SNAP4CITY

www.snap4city.org
www.snap4solutions.org

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

KM4CITY

www.km4city.org

Overview for Researchers & Developers

March 2025

AI Digital Twin Platform to set-up Sustainable Decision Support Systems & Business Intelligence

#snap4city
#km4city
#disitlab
@snap4city

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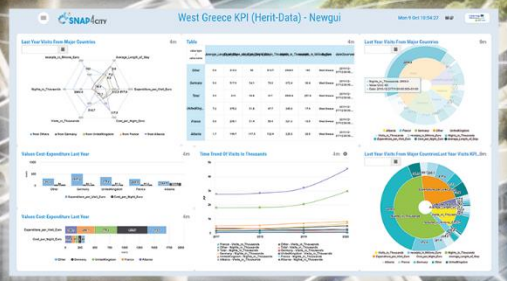
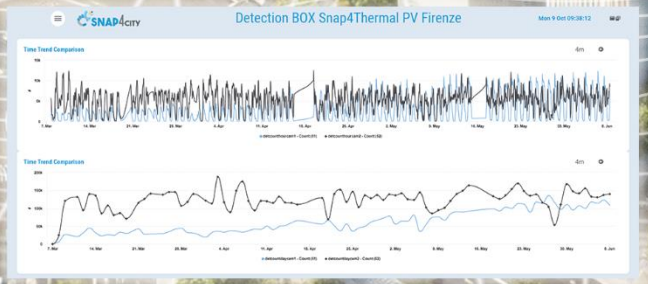
Snap4City


West Greece KPI (Herit-Data) - Newgui


Snap4Waste - Planning
switchMode


Detection BOX Snap4Thermal PV Firenze


FIRENZE - TRAFAIR - AIRQUALITY HEATMAPS - NEWGUI

Agenda

- Objectives and Tasks, architecture and Digital Twin
- Monitoring and Control: Mobility, Humans, Engagement, ..
- Decision Support Systems, planning, what-if and optimization
  - Data Analytics, Artificial Intelligence, XAI, ML
  - Traffic Light Plan Optimisation
  - Traffic Infrastructure Optimization
- Industry Domain: predictive maintenance
  - Autoclave Cycle: Energy Optimisation
- Developing on Snap4City platforms
  - Training Suggestion and publications / further reading
- Development Costs Advantages
  - Accelerating on Smart City Deploy with Snap4City
- Platform Administration
- Acknowledgements

Public Spaces as Critical Infrastructures

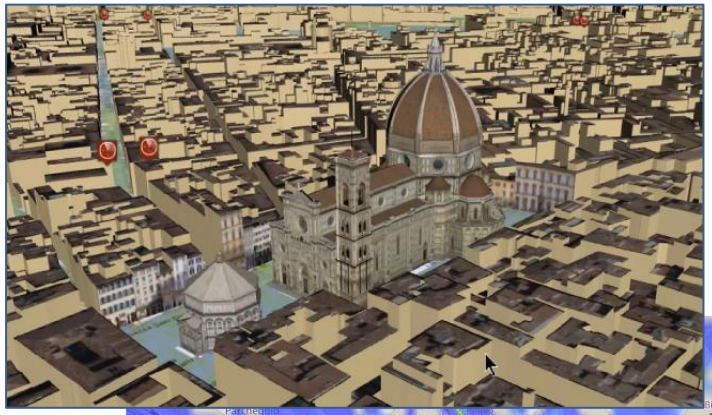
- The City is a system of systems for city users
  - Cascading effects
- **Transport** networks
  - Main means for rescue teams, food, water, etc.
- **Communication**, ICT infrastructure
  - TV cam, switches, cyber,
- **Energy** networks
  - power supply for health, cyber systems, etc.
- **Hospitals**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

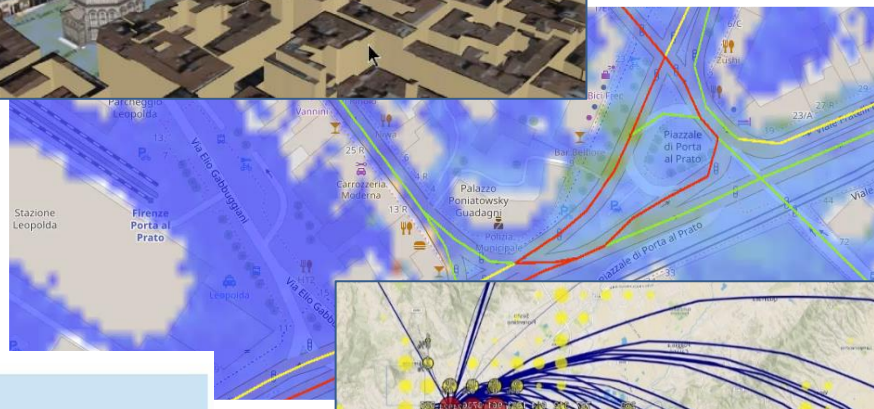
https://www.snap4city.org/download/video/DPL_SNAP4SOLU.pdf

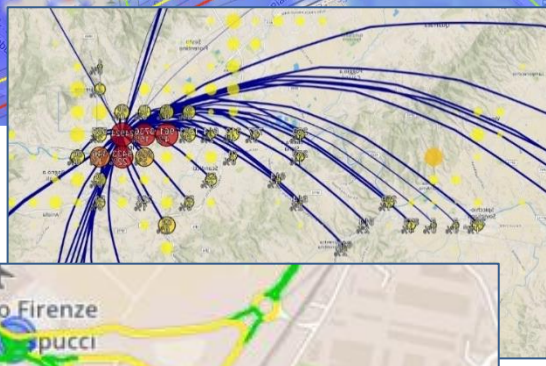
Objectives and Tasks Architecture and Digital Twin

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**

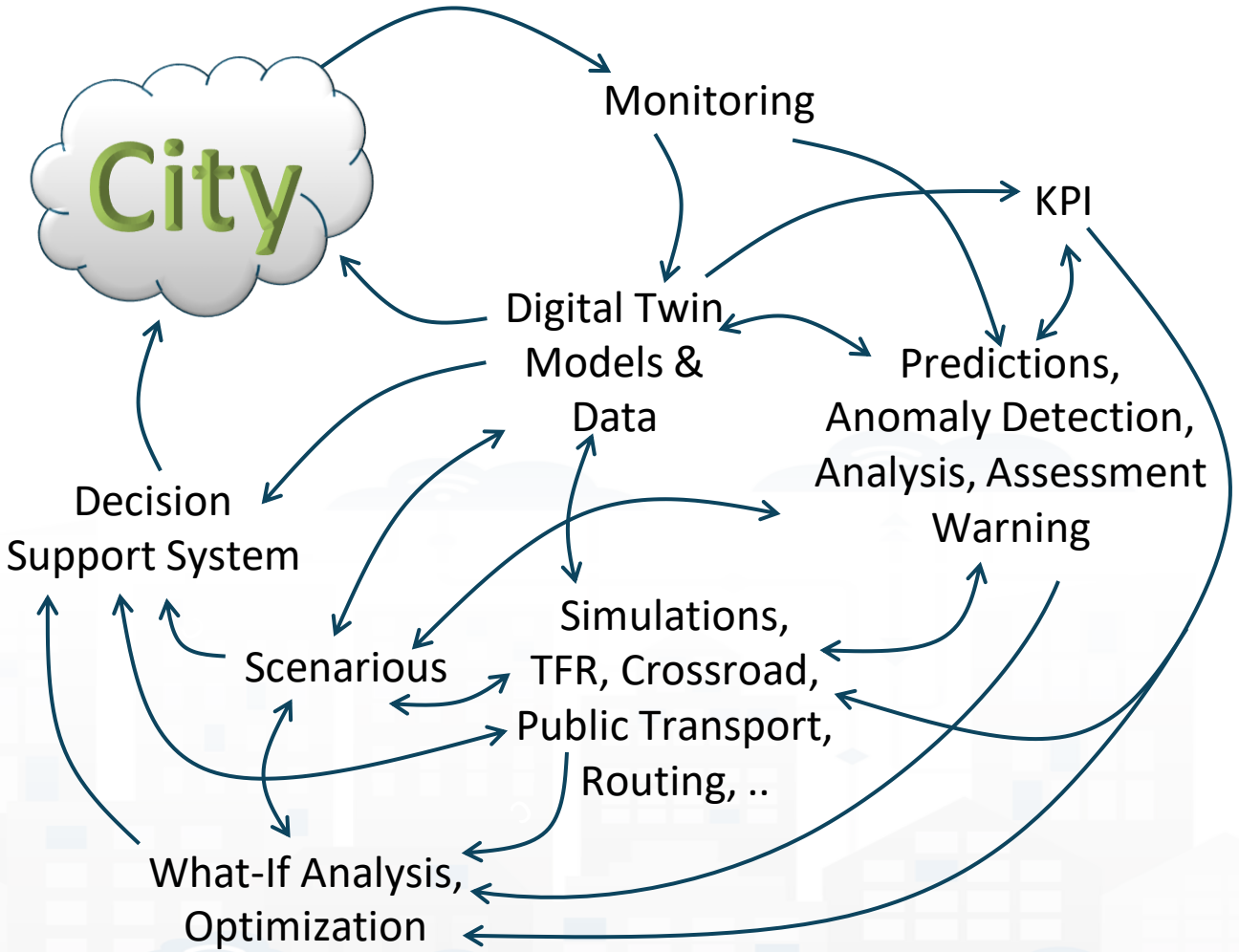


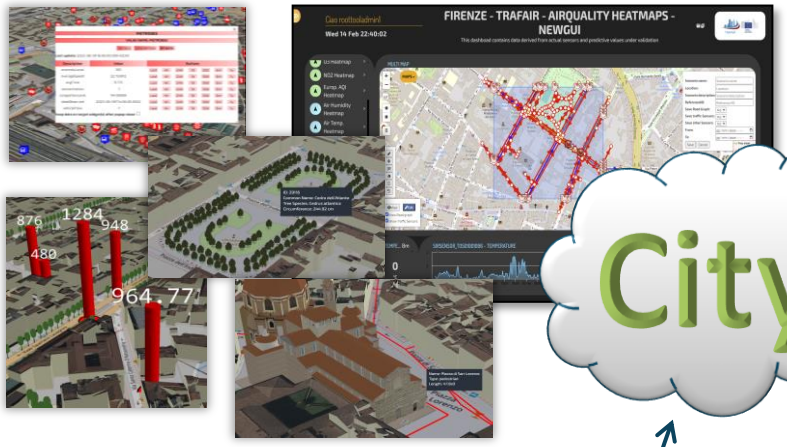




Main tasks

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





City

Monitoring

KPI

Digital Twin
Models &
Data

Predictions,
Anomaly Detection,
Analysis, Assessment
Warning

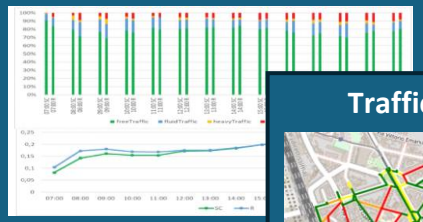
Decision
Support System

Scenarious

Simulations,
TFR, Crossroad,
Public Transport,
Routing, ..

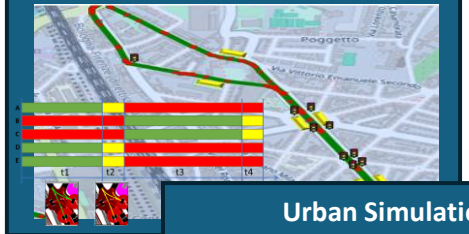
What-If Analysis,
Optimization

KPI, Predictions, ...



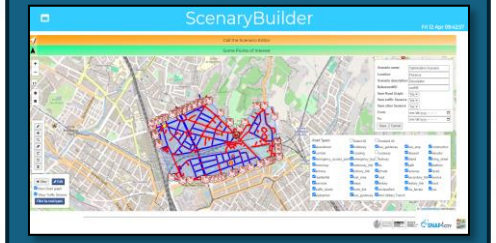
Traffic Reconstruction

Traffic Light Plan optimization

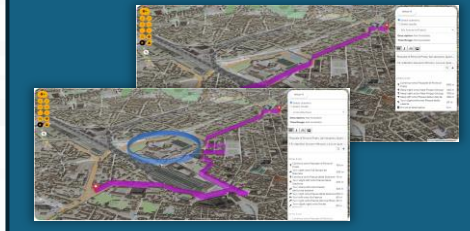


Urban Simulation

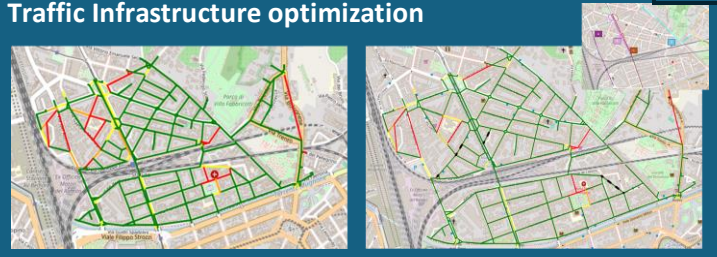
Scenario Editor



Routing / Dynamic Routing

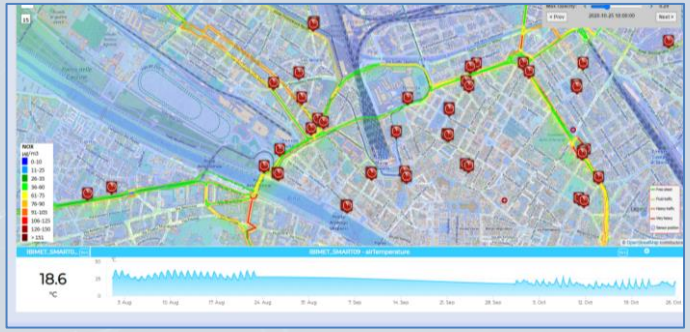


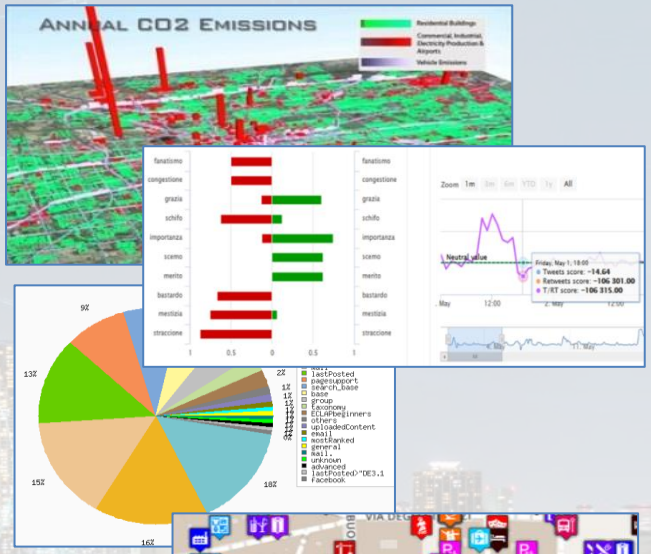
Traffic Infrastructure optimization

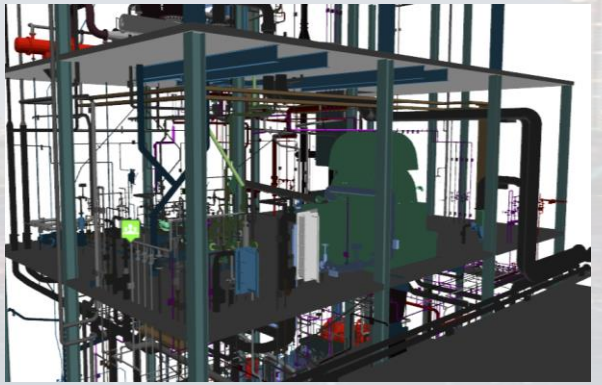


Digital Twin

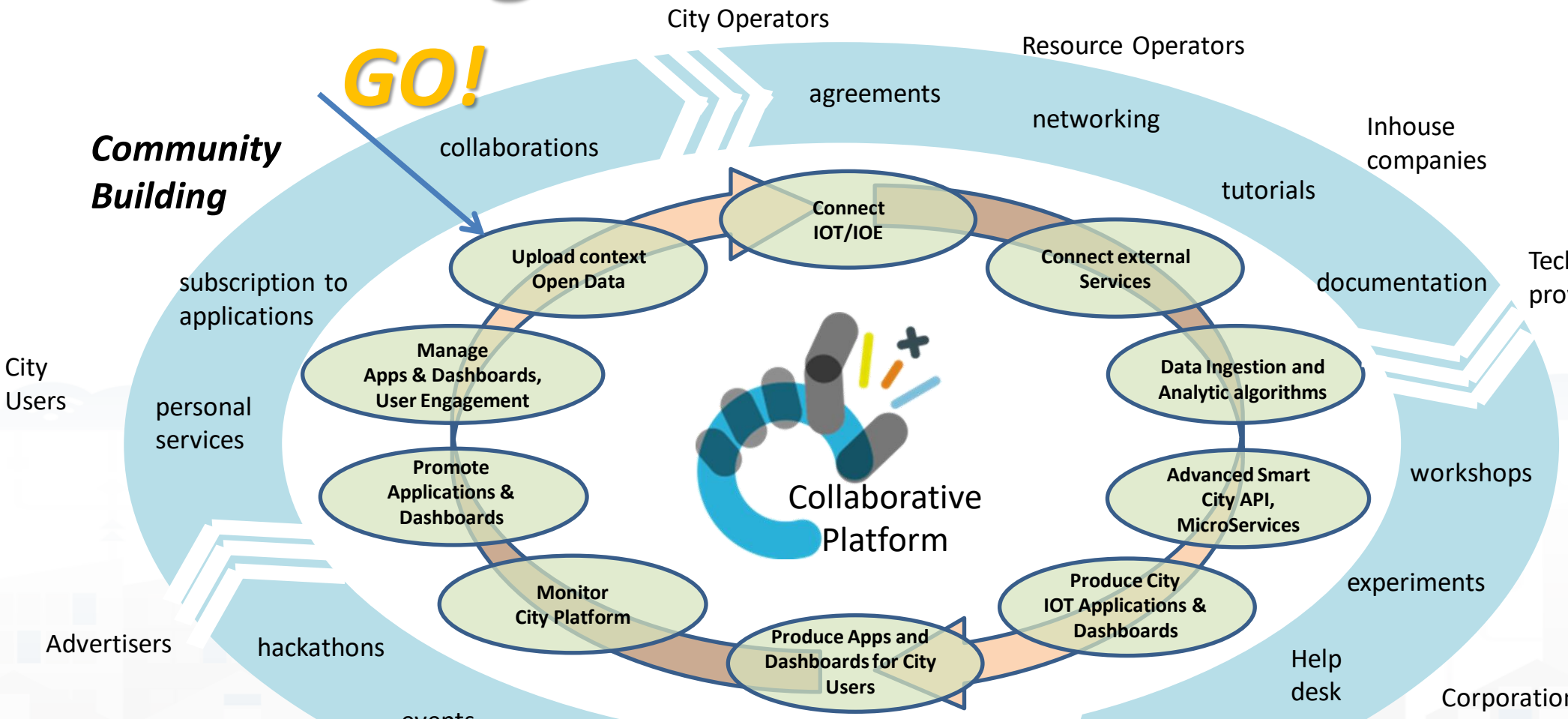
- **Digital Twin**
  - **Connected** with real systems
  - **Modelling** aspects: structural, visual, informative, real time data sensors (context), POI, functional, resources, etc.
  - **Analytics:** AI/XAI techniques, simulations, users' needs, etc.
- **Easier to understand the context, review from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





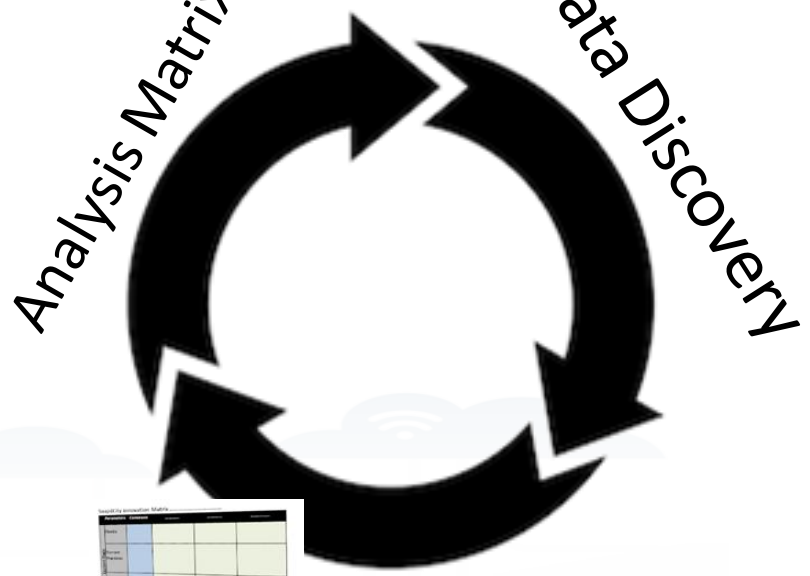


Accelerating GO!

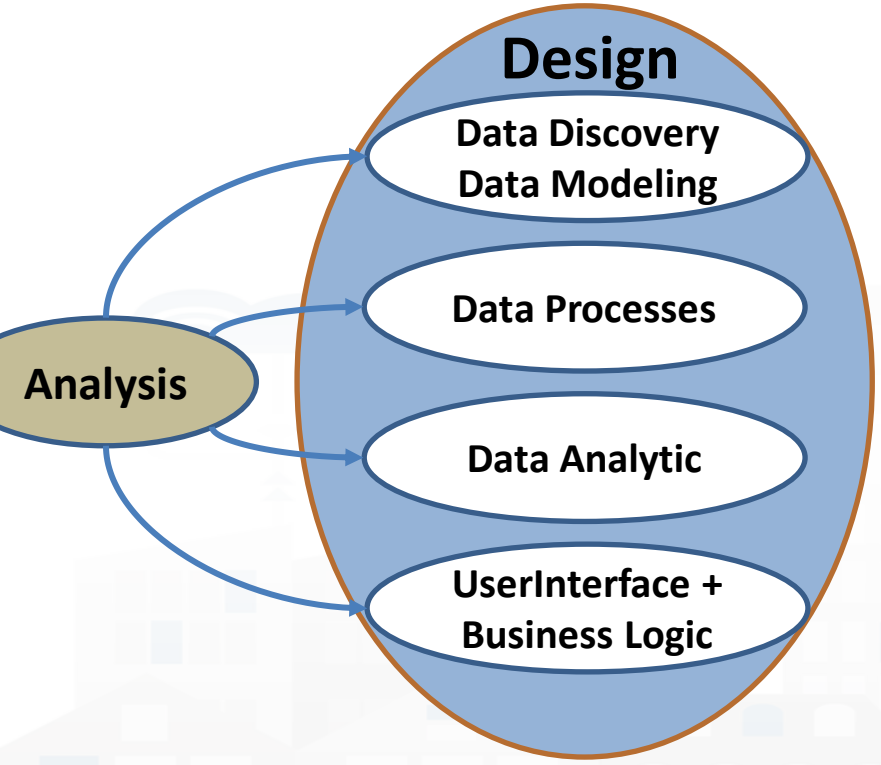


Snap4City Innovation Matrix and Process

Part 6



Main Activities of Design



- **Data Discovery**: Ingestion, gathering, interoperability, discovery, modeling, aggregation, mapping → digital twin modeling
- **Data Processing**: transformation, interoperability; computing Indexes, KPIs and benchmarks, …
- **Data Analytic**: statistic, predictions, classification, anomaly detection, simulations, optimization, routing, ML, AI, XAI, HPC, …
- **User Interface:** dashboards, web pages, business intelligence, visual analytics, what-if analysis, business logic, mobile applications.

Snap4City

Digital Twin Solutions for Sustainability

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

E015 digital ecosystem

NVIDIA

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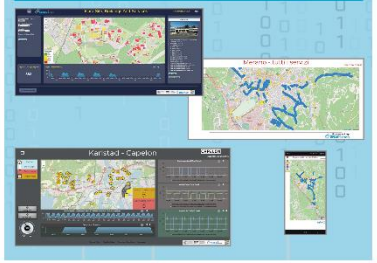
OPERATION AND PLAN - CONTROL ROOMS - DECISION SUPPORT SYSTEMS - WHAT-IF ANALYSIS - OPTIMIZATION - APPLICATIONS

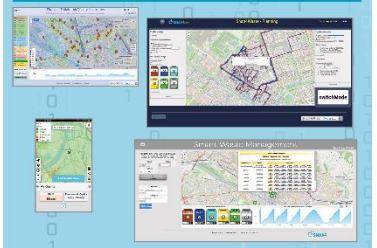
HORIZONTAL AI PLATFORM

MOBILITY AND TRANSPORT

SMART ENERGY AND SMART BUILDING



ENVIRONMENT AND WASTE MANAGEMENT

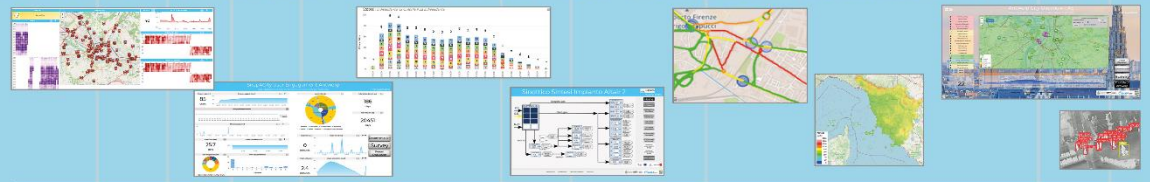


CITY USER'S SERVICES AND TOURISM MANAGEMENT

- DEVELOMENT ENVIRONMENT AND METHODOLOGY
- VISUAL PROGRAMMING, ML, AI, HPC
- TRAINING COURSES
- LIVING LABS
- GUI CUSTOM STYLES
- FULL APPLICATIONS, DASHBOARDS AND VIEWS
- MOBILE APPS

VISUAL ANALYTICS - SYNOPTICS - GRAPHICAL WIDGETS - ANALYTICS - BUSINESS INTELLIGENCE - SIMULATIONS

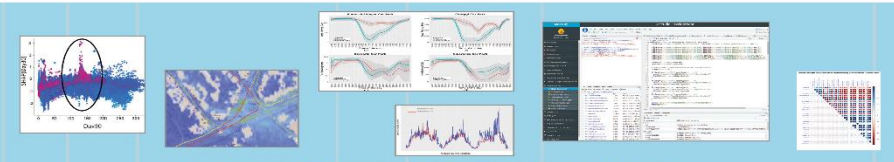
DASHBOARDS, WIDGETS
TEMPLATES



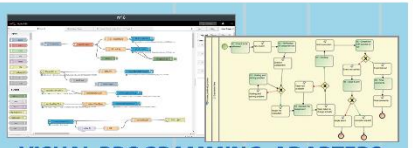
PREDICTION - ANOMALY DETECTION - CLUSTERING - ROUTING - SENTIMENT NLP - TRAFFIC FLOW - PEOPLE FLOWS - SDG
15 MIN CITY INDEX - KPI - HEATMAPS - ORIGIN DESTINATION - ETC...

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

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

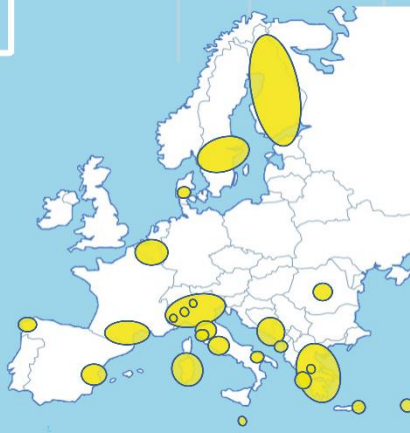


BIG DATA ANALYTICS, ARTIFICIAL INTELLIGENCE
EXPLAINABLE AI, MACHINE LEARNING, GENERATIVE AI
OPERATIVE RESEARCH, STATISTICS

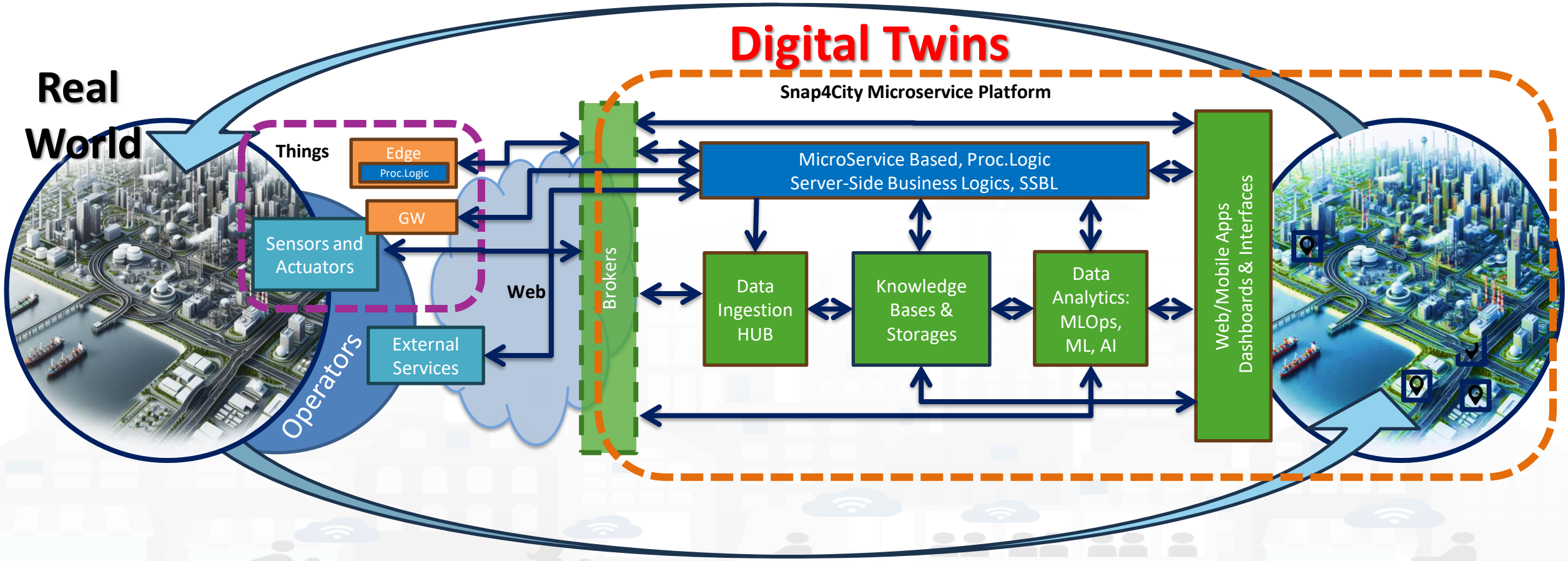


VISUAL PROGRAMMING, ADAPTERS
DATA FLOWS, WORKFLOWS
PARALLEL DISTRIBUTED PROCESSING
DATA DRIVEN

FULL INTEROPERABILITY, ANY: DATA, BROKERS, NETWORKS AND VERTICALS



Digital Twin Development Platform

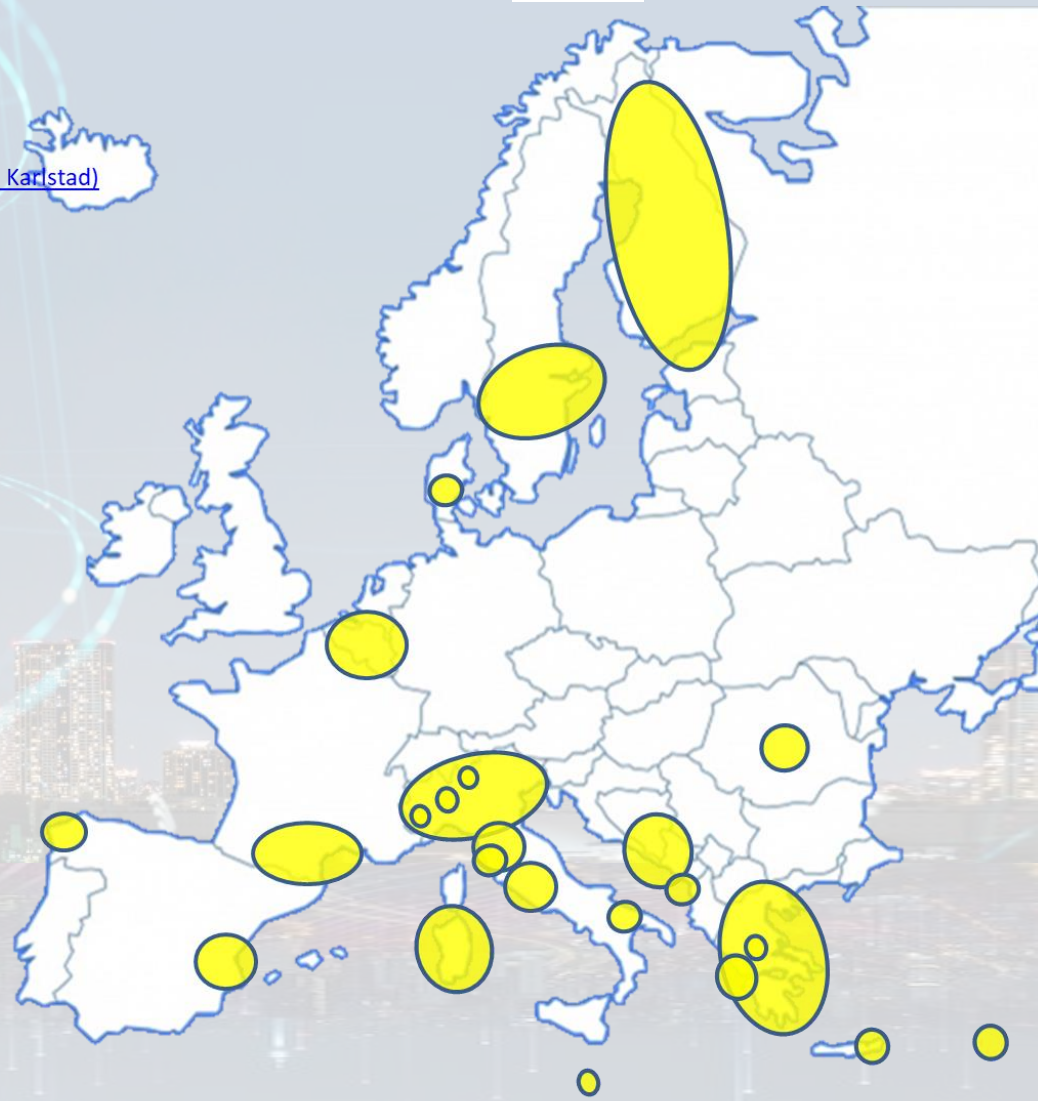


https://www.Snap4City.org

- 11 running installations in Europe
  - Snap4.city.org, Greece, Merano, Cuneo, …
  - Toscana, Pisa, Sweden, ISPRA, Snap4.eu,
  - Altair, Italmatic, M4F, Romania, ….
- 18 projects, 12 pilots on 10 Countries
  - >40 cities/area
- **Widest MULTI-tenant deploy has**
  - 25 Organizations / tenant
  - > 8850 users on
  - > 1800 Dashboards
  - > 17 mobile Apps
  - **> 2.2 Million of structured data per day**
  - > 580 IoT Applications/node-RED
  - > 750 web pages with training
  - > 75 videos, training videos

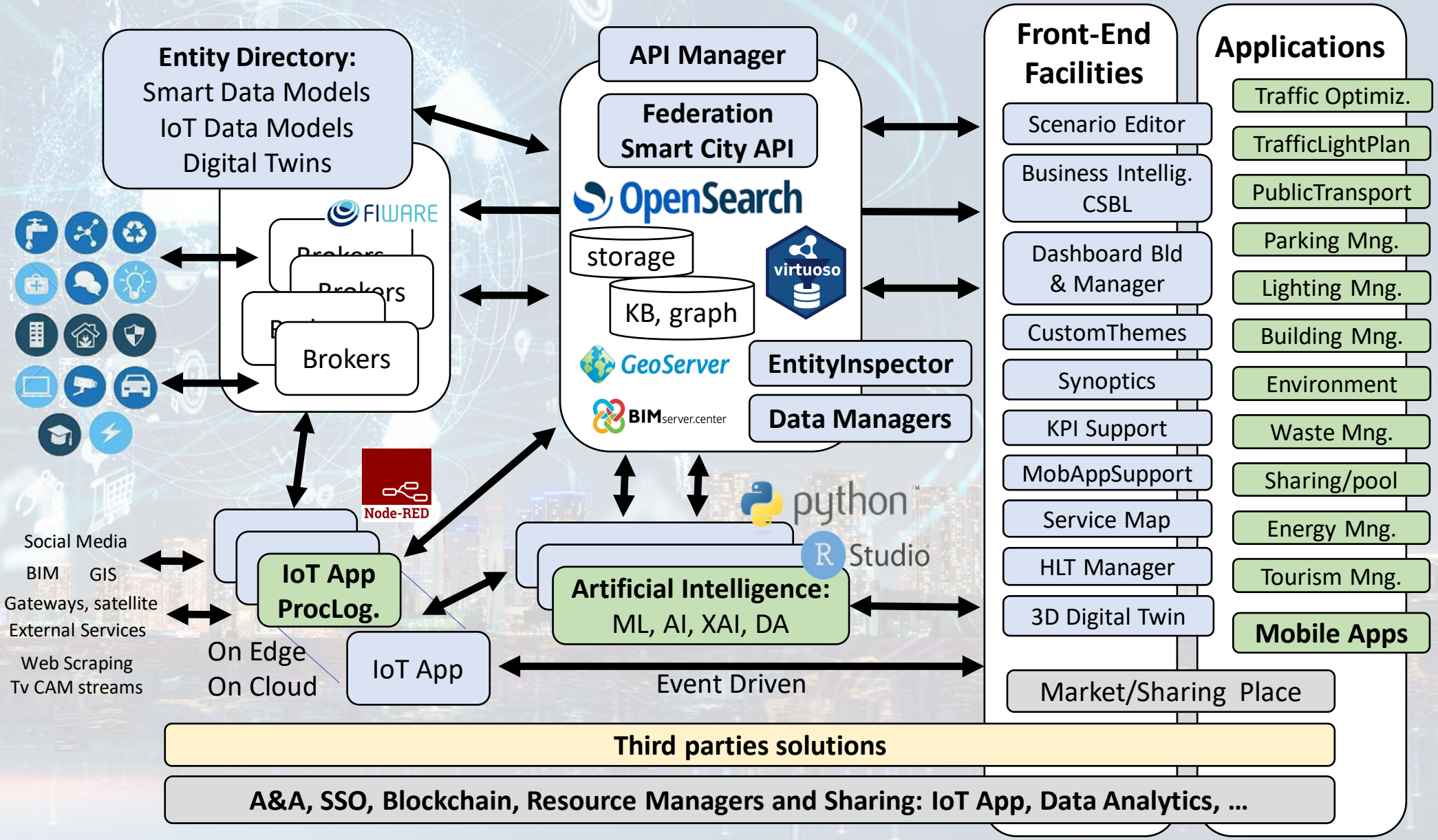
Main Organizations/areas

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



- **+ Israel, Colombia, Brasile, Australia, India, China, etc.**

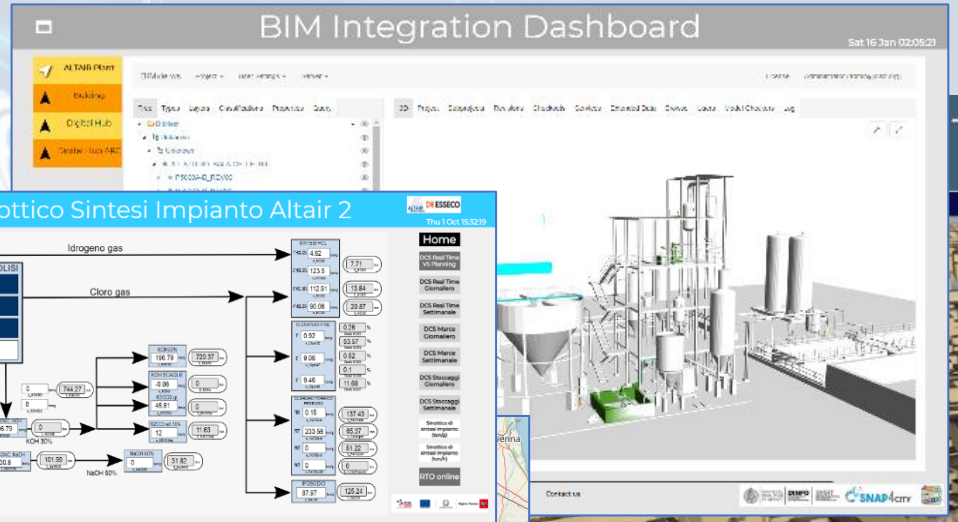
Technical Architecture

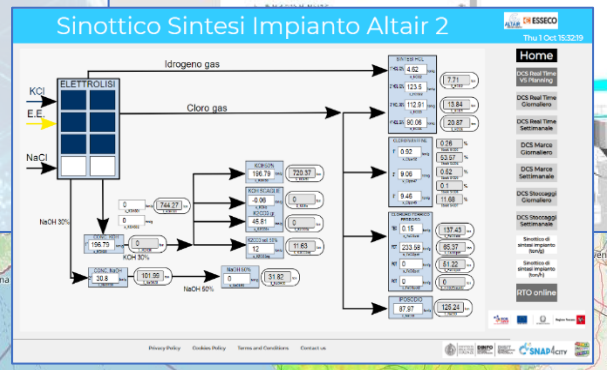


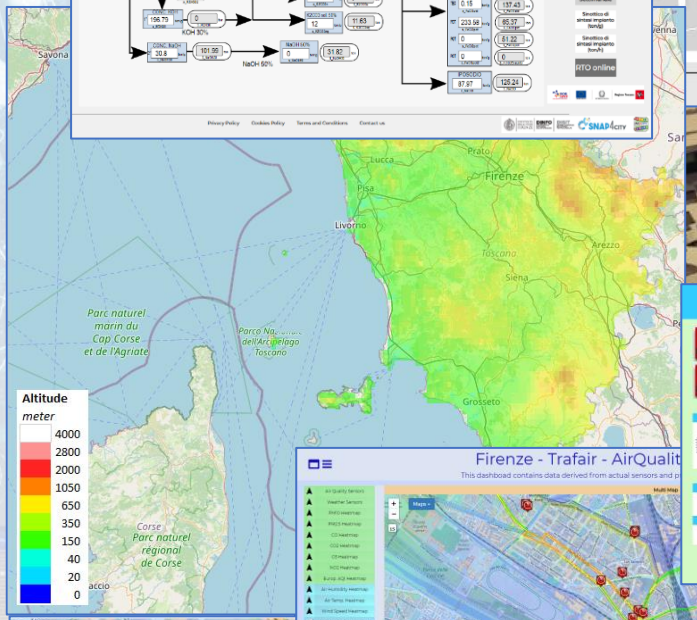
High Level Types

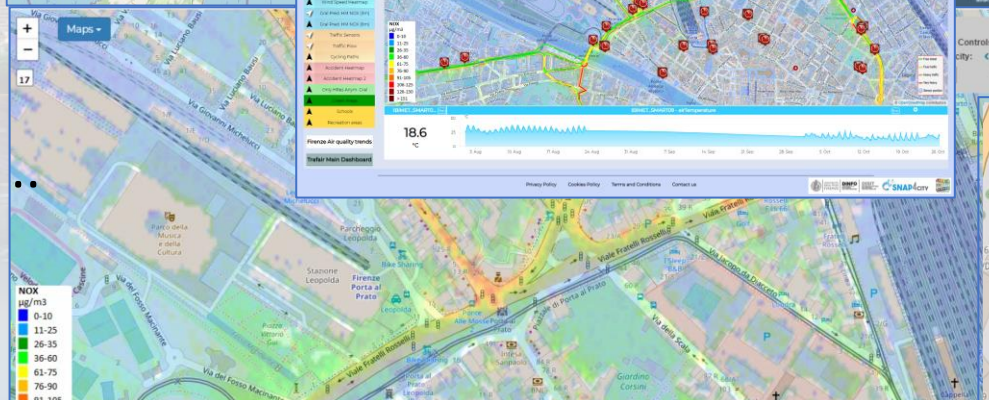
Snap4City (C), March 2025

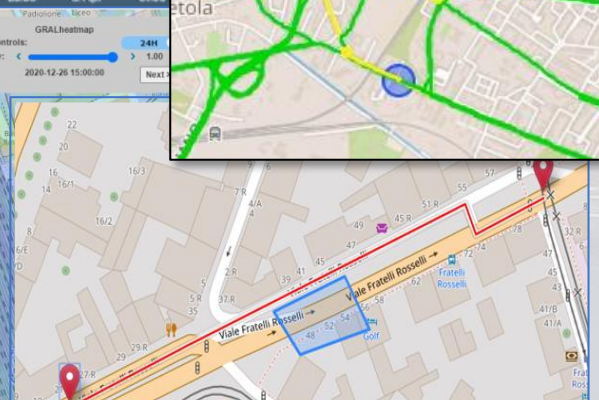
- POI, IOT Devices, shapes,..
  - FIWARE Smart Data Models,
  - IoT Device Models
- GIS, maps, orthomaps, WFS/WMS, GeoTiff, calibrated heatmaps, ..
- Satellite data, any kind..
- traffic flow, typical trends, ..
- trajectories, events, Workflow, ..
- 3D Models, BIM, Digital Twins, ..
- OD Matrices of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











Standards and Interoperability (10/2024)

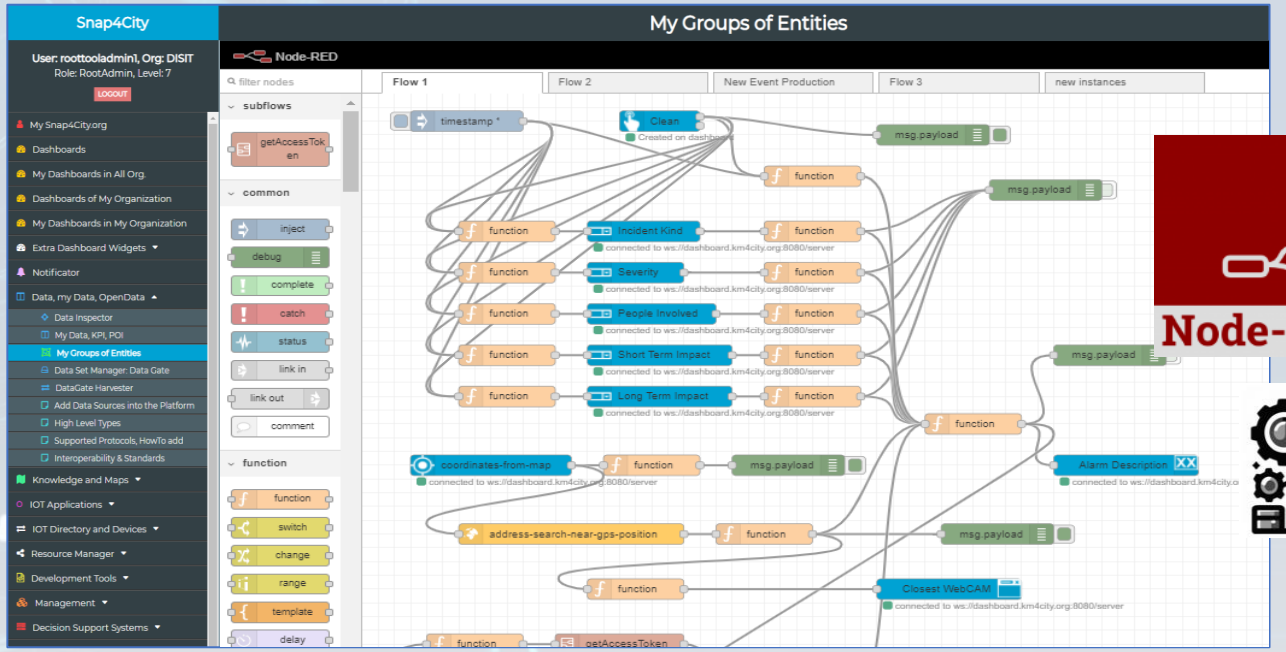
Compliant with:

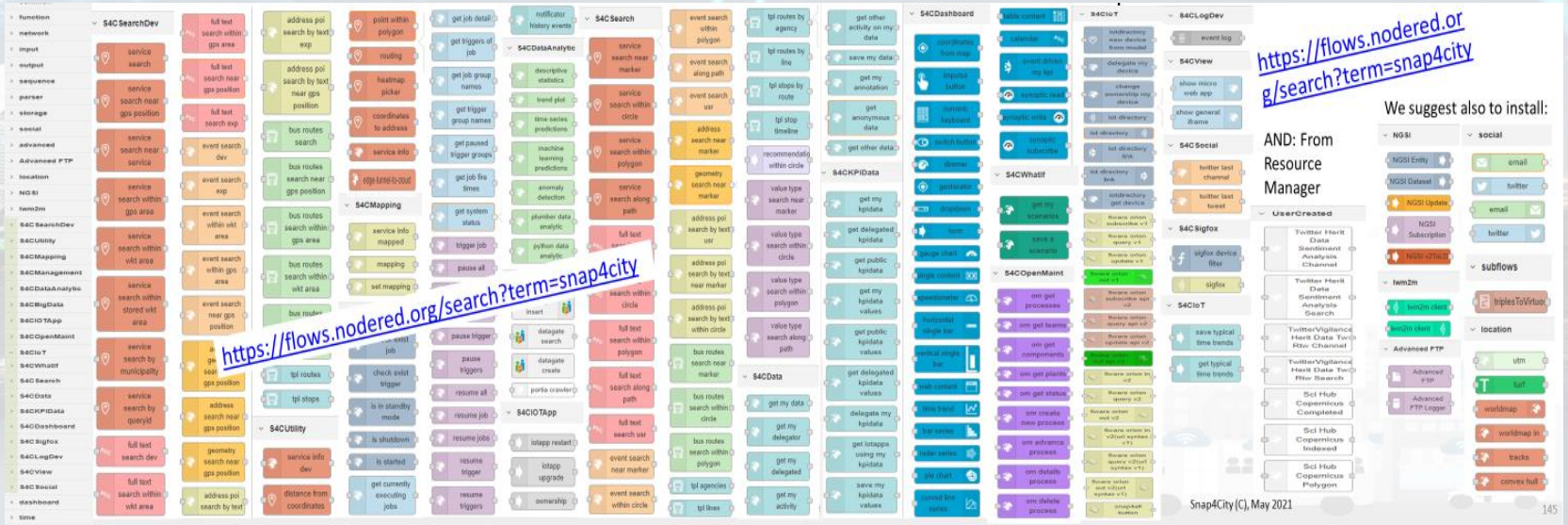
- **IoT:** NGSI V2/LD, LoRa, LoRaWan, MQTT, AMQP, COAP, OneM2M, TheThingsNetwork, SigFOX, Libelium, IBIMET/IBE, Enocean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, BACnet, TALQ, Protocol Buffer, KNX, OBD2, Proximus, ..
- **IoT model:** FIWARE Smart Data Model, Snap4City IoT Device Models
- **General**: HTTP, HTTPS, TLS, Rest Call, SNMP, 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 Milestone, TIM, HERE, ….
- **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

Ingestion, aggreg. → exploitation

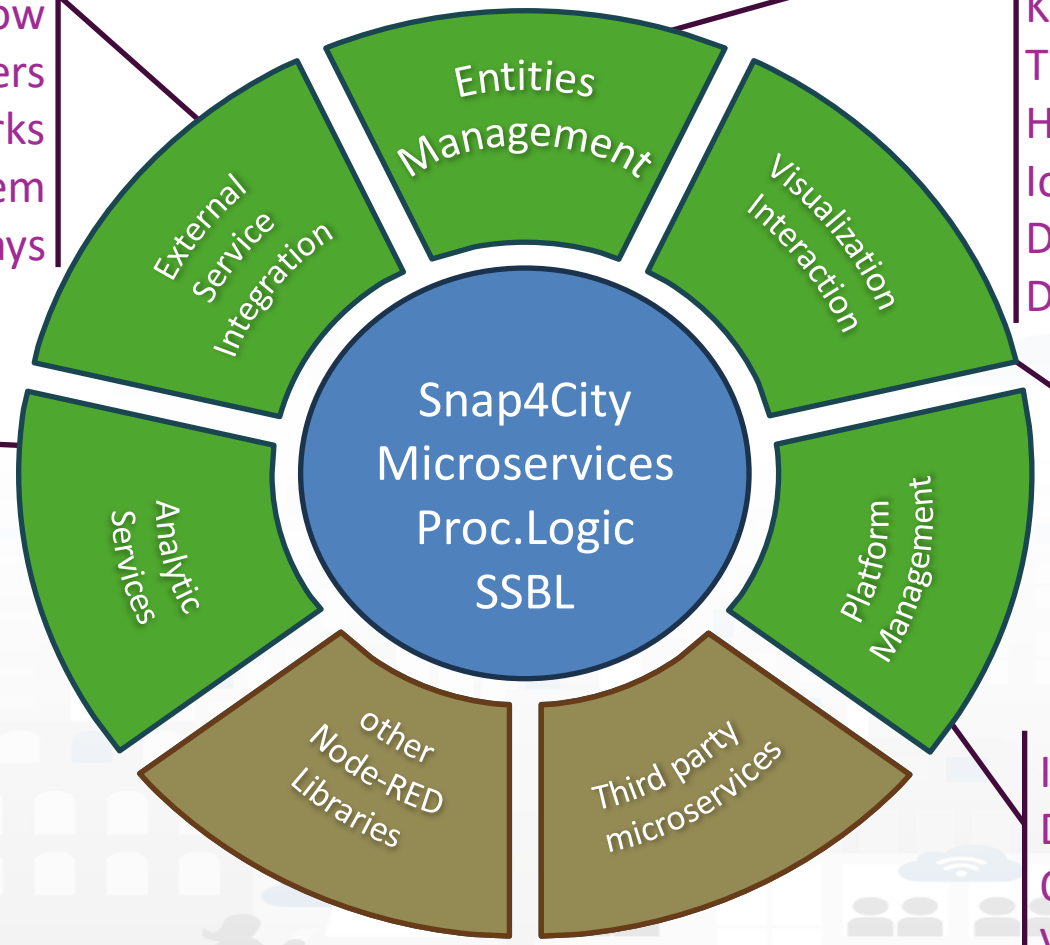
- **IoT App Visual Programming, no coding**
  - **Data transformation**
  - **Integration, Interoperab.**
  - **Scripting Data Analytics**
  - **Data ingestion**
  - **Business logic Server Side**
- **Edge and Cloud**
- **MicroServices** data event driven develop via visual language Node-RED





MicroServices Areas

> 60.000 downloads



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

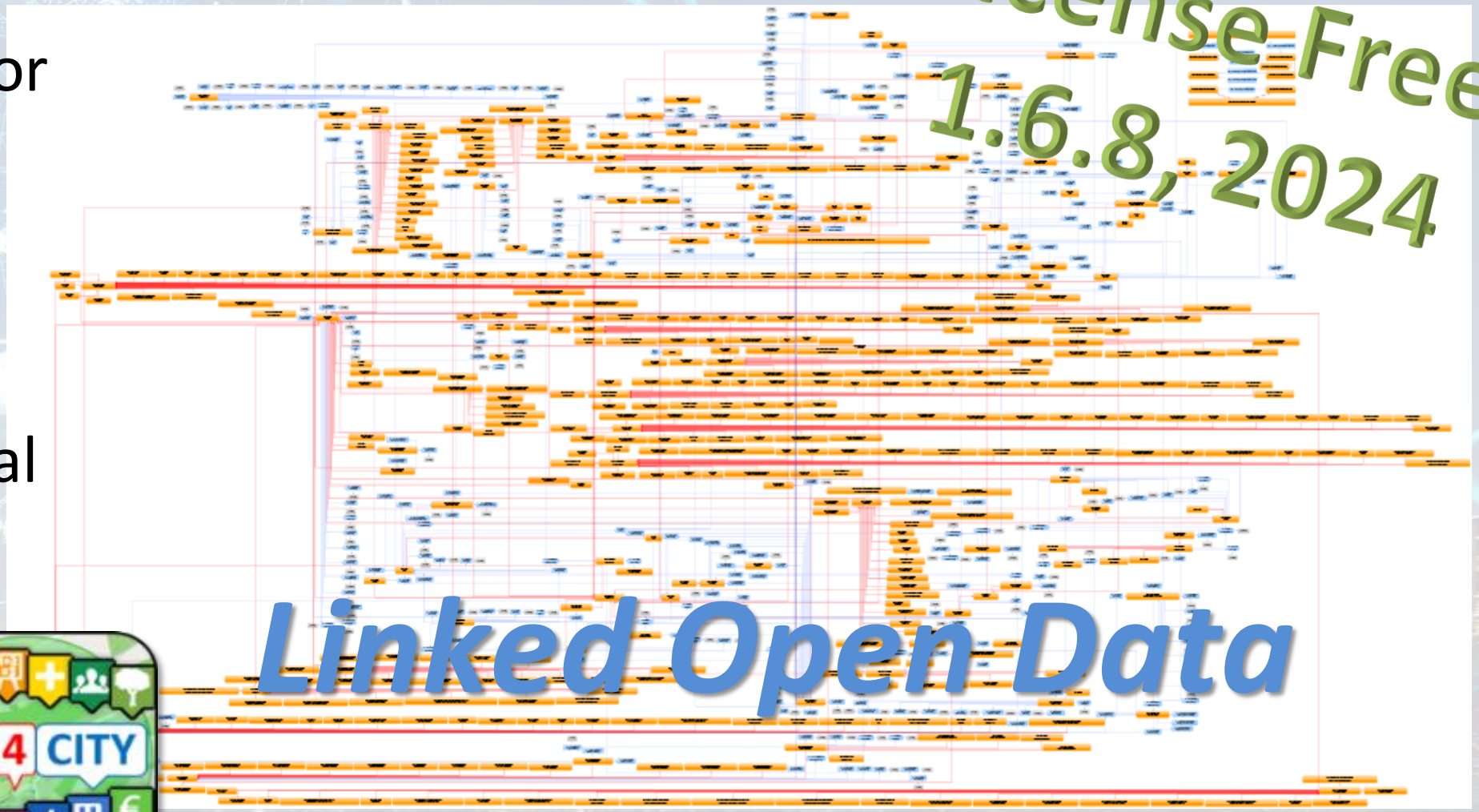
Dashboards
Widgets: Graphic Libraries
Interactive Widgets
Maps, 3D representations
Synoptics, External Content
Micro Web App

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

Node-RED

Expert System semantic queries

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



License Free
1.6.8, 2024

Linked Open Data

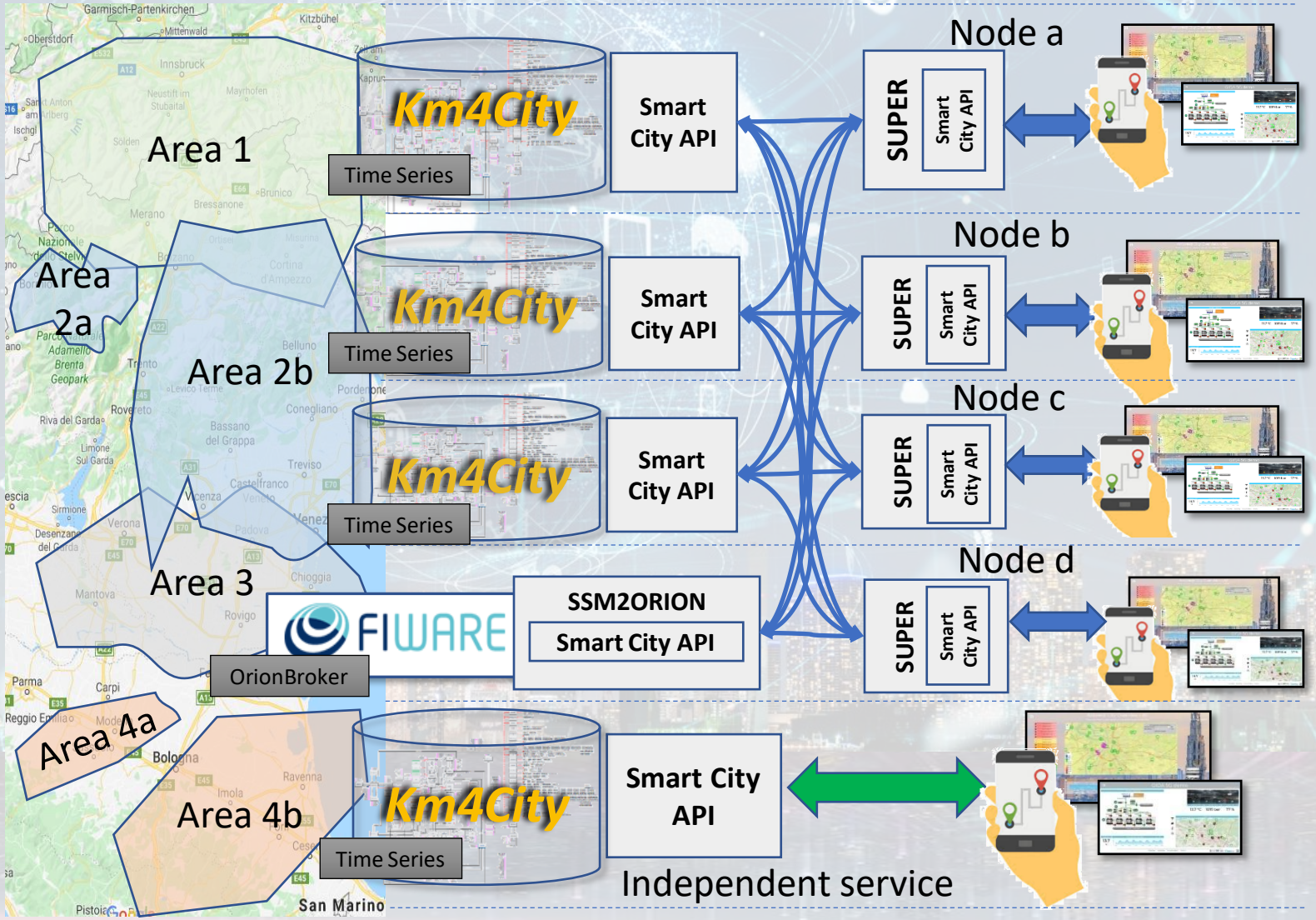
https://www.snap4city.org/19

Km4City Ontology elements 1.6.8

- **Km4C**: Km4City 1.6.8
- Using
  - **DCTERMS**: for metadata Dublin Core Metadata Initiative
  - **FOAF**: friends of a friends
  - **Good Relation**: entities relationships
  - **iot-lite**: IOT Vocabuary
  - **OTN**: Ontology of Transportation Networks
  - **OWL-Time**: time reasoning
  - **SAREF** Smart Appliances REFerence extension for building devices available at https://saref.etsi.org/saref4bldg/
  - **Schema.org** for people and organizations
  - **SSN**: Semantic Sensor Network Ontology (see https://www.w3.org/TR/vocab-ssn/
  - **WGS84** Datum of Geo-Objects
  - **GTFS**, General Transit Feed Specification, and **Transmodel**, for public transport infrastructures: lines/rides time schedules, real-time records, paths, etc.;
  - **BOT**: Building Topology Ontology. https://w3c-lbd-cg.github.io/bot/
  - **S4CITY**: SAREF extension for Smart City. https://saref.etsi.org/saref4city/v1.1.2/

Federation of Smart City Services

Knowledge Base
Semantic Reasoners

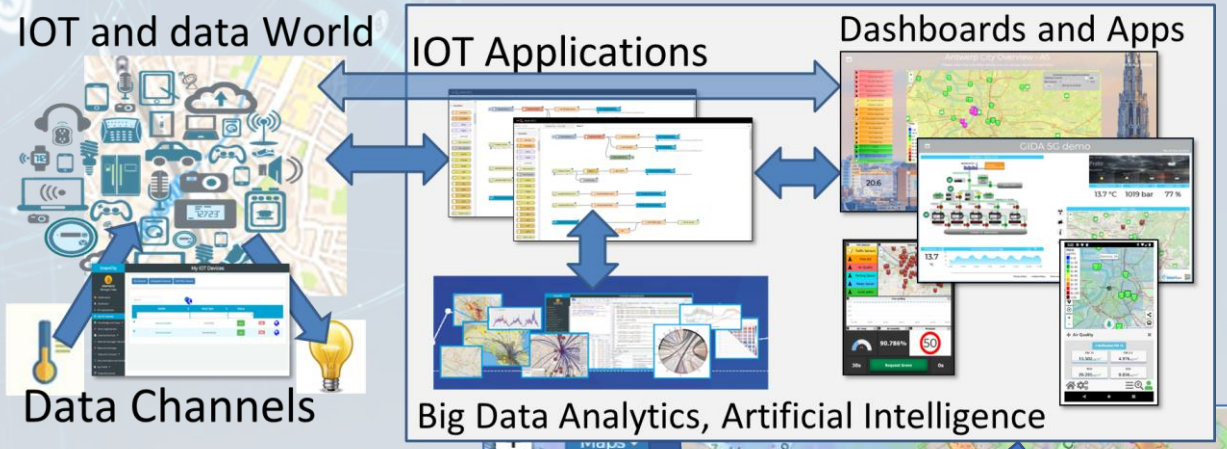


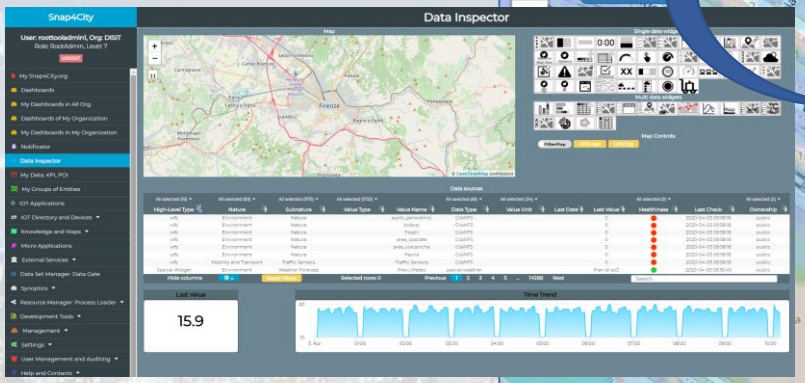
- Km4City **Semantic Reasoner**
- **ServiceMap** interoperability
- **Seamless for multiple Mobile Apps**
- **Smart City API**
- **Super**:
  - distributed access and sharing services
  - Each city control its own data
  - Final user can pass from one city / area to another in seamless manner: without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

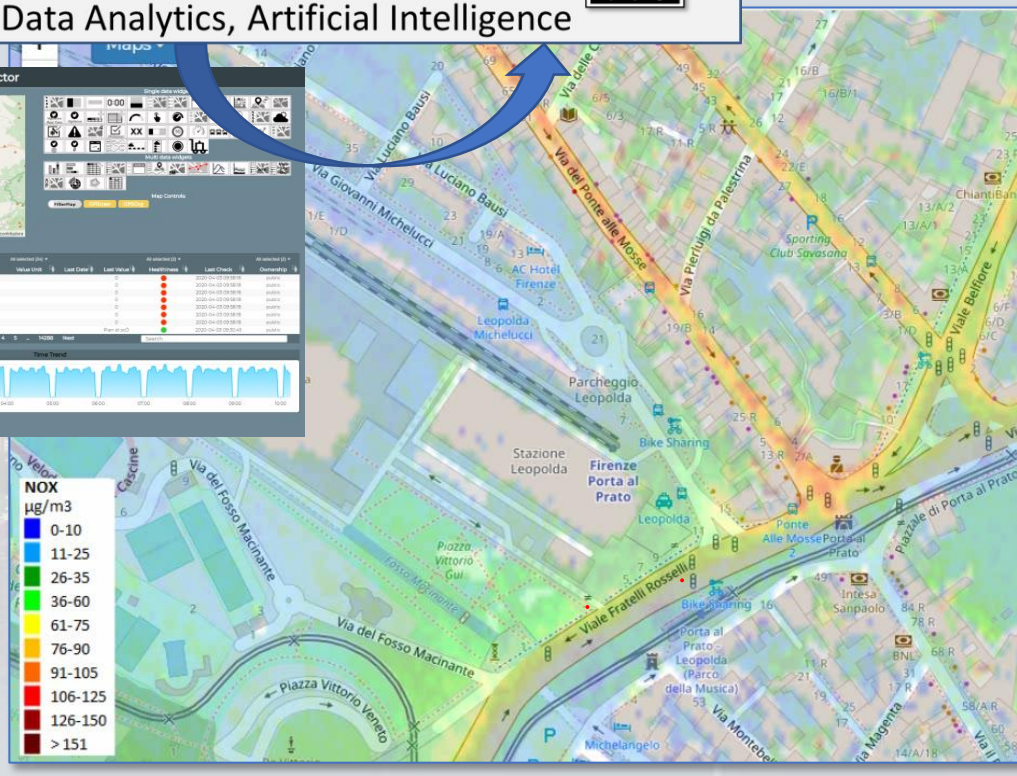
Solutions: reliable, secure and fast to realize

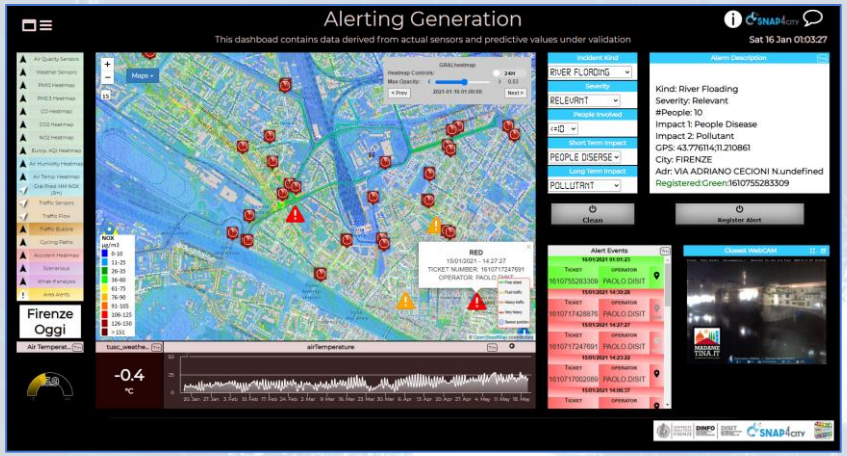
- Via Snap4City tools
  - Dashboard Wizard
  - Dashboard Builder
  - Data/Visual Analytic

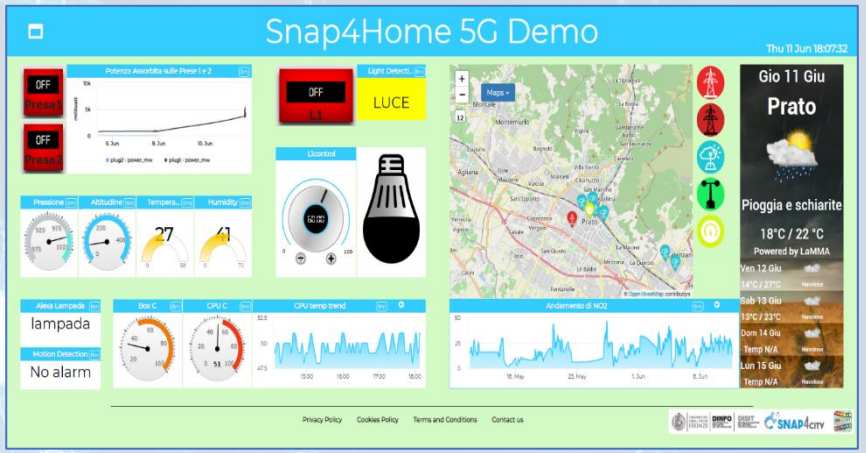
- Smart Solutions results to be
  - Real time data drive
  - Secure end-to-end
  - GDPR compliant
  - Reliable, interoperable
  - Auditable, marketable

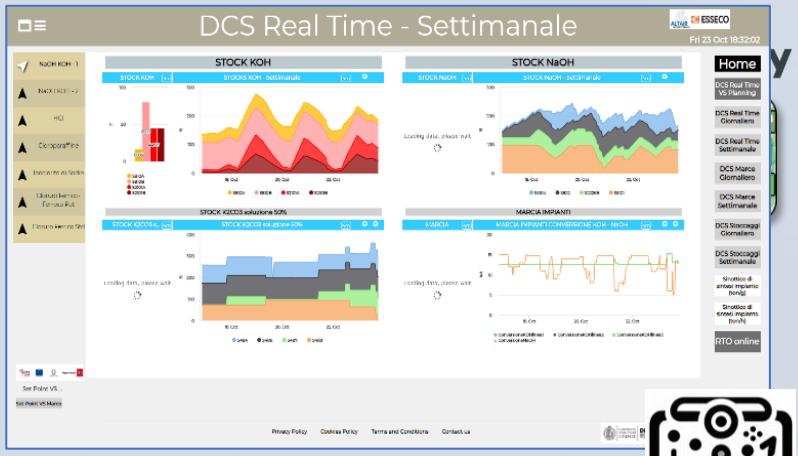


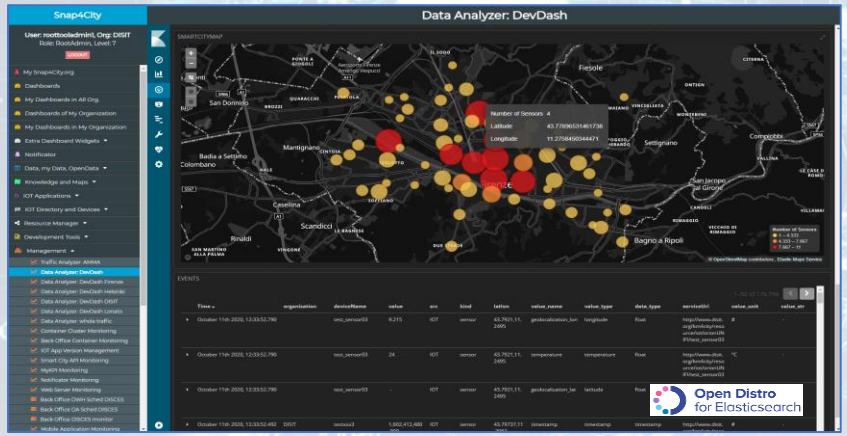


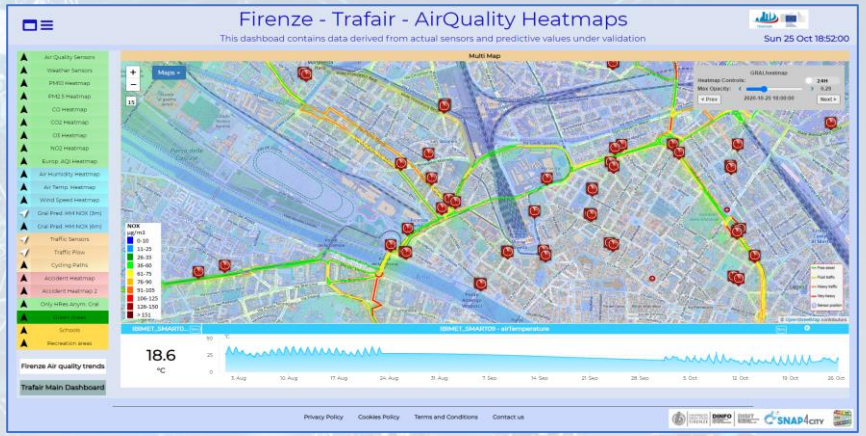


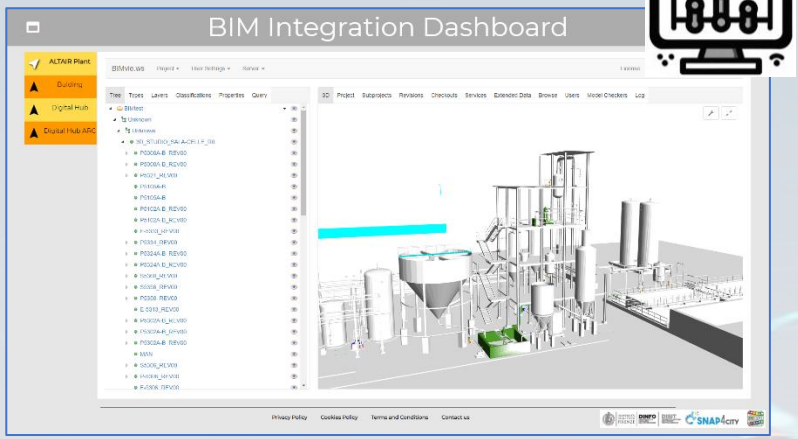

Alerting Generation
This dashboad contains data derived from actual sensors and predictive values under validation
Sat 16 Jan 01:03:27
Firenze Oggi
-0.4


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

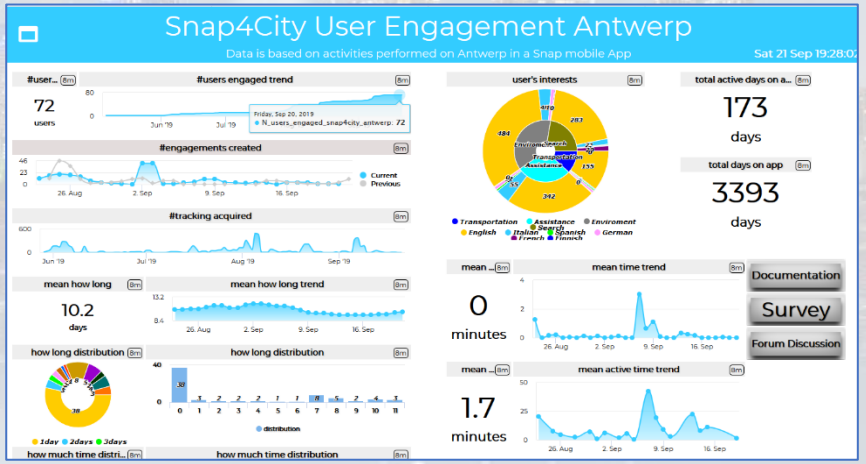

DCS Real Time - Settimanale
Fri 23 Oct 18:32:02
STOCK KOH
STOCK NaOH
Home

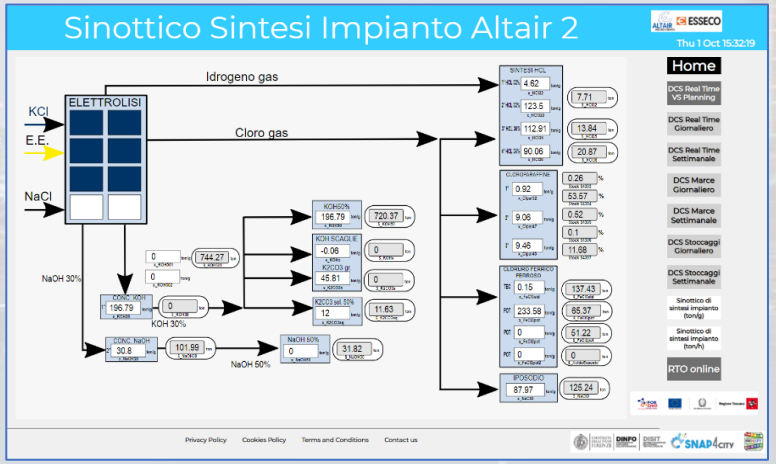

Data Analyzer: DevDash
Open Distro for Elasticsearch


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

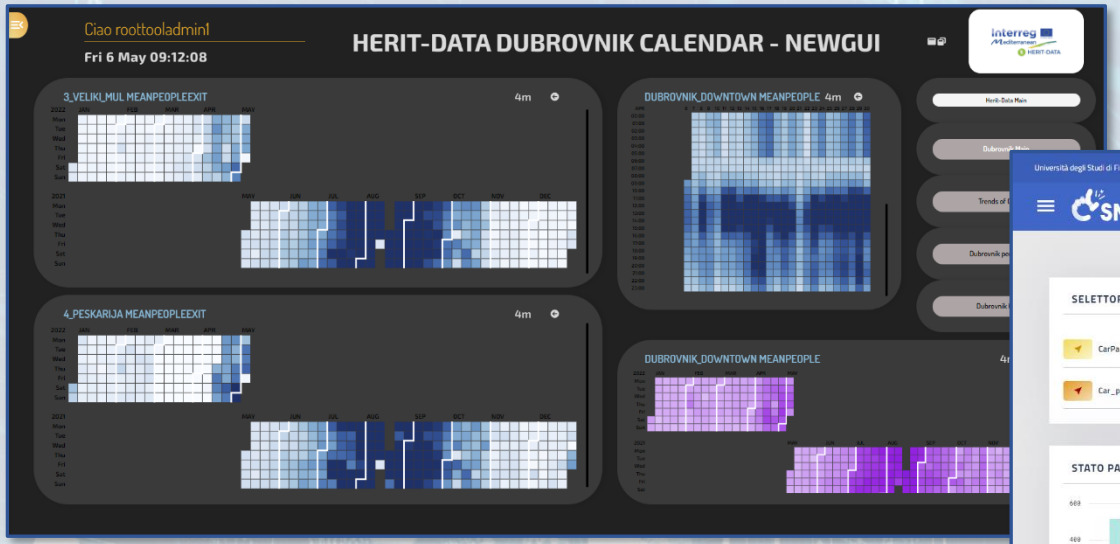

BIM Integration Dashboard

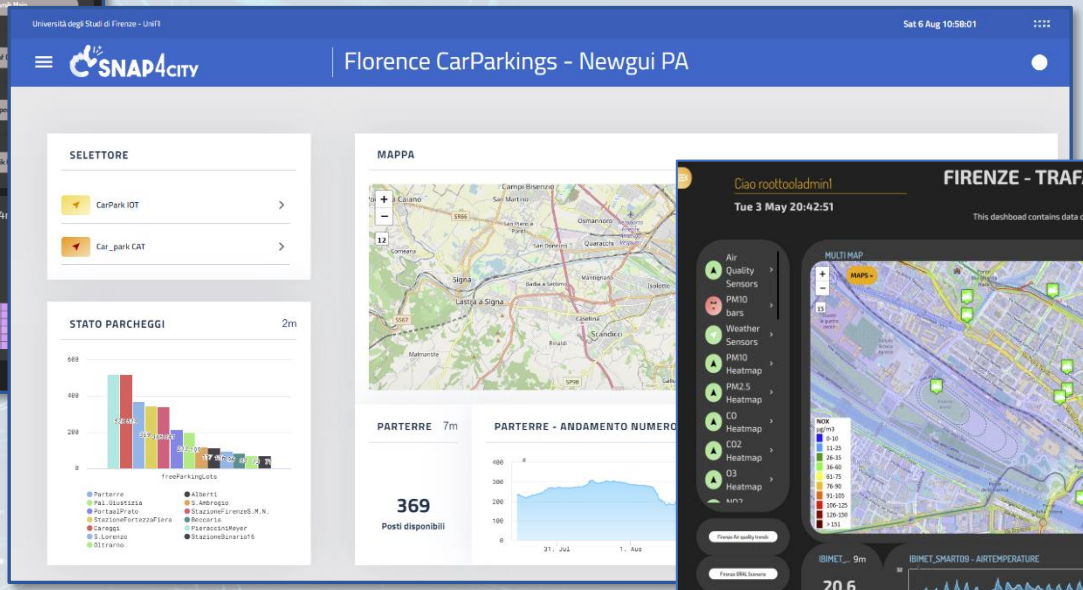

3D Multi Data Map - Digital Twin Global - Firenze
demonstrator
Sun 3 Apr 16:03:52
192

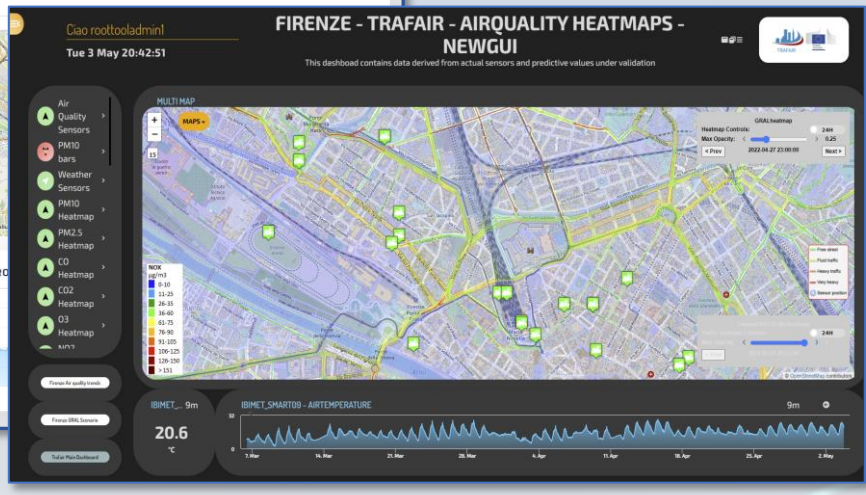

Snap4City User Engagement Antwerp
Data is based on activities performed on Antwerp in a Snap mobile App
Sat 21 Sep 19:28:0
72
users
173
days
3393
days
10.2
days
0
minutes
1.7
minutes
Documentation
Survey
Forum Discussion

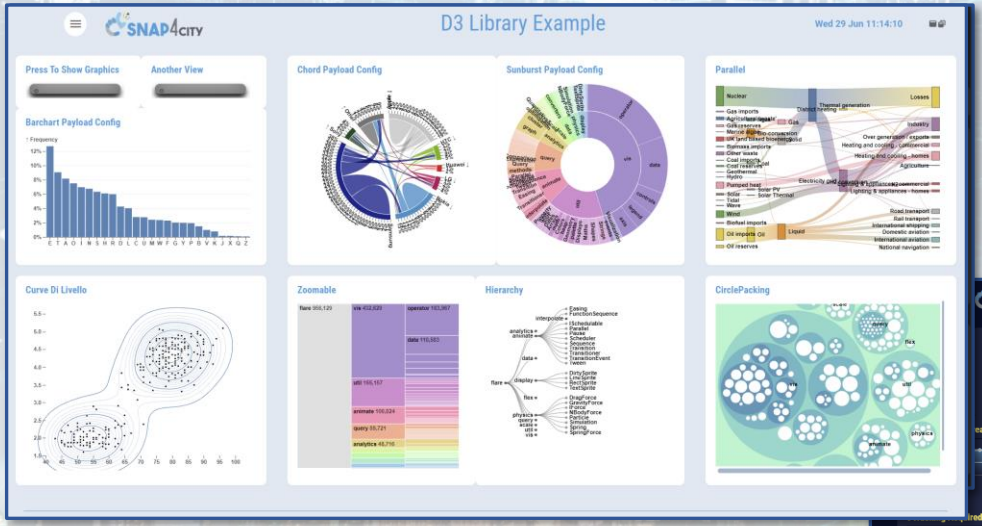

Sinottico Sintesi Impianto Altair 2
Thu 1 Oct 15:32:19
Home
Idrogeno gas
Cloro gas
ELETTROLISI
KCl
E.E.
NaCl
NaOH 30%
KOH 30%
NaOH 50%

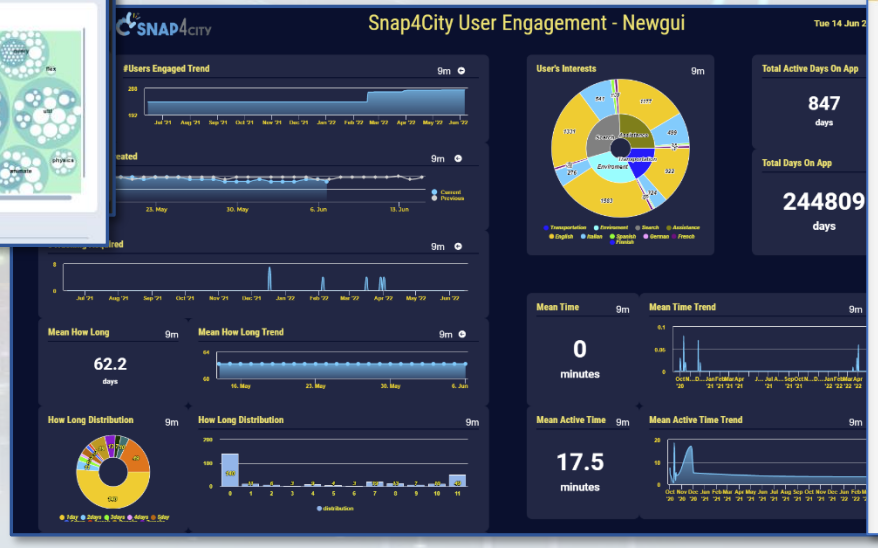
Different Themes

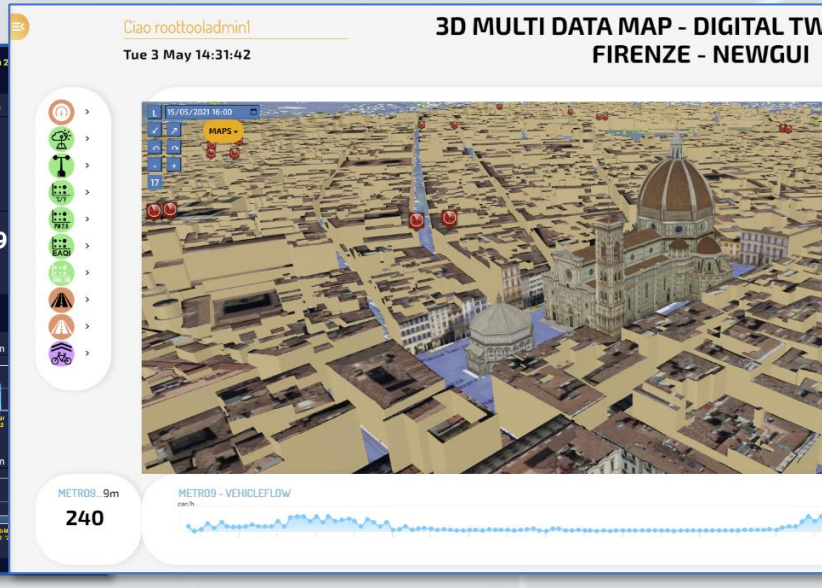








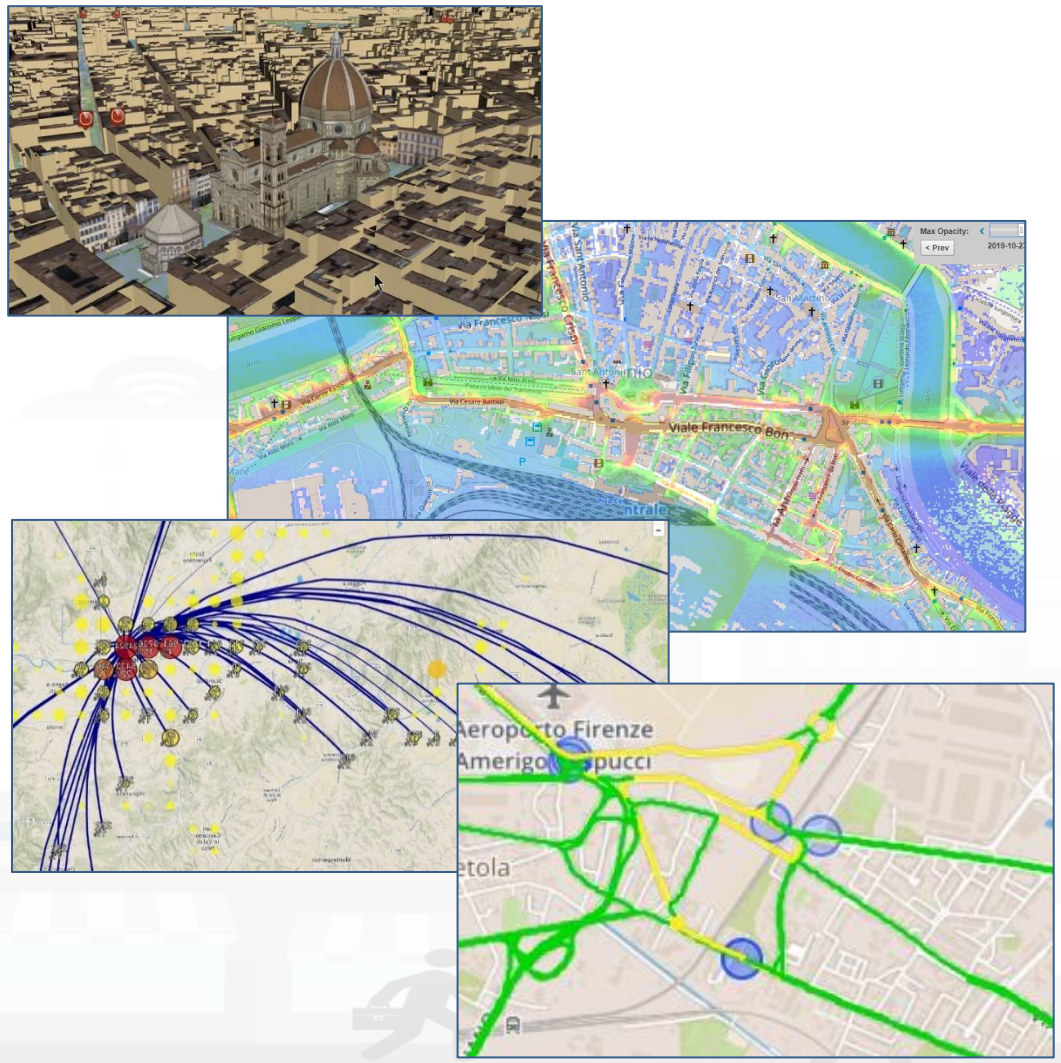




New styles/themes can be developed by specializing a few files from open source

https://www.snap4city.org/793

Smart City Digital Twin



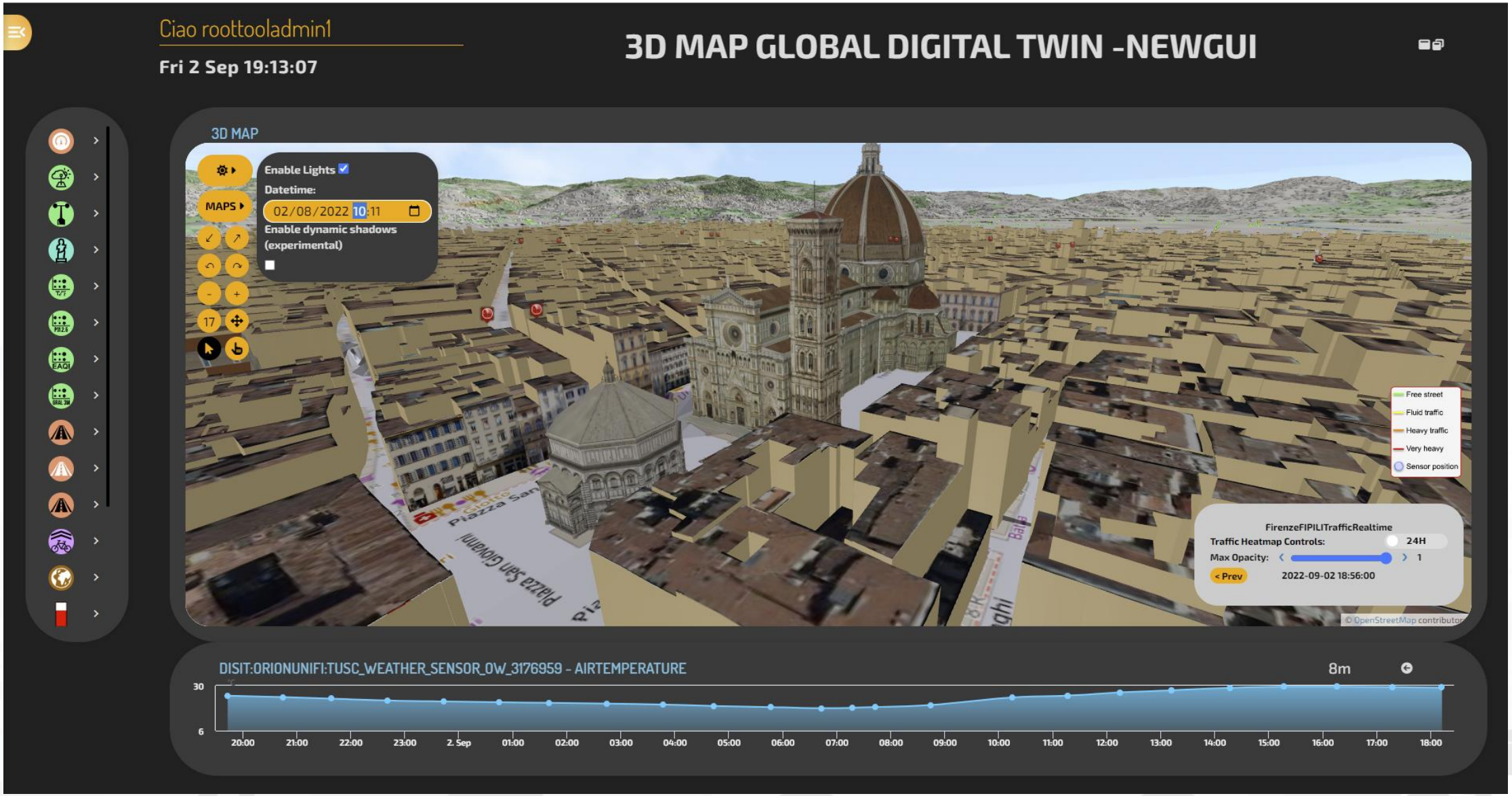
City Digital Model with…

- Intuitive platform
- Any Data TYPE, any data source, any protocol
- Data storage seamless
- Data analytics → artificial intelligence, AI/XAI
- Data Ethics, AI Ethics, GDPR
- Interactive 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 / optimization
- Collaborative and shared representation
- Sustainable, shared, open source 100%

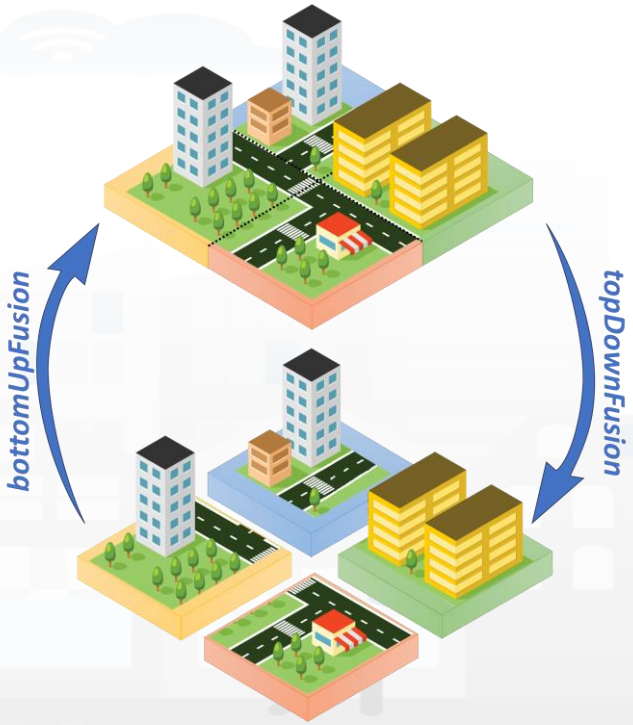
Complex and heterogeneous information, interoperability

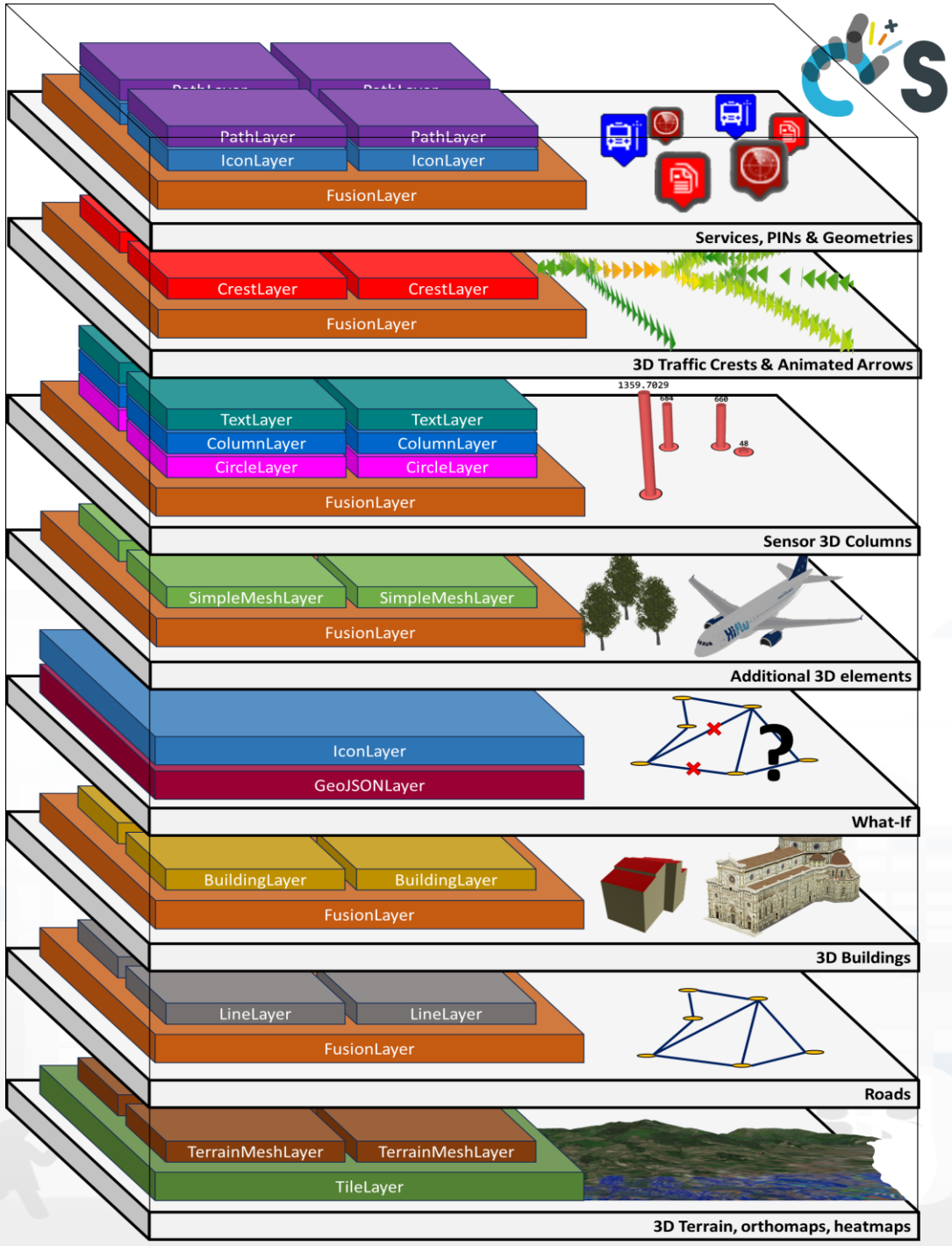
- GIS, ITS, AVM, IoT, BIM, CKAN, etc.
- Satellite services
- MaaS, last-mile delivery HUBs
- etc.

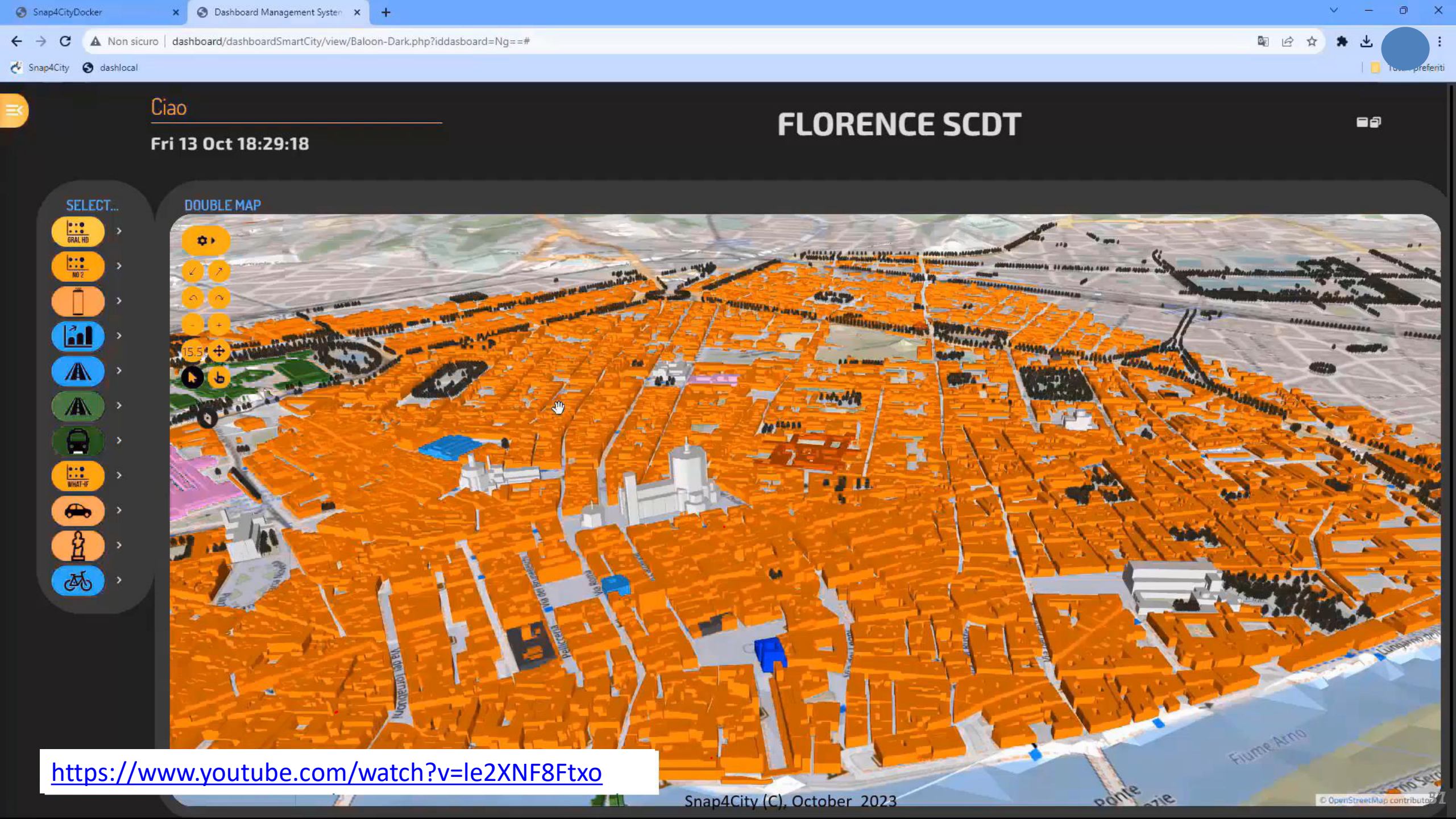
3D Digital Twin



Layers vs Fusion Layers





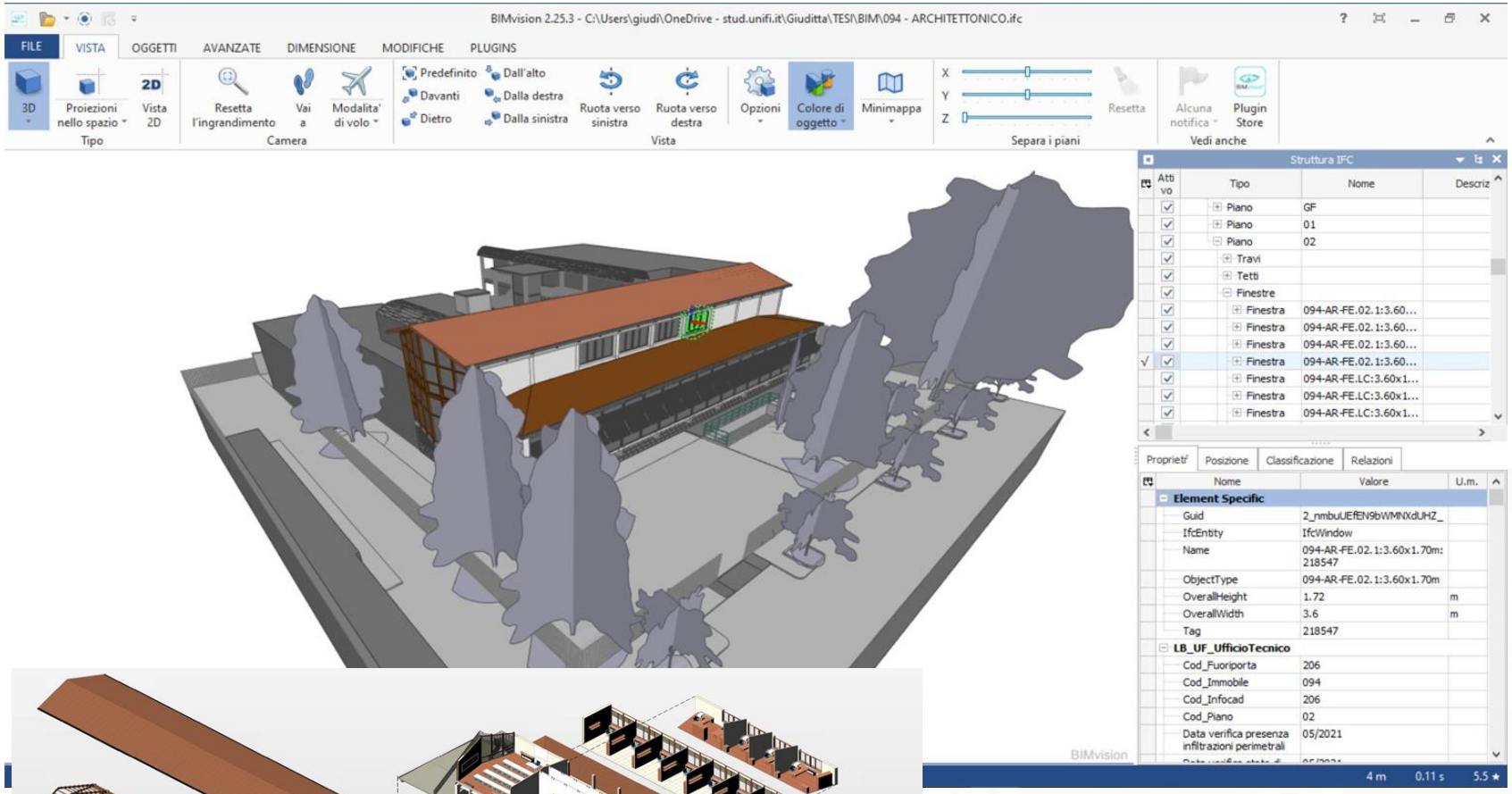


https://www.youtube.com/watch?v=le2XNF8Ftxo

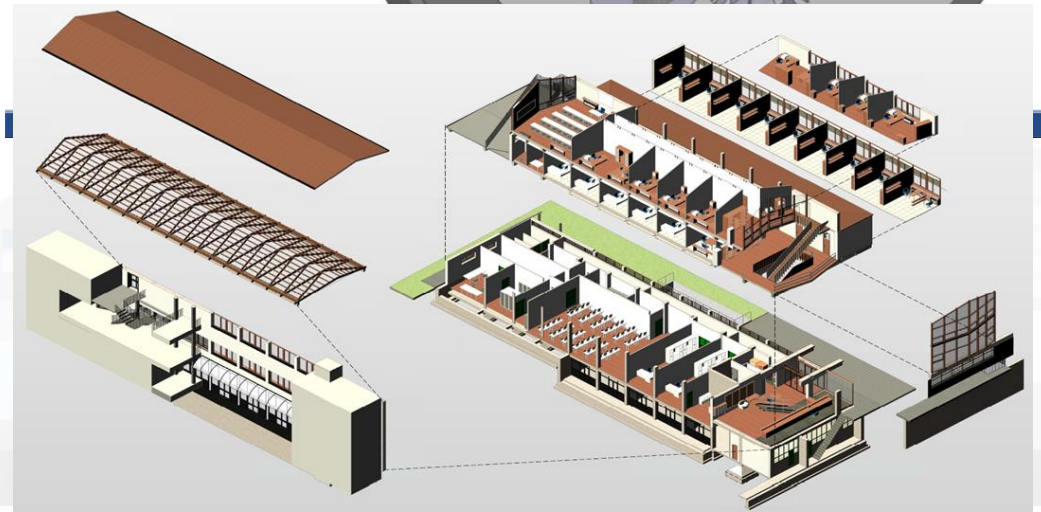
OCULUS

https://www.youtube.com/watch?v=Rcf_B2_GOio

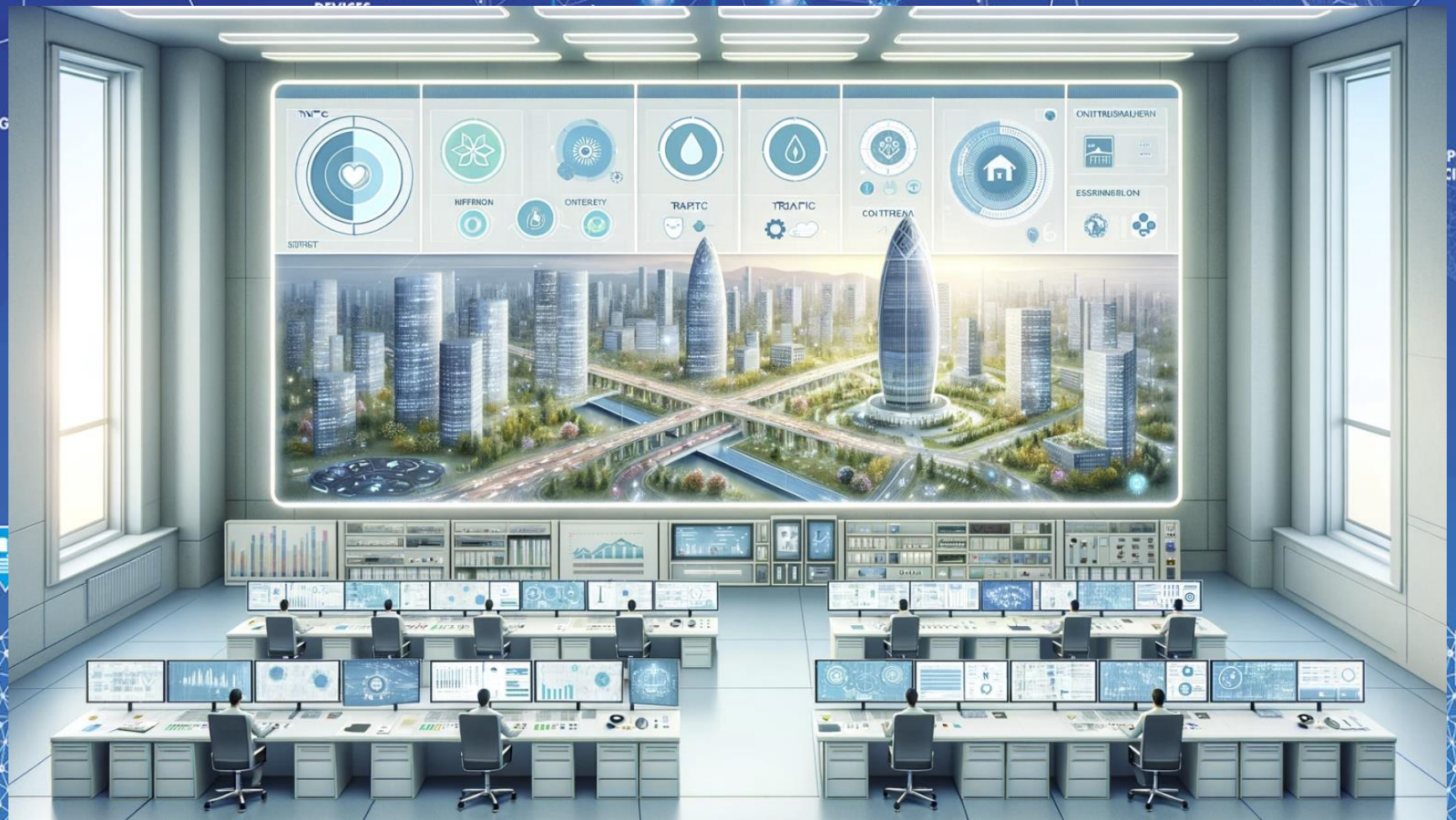
.IFC



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	



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

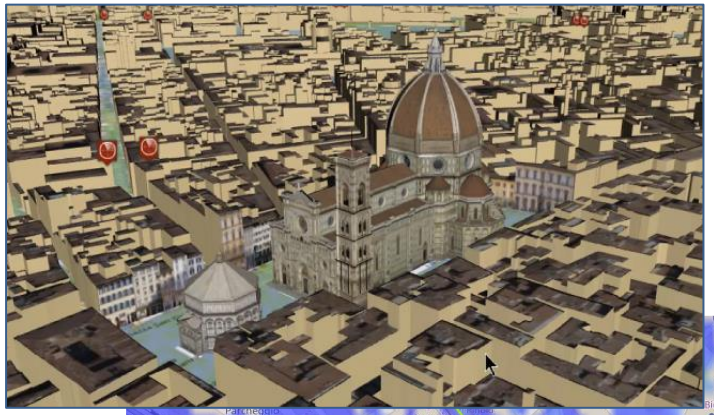
100% OPEN SOURCE

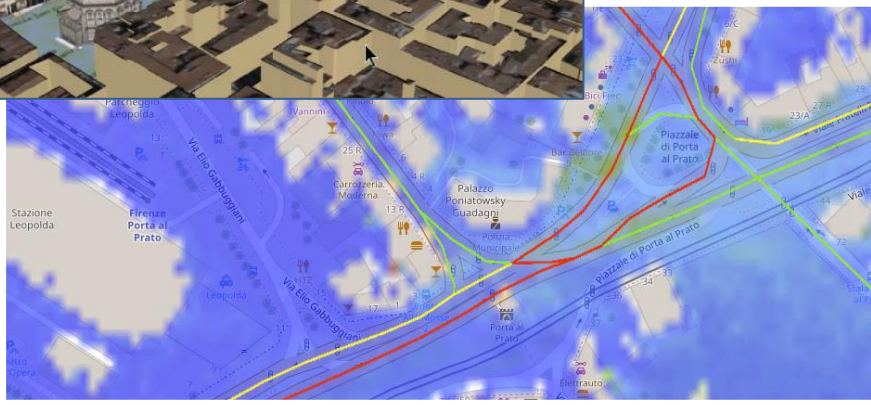
Control Horizontal Platform

- **Goals:**
  - Increasing quality of Life, quality of services,
  - Decongestion, Decarbonization, Sustainability
  - increase efficiency and production optimization
  - Improve accessibility to services: citizens, Tourists, commuters, etc.
  - Improve security/Safety of city users, risk reduction
  - Costs reduction of services, energy consumption reduction
  - Reduction of emissions and EC taxations
- **Horizontal homogeneous platform Uniform Technology for**
  - **Any Vertical operation/plan:** mobility, energy, environment, security, tourism, infrastructure and assets control, buildings, etc.
  - **AI Solutions**: early warning, predictions, simulations, what-if, optimization; Deep Learning, ML, BERT, LLM, XAI (Shap/Lime),
  - **Development Environment for any vertical, Digital Twin**: City Global and Local, IoT, VR, Visual Programming, business intelligence, CSBL, SSBL, etc.
  - **Interoperability**: any format, any protocol, any video management system, any sensor, any device, etc.
- **KPI:** multidomain KPI, general management, early warning, early detection of critical conditions, 15 Min City Index, SDG
- **Mobile App:** modular applications, operators' modules, multiple cities, etc.
- **Participatory**: problem reporting, ticketing, etc.
- **Integration of any kind**

Monitoring

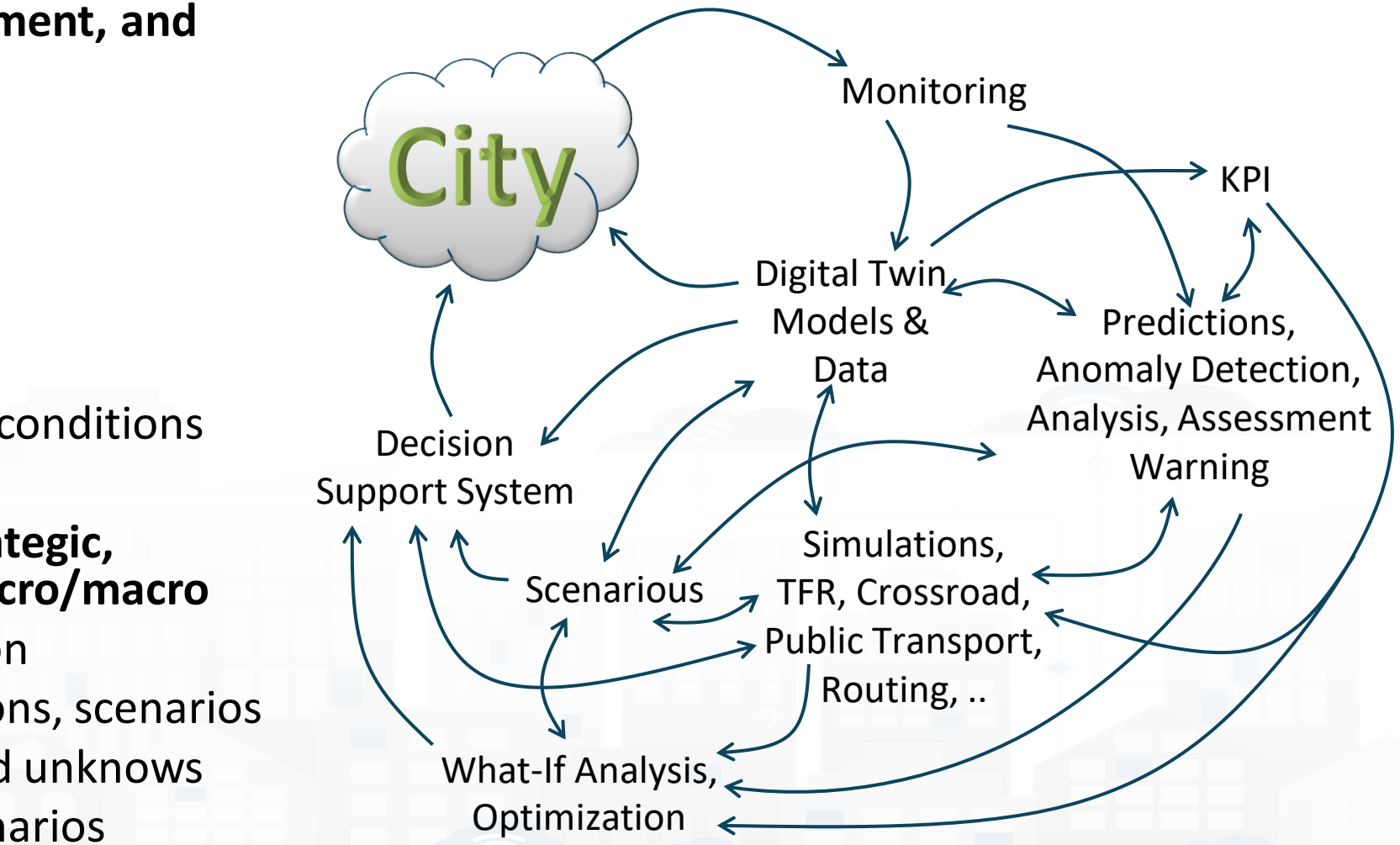
- **Controlling Status: management, and operational**
  - Monitoring via KPI
  - Computing predictions and KPI
  - Anomaly detection, Early warning
  - Control Rooms, situation rooms
- **Reacting: Computing in real time**
  - Changing semaphore maps
  - Changing Dynamic signage
  - Real time Info Mobility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





Main tasks

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



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.

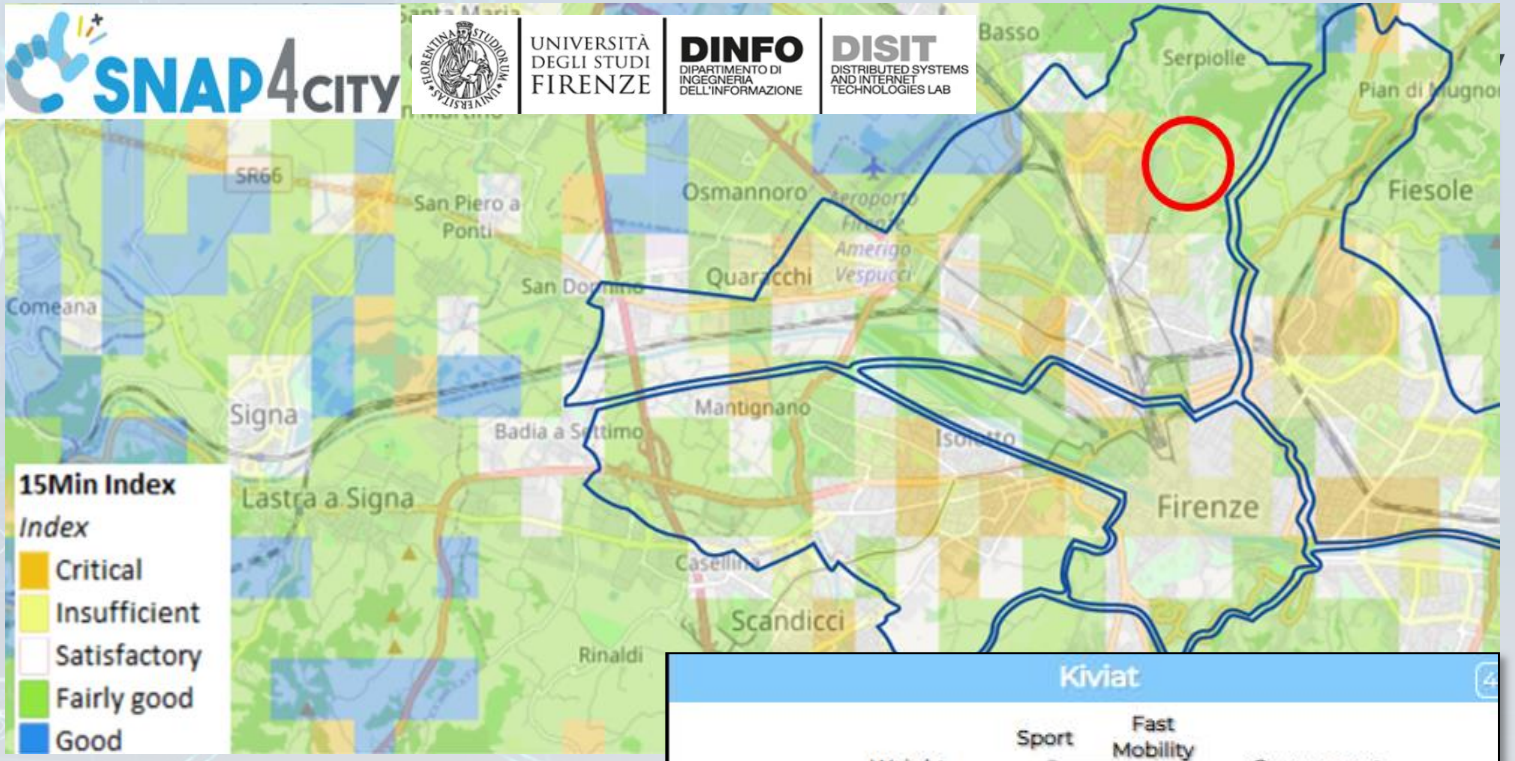
Global & Local

Periodic & Realtime

15MinCityIndex

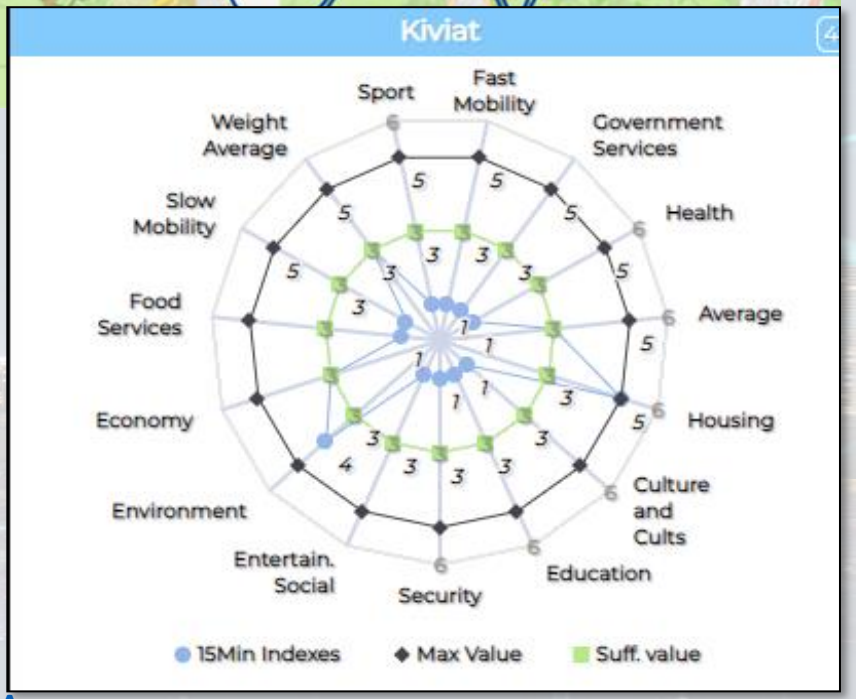
What would support my neighborhood to become a 15-Minute City?

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.

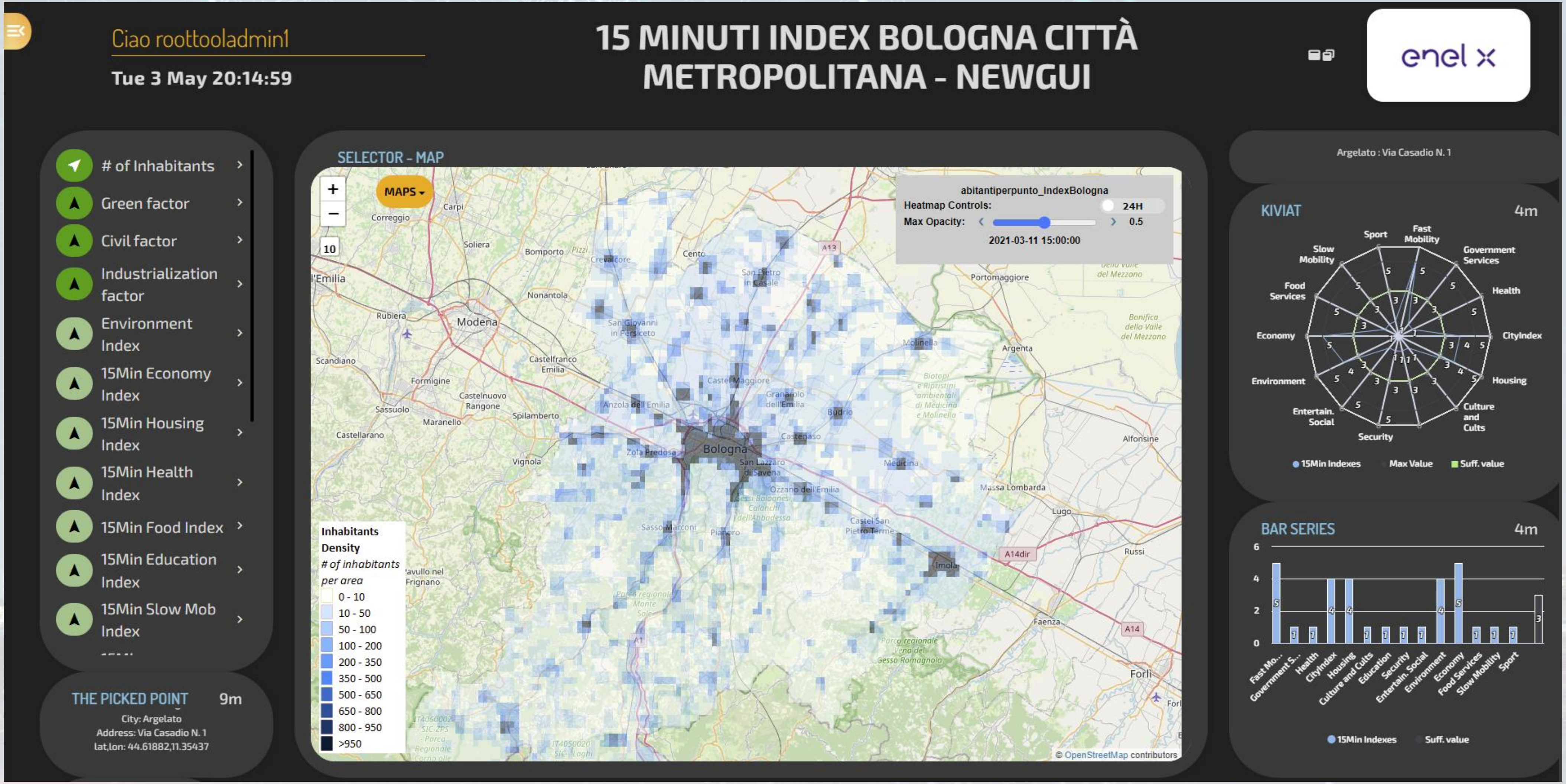
The tool supports the becoming of a 15-Minute city evaluating the service level in various domains.



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==

Real Time: control room, monitoring

- **Video Wall:** physical and virtual:
  - control room but also distributed control room: web and mobile views
- **Many Decision Makers** that have to
  - Early Warning: receiving real time notifications in push, telegram, etc.
  - share the same view monitoring a specific situation
    - may be located in multiple places
    - may be connected by using multiple kind of devices
  - Chatting privately on the same context
  - Receiving in real time the same changes and events

Control Room

Smart City Control Room
Florence Metropolitan City

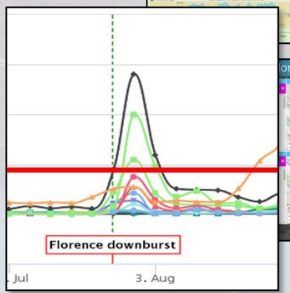
COMUNE DI FIRENZE

reference

SNAP4CITY

KM 4 CITY

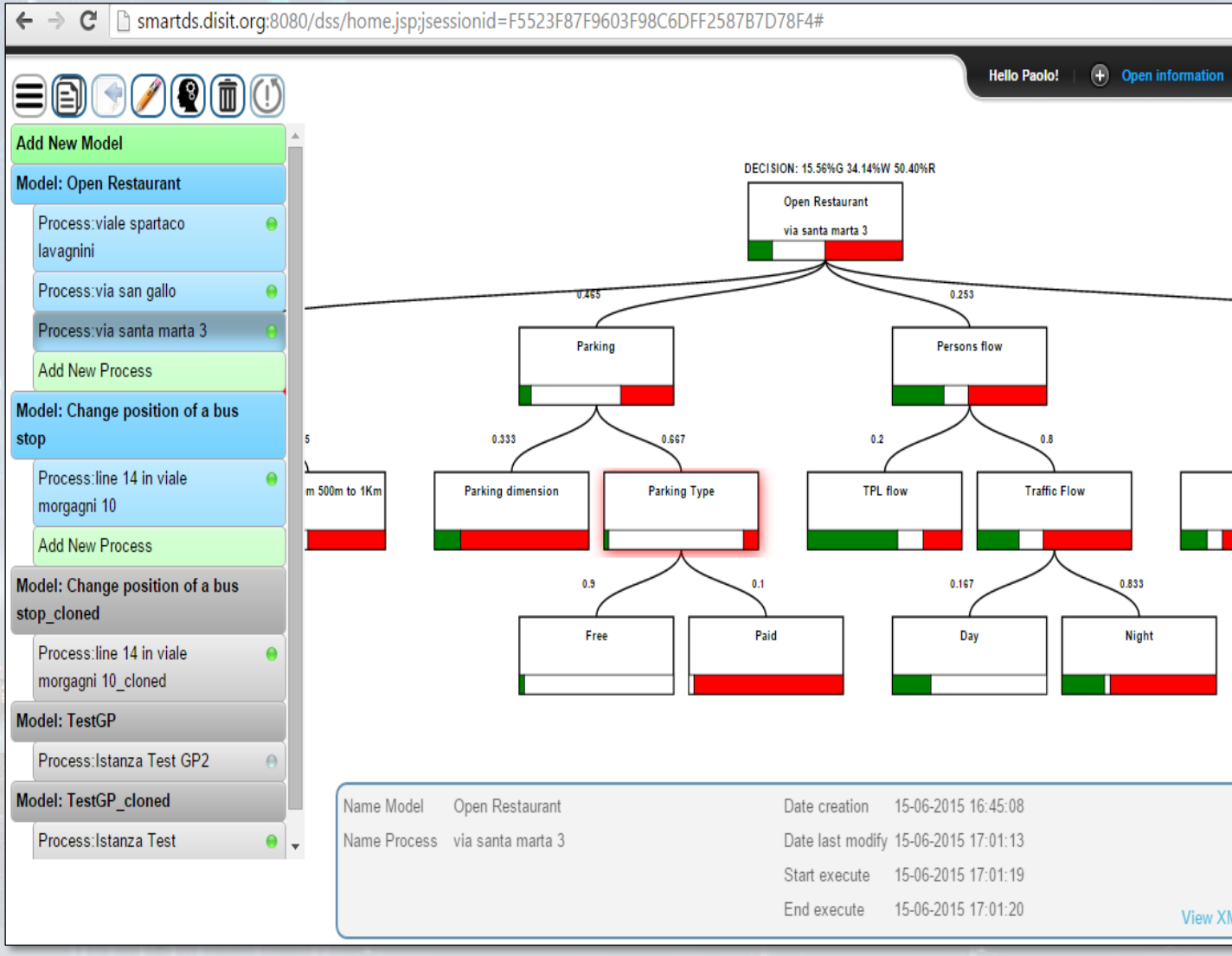
- **Multiple Domain Data**
  - Thousands of Open/Private data, POI, IOT, etc.
  - ***mobility and transport***: accidents, public transport, parking, traffic flow, Traffic Reconstruction, KPI, …
  - ***AND***: environment, civil protection, gov KPI, covid-19, social & social media, people flow, tourism, 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**



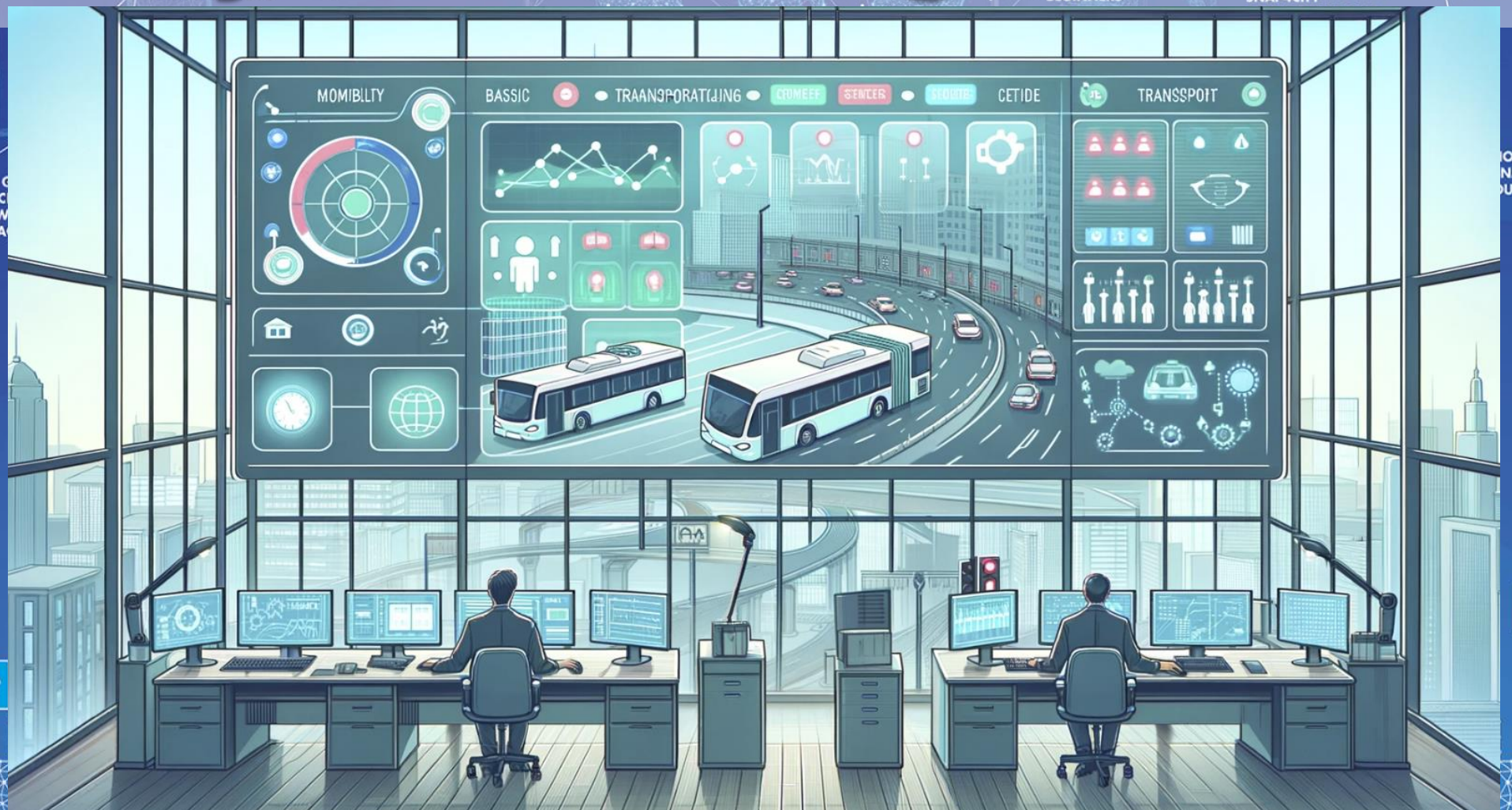
https://www.snap4city.org/747

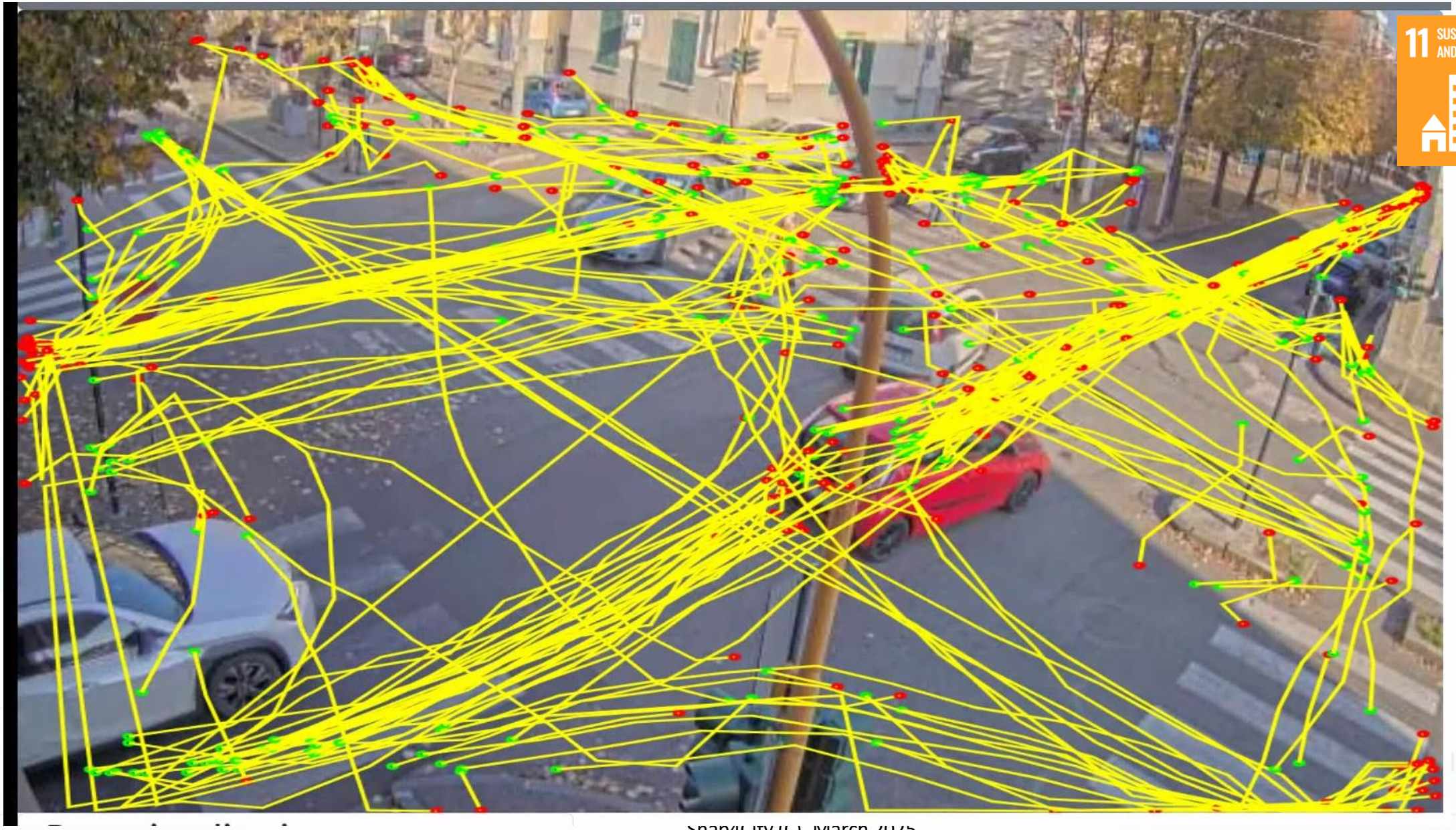
Smart Decision Support , system thinking

- **Smart Decision Support System** based on System Thinking plus
- Actions to city reaction, resilience, smartness, …
- Enforcing Mathematical model for propagation of decision confidence..
- Collaborative work, …
- Processes connected to city data: DB, RDF Store, Twitter, etc.
- Production of alerts/alarms
- Data analytics process
- Twitter Processes
- reuse, copy past, …



Mobility Monitoring and Control

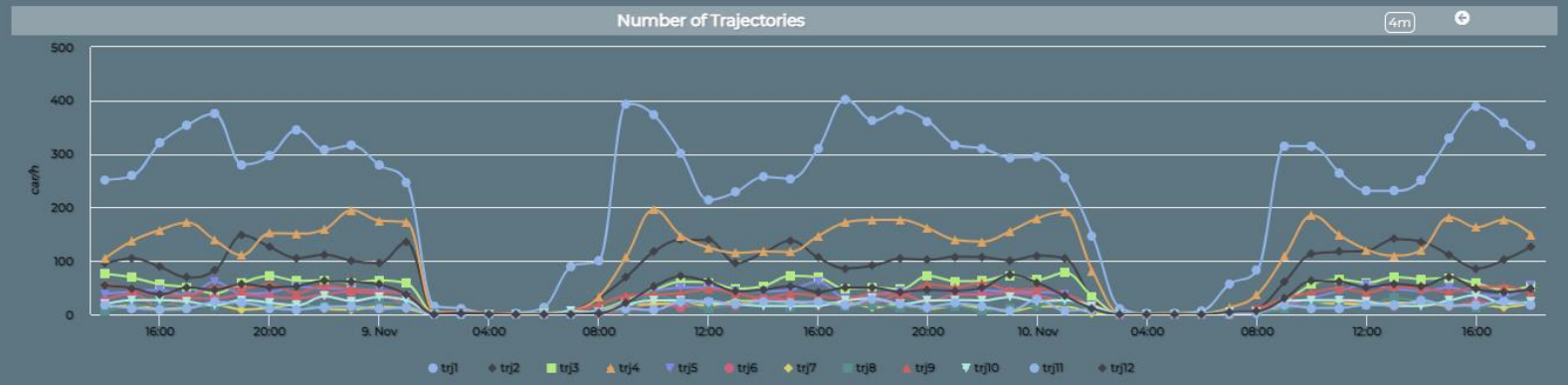


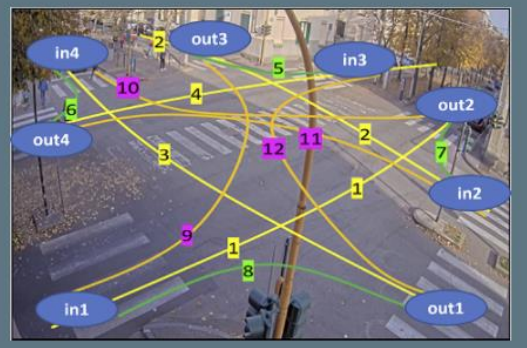


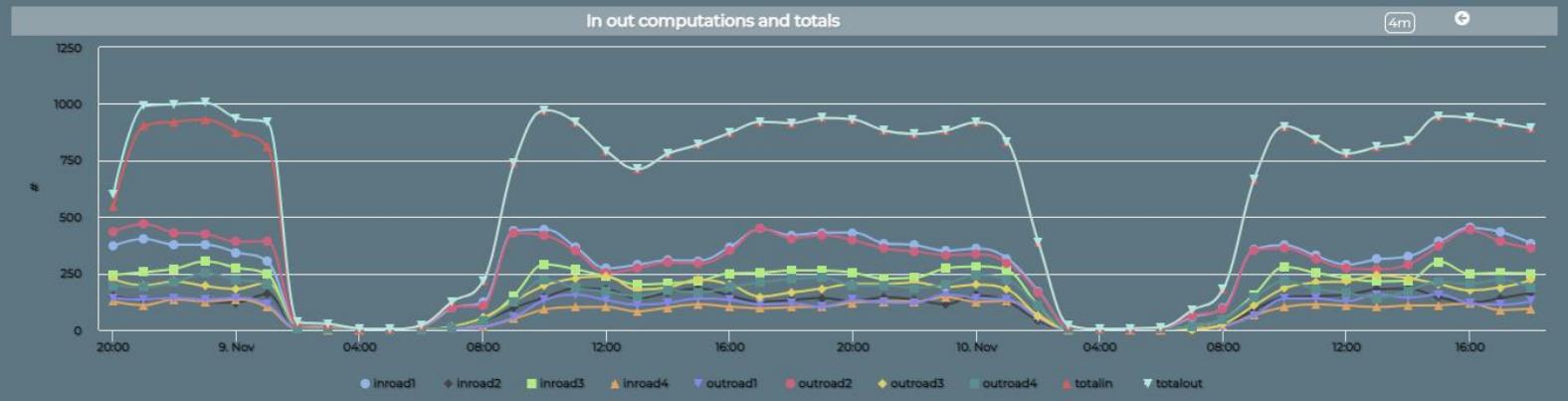
Venaria Reale

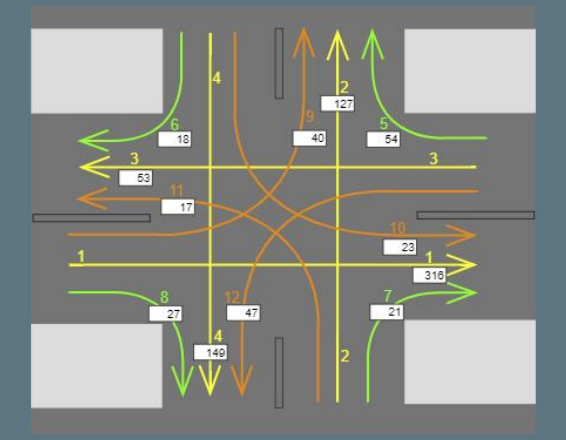
Monitoring Cross Road Venaria - (AXIS Camera)

Wed 10 Nov 18:50:53







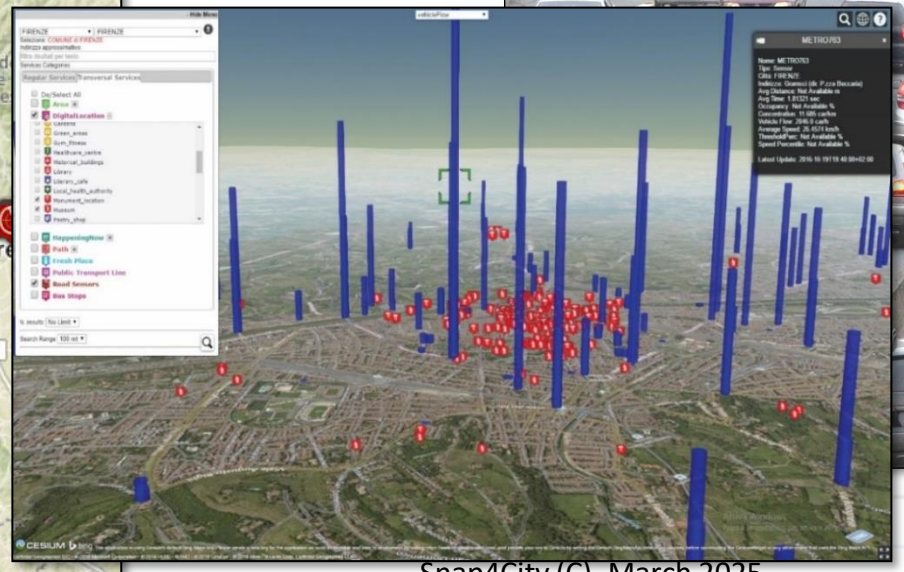


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzI5Ng==

Traffic Flow Tools

Spire and Virtual Spires (cameras), Bluetooth, ...

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



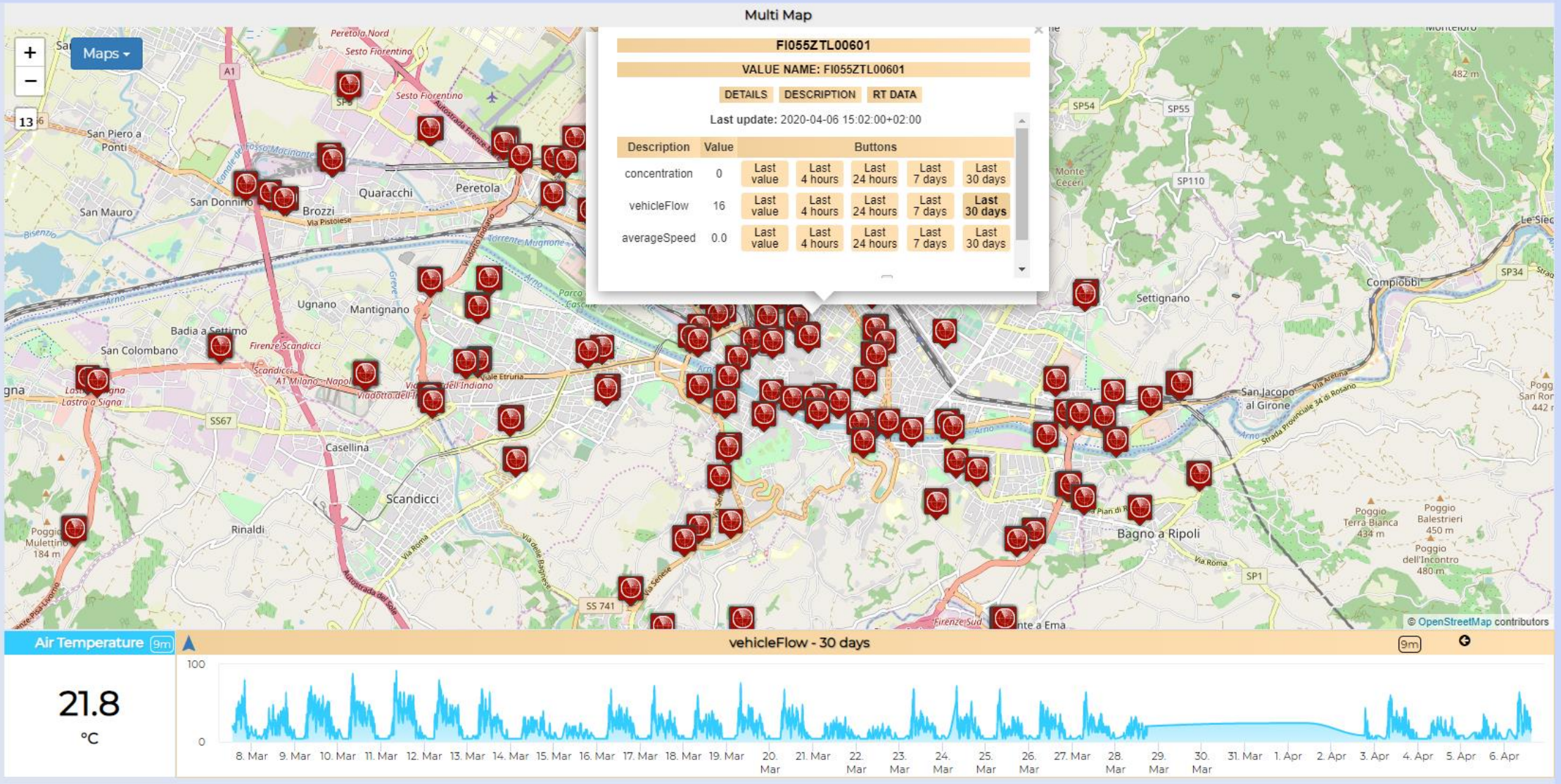
Firenze - Trafair - AirQuality Heatmaps

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



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

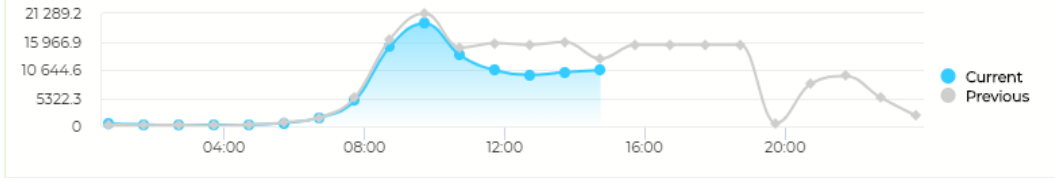
Traffic Flow Monitoring - Firenze - Cloned2

Wed 11 Nov 15:01:32

 # IN FLOW 9m

10549 #ofvehicles

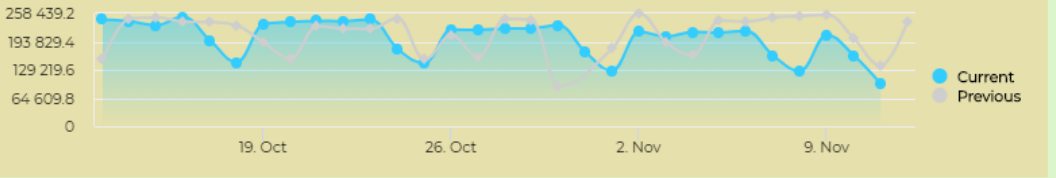
Firenze IN Traffic Flow (number of vehicles) 9m



Inc Daily Inp... 9m

97137 #ofvehicles

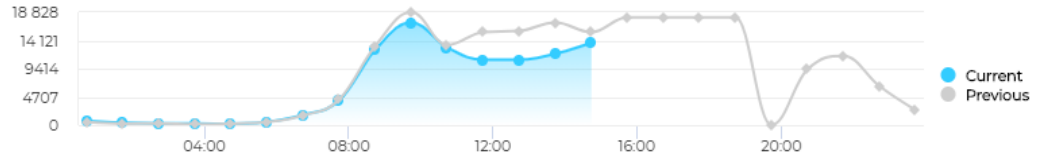
Daily Inputs (monthly) (last value is incremental, real time) 9m



 # OUT FLOW 9m

13720 #ofvehicles

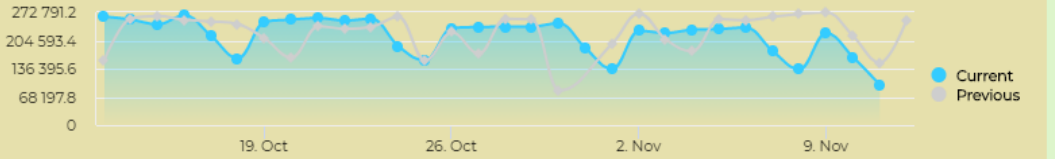
Firenze OUT Traffic Flow (number of vehicles) 9m



Inc Daily Out... 9m

97457 #ofvehicles

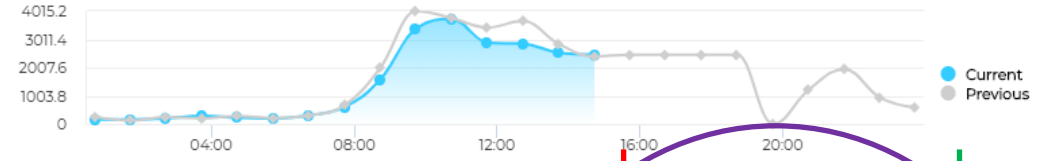
Daily Outputs (monthly) (last value is incremental real time) 9m



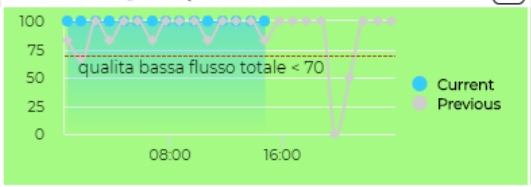
ZTL in 9m

2468 #ofvehicles

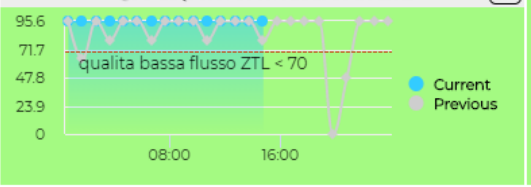
ZTL in Traffic Flow daily trend, entering in ZTL 9m



QoS as perc. of measures taken 9m



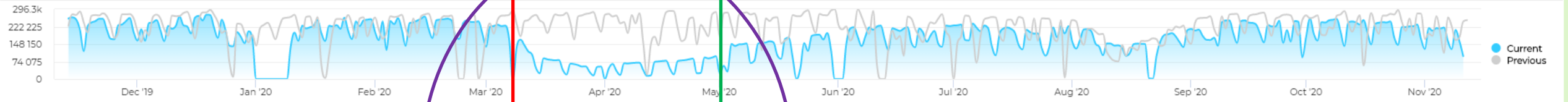
QoS as perc. of measures in ZTL 9m



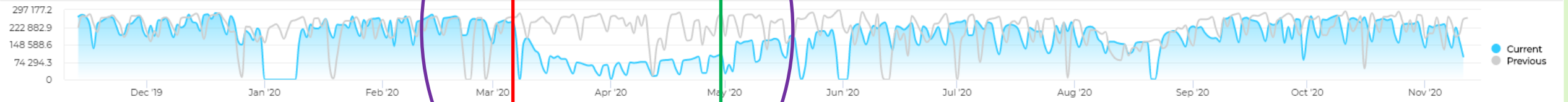
11/11/2020

15:01:33

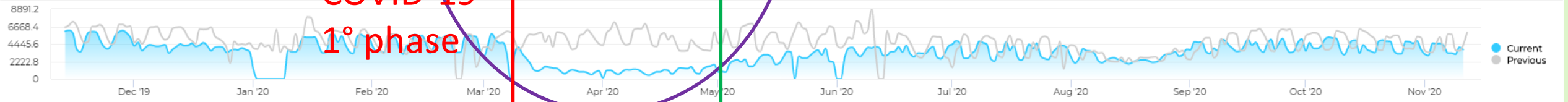
inflow total of the day, yearly 9m



outflow total over the day Yearly 9m



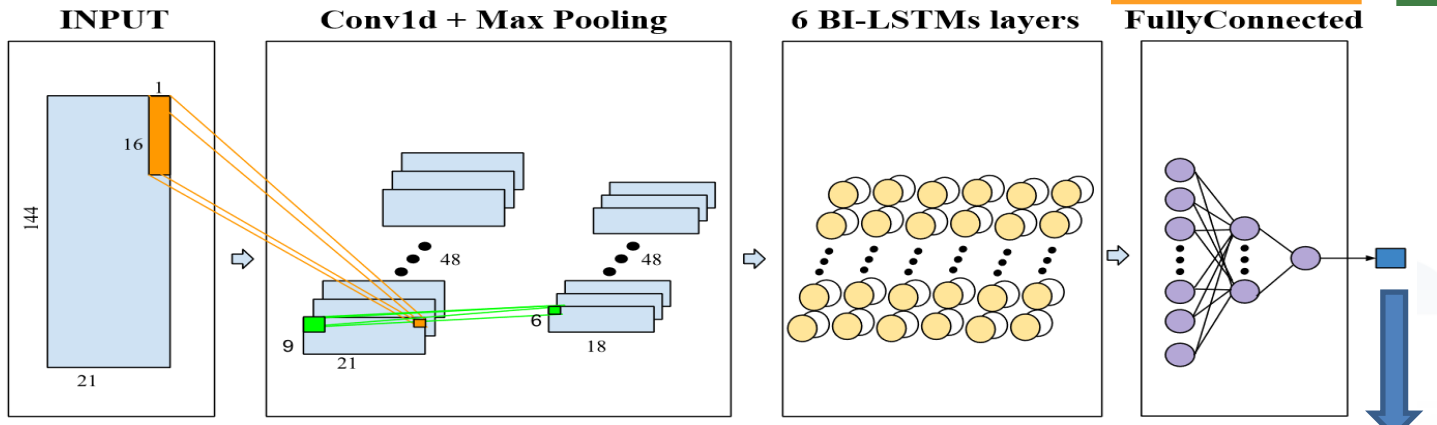
in ZTL yearly compare 9m



COVID-19

1° phase

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

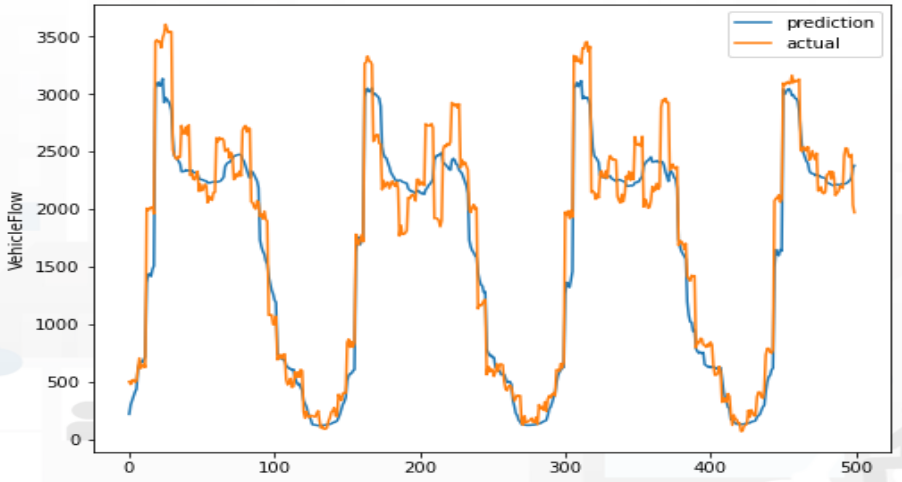


Urban data:

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

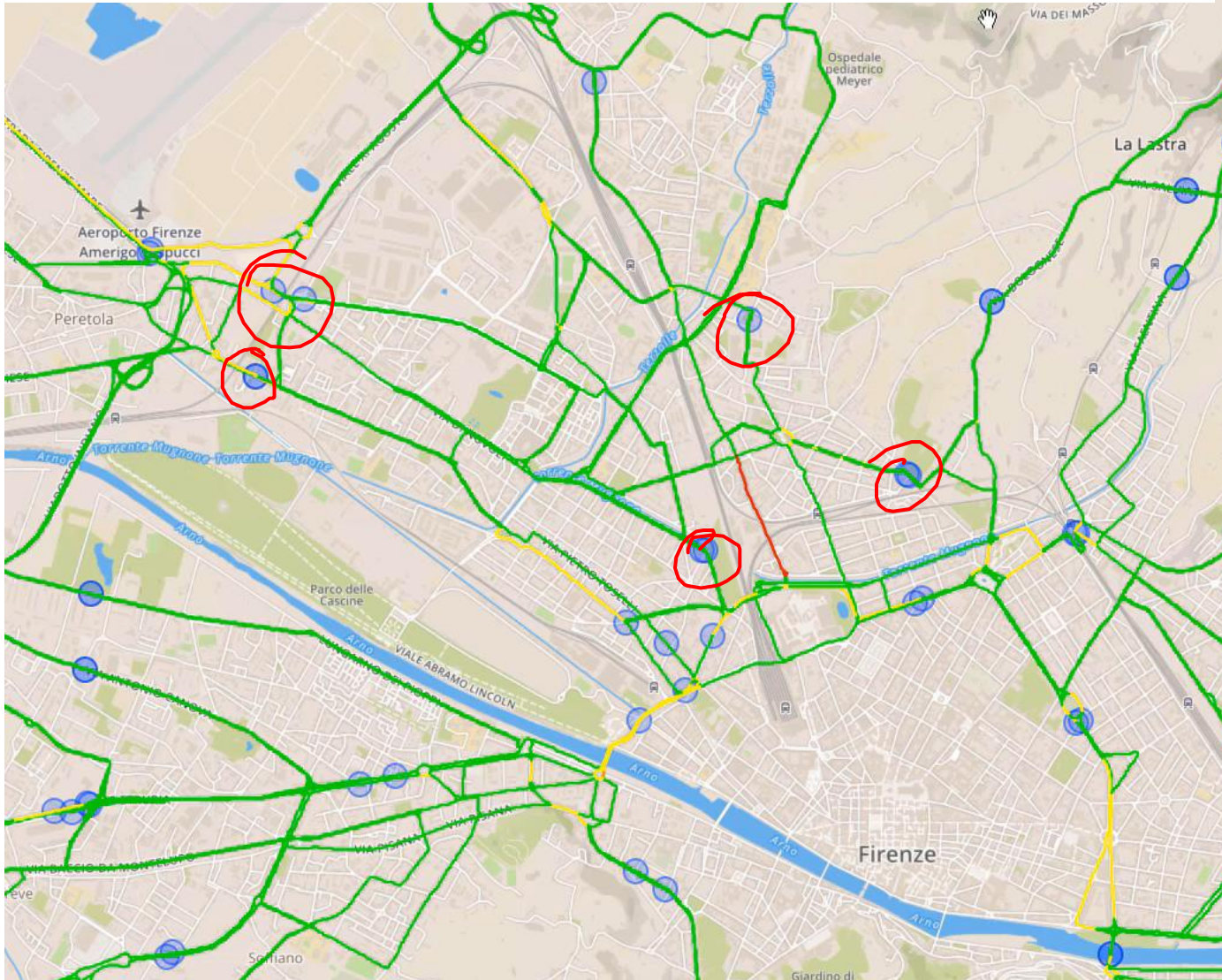
RF
XGBOOST
DNN
LSTM
BI-LSTM
Autoencoder BI-LSTM
Attention CONV-LSTM
CONV-BI-LSTM

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



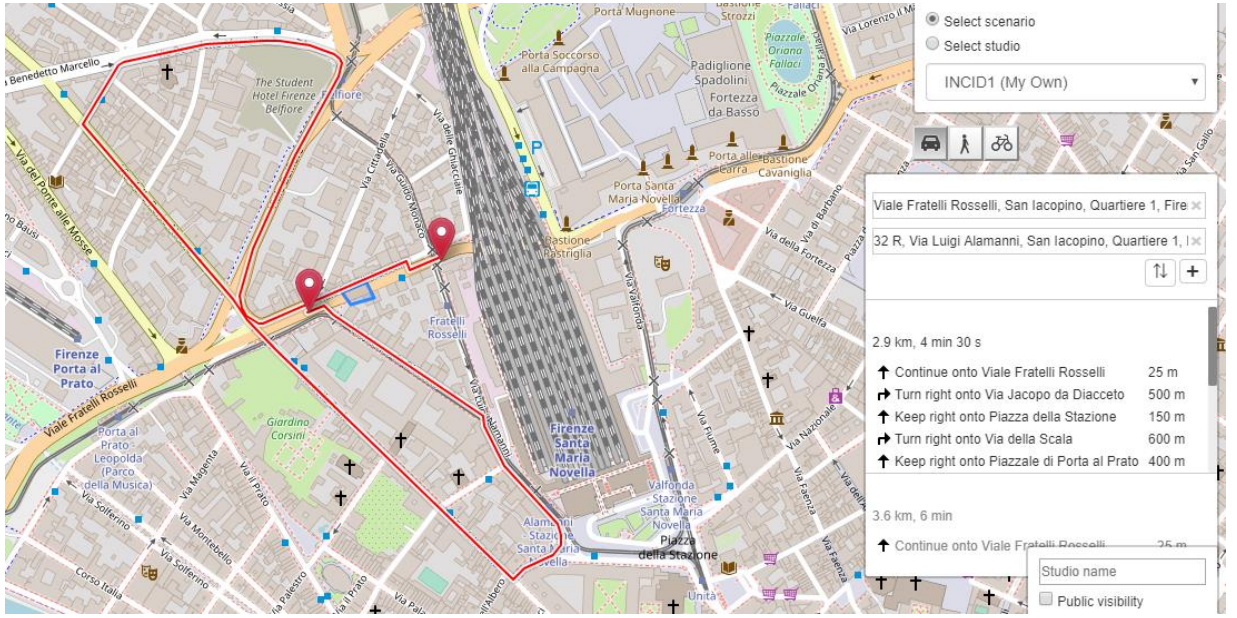
What-If Analysis

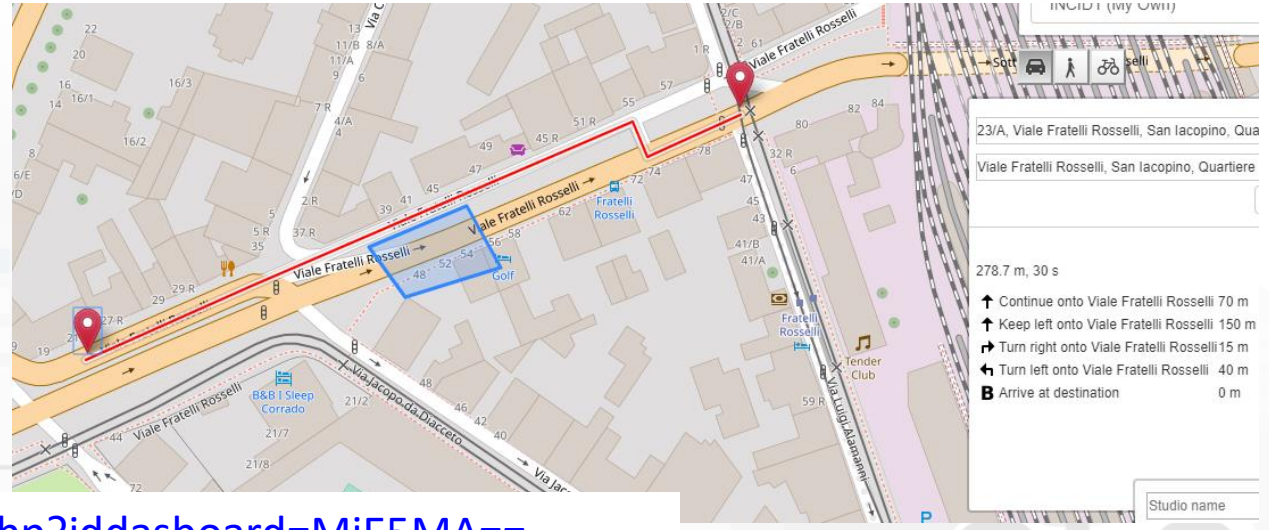
Accidents and elements blocking Points and Shapes taken into account for:

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

Assessment on the basis of changes:

- Mobility demand assessment
- Mobility Offer assessment

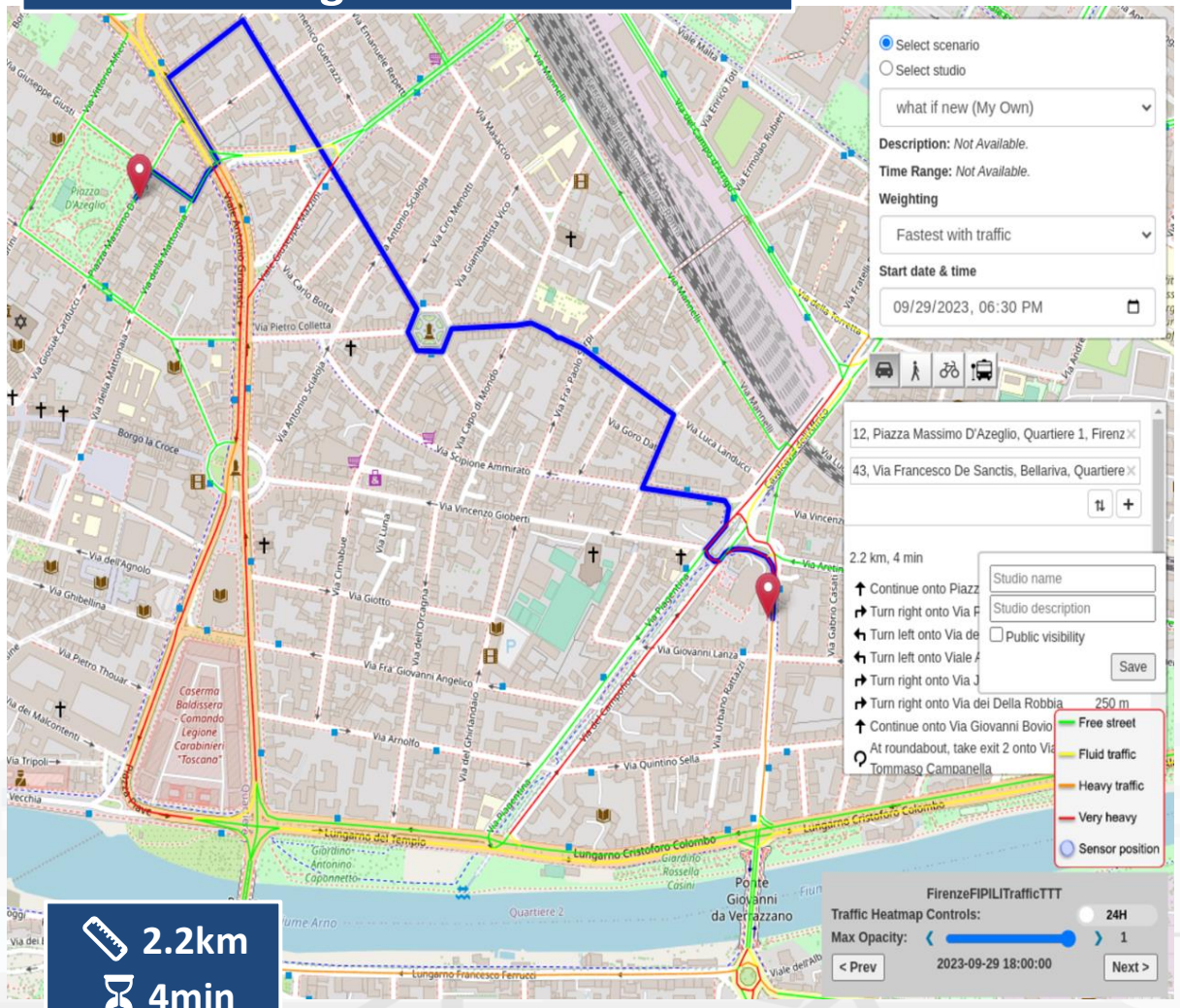




https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjE5MA==

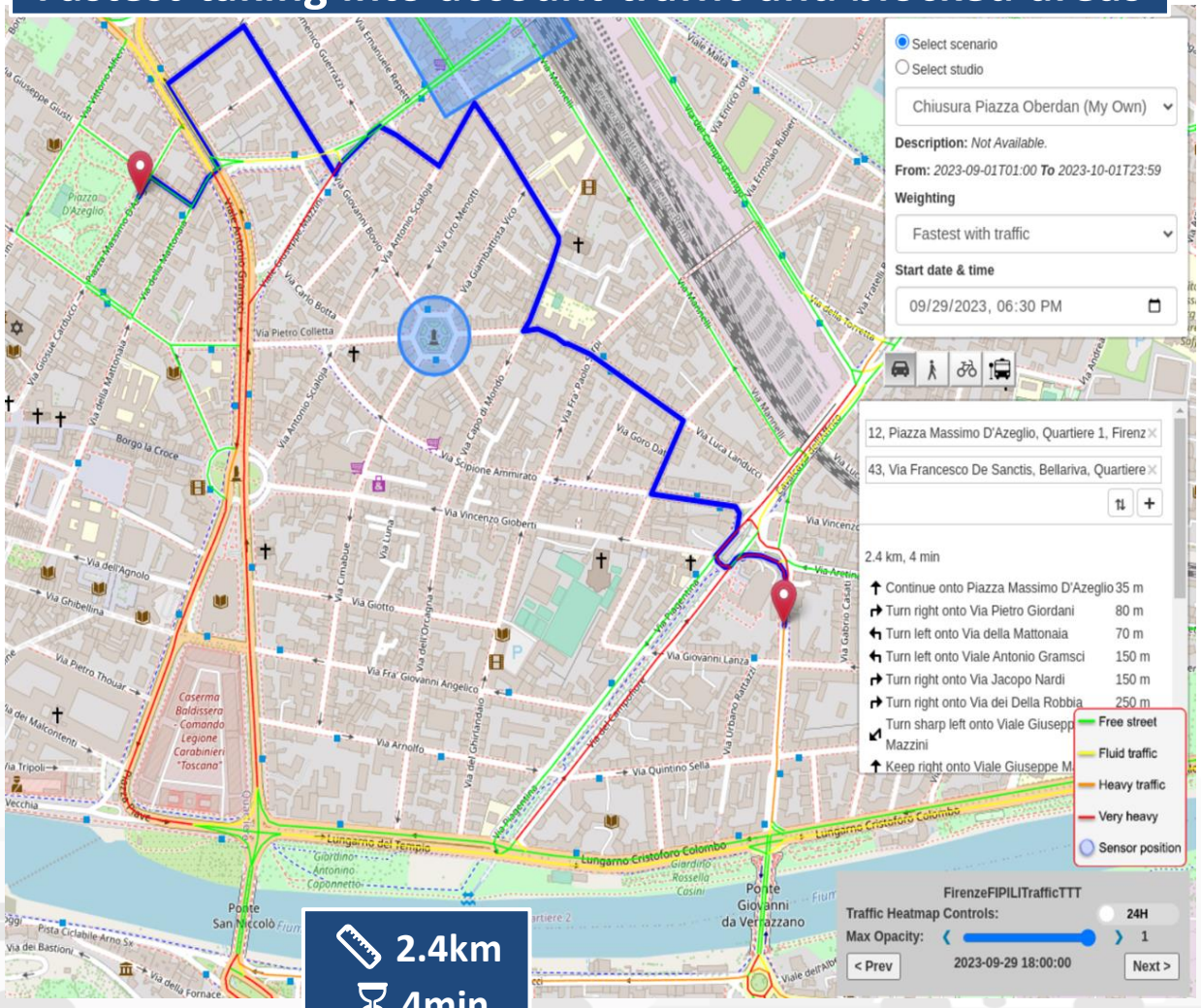
Constrained Dynamic Routing: Traffic Flow

Fastest taking into account traffic



2.2km
4min

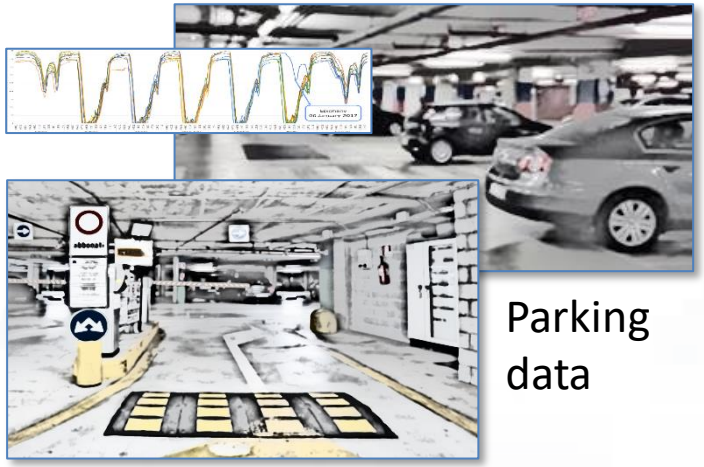
Fastest taking into account traffic and blocked areas



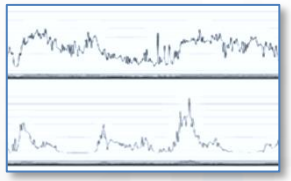
2.4km
4min


autostrada
FIESOLE
SIENA
AREZZO - FORLI'

Deep Learning AI to surely Park!

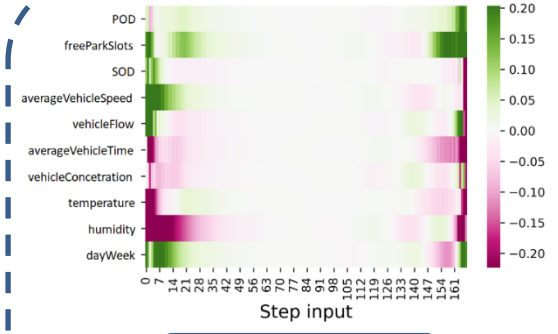


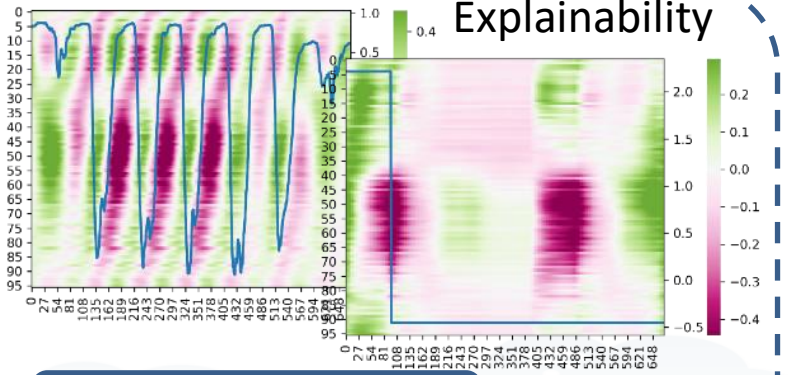
Parking data



Traffic sensors data

Weather Features

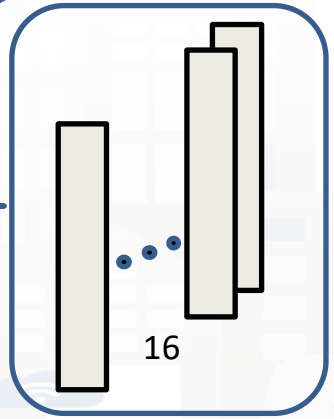


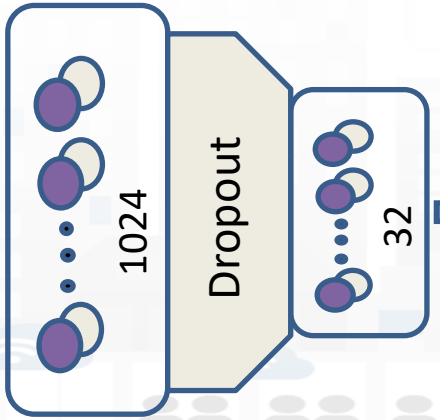


Explainability

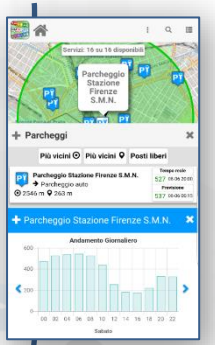
Gradient

Integrated Gradient



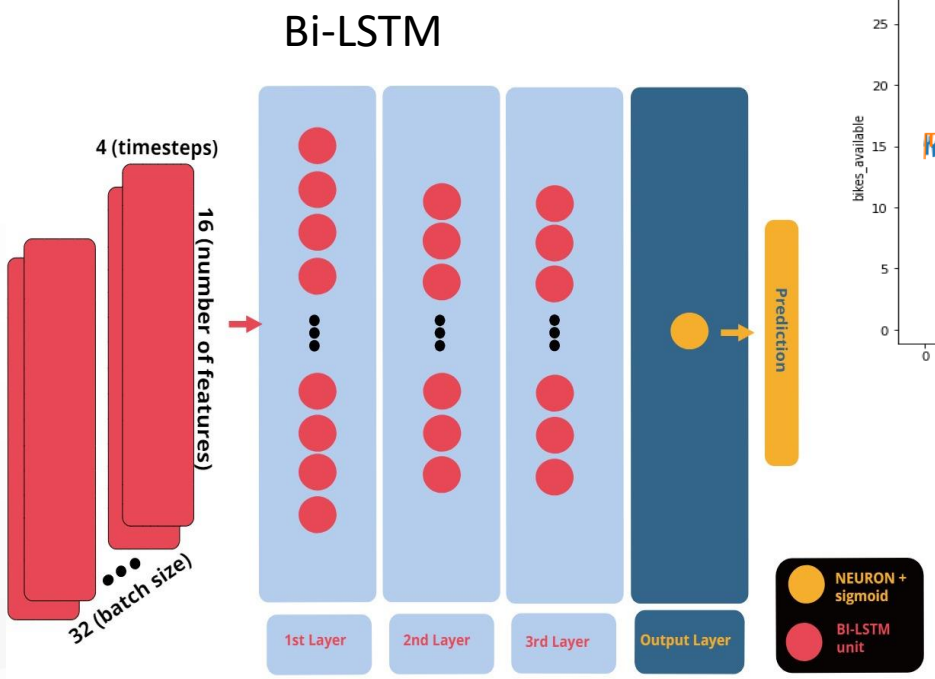


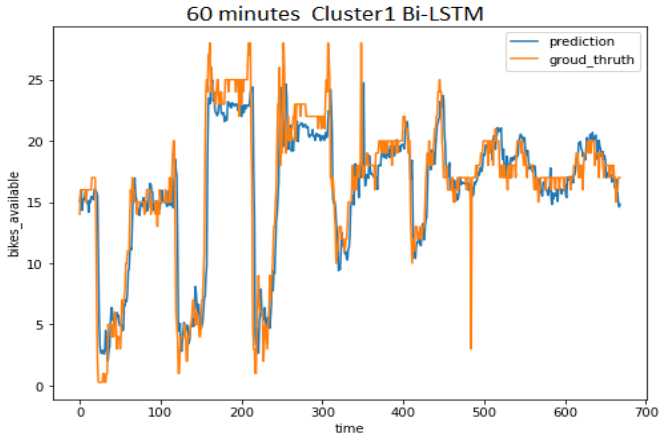
Multi-step Predictions



Conv1D+AvPooling1D BI-LSTM BI-LSTM Dense

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

Road Parking

Parking Conditions Monitoring

Wed 23 Oct 16:24:41

- Status of Slots
- Types of Slots
- As Pins
- Geolocation
- Types of Parking Zones
- Fines on Parking Zones
- Parking Meters
- Recharge Stations
- Parking Structures

Management

Parking Slots

DISIT:OrionUNIFI:METRO1095 - VehicleFlow

8m

Parking KPIs

Select Group: Alberti 11

Group capacity : 26

Grouped by slot type

Event Car

Free Slots: 4/22

Busy Slots: 2/22

Busy Bluetooth Slots: 3/22

Busy Authorized Slots: 5/22

To Be Fined Slots: 5/22

Fined Slots: 1/22

Do Not Care Slots: 2/22

Event Moto

Free Slots: 0/4

Busy Slots: 1/4

Busy Authorized Slots: 0/4

To Be Fined Slots: 1/4

Fined Slots: 1/4

My Profile

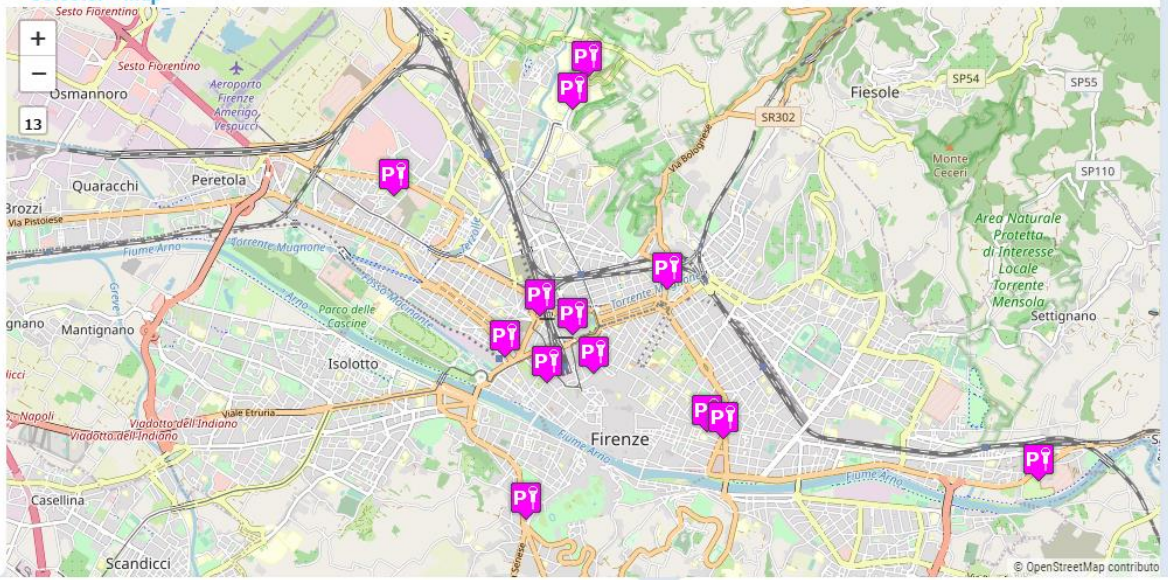
Monitoraggio Parcheggi

Sat 13 May 23:26:20

Selector

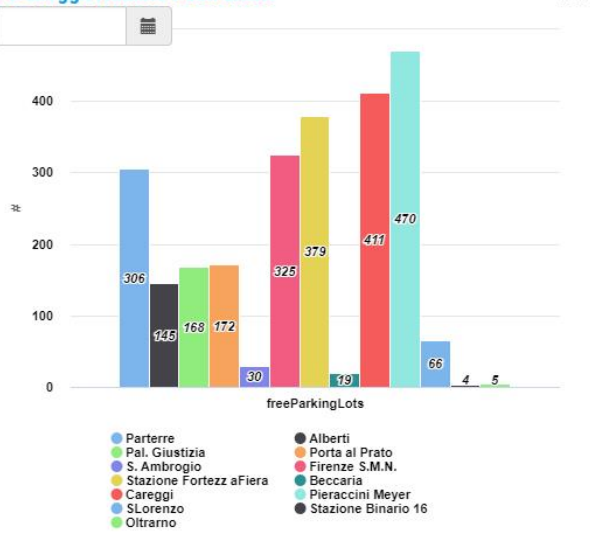
- Parterre
- Piazza Alberti
- Palazzo di.Giustizia
- Porta al Prato
- S. Ambrogio
- Stazione Firenze S.M.N.
- Stazione Fortezza Fiera
- Piazza Beccaria

Selector - Map



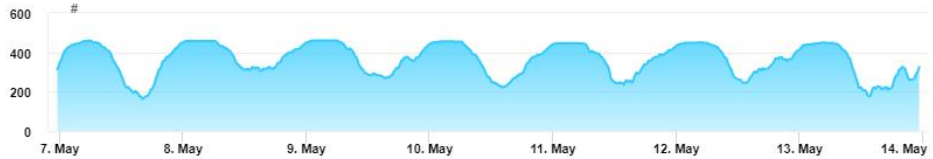
Parcheggi: Numero Posti Liberi

4m



StazioneFirenzeS.M.N. - FreeParkingLots

9m



Andamento Posti Occupati

4m

My Profile

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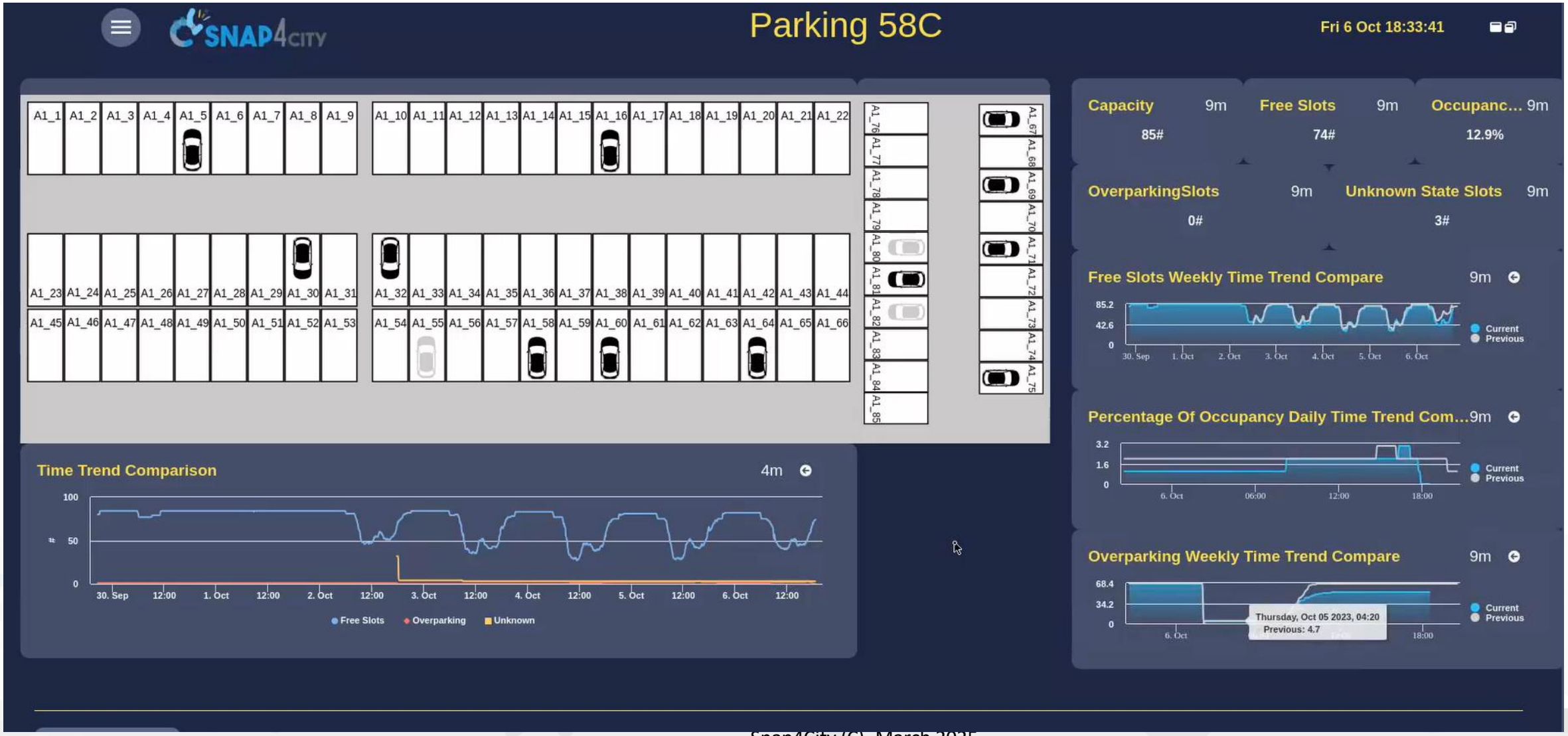
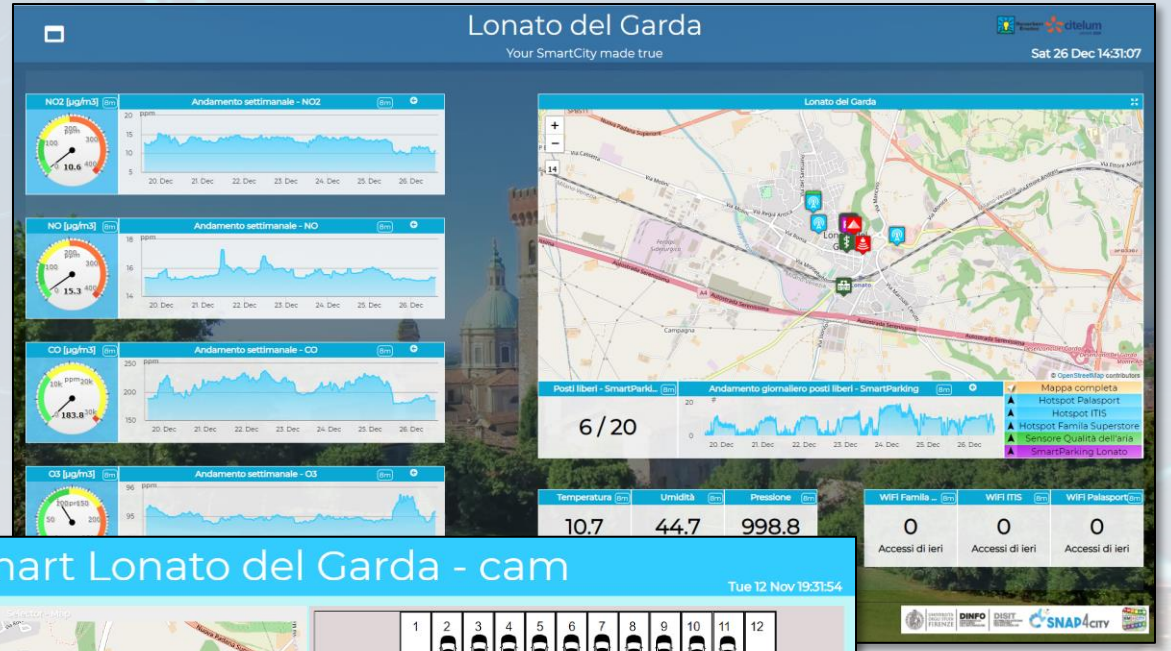
Snap4ISPRA Parking: ISPRA JRC

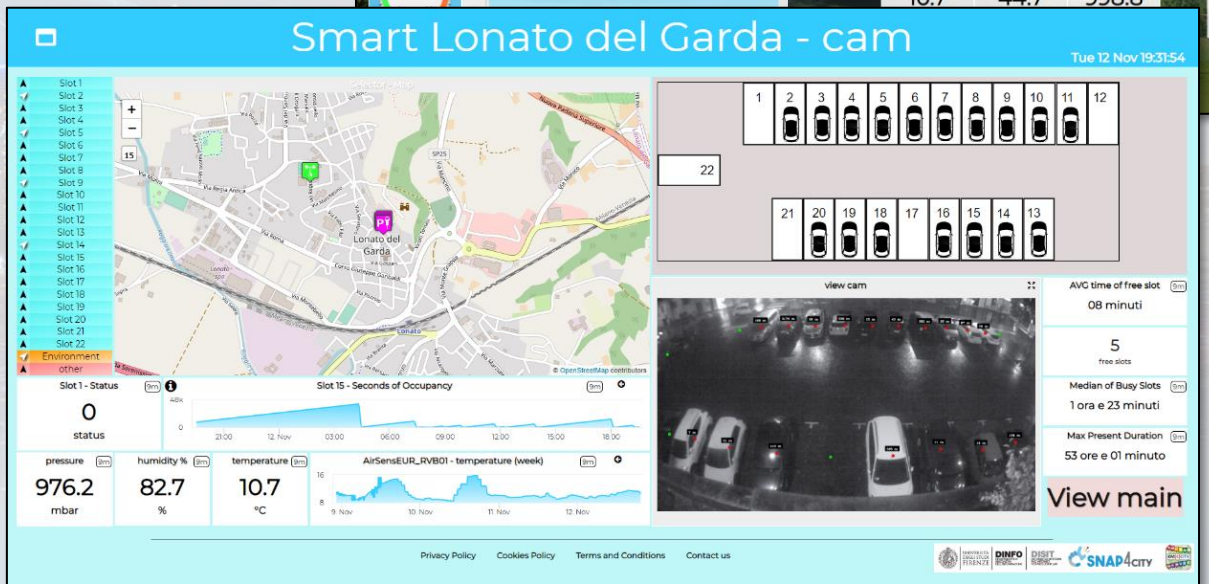


Smart City / Smart Parking + Environment Reverberi, Lonato del Garda

reference

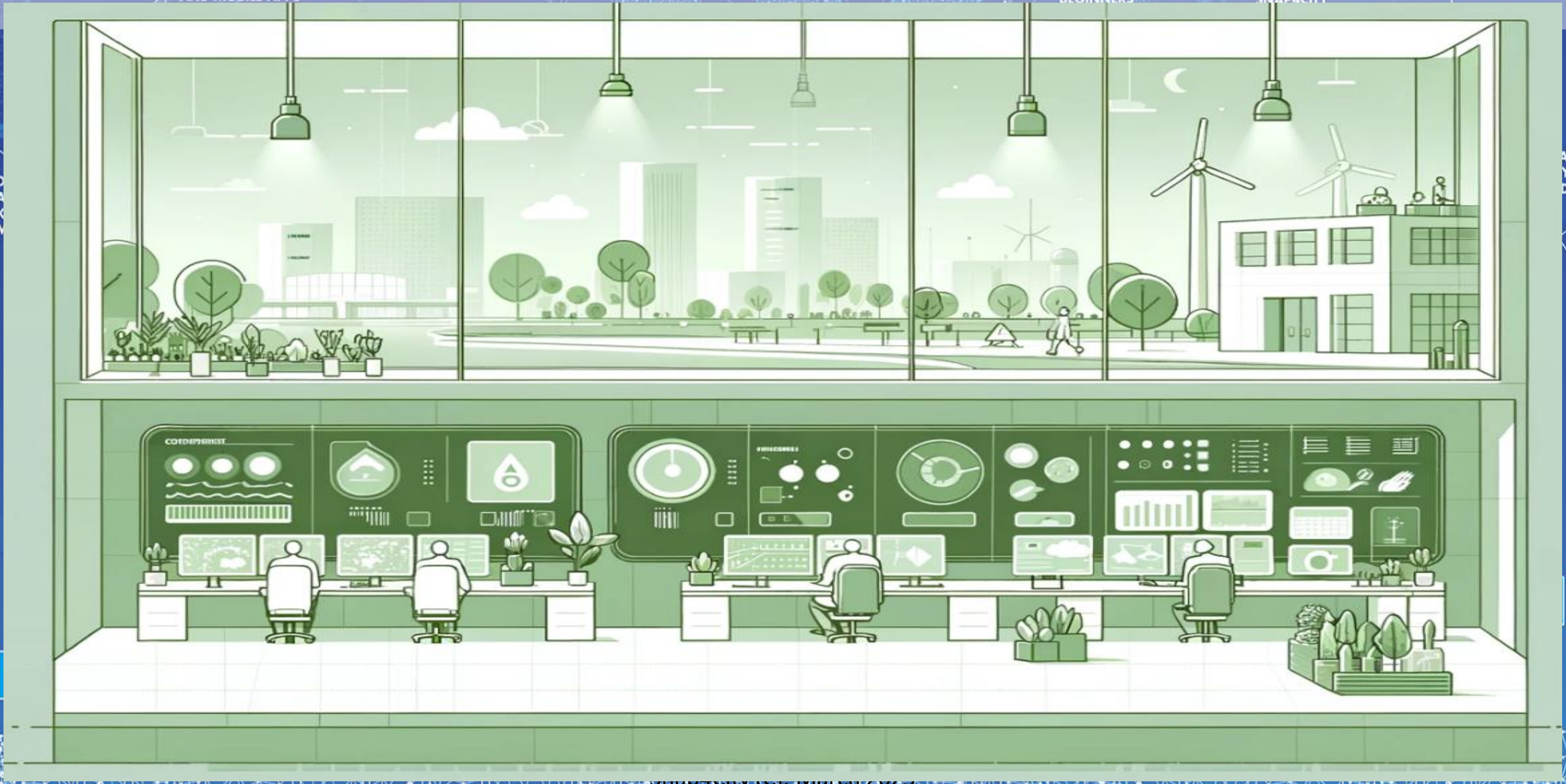
- **Multiple Domain Data**
  - Smart Parking, Environment, Wi-Fi
- **Multiple Decision Makers**
  - City Officer, operators
  - Data monitoring, alerting
  - analytics
- **Historical and Real Time data**
  - Dashboards
- **Services Exploited on:**
  - Dashboards, API
- **Since 2019**





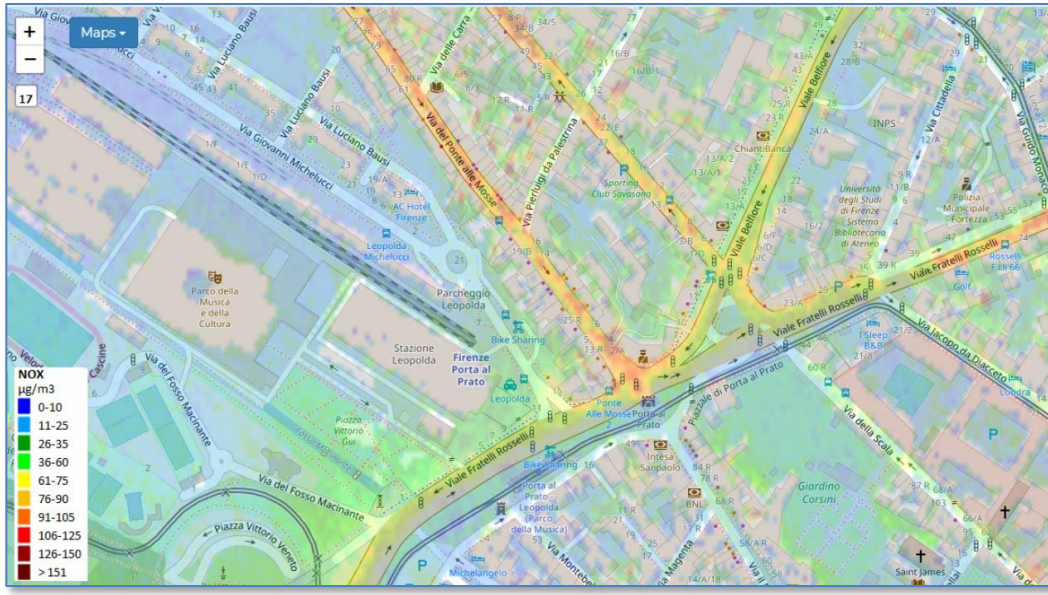
11 SUSTAINABLE CITIES AND COMMUNITIES

Environmental Monitoring and Control

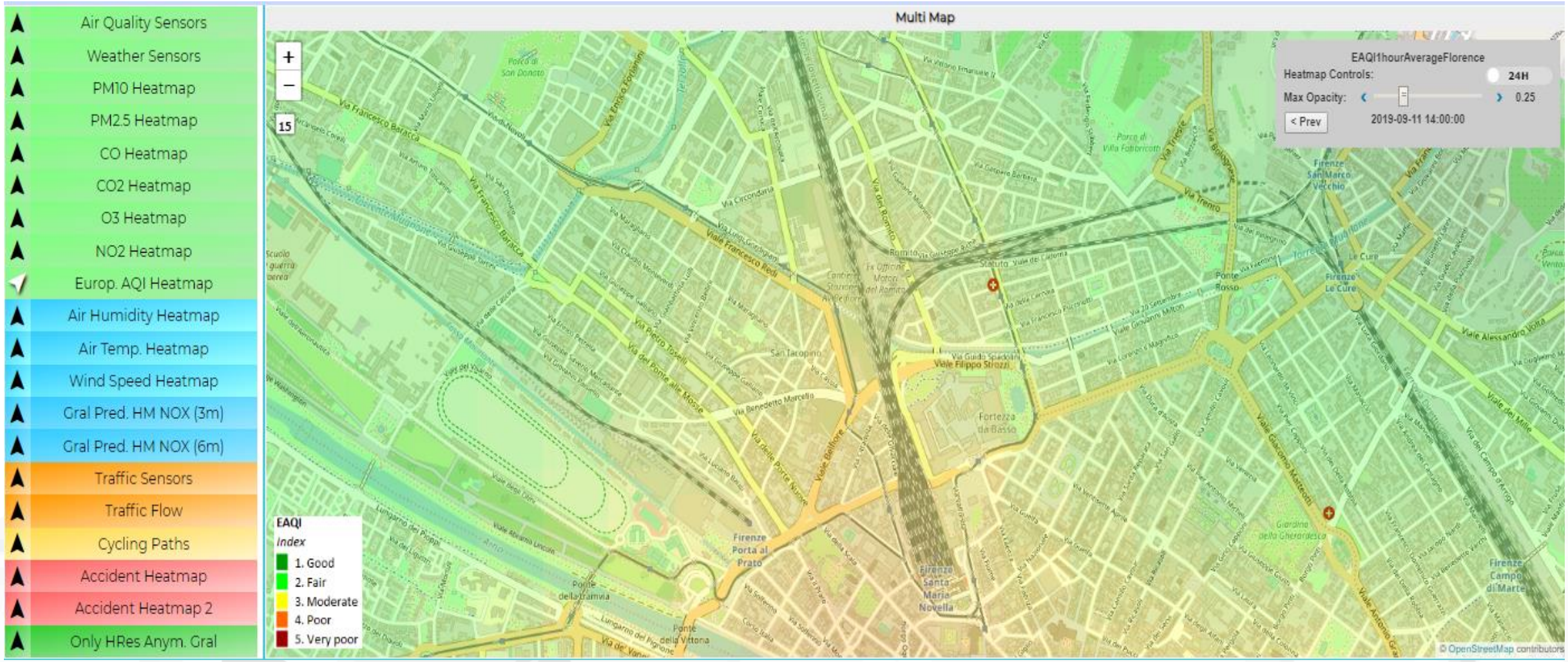


Environment and Waste

- **Goals:**
  - Reduction of emissions and EC taxations
  - Cost reduction for waste collection,
  - reduction of waste collection impact on mobility
- **Environment Management producing prescriptions:**
  - Monitoring and long and short-term predictions, warning for:
    - GHG, emissions, pollutants, aerosol, chemical plants analysis
    - land slide, coastal erosion (blue economy)
  - Traffic Flow impact emissions, predictions
- **Waste Management and Optimisation:**
  - costs reduction, optimal routing production, pay as you throw,
  - avoiding out of bins, predictions of waste production on bins, alarms
- **KPI:** SDG, 15MinCityIndex, QOS, costs, Km, colleting time, EC KPI, emissions
- **Mobile App**: final users services/informing and operators
  - Info Waste for operators, participation, optimal routing, RAEE Collection, ..
- **Participatory**: problem reporting, ticketing, etc.
- **Integration of any kind: env/weather, mobility, ticketing, presences, POI, ..**



EAQI Heatmap and sequence



UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

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

11 SUSTAINABLE CITIES AND COMMUNITIES

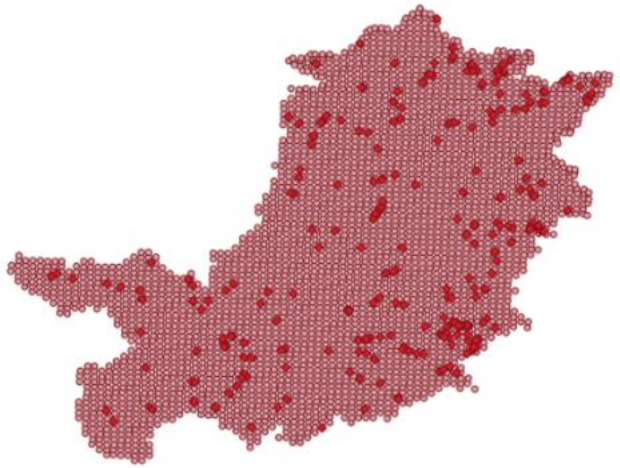
13 CLIMATE ACTION

15 LIFE ON LAND

SNAP4CITY

KM 4 CITY

Predicting Land slides



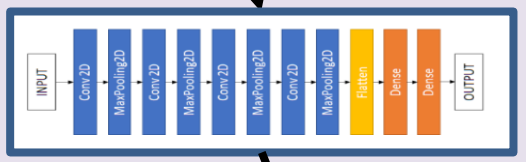
Dataset Construction

Previsional Model

Dataset Construction

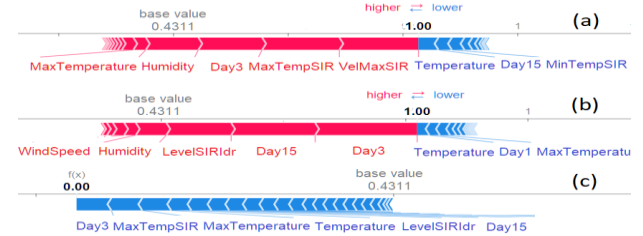
Model training And validation

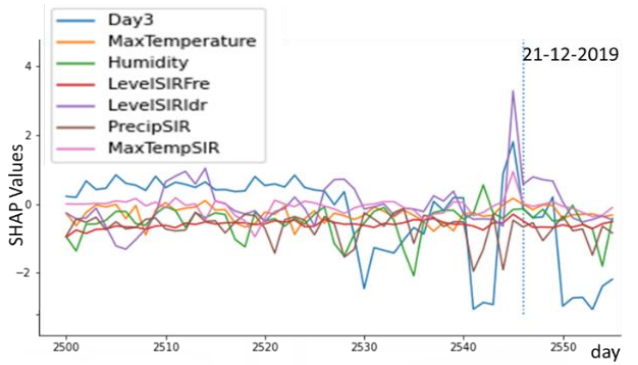
Model



Data

SNAP4City Advanced APIs





landslide DB

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

Processes

Ingestion

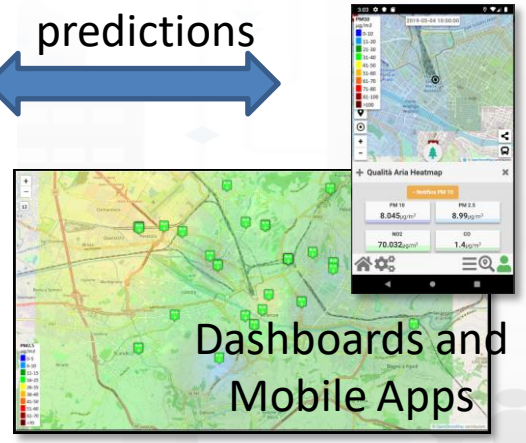
Big Data Storage and KB

Predictions

Model execution Shap Assessment

Data Analytics IOT App Management

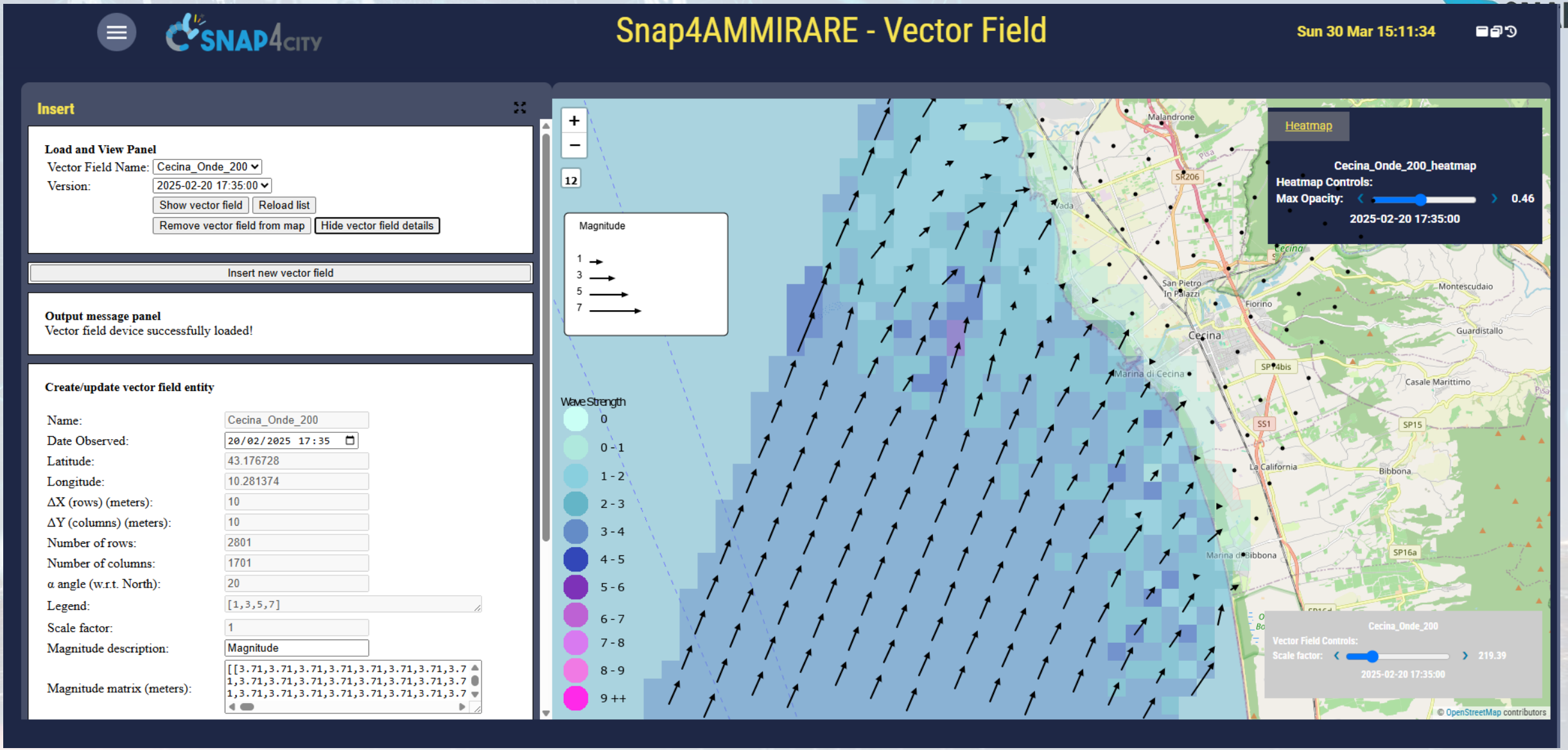
predictions



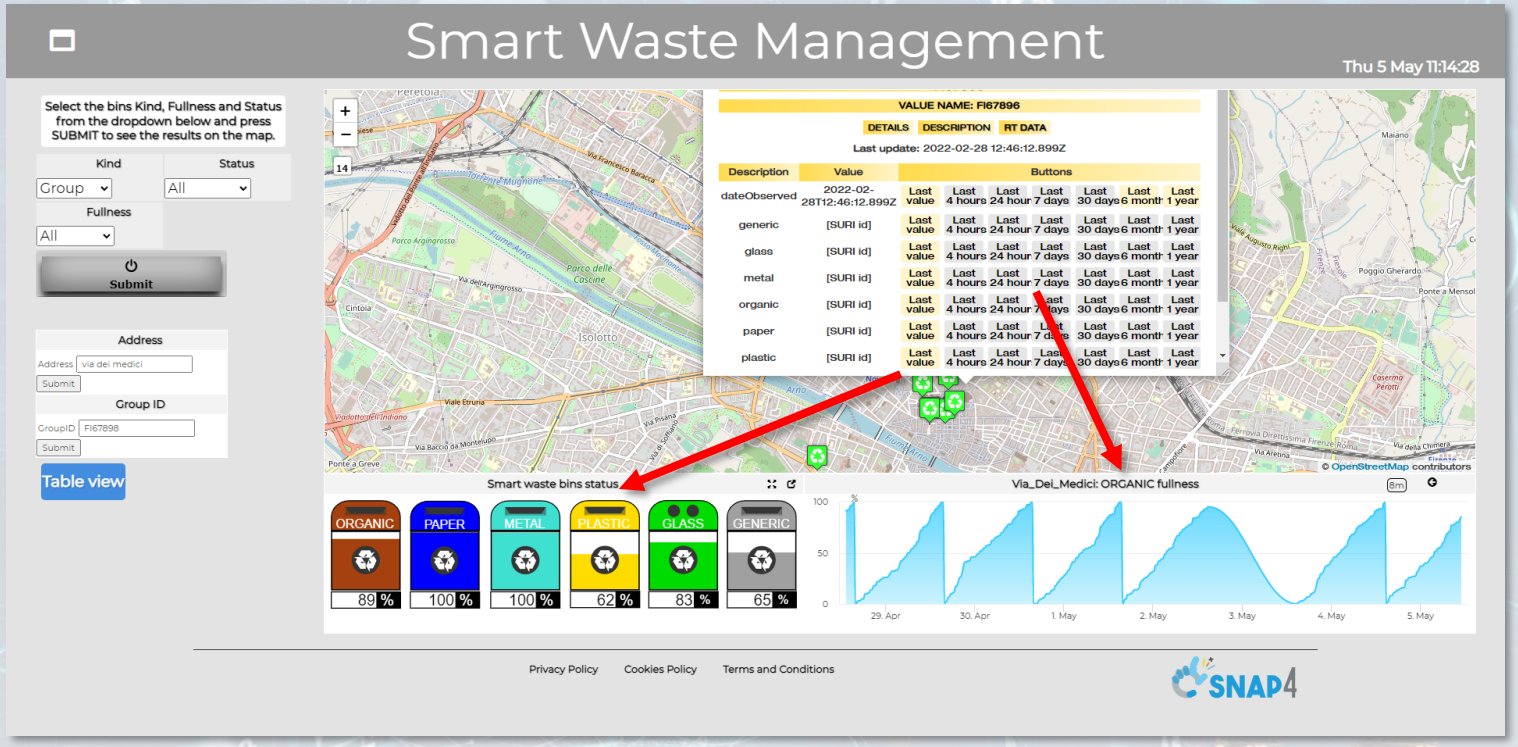
Snap4City Servers and Tools: Dashboard manager, Heatmap manager, GeoServer, Smart City API.

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

Monitoring Costal Bathymetry and Waves



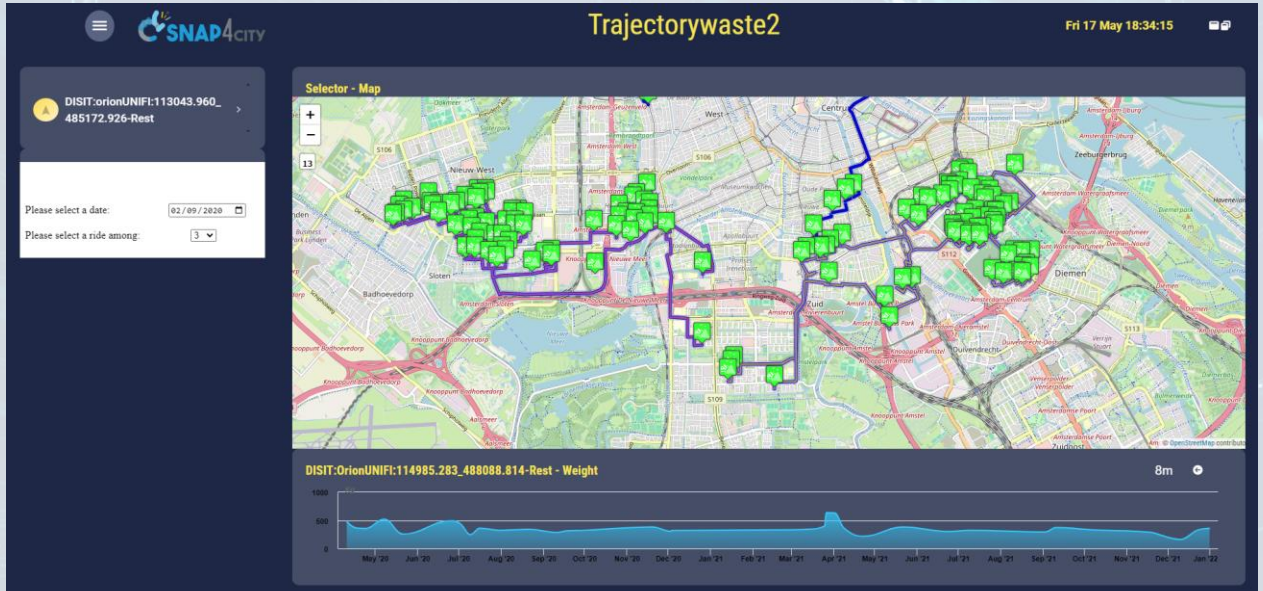
Smart Waste – Map view

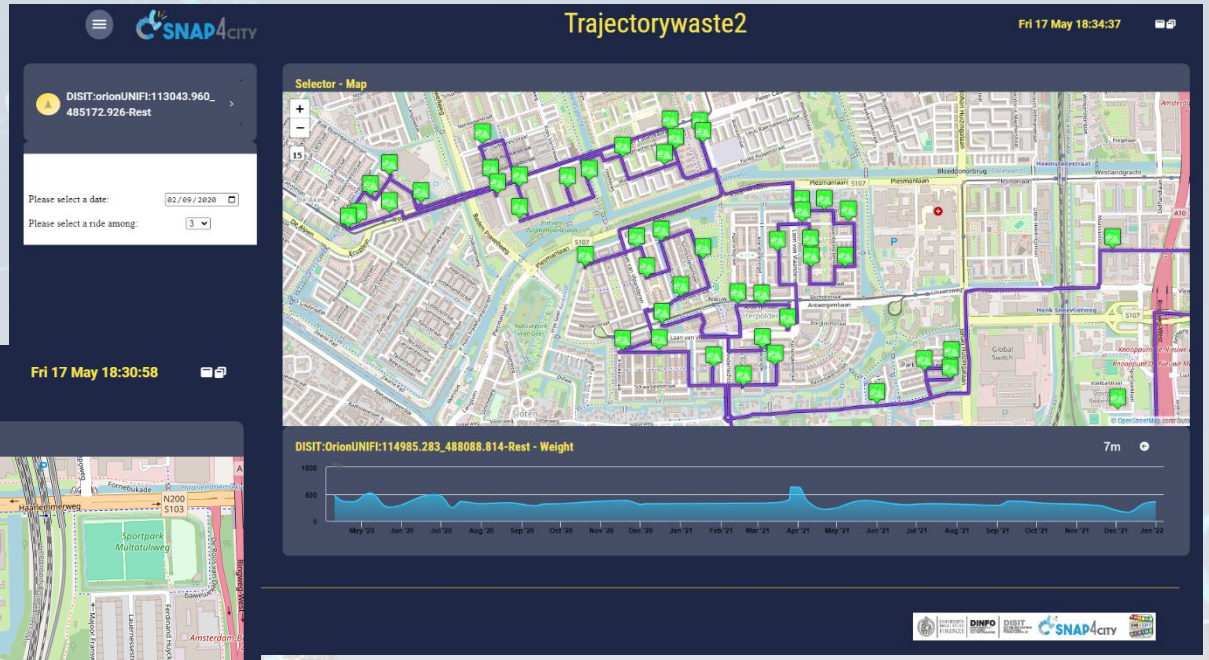


Search bins on map by filtering per:

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

- Reduction of costs for waste collection
  - Optimization of waste collection for the next day, forecast
  - Production of rides and paths for the drivers on waste collection
- Operator:
  - Refine a search by using the filters on the left side
  - Click on a waste bin pin on the map:
  - A popup with real time data is shown
  - The fullness status of the selected group of bins is shown in the synoptic below the map
  - Specific fullness weekly trends are shown below the map
  - Chick on the «Table view» button to access the other dashboard


SNAP4CITY
Trajectorywaste2
Fri 17 May 18:34:15
DISIT:orionUNIFI:113043.960_485172.926-Rest
Please select a date:
02/09/2020
Please select a ride among:
3
Selector - Map
DISIT:OrionUNIFI:114985.283_488088.814-Rest - Weight
8m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02/09/2020
Please select a ride among:
3
Selector - Map
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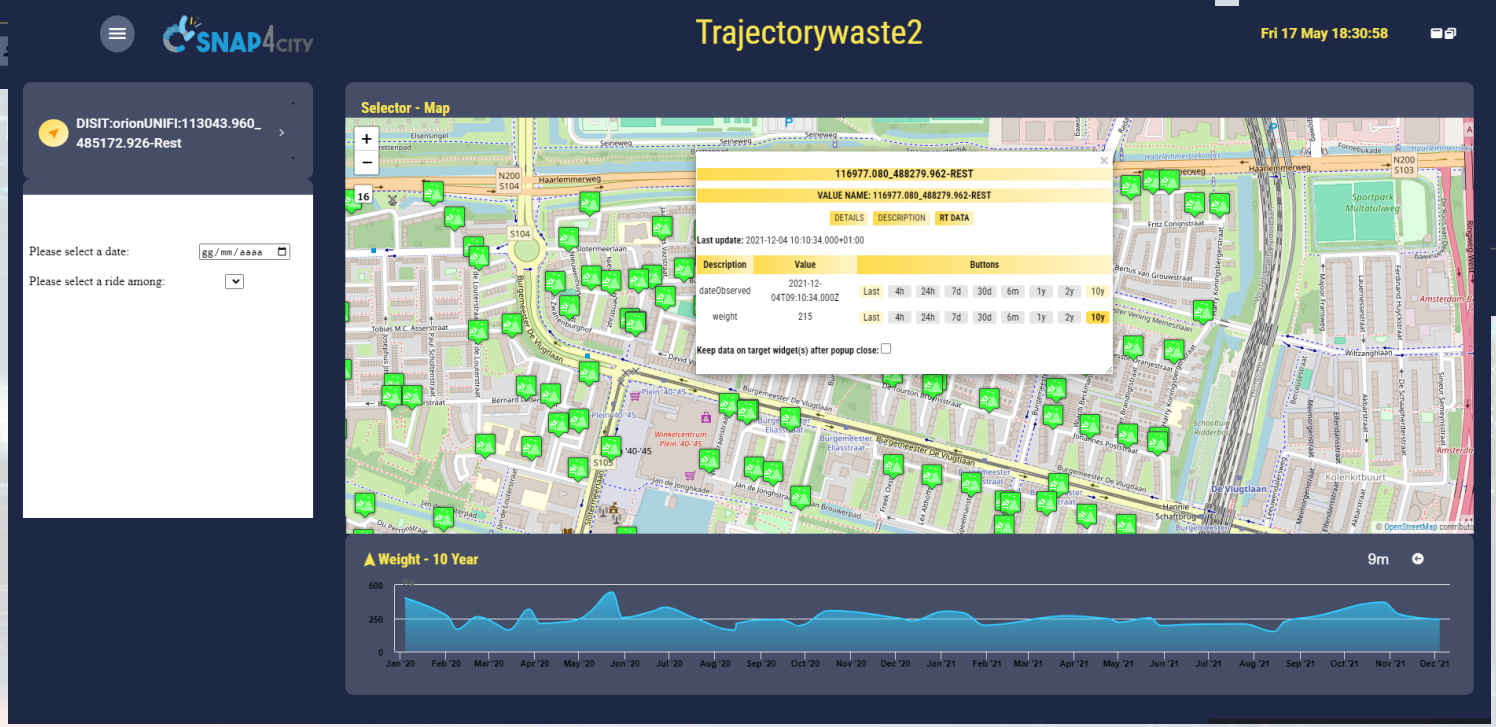
7m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Trajectorywaste2
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Please select a date:
gg/mm/aaaa
Please select a ride among:
Selector - Map
116977.080_488279.962-REST
VALUE NAME: 116977.080_488279.962-REST
DETAILS
DESCRIPTION
RT DATA
Last update: 2021-12-04 10:10:34.000+01:00
Description
Value
Buttons
dateObserved
2021-12-04T09:10:34.000Z
weight
215
Keep data on target widget(s) after popup close:
Weight - 10 Year
9m

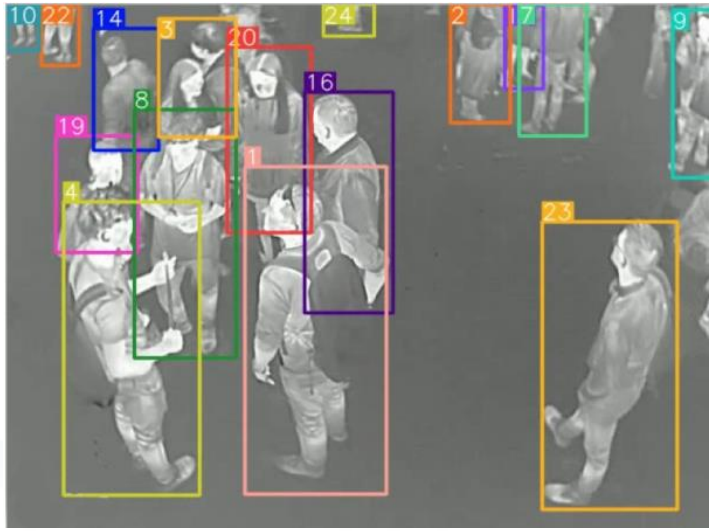

11
SUSTAINABLE CITIES AND COMMUNITIES

3
GOOD HEALTH AND WELL-BEING

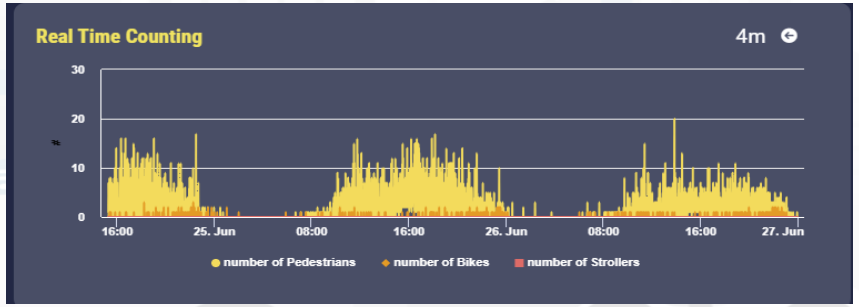
Human Behaviour Monitoring/engagement

City User Behaviour/services, Tourism and Safety

- **Goals:**
  - Improve Quality of Life and quality of services,
  - Over tourism mitigation, sustainability
  - Costs reduction of services
  - Improve accessibility to services: citizens, Tourists, commuters, etc.
  - Improve Security/Safety of city users

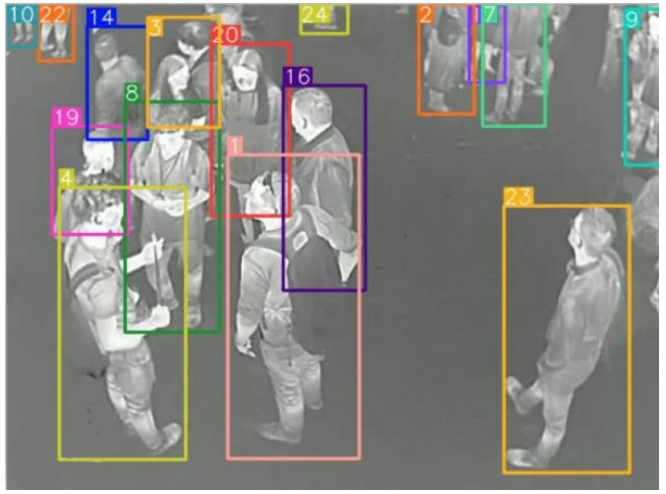


- **People Flow Analysis / Management:** in/out-door, retail, attractions
  - Counting, tracking, Flows, ODM, sentiment, etc.,
  - multiple sources: thermal & TV cameras, radar sensors, PAX sniffers, mobile data, …
  - Data and/or OD matrices from: Wi-Fi, traffic data, mobile phone data
  - **Suggestions**: info Tourism, digital signages, engagement, ..
- **Tourists Flows & Retail Management**: predictions of presences, services' reputations, suggestions on second offer, over-tourism, notifications, early warning,
- **KPI**: 15 MinCityIndex, energy vs people, over-tourism, accepted suggetions, precision
- **Mobile App**: final users services/informing and operators
  - Info Tourism, people flows, info mobility, sharing, …
  - Participation, engagement, ..
- **Participatory**: problem reporting, ticketing, etc.
- **Integration of any kind: env/weather, mobility, ticketing, presences, POI, ..**



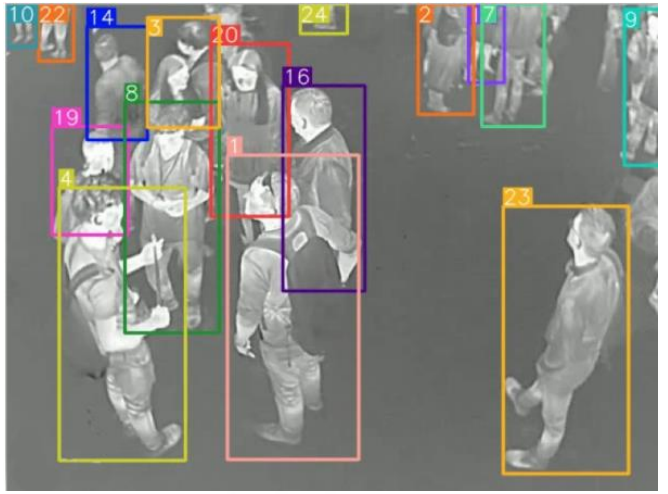
City User Behaviour/services, Tourism and Safety (2024/8)

- Goals:
  - Quality of Life, quality of services, over tourism mitigation, sustainability
  - Costs reduction of services
  - Accessibility to services: citizens, Tourists, commuters, etc.
  - Security/Safety of city users
- Solutions for Operation (monitoring, managing, mobile apps, digital signages, control rooms)
  - People Mobility Demand via Origin Destination Matrices
  - Monitoring services: tickets, reputation, usages, areas, etc.
  - Monitoring user behaviour (counting, trajectories): indoor/outdoor, hot places/services, ports, beaches,
  - Computing: origin destination, trajectories, travel means, etc.
  - Early detection/warning of critical conditions, connection with Video Management Systems
  - Managing entrances in city areas: restricted areas, touristic busses, etc.
  - Production of info-toursim, recommendations, nudging to city users and operators, second offer promotion
  - Providing Virtual Assistants for City Services, Tourist Offices, etc.
  - Monitoring reputation of services via: social media, blogs, etc.
  - Collecting complains, requests, participations from City users via mobile apps
  - Computing predictions of any kind
- Solutions for Planning (optimization and what-if analysis)
  - Reduction of Pollutant Emissions, via optimization
  - Optimization plan to distribution of workload on multiple touristic offers/services, area cleaning, etc.
  - Predicting reputation of services, touristic and operative

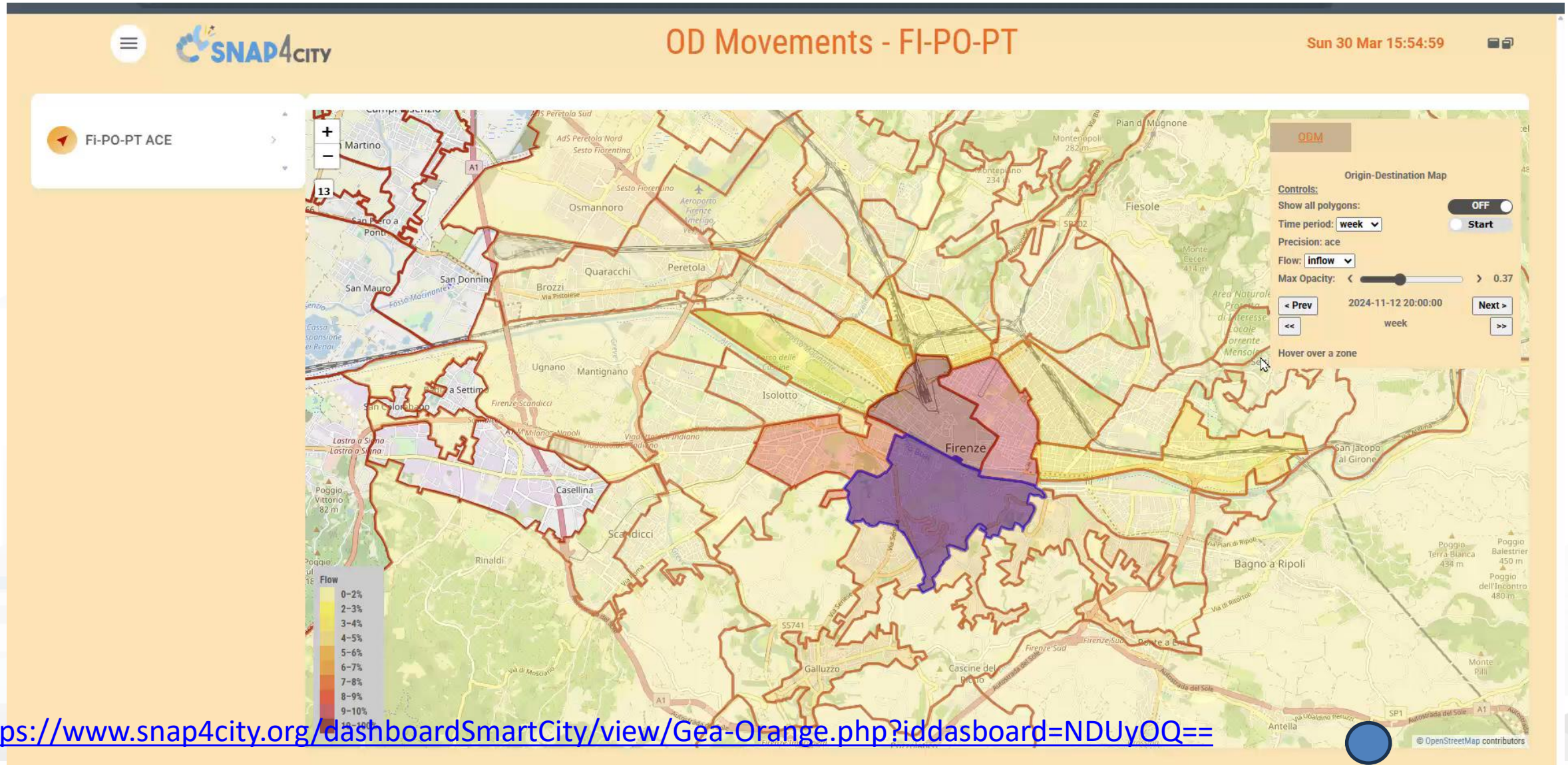


City Users Behaviour, Safety, Security and Social Analysis (2024/8)

- **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



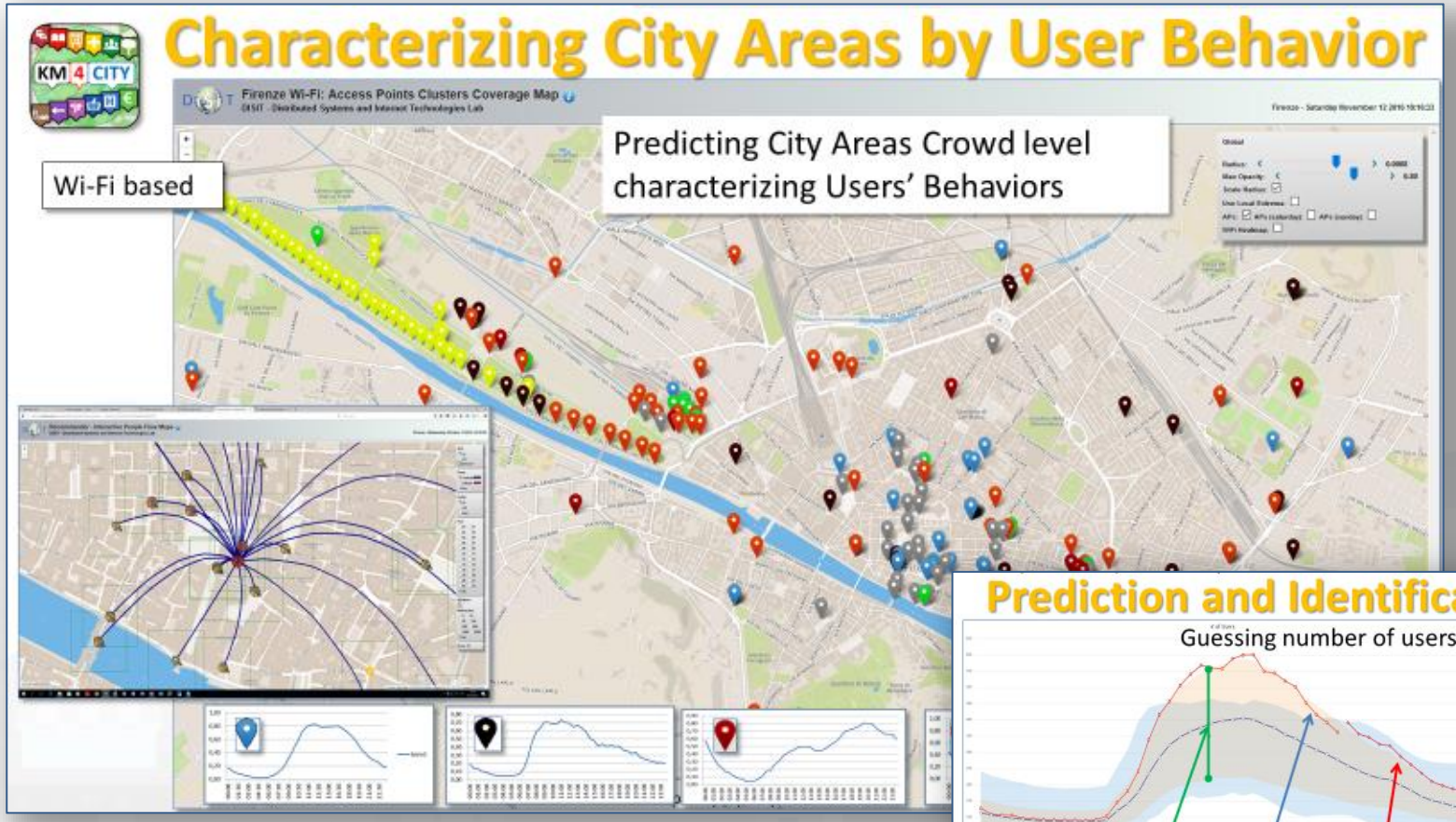
Origin Destination Matrices: Mobility Demand



https://www.snap4city.org/dashboardSmartCity/view/Gea-Orange.php?iddasboard=NDUyOQ==

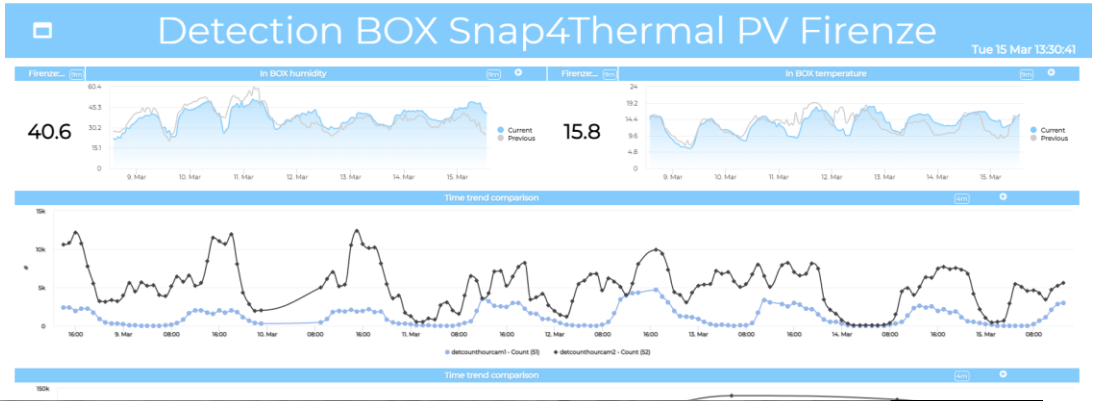
People Flows

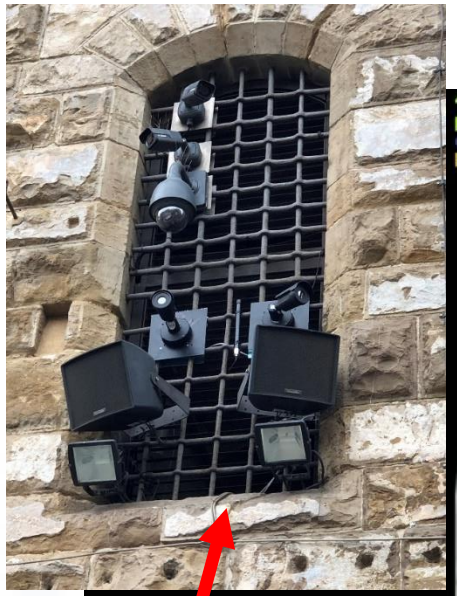
- **Prediction of people flows** on the basis of Wi-Fi data
- **Anomaly** detection
- **Resolute** H2020
- Classification of city areas

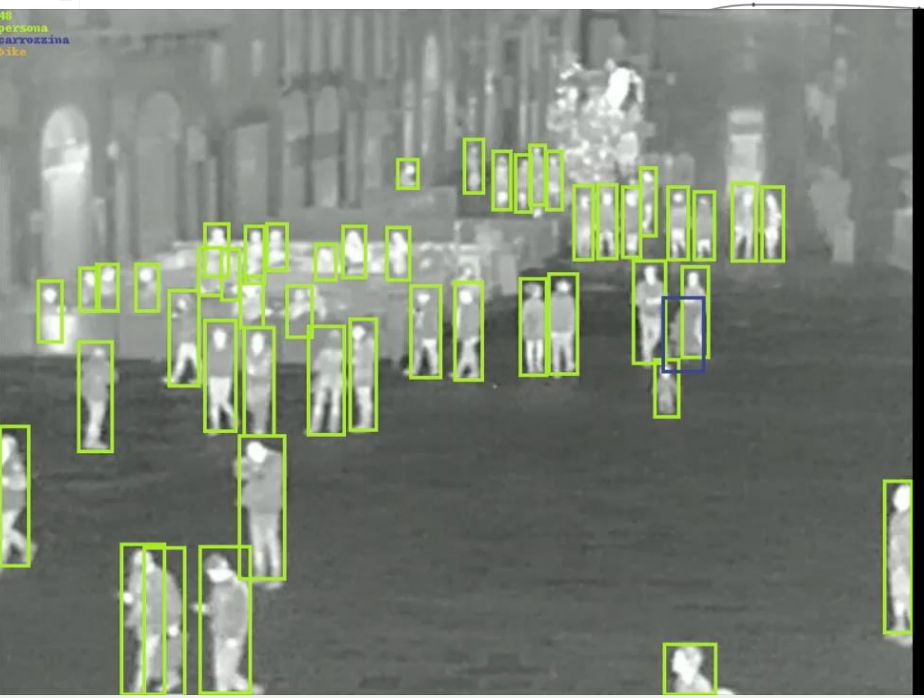


11 SUSTAINABLE CITIES AND COMMUNITIES

A view and data from the Thermal Camera

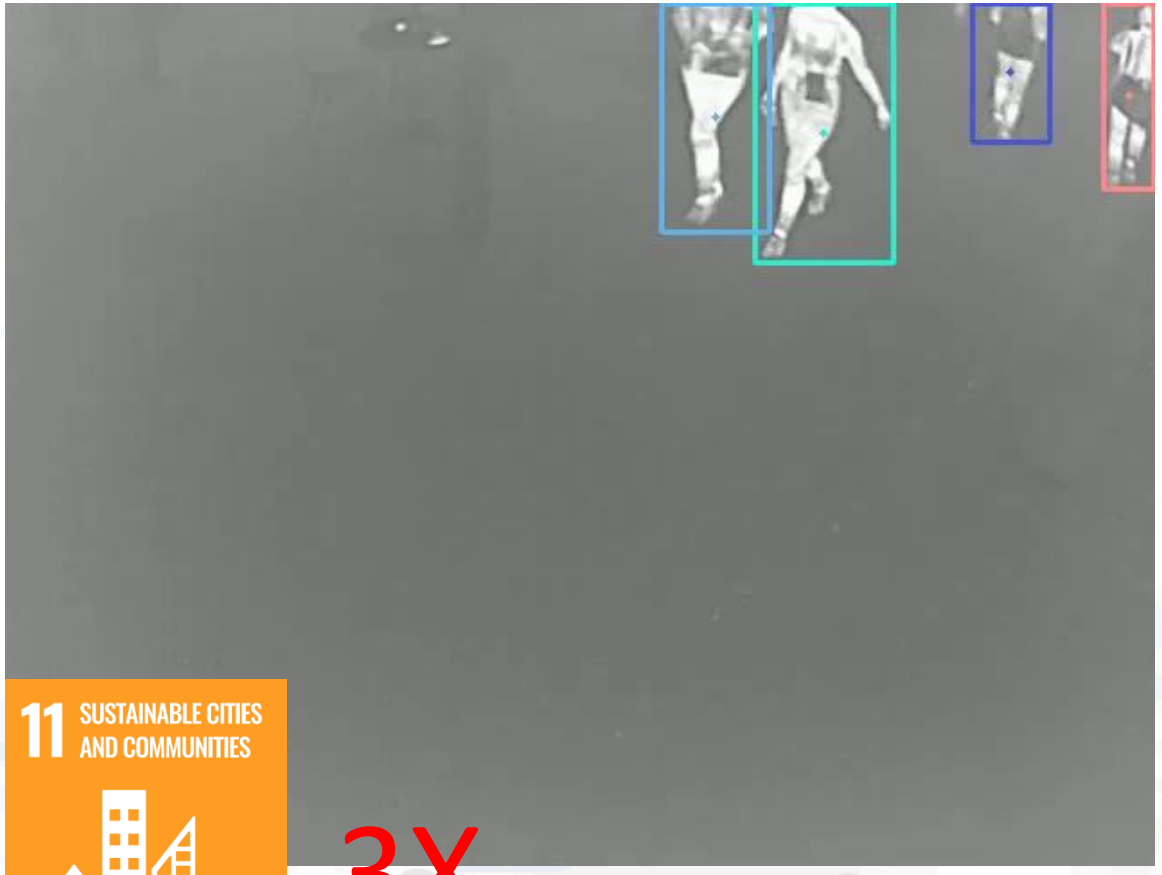


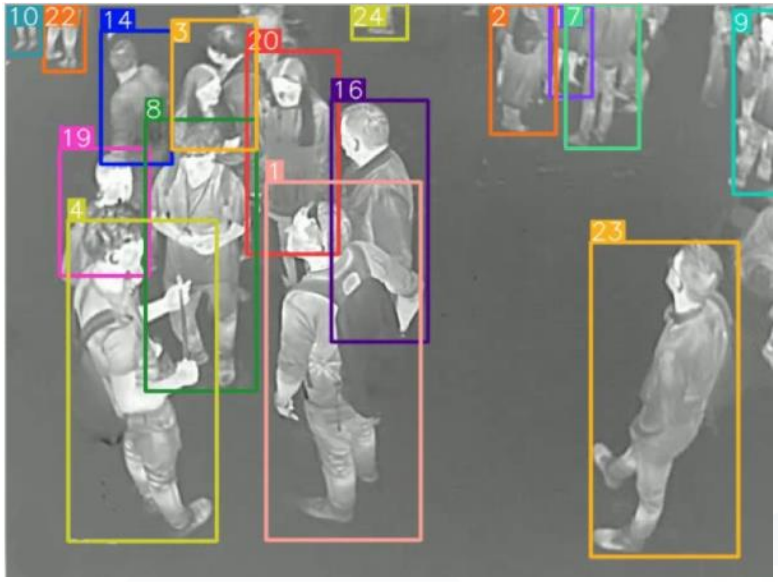


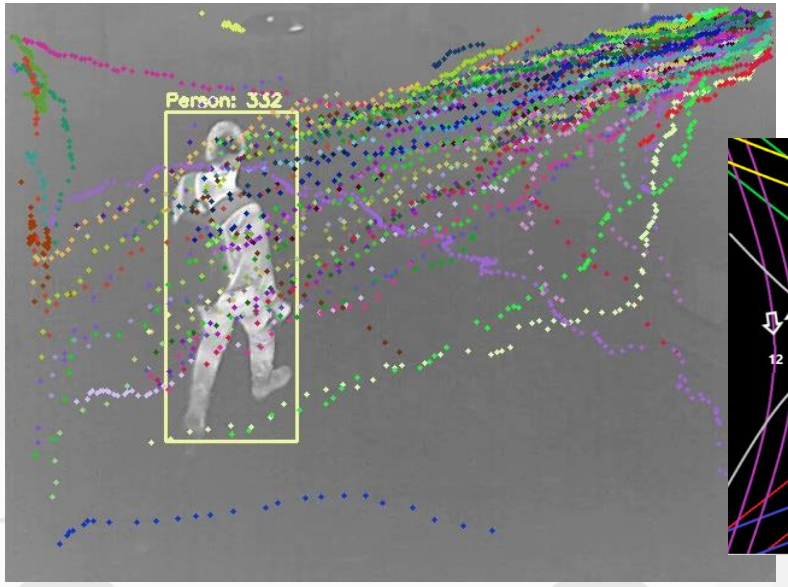


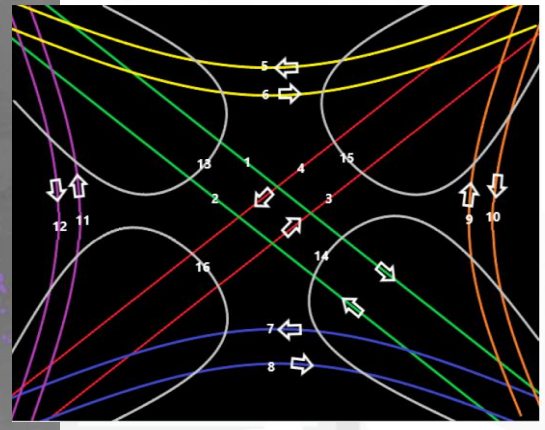
11 SUSTAINABLE CITIES AND COMMUNITIES

People Counting and Tracking



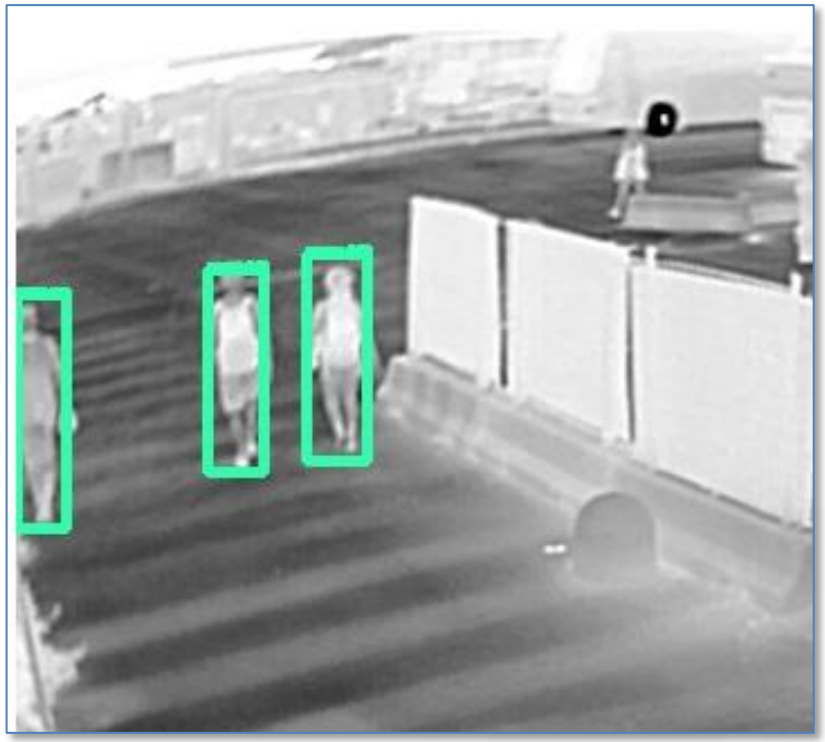






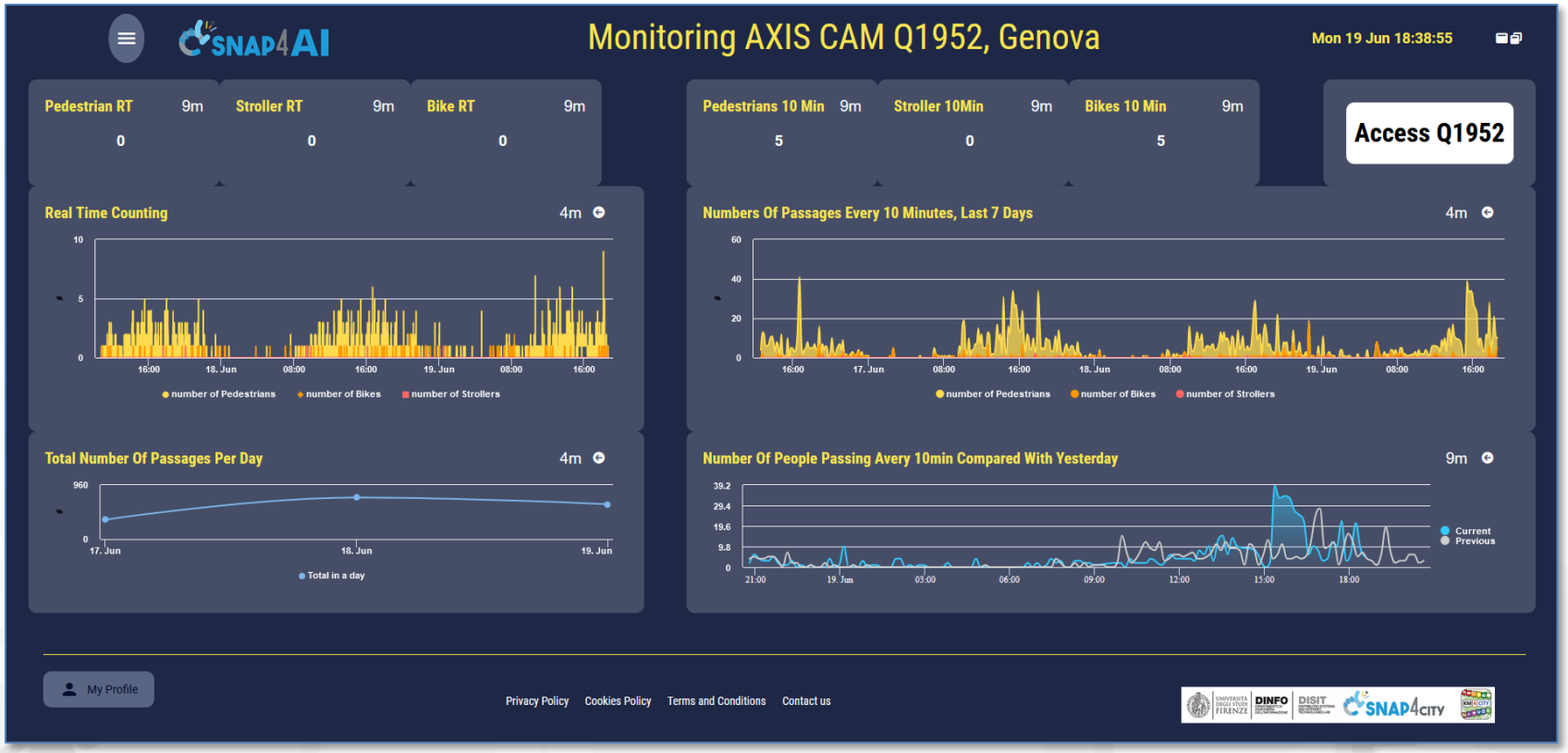
11 SUSTAINABLE CITIES AND COMMUNITIES

3X



Monitoring Passages AXIS Q1952

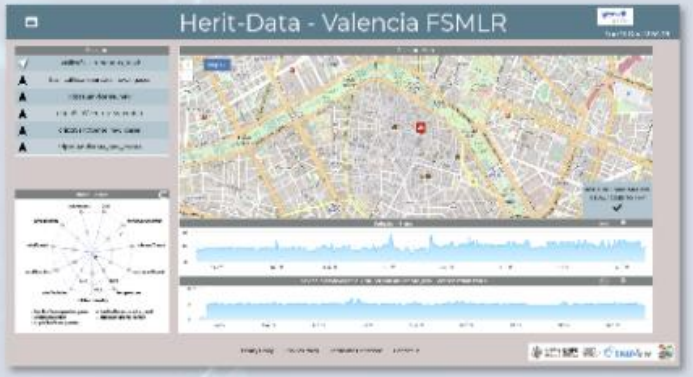
- Genova: Ocean Race, 2023

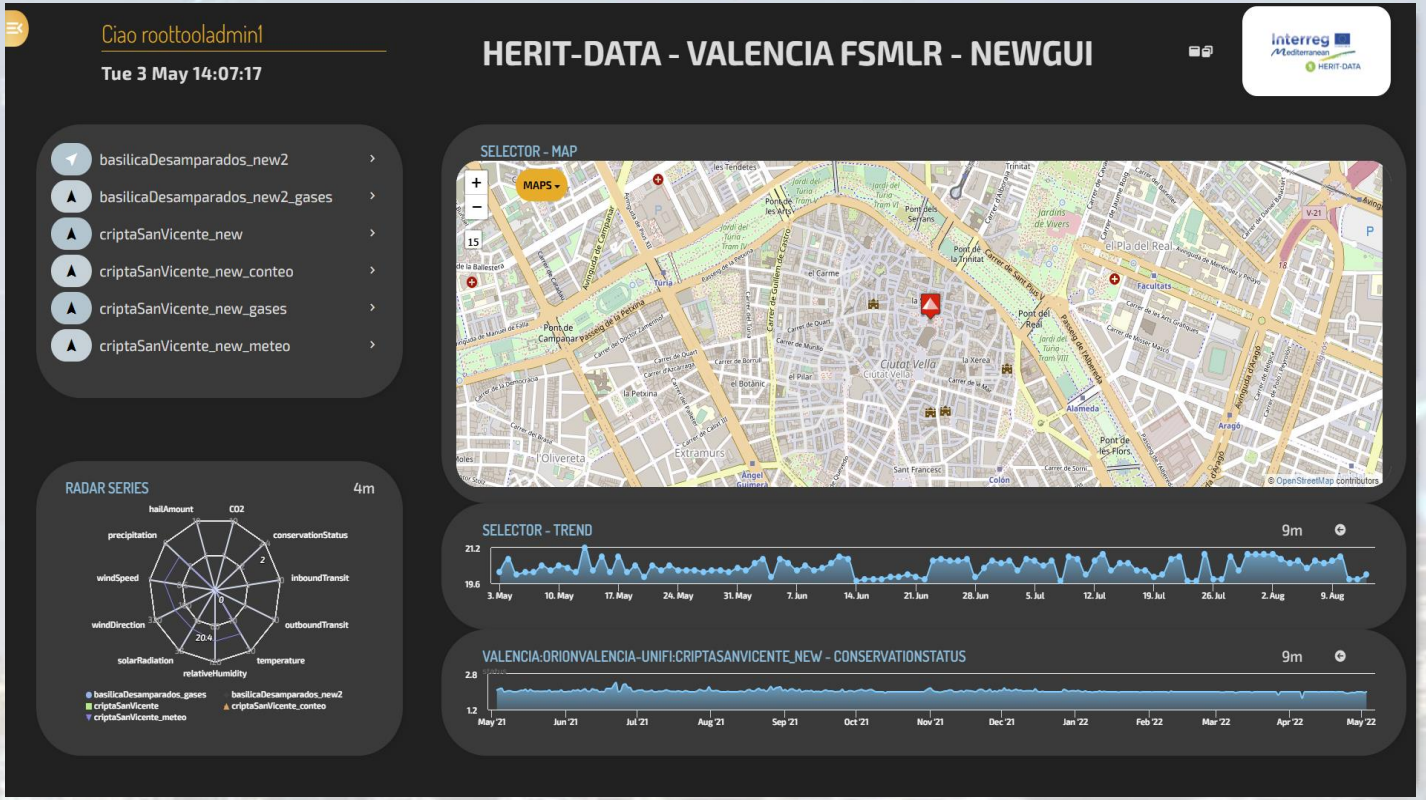


11 SUSTAINABLE CITIES AND COMMUNITIES

Valencia, FSMLR

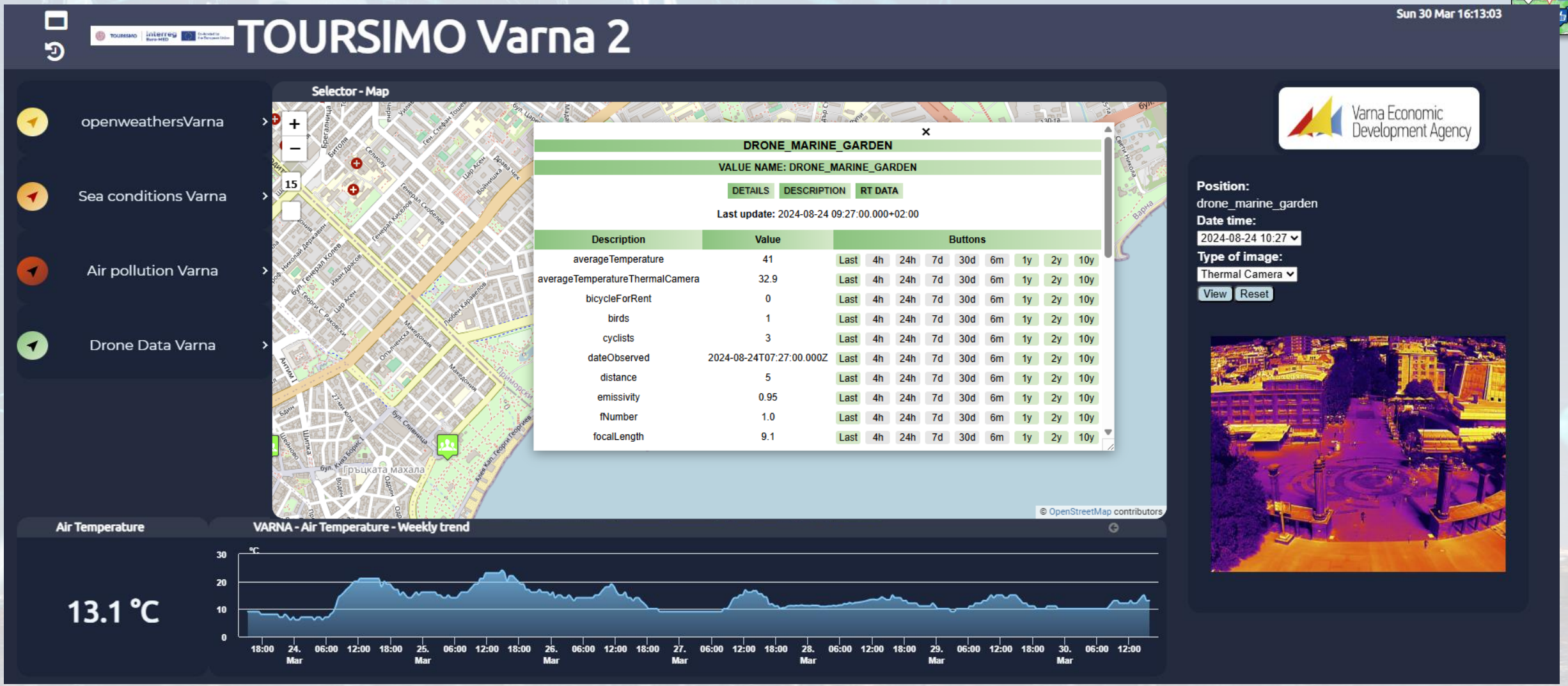
- **Tourism Domain**
  - Counting People
  - Environmental data
  - Social Media
- **Dashboards**
  - Monitoring and real time control
  - People flow
  - Twitter Vigilance
- **Historical and Real Time data**
- **Services Exploited on:**
  - Dashboard
- **Since 2020**





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

Counting People by Drones in Varna



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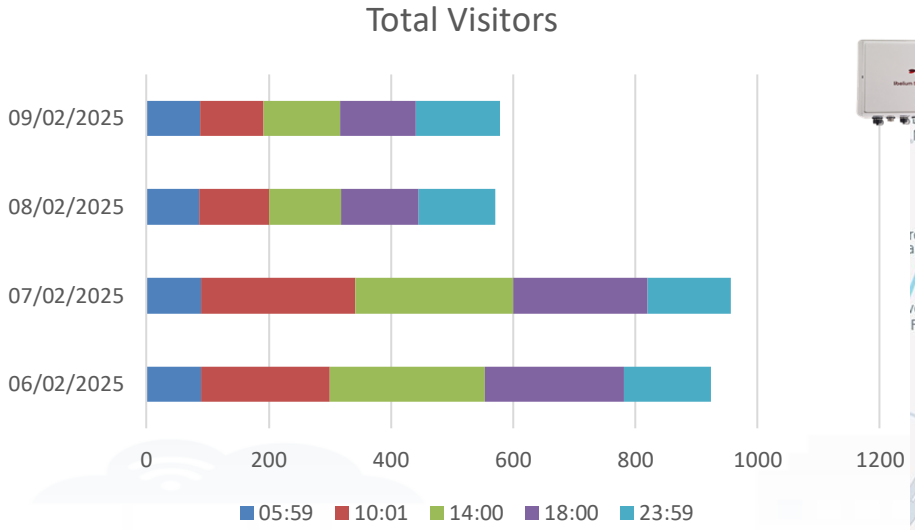
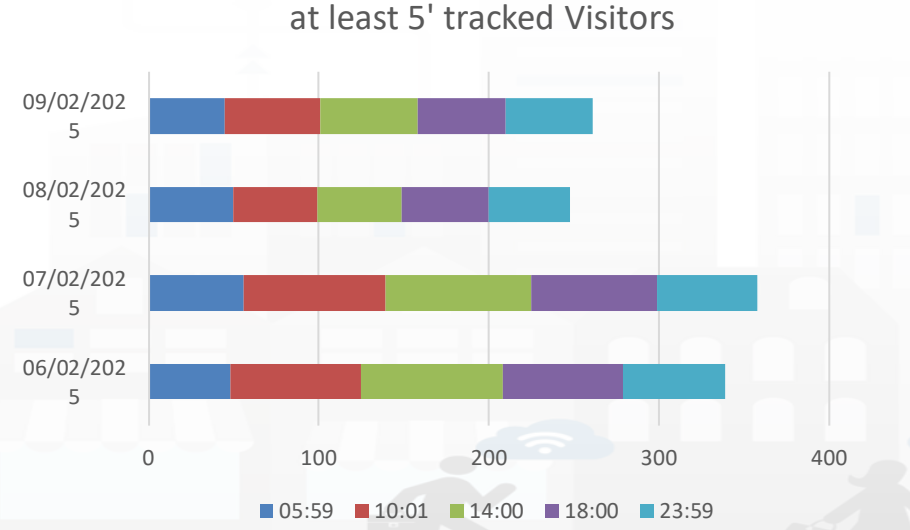
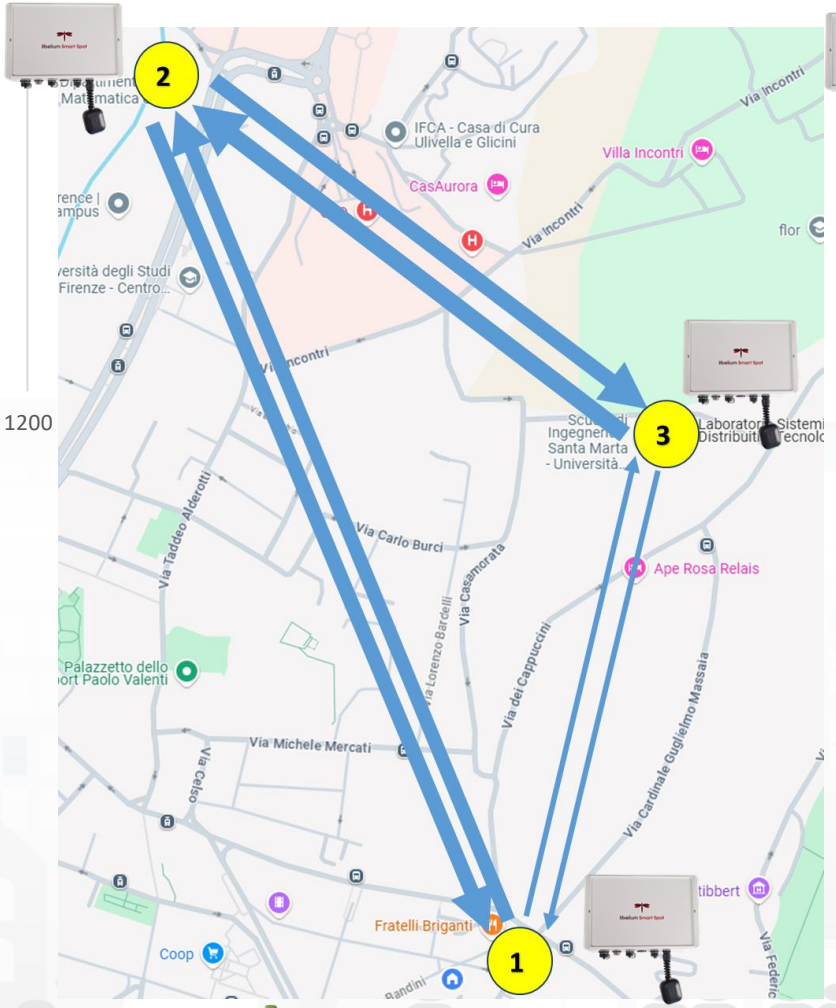
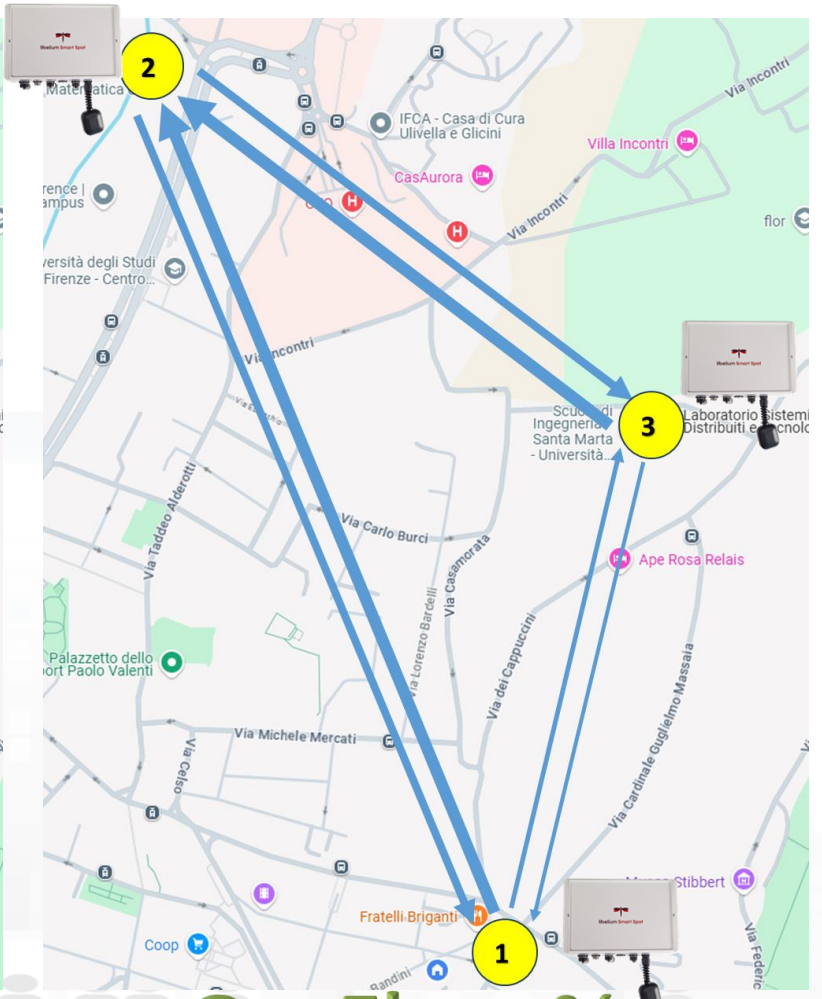
Libelium PaxCounters





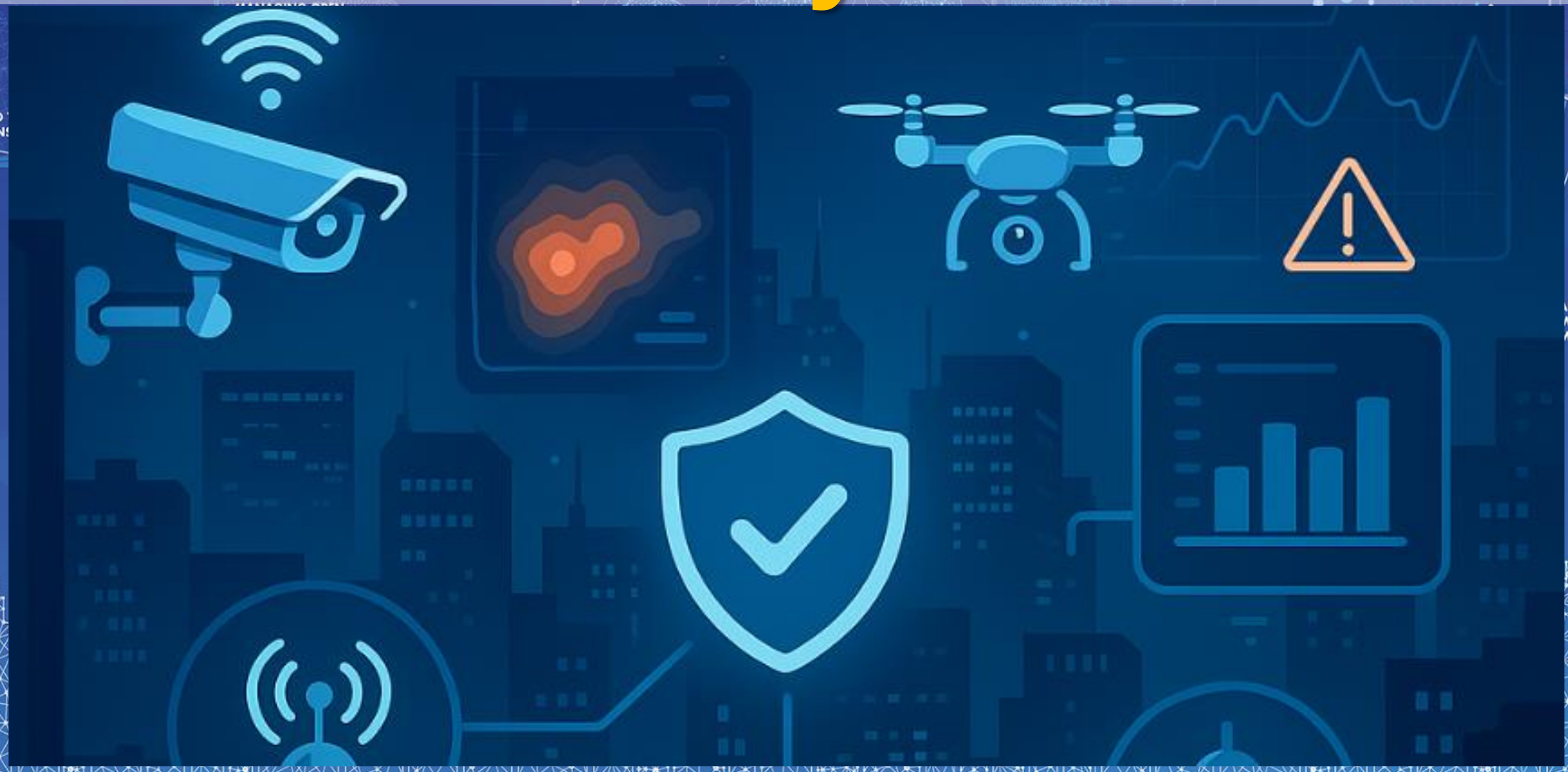


Flow Counts



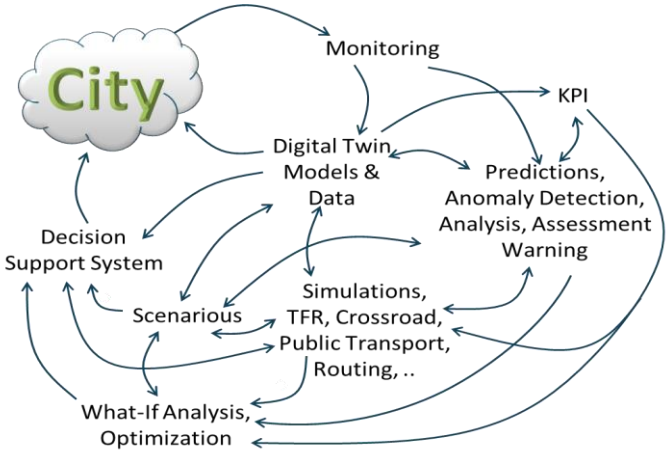
OutFlow %

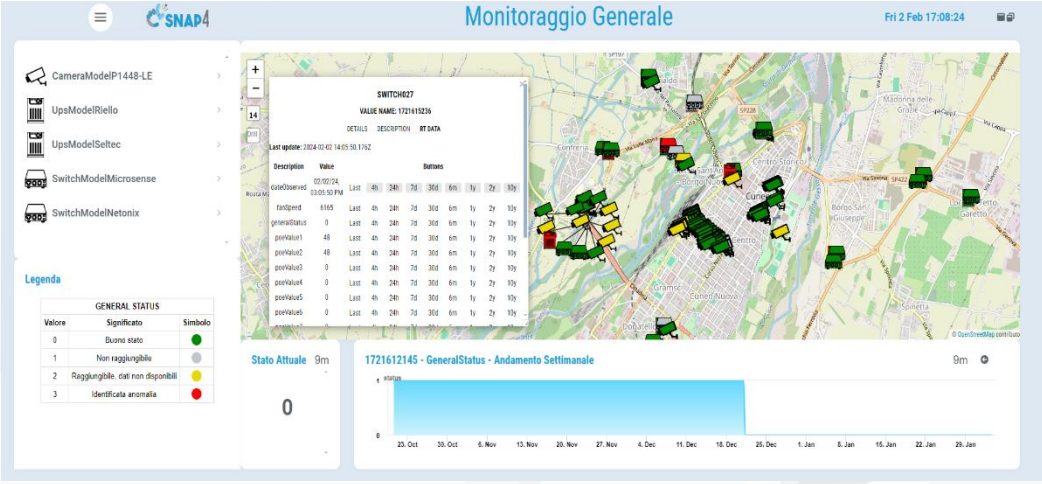
Assets Security and Control



Assets Control Domain (2024/8)

- Goals:
  - Costs reduction, increase service availability, risk reduction
  - Quality Level
- Solutions for Operation (monitoring, managing, mobile apps, digital signages, control rooms)
  - Monitoring :
    - **Assets**: switches, Wi-Fi, servers, UPS, sensors, building, TV Cams, etc.
    - **Energy**: consumption, operative conditions, UPS continuity, etc.
    - **Production**: continuous serviceability analysis
    - Etc.
  - Early detection/warning, alarm, of critical conditions
    - **Multichannel** Event reporting, notifications: email, Telegram, mobile apps, SMS, etc.
  - Managing maintenance operation, predictive maintenance
  - Computing predictions of any kind
- Solutions for Planning (optimization and what-if analysis)
  - Reduction maintenance costs, reduction of critical SLA conditions, improve service level
- Algorithms and computational solutions, see next slide

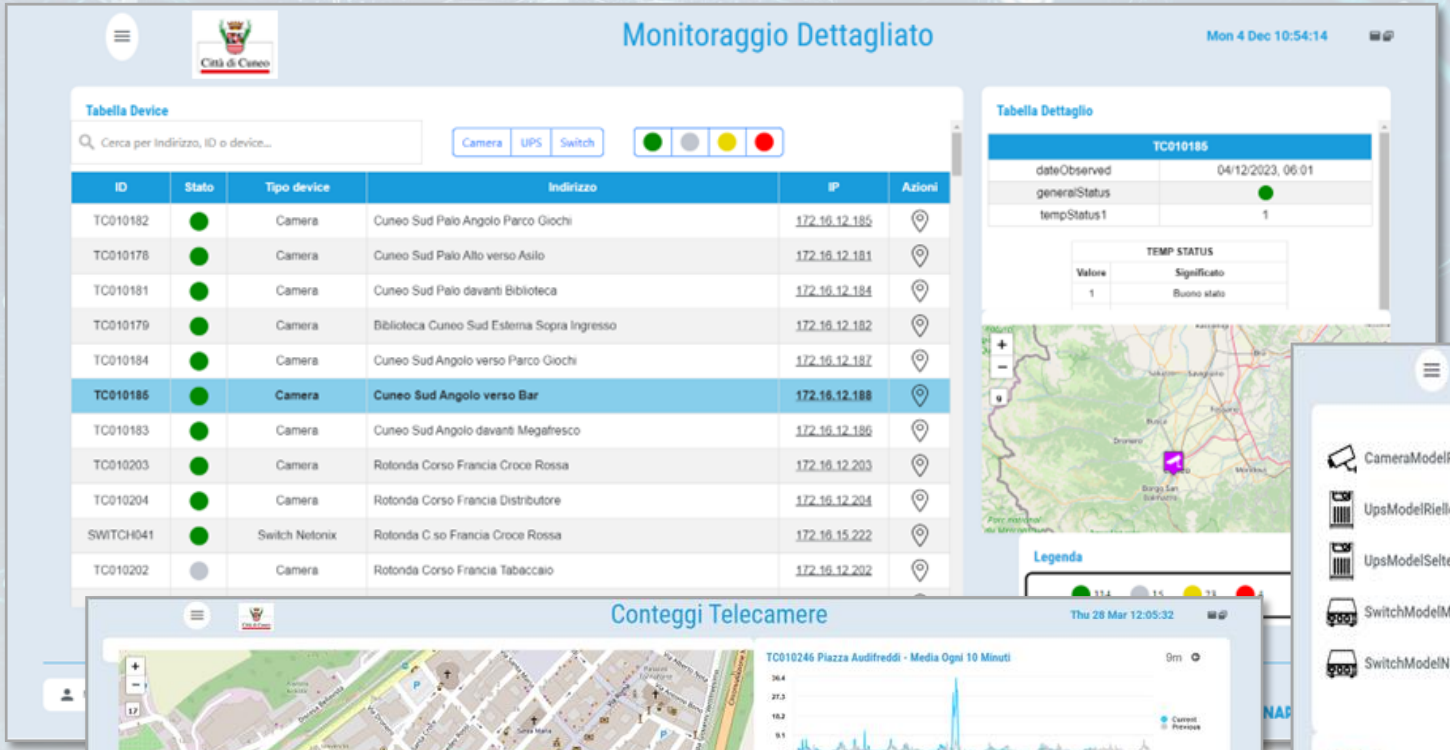


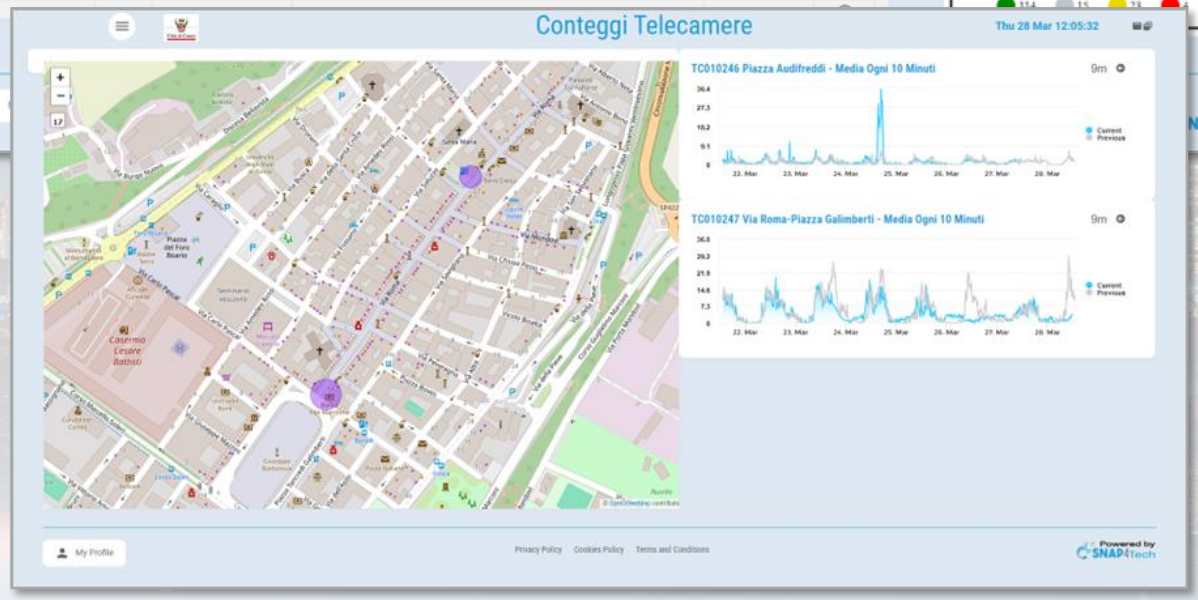


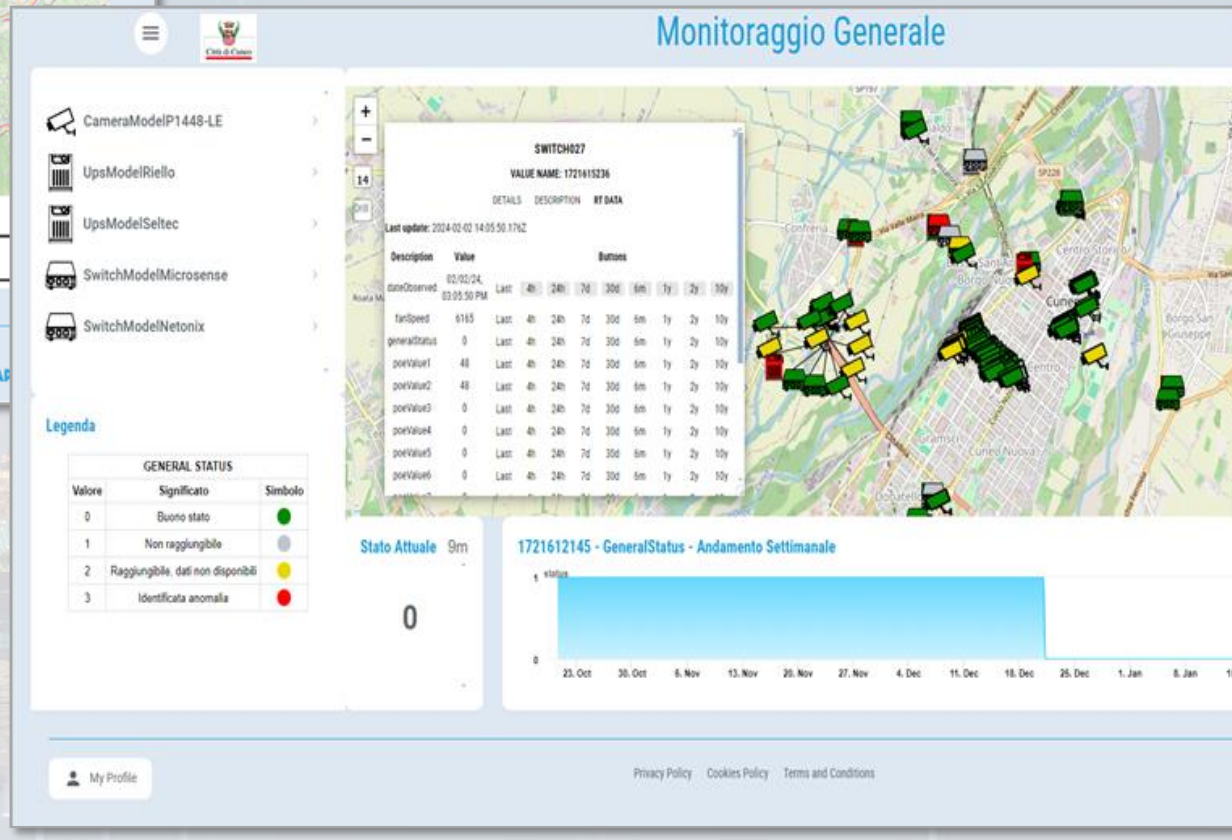
ICT Assets Control: CUNEO Municipality

- Cabinets, Switches, UPS
- TV Cameras, etc.

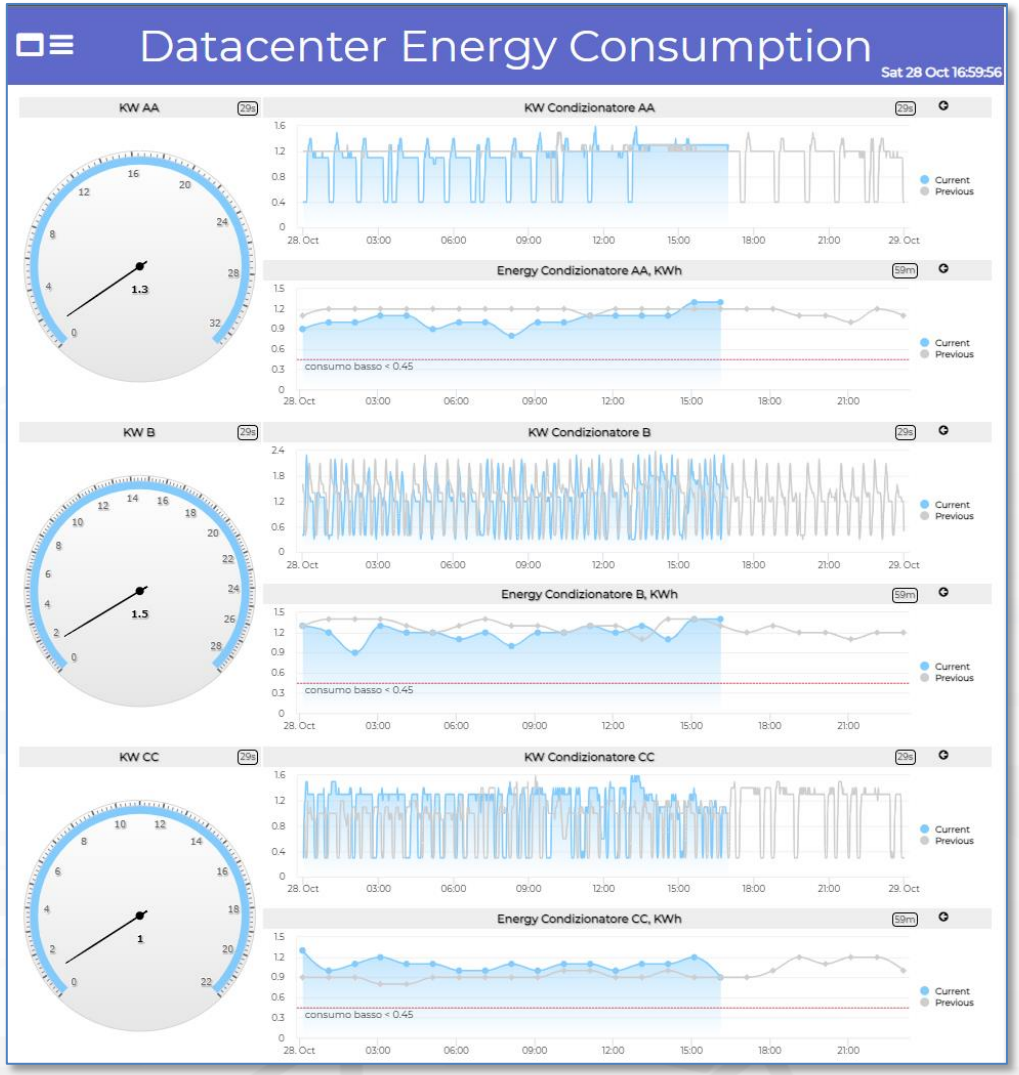
Manage the status, tickets, notifications

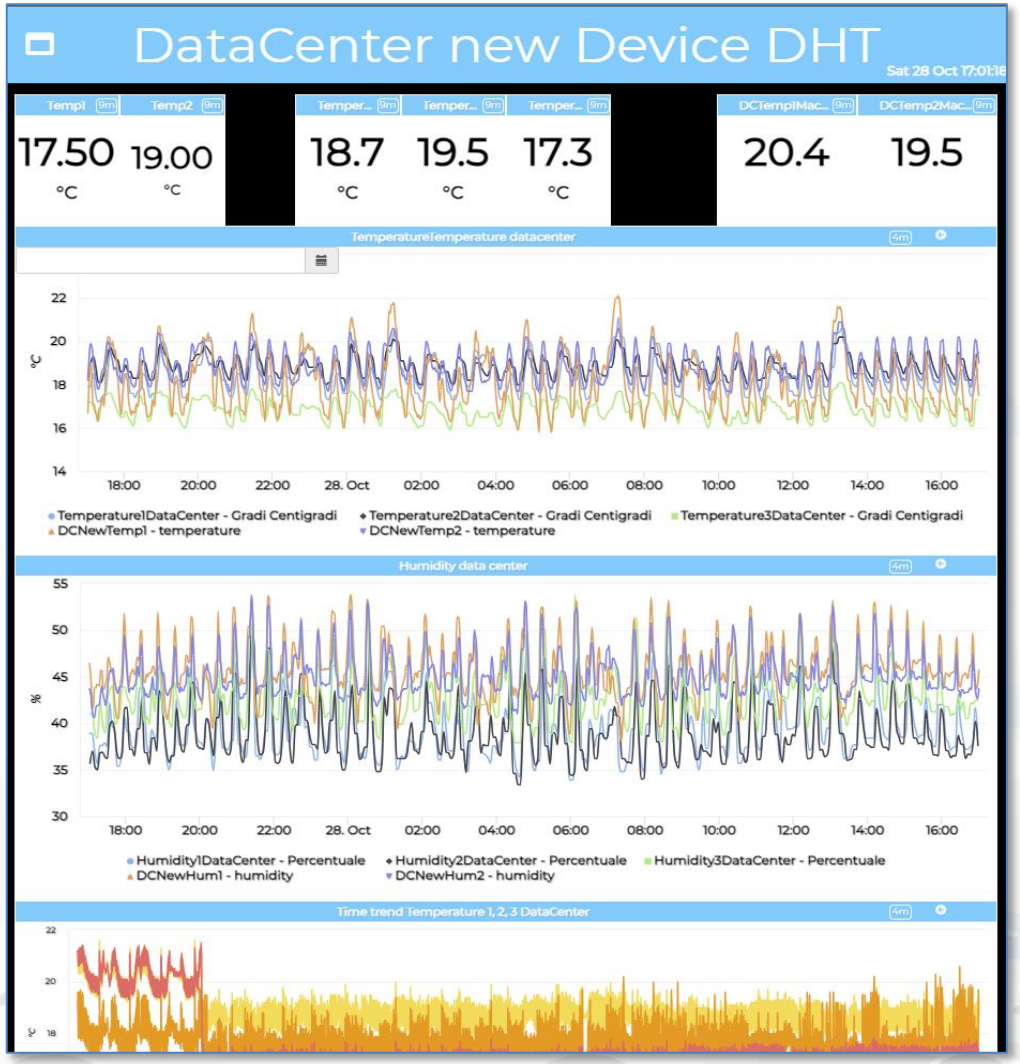






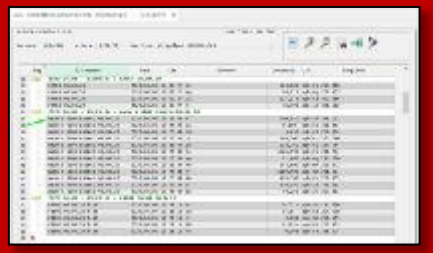
Data Center monitoring





GeNotiLab Architecture for ALTAIR

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



AS400

IOT App

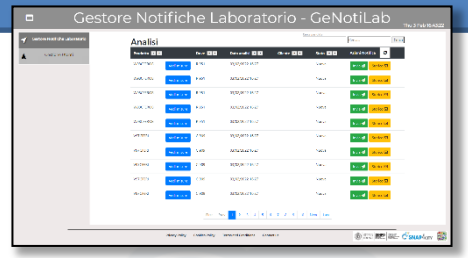
Users

Analysis

Notifications

IOT App Analytics

Dashboards



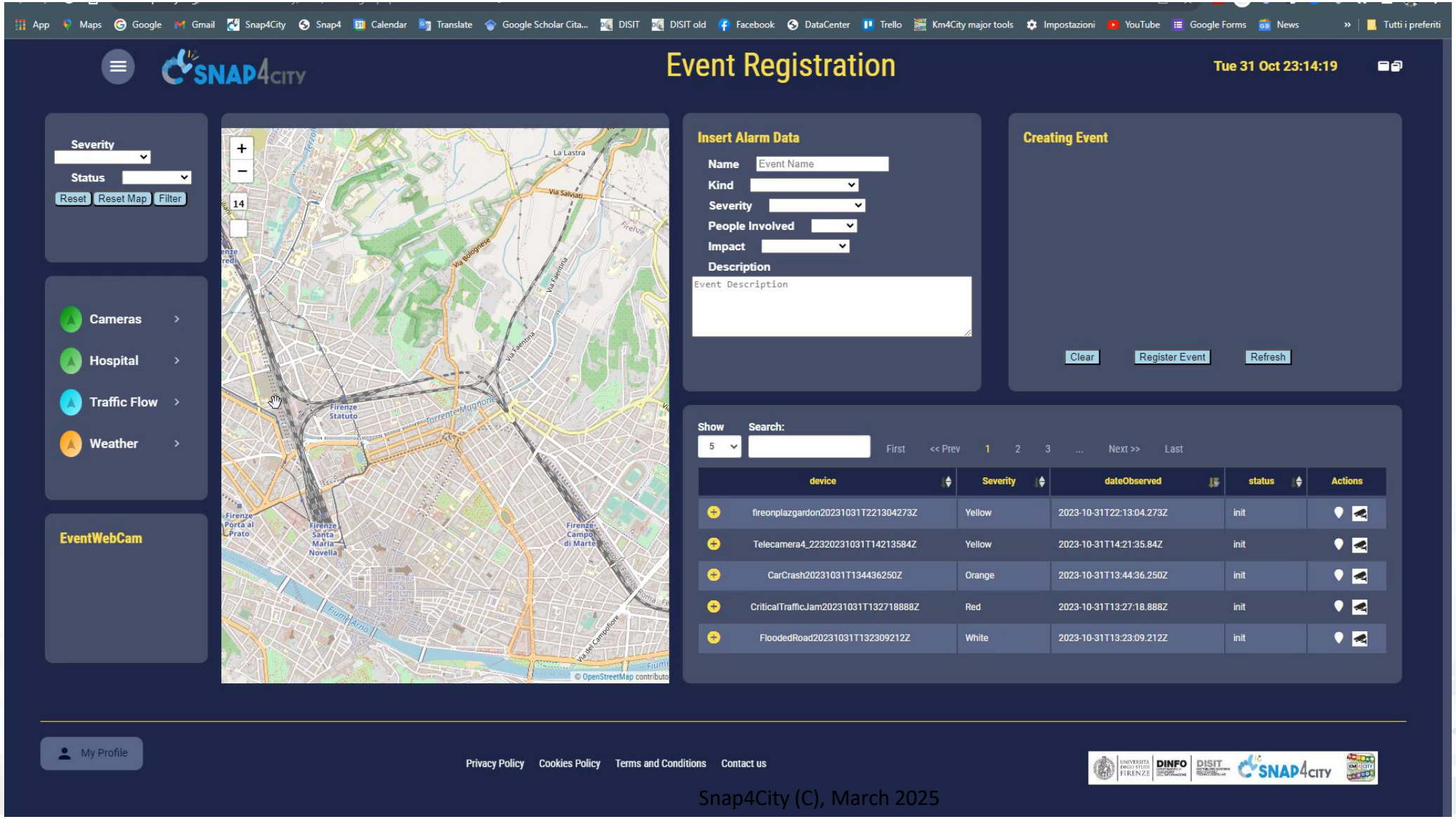
IOT App Management

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

IOT App Vs Telegram

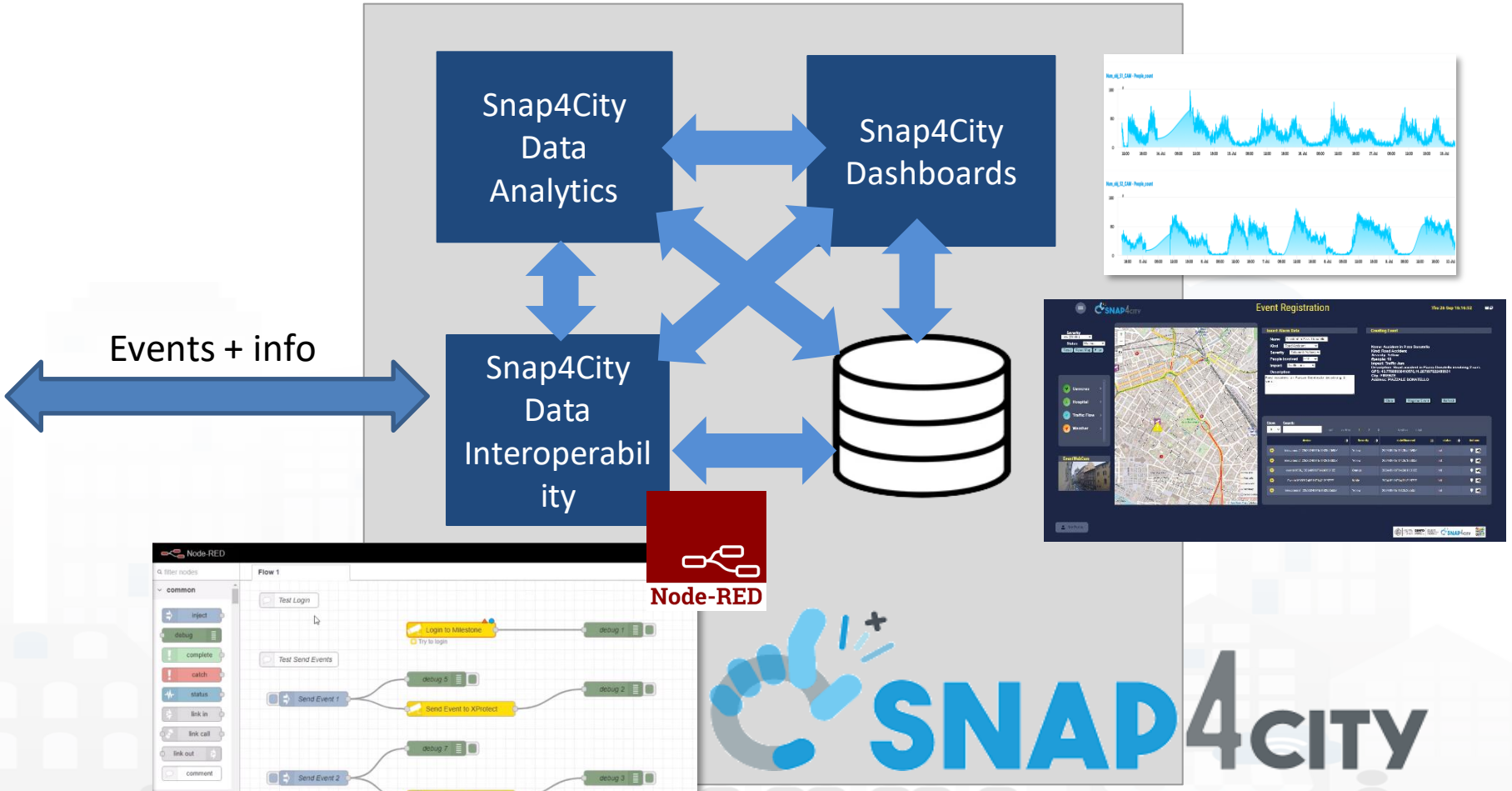
Telegram Bot

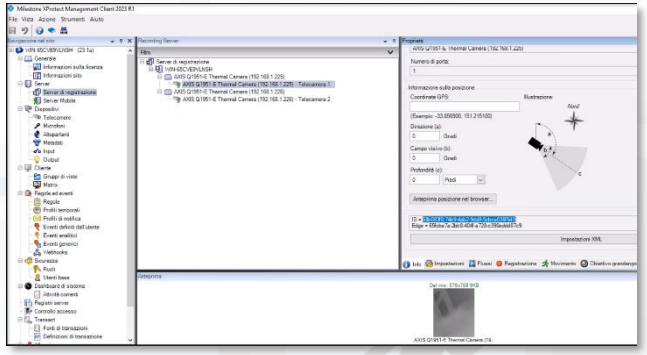
Video Event Management



VMS vs Snap4City: sending and getting events, AI solutions

Events + info





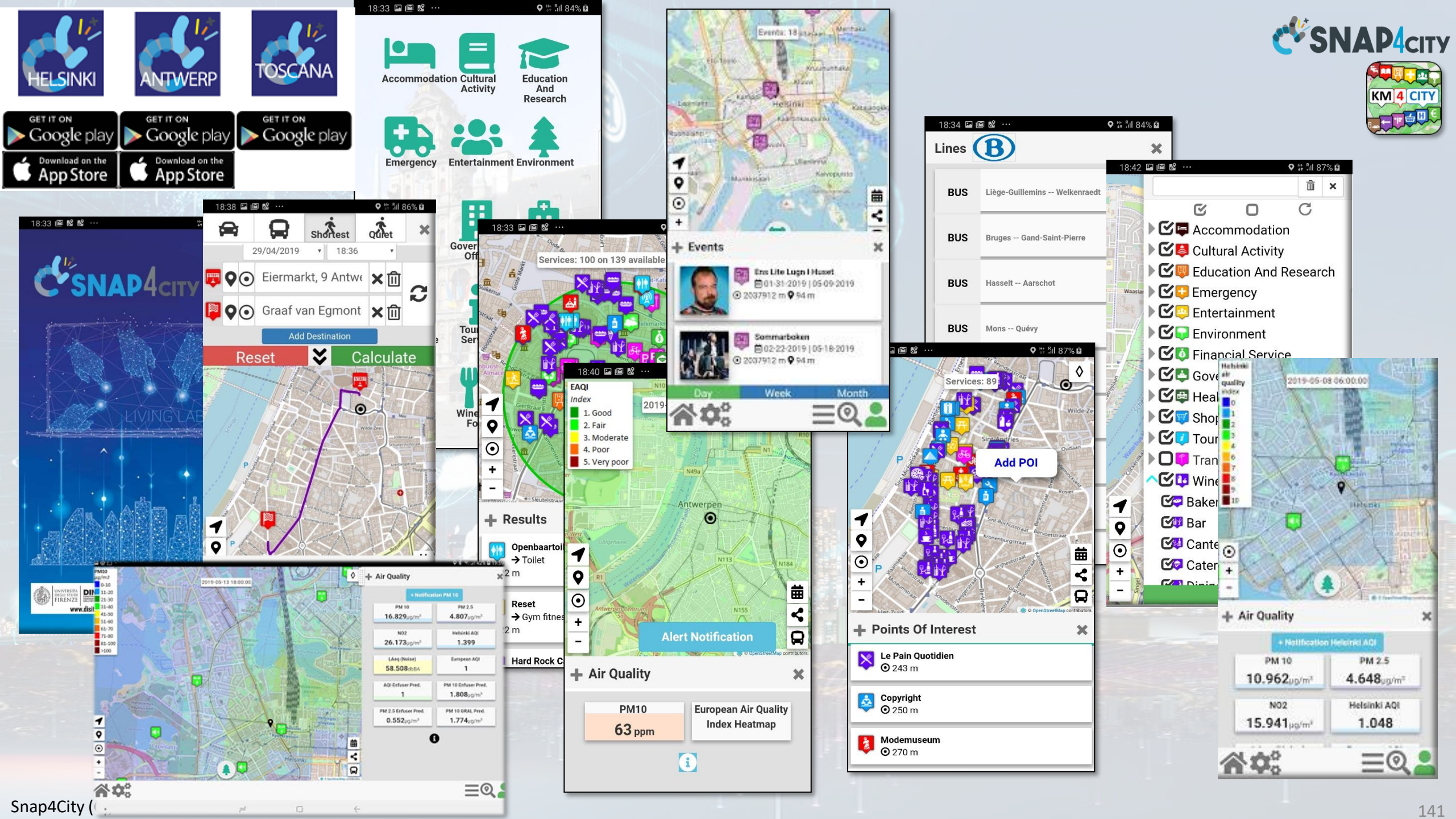
Engaging via Mobile Apps

FROM CITY DASHBOARD TO APPLICATIONS

SNAP4CITY AND KM4CITY PROJECTS

SNAP4CITY THE VIEW OF THE ADMINISTRATORS

100% OPEN SOURCE


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

Citizen Engagement/Participation 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

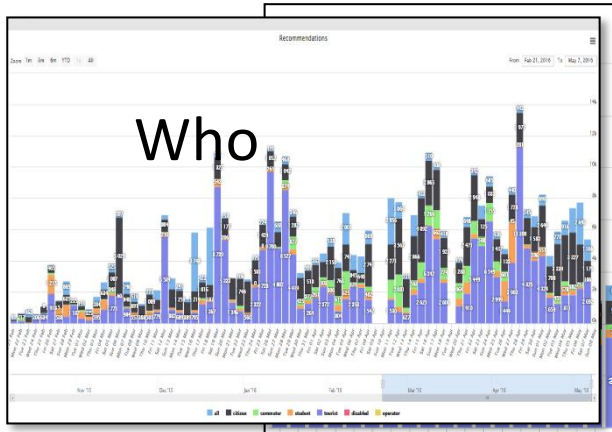
- Trajectories
- Hot Places by click and by move
- Origin destination matrices
- Most interested topics
- Most interested POI
- Delegation and relationships
- Accesses to Dashboards
- **Cumulated Scores from Actions**
- Requested information
- Routing performed
- …..

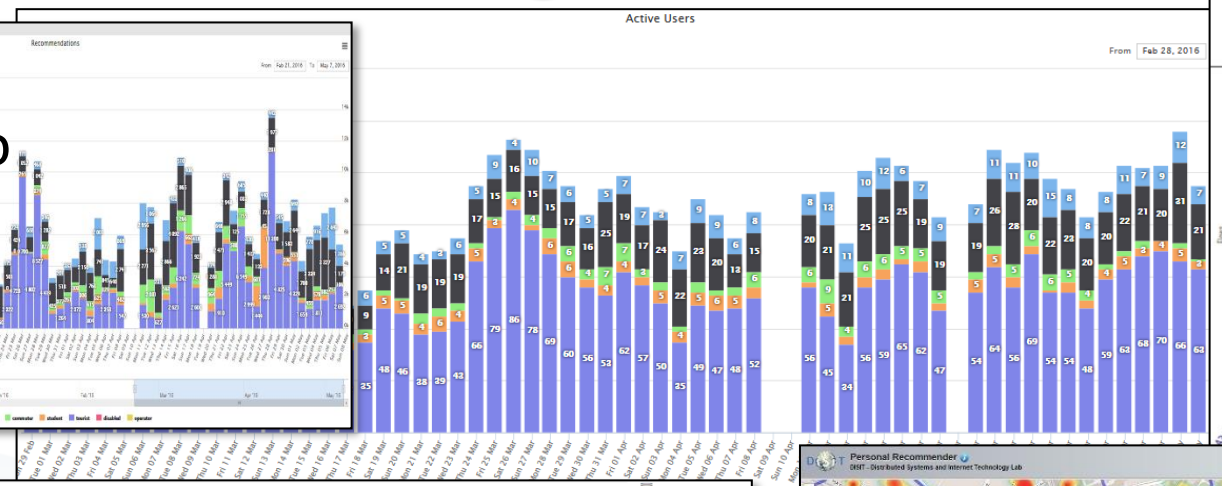
Produced information

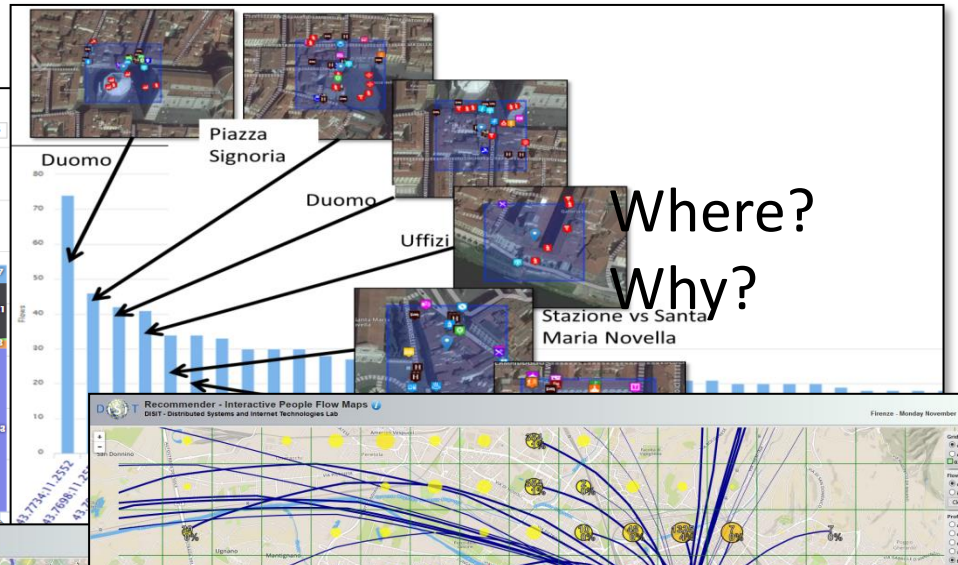
- Suggestions
- Engagements
- Notifications
- …

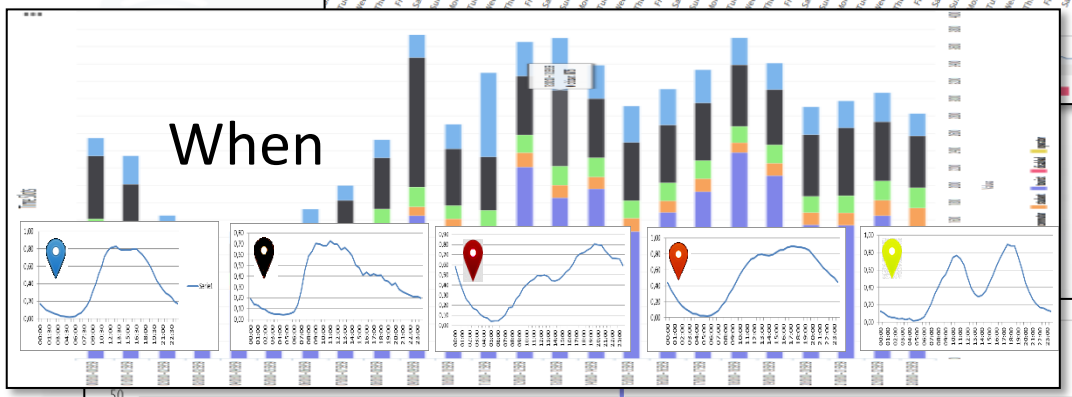
System

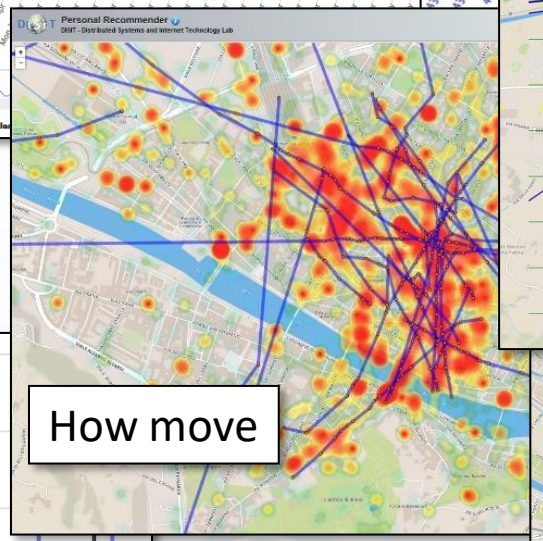
User Behavior Analyser for Collective Profiling

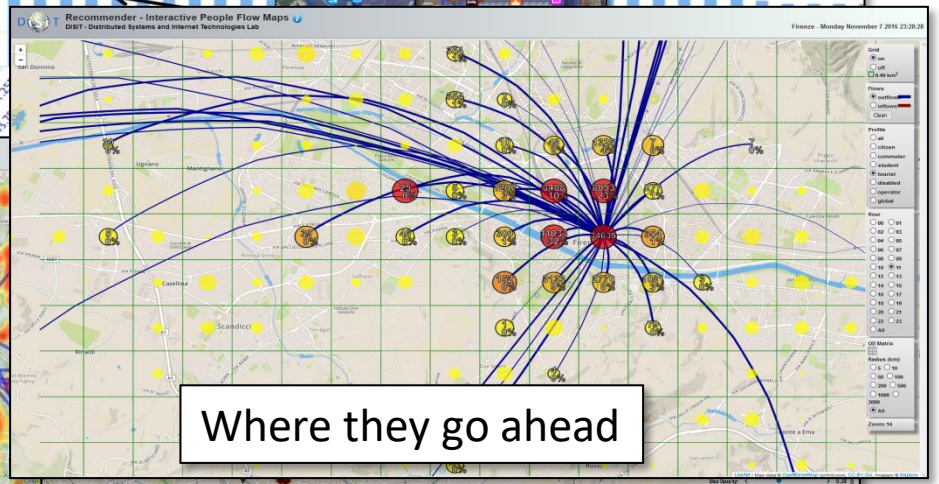


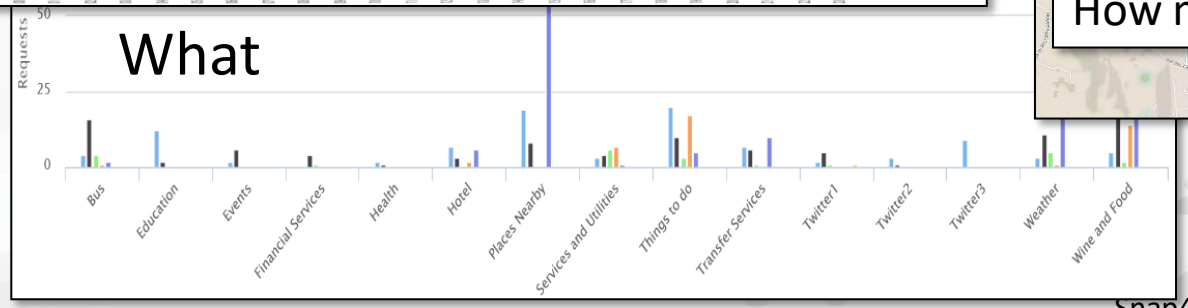


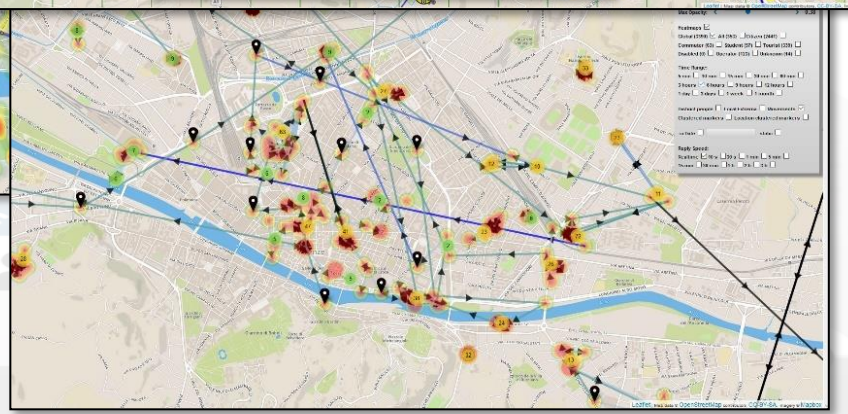












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DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB
DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

7 AFFORDABLE AND CLEAN ENERGY

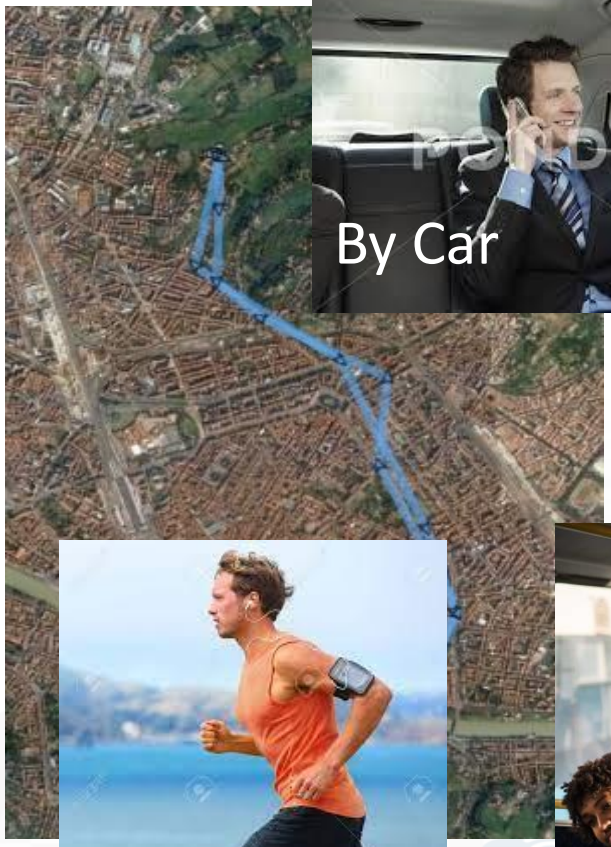
11 SUSTAINABLE CITIES AND COMMUNITIES

13 CLIMATE ACTION

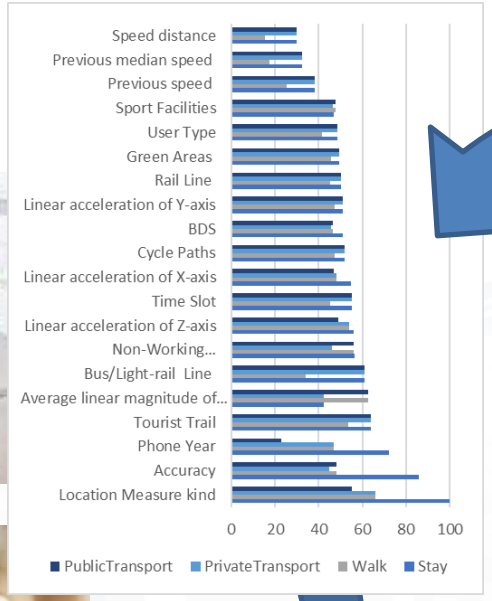
SNAP4CITY KM4CITY

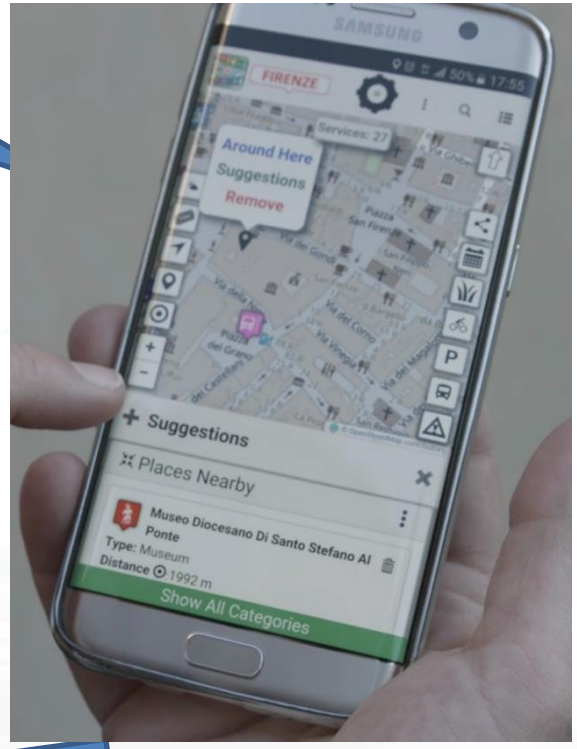
To propose suggestions and Engage city user

we need to know how they are moving



Walk

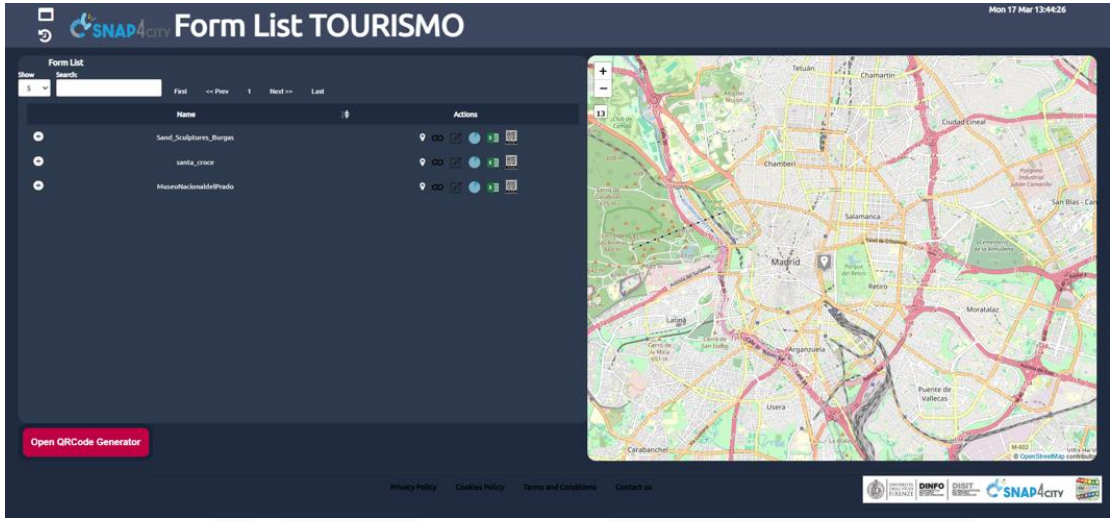


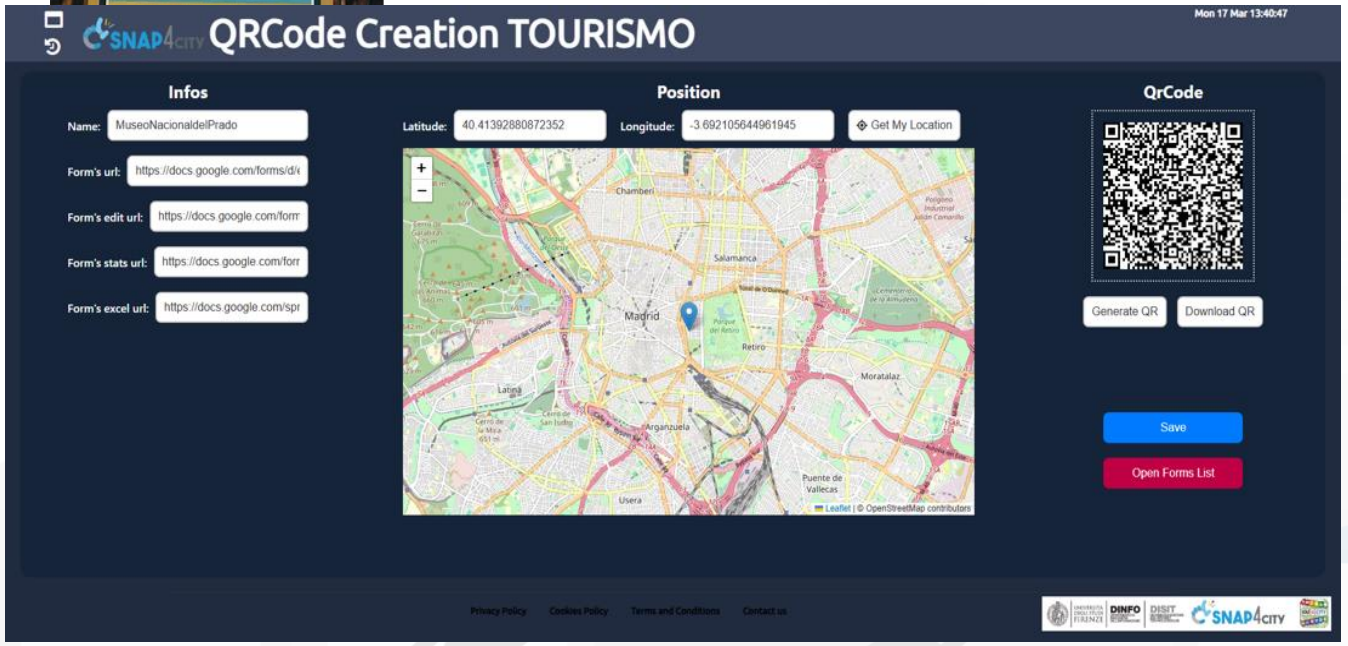


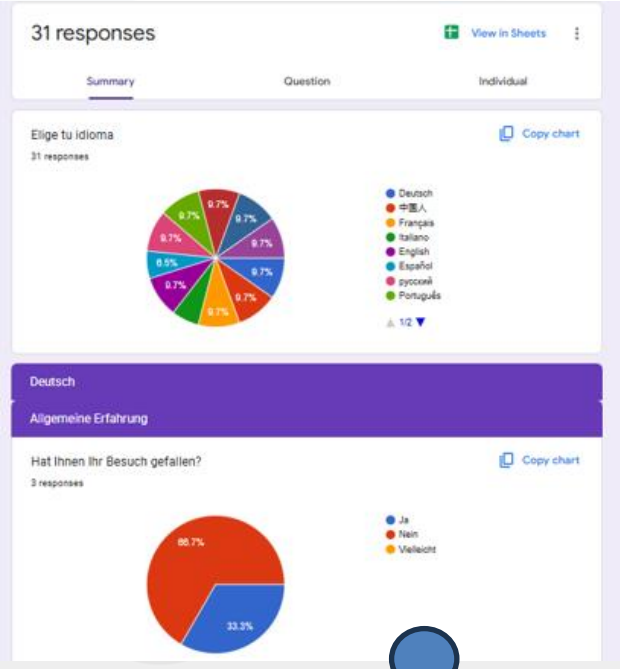
Artificial Intelligence Classification

Suggestions

QR Engagement



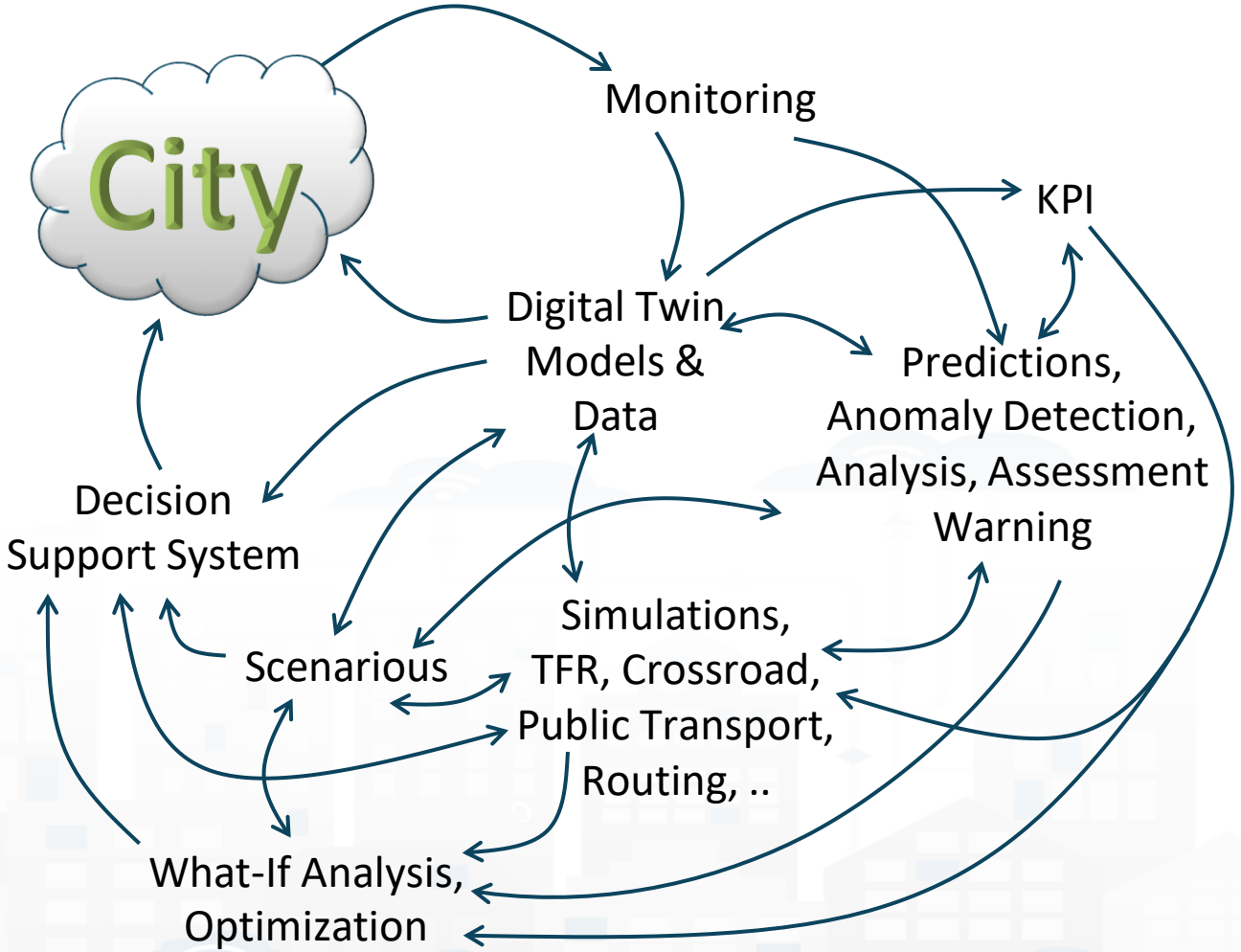




Decision Support System: Immediate response and Tactic and Strategic Plans, via What-if Analysis, Optimization

Main tasks

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



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

SUSTAINABLE DEVELOPMENT GOALS

SNAP4CITY

KM 4 CITY

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

- Optimization of car sharing/pooling
- Monitoring and Prediction of energy consumption
- Stimulating: Bike sharing, e-bikes, car charge, etc.
- Sizing energy plants

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

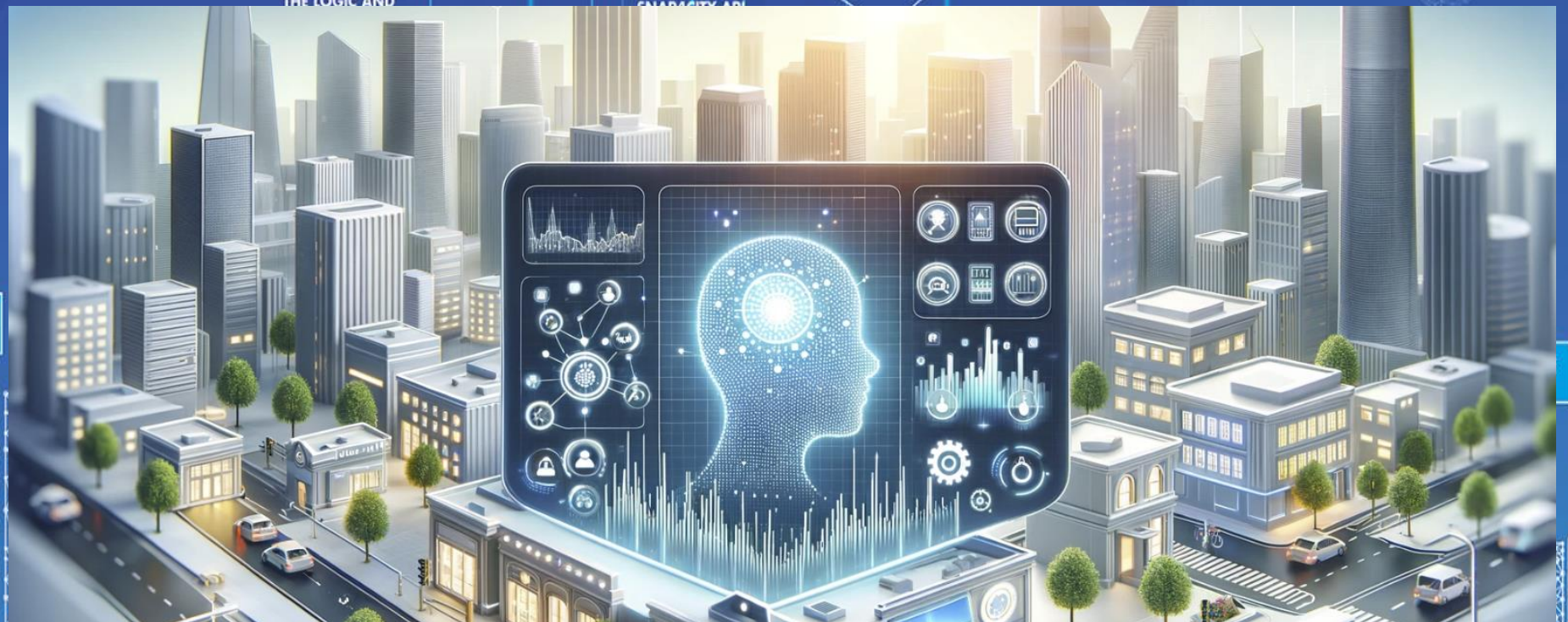
- Reduction of emission, reduction of congestion
- Smart City infrastructure: monitoring and resilience, long terms predictions
- Effective and Low cost smart solutions
- What-if analysis, Simulations
- Origin Destination matrices computation

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

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

- Shortening justice time
- Prediction of mediation proneness
- Assisting institution is taking legal decisions
- Anonymization and indexing legal docs.
- Ethical Explainable Artificial Intelligence

Data Analytic Artificial Intelligence, XAI, Machine and Deep Learning



100% OPEN SOURCE

Available AI Solutions on Snap4City

https://www.snap4city.org/997

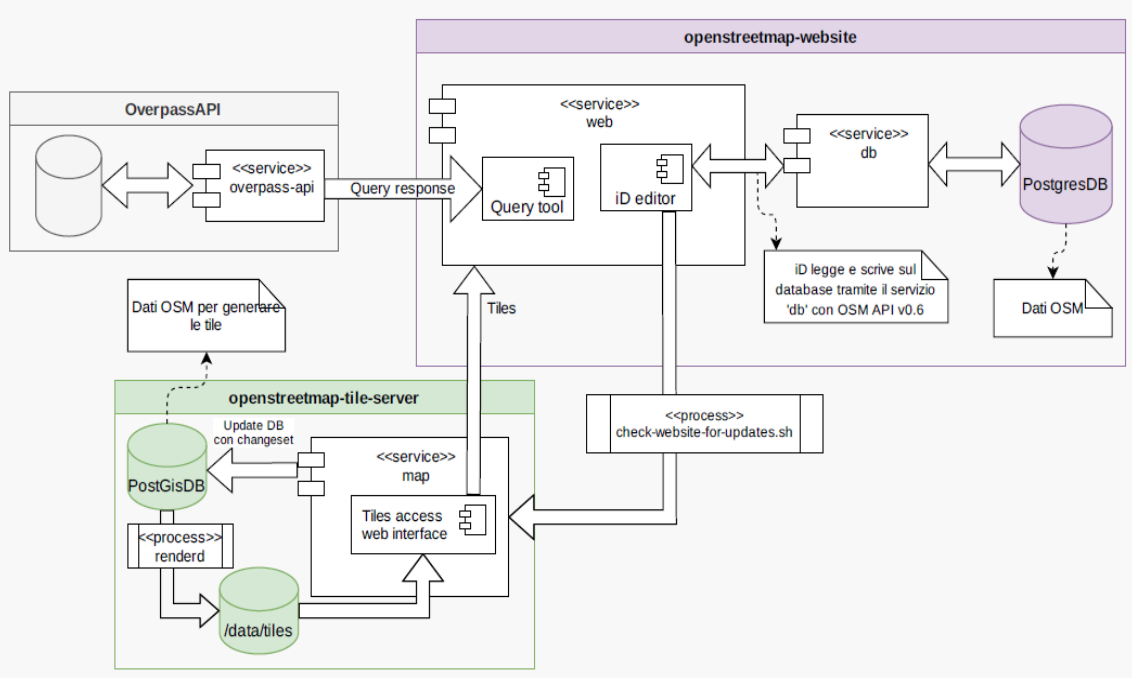
More than 80 Available Solutions & 300 AI applic.

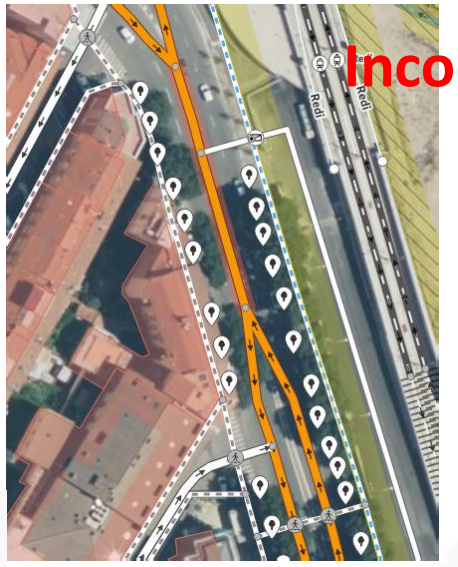
- Mobility and Transport
- Environment, Weather, Waste, Water
- City Users Behaviour and Social analysis
- Energy and Control
- Tourism and People
- Security and Safety
- High Level Decision Support Solutions
  - Asset management
  - Resilience and Risks Analysis
- Low level Techniques

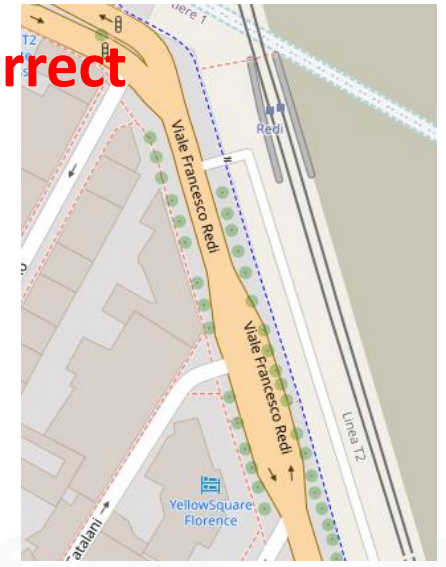
https://www.snap4city.org/download/video/DPL_SNAP4SOLU.pdf

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

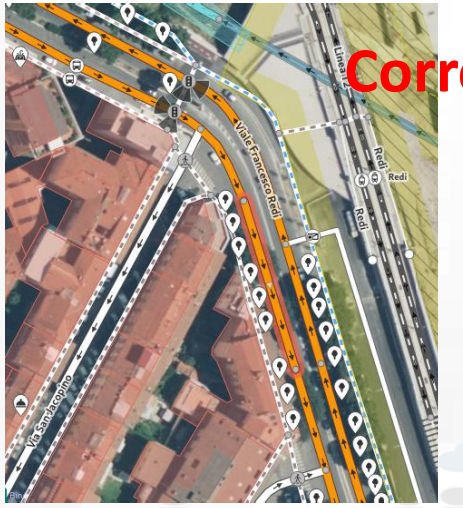
Correcting road graphs from OSM

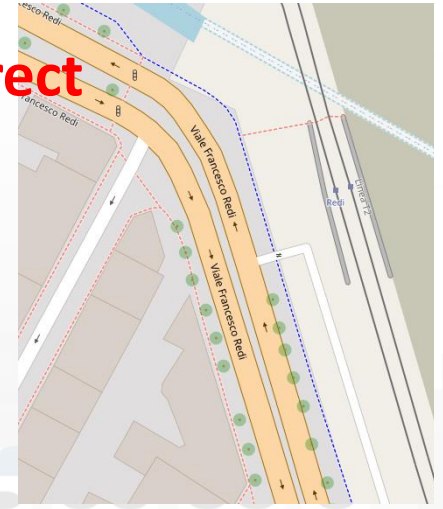






OSM data with non clear double bidirection lane on Viale Redi, Florence.
Editing OSM data and present Tiles





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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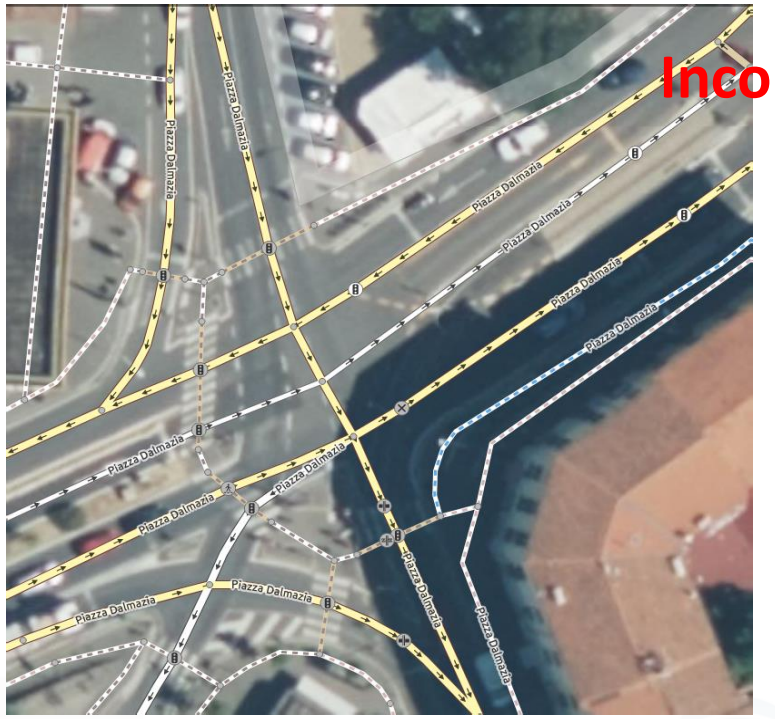
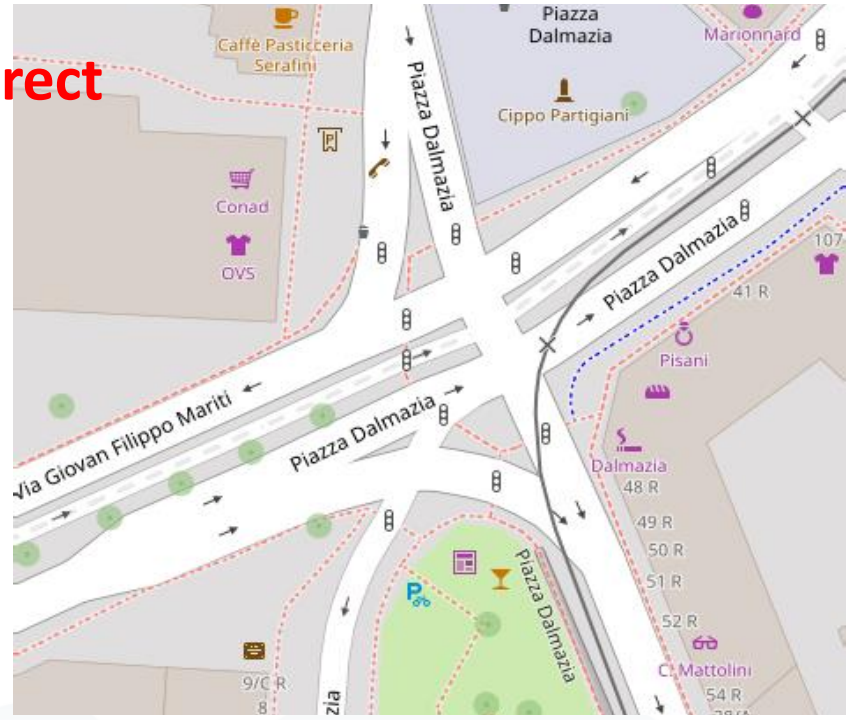
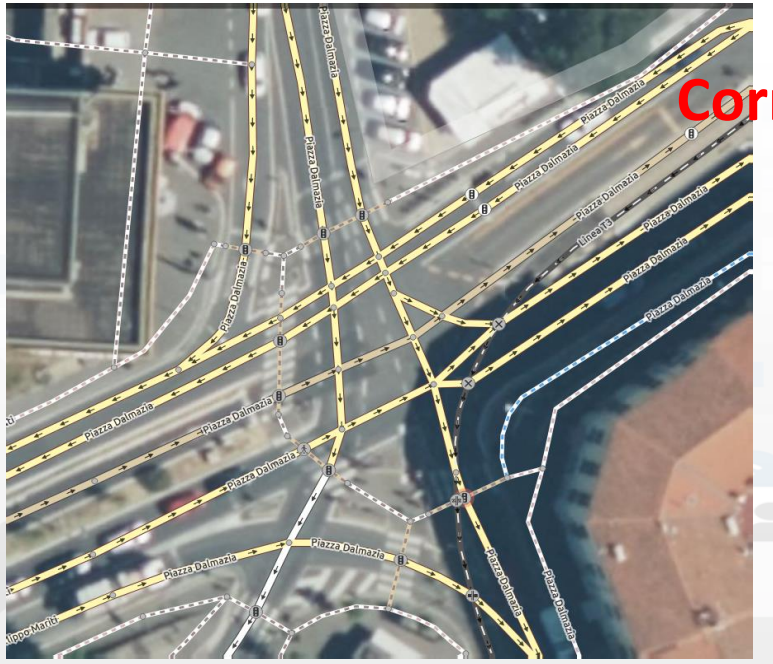
OSM data with non correct viability in Piazza Dalmazia, Firenze



Incorrect



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



Correct

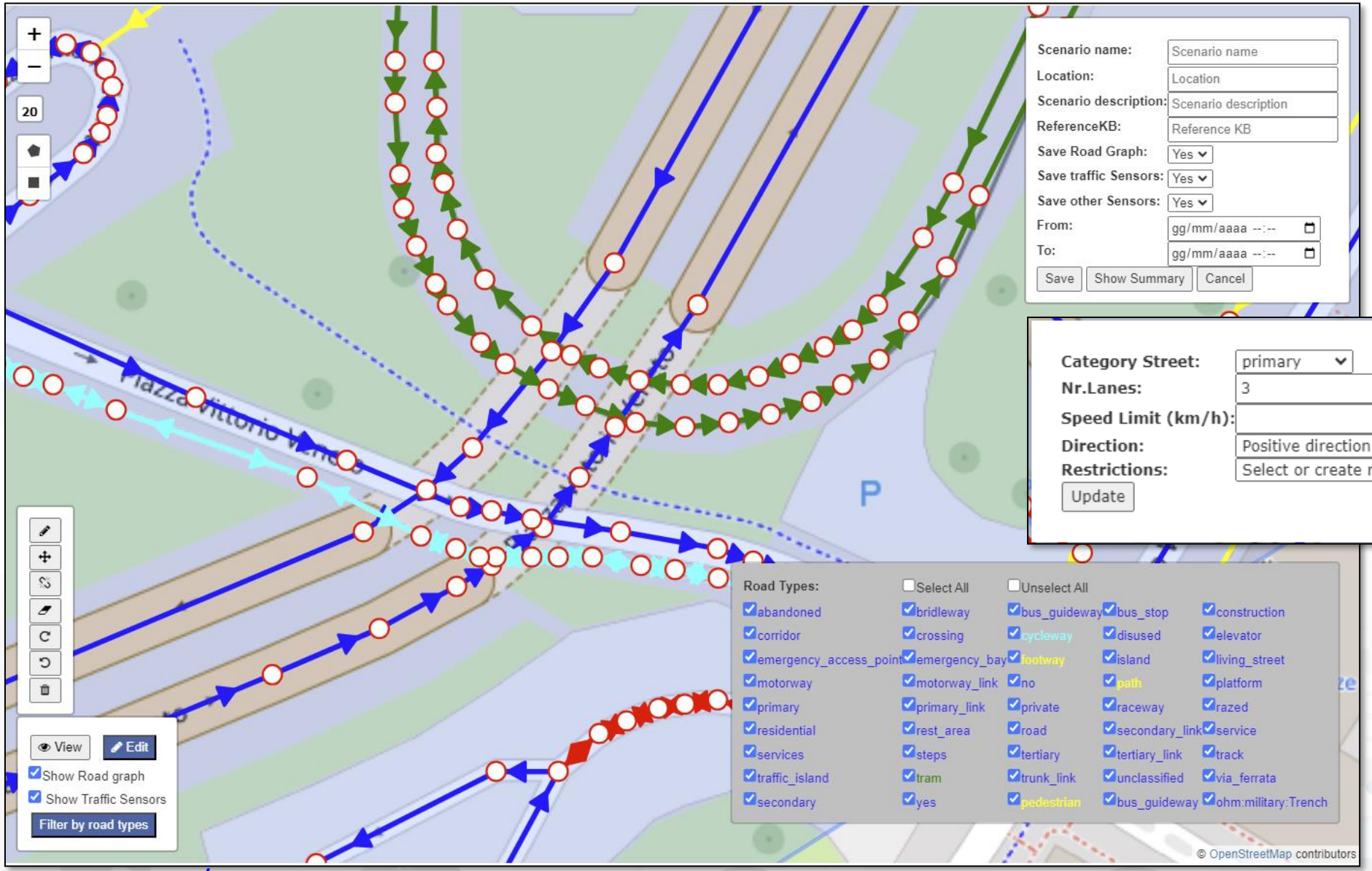
Scenario Editor

Select map

Zoom

New Scenario

Editing
Drag & drop
Split & Join
Delete
Do and Undo



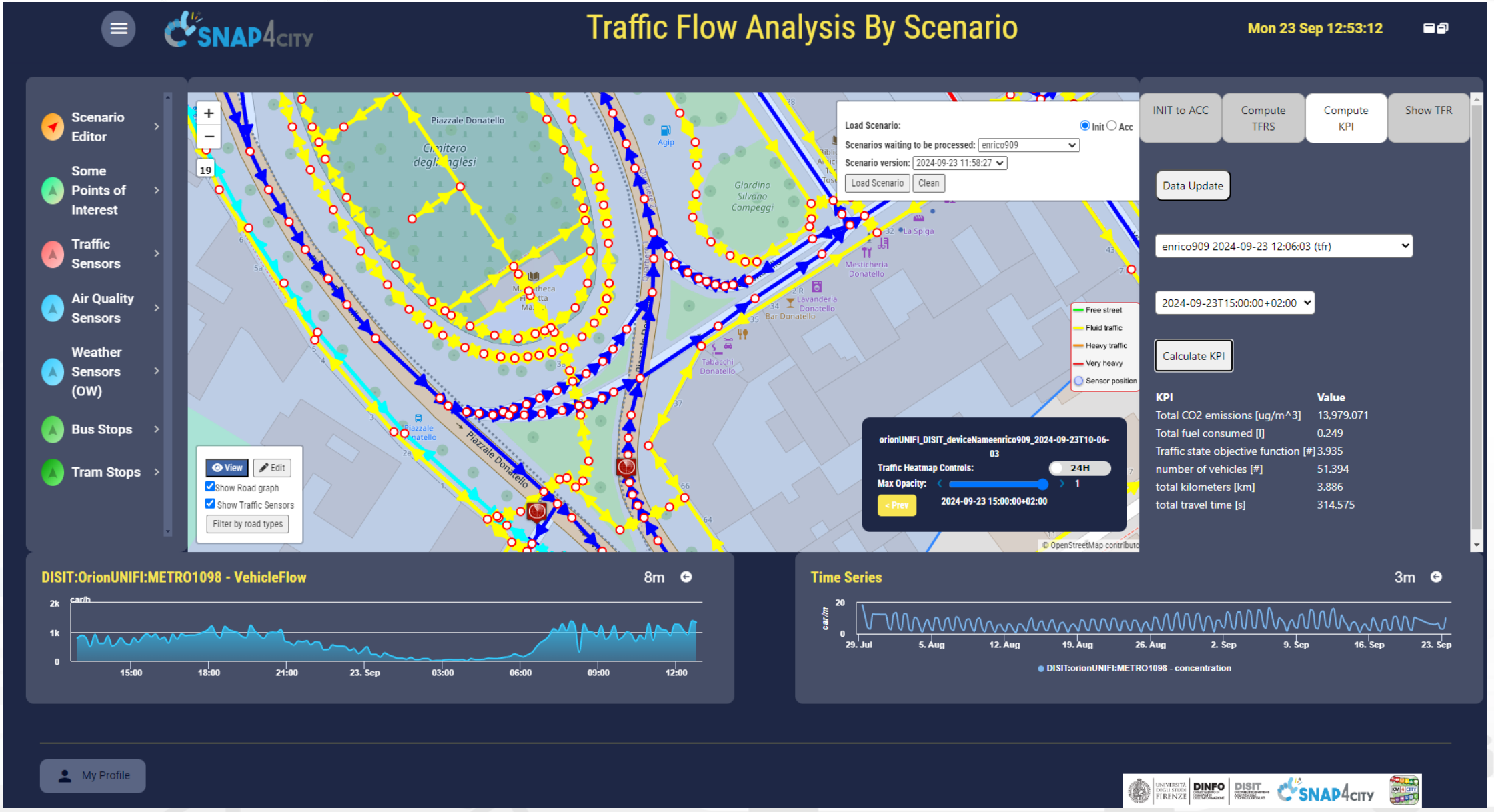
Edit Road Segment

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

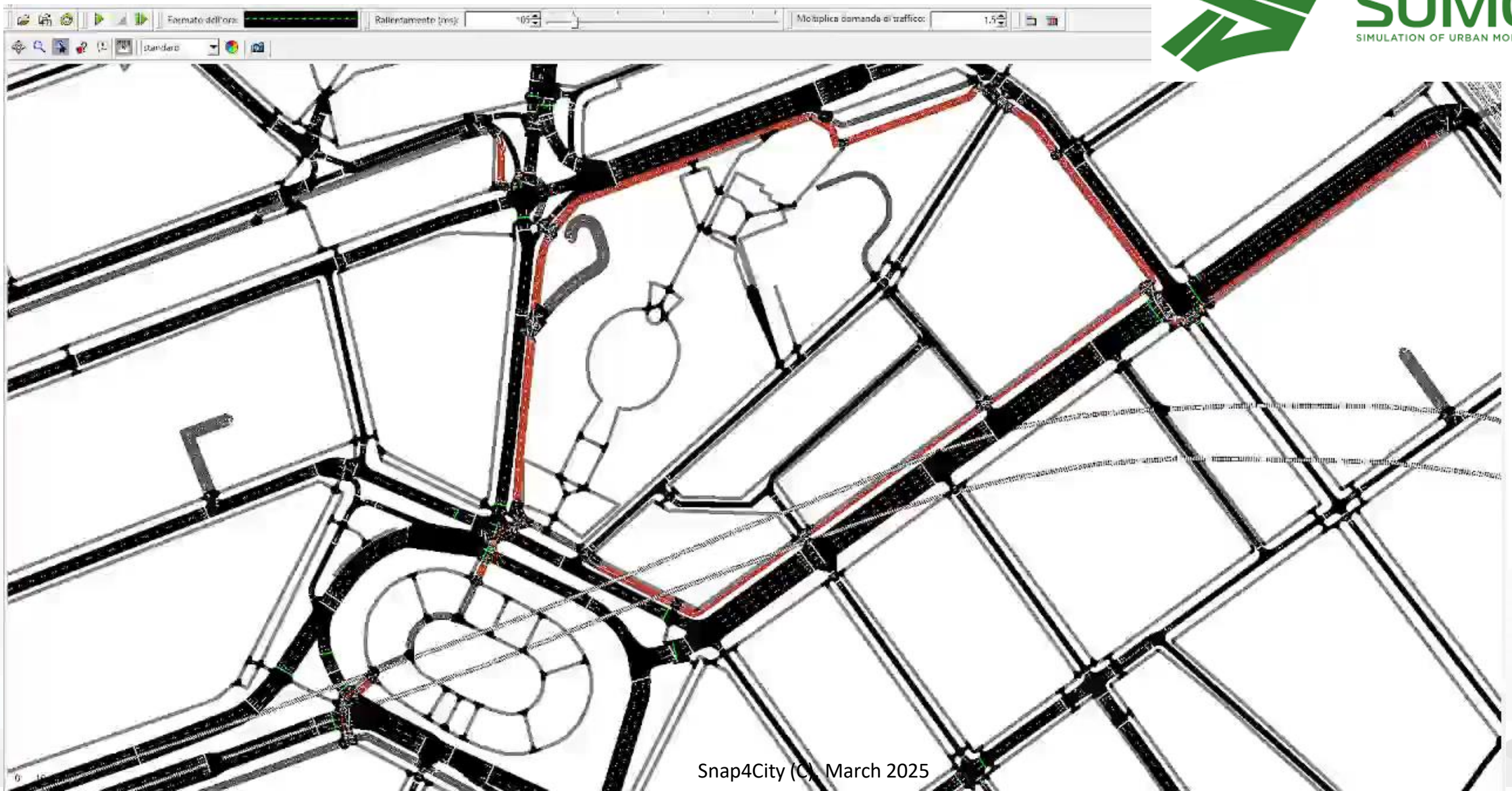
Properties of Road Elements

https://www.snap4city.org/976

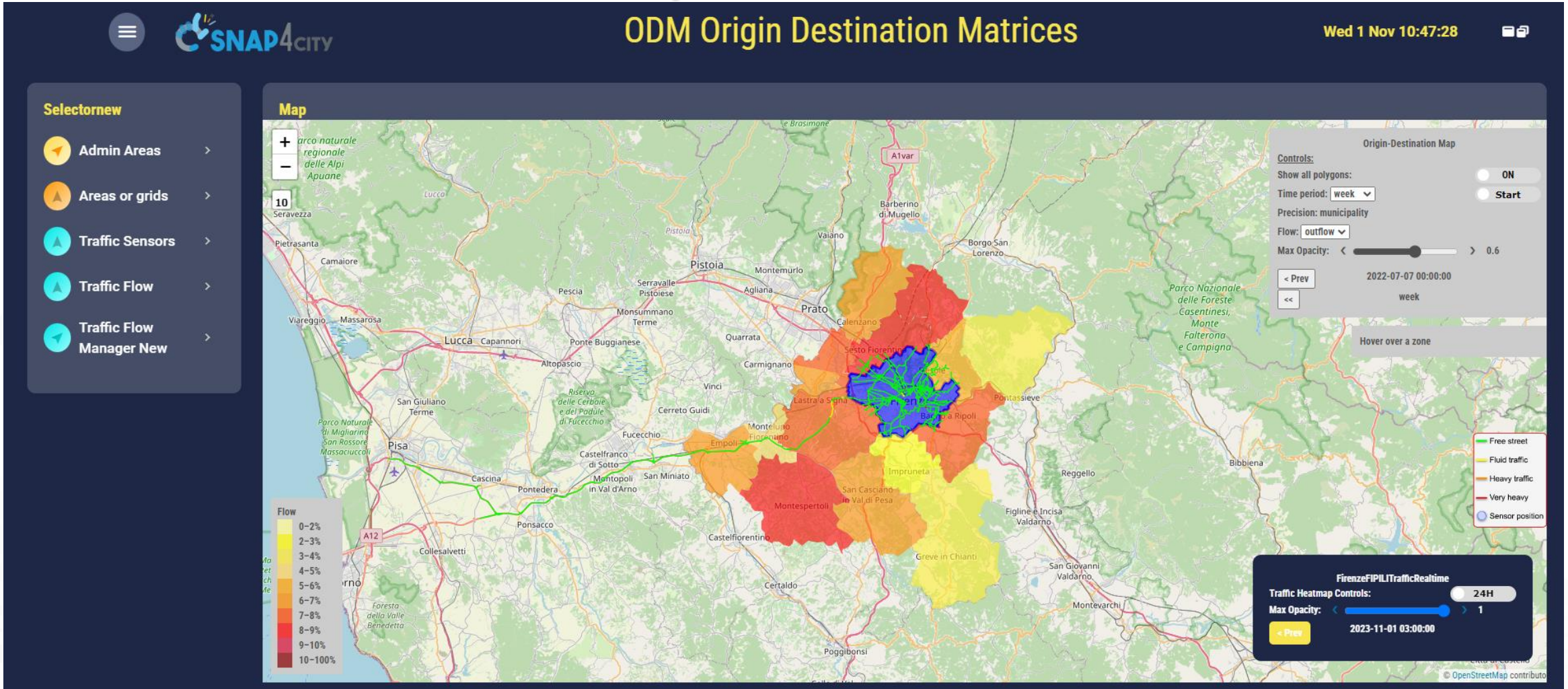
What-if on TFR



Micro Simulation

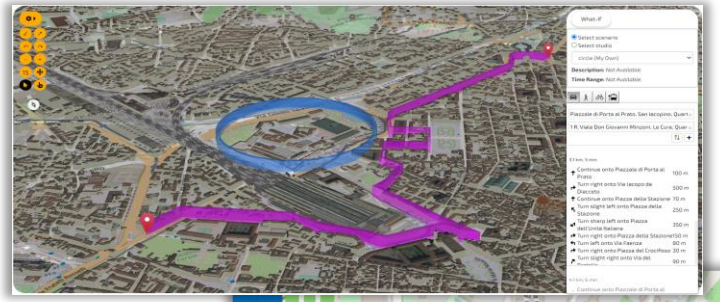


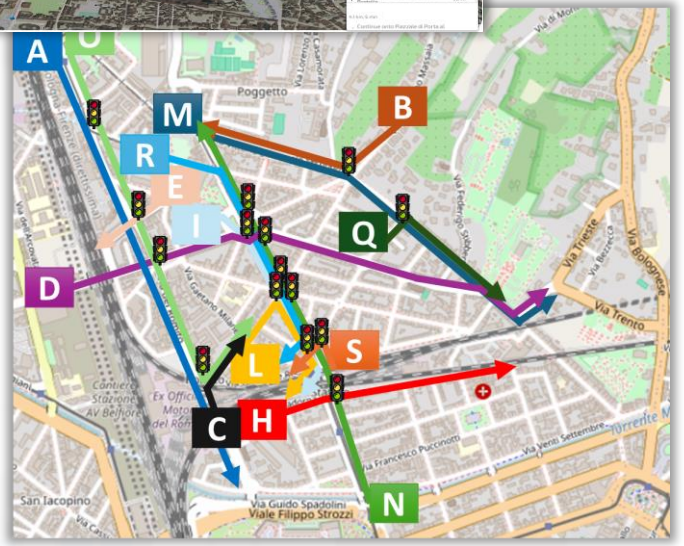
ODM, Traffic Flow



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

Mobility

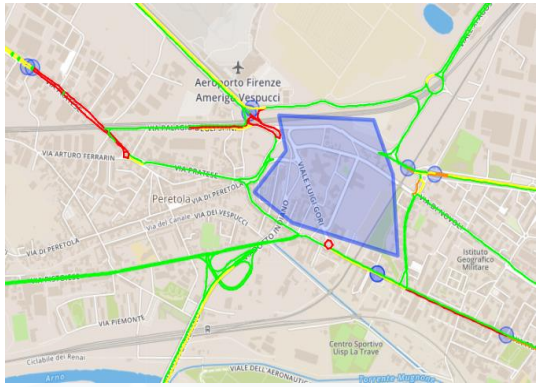


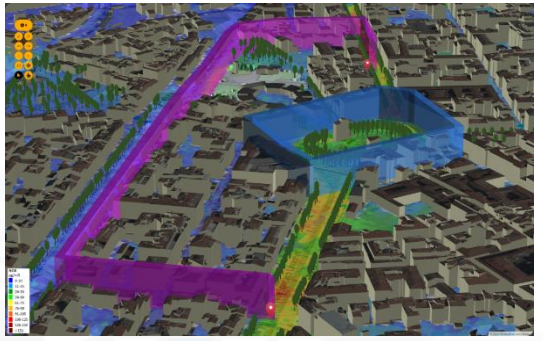


- **Goals:**
  - Decongestion, Decarbonization, costs reductions
  - Improve Accessibility to services
  - Improve Security/Safety of city users
- **Operation and Plan**:
  - Traffic monitoring, prediction, reconstruction, identification of critical conditions (early warning), fleet management, dynamic routing, multimodal routing, city user behaviour analysis
- **Optimization and what-if analysis traffic light, infrastructure**
  - **Reduction**: travel time, waiting time, stops, CO2 emissions, consume fuel, travel time for tramways
- **Public Transport**: analysis of Mobility Demand vs Offer of Transportation
- **Parking Management:** monitoring, prediction, any payments, on/off-road
- **Sharing / Pooling Management**: eShare and mobile app, bikesharing, smart bike, fleet management
- **KPI:** SUMI/SUMP, travel time, emissions, traffic status, accessibility, ..
- **Mobile App**: final users and operators
  - Info Mobility, traffic reconstruction, charging, participation,
  - Parking, payments, overparking, fine reporting, ..
- **Participatory**: problem reporting, ticketing, etc.
- **Data Integration of any kind: env, weather. Tickets, presences, POI, sat, etc.**

Mobility and Transport Domain (2024/8)

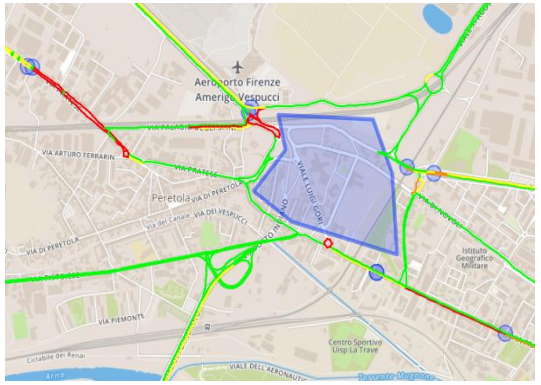
- Goals:
  - Decongestion
  - Decarbonization
  - Accessibility to services
  - Security/Safety of city users
- Solutions for Operation (monitoring, managing, mobile apps, digital signages, control rooms)
  - Monitoring traffic, parking, people flow, services, boats, ports, beaches, etc.
  - Early detection/warning of critical conditions: traffic, congestion, security/safety
  - Managing Smart Parking, transportation services, fines, etc.
  - Managing fleets: personal, sharing, waste collection, maintenance, etc.
  - Managing E-sharing, pooling services, MaaS, etc.
  - Managing entrances in city areas: restricted areas, touristic busses, etc.
  - Production of suggestions, recommendations, nudging
  - Computing predictions of any kind
- Solutions for Planning (optimization and what-if analysis)
  - Reduction of traffic congestion, via optimization: traffic light plans, viability, routing
  - Reduction of Pollutant Emissions, via optimization: traffic light plans, viability
  - Optimization of transportation offers wrt multimodal mobility demand
- Algorithms and computational solutions, see next slide

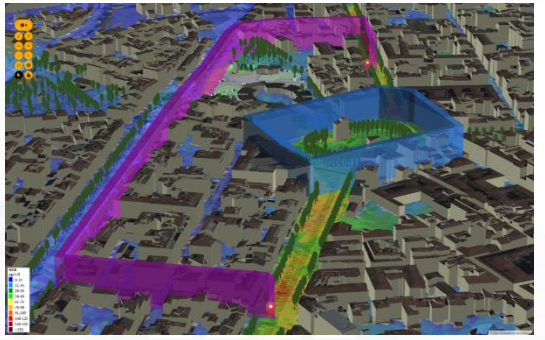




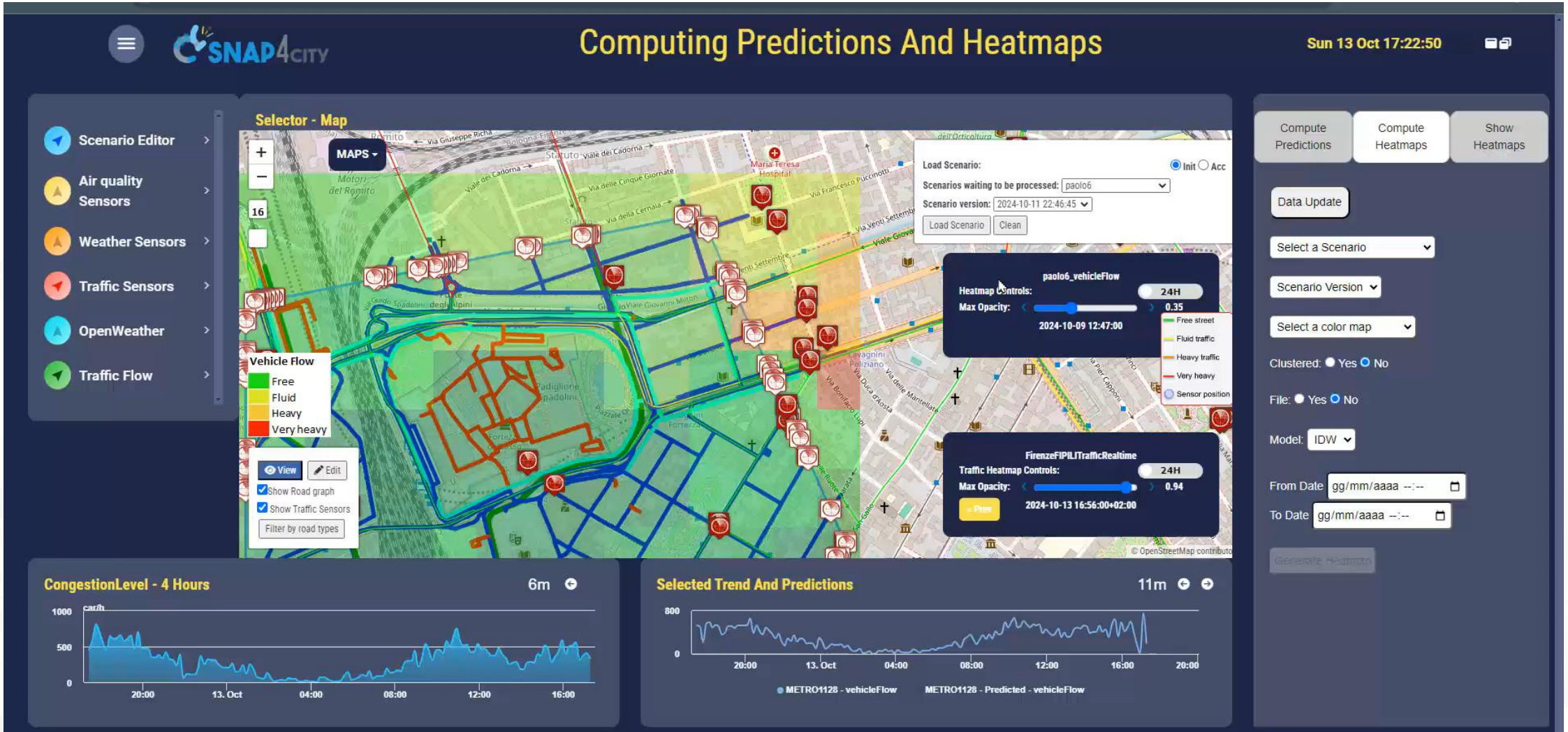
Tools for Mobility and Transport (2024/8)

- Optimisation of viability of an area for reducing congestion, waiting time, stops
- Optimisation of Traffic Light Plans, synchronization, in an area for reducing congestion, waiting time, stops
- 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)
- Road light controlled by traffic conditions
- 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)
- Fleet management, monitoring, booking, allocation, maintenance
- 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.



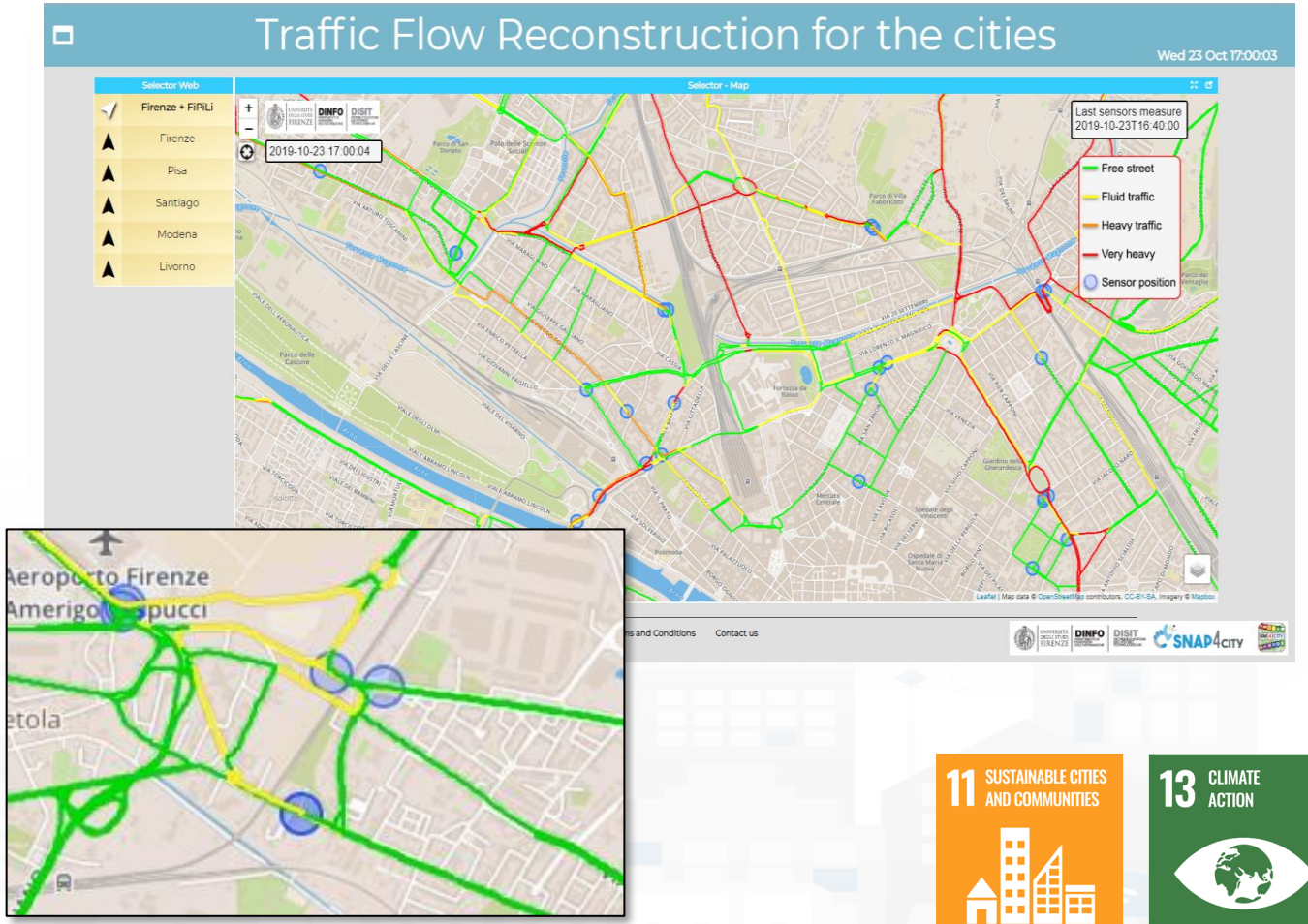


Predictions and Heatmaps in Real Time



Why Dense Traffic Flow Reconstruction ?

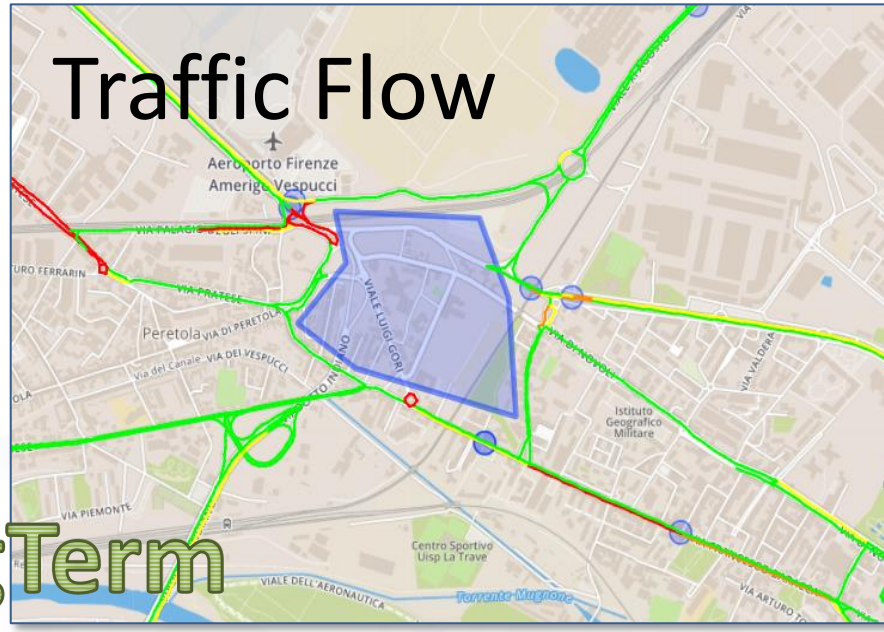
- Making decision on mobility and transport solutions → what if analysis
- Controlling pollution
- Dynamic Routing for Firebrigade, Ambulances, general public
- Planning Public Transportation routing

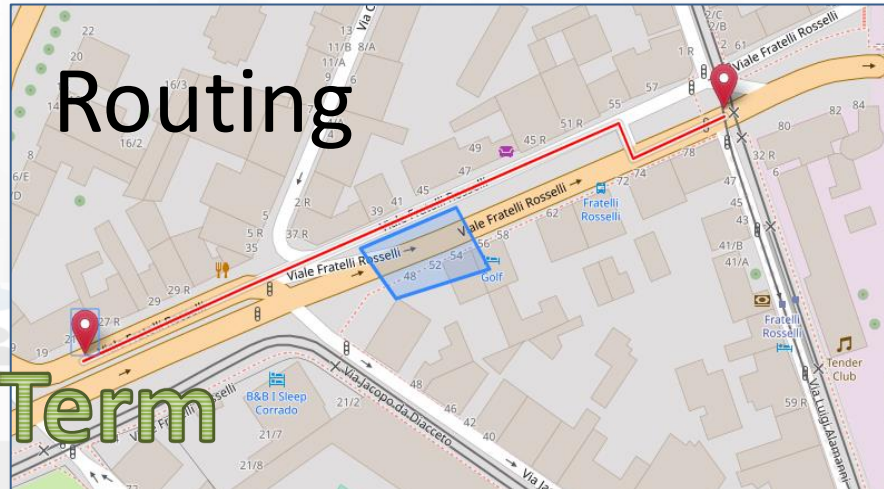


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc5NQ==

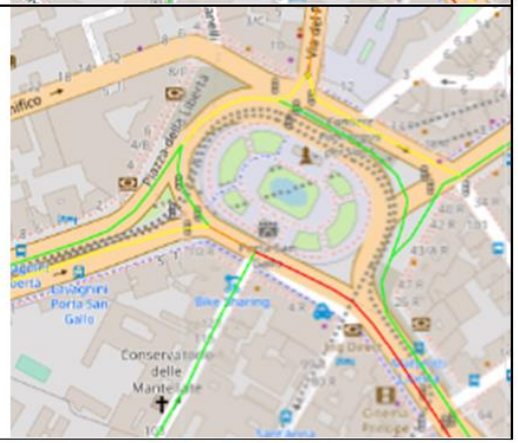
Decision Support Systems, What-if

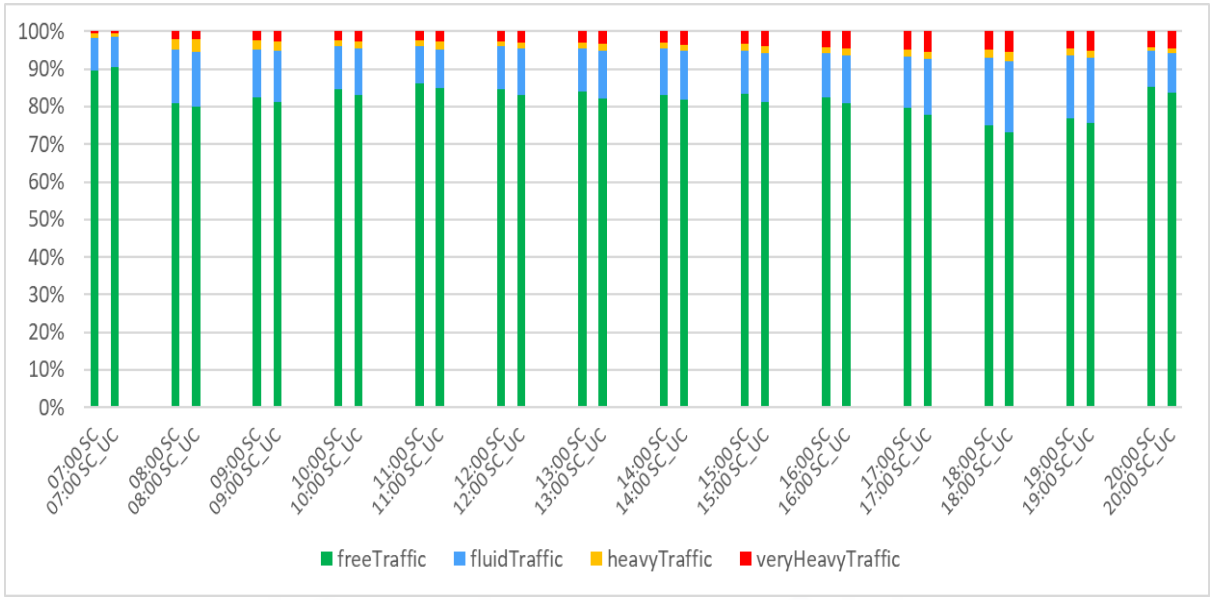
- **Event planning, via what-if analysis**
  - Change in the graph structure of the city
  - Impact on the flow of people and vehicles
  - Adaptation: public transport, traffic, pedestrian management, etc.
- **Immediate reaction to natural events or not**
  - Everything is ready and updated in real time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

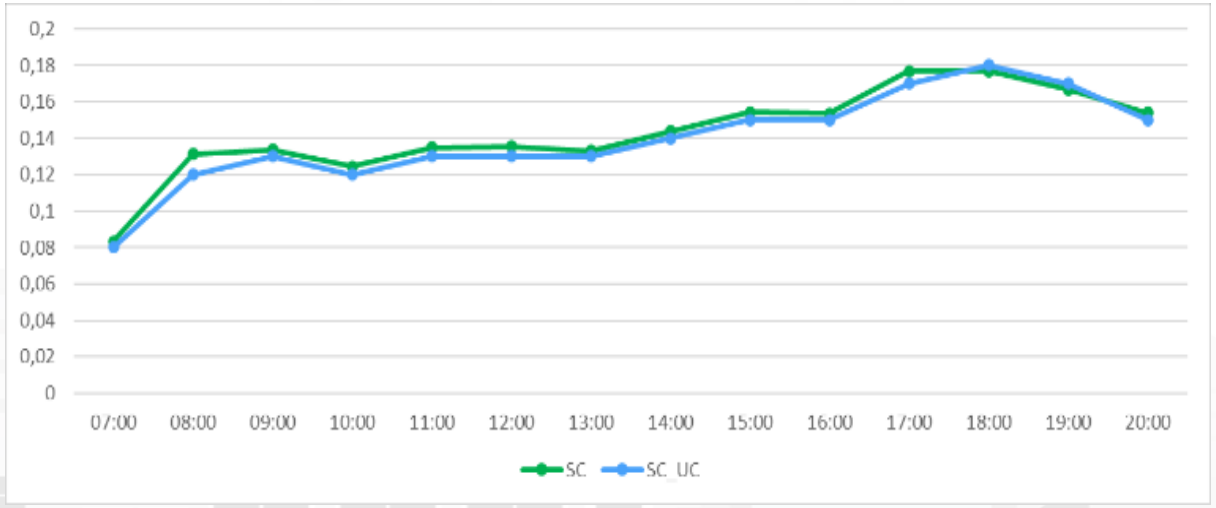




What-if

	analysis results of $SC_{i,\hat{T}}$	Actual Traffic Flow results of $R_{\hat{T}1}$
09:00		
15:00		





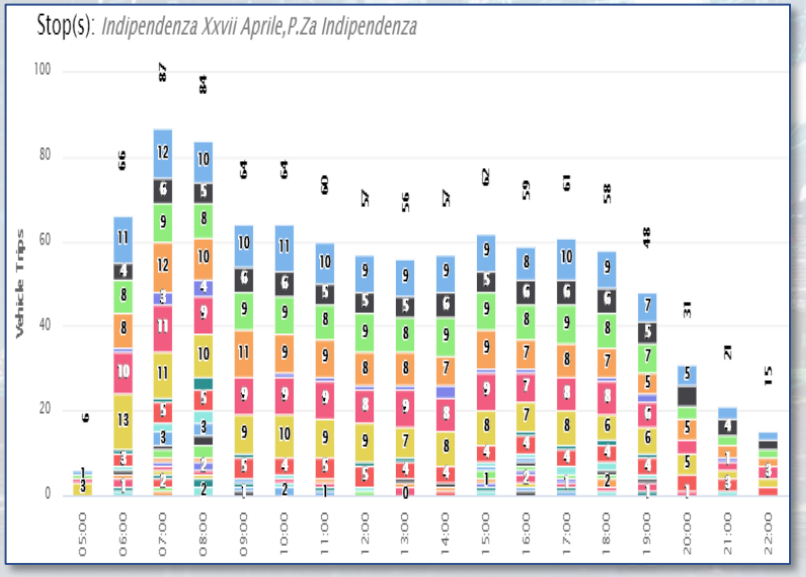
Mobility Demand vs Transportation Offer

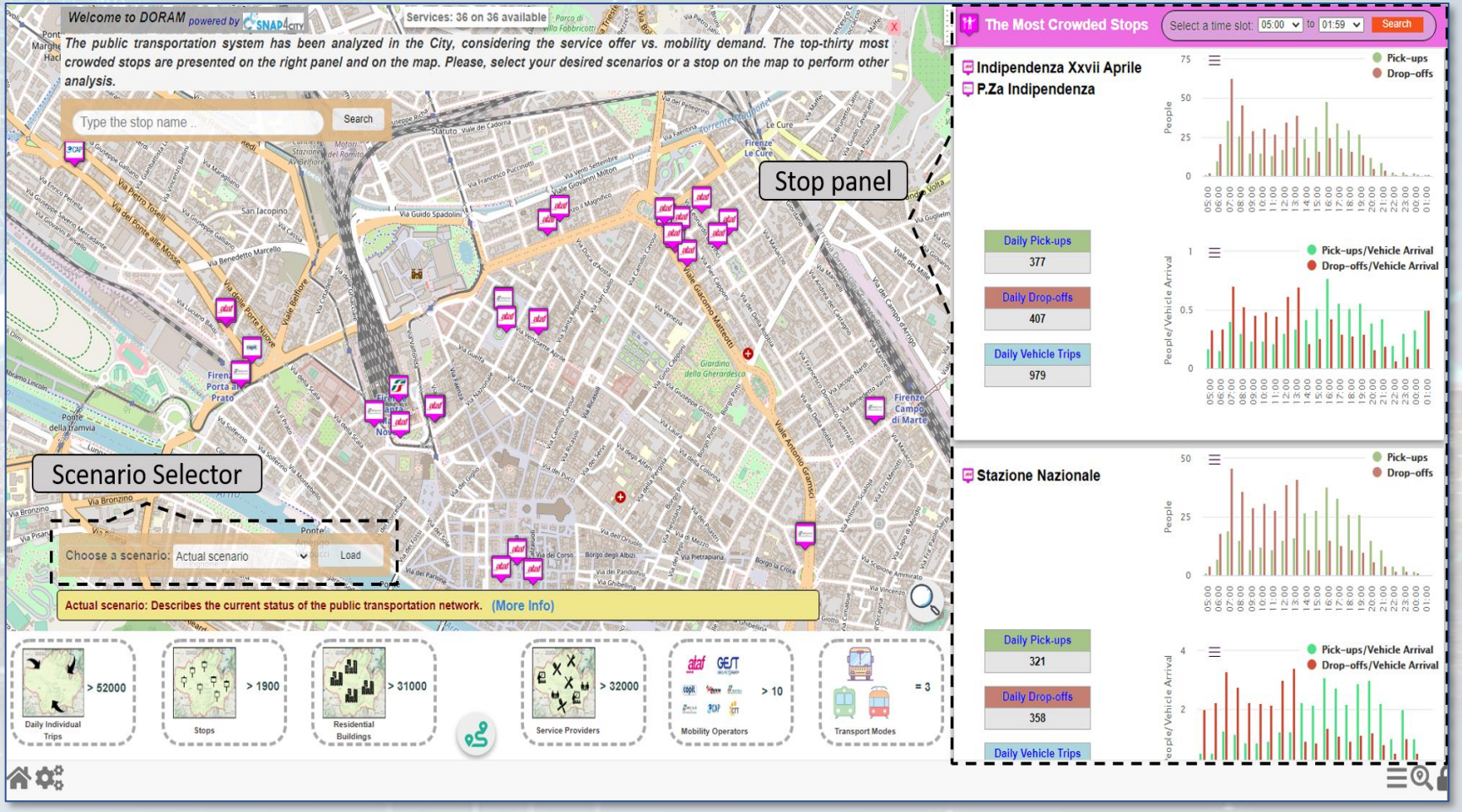
MOST
CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

What-if Analysis on Pub Transport

- Simulation / analysis of Mobility Demand wrt Transportation Offer
- Definition of scenarious impact on
  - Traffic, Pollutant, parking, public transport, private flows, etc.
  - KPI analysis

Public Services





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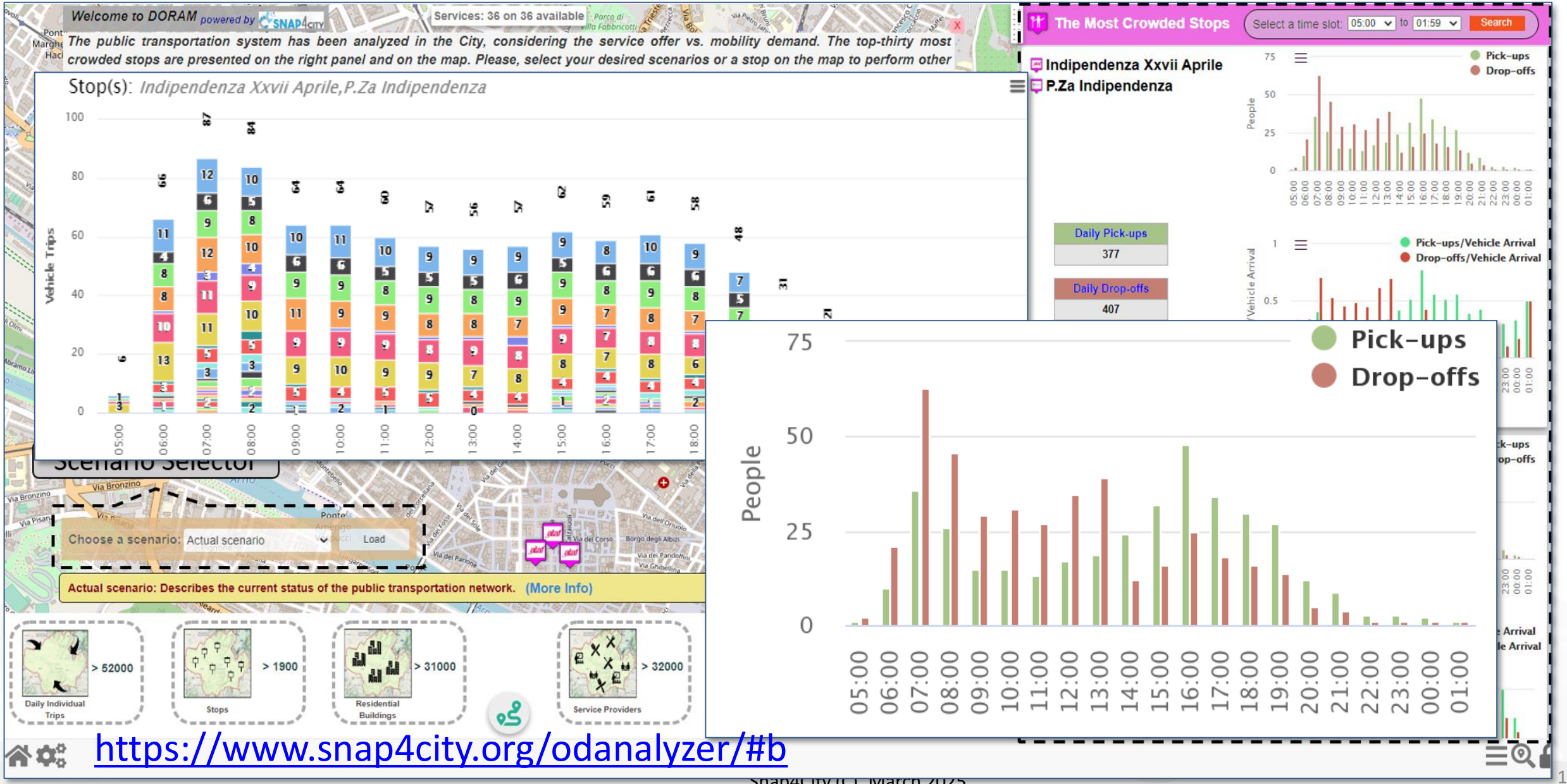
DORAM

SNAP4CITY | KM 4 CITY



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

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Traffic Light Plan Optimization

MOST
CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

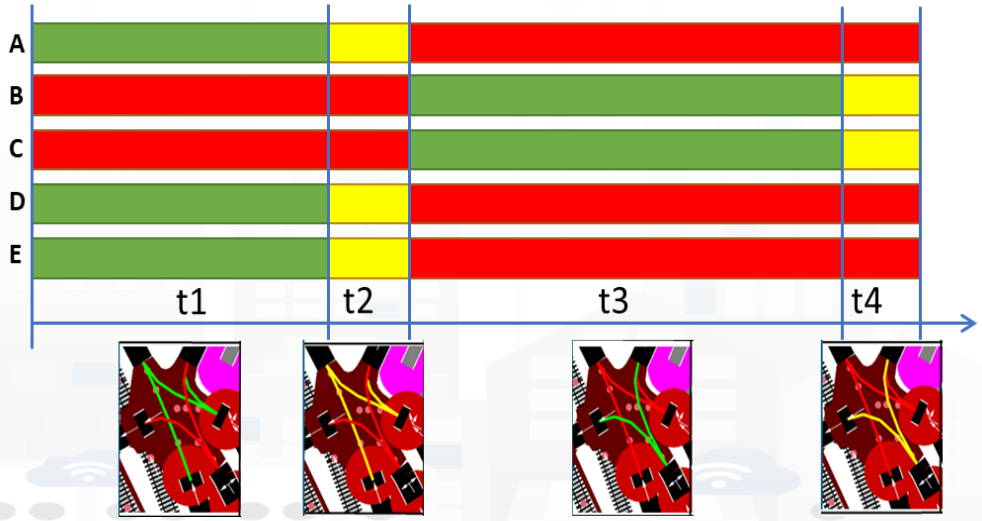
11 SUSTAINABLE CITIES AND COMMUNITIES

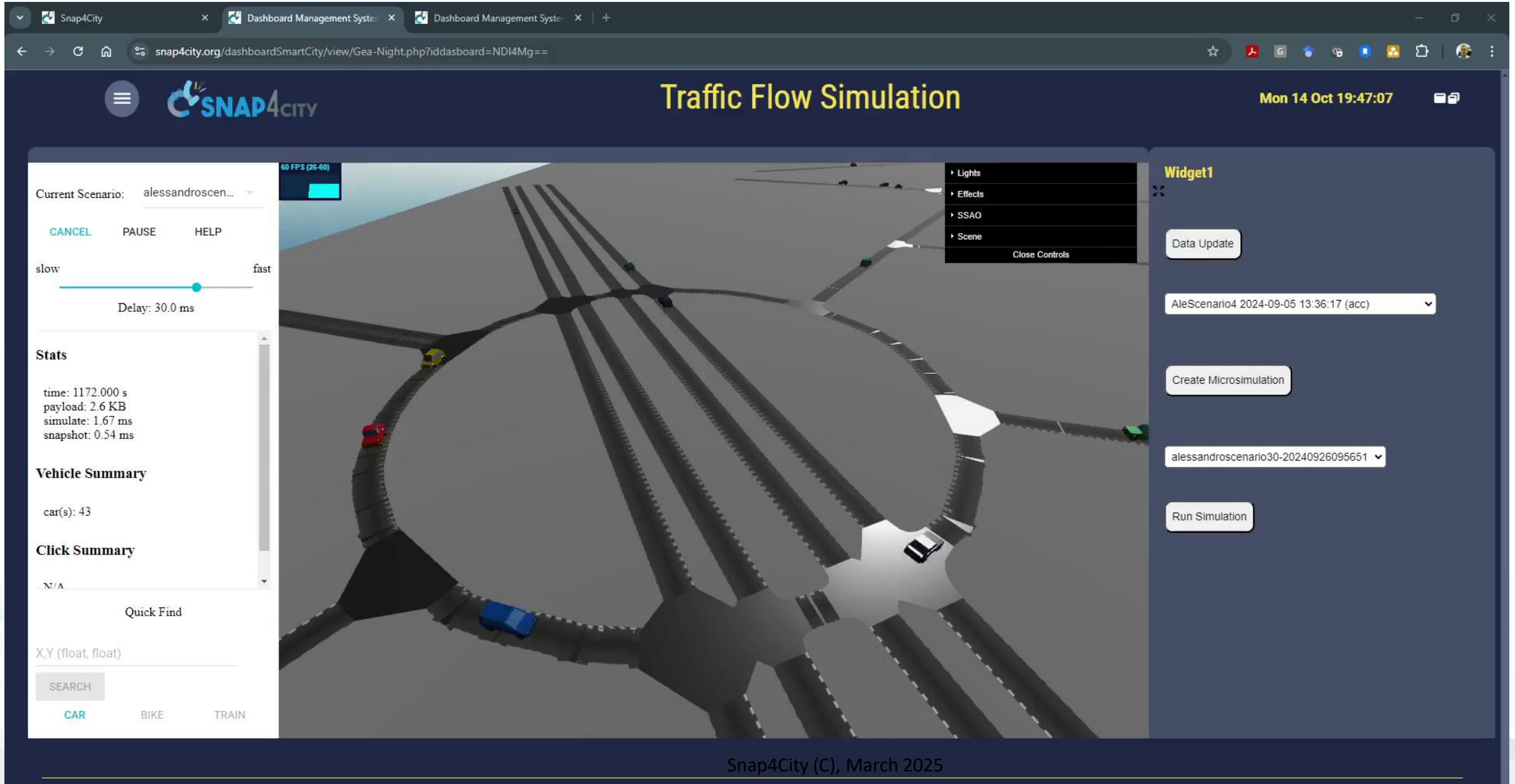
https://www.snap4city.org/1015

Traffic Light Plan Optimisation, Digital Twin

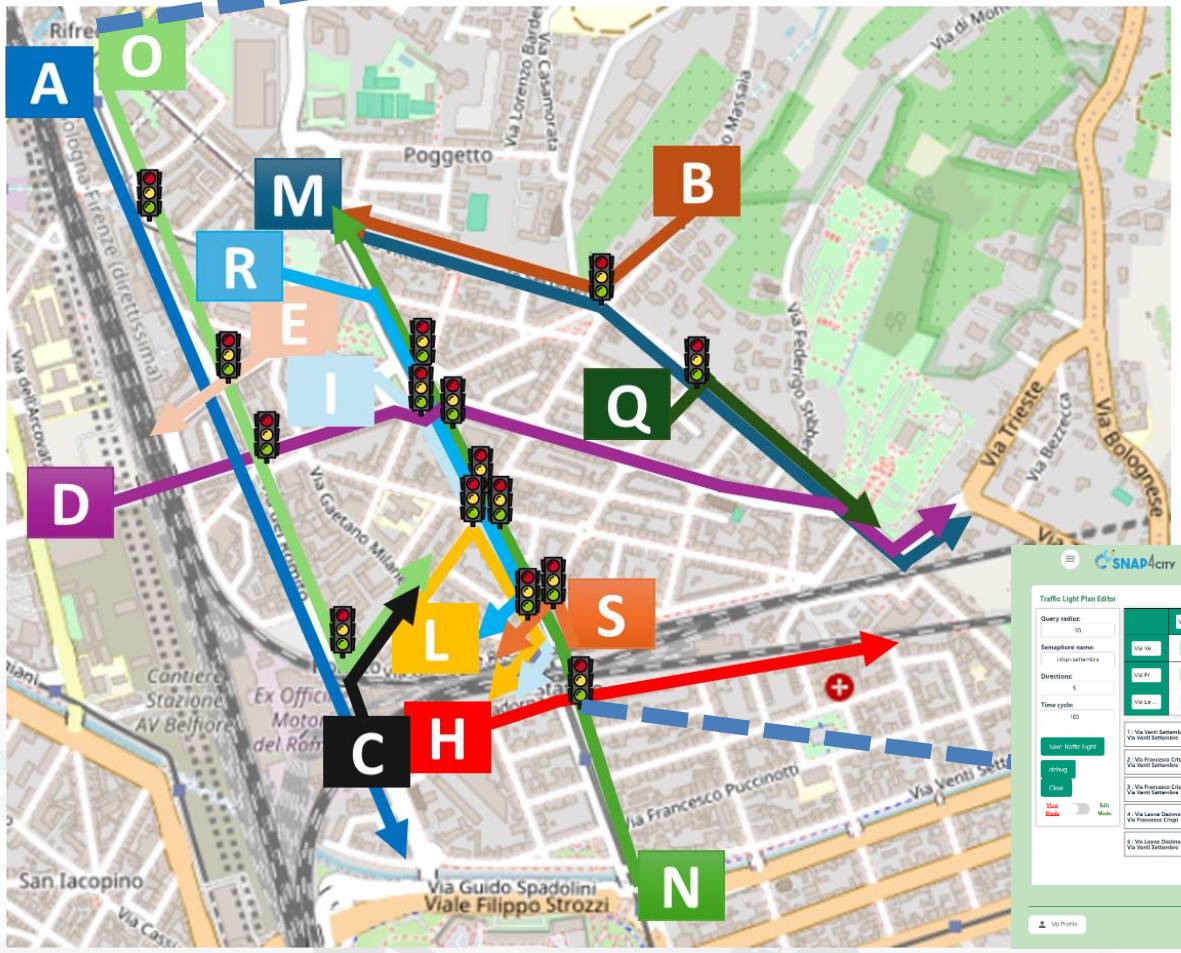
- **Match Multiple Objectives and Synchronization:**
  - public and private traffic, tramway priority
  - Micro and Macro Scales
  - **AI: Genetic Algorithms, Reinforced Learning**
    - Fixed and Actuated Cycles
    - Adjusted on Demand
- **Validation/integ.** with ***SUMO*** simulation
  - Travel Time, waiting time, waiting count
  - Specific travel time on directions
  - CO2 emissions, etc.
- **Reductions from 5% to 15%**

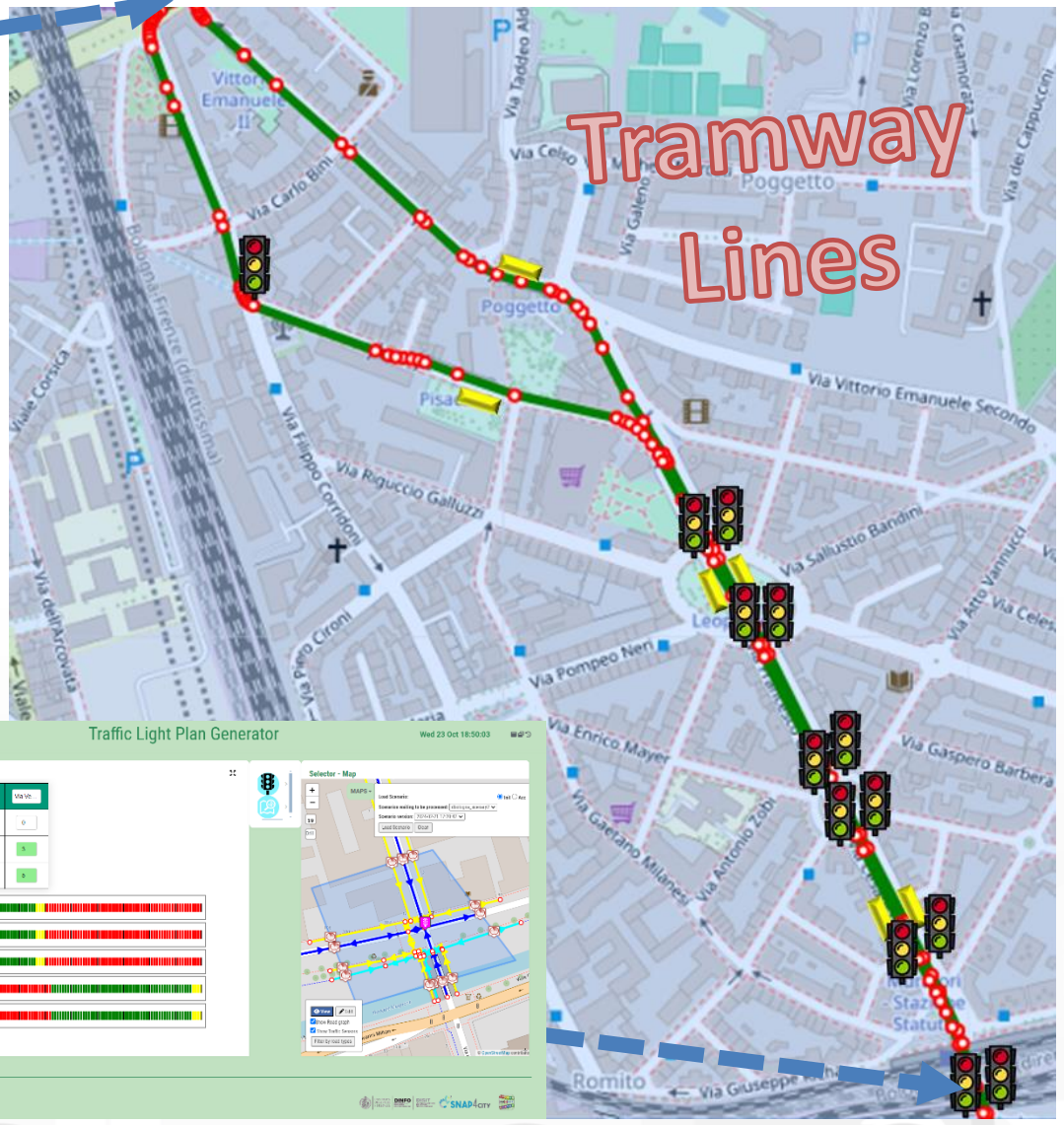
MOST CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

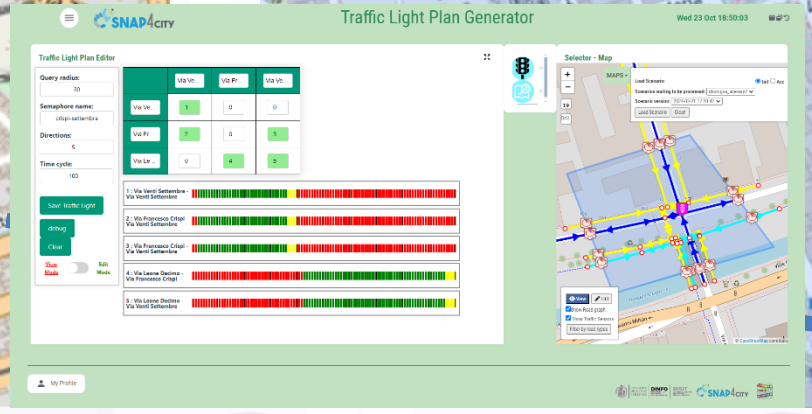



Snap4City
Dashboard Management Syste
Dashboard Management Syste
snap4city.org/dashboardSmartCity/view/Gea-Night.php?iddasboard=NDI4Mg==
SNAP4CITY
Traffic Flow Simulation
Mon 14 Oct 19:47:07
Current Scenario:
alessandroscen...
CANCEL
PAUSE
HELP
slow
fast
Delay: 30.0 ms
Stats
time: 1172.000 s
payload: 2.6 KB
simulate: 1.67 ms
snapshot: 0.54 ms
Vehicle Summary
car(s): 43
Click Summary
N/A
Quick Find
X,Y (float, float)
SEARCH
CAR
BIKE
TRAIN
60 FPS (26-60)
Lights
Effects
SSAO
Scene
Close Controls
Widget1
Data Update
AleScenario4 2024-09-05 13:36:17 (acc)
Create Microsimulation
alessandroscenario30-20240926095651
Run Simulation

Example, main paths





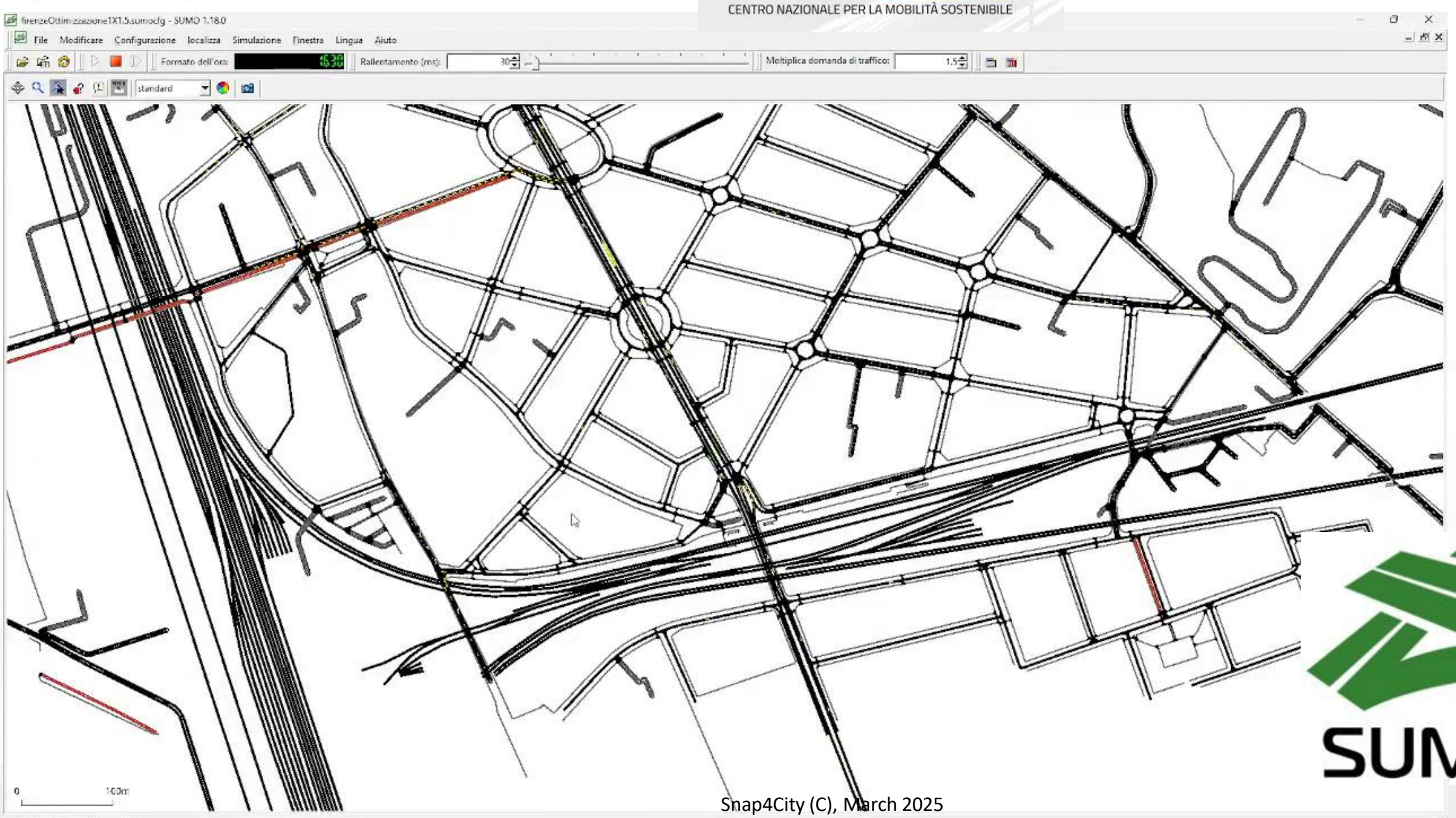


Mean Travel Time

	Traffic Load	MTTall	MTT dir_N	MTT dir_M	MTT dir_A	MTT TW Careggi	MTT TW Costanza
4TW-NTNS-MWD-P	1.5	3542.50	198.90	**242.14**	197.64	**436.00**	**427.00**
4TW-NTNS-MWD-A	1.5	**3242.71**	**178.33**	**243.28**	**195.79**	**436.00**	**427.00**
4TW-NTNS-MWD-P-A	1.5	**3242.71**	**178.33**	**243.28**	**195.79**	**436.00**	**427.00**
2TW-NTNS-MWD-P	1.5	4538.02	207.40	456.14	615.00	**436.00**	**427.00**
2TW-NTNS-MWD-A	1.5	3940.07	**179.30**	428.67	481.53	**436.00**	429.75
2TW-NTNS-MWD-P-A	1.5	4380.63	182.05	456.59	654.21	**436.00**	**427.00**
SUMO Actuated	1.5	3409.13	280.09	515.34	200.66	497.54	499.81
Webster	1.5	6474.95	465.45	441.93	210.50	1379.25	493.87
WebsterAdjusted	1.5	4035.08	195.82	441.09	205.66	463.87	447.06
		-5%	**-8%**	**-45%**	**-3%**	**-6%**	**-4.5%**

Reductions of Travel time of 3-45% and elimination of the #stops for the tramways

4TWD-NTNS-MWD-P-A: optimization by prioritizing traffic **directions,** the normalized number of **vehicles stops, *NTNS* , the mean waiting delay *MWD***, for all traffic lights, and post synchronization, with Penalty and Adjust dynamically performed


firenzeOttimizzazione1X1.5.sumocfg - SUMO 1.18.0
File Modificare Configurazione localizza Simulazione Finestra Lingua Aiuto
Formato dell'ora:
Rallentamento (ms):
30
Moltiplica domanda di traffico:
1.5
standard
0
100m

SUMO

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Traffic Infrastructure Optimization

MOST
CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

FROM CITY DASHBOARD TO APPLICATIONS

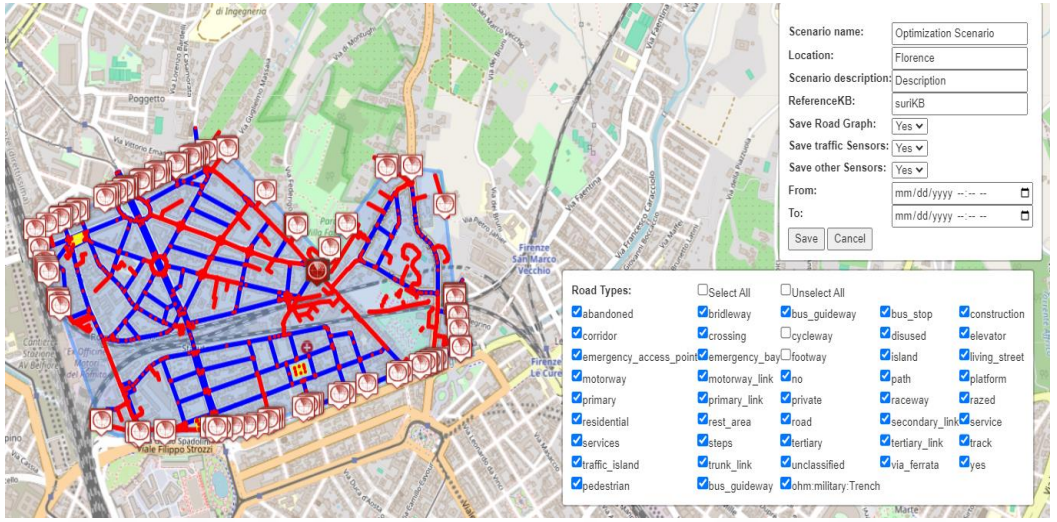
SNAP4CITY THE VIEW OF THE ADMINISTRATORS

11 SUSTAINABLE CITIES AND COMMUNITIES

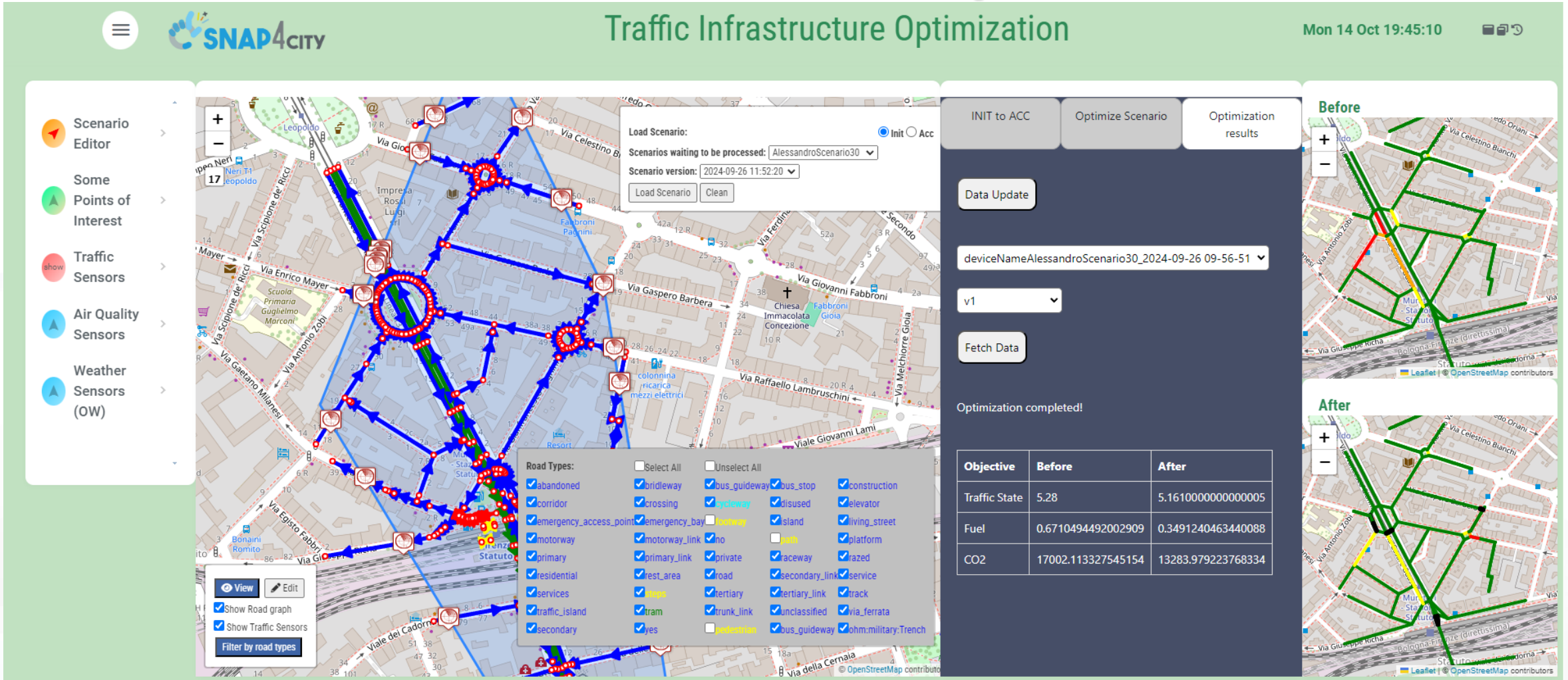
https://www.snap4city.org/1014

Traffic Infrastructure Optimisation, Digital Twin

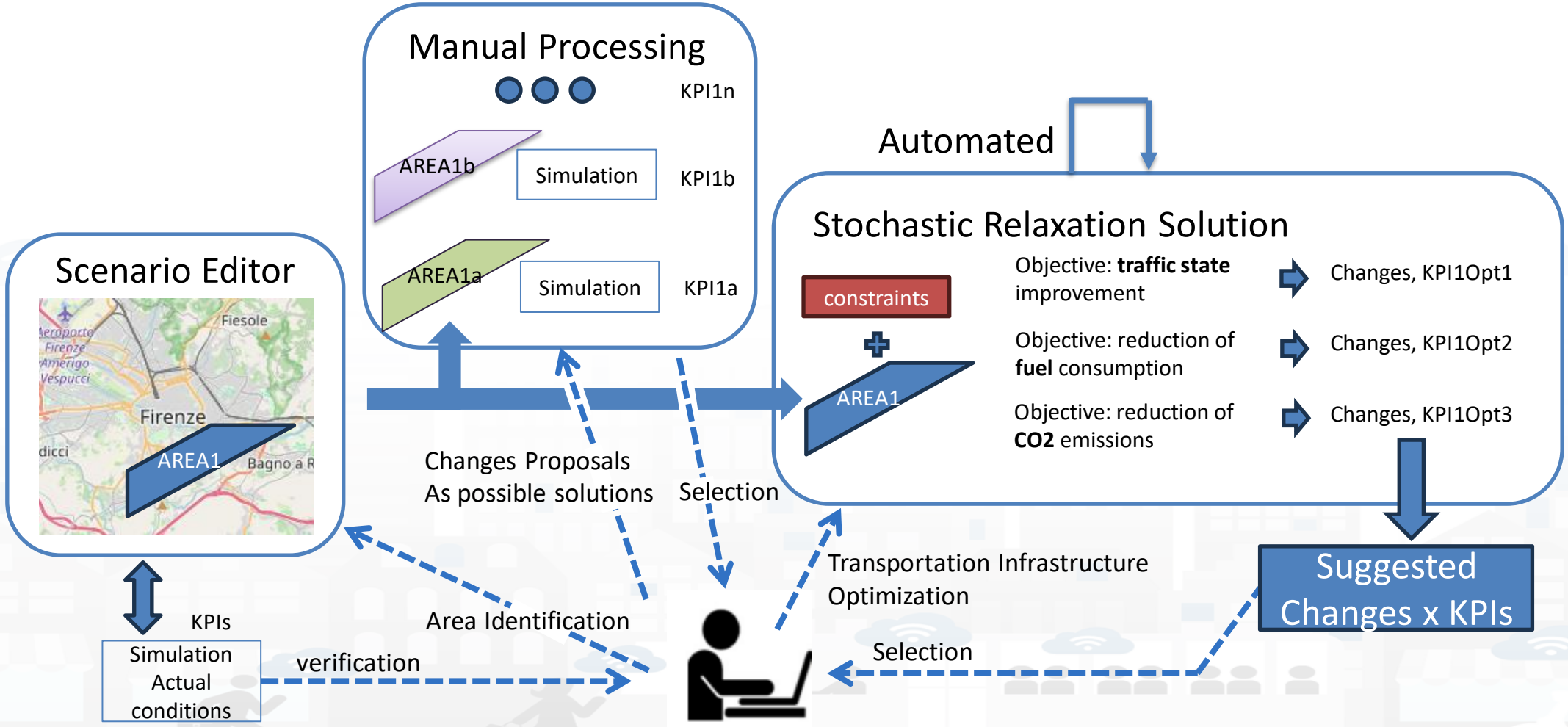
- **Identification of Scenario** (Scenario Editor), any changes
  - Definition of traffic loads by flows
- What-if or Automated Optimisation
- **Automated Optimisation:**
  - Stochastic Relaxation, Simulated Annealing, Traffic Flow Reconstruction
  - Multiple objectives targeting
    - Travel time, emissions, fuel consumption, traffic status
  - Limiting the number of changes



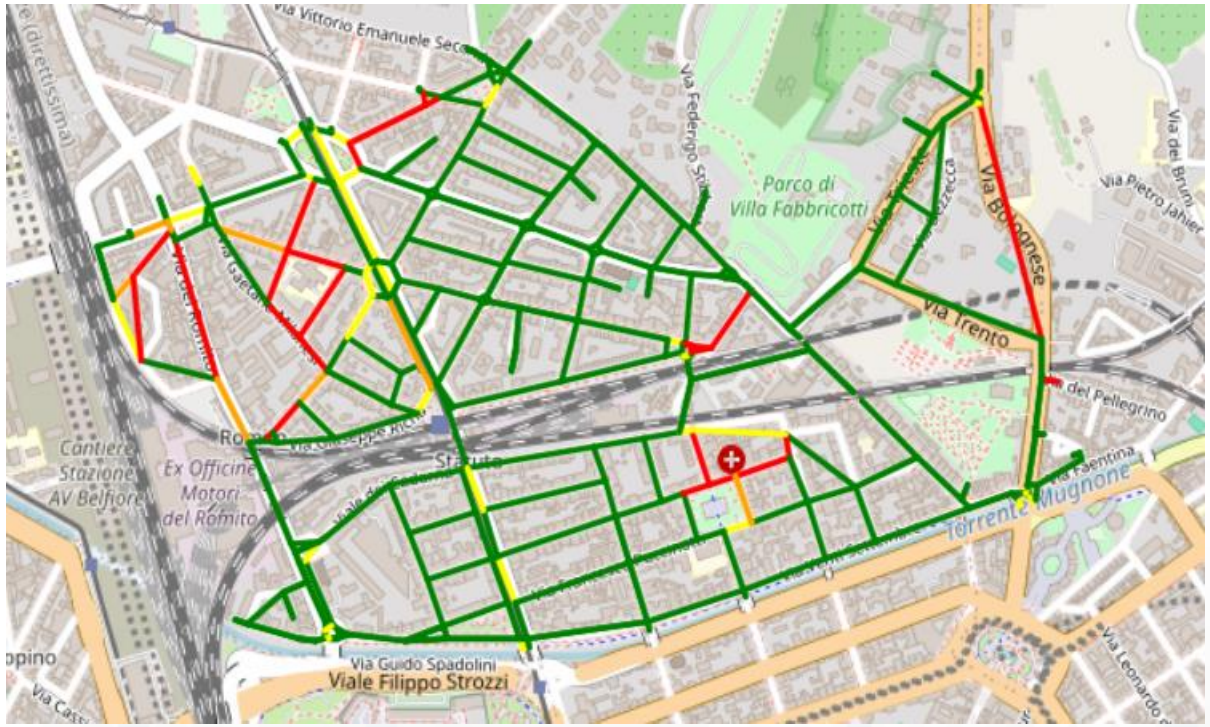
Traffic Infrastructure Optimization

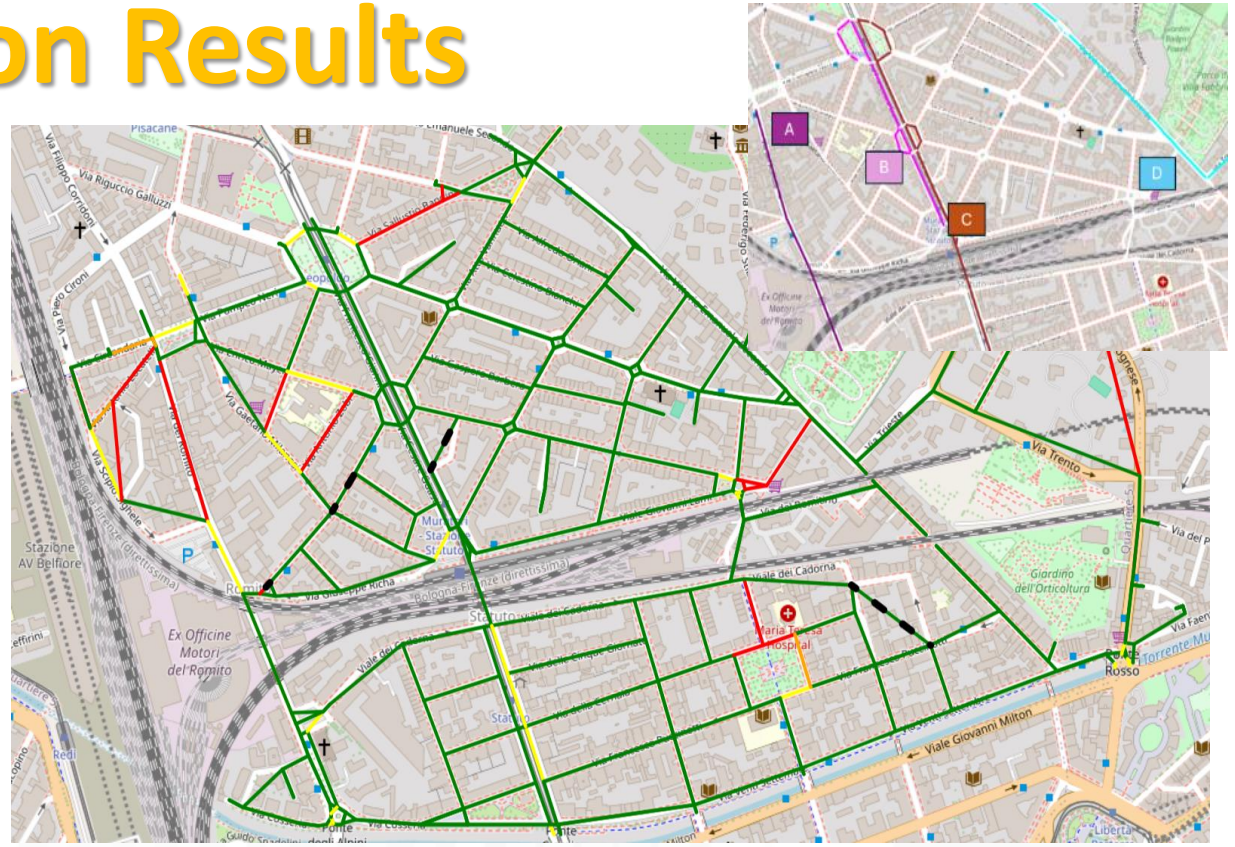


Traffic Infrastructure Optimisation



Optimization Results

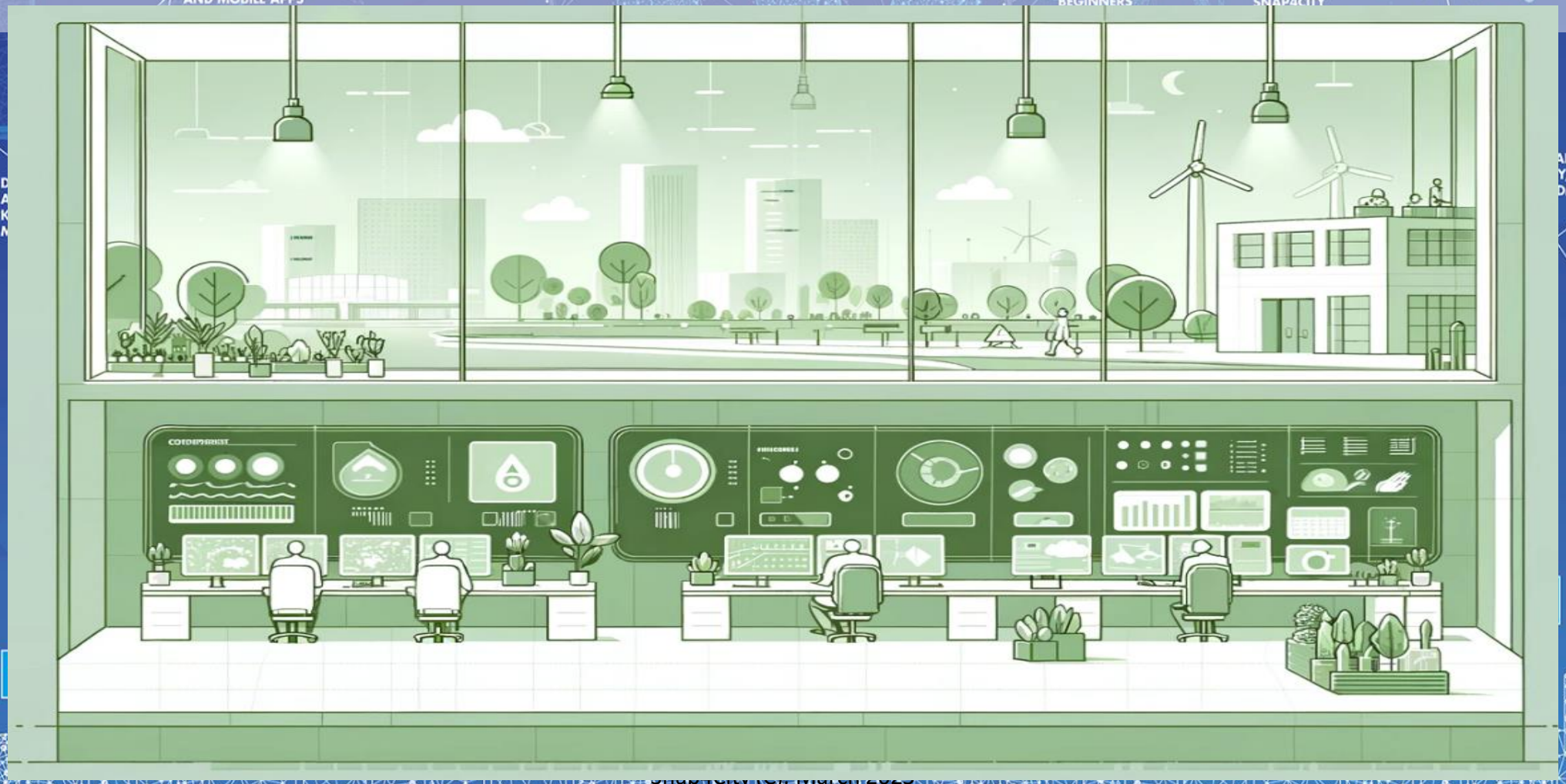




Case max 4 changes	*KPI estimation on the best solution*		
Optimization Target	***Traffic State***	***Fuel***	***CO2***
Optim 4 Traffic State	**91.341** -21%	17.964	128536
Optim 5 Fuel	91.514	**16.633** -35%	128227
Optim 6 CO2	92.859	19.192	**127876** -23%
Original	115.475	25.680	165822

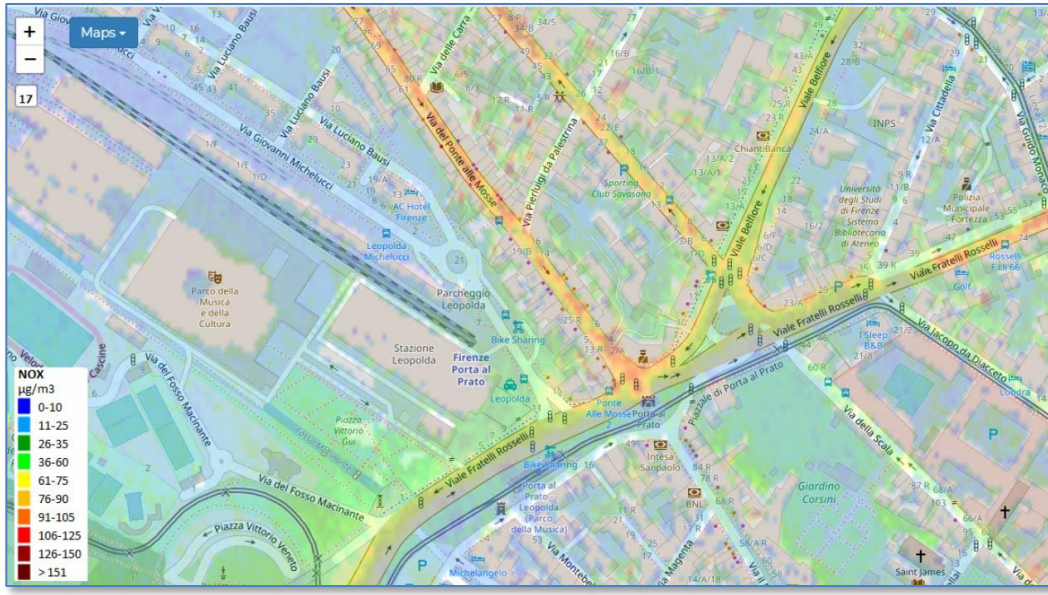
Travel Time [s]	*Path A*	*Path B*	*Path C*	*Path D*	*Total Time*
Original Scenario	183.2	59.6	80.9	132.5	456.4
Optim 4 Traffic State	93.2	60.0	63.7	**96.0**	313.1
Optim 5 Fuel	89.6	**51.2**	59.7	96.4	**296.9**
Optim 6 CO2	**89.5**	53.2	**58.4**	100.1	301.3
	-51%	-14%	-28%	-28%	

Environmental Predictions/Optimization



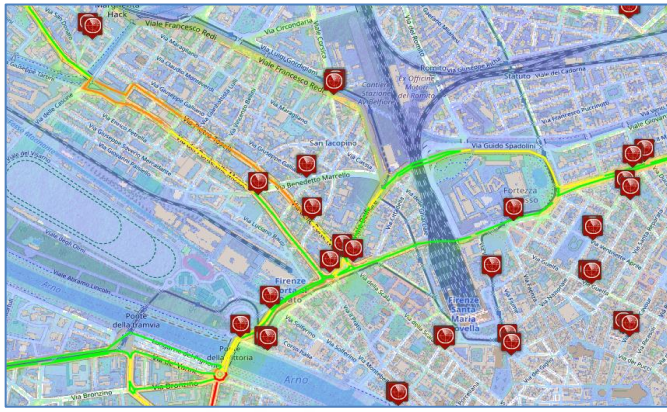
Environment and Waste

- **Goals:**
  - Reduction of emissions and EC taxations
  - Cost reduction for waste collection,
  - reduction of waste collection impact on mobility
- **Environment Management producing prescriptions:**
  - Monitoring and long and short-term predictions, warning for:
    - GHG, emissions, pollutants, aerosol, chemical plants analysis
    - land slide, coastal erosion (blue economy)
  - Traffic Flow impact emissions, predictions
  - What-if analysis, optimisation tools
- **Waste Management and Optimisation:**
  - costs reduction, optimal routing production, pay as you throw,
  - avoiding out of bins, predictions of waste production on bins, alarms
- **KPI:** SDG, 15MinCityIndex, QOS, costs, Km, colleting time, EC KPI, emissions
- **Mobile App**: final users services/informing and operators
  - Info Waste for operators, participation, optimal routing, RAEE Collection, ..
- **Participatory**: problem reporting, ticketing, etc.
- **Integration of any kind: env/weather, mobility, ticketing, presences, POI, ..**



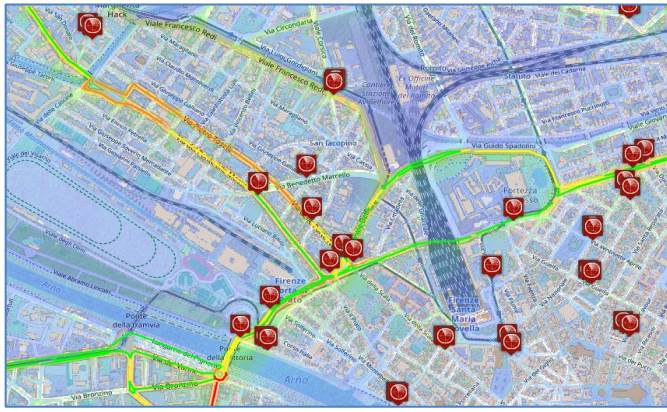
Environment, waste, land, etc., domain (2024/8)

- Goals:
  - Reduction of emissions and EC taxations
  - Cost Reduction for waste collection, reduction of waste collection impact on mobility
- Solutions for Operation (monitoring, managing, mobile apps, digital signages, control rooms)
  - Monitoring emissions, weather, waste, water, etc.: sensors, traffic, flows, ….
  - Early detection/warning of critical conditions on *emissions, weather, waste, water, fire, animals, …*
  - Early detection/warning of critical conditions for *landslides, water flooding, beach*
  - Smart Waste Management: bins/lockers, waste collection daily plan, pay as you throw, PAYT, etc.
  - Short terms prediction of emissions: CO2, NO2, etc.
  - Production of suggestions, nudging
  - Computing and predicting of long terms KPI indicators of the European Commission
- Solutions for Planning (optimization and what-if analysis)
  - Identification of main CO2/NO2 emissions locations in the city, total production from traffic
  - Reduction of Pollutant Emissions, via optimization: semaphore cycles, viability
- Algorithms and computational solutions, see next slide



Tools: Environment, waste, land, (2024/8)

- **Pollutant Predictions: short, long and very long term** European Commission KPIs
  - NOX, PM10, PM2.5 pollution on the basis of traffic flow, 48 hours (ML, AI, DL)
  - Cumulated NO2 average over 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)
- prediction of **waste collection, & o**ptimisation of schedule and paths (DP, ML)
- **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)
- Computing **SDG, SUMI, SUMP,** .. (mainly DP)
- Etc.

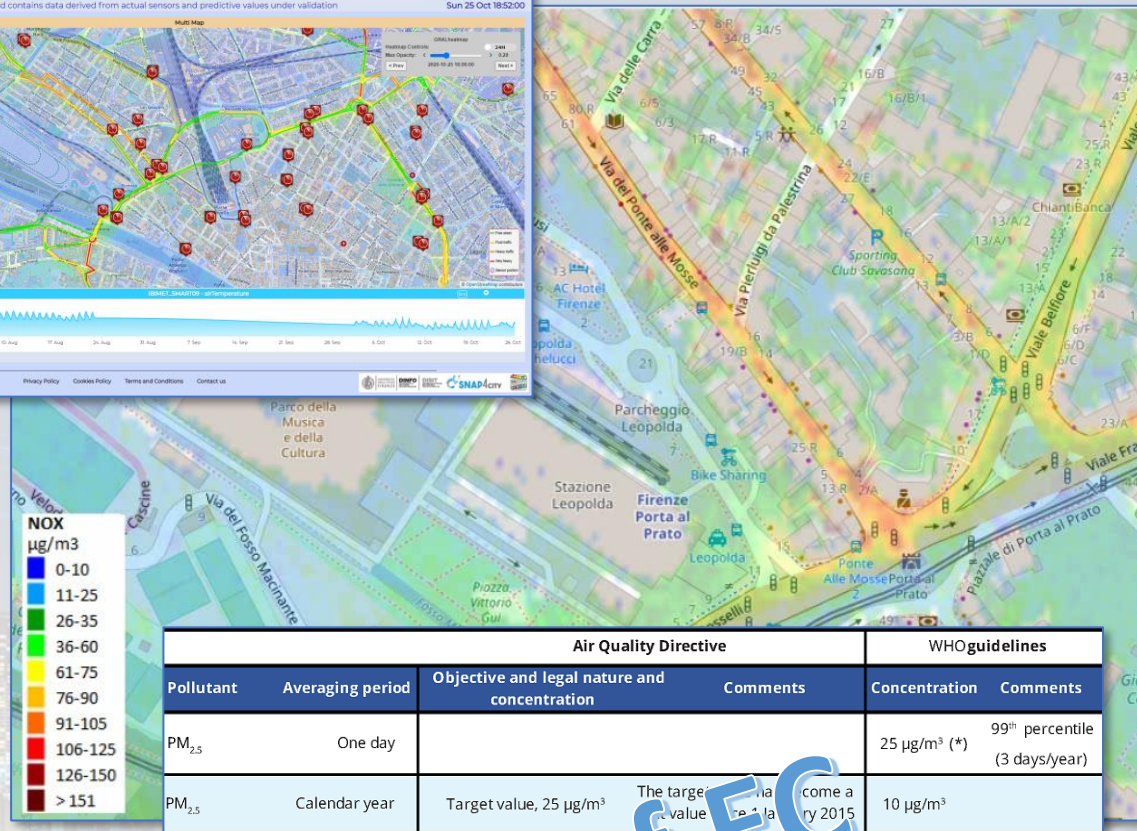


Environment and Quality of Life
Air Quality Predictions

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**

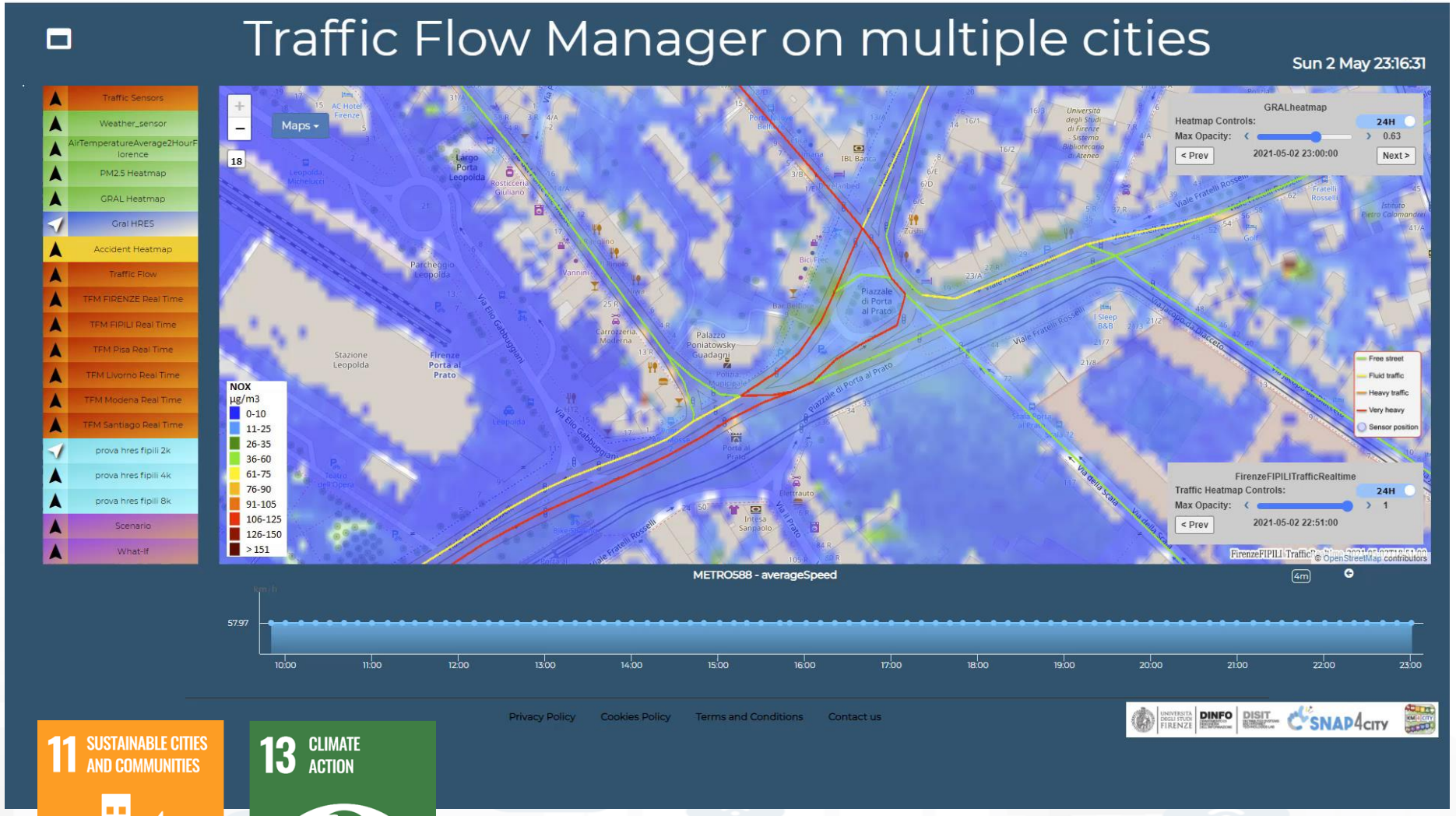


	Air Quality Directive			WHO guidelines	
Pollutant	Averaging period	Objective and legal nature and concentration	Comments	Concentration	Comments
$PM_{2.5}$	One day			25 µg/m³ (*)	99th percentile (3 days/year)
$PM_{2.5}$	Calendar year	Target value, 25 µg/m³	The target … come a … value … 1 Ja… ry 2015	10 µg/m³	
PM_{10}	One day	Limit … e, 50 µ…	… to be e…ed … on more than 35 d… per year.	50 µg/m³ (*)	99th percentile (3 days/year)
PM_{10}	Calend…	… va… 40 µg/m… (*)		20 µg/m³	
O_3	Maximum … ly 8-hour m…n	Target value, 120 µg/m³	Not to be exceeded on more than 25 days per year, averaged over three years	100 µg/m³	
NO_2	One hour	Limit value, 200 µg/m³ (*)	Not to be exceeded more than 18 times a calendar year	200 µg/m³ (*)	
NO_2	Calendar year	Limit value, 40 µg/m³		40 µg/m³	

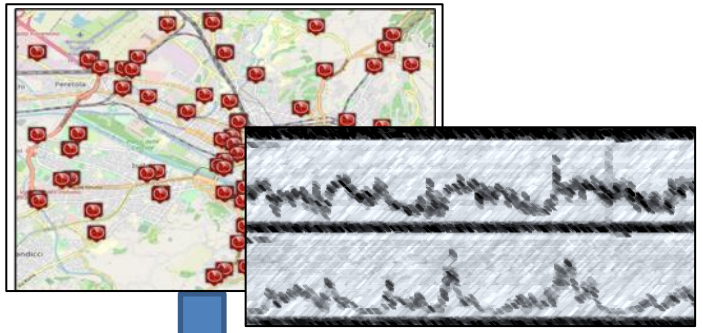
KPI of EC

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



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

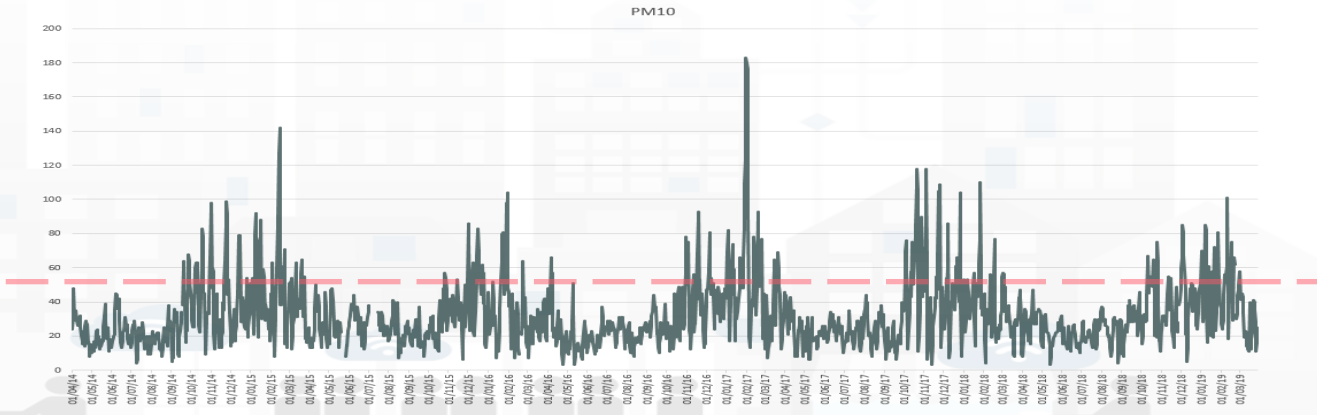
CO2 estimation

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

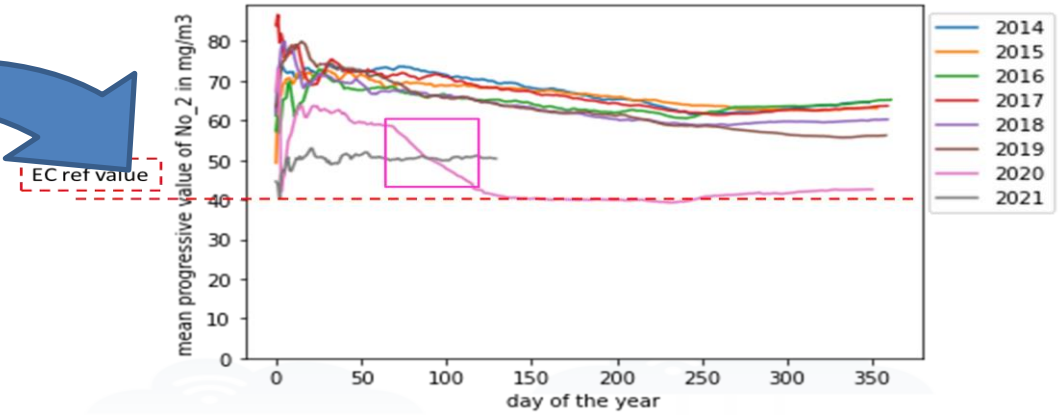
- European Air Quality Directive
- Predicting critical days
  - PM10 with an accuracy of more than 90% and precision of 85%;
  - PM2.5 with an accuracy of 90% and precision greater than the 95%.
- Simulating Long terms values
  - For long terms predictions

		Air Quality Directive		WHO guidelines	
Pollutant	**Averaging period**	**Objective and legal nature and concentration**	**Comments**	**Concentration**	**Comments**
$PM_{2.5}$	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	

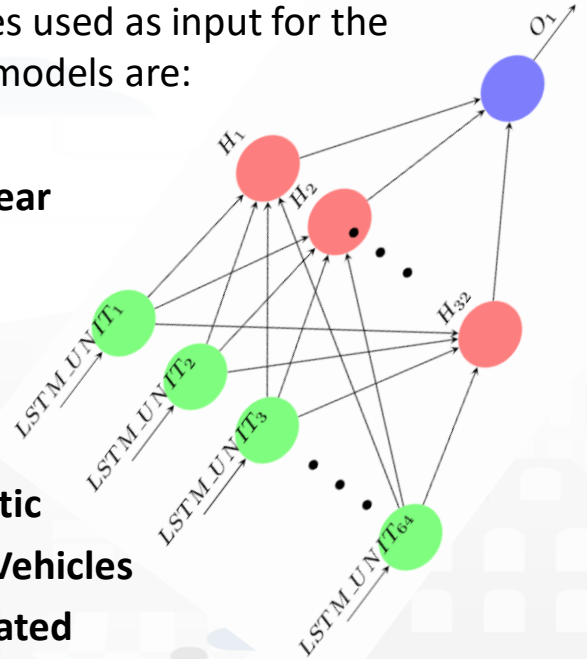


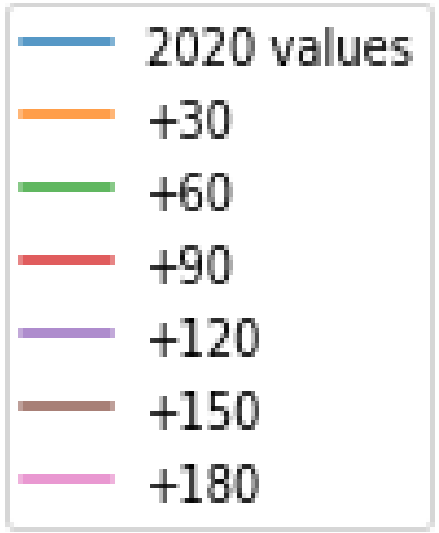
Predicting EC's KPI on NO2 months in advance

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**



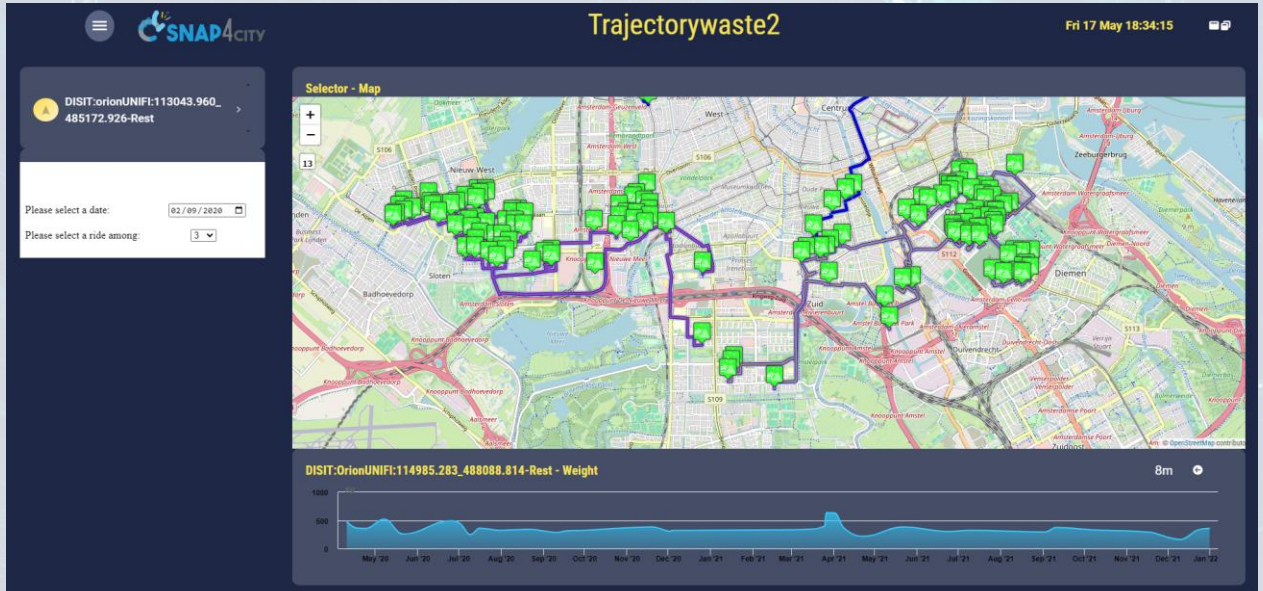


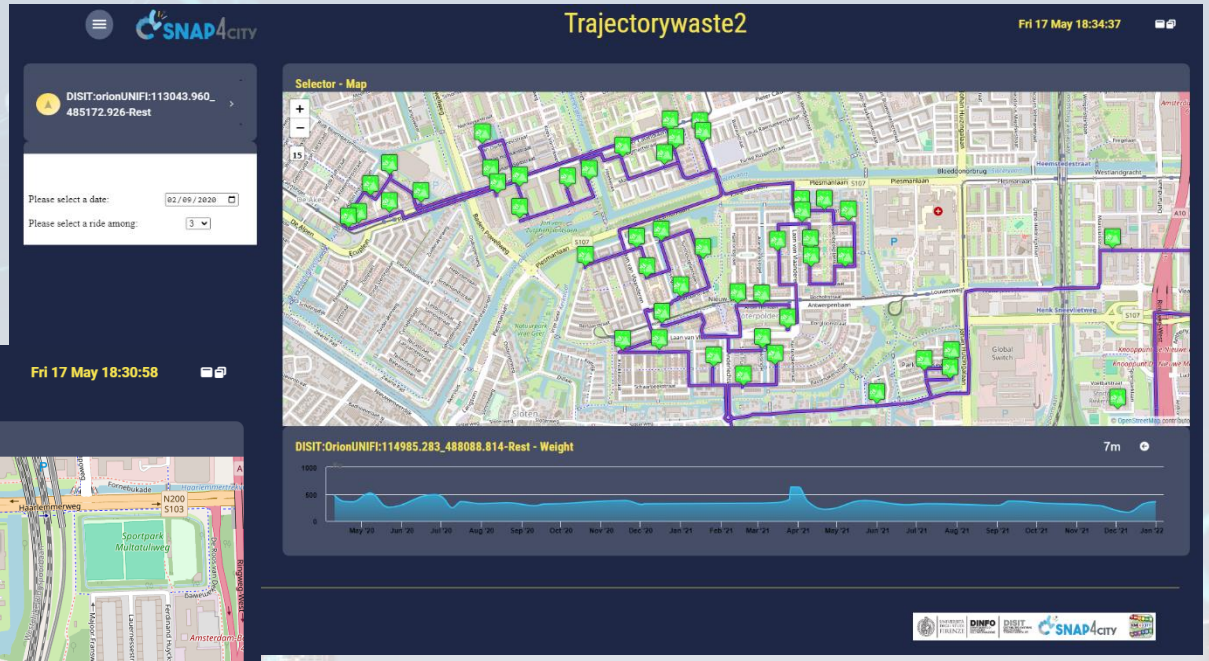
	Air Quality Directive			WHO guidelines	
Pollutant	Averaging period	Objective and legal nature and concentration	Comments	Concentration	Comments
$PM_{2.5}$	One day			25 µg/m³ (*)	99th percentile (3 days/year)
$PM_{2.5}$	Calendar year	Target value, 25 µg/m³	The target value has become a limit value since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

Waste Manager:

- **Collects and monitors data** from bins (status, temperature, and a number of alarms, etc.) and trucks (weights collected, when possible) according to differentiated waste collection;
  - Interoperable with different waste bin sensors and lockers.
  - Monitor waste bin status including alarms of critical conditions notified from the citizens, and/or detected by sensors such as: fire, up-side-down, hurts, too filled, run out of battery, errors, etc. (some of these events can be enabled on the basis of the sensors positioned to the bin)
- **supports of policies** as Pay As You Throw, PAYT, provided that the bins are controlled with fobs, NFC, rfid, etc.
- **promoting citizen engagement/participation**, to help cities optimize their waste management practices and move towards a more sustainable future. The engagement is especially addressed to the city commercial operators which have special need in providing a large amount of waste (such as restaurants, fast food, bars, and shopping centers). https://www.snap4city.org/1018
- **Reduce costs:** optimize waste collection and management in urban environments
  - identify the bins that risk to become full in advance (using predictive technologies based on AI, Deep Learning).
  - Computer the optimal path for waste collection provided to map on mobiles, reduction of costs for waste collection.
  - dashboards provides statistics and forecast.
- **Custom user interface** and theme can be defined for each municipality as usual on Snap4City.


SNAP4CITY
Trajectorywaste2
Fri 17 May 18:34:15
DISIT:orionUNIFI:113043.960_485172.926-Rest
Please select a date:
02/09/2020
Please select a ride among:
3
Selector - Map
DISIT:OrionUNIFI:114985.283_488088.814-Rest - Weight
8m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Trajectorywaste2
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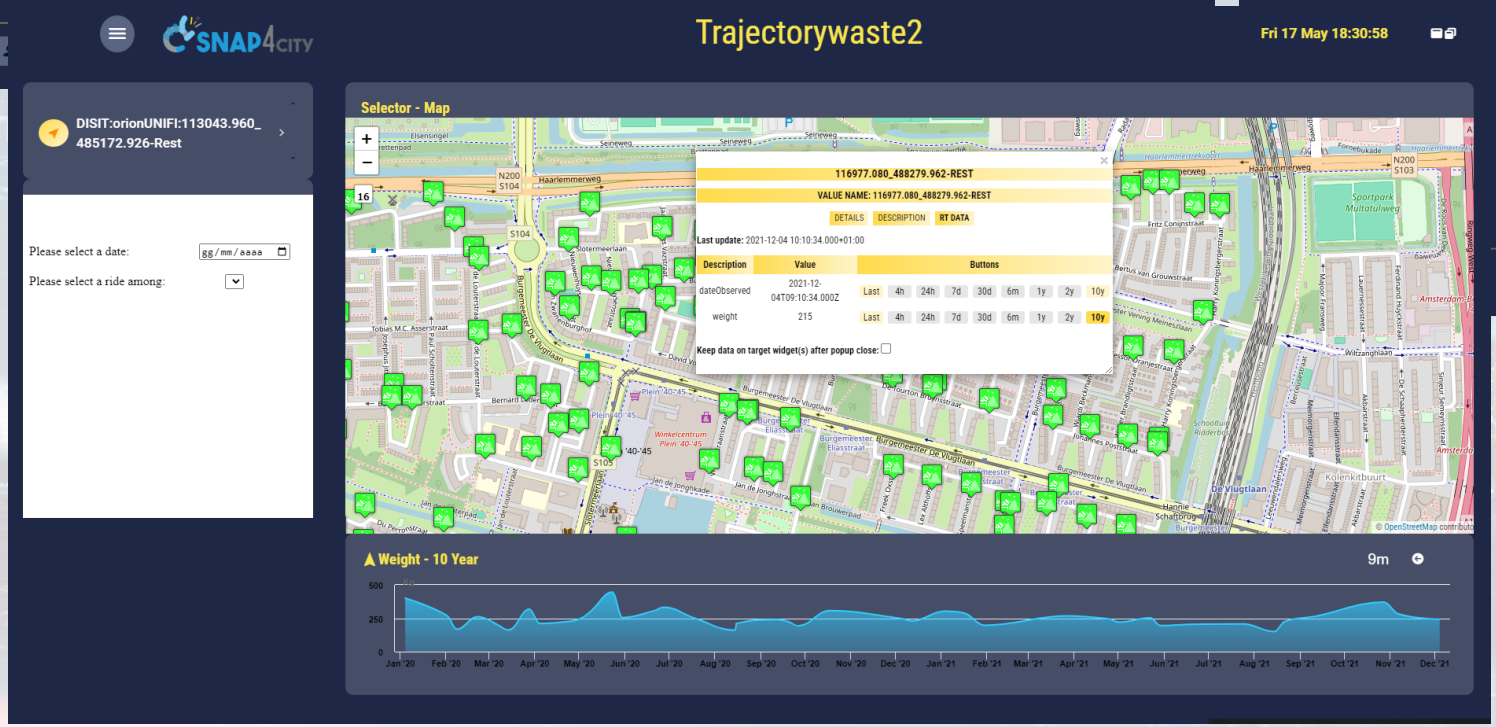
Please select a date:
02/09/2020
Please select a ride among:
3
Selector - Map
DISIT:OrionUNIFI:114985.283_488088.814-Rest - Weight
7m


SNAP4CITY
Trajectorywaste2
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gg/mm/aaaa
Please select a ride among:
Selector - Map
116977.080_488279.962-REST
VALUE NAME: 116977.080_488279.962-REST
DETAILS
DESCRIPTION
RT DATA
Last update: 2021-12-04 10:10:34.000+01:00
Description
Value
Buttons
dateObserved
2021-12-04T09:10:34.000Z
weight
215
Keep data on target widget(s) after popup close:
Weight - 10 Year
9m

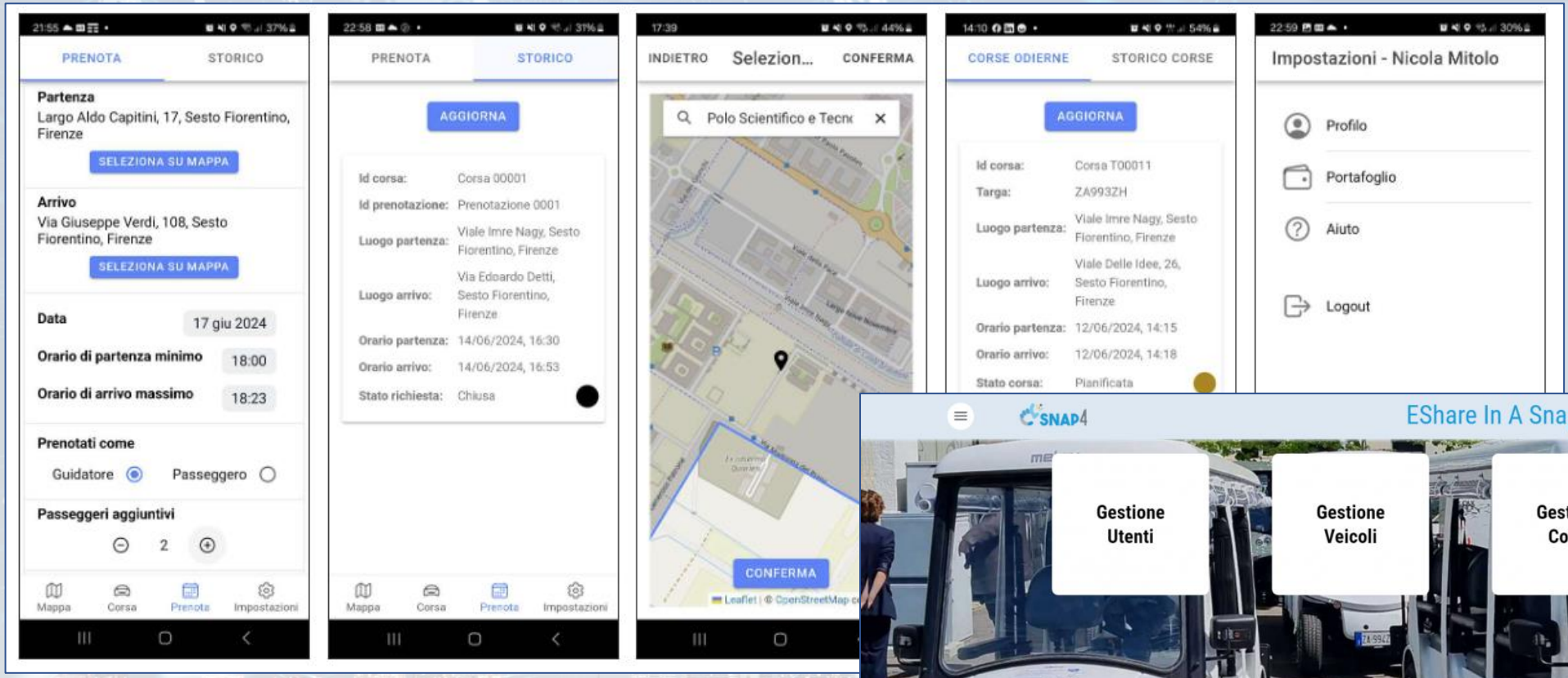

11
SUSTAINABLE CITIES AND COMMUNITIES

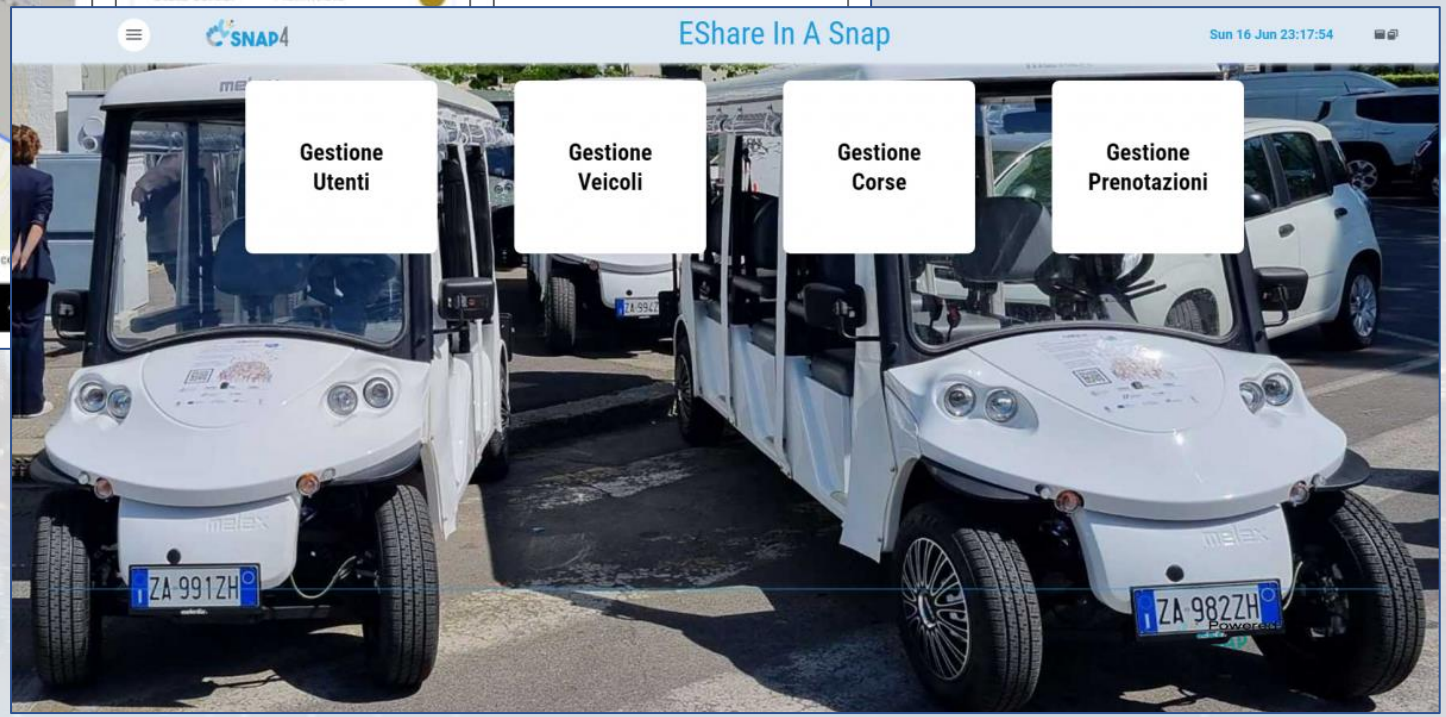
3
GOOD HEALTH AND WELL-BEING

Application: eSharing and Pooling

eShare in a Snap, by Snap4 s.r.l.

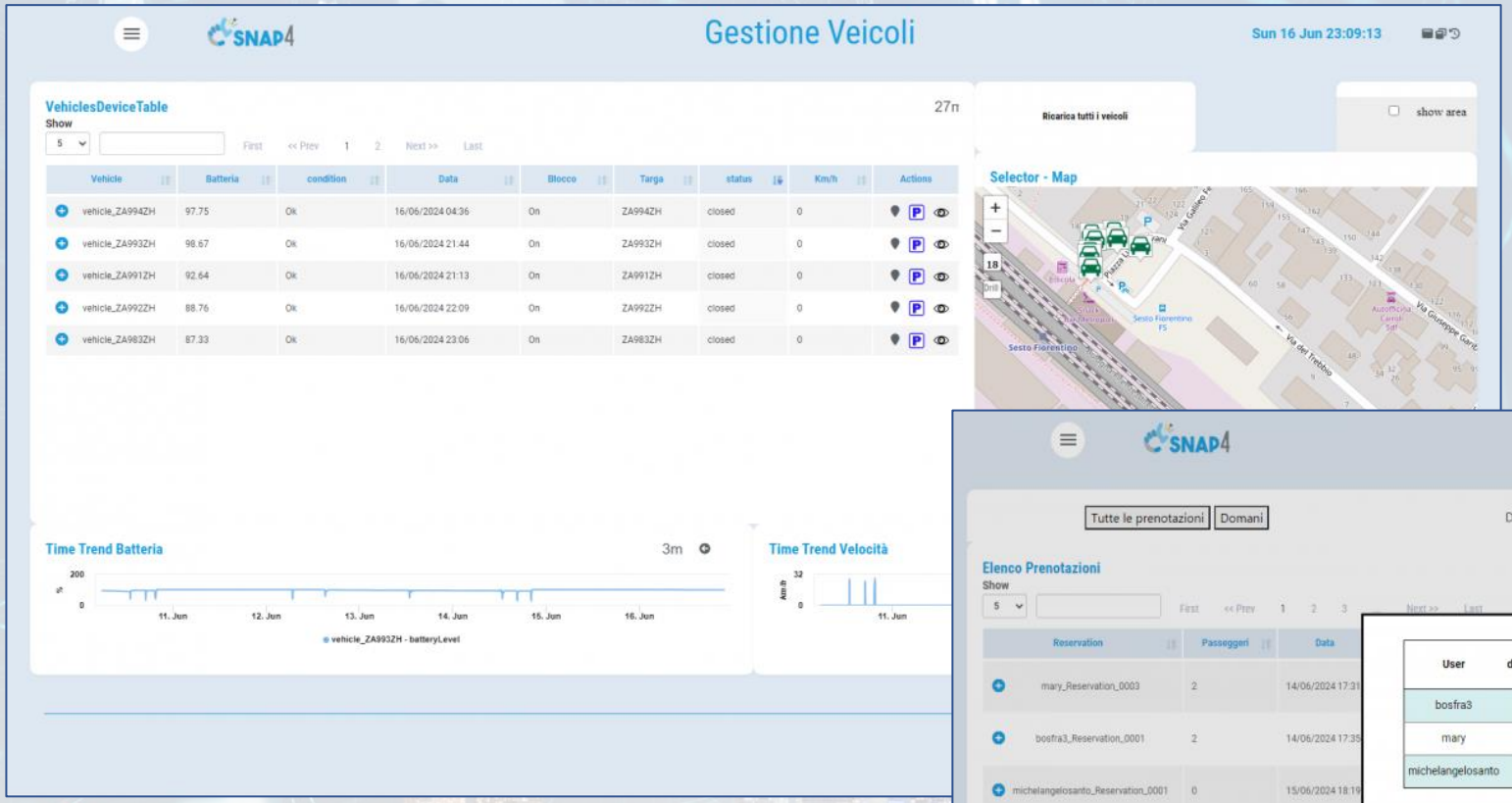
eShare in a Snap, by Snap4





Integrated car sharing and pooling
Multiple drivers on the same means
Dynamic pooling and e-sharing

eShare in a Snap, by Snap4



Integrated car sharing and pooling
Multiple drivers on the same means
Dynamic pooling and e-sharing

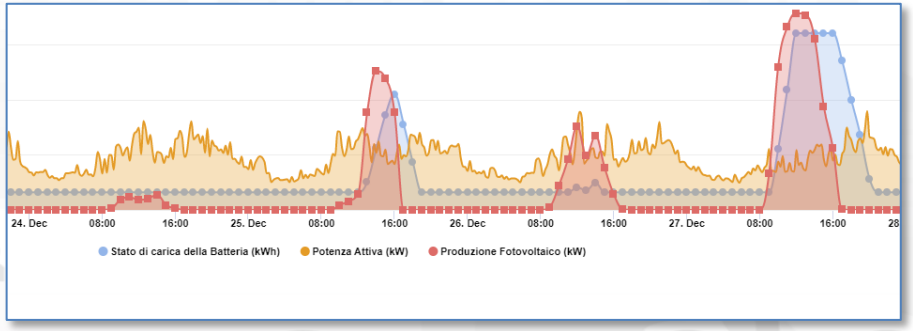
Smart Energy

FROM CITY DASHBOARD TO APPLICATIONS

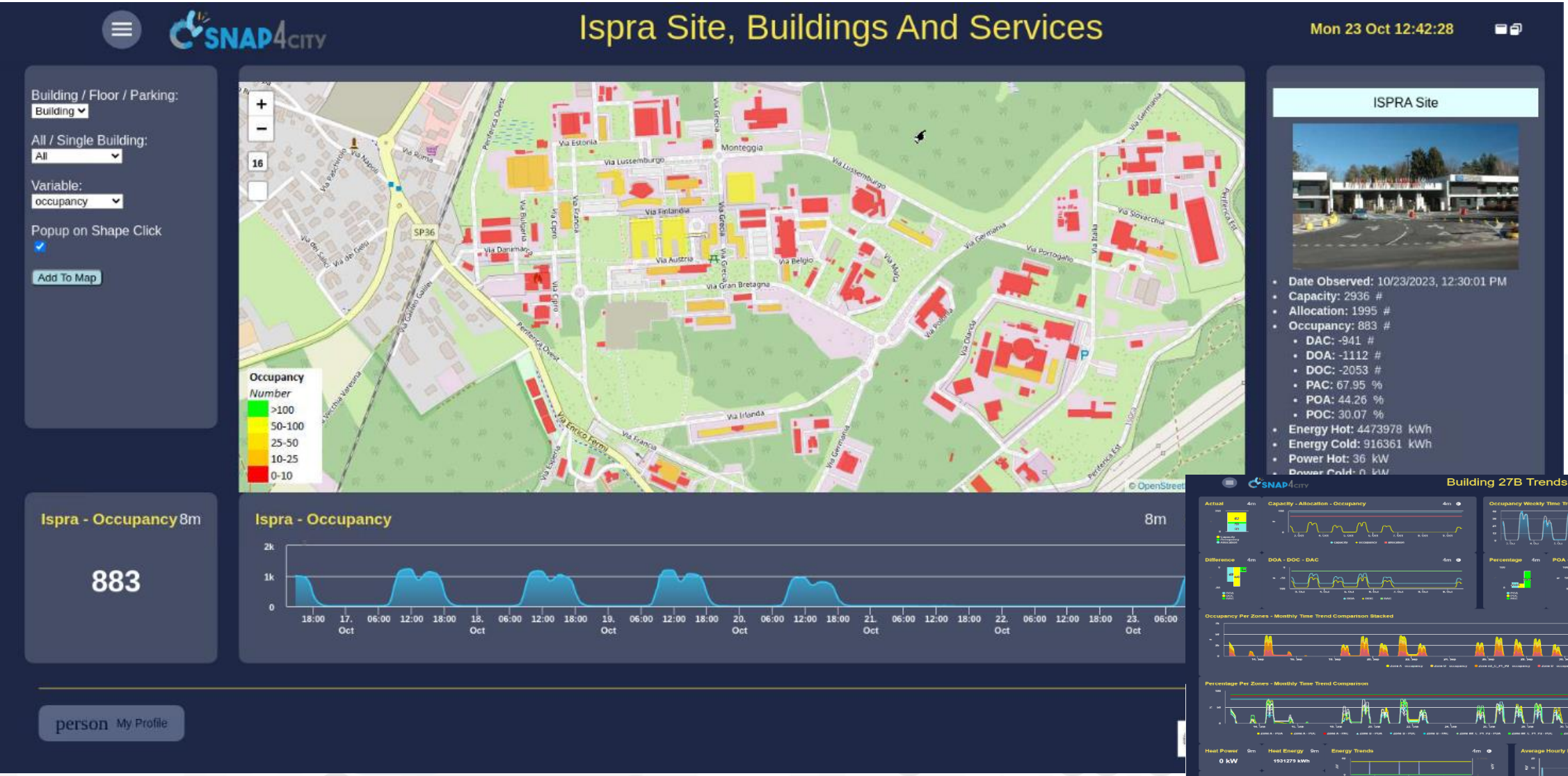
100% OPEN SOURCE

City Energy and Buildings

- **Goals:**
  - Energy consumption reduction, increment of efficiency,
  - Areas and building sustainability
  - Improve accessibility to services, security and safety
- **Energy Monitoring:** Building, floors, rooms, recharging poles, cabinets, Community of Energy, Data centers, Energy for Hot / cold, air condition, energy vs temperature and usage, etc.
- **Energy Management:** Predictions, early warning, identification of critical conditions
- **Smart Light Management**: LED/mixt, cabinets, lights vs traffic, lights vs security, energy saving, luminaries profiling, group management.
- **Smart Building Management:** consumption, number of people, etc.
  - Communities of Energy, Photovoltaic plants, sustainability
  - What-if analysis, optimisation tools
- **KPI: Energy consumption, efficiency, pros/cons**
  - Light profiling and adaptation
  - Autoclave industrial plants simulation, Photovoltaic plant simulation
  - consumption / usage, energy vs temperature
- **Mobile App:** monitoring, info-recharge, eSharing, booking, ..
- **Participatory**: problem reporting, ticketing, etc.
- **Integration of any kind**

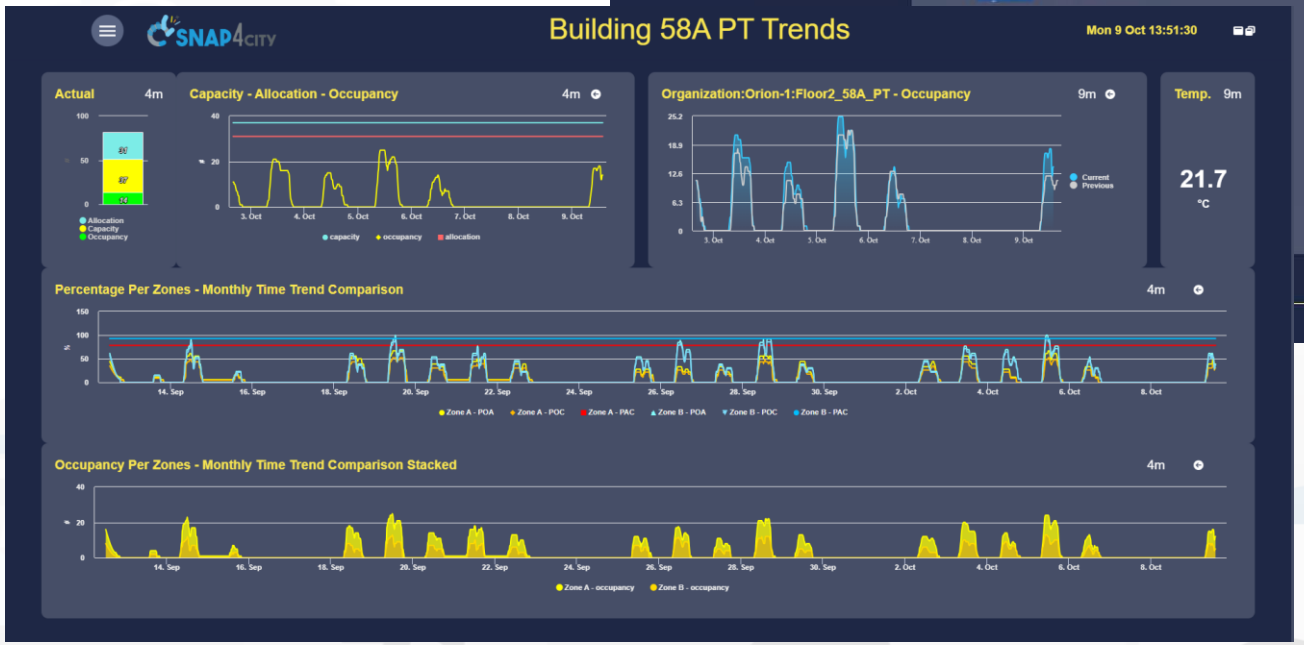


ISPRA JRC Site



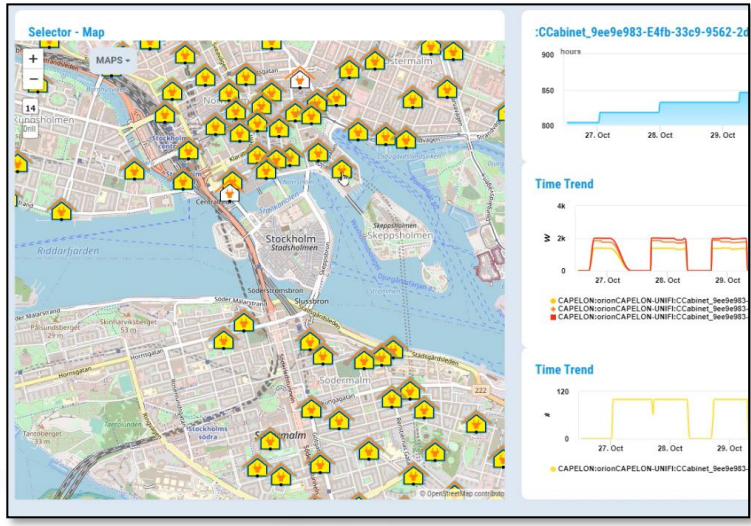
Floor Details

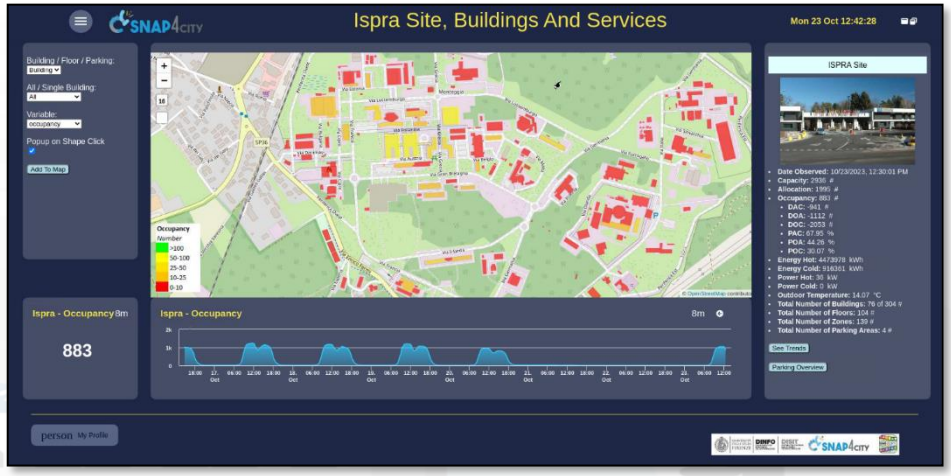
ISPRA JRC Site



Energy Domain (2024/8)

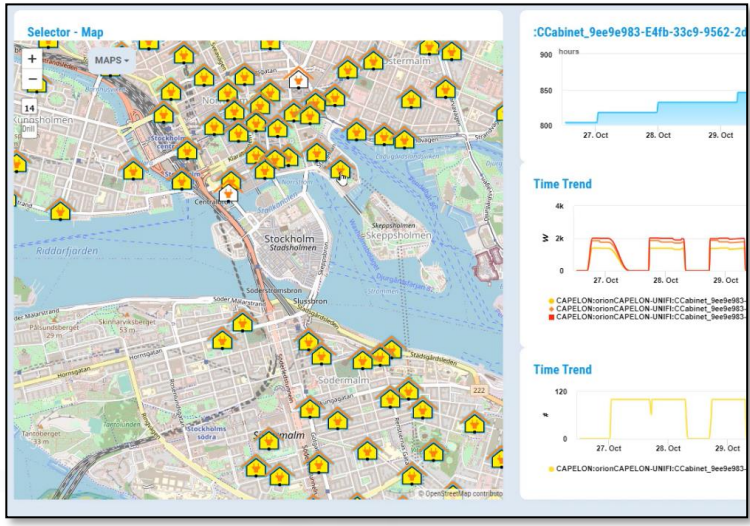
- Goals:
  - Energy consumption reduction, increment of efficiency, sustainability
  - accessibility to services
- Solutions for Operation (monitoring, managing, mobile apps, digital signages, control rooms)
  - Monitoring energy consumption (heating, cooling, prod.,..), conditions, charging stations, etc.
  - Managing Smart Light for city: dimering, programming, traffic control, controllers, legacy, etc.
  - Early detection/warning, alarm, of critical conditions
  - Managing smart services: cabinets, lockers, etc.
  - Production of suggestions, nudging
  - Global and local 3D/2D representations of area and buildings
  - Managing Communities of Energy, certification via Blockchain
  - Computing predictions of any kind
- Solutions for Planning (optimization and what-if analysis)
  - Reduction of energy costs, via optimization
  - Identification of roofs with better orientation
  - Optimization of battery storage size for PV plants
  - Community of Energy planning and viability
- Algorithms and computational solutions, see next slide

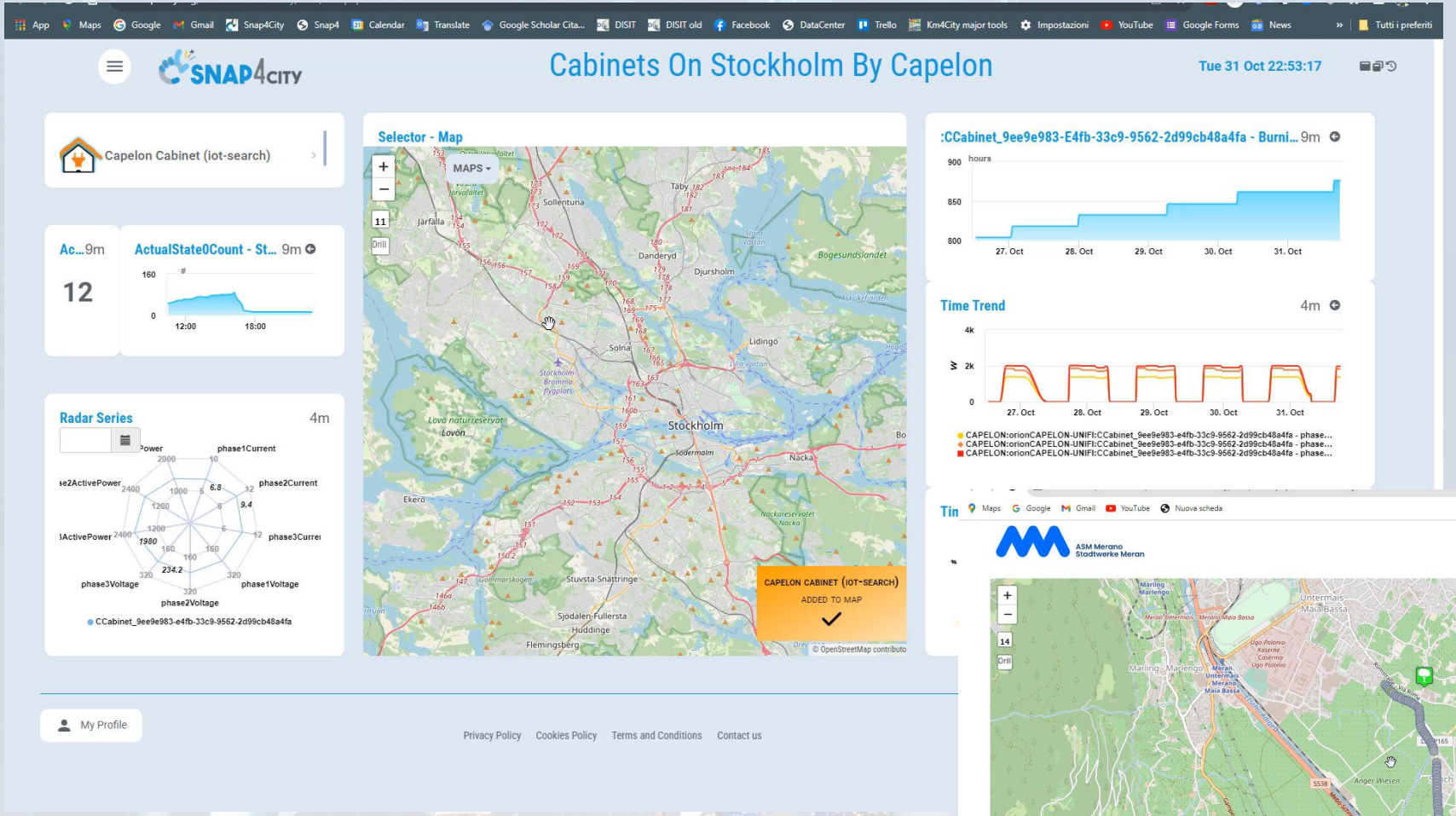


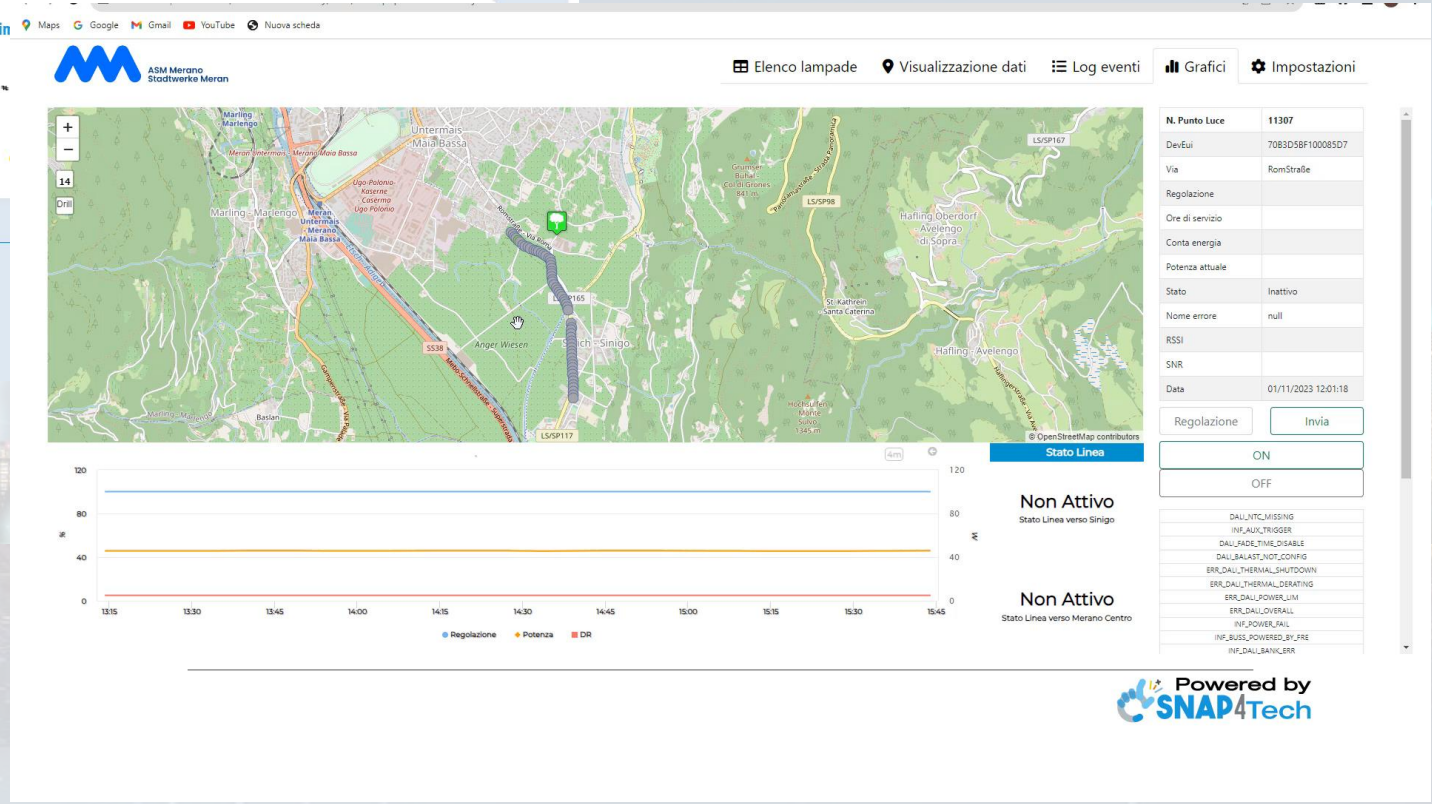


Tools: Energy Domain (2024/8)

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

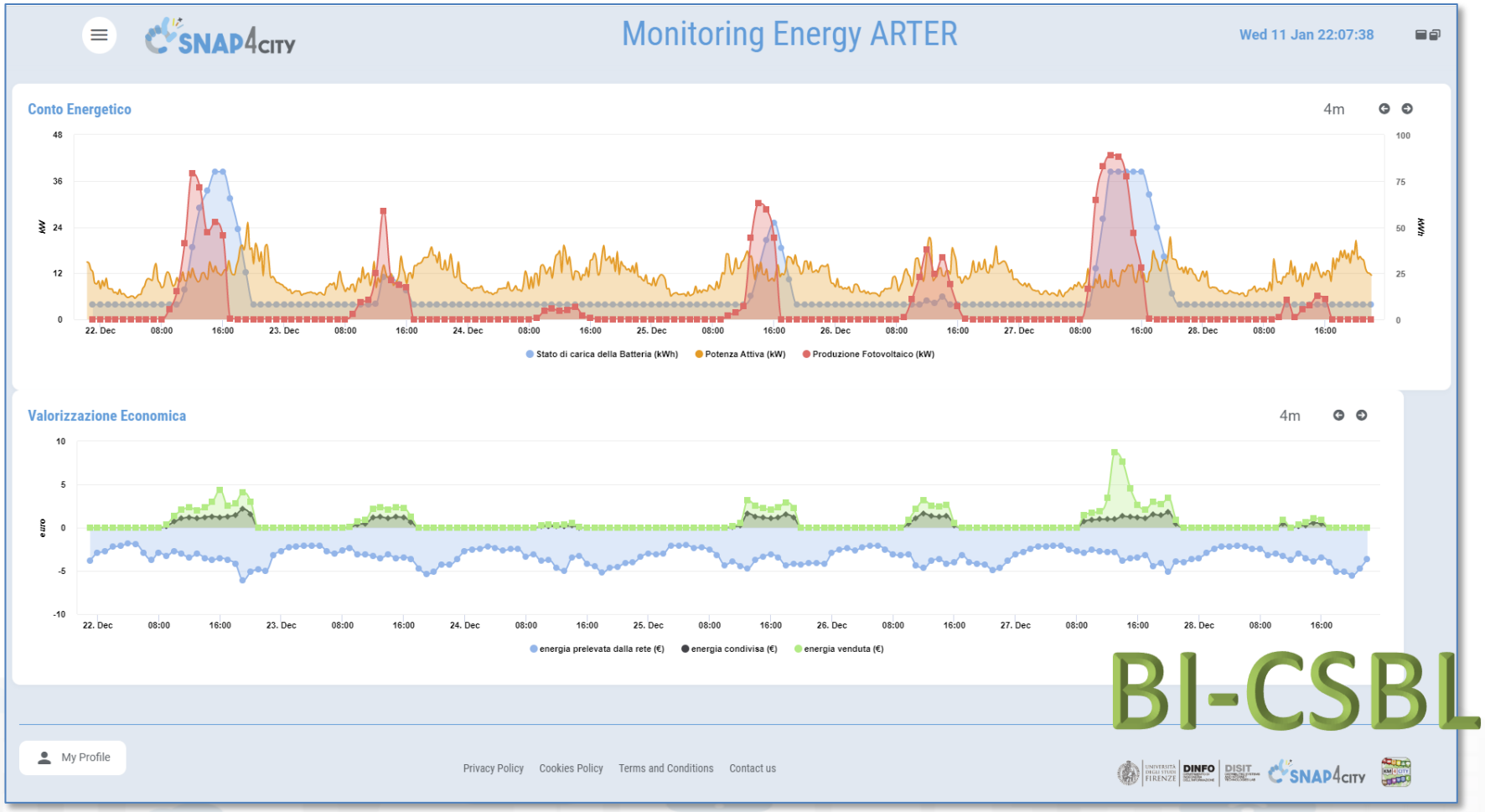






Smart Light Management

- **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

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

Ciao roottooladmin1

Sat 11 Nov 17:26:28

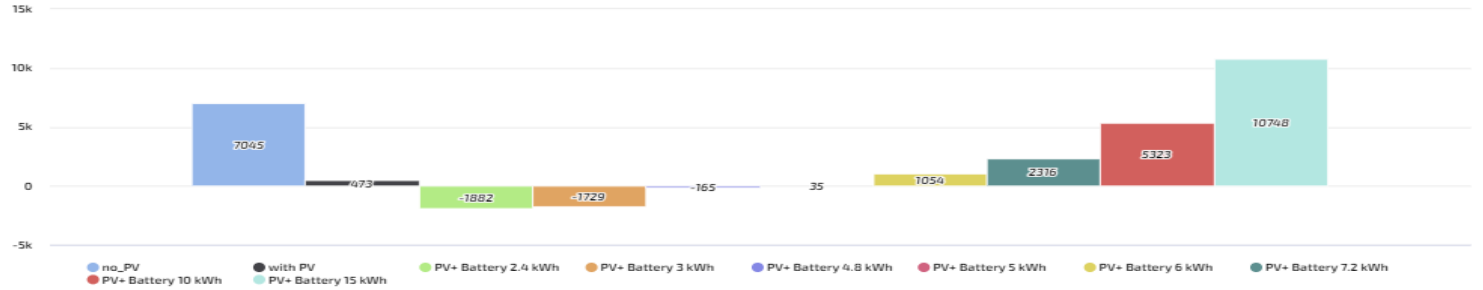
ONLINE PHOTOVOLTAIC SYSTEM SIMULATOR

User Manual

Italian Version

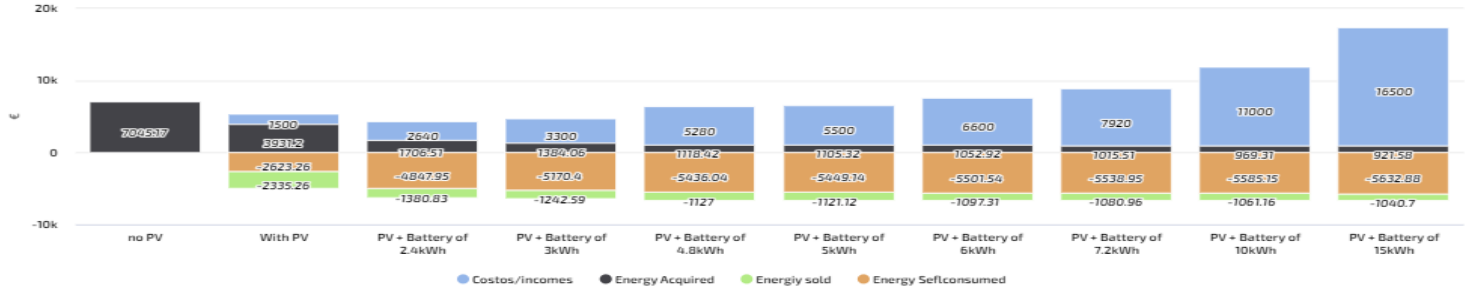
TOTAL COSTS OVER THE INVESTMENT YEARS

599m



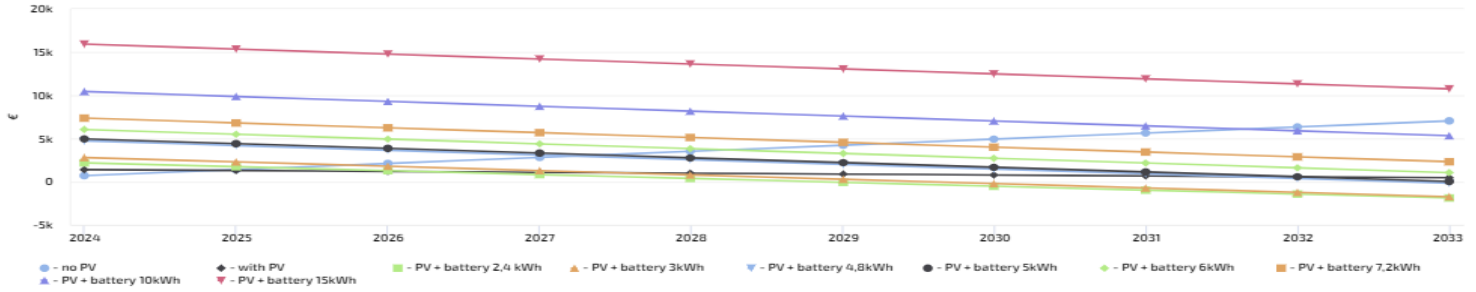
TOTAL COSTS OVER YEARS DECOMPOSED IN COSTS AND INCOMES

599m



BREAK EVEN TREND FOR THE DIFFERENT KIND OF PLANTS

599m



PARAMETERS OF YOUR PV PLANT

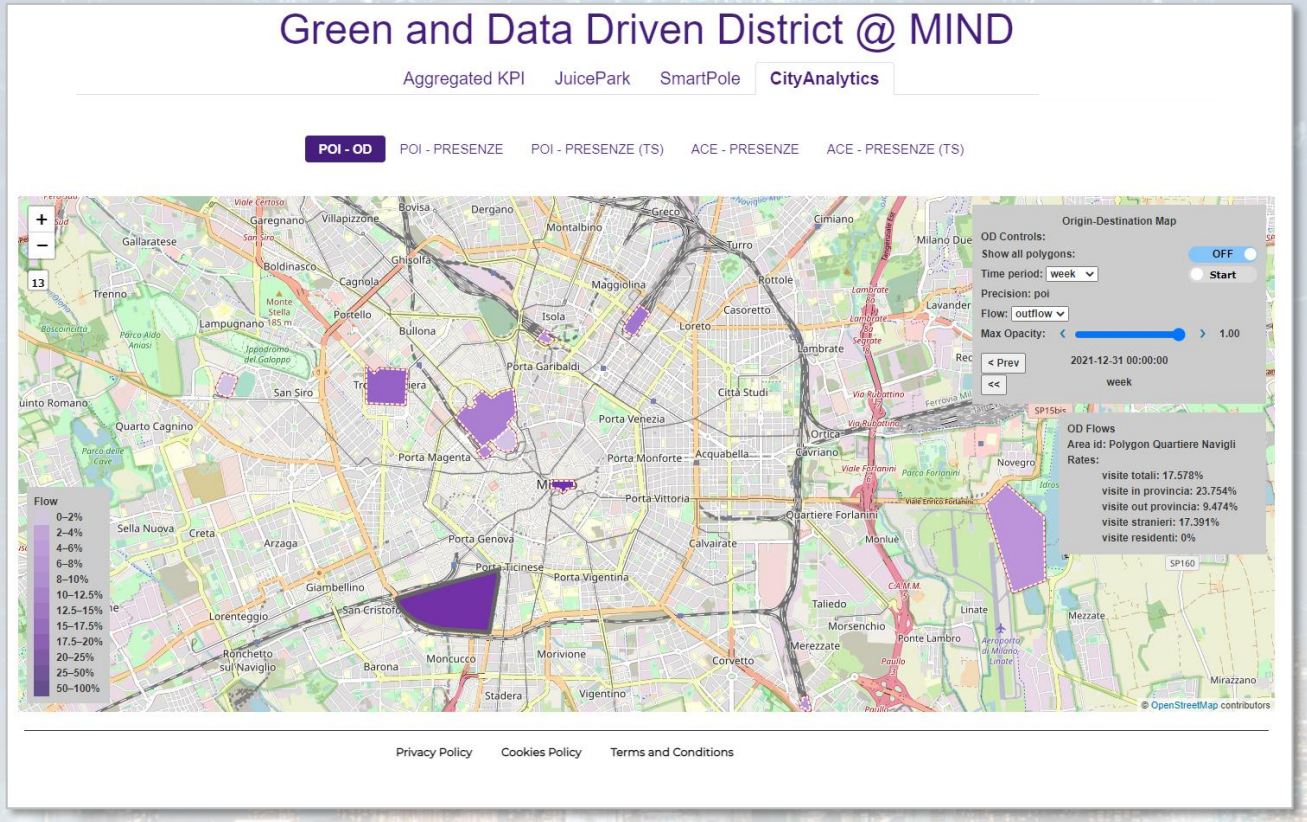
We suggest you PV plus battery of 2.4 kWh

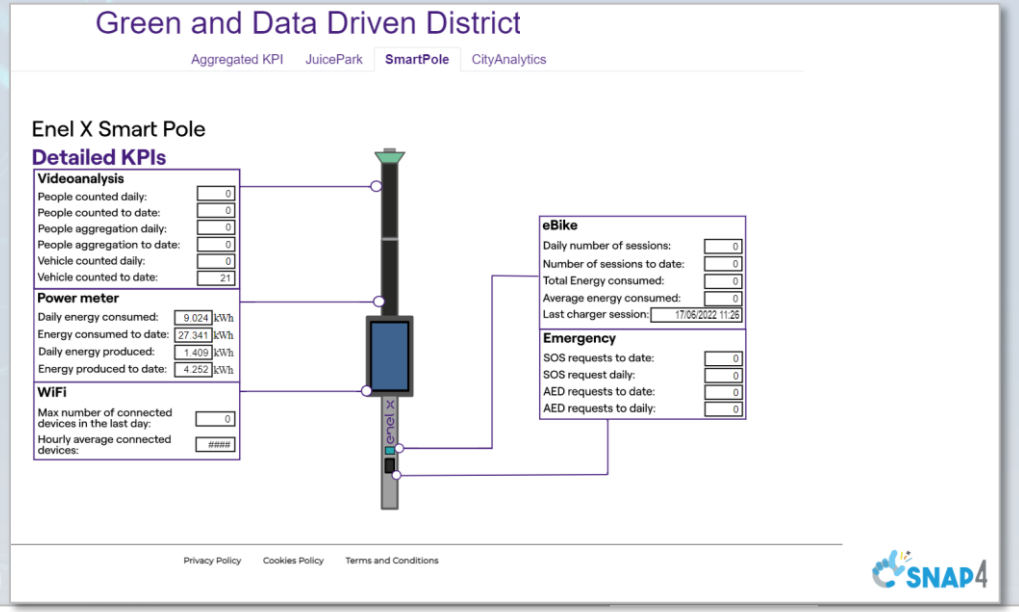
Annual Consumption	2000 kWh
Price of energy sold (€/kWh)	0,15
Price of Energy Acquired (€/kWh)	0,35
Years of Investiment	10
Months for typical trends	Gennaio

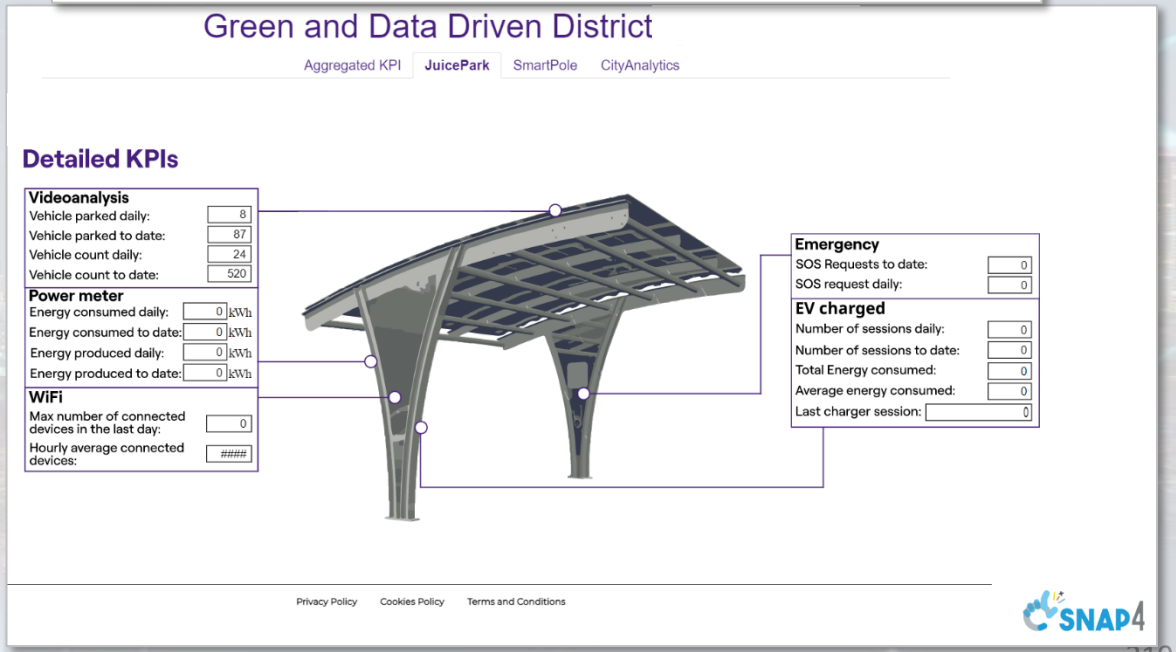
Compute

7 AFFORDABLE AND CLEAN ENERGY

Energy monitoring and business intelligence







7 AFFORDABLE AND CLEAN ENERGY

11 SUSTAINABLE CITIES AND COMMUNITIES

SNAP4CITY

KM4CITY

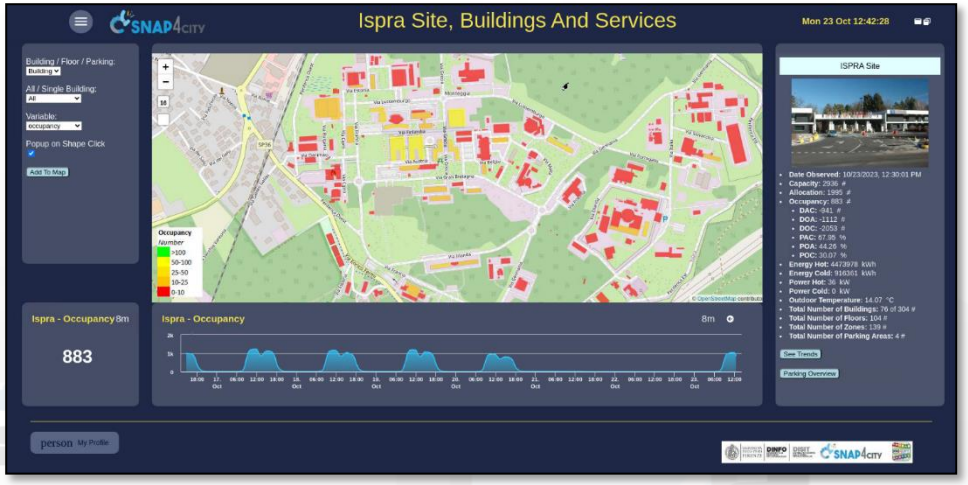
Smart Building

FROM CITY DASHBOARD TO APPLICATIONS

100% OPEN SOURCE

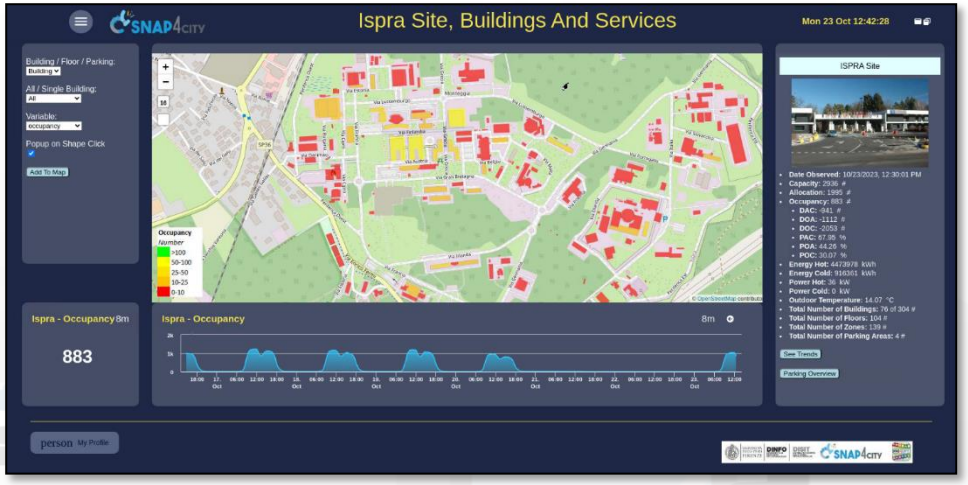
Snap4Building Domain (2024/8)

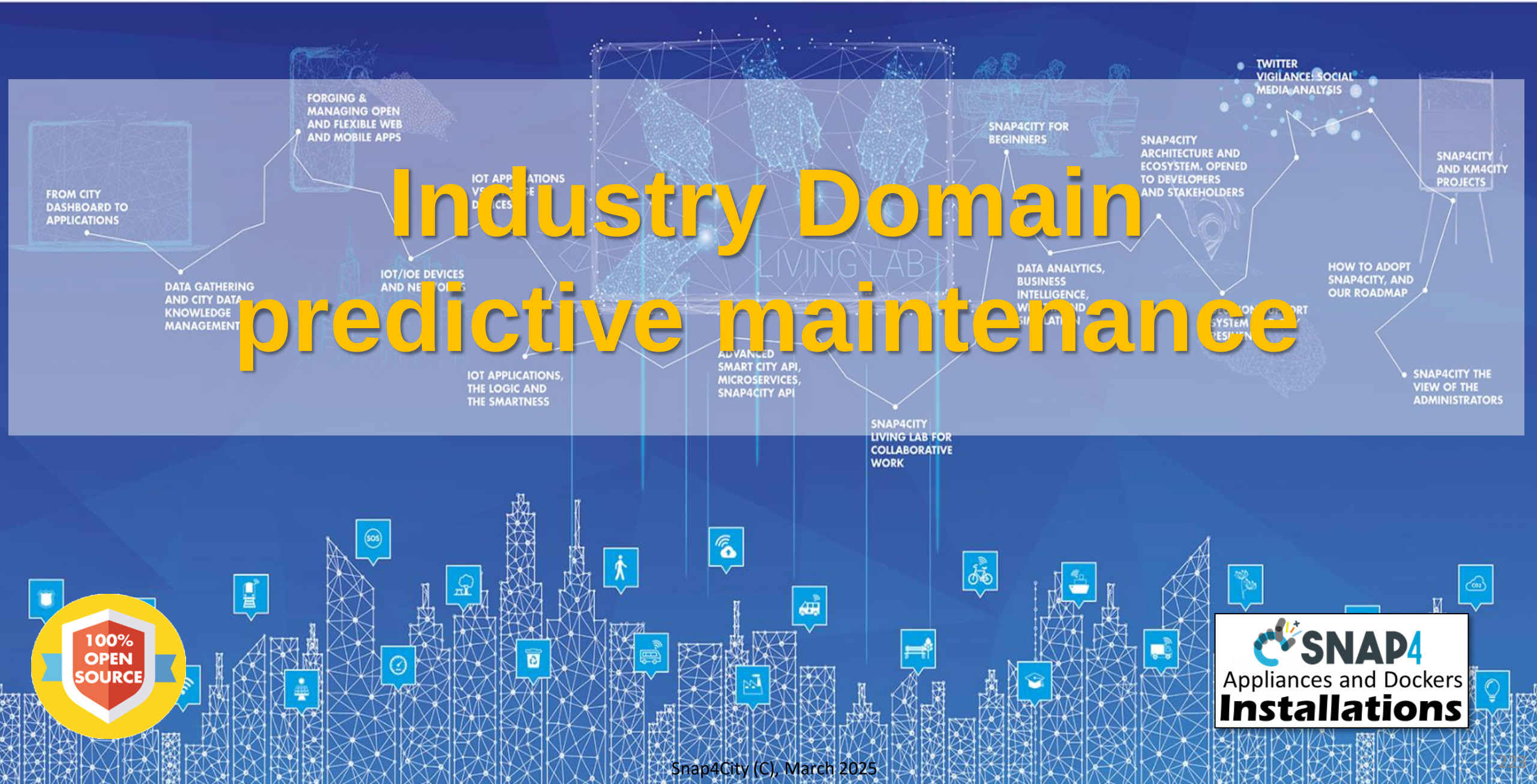
- Goals:
  - increase efficiency, cost reduction, sustainability
  - Accessibility to services, Security/Safety
- Solutions for Operation (monitoring, managing, mobile apps, digital signages, control rooms)
  - Monitoring: usage, energy, environmental conditions, people flows, services, etc.
  - Early detection/warning, alarm, of critical conditions, notifications, decision support
  - Production of suggestions/prescriptions, nudging
  - Managing smart services: cabinets, dispenser, lockers, etc.
  - Global and local 3D/2D representations of area and buildings
  - Integration with Video Management Systems
  - Computing predictions of any kind
- Solutions for Planning (optimization and what-if analysis)
  - Reduction of energy costs via optimization
- Algorithms and computational solutions, see next slide



Smart Buildings, Snap4Building (2024/8)

- **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 KPIs 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**

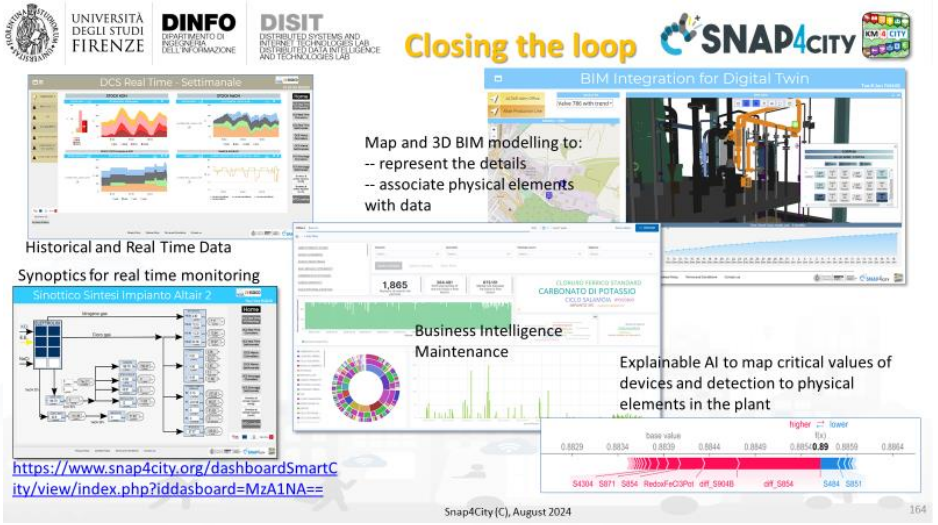


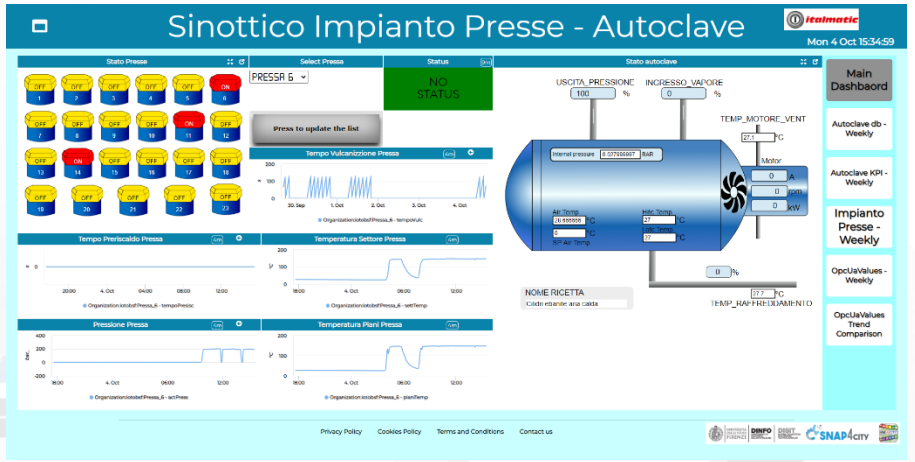


Industry Domain predictive maintenance

Industry production Domain (2024/8)

- Goals:
  - Cost reduction, increase control on production
  - Production optimisation
  - Quality Level
- Solutions for Operation (monitoring, managing, mobile apps, digital signages, control rooms)
  - Monitoring KPI: administration, production, commercial, faults, etc.
  - Early detection/warning, alarm, of critical conditions
    - **Multichannel** Event reporting: email, Telegram, mobile apps, SMS, etc.
  - Managing maintenance operation
  - Computing predictions on KPI
  - Computing predictive maintenance
- Solutions for Planning (optimization and what-if analysis)
  - Generative AI and predictive AI for production plan optimisation
  - Reduction maintenance costs, reduction of critical SLA conditions, improving quality level
- Algorithms and computational solutions, see next slide





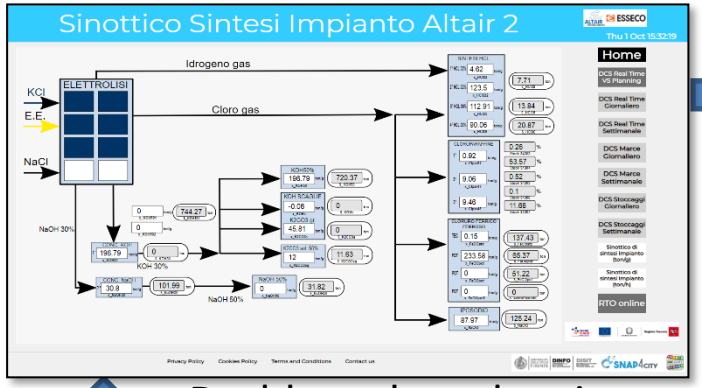
UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

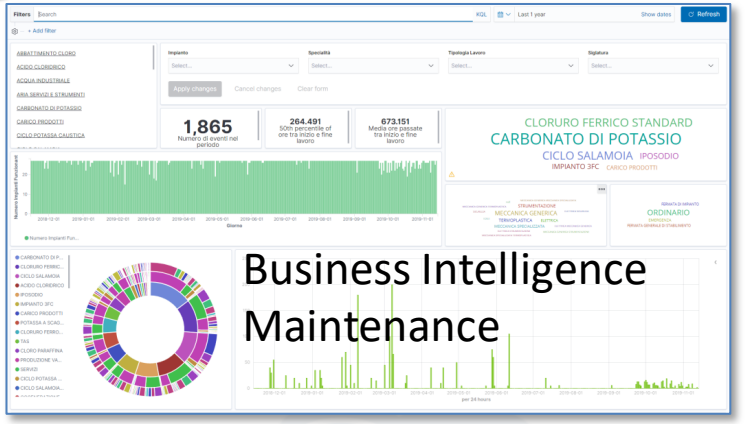
DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB
DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

SNAP4CITY KM4CITY

Workflow for Ticket management



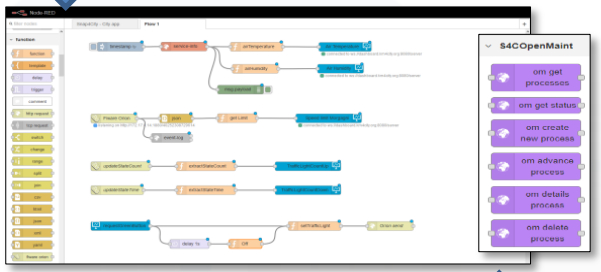
Consumptions/productions

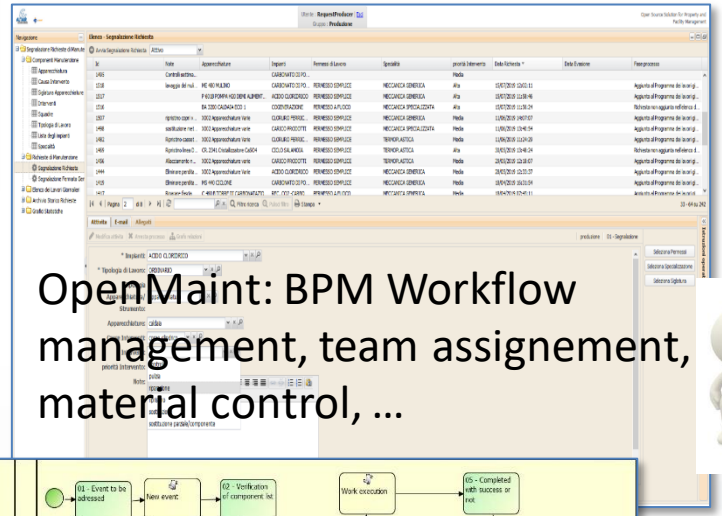


Events/actions

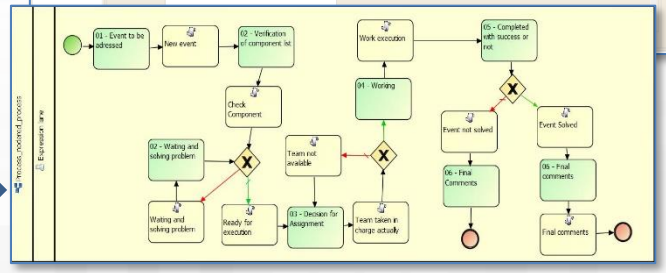
Business Intelligence
Maintenance

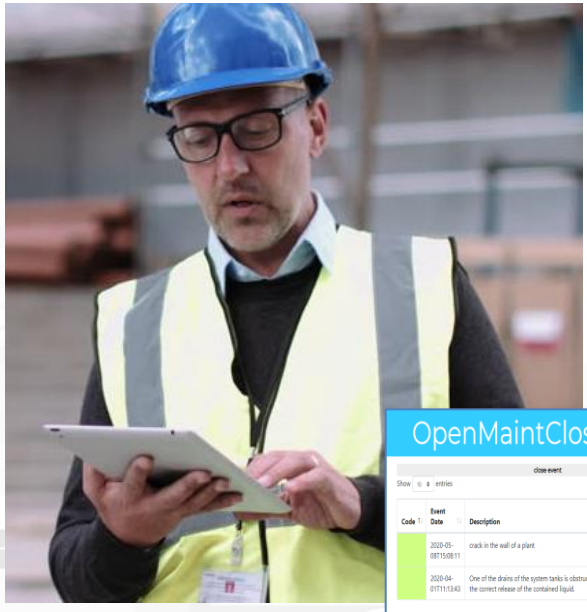
Dashboards and actions





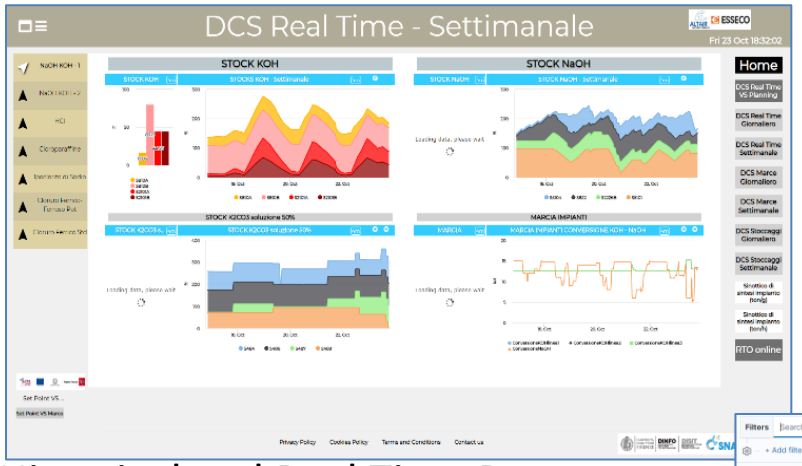
OpenMaint: BPM Workflow management, team assignement, material control, …



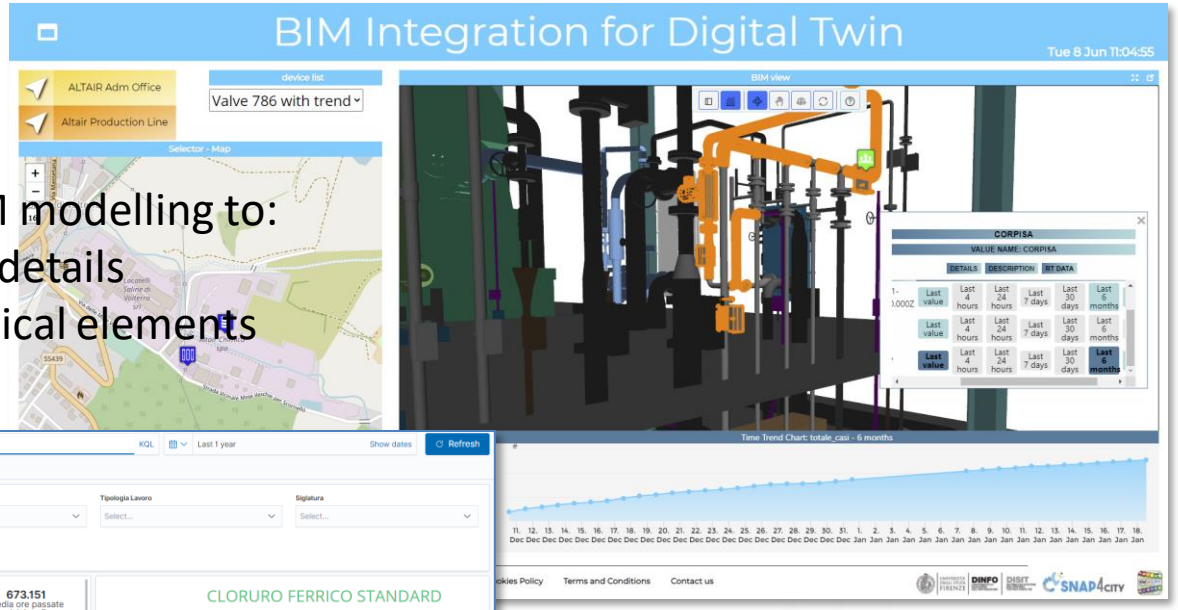


IOT App, Data event firing, event detection and firing Critical event management

Closing the loop

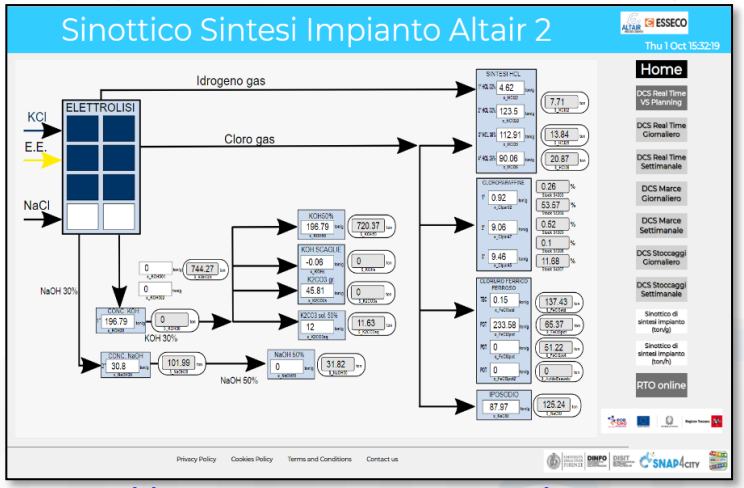


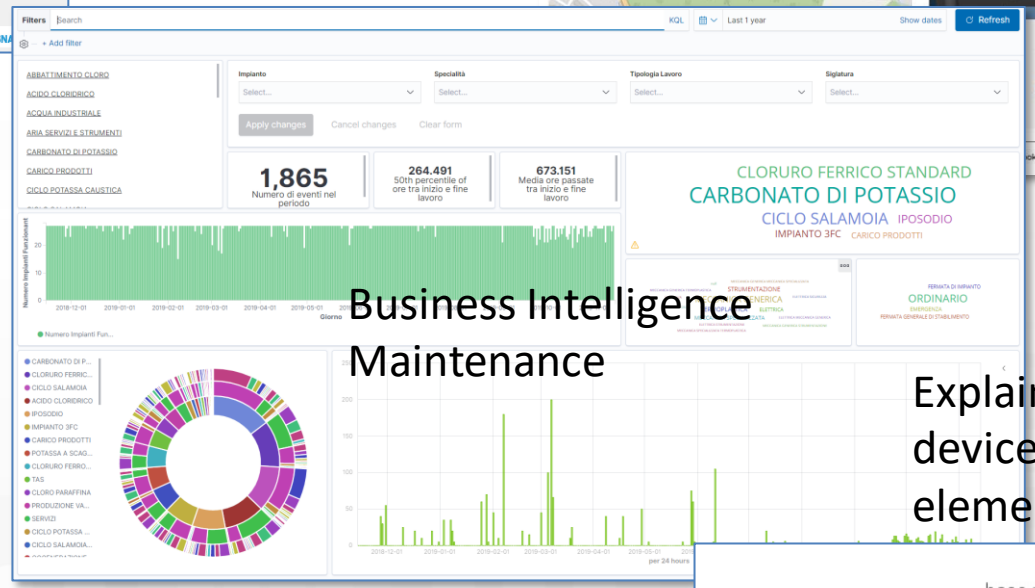
Historical and Real Time Data



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

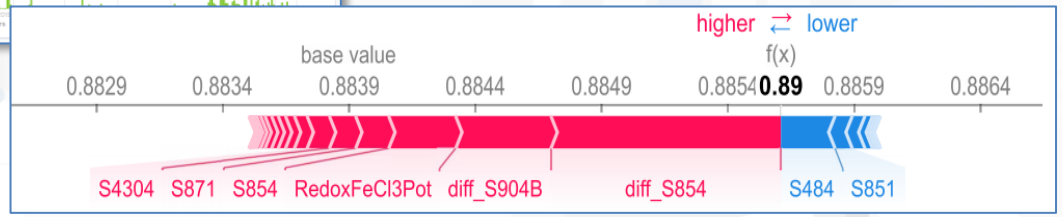
Synoptics for real time monitoring



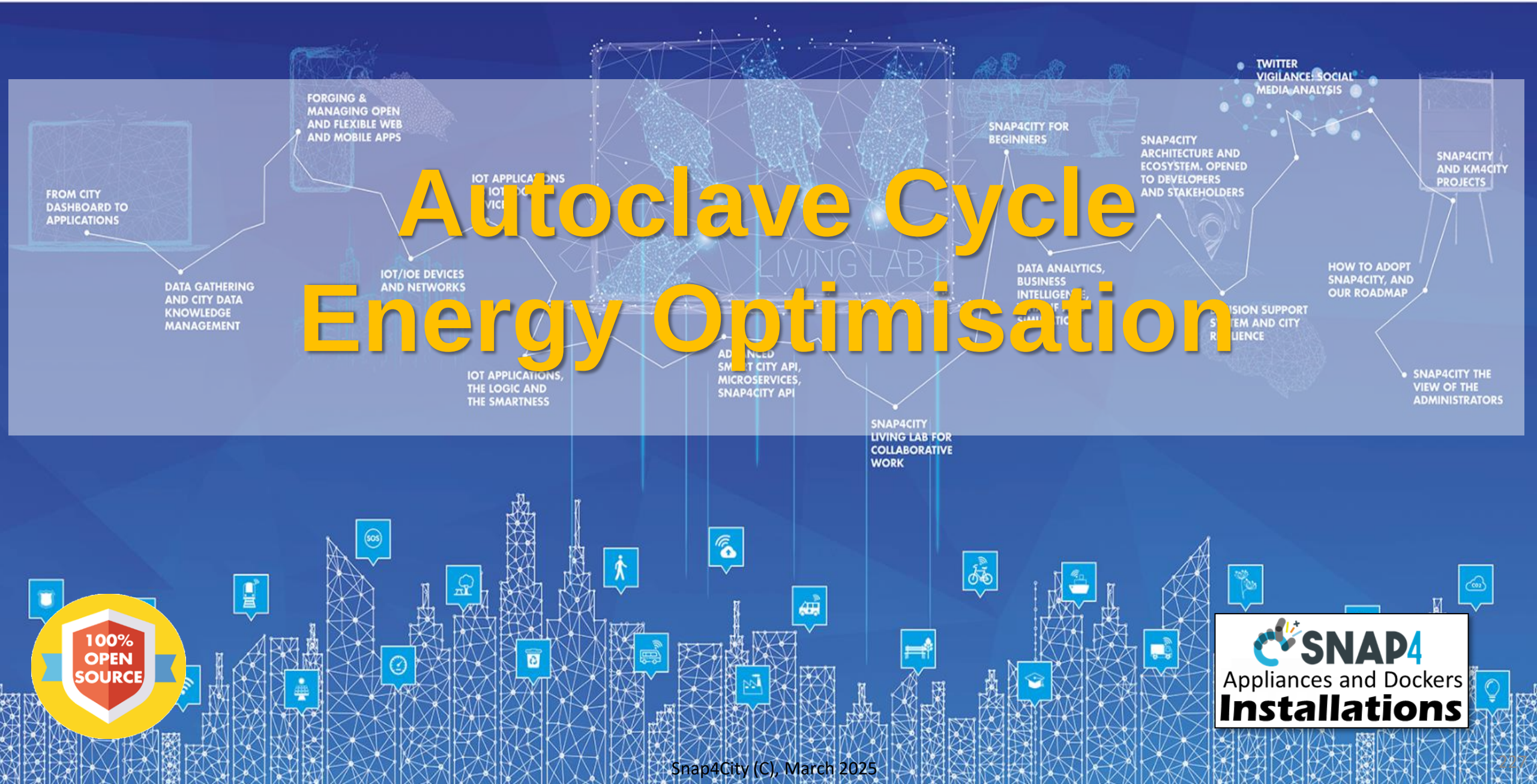


Business Intelligence Maintenance

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



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



Autoclave Cycle Energy Optimisation

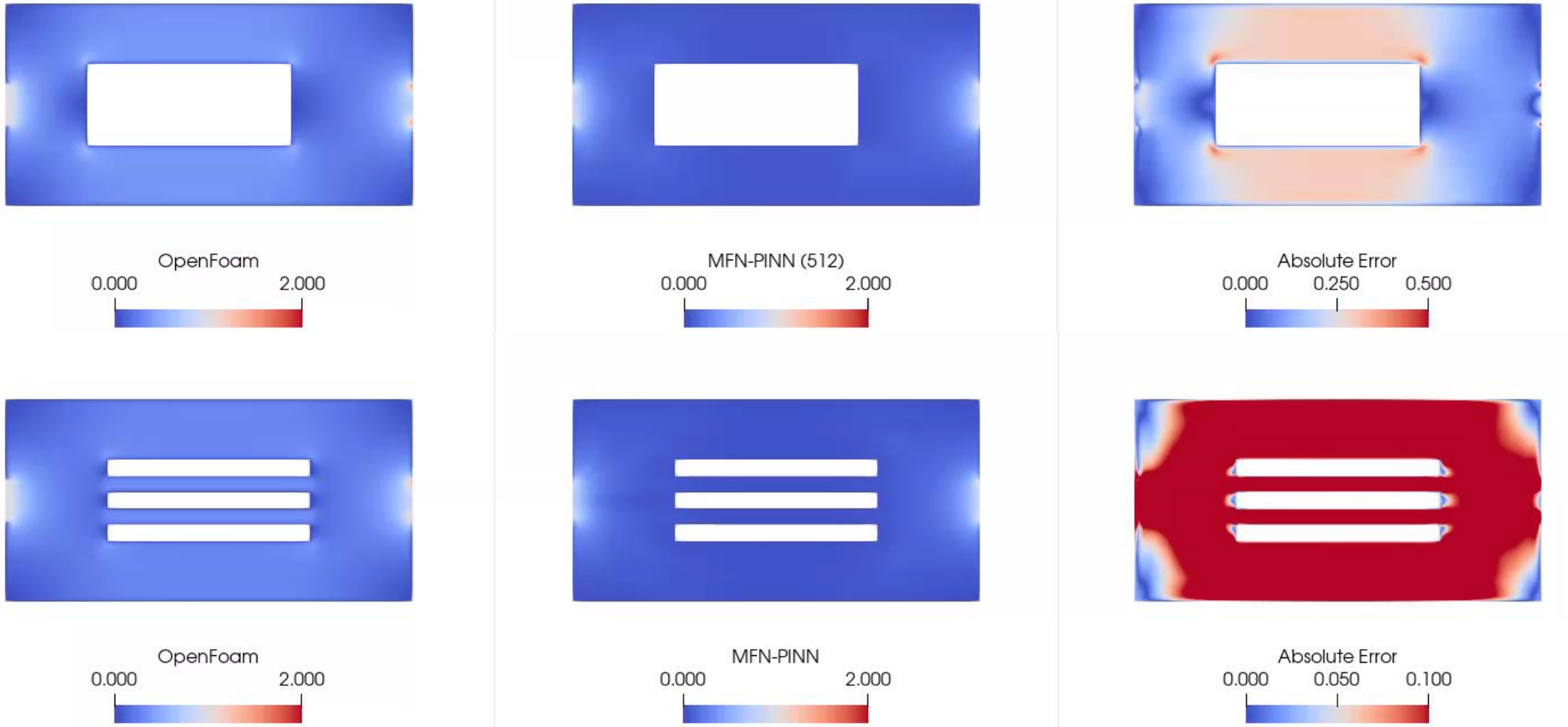
100% OPEN SOURCE

SNAP4 Appliances and Dockers **Installations**

PINN: Physically Informed Neural Neworks Models

- **Solving Navier-Stokes PDE** (partial differential equations) equation, **via PINN** approach
  - Reduction of computing costs for simulating load effect into the autoclaves curing process
  - Validation wrt Open Foam
  - Precision on steady and transitory cases
  - Definition of Transfer Learning techniques
- Videos on https://www.snap4city.org/1010

Comparison of PINN vs OpenFoam and error



Sinottico Impianto

Sinottico Impianto Presse - Autoclave

italmatic

Mon 4 Oct 15:34:59

Stato Presse

OFF 1	OFF 2	OFF 3	OFF 4	OFF 5	ON 6
OFF 7	OFF 8	OFF 9	OFF 10	ON 11	OFF 12
OFF 13	ON 14	OFF 15	OFF 16	OFF 17	OFF 18
OFF 19	OFF 20	OFF 21	OFF 22	OFF 23	

Select Pressa

PRESSA 6

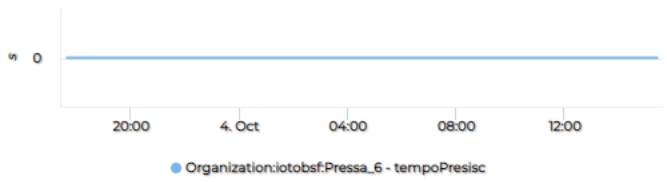
Press to update the list

Status 9m

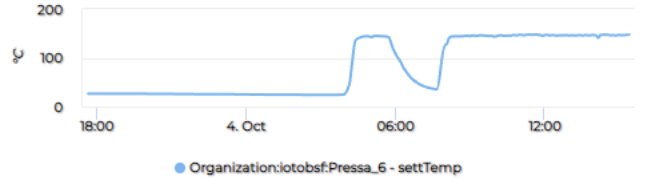
NO STATUS

Tempo Vulcanizzione Pressa 4m

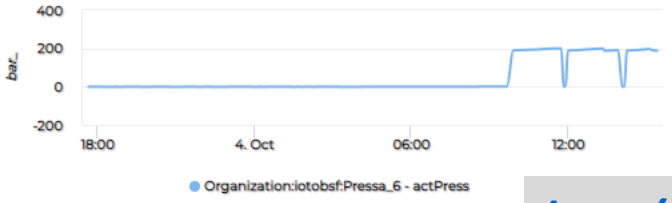
Tempo Preriscaldo Pressa 4m



Temperatura Settore Pressa 4m

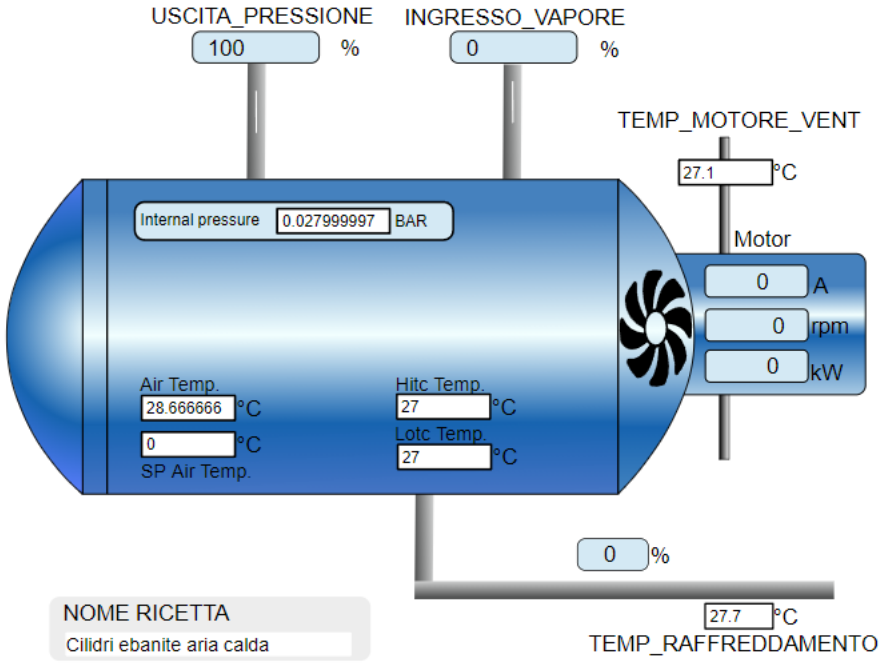


Pressione Pressa 4m



Temperatura Piani Pressa 4m

Stato autoclave



- Main Dashbaord
- Autoclave db - Weekly
- Autoclave KPI - Weekly
- Impianto Presse - Weekly
- OpcUaValues - Weekly
- OpcUaValues ...rison

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

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

https://www.snap4city.org/944

Developing on Snap4City

FROM CITY DASHBOARD TO APPLICATIONS

IOT APPLICATIONS VS IOT EDGE DEVICES

TWITTER VIGILANCE: SOCIAL ANALYSIS

ECOSYSTEM. OPENED TO DEVELOPERS AND STAKEHOLDERS

SNAP4CITY AND KM4CITY PROJECTS

SNAP4CITY THE VIEW OF THE ADMINISTRATORS

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
							
							

100% OPEN SOURCE

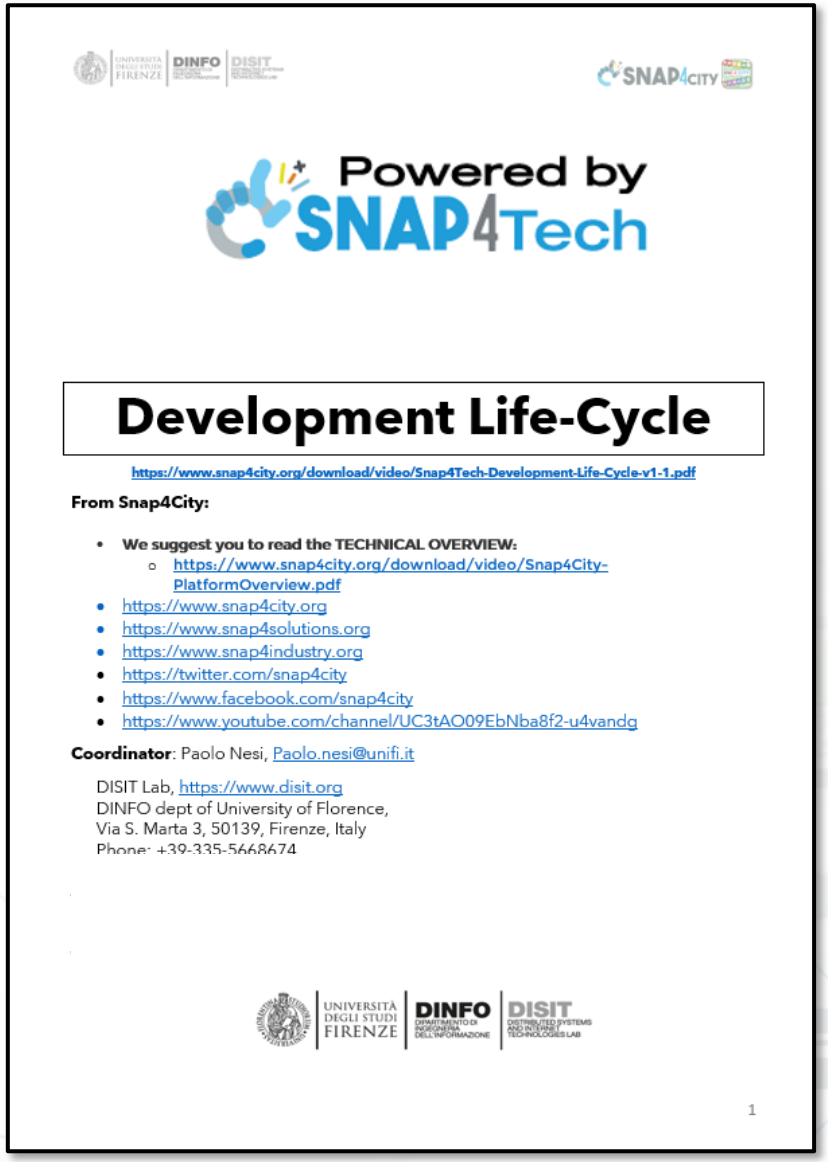
https://www.snap4city.org/944

On Line Training Material (free of charge)

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

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



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

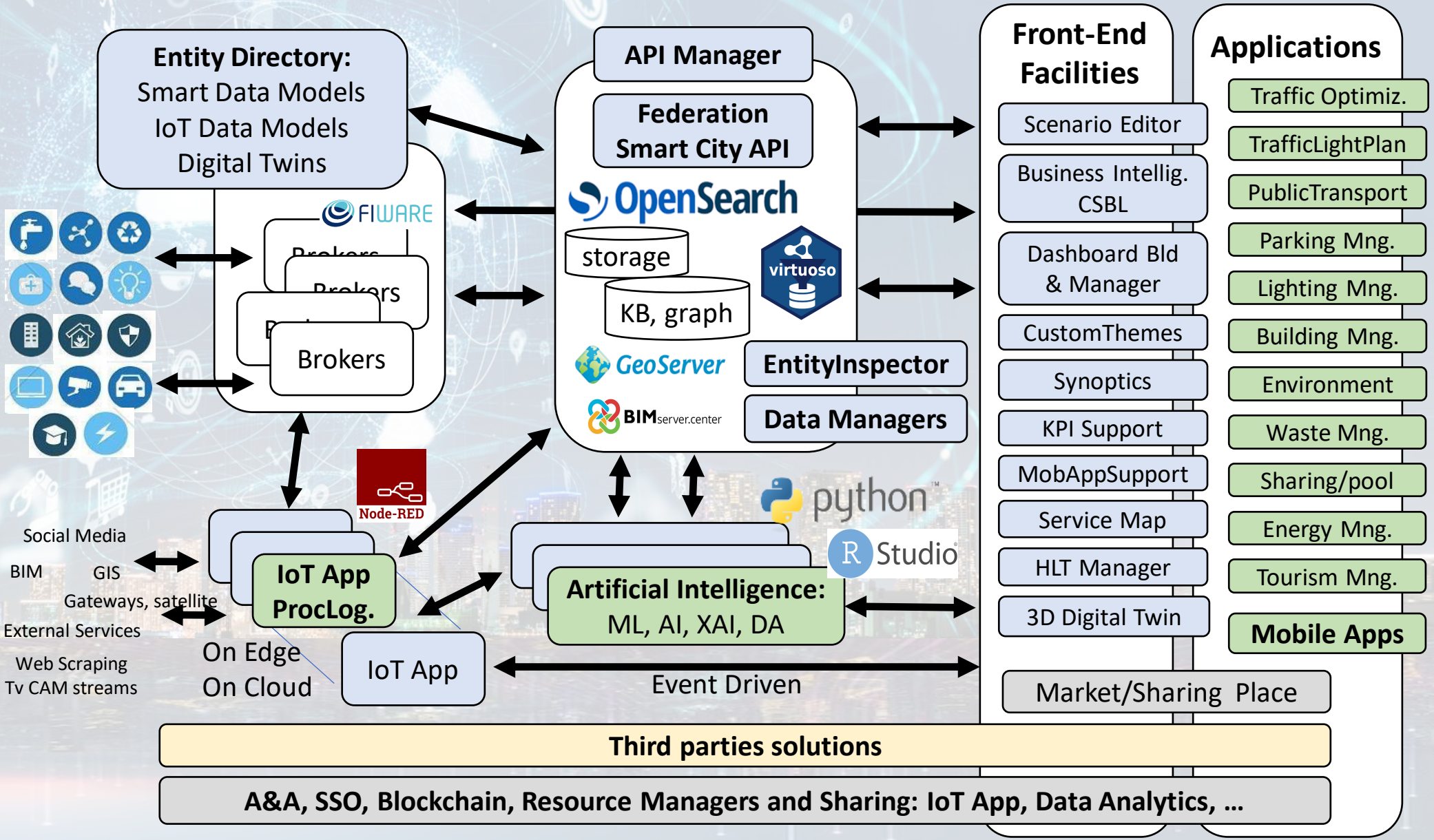
DISIT Lab, https://www.disit.org
DINFO dept of University of Florence,
Via S. Marta 3, 50139, Firenze, Italy
Phone: +39-335-5668674

1

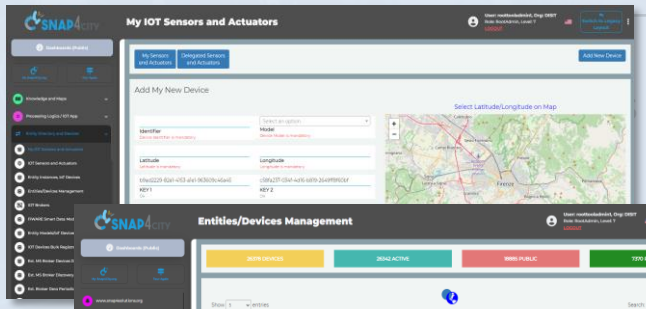
Snap4City Developers ? Who they are?

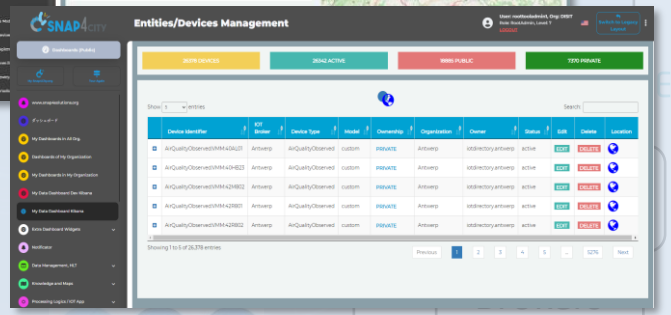
- **Operators of the City** on: mobility and transport, environment, energy, tourism, safety, etc. Typically they work on
  - **Operation**: load data, monitor conditions via dashboards, receive multimodal early warning, act on ticketing systems, etc.
  - **Planning**: solving they problems via optimization tools provided
- **Integrators and Researchers.** Typically they:
  - **exploit tools and AI/XAI of Snap4City** for implementing advanced solutions, which remain of their Property Right
  - **develop new:** AI/XAI solutions, applications and tools which remain of their Property Right
- **Living Lab support and Development Support**

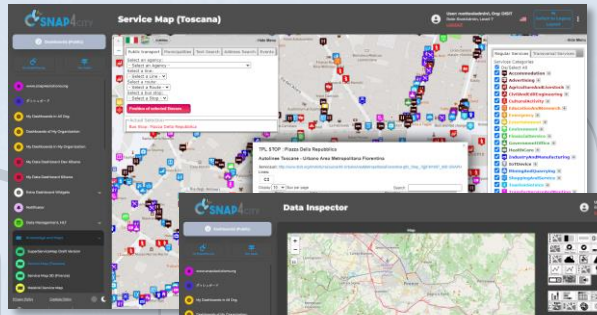
Technical Architecture

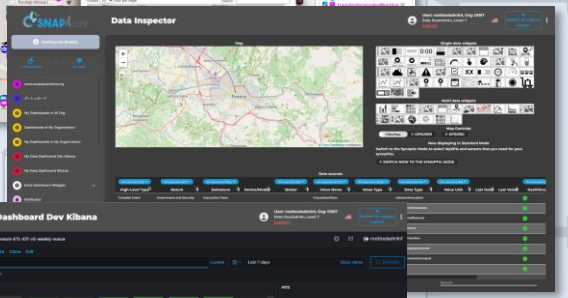


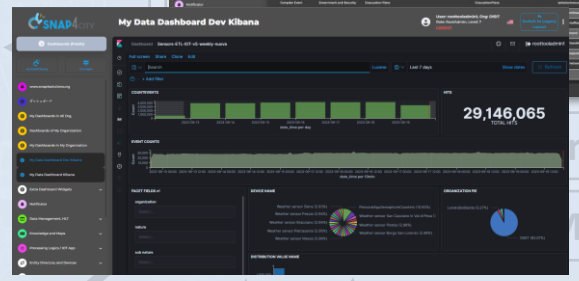
Visual Development Tools

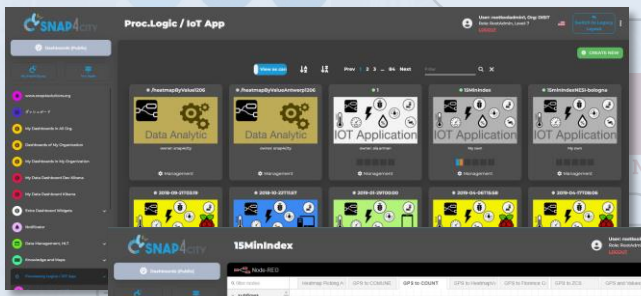


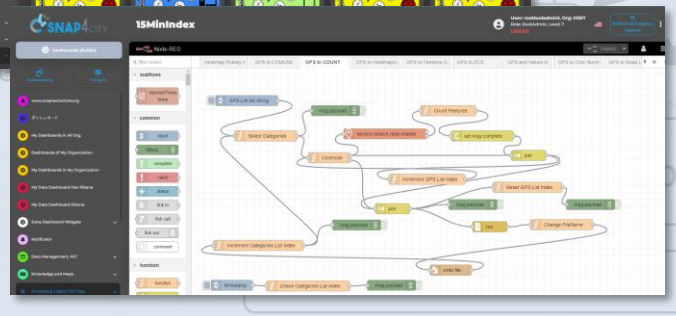


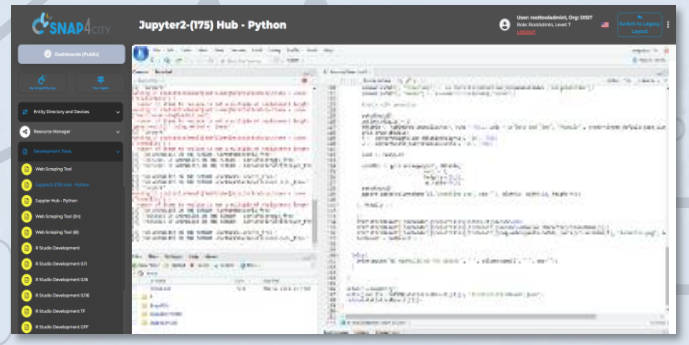


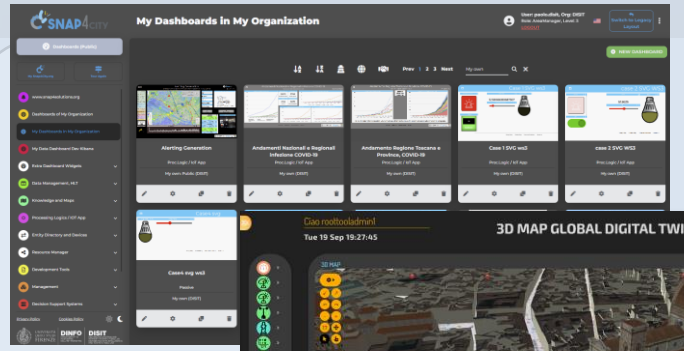


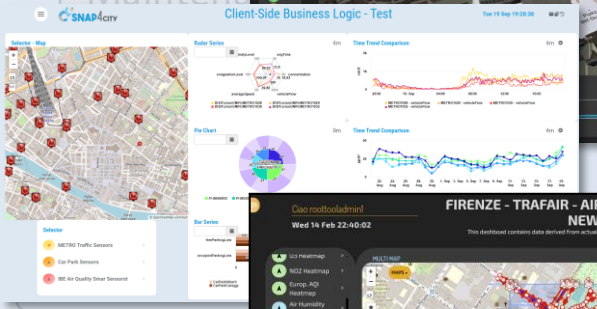


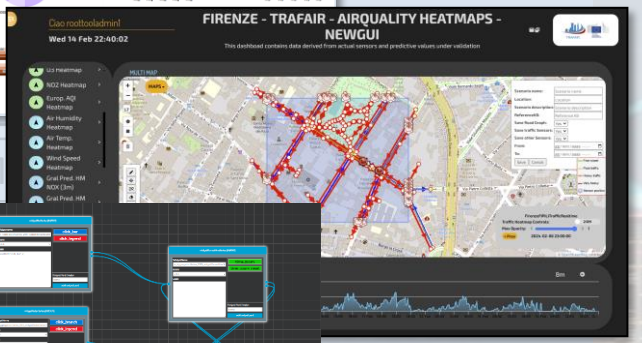


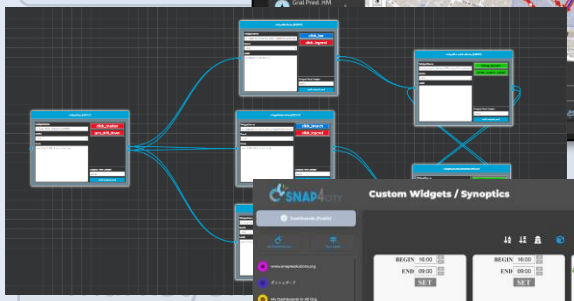












Maintena

nspector

Managers

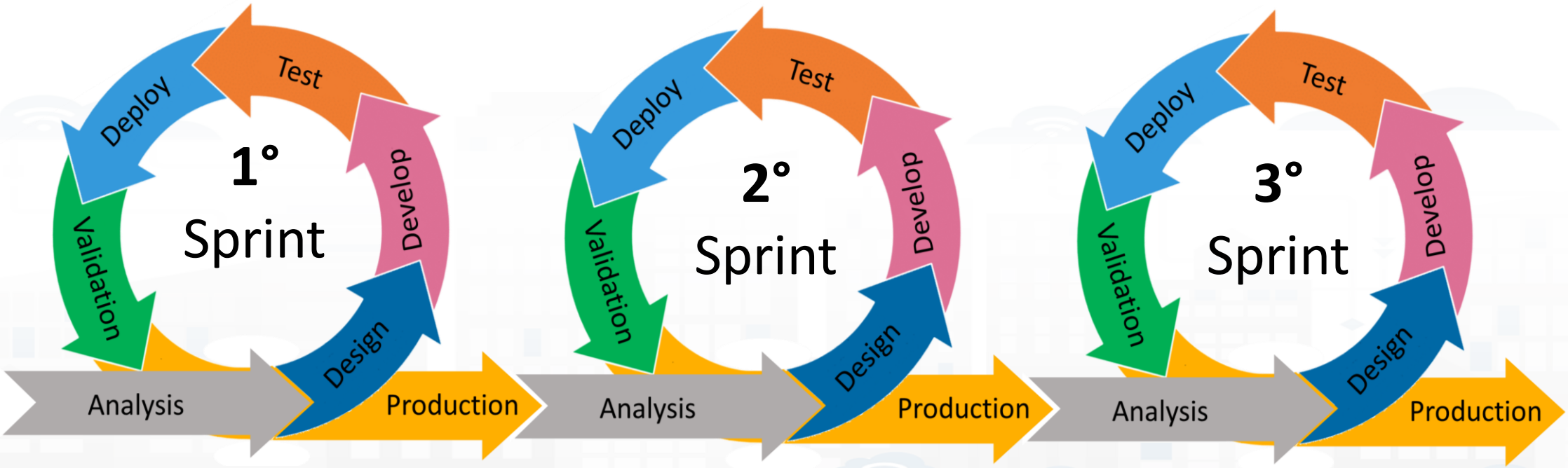
Service M

Node-RED

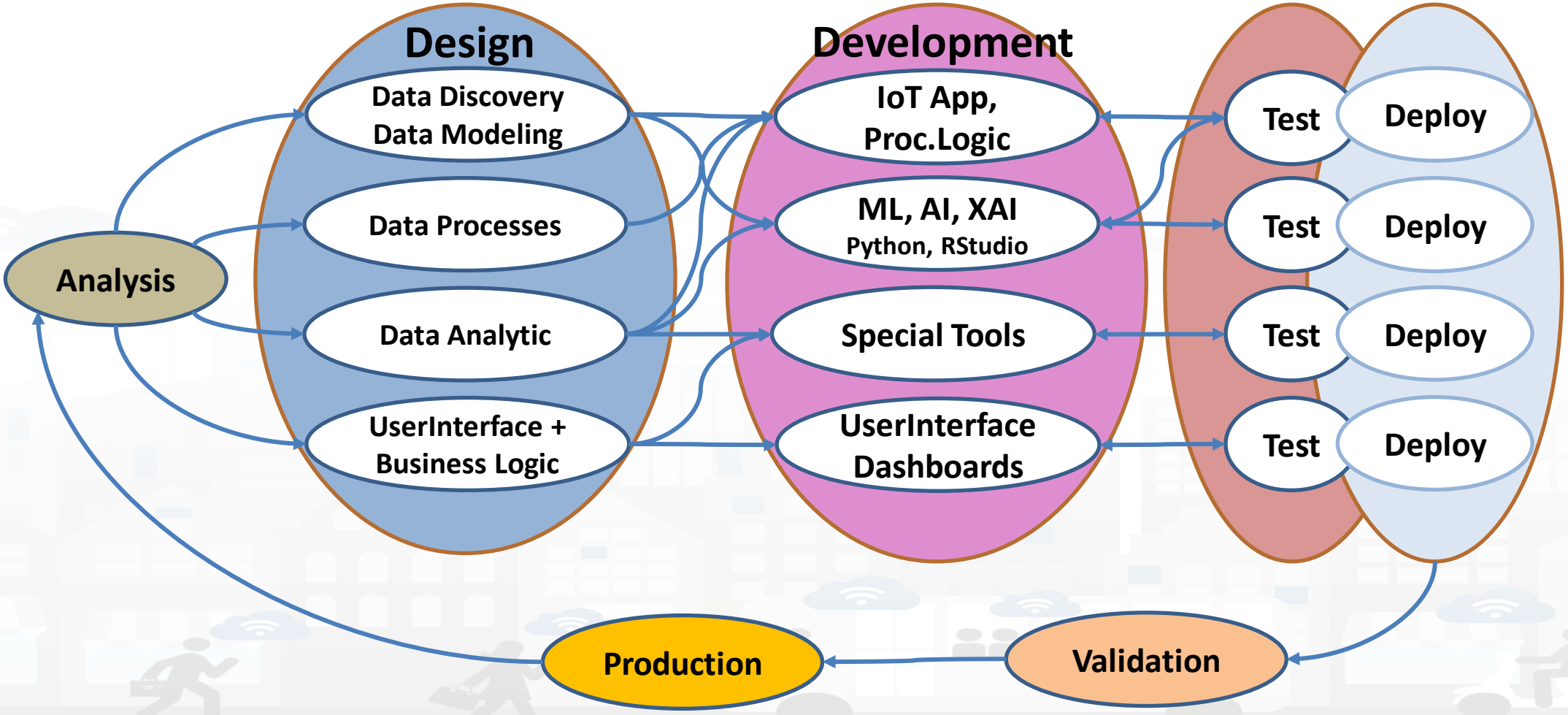
Third parties solutions

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

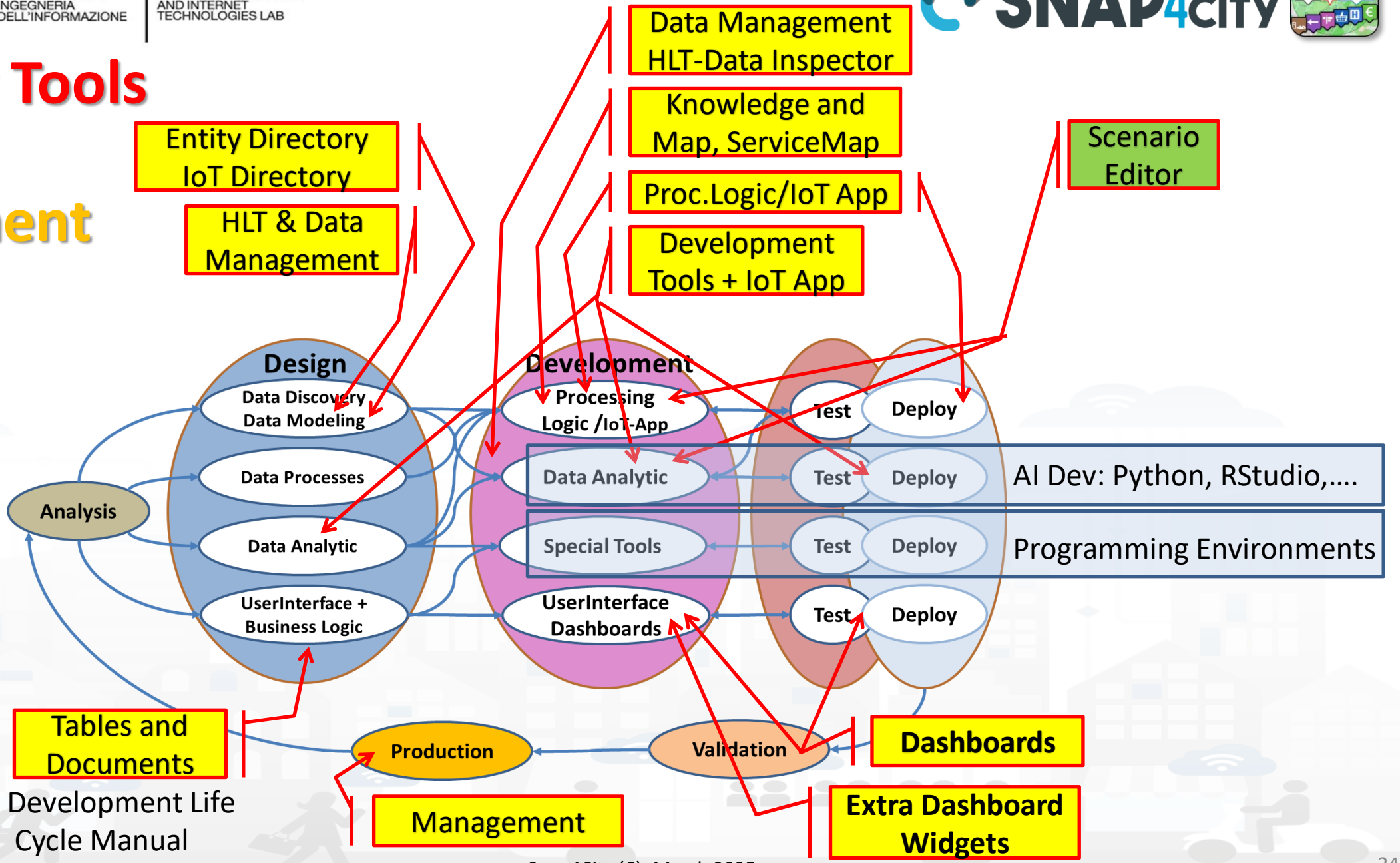
Agile Development Life Cycle by sprint Smart Solutions



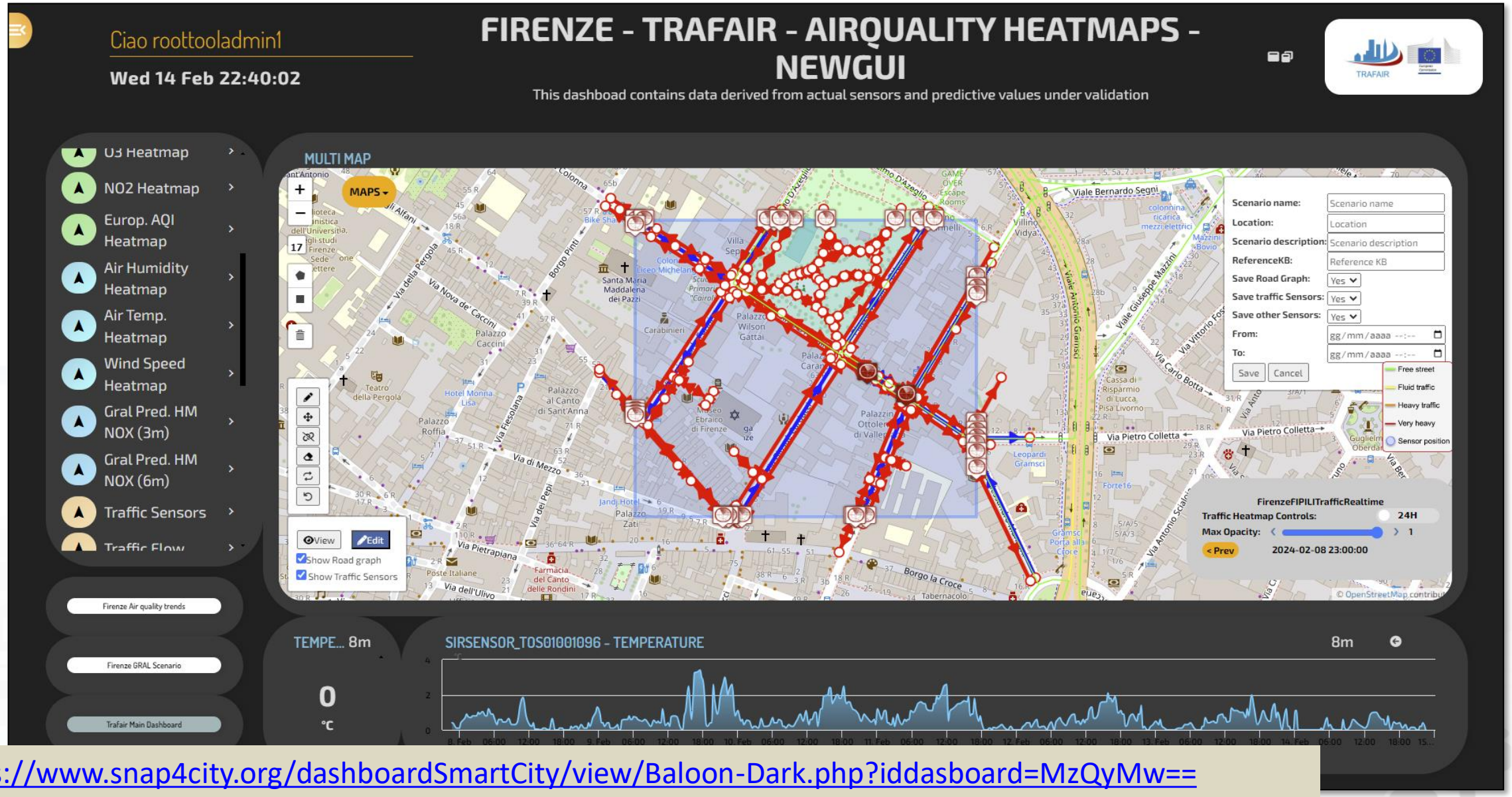
Development Life Cycle Smart Solutions



Snap4City Tools vs Development Life Cycle



Trial:



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

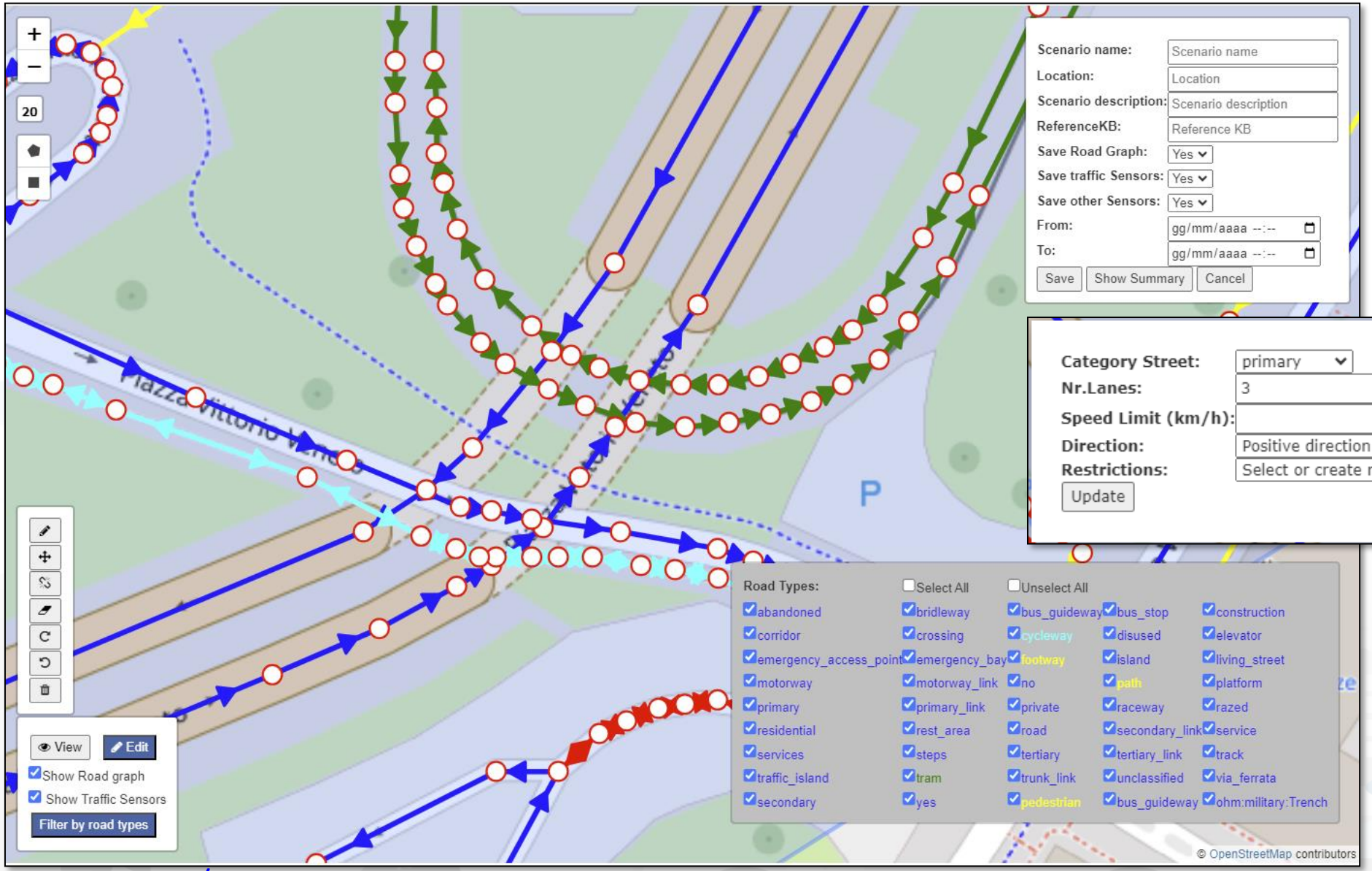
Scenario Editor

Select map

Zoom

New Scenario

Editing
Drag & drop
Split & Join
Delete
Do and Undo



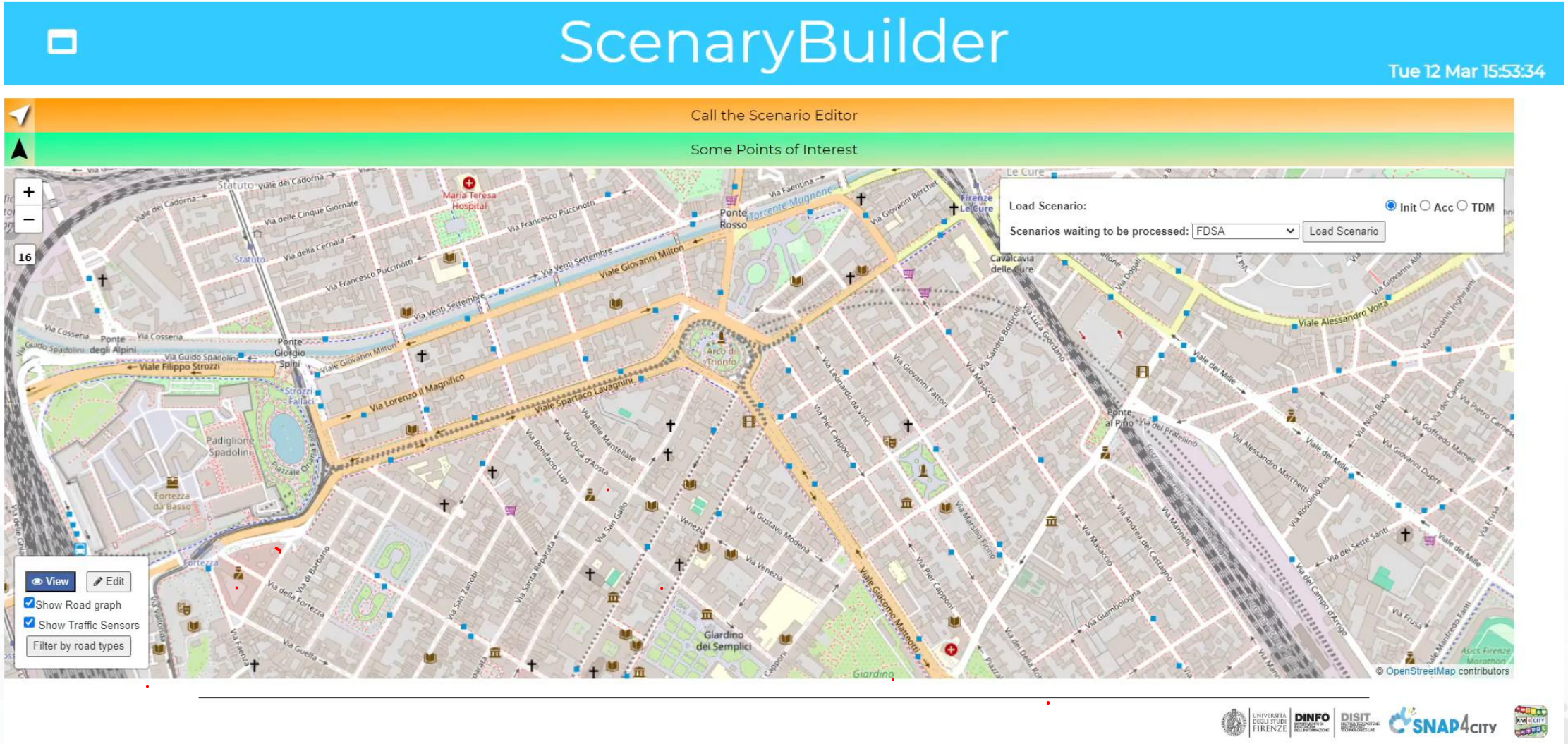
Edit Road Segment

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

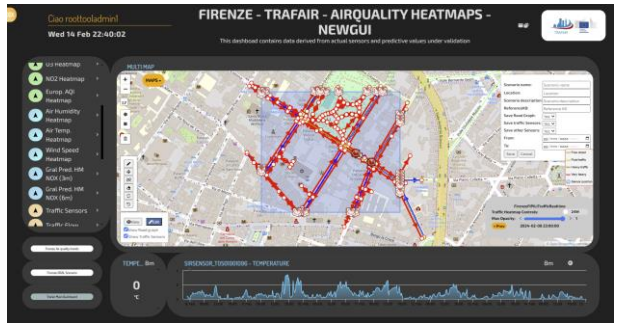
Properties of Road Elements

https://www.snap4city.org/976

Scenario Editor



The actual Scenario Exploitation

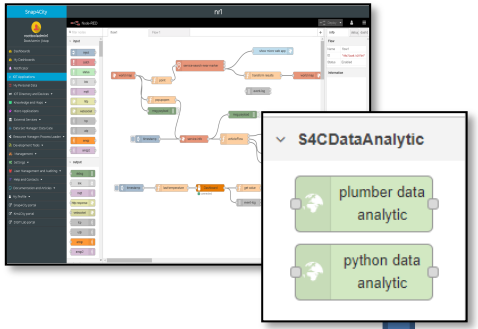


Defining Context via Editing Scenario:

- 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.

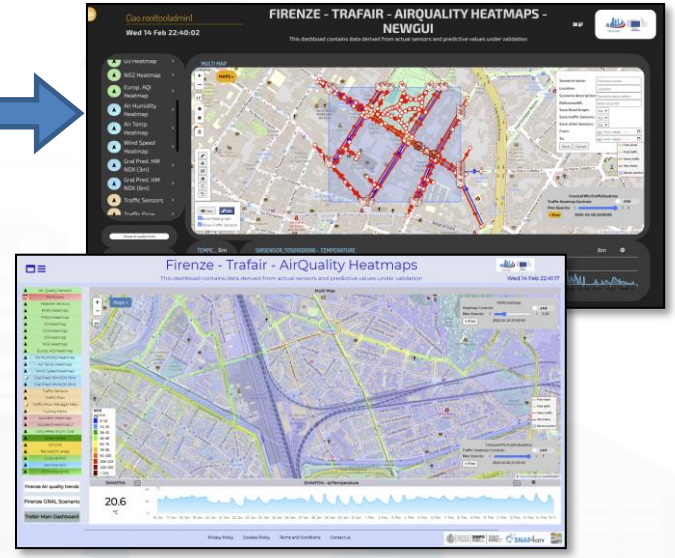


Computing in the Scenario Context as:

- 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

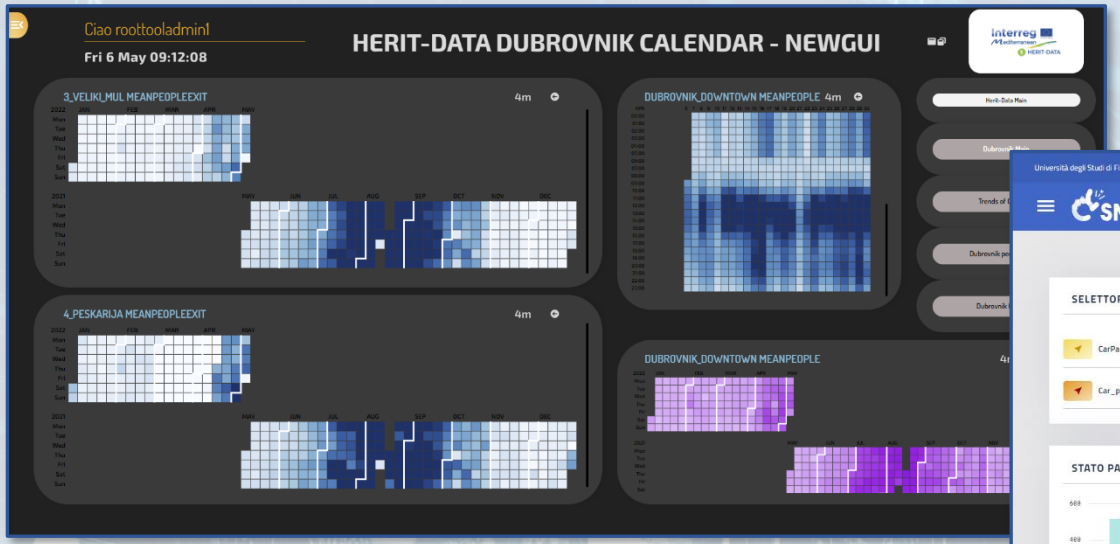
Part 2: Dashboards production and management

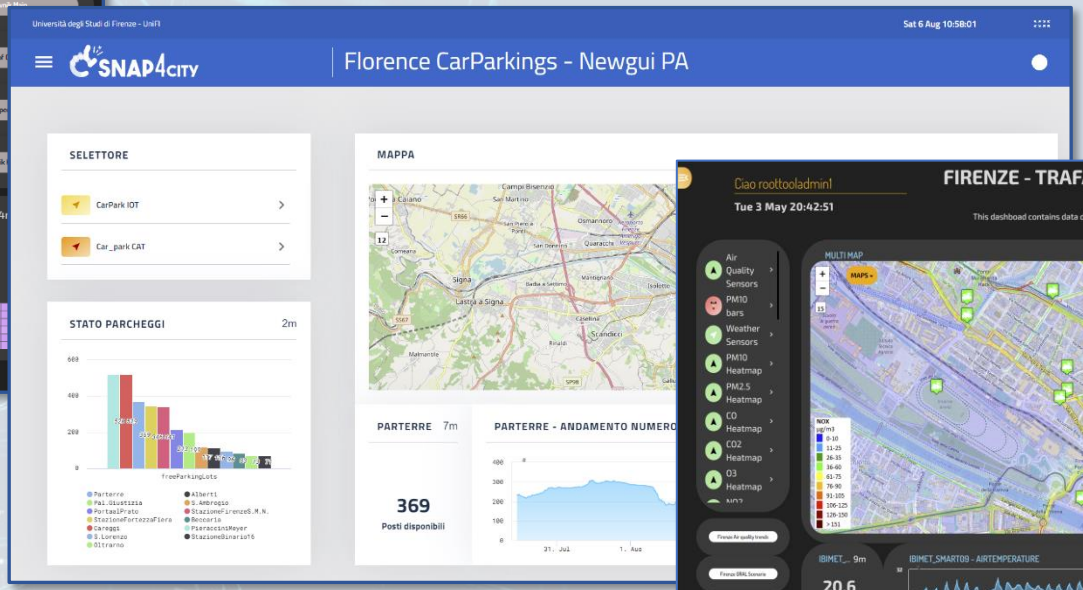
SLIDES

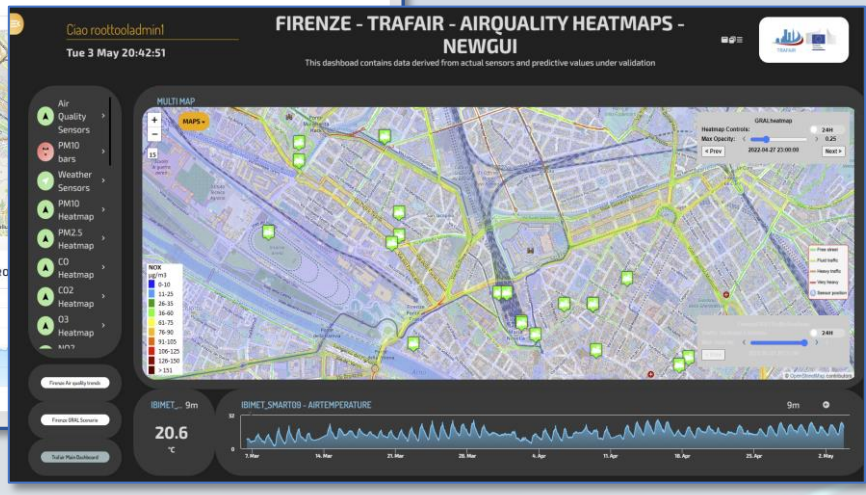
Interactive Slides

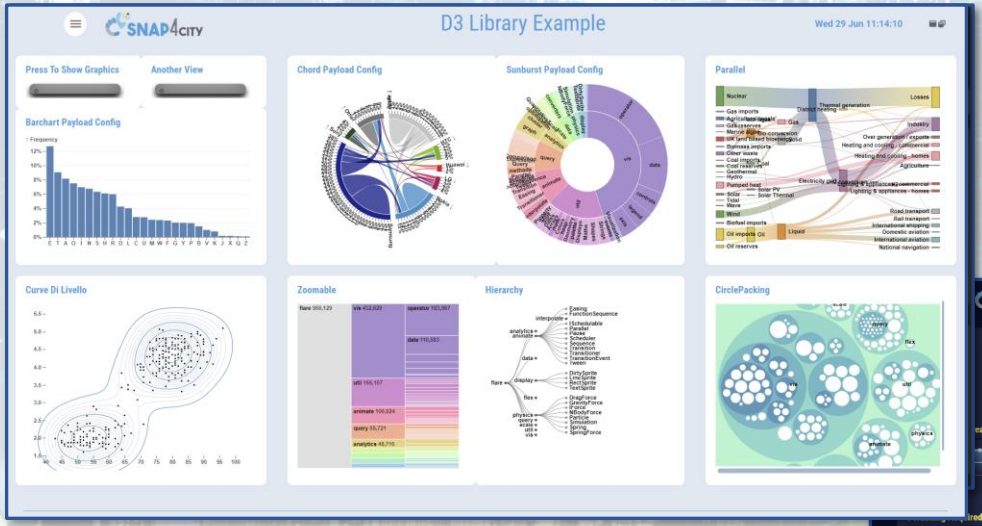
- Recall on Snap4City Architecture
- Dashboards Purposes and Uses
- Main Data Kinds: data vs representations
- Dashboards Main Concepts and simple Widgets
- Creating a Snap4City Dashboard, wizard
- Multi Data Map Widget
- High Level Types, video, external services, synoptics
- Selector for the Multi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

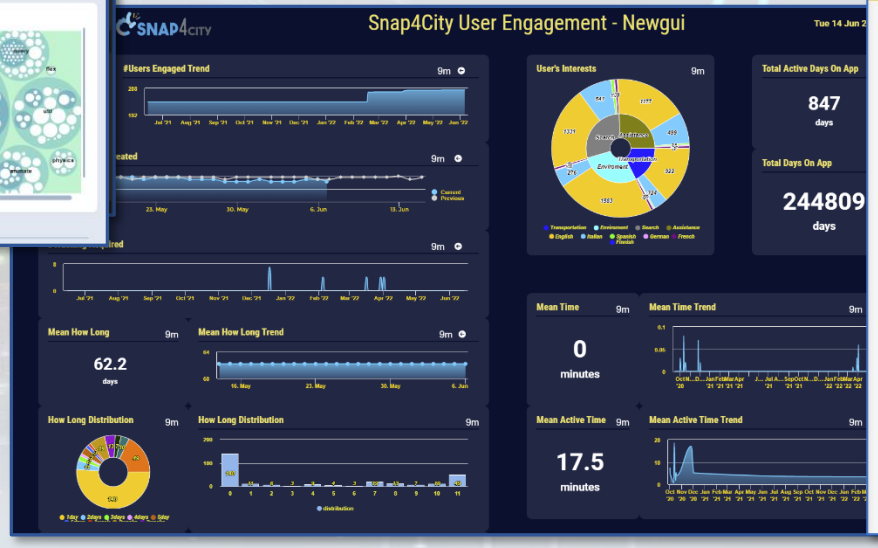
Different Themes

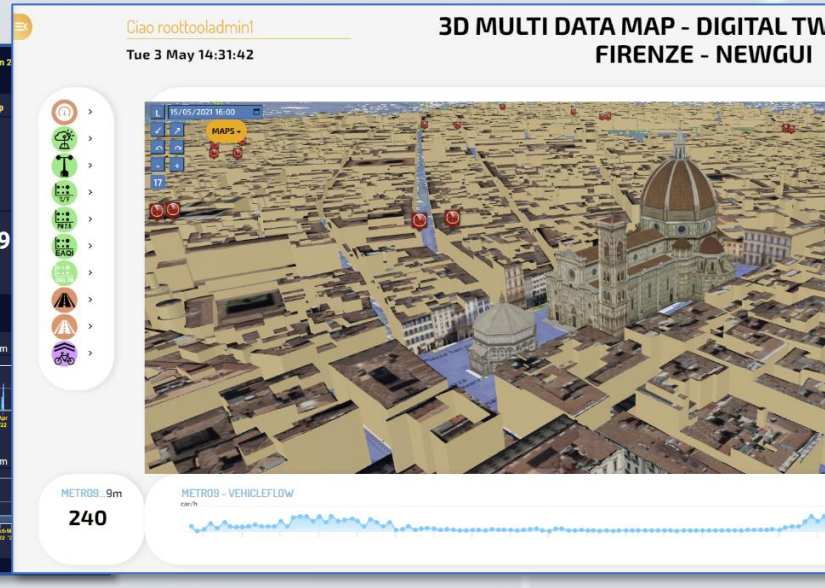










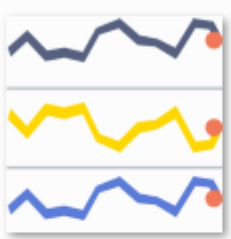


New styles/themes can be developed by specializing a few files from open source

https://www.snap4city.org/793

Visual Representations


Sliderwith-multiple-steps-for-KPI


sparklines

kpi


histogram


heatmap


flow-maps


geo-maps

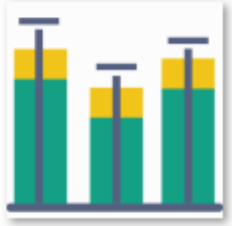

donut-chart

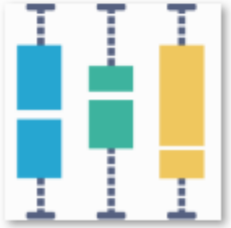

Data-grid


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

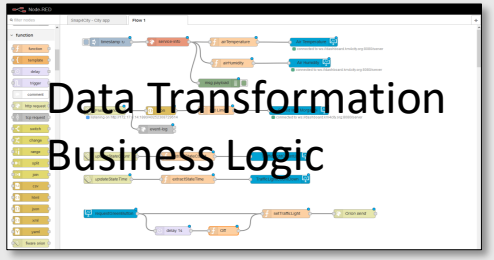

Bubble-maps


waterfall


Sunburst


Sankey

Dashboard Builder: Development



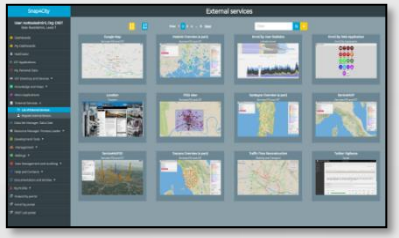
Data Transformation
Business Logic

IOT Applications

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

Widget Collection

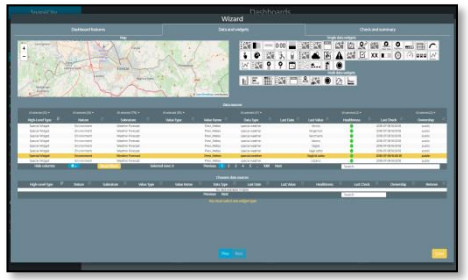
Micro
Applicat
ions



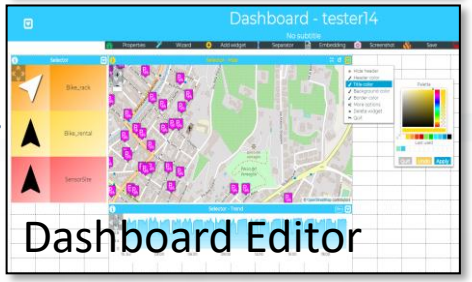
External
Services

Custom
Widgets/
Synoptics

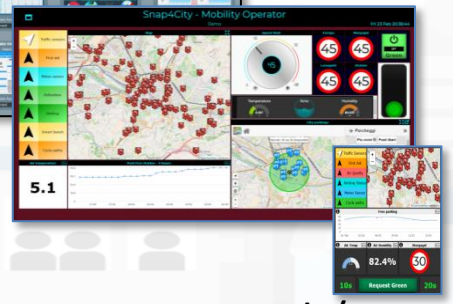
Dashboard Wizard



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

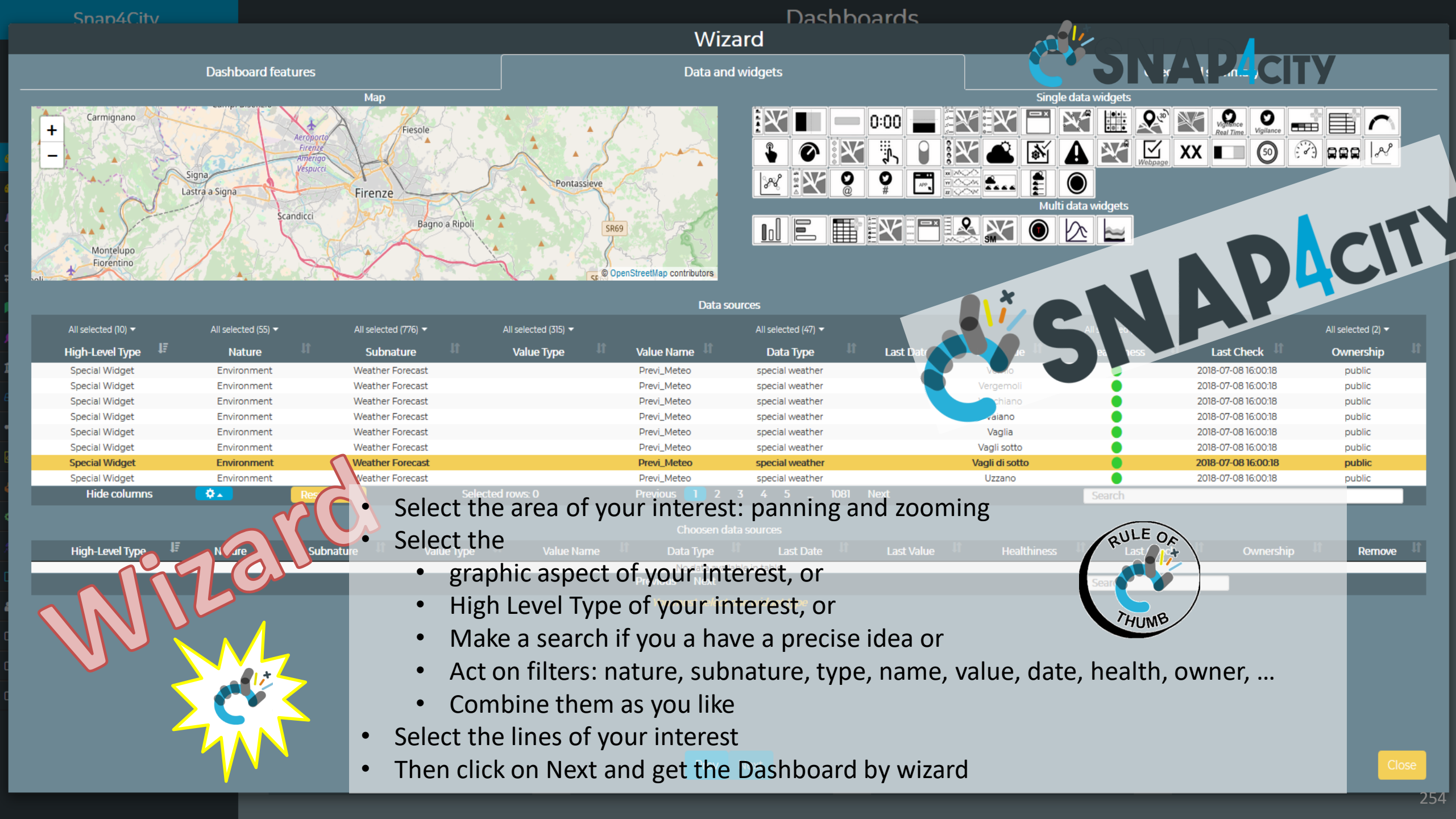


Dashboard Editor



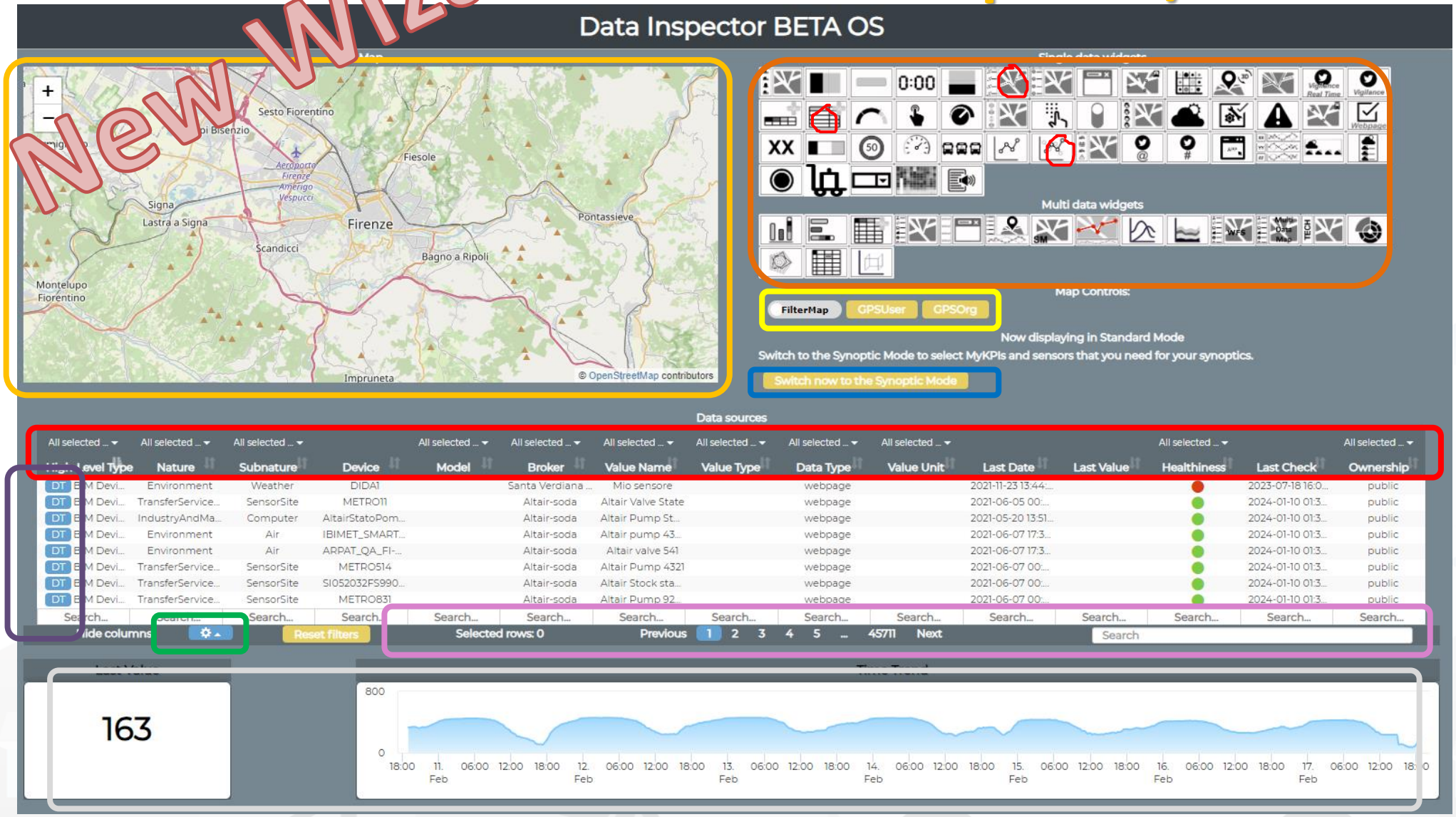
Public
Dashboard
Collection

My Own Dash/App


Wizard
Dashboard features
Data and widgets
Map
Single data widgets
Multi data widgets
Data sources
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
RULE OF THUMB
Close

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)

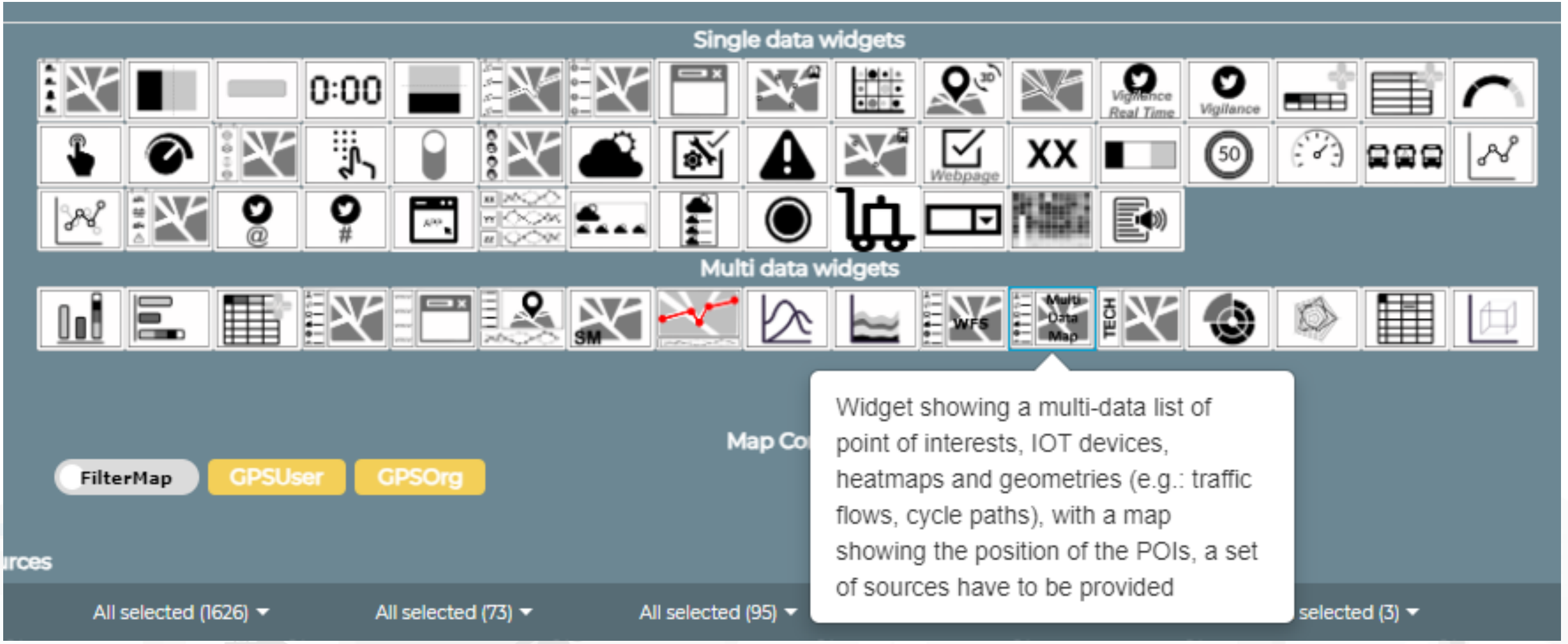
Data and Trend visualization

Opening Digital Twin

Pass to Synoptic mode

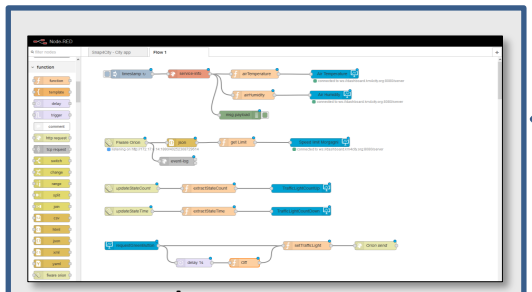
Select the graph representation

Widget selection

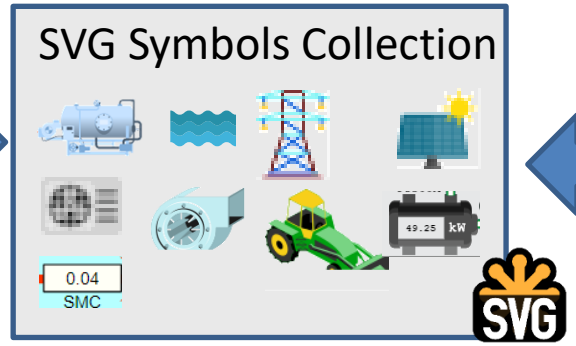


Part 3

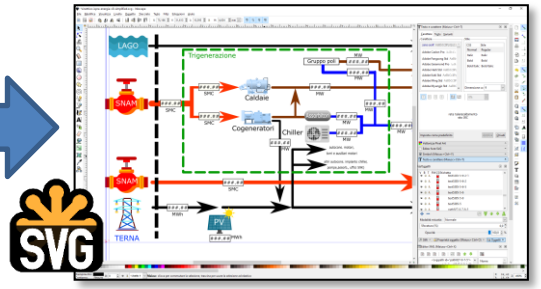
Custom Widget / Synoptic / PIN Development



IOT Applications

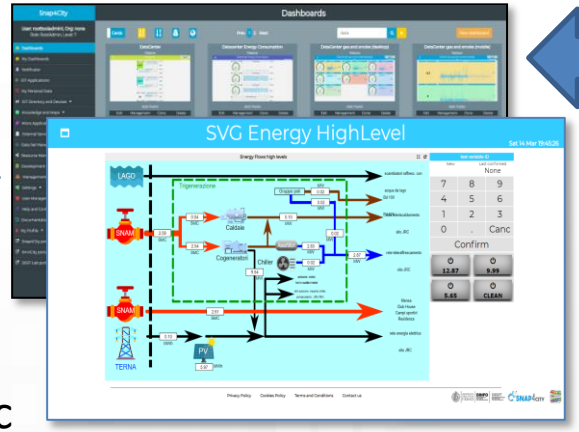


Inkscape editor on your computer

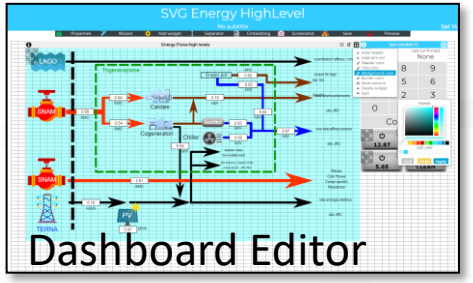


Create, save a Custom Widget in SVG

Knowledge and Storage Data from the Field and City



Public Dashboard Collection



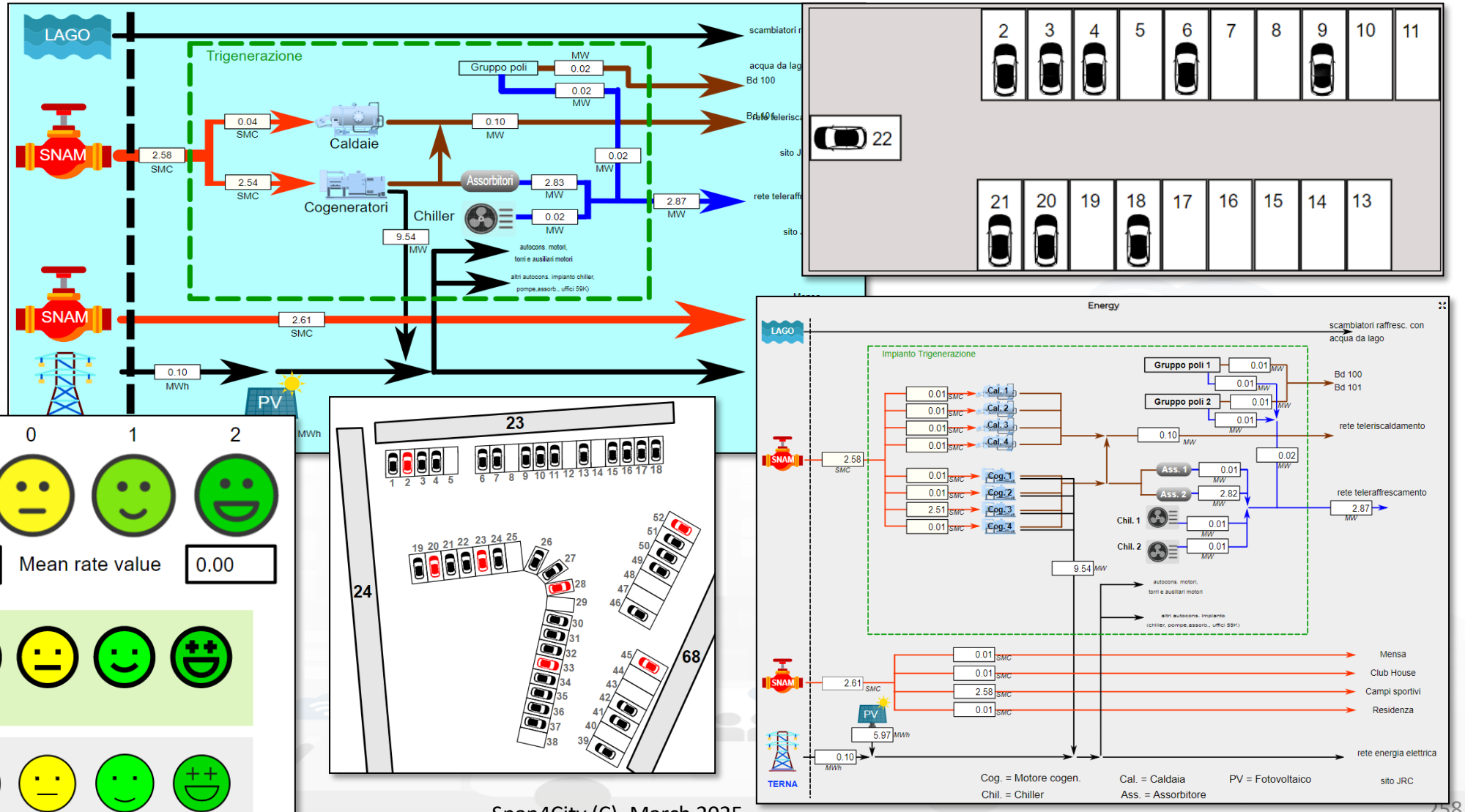
Create, save, load, delegate, grant access

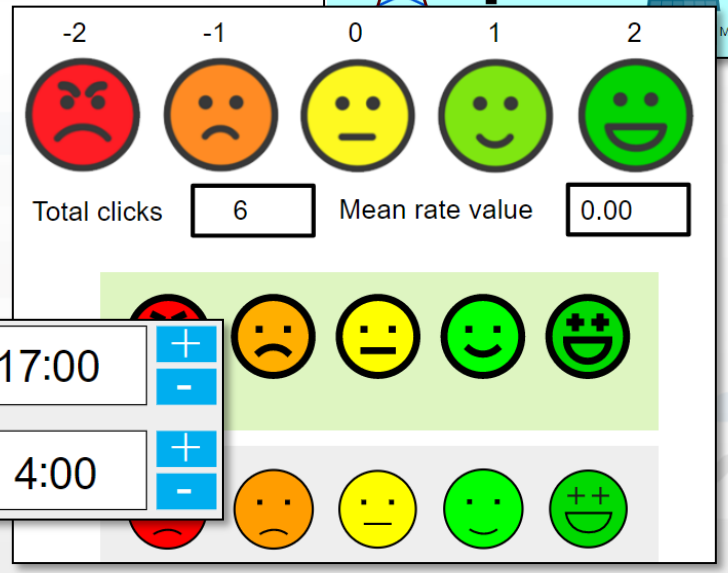
My Own Dash/App

1. Create and Load a Custom SVG
2. Select/Reuse an SVG
3. Make and Instance of Synoptic by Associate Variables with MyKPI
4. Create on Dashboard a Widget based on Synoptic HLT such as Ext. Srv.:
   - https://www.snap4city.org/synoptic/v2/synoptic.html?id=xxxx

Special Custom Widgets

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

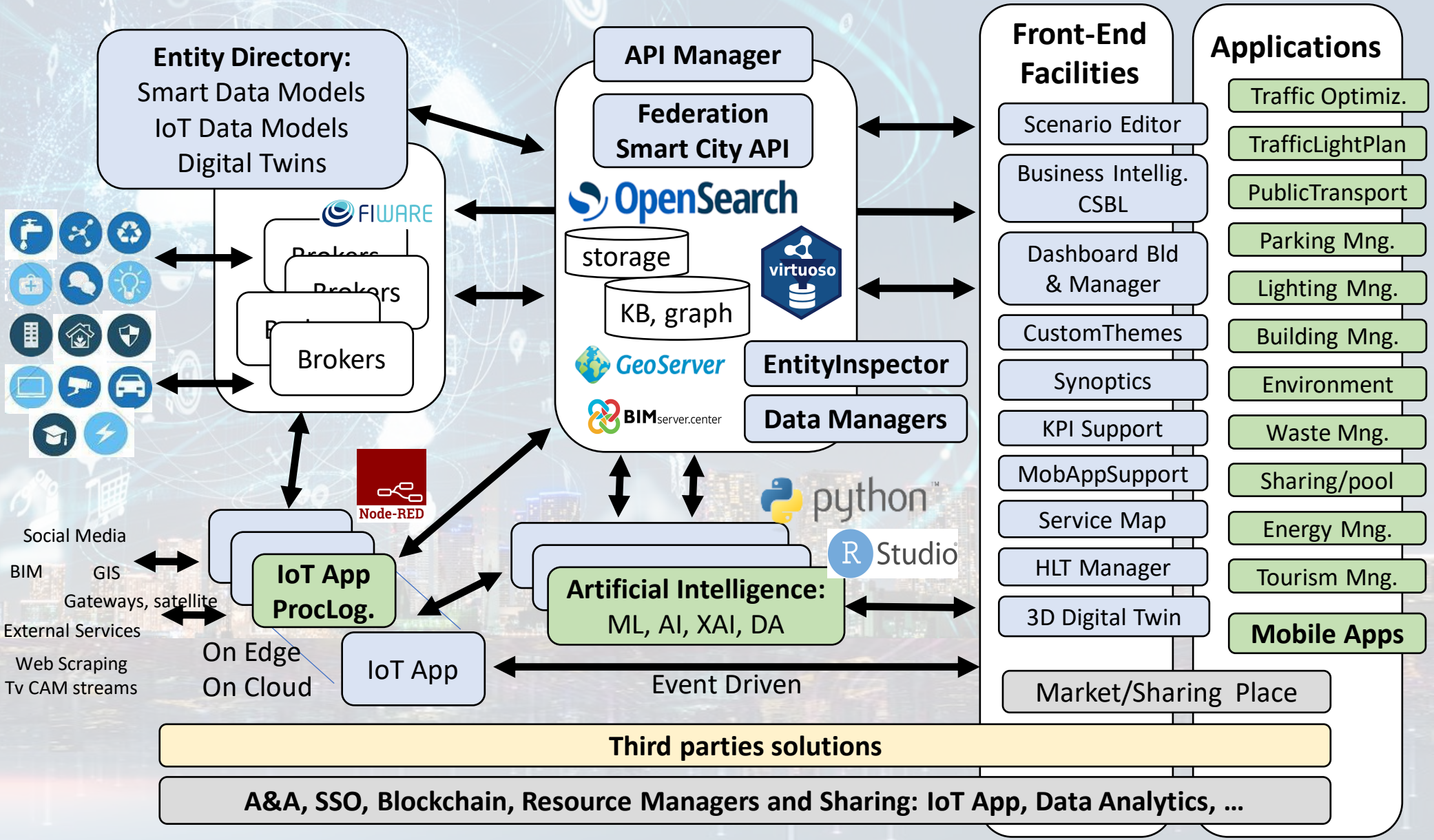


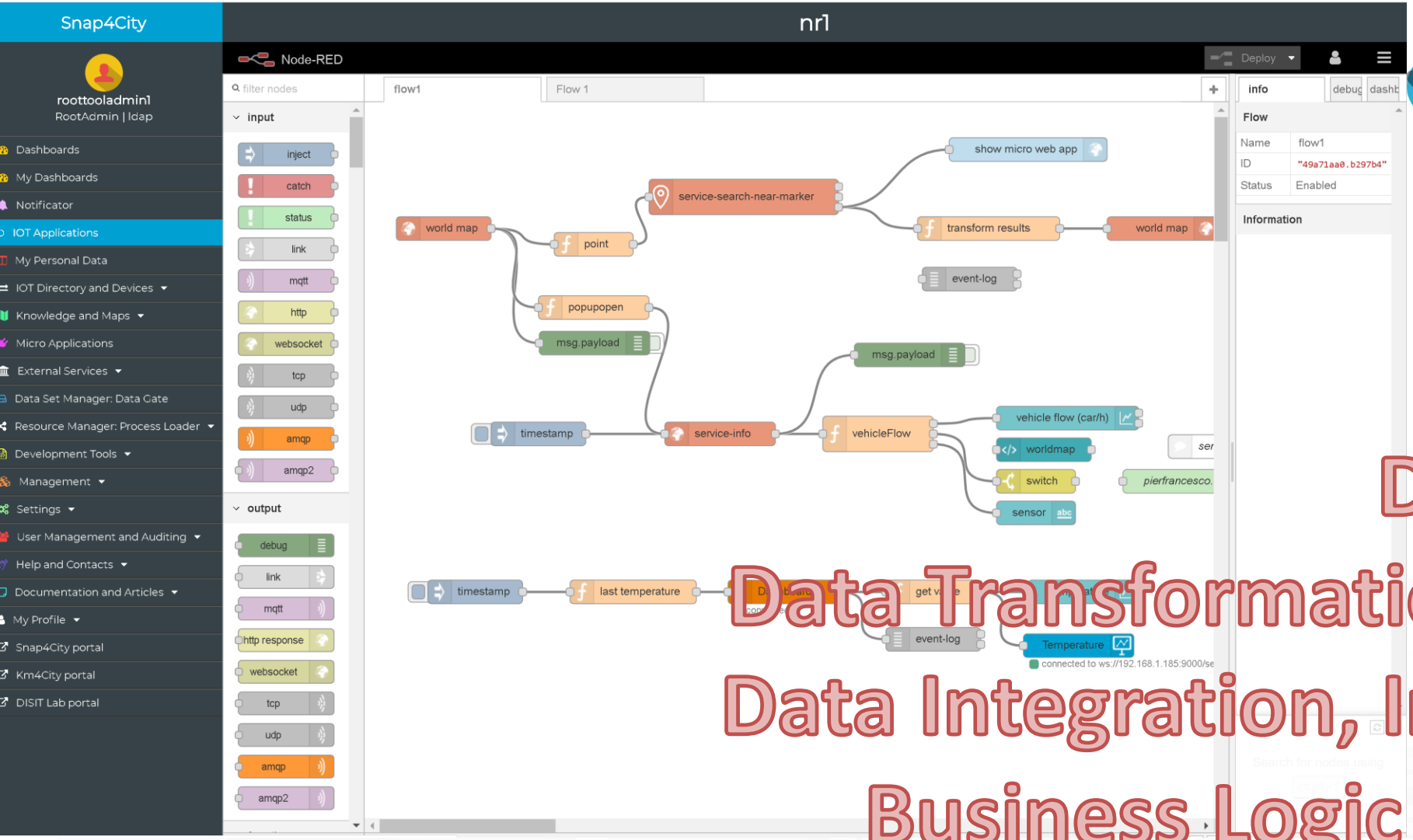


Part 3: IoT App, process logic, server side BL

- 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

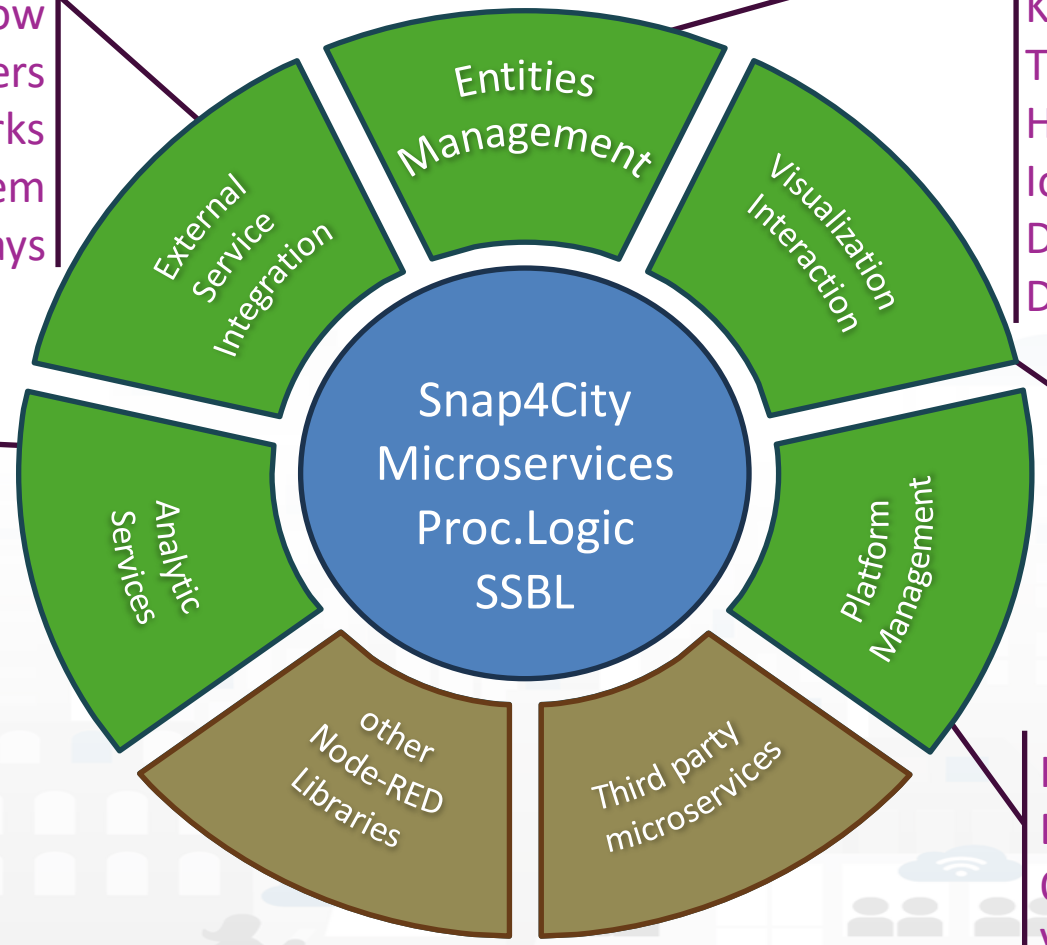
Data Analytics control

Editing IOT Applications

Everywhere: Cloud, on IoT Edge Devices

MicroServices Areas

> 60.000 downloads



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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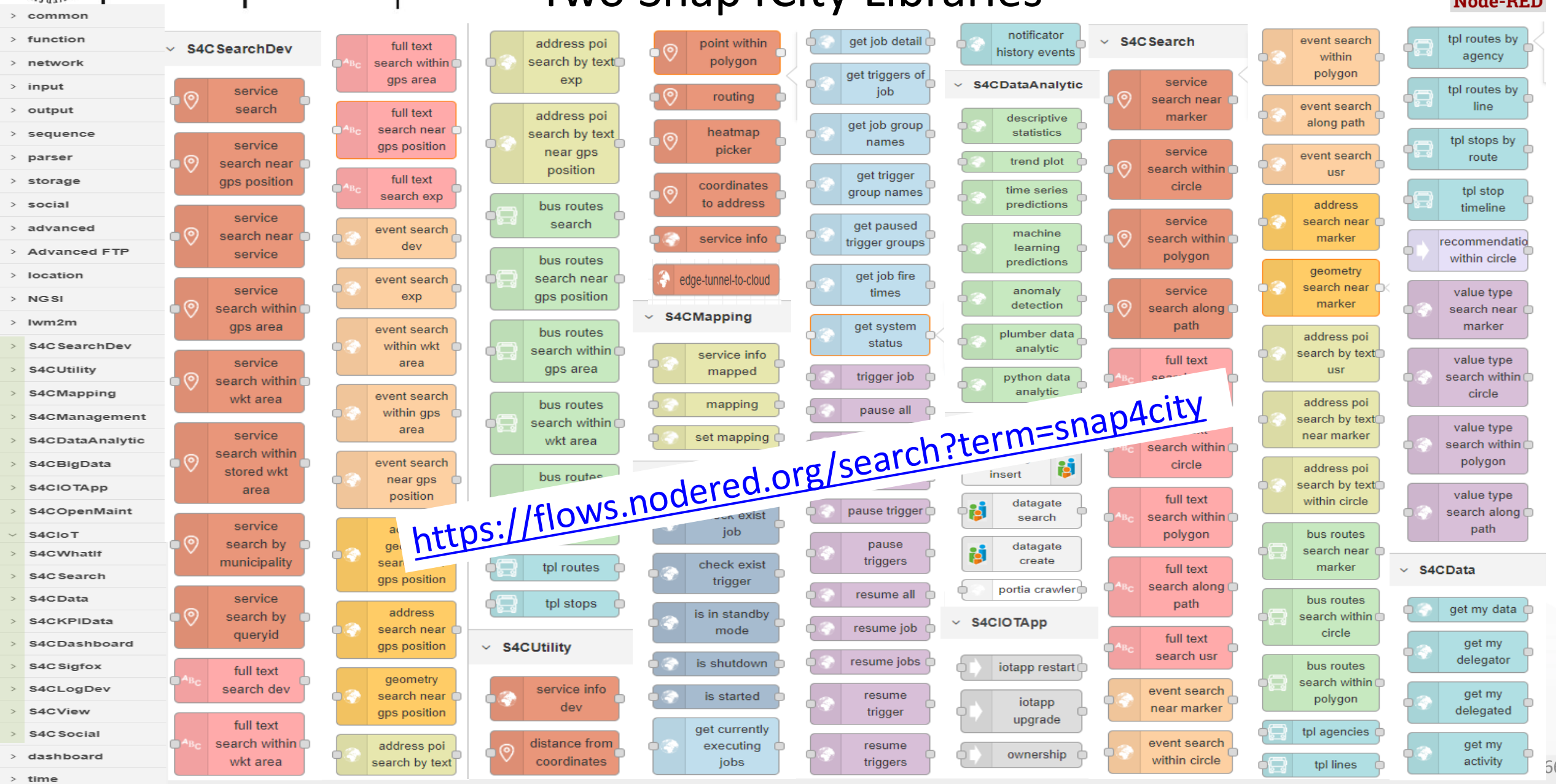
Sept 2024 collection

Two Snap4City Libraries

SNAP4CITY | Node-RED

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



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Sept 2024 collection

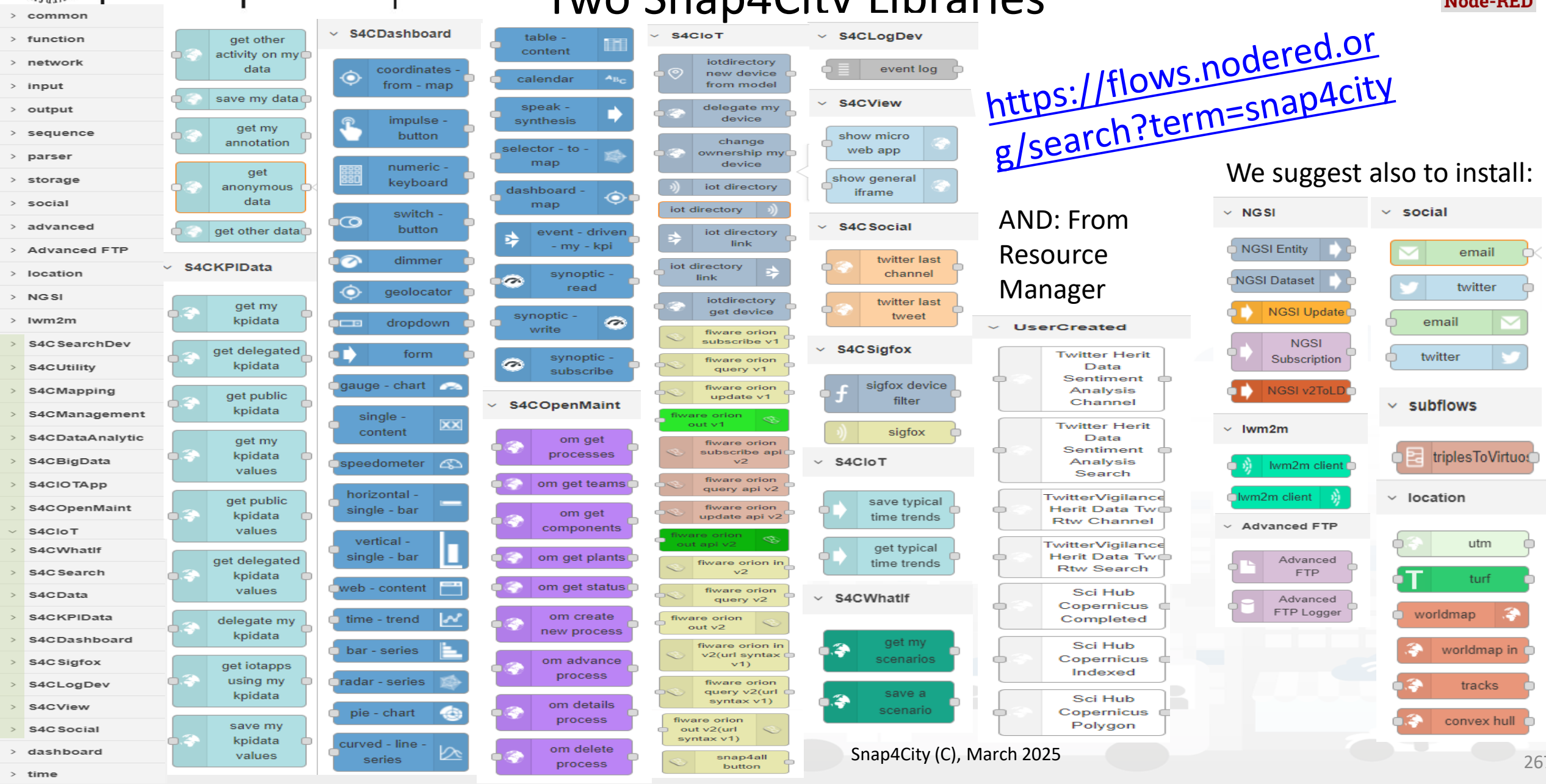
Two Snap4Citv Libraries

SNAP4CITY | Node-RED

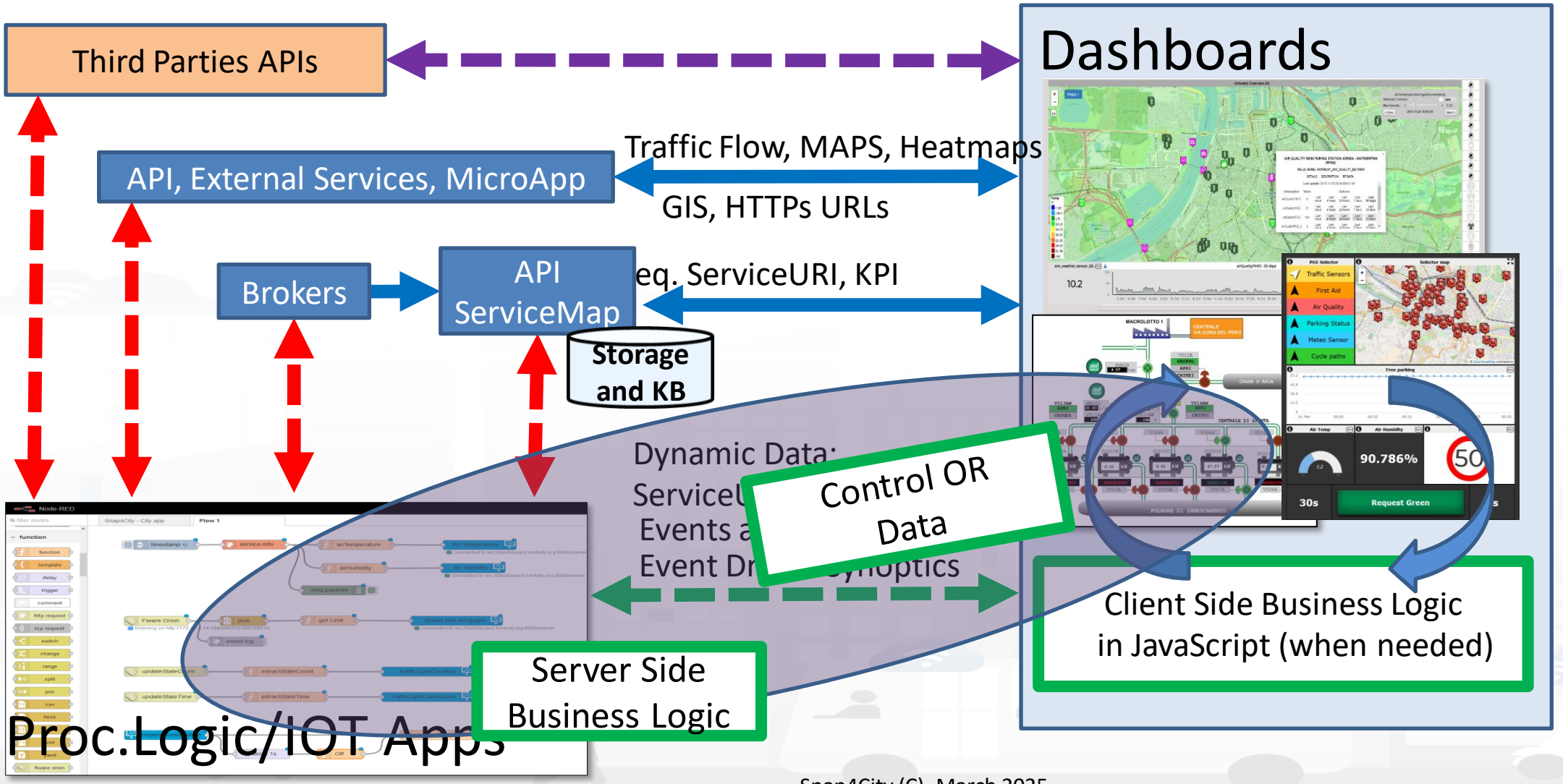
https://flows.nodered.org/search?term=snap4city

We suggest also to install:

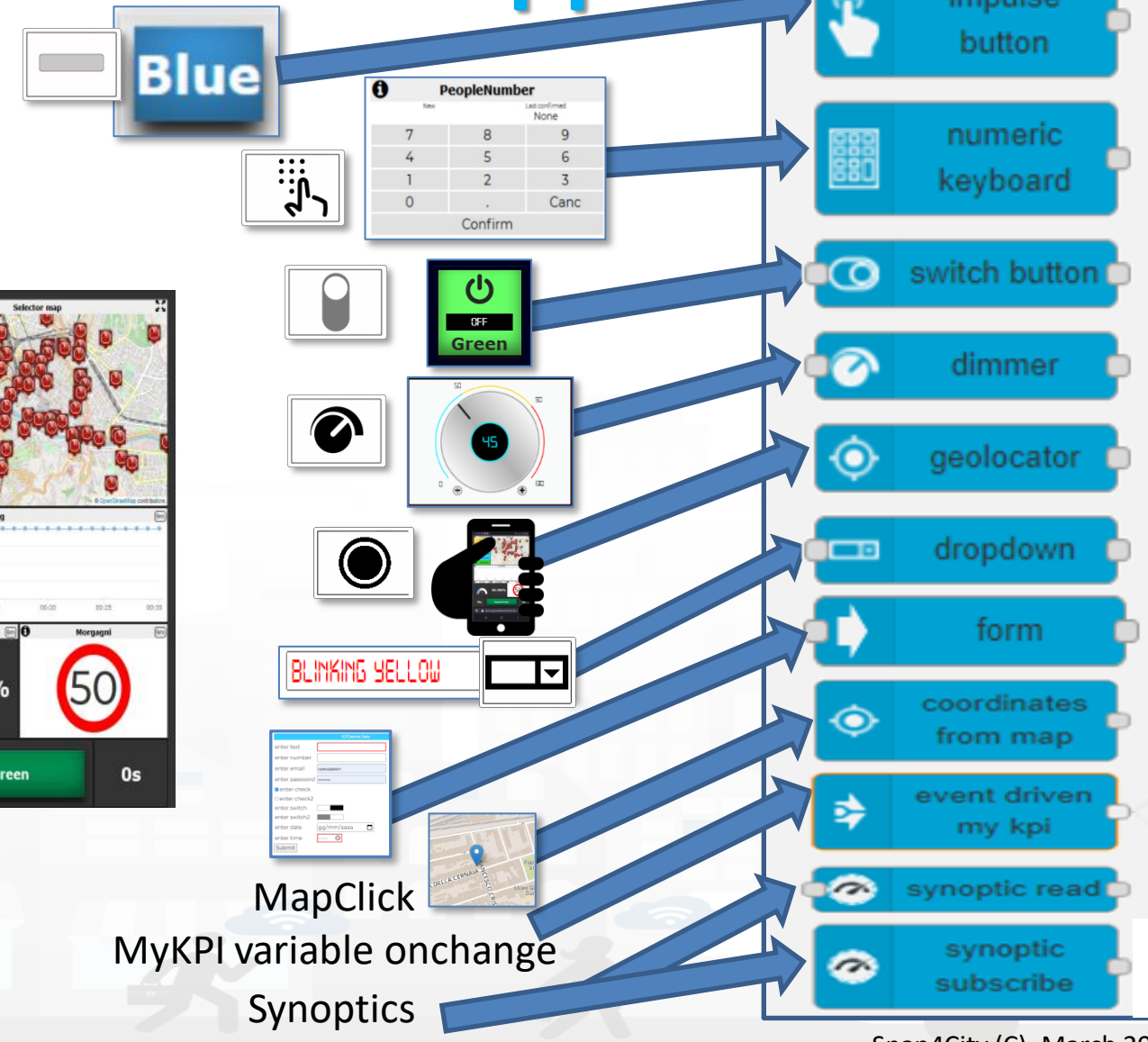
AND: From Resource Manager



How the Dashboards exchange data



Dashboard-IoT App

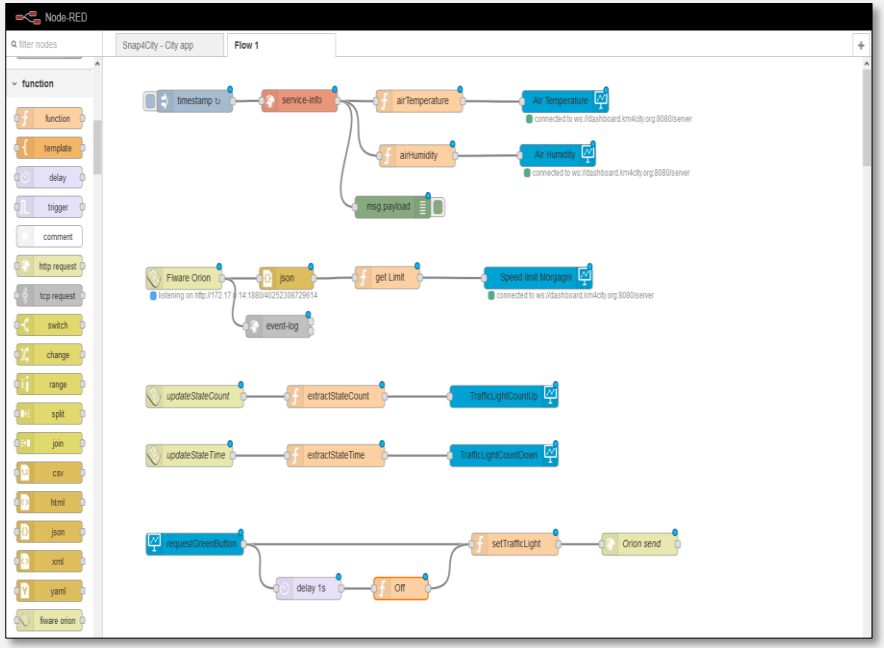


MapClick

MyKPI variable onchange

Synoptics

From Dashboard to IOT App



IOT Application

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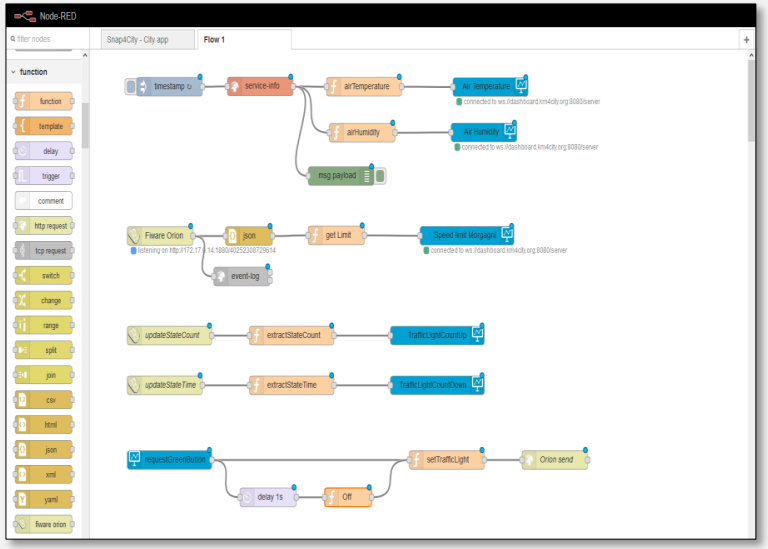
Nature Dashboard-IOT App

SNAP4CITY Node-RED

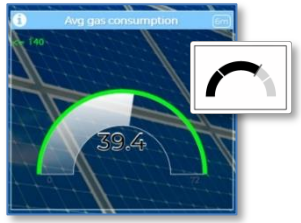
From IoT App to Dashboard

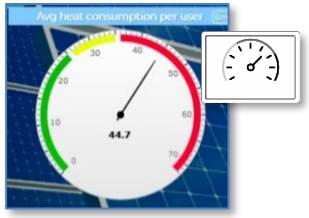


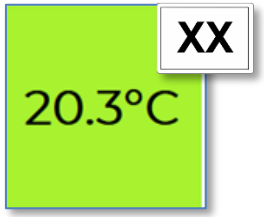
IOT Application

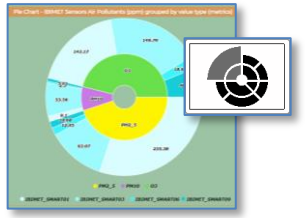
- gauge chart
- single content
- speedometer
- horizontal single bar
- vertical single bar
- web content
- time trend
- bar series
- radar series
- pie chart
- curved line series
- table content
- calendar
- speak synthesis
- synoptic write
- Selector - Map

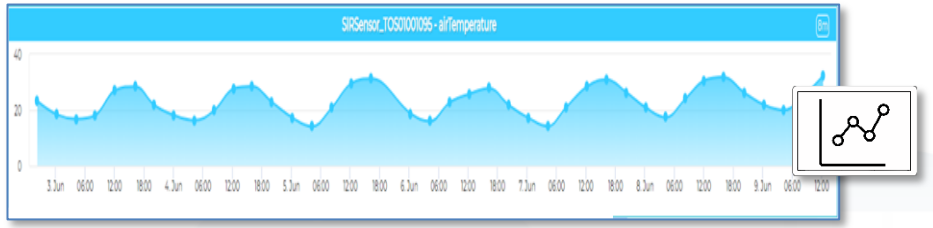
- Snap4D3
- dashboard - map
- event table
- device table

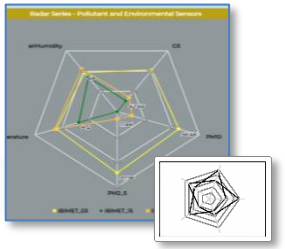


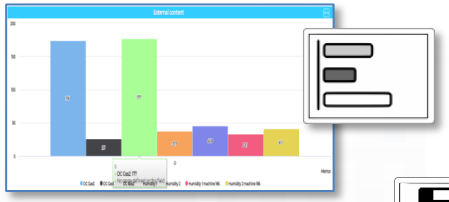


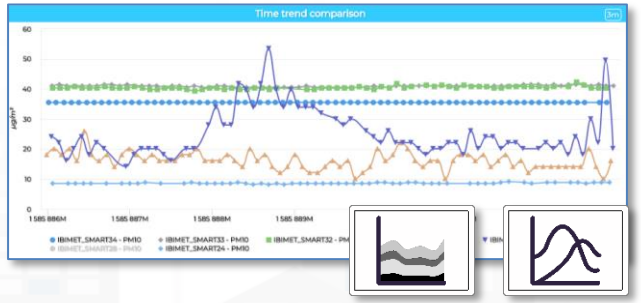


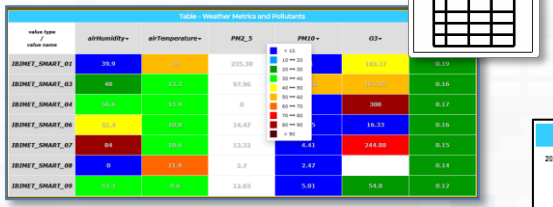


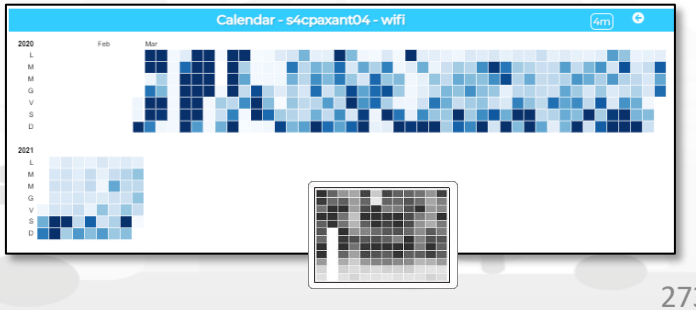










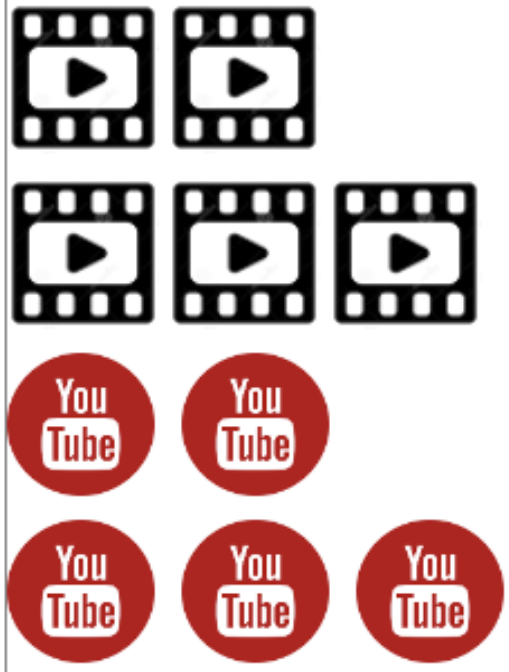


Part 5: Data Ingestion and Interoperability

Part 5: Data Ingestion and Interoperability

SLIDES

Interactive Slides

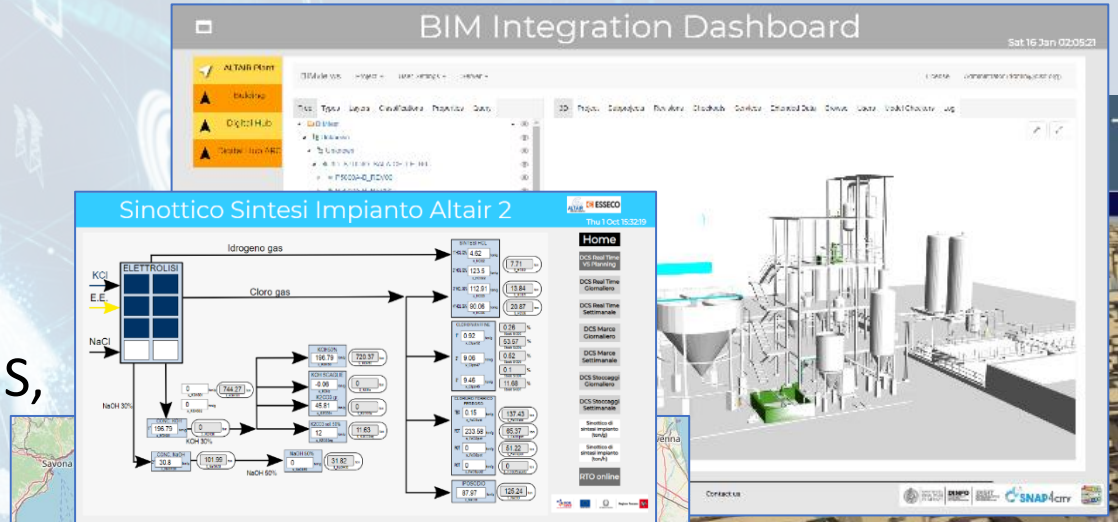


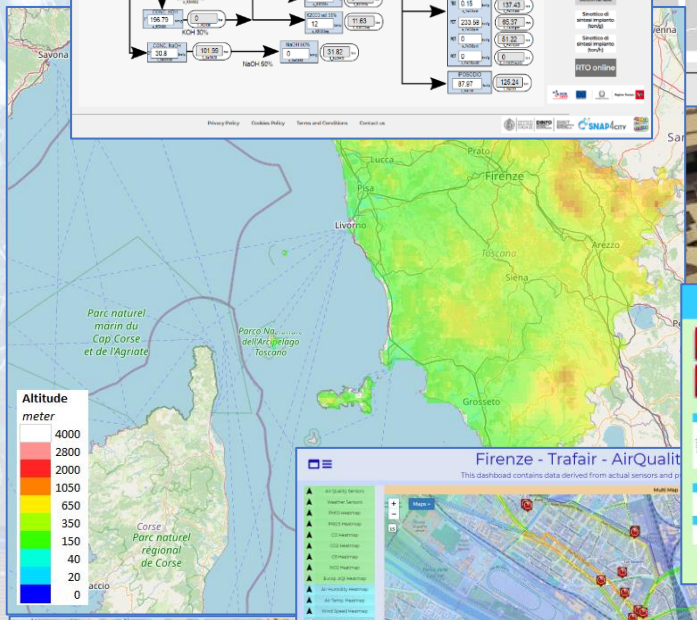
- When Solutions and tools for Data Ingestion and Interoperability are needed
- Overview of Snap4City Data Storage and Stack
- Knowledge Base: Modelling and Setting Up
- High Level Types vs Ingestion Process
- Data Ingestion Strategy and Orientation
- Ingestion of Points of Interest with POI Loader
- 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

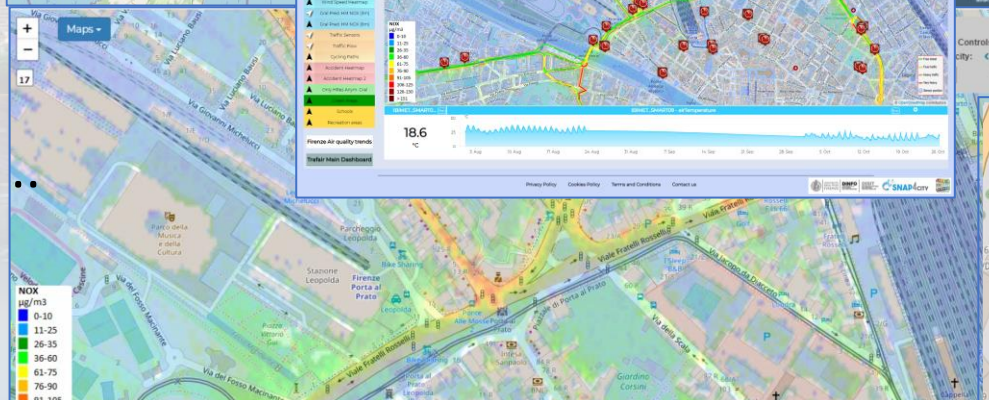
High Level Types

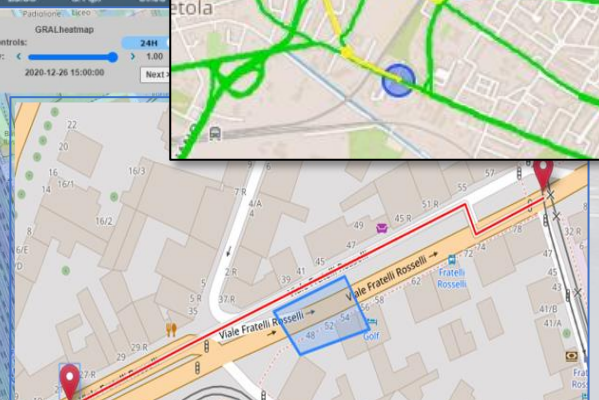
Snap4City (C), March 2025

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









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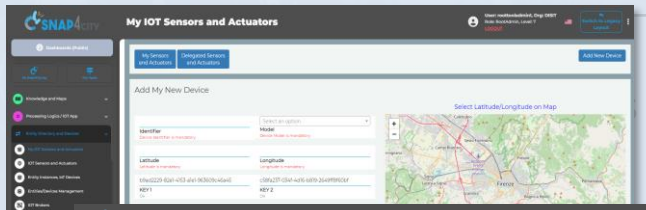
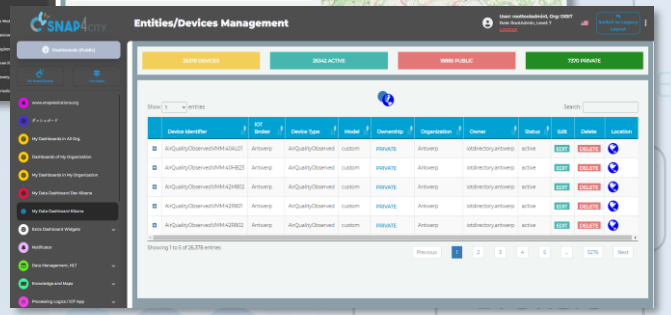
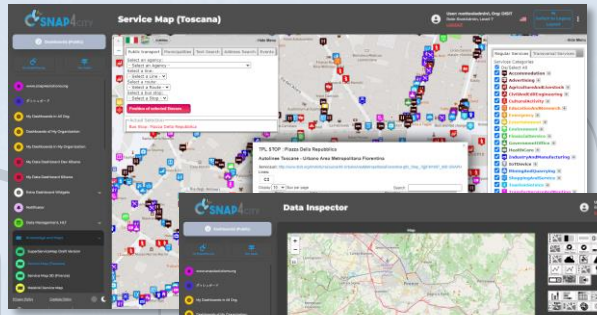
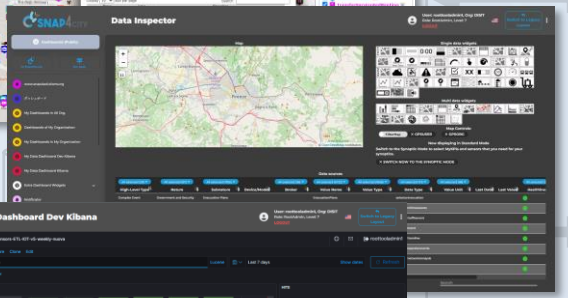
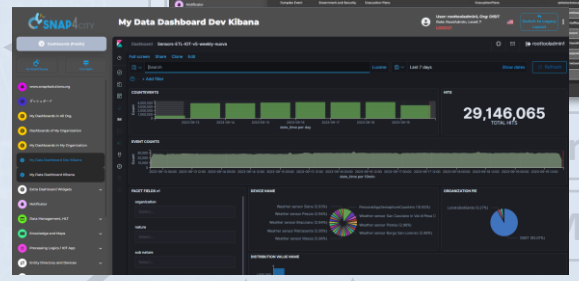
Visual Development Tools

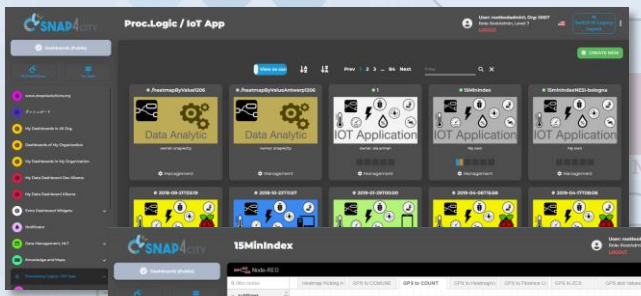


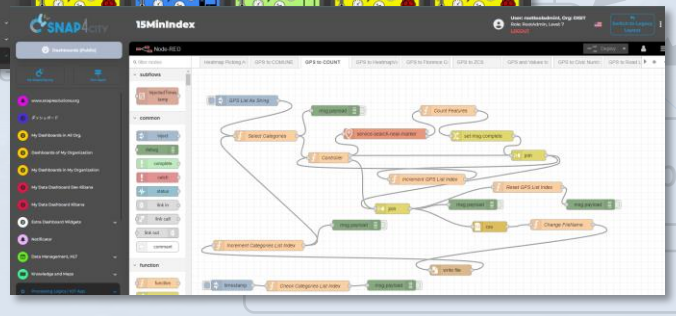


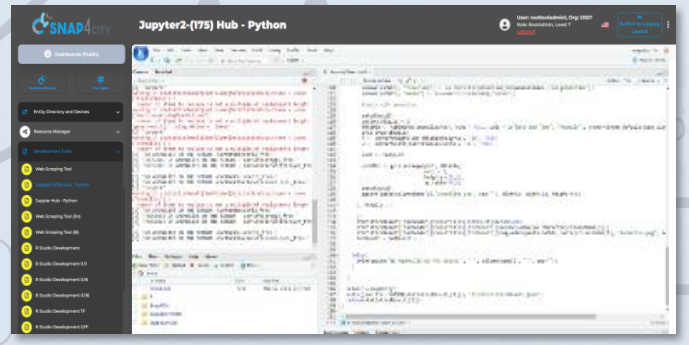


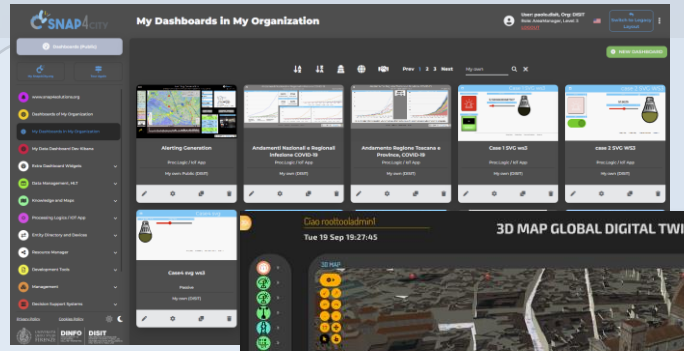


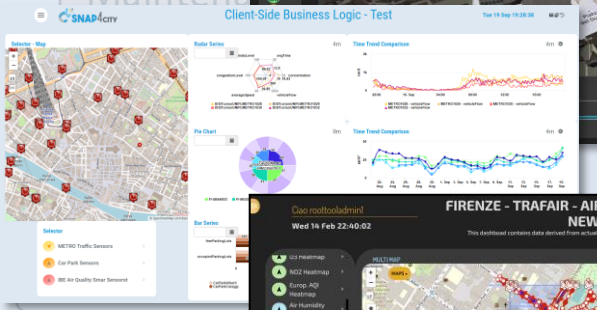


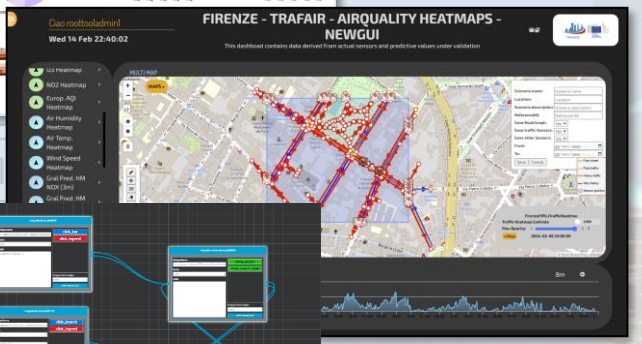


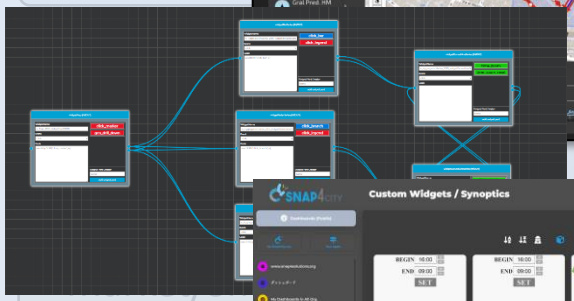












Maintena

nspector

Managers

Service M

Node-RED

Third parties solutions

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

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

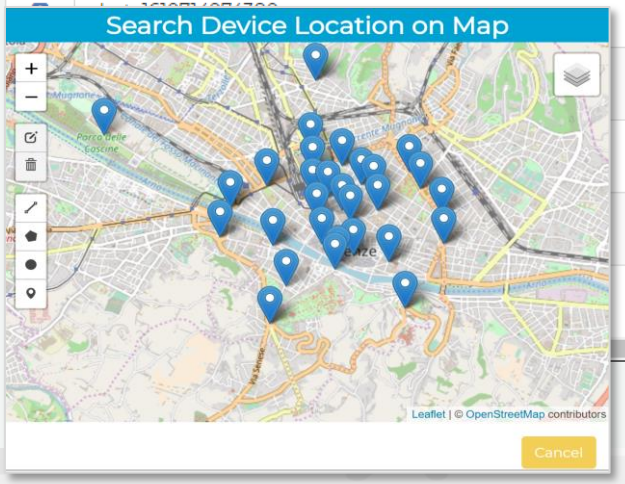
Add new device

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

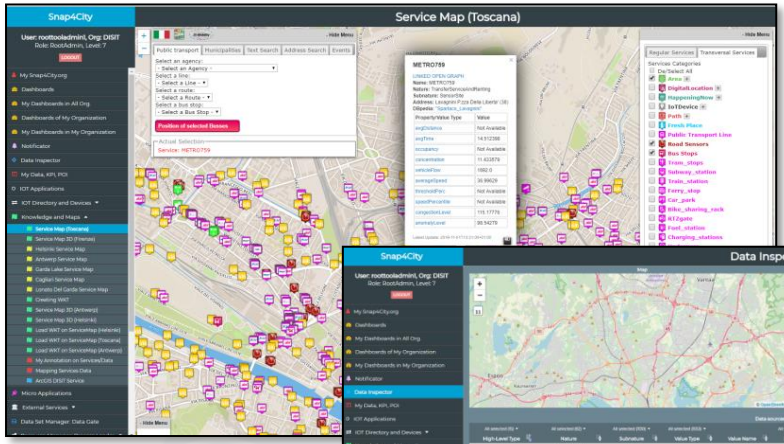


Checking data/Entity ingestion results

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



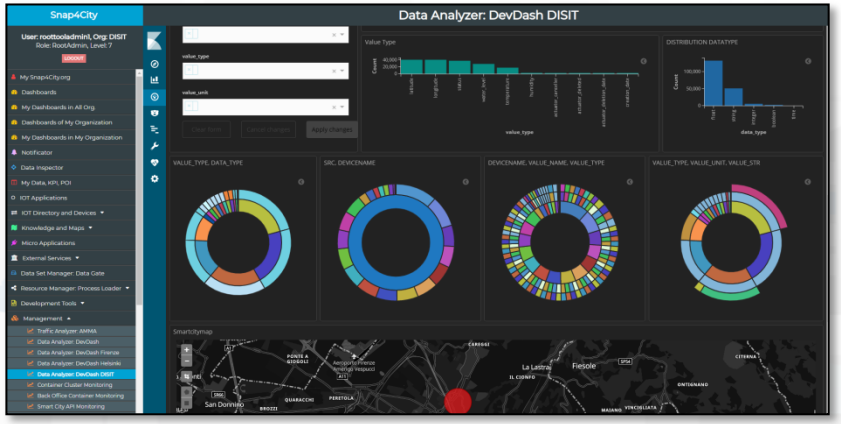
ServiceMap or
Super ServiceMap

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)**

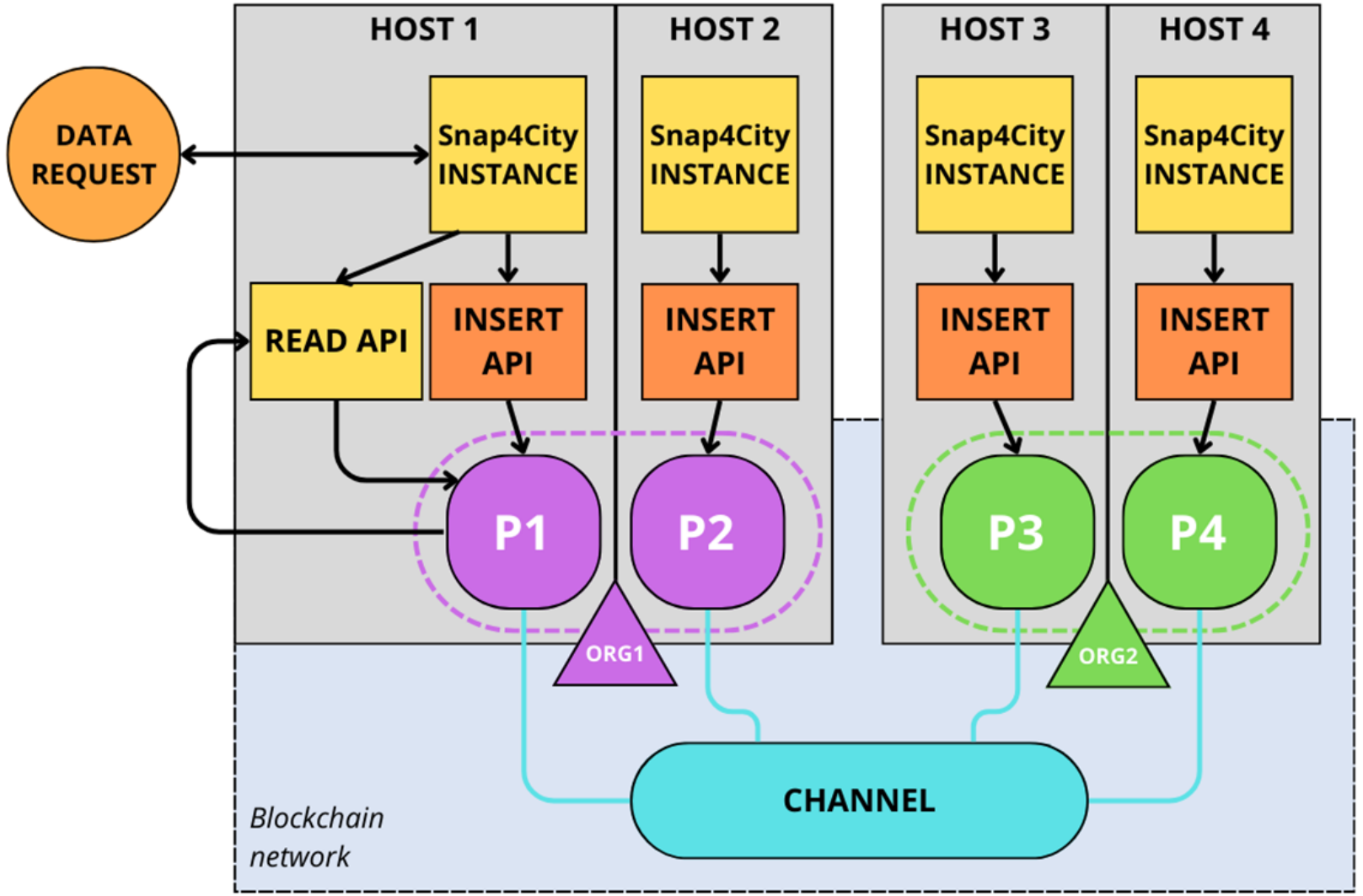


My Data Dashboard

DevDash

Some functionalities are limited to certain roles

Snap4City with Blockchain



Part 4: Data Analytics

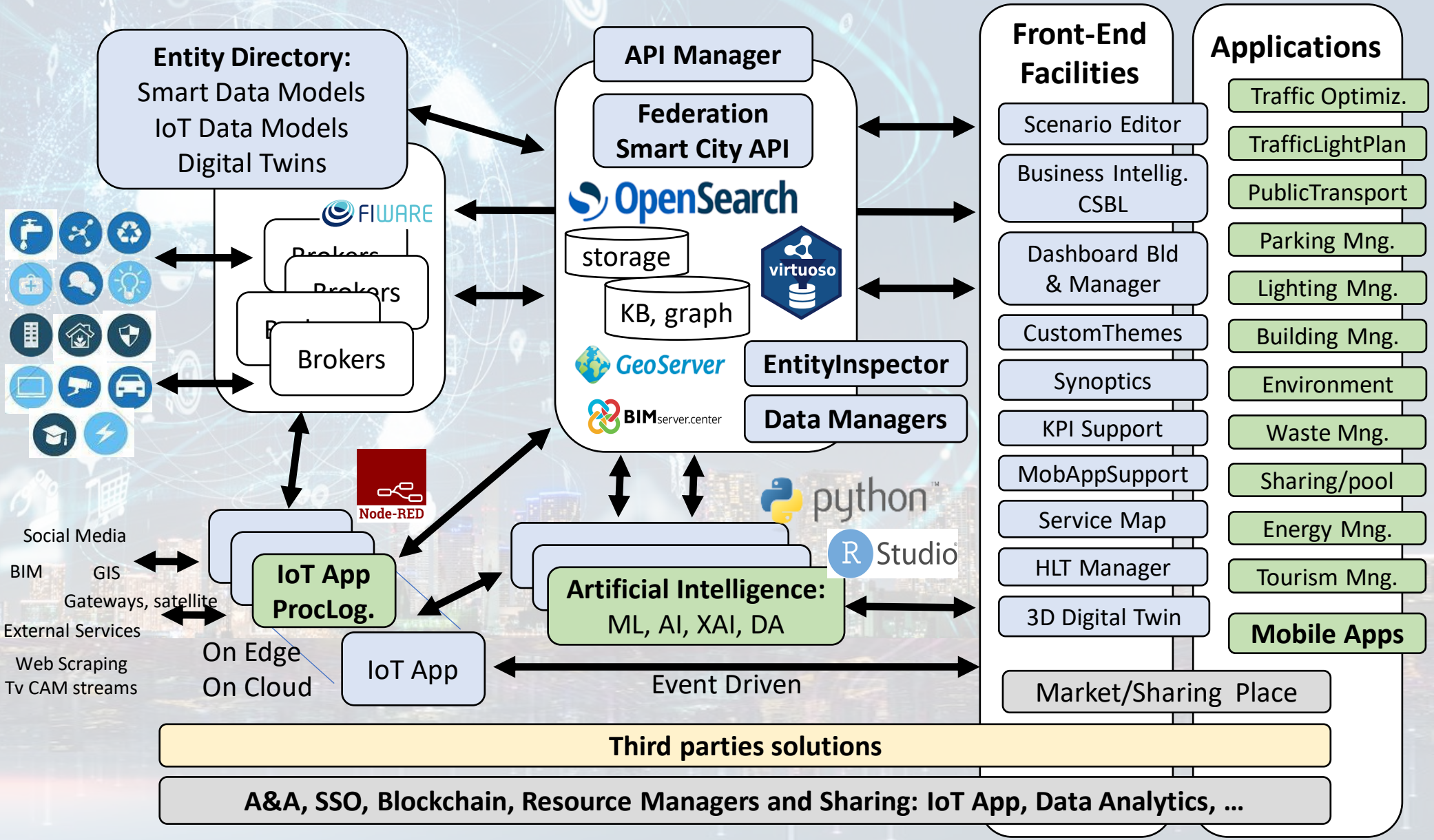
Part 4: Data Analytics and Artificial Intelligence

SLIDES

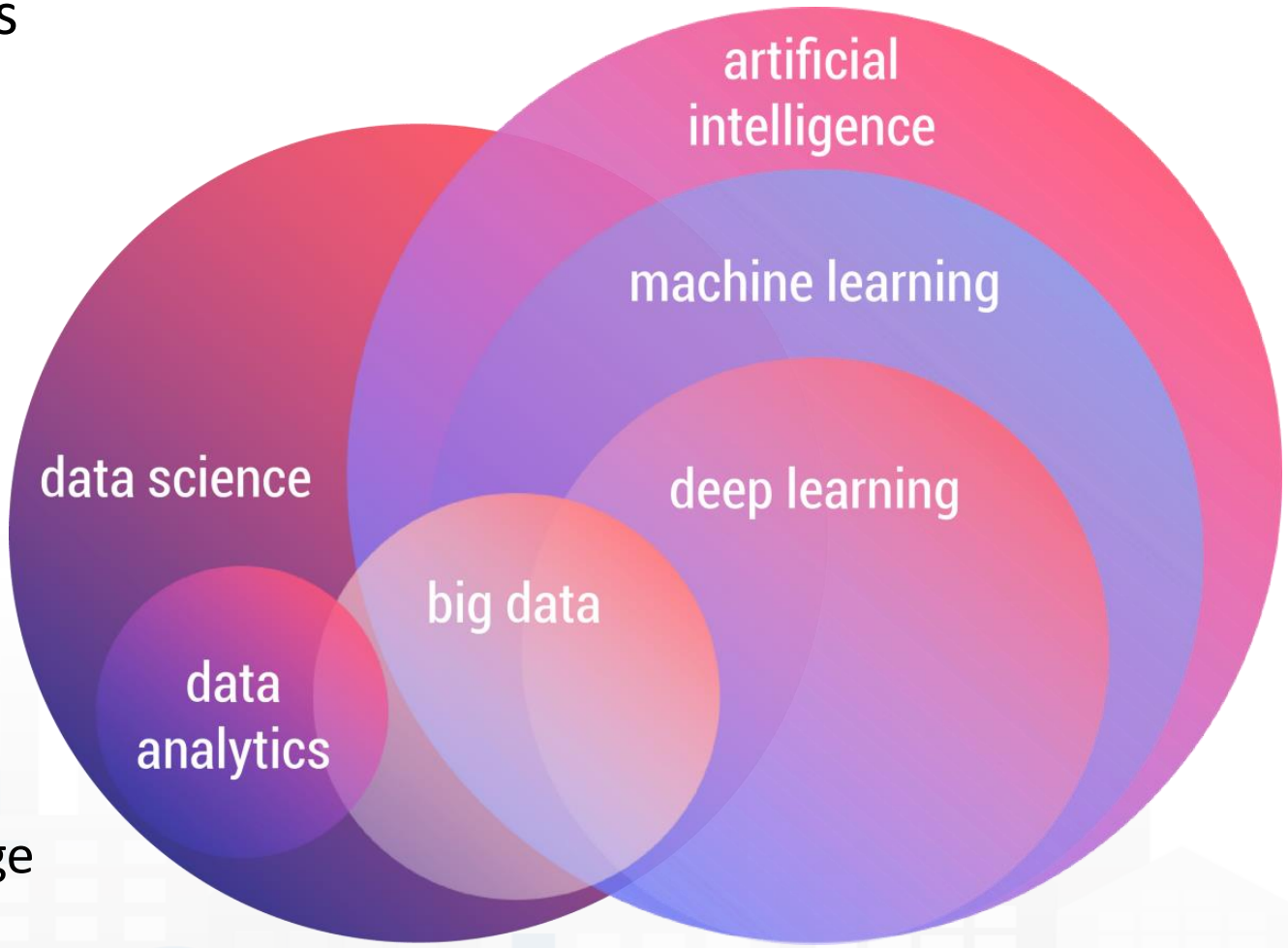
Interactive Slides

- Why and Where use DA, AI and XAI -> General Life Cycle, scenario editor, monitoring and control
- Data Processing: KPI, traffic, emissions, public transport quality, ..
- From Data Analytics, DA to Artificial Intelligence, AI
- List of the most relevant available DA and AI Solutions
- Predictions and Anomaly detections: parking, biking, NOx, landslide, people
- Computing: Higher Level Types Data and their representations: traffic, heatmaps, 3D
- Human Behavior, Engagement, Typical Time trends, WIFI sniffing
- Using AI in main domains: Mobility and transport, traffic optimization, Smart Energy, Smart Building,
- How AI/XAI, and Life Cycle, AI/ML requirements, XAI,
- Using DA, AI/XAI in Snap4City infrastructures
  - Data Analytics <-> IoT App / Proc.Logic
  - MLOps, ClearML, exploiting clusters of GPU/CPU
- Decision Support Systems and What-If Analysis, transport offer, DORAM tool
- Routing, Multimodal Routing, Dynamic Routing
- Predictive Maintenance
- Training Material

Technical Architecture

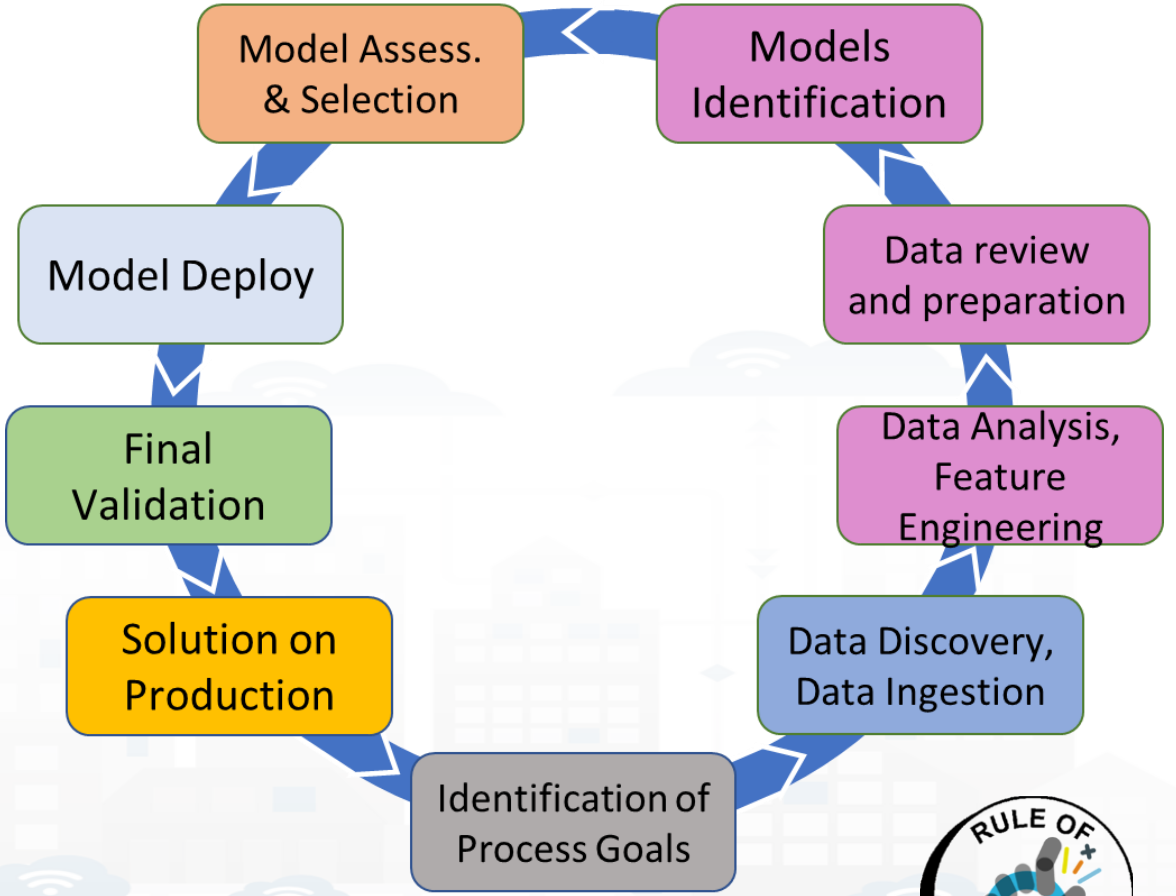


- **Artificial Intelligence** usually also includes
  - Code, learning and reasoning
  - Semantic computing, Knowledge Bases
  - Neuro-symbolic reasoning
  - Decision Support Systems
  - Problem solving
- **Machine Learning** usually includes
  - Learn without coding
  - Predictions, decisions (classifications)
  - Supervised or not
  - NLP, vision, pattern recognition
- **Deep Learning** usually includes
  - Capability to learn complex patterns on huge amount of data
  - Generative AI, continous learning, graph NN, etc.
  - Specialized ML solutions



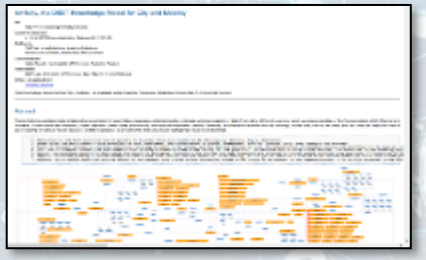
Model/Technique Development/testing

- **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

TensorFlow

NVIDIA CUDA

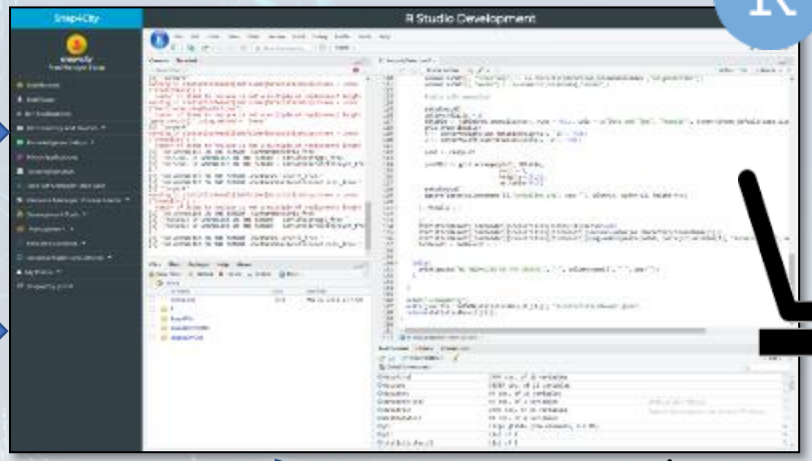
python

jupyter

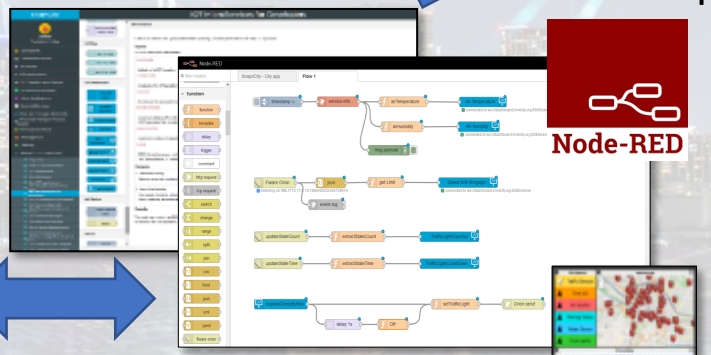
R Studio

SNAP4CITY

KM4CITY



Creating MicroServices



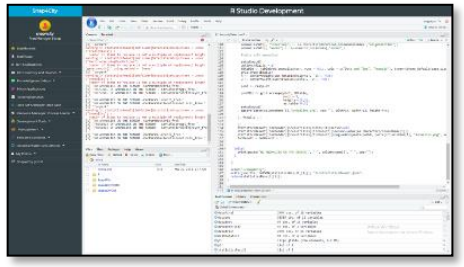
Node-RED

Using them into IOT Applications

Saving / Sharing reusing

Resource Manager

Development



API

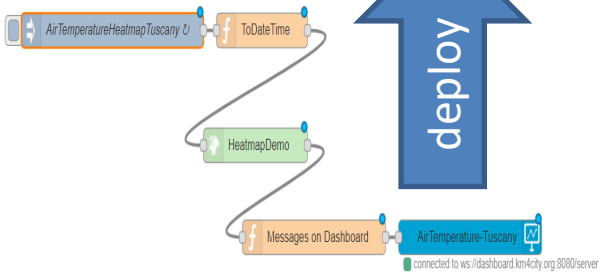
Big Data Store Facility

API

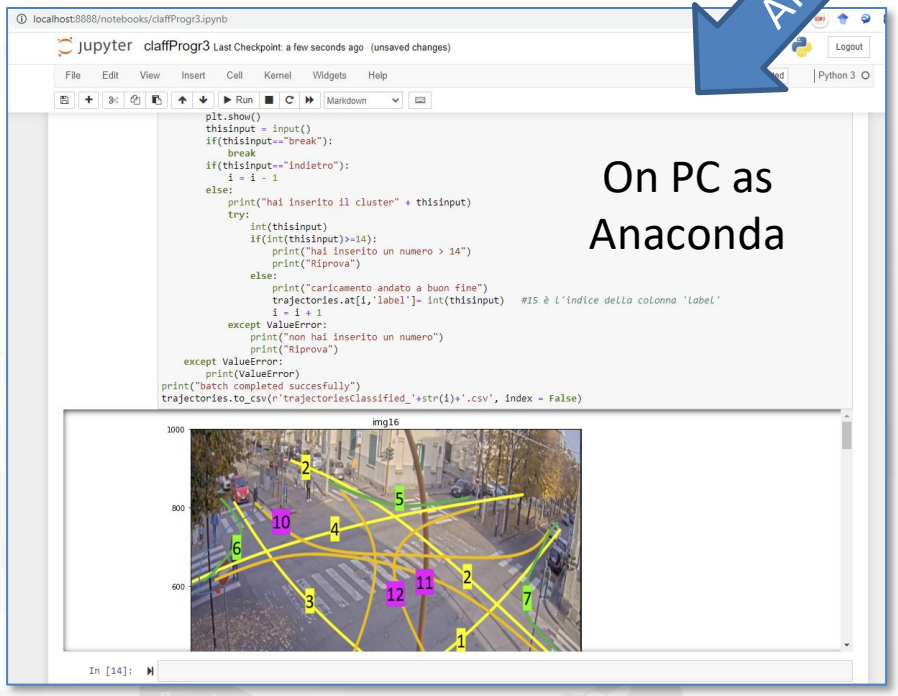
docker

Data Analytic

deploy



On Server
Or
On PC



On PC as Anaconda

Once finalized

File.py
AI Model
Mapping Data..

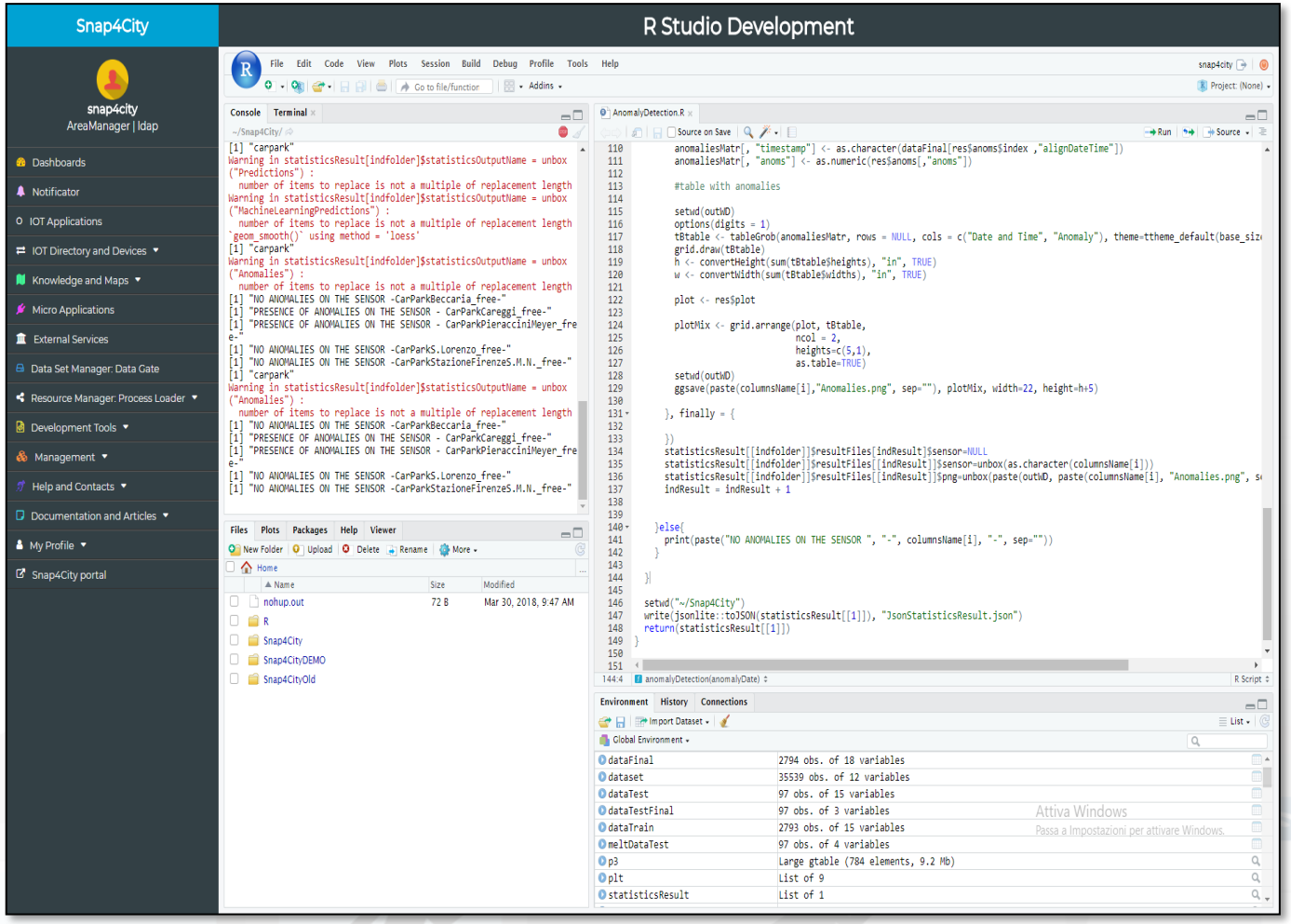
ZIP

Load File.py or .zip

python data analytic

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

1 Developer in R Studio + Tensor Flow

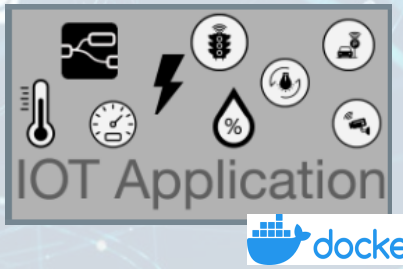


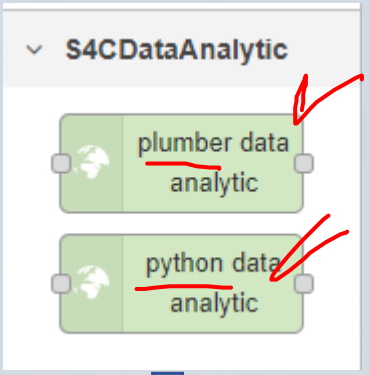
Data Analytic Container

1

Develop .py **or** .r program on (i) Snap4City platform online, or (ii) your Development Machine.
The code has to respect the guidelines provided for creating API.
The API are called as a MicroService
For example see:
https://www.snap4city.org/641
https://www.snap4city.org/645

2 Open an Advanced IoT App / Node-RED

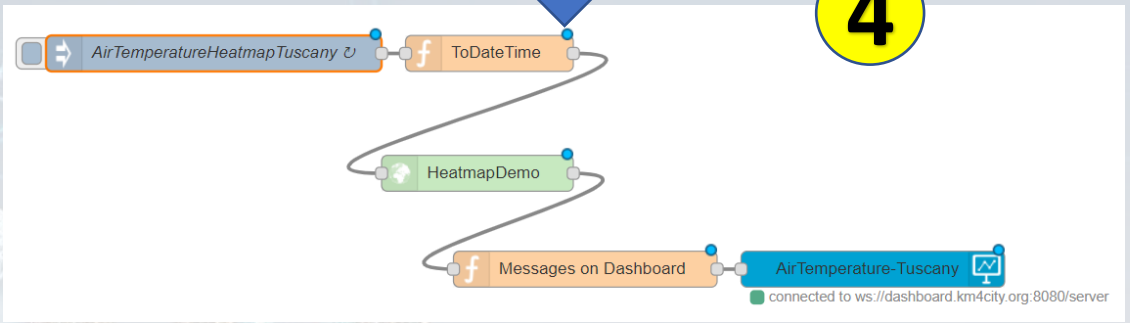




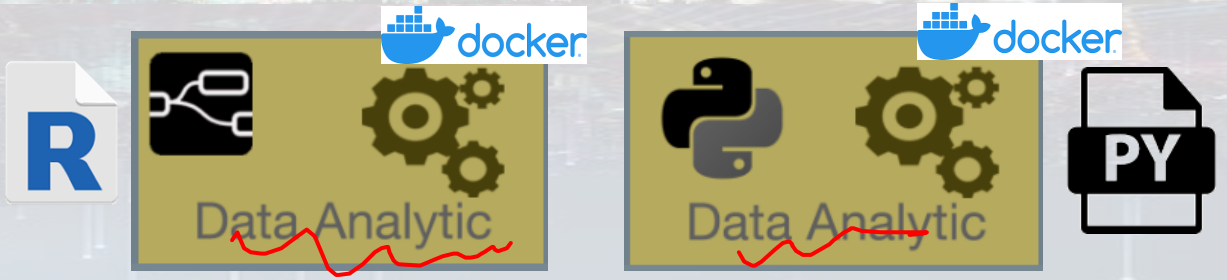
3

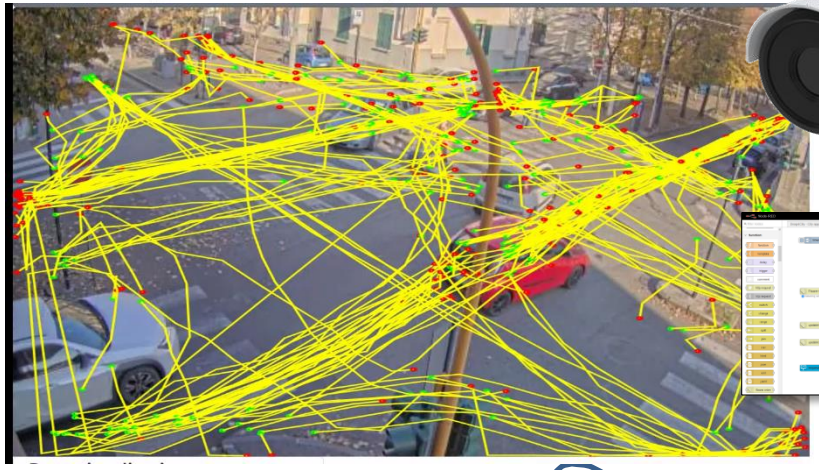
Use Snap4City Data Analytic Node, and load in the code you developed.

4



5 Deploy the IoT App → Snap4City Container Manager based on Marathon/Mesos is creating a Container for your Data Analytic code





IoT edge on TV Camera

1

Send data to Broker

Send Trajectories

2

IOT Broker

Device: CrossVenaria2 with trajectories

Save data

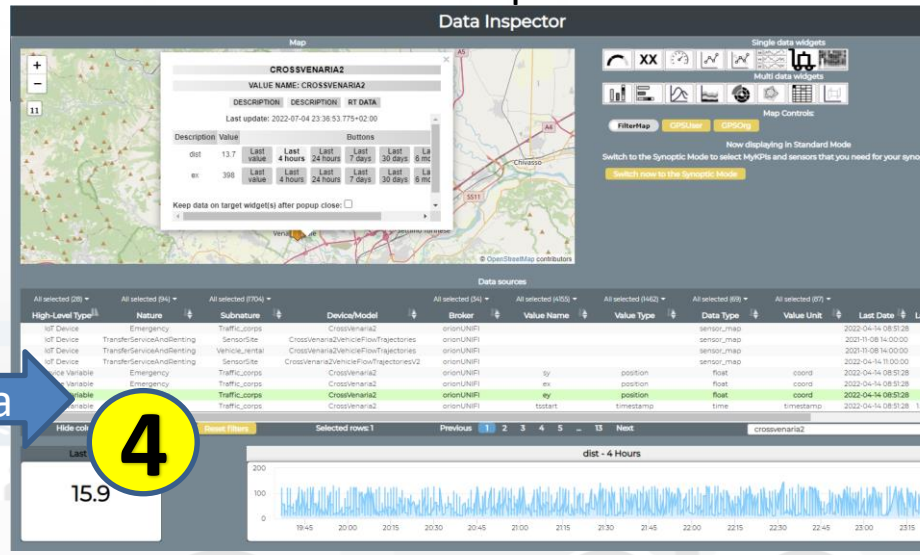
3

Big Data Store Facility

show data

4

Data Inspector



IoT edge on
TV Camera

Send Trajectories

Send data to Broker

IOT Broker

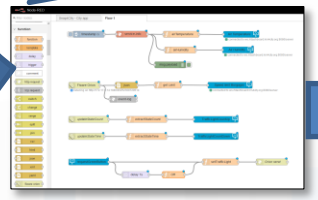
Devices:
- CrossVenaria2VehicleFlowTrajectoriesV2
- VenariaConteggio

Save data

f Save Counting per Cluster

e Send data to Broker

Periodically



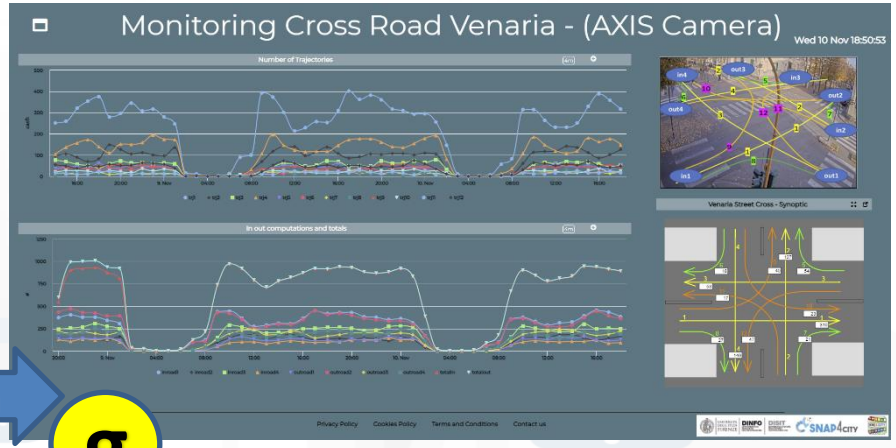
b Activate

d

Get data

c

Big Data
Store
Facility



show data

g Create and use a Dashboard

a

python data
analytic

From Trajectories
to clusters.
Counting in/out
and flows

Device:
CrossVenaria2
with
trajectories

MLOps Possibilities on Snap4City infrastructure

The developers can create their AI models using Snap4City data and infrastructure (Jupiter Hub):

- 1) **to put them in execution** (they could develop the solution on their Computer as well)
  - A) on stable container on CPUs via Node-RED, Docker
  - B) on some server with GPU/CPUs
- 2) **using ClearML and to put them in execution** on a process managed by ClearML on some cluster of GPU/CPU
  - 2a) **OnDemand:** as stable process on ClearML managed Docker, via API (usable from Rest Calls as well as from Node-RED Snap4City MicroServices, from the platform)
  - 2b) **Enqueue:** as sporadic process ClearML managed, via API (usable from Rest Calls as well as from Node-RED Snap4City MicroServices, from the platform)

Development

SNAP4CITY

DEVELOPMENT

python jupyter RStudio

API

Snap4City API

EXECUTION

Node-RED

IOT Application

S4CDataAnalytic

plumber data analytic

python data analytic

docker

API

CLEAR|ML

NVIDIA CUDA

HPC

HPC

API

Servers

On Server or On PC

TensorFlow

NVIDIA CUDA

Any API

On PC as Local Environment

DEVELOPMENT

Once finalized

A

B

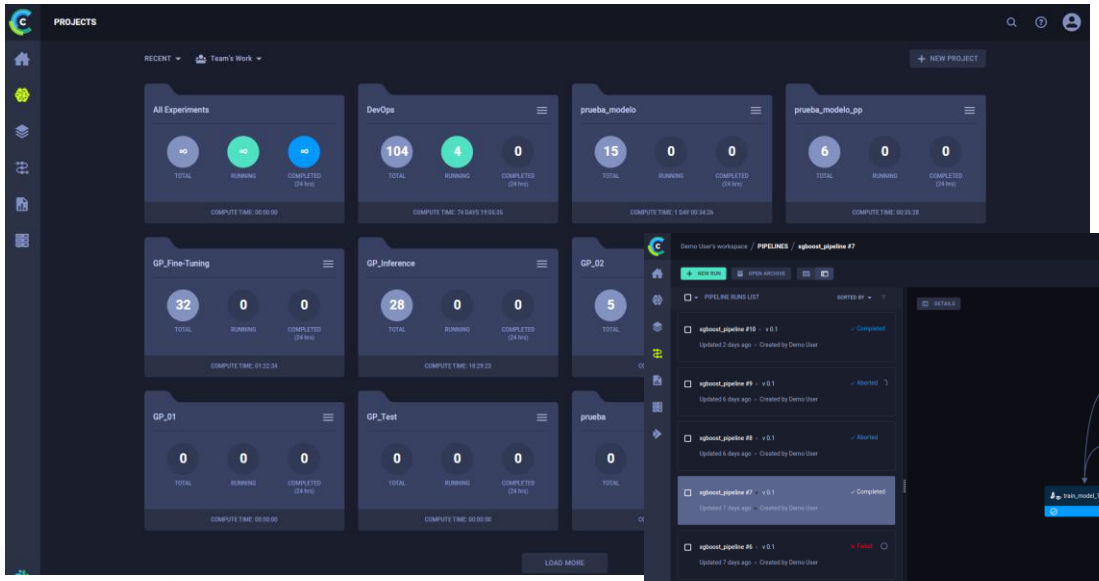
C

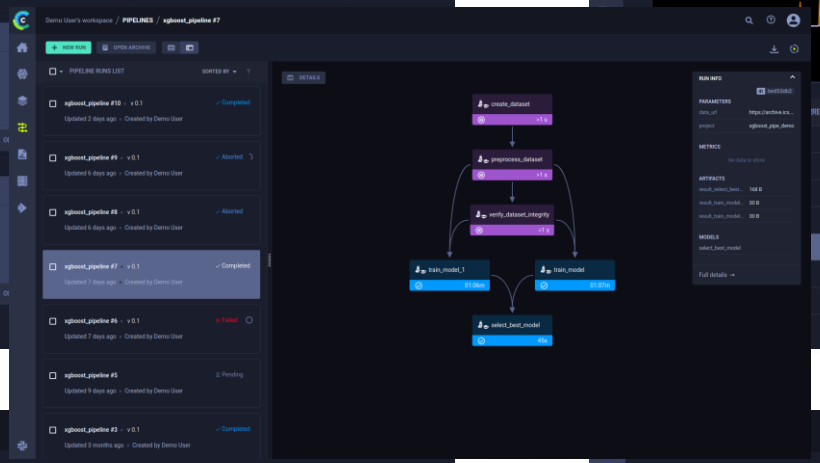
NVIDIA CUDA API

Server Execution

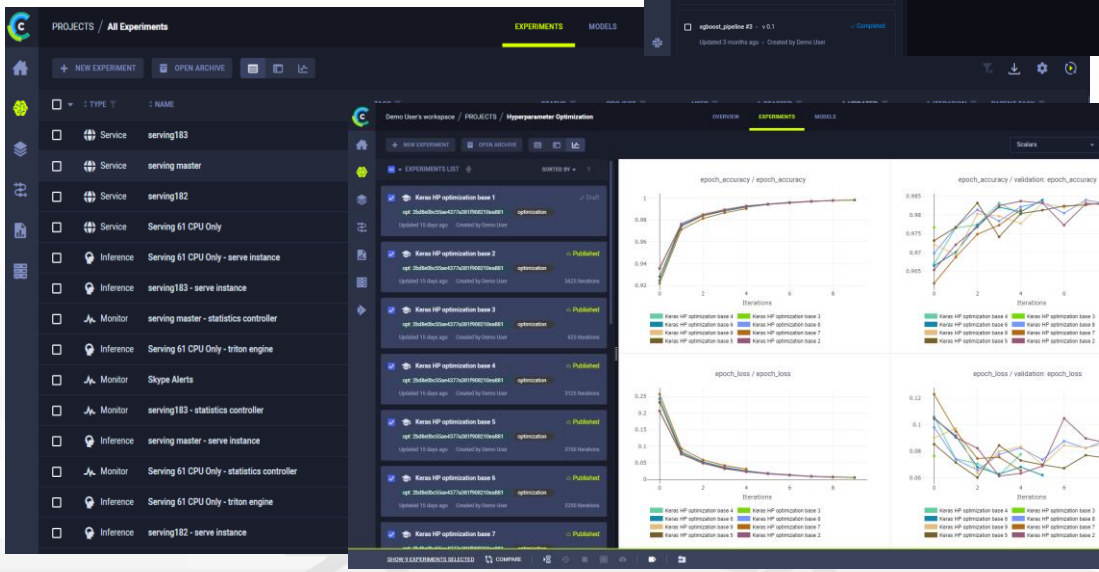
Process: file .R or .Py (+ the AI/ML model, data) can be put in execution with local scheduler or Cron

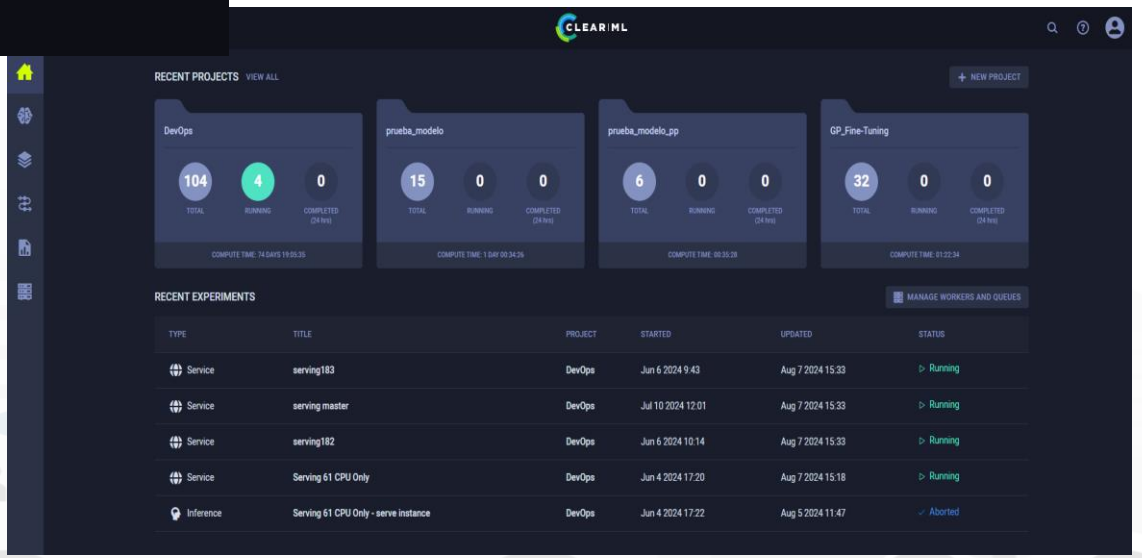
MLOps

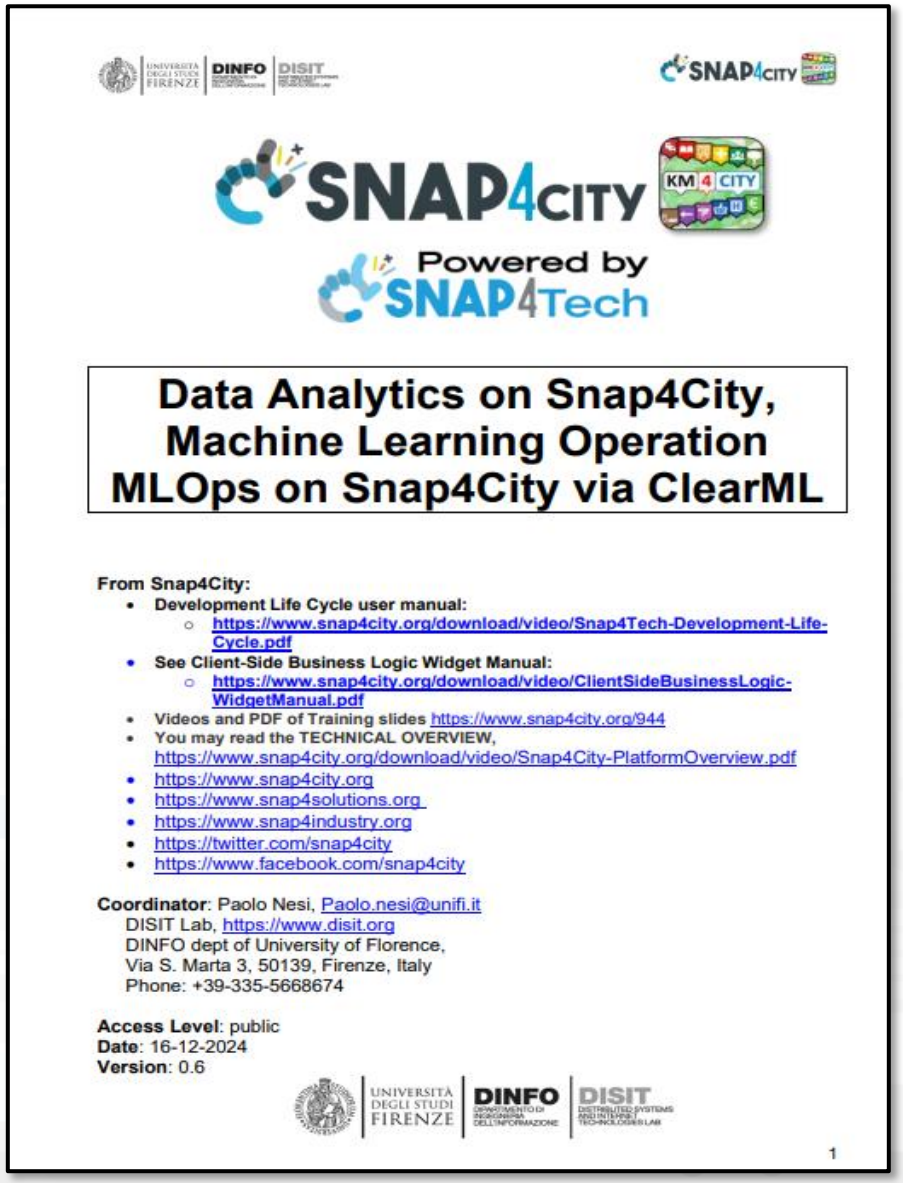




CLEARML







SNAP4CITY

Powered by SNAP4Tech

Data Analytics on Snap4City, Machine Learning Operation MLOps on Snap4City via ClearML

From Snap4City:

- **Development Life Cycle user manual:**
  - https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf
- **See Client-Side Business Logic Widget Manual:**
  - https://www.snap4city.org/download/video/ClientSideBusinessLogic-WidgetManual.pdf
- **Videos and PDF of Training slides** https://www.snap4city.org/944
- **You may 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

Coordinator: Paolo Nesi, Paolo.nesi@unifi.it
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Phone: +39-335-5668674

Access Level: public
Date: 16-12-2024
Version: 0.6

1

MLOperation

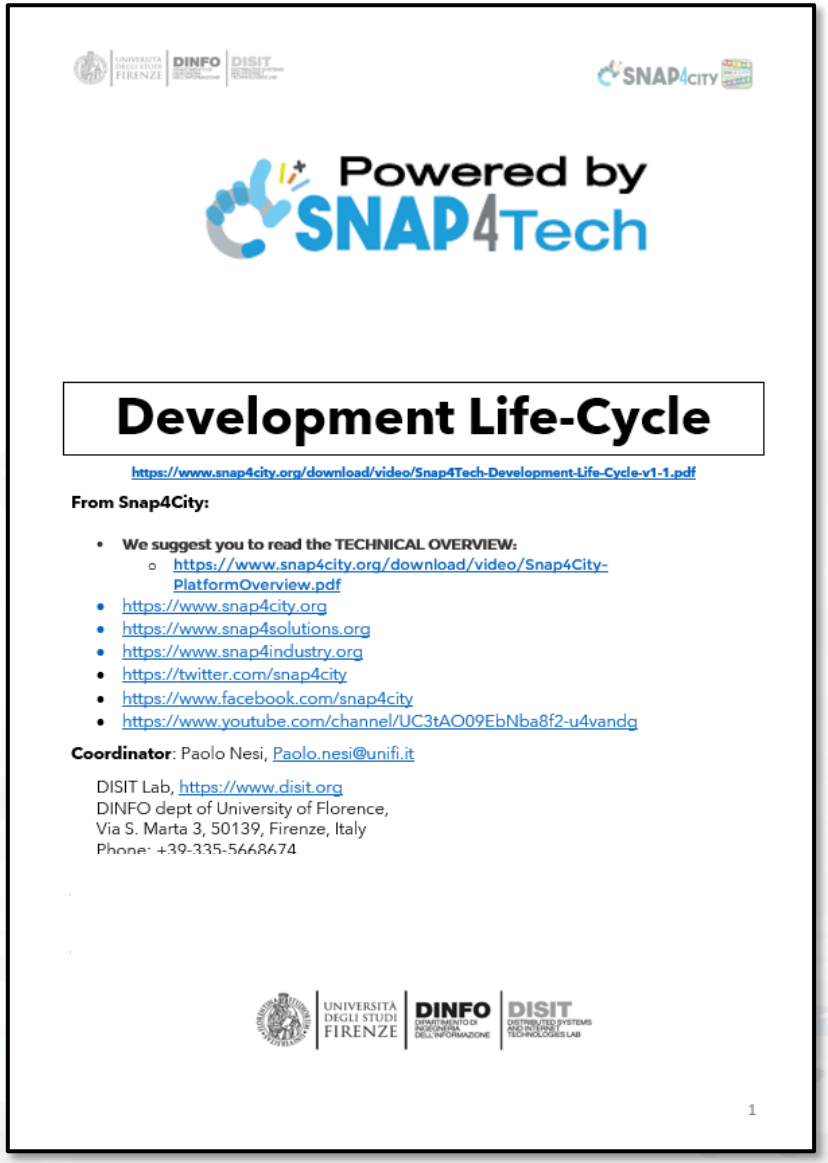
https://www.snap4city.org/download/video/Snap4City-MLOps-Manual.pdf

Parts 7 & 8: API, Mobil, Business Intelligence

Part 7: Exploiting Snap4City API, and Web/Mobile Applications SDK SLIDES Interactive Slides	
Part 8: Developing Smart Applications & Business Intelligence Solutions SLIDES 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
- What is missing here and you can get from former course

Development



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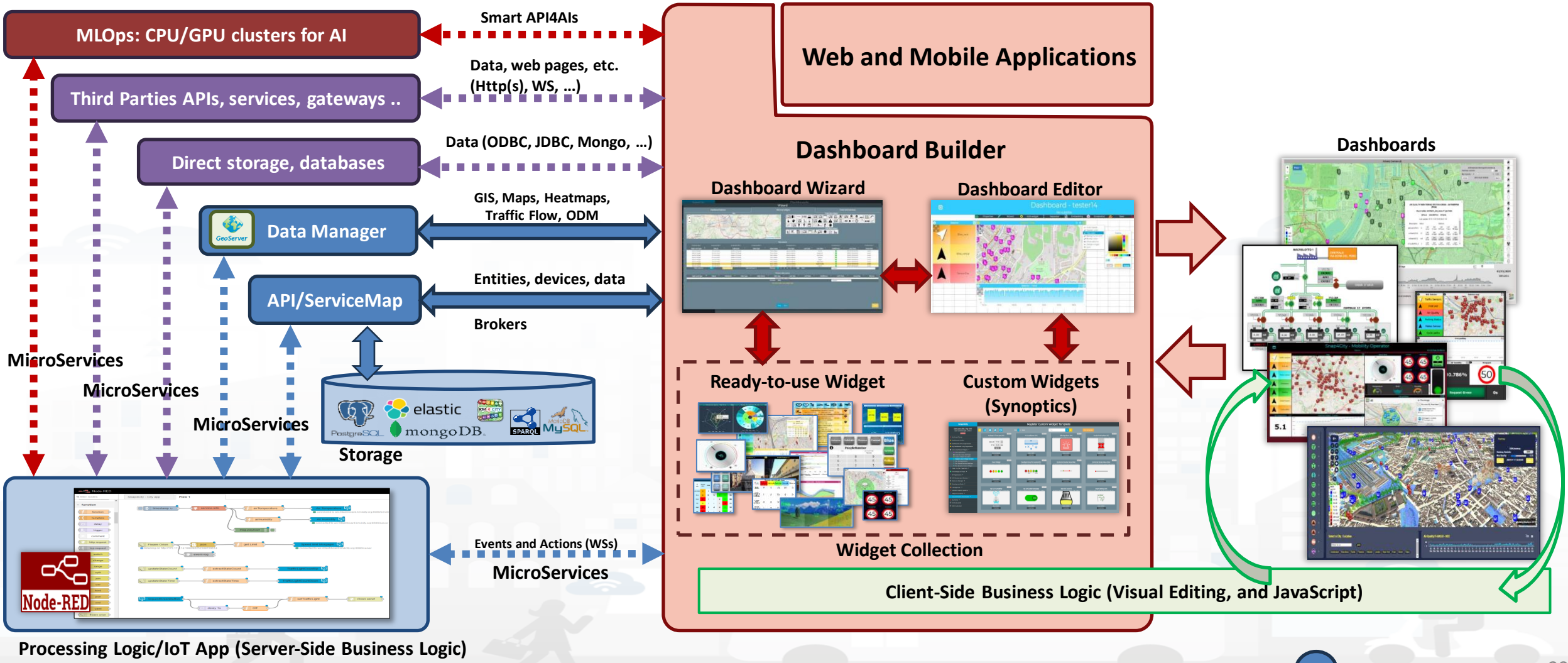
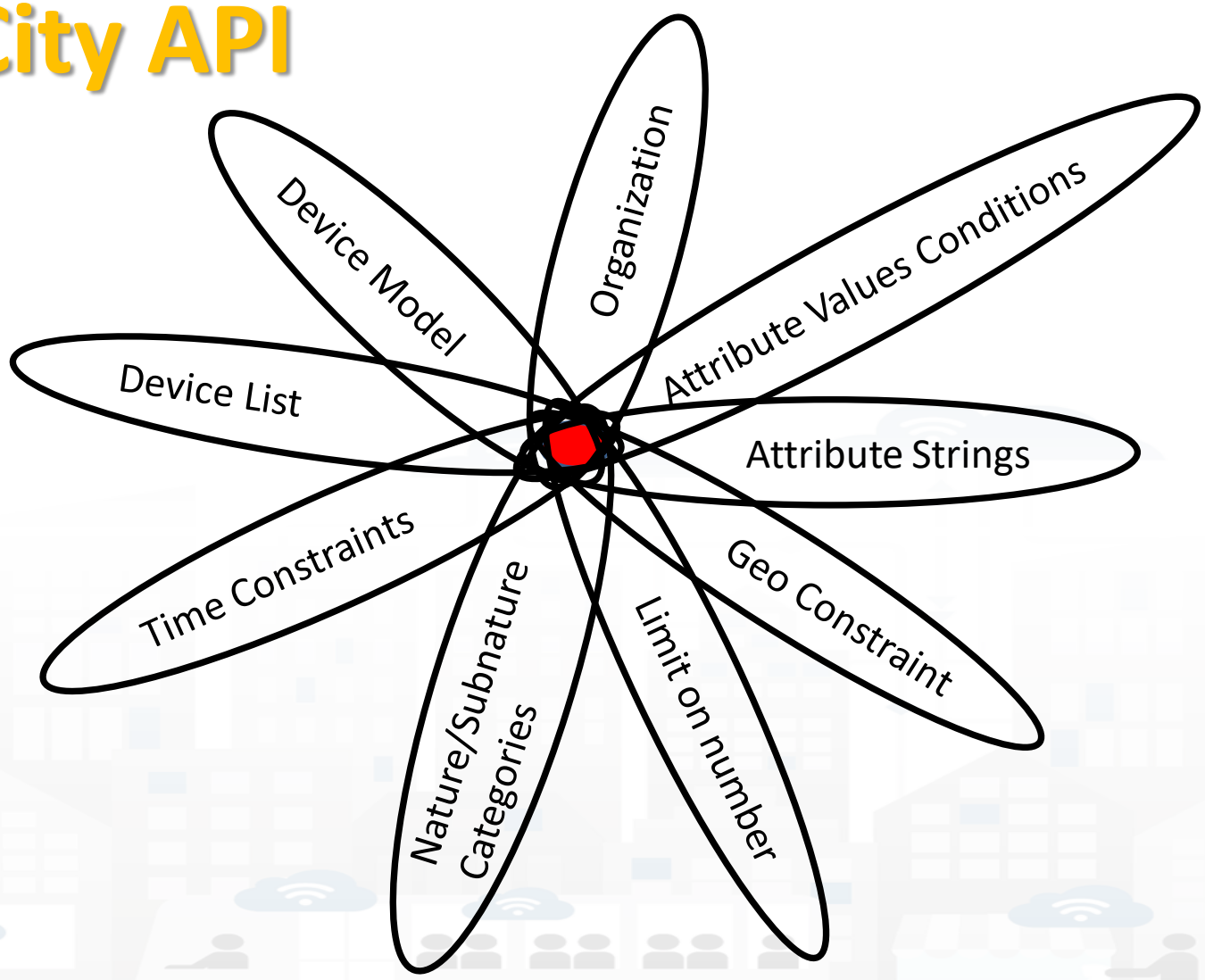
https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf

How the Dashboards / Apps Exchange data (2024/8)

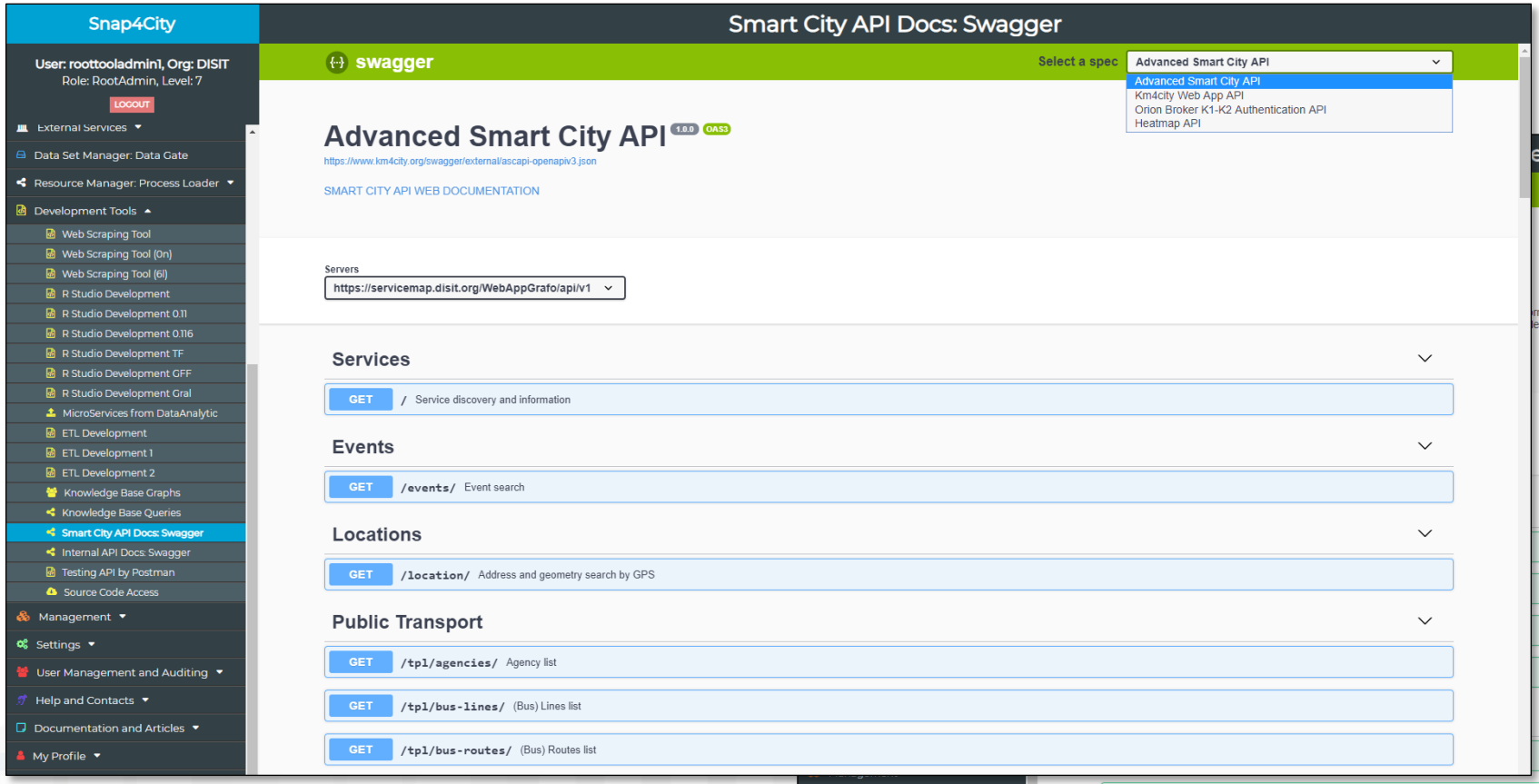


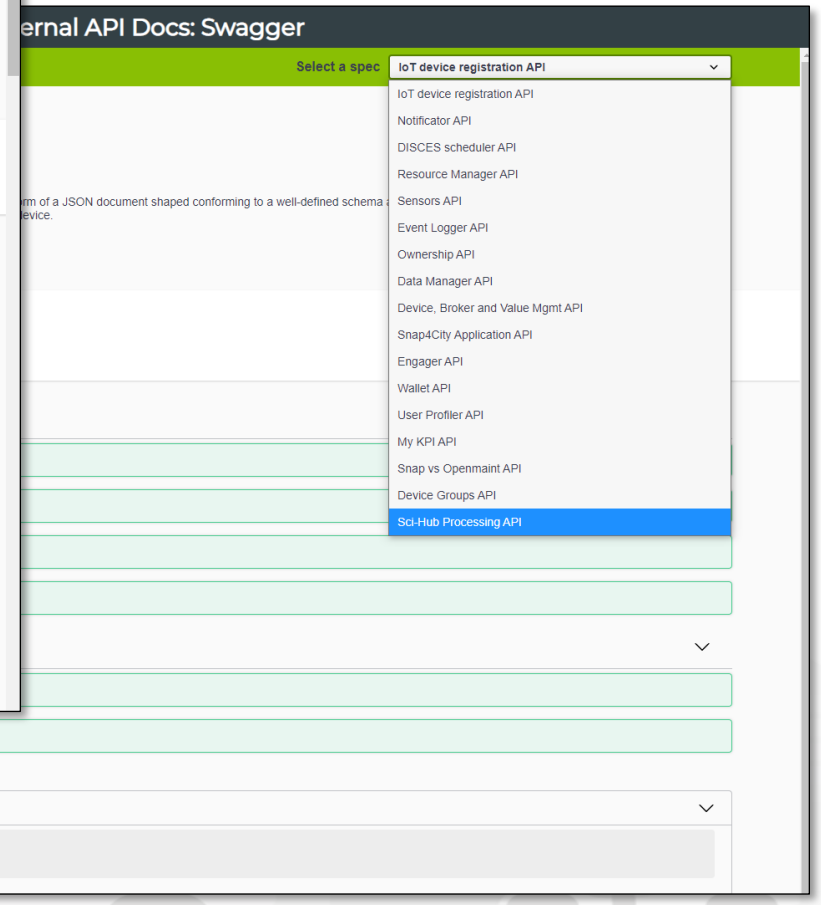
Selection on Smart City API

- Combining different filters for selecting entities from Smart City APIs
- ***Be care***: filtering too much may lead to empty set ☺



Internal and External Smart City API





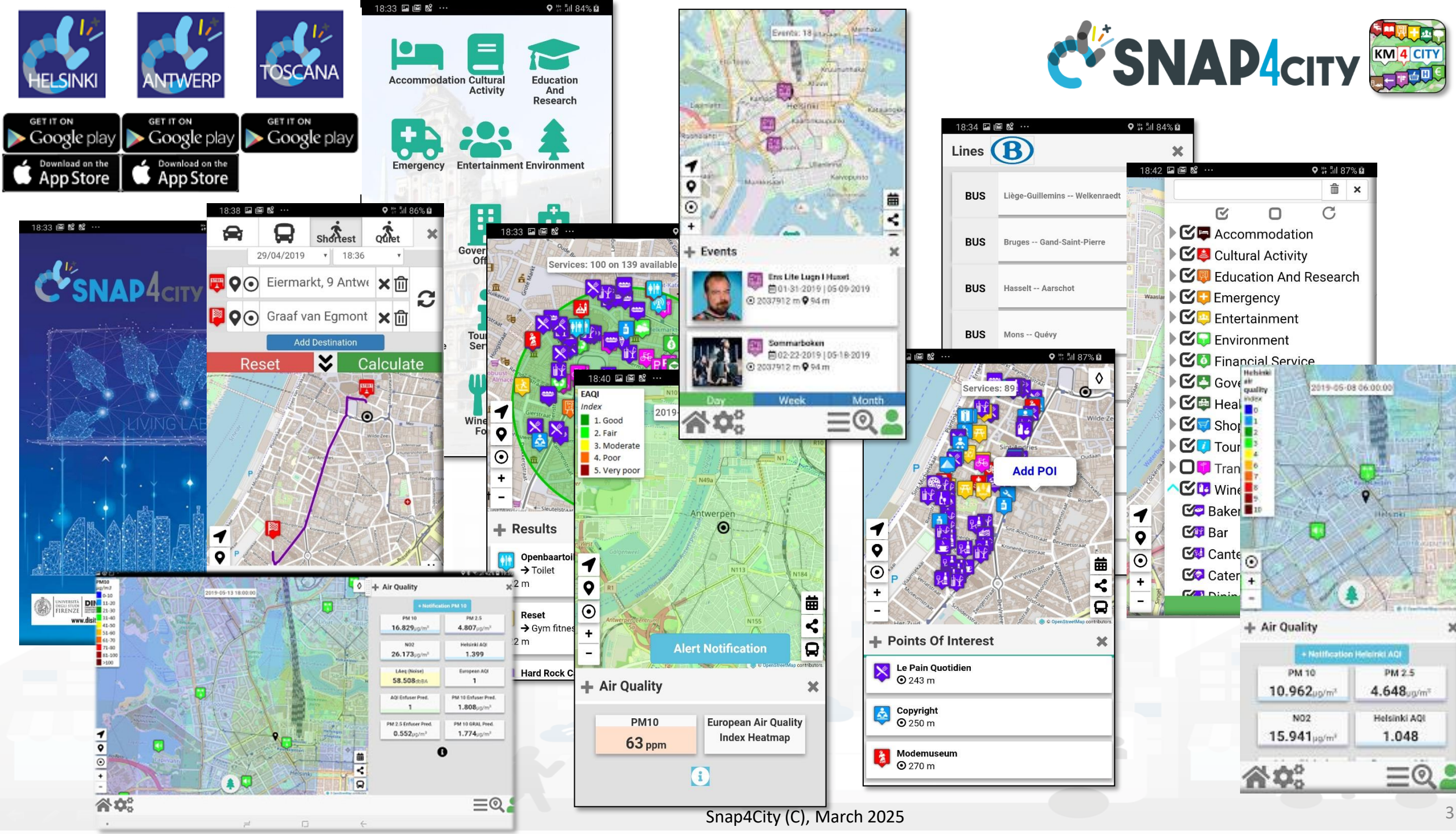
https://www.km4city.org/swagger/external/index.html

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

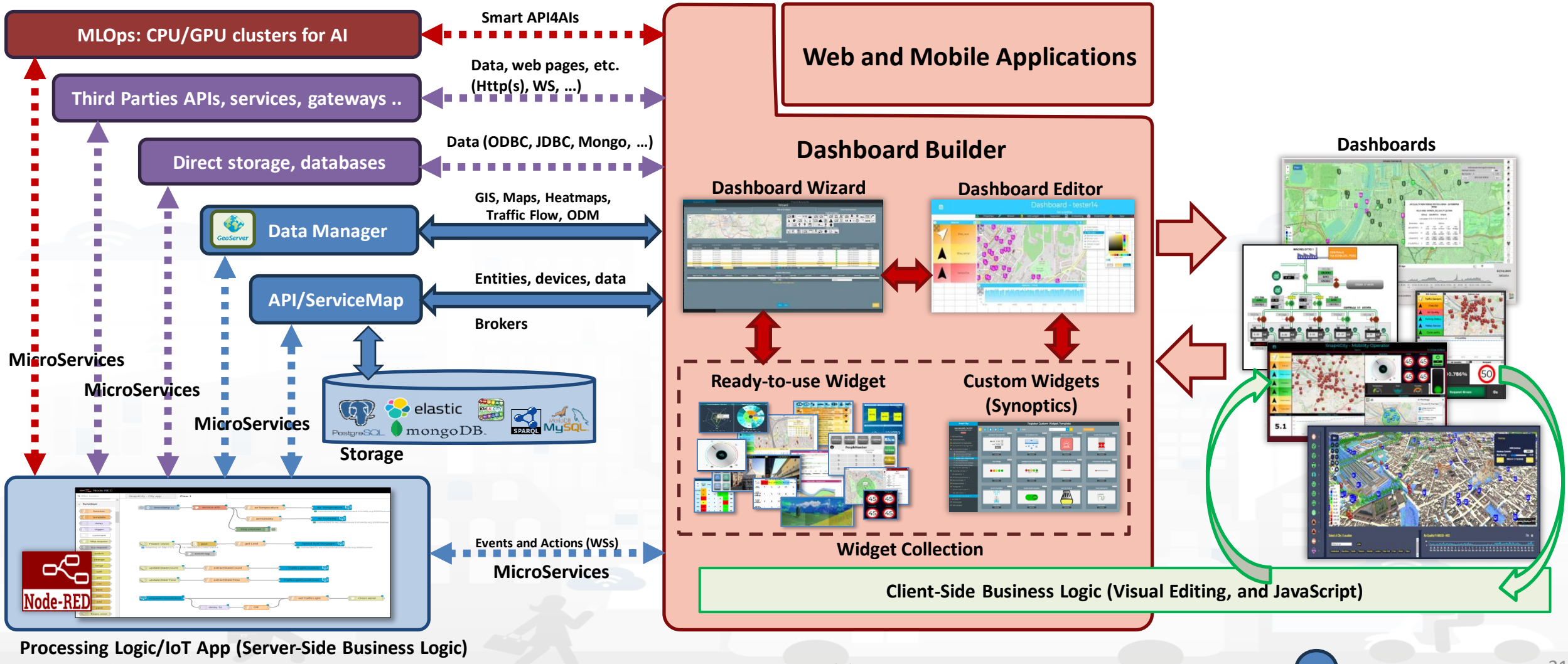
How to Get the «Query» used in More Options (2a)

- **REST CALL by category → JSON (Options in RED), they are REST ASCAPI calls**
  - **Requesting a category, so that to see all Services of the same category (subNature)**
    - http://svealand.snap4city.org/ServiceMap/api/v1/?selection=59.581458578537955;16.71183586120606;59.62875017053684;16.875171661376957&categories=Street_light&maxResults=100&format=json
      - Please note that in the MoreOption dashboard the GPS area is neglected
    - https://servicemap.disit.org/WebAppGrafo/api/v1/?selection=43.64471;11.005751;43.89471;11.505751&categories=Green_areas&maxResults=200&format=json
      - Please note that in the MoreOption dashboard the GPS area is neglected
    - Custom PINS note: "selection" coordinates are used for collecting attributes in custom PINS. Other options such as "maxDists" cannot be used in custom PIN. All parameters can be used in other cases.
    - Different KB links are identified by their ASCAPI links: svealand.snap4city.org, servicemap.disit.org, ….
  - **Requests to SuperServiceMap for the network of Federated KBs** by using /api/…….

    Without prefixed KB to obtain merged results from more KBs. For example as:
    - /api/v1/?categories=Air_quality_monitoring_station&format=json
    - Please note that the direct links to the superservicemap can be of the form:
      - https://www.disit.org/superservicemap/api/v1/? ……

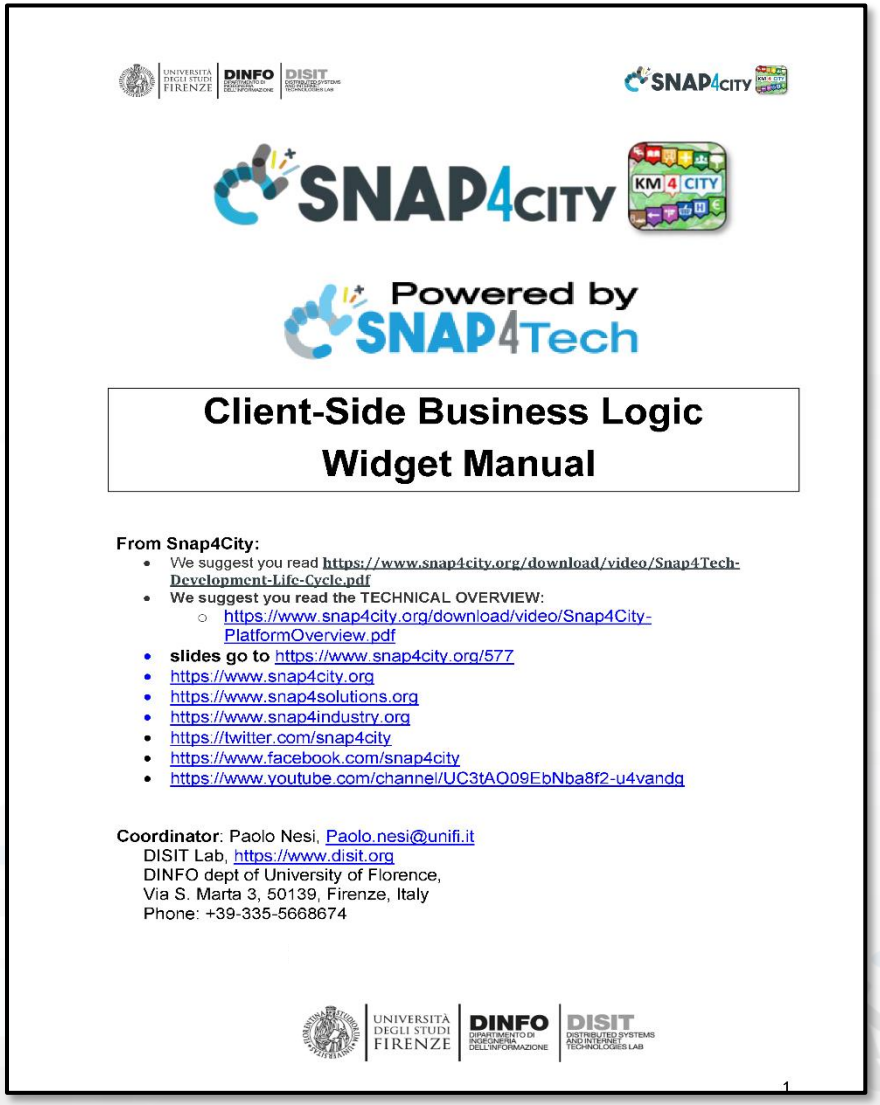

HELSINKI
ANTWERP
TOSCANA
GET IT ON Google play
Download on the App Store
SNAP4CITY
KM 4 CITY
Accommodation
Cultural Activity
Education And Research
Emergency
Entertainment
Environment
Shortest
Quiet
Add Destination
Reset
Calculate
Events
Day
Week
Month
Services: 100 on 139 available
EAQI
Index
1. Good
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
PM 10
10.962
PM 2.5
4.648
NO2
15.941
Helsinki AQI
1.048

How the Dashboards / Apps Exchange data (2024/8)



CSBL

Client Side Business Logic



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Client-Side Business Logic Widget Manual

From Snap4City:

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- **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/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

1

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

How the Dashboards & Apps exchange data

Third Parties APIs

API, External Services, MicroApp

Traffic Flow, MAPS, Heatmaps

GIS, HTTPs URLs

Brokers

API ServiceMap

eq. ServiceURI, KPI

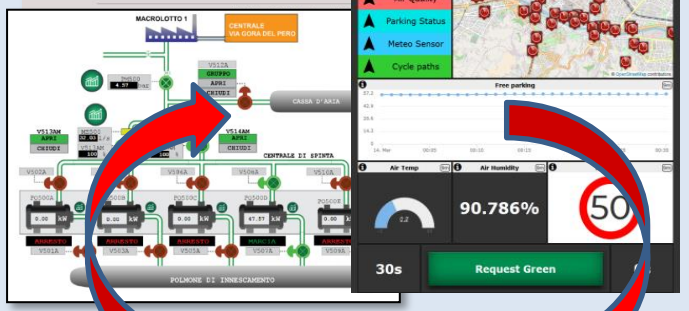
Storage and KB

Dynamic Data:
ServiceURI, MyKPI,
Events and Actions
Event Driven Synoptics

Server Side Business Logic

Proc.Logic/IOT Apps

Dashboards

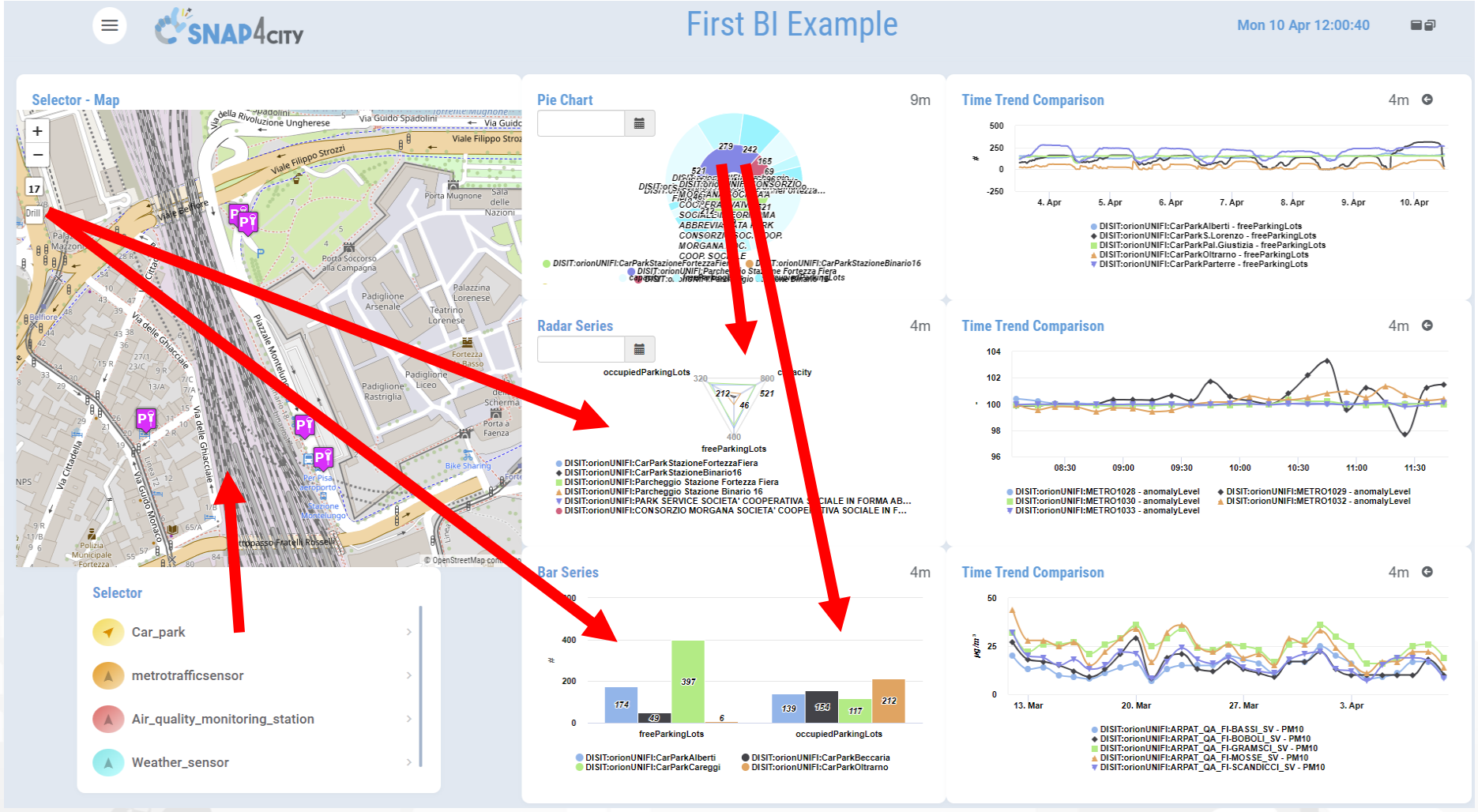


Client Side Business Logic
Visual editor and JavaScript
(when needed)

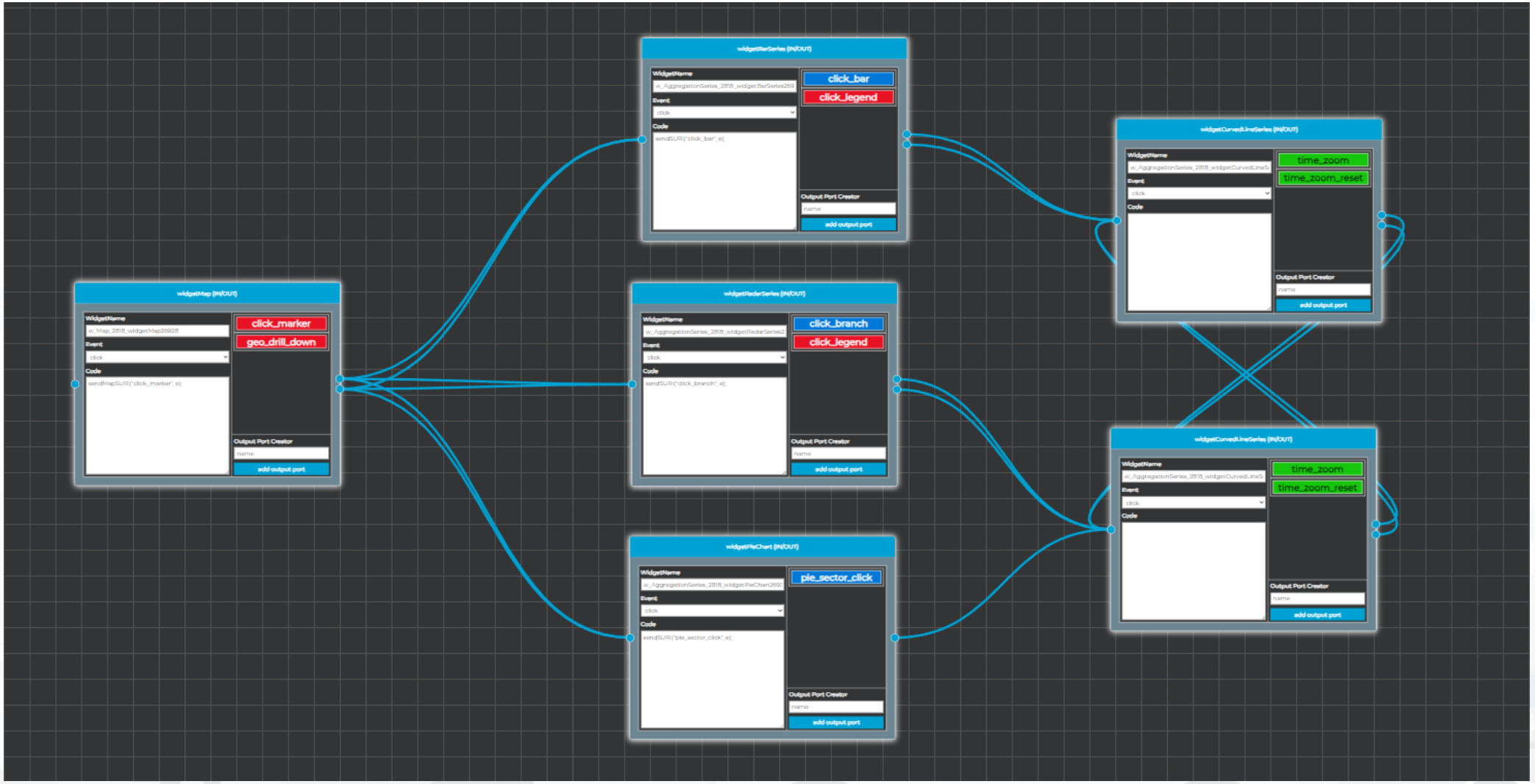
Example: From Map to Graphs (spatial drill down)

1) Select the area of interest on map
2) Select the sensors kind of interest
3) Drill down on map

4) The JavaScript CSBL on Map will send data to the programmed Widgets. In this case, arrowed in RED



Visual programming for CSBL, accessible in beta



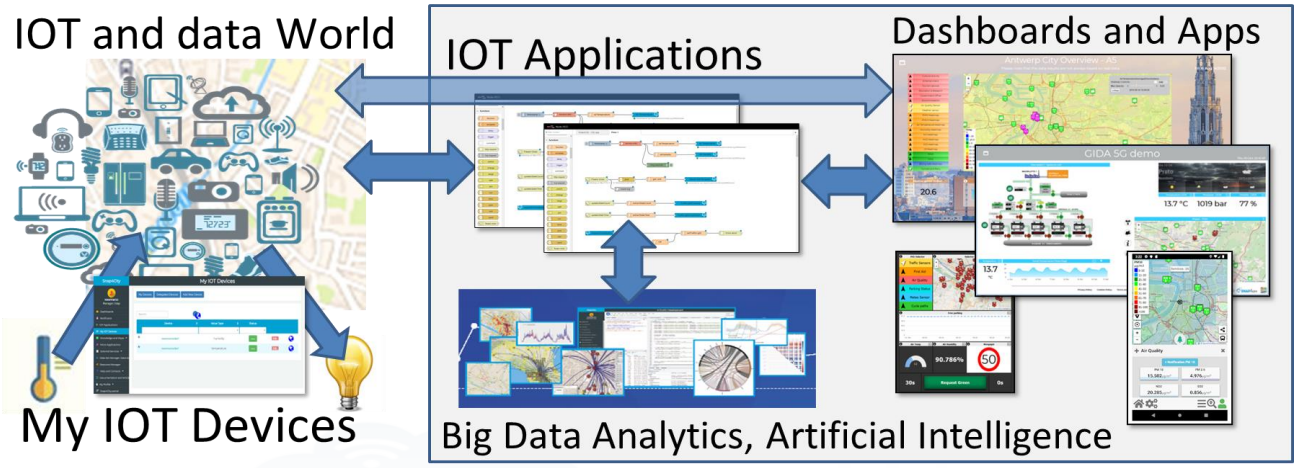
Training Suggestions
DISIT publications

100% OPEN SOURCE

SNAP4 Appliances and Dockers **Installations**

Free Trial

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



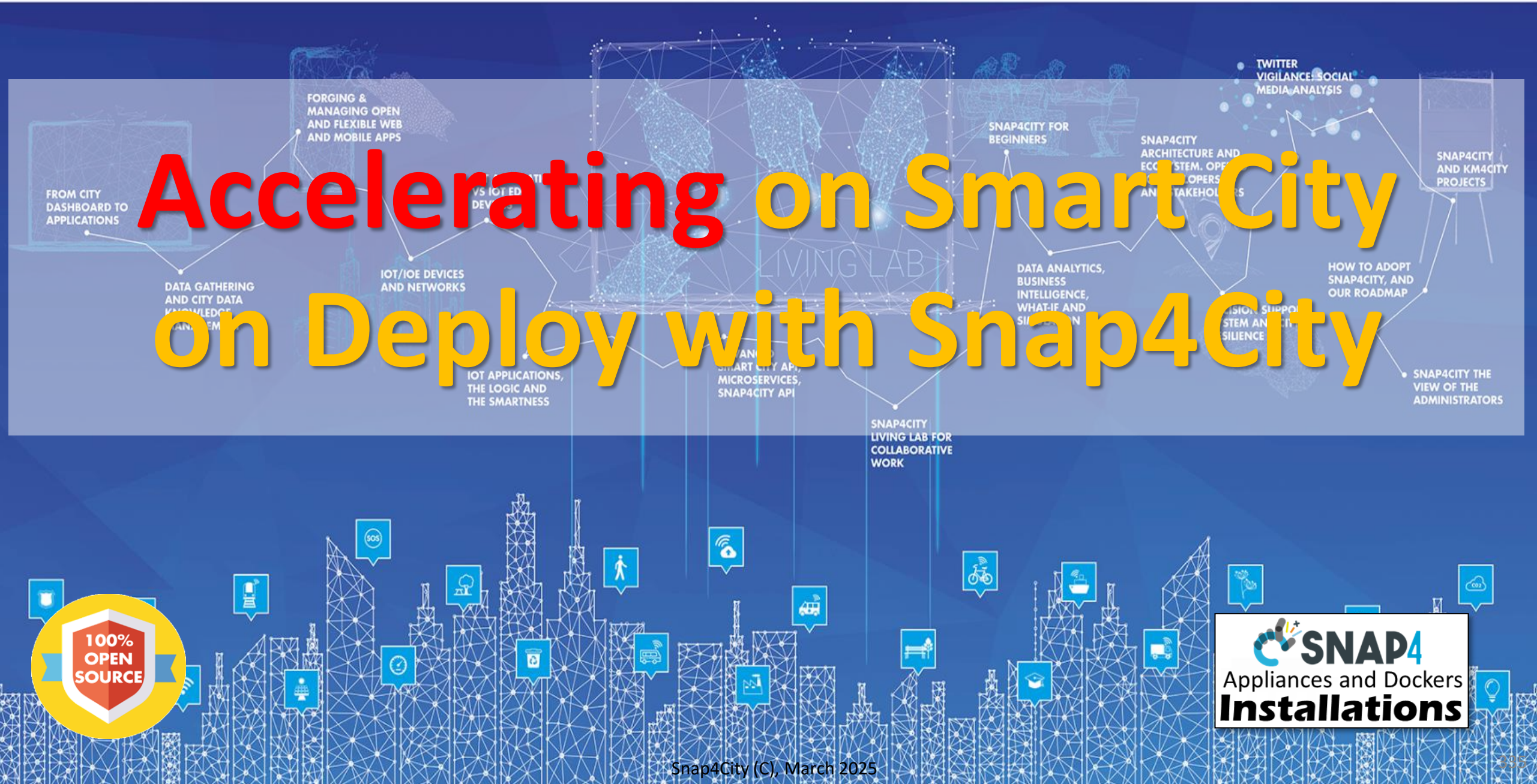
License Free Installation scripts for: Pub cloud & on premises

Note on Training Material

- **Course 2023**: https://www.snap4city.org/944
  - Introductionary course to Snap4City technology
- **Course** https://www.snap4city.org/577
  - Full training course with much more details on mechanisms and a wider set of cases/solutions of the Snap4City Technology
- **Documentation** includes a deeper round of details
  - Snap4City Platform Overview:
    - https://www.snap4city.org/drupal/sites/default/files/files/Snap4City-PlatformOverview.pdf
  - Development Life Cycle:
    - https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf
  - Client Side Business Logic:
    - https://www.snap4city.org/download/video/ClientSideBusinessLogic-WidgetManual.pdf
- **On line cases and documentation**:
  - https://www.snap4city.org/108
  - https://www.snap4city.org/78
  - https://www.snap4city.org/426

Snap4City Training vs Targets

- **Estimate Indicators: P1, P2, P3, P4, P5**
  - IoT App/Proc.Logic JavaScript, Data Analytics, Dashboards to see data and results
- **Load additional data: P1, P2, P3, P5**
  - IoT App/Proc.Logic JavaScript, IoT Directory, ServiceMap, advanced interoperability, Dashboards to see them
- **Performing AI/XAI on accessible data: P1, P2, P3, P4, P5 (P8)**
  - IoT App/Proc.Logic JavaScript, ServiceMap, ASCAPI, Python, Dashboards to see data/results
- **Developing Business intelligence: P1, P2, P3, P7, P8**
  - IoT App/Proc.Logic JavaScript, Dashboards to see them, ASCAPI, CSBL for making them intelligent, JavaScript
- **Developing Web and Mobile Apps: P1, P2, P3, P7, P8**
  - ServiceMap, ASCAPI, Dashboards
- **Deploy, install, test and management: P1, P2, P3, P6**
  - IoT App/Proc.Logic JavaScript, ServiceMap, Dashboards to see them



Accelerating on Smart City
on Deploy with Snap4City

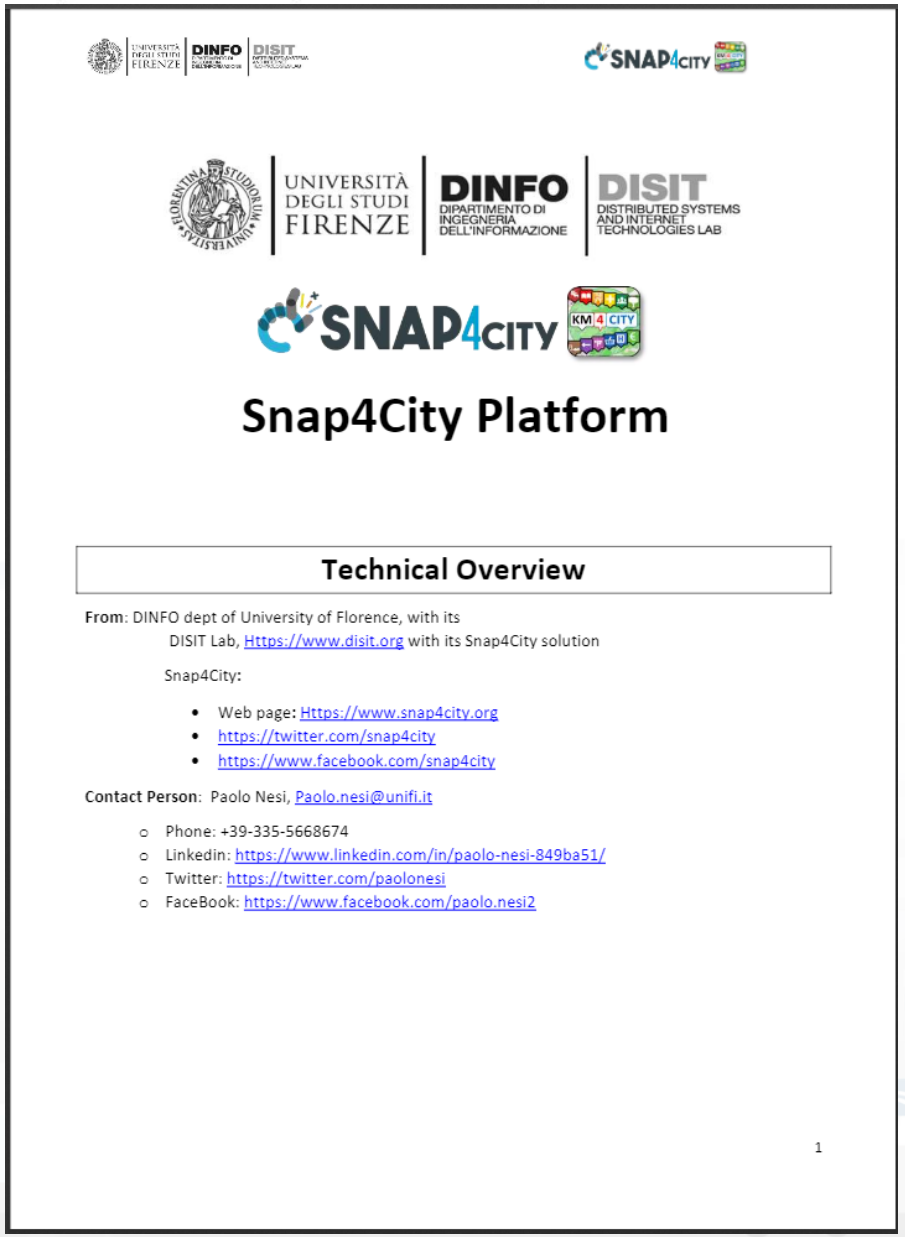
Part 6: Platform Architecture, interop and Deploy

Part 6: Snap4City Platform Architecture, Interoperability, Management and Deploy

SLIDES

Interactive Slides

- Snap4City Architecture
- Interoperability of Snap4City Platform
- Interoperability with respect to Hardware staff
- Adding Features and Modules to Snap4City
- FIWARE and Snap4City
- Snap4City vs State of the Art Solutions
- Smart City planning with Snap4City Team Support
- The Role of the Living Lab Support
- Snap4City Platform: Administration Overview
- Snap4Tech: Smart Solutions as a Service
- Deploy Snap4Tech solutions: Docker Based



Snap4City Platform

Technical Overview

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

Snap4City:

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

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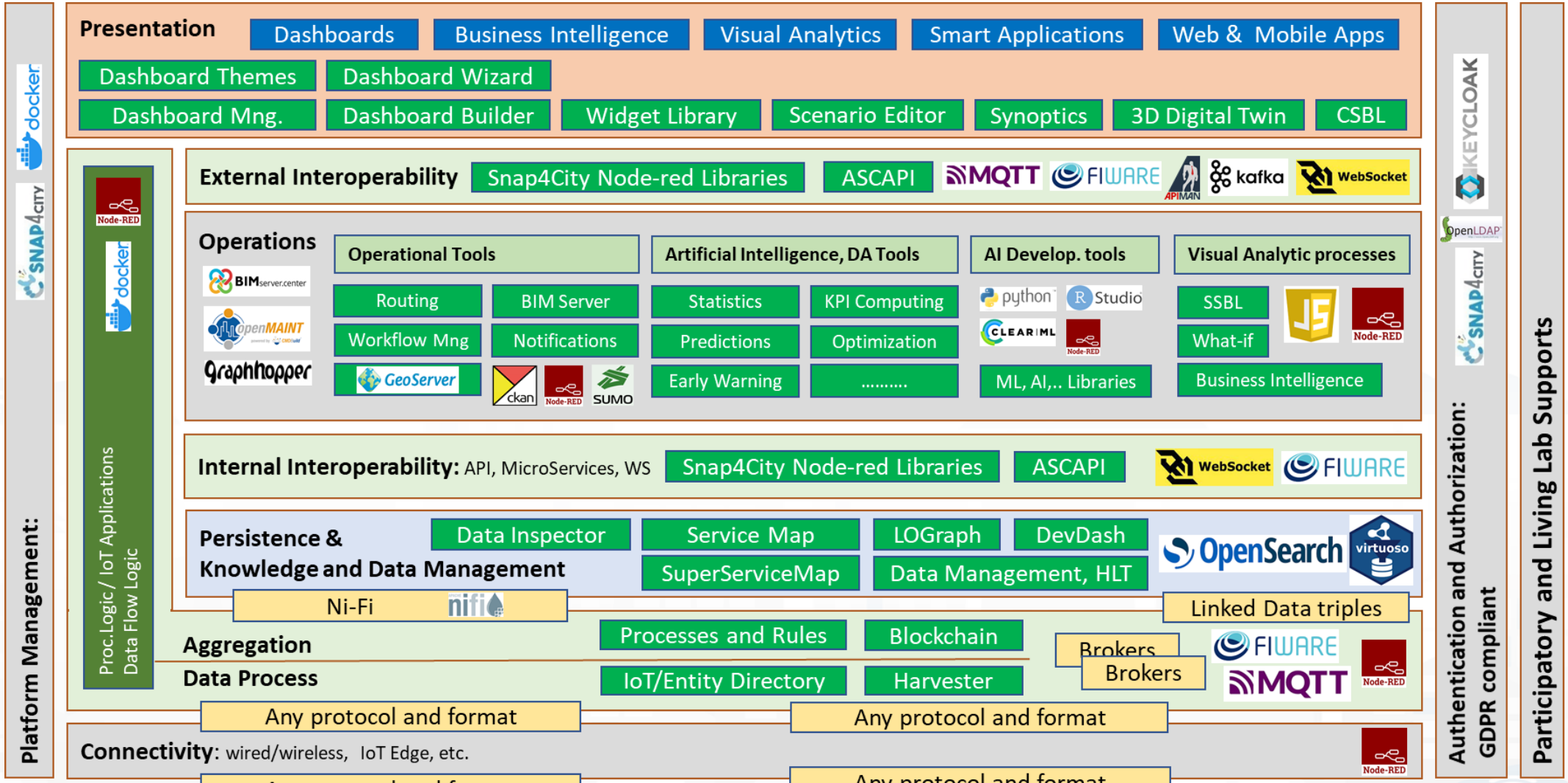
- FaceBook: https://www.facebook.com/paolo.nesi2

1

Tech Overview

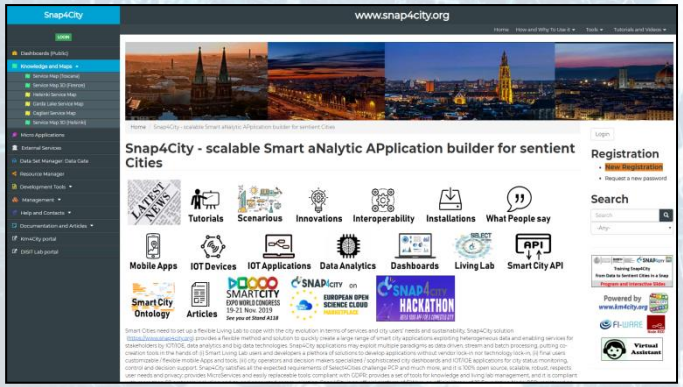
- https://www.snap4city.org/drupal/sites/default/files/files/Snap4City-PlatformOverview.pdf


Platform Management:
docker
SNAP4CITY
Presentation
Dashboards
Business Intelligence
Visual Analytics
Smart Applications
Web & Mobile Apps
Dashboard Themes
Dashboard Wizard
Dashboard Mng.
Dashboard Builder
Widget Library
Scenario Editor
Synoptics
3D Digital Twin
CSBL
Node-RED
docker
Proc.Logic / IoT Applications
Data Flow Logic
External Interoperability
Snap4City Node-red Libraries
ASCAPI
MQTT
FIWARE
APIMAN
kafka
WebSocket
Operations
Operational Tools
Artificial Intelligence, DA Tools
AI Develop. tools
Visual Analytic processes
BIM server.center
openMAINT
GraphHopper
Routing
BIM Server
Workflow Mng
Notifications
GeoServer
ckan
Node-RED
SUMO
Statistics
KPI Computing
Predictions
Optimization
Early Warning
.....
python
R Studio
CLEARML
Node-RED
ML, AI,.. Libraries
SSBL
What-if
Business Intelligence
Node-RED
Internal Interoperability: API, MicroServices, WS
Snap4City Node-red Libraries
ASCAPI
WebSocket
FIWARE
Persistence & Knowledge and Data Management
Data Inspector
Service Map
LOGraph
DevDash
SuperServiceMap
Data Management, HLT
OpenSearch
virtuoso
Ni-Fi
nifi
Linked Data triples
Aggregation
Data Process
Processes and Rules
Blockchain
IoT/Entity Directory
Harvester
Brokers
Brokers
FIWARE
MQTT
Node-RED
Any protocol and format
Any protocol and format
Connectivity: wired/wireless, IoT Edge, etc.
Node-RED
Any protocol and format
Any protocol and format
Device Layer
GIS
BIM
OSM
Gateways
External Services
ERP
Social Media
External Third Party Services
KEYCLOAK
OpenLDAP
SNAP4CITY
Authentication and Authorization: GDPR compliant
Participatory and Living Lab Supports

How to adopt Snap4City

SNAP4CITY

Https://www.snap4city.org



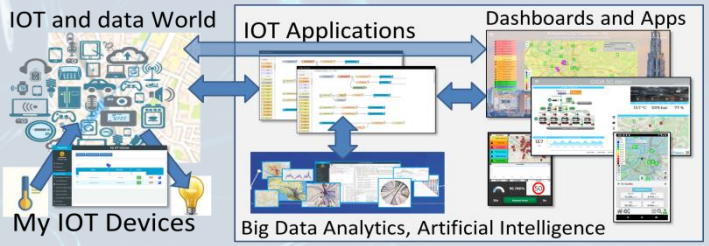
Smart City as a Service

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

SNAP4CITY on EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE

Download and deploy

On your premise



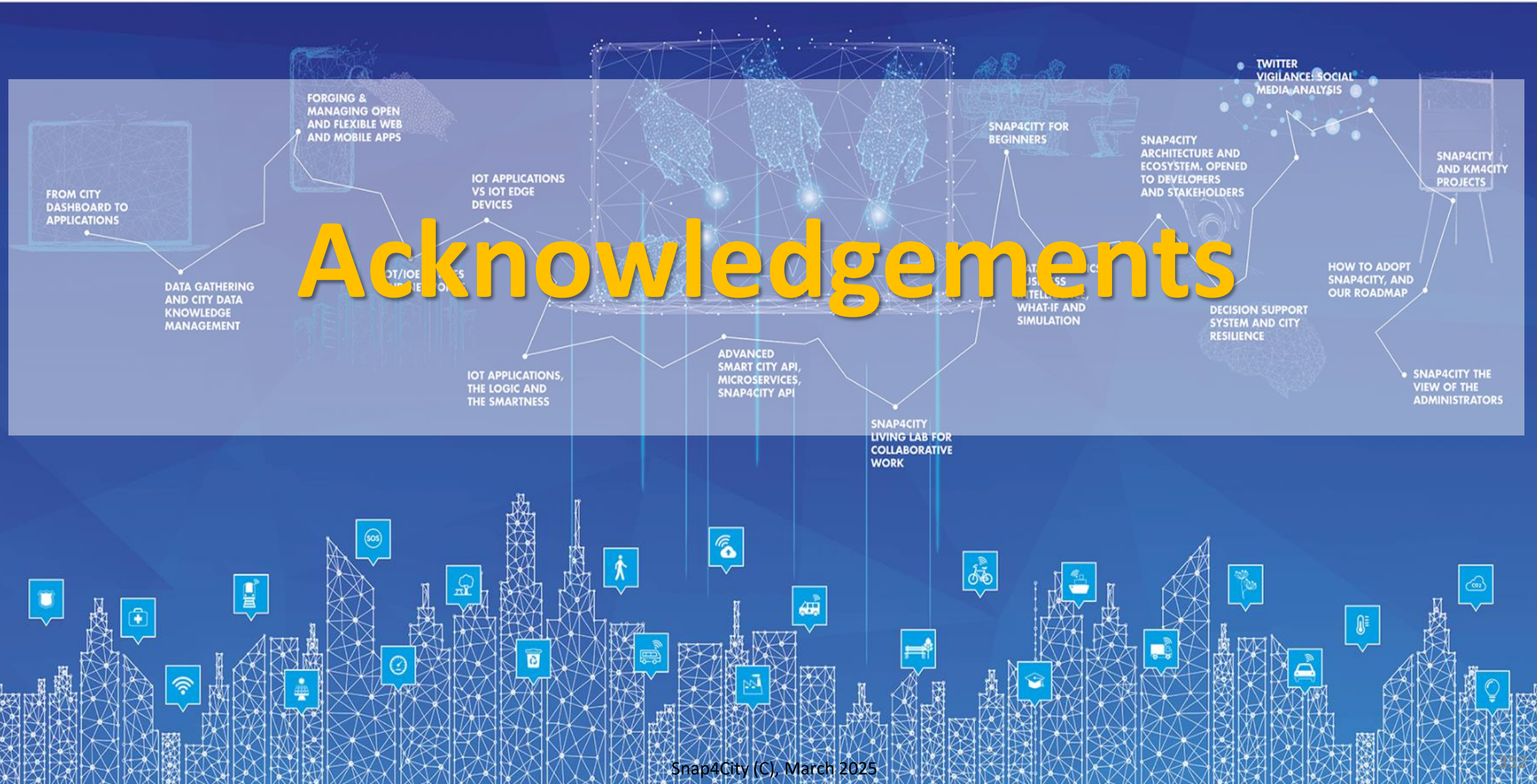
Powered by SNAP4Tech

Installation on your premise

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

Mixed solutions! For example:

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



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

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


SNAP4CITY
Digital Twin Solutions for Sustainability
MOBILITY AND TRANSPORT
TRAFFIC INFRASTRUCTURE OPTIMIZATION
WHAT-IF ANALYSIS
PUBLIC TRANSPORT ANALYSIS
PARKING MANAGEMENT
SHARING AND POOLING MANAGEMENT
MOST
3D Global Digital Twin - 2023b1
SNAP4CITY
SMARTCITY
EXPO WORLD CONGRESS
THE EVENT FOR BETTER CITIES
ParkHelp

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

2017
Sii-Mobility

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

E0I5 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

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

(2018-20)

2018
- Mobility Demand / Offer Analytics and Strategy

Sii-Mobility

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

IOT/IOE

Km4City 1.6.6

Node-RED

SNAP4CITY SELECT for Cities H2020 (2017-19)

5G (2018-21)

- 5G tech
- Energy
- Industry 4.0
- Synoptics

TRAFAIR CEF (2018-21)

- Traffic and Mobility Impact on Pollution
- NOX predictions

2019
EUROPEAN OPEN SCIENCE CLOUD

SIRIUS

LAID Smart Bed (POR CreO, Regione Toscana)

- Smart Health

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

- Industry 4.0

bee smart city

- Smart Lonato

Reverberi Enetec Gruppo MPES

SODA

Winner of Select4Cities PCP

SELECT for Cities — 1° place award to UNIVERSITY OF FLORENCE - DEPARTMENT OF INFORMATION ENGINEERING — SNAP4CITY

SNAP4CITY KM4CITY

SNAP4CITY roadmap

2020

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

- Smart Mobility
- PISA, PUMS
- Living lab

Km4City 1.6.7

smartGARDAlake

2021

Smart Ambulance (2021-22)

Sii-Mobility

Contract

Contract

PC4City (2020-21) Monitoring Terrain

Winner of Open Data Challenge of

- Smart Light
- Sweden

Enterprise (2021-22) Industry 4.0

Almafluida Industry 4.0 (2021-22)

AMPERE (2021-22) Industry 4.0

SYN-RG-AI SmartCity

Industry 4.0

SmartCity, 2021-23

AXIS collab SmartCity

2022

Asymmetrica Smart City, 2022-23

Contract, 2022-23

Italferr, Smart City

2023

Contract, 2022-23

2022-2023

Contract, 15min

Security and Risk

Contract, 2024-25

CN MOST, 2022-26

EI THE, 2022-26

G. Agile, 2021-23

2023-26

Merano, smart light

OceanRace, Genova, AWS

Cuneo, smart city

2024

Km4City 1.6.8

TOURISMO

Interreg Euro-MED

Co-funded by the European Union

ELLIE IA 2025-2027

UrbanDT4TF

CAI4DSA

OPTIFaaS

SASUAM

Rhodes, smart city

eShare UNIFI TUSS

AMMIRARE

Interreg MARITTIMO-IT FR-MARITIME

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

2024/25

SNAP4CITY KM4CITY

- **UrbanDT4TF**, CN HPC: Digital Twin mobility
- **DI-DTPlatform**, CN HPC: Digital Twin, mobility, environment
- **Sasuam**, CN MOST, PNRR: AI, mobility
- **OPTIFaaS**, CN MOST, PNRR: AI, mobility, DSS
- **LeverageOPTIFaaS**, CN MOST: PNRR, mobility
- **TOURISMO**, Interreg, EC: Tourism, NLP, DSS
- **ELLIE**, Horizon Europe, EC: AI, VR
- **CN MOST**, PNRR: sustainable mobility, platform
- **ISPRA JRC contract**, EC: DSS, SOC, control room, energy
- **The IE**, PNRR: AI, NLP, Legal Aspects
- **AMMIRARE**, Interreg, EC: AI, environment, Big Data
- **CAI4DSA**, FAIR PE1, PNRR: AI, Neuro-Symbolic, PINN, NG-DSS
- **SADI-MIAC**, RT, partner: AI, Tourism, Retail, Computer Vision
- **Energia**, RT, conv: AI, PINN, DSS
- **RFI contract**: mobility, AI, DSS
- **PRIN UNICagliari**: mobility, DSS
- **Talent Hub**, ECRF, conv: NLP, match demand vs offer

Spoke 8: MaaS & Innovative Mobility Services

National Center for Sustainable Mobility

OPTIFaas: Operation and Plan, Transport Infrastructure and Facilities Support as a Service

Ecosystem to support a rapid and effective sharing of solutions and opportunities between researchers and companies belonging to MOST and Local Public Administrations, PA, and Transport Operators, TO.
Marketplace-type mechanism:

- **researchers and companies** have an environment in which to propose and test proposals and solutions;
- **PA and TO** always use state-of-the-art solutions to solve problems and pursue their mission.

Everything is configured with as a service mode in order to minimize investments in infrastructure and personnel by PA and TO.

Spoke 8 MaaS & Innovative Mobility Services

National Center for Sustainable Mobility

SASUAM - Solutions for Safe, Sustainable and Accessible Urban Mobility

- **Scalable methods and algorithms for urban traffic management** using the macroscopic fundamental diagram (MFD) paradigm and a generative optimization solution for urban traffic decongestion, accessibility and safety.
- **The solution plans to use data and validation support from the city of Bari** where the extended experimentation will be performed.
- **The solution has been designed to contribute to urban sustainability, through the provision of innovative traffic analysis, monitoring and optimization services.**

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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Università degli Studi di Firenze - School of Engineering

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