









# **Smart City and Digital Twin**

https://www.Snap4City.org





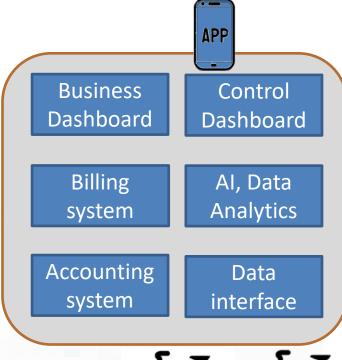


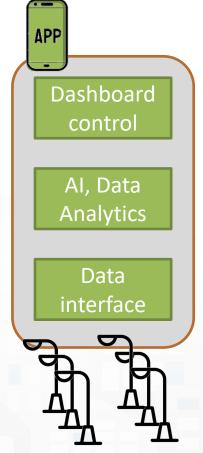


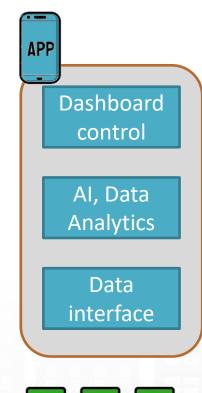


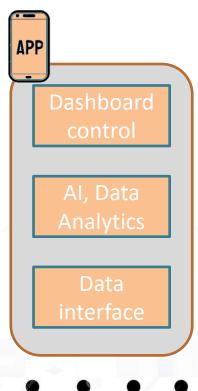


## Avoiding to have a collection of verticals











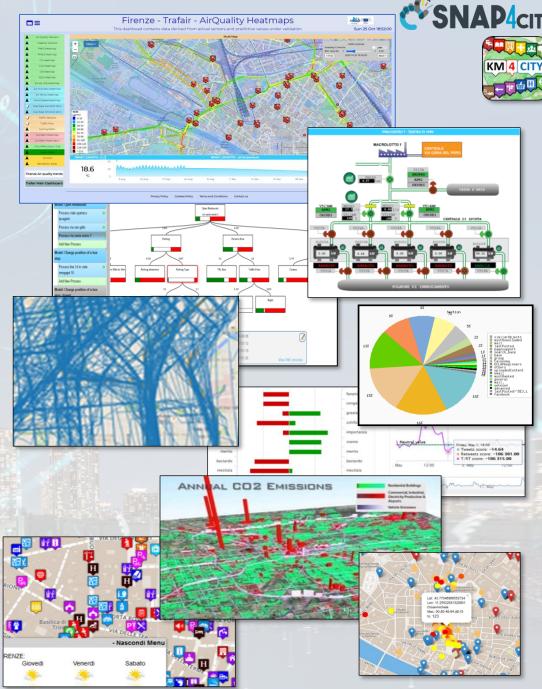


Simplifying the development and integration of verticals

## Data Driven Decision Support

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









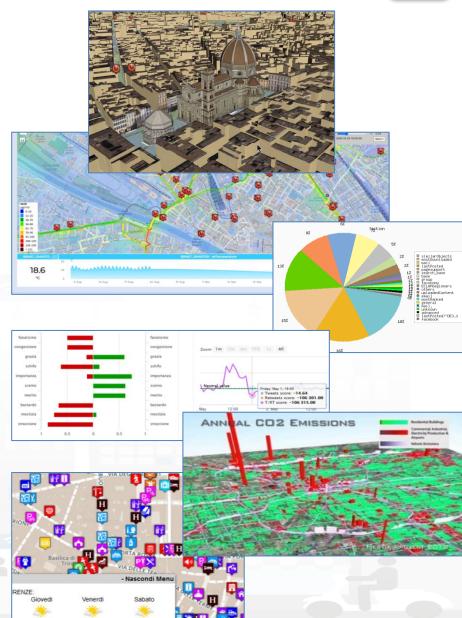




## **Challenges vs Technologies**

- **DSS, Decision Support Systems**, with multiple objectives:
  - Quality of life for citizens, improvements of services, cost reduction, innovation, attractiveness for tourists and/or industries and/or commercial activities, etc.
- provide the decision-making process with simulation tools integrated with short-, long- and very long-term prediction algorithms

  → what-if analysis
  - Analyze incipient events to cope with events;
  - analyze future situations for structural planning.
- Opportunities and needs
  - exploit **huge amounts of heterogeneous data (Big Data)** that come from the territory, from the structures and services of the city and from the stakeholders;
  - flexible, dynamic and interoperable models and analysis tools;
  - accessible for:
    - Operators, decision-makers, stakeholders;
    - citizens as a tool for illustrating and discussing possible solutions and development plans with them.







### **Digital Twin**



### Digital Twin

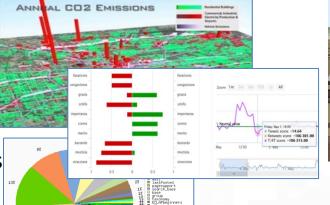
- Connected with real systems
- Modelling aspects: structural, visual, informative, real time data sensors (context), POI, functional, resources, etc.
- Integration: AI/XAI techniques, simulations, users' needs, etc.

### Utility to

- Experiment via simulations and analysis by case
  - Reduction of costs to experiments new solutions
  - Share the possibilities with city users
- Virtual Representation
  - Easier to understand the context, review from multiple points of view
- Who
  - Discussion with city users, decision makers
  - Support: decision makers, proposers of solutions

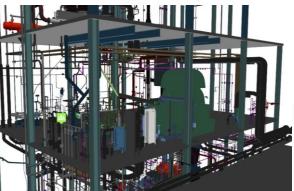














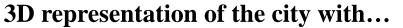








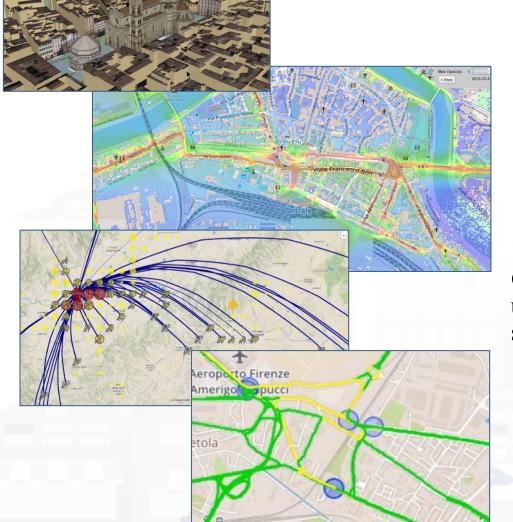
# Global Digital Twin



- geomorphological, hydrogeological aspects,
- private and public transport networks,
- waste recovery systems,
- weather conditions, climate and microclimate,
- events, emergencies, ..., parking, sharing, ...
- tourist and city user flows, origin destination matrices,
- commercial activities, urban decorum, public lighting,
- green areas, cleanliness, safety on the road and in pedestrian areas,
- places for entertainment events, cultural activities, attraction and aggregation points of the city,

Complex and heterogeneous information, structured unstructured, historical series and in real time data, public/private and sensitive data for security aspects.

- → Reuse of legacy systems
  - o GIS (Geographical Information System),
  - o ITS (Intelligent Transportation System),
  - o AVM (Automatic vehicle monitoring),
  - o from IoT (Internet of Thing) systems and networks.









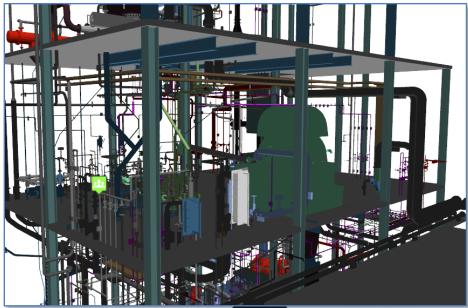


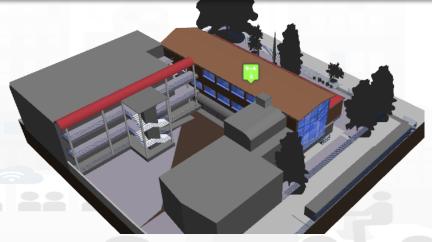


## **The Local Digital Twin**

### **Digital Twin:**

- From a single sub-system (**Local Digital Twin**) to
- A whole city or apart of it (**Global Digital Twin**)
- To model various data kind and to keep them connected to each other ad to its counterparts in physical world:
  - a building with its BIM (Building Information Modeling) model with details of the floors, plumbing, electrical subsystems, services, construction materials, etc.;
  - **control systems** with their real-time data (data from the IoT world): boilers, air conditioners, electrical systems, sensors, network connection, etc.;
  - events and the evolution of their status;
  - functional and structural aspects;
  - How they are used;
  - microclimatic aspects,







Powered by **S**FIWARE

> **FREE** TRIAL



















### **SMART SOLUTIONS AND DECISION SUPPORT SYSTEMS**



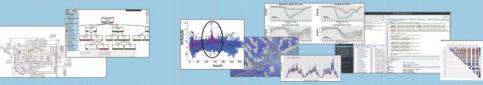




PREDICTION - ANOMALY DETECTION - CLUSTERING - ROUTING - SENTIMENT NLP - TRAFFIC FLOW DASHBOARDS, WIDGETS **TEMPLATES** PEOPLE FLOWS - SDG - 15 MIN CITY INDEX - KPI - HEATMAPS - ORIGIN DESTINATION - ETC...

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

#### **ANY: DATA, BROKER, NETWORK AND VERTICAL**



**EXPERT SYSTEM, KNOWLEDGE BASE BIG DATA ANALYTICS, ARTIFICIAL INTELLIGENCE** SEMANTIC REASONING **EXPLAINABLE AI, MACHINE LEARNING SMART DATA MODEL OPERATIVE RESEARCH, STATISTICS IOT DEVICE MODELS, STORAGE** 



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

#### **Native and External Applications**

**Smart Parking** 

**Smart Light** 

**Smart Waste** 

**Smart Energy** 

**Social Media Analysis** 



**METHODOLOGIES** LIVING LABS **COURSES AND COMMUNITY DEVELOPMENT TOOLS** 





## https://www.Snap4City.org







Node-RED





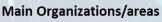


### 11 running installations in Europe

- Snap4.city.org, Greece, Merano, ...
- Toscana, Pisa, Sweden, ISPRA, Snap4.eu,
- Altair, Italmatic, Sweden, Romania, ....
- 16 projects, 12 pilots on 10 Countries
  - >40 cities/area

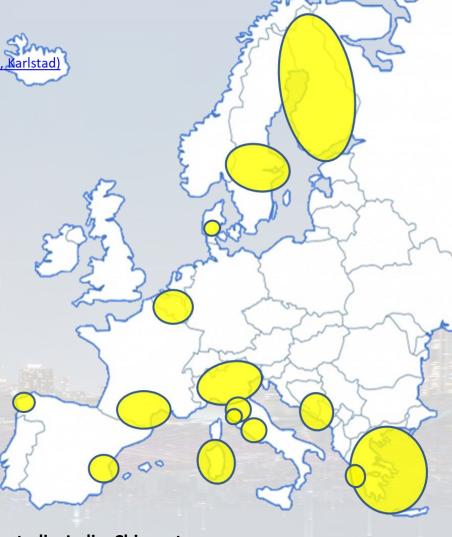
### Widest MULTI-tenant deploy has

- 19 Organizations / tenant
- > 8000 users on
- > 1600 Dashboards
- > 16 mobile Apps
- > 2.1 Million of structured data per day
- > 520 IoT Applications/node-RED
- > 700 web pages with training
- > 70 videos, training videos



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

• + Israel, Colombia, Brasile, Australia, India, China, etc.



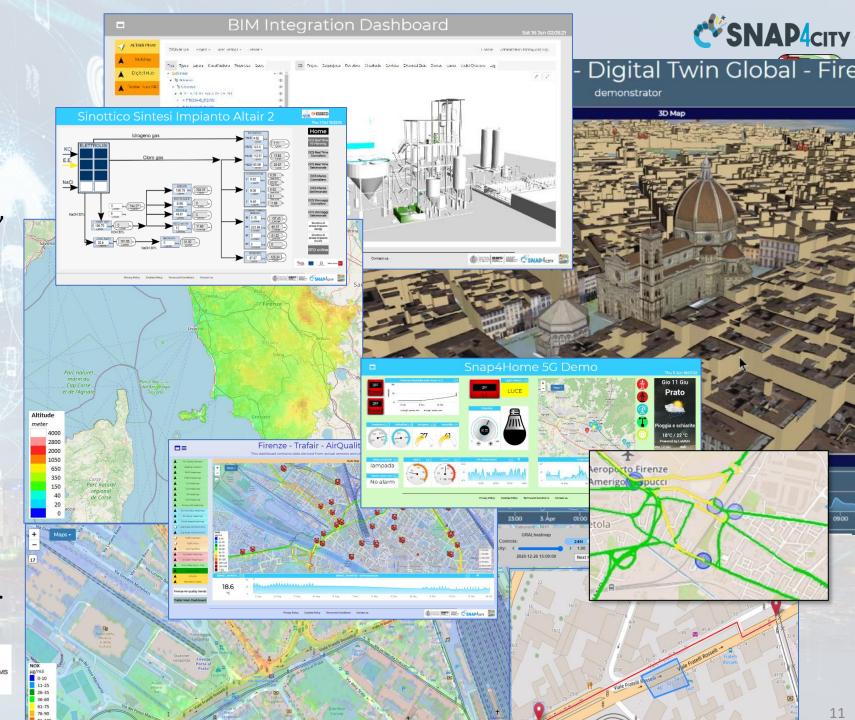
## High Level Types

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











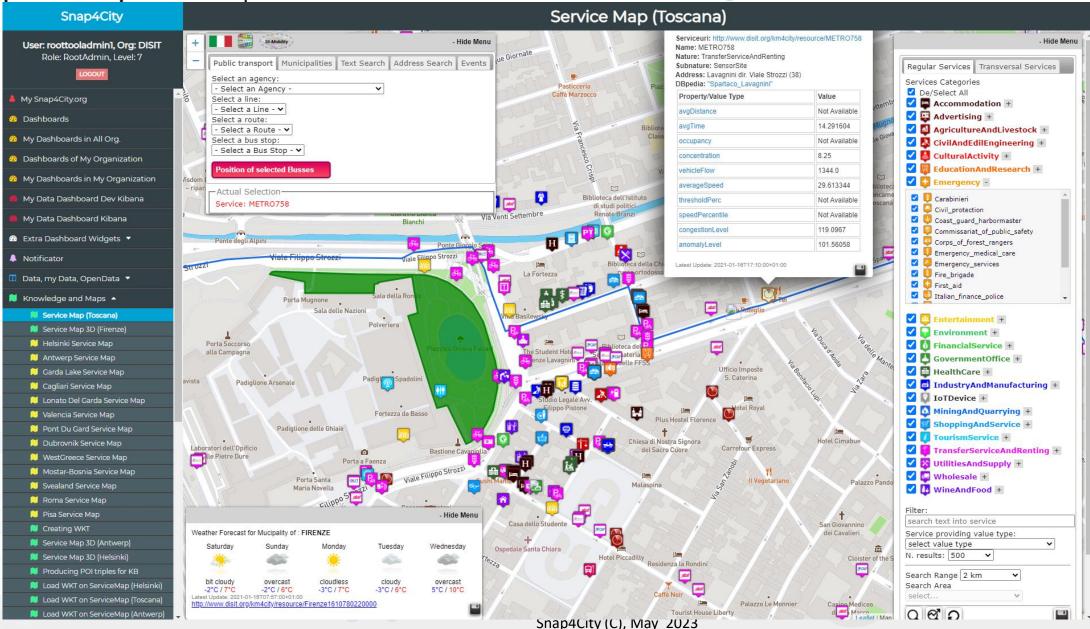
#### UNIVERSITÀ **DEGLI STUDI** FIRENZE

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## KB, ServiceMap







# Standards and Interoperability (9/2022)

### **SNAP4**city

#### **Compliant with:**

- IoT: NGSI V2/LD, LoRa, LoRaWan, MQTT, AMQP, COAP, OneM2M, TheThingsNetwork, SigFOX, Libelium, IBIMET/IBE, Enocean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, BACnet, TALQ, Protocol Buffer, KNX, OBD2, Proximus, ..
- **IoT model:** FIWARE Smart Data Model, Snap4City IoT Device Models
- **General**: HTTP, HTTPS, TLS, Rest Call, SMTP, TCP, UDP, SOAP, WSDL, FTP, FTPS, WebSocket, WebSocket Secure, GML, WFS, WMS, RTSP, ONVIF, AXIS TVCam, CISCO Meraki, OSM, Copernicus, The Weather Channel, Open Weather, OLAP, ....
- Formats: JSON, GeoJSON, XML, CSV, GeoTIFF, OWL, WKT, KML, SHP, db, XLS, XLSX, TXT, HTML, CSS, SVG, IFC, XPDL, OSM, Enfuser FMI, Lidar, glTF, GLB, DTM, GDAL, Satellite, D3 JSON, ...
- Database: Open Search, MySQL, Mongo, HBASE, SOLR, SPARQL, ODBC, JDBC, Elastic Search, Phoenix, PostGres, MS Azure, ...
- Industry: OPC/OPC-UA, OLAP, ModBUS, RS485, RS232,...
- Mobility: DATEX, GTFS, Transmodel, ETSI, ...
- Social:Twitter, FaceBook, Telegram, ...
- Events: SMS, EMAIL, CAP, RSS Feed, ...
- OS: Linux, Windows, Android, Raspberry Pi, Local File System, AXIS, ESP32, etc.



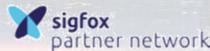






















https://www.snap4city.org/65







## Ingestion, agg. -> exploitation



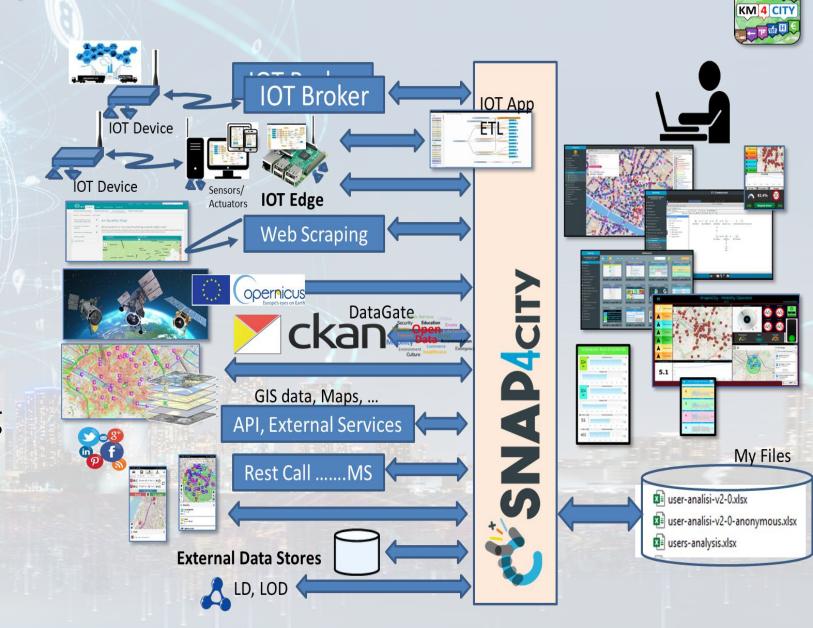






### Snap4City efficient tools for

- Bidirectional data channels
- Any format, any channel, any data, any broker, any protocol, ...
- Km4City Knowledge base Ontology reasoning on geo, space, time, relationships



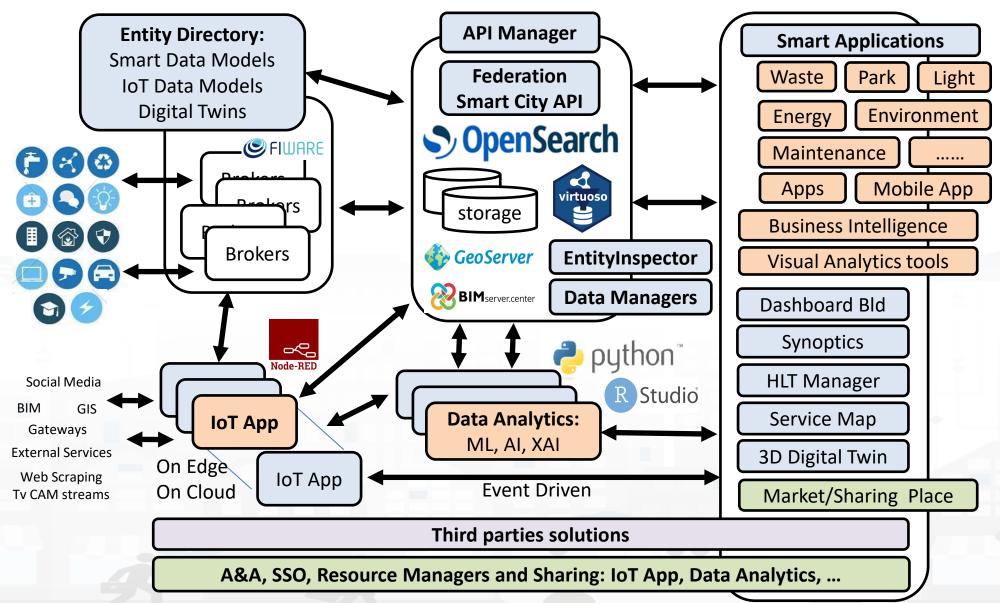




## DISIT DISTRIBUTED SYSTEMS TECHNOLOGIES LAB TECHNOLOGIES LAB TECHNOLOGIES LAB







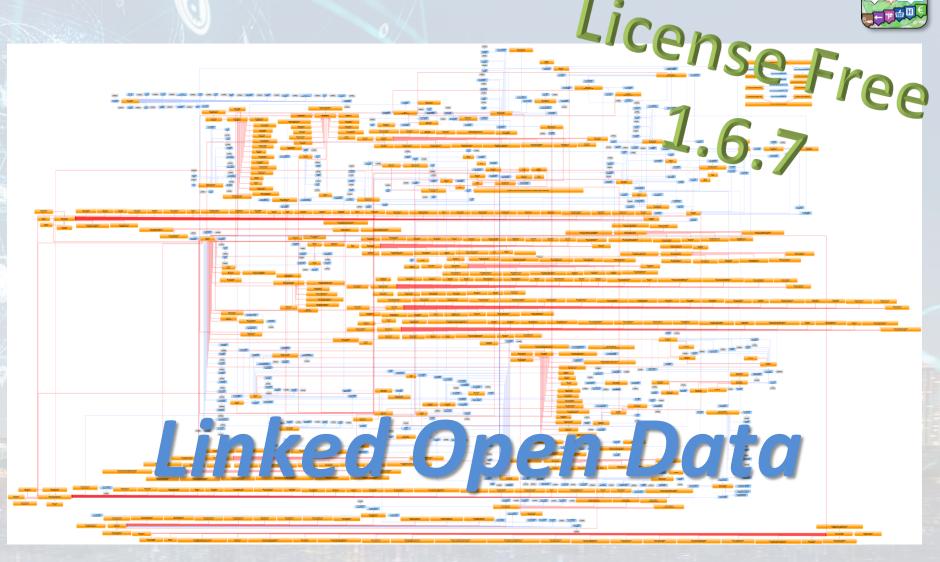
## Expert System semantic queries

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



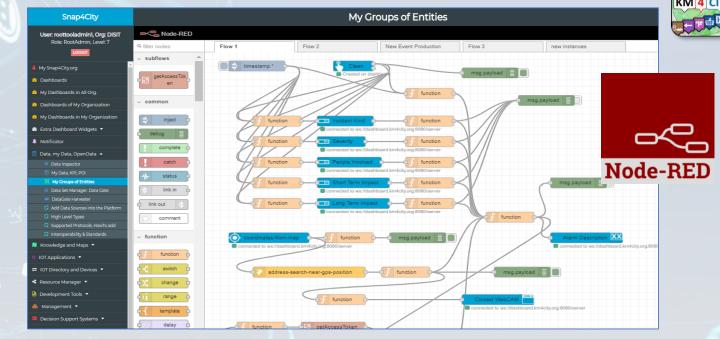
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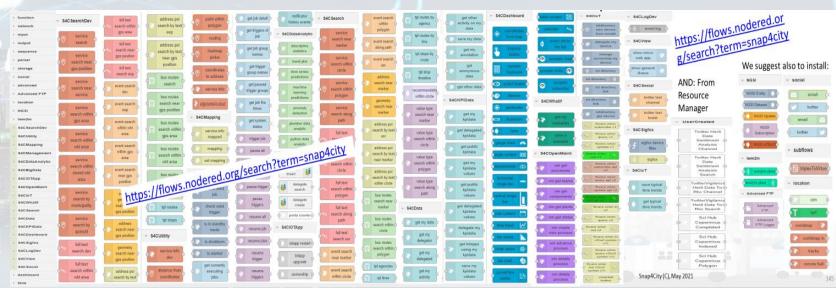
Snap4City (C), May 2023

## Almost no coding platform

- UNIVERSITÀ DEGLI STUDI FIRENZE DINFO DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB
  - ISIT BIBLITED SYSTEMS VITENUT NOLOGIES LAB

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

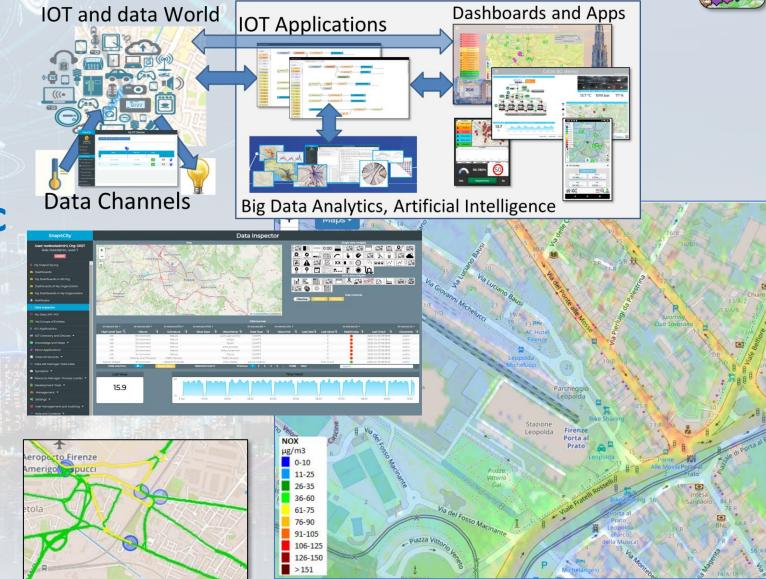


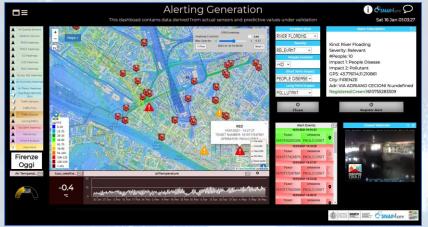


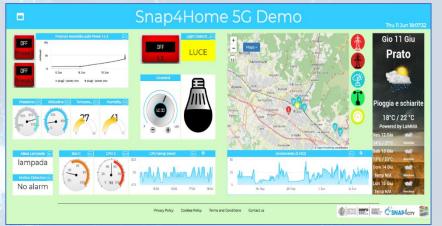
### Fast to realize reliable & secure Solutions

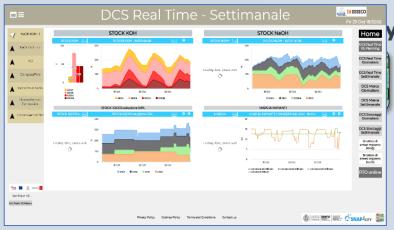
**CYSNAP4**CITY

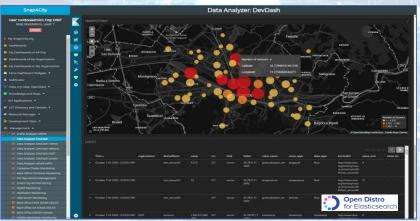
- Via Snap4City tools
  - Dashboard Wizard
  - Dashboard Builder
  - Data/Visual Analytic
- Smart Solutions results to be
  - Real time data drive
  - Secure end-to-end
  - GDPR compliant
  - Reliable, interoperable
  - Auditable, marketable



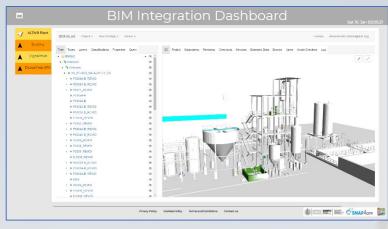




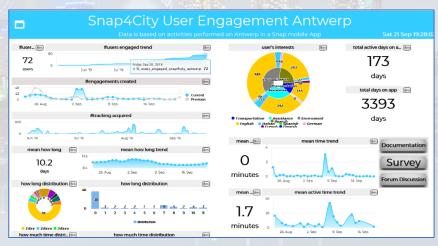


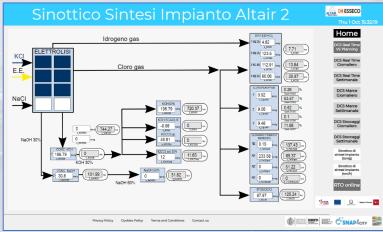


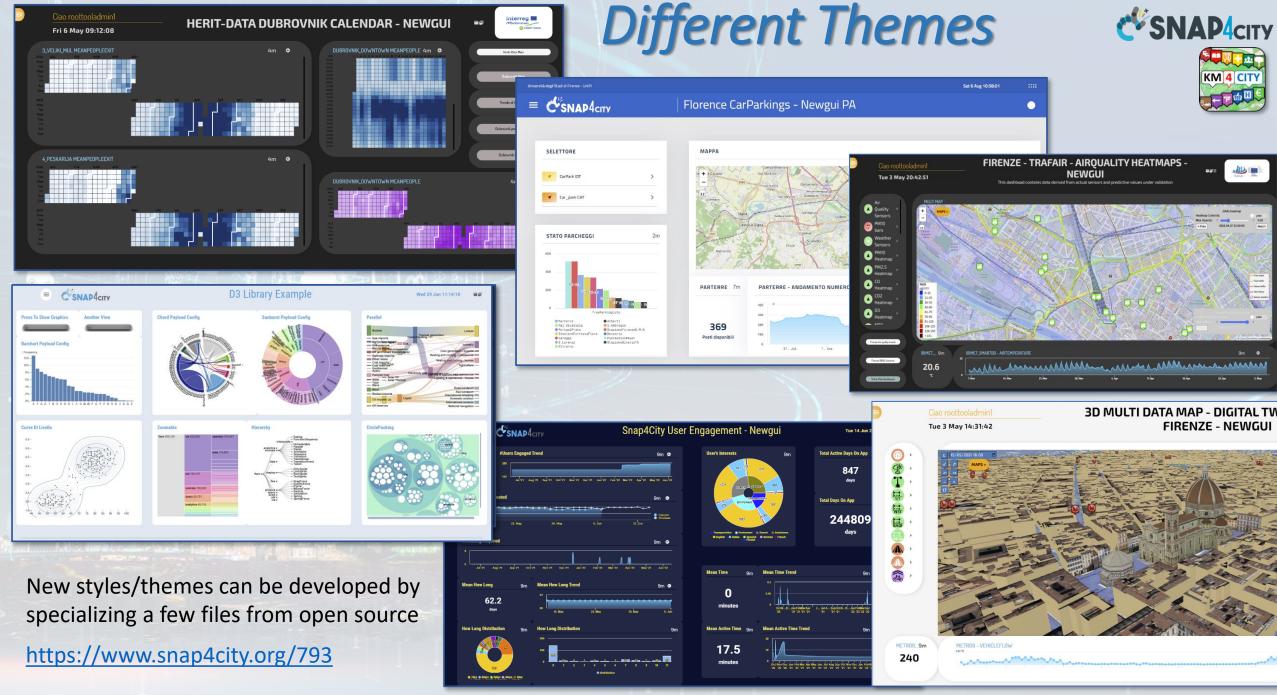












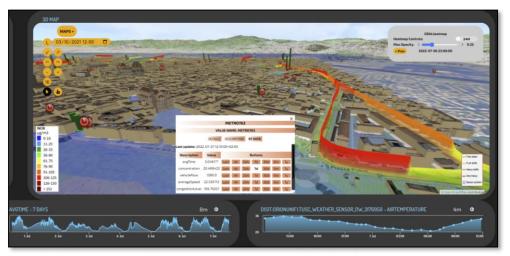
Snap4City (C), May 2023 20





## Why to build a Digital Twin?

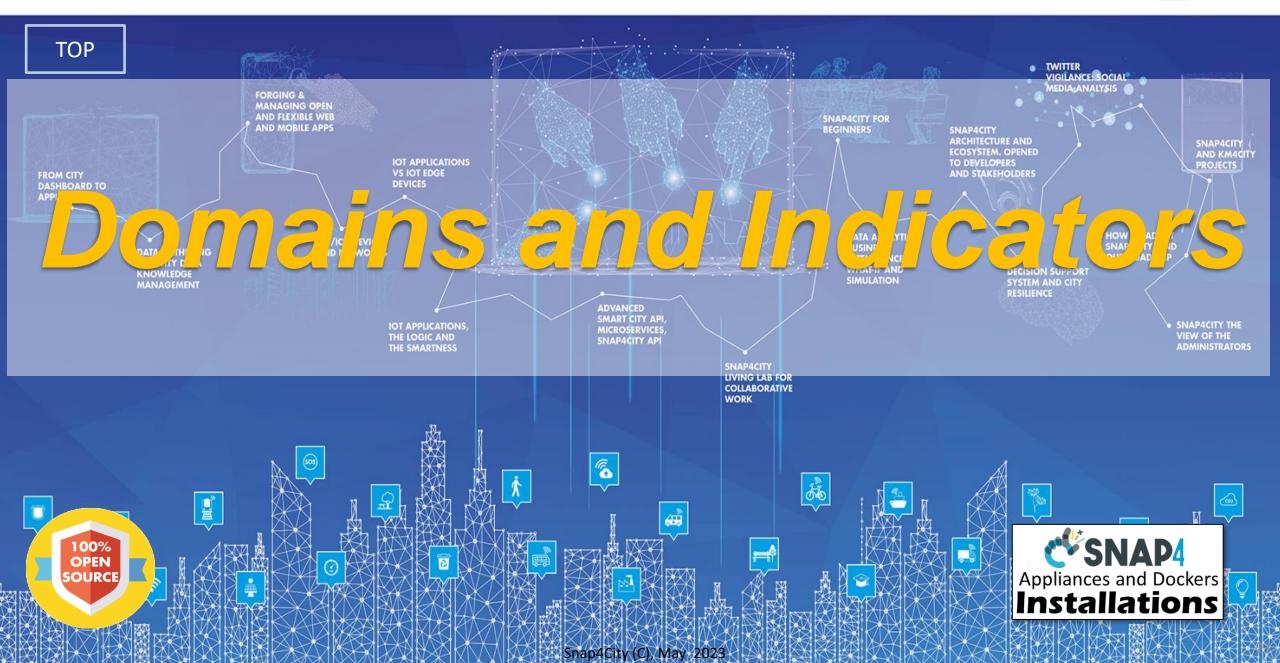
- They increase the level of confidence in the perception and understanding of the system by providing various types of information in the same view:
  - The physical model is not able to provide integrated information in an immediate way, some are not easily accessible or perceivable/visible
- They can provide a preventive / predictive vision of the situation that will arise in the future contextually / realistic and at low cost. The impact of the renovations on:
  - road traffic
  - Noise, NOX, CO2, etc. Particle distribution
  - Offer of public transport, → citizens
- Visions are an aid tool for:
  - Complexity management
  - Understanding and consultation





### **SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES**











Not to be exceeded more tha 18 times a calendar year



Calendar year

Limit value, 40 µg/m





## indicators

- **United Nations Sustainable Development Goals, SDGs** (for which cities can do more to achieve some of the 17 SDGs, <a href="https://sdgs.un.org/goals">https://sdgs.un.org/goals</a>);
- **15 minutes cities** (where primary services must be accessible within 15 minutes on foot);
- Global
- objectives of the European Commission in terms of pollutant emissions for: NO2, PM10, PM2.5 (https://environment.ec.europa.eu/topic s/air en);

- **PUMS**
- **SUMI**
- **ISO** indicators
- **ISTAT**

### **Domains**

- Smart City, control room
- Green Deal, smart light, ..
- Environment, pollutant, ...
- Mobility and transport
- Tourism and People
- Energy, Industry
- Social Media

- Big Data
- Artificial Intelligence
- Public and private data

























### 15 Minute City Index:

13 subindexes: energy, slow mobility, fast mobility, housing, economy education, culture and cults, health, entertainment, gov, food, security...





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



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



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



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



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



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

## 15MinCityIndex

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

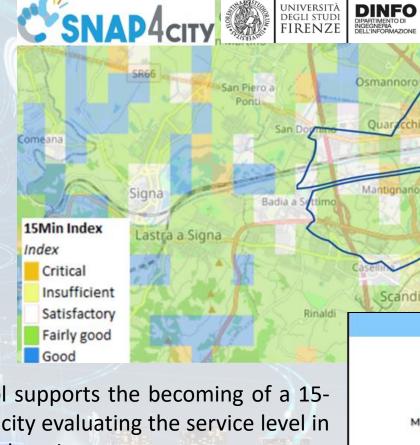
### **Using the Open Data:**

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.

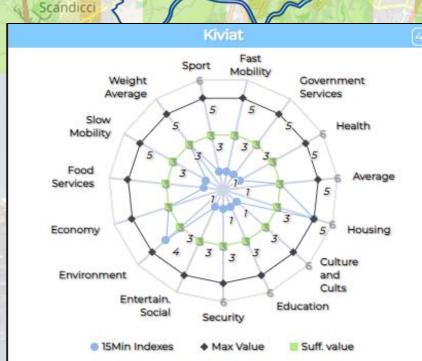


Careggi/Rifredi is a relevant district in Florence because of hosting the main Florence/Tuscany hospitals Careggi and Meyer, but also university headquarters and many other workplaces.



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





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

Snap4City (C), May 2023



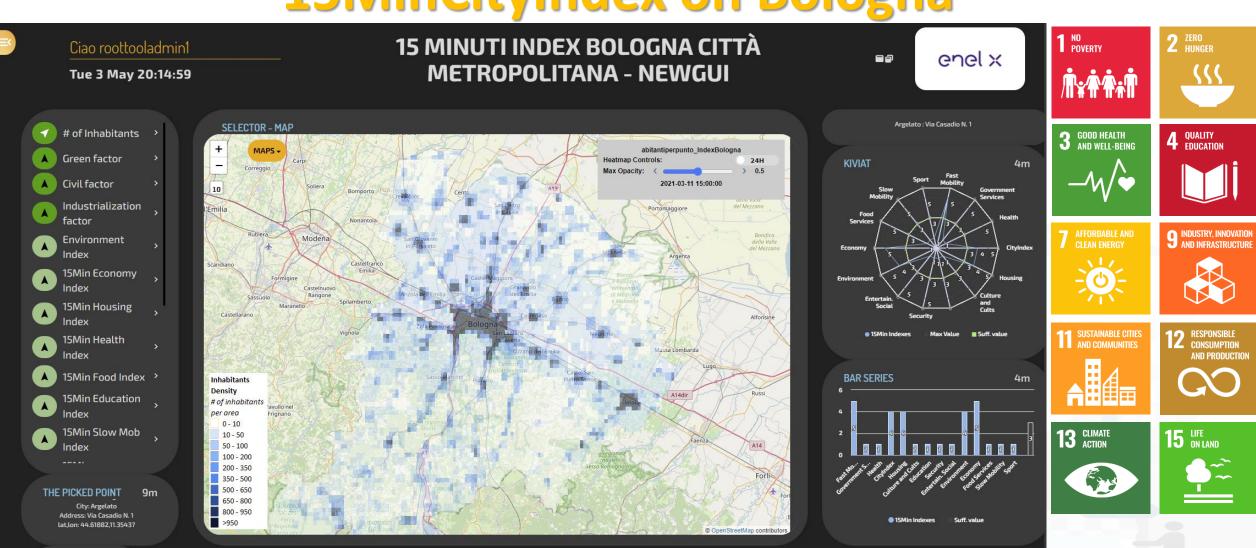








## 15MinCityIndex on Bologna













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

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



### Scenarious

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









### **SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES**







# **Smart City Control Room** Florence Metropolitan City





Firenze Oggi



### 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





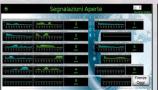




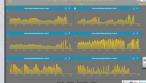


















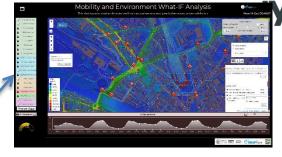








Energy















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### Florence Case



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

**FIRENZE** 





#### Mobility:

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

#### **Environment:**

- smart irrigators
- smart waste
- Sensors: PM10. PM2.5,.....
- Heatmaps: PM10, PM2.5, ....
- **NOX** predictions

#### Energy:

- recharging stations (fast and reg.)
- consumption meters (smart info)
- smart light, street lights

#### Weather

#### Social:

- smart benches
- Twitter monitoring, Sentiment analysis, NLP text
- TV camera streams

#### **People Flows:**

- Wi-Fi, people flow
- Origin destination matrices

#### **Governmental and Communications:**

- KPI of the City
- **Digital Signage**
- Civil protection, Resilience (Resolute)

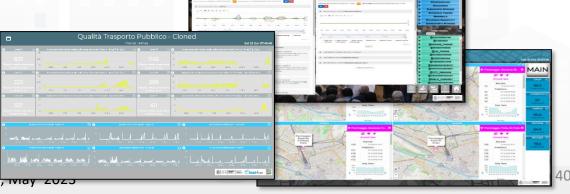
#### **Tourism and Culture:**

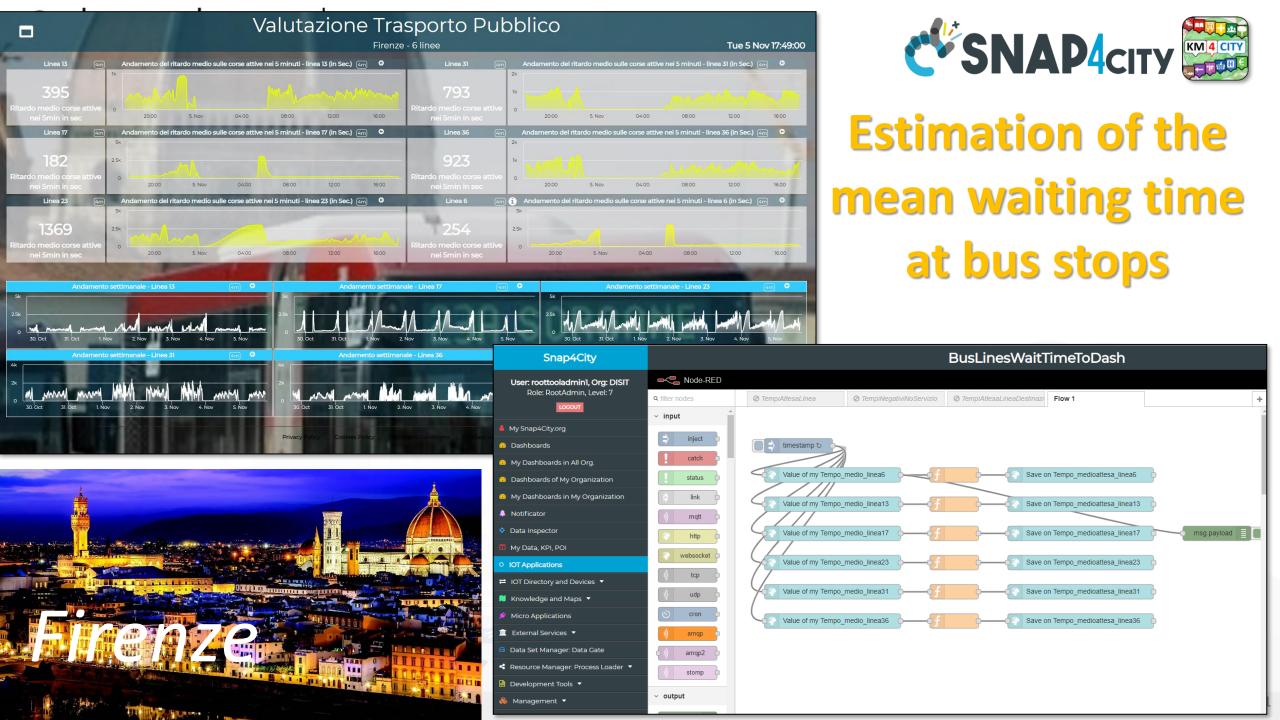
POI, etc.

#### **Analysis:**

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

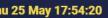








## 3D Map Global Digital Twin -Newgui2







































**DINFO** 





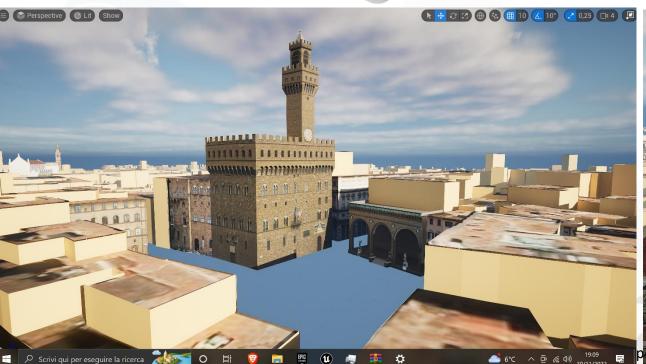


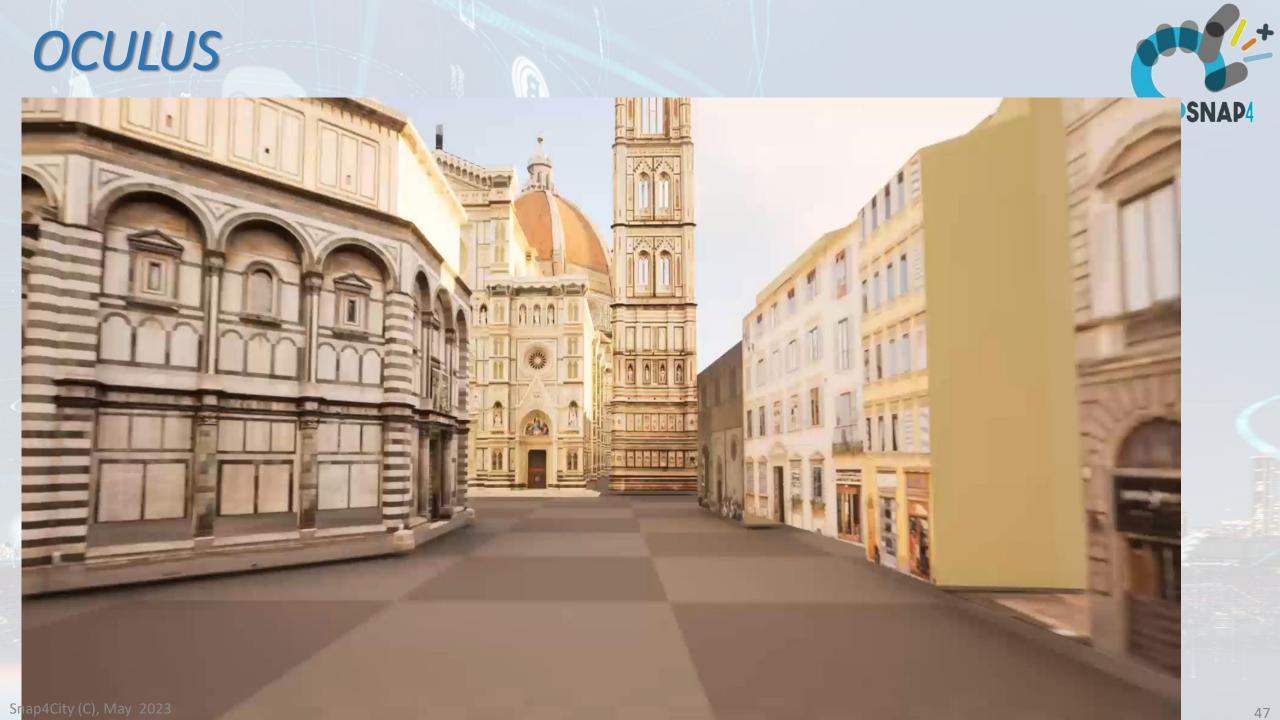
# **OCULUS**

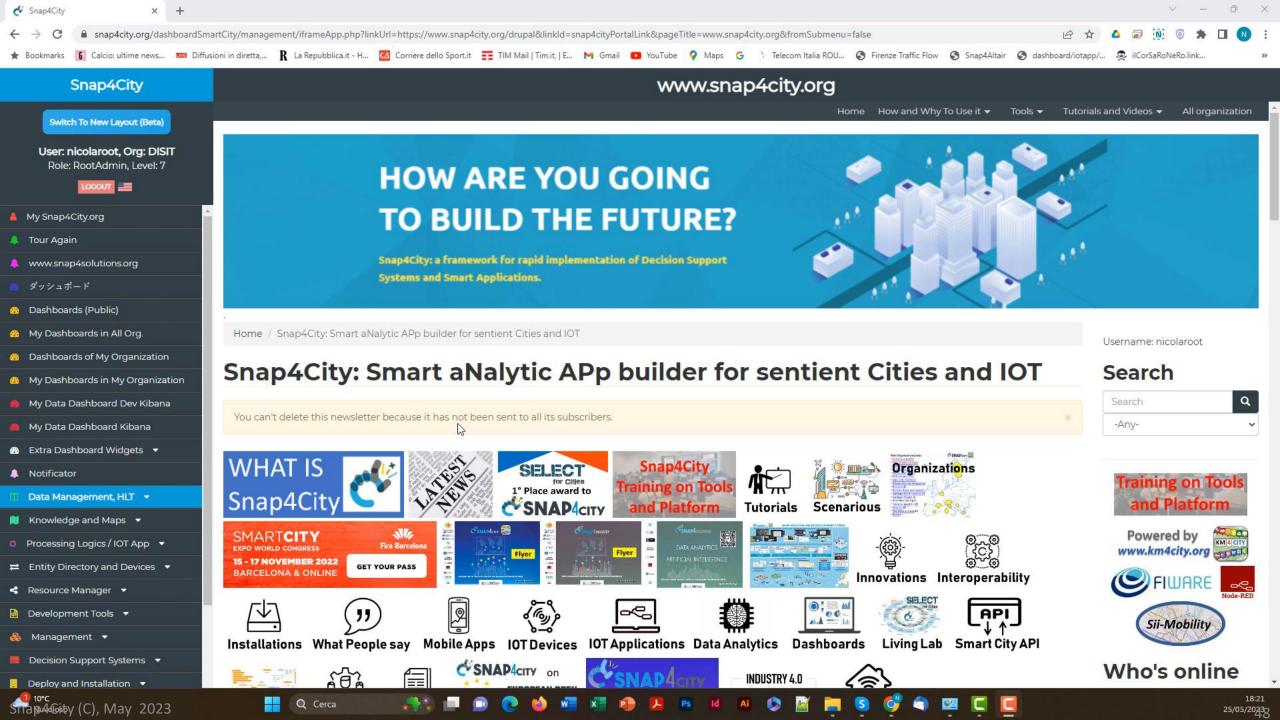


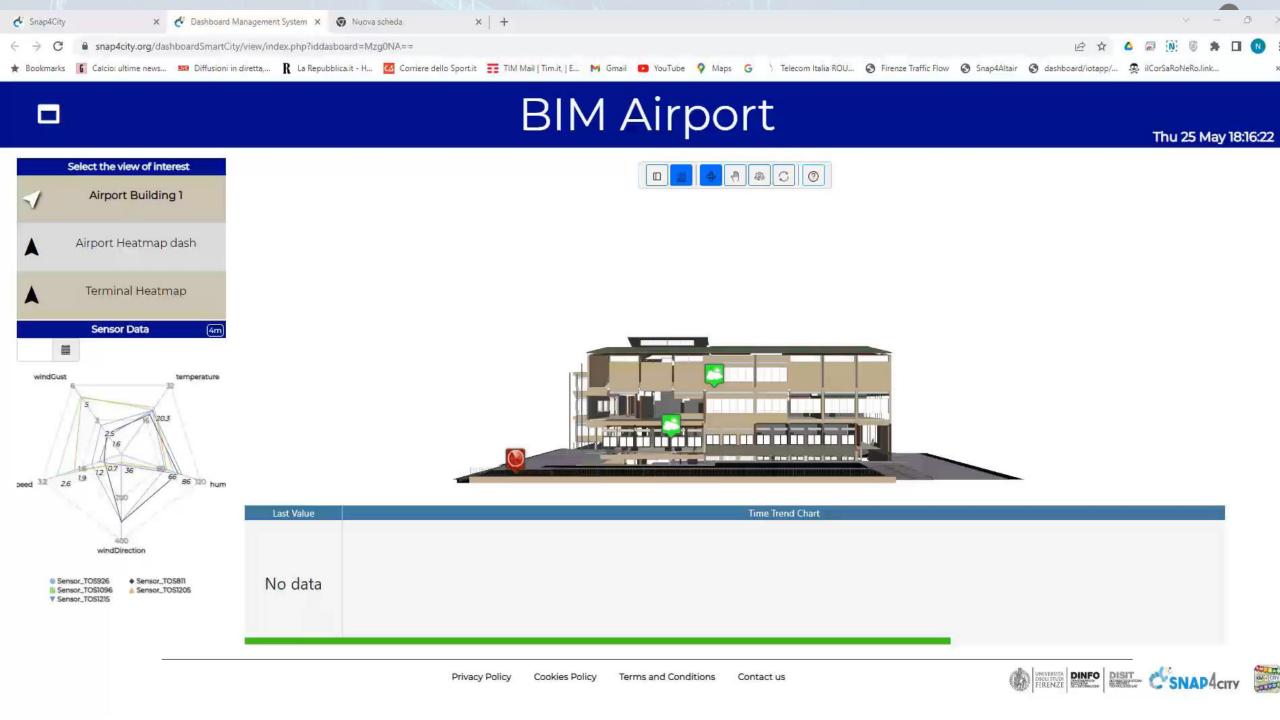


























# A view and data from the Thermal Camera















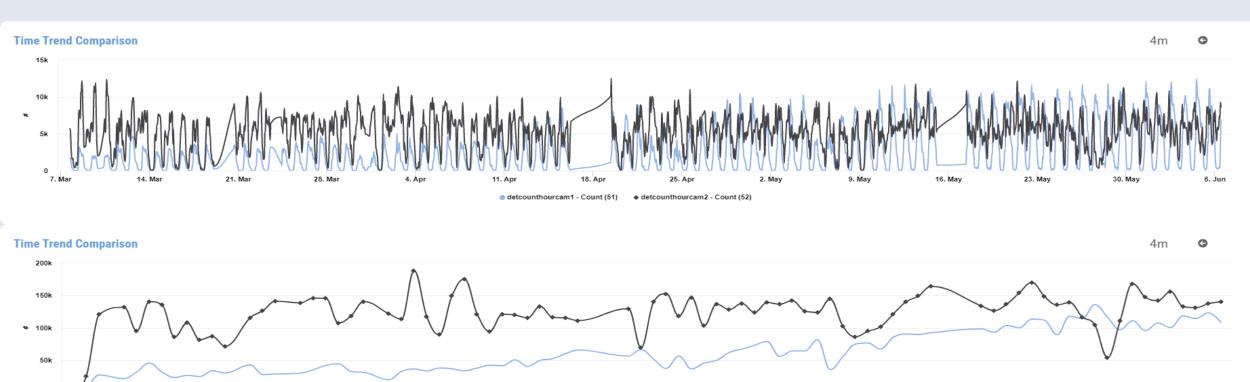
## https://www.snap4city.org/dashboardSmartCity/view/Gea.php?iddasboard=MzM3Ng==



## **Detection BOX Snap4Thermal PV Firenze**

Thu 30 Mar 23:55:16





18. Apr

detcountdaycam2 - Count (52)

2. Mav







detcountdaycam1 - Count (51)

**SNAP4**CITY User Behavior Analysis KM 4 CITY Where? Who Why? How move Where they go ahead When la fina lanta fada fada fada era What Snap4City (C), iviay 2025









# Mobility and Transport Traffic Flow Analysis

Multiple Domain Data

Traffic Flow sensors, city structure, weather

Decision Makers Multiple Locations

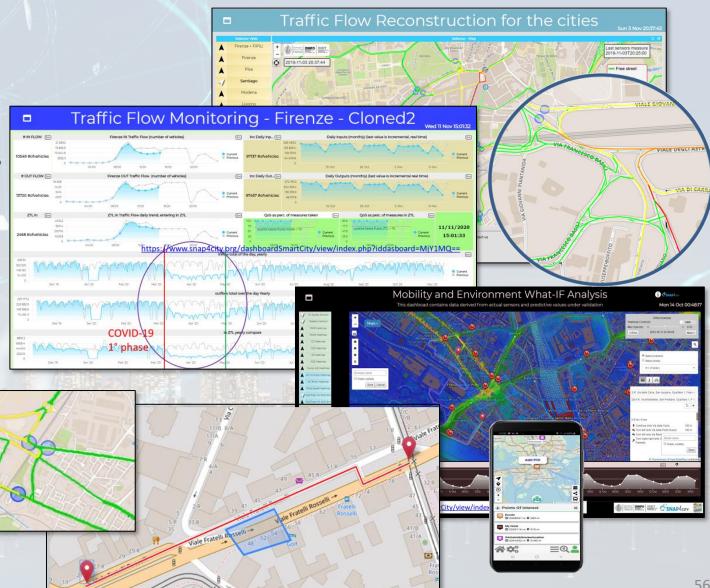
- Real time Monitoring, predictions
- Traffic Flow Predictions,
- Traffic Reconstructions, routing
- Dashboards, What-IF analysis
- Mobile App, people flows

Historical and Real Time data

- Services Exploited on:
  - Dashboards, Mobile App
- Since 2017, 2019

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













# The App is a Bidirectional Device

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

#### **Produced information**

- Accepted ?
- Performed?

•





#### **Derived information**

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

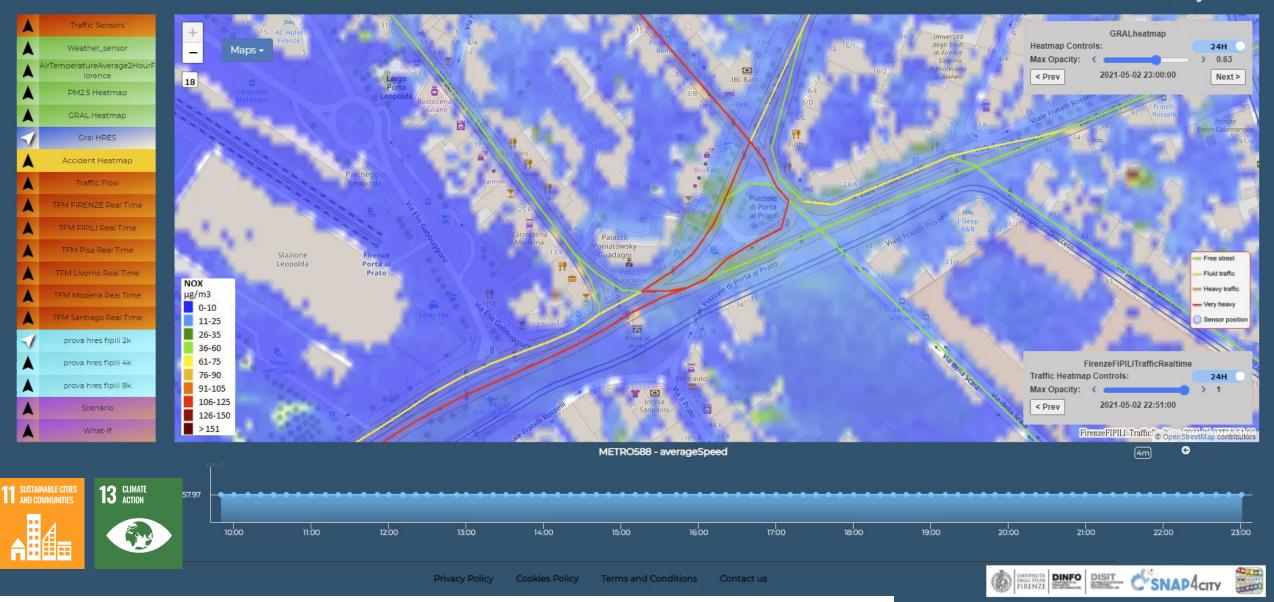
#### **Produced information**

- Suggestions
- Engagements
- Notifications

System

# Traffic Flow Manager on multiple cities

Sun 2 May 23:16:31



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





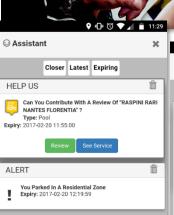




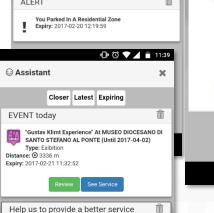
1 Engagement Sent (4 hours)



**Users' Engagement** 

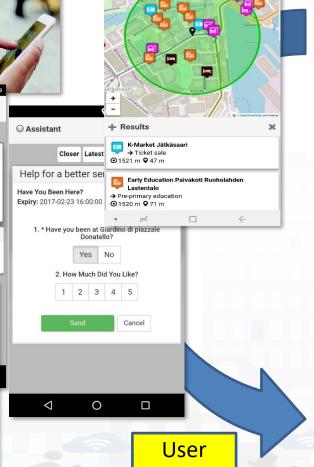






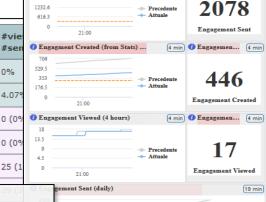
Expiry: 2017-02-20 19:35:39

Can confirm that you LIVE around VIA TRIPOLI?



context

Rule name Type #sent #viewed #se 1 (0%) daily event de **ENGAGEMENT** 0 (0%) 0% 1720 (2.12%) 4.07 **ENGAGEMENT** 70 (7.1%) daily event en 5 (0.29%) 0 (0%) commuter 14 (0.81%) 0 (0%) 0 (09 student 1462 (85%) 25 (35.71%) tourist 25 (1



4 min DEngagemen... 4 min

#### Inform

Air Quality forecast is not very nice You have parked out of your residential parking zone

The Road cleaning is this night The waste in S.Andreas Road is full

#### **Engage**

Provide a comment, a score, etc.

#### Stimulate / recommend

Events in the city, services you may be interested, etc...

#### Provide Bonus, rewards if needed

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



Rules

City

context

29 min

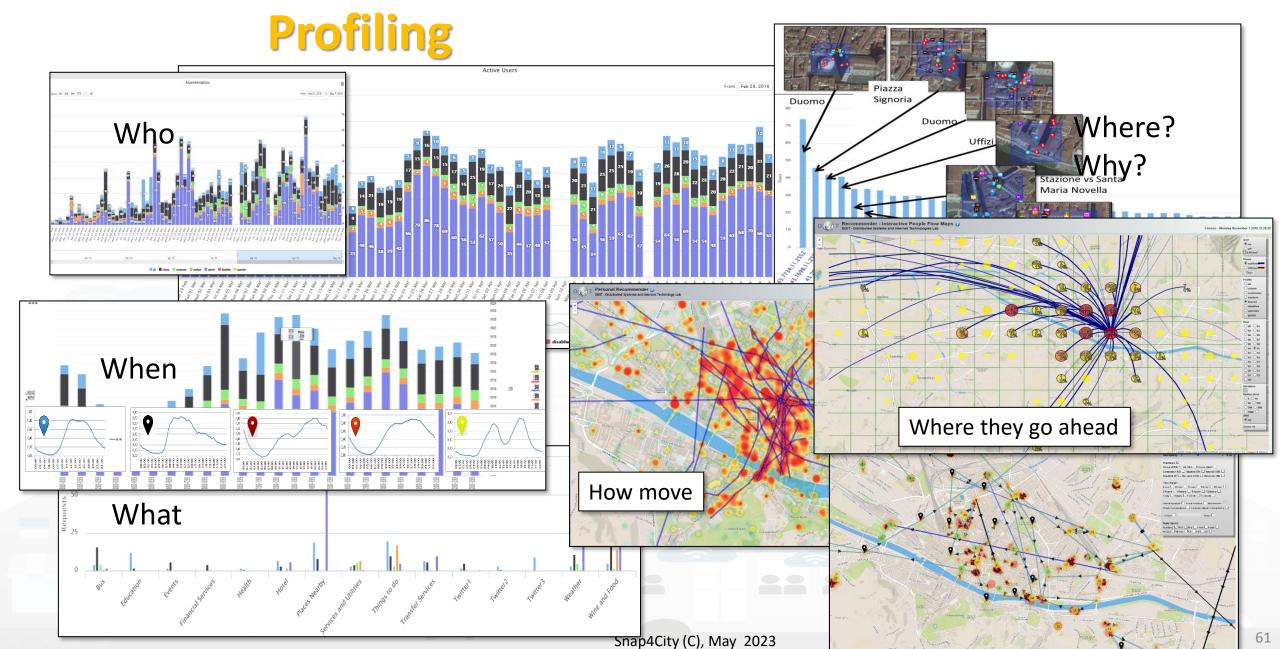






# **User Behavior Analyser for Collective**





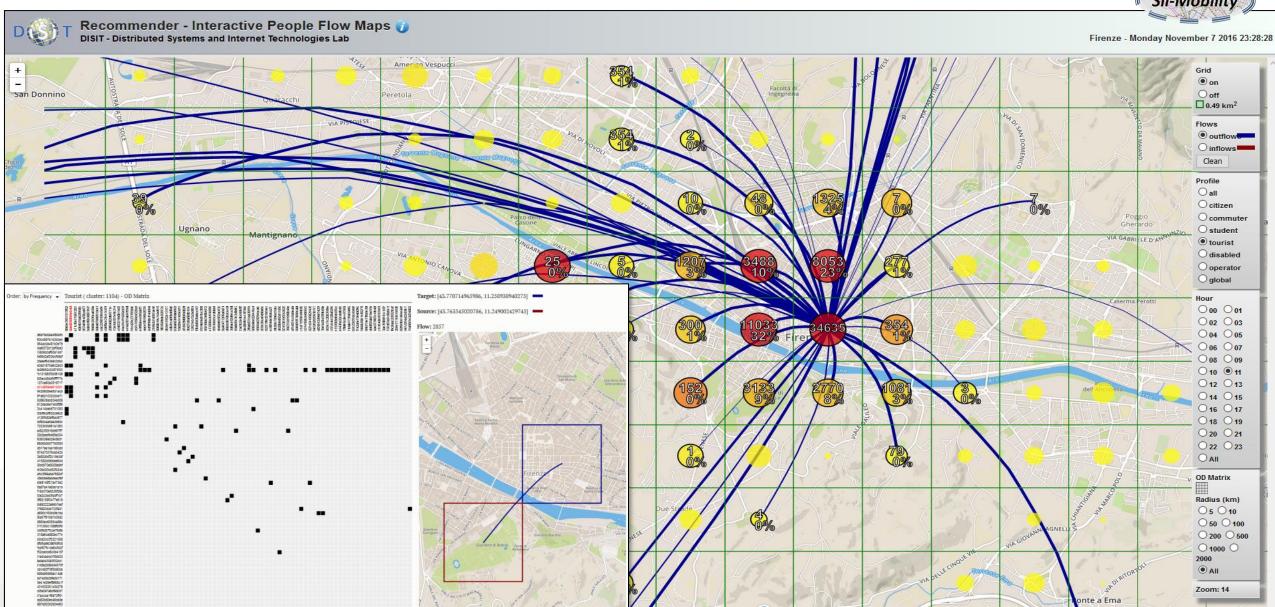




# DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES SCALABLE COD Matrix SNAP4CITY SNAP4CITY









# People Monitoring on Pub Services DIGIPOLIS Antwerp







• PAX Counters: museum, pub services, COVID-19

Multiple Levels & Decision Makers

- Business Intelligence Dashboards
- People flow, OD flows
- Detection of critical conditions

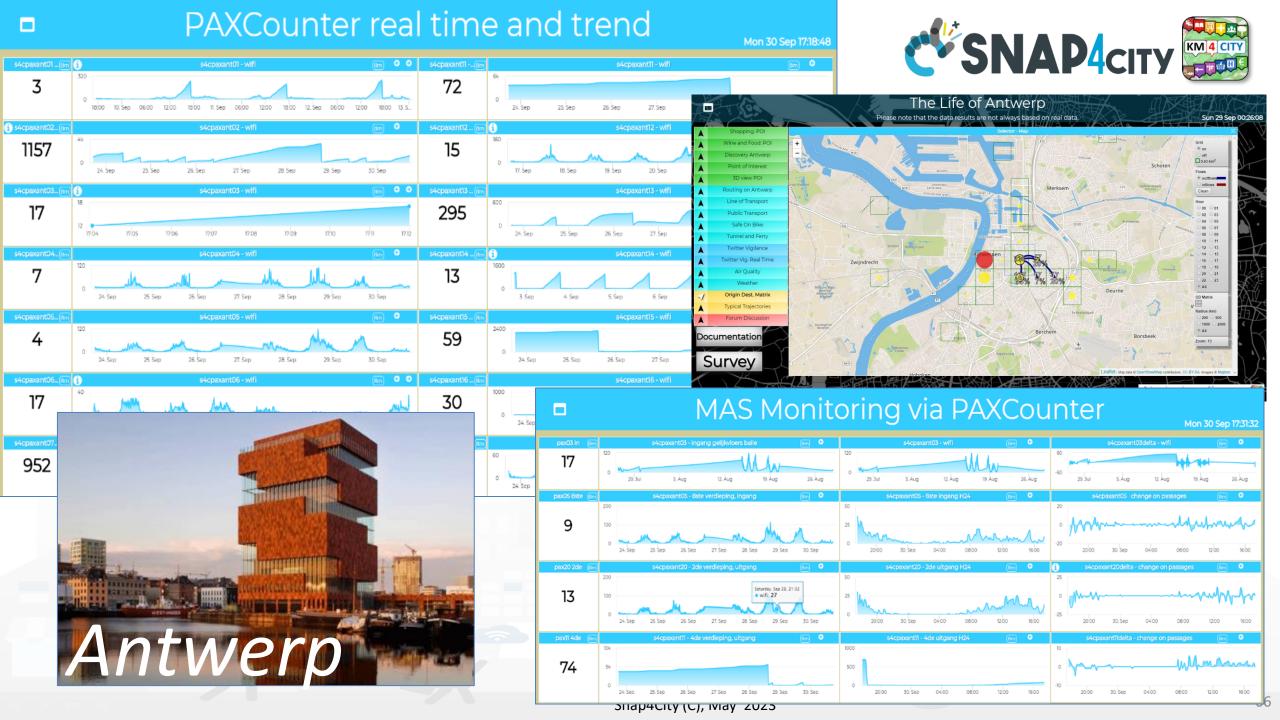
## Historical and Real Time data

- 20 fixed PaxCounters
- 2 Mobile PaxCounters

## Services Exploited on:

- Dashboards, Mobile Apps, API/data
- Fully Controlled Devices by Digipolis
- Since 2019





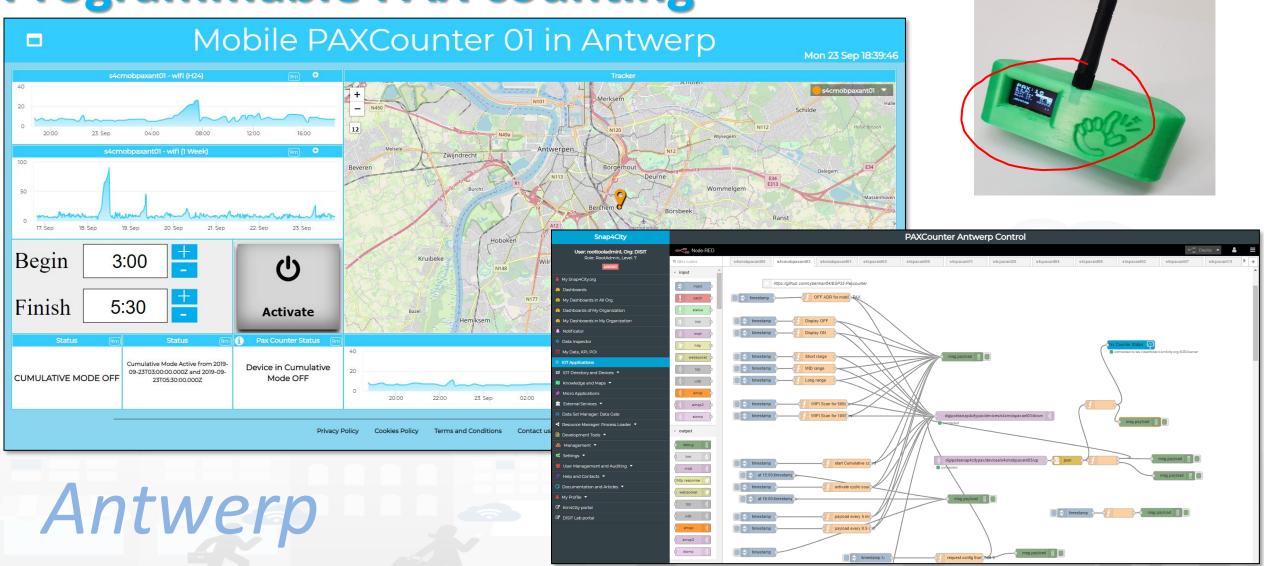








**Programmable PAX counting** 





# Snap4Altair Decision Support supervision and control, Industry 4.0







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

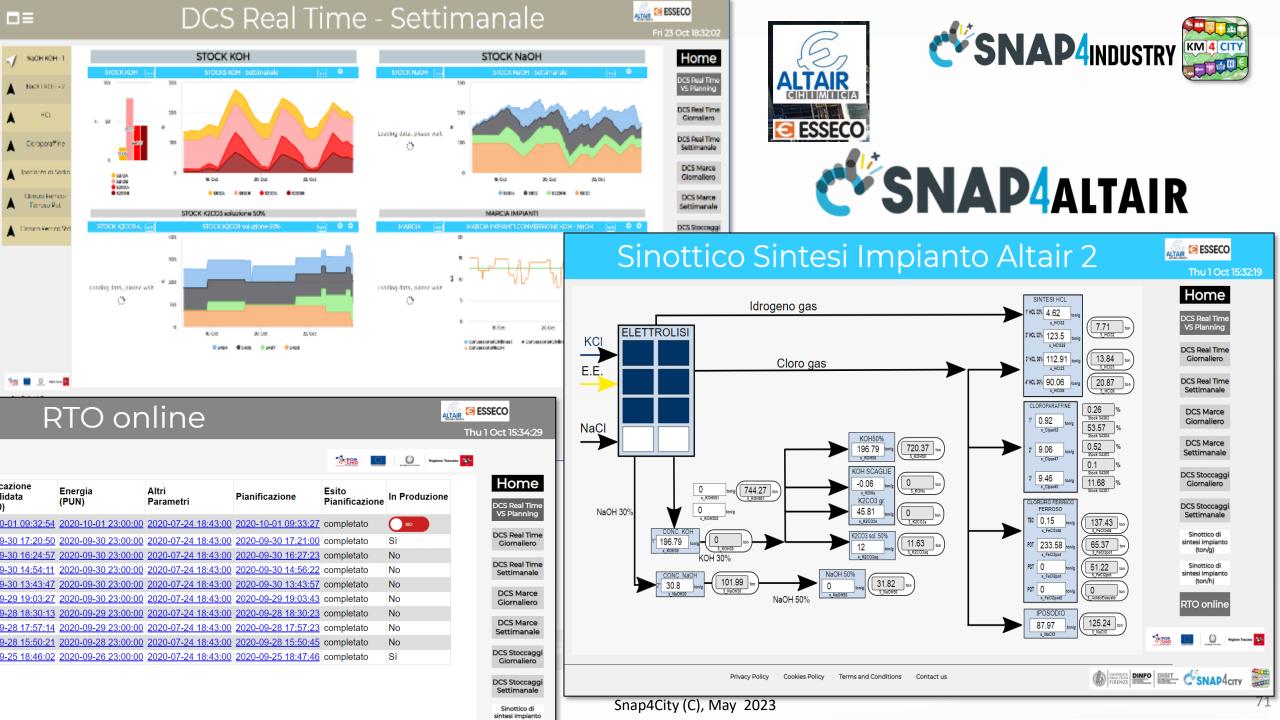












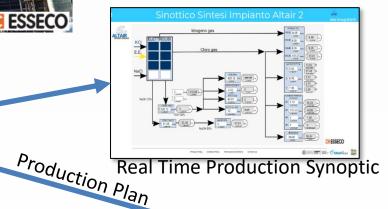














Orders

Data Ingestion

1 Other Costs

**Energy Service** 

**AS400** 

Transportation

**Production** Plant Management

Data Storage

Optimized Production Planner

Possible Plan

**Decision Support** 

Possible Plans



Production **Parameters Plant** 

Management

Snap4City (C), May 2023



#### UNIVERSITÀ **DEGLI STUDI** FIRENZE

Node-RED

subflows

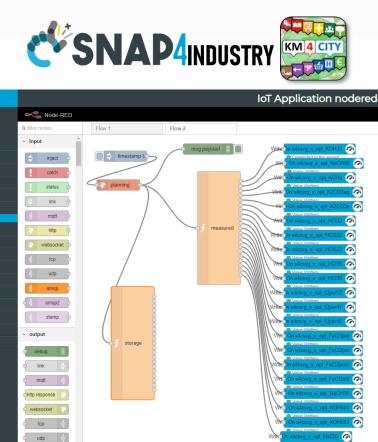
## **INGEGNERIA DELL'INFORMAZIONE**

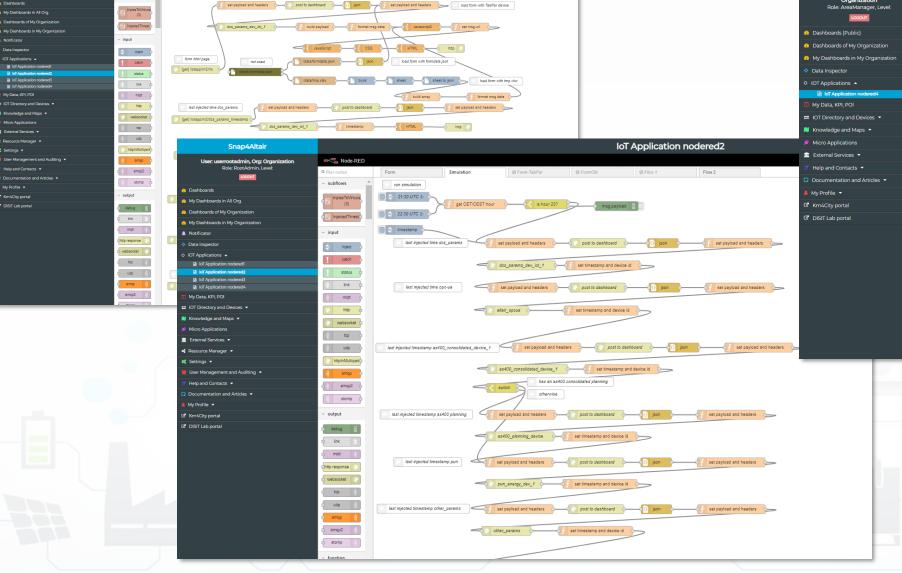
IoT Application nodered2

# DISIT DISTRIBUTED SYSTEMS SOME Altair Flows SNAP4INDUSTRY

Snap4Altair

User: userareamanager, Org:







amqp

amqp2



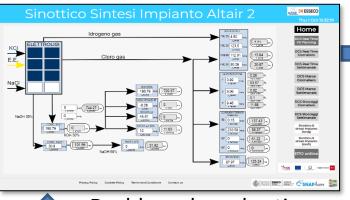








# orkflow for Ticket management

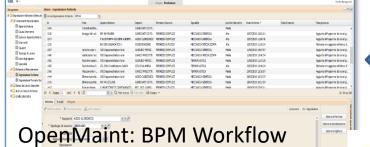


Dashboards and actions

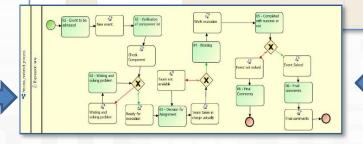


IOT App, Data event firing, event detection and firing Critical event management

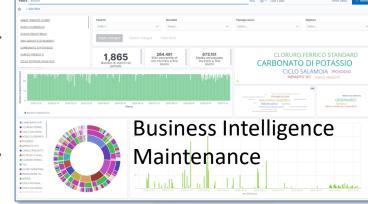
## Consumptions/productions

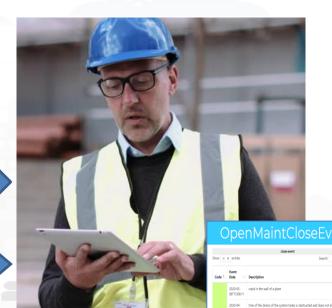


management, team assignement, material control, ...



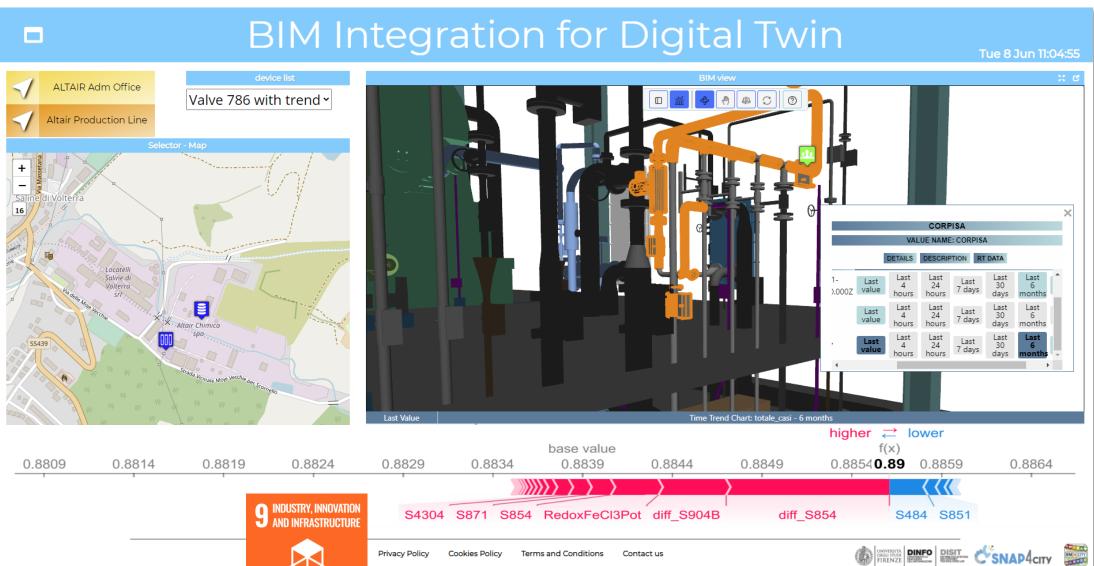
### **Events/actions**





## Digital Twin Local, 3D vs Real Time Data













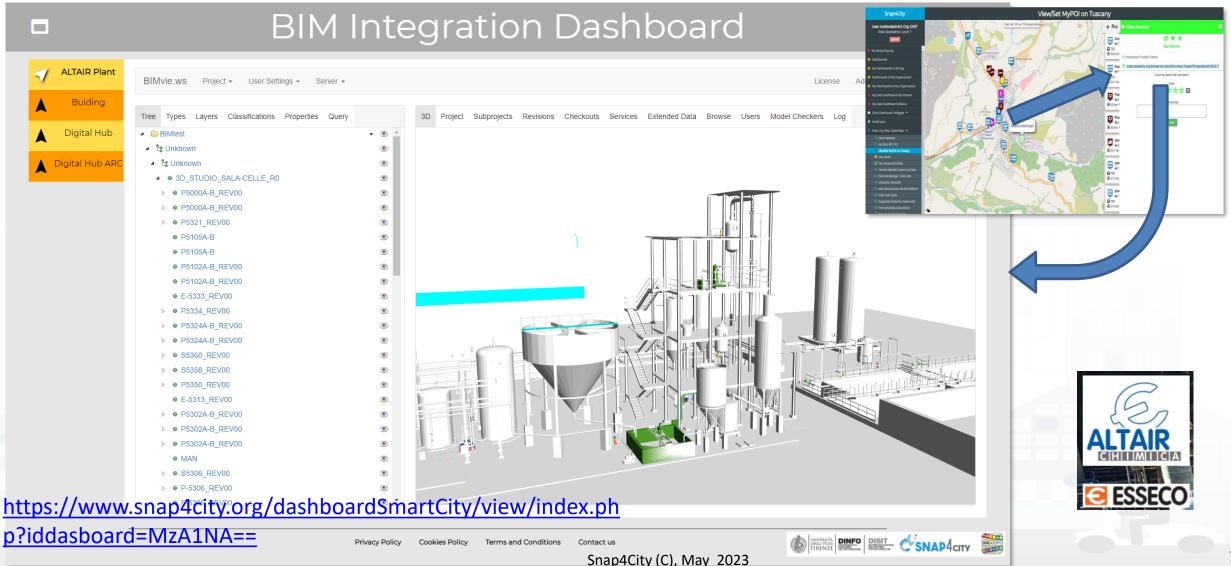






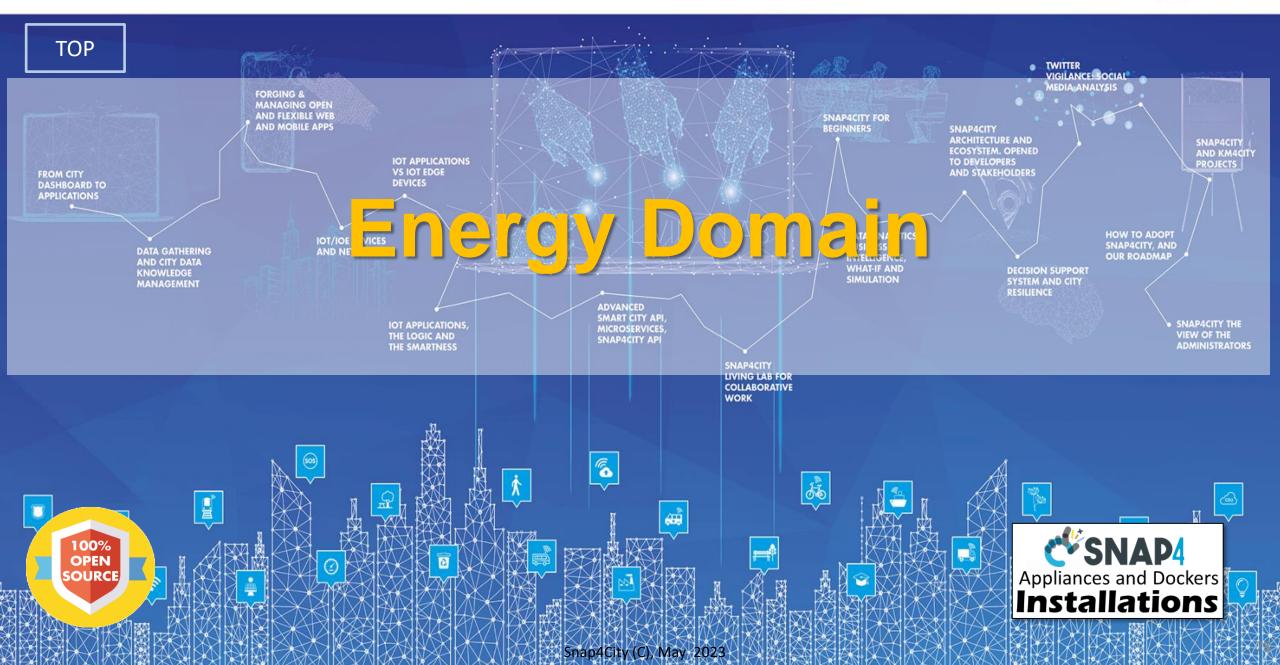


# **BIM view of the Altair Chemical Plant**



### **SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES**













# https://www.snap4city.org/dashboardSmartCity/view/Gea.php?iddasboard=MzY3Ng==



### SELF USER

Monitoraggio in tempo reale della comunità energetica condominiale

Tue 4 Apr 13:20:04

KWh Da Inizio Anno

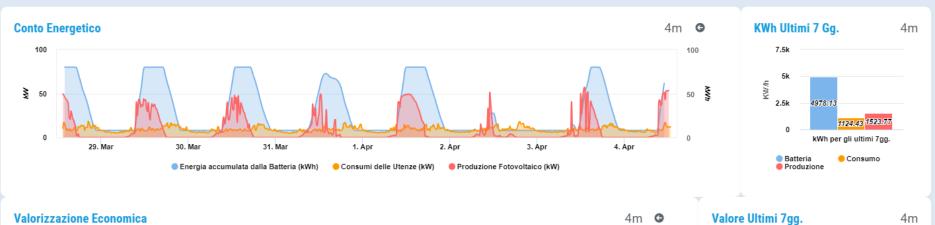
45839.47

Batteria

Produzione



4m





Prelevata

Venduta

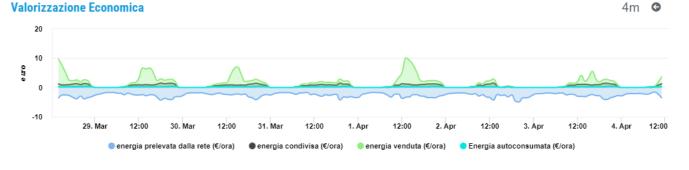
Condivisa



11149.2 9873.16

kWh da inizio anno

Consumo

















2026

- no impianto

2028

- impianto + hatteria 2 4 kWh

🛕 - impianto + batteria 10 kWh

2029

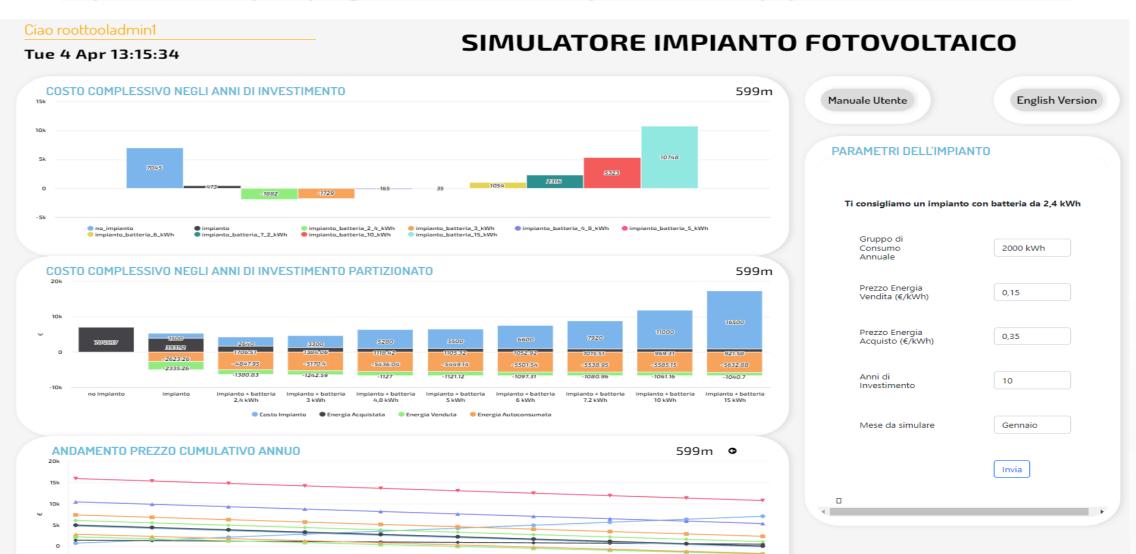
A - impianto + hatteria 3 kWh

▼ - impianto + batteria 15 kWh





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

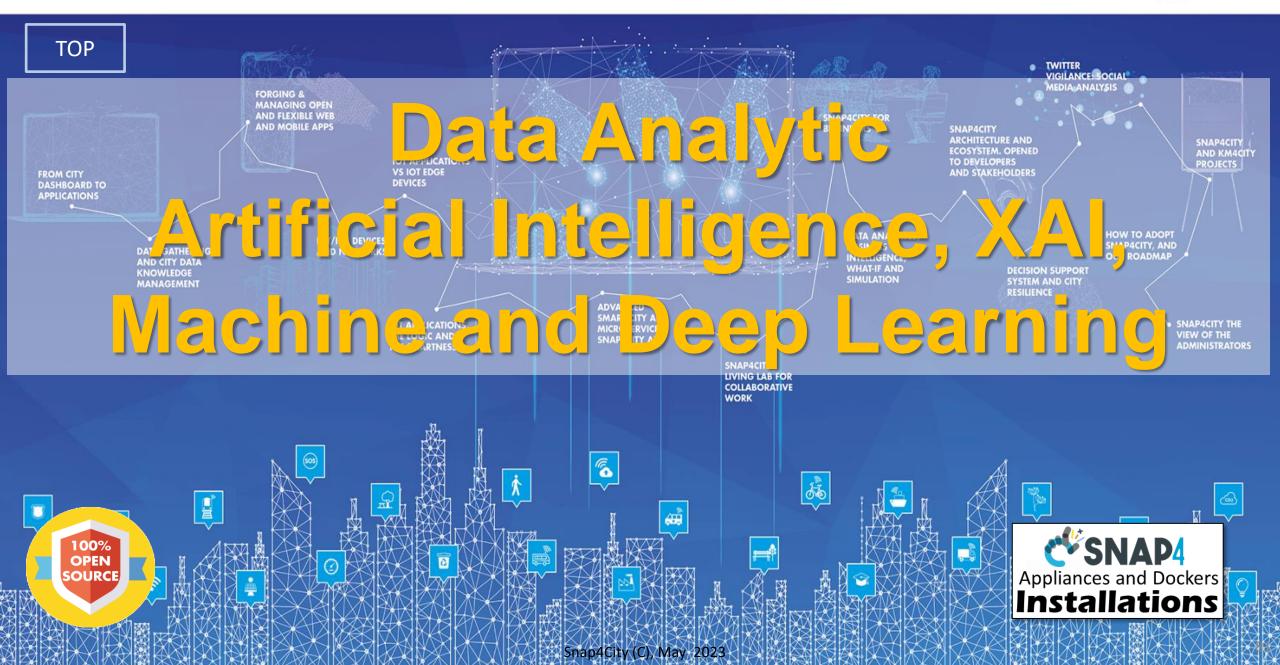


2032

2033

### SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES















# **Available Data Analytics**

- Mobility and Transport
- Users Behaviour analysis
- Environment and Weather analysis
- Management and strategies
  - -Early Warning, What-If analysis
  - -Resilience and Risks Analysis
  - -Semantic Reasoning





https://www.snap4city.o rg/download/video/DPL SNAP4SOLU.pdf

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

# Big Data Analytics + Artificial Intelligence

SNAP4city

KM4 city

- Decision support
  - Early warning, City Indexes, etc.
  - What-IF analysis (simulation + Al + data)
- Predictions
  - Short and Long terms predictive models on:
    - traffic, parking, people flow, maintenance, land sliding, NO2
  - 3D Flow prediction: Pollutant (NOX, NO2, ...)
- Suggestions and recommendations
- Modeling, simulation, routing
  - Traffic Flow reconstruction
  - Constrained Routing

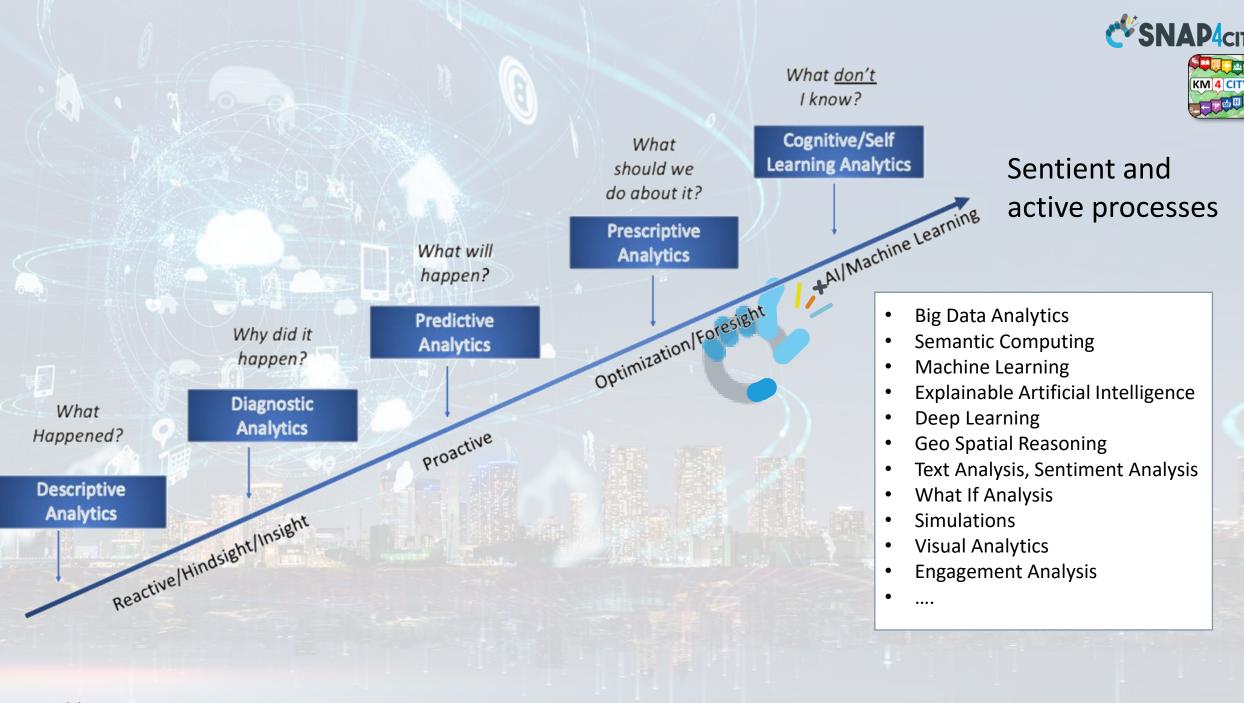
## AI & XAI:

- RF, XGBoost, BRNN, RNN, SVR, DNN, LSTM, CNN-LSTM, Autoencoders, ...
- Clustering: K-means, K-Medoid, ...
- XAI: Shap, variations,

## **Computational processes:**

- Heatmaps, ..
- trajectories,
- OD matrices,
- Typical Time Trends, etc.

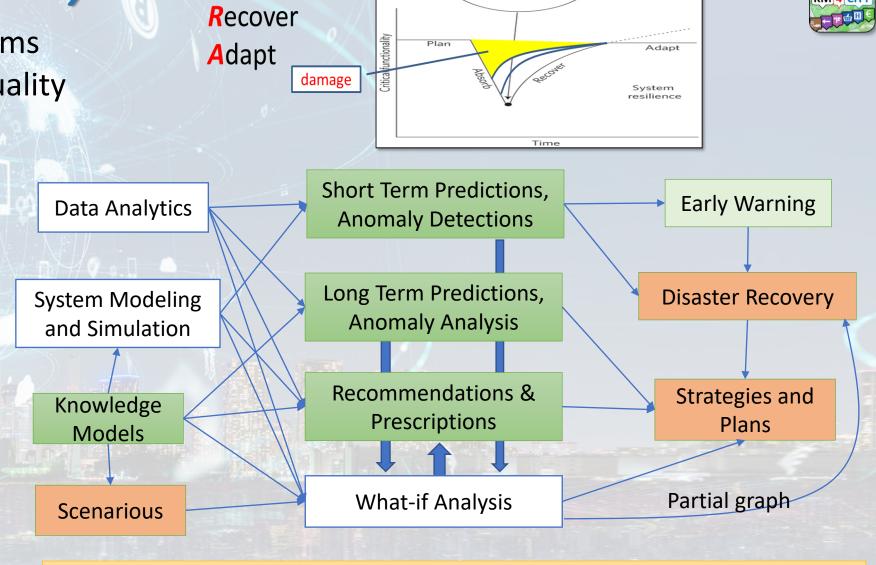
https://www.snap4city.org/download/video/course2020/da/Snap4City-4th-slot-Data-Analytic-v4-6.pdf



Snap4City (C), May 2023 86

# **Snap4City Analytics**

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



Consequence

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

Snap4City (C), May 2023

**P**repare

**A**bsorb











## **Decision Support Systems, What-if**

### Event planning, via what-if analysis

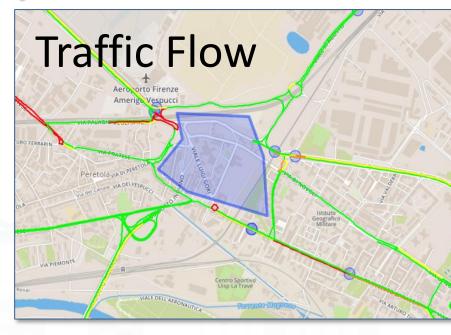
- Change in the graph structure of the city
- Impact on the flow of people and vehicles
- Adaptation: public transport, traffic, pedestrian management, etc.

#### Immediate reaction to natural events or not

- Everything is ready and updated in real time
- Each view is contextualized in terms of data: descriptive and prescriptive

### Digital Twin

- More detail in the context integrated data
- Greater realism in deductions and representations
- Less fragmentation and non-uniformity in the views to support decisions



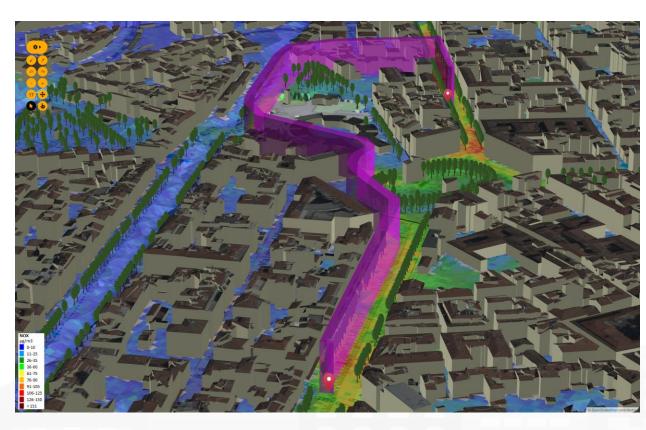


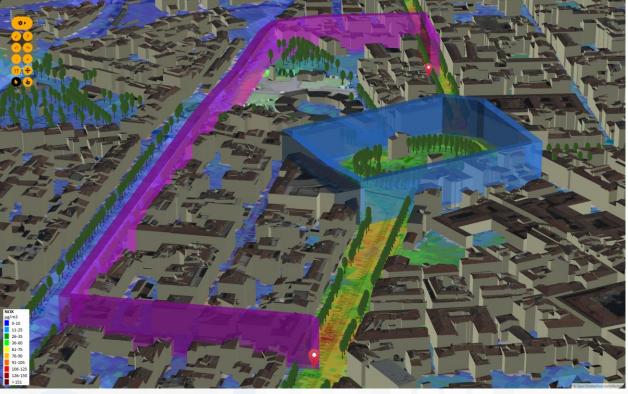






## **Dyamic Routing in 3D space**





## What-if Analysis on Pub Transport







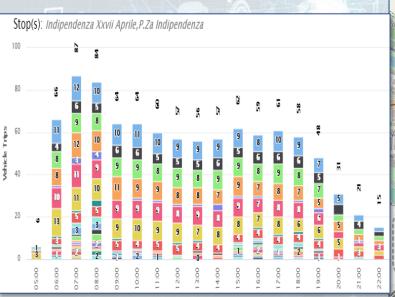


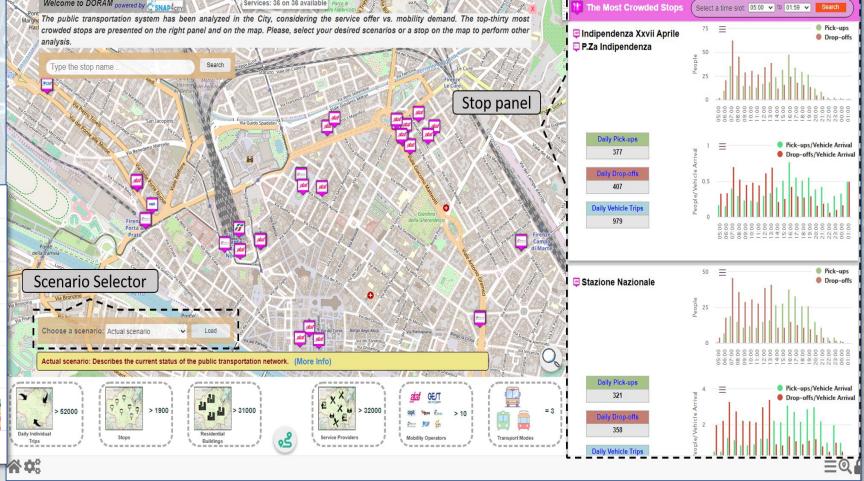


- Definition of scenarious impact on
  - Traffic, Pollutant, parking, public transport, private flows, etc.

KPI analysis

**Public Services** 









## AI/XAI on: Mobility and Transport

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





# Towards a Sustainable Mobility



### Traffic and Mobility of people is the key:

- High costs for society and for people
- Sources of pollution: NO2, CO2, etc.
- Increased multimodal supply / demand
- Increased complexity of mobility
- Impact on quality of life: SDG, 15MinCityIndex
- Impact on primary and emergency services: firefighters, ambulances, security, freight transport, ...

### **Environmental impact**

Due to traffic but also to climatic factors

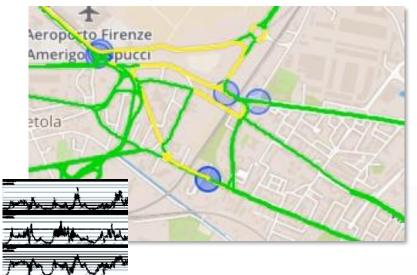






### **Towards Sustainable Mobility**

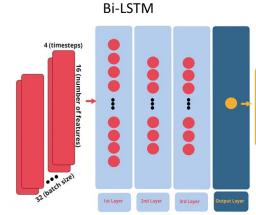
Information on complex networks
Few measuring points with data over time



Traffic predictions with respect to unforeseen events Predictions on parking, bike sharing, etc.











#### **Assessment of local CO2**



#### **Predictions NO, NO2 (NOX)**











enel x

### **Towards Sustainable Mobility**

Tue 3 May 20:14:59

Green facto

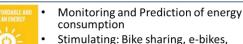


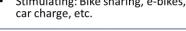








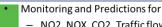






- Smart City infrastructure: monitoring and resilience
- Effective and Low cost smart solutions
- What-if analysis, Simulations





- NO2, NOX, CO2, Traffic flow, pollutant, landslide, etc.
- Traffic flow reconstruction



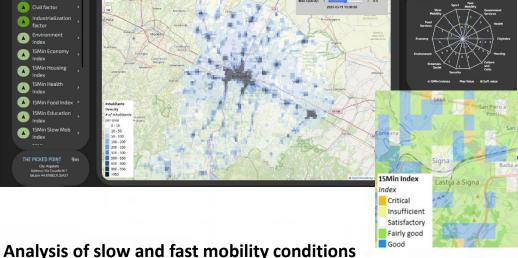
- Industry 4.0 integrated solutions
- **Decisions Support Systems**
- **Process optimization**
- Predictive maintenance



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



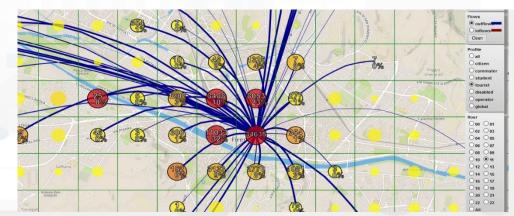
- Shortening justice time
- Prediction of mediation proneness
- Ethical Explainable Artificial Intelligence



15 MINUTI INDEX BOLOGNA CITTÀ

**METROPOLITANA - NEWGUI** 

### to provide suggestions to operators



#### **Suggest sustainable transport solutions:**











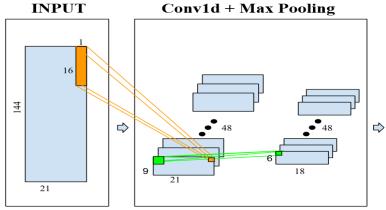


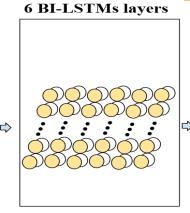
### Short-Term Prediction of City Traffic Flow via Convolutional Deep Learning

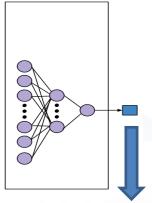






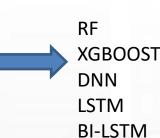






#### Urban data:

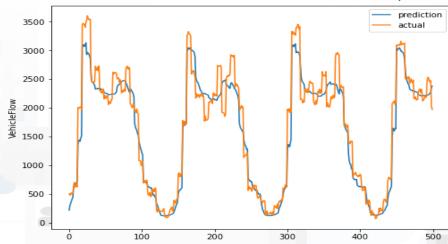
- Date-time
- Traffic
- **Temporal**
- Seasonality
- Pollution
- Weather



Autoencoder BI-LSTM Attention CONV-LSTM

**CONV-BI-LSTM** 

**CONV-BI-LSTM** 

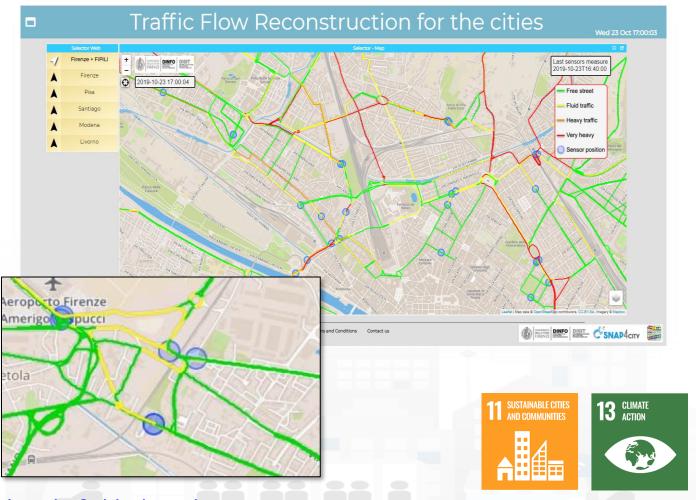




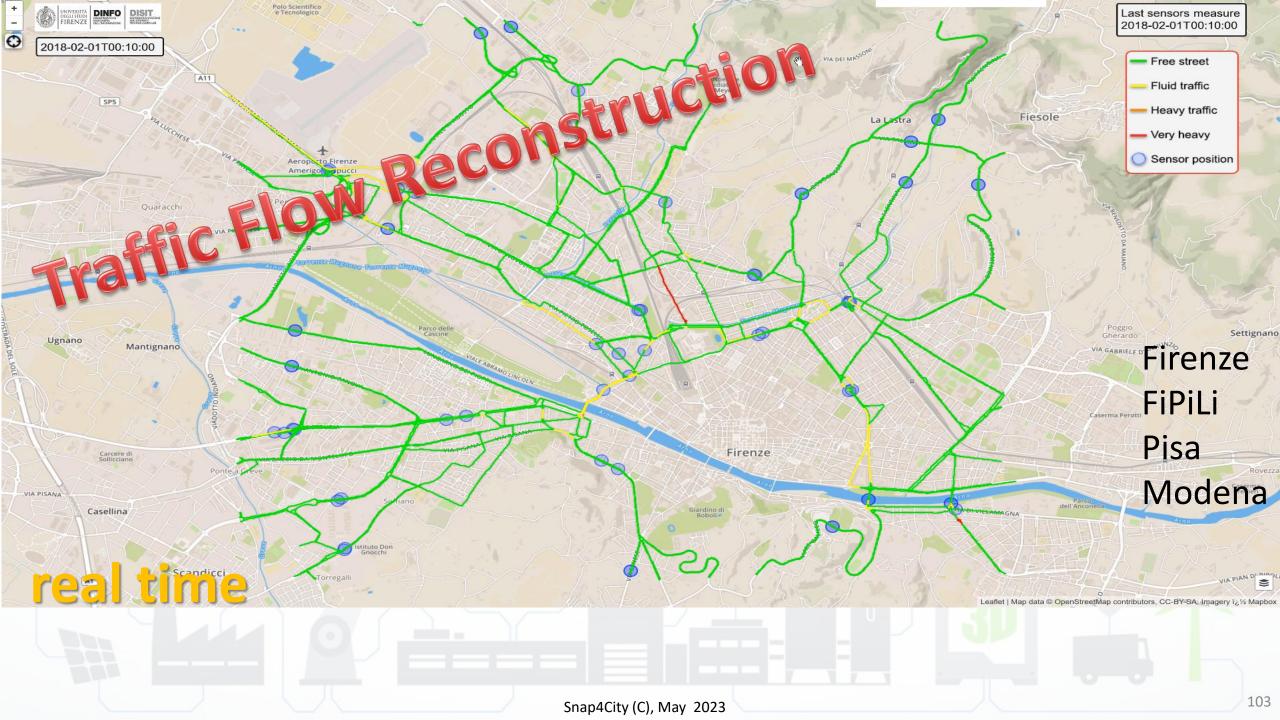


## Why Dense Traffic Flow Reconstruction?

- Controlling pollution
- Dynamic Routing for Firebrigade, Ambulances, general public
- Planning Public
   Transportation routing



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





STREET, STREET,





# Parking predictions SNAP4city

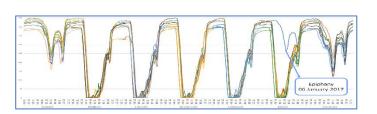




106

## I would arrive to surely Park in 45 Minutes??

Description of features variable



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

**Features** 

Artificial Intelligence **Predictions** 

97% of precision









### AI/XAI on: Environment and Weather

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







### **Environment**

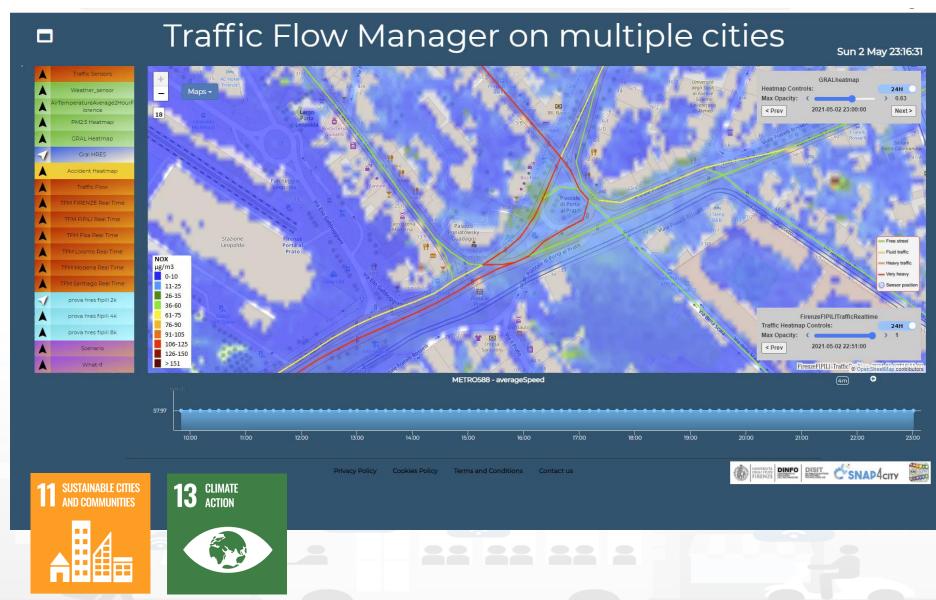


### Prediction

- NOX Pollutant
   diffusion on the
   basis of Traffic
   Flow (prediction),
   weather and 3D
   structure
- NO2 progressive average (Long term)

### Project:

- Trafair CEF EC
- Mixed solutions of Fluidinamics modeling and Al











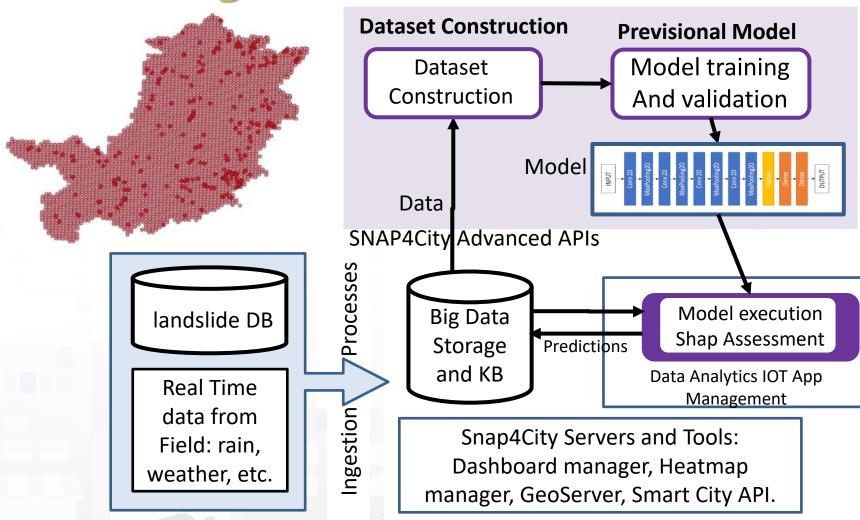








## **Predicting Land slides**



(c) 21-12-2019 predictions

Dashboards and

Mobile Apps

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.

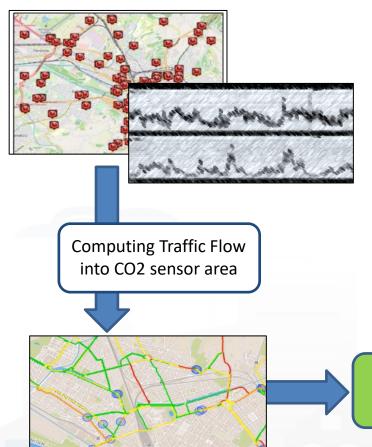








# **Estimating City Local CO2 from Traffic Flow Data**



Traffic Flow data

Traffic Flow is one the main source of CO2

Dense estimation of CO2 into the city is very useful to know to target EC's KPIs

Computing CO2 on the basis of





CO<sub>2</sub> estimation

traffic flow data

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



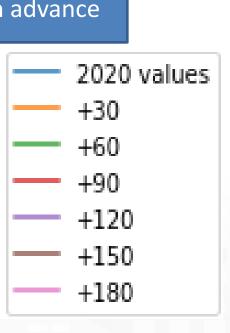




## Predicting EC's KPI on NO2 months in advance

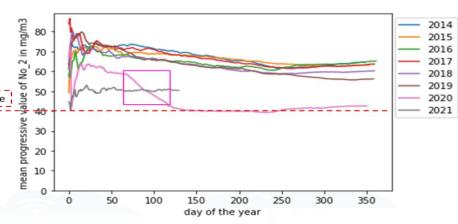
Deep Learning Long Terms Predictions of NO2 mean values, From 30 to 180 days in advance

- The features used as input for the predictive models are:
- Month
- dayOfTheYear
- NO2
- Tmean
- Humidity
- windMean <sup>نځت</sup>
- NoxDomestic
- numberOfVehicles
- NO2cumulated
- NO2progresseveMean
- numberOfVehiclesCumulated









		WHOguidelines			
Pollutant	Averaging period	Objective and legal nature concentration	and Comments	Concentration	Comments
PM <sub>2.5</sub>	One day			25 μg/m³ (*)	99 <sup>th</sup> percentile (3 days/year)
PM <sub>2.5</sub>	Calendar year	Target value 75 ug/m³	The target value has become a limit value since 1 January 2015	10 μg/m³	
PM <sub>10</sub>	One day	Limit value, 50 μg/m³	Not to be exceeded on more than 35 days per year.	50 μg/m³ (*)	99 <sup>th</sup> percentile (3 days/year)
PM <sub>10</sub>	Calendar year	Limit value, 40 µg/m³ (*)		20 μg/m³	
O <sub>3</sub>	Maximum daily 8–hour mean	Target value, 120 µg/m³ t	Not to be exceeded on more than 25 days per year, averaged over three years	100 µg/m³	
NO <sub>2</sub>	One hour	Limit value, 200 μg/m³(*)	Not to be exceeded more than 18 times a calendar year	200 µg/m³ (*)	
NO <sub>2</sub>	Calendar year	Limit value, 40 µg/m³		40 μg/m³	





## AI/XAI on: City Users and Social

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



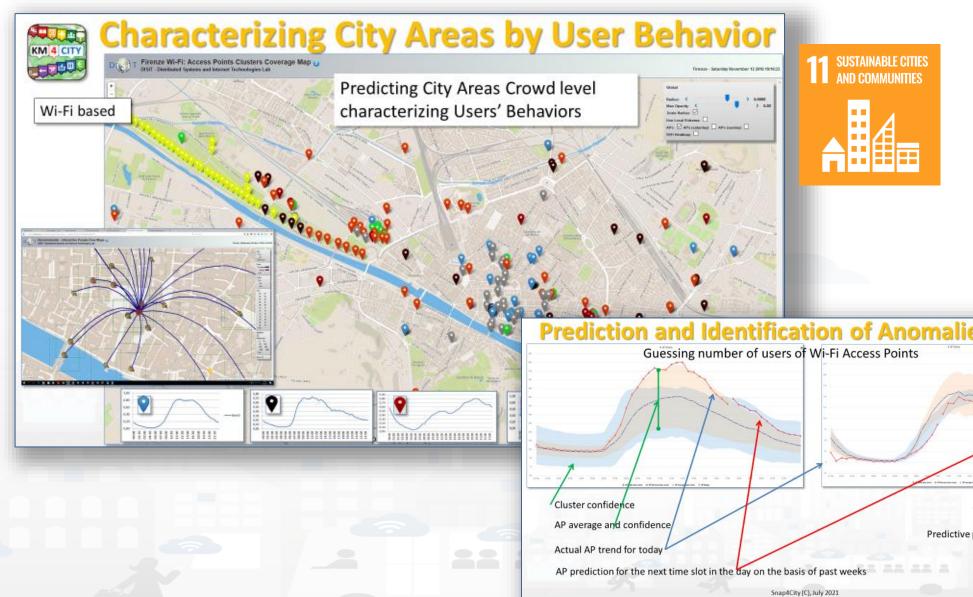


## **People Flows**





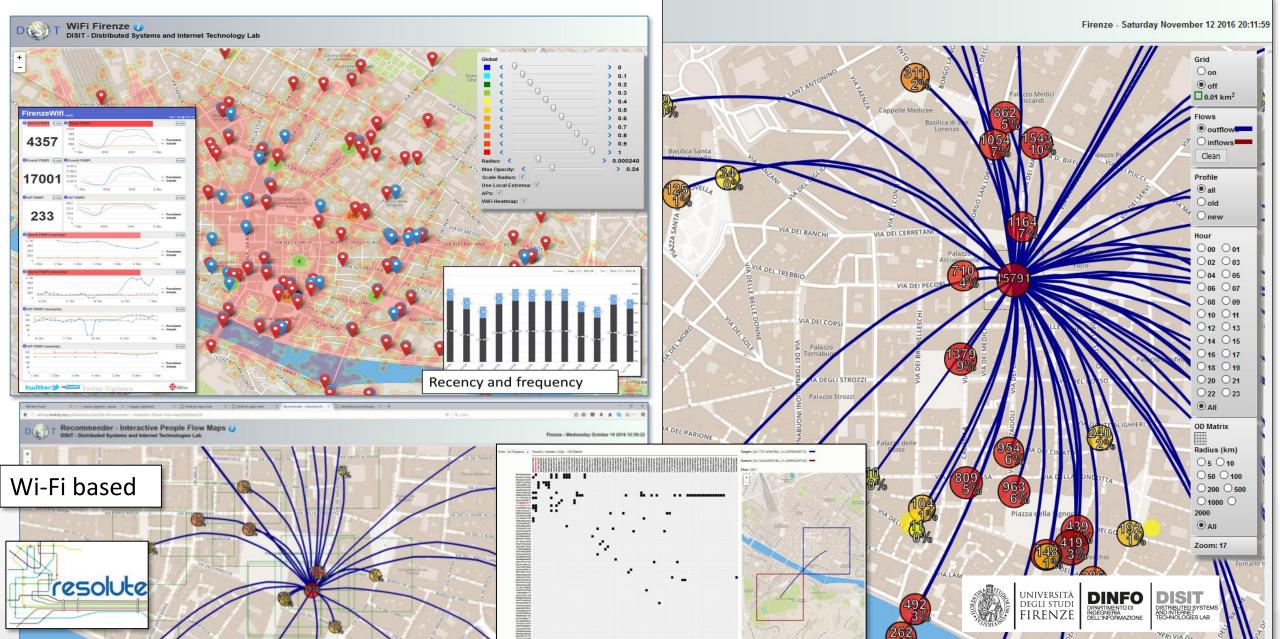
- Prediction of people flows on the basis of Wi-Fi data
- Anomaly detection
- Resolute H2020
- Classification of city areas



Snap4City (C), May 2023

**Origin Destination Matrix Estimation** 





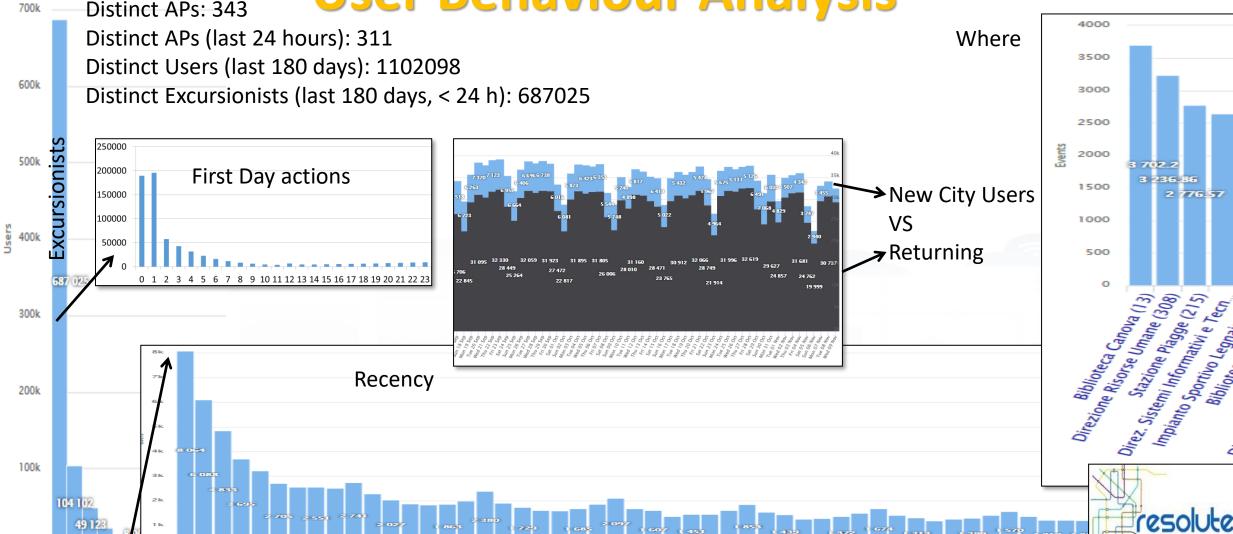








**User Behaviour Analysis** 



SNAD CITY KM 4 CITY Characterizing City Areas

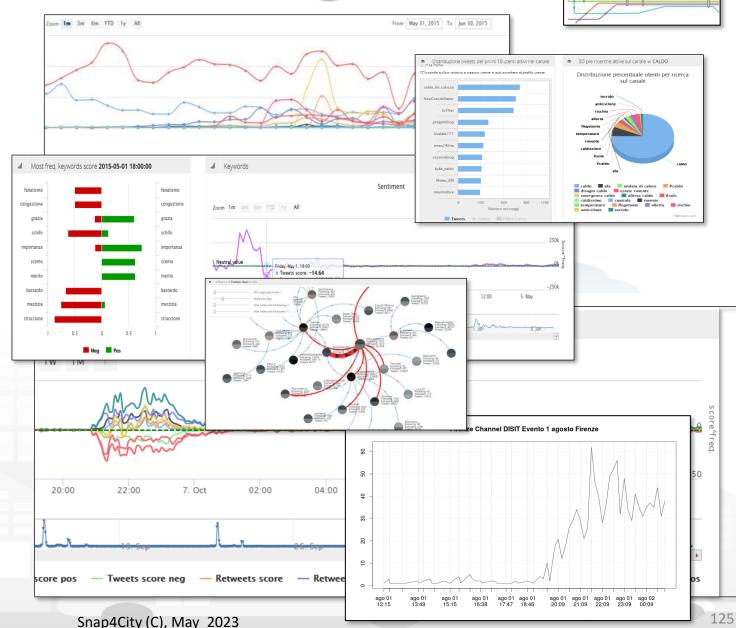
Pirenze Wi-Fi: Access Points Clusters Coverage Map

DISIT - Distributed Systems and Internet Technologies Lab **Predicting City Areas Crowd level** characterizing Users' Behaviors Wi-Fi based APs: APs (saturday): APs (sunday): Prediction resolute



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

## **Twitter Vigilance**



resolute







### **Social Media**



#elioperilsociale

-- @urban strangers

---#moseek

---fedez

-skin

-#eleonora

---#giosada

-#xf9Live

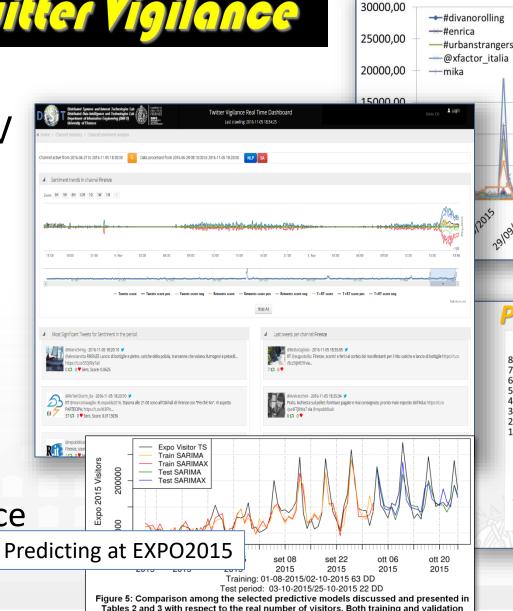
-sciortino

---elio

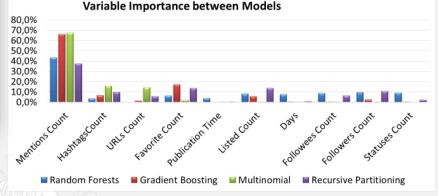
# Twitter Vigilance

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

- +NLP, SA











DISTRIBUTED SYSTEM AND INTERNET TECHNOLOGIES LAB





Zoom 1m 3m 6m YTD 1y All





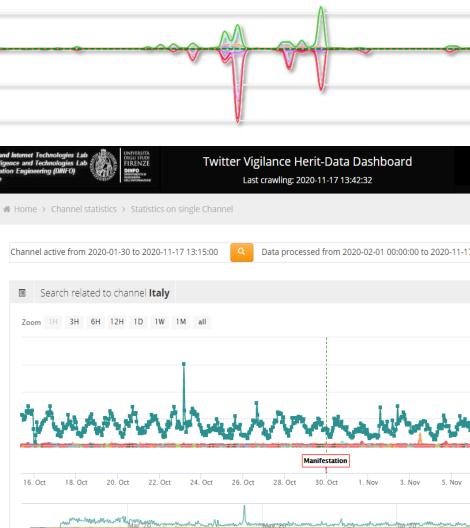
From Aug 1, 2020 To N

### TV on Florence









- #affittibrevi

#4thIndustrialRevolution





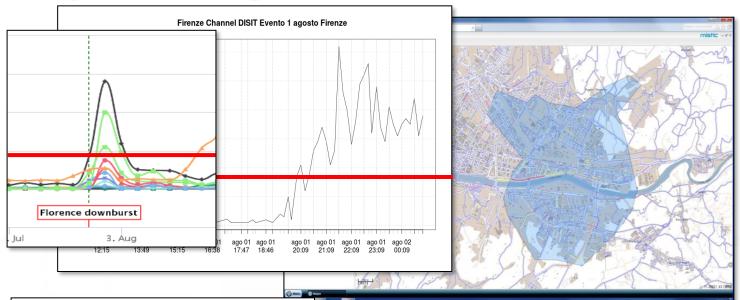


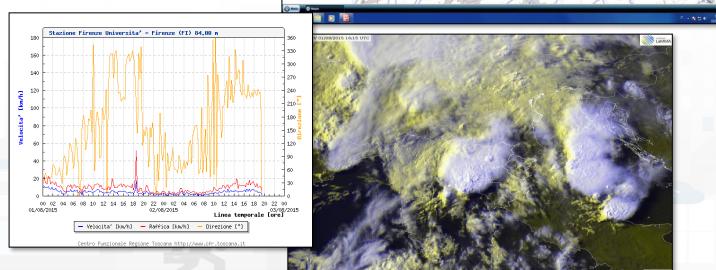




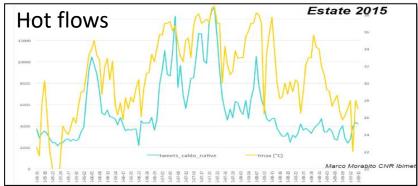


### **Early Warning**

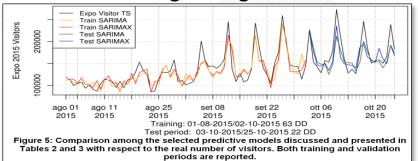




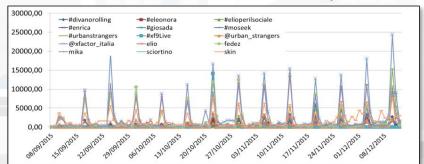
# **Predictive models**



#### Attendance at long lasting events: EXPO2015



#### Attendance at recurrent events: TV, footbal

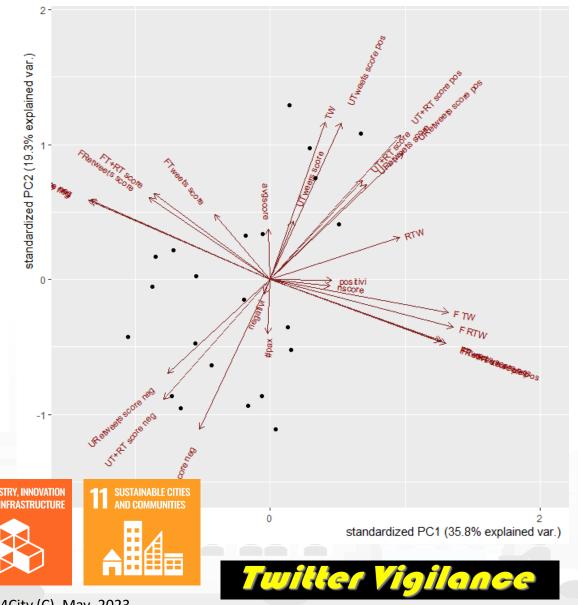




## Reputation



- 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







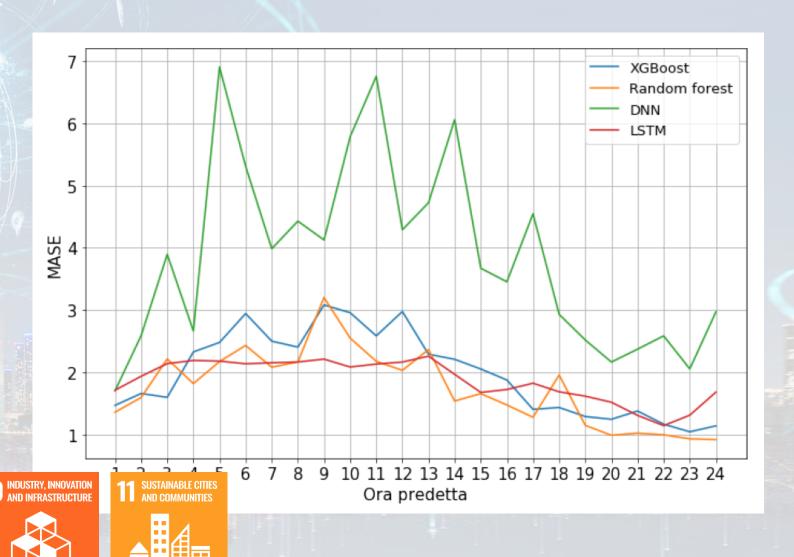
## Pont du Gard: data analytics

 Prediction of the number of sold tickets
 24 hours in advance

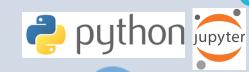
### • Using:

- Historical data
- Weather conditions
- Social Media

Twitter Vigilance



## Data Analytics on Snap4City platform



Studio





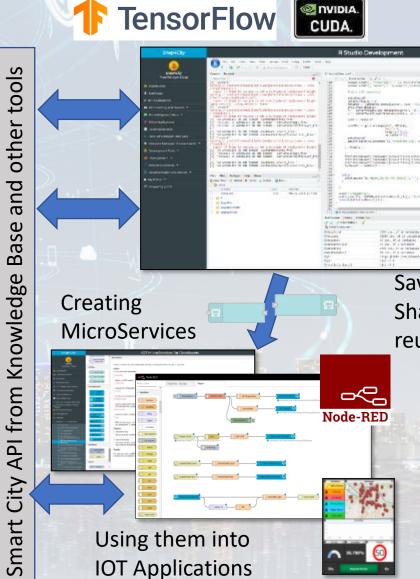




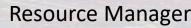
**Ontology Schema** 



LOG.disit.org **Big Data Store Facility** 



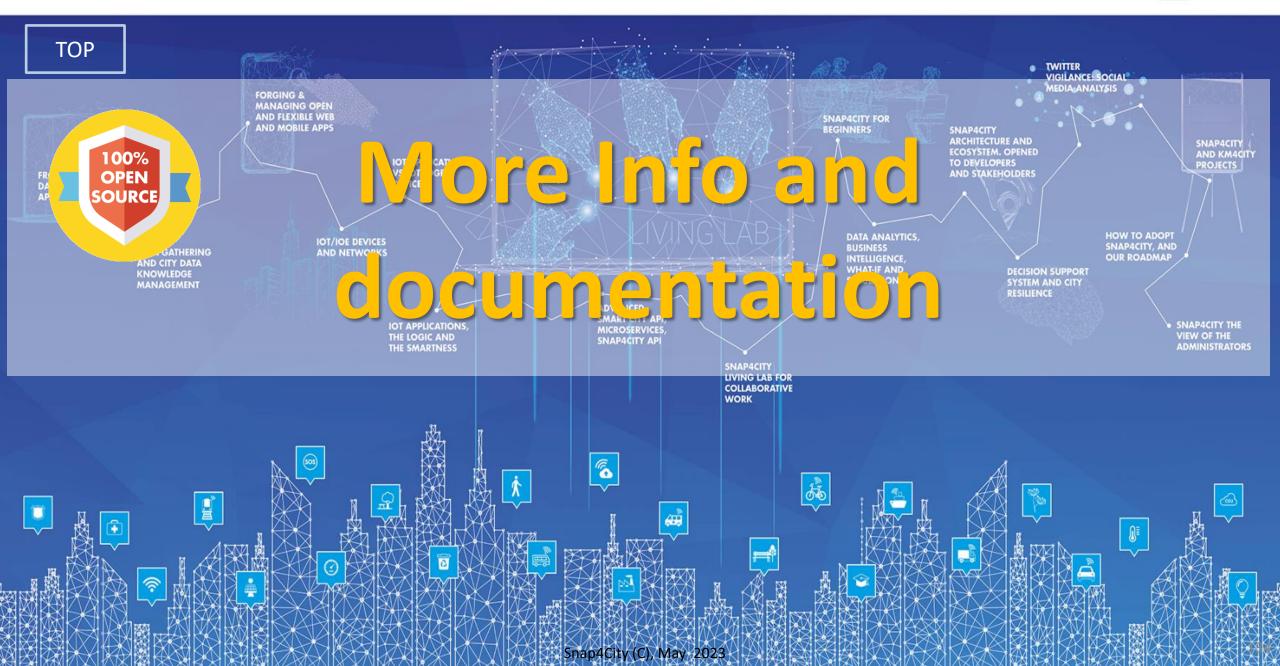




Snap4City (C), May 2023 133

#### **SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES**







Tools ▼





Tutorials and Videos ▼

2 Dashboards (Public)

www.snap4solutions.org

Extra Dashboard Widgets

Data Management, HLT

Knowledge and Maps

Processing Logics / IOT App

**Entity Directory and Devices** 

Resource Manager

**Development Tools** 

ecision Support Systems

Deploy and Installation

Help and Contacts

**Full Training Course** 

Videos: Overviews and Tutorials

List of Conn. (City Article)

Privacy Policy

Cookies Policy







### **HOW ARE YOU GOING** TO BUILD THE FUTURE?

Snap4City: a framework for rapid implementation of Decision Support Systems and Smart Applications.



Home How and Why To Use it ▼

Home / Snap4City: Smart aNalytic APp builder for sentient Cities and IOT

Fira Barceloni

**GET YOUR PASS** 

#### Snap4City: Smart aNalytic APp builder for sentient Cities and IOT





















15 - 17 NOVEMBER 2022

BARCELONA & ONLINE



















What People say

Mobile Apps IOT Devices

IOT Applications Data Analytics Dashboards

Living Lab Smart City API

















- Development Life Cycle: https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf
- Client-Side Business Logic Widget Manual: https://www.snap4city.org/download/video/ClientSideBusinessLogic-WidgetManual.pdf
- Booklet Data Analytics, Snap4Solutions: https://www.snap4city.org/download/video/DPL\_SNAP4SOLU.pdf

Login

#### Registration

- New Registration
- Request a new password
- Recover your registration

#### Search











### 2022 booklets

Snap4City





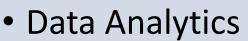
https://www.snap4city.org/download/video/DPL\_SN AP4CITY 2022-v02.pdf Snap4Industry





https://www.snap4city.org/download/video/DPL SNAP4INDUSTRY 2022-v03.pdf

Solutions







https://www.snap4city.o rg/download/video/DPL SNAP4SOLU.pdf

## Overview













#### **Snap4City Platform**

#### **Technical Overview**

From: DINFO dept of University of Florence, with its

DISIT Lab, Https://www.disit.org with its Snap4City solution

#### Snap4City:

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

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

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

Access Level: Public

Date: 05-04-2021

Version: 5.3

 https://www.snap4city.o rg/drupal/sites/default/f iles/files/Snap4City-PlatformOverview.pdf



.



# Development









#### **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.snap4citv.org/download/video/Snap4Citv-
- https://www.snap4citv.org
- https://www.snap4solutions.org
- https://www.snap4industrv.org
- https://twitter.com/snap4city
- https://www.facebook.com/snap4city
- https://www.youtube.com/channel/UC3tAO09EbNba8f2-u4vandg

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

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

Access Level: public

Date: 21-10-2022

Version: 1.4







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



Snap4City (C), May 2023

## Overview



SMART CITIES AND SMART INDUSTRY

**Snap4City: FIWARE** powered smart app builder for sentient cities



- FIWARE
- https://fiwarefoundation.medium.com/snap4cityfiware-powered-smart-app-builderfor-sentient-cities-acfe24df49d5
- https://www.snap4city.org/drupal/sit es/default/files/files/FF ImpactStorie s Snap4City.pdf



### https://www.snap4city.org/577





### On Line Training Material (free of charge)

	1st part	2nd part	3rd part	4th part	5th part	6th part	7th part	8th
what	Overview	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App	Design and Develop Smart Solutions
PDF 2022	C SHAP4cm Services in State  C SHAP4cm Servic	C'SNADAdor Water to a State of the State of	CERNAPAOR STATE OF ST	CENANON STATES AND STA	C SAASA CON CONTROL OF THE SAASA CONTROL OF THE SAA	C'ENADADO SA SUAPA DE SERVICIO	C'SNAMOR STATE OF STA	C'SNADAure Comment of SNAP
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Video3	You Tube	You	You Tube				
Video4	You Tube	You Tube	You Tube	none	You Tube	none	none

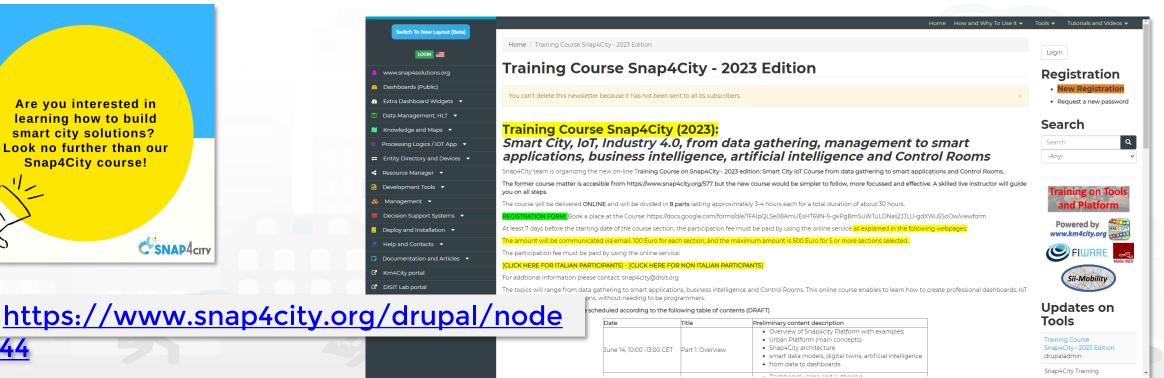




## **Training Course Snap4City - 2023 Edition**

Snap4City team is organizing the new on-line Training Course on Snap4City - 2023 edition: "Smart City IoT Course from data gathering to smart applications and Control Rooms".





TOP









### CONTACT

DISIT Lab, DINFO: Department of Information Engineering Università degli Studi di Firenze - School of Engineering

Via S. Marta, 3 - 50139 Firenze, ITALY https://www.disit.org









Email: snap4city@disit.org

Office: +39-055-2758-515 / 517

Cell: +39-335-566-86-74 Fax.: +39-055-2758570







# People Monitoring on Pub Services DIGIPOLIS Antwerp







• PAX Counters: museum, pub services, COVID-19

Multiple Levels & Decision Makers

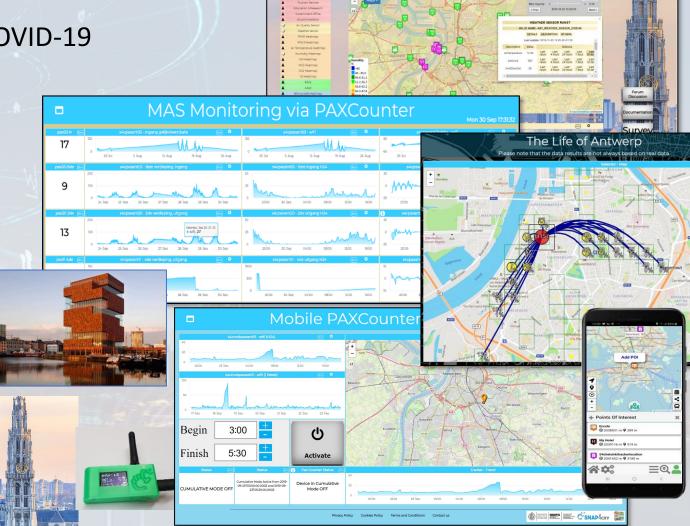
- Business Intelligence Dashboards
- People flow, OD flows
- Detection of critical conditions

### Historical and Real Time data

- 20 fixed PaxCounters
- 2 Mobile PaxCounters

### Services Exploited on:

- Dashboards, Mobile Apps, API/data
- Fully Controlled Devices by Digipolis
- Since 2019



# Impact of COVID-19

### Multiple Domains Data

 Traffic, environment, People, parking, stock options, Twitter, tc.

### Decision Makers Multiple Locations

- NO2 long term predictions
- Twitter analysis

### Historical and Real Time data

### Services Exploited on:

- Dashboards
- Social media,
- Sentiment Analysis
- Since 2019, 2020

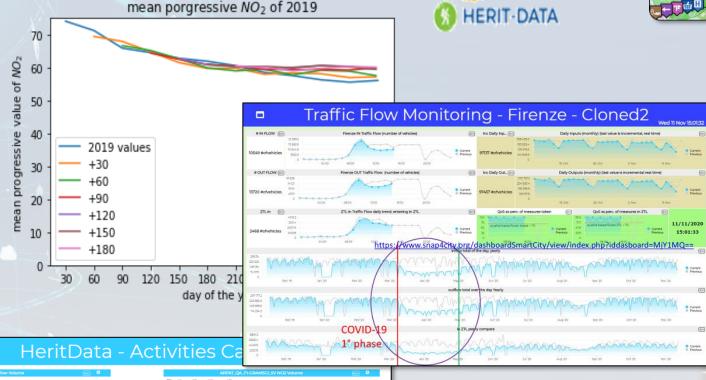
### Cities: Firenze, Pisa, Livorno, Toscana











	HeritData	- Activities	Ca	0000+ 4440.6 1222.6 0 Dec. 79		1° phase
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2007 NO FEE MAN APR		100 PM (100 PM )	APR		119 07	
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2020 APR MOC. Man Service Control of the Control of	AA AA AA DZ GZ NCY USS	2020 Man Tur Visit Tur En Sim	APR	A A A A A A A A A A A A A A A A A A A	6P 007	occ

metric	model30	model60	model90	model120	model150	model180
MAE	1.21	1.31	1.52	2.04	2.31	2.37
<b>RMSE</b>	2.16	2.61	4.18	6.77	7.83	7.93
MAPE	1.99	2.20	2.65	3.57	4.07	4.18
R2	0.91	0.83	0.80	0.54	0.45	0.14
Table 4	. Assessn	nent of th	e predict	ive model	s with resp	pect to the
actual v	alues of t	he 2019.				

Snap4City (C), May 2023

# **Environment and Quality of Life**

**Air Quality Predictions** 

### Multiple Domain Data

- Traffic Flow data, Pollutant: NOX, CO2, PM10, PM2.5, O3, ....
- 3D City structure, weather, ...

### Multiple Decision Makers

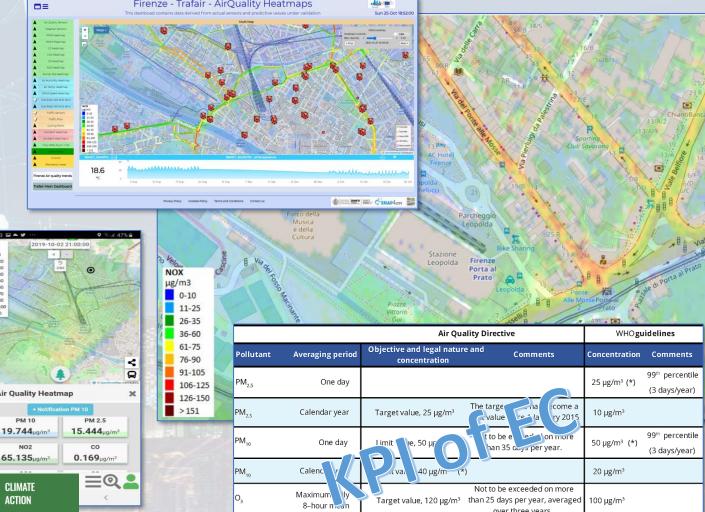
- Pollutant Predictions: NOX, NO2, ...
- City officers, energy industries
- Dashboards, What-IF analysis
- Traffic Flow Reconstruction

### Historical and Real Time data

- Billions of Data
- Services Exploited on:
  - Dashboards, Mobile App
- Since 2020



# Cities of: Firenze, Pisa, Livorno



200 μg/m³ (\*) 40 μg/m³

# Smart City / Smart Parking + Environment

Reverberi, Lonato del Garda







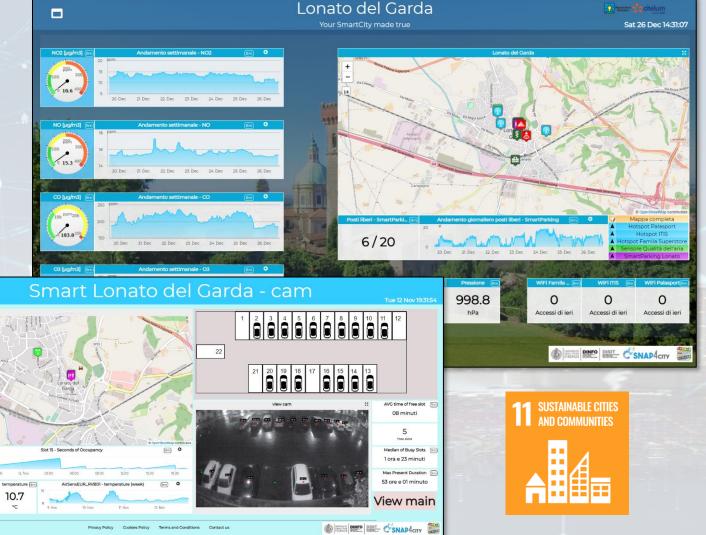
Smart Parking, Environment, Wi-Fi

### Multiple Decision Makers

- City Officer, operators
- Data monitoring, alerting
- analytics

Historical and Real Time data

- Dashboards
- Services Exploited on:
  - Dashboards, API
- Since 2019





# Smart Light Control of CAPELON

25. Apr

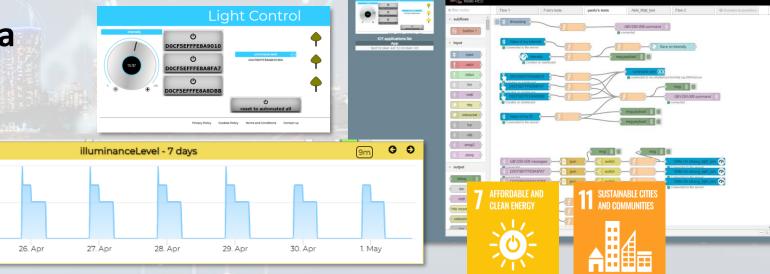




- Energy Domain
  - Smart Light, MQTT, ....
  - IoT Orion Broker FIWARE
- Dashboards
  - Map coverage on Sweden
  - Monitoring and real time control
  - Energy control, analytics
  - Direct control
- Historical and Real Time data
- Services Exploited on:
  - Multiple Levels, API
  - Dashboards
- Since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







# 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



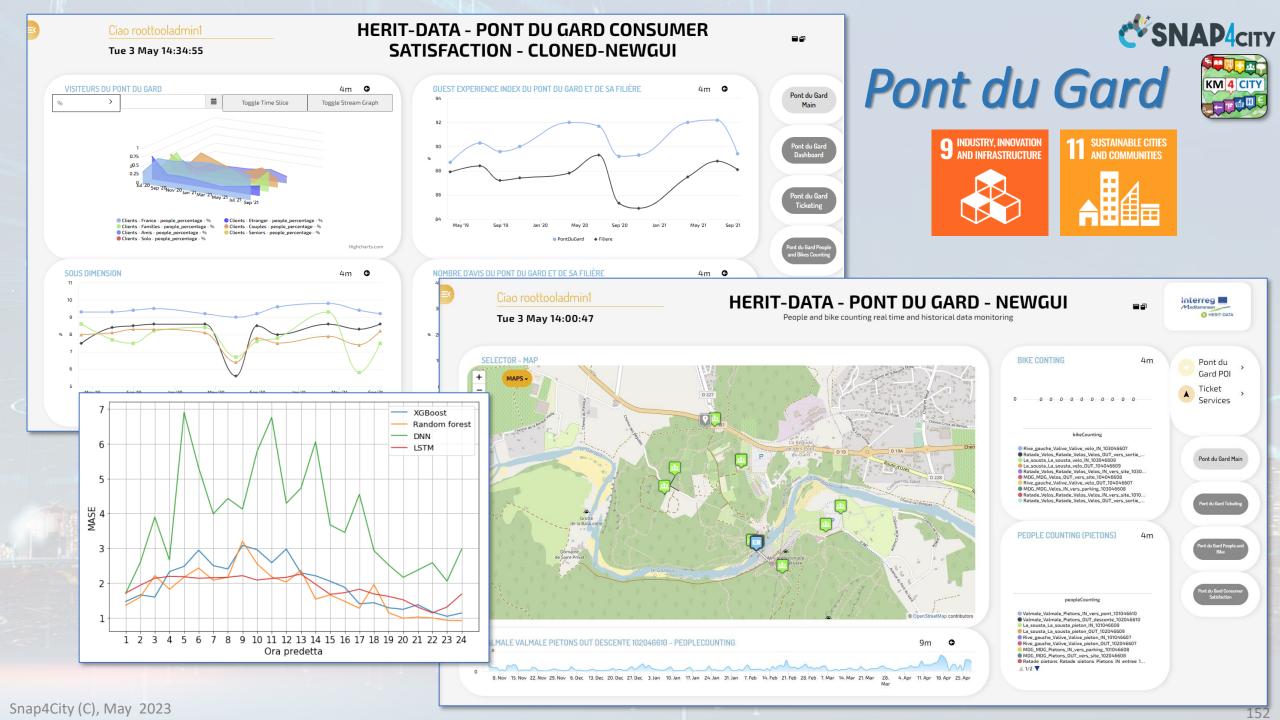










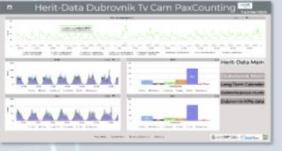


# Dubrovnik

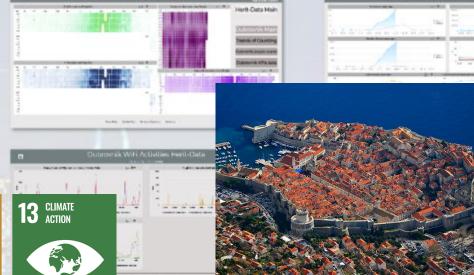
- Tourism Domain
  - Counting People
  - TV Cameras and WiFi
  - Social Media
- Dashboards
  - Monitoring and real time control
  - People flow
  - Twitter Vigilance
- Historical and Real Time data
- Services Exploited on:
  - Dashboard
- Since 2020





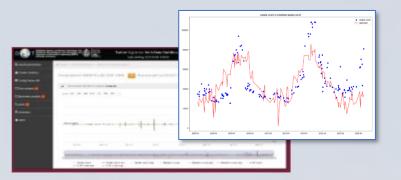
















# Valencia, FSMLR

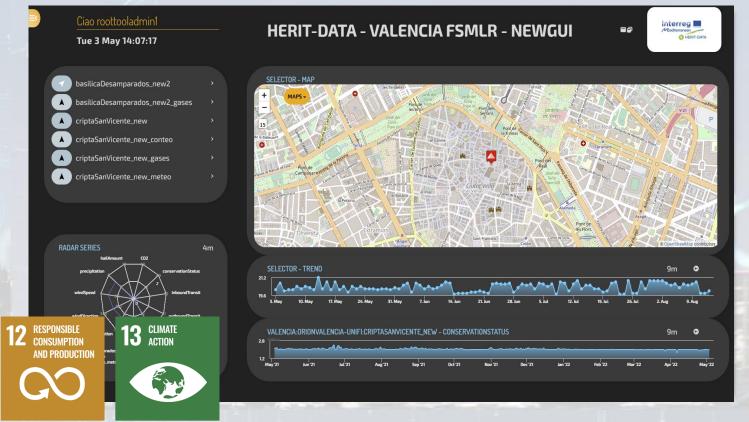
- Tourism Domain
  - Counting People
  - Environmental data
  - Social Media
- Dashboards
  - Monitoring and real time control
  - People flow
  - Twitter Vigilance
- Historical and Real Time data
- Services Exploited on:
  - Dashboard
- Since 2020











# West Greece

### Tourism Domain

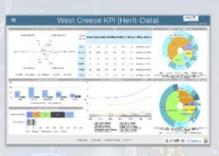
- KPIs: ODM, Flows, ...
- Social Media
- People Flows

### Dashboards

- Monitoring KPI
- People flows
- Twitter Vigilance
- Historical and updated data
- Services Exploited on:
  - Dashboard
- Since 2020

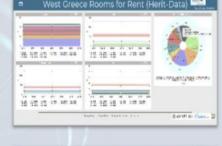






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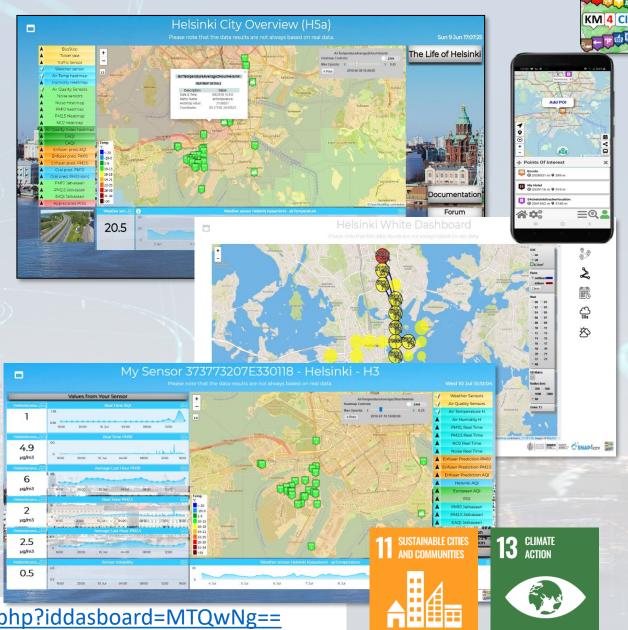
Interregi

MERIT-DATA



# Helsinki, Finland

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



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

Snap4City (C), May 2023

# Industry Plant Supervision and Maintenance









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



# Snap4Altair Decision Support supervision and control, Industry 4.0





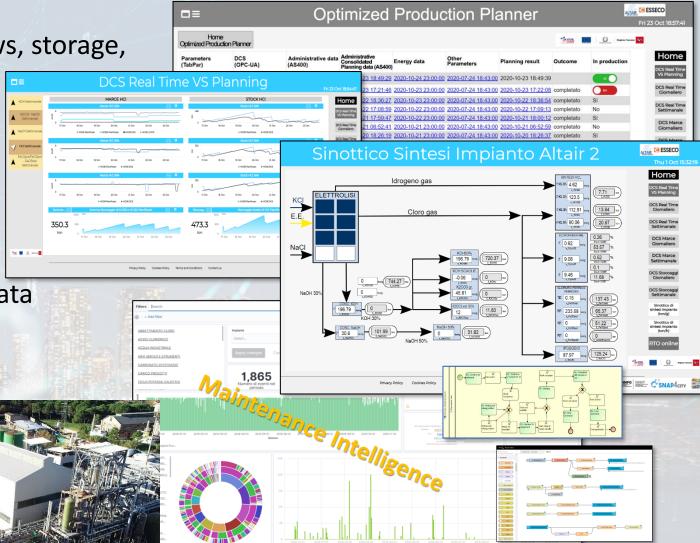
Multiple Domain Data

• Distributed Control System: energy, flows, storage,

chemical data, settings, ...

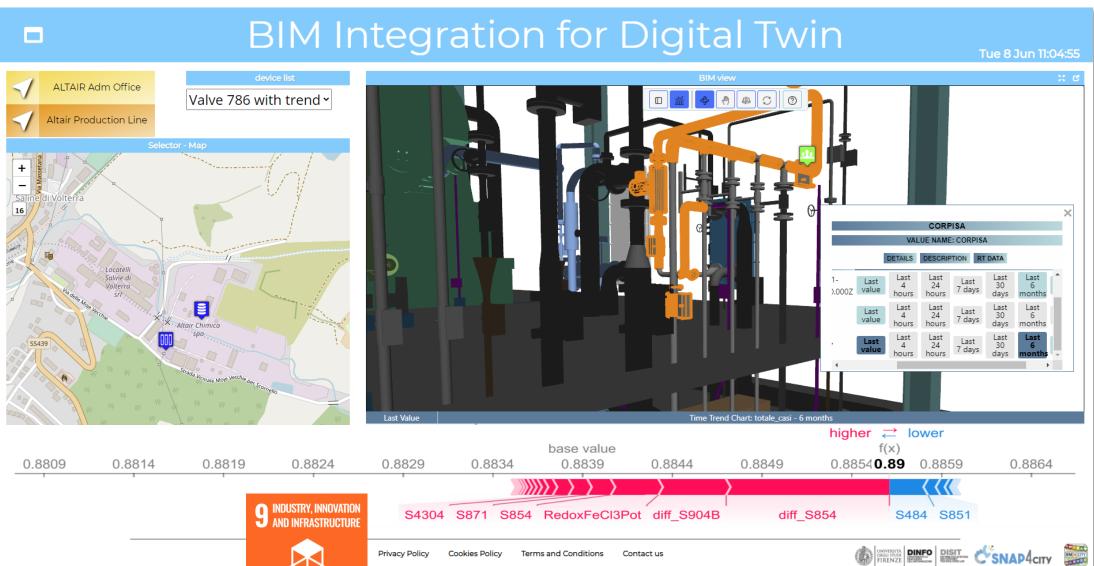
- · Cost of energy, Orders,
- Production Parameters
- Maintenance data
- Multiple Levels & Decision Makers
  - Optimized planning on chemical model
  - Business Intelligence on Maintenance data
- Historical and Real Time data
  - Billions of Data
- Services Exploited on:
  - Multiple Levels, Mobile Apps, API





### Digital Twin Local, 3D vs Real Time Data











## **GeNotiLab Architecture for ALTAIR**





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

**AS400** 

**IOT App** 



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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





Telegram Bot

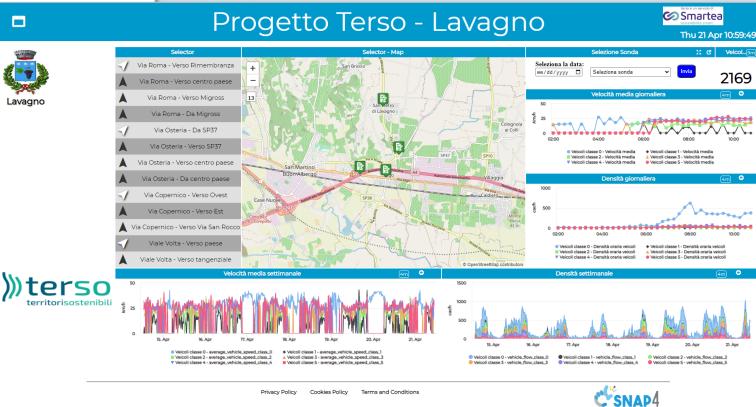


Snap4City (C), May 2023









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

Snap4City (C), May 2023 164

### PaD

### Predictive Analytics Dashboarc

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

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### Analytics Dashboard

# Simulazione Allocazione Sat 22 Jan 092218 Sat 22 Jan 092218 Sat 22 Jan 092218 Sat 22 Jan 092218 MaxSquadre | MaxSqua



# Jewel Alarms **AMPERE**







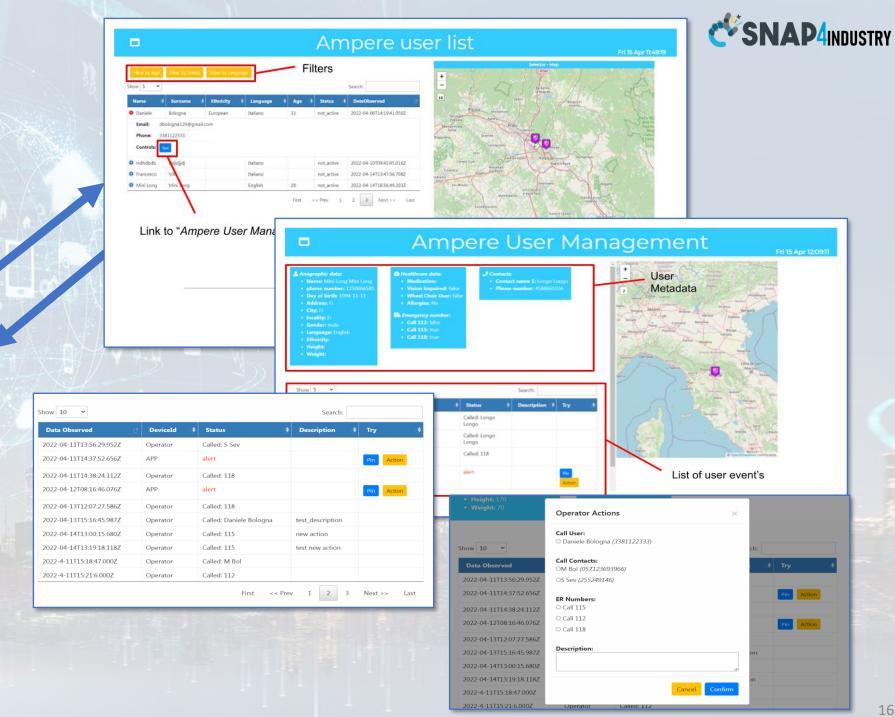






Click on Jewel





### **Smart Waste – Map view**

# Smart Waste Management Thu 5 May 11:14:28 from the dropdown below and press [SURI id] CSNAP4





Search bins on map by filtering per:

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







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











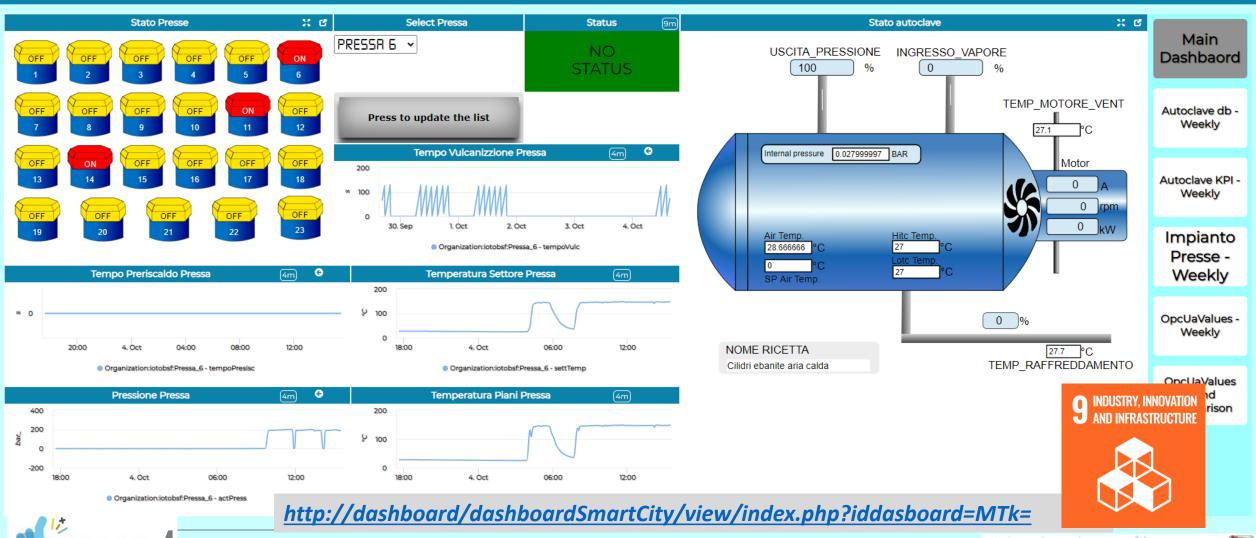


## **Sinottico Impianto**

### Sinottico Impianto Presse - Autoclave



Mon 4 Oct 15:34:59



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TOP

# Data Ingestion and Digital Twin Management





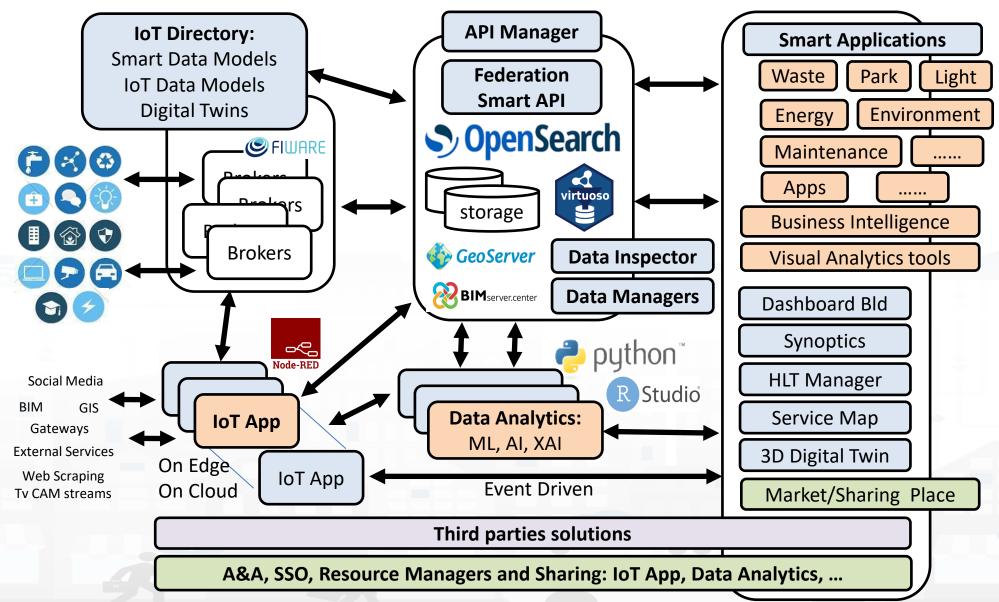


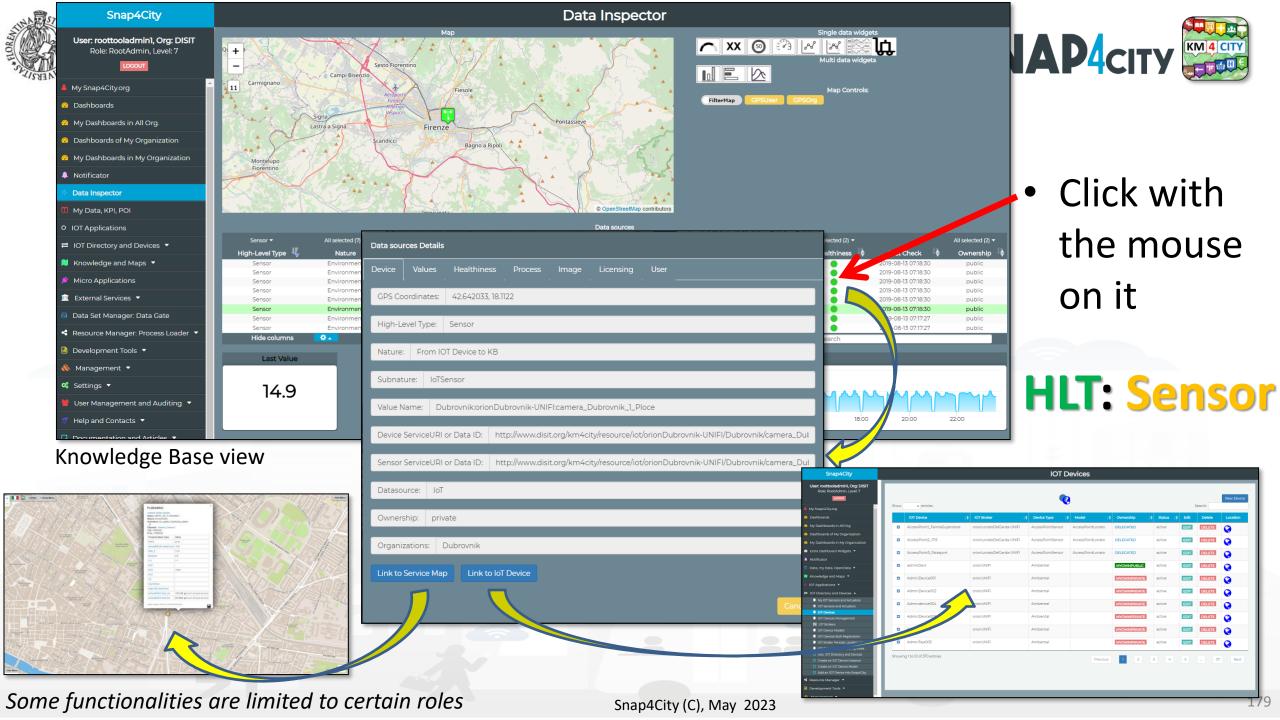


# DISIT DISTRIBUTED SYSTEMS TECHNOLOGIES LAB TECHNOLOGIES LAB TECHNOLOGIES LAB













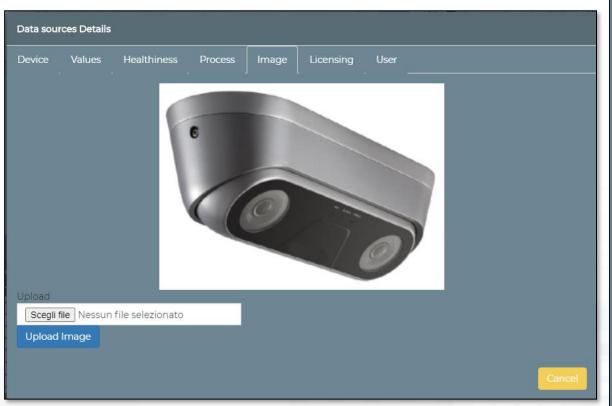








# **Image of the Devices and Licensing**



Some functionalities are limited to certain roles

Data sources Details			,			
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### SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES





# 15MinCityIndex

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

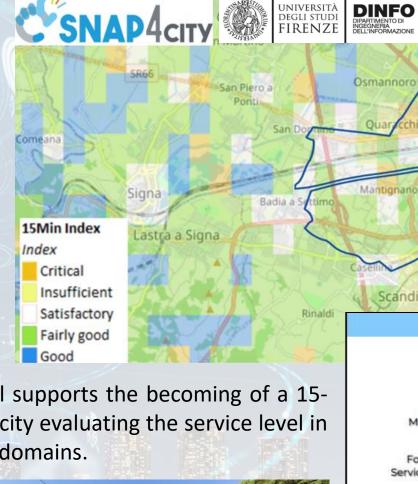
### **Using the Open Data:**

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.

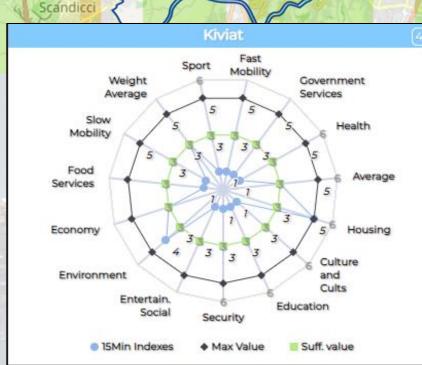


Careggi/Rifredi is a relevant district in Florence because of hosting the main Florence/Tuscany hospitals Careggi and Meyer, but also university headquarters and many other workplaces.



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





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

Snap4City (C), May 2023 182



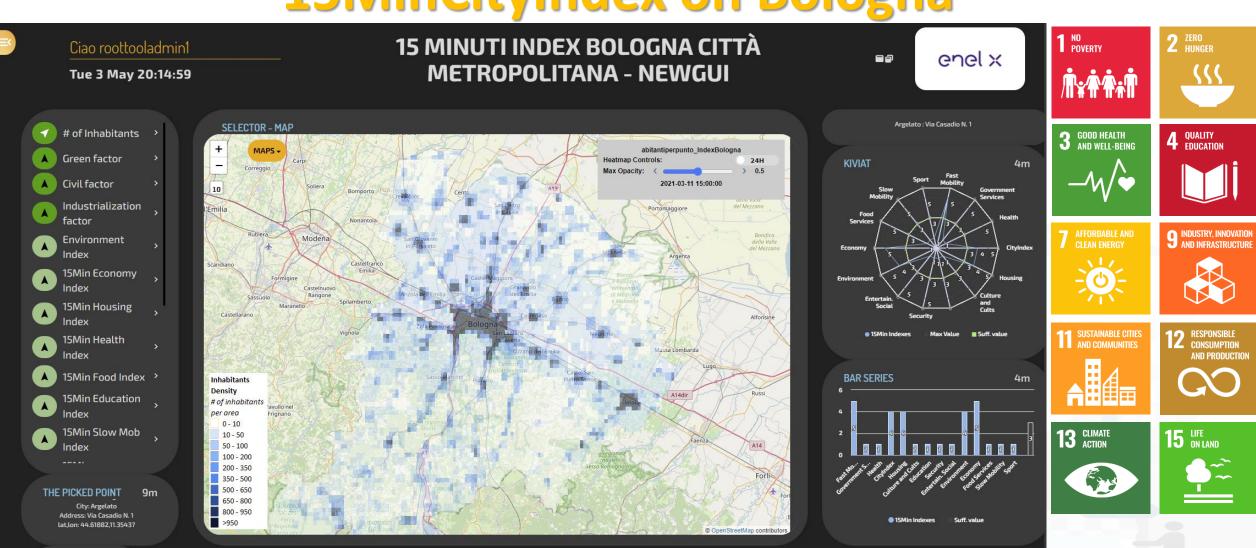






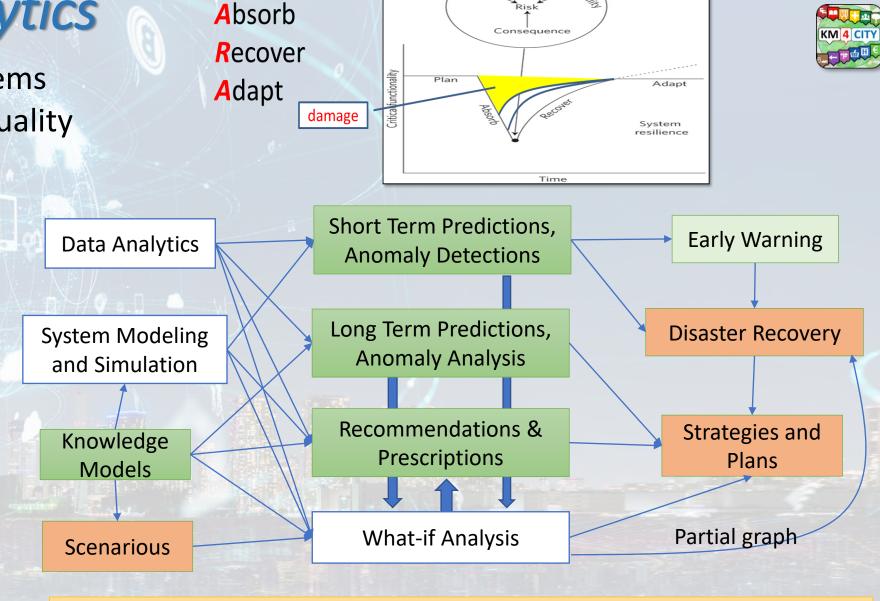


# 15MinCityIndex on Bologna



# **Snap4City Analytics**

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



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

Snap4City (C), May 2023

**P**repare

# What-if Analysis on Pub Transport







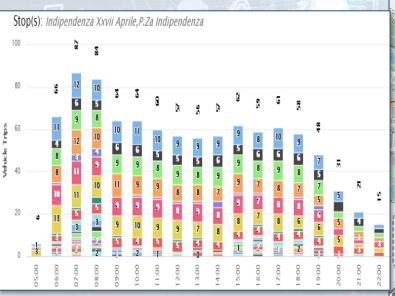




- Definition of scenarious impact on
  - Traffic, Pollutant, parking, public transport, private flows, etc.

KPI analysis

**Public Services** 





Snap4City (C), May 2023 Snap4City (C), May 2022











## **Decision Support Systems, What-if**

### Event planning, via what-if analysis

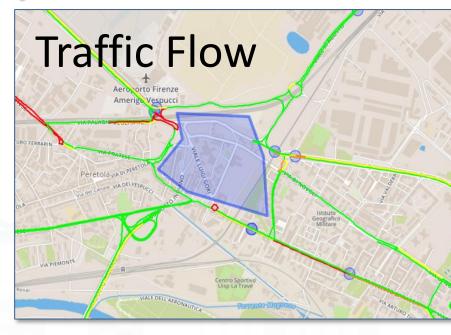
- Change in the graph structure of the city
- Impact on the flow of people and vehicles
- Adaptation: public transport, traffic, pedestrian management, etc.

### Immediate reaction to natural events or not

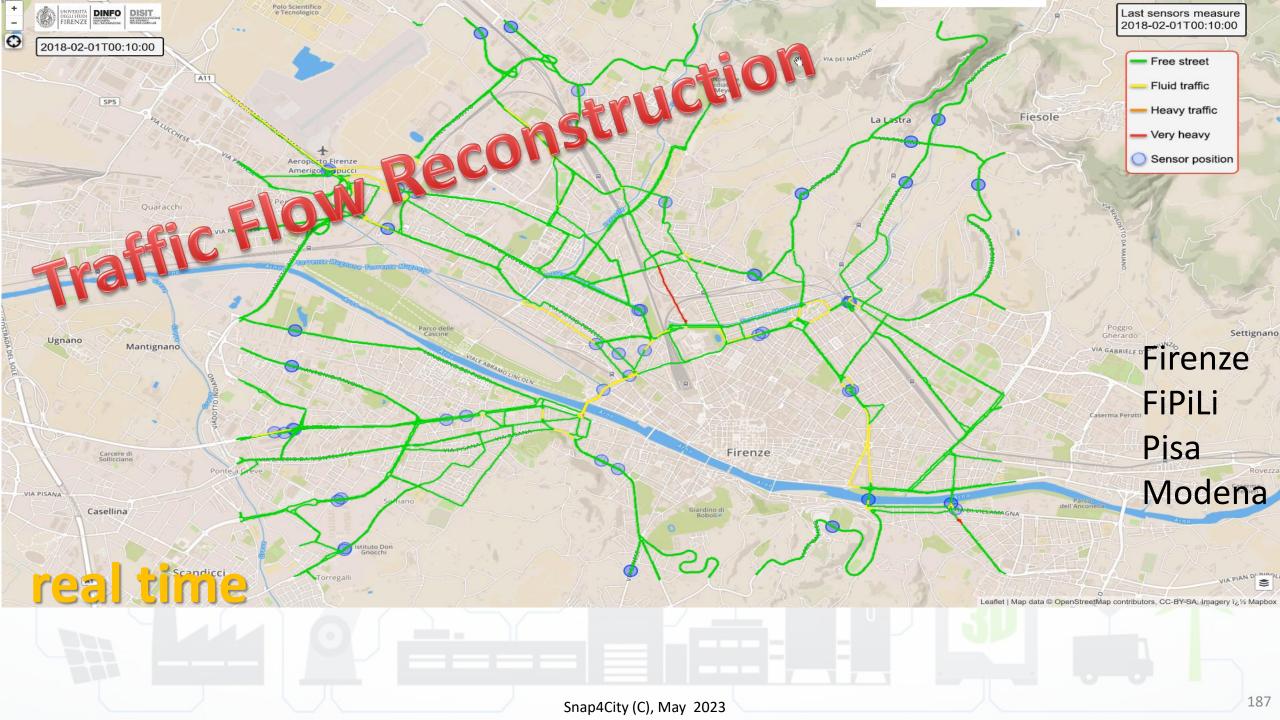
- Everything is ready and updated in real time
- Each view is contextualized in terms of data: descriptive and prescriptive

### Digital Twin

- More detail in the context integrated data
- Greater realism in deductions and representations
- Less fragmentation and non-uniformity in the views to support decisions







SNAD CITY KM 4 CITY Characterizing City Areas

Pirenze Wi-Fi: Access Points Clusters Coverage Map

DISIT - Distributed Systems and Internet Technologies Lab **Predicting City Areas Crowd level** characterizing Users' Behaviors Wi-Fi based APs: APs (saturday): APs (sunday): Prediction resolute









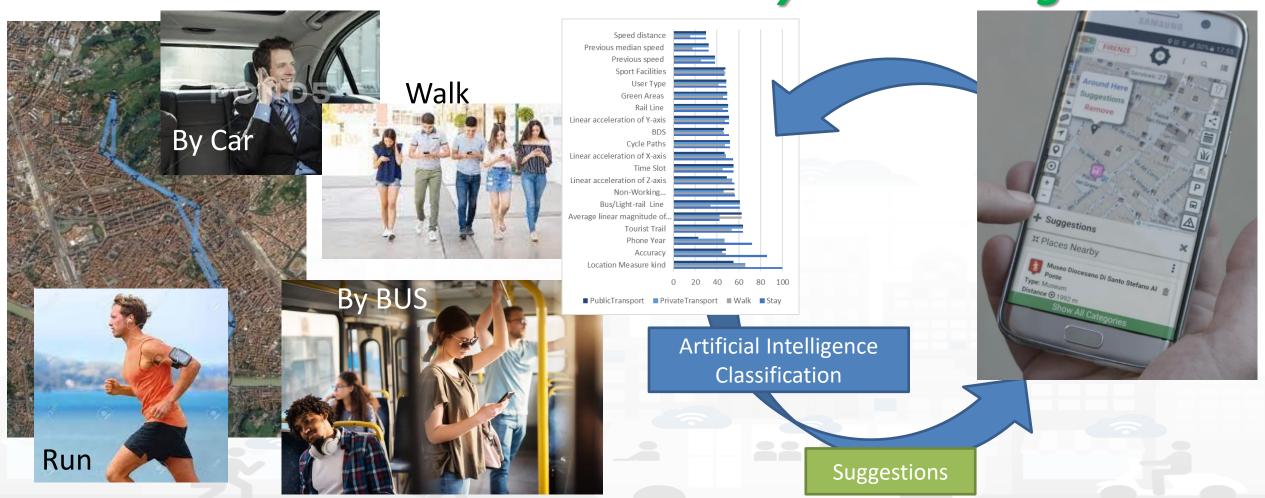








# To propose suggestions and Engage city user we need to know how they are moving



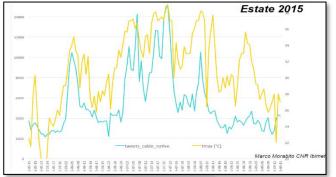


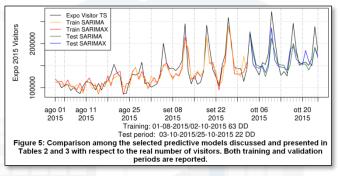


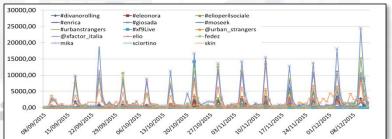


# Prediction/Assessment

- Football game results as related to the volume of Tweets
- Number of votes on political elections, via sentiment analysis, SA
- Size and inception of contagious diseases
- marketability of consumer goods
- public health seasonal flu
- box-office revenues for movies
- places to be visited, most visited
- number of people in locations like airports
- audience of TV programmes, political TV shows
- weather forecast information
- Appreciation of services















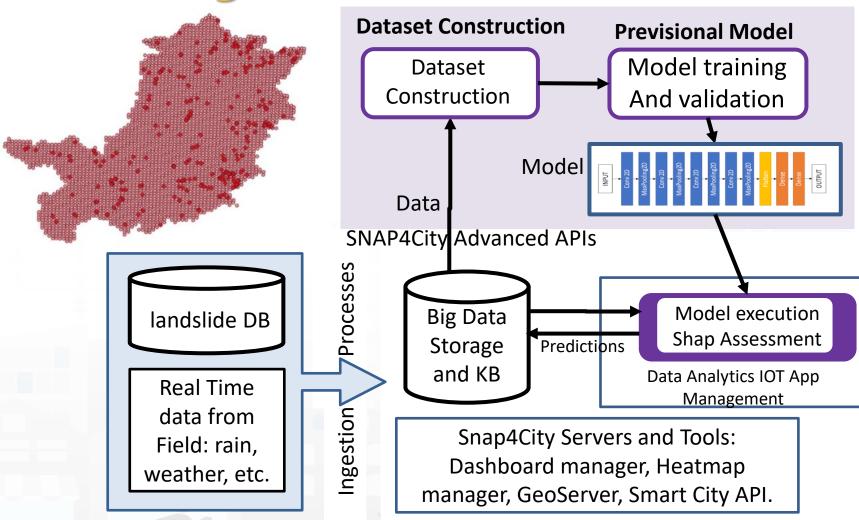


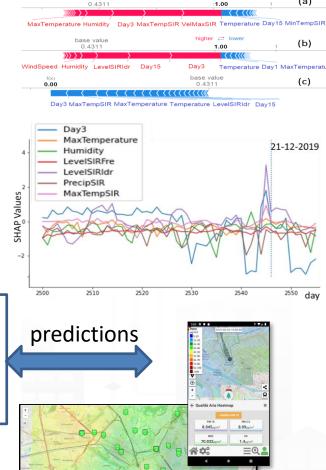






# **Predicting Land slides**





Dashboards and

Mobile Apps

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.

# Data Analytics on Snap4City platform

tools

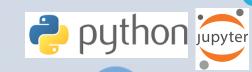
other

and

API

City

Smart



Studio











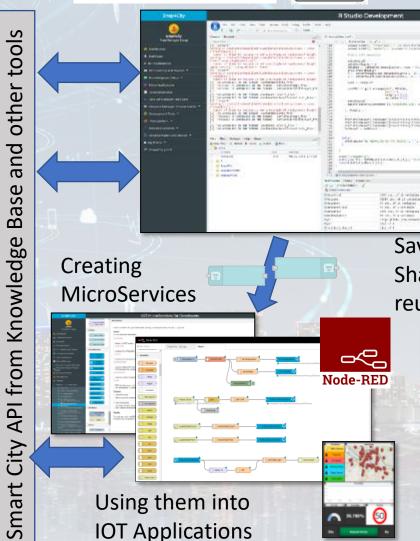


**Ontology Schema** 

LOG.disit.org



**Big Data Store Facility** 



TensorFlow

OUDA.

Saving / **Sharing** reusing



Resource Manager



### SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES











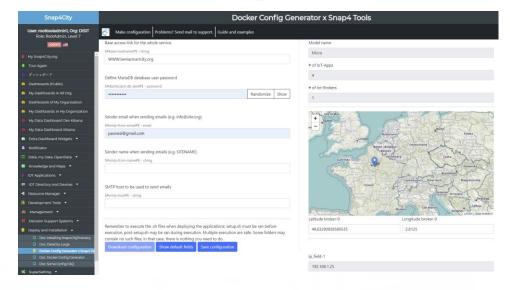


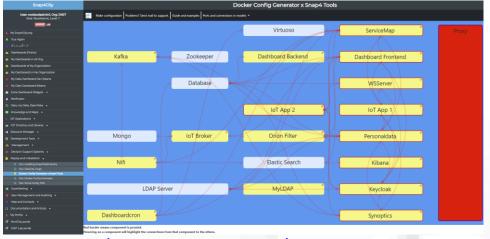


## Installations, different models a TOOL to get them

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





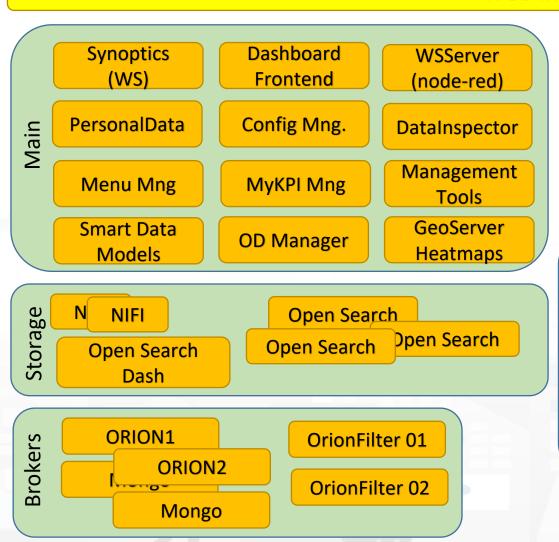






### **DataCitySmall** X-2-2

### Web Interfaces



ServiceMap1 **LDAP** GeoServer Virtuoso1 **MyLDAP Heatmap Mng** ServiceMap2 **Resource Mng** KeyCloak Virtuoso2 Auth.Author **Drupal CMS** Knowledge base **OpenMaint** IOT App 01 **Report Generator** IOT App 02 1 or more **Data Analytics** VM IOT App X Analytic 01 1 or more Analytic 02 Containers Analytic N Computing Computing







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

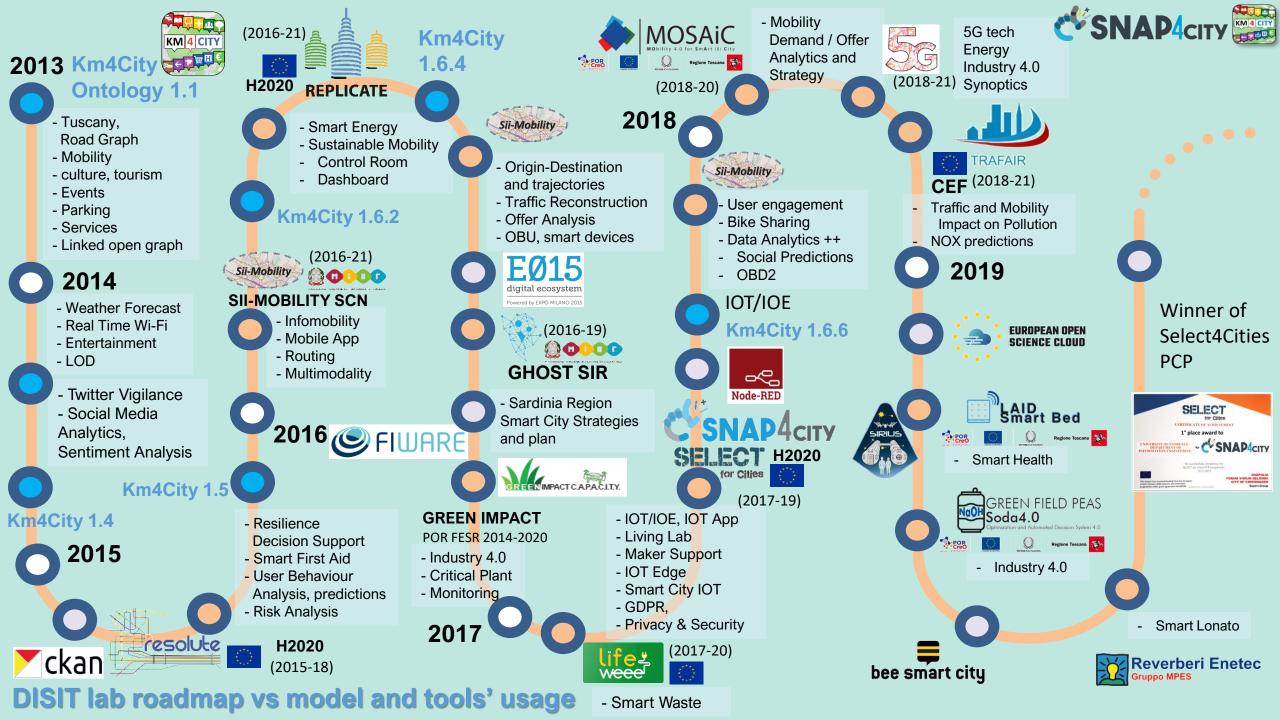
- <u>Scenario: SnapBot: Real Time Smart City services via Telegram</u>
- <u>Scenario: Copernicus Satellite Data</u>
- Scenario: SmartBed, Materasso Intelligente
- MicroServices Suite for Smart City Applications
- Scenario: MODBUS for Snap4Industry Snap4City Applications
- Scenario: MOBIMART Interreg: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

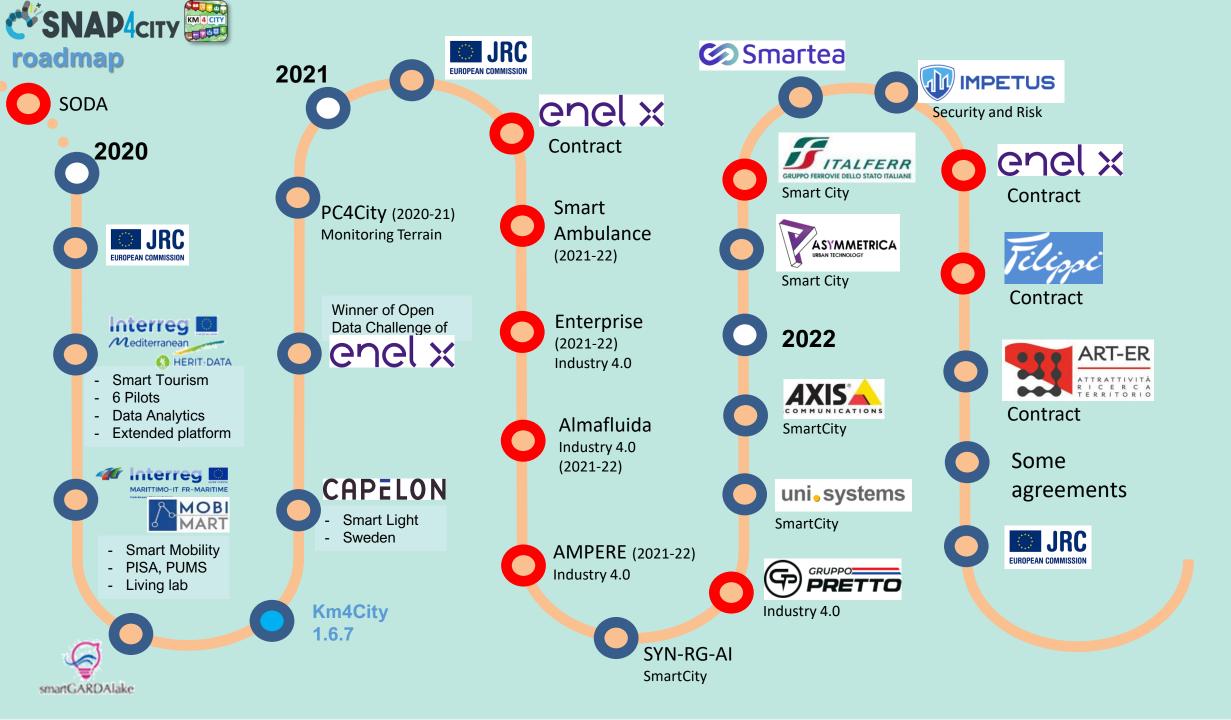




# Scenarious

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





TOP









### CONTACT

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