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www.snap4city.org www.snap4solutions.org

Nov. 2023, Course

Part 1: overview

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







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https://www.Km4City.org
https://www.disit.org





















SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES









Domains

- Smart City, control room
- **Mobility and transport**
- Environment, pollutant, waste, water, green, ...
- Energy, light, recharge
- **Tourism and People**
- Asset management
- Security and Safety
- Social Media
- Big Data, AI/XAI
- **Public and private data**











15Min Ir



erformance indicators

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);

Global

objectives of the European Commission in terms of pollutant emissions for: NO2, PM10, PM2.5

(https://environment.ec.europa.eu/topic

s/air en);

PUMS: mobility and transport vs wnv

SUMI: mobility and transport vs env

ISO indicators: city smartness, digitization. Tech level

































DEGLI STUDI FIRENZE











10/22









15 Minute City Index:

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



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



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



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



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



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



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

15MinCityIndex

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

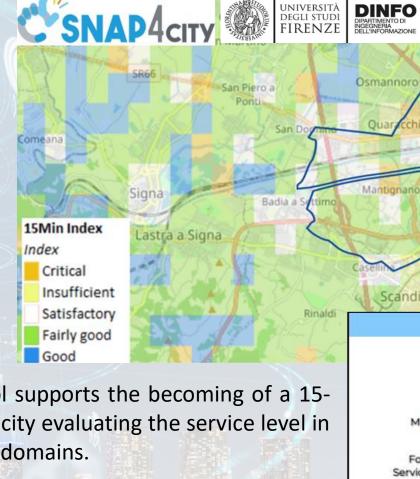
Using the Open Data:

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

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

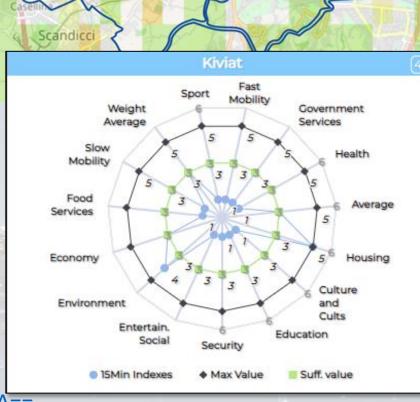


Careggi/Rifredi is a relevant district in Florence because of hosting the main Florence/Tuscany hospitals Careggi and Meyer, but also university headquarters and many other workplaces.



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





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

Snap4City (C), November 2023



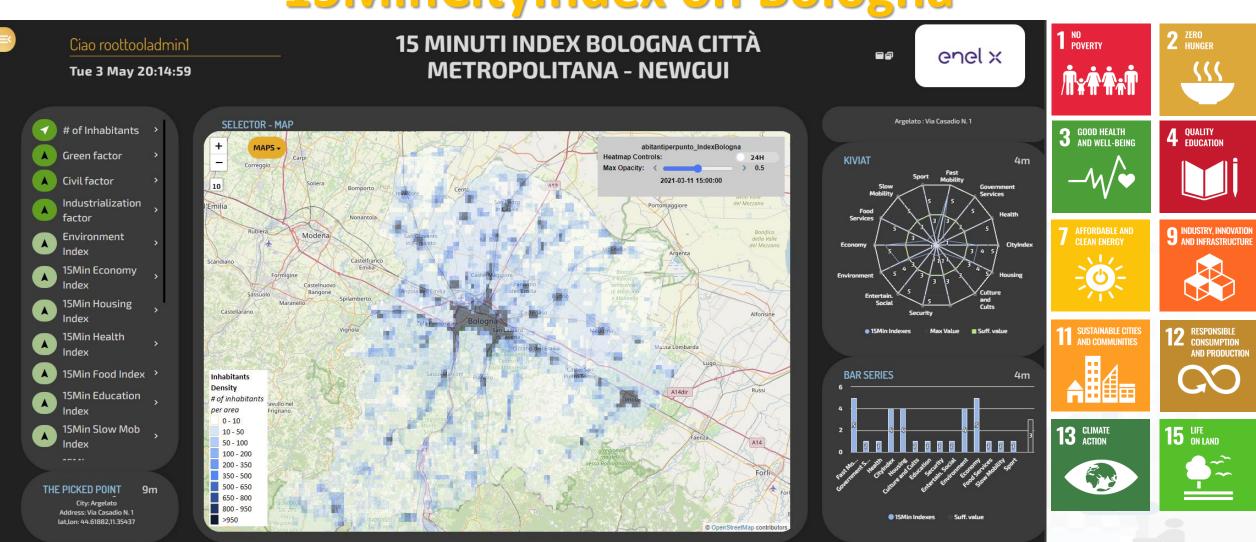








15MinCityIndex on Bologna













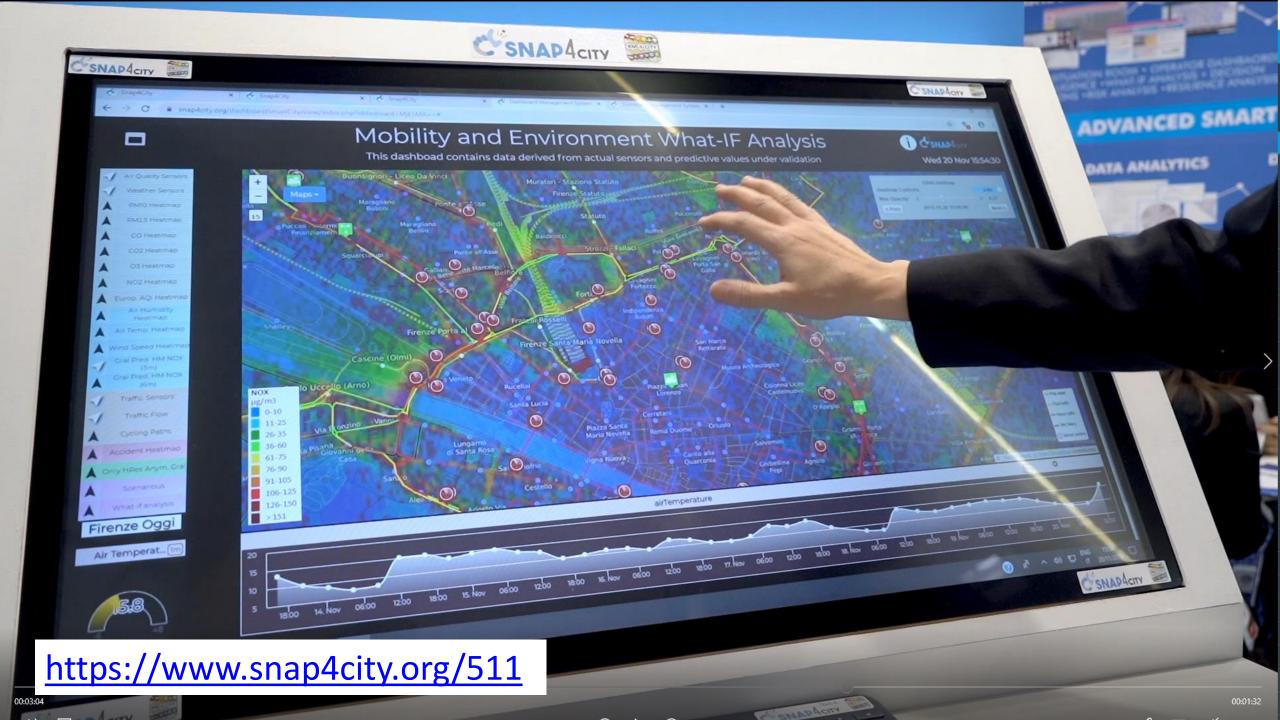




Public Spaces as Critical Infrastructures

- 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

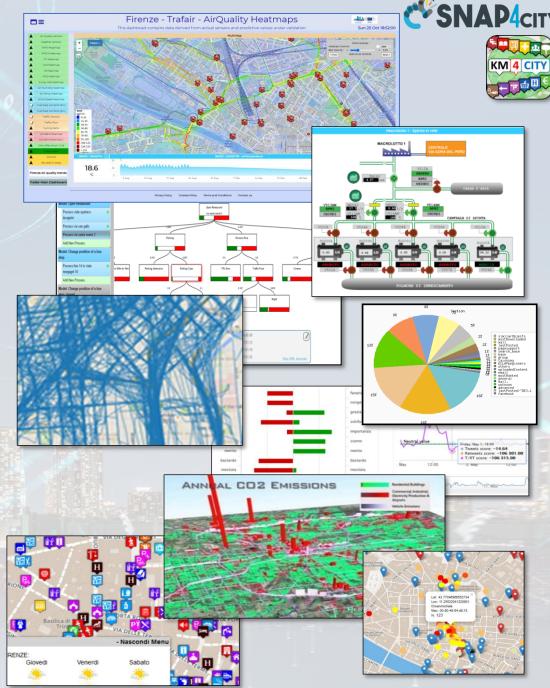




Data Driven Decision Support

- Decision Support system
- Assessment / Strategies
- Data Rendering,
 - visual analytics, business intel..
- Data Analytics, ML, Al
- Data aggregation, Storage, indexing
- Data Ingestion











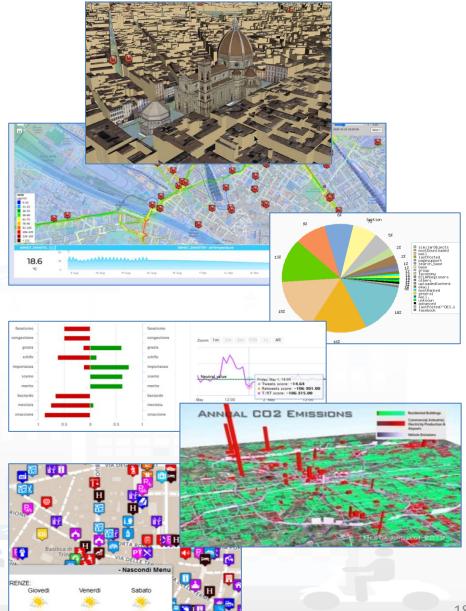


Challenges vs Technologies

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

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









Digital Twin

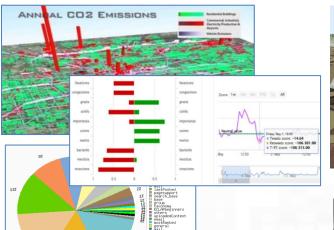


Digital Twin

- 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

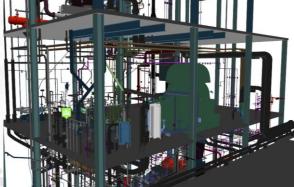












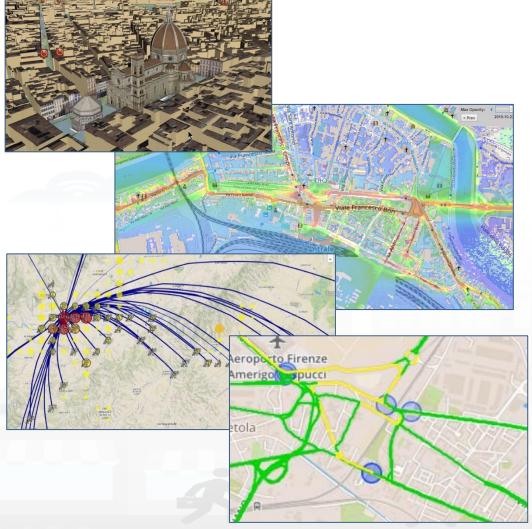








Smart City Digital Twin



Digital representation of the city with...

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

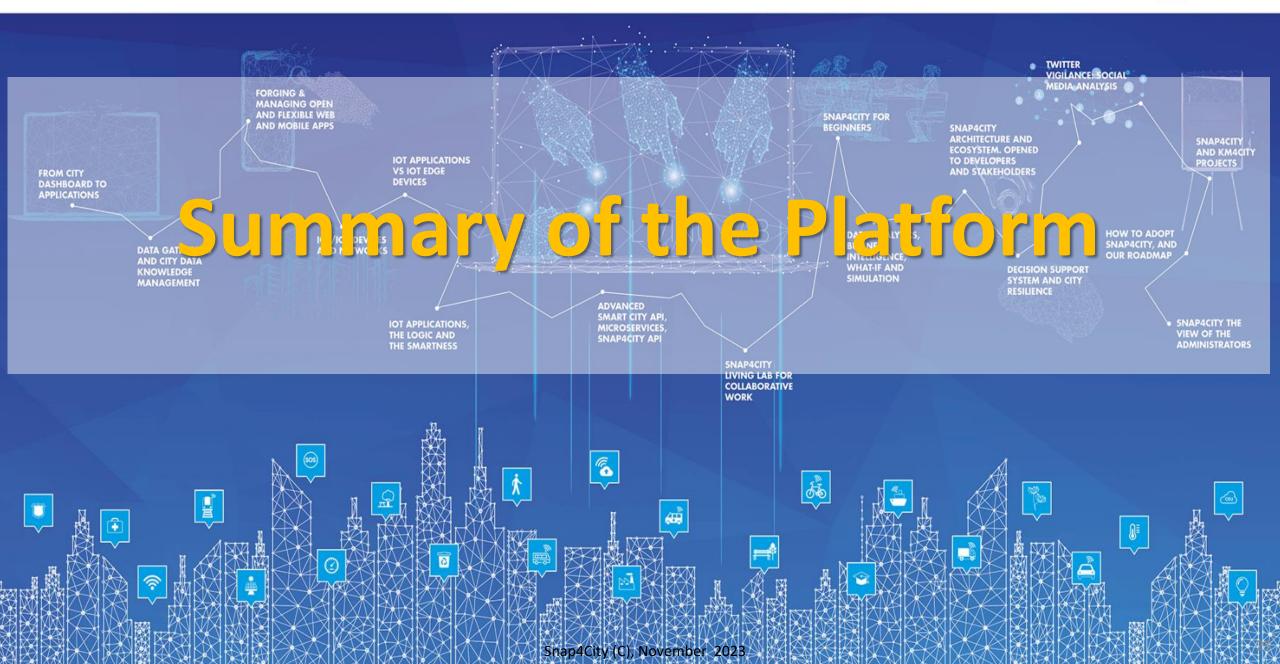
Complex and heterogeneous information, interoperability

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

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT SNAP4INDUSTRY









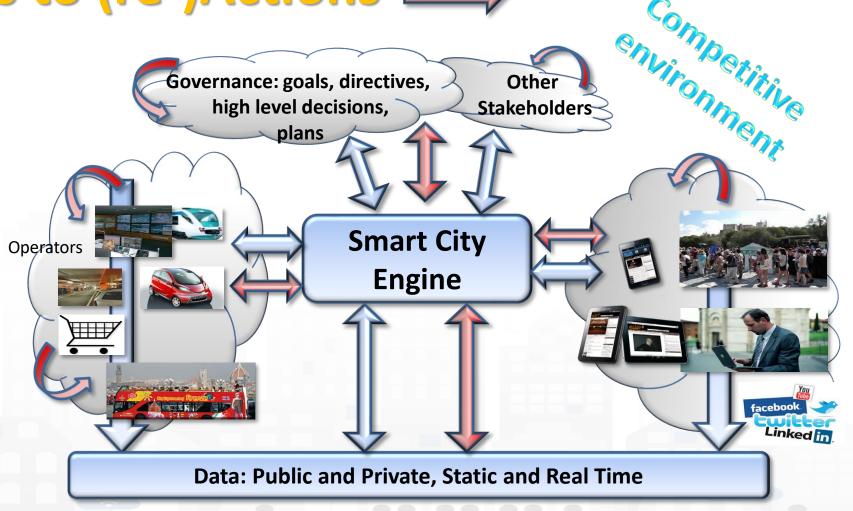






From Strategies to (re-)Actions

- Analyze
- Alerting, Early Warning
- Support Decision makers
- Plans
- Prescriptions
- Inform
- Suggest
- Engage
- Research







FREE TRIAL





















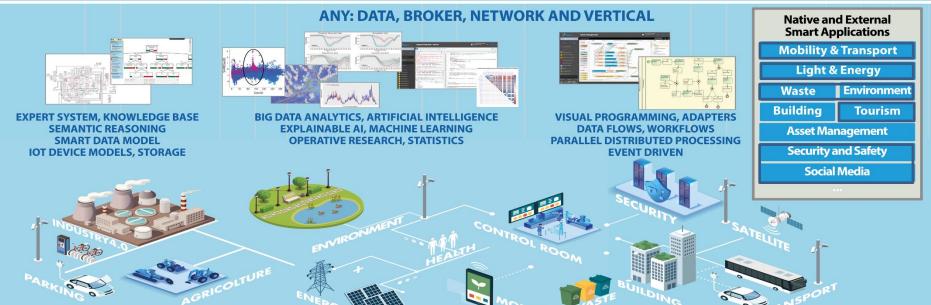
Smart Solutions and Decision Support Systems







TEMPLATES PEOPLE FLOWS - SDG - 15 MIN CITY INDEX - KPI - HEATMAPS - ORIGIN DESTINATION - ETC... VIDEO - REPORTS - MAPS - 3D ...





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







FREE TRIAL











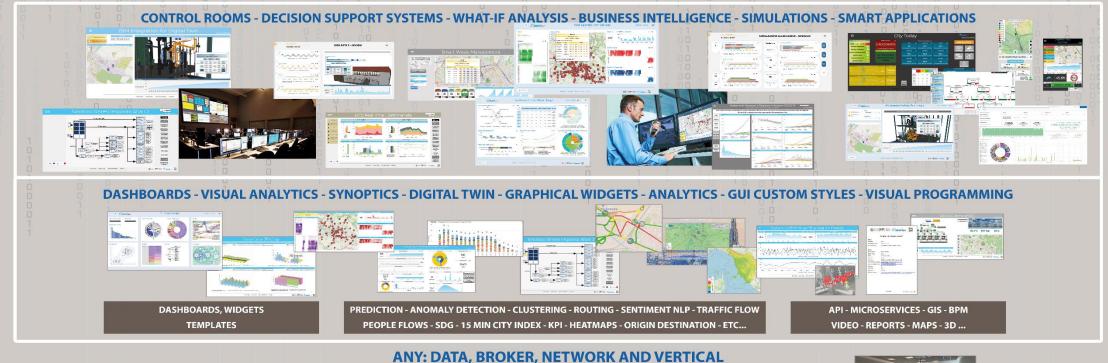


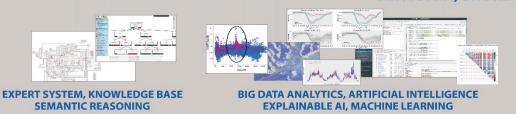






SNAP4INDUSTRY SMART Solutions and Decision Support Systems

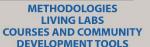


















https://www.Snap4City.org













11 running installations in Europe

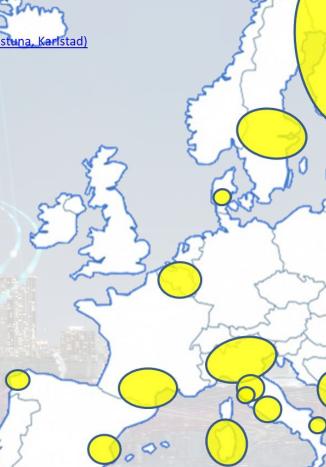
- Snap4.city.org, Greece, Merano, ...
- Toscana, Pisa, Sweden, ISPRA, Snap4.eu,
- Altair, Italmatic, Sweden, Romania,
- 16 projects, 12 pilots on 10 Countries
 - >40 cities/area

Widest MULTI-tenant deploy has

- 19 Organizations / tenant
- > 8000 users on
- > 1600 Dashboards
- > 16 mobile Apps
- > 2.2 Million of structured data per day
- > 520 IoT Applications/node-RED
- > 700 web pages with training
- > 70 videos, training videos



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



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

Standards and Interoperability (6/2023)

SNAP4city

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, glTF, GLB, DTM, GDAL, Satellite, D3 JSON, ...
- Database: Open Search, MySQL, Mongo, HBASE, SOLR, SPARQL, ODBC, JDBC, Elastic Search, Phoenix, PostGres, MS Azure, ...
- Industry: OPC/OPC-UA, OLAP, ModBUS, RS485, RS232,...
- Mobility: DATEX, GTFS, Transmodel, ETSI, NeTEx, ...
- Social:Twitter, FaceBook, Telegram, ...
- Events: SMS, EMAIL, CAP, RSS Feed, ...
- OS: Linux, Windows, Android, Raspberry Pi, Local File System, AXIS, ESP32, etc.

























https://www.snap4city.org/65







Ingestion, agg. -> exploitation



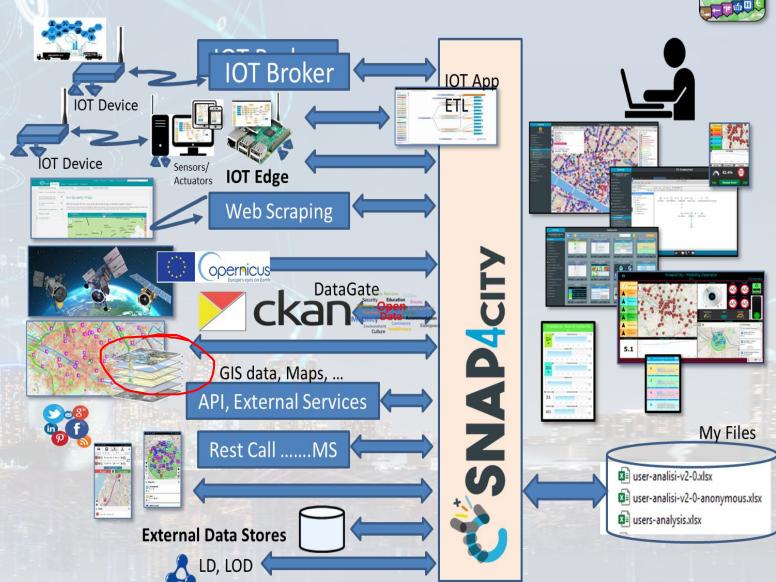






KM 4 CITY

- Snap4City efficient tools for
 - Bidirectional data channels
 - Any format, any channel, any data, any broker, any protocol, ...
 - Km4City Knowledge base Ontology reasoning on geo, space, time, relationships



Expert System semantic queries

UNIVERSITÀ DINFO DIPARTMENTO DI DIPA

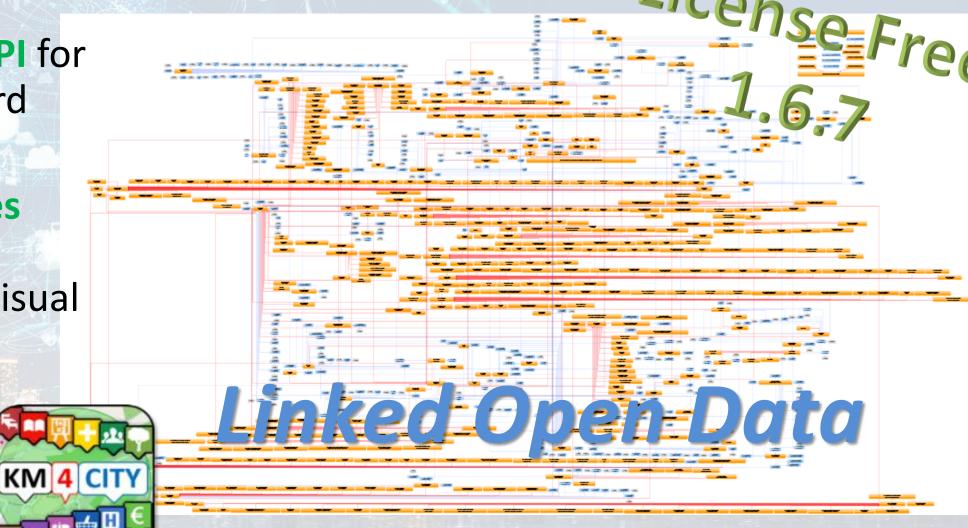




• via:

 Smart City API for Apps and third party

MicroServices
 data driven
 develop via visual
 language
 Node-RED



https://www.snap4city.org/19

High Level Types

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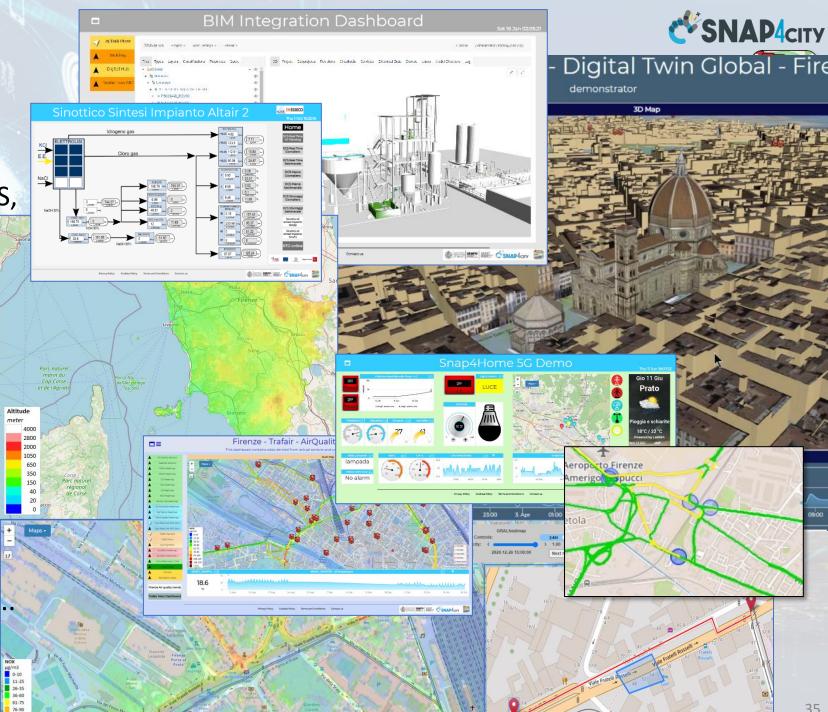
- POI, IOT Devices, shapes,...
 - FIWARE Smart Data Models,
 - IoT Device Models
- GIS, maps, orthomaps, WFS/WMS, GeoTiff, calibrated heatmaps, ..
- Satellite data, ..
- traffic flow, typical trends, ...
- trajectories, events, Workflow, ...
- 3D Models, BIM, Digital Twins, ...
- OD Matrices of several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











Ingestion, aggreg. > exploitation

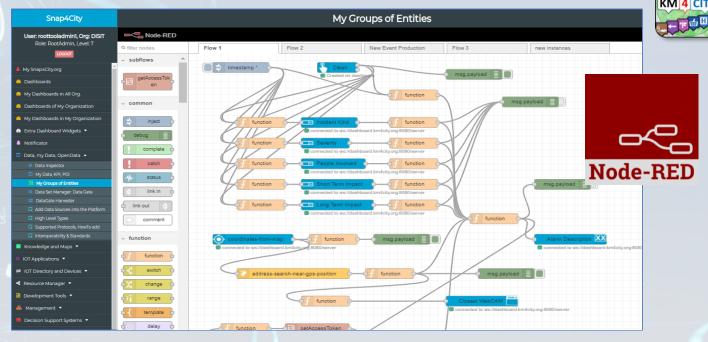


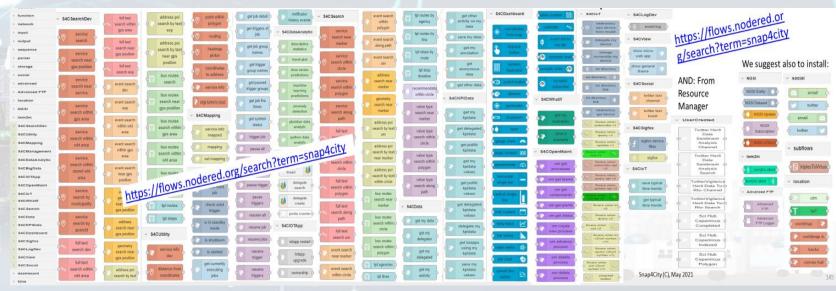






- IoT App Visual Programming, no coding
 - Data transformation
 - Integration, Interoperab.
 - Scripting Data Analytics
 - Data ingestion
 - Business logic
- Edge and Cloud
- MicroServices data driven develop via visual language Node-RED

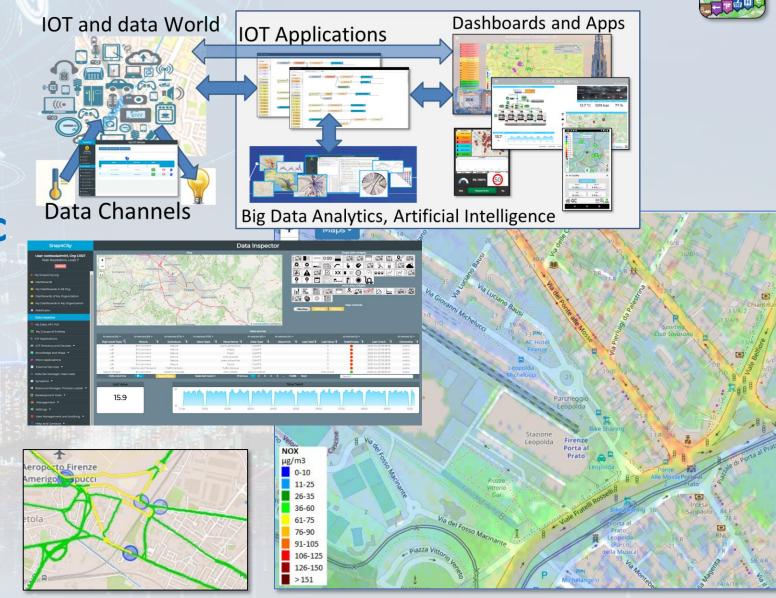




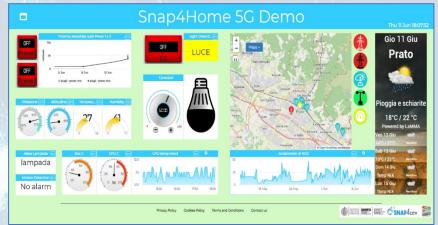
Solutions: reliable, secure and fast to realize

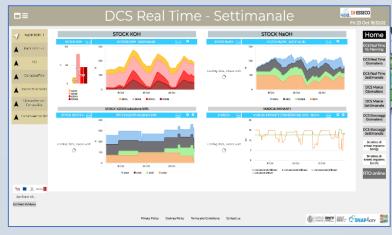
SNAP4CITY KM/4 CITY

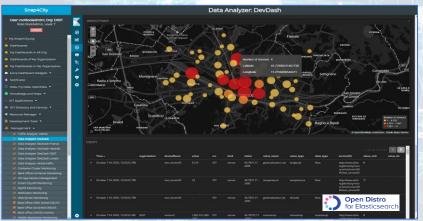
- Via Snap4City tools
 - Dashboard Wizard
 - Dashboard Builder
 - Data/Visual Analytic
- Smart Solutions results to be
 - Real time data drive
 - Secure end-to-end
 - GDPR compliant
 - Reliable, interoperable
 - · Auditable, marketable



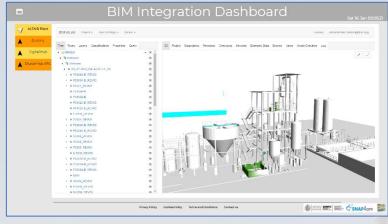




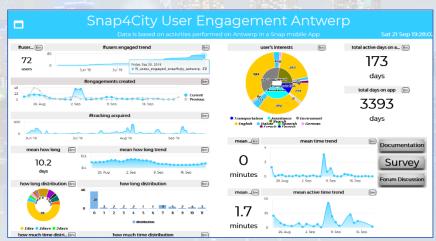


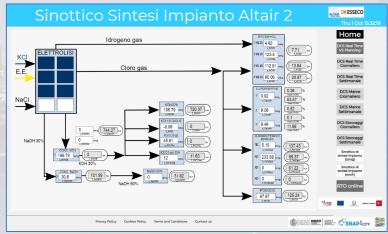


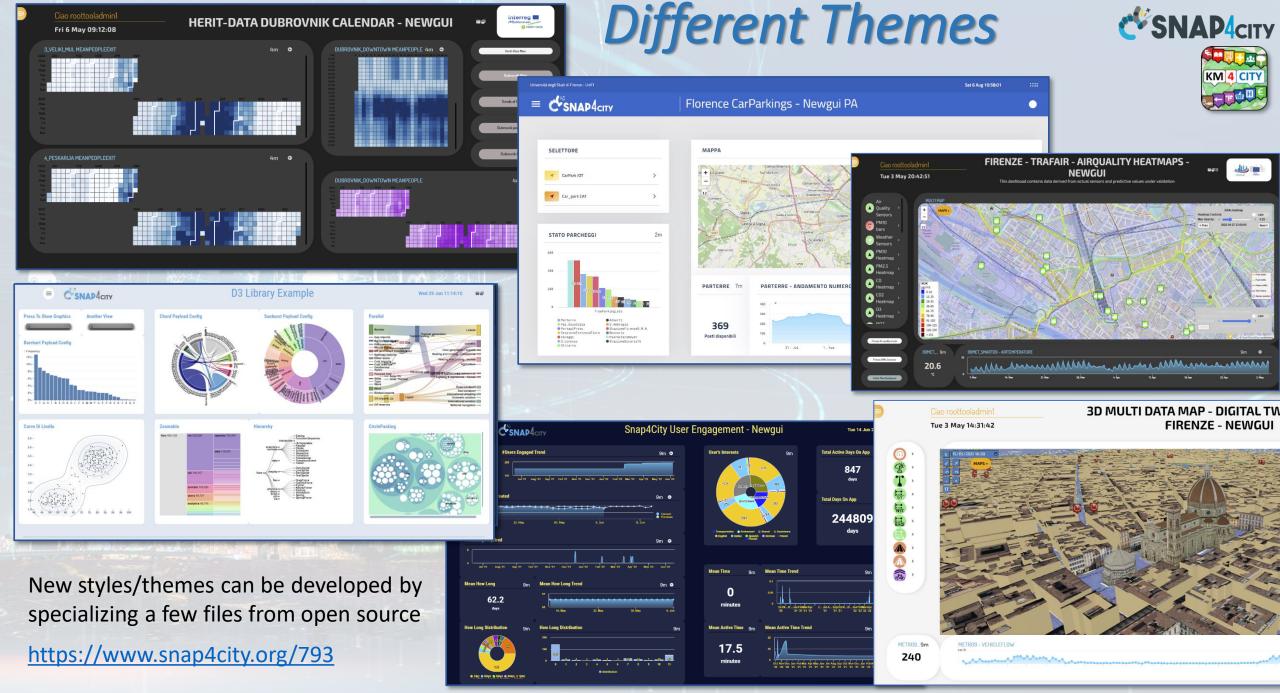












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SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES



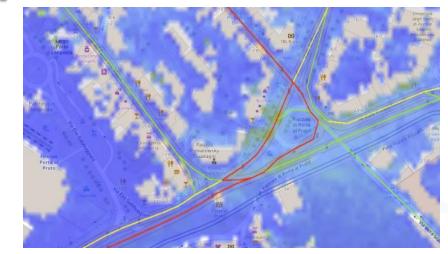


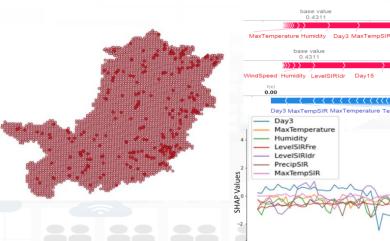




The difference is on computational models

- Simulation models,
- statistics and operations research techniques
- Machine Learning and Artificial Intelligence techniques
 - o exploitation of heterogeneous data, **BIG DATA**
 - o Predictions, Early Warning, Anomaly Detection, ...
 - What-If Analysis integrating predictive models and simulations
 - Explainable AI, XAI, providing to the decision-maker
 - o **detailed explanations** on the motivations behind the suggestions provided, so that the decision maker can understand the process and the motivations
 - evidence of compliance with ethical aspects with confidence
 - To be able to use the systems as a trusted expert system.





Big Data Analytics + Artificial Intelligence

SNAP4city

KM 4 CITY

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

AI & XAI:

- RF, XGBoost, BRNN, RNN, SVR, DNN, LSTM, CNN-LSTM, Autoencoders, neuro-symbolic...
- Clustering: K-means, K-Medoid, ...
- Semantic Reasoning, ...
- XAI: Shap, variations, Lime, gradients, ...

Representations, animated

- Heatmaps, Traffic, Flows, ...
- Trajectories, OD matrices,
- 3D Rendering
- Typical Time Trends, etc.

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

Snap4City (C), November 2023











Available DA / Al 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



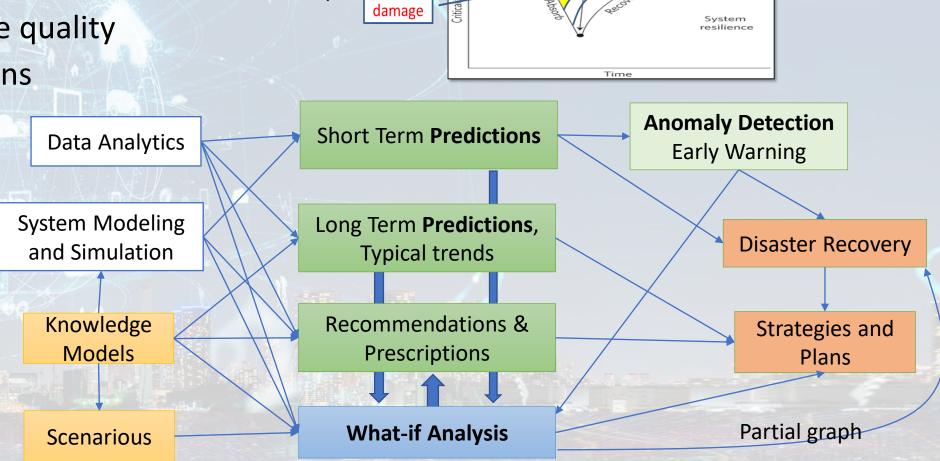


https://www.snap4city.o rg/download/video/DPL SNAP4SOLU.pdf

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

Snap4City Analytics

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



Consequence

Decision Support System: neuro-symbolic reasoning targeting Indicators: Quality of Life, PUMS, SUMI, KPI, SDG, 15MinIndex,...

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Prepare

Absorb

Recover

Adapt



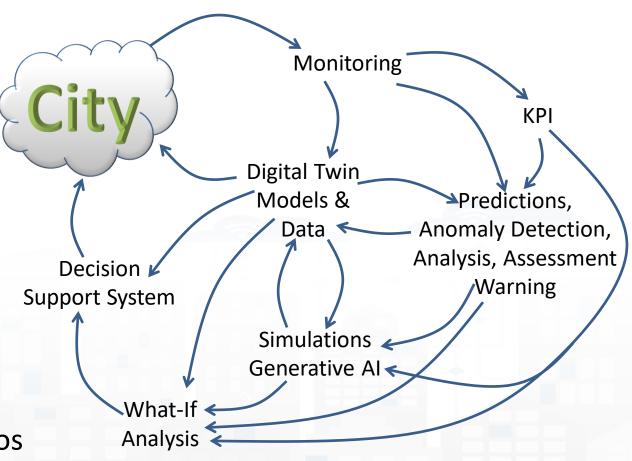


Main tasks



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 Al Prescriptions, scenarios
 - Resilience to Unexpected unknows
 - What-if analysis wrt scenarios







What-If Analysis SNAP4city MACITY



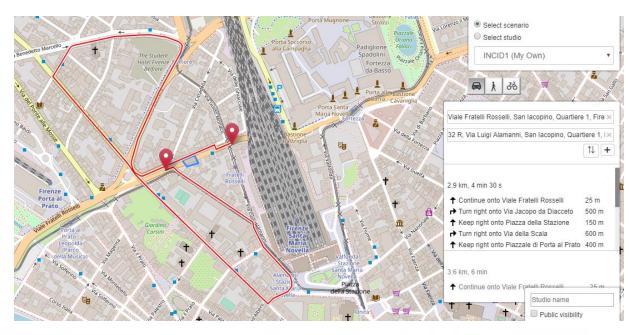


Accidents and elements blocking Points and Shapes taken into account for:

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

Assessment on the basis of changes:

- Mobility demand assessment
- Mobility Offer assessment





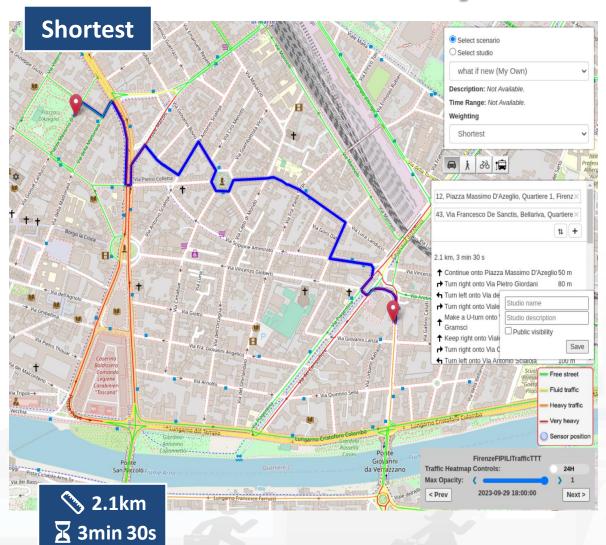


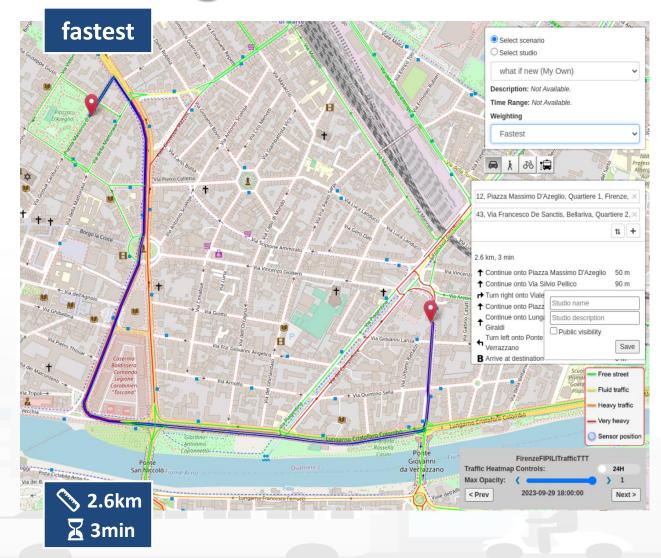






Constrained Dynamic Routing: Traffic Flow





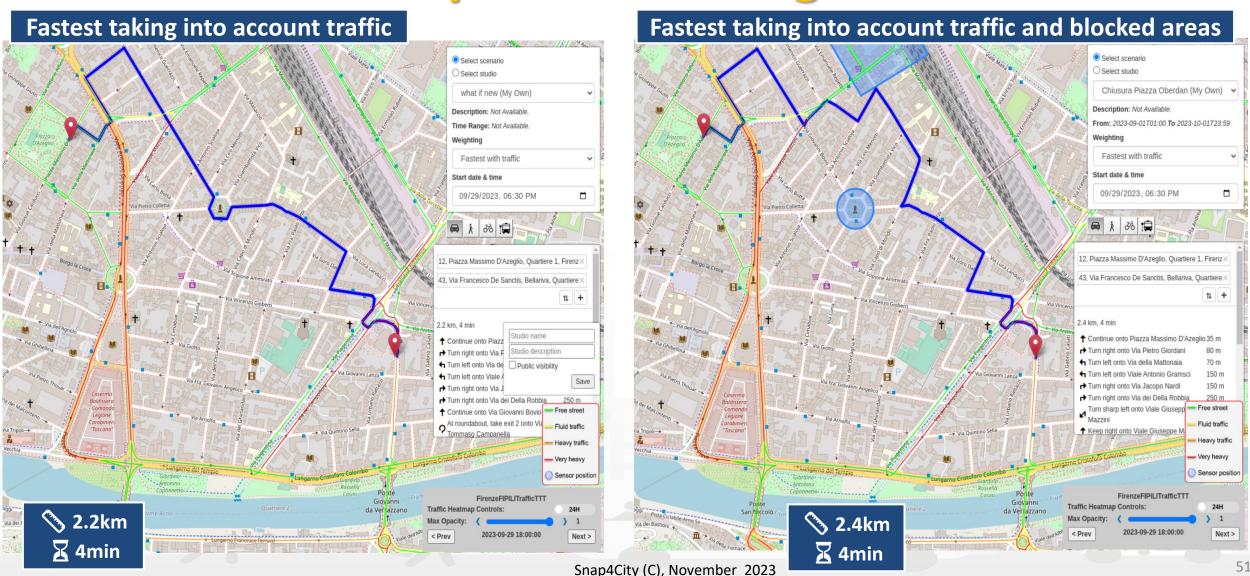








Constrained Dynamic Routing: Traffic Flow



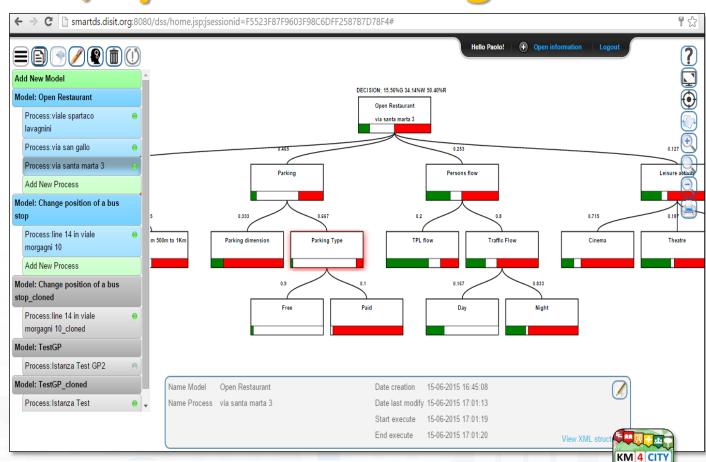






Smart Decision Support, system thinking

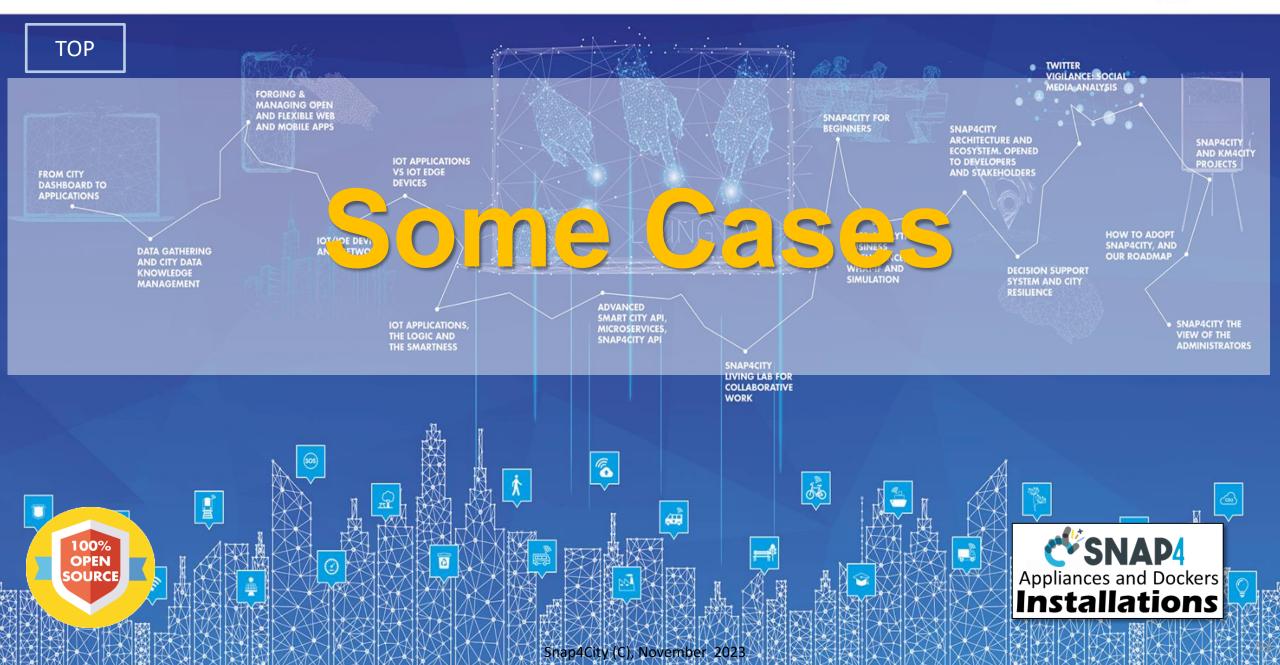
- Smart Decision Support System based on System Thinking plus
- Actions to city reaction, resilience, smartness, ...
- Enforcing Mathematical model for propagation of decision confidence..
- Collaborative work, ...
- Processes connected to city data:
 DB, RDF Store, Twitter, etc.
- Production of alerts/alarms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



http://smartds.km4city.org

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES













13 CLIMATE ACTION









Smart City Control Room Florence Metropolitan City







Multiple Domain Data

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

Multiple dash/tool Levels & Decision Makers

• Real Time monitoring, Alerting, quality assess.

Predictions, KPI, DSS, what-if analysis

Historical and Real Time data

Billions of Data

Services Exploited on:

Multiple Levels, Mobile Apps, API

Since 2017













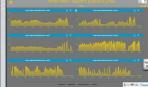
















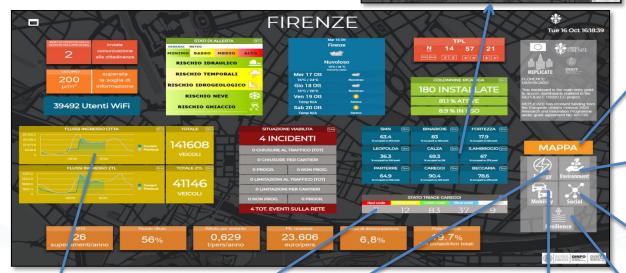


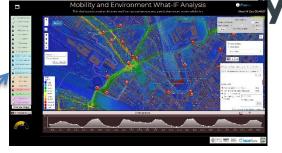
DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

























Mobility











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





Mobility:

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

Environment:

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

Energy:

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

Social:

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

People Flows:

- Wi-Fi, people flow
- Origin destination matrices

Governmental and Communications:

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

Tourism and Culture:

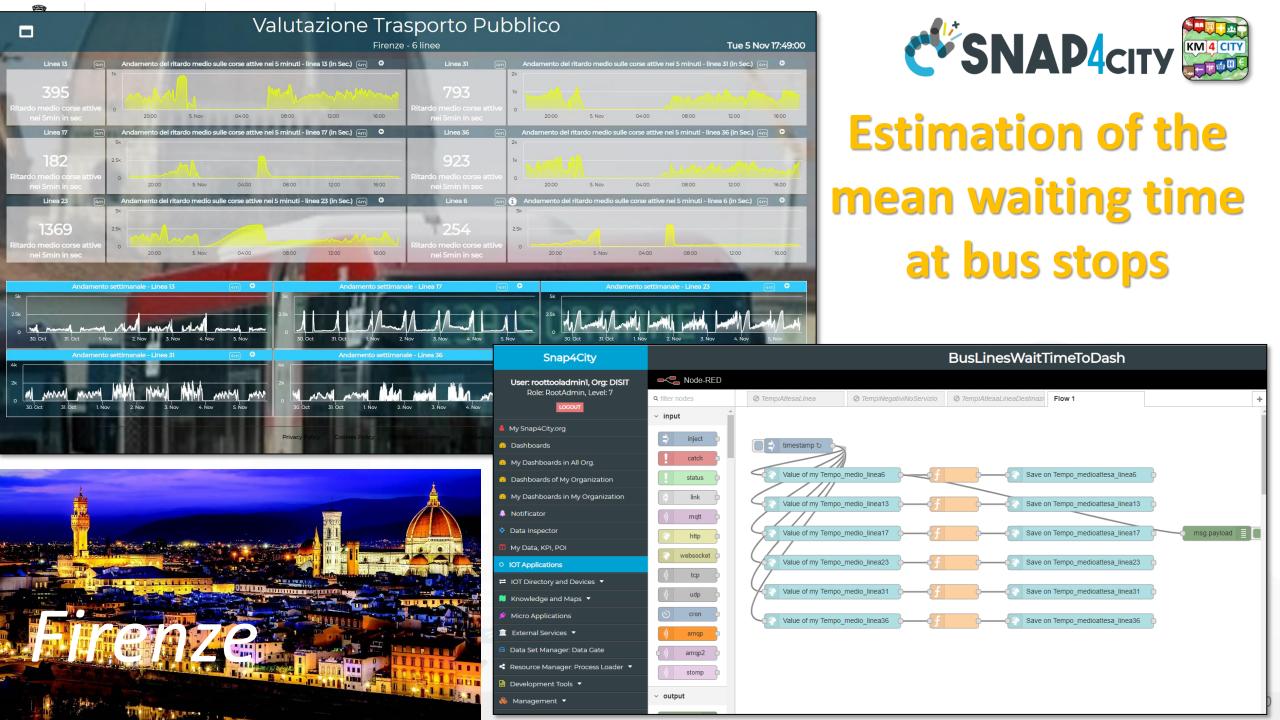
POI, etc.

Analysis:

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





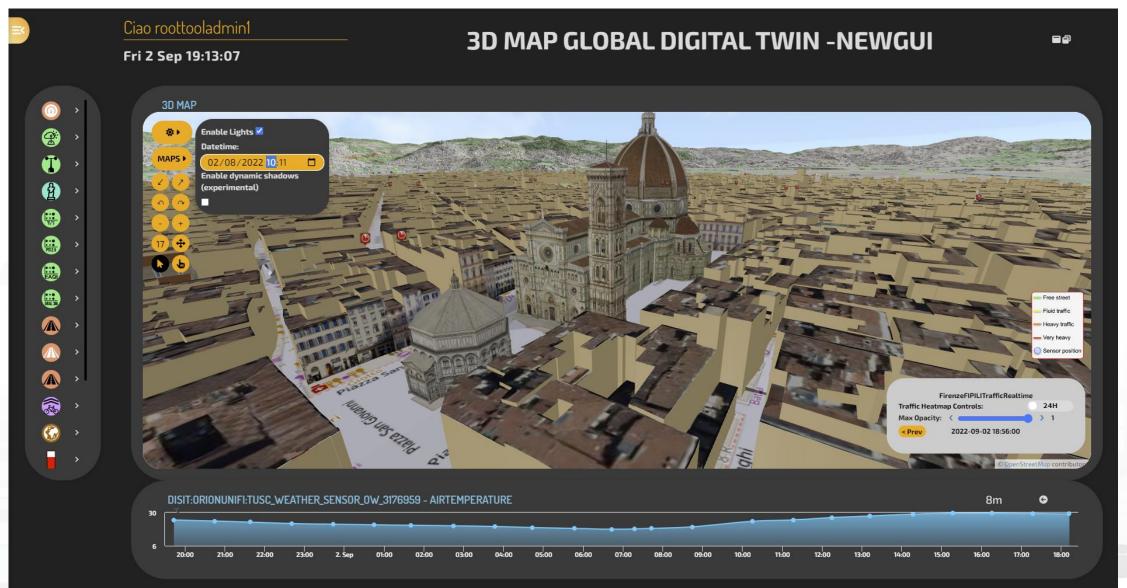


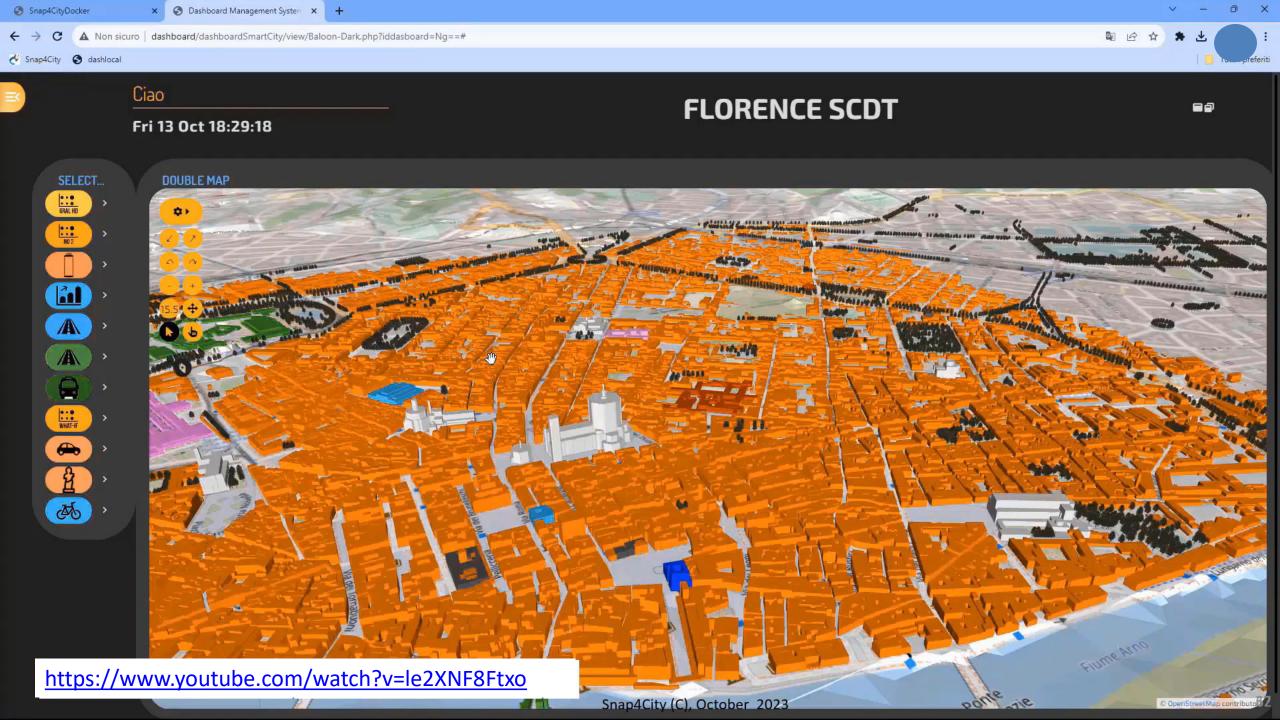














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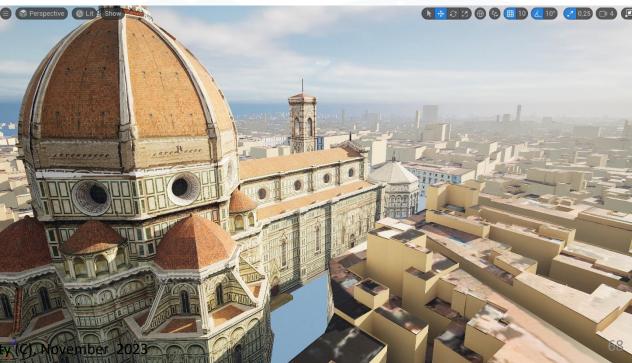


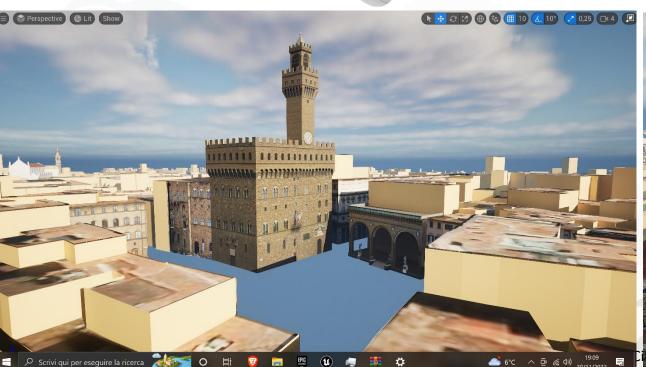


OCULUS



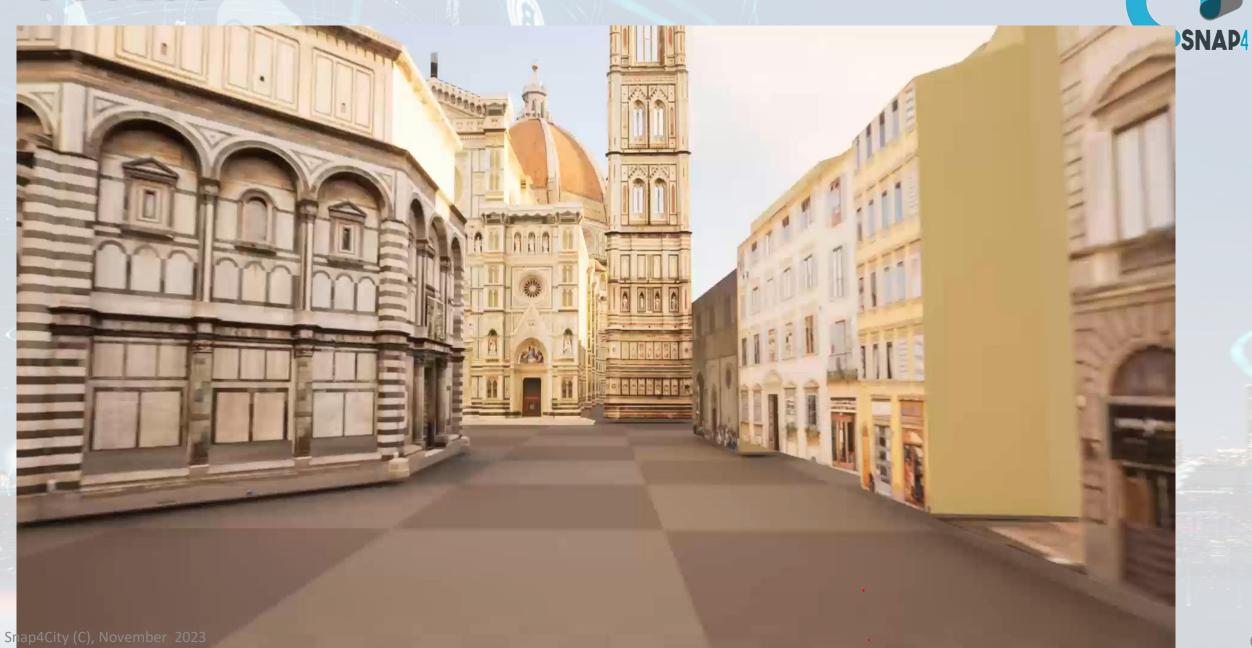






OCULUS

https://www.youtube.com/watch?v=Rcf B2 GOio



69









Exploiting Google API with Snap4City engine

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

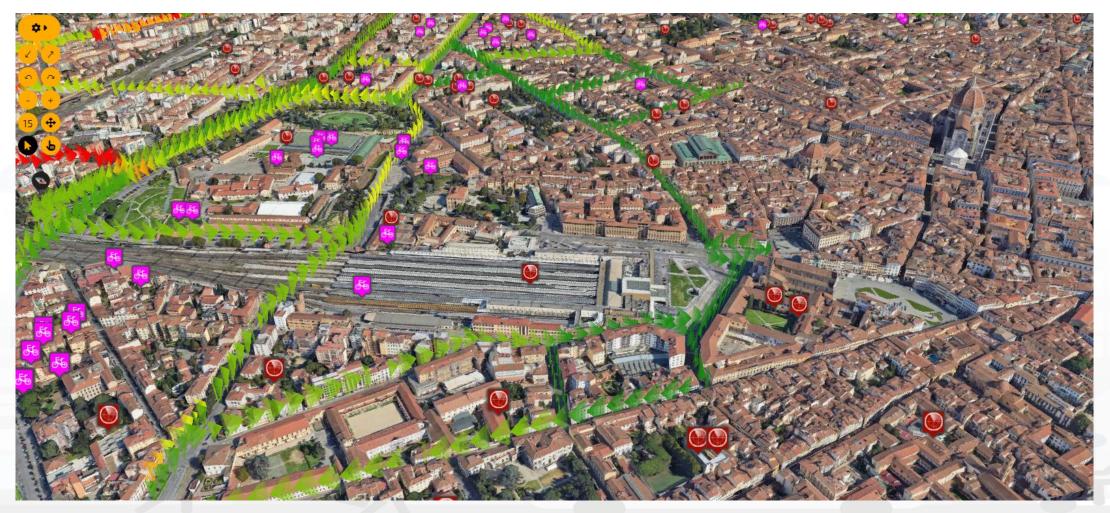








Snap4City Digital Twin Engine and data + 3D Google Data



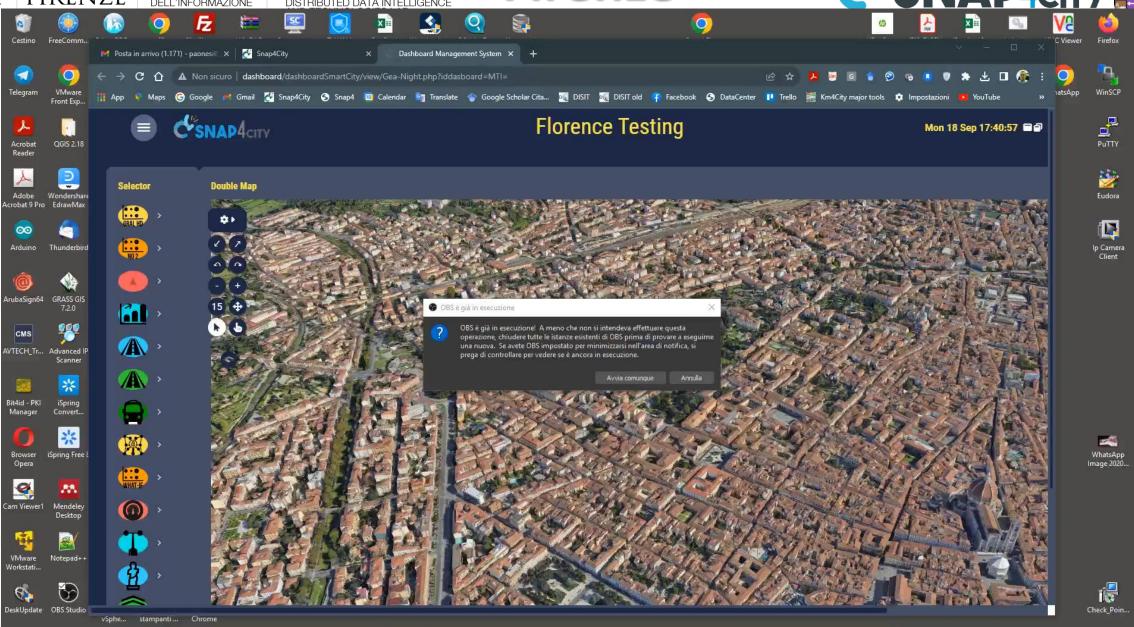


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DISTRIBUTED DATA INTELLIGENCE

Firenze





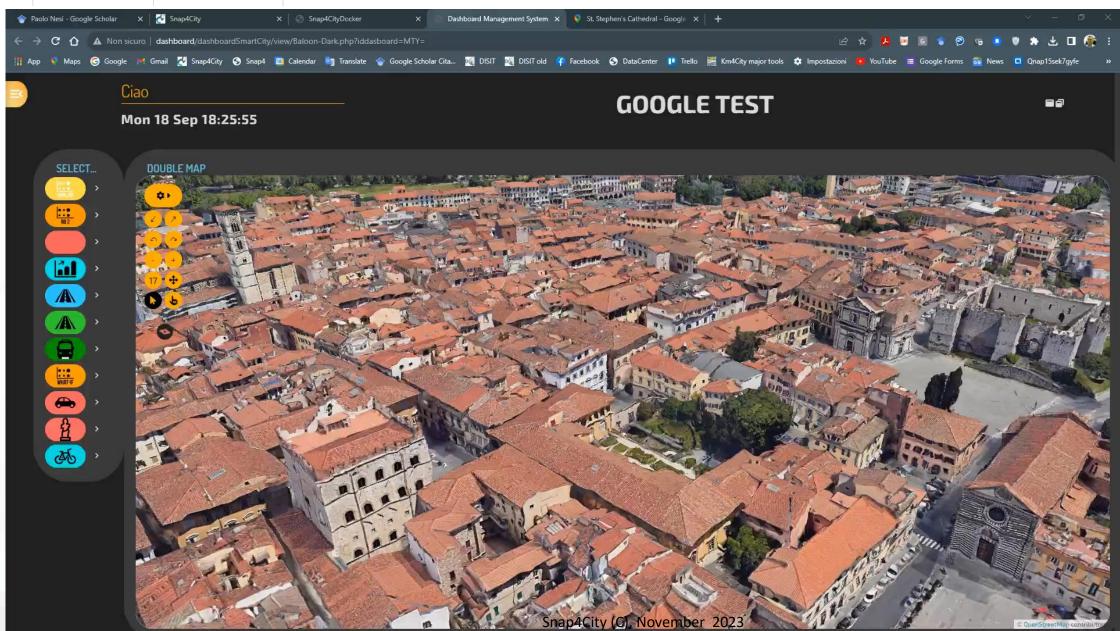














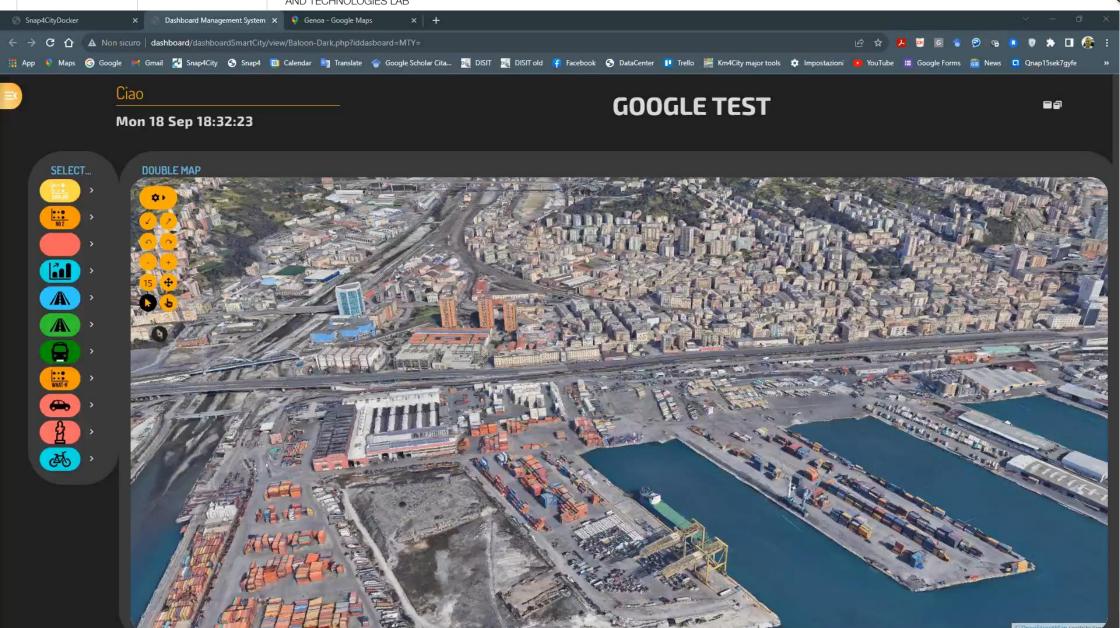
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AND TECHNOLOGIES LAB

Genova







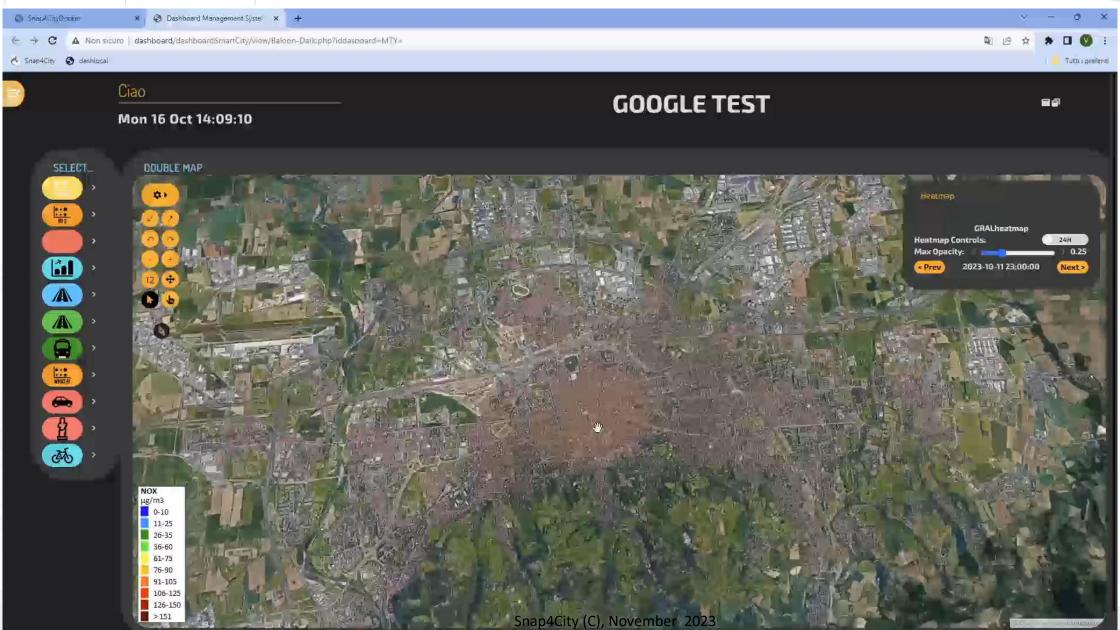
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Bologna





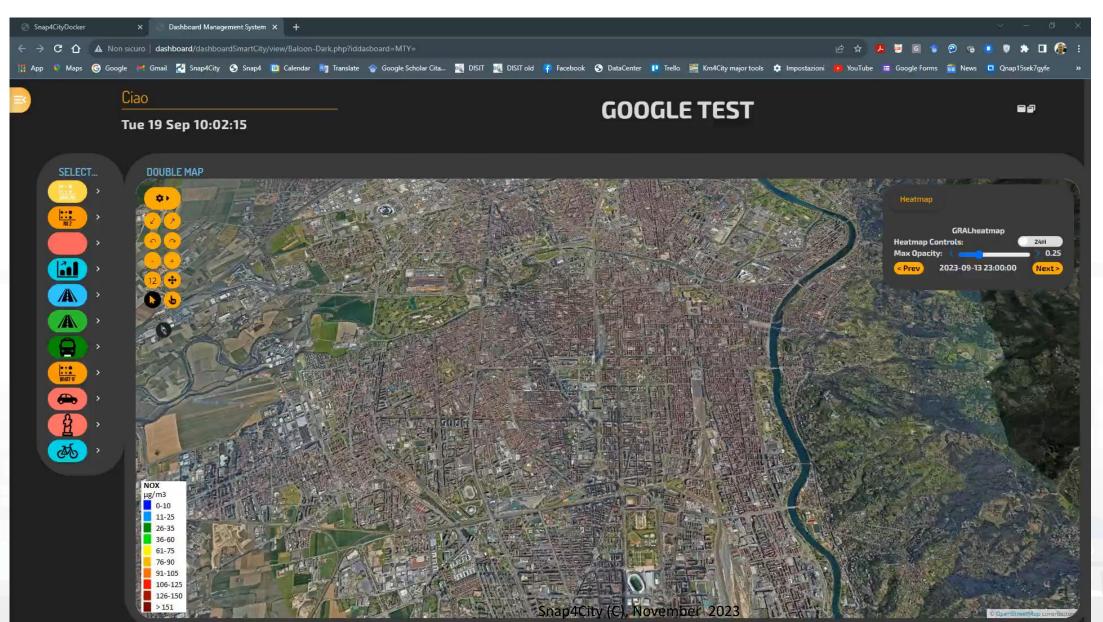




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Torino







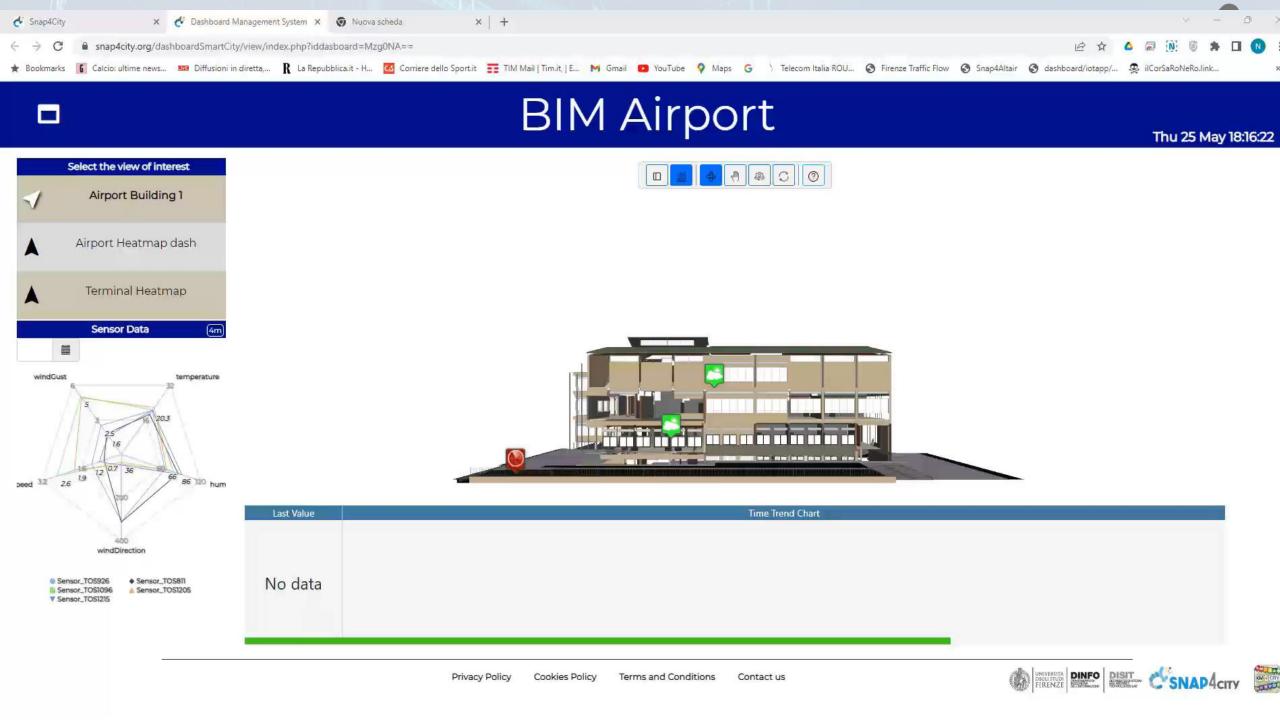


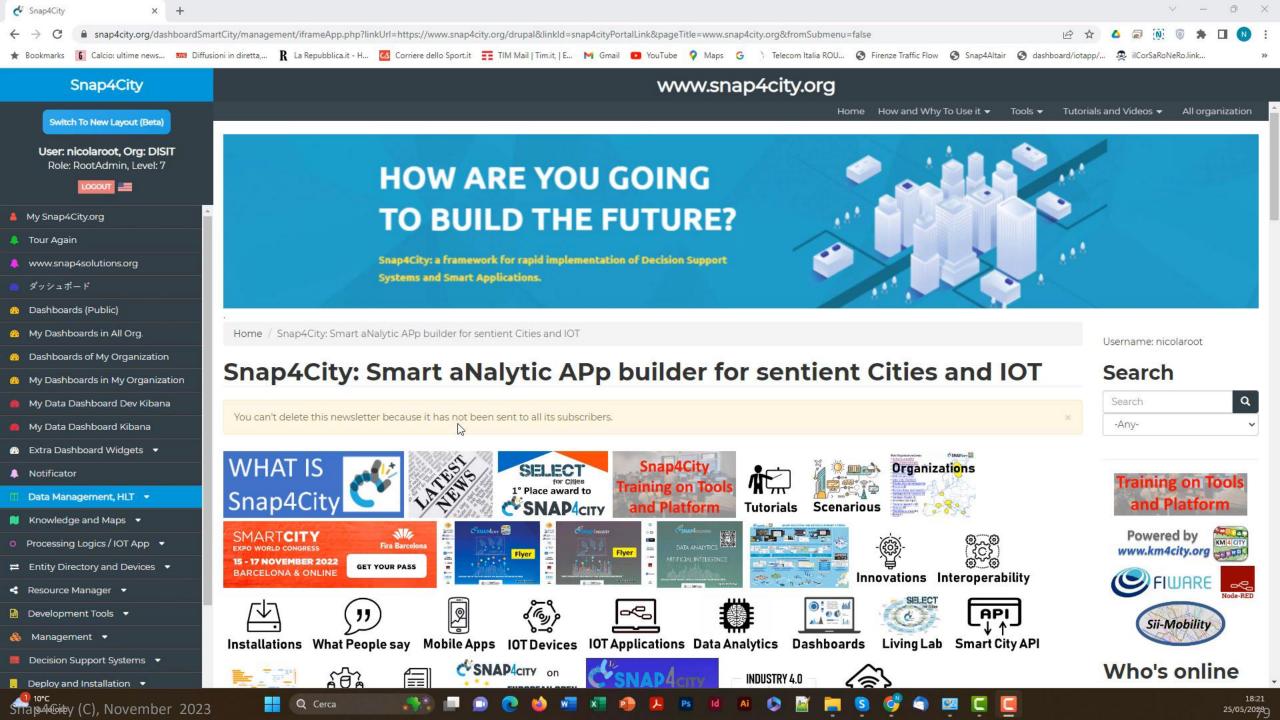




Local Digital Twin vs BIM









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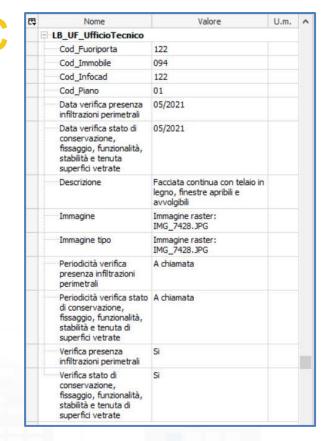
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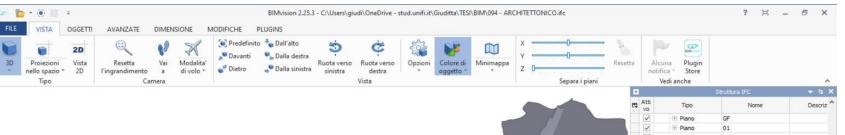
DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB











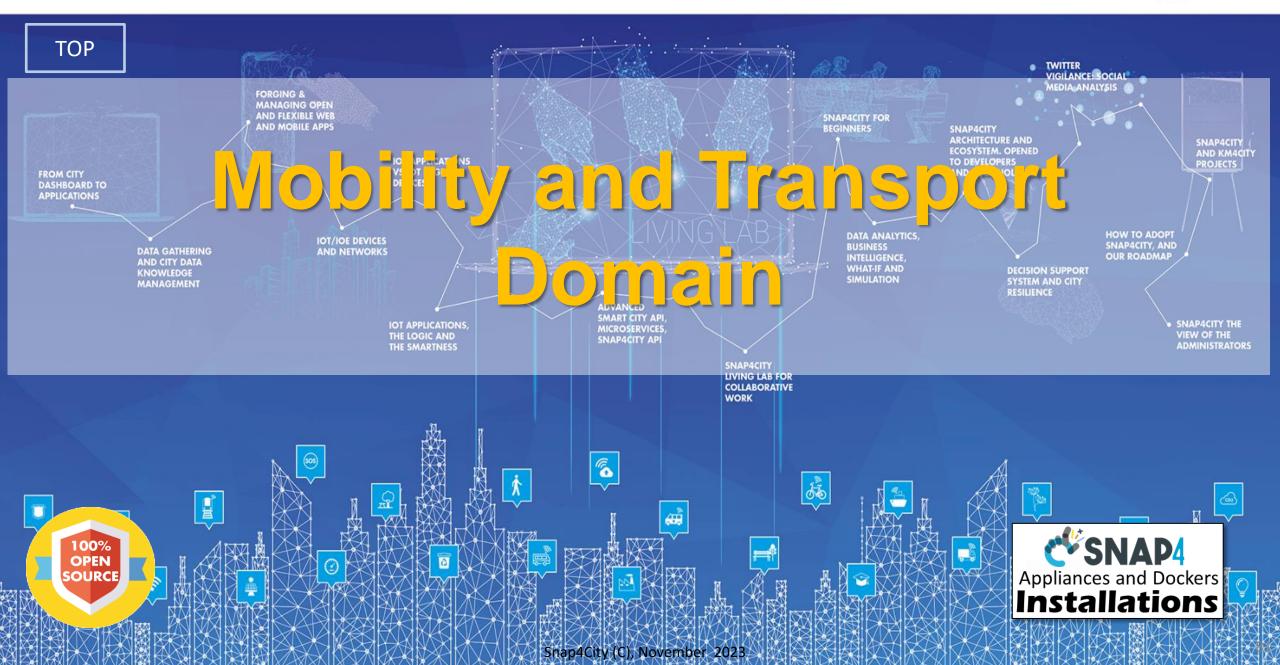




4m 0.11s 5.5 *

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES





Mobility and Transport Traffic Flow Analysis

Multiple Domain Data

Traffic Flow sensors, city structure, weather

- Decision Makers Multiple Locations
 - Real time Monitoring, predictions
 - Traffic Flow Predictions,
 - Traffic Reconstructions, routing
 - Dashboards, What-IF analysis
 - Mobile App, people flows
- Historical and Real Time data
- Services Exploited on:
 - Dashboards, Mobile App
- Since 2017, 2019

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









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)

Ftc

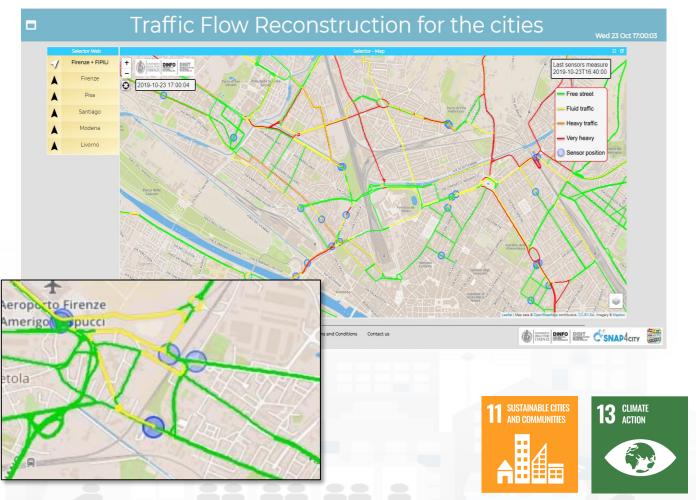
• Definition of Scenarios: traffic, road graph, conditions, etc.



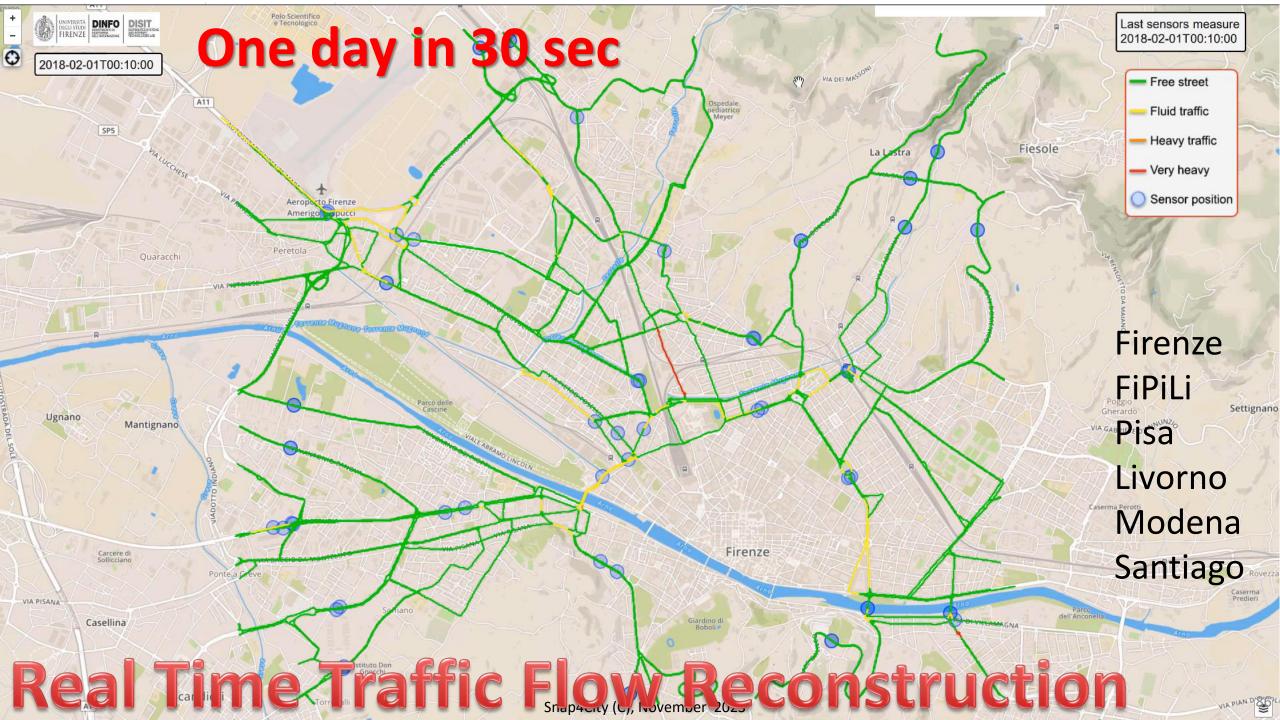


Why Dense Traffic Flow Reconstruction?

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



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









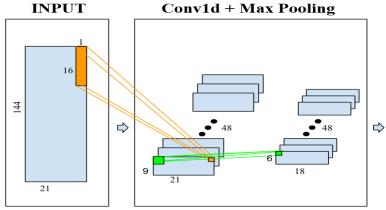


Short-Term Prediction of City Traffic Flow via Convolutional Deep Learning

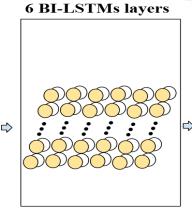


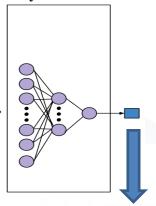






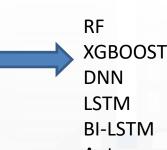
CONV-BI-LSTM



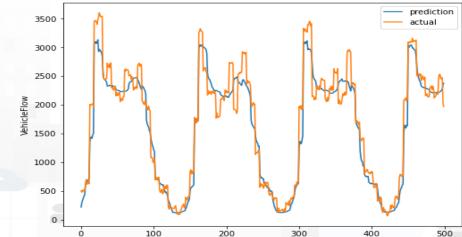


Urban data:

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



LSTM
BI-LSTM
Autoencoder BI-LSTM
Attention CONV-LSTM
CONV-BI-LSTM





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Venaria Reale

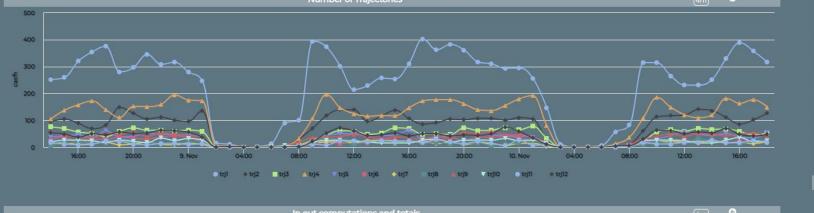


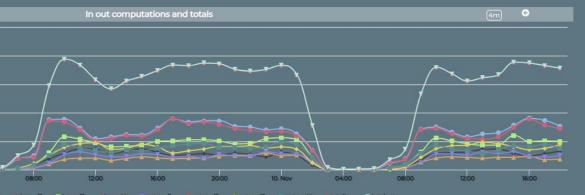
Monitoring Cross Road Venaria - (AXIS Camera)

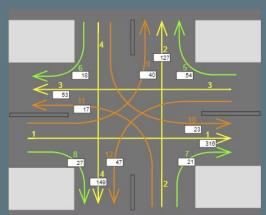












Venaria Street Cross - Synoptic

https://www.snap4city.org/dashboardsmartsitys/views/index.phacus













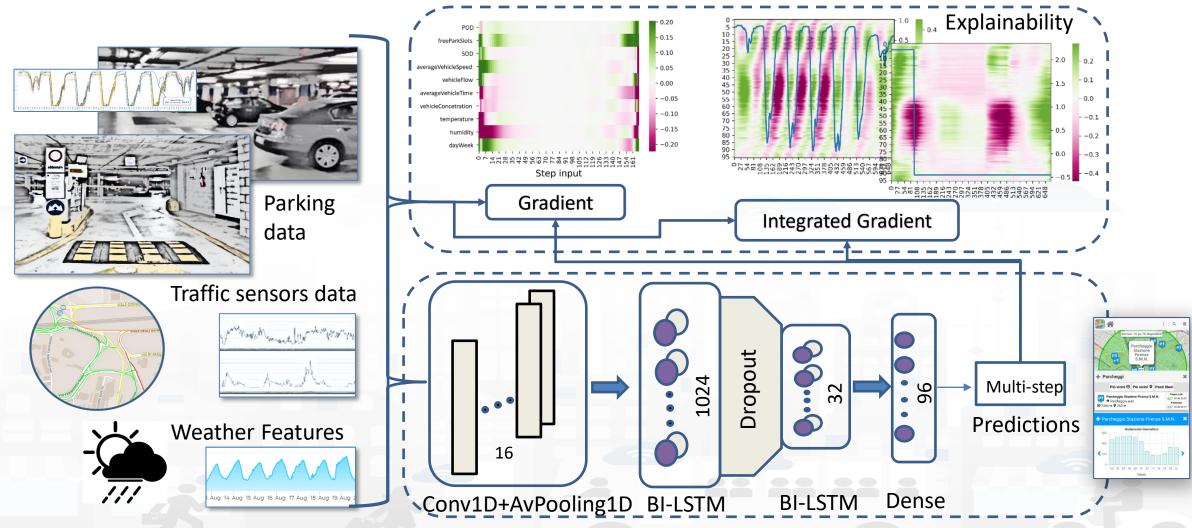








Deep Learning AI to surely Park!



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



DINFO DISIT C'SNAP4CITY



Smart Parking, Environment, Wi-Fi

Multiple Decision Makers

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

Historical and Real Time data

Dashboards

Services Exploited on:

- · Dashboards, API
- Since 2019







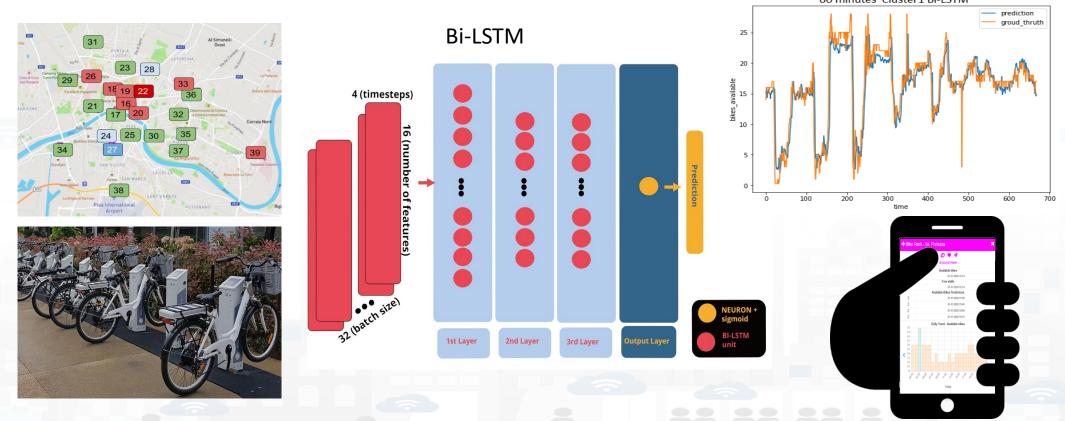








Deep Learning for Short-Term Prediction of Available Bikes on Bike-Sharing Stations



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.

What-if Analysis on Pub Transport







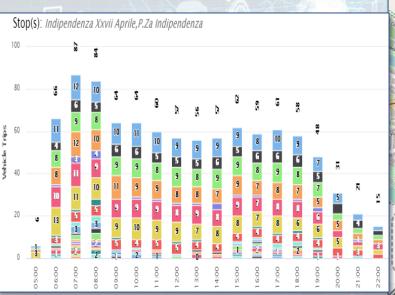


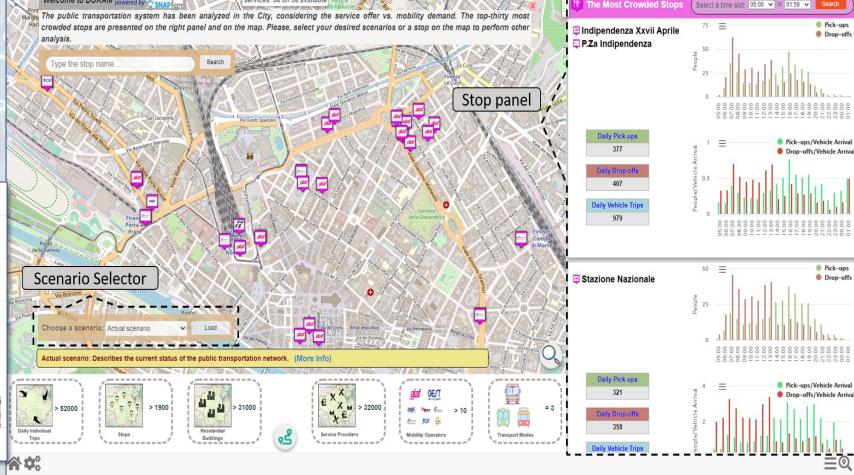


- Definition of scenarious impact on
 - Traffic, Pollutant, parking, public transport, private flows, etc.

KPI analysis

Public Services





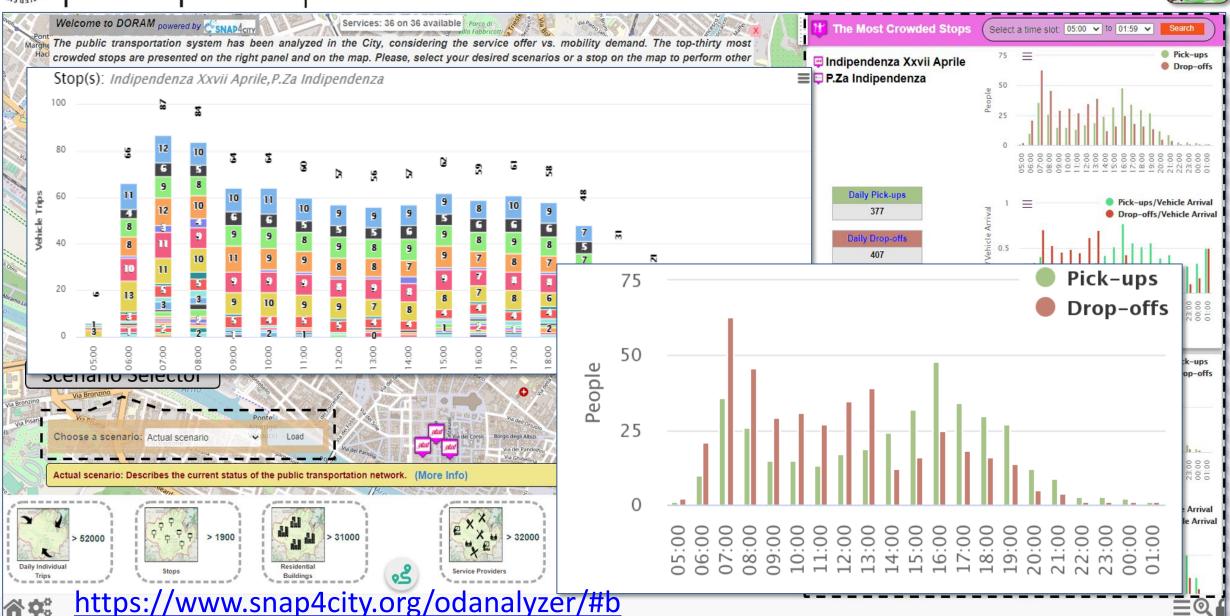


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DORAM





SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES









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)

Tuscany Region

SNAP4CITY

- Dashboards & Services:
 - Mobility: public transport operators schedule and paths, traffic Fi-Pi-Li main road, parking status and predictions, traffic sensors, Origin Destination matrix, routing, multimodal routing, etc.
 - Social: Hospitals and triage, etc.
 - Environment: sensors, heatmaps,
 - alerting,
 - Pollution Forecast: NOX, NO2
 - Weather Forecast,
 - Culture and Tourisms
 - Etc.
- Mobile App and MicroApplications:
 - Tuscany in a Snap (all stores)
 - Tuscany where what... km4city (all stores)
- Numbers: 1.5 M complex events per day Snap4City (C), November 2023

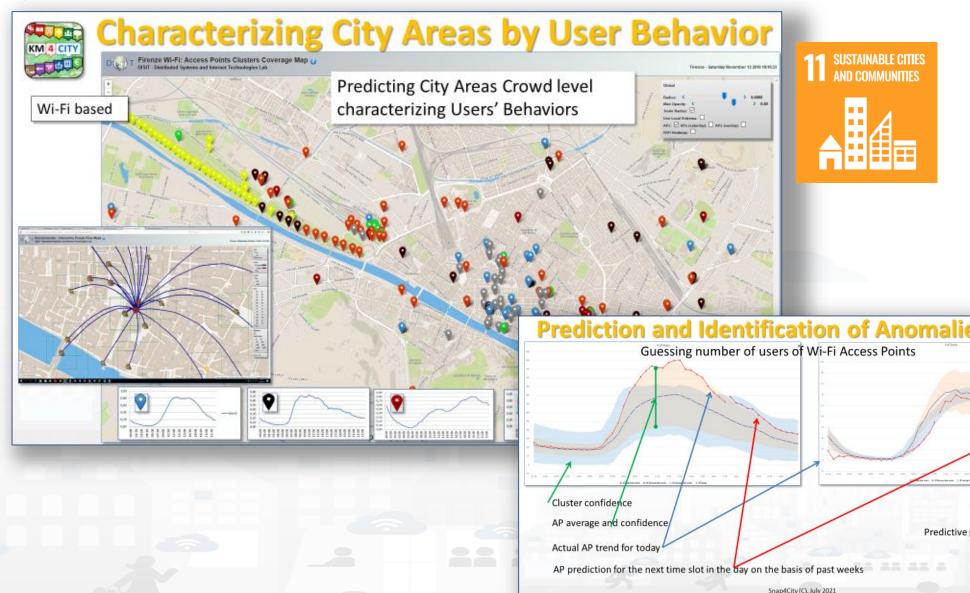






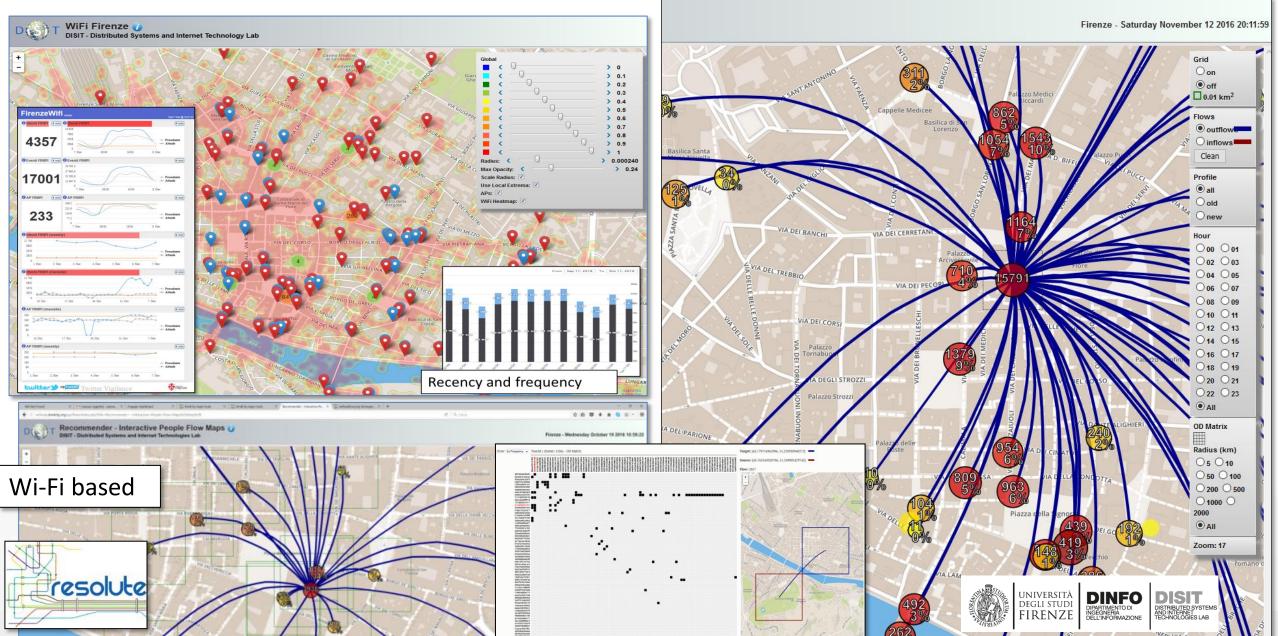


- Prediction of people flows on the basis of Wi-Fi data
- Anomaly detection
- Resolute H2020
- Classification of city areas



Origin Destination Matrix Estimation

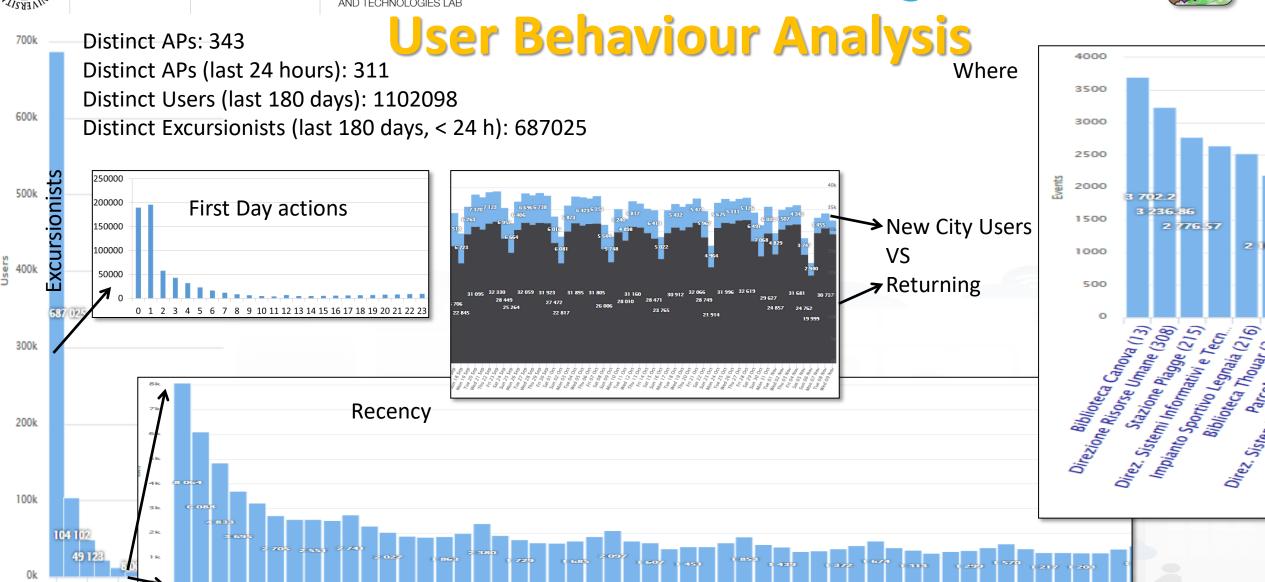




















The App is a Bidirectional Device

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

Produced information

- Viewed?
- Accepted ?
- Performed?

• ..





Derived information

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

.

Produced information

- Suggestions
- Engagements
- Notifications

System

















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



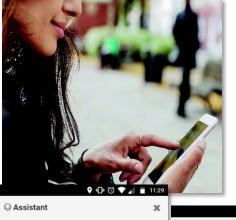


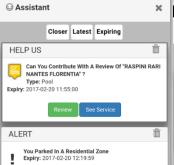


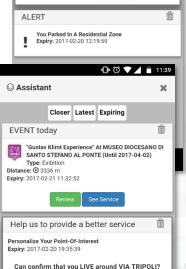


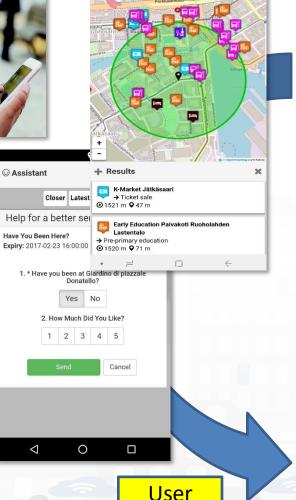




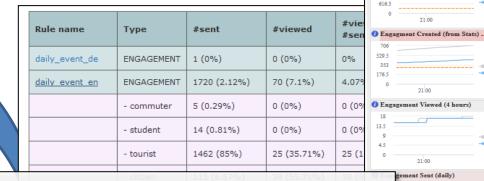








context





You have parked out of your residential parking zone

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

Engage

Provide a comment, a score, etc.

Stimulate / recommend

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

Provide Bonus, rewards if needed

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



4 min DEngagemen... 4 min

4 min DEngagemen... 4 min

2078
Engagement Sent

Engagement Created

Engagement Viewed

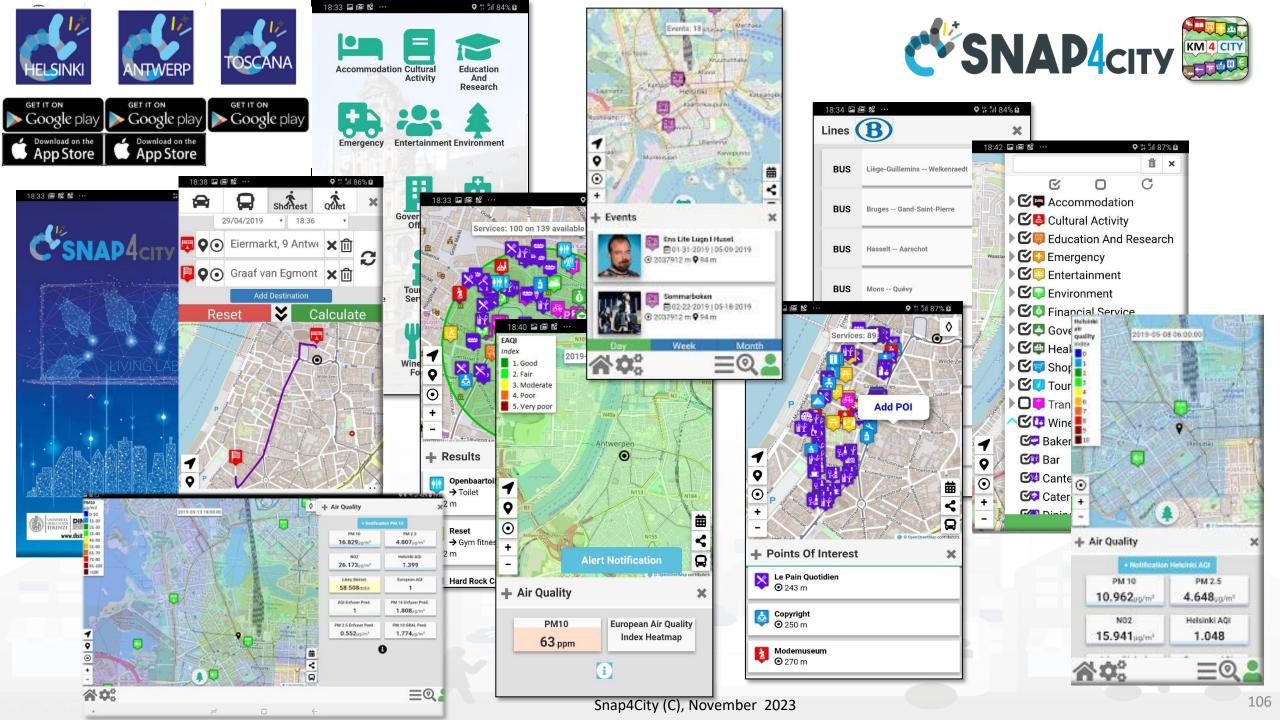
19 min

4 min DEngagemen... 4 min

Rules

City

context



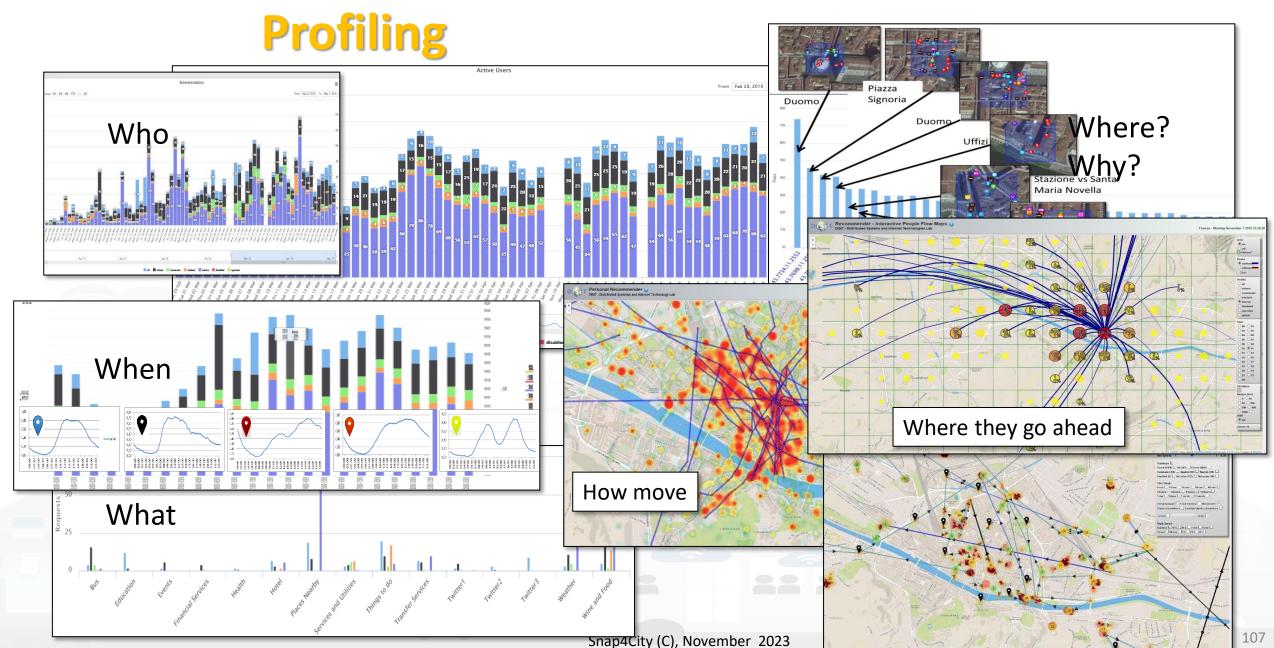






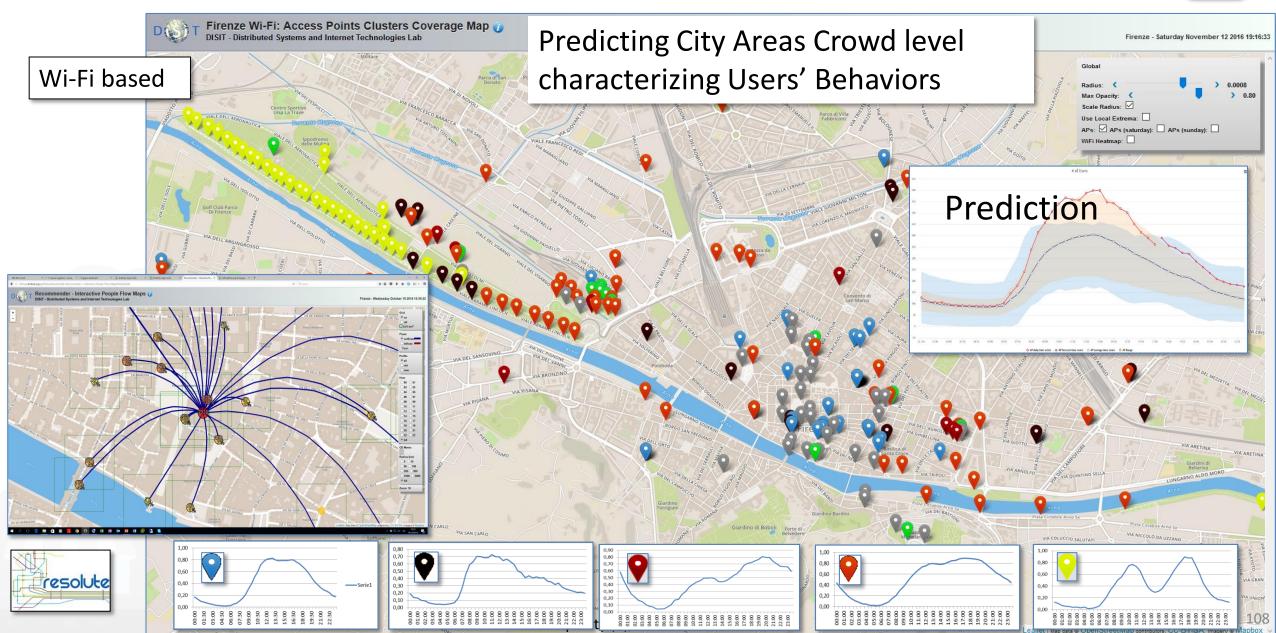
User Behavior Analyser for Collective





Characterizing City Areas











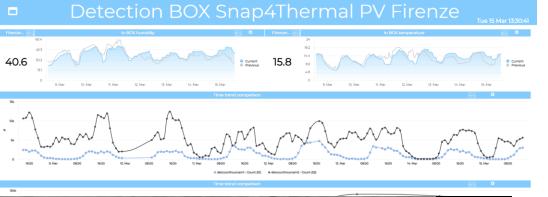








A view and data from the Thermal Camera











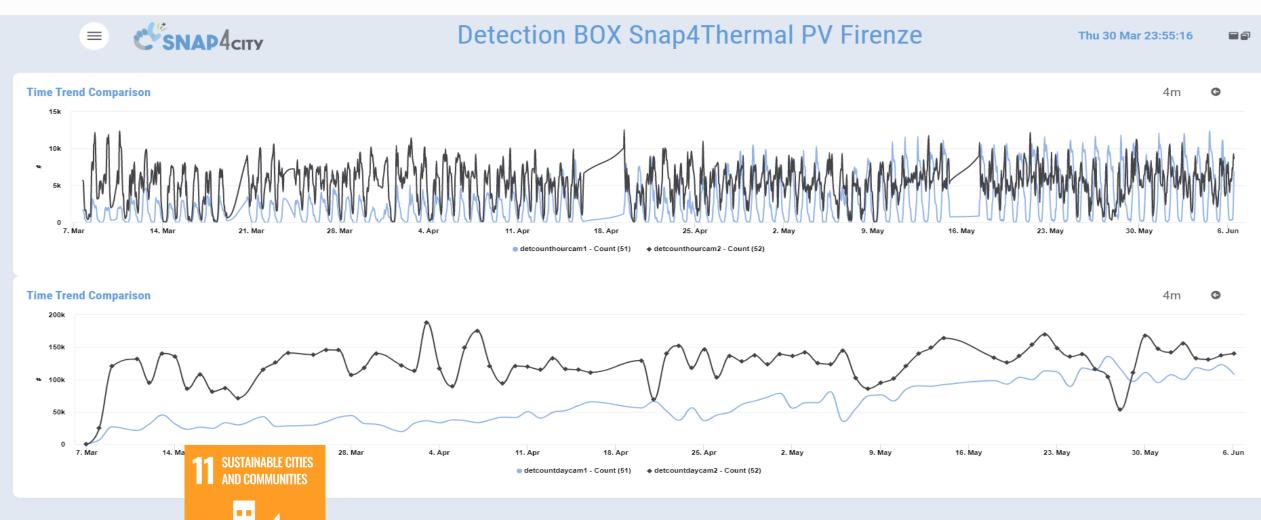




People Counting



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













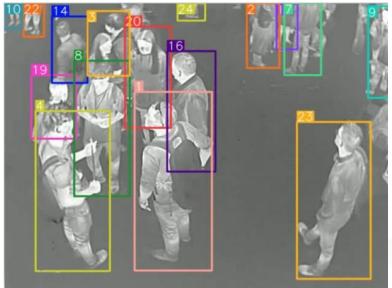


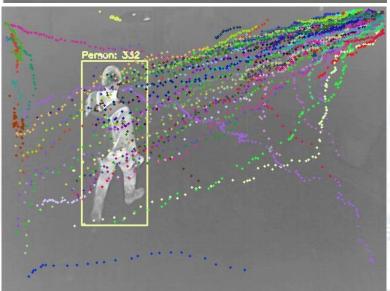




People Counting and Tracking











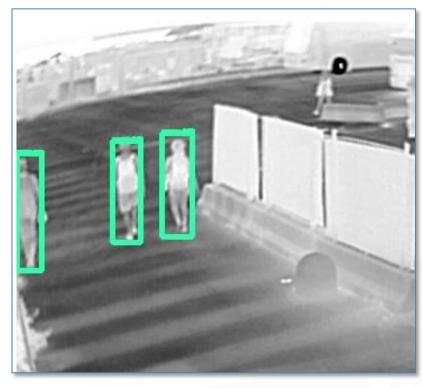










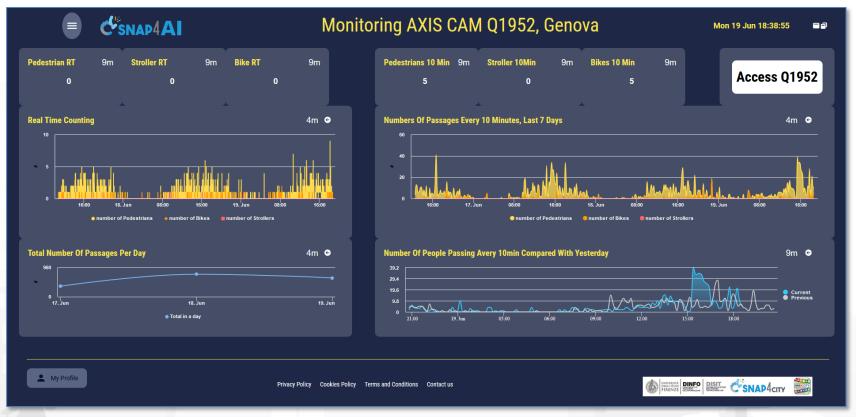


SUSTAINABLE CITIES AND COMMUNITIES

Monitoring Passages AXIS Q1952



Genova: Ocean Race, 2023







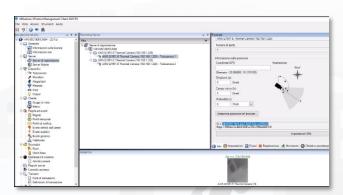


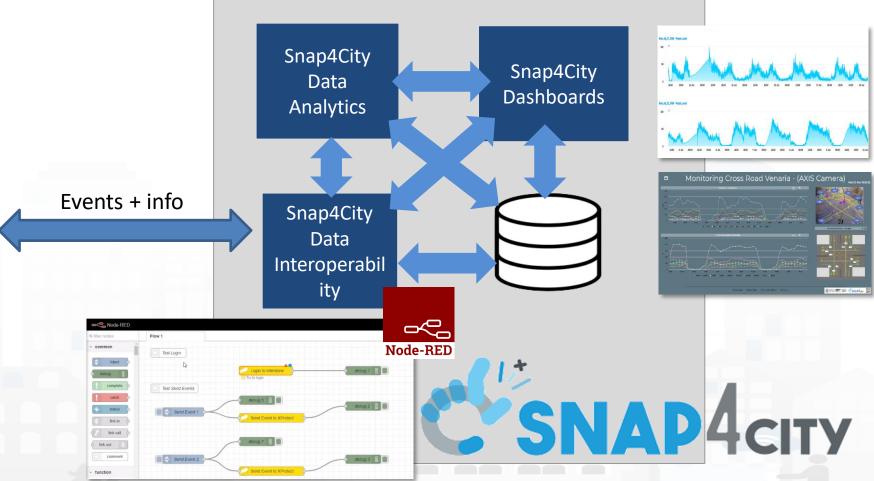




VMS vs Snap4City: sending and getting events, AI solutions

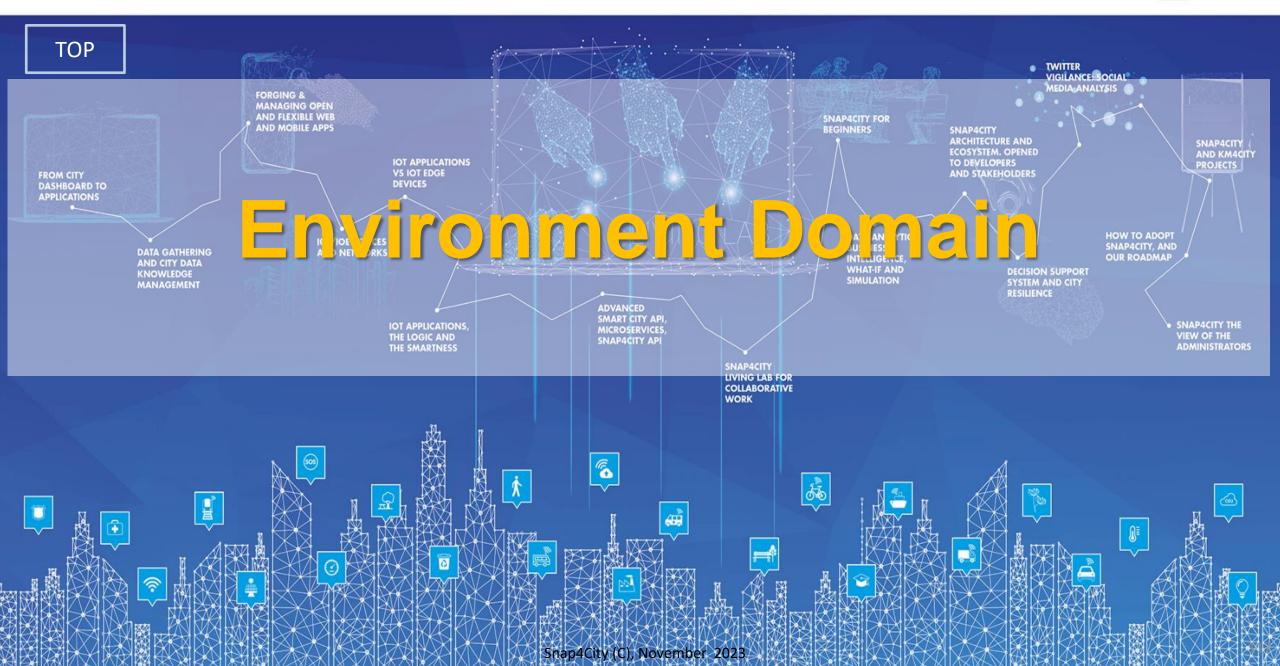






SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES





Environment and Quality of Life

Air Quality Predictions

Multiple Domain Data

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

Multiple Decision Makers

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

Historical and Real Time data

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

Cities of:









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.









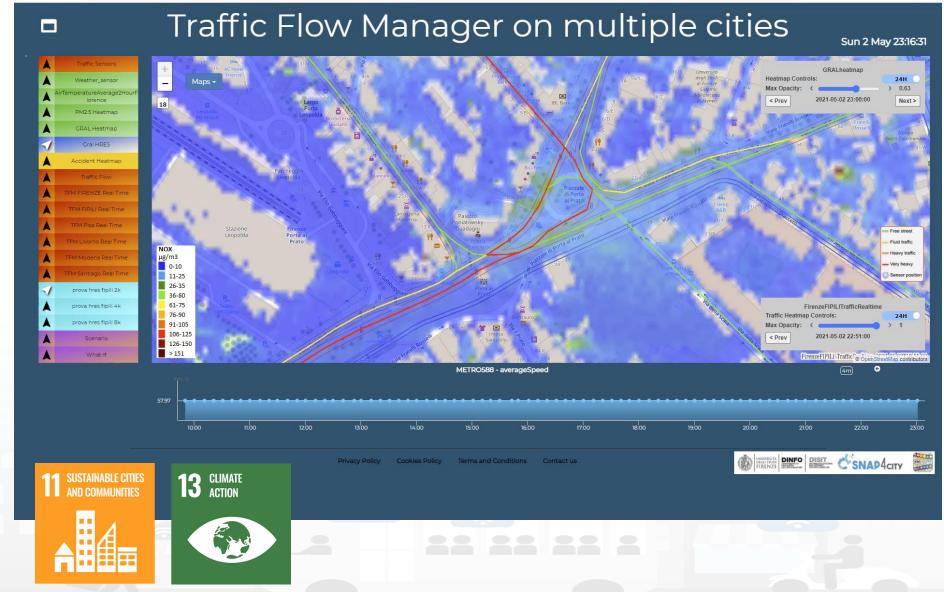


Prediction

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

Project:

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









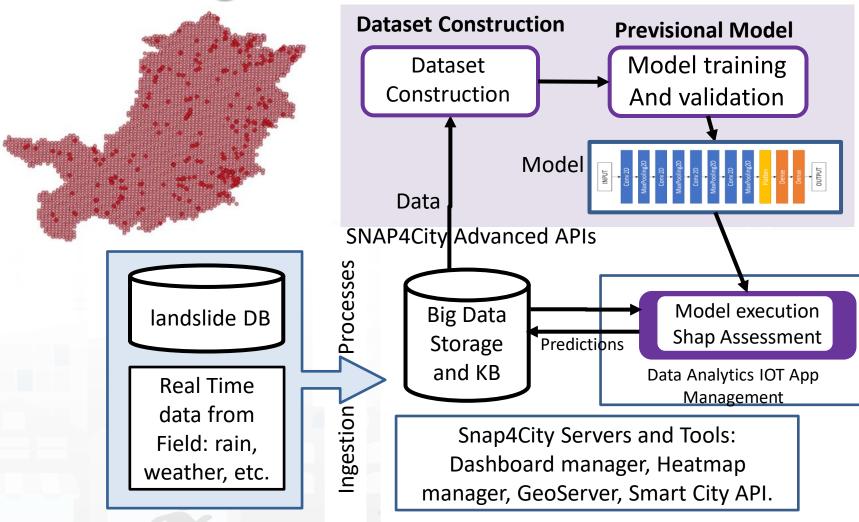


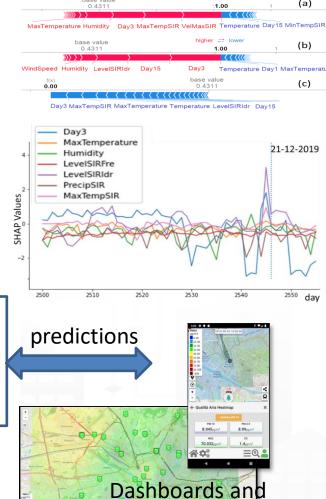






Predicting Land slides





Mobile Apps

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

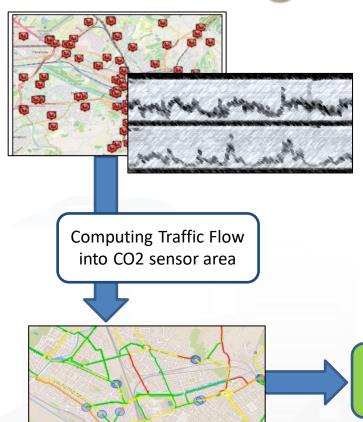








Estimating City Local CO2 from Traffic Flow Data



Traffic Flow data

 Traffic Flow is one the main source of CO2

• K1: Fluid Flow

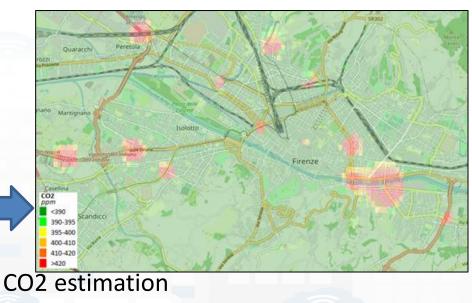
K2: Stop and Go

 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







S. Bilotta, P. Nesi, "Estimating CO2 Emissions from IoT Traffic Flow Sensors and





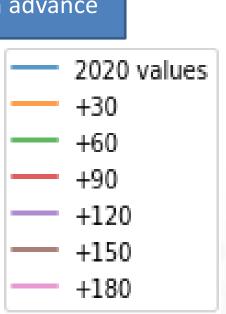




Predicting EC's KPI on NO2 months in advance

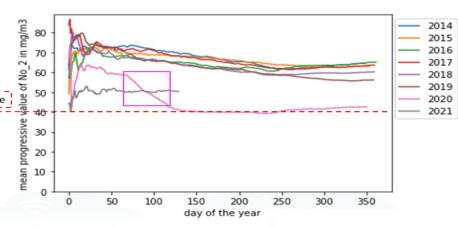
Deep Learning Long Terms Predictions of NO2 mean values, From 30 to 180 days in advance

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









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

Smart Waste – Map view



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





Search bins on map by filtering per:

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





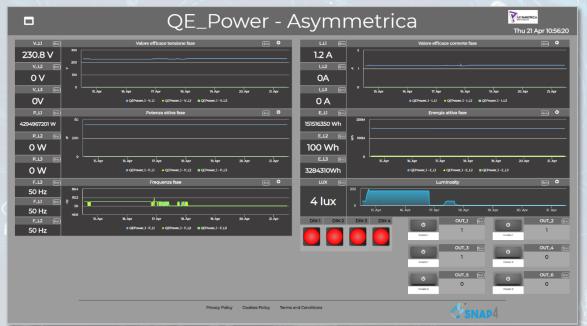
















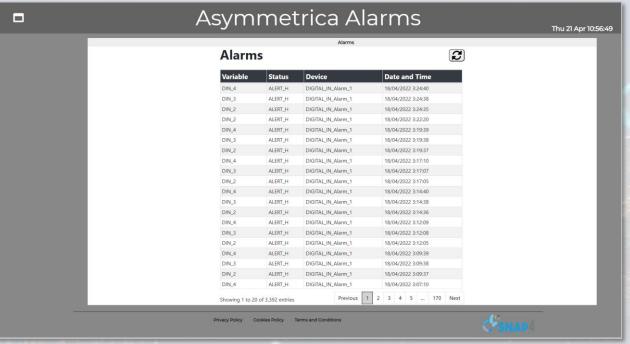








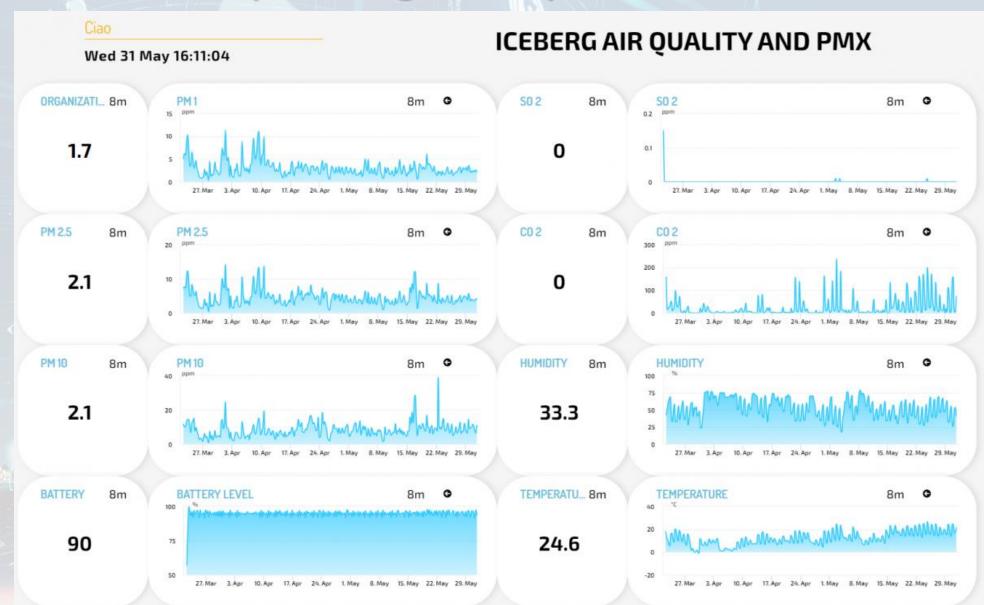
- Environmental data
- Power meter Data
- Smart Light data are coming (in collaboration with a multinational company)



Snap4City (C), November 2023

TheLab.City LivingLab by ICEBERG, Romania





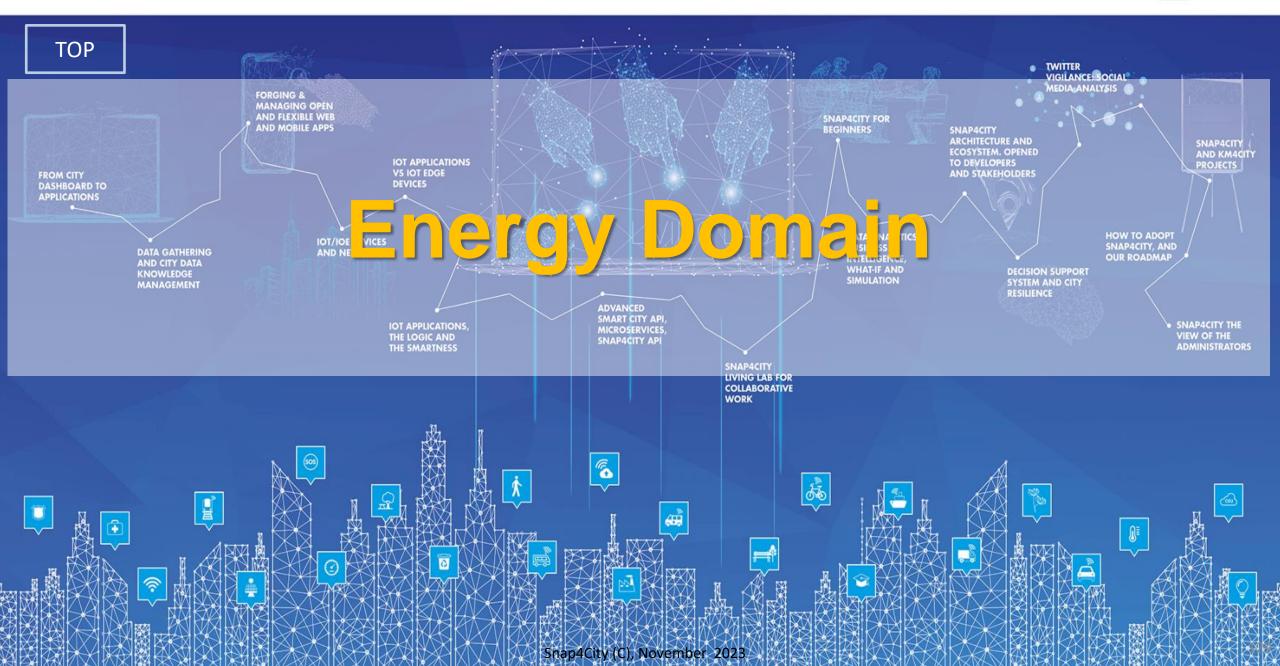
- Airquality
- Urban planning
- Parking
- Waste
- Etc.

https://thelab.city/

Snap4City (C), November 2023

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES









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 Photovoltaicc installations to identify the best parameters of size and storage
- Smart Light management, unicast and multi cast management, smart light controlled by traffic flow data
- Collecting and managing Communities of Energy
- Monitoring Energy provisioning on recharging station
- Optimization of battery life
- Computing KPI
- Etc.



Smart Light Control of CAPELON

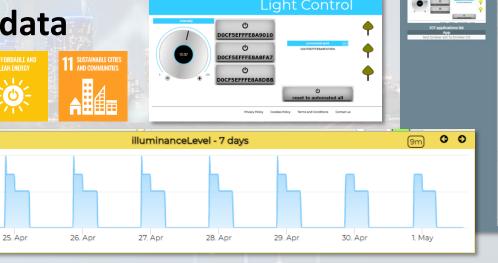


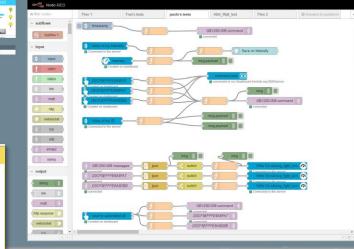


- Energy Domain
 - Smart Light, MQTT,
 - IoT Orion Broker FIWARE
- Dashboards
 - Map coverage on Sweden
 - Monitoring and real time control
 - Energy control, analytics
 - Direct control
- Historical and Real Time data
- Services Exploited on:
 - Multiple Levels, API
 - Dashboards
- Since 2020









Snap4City (C), November 2023

Karlstad Street Lights CAPELON

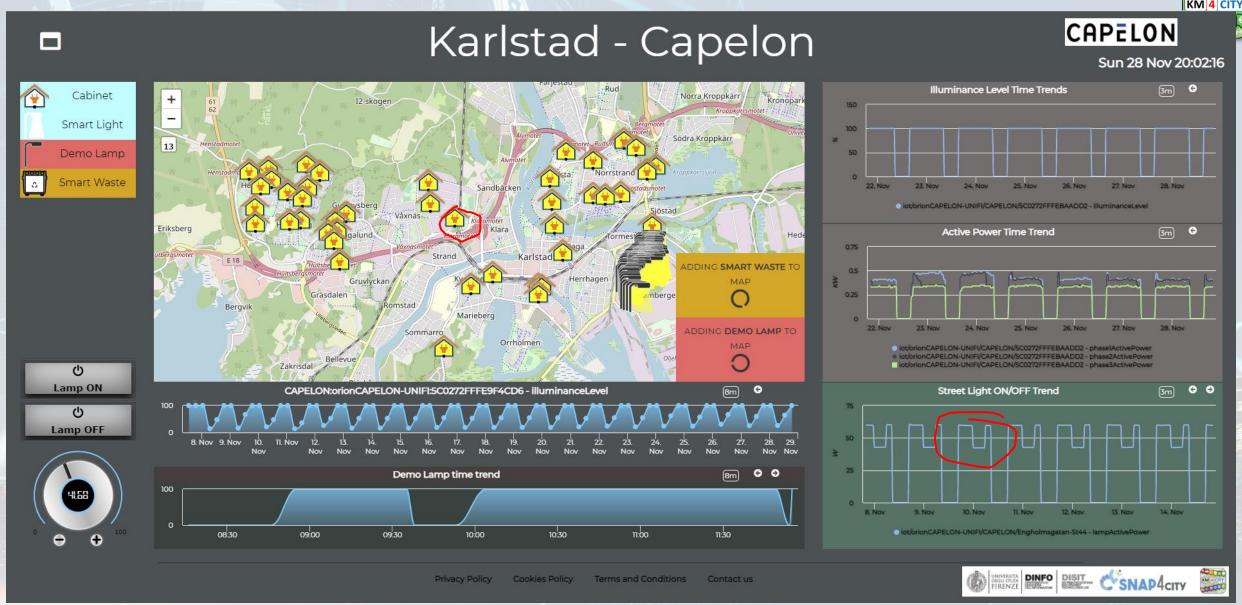
Snap4City (C), November 2023





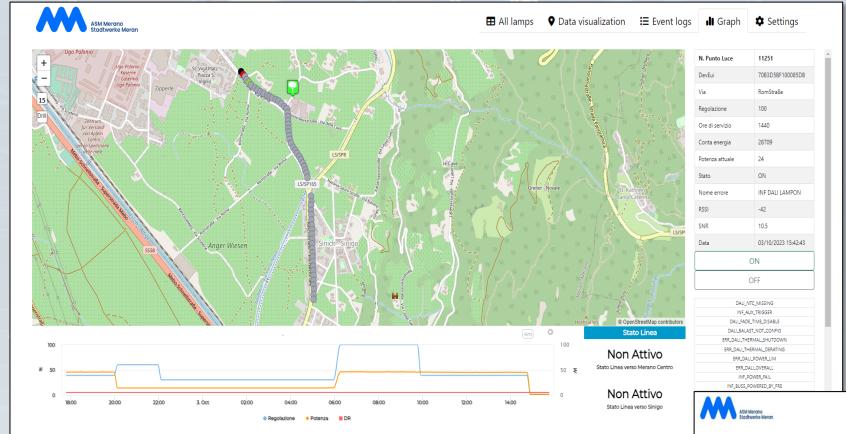






Smart Light Management in Merano





- Managing DALI 2 devices FlashNet via LoraWan
- programming SmartLight via UniCast and MultiCast

Multicast configuration

- Controlling devices
- **Automation of Smart** Light on the basis of **Traffic Flow**

https://www.snap4city.org/968



Add device to multicast



Search..

Eventi e messaggi d'errore



Show 500 **∨** entries

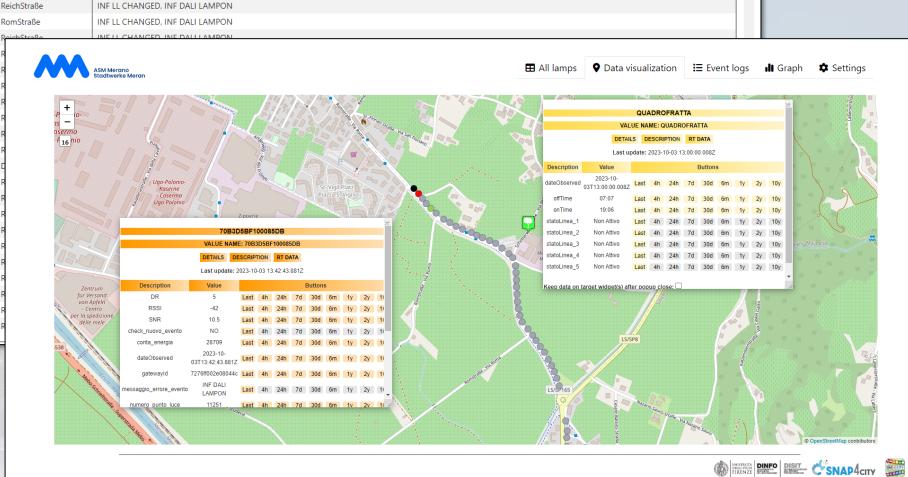
Data	A .	Numero punto luce		DevEui	Via
	▼ E	ounto Luce	X	Lorawan	
30/09/2023 23:51:59	1	1710		70B3D5BF100085E8	RomStraße
30/09/2023 23:42:28	9			70B3D5BF100085F9	RomStraße
30/09/2023 23:42:23	2	2		70B3D5BF100085ED	RomStraße
30/09/2023 23:42:22	1	1261		70B3D5BF100085E2	RomStraße
30/09/2023 23:22:38	1	0974		70B3D5BF10008610	ReichStraße
30/09/2023 23:22:35	2	8		70B3D5BF100085F7	RomStraße
30/09/2023 23:22:28	1	6421		70B3D5BF10008601	RaichStraßa
30/09/2023 23:12:34	1	6423		70B3D5BF10008603	R
30/09/2023 23:02:40	1	0968		70B3D5BF1000860A	R
30/09/2023 23:02:38	1	6427		70B3D5BF10008607	R
30/09/2023 23:02:38	1	6422		70B3D5BF10008602	R
30/09/2023 23:02:32	1	6425		70B3D5BF10008605	R
30/09/2023 23:02:31	1	7		70B3D5BF100085F0	R
30/09/2023 23:02:31	9			70B3D5BF100085F9	R
30/09/2023 23:02:26	1	6417		70B3D5BF100085FD	С
30/09/2023 23:02:26	1	6426		70B3D5BF10008606	R
30/09/2023 23:02:25	1	1352		70B3D5BF100085DA	R
30/09/2023 23:02:25	2	0		70B3D5BF100085EB	R
30/09/2023 23:02:13	2	9		70B3D5BF100085F5	R
30/09/2023 22:52:36	2	8		70B3D5BF100085F7	R
30/09/2023 22:52:34	1	0313		70B3D5BF100085FB	R
30/09/2023 22:42:31	1	6421		70B3D5BF10008601	R
30/09/2023 22:42:27	1	6416		70B3D5BF100085FC	R
30/09/2023 22:42:26	1	1261		70B3D5BF100085E2	R
30/09/2023 22:42:20	1	0972		70B3D5BF1000860D	R

Via

INF LL CHANGED, INF DALI LAMPON

INF LL CHANGED, INF DALI LAMPON

INF LL CHANGED, INF DALI LAMPON INF LL CHANGED, INF DALI LAMPON



Snap4City (C), November 2023



no impianto





- impianto + hatteria 2 4 kWh

🛕 - impianto + batteria 10 kWh

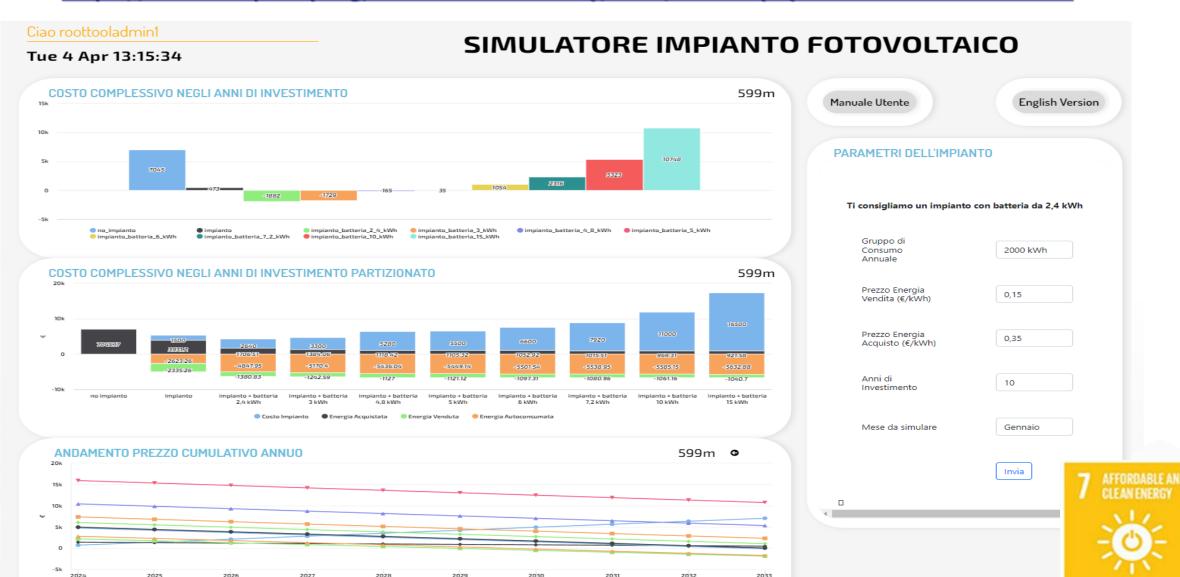
- impianto + batteria 7,2 kWh

A - impianto + hatteria 3 kWh

▼ - impianto + batteria 15 kWh













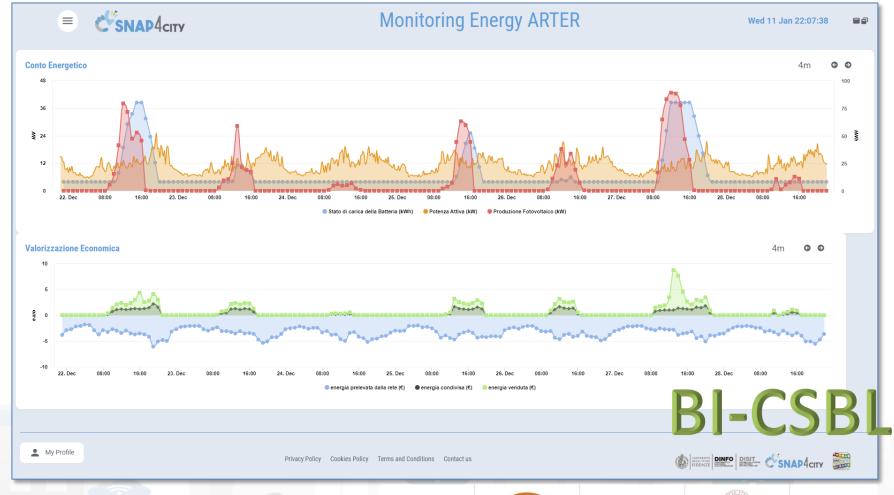








- Field-tested energy community: the selfconsumer condominium
- The Self User project creates in the pilot condominium, through the collection and analysis of data, a model for calculating and enhancing the impact of an energy community on a community of people, with a view to actions to combat energy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









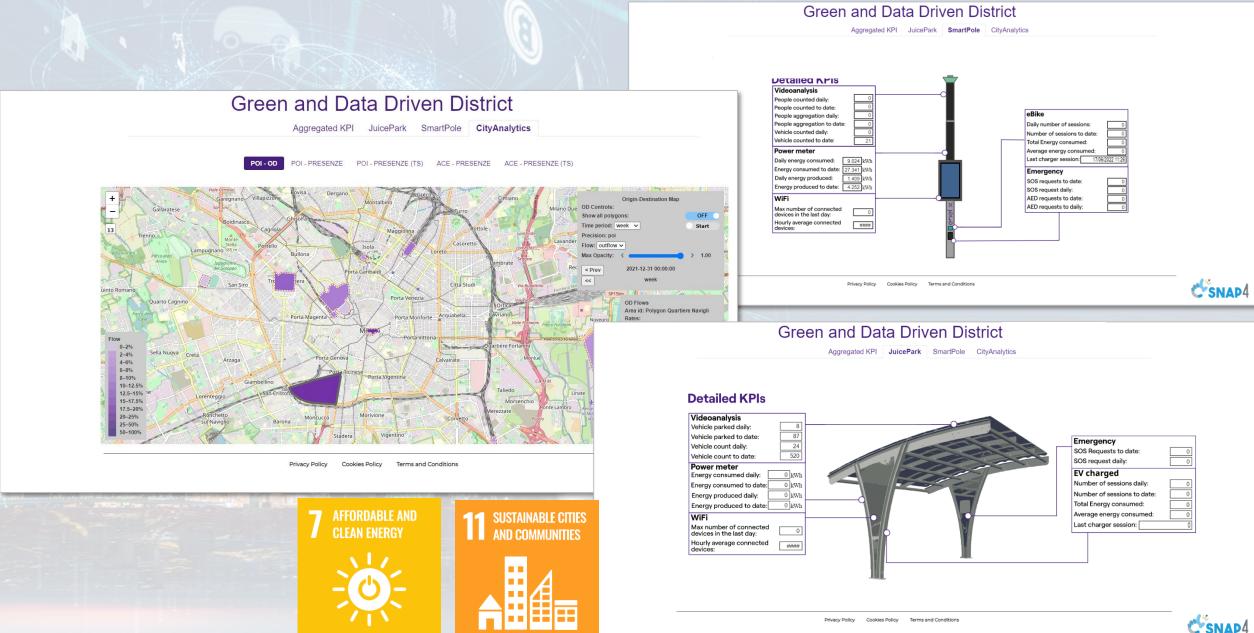




enel x

Energy monitoring and business intelligence







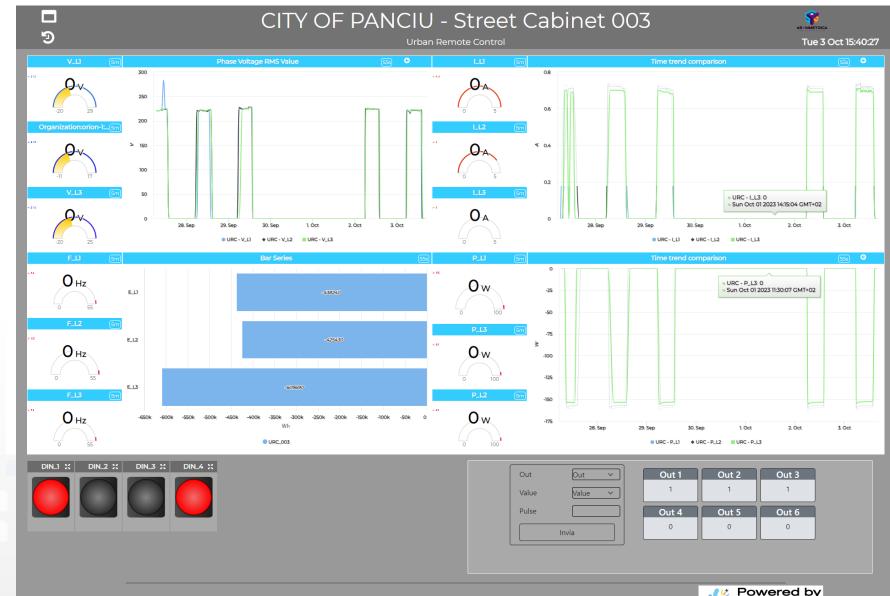






City of Panciu in Romania

By
Asymmetrica
and Snap4



SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES













Smart Buildings, Snap4Building

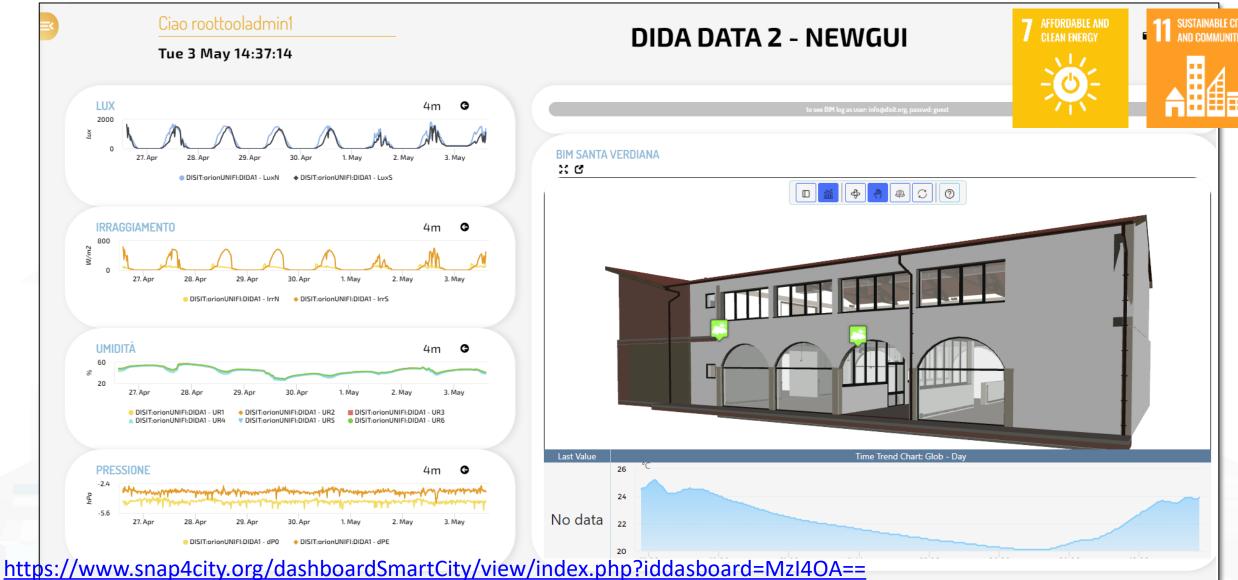
- Digital Twin for monitor, control and manage distributed infrastructures
 - 2D/3D representations of the whole set of buildings, BIM modeling
 - Entities (building, floors, rooms, parking, charging stations, gates, etc.) with their shapes and descriptors, and data monitoring the allocation to office, 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















Objectives of the Snap4ISPRA POC

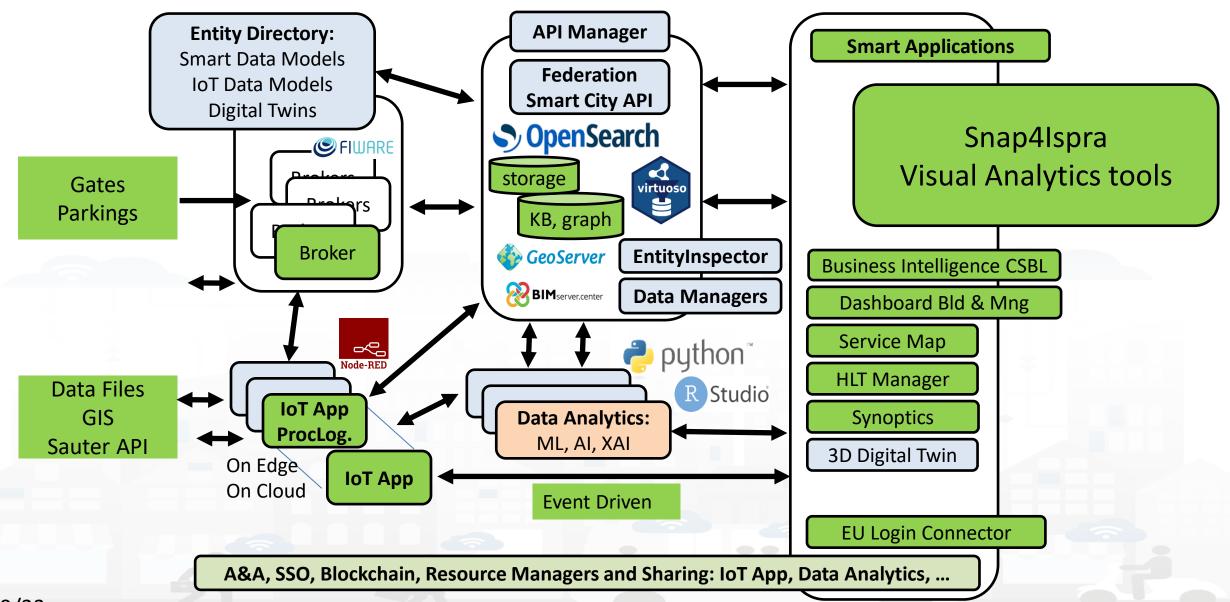
- Set up a Snap4Ispra demonstration to:
 - Enable the analysis at level of building, floors/zones for Zones'
 Occupancy vs Energy consumption
 - Enable the analysis of parking areas
 - Conformance with EU Login
 - Exploiting heterogenous data coming from multiple sources





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



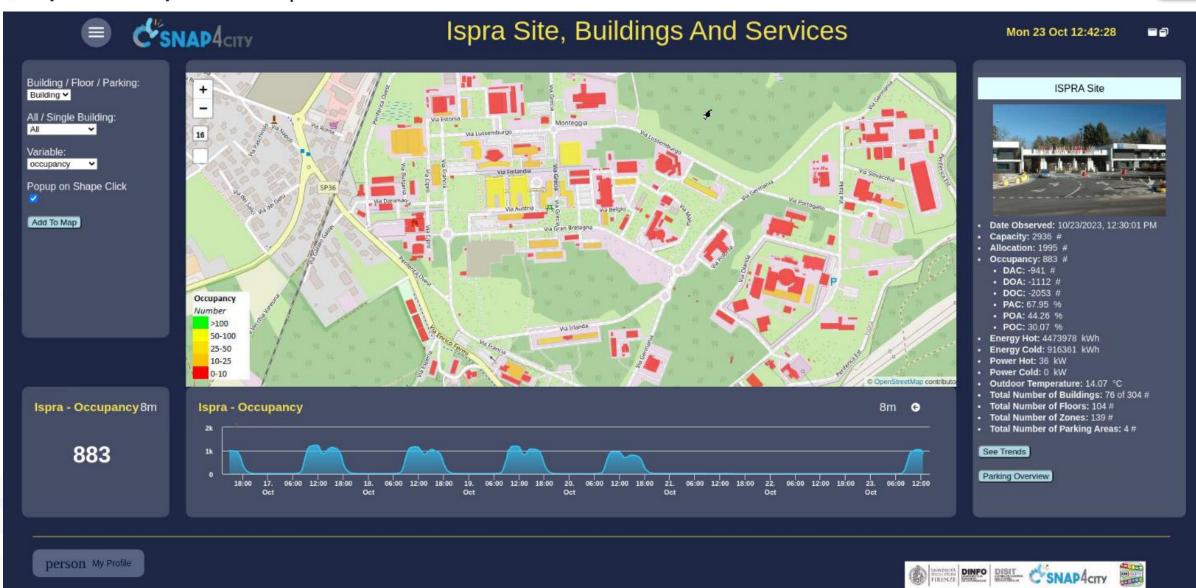














Building 27B Trends









Floor Details



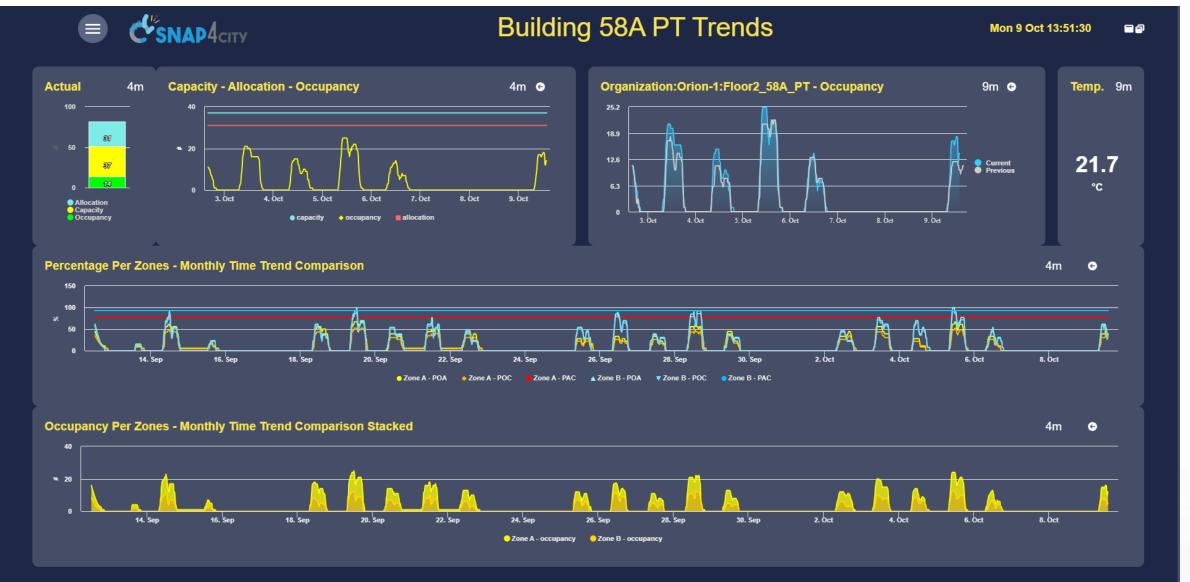










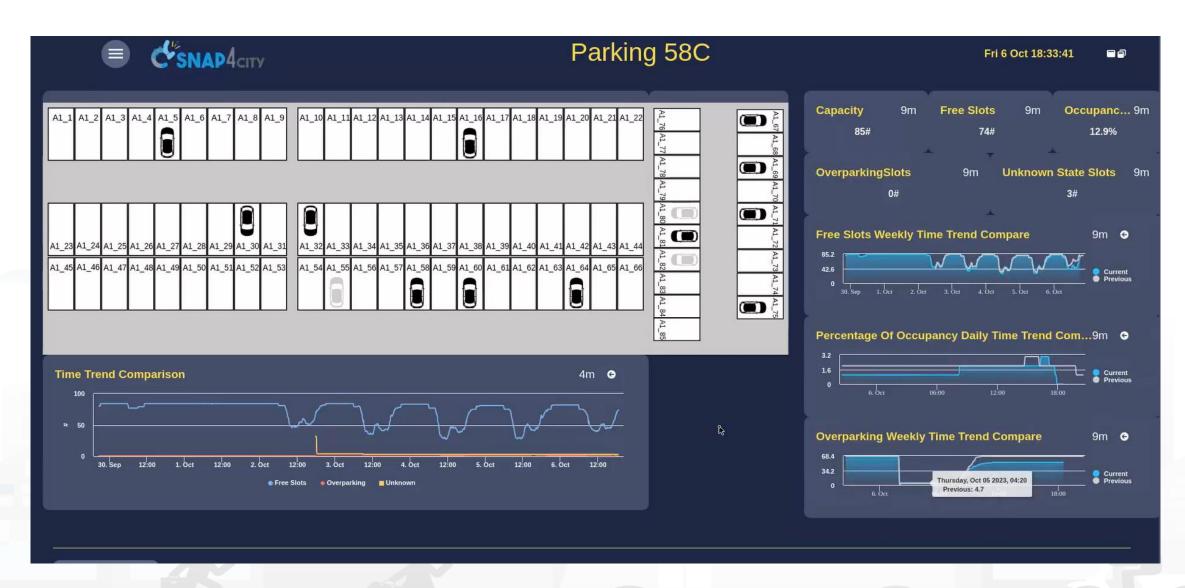






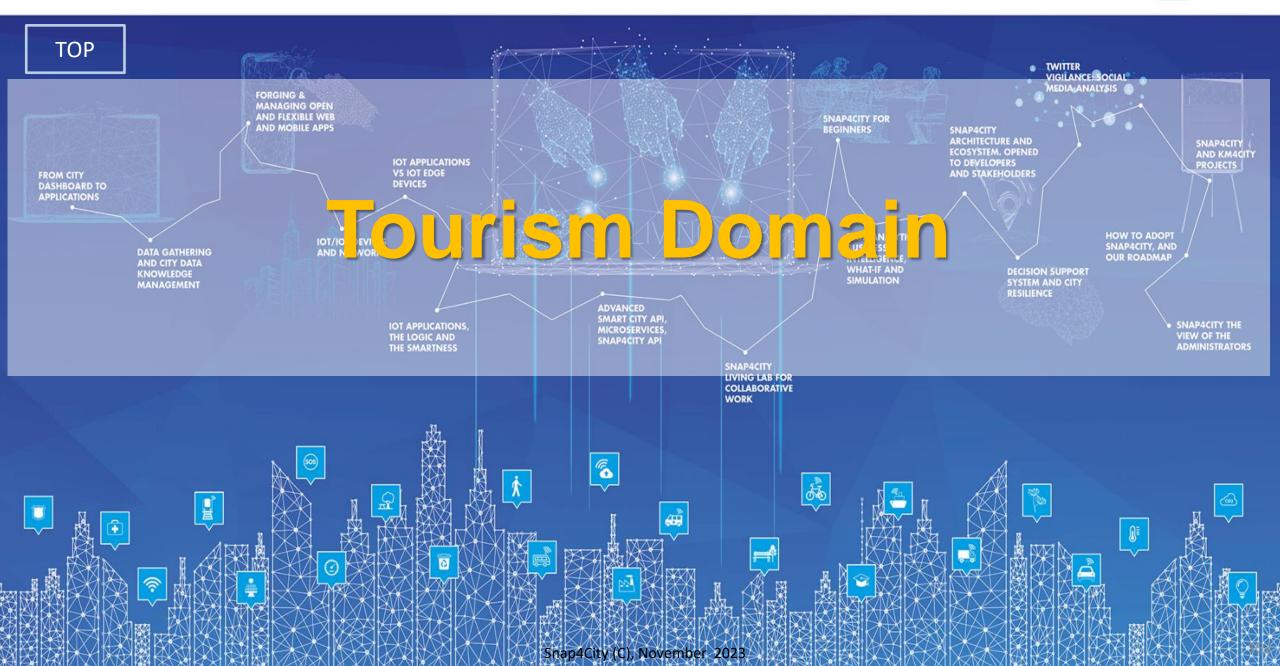






SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES



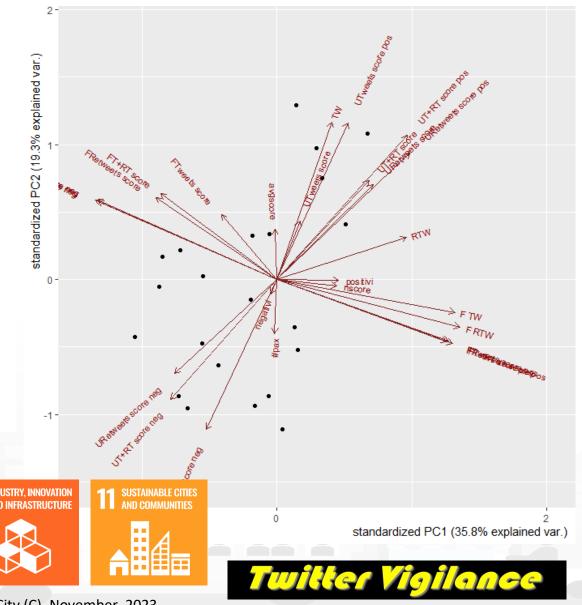




Reputation



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



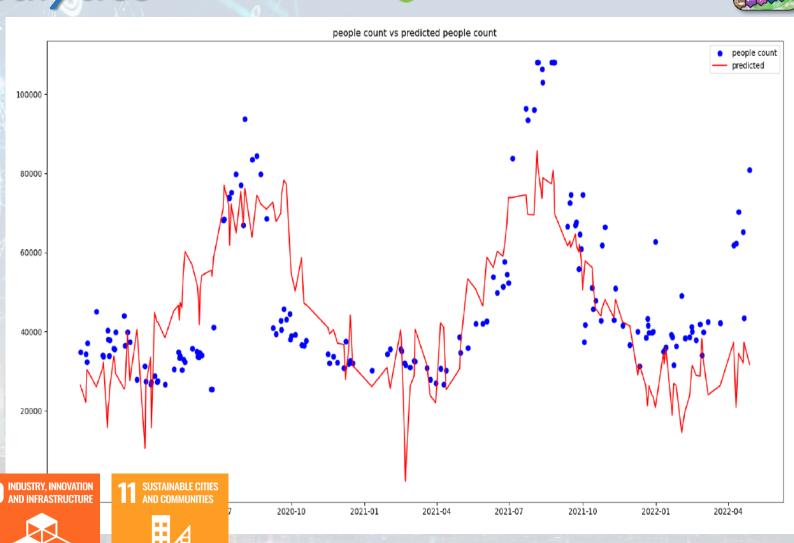
Dubrovnik: Data Analytics





- Assessing impact of advertising
- Prediction of presences on the basis of
 - Social Media Twitter
 Vigilance
 - weather conditions
 - Historical data







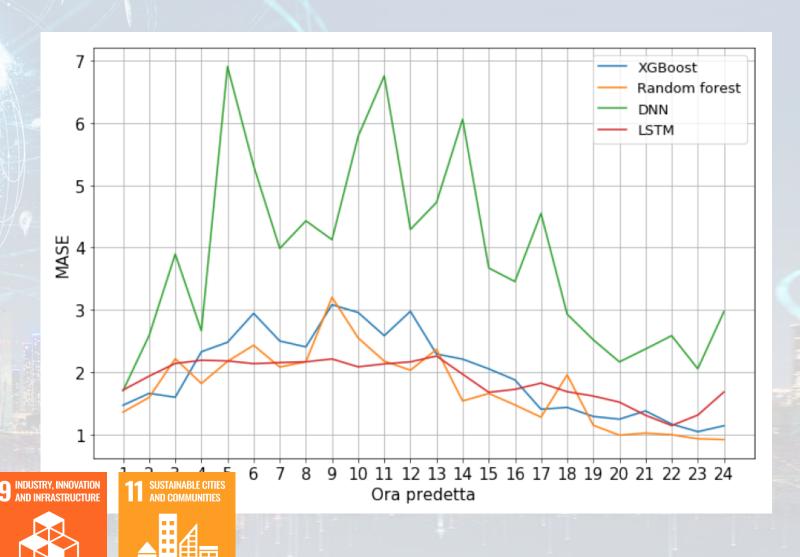


Pont du Gard: data analytics

 Prediction of the number of sold tickets
 24 hours in advance

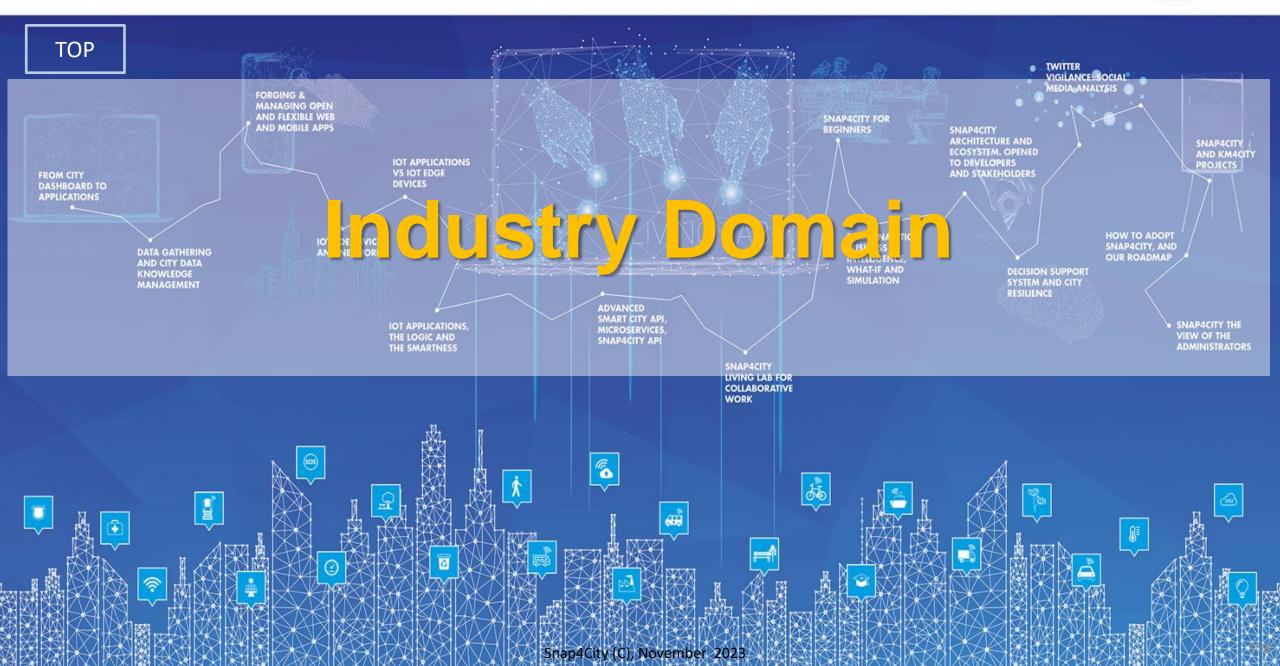
- Using:
 - Historical data
 - Weather conditions
 - Social Media

Twitter Vigilance



SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES







Industry Plant Supervision and Maintenance









Aims

- Control Room: Higher level supervision and monitoring (since 2020)
 - Management of Production Plan Öptimization
 - Control of Perimeter with drone and sensors
- Maintenance ticketing (since 2017)
 - predictive (in development)
 - 3D Digital Twin (in development)
- Monitoring production process quality
 - Alerting
 - Decision making

Snap4Altair Decision Support supervision and control, Industry 4.0





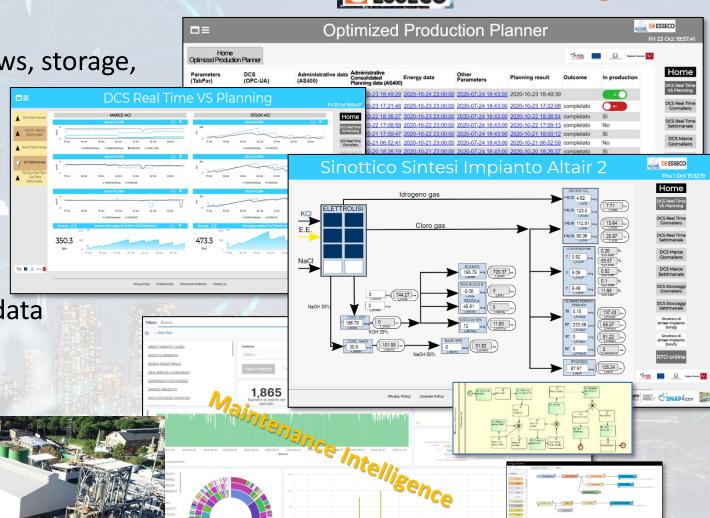


Multiple Domain Data

• Distributed Control System: energy, flows, storage,

chemical data, settings, ...

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



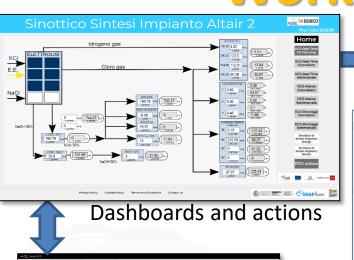




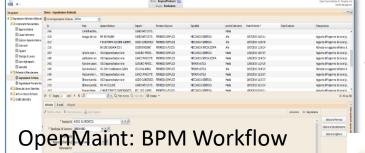




Workflow for Ticket management

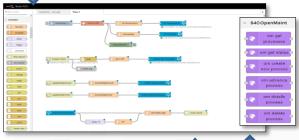




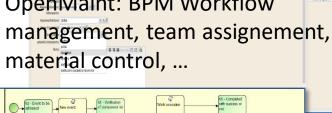


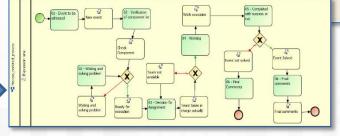
Events/actions

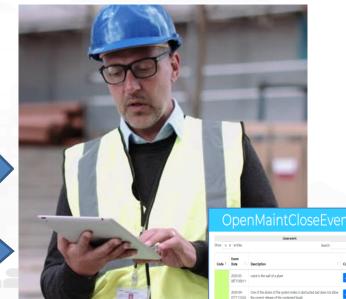




IOT App, Data event firing, event detection and firing Critical event management





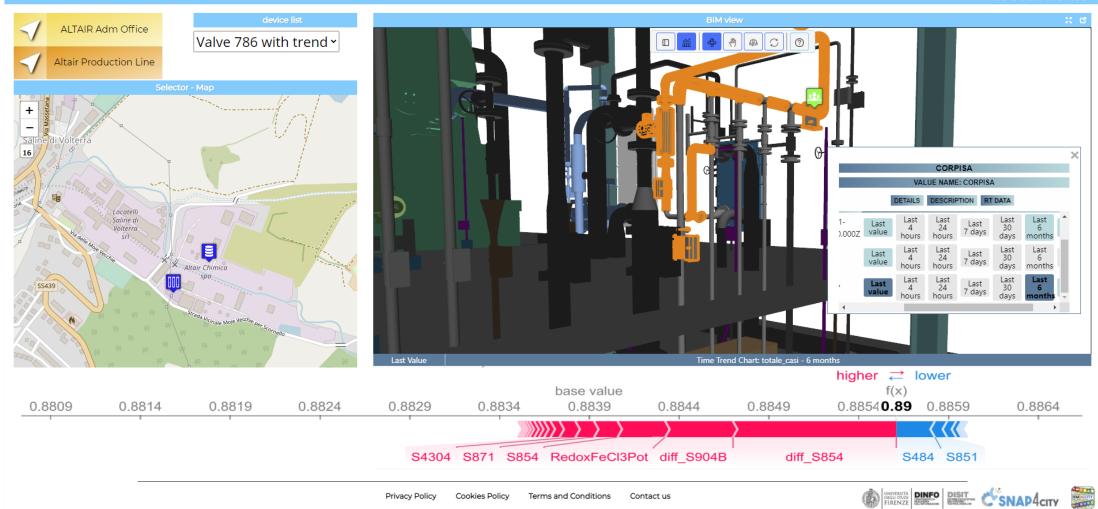


Digital Twin Local, 3D vs Real Time Data



BIM Integration for Digital Twin

Tue 8 Jun 11:04:55













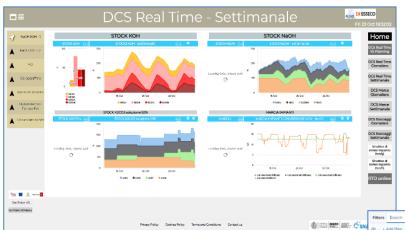




Closing the loop



BIM Integration for Digital Twin

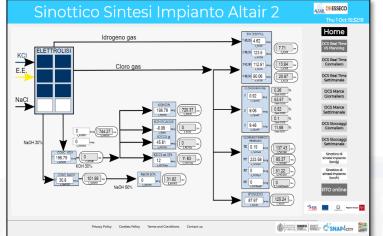


Map and 3D BIM modelling to:

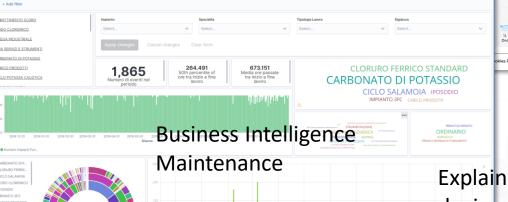
- -- represent the details
- -- associate physical elements with data

Historical and Real Time Data

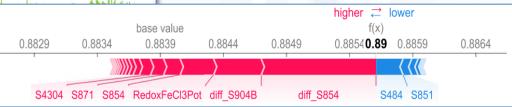
Synoptics for real time monitoring



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



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



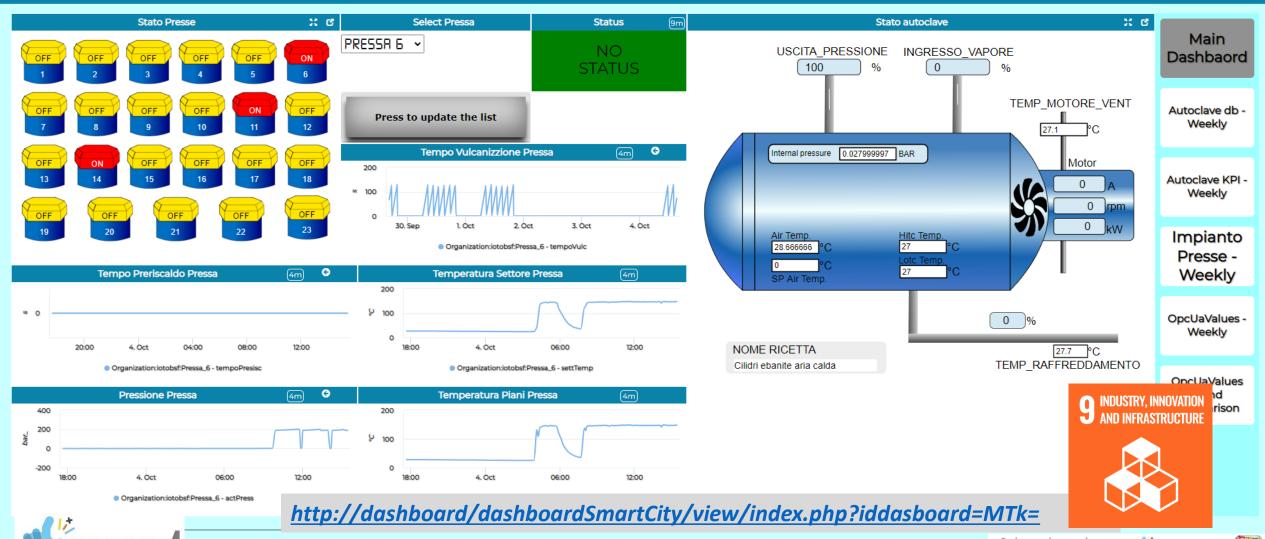


Sinottico Impianto

Sinottico Impianto Presse - Autoclave



Mon 4 Oct 15:34:59



Terms and Conditions

Snap4City (C), November 2023

Privacy Policy

Cookies Policy



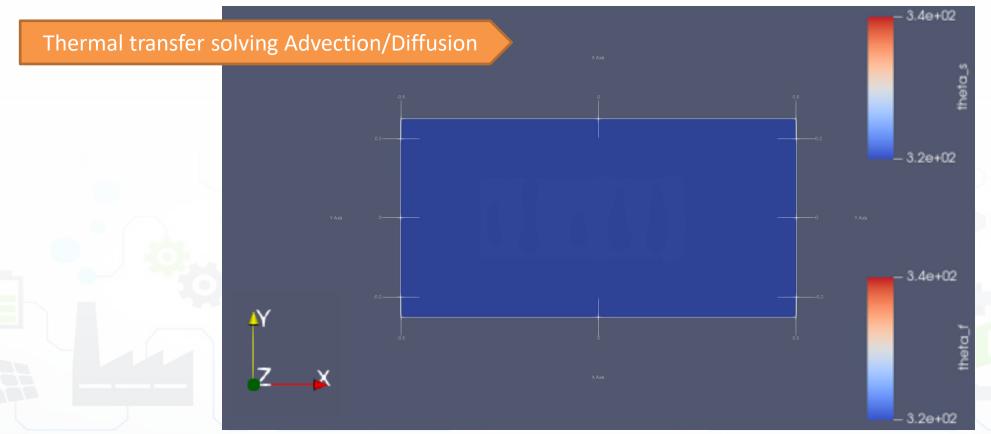






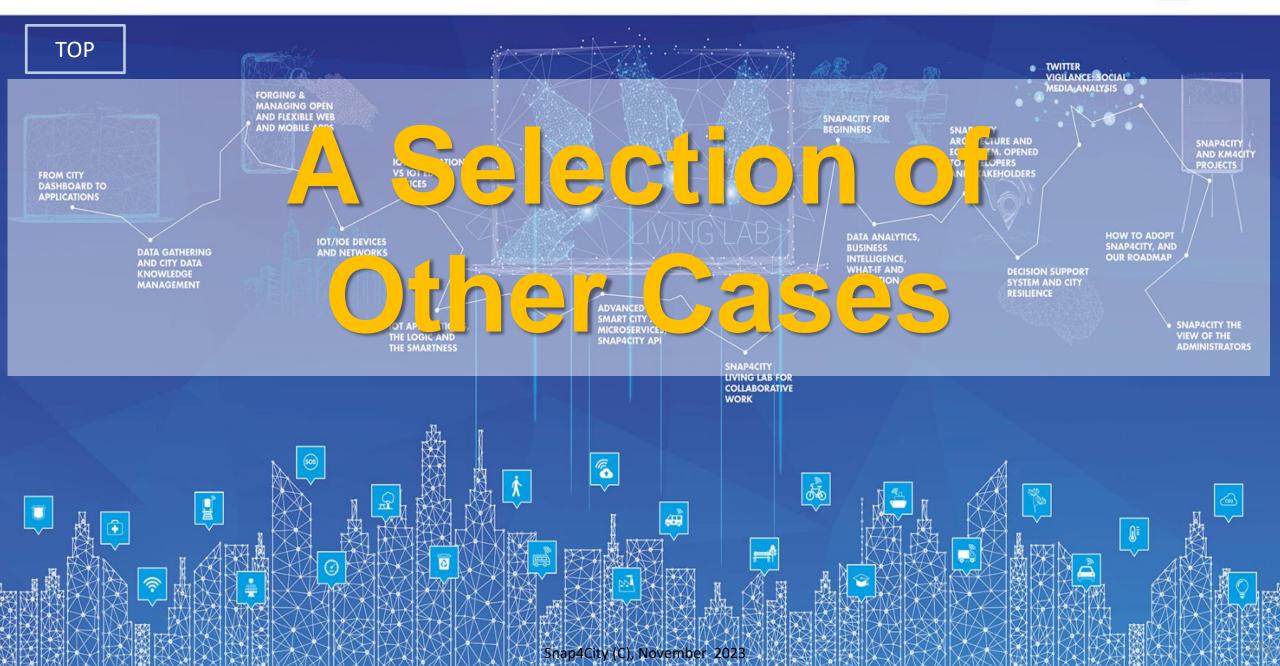
Physics-informed neural networks (PINN)

Solve complex fluid-dynamic problems based on **partial differential equation (PDE)** using neural networks



SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES













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





Scenarious

- 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
- <u>Data Analytic: Analyzing Public</u>
 <u>Transportation Offer wrt Mobility Demand</u>

People Monitoring on Pub Services **DIGIPOLIS Antwerp**





- Multiple Domain Data
 - PAX Counters: museum, pub services, COVID-19
- Multiple Levels & Decision Makers
 - **Business Intelligence Dashboards**
 - · People flow, OD flows
 - Detection of critical conditions
- Historical and Real Time data
 - 20 fixed PaxCounters
 - 2 Mobile PaxCounters
- Services Exploited on:
 - Dashboards, Mobile Apps, API/data
 - Fully Controlled Devices by Digipolis
- Since 2019





Valencia, FSMLR

Tourism Domain

- Counting People
- Environmental data
- Social Media

Dashboards

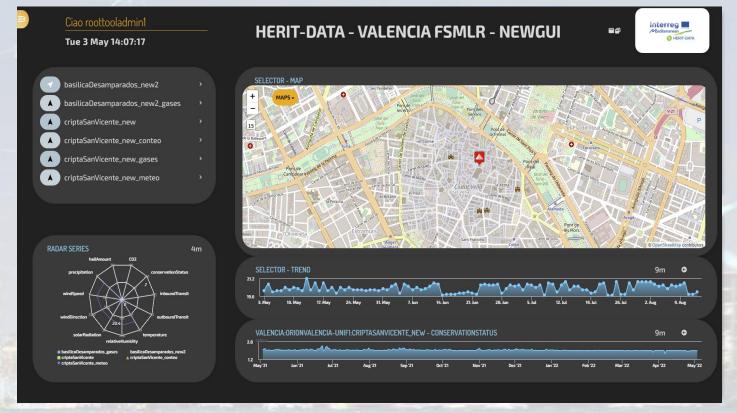
- Monitoring and real time control
- People flow
- Twitter Vigilance
- Historical and Real Time data
- Services Exploited on:
 - Dashboard
- Since 2020











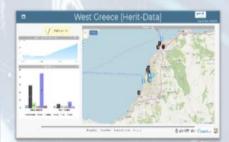
West Greece

Tourism Domain

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

Dashboards

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



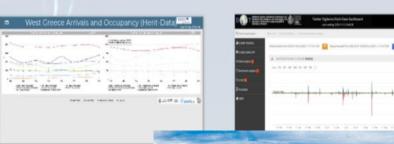












Interreg **M**editerranear

HERIT-DATA





Helsinki, Finland

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



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

Snap4City (C), November 2023





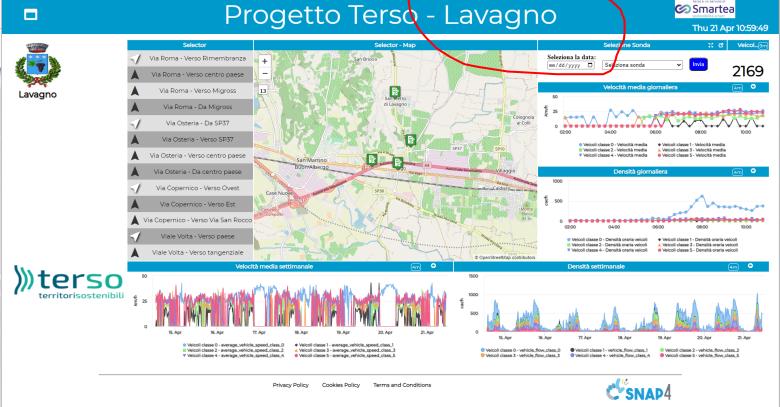








- Traffic Data
- Environmental Data
- People counting (pedestrian)



Snap4City (C), November 2023

Jewel Alarms **AMPERE**





세 역 제 68%을



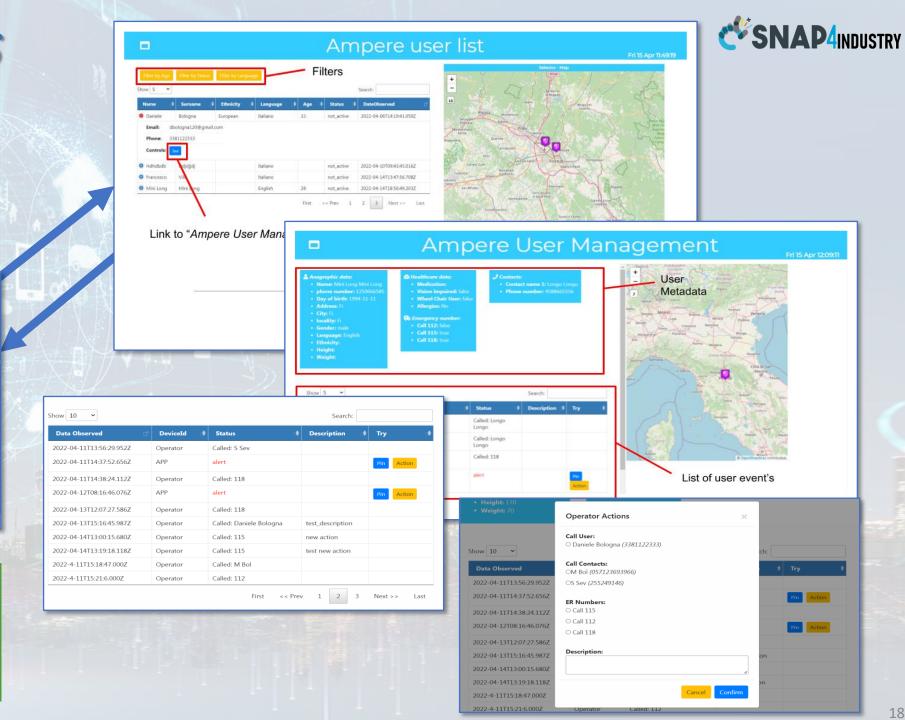






Click on Jewel





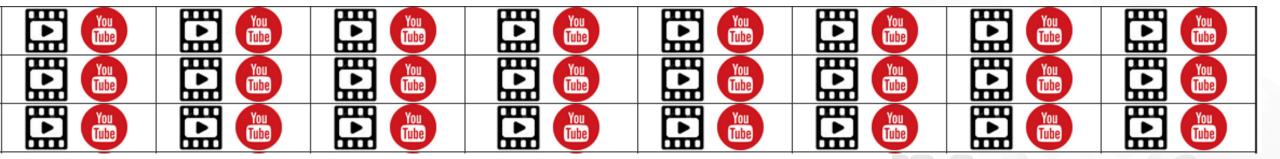
https://www.snap4city.org/944

On Line Training Material (free of charge)





2nd part	3rd part	4th part	5th part	6th part	7th part	8th
Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App	Design and Develop Smart Solutions
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	Dashboards CSNAMor CARLES AND CONTROL OF THE PARTY OF TH	Dashboards IOT App, IOT Network Canapage Canapage	Dashboards IOT App, IOT Network Data Analytics Canapage Canap	Dashboards IOT App, IOT Network Data Analytics Data Ingestion processes Data Ingestion processes Data Ingestion processes	Dashboards IOT App, IOT Network Data Analytics Data Ingestion processes Install Data In	Dashboards IOT App, IOT Network Data Analytics Data Ingestion processes System and Deploy Install Web & Mob. App Shandor Service



SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES







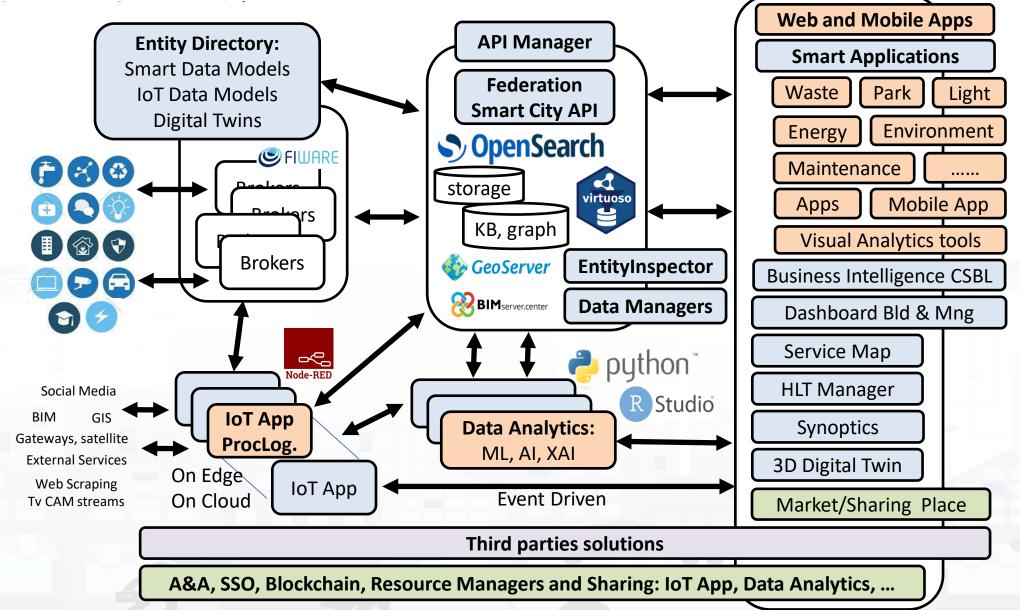
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Agenda of second part

- Recall on Snap4City Architecture
- Snap4City Dashboards Purposes and Uses
 - Snap4City Dashboards vs Technical data monitoring dashboards
 - Snap4City Dashboards main concepts
- Main Data Kinds: data vs representations
- Snap4City DASHBOARDS: Main Concepts and simple Widgets
- Creating a Snap4City Dashboard
- Snap4City Multi Data Map Widget
- Snap4City High Level Types
 - Video Streams from TV Cameras
 - External Services (integration of) your or third party web pages
 - Synoptics, Custom Widgets as External Services
- Selector for the Multi Data Map Widget
- Data Inspector vs Data Processes Details
- **Dashboard Management**
- **Training Material**

https://www.snap4city.org/



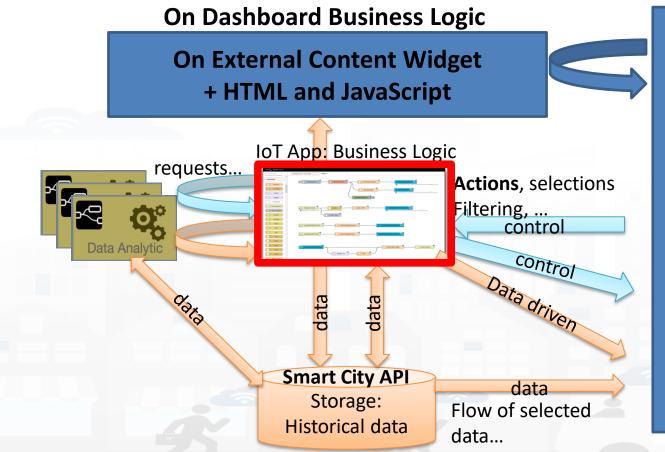


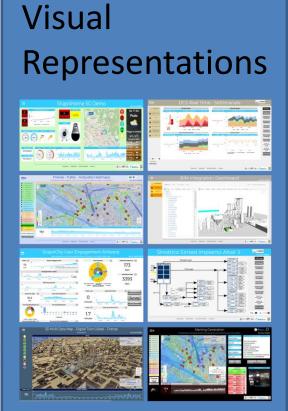


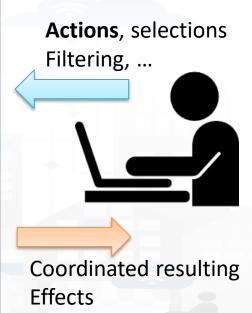




- implementing sophisticated **Business Intelligence Tools**
- Open to receive a range of possible Actions, to produce a large combination of results in terms of data and representations.













Dashboard Builder: Development

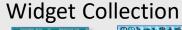


IOT Applications



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











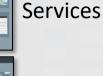
External

Custom

Widgets/

Synoptics





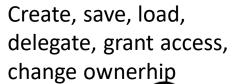




Dashboard Wizard









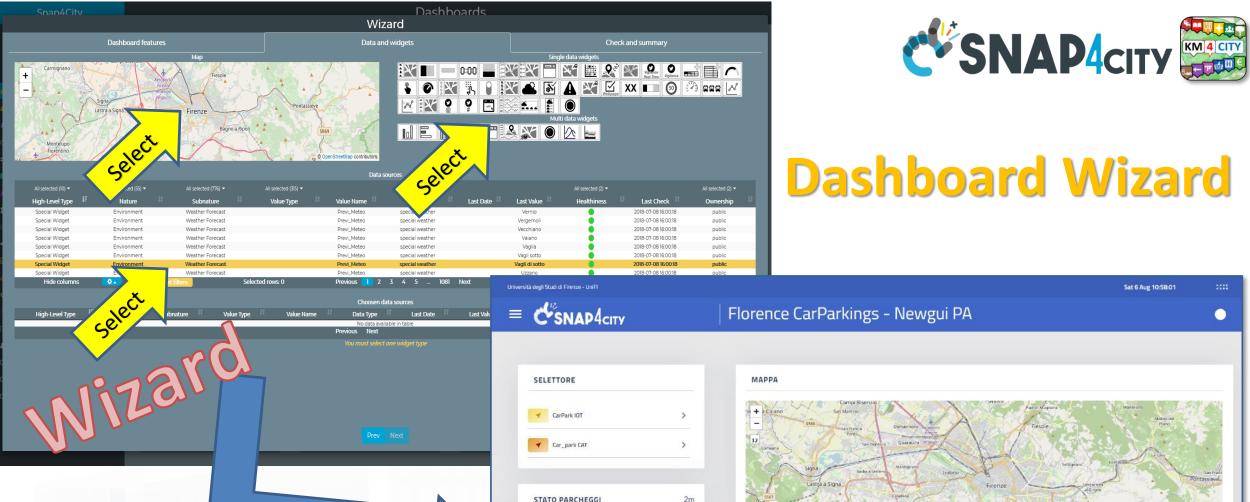




Dashboard

Collection

My Own Dash/App



The Wizard help you in selecting only possible combination of data vs graphic representation

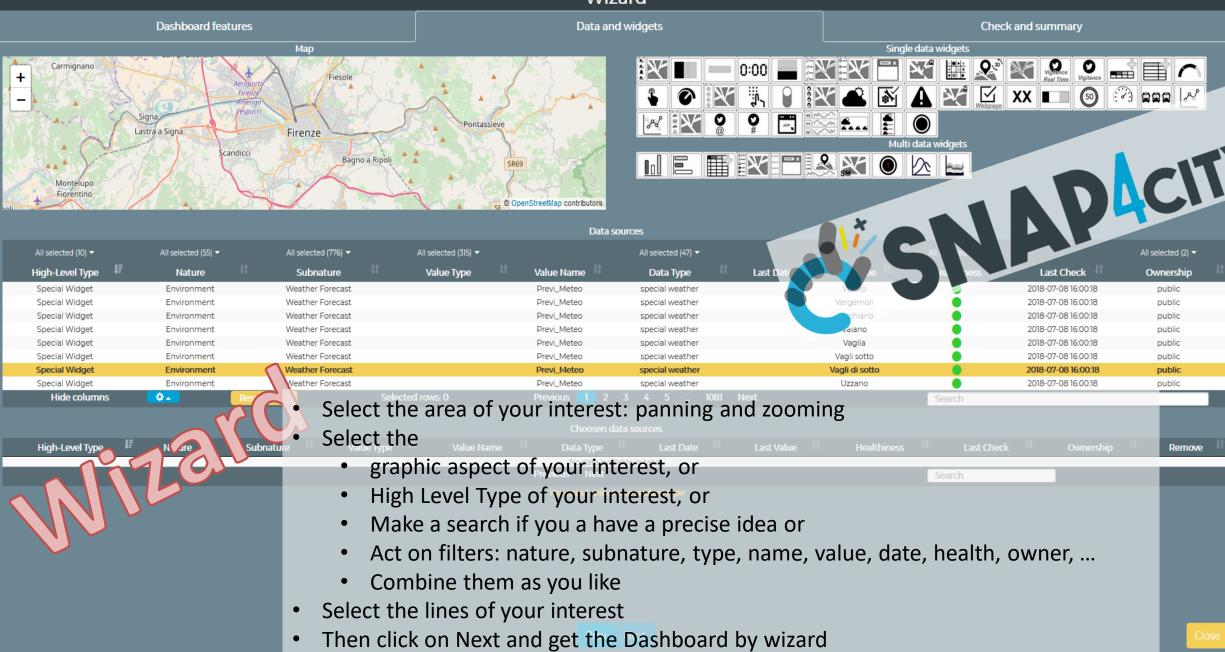
StazioneFirenzeS.M.I

@ Careggi

Snap4City

Wizard

Dashboards







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Dashboard Widgets: List and Editor



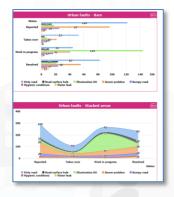


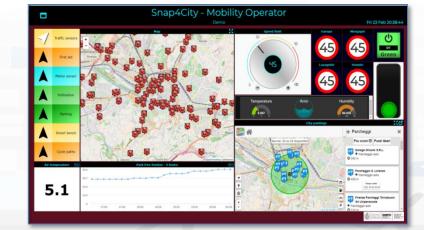












Test 1



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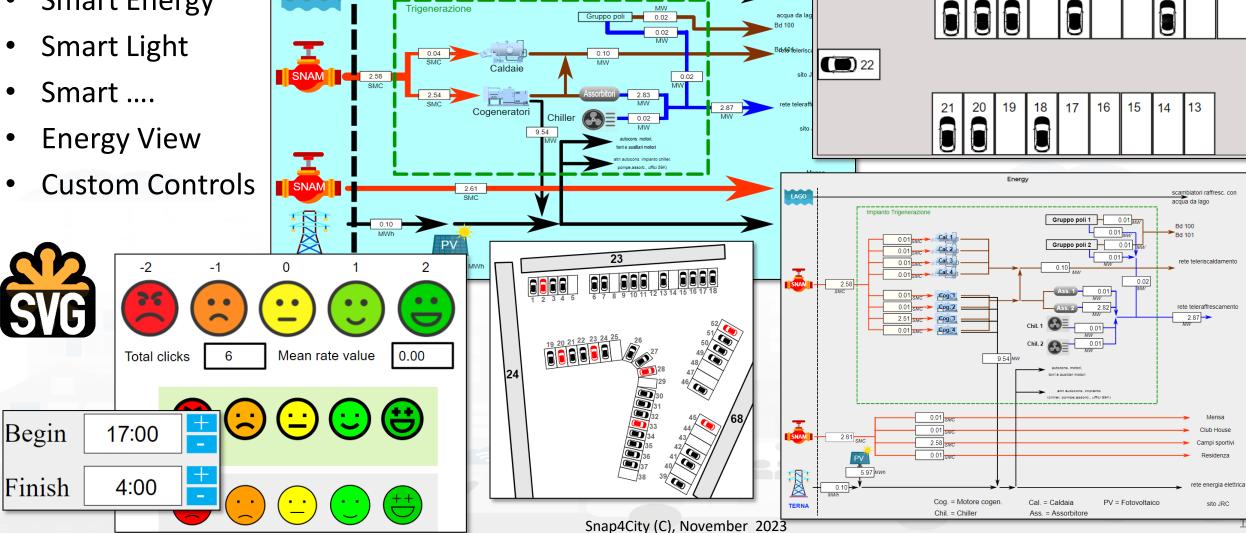
LAGO



Smart parking

- **Smart Energy**

Special Custom Widgets



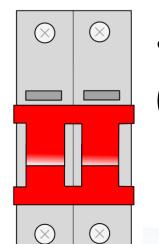










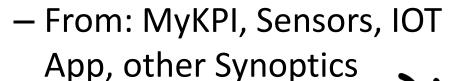


Virtual Actuators (sensor-actuator)

- From: Dashboard

To: IOT App, MyKPI, other Synoptics

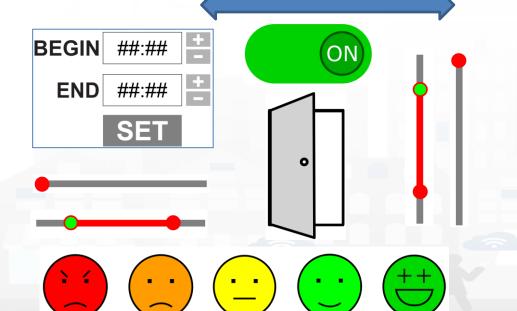


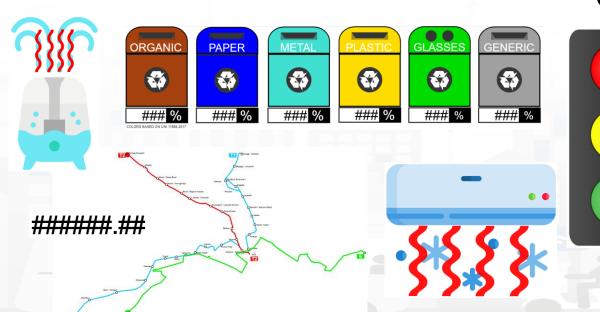


– To: Dashboards











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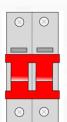




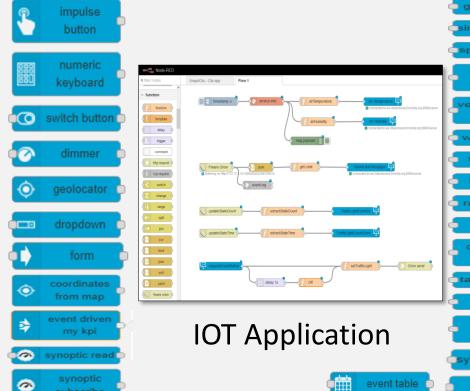




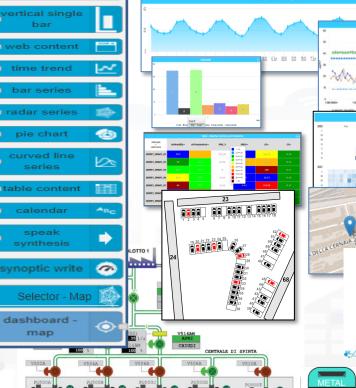








Snap4D3















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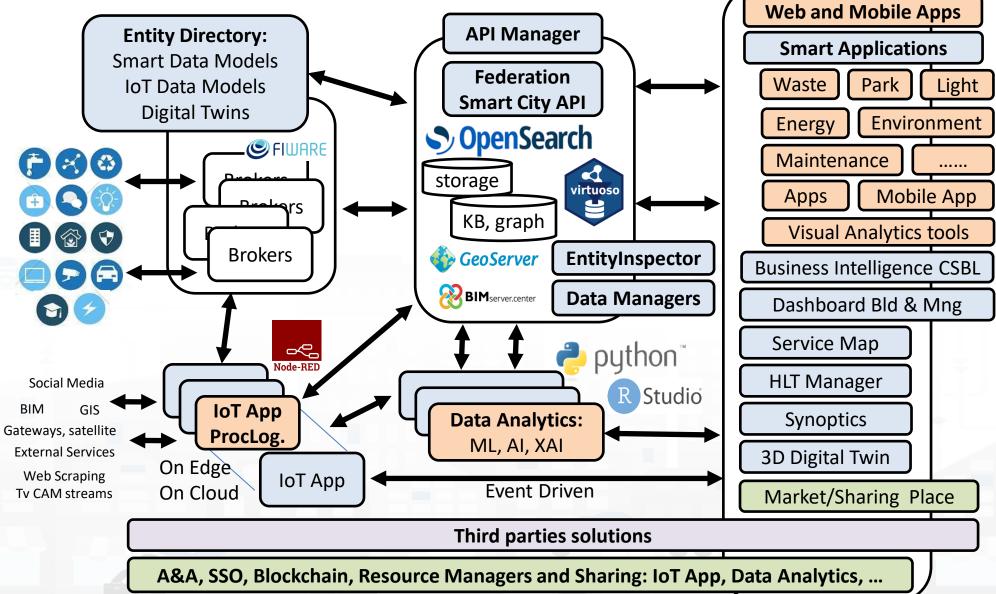
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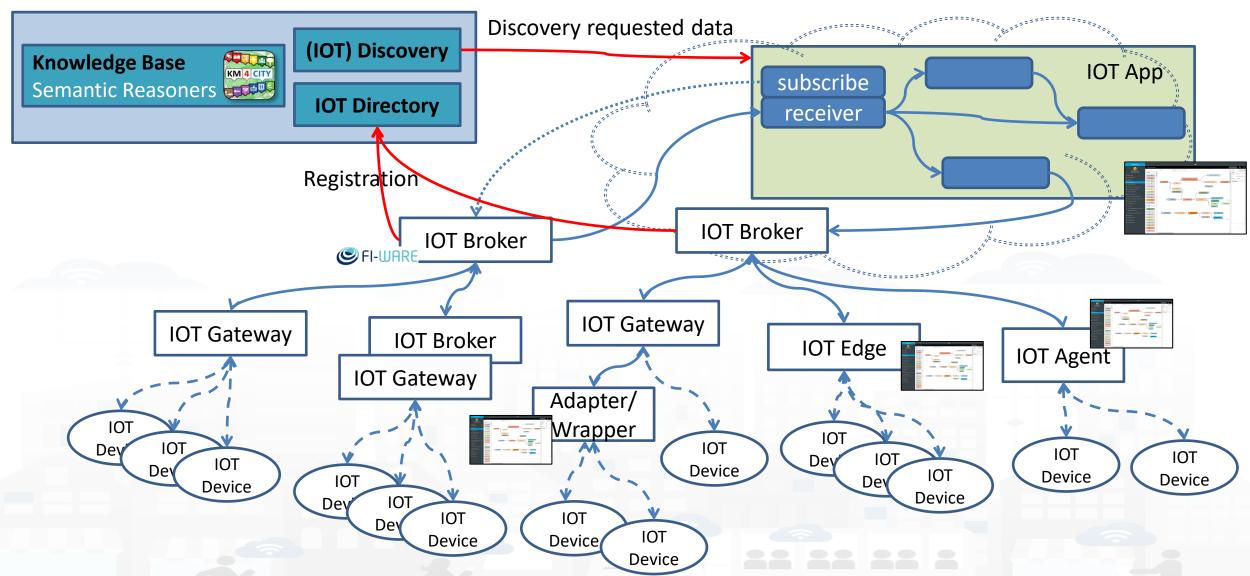






IoT Network





Ingestion, aggreg. > exploitation

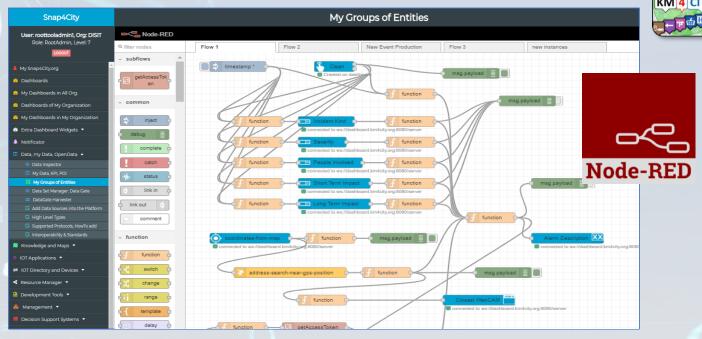


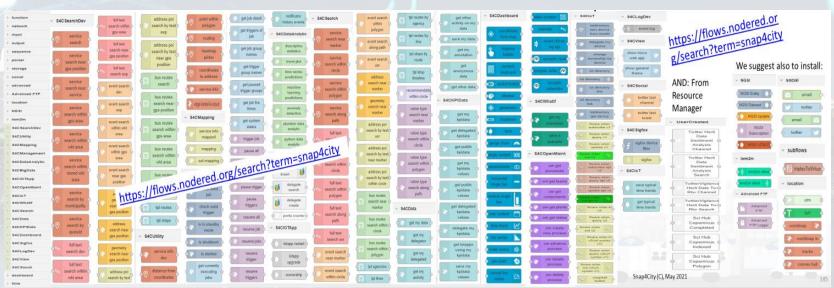






- IoT App Visual Programming, no coding
 - Data transformation
 - Integration, Interoperab.
 - Scripting Data Analytics
 - Data ingestion
 - Business logic
- Edge and Cloud
- MicroServices data driven develop via visual language Node-RED









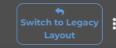




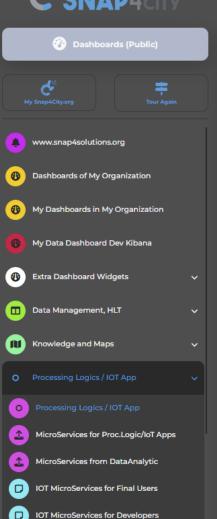
SNAP4CITY

Proc.Logic / IoT App

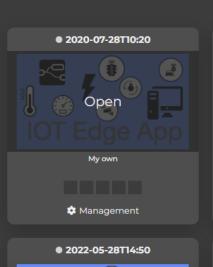




• CREATE NEW



DOC: Processing Logic/IOT App



My own

Management



● 2020-07-28T12:32

My own



Prev 1 2 3 Next





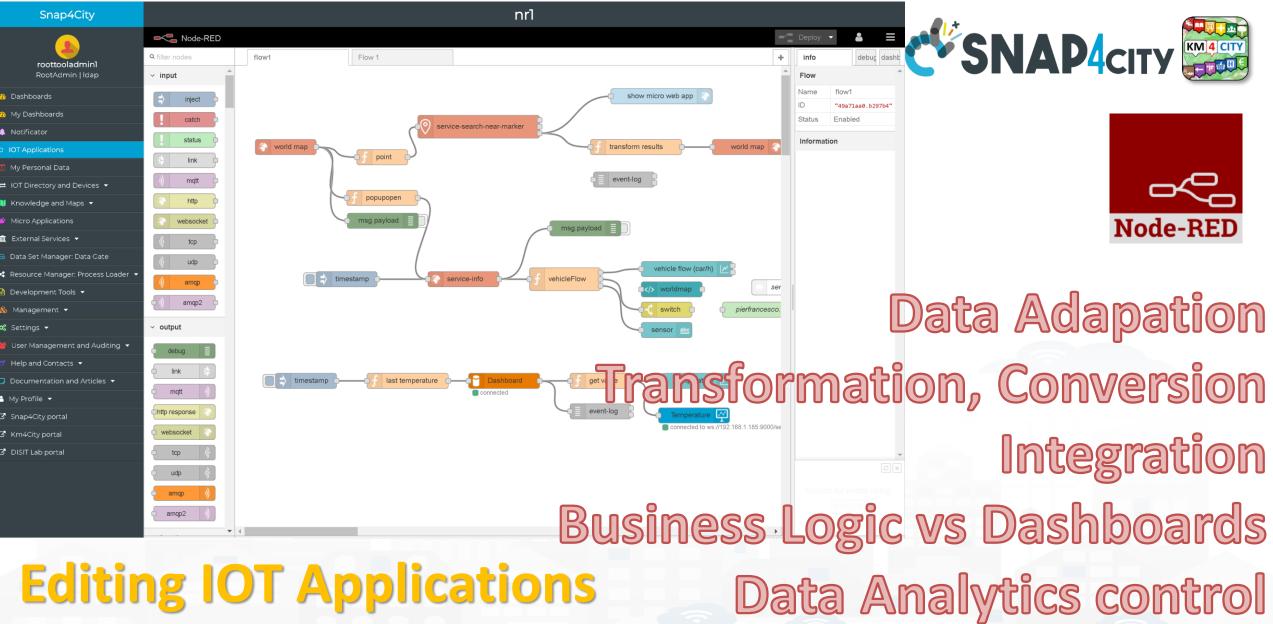
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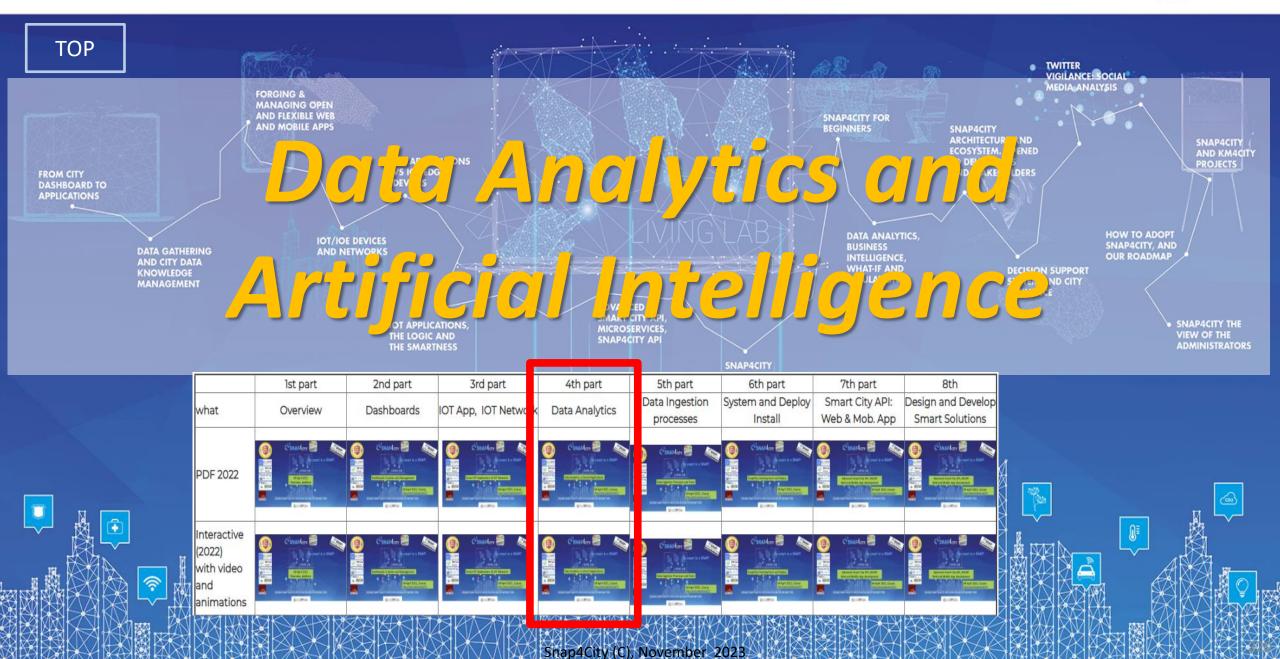




Everywhere: Cloud, on lot Edge Devices

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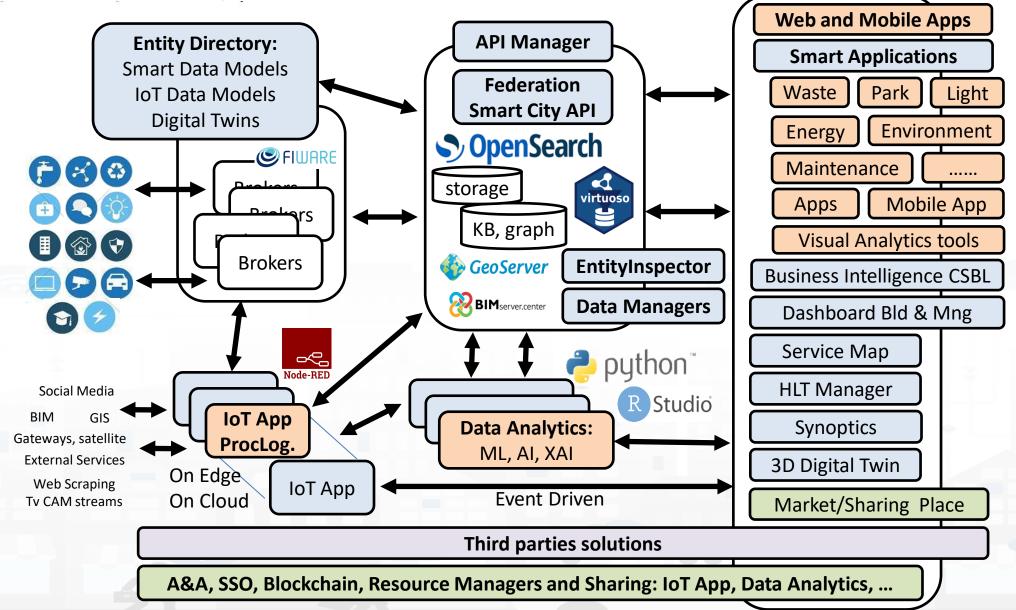
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Available DA / Al Solutions on Snap4City

- 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.o rg/download/video/DPL SNAP4SOLU.pdf



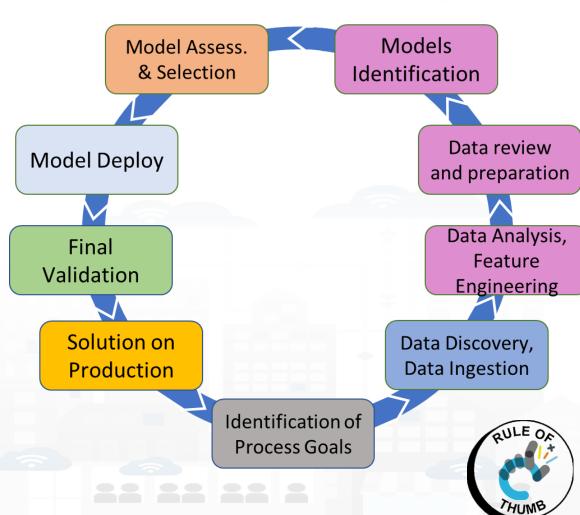








- Identification of Process goals and Planning
 - Which goals
 - How to compute, which language
 - Which environment, which libraries
- Data Discovery and Ingestion (from the general life cycle)
- Data Analysis: feature engineering, feature selection
- Data review and preparation for the model
- Model Identification and building: ML, AI, etc....
 - Training
 - Tuning hyperparameters when possible
- Model Assessment and Selection
 - 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.)



Data Analytics on Snap4City platform

tools

other

and

Base

from Knowledge

API

City

Smart



Studio









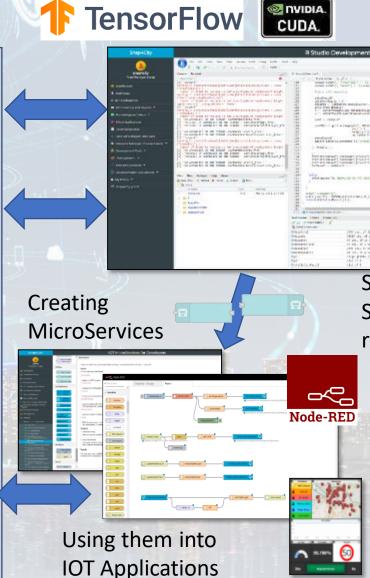


Ontology Schema

LOG.disit.org



Big Data Store Facility



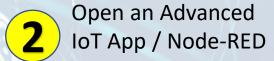
Saving / Sharing reusing



Resource Manager



Data Analytic Container









S4CDataAnalytic docker

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

Develop .py or .r program on (i) Snap4City platform online, or (ii) your Development Machine.

The code has to respect the guidelines provided for creating API.

The API are called as a MicroService For example see:

https://www.snap4city.org/641 https://www.snap4city.org/645 docker

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

plumber data

analytic

python data

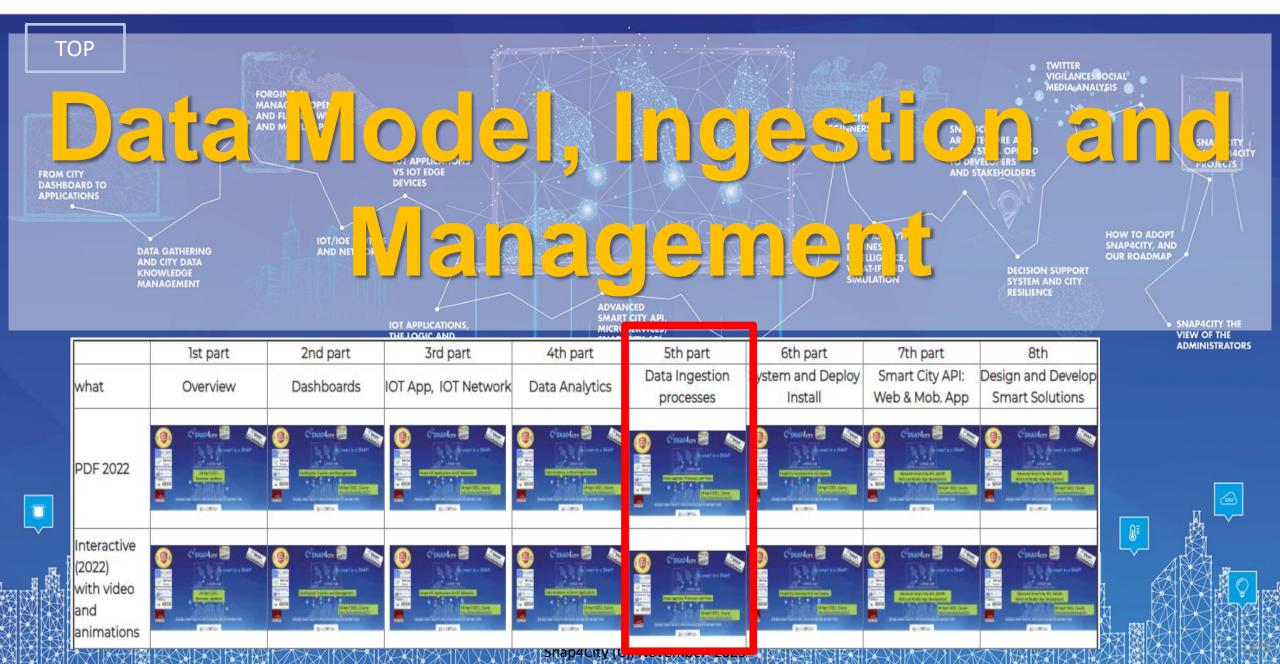
analytic





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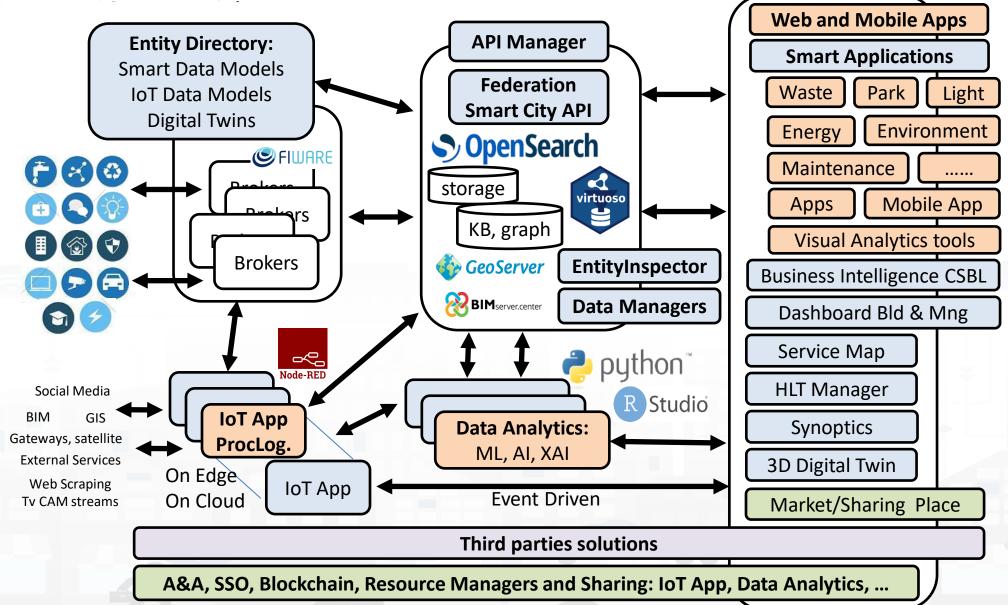


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High Level Types

Snap4City (C), November 2023

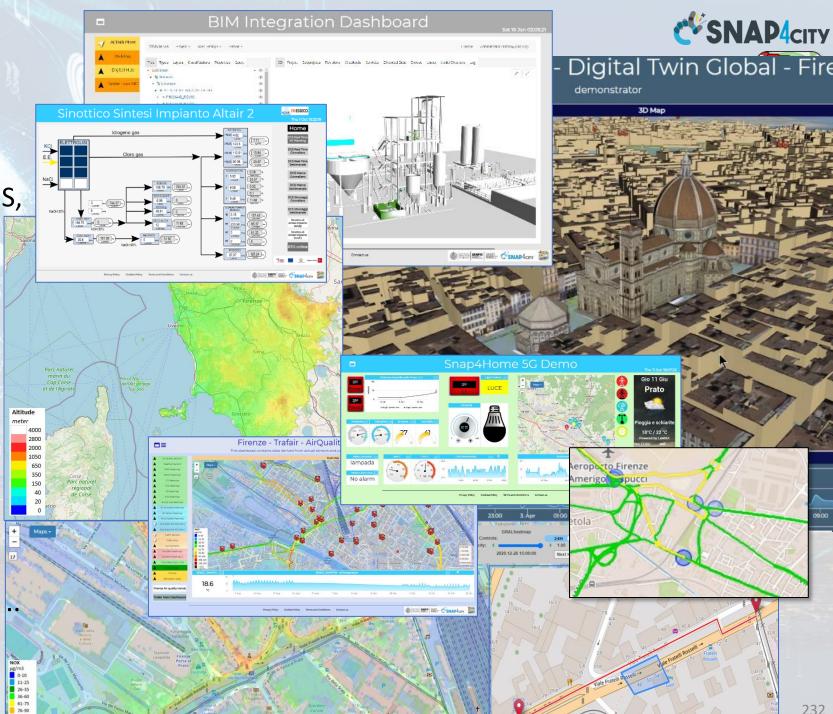
- POI, IOT Devices, shapes,...
 - FIWARE Smart Data Models,
 - IoT Device Models
- GIS, maps, orthomaps, WFS/WMS, GeoTiff, calibrated heatmaps, ..
- · Satellite data, ..
- traffic flow, typical trends, ...
- trajectories, events, Workflow, ...
- 3D Models, BIM, Digital Twins, ...
- OD Matrices of several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













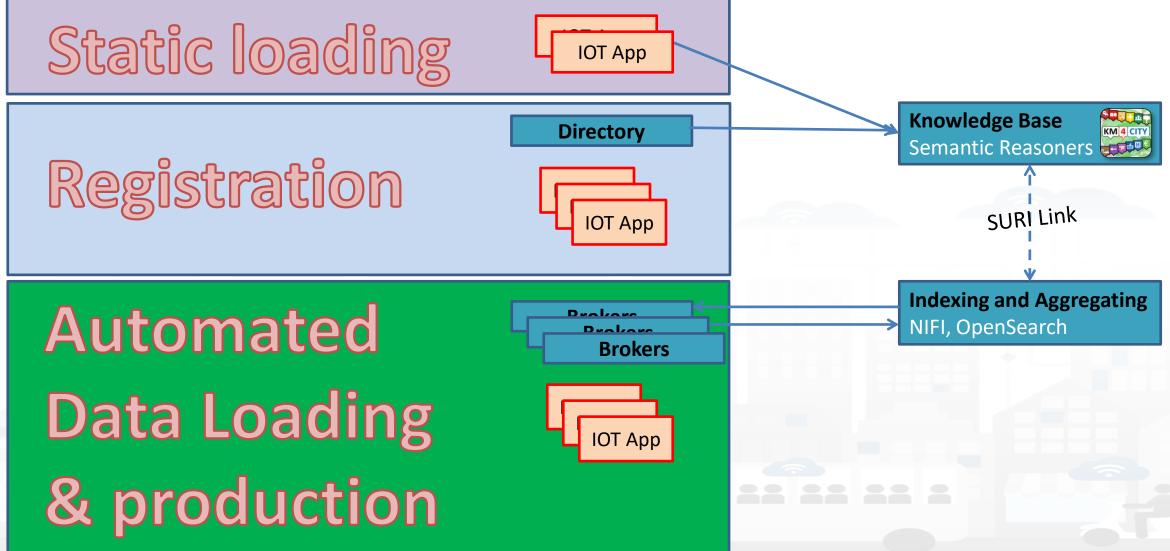








Snap4city Data Ingestion Flow Diagram















Checking data ingestion results

Knowledge base Semantic reasoners

- **Data Inspector**
- ServiceMap, SCAPI
 - LOG / LOD viewer
 - Super Service Map
- **IOT Directory**
- SCAPI: Swagger
- **IOT Broker**

Indexing and aggregating NIFI, OpenSearch

- **Data Inspector**
- ServiceMap, SCAPI
- My Data Dashboard (Kibana), DevDash
- Open Distro (ElasticSearch)



Data Inspector Digital Twin view



ServiceMap

My Data Dashboard DevDash

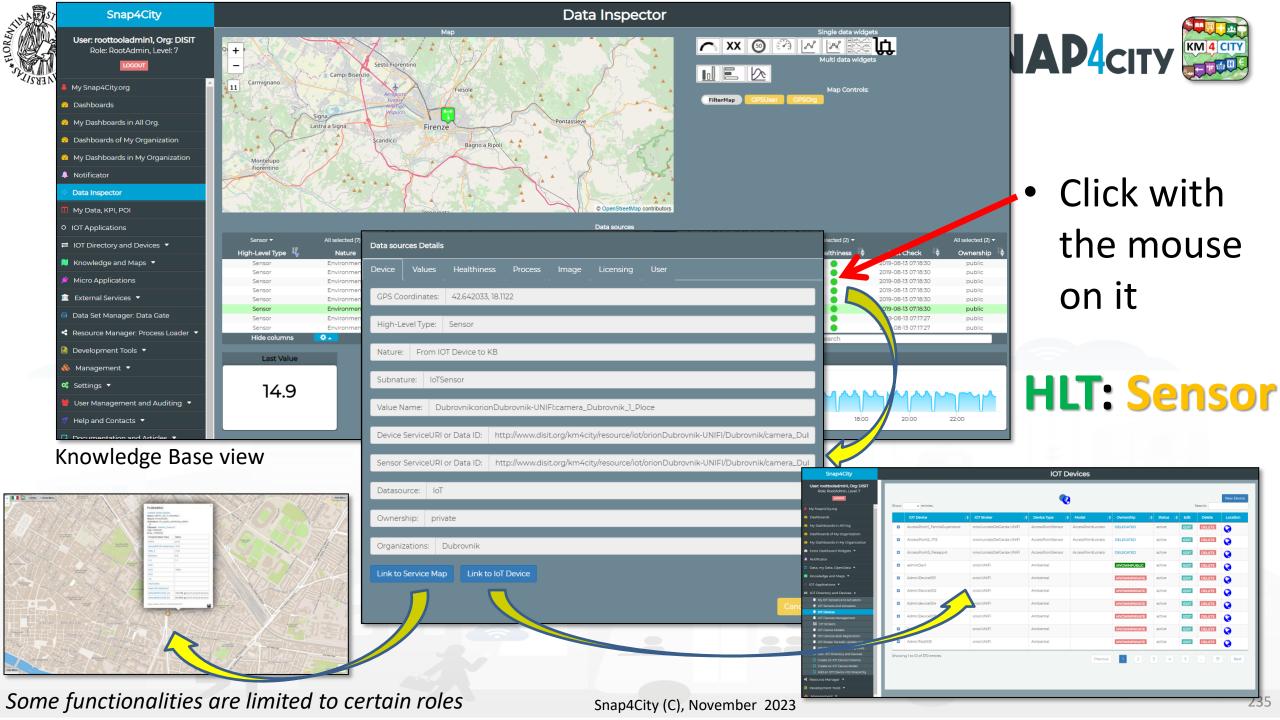






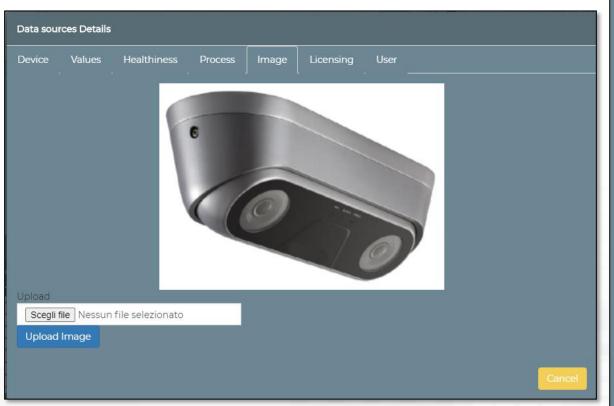








Image of the Devices and Licensing



Data sources Details User Process Image Licence (on:Dubrovnik:orionDubrovnik-UNIFI:camera_Dubrovnik_1_Ploce): ©**⊕**© https://creativecommons.org/licenses/by-nc-nd/4.0/legalcode Dubrovnik Development Agency DURA Address: E-mail: scavar@dura.hr Reference Person: Stjepan Cavar 00385 20640557 Website: Edit parameters

Some functionalities are limited to certain roles

Snap4City (C), November 2023

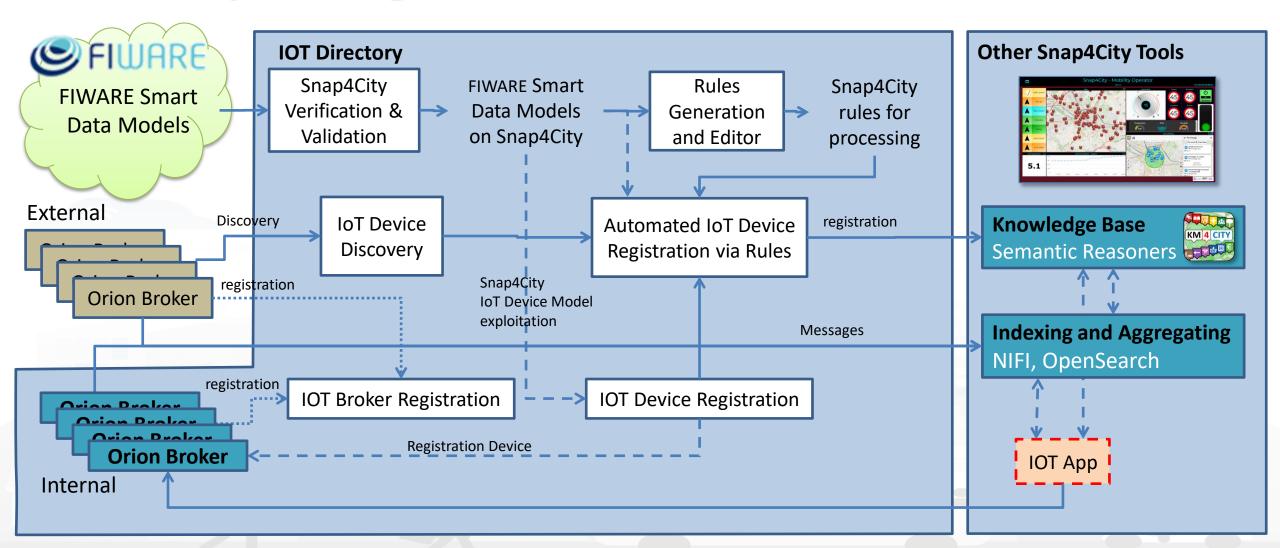








Exploiting FIWARE Smart Data Models



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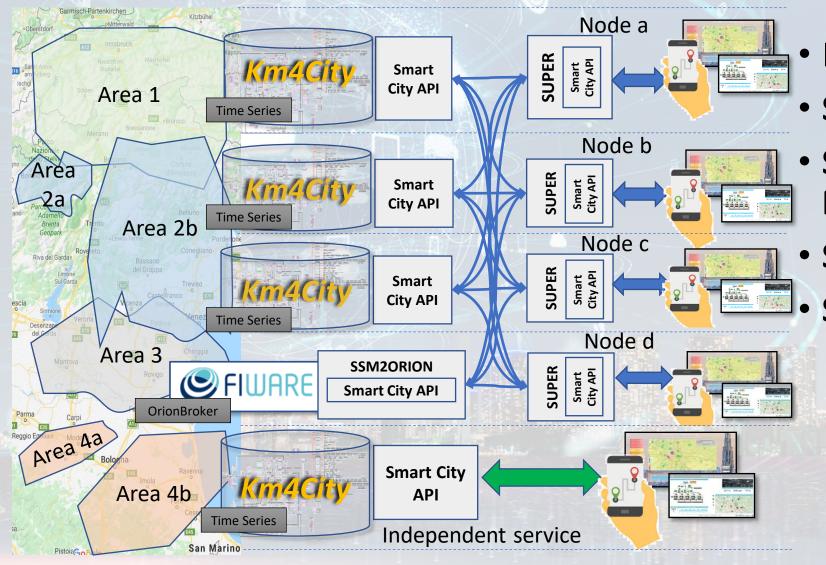




Federation of Smart City Services







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



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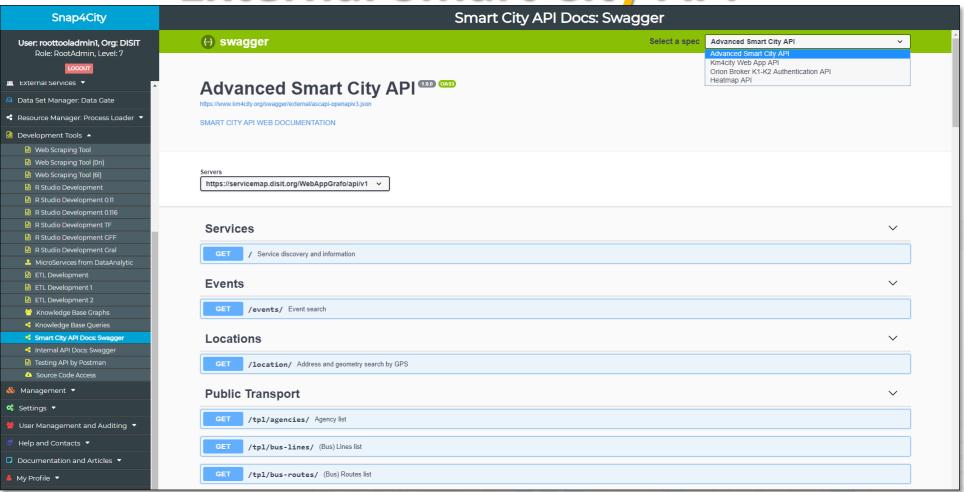








External Smart City API



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



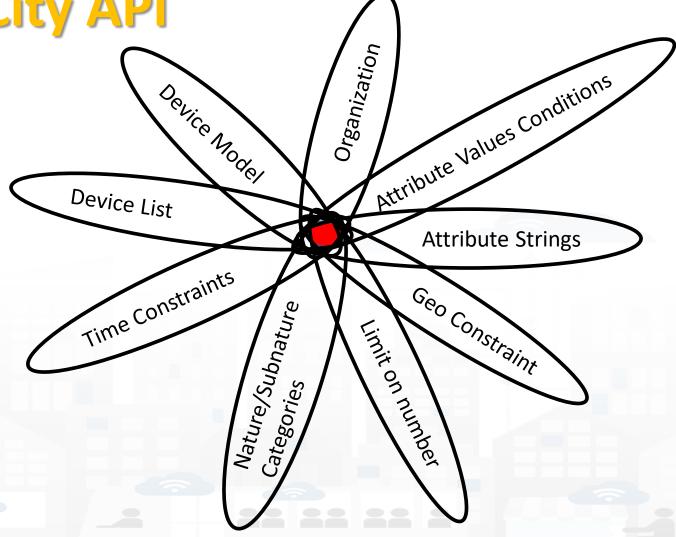


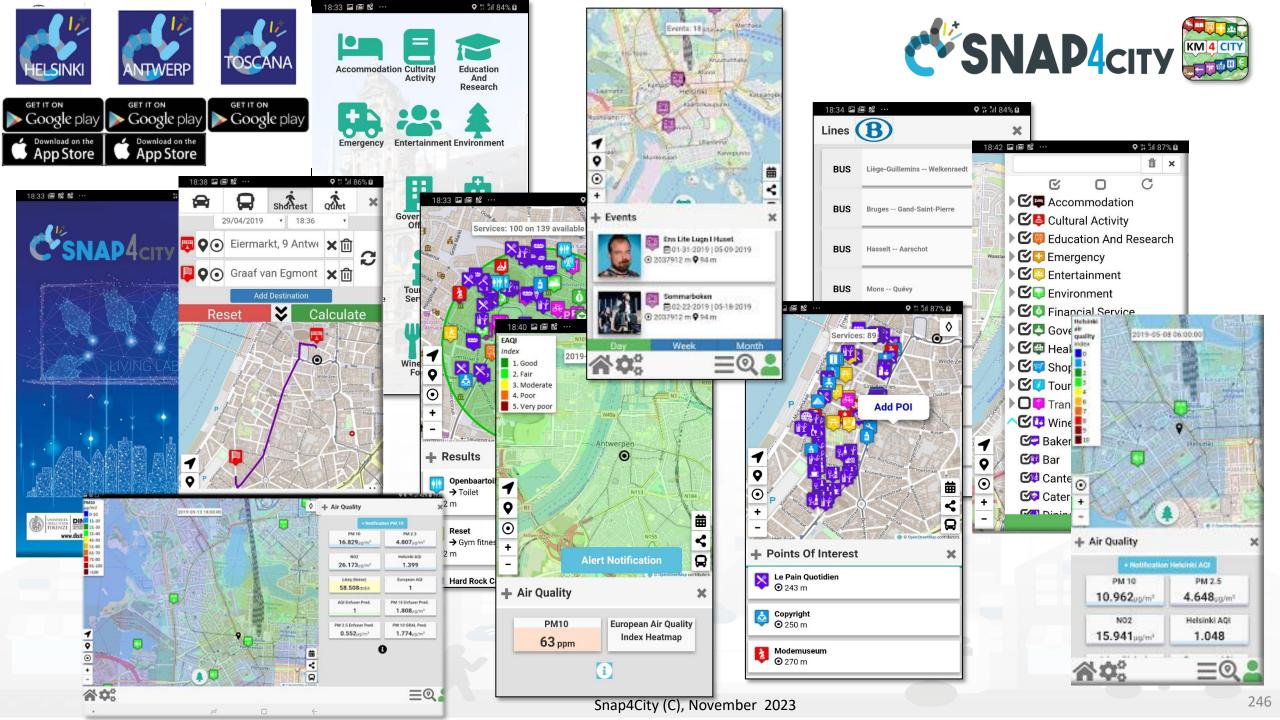




Selection on Smart City API

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





SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

















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-
- https://www.snap4city.org
- https://www.snap4industrv.org
- https://twitter.com/snap4city
- https://www.facebook.com/snap4city
- https://www.youtube.com/channel/UC3tAO09EbNba8f2-u4vandg

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

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

Access Level: public

Date: 21-10-2022

Version: 1.4









Development

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





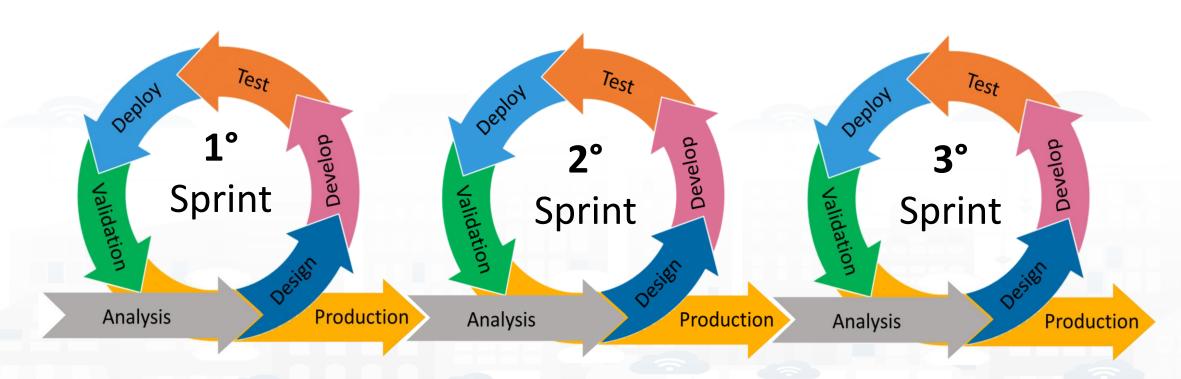






Development Life Cycle Smart Solutions





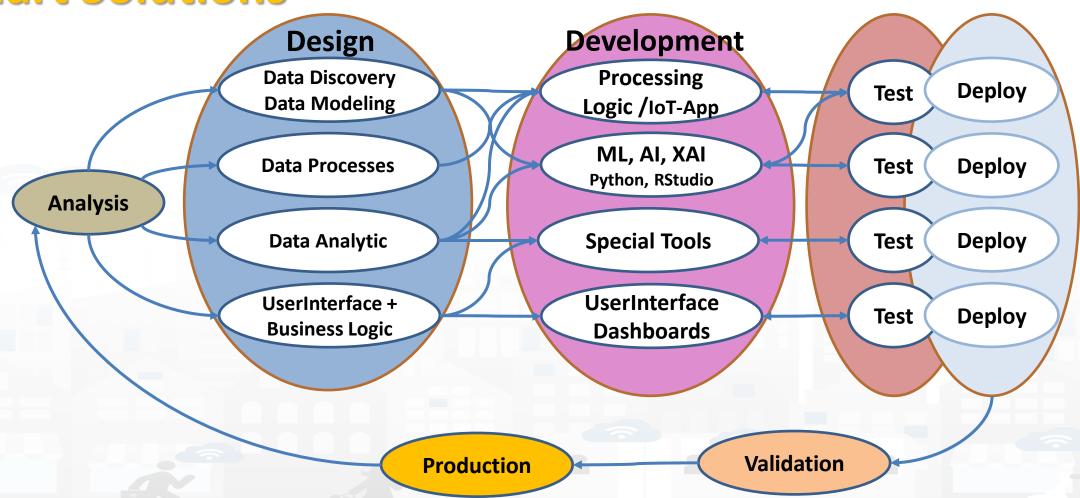


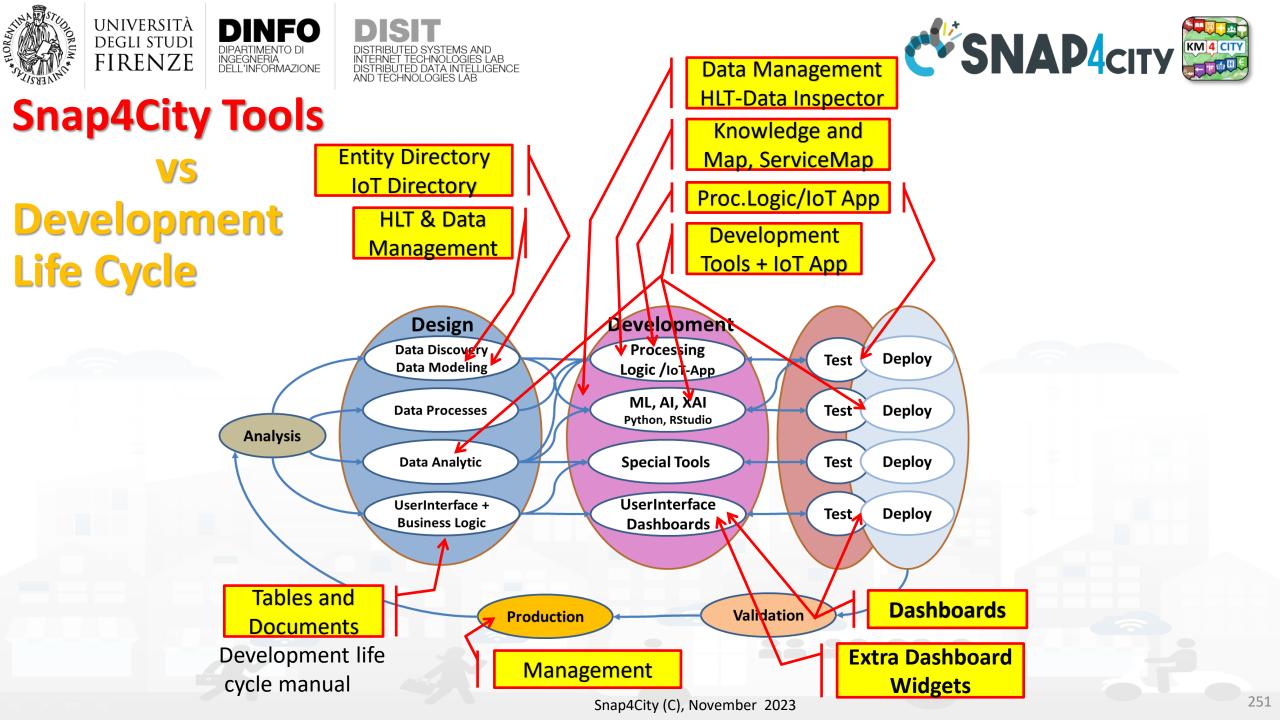






Development Life Cycle Smart Solutions







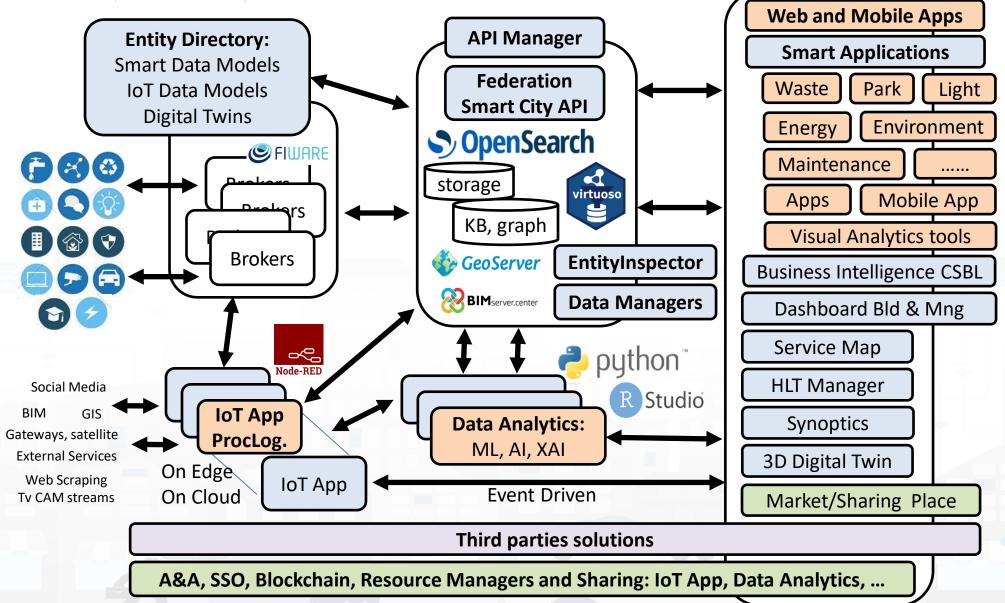


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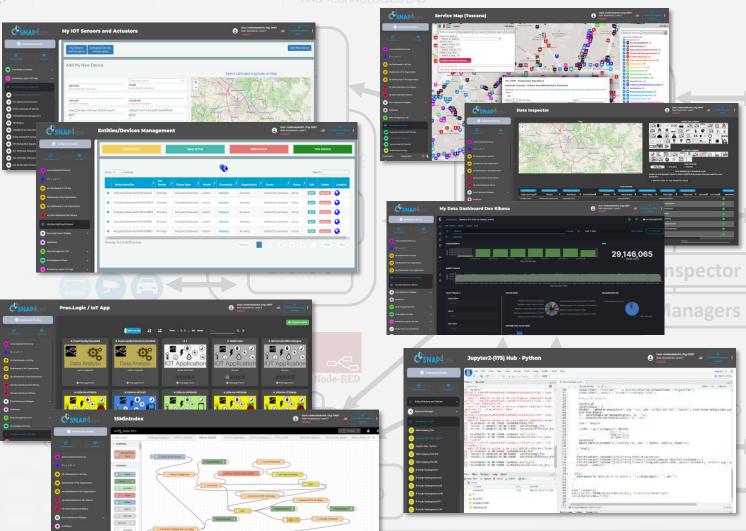


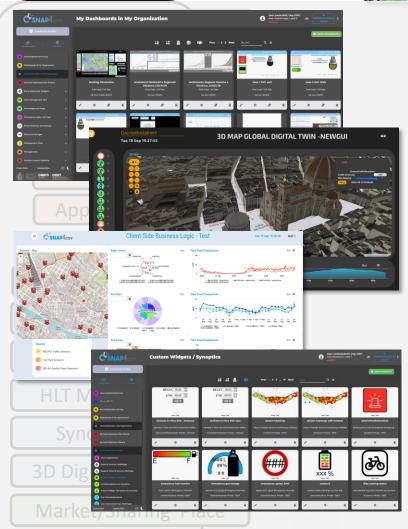


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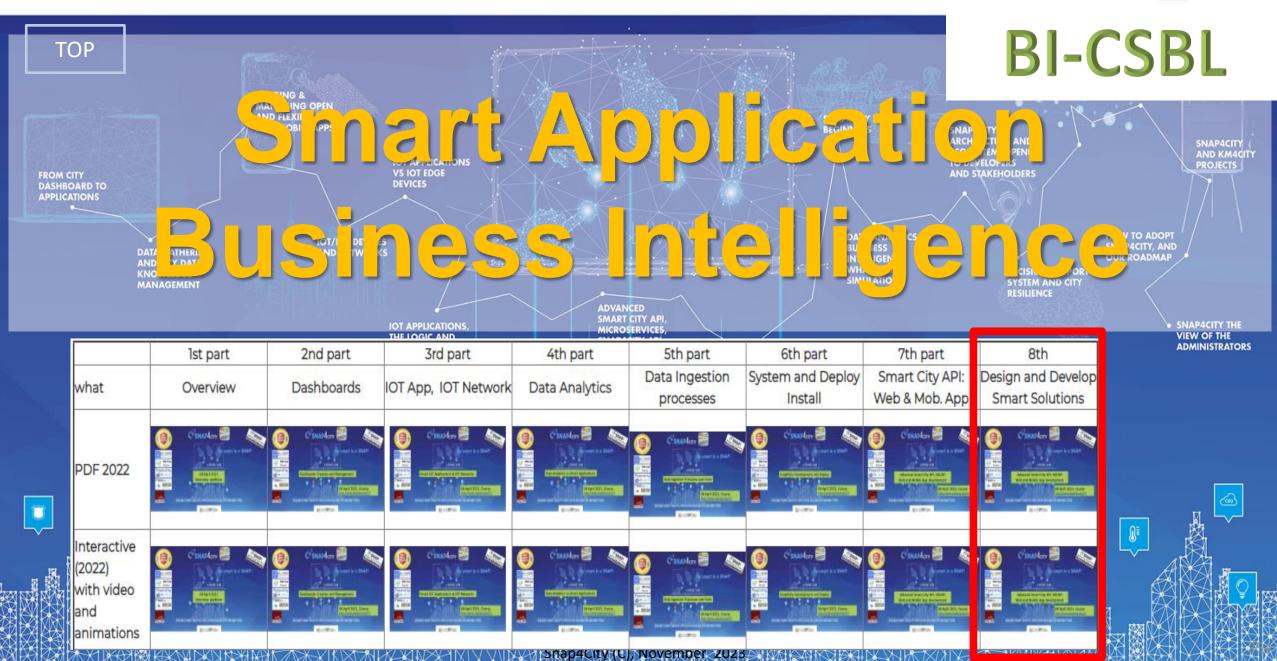


Third parties solutions

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

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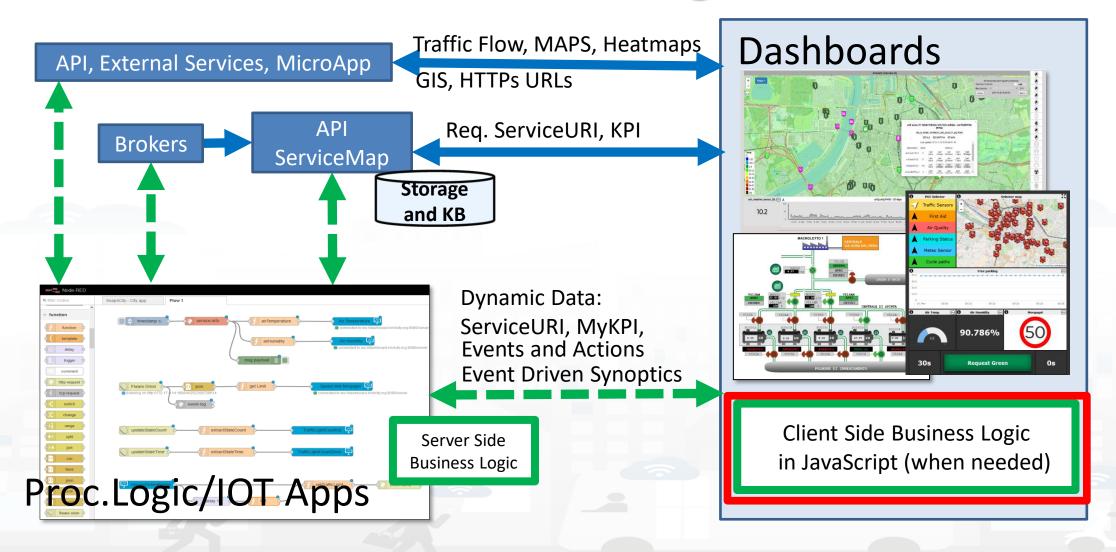








How the Dashboards exchange data





università degli studi FIRENZE

DINFO
DIPARTIMENTO DI
INGEGNERIA
DELL'INFORMAZIONE

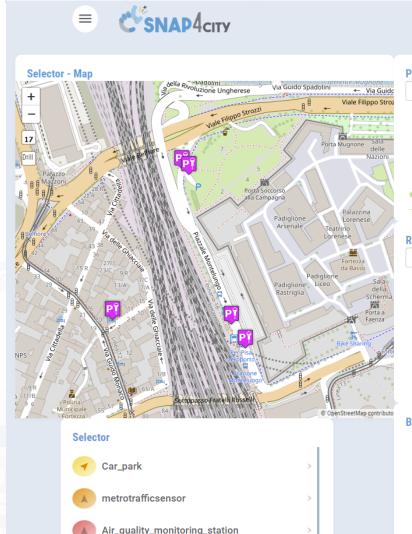
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example

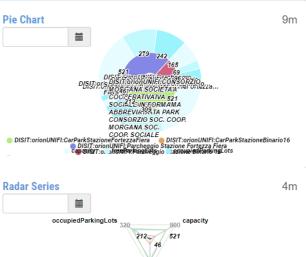
First BI Example



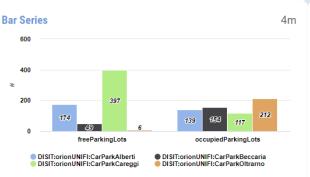
Mon 10 Apr 12:00:40



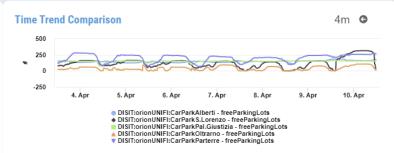
Weather_sensor

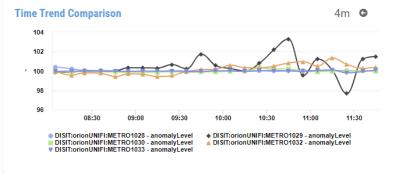


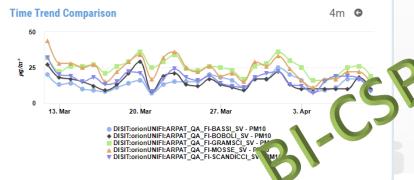
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 DISIT:orionUNIFI:Parcheggio Stazione Fortezza Fiera



▲ DISIT:orionUNIFI:Parcheggio Stazione Binario 16
▼ DISIT:orionUNIFI:PARK SERVICE SOCIETA' COOPERATIVA SOCIALE IN FORMA AB...
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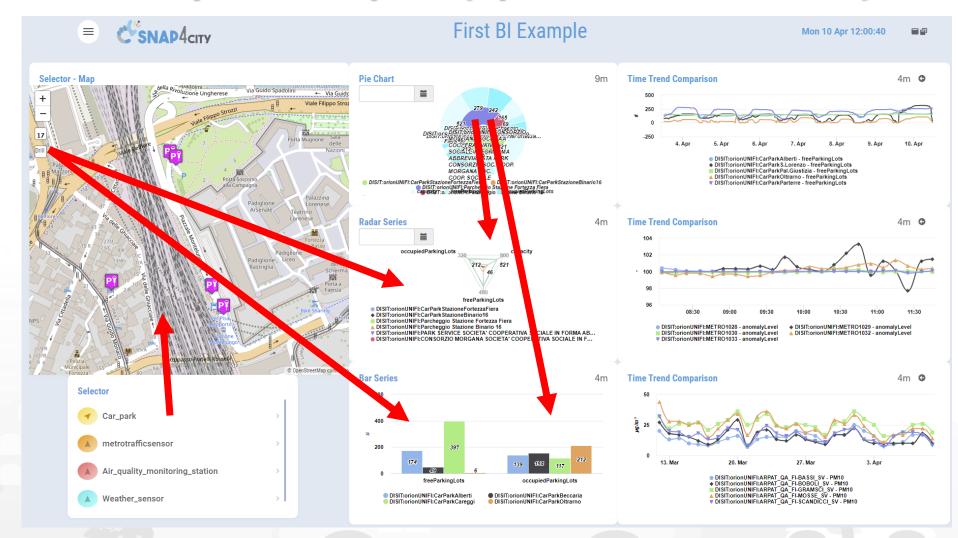






Example: From Map to Graphs (spatial drill down)

- 1) Select the area of interest on map
- 2) Select the sensors kind of interest
- 3) Drill down on map
- 4) The JavaScript
 CSBL on Map will send data to the programmed
 Widgets. In this case, arrowed in RED





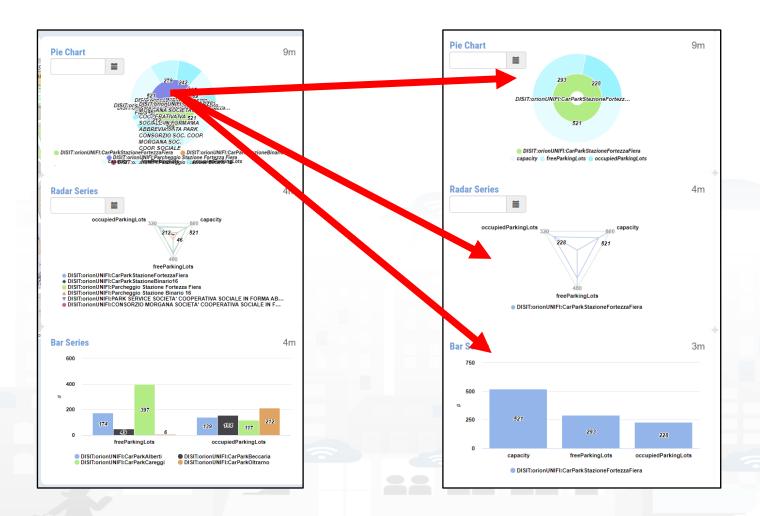






Example: From Data Graphs to Graphs (drill down)

- 1) Click on the Donut element
- 2) The JavaScript CSBL on the Donut Widget will send commands to the programmed Widgets to focus on selection, as highlighted by the red arrows





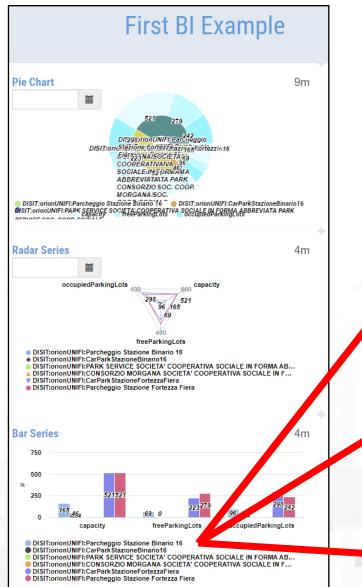


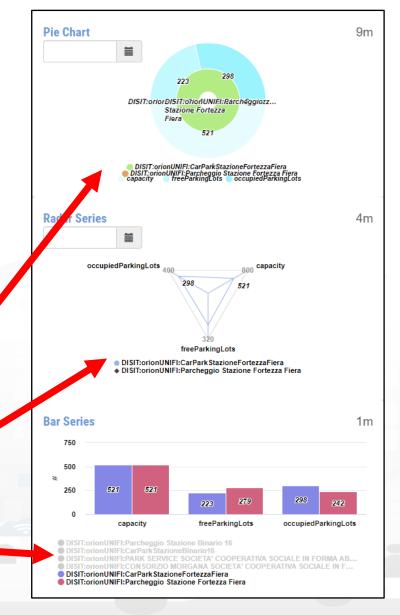




BI-CSBL

- 1) Click on the Legenda of Bar Series
- 2) The JavaScript CSBL on the Bar Series will send commands to the programmed Widgets to remove the unselected devices, as highlighted by the red arrows









BI-CSBL





Client Side Business Logic











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-
- https://www.snap4city.org

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







https://www.snap4city.org/d ownload/video/ClientSideBus

inessLogic-



SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES





https://www.snap4city.org/471 for VM https://www.snap4city.org/738 for container To get an updated version read it!

How to adopt Snap4City



Powered by







Smart City as a Service

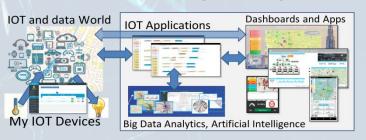
- Supporting Org
- 100% Open Source Platform: Github
- Further developments
- Publishing Appliances and Dockers
- Training courses, docs
- Consulting
- Forums
- Etc.



Download

and deploy

On your premise



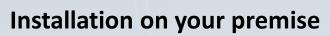


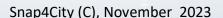


- Different configurations
 - From small to scalable
 - Exploiting your legacy tools
 - Interoperable with any tool
- No vendor lock-in, No tech lock-in

Mixed solutions! For example:

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







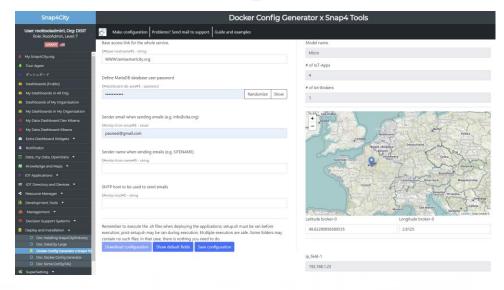


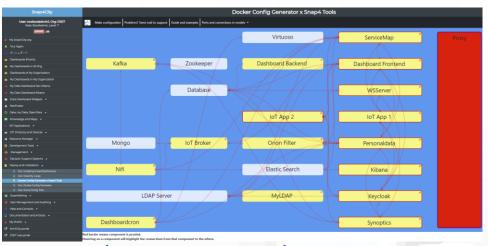


Installations, different models a TOOL to get them

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















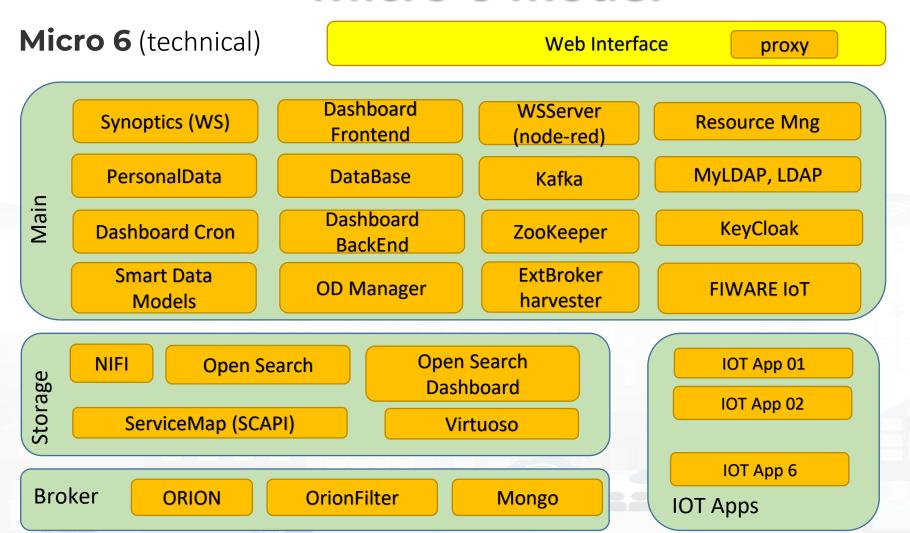
1Hour

and

installation

ready to use

Micro 6 model













• SLA:

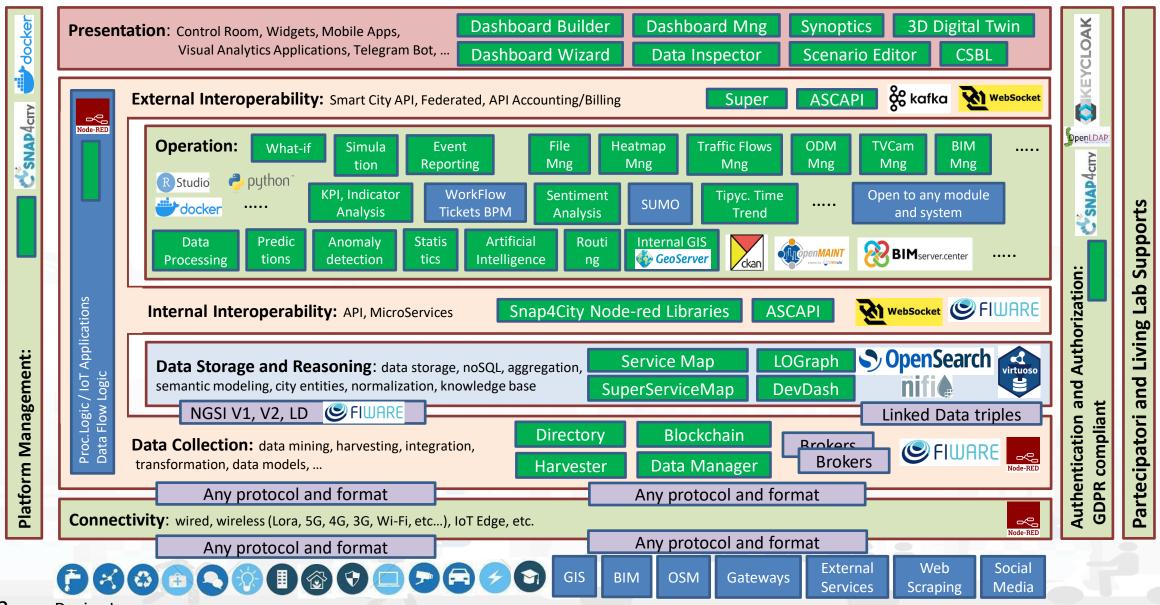
- Including: Direct Contact, POC; Help Desk
 - may be an Organization on our cloud to test new tools, and work with the community, this is typically 5-12Keuro first 2years and 1-2keuro for each successive year depending on the feature and number of users you are placing.
- Similar to: https://www.snap4city.org/497 with some adaptation on the basis of your deploy and critical conditions, if any
 - Updates, help desk, etc.

Our support can be valued on:

- The basis of the complexity of your solution: 10% of the cost
 - Or
- Block of: 16 hours, for 3000 euro / 50 hours, for 6000 euro
 - larger packages can be negotiated
- Support can be provided by: Snap4, DISIT Lab, and other companies
- Customizations can be assessed separately

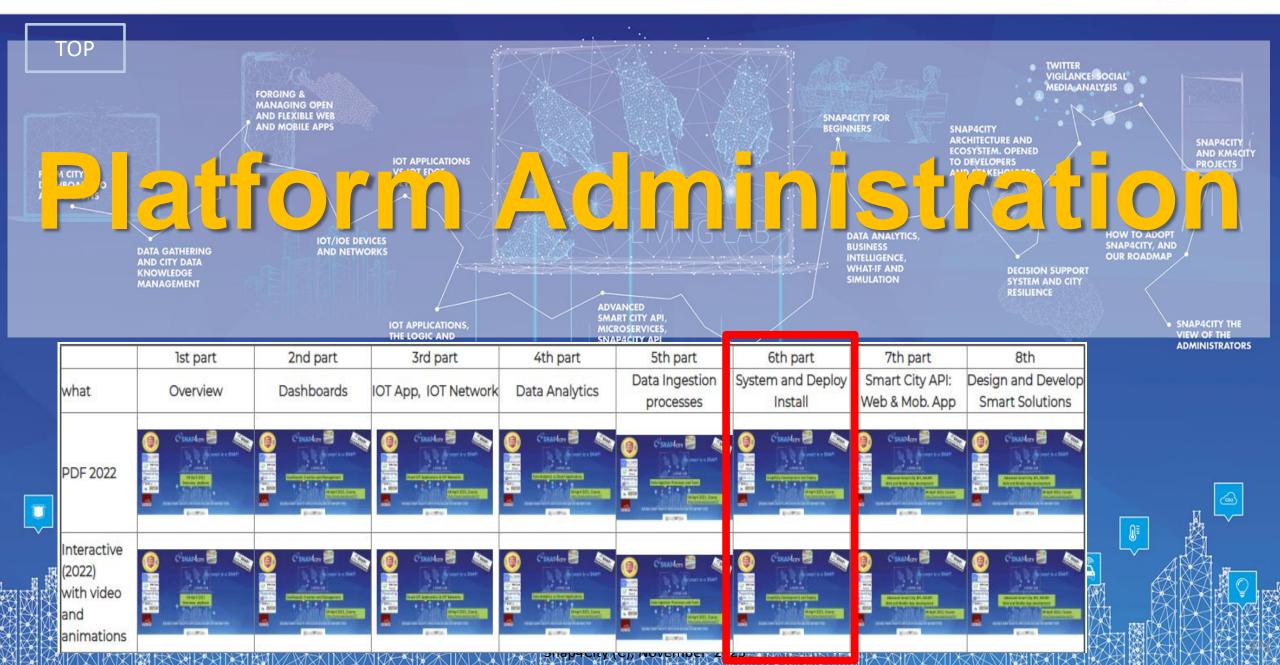






SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES







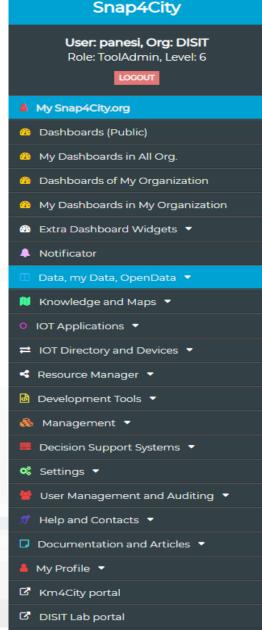






Management by Organization

- Organizations / Tenant may have
 - name, ID, GPS center, a number of Groups on Snap4City.org (living lab support Drupal)
 - users of different kinds and may impose early bounds on the resourced used by users (IOT Dev, IOT App, Dash)
 - on cloud user kinds up to level of Tool Administrator
 - One or more ServiceMap and boundaries for the federation
- ToolAdmin users (requested by Organizations) may
 - control processes, consumption of resources, healthiness, etc.
 - manage tools exploited in your configuration
- 24H/7D Help Desk and Assistance



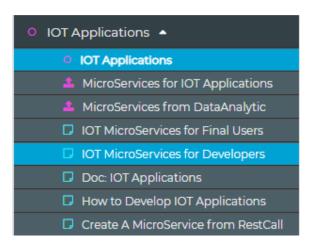






IOT Applications



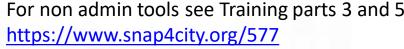


IOT Application

IOT Applications: a view to manage Containers / IOT **Edge Apps: IOT** Apps, Data Analytics (R and Python), WebScraping, IOT edge, etc.

Managing also

- **MicroServices for IOT App exploiting REST Call**
- MicroServices from **DataAnalytics**





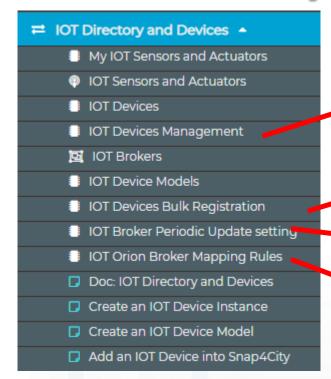




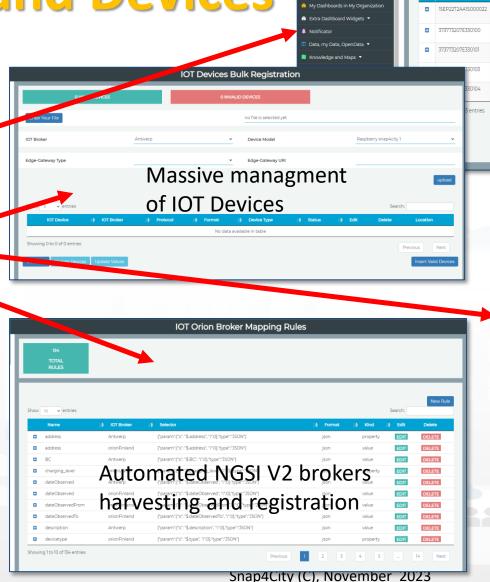
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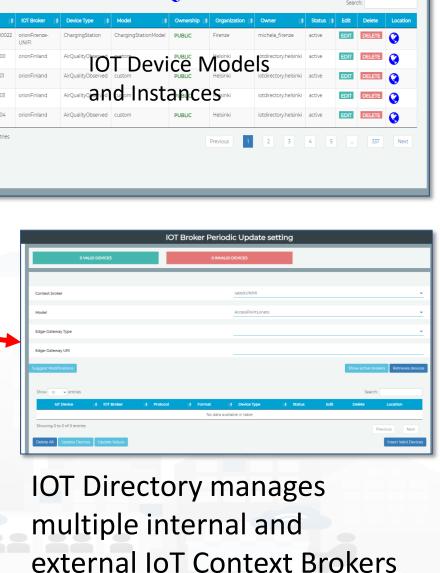
DISTRIBUTED SYSTEMS AND
INTERNET TECHNOLOGIES LAB
DISTRIBUTED DATA INTELLIGENCE
AND TECHNOLOGIES LAB

IOT Directory and Devices



For non admin tools see
 Training parts 3 and 5:
 https://www.snap4city.org/577





IOT Devices Management









- Development Tools
 All these tools are well described into Training parts: https://www.snap4city.org/577
- The Administrators may
 - access to all instances of them
 - Grant access to them at specific AreaManager users
 - **API and Swagger documentation**
 - Model Knowledge Base Graphs (LOG.disit.org)
 - Python online dev. Environment
 - R Studio Online dev. Environment
 - WebScraping tool
 - SPARQL Editor and tools (custom FLINT)
 - ETL OnLine dev. Environment (deprecated)

Development Tools • Web Scraping Tool Jupyter Hub - Python Web Scraping Tool (On) Meb Scraping Tool (61) R Studio Development R Studio Development 0.11 R Studio Development 0.116 R Studio Development TF R Studio Development GFF R Studio Development Gral ETL Development ETL Development 1 ETL Development 2 Knowledge Base Graphs Knowledge Base Queries Smart City API Docs: Swagger Internal API Docs: Swagger Testing API by Postman

Source Code Access

■ How to Develop Smart Applications









User Management and Auditing

- 🥊 User Management
- User Limits Management
- 🥊 User Engagement
- User Engagement Dash
- User Role Management via LDAP
- Manage Resource Ownership
- User Chats Management
- Auditing Data Access Try-out
- Auditing Elements vs Ownership
- Auditing Personal Data
- Auditing Accesses Authetication
- Auditing User Activities
- Auditing Activities on Queries
- Auditing Activities on Articles
- Auditing IOT Directory Data
- Dashboard Builder Local Users
- Organizations vs Groups
- Users vs Organizations

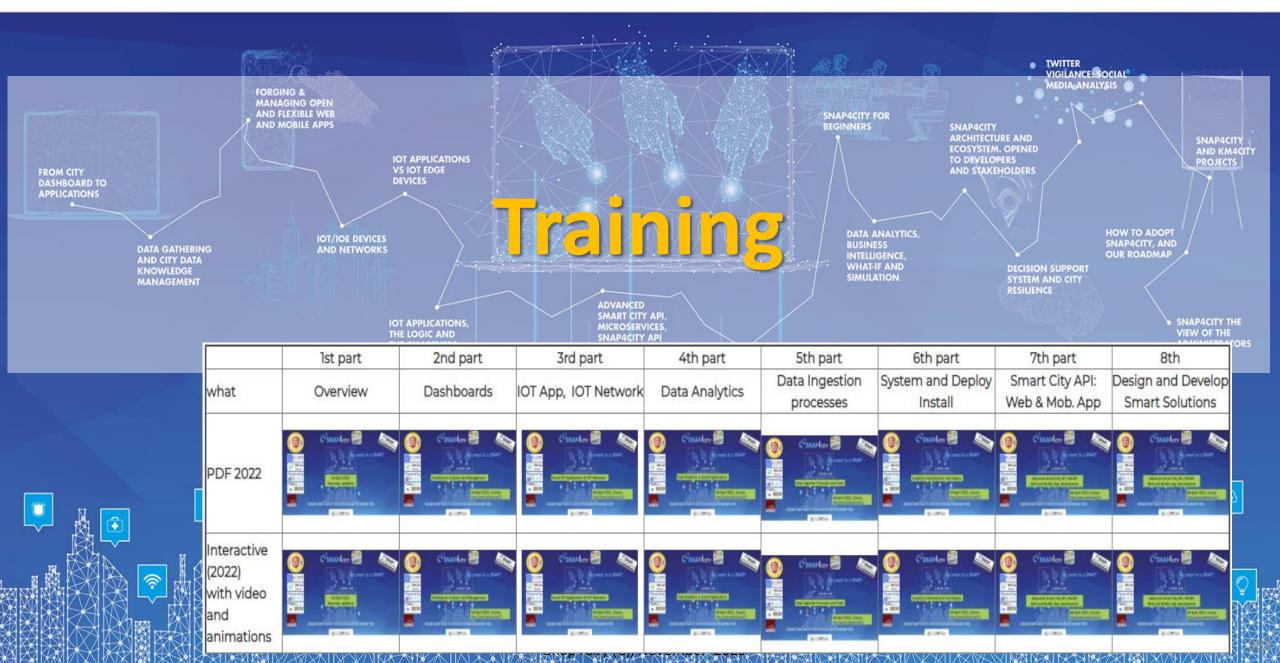
User Management and Auditing

- All that the RootAdmin needs to manage:
 - User Management: for managing
 - accounts and profiles
 - limits of the users in exploiting resources
 - Accesses and providing special authorization
 - Organization vs Groups of users
 - Users vs Organizations
 - Users vs Web and Mobile Applications
 - Engaging and monitoring users on platform and devices
 - Users on Chats room of Dashboards
 - Managing Users on Chats of Dashboards
 - Auditing of the data and resource accesses
 - Auditing all the activities on the platform (see next section)
 - Personal auditing

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT SNAP4INDUSTRY









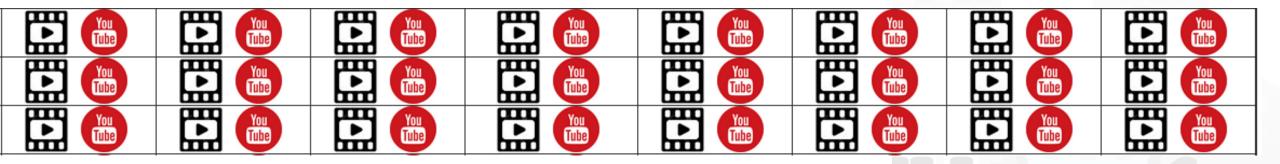
https://www.snap4city.org/944

On Line Training Material (free of charge)





2nd part	3rd part	4th part	5th part	6th part	7th part	8th
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
CSNAP4cm State Sta	CHARACTER STATE OF THE STATE OF	CENANDER STATE OF THE PROPERTY	C'SMADA CON CONTROL OF THE CONTROL OF T	COMANATOR STATE OF ST	CENADADA SON DESCRIPTION OF THE PROPERTY OF TH	CENANAGE STATE OF STA
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Note on Training Material

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

Snap4City Snap4City

Switch To New Layout (Beta)

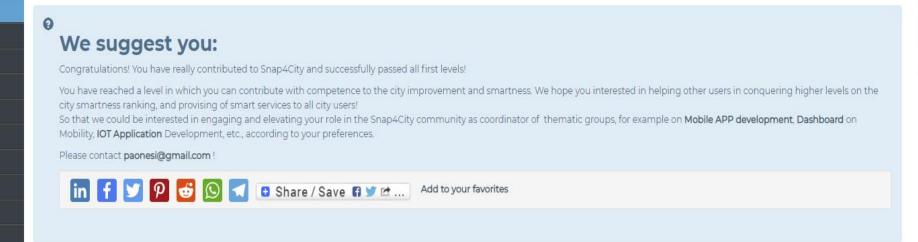
User: paolo.disit, Org: DISIT Role: AreaManager, Level: 3



- My Snap4City.org
- Tour Again
- www.snap4solutions.org
- Dashboards (Public)
- Dashboards of My Organization
- My Dashboards in My Organization
- My Data Dashboard Dev Kibana
- Data Management, HLT ▼
- Knowledge and Maps ▼
- Processing Logics / IOT App
- Resource Manager 🔻
- Development Tools ▼
- Management *
- Decision Support Systems
- Deploy and Installation ▼
- Help and Contacts -
- Documentation and Articles
- My Profile ▼
- Km4City portal
- DISIT Lab portal

Home / Tutorials and Videos / Welcome: how to start using Snap4City for beginners

Welcome: how to start using Snap4City for beginners



















Data Analytics



0:00

Dashboards



Living Lab



API

Smart City API



Smart City

Ontology

Home How and Why To Use it ▼

DISIT

Developer

Groups

Operativo

Updates on Tools

Tutorials and Videos ▼

Training on Tools

and Platform

www.km4city.org

Sii-Mobility

Organization

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Tools ▼

Username: paolo.disit

Search

Search -Any-

Training Course Snap4City -2023 Edition new drupaladmin

Snap4City Newsletter of April 2023 new roottooladmin1





Articles



SCIENCE CLOUD

C'SNAP4city on









INDUSTRY 4.0











- TECHNICAL OVERVIEW: https://www.snap4city.org/download/video/Snap4City-PlatformOverview.pdf
- Development Life Cycle: https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf
- Client-Side Business Logic Widget Manual: https://www.snap4city.org/download/video/ClientSideBusinessLogic-WidgetManual.pdf
- Booklet Data Analytics, Snap4Solutions: https://www.snap4city.org/download/video/DPL_SNAP4SOLU.pdf

Please start a fully guided training cases:

- HOW TO: create a Dashboard in Snap4City
- HOW TO: add a device to the Snap4City Platform
- HOW TO: add data sources to the Snap4City Platform.

HOW ARE YOU GOING TO BUILD THE FUTURE?

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



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

GET YOUR PASS

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You can't delete this newsletter because it has not been sent to all its subscribers.



Training on Tools

and Platform

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DISIT















API

Living Lab Smart City API



Smart City

Ontology



Work with Us





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Organization Groups

- Developer
- Operativo

I Indahaa am



Dashboards (Public)

www.snap4solutions.org

Dashboards of My Organization

My Dashboards in My Organization

My Data Dashboard Dev Kibana

Extra Dashboard Widgets

Data Management, HLT

Help and Contacts

Documentation and Articles

UNIVERSITÀ DINFO

Knowledge and Maps

Processing Logics / IOT App











- Development Life Cycle: https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf
- Client-Side Business Logic Widget Manual: https://www.snap4city.org/download/video/ClientSideBusinessLogic-WidgetManual.pdf

Booklet Data Applytics Coop (Solutions, bttps://www.spap/oity.org/doupload/video/DDI_SNAD/SOLLI pdf

2023 booklets

Smart City





https://www.snap4city.org /download/video/DPL SN AP4CITY.pdf Industry





https://www.snap4city.org/download/video/DPL SNAP4lNDUSTRY.pdf

Artificial Intelligence





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



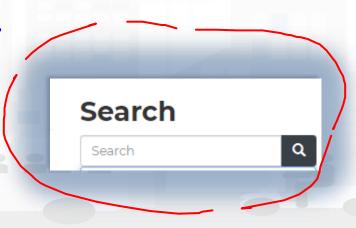








- Please select DISIT ORG to be sure to access at the examples
- Most of the cities / tenant are private and they do not left much visible
- What you get is probably the 10% of what is on the platform ©
- Training: https://www.snap4city.org/577
- Scenarious: https://www.snap4city.org/4
- Publications: https://www.snap4city.org/426
- WEB pages: https://www.snap4city.org/78
- SEARCH on the right side























Technical Overview

From: DINFO dept of University of Florence, with its

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

Snap4City:

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

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

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



Tech Overview

 https://www.snap4city.o rg/drupal/sites/default/f iles/files/Snap4City-PlatformOverview.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-
- https://www.snap4city.org
- https://www.snap4industrv.org
- https://twitter.com/snap4city
- https://www.facebook.com/snap4city
- https://www.youtube.com/channel/UC3tAO09EbNba8f2-u4vandg

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

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









Development

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













Client Side Business Logic











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-
- https://www.snap4city.org

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







https://www.snap4city.org/d ownload/video/ClientSideBus

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Overview





SMART CITIES AND SMART INDUSTRY

Snap4City: FIWARE powered smart app builder for sentient cities

Vith the contribution of





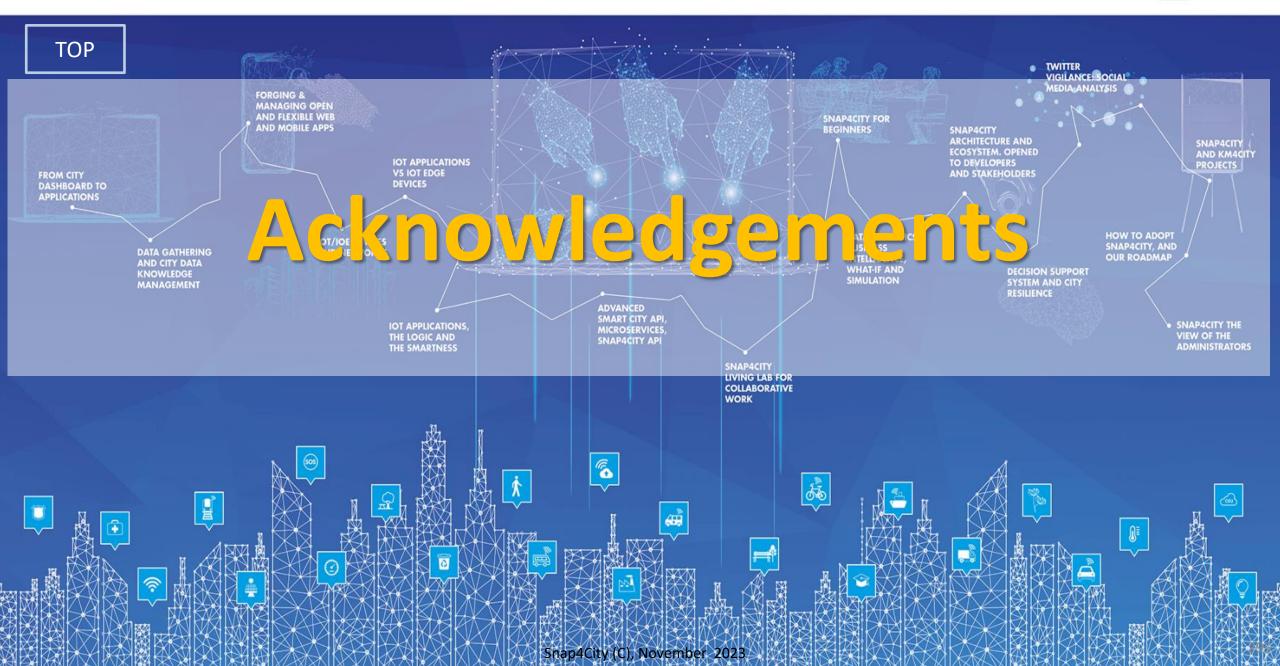


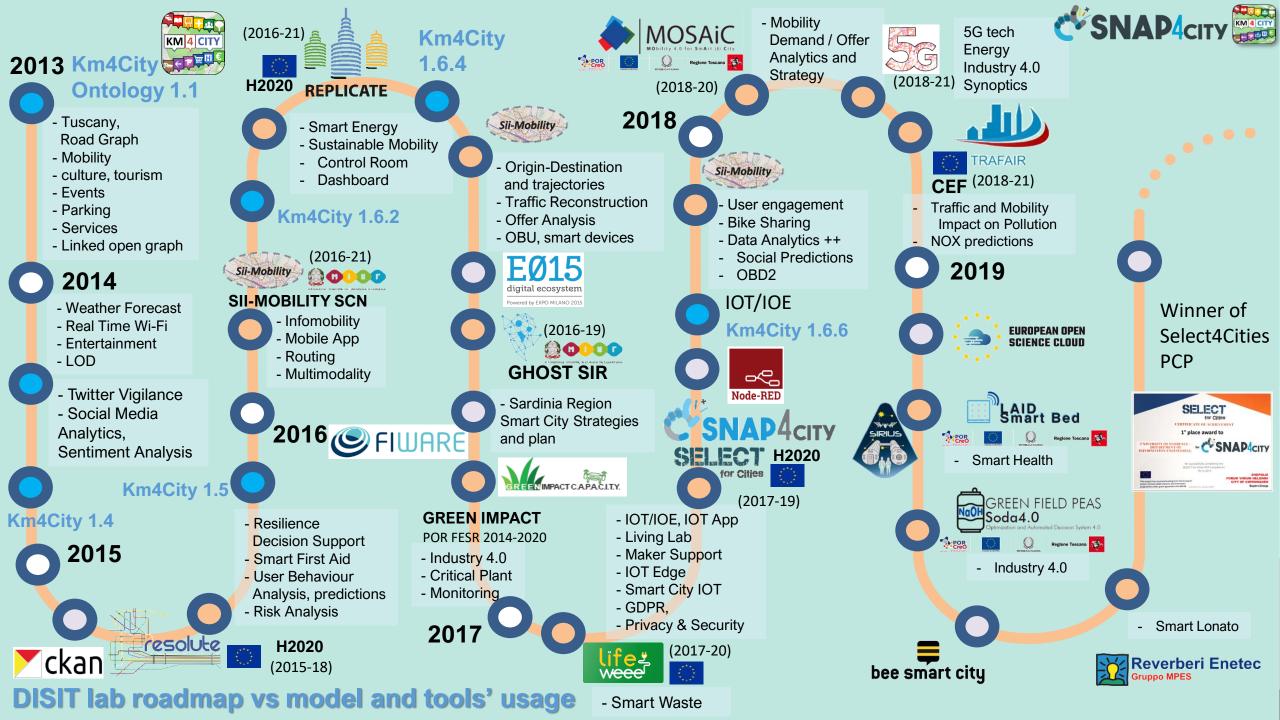


- https://fiwarefoundation.medium.com/sna
 p4city-fiware-poweredsmart-app-builder-forsentient-cities-acfe24df49d5
- https://www.snap4city.org/d rupal/sites/default/files/files /FF ImpactStories Snap4Cit y.pdf

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES









TOP







Be smart in a SNAP!





CONTACT

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

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

www.snap4city.org

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