



IL FUTURO DELLA MOBILITA' INTELLIGENTE E SOSTENIBILE

Digital Twin & Intelligenza Artificiale.
Innovazione tecnologica “As a Service “
per la gestione operativa
e la pianificazione tattico-strategica
della mobilità urbana sostenibile e interconnessa

Firenze | Milano | Roma | Bari



Finanziato
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Ministero
dell'Università
e della Ricerca



Italiadomani
PIANO NAZIONALE
DI RIFORMA E RESILIENZA

MOST
CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

Agenda



IL FUTURO DELLA MOBILITA'
INTELLIGENTE E SOSTENIBILE

Registrazione	9:00 - 9:30	
Avvio Lavori	9:30 - 10:00	Saluti Prof. Marco Pierini - Prorettore alla Ricerca e al Trasferimento Tecnologico, Università degli Studi di Firenze Gianmarco Montanari - Direttore Generale CN MOST Prof. Paolo Nesi - Unifi DisitLab/Snap4City Prof. Michele Ottomanelli - Politecnico di Bari (Da Confermare) Franco Prampolini - Head of R&D and Innovative Industry Solutions Lutech Group
Overview	10:00 - 10:20	Presentazione generale e obiettivi di OPTIFaaS Mauro Starinieri , Head of Smart City & Mobility Solutions CoE Lutech Group
Strumenti OPTIFaaS	10:20 - 11:00	Presentazione dell'infrastruttura Prof. Paolo Nesi - UNIFI DISITLab/Snap4City
Coffee Break (offered)	11:00 - 11:30	
Scenario OPTIFaaS: traffico	11:30 - 11:50	Ottimizzazione del Traffico Prof. Luigi Pariota - Università degli Studi di Napoli
Scenario OPTIFaaS: ottimizzazione semaforica	11:50 - 12:10	Ottimizzazione Semaforica e di Infrastruttura Prof. Paolo Nesi - UNIFI DISITLab/Snap4City
Scenario OPTIFaaS: ottimizzazione Trasporto Collettivo	12:10 - 12:40	Ottimizzazione Trasporto Collettivo Prof. Paolo Nesi - UNIFI DISITab/Snap4City
Q&A	12:40 - 13:00	Sessione aperta
Light Lunch	13:00 - 14:00	
Incontri 1:1	14:00 - 18:00	Incontri 1:1 con i referenti di Snap4City/OPTIFaaS (in presenza)

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Presentazione dell'infrastruttura

Prof. Paolo Nesi, UNIFI DISIT



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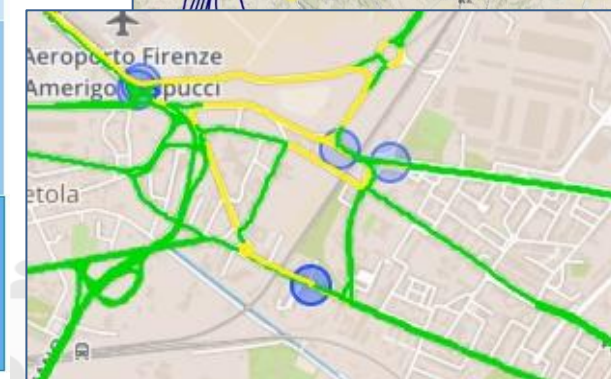
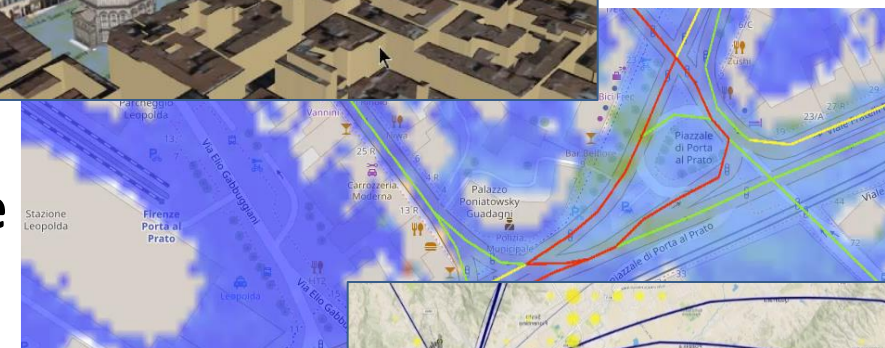
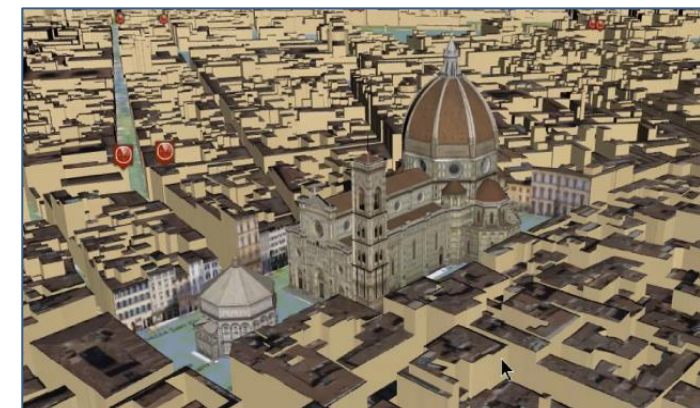


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PIANTO NAZIONALE
DI RISERVA E INNOVAZIONE

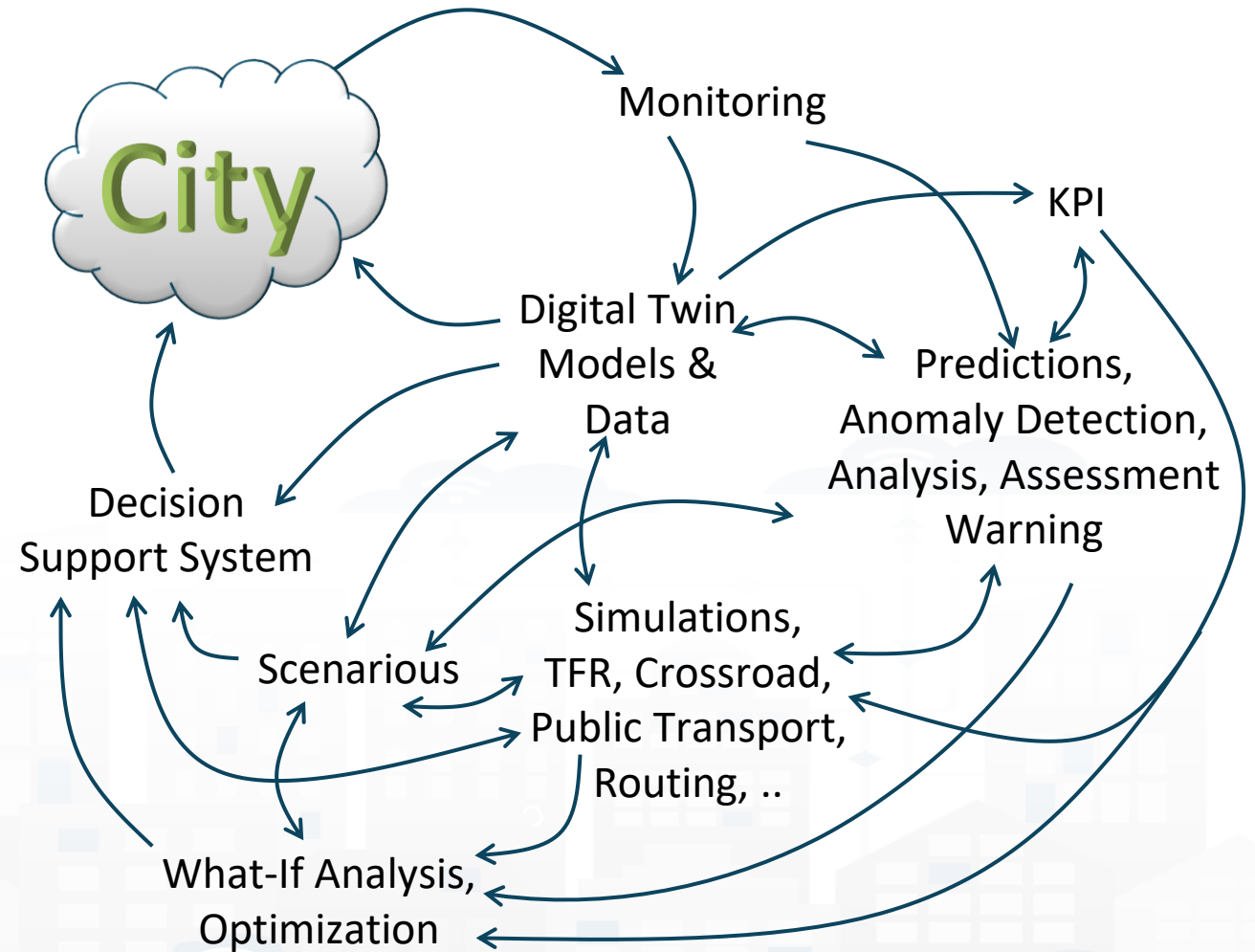
Snap4City **MOST**
CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

Main Tasks

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



- **Controlling Status:** management, and operational
 - Monitoring via KPI
 - Predictions vs KPI
 - Anomaly detection
 - Neuro-Symbolic analysis
 - Risk assessment
 - Early warning on critical conditions
 - Fast What-if analysis
- **Making plan:** tactic and strategic, medium and long range, micro/macro
 - Simulation & optimization
 - Generative AI Prescriptions, scenarios
 - Resilience to Unexpected unknowns
 - What-if analysis wrt scenarios
 - Collaboration with stakeholders





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

www.snap4city.org



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Powered by
FIWARE

**FREE
TRIAL**

**PEN Test
Passed**

**EU GDPR
COMPLIANT**

SNAP4
Appliances and Dockers
Installations

**EUROPEAN OPEN
SCIENCE CLOUD**

Node-RED

JS Foundation

E015
digital ecosystem

NVIDIA

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



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



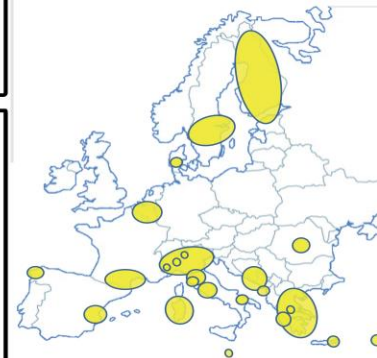
**EXPERT SYSTEM, KNOWLEDGE BASE
SEMANTIC REASONING
SMART DATA MODEL
IOT DEVICE MODELS, DATA SPACES**

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

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

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

- DEVELOPMENT ENVIRONMENT AND METHODOLOGY
- VISUAL PROGRAMMING, ML, AI, HPC
- TRAINING COURSES
- LLM ADVISOR

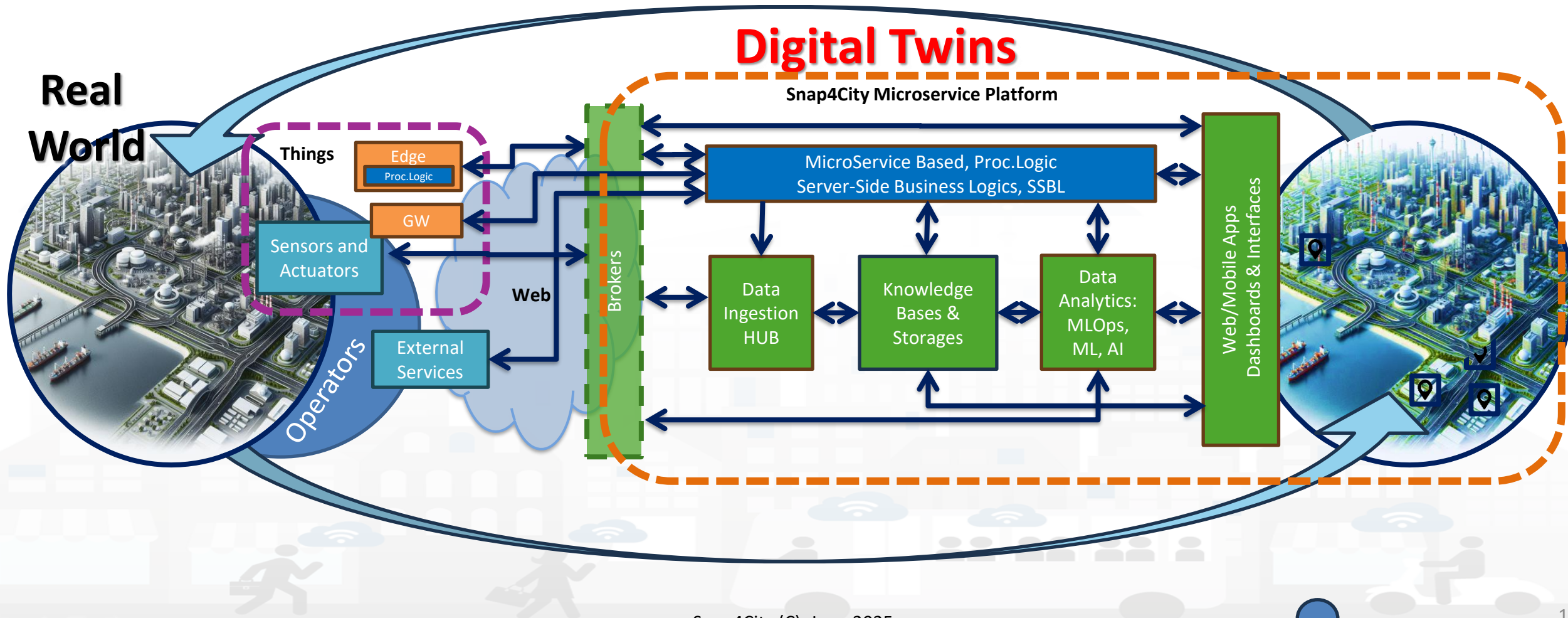


**NATIVE AND EXTERNAL
APPLICATIONS**

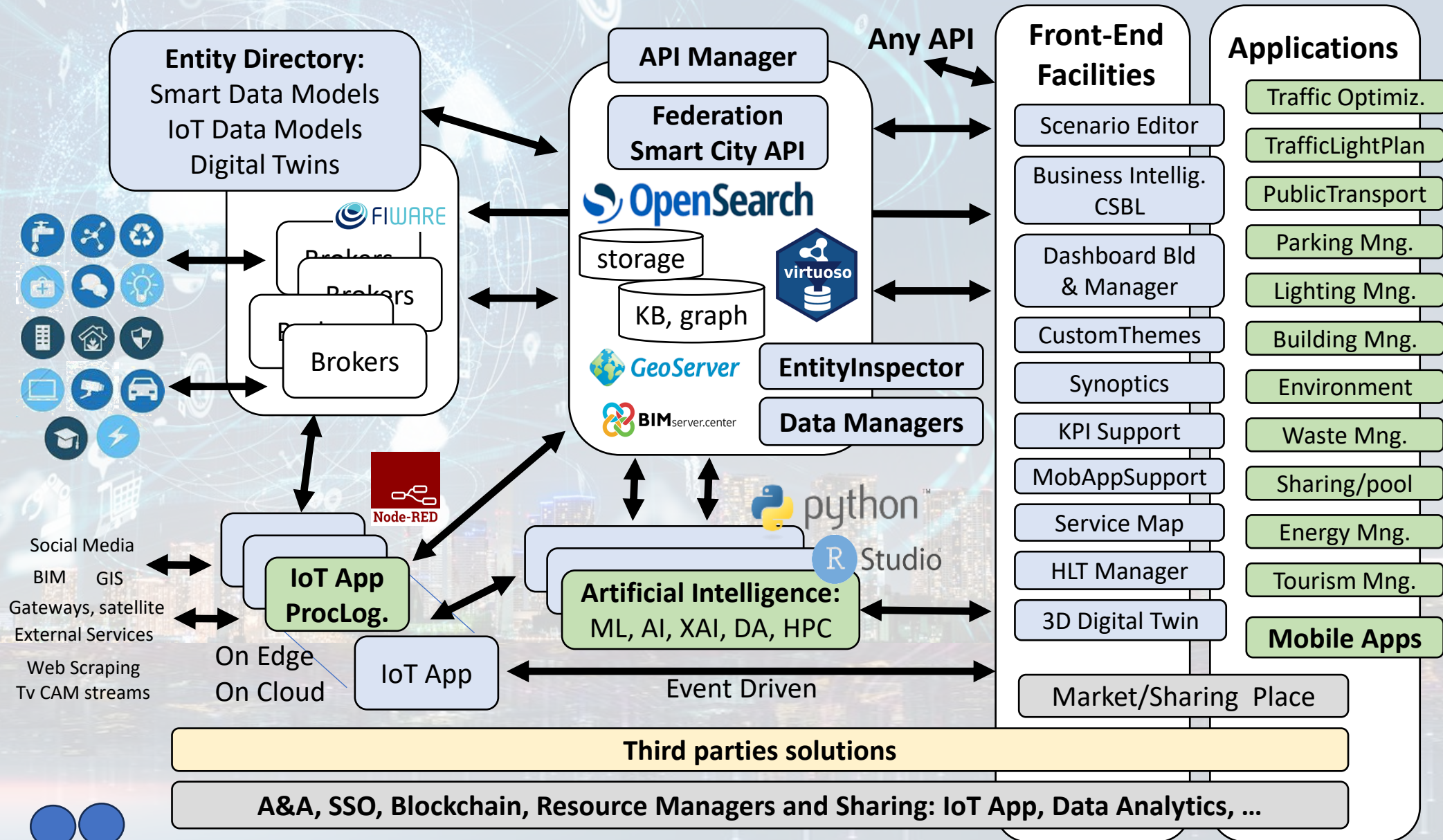
Smart Parking
Smart Light
Smart Waste
Smart Energy
Smart Building
Smart Tourism
...



Digital Twin Development Platform



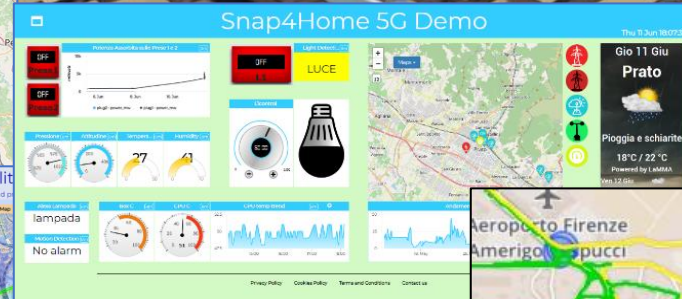
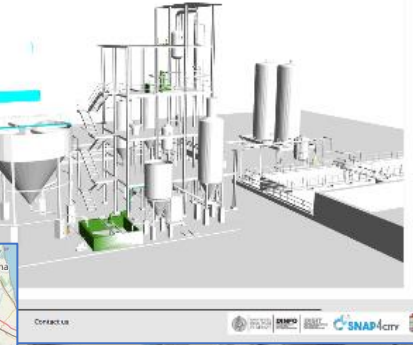
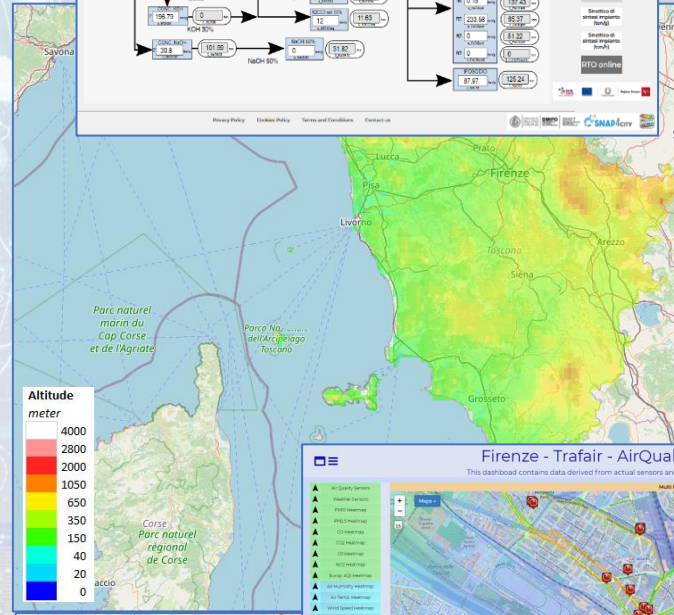
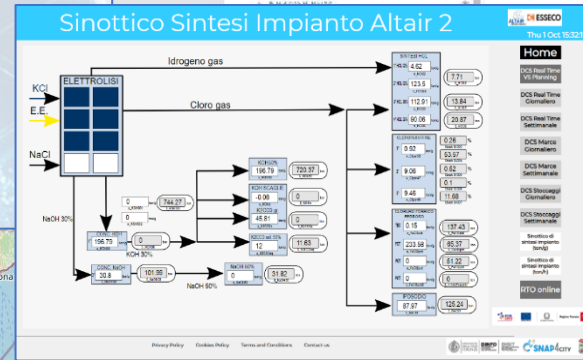
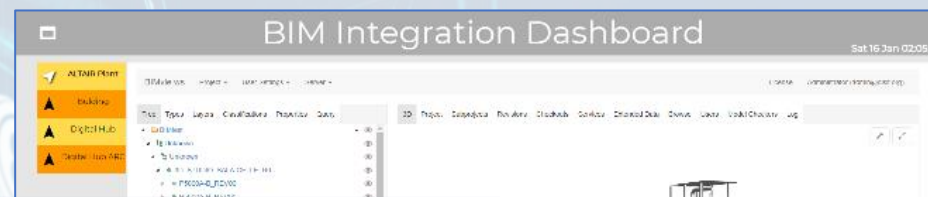
Technical Architecture



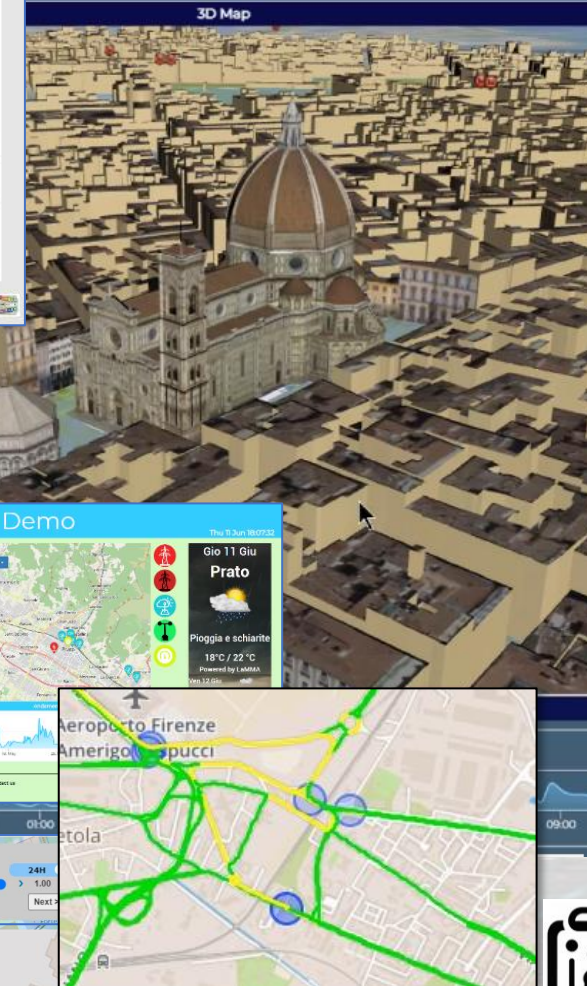
High Level Types

Snap4City (C), June 2025

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



SNAP4CITY
Digital Twin Global - Fire
demonstrator



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Standards and Interoperability



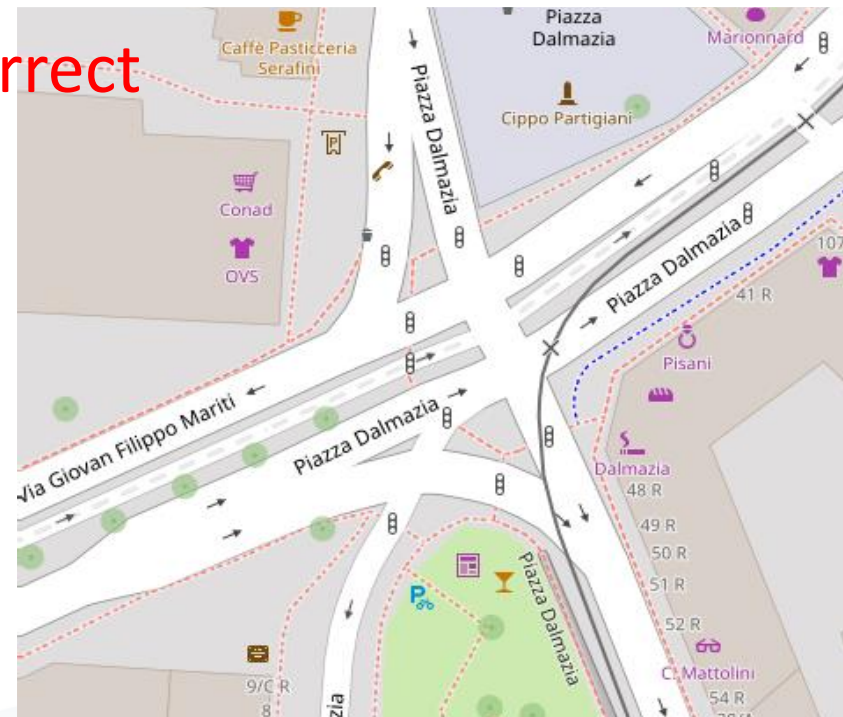
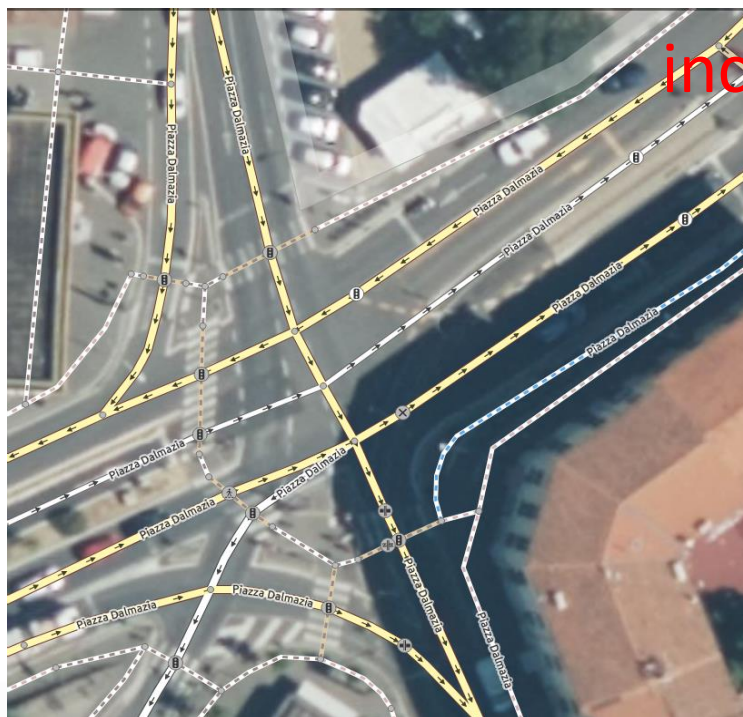
Compliant with:

- **IoT:** NGSI V2/LD, LoRa, LoRaWan, MQTT, AMQP, COAP, OneM2M, TheThingsNetwork, SigFOX, Libelium, IBIMET/IBE, EnOcean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, BACnet, TALQ, Protocol Buffer, KNX, OBD2, Proximus, ..
- **IoT model:** FIWARE Smart Data Model, Snap4City IoT Device Models
- **General:** HTTP, HTTPS, TLS, Rest Call, SNMP, TCP, UDP, SOAP, WSDL, FTP, FTPS, WebSocket, WebSocket Secure, GML, WFS, WMS, WCS, RTSP, ONVIF, AXIS TVCam, CISCO Meraki, OSM, Copernicus, The Weather Channel, Open Weather, OLAP, VMS Milestone, TIM, HERE,
- **Formats:** JSON, GeoJSON, XML, CSV, GeoTIFF, OWL, WKT, KML, SHP, db, XLS, XLSX, TXT, HTML, CSS, SVG, IFC, XPD, 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.

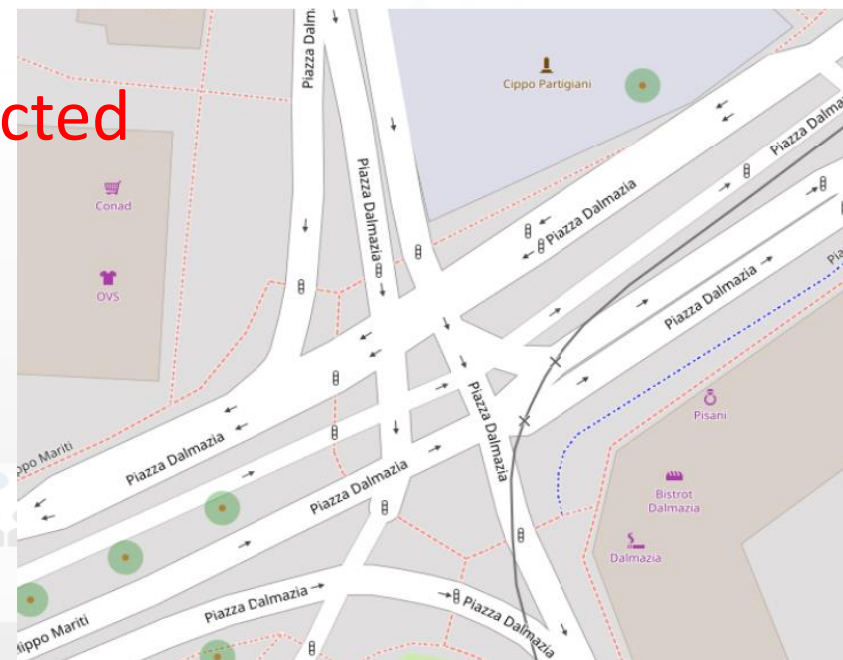
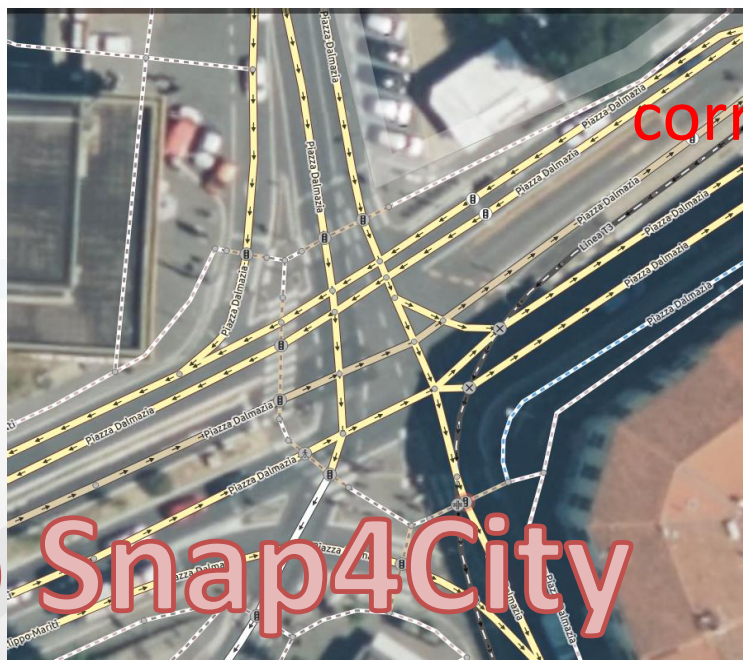
<https://www.snap4city.org/65>



OSM data with non
correct viability in Piazza
Dalmazia, Firenze



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



From OSM to Snap4City

Scenario Editor

Select map

Zoom

New Scenario

Editing
Drag & drop
Split & Join
Delete
Do and Undo

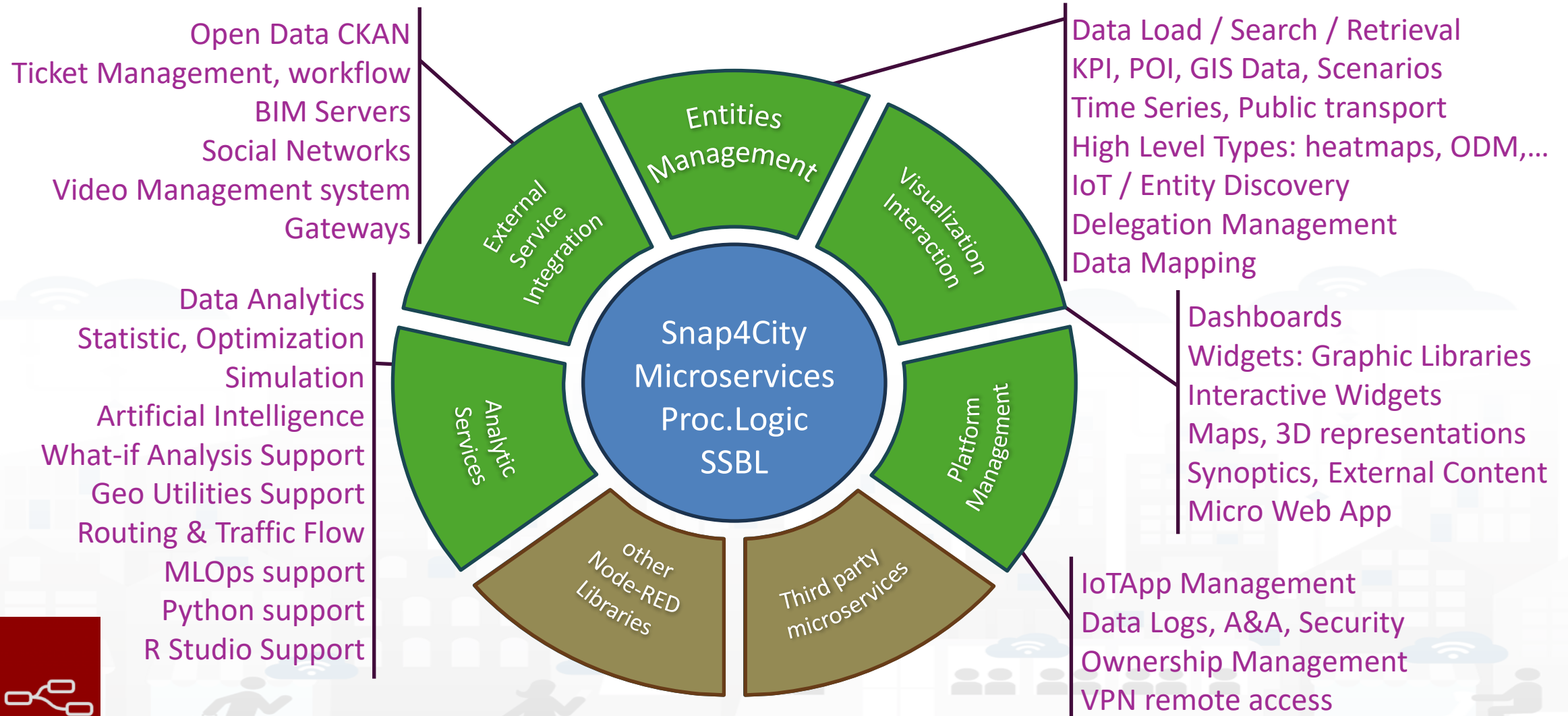
The main interface displays a map with various road segments represented by colored lines and arrows. A left toolbar contains icons for map selection, zooming, and editing. A top-right panel allows for scenario configuration, including name, location, description, and sensor settings. A bottom-right panel shows the 'Road Types' selection, with a grid of checkboxes for different road categories like 'abandoned', 'corridor', 'motorway', etc. A bottom-left panel shows 'View' and 'Edit' options, with checkboxes for 'Show Road graph' and 'Show Traffic Sensors'.

Edit Road
Segment

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

> 60.000 downloads (up to 2024)

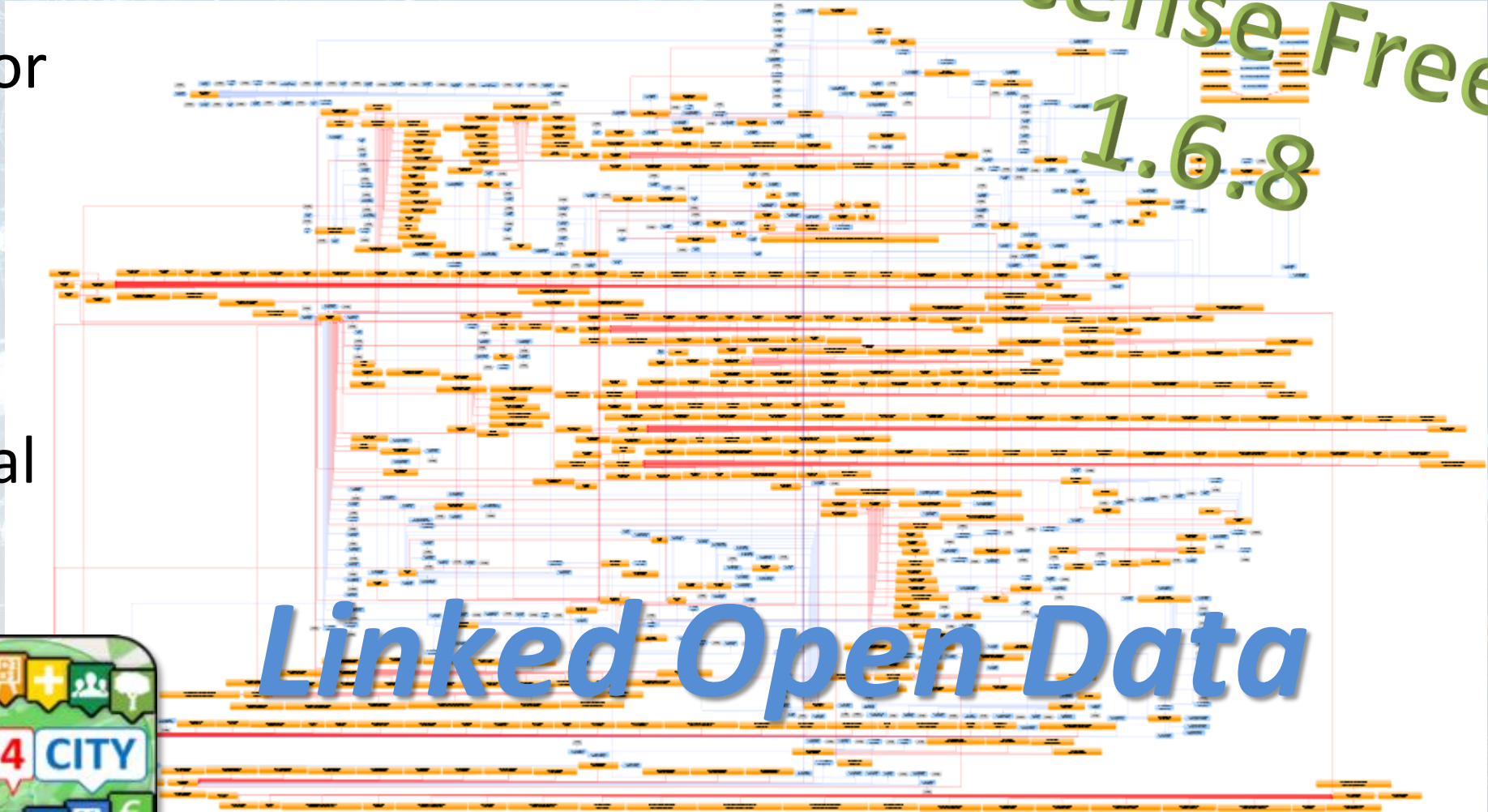
Areas



Expert System *semantic queries*



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



License Free
1.6.8

Linked Open Data



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



Available AI Solutions on Snap4City

<https://www.snap4city.org/997>

More than 80 Available Solutions & 300 AI applic.

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

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



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



• 15 Minute City Index:

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



- Optimization of car sharing/pooling
- Monitoring and Prediction of energy consumption
- Stimulating: Bike sharing, e-bikes, car charge, etc.
- Sizing energy plants



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



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



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

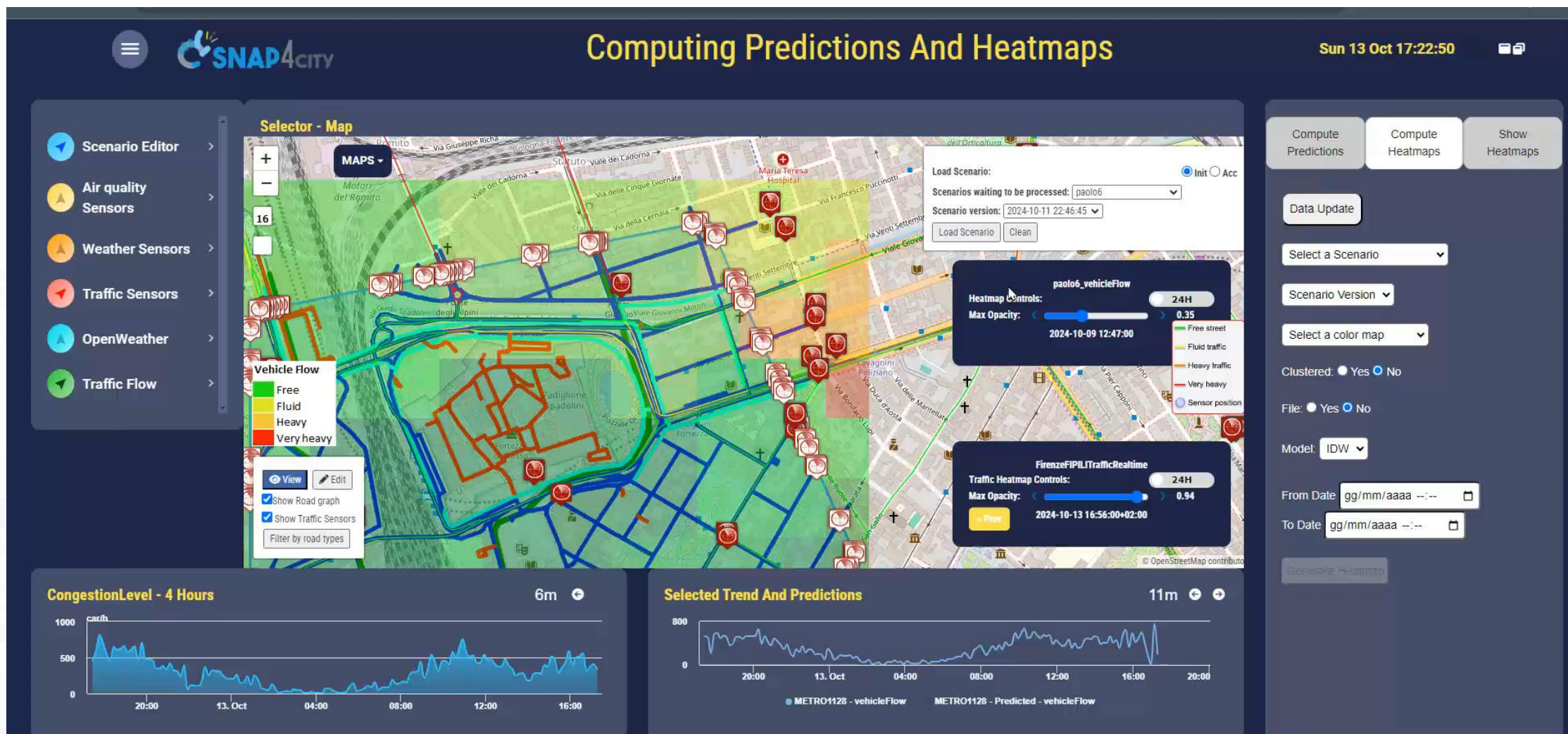


- Optimization of Waste Collection
- business intelligence tools for decision makers
- Reduction production costs
- Monitoring resource consumption



- Shortening justice time
- Prediction of mediation proneness
- Assisting institution is taking legal decisions
- Anonymization and indexing legal docs.
- Ethical Explainable Artificial Intelligence

Predictions and Heatmaps in Real Time

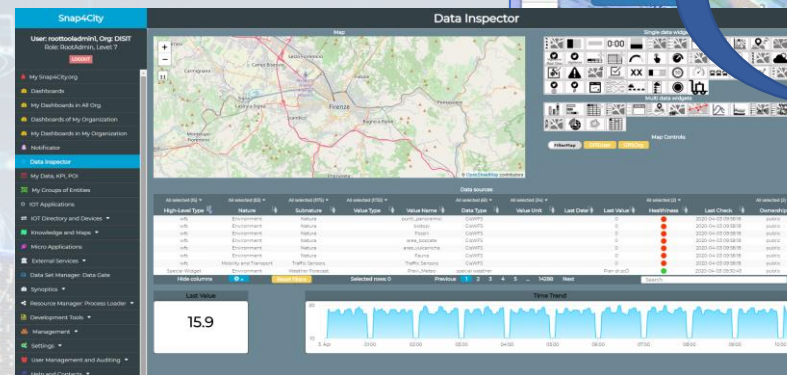
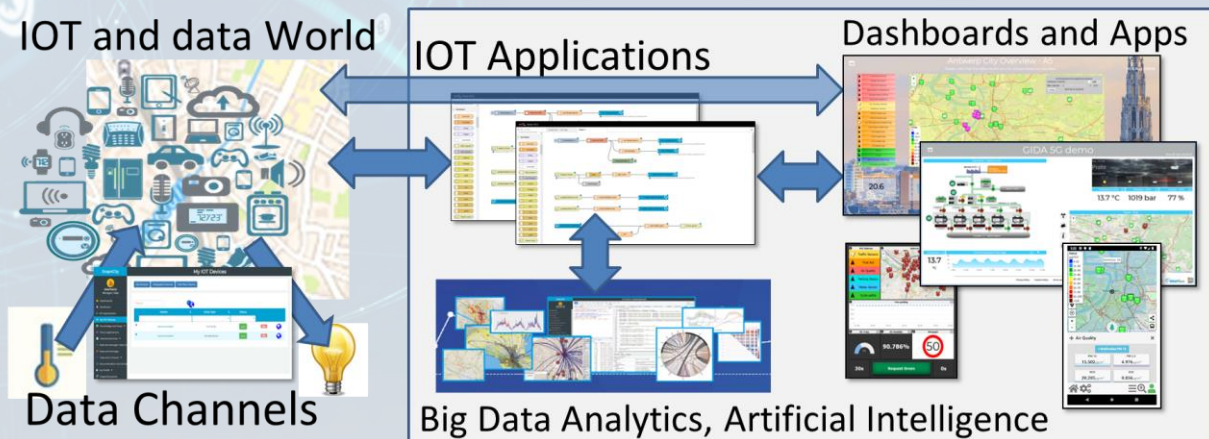


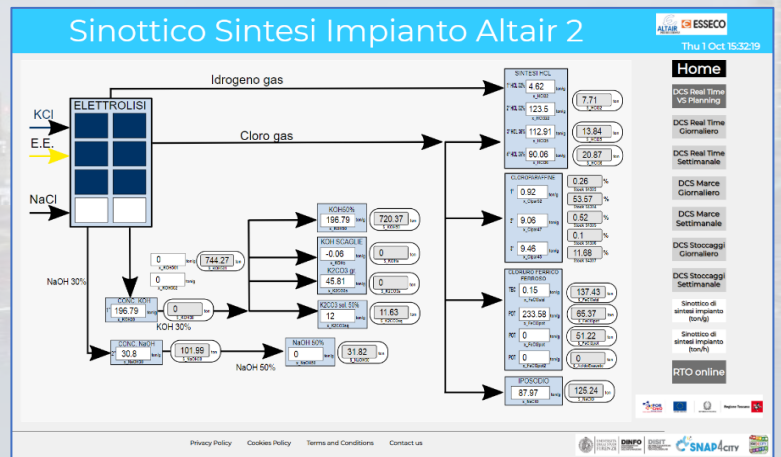
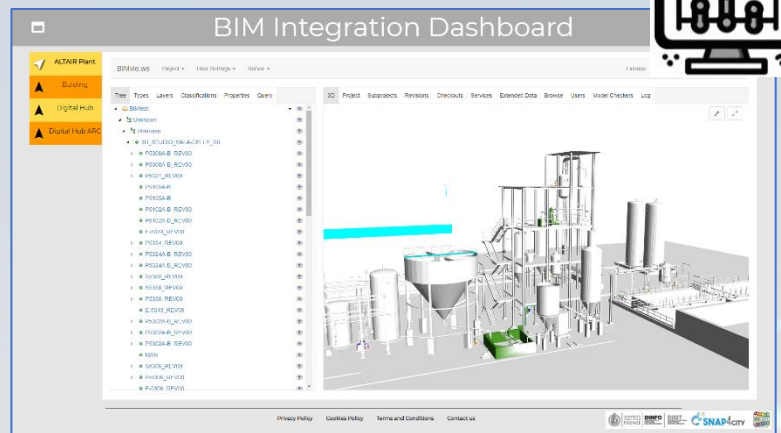
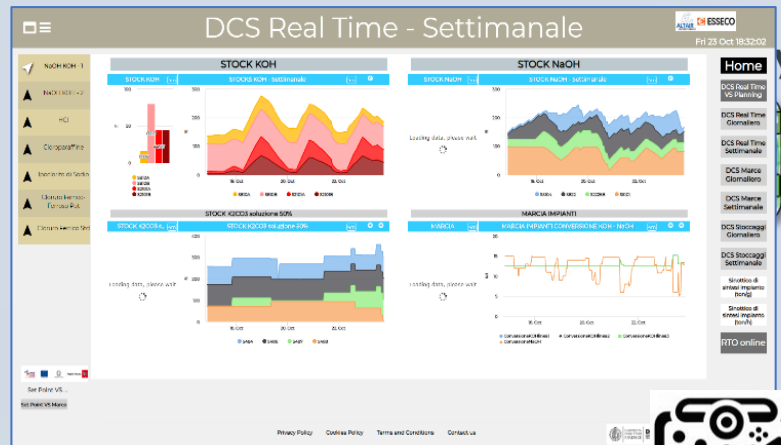
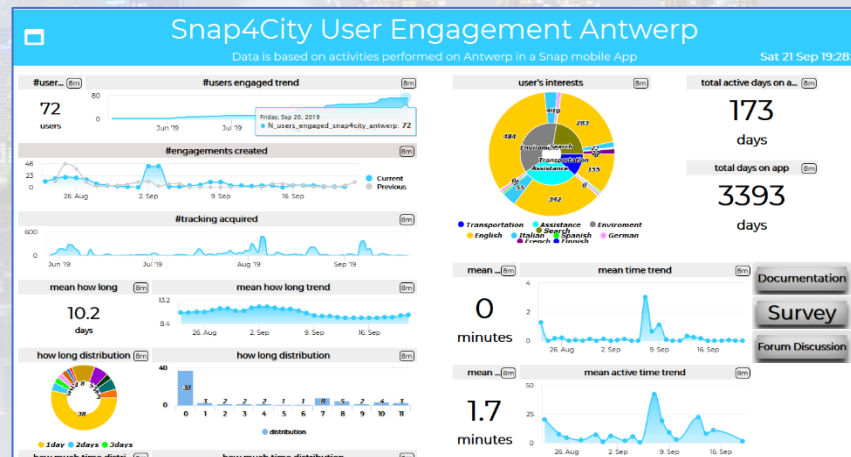
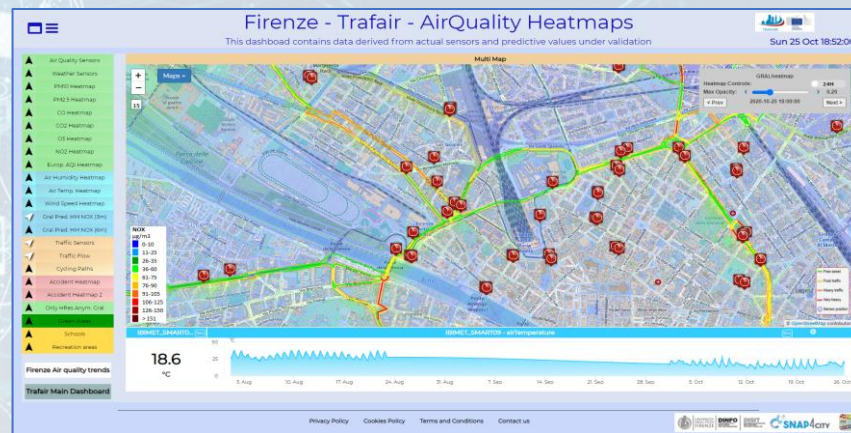
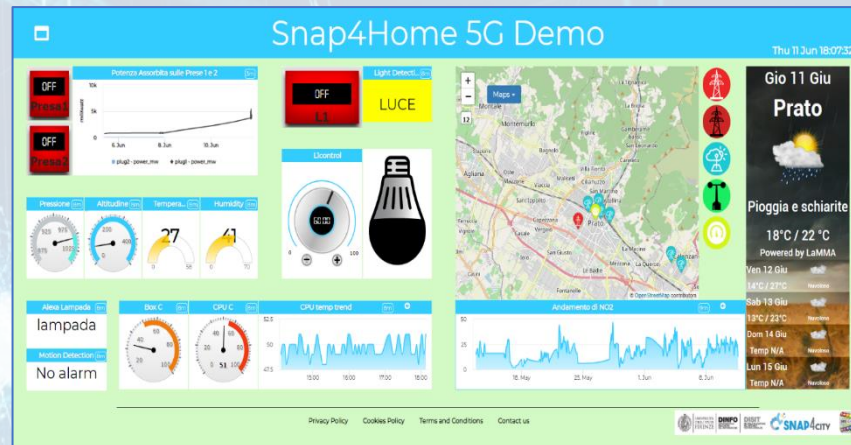
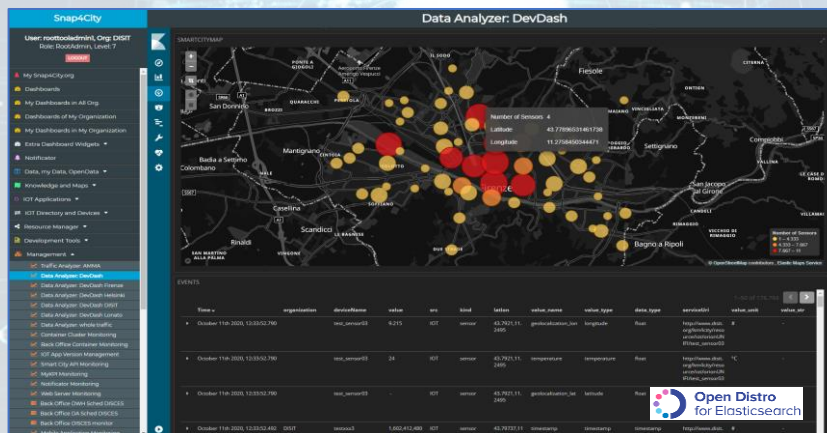
Solutions: reliable, secure and fast to realize

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

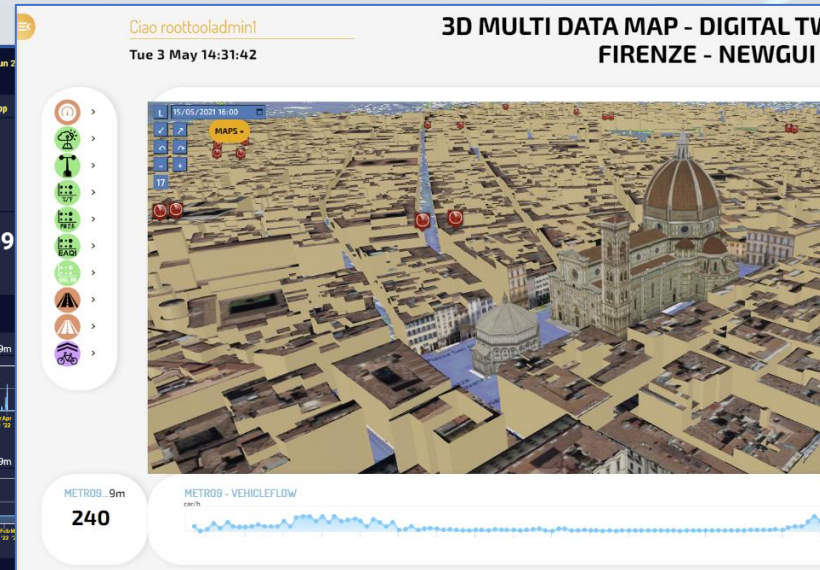
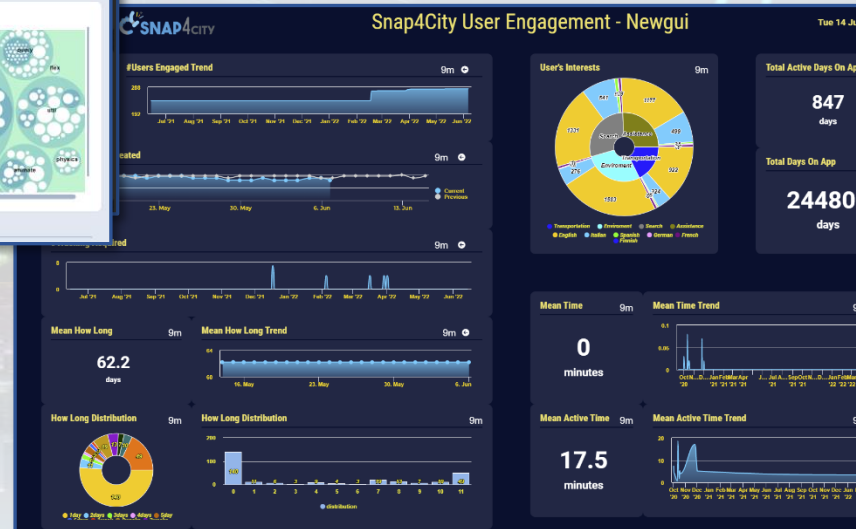
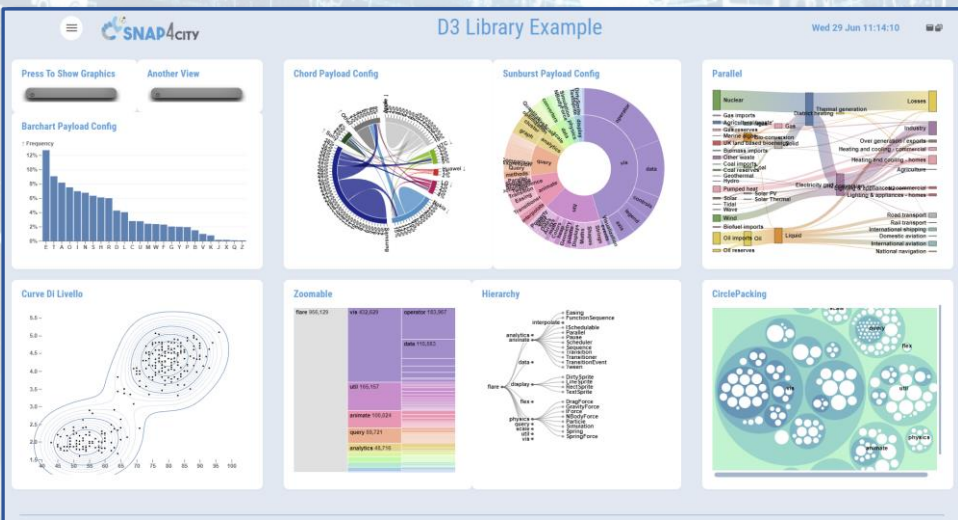
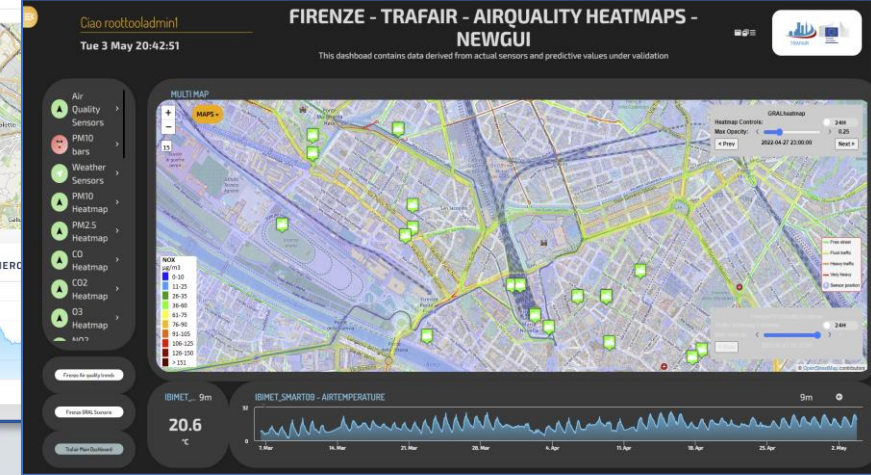
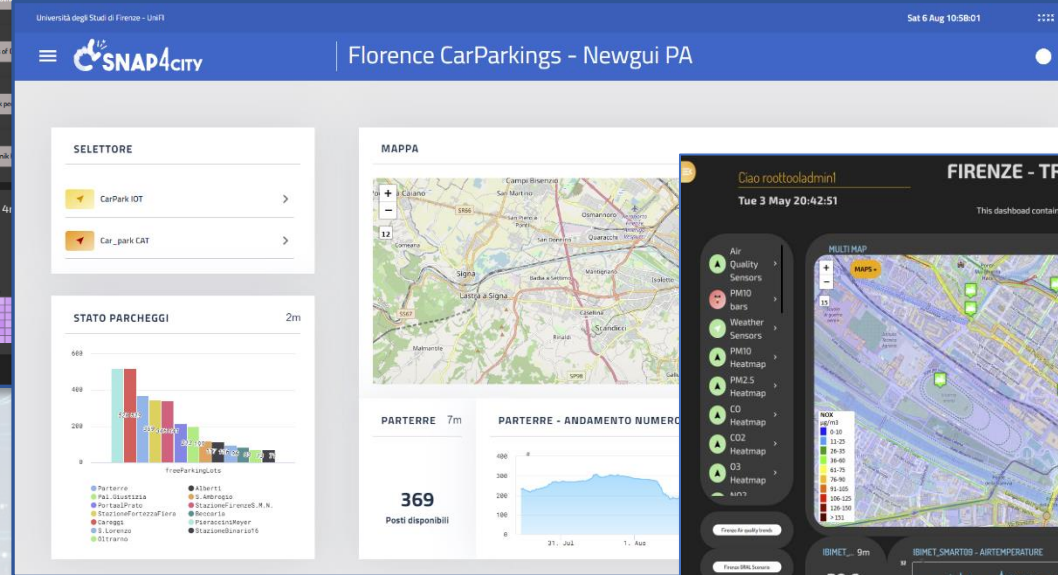
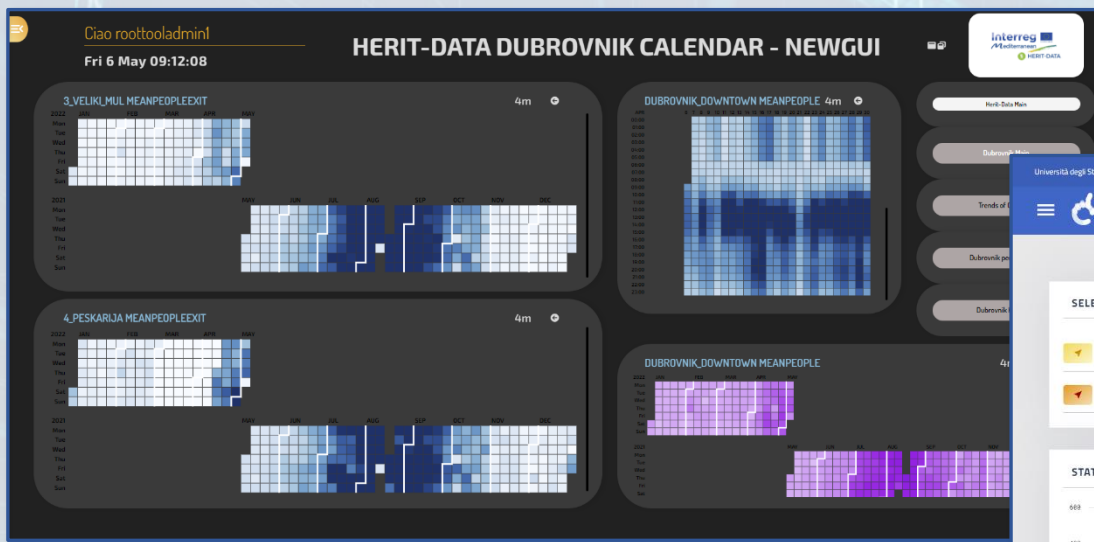
- Smart Solutions results to be

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





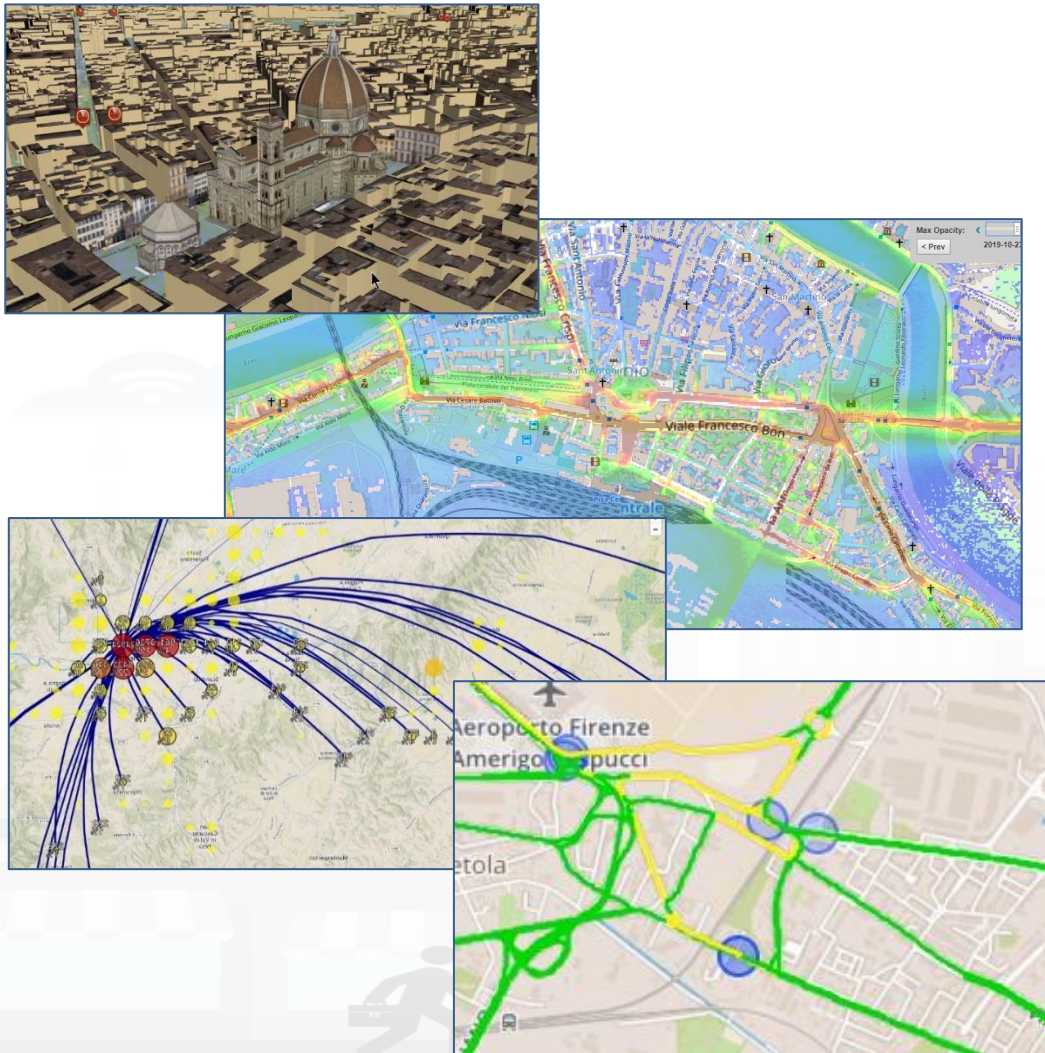
Different Themes



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

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

Smart City Digital Twin



City Digital Model with...

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



Complex and heterogeneous information, interoperability

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



Ciao roottooladmin!

Fri 2 Sep 19:13:07

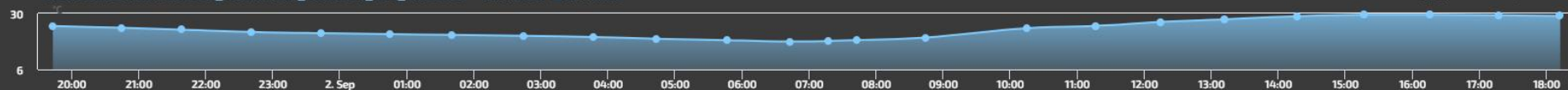
3D MAP GLOBAL DIGITAL TWIN - NEWGUI



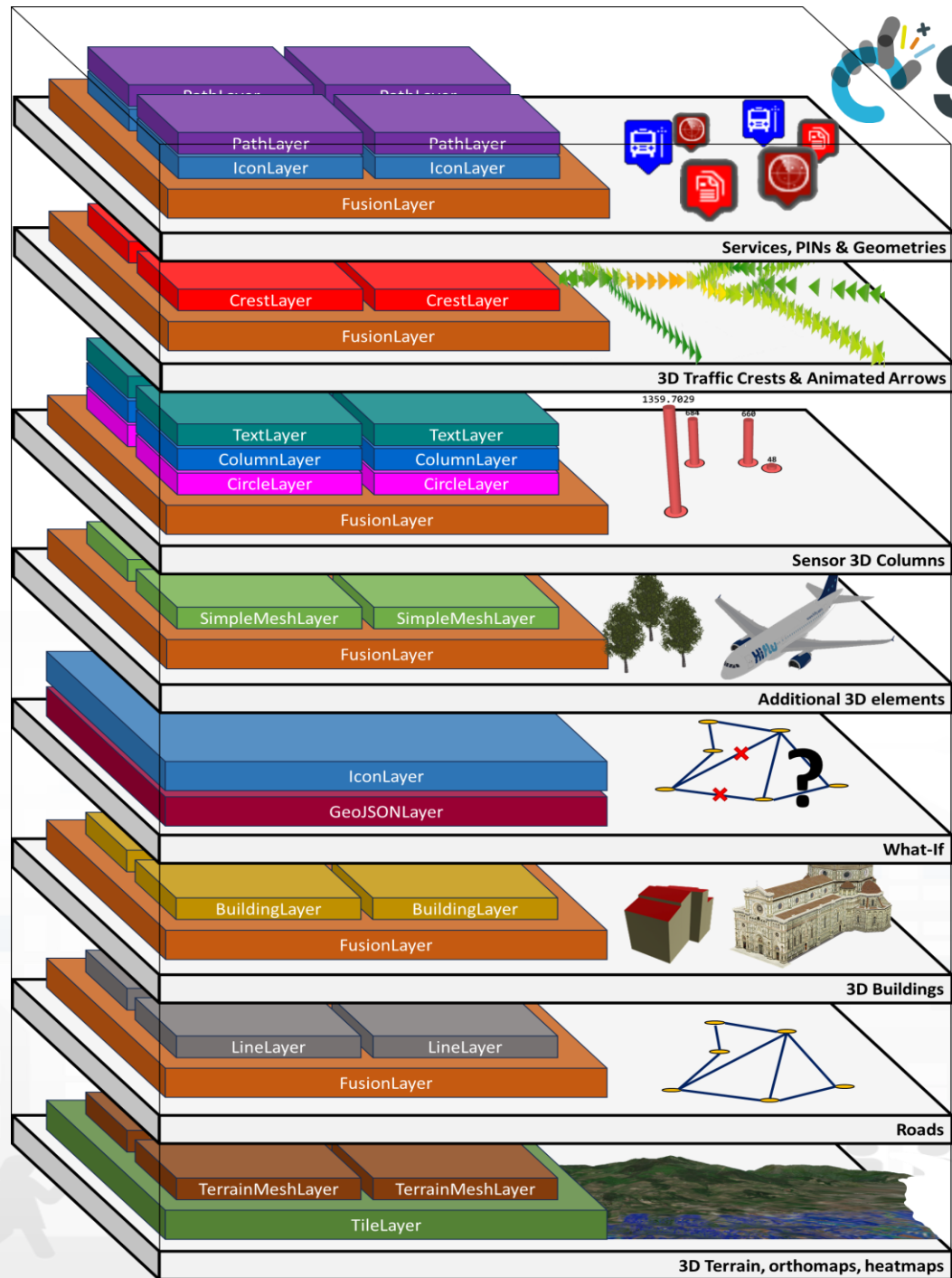
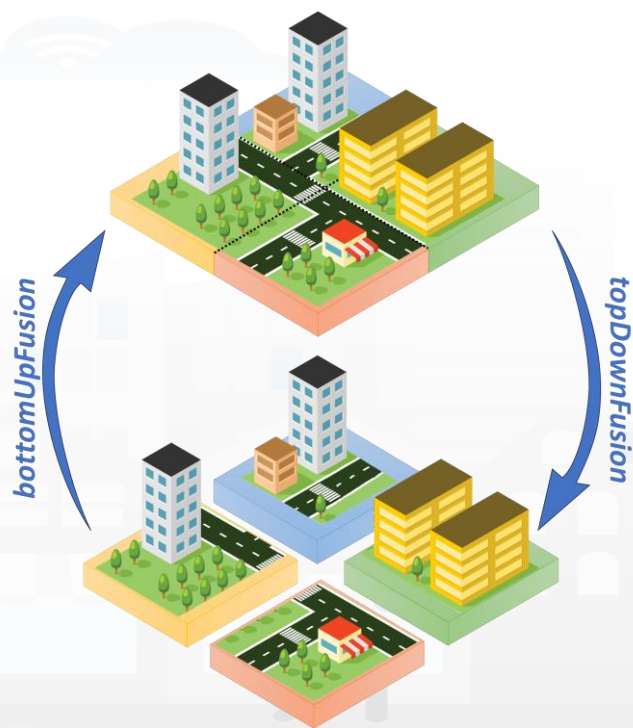
3D MAP

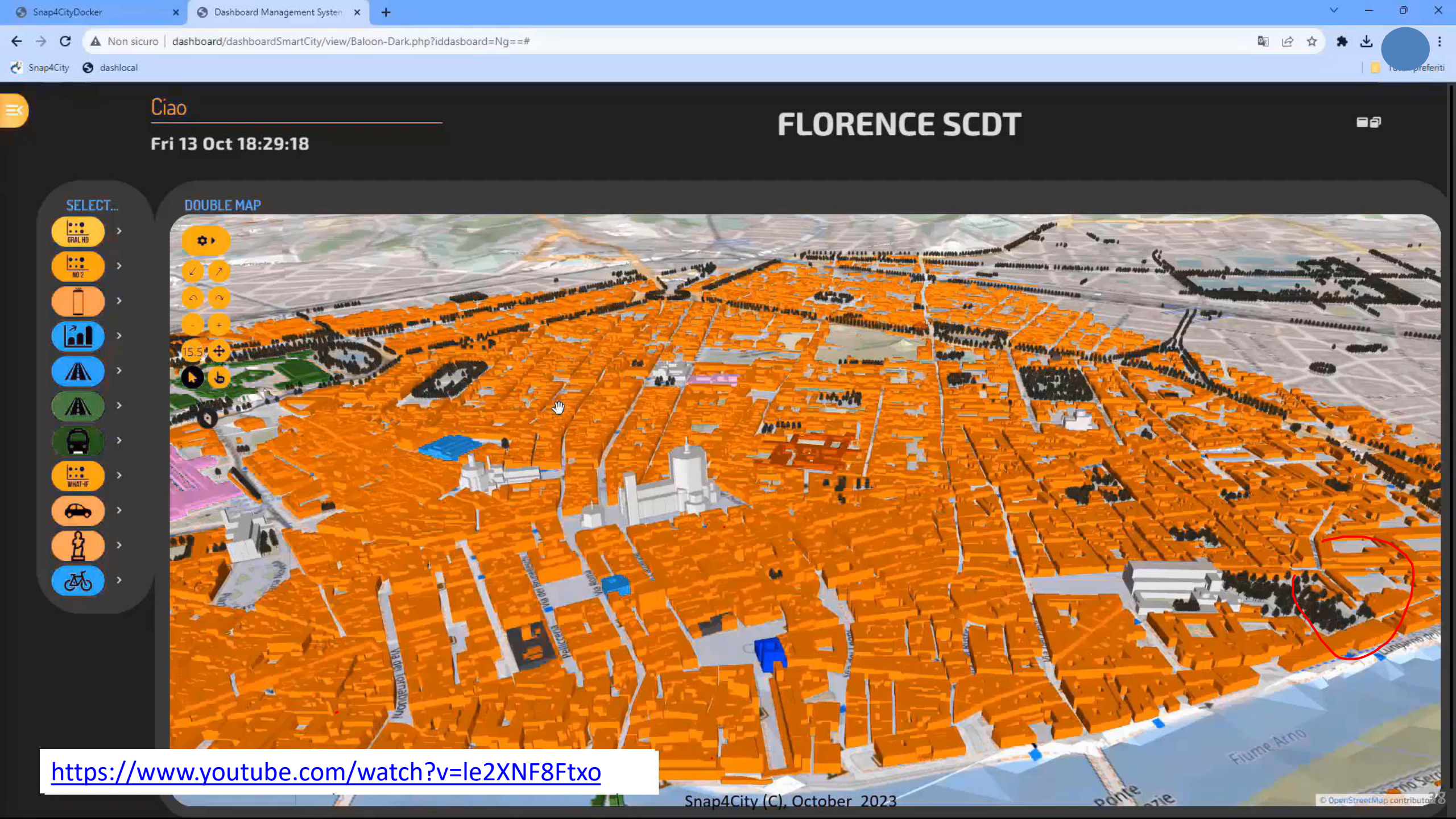


DISIT:ORIONUNIFI:TUSC_WEATHER_SENSOR_OW_3176959 - AIRTEMPERATURE



Layers VS Fusion Layers



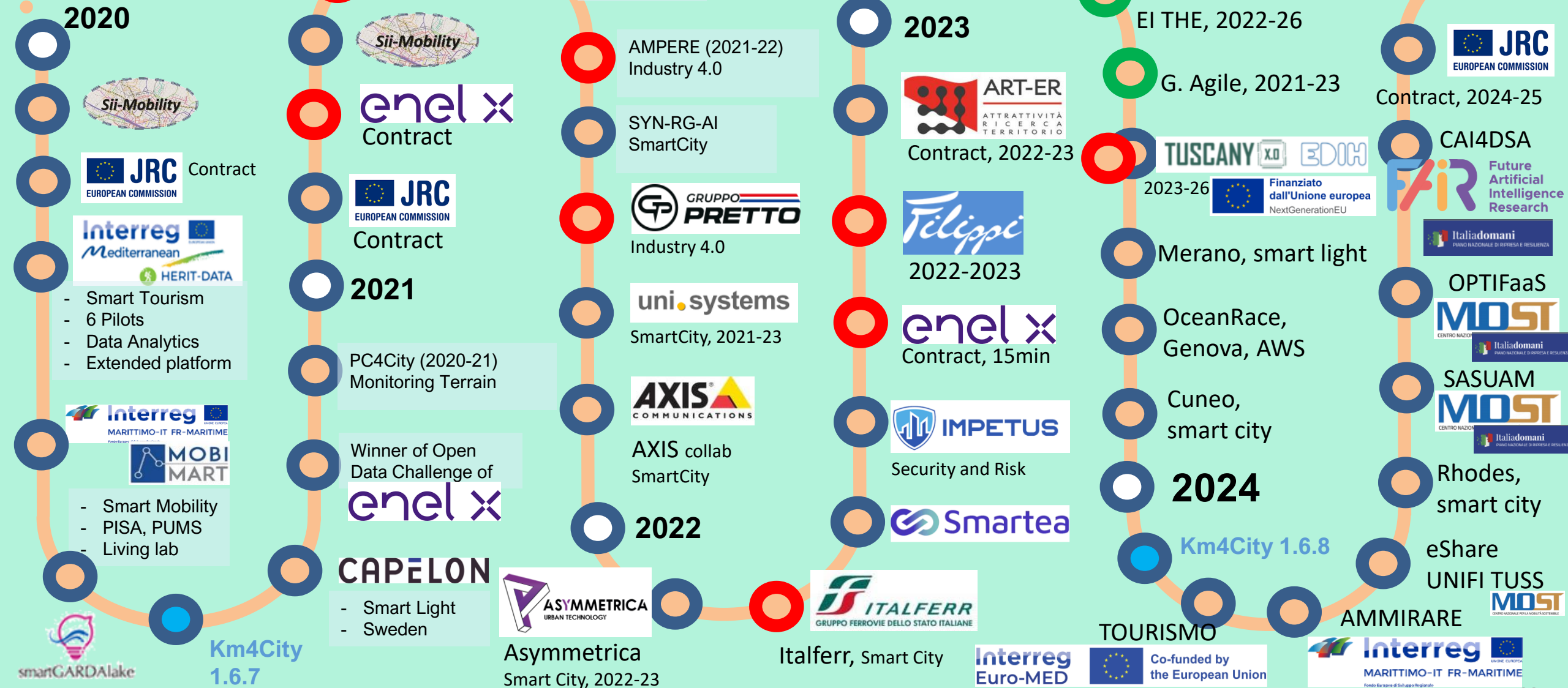


<https://www.youtube.com/watch?v=le2XNF8Ftxo>



- Snap4City at OSAKA with OPTIFaaS and CN MOST
- SMART3R-FLITS: SMART Transport for TRavellers and Freight Logistics Integration Towards Sustainability
- SOLUTION: Security, Smart City Asset Management for Cuneo, Italy [PDF](#)
- ENERGIA: R&S di autoclave a mandrini multipli nel curing di serbatoi in composito per storage di H2 mediante ottimizzazione energetica machine learning.
- UrbanDT4TF: Urban Digital Twin for Traffic Flow
- ELLIE: On the Use of Internet of Senses for the Cultural Heritage
- Snap4Rhodes: The "Single Smart City & Cyber Security Monitoring Platform" for the Municipality of Rhodes
- SADI-MIAC: Integrated Decision Support System with Digital Twin Models and Artificial Intelligence for Business
- SADI-MIAC: Sistema di Assistenza alle Decisioni Integrato con Modelli Digital Twin e Intelligenza Artificiale per le attività commerciali
- SCENARIO: City Users' Participation and Engagement with Snap4City, [PDF](#)
- OPTIFaaS: Operation and Plan, Transport Infrastructure and Facilities Support as a Service
- SOLUTION: 15MinCityIndex: understanding city areas by means of 13 different aspects, [PDF](#)
- SOLUTION: Energy Management and Control, [PDF](#)
- SOLUTION: Environment Control, Predictions & Prescriptions, [PDF](#)
- SOLUTION: Smart Light Control and Light Adaptive with Traffic Density [PDF](#)
- SOLUTION: Smart Tourism Management with Snap4City [PDF](#)
- SOLUTION: Traffic Infrastructure Optimisation: reducing travel time and emissions [PDF](#)
- SOLUTION: Traffic Light Plan Optimisation: reducing travel time, number of stops for vehicles and tramway lines: [PDF](#)
- SOLUTION: Snap4Building: monitoring, managing, controlling infrastructures [PDF](#)
- SOLUTION: Snap4City integration with Milestone X Protect, VMS, Video Management System [PDF](#)
- SOLUTION: Snap4City Digital Twin, [PDF](#)
- SOLUTION: eShare in a Snap - The innovative car sharing and car pooling service, [PDF](#)
- SOLUTION: Snap4City Smart Parking Manager and mobile App supports [PDF](#)
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++2024/25

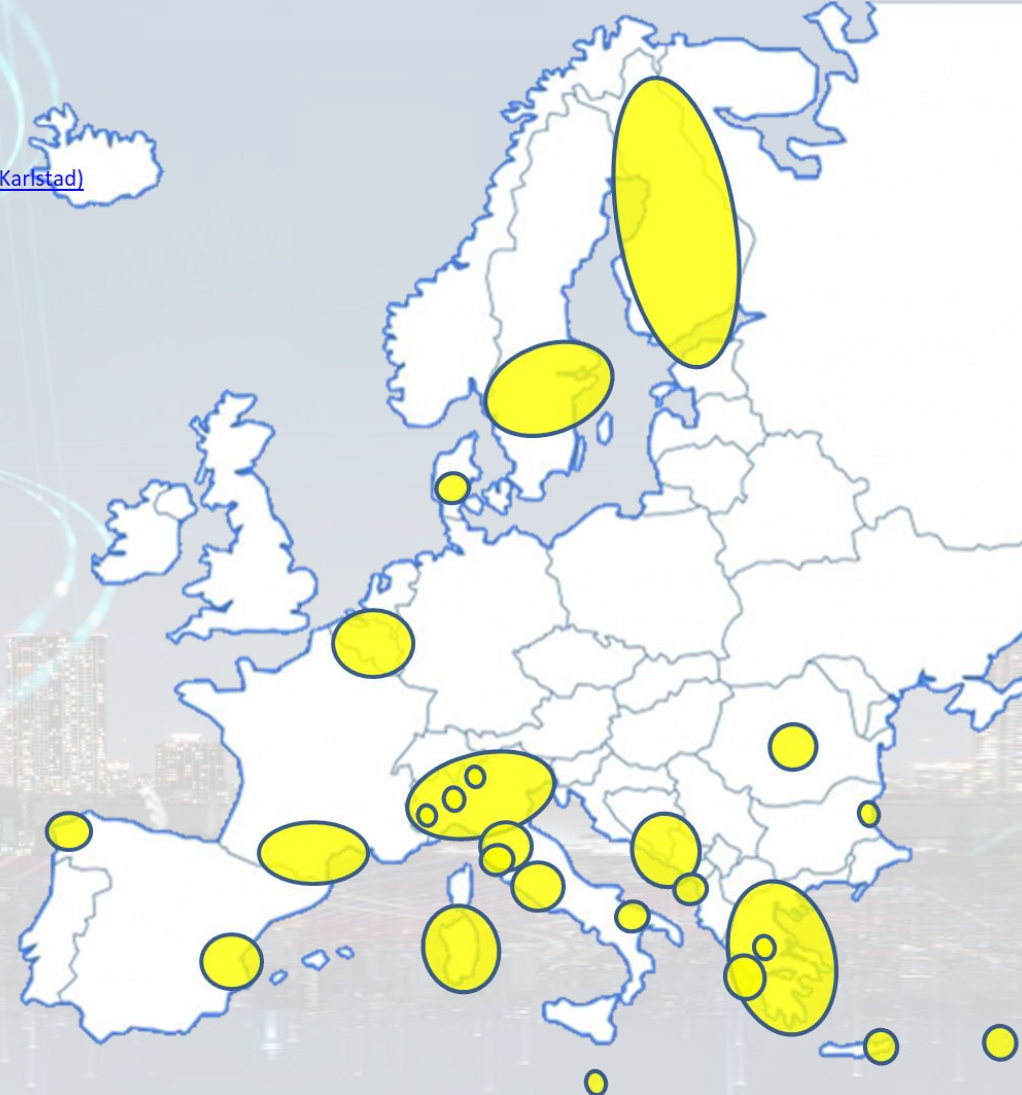
- **UrbanDT4TF**, CN HPC: Digital Twin mobility, <https://www.snap4city.org/drupal/node/1057>
 - **DI-DTPlatform**, CN HPC: Digital Twin, mobility, environment, <https://www.snap4city.org/drupal/node/1097>
 - **Sasuum**, CN MOST, PNRR: AI, mobility, <https://www.snap4city.org/drupal/node/999>
 - **OPTIFaaS**, CN MOST, PNRR: AI, mobility, DSS, <https://www.snap4city.org/drupal/node/1008>
 - **LeverageOPTIFaaS**, CN MOST: PNRR, mobility, <https://www.snap4city.org/drupal/node/1064>
 - **TOURISMO**, Interreg, EC: Tourism, NLP, DSS, <https://www.snap4city.org/drupal/node/1001>
 - **ELLIE**, Horizon Europe, EC: AI, VR, <https://www.snap4city.org/drupal/node/1056>
 - **CN MOST**, PNRR: sustainable mobility, platform, <https://www.snap4city.org/drupal/node/1050>
 - **ISPRA JRC contract**, EC: DSS, SOC, control room, energy, <https://www.snap4city.org/drupal/node/970>
 - **AMMIRARE**, Interreg, EC: AI, environment, Big Data, <https://www.snap4city.org/drupal/node/1002>
 - **CAI4DSA**, FAIR PE1, PNRR: AI, Neuro-Symbolic, PINN, NG-DSS, <https://www.snap4city.org/drupal/node/1016>
 - **SADI-MIAC**, RT, partner: AI, Tourism, Retail, Computer Vision, <https://www.snap4city.org/drupal/node/1055>
 - **PRIN UNICagliari**, **SMART3R**: mobility, DSS, <https://www.snap4city.org/drupal/node/1087>
 - **Tuscany X.0**, **EDIH**, TestBeforeInvest, Training on AI, Big Data, Security, HPC: <https://www.tuscanyx.eu/>
 - **The IE**, PNRR: AI, NLP, Legal Aspects
 - **Energia**, RT, conv: AI, PINN, DSS
 - **RFI contract**: mobility, AI, DSS
 - **Salerno Port**: for container ID recognition
 - **Talent Hub**, ECRF, conv: NLP, match demand vs offer
- + currently: Merano, Salerno, Cuneo, Rhodes, Reverberi, Florence, IDTS, ALTAIR, etc.



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

Main Organizations/areas

- [Antwerp area \(Be\)](#)
- [Bari \(I\)](#)
- [Bisevo, Croatia](#)
- [Bologna \(I\)](#)
- [Brasov \(Ro\)](#), by ICEBERG
- [Capelon \(Sweden: Västerås, Eskilstuna, Karlstad\)](#)
- [Cuneo \(I\)](#)
- [DISIT demo \(multiple\)](#)
- [Dubrovnik, Croatia](#)
- [Firenze area \(I\)](#)
- [Garda Lake area \(I\)](#)
- [Greece \(Gr\)](#)
- [Helsinki area \(Fin\)](#)
- [Limassol \(Cy\)](#)
- [Livorno area \(I\)](#)
- [Lonato del Garda \(I\)](#)
- [Malta \(Malta\)](#)
- [Merano \(I\)](#)
- [Modena \(I\)](#)
- [Mostar, Bosnia-Herzegovina](#)
- [Oslo & Padova \(Impetus\)](#)
- [Pisa area \(I\)](#)
- [Pistoia \(I\)](#)
- [Pont du Gard, Occitanie \(Fr\)](#)
- [Prato \(I\)](#)
- [Rhodes \(Gr\)](#)
- [Roma \(I\)](#)
- [Santiago de Compostela \(S\)](#)
- [Sardegna Region \(I\)](#)
- [Siena \(I\)](#)
- [SmartBed \(multiple\)](#)
- [Toscana Region \(I\), SM](#)
- [Valencia \(S\)](#)
- [Varna \(Bulgaria\)](#)
- [Venezia area \(I\)](#)
- [WestGreece area \(Gr\)](#)



booklets

- Smart City



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

- Industry



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

- Artificial Intelligence



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



Control Planning

Goals

Control

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

Planning

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



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

www.snap4city.org



UNIVERSITÀ
DEGLI STUDI
FIRENZE

DINFO
DIPARTIMENTO DI
INGEGNERIA
DELL'INFORMAZIONE

DISIT
DISTRIBUTED SYSTEMS
AND INTERFACES
TECHNOLOGIES LAB

Powered by
FIWARE

**FREE
TRIAL**



**PEN Test
Passed**



**EU GDPR
COMPLIANT**



**SNAP4
Appliances and Dockers
Installations**



**EUROPEAN OPEN
SCIENCE CLOUD**



Node-RED



JS Foundation

E015
digital ecosystem



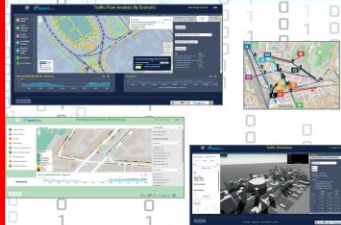
NVIDIA

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

HORIZONTAL AI PLATFORM



MOBILITY AND TRANSPORT



SMART ENERGY AND SMART BUILDING



ENVIRONMENT AND WASTE MANAGEMENT



CITY USER'S SERVICES AND TOURISM MANAGEMENT



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



DASHBOARDS, WIDGETS
TEMPLATES



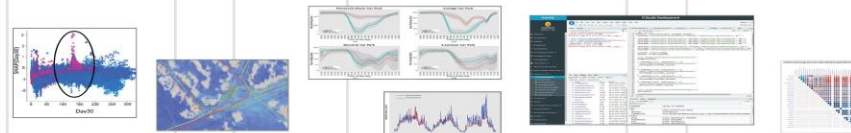
PREDICTION - ANOMALY DETECTION - CLUSTERING - ROUTING - SENTIMENT NLP - TRAFFIC FLOW - PEOPLE FLOWS - SDG
15 MIN CITY INDEX - KPI - HEATMAPS - ORIGIN DESTINATION - MAPS - VECTOR FIELD - ETC...



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



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



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



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

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



NATIVE AND EXTERNAL APPLICATIONS

Smart Parking

Smart Light

Smart Waste

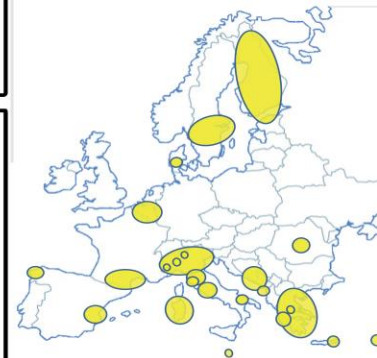
Smart Energy

Smart Building

Smart Tourism

...

- DEVELOPMENT ENVIRONMENT AND METHODOLOGY
- VISUAL PROGRAMMING, ML, AI, HPC
- TRAINING COURSES
- LLM ADVISOR



Key Performance Indicators, KPI



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

- **United Nations Sustainable Development Goals, SDGs** (for which cities can do more to achieve some of the 17 SDGs, <https://sdgs.un.org/goals>);
- **15 minutes cities** (where primary services must be accessible within 15 minutes on foot);
- **objectives of the European Commission** in terms of pollutant emissions for: NO₂, PM₁₀, PM_{2.5} (https://environment.ec.europa.eu/topics/air_en);
- **SUMI: mobility and transport vs env**
 - <https://www.snap4city.org/951>
- **SUMP/PUMS: mobility and transport vs env.**
- **ISO indicators:** city smartness, digitization, tech level.
- **Low Level/Real Time:** global traffic, quality of service, betweenness, centrality, queue, time to travel, etc.

Global
&
Local

Periodic
&
Realtime

15MinCityIndex

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

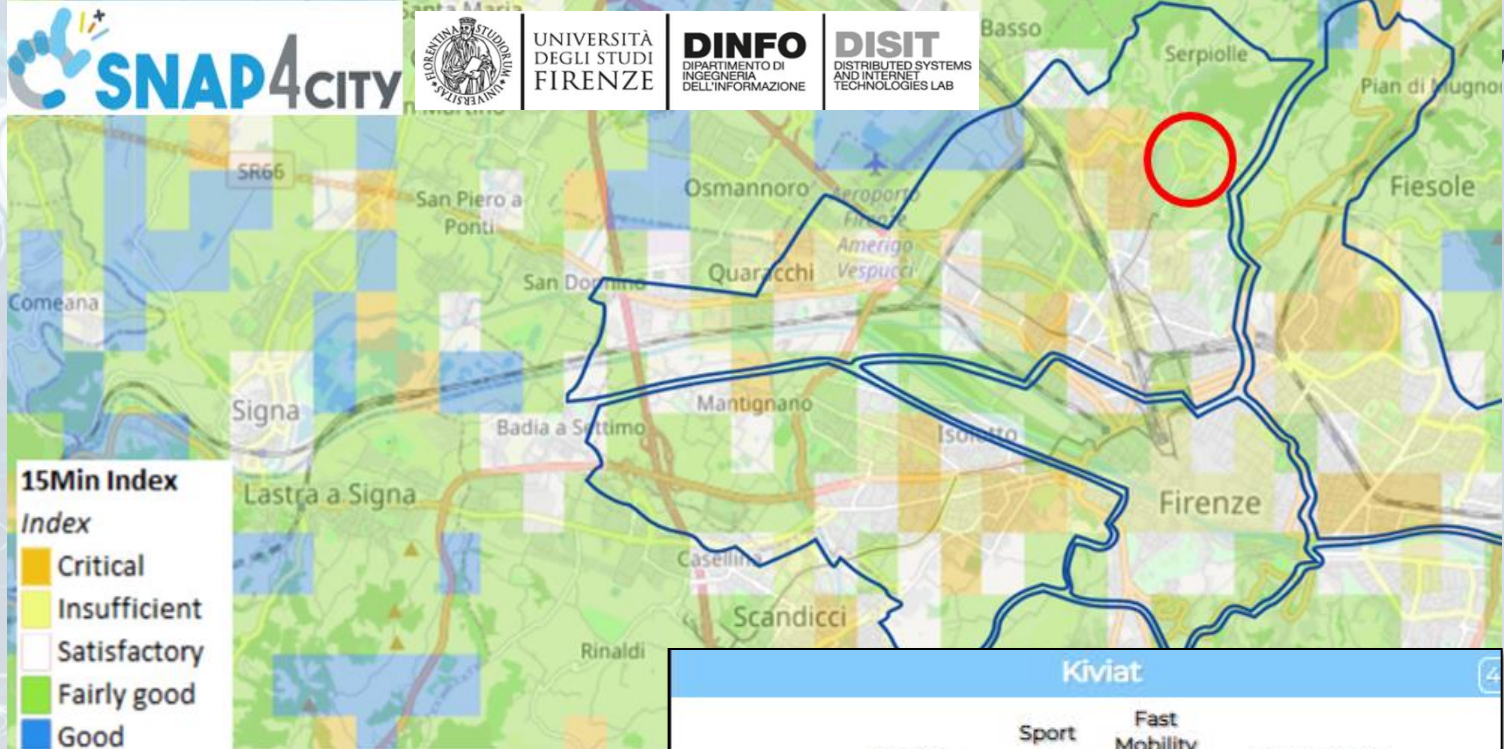
Using the Open Data:

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

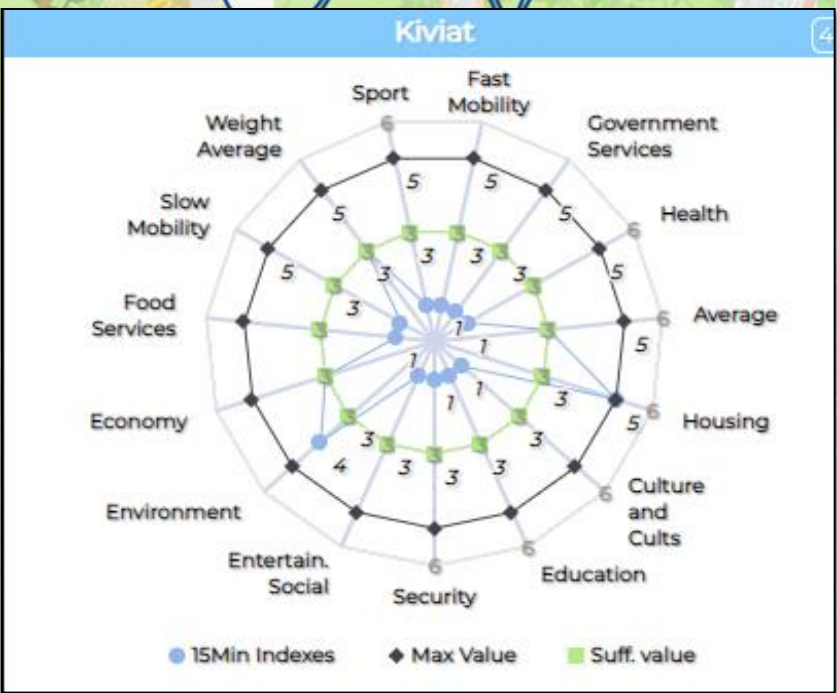
Good public transport services: bus, new tram line, train stations, cycle paths.



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



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



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

15MinCityIndex on Bologna

enel x



Ciao roottooladmin!

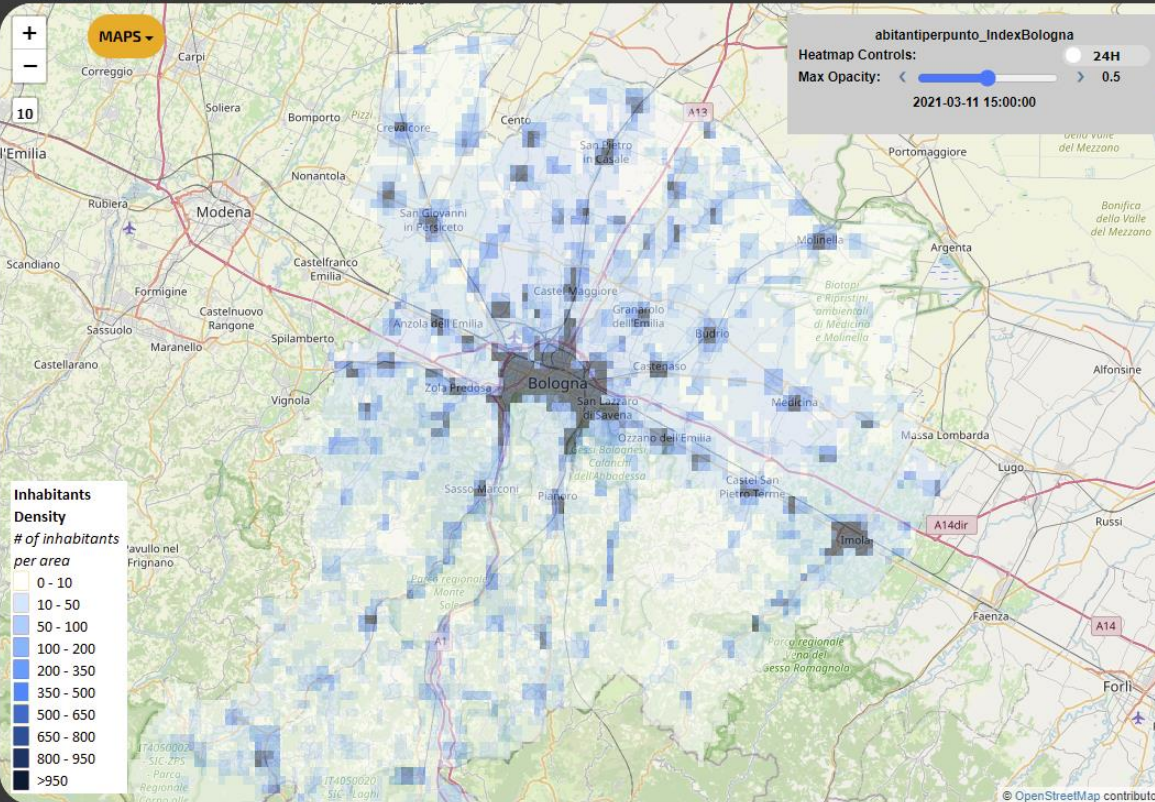
Tue 3 May 20:14:59

15 MINUTI INDEX BOLOGNA CITTÀ METROPOLITANA - NEWGUI

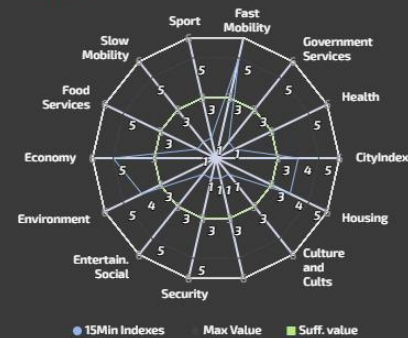


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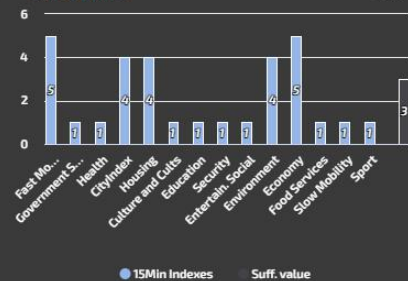
SELECTOR - MAP



KIVIAT



BAR SERIES



1 NO POVERTY



2 ZERO HUNGER



3 GOOD HEALTH AND WELL-BEING



4 QUALITY EDUCATION



7 AFFORDABLE AND CLEAN ENERGY



9 INDUSTRY, INNOVATION AND INFRASTRUCTURE



11 SUSTAINABLE CITIES AND COMMUNITIES



12 RESPONSIBLE CONSUMPTION AND PRODUCTION



13 CLIMATE ACTION



15 LIFE ON LAND



THE PICKED POINT

9m

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



Control Room









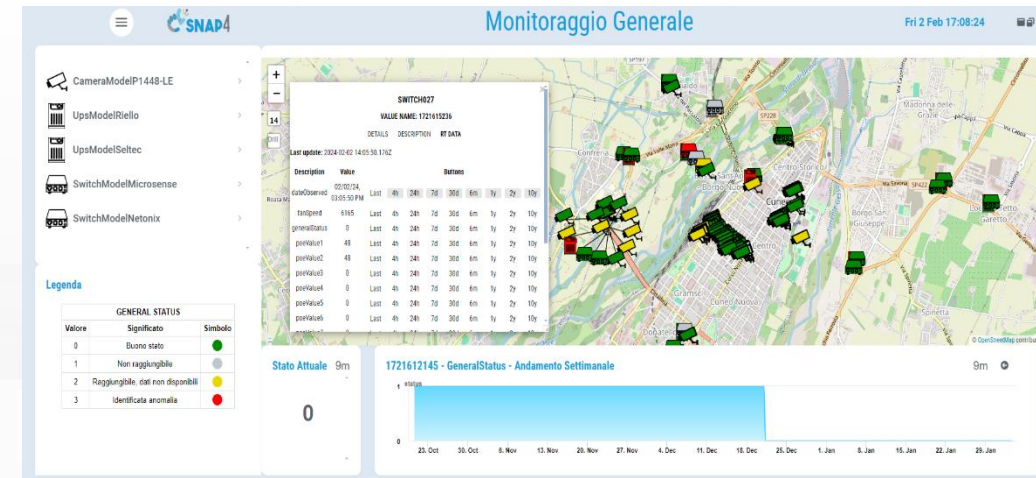
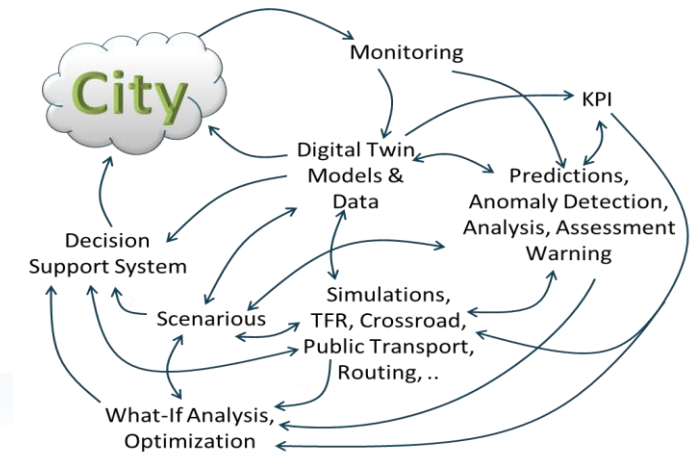






Assets Control Domain (2024/8)

- Goals:
 - Costs reduction, increase service availability, risk reduction
 - Quality Level
- Solutions for Operation (monitoring, managing, mobile apps, digital signages, control rooms)
 - Monitoring :
 - Assets:** switches, Wi-Fi, servers, UPS, sensors, building, TV Cams, etc.
 - Energy:** consumption, operative conditions, UPS continuity, etc.
 - Production:** continuous serviceability analysis
 - Etc.
 - Early detection/warning, alarm, of critical conditions
 - Multichannel** Event reporting, notifications: email, Telegram, mobile apps, SMS, etc.
 - Managing maintenance operation, predictive maintenance
 - Computing predictions of any kind
- Solutions for Planning (optimization and what-if analysis)
 - Reduction maintenance costs, reduction of critical SLA conditions, improve service level
- Algorithms and computational solutions, see next slide



ICT Assets Control: CUNEO Municipality



Monitoraggio Dettagliato Mon 4 Dec 10:54:14

Tabella Device

Cerca per Indirizzo, ID o device...

Camera UPS Switch

ID	Stato	Tipo device	Indirizzo	IP	Azioni
TC010182	●	Camera	Cuneo Sud Palo Angolo Parco Giochi	172.16.12.185	
TC010178	●	Camera	Cuneo Sud Palo Alto verso Asilo	172.16.12.181	
TC010181	●	Camera	Cuneo Sud Palo davanti Biblioteca	172.16.12.184	
TC010179	●	Camera	Biblioteca Cuneo Sud Esterna Sopra Ingresso	172.16.12.182	
TC010184	●	Camera	Cuneo Sud Angolo verso Parco Giochi	172.16.12.187	
TC010185	●	Camera	Cuneo Sud Angolo verso Bar	172.16.12.188	
TC010183	●	Camera	Cuneo Sud Angolo davanti Megafresco	172.16.12.186	
TC010203	●	Camera	Rotonda Corso Francia Croce Rossa	172.16.12.203	
TC010204	●	Camera	Rotonda Corso Francia Distributore	172.16.12.204	
SWITCH041	●	Switch Netonix	Rotonda C.so Francia Croce Rossa	172.16.15.222	
TC010202	●	Camera	Rotonda Corso Francia Tabaccaio	172.16.12.202	

Tabella Dettaglio

TC010185

dateObserved: 04/12/2023, 06:01

generalStatus: ●

tempStatus1: 1

TEMP STATUS

Valore	Significato
1	Buono stato

Legenda

3.5.4 3.6 3.8

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

Manage the status, tickets, notifications

Monitoraggio Generale

CameraModelP1448-LE

UpsModelRiello

UpsModelSeltec

SwitchModelMicrosense

SwitchModelNetonix

Legenda

Valore	Significato	Simbolo
0	Buono stato	●
1	Non raggiungibile	●
2	Raggiungibile, dati non disponibili	●
3	Identificata anomalia	●

SWITCH027

VALUE NAME: 1721615234

DETAILS DESCRIPTION RT DATA

Last update: 2024-02-02 14:05:50.176Z

Description	Value	Buttons
dateObserved	02/02/24, 02:05:50 PM	
farSpeed	6185	Last 4h: 24h: 7d: 30d: 6m: 1y: 2y: 10y
generalStatus	0	Last 4h: 24h: 7d: 30d: 6m: 1y: 2y: 10y
portValue1	48	Last 4h: 24h: 7d: 30d: 6m: 1y: 2y: 10y
portValue2	48	Last 4h: 24h: 7d: 30d: 6m: 1y: 2y: 10y
portValue3	0	Last 4h: 24h: 7d: 30d: 6m: 1y: 2y: 10y
portValue4	0	Last 4h: 24h: 7d: 30d: 6m: 1y: 2y: 10y
portValue5	0	Last 4h: 24h: 7d: 30d: 6m: 1y: 2y: 10y
portValue6	0	Last 4h: 24h: 7d: 30d: 6m: 1y: 2y: 10y

Stato Attuale 0

1721612145 - GeneralStatus - Andamento Settimanale

1 status

23. Oct 30. Oct 6. Nov 13. Nov 20. Nov 27. Nov 4. Dec 11. Dec 18. Dec 25. Dec 1. Jan 8. Jan 15. Jan

My Profile

Privacy Policy Cookies Policy Terms and Conditions

Conteggi Telecamere Thu 28 Mar 12:05:32

TC010246 Piazza Audifreddi - Media Ogni 10 Minuti

36.4

27.3

18.2

9.1

0

22. Mar 23. Mar 24. Mar 25. Mar 26. Mar 27. Mar 28. Mar

TC010247 Via Roma-Piazza Galimberti - Media Ogni 10 Minuti

36.4

27.3

18.2

9.1

0

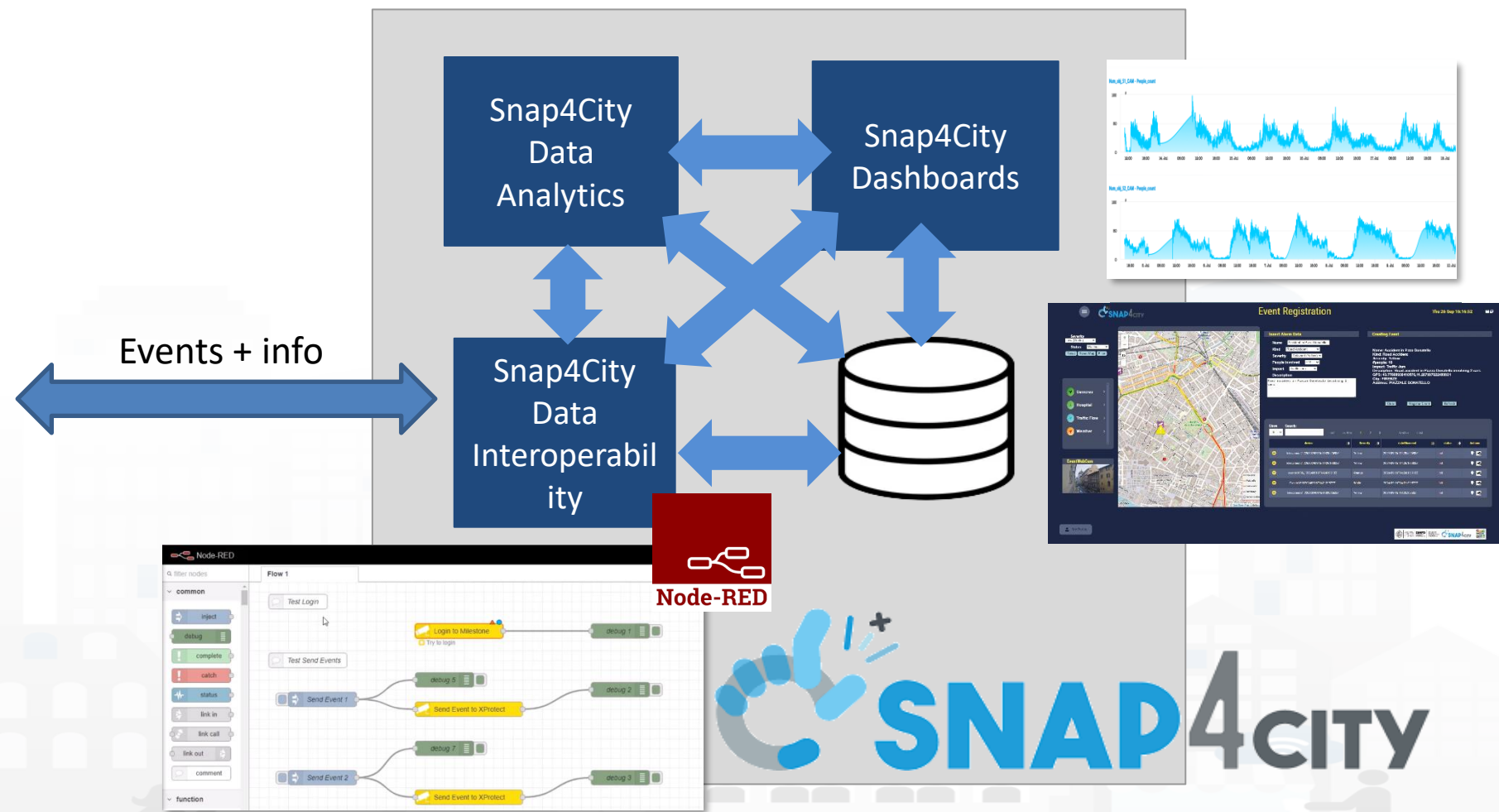
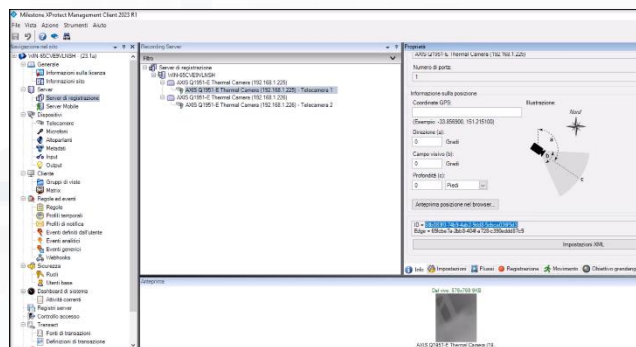
22. Mar 23. Mar 24. Mar 25. Mar 26. Mar 27. Mar 28. Mar

My Profile

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Powered by SNAP4Tech

VMS vs Snap4City: sending and getting events, AI solutions



***Assistants on taking decision
and for development/training***

Goals

Details



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

www.snap4city.org



UNIVERSITÀ
DEGLI STUDI
FIRENZE

DINFO
DIPARTIMENTO DI
INGEGNERIA
DELL'INFORMAZIONE

DISIT
DISTRIBUTED SYSTEMS
AND INTERPRETIVE
TECHNOLOGIES LAB

Powered by
FIWARE

**FREE
TRIAL**



**PEN Test
Passed**



**EU GDPR
COMPLIANT**



**SNAP4
Appliances and Dockers
Installations**



**EUROPEAN OPEN
SCIENCE CLOUD**



Node-RED



JS Foundation

E015
digital ecosystem



NVIDIA

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

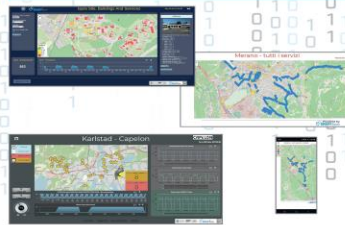
HORIZONTAL AI PLATFORM



MOBILITY AND TRANSPORT



SMART ENERGY AND SMART BUILDING



ENVIRONMENT AND WASTE MANAGEMENT



CITY USER'S SERVICES AND TOURISM MANAGEMENT



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



**DASHBOARDS, WIDGETS
TEMPLATES**

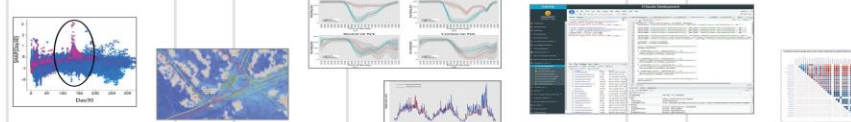


**PREDICTION - ANOMALY DETECTION - CLUSTERING - ROUTING - SENTIMENT NLP - TRAFFIC FLOW - PEOPLE FLOWS - SDG
15 MIN CITY INDEX - KPI - HEATMAPS - ORIGIN DESTINATION - MAPS - VECTOR FIELD - ETC...**



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

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



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



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

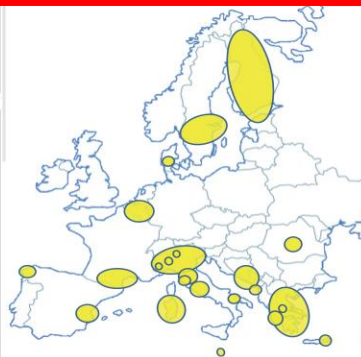
FULL INTEROPERABILITY, ANY: DATA, BROKERS, NETWORKS AND VERTICALS



**NATIVE AND EXTERNAL
APPLICATIONS**

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


- DEVELOPMENT ENVIRONMENT AND METHODOLOGY
- VISUAL PROGRAMMING, ML, AI, HPC
- TRAINING COURSES
- LLM ADVISOR



AI based Assistants, DSS

- **Tourism domain**
 - PAVAL assistant for providing Touristic information
- **Legal domain**
 - Assessment of mediation proneness, prediction of mediation results, NLP, BERT (Florence Forum)
 - Assessment/prediction of risk on legal disputes wrt hospitals
- **Training and development domains**
 - **SnapAdvisor**: LLM advanced RAG, covering both applications and much more including the Advisor / HelpDesk for Snap4City platform
 - Multi language on private documents, etc.

Logged in as:
edoardo_tester

 Your Profile

Logout

SnapAssistant model:

Llama3.3 ▾

New Chat

EdoChat1

EdoChat2

EdoChat3

EdoChat4

prova

chatNuova

chatTest1LLAMA

chatTest2LLAMA

testGianniLLAMA

testTastoInvioPreChanges

ChatTestPostPSWINVIO

SnapAdvisor

Current chat: debug0

Visualize references

Personal
Advisor LLM



Come creo una dashboard?



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

Write a message...



Developing on Snap4City

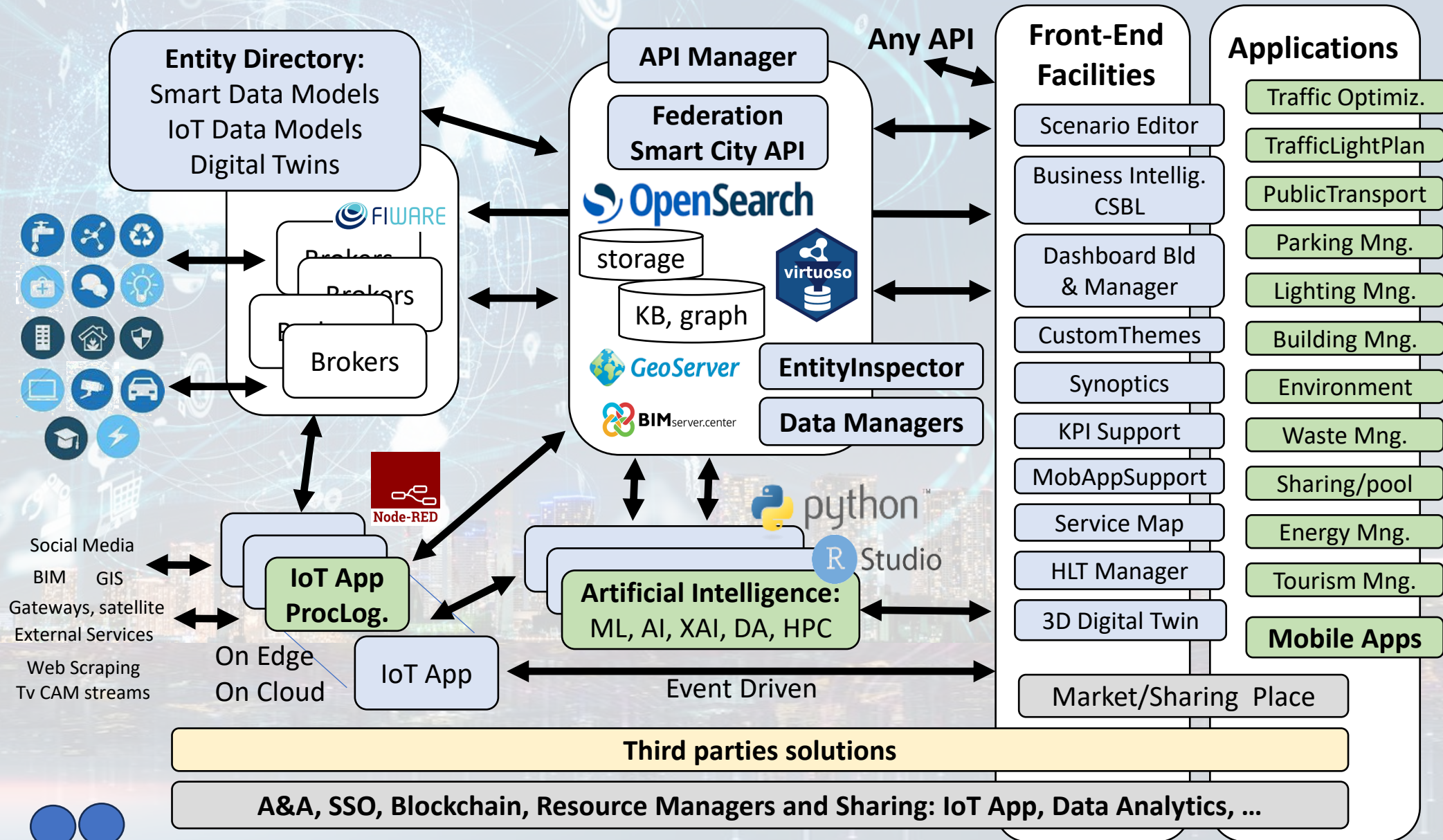
1st part	2nd part	3rd part	4th part	5th part	6th part	7th part	8th
Overview	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App	Design and Develop Smart Solutions



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

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

Technical Architecture



Visual Development Tools



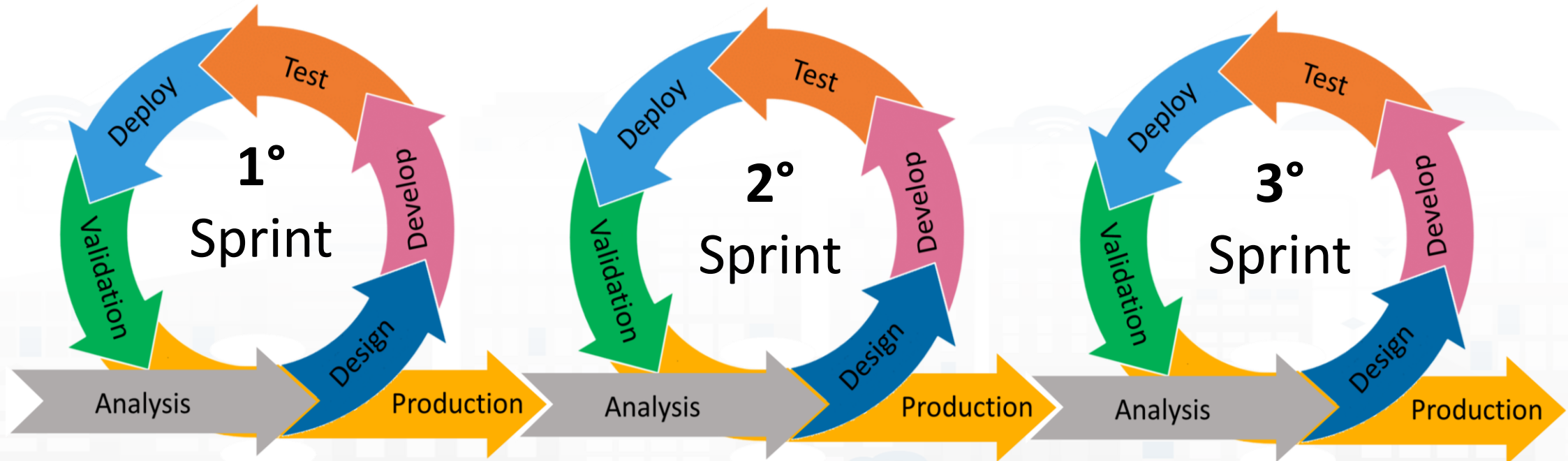
The collage displays several key features of the SNAP4CITY platform:

- My IoT Sensors and Actuators:** A form to add new devices with fields for Identifier, Latitude, and Longitude, alongside a map.
- Entities/Devices Management:** A table listing various devices with columns for Name, ID, Status, and Location.
- Service Map (Toscana):** A map showing service locations with a list of details on the right.
- Data Inspector:** A detailed view of a specific data point on a map.
- My Data Dashboard Dev Kibana:** A dashboard showing a large number (29,146,065) and various charts.
- Proc.Logic / IoT App:** A screen with icons for different IoT applications like Data Analytics and IOT Application.
- ISMinindex:** A flowchart or logic diagram showing data processing steps.
- Jupyter2-(75) Hub - Python:** Two screenshots of a Jupyter notebook showing Python code and data visualizations.
- 3D MAP GLOBAL DIGITAL TWIN - NEWGUI:** A 3D architectural model of a building.
- Client-Side Business Logic - Test:** A screen with a map and several line charts.
- FIRENZE - TRAFFAIR - AIRQUALITY HEATMAPS - NEWGUI:** A map of Florence showing traffic and air quality heatmaps.
- Custom Widgets / Synoptics:** A grid of various small widgets and icons for different data types.



Agile Development Life Cycle by sprint

Smart Solutions



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

On Line Training Material (free of charge)



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

Development

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



Development Life-Cycle

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


From Snap4City:

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

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

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

Logged in as:
edoardo_tester

 Your Profile

Logout

SnapAssistant model:

Llama3.3 ▾

New Chat

EdoChat1

EdoChat2

EdoChat3

EdoChat4

prova

chatNuova

chatTest1LLAMA

chatTest2LLAMA

testGianniLLAMA

testTastoInvioPreChanges

ChatTestPostPSWINVIO

SnapAdvisor

Current chat: debug0

Visualize references

Personal
Advisor LLM



Come creo una dashboard?



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Write a message...



Part 2: Dashboard production and management

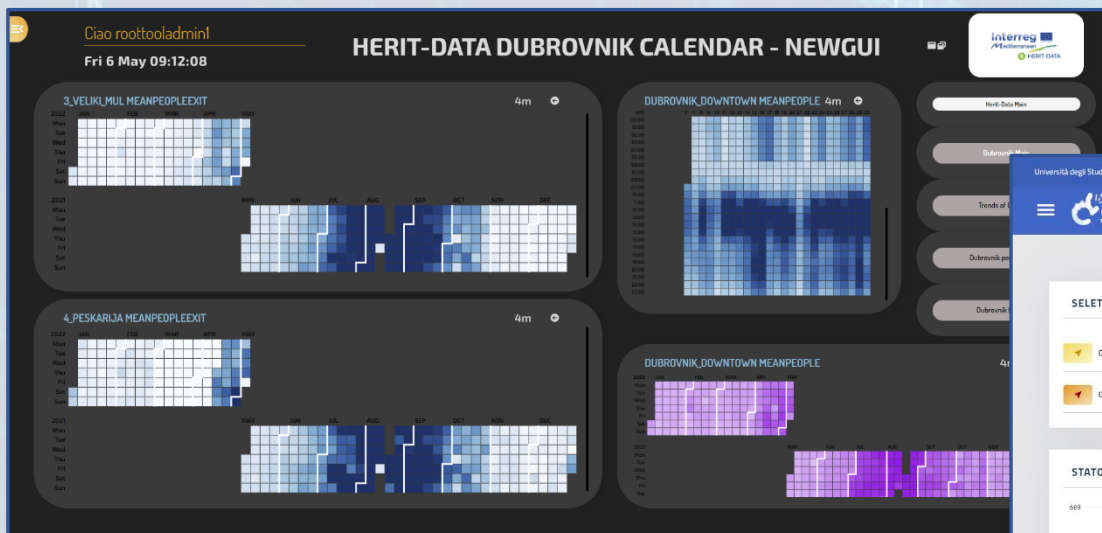
Part 2: Dashboards
production and
management

SLIDES

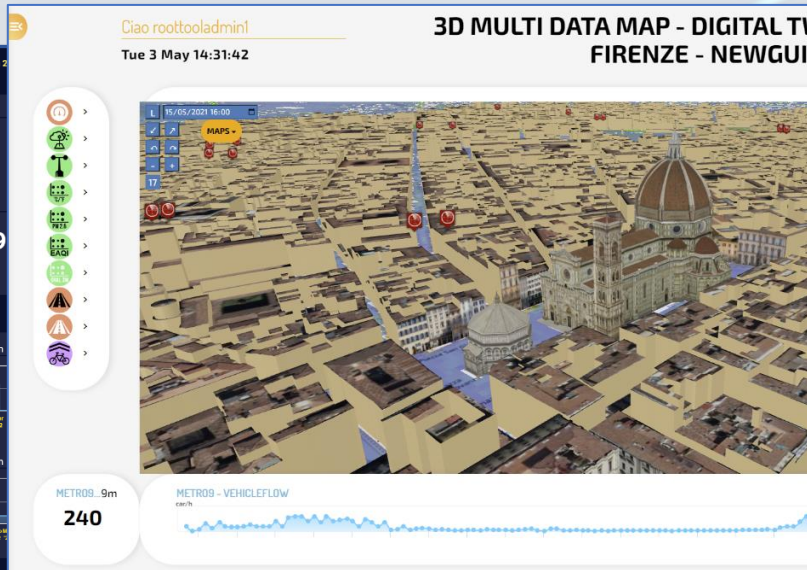
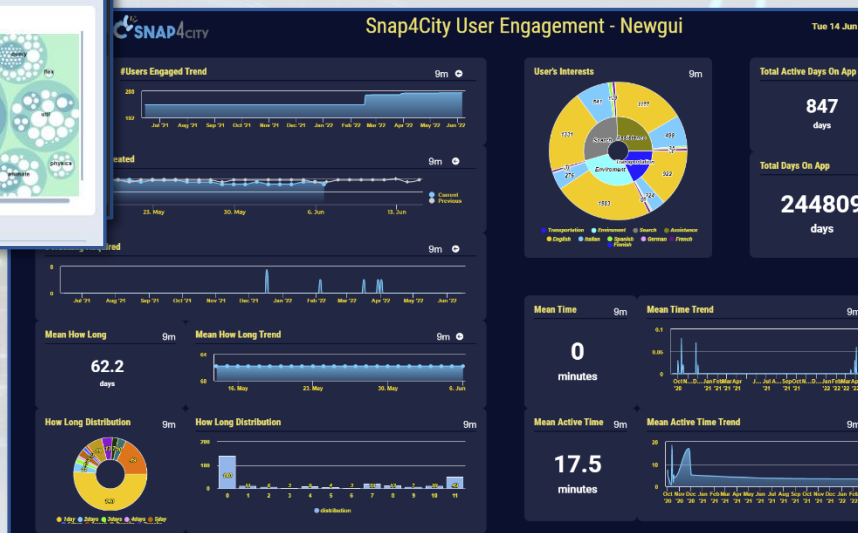
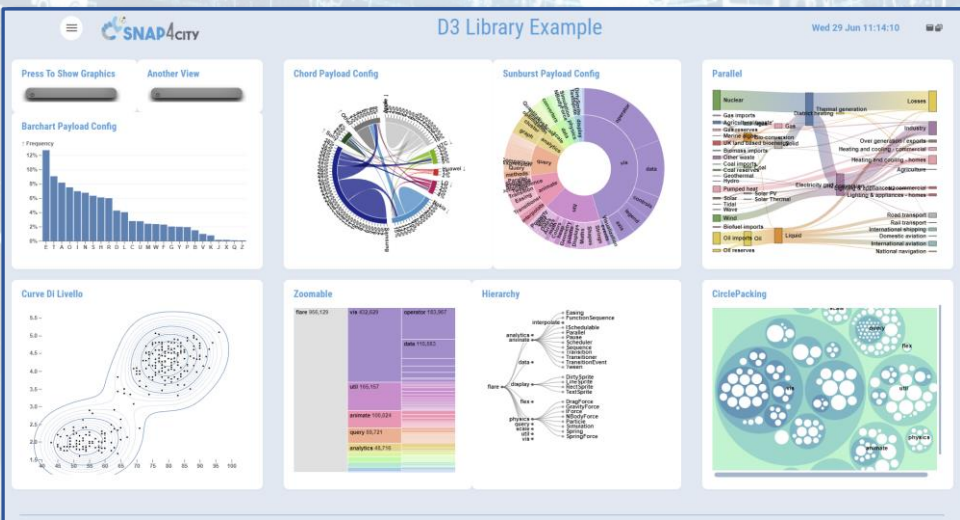
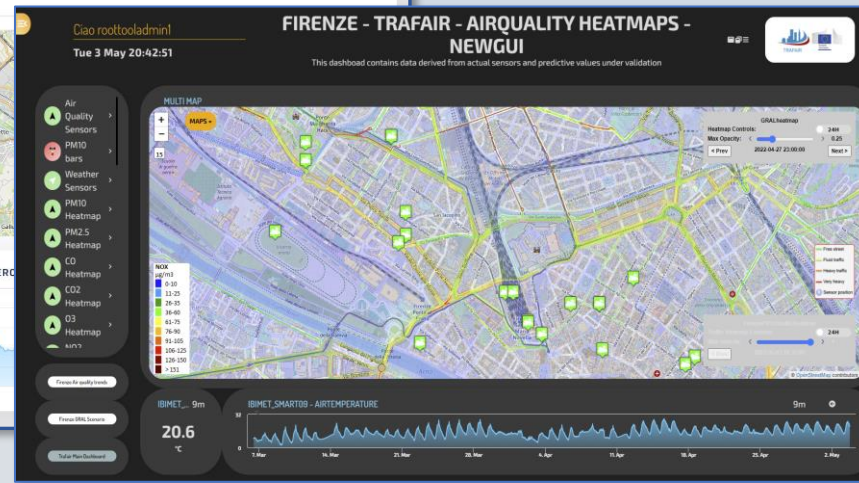
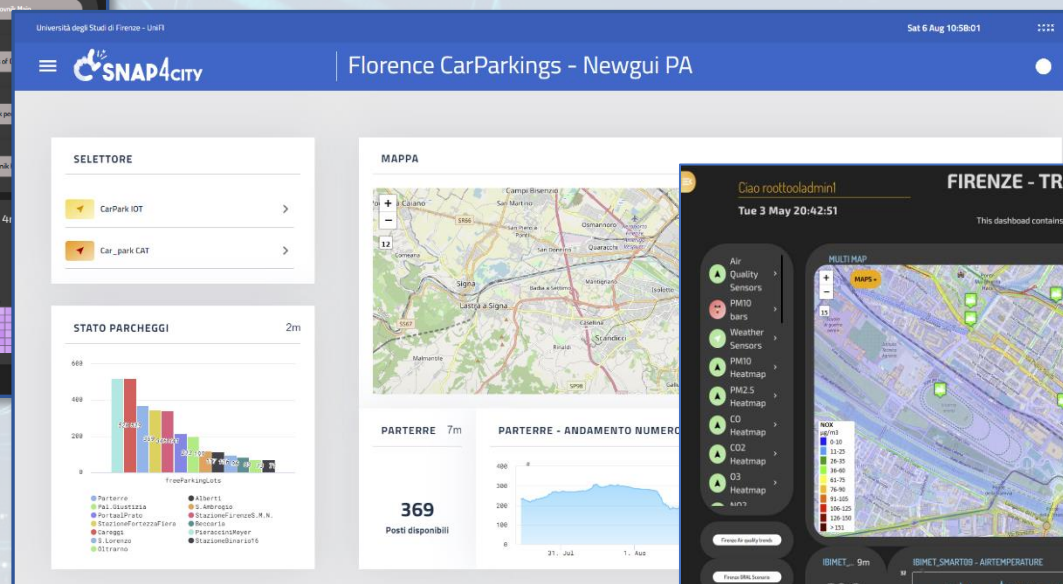
Interactive Slides



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



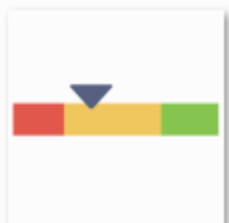
Different Themes



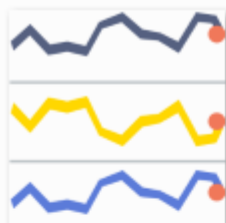
New styles/themes can be developed by specializing a few files from open source

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

Visual Representations



Slider with multiple steps for KPI



sparklines



kpi



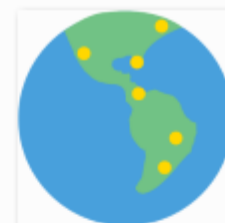
histogram



heatmap



flow-maps



geo-maps



donut-chart



Data-grid



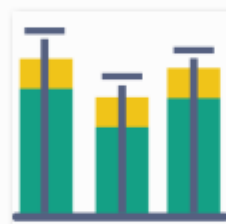
chord



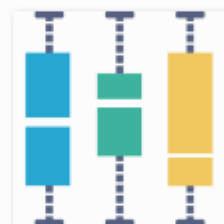
Cone



Bubble matrix chart



Bullet



Box-plot



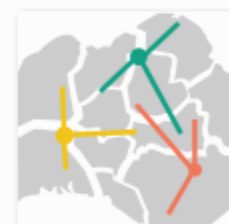
stacked-area



Stacked line chart



Stacked combination Chart



spider-maps



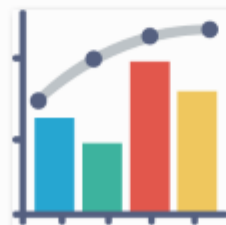
Sequence-Sunburst



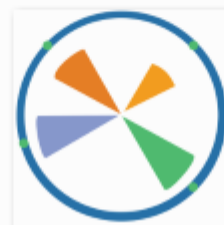
Pivot



pie-chart-1



Pareto chart



radar



Bubble maps



waterfall



Sunburst



Sankey

New Data Inspector/Wizard

Single data widgets

Multi data widgets

Map Controls:

FilterMap GPSUser GPSOrg

Now displaying in Standard Mode

Switch to the Synoptic Mode to select MyKPIs and sensors that you need for your synoptics.

Switch now to the Synoptic Mode

Data sources

Level	Type	Nature	Subnature	Device	Model	Broker	Value Name	Value Type	Data Type	Value Unit	Last Date	Last Value	Healthiness	Last Check	Ownership
DT	EM Devl...	Environment	Weather	DIDA1		Santa Verdiana ...	Mio sensore		webpage		2021-11-23 13:44...			2023-07-18 16:0...	public
DT	EM Devl...	TransferService...	SensorSite	METRO11		Altair-soda	Altair Valve State		webpage		2021-06-05 00:00...			2024-01-10 01:3...	public
DT	EM Devl...	IndustryAndMa...	Computer	AltairStatoPom...		Altair-soda	Altair Pump St...		webpage		2021-05-20 13:51...			2024-01-10 01:3...	public
DT	EM Devl...	Environment	Air	IBIMET_SMART...		Altair-soda	Altair Pump 43...		webpage		2021-06-07 17:3...			2024-01-10 01:3...	public
DT	EM Devl...	Environment	Air	ARPAT_QA_FI...		Altair-soda	Altair valve 541		webpage		2021-06-07 17:3...			2024-01-10 01:3...	public
DT	EM Devl...	TransferService...	SensorSite	METRO514		Altair-soda	Altair Pump 4321		webpage		2021-06-07 00:00...			2024-01-10 01:3...	public
DT	EM Devl...	TransferService...	SensorSite	SI052032FS990...		Altair-soda	Altair Stock sta...		webpage		2021-06-07 00:00...			2024-01-10 01:3...	public
DT	EM Devl...	TransferService...	SensorSite	METRO831		Altair-soda	Altair Pump 92		webpage		2021-06-07 00:00...			2024-01-10 01:3...	public

Search... Search... Search... Search... Search... Search... Search... Search... Search... Search... Search... Search... Search... Search...

Selected rows: 0 Previous 1 2 3 4 5 ... 45711 Next



Search

163

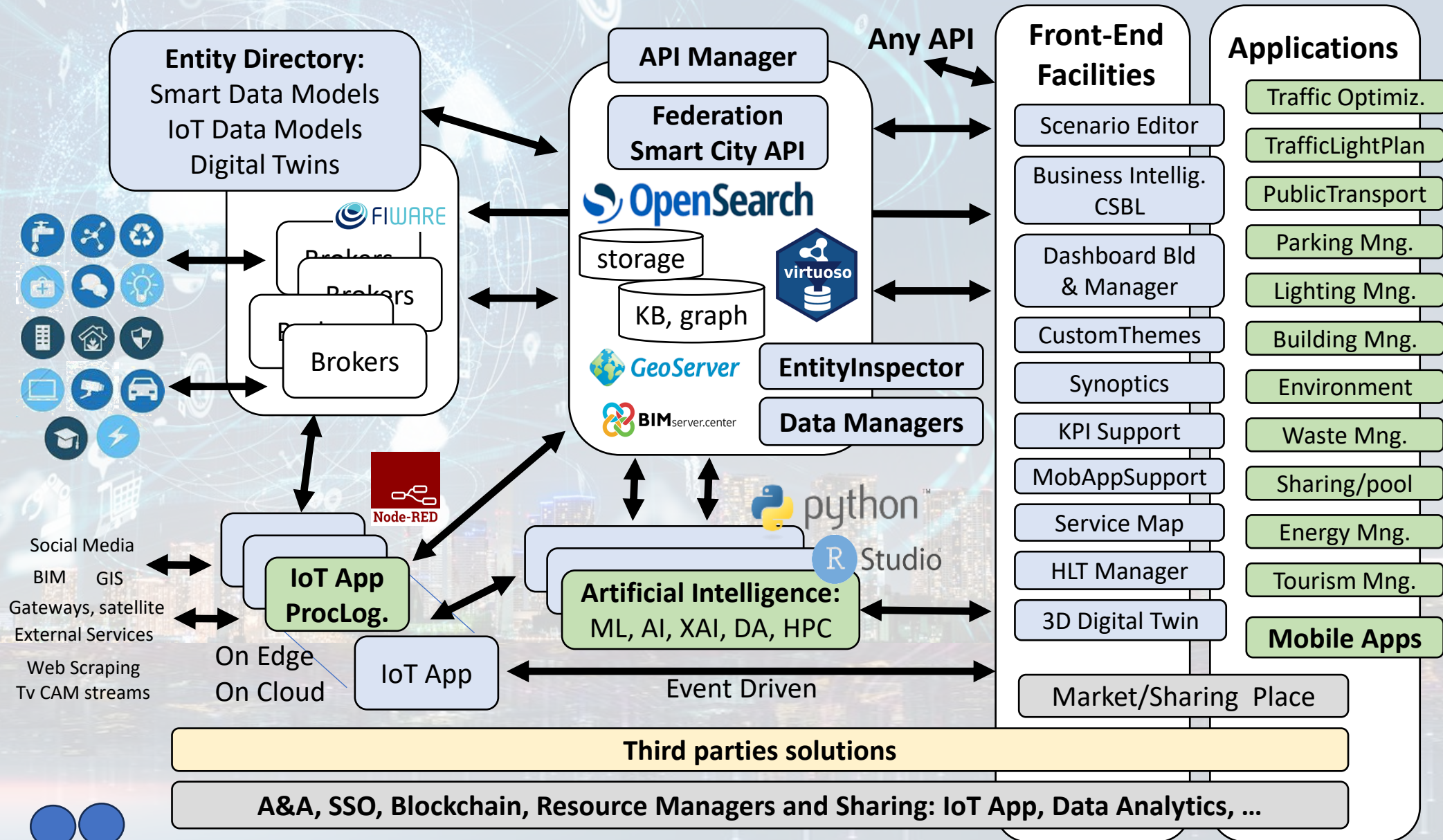
- Filtering/Searching for individual fields (even for some fields not displayed as geographic coordinates)
- Geographic Filtering
- Text Search on all fields
- Menu for choosing the fields to display in the table
- View on Map(via PREVIEW)
- Data and Trend visualization
- Opening Digital Twin
- Pass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

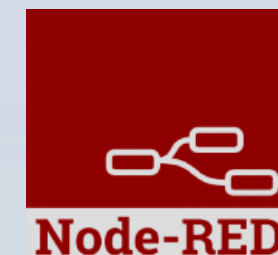
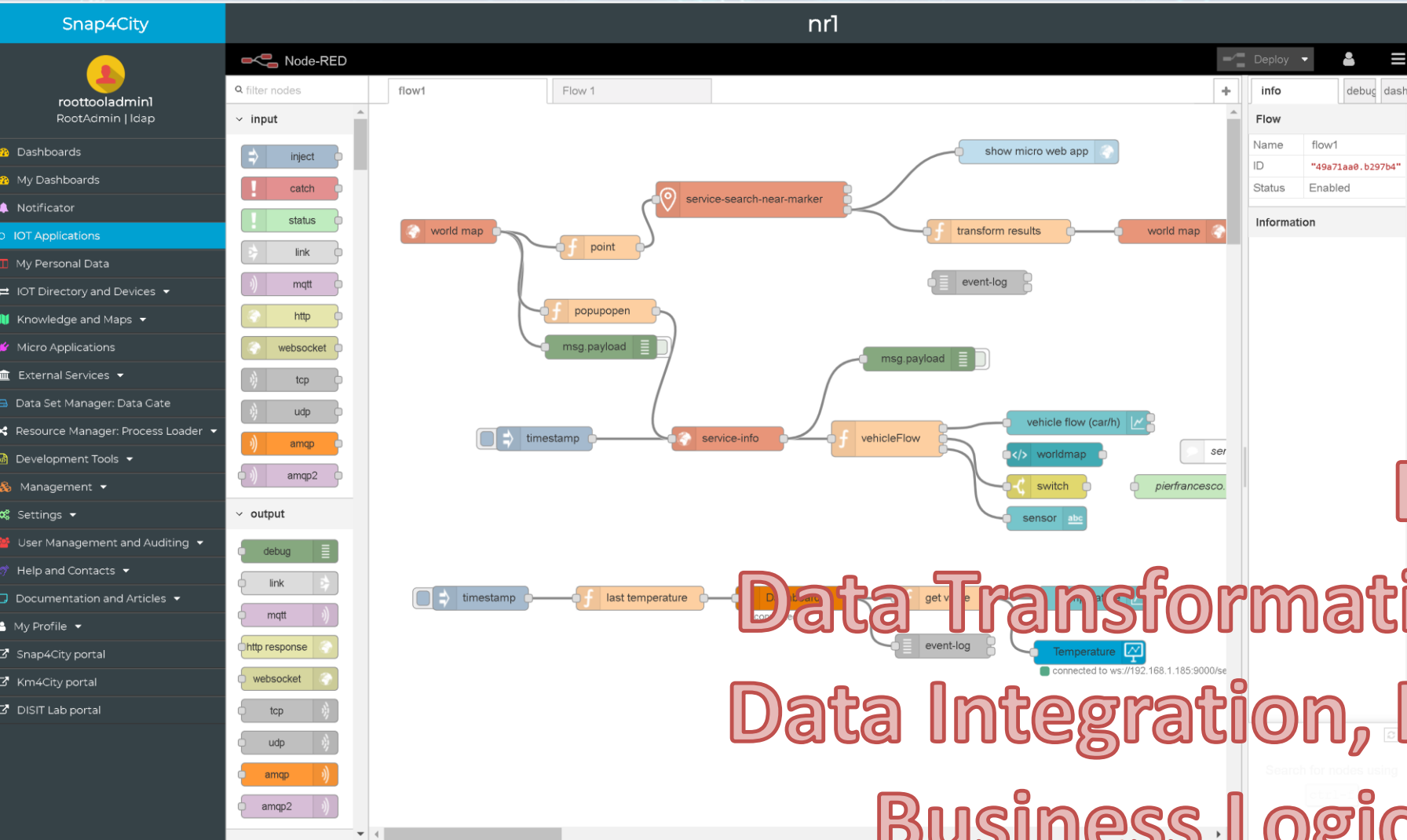
Part 3: IoT App, process logic, server side BL

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

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





Editing IOT Applications

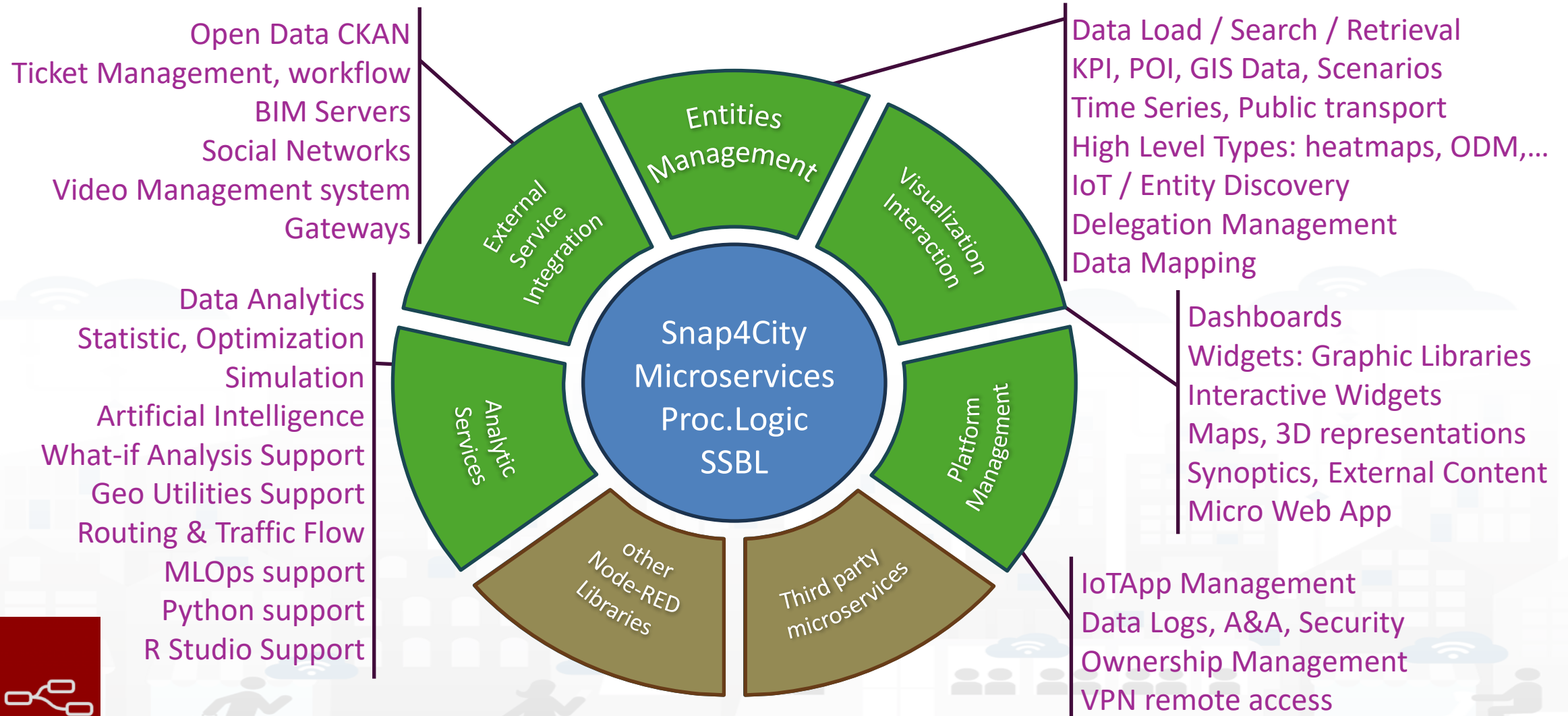
Data Adaption
Data Transformation, Conversion
Data Integration, Interoperability
Business Logic vs Dashboards

Data Analytics control

Everywhere: Cloud, on IoT Edge Devices

> 60.000 downloads (up to 2024)

Areas





Sept 2024 collection

Two Snap4City Libraries

> common

> function

> network

> input

> output

> sequence

> parser

> storage

> social

> advanced

> Advanced FTP

> location

> NGSi

> Iwm2m

> S4C SearchDev

> S4C Utility

> S4C Mapping

> S4C Management

> S4C DataAnalytic

> S4C BigData

> S4C IoT App

> S4C OpenMaint

> S4C IoT

> S4C Whatif

> S4C Search

> S4C Data

> S4C KPiData

> S4C Dashboard

> S4C Sigfox

> S4C LogDev

> S4C View

> S4C Social

> dashboard

> time

S4C SearchDev

- service search
- service search near gps position
- service search near service
- service search within gps area
- service search within wkt area
- service search within stored wkt area
- service search by municipality
- service search by queryid
- full text search dev
- full text search within wkt area

full text search within gps area

full text search near gps position

full text search exp

event search dev

event search exp

event search within wkt area

event search within gps area

event search near gps position

address search near gps position

geometry search near gps position

address poi search by text

address poi search by text exp

address poi search by text near gps position

bus routes search

bus routes search near gps position

bus routes search within gps area

bus routes search within wkt area

bus routes

point within polygon

routing

heatmap picker

coordinates to address

service info

edge-tunnel-to-cloud

S4C Mapping

- service info mapped
- mapping
- set mapping

tpl routes

tpl stops

S4C Utility

- service info dev
- distance from coordinates

get job detail

get triggers of job

get job group names

get trigger group names

get paused trigger groups

get job fire times

get system status

trigger job

pause all

pause trigger

pause triggers

resume all

resume job

resume jobs

resume trigger

resume triggers

notifier history events

S4C DataAnalytic

- descriptive statistics
- trend plot
- time series predictions
- machine learning predictions
- anomaly detection
- plumber data analytic
- python data analytic

S4C Search

- service search near marker
- service search within circle
- service search within polygon
- service search along path
- full text search within circle
- full text search within polygon
- full text search along path
- full text search usr
- event search near marker
- event search within circle
- event search within polygon
- event search along path
- event search usr
- address search near marker
- geometry search near marker
- address poi search by text usr
- address poi search by text near marker
- address poi search by text within circle
- address poi search by text within polygon
- value type search near marker
- value type search within circle
- value type search within polygon
- value type search along path

event search within polygon

event search along path

event search usr

address search near marker

geometry search near marker

address poi search by text usr

address poi search by text near marker

address poi search by text within circle

address poi search by text within polygon

value type search near marker

value type search within circle

value type search within polygon

value type search along path

tpl routes by agency

tpl routes by line

tpl stops by route

tpl stop timeline

recommendation within circle

value type search near marker

value type search within circle

value type search within polygon

value type search along path

S4C Data

- get my data
- get my delegator
- get my delegated
- get my activity

get my data

get my delegator

get my delegated

get my activity

insert

datagate search

datagate create

portia crawler

S4C IoT App

- iotapp restart
- iotapp upgrade
- ownership

event search near marker

event search within circle

bus routes search near marker

bus routes search within circle

bus routes search within polygon

tpl agencies

tpl lines

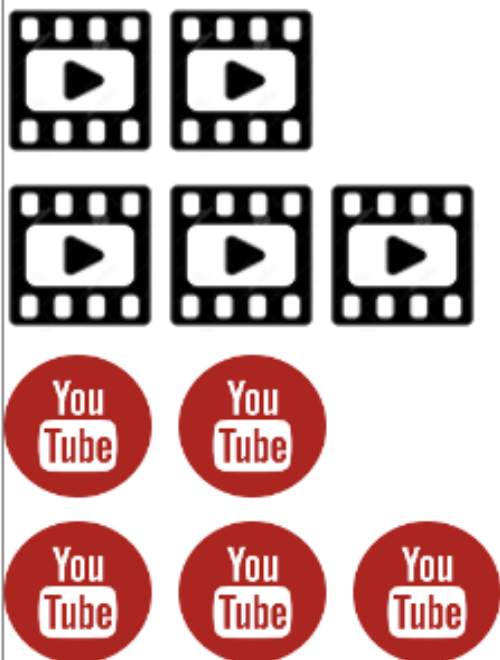
<https://flows.nodered.org/search?term=snap4city>

Part 5: Data Ingestion and Interoperability

Part 5: Data Ingestion
and Interoperability

SLIDES

Interactive Slides

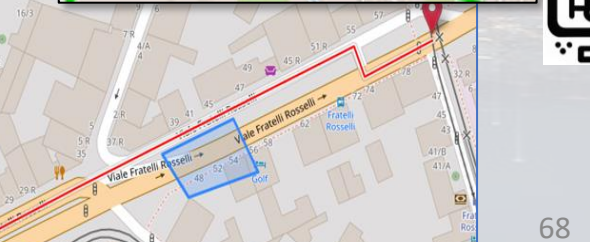
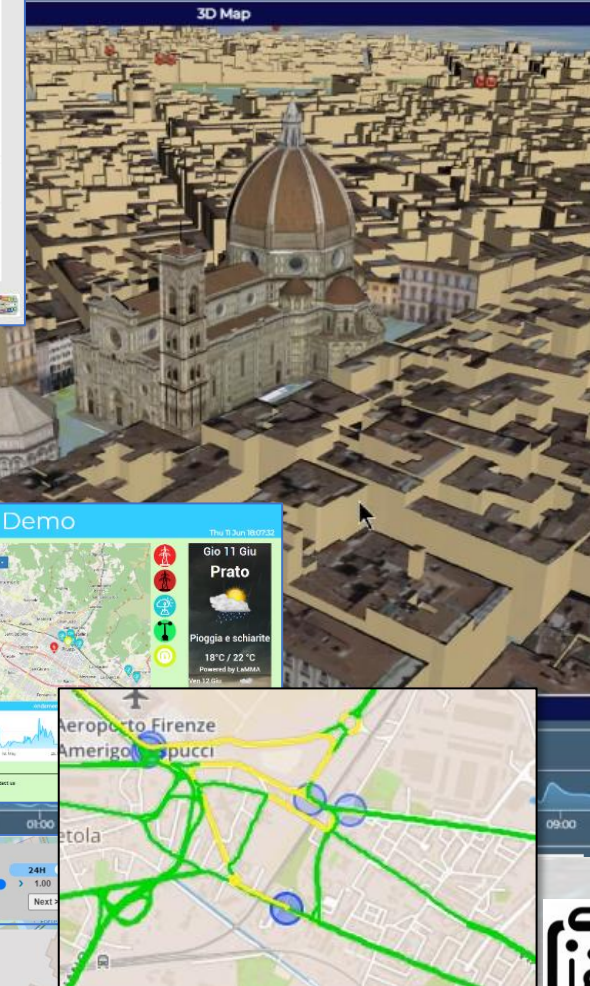
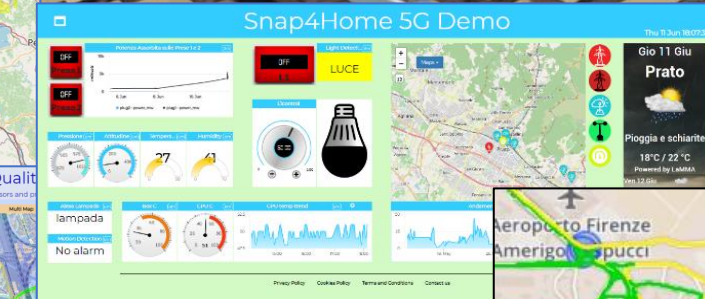
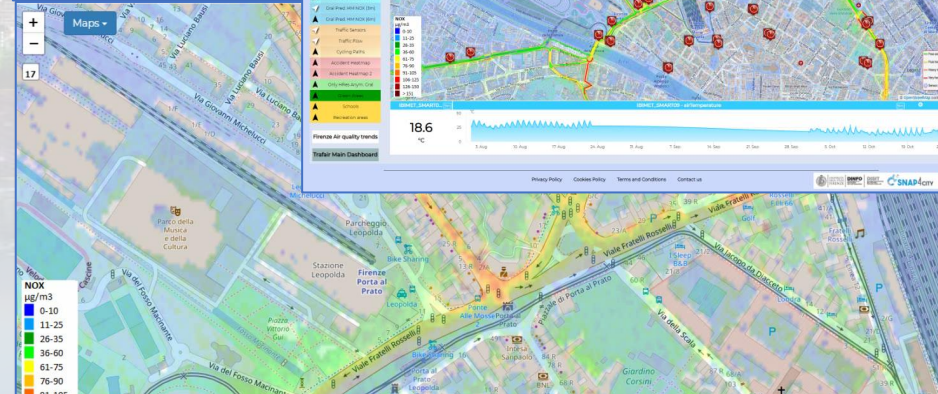
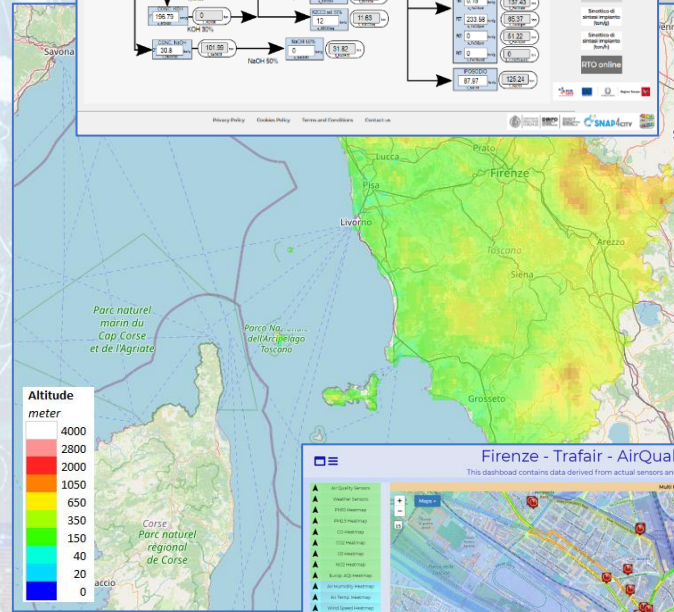
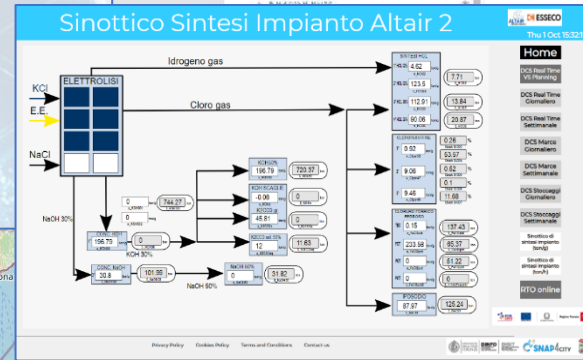
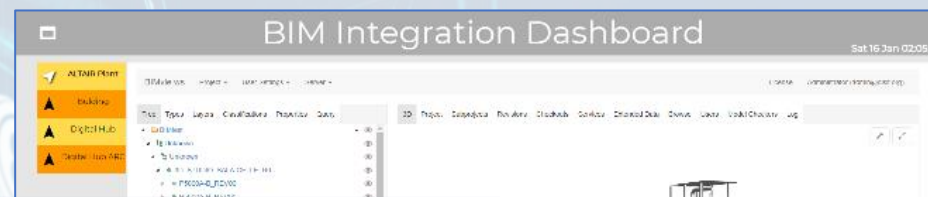


- When Solutions and tools for Data Ingestion and Interoperability are needed
- Overview of Snap4City Data Storage and Stack
- Knowledge Base: Modelling and Setting Up
- High Level Types vs Ingestion Process
- Data Ingestion Strategy and Orientation
- Ingestion of Points of Interest with POI Loader
-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

High Level Types

Snap4City (C), June 2025

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



UNIVERSITÀ
DEGLI STUDI
FIRENZE

DINFO
DIPARTIMENTO DI
INGEGNERIA
DELL'INFORMAZIONE

DISIT
DISTRIBUTED SYSTEMS
AND INTERNET
TECHNOLOGIES LAB

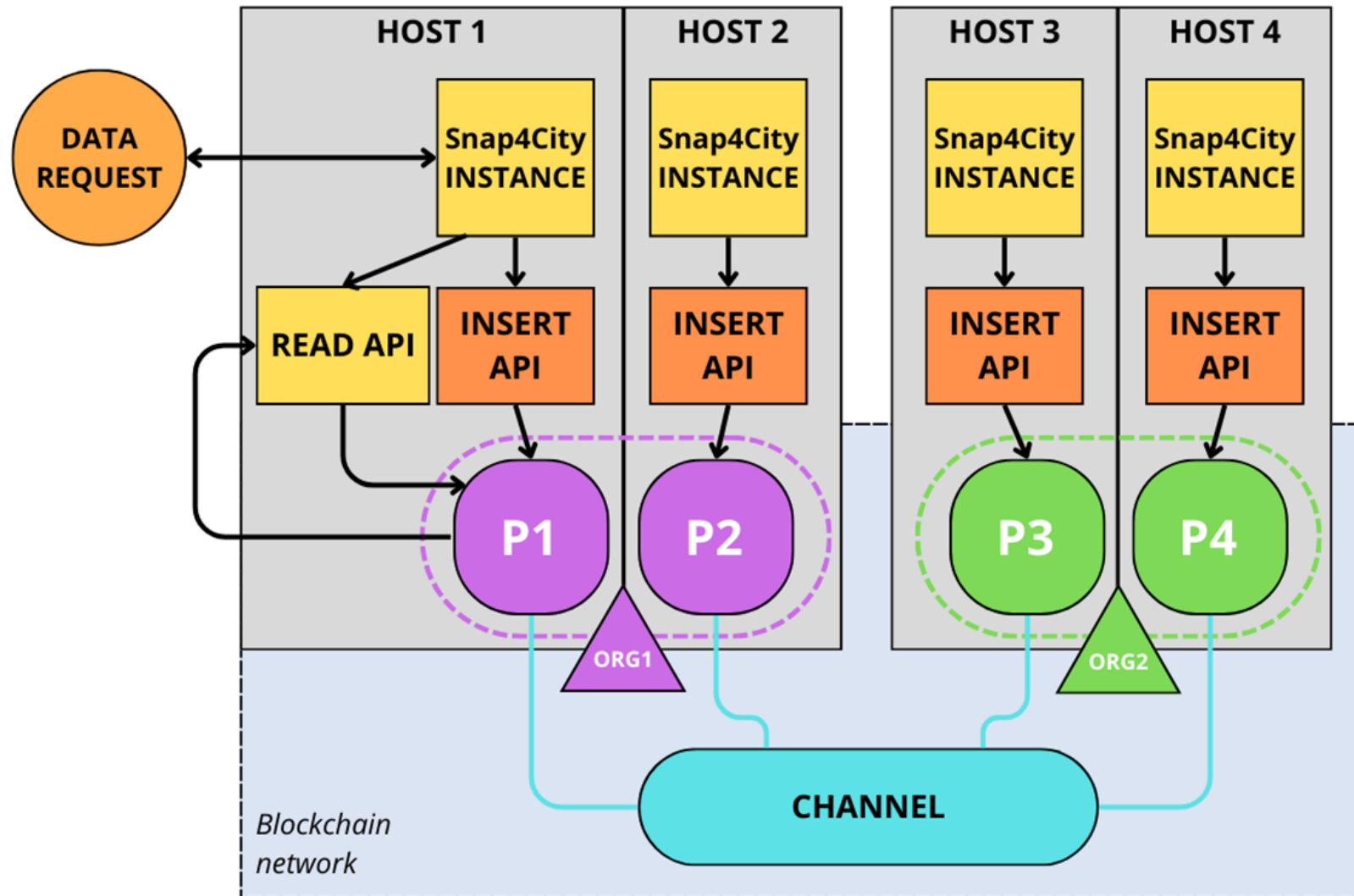
Visual Development Tools



The collage displays several key components of the SNAP4CITY platform:

- My IoT Sensors and Actuators:** A form to add new devices with fields for Identifier, Name, Latitude, Longitude, and a map selection tool.
- Entities/Devices Management:** A table listing various devices with columns for Name, ID, Type, Status, and Location.
- Service Map (Toscana):** A map showing service locations and data points across the region.
- Data Inspector:** A detailed view of data points with a map and a list of attributes.
- My Data Dashboard Dev Kibana:** A dashboard showing data trends and statistics, including a large number '29,146,065'.
- Jupyter2 (75) Hub - Python:** Two instances of a Jupyter notebook interface for data analysis and code execution.
- Proc.Logic / IoT App:** A workflow editor for creating IoT applications.
- ISMinIndex:** A diagram showing a complex network of nodes and connections.
- My Dashboards in My Organization:** A collection of various charts, maps, and data visualizations.
- Client-Side Business Logic - Test:** A dashboard for testing business logic with various charts and maps.
- FIRENZE - TRAFFIC - AIRQUALITY HEATMAPS - NEWGUI:** A dashboard showing heatmaps and data for traffic and air quality in Florence.
- Custom Widgets / Synopsics:** A collection of various widgets and synopsics for data visualization.

Snap4City with Blockchain



Part 4: Data Analytics

Part 4: Data Analytics
and Artificial
Intelligence

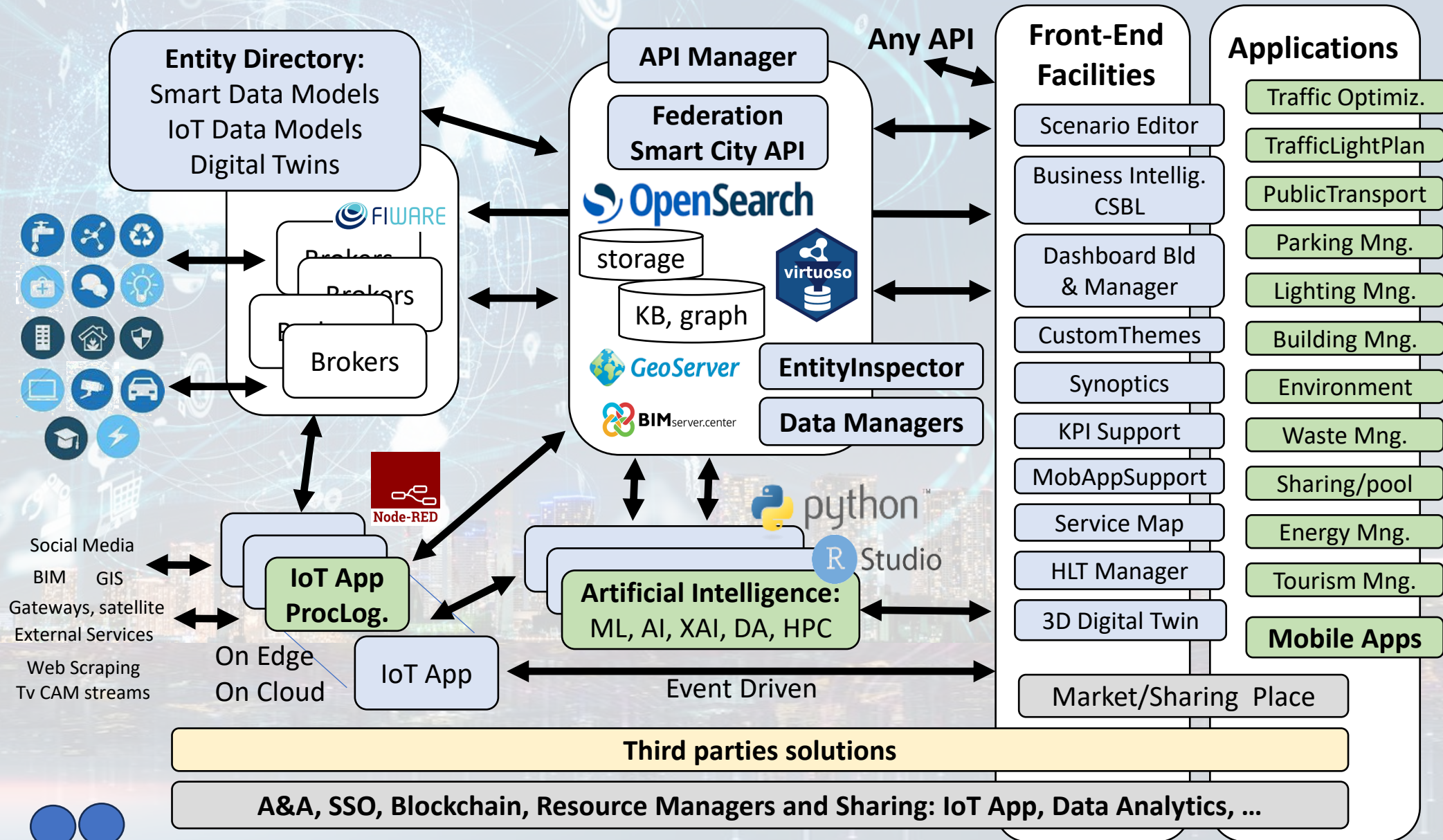
SLIDES

Interactive Slides



- Why and Where use DA, AI and XAI -> General Life Cycle, scenario editor, monitoring and control
- Data Processing: KPI, traffic, emissions, public transport quality, ..
- From Data Analytics, DA to Artificial Intelligence, AI
- List of the most relevant available DA and AI Solutions
- Predictions and Anomaly detections: parking, biking, NOx, landslide, people
- Computing: Higher Level Types Data and their representations: traffic, heatmaps, 3D
- Human Behavior, Engagement, Typical Time trends, WIFI sniffing
- Using AI in main domains: Mobility and transport, traffic optimization, Smart Energy, Smart Building,
- How AI/XAI, and Life Cycle, AI/ML requirements, XAI,
- Using DA, AI/XAI in Snap4City infrastructures
 - Data Analytics <-> IoT App / Proc.Logic
 - MLOps, ClearML, exploiting clusters of GPU/CPU
- Decision Support Systems and What-If Analysis, transport offer, DORAM tool
- Routing, Multimodal Routing, Dynamic Routing
- Predictive Maintenance
- Training Material

Technical Architecture

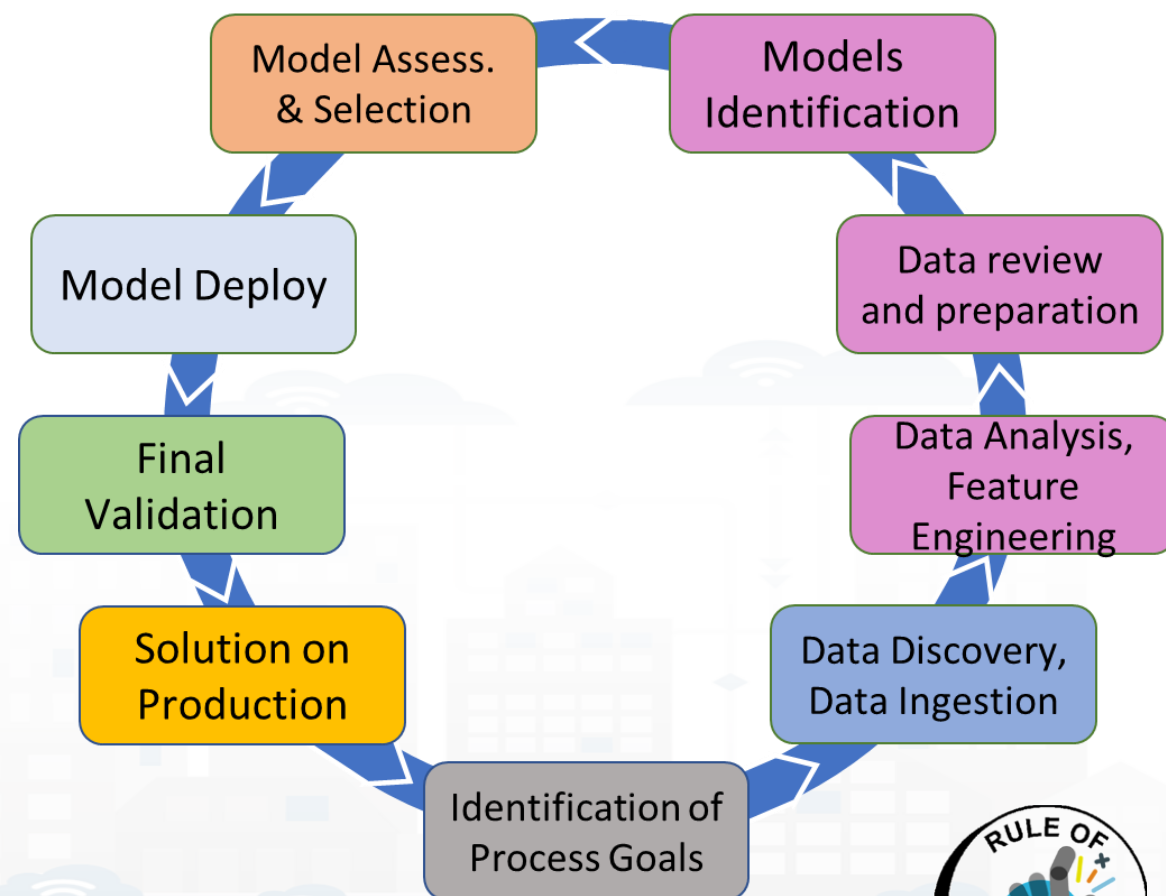


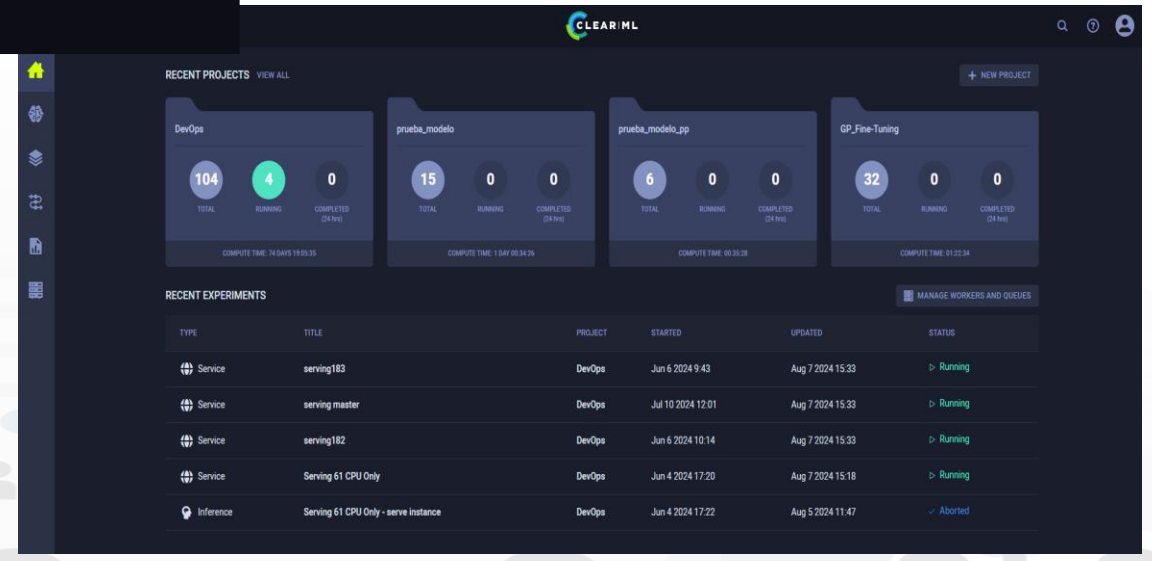
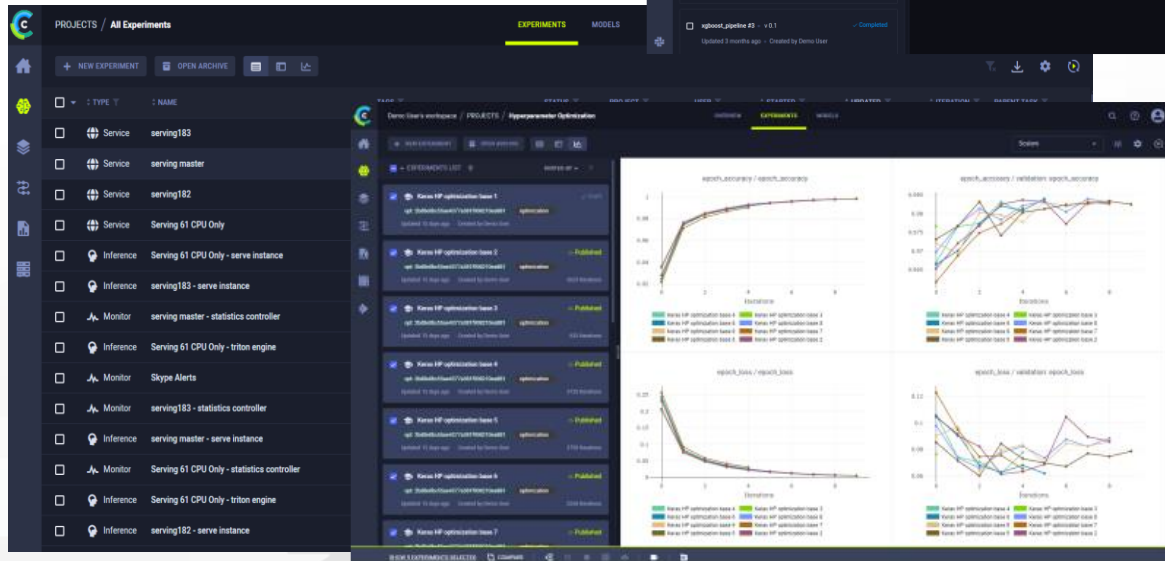
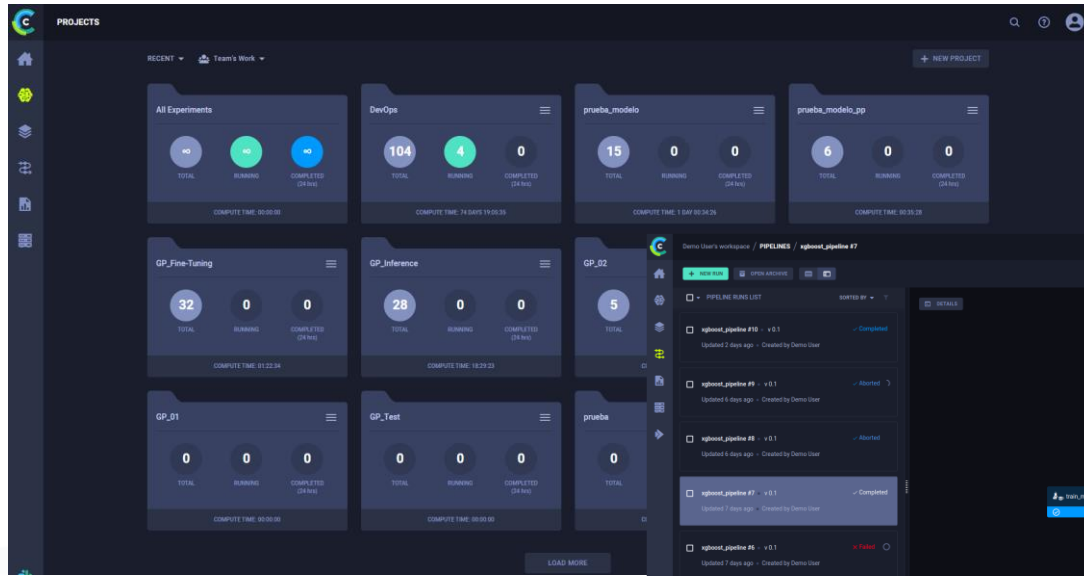
Main Functionalities of DA, ML, AI Support

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

Model/Technique Development/testing

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





MLOperation

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



Data Analytics on Snap4City, Machine Learning Operation MLOps on Snap4City via ClearML

From Snap4City:

- Development Life Cycle user manual:
 - <https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf>
- See Client-Side Business Logic Widget Manual:
 - <https://www.snap4city.org/download/video/ClientSideBusinessLogic-WidgetManual.pdf>
- Videos and PDF of Training slides <https://www.snap4city.org/944>
- You may read the TECHNICAL OVERVIEW, <https://www.snap4city.org/download/video/Snap4City-PlatformOverview.pdf>
- <https://www.snap4city.org>
- <https://www.snap4solutions.org>
- <https://www.snap4industry.org>
- <https://twitter.com/snap4city>
- <https://www.facebook.com/snap4city>

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: 16-12-2024
Version: 0.6

Parts 7 & 8: API, Mobile, Business Intelligence

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

[SLIDES](#)

[Interactive Slides](#)



Part 8: Developing
Smart Applications &
Business Intelligence
Solutions

[SLIDES](#)

[Interactive Slides](#)



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

Development

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



Development Life-Cycle

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

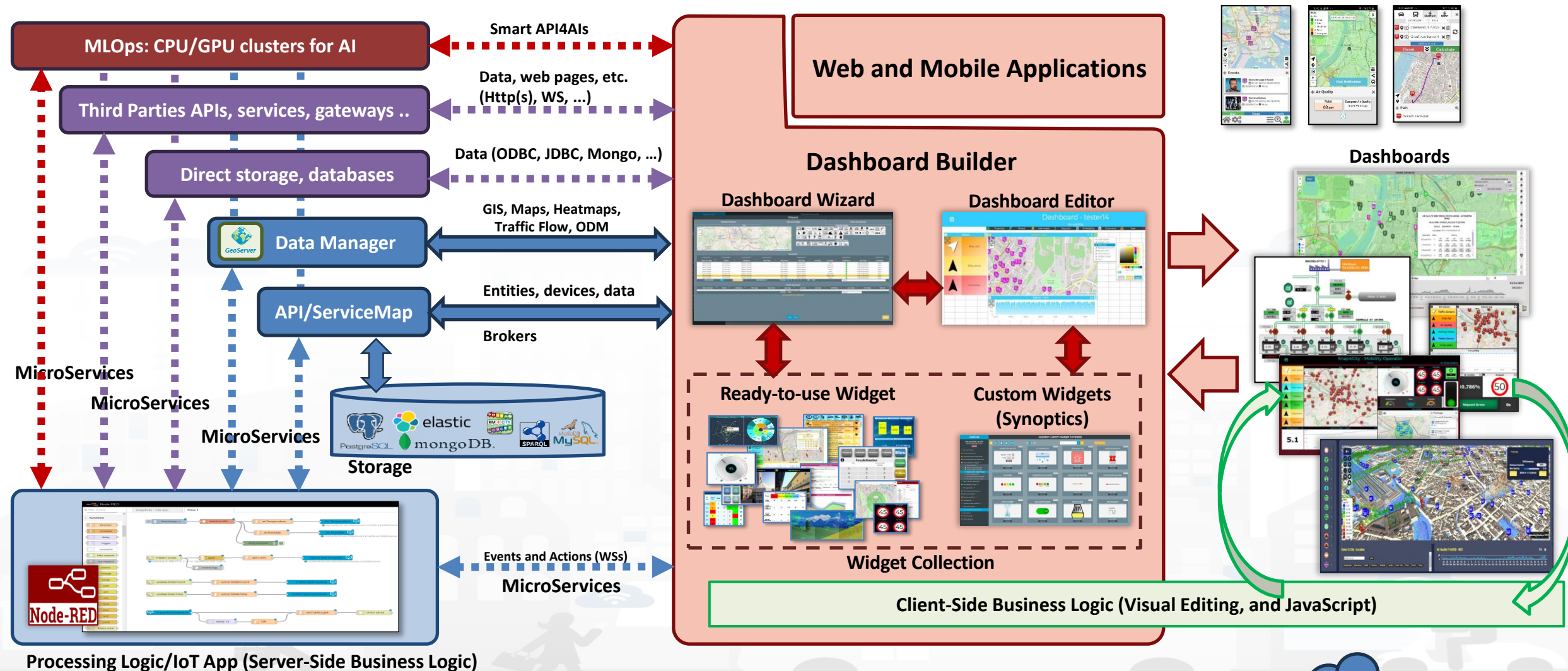
From Snap4City:

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

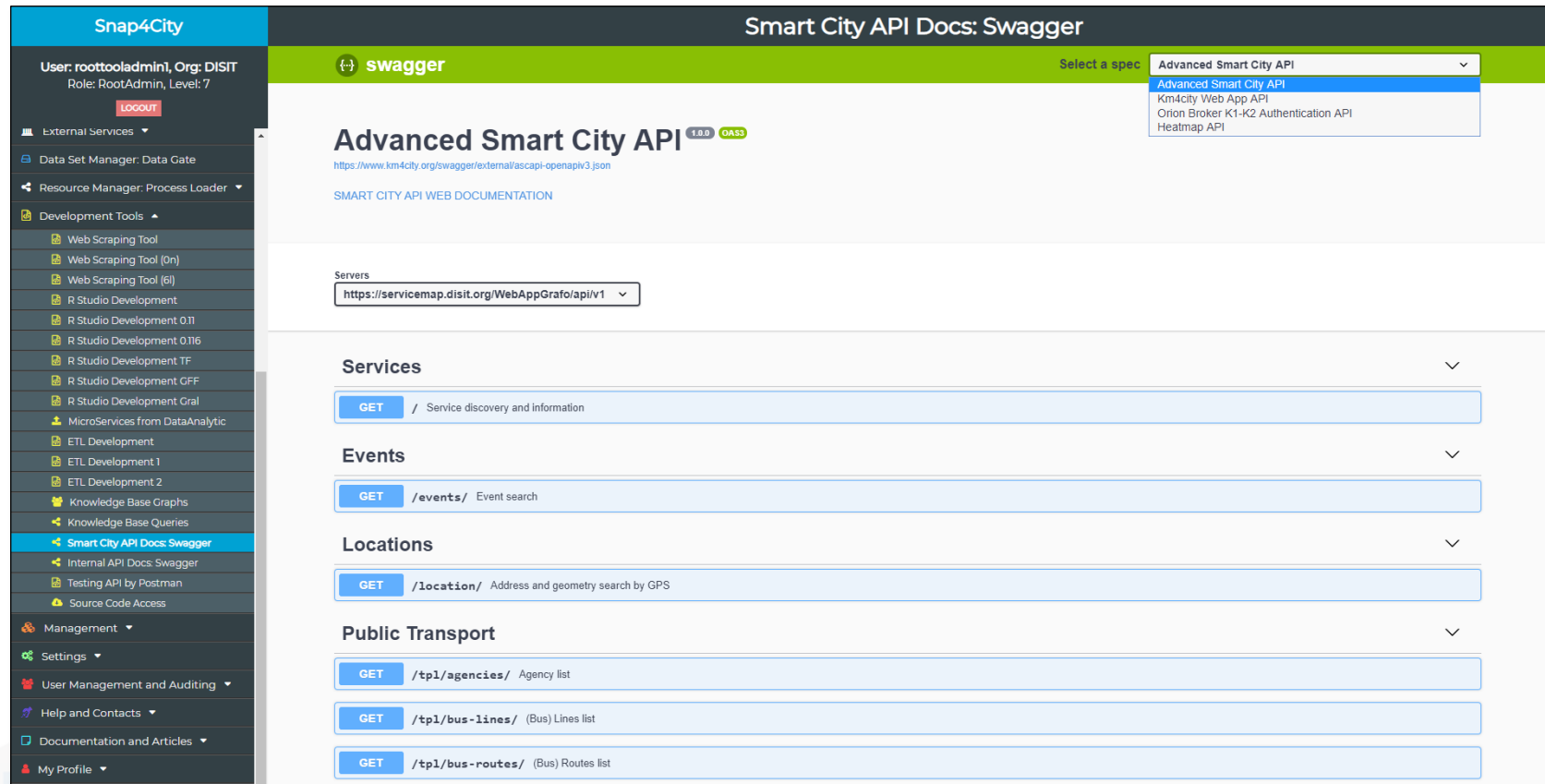
Coordinator: Paolo Nesi, Paolo.nesi@unifi.it

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

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



Internal and External Smart City API



Snap4City

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

Smart City API Docs: Swagger

Select a spec: **Advanced Smart City API**

Advanced Smart City API 1.0.0 GA53

<https://www.km4city.org/swagger/external/ascapi-openapi3.json>

SMART CITY API WEB DOCUMENTATION

Servers:

Services

- GET** / Service discovery and information

Events

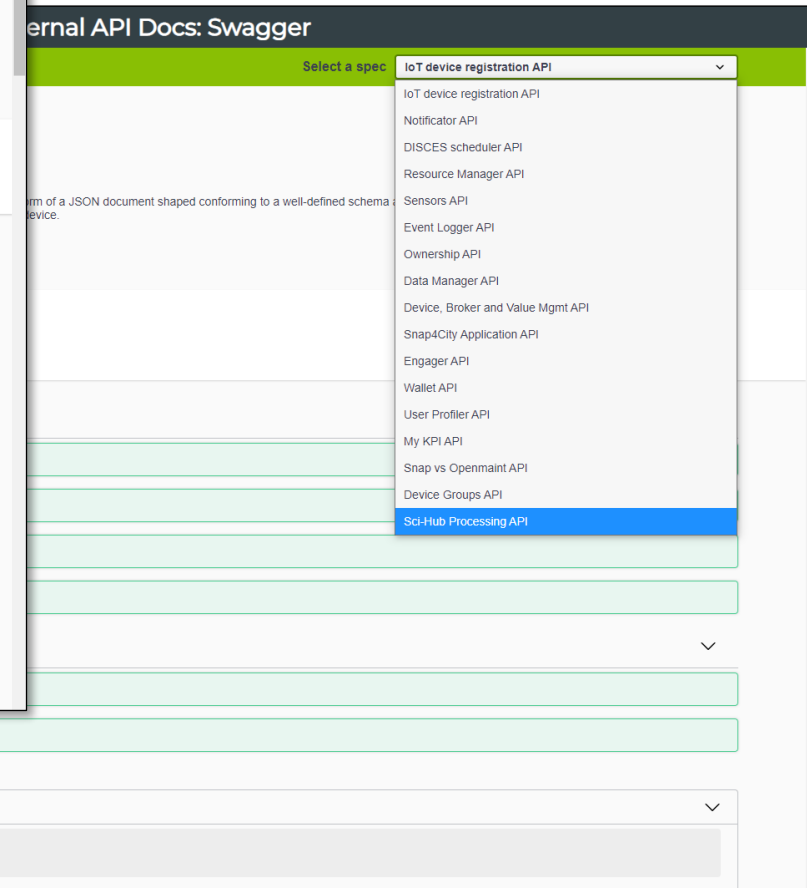
- GET** /events/ Event search

Locations

- GET** /location/ Address and geometry search by GPS

Public Transport

- GET** /tpl/agencies/ Agency list
- GET** /tpl/bus-lines/ (Bus) Lines list
- GET** /tpl/bus-routes/ (Bus) Routes list



Internal API Docs: Swagger

Select a spec: **IoT device registration API**

- IoT device registration API
- Notifier API
- DISCES scheduler API
- Resource Manager API
- Sensors API
- Event Logger API
- Ownership API
- Data Manager API
- Device, Broker and Value Mgmt API
- Snap4City Application API
- Engager API
- Wallet API
- User Profiler API
- My KPI API
- Snap vs Openmaint API
- Device Groups API
- Sci-Hub Processing API**

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

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

Client Side Business Logic

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



Client-Side Business Logic Widget Manual

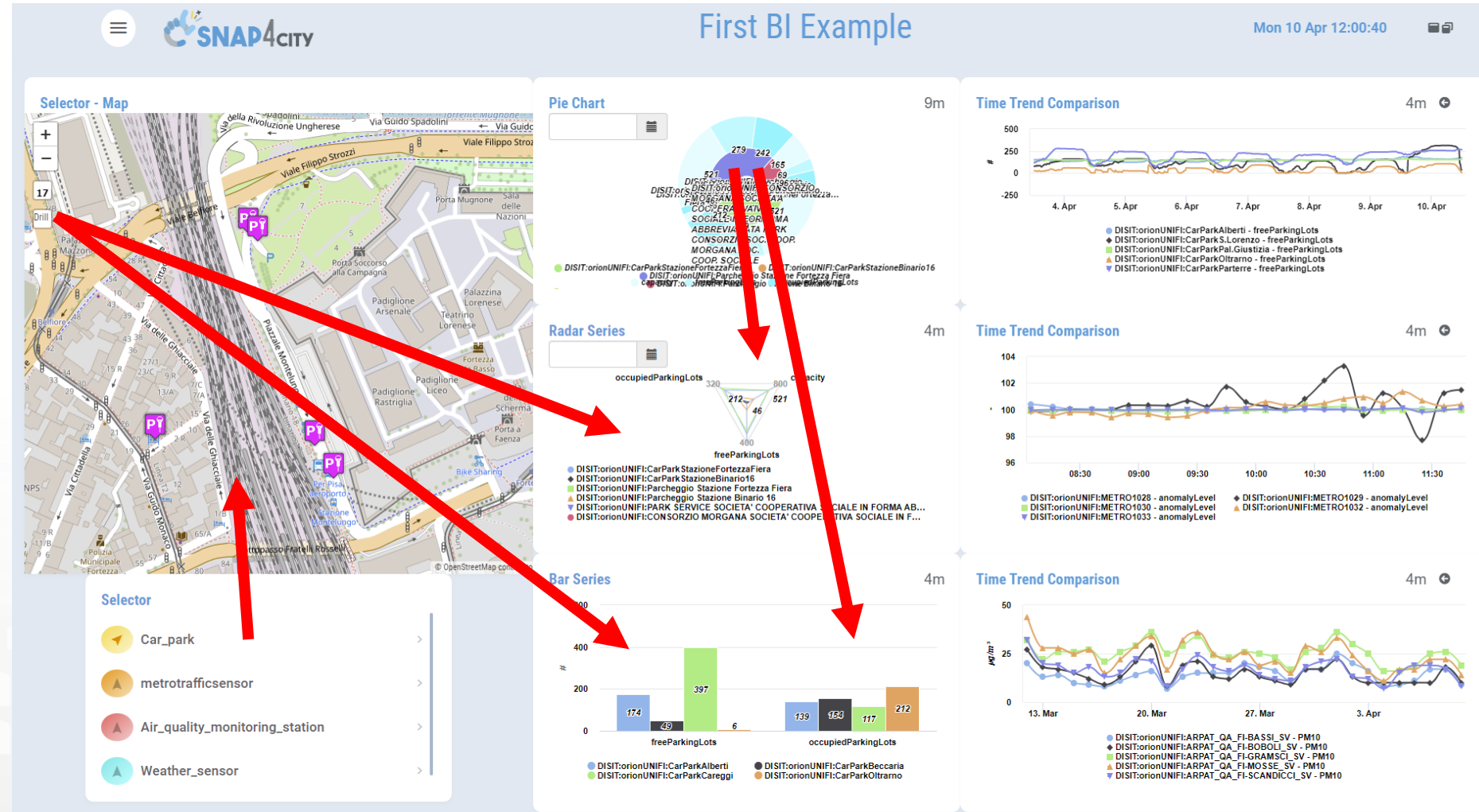
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- slides go to <https://www.snap4city.org/577>
- <https://www.snap4city.org>
- <https://www.snap4solutions.org>
- <https://www.snap4industry.org>
- <https://twitter.com/snap4city>
- <https://www.facebook.com/snap4city>
- <https://www.youtube.com/channel/UC3tAQ09EbNba8f2-u4vanda>

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Example: From Map to Graphs (spatial drill down)

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



Accelerating on Smart City on Deploy with Snap4City

<https://www.snap4city.org/738>











SNAP4
Appliances and Dockers
Installations



Tech Overview

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









Snap4City Platform

Technical Overview

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

Snap4City:

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

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

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

1

How to adopt Snap4City



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

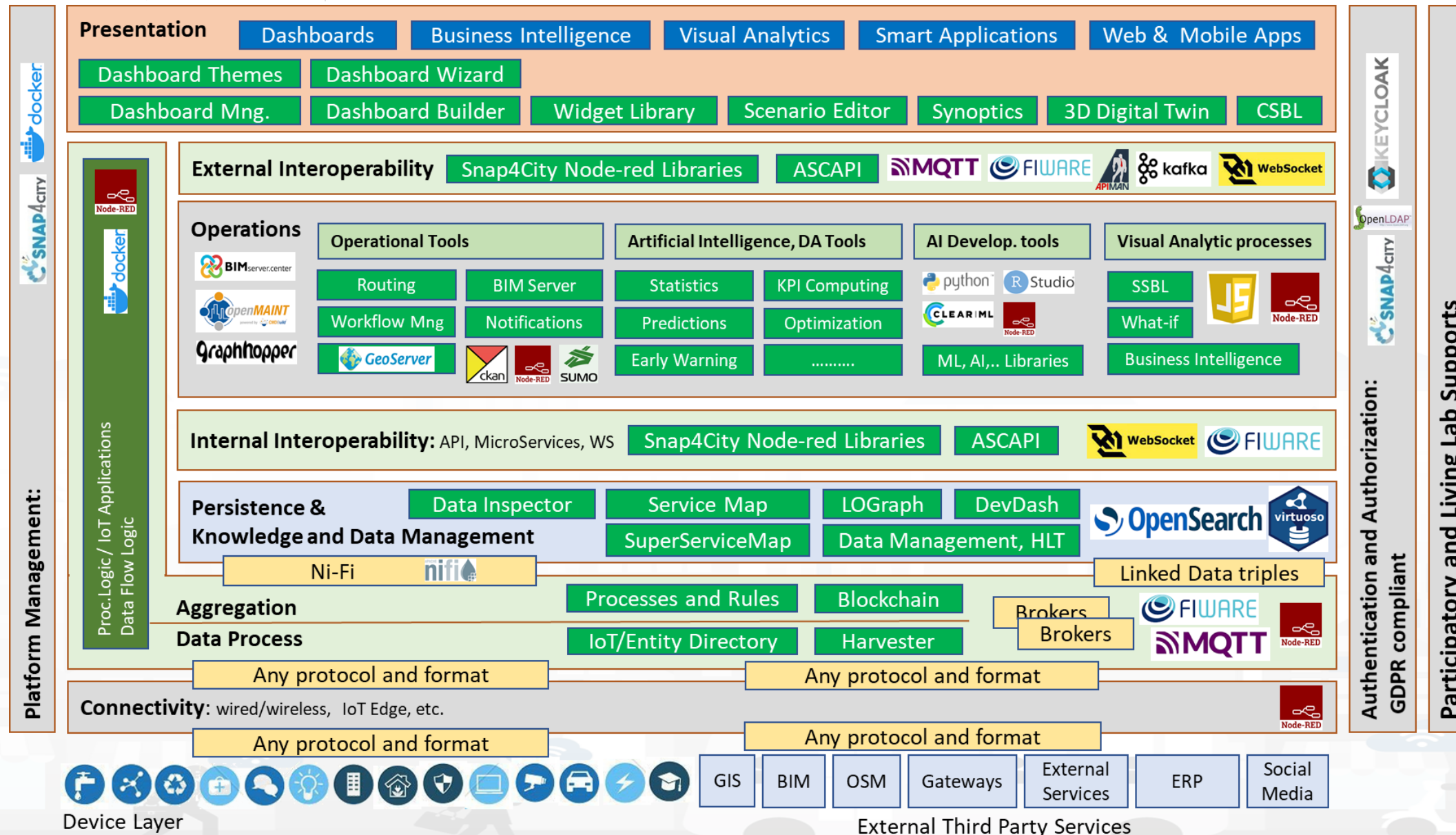


Installation on your premise

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

Mixed solutions! For example:

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



Smart Energy and Smart Building

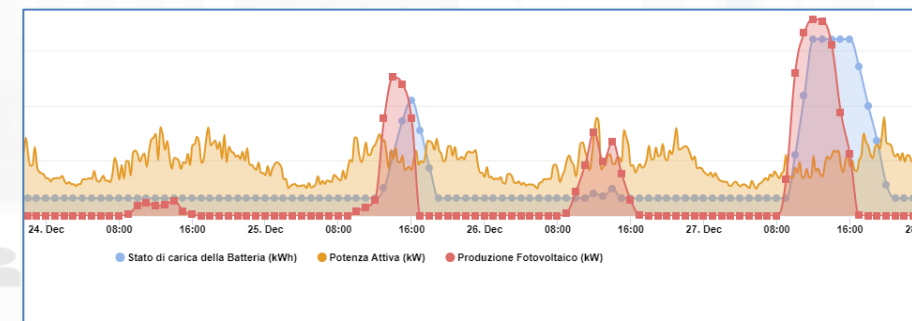
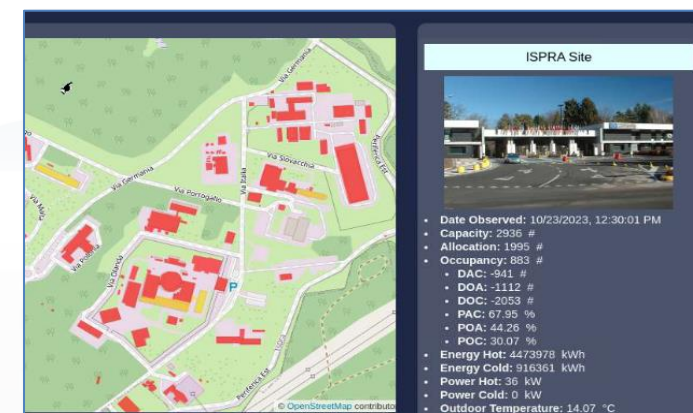
Goals

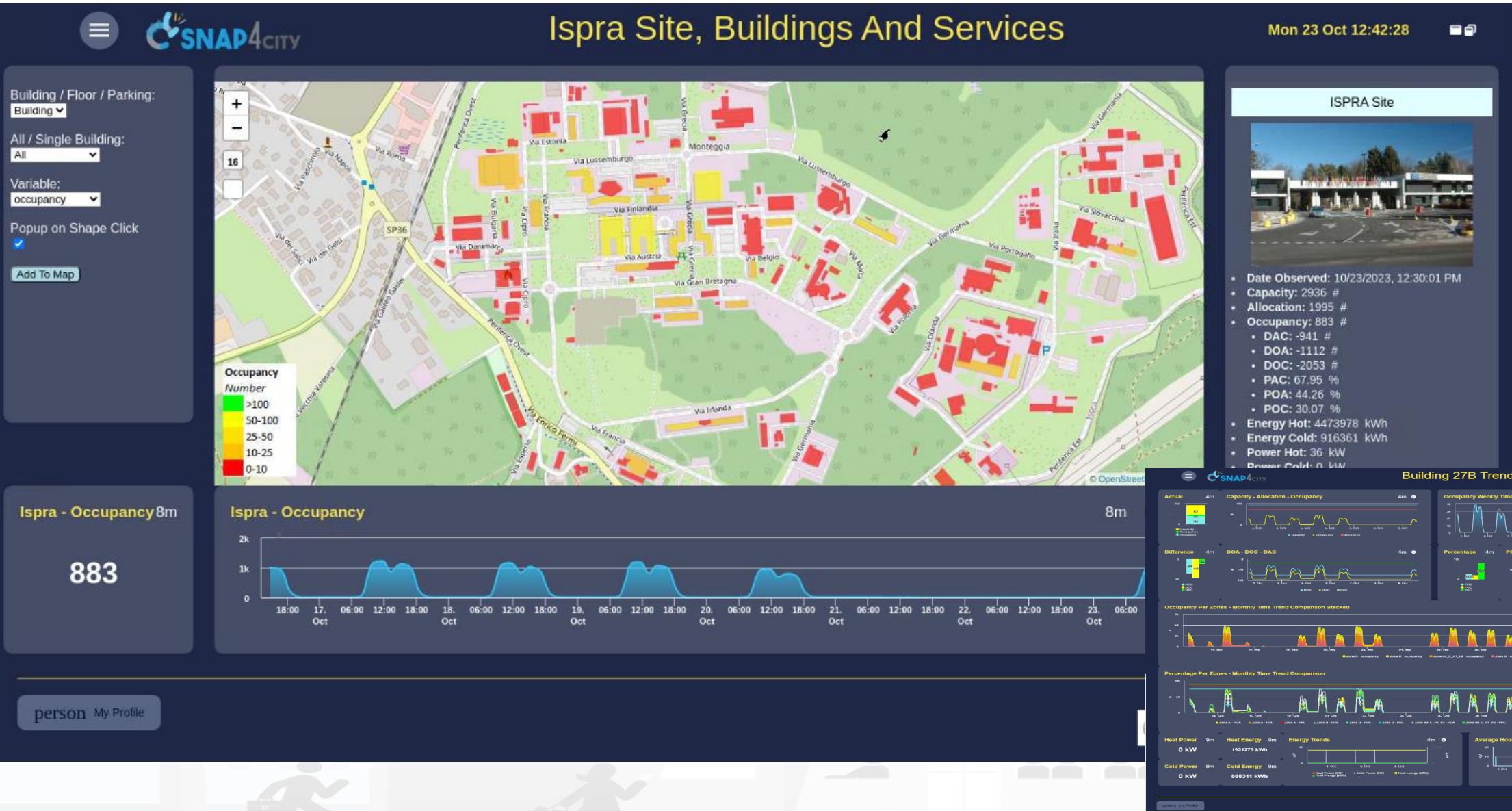


Cost Reduction

City Energy and Buildings

- **Goals:**
 - Energy consumption reduction, increment of efficiency,
 - Areas and building sustainability
 - Improve accessibility to services, security and safety
- **Energy Monitoring:** Building, floors, rooms, recharging poles, cabinets, Community of Energy, Data centers, Energy for Hot / cold, air condition, energy vs temperature and usage, etc.
- **Energy Management:** Predictions, early warning, identification of critical conditions
- **Smart Light Management:** LED/mixt, cabinets, lights vs traffic, lights vs security, energy saving, luminaries profiling, group management.
- **Smart Building Management:** consumption, number of people, etc.
 - Communities of Energy, Photovoltaic plants, sustainability
 - What-if analysis, optimisation tools
- **KPI: Energy consumption, efficiency, pros/cons**
 - Light profiling and adaptation
 - Autoclave industrial plants simulation, Photovoltaic plant simulation
 - consumption / usage, energy vs temperature
- **Mobile App:** monitoring, info-recharge, eSharing, booking, ..
- **Participatory:** problem reporting, ticketing, etc.
- **Integration of any kind**



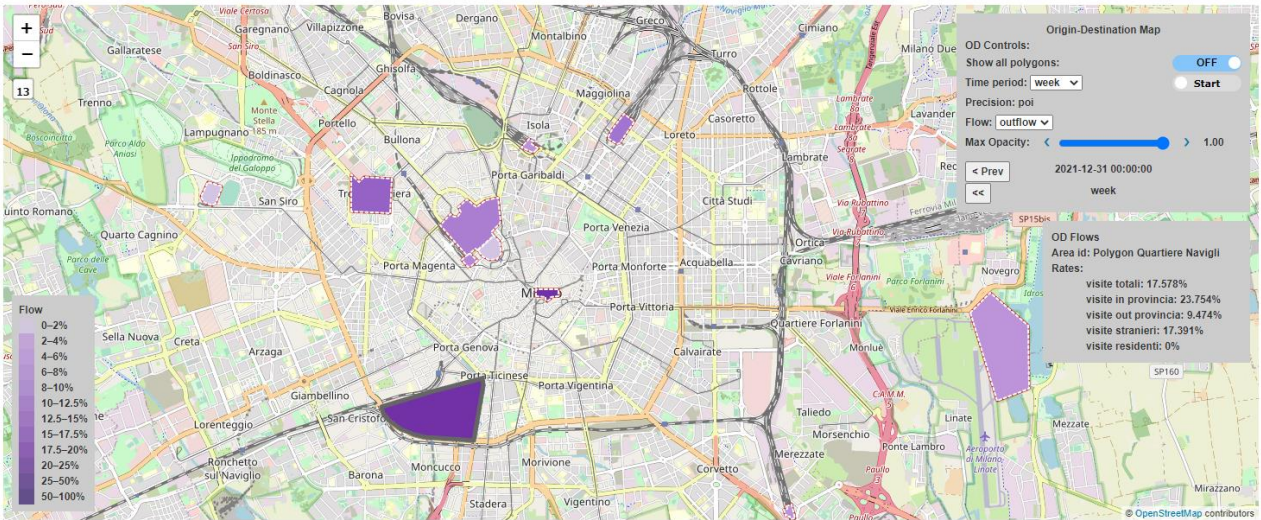


Energy monitoring and business intelligence

Green and Data Driven District @ MIND

Aggregated KPI JuicePark SmartPole CityAnalytics

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



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7 AFFORDABLE AND CLEAN ENERGY



11 SUSTAINABLE CITIES AND COMMUNITIES



Green and Data Driven District

Aggregated KPI JuicePark SmartPole CityAnalytics

Enel X Smart Pole

Detailed KPIs

Videoanalysis	
People counted daily:	0
People counted to date:	0
People aggregation daily:	0
People aggregation to date:	0
Vehicle counted daily:	0
Vehicle counted to date:	21

Power meter	
Daily energy consumed:	9.024 kWh
Energy consumed to date:	27.341 kWh
Daily energy produced:	1.409 kWh
Energy produced to date:	4.252 kWh

WiFi	
Max number of connected devices in the last day:	0
Hourly average connected devices:	####

eBike	
Daily number of sessions:	0
Number of sessions to date:	0
Total Energy consumed:	0
Average energy consumed:	0
Last charger session:	17/05/2022 11:25

Emergency	
SOS requests to date:	0
SOS request daily:	0
AED requests to date:	0
AED requests to daily:	0

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Green and Data Driven District

Aggregated KPI JuicePark SmartPole CityAnalytics

Detailed KPIs

Videoanalysis	
Vehicle parked daily:	8
Vehicle parked to date:	87
Vehicle count daily:	24
Vehicle count to date:	520

Power meter	
Energy consumed daily:	0 kWh
Energy consumed to date:	0 kWh
Energy produced daily:	0 kWh
Energy produced to date:	0 kWh

WiFi	
Max number of connected devices in the last day:	0
Hourly average connected devices:	####

Emergency	
SOS Requests to date:	0
SOS request daily:	0
EV charged	
Number of sessions daily:	0
Number of sessions to date:	0
Total Energy consumed:	0
Average energy consumed:	0
Last charger session:	0

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Capelon Cabinet (iot-search)

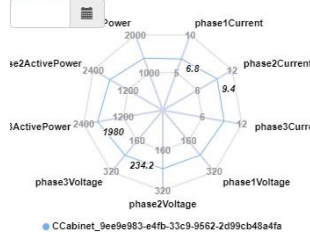
Ac...9m

12

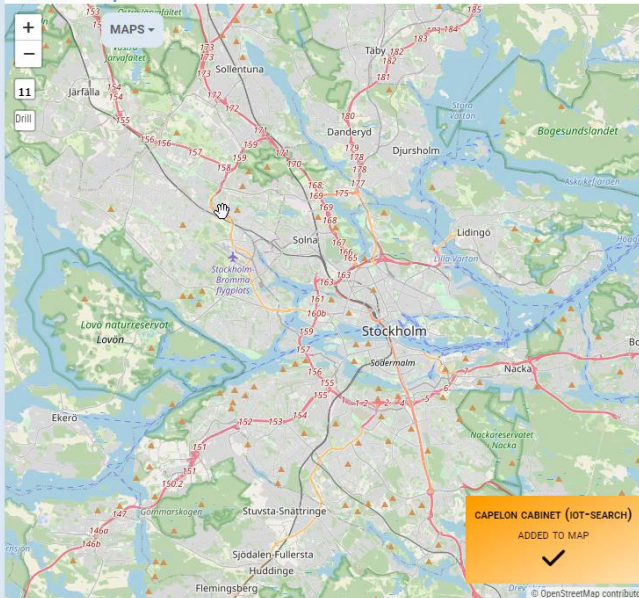
ActualState0Count - St... 9m



Radars Series



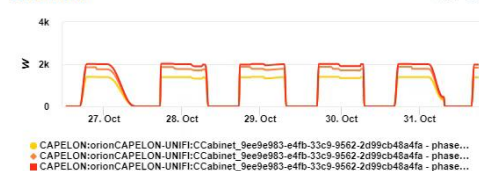
Selector - Map



:CCabinet_9ee9e983-E4fb-33c9-9562-2d99cb48a4fa - Burni... 9m



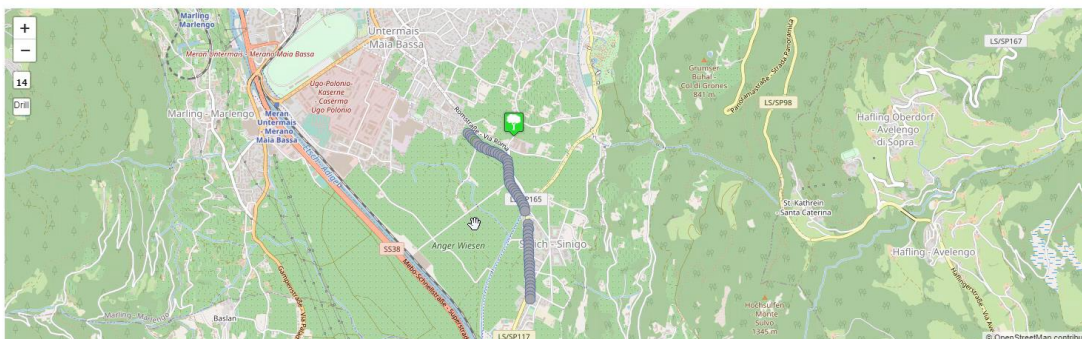
Time Trend



Tin Maps Google Gmail YouTube Nuova scheda

ASM Merano
Stadtwerke Merano

Elenco lampade Visualizzazione dati Log eventi Grafici Impostazioni



N. Punto Luce	11307
DevEui	7083D5BF100085D7
Via	RomSträße
Regolazione	
Ore di servizio	
Conta energia	
Potenza attuale	
Stato	Inattivo
Nome errore	null
RSSI	
SNR	
Data	01/11/2023 12:01:18
Regolazione	Invia
ON	
OFF	
DALUTCMISSING	
INF_AULTTRIGGER	
DAL_BALAST_DISABLE	
ERR_BALAST_NOT_CONFIG	
ERR_DAL_THERMAL_SHUTDOWN	
ERR_DAL_THERMAL_DERATING	
ERR_DAL_POWER_LIM	
ERR_DAL_OVERALL	
INF_POWER_FAIL	
INF_BUS_POWERED_BY_FREE	
INF_DAL_BATT_ERR	

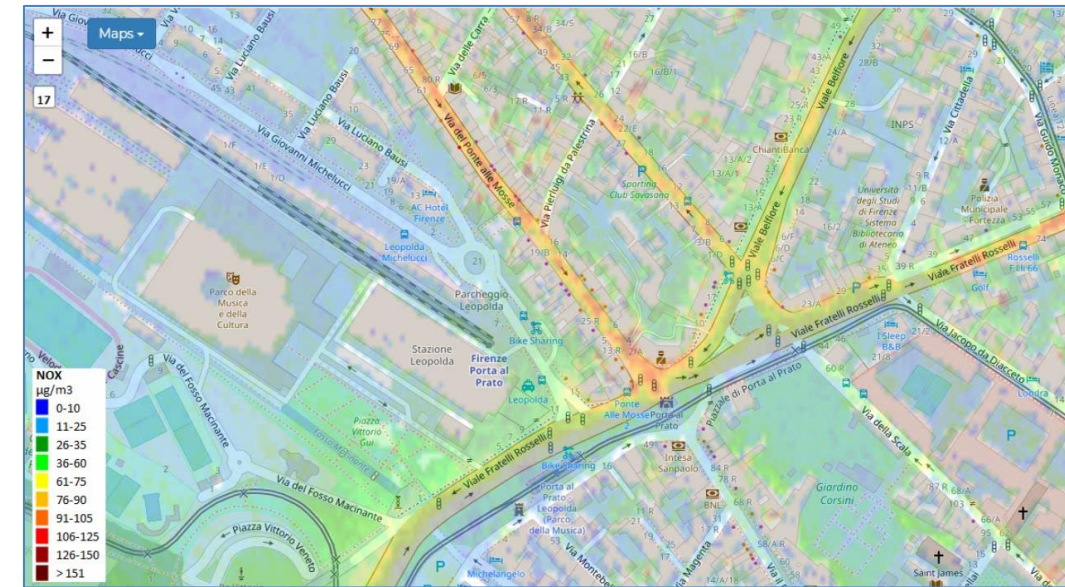
Non Attivo
Stato Linea verso Sinigo

Non Attivo
Stato Linea verso Merano Centro

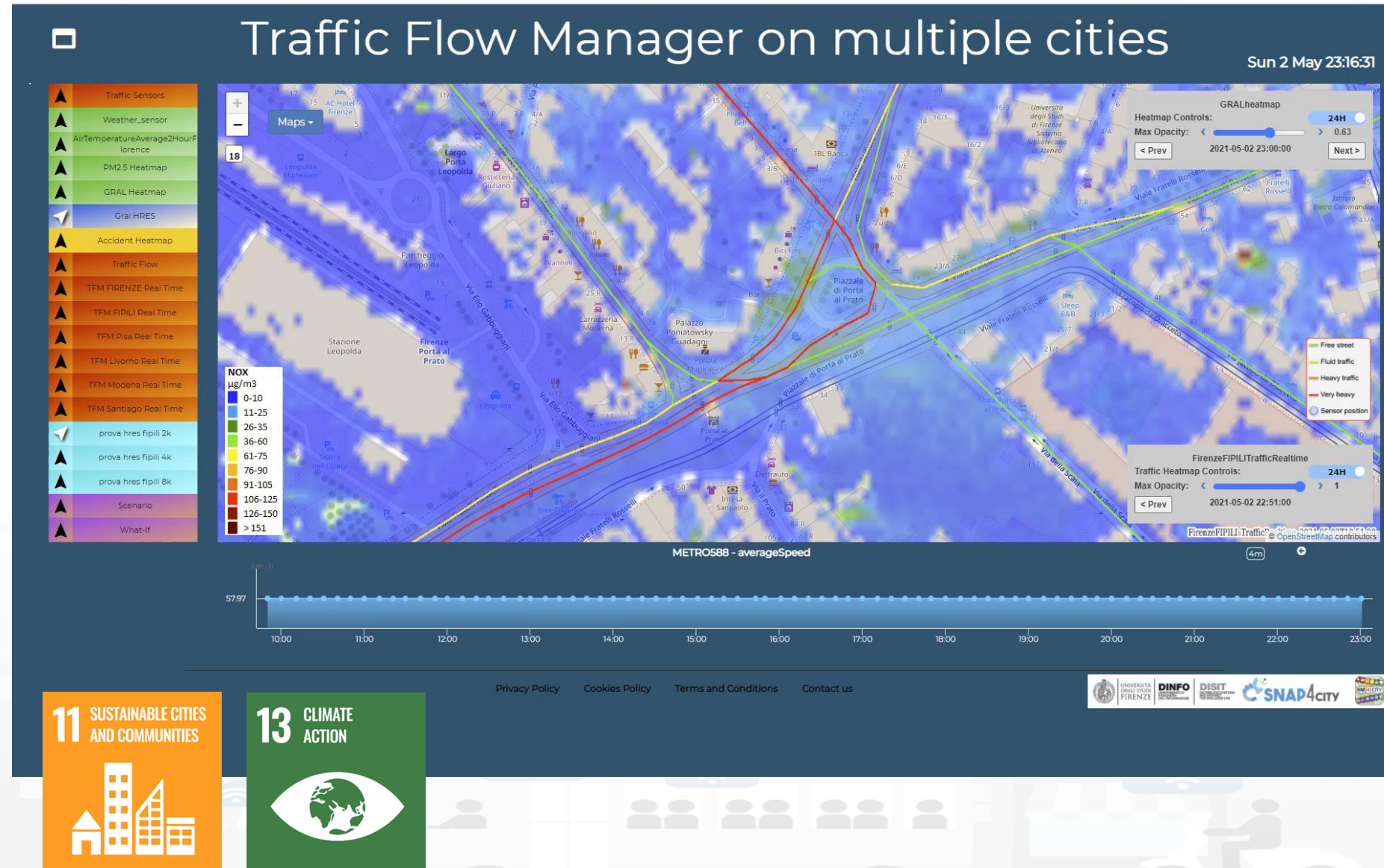
Smart Light Management

Environment and Waste

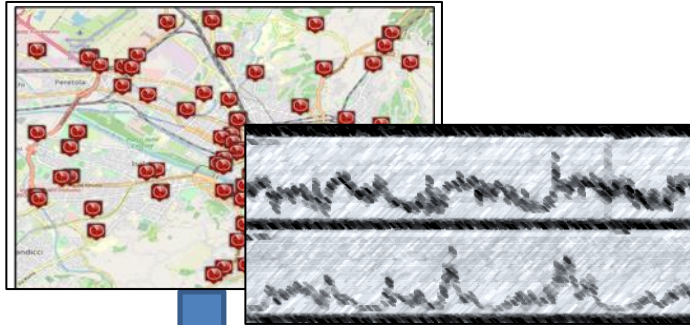
- **Goals:**
 - Reduction of emissions and EC taxations
 - Cost reduction for waste collection,
 - reduction of waste collection impact on mobility
- **AIR quality (Indexes) monitoring and warning**
- **Environment Management & producing prescriptions:**
 - Monitoring, long and short-term predictions, warning for:
 - GHG, emissions, pollutants, aerosol, chemical plants analysis
 - Traffic Flow impact emissions, predictions
 - Sea conditions, UV conditions, etc.
- **Land slide prediction warning**
- **Coastal erosion monitoring and analysis**
- **Smart Waste Management and Optimisation:**
 - costs reduction, optimal routing production, pay as you throw,
 - avoiding out of bins, predictions of waste production on bins, alarms
- **KPI:** SDG, 15MinCityIndex, QOS, costs, Km, collecting time, EC KPI, emissions
- **Mobile App:** final users services/informing and operators
 - Info Waste for operators, participation, optimal routing, RAEE Collection, ..
- **Participatory:** problem reporting, ticketing, etc.
- **Integration of any kind: env/weather, mobility, ticketing, presences, POI, ..**



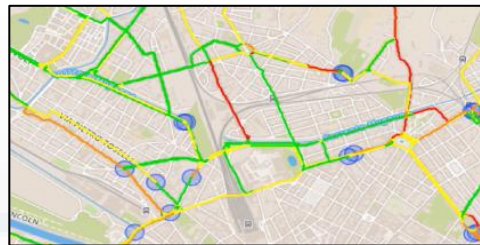
- **Prediction**
 - **NOX Pollutant** diffusion on the basis of Traffic Flow (prediction), weather and 3D structure
 - **NO2 progressive average** (Long term)
- **Project:**
 - **Trafair CEF EC**
 - Mixed solutions of Fluidinamics modeling and AI



Estimating City Local CO2 from Traffic Flow Data



Computing Traffic Flow
into CO2 sensor area



Traffic Flow data

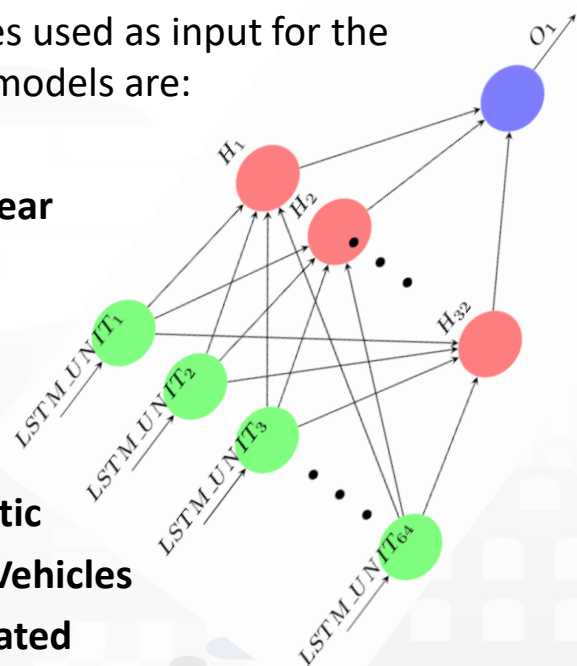
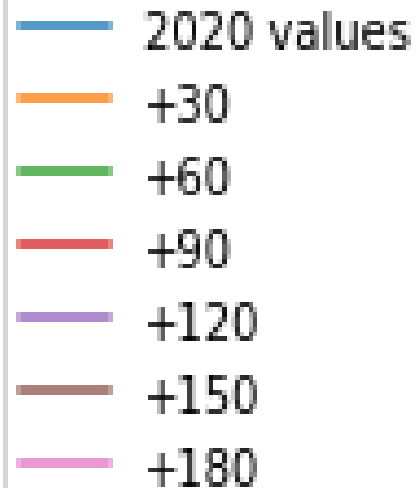
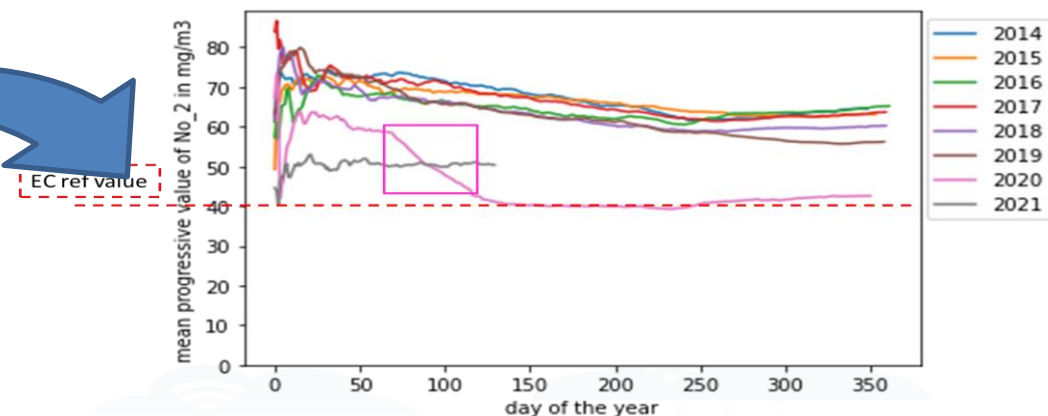
- Traffic Flow is one the main source of CO2 (**ton of CO2 x Km x Vehicle**)
 - **K1: Fluid Flow**
 - **K2: Stop and Go**
- **Dense estimation of CO2 into the city** is very useful to know to target EC's KPIs

Computing CO2 on the basis of
traffic flow data



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



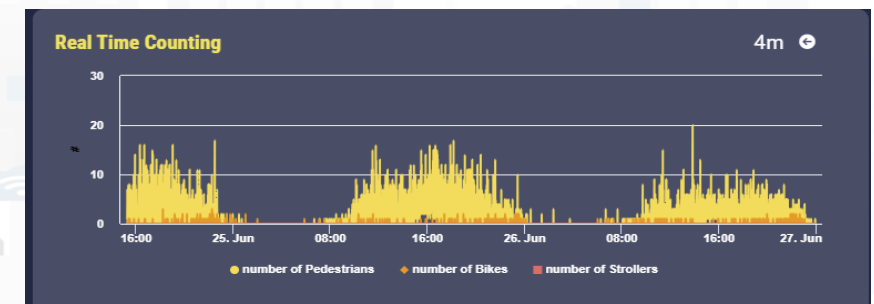
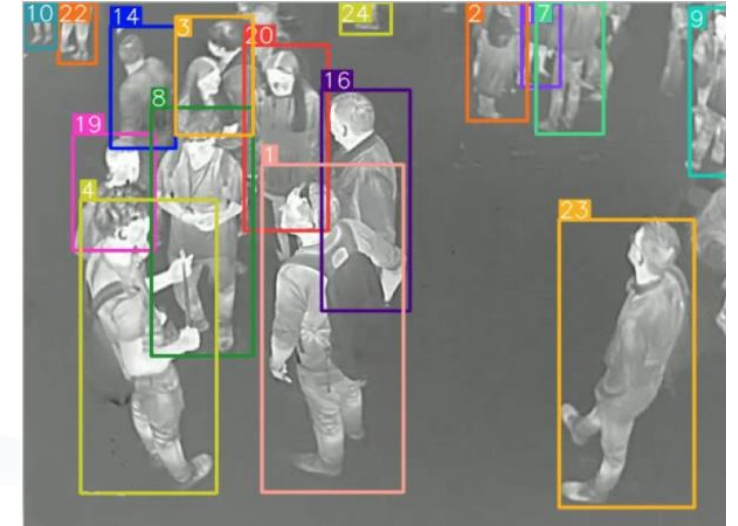
Air Quality Directive				WHO guidelines	
Pollutant	Averaging period	Objective and legal nature and concentration		Comments	
PM _{2.5}	One day				99 th percentile (3 days/year)
PM _{2.5}	Calendar year	Target value, 25 µg/m ³	The target value has become a limit value since 1 January 2015	10 µg/m ³	
PM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

City Users' Services
and Tourism Management

Goals

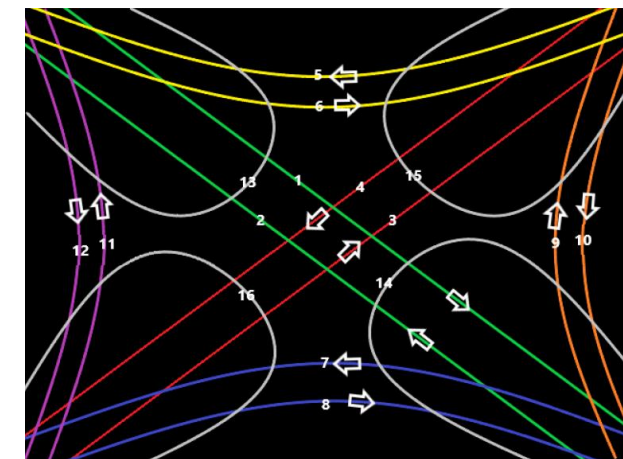
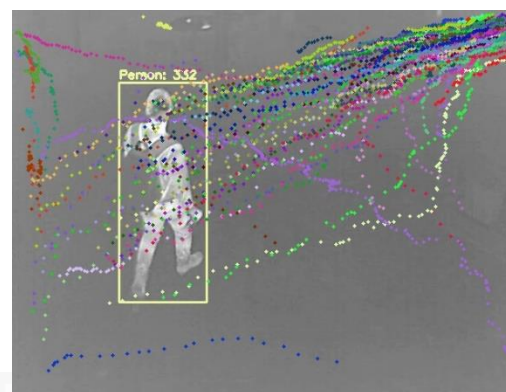
City User Behaviour/services, Tourism and Safety

- **Goals:**
 - Improve Quality of Life and quality of services,
 - Over tourism mitigation, sustainability
 - Costs reduction of services
 - Improve accessibility to services: citizens, Tourists, commuters, etc.
 - Improve Security/Safety of city users
- **People Flow Analysis / Management:** in/out-door, retail, attractions
 - Counting, tracking, Flows, ODM, sentiment, recency/frequency, etc.,
 - multiple sources: thermal & TV cameras, radar sensors, PAX sniffers, mobile data, ...
 - Data and/or **OD matrices** from: Wi-Fi, traffic data, mobile phone data
 - **Suggestions:** info Tourism, digital signages, engagement, ..
- **Tourists Flows & Retail Management:** predictions of presences, services' reputations, suggestions on second offer, over-tourism, notifications, early warning,
- **KPI:** 15 MinCityIndex, energy vs people, over-tourism, accepted suggestions, precision
- **Mobile App:** final users services/informing and operators
 - Info Tourism, people flows, info mobility, sharing, ...
 - Participation, engagement, ..
- **Participatory:** problem reporting, ticketing, etc.
- **Integration of any kind:** env/weather, mobility, ticketing, presences, POI, ..



User Behaviour: People Counting, Tracking, etc.

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



Mobility and Transport

Goals



Decongestion



Safety



Accessibility



Cost Reduction



Decarbonization

AI-Powered Digital Twin Platform for Mobility & Transport Operation and Plan

Urban Challenges & OPTIFaaS Objectives
From data to action : Tailored Mobility Services

The Core

Snap4City / OPTIFaaS delivers mobility solutions for operational management and strategic-tactical planning through an integrated Digital Twin and various AI models, enabling what-if analysis, simulation, and optimization

Objectives



Decongestion



Safety



Accessibility



Cost



Decarbonization

OPTIFaaS



Scalable, flexible, customized mobility solutions
Reduction
Supports various urban contexts from small communities to large metropolises

Mobility & Transport



- **Goals:**
 - Decongestion, Decarbonization, costs reductions
 - Improve Accessibility to services
 - Improve Security/Safety of city users
- **Operation and Plan:**
 - Traffic monitoring, prediction, reconstruction, identification of critical conditions (early warning), fleet management, dynamic routing, multimodal routing, city user behaviour analysis
- **Optimization and what-if analysis traffic light, infrastructure**
 - **Reduction:** travel time, waiting time, stops, CO2 emissions, consume fuel, travel time for tramways
- **Public Transport:** analysis of Mobility Demand vs Offer of Transportation
- **Parking Management:** monitoring, prediction, any payments, on/off-road
- **Sharing / Pooling Management:** eShare and mobile app, bikesharing, smart bike, fleet management
- **KPI:** SUMI/SUMP, travel time, emissions, traffic status, accessibility, ..
- **Mobile App:** final users and operators
 - Info Mobility, traffic reconstruction, charging, participation,
 - Parking, payments, overparking, fine reporting, ..
- **Participatory:** problem reporting, ticketing, etc.
- **Data Integration of any kind:** env, weather. Tickets, presences, POI, sat, etc.

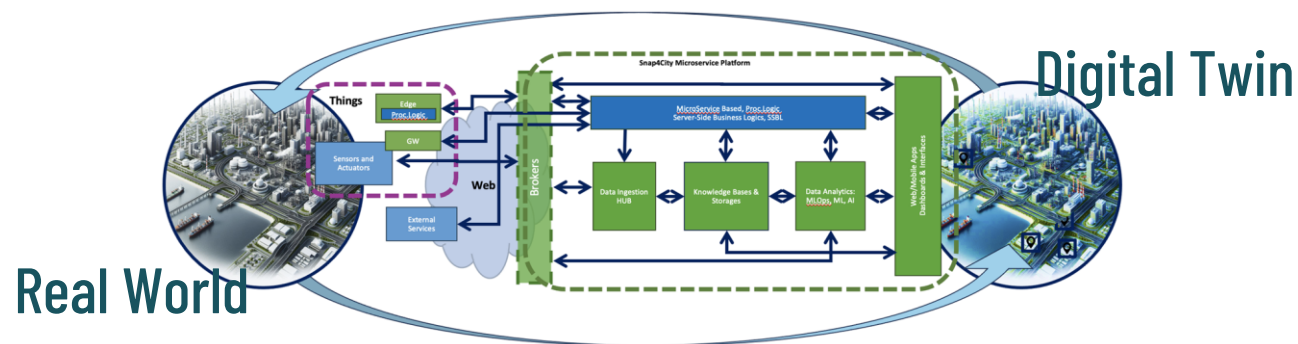
AI-Powered Digital Twin Platform for Mobility & Transport Operation and Plan

Integrated Digital Twin + Artificial Intelligence platform for real-time urban mobility monitoring and optimization

Smart & Sustainable Mobility with Snap4City / OPTIFaaS
Empowering Cities with AI based Digital Twin

AI Technologies

- Deep Learning
- Reinforcement Learning
- Generative AI
- GNN-DRL and similar



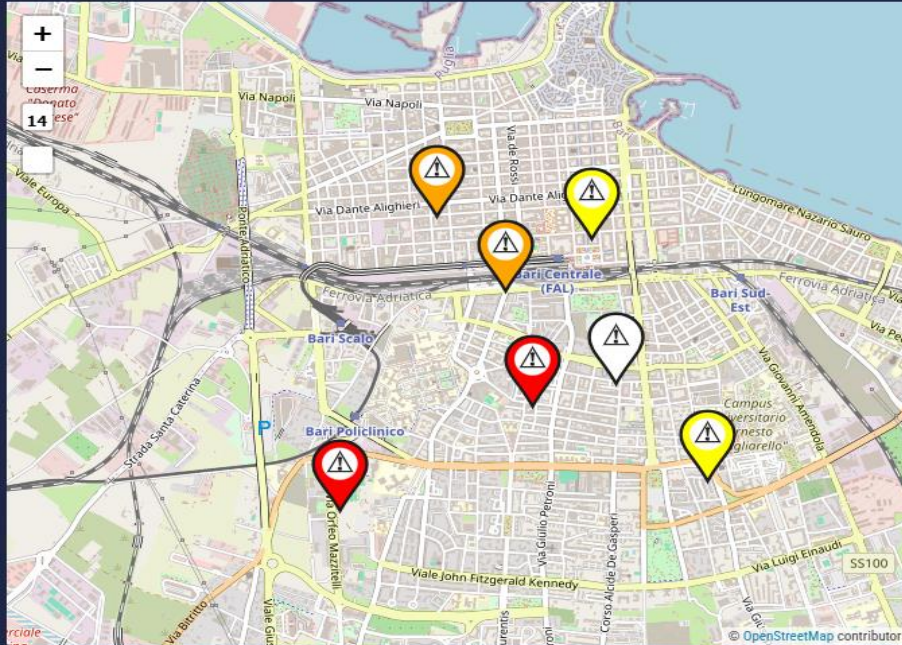
Designed for Tactic and Strategic Planning

- What-if scenarios
- Simulations
- Optimizations

Supports Operational Management

- Traffic monitoring, forecasting, and reconstruction
- Infrastructure evaluation
- Traffic light plan generation
- Early warning systems
- Dynamic/multimodal routing
- Analysis of city users' behavior

- Home
- Traffic Monitoring
- Smart Parking
- 15 minuti index
- Urban Security



Road Monitoring

Media congestioniC	Nr. congestioniC	Picco congestioniC	Riduzione Co2 ZTLC	Emissioni medie CO2 C	Emissioni totali CO2 C
28.4 %	17	18:27	-5.2 %	282 ppm	846 ppm

Traffico in ingresso



Tot. veicoli in ingresso C	Velocità media C
12105 Veicoli	27 km/h

Traffico in uscita



Tot. veicoli in uscita C	Veicoli totali C
11703 Veicoli	7825 -

Pannello Rischi Meteo

MINIMO	BASSO	MEDIO	ALTO
Rischio Idraulico	MINIMO	Rischio Idrogeologico	MINIMO
Rischio Temporali	MINIMO	Rischio Neve	MINIMO
Rischio Ghiaccio	MINIMO	Rischio Vento	MINIMO

Viabilità

INCIDENTI	3
Chiusura Traffico	2
Chiusura Lavori	0
Limitazioni Traffico	4
Limitazioni Lavori	0
SEGNALAZIONI	7

Trasporto Pubblico

Tempo medio di attesa C	
5.9 sec	
Ritardo autobus C	
0 %	

Attesa Media Fermate

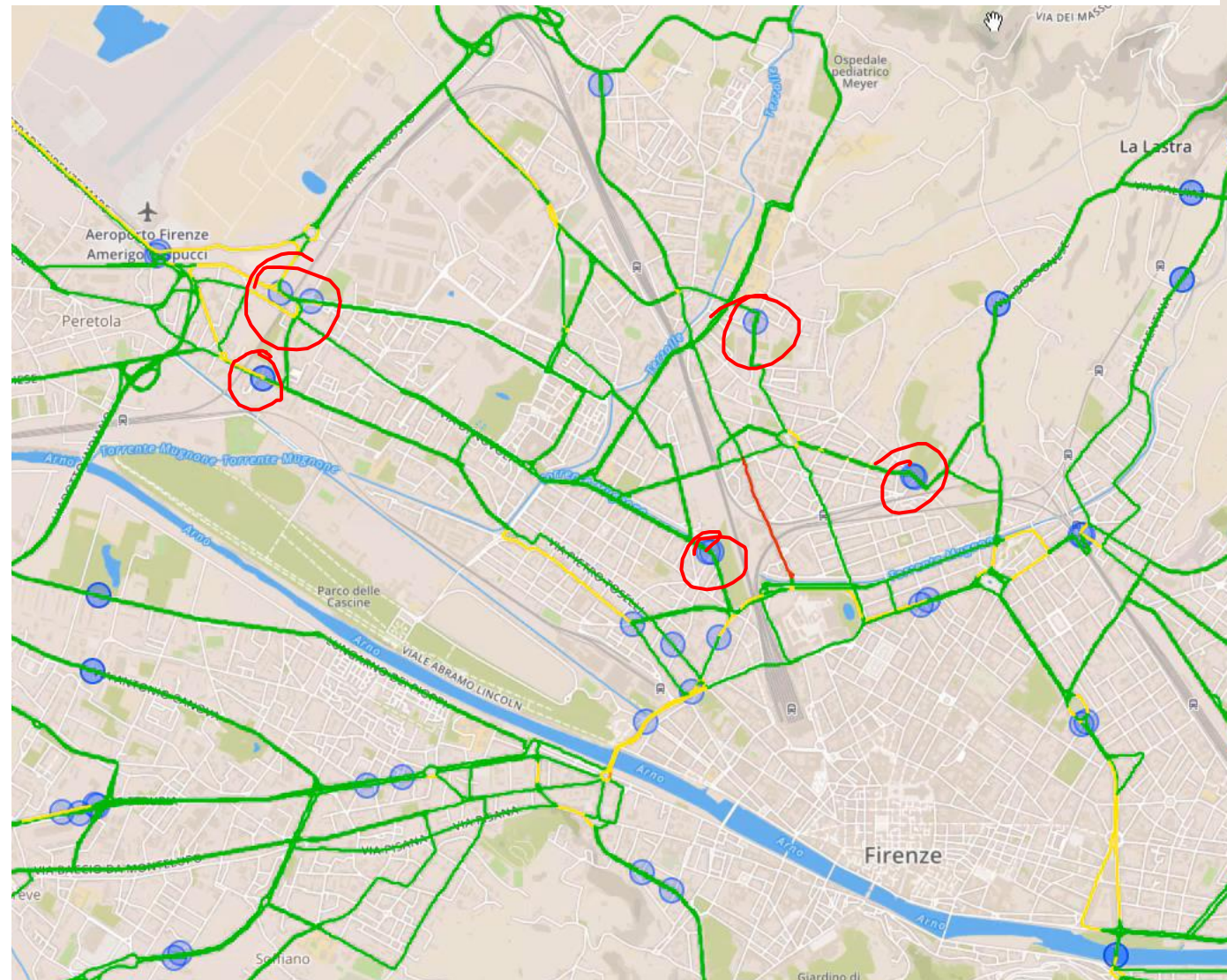
Linea 50	12 sec
Linea 11	10 sec
Linea 33	6 sec
Linea 02/	5 sec
Linea E	5 sec
Linea 19	4 sec

Sensori

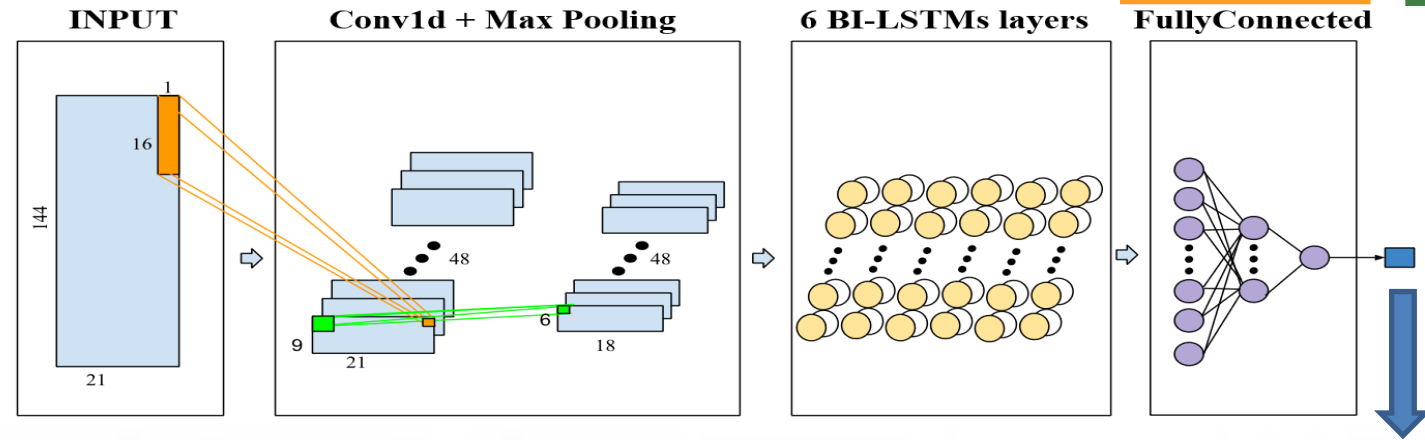
15	3
Semafori	
22	0
Videocamere	
4	1
Sensori	

Dense Traffic Flow Reconstruction ?

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



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



Urban data:

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

RF

XGBOOST

DNN

LSTM

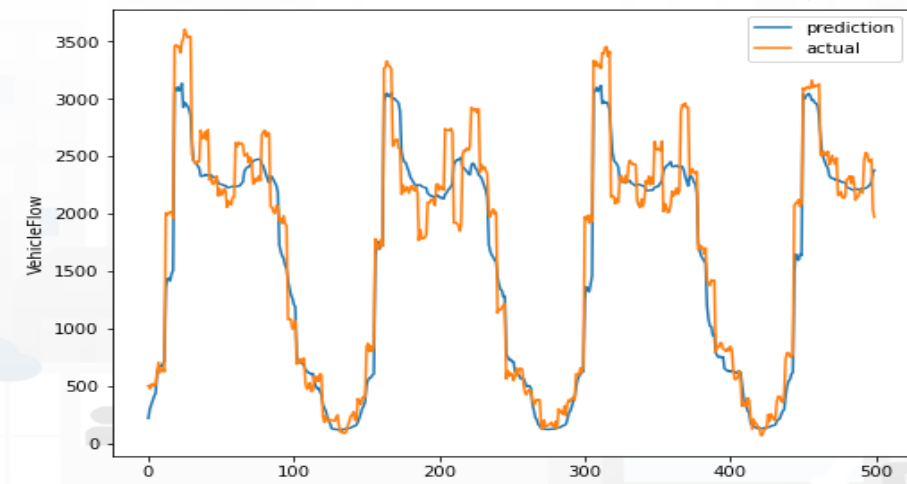
BI-LSTM

Autoencoder BI-LSTM

Attention CONV-LSTM

CONV-BI-LSTM

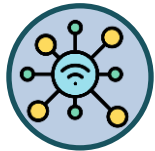
CONV-BI-LSTM



AI-Powered Digital Twin Platform for Mobility & Transport Operation and Plan

Snap4City

Is an **open platform** designed to support cities and organizations in enhancing urban mobility through the integration of **heterogeneous data sources** and **AI**



Open

open source, interoperable, modular, microservices

Snap4City (C), June 2025



Scalable

with city size and complexity



AI-powered platform

data-driven platform for mobility innovation



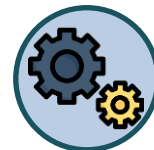
Optimizing Transportation Systems

improving efficiency, sustainability, quality of life



Business Intelligence Tools

available for decision makers, operators, control rooms



Minimal Set up Costs

maximum flexibility, visual programming, no-code platform

Platform Value & Business Model

Scalable Solutions for Smart City Growth

OPTIFaaS

Adopts a **service-based business model** tailored to the **needs of small and medium-sized cities and mobility operators**. It emphasizes cost-effectiveness, offering flexible and scalable solutions for urban mobility and sustainability

-  Home
-  Traffic Monitoring
-  Smart Parking
-  15 minuti index
-  Urban Security



Road Monitoring

Media congestioniC	Nr. congestioniC	Picco congestioniC	Riduzione Co2 ZTLC	Emissioni medie CO2 C	Emissioni totali CO2 C
28.4 %	17	18:27	-5.2 %	282 ppm	846 ppm

Traffico in ingresso



Tot. veicoli in ingresso C	Velocità media C
7152 Veicoli	27 km/h

Traffico in uscita



Tot. veicoli in uscita C	Veicoli totali C
6988 Veicoli	7825

Pannello Rischi Meteo

	MINIMO	BASSO	MEDIO	ALTO
Rischio Idraulico	MINIMO		Rischio Idrogeologico	MINIMO
Rischio Temporali	MINIMO		Rischio Neve	MINIMO
Rischio Ghiaccio	MINIMO		Rischio Vento	MINIMO

Viabilità

INCIDENTI	3
Chiusura Traffico	2
Chiusura Lavori	1
Limitazioni Traffico	7
Limitazioni Lavori	0
SEGNALAZIONI	9

Trasporto Pubblico

Tempo medio di attesa C	
11.6 min	
Ritardo autobus C	
11.1 %	

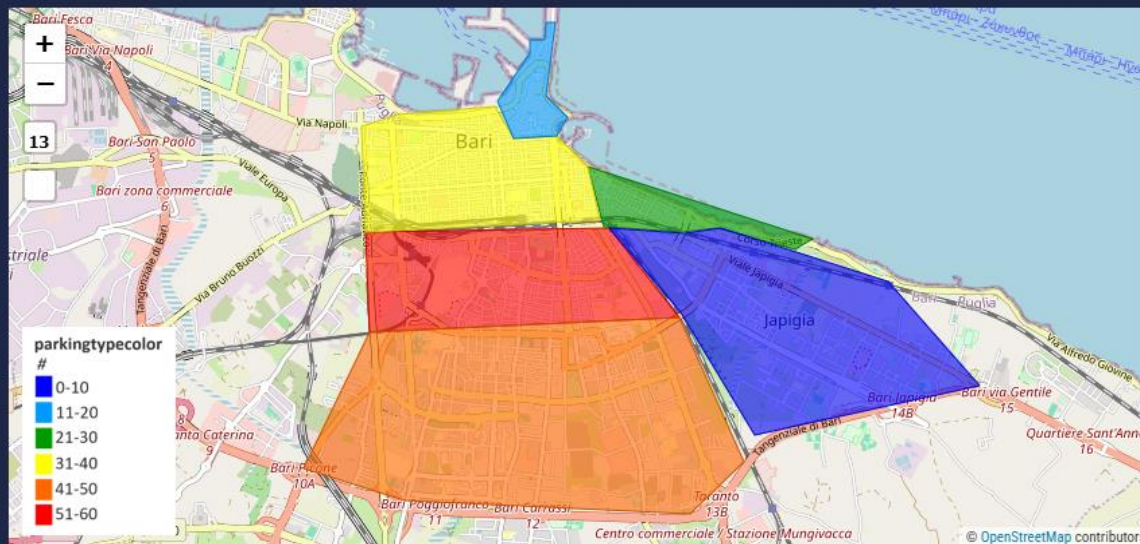
Attesa Media Fermate

Linea 22	21.1 min
Linea 02/	10 min
Linea 09	10 min
Linea 27	8.3 min
Linea 06	8.3 min
Linea 01	7.2 min

Sensori

15	3
Semafori	
22	0
Videocamere	
4	1
Sensori	

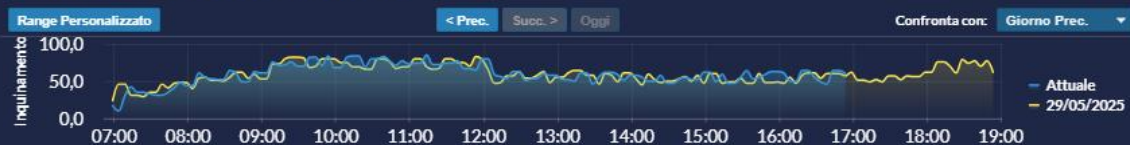
- Home
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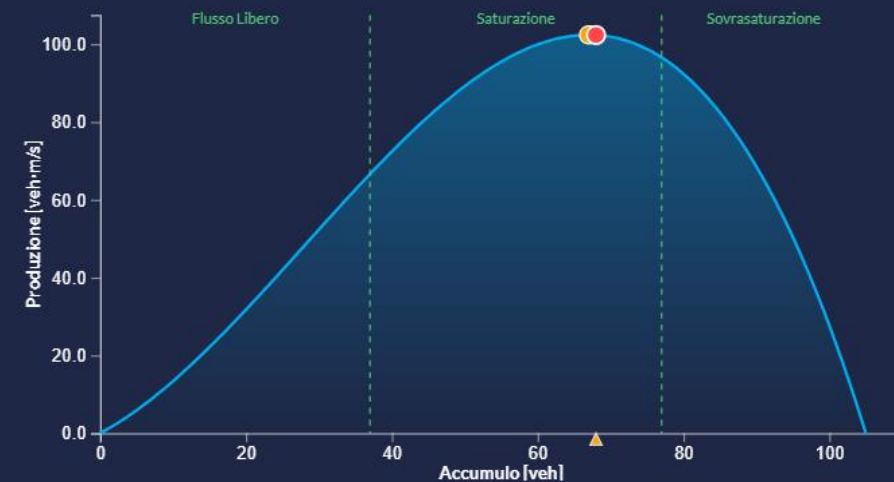
Trend Accumulo - Poggiofranco (Attuale)



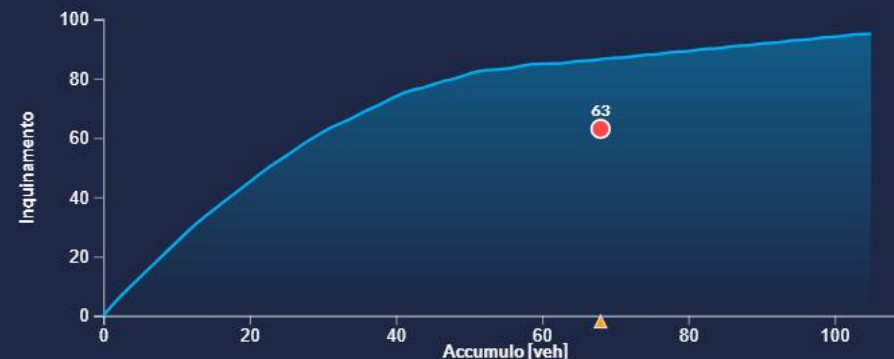
Trend Inquinamento - Poggiofranco (Attuale)



MFD - Poggiofranco

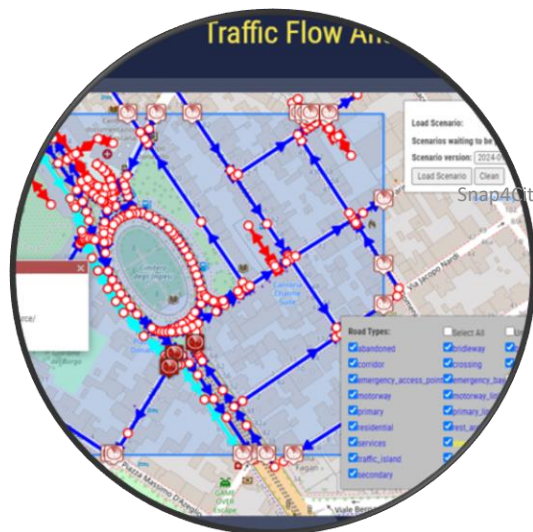


EMFD - Poggiofranco



AI-Powered Digital Twin Platform for Mobility & Transport Operation and Plan

“ Snap4City / OPTIFaaS promotes efficient and safe urban mobility, contributing to an improved quality of life and the sustainable growth of the community ”



Snap4City (C), June 2025

110

Sustainability Features

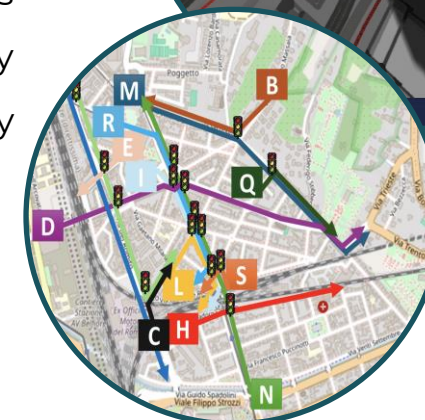
- Traffic optimization
- Multimodal transport integration
- Data-driven simulation and what-if analysis
- Fuel consumption reduction

Social Impact

- Reduced travel times and emissions
- Accessibility and inclusivity
- Road safety

Sustainability & Social Benefits

Driving the Future: Smarter. Greener. Together.



- Home
- Traffic Monitoring
- Smart Parking
- 15 minuti index
- Urban Security

Scenario

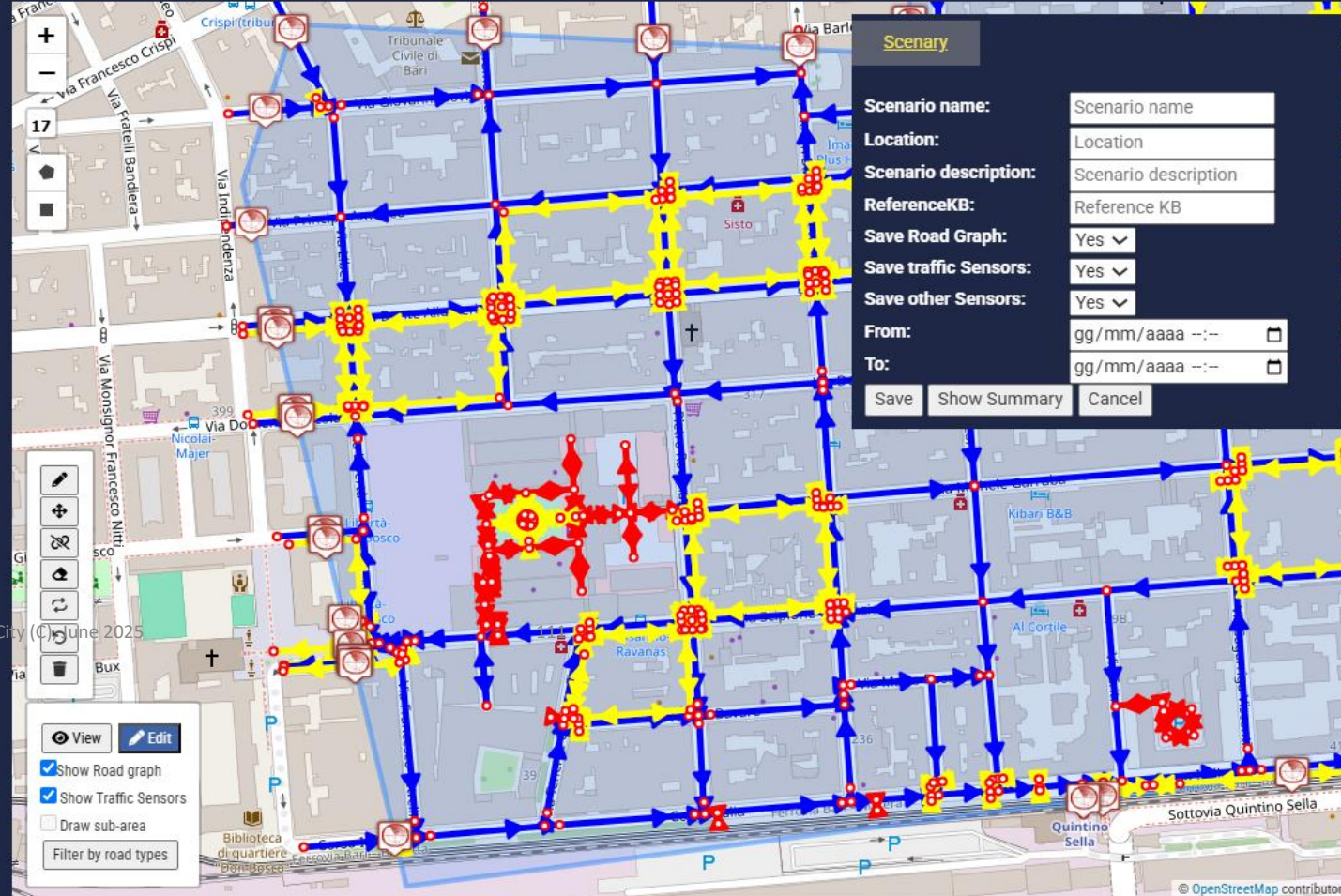
View Edit

☒ Show Road graph

☒ Show Traffic Sensors

☐ Draw sub-area

Filter by road types



INIT to ACC

Compute TFRS

Compute KPI

Show TFR

Data Update

HeatmapScenarioTest

2025-04-01 11:29:35

Execution

Snapshot4City

Dashboard Management System


Dashboard Management System

← → ↺ ↻ 🏠 🌐 📄 📱 📺 📷 📹 📺 📷 📹

🔍 snap4city.org/dashboardSmartCity/view/Gea-Night.php?iddasboard=NDI4Mg==

☆ 📄 📱 📺 📷 📹 📺 📷 📹

☰

 **SNAP4CITY**

Traffic Flow Simulation

Mon 14 Oct 19:47:07

Current Scenario: alessandroscen...

CANCEL

PAUSE

HELP

slow

fast

Delay: 30.0 ms

Stats

time: 1172.000 s
payload: 2.6 KB
simulate: 1.67 ms
snapshot: 0.54 ms

Vehicle Summary

car(s): 43

Click Summary

N/A

Quick Find

X,Y (float, float)

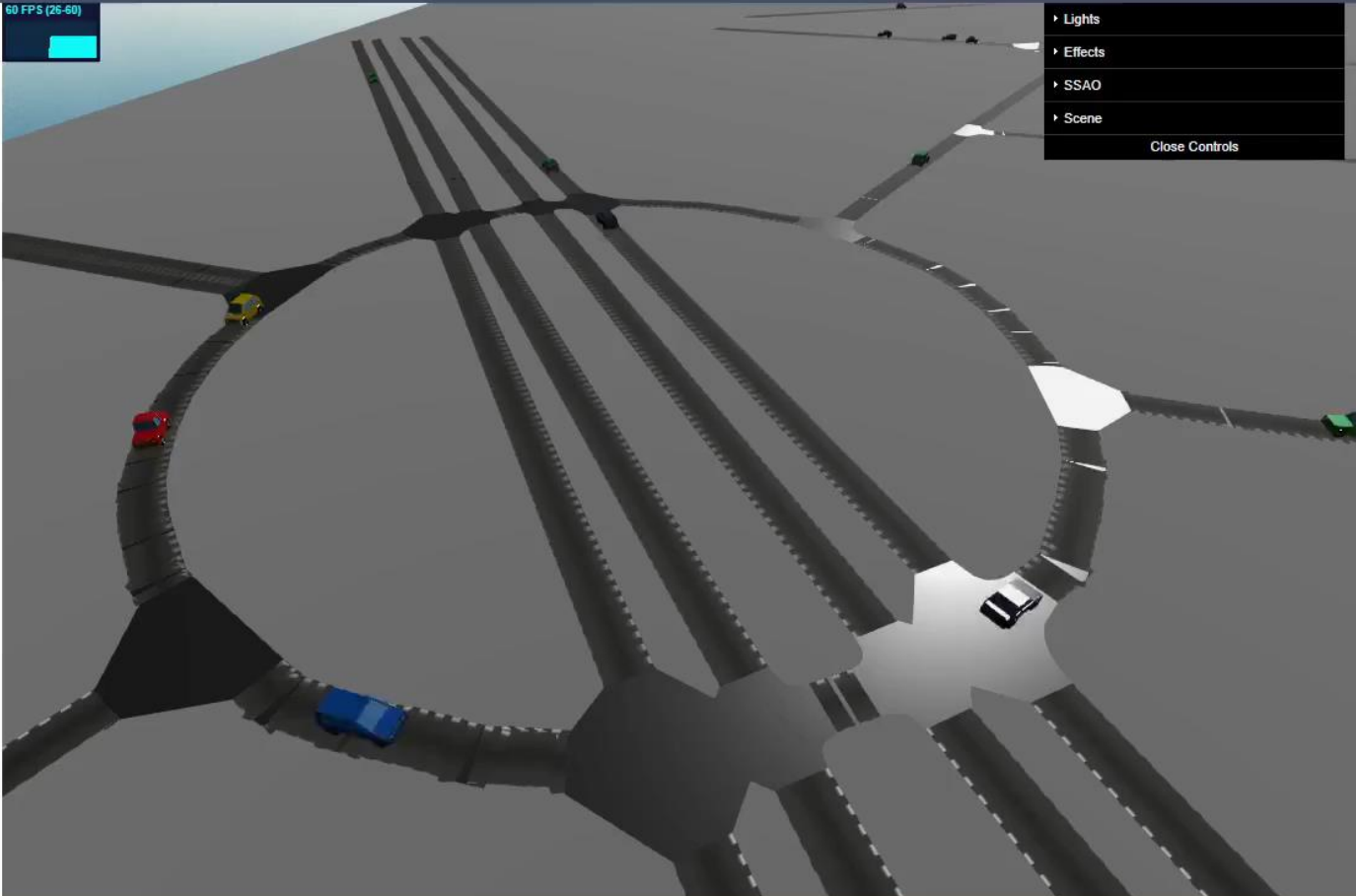
SEARCH

CAR

BIKE

TRAIN

60 FPS (26-60)



▸ Lights

▸ Effects

▸ SSAO

▸ Scene

Close Controls

Widget1

Data Update

AleScenario4 2024-09-05 13:36:17 (acc)

Create Microsimulation

alessandroscenario30-20240926095651

Run Simulation

Agenda



IL FUTURO DELLA MOBILITA'
INTELLIGENTE E SOSTENIBILE

Registrazione 9:00 - 9:30

Avvio Lavori 9:30 - 10:00

Saluti

Prof. Marco Pierini - Prorettore alla Ricerca e al Trasferimento Tecnologico, Università degli Studi di Firenze

Gianmarco Montanari - Direttore Generale CN MOST

Prof. Paolo Nesi - Unifi DisitLab/Snap4City

Prof. Michele Ottomanelli - Politecnico di Bari (Da Confermare)

Franco Prampolini - Head of R&D and Innovative Industry Solutions Lutech Group

Overview 10:00 - 10:20

Presentazione generale e obiettivi di OPTIFaaS

Mauro Starinieri, Head of Smart City & Mobility Solutions CoE Lutech Group

Strumenti OPTIFaaS 10:20 - 11:00

Presentazione dell'infrastruttura

Prof. Paolo Nesi - UNIFI DISITLab/Snap4City

Coffee Break 11:00 - 11:30

Scenario OPTIFaaS: traffico 11:30 - 11:50

Ottimizzazione del Traffico

Prof. Luigi Pariota - Università degli Studi di Napoli

Scenario OPTIFaaS: ottimizzazione semaforica 11:50 - 12:10

Ottimizzazione Semaforica e di Infrastruttura

Prof. Paolo Nesi - UNIFI DISITLab/Snap4City

Scenario OPTIFaaS: ottimizzazione **Trasporto** Collettivo 12:10 - 12:40

Ottimizzazione Trasporto Collettivo

Prof. Paolo Nesi - UNIFI DISITab/Snap4City

Q&A 12:40 - 13:00

Sessione aperta

Light Lunch 13:00 - 14:00

Incontri 1:1 14:00 - 18:00

Incontri 1:1 con i referenti di Snap4City/OPTIFaaS (in presenza)



IL FUTURO DELLA MOBILITA' INTELLIGENTE E SOSTENIBILE

Digital Twin & Intelligenza Artificiale.
Innovazione tecnologica “As a Service “
per la gestione operativa
e la pianificazione tattico-strategica
della mobilità urbana sostenibile e interconnessa

Firenze | Milano | Roma | Bari