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
October 2025

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

#snap4city
#km4city
#disitlab
@snap4city

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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

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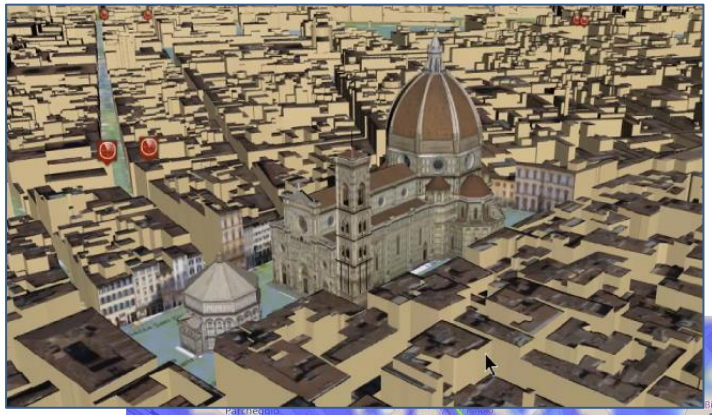
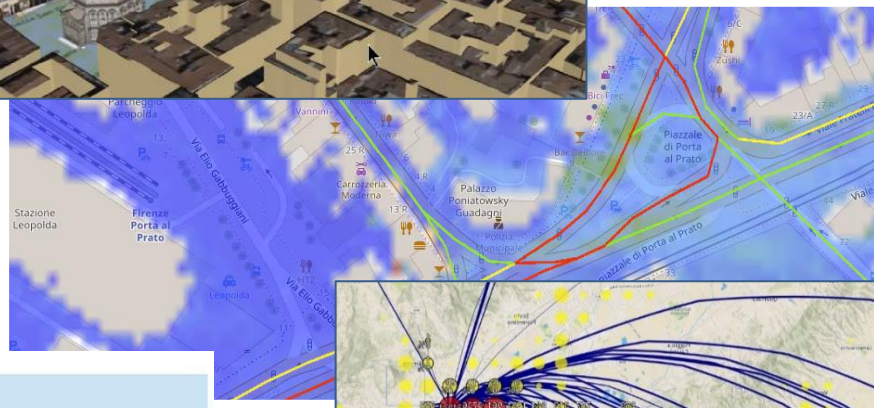
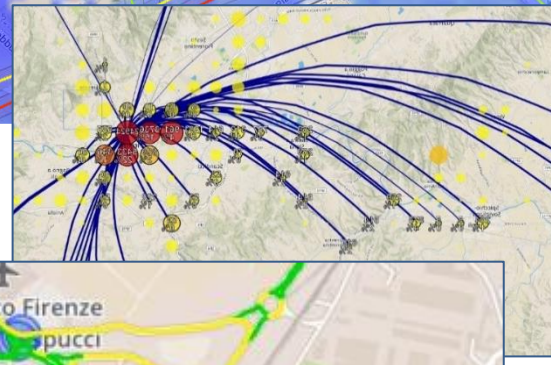
Main Tasks

- **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**





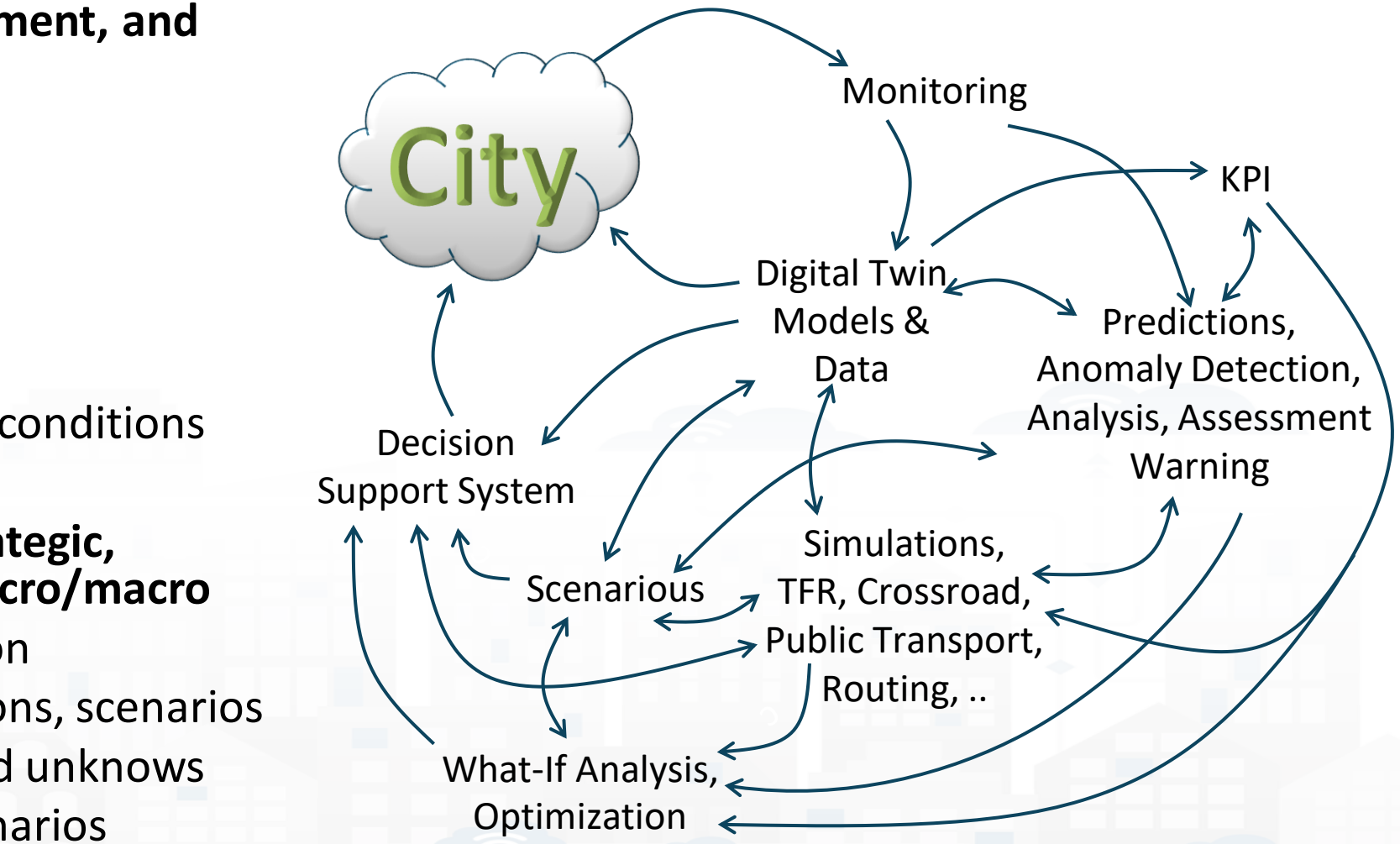






Main tasks

- **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



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City

Monitoring

KPI

Digital Twin
Models &
Data

Predictions,
Anomaly Detection,
Analysis, Assessment
Warning

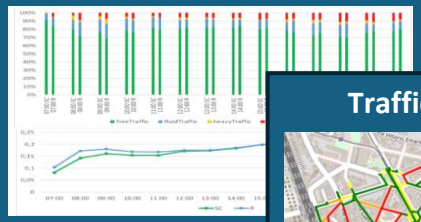
Decision
Support System

Scenarious

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

What-If Analysis,
Optimization

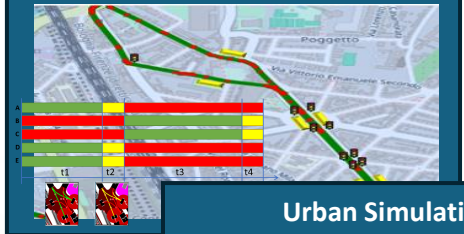
KPI, Predictions, ...



Traffic Reconstruction



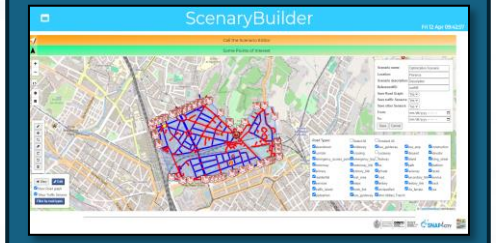
Traffic Light Plan optimization



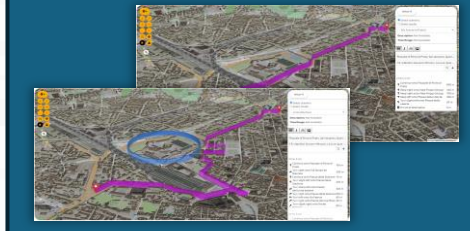
Urban Simulation



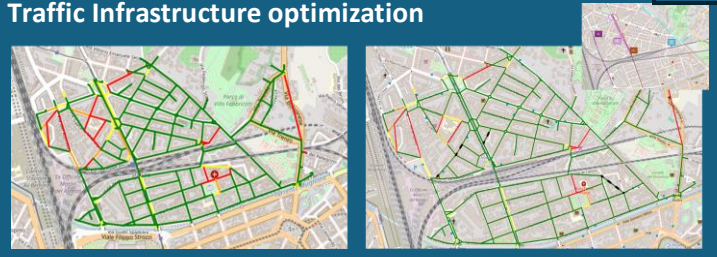
Scenario Editor



Routing / Dynamic Routing



Traffic Infrastructure optimization



100% OPEN SOURCE

THE POWER OF ARTIFICIAL INTELLIGENCE AT THE SERVICE OF YOUR OPERATION AND PLAN

SNAP4CITY · KM4CITY

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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

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



SNAPADVISOR



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



DASHBOARDS, WIDGETS
TEMPLATES



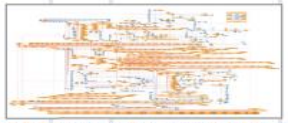
PREDICTION - ANOMALY DETECTION - CLUSTERING - ROUTING - SENTIMENT NLP - TRAFFIC FLOW - PEOPLE FLOWS - SDG
15 MIN CITY INDEX - KPI - HEATMAPS - ORIGIN DESTINATION - MAPS - VECTOR FIELD - ETC...



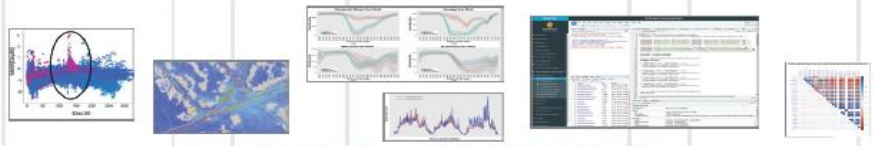
API - MICROSERVICES - GIS - BPM
VIDEO - REPORTS - MAPS - 3D ...

- DEVELOMENT ENVIRONMENT AND METHODOLOGY
- VISUAL PROGRAMMING, ML, AI, HPC
- TRAINING COURSES





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



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



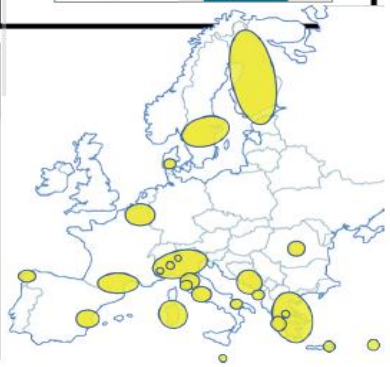
VISUAL PROGRAMMING, ADAPTERS
DATA FLOWS, WORKFLOWS
PARALLEL DISTRIBUTED PROCESSING
DATA DRIVEN

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



NATIVE AND EXTERNAL APPLICATIONS

- Smart Parking
- Smart Light
- Smart Waste
- Smart Energy
- Smart Building
- Smart Tourism
- ...



Technical Architecture



Entity Directory:
Smart Data Models
IoT Data Models
Digital Twins

FIWARE Brokers
MQTT Brokers
Brokers

API Manager
Federation Smart City API
OpenSearch
virtuoso
storage
KB, graph
GeoServer
BIMserver.center
Entity Inspector
Data Manager
HLT Manager
Service Map

Any API

Front-End

Facilities
- Dashboard/View Builder & Mng.
- Business Intelligence CSBL
- Custom Themes
- Synoptics & Widgets
- 2/3D Digital Twin

Tools
- Routing, MulDyn
- Heatmap Gen.
- Prediction Gen.
- Measure & Compare
- Notification Mng.
- KPI Support
- Scenario, What-If

Applications
- Traffic Optimiz.
- Traffic Light Plan
- Public Transport
- Parking Mng.
- Fines Mng.
- Participation Mng.
- Lighting Mng.
- Building Mng.
- Environment Mng.
- Waste Mng.
- Sharing/pool Mng.
- Energy Mng.
- Tourism Mng.
- Mobile Apps

Node-RED

Simulators' tools:
SUMO, DORAM, TFR, ..

python R Studio

Artificial Intelligence tools:
pred., classif., optim., LLM, ...

Social Media
OSM, BIM, GIS, ITS
Gateways, satellite
External Services
Web Scraping
TV CAM streams

IoT App ProcLog.

On Edge
On Cloud

IoT App
ProcLogic

Event Driven

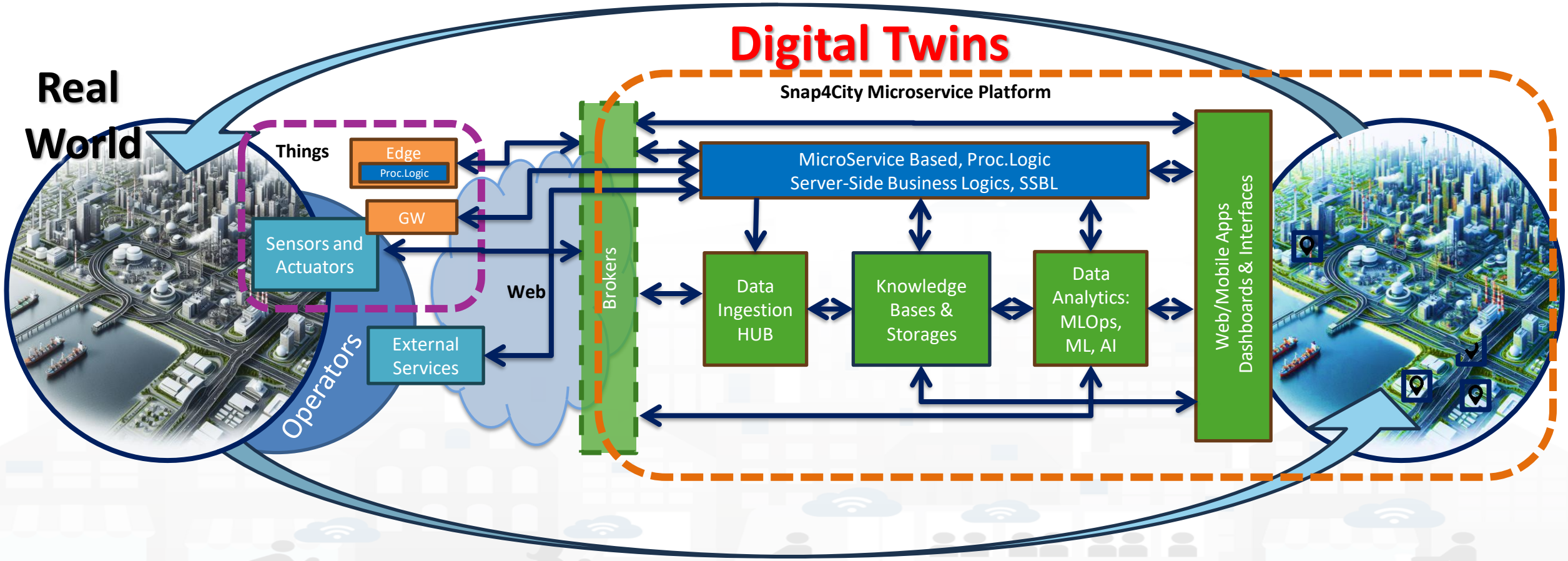
SnapAdvisor / Generative AI

A&A, RBAC, SSO, Blockchain, Resource Managers and Sharing

Sharing / Market Place

Third parties solutions

Digital Twin Development Platform



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High Level Types

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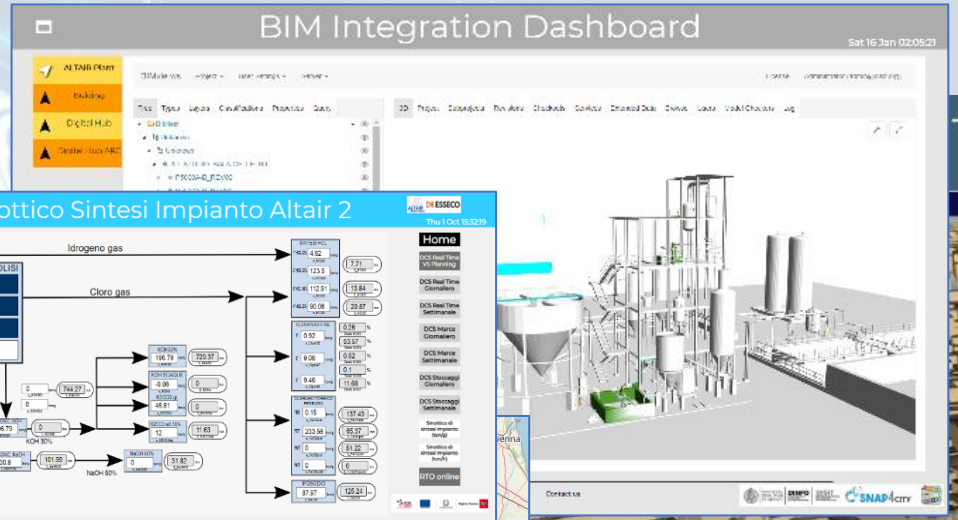
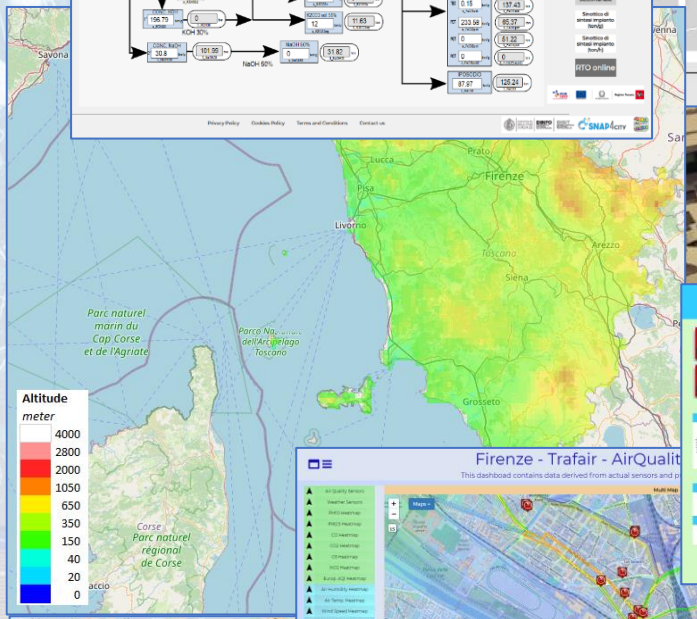
- POI, IOT Devices, shapes,..
  - FIWARE Smart Data Models,
  - IoT Device Models
- GIS, maps, orthomaps, WFS/WMS, GeoTiff, calibrated heatmaps, ..
- Satellite data, any kind..
- traffic flow, typical trends, ..
- Vector fields + heatmaps, ..
- trajectories, events, workflow, ..
- 3D Models, BIM, Digital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





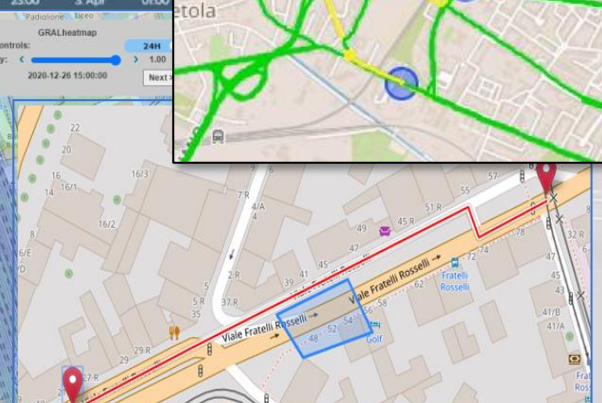








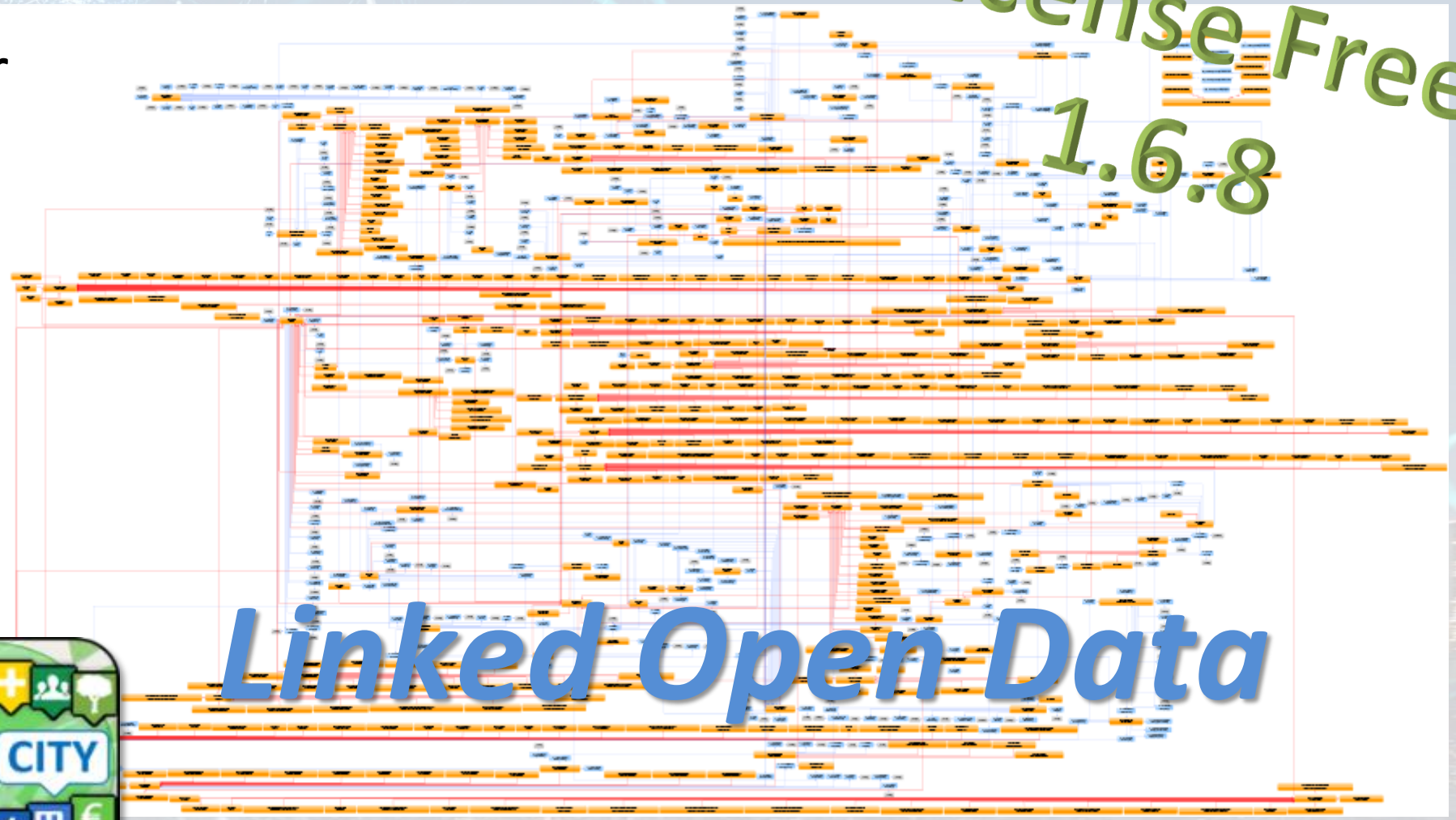






Expert System semantic queries

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



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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/

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Standards and Interoperability

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, WCS, RTSP, ONVIF, AXIS TVCam, CISCO Meraki, OSM, Copernicus, The Weather Channel, Open Weather, OLAP, VMS Milestone, TIM, HERE, OGC, ….
- **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.

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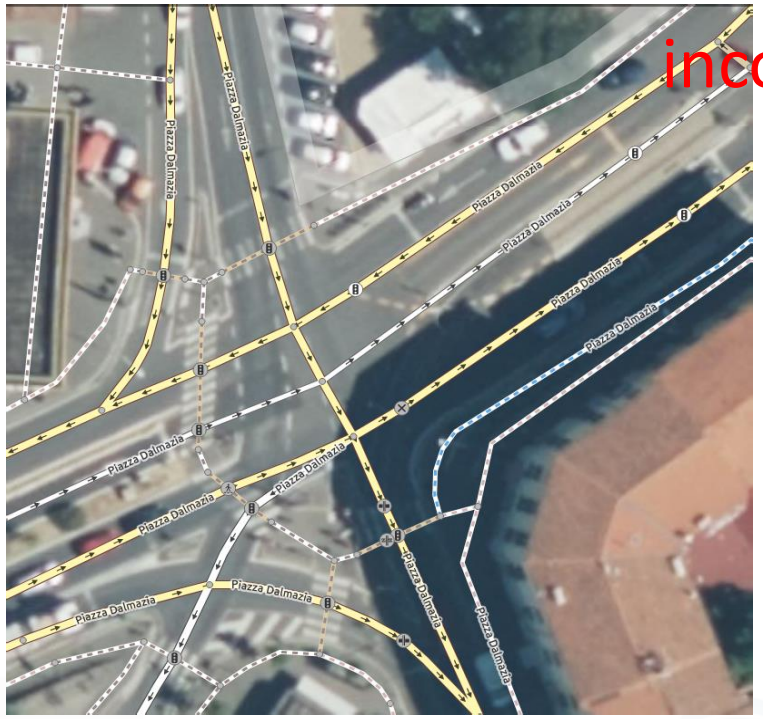
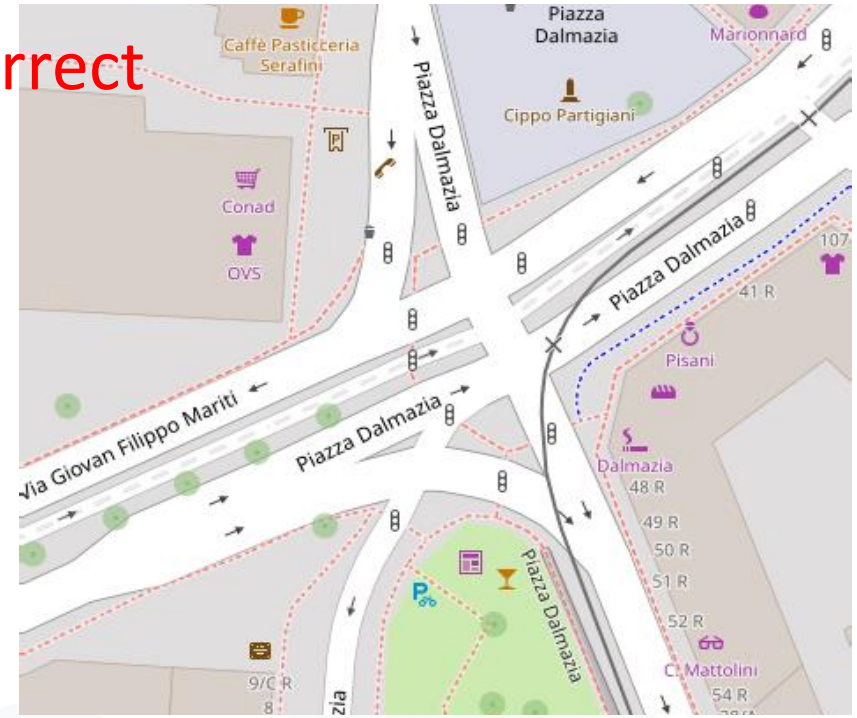
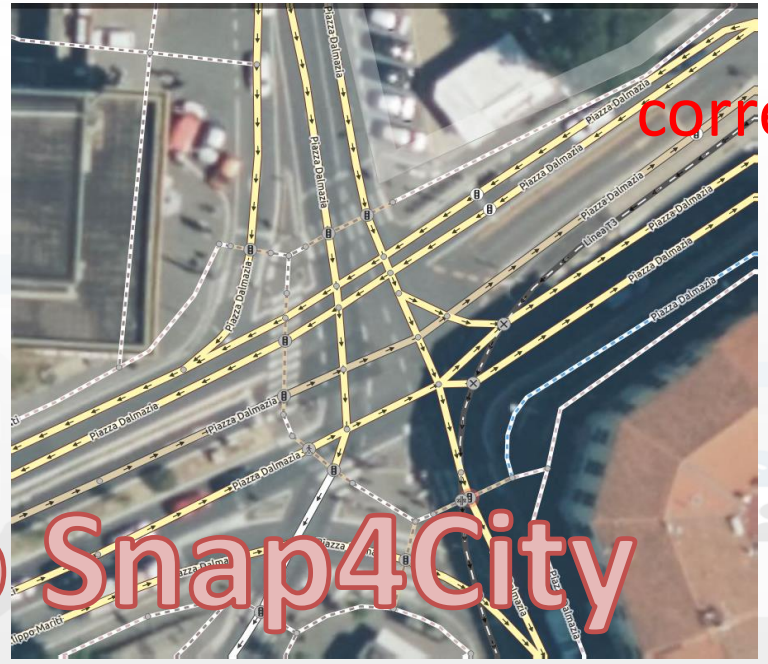
OSM data with non correct viability in Piazza Dalmazia, Firenze



incorrect



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



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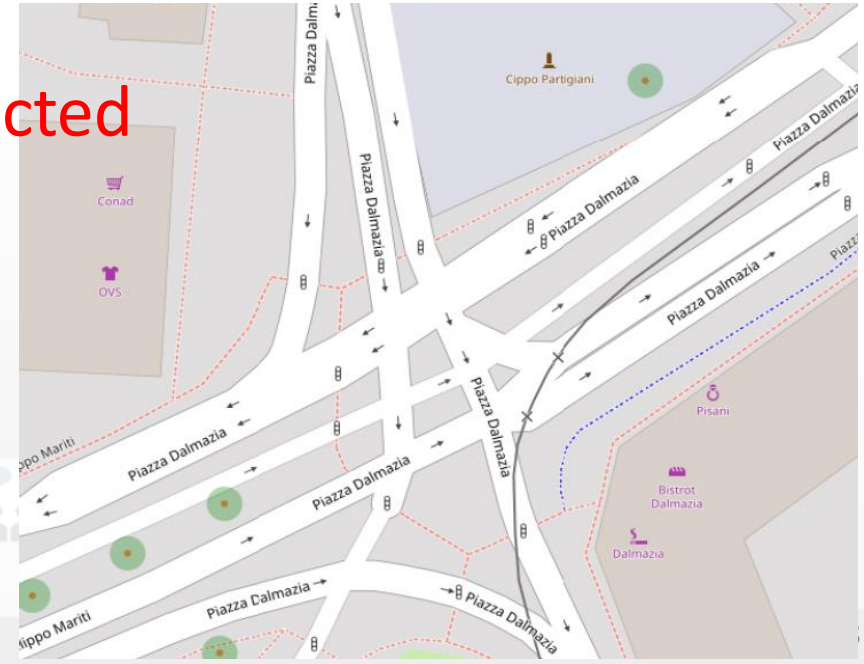
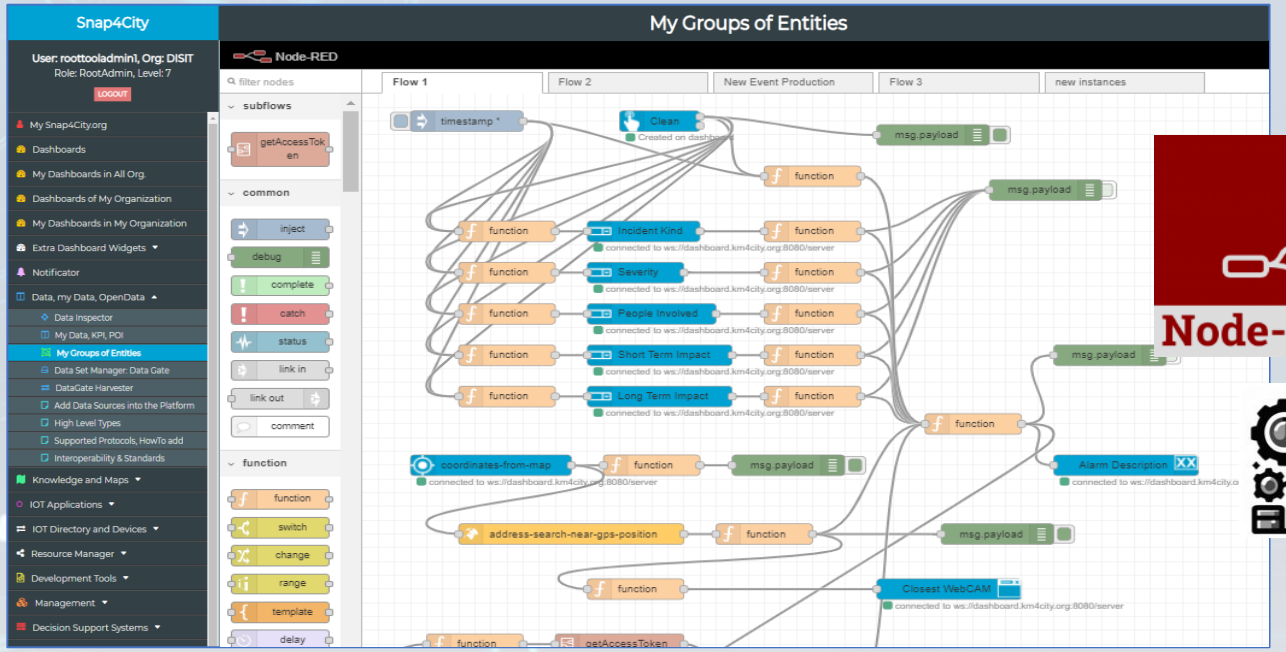
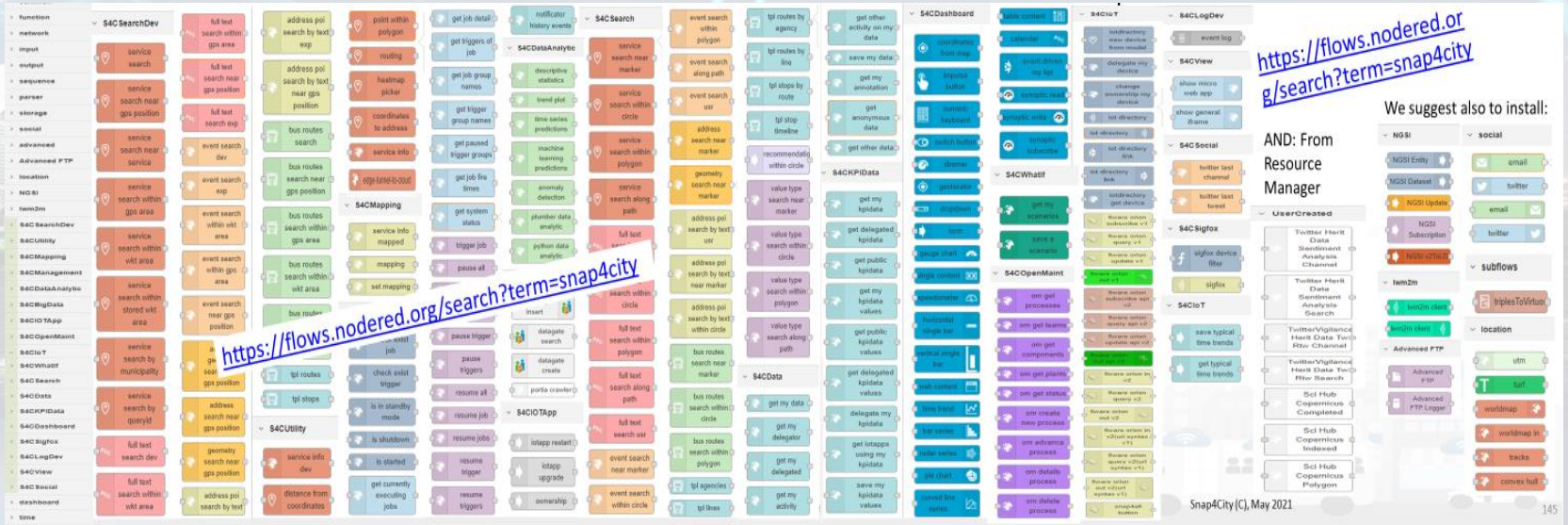


From OSM to Snap4City

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





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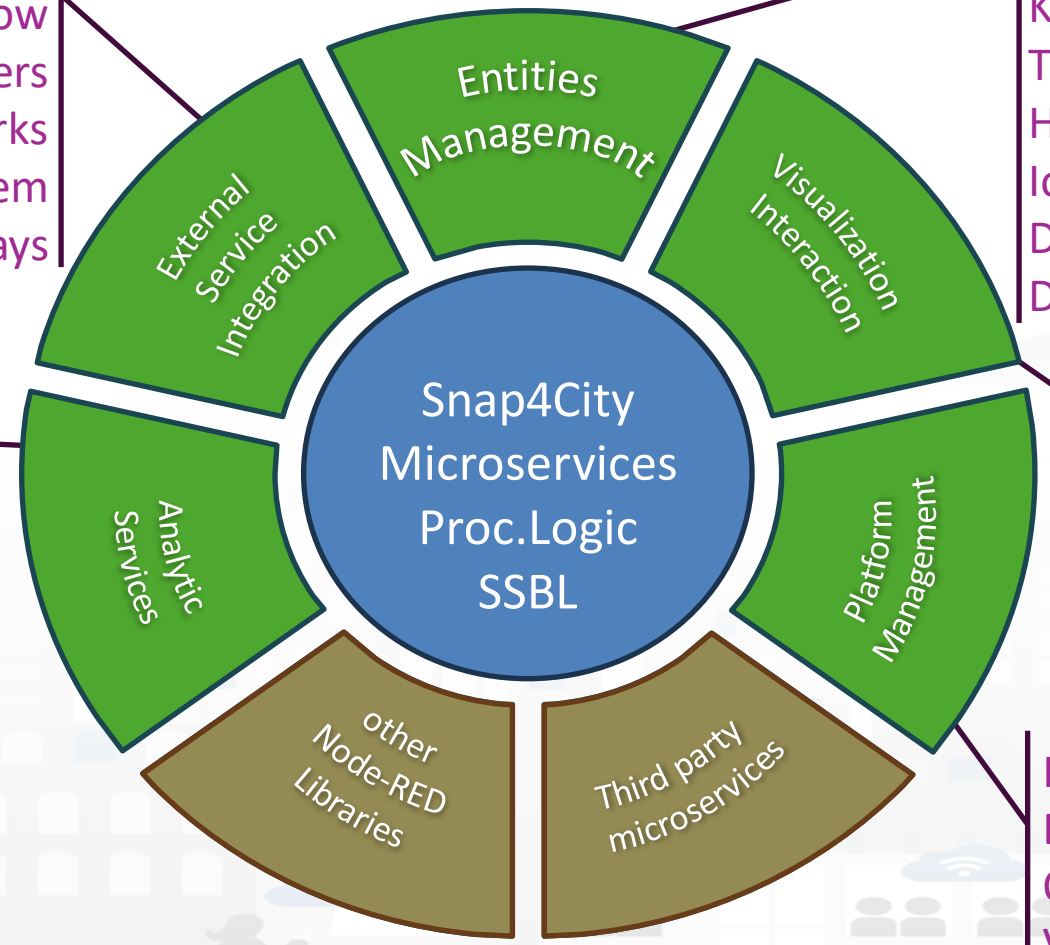
MicroServices Areas

> 60.000 downloads (up to 2024)



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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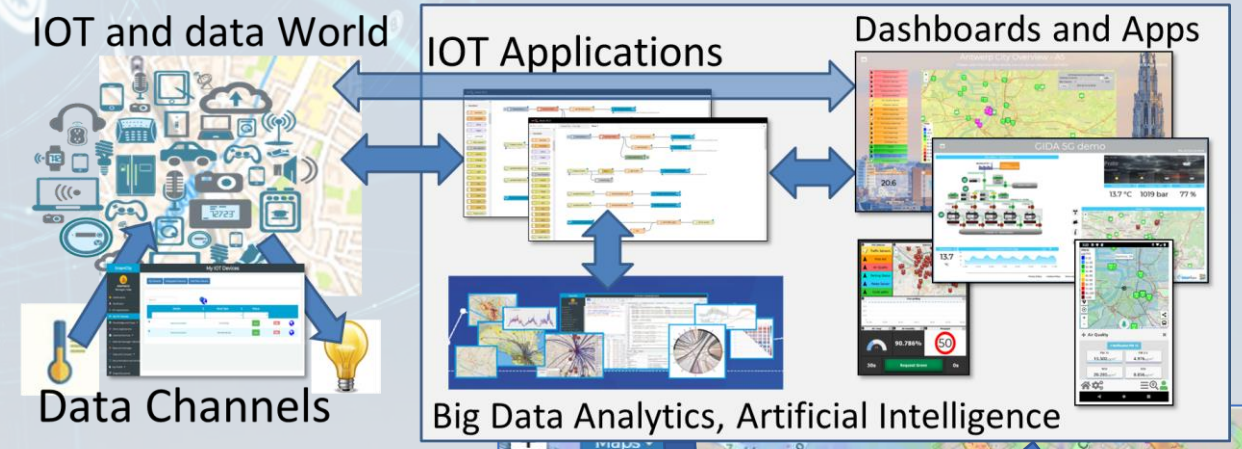
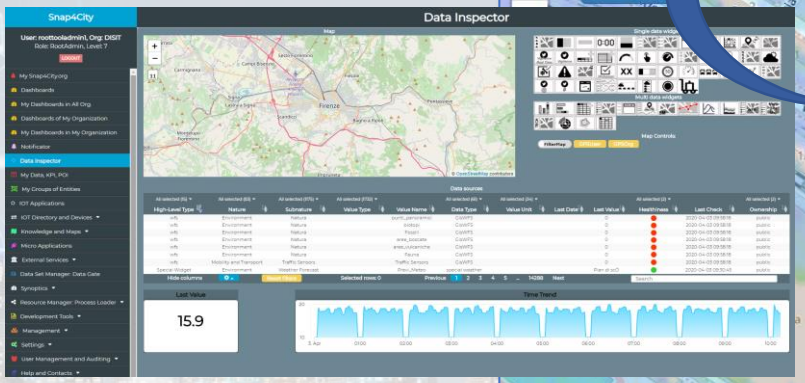
Solutions: reliable, secure and fast to realize

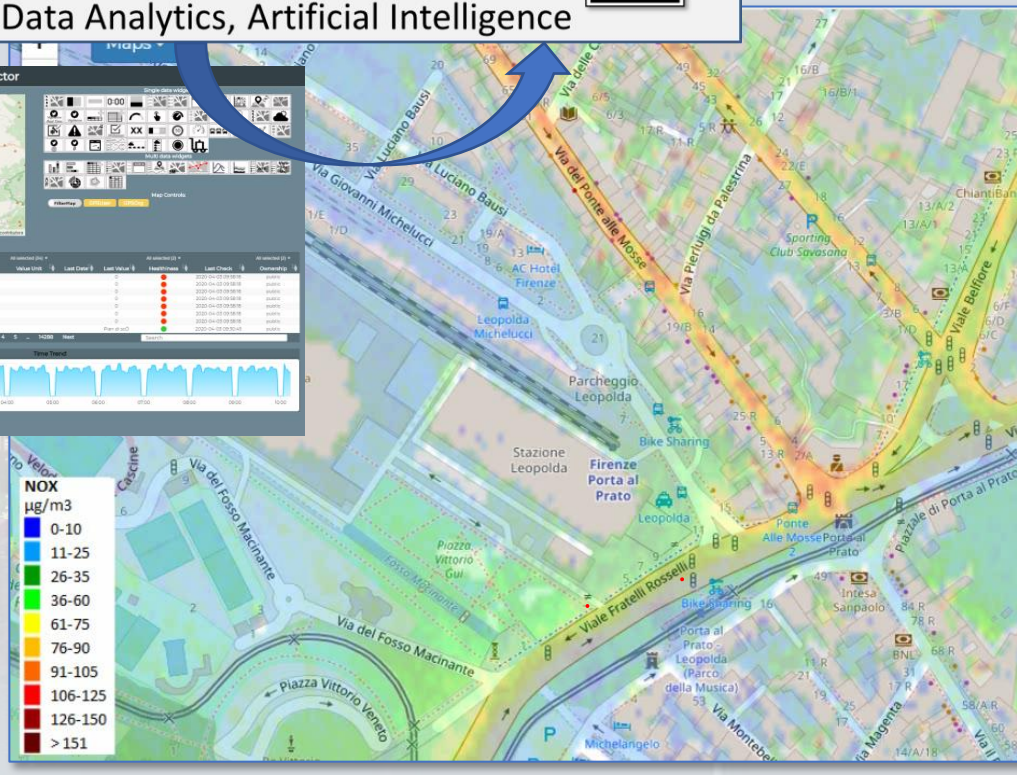
- **Via Snap4City tools**
  - **Dashboard Wizard**
  - **Dashboard Builder**
  - **Data/Visual Analytic**

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









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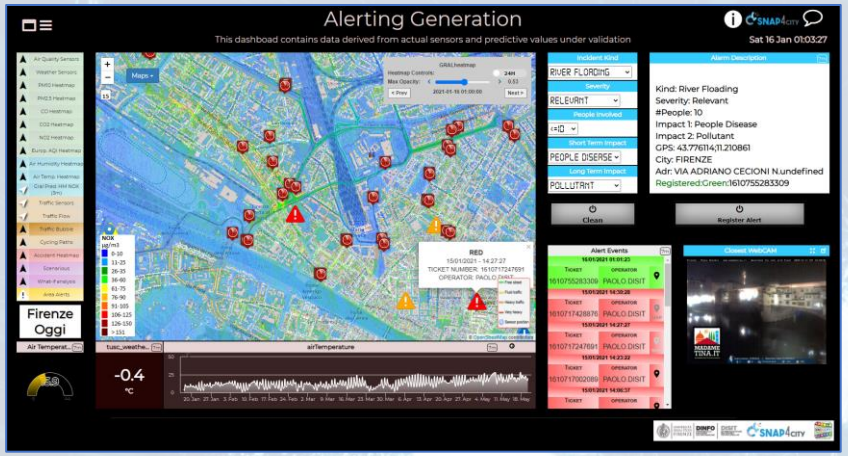

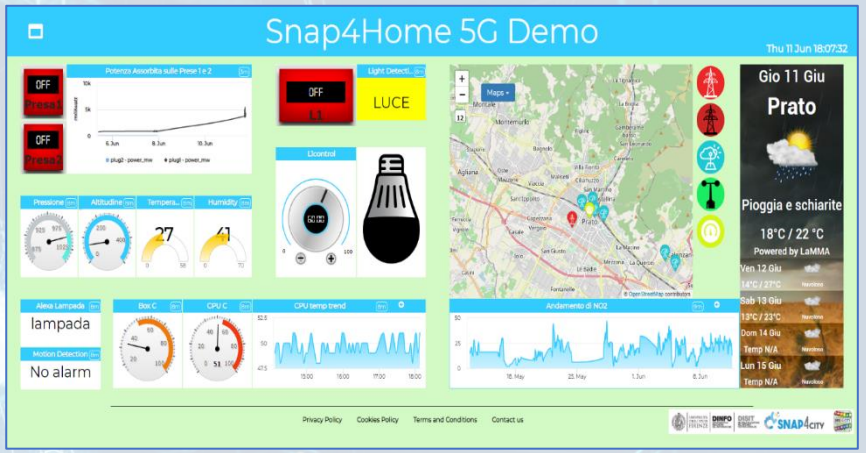

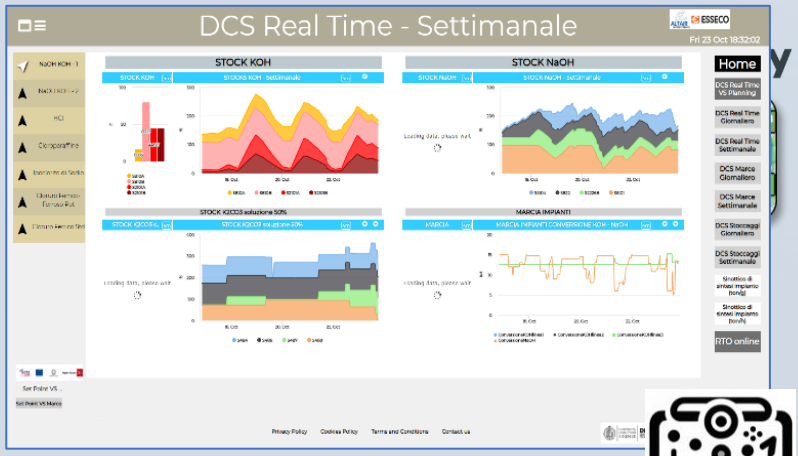

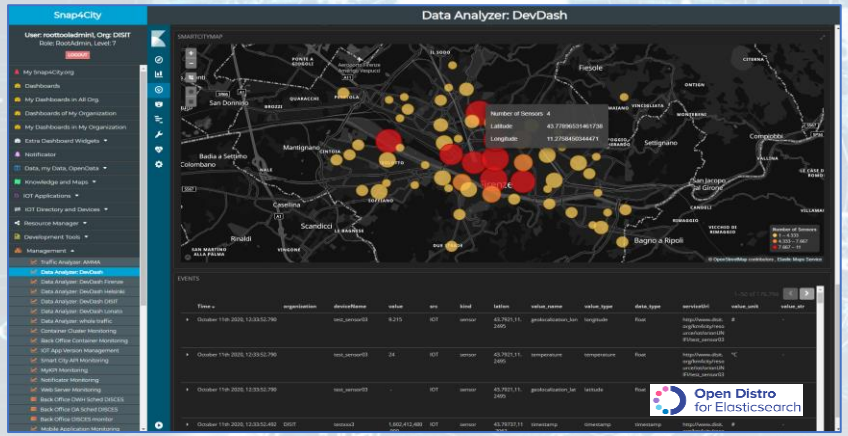

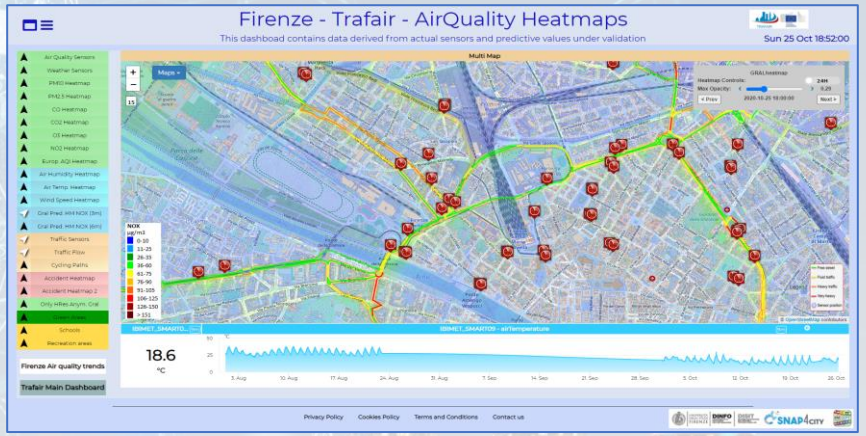

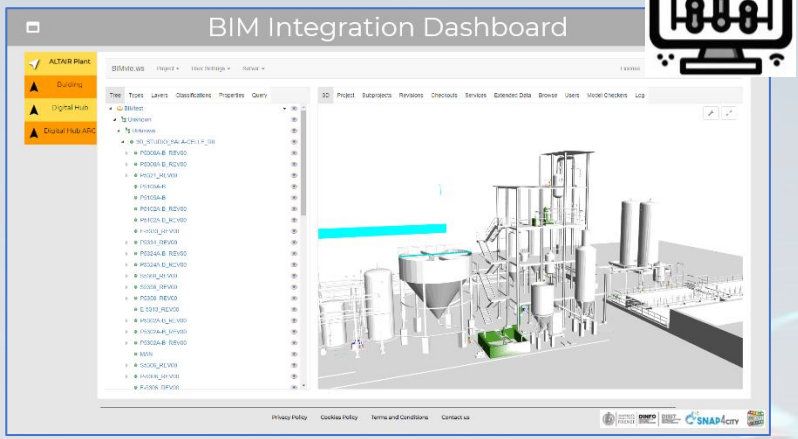



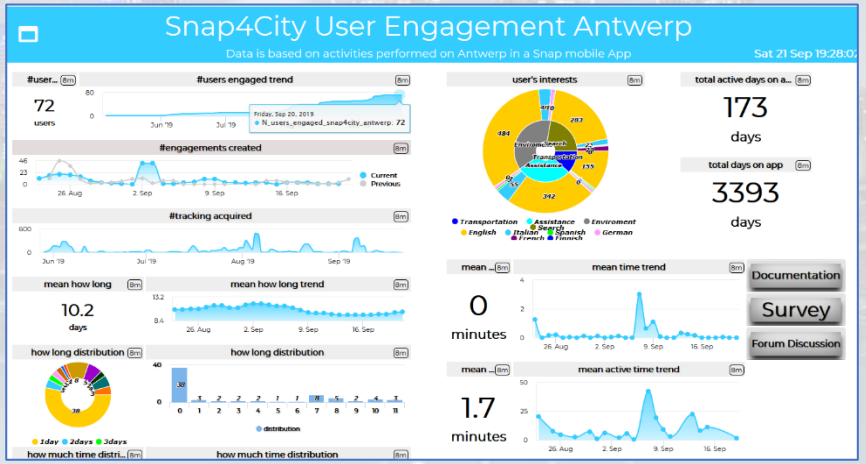

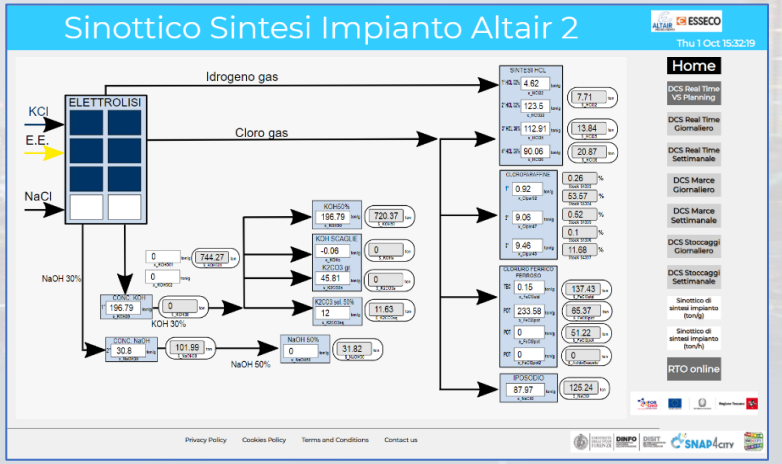

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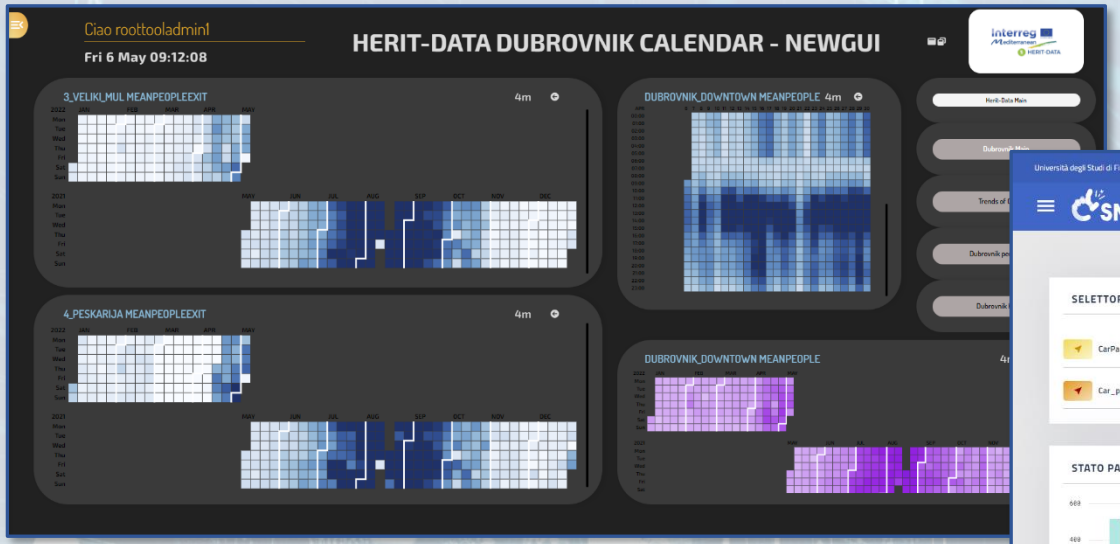
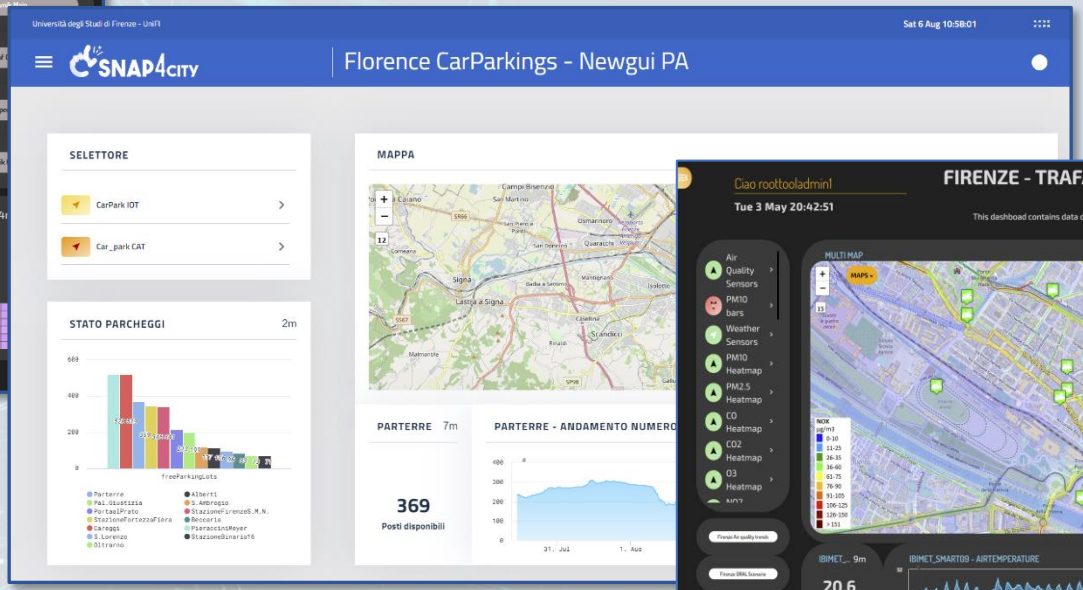
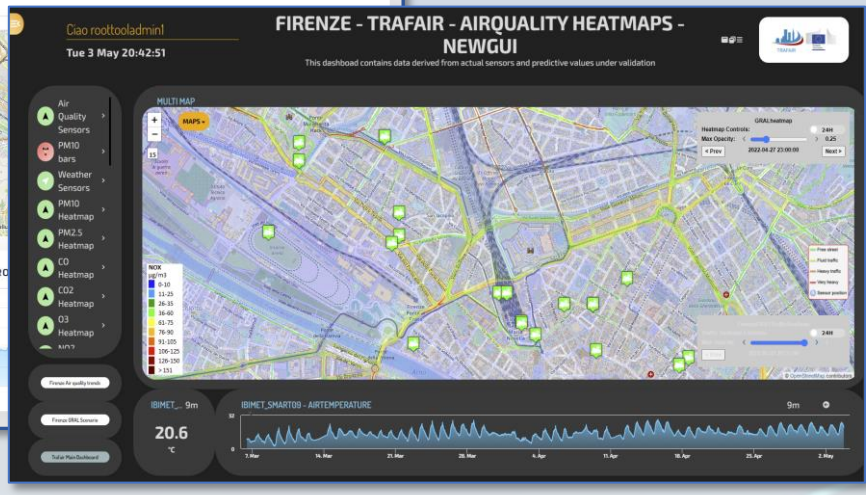
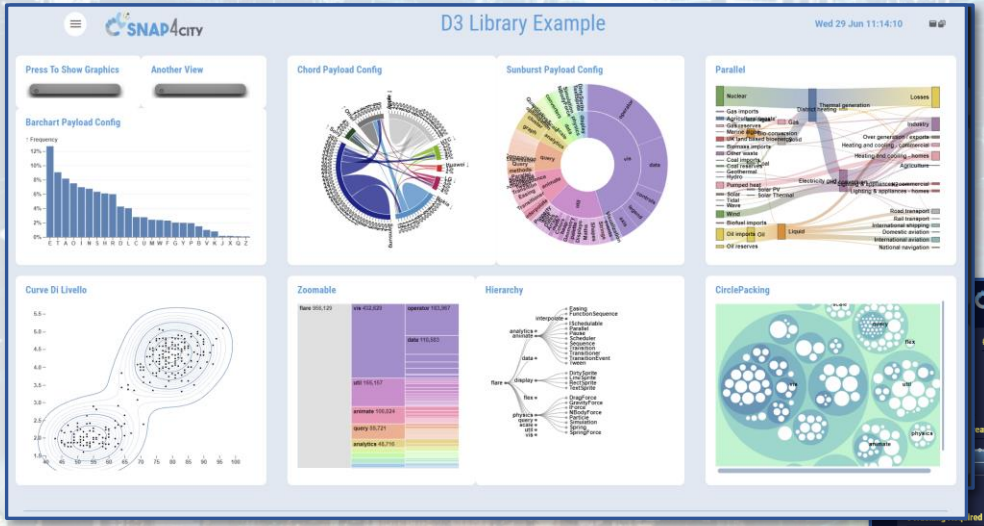
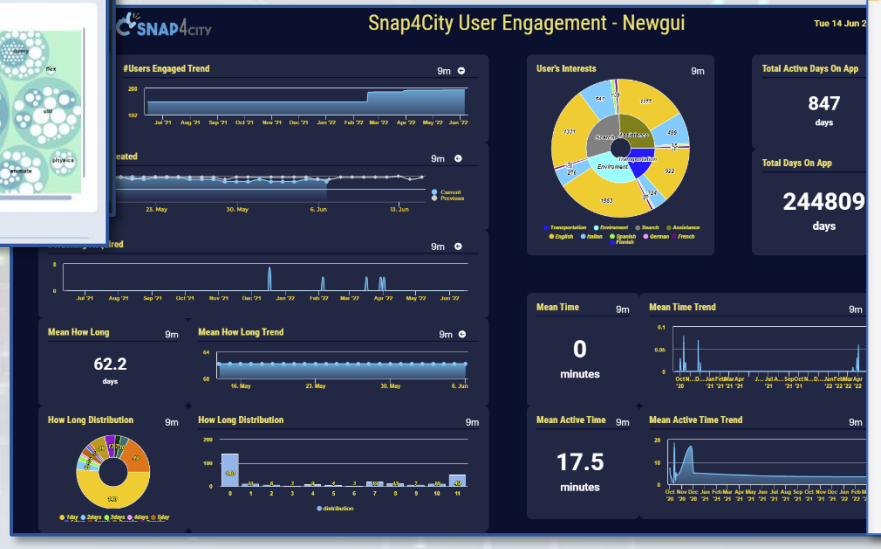
Different Themes

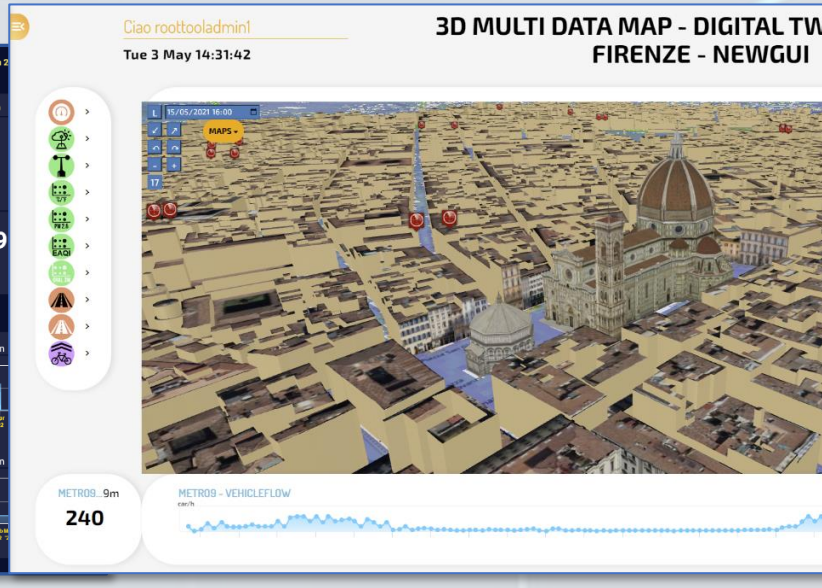












New styles/themes can be developed by specializing a few files from open source

https://www.snap4city.org/793

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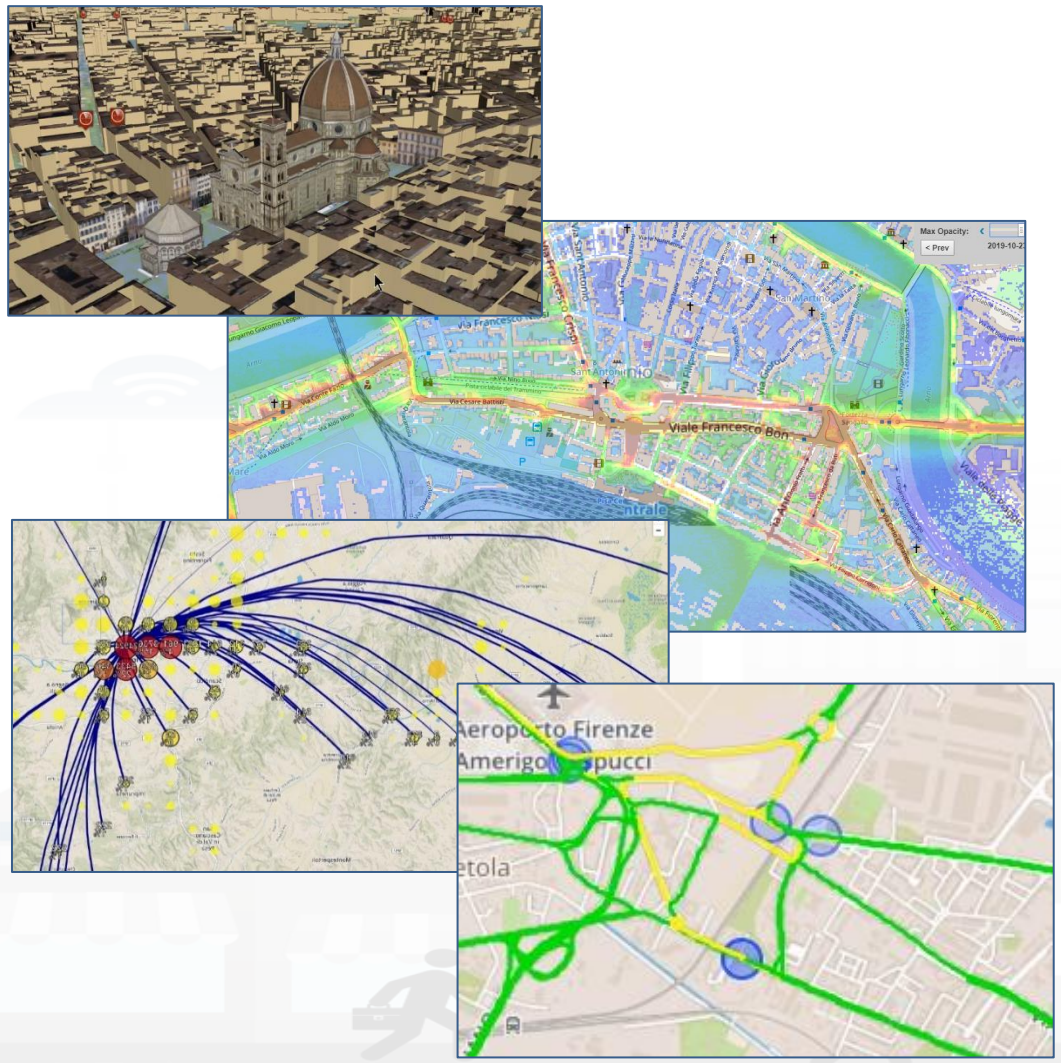
Smart City Digital Twin



City Digital Model with…

- Intuitive platform
- Any Data TYPE, any data source, any protocol
- Data storage seamless
- Data analytics → artificial intelligence, AI/XAI
- Data Ethics, AI Ethics, GDPR
- 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.

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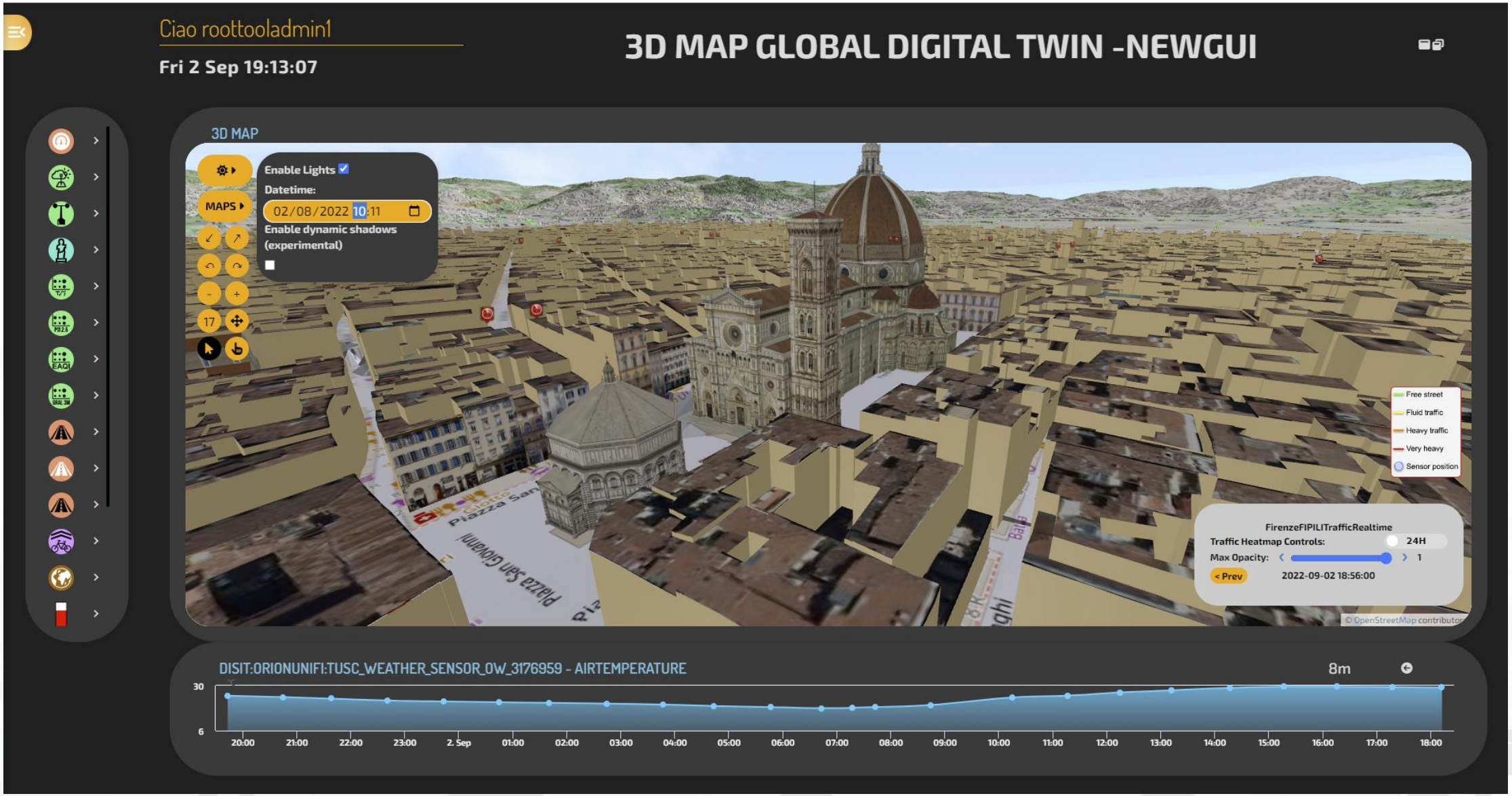
3D Digital Twin



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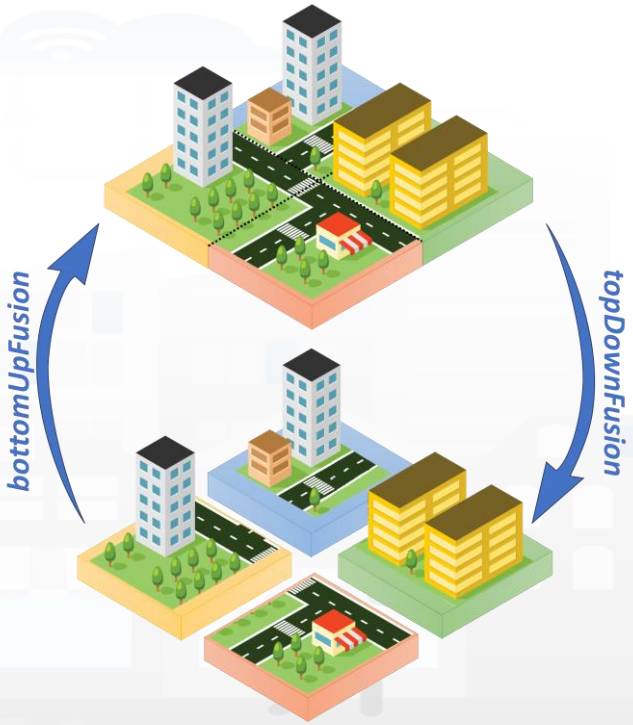
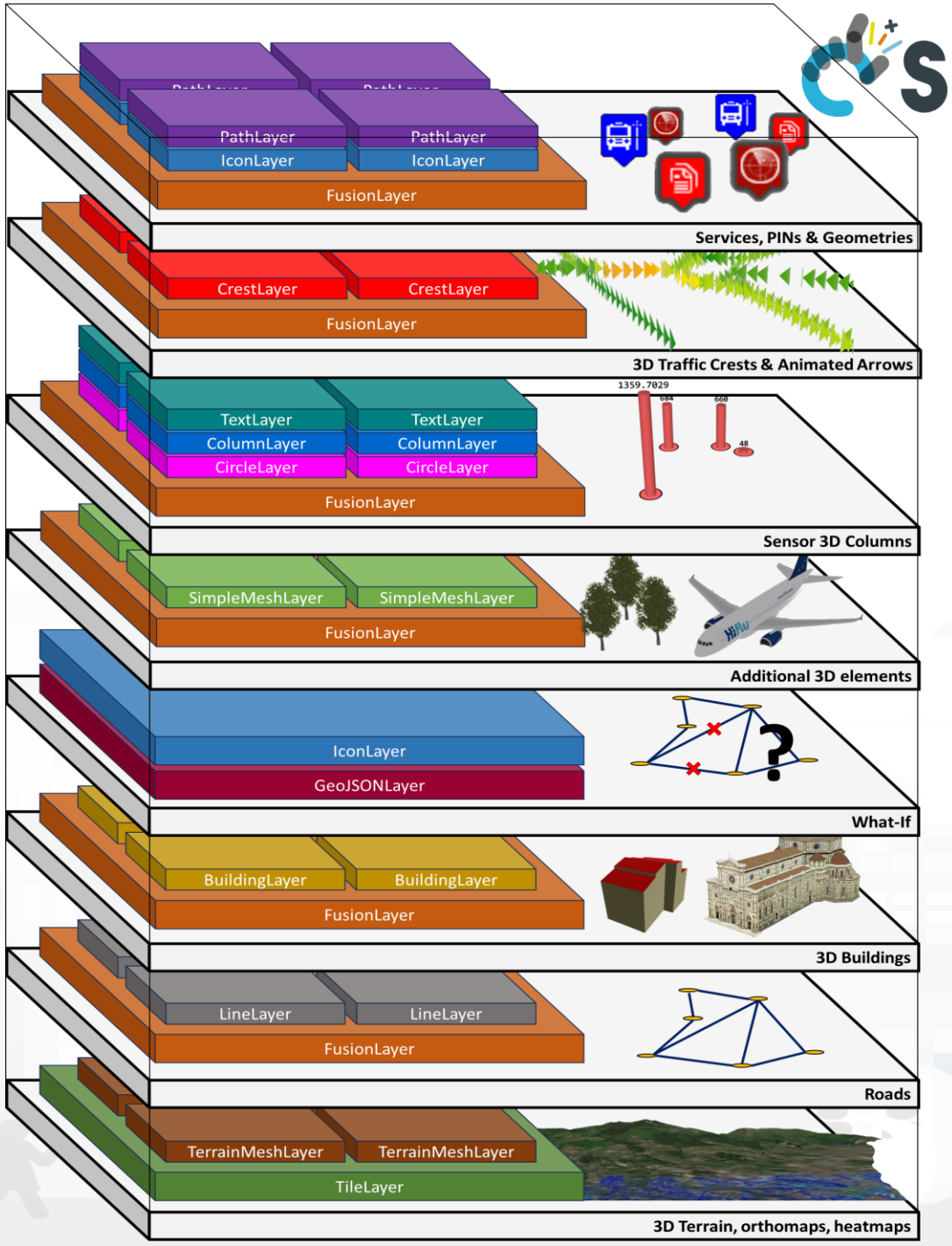
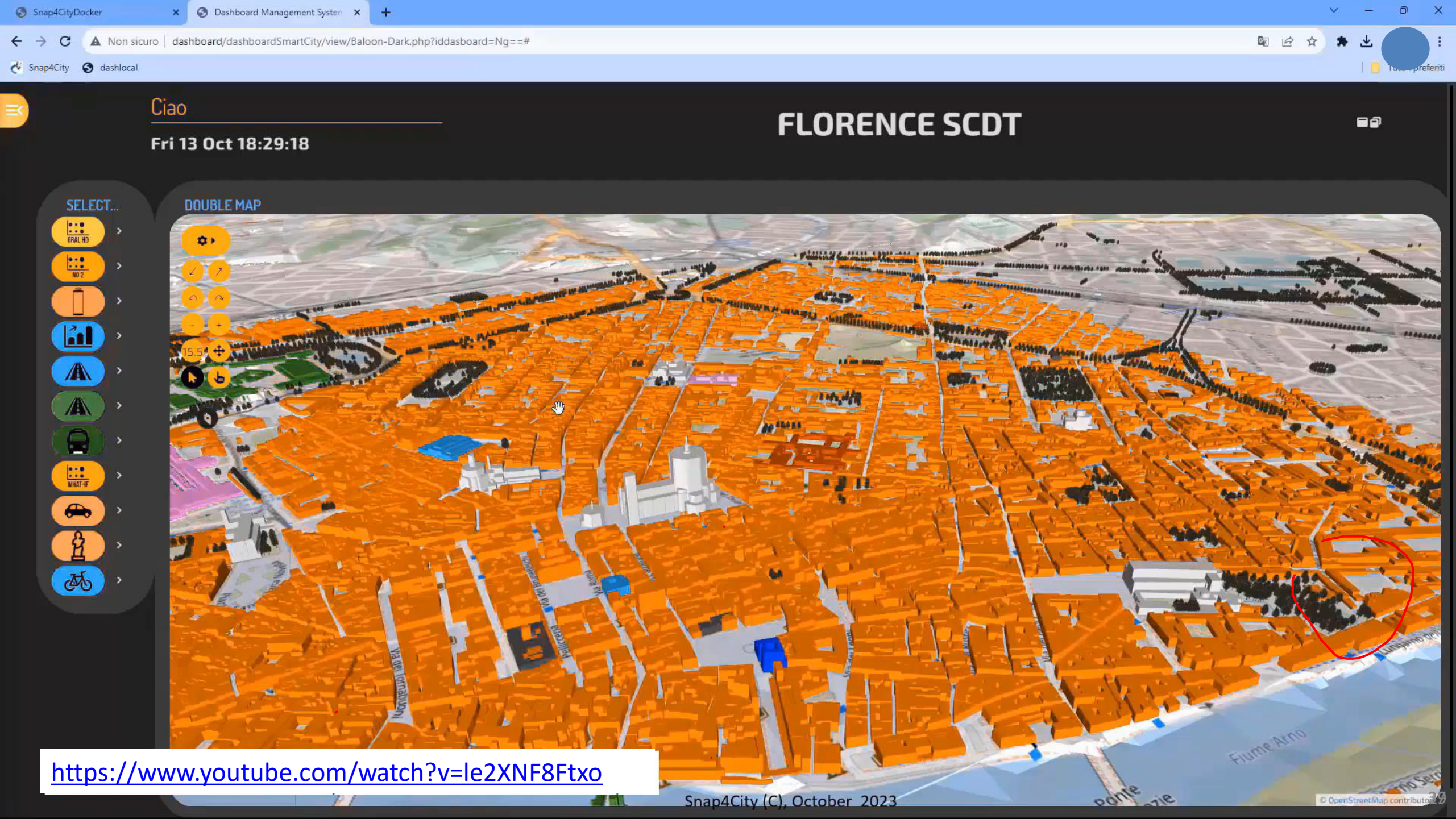
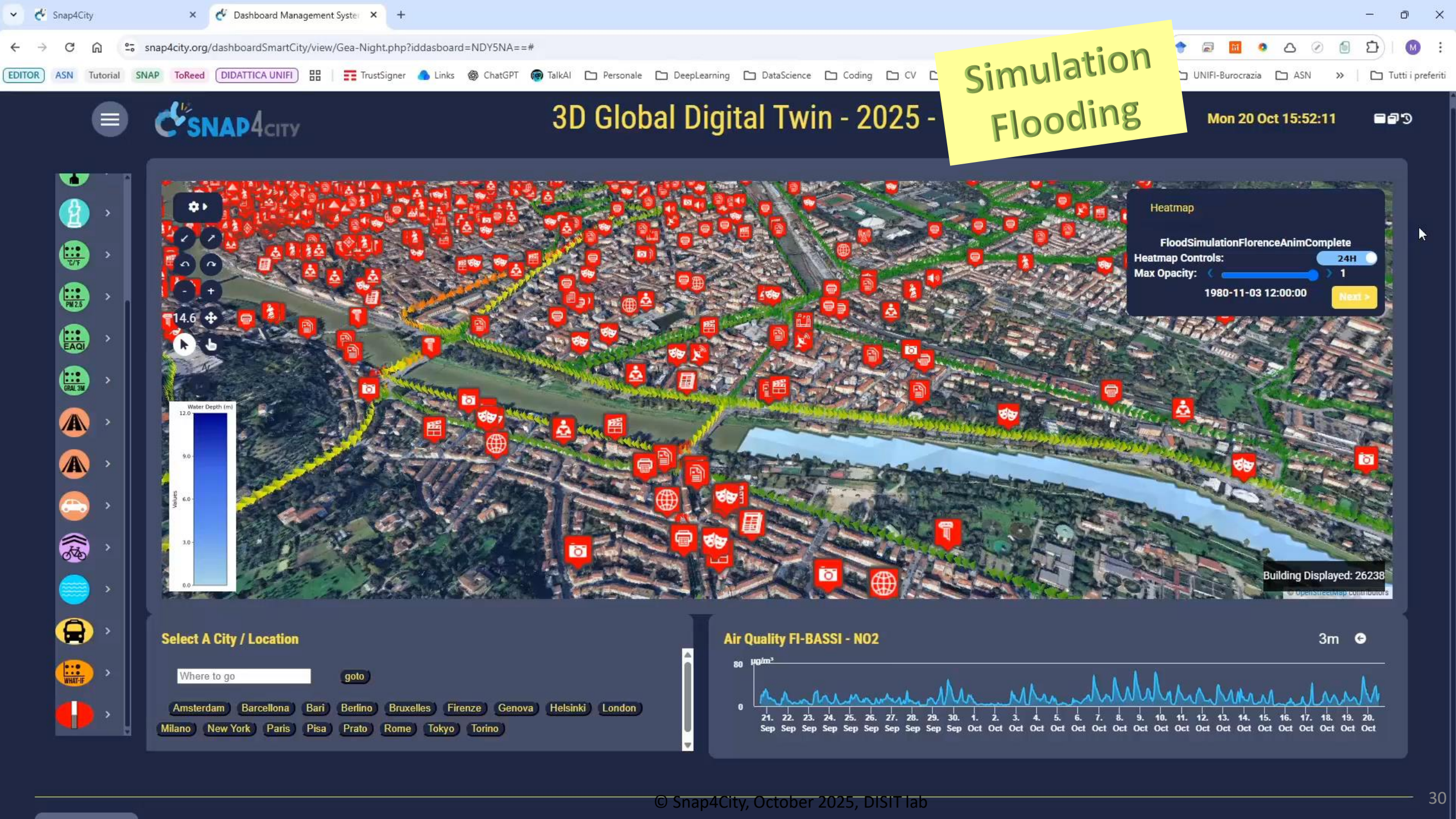
Layers vs Fusion Layers







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



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Snap4City Platform tools

- **Routing**, Multi modal and Dynamic
- **Heatmap** Generation and management
- **Prediction** Generation and management
- **Measures on Floors, Maps and orthomaps**
- **Compare Orthomaps with overlapped structures**
- **Scenario**, editor, scenario based **optimisation**
- **Notification** Management, multichannel
- **KPI Support**: SUMI, PUMS/SUMP
- **What-If analysis**, grounded on **predictions**, **simulations**, etc.

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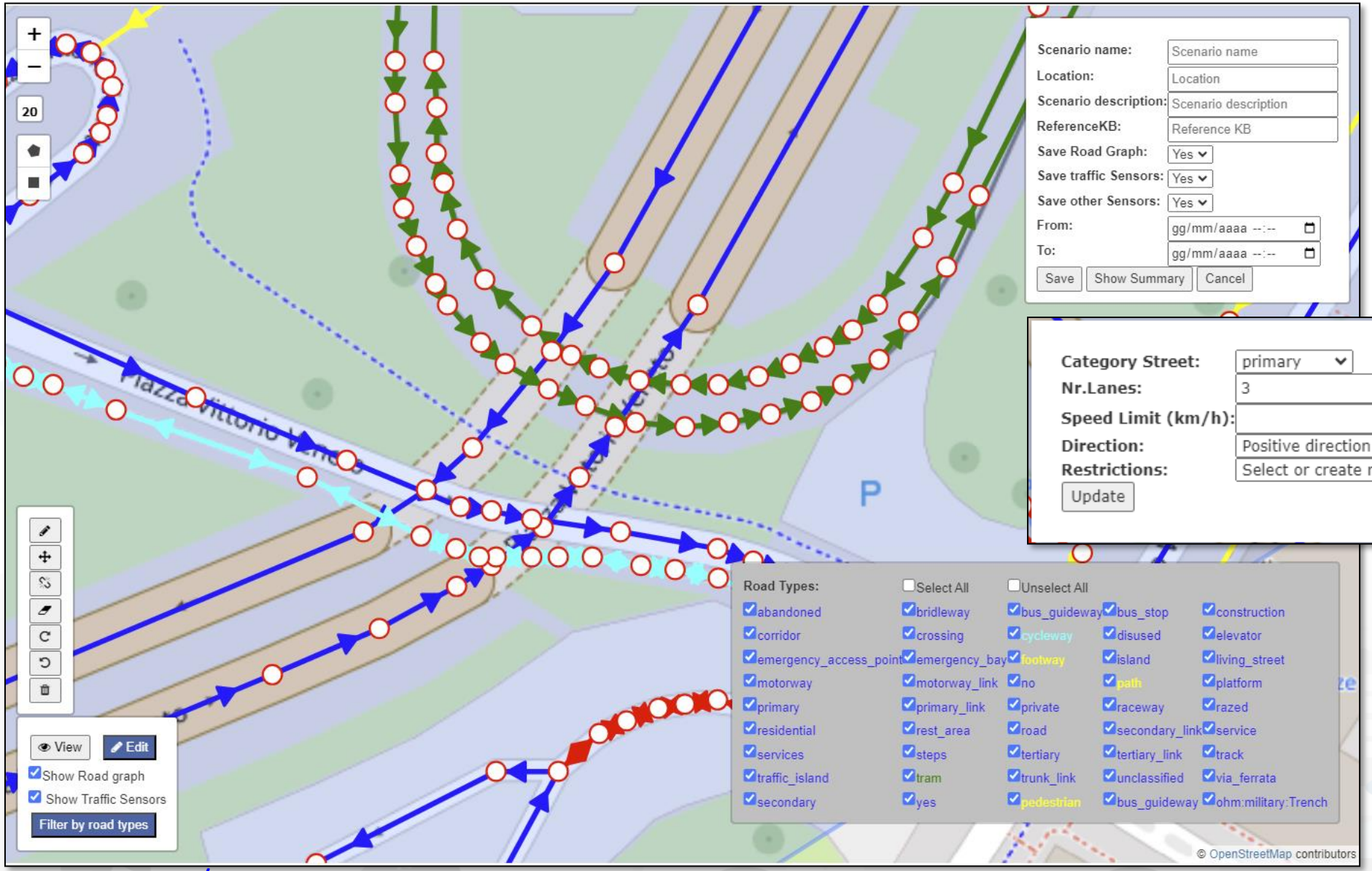
Scenario Editor

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

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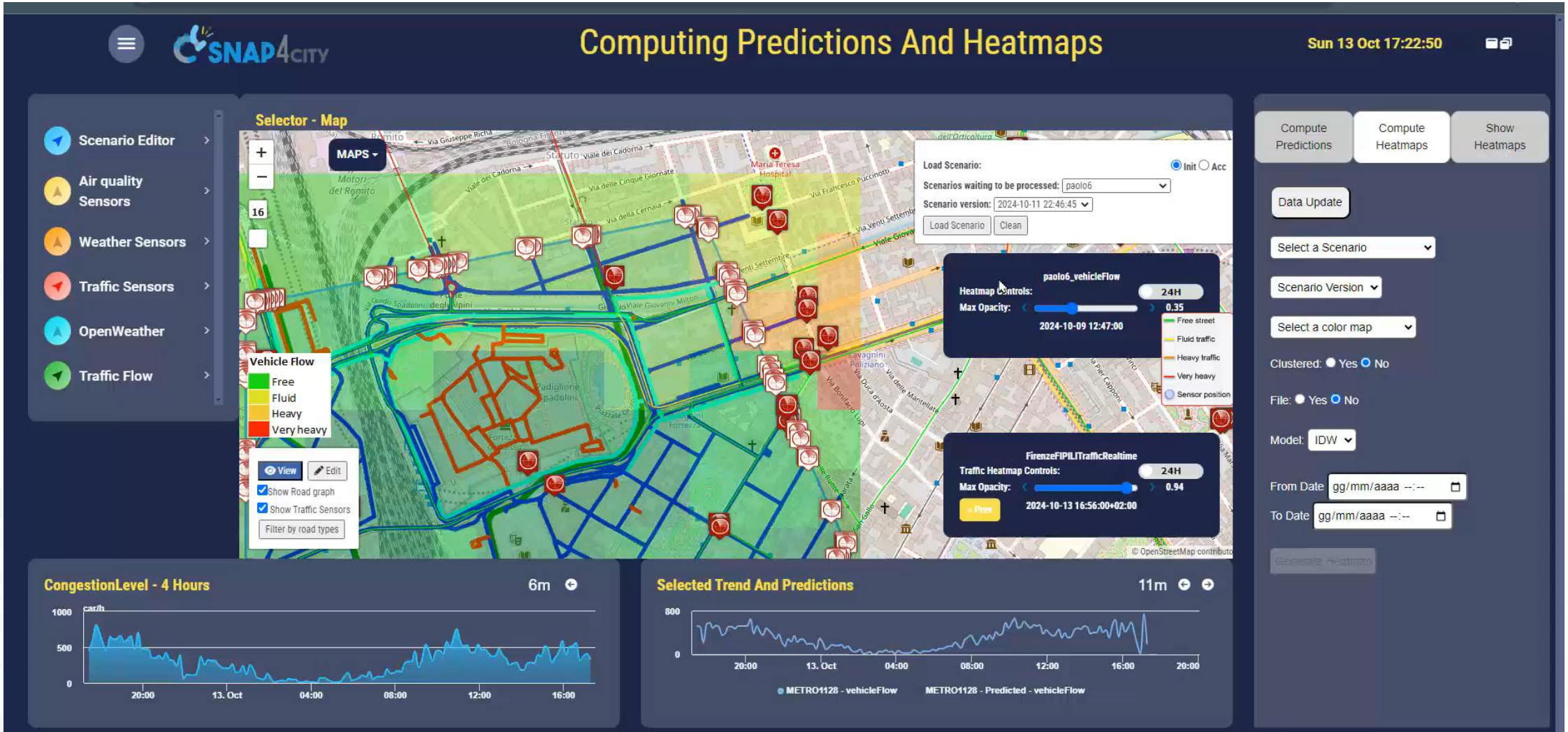
Predictions and Heatmaps in Real Time



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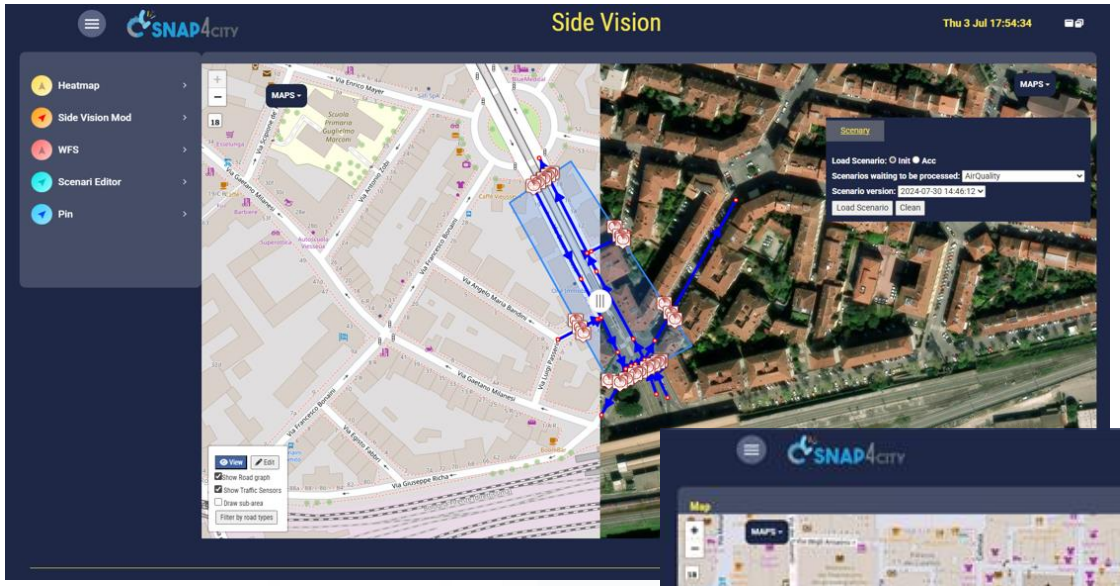
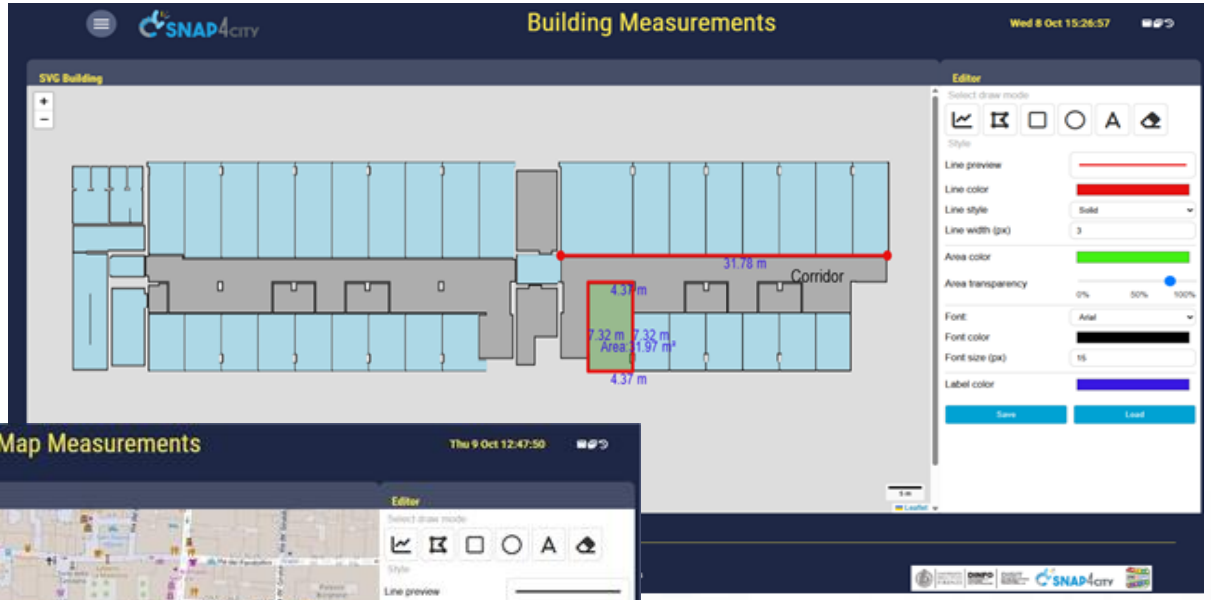
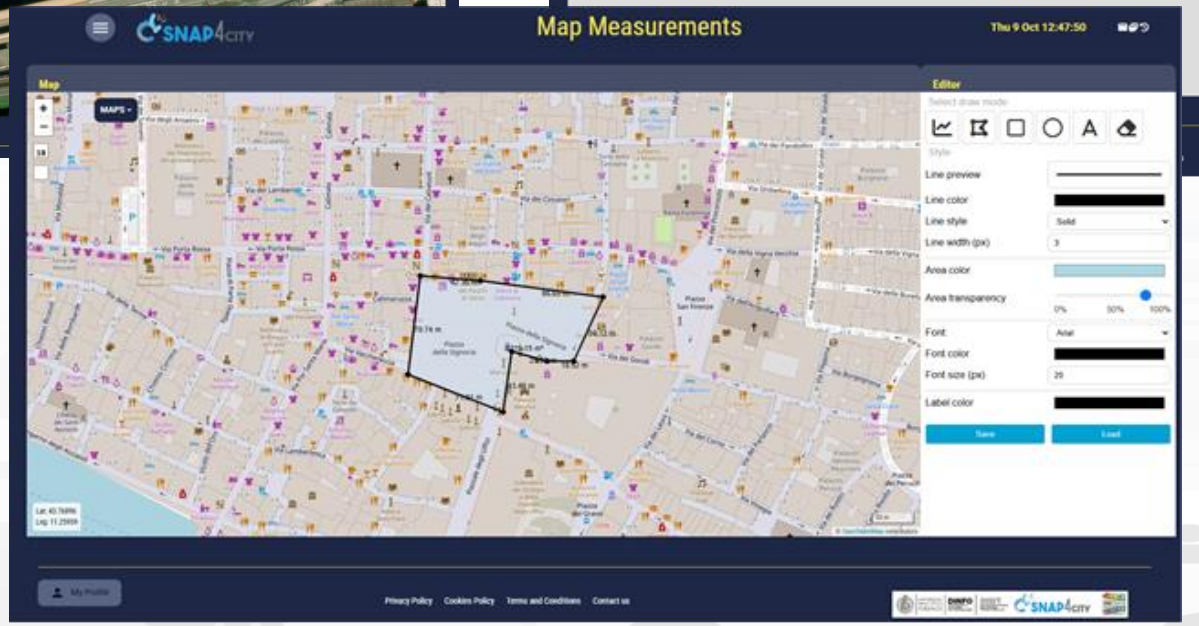
Compare and Measure







Draw, Measure,
Save, reload,
Share, Modify,
Versioning, ….

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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/

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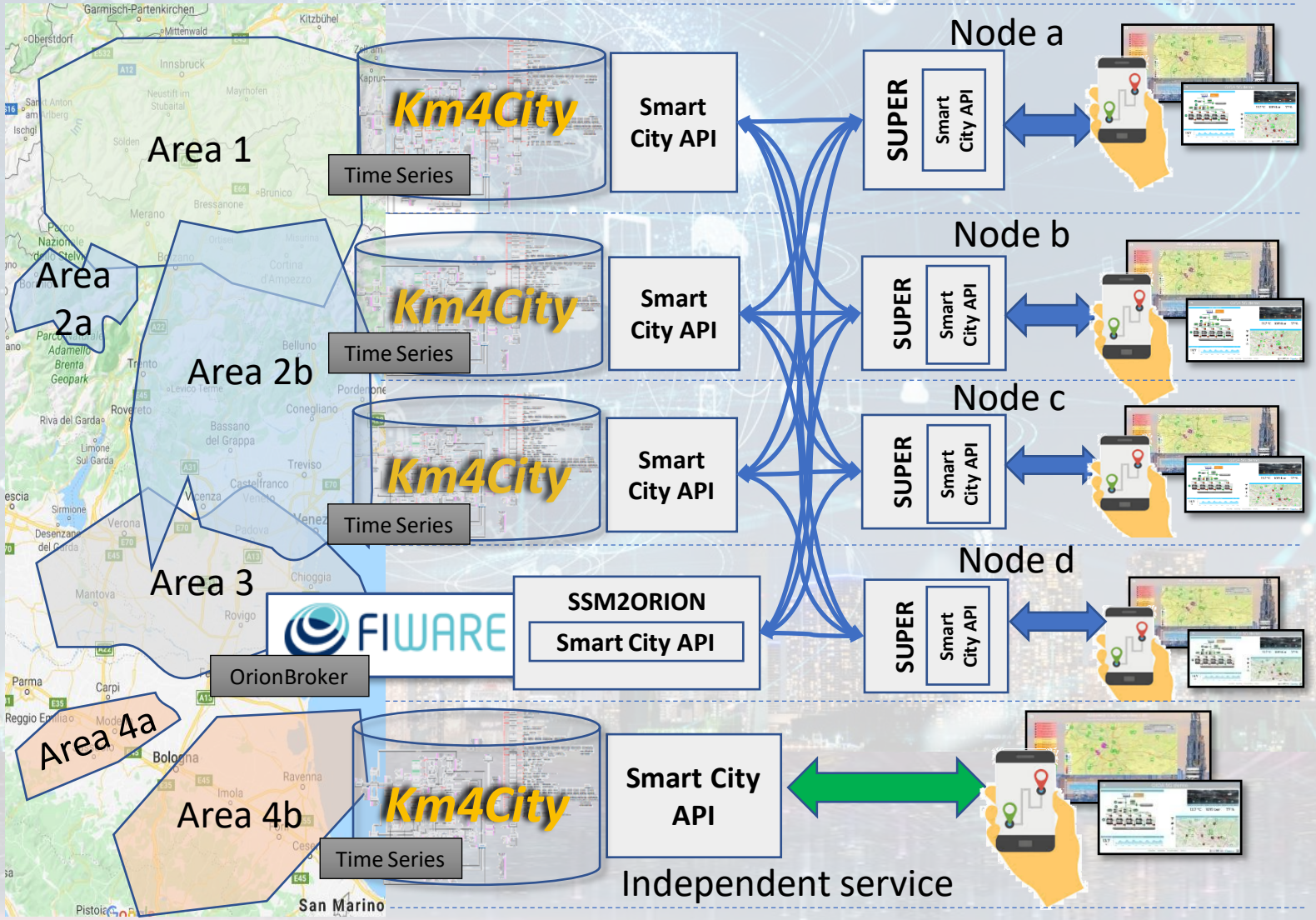
Federation of Smart City Services

Knowledge Base
Semantic Reasoners



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

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Scenarious

https://www.snap4city.org/4

- Snap4City at OSAKA with OPTIFaaS and CN MOST
- SMART3R-FLITS: SMART Transport for TRavellers and Freight Logistics Integration Towards Sustainability
- SOLUTION: Security, Smart City Asset Management for Cuneo, Italy PDF
- ENERGIA: R&S di autoclave a mandrini multipli nel curing di serbatoi in composito per storage di H2 mediante ottimizzazione energetica
  machine learning.
- UrbanDT4TF: Urban Digital Twin for Traffic Flow
- ELLIE: On the UsE of Internet of Senses for the CuLturaL HerItagE
- Snap4Rhodes: The "Single Smart City & Cyber Security Monitoring Platform" for the Municipality of Rhodes
- SADI-MIAC: Integrated Decision Support System with Digital Twin Models and Artificial Intelligence for Business
- SADI-MIAC: Sistema di Assistenza alle Decisioni Integrato con Modelli Digital Twin e Intelligenza Artificiale per le attività commerciali
- SCENARIO: City Users' Participation and Engagement with Snap4City, PDF
- OPTIFaaS: Operation and Plan, Transport Infrastructure and Facilities Support as a Service
- SOLUTION: 15MinCityIndex: understanding city areas by means of 13 different aspects, PDF
- **SOLUTION**: Energy Management and Control, PDF
- **SOLUTION: Environment Control, Predictions & Prescriptions,** PDF
- **SOLUTION:** Smart Light Control and Light Adaptive with Traffic Density PDF
- **SOLUTION**: Smart Tourism Management with Snap4City PDF
- **SOLUTION:** Traffic Infrastructure Optimisation: reducing travel time and emissions PDF
- **SOLUTION:** Traffic Light Plan Optimisation: reducing travel time, number of stops for vehicles and tramway lines: PDF
- **SOLUTION:** Snap4Building: monitoring, managing, controlling infrastructures PDF
- SOLUTION: Snap4City integration with Milestone X Protect, VMS, Video Management System PDF
- SOLUTION: Snap4City Digital Twin, PDF
- SOLUTION: eShare in a Snap - The innovative car sharing and car pooling service, PDF
- SOLUTION: Snap4City Smart Parking Manager and mobile App supports PDF
- SOLUTION: Exploit Snap4City in different Smart Waste use cases, waste manager, PDF
- eShare in a Snap - The innovative car sharing and car pooling service
- Digital Twin Cityverse FAQ to Snap4City
- AMMIRARE: make the beach system more resilient to climate change risks through the implementation of natural based solutions
- TOURISMO: TOURism Innovative and Sustainable Management of flOws
- CAI4DSA: Collaborative explainable neuro-symbolic AI for Decision Support Assistant
- SASUAM: Solutions for Safe, Sustainable and Accessible Urban Mobility
- SCENARIO: Exploit Snap4City in different Smart Waste use cases
- SCENARIO: Smart City Asset Management for Cuneo, Italy
- Digital Twin Analytic Data Models / Digital Twin (ITA)
- Smart Light Control and Light Adaptive for Traffic Density (the actual case of Merano) PDF
- Key performance Indicator, KPI, mobilità e trasporti, MaaS, parcheggi, inquinamento (ITA)
- Snap4City integration with Milestone X Protect, VMS, Video Management System PDF
- SCENARIO: Smart Light Control, 2023, CAPELON, PDF
- Florence HeritData FactSheet: https://www.snap4city.org/drupal/sites/default/files/files/FACTSHEET%20FLORENCE.pdf
- SCENARIO: Smart City Living Lab in Romania, PDF
- Snap4PVenergy: Online Photovoltaic System Simulator
- SCENARIO: Fashion Retail Recommendation System via Multiple Clustering Approach
- SCENARIO: Energy Community, CER, SELFUSER
- SCENARIO: Supporting Decision Makers in Real Time about Quality Lab Analyses on the production process, PDF
- Herit-Data and Snap4City: to better manage tourism flows, PDF
- Digital Twin Local and Global, PDF
- Social Media Analysis: Twitter Vigilance, PDF
- GDPR Compliant People Detection and Counting using Thermal Cameras, PDF
- Artificial Intelligence Predicts Landslides in Florence Area, PDF
- Available Parking Slots Prediction, PDF
- Available Bikes and Free Slots Prediction On Bike Sharing Stations, PDF
- Long Term Prediction of NO2 KPI of European Commission reference values, PDF
- Inventory of transferable digital applications and solutions for the tourism ecosystem
- Scenario: AMPERE Operator Manual
- Scenario: IMPETUS Intelligent Management of Processes, Ethics and Technology for Urban Safety (Oslo and Padova)

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SNAP4CITY roadmap

2020

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

- Smart Mobility
- PISA, PUMS
- Living lab

Km4City 1.6.7

2021

Smart Ambulance (2021-22)

Enterprise (2021-22) Industry 4.0

Sii-Mobility Contract

JRC Contract

PC4City (2020-21) Monitoring Terrain

Winner of Open Data Challenge of enel x

- Smart Light
- Sweden

2022

Almafluida Industry 4.0 (2021-22)

AMPERE (2021-22) Industry 4.0

SYN-RG-AI SmartCity

Gruppo Pretto Industry 4.0

uni.systems SmartCity, 2021-23

AXIS collab SmartCity

Asymmetrica Smart City, 2022-23

2023

JRC Contract, 2022-23

ART-ER Contract, 2022-23

Filippi 2022-2023

enel x Contract, 15min

IMPETUS Security and Risk

Smartea

Italferr, Smart City

CN MOST, 2022-26

EI THE, 2022-26

G. Agile, 2021-23

TUSCANY EDIH 2023-26 Finanziato dall'Unione europea NextGenerationEU

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

ICSC Centro Nazionale di Ricerca in HPC, Big Data and Quantum Computing

UrbanDT4TF

JRC Contract, 2024-25

CAI4DSA

FAIR Future Artificial Intelligence Research

OPTIFaaS

SASUAM

Rhodes, smart city

eShare UNIFI TUSS

AMMIRARE

Interreg MARITTIMO-IT FR-MARITIME

Currently 2025

- **UrbanDT4TF**, CN HPC: Digital Twin mobility, https://www.snap4city.org/drupal/node/1057
- **DI-DTPlatform**, CN HPC: Digital Twin, mobility, environment, https://www.snap4city.org/drupal/node/1097
- **Sasuam**, CN MOST, PNRR: AI, mobility, https://www.snap4city.org/drupal/node/999
- **OPTIFaaS**, CN MOST, PNRR: AI, mobility, DSS, https://www.snap4city.org/drupal/node/1008
- **LeverageOPTIFaaS**, CN MOST: PNRR, mobility, https://www.snap4city.org/drupal/node/1064
- **TOURISMO**, Interreg, EC: Tourism, NLP, DSS, https://www.snap4city.org/drupal/node/1001
- **ELLIE**, Horizon Europe, EC: AI, VR, https://www.snap4city.org/drupal/node/1056
- **CN MOST**, PNRR: sustainable mobility, platform, https://www.snap4city.org/drupal/node/1050
- **ISPRA JRC contract**, EC: DSS, SOC, control room, energy, https://www.snap4city.org/drupal/node/970
- **AMMIRARE**, Interreg, EC: AI, environment, Big Data, https://www.snap4city.org/drupal/node/1002
- **CAI4DSA**, FAIR PE1, PNRR: AI, Neuro-Symbolic, PINN, NG-DSS, https://www.snap4city.org/drupal/node/1016
- **SADI-MIAC**, RT, partner: AI, Tourism, Retail, Computer Vision, https://www.snap4city.org/drupal/node/1055
- **SMART3R,** PRIN UNICagliari: mobility, DSS, https://www.snap4city.org/drupal/node/1087
- **Tuscany X.0, EDIH,** TestBeforeInvest, Training on AI, Big Data, Security, HPC: https://www.tuscanyx.eu/
- **Reg4IA**, AI for regional public administration, A project of presidency of national council
- **SmartCyprus**, a project of Cyprus Ministry of Digital Innovation and Policy
- **The IE**, PNRR: AI, NLP, LLM, Legal Aspects
- **BullVIT**, RT, conv: AI, NLP, LLM on commercial phases
- **Energia**, RT, conv: AI, PINN, DSS, on manufacturing
- **RFI contract**: mobility, AI, DSS
- **Salerno Port**: AI for container ID recognition and tracking
- **Talent Hub**, ECRF, conv: NLP, match demand vs offer

+ currently: Merano, Salerno, Cuneo, Rhodes, Reverberi, Florence, IDTS, ALTAIR, etc.

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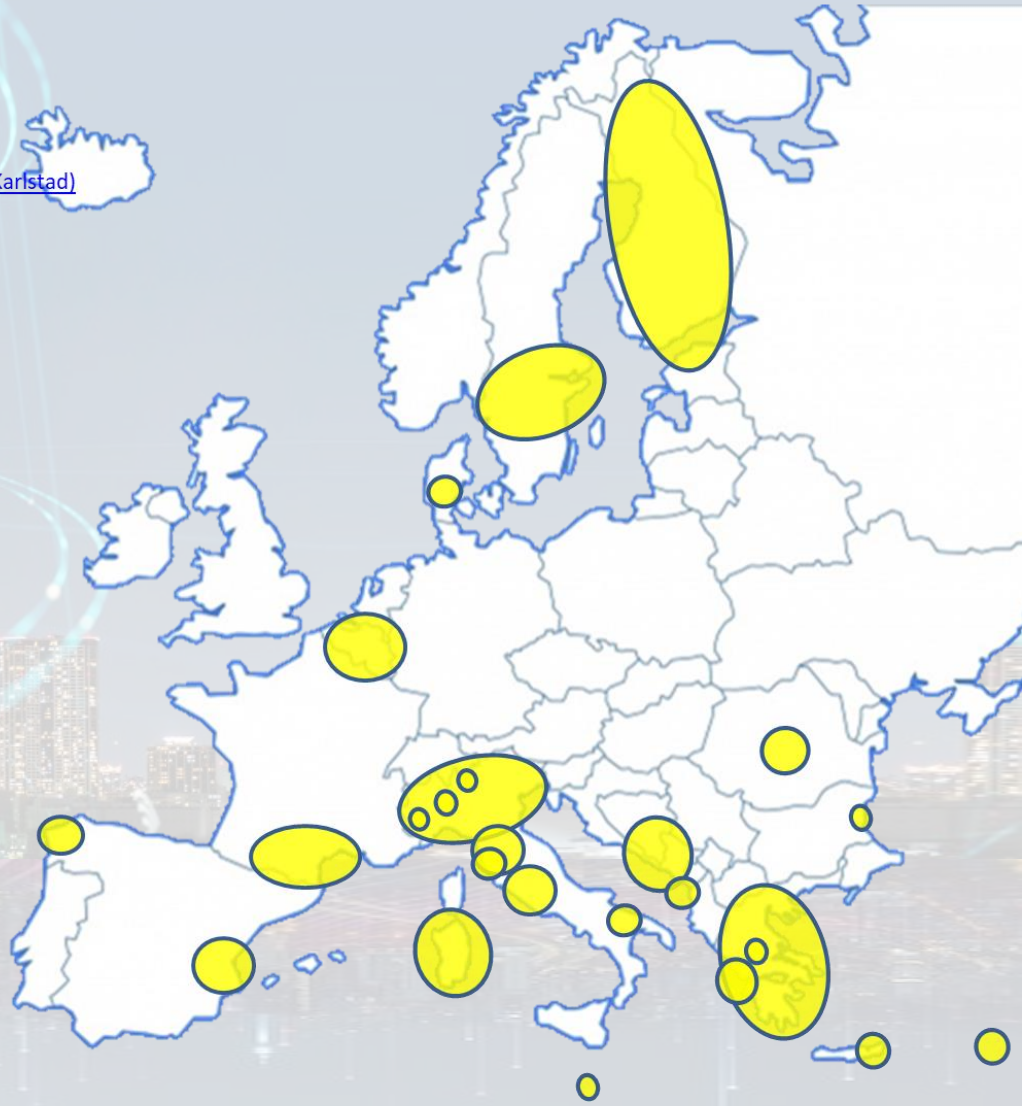
https://www.Snap4City.org

- 11 running installations in Europe
  - Snap4city.org, Greece, Merano, Cuneo, …
  - Toscana, Pisa, Sweden, ISPRA, Snap4.eu,
  - Altair, Italmatic, M4F, Romania, ….
- 20 projects, 12 pilots on 10 Countries
  - >40 cities/area
- **Widest MULTI-tenant deploy has**
  - 26 Organizations / tenant
  - > 8850 users on
  - > 1800 Dashboards
  - > 17 mobile Apps
  - **> 2.2 Million of structured data per day**
  - > 580 IoT Applications/node-RED
  - > 850 web pages with training
  - > 85 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)
- Varna (Bulgaria)
- Venezia area (I)
- WestGreece area (Gr)



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

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

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

Control Planning Goals

Control

Management and Operational
(monitoring, KPI, anomaly detection, early warning)

Planning

Tactic and strategic, medium and long range, micro/macro
(simulations and predictions, what-if analysis)

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



SNAPADVISOR



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



DASHBOARDS, WIDGETS
TEMPLATES



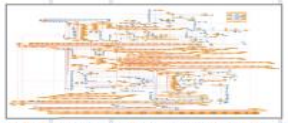
PREDICTION - ANOMALY DETECTION - CLUSTERING - ROUTING - SENTIMENT NLP - TRAFFIC FLOW - PEOPLE FLOWS - SDG
15 MIN CITY INDEX - KPI - HEATMAPS - ORIGIN DESTINATION - MAPS - VECTOR FIELD - ETC...



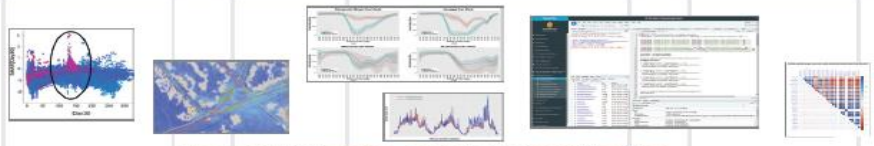
API - MICROSERVICES - GIS - BPM
VIDEO - REPORTS - MAPS - 3D ...

- DEVELOMENT ENVIRONMENT AND METHODOLOGY
- VISUAL PROGRAMMING, ML, AI, HPC
- TRAINING COURSES





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



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



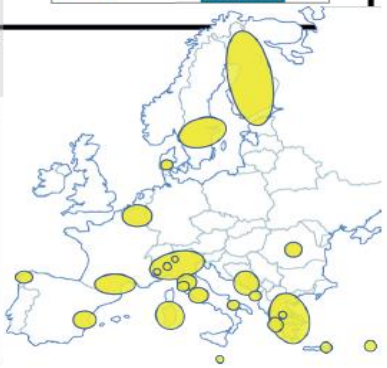
VISUAL PROGRAMMING, ADAPTERS
DATA FLOWS, WORKFLOWS
PARALLEL DISTRIBUTED PROCESSING
DATA DRIVEN

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



NATIVE AND EXTERNAL APPLICATIONS

- Smart Parking
- Smart Light
- Smart Waste
- Smart Energy
- Smart Building
- Smart Tourism
- ...



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, simulation, what-if, optimisation, MLOps;**
    - AI: Deep Learning, ML, BERT, LLM/RAG, XAI (Shap/Lime), etc.
    - Simulations: SUMO, DORAM, Routing, TFR, Flooding, people flow, etc.
  - **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, SUMI/SUMP
- **Mobile App:** modular applications, operators' modules, multiple cities, etc.
- **Participatory**: problem reporting, ticketing, etc.
- **Integration of any kind**

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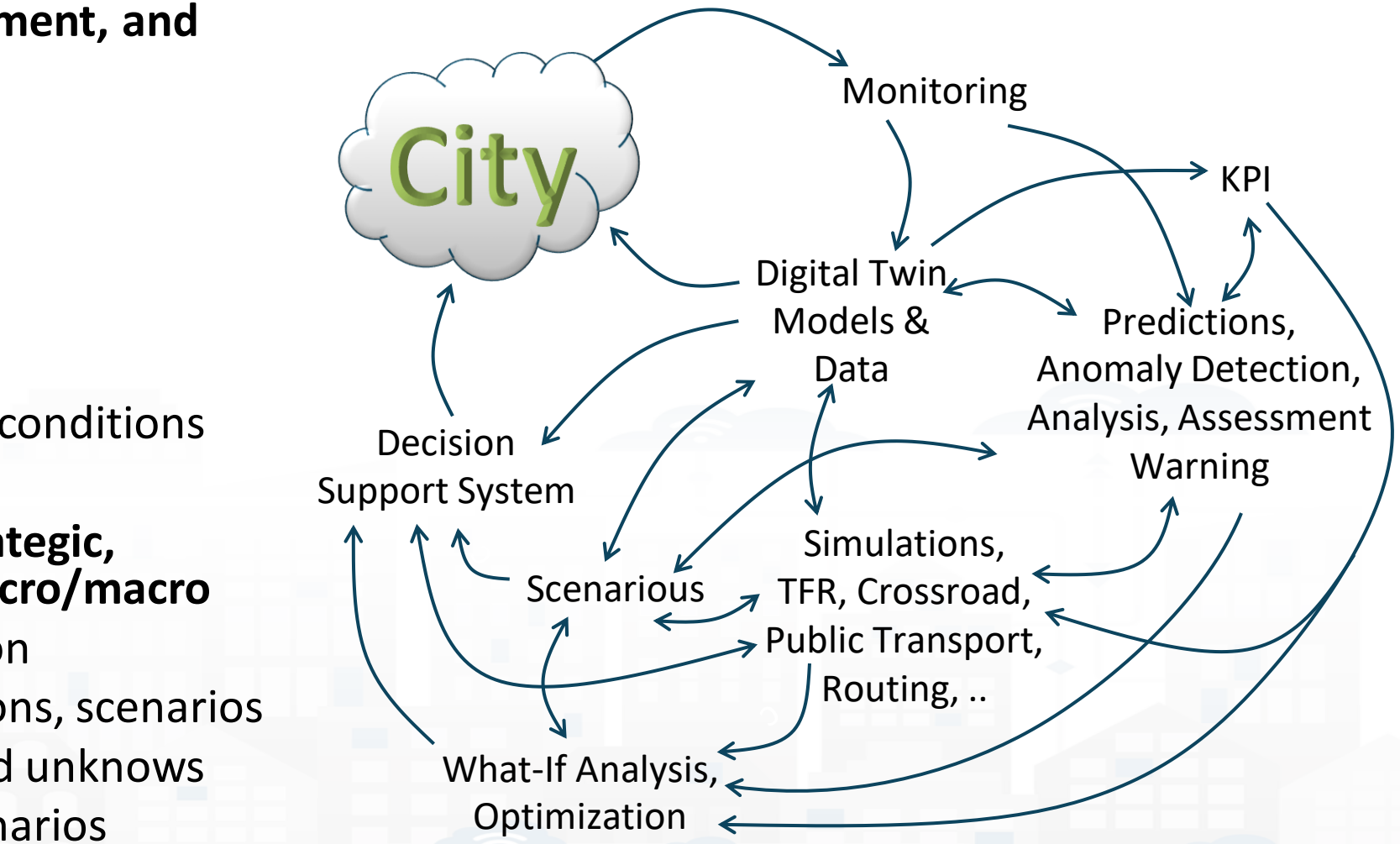
Main tasks

- **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



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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, Community of energy



- Reduction of emissions, reduction of congestions
- Smart City infrastructure: monitoring and resilience, long terms predictions, optim. operation and plan
- Effective and Low cost smart solutions
- What-if analysis, Simulations, optimization
- Origin Destination matrices computation





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



- Predictive maintenance
- Decisions Support Systems
- Process optimization, control
- Industry 4.0 integrated solutions
- AI assistant for commercial activities



- Optimization of Waste Collection
- business intelligence tools for decision makers
- Reduction production costs
- Monitoring resource consumption
- Advisor for documentation, generative AI



- Shortening justice time
- Prediction of mediation proneness
- Assisting institution is taking legal decisions
- Anonymization and indexing legal docs.
- Ethical Explainable Artificial Intelligence
- Advisor for legal documentation, generative AI

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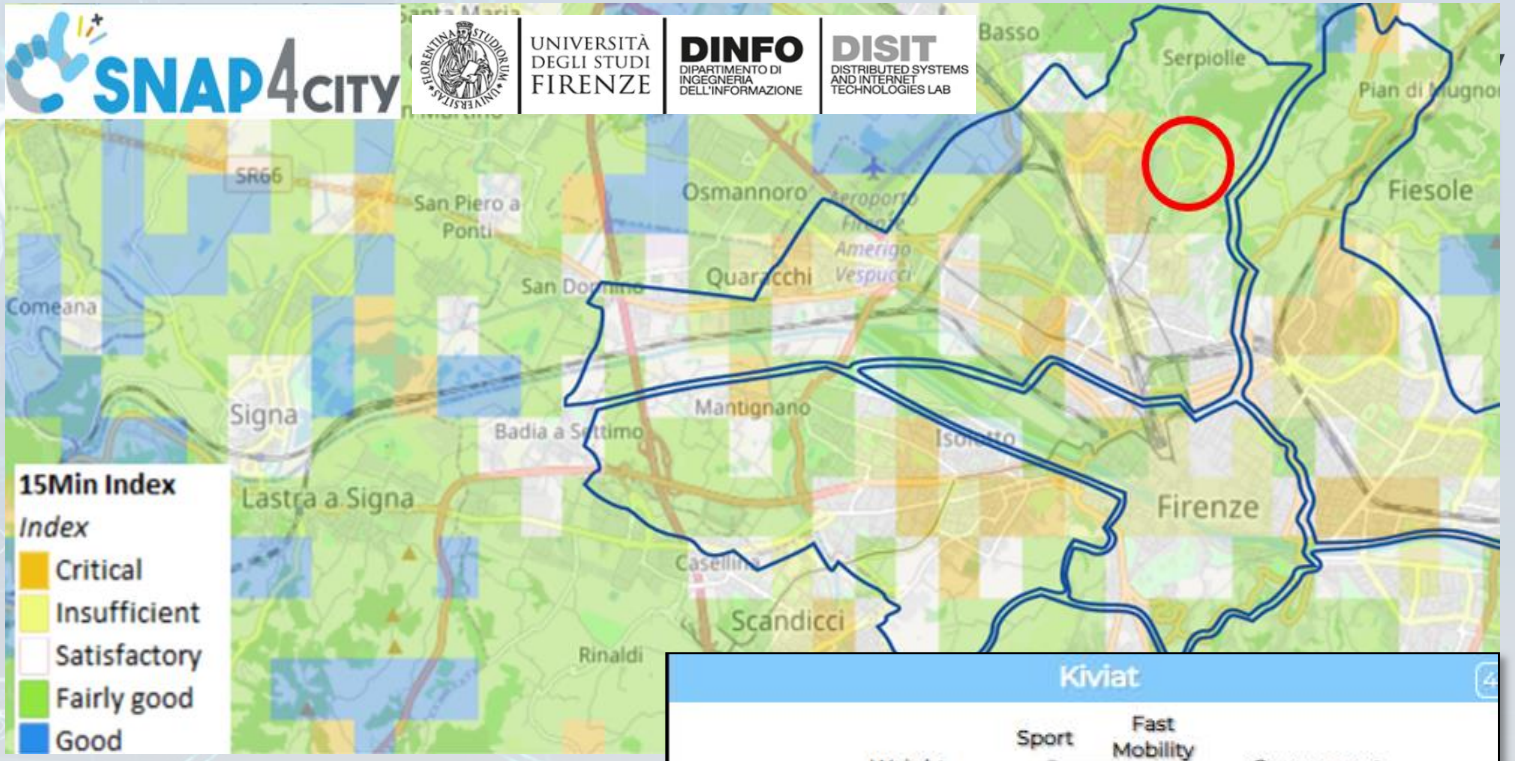
(9/2025)

15MinCityIndex

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

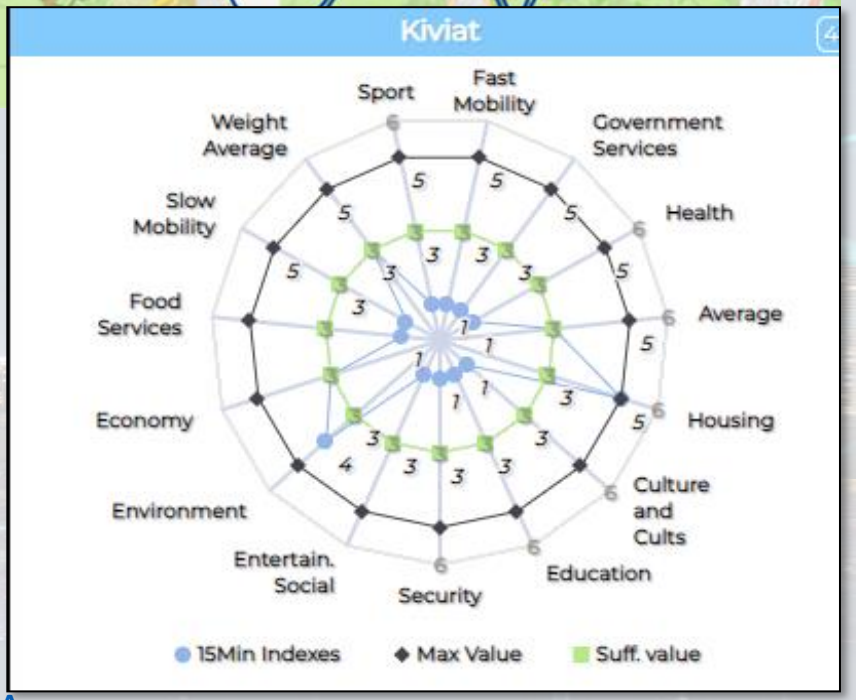
Using the Open Data:
We developed a data analytic tool based on municipal and national open data to assess services adequacy for people living in each 15 minutes areas of the city.



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==

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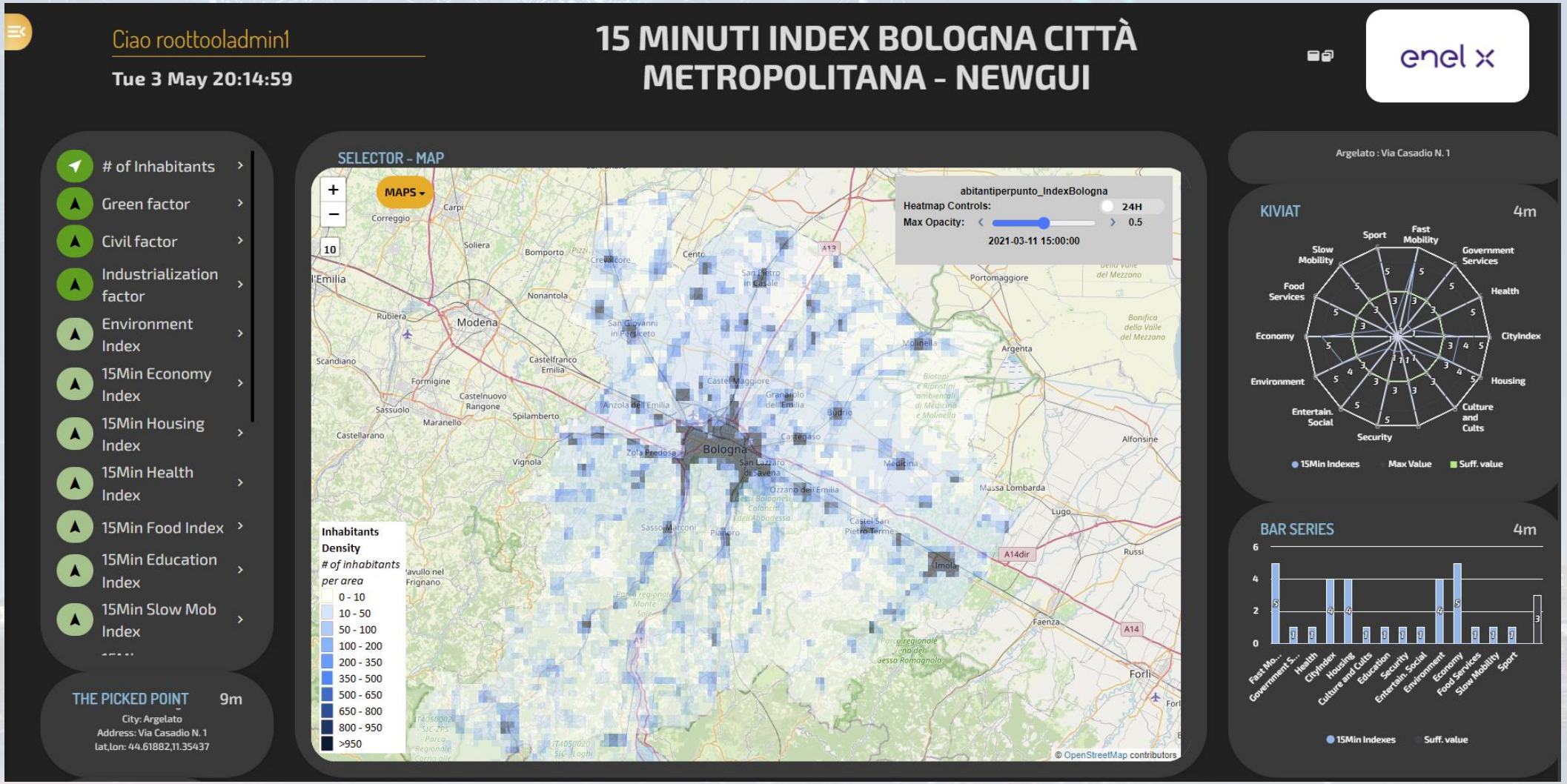
15MinCityIndex on Bologna





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SUMI: Sustainable Urban Mobility Indicators

- **Core indicators (13)**
  1. Affordability of public transport for the poorest group
  2. Accessibility of public transport for mobility-impaired groups
  3. Air pollutant emissions
  4. Noise hindrance
  5. Road deaths
  6. Access to mobility services
  7. Greenhouse gas emissions (GHG)
  8. Congestion and delays
  9. Energy efficiency
  10. Opportunity for active mobility
  11. Multimodal integration
  12. Satisfaction with public transport
  13. Traffic safety (active modes)

- **Non-core indicators (5)**
  14. Quality of public spaces
  15. Urban functional diversity
  16. Commuting travel time
  17. Mobility space usage
  18. Security on mobility and transport

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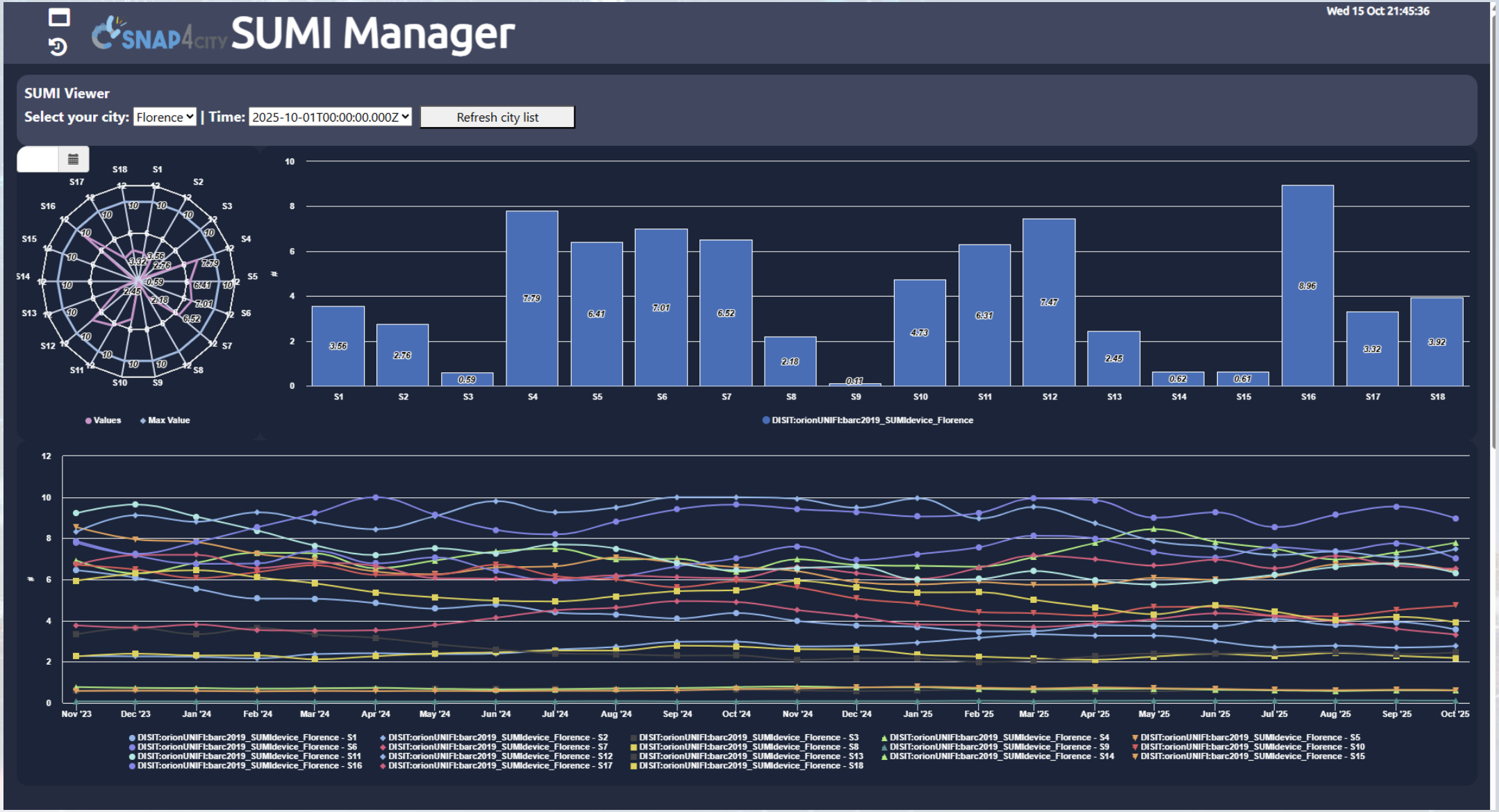
SUMI: Sustainable Urban Mobility Indicators



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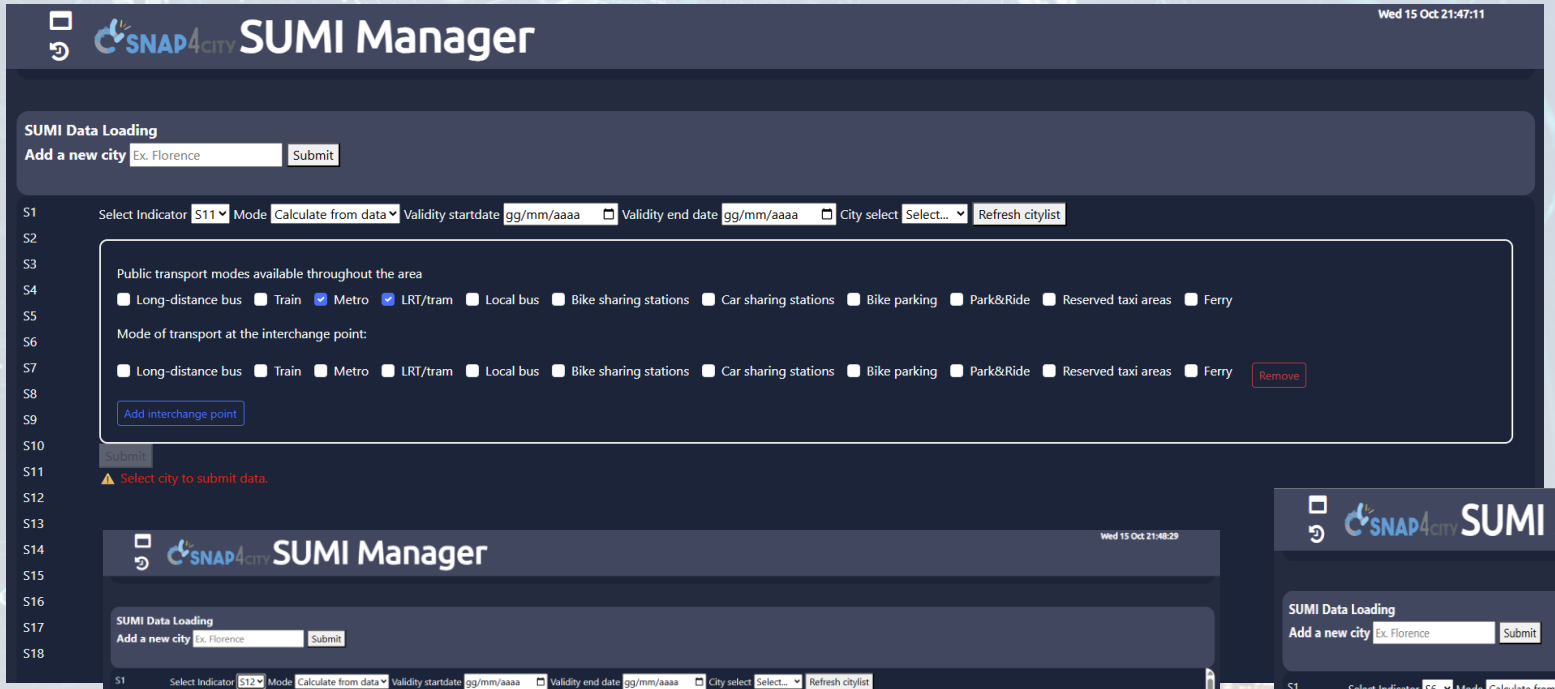
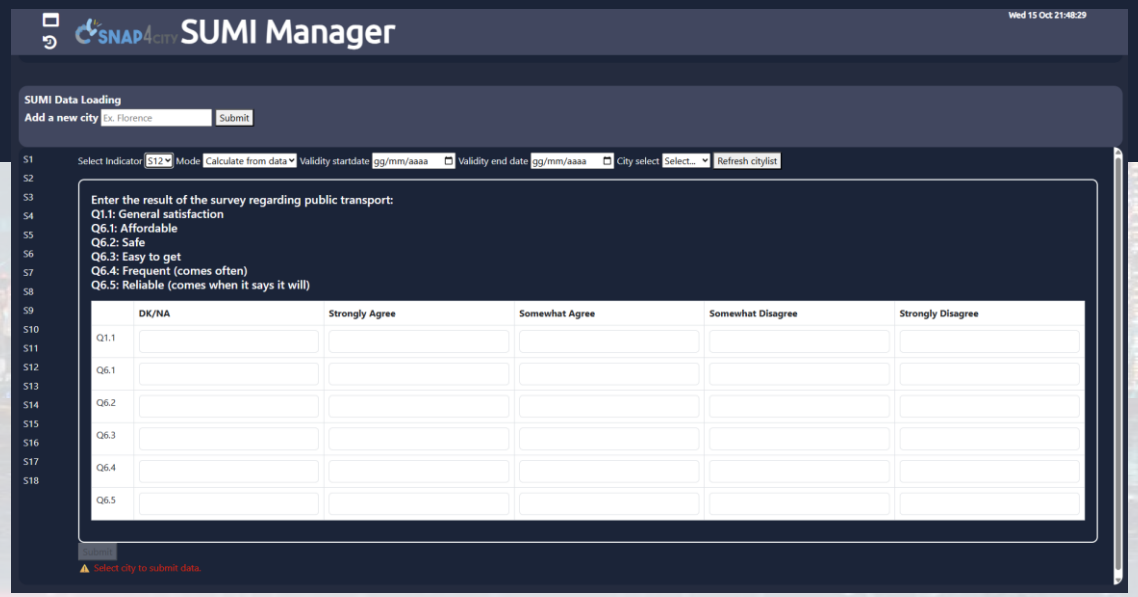
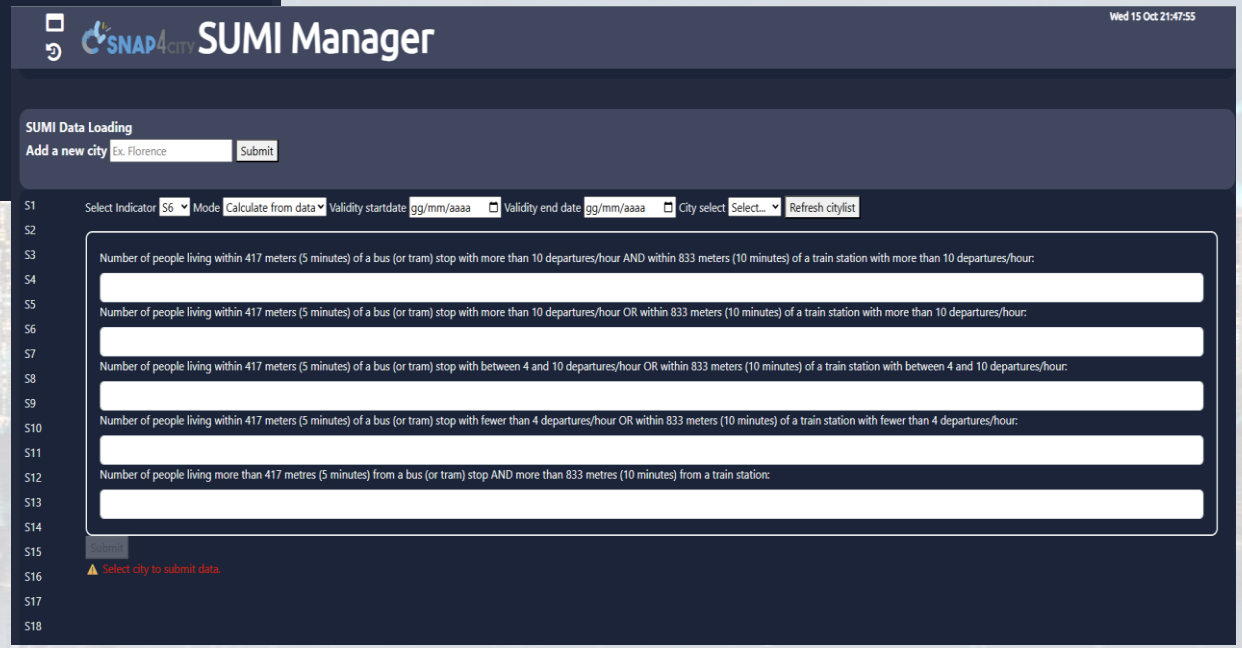
SUMI: Sustainable Urban Mobility Indicators







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Control Room





Smart City Control Room
Florence Metropolitan City

COMUNE DI FIRENZE

reference

SNAP4CITY

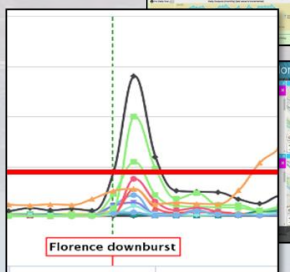
KM 4 CITY

- **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

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Early Warning, Detection

Issue:

- Detection of critical condition
- Not easily detected with other means

Impact:

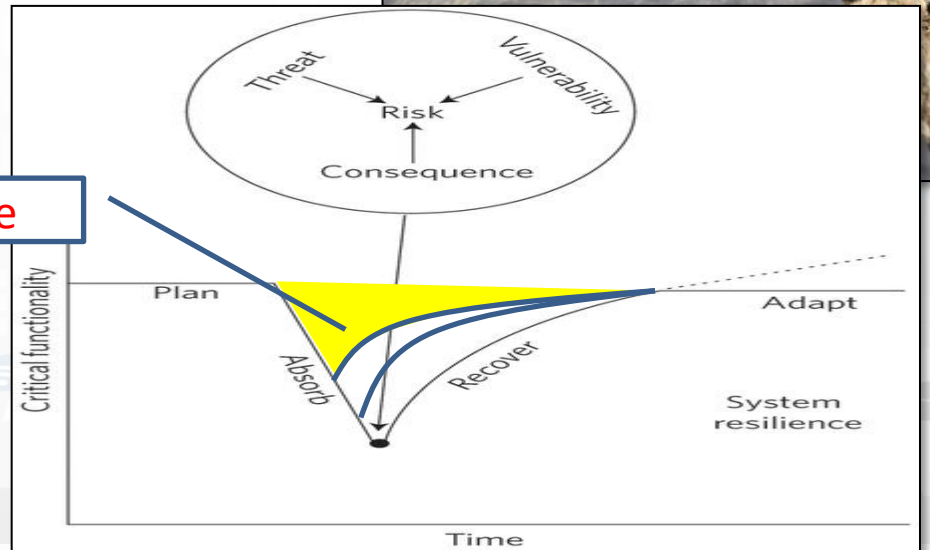
- Early warning, faster reaction
- Increased resilience

Several metrics related to:

- Volume of retweets
- Sentiment analysis

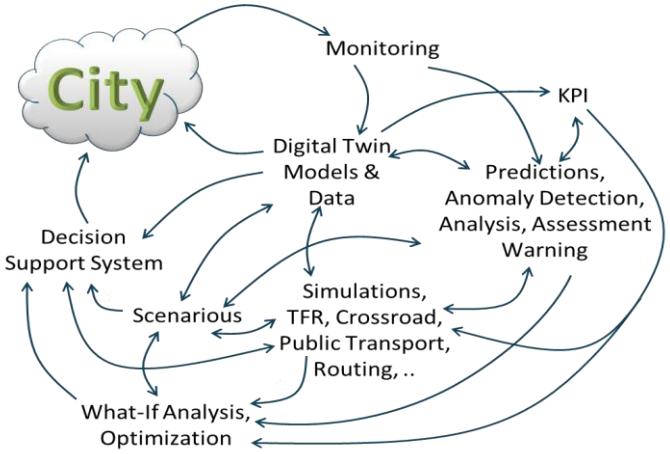
Prepare
Absorb
Recover
Adapt

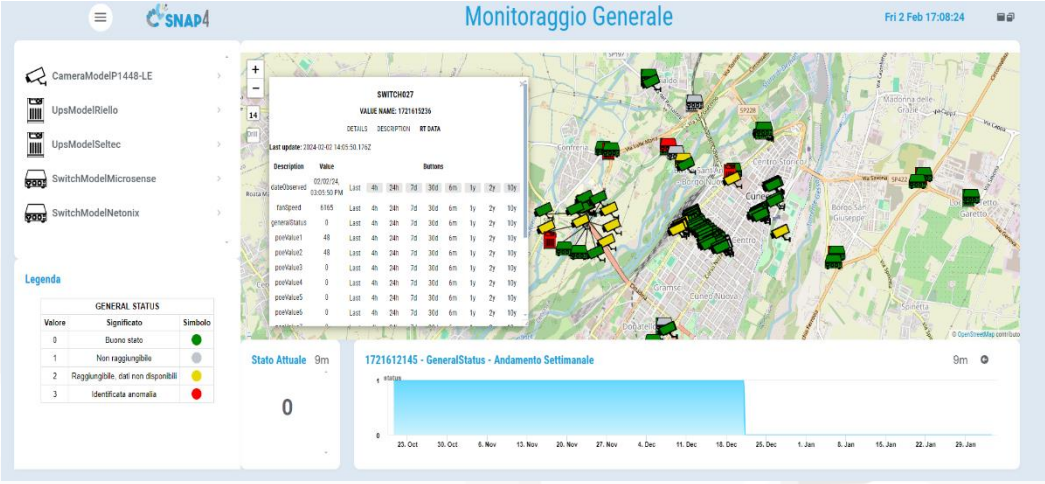




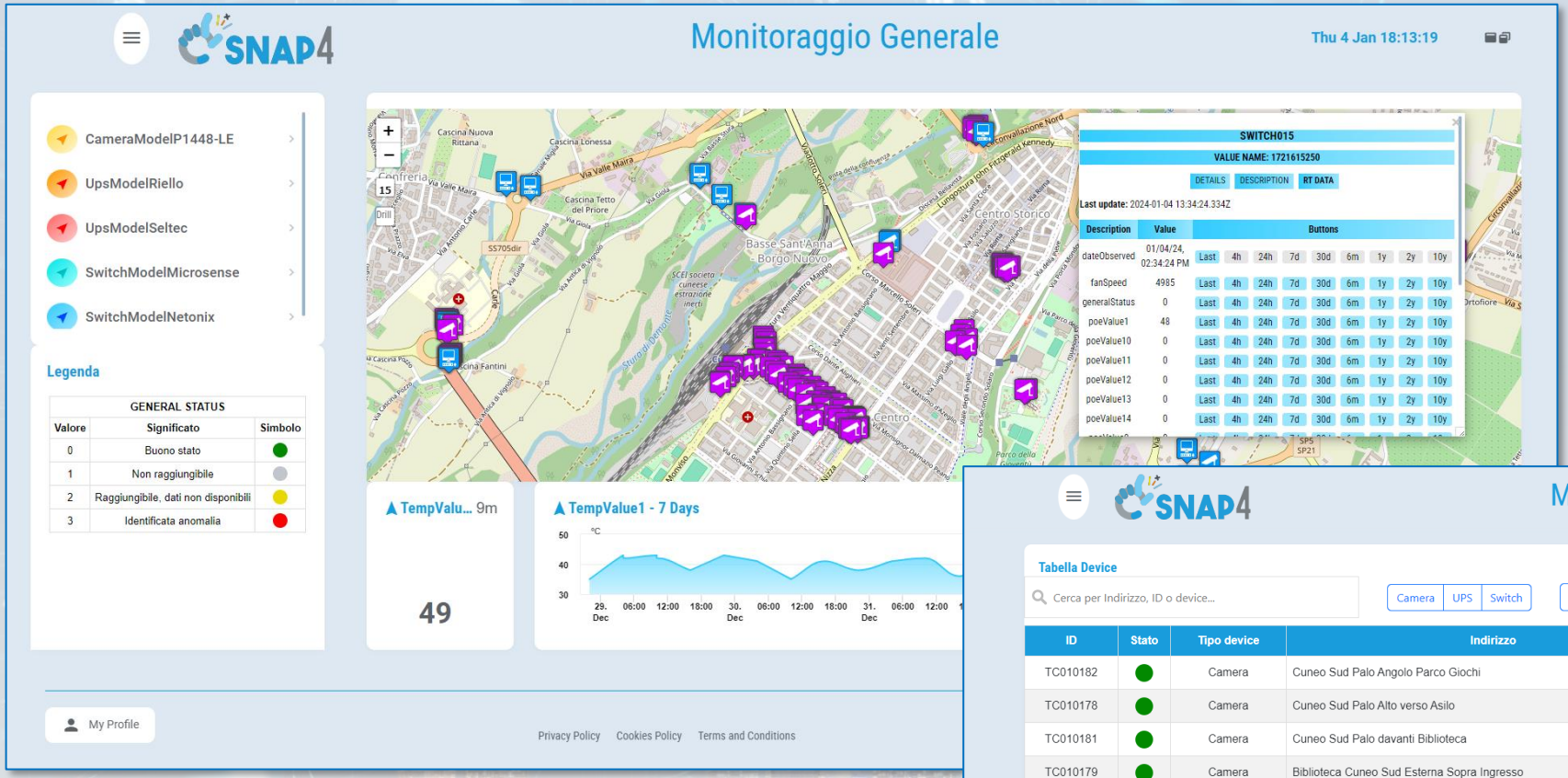
Assets Control Domain (2024/8)

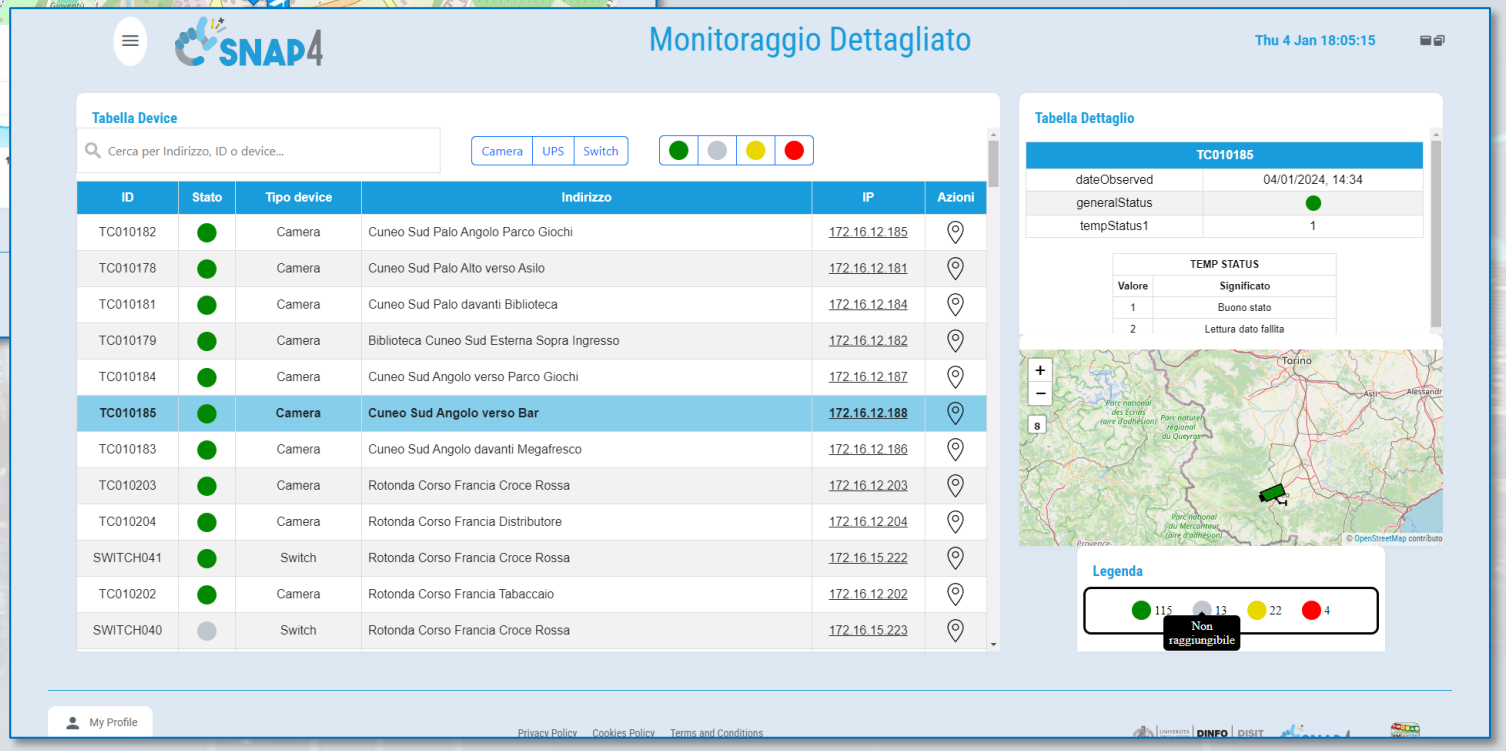
- Goals:
  - Costs reduction, increase service availability, risk reduction
  - Quality Level
- Solutions for Operation (monitoring, managing, mobile apps, digital signages, control rooms)
  - Monitoring :
    - **Assets**: switches, Wi-Fi, servers, UPS, sensors, building, TV Cams, etc.
    - **Energy**: 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





Cuneo Assets' Monitoring, Safety





- More than 400 devices

- TV Cams: color, Thermal
- Traffic Gates
- Switches
- UPS

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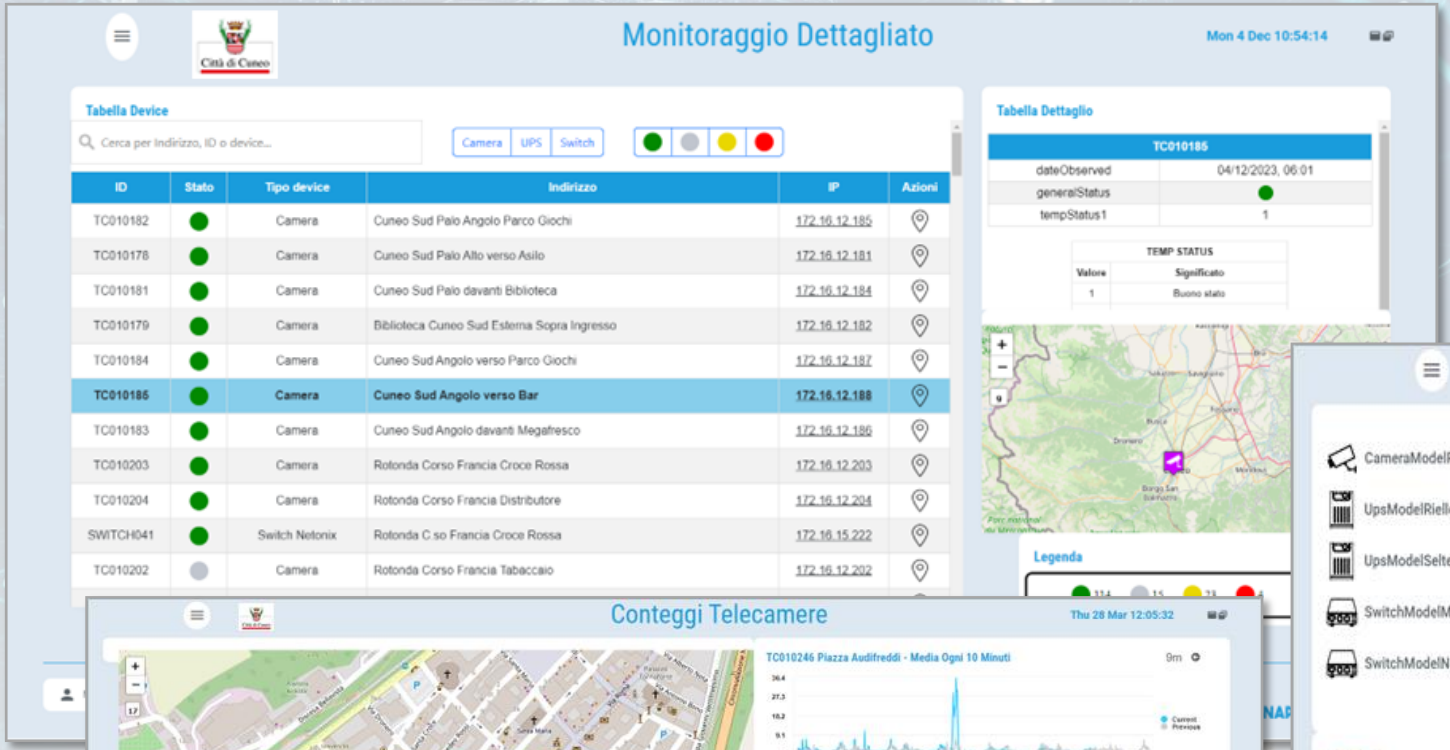
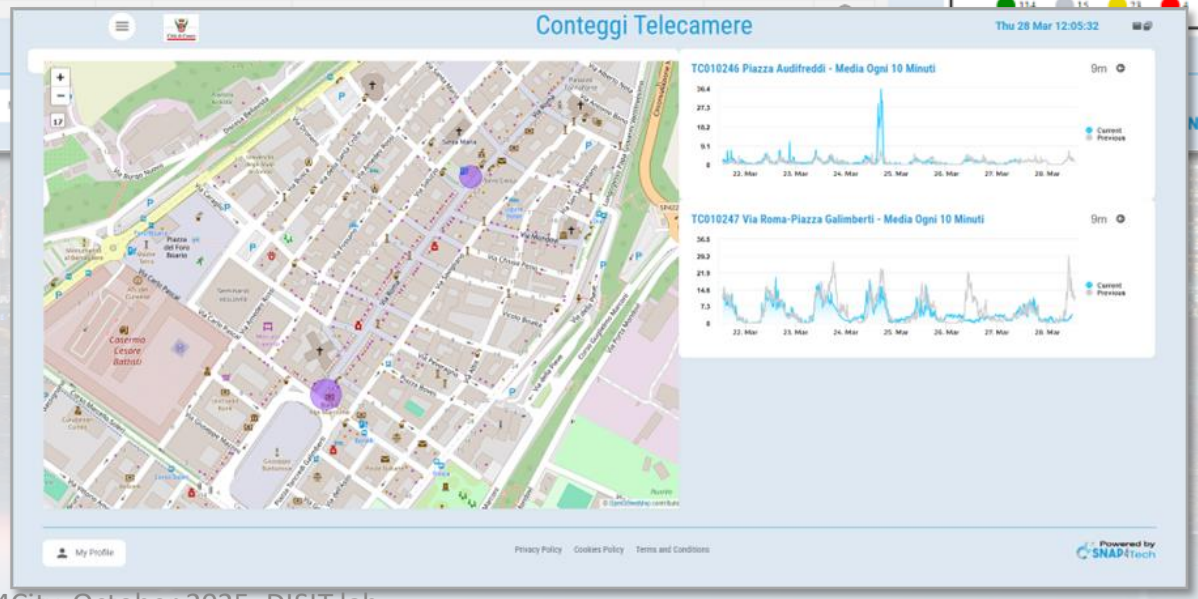
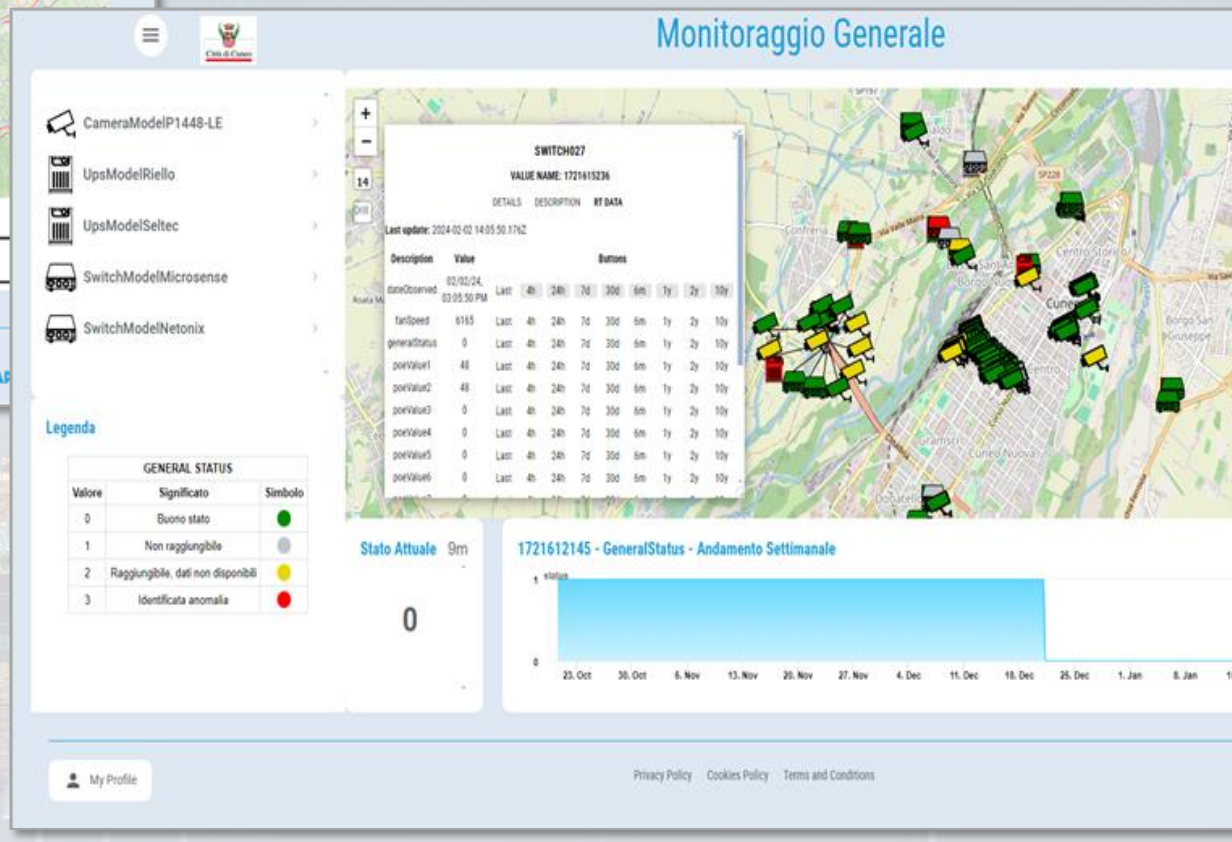
ICT Assets Control: CUNEO Municipality







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

Manage the status, tickets, notifications

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VMS vs Snap4City: sending and getting events, AI solutions

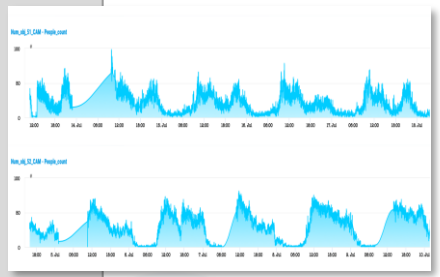


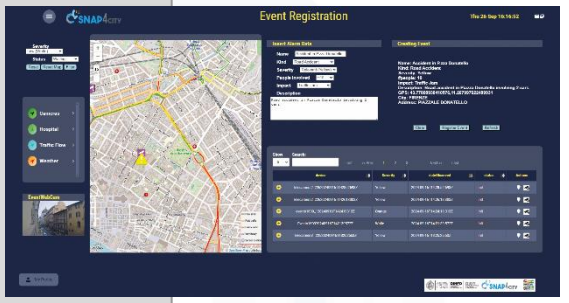
Events + info

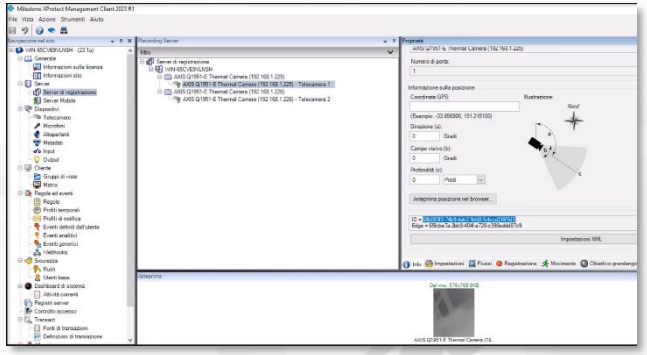
Snap4City Data Analytics

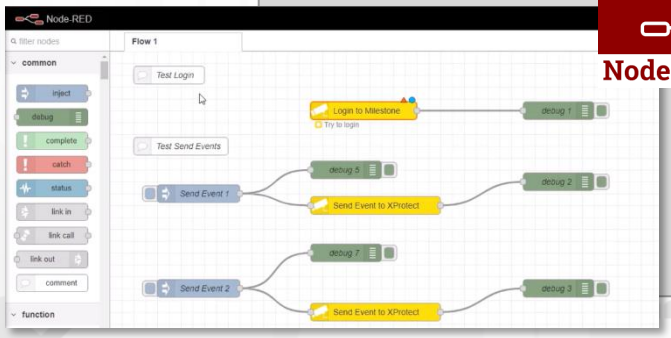
Snap4City Dashboards

Snap4City Data Interoperability









Node-RED

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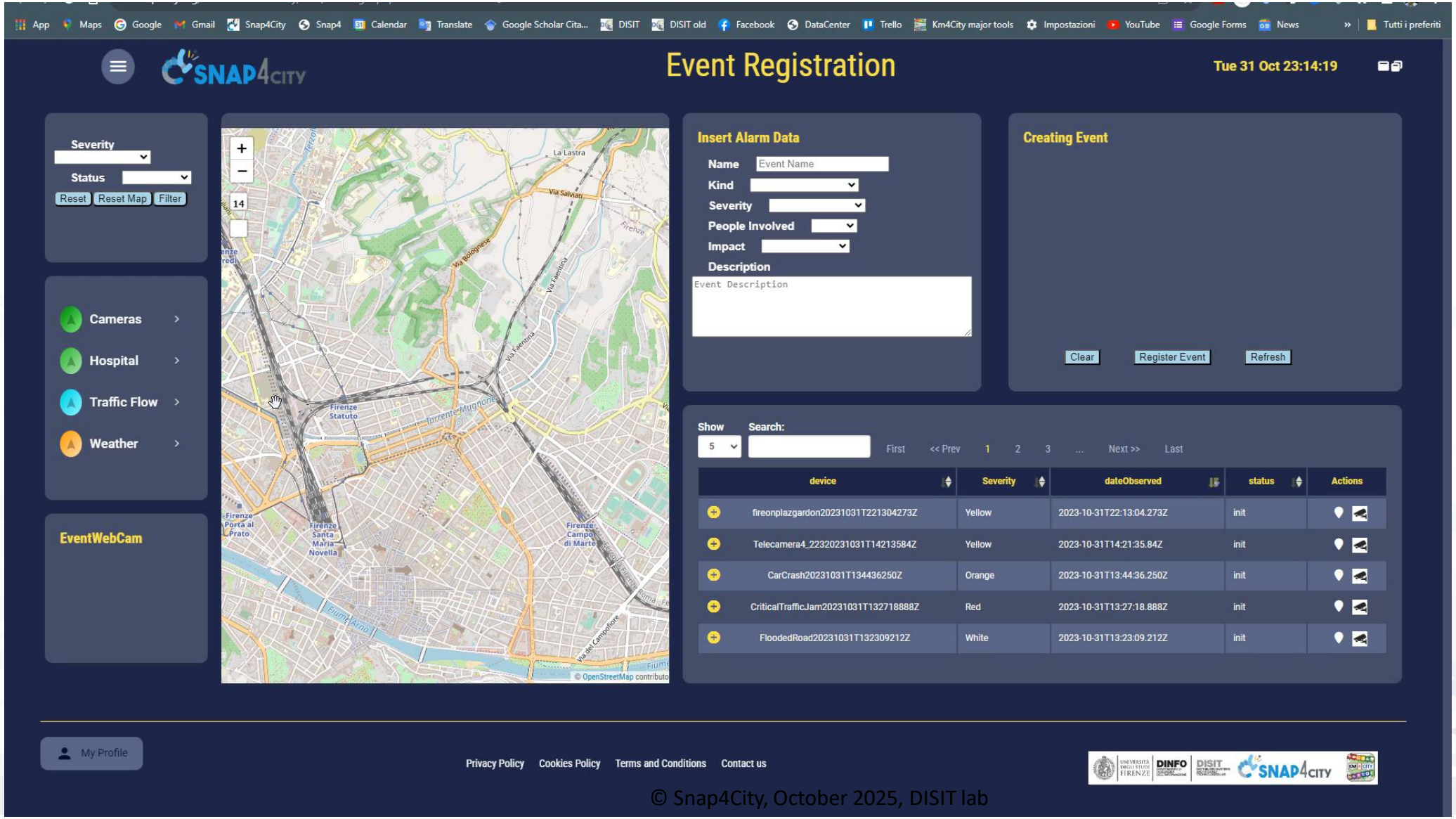
Video Event Management



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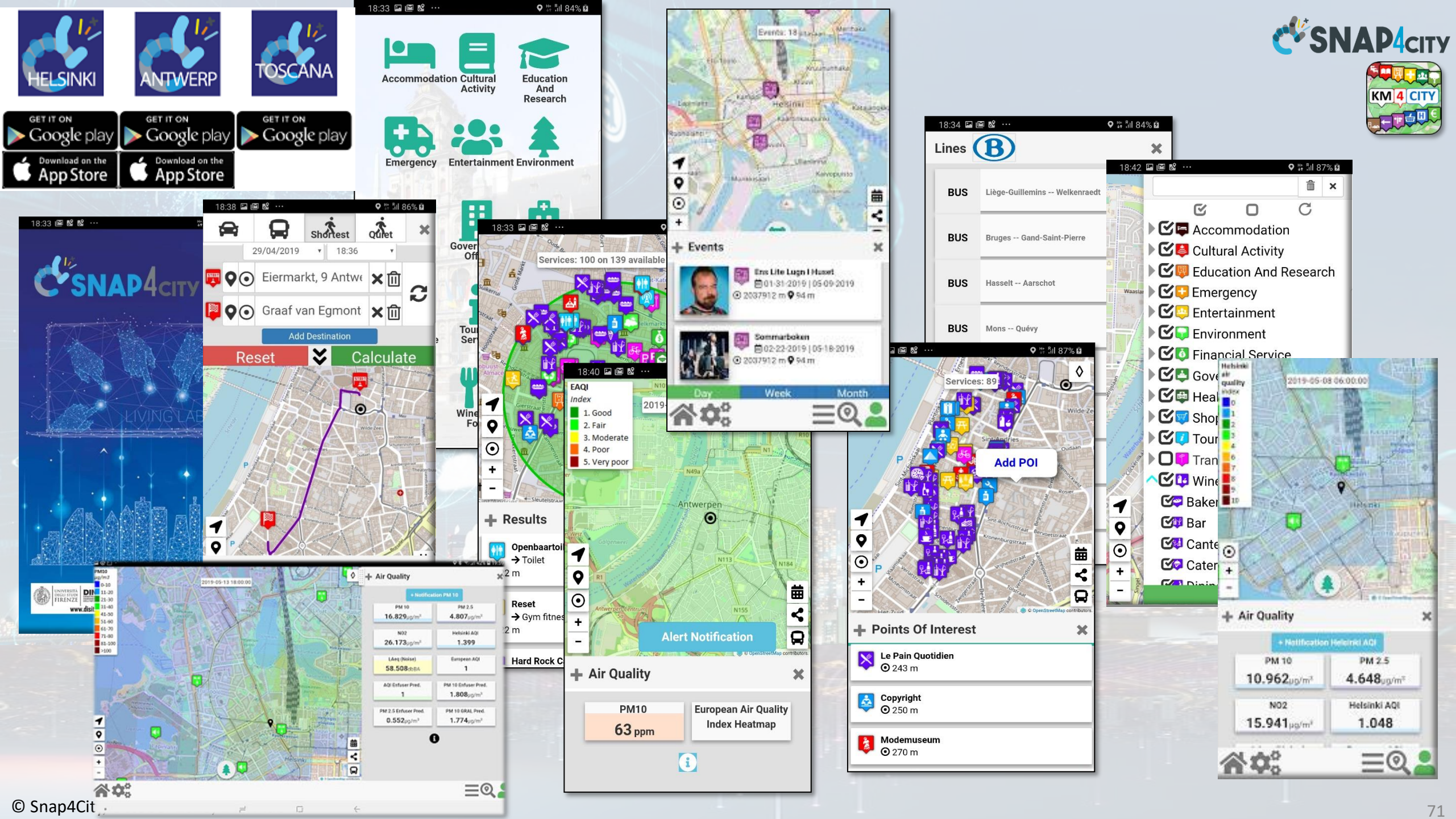
Engaging via Mobile Apps

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Cultural Activity
Education And Research
Emergency
Entertainment
Environment
SNAP4CITY
KM4CITY
Shortest
Quiet
29/04/2019
18:36
Eiermarkt, 9 Antwe
Graaf van Egmont
Add Destination
Reset
Calculate
Services: 100 on 139 available
Results
Openbaartoi
→ Toilet
Reset
→ Gym fitnes
Hard Rock C
EAQI
Index
1. Good
2. Fair
3. Moderate
4. Poor
5. Very poor
Antwerpen
Alert Notification
Air Quality
PM10
63 ppm
European Air Quality Index Heatmap
Events
Ens Lite Lugn I Huset
Sommarboken
Day
Week
Month
Lines
BUS
Liège-Guillemins -- Welkenraedt
Bruges -- Gand-Saint-Pierre
Hasselt -- Aarschot
Mons -- Quévy
Services: 89
Add POI
Points Of Interest
Le Pain Quotidien
243 m
Copyright
250 m
Modemuseum
270 m
Accommodation
Cultural Activity
Education And Research
Emergency
Entertainment
Environment
Financial Service
Bar
Air Quality
PM 10
10.962
PM 2.5
4.648
NO2
15.941
Helsinki AQI
1.048

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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

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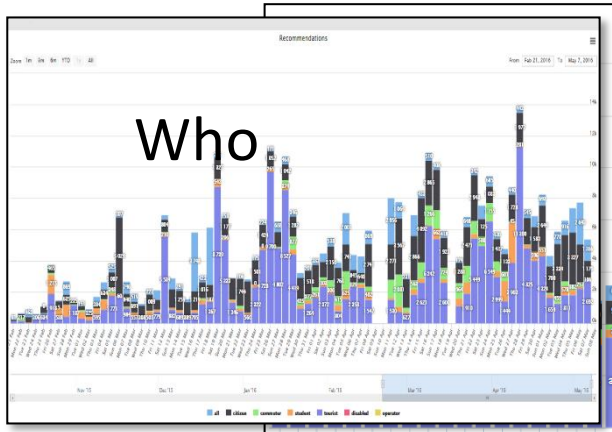
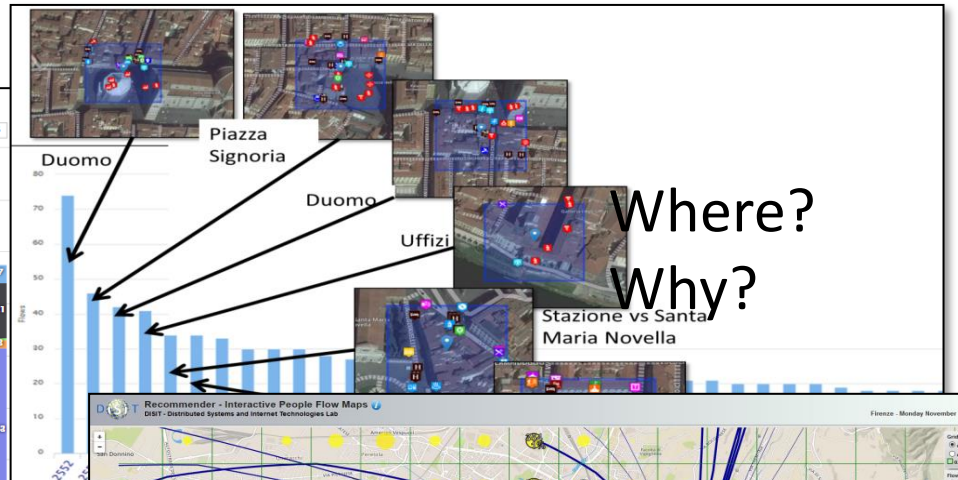
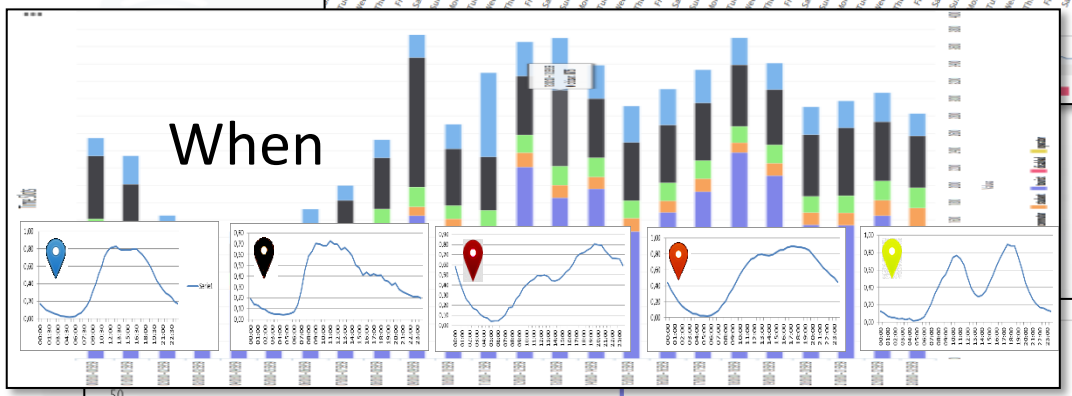
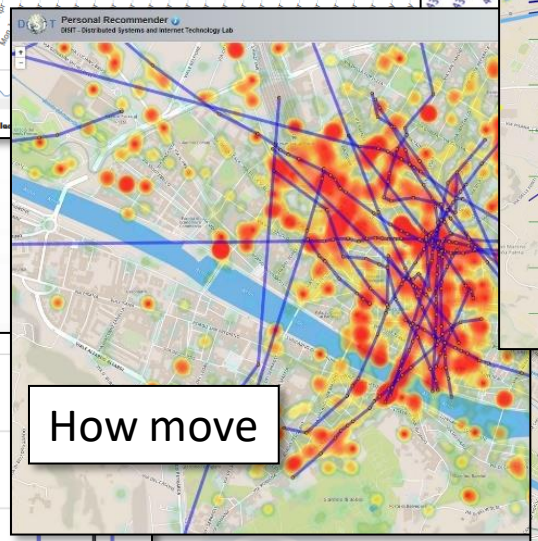
User Behavior Analyser for Collective Profiling

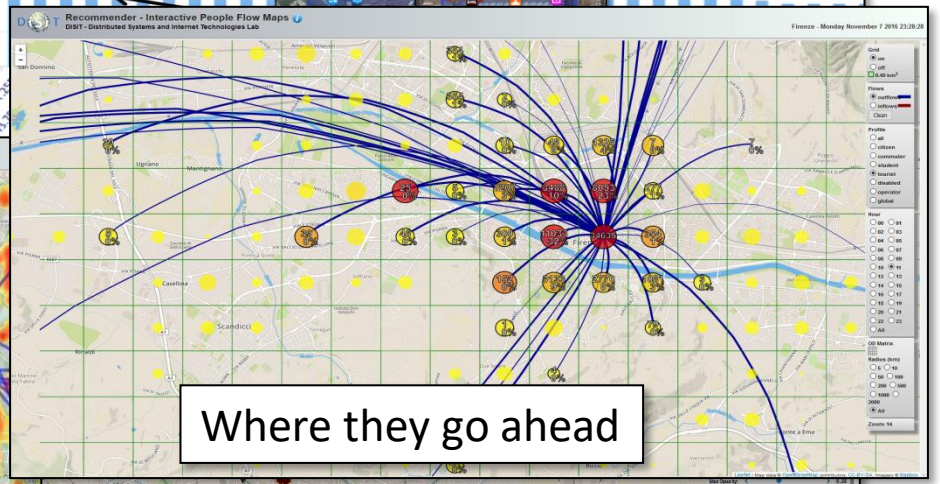


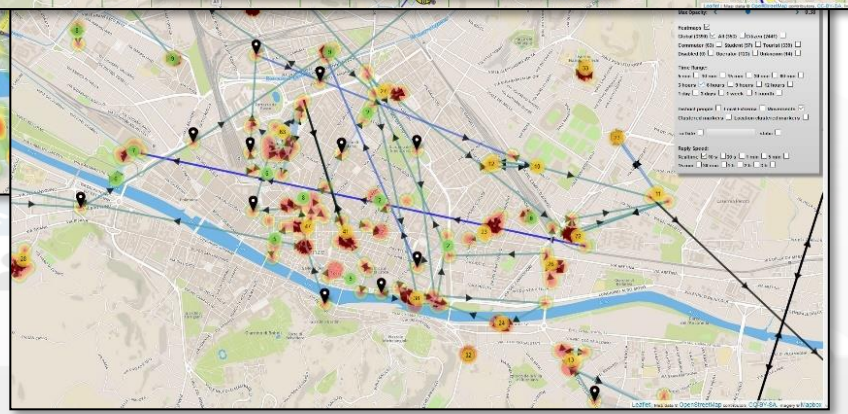












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UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

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

7 AFFORDABLE AND CLEAN ENERGY

11 SUSTAINABLE CITIES AND COMMUNITIES

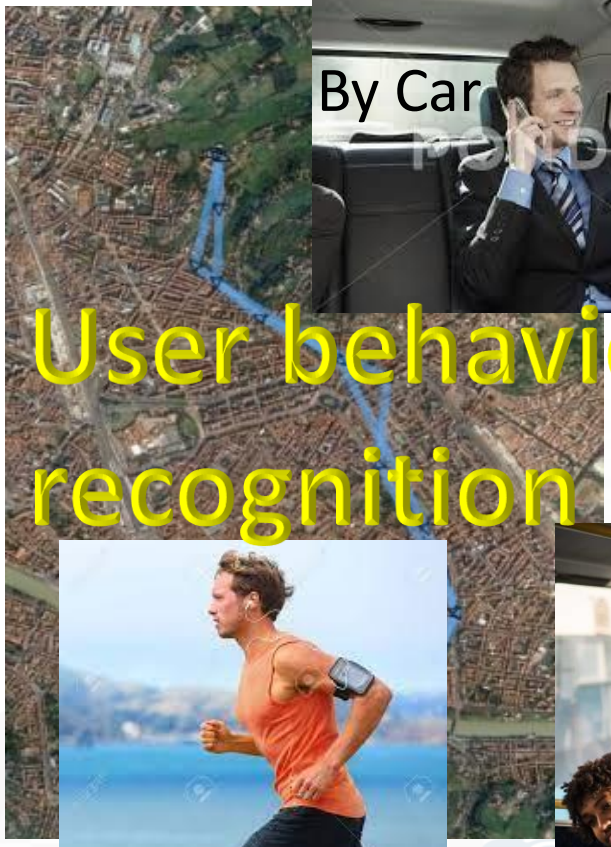
13 CLIMATE ACTION

SNAP4CITY

KM4CITY

To propose suggestions and Engage city user

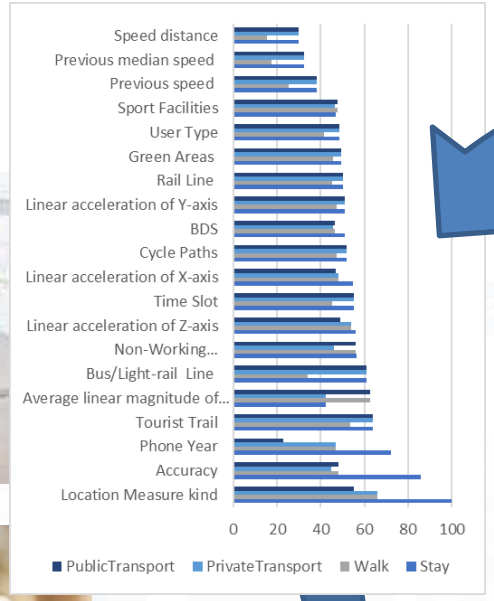
we need to know how they are moving



User behavior recognition

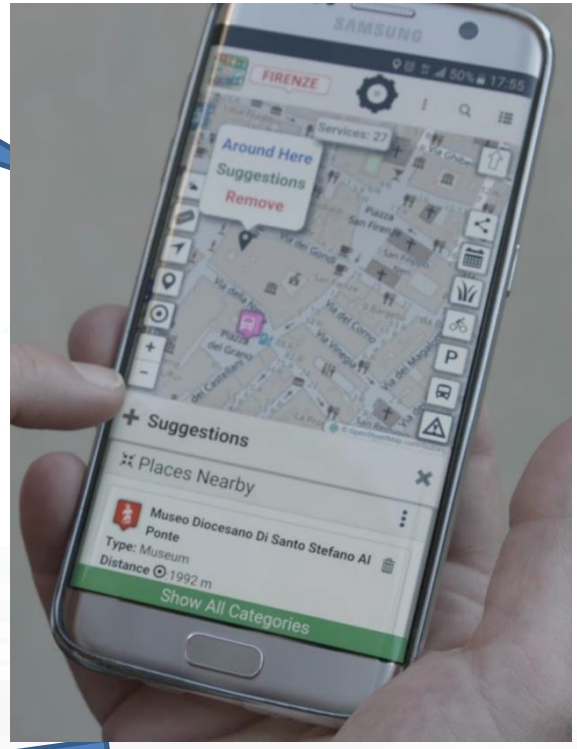






Behavior Classification

Suggestions



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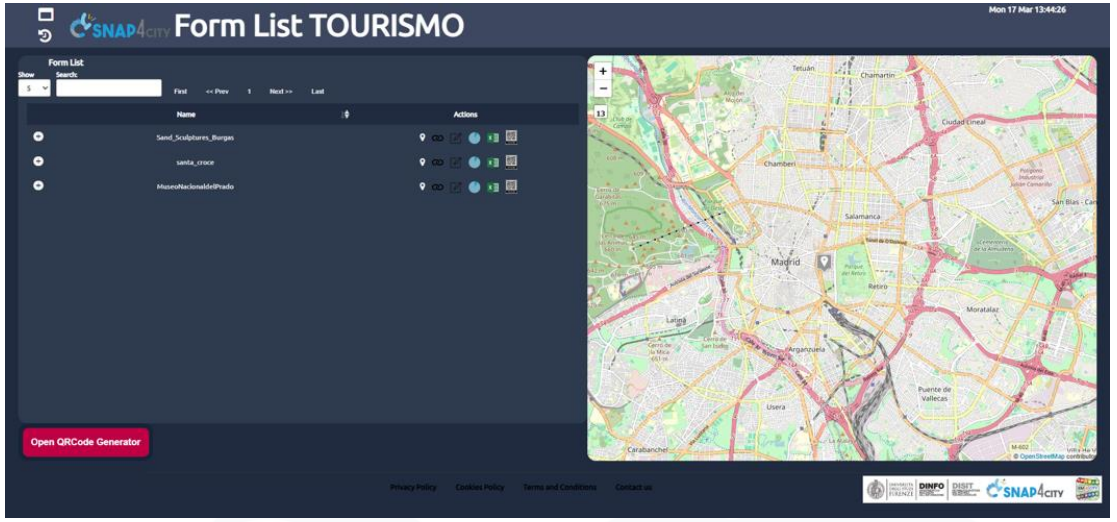
QR Engagement

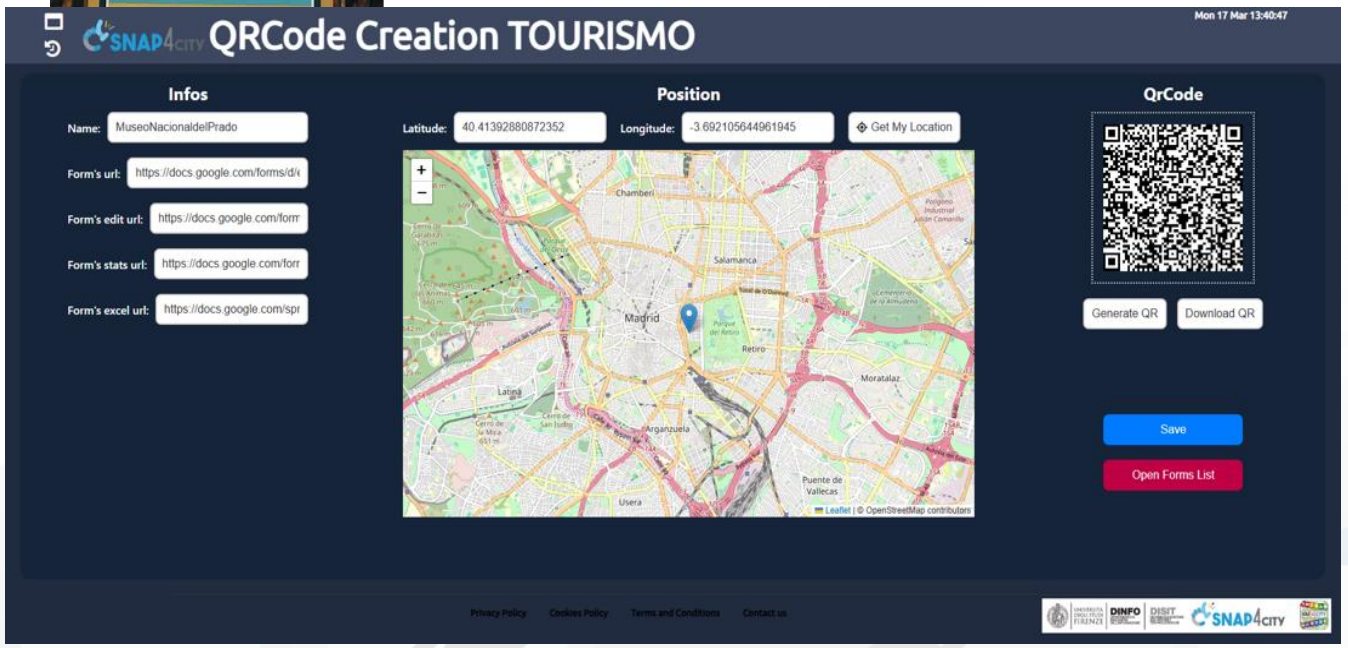


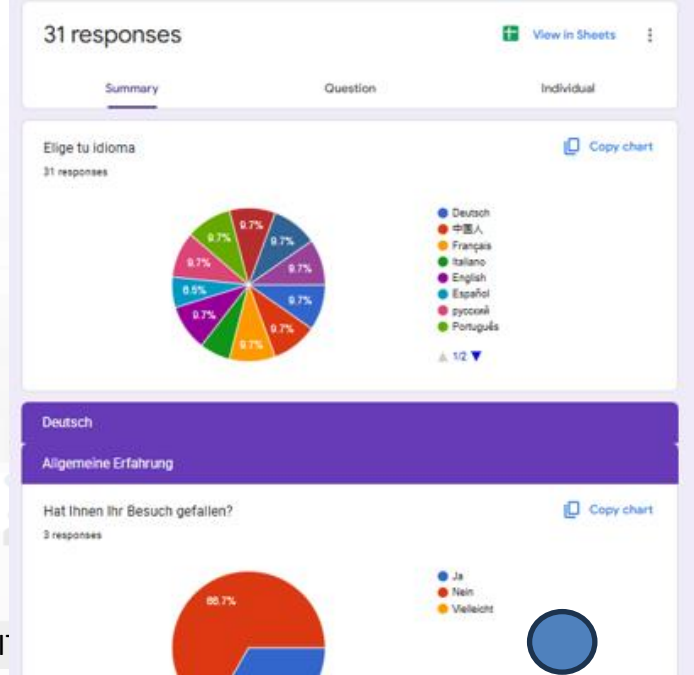












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Participation and Engagement

- **City users:** residents, students, commuters, tourists, visitors, business visitors, etc.
- **Participation**
  - Collect complaints about city services
  - Multichannel: mobile Apps, open call numbers, web pages and blogs, social media, help desk, info points, white boxes in the city, telegrams, SMS, etc.
  - Data integration, usage of LLM, AI deep learning
- **Engagement**
  - Involving city users to perform actions: take photo, provide a suggestion a rank, etc.
- **Commonalities**: data collection, workflow management, operators, etc.

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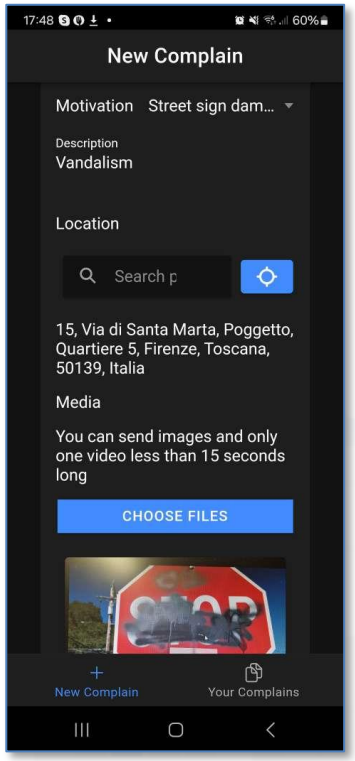
Operator Interface to manage complains





- mobile app Toscana in a Snap: https://www.snap4city.org/541
- User Engagement: https://www.snap4city.org/486
- MultiPurpose user engagement: https://www.snap4city.org/548
- User Engagement admin: https://www.snap4city.org/472

https://www.snap4city.org/1018

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Mobility and Transport goals



Decongestion



Safety



Accessibility



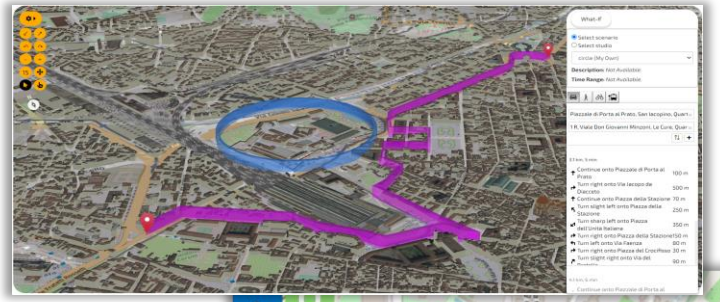
Cost Reduction

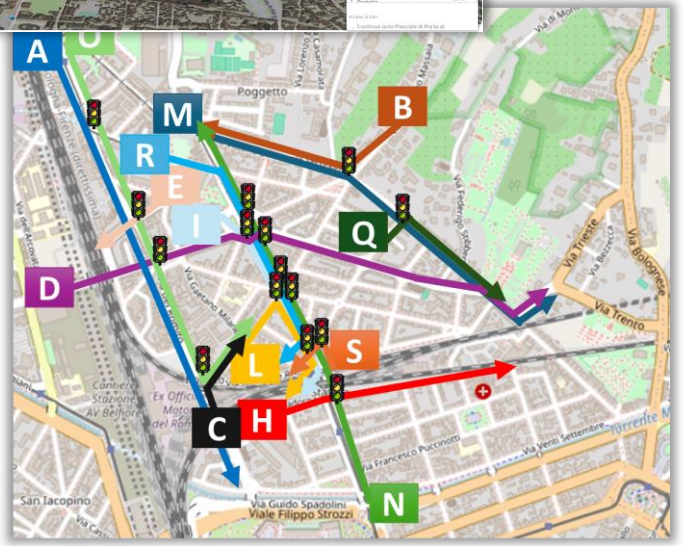


Decarbonization

Mobility & Transport

- **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 plans, infrastructure**
  - **Reduction**: travel time, waiting time, # stops, CO2 emissions, consume fuel, travel time for tramways and busses
- **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.**







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Smart Energy and Smart Building

Goals



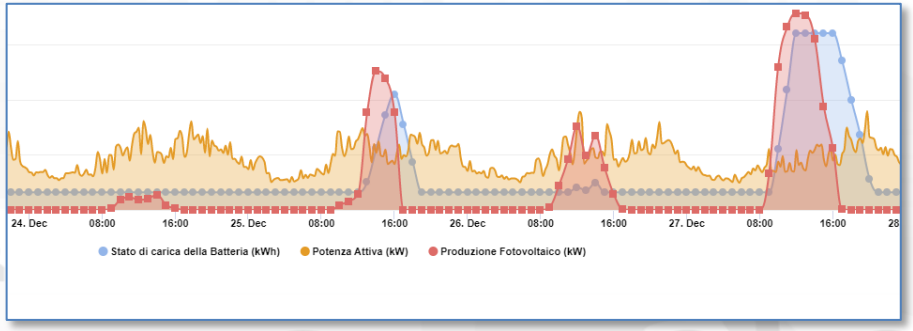
Cost Reduction

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**







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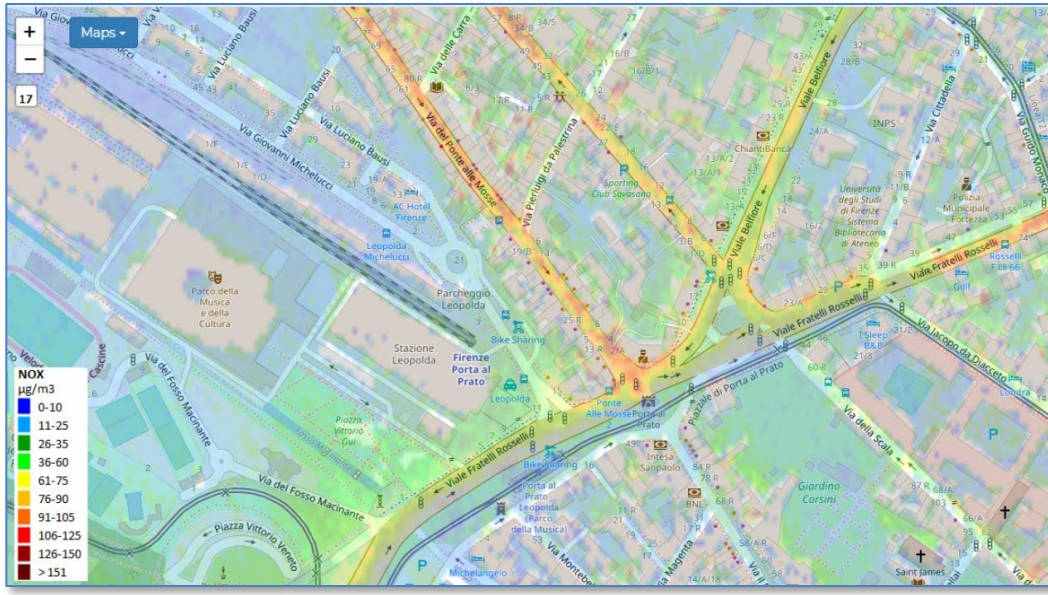
Environment and Waste Management

Goals

Control of emissions
Reduction of emissions
Early warning
Meet the EC targets
Reduction of EC taxation

Environment and Waste

- **Goals:**
  - Reduction of emissions and EC taxations
  - Cost reduction for waste collection,
  - reduction of waste collection impact on mobility
- **AIR quality (Indexes) monitoring and warning**
- **Environment Management & producing predictions/prescriptions:**
  - Monitoring, long and short-term predictions, warning for:
    - GHG, emissions, pollutants, aerosol, chemical plants analysis
  - Traffic Flow impact emissions, predictions
  - Sea conditions, UV conditions, etc.
- **Land slide prediction warning**
- **Coastal erosion monitoring and analysis**
- **Smart 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, ..**





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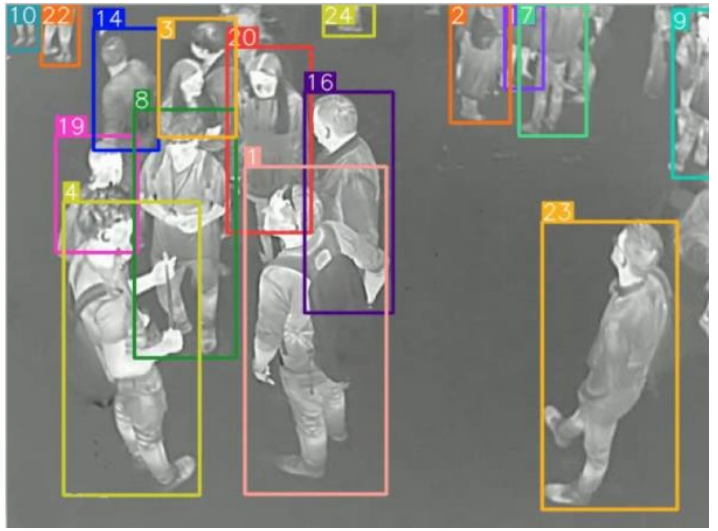
City Users' Services and Tourism Management

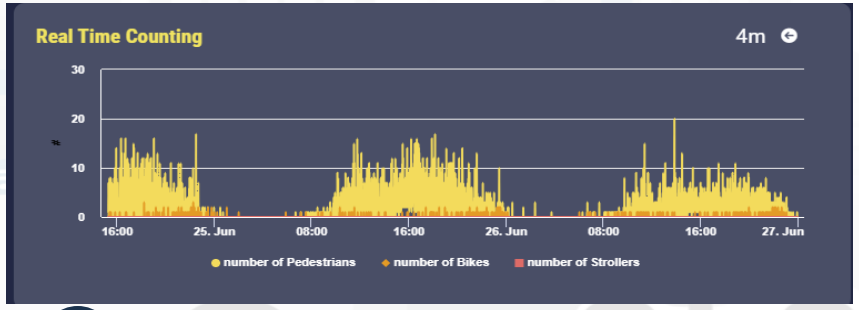
Goals

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, recency/frequency, 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, .., via email, mobile apps, etc.
- **Tourists Flows & Retail Management**: predictions of presences, services' reputations, suggestions on second offers, over-tourism, notifications, early warning,
- **KPI**: 15 MinCityIndex, energy vs people, over-tourism, accepted suggestions, 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, ..**



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SNAP4INDUSTRY

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

info@disit.org
https://www.Snap4city.org,
https://www.Snap4Industry.org

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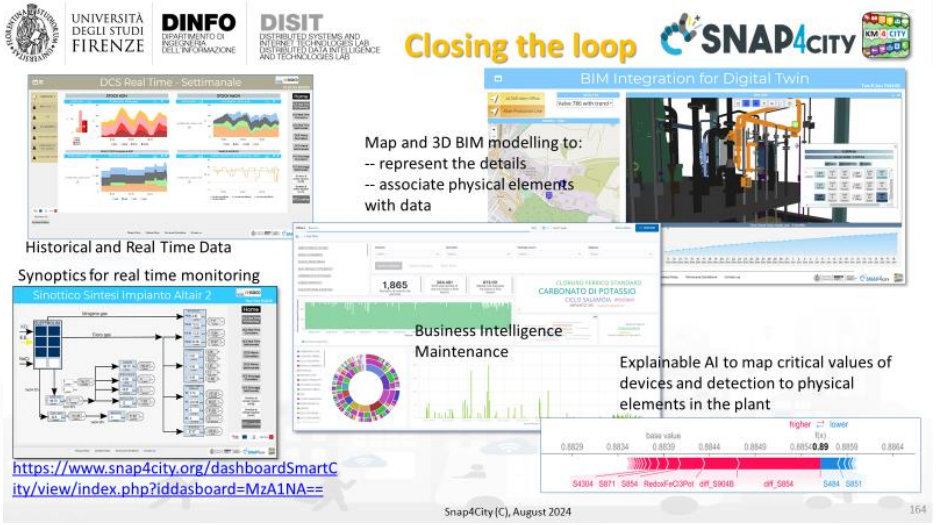
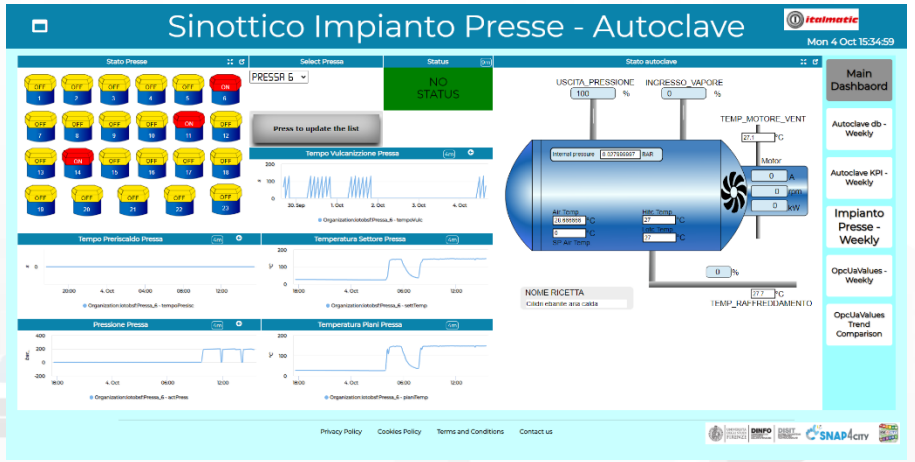
Industry production Domain (2025/5)

- 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, mob apps, etc.
  - Managing maintenance operation, predictive maintenance
  - Simulation of Fluid dynamic on Autoclaves
- 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





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PEN Test Passed

EU GDPR COMPLIANT

SNAP4 Appliances and Dockers Installations

EUROPEAN OPEN SCIENCE CLOUD

Node-RED

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E015 digital ecosystem

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COMMERCIAL MARKETING AI ADVISOR DSS



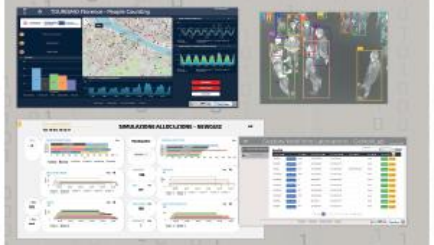
ENERGY, eVEHICLES, BUILDING



MOBILITY AND TRANSPORT



CUSTOMER BEHAVIOUR



ENVIRONMENT AND WASTE MANAGEMENT



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

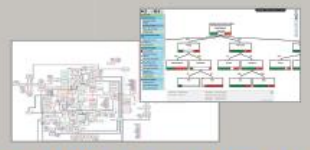


DASHBOARDS, WIDGETS
TEMPLATES

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

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

ANY: DATA, BROKER, NETWORK AND VERTICAL



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



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

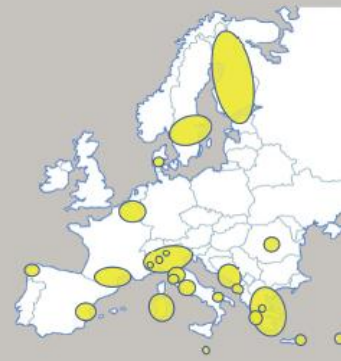


VISUAL PROGRAMMING, ADAPTERS
DATA FLOWS, WORKFLOWS
PARALLEL DISTRIBUTED PROCESSING
DATA DRIVEN



METHODOLOGIES
LIVING LABS
COURSES AND COMMUNITY
DEVELOPMENT TOOLS





Assistants on taking decision and for development/training

Goals

Details

THE POWER OF ARTIFICIAL INTELLIGENCE AT THE SERVICE OF YOUR OPERATION AND PLAN

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100% OPEN SOURCE

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KM4CITY

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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



SNAPADVISOR



- DEVELOMENT ENVIRONMENT AND METHODOLOGY
- VISUAL PROGRAMMING, ML, AI, HPC
- TRAINING COURSES



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



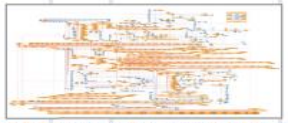
DASHBOARDS, WIDGETS
TEMPLATES



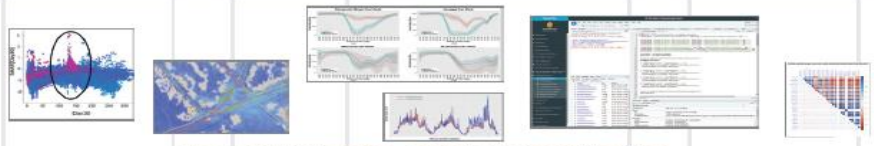
PREDICTION - ANOMALY DETECTION - CLUSTERING - ROUTING - SENTIMENT NLP - TRAFFIC FLOW - PEOPLE FLOWS - SDG
15 MIN CITY INDEX - KPI - HEATMAPS - ORIGIN DESTINATION - MAPS - VECTOR FIELD - ETC...



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



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



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



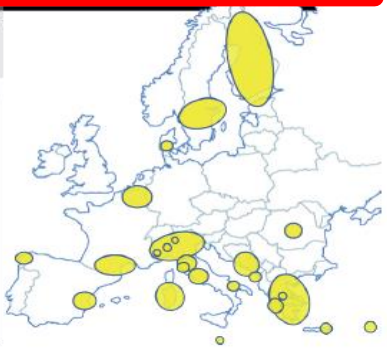
VISUAL PROGRAMMING, ADAPTERS
DATA FLOWS, WORKFLOWS
PARALLEL DISTRIBUTED PROCESSING
DATA DRIVEN

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



NATIVE AND EXTERNAL APPLICATIONS

- Smart Parking
- Smart Light
- Smart Waste
- Smart Energy
- Smart Building
- Smart Tourism
- ...



SnapAdvisor: AI based Assistants, DSS

- **Snap4CityAdvisor:**
  - for developers and promoters knowing all Snap4City and DISIT Lab literature, articles, manuals, slides, codes, etc. The SnapAdvisor with this skill is accessible only for selected Snap4City users. It allows users of saving a lot of time by providing answers to facilitate the development of smart solutions, to the exploitation of Snap4City tools, and recently on data and services accessible on the platform, producing offers, etc.
- **Legal Advisor**
  - expert on specific disputes at service of the Legal department of Careggi Hospital of Florence. It allows to save time in recovering precise information from complex legal documents, ordering of events, understanding causes and effects, producing reports, etc.
- **Expert of industrial machines, user manuals, technical manuals, rules,**
  - Answering on technical manuals
- **Complains and Questionnaire analysis**
  - Answering on trends, via questionnaires collected via QR, blobs, emails, etc.
- **Commercial Advisor:**
  - processing orders understanding them and preparing the offer, thus reducing the time to process them.
- **Generative Designs:**
  - Multimodal Generative AI supporting designers in producing innovations
- etc.

See: "Context-Aware Retrieval Augmented Generation using Similarity Validation to handle Context Inconsistencies in Large Language Models", IEEE Access, 2025. https://doi.org/10.1109/ACCESS.2025.3614553

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SNAP4CITY

Logged in as:
edoardo_tester

Your Profile

Logout

SnapAssistant model:

Llama3.3

New Chat

- EdoChat1
- EdoChat2
- EdoChat3
- EdoChat4
- prova
- chatNuova
- chatTest1LLAMA
- chatTest2LLAMA
- testGianniLLAMA
- testTastoInvioPreChanges
- ChatTestPostPSWINVIO

https://www.snap4city.org/1116

SnapAdvisor

Current chat: debug0

Visualize references

Personal Advisor LLM

Come creo una dashboard?

Per creare una dashboard, puoi utilizzare la piattaforma Snap4City. La dashboard si compone di un insieme di widget grafici che possono essere impostati separatamente assegnando una serie di parametri, come origine dati, dimensioni, colori, forma, font, allarmi, relazioni con altri, ecc. (SOURCE: Snap4 City per la creazione di Smart City Control Room, SCCR). Inoltre, la piattaforma offre la possibilità di creare vere e proprie applicazioni interattive, multipagina/multidashboard, e non semplici storie monopagina da scrollare. Puoi anche condividere la dashboard con altri utenti anche fuori dalla Smart City Control Room tramite canali autenticati e protetti in HTTPS, in accordo al GDPR (SOURCE: Snap4 City per la creazione di Smart City Control Room, SCCR). Per vedere alcuni esempi di dashboard, puoi visitare il sito https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjU0Mg== (SOURCE: Snap4 City 1st Overview v4 8 annot). Tuttavia, non ho trovato informazioni dettagliate sulla procedura di creazione di una dashboard. Se hai bisogno di ulteriore assistenza, ti consiglio di contattare direttamente il team di supporto di Snap4City. Non so dirti altro in merito.

Write a message...

SnapAdvisor

- **working on your private content** and thus producing answers.
  - Select a subset of documents
- **domain control**: you can decide the knowledge base (internal wikis, PDFs, APIs),
- **explainability** capability, provide references to your documents
- **multilingual via content**
- **modularity**: it is possible to pass from one collection of documents to another, and multiple users can work on the advisor asking for different topic on different collections/domains at the same time, independently as needs change, without any interferences among them.
- **lower hallucinations**

https://www.snap4city.org/1116

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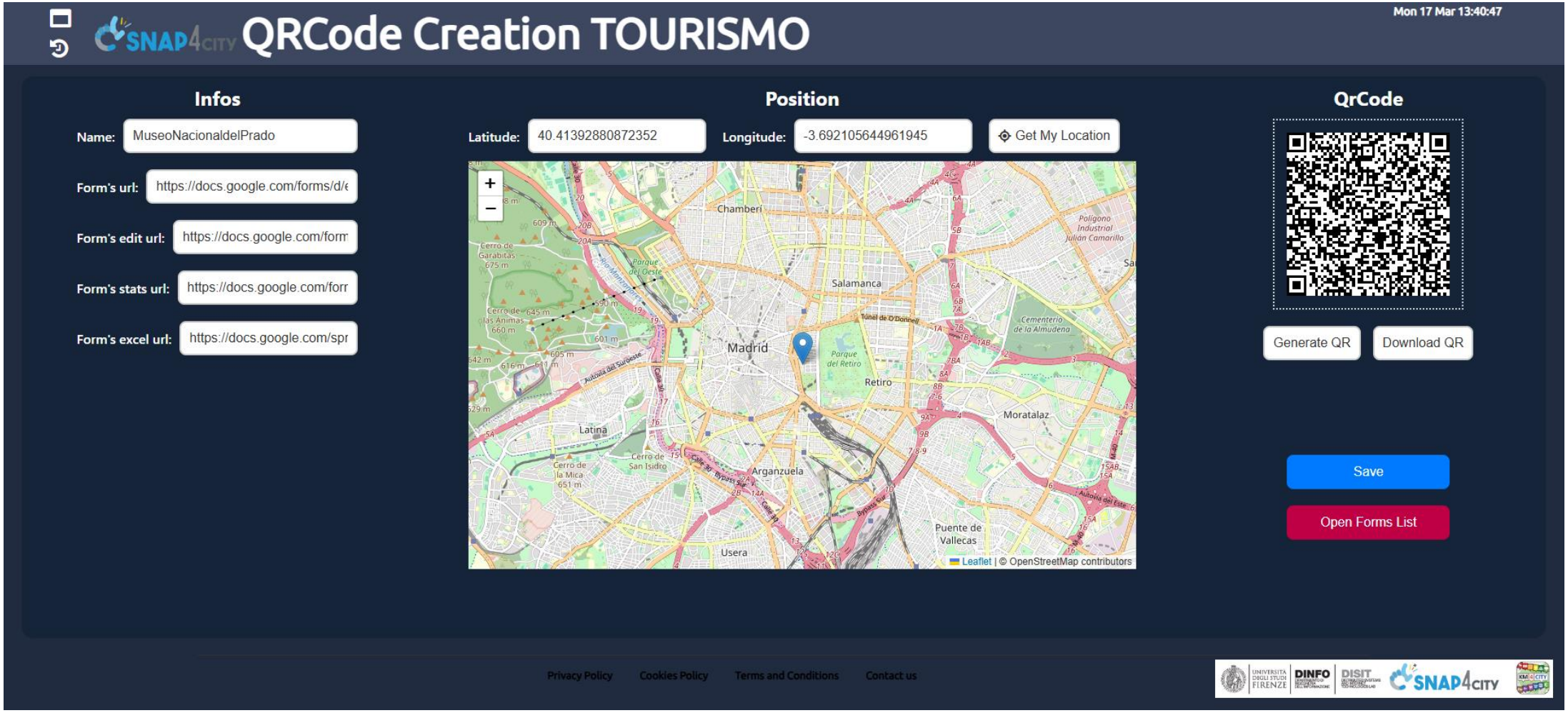
Complains Analysis to Support Decision Making Processes



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Complains Analysis to Support Decision Making Processes

Standard data/form creation
for reputation analysis:

- Initial Sentiment Analysis/NLP by analysing questionnaires collected from QR code distribution.

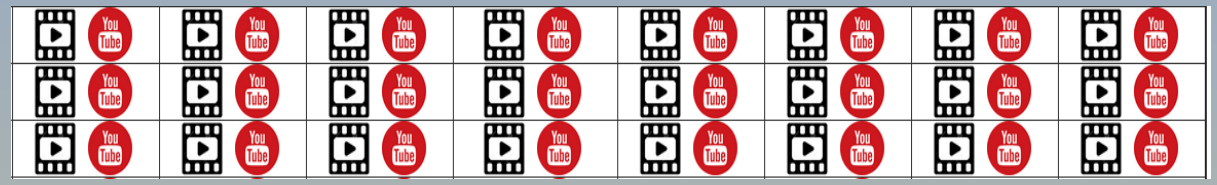
Summary of Findings (June–August 2025, 36 responses received - Golden Bay, Malta) produced by a Large Language Model (LLM) based on the responses obtained from questionnaire

Average Ratings (scale -2 to +2)

Overall experience: +0.67 → slightly positive but inconsistent (range -2 to +2)
Toilets: -0.83 → strongly negative, among the worst-rated aspects.
Showers: -0.31 → generally negative.
Bins distribution: -0.33 → slightly negative, with complaints about lack of bins.
Safety & lifeguard services: +0.55 → moderately positive.
Cleanliness: -0.52 → overall negative, many complaints about cigarette butts and plastics.
Natural conditions (dunes, seawater, etc.): -0.40 → negative, issues with seagrass, water quality.

Developing on Snap4City

1st part	2nd part	3rd part	4th part	5th part	6th part	7th part	8th
Overview	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App	Design and Develop Smart Solutions
							
							





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Why/How to Develop https://www.snap4city.org/1093

1. Data Integration Interoperability, standards
2. Advanced Analytics and AI Integration
3. Dashboard and Visualization Tools, custom graphics
4. Digital Twin Support
5. Scalability and Modularity, cloud usage
6. Compliance and Security
7. Real-World Applications, use cases
8. Applications development

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ダッシュボード
Dashboards (Public)
My Dashboards in All Org.
Dashboards of My Organization
My Dashboards in My Organization
My Data Dash Dev OpenSrcDash
My Data Dashboard OpenSrcDash
Extra Dashboard Widgets
Notificator
Data Management, HLT
Knowledge and Maps
Processing Logics / IOT App
Entity Directory and Devices
Resource Manager
Development Tools
Management
Decision Support Systems
Deploy and Installation
SuperSetting
User Management and Auditing
Help and Contacts
Documentation and Articles

How To Develop - Create Smart Applications exploiting Snap4City platform and tools

Snap4City is a comprehensive, open-source platform designed to facilitate the development of smart applications across various domains, including urban planning, mobility, energy, environment, and industry. Developed by the DISIT Lab at the University of Florence, Snap4City integrates a wide array of tools and services to support data-driven decision-making and enhance the quality of life in smart cities.

- **Development Life Cycle: https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf**
- How to Design and Develop Smart Solutions with Snap4City,
- Snap4City: FIWARE powered smart app builder for sentient cities
- Full training: https://www.snap4city.org/944
- https://www.snap4city.org/download/video/course/p1-rnd/Snap4City-P1-Overview-x-RnD-2024-v8-1.pdf

Key Capabilities

1. Data Integration Interoperability, standards

Snap4City excels in aggregating and harmonizing data from diverse sources such as IoT devices, GIS systems, open data portals, and social media. Utilizing the Km4City ontology, it ensures semantic interoperability, enabling seamless integration and analysis of heterogeneous data streams. It also Supports real-time data collection and historical data storage. Most of the data interoperability is due to the Node-RED from which any kind of protocols and data can be ingested and produced. Snap4City on that processes can be customized by using the Node-RED visual programming environment and its more than 190 microservices / nodes developed and provided to be installed on any platform; to run on edge and cloud, on mobile and TV cameras, etc.

- Full training: https://www.snap4city.org/944
- https://www.snap4city.org/download/video/course/p1-rnd/Snap4City-P1-Overview-x-RnD-2024-v8-1.pdf
- https://www.snap4city.org/download/video/course/p3/Snap4City-p3-iot-app-proc-logic-v12-8.pdf
- https://www.snap4city.org/download/video/course/p5/Snap4City-p5-Data-Ingestion-n-Interoperability-v12-6.pdf
- https://www.snap4city.org/download/video/course/p3-n/Snap4City-p3-5-6-iot-app-proc-logic-ingestion-interop-v13-6-all.pdf
- Protocols and formats: https://www.snap4city.org/65
- Snap4City Platform to Speed Up Policies - PMC - PubMed Central
- Powered by FIWARE - Snap4City

2. Advanced Analytics and AI Integration

The platform supports the development and deployment of advanced analytics, including machine learning and artificial intelligence algorithms. These capabilities allow for real-time data processing, predictive analytics, anomaly detection, and simulation-based what-if analyses, aiding in proactive urban management. A large set of AI tools is available in various domains. The developers can easily create their own AI tools on platform and put them in execution on clusters of CPU/GPU, the solution also support MLOps modalities.

- https://www.snap4city.org/download/video/DPL_SNAP4SOLU.pdf
- https://www.snap4city.org/download/video/course/p4/Snap4City-p4-Data-Analytics-Artificial-Intelligence-v12-8.pdf
- **MLOps for AI and DA development: https://www.snap4city.org/download/video/Snap4City-MLOps-Manual.pdf**
- https://www.snap4city.org/download/video/course/p8/Snap4City-p8-Solutions-Development-v13-3.pdf

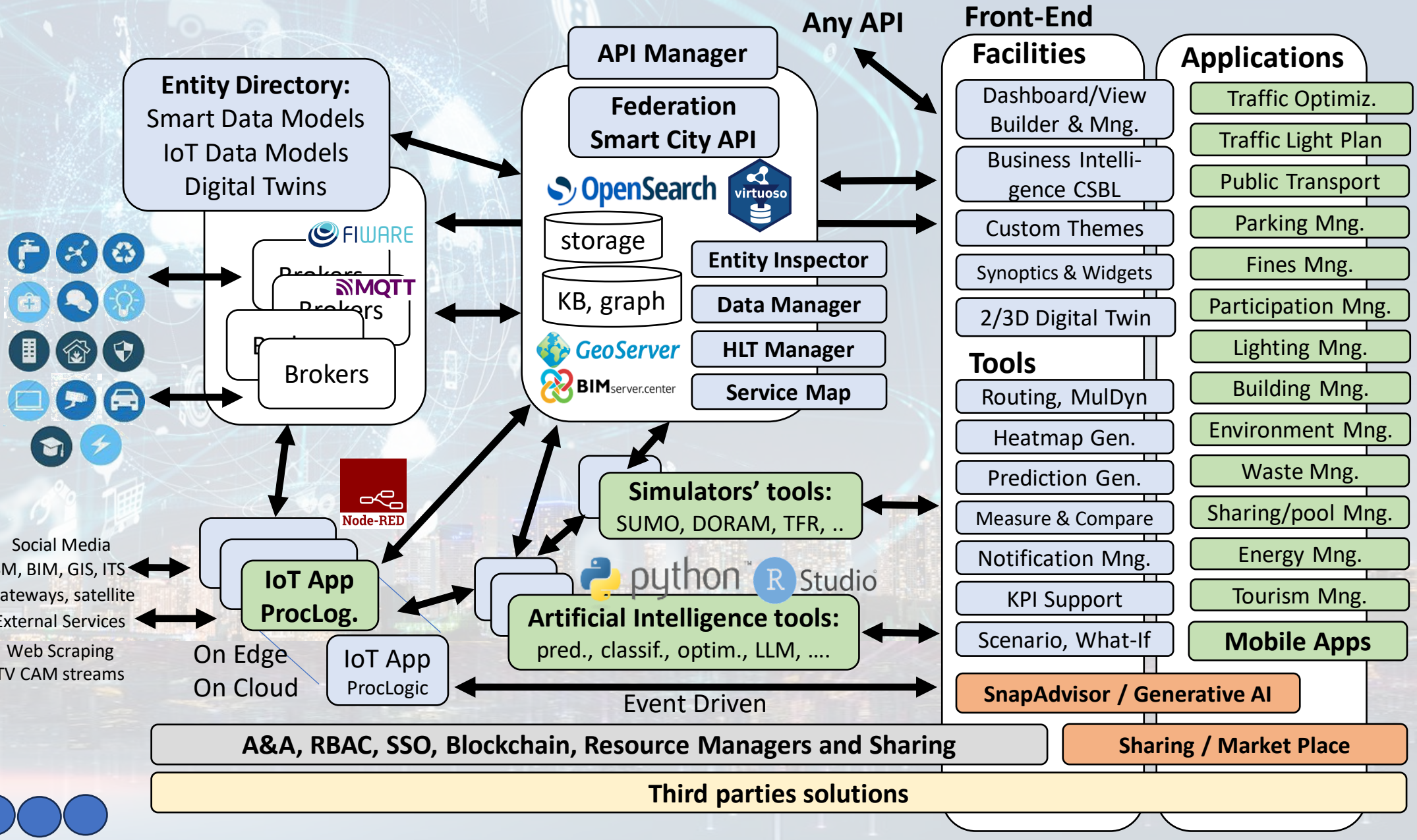


Who's online

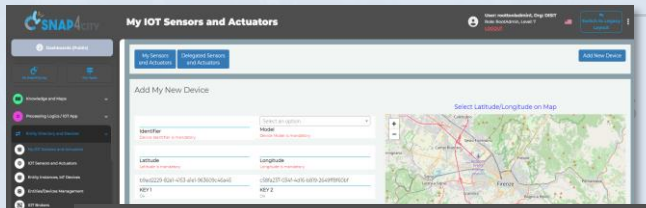
There are currently 24 users online.

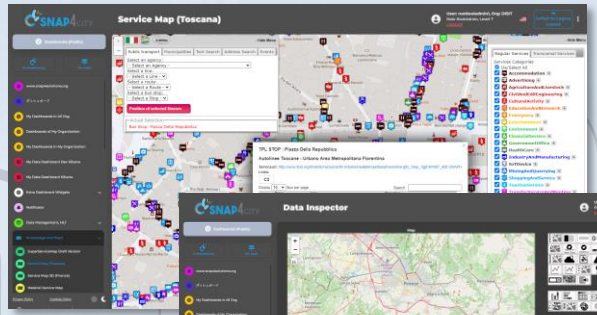
- roottooladmin1
- CL
- a.solimine
- g.bonicolini
- trafficflowscen...
- n.grassi
- trafficweatherdisit
- disit.malta

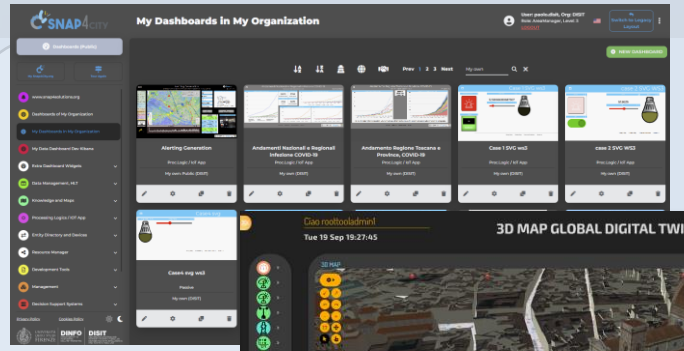
Technical Architecture

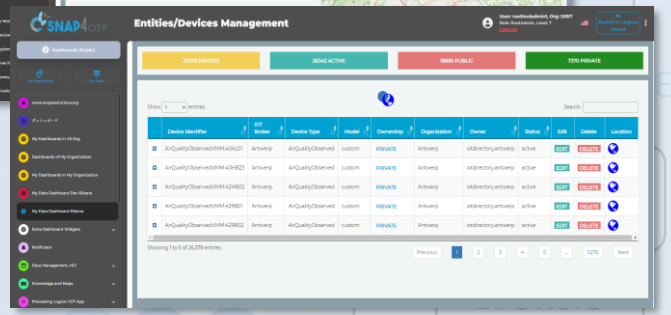


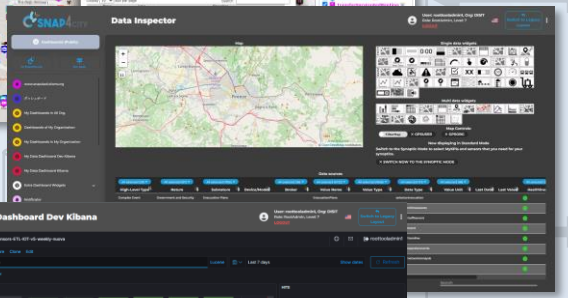
Visual Development Tools



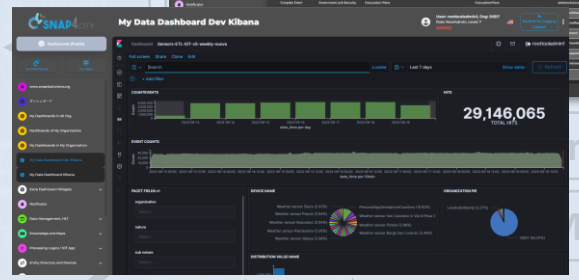


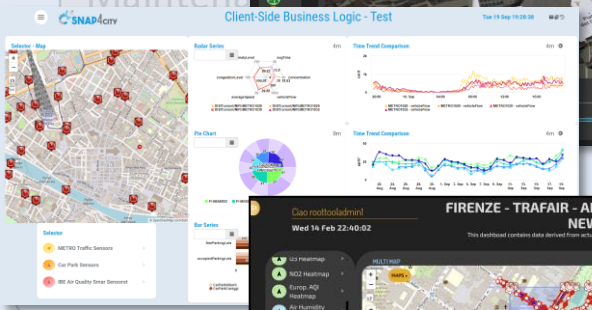


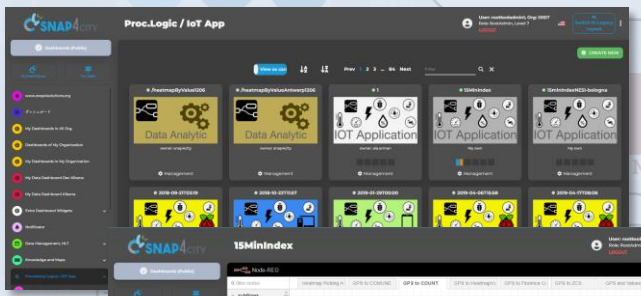


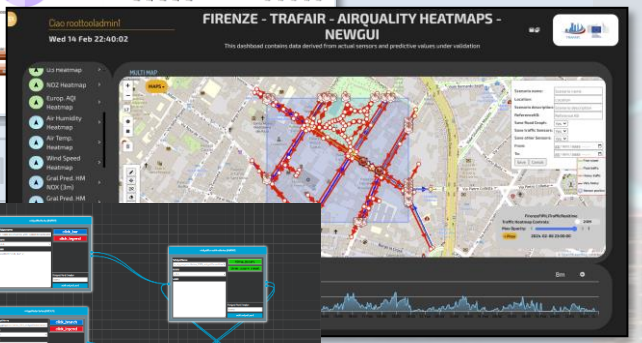


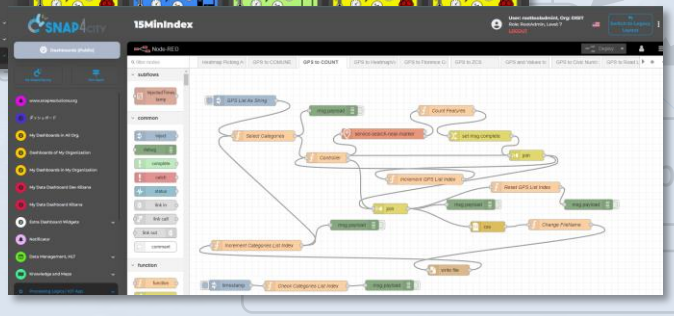


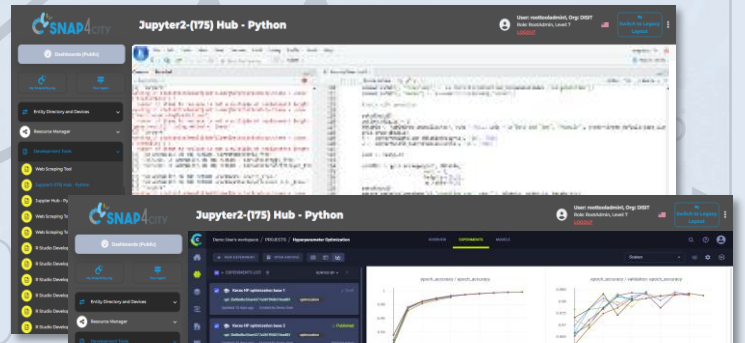


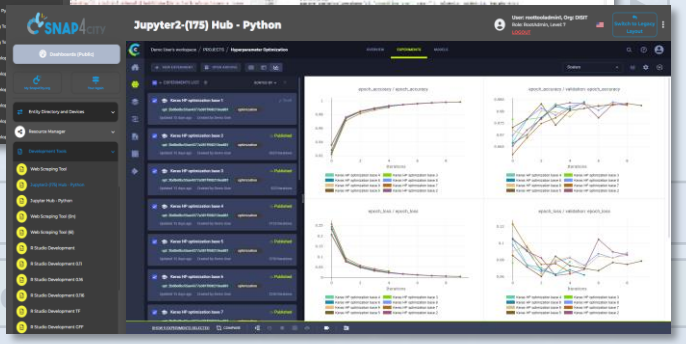


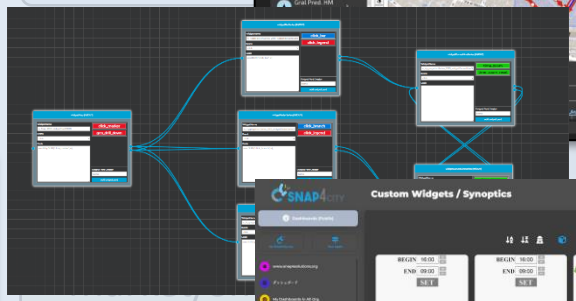














Snap4City Platform tools

- Routing, Multi modal and Dynamic
- Heatmap Generation and management
- Prediction Generation and management
- Measures on Floors, Maps and orthomaps
- Compare Orthomaps with overlapped structures
- Notification Management, multichannel
- KPI Support: SUMI, PUMS/SUMP
- Scenario, editor, scenario based optimisation
- What-If analysis, grounded on predictions, simulations, etc.

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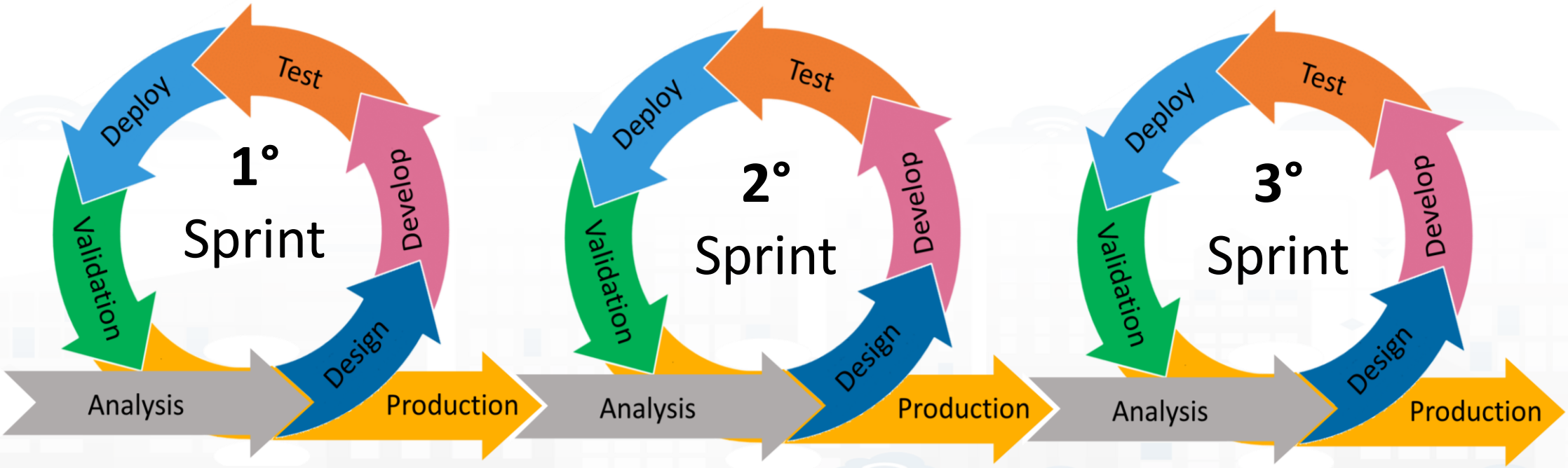
Agile Development Life Cycle by sprint Smart Solutions



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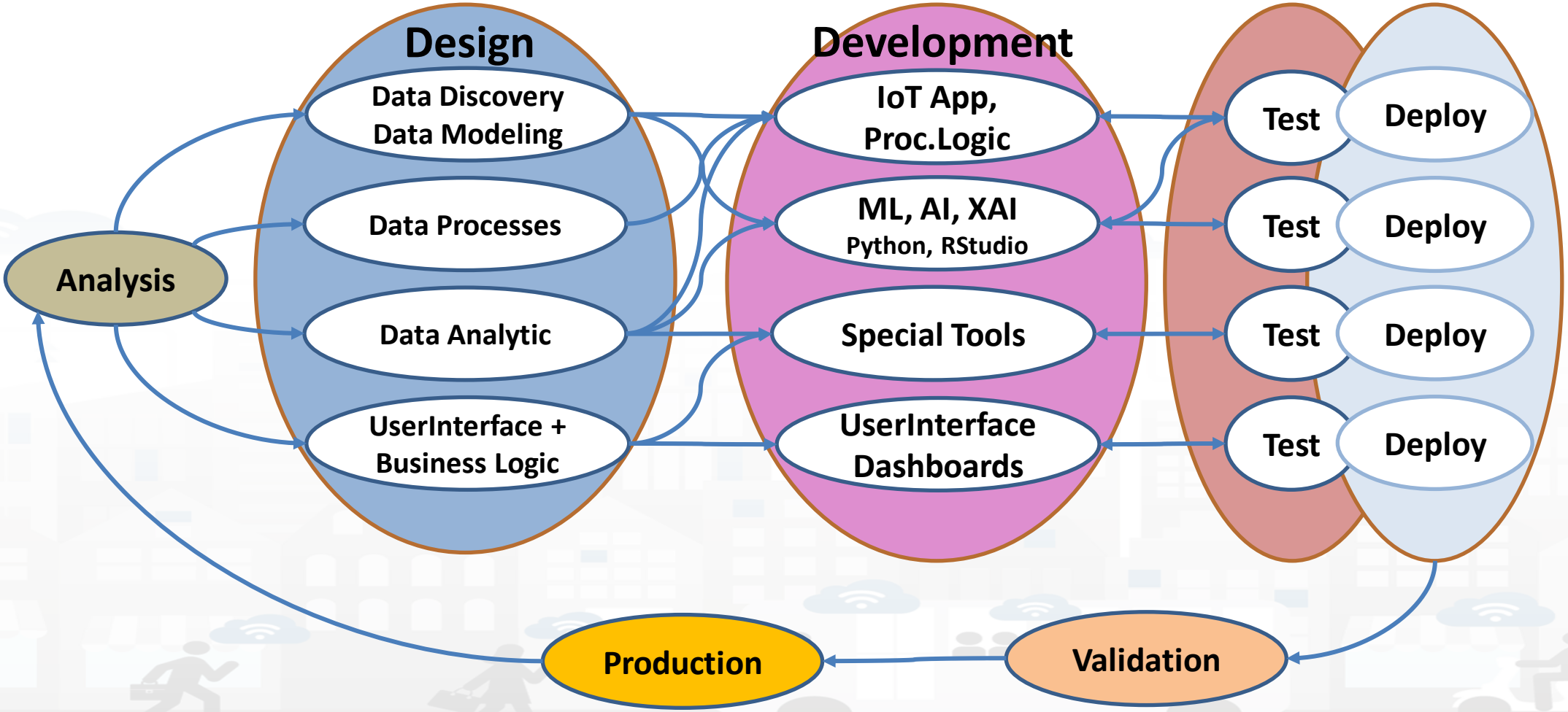
Development Life Cycle Smart Solutions



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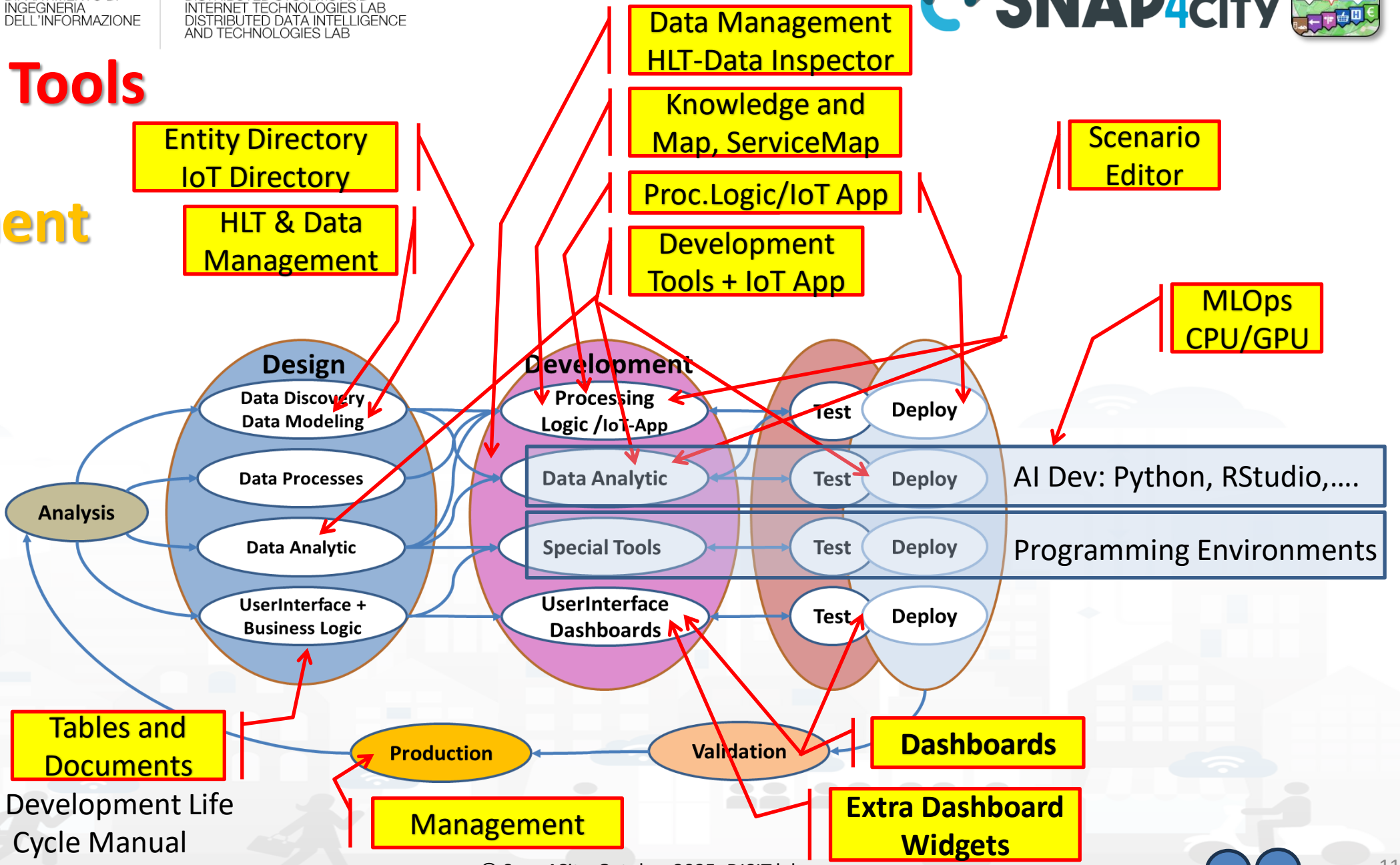
Snap4City Tools vs Development Life Cycle



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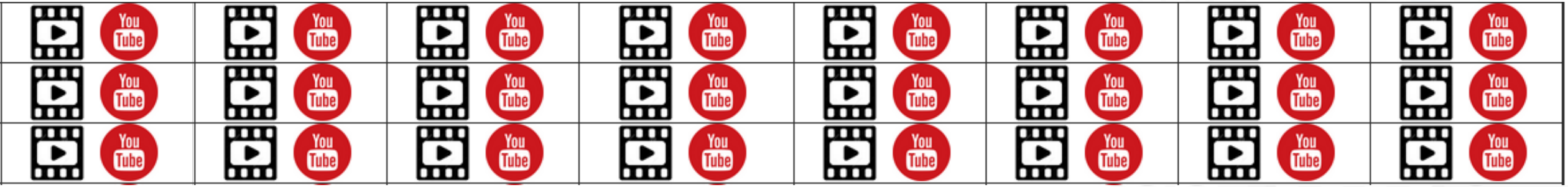
https://www.snap4city.org/944

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
							
							



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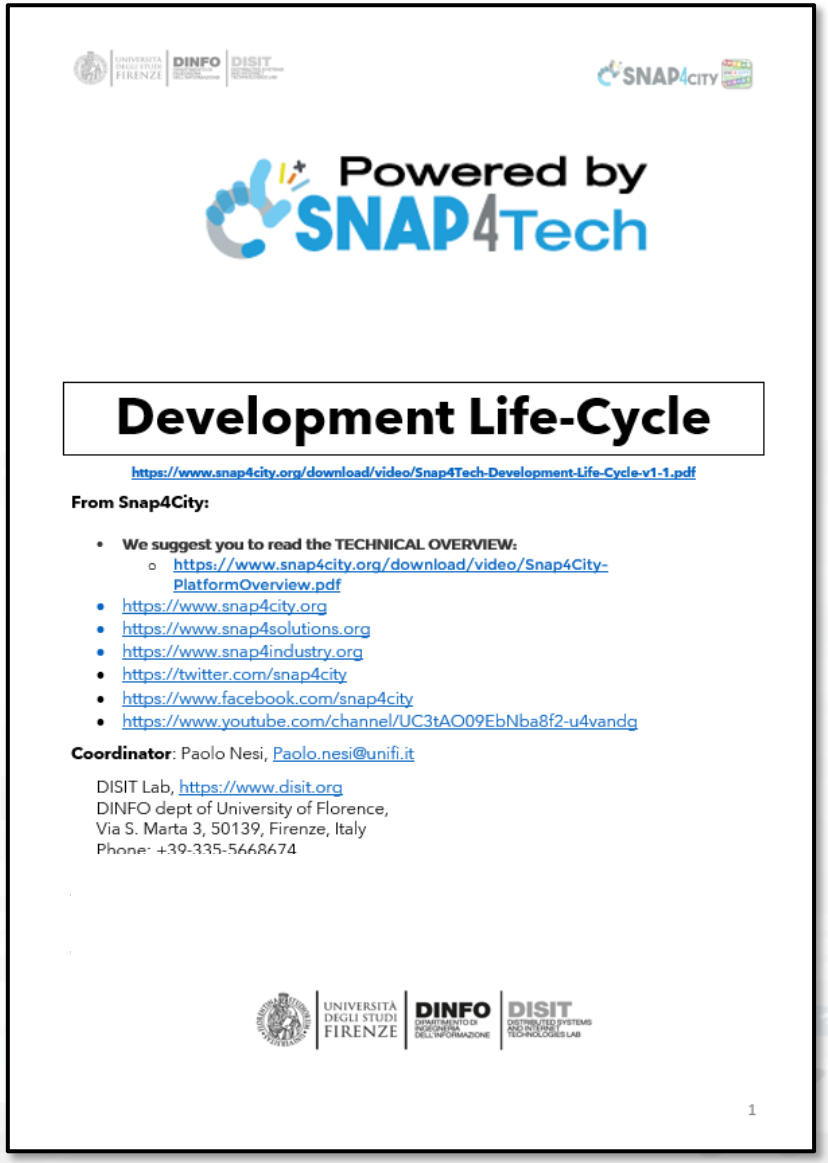
Development



Powered by SNAP4Tech

Development Life-Cycle

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

From Snap4City:

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

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

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DINFO dept of University of Florence,
Via S. Marta 3, 50139, Firenze, Italy
Phone: +39-335-5668674

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1

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

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Snap4City strongly reduces the effort/costs for

- **Learn Visualization Tools or Libraries**: 5-15% → **10%**
  - Visual tools, visual programming, training course, dev. Manuals, etc.
- **Software Licenses**: 5-15% → **0%**
  - Development environment fully open source
- **Development Time**: 20-30% → **5%**
  - Dashboard builder, synoptics, widget exchange, dashboard exchange, clone, delegations, etc.
  - Reused cloned and shared solutions, artefacts
- **Customization and Interactivity**: 10-20% → **10%**
  - Dashboards with Business Logic: CSBL, Node-red SSBL
  - Direct development of Business Intelligence without coding all details
- **Design for Security/privacy**: 5-10% → **only respect the guidelines**
  - Snap4City is end-to-end secure and GDPR compliant, all is already in place
- **Design for Scalability**: 5-15% → **only respect the guidelines**
  - Snap4City is scalable from Back-End to Front-End, all is already in place

- ***Reduction of: 45% for development effort of smart city solutions***

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Snap4City on *Data Collection and PreProcess*

- **Effort reduction from 25-35% to 10-15%, >55% reduction of effort for**
  - **Data Collection** via
    - Direct collection access with Brokers, harvesting of external brokers and data models
    - Usage of library of data models, more than 1700 models: saving analysis
      - Custom data models, massive automated construction of entities
    - Automated enrichment of Km4City Ontology and knowledge base: saving time analysis
    - IoT App / Node-red development of data collection processes: fast development
  - **Data PreProcess** via
    - Node-red visual programming (node.js) for preprocessing, transcoding, thousands of microservices and libraries, reuse of blocks and data flows, etc.
    - Semantic recovering of data relationships via semantic graph DB with Km4City models
    - Eventually usage of Python or R-studio or others when needed
  - *Reuse and share of Node-RED solutions, large number of cases*

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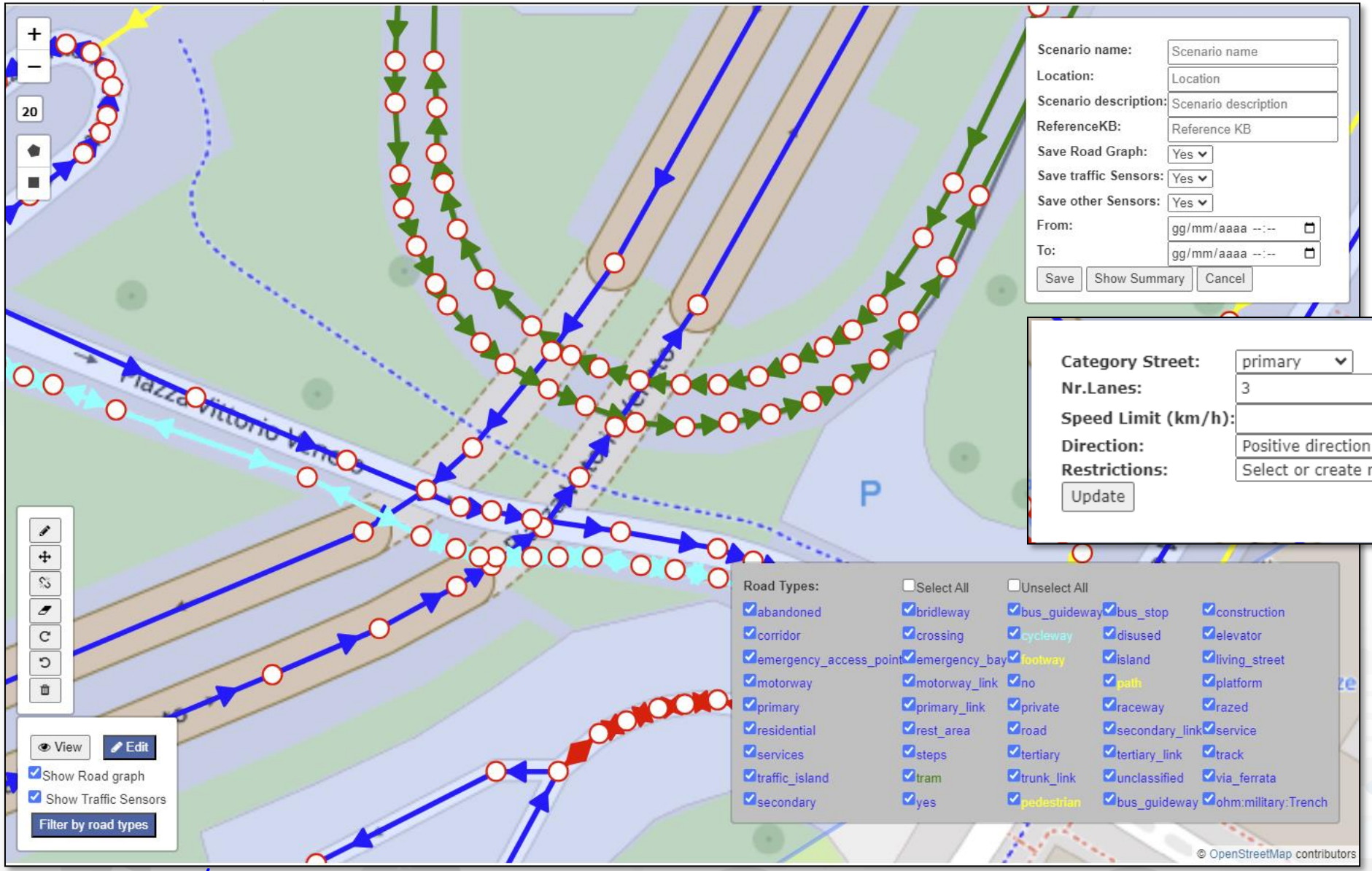
Scenario Editor

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

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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

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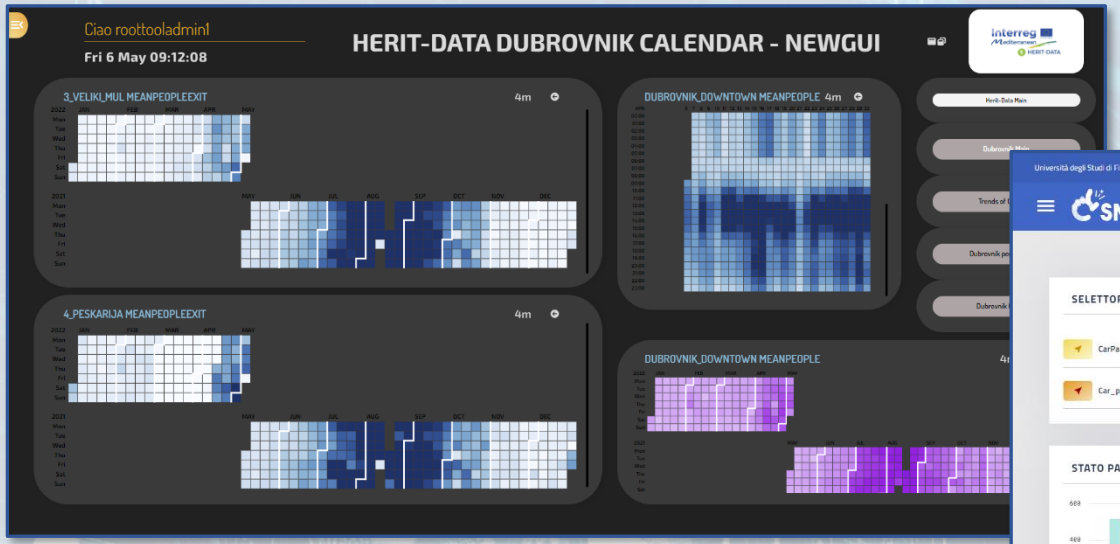
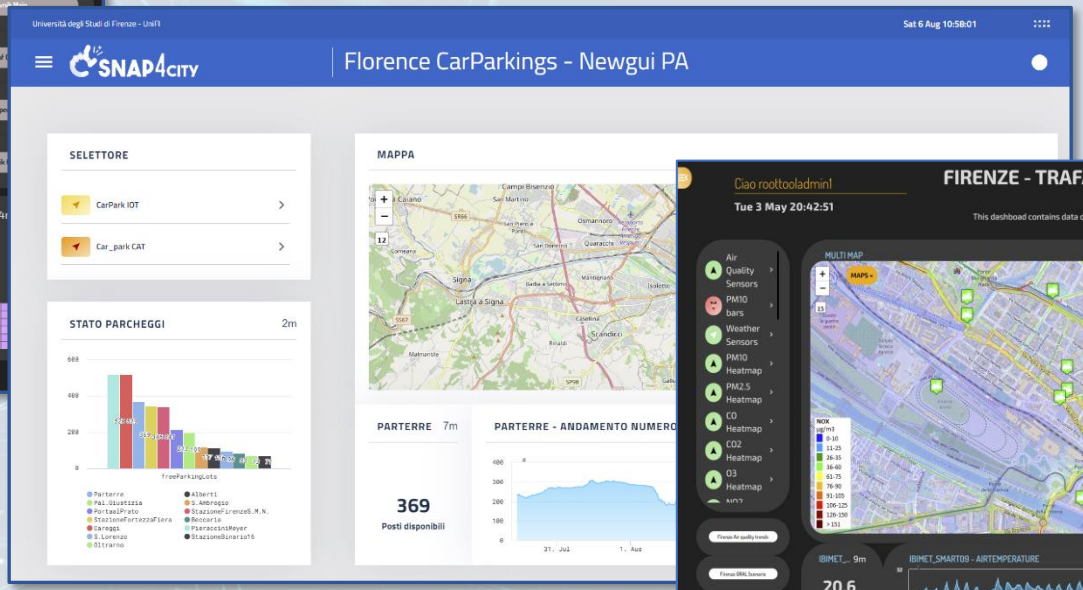
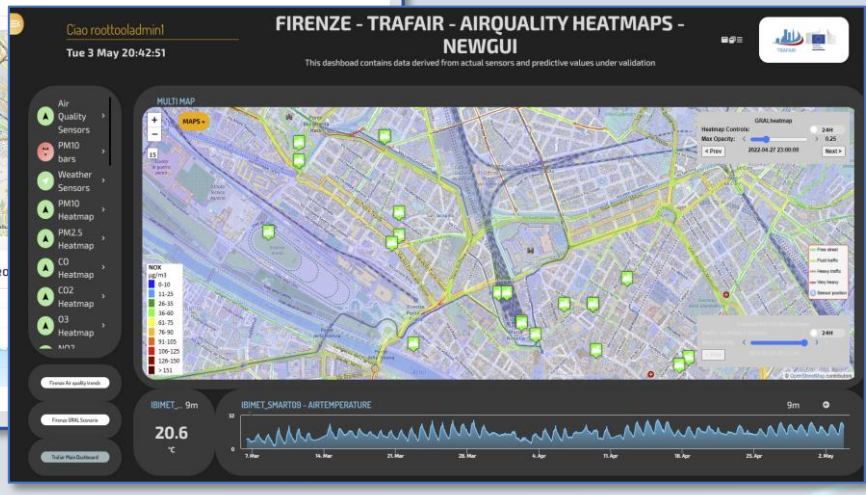
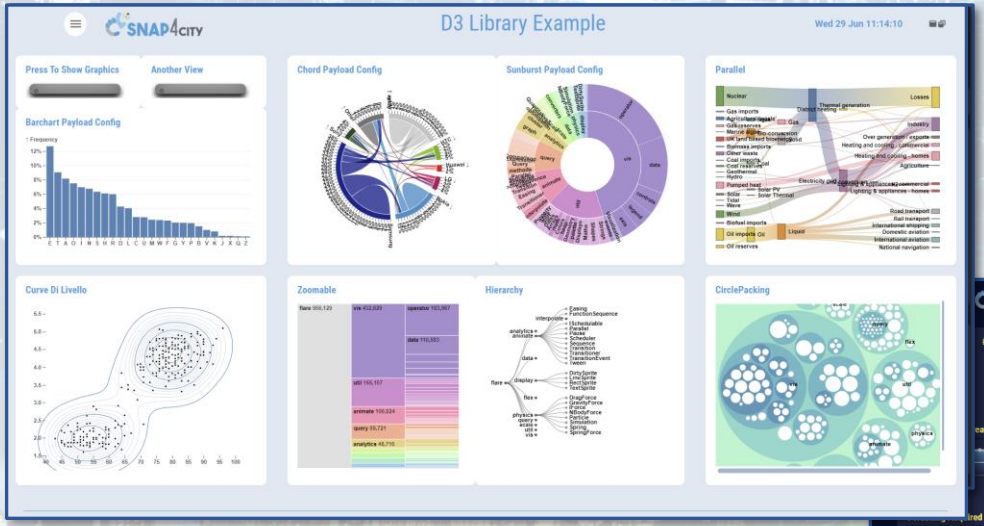
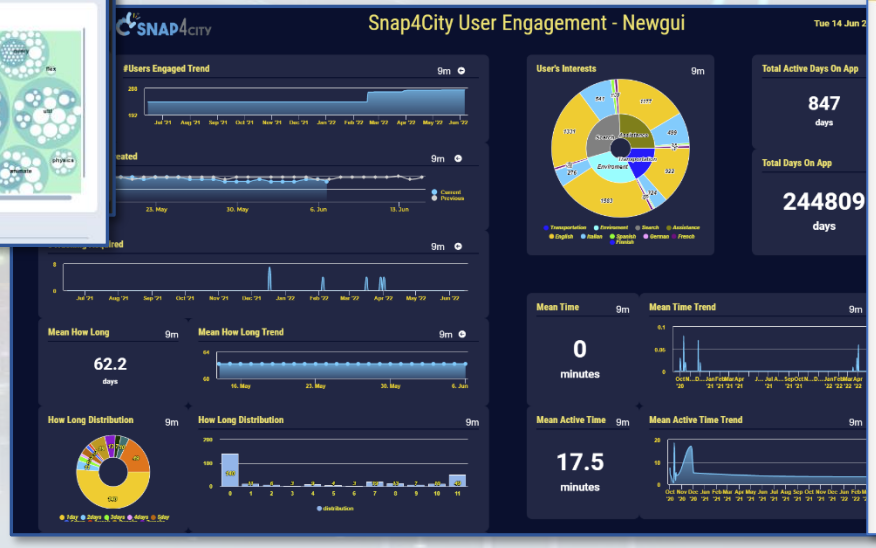
Different Themes

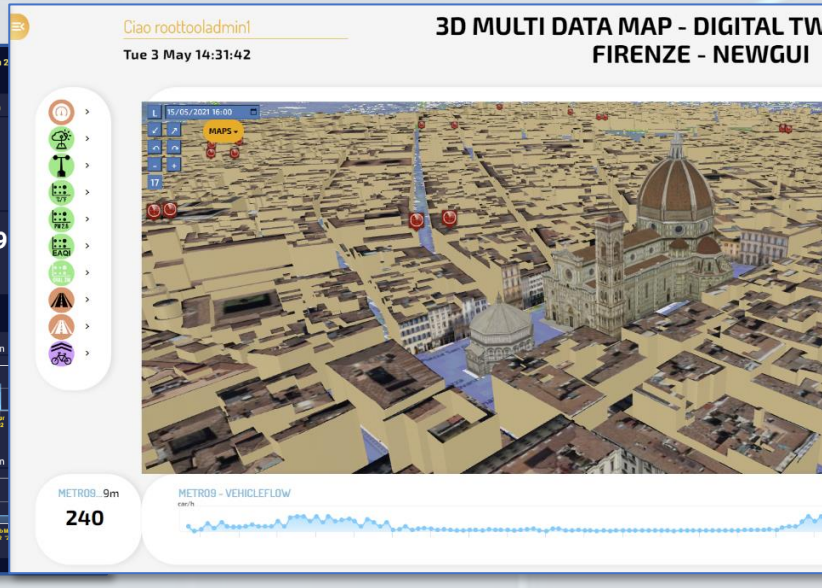












New styles/themes can be developed by specializing a few files from open source

https://www.snap4city.org/793

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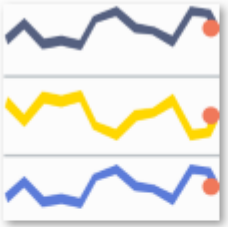
Visual Representations


Sliderwith-multiple-steps-for-KPI


sparklines



kpi


histogram


heatmap


flow-maps


geo-maps

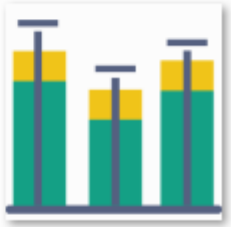

donut-chart


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

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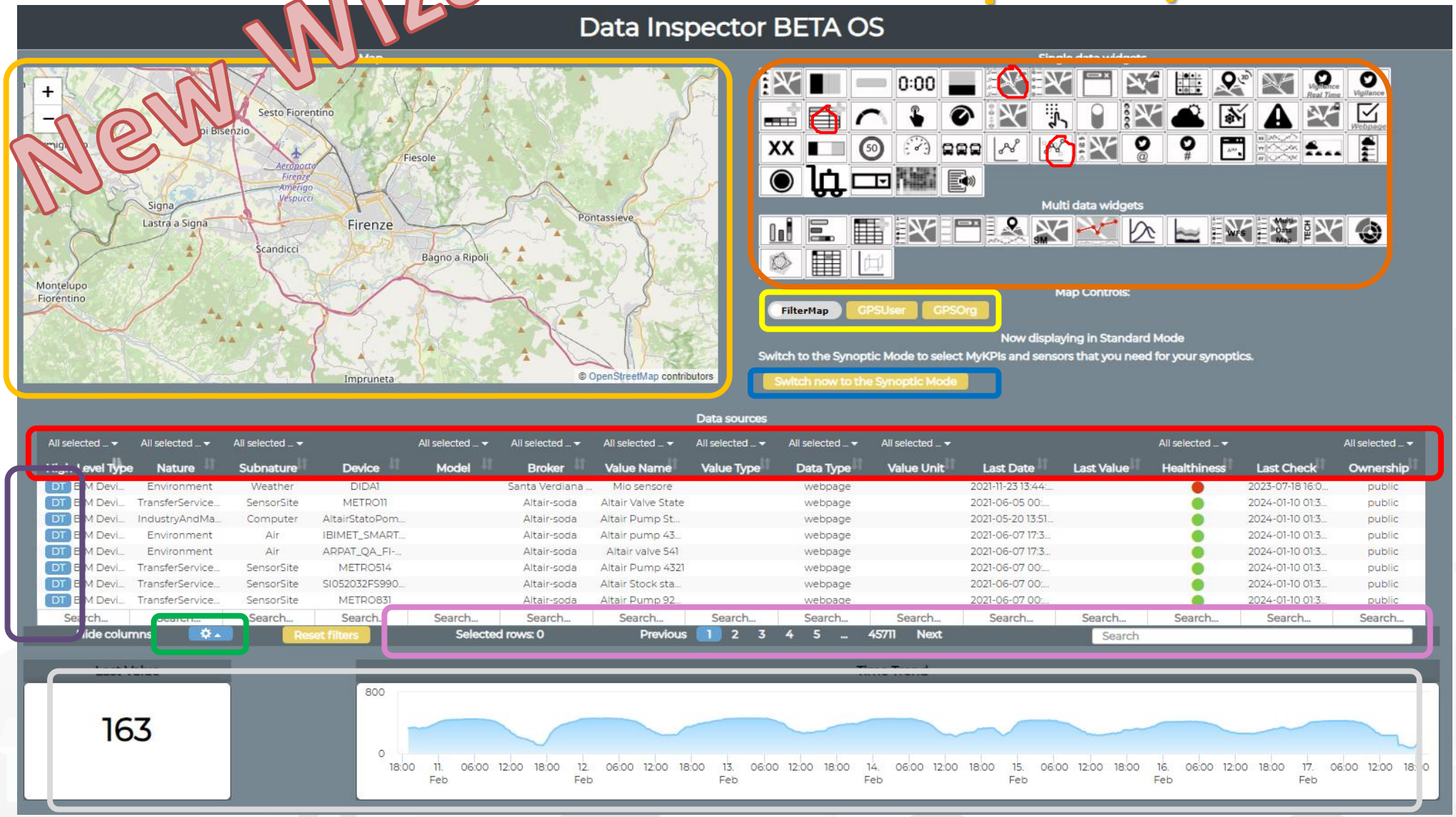
New Data Inspector/Wizard

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

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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

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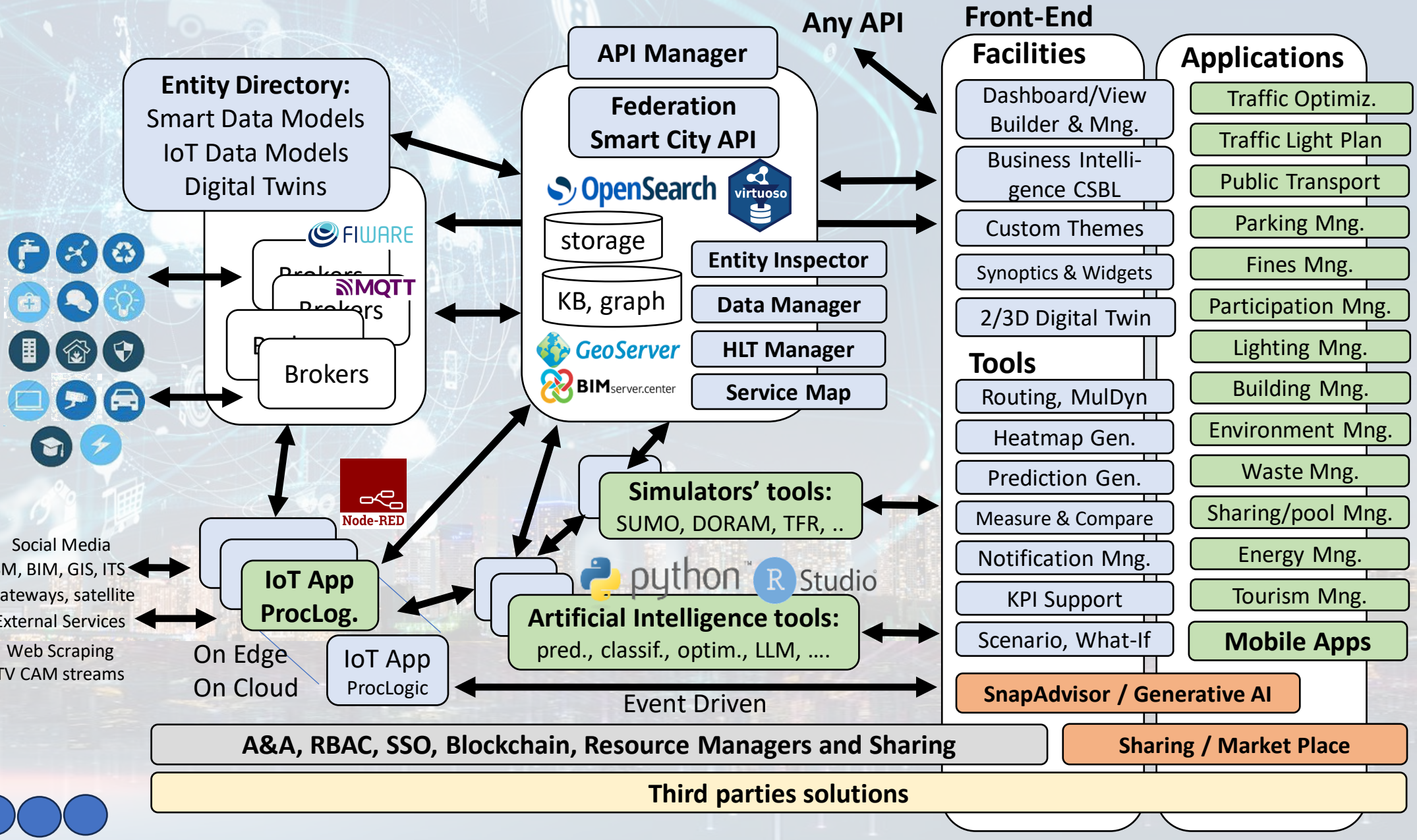
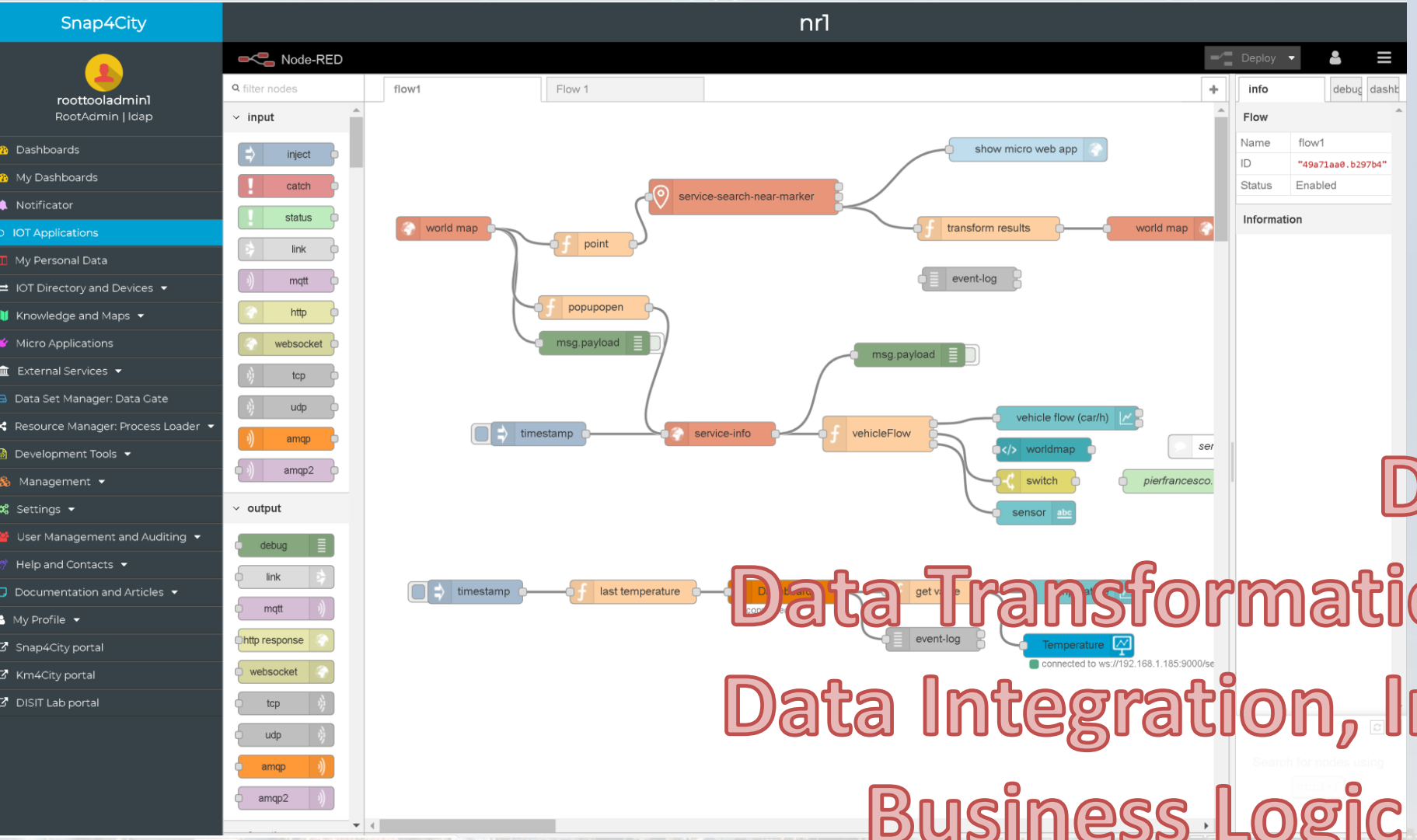
Technical Architecture





Data Adapation

Data Transformation, Conversion

Data Integration, Interoperability

Business Logic vs Dashboards

Data Analytics control

Everywhere: Cloud, on IoT Edge Devices

...diting IOT Applications

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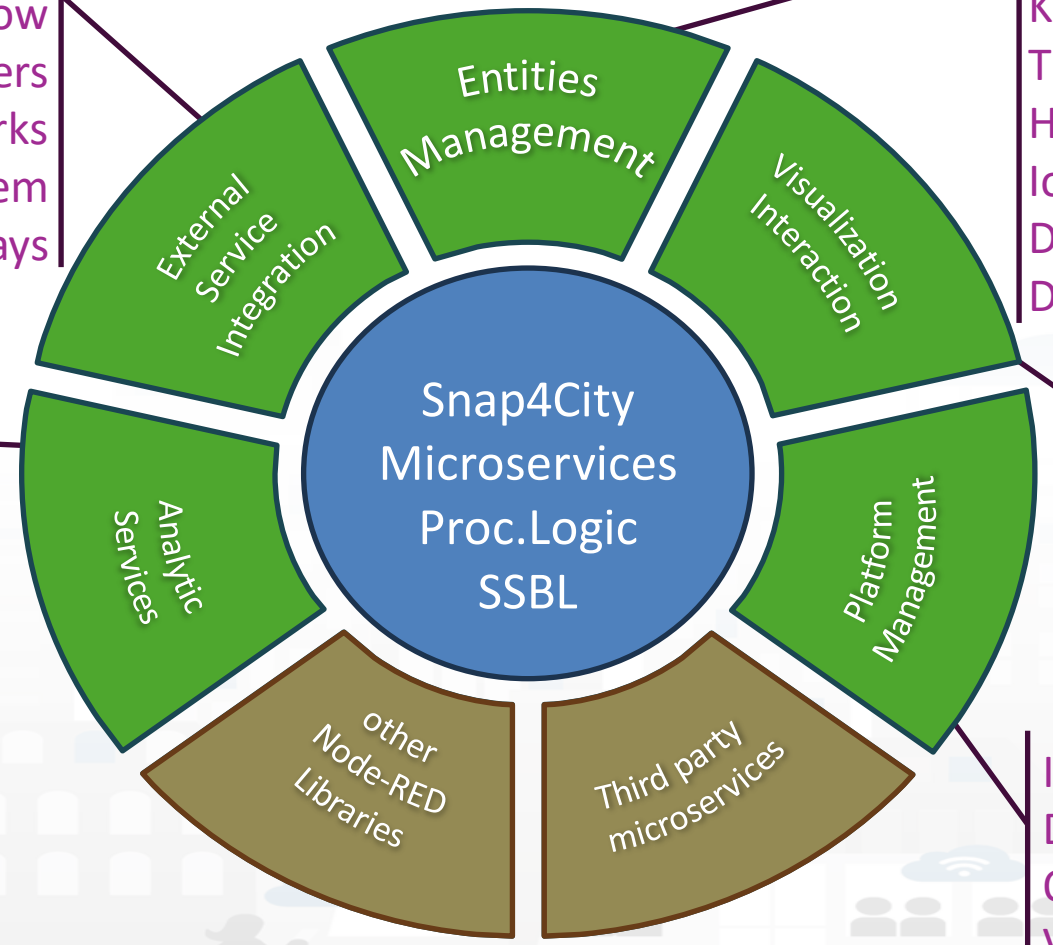
MicroServices Areas

> 60.000 downloads (up to 2024)



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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DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

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

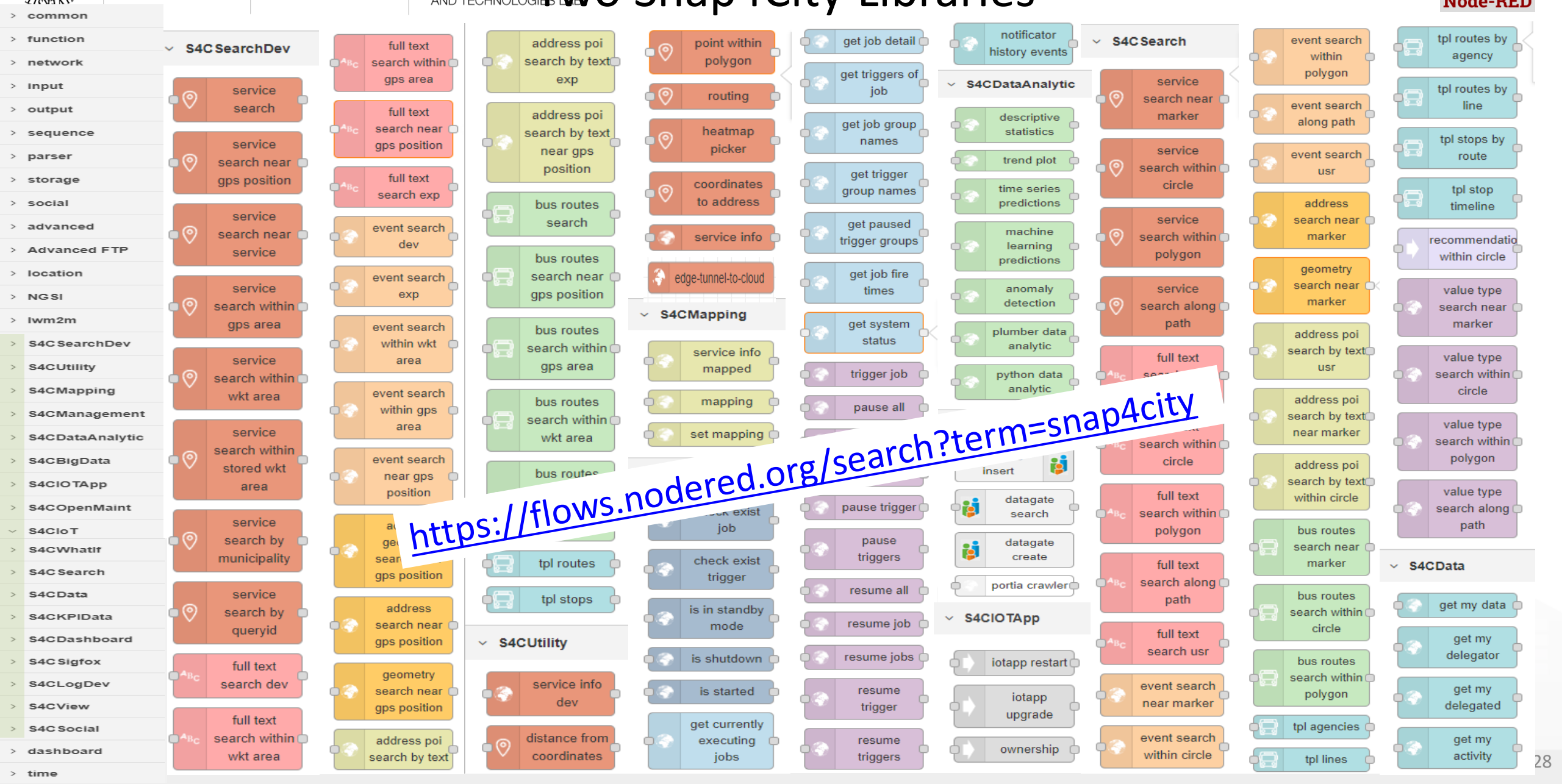
Sept 2025 collection

Two Snap4City Libraries

SNAP4CITY

Node-RED

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

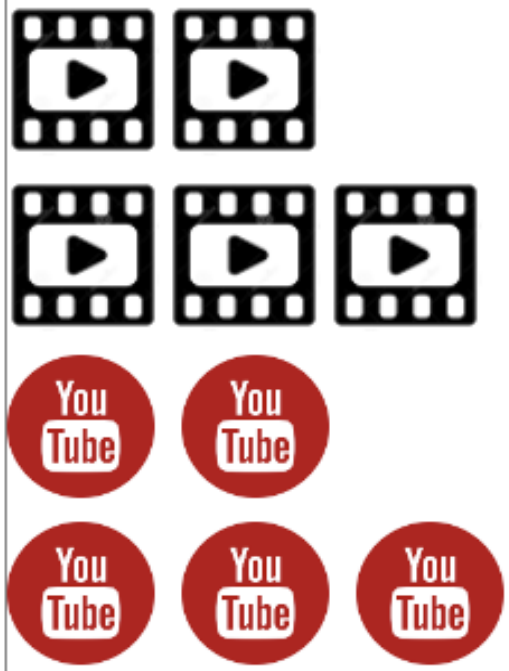


Part 5: Data Ingestion and Interoperability

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

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High Level Types

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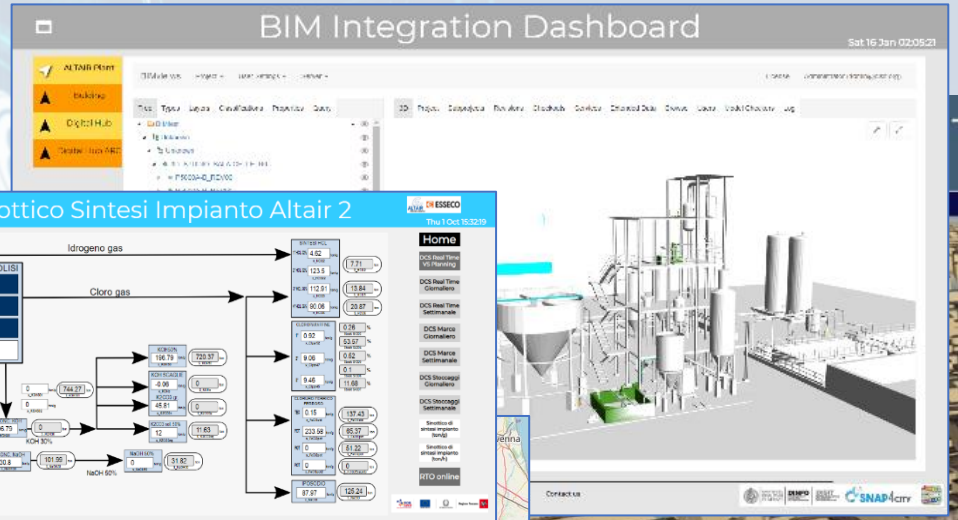
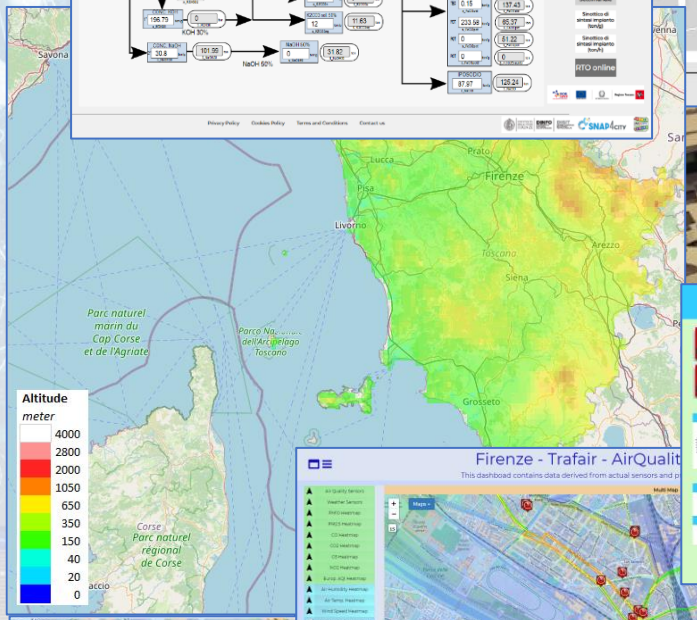
- POI, IOT Devices, shapes,..
  - FIWARE Smart Data Models,
  - IoT Device Models
- GIS, maps, orthomaps, WFS/WMS, GeoTiff, calibrated heatmaps, ..
- Satellite data, any kind..
- traffic flow, typical trends, ..
- Vector fields + heatmaps, ..
- trajectories, events, workflow, ..
- 3D Models, BIM, Digital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





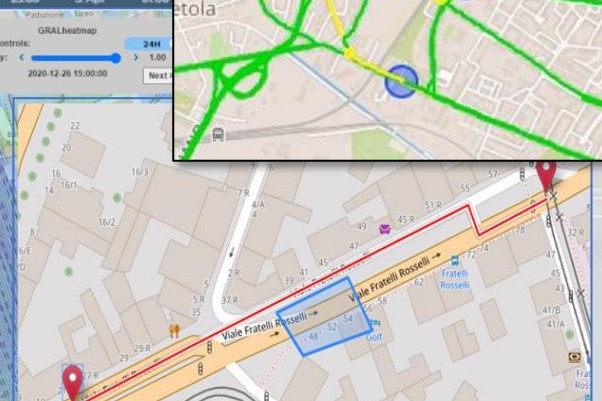




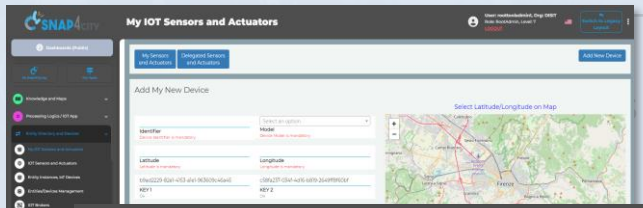


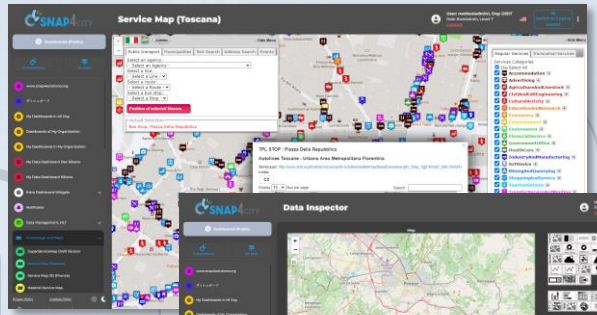


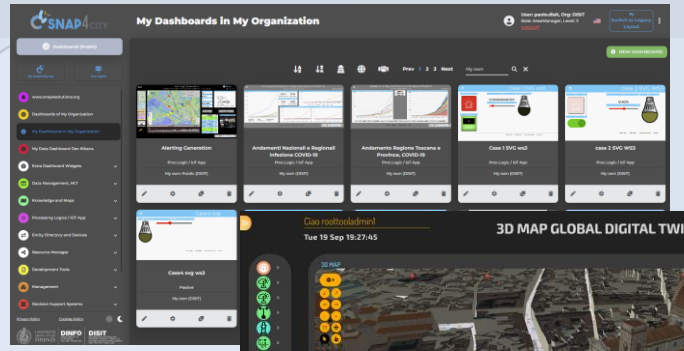


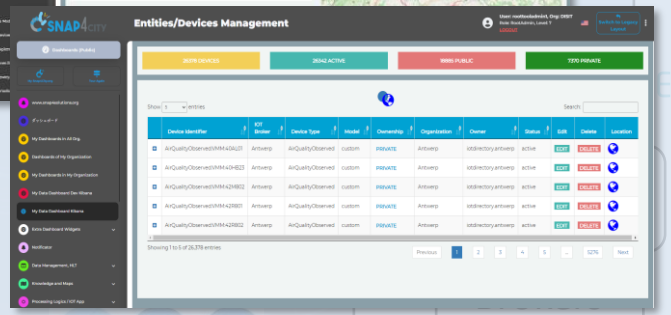


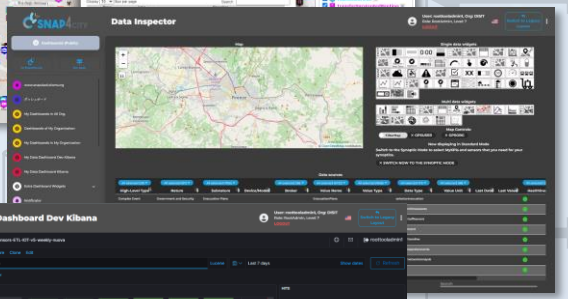
Visual Development Tools



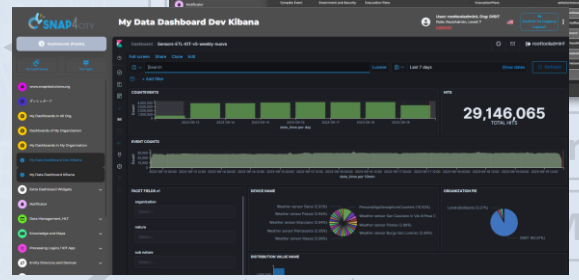


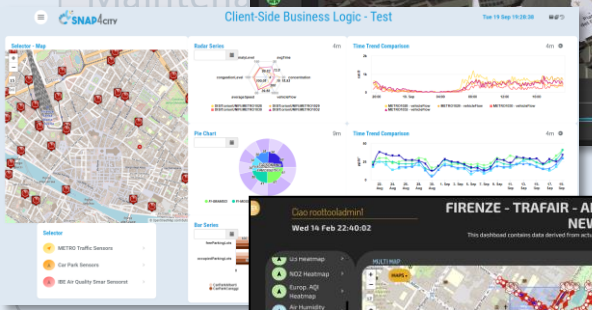


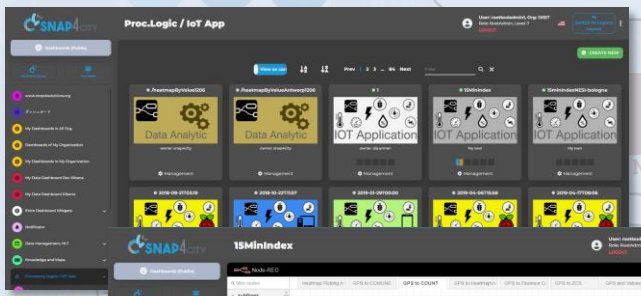


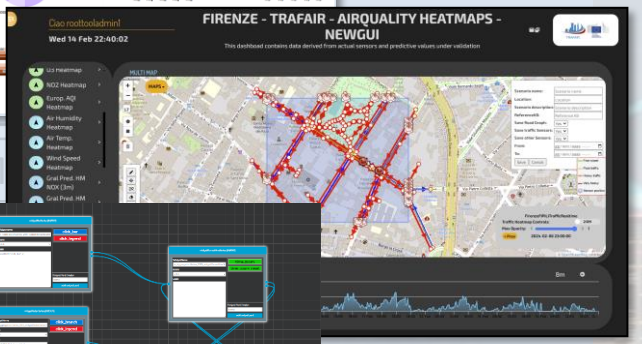


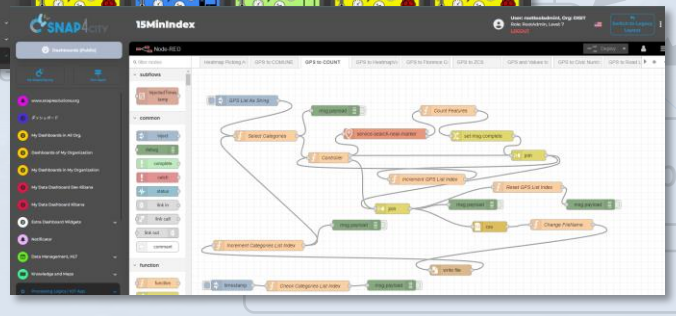


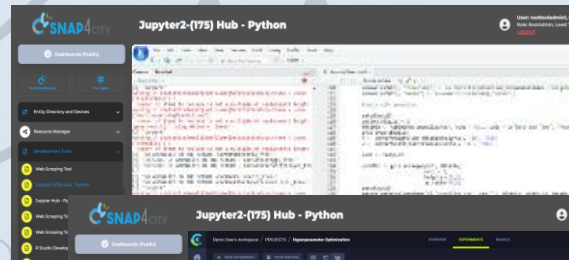


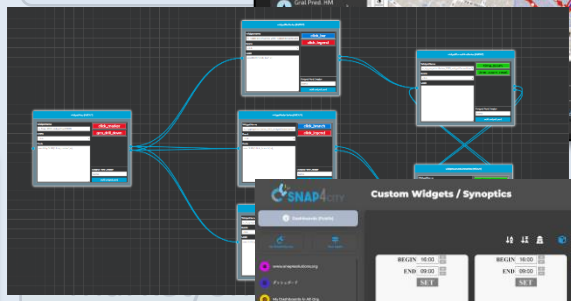


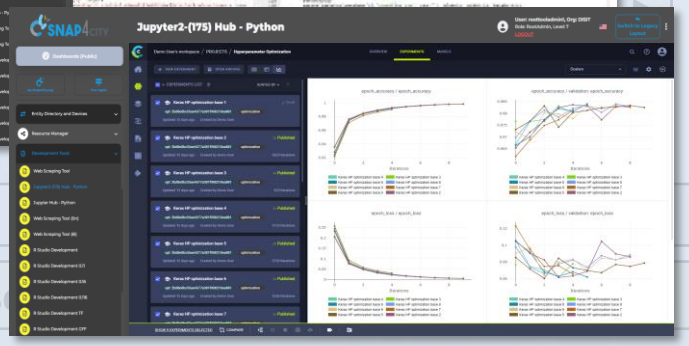






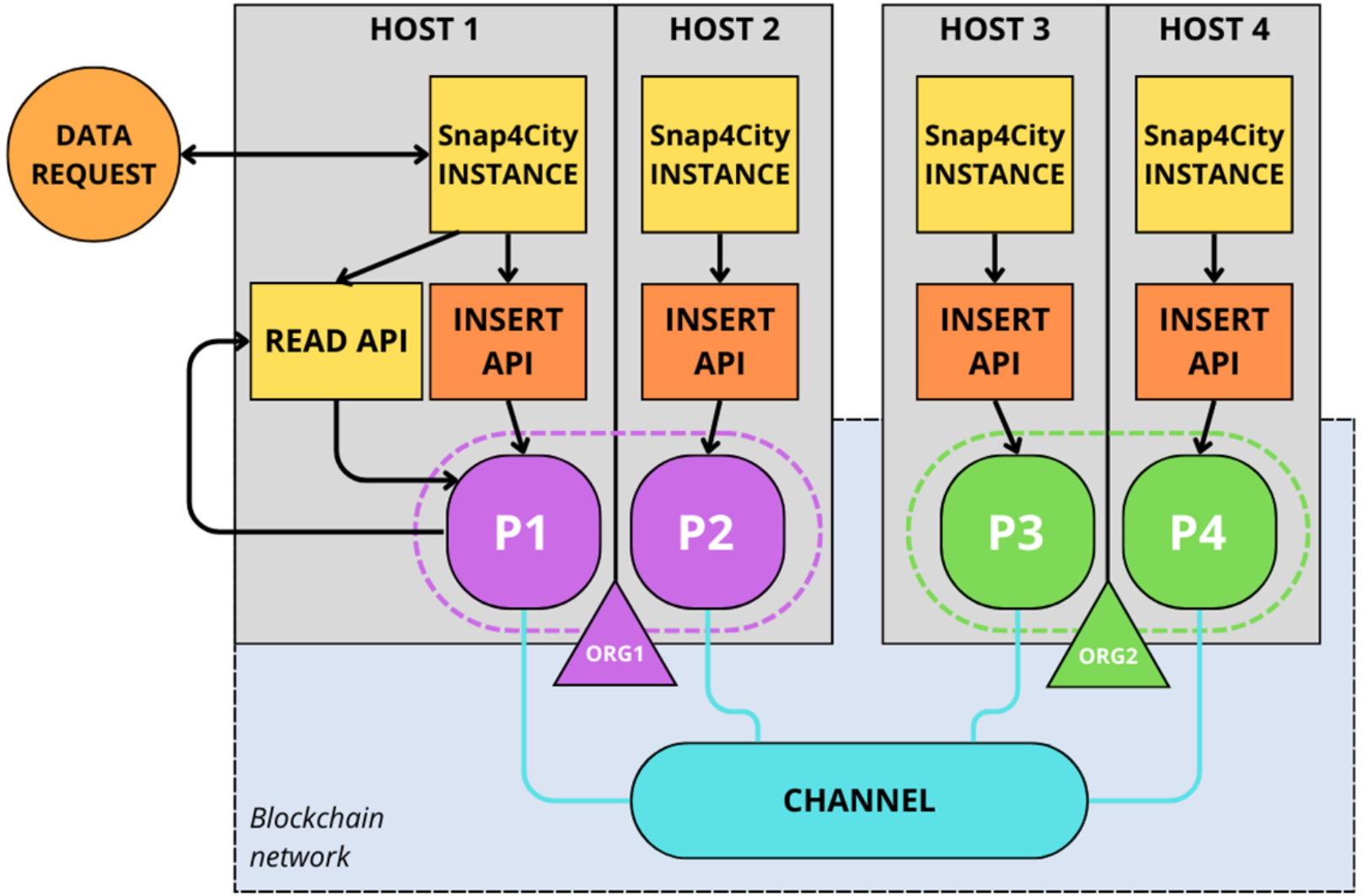




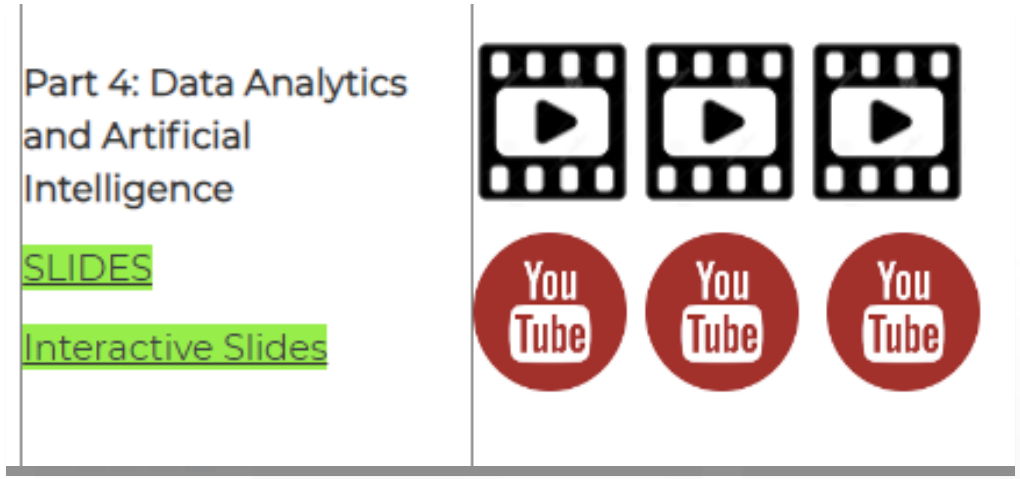




Snap4City with Blockchain



Part 4: Data Analytics



- 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

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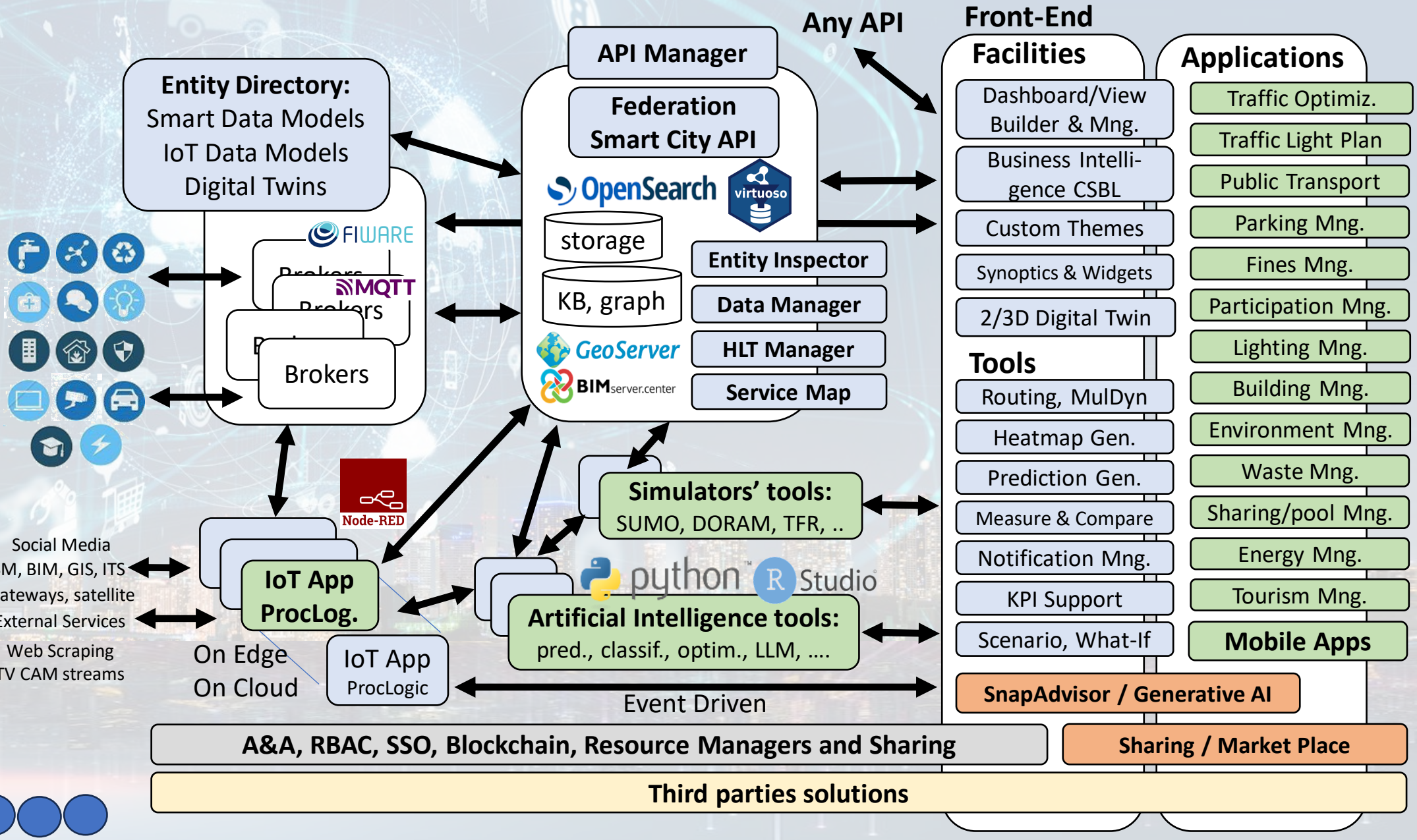
Technical Architecture



Main Functionalities of DA, ML, AI Support

- **High Interoperability**, HLT management, any format/protocol
  - Users and data support GDPR compliant
- **Integrated MLOps, agile CI/CD Orchestration on CPU/GPU, HPC** clusters, Kubernetes (DISIT Lab, HPC Lutech, CN MOST, etc.)
  - Develop, optimization, tracking experiments, etc.
  - Online and Offline development
  - Stable and one demand execution (deploy)
  - Automated transformation of AI,ML,DA processes on MicroServices
  - Node-RED visual programming
- **Monitoring, Accounting** and Billing → Market Place
  - AI Control and Plan as a Service

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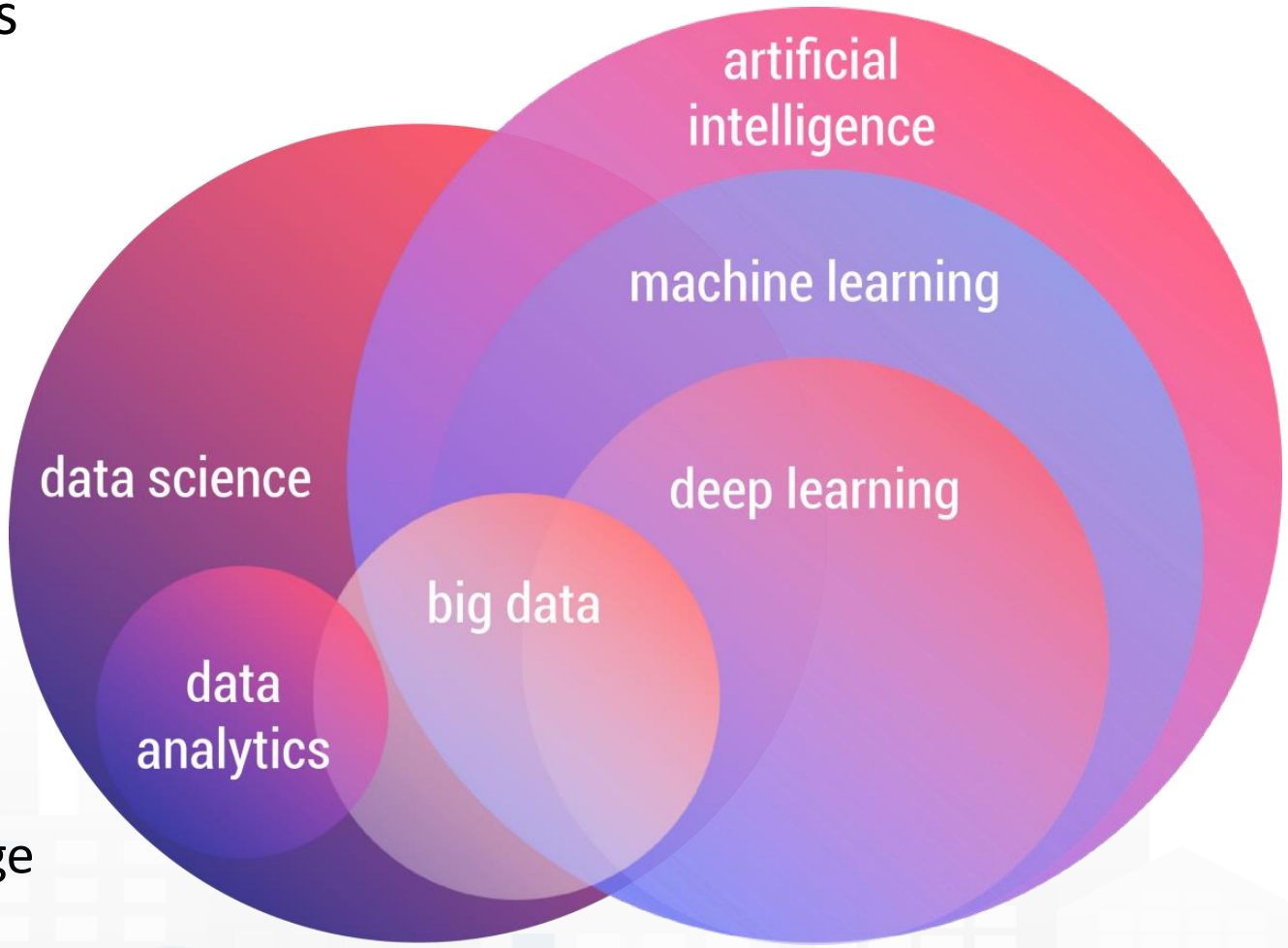
- **Artificial Intelligence** usually also includes
  - Code, learning and reasoning
  - Semantic computing, Knowledge Bases
  - Neuro-symbolic reasoning
  - Decision Support Systems
  - Problem solving
- **Machine Learning** usually includes
  - Learn without coding
  - Predictions, decisions (classifications)
  - 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



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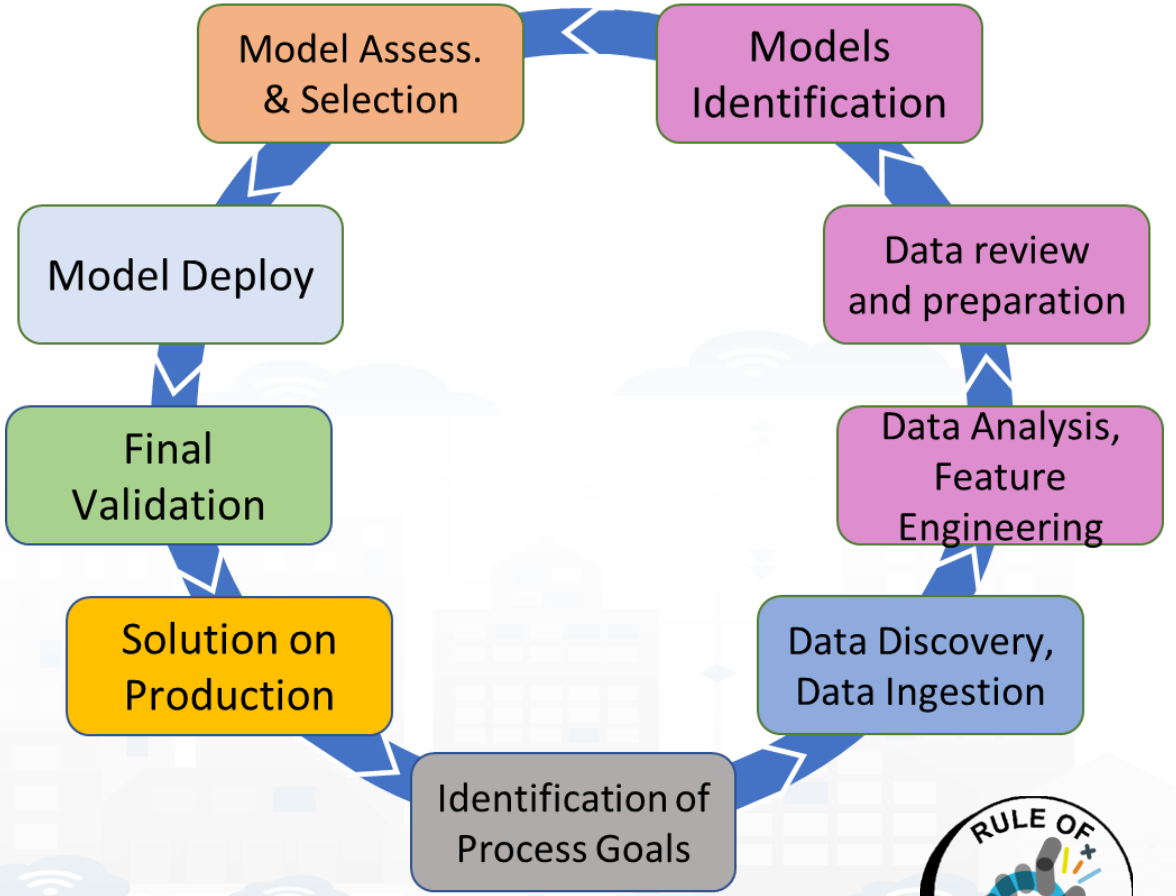
Model/Technique Development/testing

- **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**



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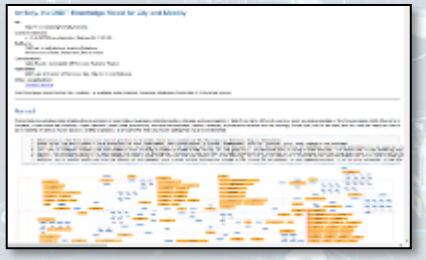
Data Analytics on Snap4City platform

Swagger







Ontology Schema



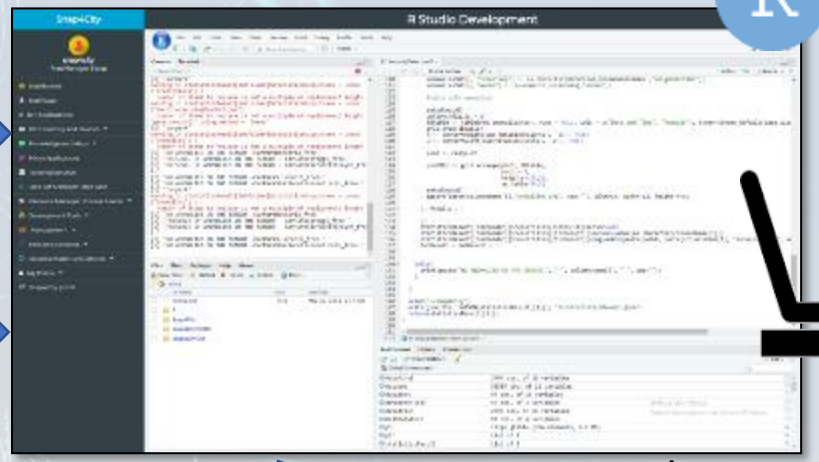
LOG.disit.org

Knowledge Base, Km4City

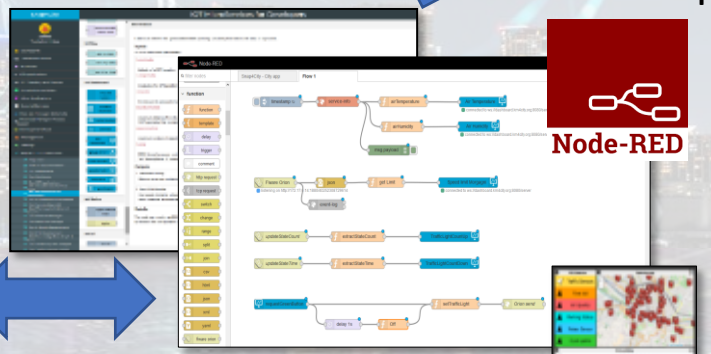


Big Data Store Facility

Smart City API from Knowledge Base and other tools



Creating MicroServices



Node-RED

Using them into IOT Applications

Saving / Sharing reusing



Resource Manager



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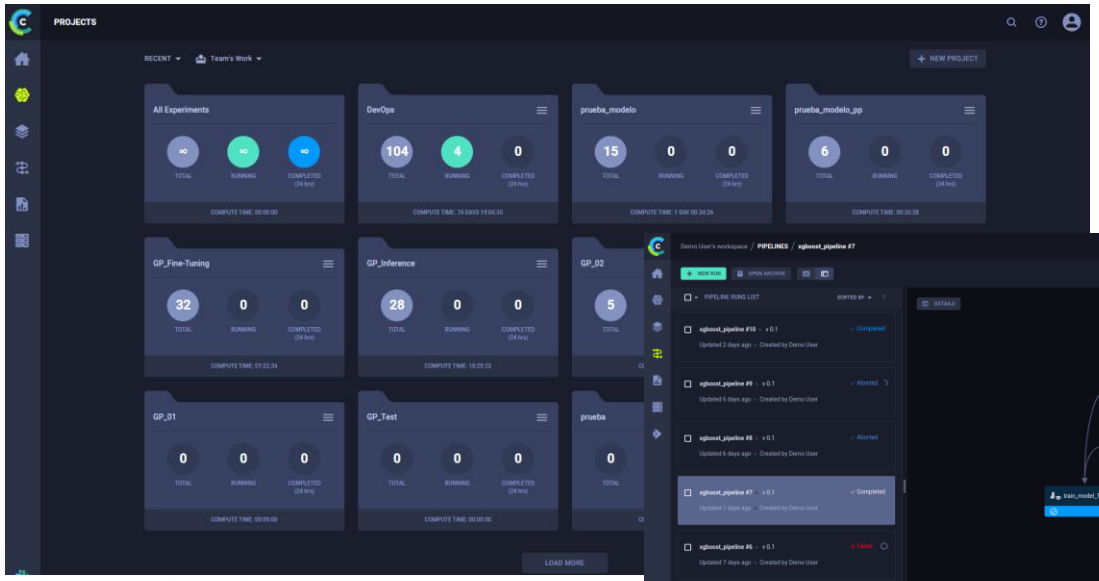
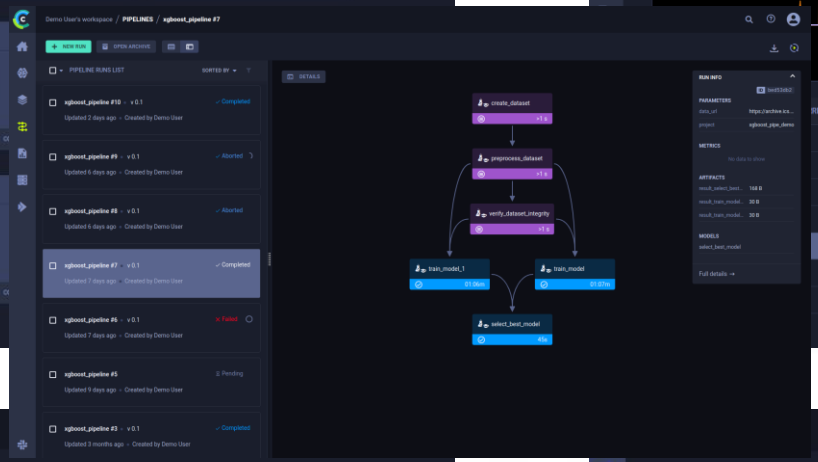
DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

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

MLOps

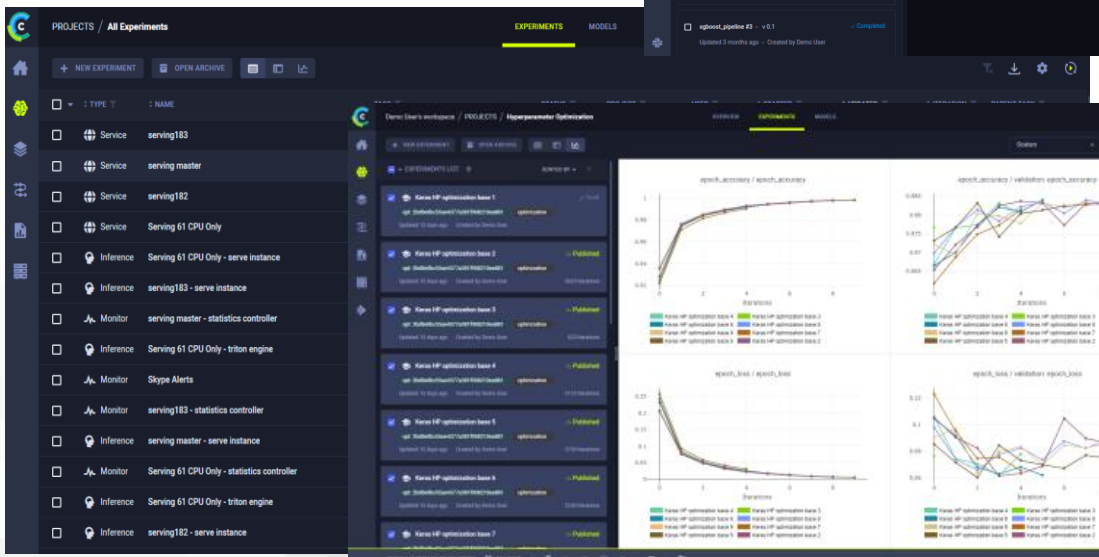
SNAP4CITY KM4CITY

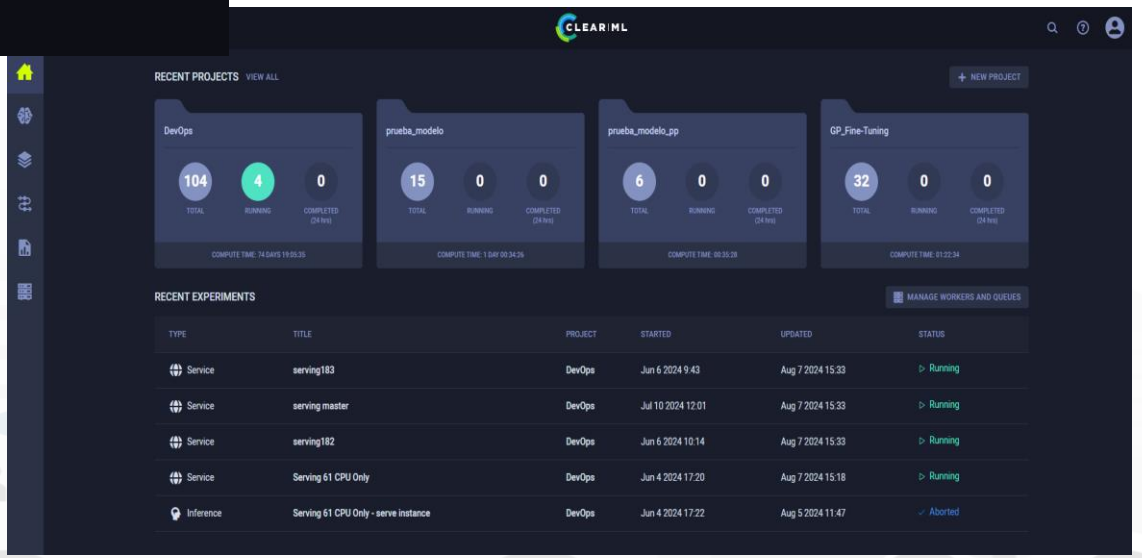


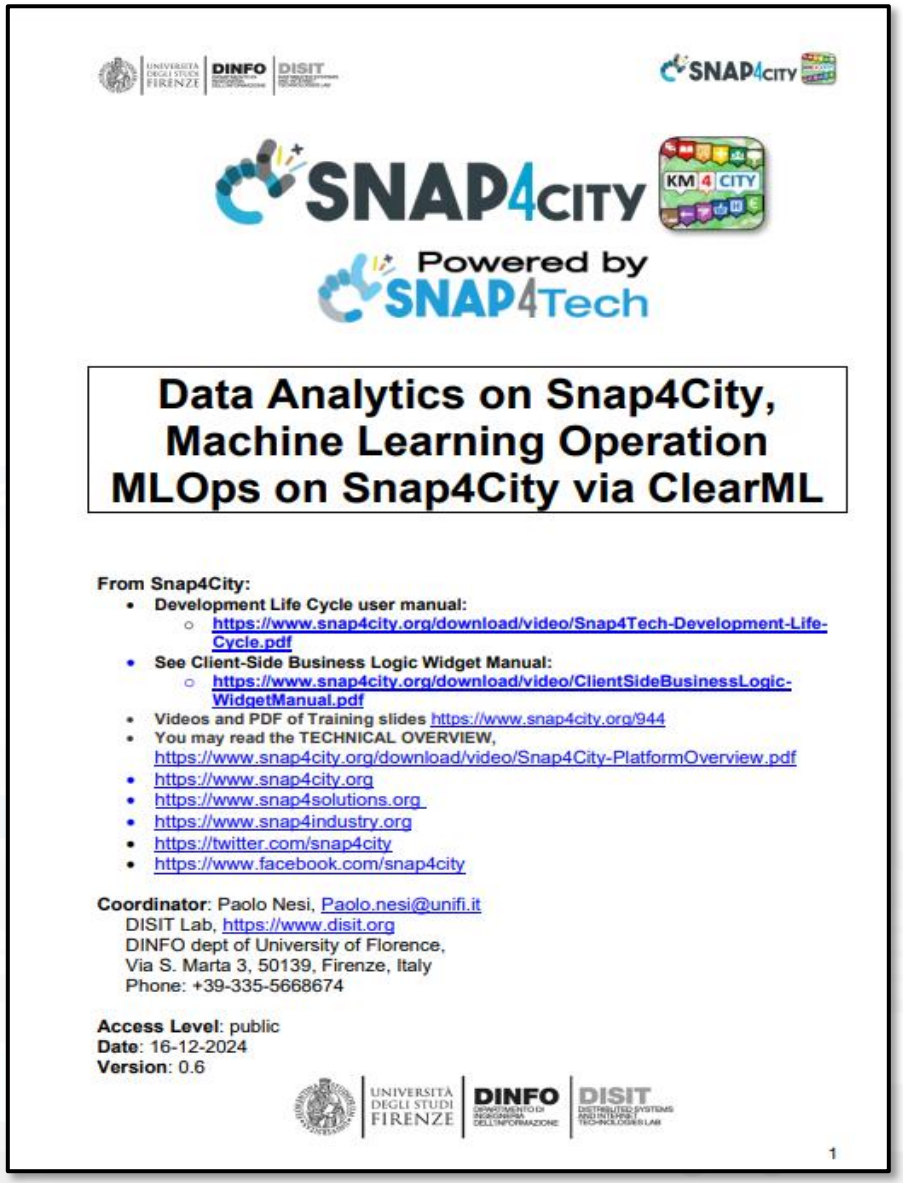




CLEARML







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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

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

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MLOperation

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

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Parts 7 & 8: API, Mobile, 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

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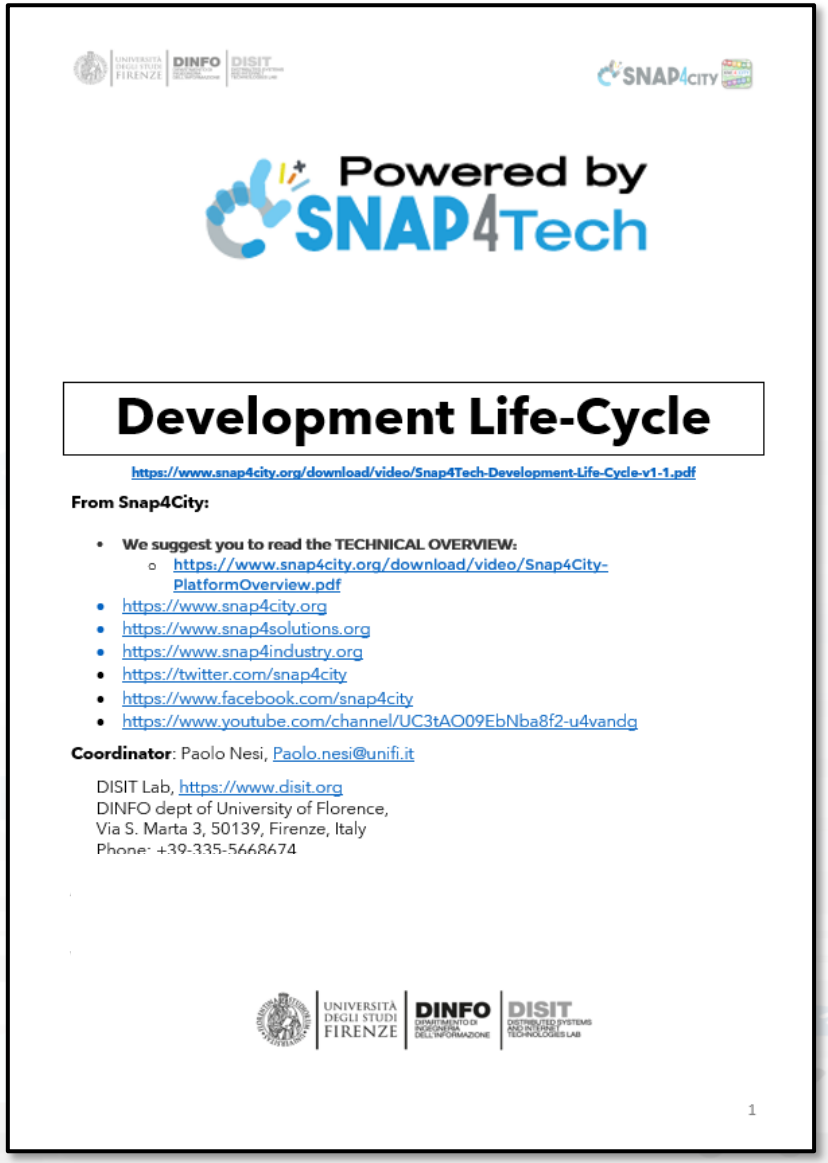
Development



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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

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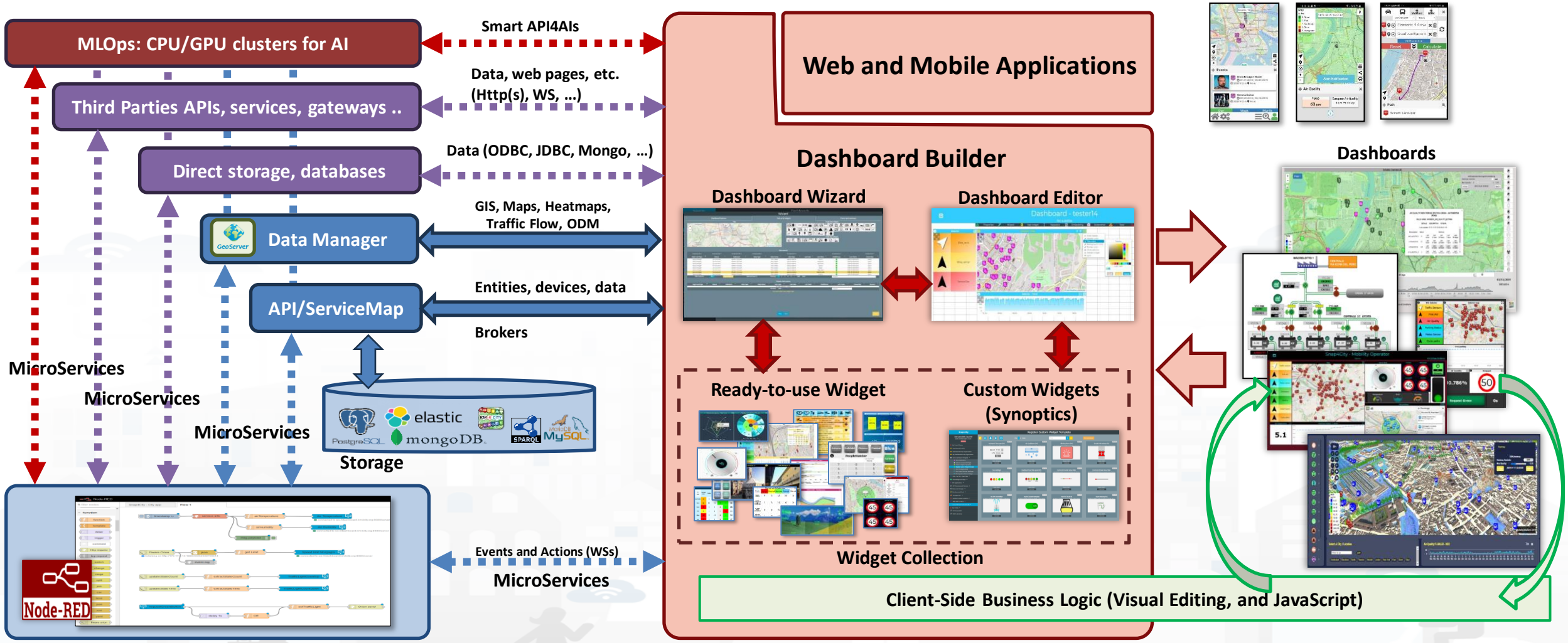
How the Dashboards / Apps Exchange data (2024/8)



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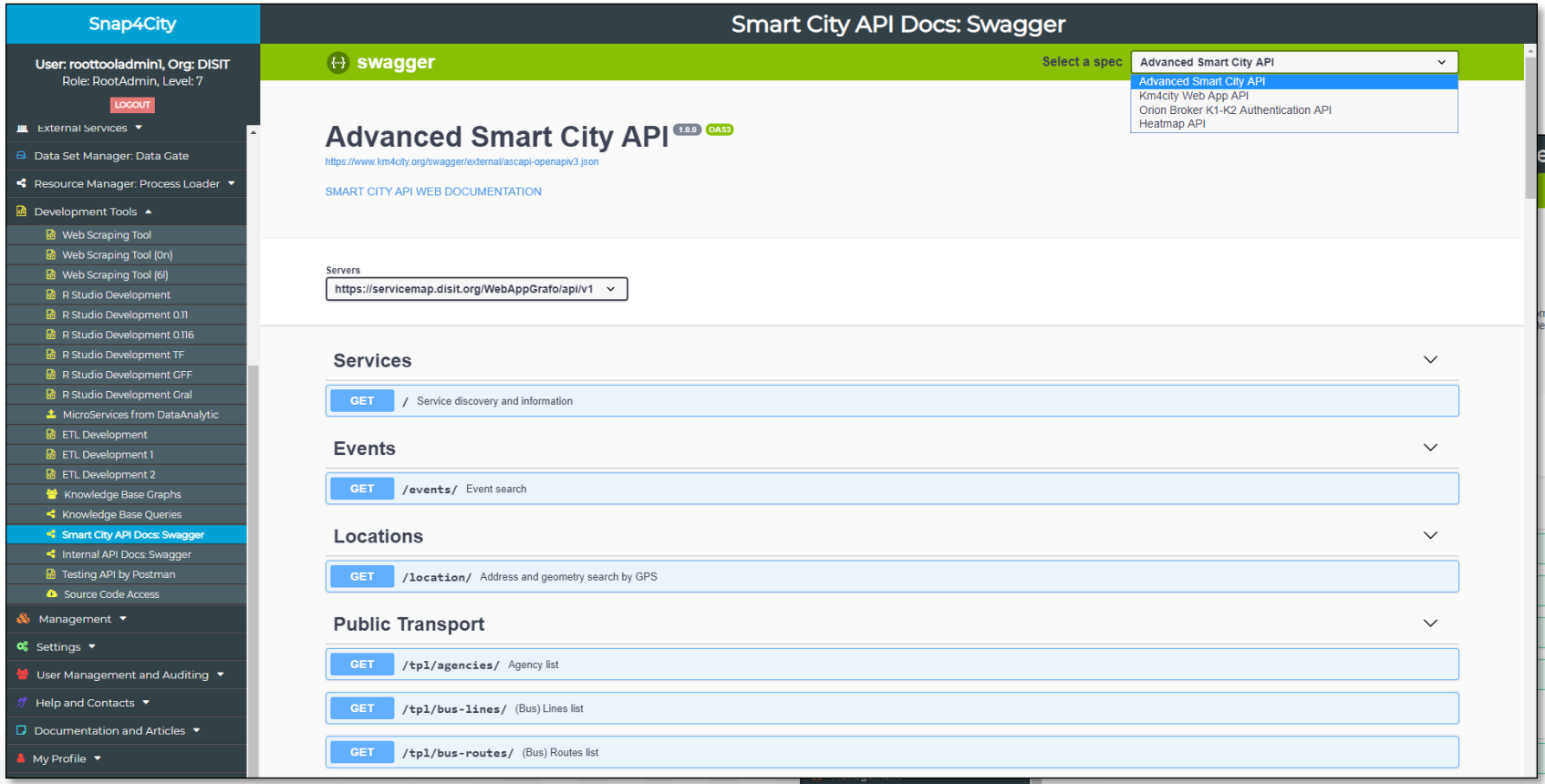
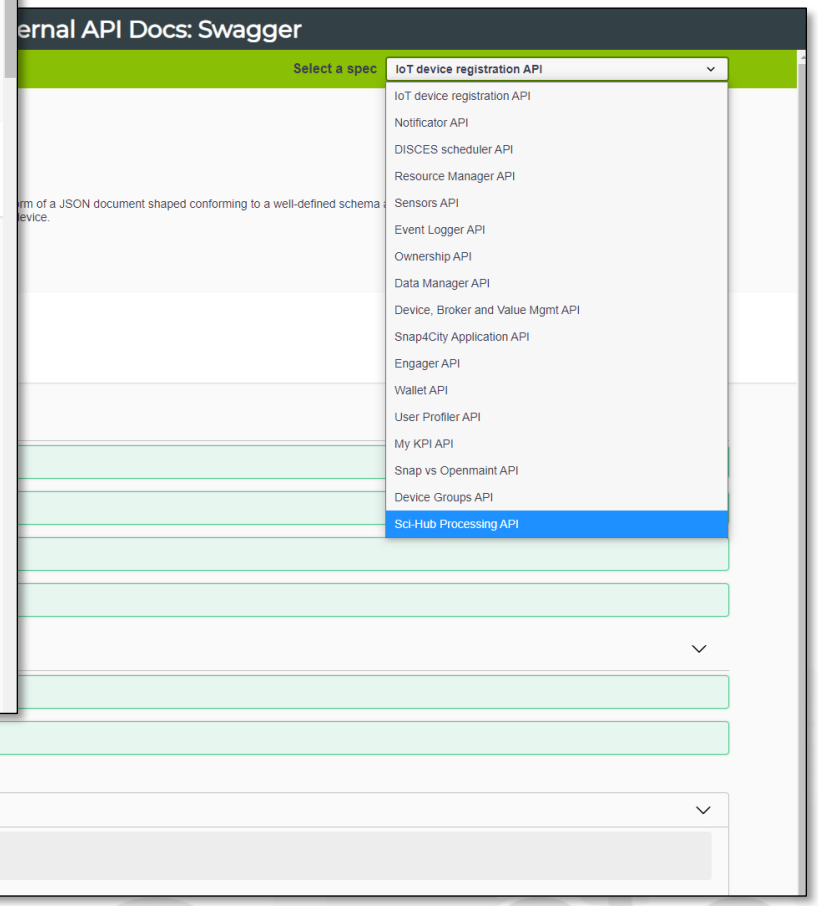
Internal and External Smart City API





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

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

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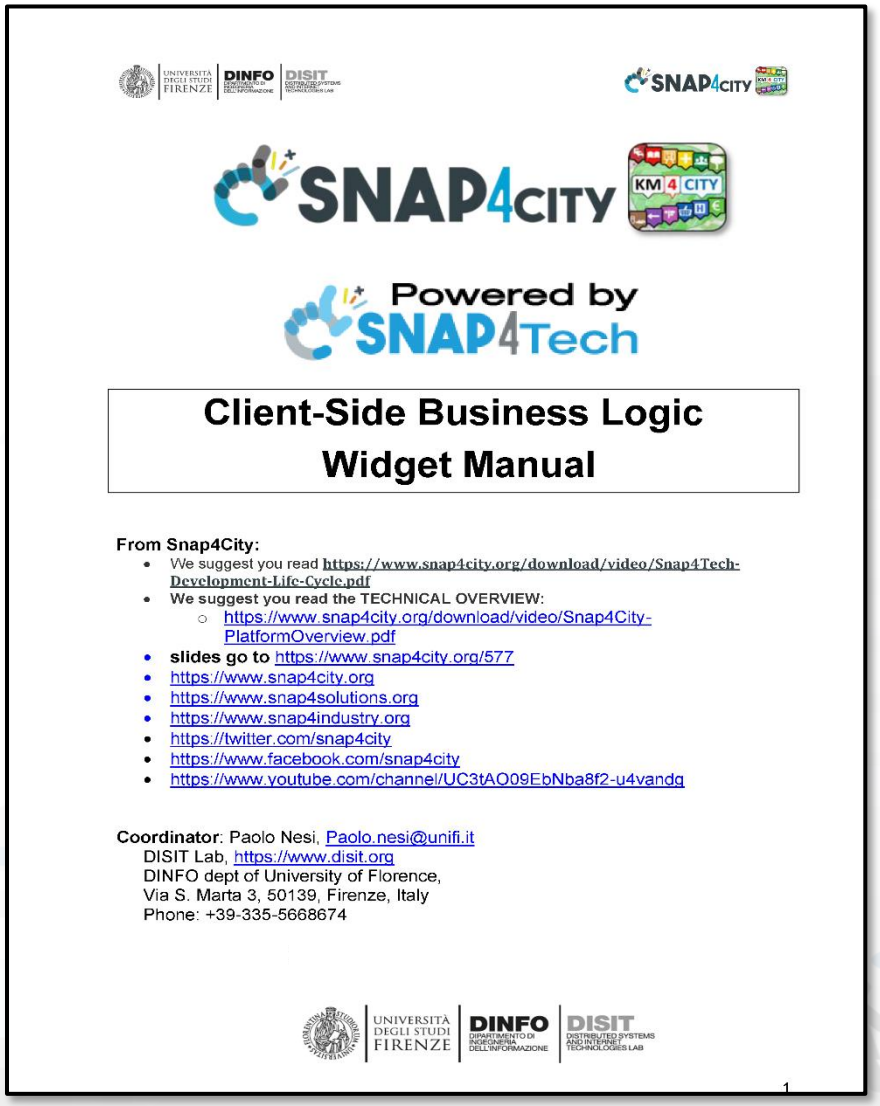
Client Side Business Logic



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Client-Side Business Logic Widget Manual

From Snap4City:

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

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

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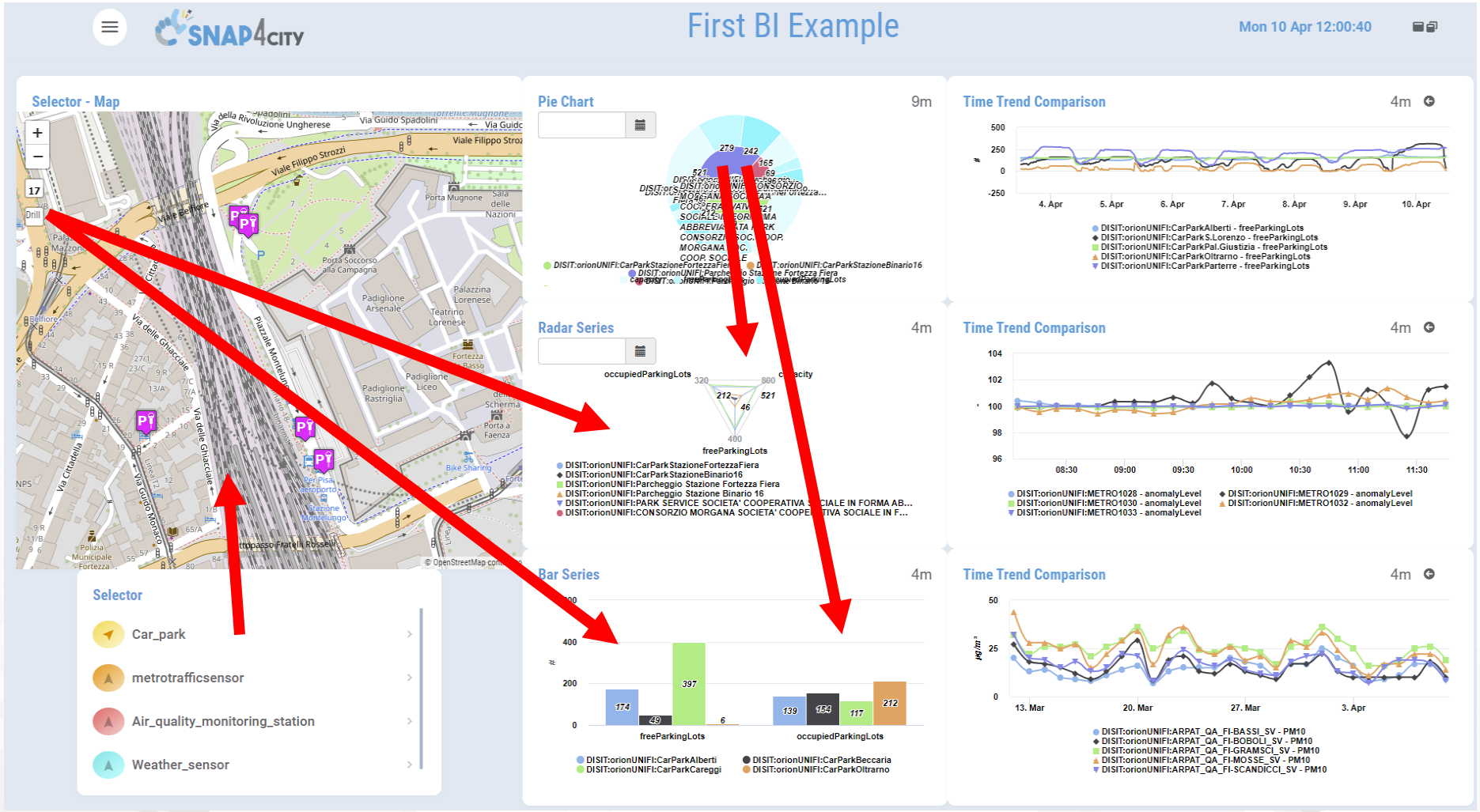
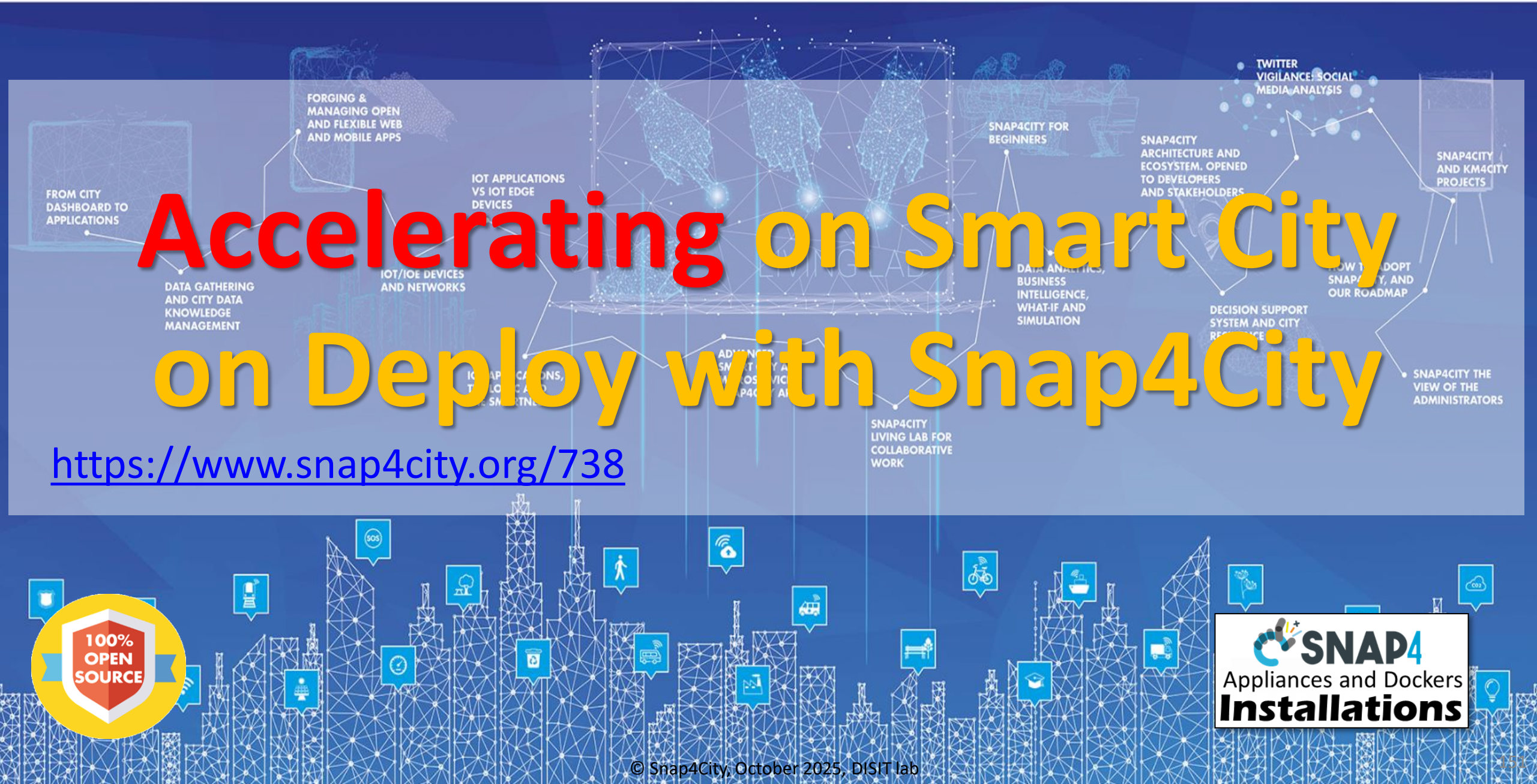
Example: From Map to Graphs (spatial drill down)

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





Accelerating on Smart City

on Deploy with Snap4City

https://www.snap4city.org/738

100% OPEN SOURCE

SNAP4 Appliances and Dockers **Installations**

© Snap4City, October 2025, DISIT lab

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

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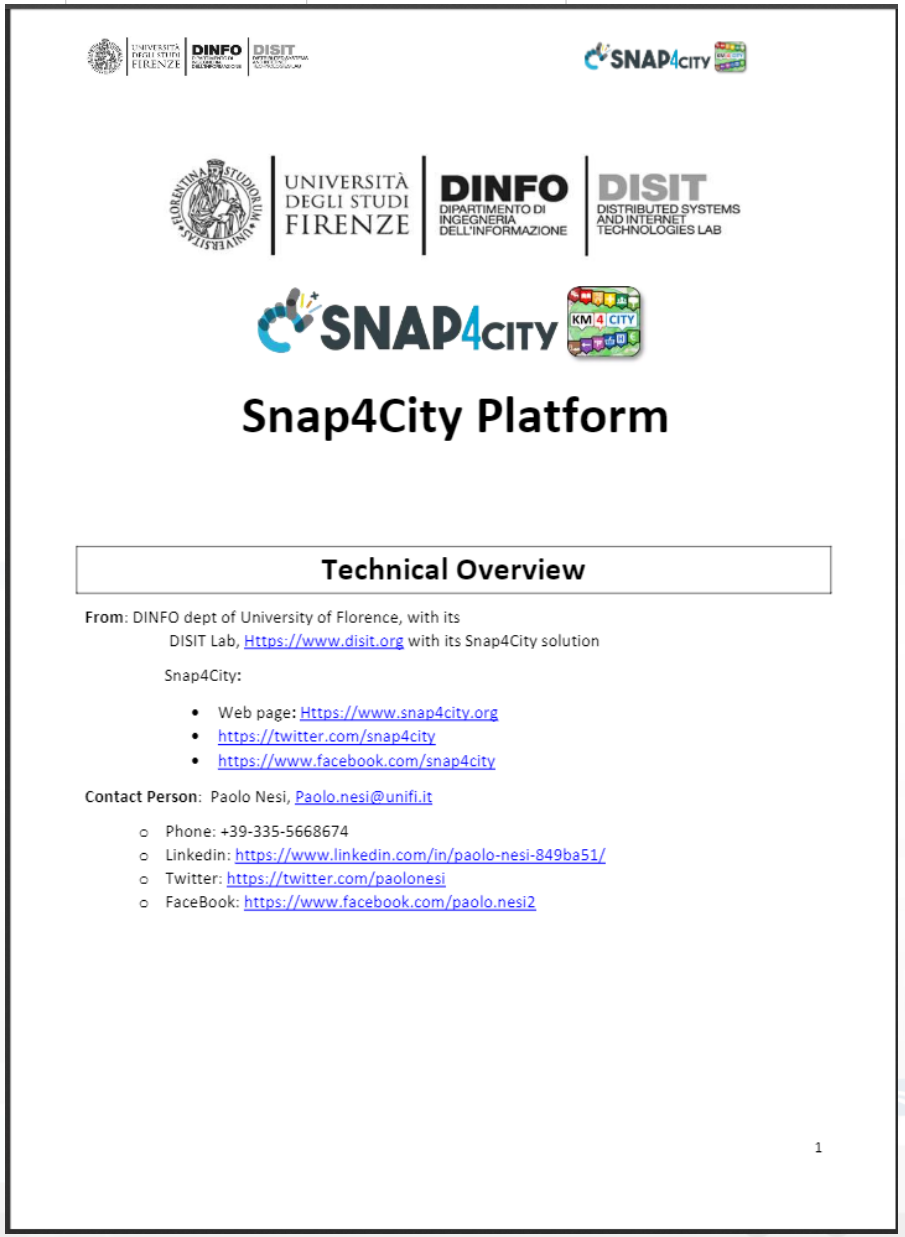

Snap4City Platform

Technical Overview

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

Snap4City:

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

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

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

1

Tech Overview

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

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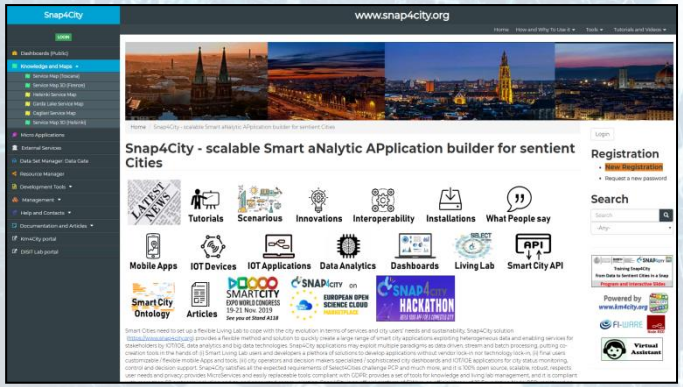
How to adopt Snap4City

Https://www.snap4city.org



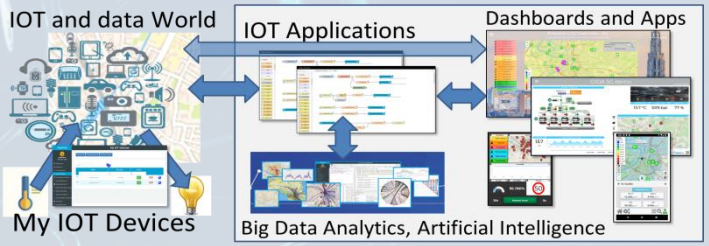
Smart City as a Service

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

SNAP4CITY on EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE

Download and deploy

On your premise





Powered by SNAP4Tech

Installation on your premise

- **Dockers / Kubernetes, VM**
- 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

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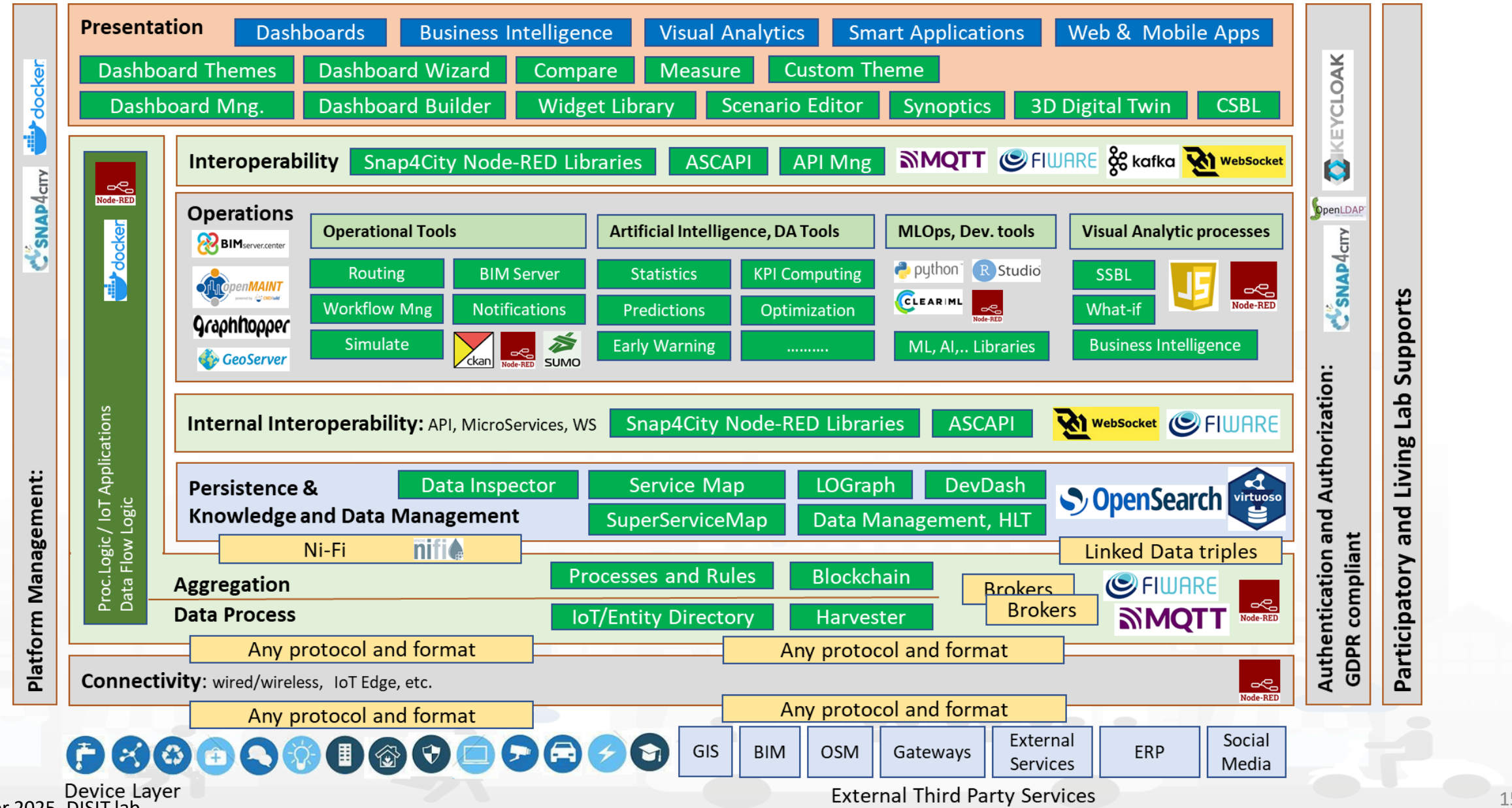
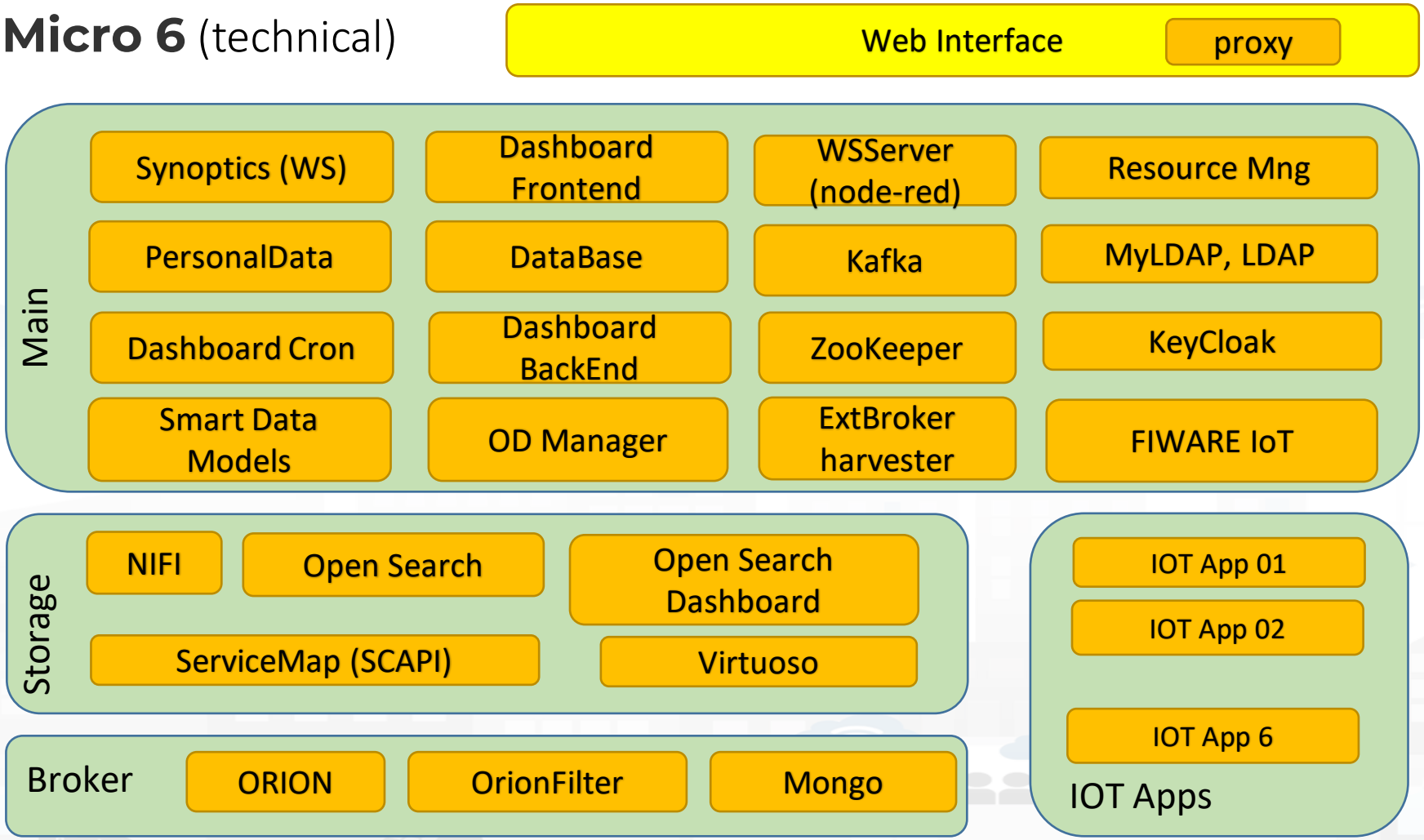

Presentation
Dashboards
Business Intelligence
Visual Analytics
Smart Applications
Web & Mobile Apps
Dashboard Themes
Dashboard Wizard
Compare
Measure
Custom Theme
Dashboard Mng.
Dashboard Builder
Widget Library
Scenario Editor
Synoptics
3D Digital Twin
CSBL
Interoperability
Snap4City Node-RED Libraries
ASCAPI
API Mng
MQTT
FIWARE
kafka
WebSocket
Operations
Operational Tools
Routing
BIM Server
Workflow Mng
Notifications
Simulate
Artificial Intelligence, DA Tools
Statistics
KPI Computing
Predictions
Optimization
Early Warning
.....
MLOps, Dev. tools
ML, AI,.. Libraries
Visual Analytic processes
SSBL
What-if
Business Intelligence
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
Linked Data triples
Aggregation
Data Process
Processes and Rules
Blockchain
IoT/Entity Directory
Harvester
Brokers
Brokers
Any protocol and format
Any protocol and format
Connectivity: wired/wireless, IoT Edge, etc.
Any protocol and format
Any protocol and format
Device Layer
GIS
BIM
OSM
Gateways
External Services
ERP
Social Media
External Third Party Services
Platform Management:
Proc.Logic / IoT Applications Data Flow Logic
Authentication and Authorization: GDPR compliant
Participatory and Living Lab Supports

Micro 6 model

Micro 6 (technical)



1Hour installation and ready to use

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Roles in Snap4City/Industry solutions

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

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

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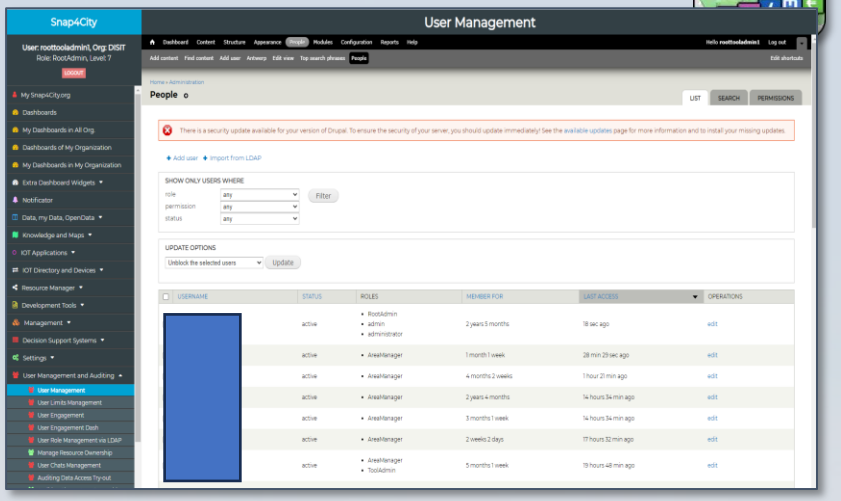
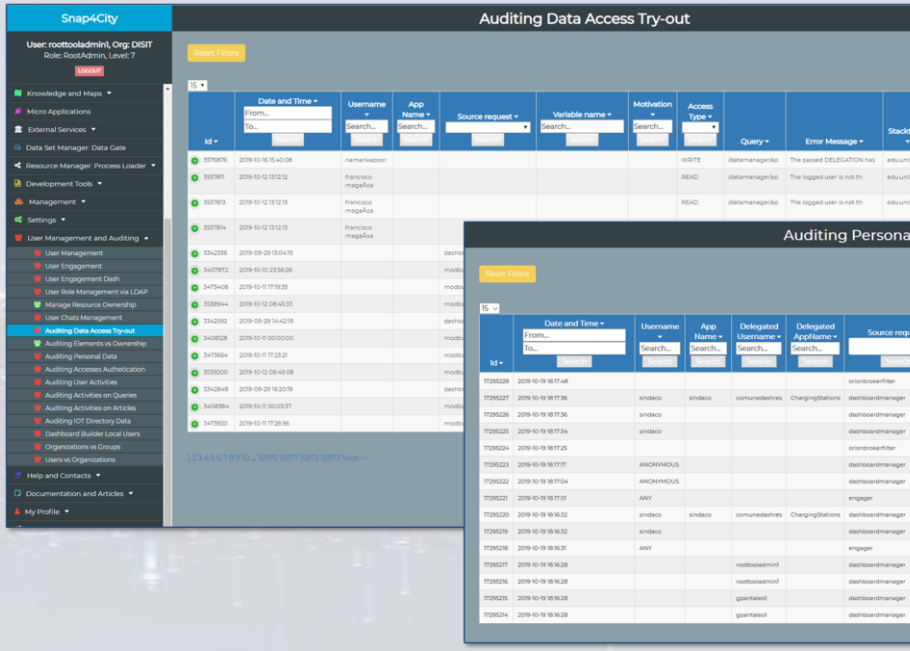
Platform Management and control



- **Platform Management** tools
  - Installation procedures
  - monitoring and control tools
  - Quality control
  - Help desk and SLA
- **User management tools**
  - **User profiling, limiting**
  - **Auditing** tools according to GDPR
  - **Menu profiling**
  - **CRM**
- **Training** and tutoring tools
  - Develop. Life Cycle
  - Develop. tools
  - Manual, courses, etc.
  - Community
- etc.





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Mobility and Transport

SNAP4CITY



Mobility and Transport

Goals



Decongestion



Safety



Accessibility



Cost Reduction



Decarbonization

Details

THE POWER OF ARTIFICIAL INTELLIGENCE AT THE SERVICE OF YOUR OPERATION AND PLAN

SNAP4CITY · KM4CITY

www.snap4city.org

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

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

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
- SNAPADVISOR



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

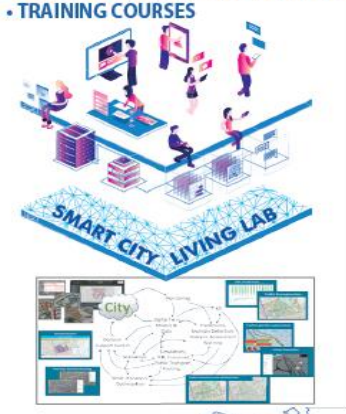


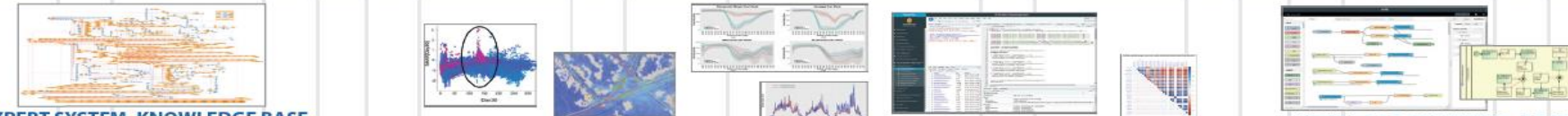
DASHBOARDS, WIDGETS TEMPLATES

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

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

- DEVELOMENT ENVIRONMENT AND METHODOLOGY
- VISUAL PROGRAMMING, ML, AI, HPC
- TRAINING COURSES





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

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

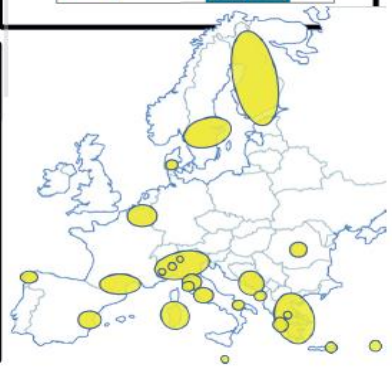
VISUAL PROGRAMMING, ADAPTERS
DATA FLOWS, WORKFLOWS
PARALLEL DISTRIBUTED PROCESSING
DATA DRIVEN

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



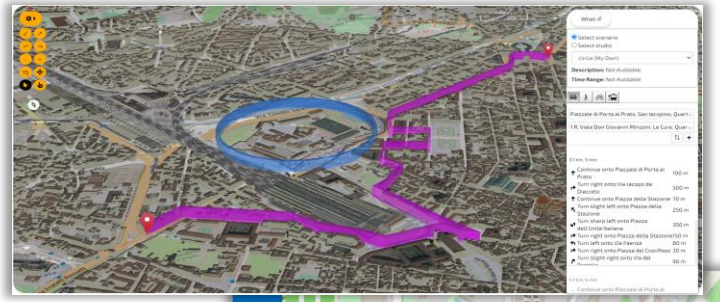
NATIVE AND EXTERNAL APPLICATIONS

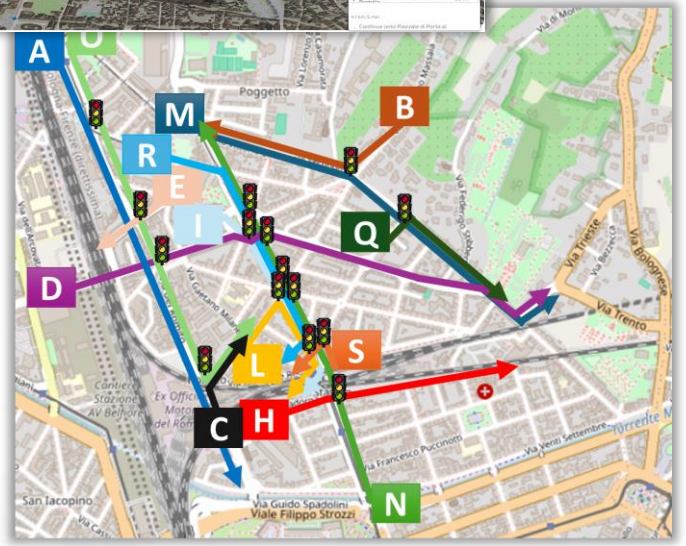
- Smart Parking
- Smart Light
- Smart Waste
- Smart Energy
- Smart Building
- Smart Tourism
- ...



Mobility & Transport

- **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.**







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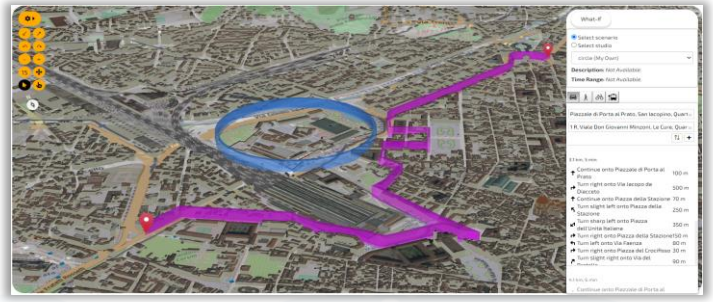
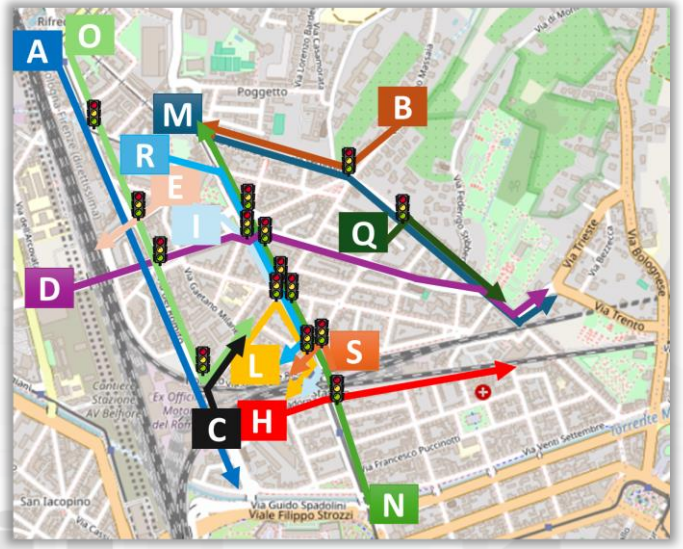
AI vs Mobility and Transport: DSS

- From traffic flow, TF, data of scattered sensors to dense TF graph
  - Computation of TF partitioning at junctions
  - PDE solutions with hybrid methods: Finite elements plus NN
- Predictions and XAI of
  - TF data of sensors
  - Parking slots, Bike slots, bike rack status, etc.
- Anomaly detection on TF, etc.
- Optimisation of Traffic Light Plans: GA, DRL, agent and multiagent
- Match mobility demand vs transportation offer: agent based





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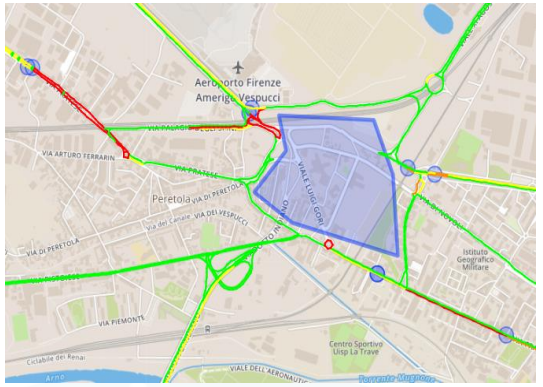
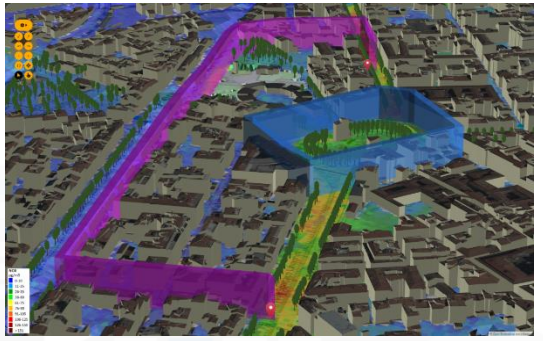
Mobility and Transport Domain (2024/8)

- 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





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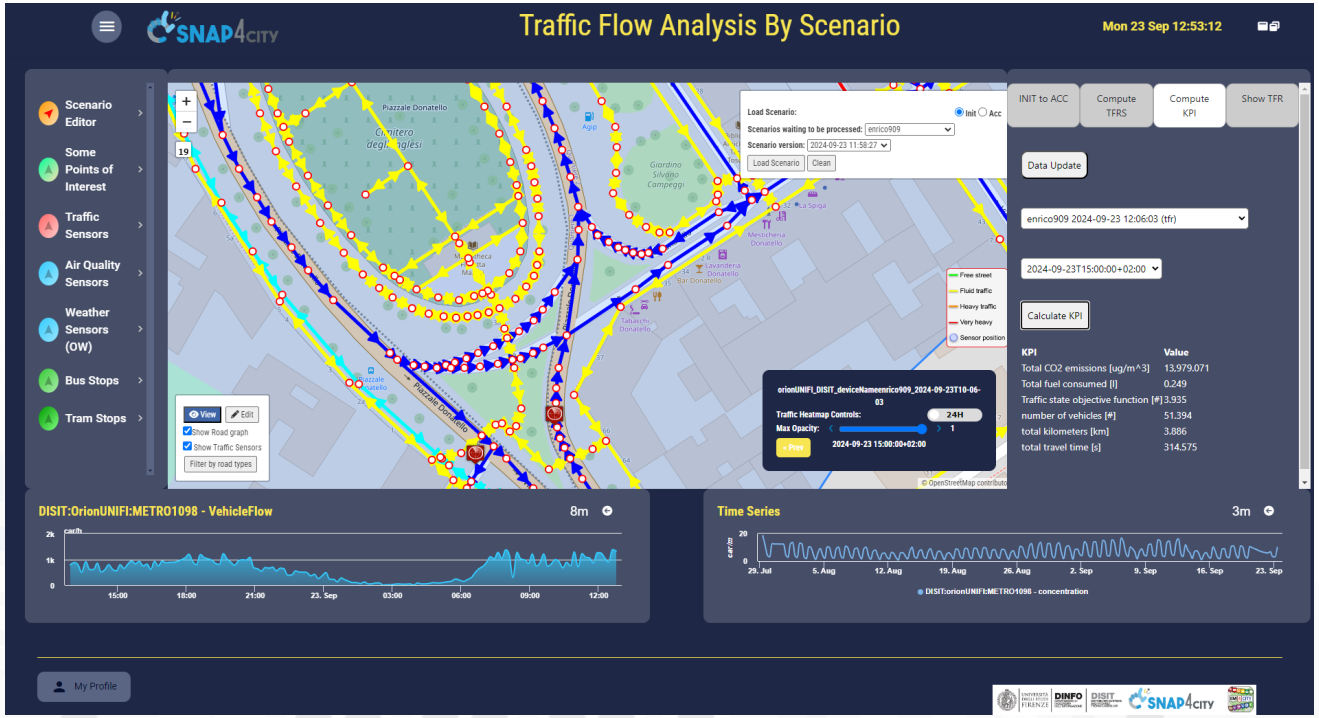
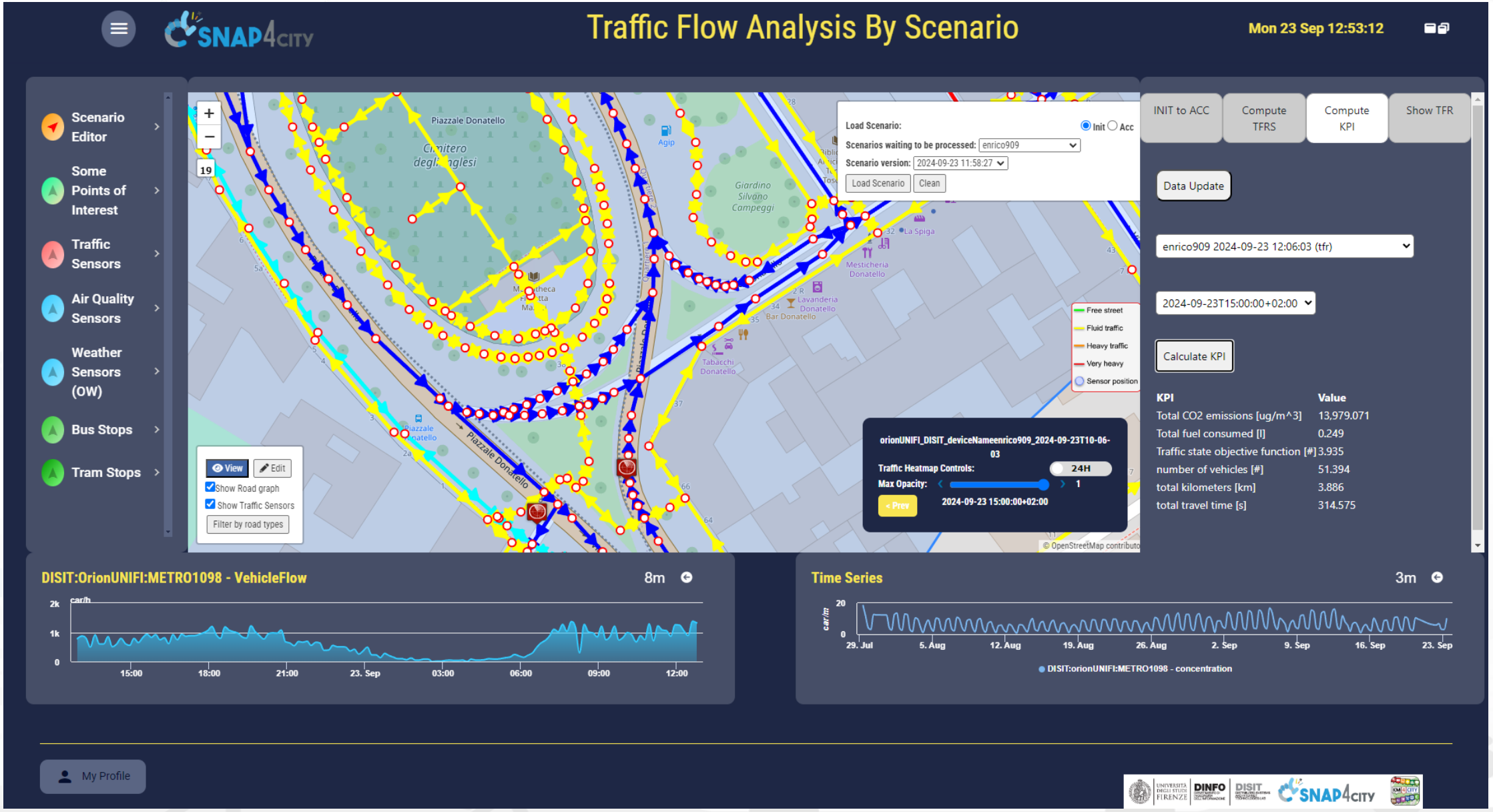
What you can do with advanced tools

- **Advanced Scenario Editor**
  - Create complex and full detailed scenario, with road graph, sensors, of any kind, even new roads, restrictions, parameters, etc.
  - Exploit these scenarios to create
    - Simulation
    - Business intelligence tools and visual/business analytic tools also working in real time
    - Traffic flow reconstruction
    - Traffic infrastructure optimisation
    - Traffic light plan optimization
    - Pedestrian analysis and simulation
    - Match demand vs Offer, simulation and analysis
    - Computation of SUMI, SUMP, 15 Min City Indexes, etc.
    - Heatmaps computation
    - Etc. etc.



What-if on TFR



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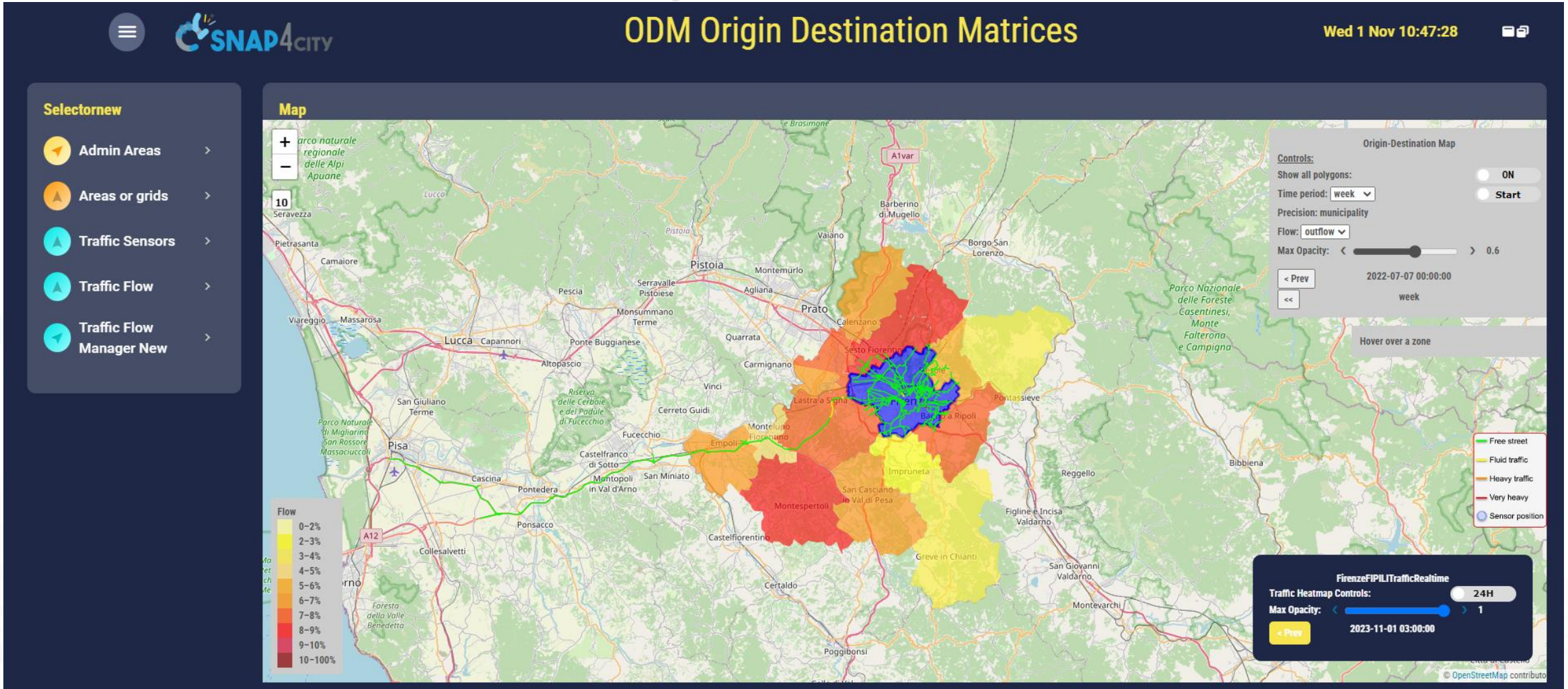
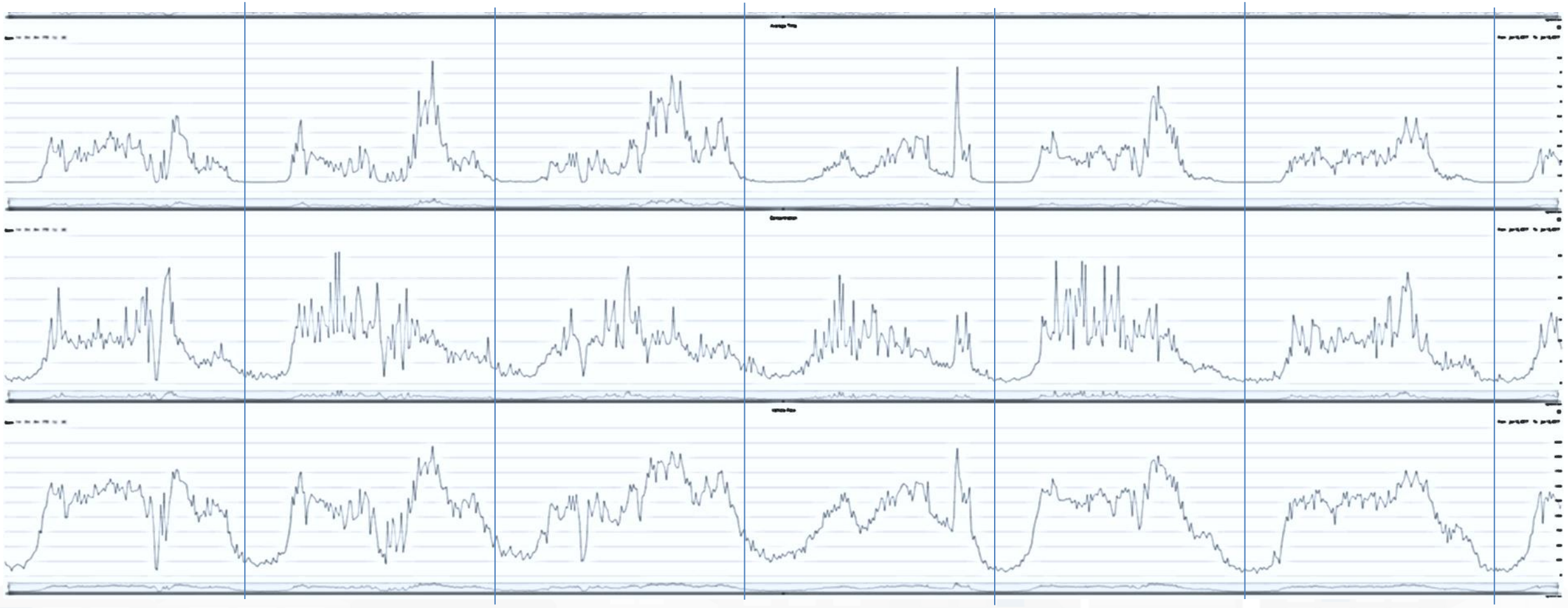
ODM, Traffic Flow



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

Traffic Flow data



- Day by day traffic flow, on the week data from 3 sensors

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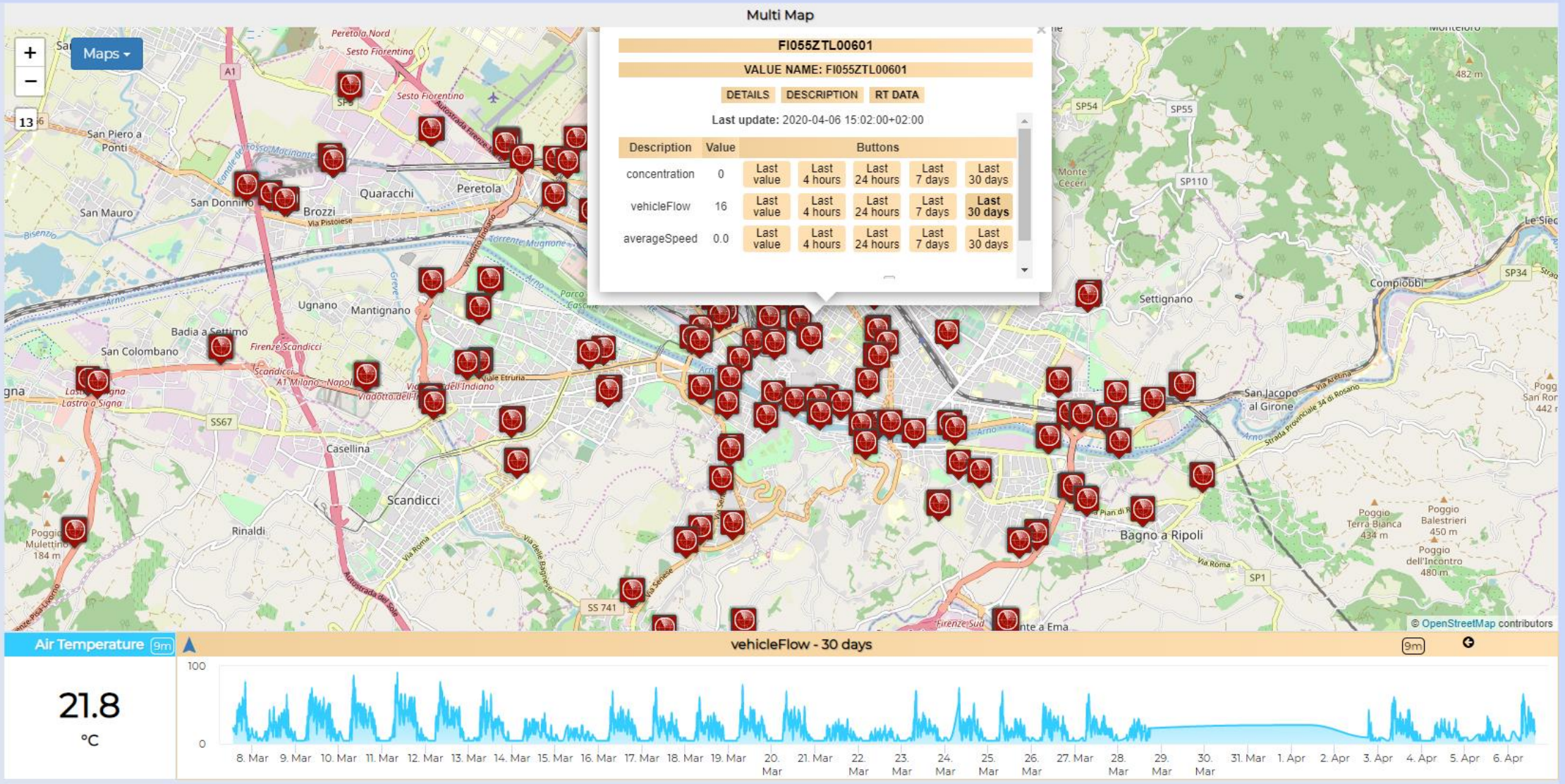
Firenze - Trafair - AirQuality Heatmaps

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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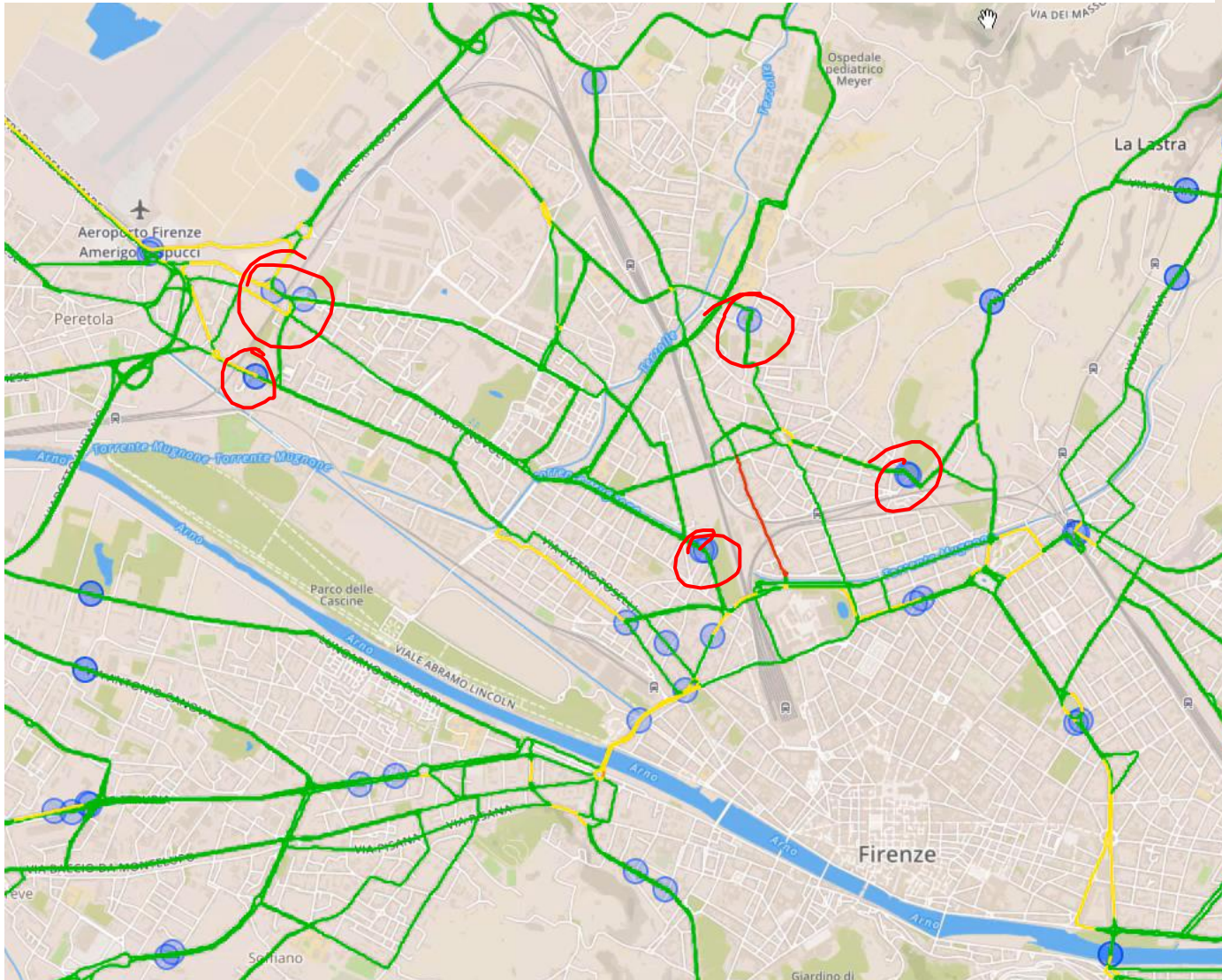
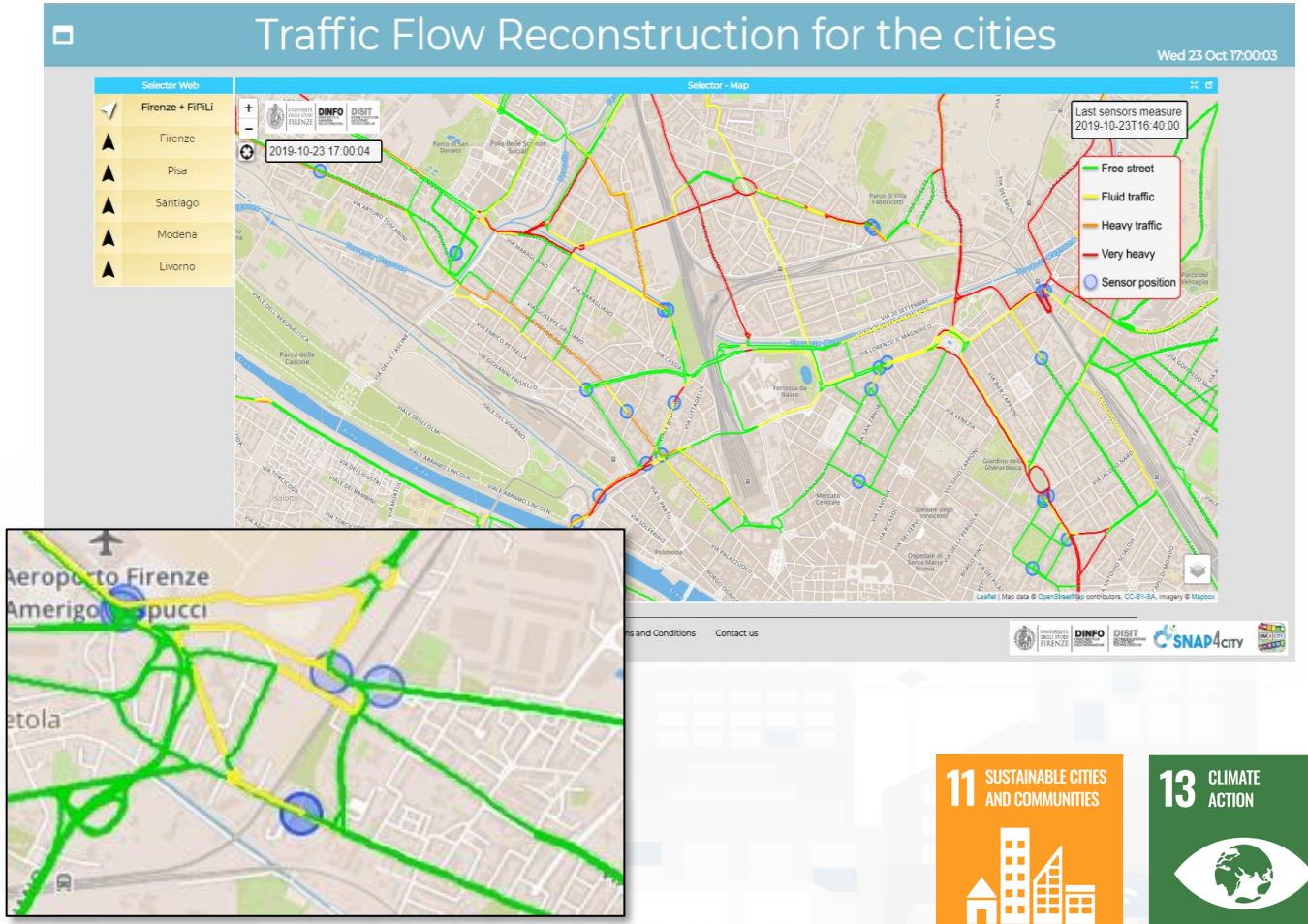
Dense Traffic Flow Reconstruction ?

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



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==

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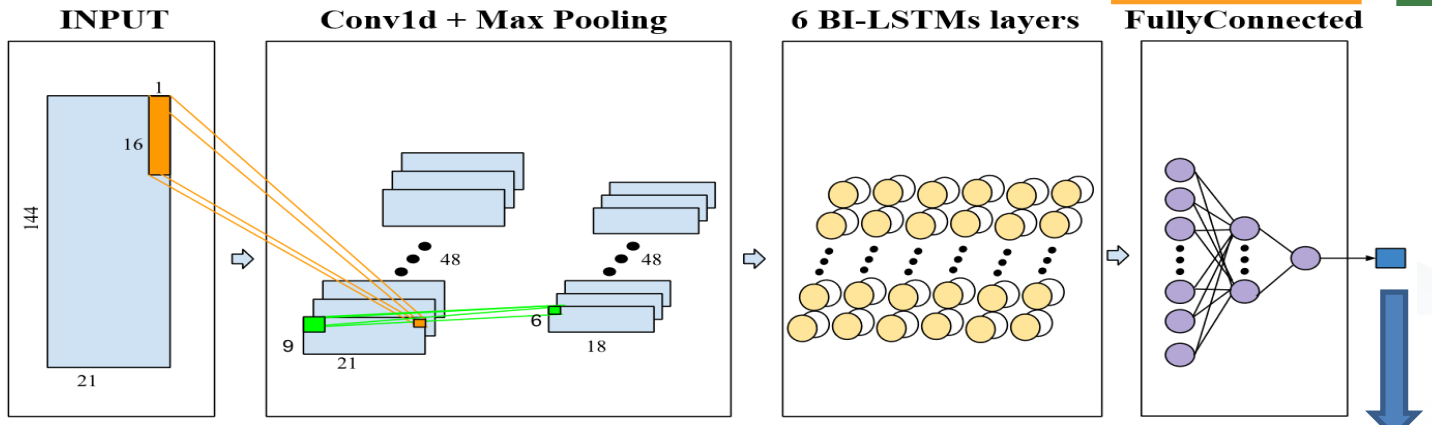
Short-Term Prediction of City Traffic Flow via Convolutional Deep Learning



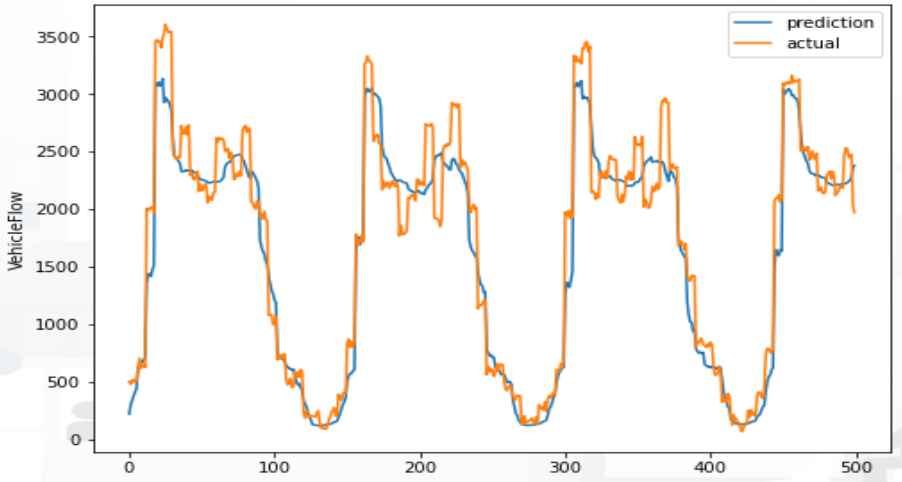


Urban data:

- 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



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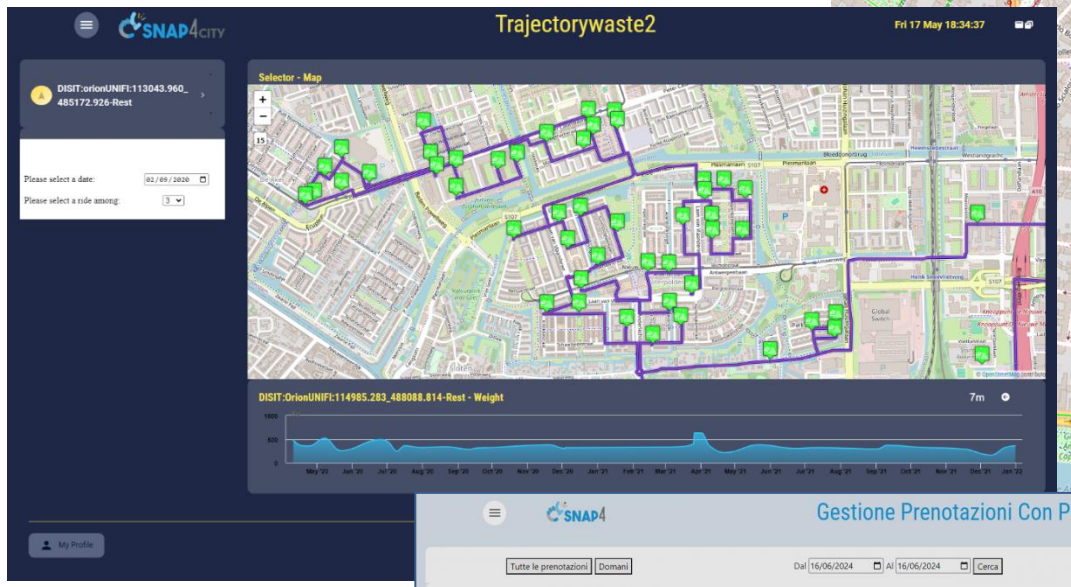
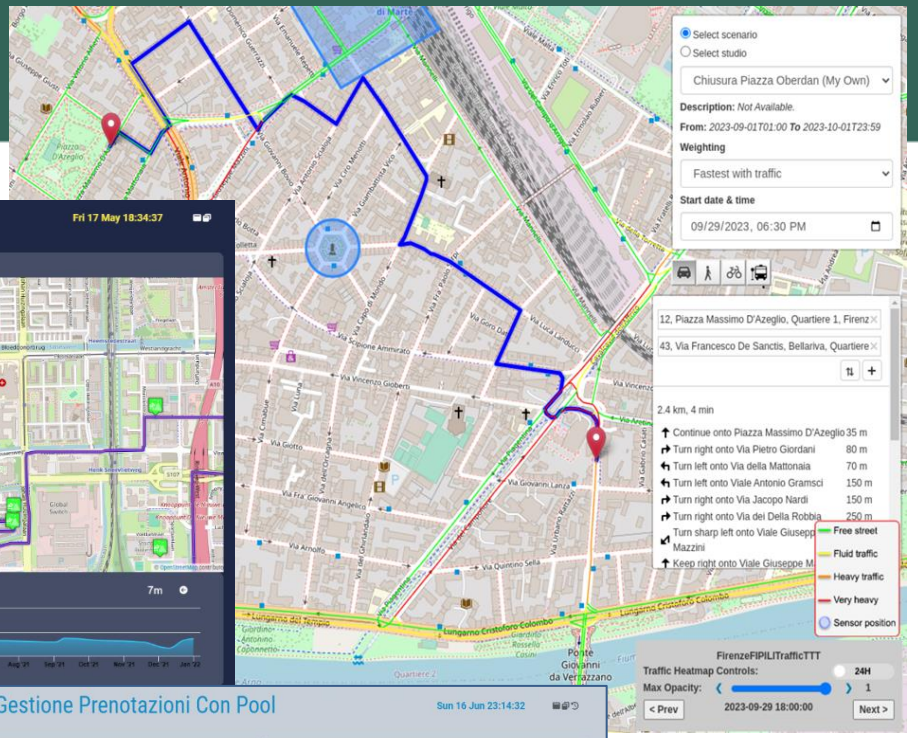
Routing Optimization

Goals on planning:

- Reduction **of costs on plan**
- **waste collection** optimization, Reduction of Km
- **car pooling trajectories** optimization for maximize the pool usage
- **delivering optimization**, reduction of travel time, reduction of Km
- etc.







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Dynamic Routing on operation:

- React in operation to define immediate routing solutions: rescue teams, ambulance, etc.
- Recovery from failure

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

SNAP4CITY

Routing Facitilities

- **modal routing: private vehicles, bikes, pedestrian**
  - with start, end and multiple intermediate points
  - selecting: shorter, faster, quitter, etc..
  - dynamic conditional routing taking into account the effective traffic flow status, or typical traffic flow status
  - dynamic conditional routing taking into account eventual blocked areas (by scenario) for example for street working, restoring, etc. (what-if cases and analysis)
- **multimodal routing** for the city users to walk and take the public collective transport
- **modal routing for public administrations** (ambulance, fire brigade, police, busses, etc.) exploiting the reserved lanes, etc.
- **a combination of cases**.
- **Full API for exploitation from your applications**

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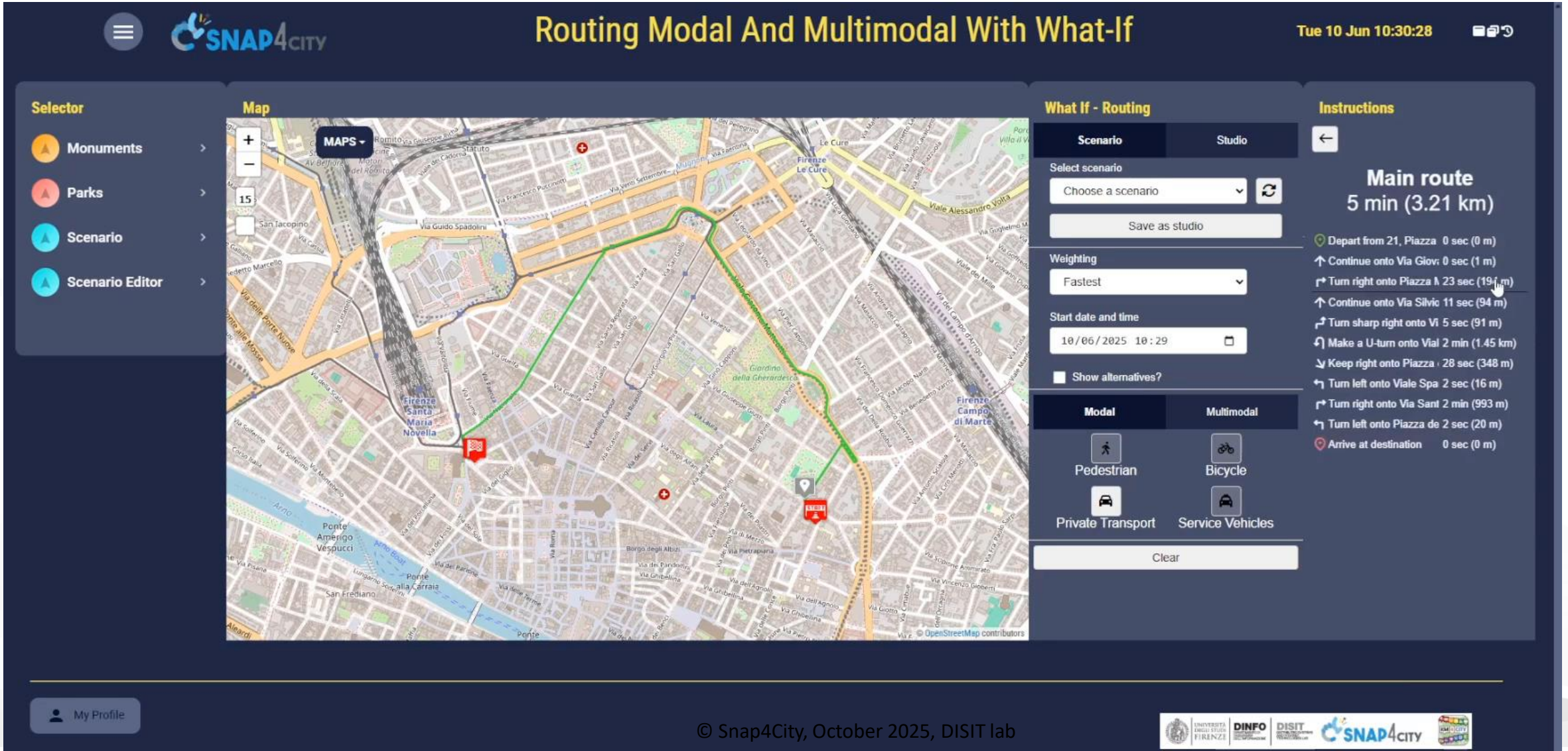
Some Routing Service Capabilities



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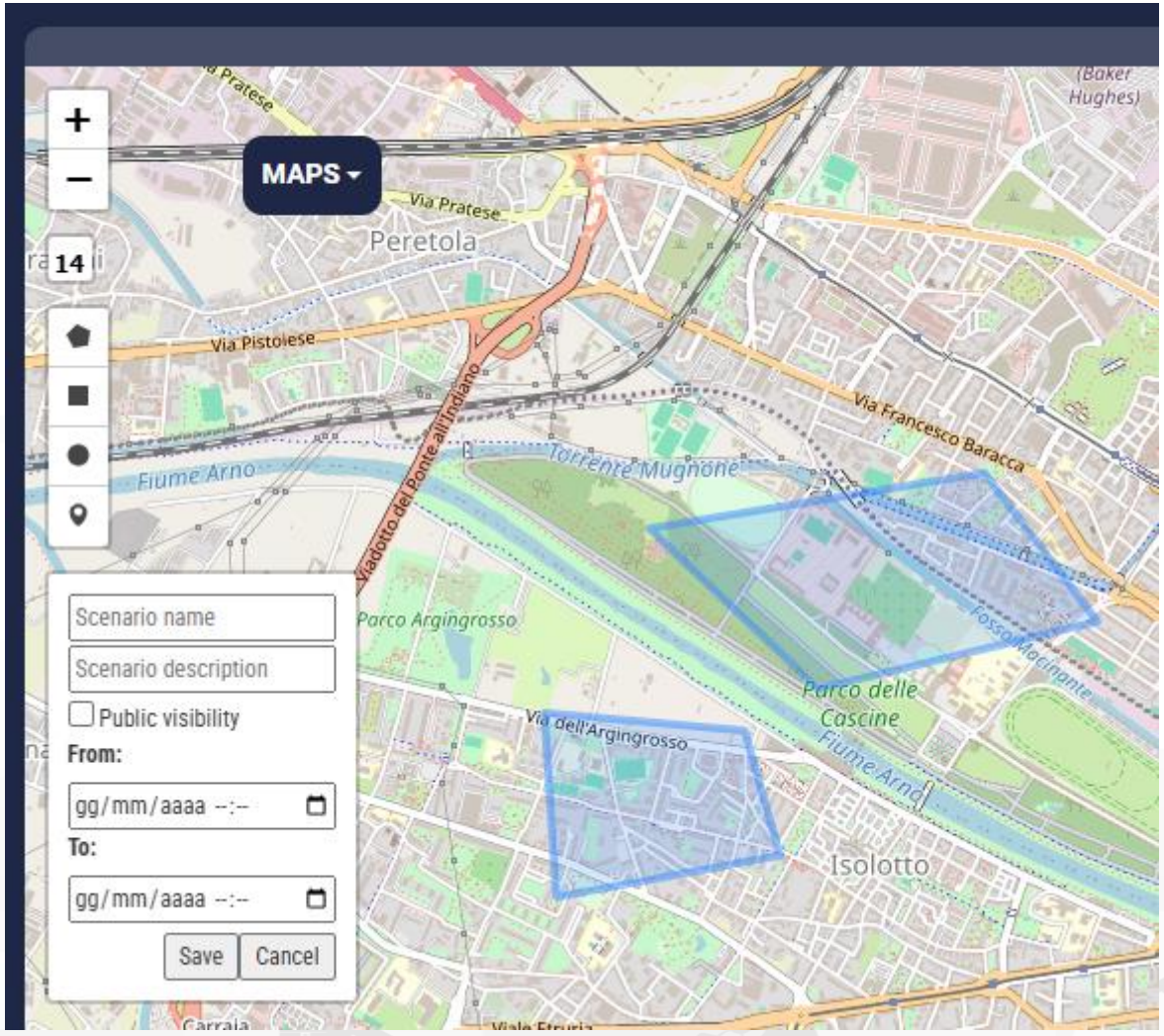
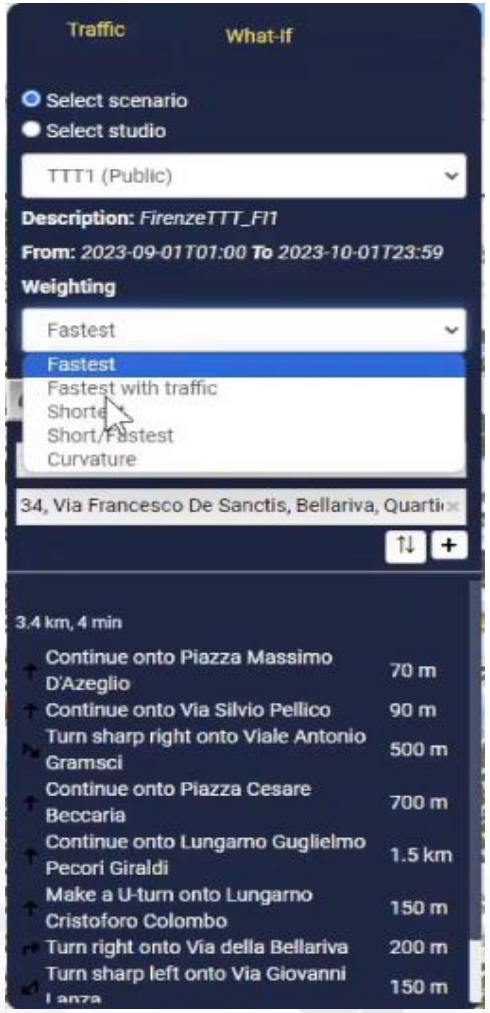
What you can do with advanced tools



- **Basic Scenario editor**
  - Single and multiple blocked areas, which can be shared among users
- **What-if analysis tool**
  - Ready to use tools for exploiting Basic Scenarios as blocked areas and simulating/
  - computing in real time routing, in different traffic conditions



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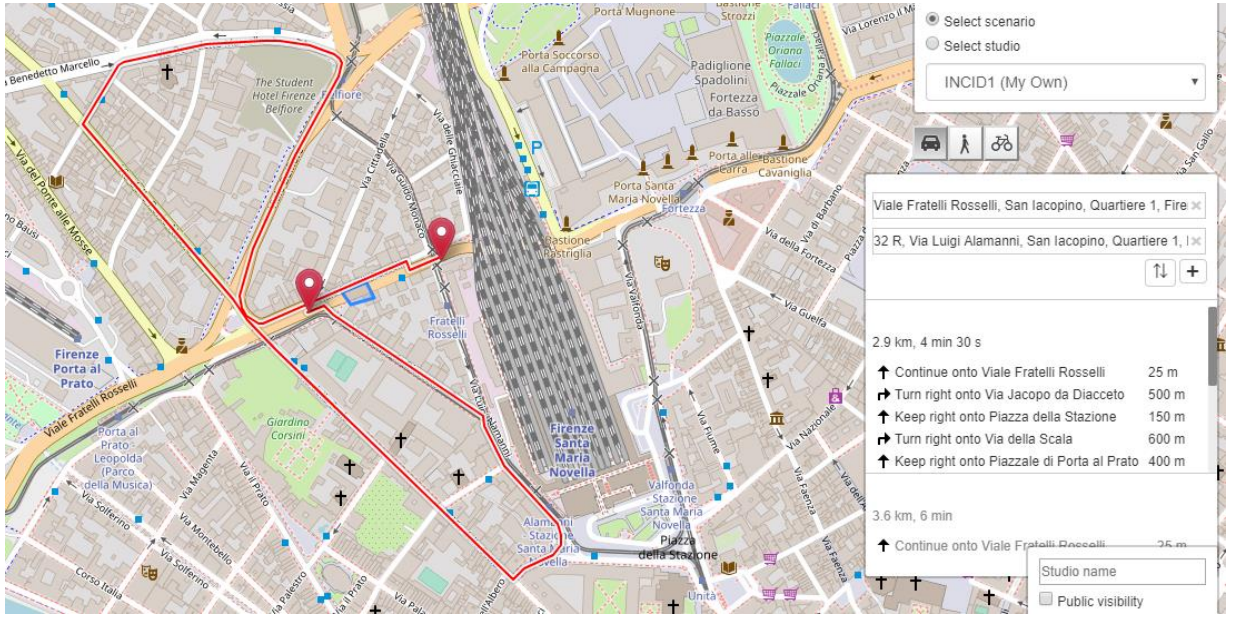
What-If Analysis

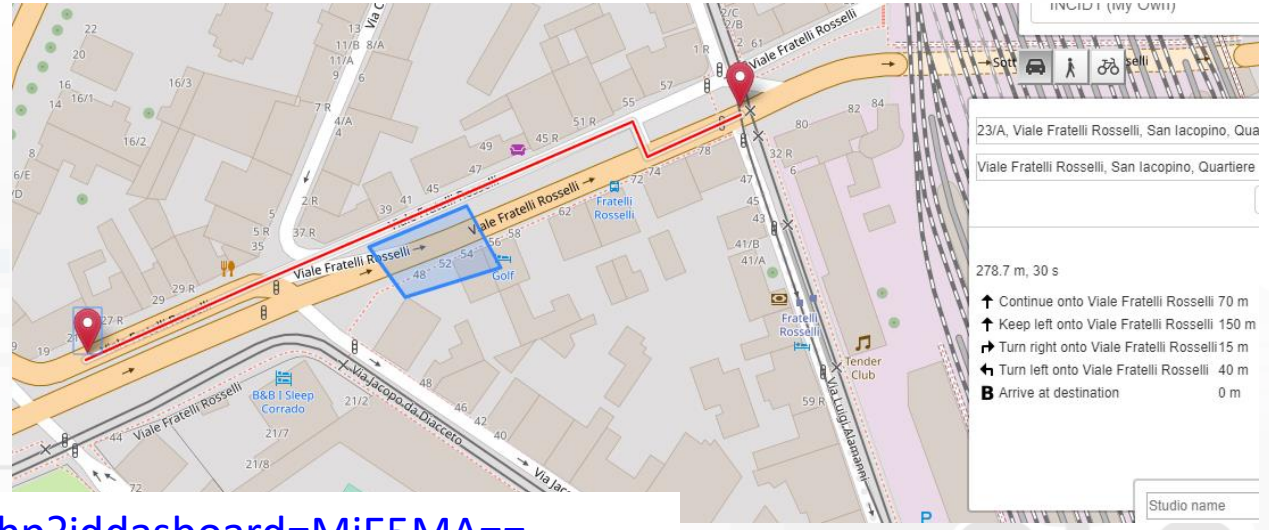
Accidents and elements blocking Points and Shapes taken into account for:

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

Assessment on the basis of changes:

- Mobility demand assessment
- Mobility Offer assessment





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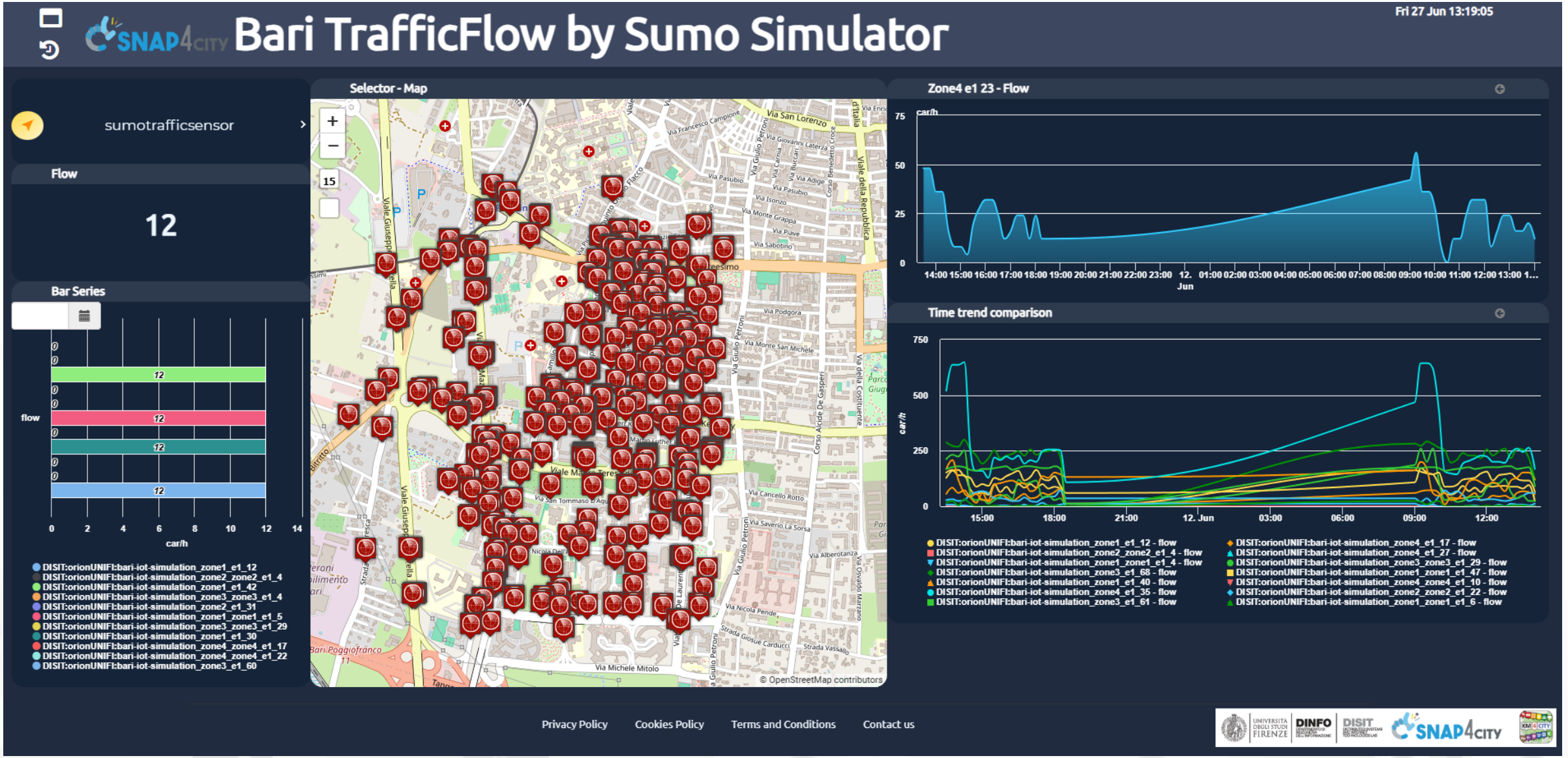
Bari TrafficFlow by Sumo Simulator
Fri 27 Jun 13:19:05
sumotrafficsensor
Flow
12
Bar Series
flow
car/h
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DISIT:orionUNIFI:bari-iot-simulation_zone2_zone2_e1_4
DISIT:orionUNIFI:bari-iot-simulation_zone1_e1_42
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Selector - Map
© OpenStreetMap contributors
Zone4 e1 23 - Flow
car/h
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Time trend comparison
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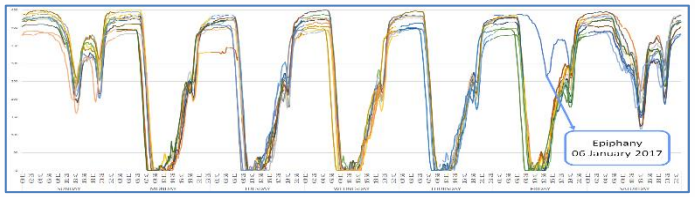
Parking predictions

I would arrive to surely Park in 45 Minutes??



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



Artificial Intelligence Predictions

97% of precision



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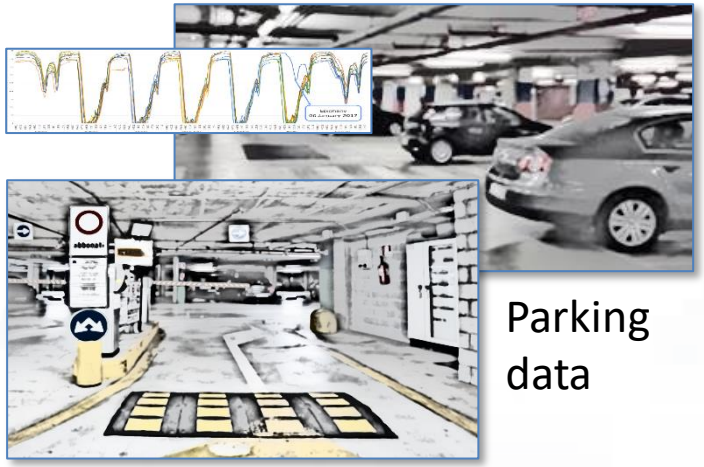
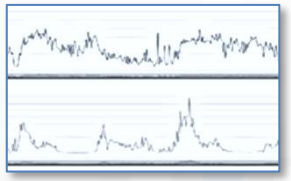
Deep Learning AI to surely Park!



Parking data



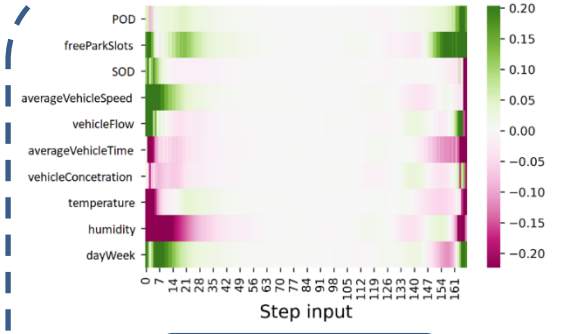
Traffic sensors data

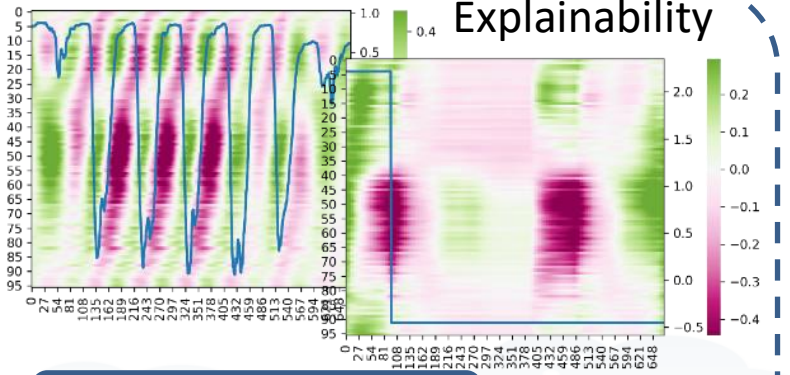




Weather Features



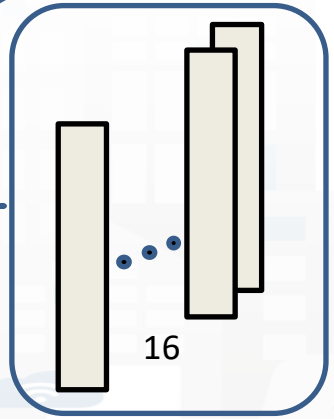


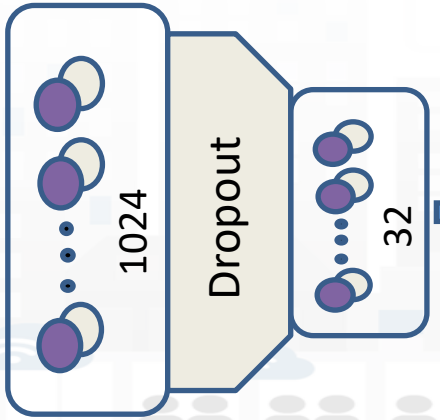


Explainability

Gradient

Integrated Gradient



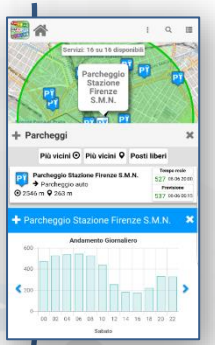


Dropout



Multi-step

Predictions



Conv1D+AvPooling1D BI-LSTM BI-LSTM Dense

Compared with: BRANN, RNN, CNN-GRU, CNN-LSTM

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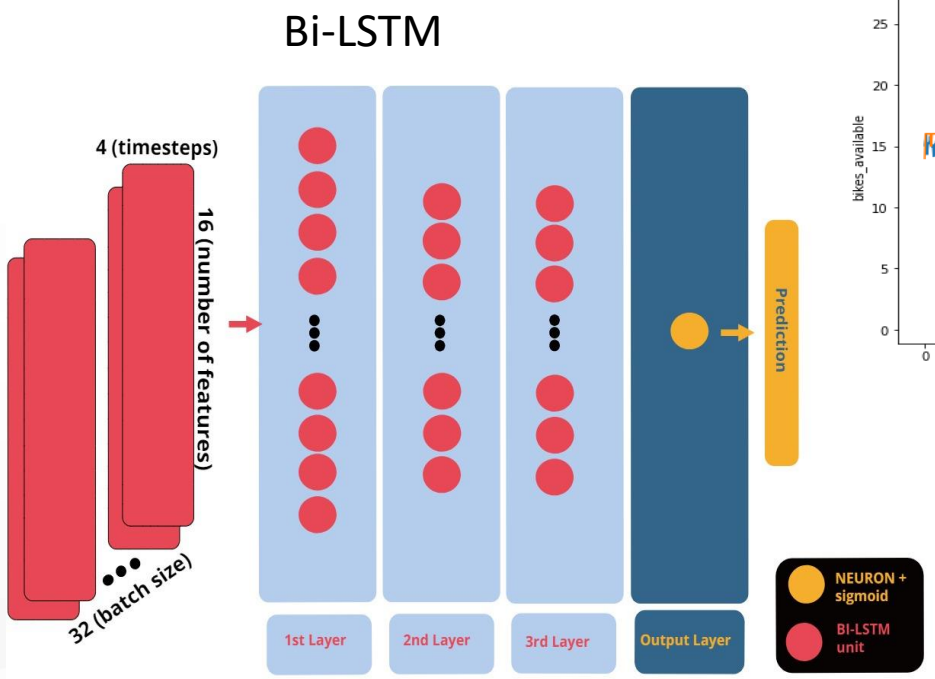
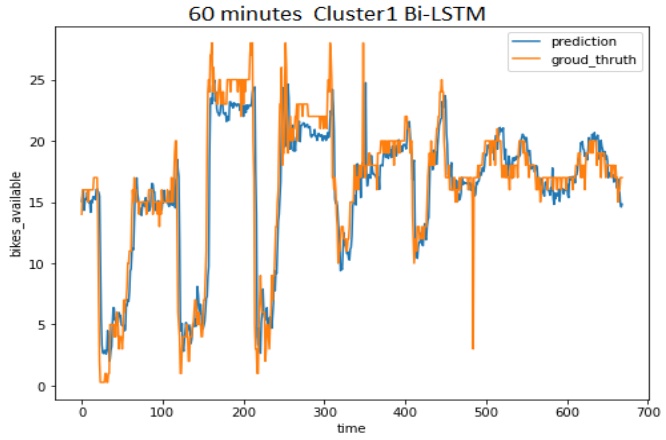
Deep Learning for Short-Term Prediction of Available Bikes on Bike-Sharing Stations











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

Comp: RF, XGBoost, DNN, LSTM

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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

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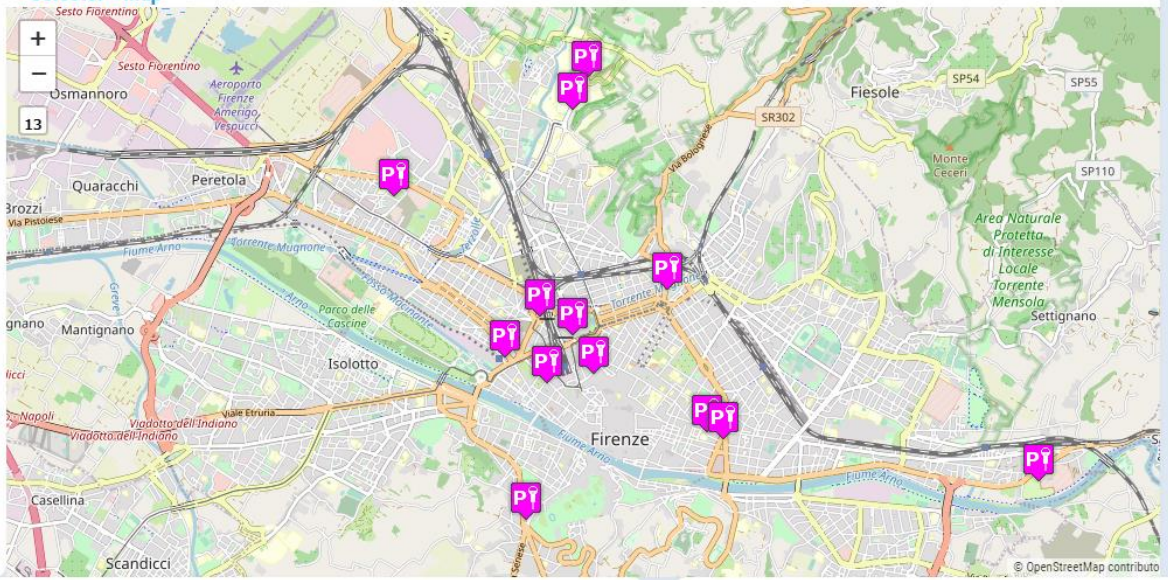
Monitoraggio Parcheggi

Sat 13 May 23:26:20

Selector

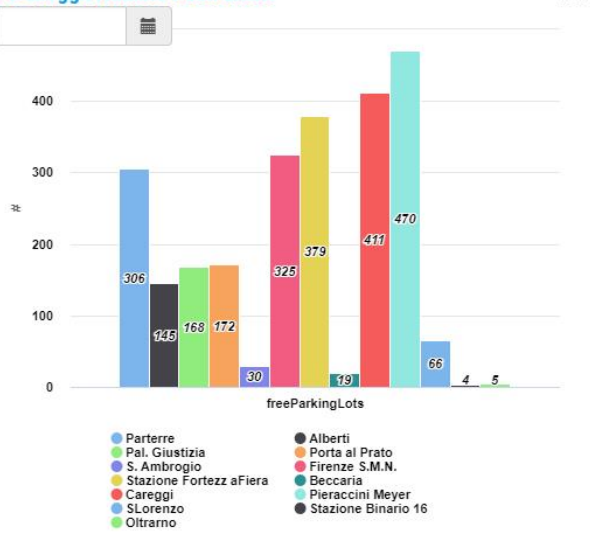
- Parterre
- Piazza Alberti
- Palazzo di.Giustizia
- Porta al Prato
- S. Ambrogio
- Stazione Firenze S.M.N.
- Stazione Fortezza Fiera
- Piazza Beccaria

Selector - Map



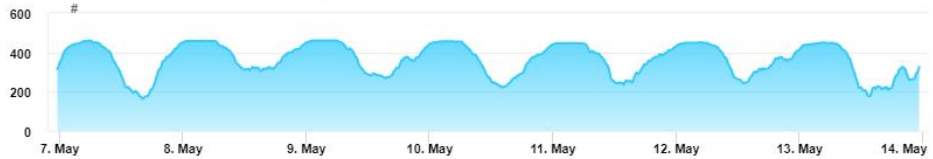
Parcheggi: Numero Posti Liberi

4m



StazioneFirenzeS.M.N. - FreeParkingLots

9m



Andamento Posti Occupati

4m



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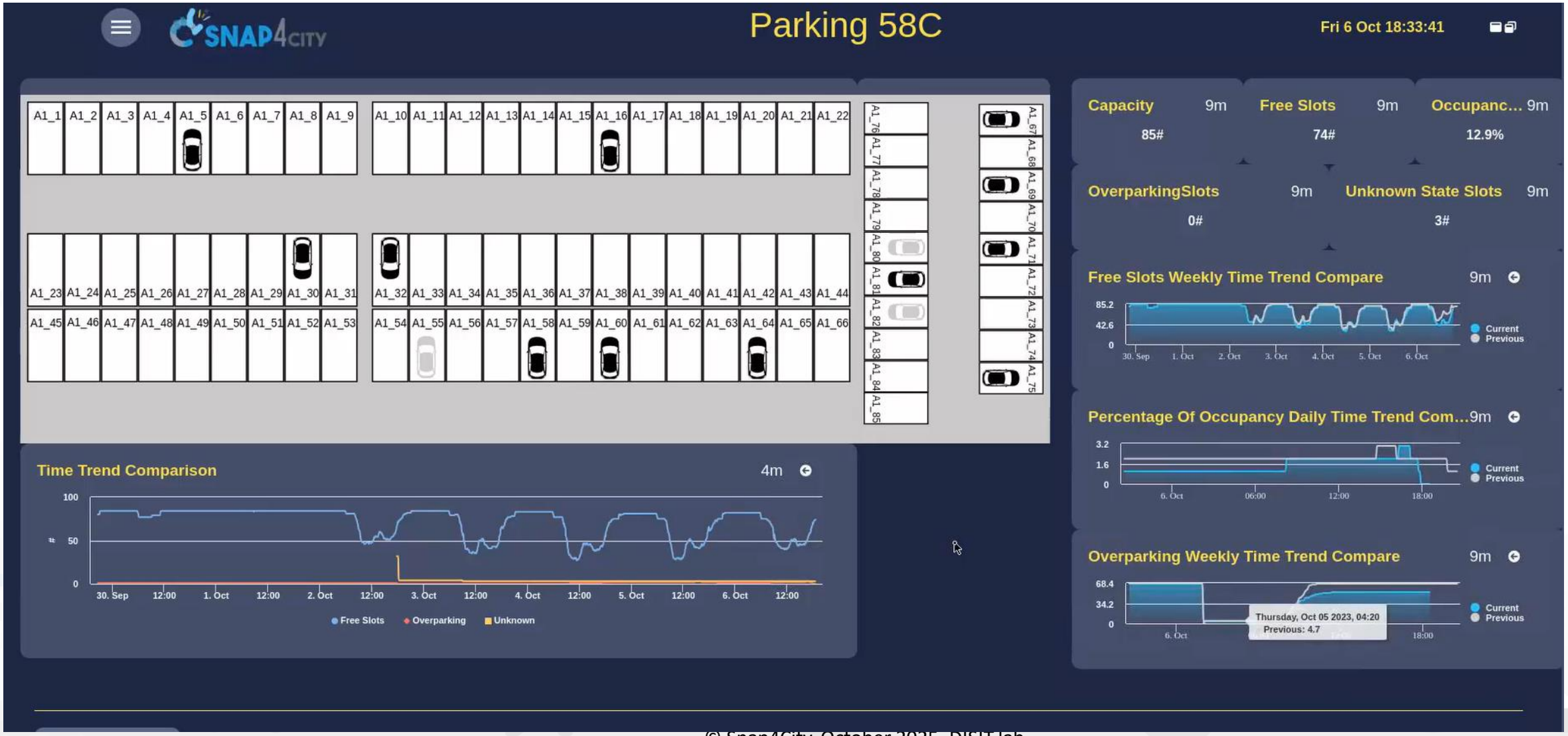
Snap4ISPRA Parking: ISPRA JRC



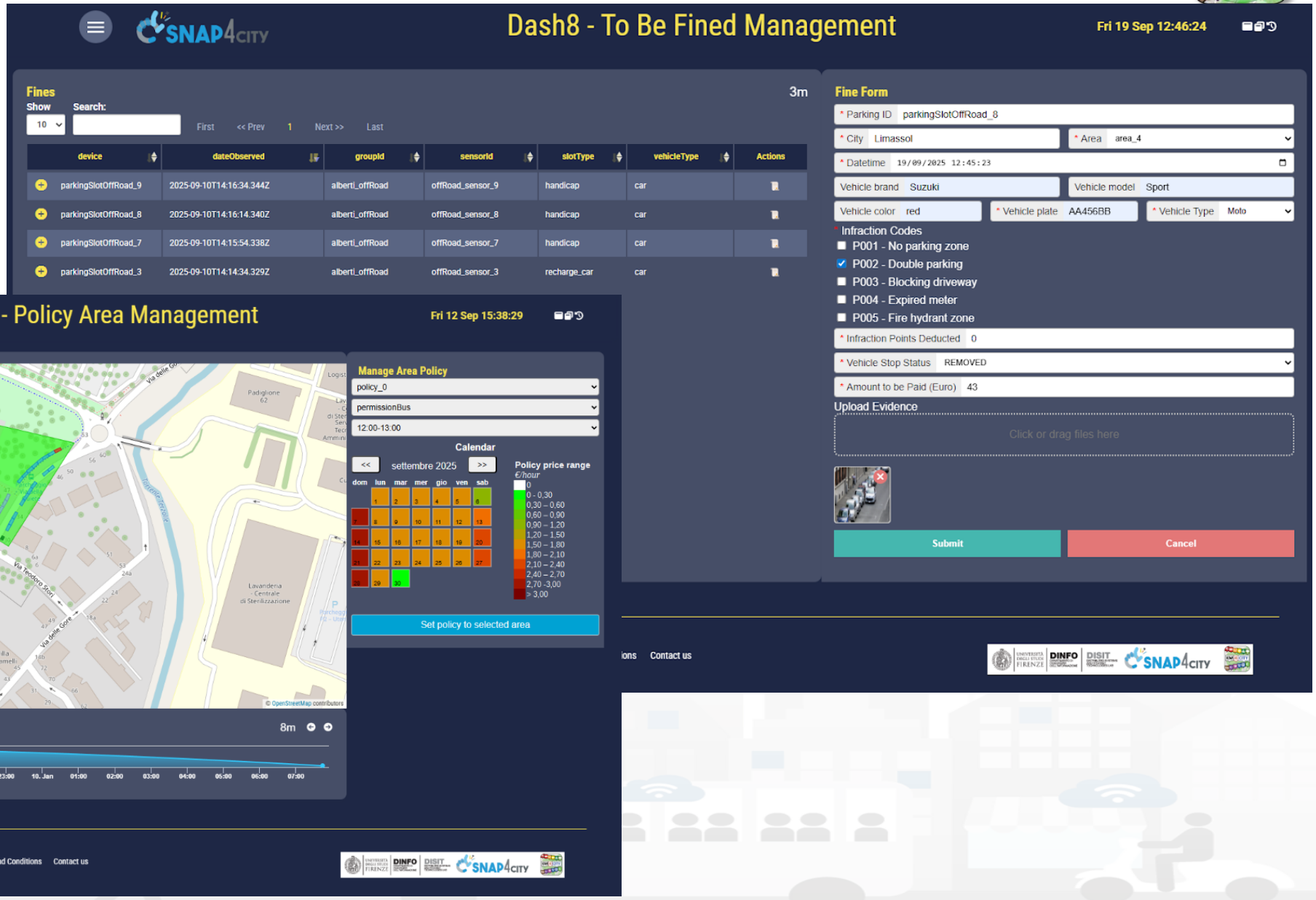
Snap4Parking

Smart Parking

-- payments, profiles

-- Fines

-- mobile for parking



Trucks' Plates and Container ID Recognition



- **Managing Gates to Salerno Port**
- Gates: in/out
- **Recognition and decoding**
  - BIC code: TSSU 204006
  - ISO code: 22G1
  - Seal status: on/off
  - Multi-national Plates: 74-0771



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Mobility Demand vs Transportation Offer



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In the large

- **Mobility Demand → ODM:**
  - Telecom Operator ODM, all movements on ACE Area
  - Reduction on local actual percentage and behaviour distributions
  - Matching on MGRS 200 mt, exploiting presence data of Telecom Operators
- **Transportation offer**
  - Road graph
  - GTFS/NeTex, transmodel
  - Bike sharing, carsharing, scooters, etc.

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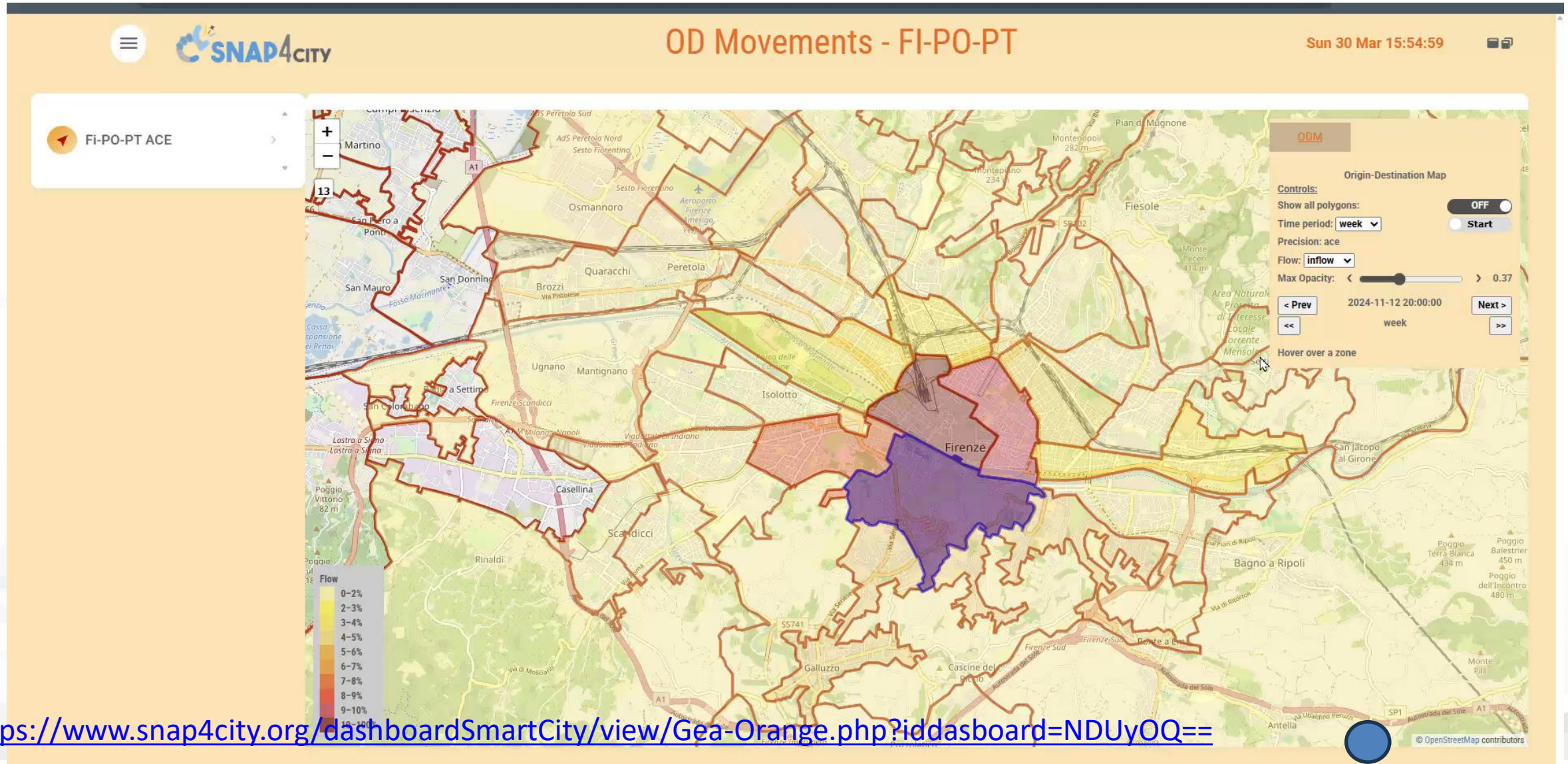
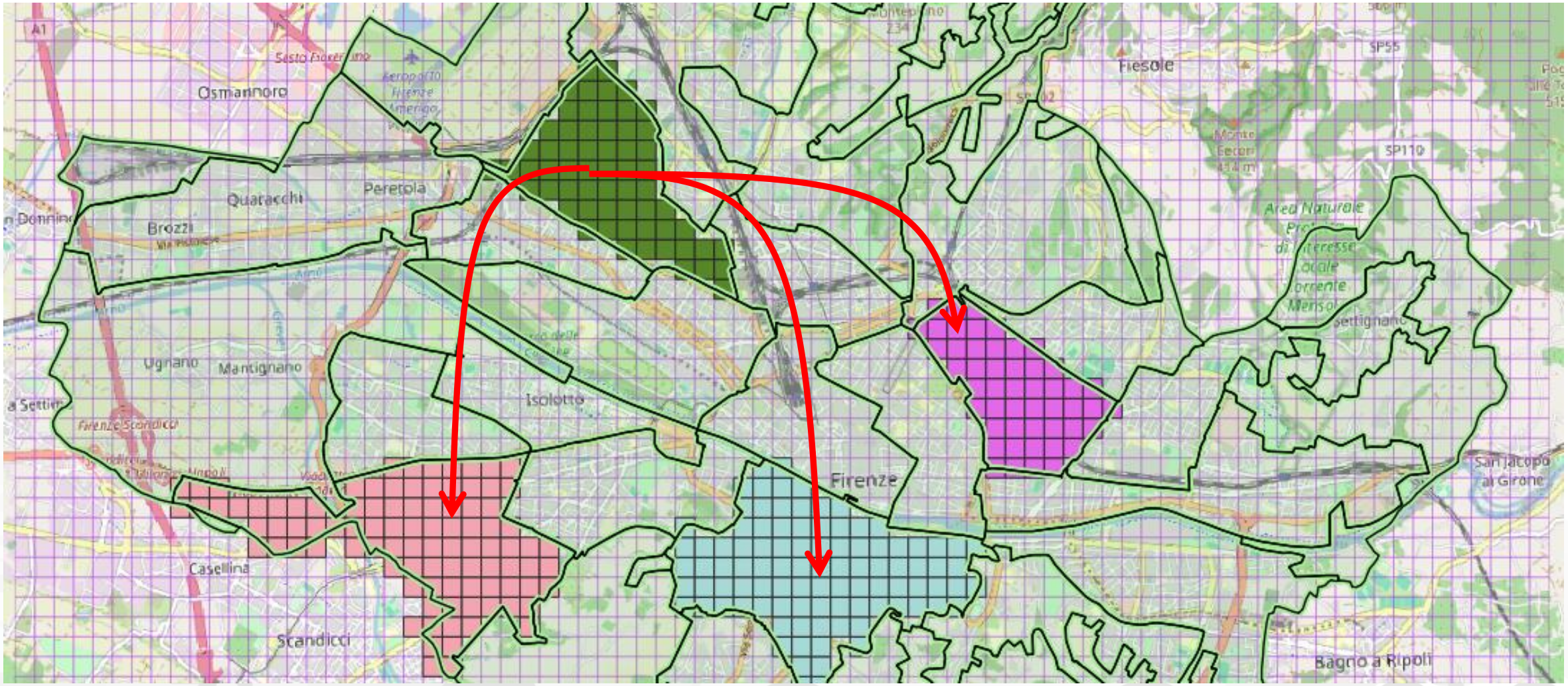
Origin Destination Matrices: Mobility Demand



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

Mapping ODM ACE based on MGRS



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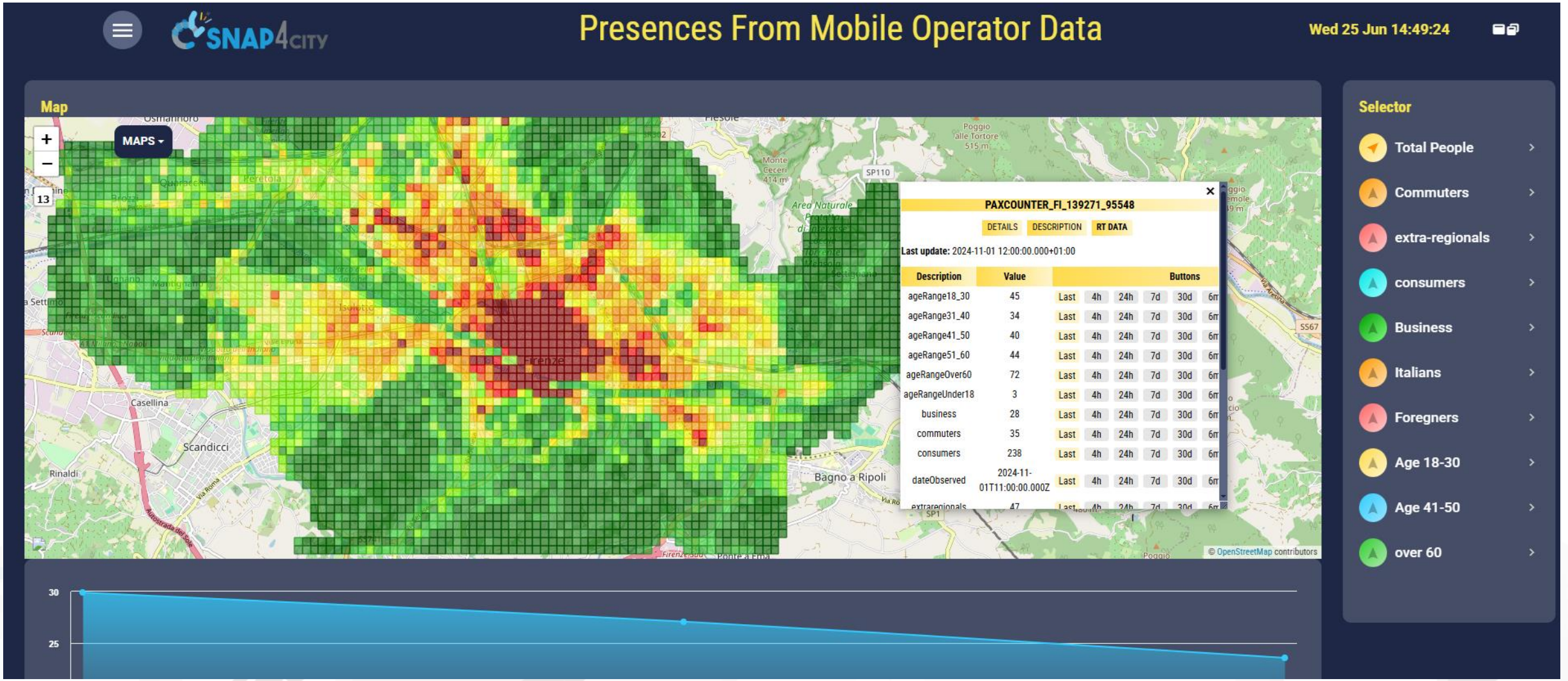
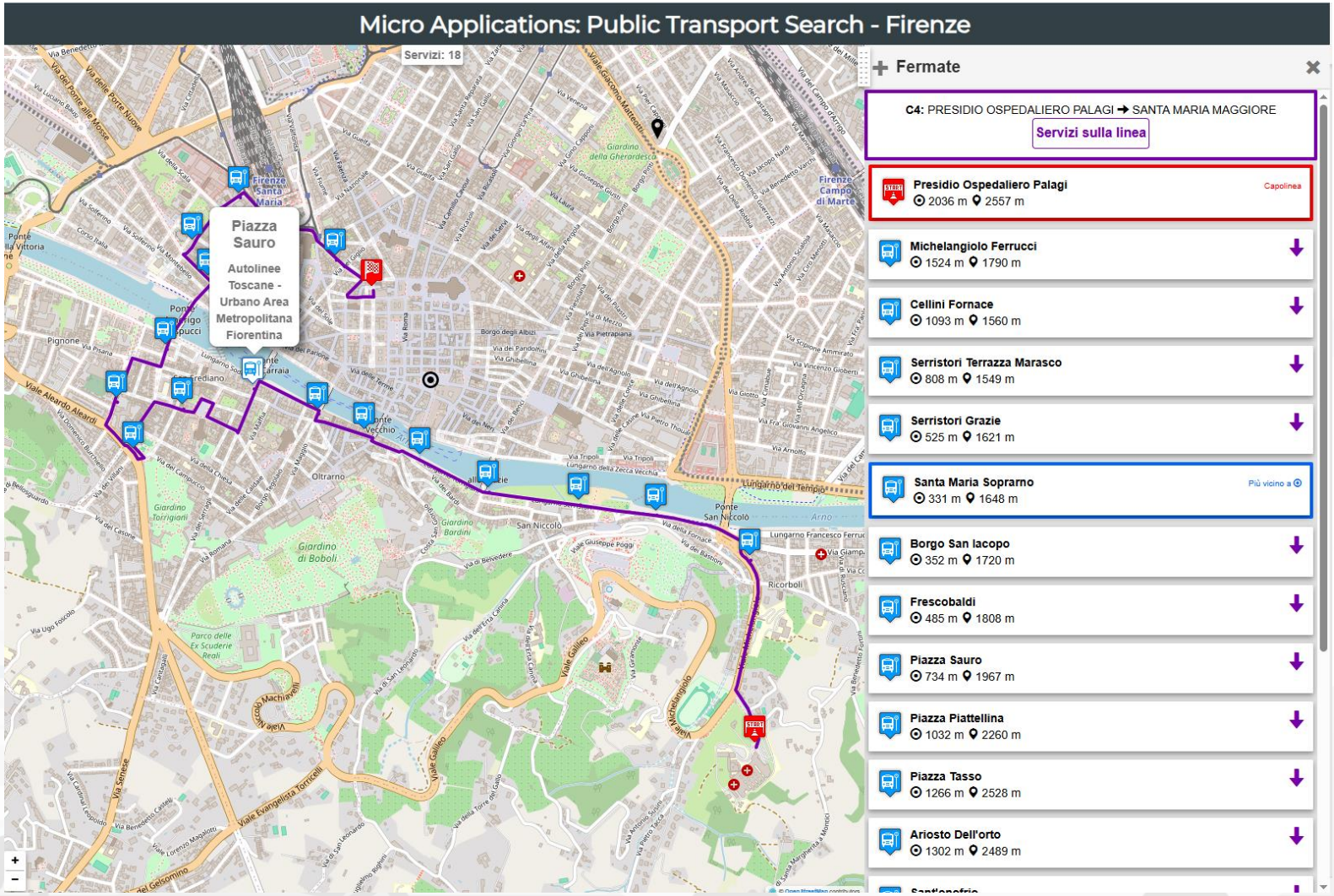
Presences from Mobile Operator



Offer of Transportation, GTFS, for example



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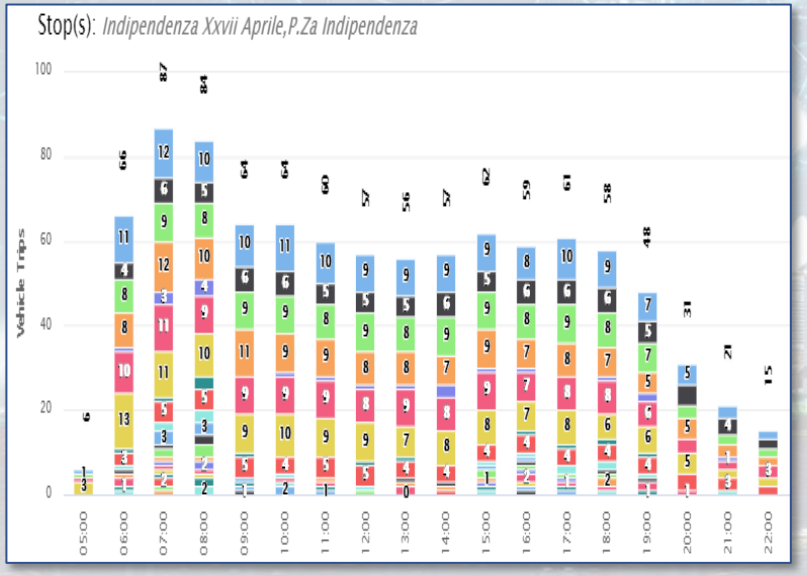
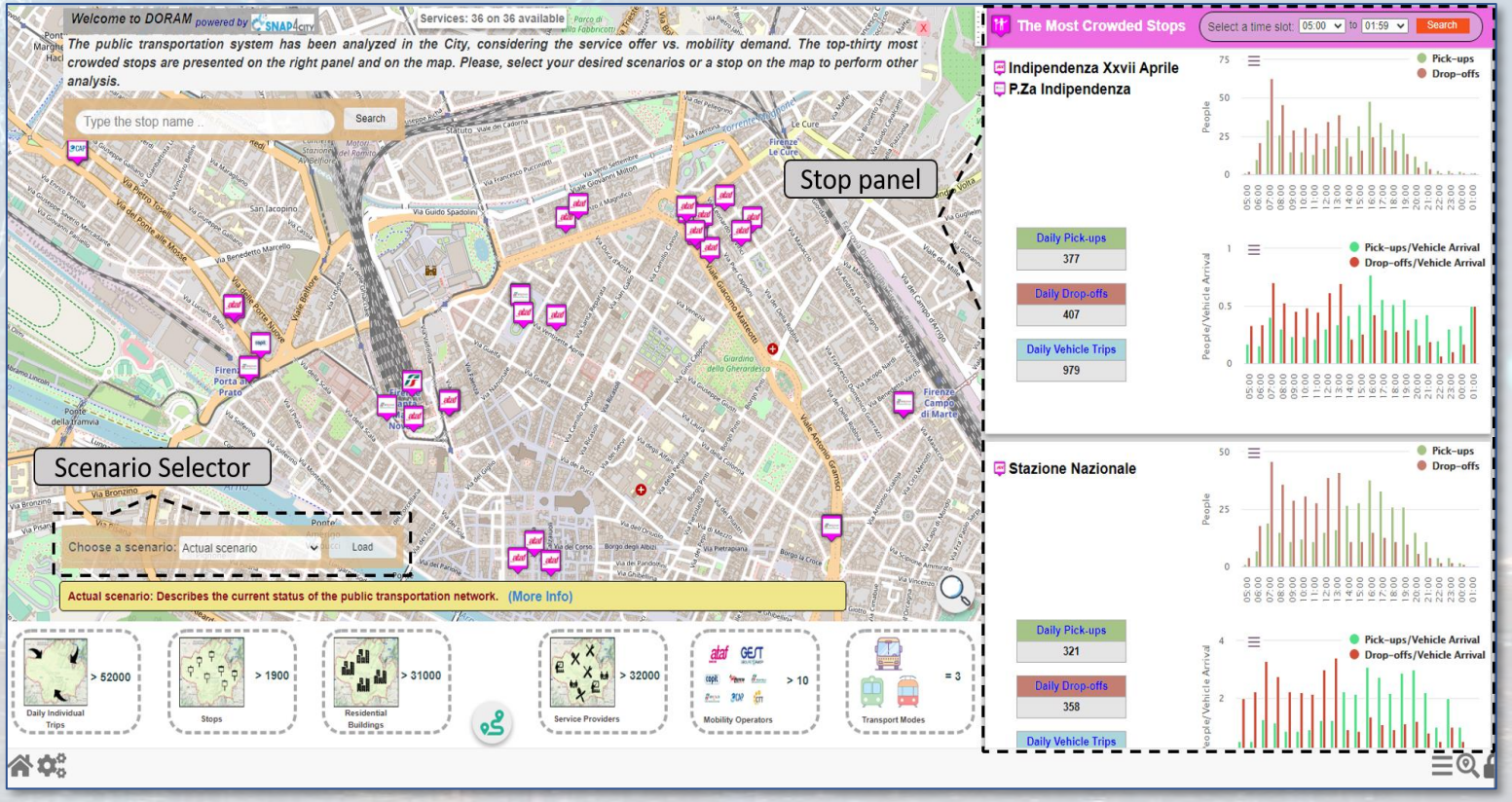
What-if Analysis on Collective Transport: DORAM

- Simulation / analysis of Mobility Demand wrt Transportation Offer
  - **GTFS/TranSmodel vs ODM**, taking into account road graph and services
- Definition of scenarios impact on
  - Traffic, Pollutant, parking, public transport, private flows, etc.
  - KPI analysis

Public Services





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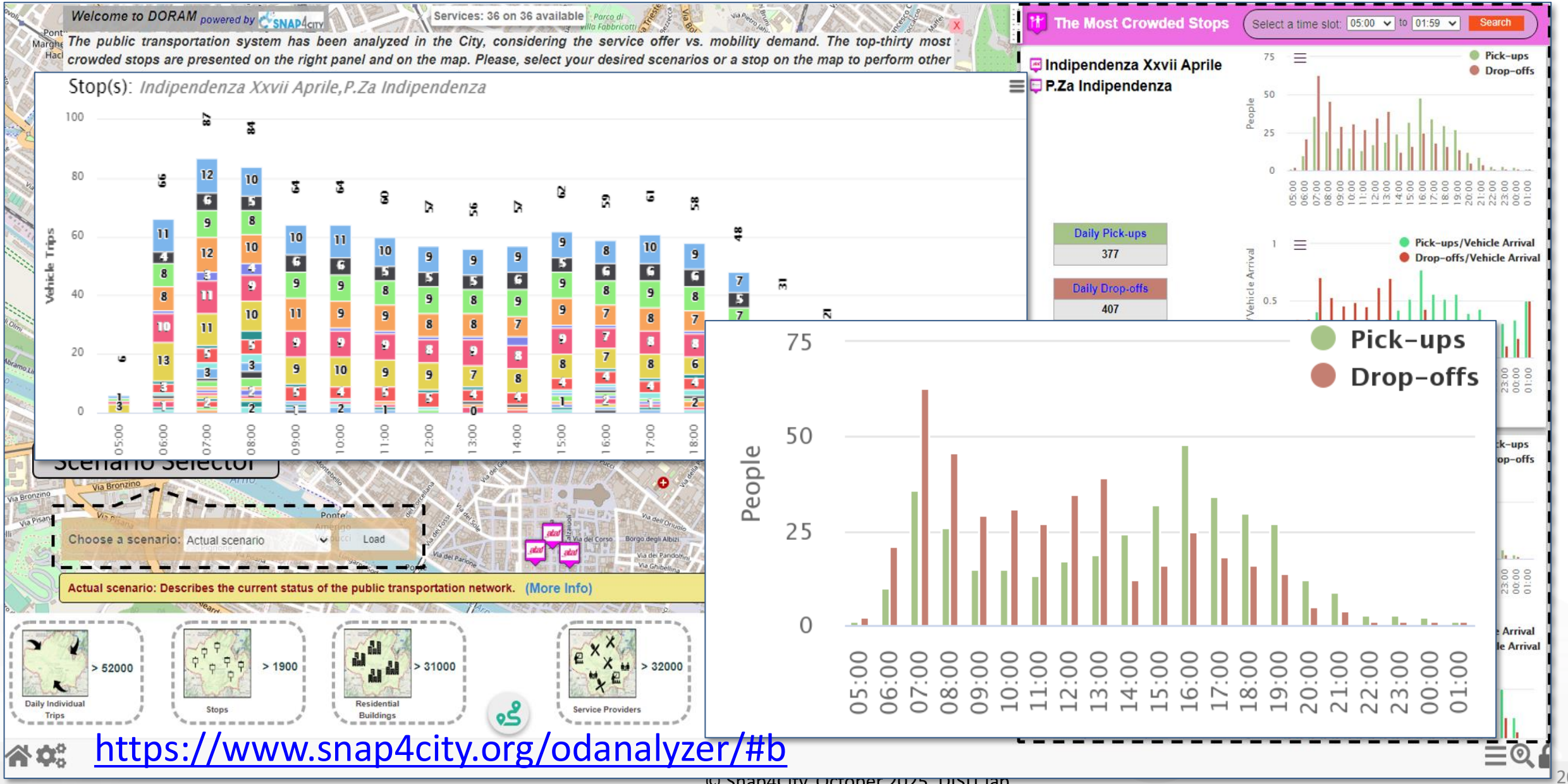
DORAM

SNAP4CITY | KM 4 CITY



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

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SNAP4CITY KM4CITY

SNAP4CITY

Traffic Simulation-K8S

Sun 22 Jun 11:53:30

Ext

STOP PAUSE HELP

slow fast

Delay: 30.0 ms

Stats

time: 0.000 s
payload: 0.0 KB
simulate: 0.00 ms
snapshot: 0.00 ms

Vehicle Summary

Quick Find

ID Edge / Lat, Long (float, float) / X,Y (int, int)

SEARCH

CAR BIKE TRAIN TRAM PERSON BUS LIGHT



Wid

Prepare Simulation | Execute Simulation | KPI Simulation

Simulation:

firenzeodbus

Execute

Simulation: 2025/06/22 11:53:27

My Profile

KPI on Match D-O of Collective Transport

- **On users**
  - **Unmet Demand**
    - Number of passengers who could not board their planned bus
  - **Average Walk Time**
    - The average time spent by passengers during walking before and after taking a ride from source to destination of their trip.
- **On Service performance**
  - **Average Ride Wait Time**
    - The average amount of time spent by passengers at bus stops while waiting for their desired vehicle.
  - **Average Ride Duration**
    - The average time spent by passengers in a vehicle taking a ride from source to destination of their trip.
  - **Average Vehicle Occupancy**
    - The average number of people boarded in vehicles of different bus lines at different timestamps of a day.
  - **Critical Bus Lines**
    - Bus lines for which the load factor of a bus line exceeds the threshold value of 15 in the service hours.
  - **Critical Bus Stops**
    - Bus stops where the crowding ratio is highest at top 20 bus stops served by different bus lines.
  - **Average Vehicle Depart Delay**
    - Vehicles which depart later than their expected time from the bus stops.

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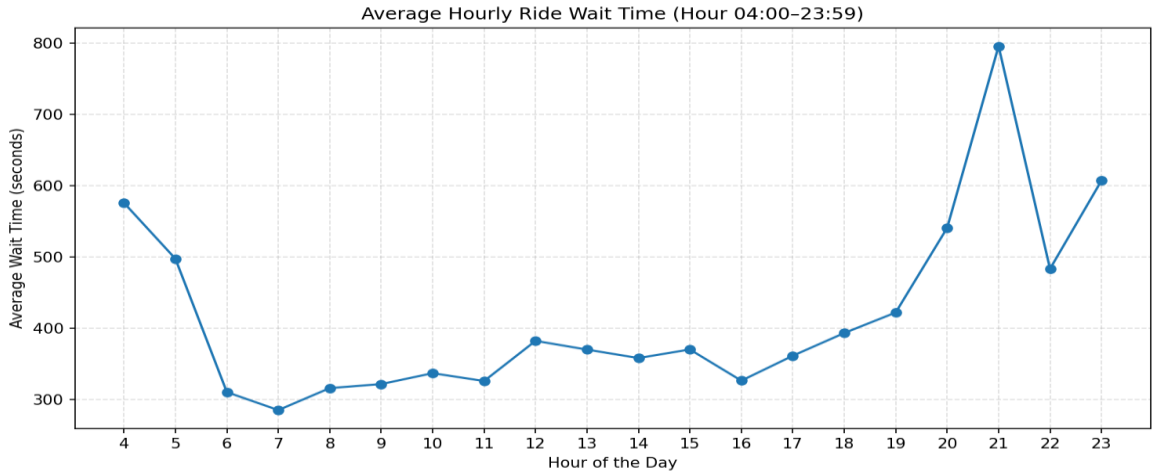
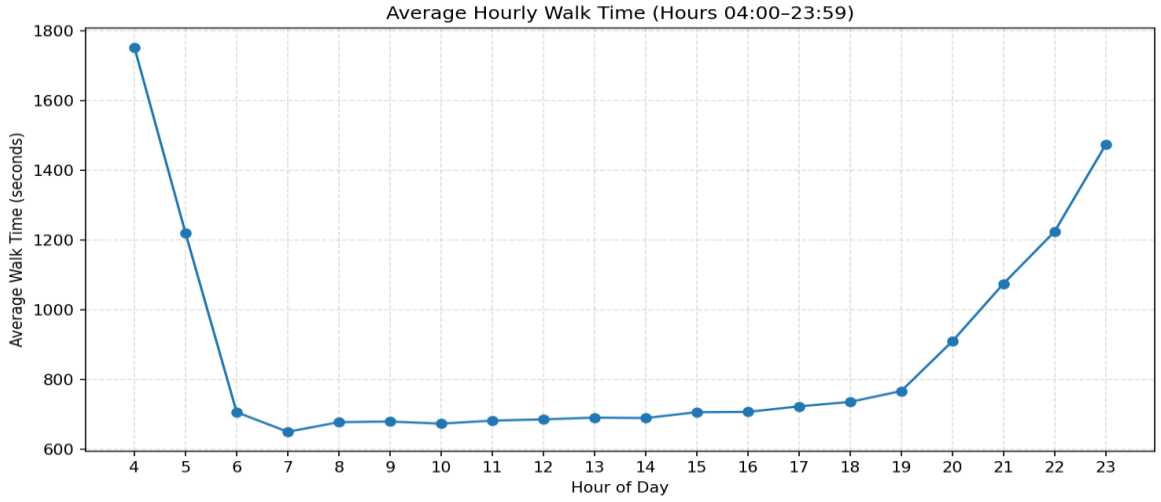
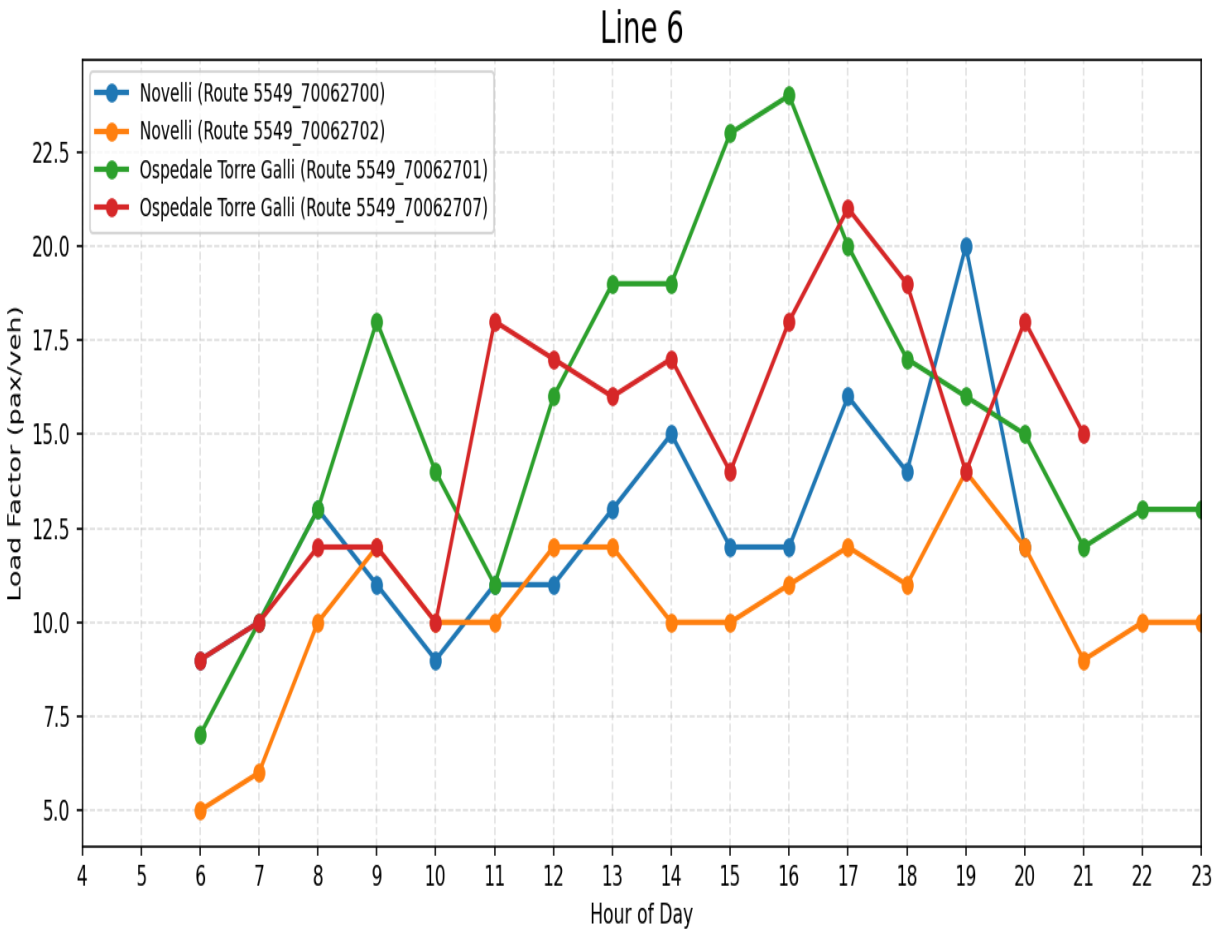
The typical working day







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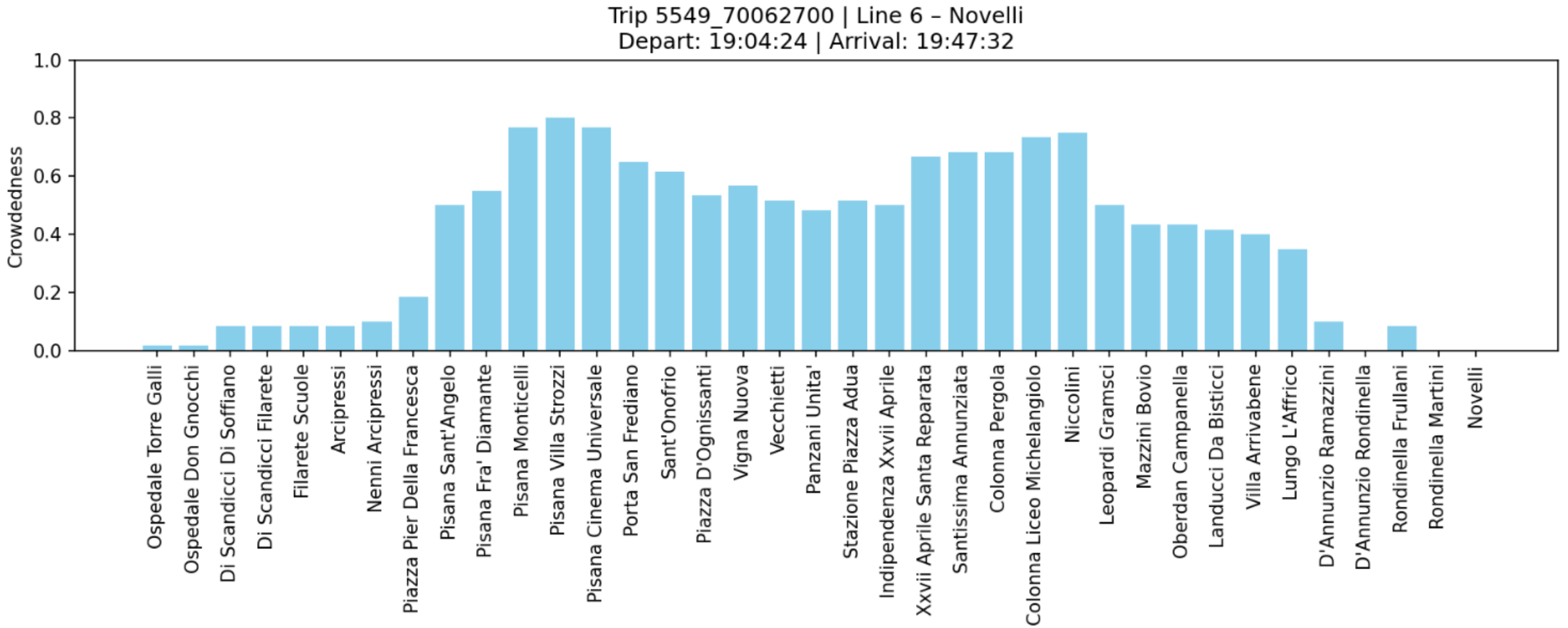
Crowdedness



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Traffic Light Plan Optimization



11 SUSTAINABLE CITIES AND COMMUNITIES

MOST
CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

https://www.snap4city.org/1015

Traffic Light Optimisation

- **Traffic Light Plan:**
  - General construction of Traffic Light Plans for the area
  - TLP are loaded on the basis of the expected conditions: football game, ferial and festive, school period, morning and afternoon, etc.
  - Single Junction TLP can be:
    - adjusted exploiting local data, on demand signals, etc.
    - Actuated on the basis of the measures of traffic
- **Issues:**
  - Making multijunction synchronization to keep under control of quality of Service for TRAMWAYS and/or Busses Rapid Transit, BRT/HRB



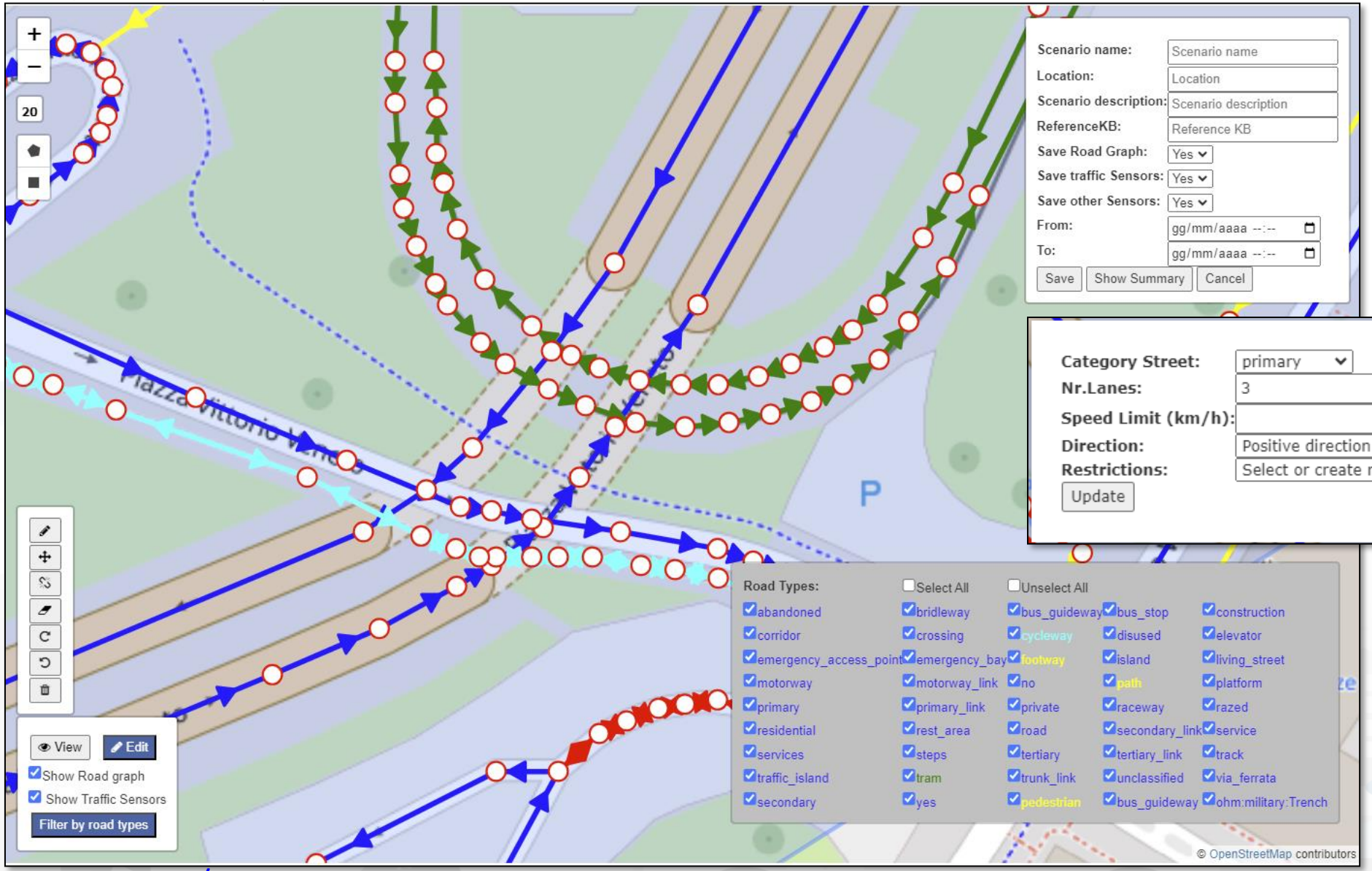
Scenario Editor

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

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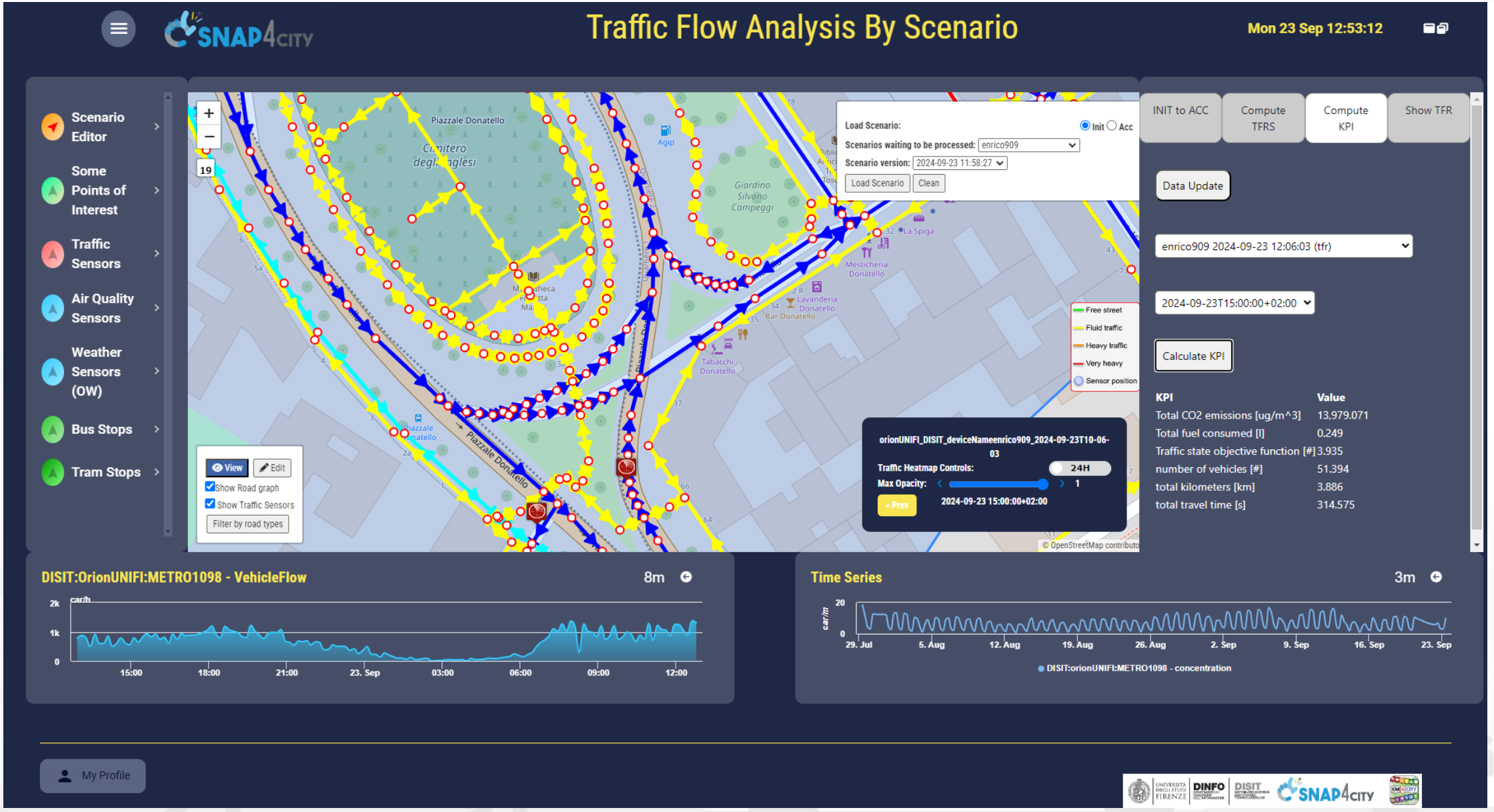
What-if on TFR



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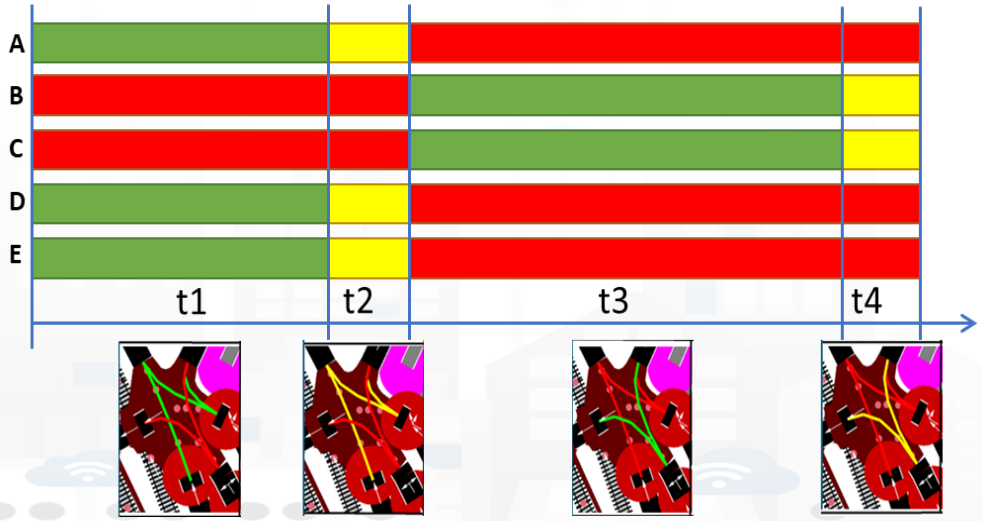
Traffic Light Plan Optimisation, Digital Twin

- **Match Multiple Objectives and Synchronization:**
  - public and private traffic, tramway priority
  - Micro and Macro Scales
  - **AI: Genetic Algorithms, Deep 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



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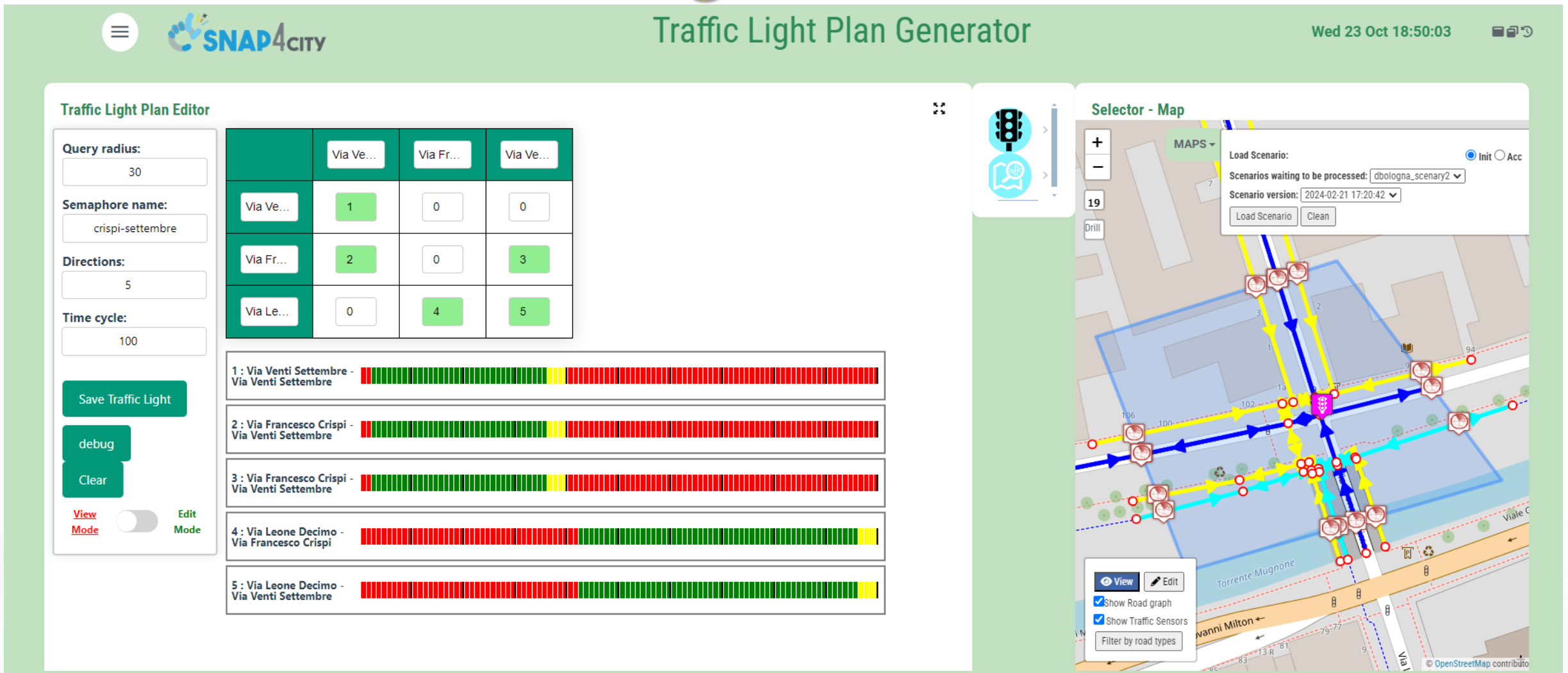
Traffic Light Plan Editor



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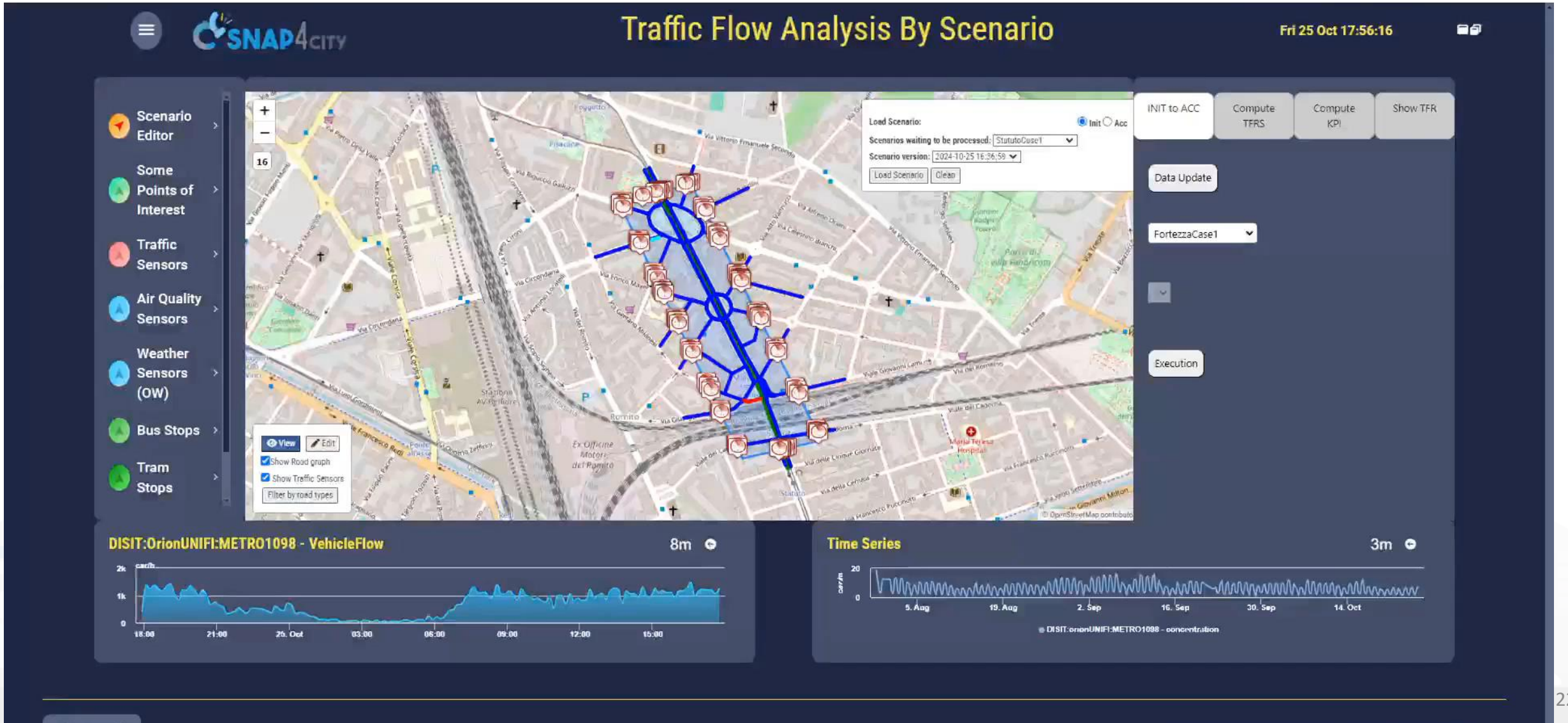
Optimization of Traffic Light Plan



GA based: 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

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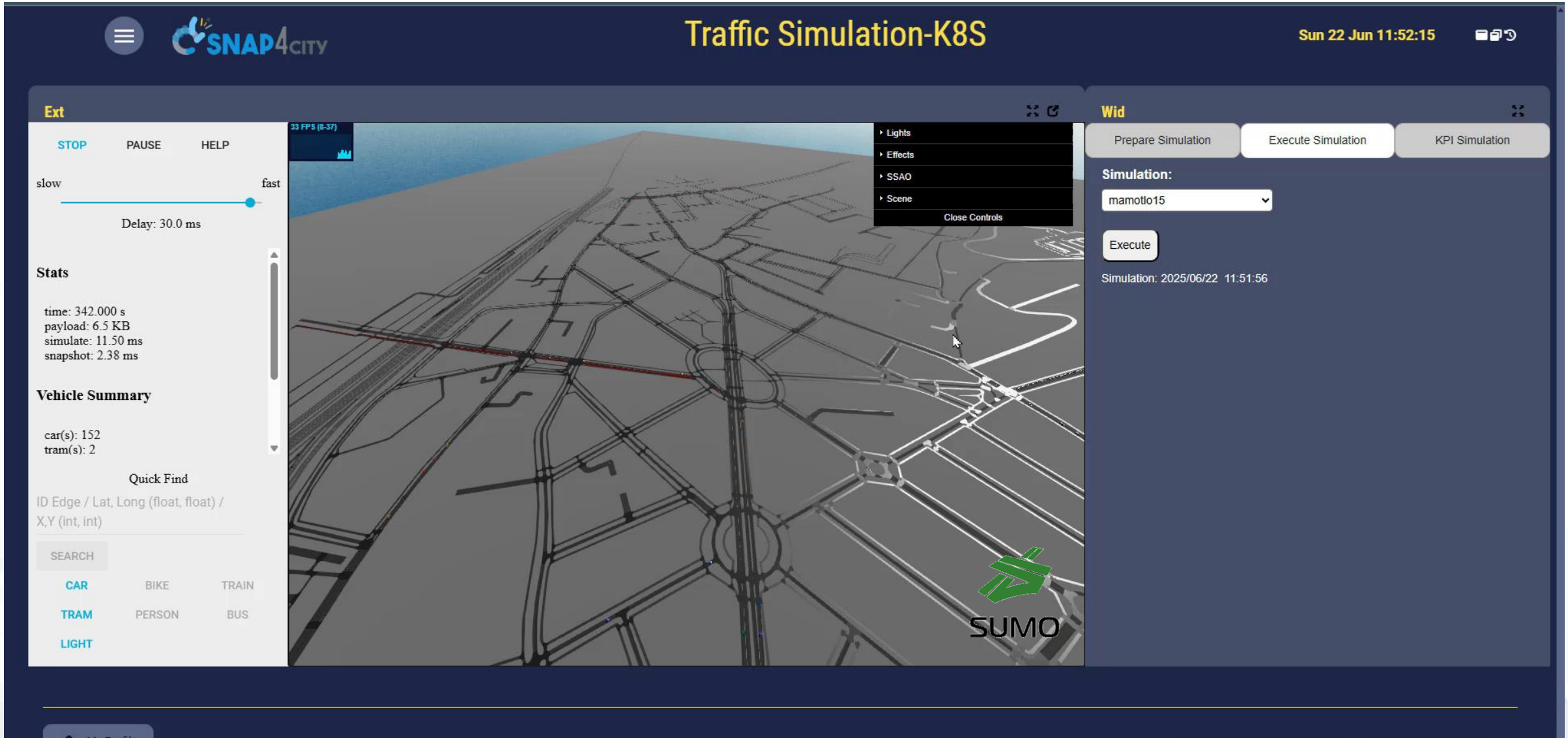
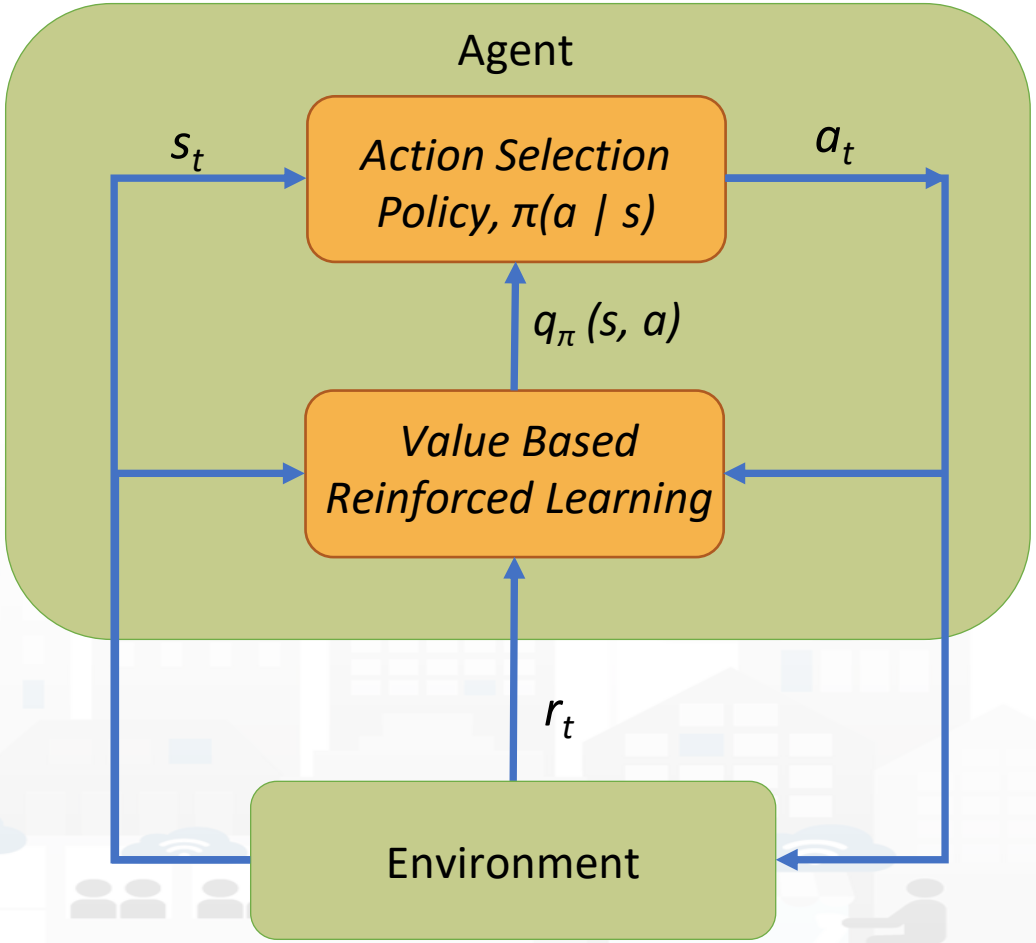
S. Bilotta, Z. Fereidooni, L.A. Ipsaro Palesi, P. Nesi, "Macroscopic GA-based Multi-Objective Traffic Light Optimization Prioritizing Tramways", Applied Soft Comp. Journal, Elsevier, 2025.



Multi Agent Reinforced Learning

- **Single Actuated**
  - Taking into account the status of each traffic source of each Juction
  - Compouting the best compromise of G/R ratio
  - Act on the next cycle
- **Multi Agent**
  - As Single Actuated
  - Taking into account syncronization, as condition and travel time of main specific travel means



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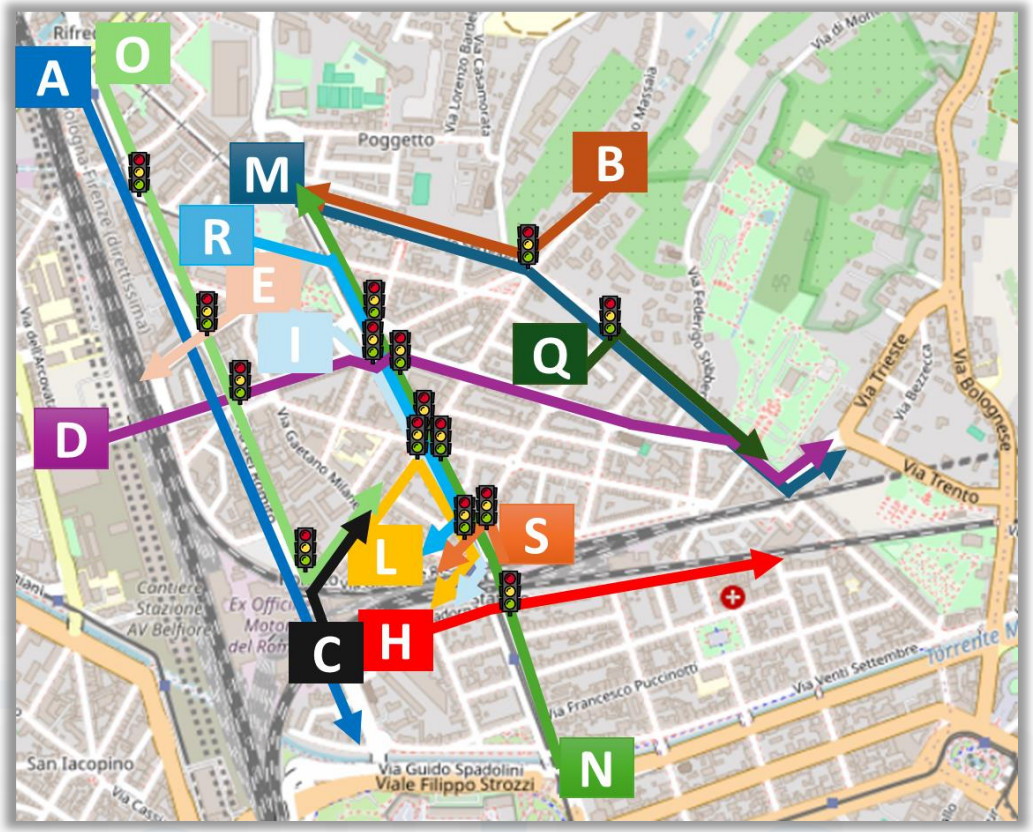
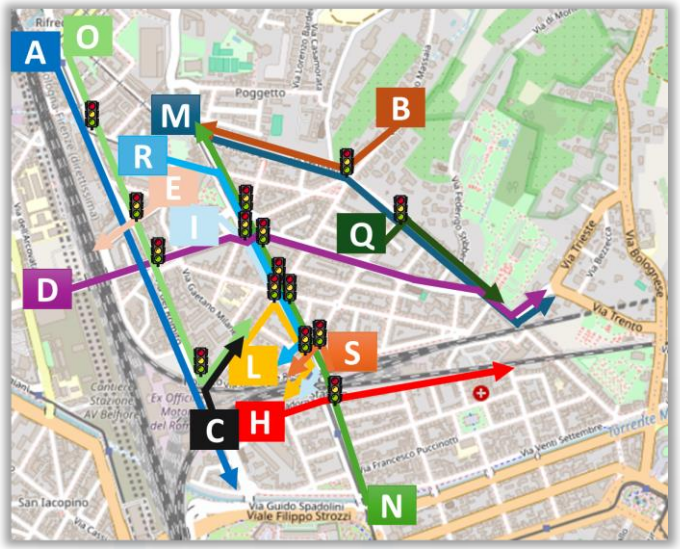
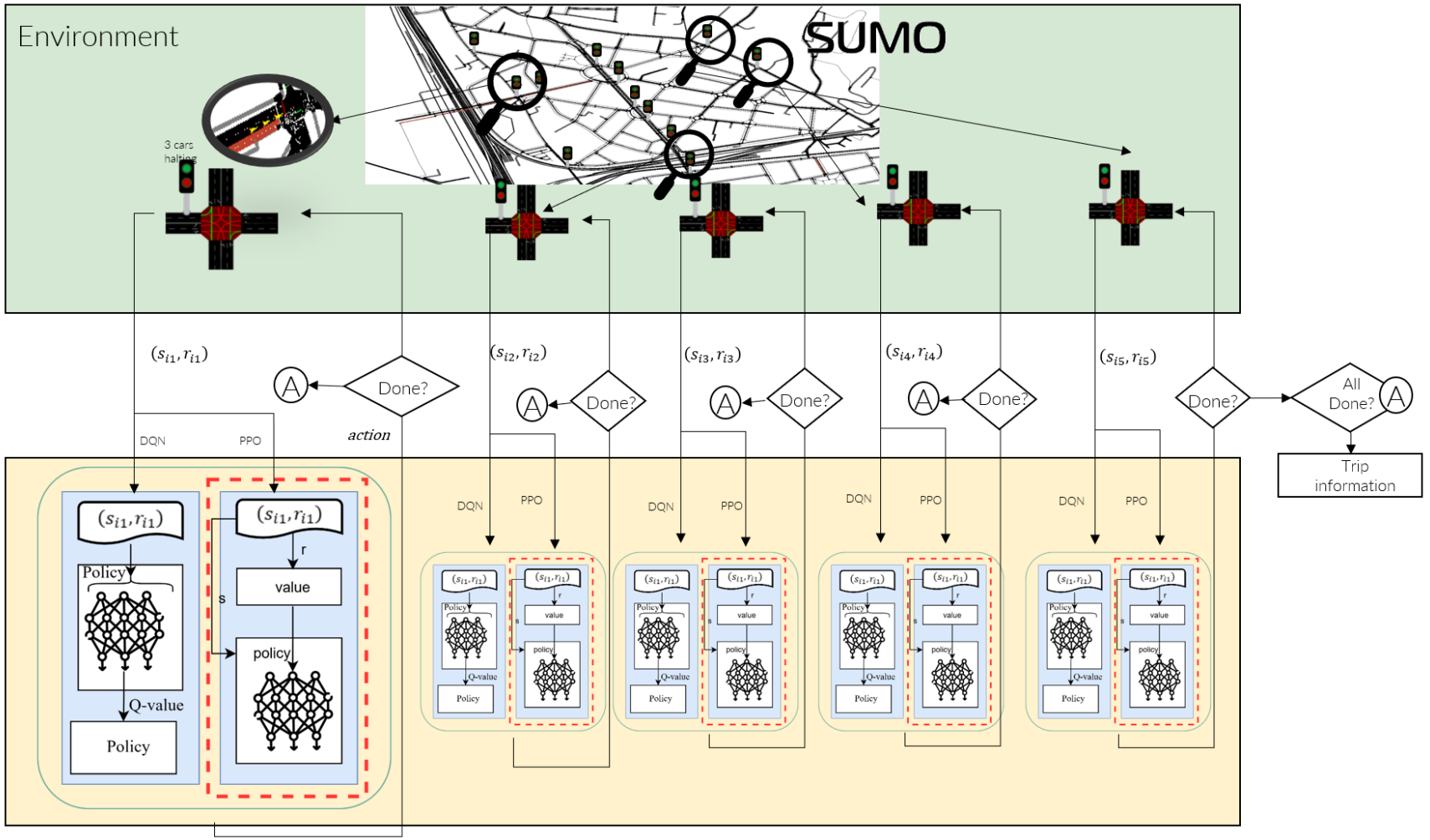
Optimization Drivers

- ***MTT*, Mean Travel Time** on
  - Multiple Directions or globally
  - For specific service
- ***MWT*, Mean Waiting Time** on
  - specific direction or globally
  - For specific service
- ***MNS*, Mean Number of Stops** on
  - specific direction or globally
  - For specific service



Multi Agent DRL





Z. Fereidooni, L.A. Ipsaro Plaesi, P. Nesi, Multi Agent Optimizing Traffic Light Signals Using Deep Reinforcement Learning, IEEE Access, 2025.

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MTT for Multi Agent DRL for TLP

Model	TL	all	dir_N	dir_M	dir_A	dir_D	Careggi	Costanza
4TWD-NTNS-MWD-A	1	3013.85	176.93	233.75	194.46	237.65	436.00	427.00
4TWD-NTNS-MWD-P-A	1	3013.85	176.93	233.75	194.46	237.65	436.00	427.00
SUMO Actuated	1	2935.41	249.60	209.77	202.42	270.86	486.73	478.36
Webster	1	5188.87	211.66	242.32	205.46	562.31	984.00	427.00
Webster A	1	2968.90	183.50	242.67	201.27	251.76	482.27	427.00
SARL-FC DQN	1	2834.93	206.68	244.78	199.21	243.26	486.72	485.00
SARL-FC DQN A	1	2760.12	206.35	244.63	198.00	244.76	436.00	427.00
MADRL-FC DQN	1	3089.20	188.29	220.91	205.07	248.06	485.00	445.00
MADRL-FC DQN A	1	2983.69	189.11	220.70	187.00	248.79	436.00	427.00
MARL-FC PPO	1	2910.76	200.38	235.41	198.14	237.78	547.00	445.00
MARL-FC PPO A	1	2855.12	200.93	235.53	196.39	237.97	436.00	427.00
SMART A	1	2599.13	182.14	200	188.28	235.11	436.00	427.00

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SNAP4CITY | KM 4 CITY

Traffic Infrastructure Optimization



MOST
CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

FROM CITY DASHBOARD TO APPLICATIONS

SNAP4CITY THE VIEW OF THE ADMINISTRATORS

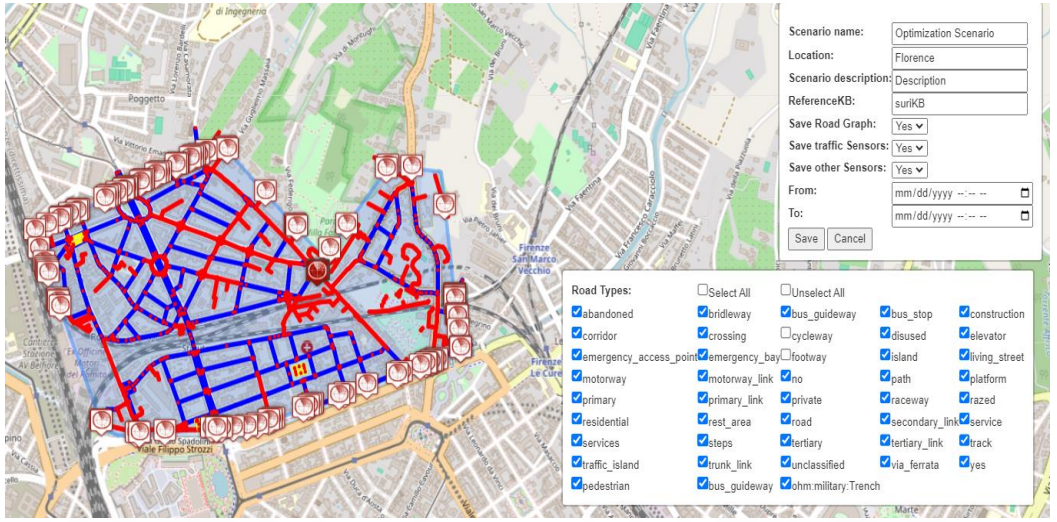
11 SUSTAINABLE CITIES AND COMMUNITIES

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



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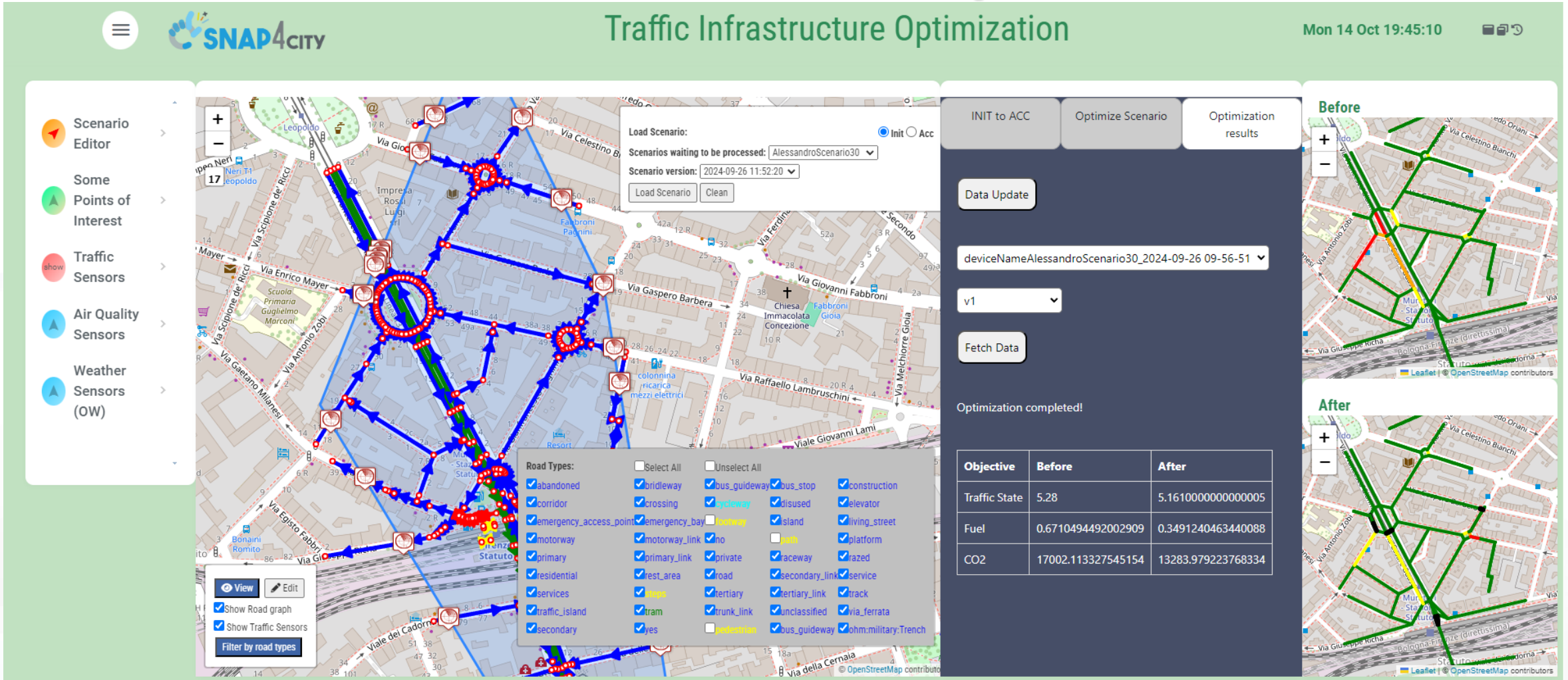
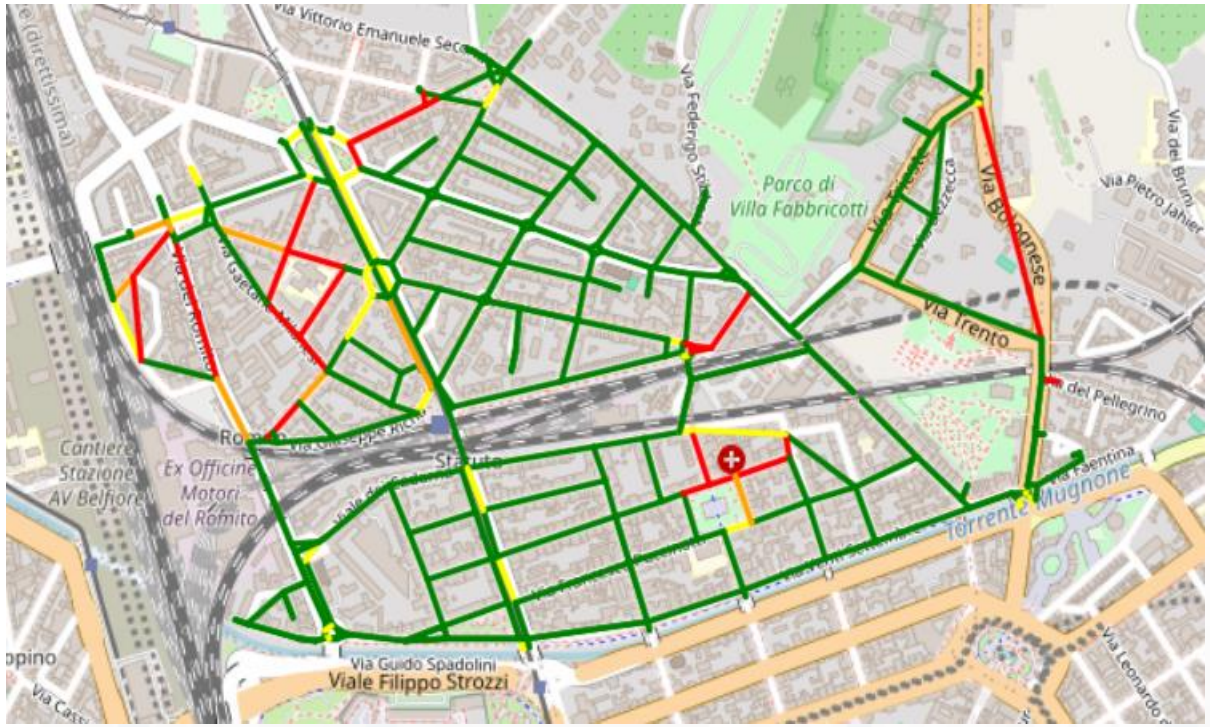
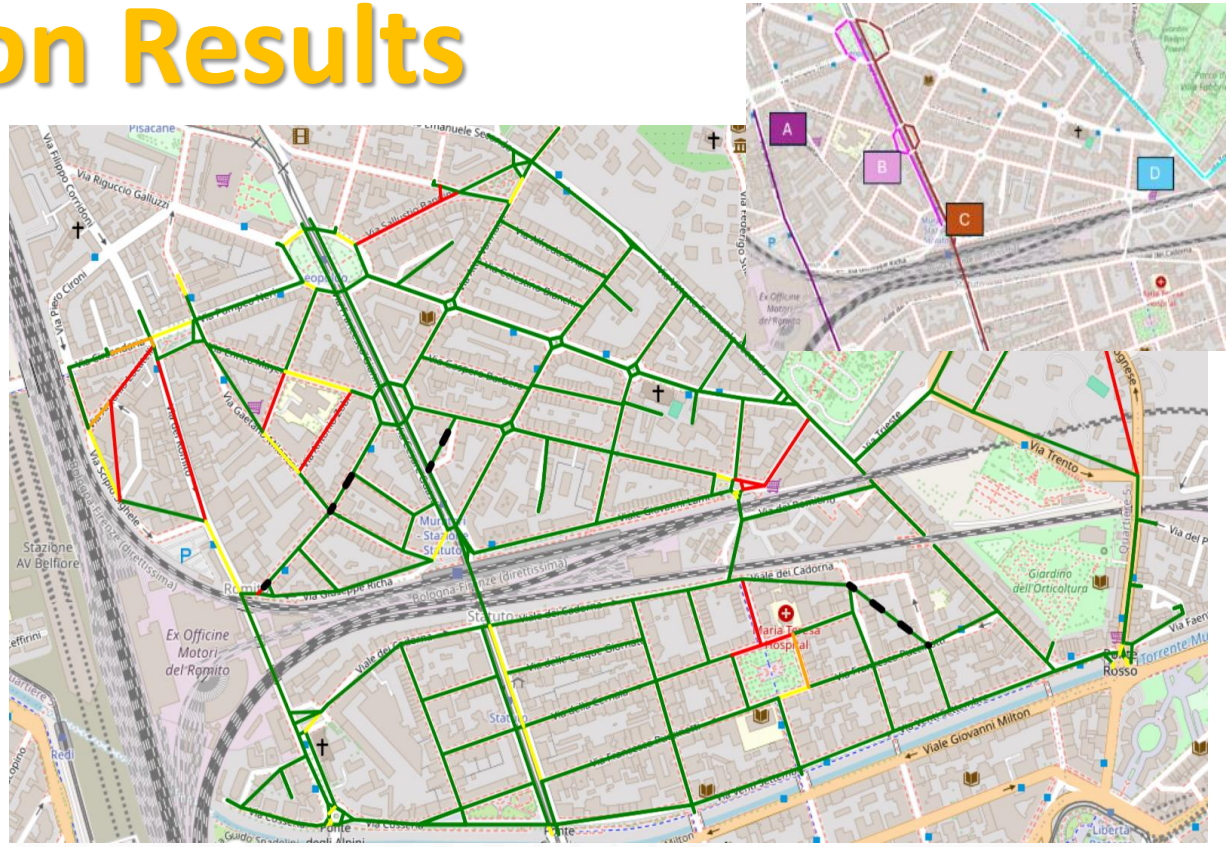
Traffic Infrastructure Optimization



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%	

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SNAP4CITY

KM4CITY

Solution: eSharing and Pooling



FROM CITY DASHBOARD TO APPLICATIONS

DATA GATHERING AND CITY DATA KNOWLEDGE MANAGEMENT

MEDIA ANALYSIS

SNAP4CITY AND KM4CITY PROJECTS

HOW TO ADOPT SNAP4CITY, AND OUR ROADMAP

SNAP4CITY THE VIEW OF THE ADMINISTRATORS

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

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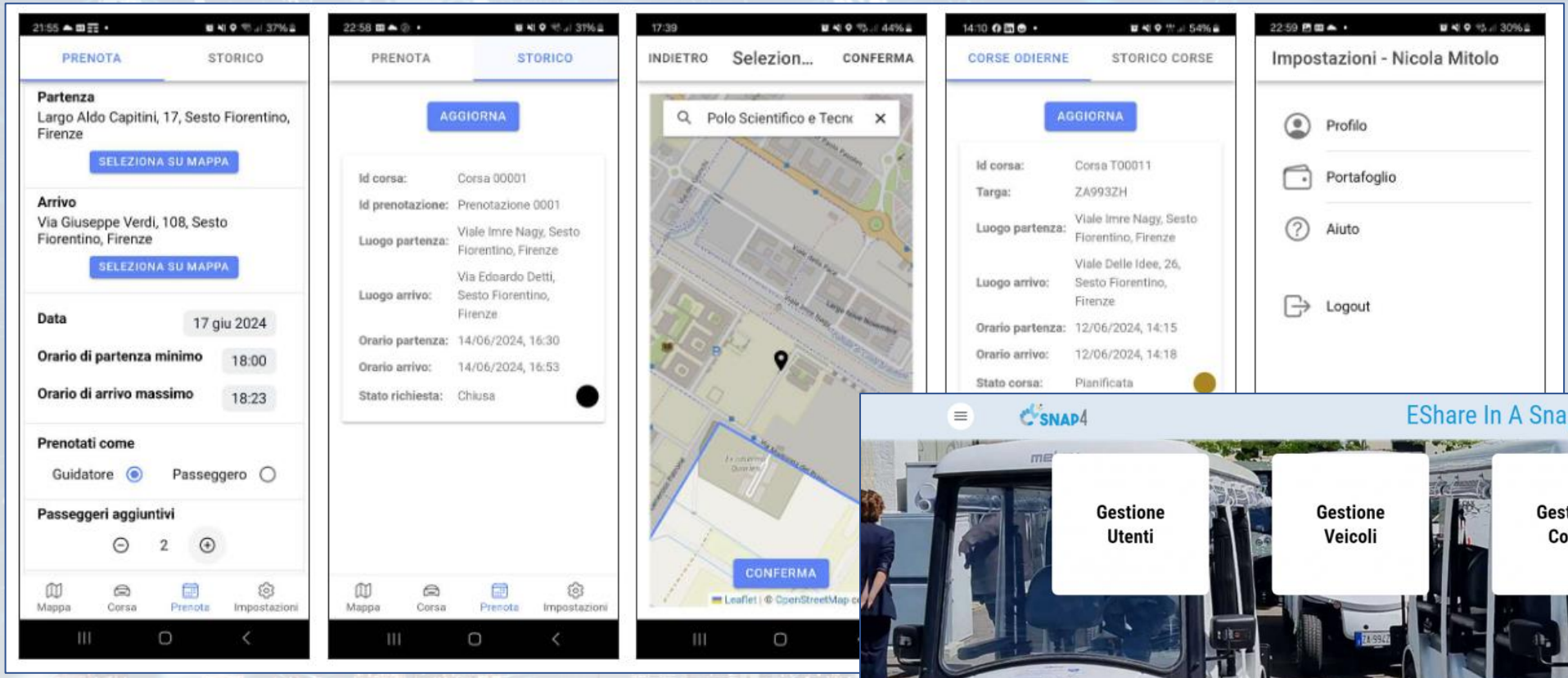
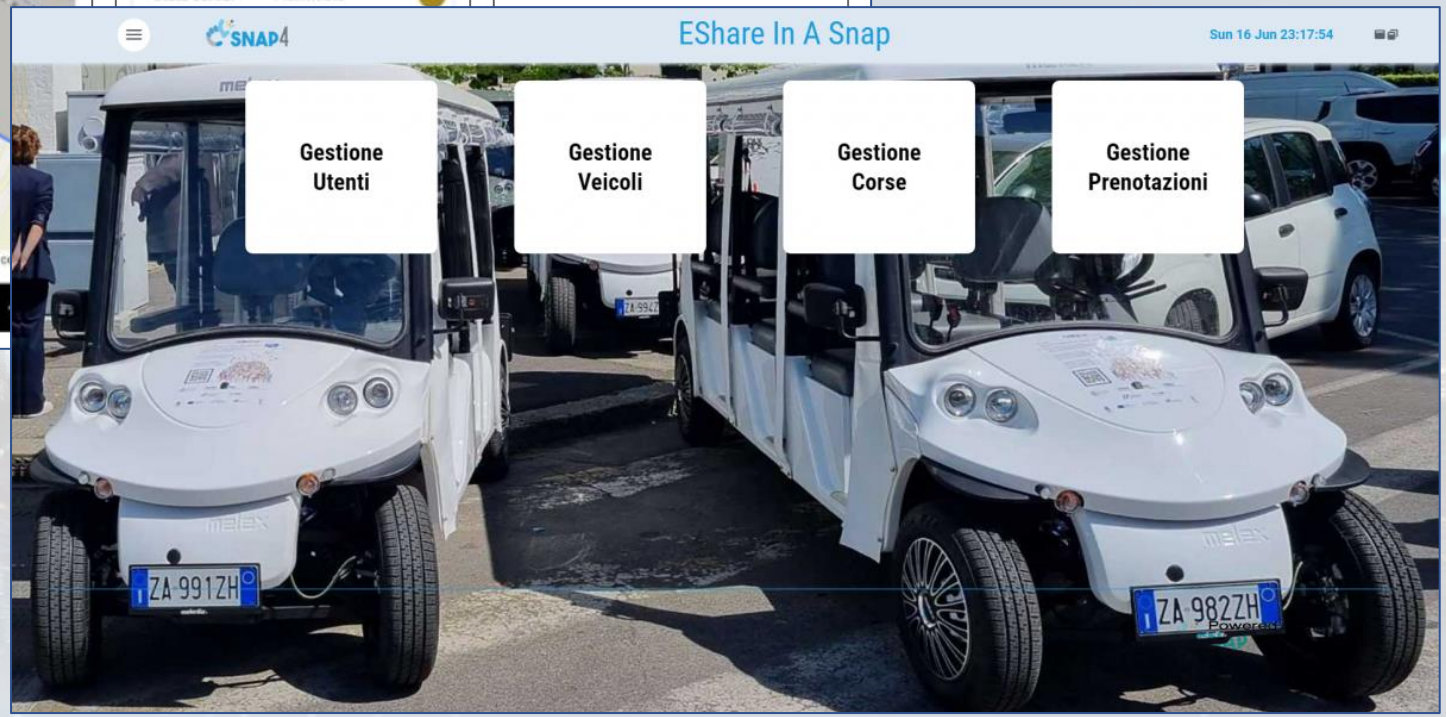
eShare in a Snap, by Snap4





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

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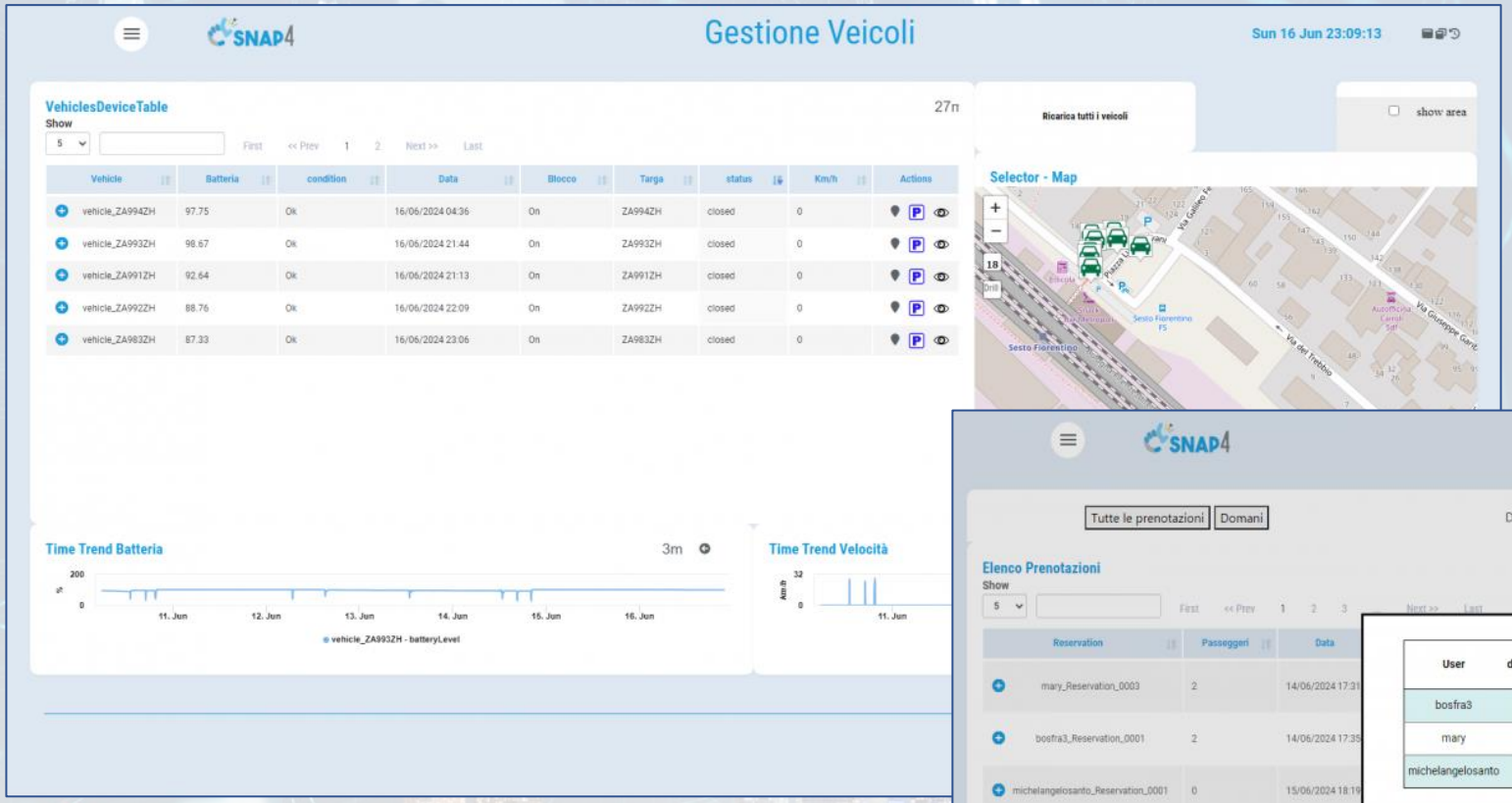
eShare in a Snap, by Snap4





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

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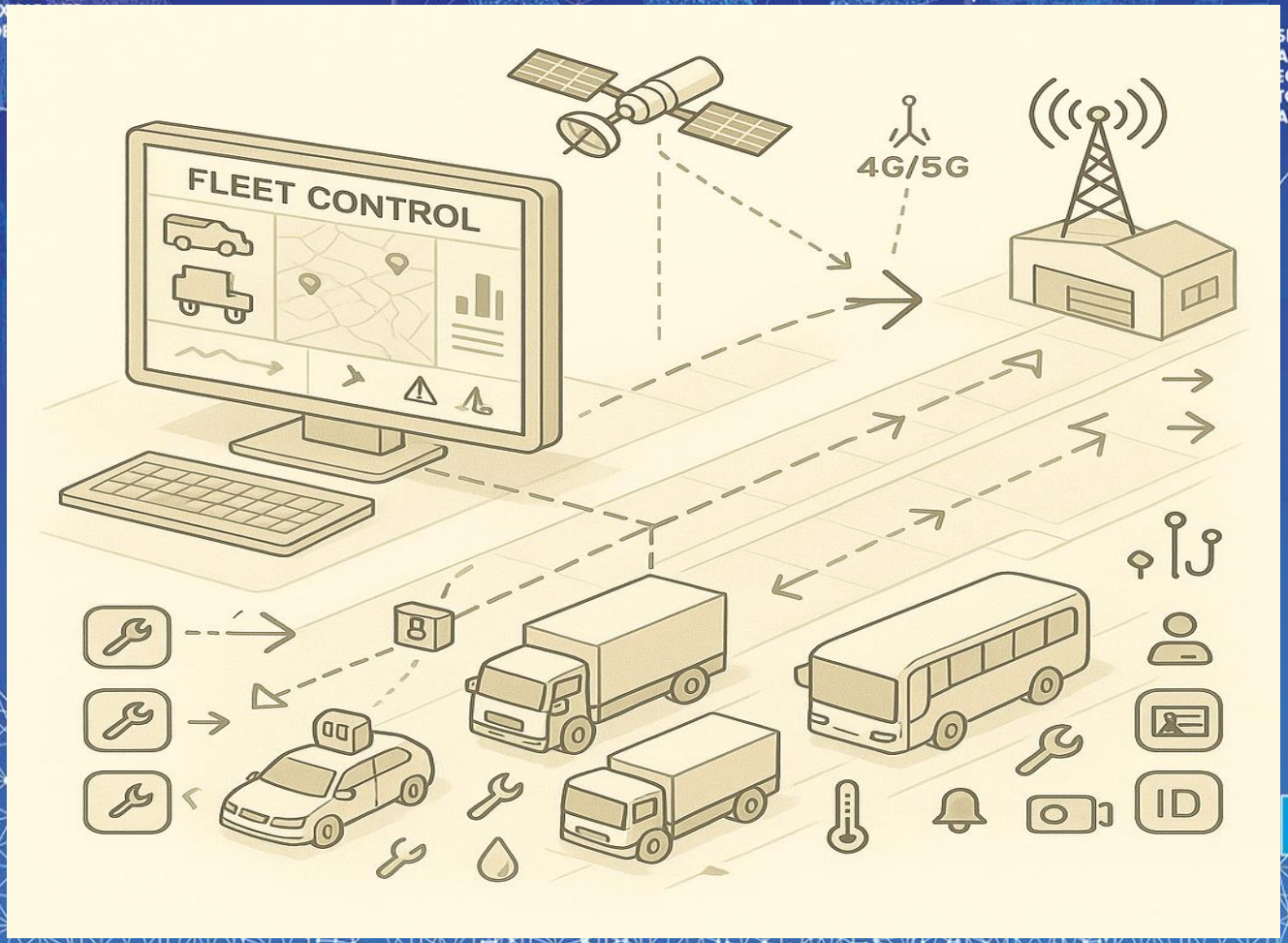
Solution: Fleet Monitoring and tracking



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Fleet Monitoring and Management



https://www.csselectronics.com/

ASAM MDF
Configuration

Snap4Fleet Logger

Data Lake	Decoder MDF Decoder CAN (DBC)

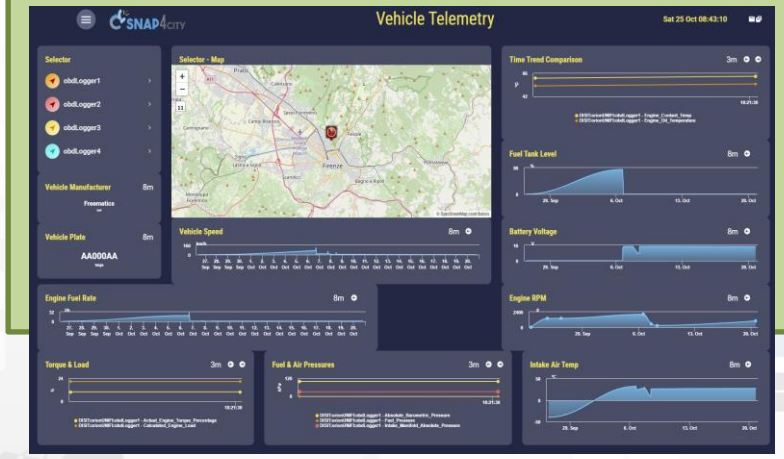
IoT App/Proc.Logic
Snap4City Edge

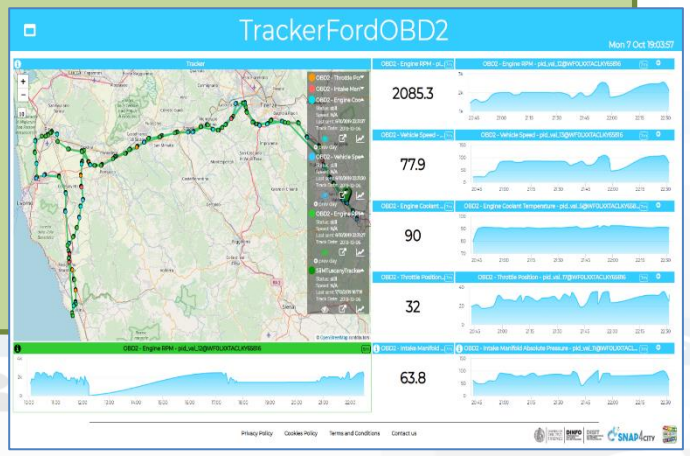


- Configuring data logger
- Selecting parameters
- Decoding and pushing data on Snap4City Platform AI enabled platform
- Toward the Snap4Fleet Manager



Snap4Fleet Manager **on Snap4City Platform**





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For Fleet Management

MyKPI: Tracking of Devices and Mobiles

- Real Time Trajectories for
  - Mobile Phone
  - Moving IOT Devices
  - OBU, Vehicular Kits
  - Multiple tracks
  - Day by day
- Micro Application



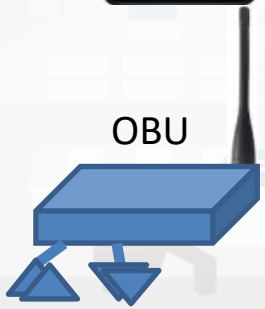
Mobile
PAX Counter



Apps

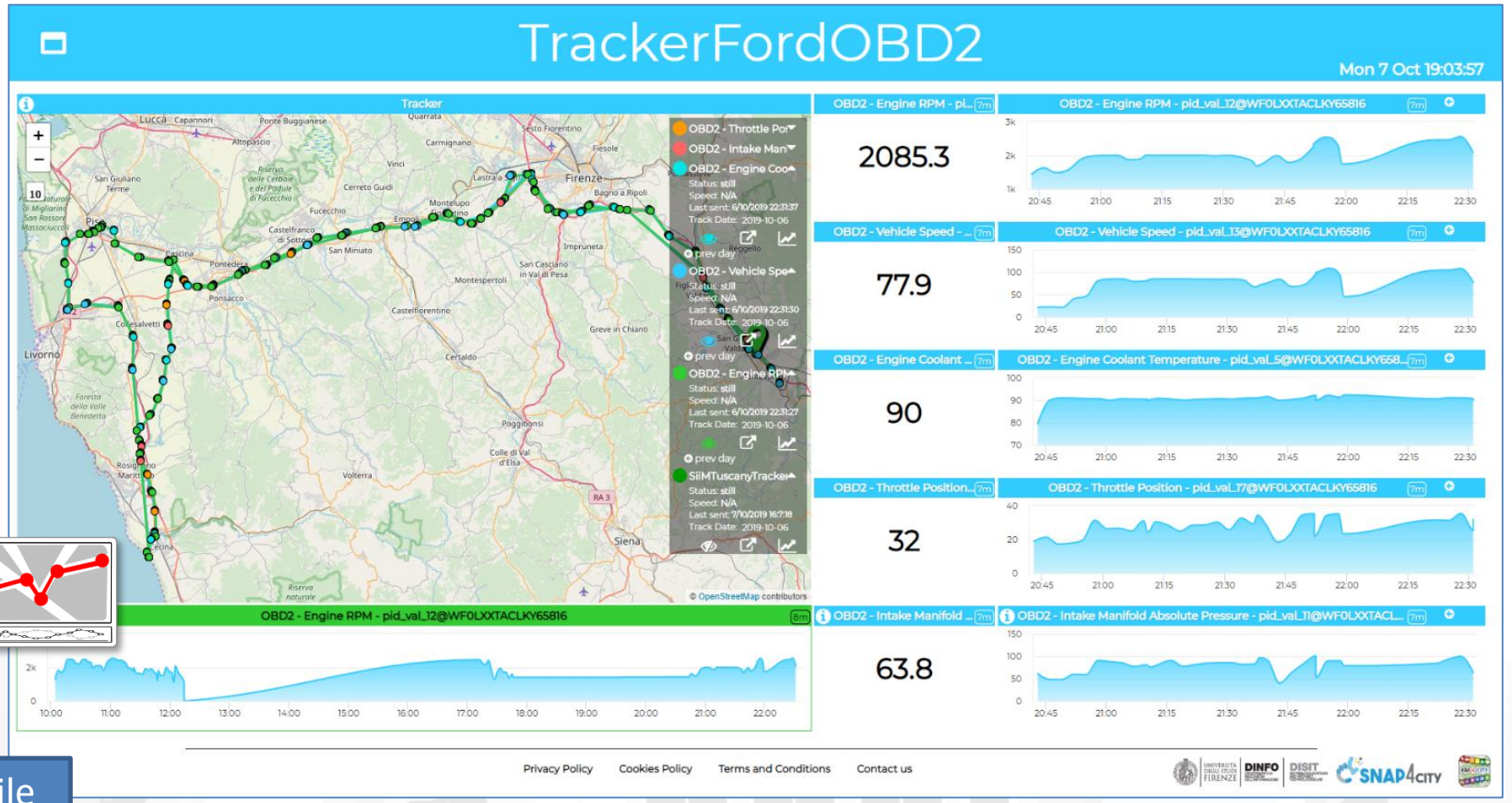


OBD2



OBU

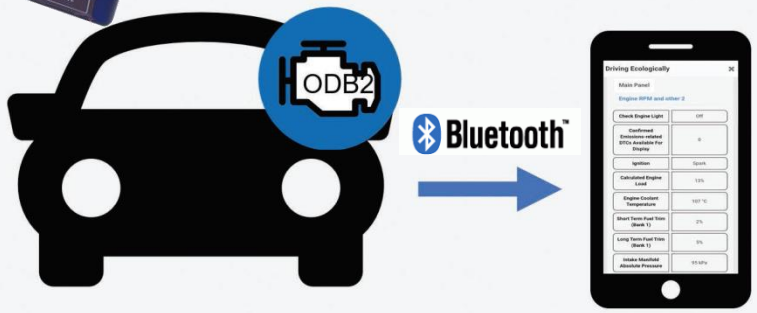
Mobile sensors

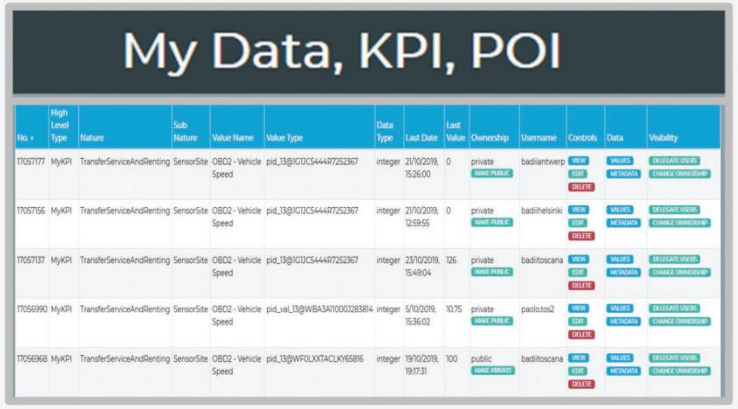


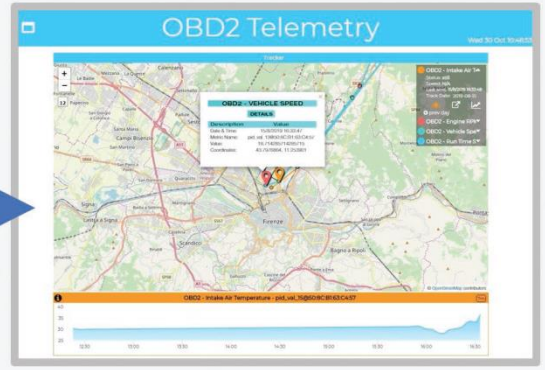
IOE – Vehicle Monitoring



CANBUS sniffer



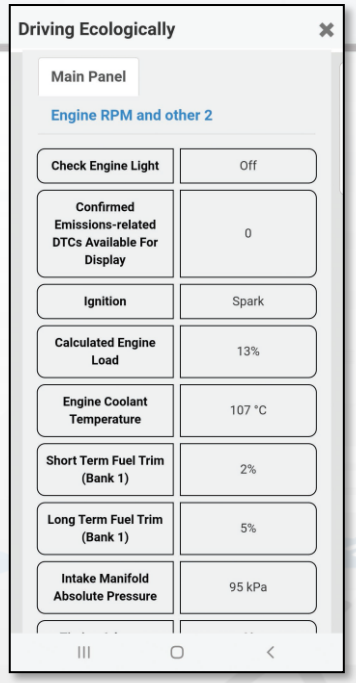


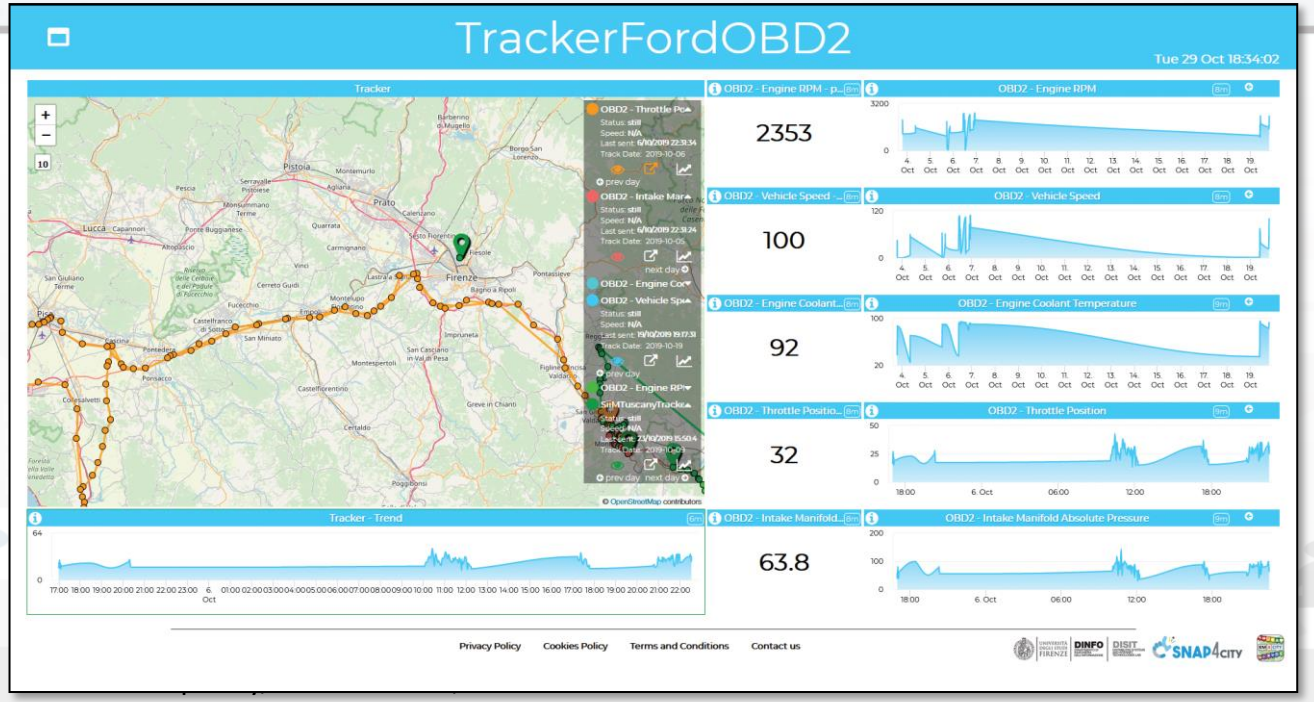


Tuscany in a Snap Mobile App on Android

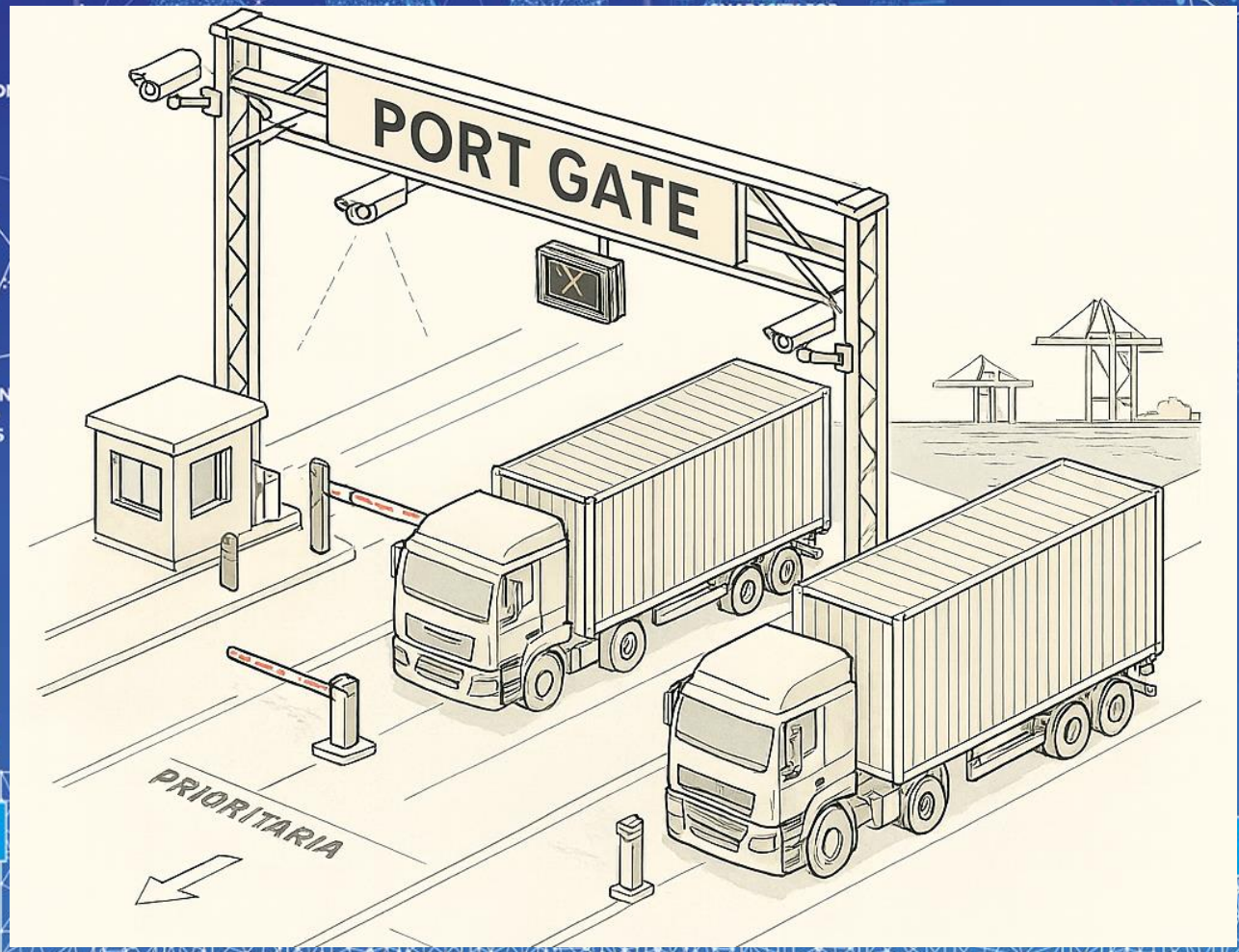








Solution: Plate/Container ID recognition



by Snap4 s.r.l.

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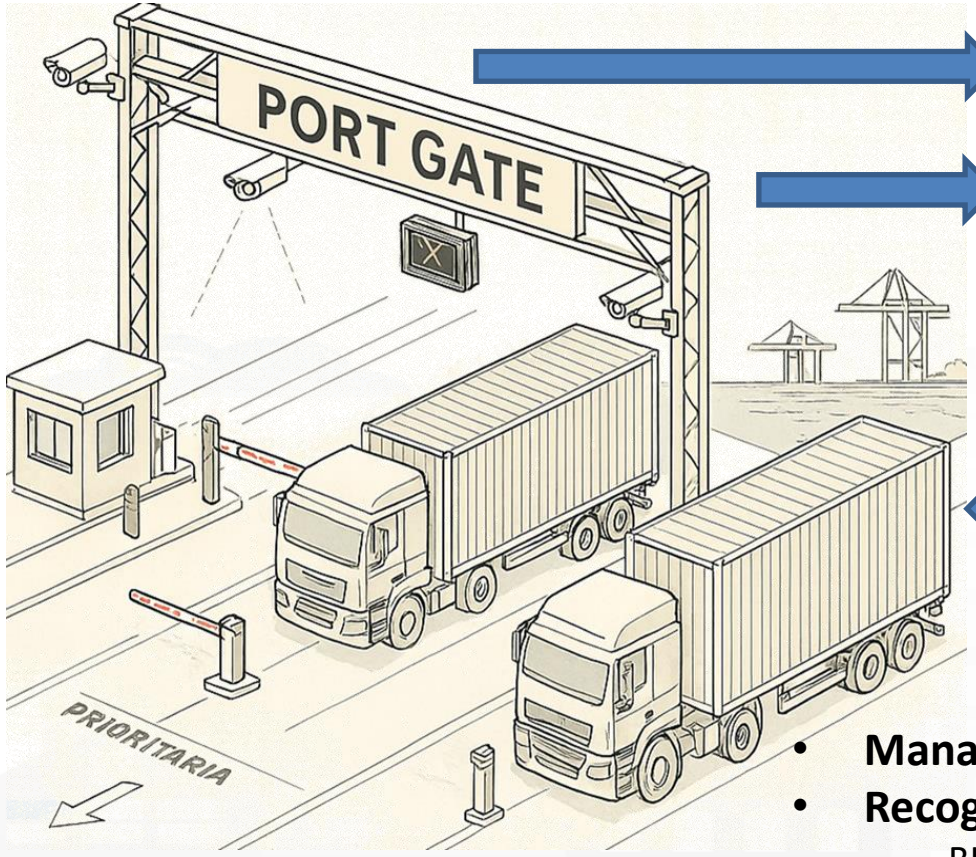
Trucks' Plates and Container ID Recognition





Interoperability

Snap4City Platform

Signage/Control



- **Managing Gates** in/out
- **Recognition and decoding**
  - BIC code: FCIU 964484 8
  - ISO code: 45G1
  - Seal status: on/off
  - Multi-national Plates: EX 398AE

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Trucks' Plates and Container ID Recognition

- **Managing Gates (see Salerno Port)**
  - Multiple Gates/Lanes and multiple TV Cameras: in/out
  - Measuring accuracy
  - Recognition of nationality
  - Single of Multipoint detection
  - Trucks and trailers
  - Storing images for Furter analysis
  - History of in/out events, administration, interoperability

- **Recognition and decoding**
  - BIC code: FCIU 964484 8
  - ISO code: 45G1
  - Enabled for Seal status detection: on/off
  - Multi-national Plates: EX 398AE



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Smart Energy and Smart Building

Goals

Details

THE POWER OF ARTIFICIAL INTELLIGENCE AT THE SERVICE OF YOUR OPERATION AND PLAN

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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

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

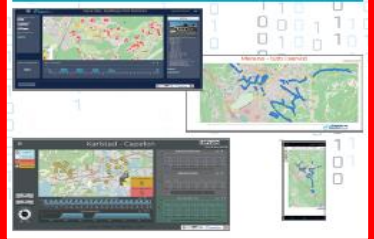
HORIZONTAL AI PLATFORM



MOBILITY AND TRANSPORT



SMART ENERGY AND SMART BUILDING



ENVIRONMENT AND WASTE MANAGEMENT



CITY USER'S SERVICES AND TOURISM MANAGEMENT



SNAPADVISOR



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



DASHBOARDS, WIDGETS
TEMPLATES



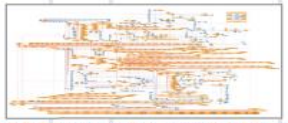
PREDICTION - ANOMALY DETECTION - CLUSTERING - ROUTING - SENTIMENT NLP - TRAFFIC FLOW - PEOPLE FLOWS - SDG
15 MIN CITY INDEX - KPI - HEATMAPS - ORIGIN DESTINATION - MAPS - VECTOR FIELD - ETC...



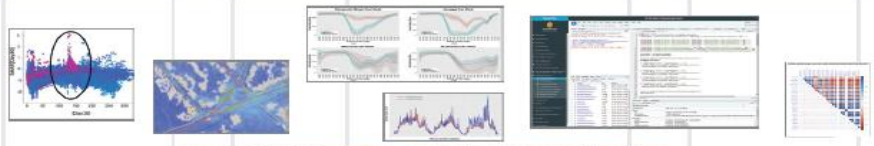
API - MICROSERVICES - GIS - BPM
VIDEO - REPORTS - MAPS - 3D ...

- DEVELOMENT ENVIRONMENT AND METHODOLOGY
- VISUAL PROGRAMMING, ML, AI, HPC
- TRAINING COURSES





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



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



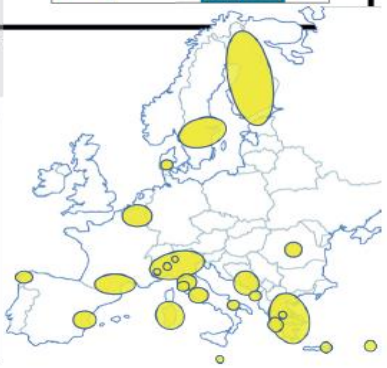
VISUAL PROGRAMMING, ADAPTERS
DATA FLOWS, WORKFLOWS
PARALLEL DISTRIBUTED PROCESSING
DATA DRIVEN

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



NATIVE AND EXTERNAL APPLICATIONS

- Smart Parking
- Smart Light
- Smart Waste
- Smart Energy
- Smart Building
- Smart Tourism
- ...

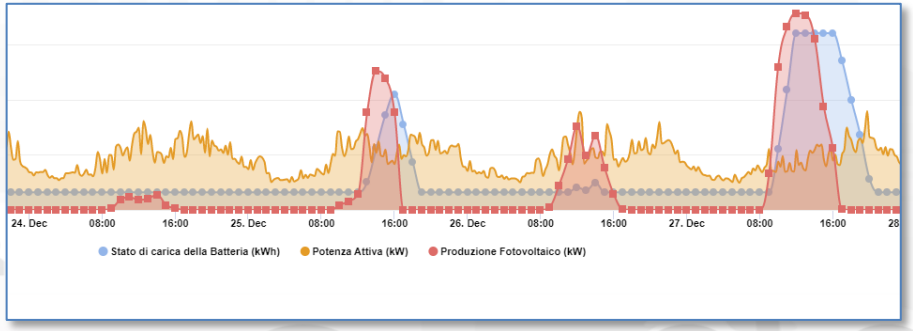


City Energy and Buildings

- **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**







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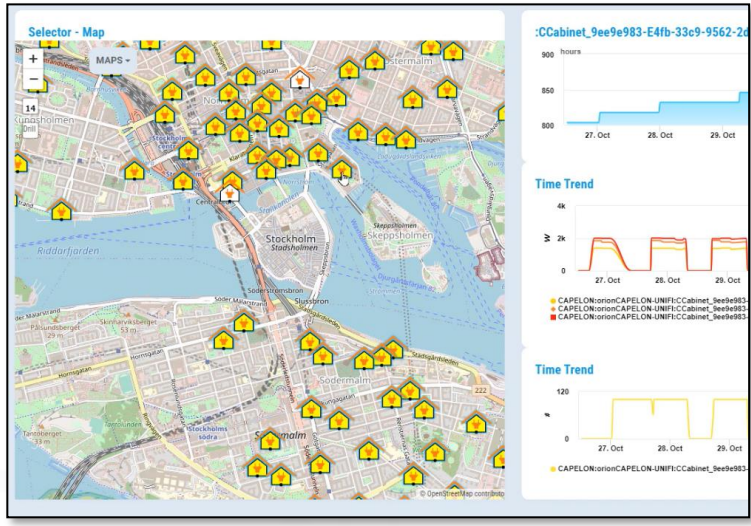
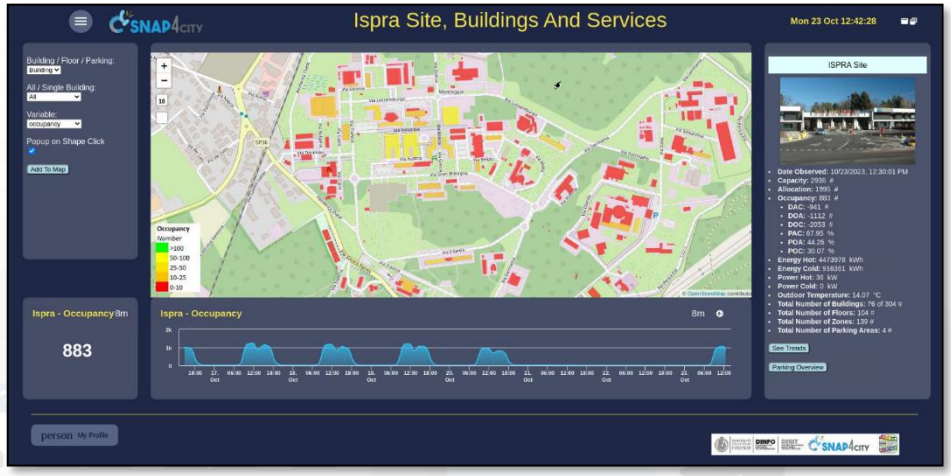
Energy Domain (2024/8)

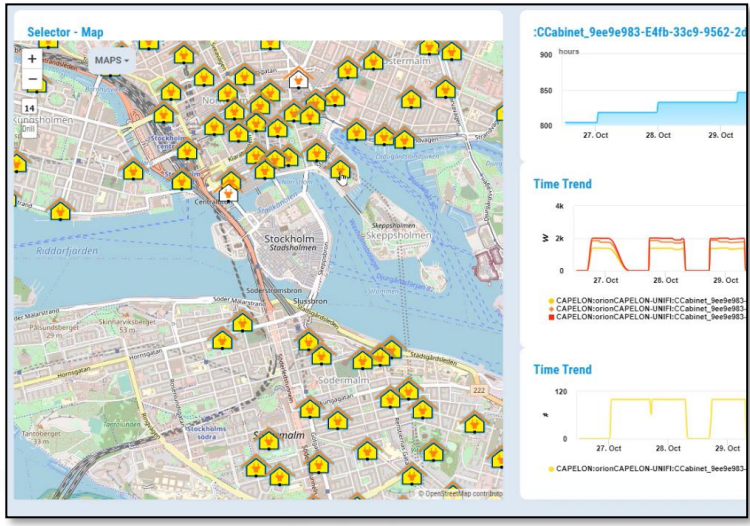
- Goals:
  - Energy consumption reduction, increment of efficiency, sustainability
  - accessibility to services
- Solutions for Operation (monitoring, managing, mobile apps, digital signages, control rooms)
  - Monitoring energy consumption (heating, cooling, prod.,..), conditions, charging stations, 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



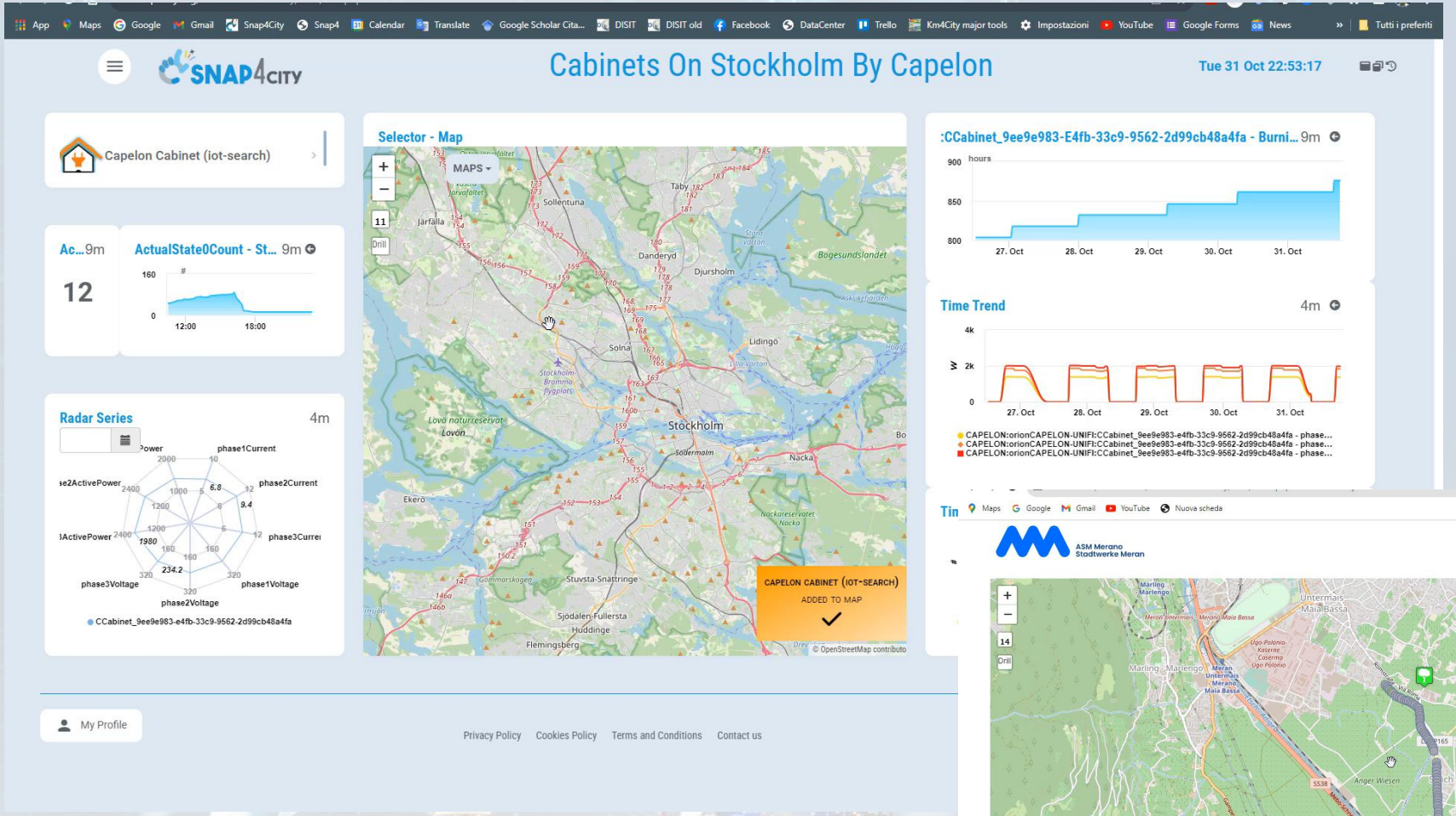


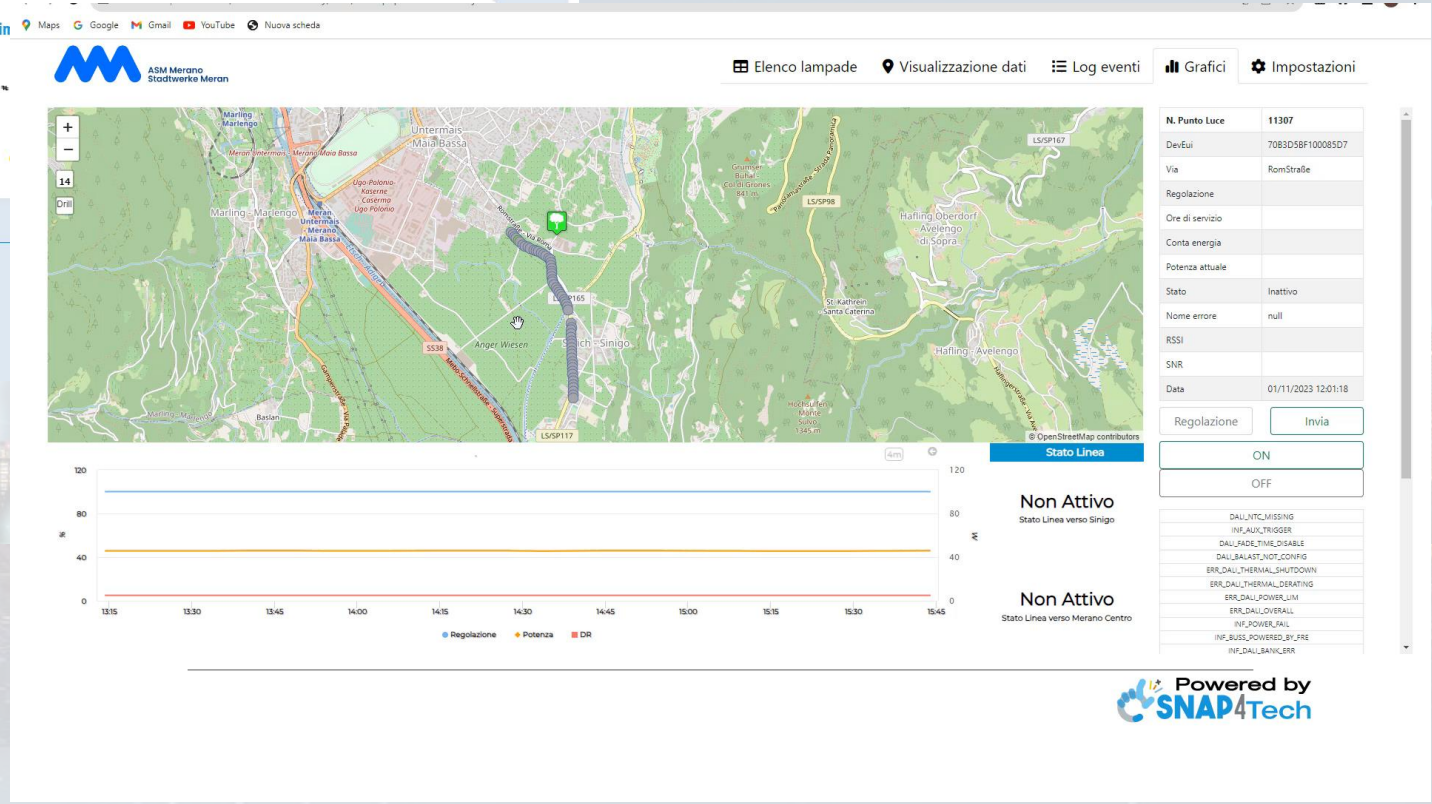
Tools: Energy Domain (2024/8)

- **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

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Snap4Cuneo | Snap4CityDocker | Dashboard Management Syste

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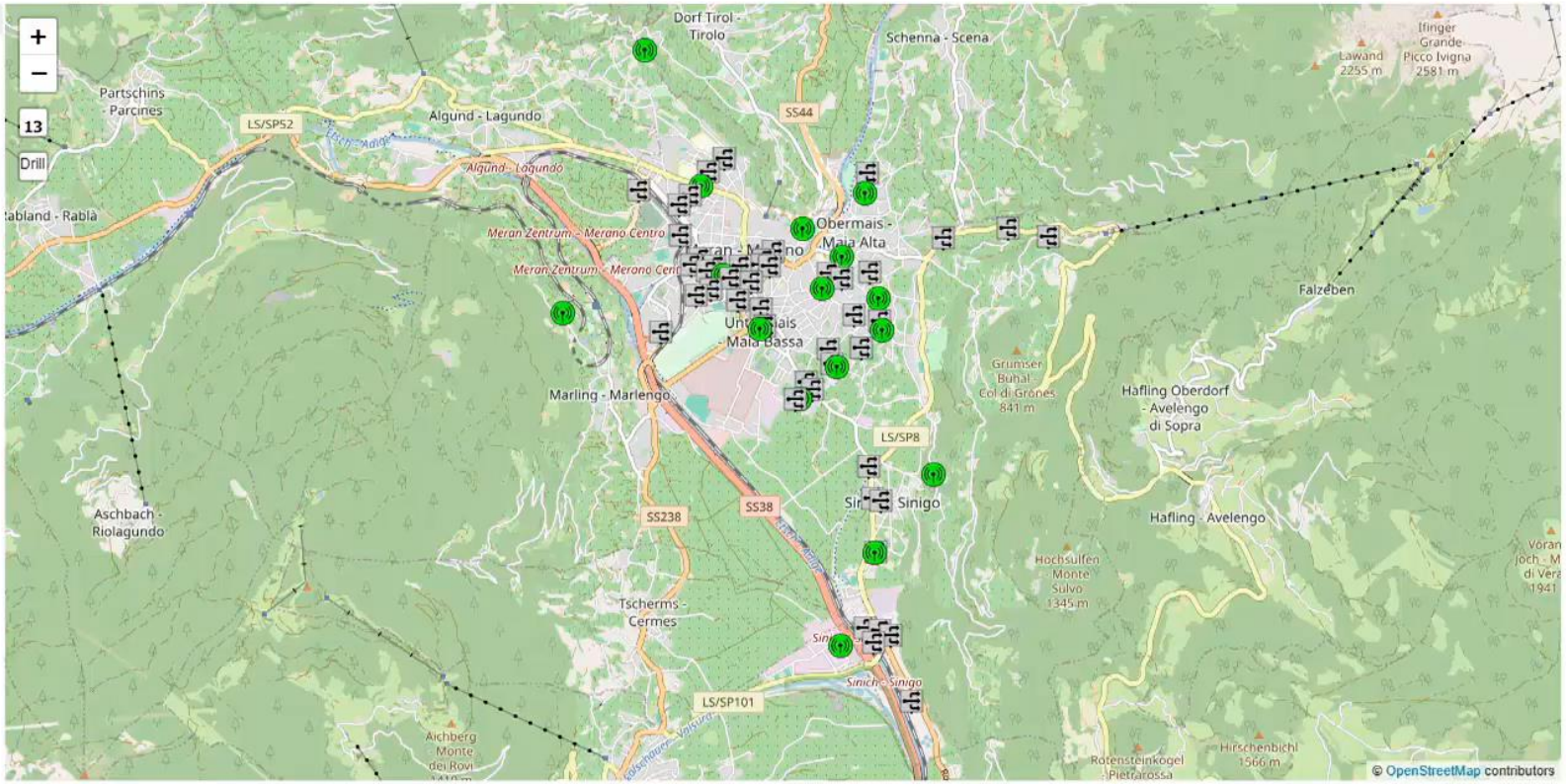
ASM Merano Stadtwerke Meran

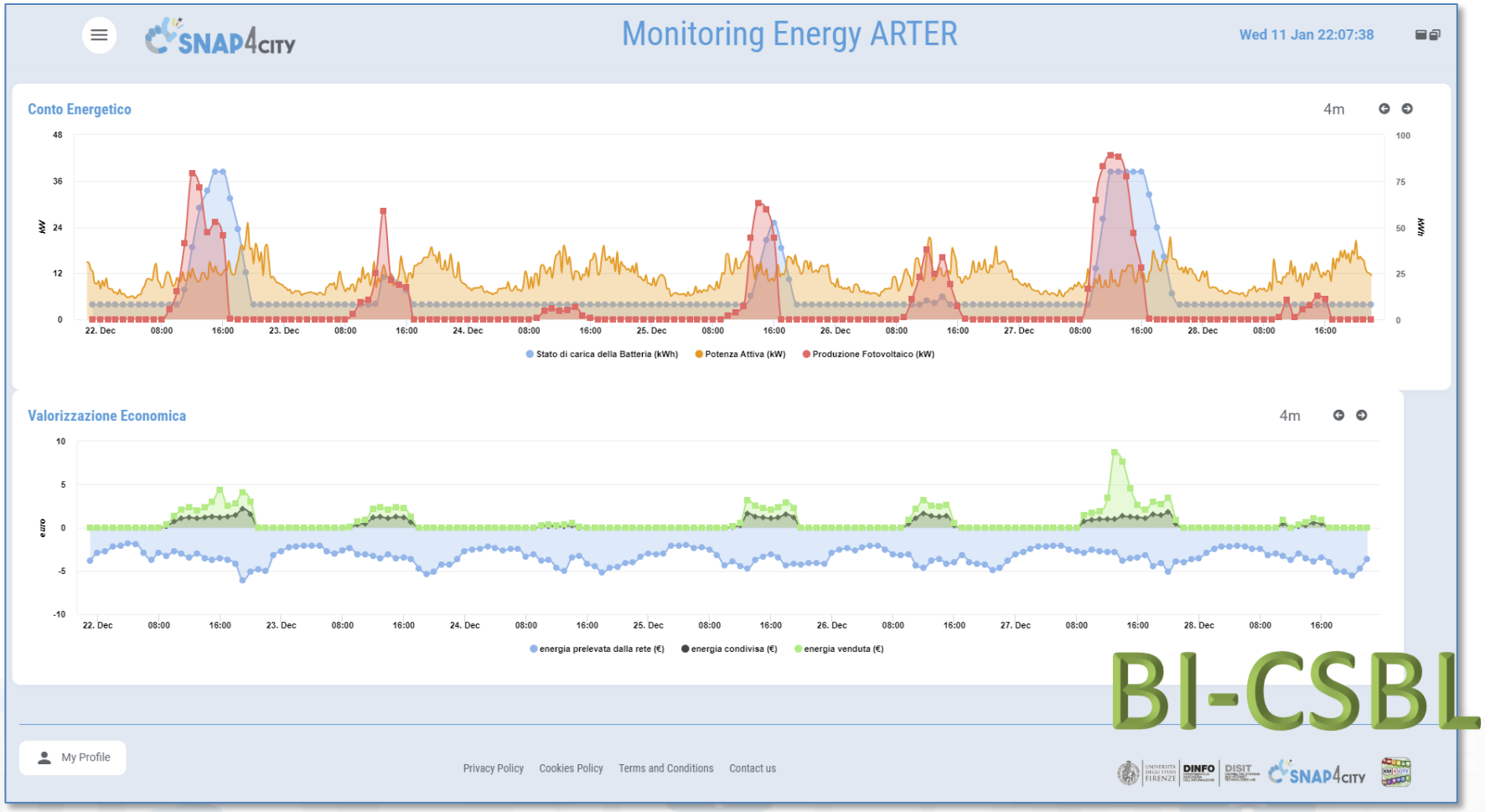
Visualizzazione dati | Elenco lampade | Log eventi | Traffico | Quadri Elettrici | Grafici | Impostazioni | Profili | Configurazione

legenda	
Comunicazione inattiva	47
Comunicazione attiva e spento	0
Comunicazione attiva e acceso	0
Punto Luce in errore	0



Powered by SNAP4Tech

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



BI-CSBL

https://www.selfuser.it

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

Ciao roottooladmin1

Sat 11 Nov 17:26:28

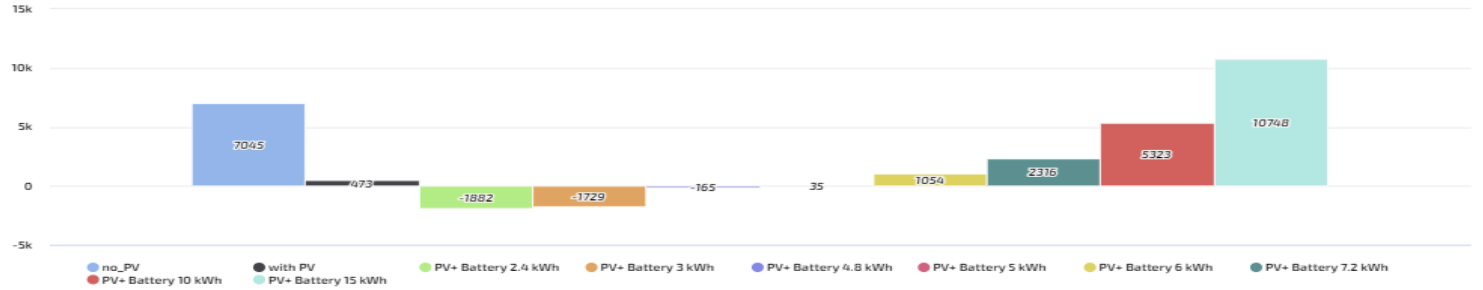
ONLINE PHOTOVOLTAIC SYSTEM SIMULATOR

User Manual

Italian Version

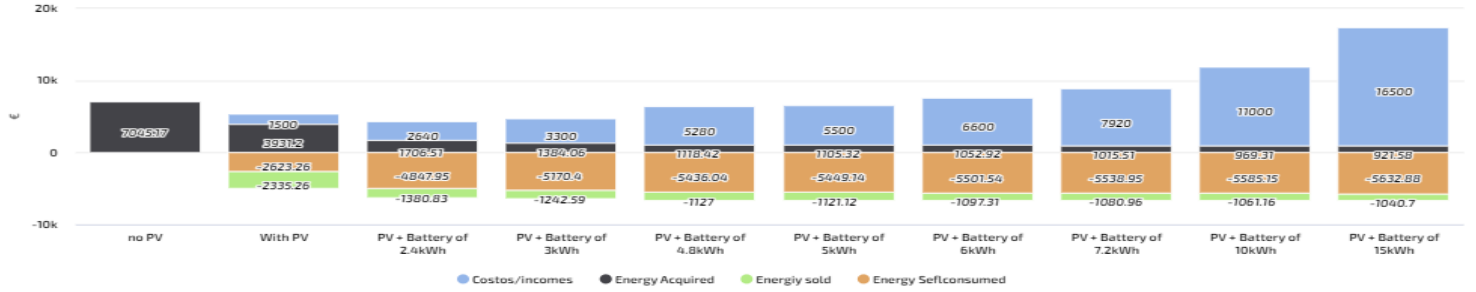
TOTAL COSTS OVER THE INVESTMENT YEARS

599m



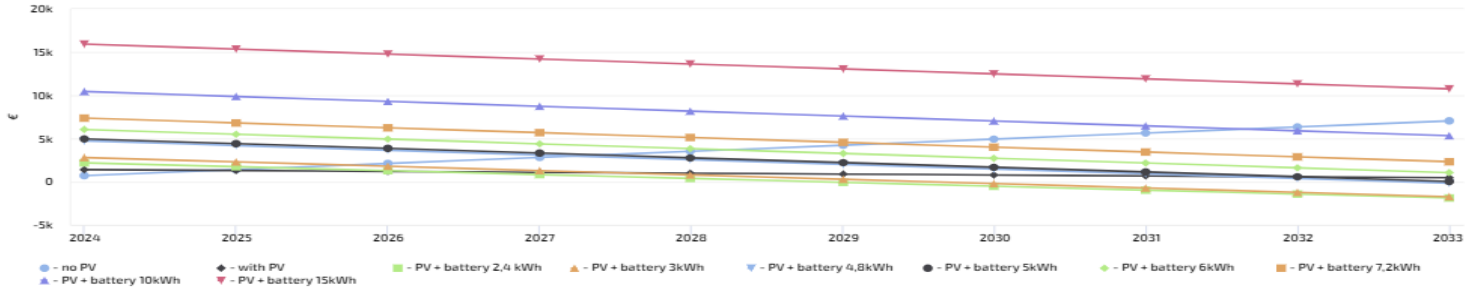
TOTAL COSTS OVER YEARS DECOMPOSED IN COSTS AND INCOMES

599m



BREAK EVEN TREND FOR THE DIFFERENT KIND OF PLANTS

599m



PARAMETERS OF YOUR PV PLANT

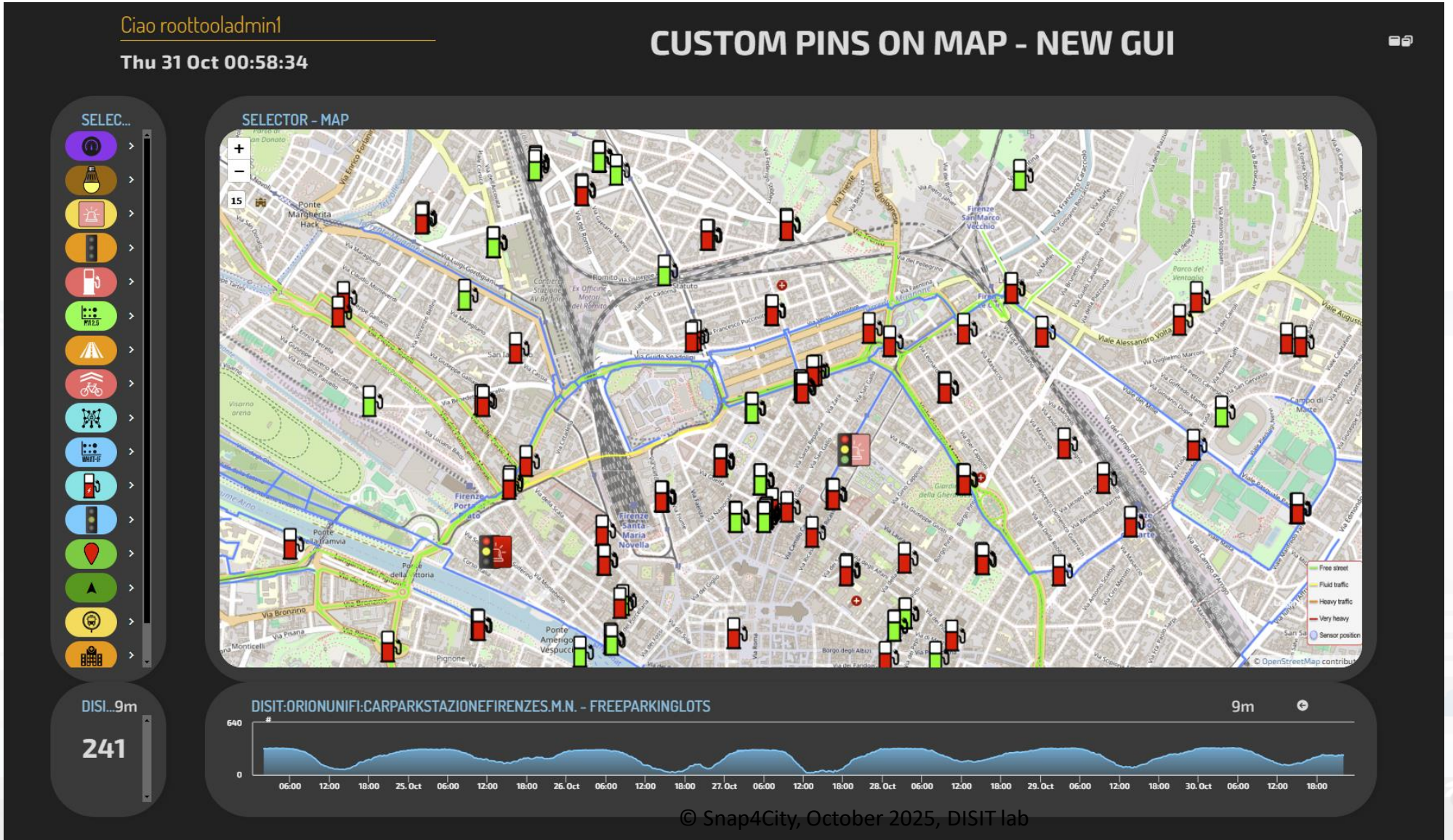
We suggest you PV plus battery of 2.4 kWh

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

Monitoring recharing station and assets



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Energy monitoring and business intelligence

Green and Data Driven District

Aggregated KPI | JuicePark | SmartPole | CityAnalytics

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

Juice Park
Detailed KPIs



Smart Pole
Detailed KPIs



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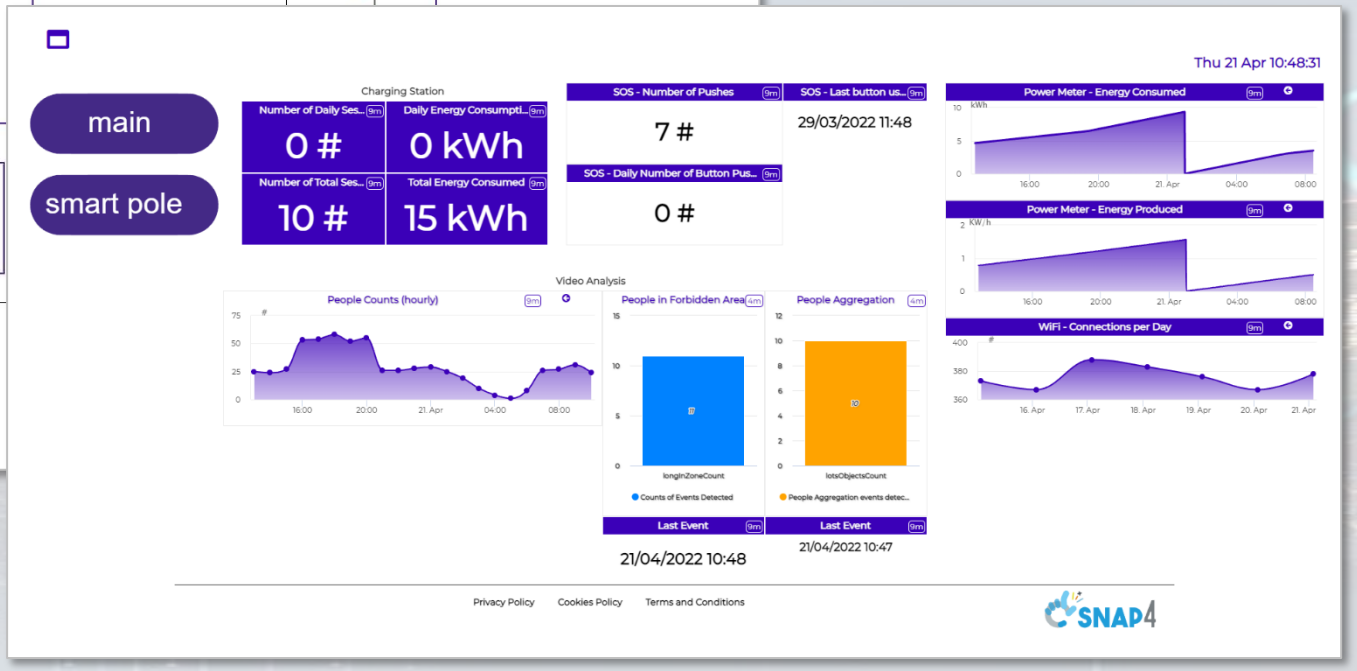





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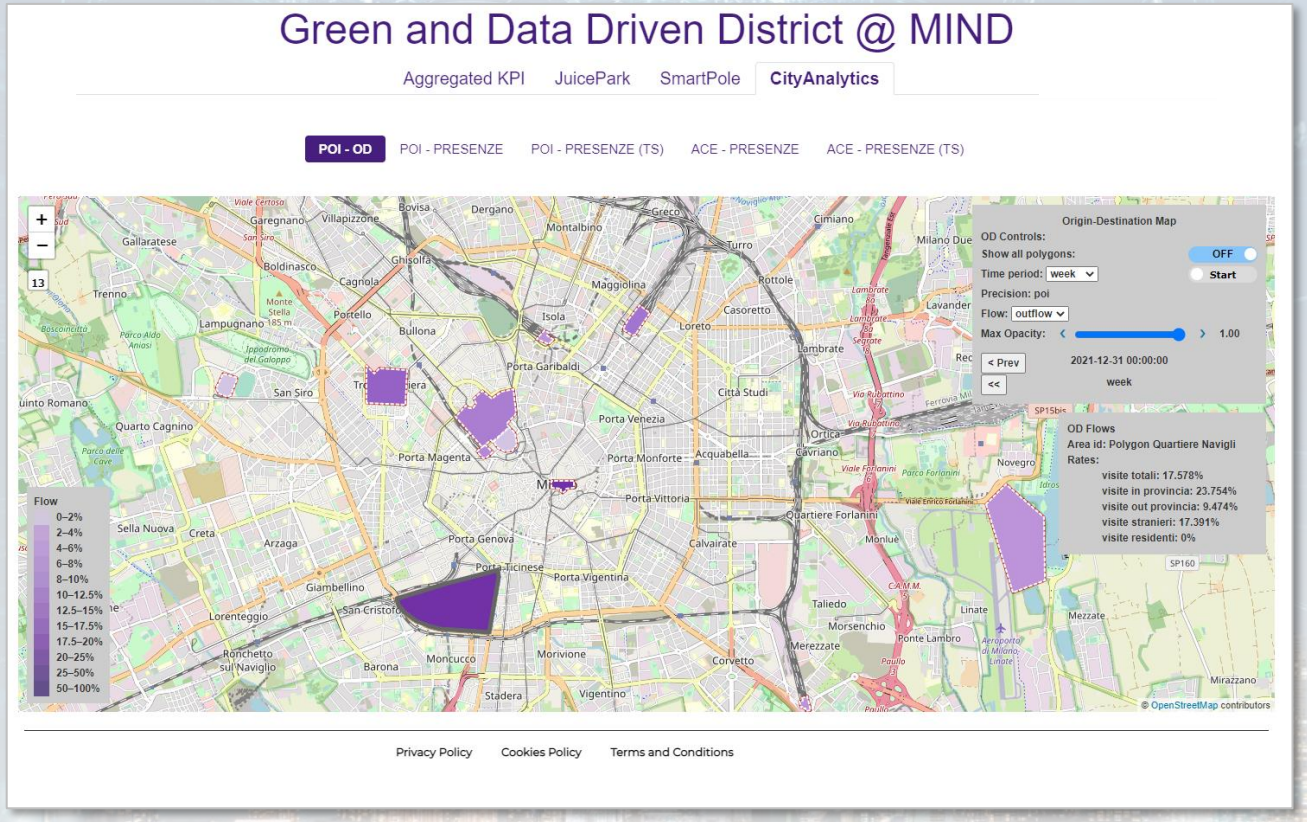
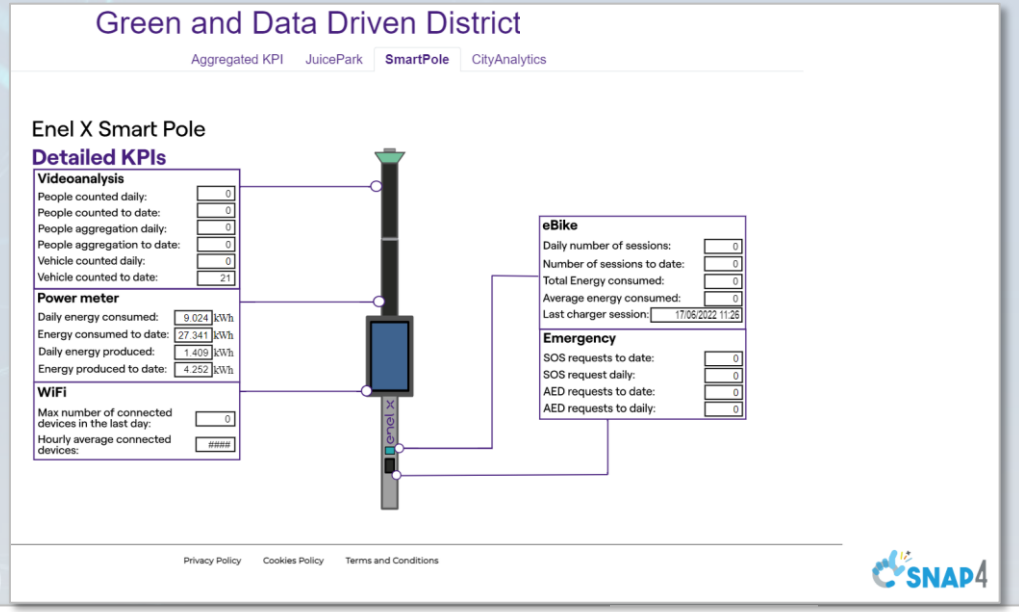
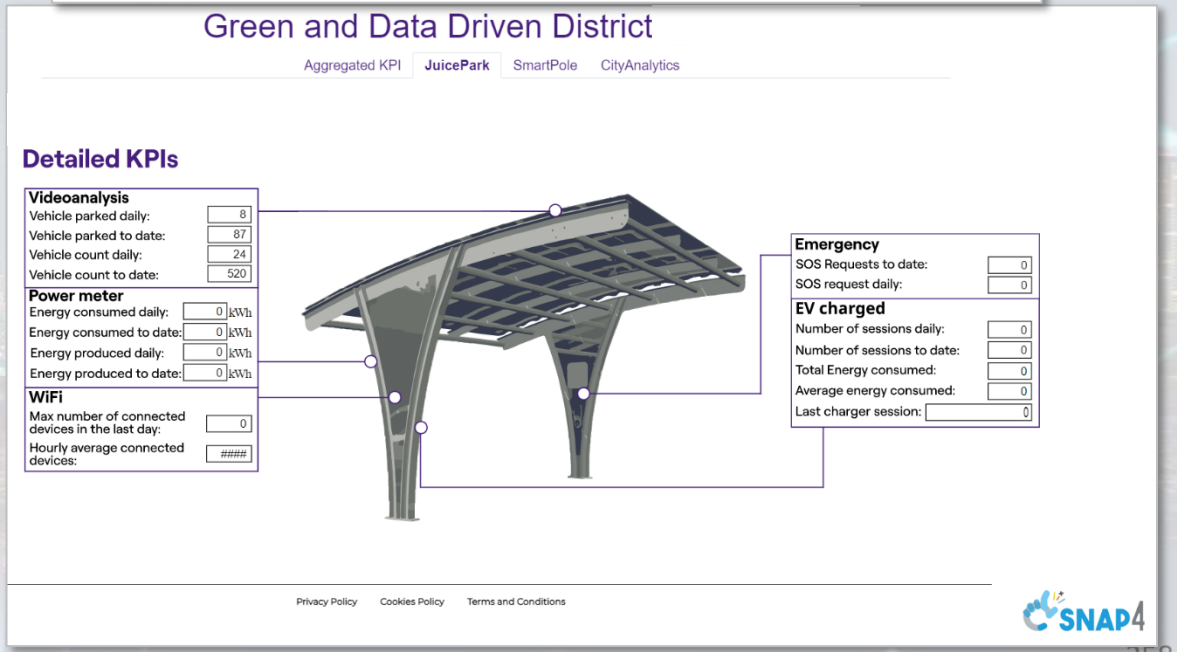
Energy monitoring and business intelligence







7 AFFORDABLE AND CLEAN ENERGY

11 SUSTAINABLE CITIES AND COMMUNITIES

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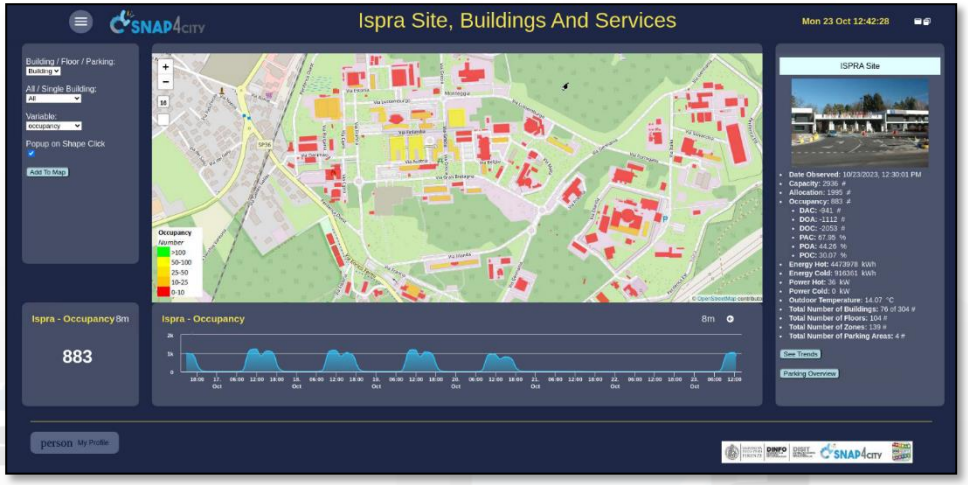
Snap4Building Domain (2024/8)

- 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

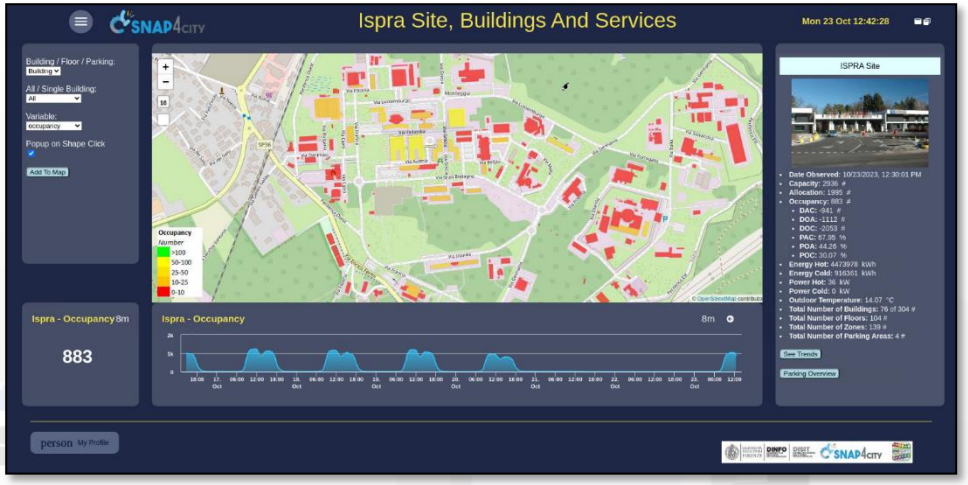




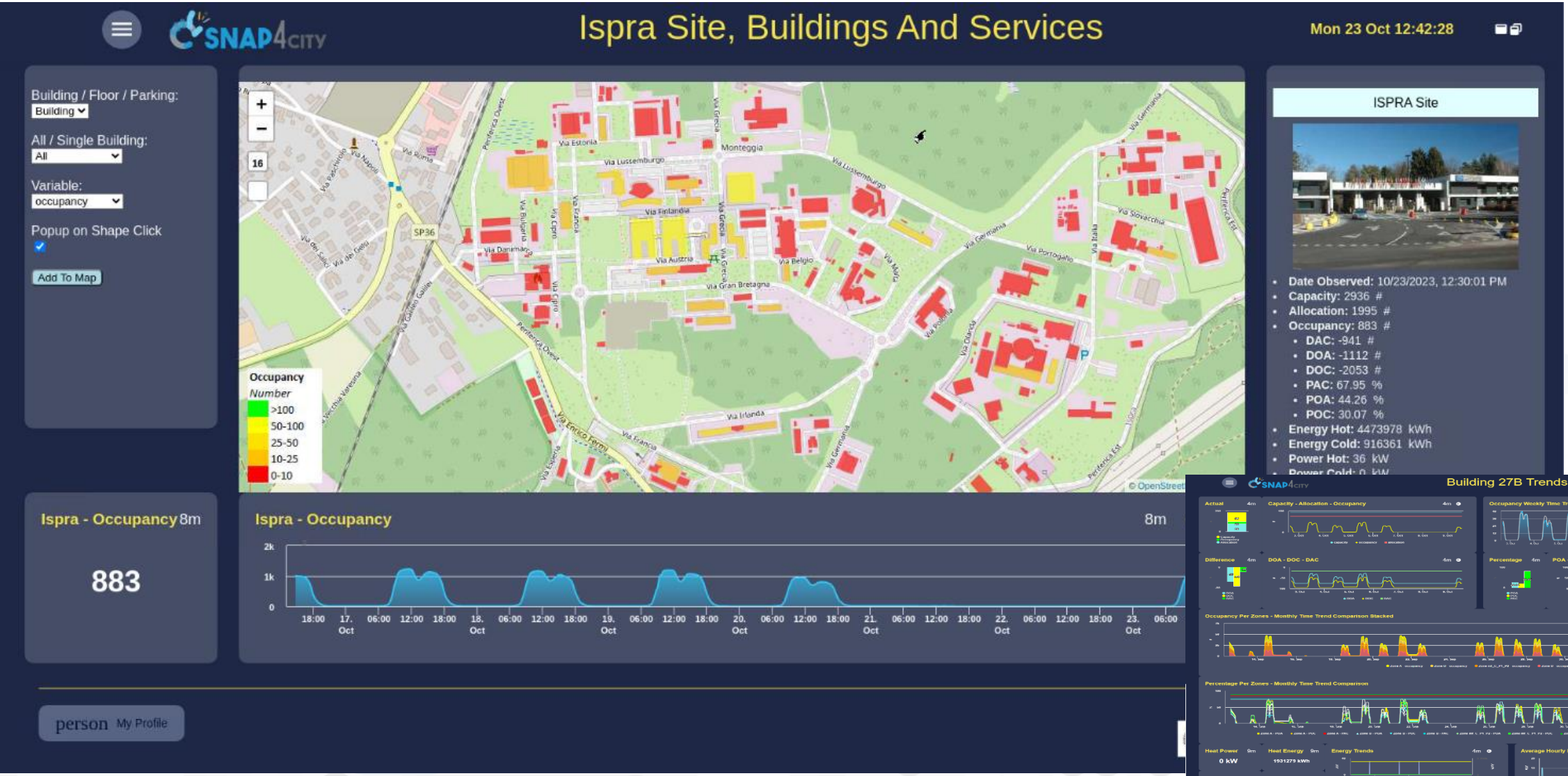
Smart Buildings, Snap4Building (2024/8)

- **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**





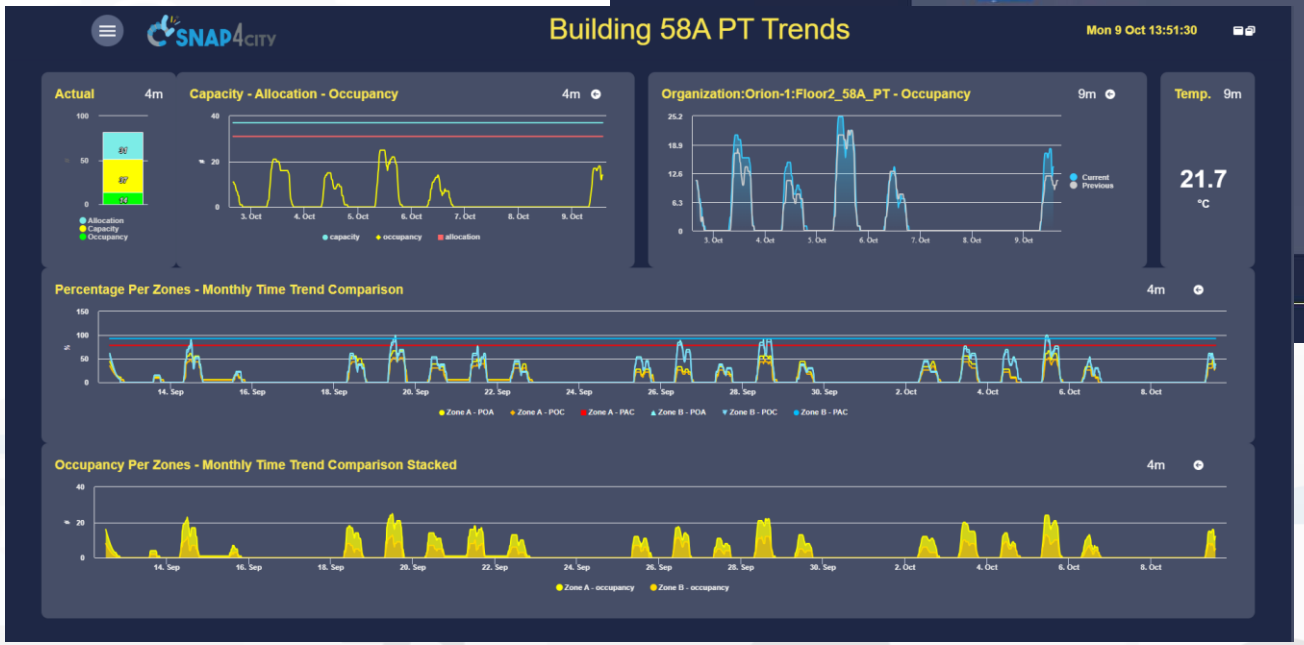
ISPRA JRC Site



Floor Details

ISPRA JRC Site





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Smart Building



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Environment and Waste Management

Goals

Control of emissions
Reduction of emissions
Early warning
Meet the EC targets
Reduction of EC taxation

Details

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PEN Test Passed

EU GDPR COMPLIANT

SNAP4 Appliances and Dockers Installations

EUROPEAN OPEN SCIENCE CLOUD

Node-RED

JS Foundation

EØ15 digital ecosystem

NVIDIA

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

HORIZONTAL AI PLATFORM



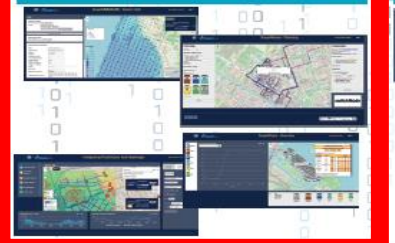
MOBILITY AND TRANSPORT



SMART ENERGY AND SMART BUILDING



ENVIRONMENT AND WASTE MANAGEMENT



CITY USER'S SERVICES AND TOURISM MANAGEMENT



SNAPADVISOR



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



DASHBOARDS, WIDGETS TEMPLATES



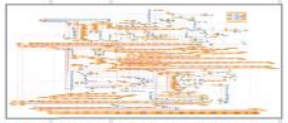
PREDICTION - ANOMALY DETECTION - CLUSTERING - ROUTING - SENTIMENT NLP - TRAFFIC FLOW - PEOPLE FLOWS - SDG
15 MIN CITY INDEX - KPI - HEATMAPS - ORIGIN DESTINATION - MAPS - VECTOR FIELD - ETC...



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

- DEVELOMENT ENVIRONMENT AND METHODOLOGY
- VISUAL PROGRAMMING, ML, AI, HPC
- TRAINING COURSES





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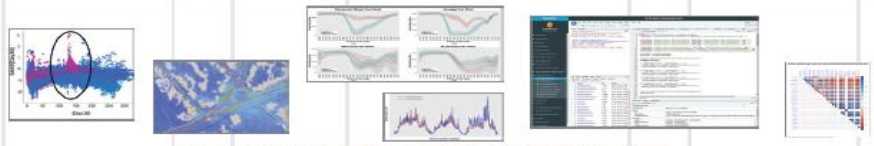

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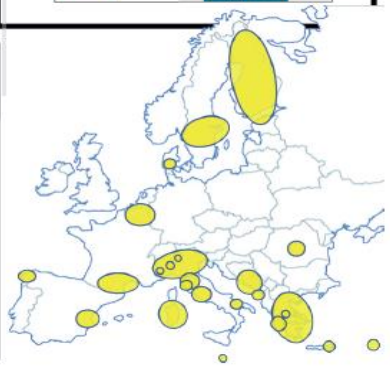
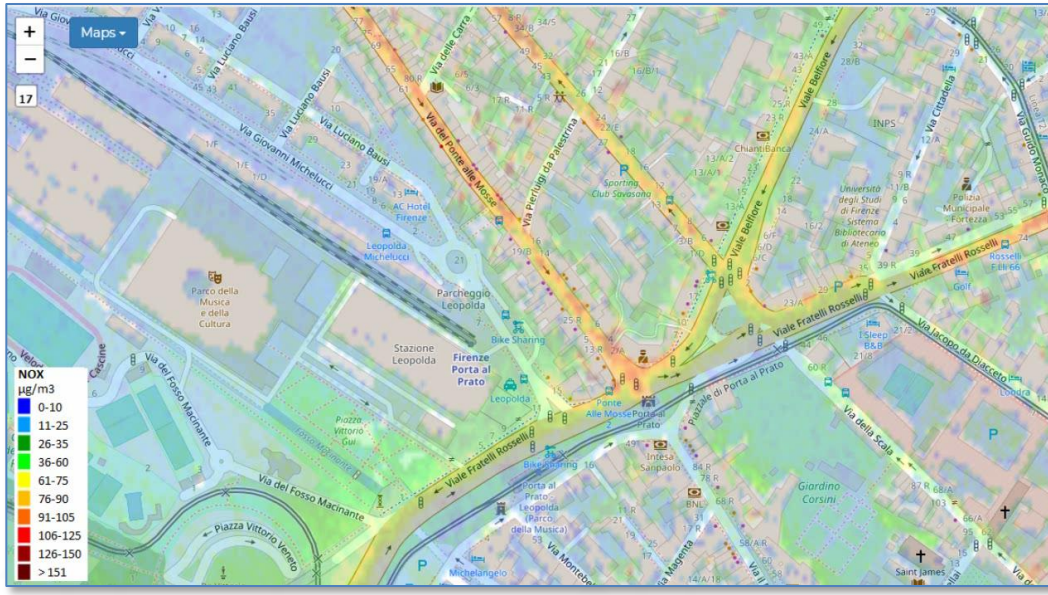
- ...



Environment and Waste

- **Goals:**
  - Reduction of emissions and EC taxations
  - Cost reduction for waste collection,
  - reduction of waste collection impact on mobility
- **AIR quality (Indexes) monitoring and warning**
- **Environment Management & producing prescriptions:**
  - Monitoring, long and short-term predictions, warning for:
    - GHG, wmissions, pollutants, aerosol, chemical plants analysis
  - Traffic Flow impact emissions, predictions
  - Sea conditions, UV conditions, etc.
- **Land slide prediction warning**
- **Coastal erosion monitoring and analysis**
- **Smart 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, ..**





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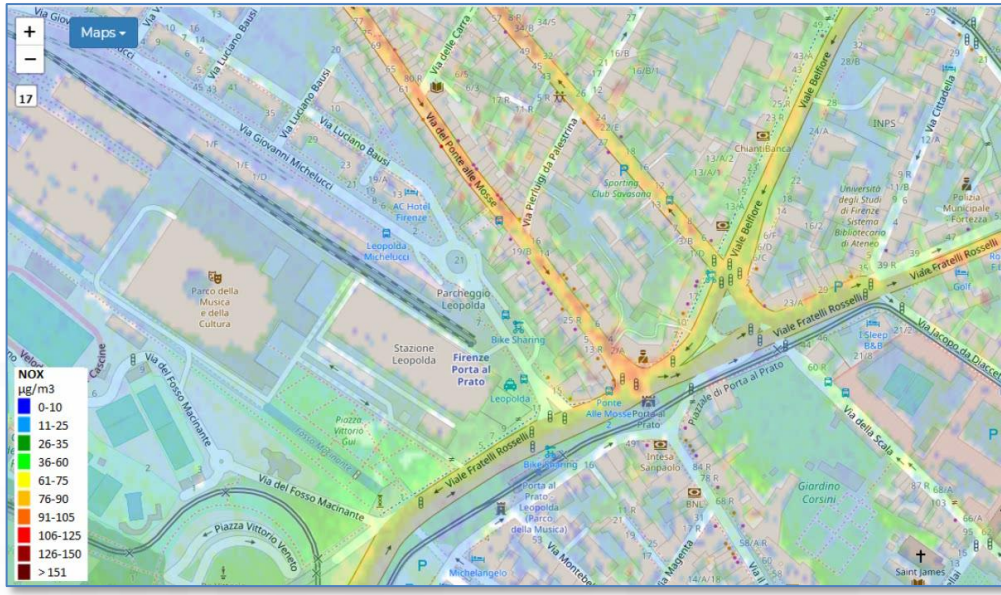
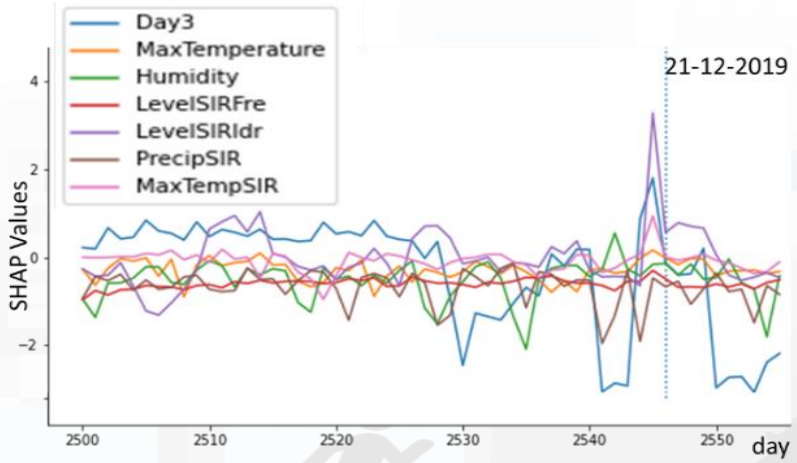
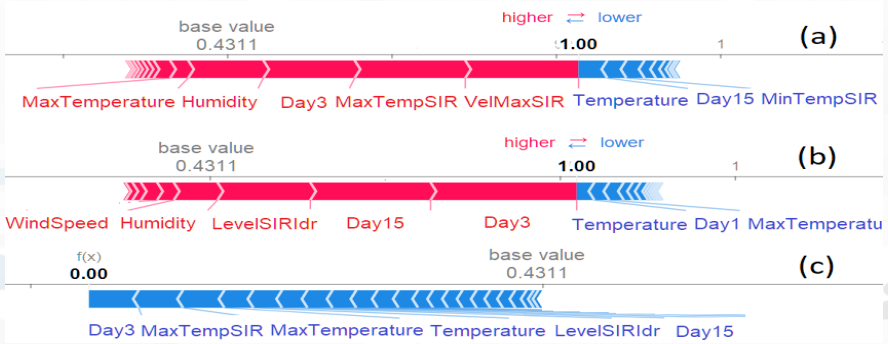
AI for Environment, DSS

- Computation of CO2 from traffic, open data (identification of crit. Areas)
- Computation of NO2 from traffic
- Predictions of LandSlides







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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…	…t to be e…ed … on more …han 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 … 8-hour m…	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

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Devices data

- **Air Quality sensors are**
  - Collected on scattered positions
  - Not all sensors have sull set of data, complexity of computing AQI
- **AirQuality Services**
  - AirQuality indicators independent on the sensors' position, in any GPS position of the area
  - **Multiple data:** PM_{10}, $PM_{2.5}$, CO, CO_2, SO_2, O_3, H_2S, NO, NO_2, NO_x, air temperature, air humidity, velocity of wind speed, dew point, etc.
- **Applications**
  - Control Room Rendering
  - Alerting on specific personal GPS locations
  - Constrained routing for: runners, walking with baby, people with pulmonary problems,
  - Mobile Phone Rendering, this means to have thousands of users active at the same time, and a reasonable memory consumption in the server.

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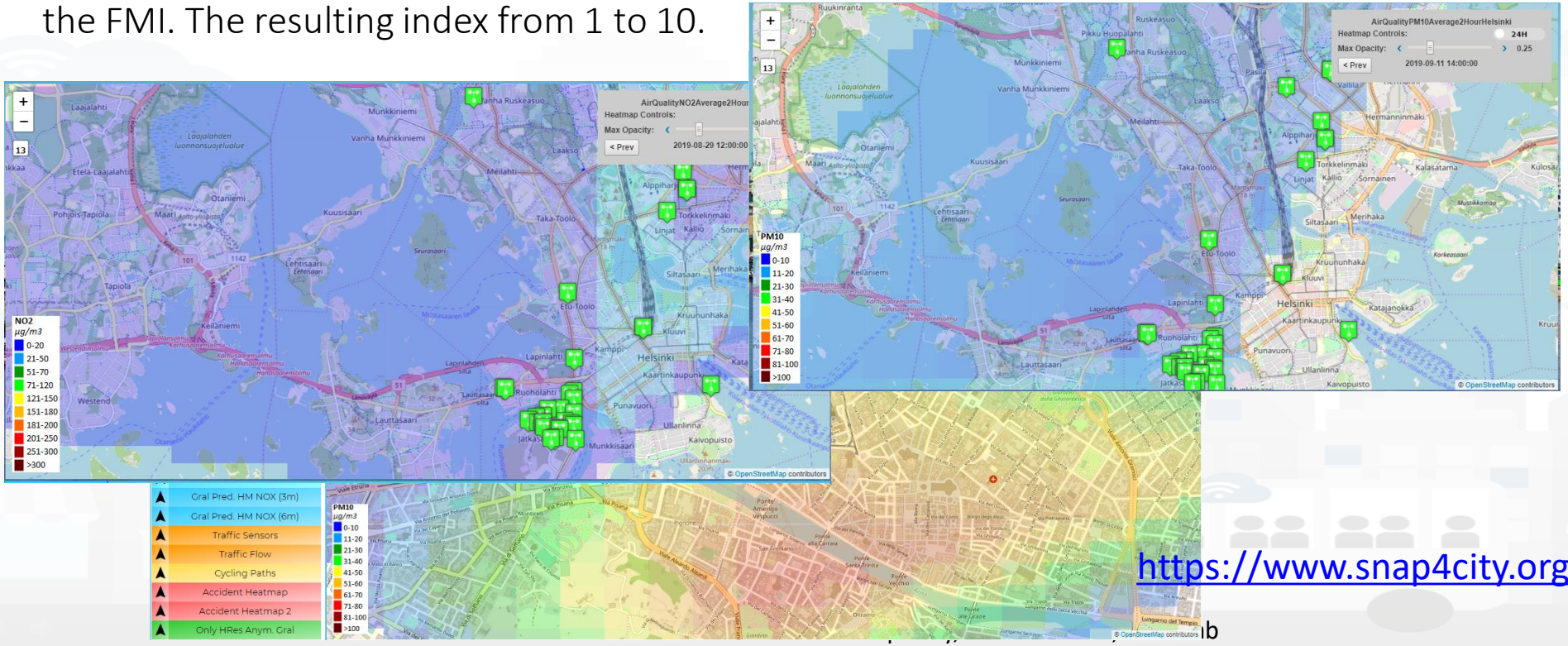
Environmental Real Time Measures

- **Noise:** real time noise levels (measured in dBA).
- **PM_{10}:** real time pollutant levels in air in terms of PM_{10}(measured in µg/m_3) particles.
- **$PM_{2,5}$**: real time pollutant levels in air in terms of $PM_{2.5}$(measured in µg/m_3) particles
- **NO_2**: real time pollutant levels in air in terms of nitrogen dioxide (measured in µg/m_3).
- **Air Quality Index (AQI):** real time air quality index of the Helsinki area, provided by the FMI. The resulting index from 1 to 10.



- BusStop
- Ticket sale
- Traffic Sensor
- Weather sensor
- Air Temp heatmap
- Humidity Heatmap
- Air Quality Sensors
- Noise sensors
- Noise Heatmap
- PM10 heatmap
- PM2.5 Heatmap
- NO2 heatmap
- Air Quality Index HeatM.
- EAQI HeatM.
- CAQI HeatM.
- Enfuser pred. AQI
- Enfuser pred. PM10
- Enfuser pred. PM2.5
- Gral pred. PM10
- Gral pred. PM10 (6m)
- PM10 Jätkäsaari
- PM2.5 Jätkäsaari
- EAQI Jätkäsaari
- Appreciated POIs

https://www.snap4city.org/435

AQI Indexes estimation via R studio and IOT App

European Air Quality Index **EAQI**

http://airindex.eea.europa.eu/

Pollutant	Index level (based on pollutant concentrations in µg/m3)				
	Good	Fair	Moderate	Poor	Very poor
Particles less than 2.5 µm ($PM_{2.5}$)	0-10	10-20	20-25	25-50	50-800
Particles less than 10 µm (PM_{10})	0-20	20-35	35-50	50-100	100-1200
Nitrogen dioxide (NO_2)	0-40	40-100	100-200	200-400	400-1000
Ozone (O_3)	0-80	80-120	120-180	180-240	240-600
Sulphur dioxide (SO_2)	0-100	100-200	200-350	350-500	500-1250

Measurements of up to five key pollutants supported by modelled data determine the index level that describes *the current air quality situation at each monitoring station*.

The index corresponds to **the poorest level for any of five pollutants according to the following scheme.**

Common Air Quality Index **CAQI**

http://www.airqualitynow.eu

Qualitative name	Index or sub-index	Pollutant (hourly) density in µg/m³			
		NO_2	PM_{10}	O_3	$PM_{2.5}$(optional)
Very low	0–25	0–50	0–25	0–60	0–15
Low	25–50	50–100	25–50	60–120	15–30
Medium	50–75	100–200	50–90	120–180	30–55
High	75–100	200–400	90–180	180–240	55–110
Very high	>100	>400	>180	>240	>110

The index is defined away from roads (a "background" index). **CAQI** is computed on the basis of NO_2, $PM_{2,5}$, PM_{10} and O_3.

Legend of Environmental data:

https://www.snap4city.org/435

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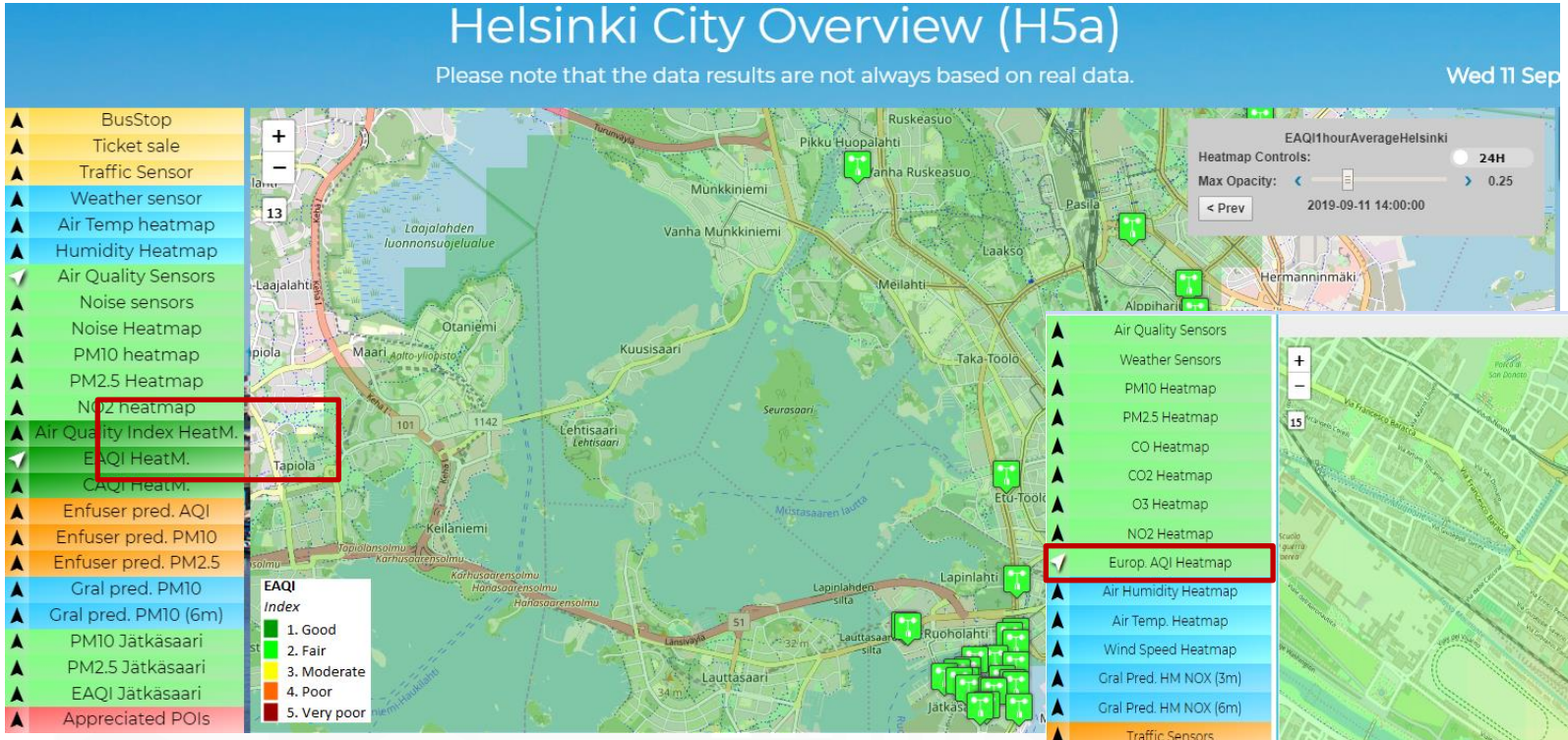
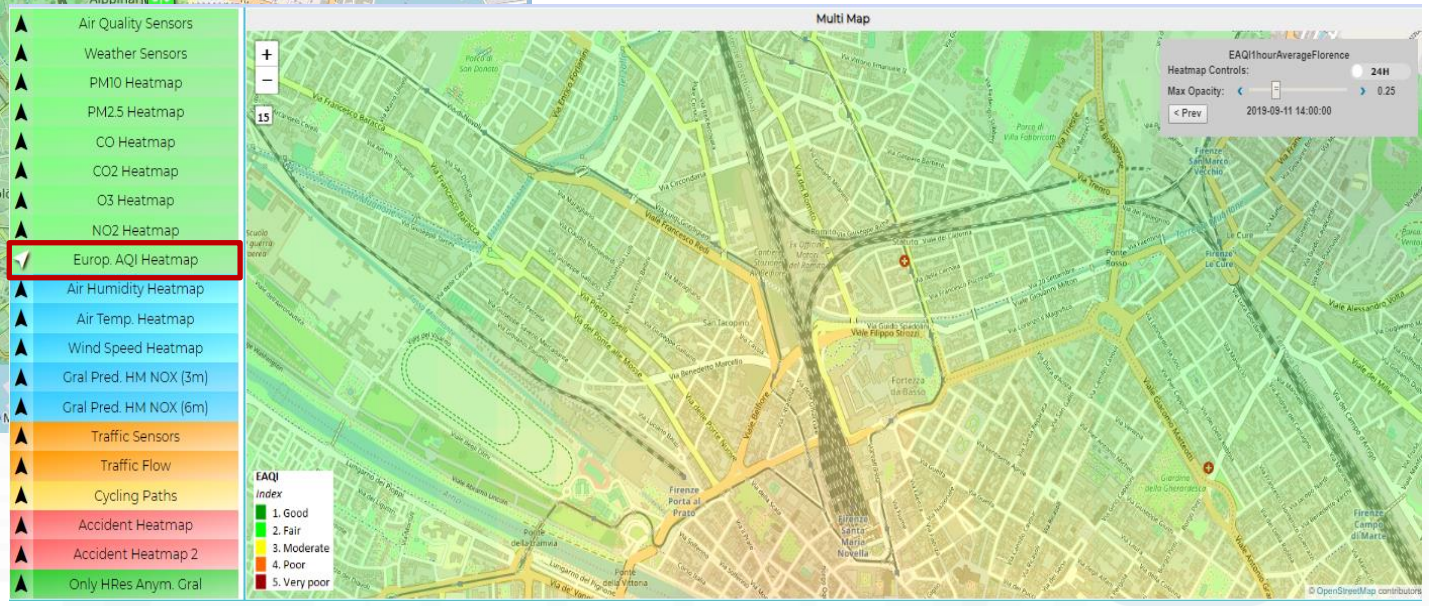
AQI Indexes estimation Heatmaps

Hourly pollutant concentration





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

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

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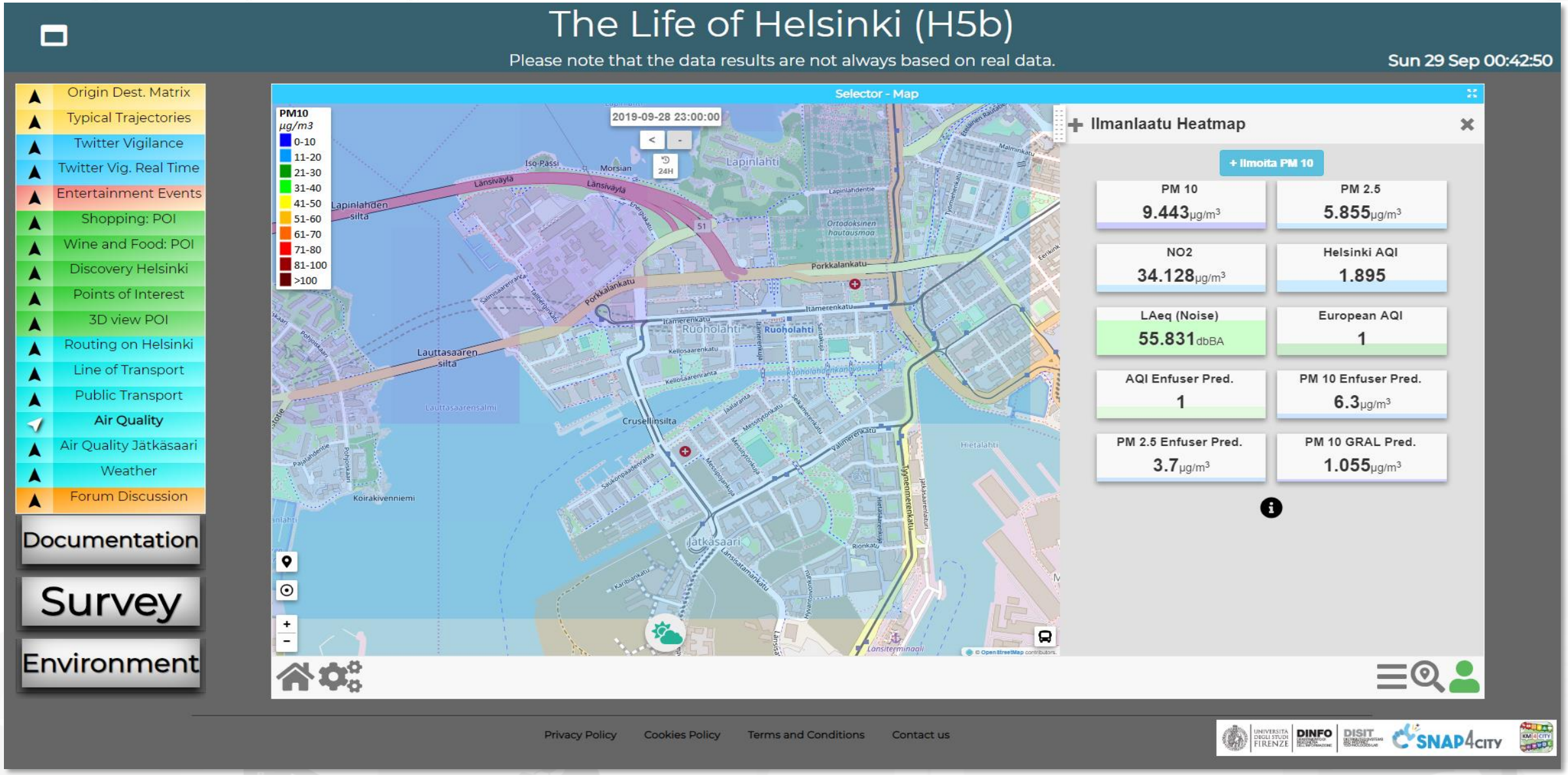
Helsinki



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

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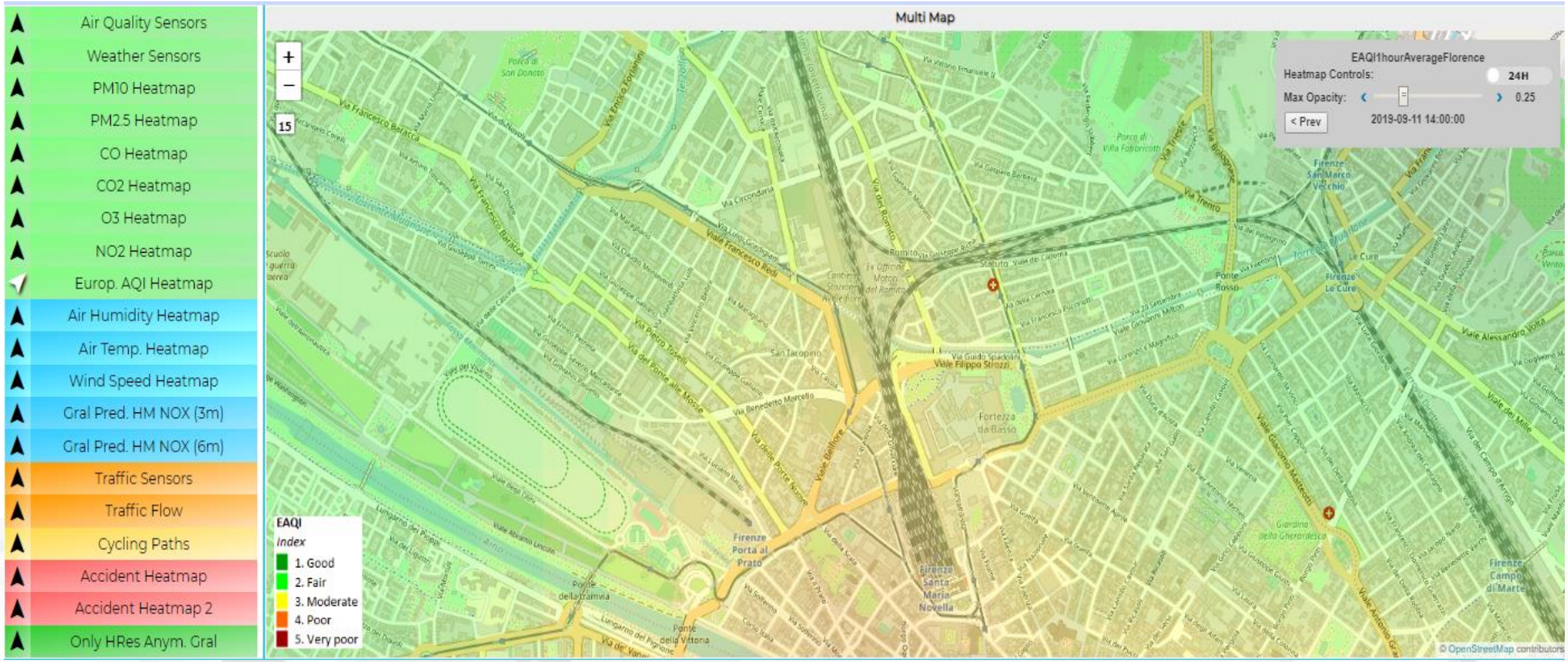
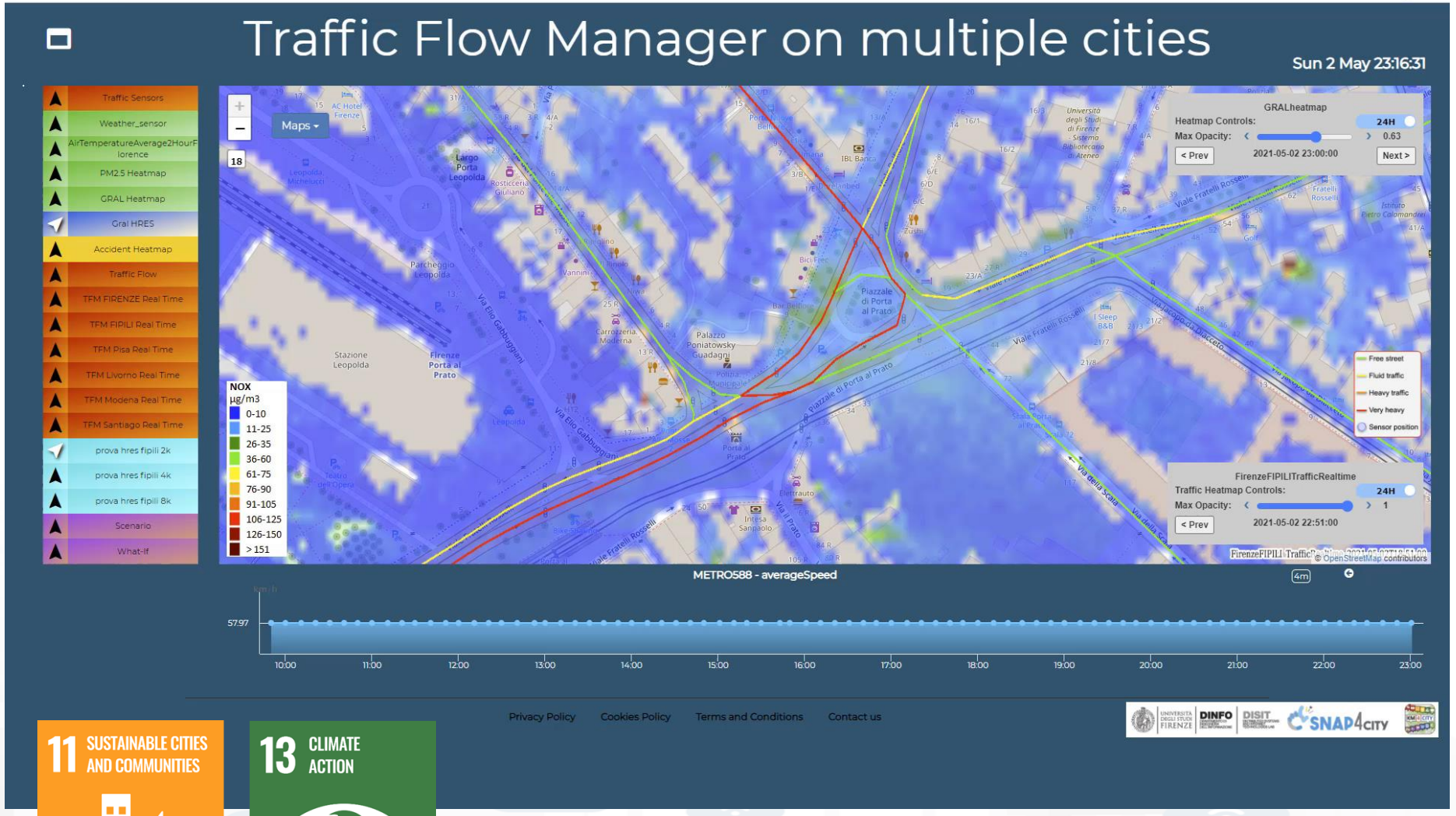
EAQI Heatmap and sequence



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







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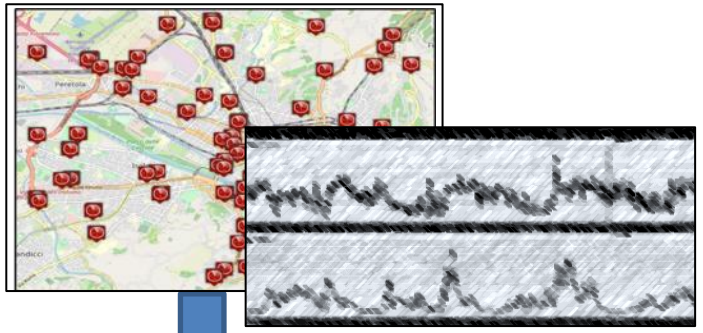
Estimating City Local CO2 from Traffic Flow Data



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/

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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 (*)	
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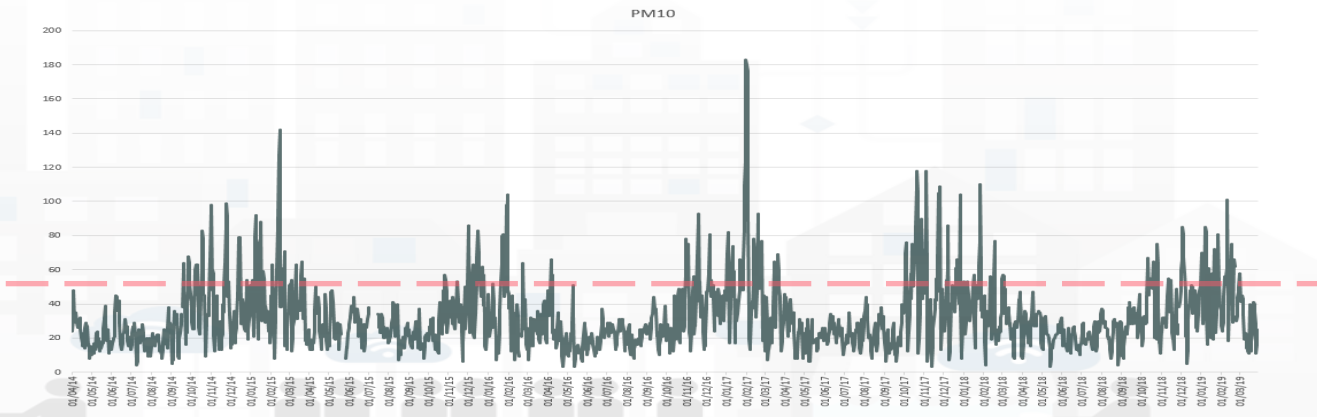

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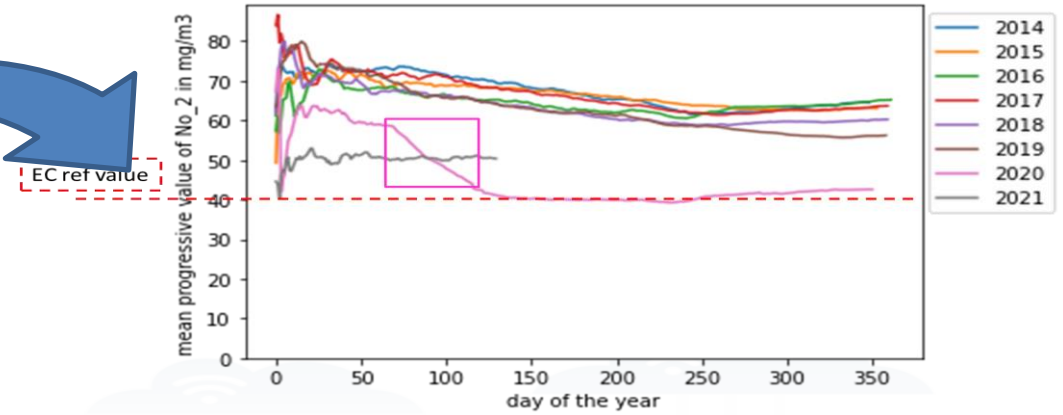
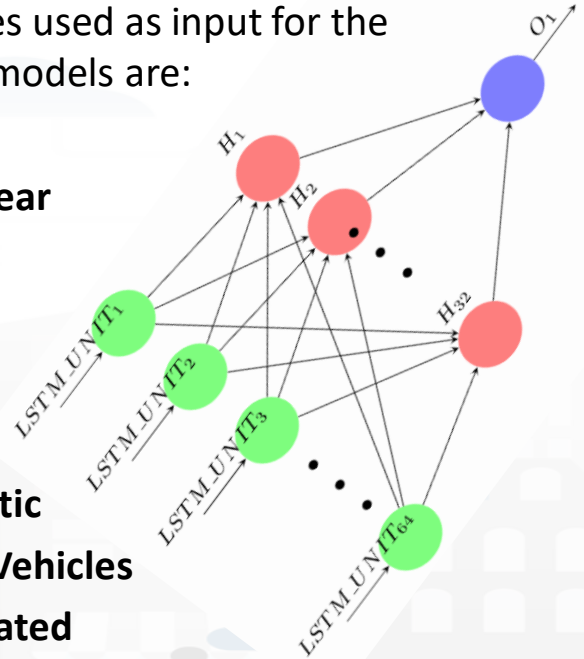
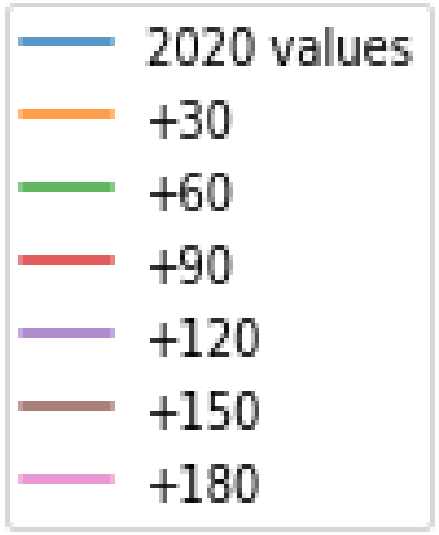
Predicting EC's KPI on NO2 months in advance

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



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





	Air Quality Directive			WHO guidelines	
Pollutant	Averaging period	Objective and legal nature and concentration	Comments	Concentration	Comments
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NO_2	Calendar year	Limit value, 40 µg/m³		40 µg/m³	

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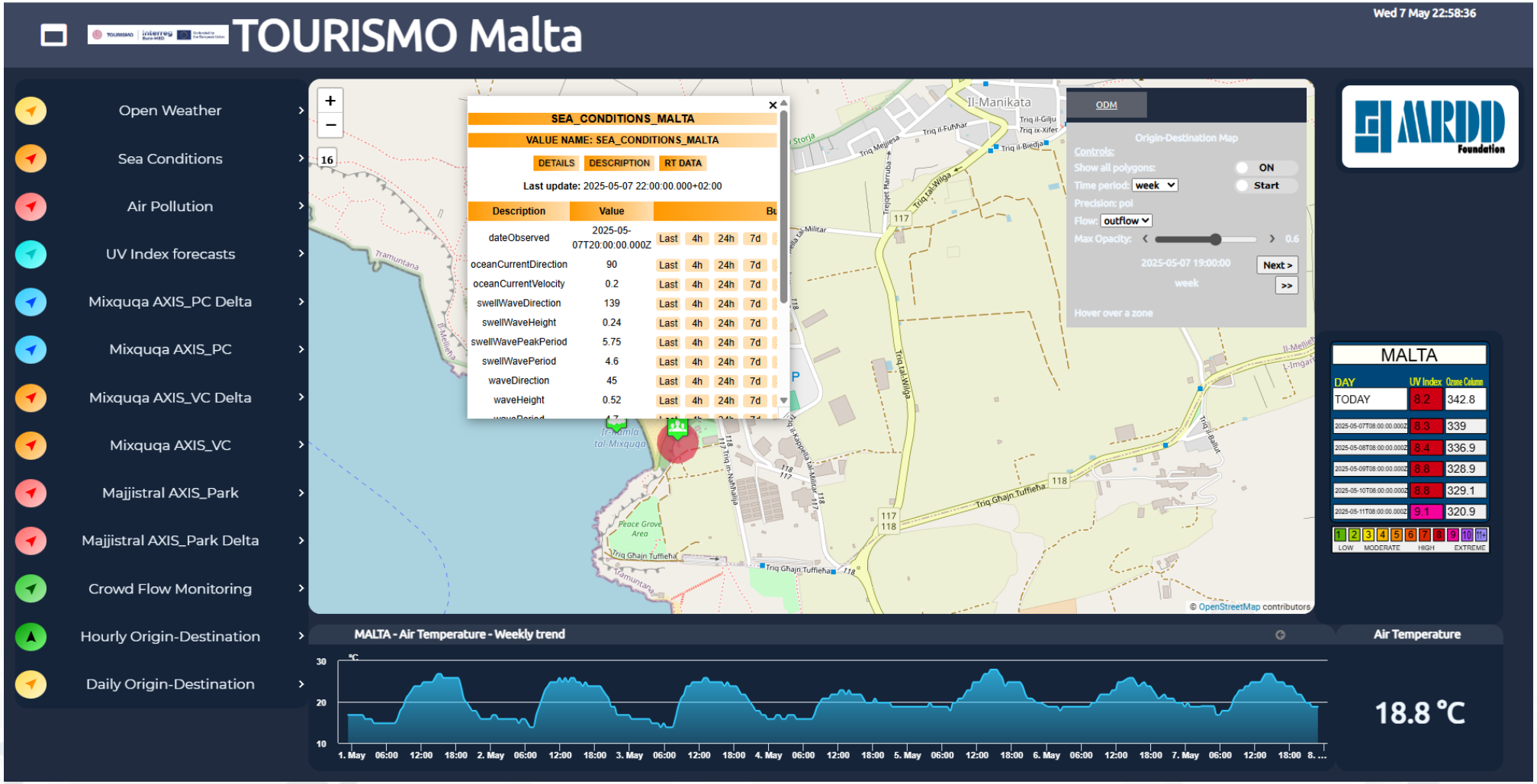
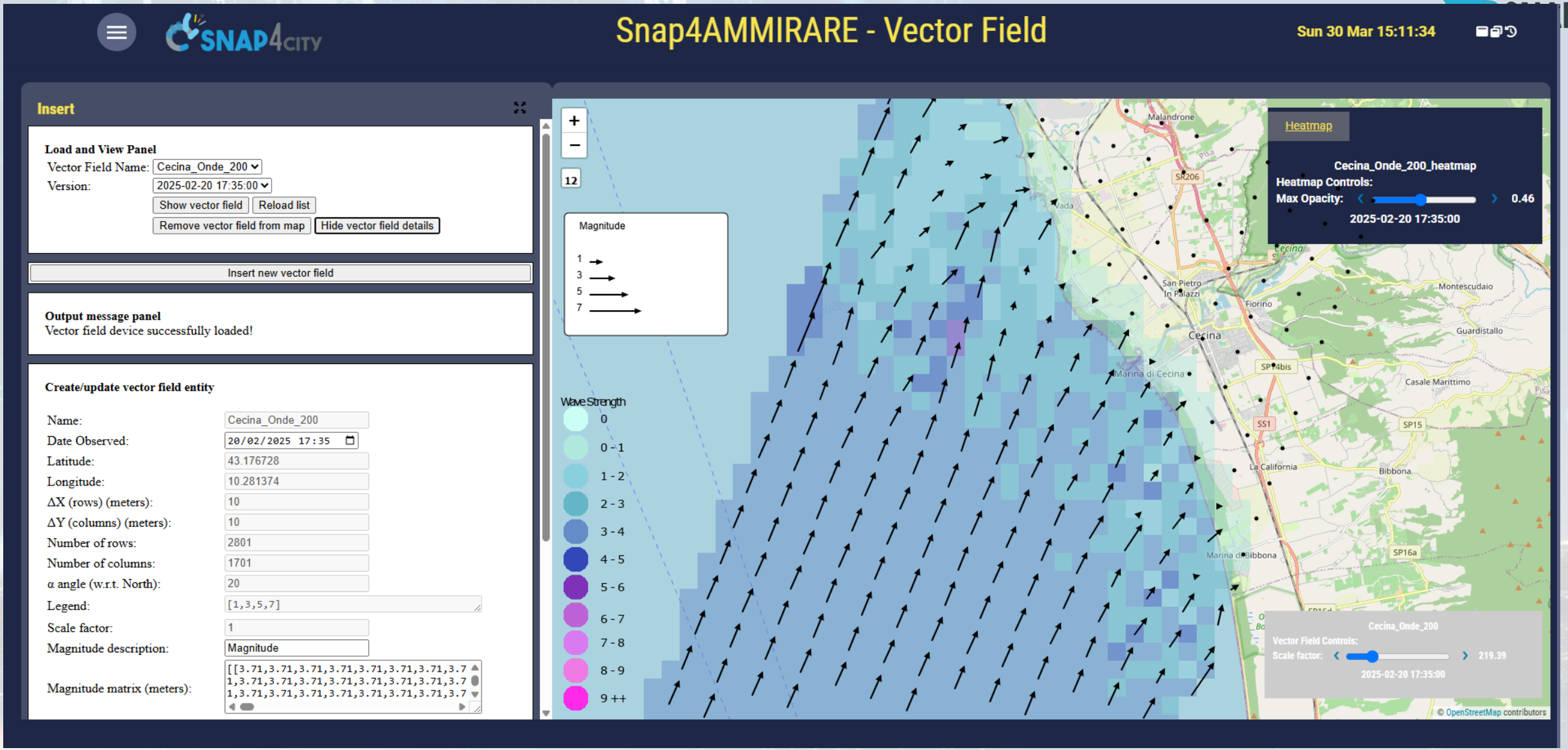
Other Environmental data

- Sea Conditions
- UB Index
- Ozone
- Pollution
- Weather Forecast



Monitoring Costal Bathymetry and Waves



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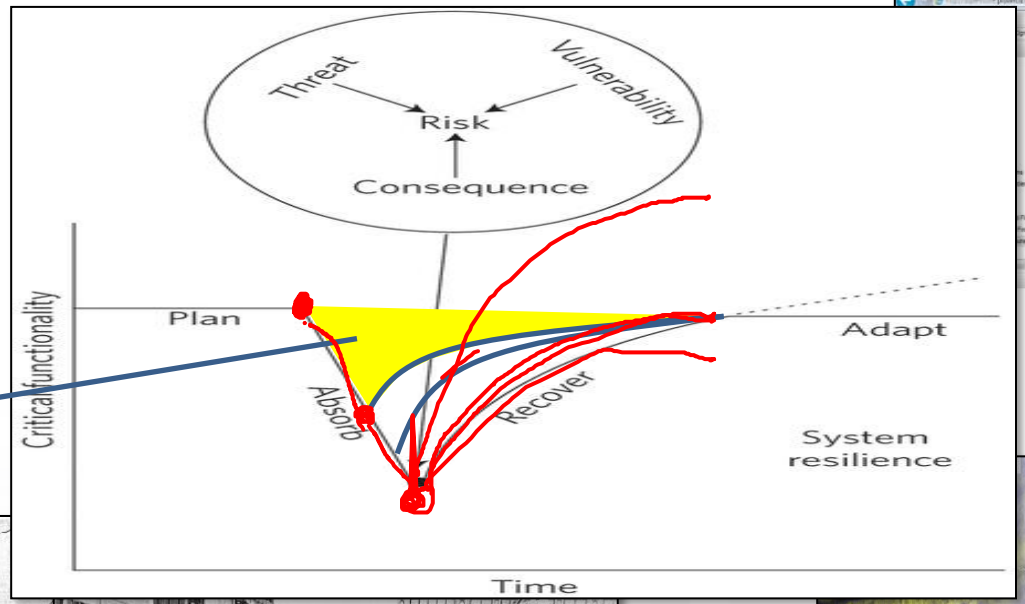
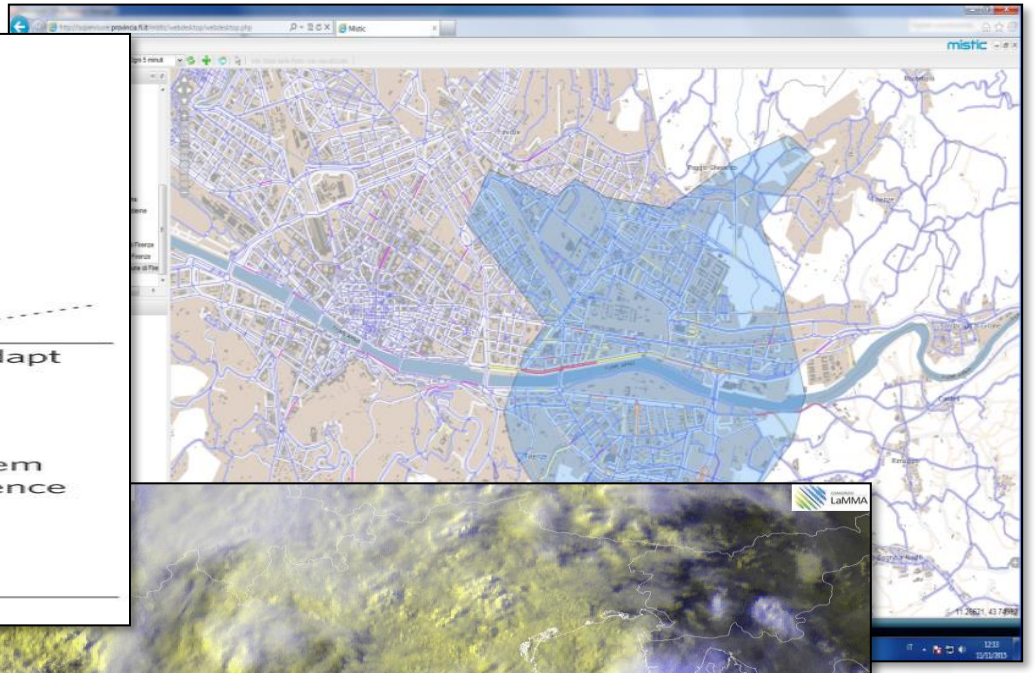
City Resilience

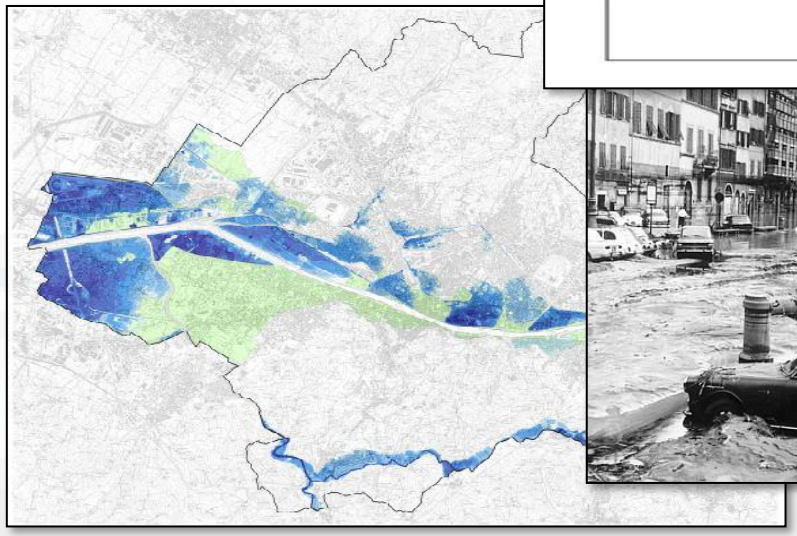
Early Warning, Detection

Prepare
Absorb
Recover
Adapt

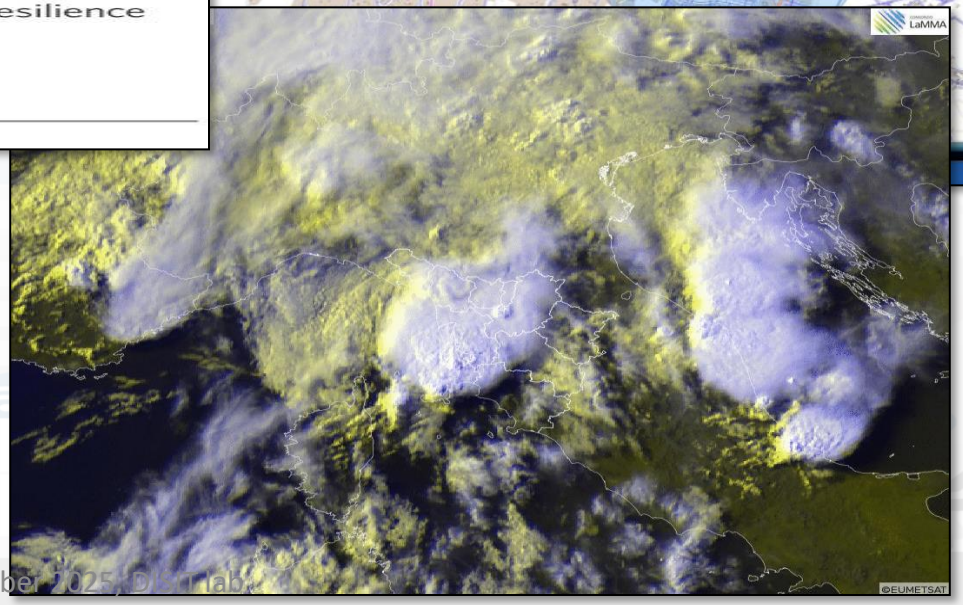
damage











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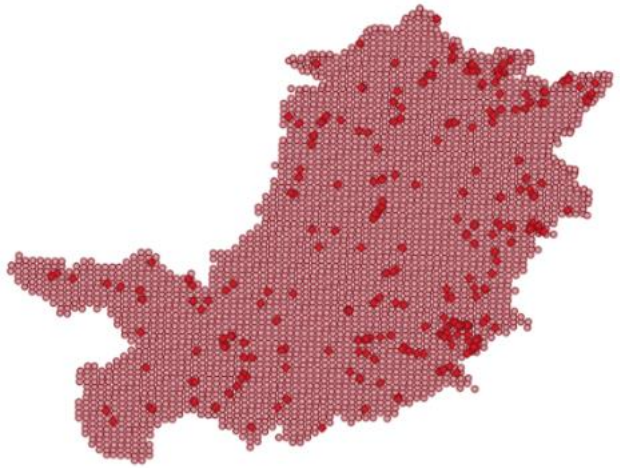
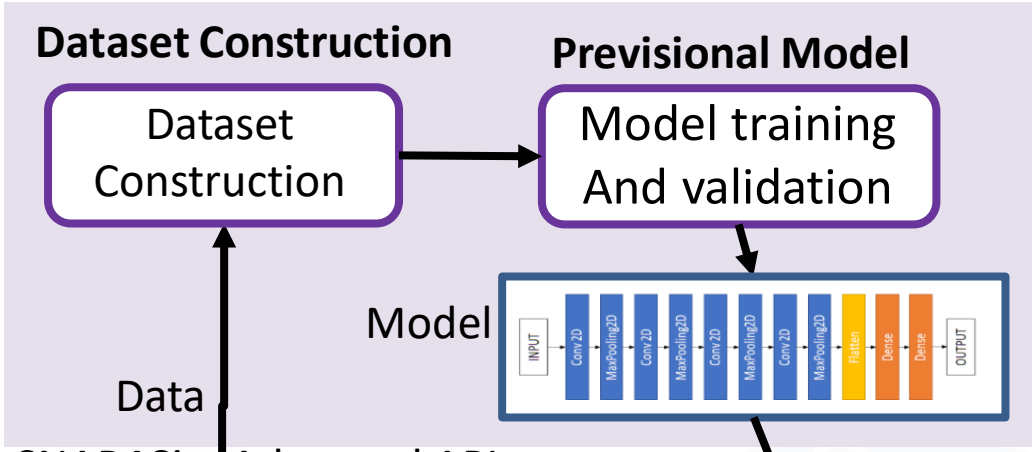
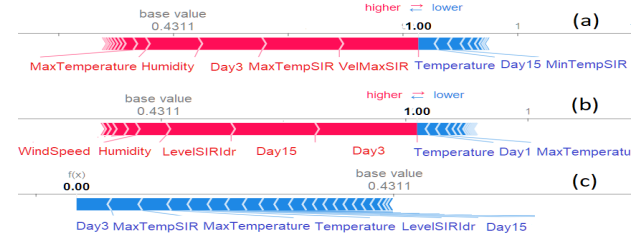
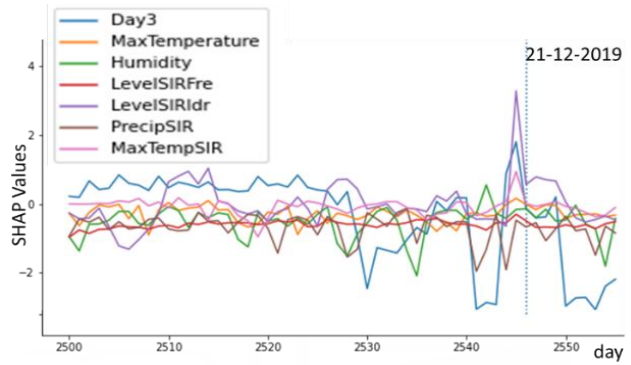
Predicting Land slides









landslide DB

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

Ingestion Processes

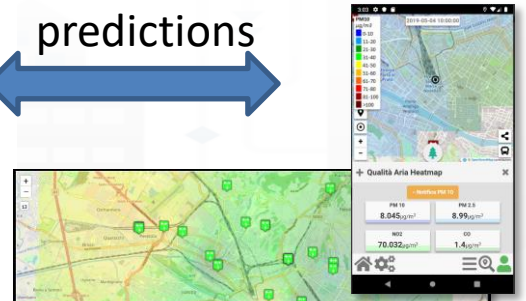
Big Data Storage and KB

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

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Local Explainable AI - understanding the single event

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

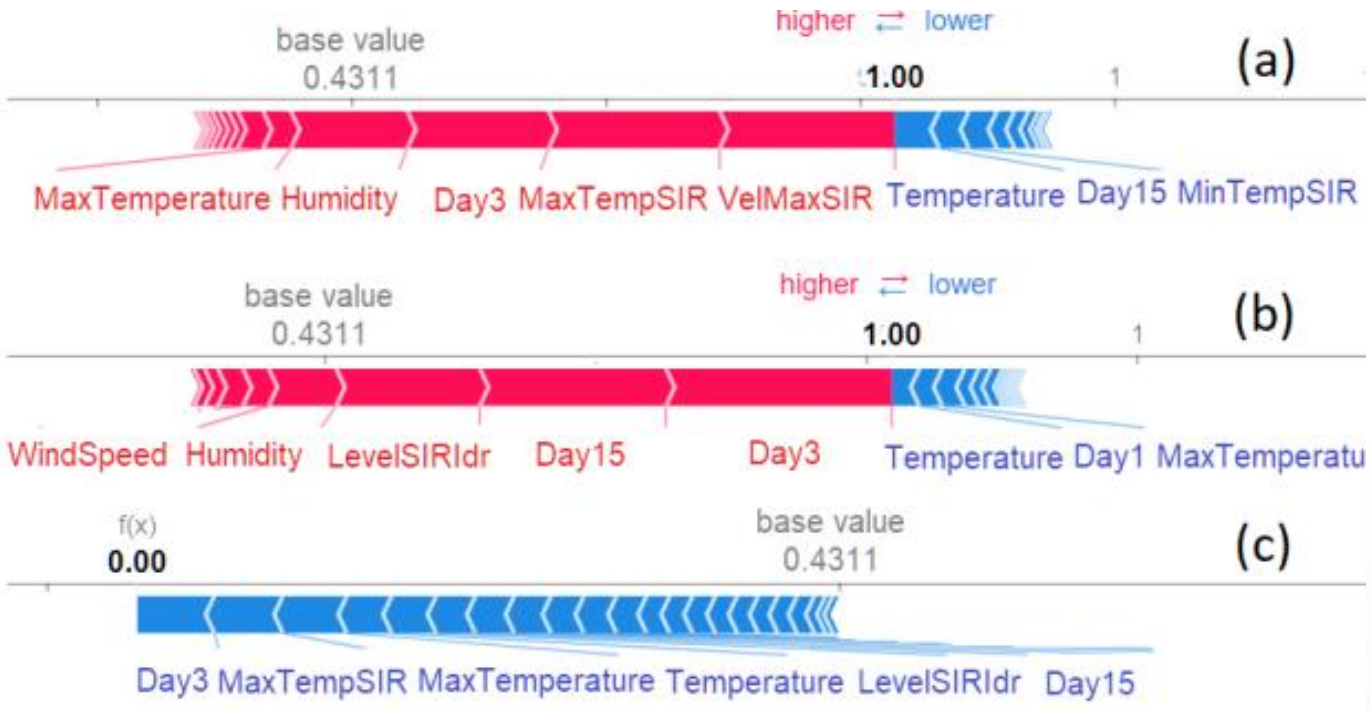

FIGURE 10. **Local feature relevance via SHAP, as interpretation of events in terms of feature values: (a) and (b) are events with predictions of landslide, (c) a no landslide event.**

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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.

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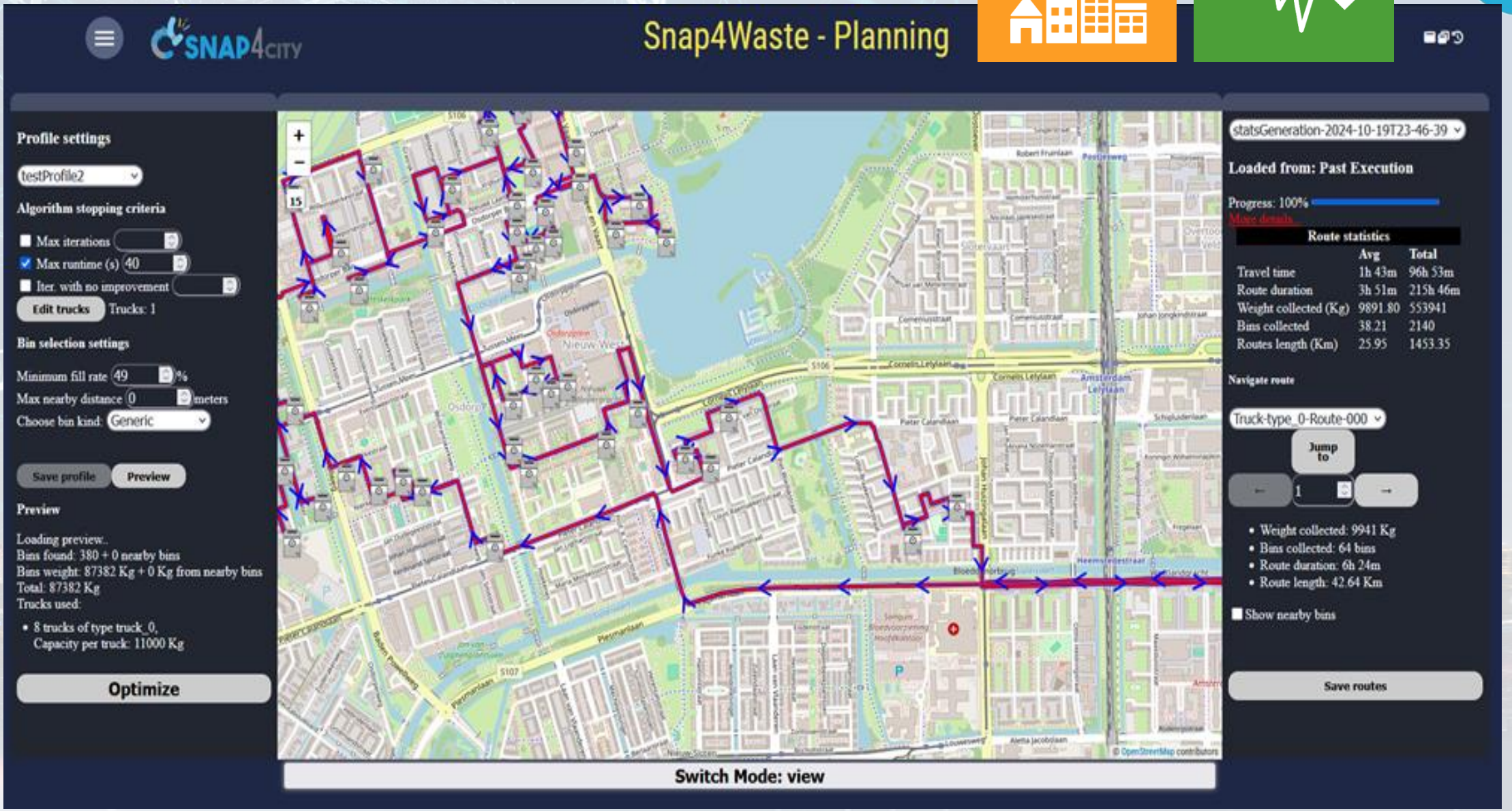
Waste Collection Optimization

11 SUSTAINABLE CITIES AND COMMUNITIES

3 GOOD HEALTH AND WELL-BEING



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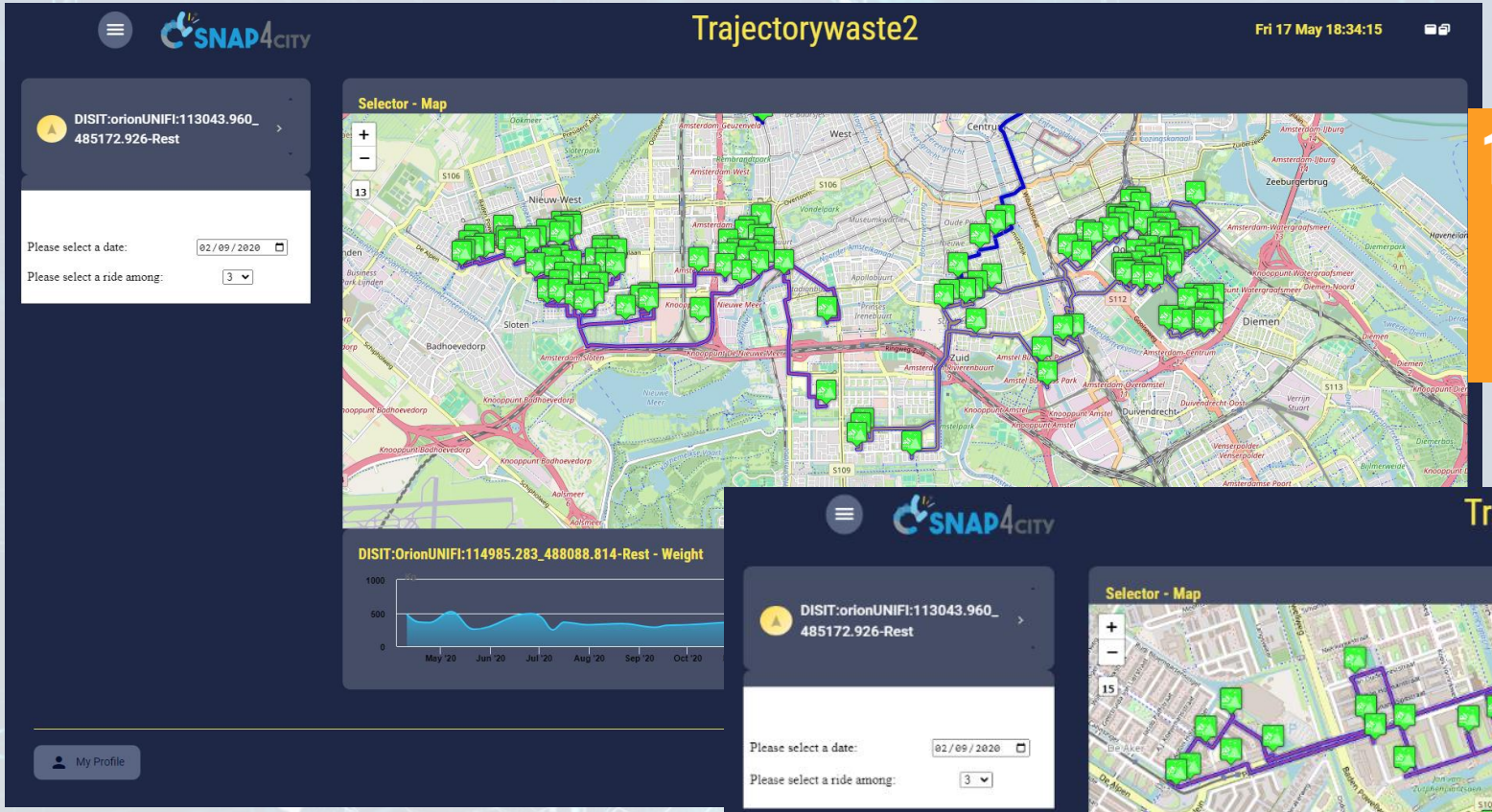

11 SUSTAINABLE CITIES AND COMMUNITIES

3 GOOD HEALTH AND WELL-BEING



Optimal Routing Collection

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City Users' Services and Tourism Management

Goals

Details

100% OPEN SOURCE

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PEN Test Passed

EU GDPR COMPLIANT

SNAP4 Appliances and Dockers Installations

EUROPEAN OPEN SCIENCE CLOUD

Node-RED

JS Foundation

E015 digital ecosystem

NVIDIA

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



SNAPADVISOR



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



DASHBOARDS, WIDGETS TEMPLATES



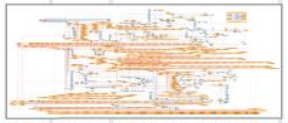
PREDICTION - ANOMALY DETECTION - CLUSTERING - ROUTING - SENTIMENT NLP - TRAFFIC FLOW - PEOPLE FLOWS - SDG
15 MIN CITY INDEX - KPI - HEATMAPS - ORIGIN DESTINATION - MAPS - VECTOR FIELD - ETC...



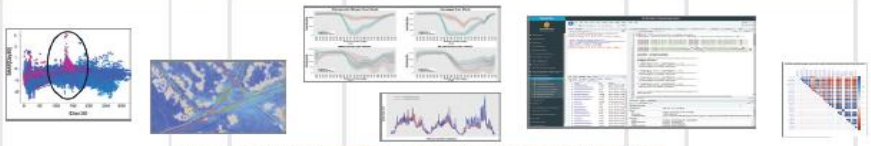
API - MICROSERVICES - GIS - BPM
VIDEO - REPORTS - MAPS - 3D ...

- DEVELOMENT ENVIRONMENT AND METHODOLOGY
- VISUAL PROGRAMMING, ML, AI, HPC
- TRAINING COURSES





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



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



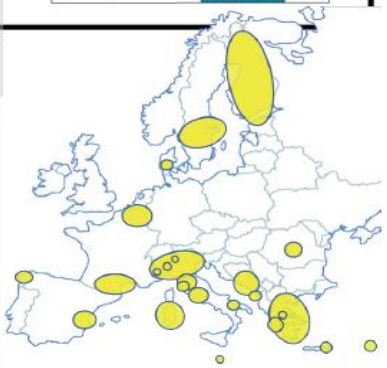
VISUAL PROGRAMMING, ADAPTERS
DATA FLOWS, WORKFLOWS
PARALLEL DISTRIBUTED PROCESSING
DATA DRIVEN

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



NATIVE AND EXTERNAL APPLICATIONS

- Smart Parking
- Smart Light
- Smart Waste
- Smart Energy
- Smart Building
- Smart Tourism
- ...



Goals

Goals	How to	technicalities
Keep under control reputation	Measuring and predicting	Multichannel collections of appreciations, AI/LLM, sentiment analysis
Predicting number of presences in advances	Measuring and predicting	Counting, tracking and computing Orig. Dest. Matrices
Controlling the overtourism	Measuring, predicting, suggesting, producing tactics and strategies	Production of suggestions, serious games, engagements, ..
Stimulating actions, stimulating the second offer	Suggesting, engaging, producing tactics and strategies	Production of suggestions, and engagements
Identification of critical conditions	Short and long terms Measuring	In deep data analysis, AI for anomaly detections
Increasing resilience	Monitoring and early warning	Strategies, dynamic routing, real time information to city users

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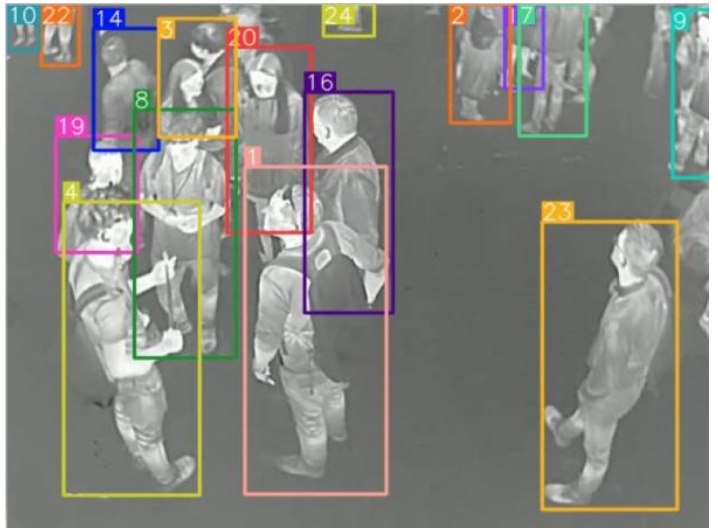
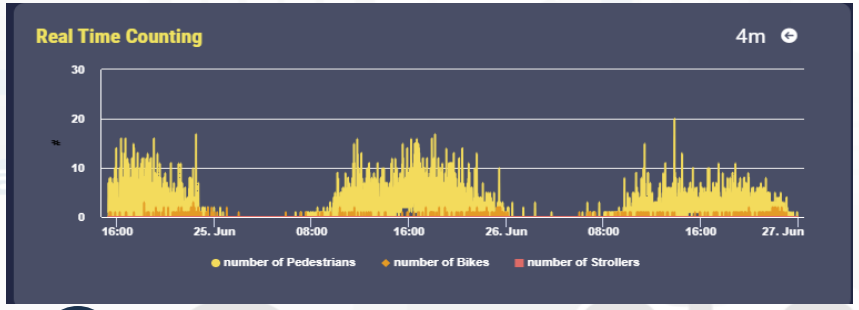
City User Behaviour/services, Tourism and Safety

- **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, recency/frequency, 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, .., via email, mobile apps, etc.
- **Tourists Flows & Retail Management**: predictions of presences, services' reputations, suggestions on second offers, over-tourism, notifications, early warning,
- **KPI**: 15 MinCityIndex, energy vs people, over-tourism, accepted suggestions, 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, ..**



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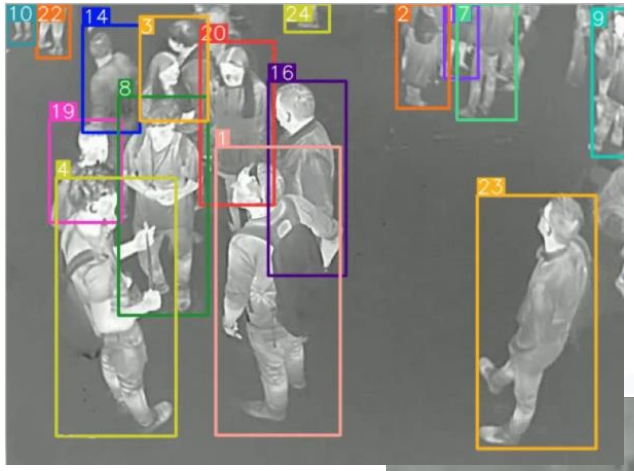
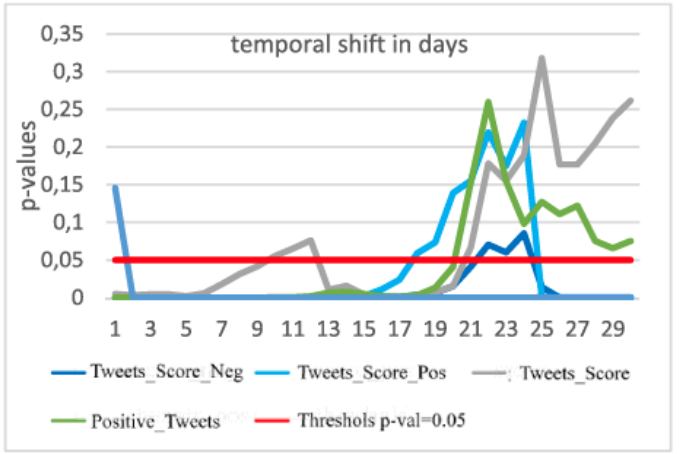
AI to Understand Users' Behavior, Tourism, DSS

- Classification of Users' transportation modalities
- Counting and tracking user via thermal cameras
- Prediction of Offered Services Reputation
- Assessing the causality time of advertising
- From Wi-Fi/BT Sniffing to ODM







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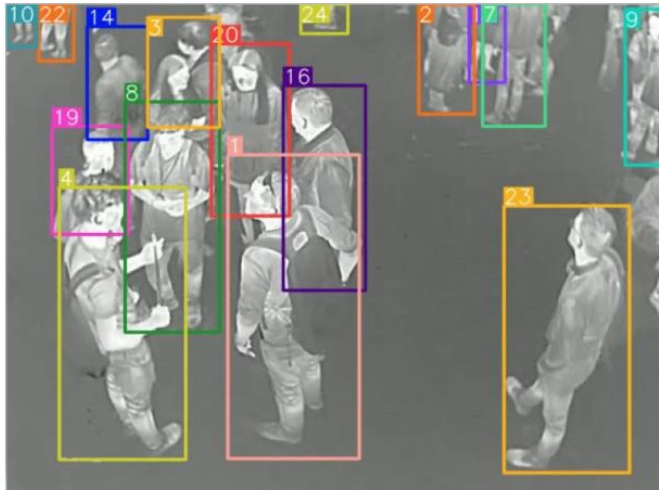
City User Behaviour/services, Tourism and Safety (2024/8)

- 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





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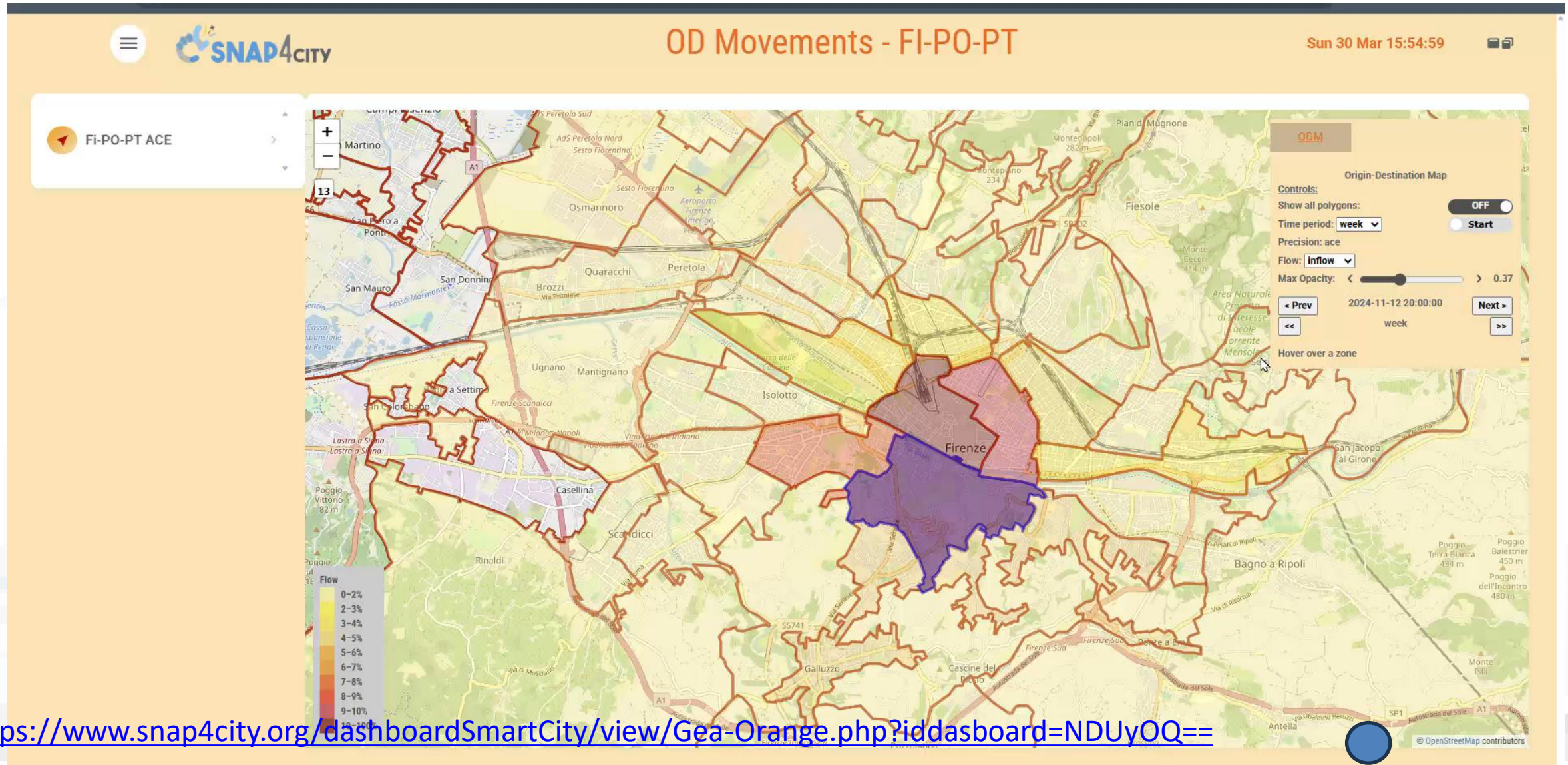
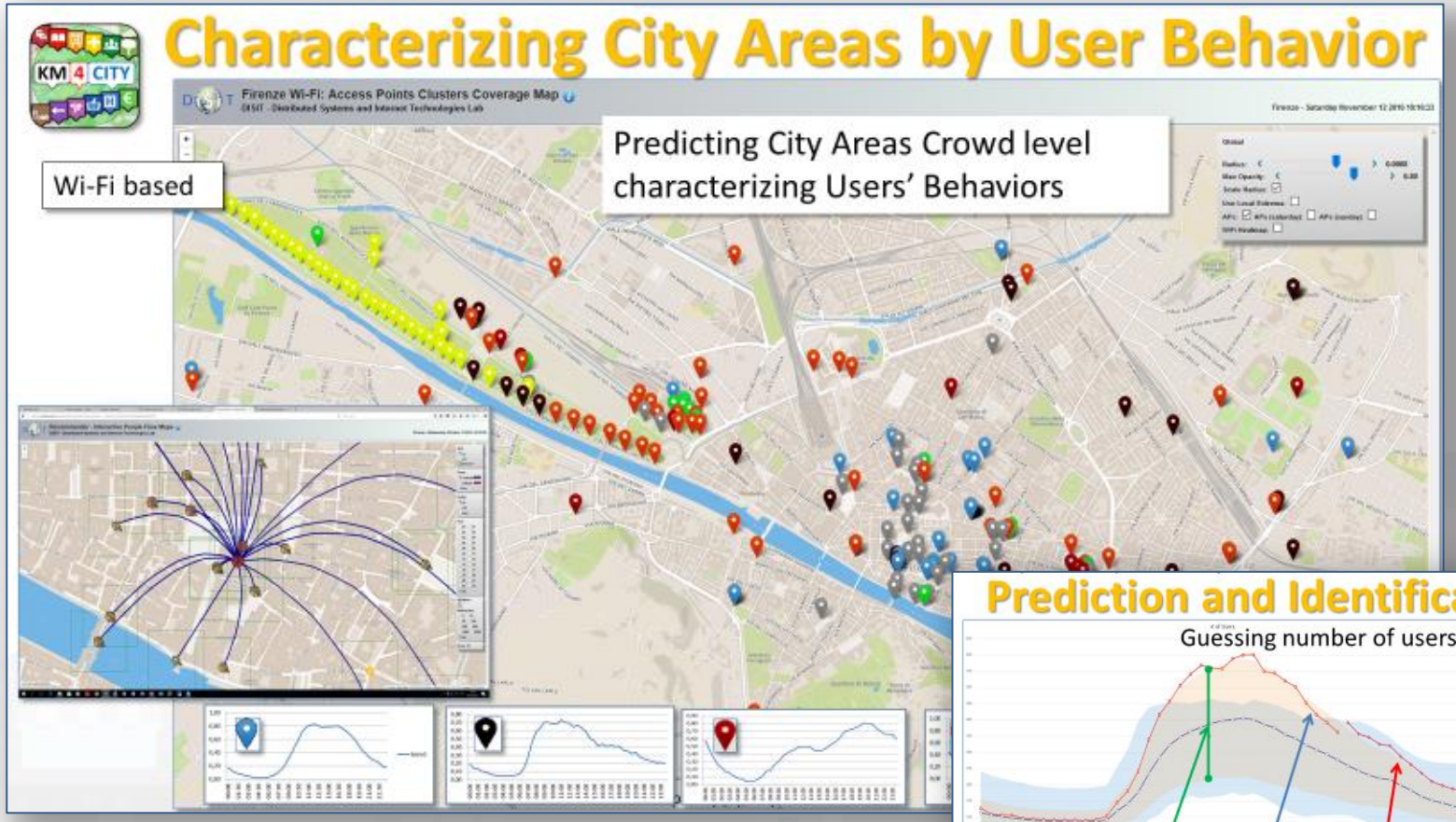
Origin Destination Matrices: Mobility Demand

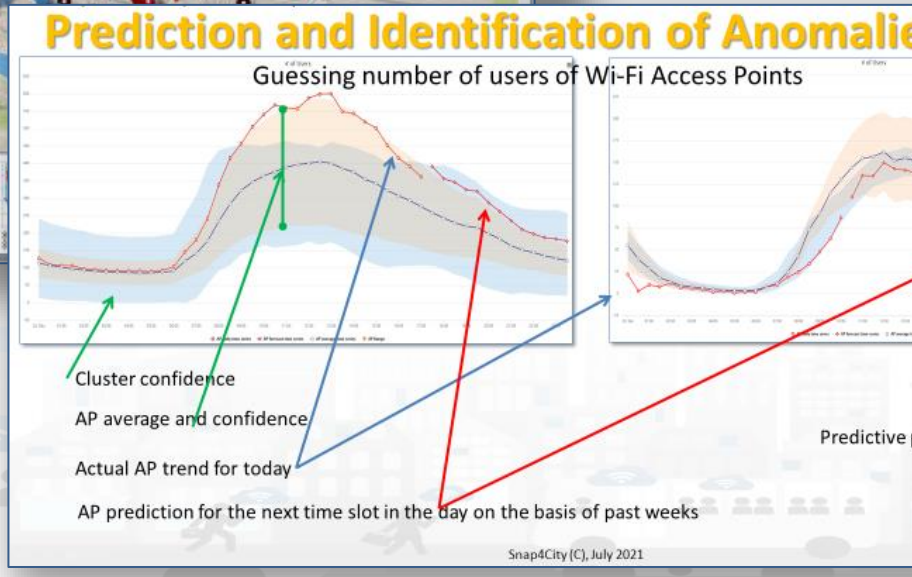


https://www.snap4city.org/dashboardSmartCity/view/Gea-Orange.php?iddasboard=NDUyOQ==

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

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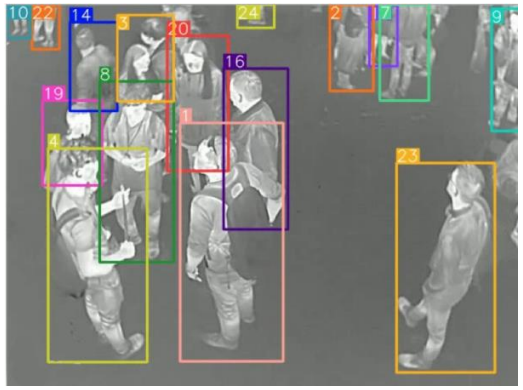
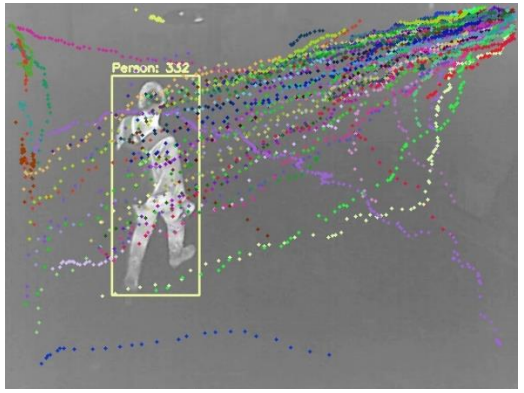
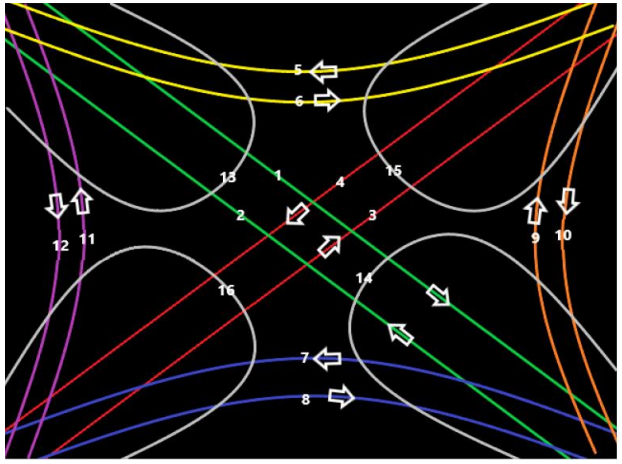
User Behaviour: People Counting, Tracking, etc.

- **Behavior analysis in open or closed spaces**
  - HUB, metro, stations, production lines, parking lots, critical areas in cities,
  - shopping centers, retail, etc.
- **Thermal Cameras**
  - GDPR compliant
- **AI injection**
  - classification and counting
  - Identification of critical situations
  - Early warning
  - Integration with PAX counters, and with ODM data from operators
- **Real-time estimation**
  - Directly on the camera
  - High precision and reliability
  - Used by: Cuneo, Florence, Genoa, etc









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Interreg Mediterranean HERIT-DATA

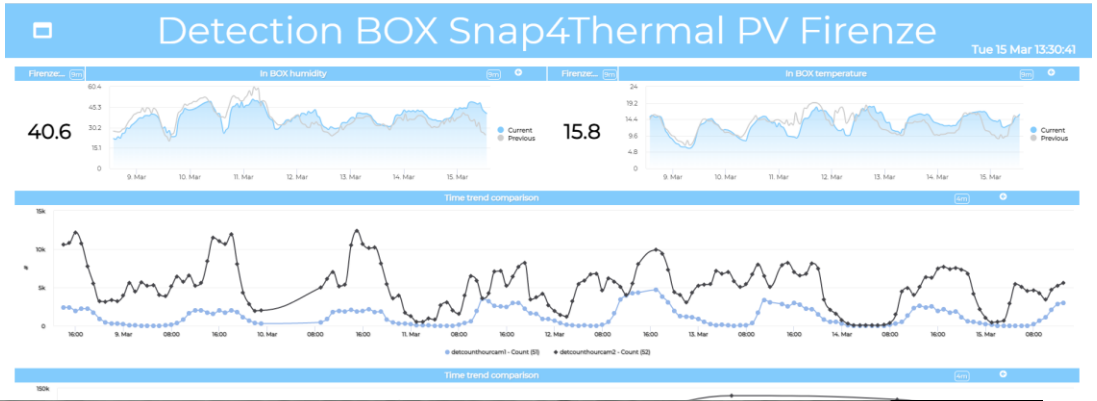
AXIS COMMUNICATIONS

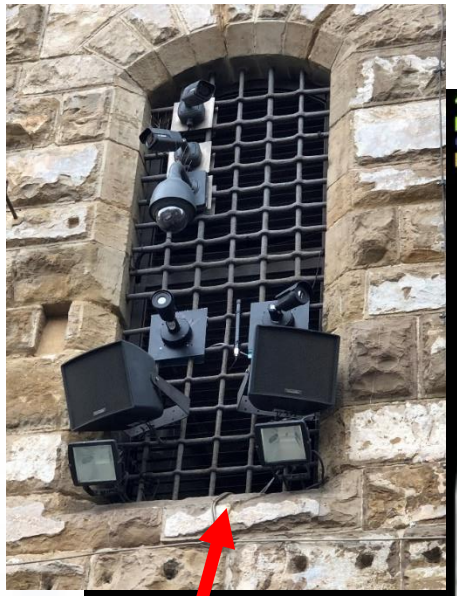
SNAP4CITY

KM 4 CITY

A view and data from the Thermal Camera









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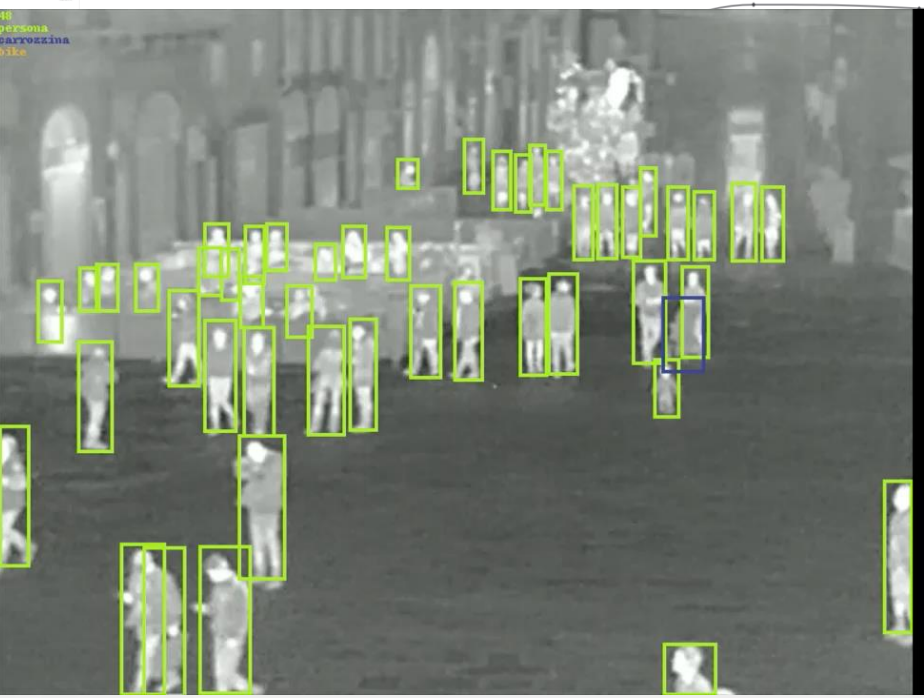



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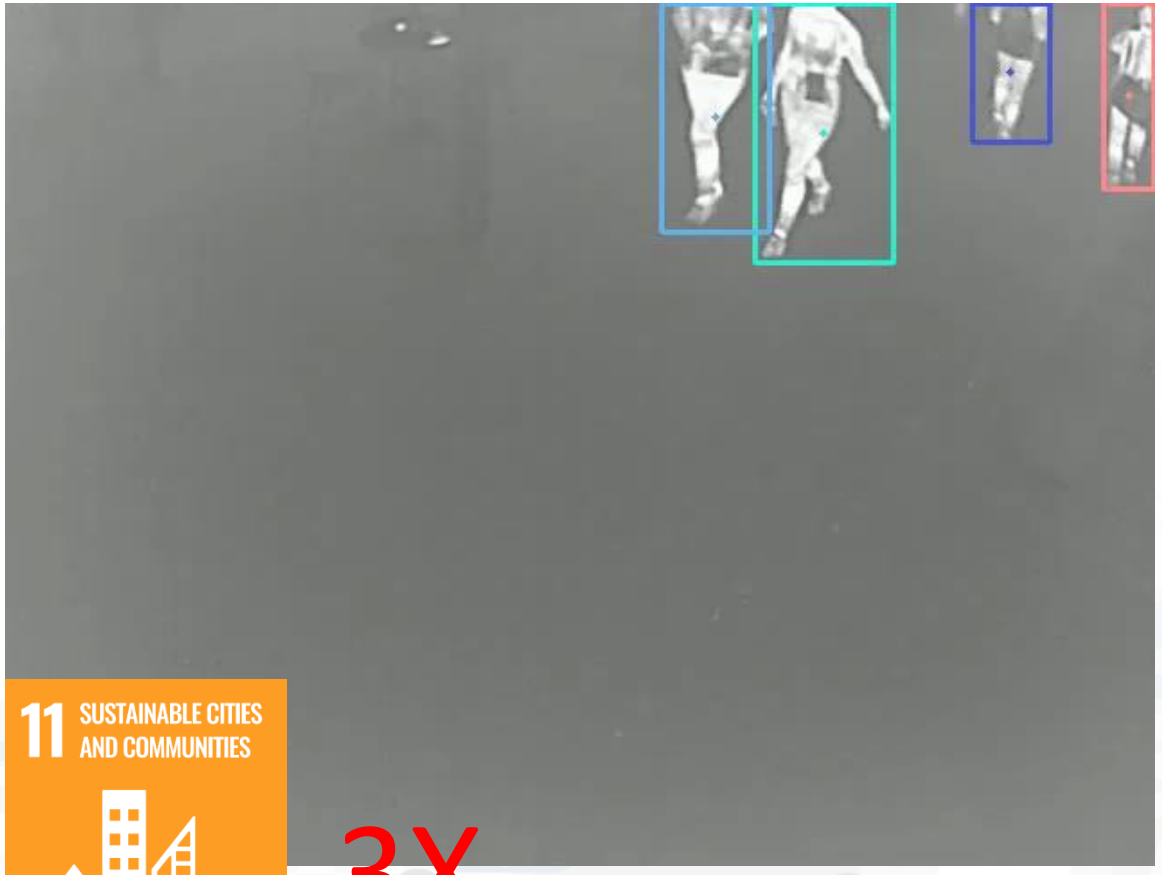
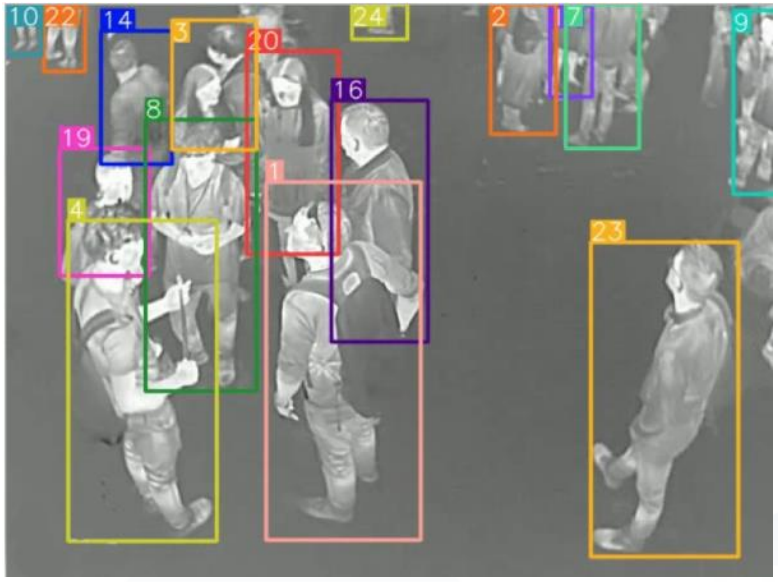
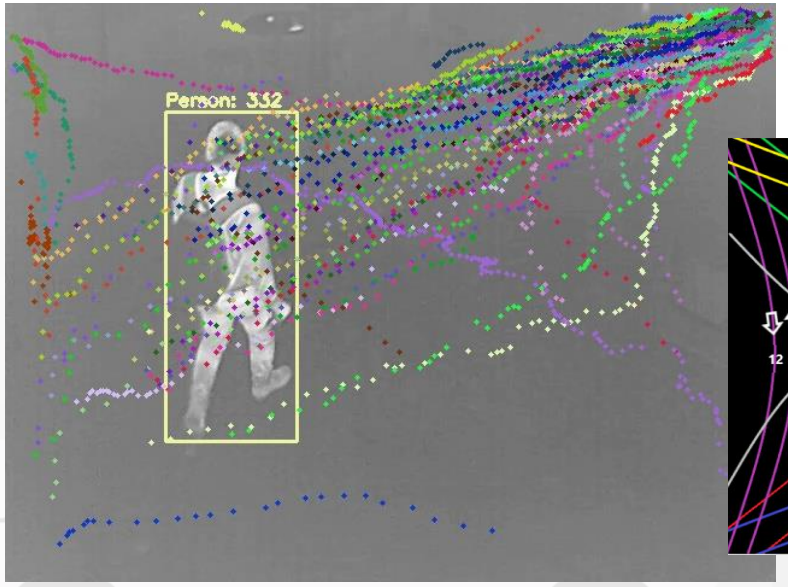
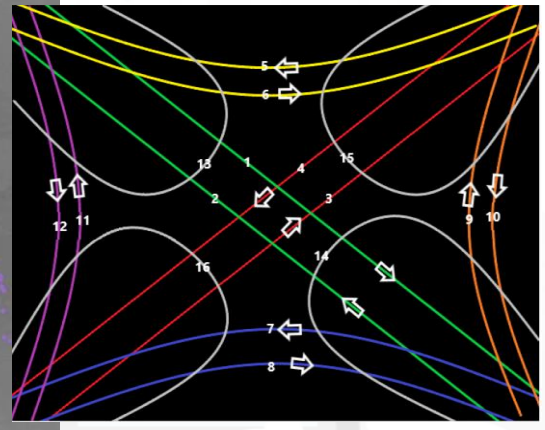
People Counting and Tracking









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3X

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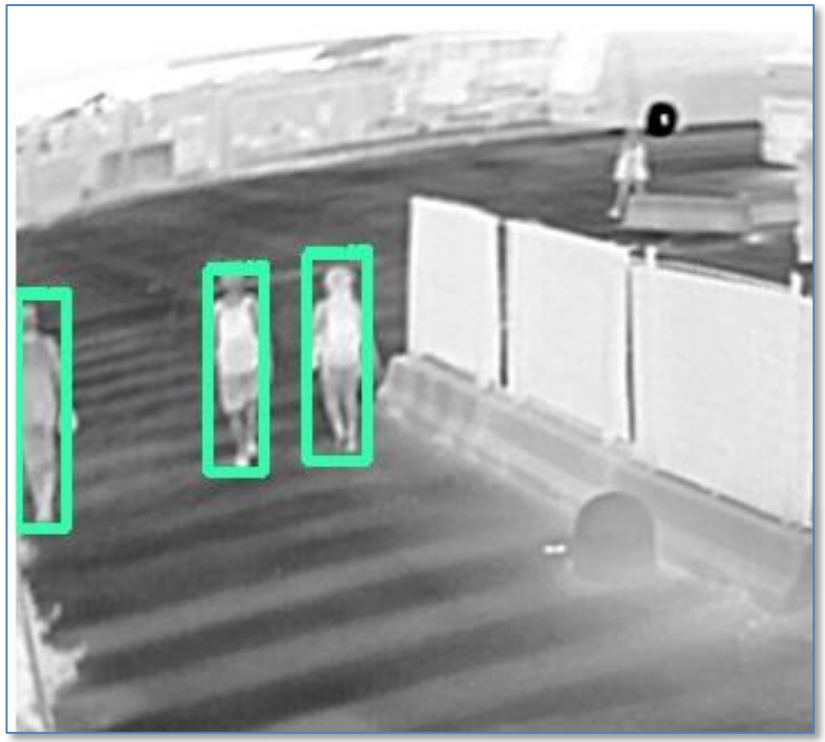
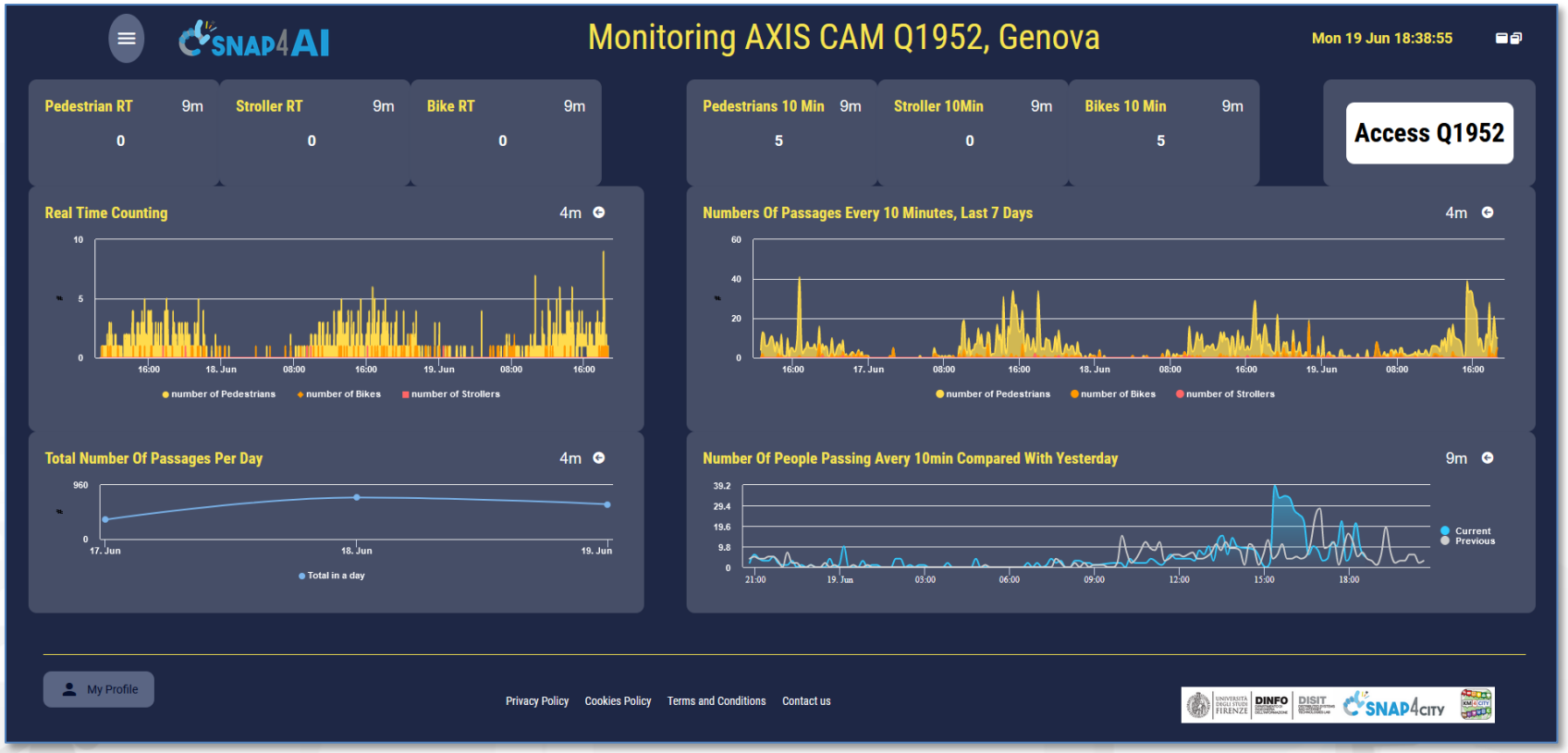


Monitoring Passages AXIS Q1952



- Genova: Ocean Race, 2023





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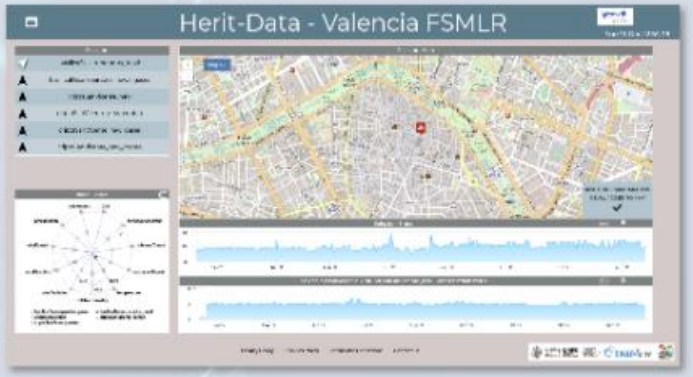
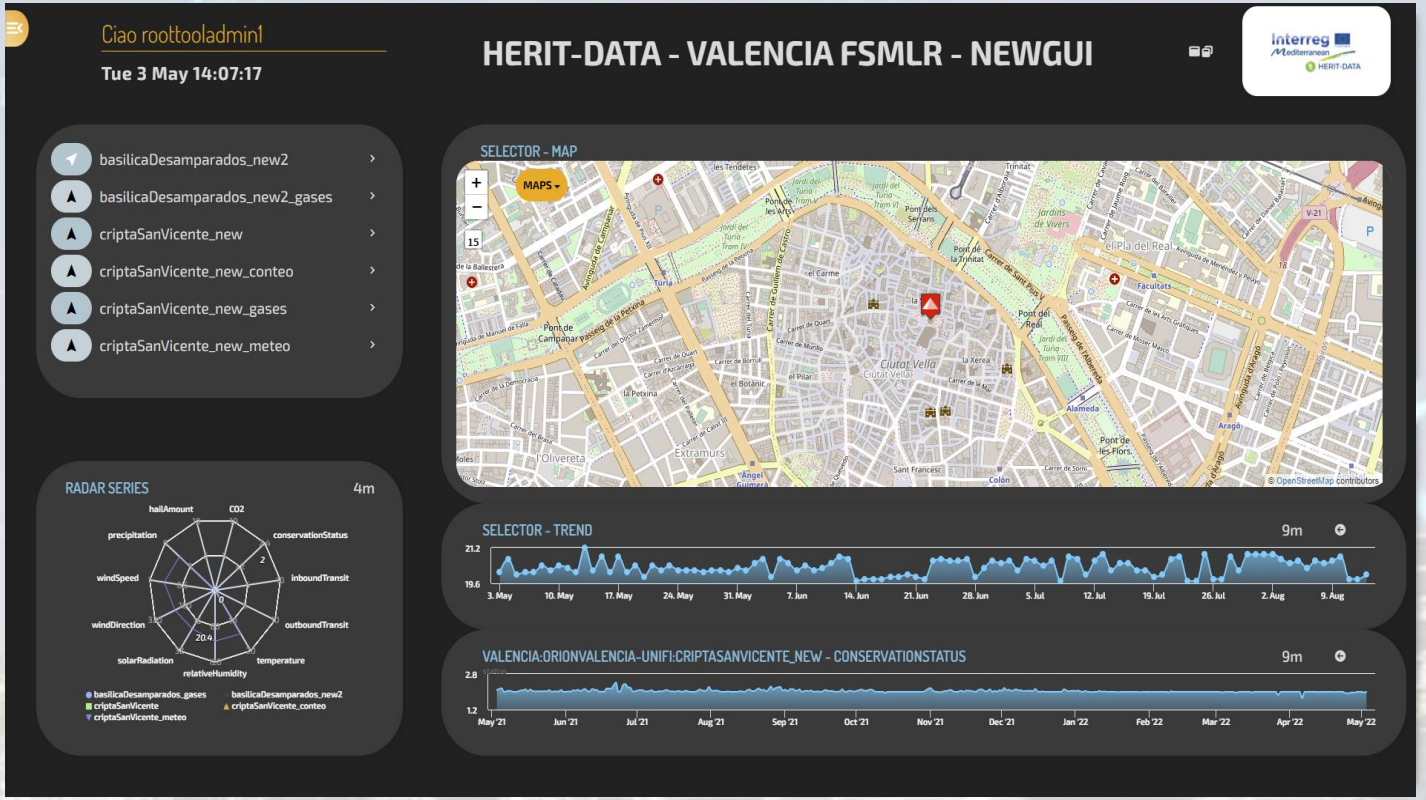
Valencia, FSMLR

- **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**





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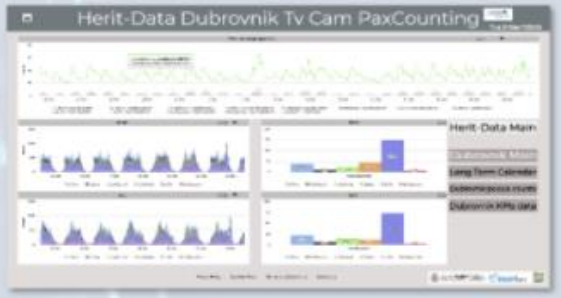
Dubrovnik

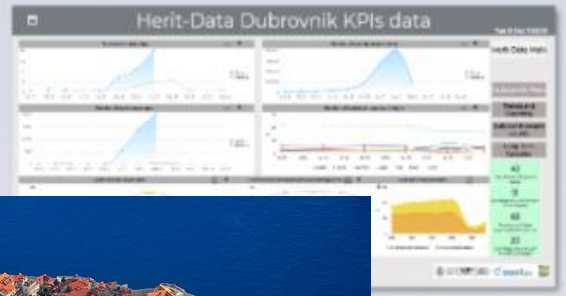
- **Tourism Domain**
  - Counting People
  - TV Cameras and WiFi
  - Social Media
- **Dashboards**
  - Monitoring and real time control
  - People flow
  - Twitter Vigilance
- **Historical and Real Time data**
- **Services Exploited on:**
  - Dashboard
- **Since 2020**

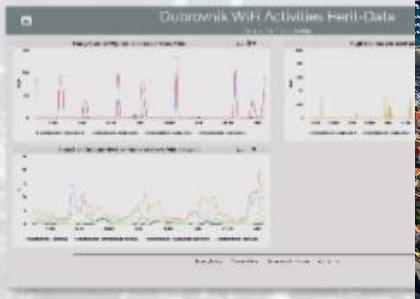


















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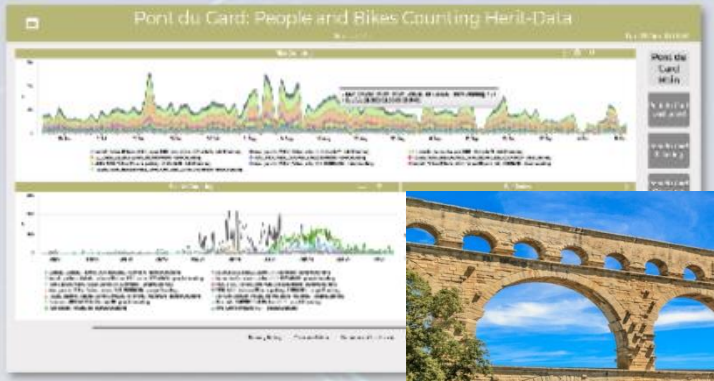
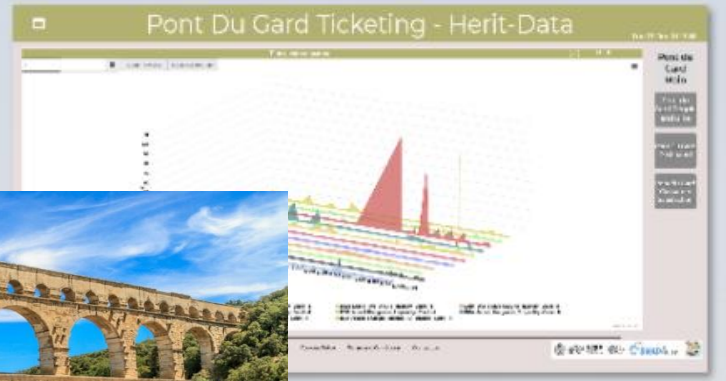
Pont du Gard

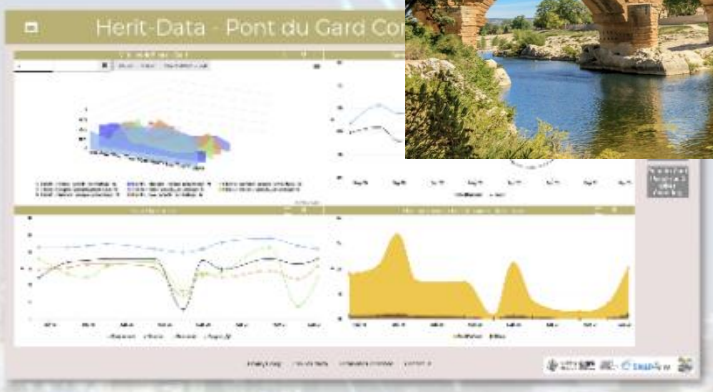
- **Tourism Domain**
  - KPIs
  - Social Media
  - People Flows
  - Bike Flows
- **Dashboards**
  - Monitoring KPI
  - People and bikes flows
  - Twitter Vigilance
- **Historical and updated data**
- **Services Exploited on:**
  - Dashboard
- **Since 2020**













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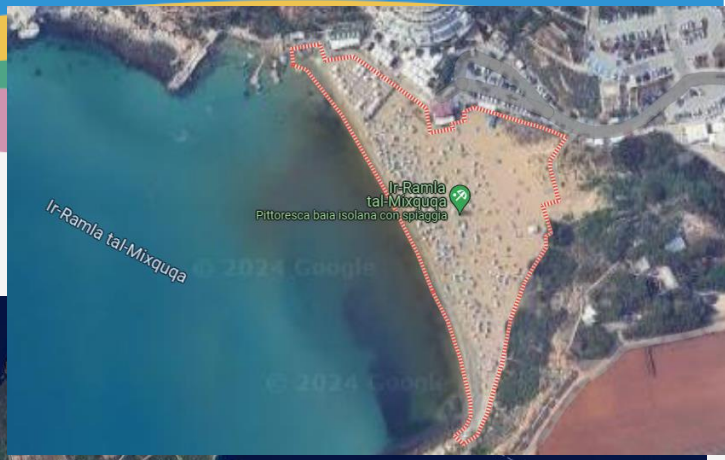
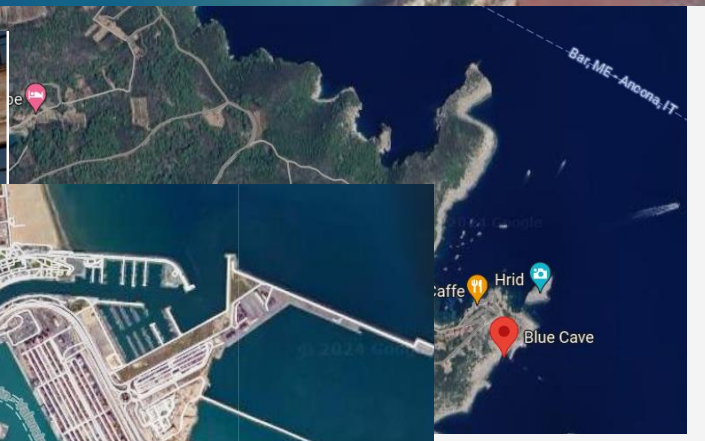
• Pilots of Snap4City on:

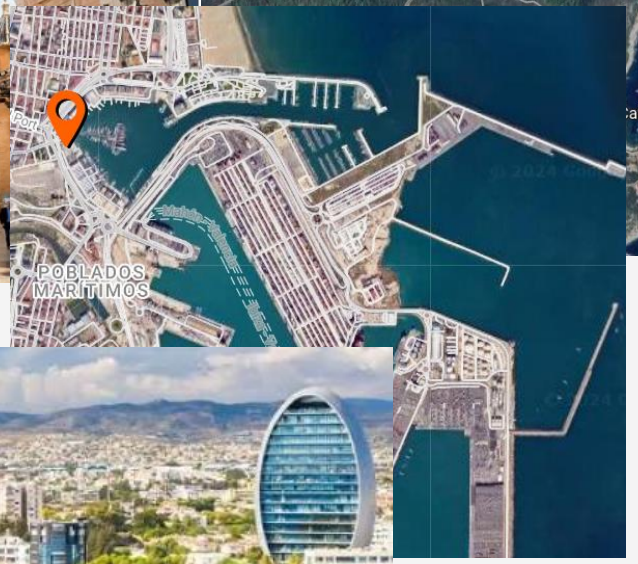
- Greece - READ S.A.: Rodi
- Italy – FRI, UNIFI: Firenze
- Spain – FV, FSMLR: Valencia
- Cyprus – ANELEM: Limassol
- Bulgaria – VEDA: Varna
- Croatia – RERA SD: Splitsko-dalmatinska županija
- Malta – MRDDF: La Valletta



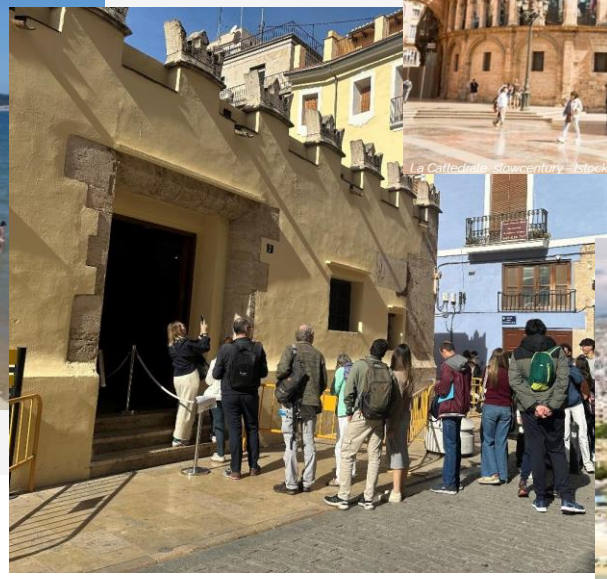








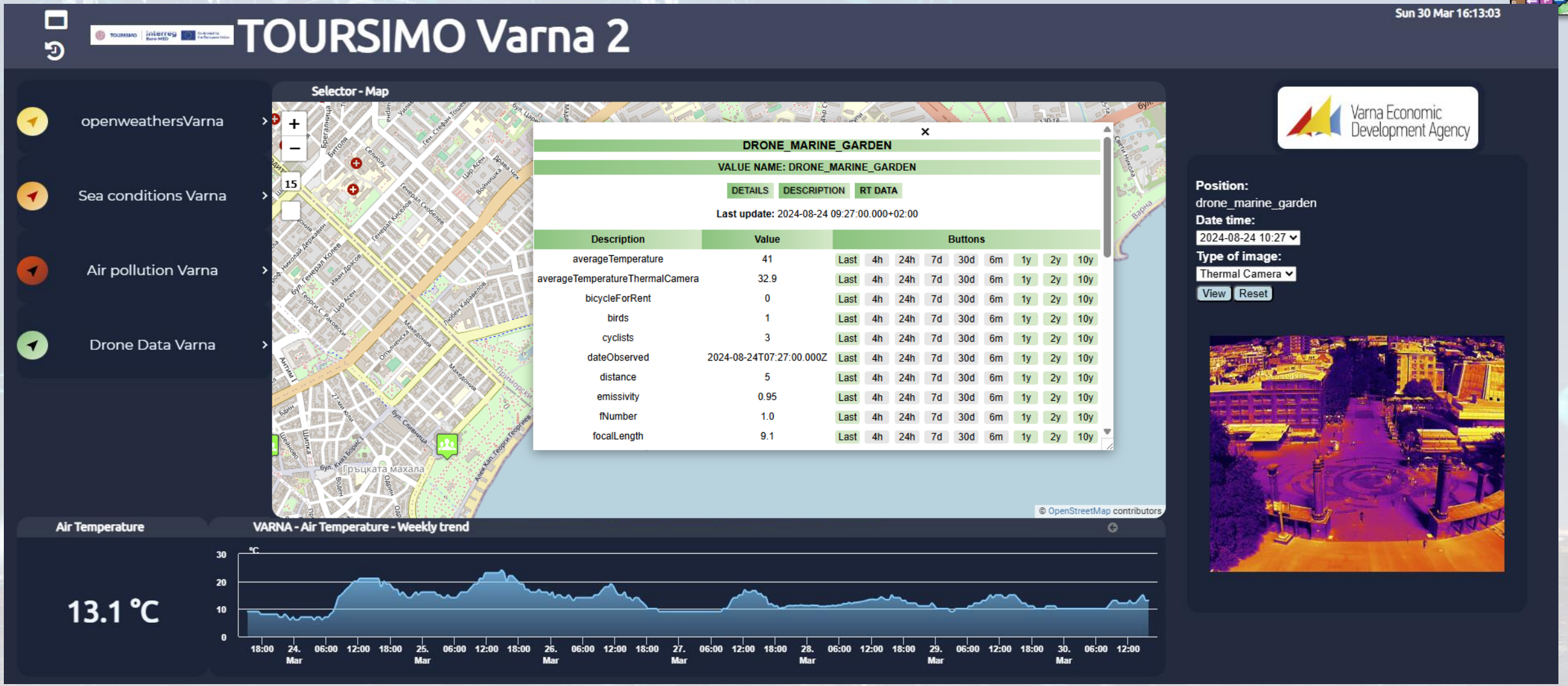






Interreg Euro-MED
Co-funded by the European Union

Counting People by Drones in Varna



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Tracking People vs Environment in Malta



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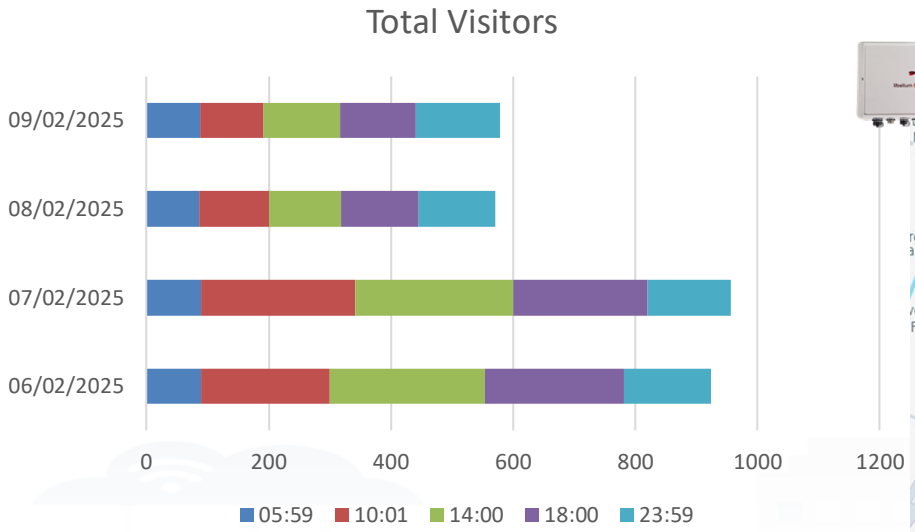
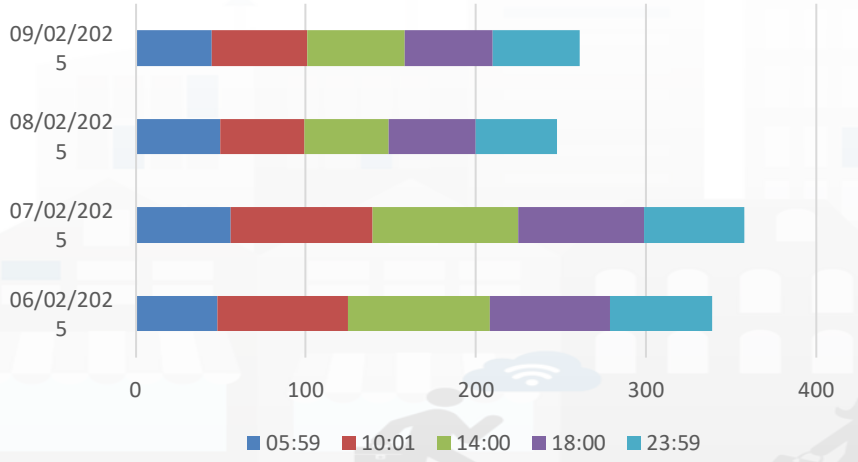
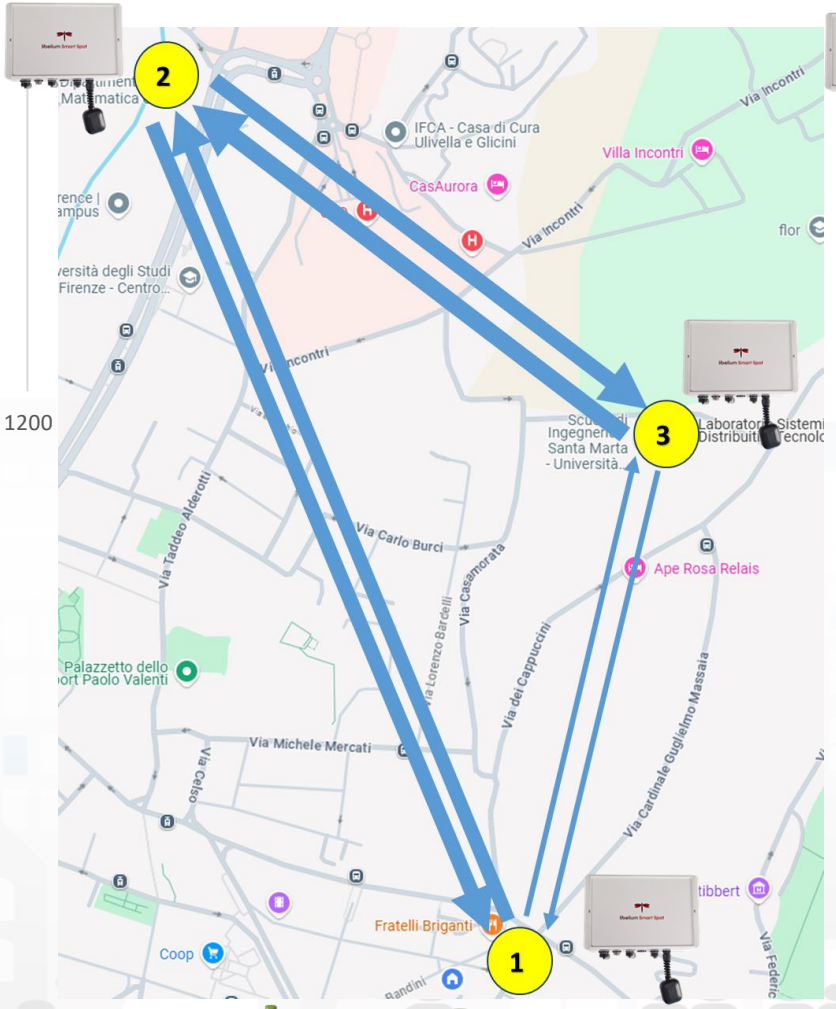
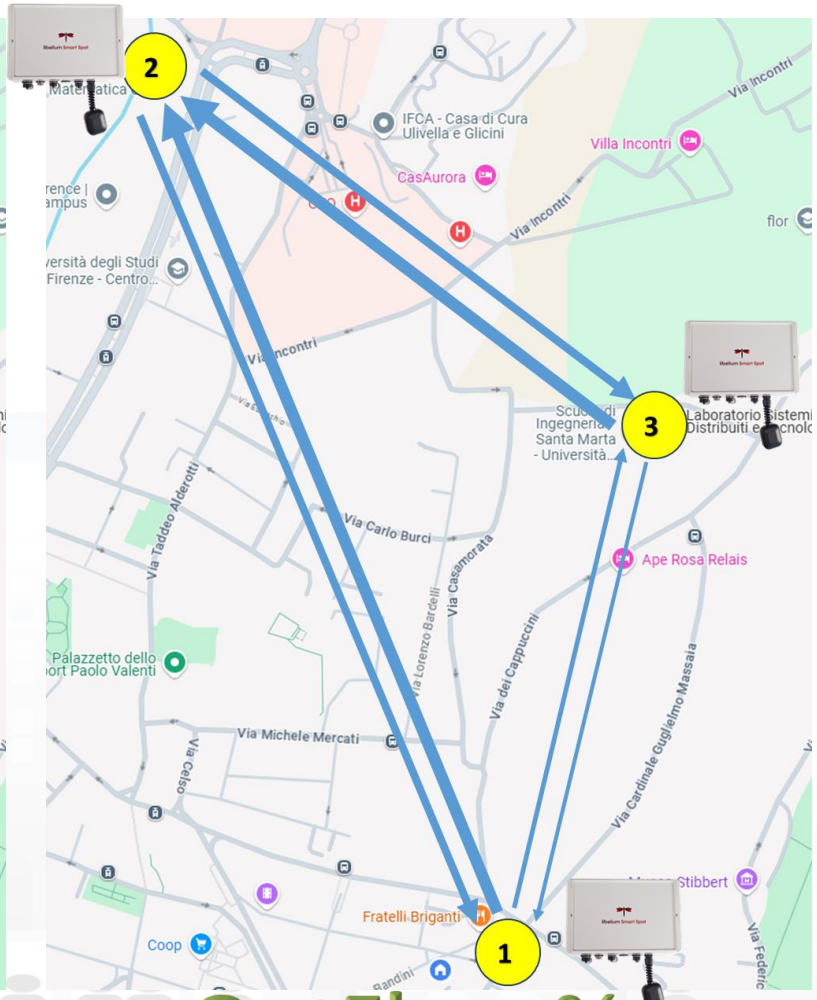
Libelium PaxCounters







Flow Counts



OutFlow %

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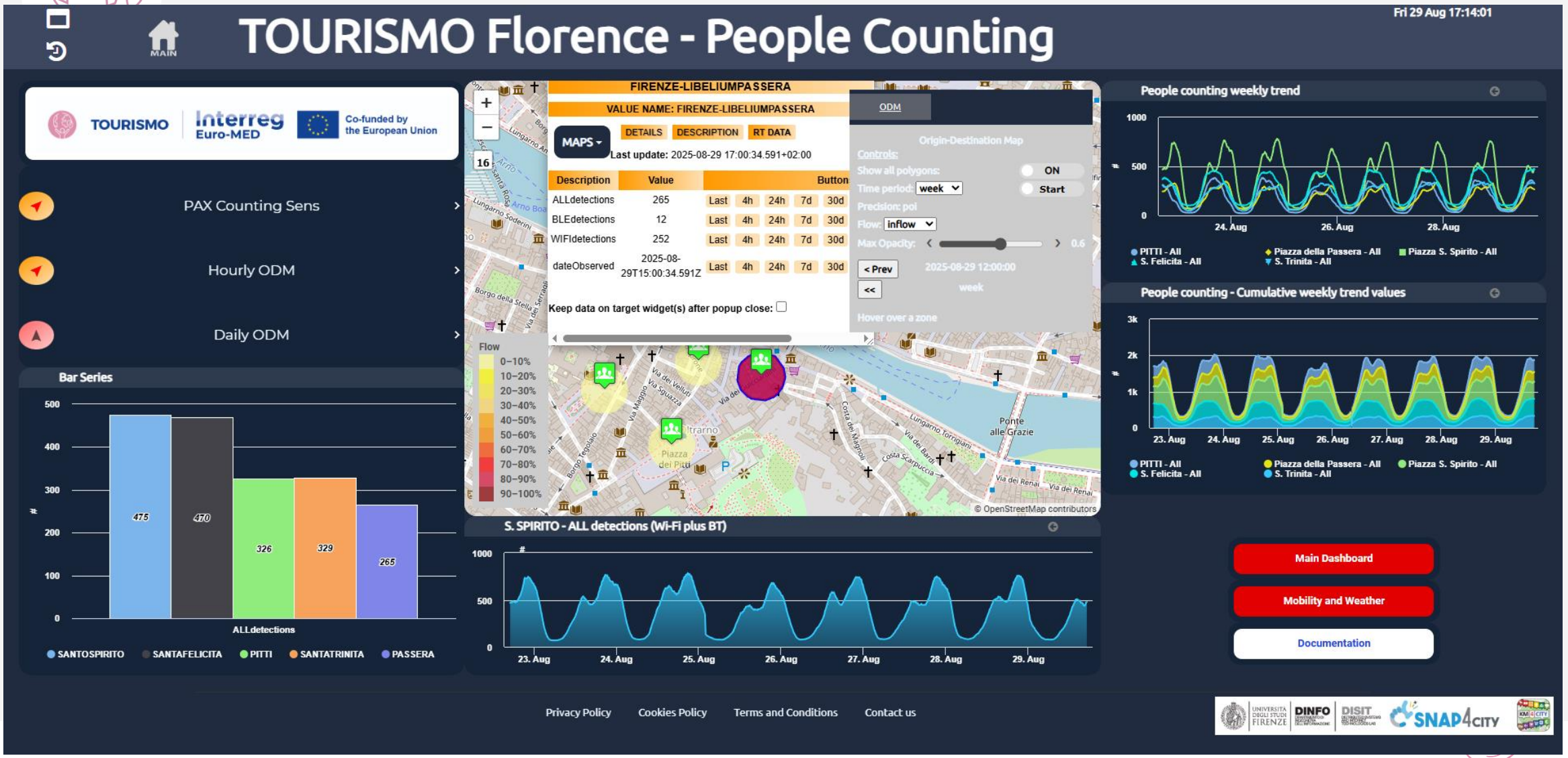

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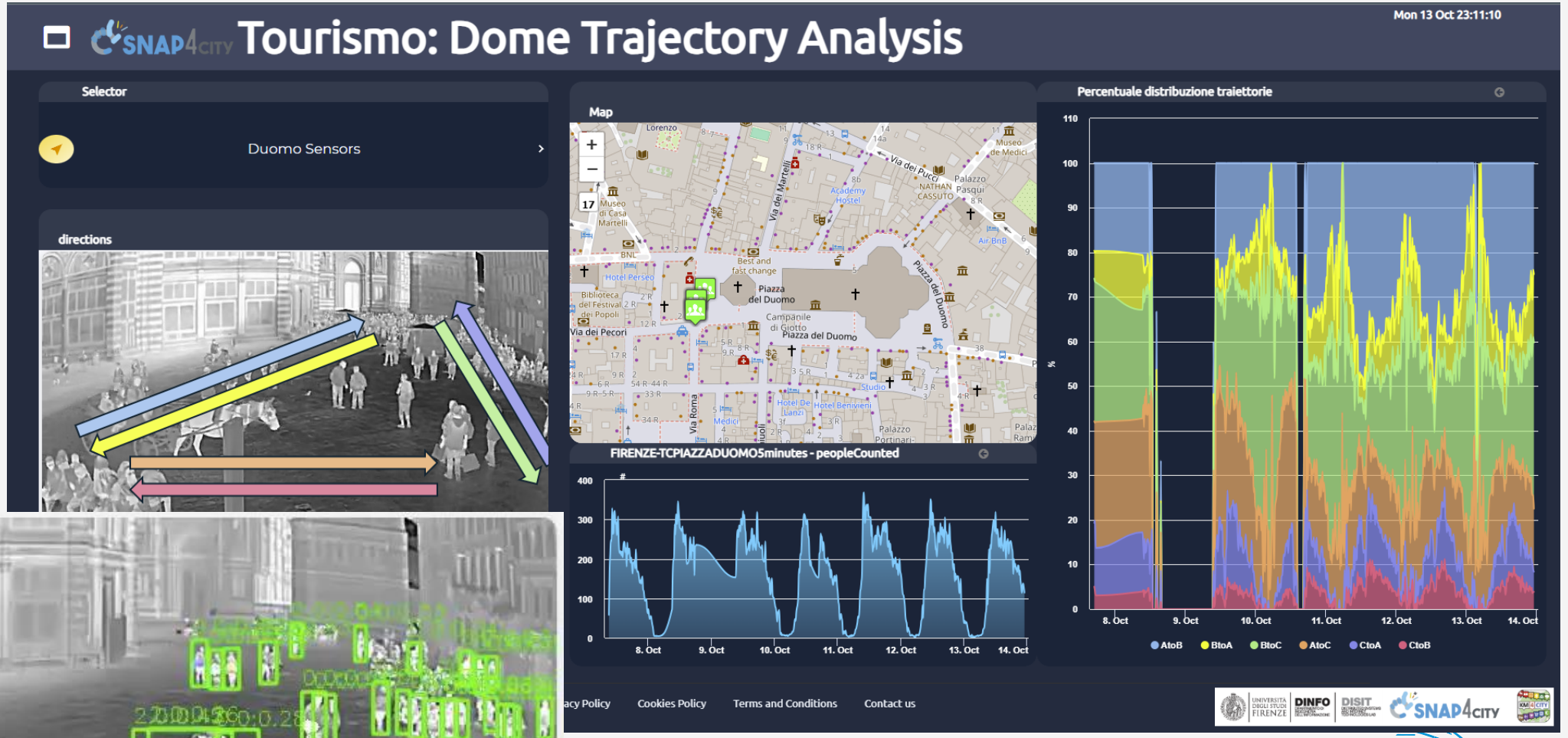
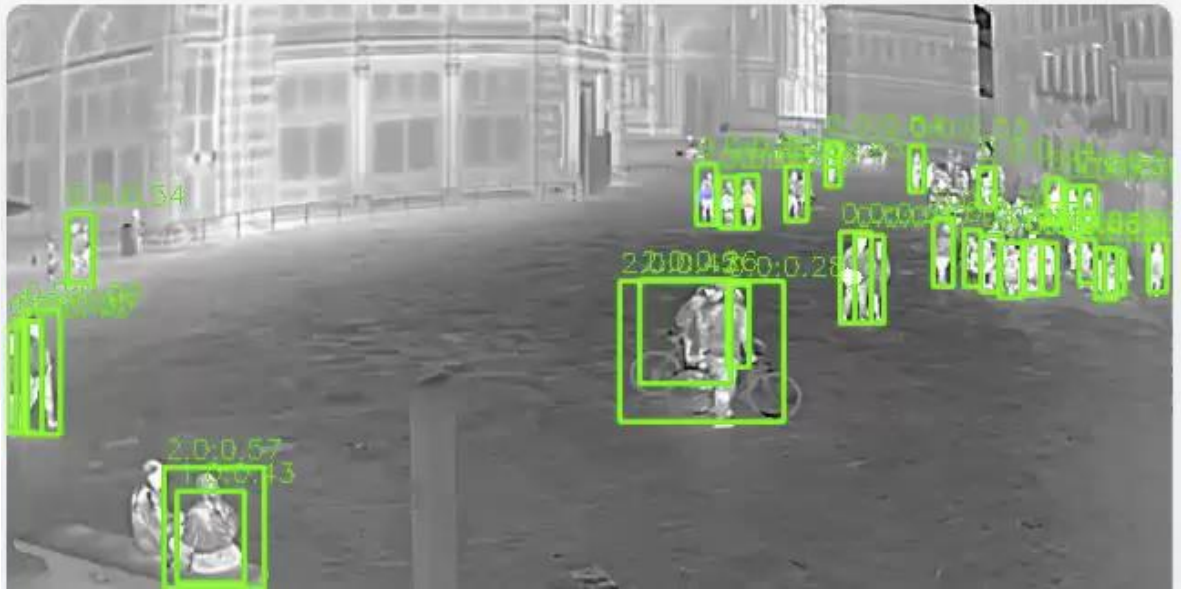


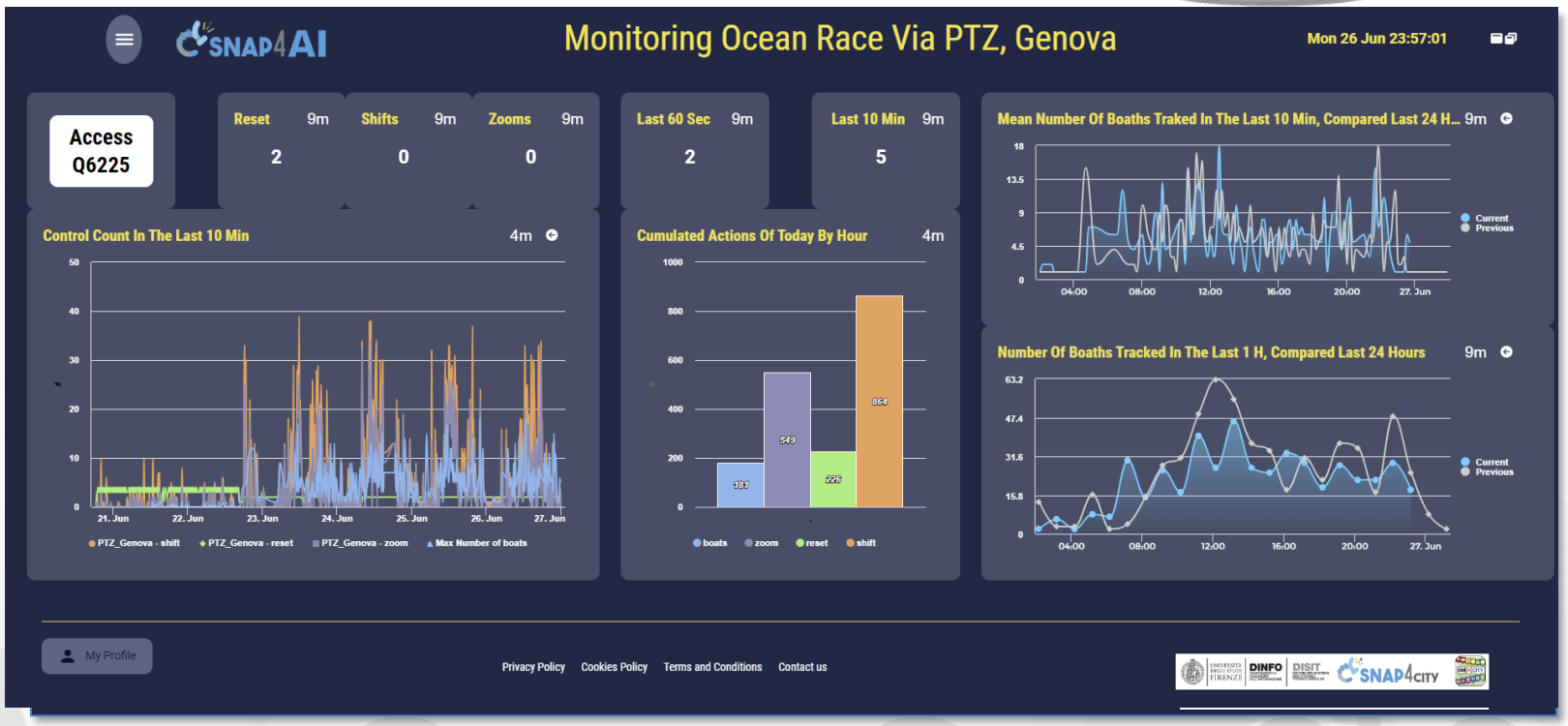


Monitoring Boats
AXIS Q6225





- Genova: Ocean Race, 2023



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7 AFFORDABLE AND CLEAN ENERGY

11 SUSTAINABLE CITIES AND COMMUNITIES

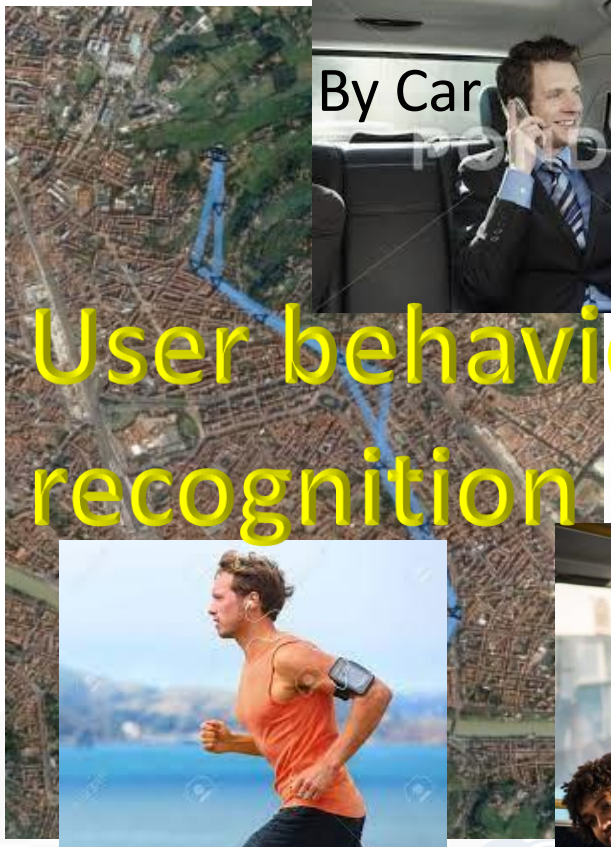
13 CLIMATE ACTION

SNAP4CITY

KM4CITY

To propose suggestions and Engage city user

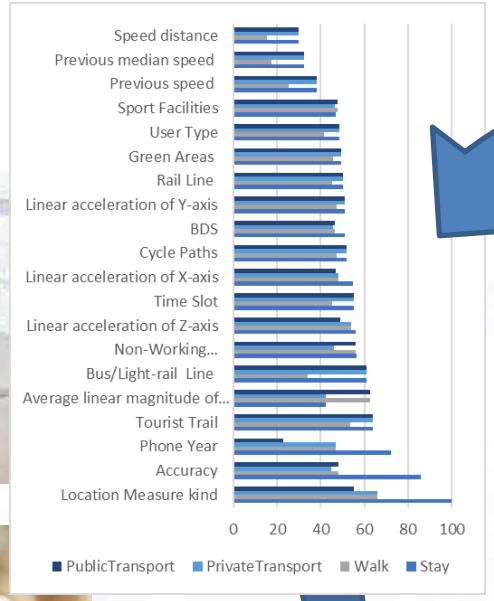
we need to know how they are moving



User behavior recognition

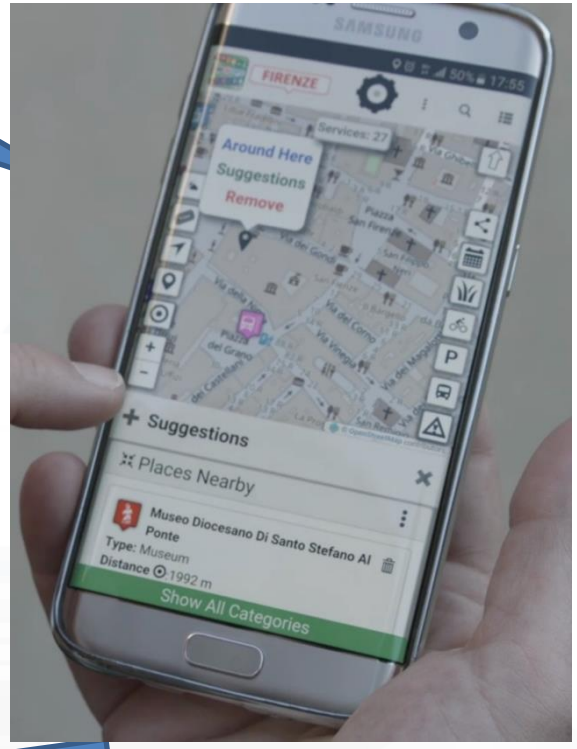






Behavior Classification

Suggestions



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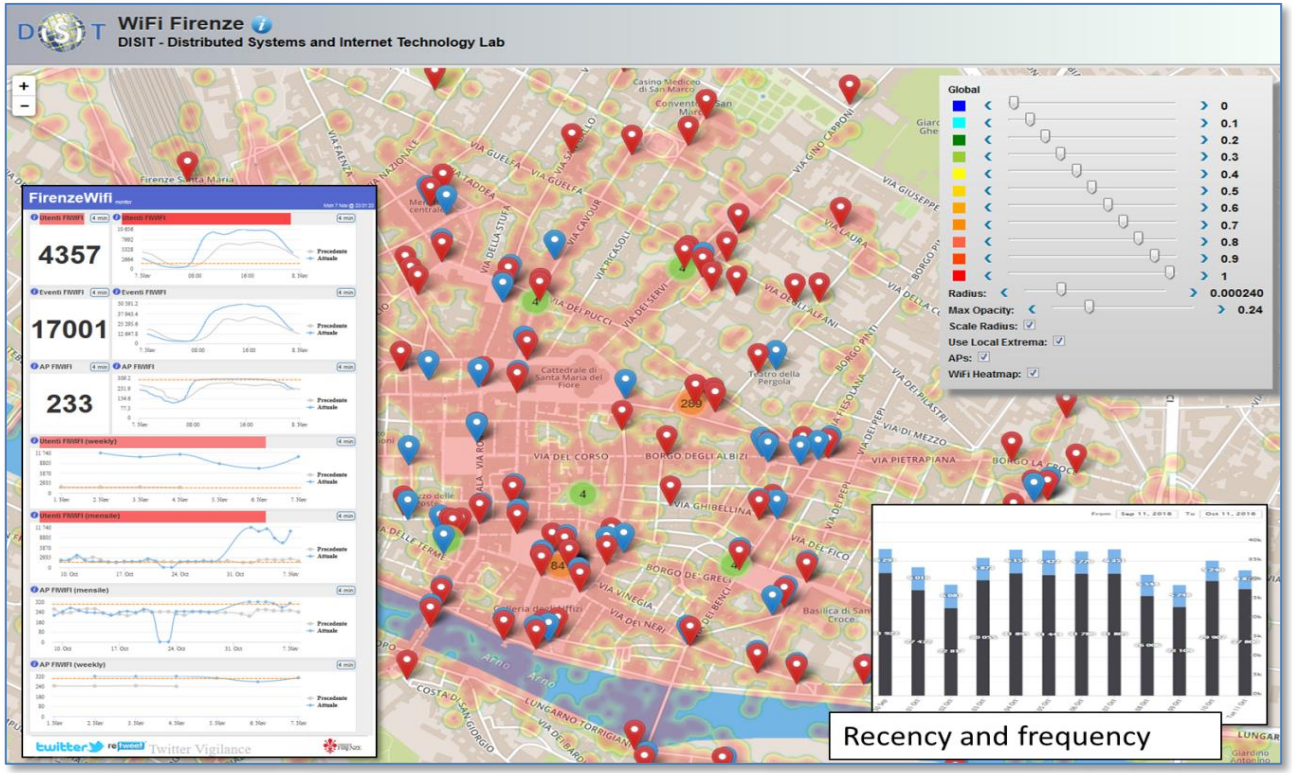
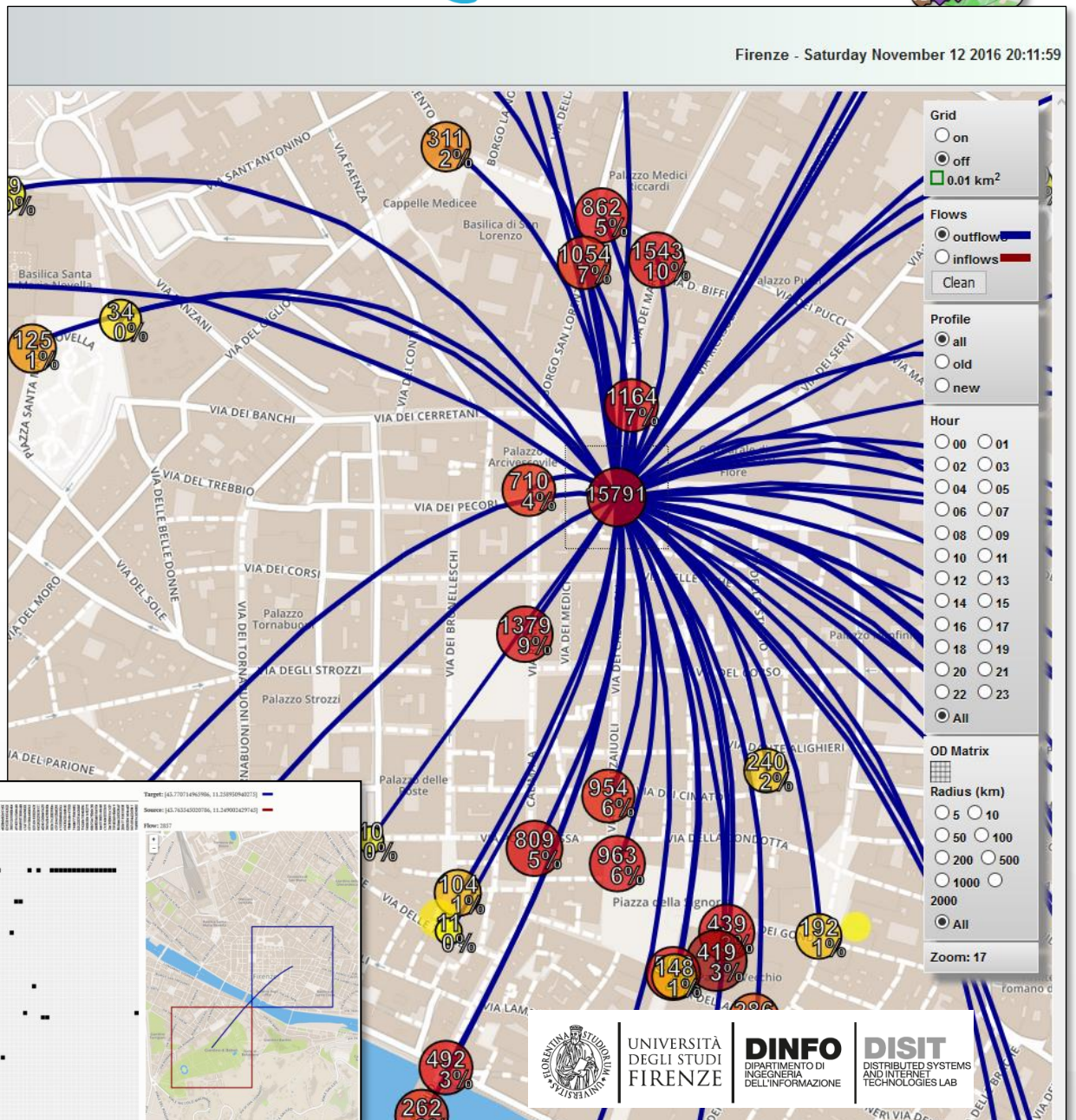
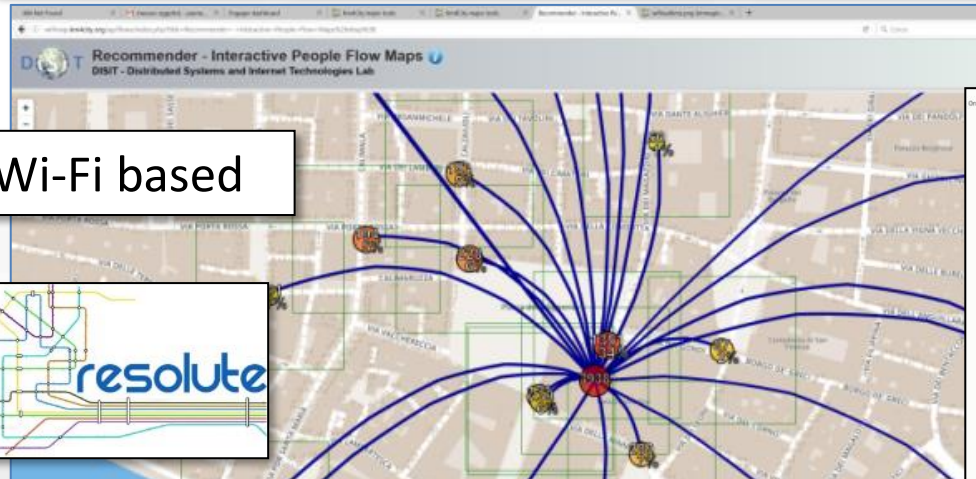
Origin Destination Matrix Estimation



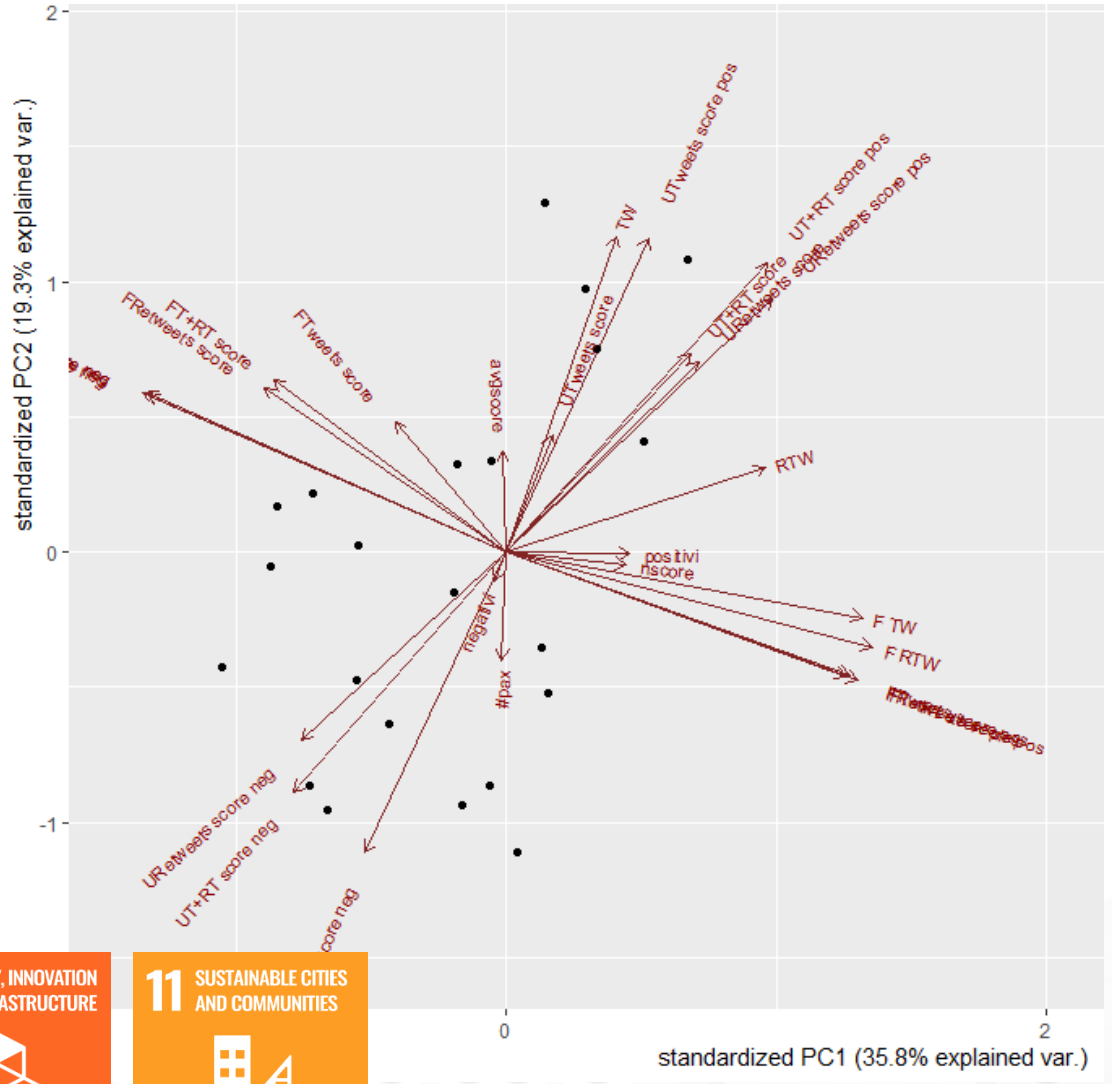




Wi-Fi based

Reputation

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



9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

11 SUSTAINABLE CITIES AND COMMUNITIES

Twitter Vigilance

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Assistants on taking decision and for training/development

Goals

Details

SnapAdvisor: AI based Assistants, DSS

- **Sna4CityAdvisor:**
  - for developers and promoters knowing all Snap4City and DISIT Lab literature, articles, manuals, slides, codes, etc. The SnapAdvisor with this skill is accessible only for selected Snap4City users. It allows users of saving a lot of time by providing answers to facilitate the development of smart solutions, to the exploitation of Snap4City tools, and recently on data and services accessible on the platform, producing offers, etc.
- **Legal Advisor**
  - expert on specific disputes at service of the Legal department of Careggi Hospital of Florence. It allows to save time in recovering precise information from complex legal documents, ordering of events, understanding causes and effects, producing reports, etc.
- **Expert of industrial machines, user manuals, technical manuals, rules,**
  - Answering on technical manuals
- **Complains and Questionnaire analysis**
  - Answering on trends, via questionnaires collected via QR, blobs, emails, etc.
- **Commercial Advisor:**
  - processing orders understanding them and preparing the offer, thus reducing the time to process them.
- **Generative Designs:**
  - Multimodal Generative AI supporting designers in producing innovations
- etc.

https://www.snap4city.org/1116

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SNAP4CITY

Logged in as:
edoardo_tester

Your Profile

Logout

SnapAssistant model:

Llama3.3

New Chat

- EdoChat1
- EdoChat2
- EdoChat3
- EdoChat4
- prova
- chatNuova
- chatTest1LLAMA
- chatTest2LLAMA
- testGianniLLAMA
- testTastoInvioPreChanges
- ChatTestPostPSWINVIO

https://www.snap4city.org/1116

SnapAdvisor

Current chat: debug0

Visualize references

Personal Advisor LLM

Come creo una dashboard?

Per creare una dashboard, puoi utilizzare la piattaforma Snap4City. La dashboard si compone di un insieme di widget grafici che possono essere impostati separatamente assegnando una serie di parametri, come origine dati, dimensioni, colori, forma, font, allarmi, relazioni con altri, ecc. (SOURCE: Snap4 City per la creazione di Smart City Control Room, SCCR). Inoltre, la piattaforma offre la possibilità di creare vere e proprie applicazioni interattive, multipagina/multidashboard, e non semplici storie monopagina da scrollare. Puoi anche condividere la dashboard con altri utenti anche fuori dalla Smart City Control Room tramite canali autenticati e protetti in HTTPS, in accordo al GDPR (SOURCE: Snap4 City per la creazione di Smart City Control Room, SCCR). Per vedere alcuni esempi di dashboard, puoi visitare il sito https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjU0Mg== (SOURCE: Snap4 City 1st Overview v4 8 annot). Tuttavia, non ho trovato informazioni dettagliate sulla procedura di creazione di una dashboard. Se hai bisogno di ulteriore assistenza, ti consiglio di contattare direttamente il team di supporto di Snap4City. Non so dirti altro in merito.

Write a message...

SnapAdvisor

- **working on your private content** and thus producing answers.
  - Select a subset of documents
- **domain control**: you can decide the knowledge base (internal wikis, PDFs, APIs),
- **explainability** capability, provide references to your documents
- **multilingual via content**
- **modularity**: it is possible to pass from one collection of documents to another, and multiple users can work on the advisor asking for different topic on different collections/domains at the same time, independently as needs change, without any interferences among them.
- **lower hallucinations**

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SNAP4INDUSTRY

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

Details

info@disit.org
https://www.Snap4city.org,
https://www.Snap4Industry.org

Powered by SNAP4Tech

BY NC ND SOME RIGHTS RESERVED

The Power of Artificial Intelligence at the Service of Your Operation and Plan

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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COMMERCIAL MARKETING AI ADVISOR DSS



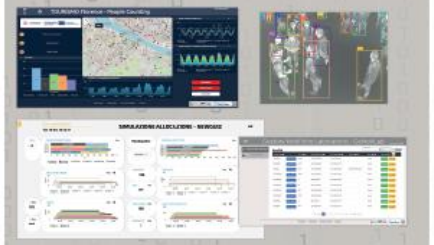
ENERGY, eVEHICLES, BUILDING



MOBILITY AND TRANSPORT



CUSTOMER BEHAVIOUR



ENVIRONMENT AND WASTE MANAGEMENT



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

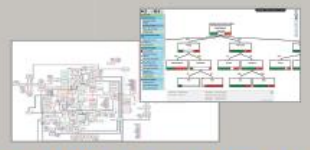


DASHBOARDS, WIDGETS
TEMPLATES

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

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

ANY: DATA, BROKER, NETWORK AND VERTICAL



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



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

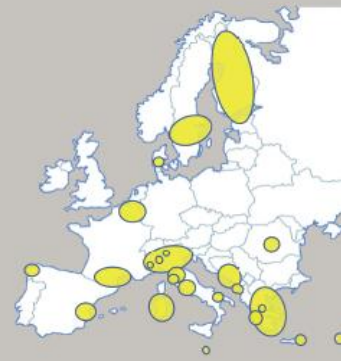


VISUAL PROGRAMMING, ADAPTERS
DATA FLOWS, WORKFLOWS
PARALLEL DISTRIBUTED PROCESSING
DATA DRIVEN



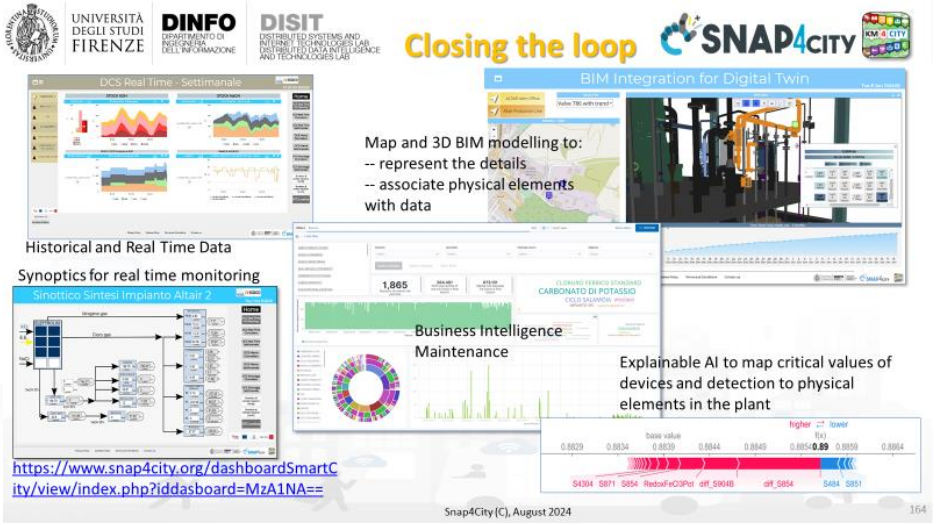
METHODOLOGIES
LIVING LABS
COURSES AND COMMUNITY
DEVELOPMENT TOOLS

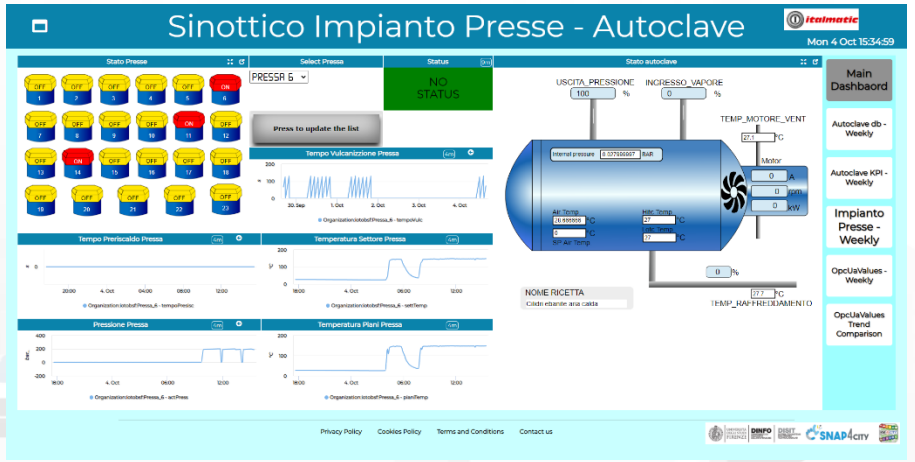




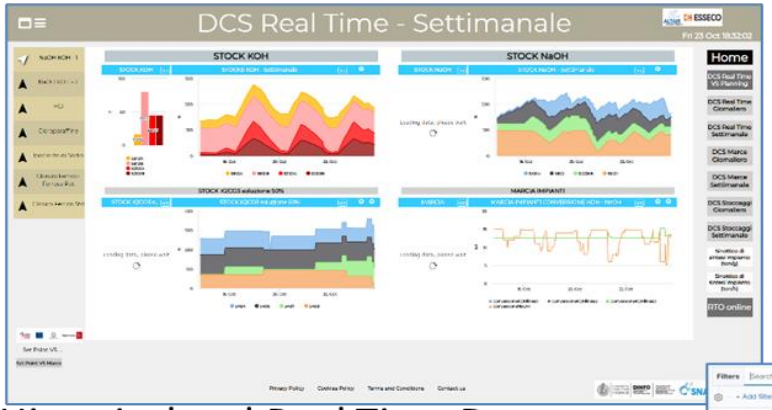
Industry production Domain (2025/5)

- 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, mob apps, etc.
  - Managing maintenance operation, predictive maintenance
  - Simulation of Fluid dynamic on Autoclaves
- 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



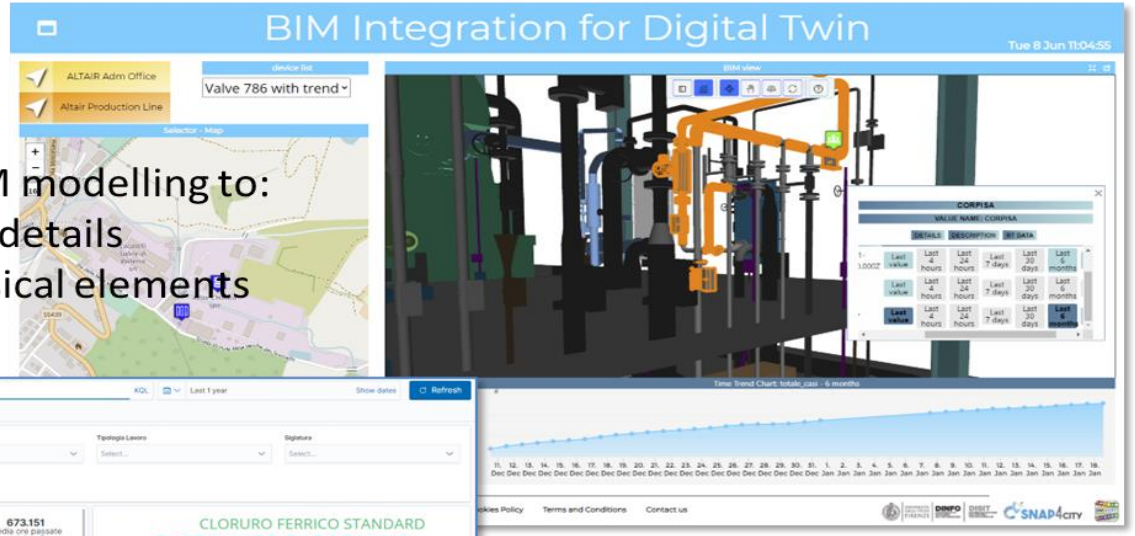


Predictive Maintenance

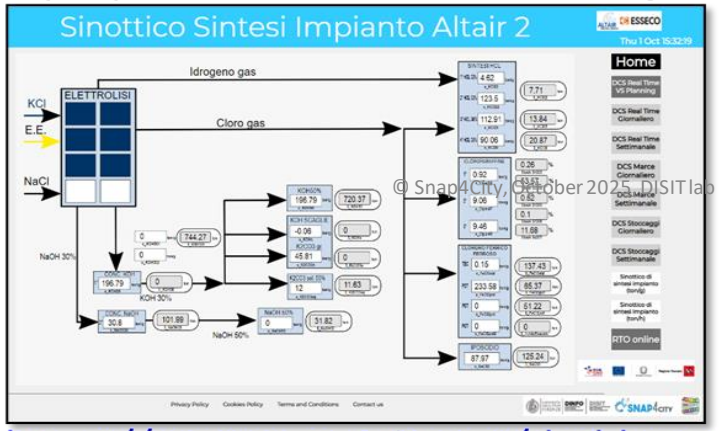


Historical and Real Time Data

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



Synoptics for real time monitoring



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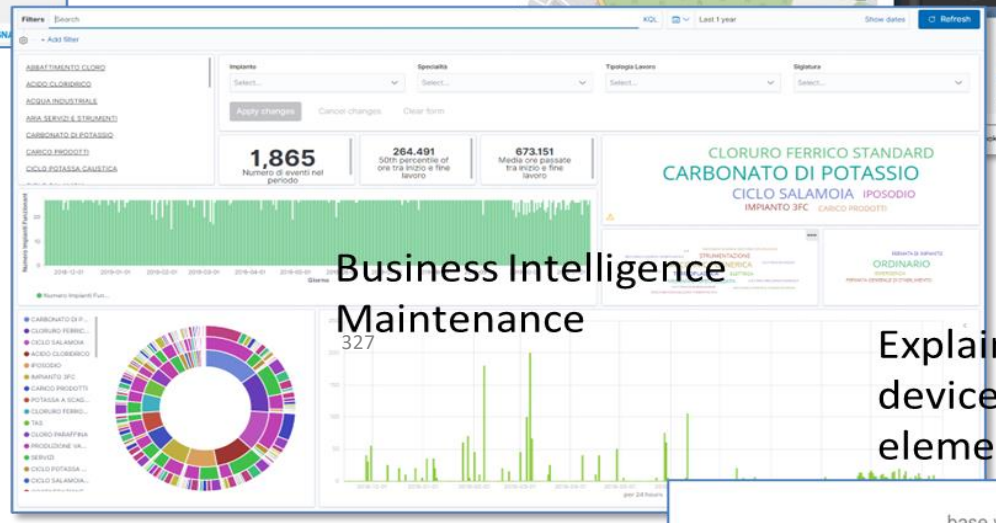
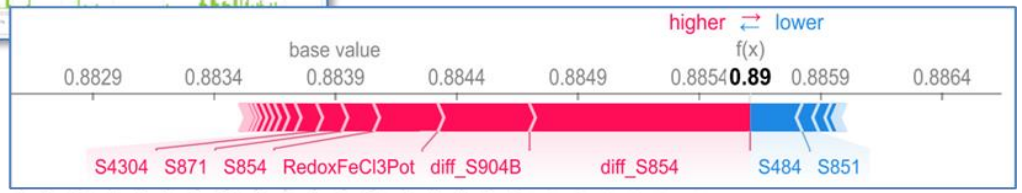


Business Intelligence Maintenance

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==

TUSCANY X.0

EDIH European Digital Innovation Hubs Network

Finanziato dall'Unione europea NextGenerationEU

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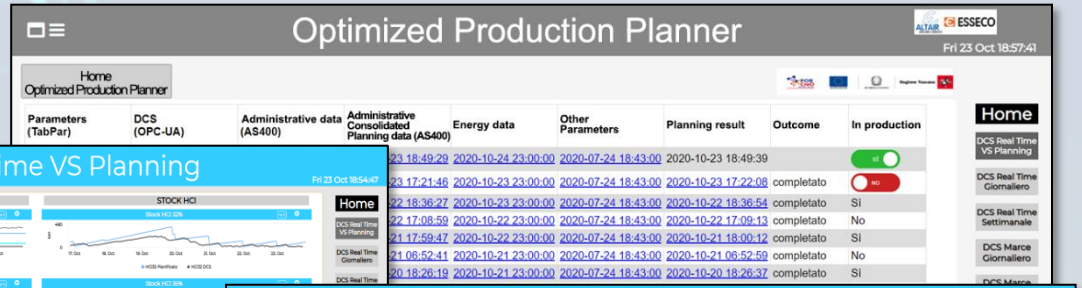
DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

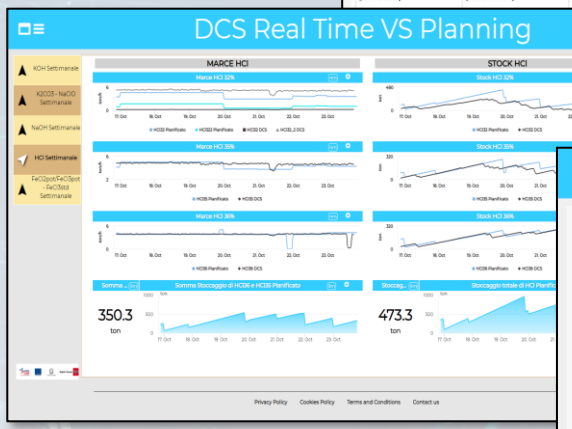
Snap4Altair Decision Support supervision and control, Industry 4.0

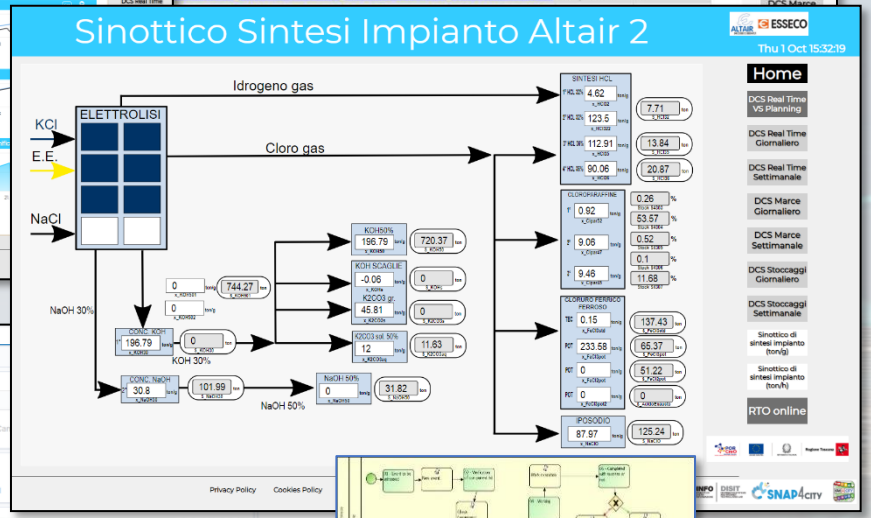


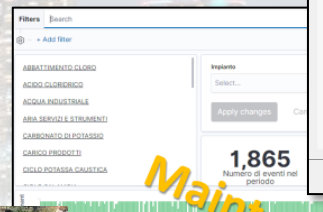
SNAP4INDUSTRY reference

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

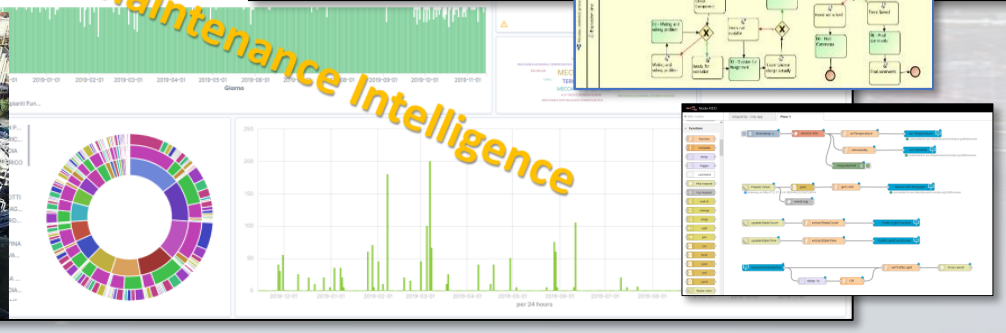












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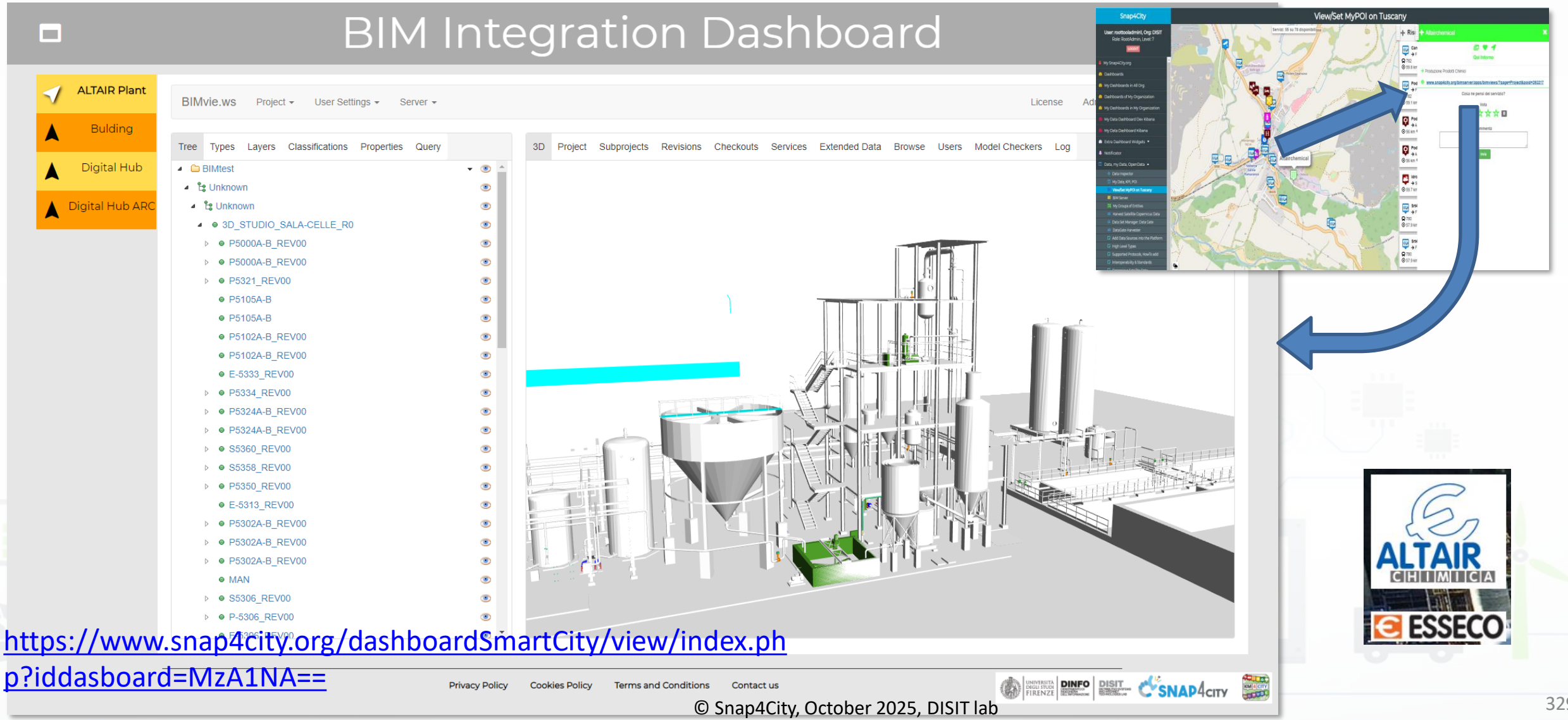
BIM view of the Altair Chemical Plant



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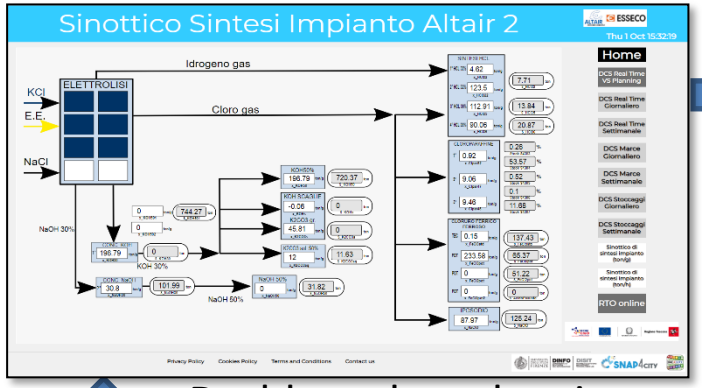
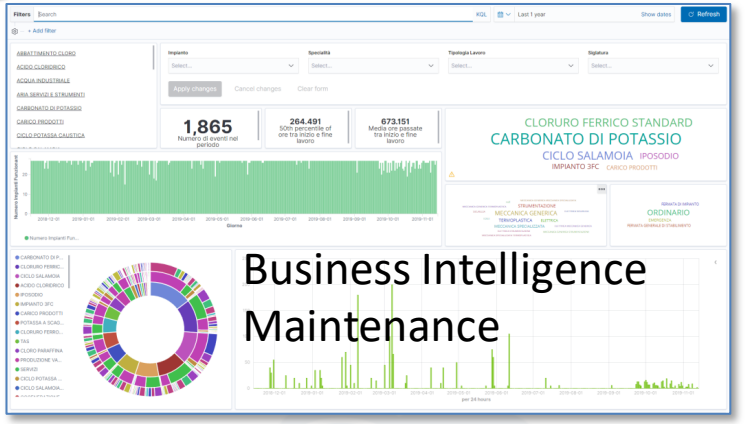
DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

SNAP4CITY KM4CITY

Workflow for Ticket management



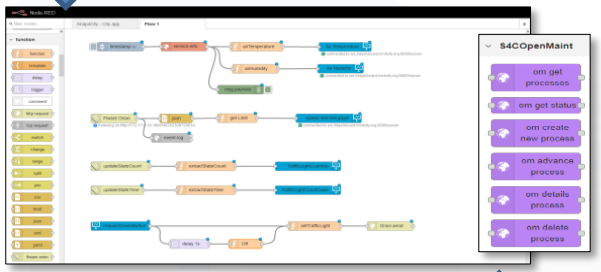
Consumptions/productions

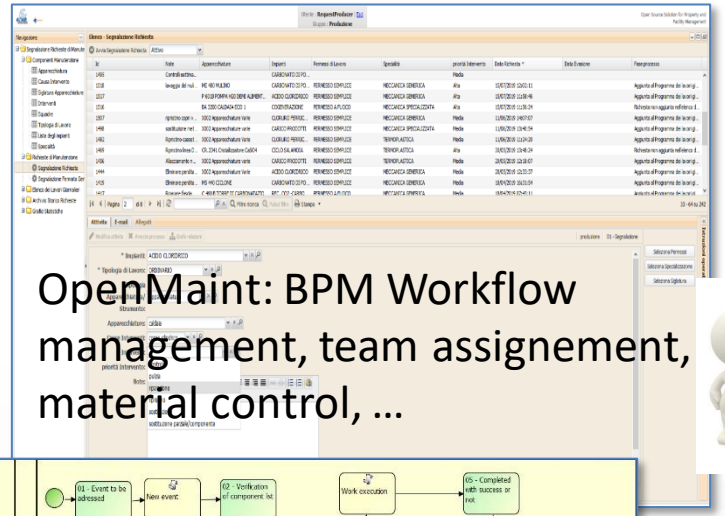


Events/actions

Business Intelligence
Maintenance

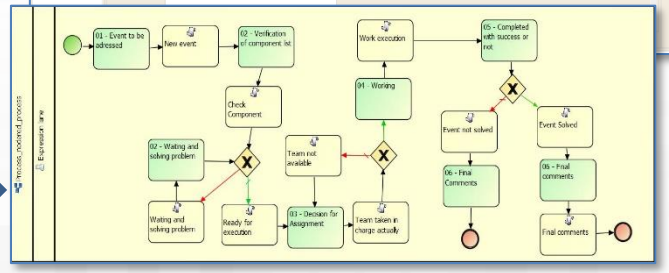
Dashboards and actions

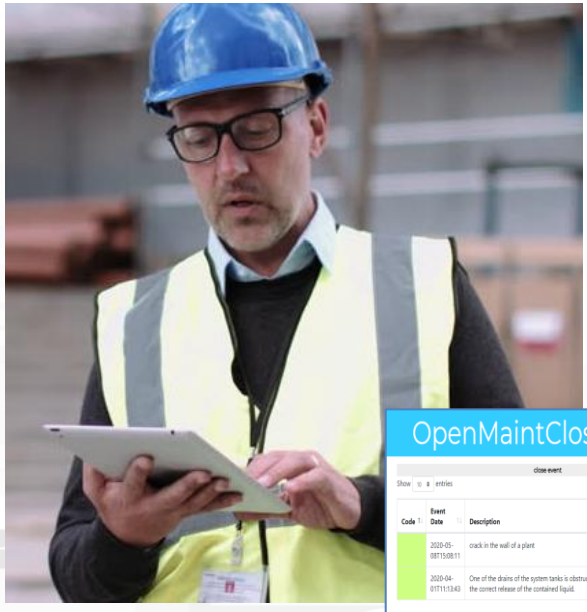




OpenMaint: BPM Workflow management, team assignement, material control, …







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

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Closing the loop

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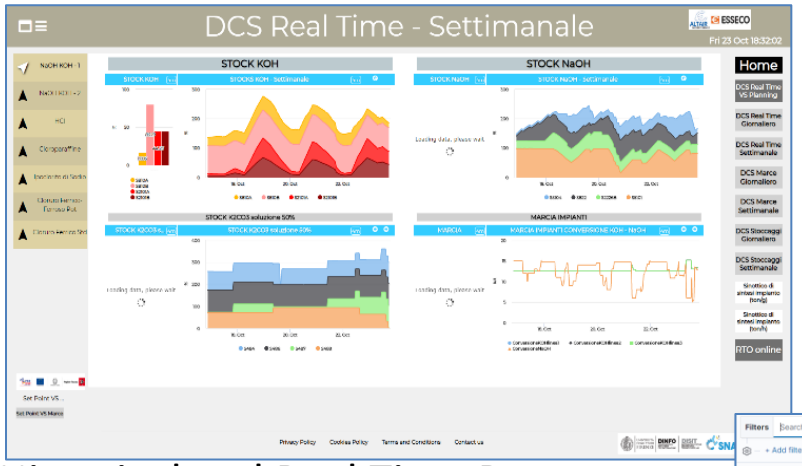
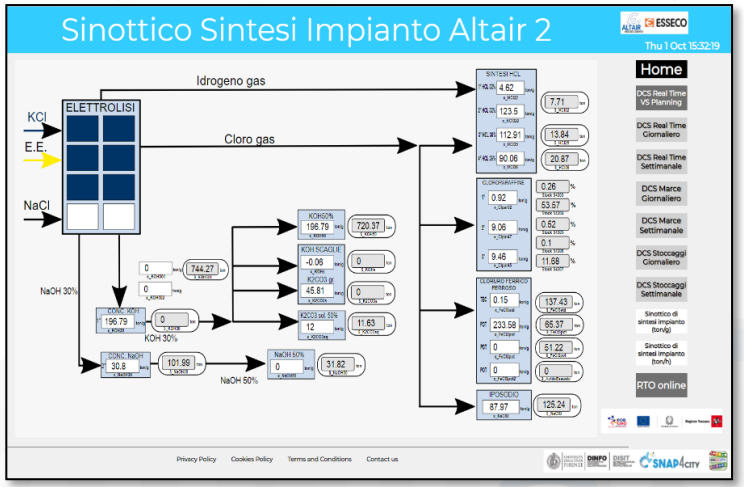


Historical and Real Time Data

Synoptics for real time monitoring



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

Map and 3D BIM modelling to:
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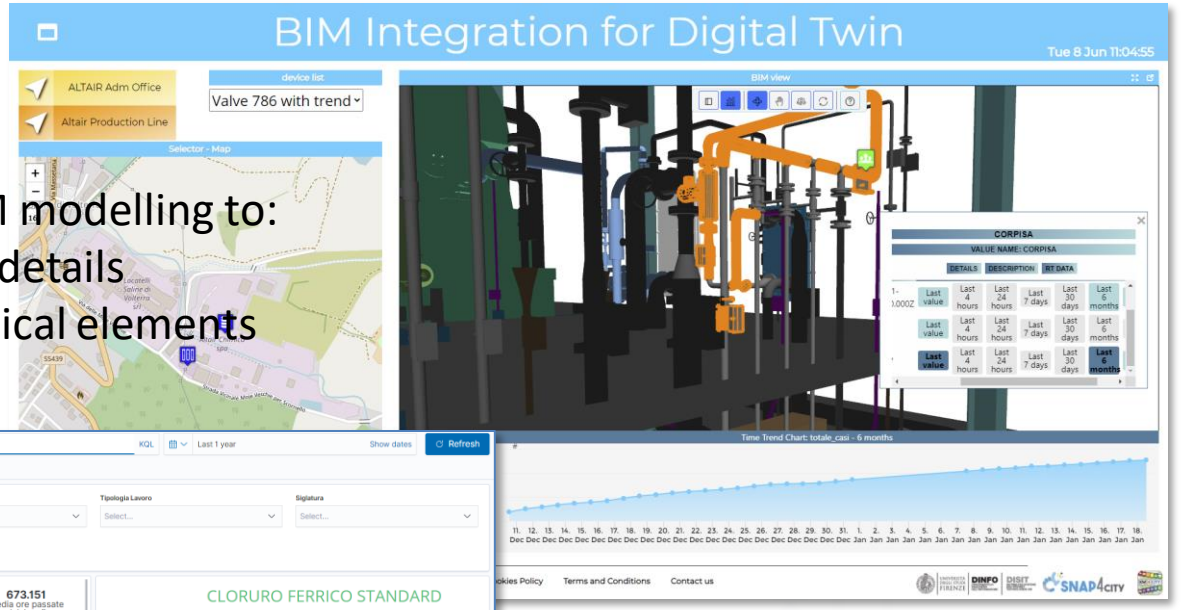
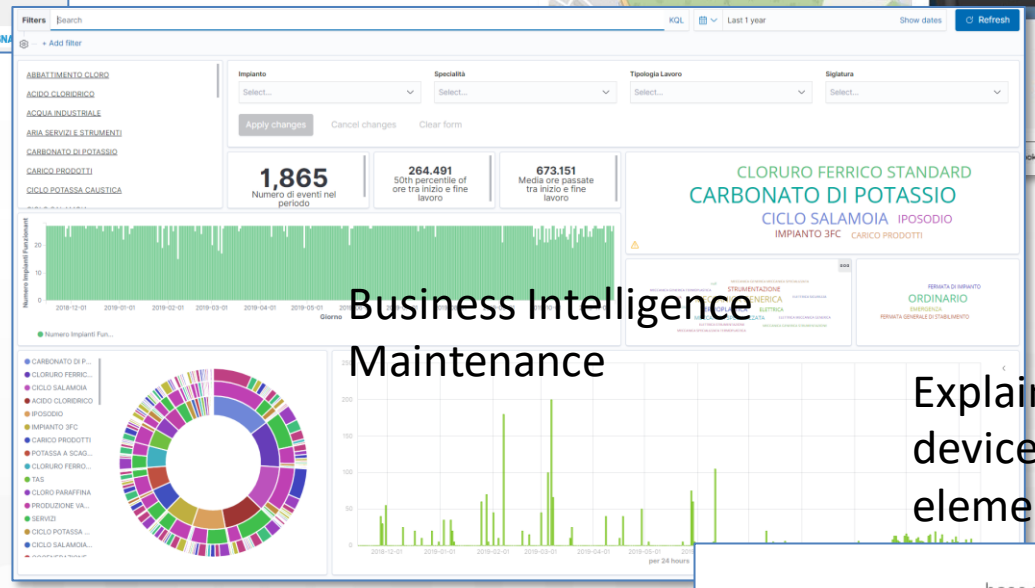
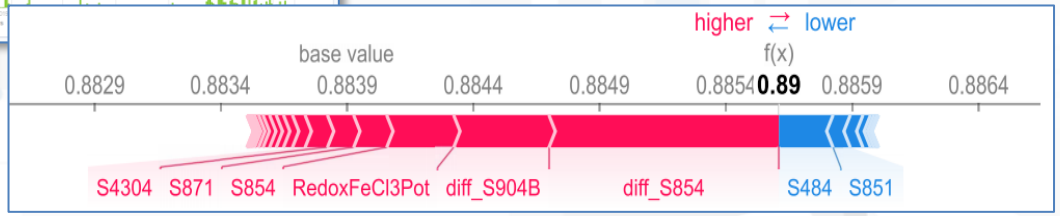




Business Intelligence Maintenance

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



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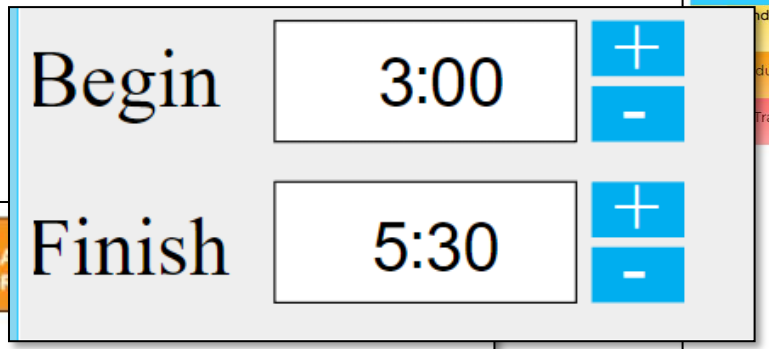
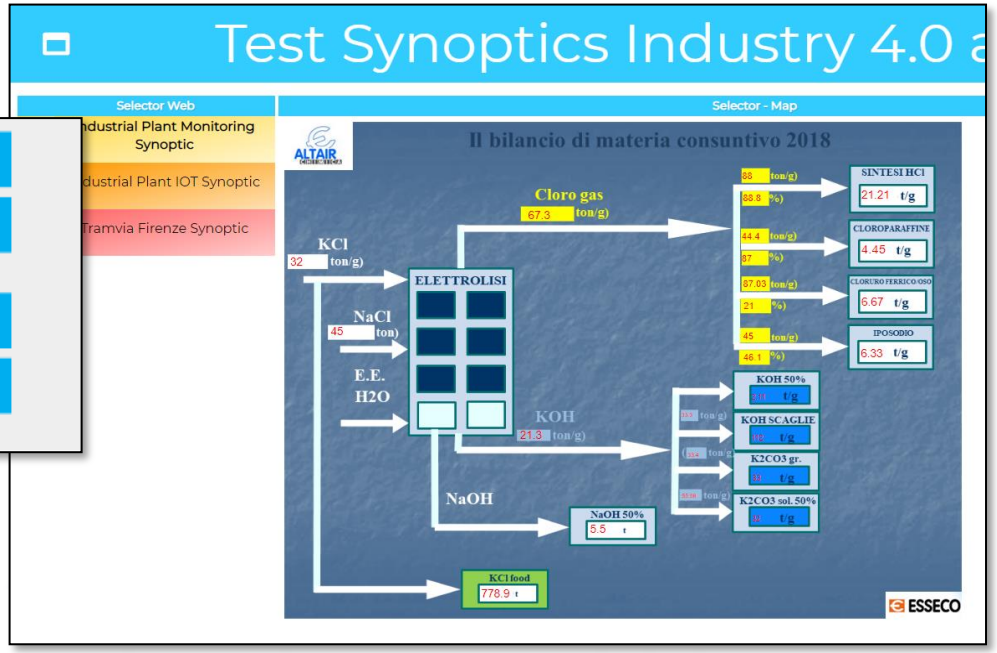
Custom Widgets

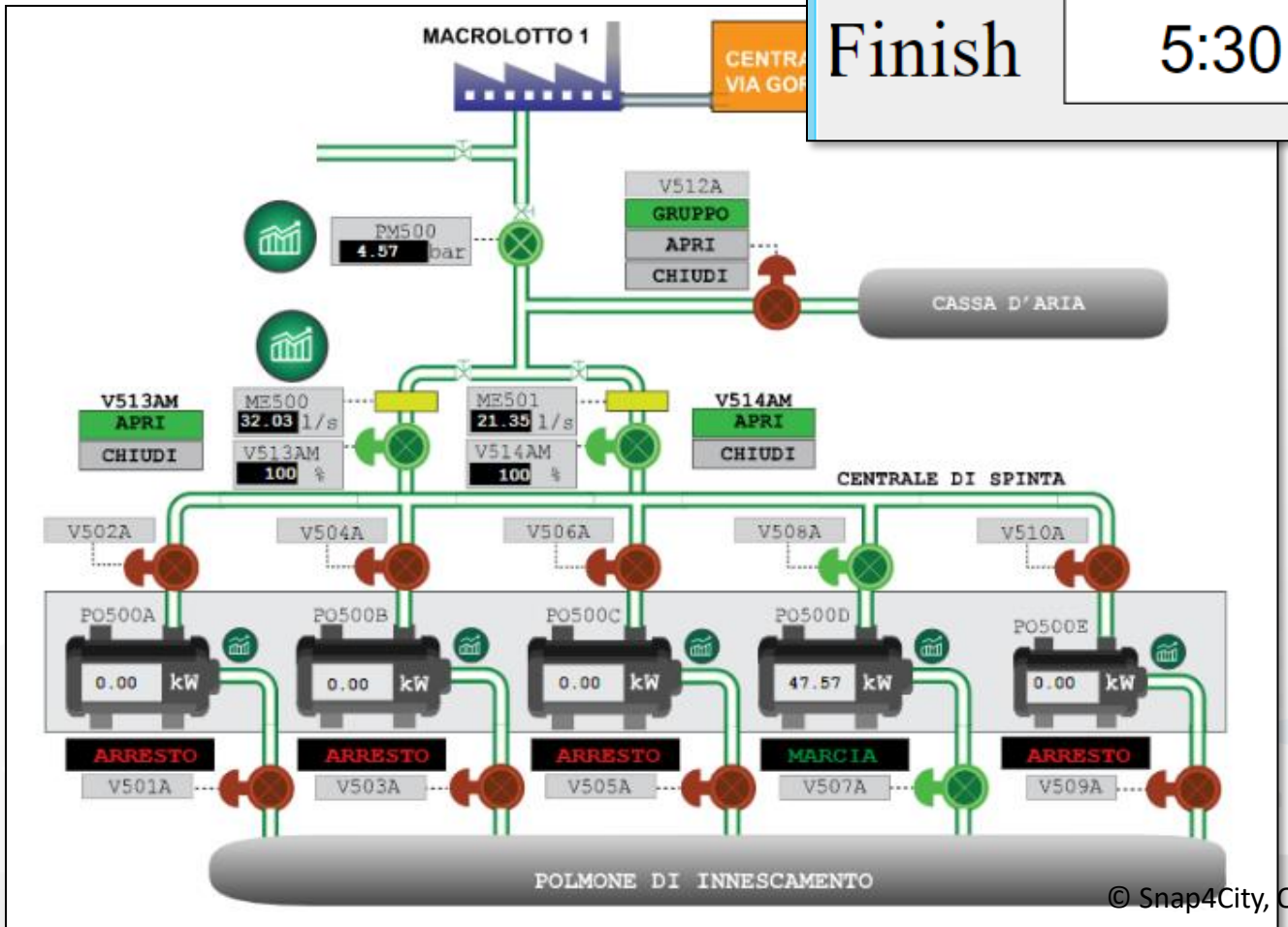
Custom Dashboards and Widgets (interactive, Animations, etc.)

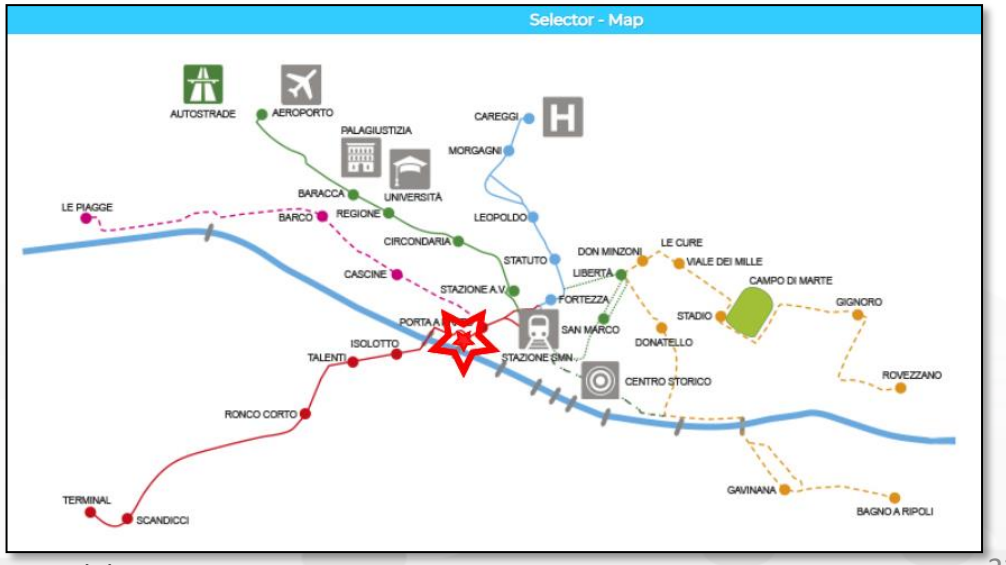
-- SVG for graphic design

-- MyKPI for collecting data









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EN.TE.R.PR.I.S.E.

(**EN**hanced **TE**chnological **R**&D of new **PR**oducts and Processes for **I**nnovation, **S**mart factory and green **E**conomy)

ALTAIR CHIMICA

Administrative Data from AS400

Real Time Data, Historical, Events from DCS

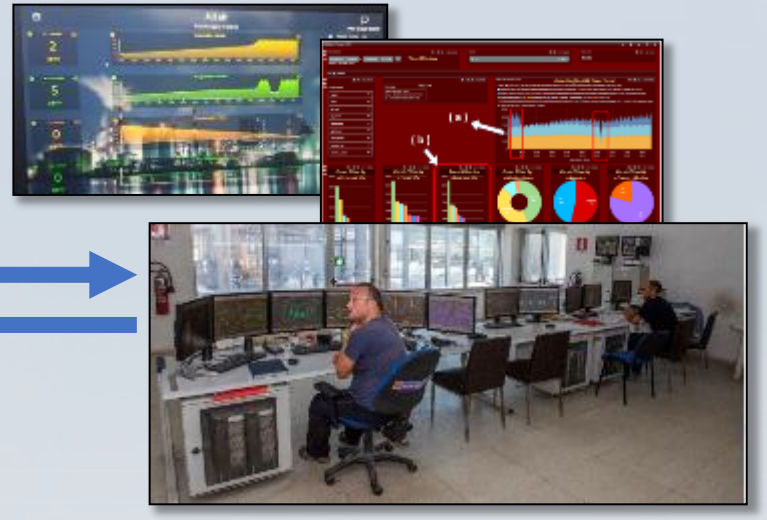
OPC UA

Unique National Energy Costs (PUN)

Big Data Analytics Artificial Intelligence Engine

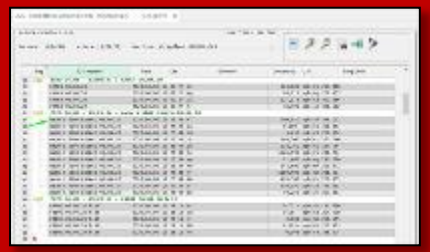
SNAP4INDUSTRY





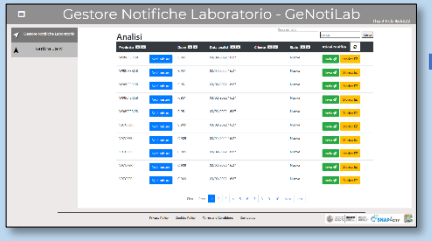
Analytical Data from the product quality Lab (LIMS/SAM)





SNAP4

GeNotiLab





POR CreO FESR 2014-2020 REGIONE TOSCANA FONDO EUROPEO DI SVILUPPO REGIONALE · UNIONE EUROPEA · REPUBBLICA ITALIANA · Regione Toscana

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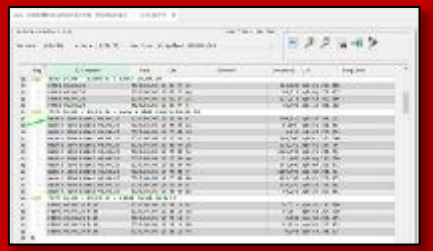
GeNotiLab Architecture for ALTAIR

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





AS400

IOT App



Users

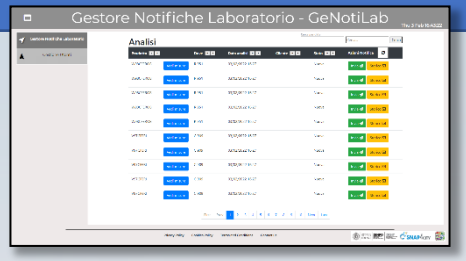
Analysis

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



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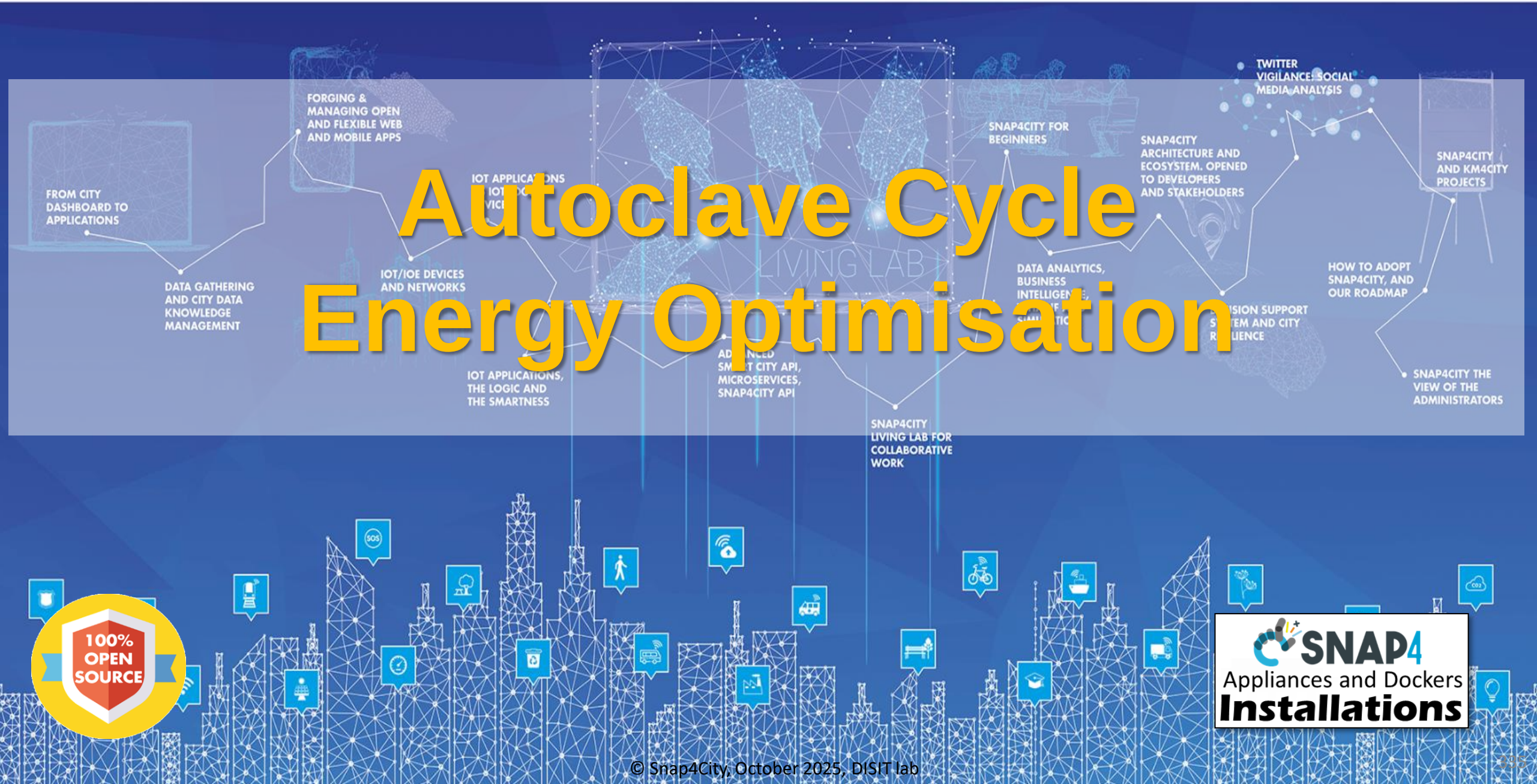

Autoclave Cycle Energy Optimisation

100% OPEN SOURCE

SNAP4 Appliances and Dockers **Installations**

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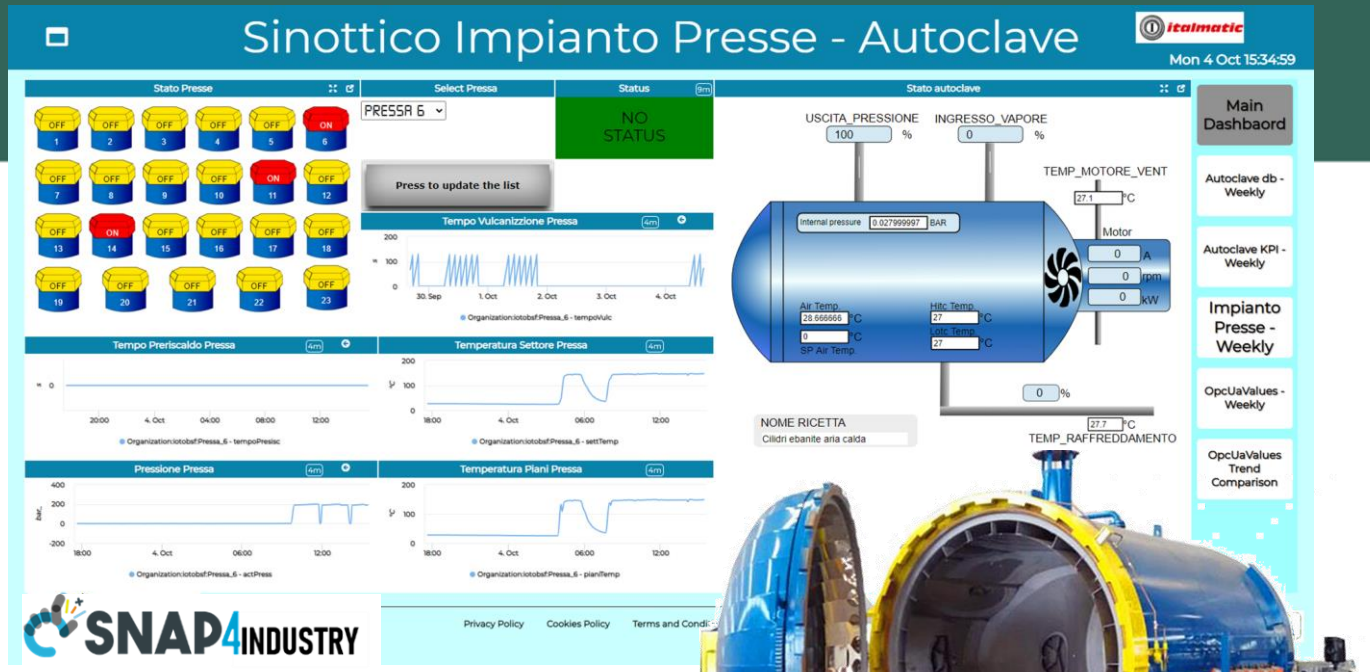
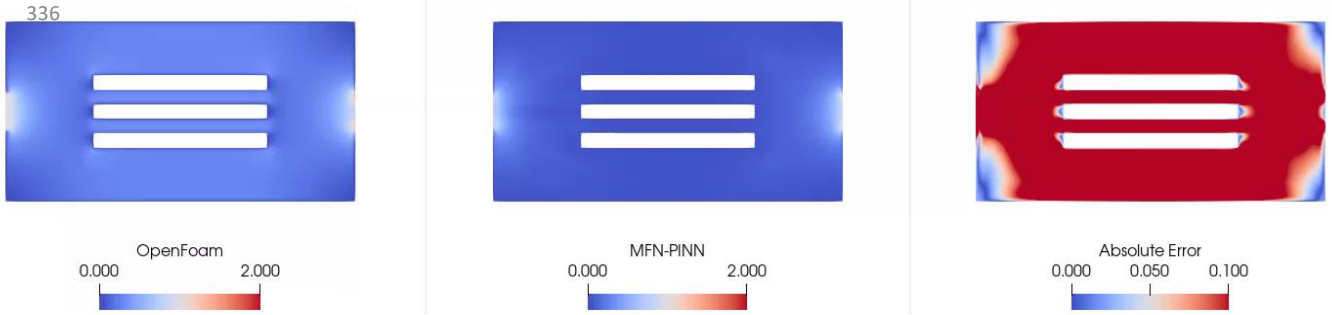
Smart Manufacturing

- **Autoclave:** curation process for: composite materials, rubber, ..
  - **Reduction of computing costs** for simulating load effect into the autoclaves curing process
  - **Similar to design problems to be validated in wind galleries**
- **Solving Navier-Stokes PDE** (partial differential equations) equation,
  - **PINN plus new** Transfer Learning techniques
  - Precision on steady and transitory cases
  - Validation wrt Open Foam
  - Reduction of computational time
- **Videos** on https://www.snap4city.org/1010





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TUSCANY X.0

EDIH European Digital Innovation Hubs Network

Finanziato dall'Unione europea NextGenerationEU

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DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

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

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

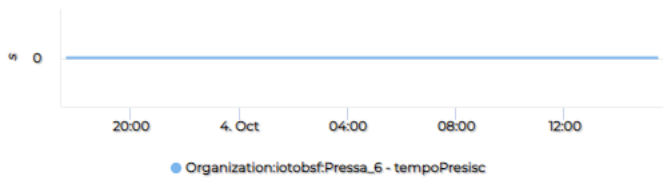
Status

NO STATUS

Tempo Vulcanizzione Pressa



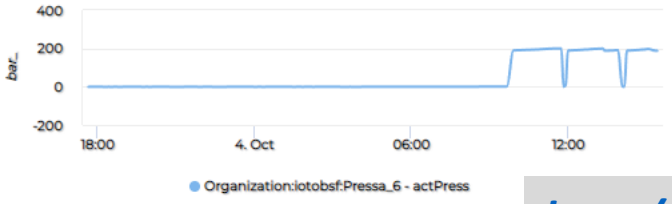
Tempo Preriscaldo Pressa



Temperatura Settore Pressa



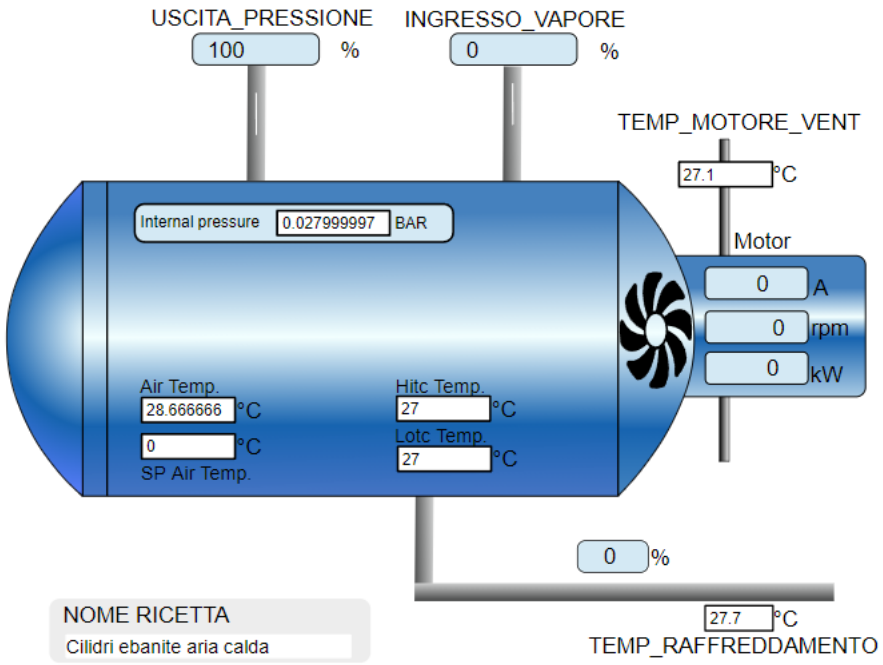
Pressione Pressa



Temperatura Piani Pressa



Stato autoclave



NOME RICETTA
Cilidri ebanite aria calda

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=

SNAP4

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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



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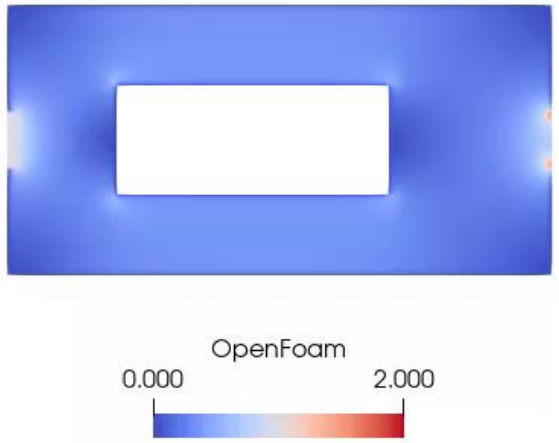
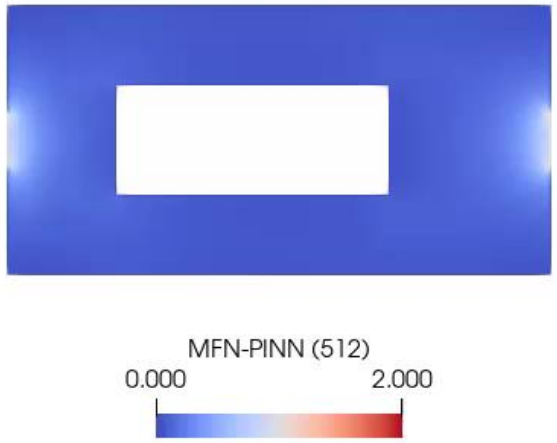
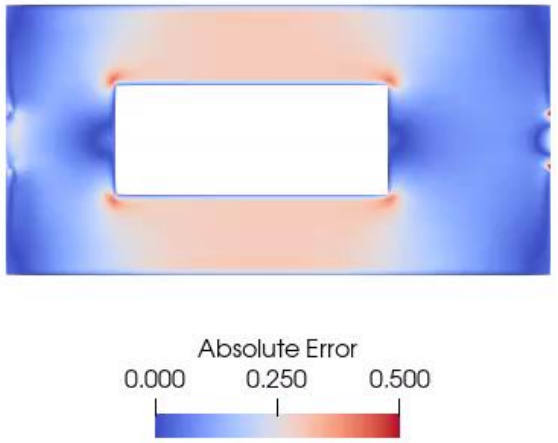
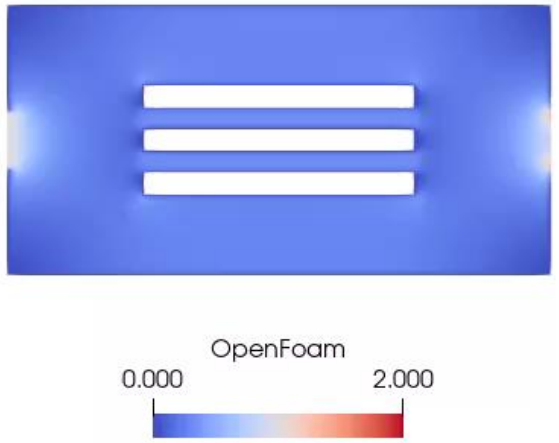
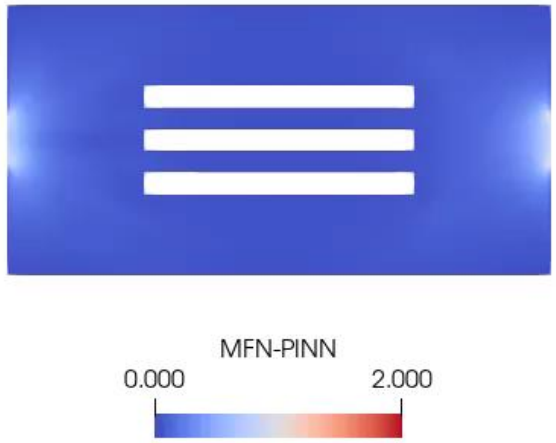
Comparison of PINN vs OpenFoam and error

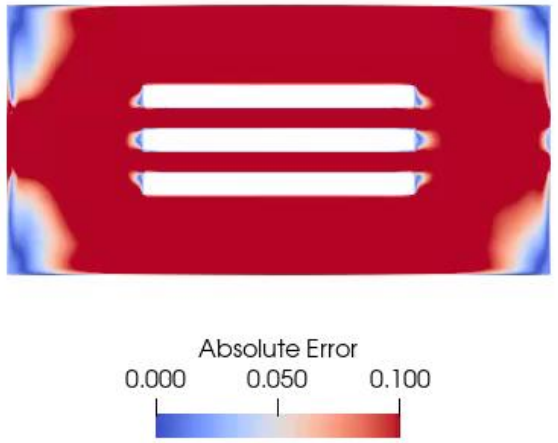












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MOST Centro Nazionale per la Mobilità Sostenibile

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Università degli Studi Firenze

DINFO Dipartimento di Ingegneria dell'Informazione

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Politecnico di Bari

FAIR Future Artificial Intelligence Research

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Varna Economic Development Agency

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Università degli Studi di Firenze - School of Engineering

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