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

SNAP4CITY KM4CITY

Snap4City: Smart Asset Management and Decision Support Decision Support

https://www.Snap4City.org

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

Sliding video at the stand
https://youtu.be/B01uuyh3RYA

A LOOM WITH A VIEW Annual Conference 2023
Weaving the digital future of communities, cities and regions

Organised by: comune di PRATO; MAJOR CITIES OF EUROPE IT USERS GROUP
With the support of: Confservizi CISPEL TOSCANA; REGIONE TOSCANA

Prato, October 25 to 27, 2023

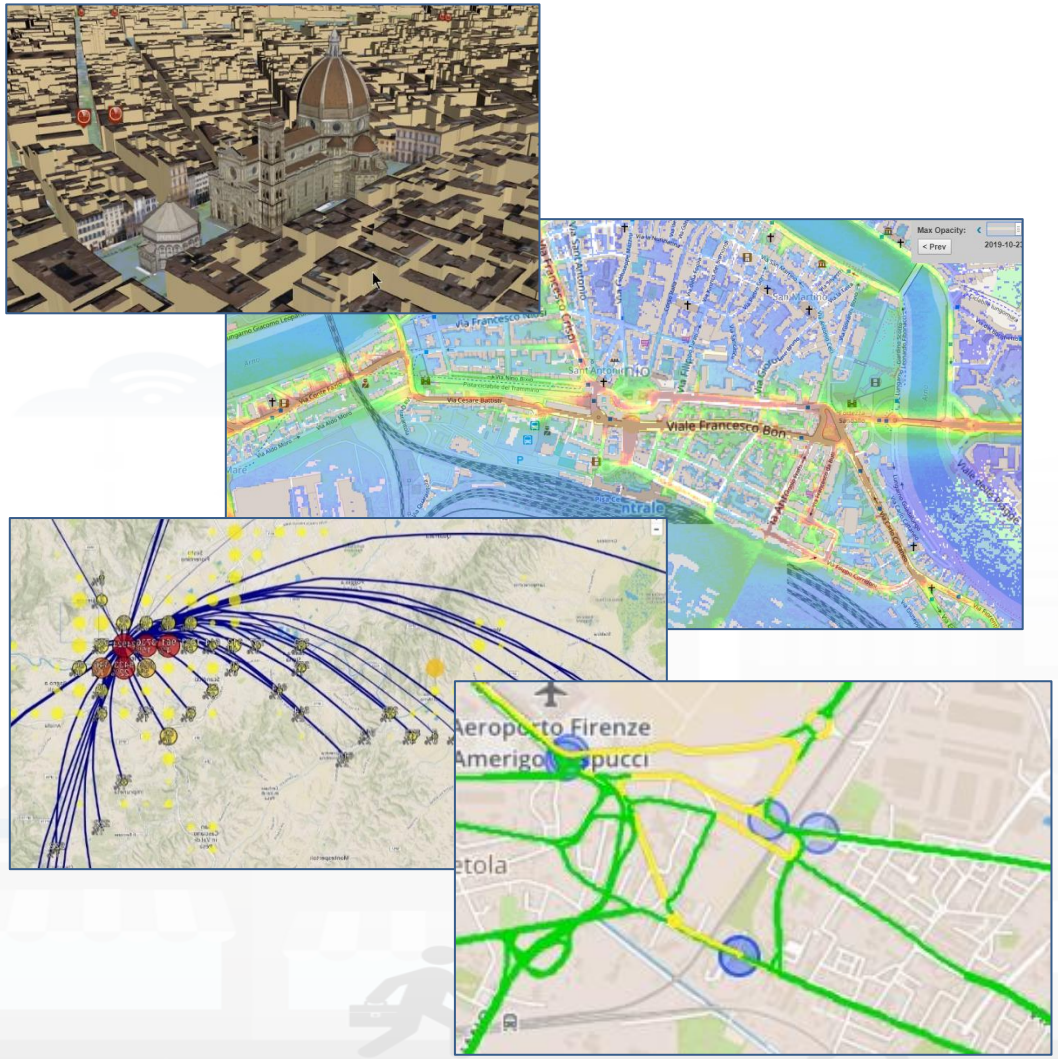
UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

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

SNAP4CITY KM4CITY

Smart City Digital Twin



Digital representation of the city with…

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

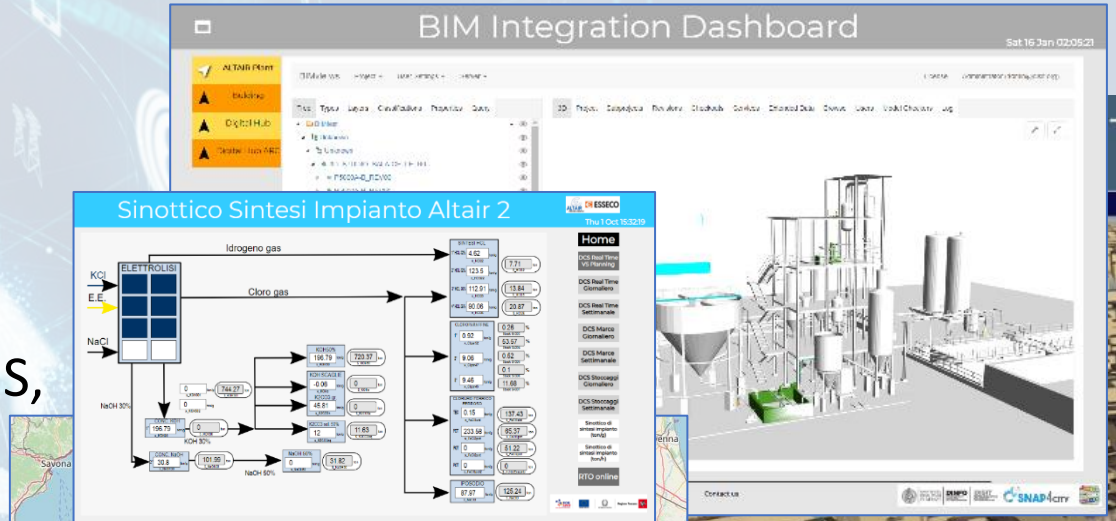
Complex and heterogeneous information, interoperability

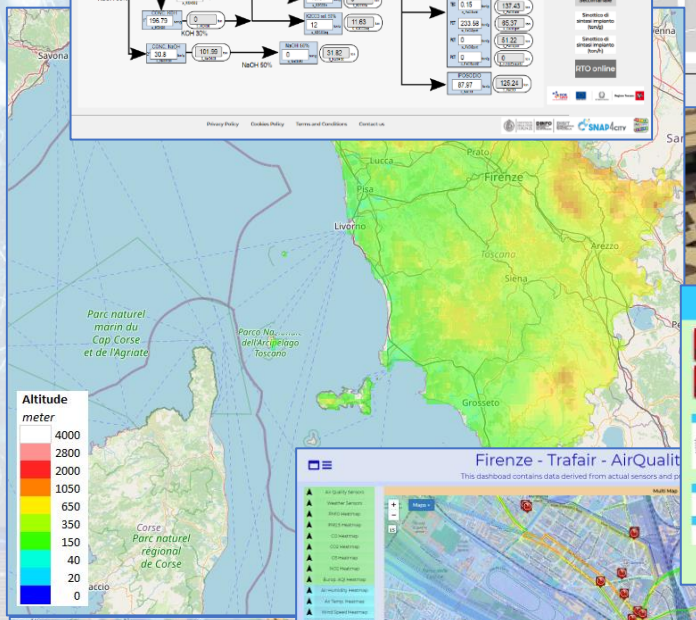
- GIS, ITS, AVM, IoT, BIM, CKAN, etc.
- Satellite services
- MaaS, lastmile delivery HUBs
- etc.

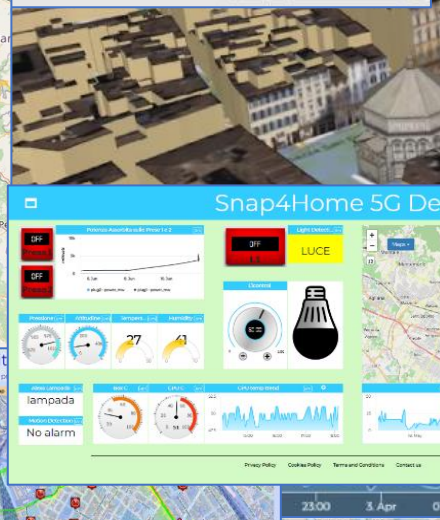
High Level Types

Snap4City (C), MajorCities Prato, Oct. 2023

- 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.







Available AI/XAI Solutions on Snap4City

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

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

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

- ***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.

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

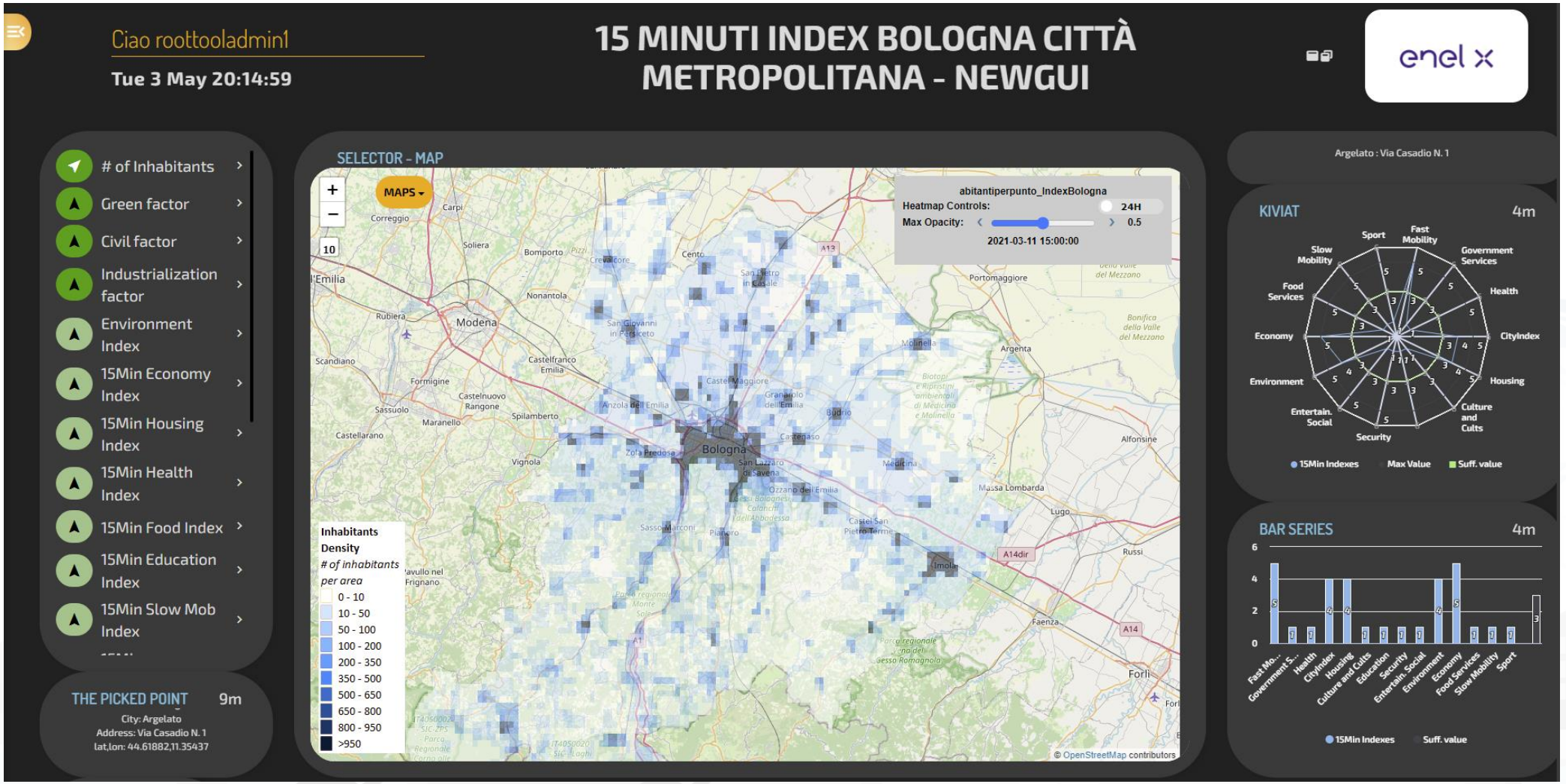
- Smart City infrastructure: monitoring and resilience, long terms predictions
- Effective and Low cost smart solutions
- What-if analysis, Simulations
- Origin Destination matrices computation

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

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

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

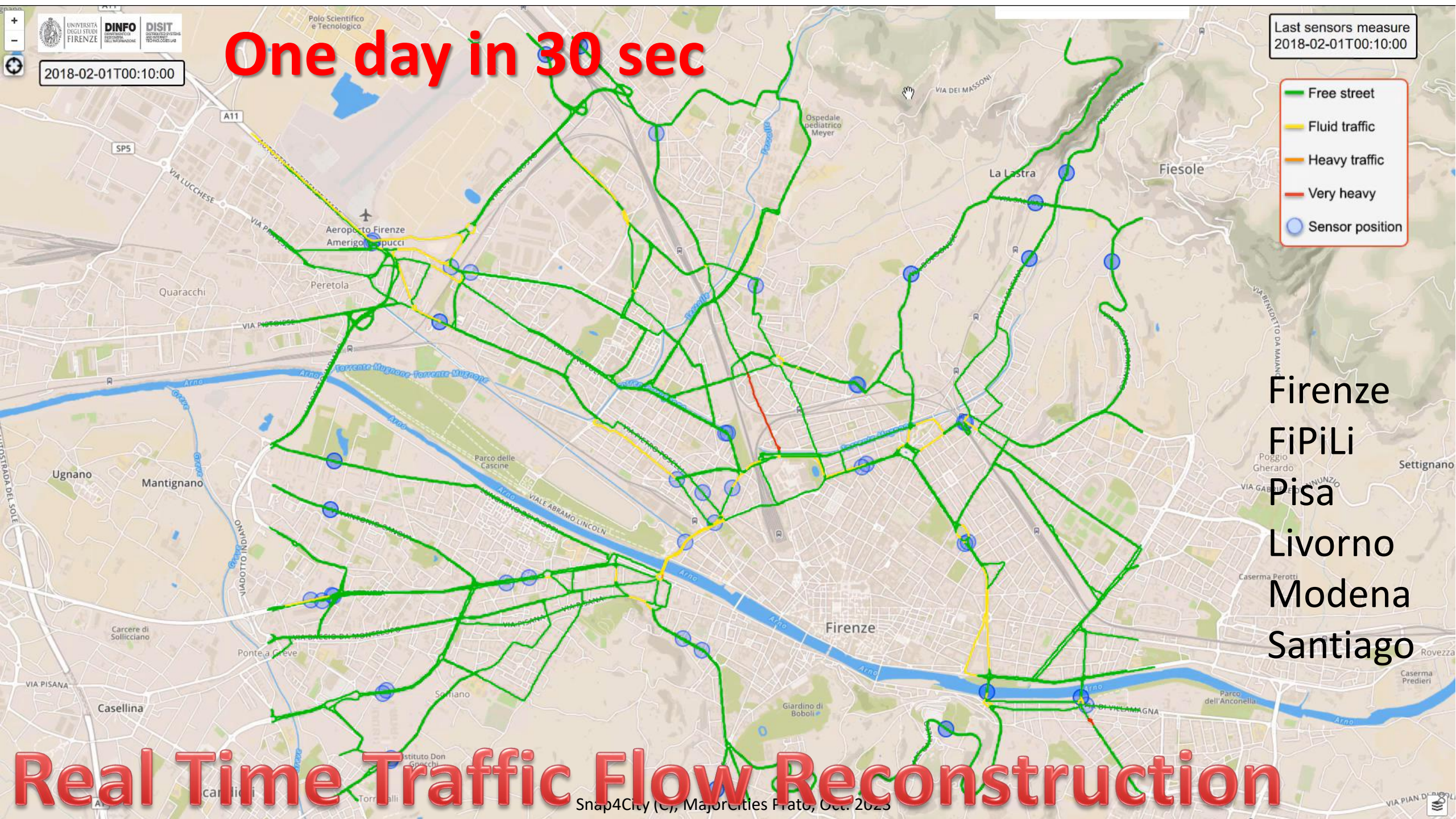
15MinCityIndex on Bologna



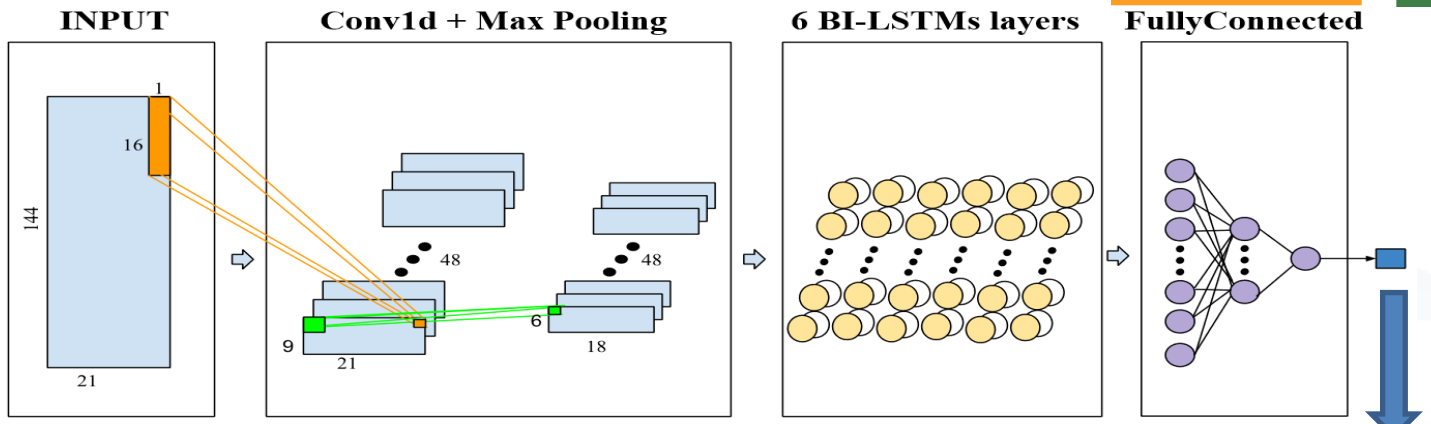
https://www.snap4city.org/dashboardSmartCity/view/Baloon-Dark.php?iddasboard=MzQxMg==

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


One day in 30 sec
2018-02-01T00:10:00
Last sensors measure
2018-02-01T00:10:00
Free street
Fluid traffic
Heavy traffic
Very heavy
Sensor position
Firenze
FiPiLi
Pisa
Livorno
Modena
Santiago
Real Time Traffic Flow Reconstruction

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

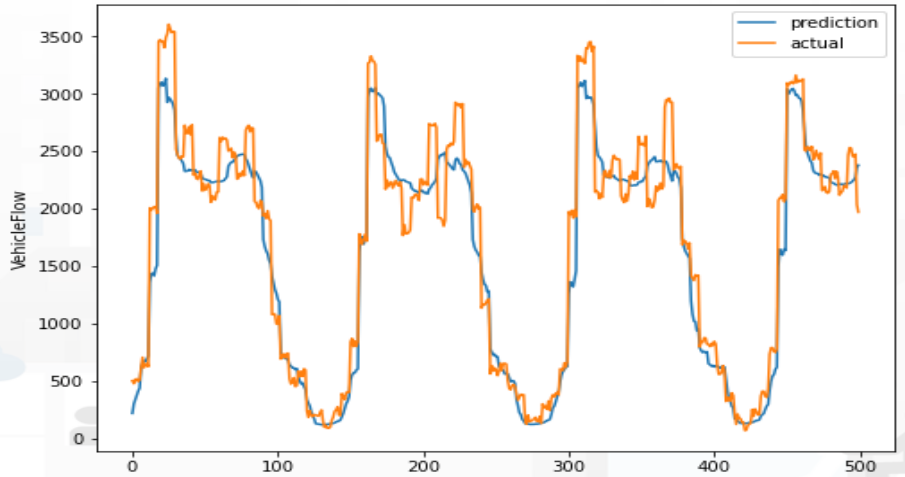


Urban data:

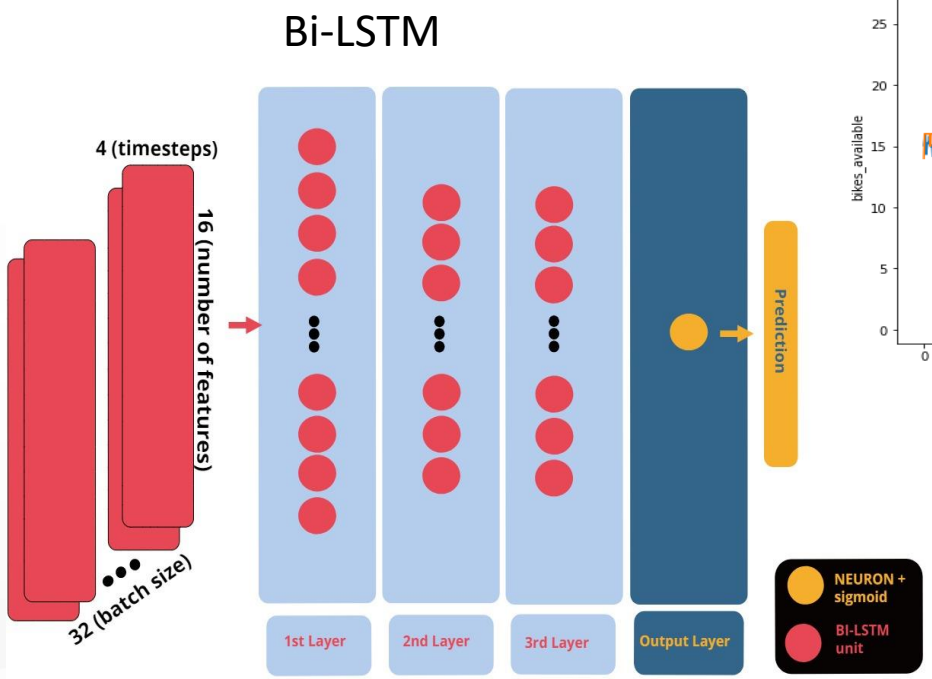
- Date-time
- Traffic
- Temporal
- Seasonality
- Pollution
- Weather

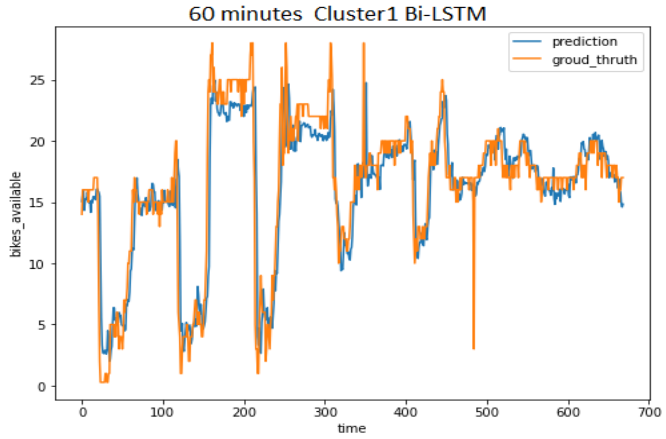
RF
XGBOOST
DNN
LSTM
BI-LSTM
Autoencoder BI-LSTM
Attention CONV-LSTM
CONV-BI-LSTM

CONV-BI-LSTM



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





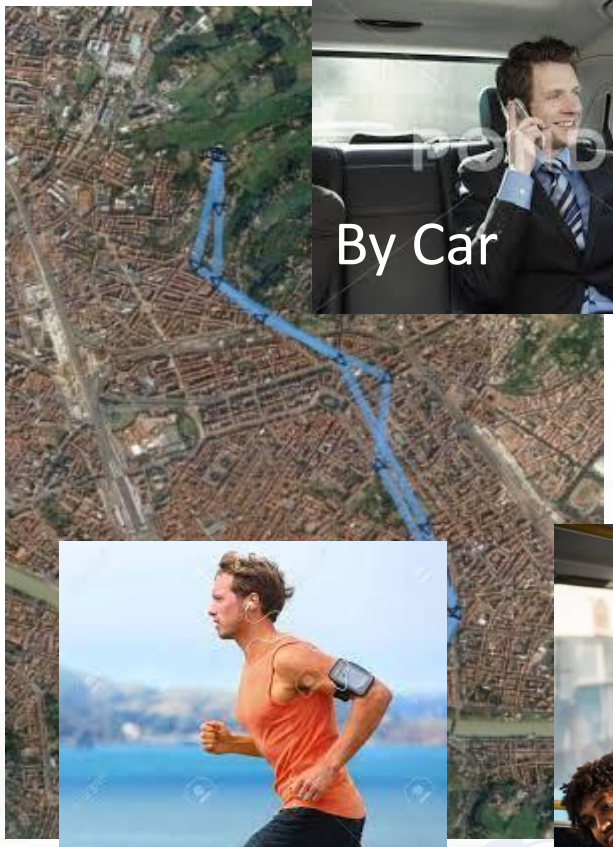
E. Collini, P. Nesi and G. Pantaleo, "Deep Learning for Short-Term Prediction of Available Bikes on Bike-Sharing Stations," in *IEEE Access*, vol. 9, pp. 124337-124347, 2021, doi: 10.1109/ACCESS.2021.3110794.
https://ieeexplore.ieee.org/abstract/document/9530580

City Users and Tourism

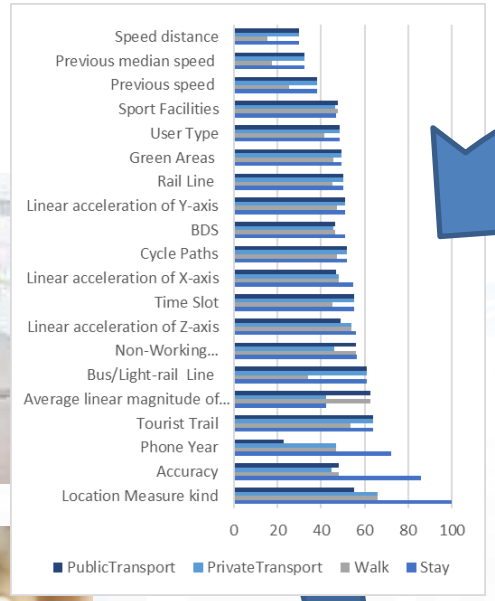
- People detection and classification: persona, carts, bikes, etc. (ML, DL)
- people counting and tracking (via thermal cameras, ML, DL)
- People prediction: wifi, mobile, etc.
- People counting via head counting (via thermal cameras, ML, DL)
- People flows prediction and reconstruction, (ML, DL)
  - 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)

To propose suggestions and Engage city user

we need to know how they are moving

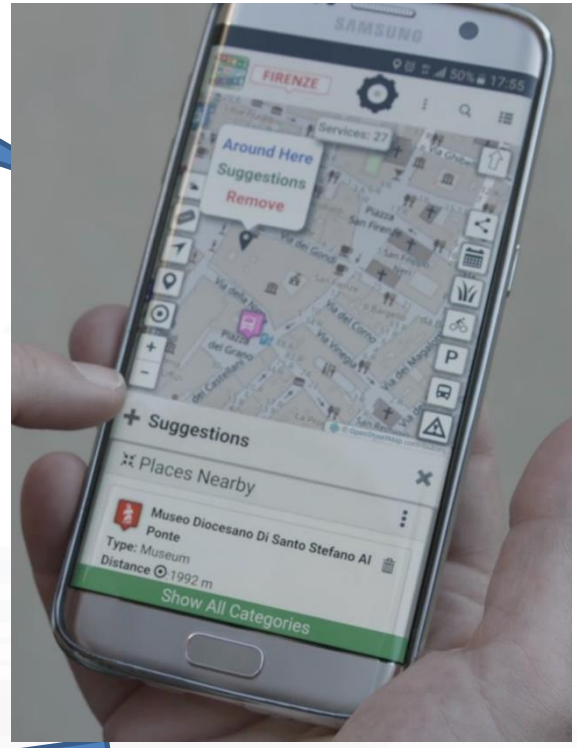


Walk

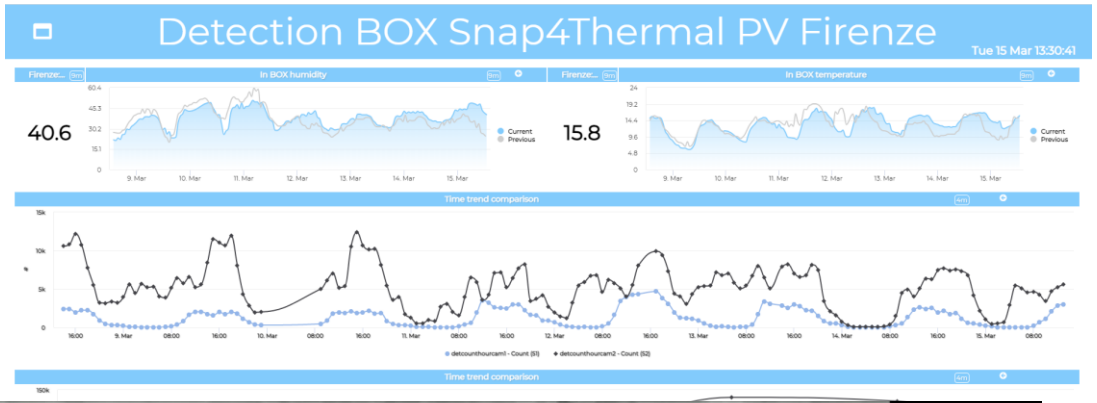


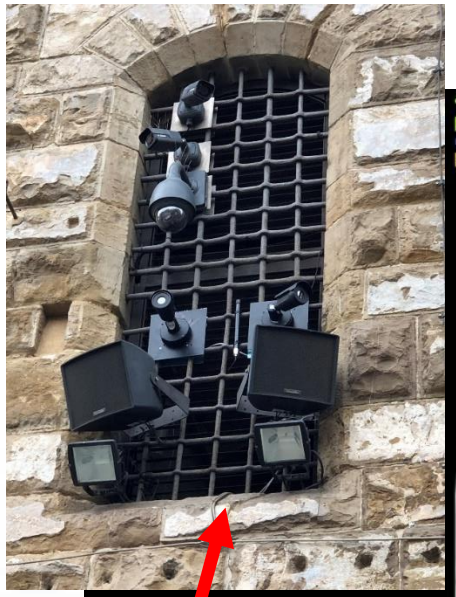
Artificial Intelligence Classification

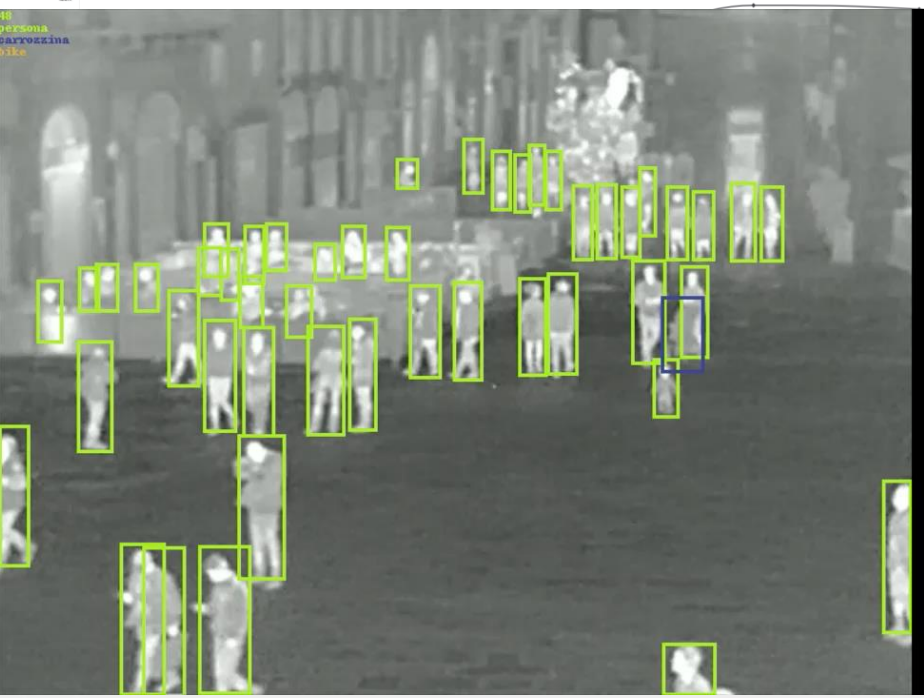
Suggestions

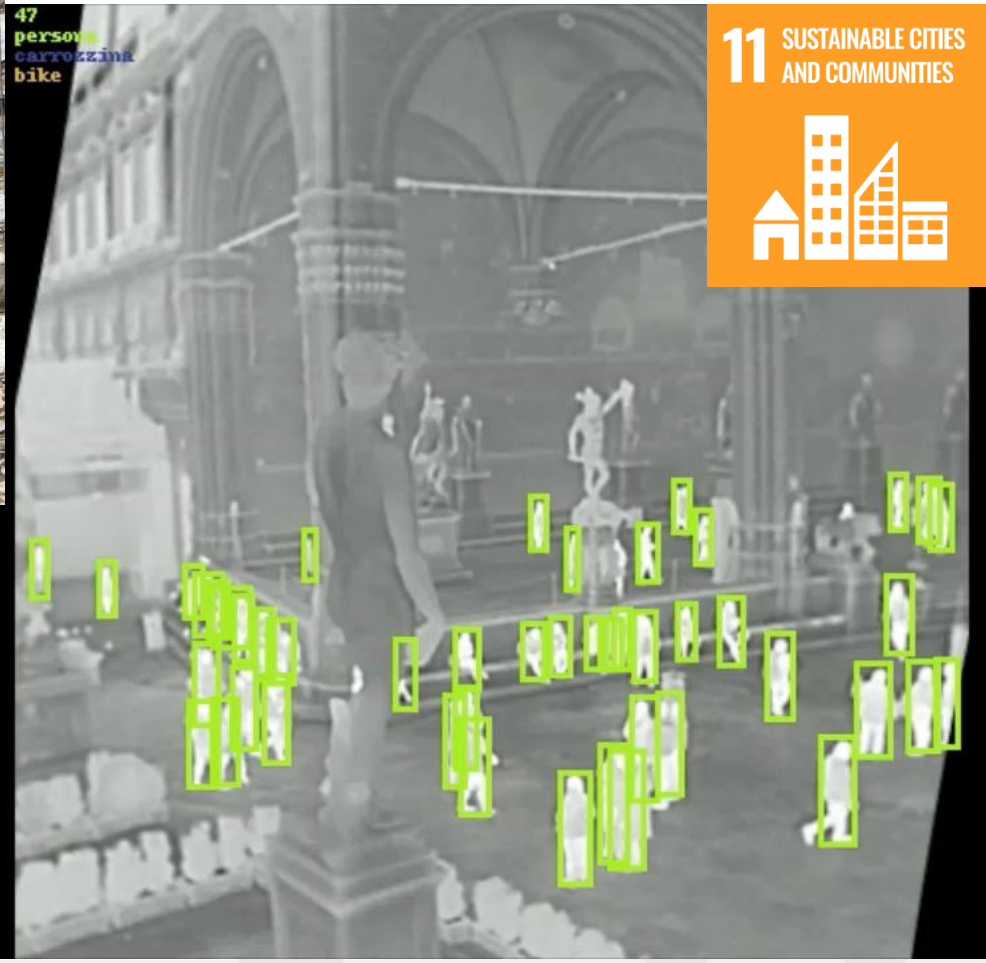


A view and data from the Thermal Camera



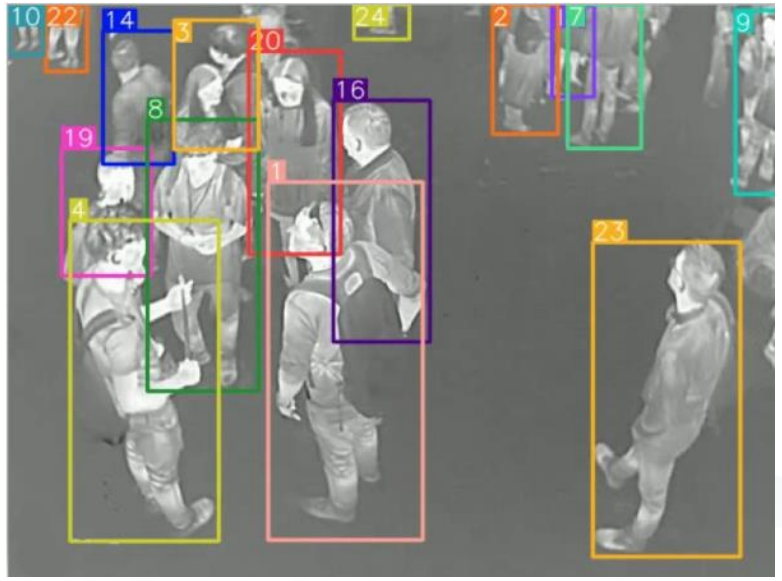


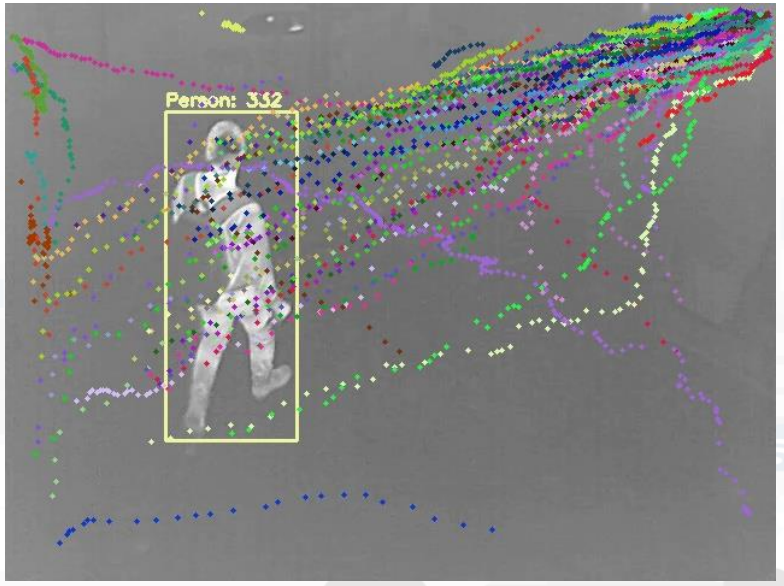




11 SUSTAINABLE CITIES AND COMMUNITIES

People Counting and Tracking





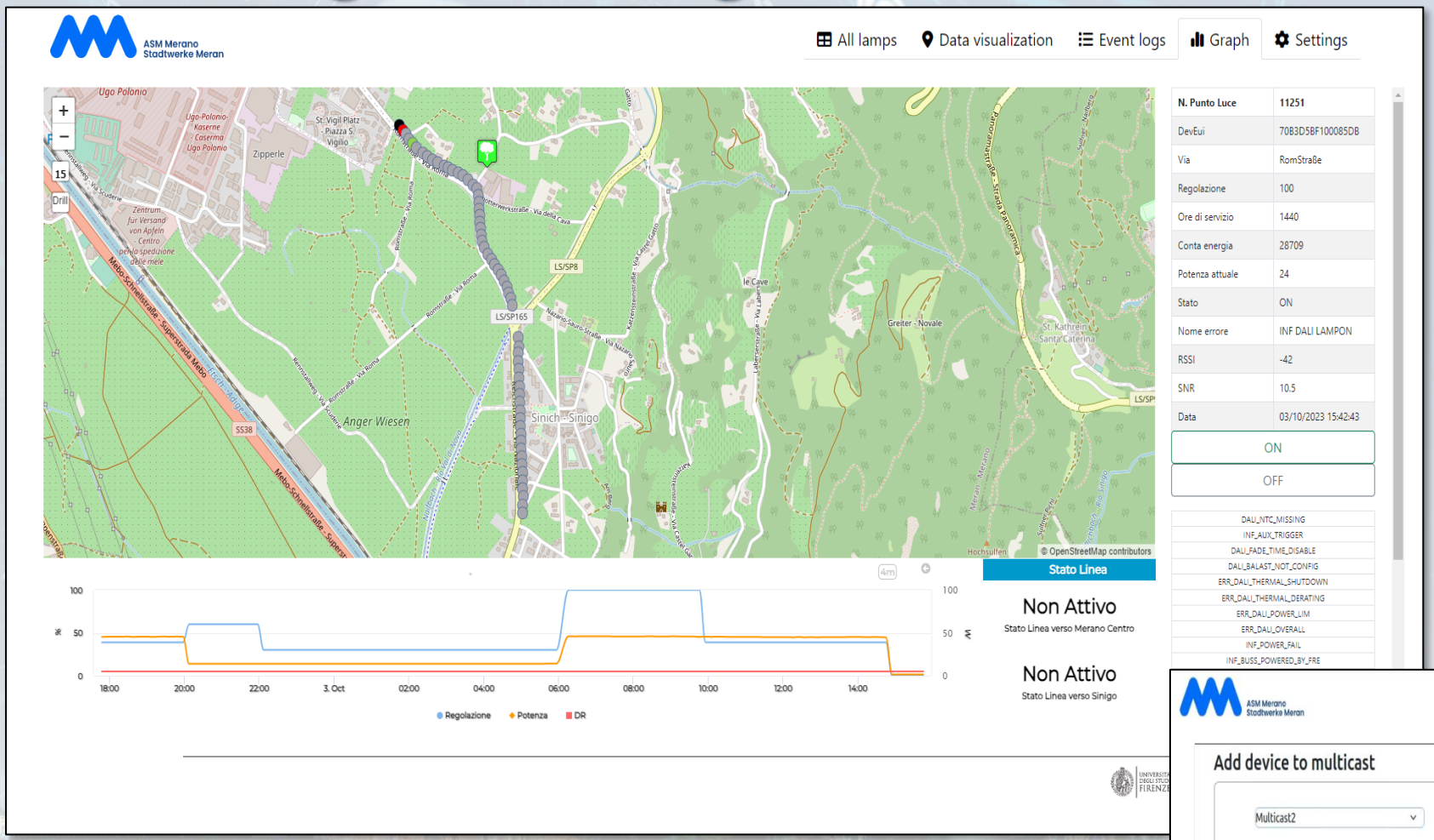
11 SUSTAINABLE CITIES AND COMMUNITIES

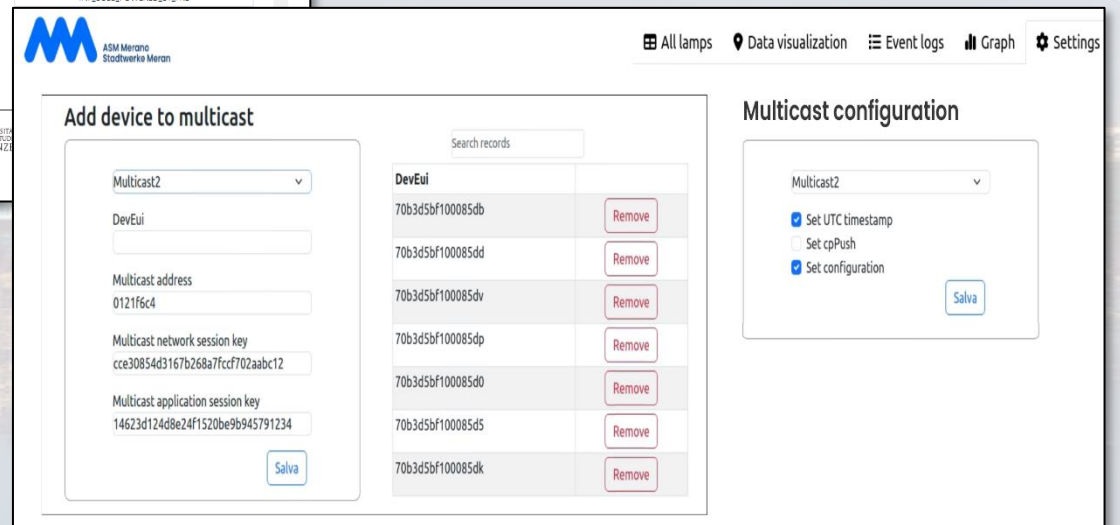
3X

Energy

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

Smart Light Management in Merano





- Managing DALI 2 devices FlashNet via LoraWan
- programming SmartLight via UniCast and MultiCast
- Controlling devices
- Automation of Smart Light on the basis of Traffic Flow

https://www.snap4city.org/968

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

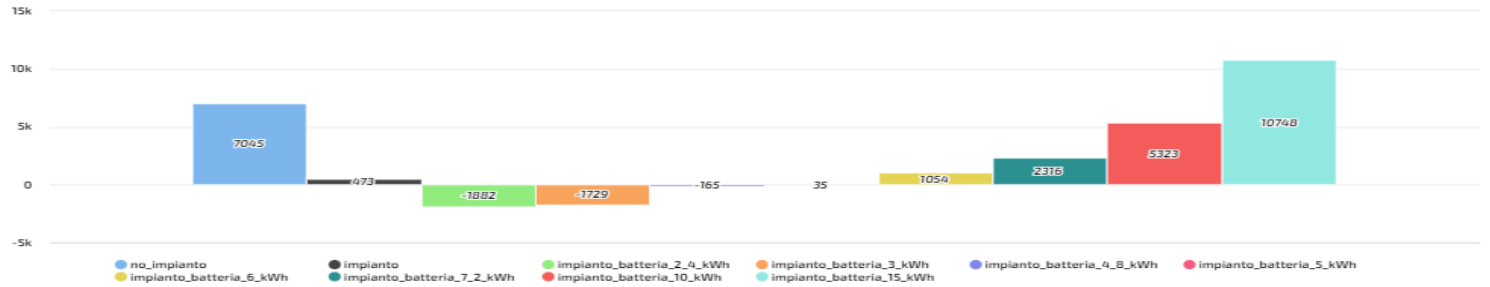
Ciao roottooladmin1

Tue 4 Apr 13:15:34

SIMULATORE IMPIANTO FOTOVOLTAICO

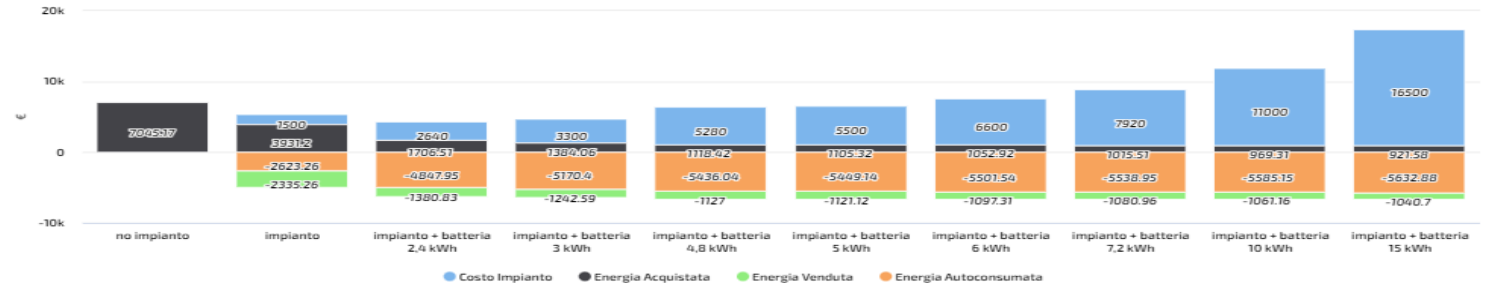
COSTO COMPLESSIVO NEGLI ANNI DI INVESTIMENTO

599m



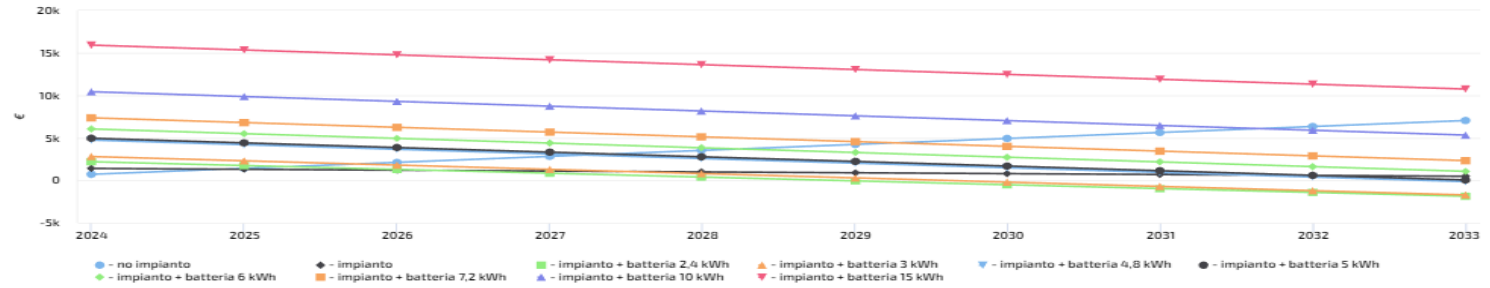
COSTO COMPLESSIVO NEGLI ANNI DI INVESTIMENTO PARTIZIONATO

599m



ANDAMENTO PREZZO CUMULATIVO ANNUO

599m



Manuale Utente

English Version

PARAMETRI DELL'IMPIANTO

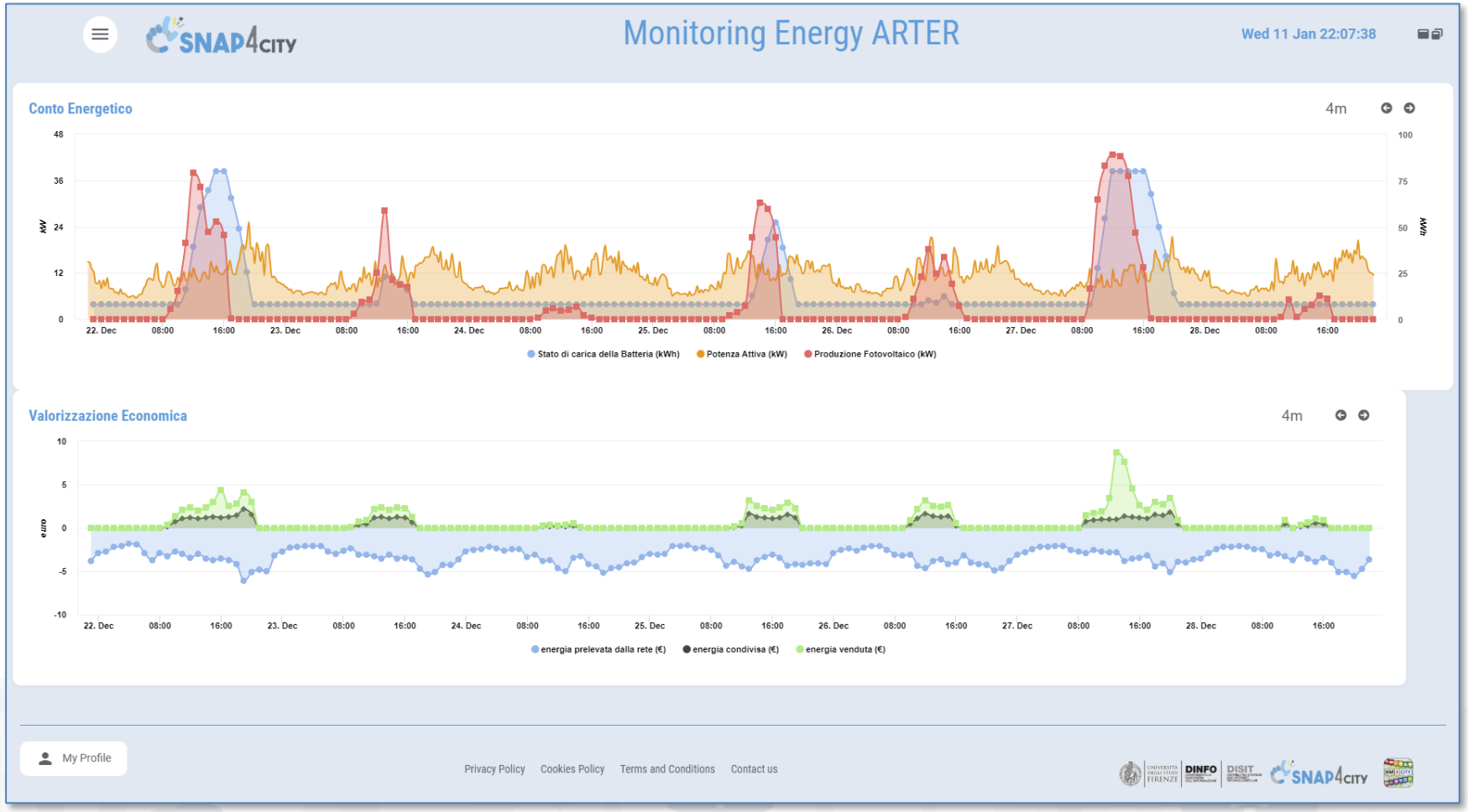
Ti consigliamo un impianto con batteria da 2,4 kWh

Gruppo di Consumo Annuale	2000 kWh
Prezzo Energia Vendita (€/kWh)	0,15
Prezzo Energia Acquisto (€/kWh)	0,35
Anni di Investimento	10
Mese da simulare	Gennaio

Invia

7 AFFORDABLE AND CLEAN ENERGY

- **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



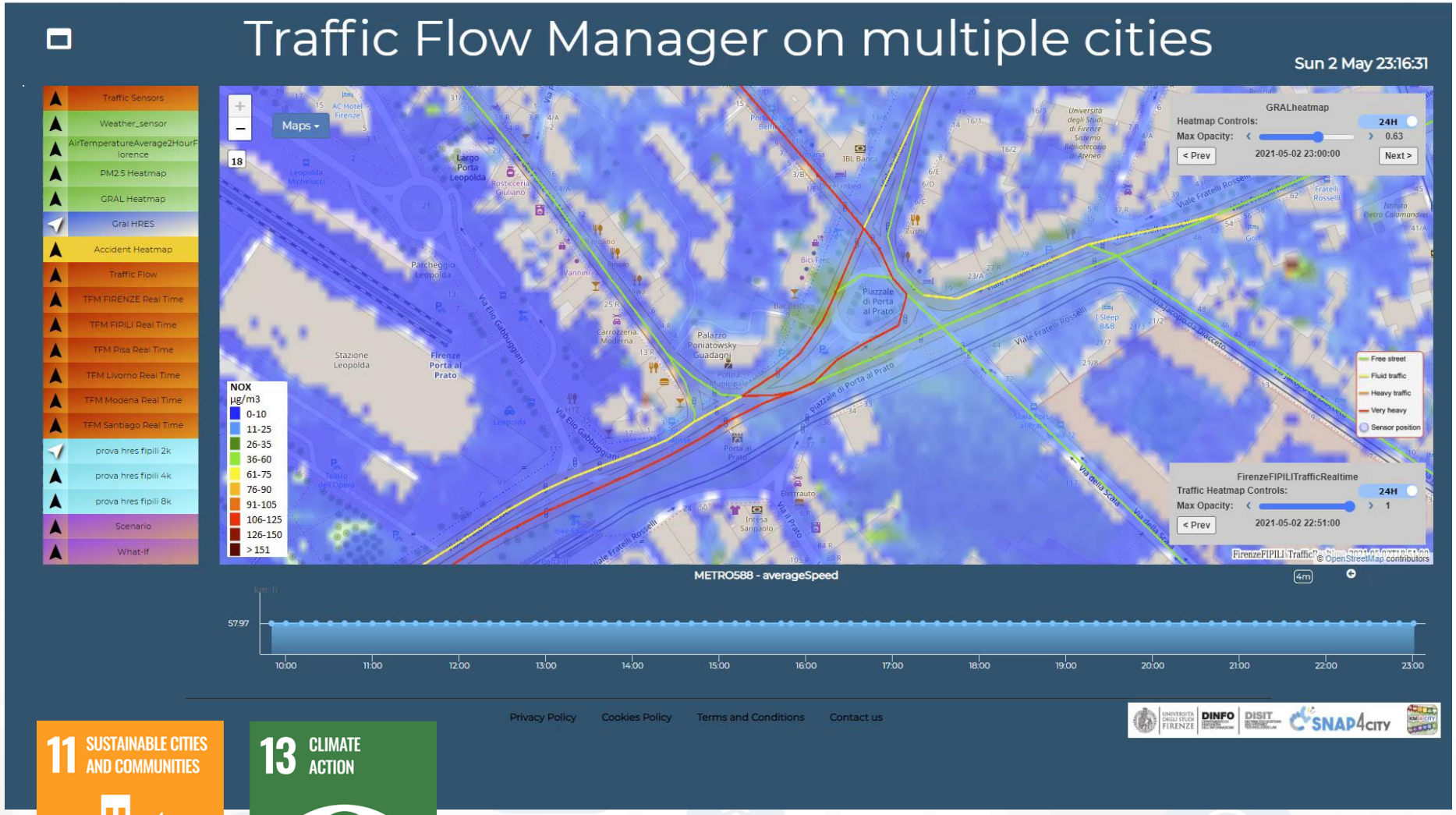
https://www.selfuser.it

Environment and Weather

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

Environment

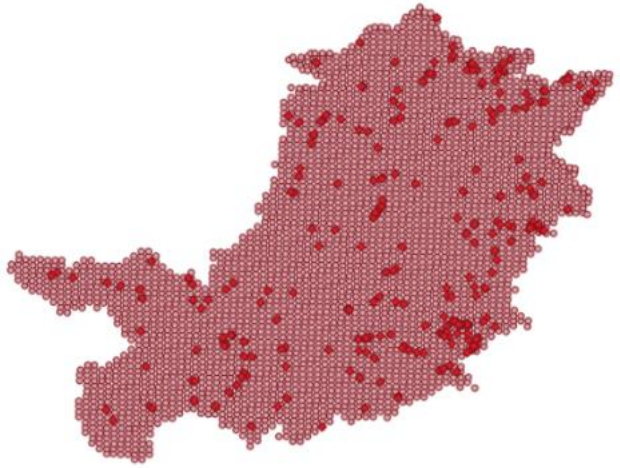
- **Prediction**
  - **NOX Pollutant** diffusion on the basis of Traffic Flow (prediction), weather and 3D structure
  - **NO2 progressive average** (Long term)
- **Project:**
  - **Trafair** CEF EC
  - Mixed solutions of Fluidinamics modeling and AI



11 SUSTAINABLE CITIES AND COMMUNITIES

13 CLIMATE ACTION

Predicting Land slides



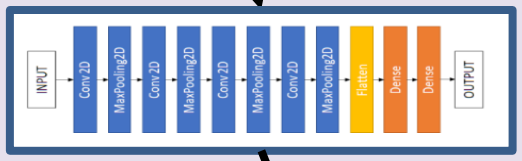
Dataset Construction

Previsional Model

Dataset Construction

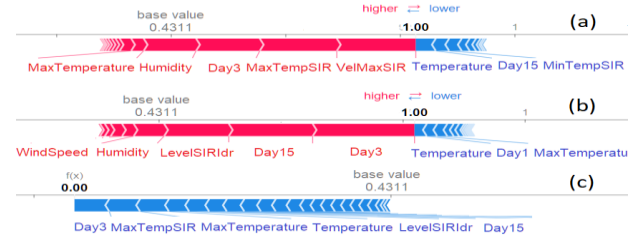
Model training And validation

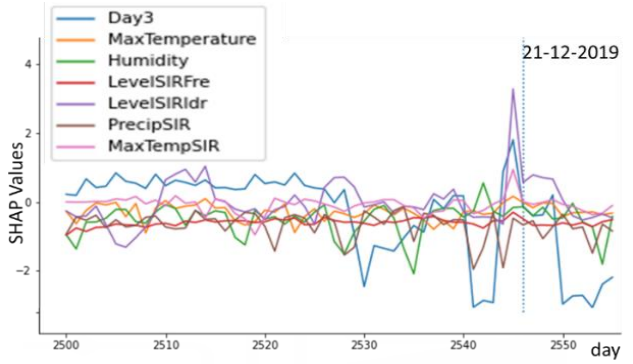
Model



Data

SNAP4City Advanced APIs





landslide DB

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

Processes

Ingestion

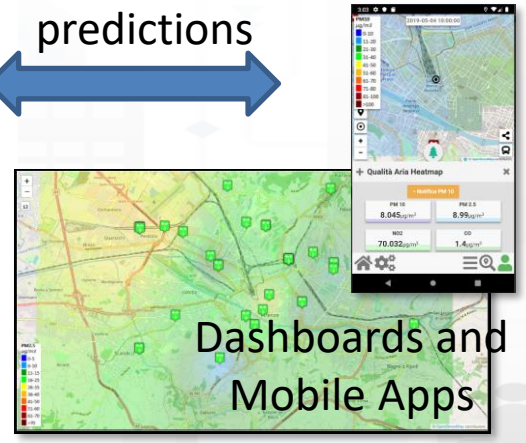
Big Data Storage and KB

Predictions

Model execution Shap Assessment

Data Analytics IOT App Management

predictions

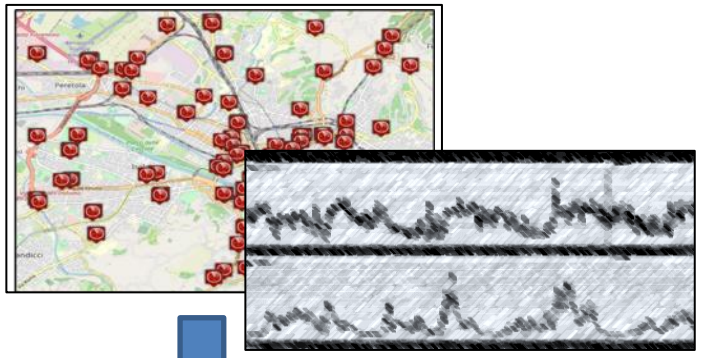


Snap4City Servers and Tools: Dashboard manager, Heatmap manager, GeoServer, Smart City API.

15 LIFE ON LAND

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

Estimating City Local CO2 from Traffic Flow Data



Computing Traffic Flow into CO2 sensor area

Traffic Flow data

- Traffic Flow is one the main source of CO2
- **Dense estimation of CO2 into the city** is very useful to know to target EC's KPIs

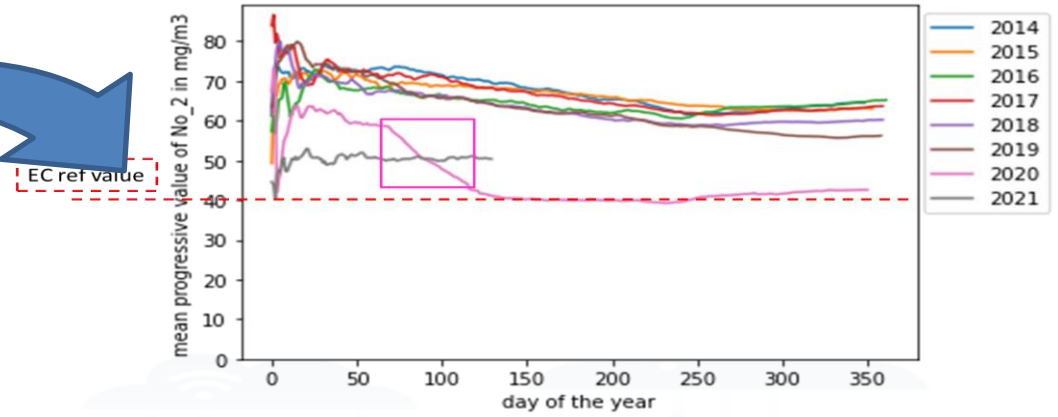
Computing CO2 on the basis of traffic flow data

Detailed CO2 estimation

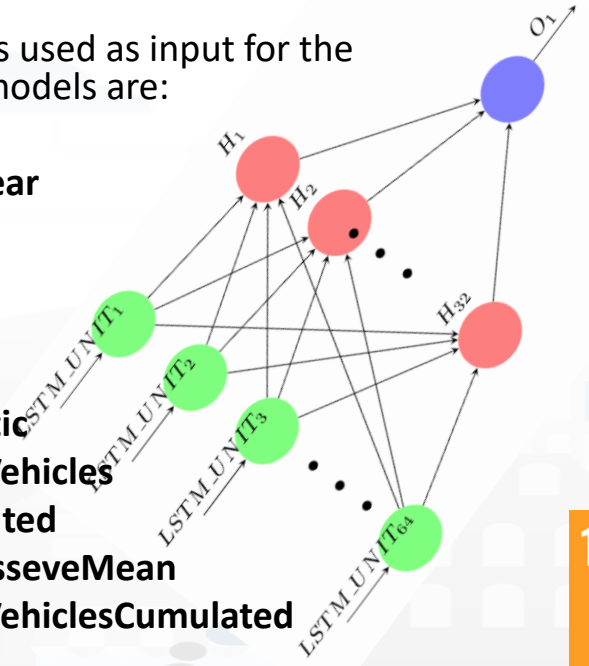
S. Bilotta, P. Nesi, "Estimating CO2 Emissions from IoT Traffic Flow Sensors and Reconstruction", Sensors, MDPI, 2022. https://www.mdpi.com/1424-8220/22/9/3382/

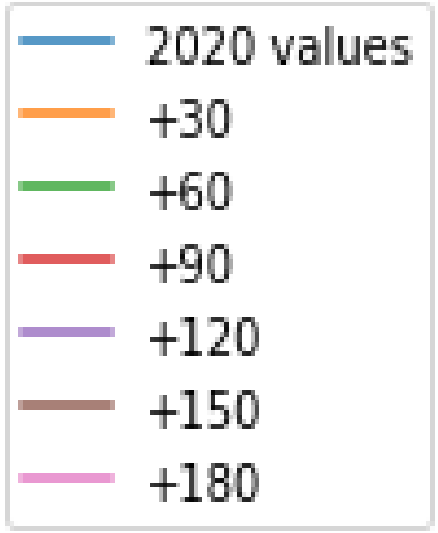
Predicting EC's KPI on NO2 months in advance

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



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





	Air Quality Directive			WHO guidelines	
Pollutant	Averaging period	Objective and legal nature and concentration	Comments	Concentration	Comments
$PM_{2.5}$	One day			25 µg/m³ (*)	99th percentile (3 days/year)
$PM_{2.5}$	Calendar year	Target value, 25 µg/m³	The target value has become a limit value since 1 January 2015	10 µg/m³	
PM_{10}	One day	Limit value, 50 µg/m³	Not to be exceeded on more than 35 days per year.	50 µg/m³ (*)	99th percentile (3 days/year)
PM_{10}	Calendar year	Limit value, 40 µg/m³ (*)		20 µg/m³	
O_3	Maximum daily 8-hour mean	Target value, 120 µg/m³	Not to be exceeded on more than 25 days per year, averaged over three years	100 µg/m³	
NO_2	One hour	Limit value, 200 µg/m³ (*)	Not to be exceeded more than 18 times a calendar year	200 µg/m³ (*)	
NO_2	Calendar year	Limit value, 40 µg/m³		40 µg/m³	

SNAP4CITY

www.snap4city.org
www.snap4solutions.org

www.km4city.org

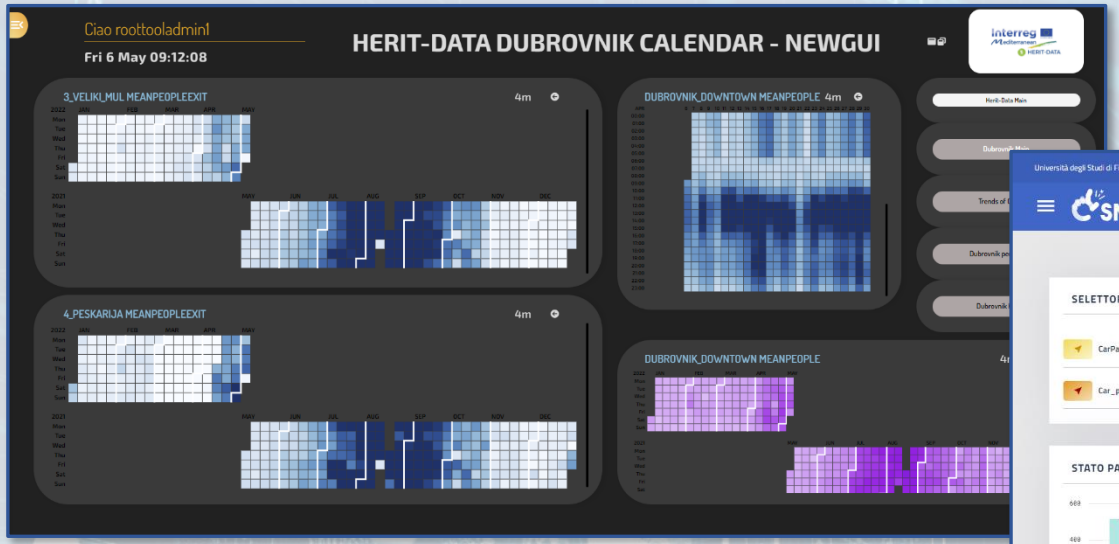
#snap4city
#km4city
#disitlab
@snap4city

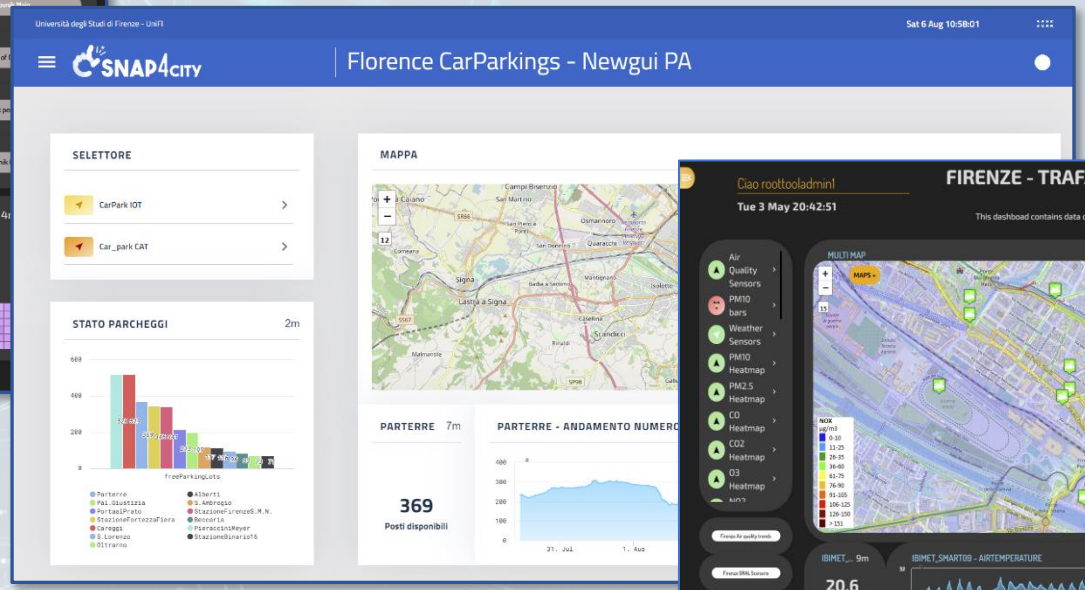
0 1 0 0 1 0 0 1 1 0 1 1
0 1 1 1 0 1 0 1 0 0 1 0

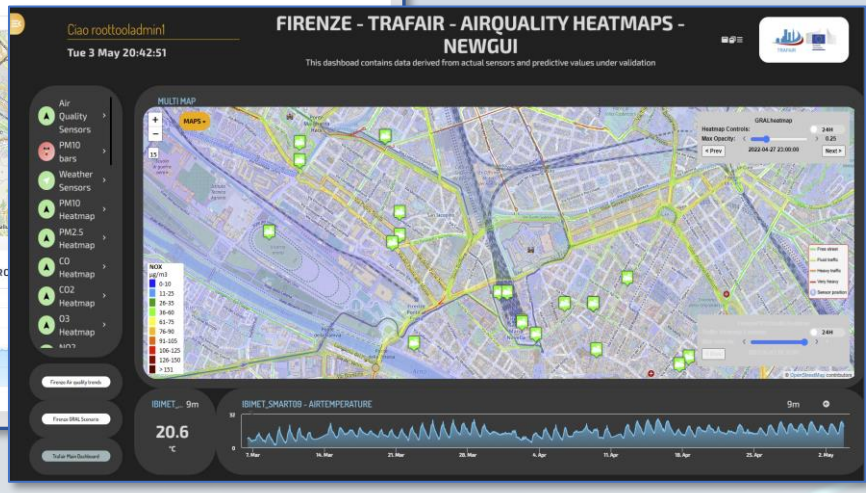
DIGITAL TWIN SOLUTIONS TO SETUP SUSTAINABLE DECISON SUPPORT SYSTEMS AND BUSINESS INTELLIGENCE

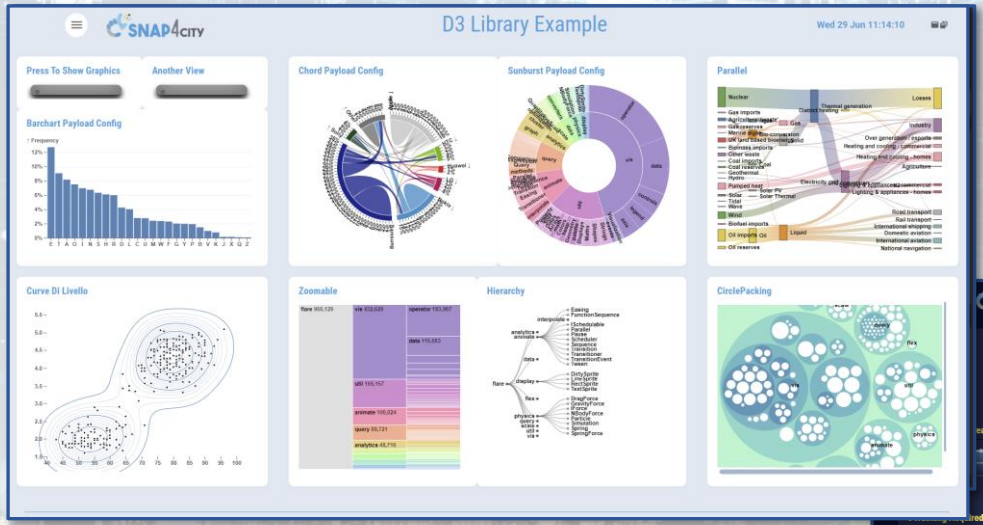
UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

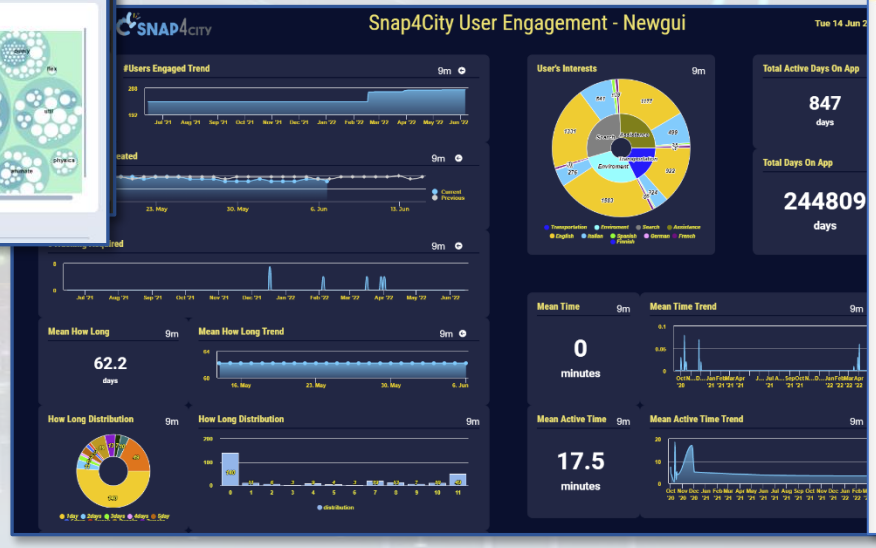
Different Themes

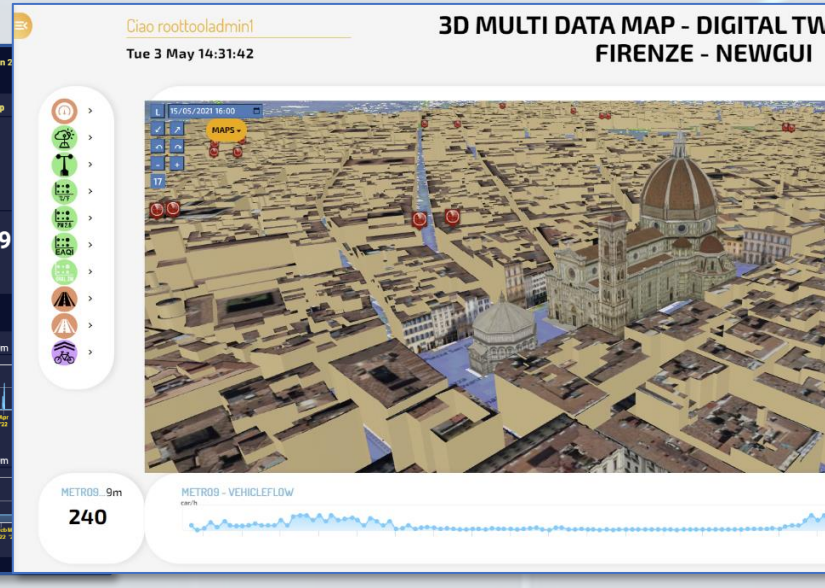








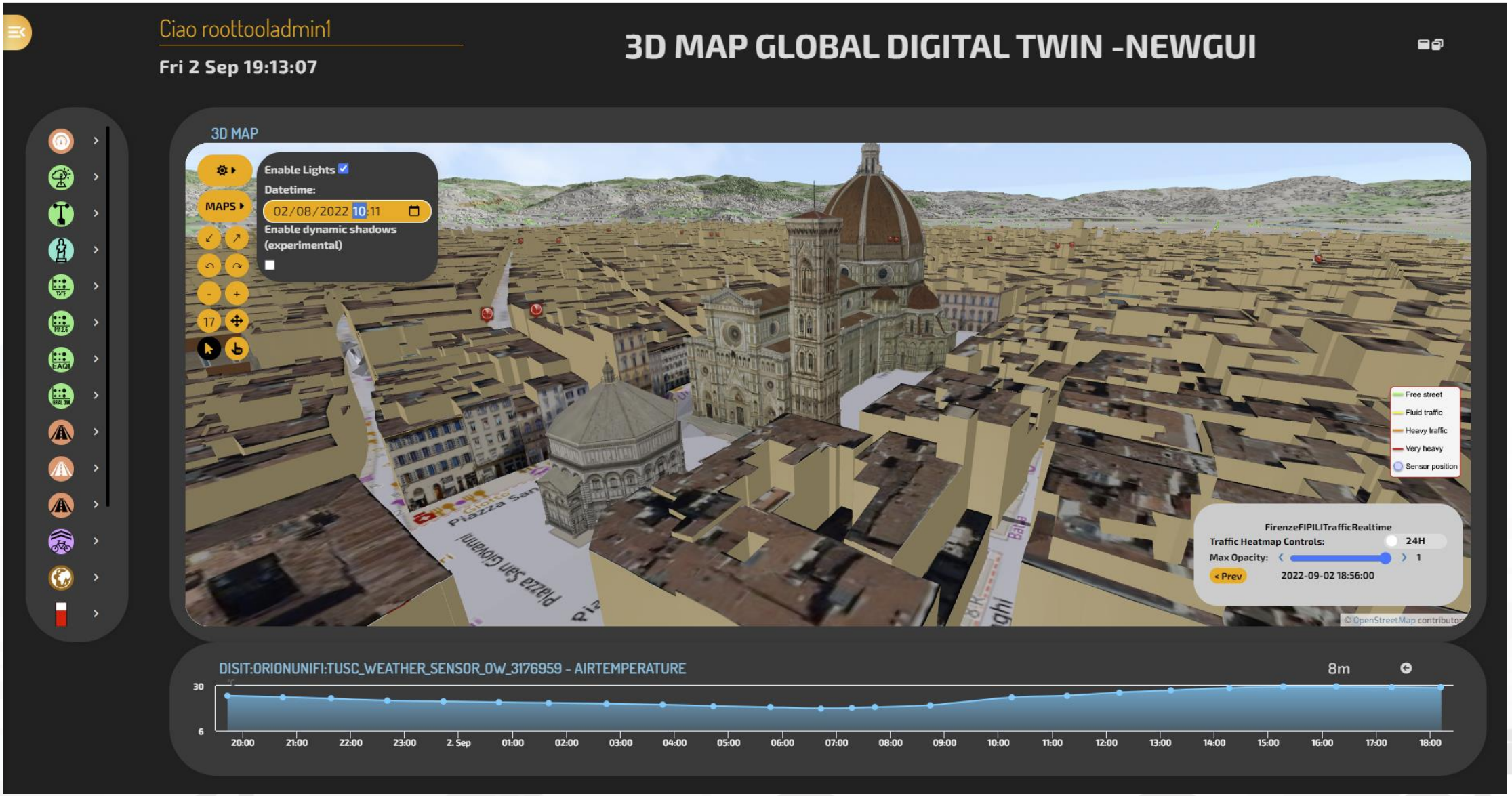


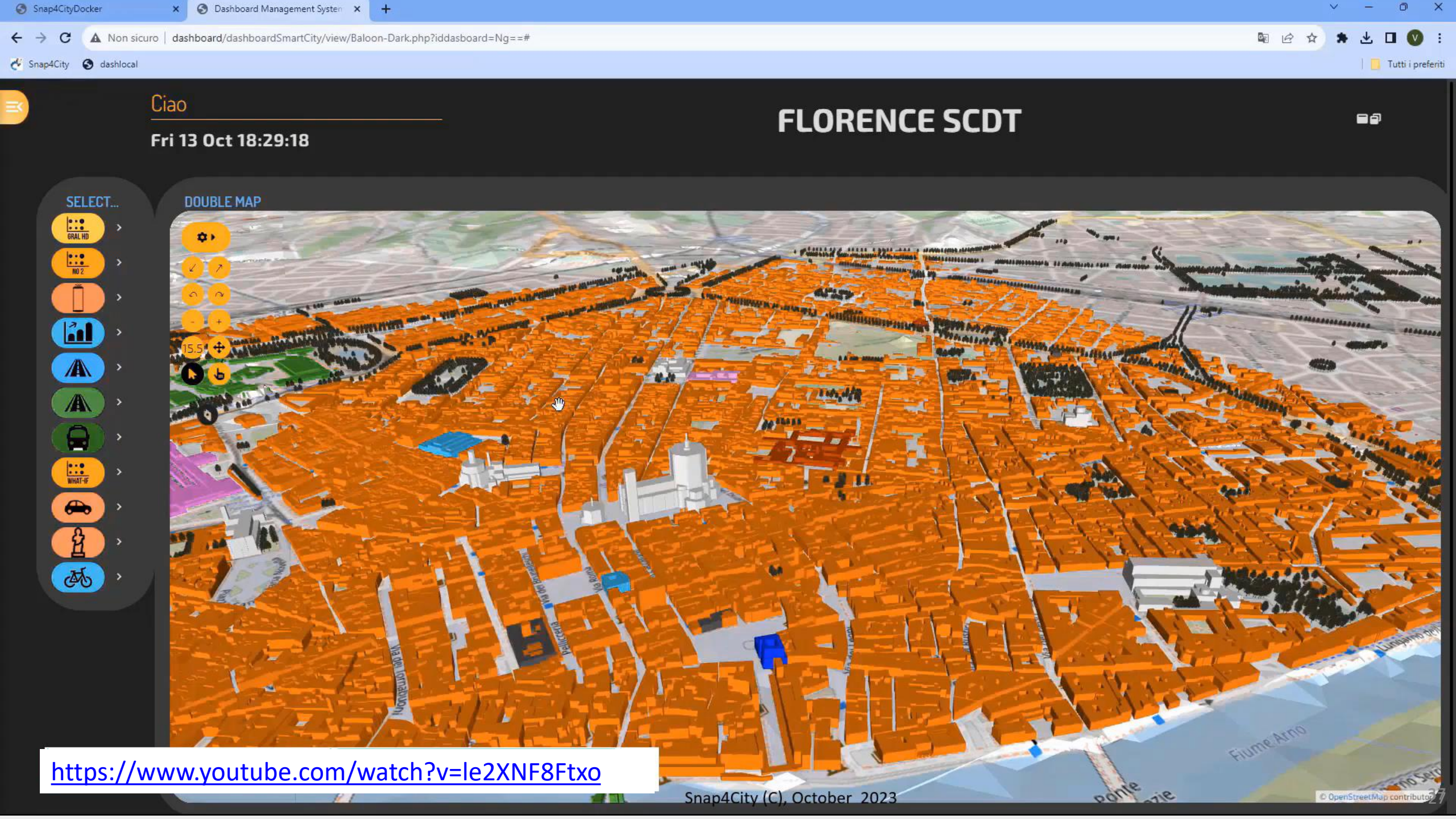


New styles/themes can be developed by specializing a few files from open source

https://www.snap4city.org/793

3D Digital Twin




Snap4CityDocker
Dashboard Management Syster
Non sicuro
dashboard/dashboardSmartCity/view/Baloon-Dark.php?iddasboard=Ng==#
Snap4City
dashlocal
Tutti i preferiti
Ciao
Fri 13 Oct 18:29:18
FLORENCE SCDT
SELECT...
DOUBLE MAP
GRAL HD
NO 2
WHAT-IF
15.5
Fiume Arno
© OpenStreetMap contributors
https://www.youtube.com/watch?v=le2XNF8Ftxo
Snap4City (C), October 2023

OCULUS

OCULUS

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

Exploiting Google API with Snap4City engine

- Select any city/locality and see if 3D Representation of your city is Available
- Snap4City redendering and distribution engine allows to
  - Optimize distribution of data
  - Integrate any kind of data on Digital Twin with 3D tileds of Google
    - PIN, IoT Data
    - Traffic Flows
    - Cycling paths
    - 3D shapes superimposed
    - Etc.

Snap4City Digital Twin Engine and data + 3D Google Data

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DISTRIBUTED DATA INTELLIGENCE

Firenze

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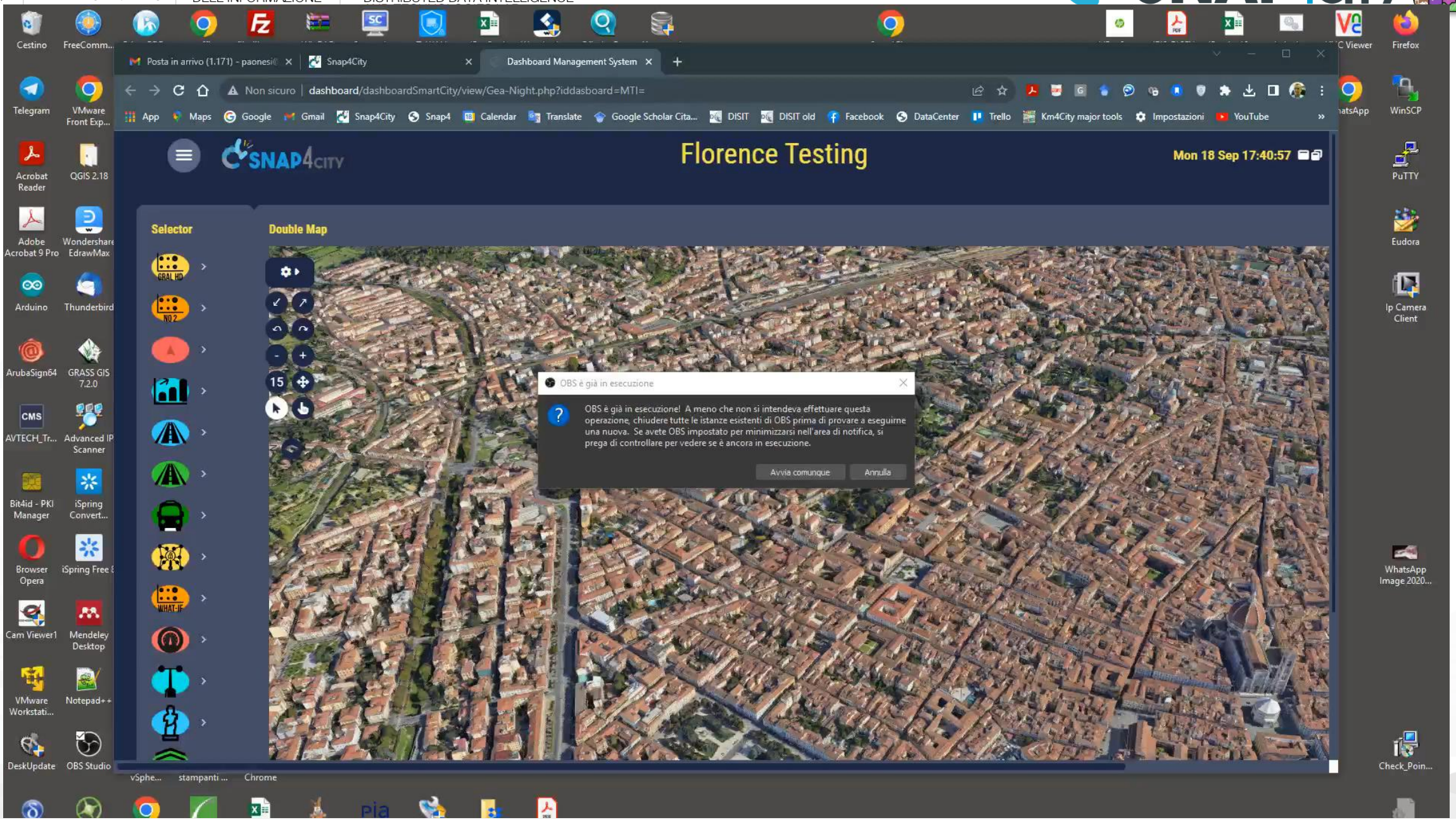

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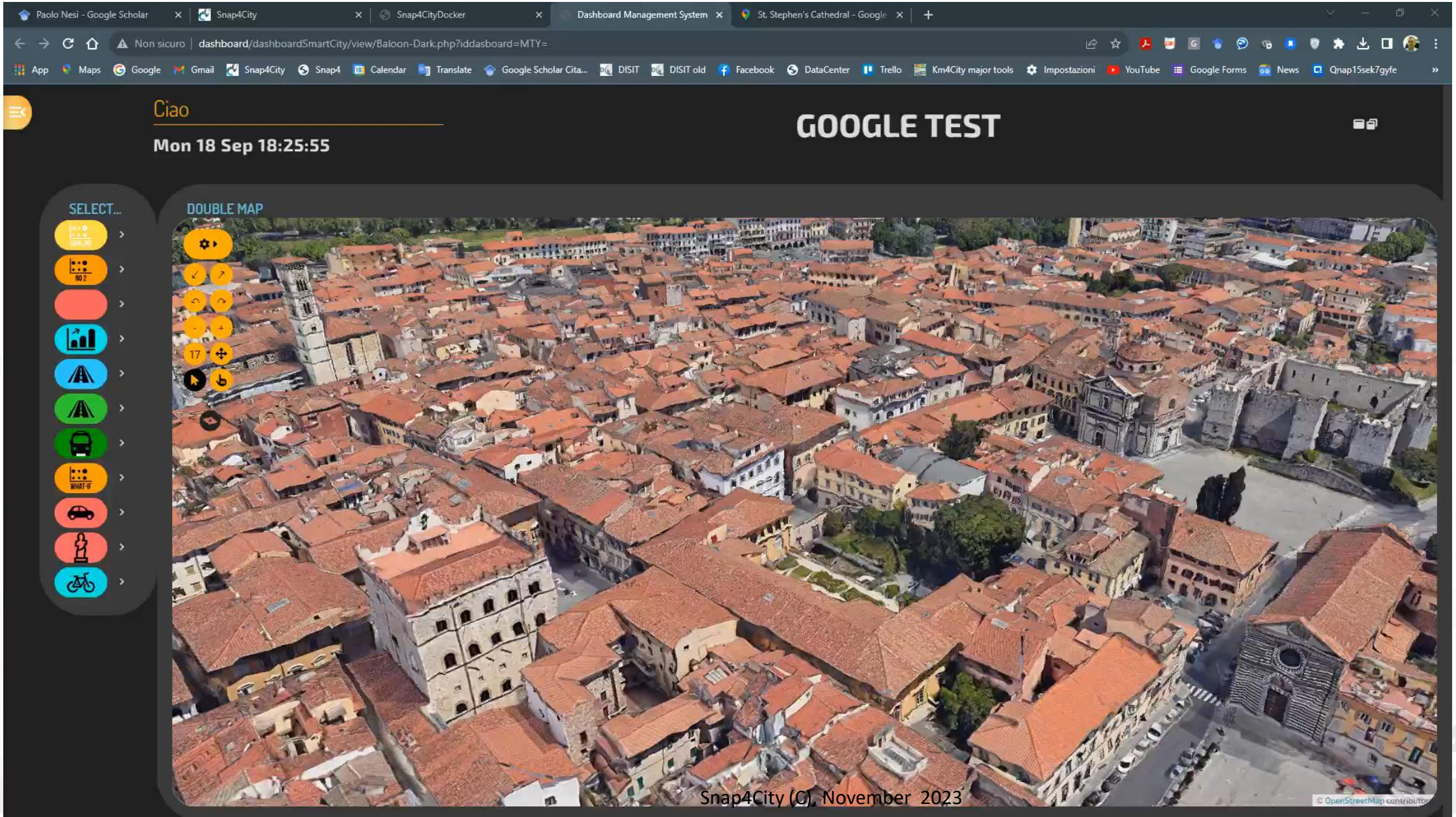
DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

Prato

SNAP4CITY KM4CITY



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Genova

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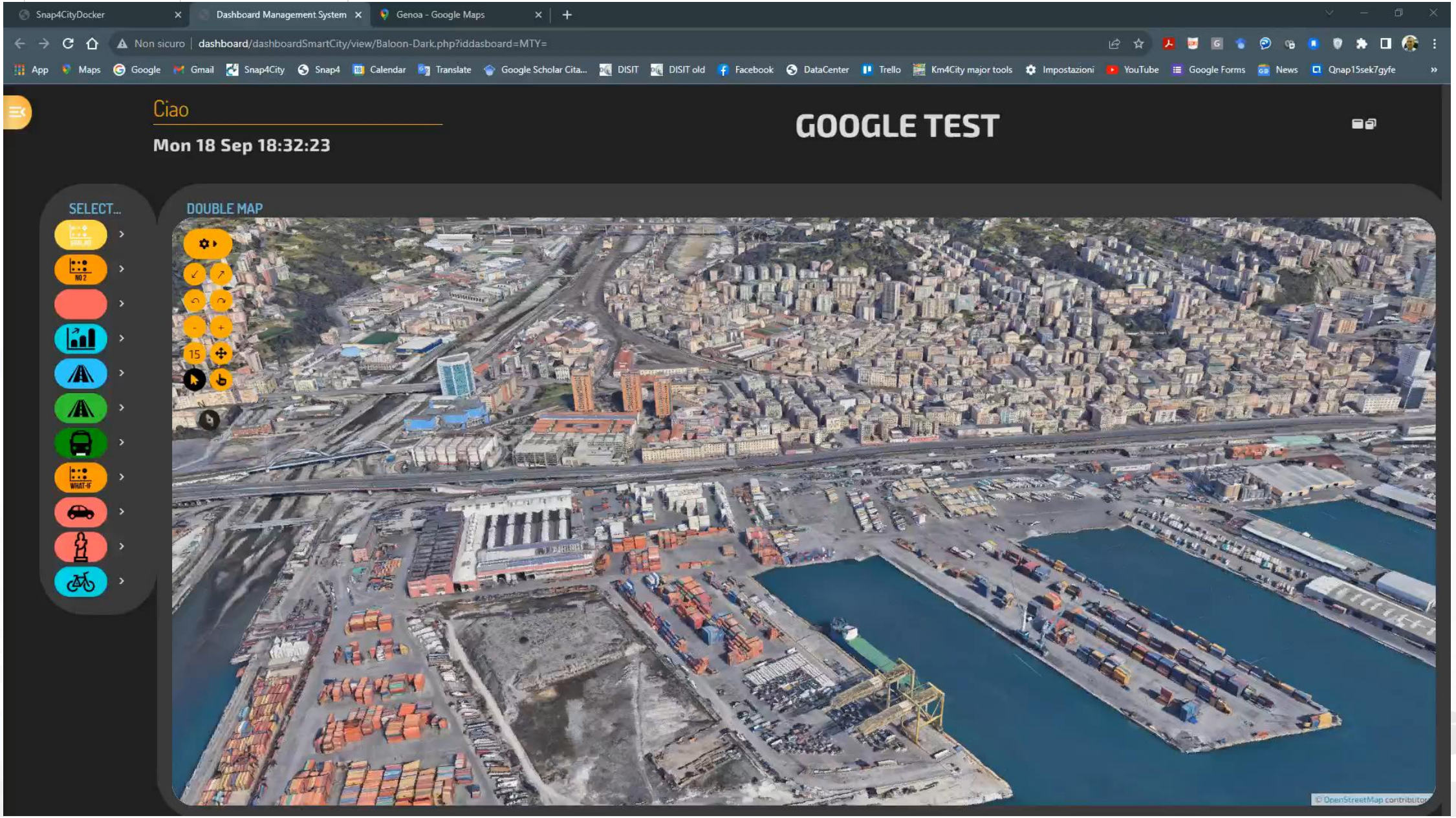


Local Digital Twin vs BIM

Snap4City | Dashboard Management System | Nuova scheda

snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mzg0NA==

Bookmarks | Calcio: ultime news... | Diffusioni in diretta,... | La Repubblica.it - H... | Corriere dello Sport.it | TIM Mail | Tim.it | E... | Gmail | YouTube | Maps | Telecom Italia ROU... | Firenze Traffic Flow | Snap4Altair | dashboard/iotapp/... | ilCorSaRoNeRo.link...

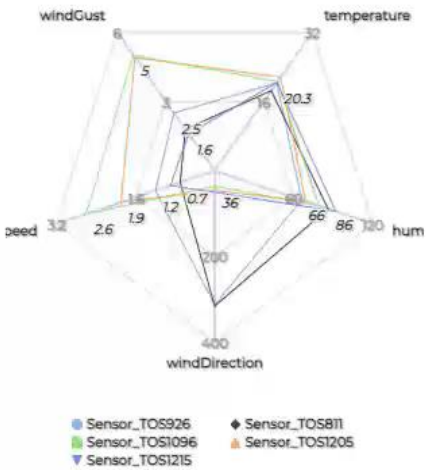
BIM Airport

Thu 25 May 18:16:22

Select the view of interest

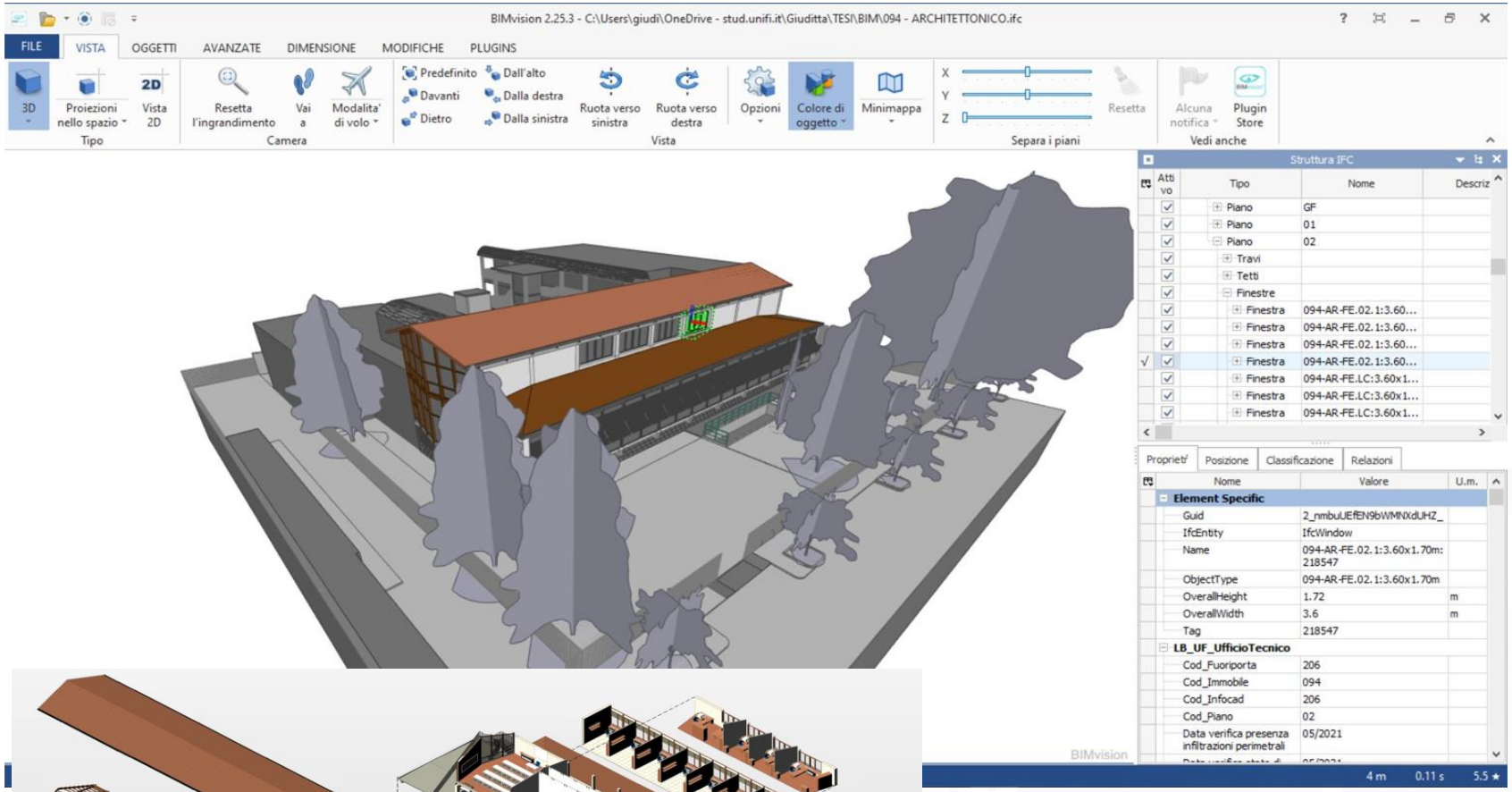
- Airport Building 1
- Airport Heatmap dash
- Terminal Heatmap

Sensor Data 4m

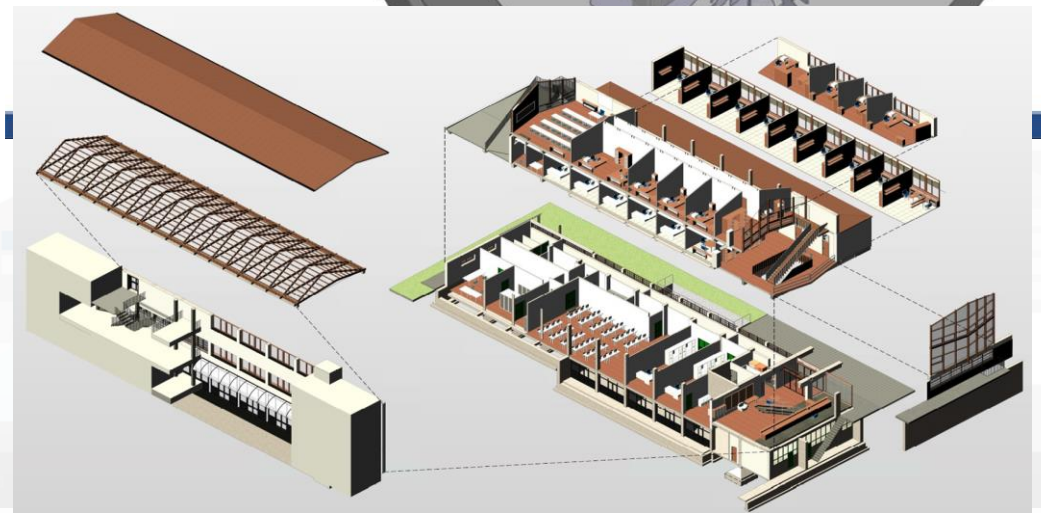


Last Value	Time Trend Chart
No data	

.IFC



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



SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

TOP

Get other info on……

2023 booklets

- Smart City

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

- Industry

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

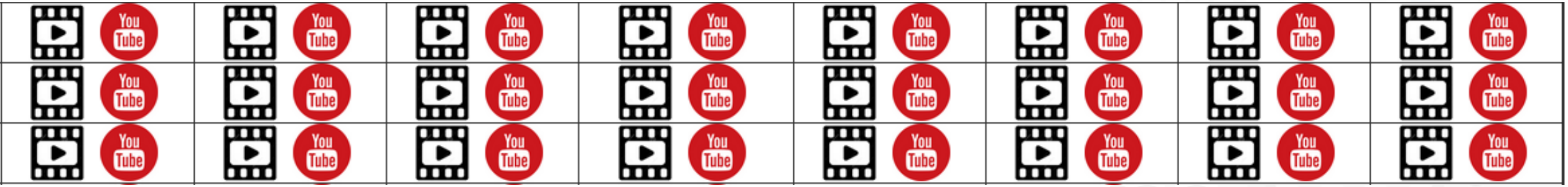
- Artificial Intelligence

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

https://www.snap4city.org/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
							
							



https://www.snap4city.org/4

Scenarious

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

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

Smart Solutions and Decision Support Systems

100% OPEN SOURCE

Powered by FIWARE

FREE TRIAL

PEN Test Passed

EU GDPR COMPLIANT

SNAP4 Appliances and Dockers Installations

EUROPEAN OPEN SCIENCE CLOUD

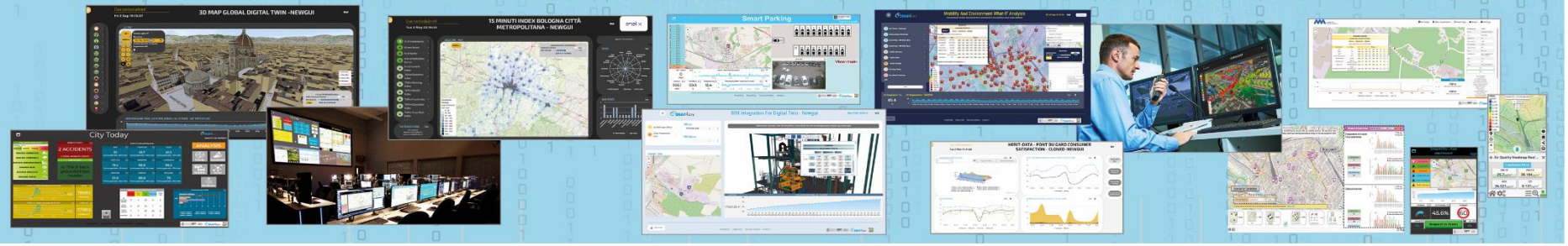
Node-RED

JS Foundation

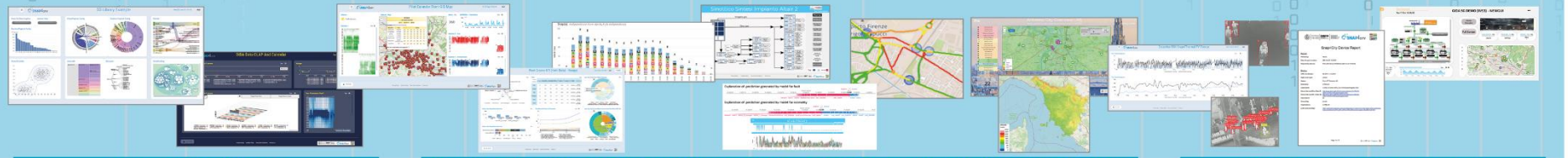
EØ15 digital ecosystem

NVIDIA

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



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

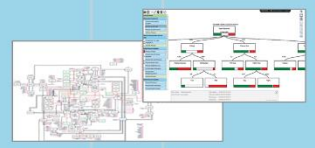


DASHBOARDS, WIDGETS
TEMPLATES

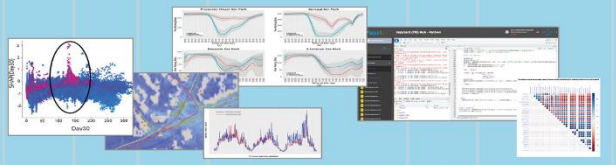
PREDICTION - ANOMALY DETECTION - CLUSTERING - ROUTING - SENTIMENT NLP - TRAFFIC FLOW
PEOPLE FLOWS - SDG - 15 MIN CITY INDEX - KPI - HEATMAPS - ORIGIN DESTINATION - ETC...

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

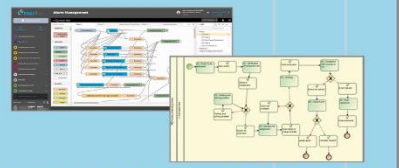
ANY: DATA, BROKER, NETWORK AND VERTICAL



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



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

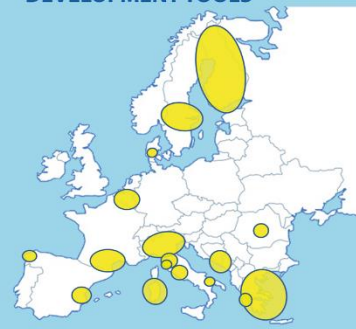


VISUAL PROGRAMMING, ADAPTERS
DATA FLOWS, WORKFLOWS
PARALLEL DISTRIBUTED PROCESSING
EVENT DRIVEN

Native and External Smart Applications

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

METHODOLOGIES
LIVING LABS
COURSES AND COMMUNITY
DEVELOPMENT TOOLS



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Be smart in a SNAP!

SMARTCITY EXPO WORLD CONGRESS

7-9 November 2023, Barcelona, Spain

Visit Snap4City in Hall 1

SNAP4 Appliances and Dockers **Installations**

CONTACT

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Università degli Studi di Firenze - School of Engineering

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Fax.: +39-055-2758570

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