

Paolo Nesi

Neuro-Symbolic Engine and
Digital Twin for Smart City
control and planning

23 Aprile 2024
ore 13:30

SMART TALKS




Dottorato in
Architettura e
Culture del
Progetto



 beatrice.turillazzi@unibo.it

 Design del Prodotto Industriale e
Advanced Design • UNIBO

 Dipartimento di Architettura • UNIBO

 @exhibitlab_adu



www.snap4city.org
www.snap4solutions.org



www.km4city.org

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UNIVERSITÀ
DEGLI STUDI
FIRENZE

DINFO
DIPARTIMENTO DI
INGEGNERIA
DELL'INFORMAZIONE

DISIT
DISTRIBUTED SYSTEMS
AND INTERNET
TECHNOLOGIES LAB

#snap4city
#km4city
#disitlab
@snap4city

Public Spaces as Critical Infrastructures

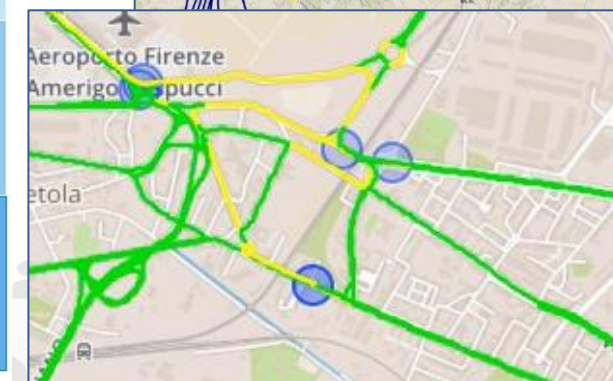
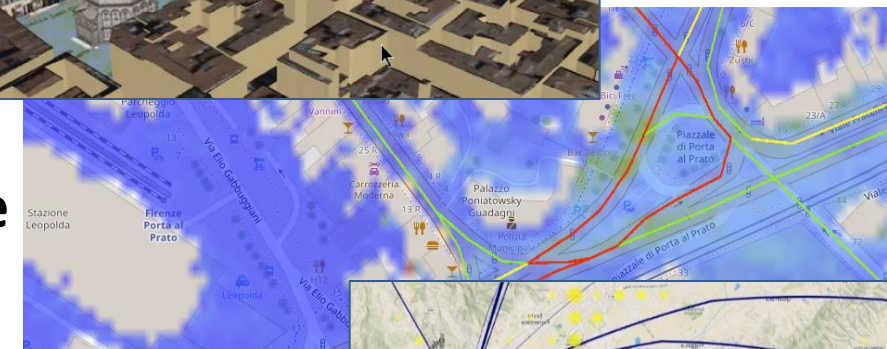
- The City is a system of systems for city users
 - Cascading effects
- **Transport** networks
 - Main means for rescue teams, food, water, etc.
- **Communication**, ICT infrastructure
 - TV cam, switches, cyber,
- **Energy** networks
 - power supply for health, cyber systems, etc.
- **Hospitals** networks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



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

Main Tasks

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



Complex Smart Applications

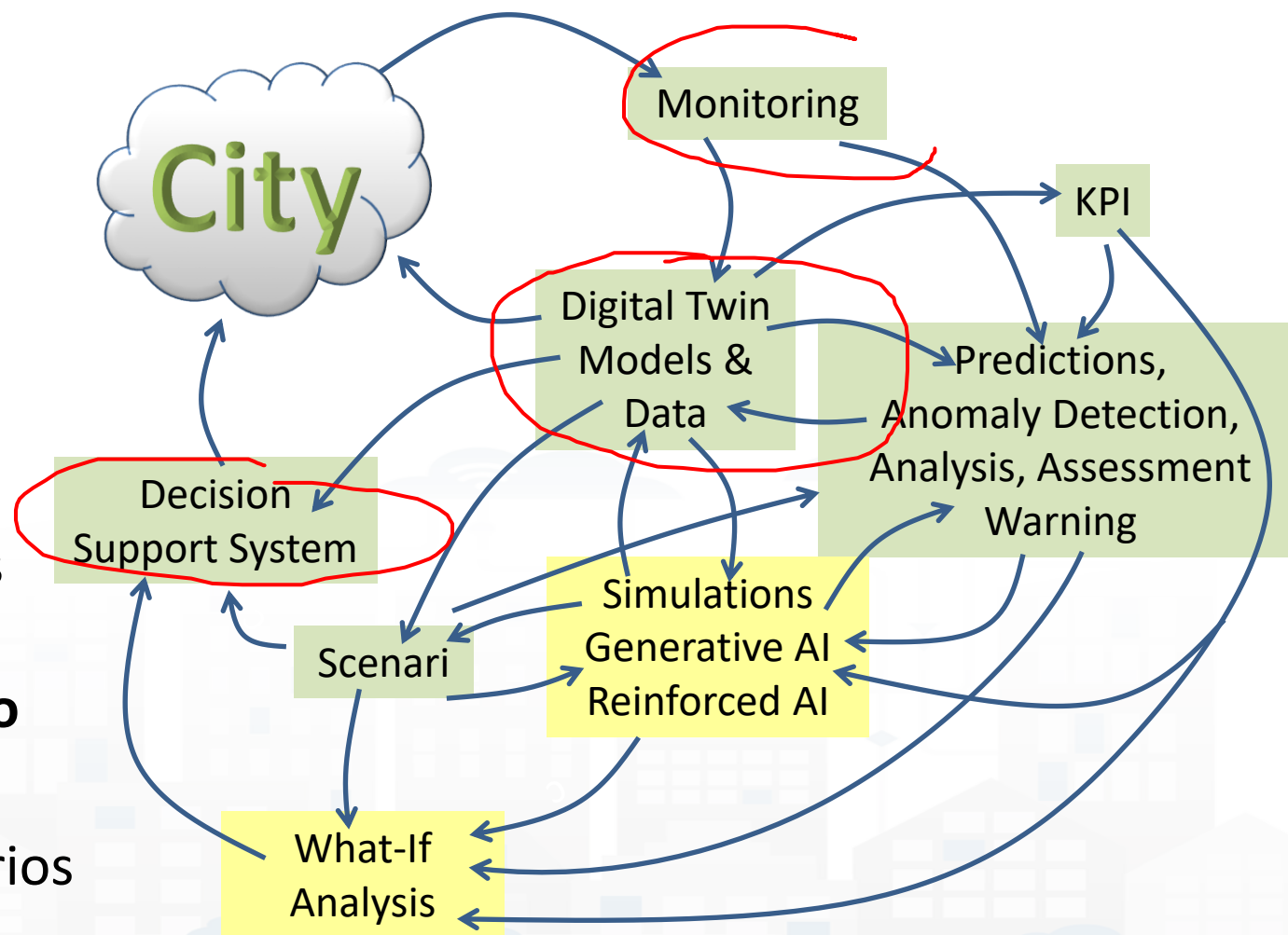
- **Recent solutions**
 - Dynamic traffic light control and synchronizations
 - MaaS, sharing, evolution of info-mobility
 - Connected and Autonomous Vehicles/solutions
 - Integrated Energy & Environmental applications
 - Etc.
- **Most of them share the same modules, differently implemented and combined,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

- **Controlling Status: management, and operational**

- Monitoring via KPI
- Computing predictions vs KPI
- Anomaly detection
- Neuro-Symbolic analysis
- Risk assessment
- Early warning on critical conditions

- **Making plan: tactic and strategic, medium and long range, micro/macro**

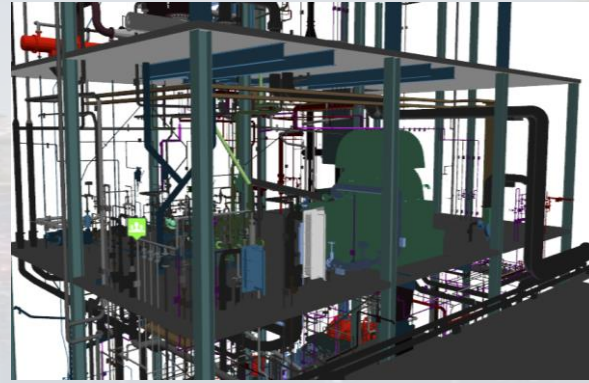
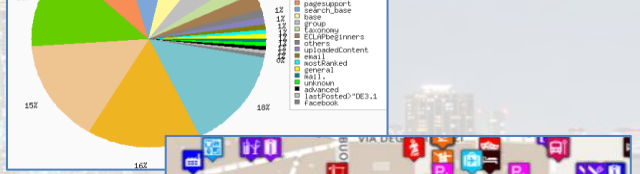
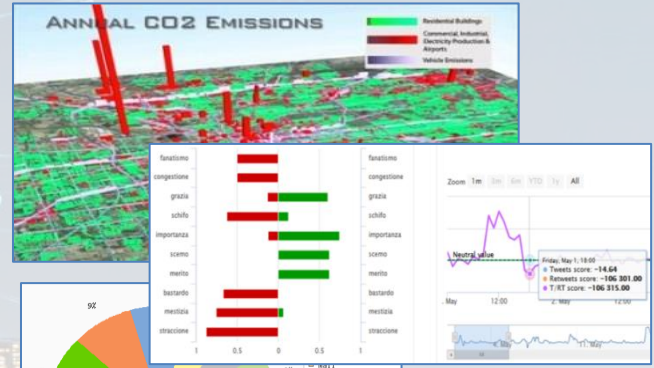
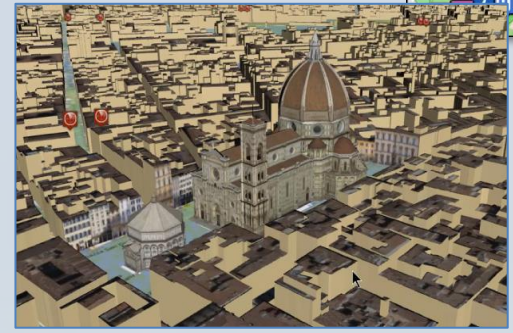
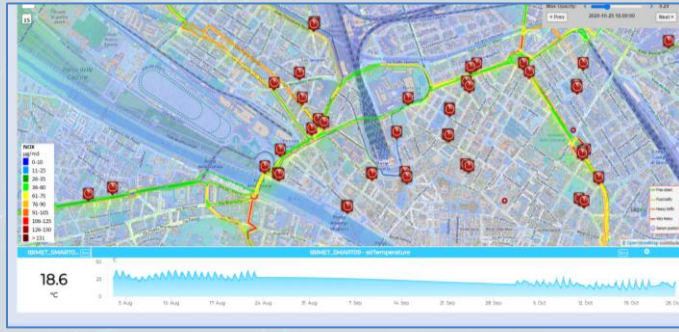
- Simulation & predictions
- Generative AI Prescriptions, scenarios
- Resilience to Unexpected unknowns
- What-if analysis wrt scenarios



Digital Twin

Digital Twin

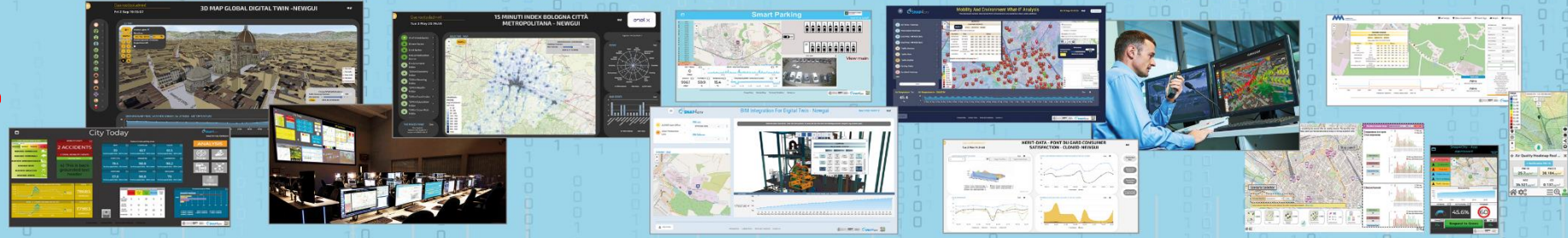
- **Connected** with real systems
 - **Modelling** aspects: structural, visual, informative, real time data sensors (context), POI, functional, resources, etc.
 - **Analytics:** AI/XAI techniques, simulations, users' needs, etc.
- **Easier to understand the context, review from multiple points of view**
- **Useful to perform**
 - Discussion with city users
 - Support decision makers
 - By Case Experiments for analysing
 - New solutions, impact of disaster (natural and provoked)
 - Reduction of costs in the analysis, in reduction of mistakes



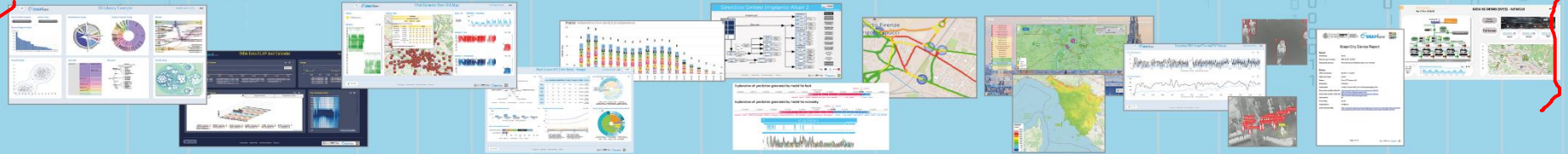
Snap4City



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 ...

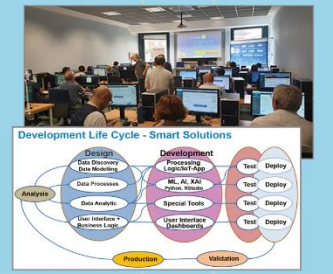
ANY: DATA, BROKER, NETWORK AND VERTICAL

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

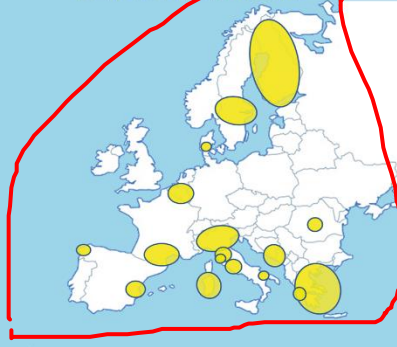
BIG DATA ANALYTICS, ARTIFICIAL INTELLIGENCE
 EXPLAINABLE AI, MACHINE LEARNING
 OPERATIVE RESEARCH, STATISTICS

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



Powered by
FIWARE

FREE TRIAL

PEN Test Passed

EU GDPR COMPLIANT

SNAP4 Appliances and Dockers Installations

EUROPEAN OPEN SCIENCE CLOUD

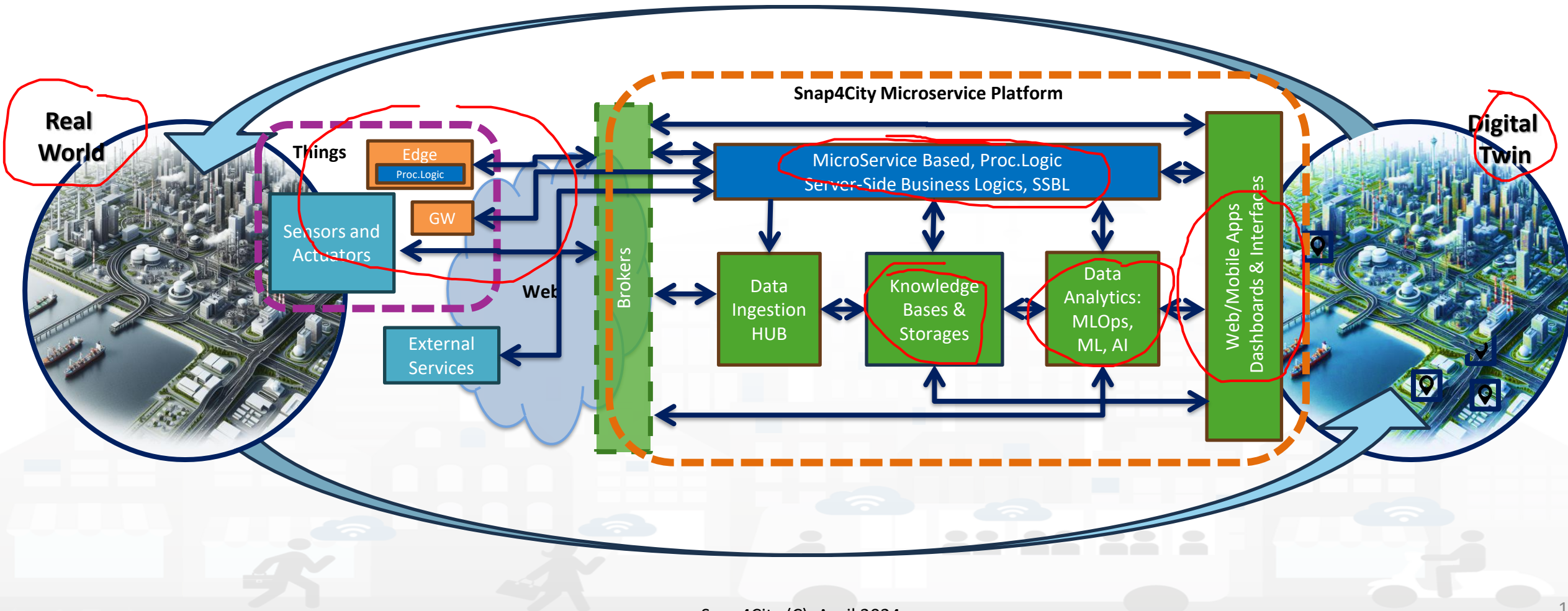
Node-RED

JS Foundation

E015 digital ecosystem

NVIDIA

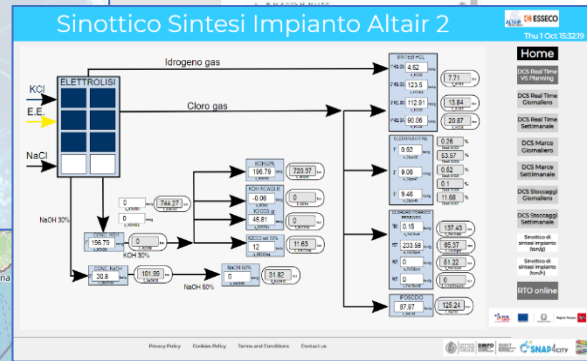
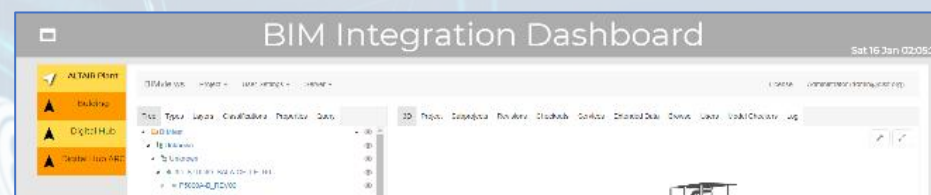
Digital Twin Development Platform



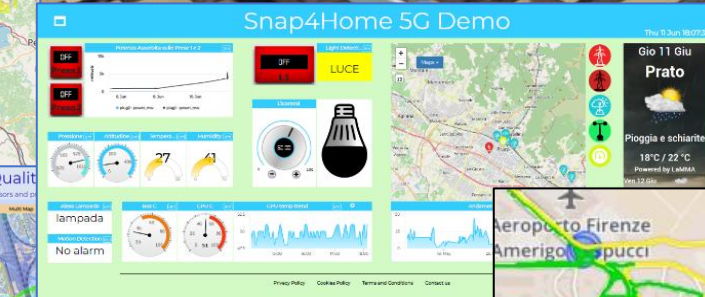
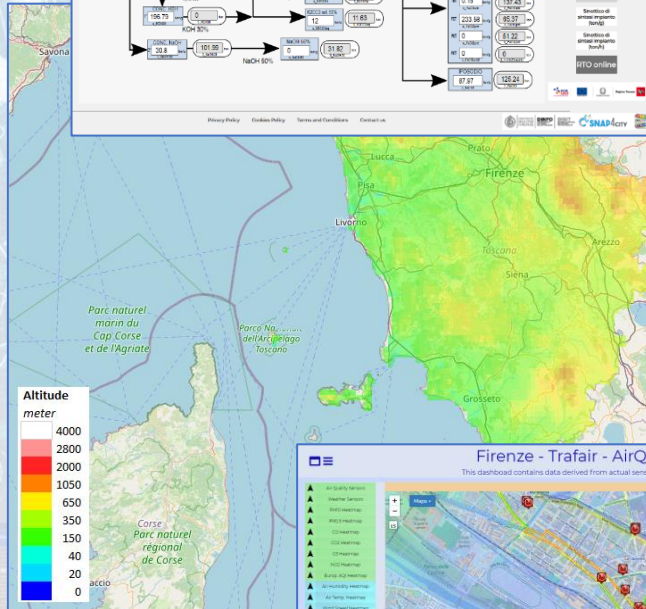
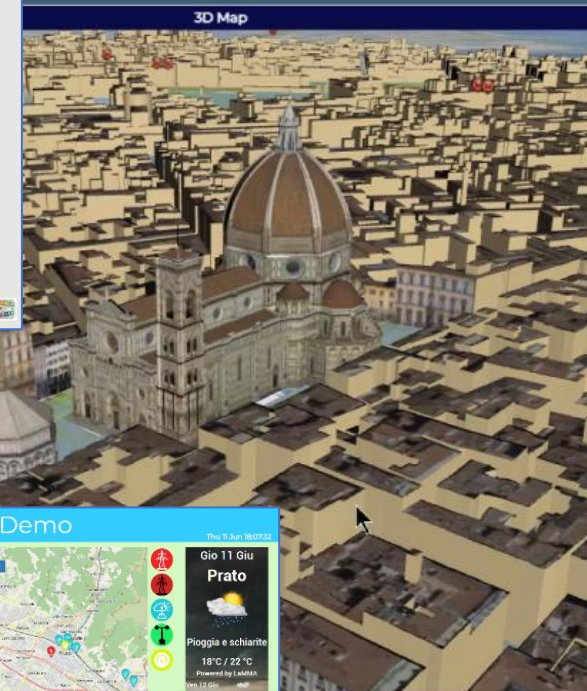
High Level Types

Snap4City (C), April 2024

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



SNAP4CITY
- Digital Twin Global - Fire
demonstrator



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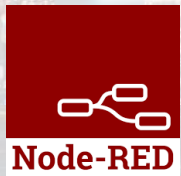
Standards and Interoperability (6/2023)



Compliant with:

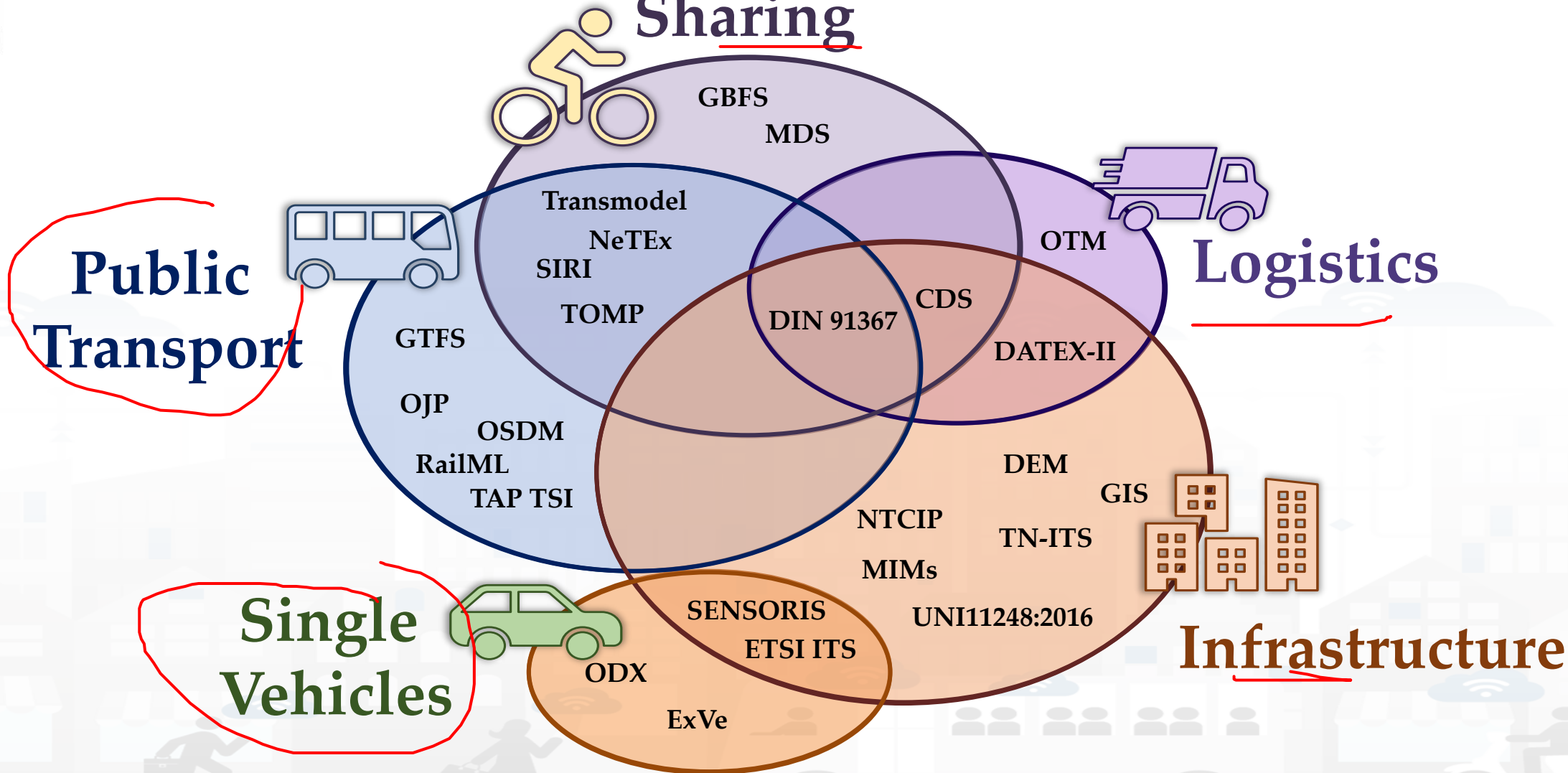
- **IoT:** NGSI V2/LD, LoRa, LoRaWan, MQTT, AMQP, COAP, OneM2M, TheThingsNetwork, SigFOX, Libelium, IBIMET/IBE, Enocean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, BACnet, TALQ, Protocol Buffer, KNX, OBD2, Proximus, ..
- **IoT model:** FIWARE Smart Data Model, Snap4City IoT Device Models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

<https://www.snap4city.org/65>



Coverage of Mobility data formats

Sharing

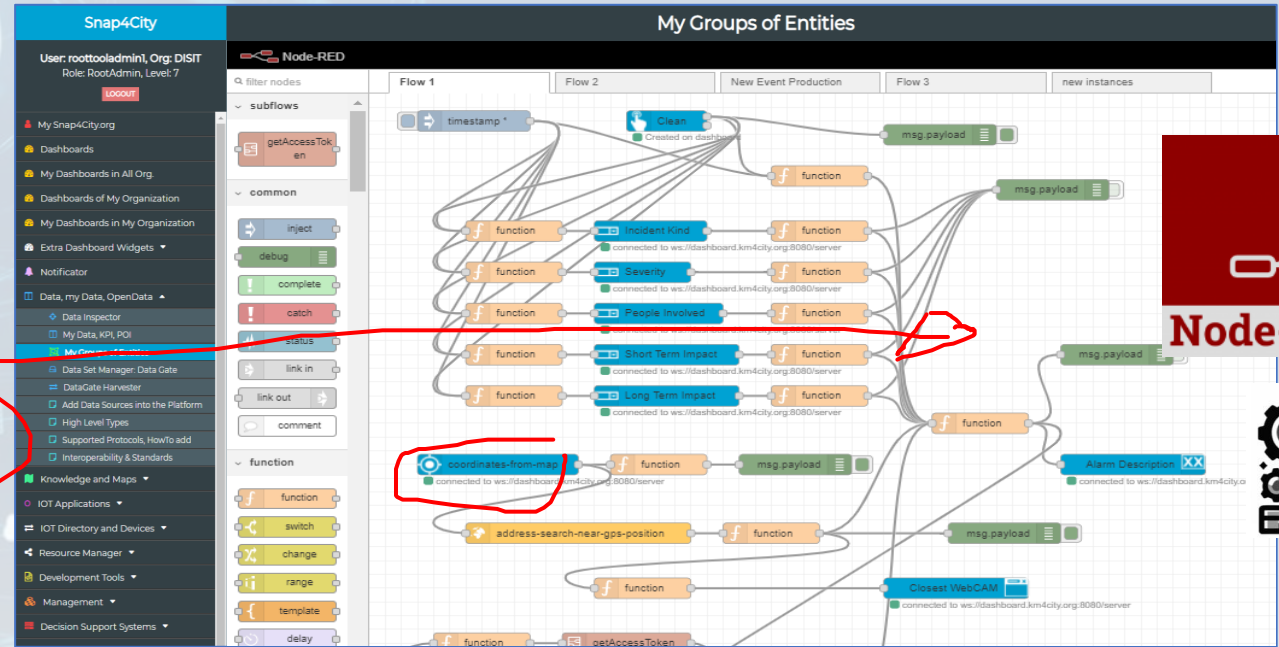


Ingestion, aggreg. → exploitation



IoT App Visual Programming, no coding

- Data transformation
- Integration, Interoperab.
- Scripting Data Analytics
- Data ingestion
- Business logic Server Side



Edge and Cloud

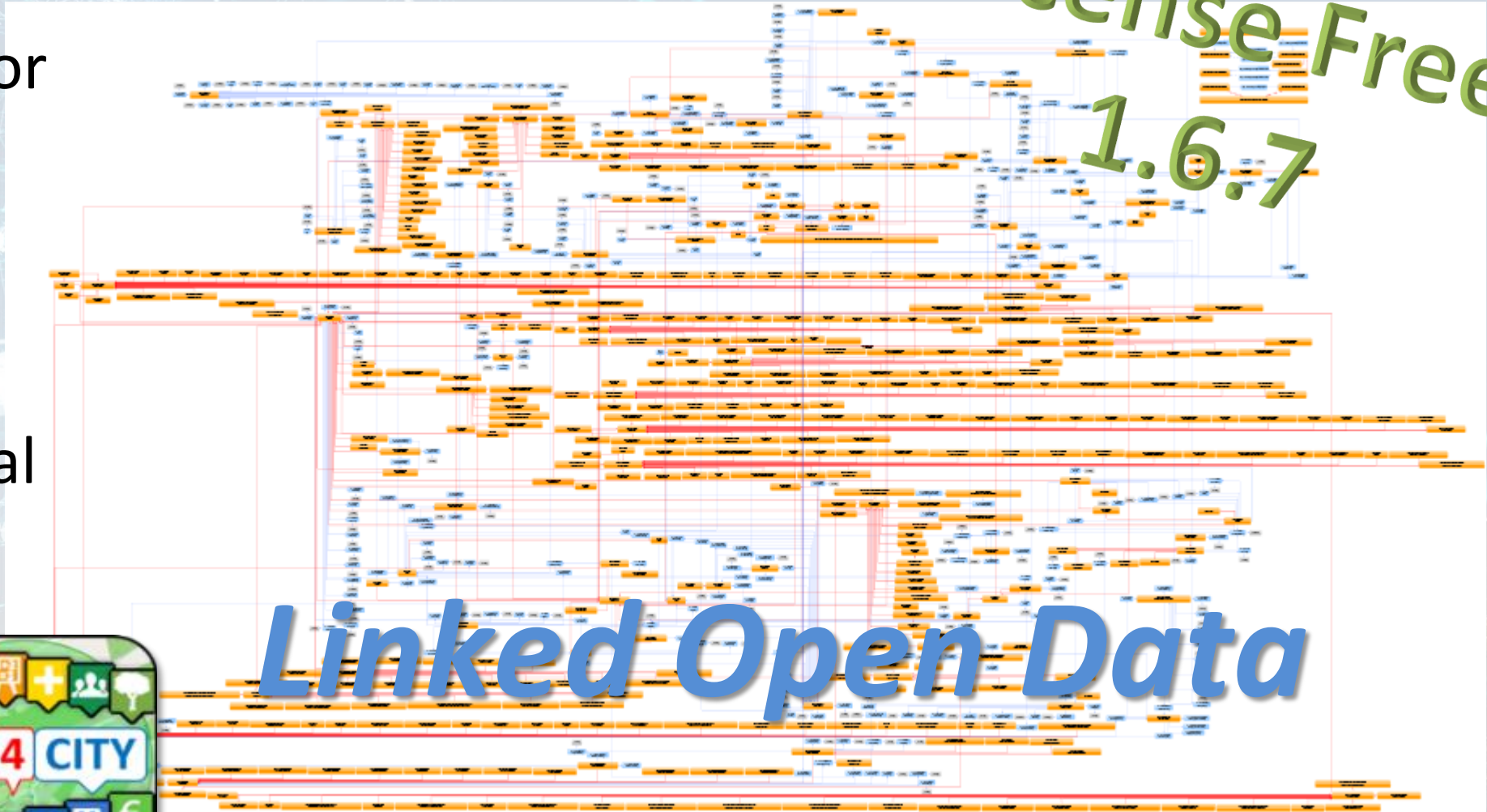
- **MicroServices** data event driven develop via visual language Node-RED

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

Expert System *semantic queries*



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



License Free
1.6.7

Linked Open Data



<https://www.snap4city.org/19>



Solutions: reliable, secure and fast to realize

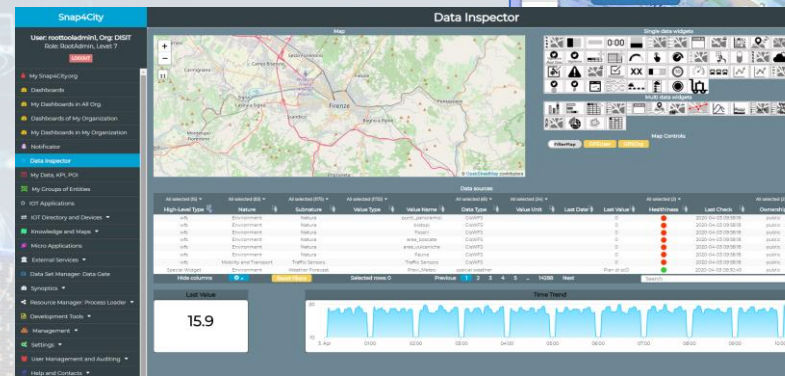
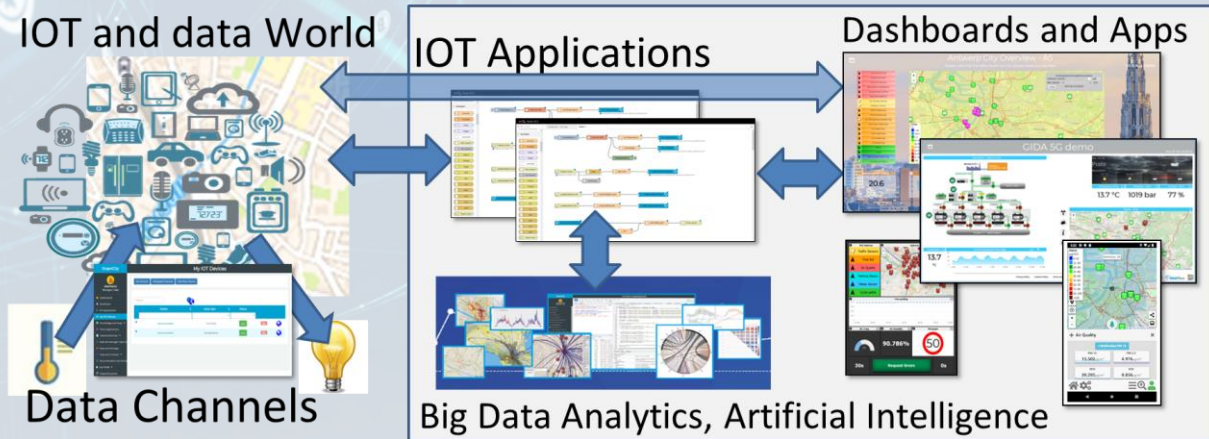


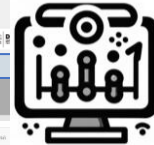
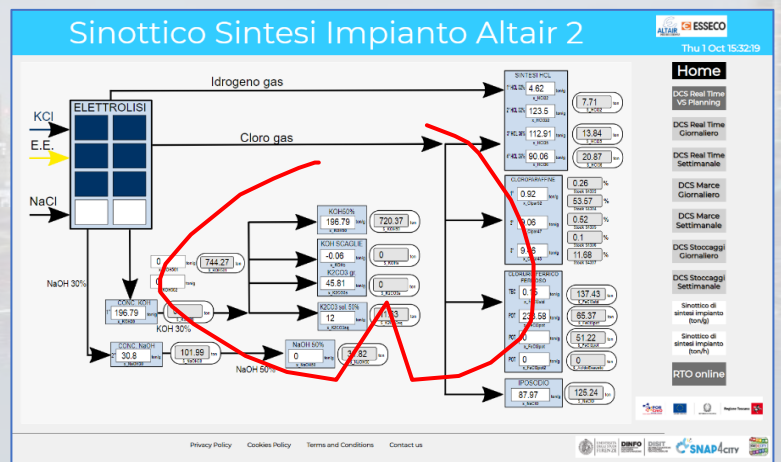
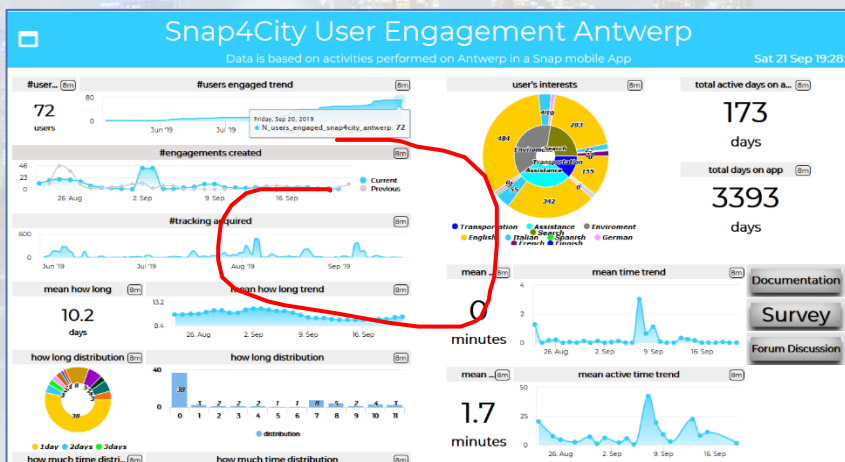
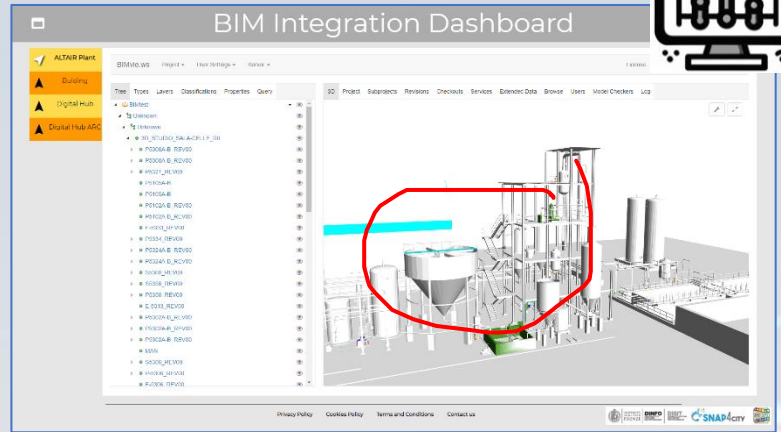
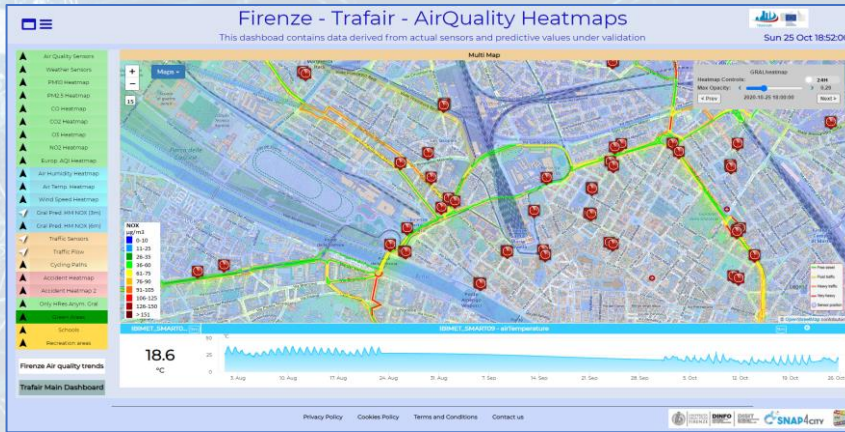
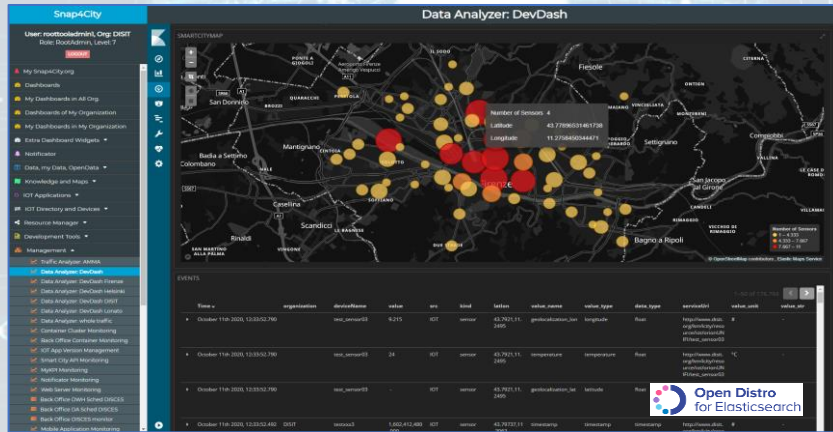
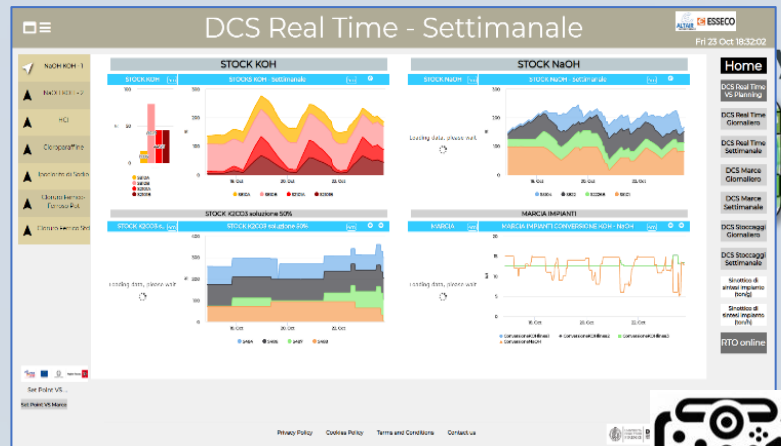
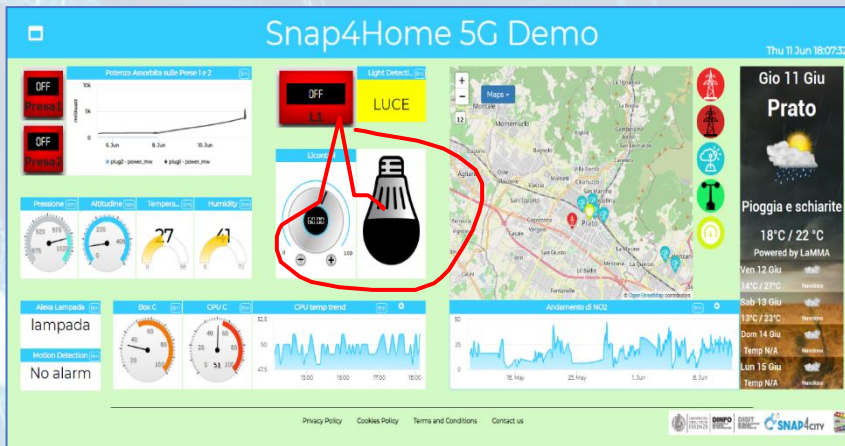
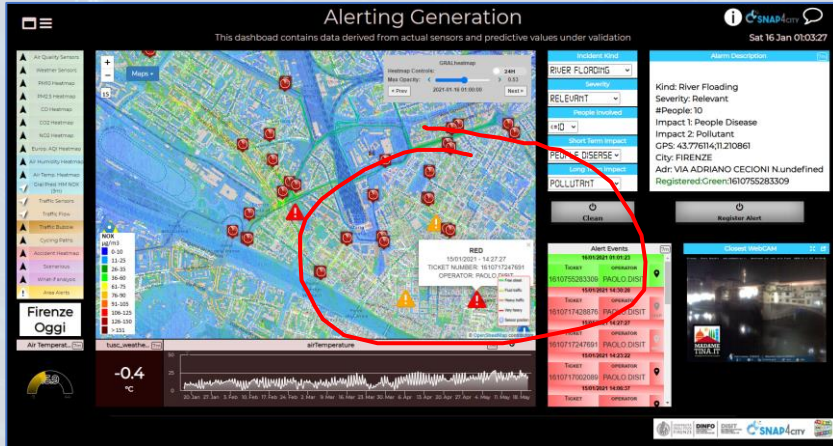
- **Via Snap4City tools**

- **Dashboard Wizard**
- **Dashboard Builder**
- **Data/Visual Analytic**

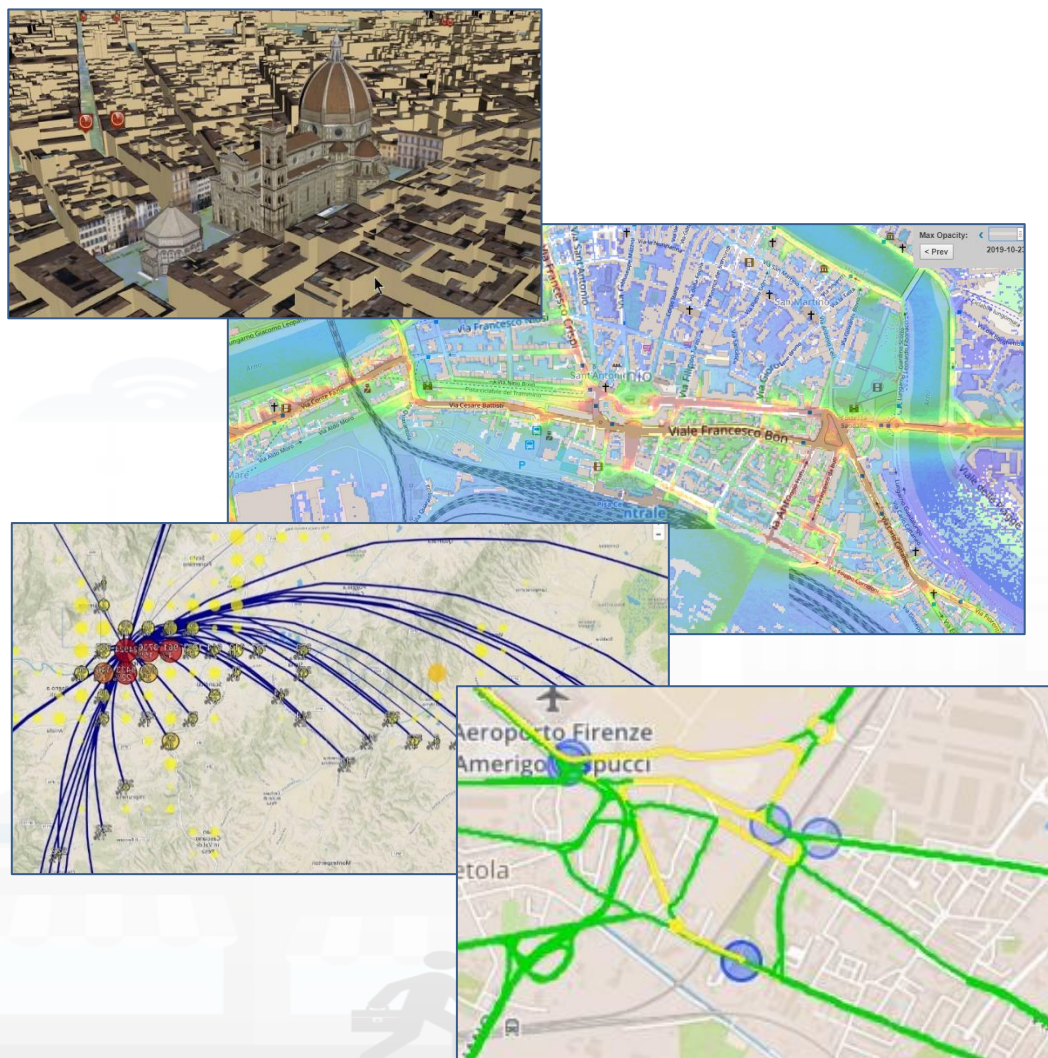
- **Smart Solutions results to be**

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





Smart City Digital Twin City Digital Model with...



City Digital Model with...

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



Complex and heterogeneous information, interoperability

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



Ciao roottooladmin!

Fri 2 Sep 19:13:07

3D MAP GLOBAL DIGITAL TWIN - NEWGUI



3D MAP

Enable Lights

Datetime: 02/08/2022 10:11

Enable dynamic shadows (experimental)

- Free street
- Fluid traffic
- Heavy traffic
- Very heavy
- Sensor position

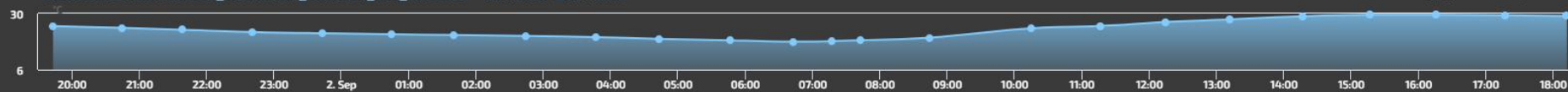
FirenzeFIPILITrafficRealtime

Traffic Heatmap Controls: 24H

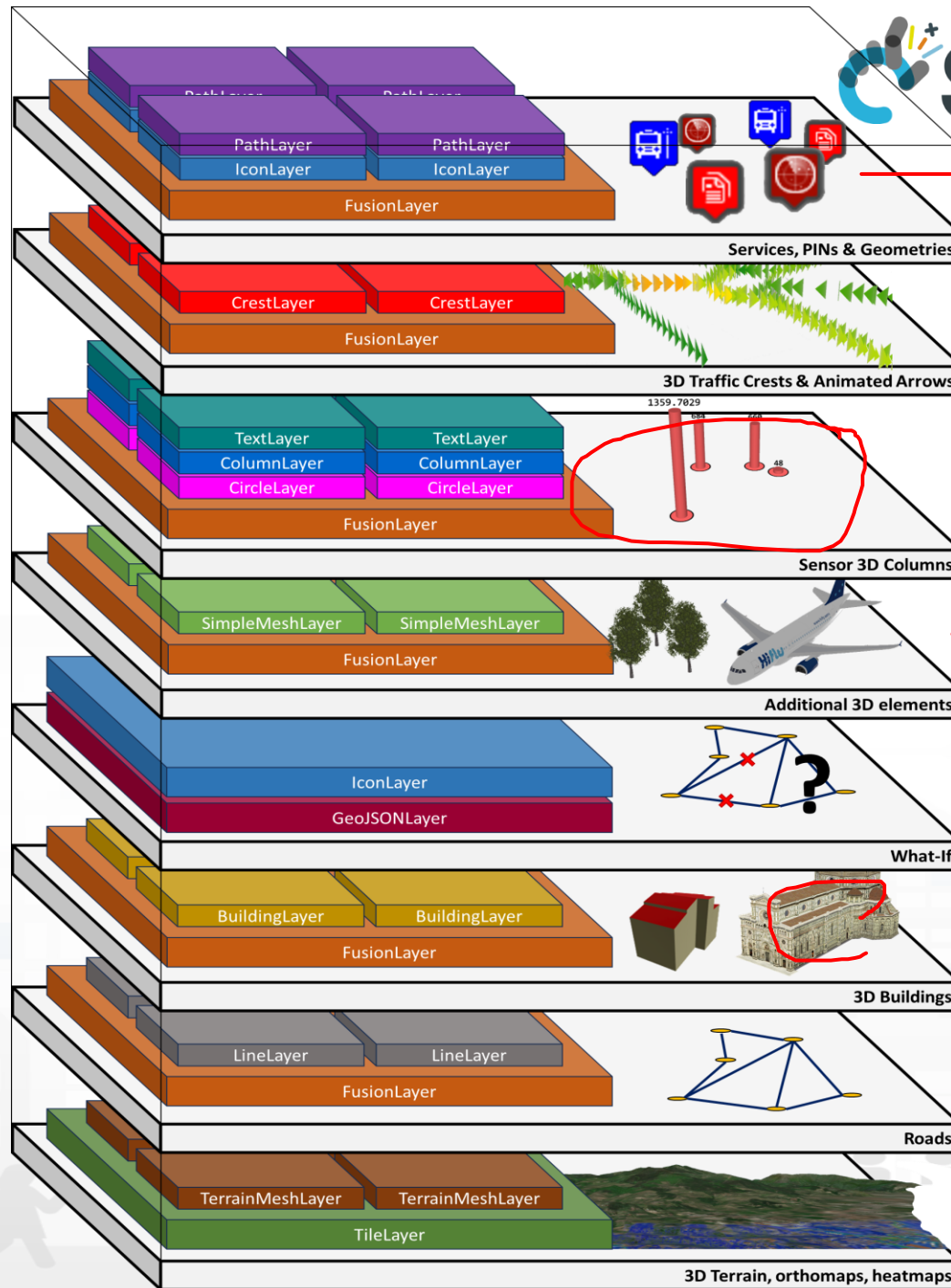
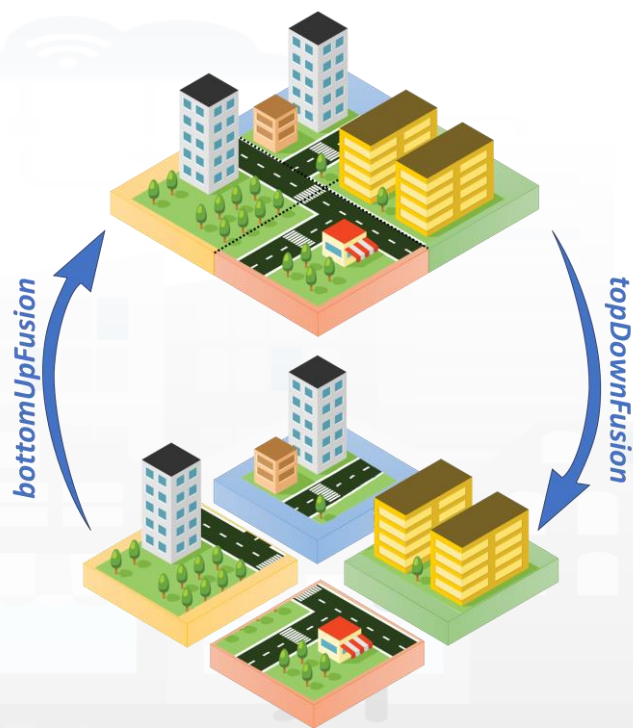
Max Opacity: 1

< Prev 2022-09-02 18:56:00

DISIT:ORIONUNIFI:TUSC_WEATHER_SENSOR_OW_3176959 - AIRTEMPERATURE



Layers VS Fusion Layers



Ciao

Fri 13 Oct 18:29:18

FLORENCE SCDT

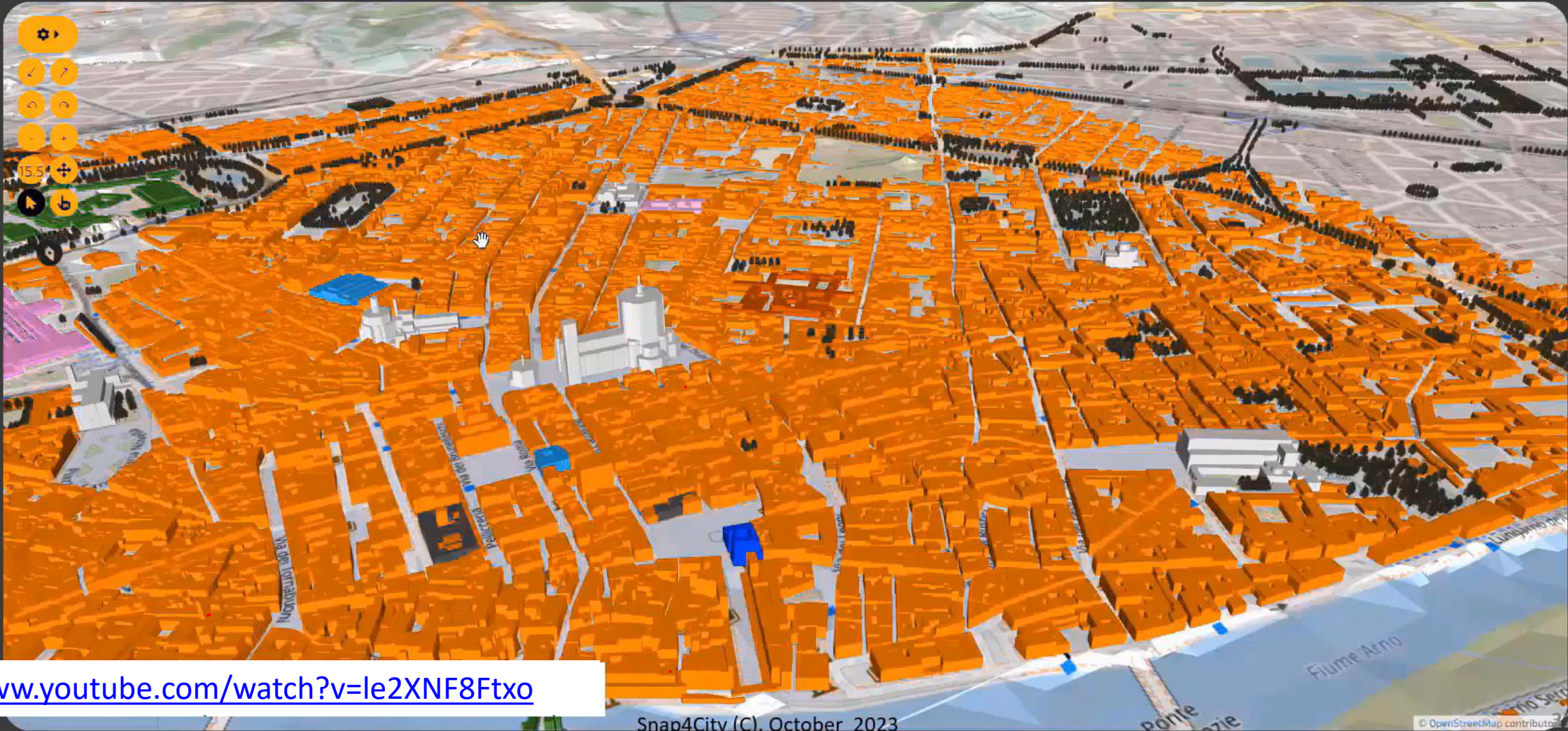


SELECT...

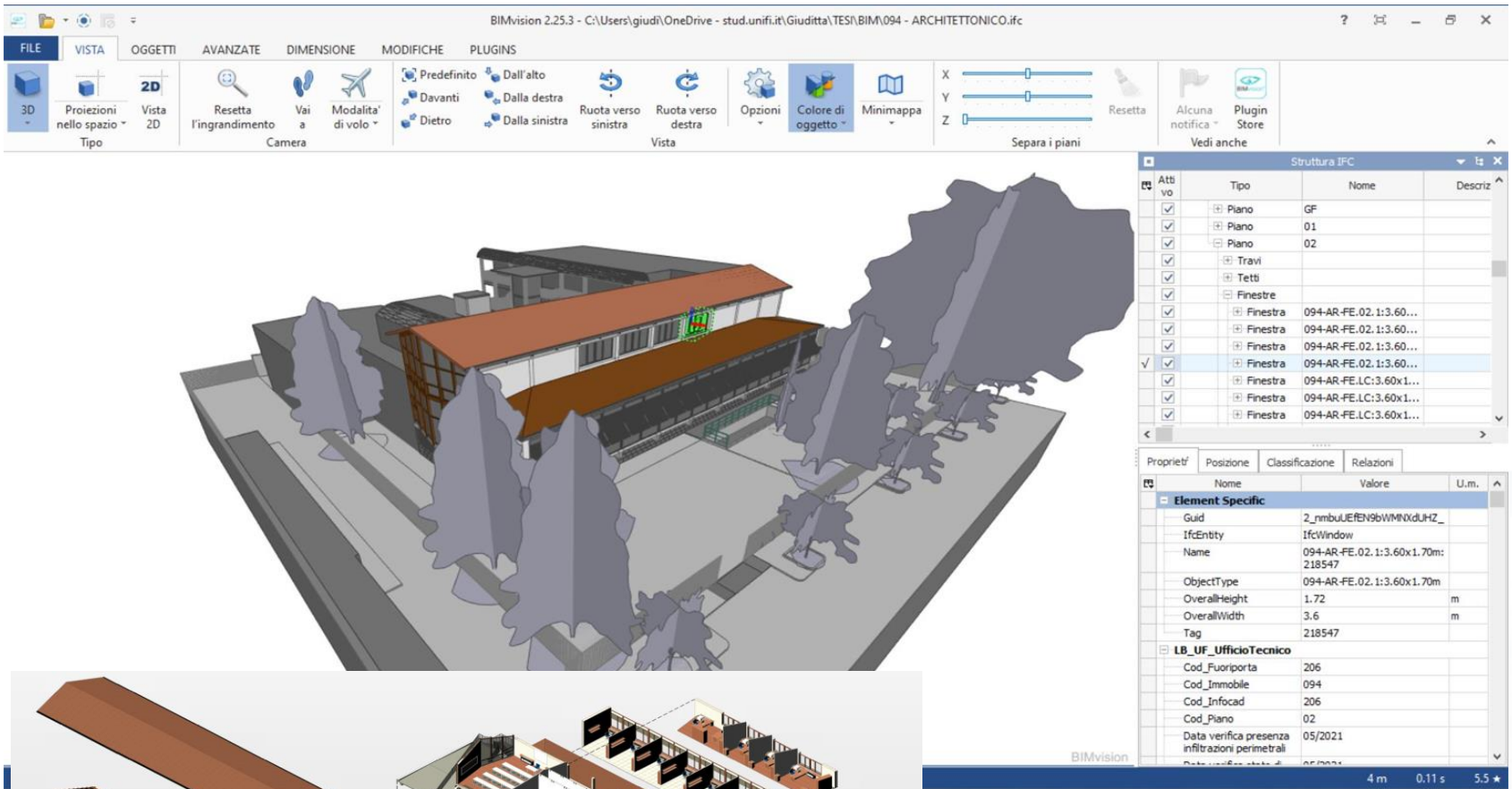
- GRAL HD
- NO 2
- Mobile
- Bar chart
- Highway
- Highway
- Bus
- WHAT-IF
- Car
- Person
- Bicycle

DOUBLE MAP

- Settings
- Layers
- Navigation
- Zoom in
- Zoom out
- 15.5
- Reset
- Home



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



.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 di superfici vetrate	05/2021	
Descrizione	Facciata continua con telaio in legno, finestre apribili e avvolgibili	
Immagine	Immagine raster: IMG_7428.JPG	
Immagine tipo	Immagine raster: IMG_7428.JPG	
Periodicità verifica presenza infiltrazioni perimetrali	A chiamata	
Periodicità verifica stato di conservazione, fissaggio, funzionalità, stabilità e tenuta di superfici vetrate	A chiamata	
Verifica presenza infiltrazioni perimetrali	Si	
Verifica stato di conservazione, fissaggio, funzionalità, stabilità e tenuta di superfici vetrate	Si	



TOP

Monitoring and Control

FROM CITY DASHBOARD TO APPLICATIONS

FORGING & MANAGING OPEN AND SCALABLE INTER-ANALYTIC APPLICATIONS

IoT APPLICATIONS VS IoT EDGE DEVICES

SNAP4CITY BEGINNING

SNAP4CITY ARCHITECTURE DESIGN ECOSYSTEM. OPEN TO DEVELOPERS AND STAKEHOLDERS

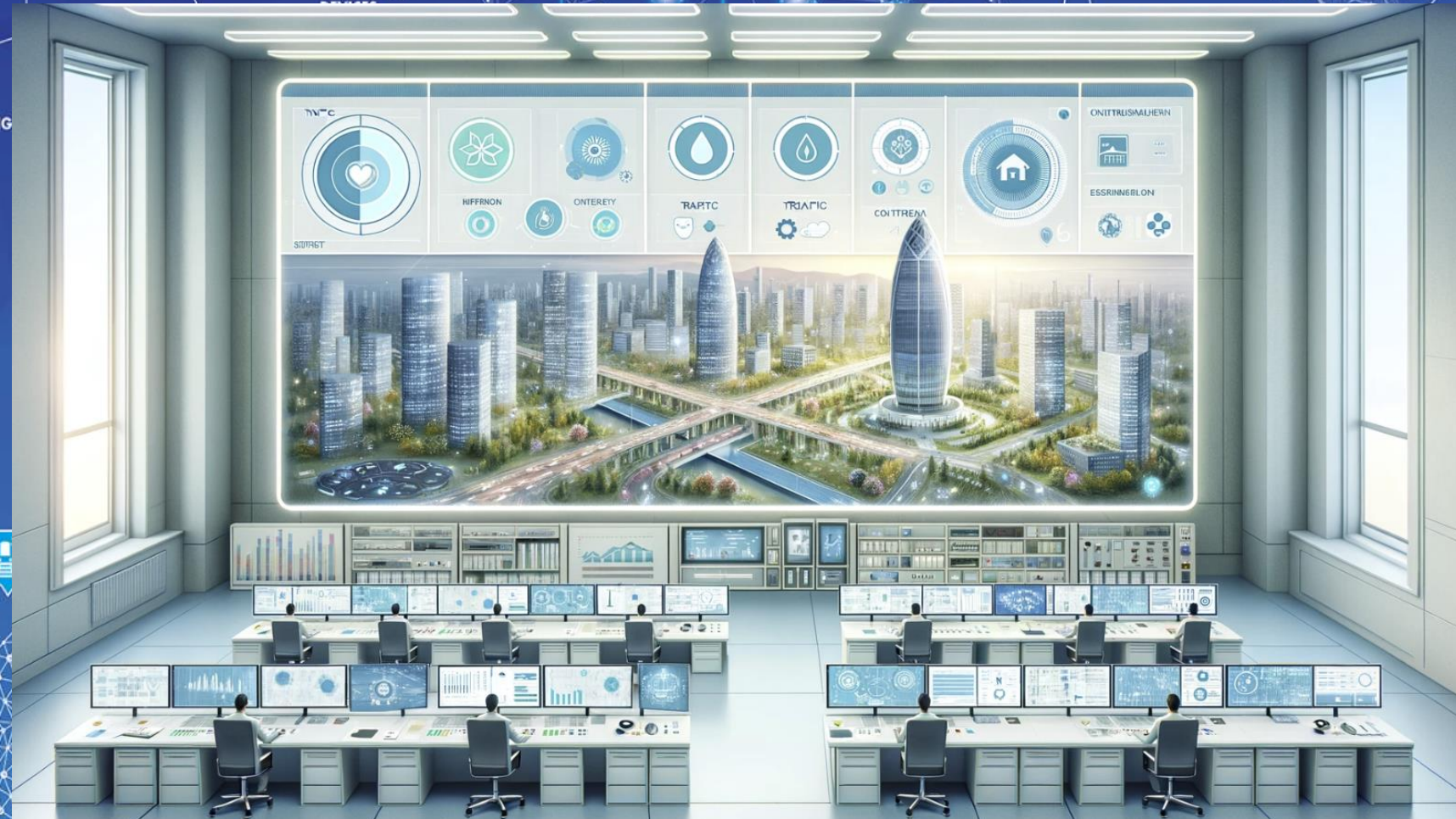
TWITTER VIGILANCE SOCIAL MEDIA ANALYSIS

SNAP4CITY AND KM4CITY PROJECTS

DATA GATHERING AND CITY DATA KNOWLEDGE MANAGEMENT

HOW TO ADOPT SNAP4CITY, AND OUR ROADMAP

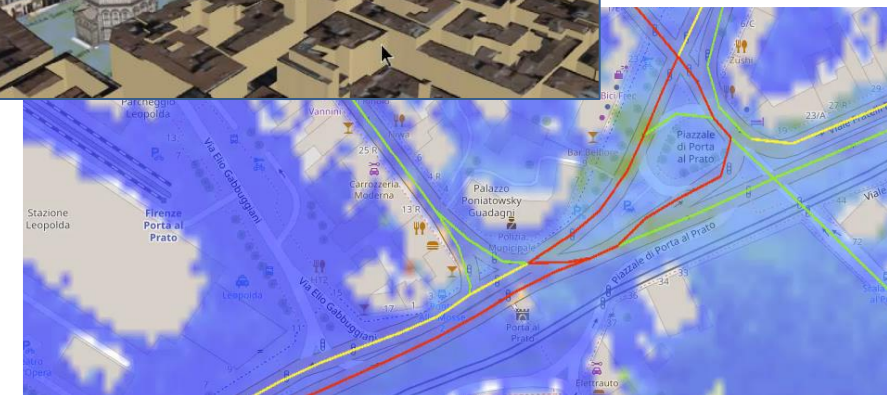
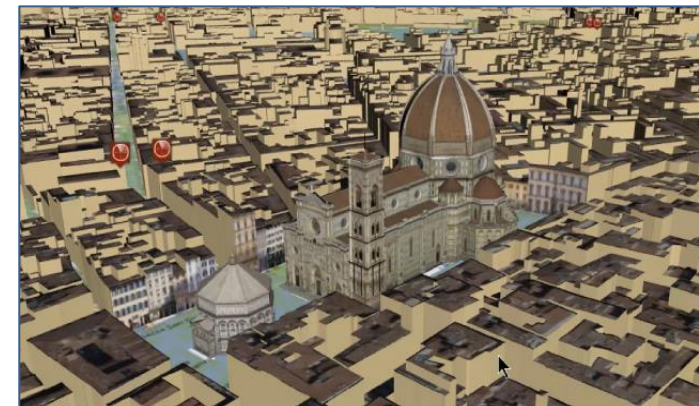
SNAP4CITY THE VIEW OF THE ADMINISTRATORS



100% OPEN SOURCE



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



Control Room



Smart City Control Room Florence Metropolitan City



reference



- **Multiple Domain Data**

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

- **Multiple dash/tool Levels & Decision Makers**

- Real Time monitoring, Alerting, quality assess.
- Predictions, KPI, DSS, what-if analysis

- **Historical and Real Time data**

- Billions of Data

- **Services Exploited on:**

- Multiple Levels, Mobile Apps, API

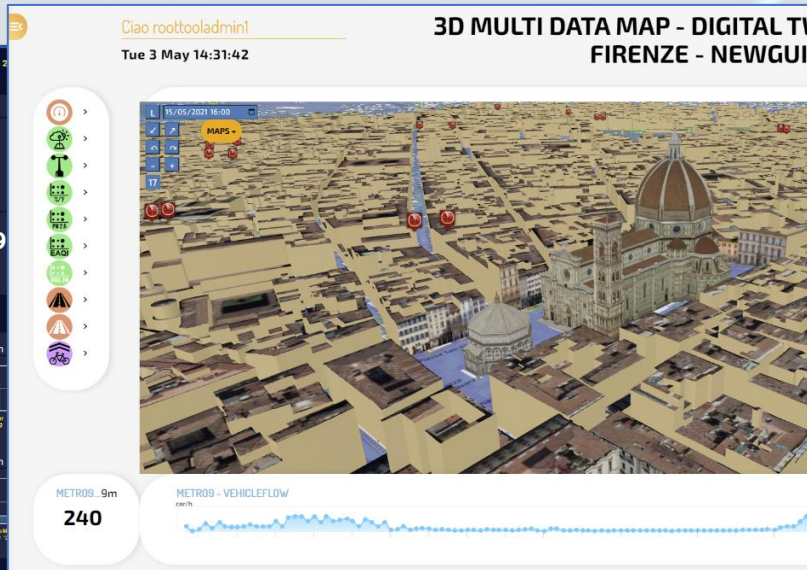
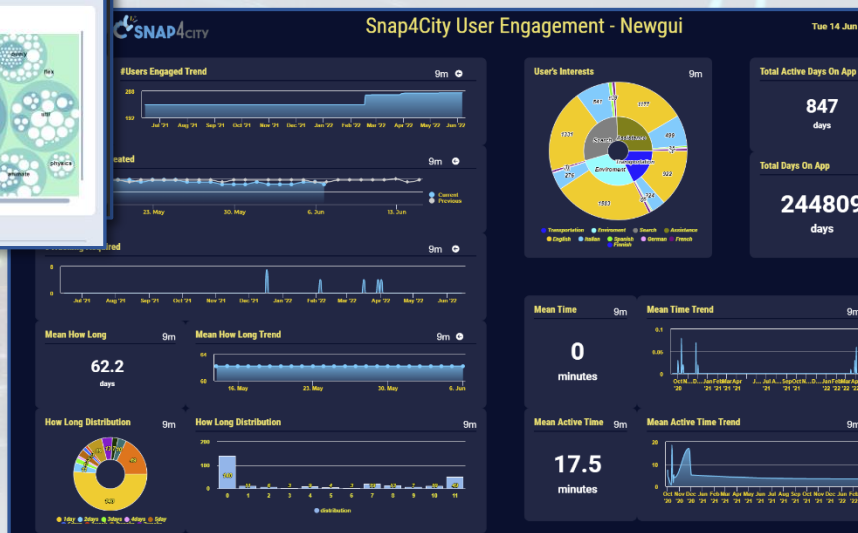
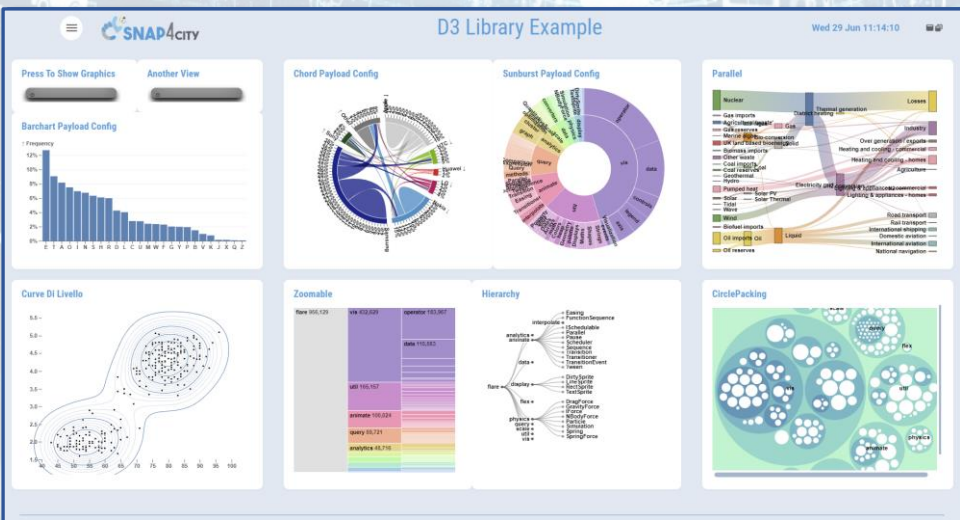
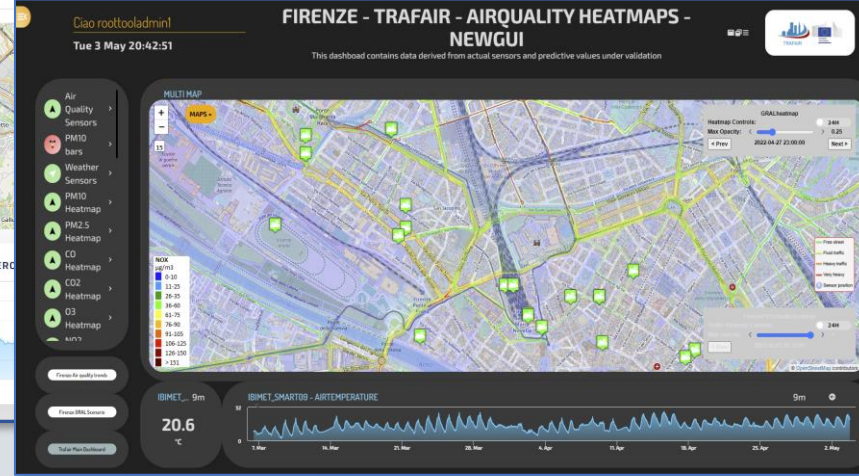
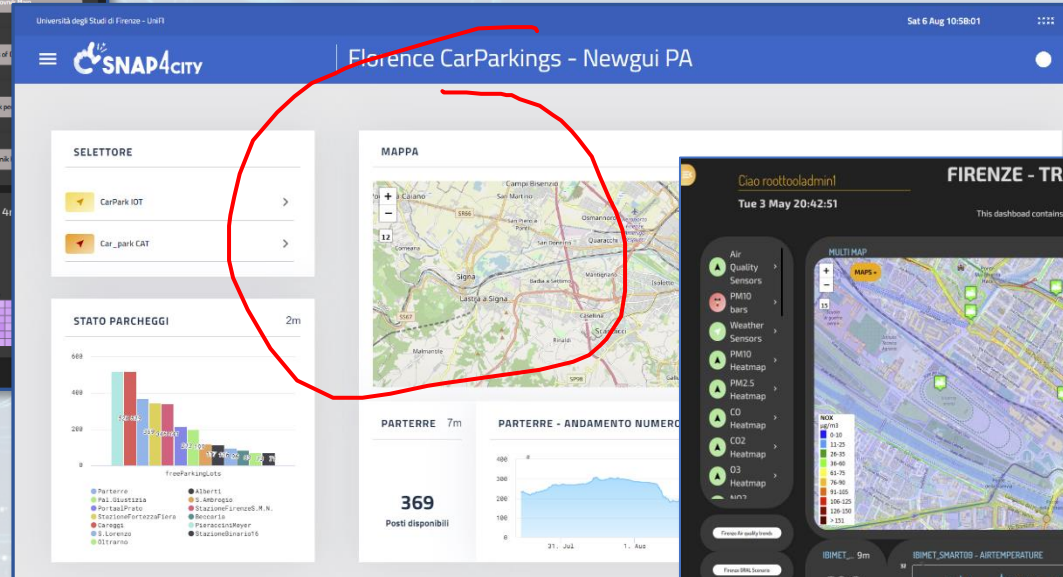
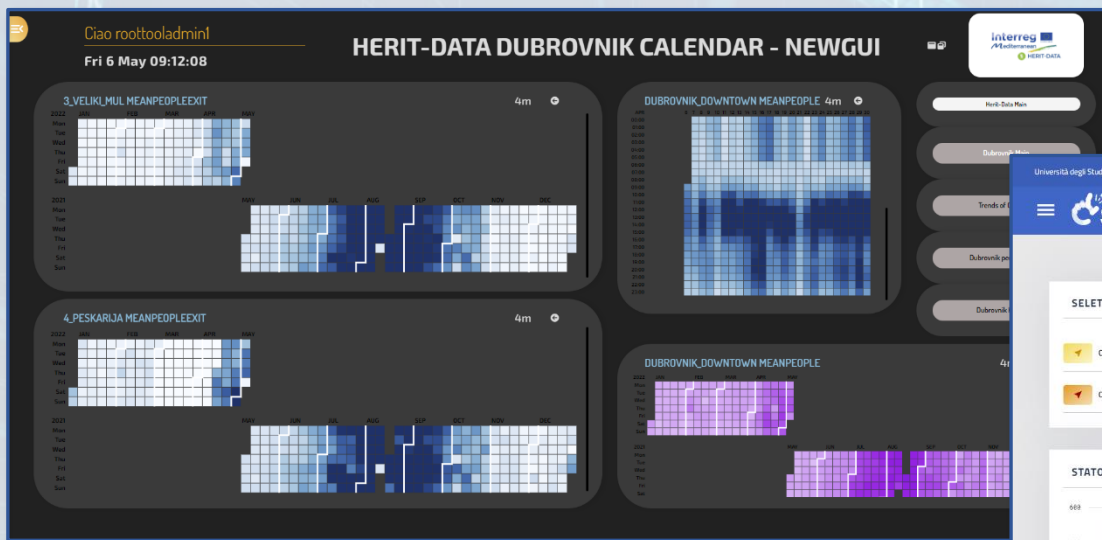
- **Since 2017**



<https://www.snap4city.org/747>



Different Themes



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

<https://www.snap4city.org/793>

Key Performance Indicators, KPI



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

Global
&
Local

Periodic
&
Realtime

Pollutant	Air Quality Directive			WHO guidelines	
	Averaging period	Objective and legal nature and concentration	Comments	Concentration	Comments
PM _{2.5}	One day			25 µg/m ³ (*)	99 th percentile (3 days/year)
PM _{2.5}	Calendar year	Target value, 25 µg/m ³	The target value has become a limit value since 1 January 2015	10 µg/m ³	
PM ₁₀	One day	Limit value, 50 µg/m ³	Not to be exceeded on more than 35 days per year.	50 µg/m ³ (*)	99 th percentile (3 days/year)
PM ₁₀	Calendar year	Limit value, 40 µg/m ³ (*)		20 µg/m ³	
O ₃	Maximum daily 8-hour mean	Target value, 120 µg/m ³	Not to be exceeded on more than 25 days per year, averaged over three years	100 µg/m ³	
NO ₂	One hour	Limit value, 200 µg/m ³ (*)	Not to be exceeded more than 18 times a calendar year	200 µg/m ³ (*)	
NO ₂	Calendar year	Limit value, 40 µg/m ³		40 µg/m ³	

15MinCityIndex

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

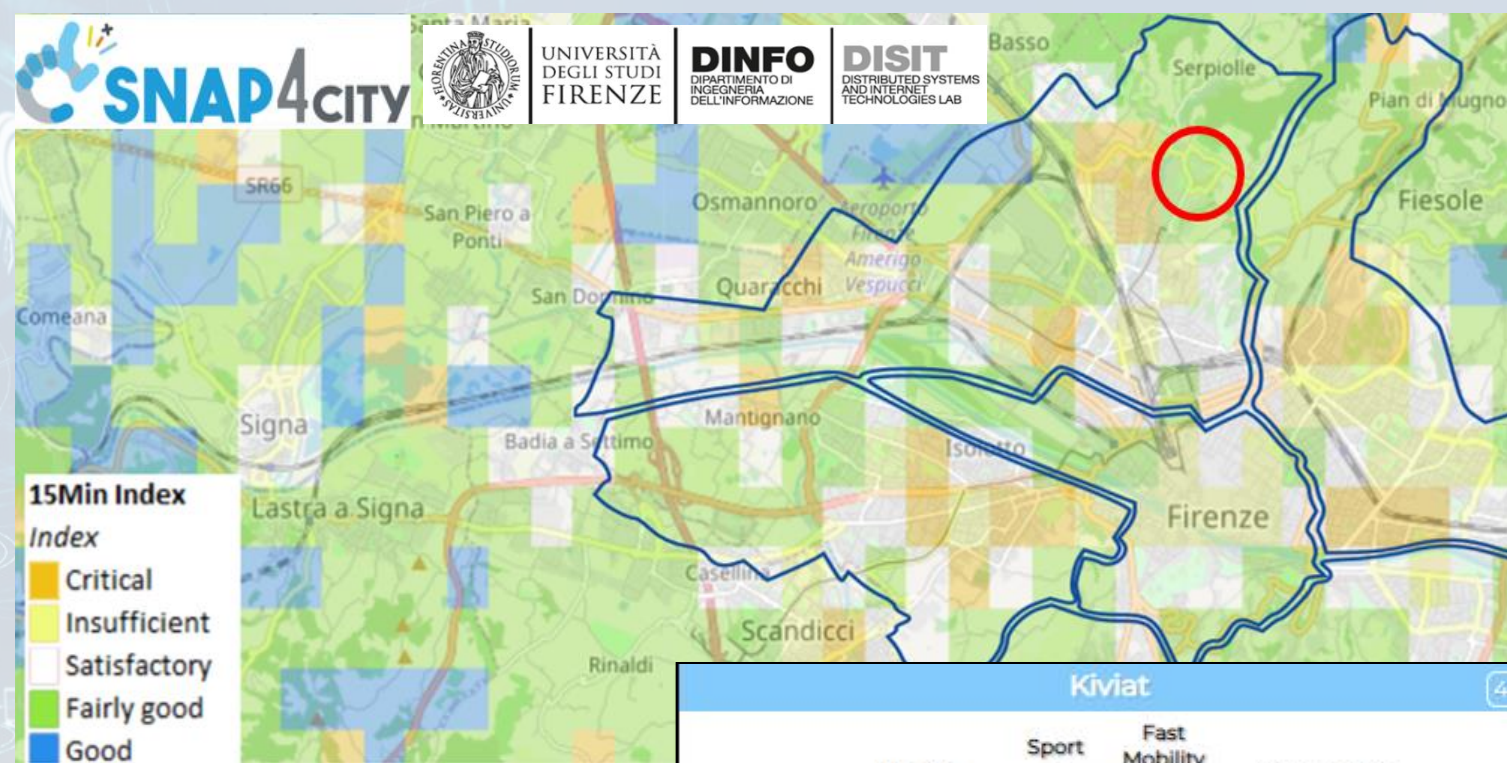
Using the Open Data:

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.

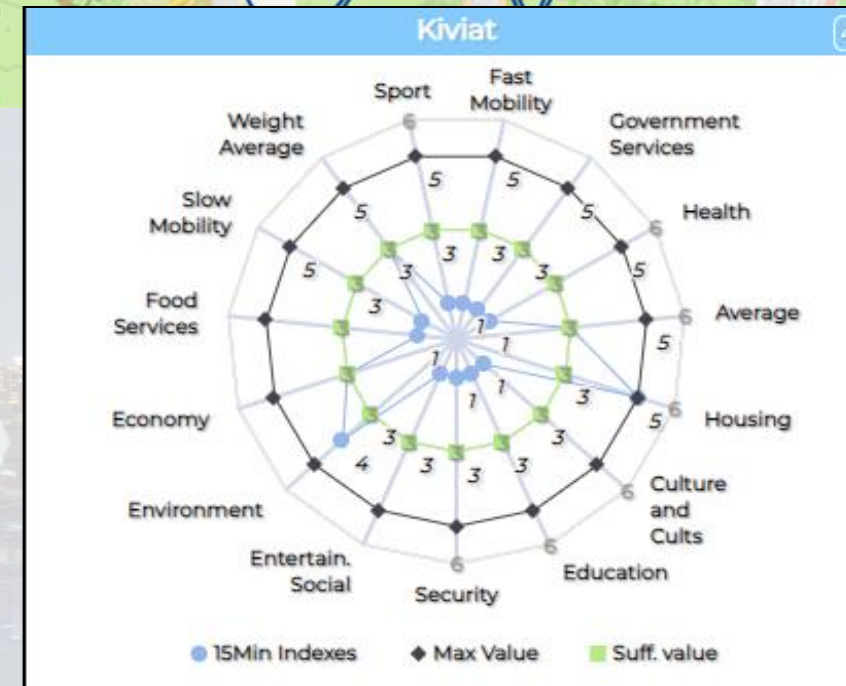
Good public transport services: bus, new tram line, train stations, cycle paths.



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?iddashboard=MjkzOA==>

15MinCityIndex on Bologna



Ciao roottooladmin!

Tue 3 May 20:14:59

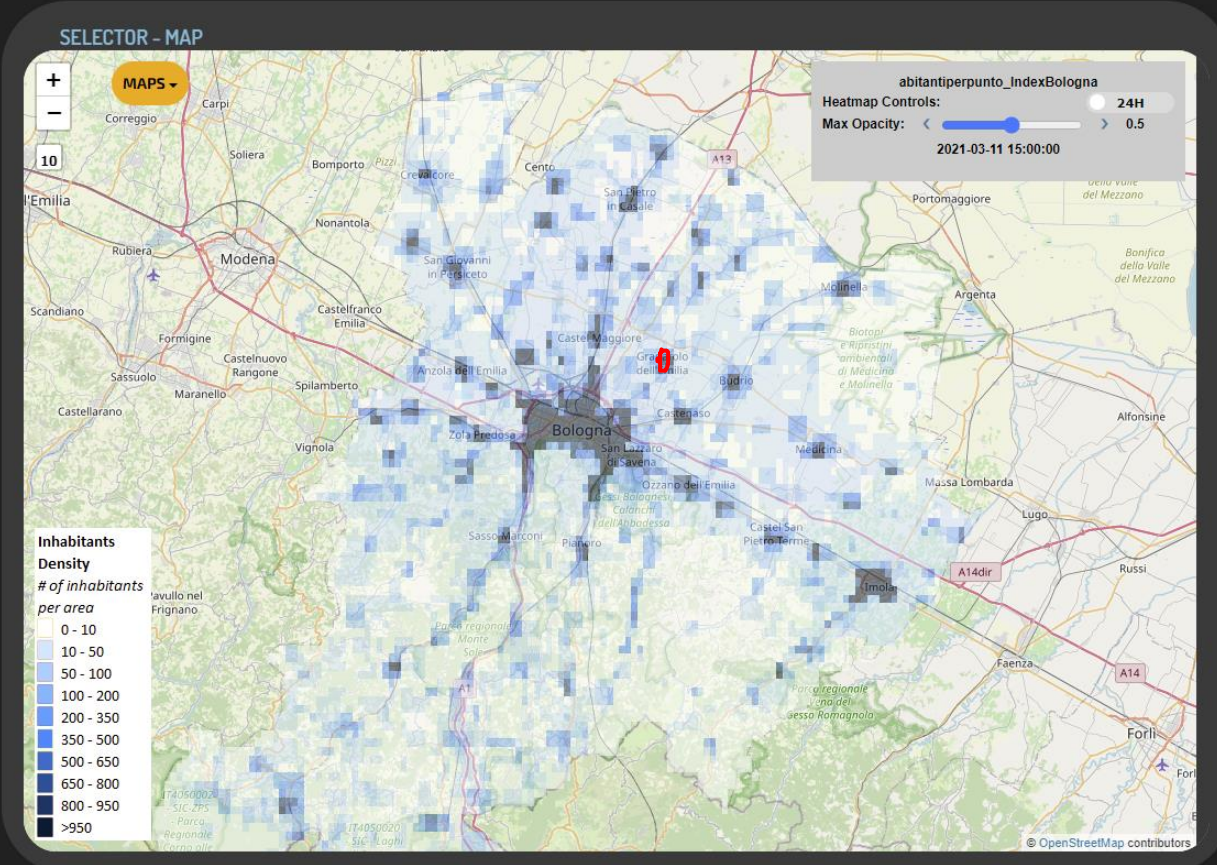
15 MINUTI INDEX BOLOGNA CITTÀ METROPOLITANA - NEWGUI



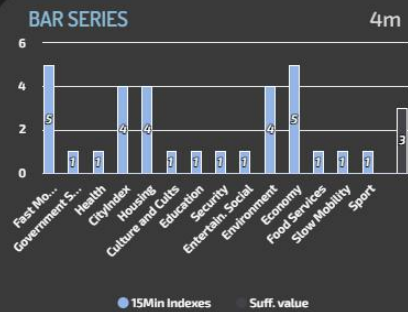
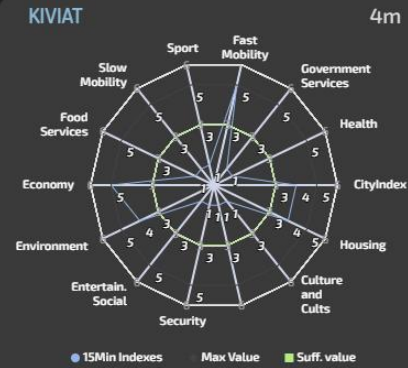
- # of Inhabitants
- Green factor
- Civil factor
- Industrialization factor
- Environment Index
- 15Min Economy Index
- 15Min Housing Index
- 15Min Health Index
- 15Min Food Index
- 15Min Education Index
- 15Min Slow Mob Index

THE PICKED POINT 9m

City: Argelato
Address: Via Casadio N. 1
Lat,lon: 44.61882,11.35437



Argelato : Via Casadio N. 1



IoT App....

Snap4City

User: roottooladmin1, Org: DISIT
Role: RootAdmin, Level: 7

[Logout](#)

- My Snap4City.org
- Dashboards
- My Dashboards in All Org.
- Dashboards of My Organization
- My Dashboards in My Organization
- Extra Dashboard Widgets
- Notifier
- Data, my Data, OpenData
- Knowledge and Maps
- IOT Applications
 - IOT Applications
 - MicroServices for IOT Applications
 - MicroServices from DataAnalytic
 - IOT MicroServices for Final Users
 - IOT MicroServices for Developers
 - Doc: IOT Applications
 - How to Develop IOT Applications
 - Create A MicroService from RestCall
- IOT Directory and Devices
- Resource Manager
- Development Tools
- Management
- Decision Support Systems
- Settings
- User Management and Auditing
- Help and Contacts

Node-RED

15MinIndex

GPS to COMUNE | GPS to COUNT | GPS to HeatmapVal | GPS to Florence Qu | GPS to ZCS | GPS and Values to

filter nodes

subflows

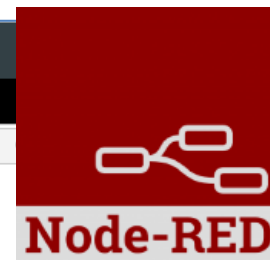
- InjectedTimes

input

- inject
- catch
- status
- link
- mqtt
- http
- websocket
- tcp
- udp
- amqp2
- stomp

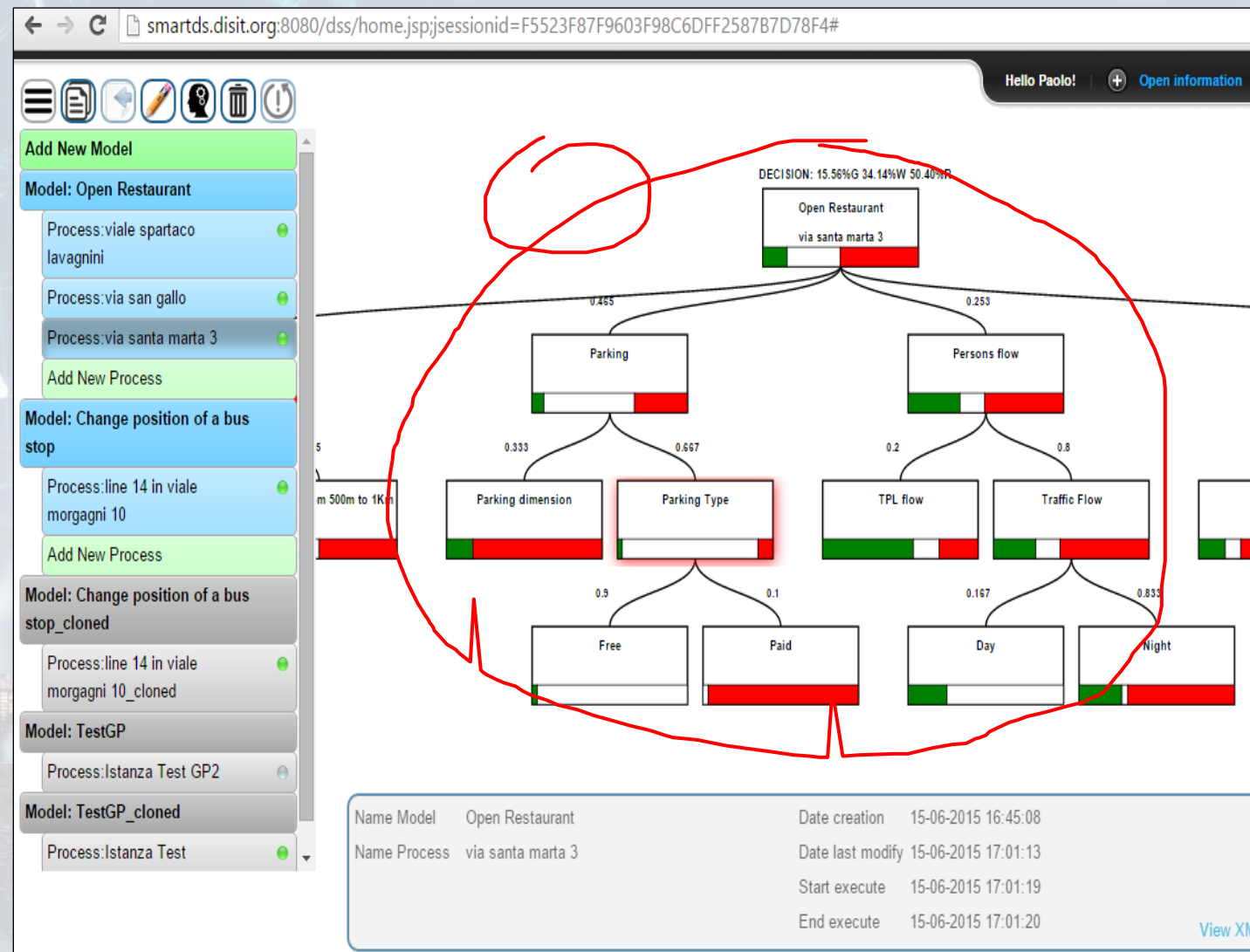
output

- debug
- link
- mqtt
- http response
- websocket
- tcp

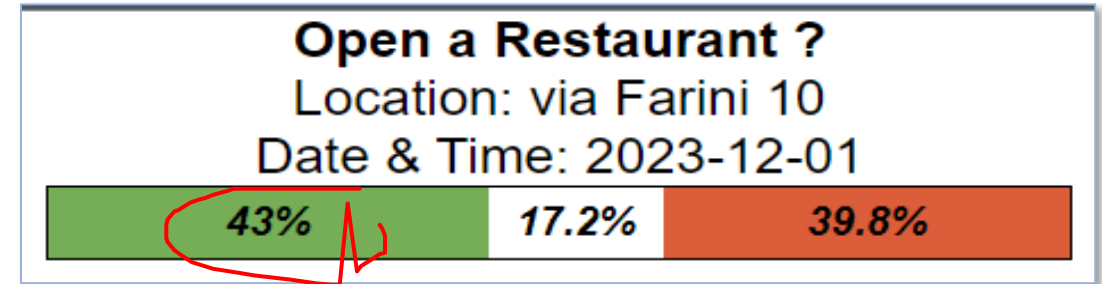


Smart Decision Support, system thinking

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



- Supports the definition of the **Decision Tree Model, DTM**, in terms of System Thinking, with Italian Flag and combinations
- Allows the **statistic composition** of subDecisions probabilities
- **Generating a DTM as an IoT App,**
- **IoT Apps with DTM can**
 - be customized
 - compute root values in real time in any context: location, parameters, etc.
 - Single DTM root value can be produced on Dashboard
 - Several DRM root values can be represented on dashboard as heatmaps for Green/White/Red values

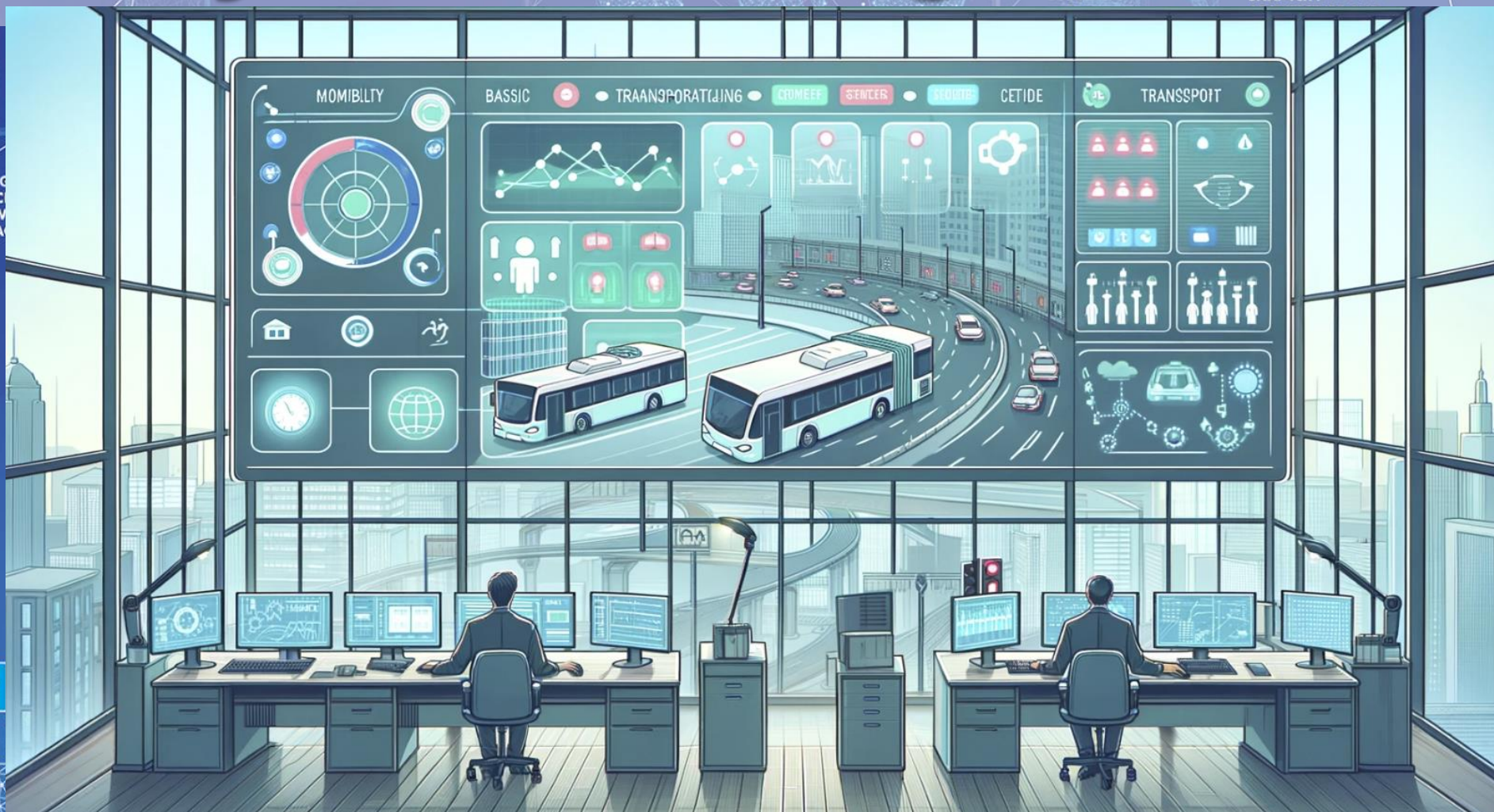




Mobility Monitoring and Control

FROM CITY
DASHBOARD TO
APPLICATIONS

DATA C
AND C
KNOW
MANA



HOW TO ADOPT
SNAP4CITY, AND
OUR ROADMAP

SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS

SNAP4CITY
AND KM4CITY
PROJECTS

SNAP4CITY FOR
BEGINNERS

SNAP4CITY

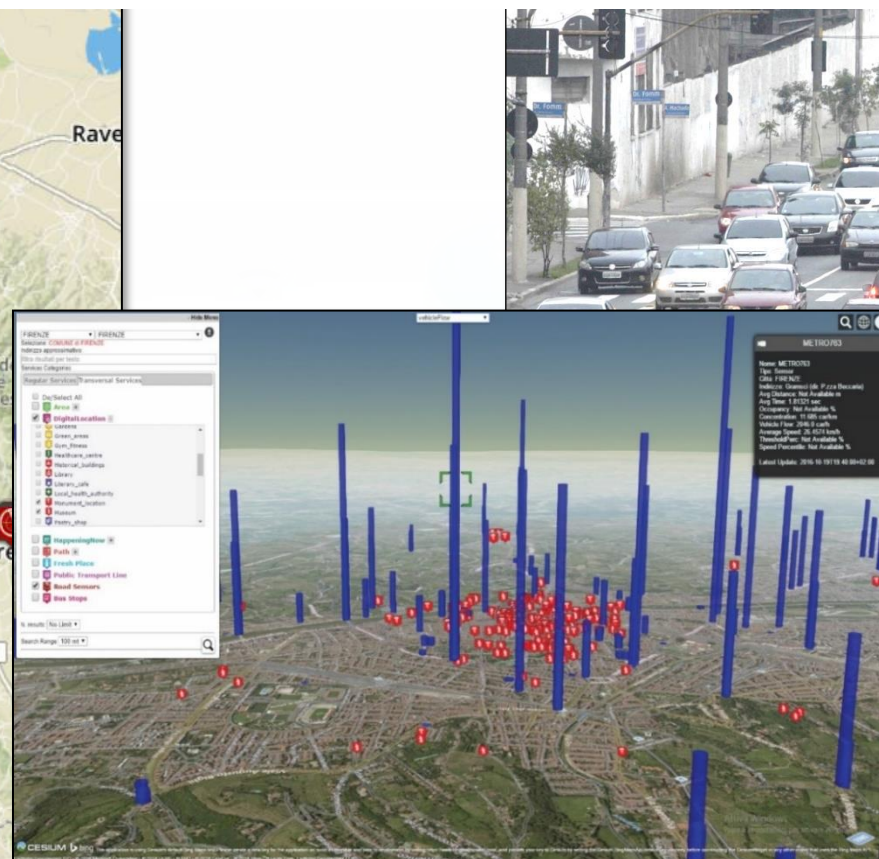
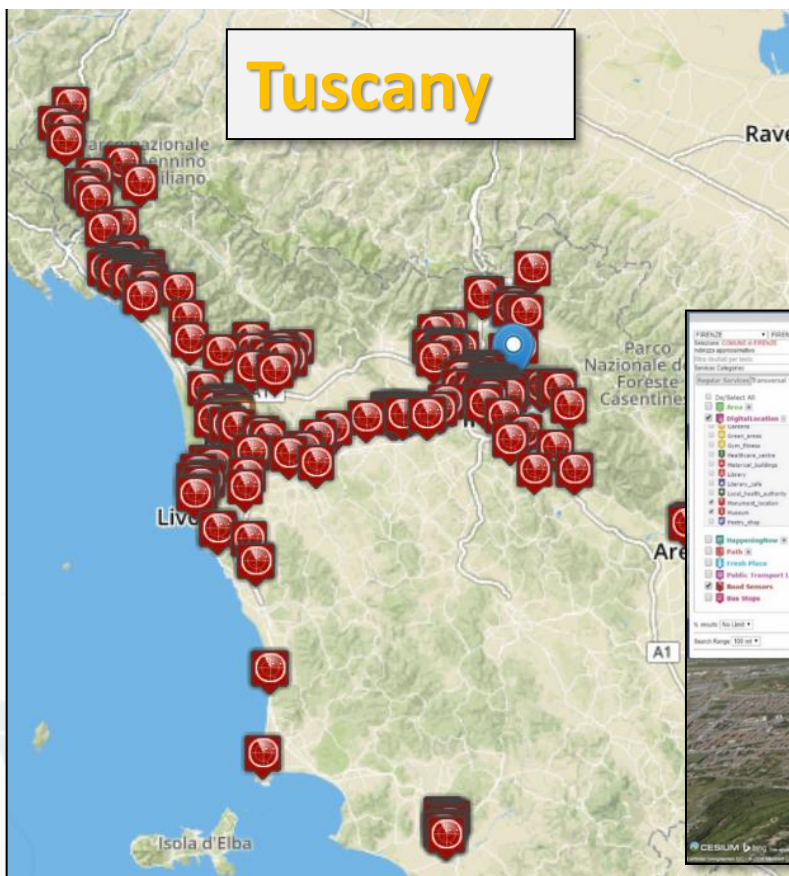
TWITTER
GHT
7
IA
NALIS

ORING &
MAING
EN
AND FLEXIB
WEB
AND MOB
APPS



Traffic Flow Tools

Spire and Virtual Spires (cameras), Bluetooth, ...
Specifically located: along, around, on gates, on x...



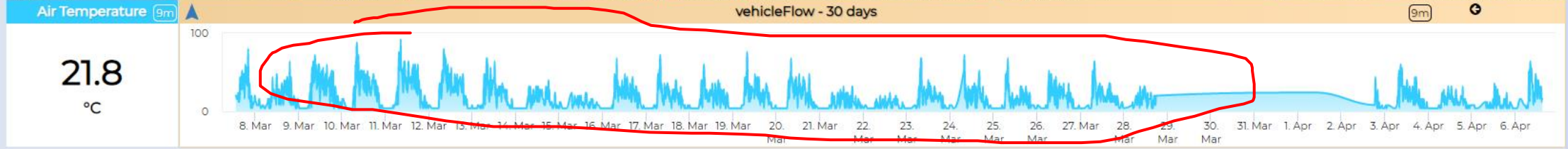
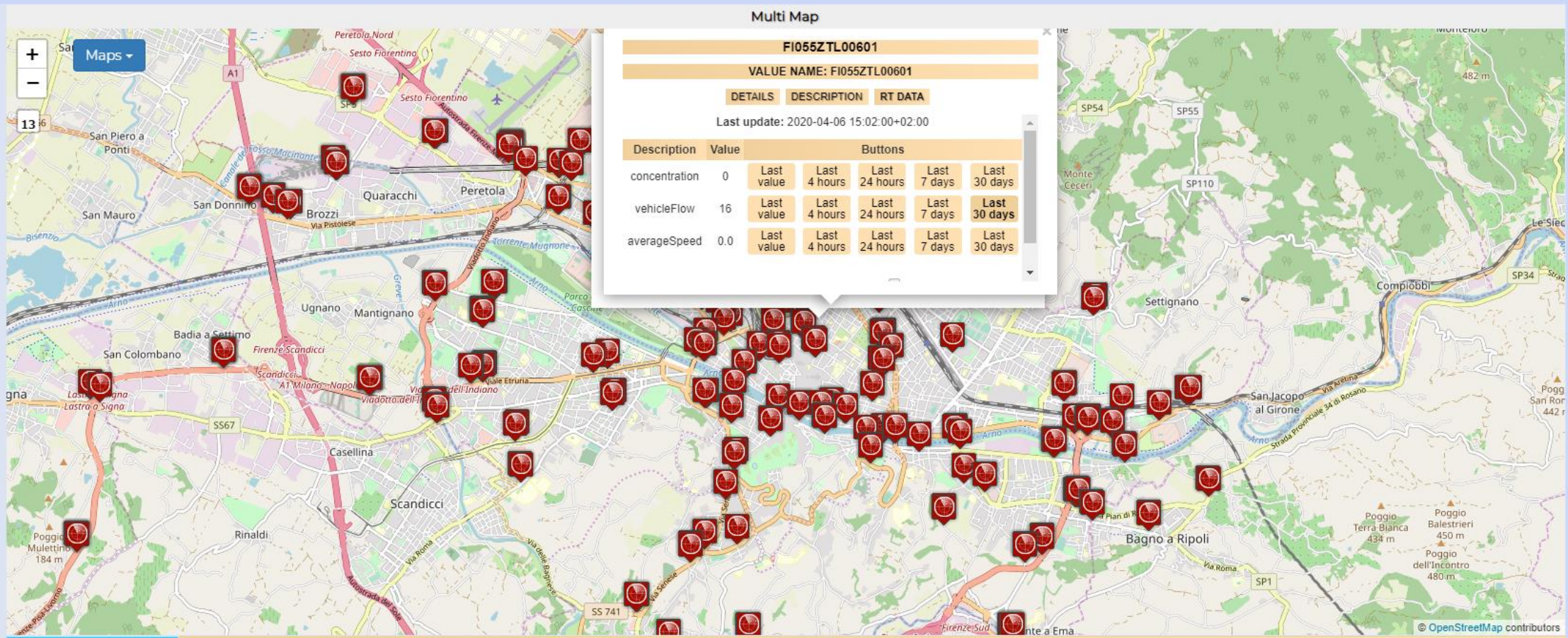
Firenze - Trafair - AirQuality Heatmaps



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

Mon 6 Apr 15:12:27

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



Air quality trends

<https://www.snap4city.org/dashboardSmartCity/view/index.php?iddashboard=MTUzMg==>

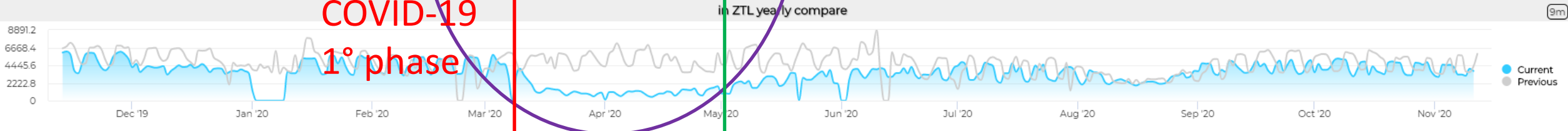
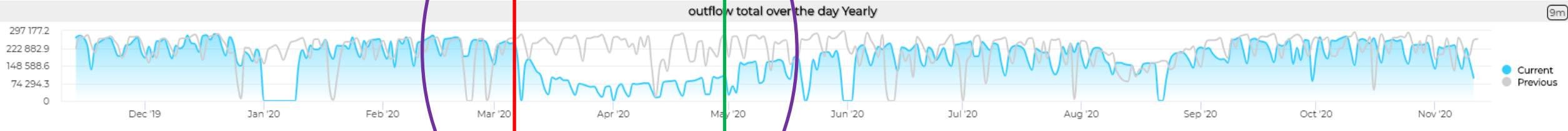
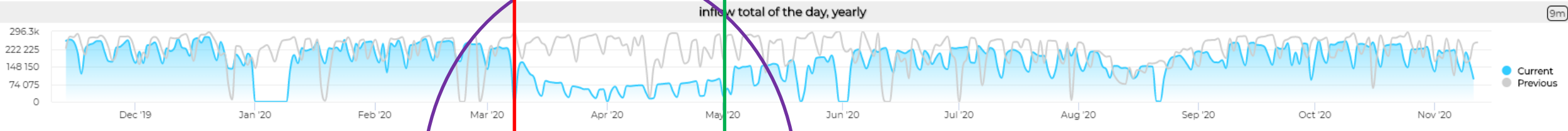
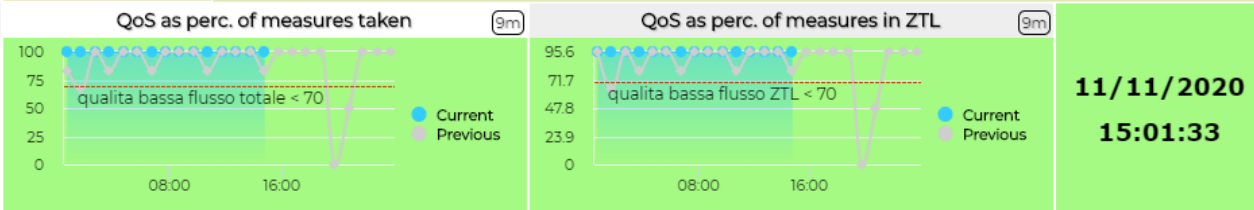
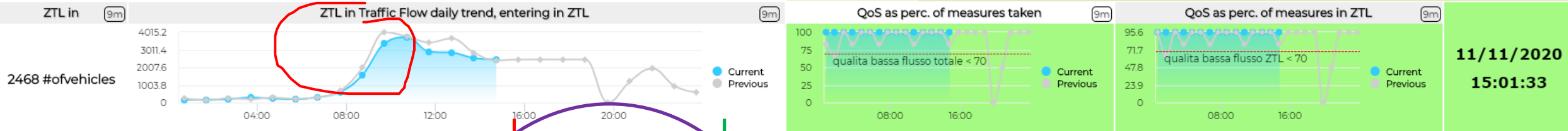
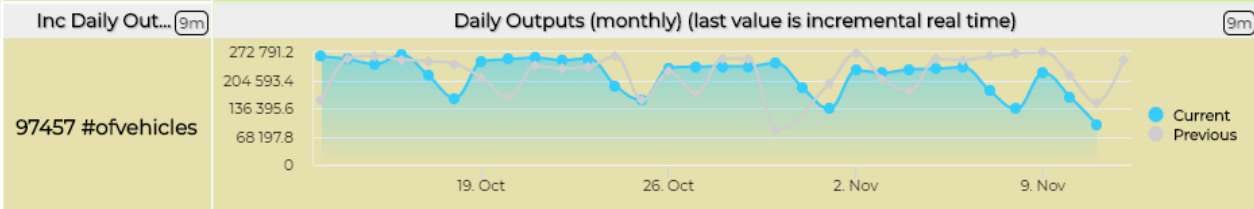
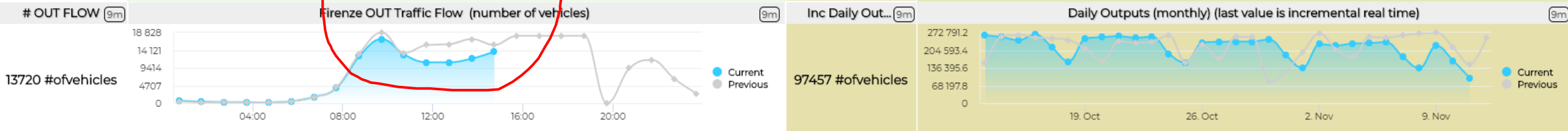
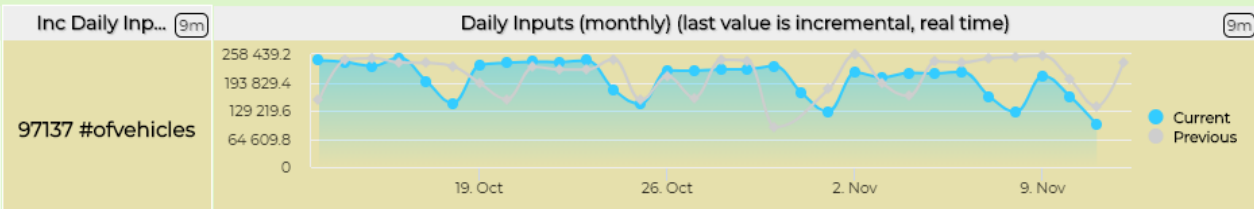
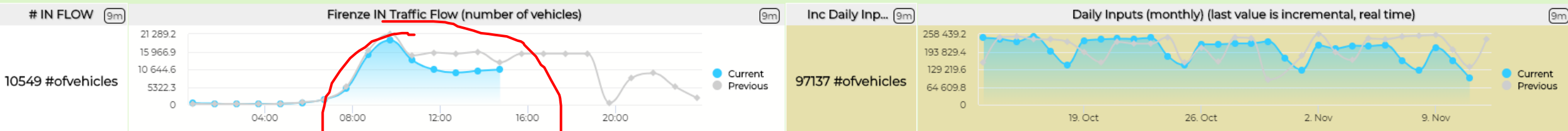
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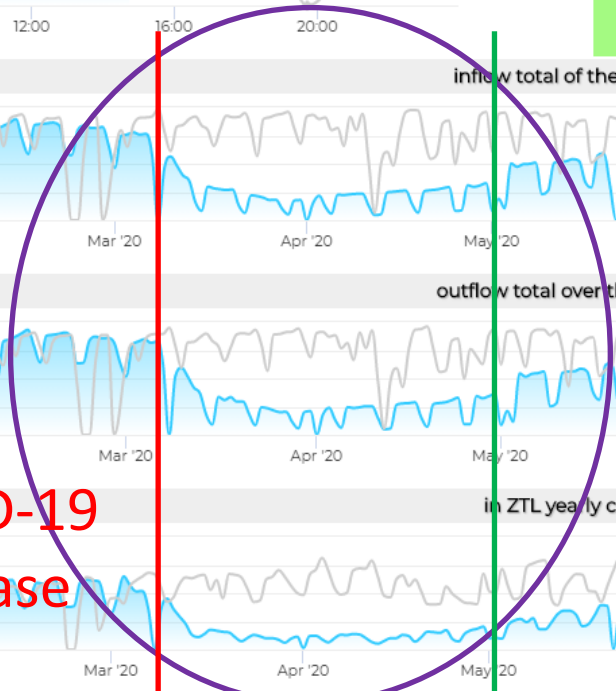


Traffic Flow Monitoring - Firenze - Cloned2

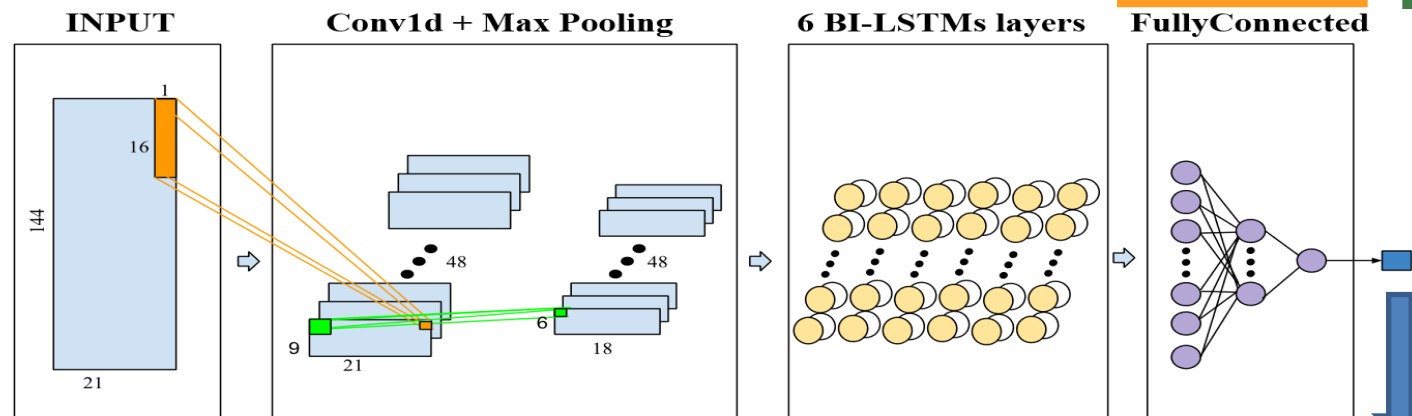
Wed 11 Nov 15:01:32



COVID-19
1° phase

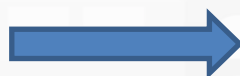


Short-Term Prediction of City Traffic Flow via Convolutional Deep Learning



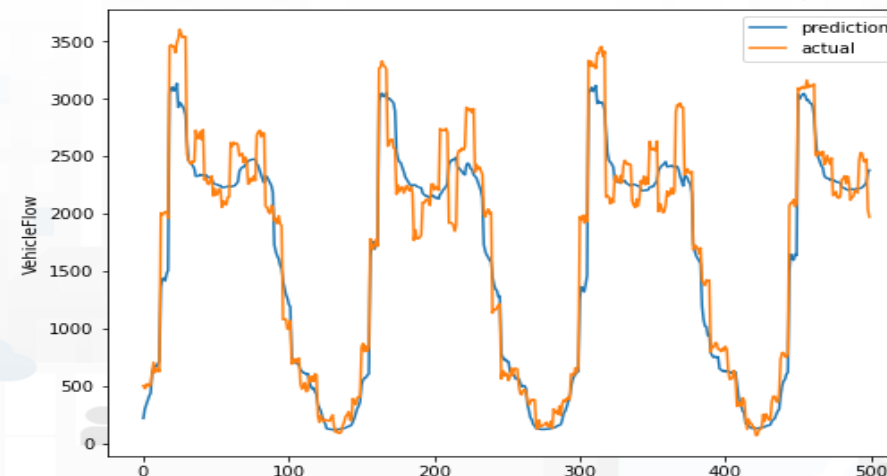
Urban data:

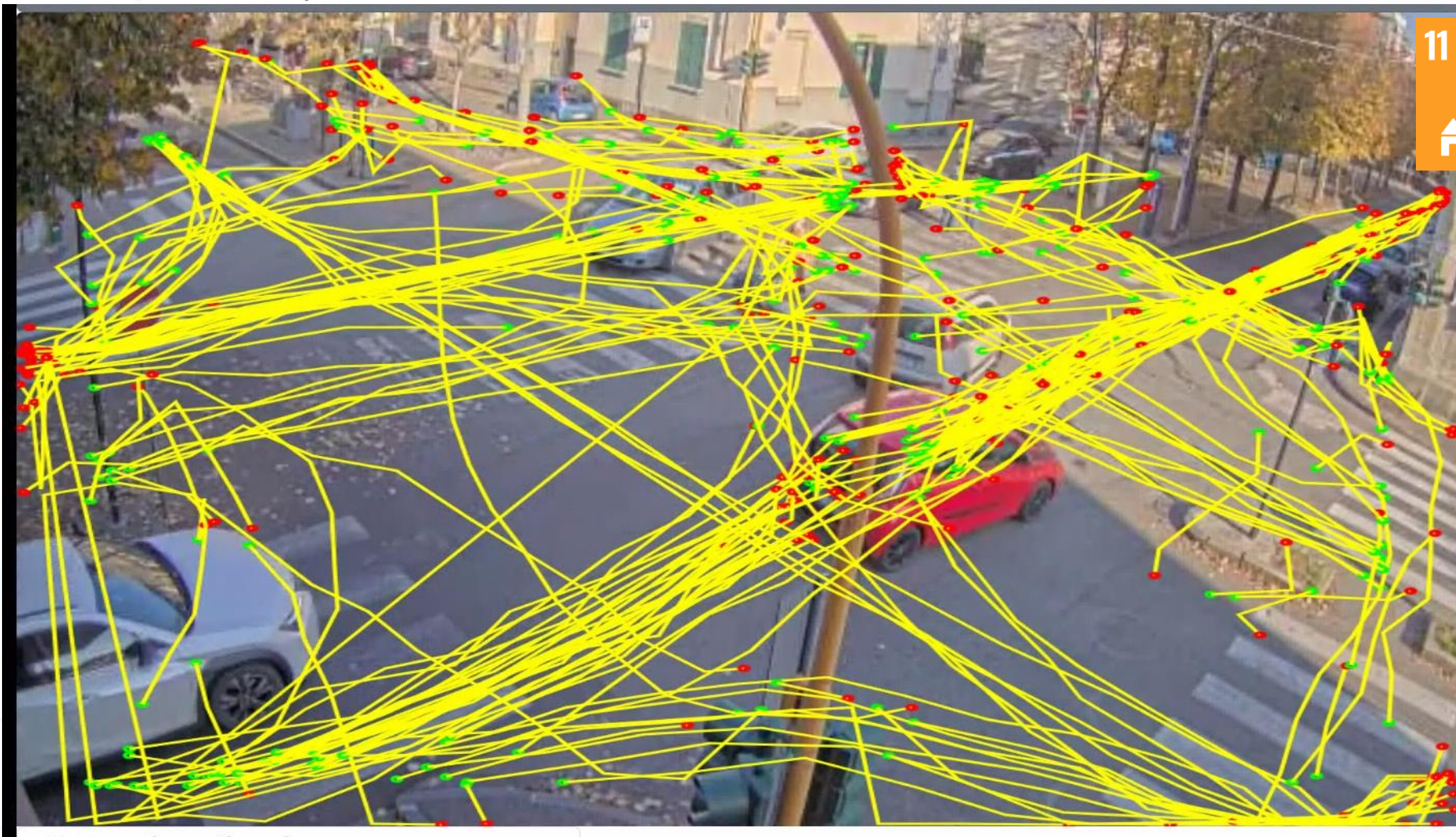
- Date-time
- Traffic
- Temporal
- Seasonality
- Pollution
- Weather



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

CONV-BI-LSTM

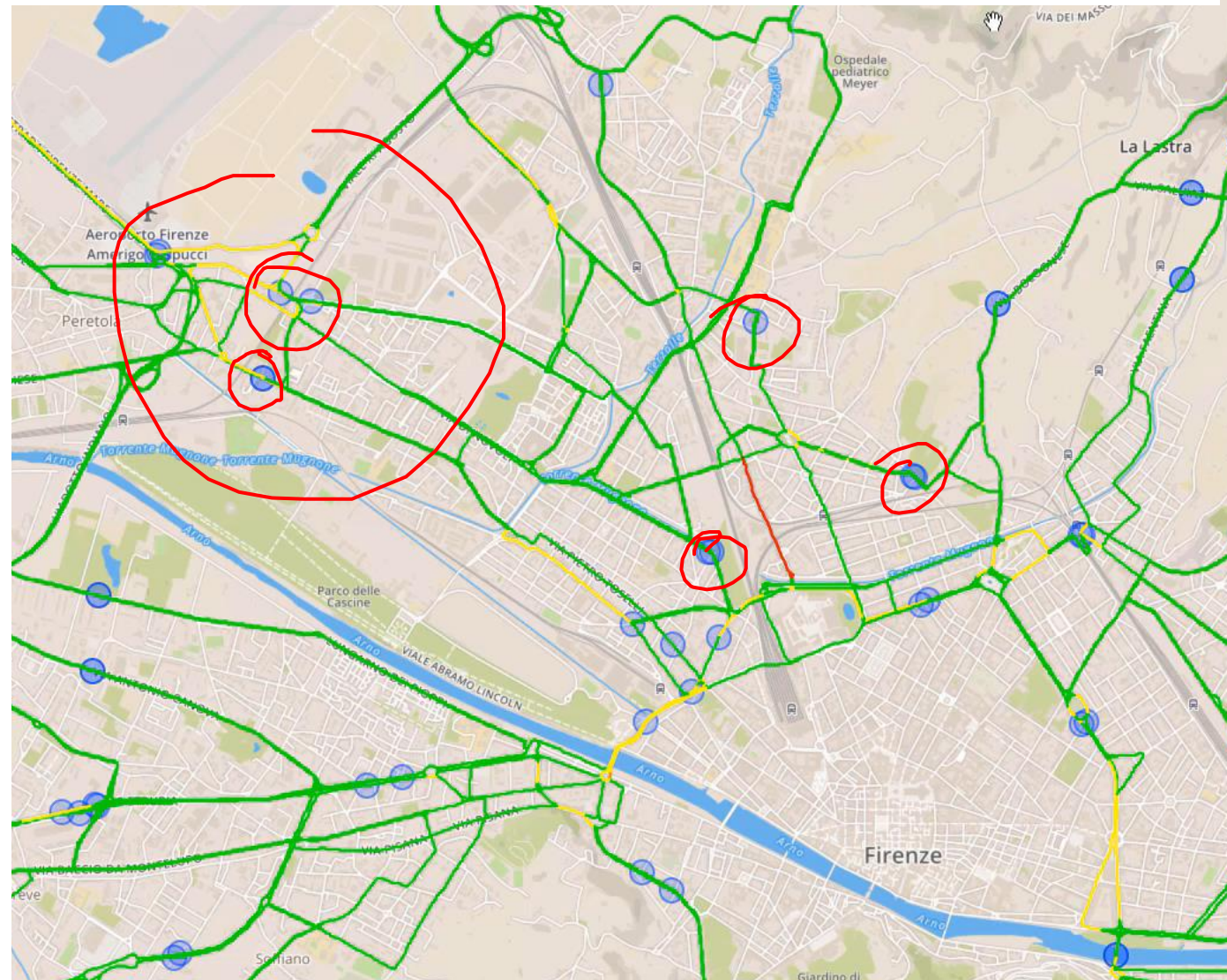




11 SUSTAINABLE CITIES
AND COMMUNITIES

Dense Traffic Flow Reconstruction ?

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

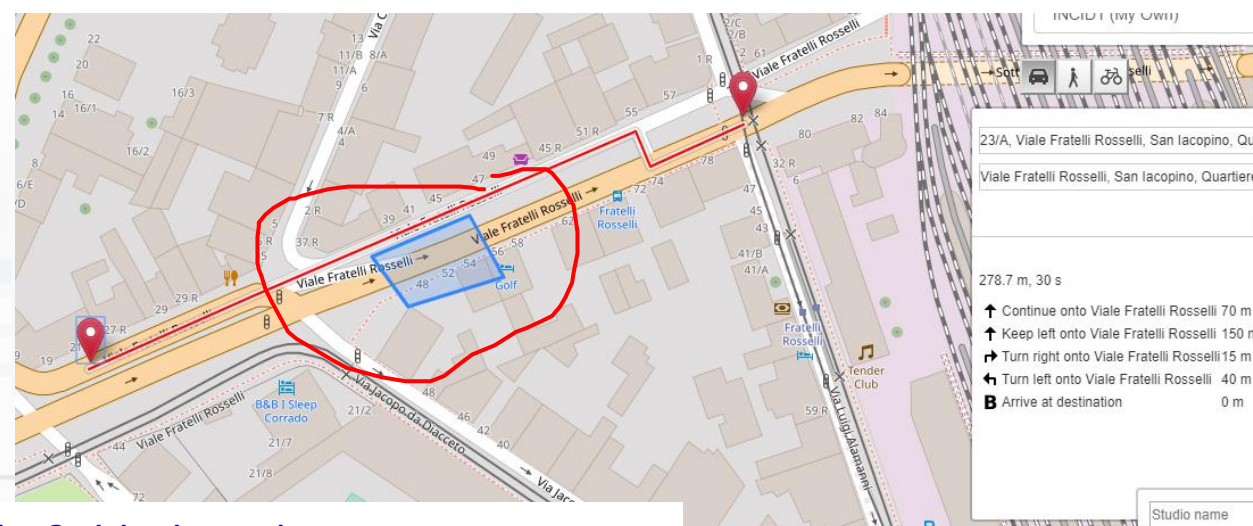
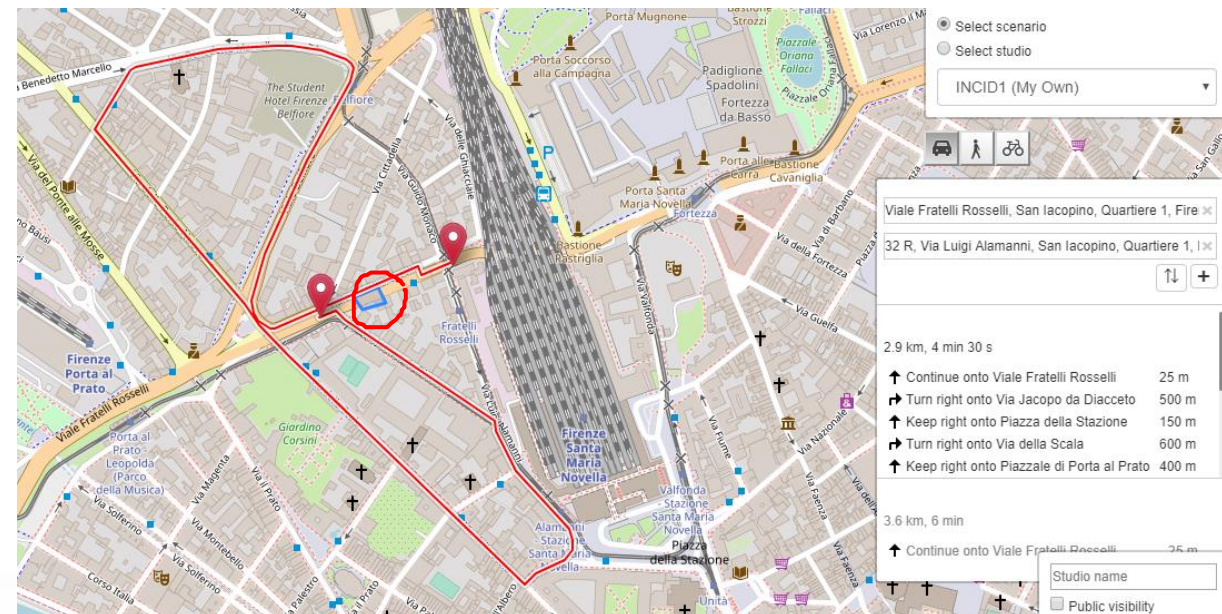


Accidents and elements blocking Points and Shapes taken into account for:

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

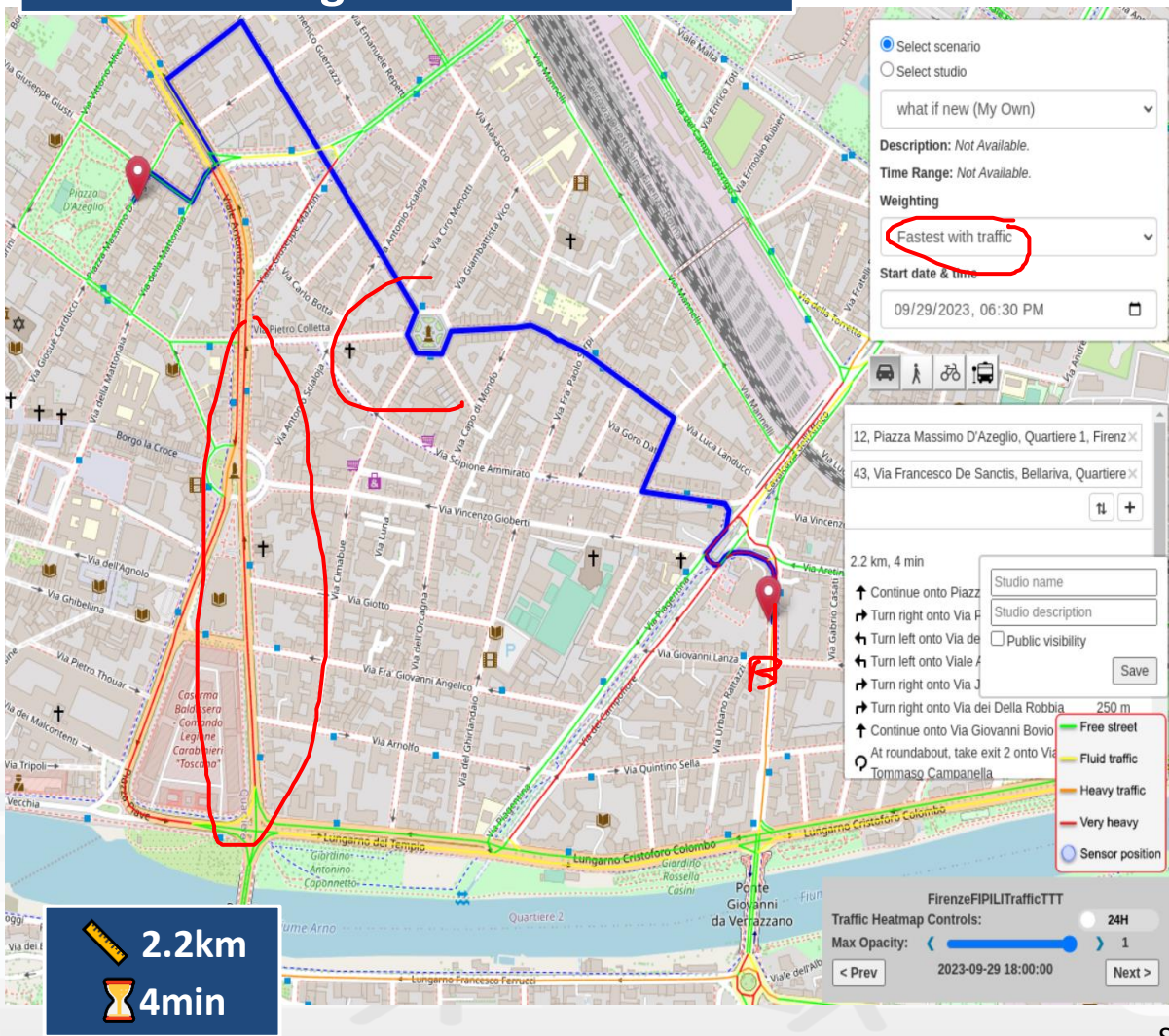
Assessment on the basis of changes:

- Mobility demand assessment
- Mobility Offer assessment

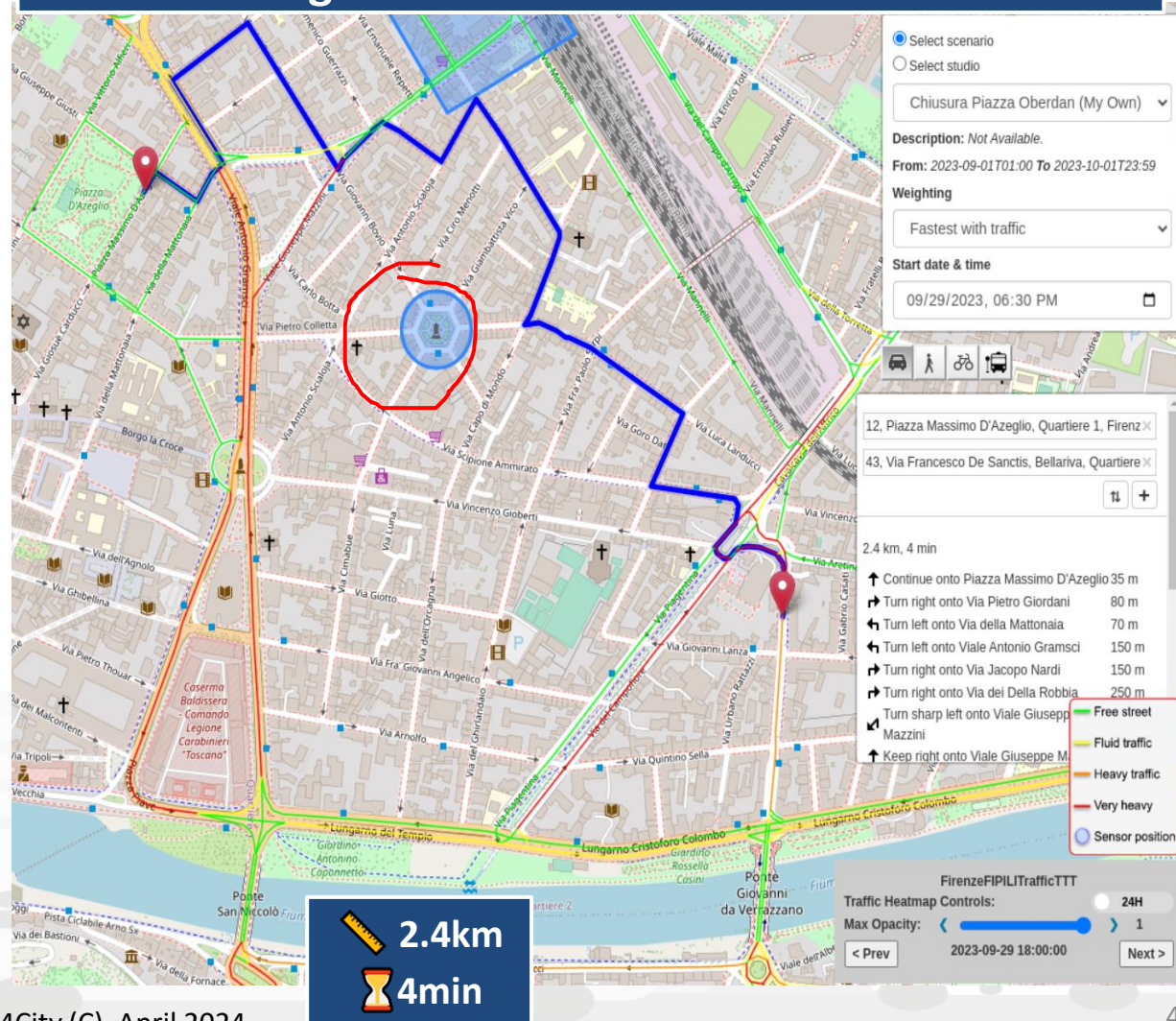


Constrained Dynamic Routing: Traffic Flow

Fastest taking into account traffic

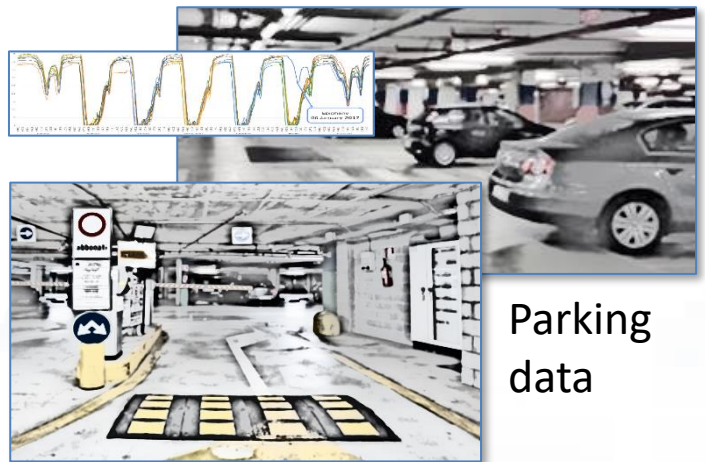


Fastest taking into account traffic and blocked areas





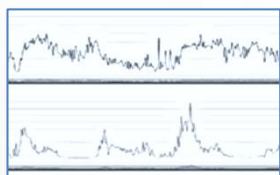
Deep Learning AI to surely Park!



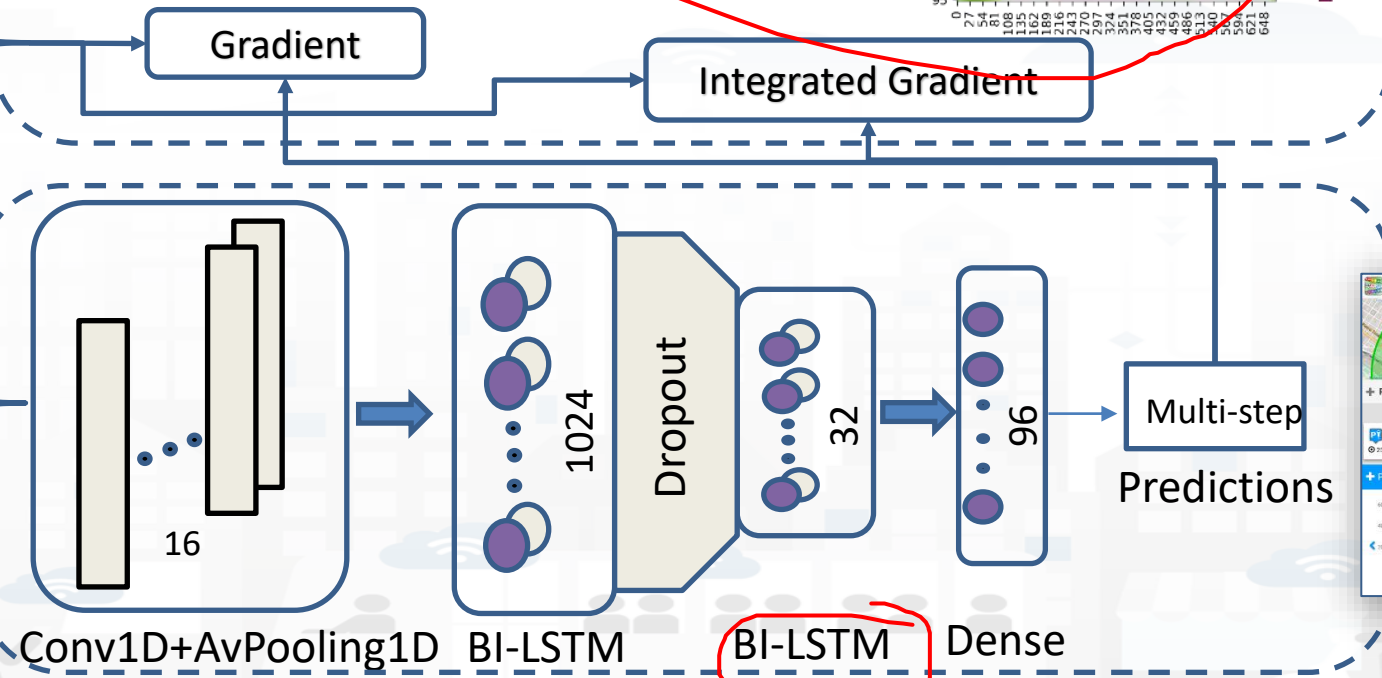
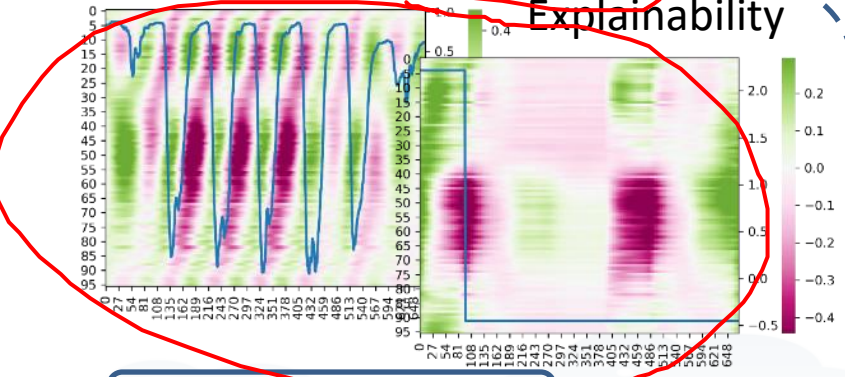
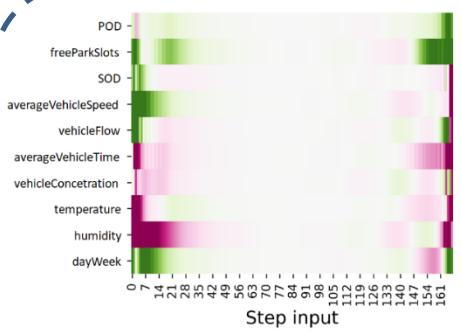
Parking data



Traffic sensors data



Weather Features



Snap4ISPRA Parking: ISPRA JRC



SNAP4CITY Parking 58C Fri 6 Oct 18:33:41

A1_1	A1_2	A1_3	A1_4	A1_5	A1_6	A1_7	A1_8	A1_9	A1_10	A1_11	A1_12	A1_13	A1_14	A1_15	A1_16	A1_17	A1_18	A1_19	A1_20	A1_21	A1_22	A1_23	A1_24	A1_25	A1_26	A1_27	A1_28	A1_29	A1_30	A1_31	A1_32	A1_33	A1_34	A1_35	A1_36	A1_37	A1_38	A1_39	A1_40	A1_41	A1_42	A1_43	A1_44	A1_45	A1_46	A1_47	A1_48	A1_49	A1_50	A1_51	A1_52	A1_53	A1_54	A1_55	A1_56	A1_57	A1_58	A1_59	A1_60	A1_61	A1_62	A1_63	A1_64	A1_65	A1_66	A1_76	A1_77	A1_78	A1_79	A1_80	A1_81	A1_82	A1_83	A1_84	A1_85	A1_67	A1_68	A1_69	A1_70	A1_71	A1_72	A1_73	A1_74	A1_75
------	------	------	------	------	------	------	------	------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

Capacity 9m Free Slots 9m Occupanc... 9m
85# 74# 12.9%

OverparkingSlots 9m Unknown State Slots 9m
0# 3#

Free Slots Weekly Time Trend Compare 9m

Percentage Of Occupancy Daily Time Trend Com...9m

Overparking Weekly Time Trend Compare 9m

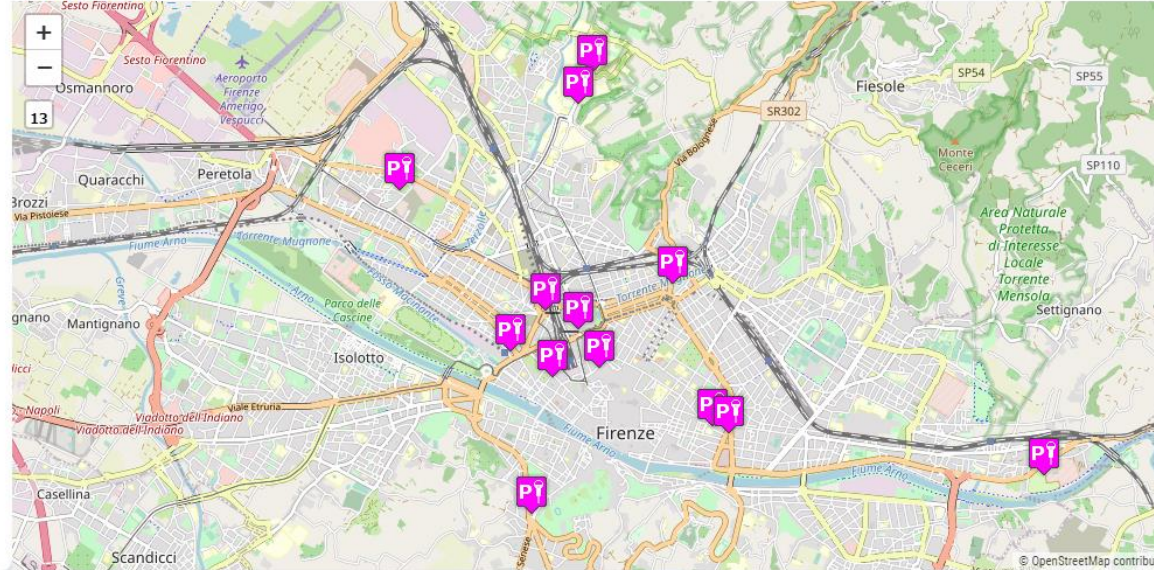
Time Trend Comparison 4m



Selector

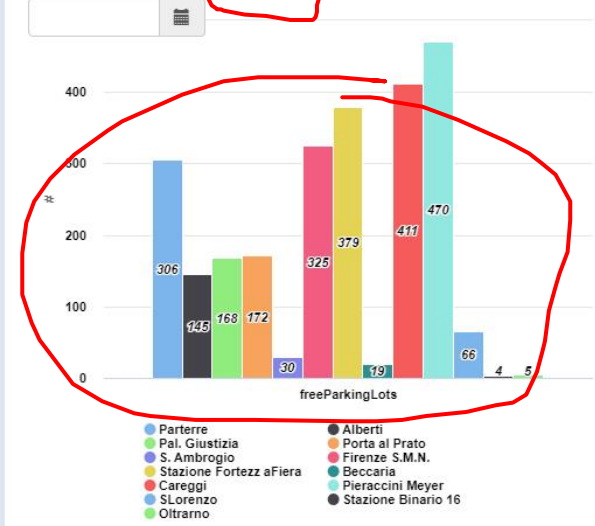
- Parterre
- Piazza Alberti
- Palazzo di Giustizia
- Porta al Prato
- S. Ambrogio
- Stazione Firenze S.M.N.
- Stazione Fortezza Fiera
- Piazza Beccaria

Selector - Map



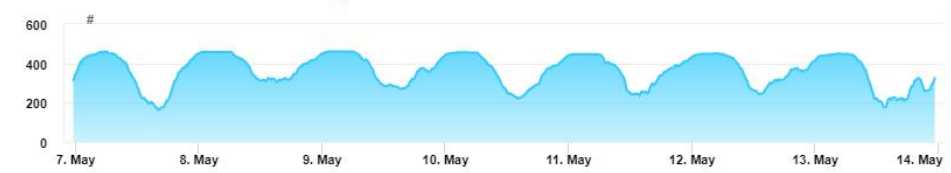
Parcheggi: Numero Posti Liberi

4m



Stazione Firenze S.M.N. - Free Parking Lots

9m



Andamento Posti Occupati

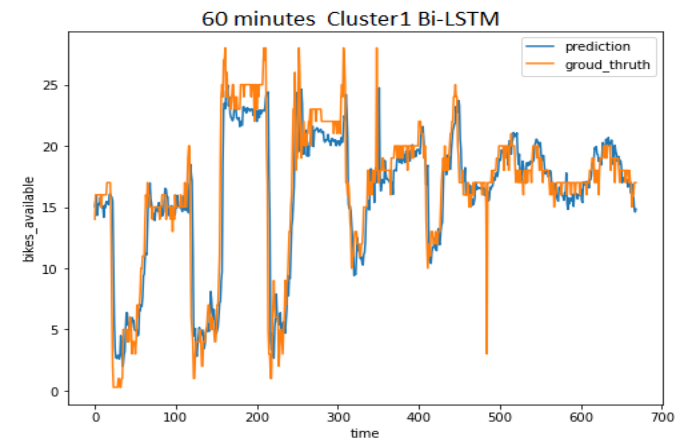
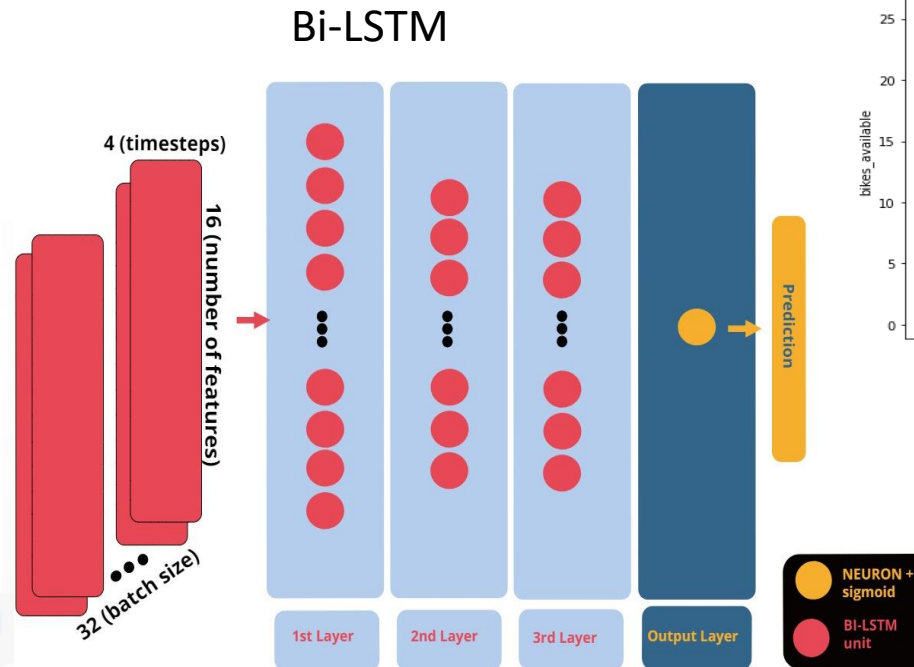
4m



My Profile



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

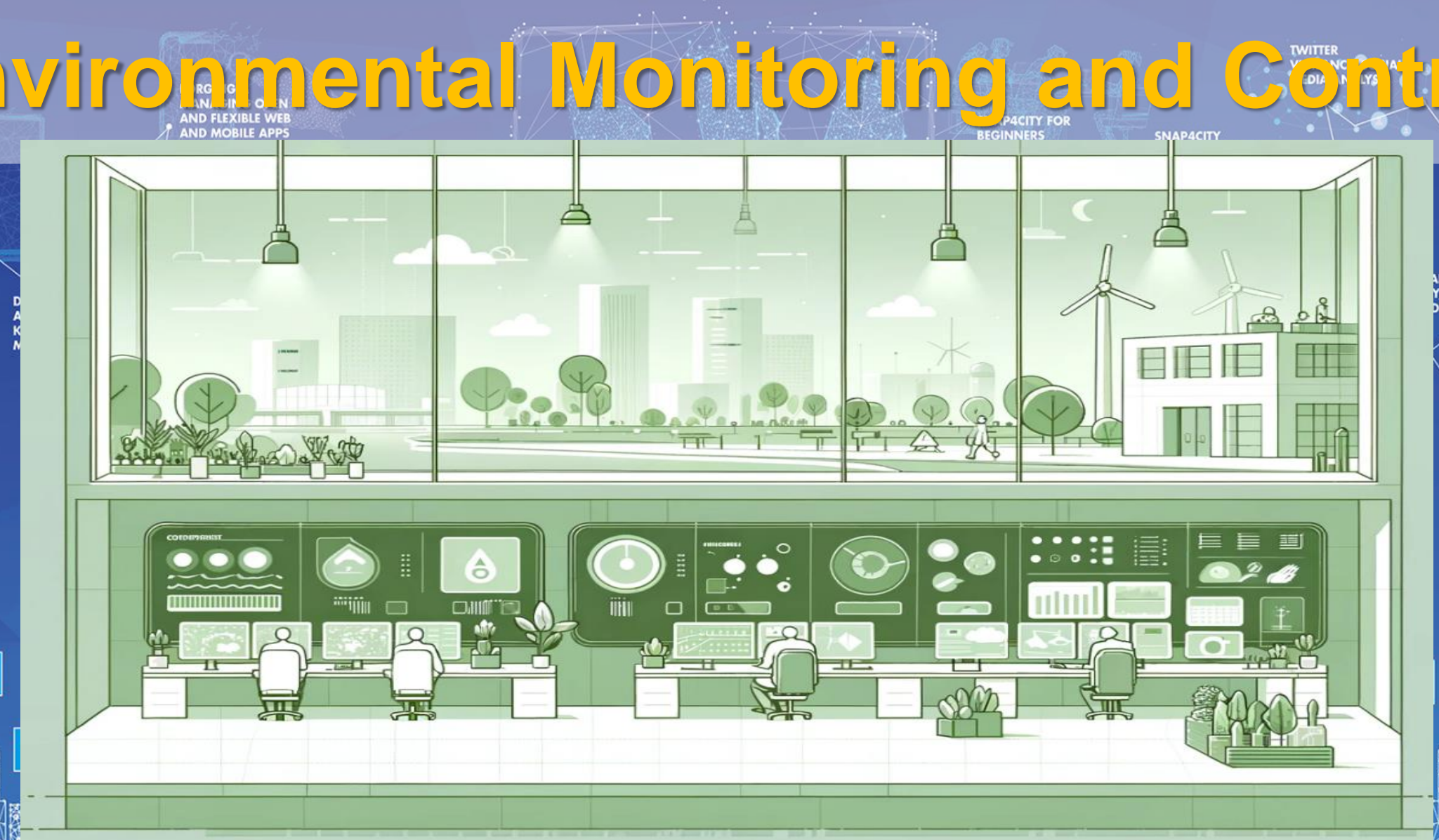


E. Collini, P. Nesi and G. Pantaleo, "Deep Learning for Short-Term Prediction of Available Bikes on Bike-Sharing Stations," in *IEEE Access*, vol. 9, pp. 124337-124347, 2021, doi: 10.1109/ACCESS.2021.3110794.
<https://ieeexplore.ieee.org/abstract/document/9530580>

Environmental Monitoring and Control

FROM CITY
DASHBOARD TO
APPLICATIONS

DATA



ORGANIZATION
AND FLEXIBLE WEB
AND MOBILE APPS

SNAP4CITY FOR
BEGINNERS

SNAP4CITY

TWITTER
ANALYTICS
DIAGNOSTICS

SNAP4CITY
AND KM4CITY
PROJECTS

ADOPT
AND
MAP

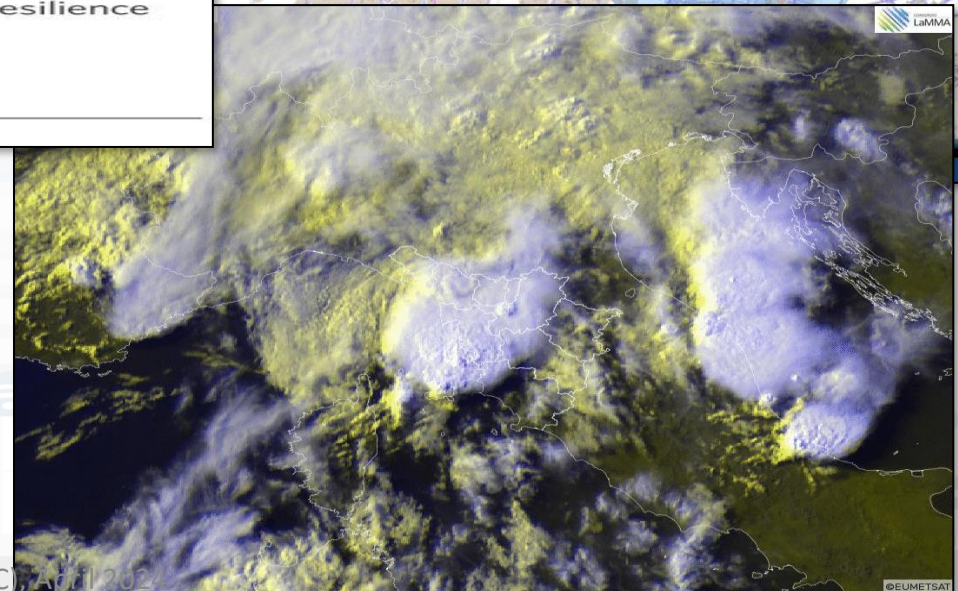
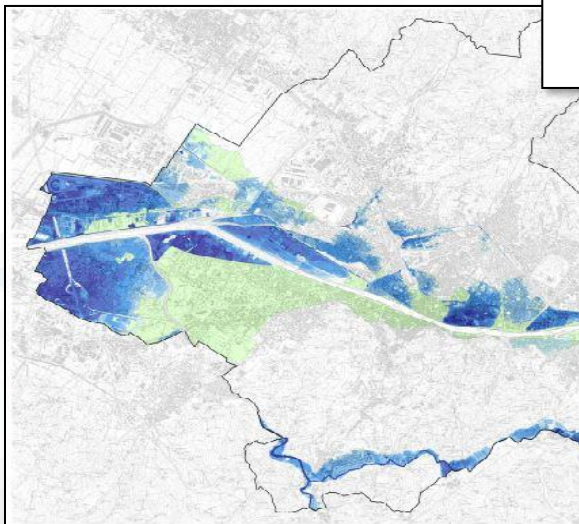
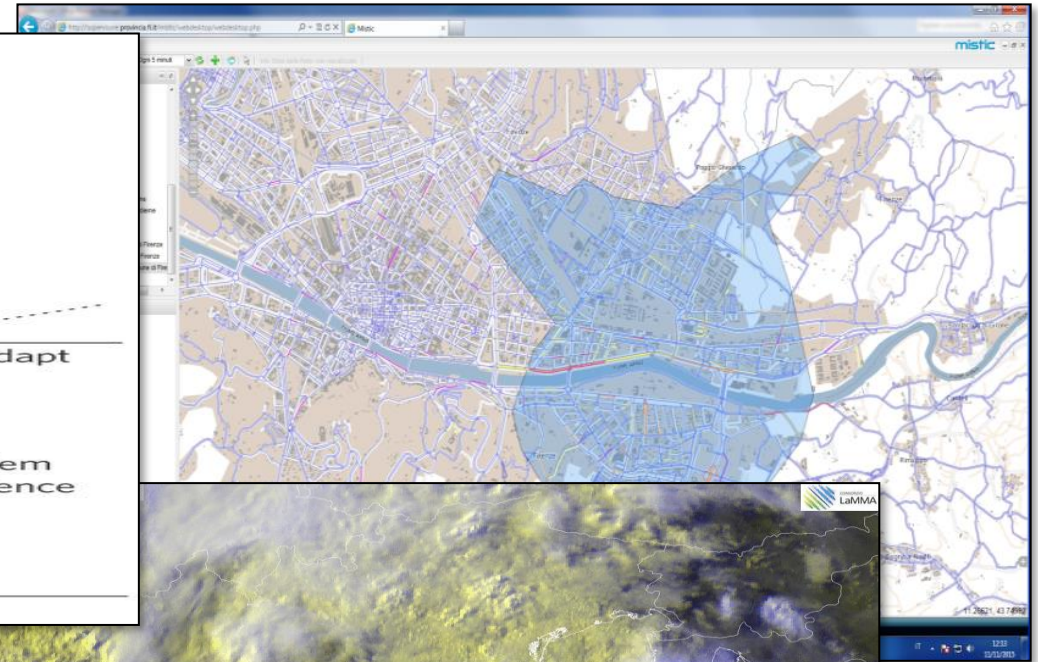
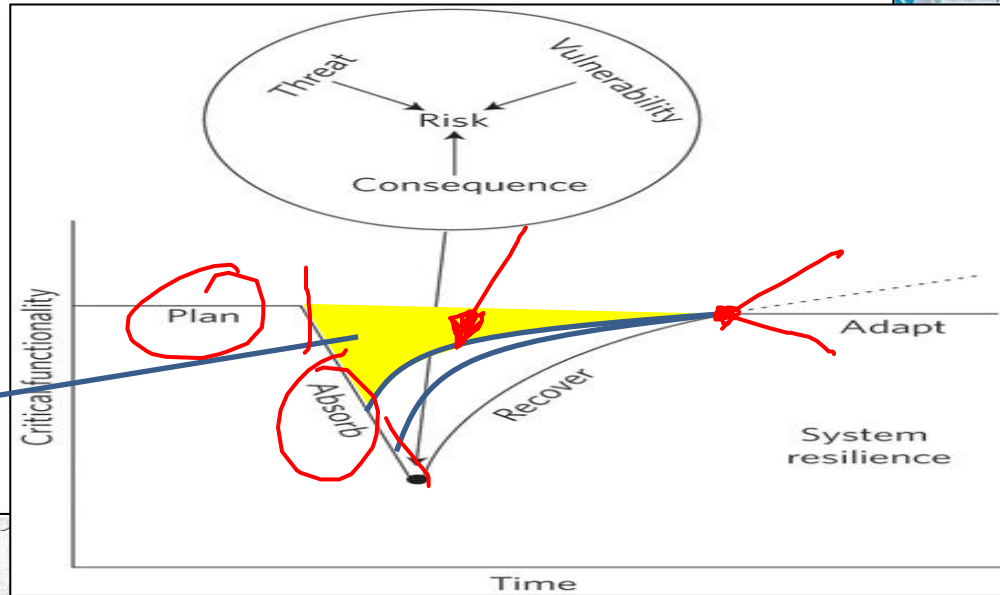
SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS



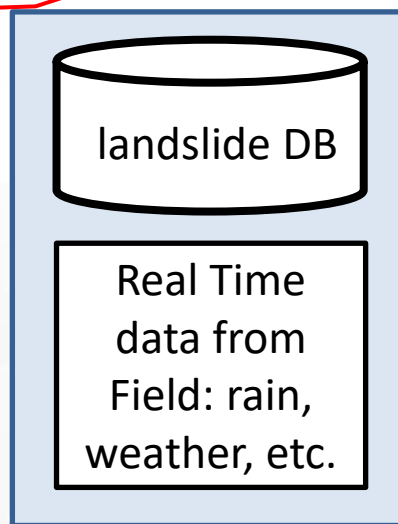
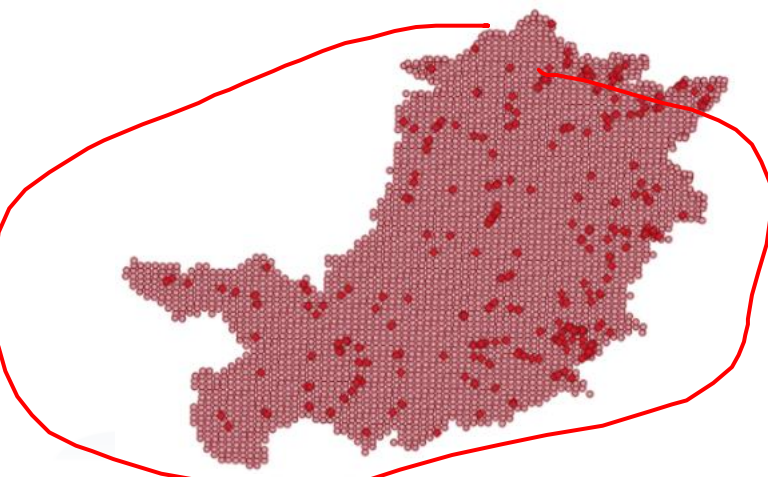
Early Warning, Detection

Prepare
Absorb
Recover
Adapt

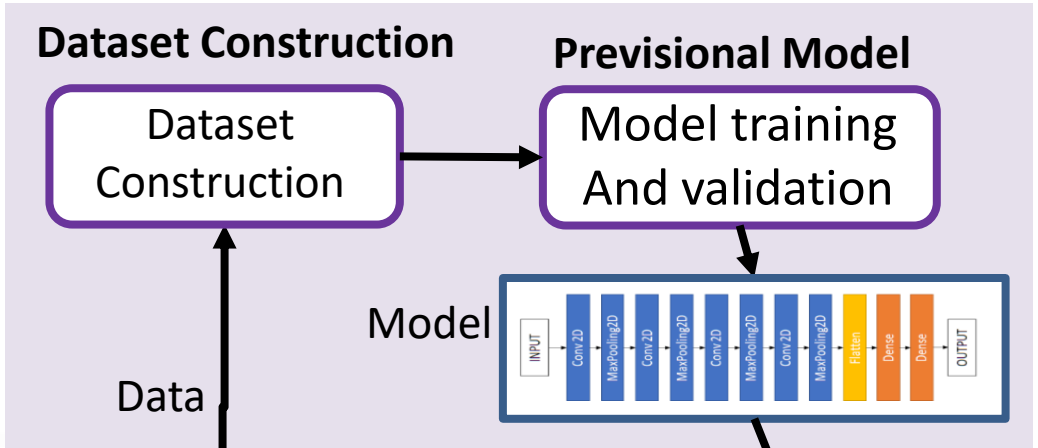
damage



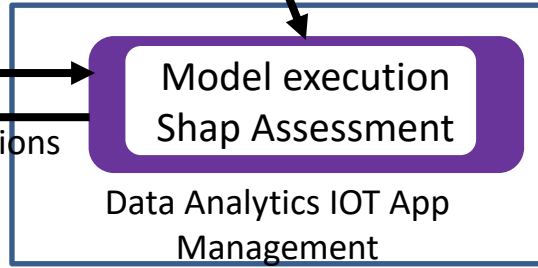
Predicting Land slides



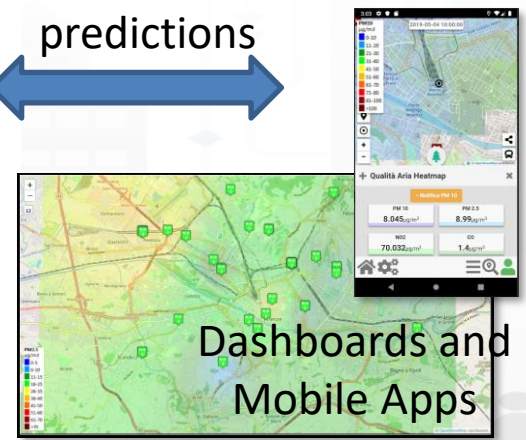
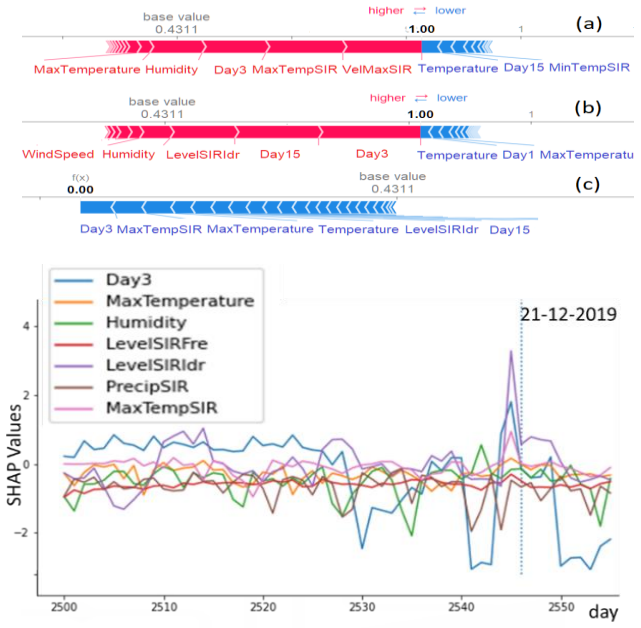
Ingestion Processes



SNAP4City Advanced APIs

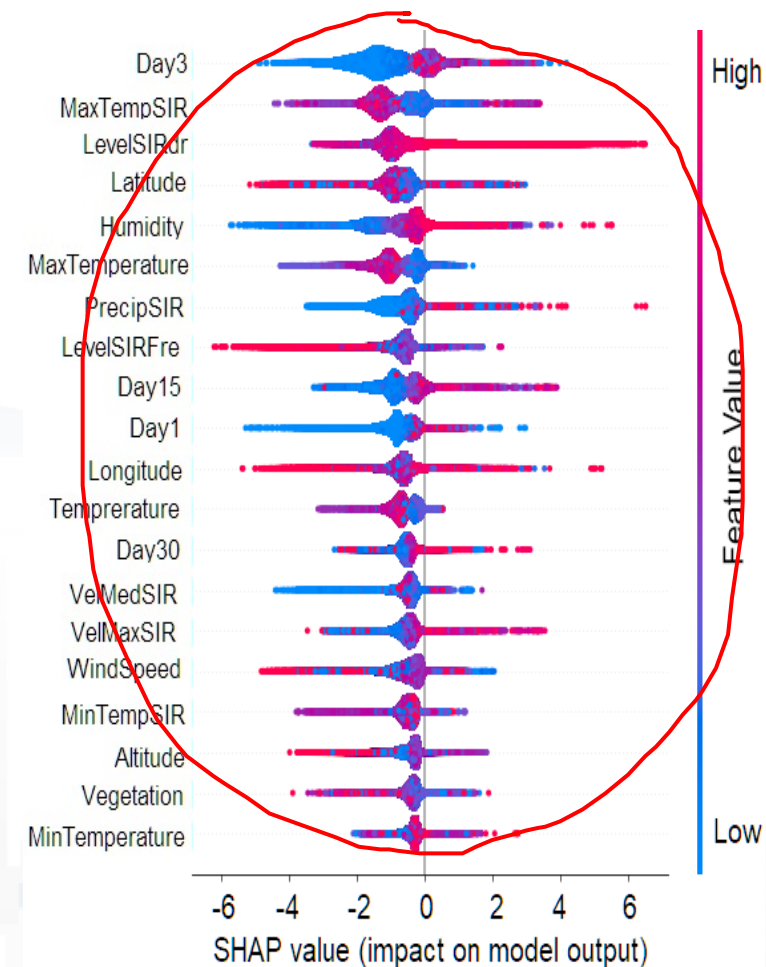
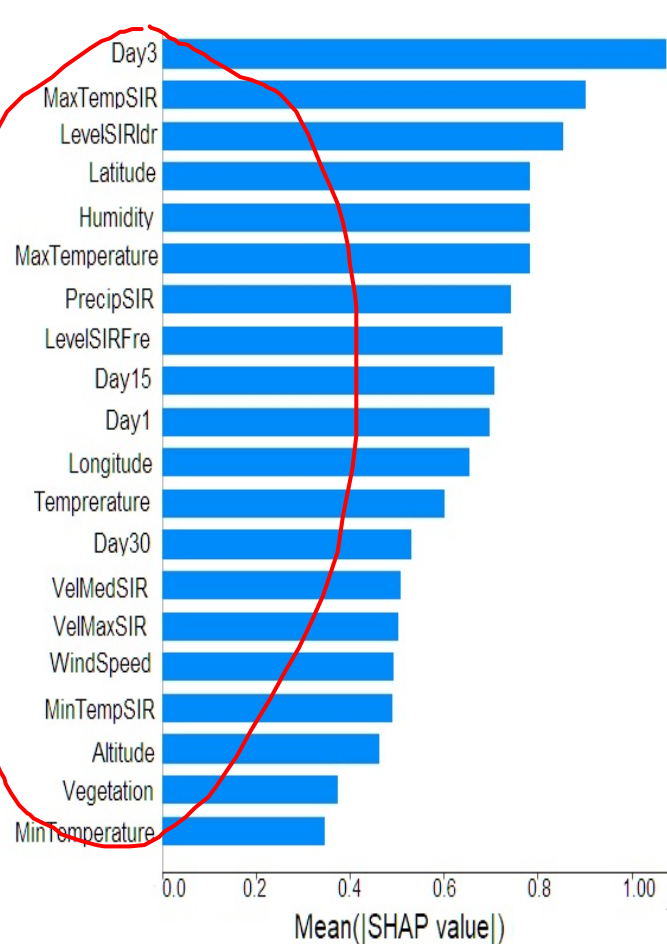


Snap4City Servers and Tools:
Dashboard manager, Heatmap
manager, GeoServer, Smart City API.



Comparing Predictive Model/architectures

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



Global Explainable AI
- Feature relevance

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

Local Explainable AI - understanding the single event

- The local explanation puts in evidence the features which provided major contribution to the prediction
- For example considering Figure 10a, the value of VelMaxSIR, MaxTempSIR, Day3 and Humidity contributed significantly to the classification of the observation as a **landslide event**

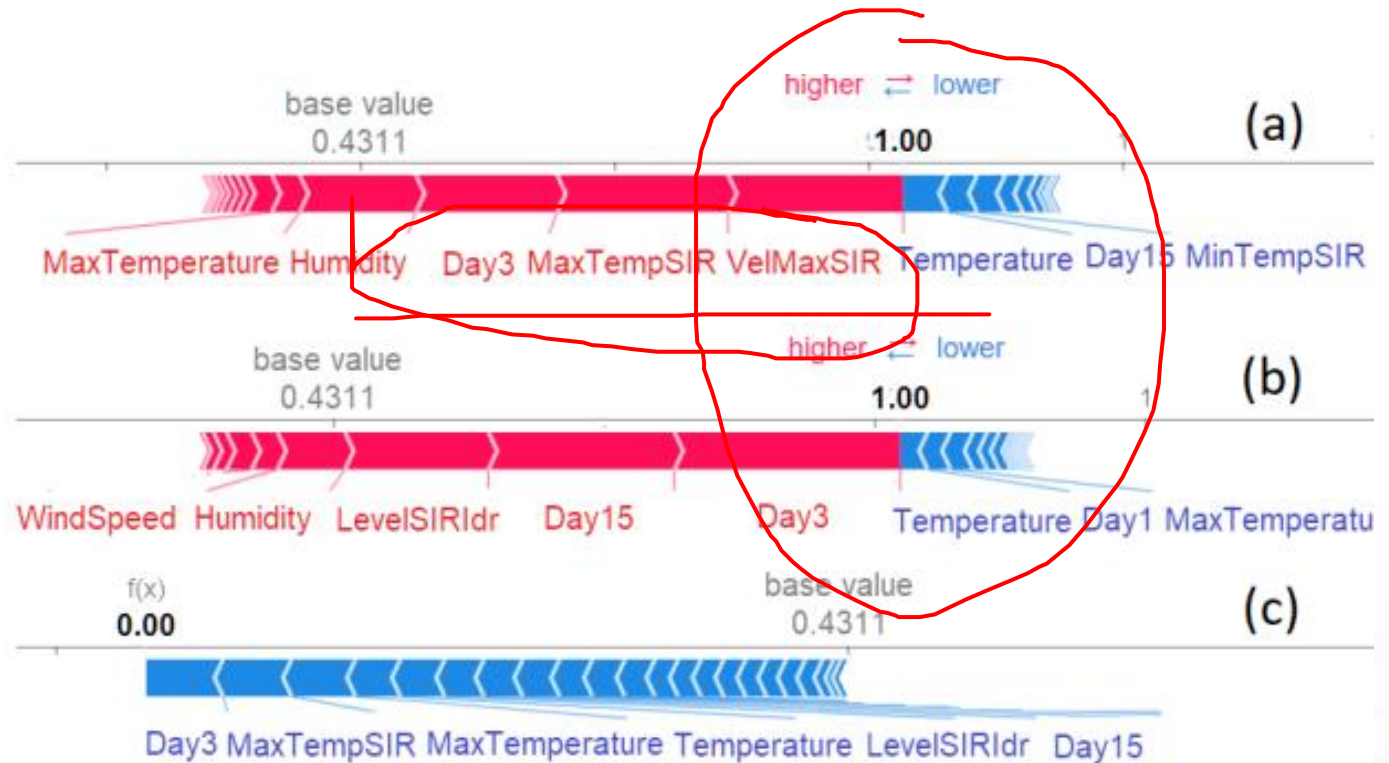


FIGURE 10. Local feature relevance via SHAP, as interpretation of events in terms of feature values: (a) and (b) are events with predictions of landslide, (c) a no landslide event.

Human Behavior Monitoring

FRONTIER
MOVEMENT
AND FLEXIBLE WEB
AND MOBILE APPS

TWITTER
FLUENCE SOCIAL
MEDIA ANALYSIS

SNAP4CITY FOR
BEGINNERS

SNAP4CITY
ARCHITECTURE AND
PROJECTS

SNAP4CITY
AND KM4CITY
PROJECTS

FROM CITY
DASHBOARD TO
APPLICATIONS



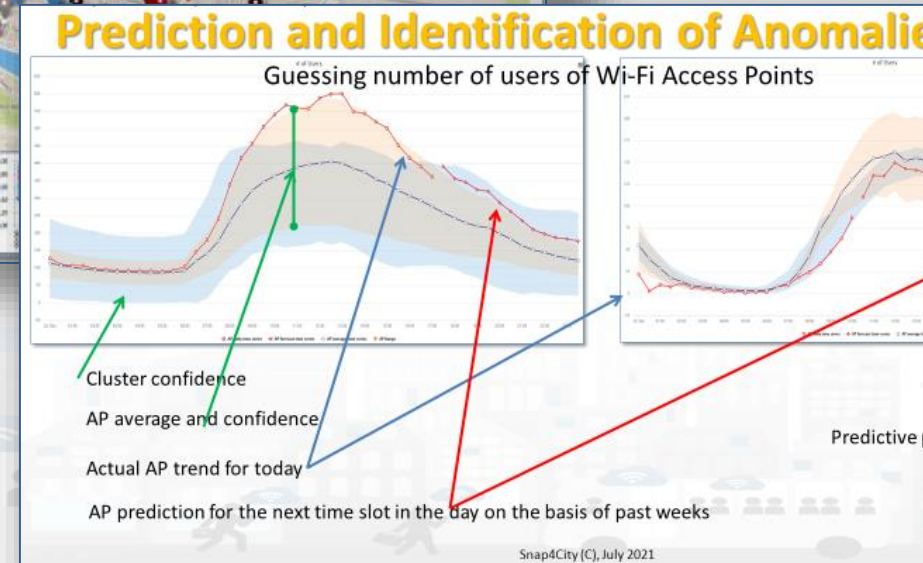
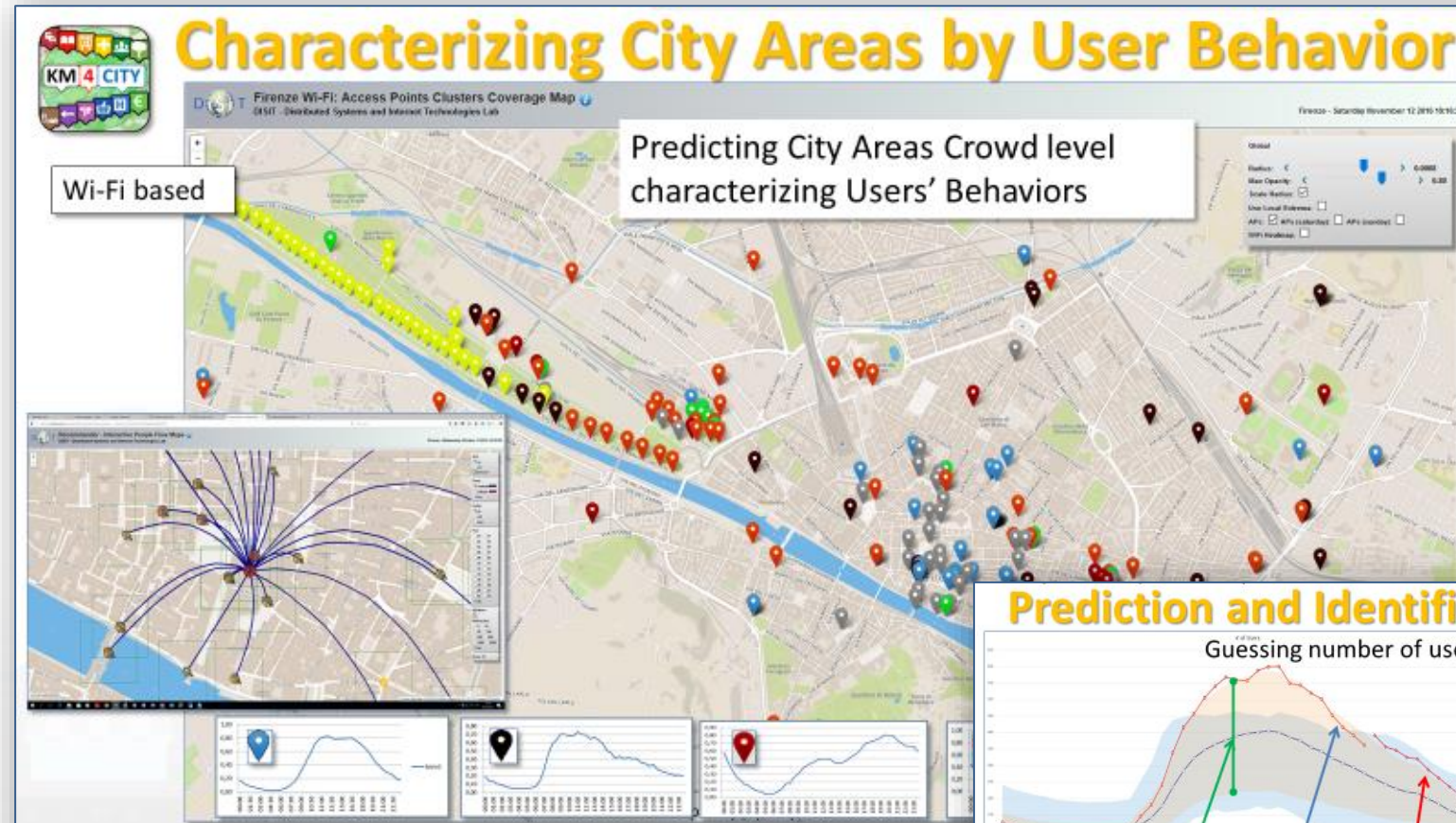
SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS



City Users Behaviour, Safety, Security and Social Analysis

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

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



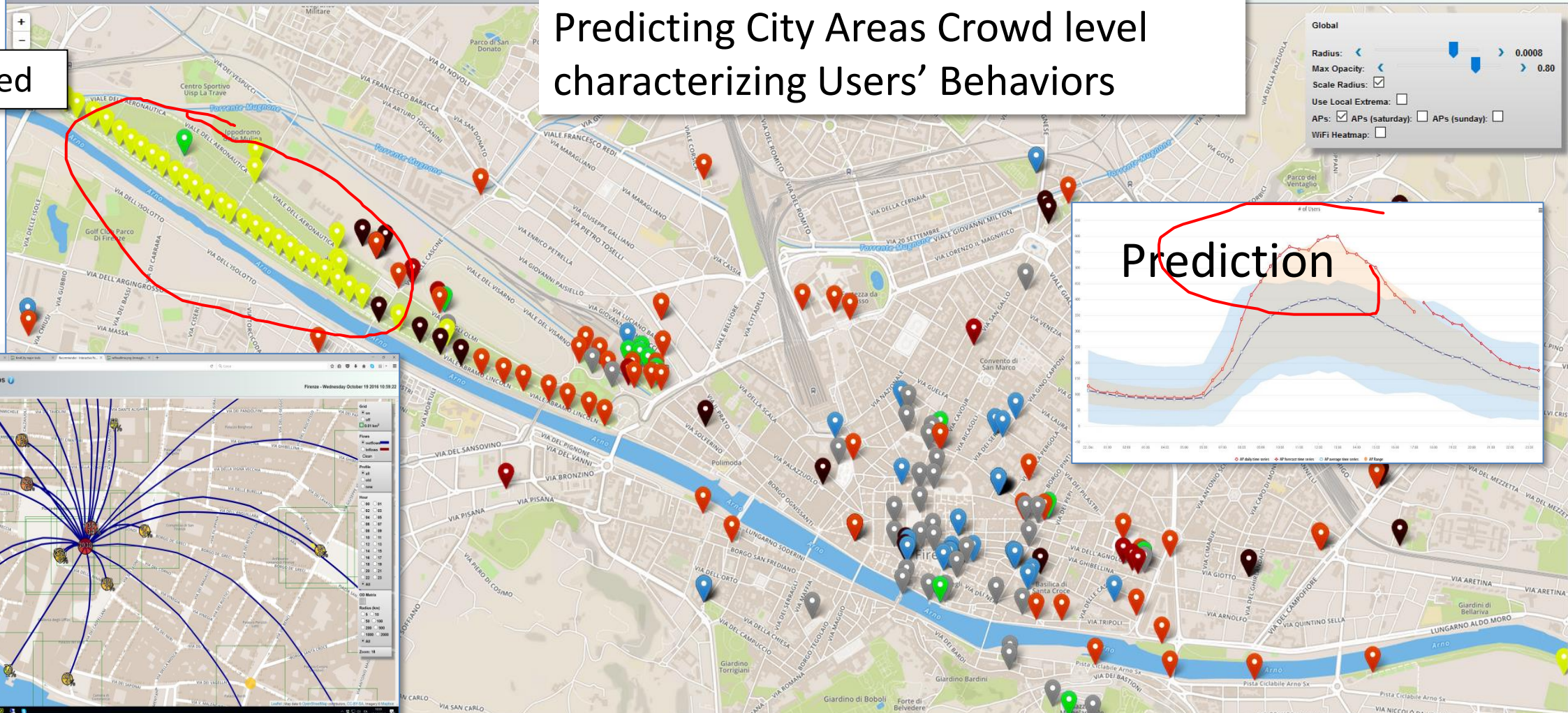
Characterizing City Areas

DISIT Firenze Wi-Fi: Access Points Clusters Coverage Map
DISIT - Distributed Systems and Internet Technologies Lab

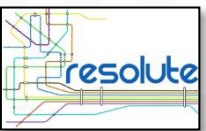
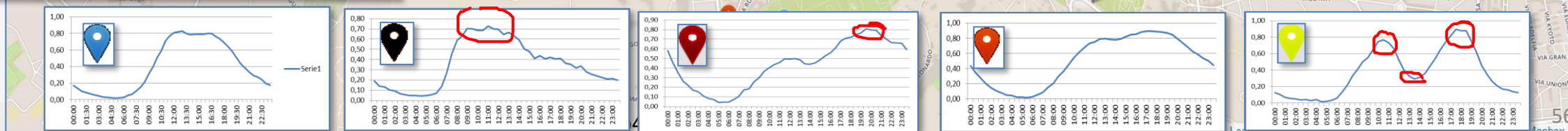
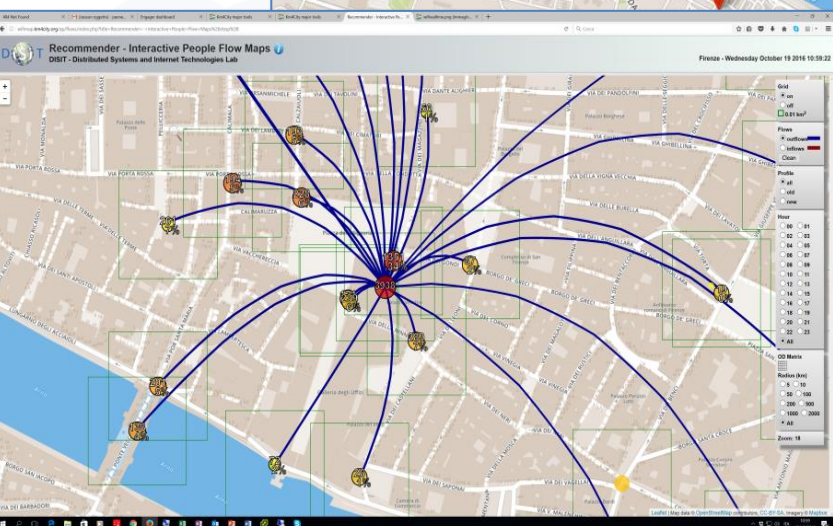
Firenze - Saturday November 12 2016 19:16:33

Wi-Fi based

Predicting City Areas Crowd level characterizing Users' Behaviors



Prediction



A view and data from the Thermal Camera



Detection BOX Snap4Thermal PV Firenze Tue 15 Mar 13:30:41

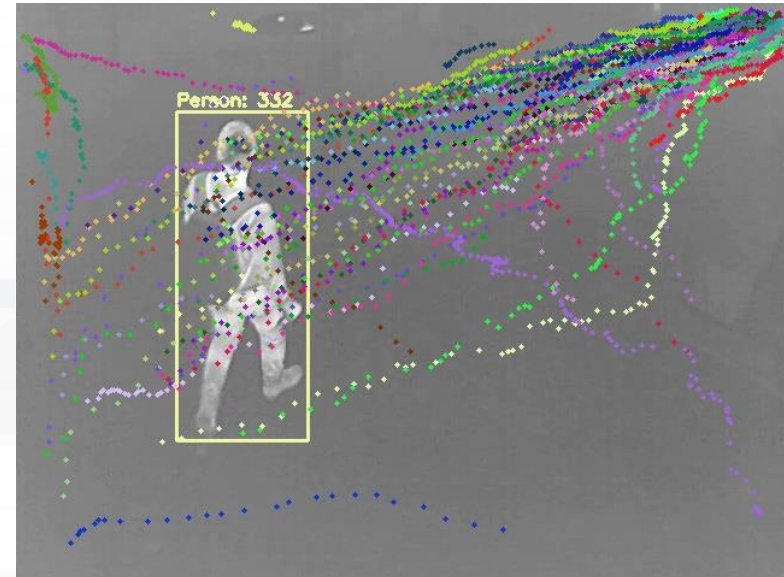
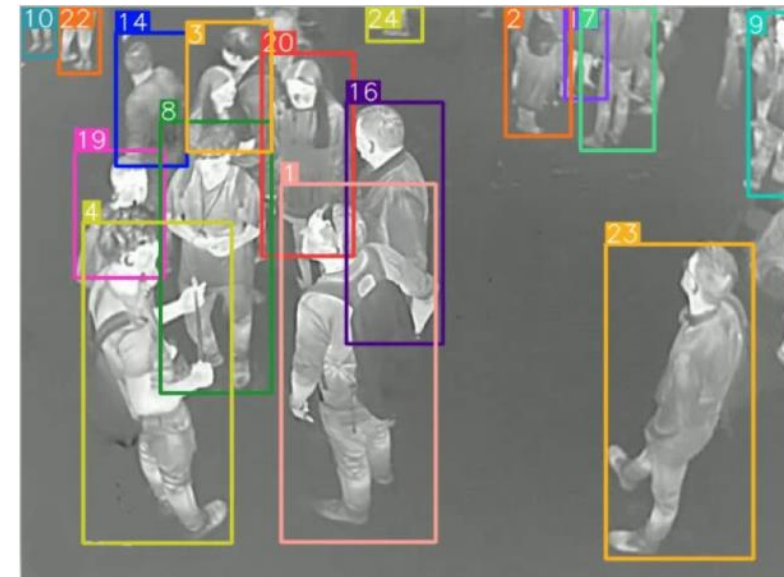
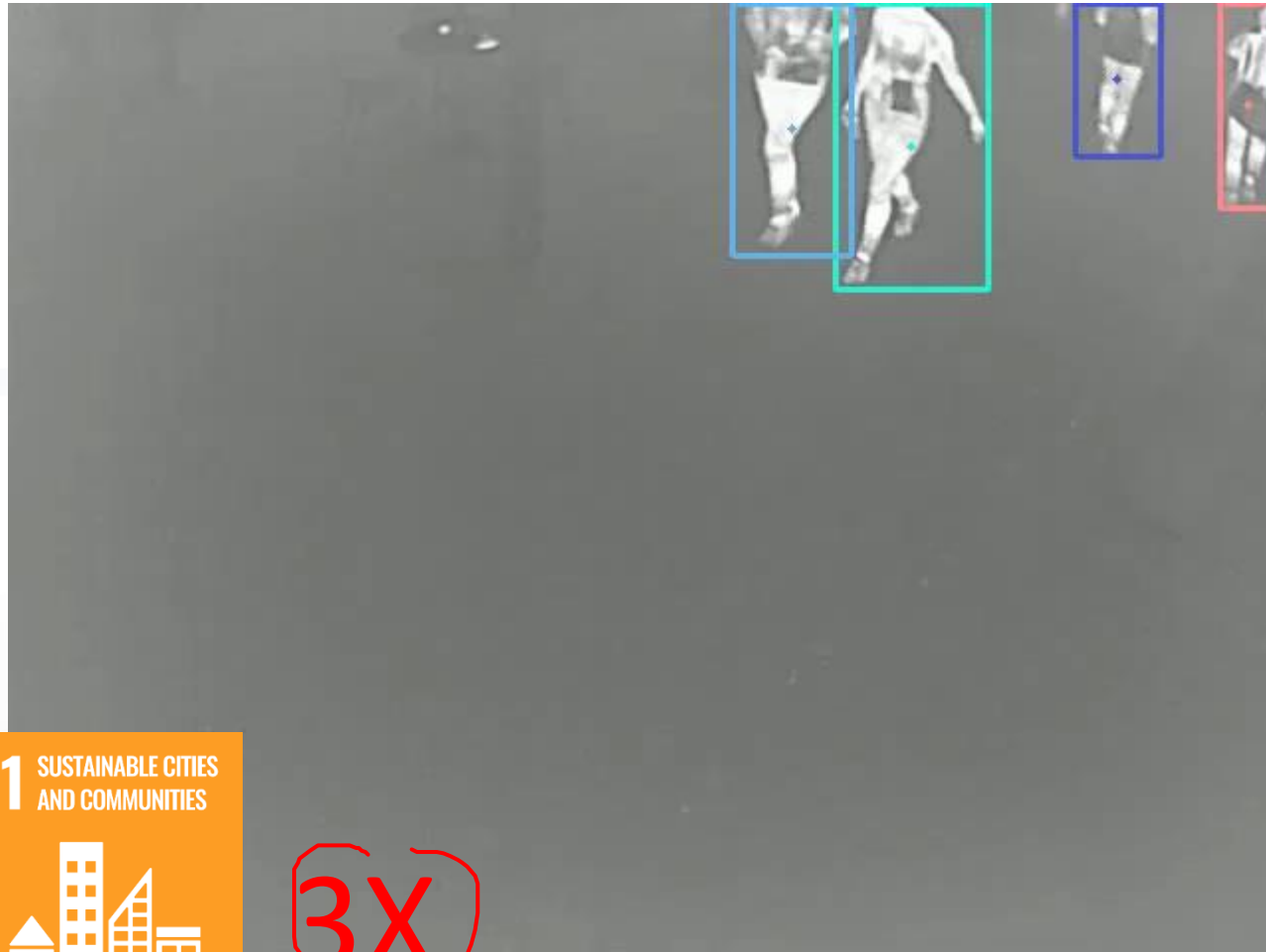


47
persone
carrozzina
bike

11 SUSTAINABLE CITIES AND COMMUNITIES



People Counting and Tracking



11 SUSTAINABLE CITIES
AND COMMUNITIES

3X

Event Management

The screenshot shows the SNAP4CITY Event Registration web application. The interface includes a navigation menu on the left with options for Cameras, Hospital, Traffic Flow, and Weather. A red circle highlights the 'EventWebCam' option. The main area features a map of Florence, an 'Insert Alarm Data' form with fields for Name, Kind, Severity, People Involved, Impact, and Description, and a 'Creating Event' section with 'Clear', 'Register Event', and 'Refresh' buttons. Below these is a table of registered events with columns for device, severity, dateObserved, status, and actions.

device	Severity	dateObserved	status	Actions
fireonplazagardon20231031T221304273Z	Yellow	2023-10-31T22:13:04.273Z	init	
Telecamera4_22320231031T14213584Z	Yellow	2023-10-31T14:21:35.84Z	init	
CarCrash20231031T134436250Z	Orange	2023-10-31T13:44:36.250Z	init	
CriticalTrafficJam20231031T132718888Z	Red	2023-10-31T13:27:18.888Z	init	
FloodedRoad20231031T132309212Z	White	2023-10-31T13:23:09.212Z	init	

Engaging via Mobile Apps

FROM CITY
DASHBOARD TO
APPLICATIONS

DATA
AND KNOW
MAN

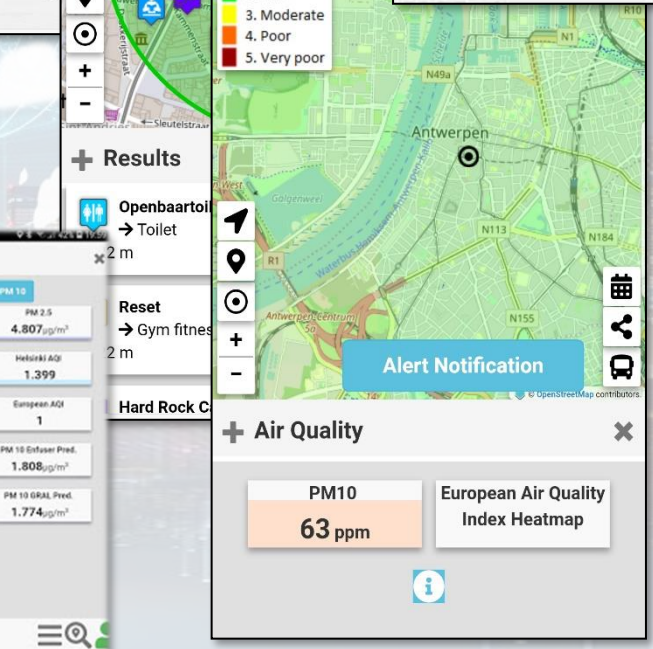
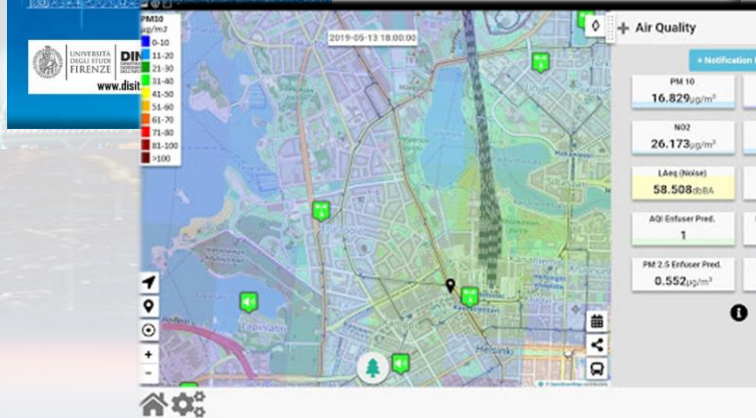
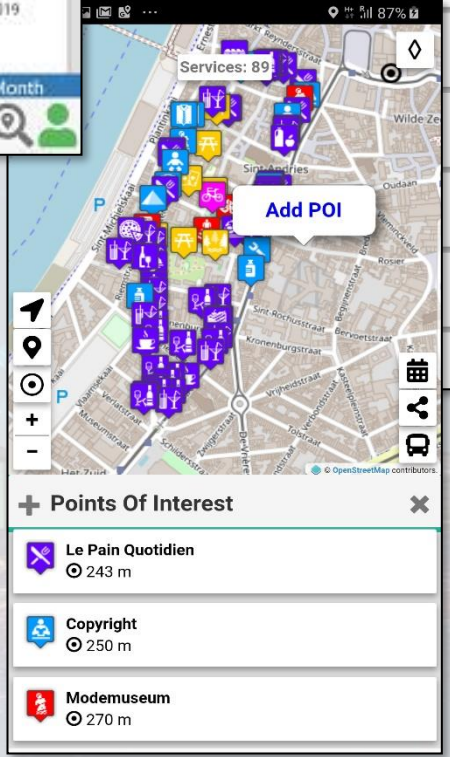
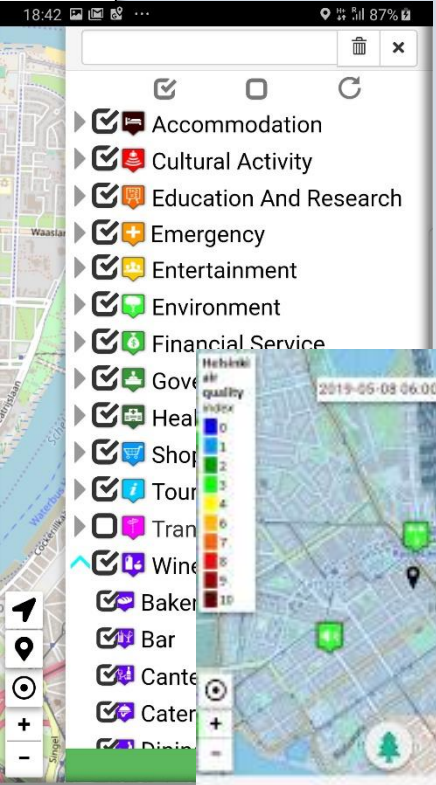
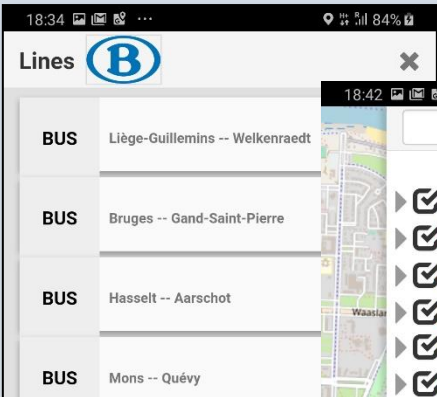
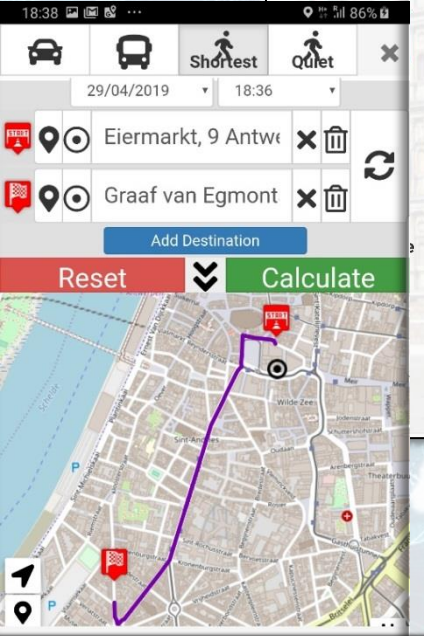
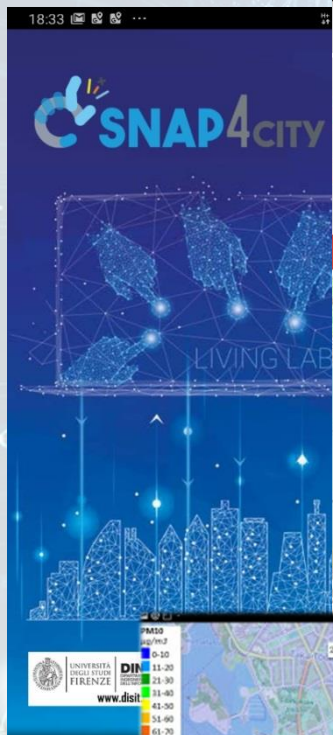
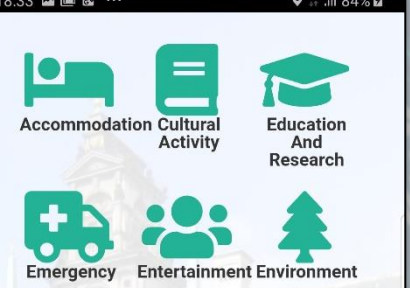


SNAP4CITY
AND KM4CITY
PROJECTS

TO ADOPT
4CITY, AND
ROADMAP

SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS







Citizen Engagement via Mobile Apps

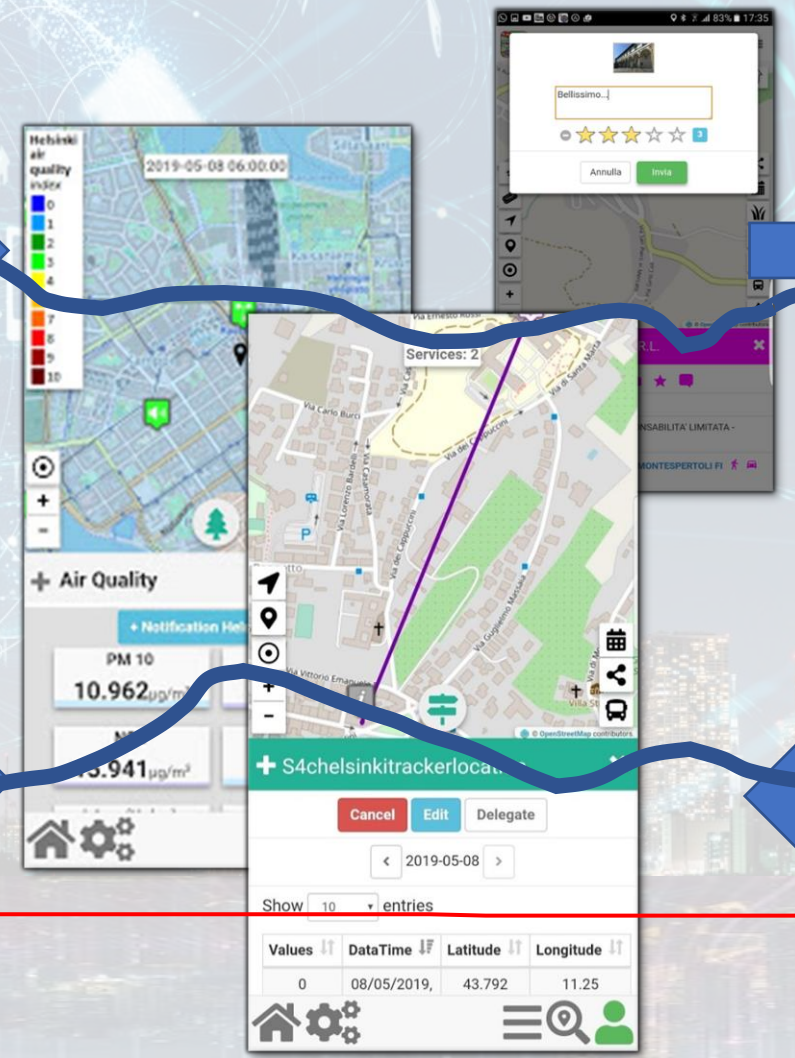
- GPS Positions
- Selections on menus
- Views of POI
- Access to Dashboards
- searched information
- Routing
- Ranks, votes
- Comments
- Images
- Subscriptions to notifications
-

Produced information

- Viewed ?
- Accepted ?
- Performed ?
- ...

Users

Snap4City (C), April 2024



Derived information

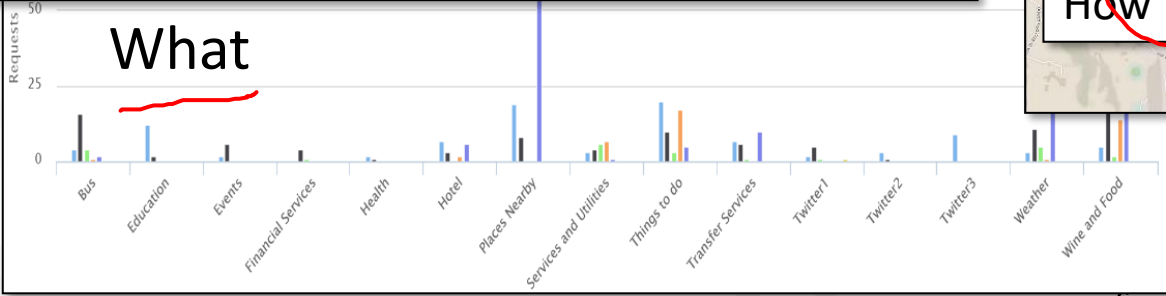
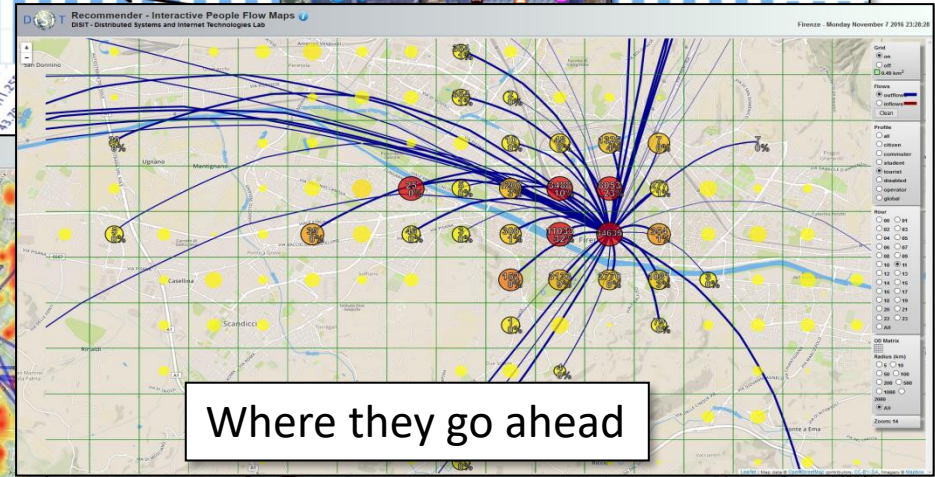
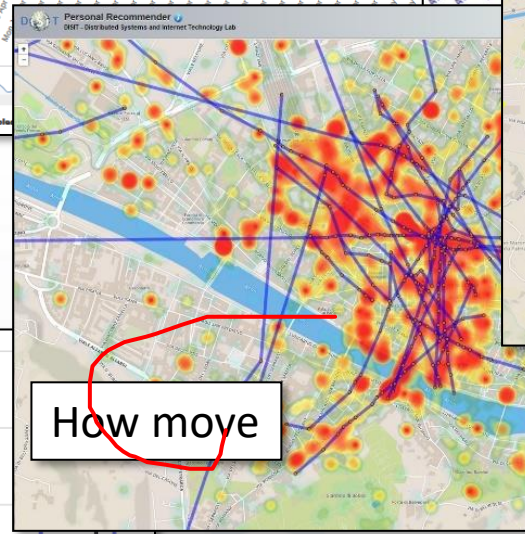
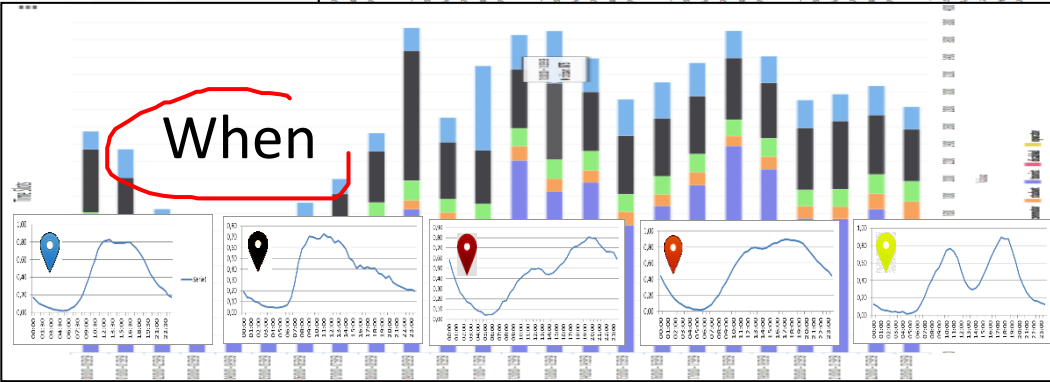
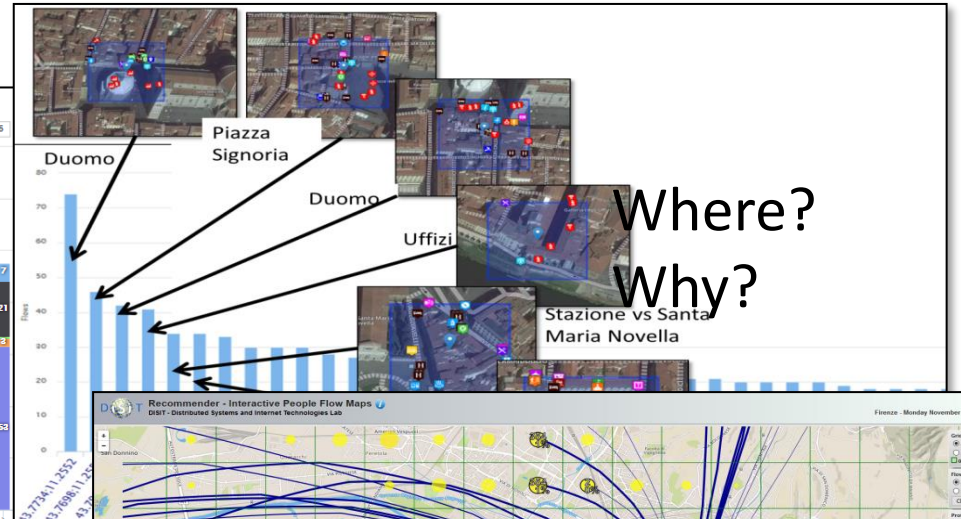
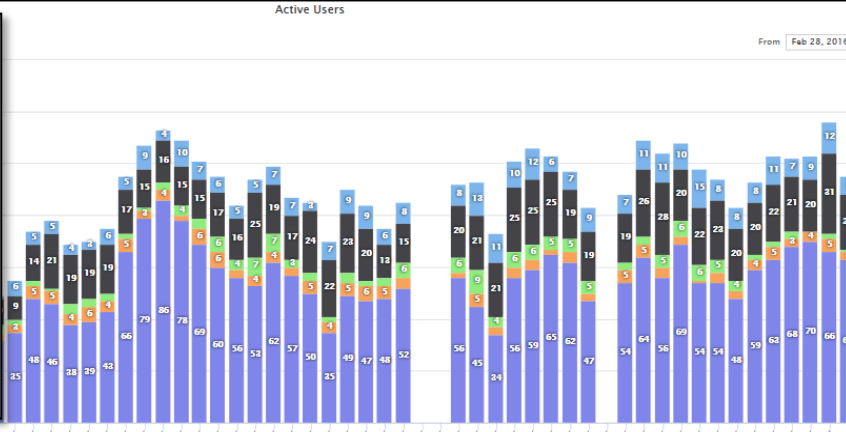
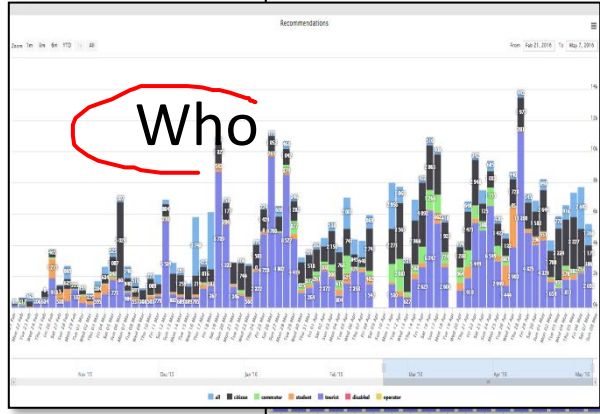
- Trajectories
- Hot Places by click and by move
- Origin destination matrices
- Most interested topics
- Most interested POI
- Delegation and relationships
- Accesses to Dashboards
- **Cumulated Scores from Actions**
- Requested information
- Routing performed
-

Produced information

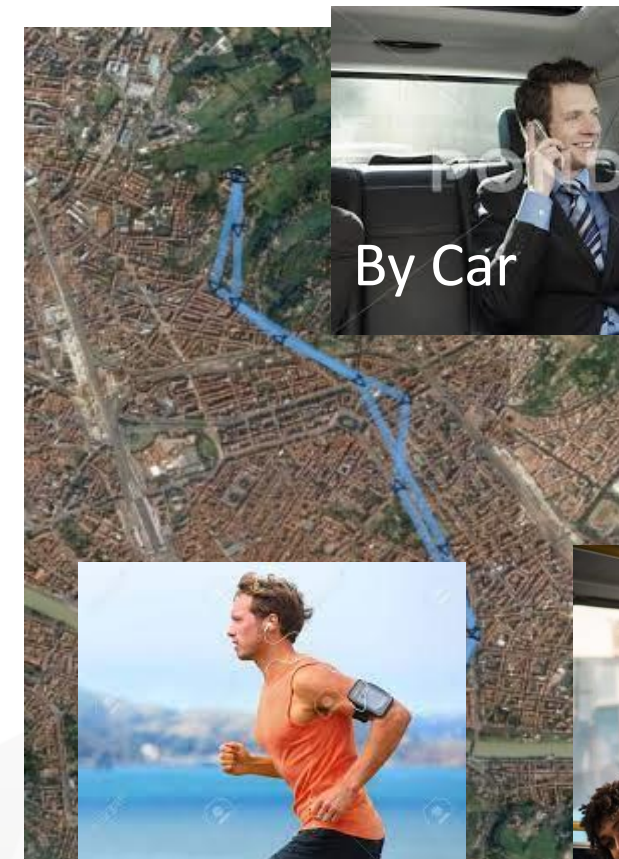
- Suggestions
- Engagements
- Notifications
- ...

System

User Behavior Analyser for Collective Profiling



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



By Car



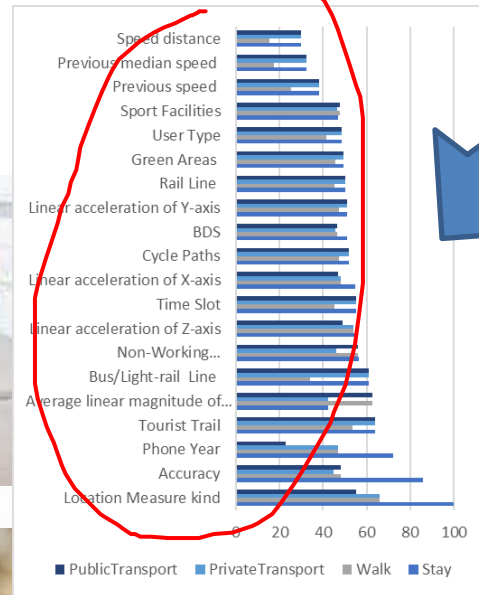
Walk



By BUS

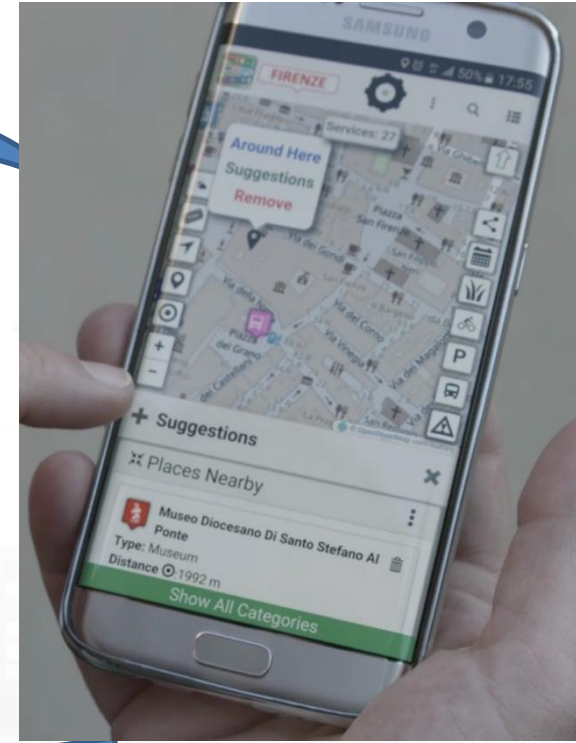


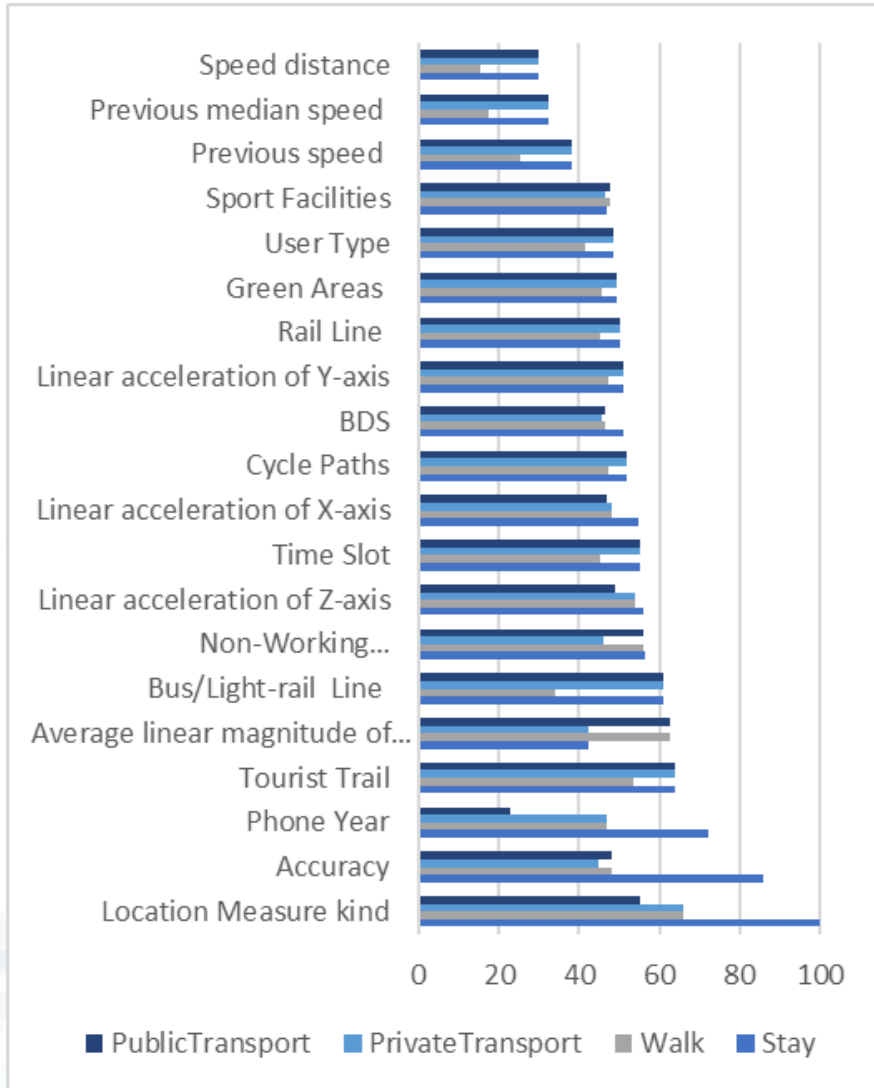
Run



Artificial Intelligence
Classification

Suggestions





Feature relevance

Model features categories	Extra Tree Model results			
	Accuracy %	Precision %	Recall %	F ₁ Score
Baseline and GPS	91.0	68.2	75.1	0.714
Baseline and GPS + proximity	92.4	73.9	69.1	0.715
Baseline and GPS + proximity + Accelerometer	92.6	81.4	74.4	0.777
Baseline and GPS + proximity + Temporal window	94.9	80.5	78.7	0.787
Baseline and GPS + proximity + Accelerometer + Temporal window	95.3	82.7	86.9	0.847

Decision Support System:

Immediate response and Tactical and Strategic Plans, via What-if Analysis

TOP

FROM CITY DASHBOARD TO APPLICATIONS

FORGING & MANAGING OPEN ARCHITECTURE AND ECOSYSTEMS

IOT APPLICATIONS AND DEVICE DEVELOPMENT

SNAP4CITY FOR MEMBERS

SNAP4CITY ARCHITECTURE AND ECOSYSTEM, OPENED TO DEVELOPERS AND STAKEHOLDERS

TWITTER VIGILANCE SOCIAL MEDIA ANALYSIS

SNAP4CITY AND KM4CITY PROJECTS



NAP4CITY THE VIEW OF THE ADMINISTRATORS

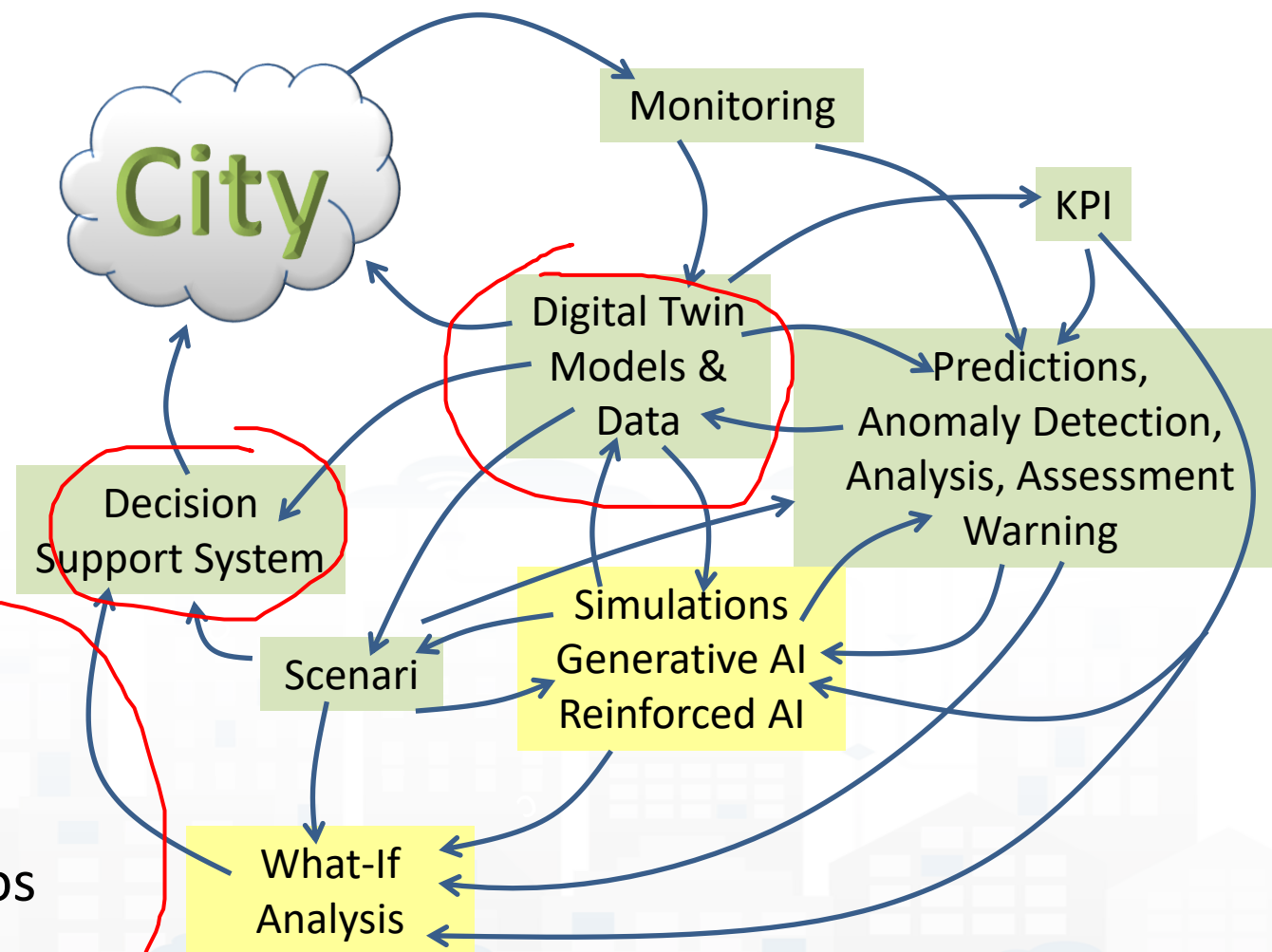


- **Controlling Status: management, and operational**

- Monitoring via KPI
- Computing predictions vs KPI
- Anomaly detection
- Neuro-Symbolic analysis
- Risk assessment
- Early warning on critical conditions

- **Making plan: tactic and strategic, medium and long range, micro/macro**

- Simulation & predictions
- Generative AI Prescriptions, scenarios
- Resilience to Unexpected unknowns
- What-if analysis wrt scenarios



Key Performance Indicators, KPI



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

Global
&
Local

Periodic
&
Realtime

Air Quality Directive				WHO guidelines	
Pollutant	Averaging period	Objective and legal nature and concentration	Comments	Concentration	Comments
PM _{2.5}	One day			25 µg/m ³ (*)	99 th percentile (3 days/year)
PM _{2.5}	Calendar year	Target value, 25 µg/m ³	The target value has become a limit value since 1 January 2015	10 µg/m ³	
PM ₁₀	One day	Limit value, 50 µg/m ³	Not to be exceeded on more than 35 days per year.	50 µg/m ³ (*)	99 th percentile (3 days/year)
PM ₁₀	Calendar year	Limit value, 40 µg/m ³ (*)		20 µg/m ³	
O ₃	Maximum daily 8-hour mean	Target value, 120 µg/m ³	Not to be exceeded on more than 25 days per year, averaged over three years	100 µg/m ³	
NO ₂	One hour	Limit value, 200 µg/m ³ (*)	Not to be exceeded more than 18 times a calendar year	200 µg/m ³ (*)	
NO ₂	Calendar year	Limit value, 40 µg/m ³		40 µg/m ³	



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

7 AFFORDABLE AND CLEAN ENERGY

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

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

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

11 SUSTAINABLE CITIES AND COMMUNITIES

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

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

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

13 CLIMATE ACTION

15 LIFE ON LAND

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

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

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

Data Analytic Artificial Intelligence, XAI, Machine and Deep Learning

FORGING & MANAGING OPEN AND FLEXIBLE WEB AND MOBILE APPS

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IOT/JOE DEVICES AND NETWORKS

DATA ANALYTICS, BUSINESS INTELLIGENCE, WHAT-IF, AND TO

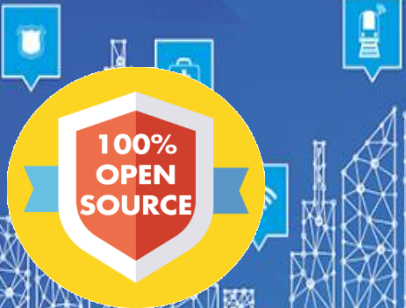
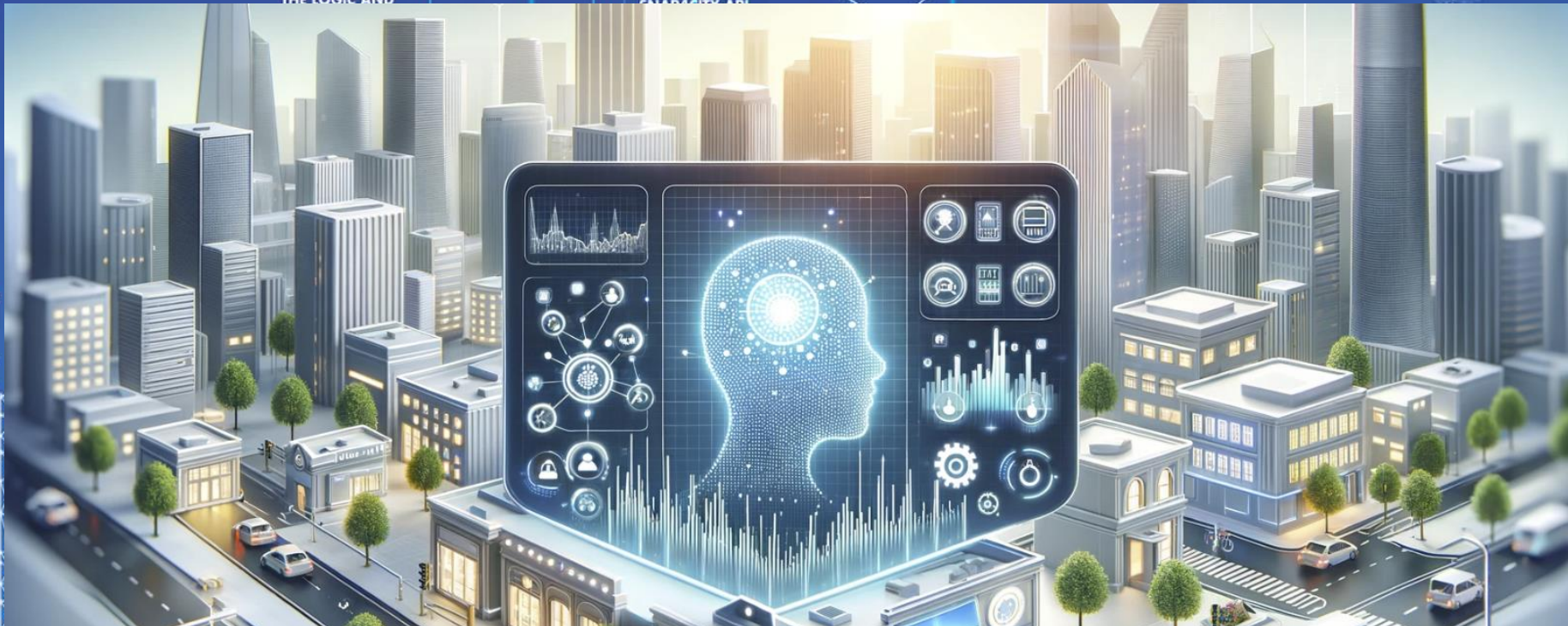
HOW TO ADOPT SNAP4CITY AND R ADIOP

DECISION SUPPORT SYSTEMS, CITY RESILIENCE

IOT APPLICATIONS, THE LOGIC AND

ADVANCED SMART CITY API, MICROSERVICES, SNAP4CITY API

SNAP4CITY THE VIEW OF THE ADMINISTRATORS





Available AI Solutions on Snap4City

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

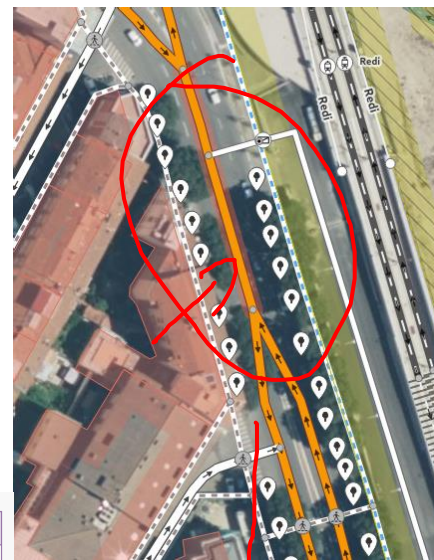
<https://www.snap4city.org/download/video/course/p4/>



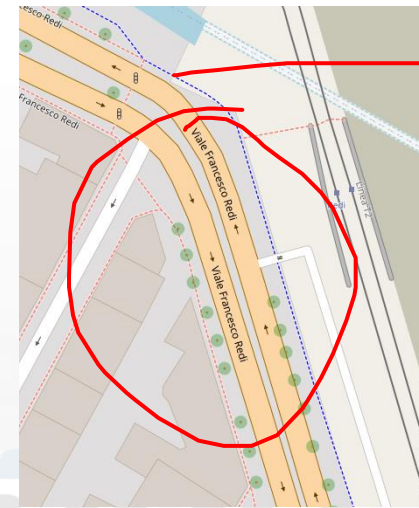
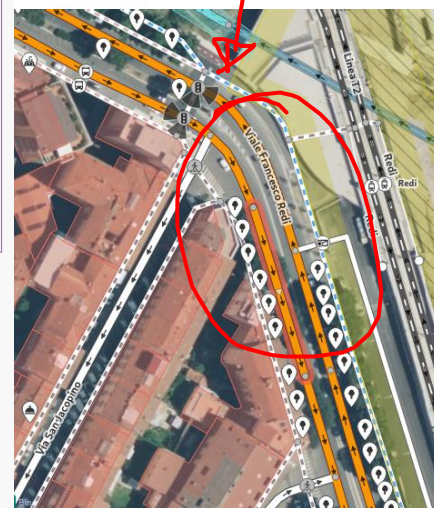
https://www.snap4city.org/download/video/DPL_SNAP4SOLU.pdf

Tactic and/or Strategic Planning

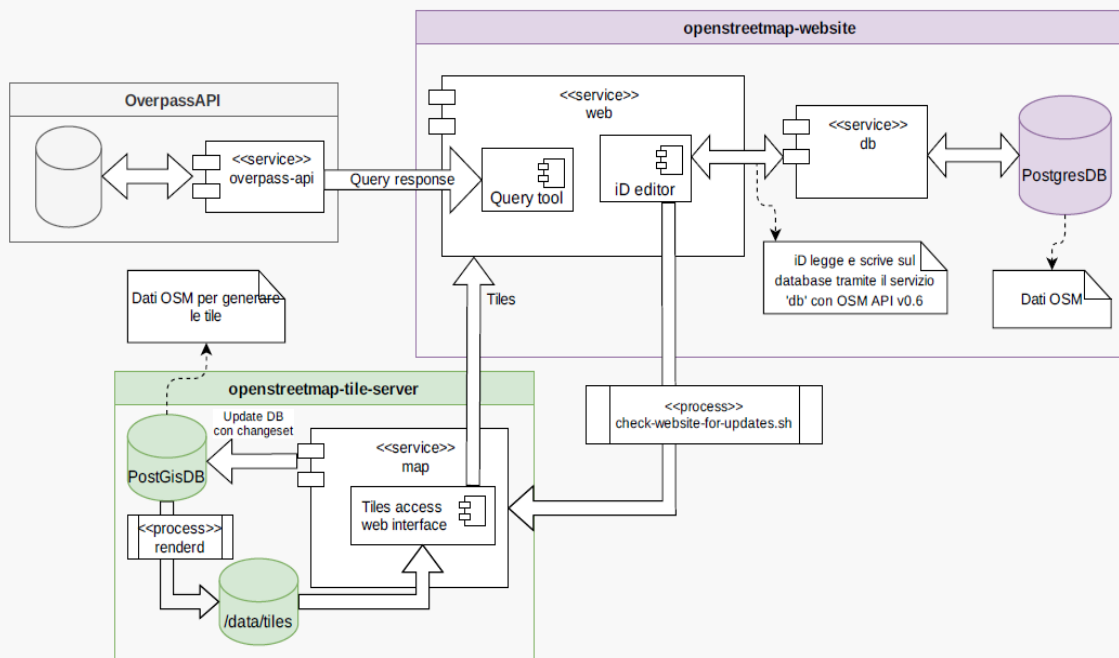
Correction of road graphs which is present on OSM



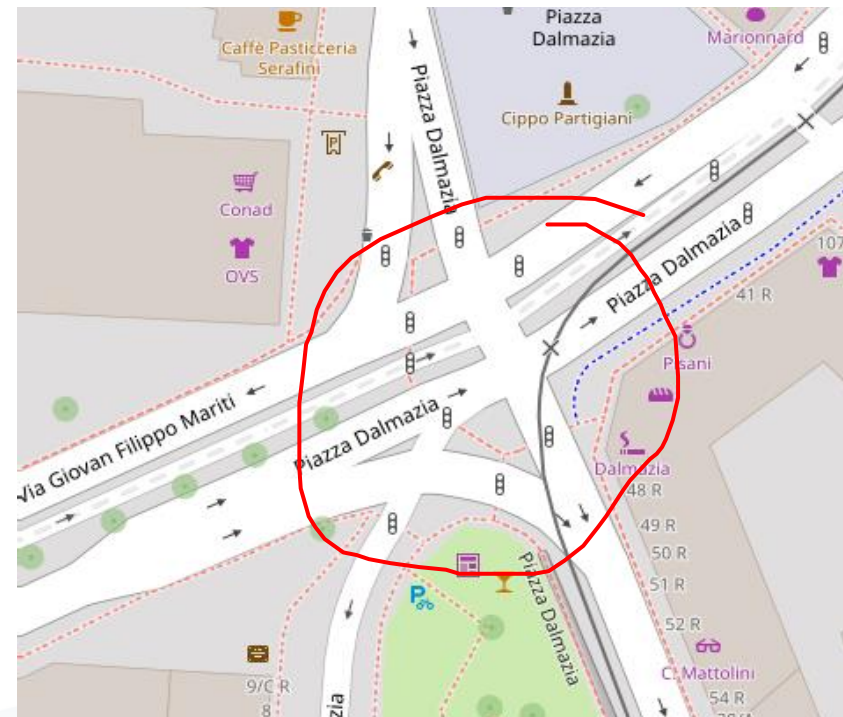
OSM data with non clear double bidirection lane on Viale Redi, Florence.
Editing OSM data and present Tiles



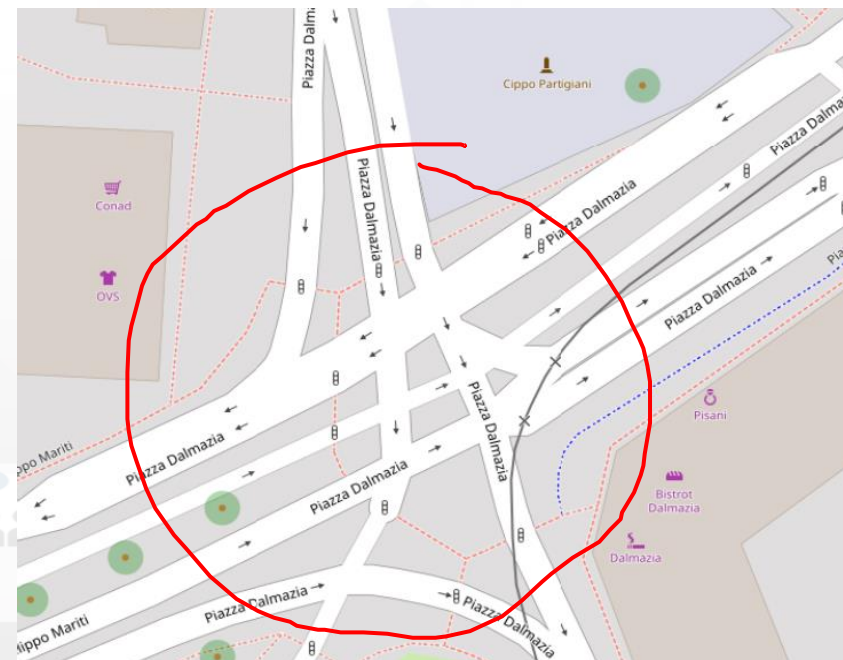
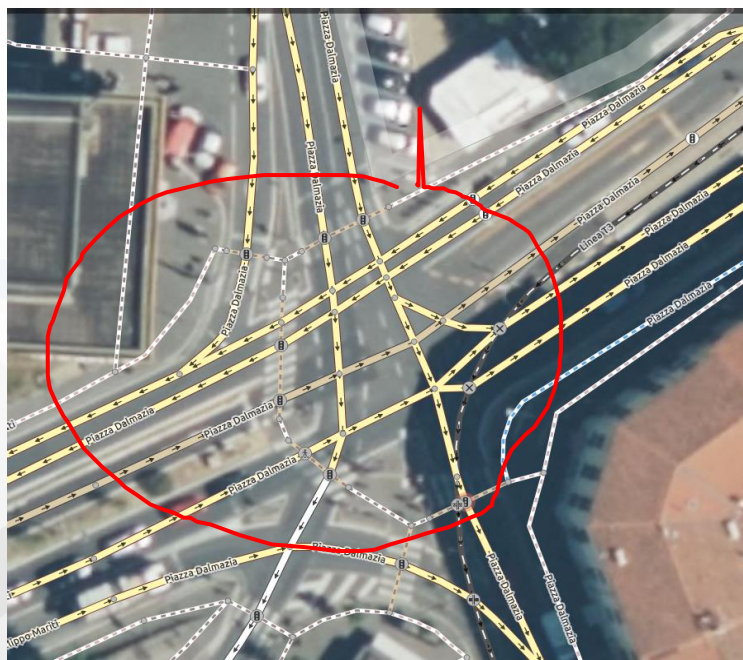
After Corretion of OSM data defining a clear double bidirection lane on Viale Redi, Florence.
Regeneration of the TILES for the maps



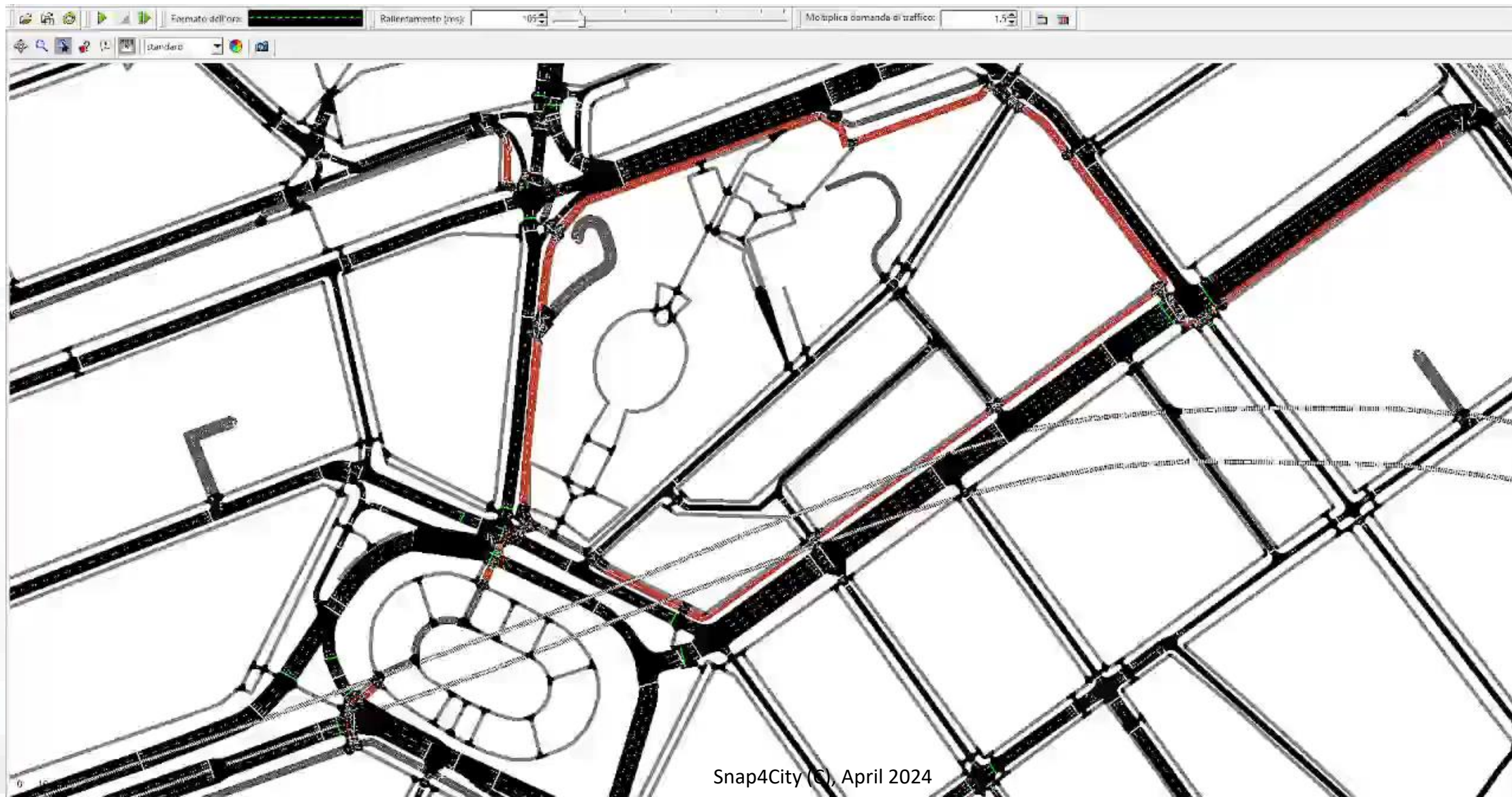
OSM data with non correct viability in Piazza Dalmazia, Firenze



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



Micro Simulation



Mobility and Transport

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

ODM, Traffic Flow

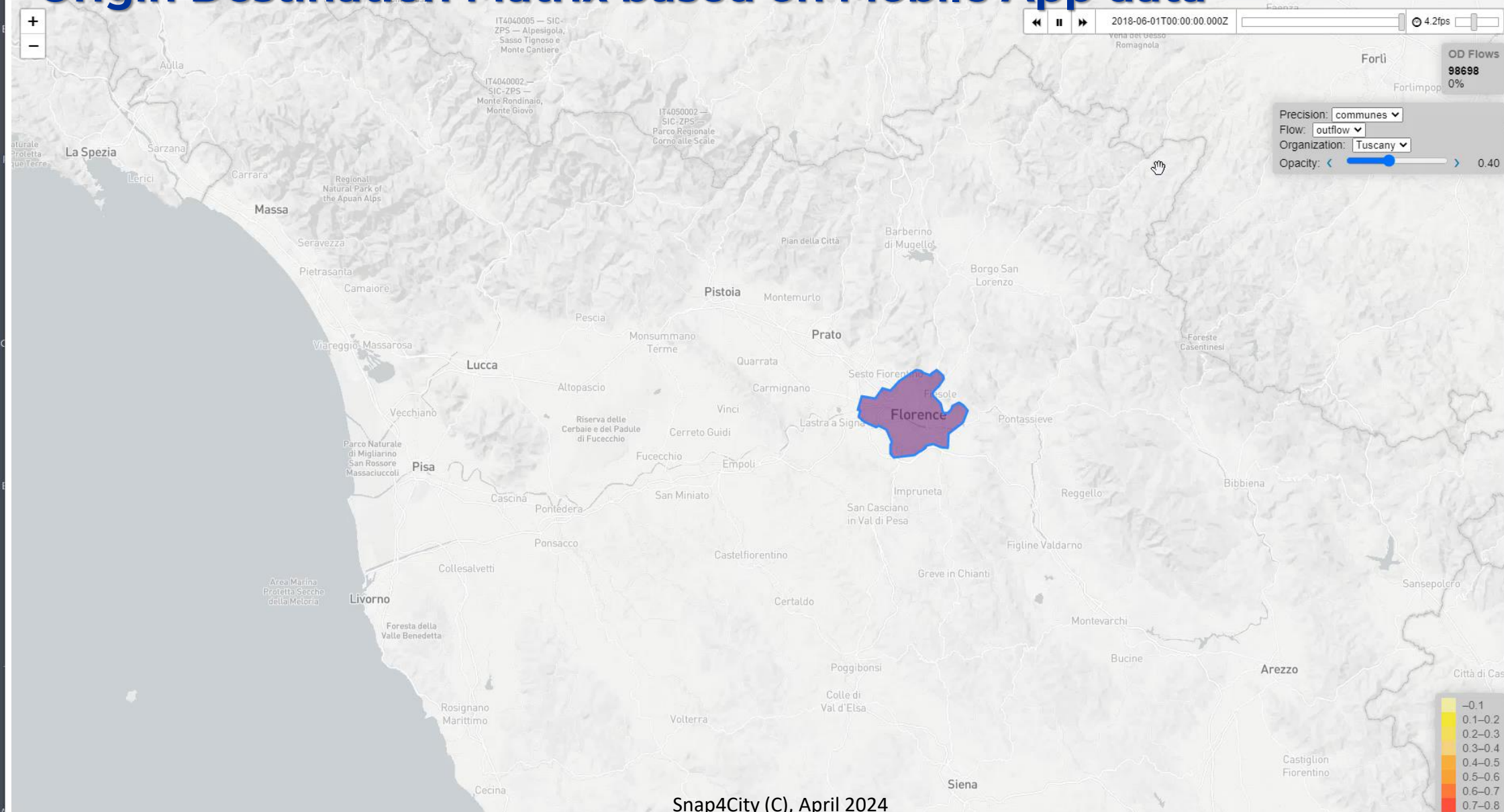
ODM Origin Destination Matrices

The screenshot displays the SNAP4CITY dashboard for ODM Origin Destination Matrices. The interface is divided into several sections:

- Sidebar (Selectornew):** Contains navigation options: Admin Areas, Areas or grids, Traffic Sensors, Traffic Flow, and Traffic Flow Manager New.
- Map:** Shows a geographical map of the Florence region with traffic flow heatmaps. A legend on the left indicates flow percentages: 0-2%, 2-3%, 3-4%, 4-5%, 5-6%, 6-7%, 7-8%, 8-9%, 9-10%, and 10-100%.
- Origin-Destination Map Controls:** Includes options for 'Show all polygons' (ON), 'Time period' (week), 'Precision' (municipality), 'Flow' (outflow), and 'Max Opacity' (0.6). It also shows a date range from 2022-07-07 00:00:00 to week.
- Traffic Heatmap Controls:** Shows 'FirenzeFIPITrafficRealtime' with 'Traffic Heatmap Controls' set to '24H' and 'Max Opacity' set to 1. The date range is 2023-11-01 03:00:00.

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

Origin Destination Matrix based on Mobile App data



Decision Support Systems, What-if

○ Event planning, via what-if analysis

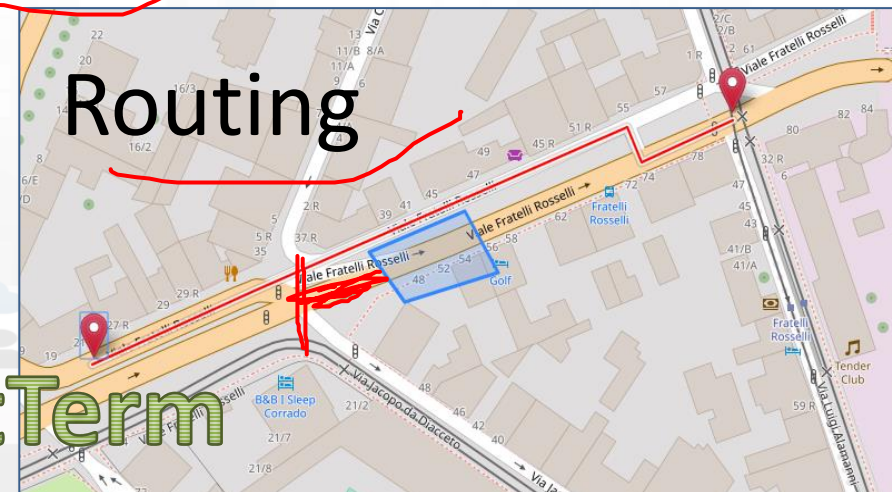
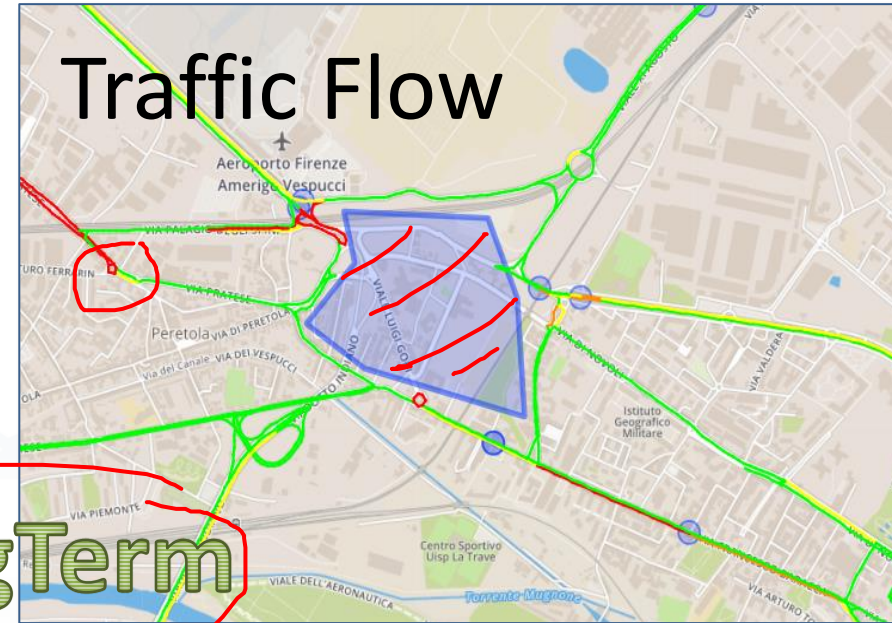
- Change in the graph structure of the city
- Impact on the flow of people and vehicles
- Adaptation: public transport, traffic, pedestrian management, etc.

○ Immediate reaction to natural events or not

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

○ Digital Twin

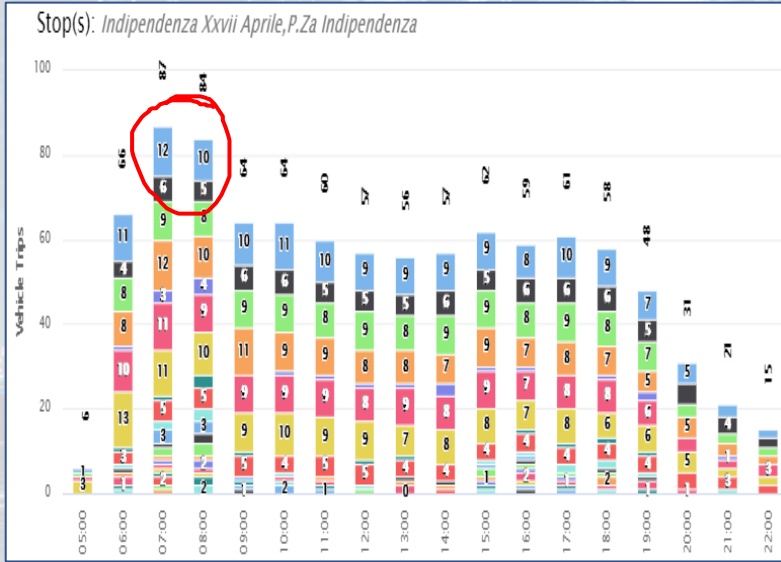
- More detail in the context integrated data
- Greater realism in deductions and representations
- Less fragmentation and non-uniformity in the views to support decisions



What-if Analysis on Pub Transport

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

Public Services



Welcome to DORAM powered by SNAP4CITY

Services: 36 on 36 available

The public transportation system has been analyzed in the City, considering the service offer vs. mobility demand. The top-thirty most crowded stops are presented on the right panel and on the map. Please, select your desired scenarios or a stop on the map to perform other analysis.

Type the stop name... Search

Stop panel

Scenario Selector

Choose a scenario: Actual scenario

Actual scenario: Describes the current status of the public transportation network. (More Info)

Daily Individual Trips > 52000

Stops > 1900

Residential Buildings > 31000

Service Providers > 32000

Mobility Operators > 10

Transport Modes = 3

The Most Crowded Stops

Indipendenza Xxvii Aprile

P.Za Indipendenza

Select a time slot: 05:00 to 01:59 Search

Daily Pick-ups: 377

Daily Drop-offs: 407

Daily Vehicle Trips: 979

Stazione Nazionale

Daily Pick-ups: 321

Daily Drop-offs: 358

Daily Vehicle Trips: [unlabeled]

Environment and Weather

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

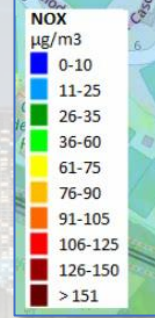
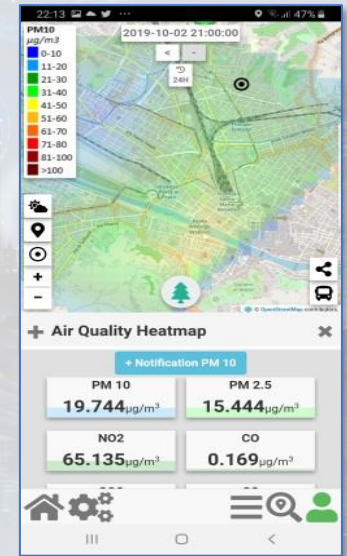
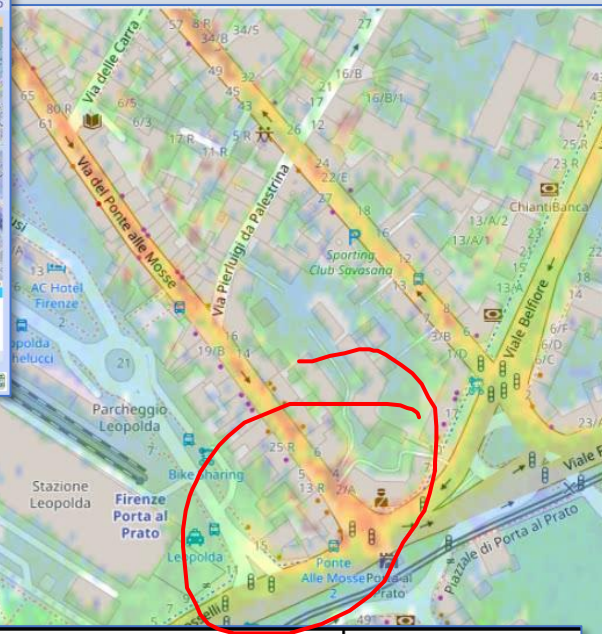
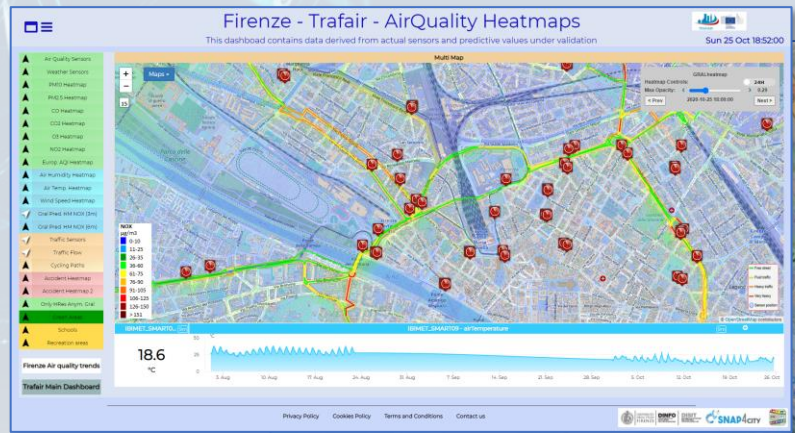
Environment and Quality of Life

Air Quality Predictions

Cities of: Firenze, Pisa, Livorno



- **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**



Pollutant	Averaging period	Air Quality Directive		WHO guidelines	
		Objective and legal nature and concentration	Comments	Concentration	Comments
PM _{2.5}	One day			25 µg/m ³ (*)	99 th percentile (3 days/year)
PM _{2.5}	Calendar year	Target value, 25 µg/m ³	The target value should become a limit value by 2015	10 µg/m ³	
PM ₁₀	One day	Limit value, 50 µg/m ³	It should be exceeded on more than 35 days per year.	50 µg/m ³ (*)	99 th percentile (3 days/year)
PM ₁₀	Calendar year	Limit value, 40 µg/m ³ (*)		20 µg/m ³	
O ₃	Maximum daily 8-hour mean	Target value, 120 µg/m ³	Not to be exceeded on more than 25 days per year, averaged over three years	100 µg/m ³	
NO ₂	One hour	Limit value, 200 µg/m ³ (*)	Not to be exceeded more than 18 times a calendar year	200 µg/m ³ (*)	
NO ₂	Calendar year	Limit value, 40 µg/m ³		40 µg/m ³	

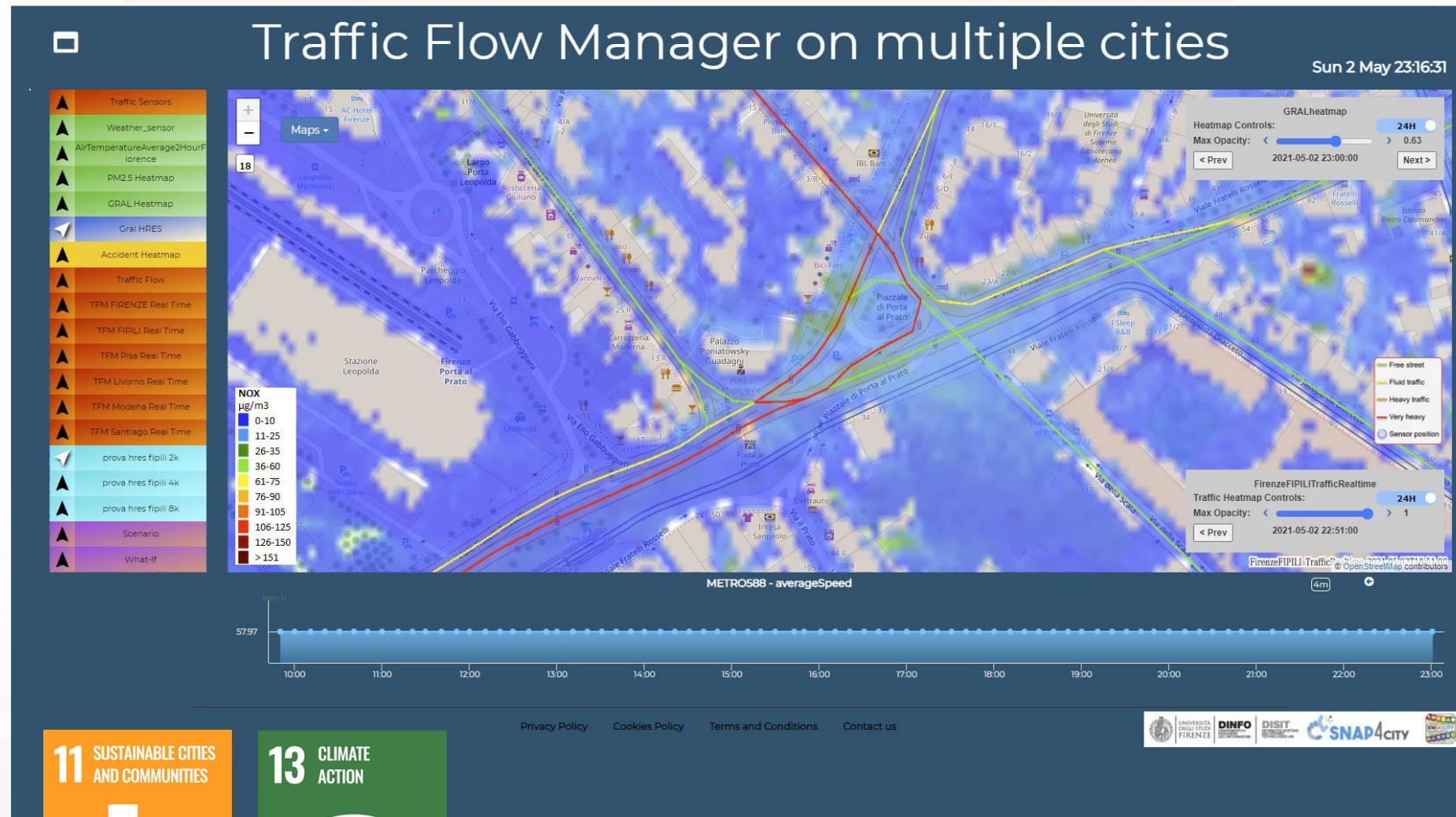
KPI of EC

• **Prediction**

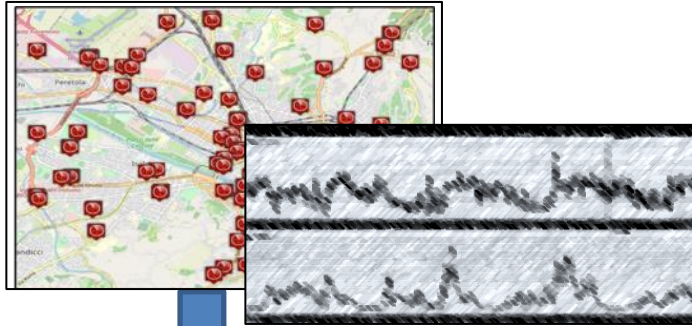
- **NOX Pollutant** diffusion on the basis of Traffic Flow (prediction), weather and 3D structure
- **NO2 progressive average** (Long term)

• **Project:**

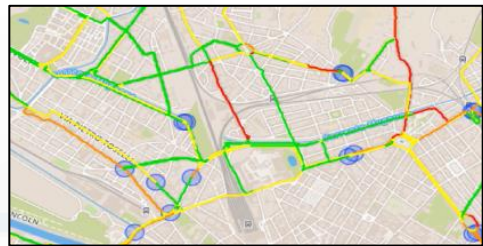
- **Trafair CEF EC**
- **Mixed solutions** of Fluidinamics modeling and AI



Estimating City Local CO2 from Traffic Flow Data



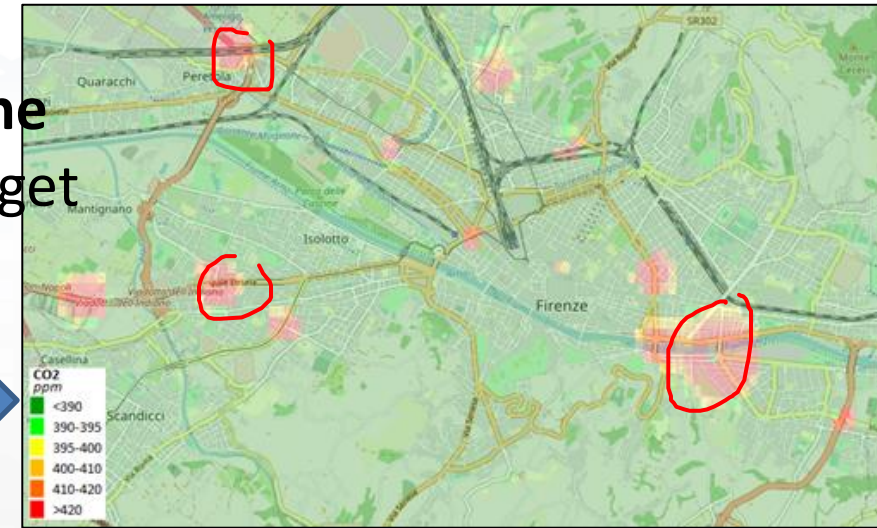
Computing Traffic Flow
into CO2 sensor area



Traffic Flow data

- Traffic Flow is one the main source of CO2 (**ton of CO2 x Km x Vehicle**)
 - K1: Fluid Flow**
 - K2: Stop and Go**
- Dense estimation of CO2 into the city** is very useful to know to target EC's KPIs

Computing CO2 on the basis of
traffic flow data



CO2 estimation

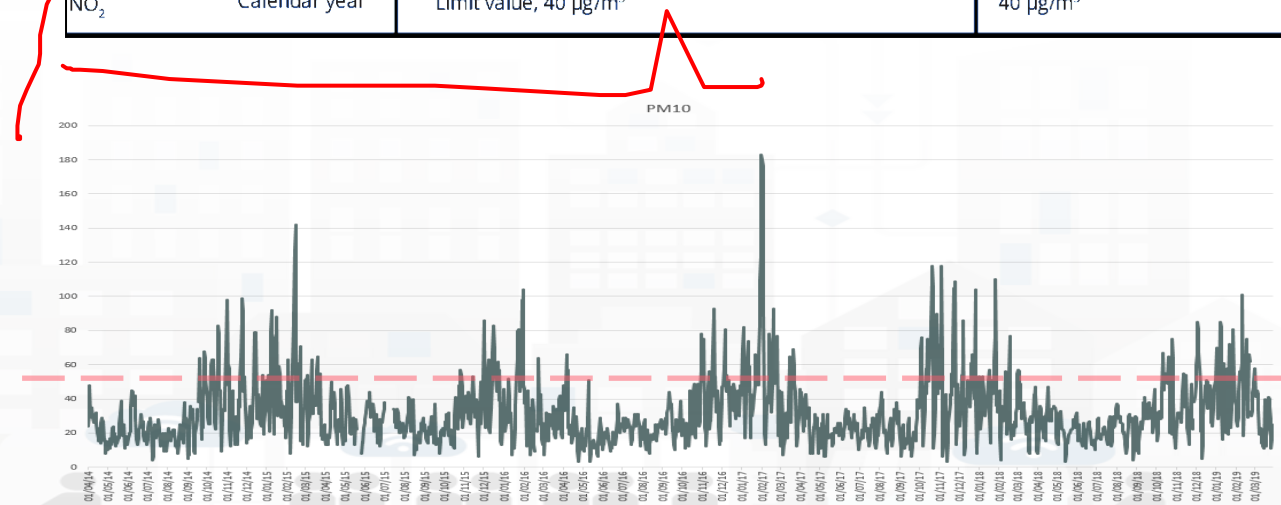


S. Bilotta, P. Nesi, "Estimating CO2 Emissions from IoT Traffic Flow Sensors and Reconstruction", Sensors, MDPI, 2022. <https://www.mdpi.com/1424-8220/22/9/3382/>

Predicting Air Quality

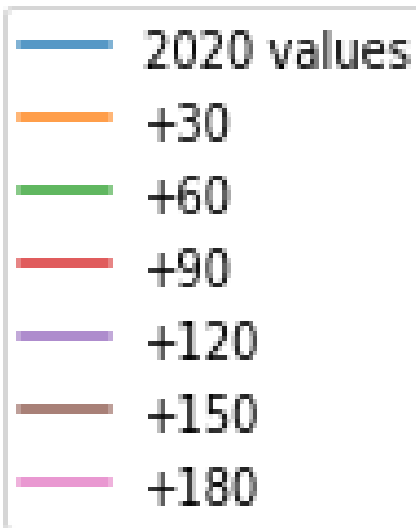
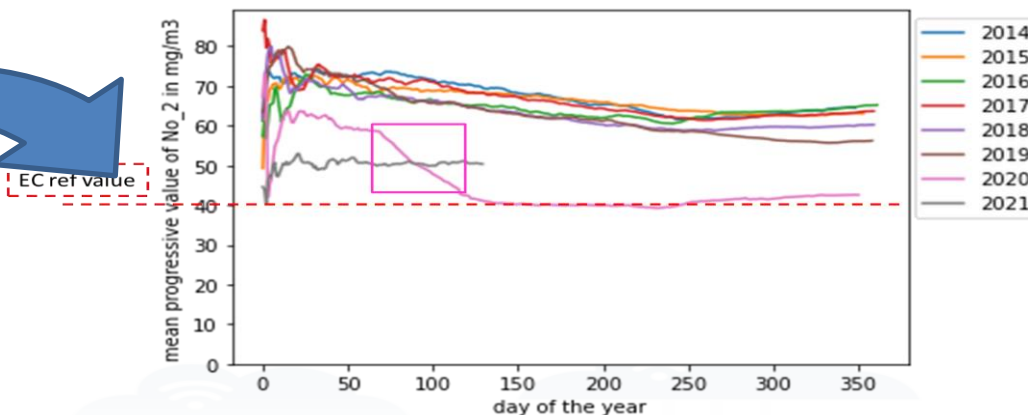
- European Air Quality Directive
- Predicting critical days
 - PM10 with an accuracy of more than 90% and precision of 85%;
 - PM2.5 with an accuracy of 90% and precision greater than the 95%.
- Simulating Long terms values
 - For long terms predictions

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



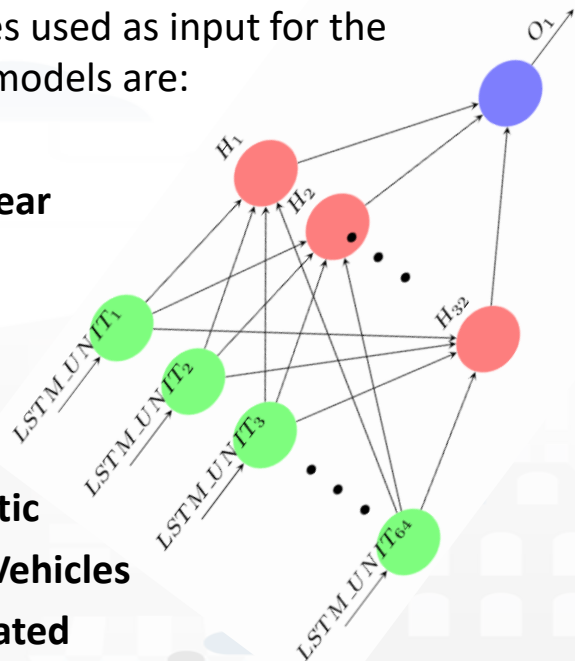
Predicting EC's KPI on NO2 months in advance

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**



Pollutant	Averaging period	Air Quality Directive		WHOguidelines	
		Objective and legal nature and concentration	Comments	Concentration	Comments
PM _{2.5}	One day			25 µg/m ³ (*)	99 th percentile (3 days/year)
PM _{2.5}	Calendar year	Target value, 25 µg/m ³	The target value has become a limit value since 1 January 2015	10 µg/m ³	
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PM ₁₀	Calendar year	Limit value, 40 µg/m ³ (*)		20 µg/m ³	
O ₃	Maximum daily 8-hour mean	Target value, 120 µg/m ³	Not to be exceeded on more than 25 days per year, averaged over three years	100 µg/m ³	
NO ₂	One hour	Limit value, 200 µg/m ³ (*)	Not to be exceeded more than 18 times a calendar year	200 µg/m ³ (*)	
NO ₂	Calendar year	Limit value, 40 µg/m ³		40 µg/m ³	

Smart Buildings, Snap4Building

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

Ciao roottooladmin!

Tue 3 May 14:37:14

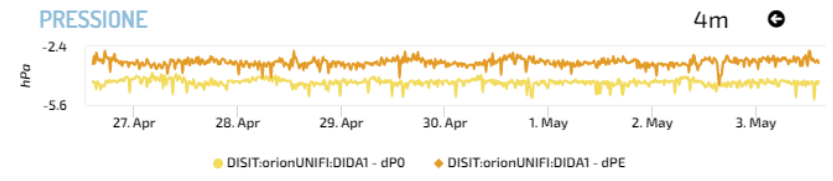
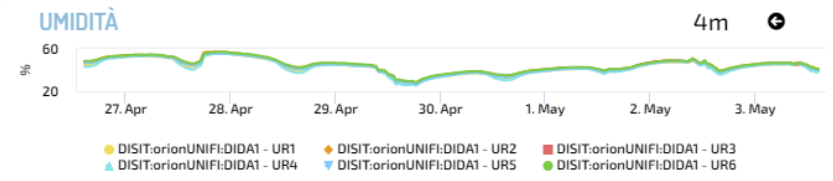
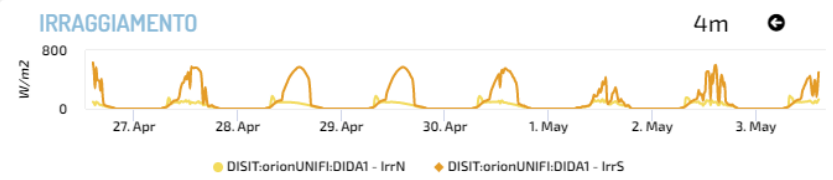
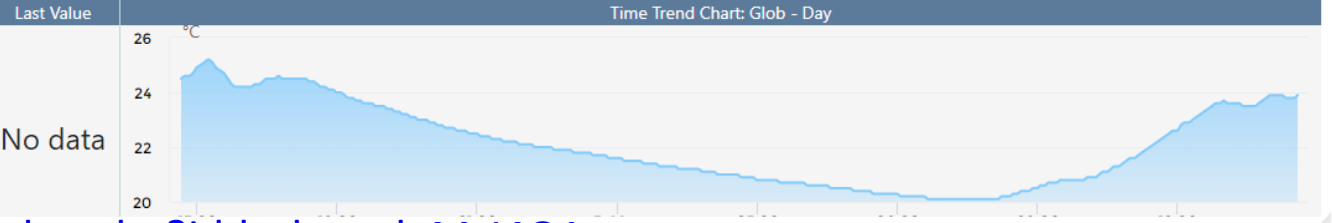
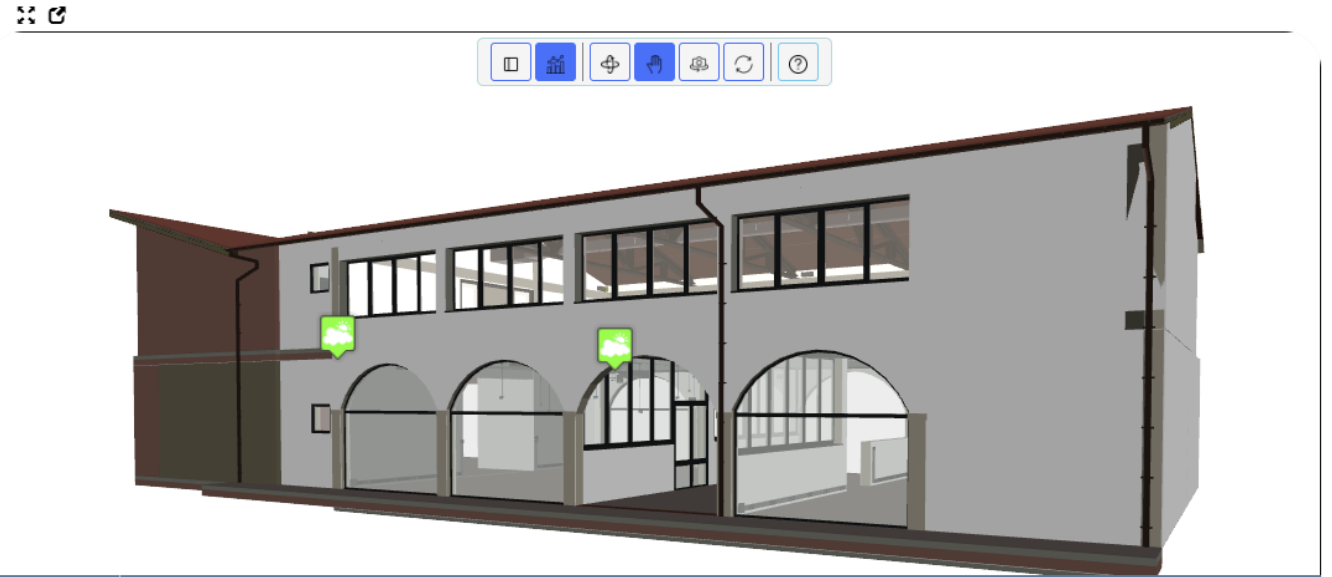
DIDA DATA 2 - NEWGUI

7 AFFORDABLE AND
CLEAN ENERGY

11 SUSTAINABLE CITIES
AND COMMUNITIES

to see BIM log as user: info@disit.org, passwd: guest

BIM SANTA VERDIANA



<https://www.snap4city.org/dashboardSmartCity/view/index.php?iddashboard=MzI4OA==>

Building / Floor / Parking:

Building

All / Single Building:

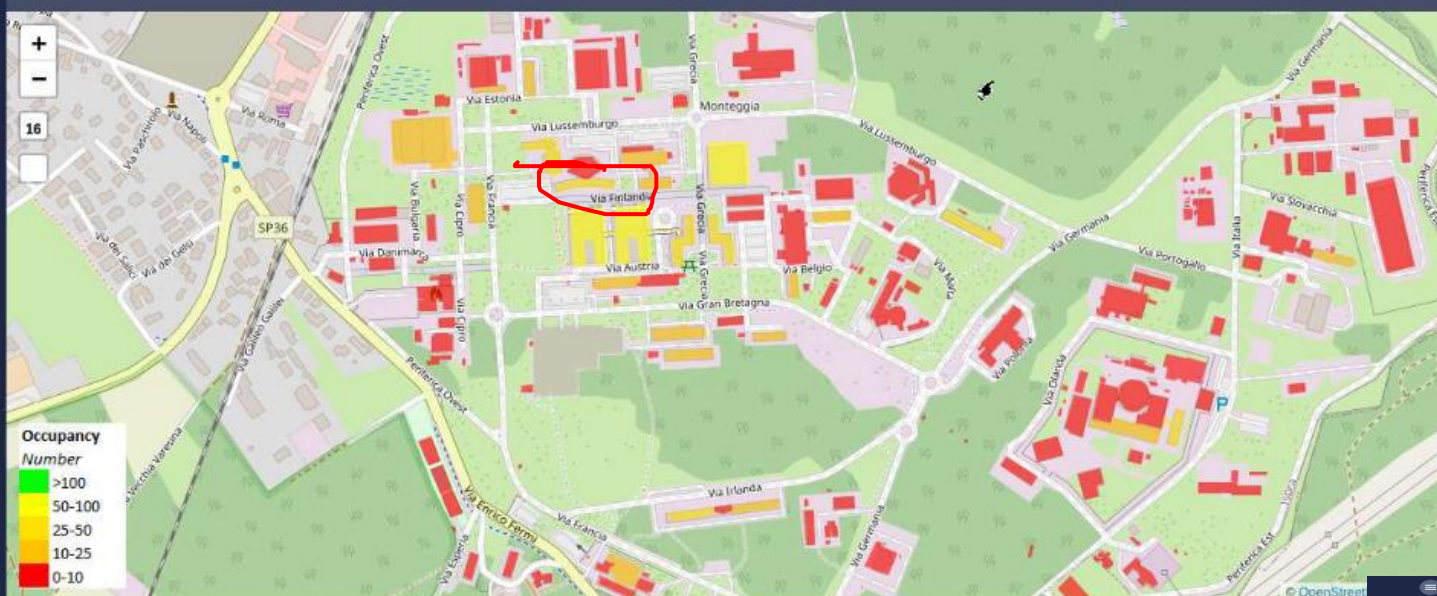
All

Variable:

occupancy

Popup on Shape Click

Add To Map



ISPRA Site



- Date Observed: 10/23/2023, 12:30:01 PM
- Capacity: 2936 #
- Allocation: 1995 #
- Occupancy: 883 #
 - DAC: -941 #
 - DOA: -1112 #
 - DOC: -2053 #
 - PAC: 67.95 %
 - POA: 44.26 %
 - POC: 30.07 %
- Energy Hot: 4473978 kWh
- Energy Cold: 916361 kWh
- Power Hot: 36 kW
- Power Cold: 0 kW

Ispra - Occupancy 8m

883

Ispra - Occupancy

8m



person My Profile

Floor Details

ISPRA JRC Site

Ispra Floor, Zone And Room Details

Fri 6 Oct 18:41:54

Allocation Number

- >50
- 25-50
- 13-25
- 5-13
- 0-5

Floor PT of Building 58A

- Date Observed: 10/6/2023, 6:30:02 PM
- Capacity: 37
- Allocation: 31
- Occupancy: 1
 - DAC: -6 #
 - DOA: -30 #
 - DOC: -36 #
 - PAC: 83.78 %
 - POA: 3.23 %
 - POC: 2.7 %

See Trends

Select a Zone metric: Allocation

Room 017

- Date Observed: 10/6/2023, 12:01:00 PM
- Zone Id: 58A_PT_B
- Capacity: 1
- Allocation: 0
- mq: 12.16
- Average hourly temp. Xi: 24.07°C
- Average hourly temp. Xs: 20.92°C
- Average hourly temp. Xt: 6.00°C
- Heat Start temp.: 17.92°C
- Cold Start temp.: 23.92°C

See Trends

Building 58A PT Trends

Mon 9 Oct 13:51:30

Actual 4m

Capacity - Allocation - Occupancy 4m

Organization: Orion-1: Floor2_58A_PT - Occupancy 9m

Temp. 9m

21.7

°C

Percentage Per Zones - Monthly Time Trend Comparison 4m

Occupancy Per Zones - Monthly Time Trend Comparison Stacked 4m

Energy

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



Cabinets On Stockholm By Capelon

Tue 31 Oct 22:53:17

Capelon Cabinet (iot-search)

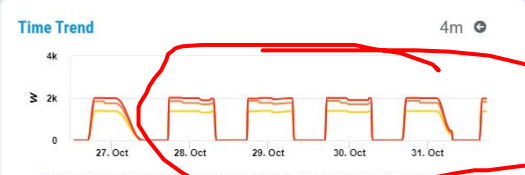
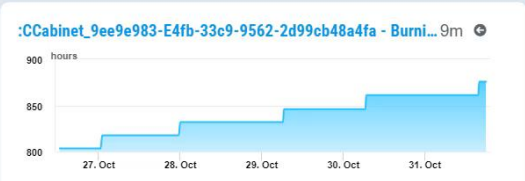
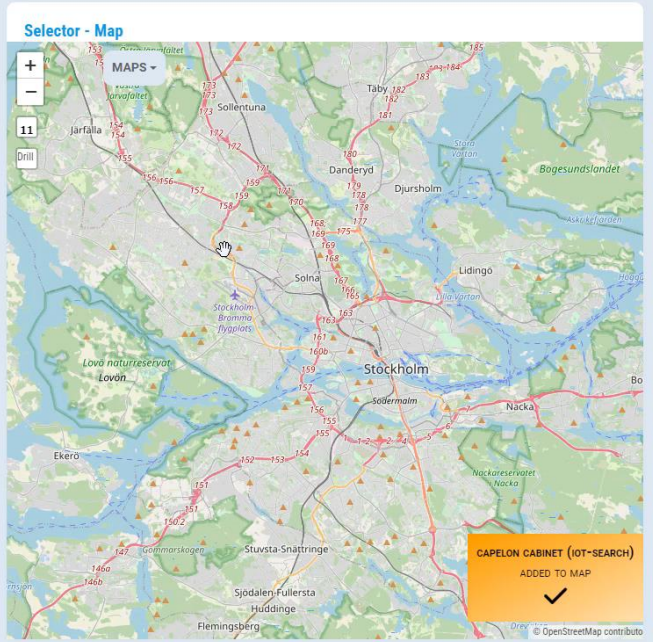
Ac...9m ActualState0Count - St... 9m

12

Radars Series

4m

● CCabinet_9ee9e983-e4fb-33c9-9562-2d99cb48a4fa



● CAPELON:orionCAPELON-UNIF:CCabinet_9ee9e983-e4fb-33c9-9562-2d99cb48a4fa - phase...
 ● CAPELON:orionCAPELON-UNIF:CCabinet_9ee9e983-e4fb-33c9-9562-2d99cb48a4fa - phase...
 ● CAPELON:orionCAPELON-UNIF:CCabinet_9ee9e983-e4fb-33c9-9562-2d99cb48a4fa - phase...

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Smart Light Management

ASM Merano Stadtwerke Merano

Elenco lampade Visualizzazione dati Log eventi Grafici Impostazioni

N. Punto Luce	11307
DevEui	7083D58F100085D7
Via	RomStraÙe
Regolazione	
Ore di servizio	
Conta energia	
Potenza attuale	
Stato	Inattivo
Nome errore	null
RSSI	
SNR	
Data	01/11/2023 12:01:18

Regolazione

ON

OFF

Non Attivo Stato Linea verso Sinigo

Non Attivo Stato Linea verso Merano Centro

Smart Light in Merano



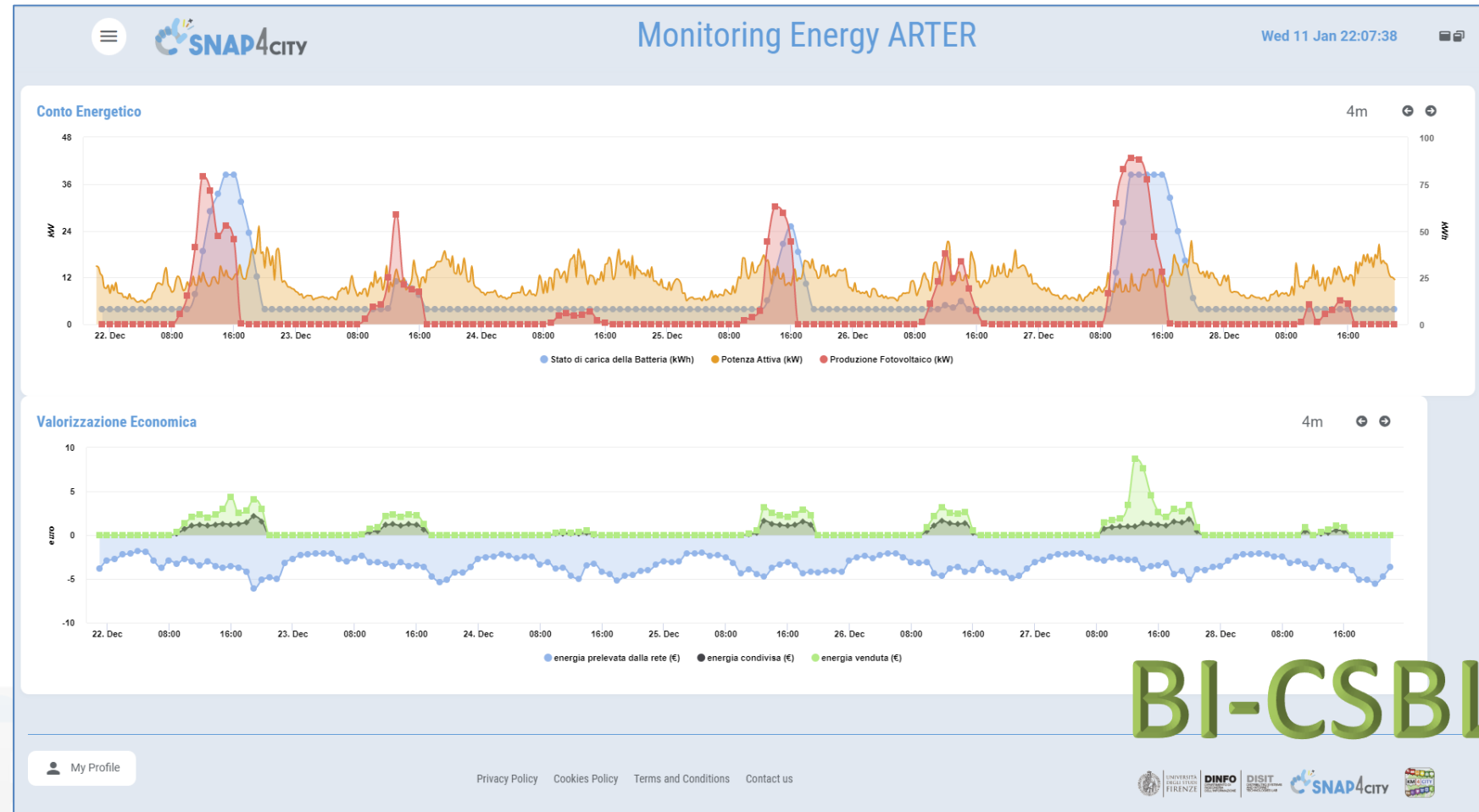
Merano - tutti i servizi

Wed 13 Dec 15:34:57





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



BI-CSBL

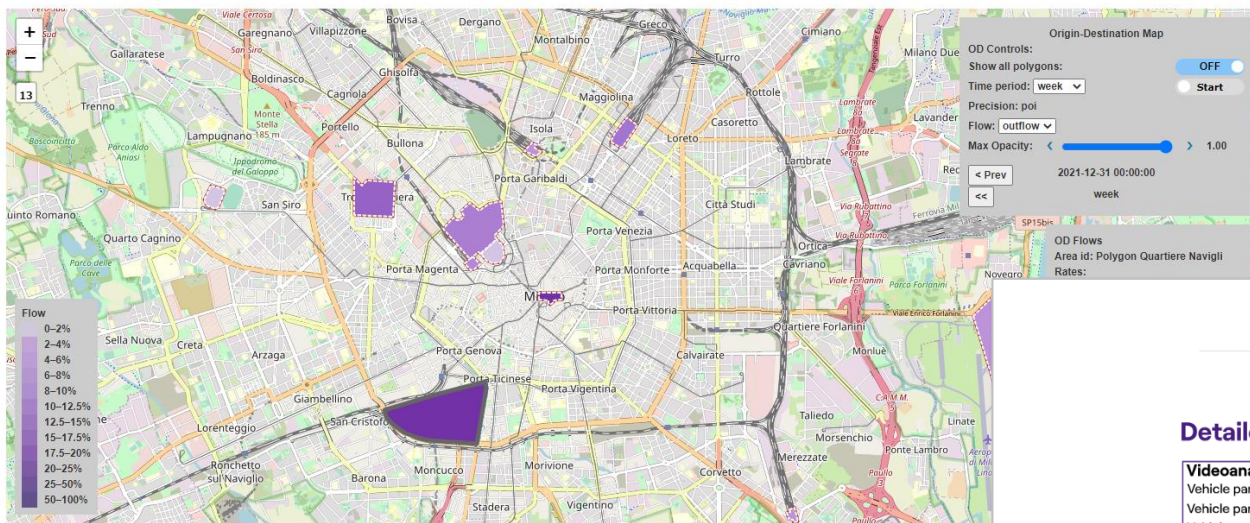
<https://www.selfuser.it>



Green and Data Driven District

Aggregated KPI JuicePark SmartPole CityAnalytics

POI - OD POI - PRESENZE POI - PRESENZE (TS) ACE - PRESENZE ACE - PRESENZE (TS)



Privacy Policy Cookies Policy Terms and Conditions

Green and Data Driven District

Aggregated KPI JuicePark SmartPole CityAnalytics

Detailed KPIs

Videoanalysis	
People counted daily:	0
People counted to date:	0
People aggregation daily:	0
People aggregation to date:	0
Vehicle counted daily:	0
Vehicle counted to date:	21
Power meter	
Daily energy consumed:	9.024 kWh
Energy consumed to date:	27.341 kWh
Daily energy produced:	1.409 kWh
Energy produced to date:	4.252 kWh
WiFi	
Max number of connected devices in the last day:	0
Hourly average connected devices:	####
eBike	
Daily number of sessions:	0
Number of sessions to date:	0
Total Energy consumed:	0
Average energy consumed:	0
Last charger session:	17/05/2022 11:25
Emergency	
SOS requests to date:	0
SOS request daily:	0
AED requests to date:	0
AED requests to daily:	0

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Green and Data Driven District

Aggregated KPI JuicePark SmartPole CityAnalytics

Detailed KPIs

Videoanalysis	
Vehicle parked daily:	8
Vehicle parked to date:	87
Vehicle count daily:	24
Vehicle count to date:	20
Power meter	
Energy consumed daily:	0 kWh
Energy consumed to date:	0 kWh
Energy produced daily:	0 kWh
Energy produced to date:	0 kWh
WiFi	
Max number of connected devices in the last day:	0
Hourly average connected devices:	####
Emergency	
SOS Requests to date:	0
SOS request daily:	0
EV charged	
Number of sessions daily:	0
Number of sessions to date:	0
Total Energy consumed:	0
Average energy consumed:	0
Last charger session:	0

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7 AFFORDABLE AND CLEAN ENERGY



11 SUSTAINABLE CITIES AND COMMUNITIES



<https://www.snap4city.org/dashboardSmartCity/view/Baloon.php?iddashboard=MzczNg==>

Ciao roottooladmin1

Sat 11 Nov 17:26:28

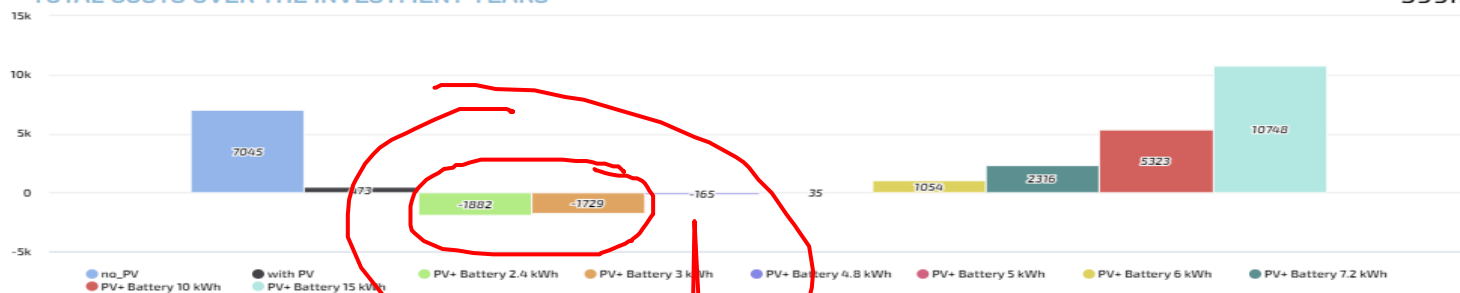
ONLINE PHOTOVOLTAIC SYSTEM SIMULATOR

User Manual

Italian Version

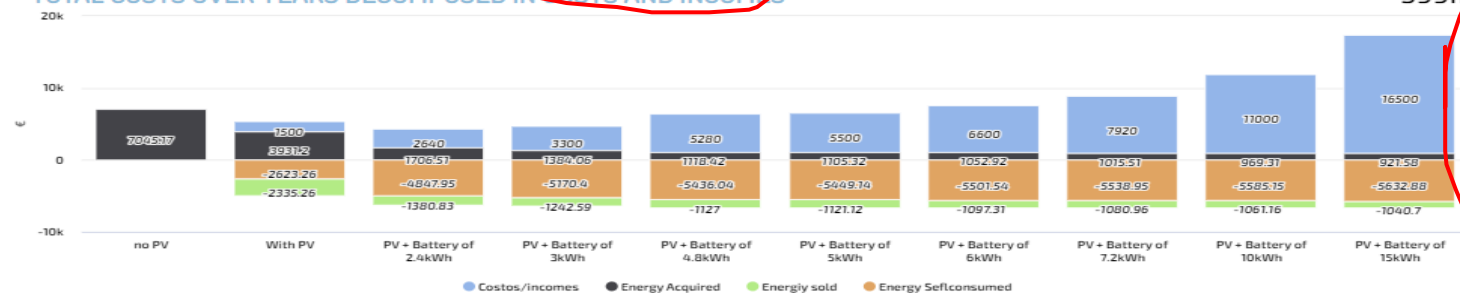
TOTAL COSTS OVER THE INVESTMENT YEARS

599m



TOTAL COSTS OVER YEARS DECOMPOSED IN COSTS AND INCOMES

599m



PARAMETERS OF YOUR PV PLANT

We suggest you PV plus battery of 2.4 kWh

Annual Consumption

Price of energy sold (€/kWh)

Price of Energy Acquired (€/kWh)

Years of Investment

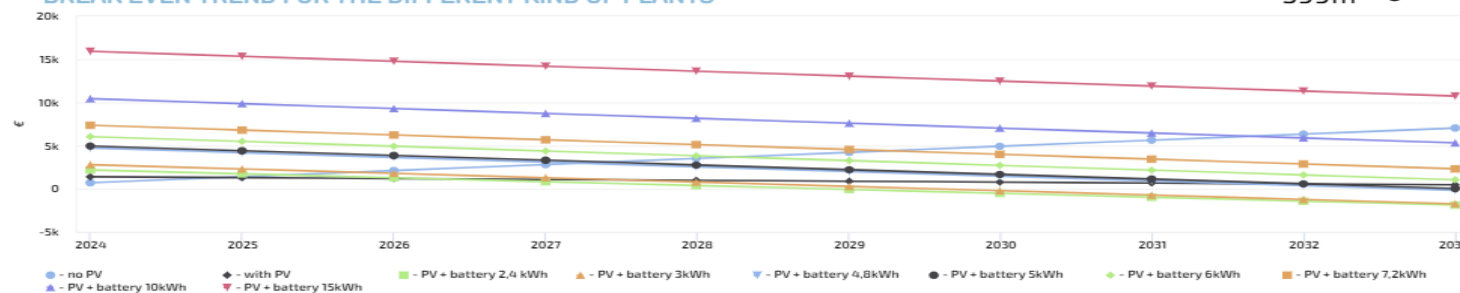
Months for typical trends

Compute



BREAK EVEN TREND FOR THE DIFFERENT KIND OF PLANTS

599m



<https://www.snap4city.org/944>

Developing on Snap4City

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



FROM CITY DASHBOARD TO APPLICATIONS

DATA AND KNOWLEDGE MANAGEMENT

IOT APPLICATIONS VS IOT EDGE DEVICES

TWITTER VIGILANCE: SOCIAL MEDIA ANALYSIS

SNAP4CITY ARCHITECTURE AND ECOSYSTEM, OPENED TO DEVELOPERS AND STAKEHOLDERS

SNAP4CITY AND KM4CITY PROJECTS

OPT AND API

SNAP4CITY THE VIEW OF THE ADMINISTRATORS

Development

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



Development Life-Cycle

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

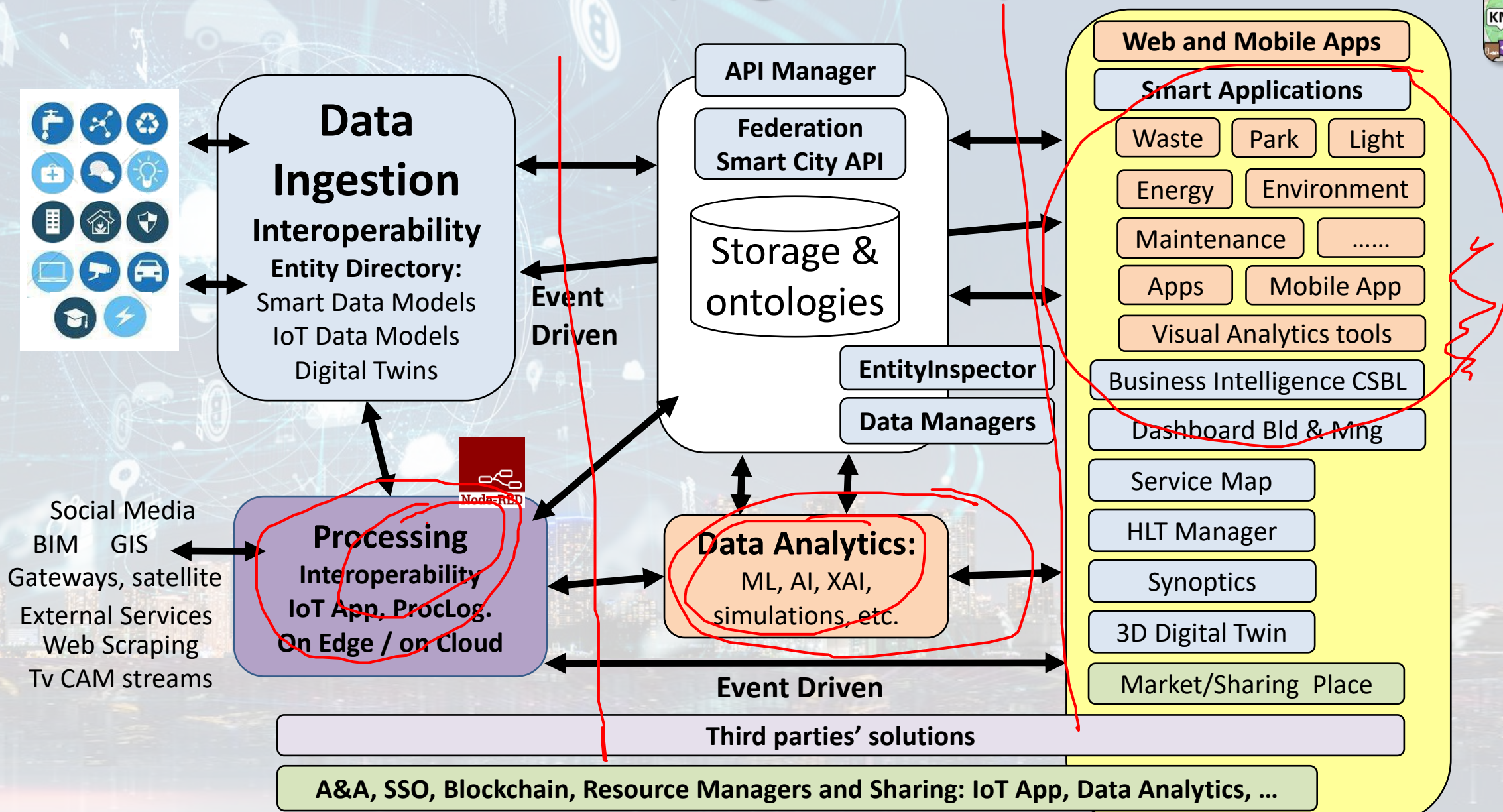
From Snap4City:

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

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

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

Technical Architecture (high level)



Tools of Tech. Arch.



My IOT Sensors and Actuators

Add My New Device

Entities/Devices Management

ID	Device Name	Device Type	Model	Category	Color	Status	IP	City	Location
ANQualityObservedMMA42802	Antwerp	ANQualityObserved	custom	PRIVATE	Antwerp	industrialfactory	active	10.0.0.1	Antwerp
ANQualityObservedMMA42803	Antwerp	ANQualityObserved	custom	PRIVATE	Antwerp	industrialfactory	active	10.0.0.2	Antwerp
ANQualityObservedMMA42804	Antwerp	ANQualityObserved	custom	PRIVATE	Antwerp	industrialfactory	active	10.0.0.3	Antwerp
ANQualityObservedMMA42805	Antwerp	ANQualityObserved	custom	PRIVATE	Antwerp	industrialfactory	active	10.0.0.4	Antwerp
ANQualityObservedMMA42806	Antwerp	ANQualityObserved	custom	PRIVATE	Antwerp	industrialfactory	active	10.0.0.5	Antwerp

Service Map (Toscana)

Data Inspector

My Dashboards in My Organization

3D MAP GLOBAL DIGITAL TWIN - NEWGUI

Client-Side Business Logic - Test

My Data Dashboard Dev Kibana

Proc.Logic / IoT App

Jupyter2-(775) Hub - Python

ISMinindex

Custom Widgets / Synoptics

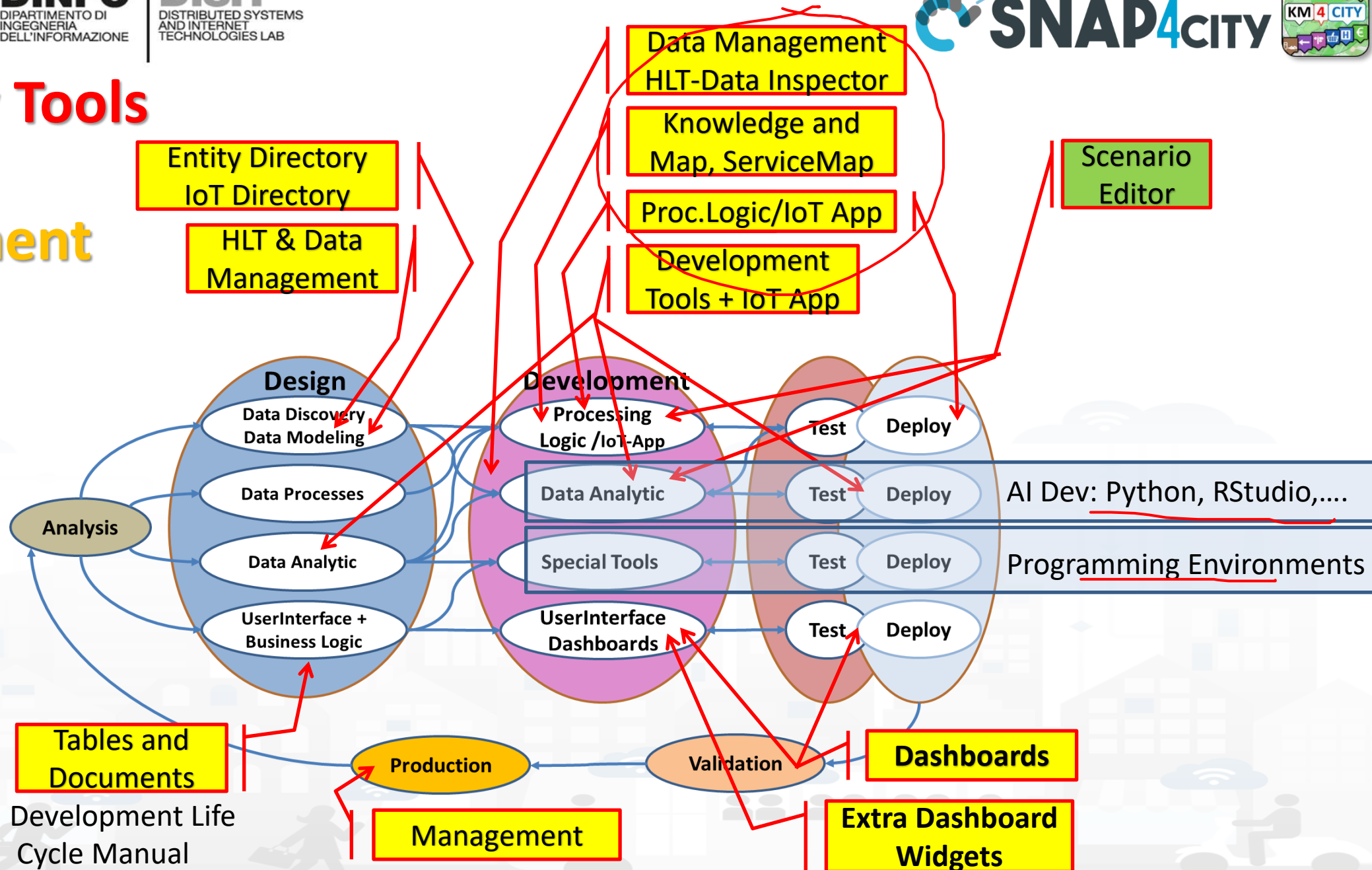
Third parties solutions

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

Snap4City Tools

vs

Development Life Cycle



Ciao roottooladmin!

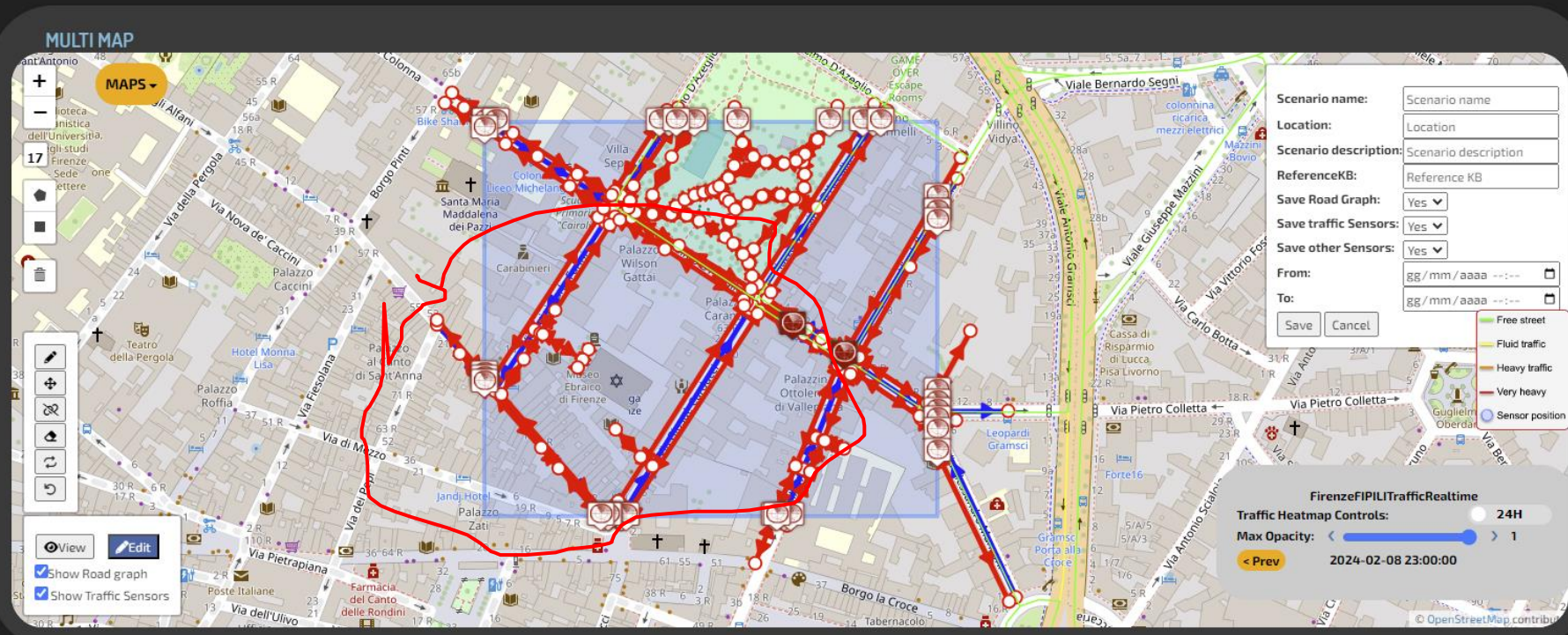
Wed 14 Feb 22:40:02

FIRENZE - TRAFAIR - AIRQUALITY HEATMAPS - NEWGUI

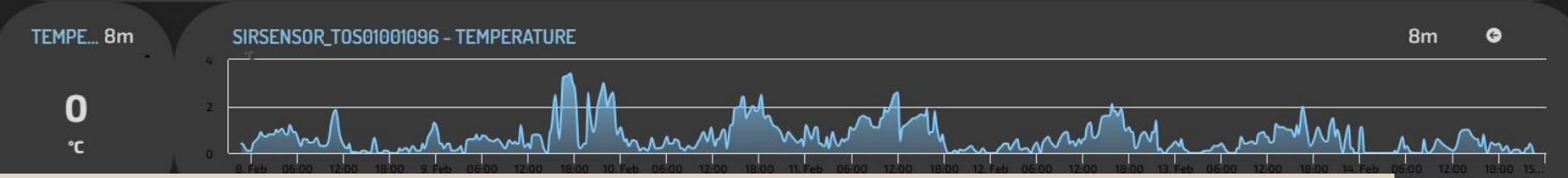
This dashboard contains data derived from actual sensors and predictive values under validation



- U3 Heatmap
- NO2 Heatmap
- Europ. AQI Heatmap
- Air Humidity Heatmap
- Air Temp. Heatmap
- Wind Speed Heatmap
- Gral Pred. HM NOX (3m)
- Gral Pred. HM NOX (6m)
- Traffic Sensors
- Traffic Flow



- Firenze Air quality trends
- Firenze GRAL Scenario
- TraFair Main Dashboard



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

For example:

Select map

Zoom

New Scenario

Editing

Drag & drop

Split & Join

Delete

Do and Undo

Scenario name:

Location:

Scenario description:

ReferenceKB:

Save Road Graph: Yes

Save traffic Sensors: Yes

Save other Sensors: Yes

From:

To:

Save

Category Street:

Nr.Lanes:

Speed Limit (km/h):

Direction:

Restrictions:

Edit Road Segment

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

ScenarioBuilder

Tue 12 Mar 15:53:34

Call the Scenario Editor

Some Points of Interest

Load Scenario: Init Acc TDM

Scenarios waiting to be processed: FDSA Load Scenario

View Edit

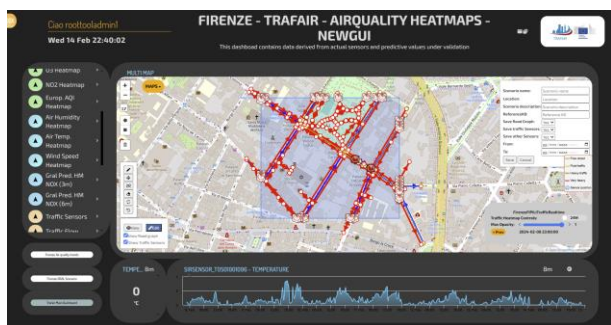
Show Road graph

Show Traffic Sensors

Filter by road types

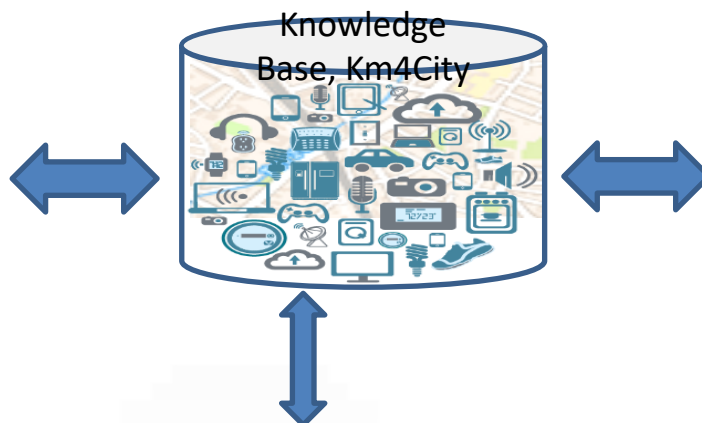
© OpenStreetMap contributors

The actual Scenario Exploitation



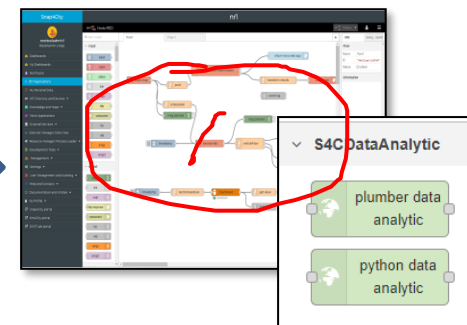
Defining Context via Editing Scenario:

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



A Scenario includes:

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



Computing in the Scenario Context as:

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

ReLoading Scenario in JavaScript

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



Part 2: Dashboard production and management

Part 2: Dashboards
production and
management

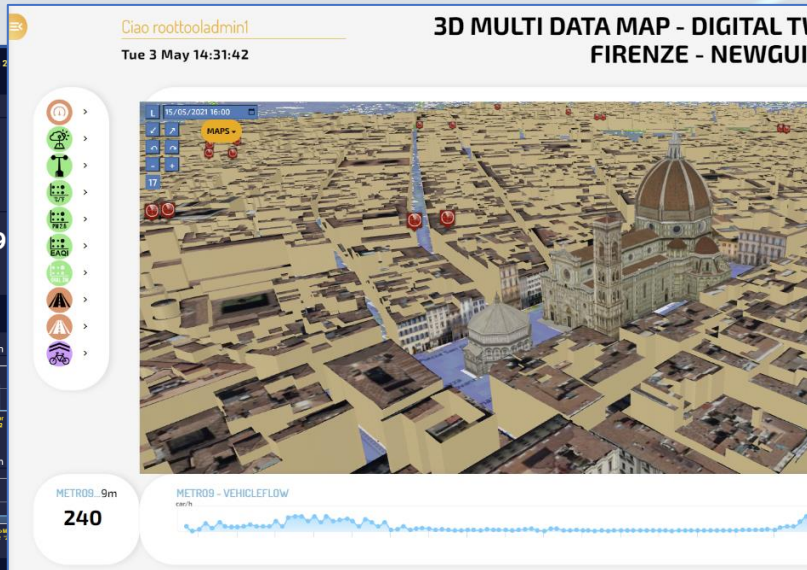
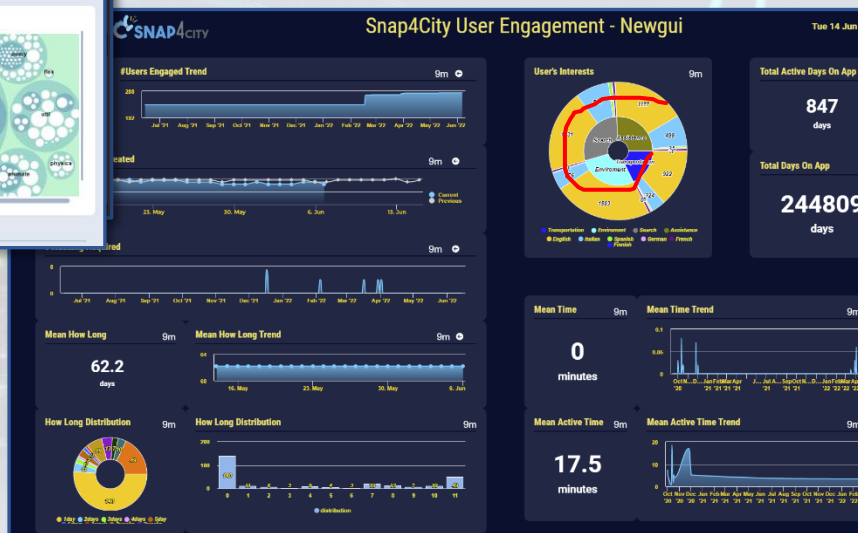
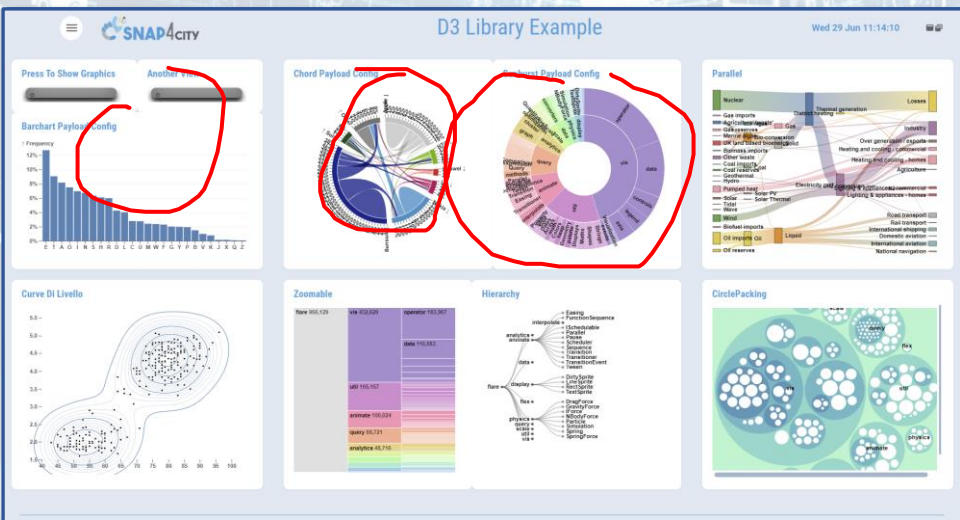
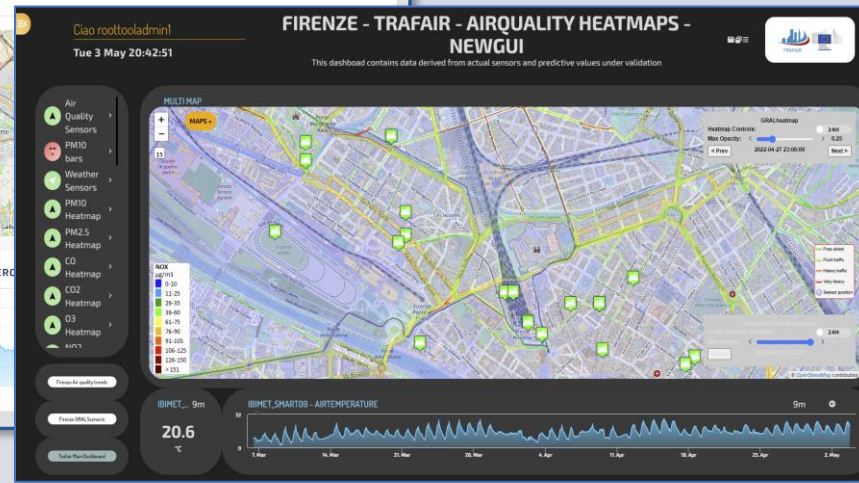
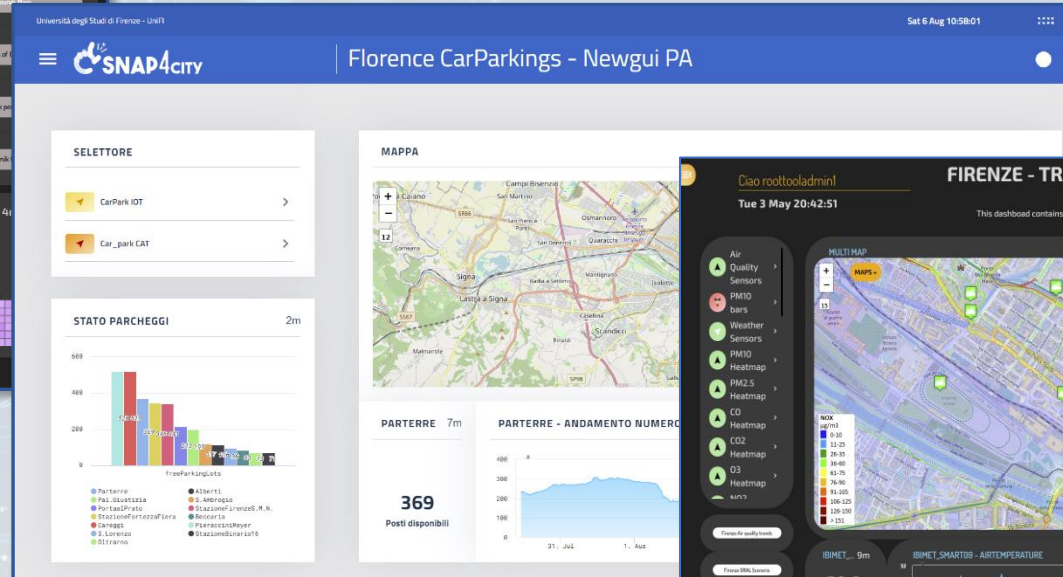
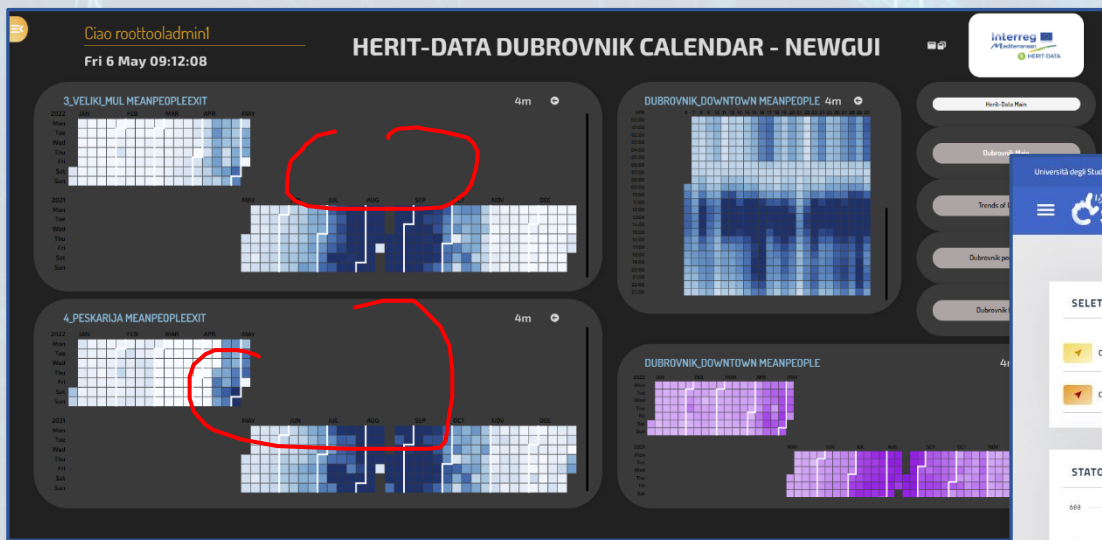
[SLIDES](#)

[Interactive Slides](#)



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

Different Themes



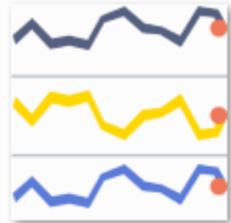
New styles/themes can be developed by specializing a few files from open source

<https://www.snap4city.org/793>

Visual Representations



Slider with multiple steps for KPI



sparklines



kpi



histogram



heatmap



flow-maps



geo-maps



donut-chart



Data-grid



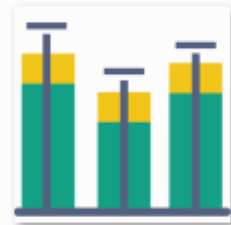
chord



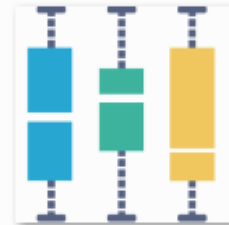
Cone



Bubble matrix chart



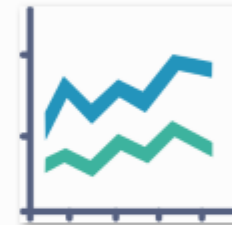
Bullet



Box-plot



staked-area



Stacked-line chart



Stacked-combination Chart



spider-maps



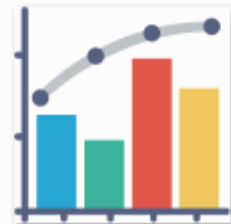
Sequence-Sunburst



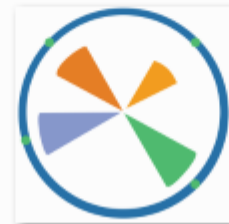
Pivot



pie-chart-1



Pareto chart



radar



Bubble maps



waterfall



Sunburst



Sankey

Dashboard Builder: Development

Data Transformation
Business Logic

IOT Applications

Knowledge Base,
Km4City

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

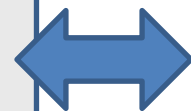


Widget Collection

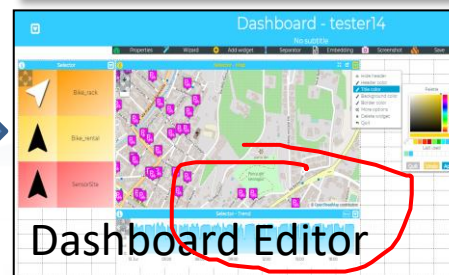
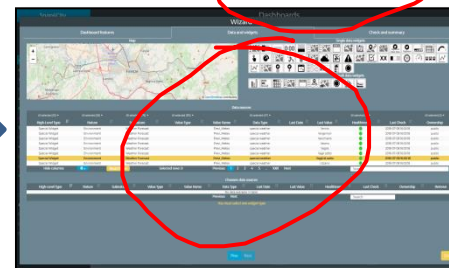
Micro Applications

External Services

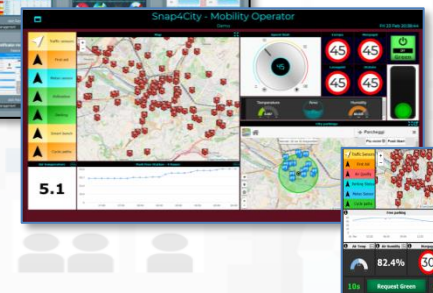
Custom Widgets/
Synoptics



Dashboard Wizard



Public
Dashboard
Collection



My Own Dash/App

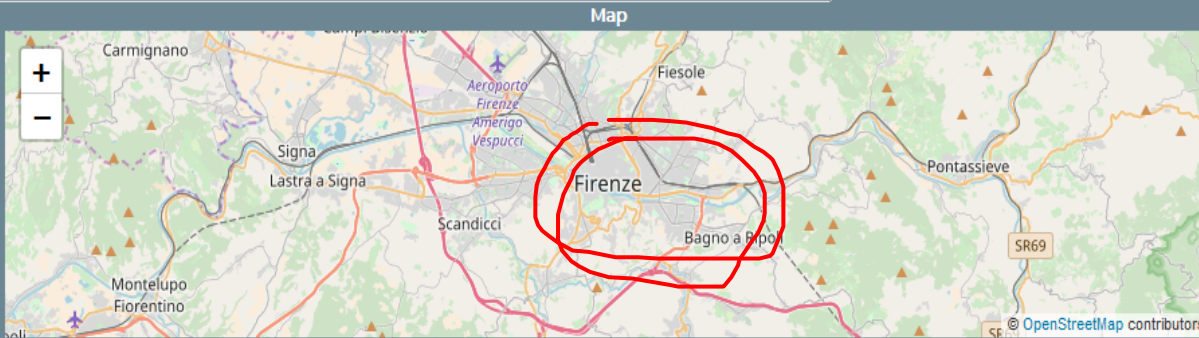
Create, save, load,
delegate, grant access,
change ownership



Wizard

Dashboard features

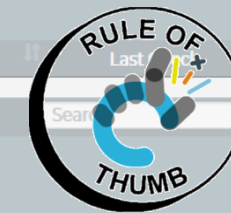
Data and widgets



Data sources

High-Level Type	Nature	Subnature	Value Type	Value Name	Data Type	Last Date	Last Value	Healthiness	Last Check	Ownership
Special Widget	Environment	Weather Forecast	Previ_Meteo	Previ_Meteo	special weather	Vigilance		●	2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast	Previ_Meteo	Previ_Meteo	special weather	Vergemoli		●	2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast	Previ_Meteo	Previ_Meteo	special weather	Vecchiano		●	2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast	Previ_Meteo	Previ_Meteo	special weather	Valiano		●	2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast	Previ_Meteo	Previ_Meteo	special weather	Vaglia		●	2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast	Previ_Meteo	Previ_Meteo	special weather	Vagli sotto		●	2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast	Previ_Meteo	Previ_Meteo	special weather	Vagli di sotto		●	2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast	Previ_Meteo	Previ_Meteo	special weather	Uzzano		●	2018-07-08 16:00:18	public

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



New Data Inspector/Wizard

New Wizard

Data Inspector BETA OS

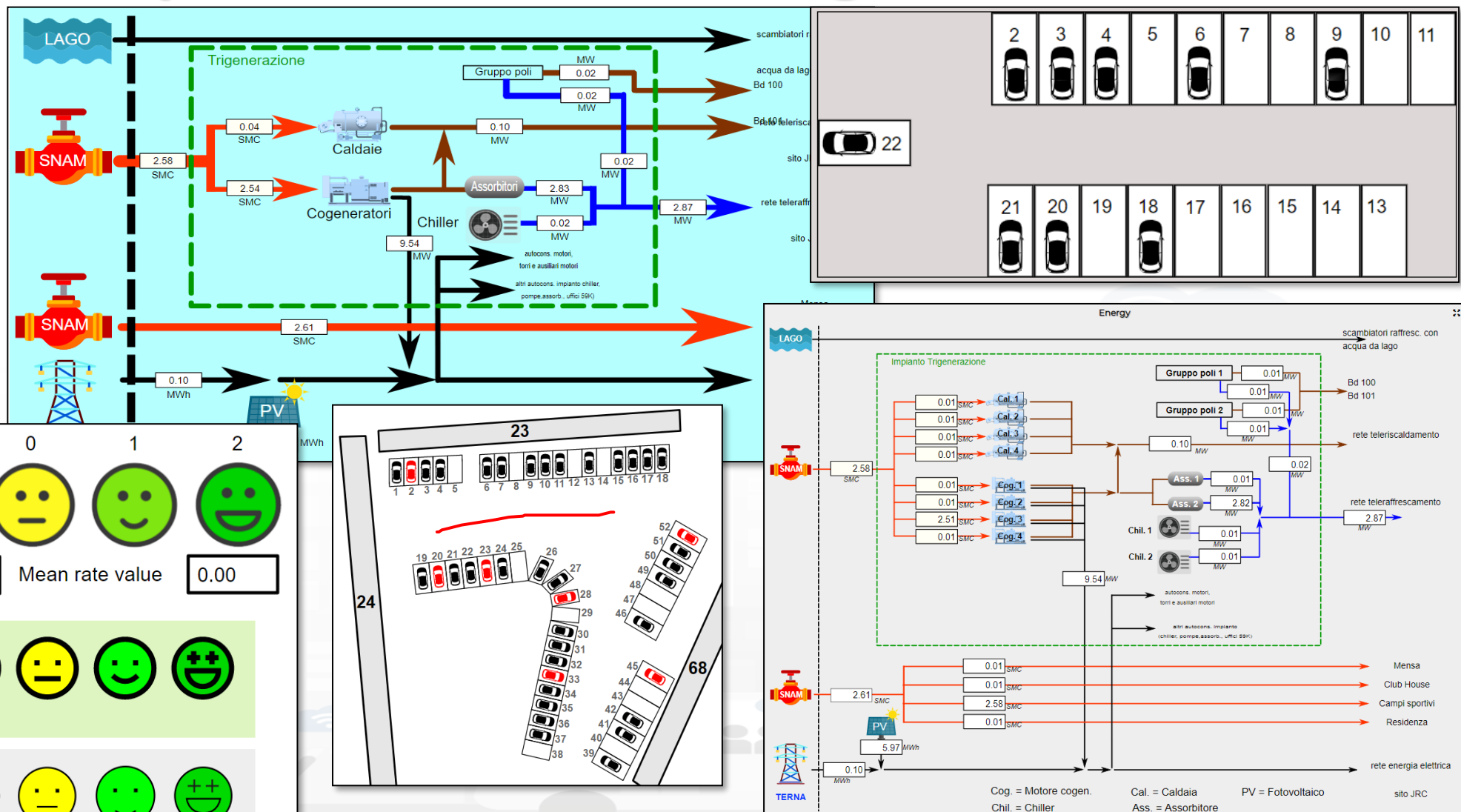
The interface includes a map of Florence, a toolbar with various visualization and control icons, a table of data sources, and a time-series graph. A large red watermark 'New Wizard' is overlaid on the top left.

Level	Type	Nature	Subnature	Device	Model	Broker	Value Name	Value Type	Data Type	Value Unit	Last Date	Last Value	Healthiness	Last Check	Ownership
DT	EM Devi...	Environment	Weather	DIDA1		Santa Verdiana ...	Mio sensore		webpage		2021-11-23 13:44...		●	2023-07-18 16:0...	public
DT	EM Devi...	TransferService...	SensorSite	METRO11		Altair-soda	Altair Valve State		webpage		2021-06-05 00:00...		●	2024-01-10 01:3...	public
DT	EM Devi...	IndustryAndMa...	Computer	AltairStatoPom...		Altair-soda	Altair Pump St...		webpage		2021-05-20 13:51...		●	2024-01-10 01:3...	public
DT	EM Devi...	Environment	Air	IBIMET_SMART...		Altair-soda	Altair pump 43...		webpage		2021-06-07 17:3...		●	2024-01-10 01:3...	public
DT	EM Devi...	Environment	Air	ARPAT_QA_FI...		Altair-soda	Altair valve 541		webpage		2021-06-07 17:3...		●	2024-01-10 01:3...	public
DT	EM Devi...	TransferService...	SensorSite	METRO514		Altair-soda	Altair Pump 4321		webpage		2021-06-07 00:00...		●	2024-01-10 01:3...	public
DT	EM Devi...	TransferService...	SensorSite	SI052032F5990...		Altair-soda	Altair Stock sta...		webpage		2021-06-07 00:00...		●	2024-01-10 01:3...	public
DT	EM Devi...	TransferService...	SensorSite	METRO831		Altair-soda	Altair Pump 92...		webpage		2021-06-07 00:00...		●	2024-01-10 01:3...	public

- Filtering/Searching for individual fields (even for some fields not displayed as geographic coordinates)
- Geographic Filtering
- Text Search on all fields
- Menu for choosing the fields to display in the table
- View on Map(via PREVIEW)
- Data and Trend visualization
- Opening Digital Twin
- Pass to Synoptic mode
- Select the graph representation

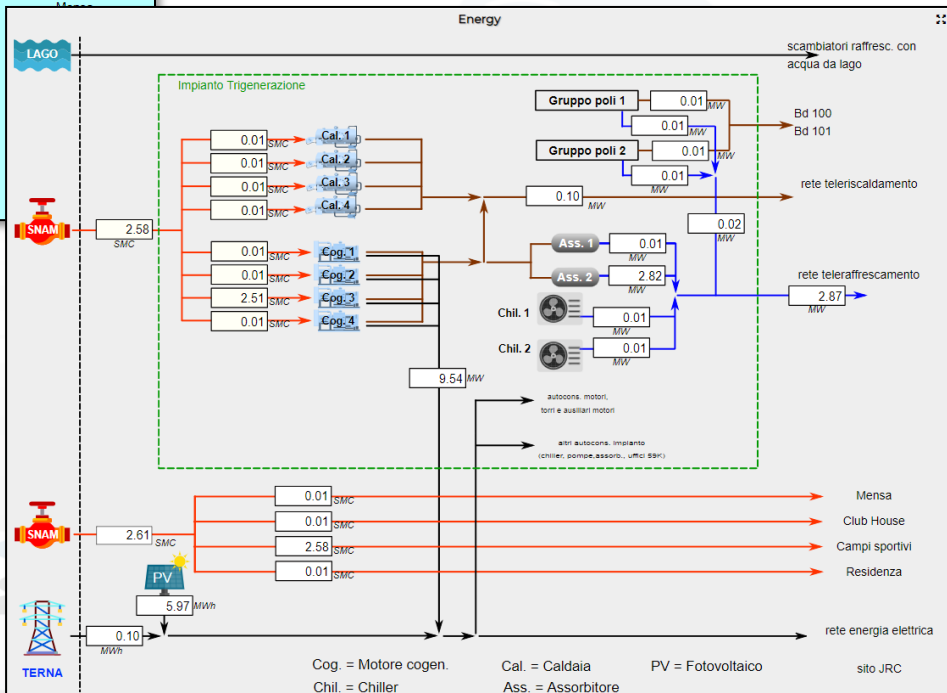
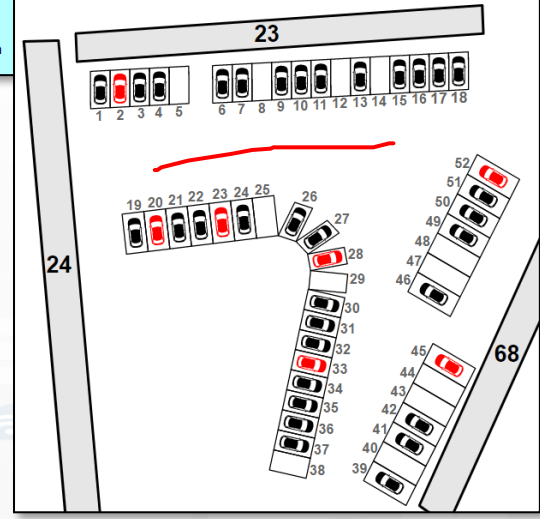
Special Custom Widgets

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





Control interface for smart parking:

- Emotion icons: -2 (angry), -1 (sad), 0 (neutral), 1 (happy), 2 (very happy)
- Total clicks: 6
- Mean rate value: 0.00
- Begin time: 17:00
- Finish time: 4:00
- Additional emotion icons for fine-tuning control.

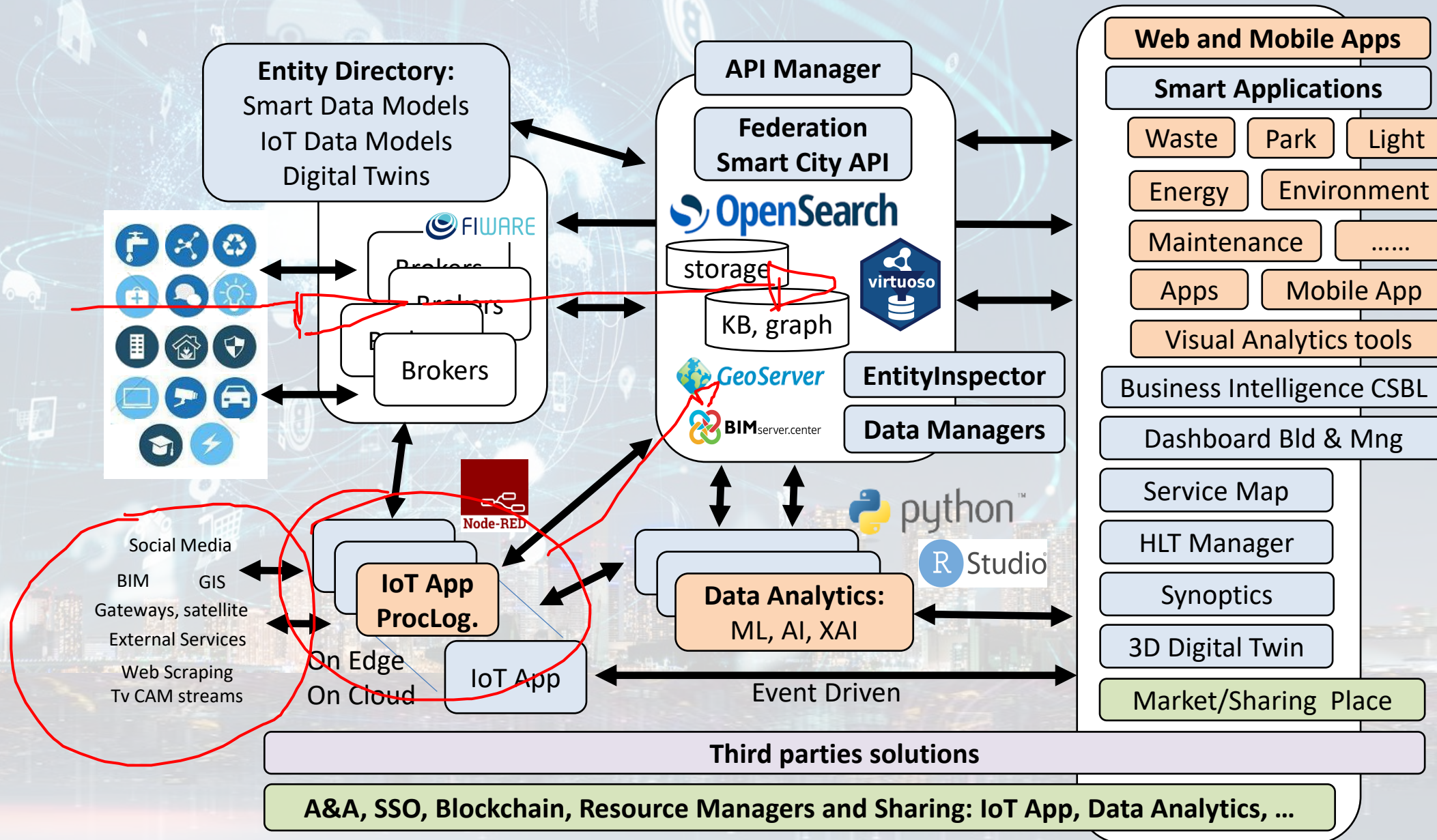


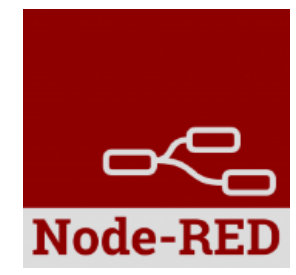
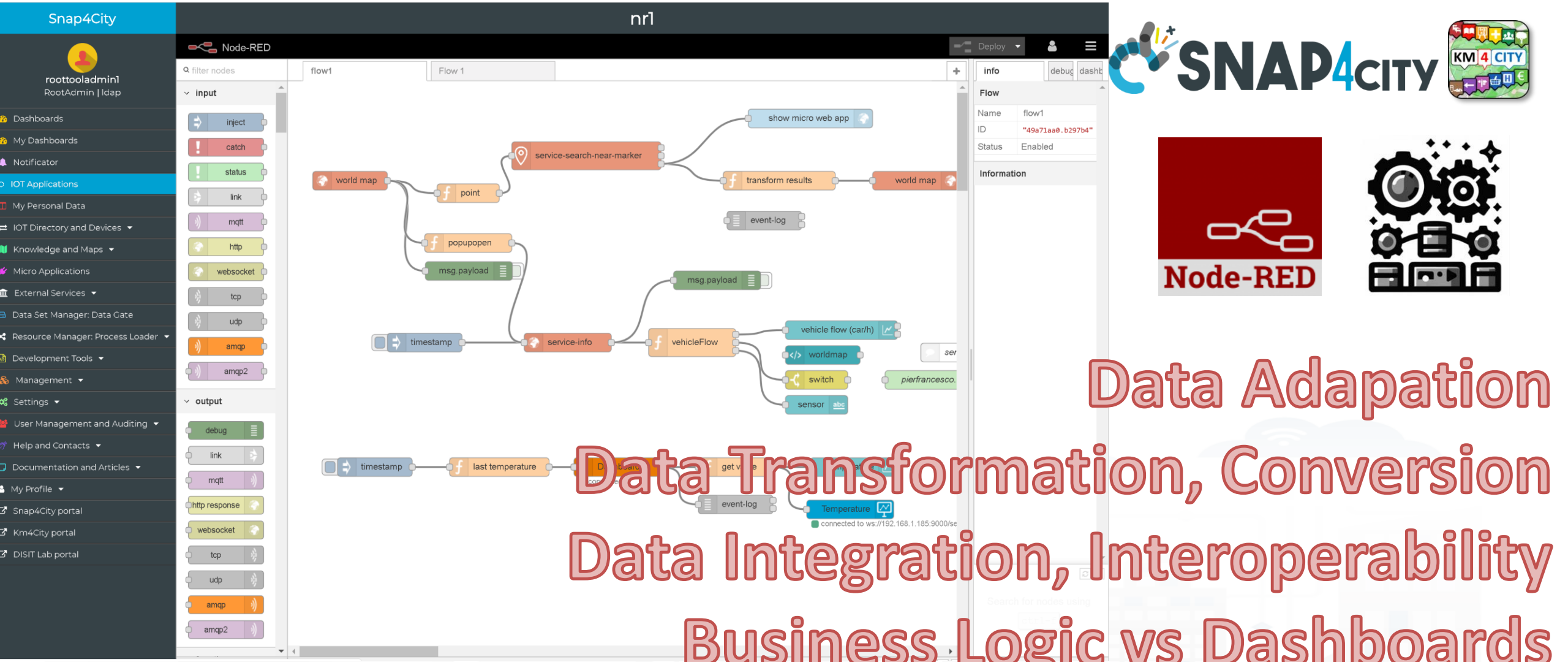
Part 3: IoT App, process logic, server side BL

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

<p>Part 3: IOT App, Process Logic, Server Side Business Logic</p> <p>SLIDES</p> <p>Interactive Slides</p>	 
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Technical Architecture





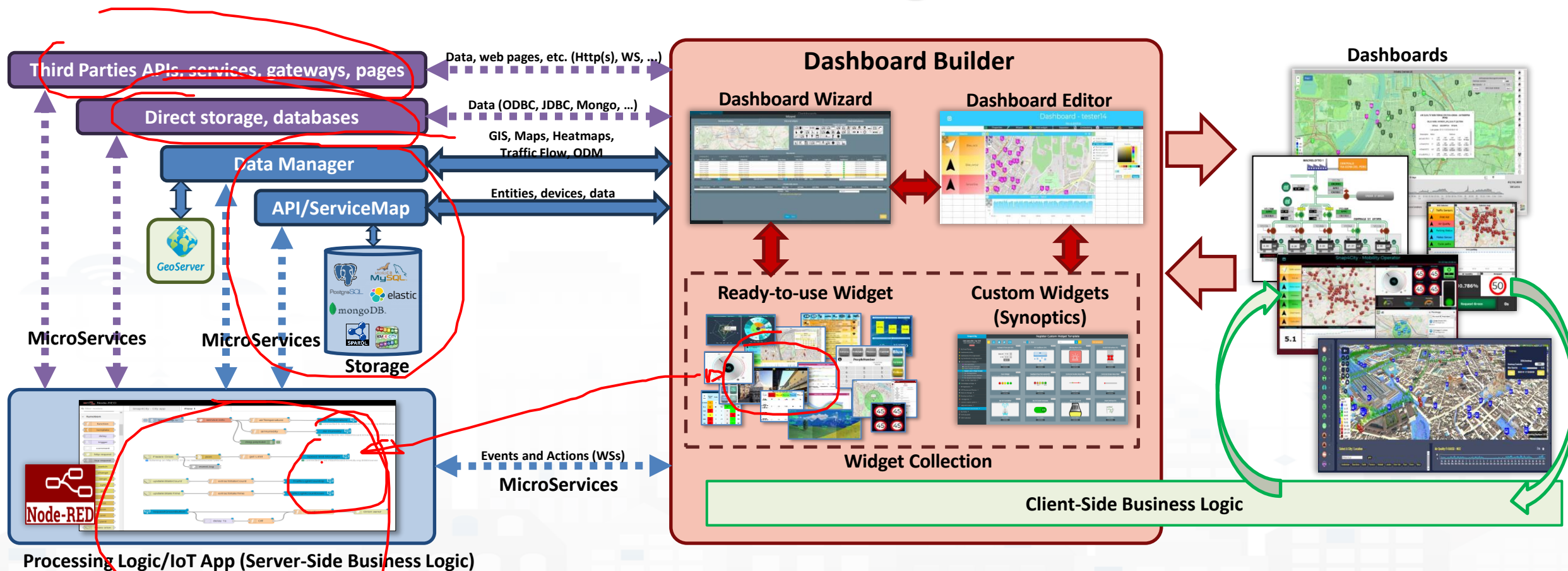
Editing IOT Applications

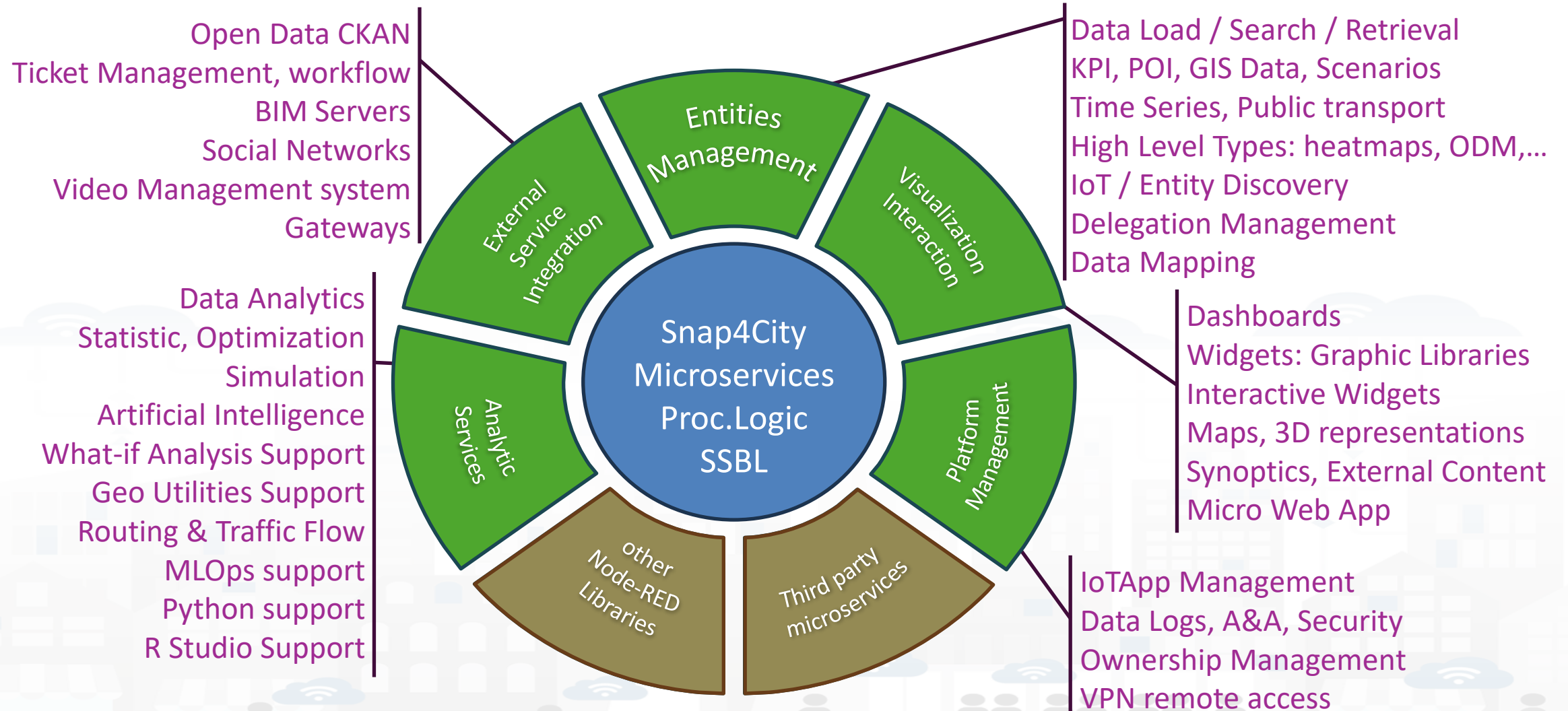
Data Analytics control

Everywhere: Cloud, on IoT Edge Devices

Data Transformation, Conversion
Data Integration, Interoperability
Business Logic vs Dashboards

How the Dashboards exchange data







Sept 2023 collection

Two Snap4City Libraries



Navigation menu on the left:

- > common
- > function
- > network
- > input
- > output
- > sequence
- > parser
- > storage
- > social
- > advanced
- > Advanced FTP
- > location
- > NGSI
- > Iwm2m
- > S4C SearchDev
- > S4C Utility
- > S4C Mapping
- > S4C Management
- > S4C DataAnalytic
- > S4C BigData
- > S4C IoTApp
- > S4C OpenMaint
- > S4C IoT
- > S4C Whatif
- > S4C Search
- > S4C Data
- > S4C KPIData
- > S4C Dashboard
- > S4C Sigfox
- > S4C LogDev
- > S4C View
- > S4C Social
- > dashboard
- > time

Library categories and their contents:

- S4C SearchDev**
 - service search
 - service search near gps position
 - service search near service
 - service search within gps area
 - service search within wkt area
 - service search within stored wkt area
 - service search by municipality
 - service search by queryid
 - full text search dev
 - full text search within wkt area
- S4C Utility**
 - full text search within gps area
 - full text search near gps position
 - full text search exp
 - event search dev
 - event search exp
 - event search within wkt area
 - event search within gps area
 - event search near gps position
 - address search near gps position
 - geometry search near gps position
 - address poi search by text
- S4C Mapping**
 - address poi search by text exp
 - address poi search by text near gps position
 - bus routes search
 - bus routes search near gps position
 - bus routes search within gps area
 - bus routes search within wkt area
 - bus routes
- S4C DataAnalytic**
 - point within polygon
 - routing
 - heatmap picker
 - coordinates to address
 - service info
 - edge-tunnel-to-cloud
 - service info mapped
 - mapping
 - set mapping
- S4C Management**
 - get job detail
 - get triggers of job
 - get job group names
 - get trigger group names
 - get paused trigger groups
 - get job fire times
 - get system status
 - trigger job
 - pause all
 - pause trigger
 - pause triggers
 - resume all
 - resume job
 - resume jobs
 - resume trigger
 - resume triggers
- S4C IoTApp**
 - notifier history events
 - descriptive statistics
 - trend plot
 - time series predictions
 - machine learning predictions
 - anomaly detection
 - plumber data analytic
 - python data analytic
 - datagate search
 - datagate create
 - portia crawler
 - iotapp restart
 - iotapp upgrade
 - ownership
- S4C Search**
 - service search near marker
 - service search within circle
 - service search within polygon
 - service search along path
 - full text search within circle
 - full text search within polygon
 - full text search along path
 - full text search usr
 - event search near marker
 - geometry search near marker
 - address poi search by text usr
 - address poi search by text near marker
 - address poi search by text within circle
 - address poi search by text within polygon
 - value type search along path
- S4C Data**
 - event search within polygon
 - event search along path
 - event search usr
 - address search near marker
 - geometry search near marker
 - address poi search by text usr
 - address poi search by text near marker
 - address poi search by text within circle
 - address poi search by text within polygon
 - bus routes search near marker
 - bus routes search within circle
 - bus routes search within polygon
 - bus routes search within polygon
 - tpl agencies
 - tpl lines
- S4C Social**
 - tpl routes by agency
 - tpl routes by line
 - tpl stops by route
 - tpl stop timeline
 - recommendatio within circle
 - value type search near marker
 - value type search within circle
 - value type search within polygon
 - value type search along path

Highlighted items:

- bus routes search (circled in red)
- distance from coordinates (circled in red)

Watermark URL: <https://flows.nodered.org/search?term=snap4city>



Sept 2023 collection

Two Snap4City Libraries



- > common
- > function
- > network
- > input
- > output
- > sequence
- > parser
- > storage
- > social
- > advanced
- > Advanced FTP
- > location
- > NGSI
- > lwm2m
- > S4CSearchDev
- > S4CUtility
- > S4CMapping
- > S4CManagement
- > S4CDataAnalytic
- > S4CBigData
- > S4CIOTApp
- > S4COpenMaint
- > S4CIoT
- > S4CWhatIf
- > S4CSearch
- > S4CData
- > S4CKPIData
- > S4CDashboard
- > S4CSigfox
- > S4CLogDev
- > S4CView
- > S4CSocial
- > dashboard
- > time

S4CDashboard

- get other activity on my data
- save my data
- get my annotation
- get anonymous data
- get other data

S4CKPIData

- get my kpdata
- get delegated kpdata
- get public kpdata
- get my kpdata values
- get public kpdata values
- get delegated kpdata values
- delegate my kpdata
- get iotapps using my kpdata
- save my kpdata values

S4COpenMaint

- om get processes
- om get teams
- om get components
- om get plants
- om get status
- om create new process
- om advance process
- om details process
- om delete process

S4CIoT

- iotdirectory new device from model
- delegate my device
- change ownership my device
- iot directory
- iot directory link
- iot directory link
- iotdirectory get device
- fiware orion subscribe v1
- fiware orion query v1
- fiware orion update v1
- fiware orion out v1
- fiware orion subscribe api v2
- fiware orion query api v2
- fiware orion update api v2
- fiware orion out api v2
- fiware orion in v2
- fiware orion query v2
- fiware orion out v2
- fiware orion in v2(url syntax v1)
- fiware orion query v2(url syntax v1)
- fiware orion v2(url syntax v1)
- snap4all button

S4CLogDev

- event log

S4CView

- show micro web app
- show general iframe

S4CSocial

- twitter last channel
- twitter last tweet

UserCreated

- Twitter Herit Data Sentiment Analysis Channel
- Twitter Herit Data Sentiment Analysis Search
- TwitterVigilance Herit Data Tw Rtw Channel
- TwitterVigilance Herit Data Tw Rtw Search
- Sci Hub Copernicus Completed
- Sci Hub Copernicus Indexed
- Sci Hub Copernicus Polygon

S4CWhatif

- get my scenarios
- save a scenario

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

AND: From Resource Manager

We suggest also to install:

NGSI

- NGSI Entity
- NGSI Dataset
- NGSI Update
- NGSI Subscription
- NGSI v2ToLD

social

- email
- twitter
- email
- twitter

subflows

- triplesToVirtual

lwm2m

- lwm2m client
- lwm2m client

Advanced FTP

- Advanced FTP
- Advanced FTP Logger

location

- utm
- turf
- worldmap
- worldmap in
- tracks
- convex hull

▼ S4CUtility

- service info dev
- distance from coordinates
- point within polygon
- service info

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

Loggia San Paolo

LINKED OPEN GRAPH

Tipology: CulturalActivity - Monument_location

Digital Location

Address: VIA DELLA SCALA, 3

Cap: 50123

City: FIRENZE

Prov.: FI

Photos:

Description: The rounded arches, the stone skeleton and the glazed terracotta medallions recall the model of the Loggiato degli Innocenti. The medallions in glazed terracotta by Andrea della Robbia and his sons Marco and Luca contain seven polychrome figures of Santi Francescani and two works of mercy Cristo conforta un Giovane and Cristo conforta un Anziano. Beneath the portico can be admired the expressive embrace between San Domenico Guzman and San Francesco d Assisi by Andrea della Robbia

TPL STOP : Piazza Stazione (Fr. Cc)

Vaubus

LINKED OPEN GRAPH

Lines:

FI-LU FI-VG

No available routes

Display 50 Bus per page

Search:

Time	Line	Direction
06:46:00 2017-03-20	FI-LU	Piazzale Verdi
08:16:00 2017-03-20	FI-LU	Piazzale Verdi
10:09:00 2017-03-20	FI-LU	Piazzale Verdi
11:09:00 2017-03-20	FI-LU	Piazzale Verdi
12:16:00 2017-03-20	FI-LU	Piazzale Verdi
13:16:00 2017-03-20	FI-LU	Piazzale Verdi

Showing page 1 of 1

Real-time data currently not available

AURORA

LINKED OPEN GRAPH

Tipology: Accommodation - Hotel

Email: info@hotelaurora.info

Website: www.hotelaurora.info

Phone: 055210283

Address: VIA L. ALAMANNI, 5

Cap: 50100

City: FIRENZE

Prov.: FI

Giardino di piazza dell'Indipendenza

LINKED OPEN GRAPH

Tipology: Entertainment - Green_areas

Digital Location

Address: PIAZZA DELLA INDIPENDENZA, 15

Cap: 50129

City: FIRENZE

Prov.: FI

Note: areeeverdi238

Remove from map

ZCS_1_D

LINKED OPEN GRAPH

Tipology: TransferServiceAndRenting - Controlled_parking_zone

Digital Location

Address: VIA GUSCIANA

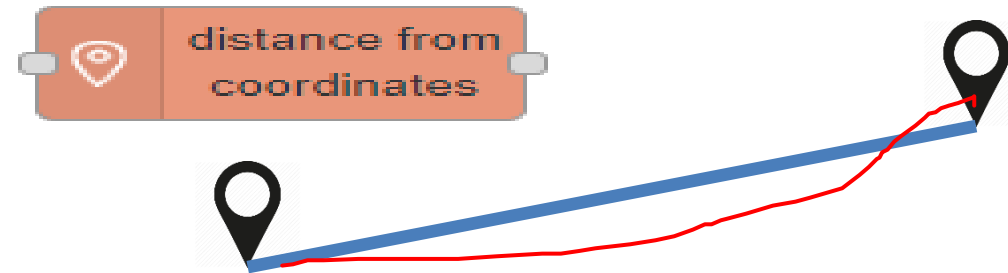
Cap: 50124

City: FIRENZE

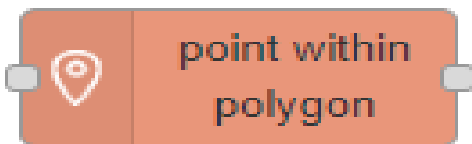
Prov.: FI

Remove from map

- **Distance from GPS point**



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

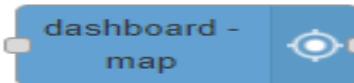
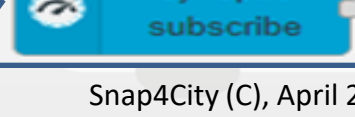
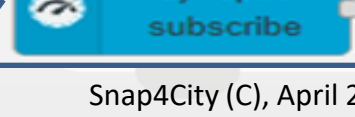
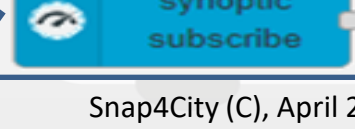
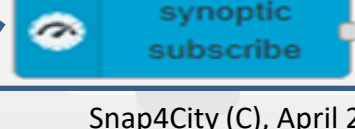
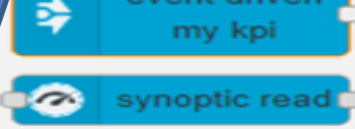
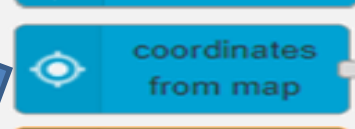
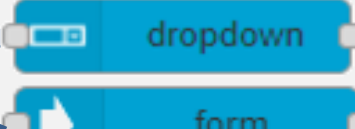
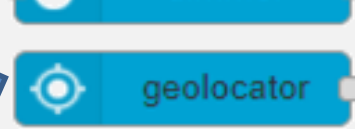
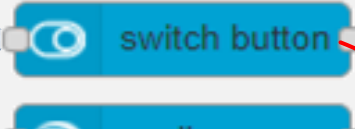
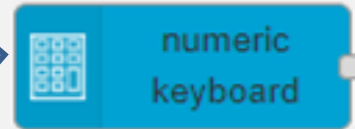
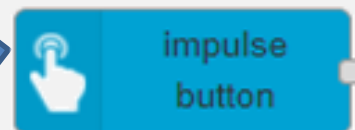
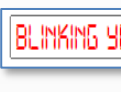
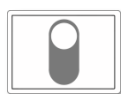


Dashboard-IoT App

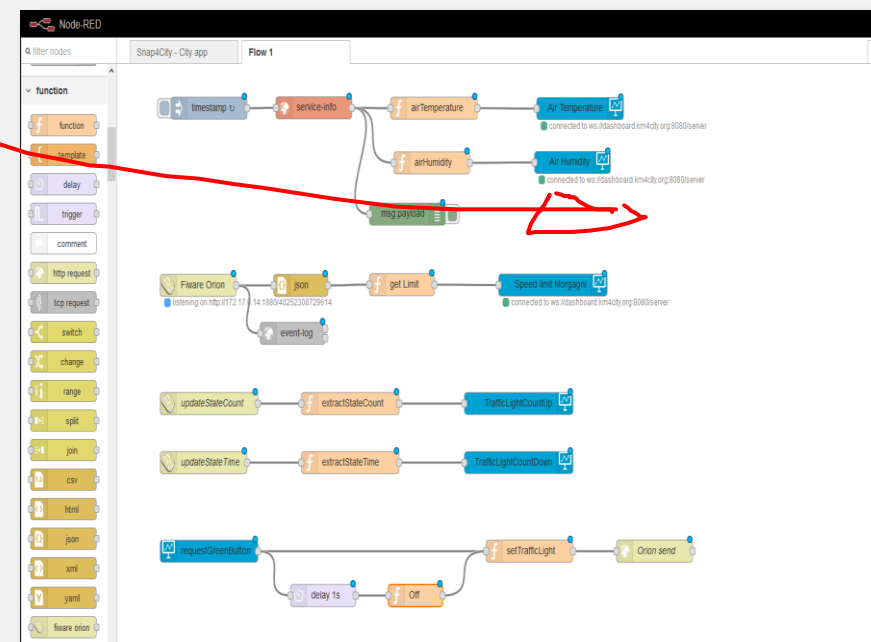


PeopleNumber		
time	Last confirmed	
7	8	9
4	5	6
1	2	3
0	.	Cancel

Confirm



From Dashboard to IOT App



IOT Application

MapClick
MyKPI variable onchange
Synoptics

Dashboard-IOT App

From IoT App to Dashboard

IOT Application

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

Dashboard Widgets:

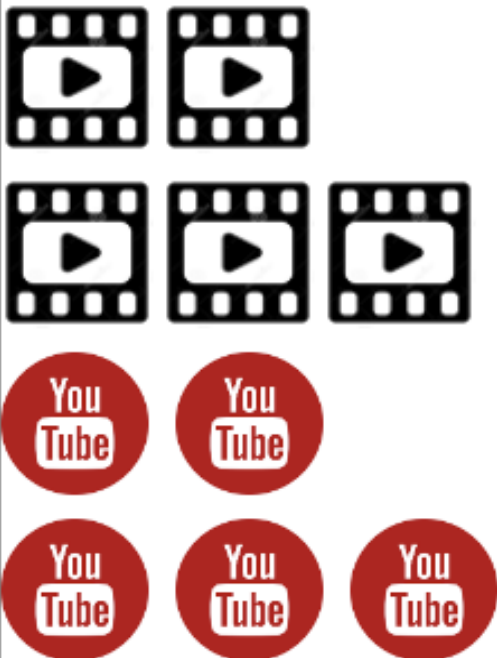
- Avg gas consumption (Gauge: 39.4)
- Avg heat consumption per user (Gauge: 44.7)
- Temperature (20.3°C)
- Pie Chart (Air Quality)
- Line Chart (Air Temperature)
- Bar Chart (Sensor Data)
- Time trend comparison (Line Chart)
- Table: Weather Metrics and Pollutants
- Calendar - s4cpaxant04 - wifi
- Speedometer
- Horizontal Single Bar
- Vertical Single Bar
- Web Content
- Table Content
- Calendar
- Speak Synthesis
- Synoptic Write
- Selector - Map

Part 5: Data Ingestion and Interoperability

Part 5: Data Ingestion
and Interoperability

[SLIDES](#)

[Interactive Slides](#)

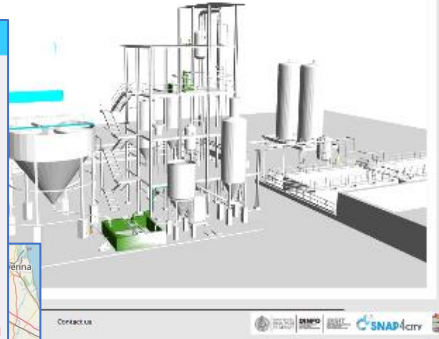
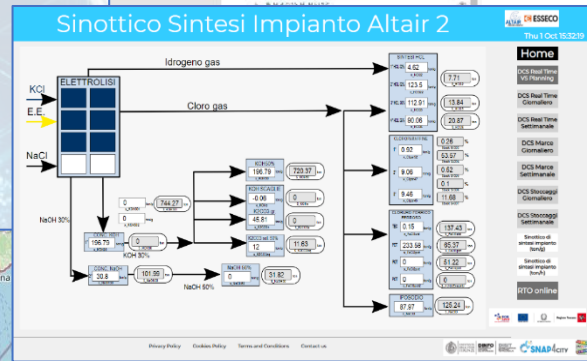
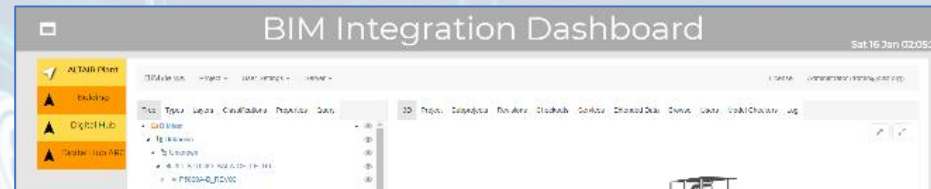


- When Solutions and tools for Data Ingestion and Interoperability are needed
- Overview of Snap4City Data Storage and Stack
- Knowledge Base: Modelling and Setting Up
- High Level Types vs Ingestion Process
- Data Ingestion Strategy and Orientation
- Ingestion of Points of Interest with POI Loader
-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

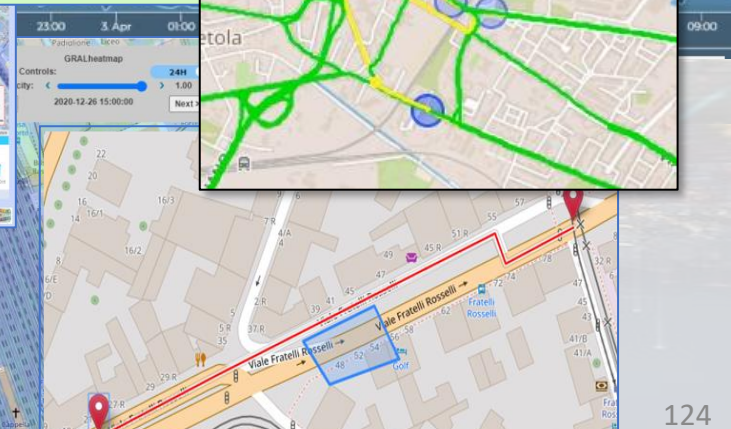
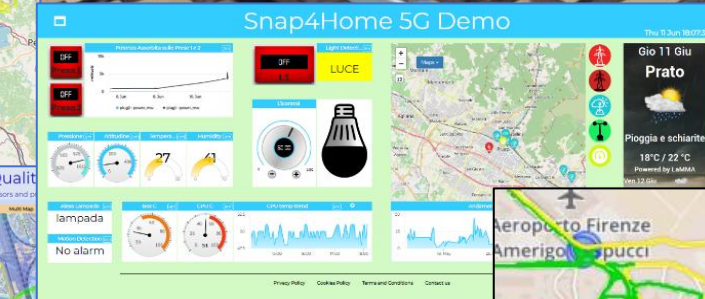
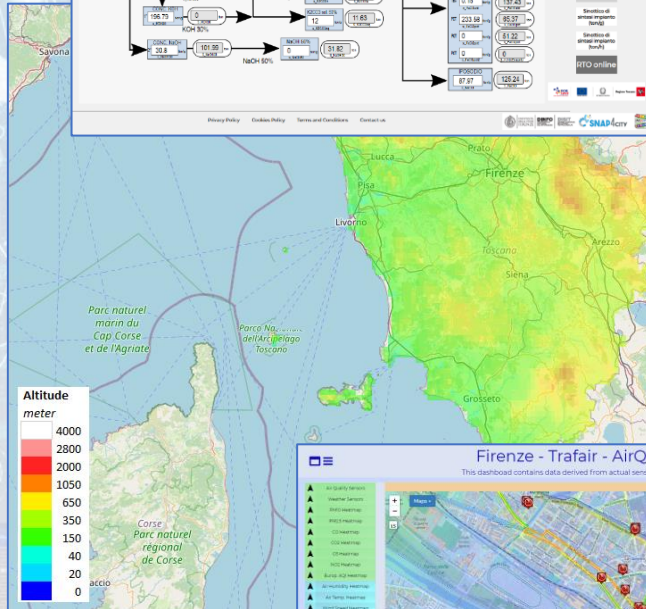
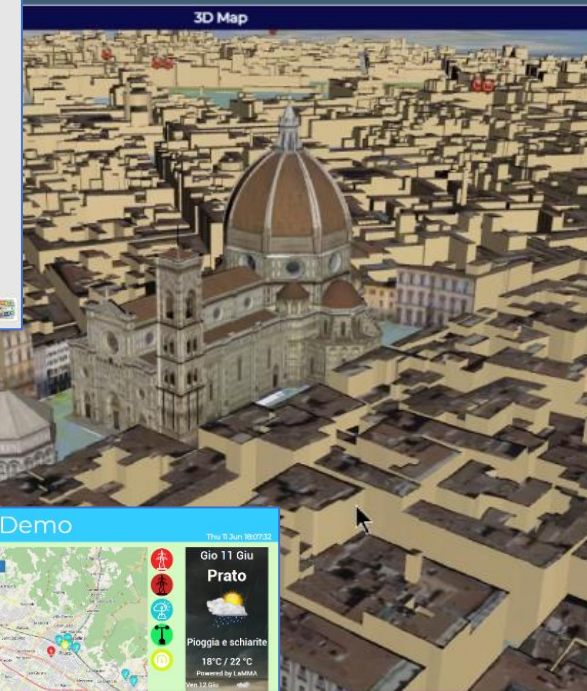
High Level Types

Snap4City (C), April 2024

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



SNAP4CITY
- Digital Twin Global - Fire
demonstrator



UNIVERSITÀ
DEGLI STUDI
FIRENZE

DINFO
DIPARTIMENTO DI
INGEGNERIA
DELL'INFORMAZIONE

DISIT
DISTRIBUTED SYSTEMS
AND INTERNET
TECHNOLOGIES LAB

Snap4City

Switch To New Layout (Beta)

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

LOGOUT

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

Entity Instances, IoT Devices

Show entries

Search:

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

Search Device Location on Map

Leaflet | © OpenStreetMap contributors

Cancel

Checking data/Entity ingestion results

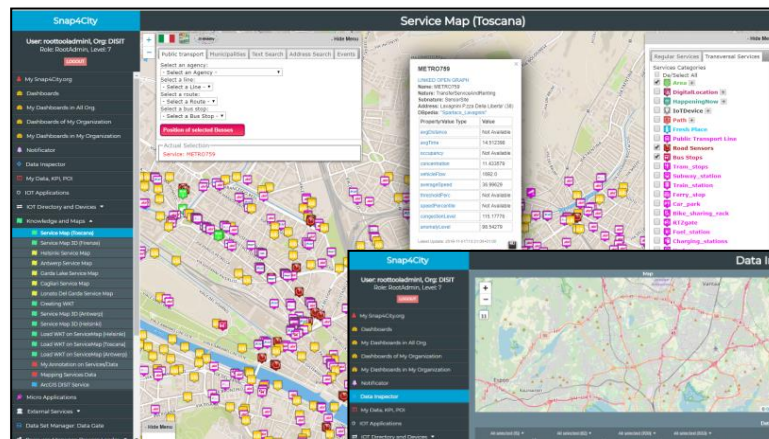
Knowledge base Semantic reasoners



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

ServiceMap, SCAPI, SuperSM

- LOG / LOD viewer
- Super Service Map
- SCAPI: Swagger
- Last data



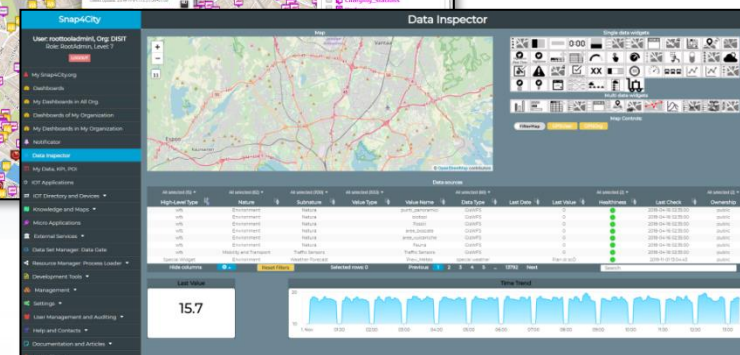
ServiceMap or Super ServiceMap

Data Inspector (last data)

IoT/Entity Directory

- IoT Brokers

Data Inspector
Digital Twin view



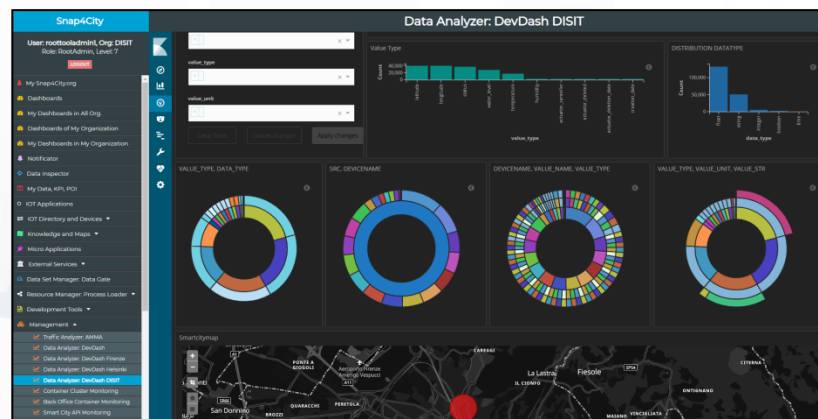
Indexing and aggregating NIFI, OpenSearch

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

ServiceMap, SCAPI (last data), SuperSM

My Data Dashboard, OpenSearchDash

Data Inspector (last data)



My Data Dashboard

DevDash

Part 4: Data Analytics

Part 4: Data Analytics
and Artificial
Intelligence

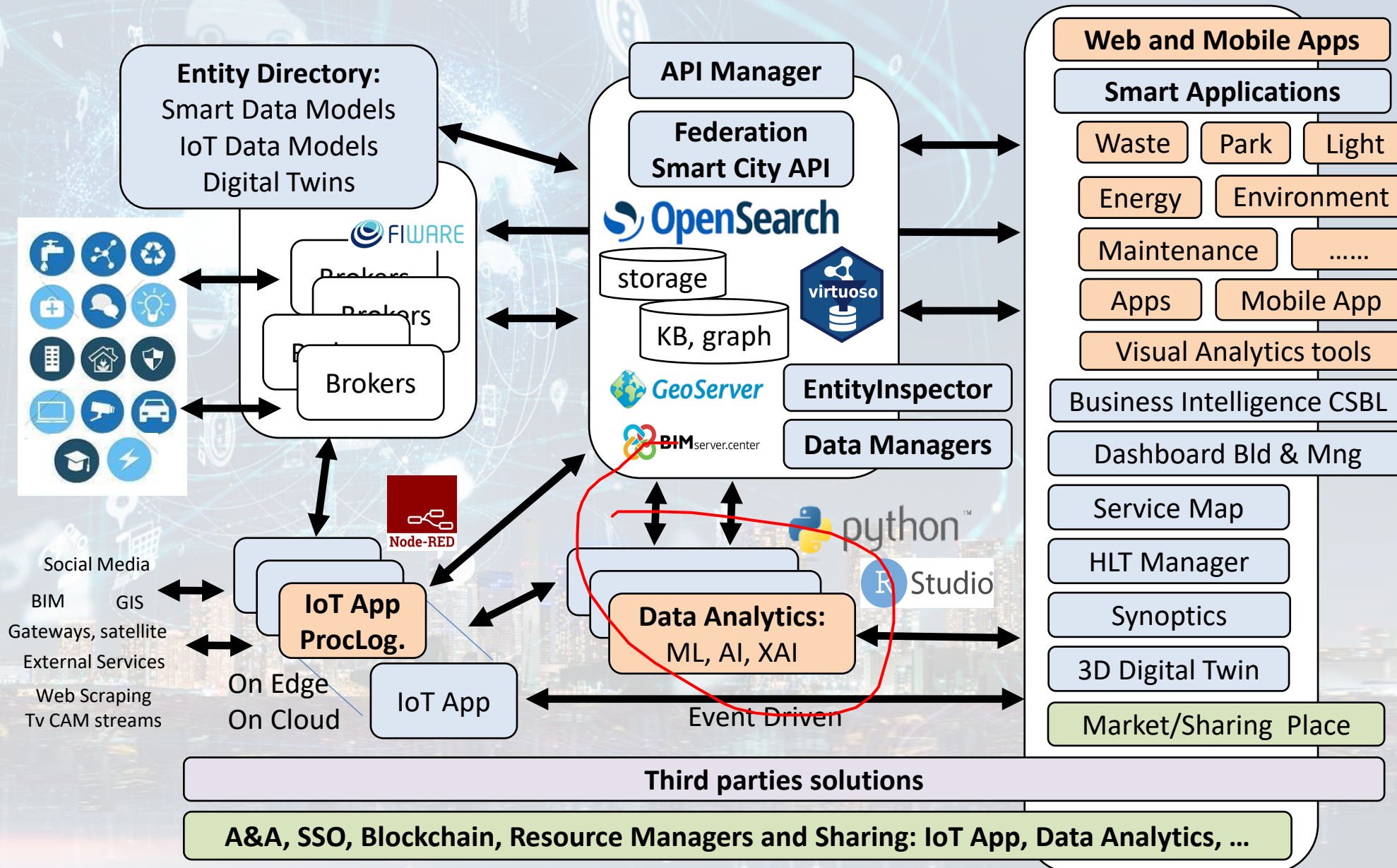
[SLIDES](#)

[Interactive Slides](#)



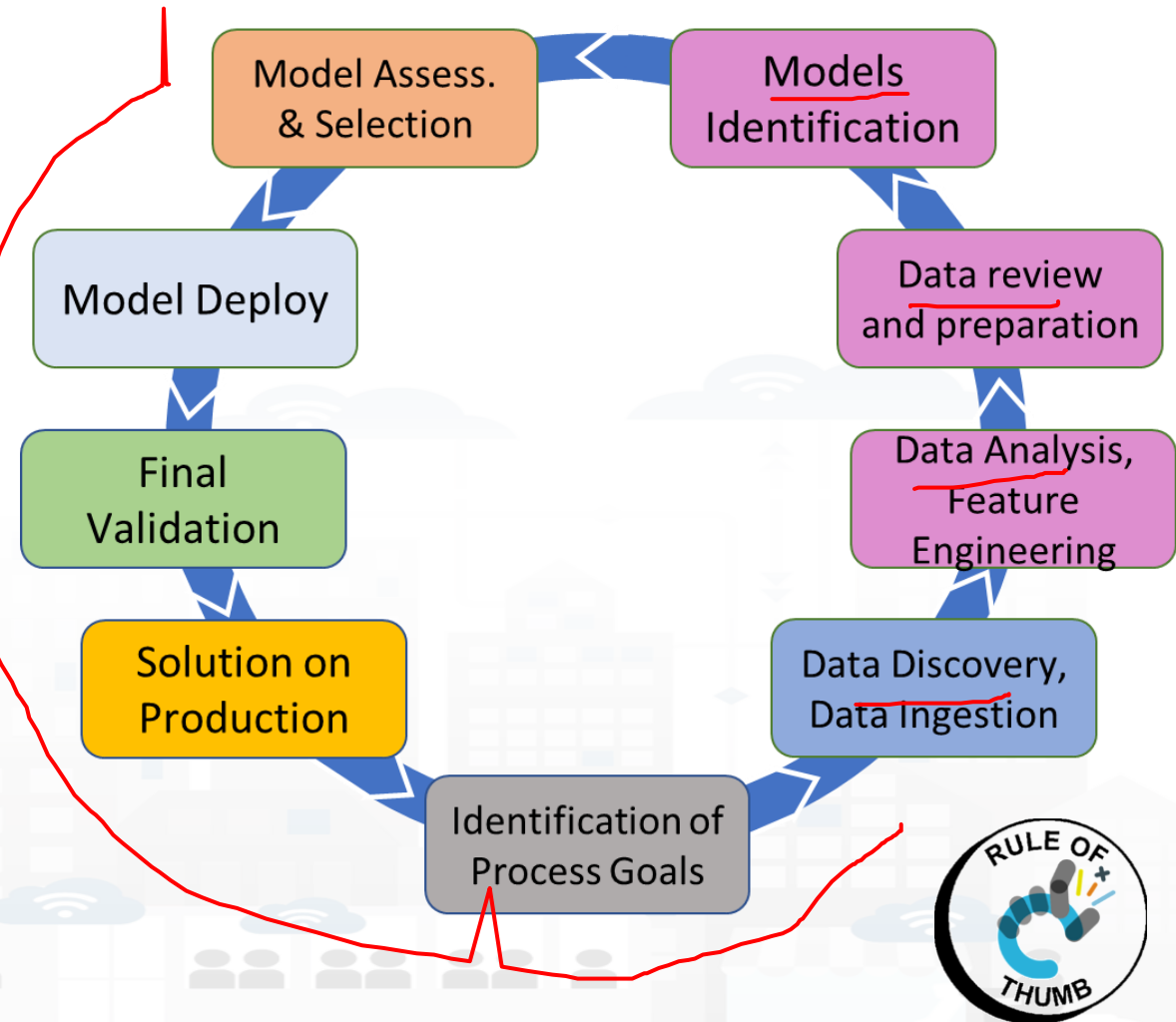
- Why and Where use DA, AI and XAI --> General Life Cycle
- Data Processing
- What is Data Analytics, DA and Artificial Intelligence, AI
- List of the most relevant available DA and AI Solutions
- Predictions and Anomaly detections
- Computing: Higher Level Types Data and their representations
- How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

Technical Architecture



Model/Technique Development/testing

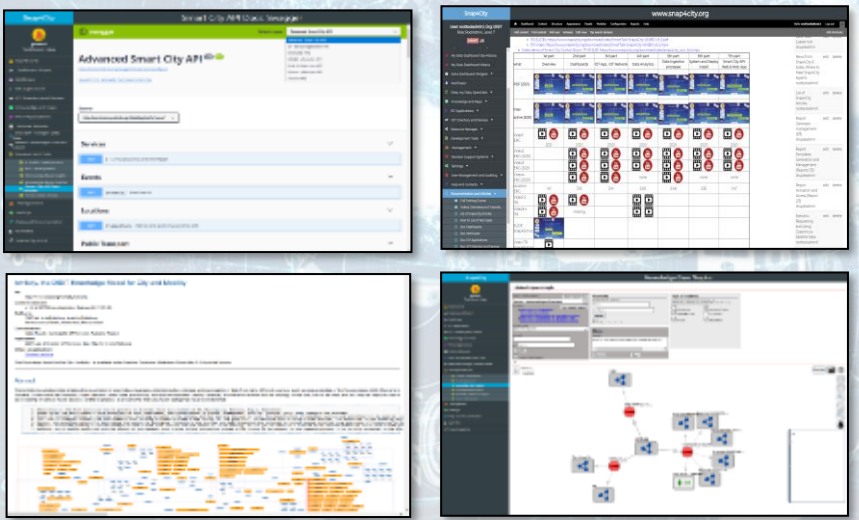
- **Identification of Process goals and Planning (problem definition)**
 - Which goals
 - How to compute, which language
 - Which environment, which libraries
- **Data Discovery and Ingestion (from the general life cycle)**
 - Data Collection, Data Preprocessing if needed
- **Data Analysis: feature engineering,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



Data Analytics on Snap4City platform



Swagger

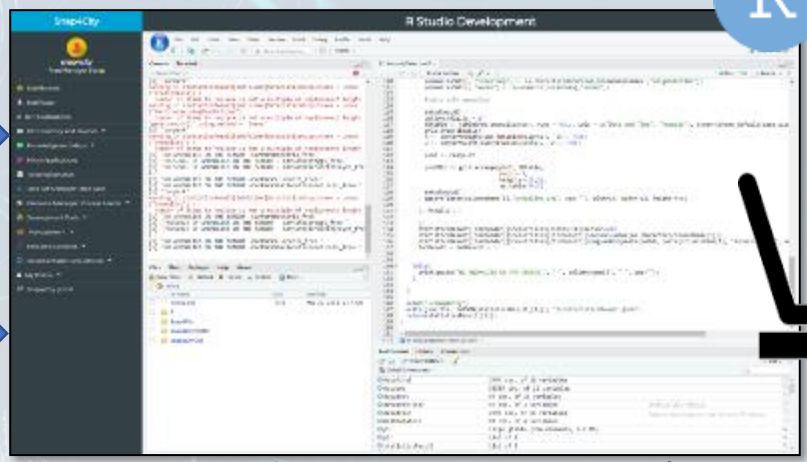


Ontology Schema

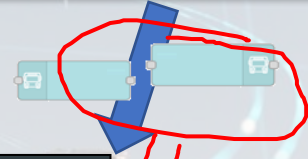
LOG.disit.org



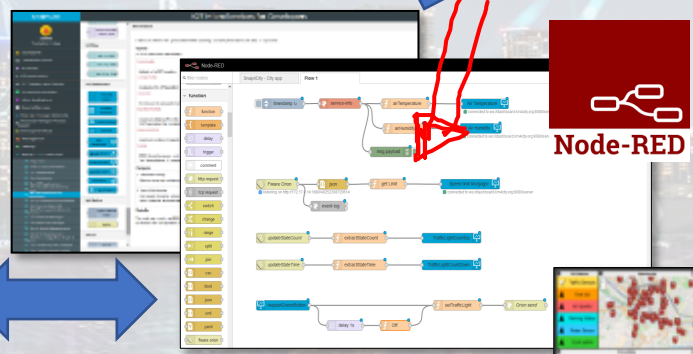
Smart City API from Knowledge Base and other tools



Creating MicroServices

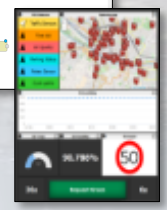


Saving / Sharing / reusing

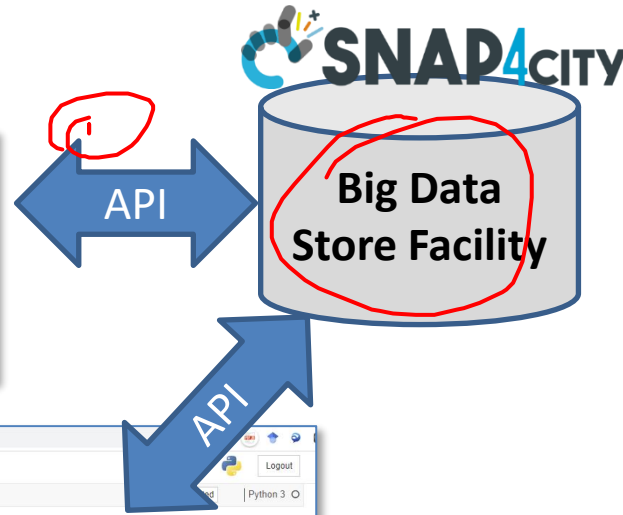
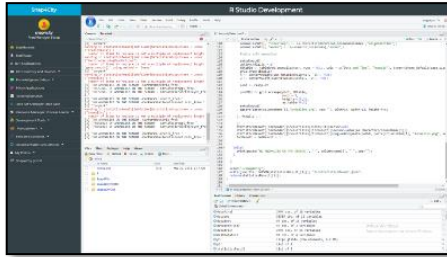


Resource Manager

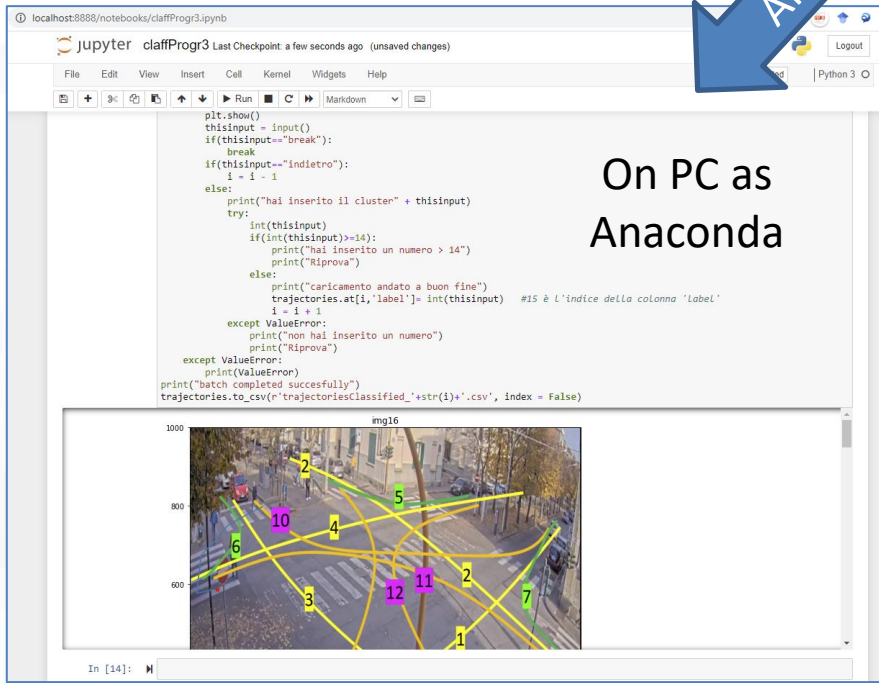
Using them into IOT Applications



Development



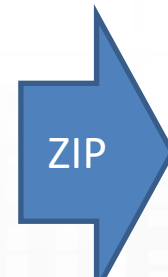
On Server
Or
On PC



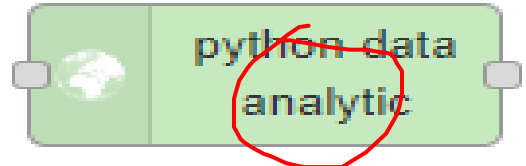
On PC as
Anaconda



File.py
AI Model
Mapping
Data..



Load
File.py
or .zip



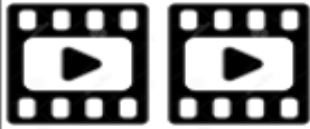
To make the .PY usable as MicroService you need to adapt it to get and send data in/out with Node-RED from a Container.
If you provide a .zip file the main .py inside has to be called doScript.py

Parts 7 & 8: API, Mobil, Business Intelligence

Part 7: Exploiting
Snap4City API, and
Web/Mobile
Applications SDK

[SLIDES](#)

[Interactive Slides](#)



Part 8: Developing
Smart Applications &
Business Intelligence
Solutions

[SLIDES](#)

[Interactive Slides](#)



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

Development

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



Development Life-Cycle

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

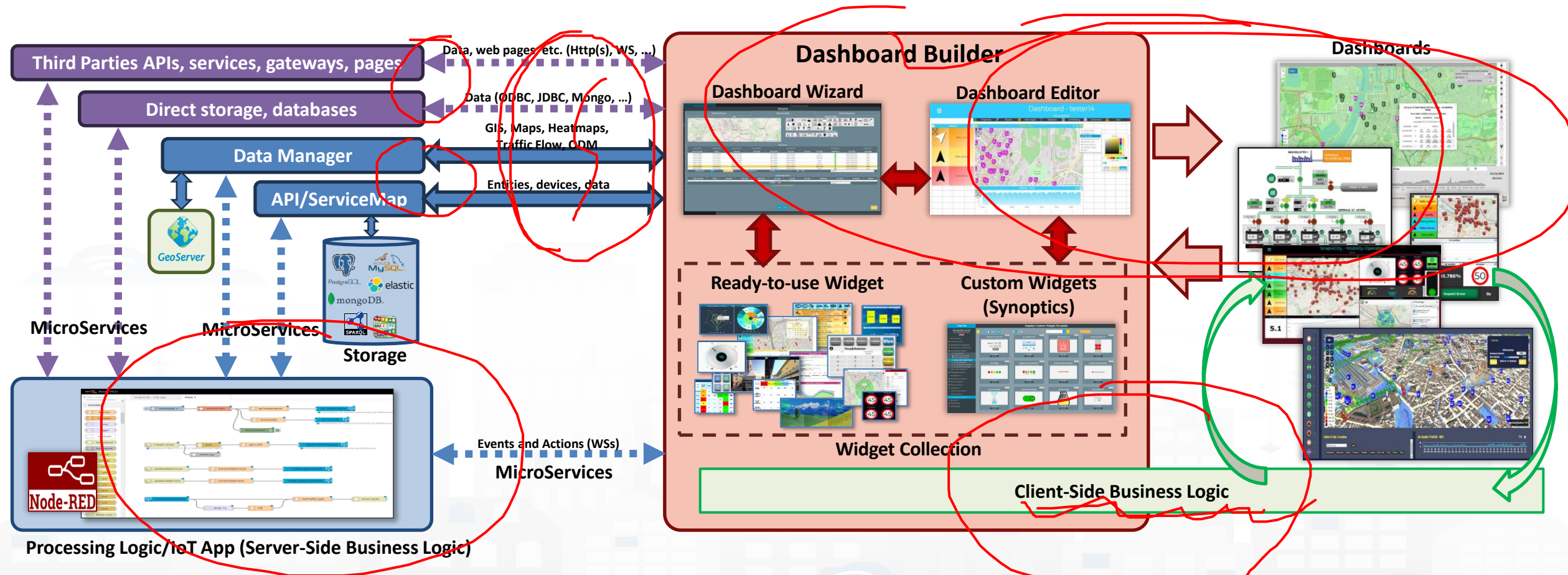
From Snap4City:

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

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

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

How the Dashboards exchange data



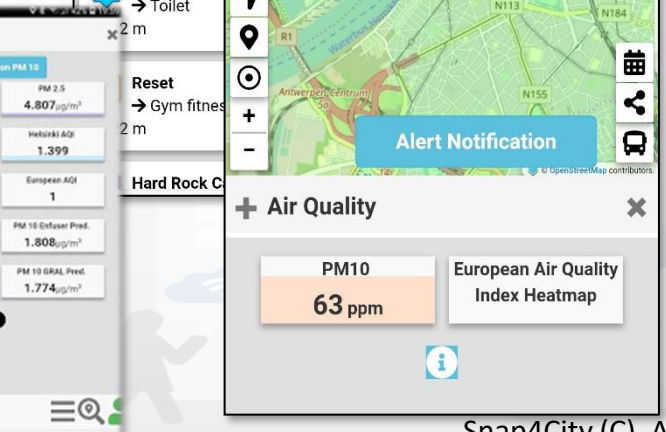
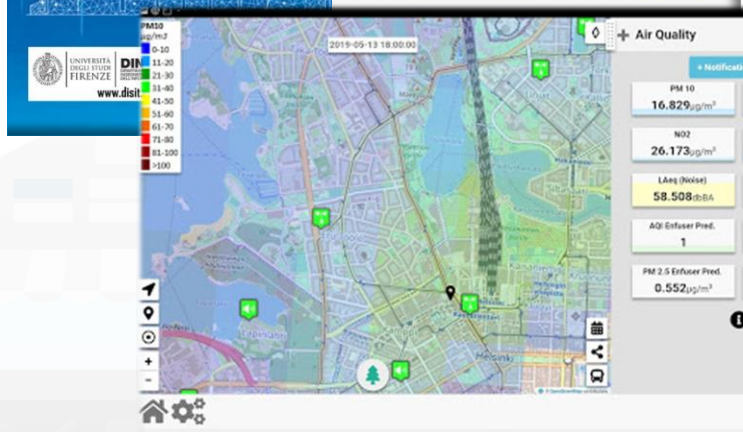
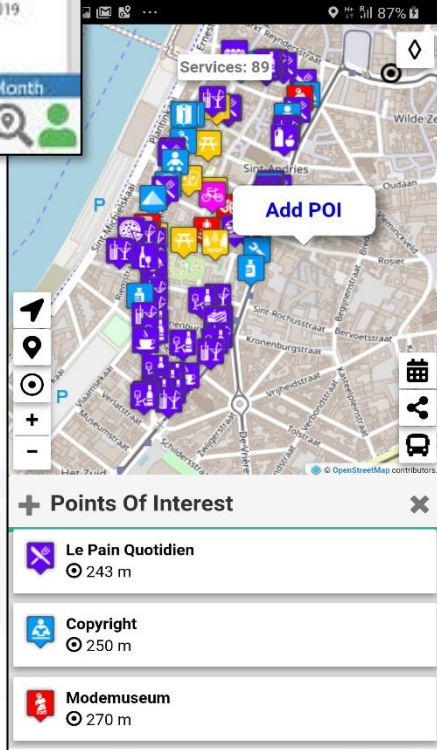
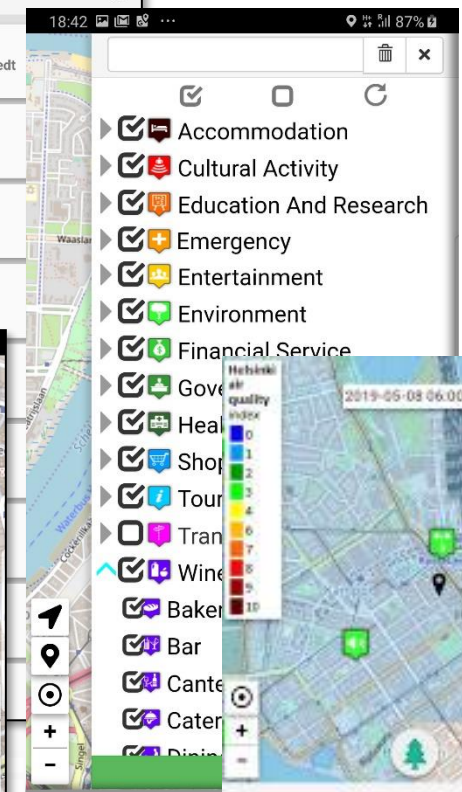
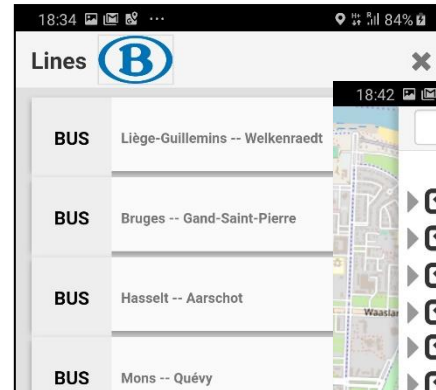
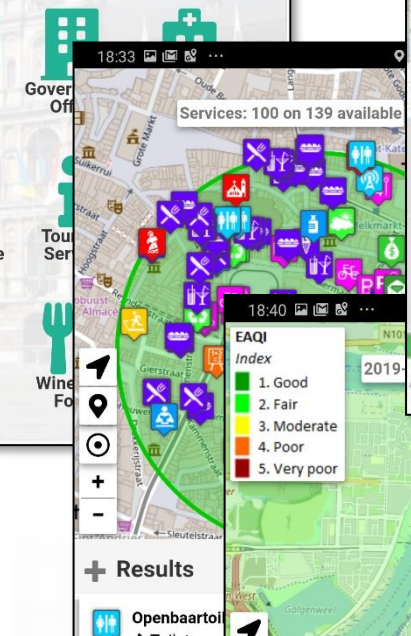
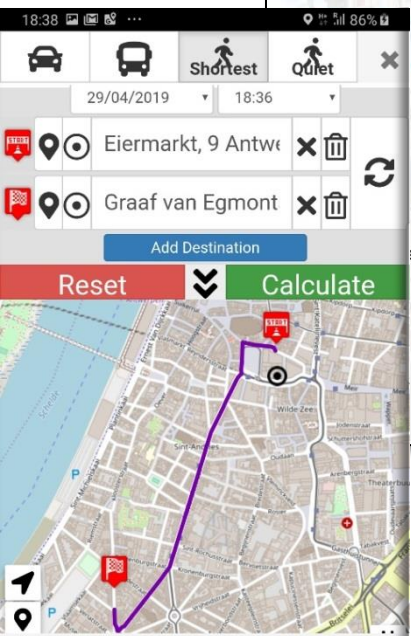
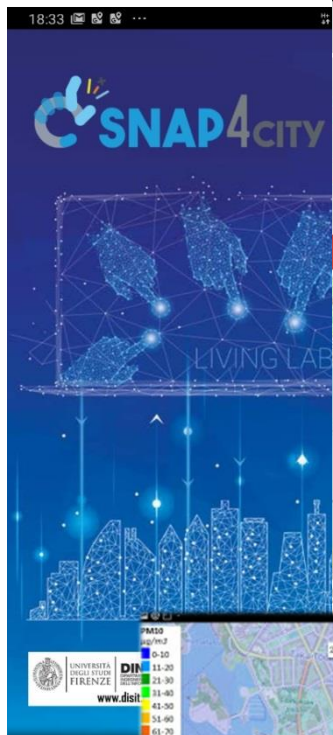
Internal and External Smart City API

The screenshot shows the 'Advanced Smart City API' documentation page. The left sidebar contains a navigation menu with items like 'External Services', 'Data Set Manager', 'Resource Manager', 'Development Tools', and 'Management'. The main content area displays the API title, version (4.0.0), and a list of services including 'Service discovery and information', 'Event search', 'Address and geometry search by GPS', and 'Agency list'. A dropdown menu is open, showing a list of API specifications to select from.

The screenshot shows the 'Internal API Docs: Swagger' interface. A dropdown menu is open, listing various internal APIs such as 'IoT device registration API', 'Notifier API', 'DISCES scheduler API', 'Resource Manager API', 'Sensors API', 'Event Logger API', 'Ownership API', 'Data Manager API', 'Device, Broker and Value Mgmt API', 'Snap4City Application API', 'Engager API', 'Wallet API', 'User Profiler API', 'My KPI API', 'Snap vs Openmaint API', 'Device Groups API', and 'Sci-Hub Processing API'. The 'Sci-Hub Processing API' is currently selected.

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

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



Client Side Business Logic

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



Powered by
SNAP4Tech

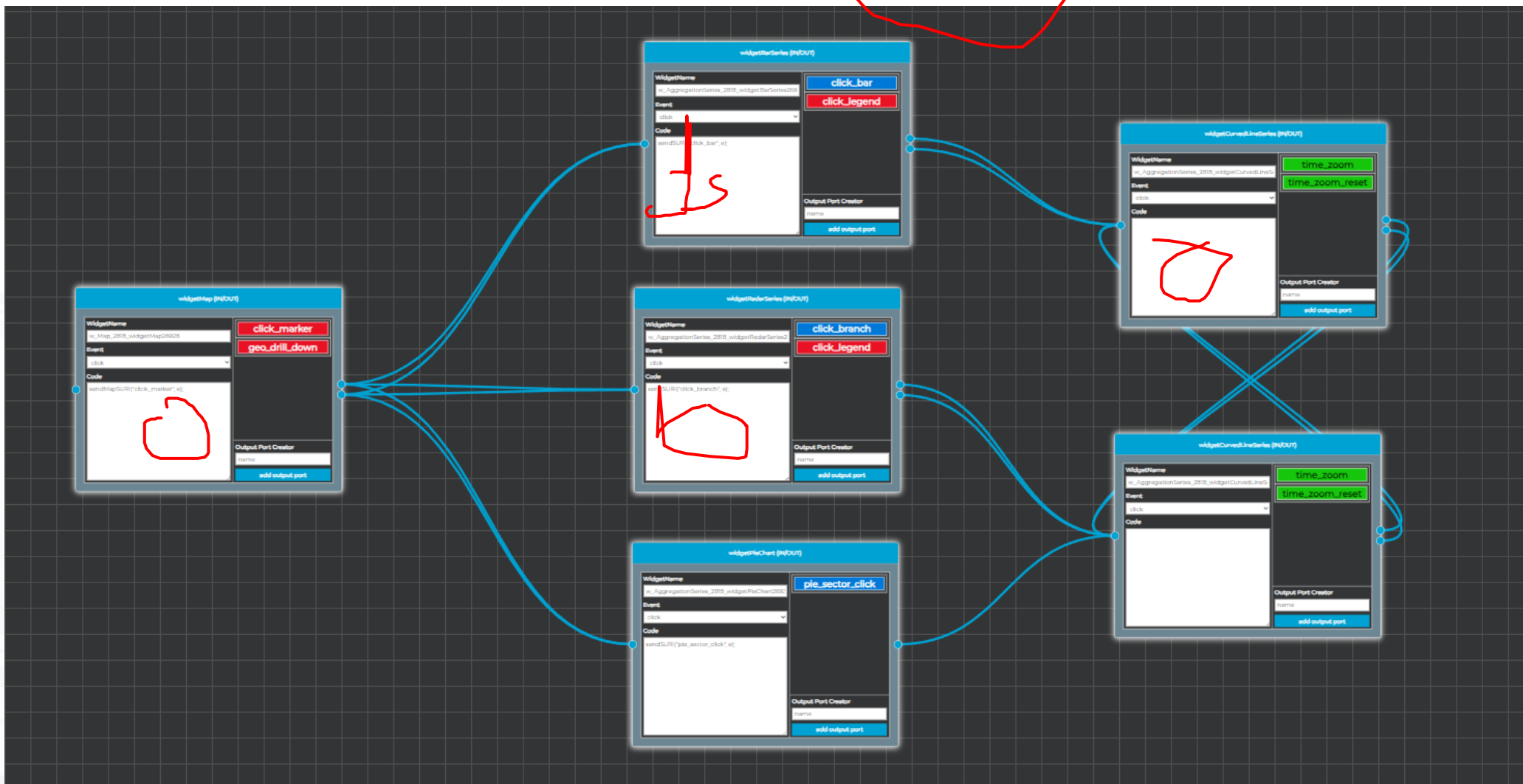
Client-Side Business Logic Widget Manual

From Snap4City:

- We suggest you read <https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf>
- We suggest you read the TECHNICAL OVERVIEW:
 - <https://www.snap4city.org/download/video/Snap4City-PlatformOverview.pdf>
- slides go to <https://www.snap4city.org/577>
- <https://www.snap4city.org>
- <https://www.snap4solutions.org>
- <https://www.snap4industry.org>
- <https://twitter.com/snap4city>
- <https://www.facebook.com/snap4city>
- <https://www.youtube.com/channel/UC3tAQ09EbNba8f2-u4vanda>

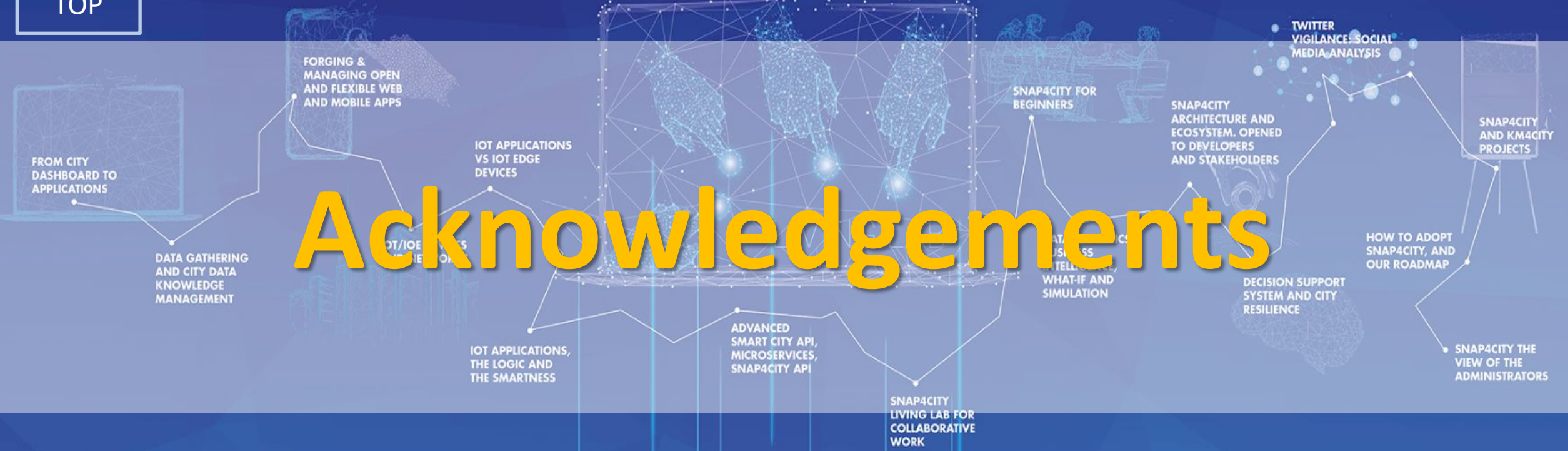
Coordinator: Paolo Nesi, Paolo.nesi@unifi.it
DISIT Lab, <https://www.disit.org>
DINFO dept of University of Florence,
Via S. Marta 3, 50139, Firenze, Italy
Phone: +39-335-5668674

Visual programming for **CSBL** is coming soon



TOP

Acknowledgements





SMART CITIES AND SMART INDUSTRY

Snap4City:
FIWARE powered smart app
builder for sentient cities

With the contribution of



- <https://fiware-foundation.medium.com/snap4city-fiware-powered-smart-app-builder-for-sentient-cities-acfe24df49d5>
- https://www.snap4city.org/download/sites/default/files/files/FF_ImpactStories_Snap4City.pdf

2023 booklets



- Smart City



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

- Industry



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

- Artificial Intelligence



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

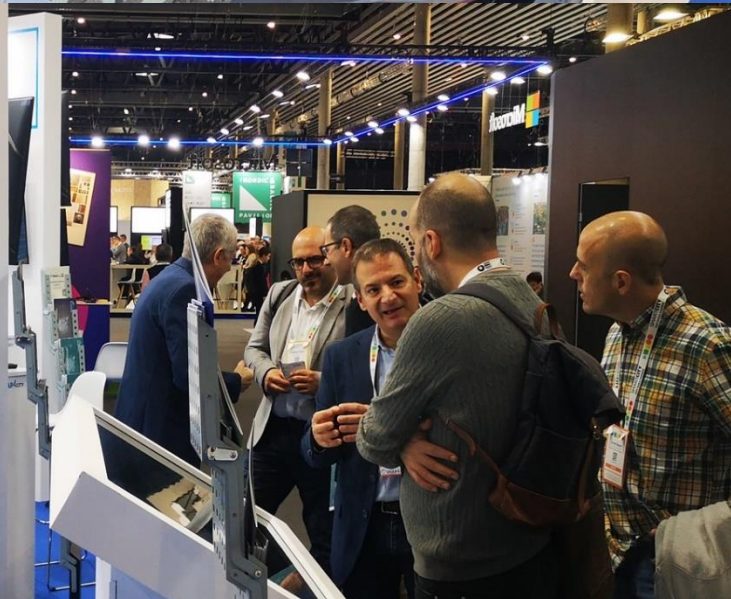
<https://www.snap4city.org/4>

- [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](#)



Scenariious

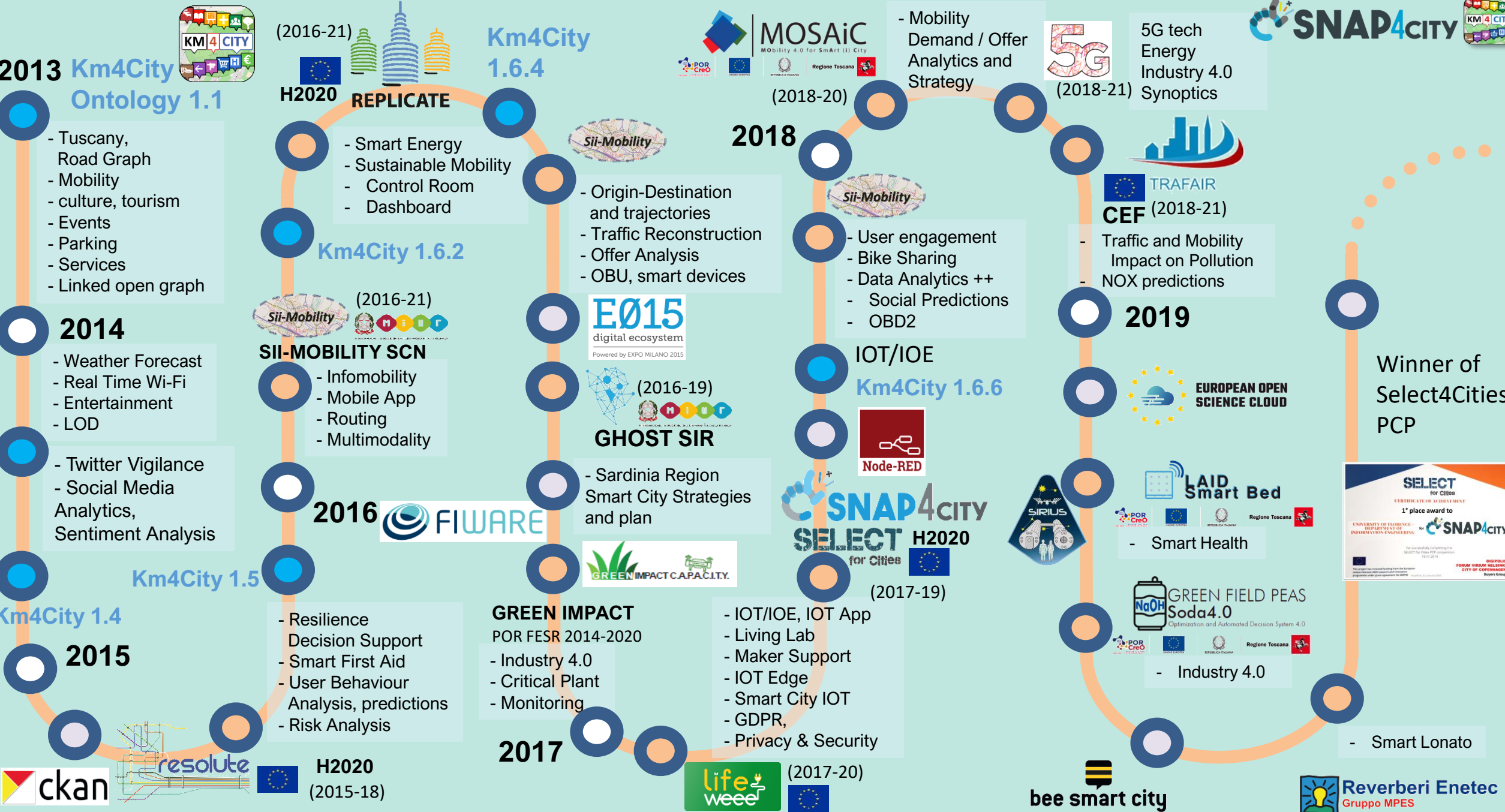
- [Data Analytic: Origin Destination Matrices, Algorithms and tools](#)
- [Data Analytic: Traffic Flow Reconstruction](#)
- [Data Analytic: in general, and the cases of Antwerp and Helsinki](#)
- [Data Analytic: Predicting Air Quality](#)
- [Data Analytic: Analyzing Public Transportation Offer wrt Mobility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



SMARTCITY
 EXPO WORLD CONGRESS
 7 - 9 NOVEMBER 2023



PAVILLON 1 - STAND D 100



2013 Km4City Ontology 1.1

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

2014

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

- Twitter Vigilance
- Social Media Analytics, Sentiment Analysis

Km4City 1.4

2015

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



(2016-21) H2020 REPLICATE

- Smart Energy
- Sustainable Mobility
- Control Room
- Dashboard

Km4City 1.6.2



- Infomobility
- Mobile App
- Routing
- Multimodality

2016 FIWARE

Km4City 1.5

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

Km4City 1.6.4



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



- Sardinia Region Smart City Strategies and plan



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

2017



- Smart Waste



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

IOT/IOE Km4City 1.6.6



- Smart Lonato



- Smart Lonato



- Traffic and Mobility Impact on Pollution
- NOX predictions

2019



- Smart Health



- Industry 4.0



- Smart Lonato

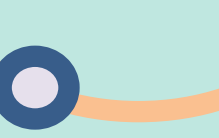


- Traffic and Mobility Impact on Pollution
- NOX predictions

2019



- Smart Health



- Industry 4.0

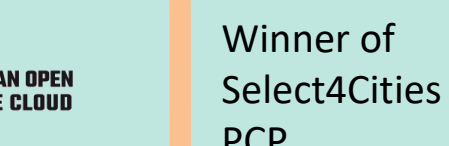


- Smart Lonato

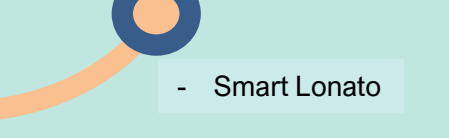


- Smart Lonato

Winner of Select4Cities PCP



- Smart Lonato



- Smart Lonato



- Smart Lonato

DISIT lab roadmap vs model and tools' usage



2020



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



- Smart Mobility
- PISA, PUMS
- Living lab



Km4City 1.6.7

Smart Ambulance (2021-22)



2021

PC4City (2020-21) Monitoring Terrain



CAPÉLON

- Smart Light
- Sweden

Enterprise (2021-22) Industry 4.0

Almafluida Industry 4.0 (2021-22)

AMPERE (2021-22) Industry 4.0

SYN-RG-AI SmartCity



uni.systems SmartCity, 2021-23



AXIS collab SmartCity

2022



Asymmetrica Smart City, 2022-23



Italferr, Smart City



Contract, 2022-23

2023



Contract, 2022-23



2022-2023



CN MOST, 2022-26

EI THE, 2022-26

G. Agile, 2021-23



2023-26



Merano, smart light

OceanRace, Genova, AWS

Cuneo, smart city

Rhodes, smart city

AMMIRARE



TOURISMO

2024



TOP



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7-9 November 2023, Barcelona, Spain

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CONTACT

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