartGARDAlake

Km4City 1.6.7

Smart Ambulance (2021-22)

Enterprise (2021-22) Industry 4.0

Sii-Mobility

enel x Contract

JRC EUROPEAN COMMISSION Contract

## 2021

PC4City (2020-21) Monitoring Terrain

Winner of Open Data Challenge of enel x

CAPELON

- Smart Light
- Sweden

Almafluida Industry 4.0 (2021-22)

AMPERE (2021-22) Industry 4.0

SYN-RG-AI SmartCity

GRUPPO PRETTO Industry 4.0

uni.systems SmartCity, 2021-23

AXIS COMMUNICATIONS AXIS collab SmartCity

## 2022

ASYMMETRICA URBAN TECHNOLOGY Asymmetrica Smart City, 2022-23

ITALFERR GRUPPO FERROVIE DELLO STATO ITALIANE Italferr, Smart City

JRC EUROPEAN COMMISSION Contract, 2022-23

## 2023

ART-ER ATTRATTIVITÀ RICERCA TERRITORIO Contract, 2022-23

Filippi 2022-2023

enel x Contract, 15min

IMPETUS Security and Risk

Smartea

MOST CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE CN MOST, 2022-26

EI THE, 2022-26

G. Agile, 2021-23

TUSCANY X.0 EDIH 2023-26

Finanziato dall'Unione europea NextGenerationEU

Merano, smart light

OceanRace, Genova, AWS

Cuneo, smart city

Rhodes, smart city

AMMIRARE

Interreg MARITTIMO-IT FR-MARITIME

## 2024

TOURISMO

Interreg Euro-MED Co-funded by the European Union

TOP

SNAP4CITY

KM 4 CITY

100% OPEN SOURCE

*Be smart in a SNAP!*

SMARTCITY
EXPO WORLD CONGRESS

SNAP4
Appliances and Dockers
**Installations**

## CONTACT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