



www.snap4city.org

www.snap4solutions.org



UNIVERSITÀ
DEGLI STUDI
FIRENZE

DINFO
DIPARTIMENTO DI
INGEGNERIA
DELL'INFORMAZIONE

DISIT
DISTRIBUTED SYSTEMS
AND INTERNET
TECHNOLOGIES LAB

Overview for Researchers & Developers



www.km4city.org

*AI Digital Twin Platform
to set-up Sustainable
Decision Support Systems
& Business Intelligence*

#snap4city
#km4city
#disitlab
@snap4city



Public Spaces as Critical Infrastructures

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



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

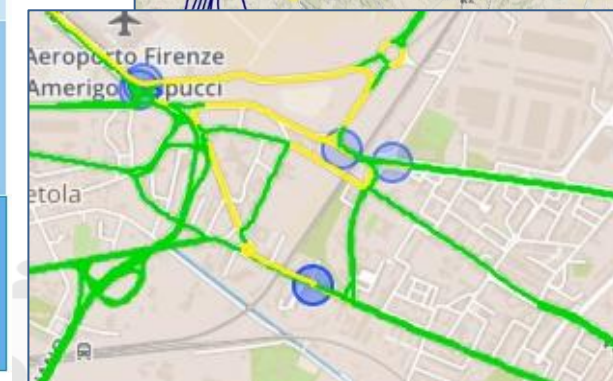
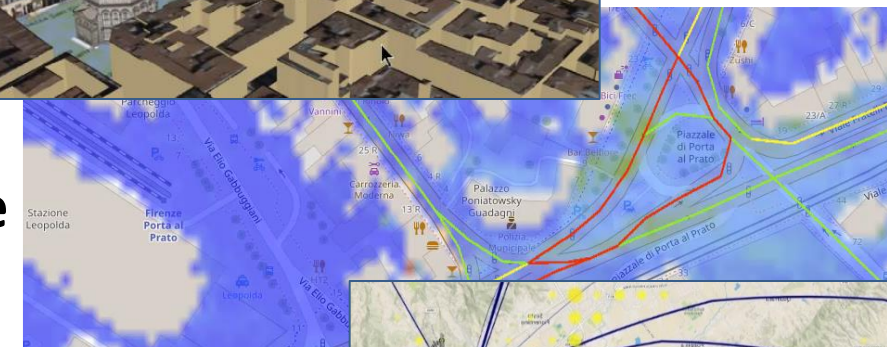
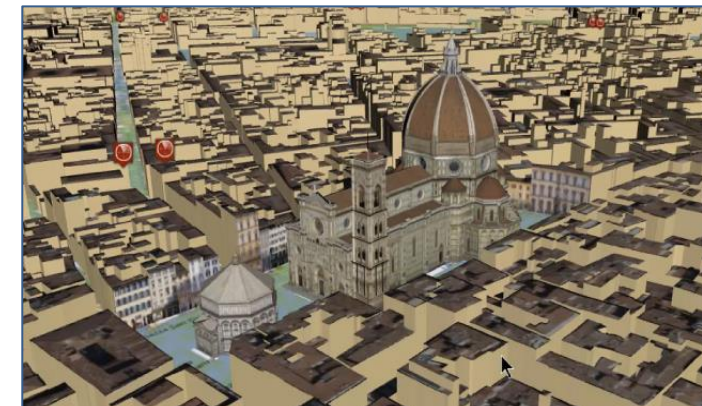
TOP

Objectives and Tasks



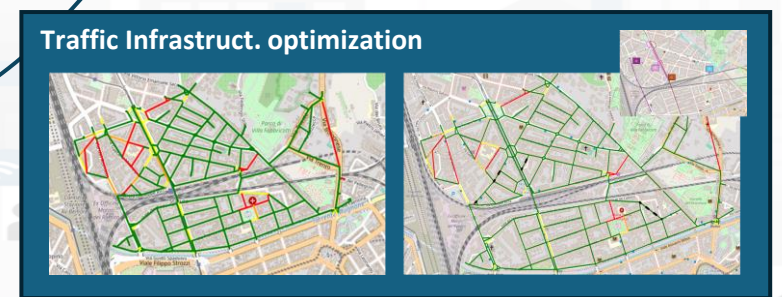
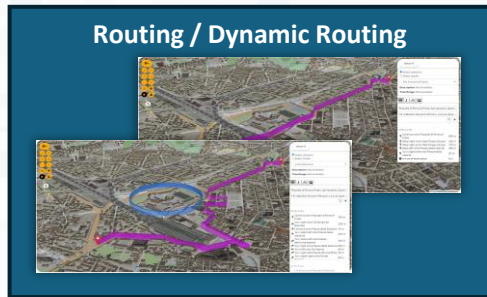
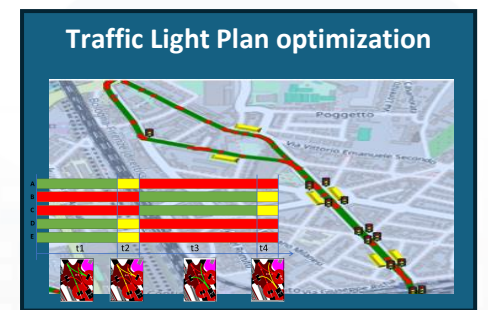
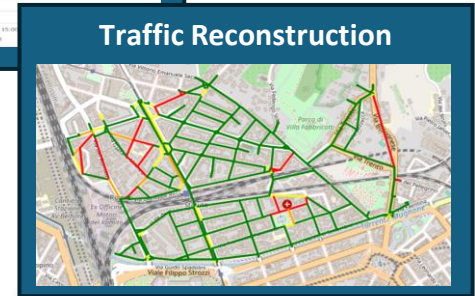
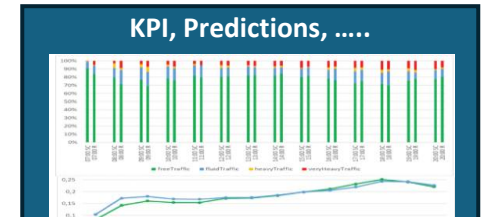
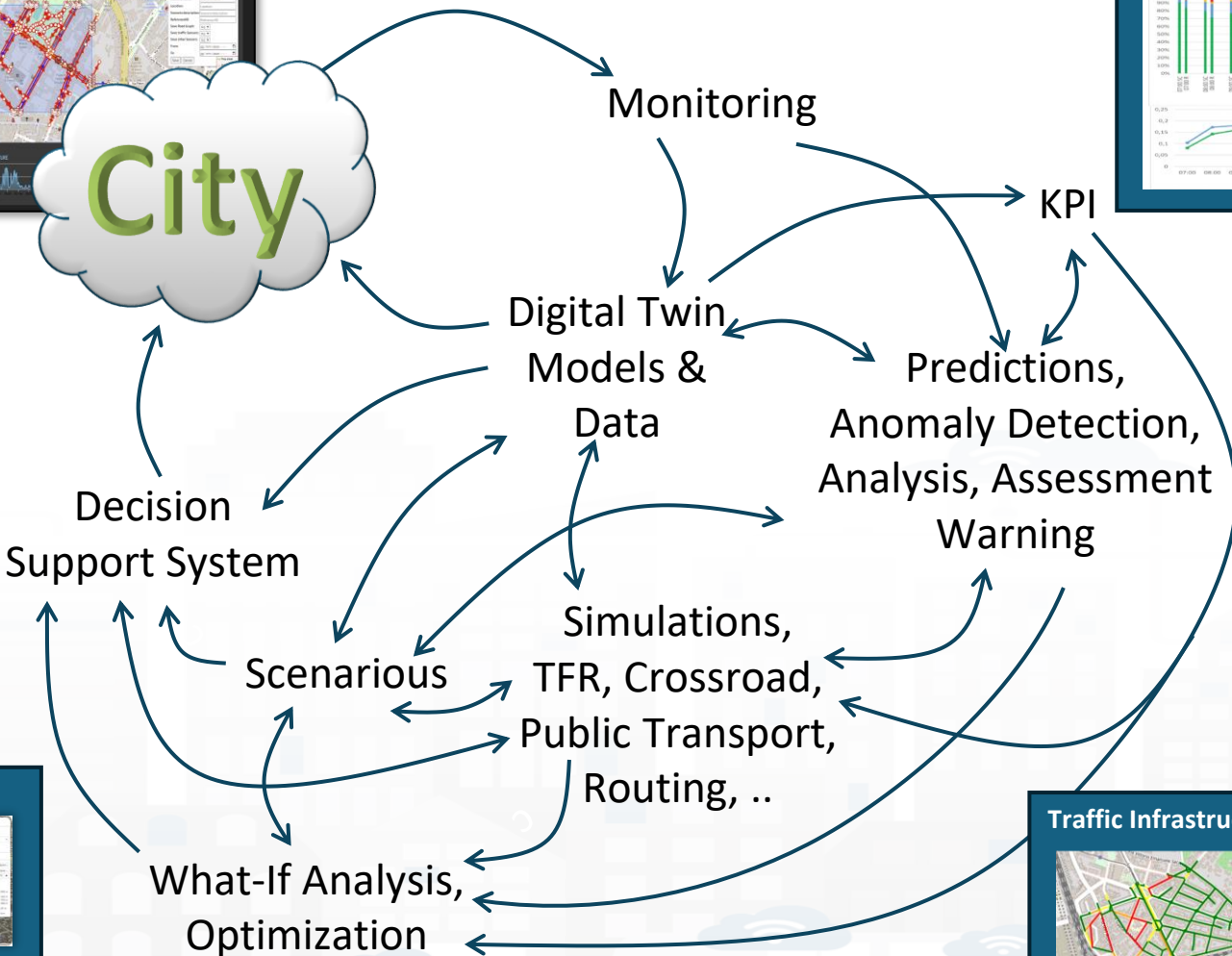
Main Tasks

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



Complex Smart Applications

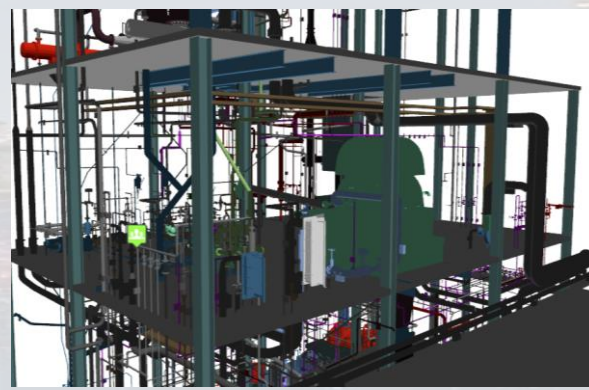
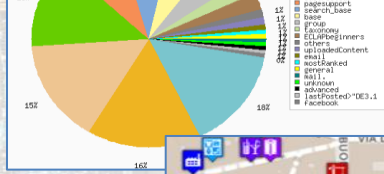
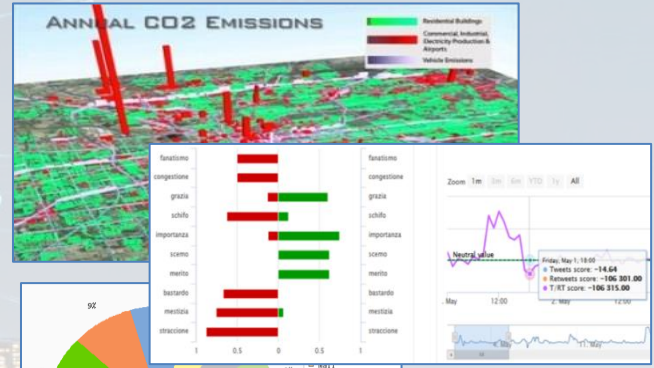
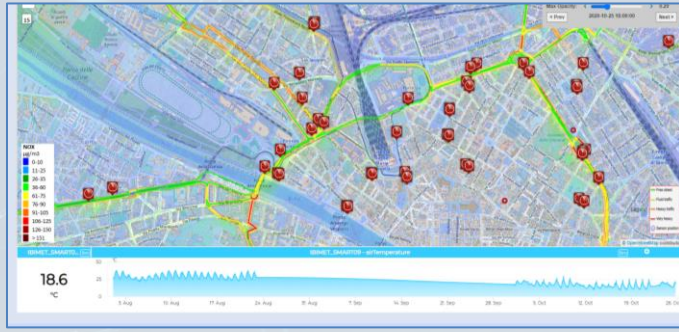
- **Recent solutions**
 - Dynamic traffic light control and synchronizations
 - MaaS, sharing, evolution of info-mobility
 - Connected and Autonomous Vehicles/solutions
 - Integrated Energy & Environmental applications
 - Etc.
- **Most of them share the same modules, differently implemented and combined,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



Digital Twin

Digital Twin

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

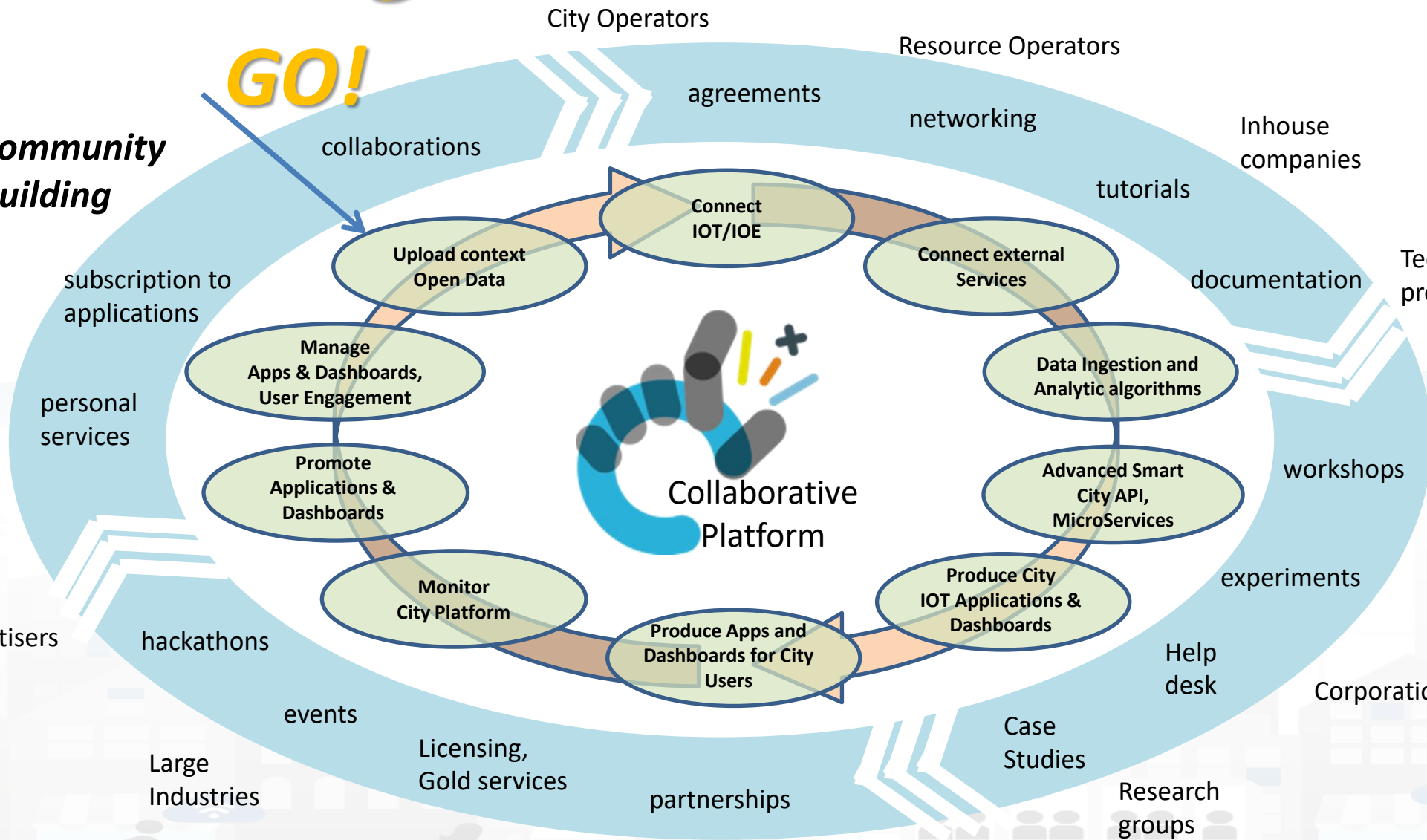


Accelerating



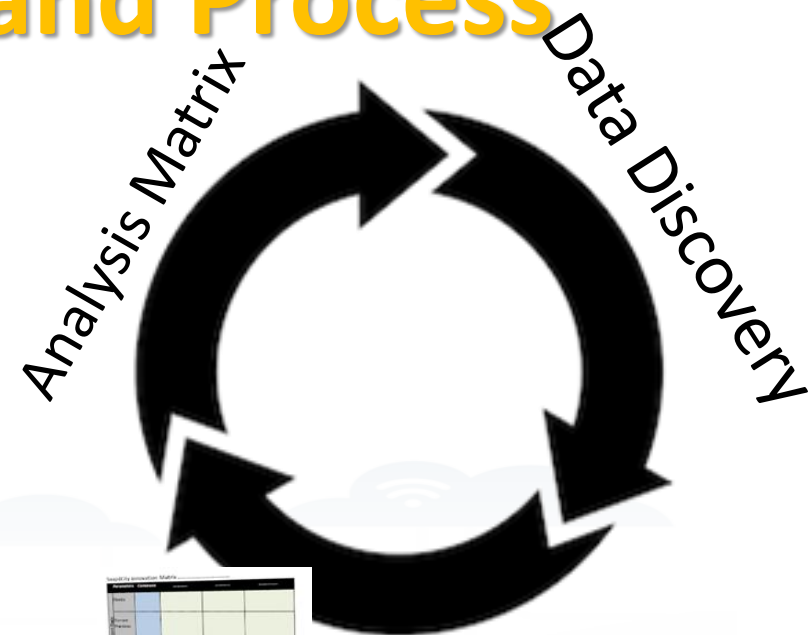
GO!

Community Building



Snap4City Innovation Matrix and Process

Part 6



Snap4City Innovation Matrix

	Parameters	Commons	Operators	360°	Visitors
Current State	Needs	[Sticky notes]	[Sticky notes]	[Sticky notes]	[Sticky notes]
	Current Practices	[Sticky notes]	[Sticky notes]	[Sticky notes]	[Sticky notes]
	Value proposition (Current)	[Sticky notes]	[Sticky notes]	[Sticky notes]	[Sticky notes]
Future State	Value proposition (Future)	[Sticky notes]	[Sticky notes]	[Sticky notes]	[Sticky notes]
	Solution	[Sticky notes]	[Sticky notes]	[Sticky notes]	[Sticky notes]
	Value Capture	[Sticky notes]	[Sticky notes]	[Sticky notes]	[Sticky notes]
	Key Partners	[Sticky notes]	[Sticky notes]	[Sticky notes]	[Sticky notes]
	Barriers	[Sticky notes]	[Sticky notes]	[Sticky notes]	[Sticky notes]

Snap4City Innovation Matrix

	Parameters	Commons
Needs		
Current Practices		
Value proposition (current)		
Value proposition (Future)		
Solution		
Value Capture		
Key Partners		



Design Scenarios

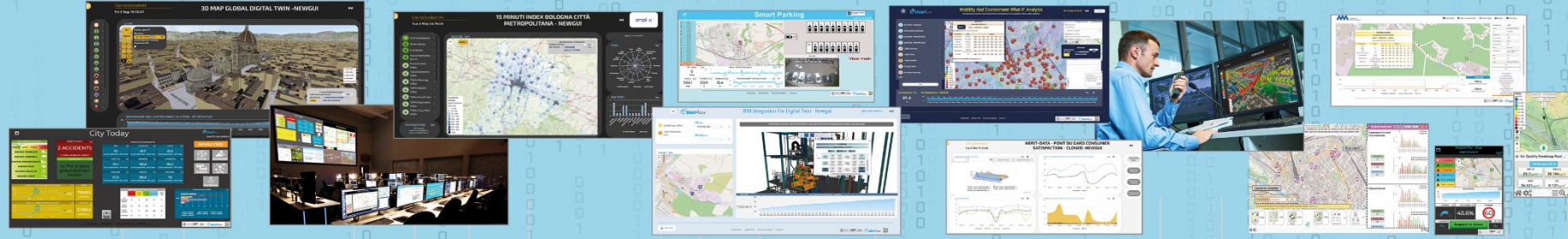
Snap4City



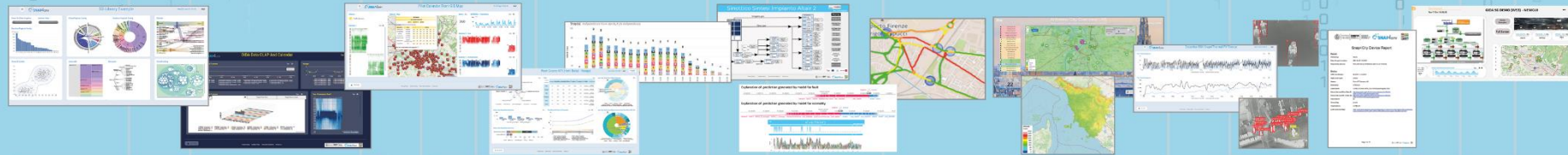


Smart Solutions and Decision Support Systems

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



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



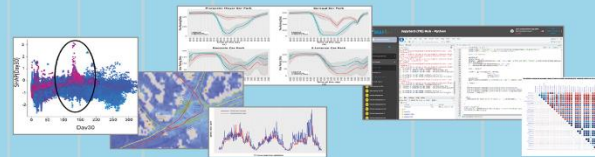
DASHBOARDS, WIDGETS
TEMPLATES

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

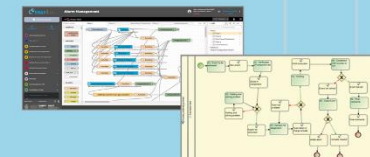
API - MICROSERVICES - GIS - BPM
VIDEO - REPORTS - MAPS - 3D ...

ANY: DATA, BROKER, NETWORK AND VERTICAL

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



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



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

Native and External
Smart Applications

Mobility & Transport

Light & Energy

Waste

Environment

Building

Tourism

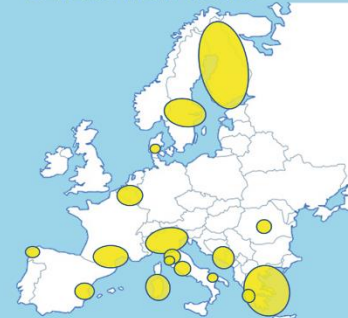
Asset Management

Security and Safety

Social Media



METHODOLOGIES
LIVING LABS
COURSES AND COMMUNITY
DEVELOPMENT TOOLS



Powered by
FIWARE

FREE
TRIAL

PEN Test
Passed

EU GDPR
COMPLIANT

SNAP4
Appliances and Dockers
Installations

EUROPEAN OPEN
SCIENCE CLOUD

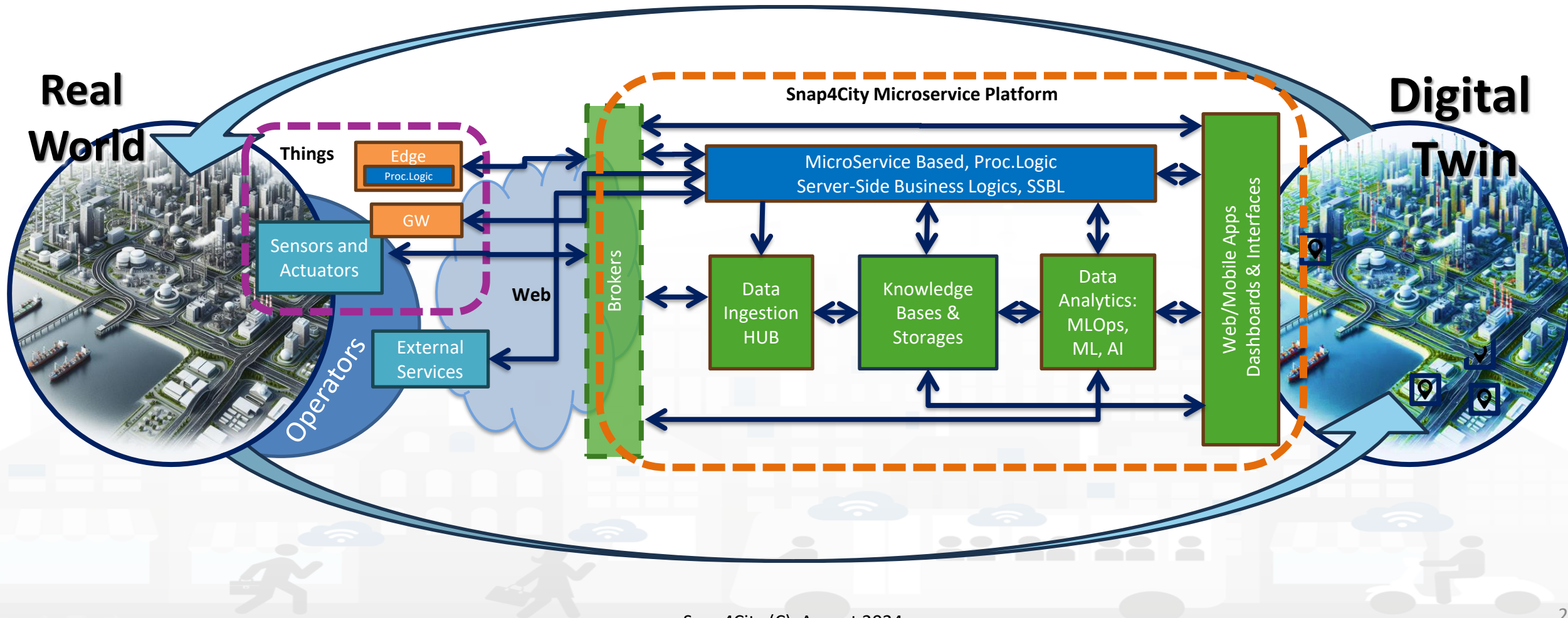
Node-RED

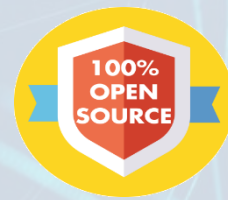
JS Foundation

E015
digital ecosystem

NVIDIA

Digital Twin Development Platform



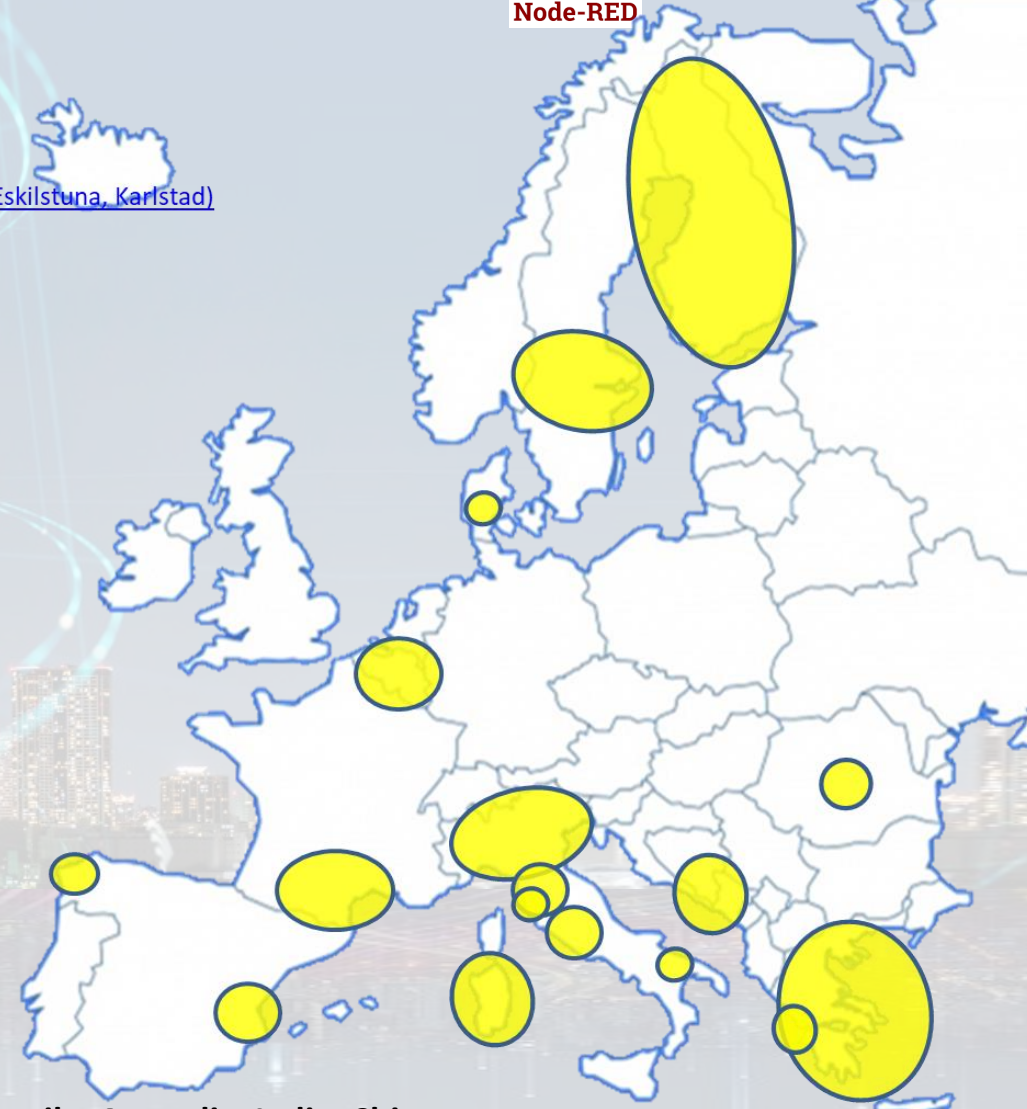


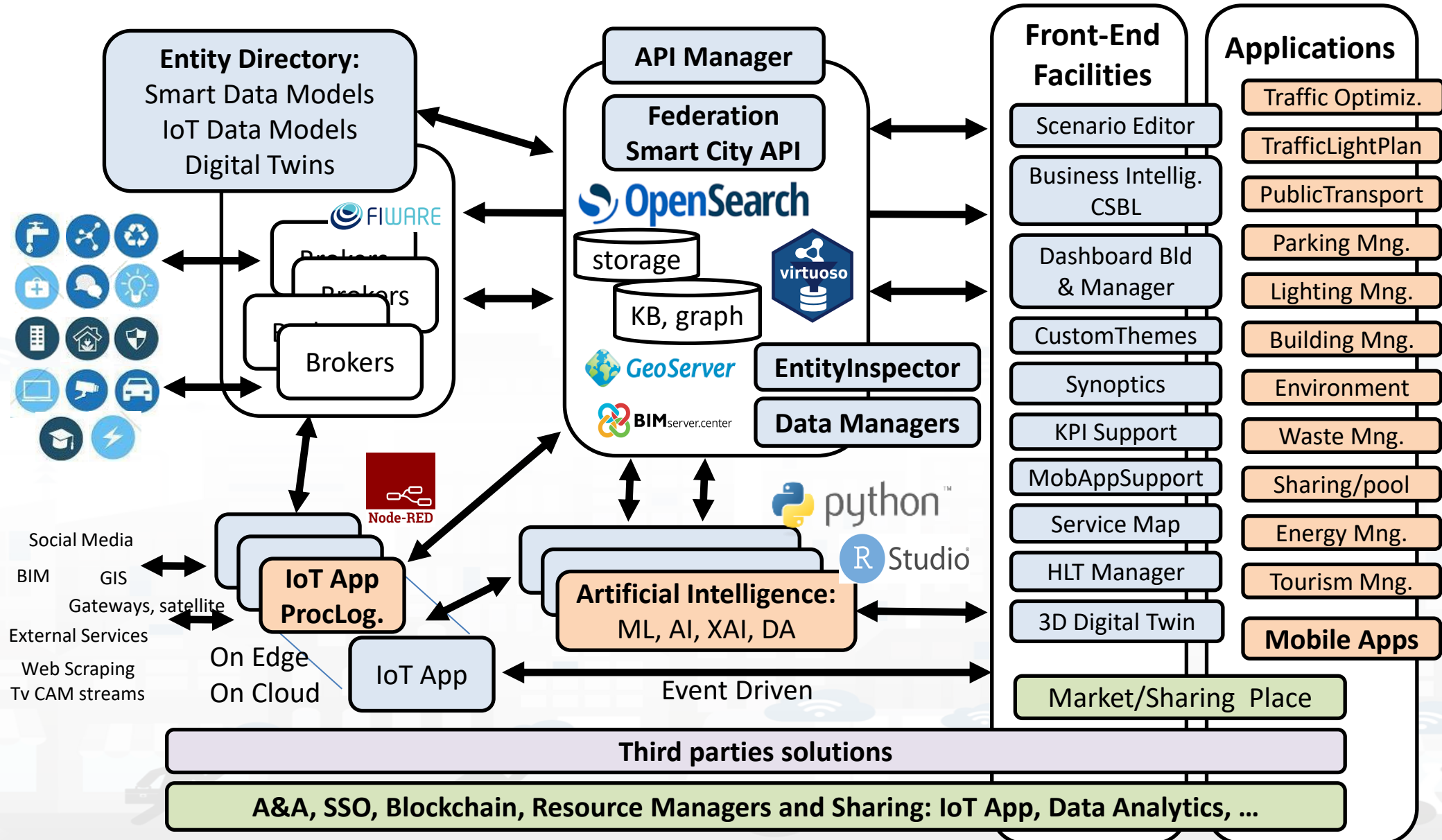
- 11 running installations in Europe
 - Snap4.city.org, Greece, Merano, ...
 - Toscana, Pisa, Sweden, ISPRA, Snap4.eu,
 - Altair, Italmatic, Sweden, Romania,
- 16 projects, 12 pilots on 10 Countries
 - >40 cities/area
- **Widest MULTI-tenant deploy has**
 - 19 Organizations / tenant
 - > 8000 users on
 - > 1600 Dashboards
 - > 16 mobile Apps
 - > **2.2 Million of structured data per day**
 - > 520 IoT Applications/node-RED
 - > 700 web pages with training
 - > 70 videos, training videos

Main Organizations/areas

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

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

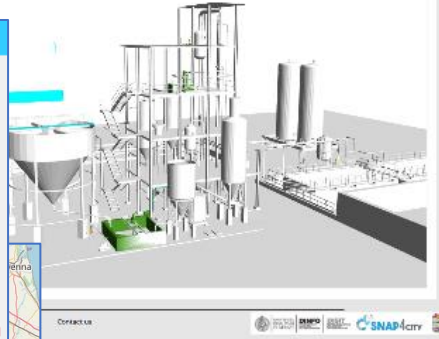
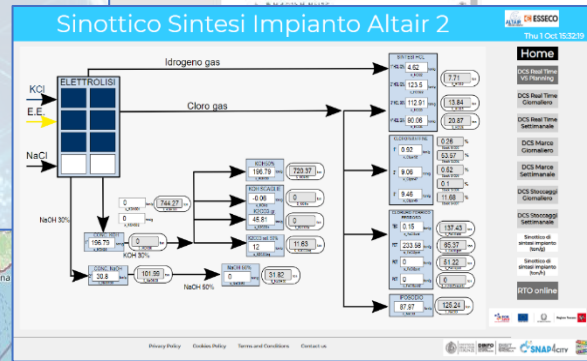
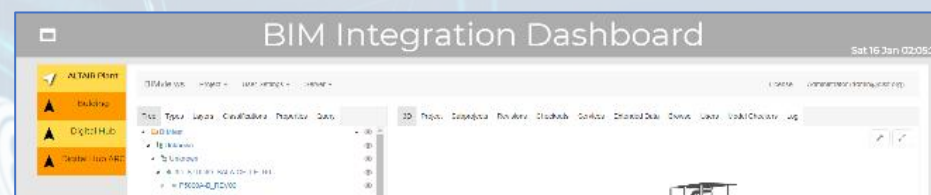




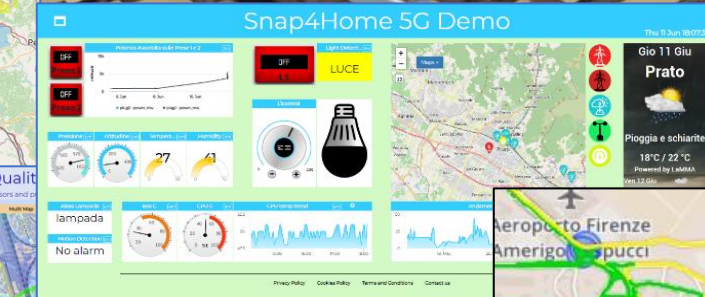
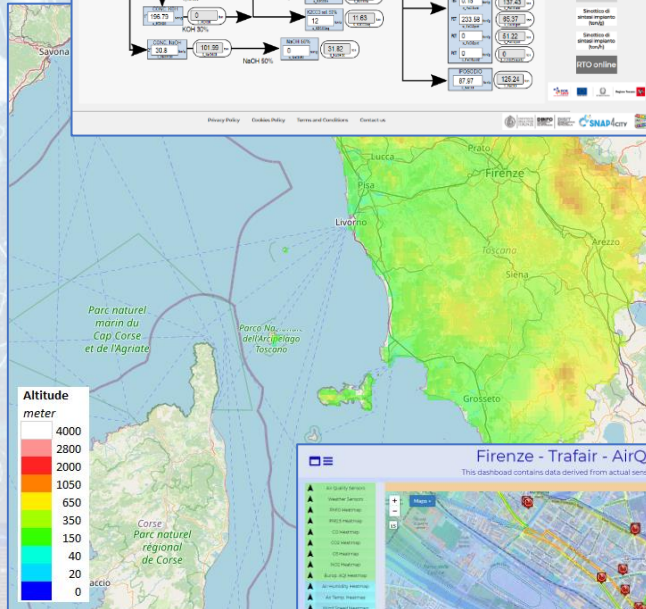
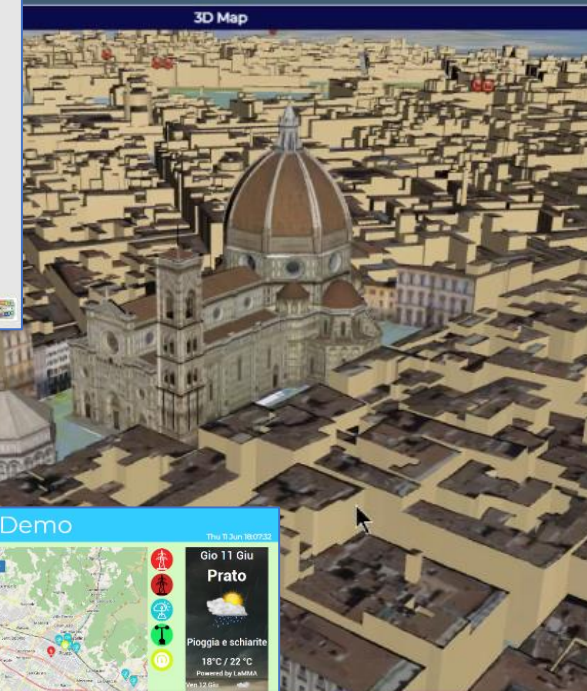
High Level Types

Snap4City (C), August 2024

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



SNAP4CITY
- Digital Twin Global - Fire
demonstrator



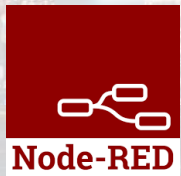
Standards and Interoperability (6/2023)



Compliant with:

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

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



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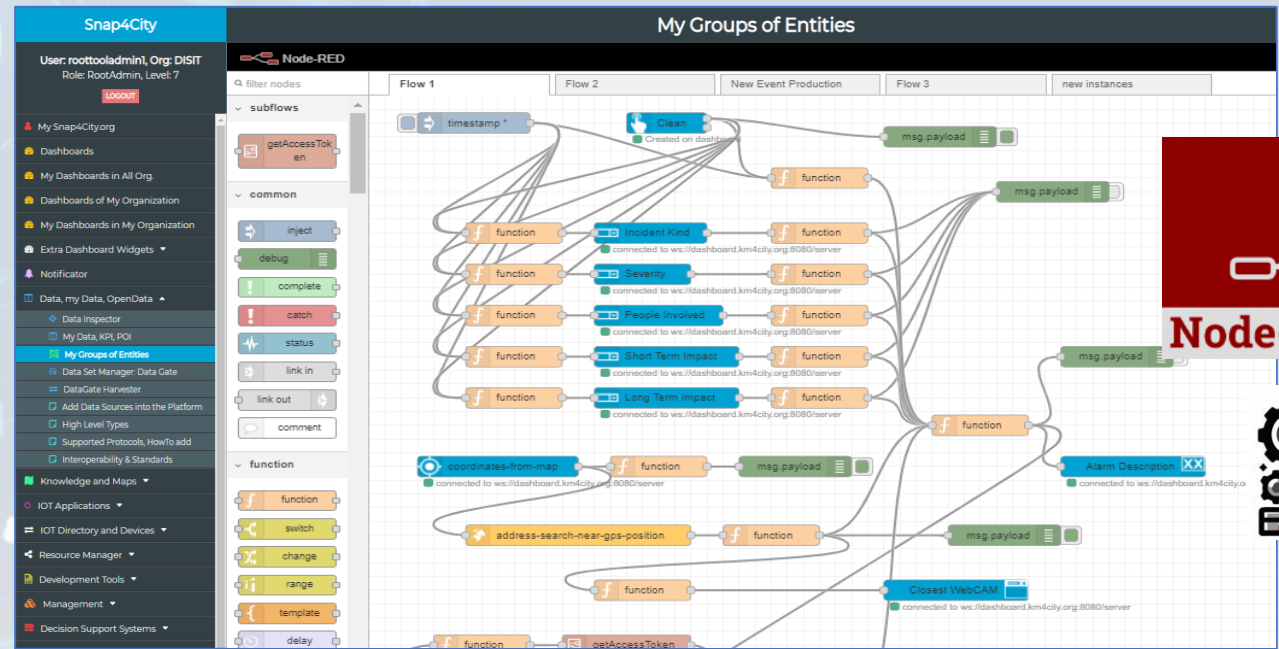
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Ingestion, aggreg. → exploitation



IoT App Visual Programming, no coding

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



Edge and Cloud

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

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

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

We suggest also to install:

- AND: From Resourcer Manager
- social
- subflows
- location

Snap4City (C), May 2021

nr1

Node-RED

flow1

Flow 1

input

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

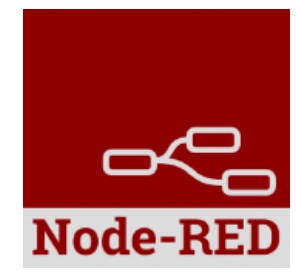
output

- debug
- link
- mqtt
- http response
- websocket
- tcp
- udp
- amqp
- amqp2

Flow Information:

Name	flow1
ID	"49a71aa0_b297b4"
Status	Enabled

Information



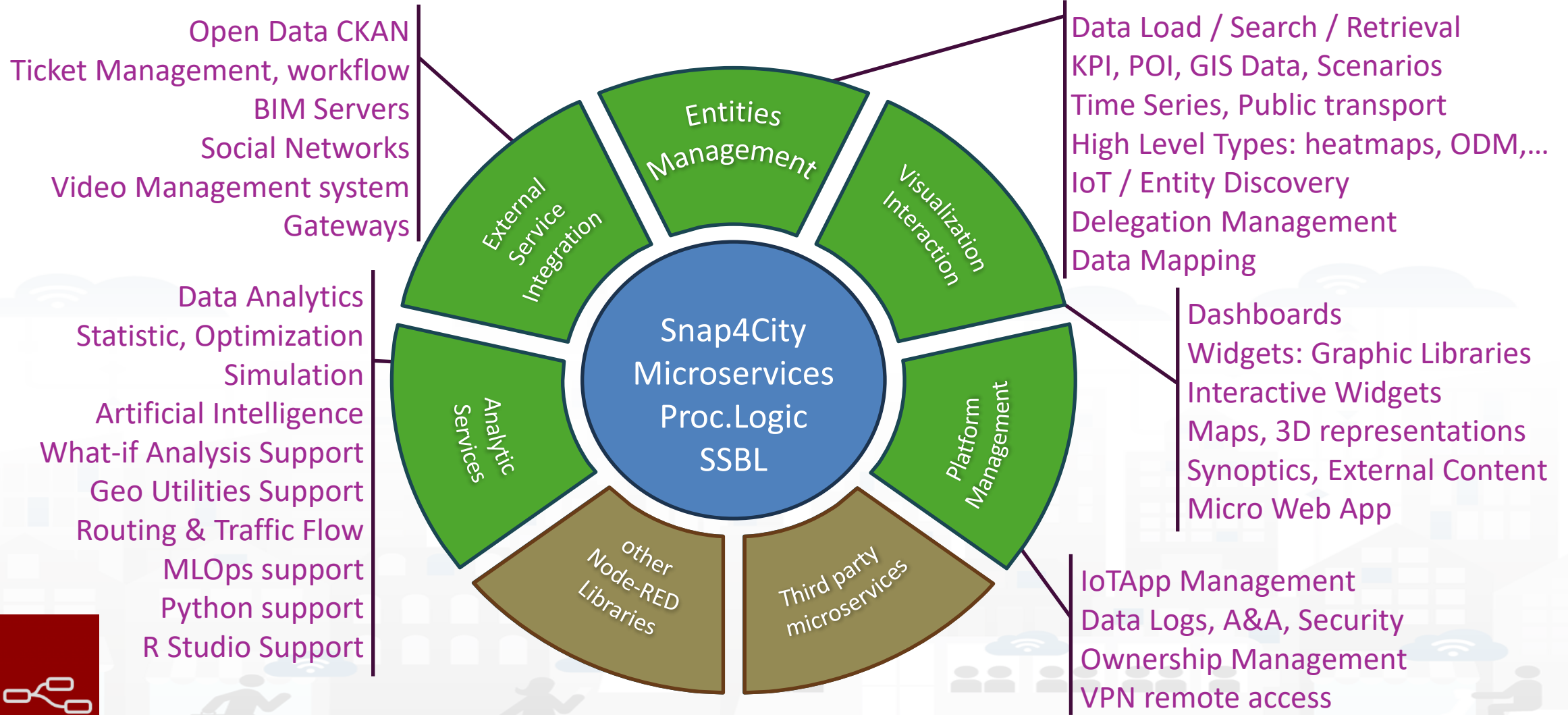
Data Adaption
 Data Transformation, Conversion
 Data Integration, Interoperability
 Business Logic vs Dashboards

Editing IOT Applications

Data Analytics control

Everywhere: Cloud, on IoT Edge Devices

Areas



Expert System *semantic queries*



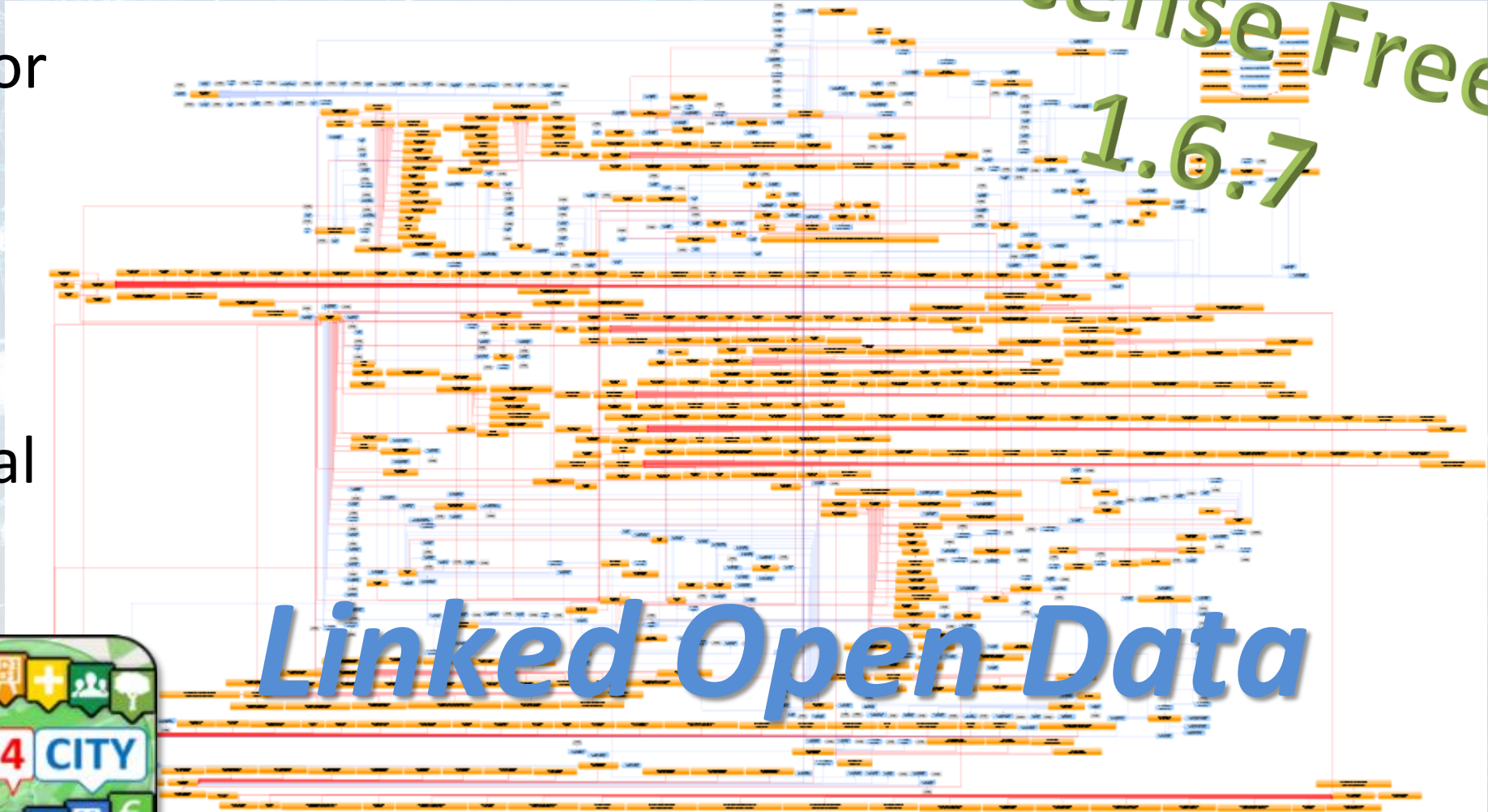
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- **via:**
- **Smart City API** for Apps and third party
- **MicroServices** data driven develop via visual language Node-RED



License Free
1.6.7

Linked Open Data



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

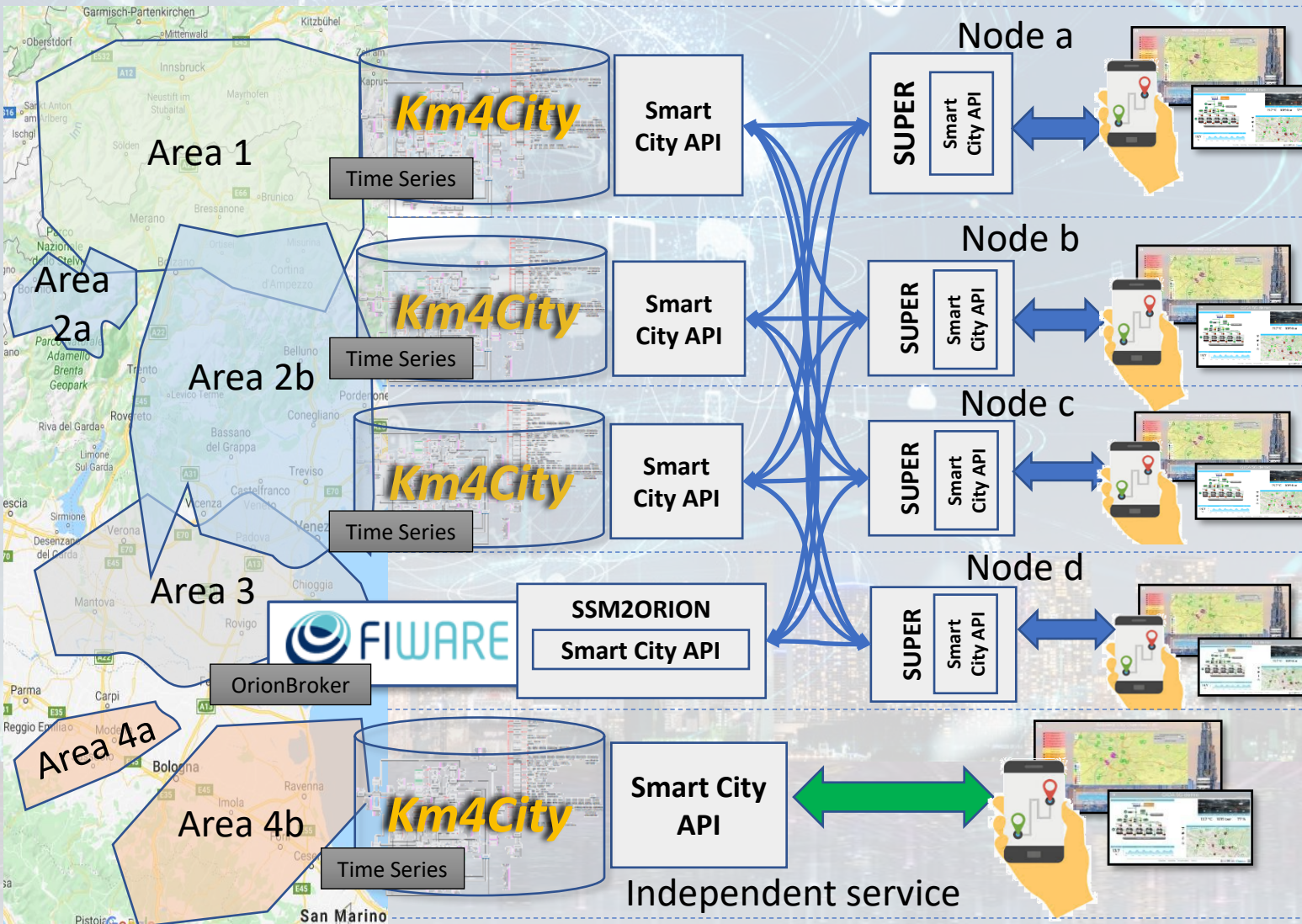


Km4City Ontology elements 1.6.7

- **Km4C:** Km4City 1.6.7
- Using
 - **DCTERMS:** for metadata Dublin Core Metadata Initiative
 - **FOAF:** friends of a friends
 - **Good Relation:** entities relationships
 - **iot-lite:** IOT Vocabulary
 - **OTN:** Ontology of Transportation Networks
 - **OWL-Time:** time reasoning
 - **SAREF** Smart Appliances REference extension for building devices available at <https://saref.etsi.org/saref4bldg/>
 - **Schema.org** for people and organizations
 - **SSN:** Semantic Sensor Network Ontology (see <https://www.w3.org/TR/vocab-ssn/>)
 - **WGS84** Datum of Geo-Objects
 - **GTFS**, General Transit Feed Specification, and **Transmodel**, for public transport infrastructures: lines/rides time schedules, real-time records, paths, etc.;



Federation of Smart City Services



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

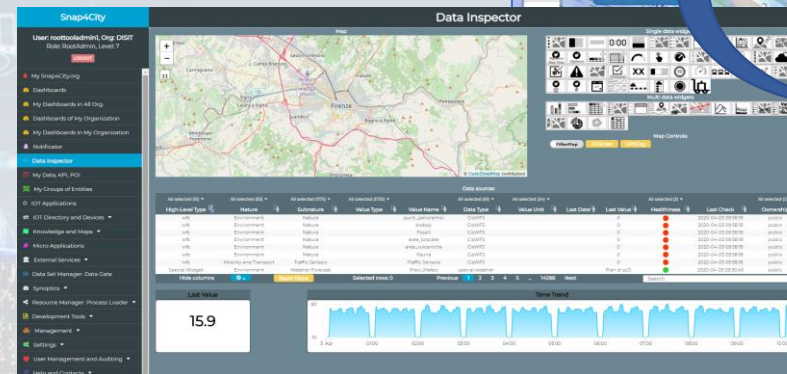
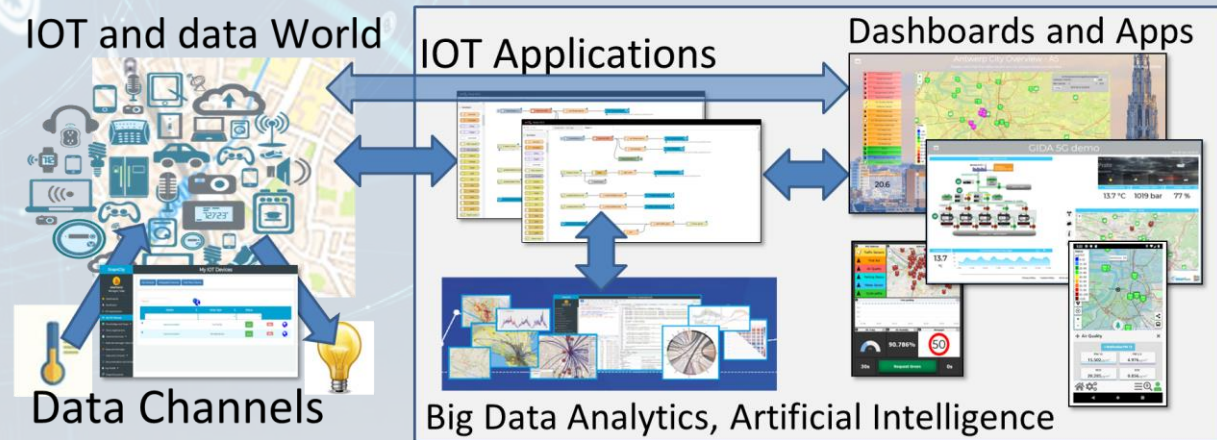
Solutions: reliable, secure and fast to realize

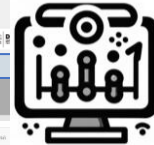
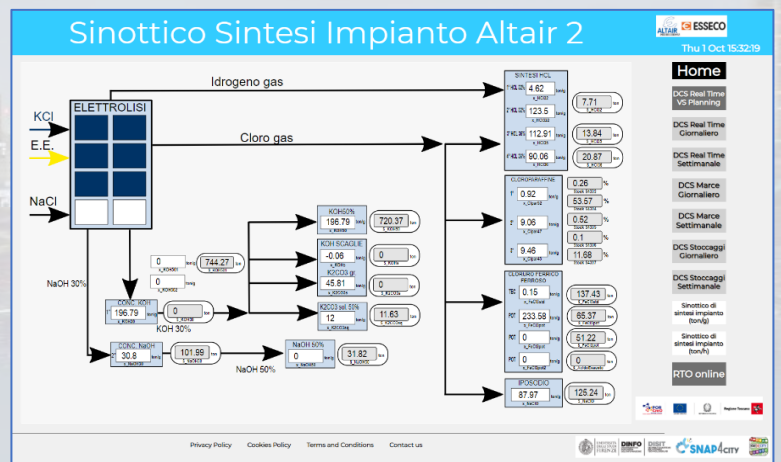
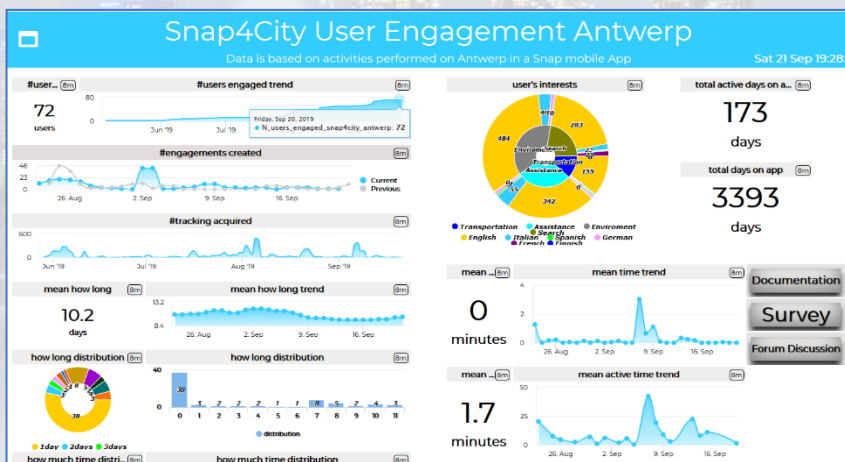
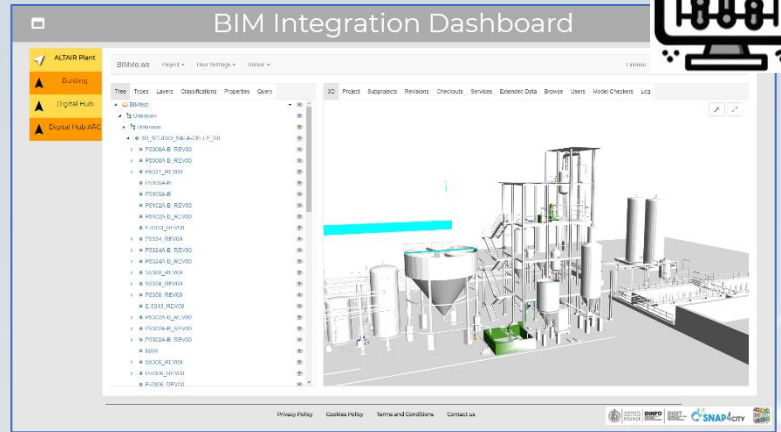
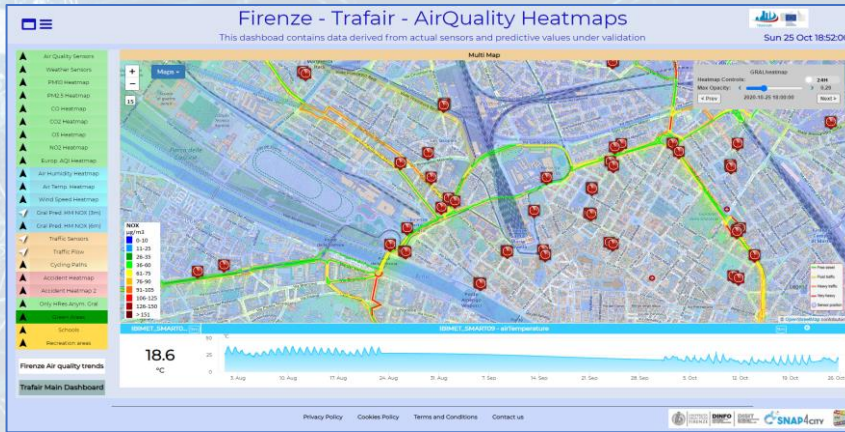
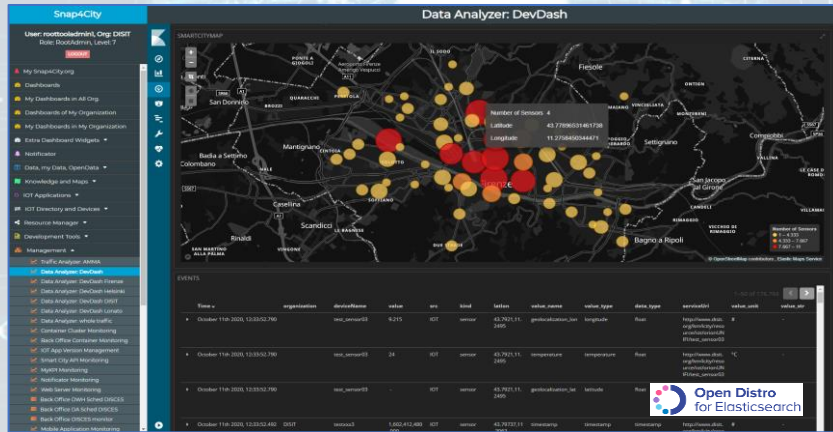
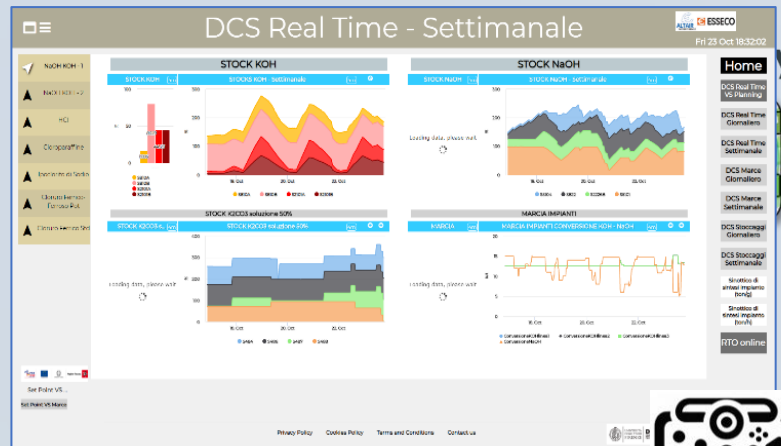
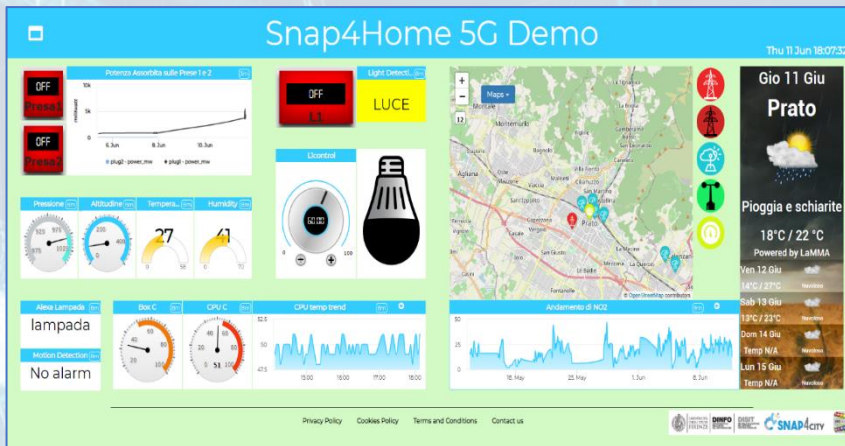
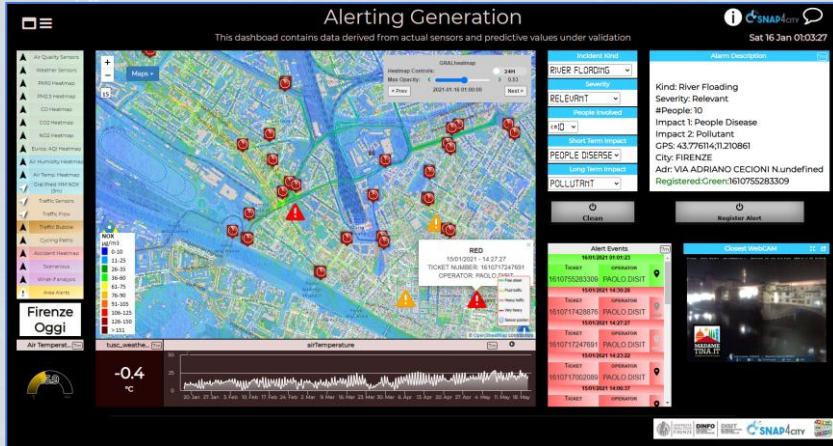
- Via Snap4City tools

- Dashboard Wizard
- Dashboard Builder
- Data/Visual Analytic

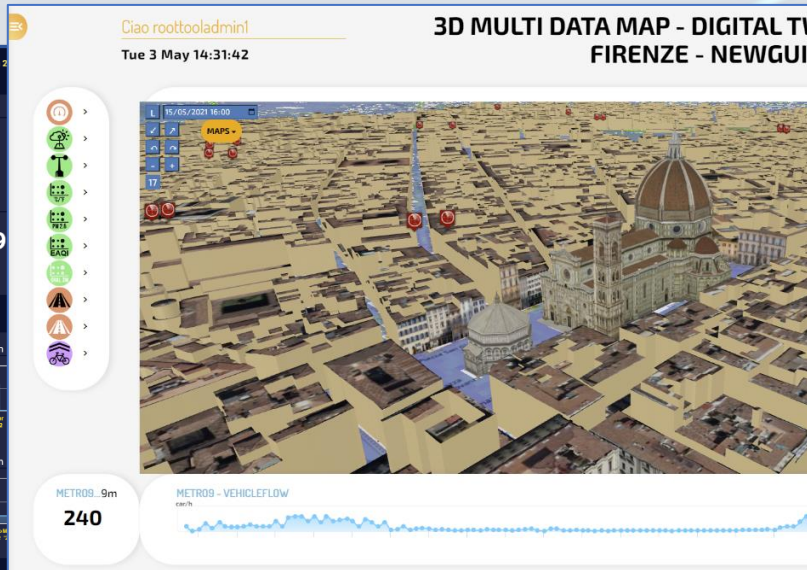
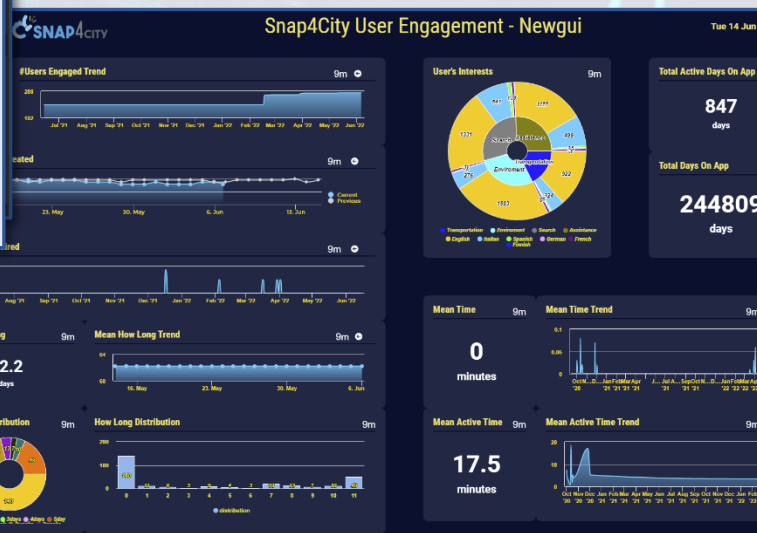
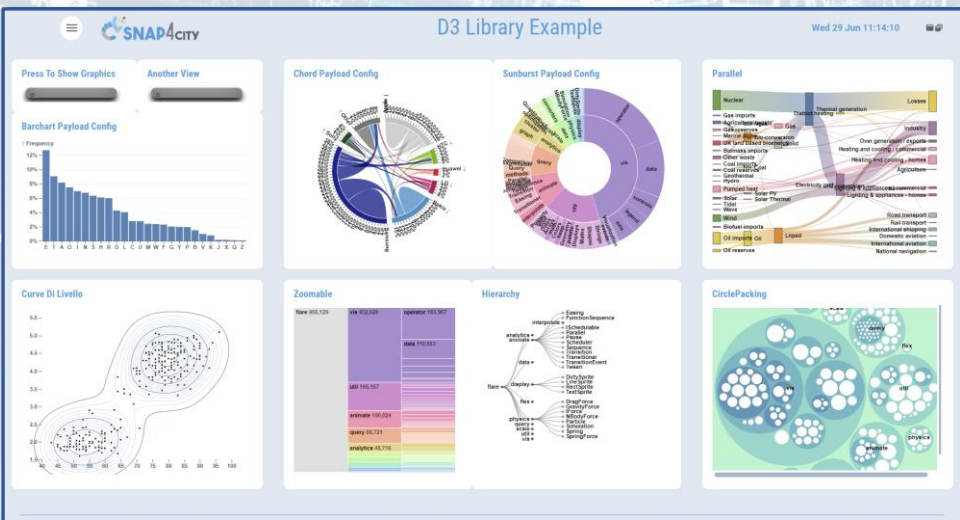
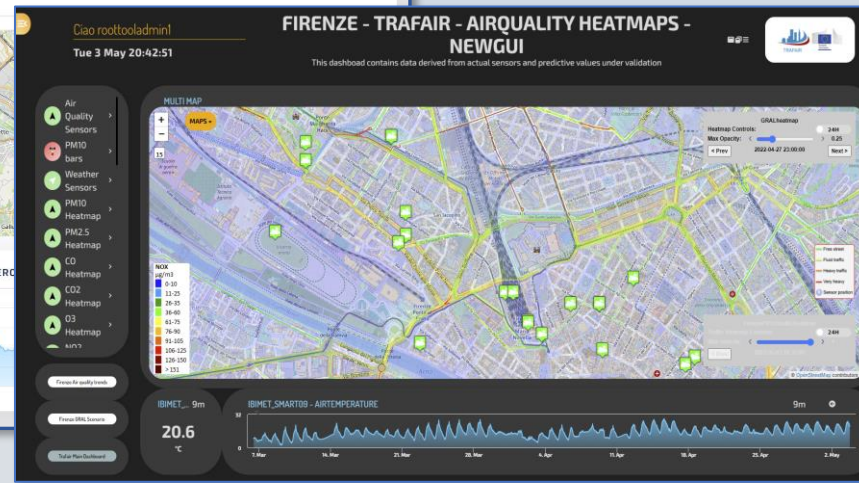
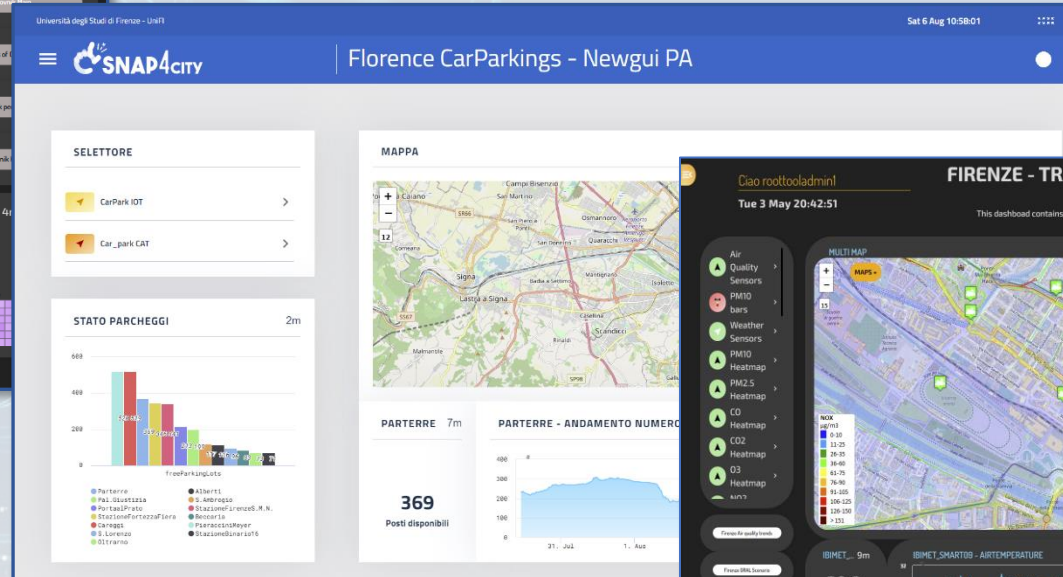
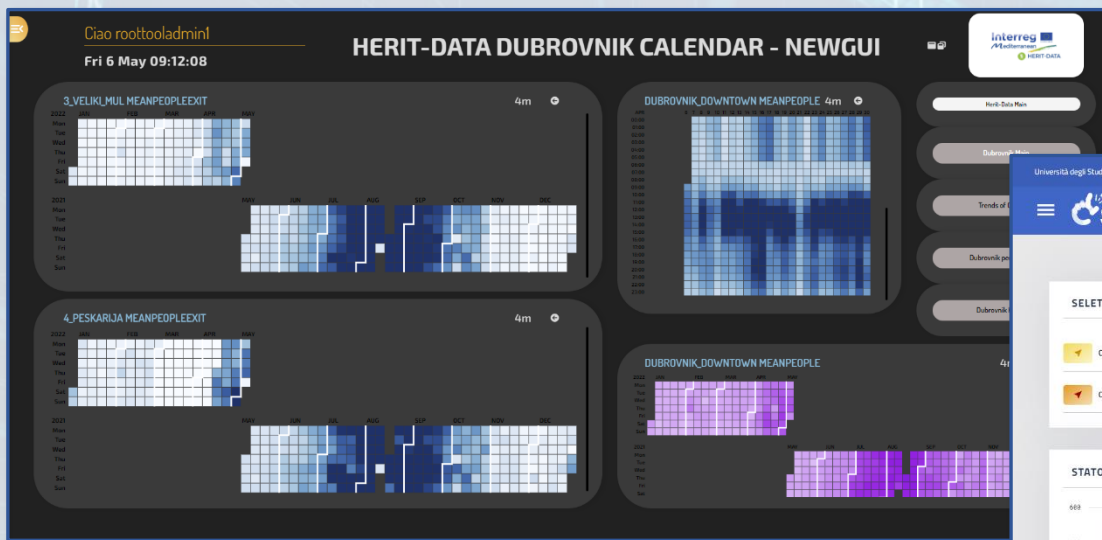
- Smart Solutions results to be

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





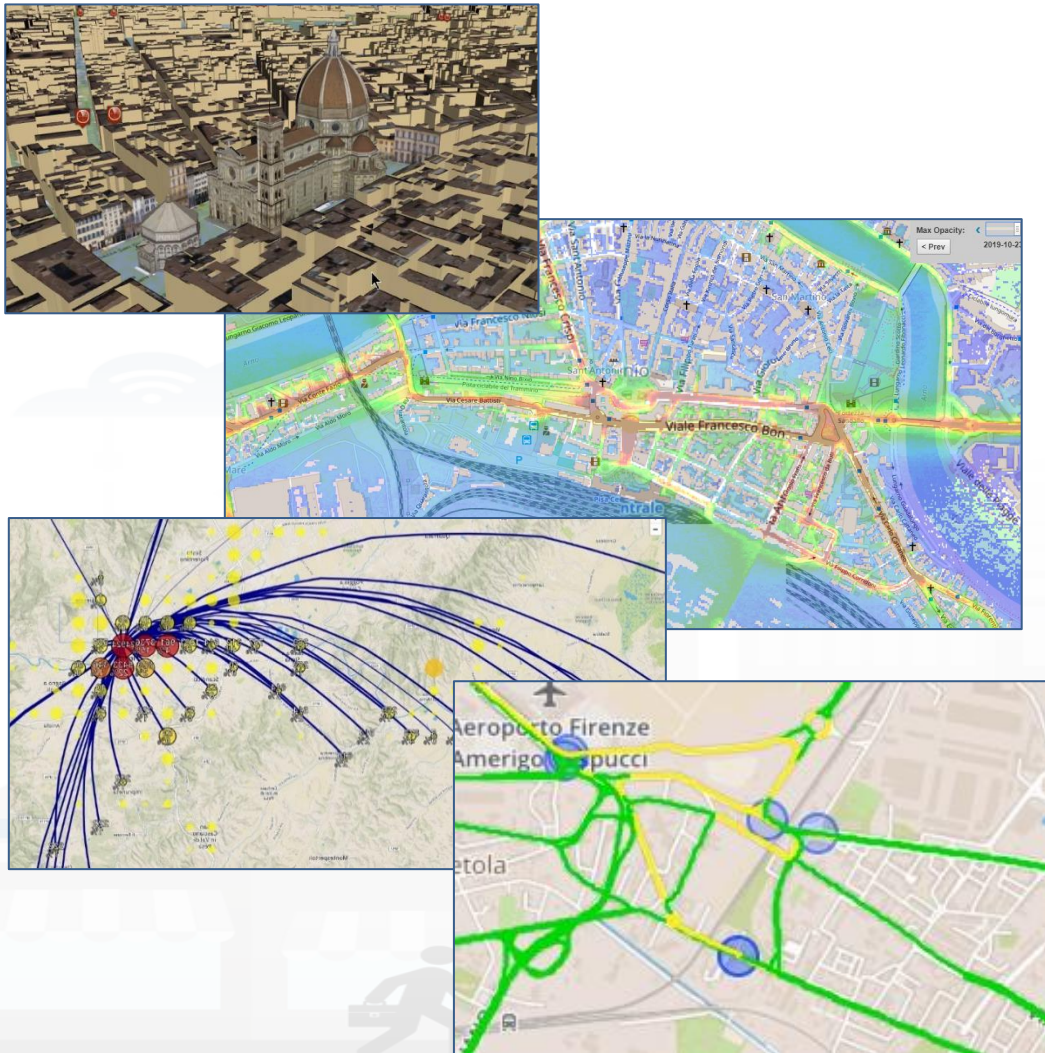
Different Themes



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

Enable Lights

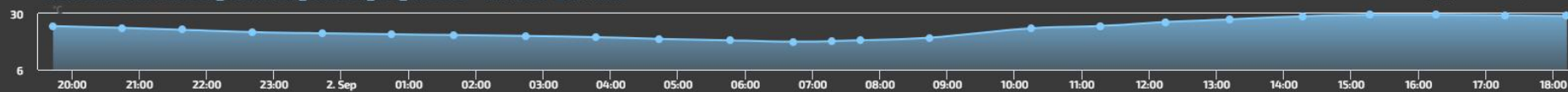
Datetime: 02/08/2022 10:11

Enable dynamic shadows (experimental)

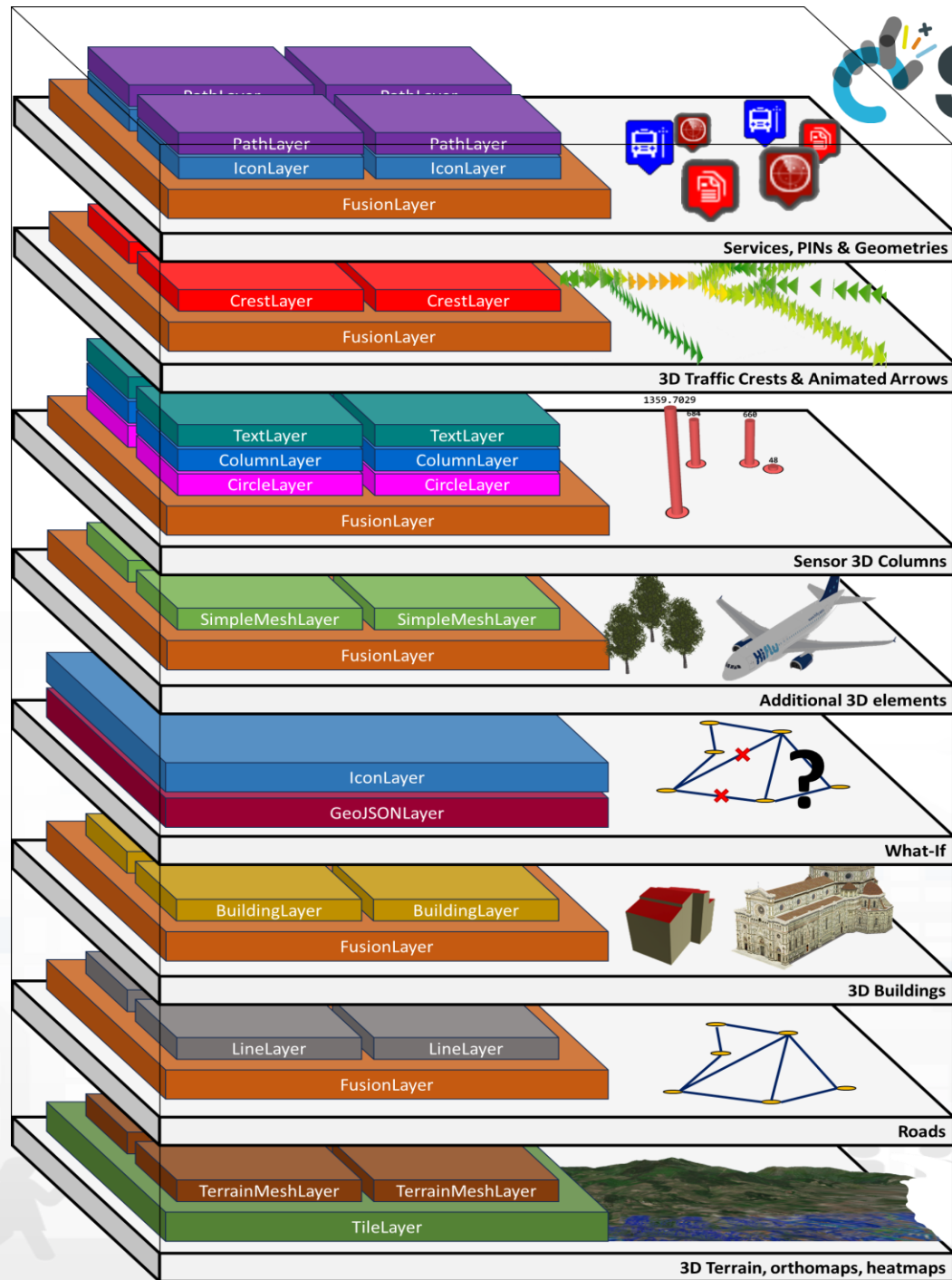
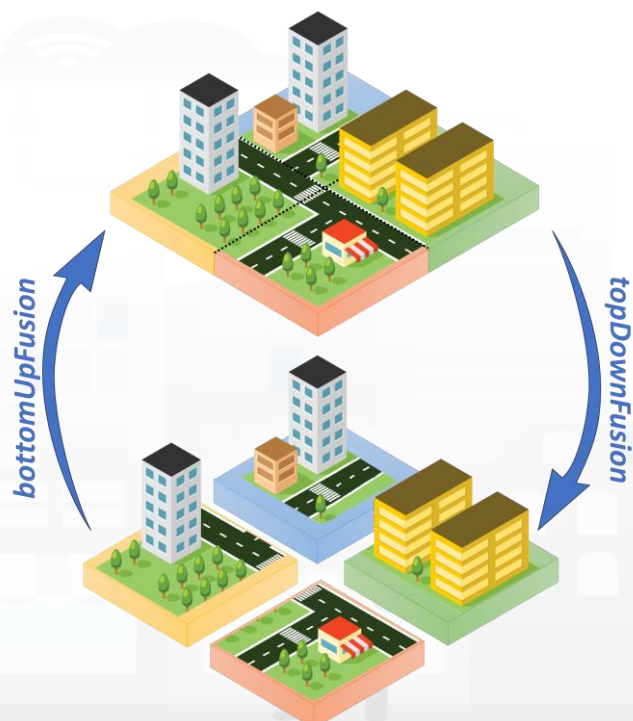
Free street
Fluid traffic
Heavy traffic
Very heavy
Sensor position

FirenzeFIPILITrafficRealtime
Traffic Heatmap Controls: 24H
Max Opacity: 1
< Prev 2022-09-02 18:56:00

DISIT:ORIONUNIFI:TUSC_WEATHER_SENSOR_OW_3176959 - AIRTEMPERATURE



Layers VS Fusion Layers



Ciao

Fri 13 Oct 18:29:18

FLORENCE SCDT

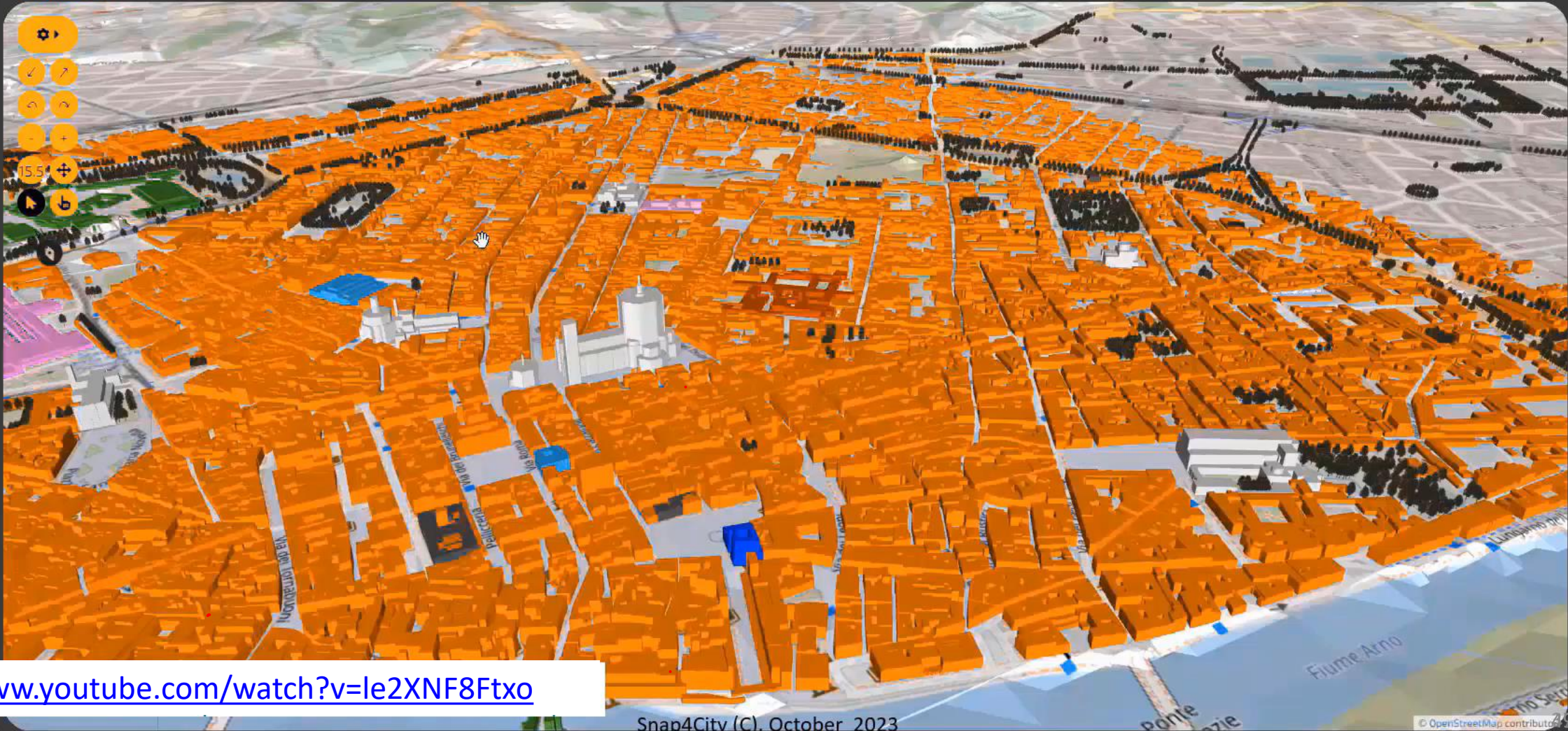


SELECT...

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

DOUBLE MAP

Map navigation controls: Home, Back, Forward, Refresh, Zoom In (15.5), Zoom Out, Fullscreen, and a hand icon for panning.



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

Paolo Nesi - Google Scholar | Snap4City | Snap4CityDocker | Dashboard Management System | St. Stephen's Cathedral - Google

Non sicuro | dashboard/dashboardSmartCity/view/Baloon-Dark.php?iddashboard=MTY=

App | Maps | Google | Gmail | Snap4City | Snap4 | Calendar | Translate | Google Scholar Cita... | DISIT | DISIT old | Facebook | DataCenter | Trello | Km4City major tools | Impostazioni | YouTube | Google Forms | News | Qnap15sek7gyfe

Ciao

Mon 18 Sep 18:25:55

GOOGLE TEST

SELECT...

- 100%
- NO ?
- Bar chart
- Map
- Map
- Bus
- WHAT-IF
- Car
- Monument
- Bicycle

DOUBLE MAP

© OpenStreetMap contributors

TOP

Monitoring and Control

FROM CITY DASHBOARD TO APPLICATIONS

FORGING & MANAGING OPEN AND SCALABLE INTERACTIVE APPLICATIONS

IoT APPLICATIONS VS IoT EDGE DEVICES

SNAP4CITY BEGINNING

SNAP4CITY ARCHITECTURE DESIGN ECOSYSTEM. OPEN TO DEVELOPERS AND STAKEHOLDERS

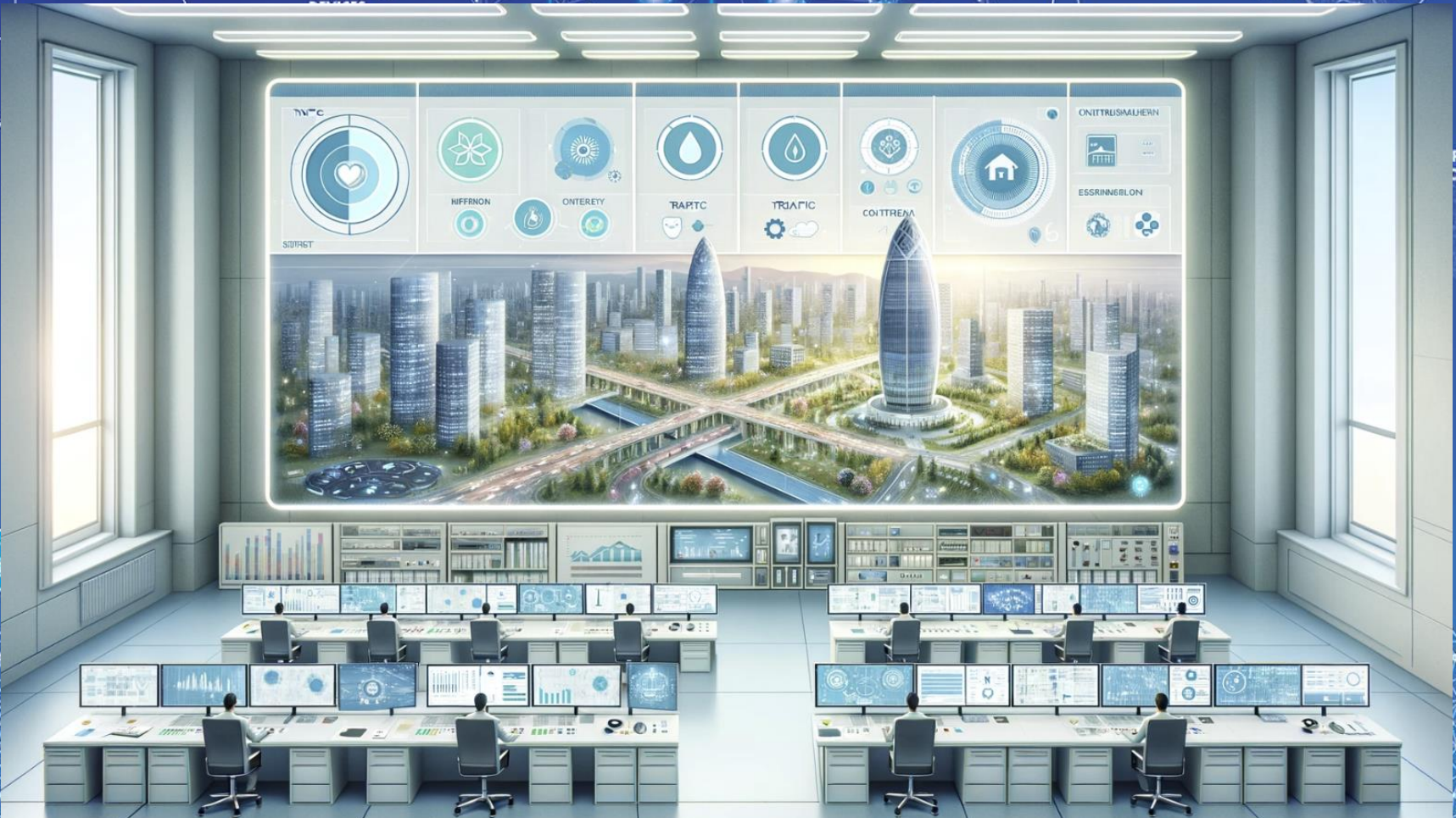
TWITTER VIGILANCE SOCIAL MEDIA ANALYSIS

SNAP4CITY AND KM4CITY PROJECTS

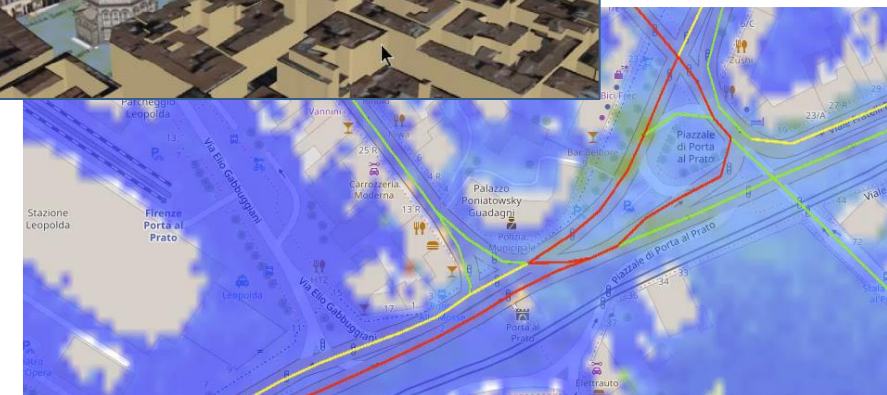
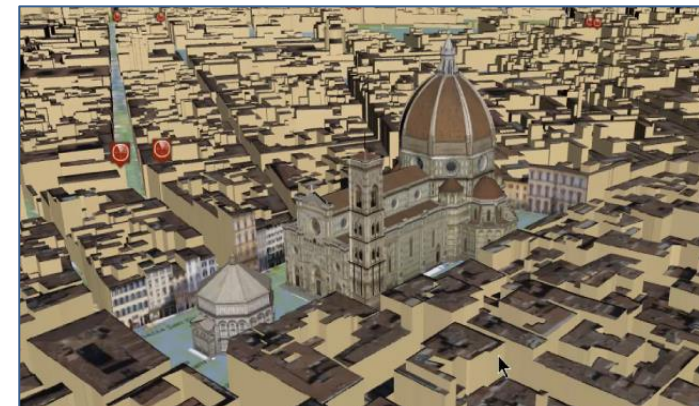
DATA GATHERING AND CITY DATA KNOWLEDGE MANAGEMENT

HOW TO ADOPT SNAP4CITY, AND OUR ROADMAP

SNAP4CITY THE VIEW OF THE ADMINISTRATORS



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

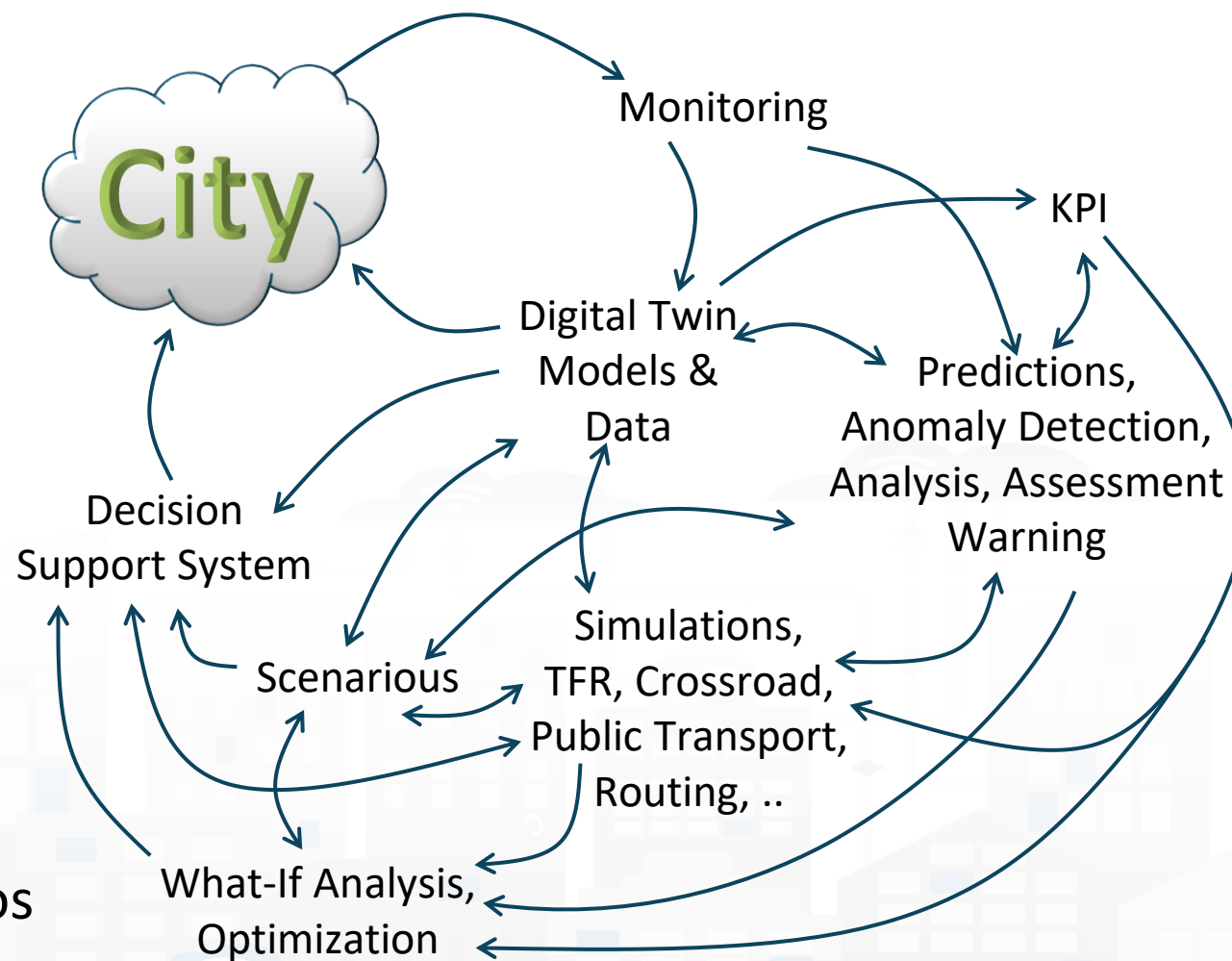


- **Controlling Status: management, and operational**

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

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

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



Key Performance Indicators, KPI



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

Global
&
Local

Periodic
&
Realtime

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

15MinCityIndex

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

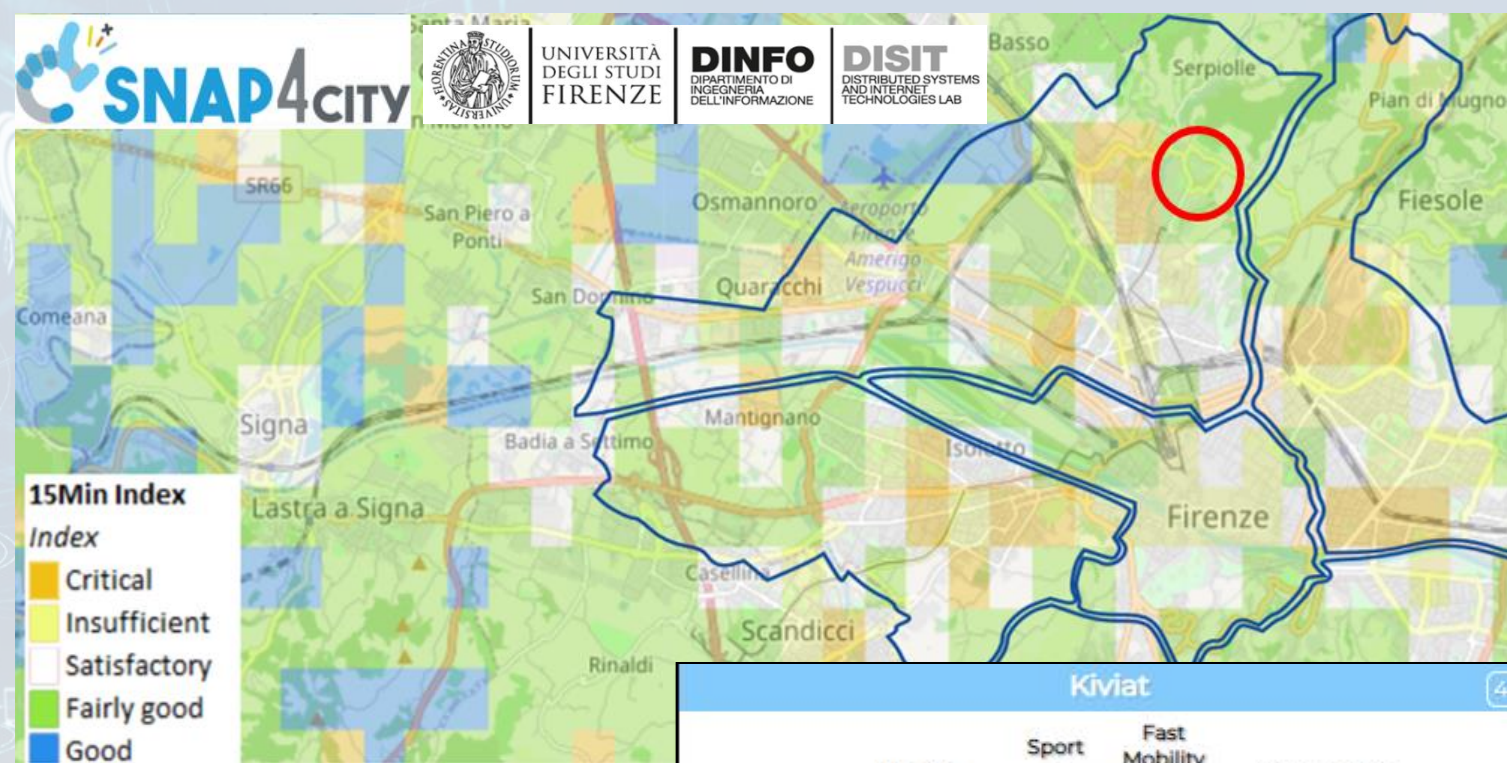
Using the Open Data:

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

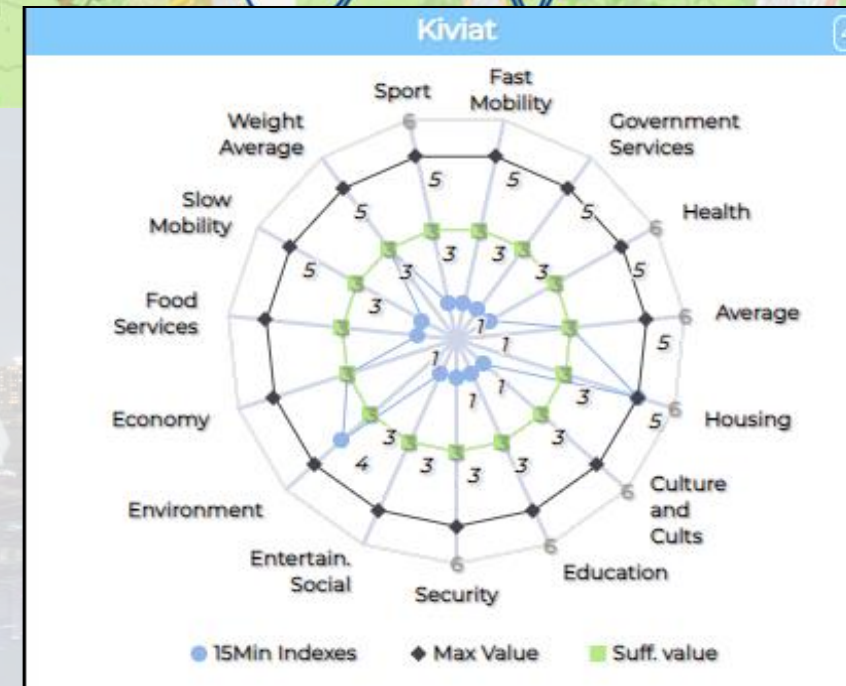
Good public transport services: bus, new tram line, train stations, cycle paths.



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



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



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

15MinCityIndex on Bologna



Ciao roottooladmin!

Tue 3 May 20:14:59

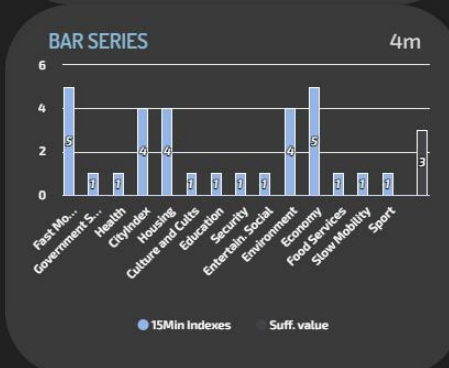
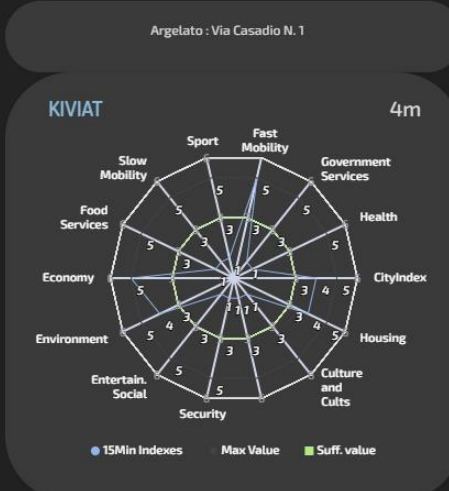
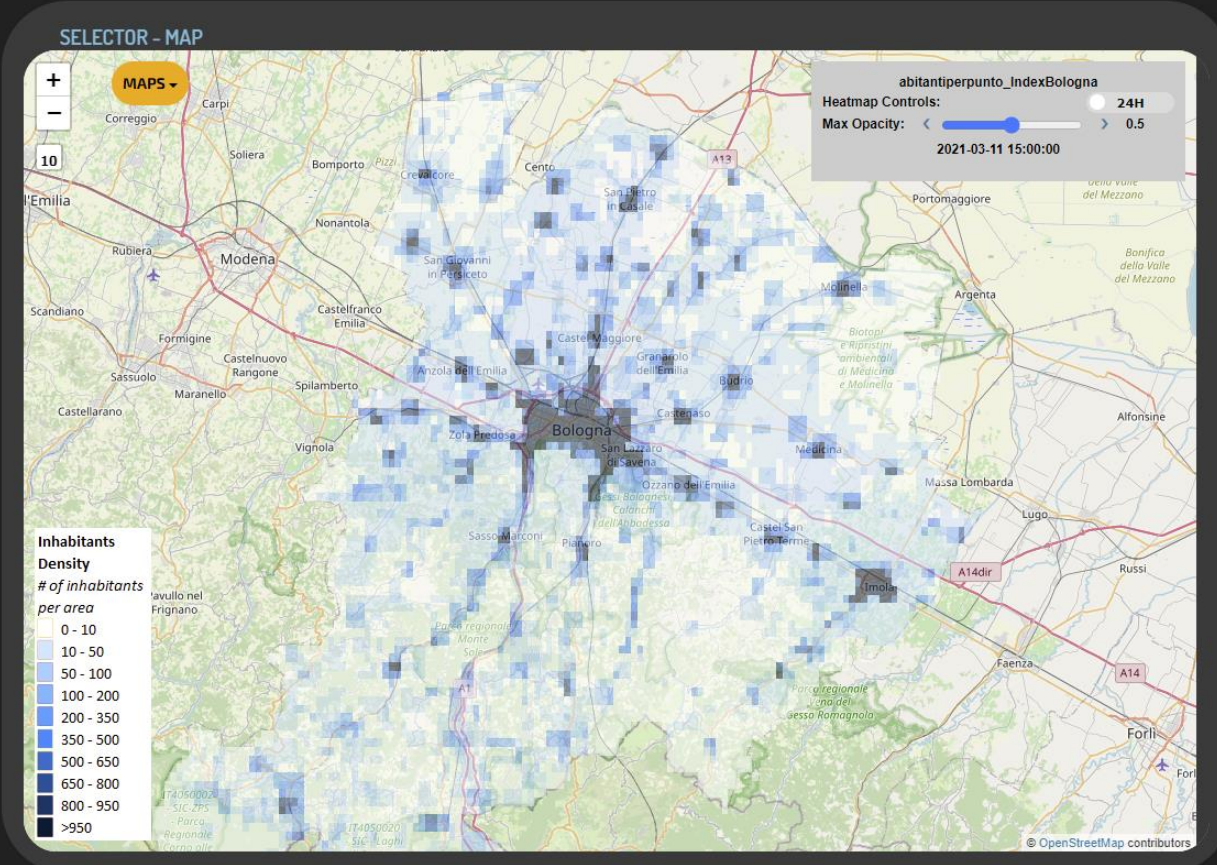
15 MINUTI INDEX BOLOGNA CITTÀ METROPOLITANA - NEWGUI



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

THE PICKED POINT 9m

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



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

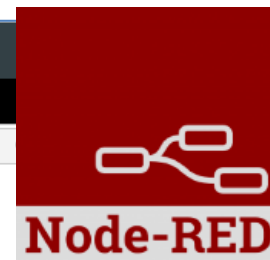
12 RESPONSIBLE CONSUMPTION AND PRODUCTION

13 CLIMATE ACTION

15 LIFE ON LAND

IoT App....

The screenshot displays the Snap4City Node-RED interface. On the left is a sidebar with navigation options like 'My Snap4City.org', 'Dashboards', and 'IOT Applications'. The main workspace shows a Node-RED flow for '15MinIndex'. The flow starts with a 'GPS List As String' node, followed by a 'Select Categories' function node. It then branches into two paths: one leading to 'Increment Categories List Index' and another to 'Controller'. The 'Controller' node connects to 'service-search-near-marker', which then feeds into 'Count Features' and 'set msg.complete'. There are also 'Increment GPS List Index' and 'Reset GPS List Index' function nodes. The flow concludes with 'msg.payload' nodes, 'join' nodes, a 'csv' node, and a 'file' node. The bottom of the interface shows four output nodes, each with a 'timestamp' node and a function node for 'Check Categories List Index', 'Reset Categories List Index', 'Check GPS List Index', and 'Reset GPS List Index'.



Smart City Control Room Florence Metropolitan City



reference



• Multiple Domain Data

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

• Multiple dash/tool Levels & Decision Makers

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

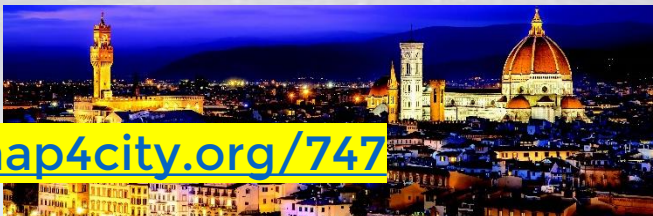
• Historical and Real Time data

- Billions of Data

• Services Exploited on:

- Multiple Levels, Mobile Apps, API

• Since 2017



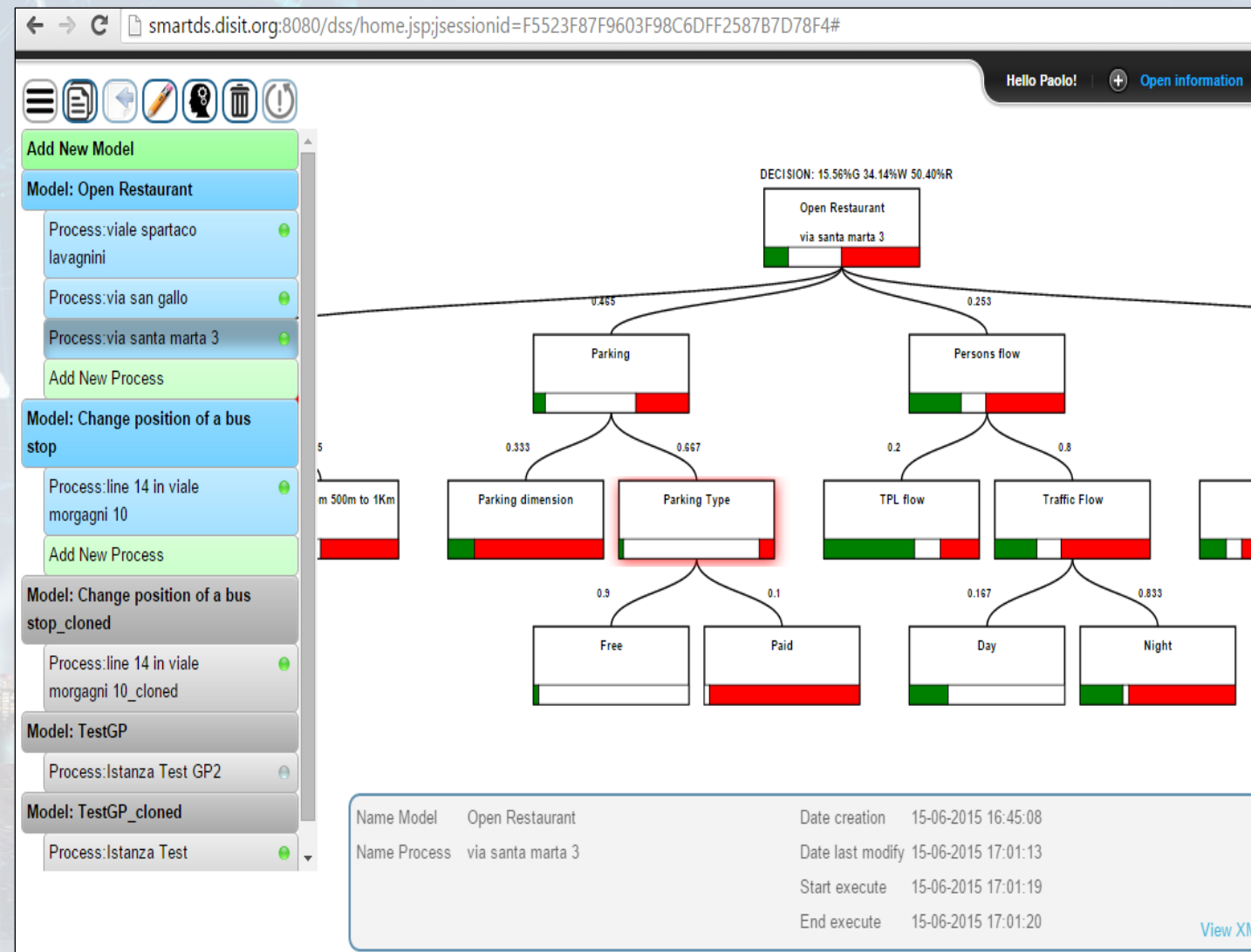
<https://www.snap4city.org/747>





Smart Decision Support, system thinking

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

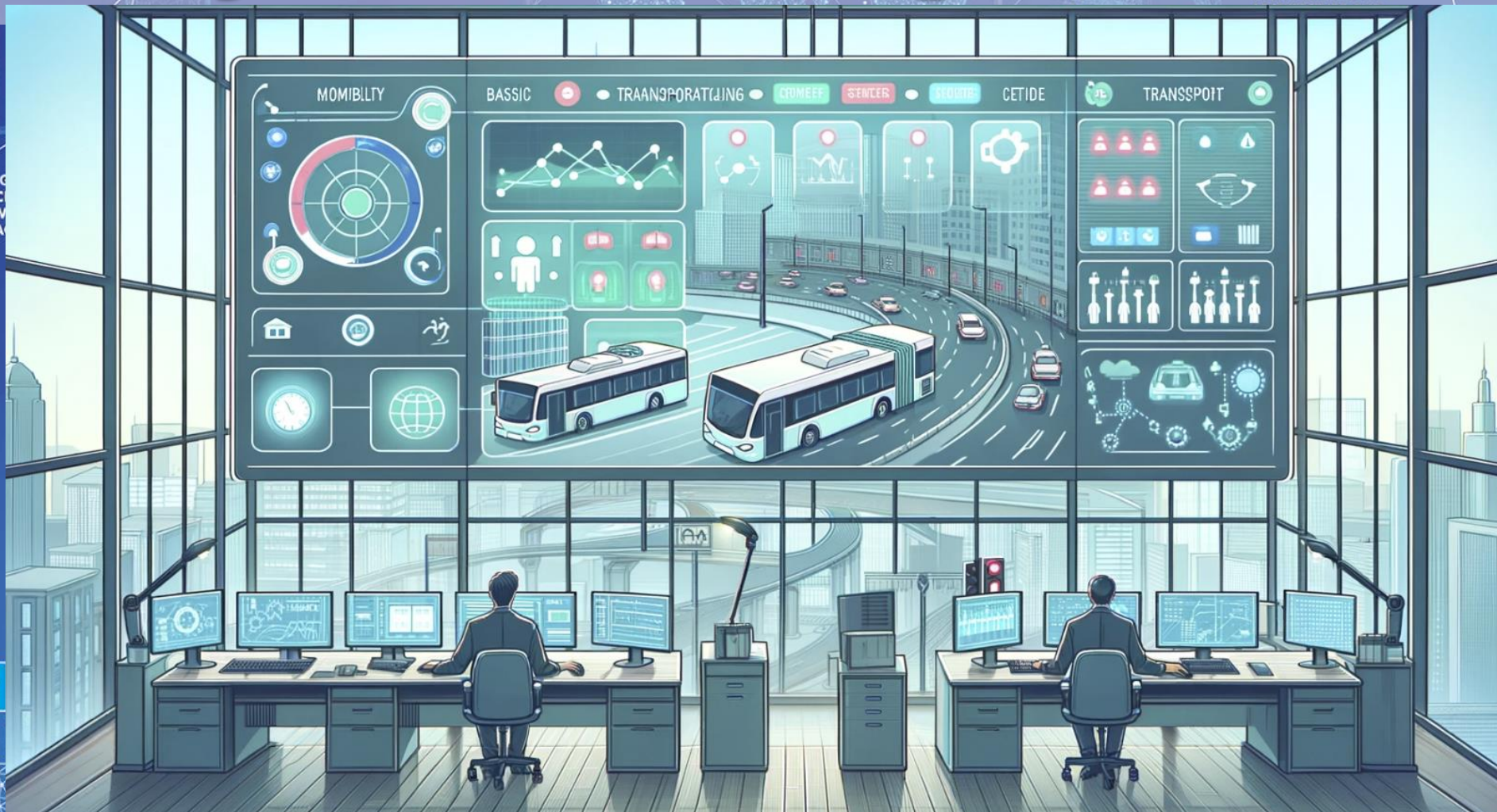




Mobility Monitoring and Control

FROM CITY
DASHBOARD TO
APPLICATIONS

DATA C
AND C
KNOW
MANA



HOW TO ADOPT
SNAP4CITY, AND
OUR ROADMAP

SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS

SNAP4CITY
AND KM4CITY
PROJECTS

SNAP4CITY FOR
BEGINNERS

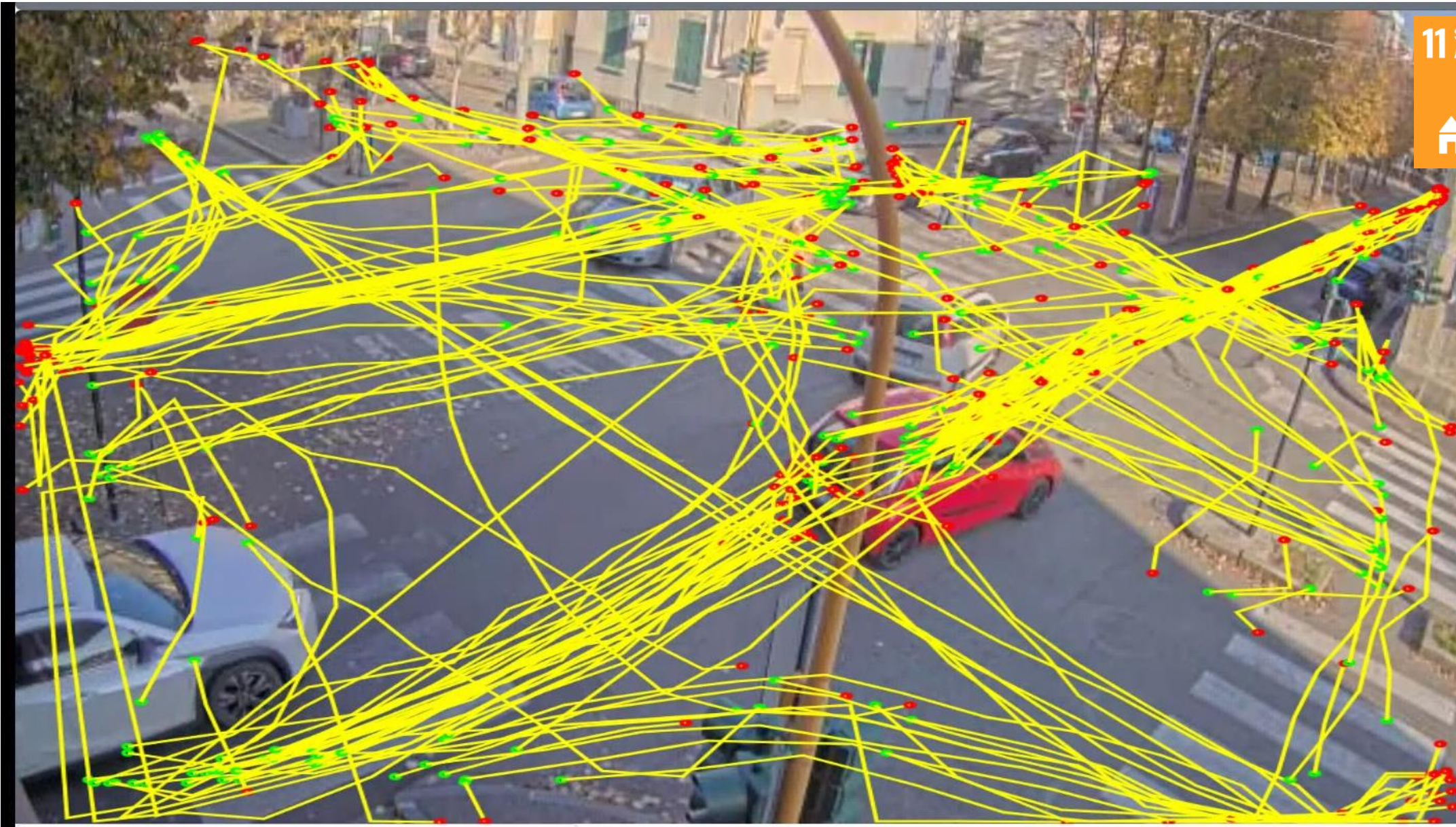
SNAP4CITY

TWITTER
GITHUB
YOUTUBE

MONITORING &
ANALYSING
AND FLEXIBLE
WEB
AND MOBILE APPS



11 SUSTAINABLE CITIES
AND COMMUNITIES



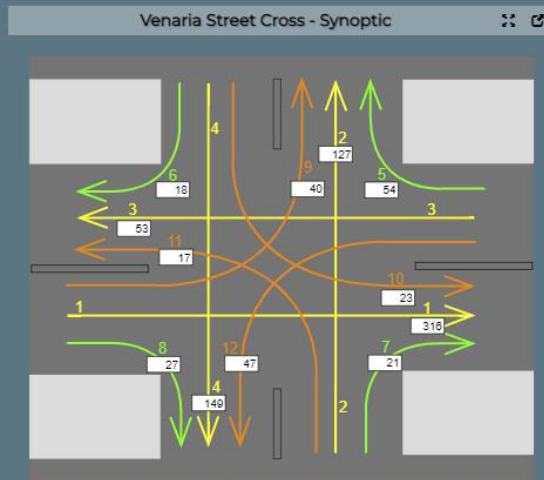
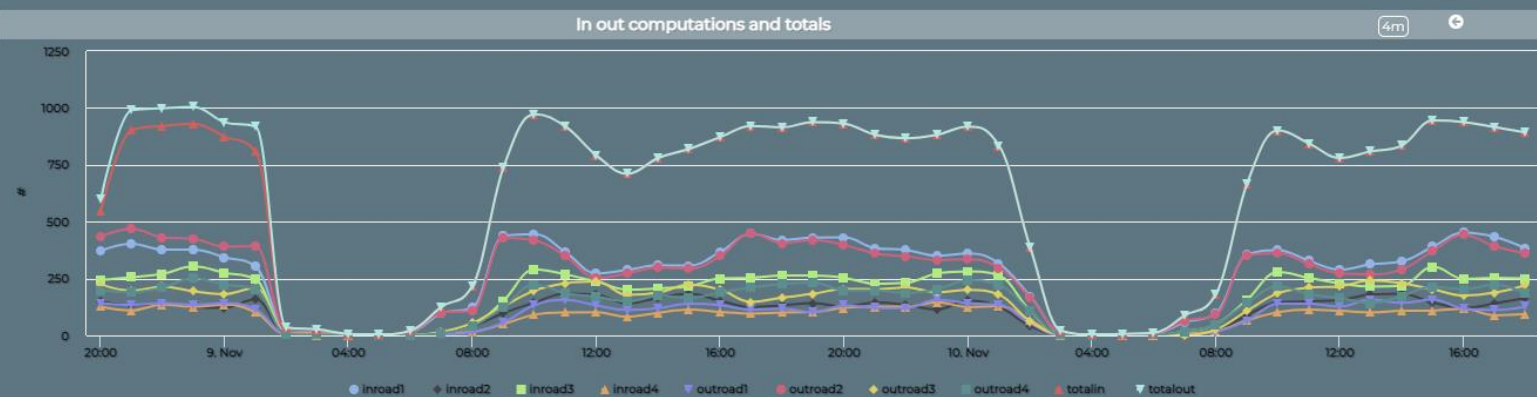
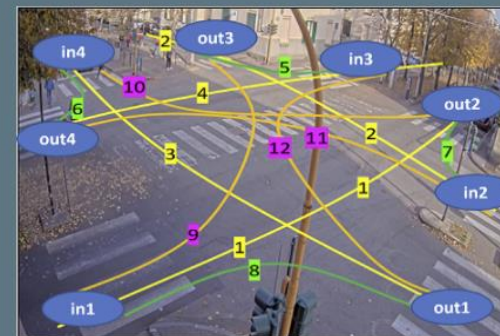
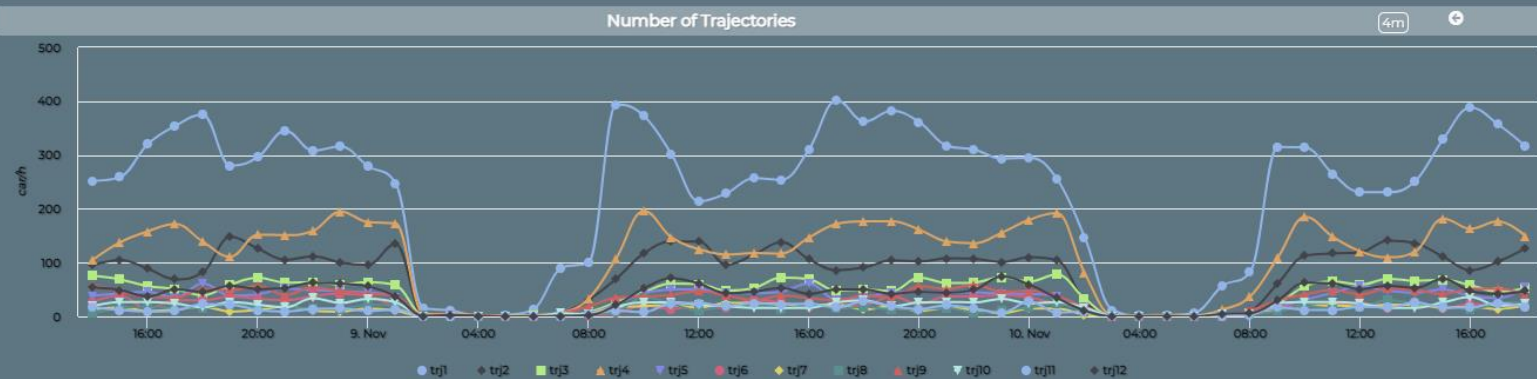
snap4City (C), August 2024

Monitoring Cross Road Venaria - (AXIS Camera)

Wed 10 Nov 18:50:53



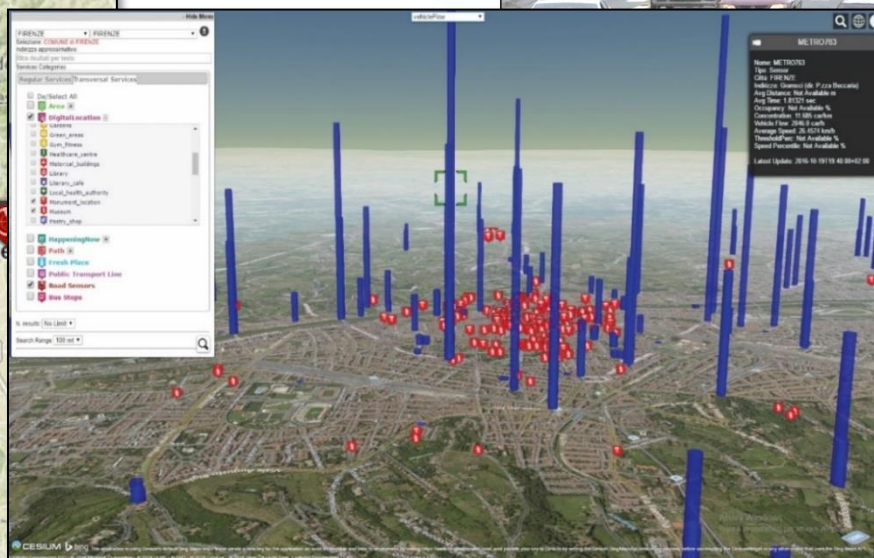
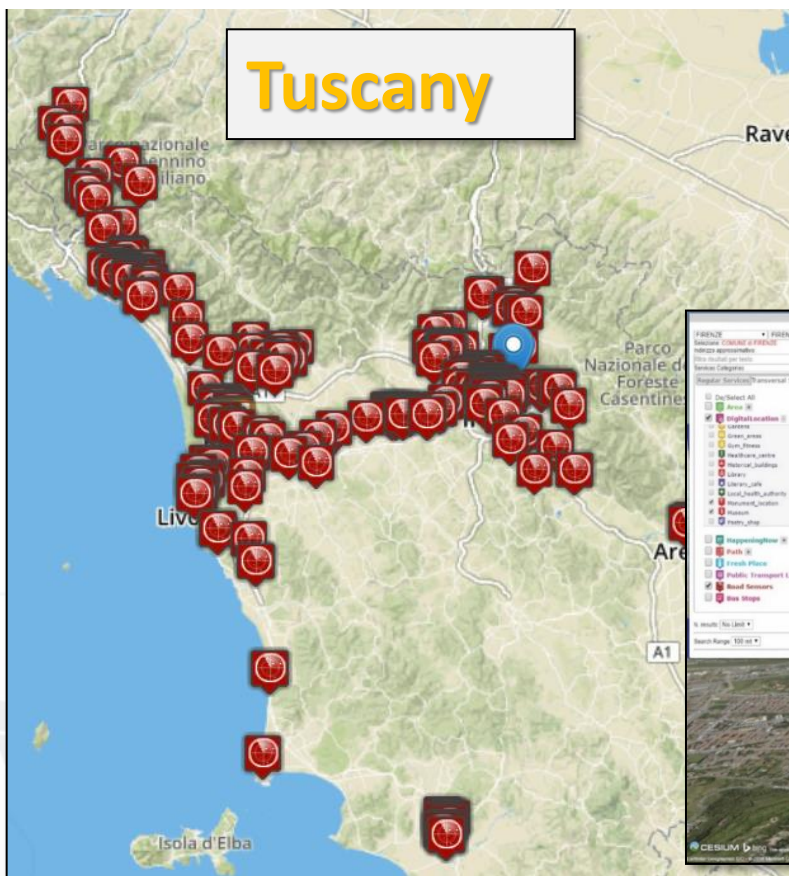
11 SUSTAINABLE CITIES
AND COMMUNITIES



<https://www.snap4city.org/dashboardSmartCity/view/index.php?iddashboard=MzI5Ng==>

Traffic Flow Tools

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



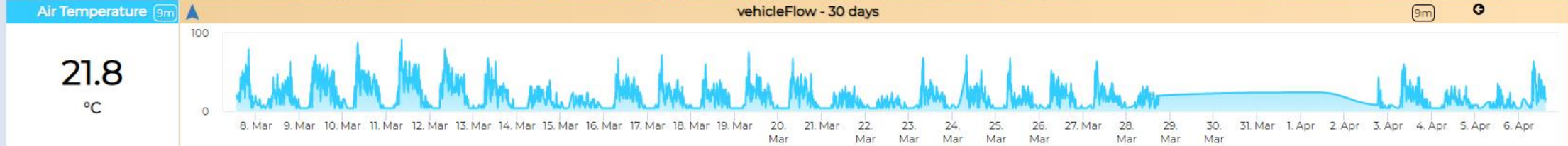
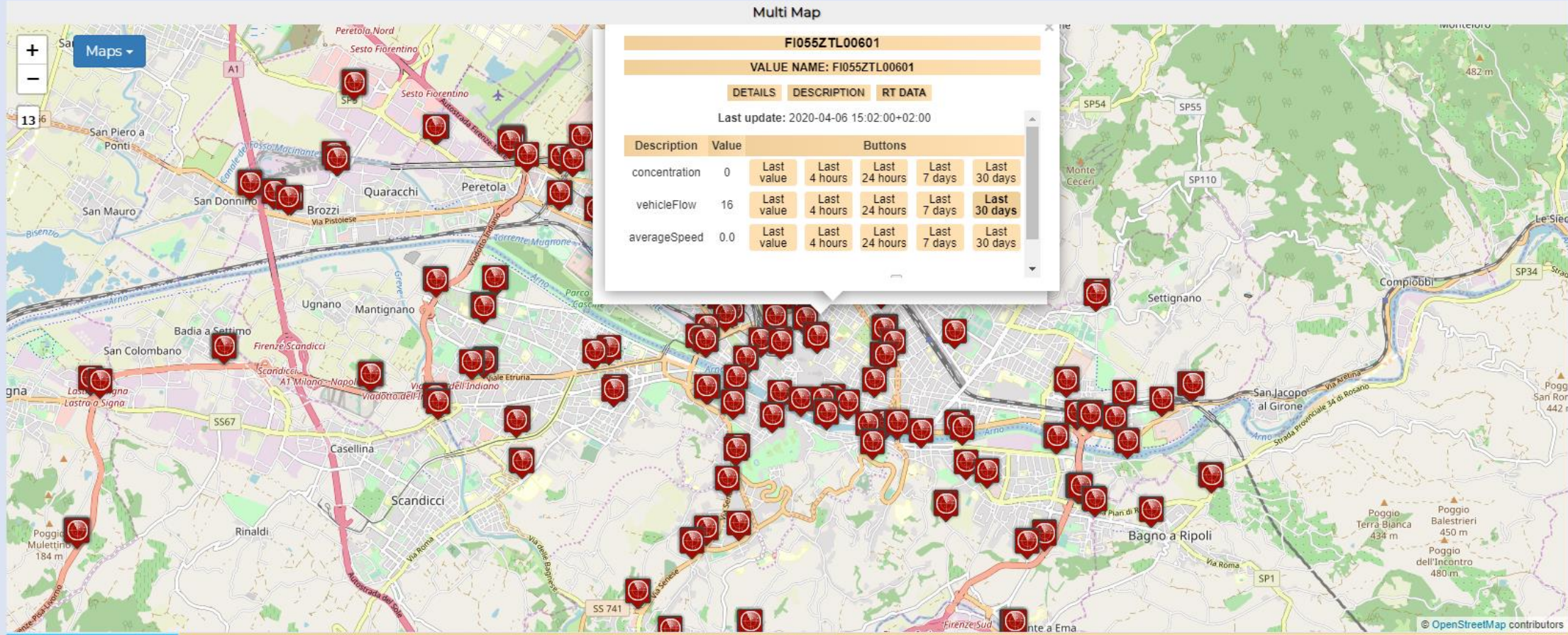
Firenze - Trafair - AirQuality Heatmaps



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

Mon 6 Apr 15:12:27

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



Air quality trends

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

Privacy Policy Cookies Policy Terms and Conditions Contact us





Traffic Flow Monitoring - Firenze - Cloned2

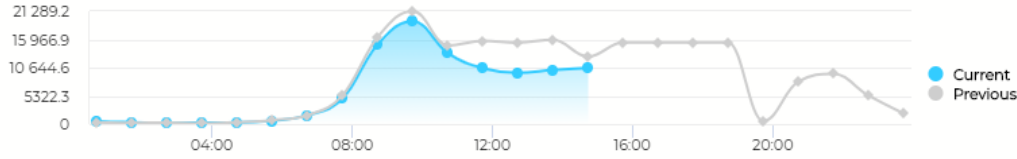
Wed 11 Nov 15:01:32

IN FLOW 9m

Firenze IN Traffic Flow (number of vehicles)

9m

10549 #ofvehicles

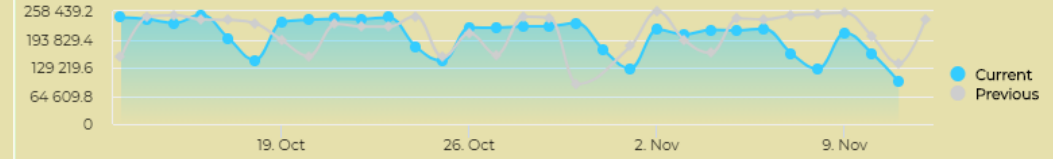


Inc Daily Inp... 9m

Daily Inputs (monthly) (last value is incremental, real time)

9m

97137 #ofvehicles

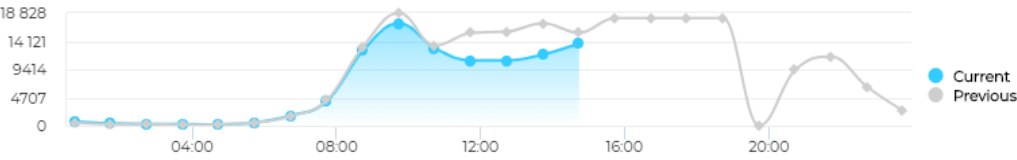


OUT FLOW 9m

Firenze OUT Traffic Flow (number of vehicles)

9m

13720 #ofvehicles

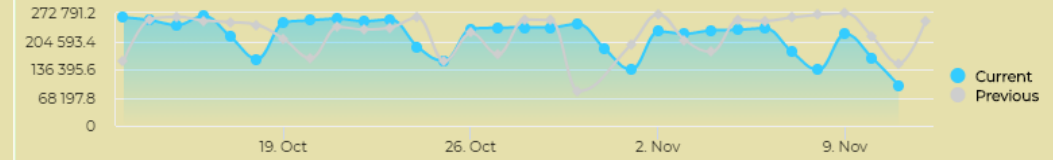


Inc Daily Out... 9m

Daily Outputs (monthly) (last value is incremental real time)

9m

97457 #ofvehicles

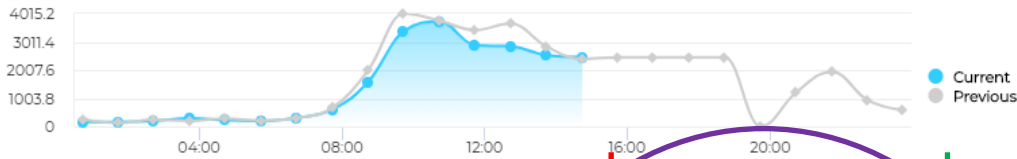


ZTL in 9m

ZTL in Traffic Flow daily trend, entering in ZTL

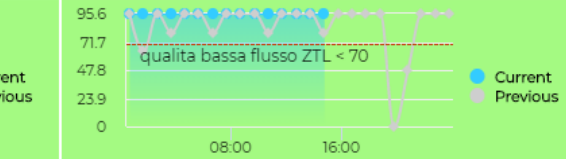
9m

2468 #ofvehicles



QoS as perc. of measures taken

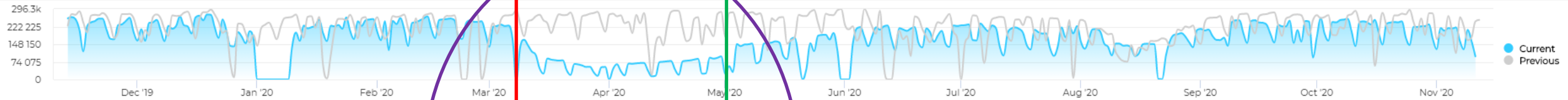
QoS as perc. of measures in ZTL



11/11/2020
15:01:33

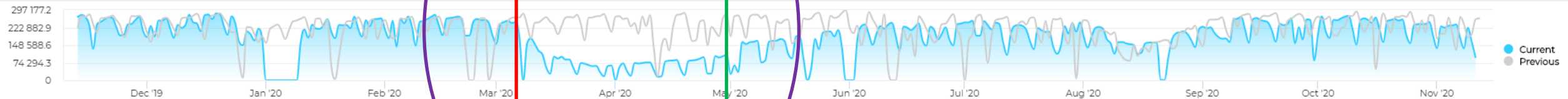
inflow total of the day, yearly

9m



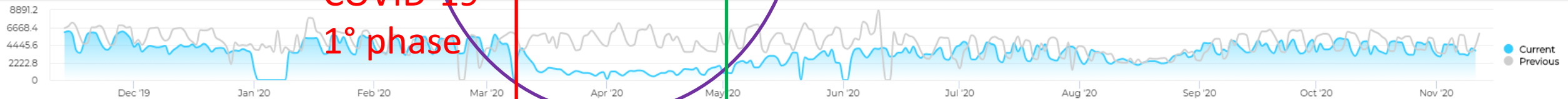
outflow total over the day Yearly

9m



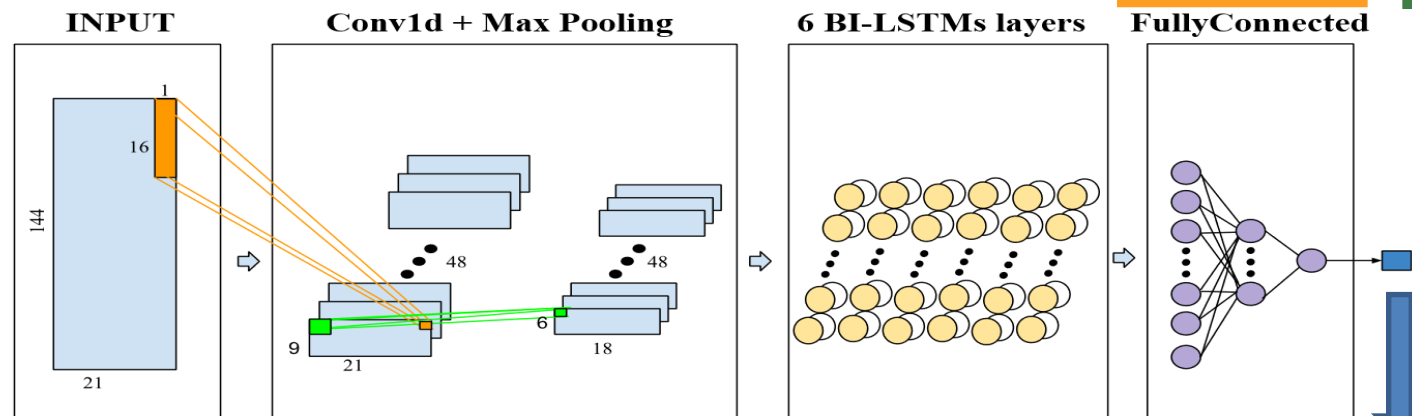
in ZTL yearly compare

9m



COVID-19
1° phase

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



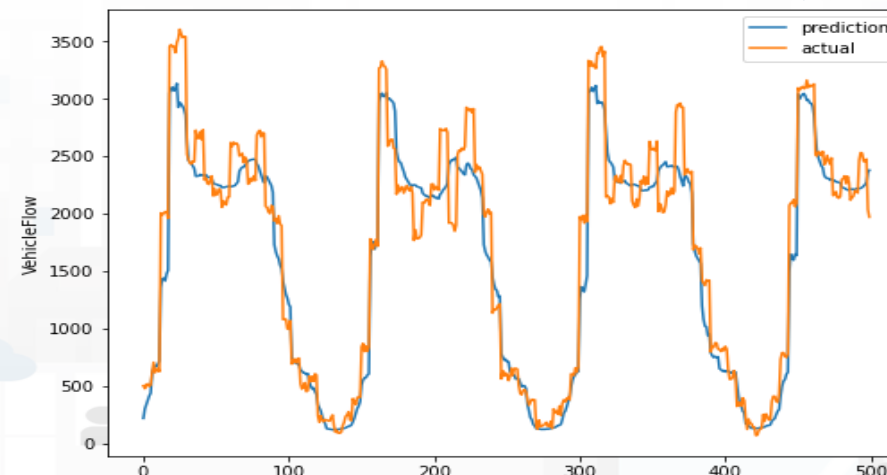
Urban data:

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



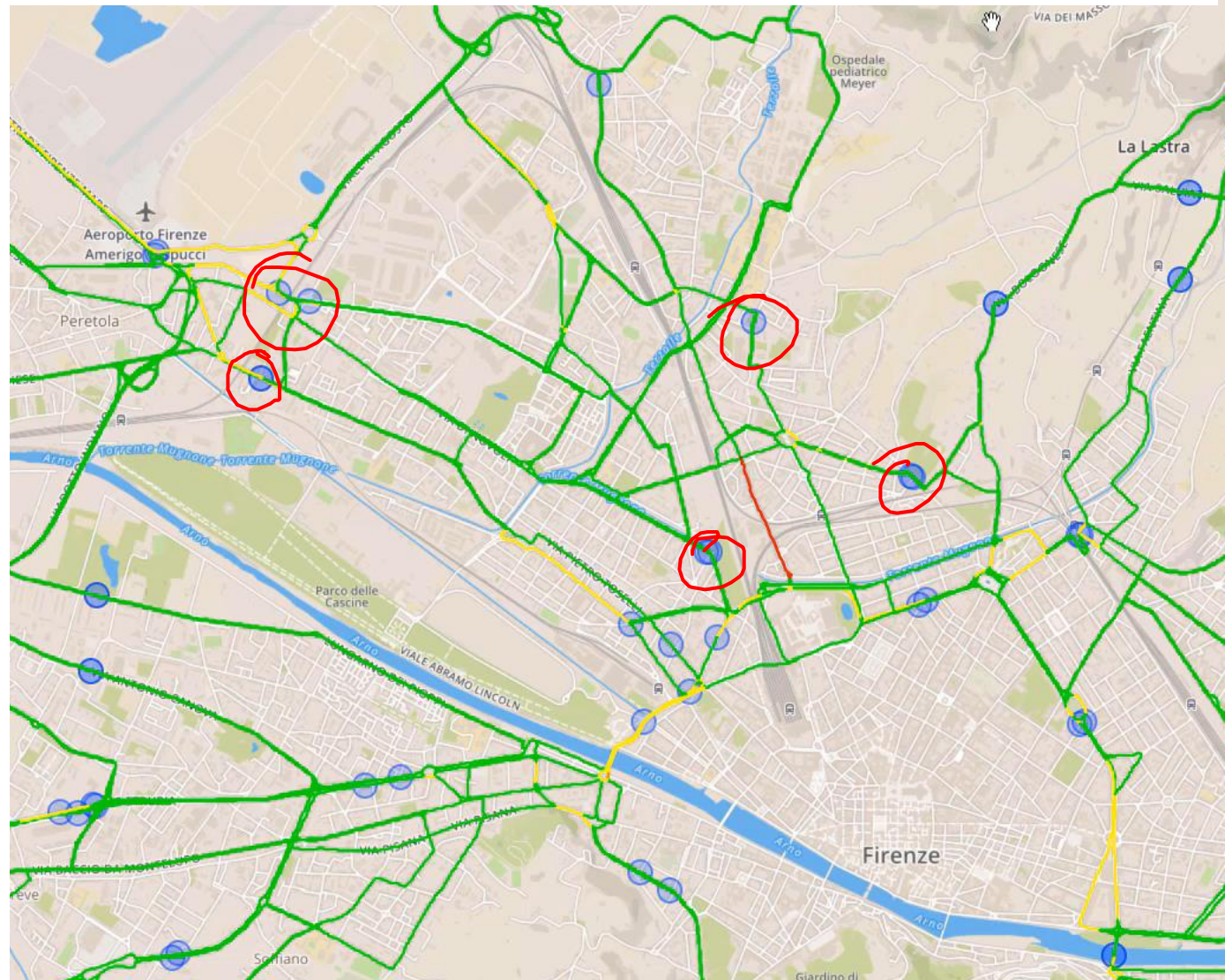
- RF
- XGBOOST
- DNN
- LSTM
- BI-LSTM
- Autoencoder BI-LSTM
- Attention CONV-LSTM
- CONV-BI-LSTM

CONV-BI-LSTM



Dense Traffic Flow Reconstruction ?

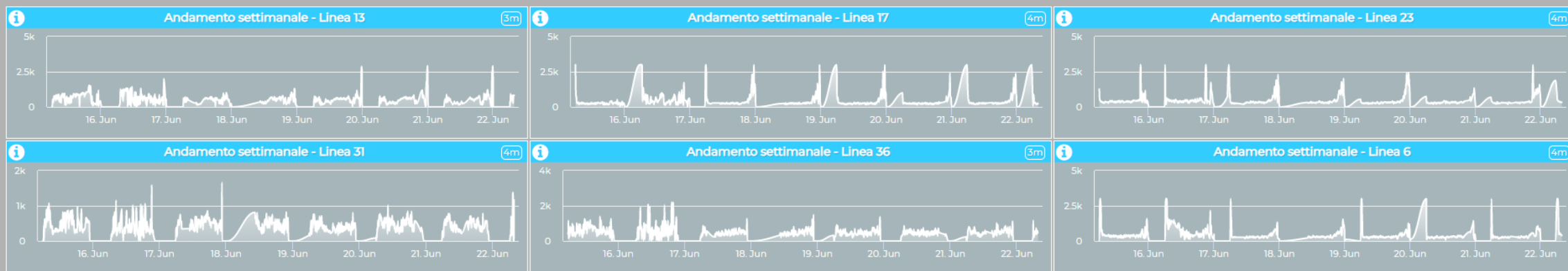
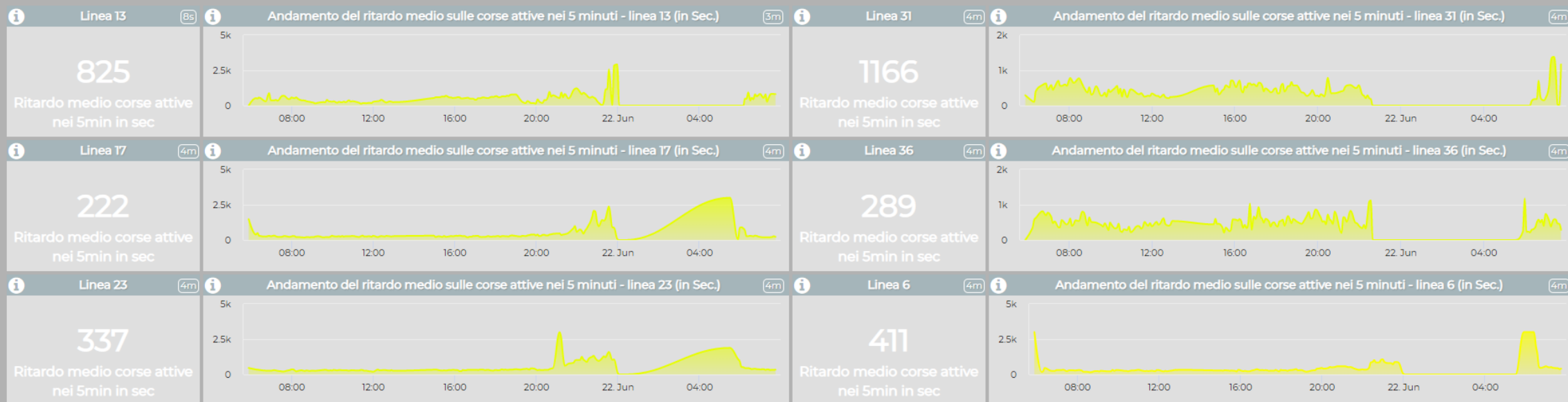
- Making decision on mobility and transport solutions → what if analysis
- Controlling pollution
- Dynamic Routing for Firebrigade, Ambulances, general public
- Planning Public Transportation routing



Qualità Trasporto Pubblico - Cloned

Firenze - 6 linee

Sat 22 Jun 07:45:48

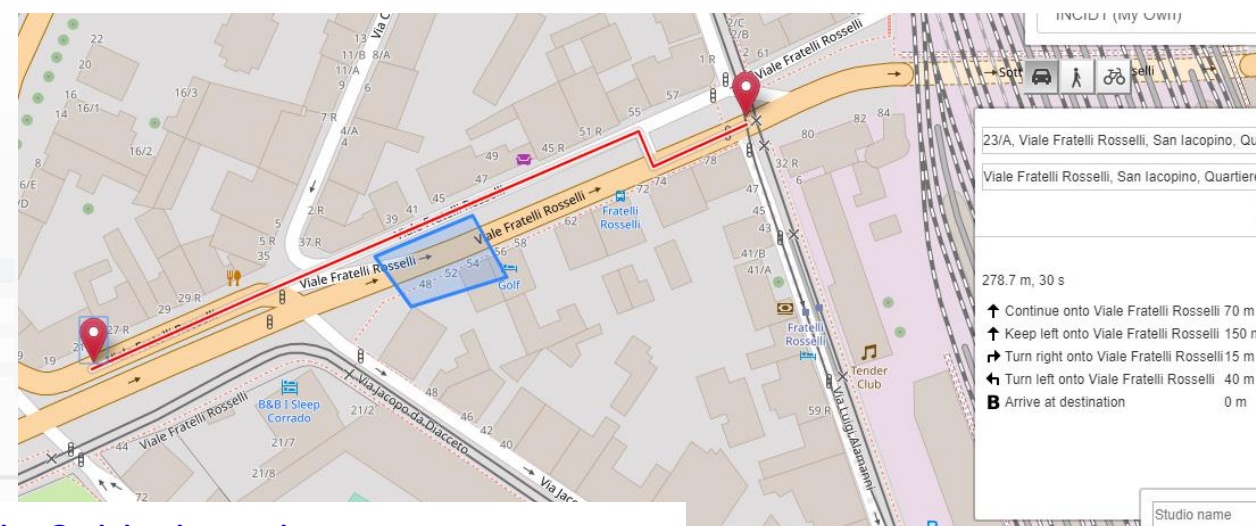
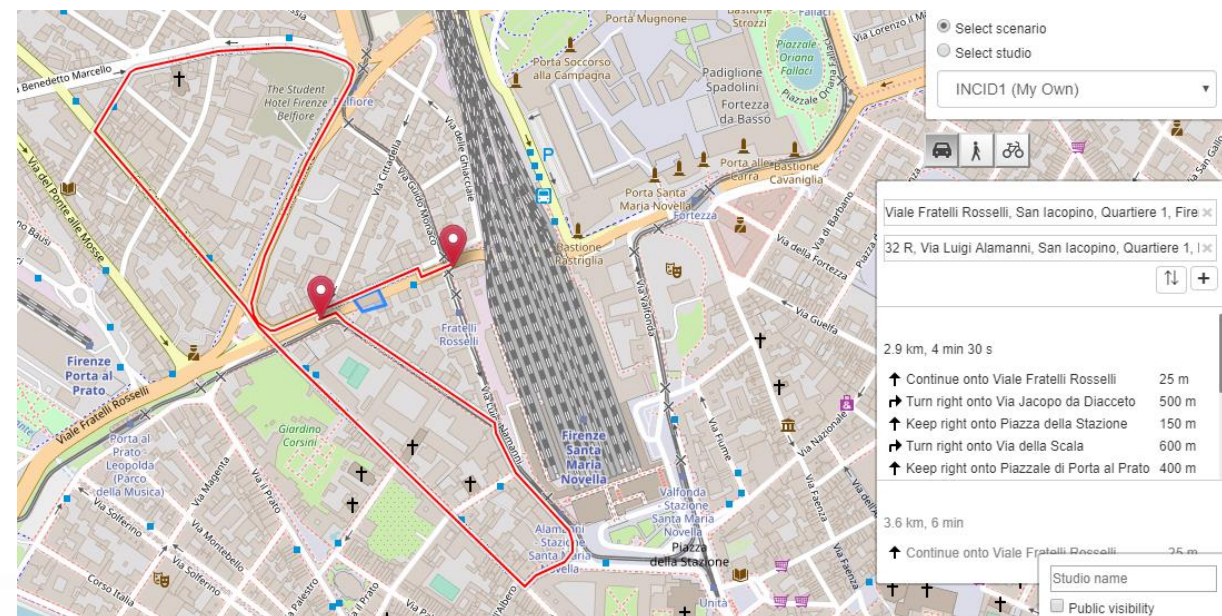


Accidents and elements blocking Points and Shapes taken into account for:

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

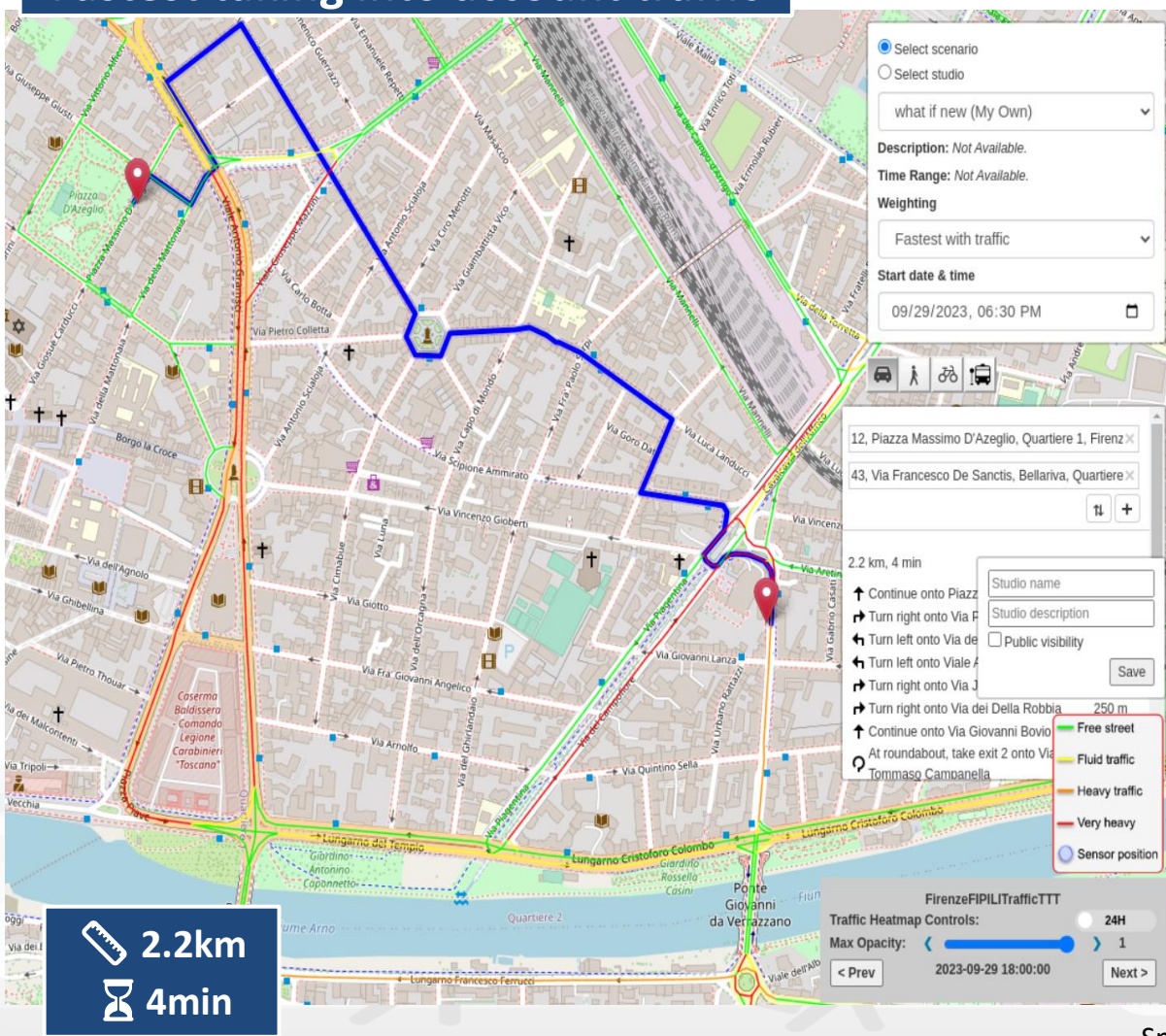
Assessment on the basis of changes:

- Mobility demand assessment
- Mobility Offer assessment

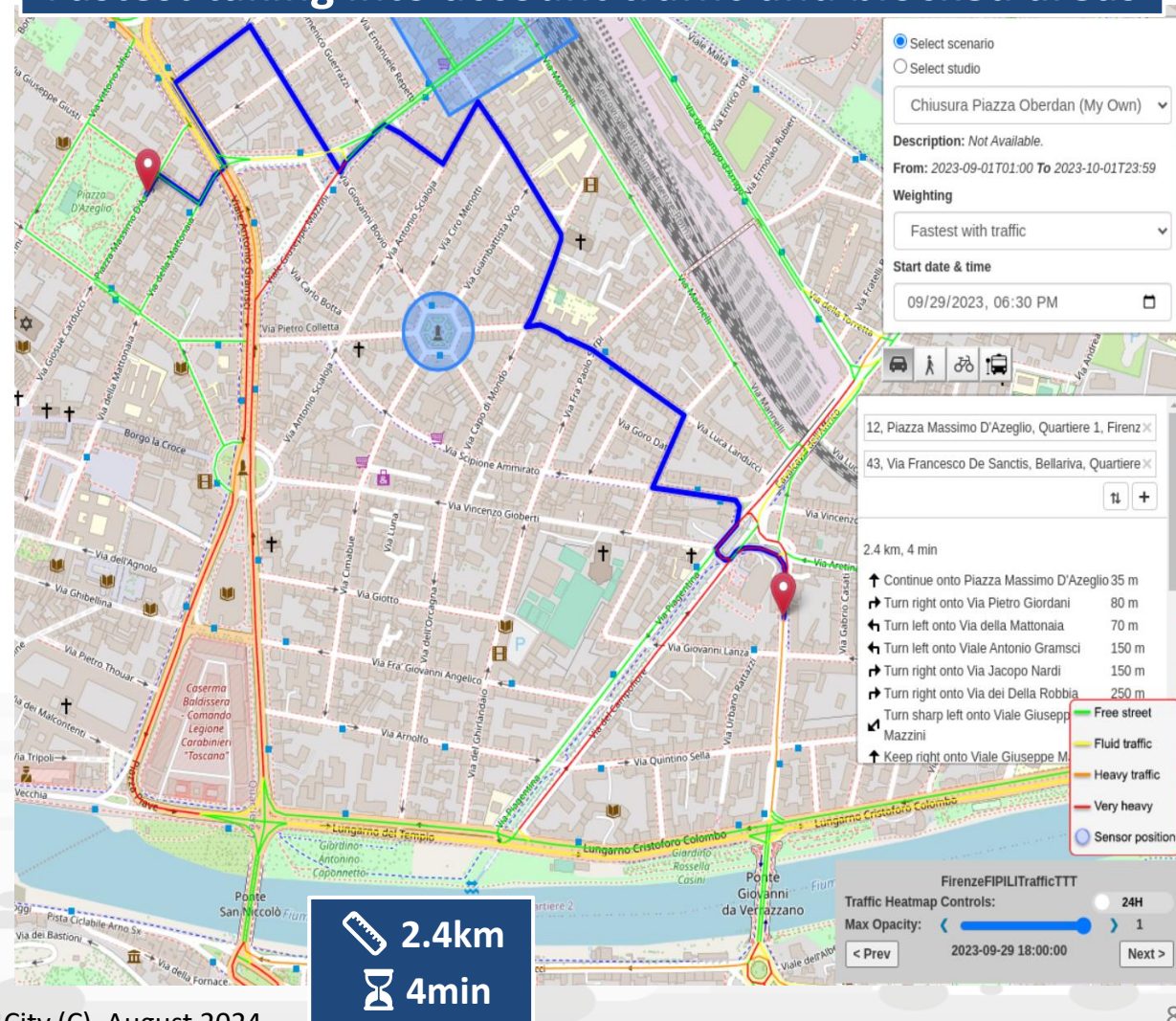


Constrained Dynamic Routing: Traffic Flow

Fastest taking into account traffic

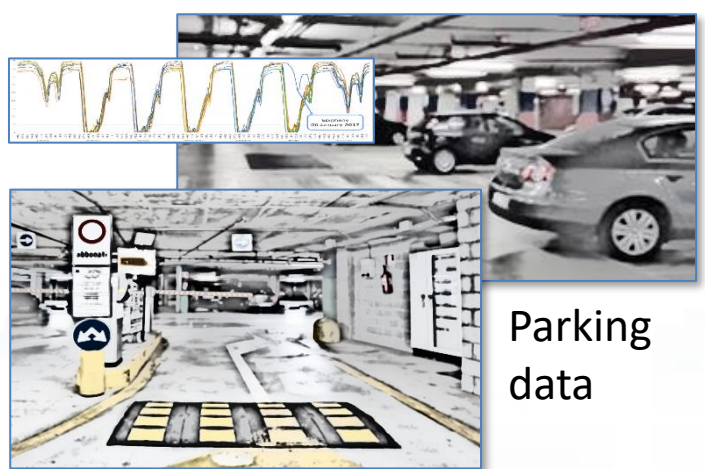


Fastest taking into account traffic and blocked areas





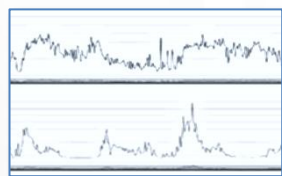
Deep Learning AI to surely Park!



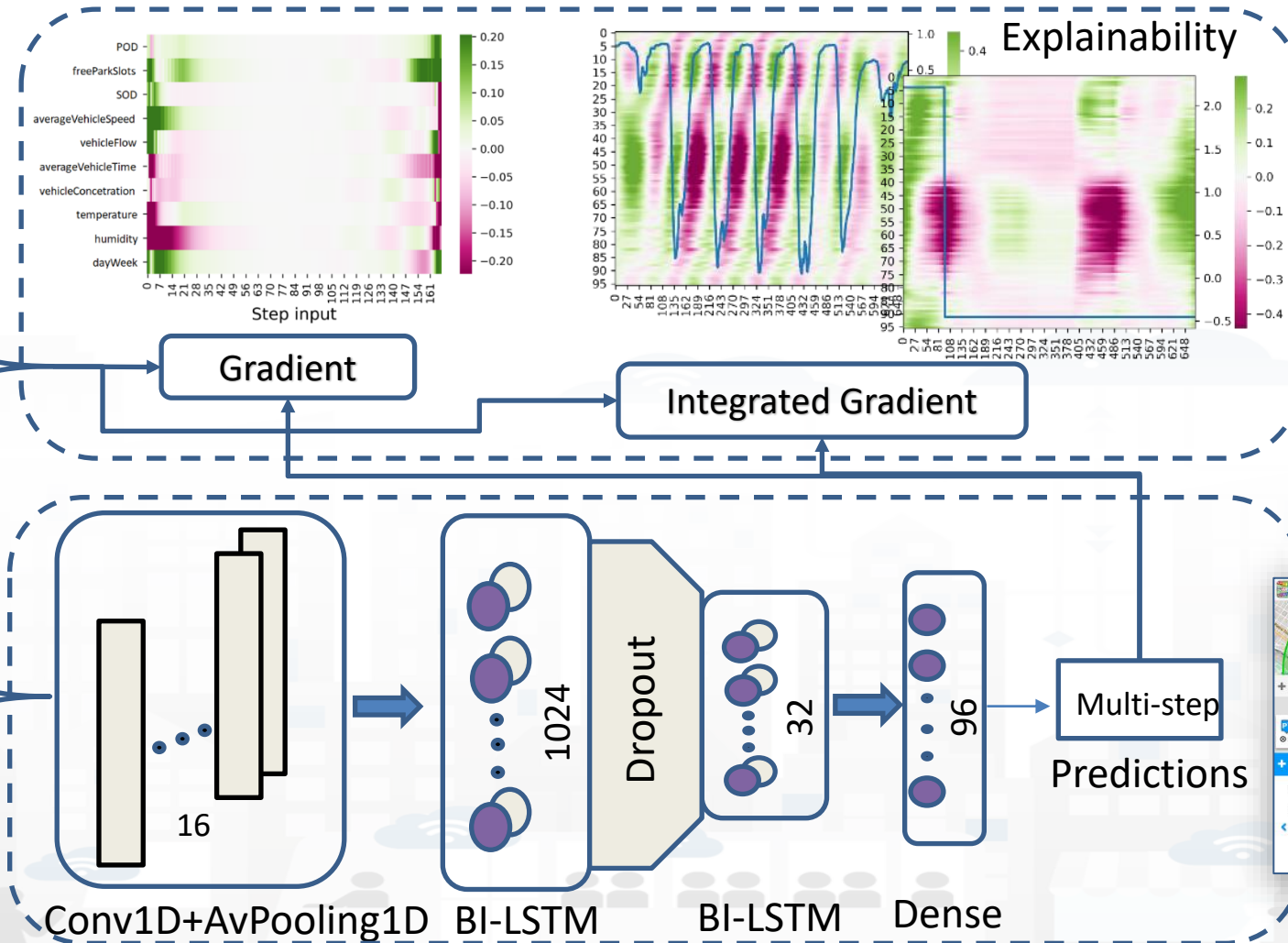
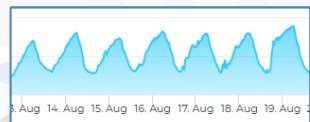
Parking data



Traffic sensors data

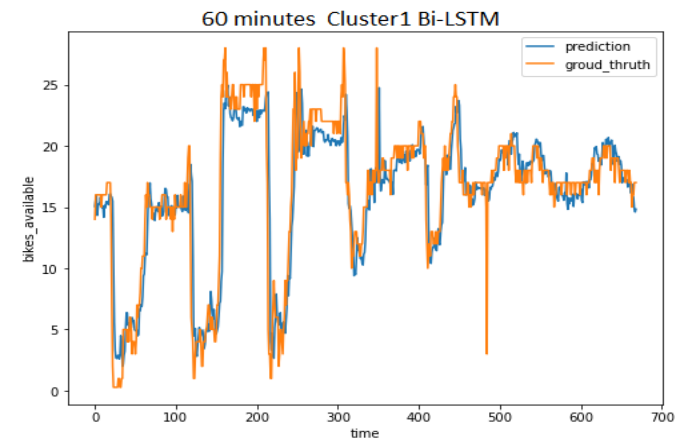
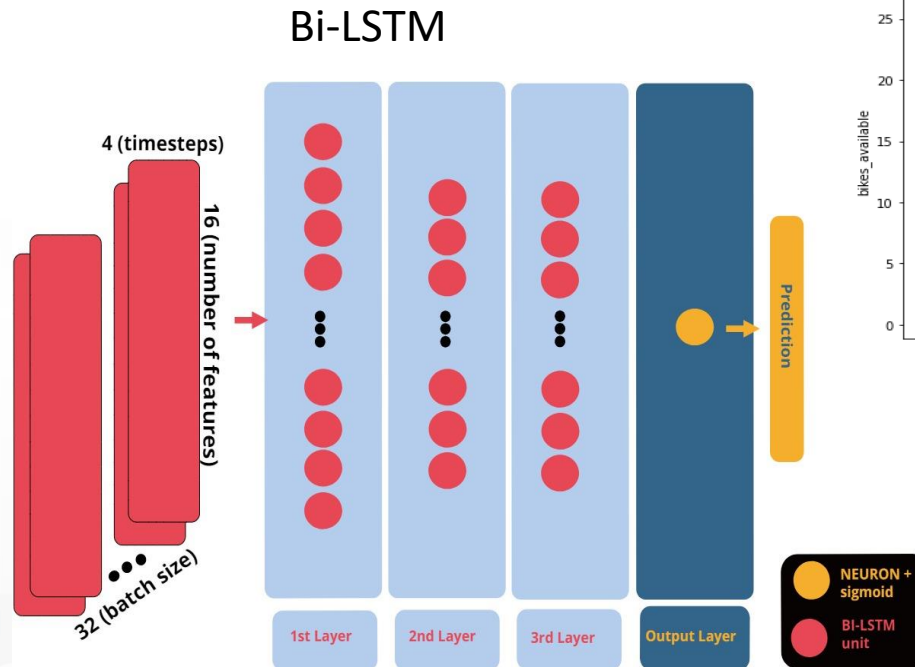


Weather Features





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

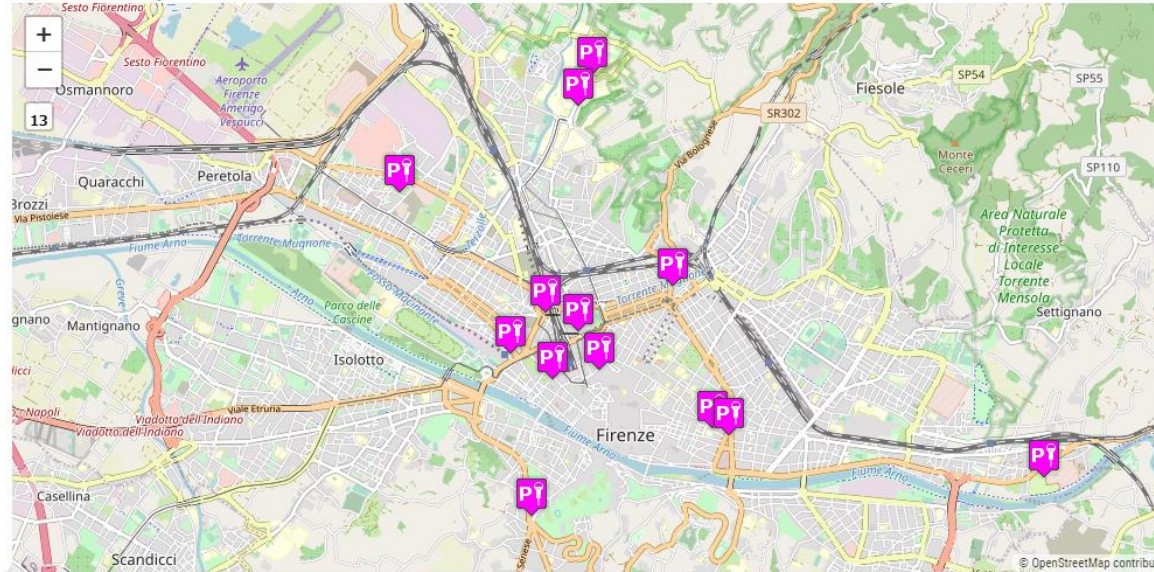




Selector

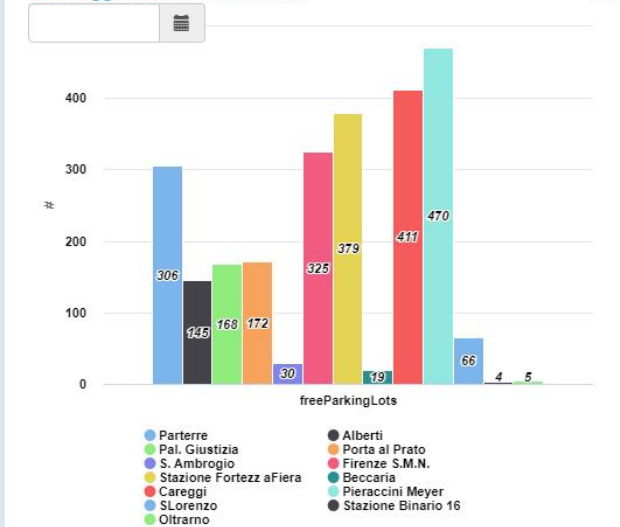
- Parterre
- Piazza Alberti
- Palazzo di Giustizia
- Porta al Prato
- S. Ambrogio
- Stazione Firenze S.M.N.
- Stazione Fortezza Fiera
- Piazza Beccaria

Selector - Map



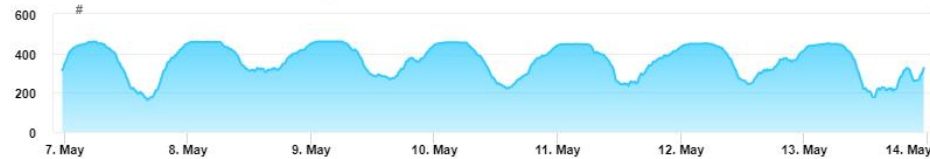
Parcheggi: Numero Posti Liberi

4m



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

9m



Andamento Posti Occupati

4m



My Profile

Smart City / Smart Parking + Environment

Reverberi, Lonato del Garda



reference

- **Multiple Domain Data**

- Smart Parking, Environment, Wi-Fi

- **Multiple Decision Makers**

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

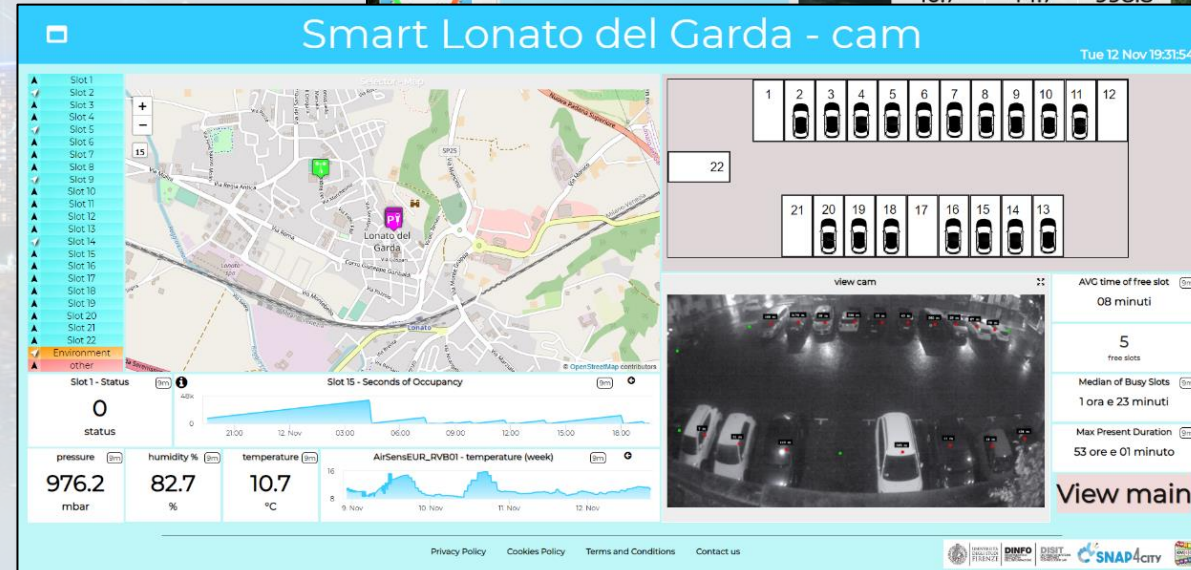
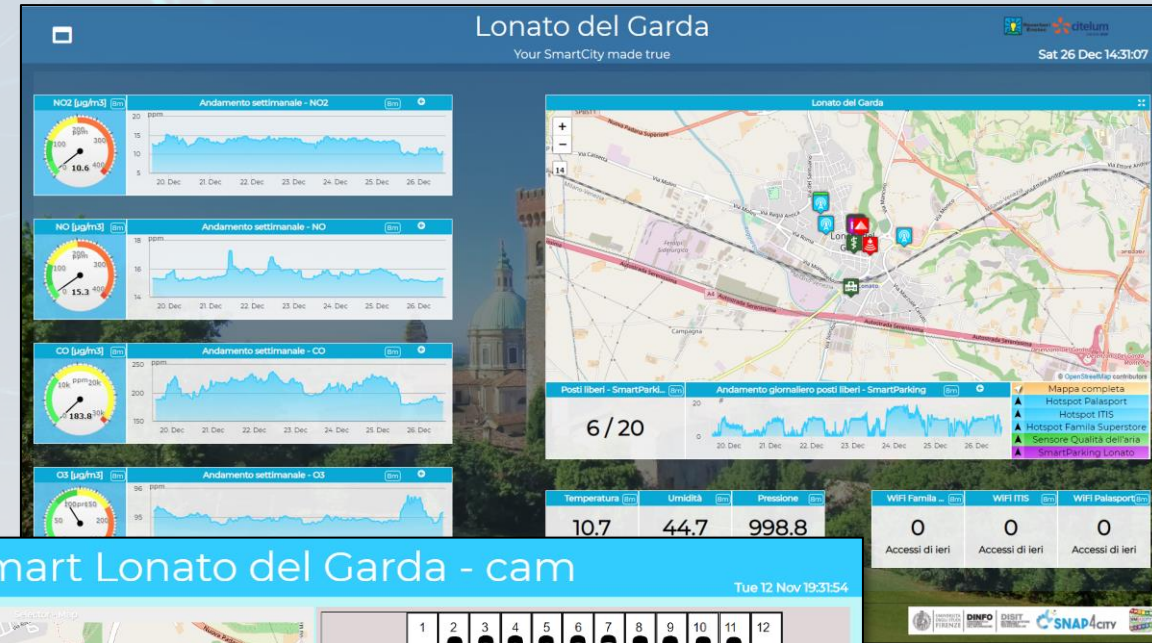
- **Historical and Real Time data**

- Dashboards

- **Services Exploited on:**

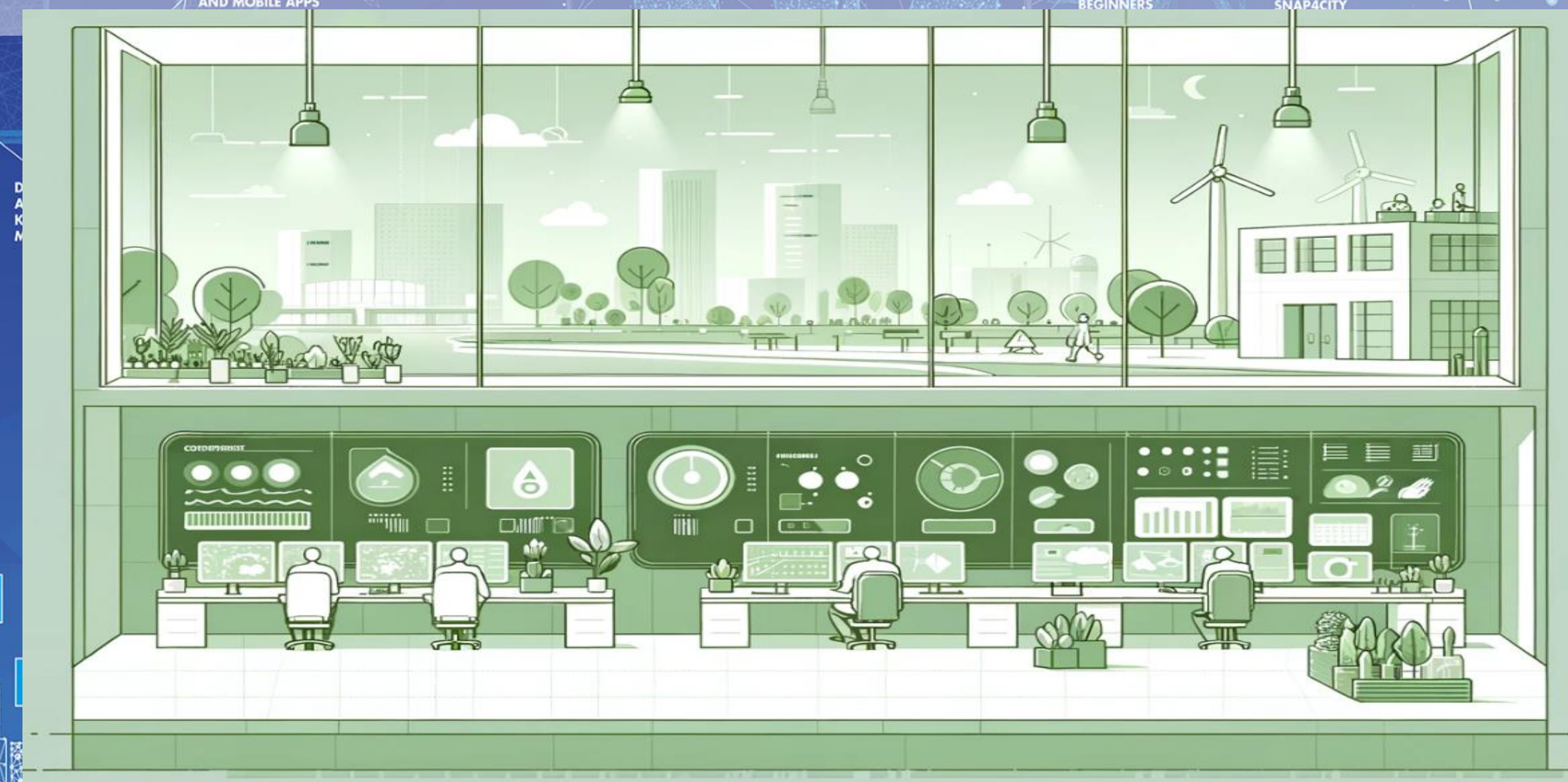
- Dashboards, API

- **Since 2019**



Environmental Monitoring and Control

FROM CITY
DASHBOARD TO
APPLICATIONS



ORGANIZATION
AND FLEXIBLE WEB
AND MOBILE APPS

SNAP4CITY FOR
BEGINNERS

SNAP4CITY

TWITTER
ANALYTICS
DIAGNOSTICS

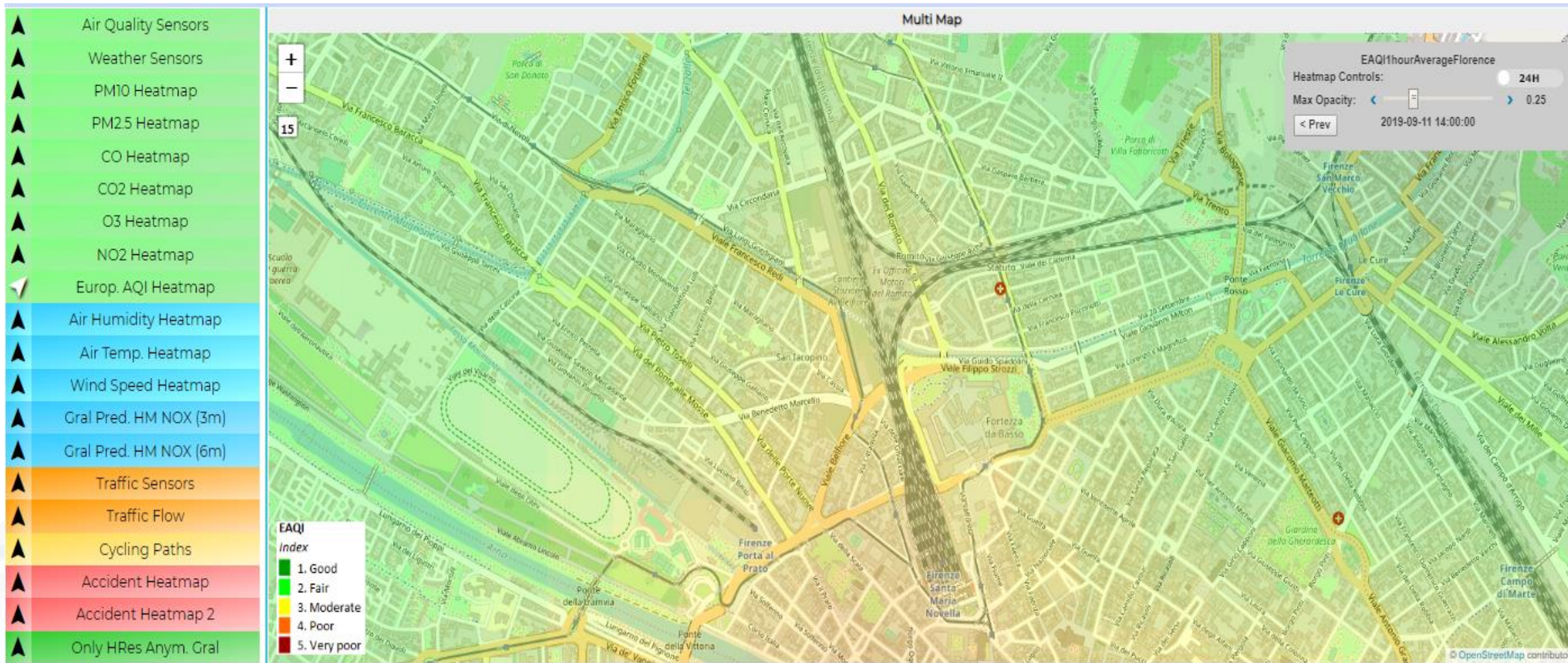
SNAP4CITY
AND KM4CITY
PROJECTS

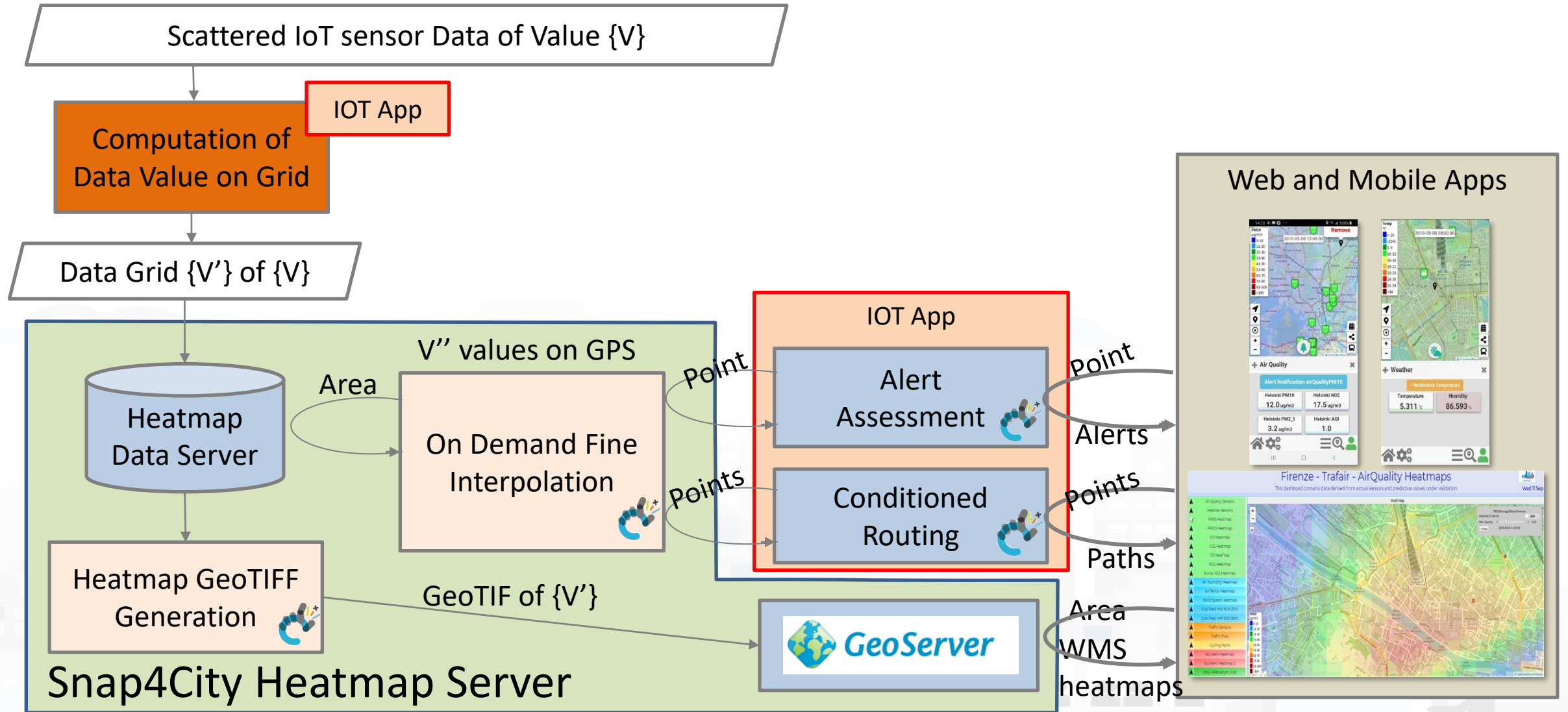
ADOPT
AND
MAP

SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS

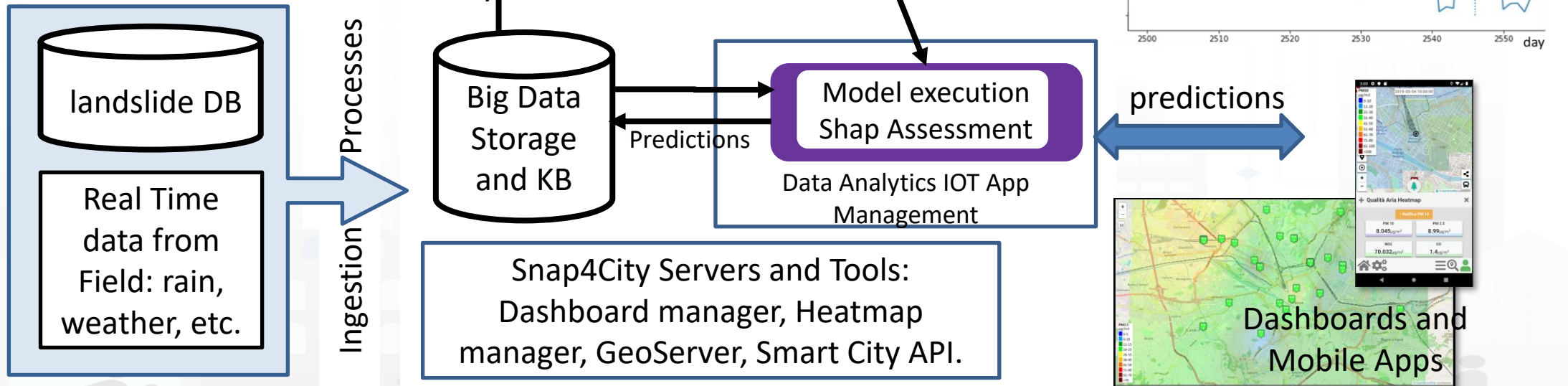
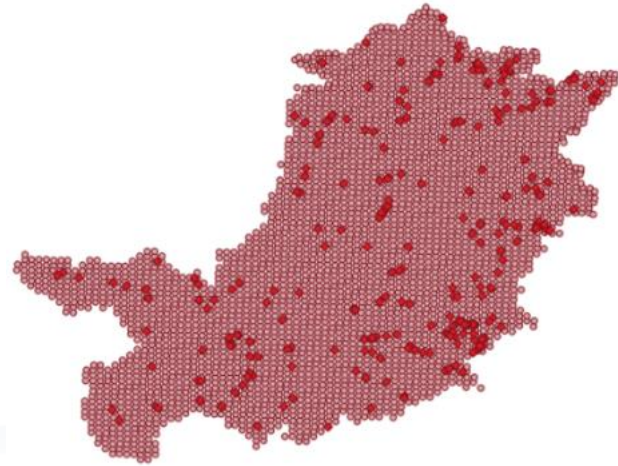


EAQI Heatmap and sequence



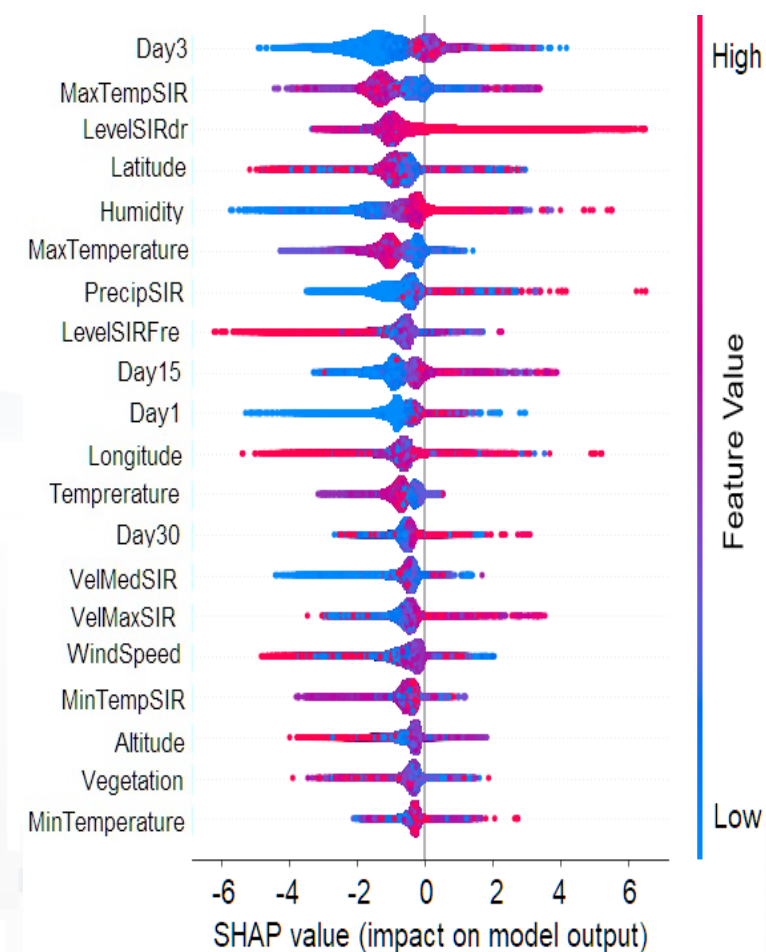
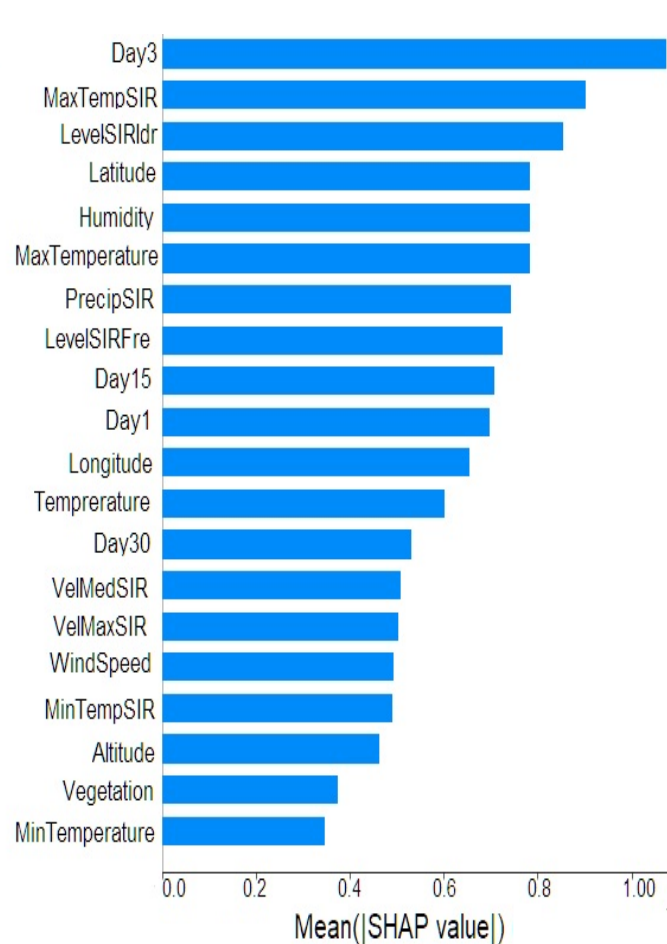


Predicting Land slides



Comparing Predictive Model/architectures

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



Global Explainable AI
- Feature relevance

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

Local Explainable AI - understanding the single event

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



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



UNIVERSITÀ
DEGLI STUDI
FIRENZE

DINFO
DIPARTIMENTO DI
INGEGNERIA
DELL'INFORMAZIONE

DISIT
DISTRIBUTED SYSTEMS
AND INTERNET
TECHNOLOGIES LAB



Human Behaviour Monitoring/engagement

FOUNDING
MANAGING CITY
AND FLEXIBLE WEB
AND MOBILE APPS

SNAP4CITY FOR
BEGINNERS

SNAP4CITY
ARCHITECTURE AND
PROJECTS

SNAP4CITY
AND KM4CITY
PROJECTS

FROM CITY
DASHBOARD TO
APPLICATIONS

SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS



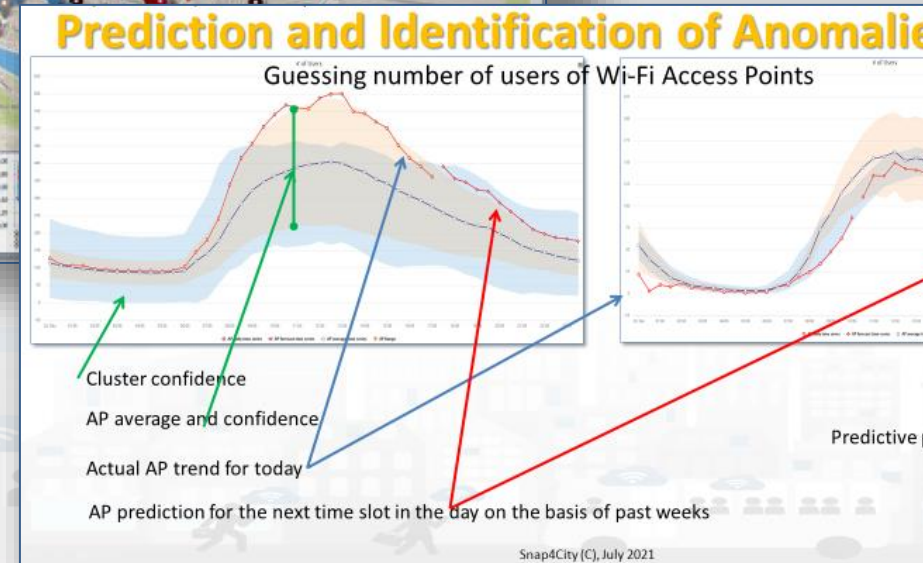
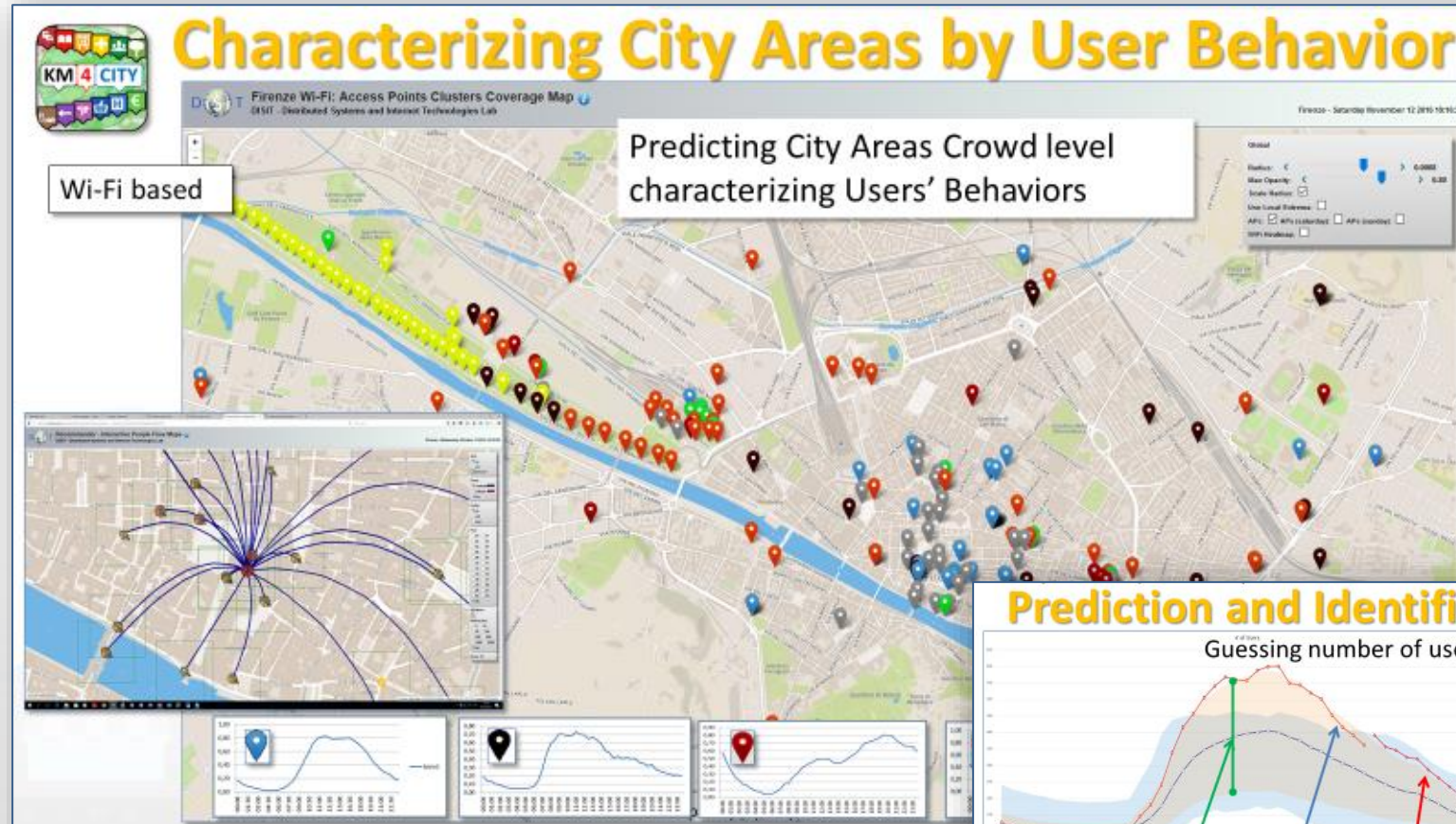
City User Behaviour/services, Tourism and Safety (2024/8)

- **Goals:**
 - Quality of Life, quality of services, over tourism mitigation, sustainability
 - Costs reduction of services
 - Accessibility to services: citizens, Tourists, commuters, etc.
 - Security/Safety of city users
- **Solutions for Operation (monitoring, managing, mobile apps, digital signages, control rooms)**
 - Monitoring services: tickets, reputation, usages, areas, etc.
 - Monitoring user behaviour (counting, trajectories): indoor/outdoor, hot places/services, ports, beaches,
 - Computing: origin destination, trajectories, travel means, etc.
 - Early detection/warning of critical conditions, connection with Video Management Systems
 - Managing entrances in city areas: restricted areas, touristic busses, etc.
 - Production of info-tourism, recommendations, nudging to city users and operators, second offer promotion
 - Providing Virtual Assistants for City Services, Tourist Offices, etc.
 - Monitoring reputation of services via: social media, blogs, etc.
 - Collecting complains, requests, participations from City users via mobile apps
 - Computing predictions of any kind
- **Solutions for Planning (optimization and what-if analysis)**
 - Reduction of Pollutant Emissions, via optimization
 - Optimization plan to distribution of workload on multiple touristic offers/services, area cleaning, etc.
 - Predicting reputation of services, touristic and operative
- **Algorithms and computational solutions, see next slide**

City Users Behaviour, Safety, Security and Social Analysis (2024/8)

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

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



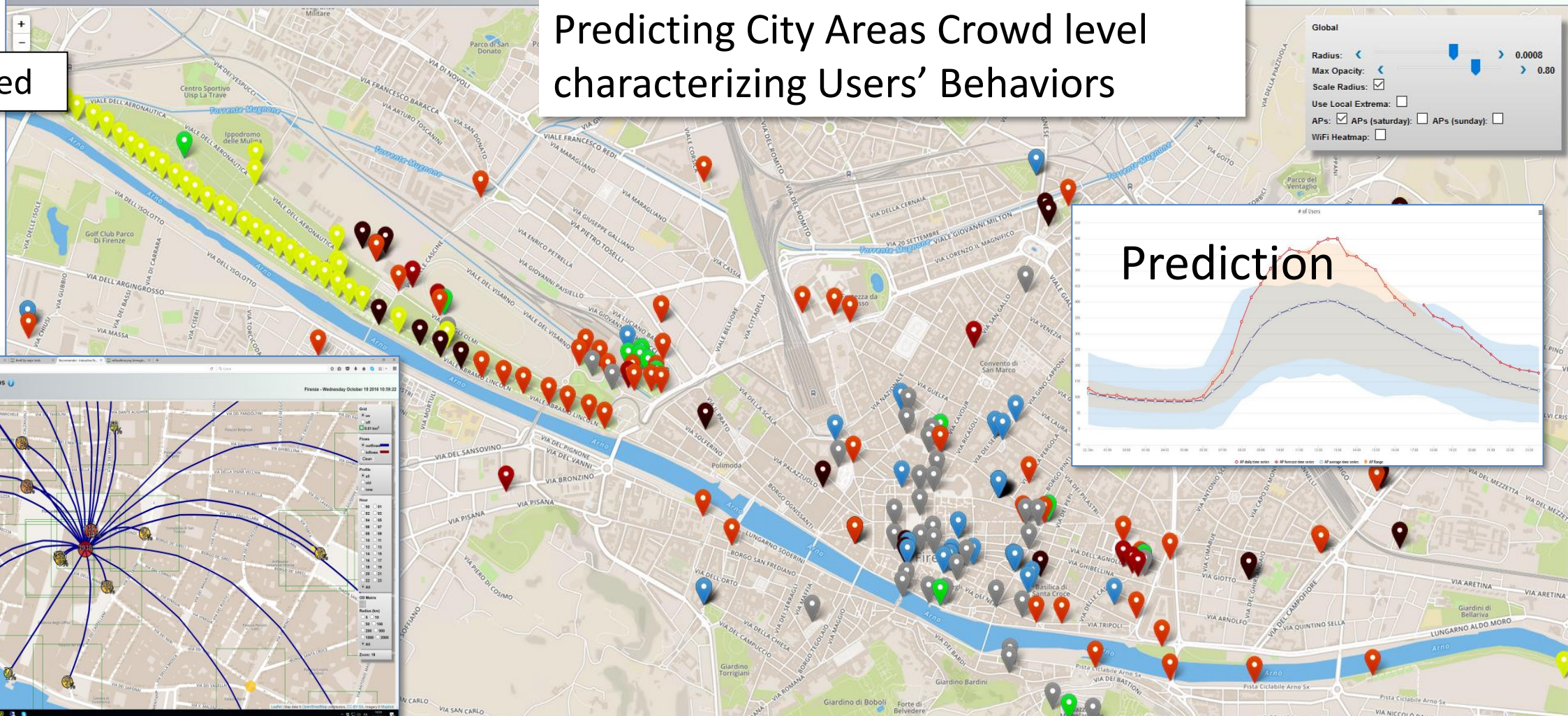
Characterizing City Areas

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

Firenze - Saturday November 12 2016 19:16:33

Wi-Fi based

Predicting City Areas Crowd level characterizing Users' Behaviors



Global

Radius: < 0.0008 >

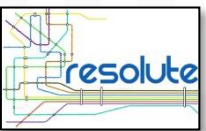
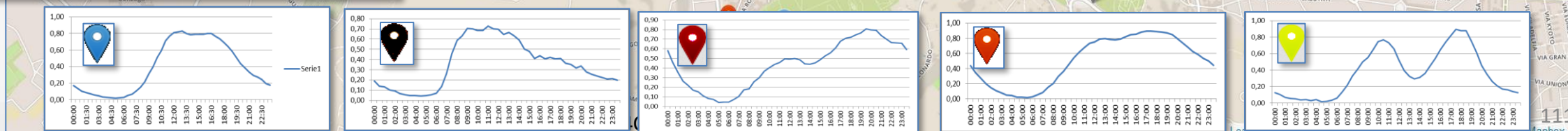
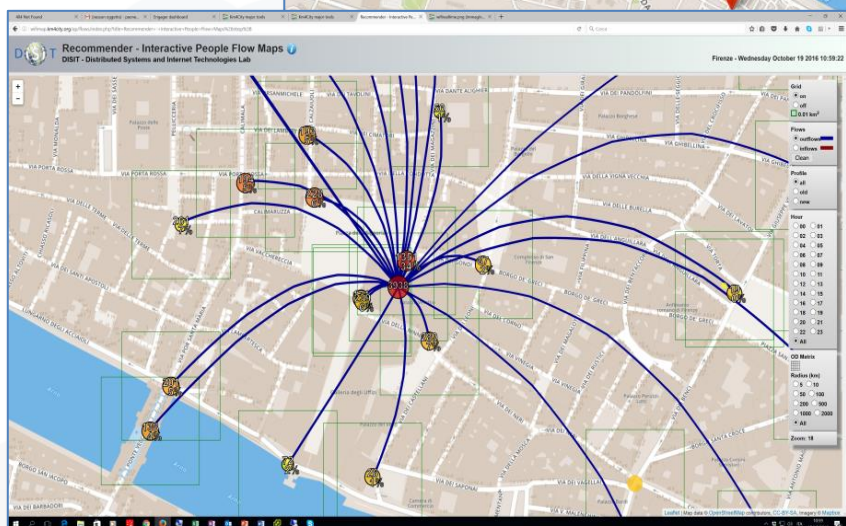
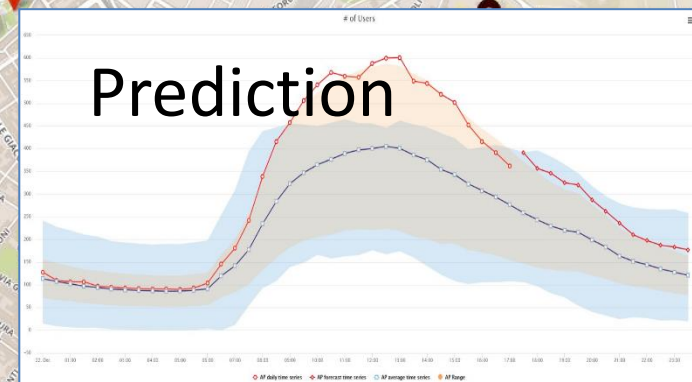
Max Opacity: < > 0.80

Scale Radius:

Use Local Extrema:

APs: APs (saturday) APs (sunday)

WiFi Heatmap:



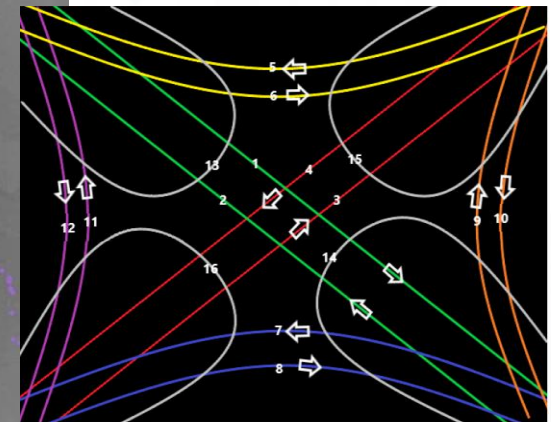
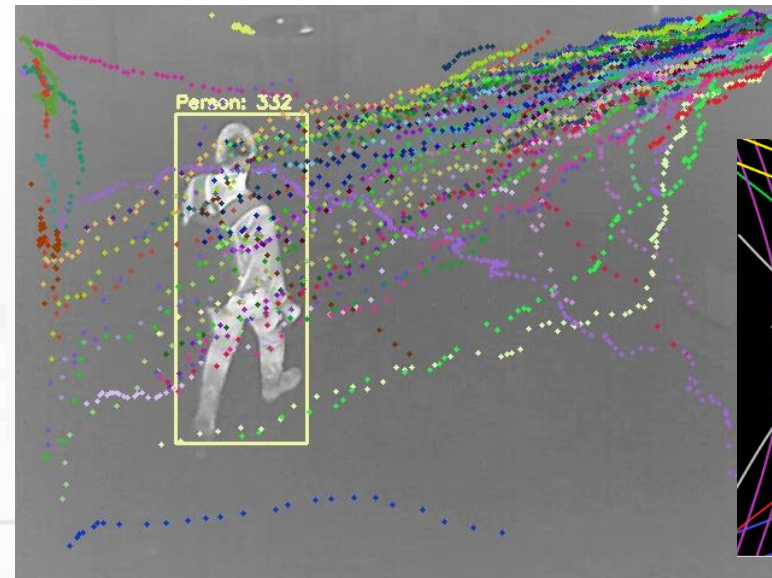


A view and data from the Thermal Camera

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



People Counting and Tracking



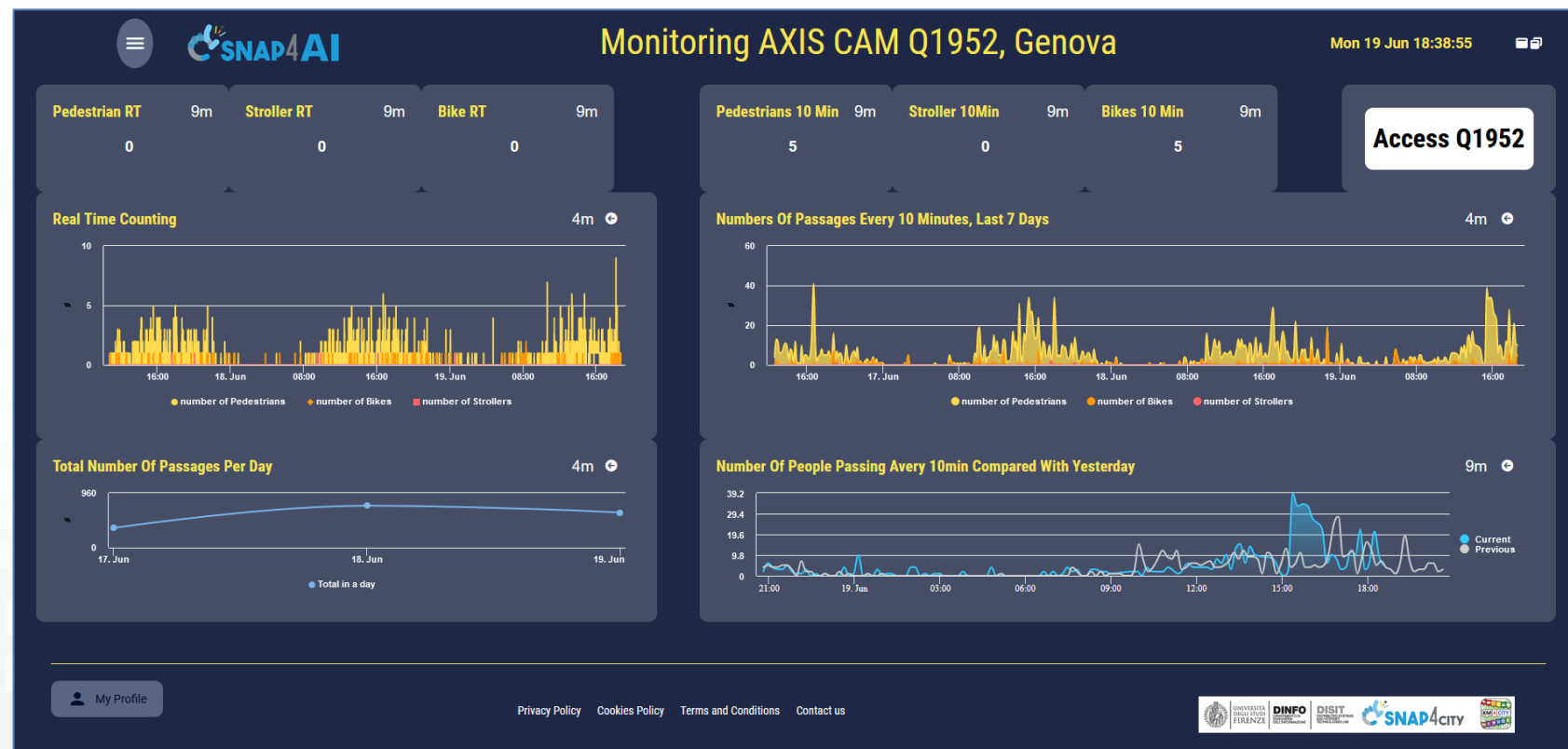
11 SUSTAINABLE CITIES
AND COMMUNITIES

3X



Monitoring Passages AXIS Q1952

- Genova: Ocean Race, 2023



11 SUSTAINABLE CITIES
AND COMMUNITIES



Valencia, FSMLR

- **Tourism Domain**

- Counting People
- Environmental data
- Social Media

- **Dashboards**

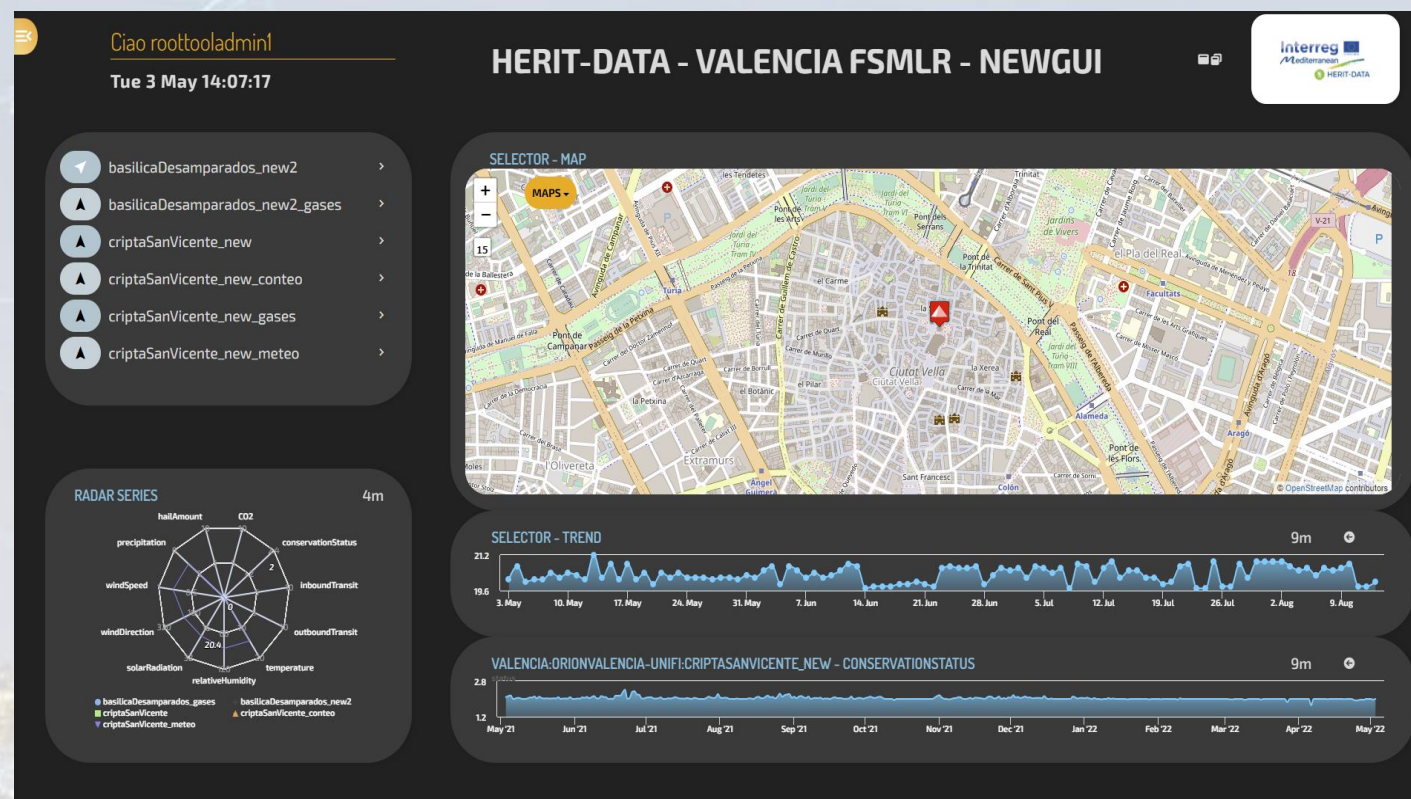
- Monitoring and real time control
- People flow
- Twitter Vigilance

- **Historical and Real Time data**

- **Services Exploited on:**

- Dashboard

- **Since 2020**



<https://www.snap4city.org/dashboardSmartCity/view/index.php?iddashboard=MzE1MA==>

Event Management

App Maps Google Gmail Snap4City Snap4 Calendar Translate Google Scholar Cita... DISIT DISIT old Facebook DataCenter Trello Km4City major tools Impostazioni YouTube Google Forms News Tutti i preferiti

Event Registration Tue 31 Oct 23:14:19

Severity

Status

[Reset](#) [Reset Map](#) [Filter](#)

Cameras >

Hospital >

Traffic Flow >

Weather >

EventWebCam

Insert Alarm Data

Name

Kind

Severity

People Involved

Impact

Description

Event Description

Creating Event

[Clear](#) [Register Event](#) [Refresh](#)

Show **Search:**

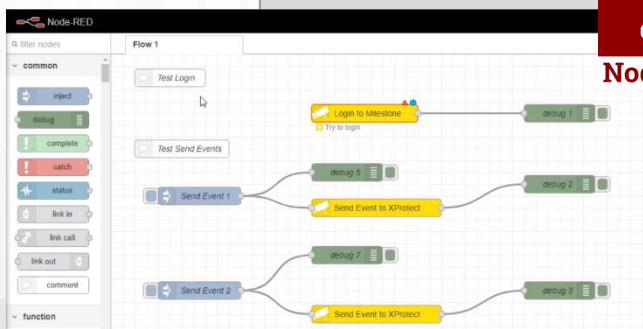
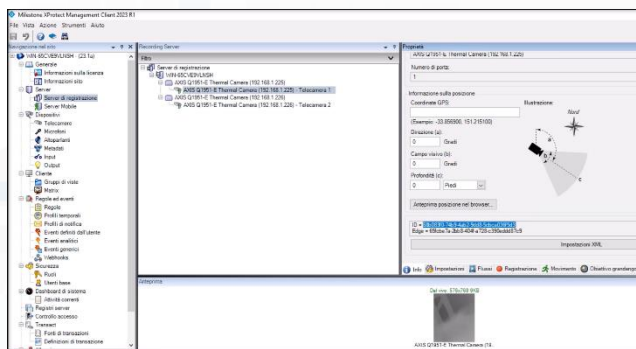
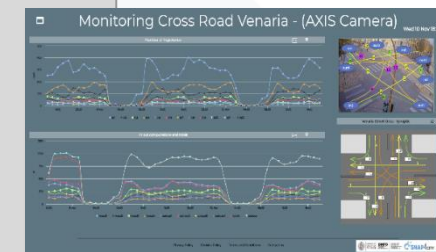
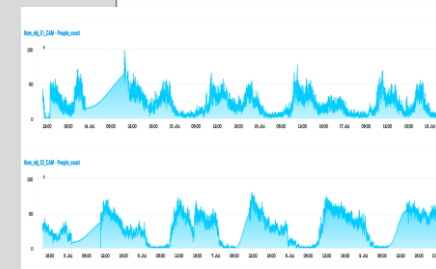
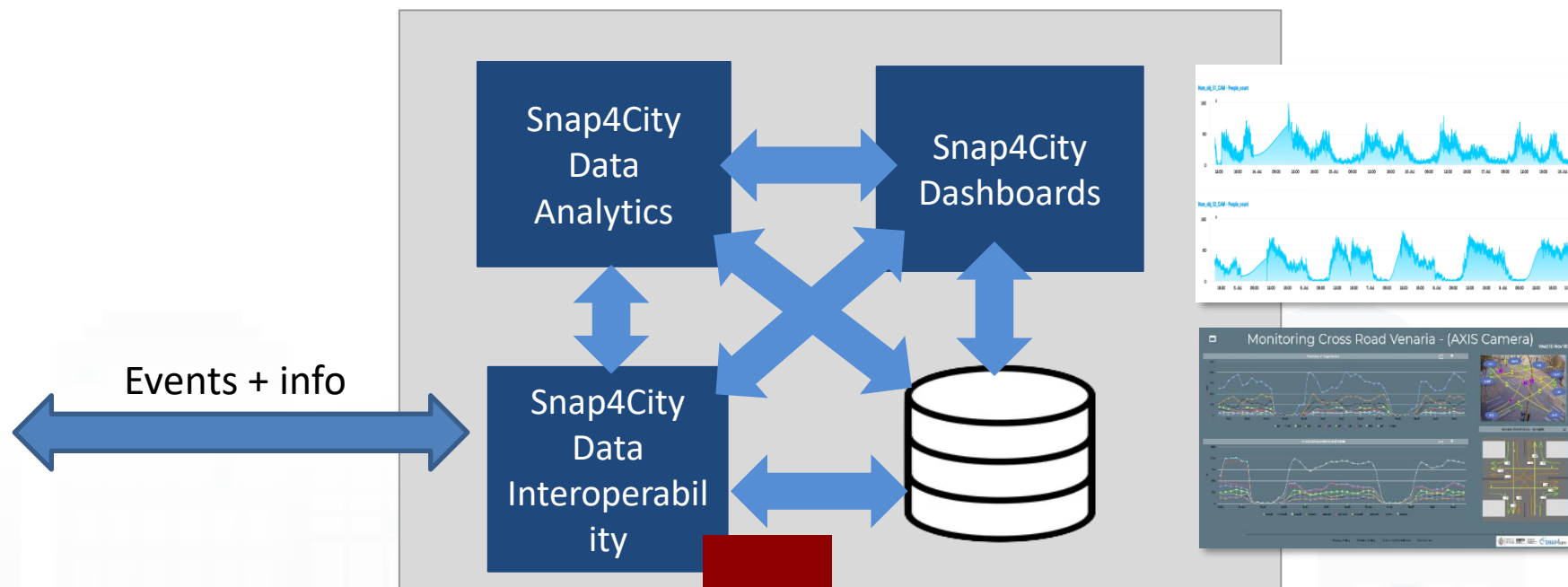
First << Prev 1 2 3 ... Next >> Last

device	Severity	dateObserved	status	Actions
fireonplazgardon20231031T221304273Z	Yellow	2023-10-31T22:13:04.273Z	init	
Telecamera4_22320231031T14213584Z	Yellow	2023-10-31T14:21:35.84Z	init	
CarCrash20231031T134436250Z	Orange	2023-10-31T13:44:36.250Z	init	
CriticalTrafficJam20231031T132718888Z	Red	2023-10-31T13:27:18.888Z	init	
FloodedRoad20231031T132309212Z	White	2023-10-31T13:23:09.212Z	init	

[My Profile](#)

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VMS vs Snap4City: sending and getting events, AI solutions



Engaging via Mobile Apps

FROM CITY
DASHBOARD TO
APPLICATIONS

DATA
AND KNOW
MAN

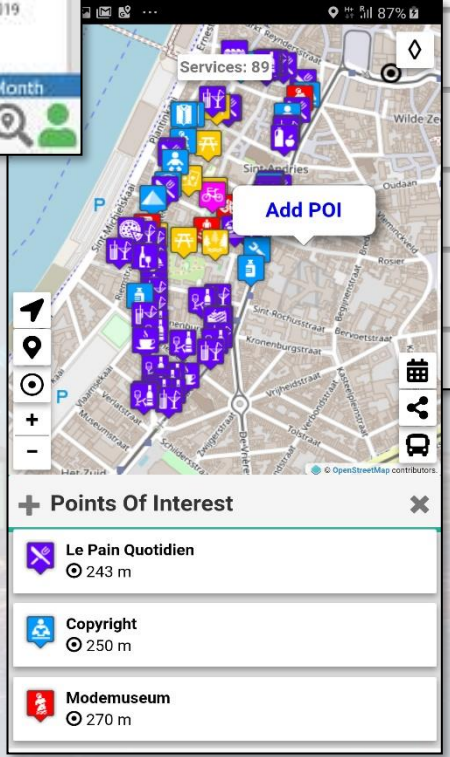
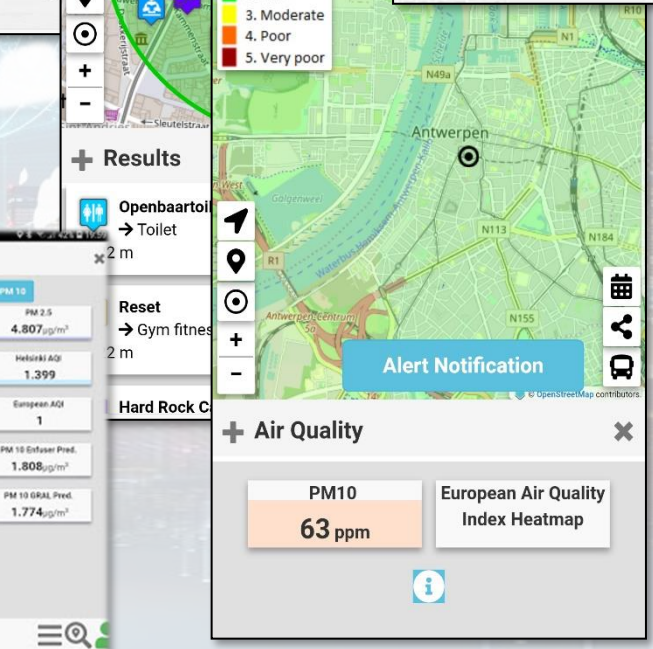
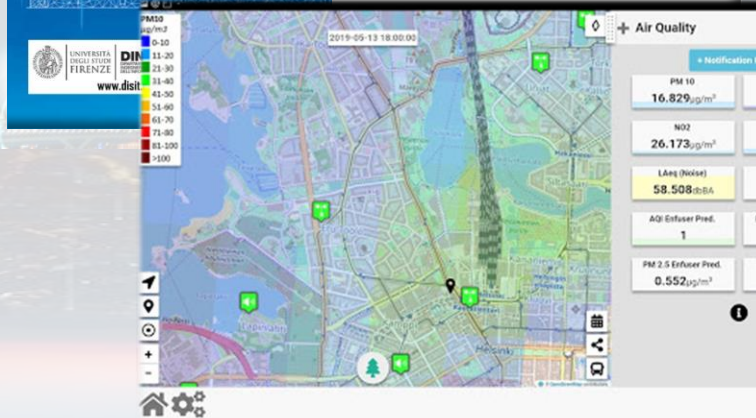
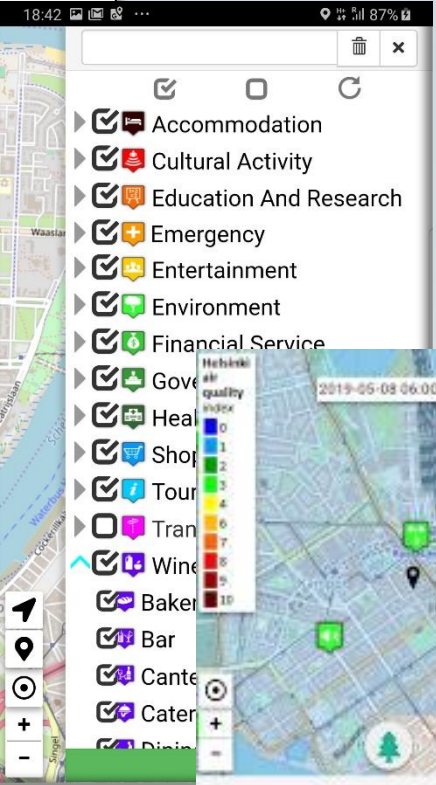
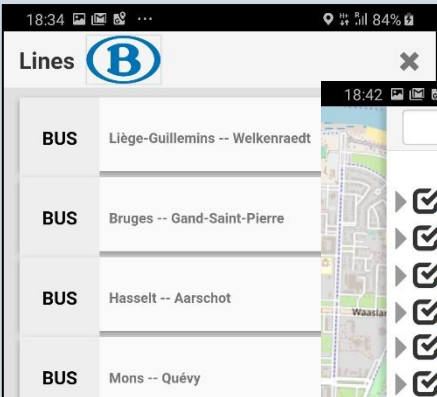
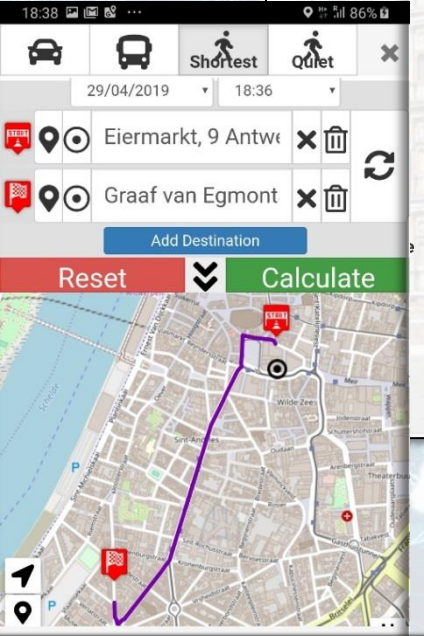
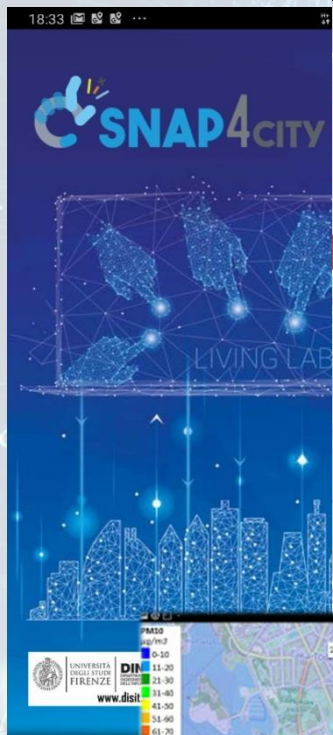
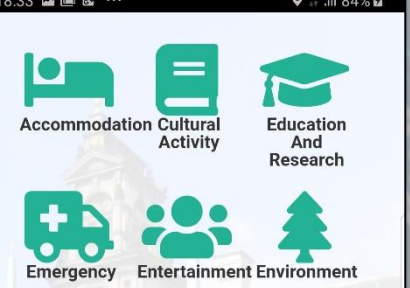


SNAP4CITY
AND KM4CITY
PROJECTS

TO ADOPT
SNAP4CITY, AND
ROADMAP

SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS





Citizen Engagement/Participation via Mobile Apps

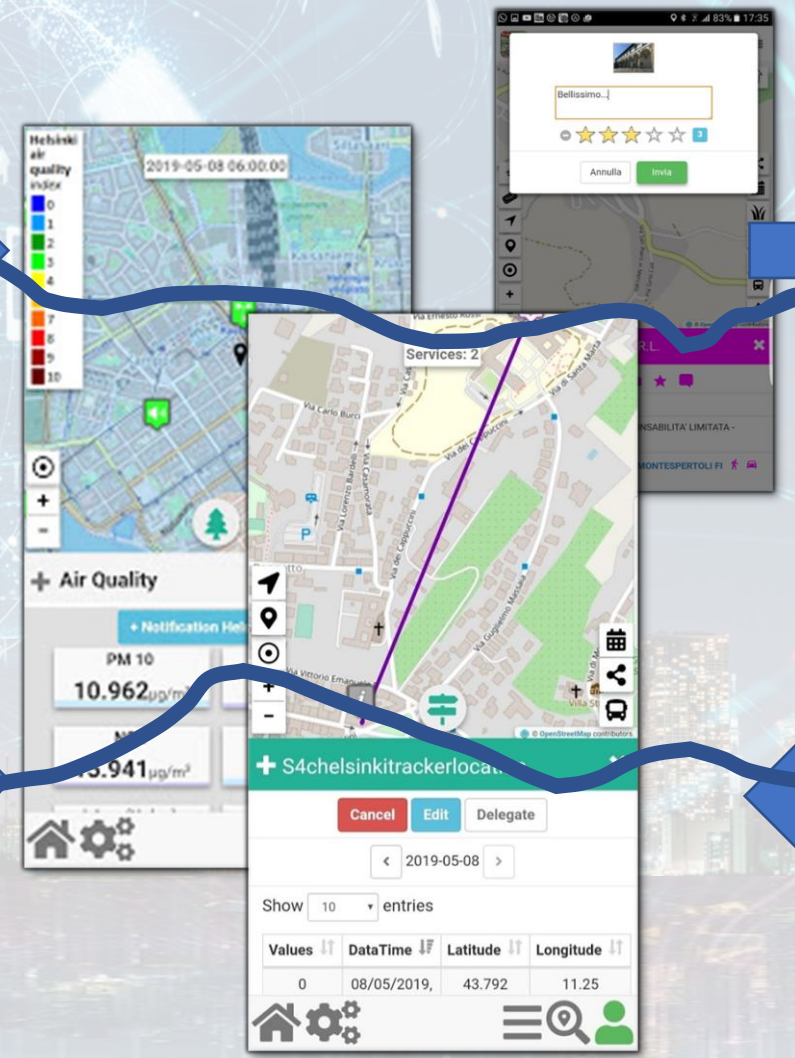
- GPS Positions
- Selections on menus
- Views of POI
- Access to Dashboards
- searched information
- Routing
- Ranks, votes
- Comments
- Images
- Subscriptions to notifications
-

Produced information

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

Users

Snap4City (C), August 2024



Derived information

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

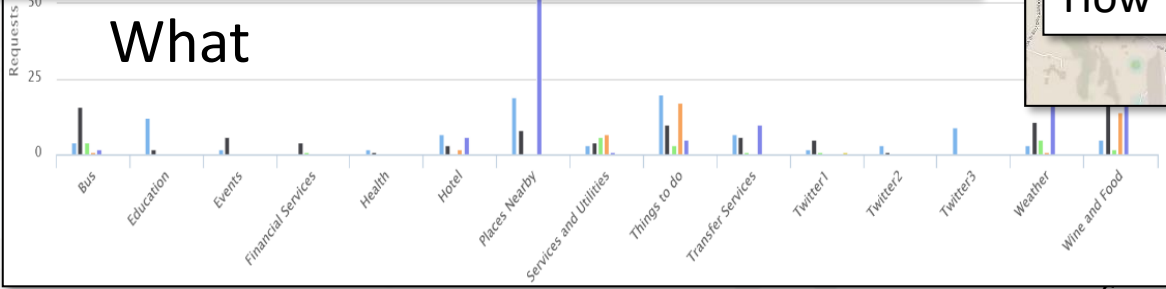
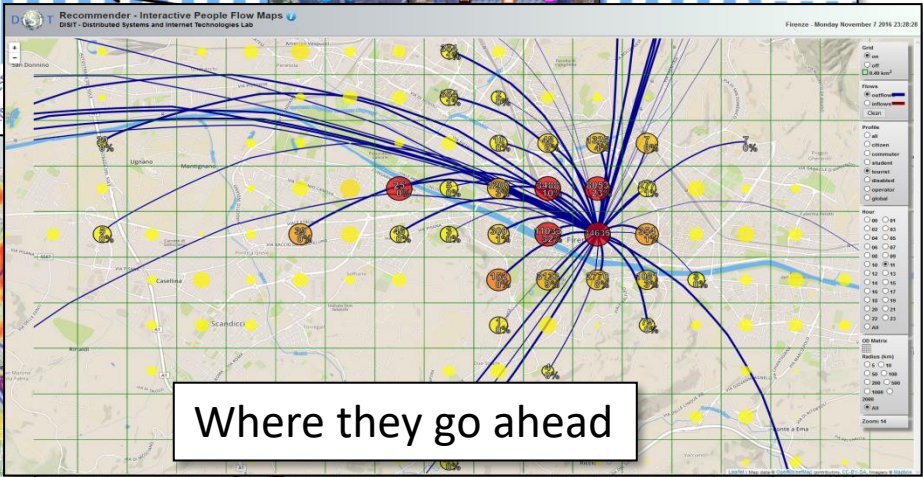
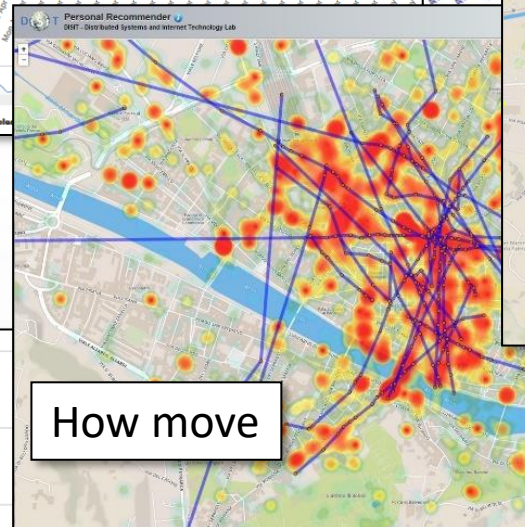
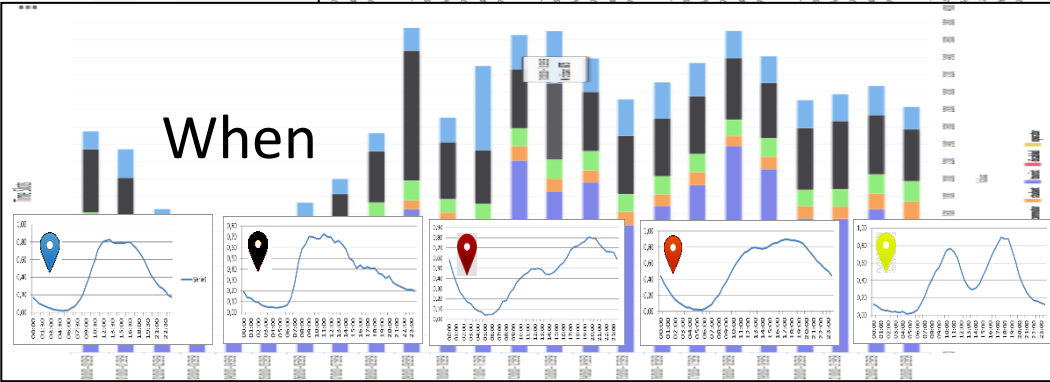
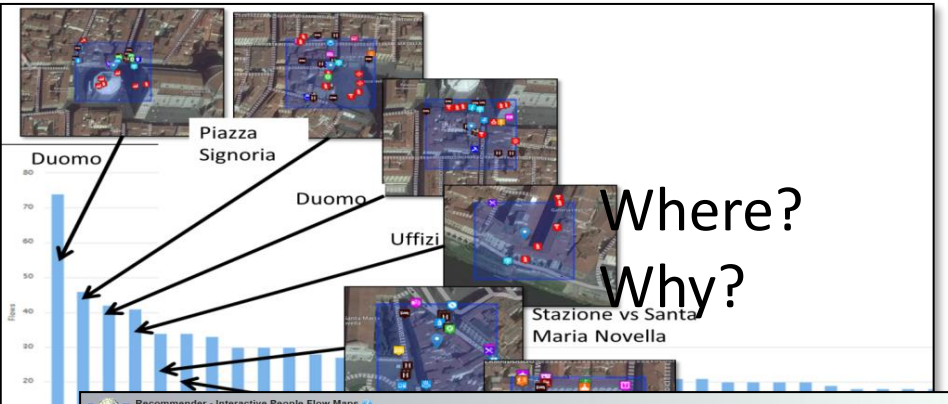
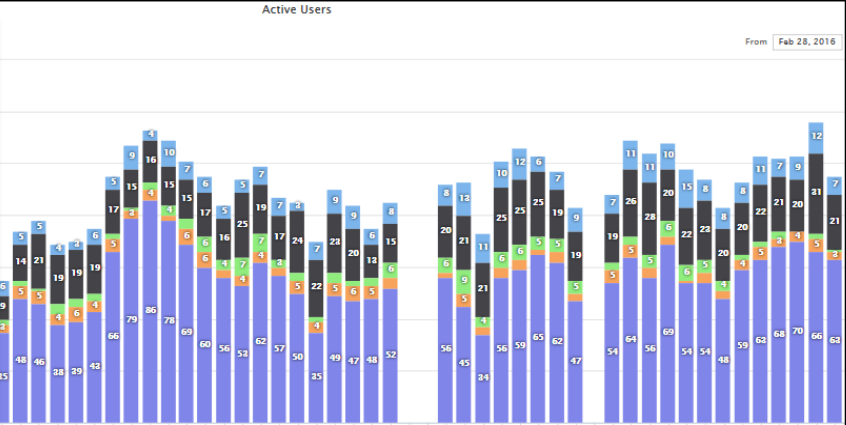
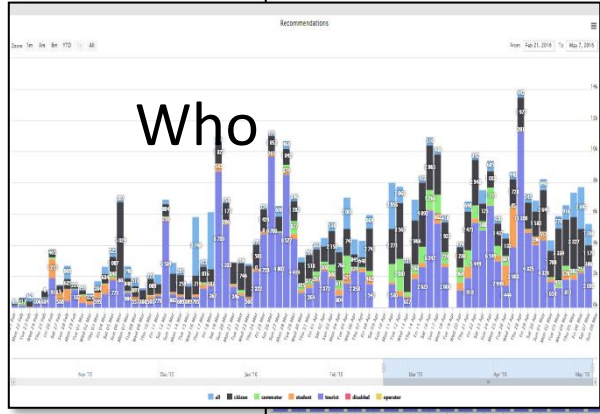


Produced information

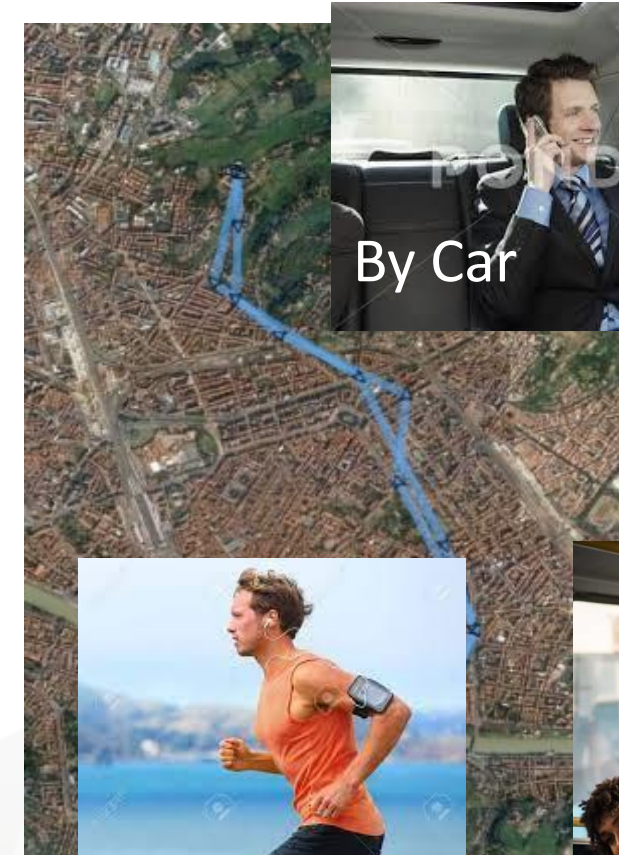
- Suggestions
- Engagements
- Notifications
- ...

System

User Behavior Analyser for Collective Profiling



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



By Car



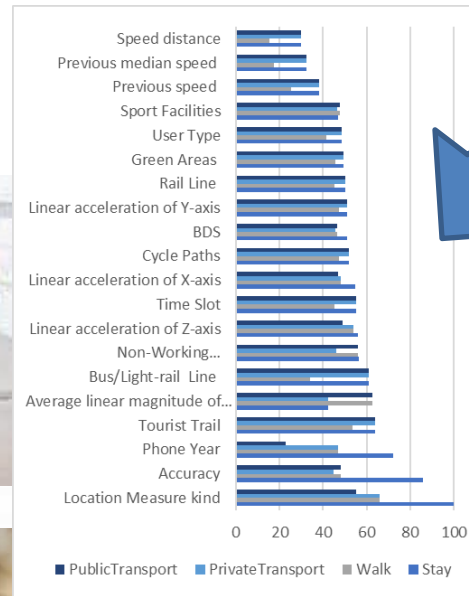
Walk



By BUS

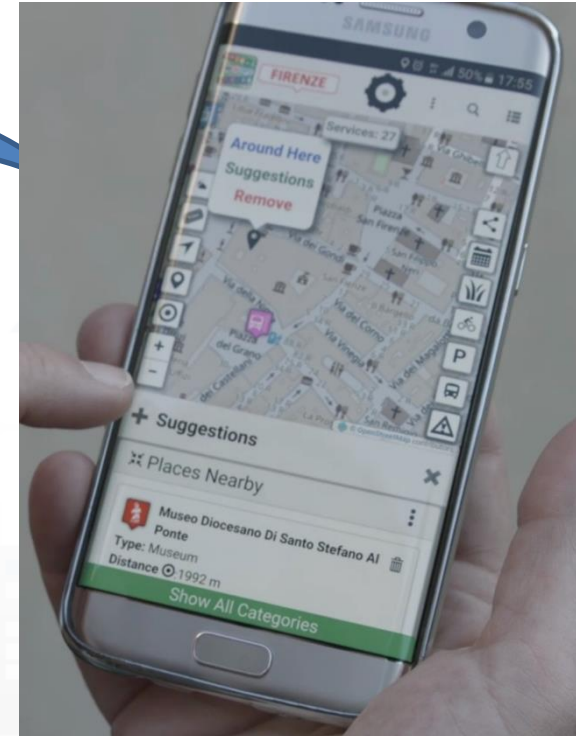


Run



Artificial Intelligence
Classification

Suggestions



Decision Support System:

TOP

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

TWITTER
VIGILANCE SOCIAL
MEDIA ANALYSIS

FROM CITY
DASHBOARD TO
APPLICATIONS

FORGING &
MANAGING OPEN
PUBLIC SPACES

SNAP4CITY
FORUMS

SNAP4CITY
ARCHITECTURE AND

SNAP4CITY
AND KM4CITY
PROJECTS



NAP4CITY THE
VIEW OF THE
ADMINISTRATORS

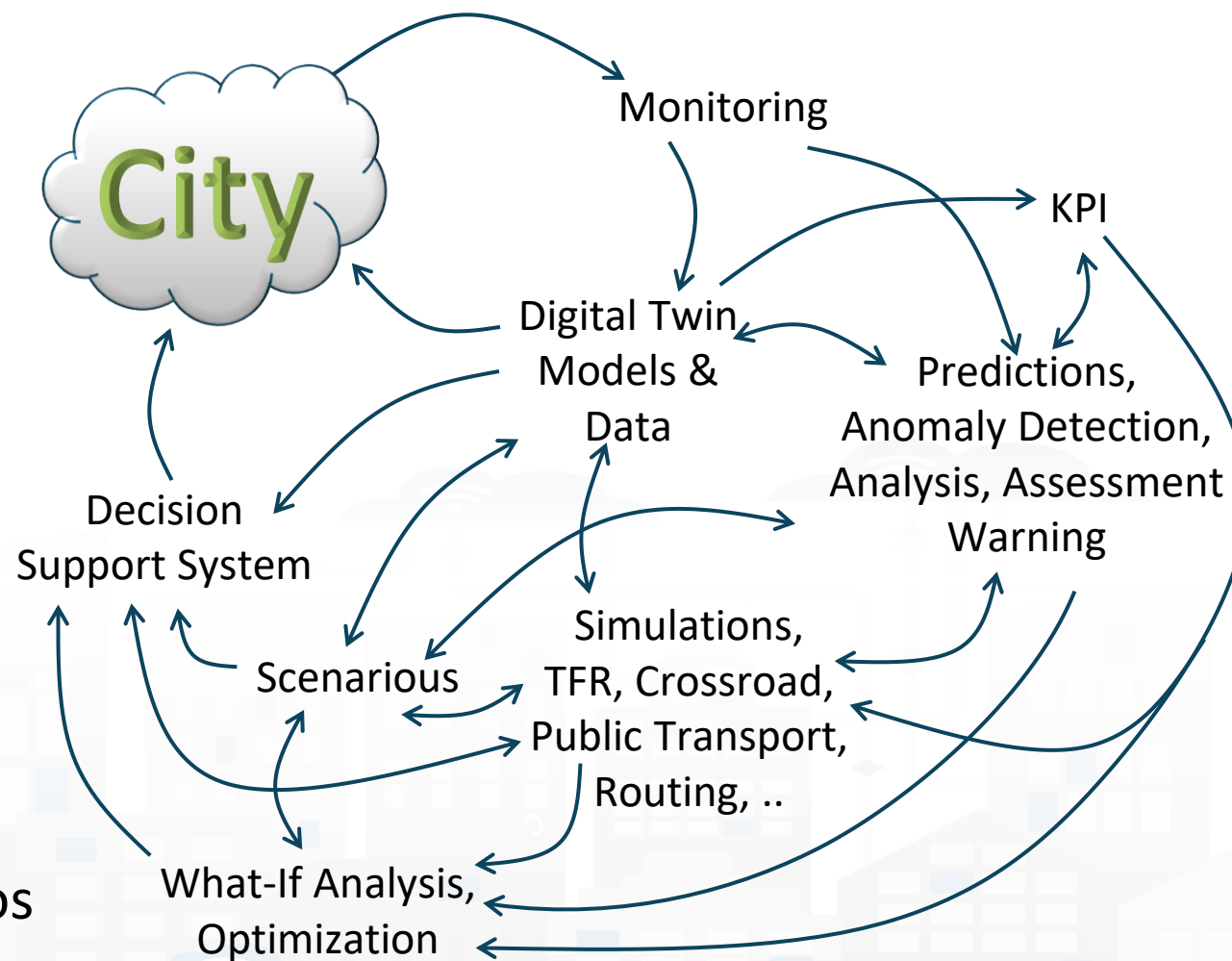


- **Controlling Status: management, and operational**

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

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

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



Key Performance Indicators, KPI



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

Global
&
Local

Periodic
&
Realtime

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



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



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



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



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



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



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



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

Data Analytic Artificial Intelligence, XAI, Machine and Deep Learning

FORGING &
MANAGING OPEN
AND FLEXIBLE WEB
AND MOBILE APPS

FROM CITY
DASHBOARD TO
APPLICATIONS

SNAP4CITY FOR
BEGINNERS

SNAP4CITY
ARCHITECTURE AND
ECOSYSTEM, HOW
TO DEVELOP AND
STAKEHOLDERS

TWITTER
VIGILANCE: SOCIAL
MEDIA ANALYSIS

SNAP4CITY
AND KM4CITY
PROJECTS

IOT/IIOT DEVICES
AND NETWORKS

DATA ANALYTICS,
BUSINESS
INTELLIGENCE
WHAT-IF
SCENARIO TO

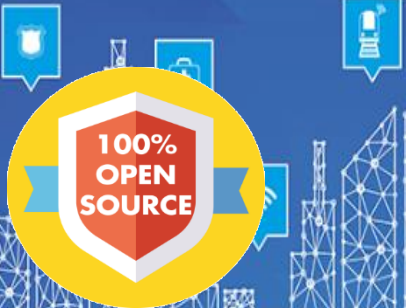
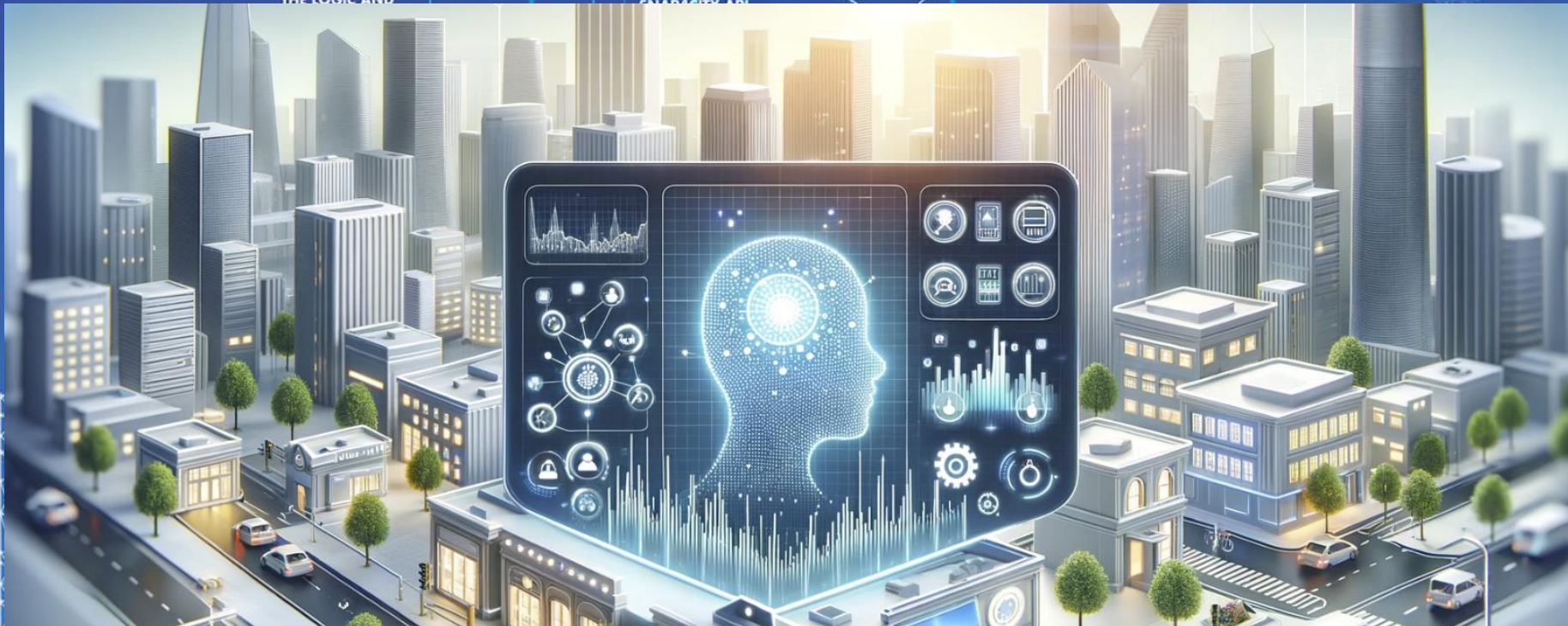
HOW TO ADOPT
SNAP4CITY AND
FOR ADIOP

DECISION SUPPORT
SYSTEMS AND CITY
RESILIENCE

SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS

IOT APPLICATIONS,
THE LOGIC AND

ADVANCED
SMART CITY API,
MICROSERVICES,
SNAP4CITY API





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



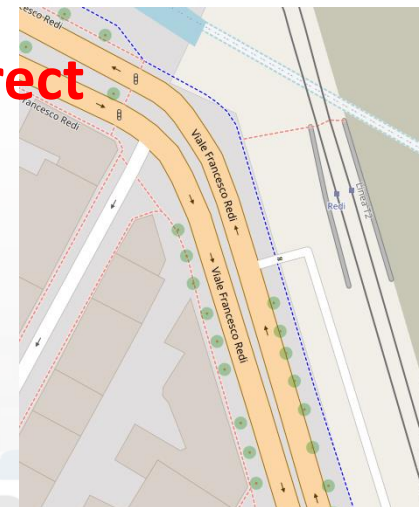
https://www.snap4city.org/download/video/DPL_SNAP4SOLU.pdf

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

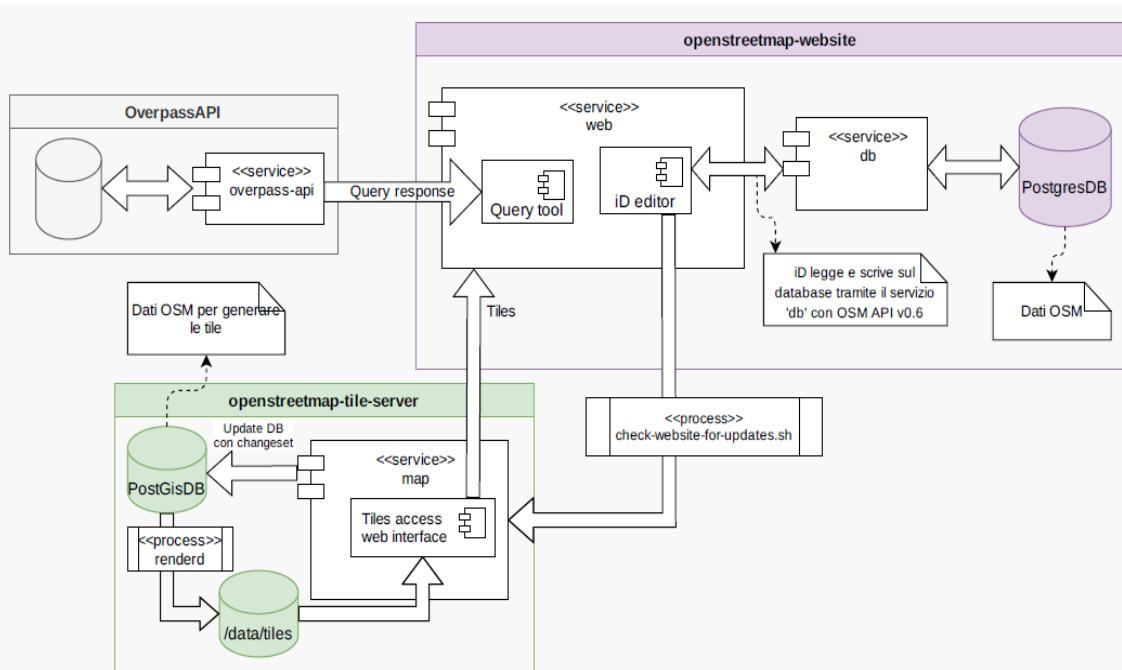
Correcting road graphs from OSM



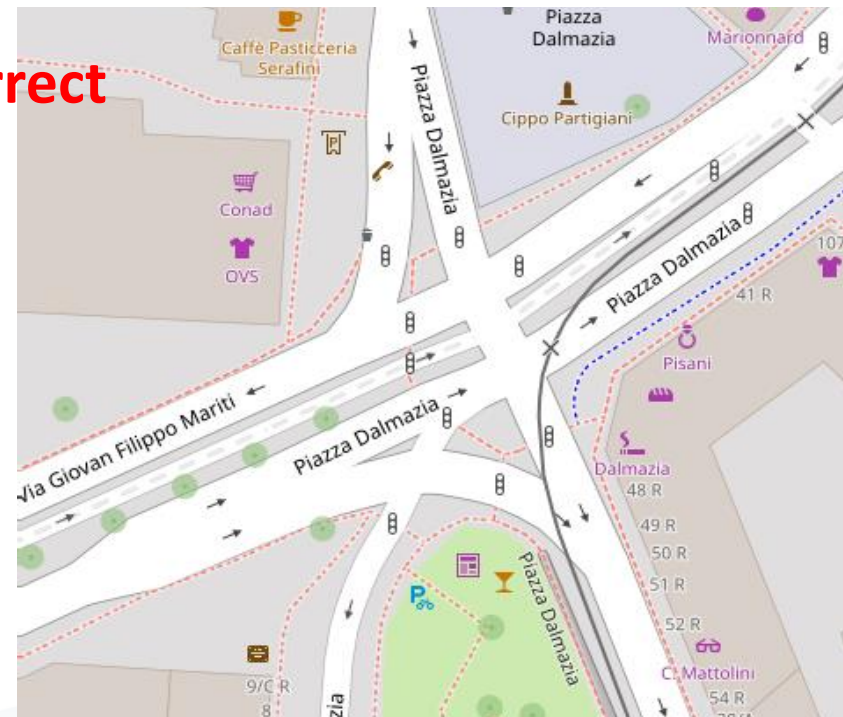
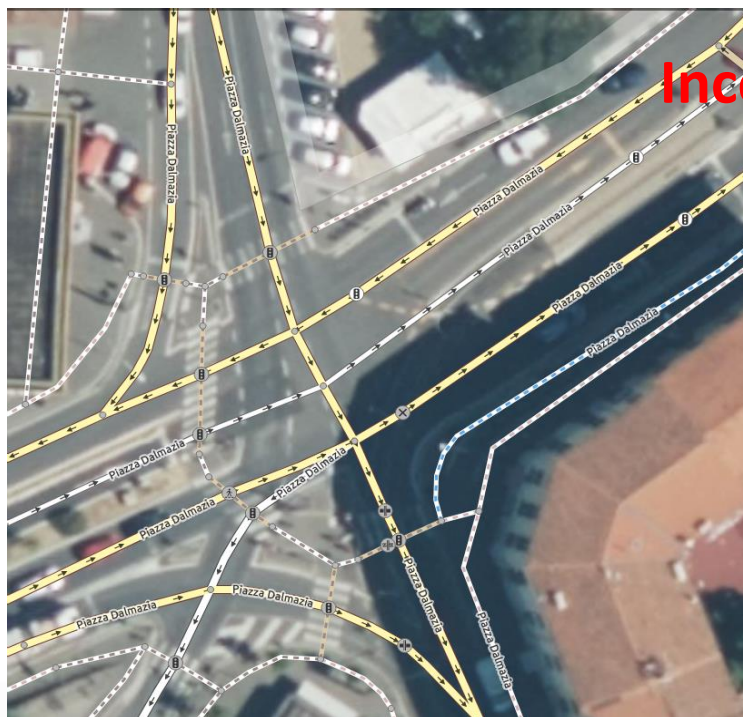
OSM data with non clear double bidirection lane on Viale Redi, Florence.
Editing OSM data and present Tiles



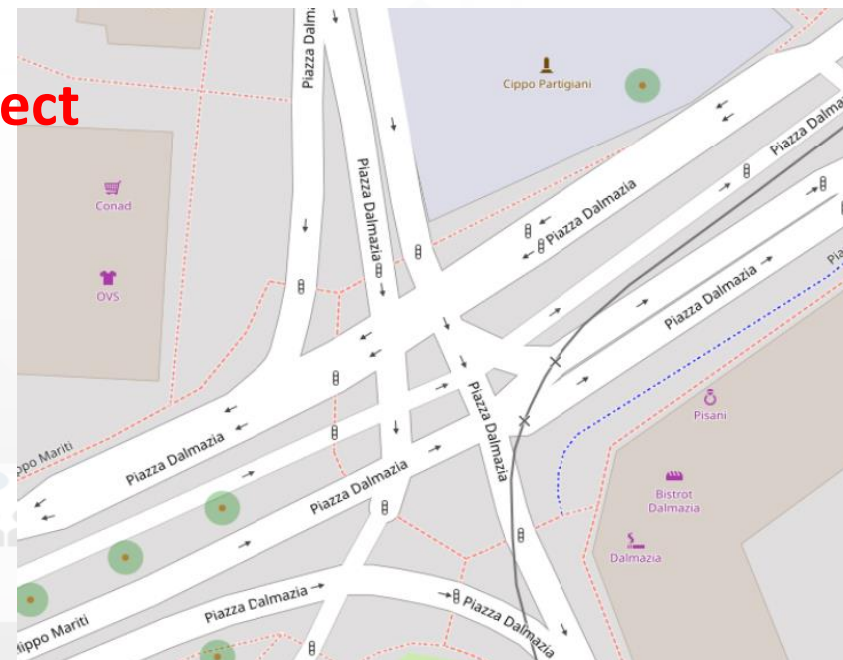
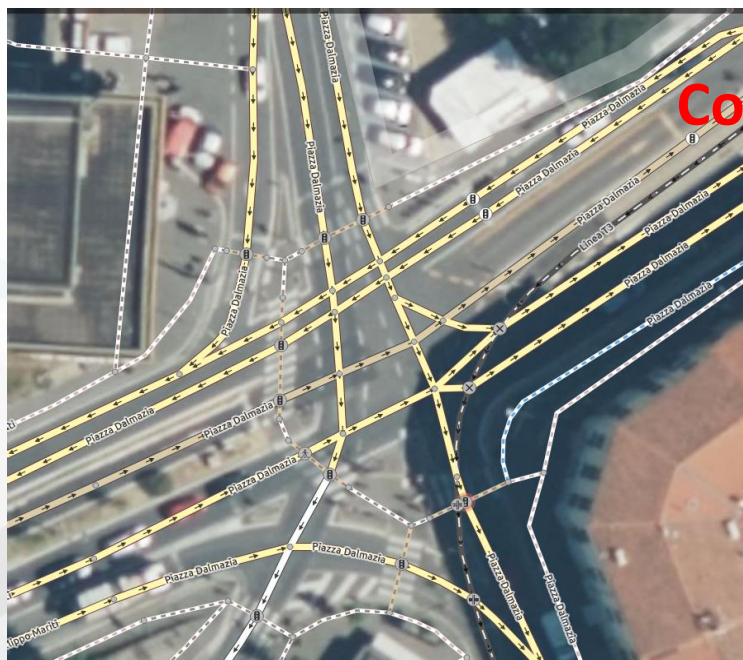
After Corretion of OSM data defining a clear double bidirection lane on Viale Redi, Florence.
Regeneration of the TILES for the maps



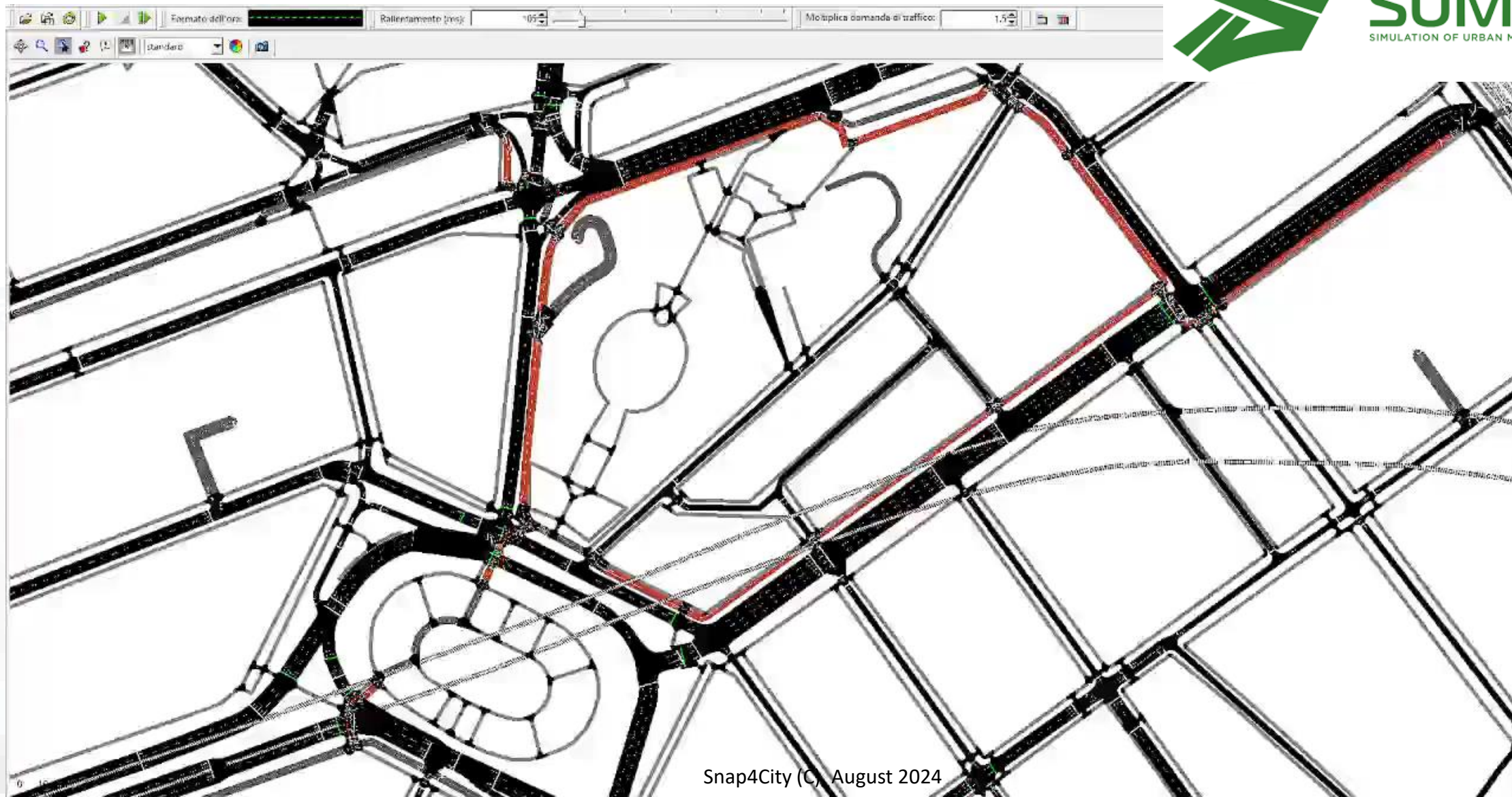
OSM data with non correct viability in Piazza Dalmazia, Firenze



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



Micro Simulation



Select map

Zoom

The screenshot shows the Scenario Editor interface. On the left, there are controls for 'Select map' and 'Zoom'. The main area displays a map with various road segments, some highlighted in blue and green. A 'New Scenario' dialog is open, allowing users to edit road segments. Below the map, there is a 'Road Types' list with checkboxes for various road categories. On the right, a 'Properties of Road Elements' table lists various attributes for road segments.

Scenario name:

Location:

Scenario description:

ReferenceKB:

Save Road Graph: ▾

Save traffic Sensors: ▾

Save other Sensors: ▾

From:

To:

Edit Road Segment

Category Street: ▾

Nr.Lanes:

Speed Limit (km/h):

Direction: ▾

Restrictions: ▾

- Road Types:
- | | | | | |
|--|---|--|--|---|
| <input checked="" type="checkbox"/> abandoned | <input checked="" type="checkbox"/> brideway | <input checked="" type="checkbox"/> bus_guideway | <input checked="" type="checkbox"/> bus_stop | <input checked="" type="checkbox"/> construction |
| <input checked="" type="checkbox"/> corridor | <input checked="" type="checkbox"/> crossing | <input checked="" type="checkbox"/> cycleway | <input checked="" type="checkbox"/> disused | <input checked="" type="checkbox"/> elevator |
| <input checked="" type="checkbox"/> emergency_access_point | <input checked="" type="checkbox"/> emergency_bay | <input checked="" type="checkbox"/> footway | <input checked="" type="checkbox"/> island | <input checked="" type="checkbox"/> living_street |
| <input checked="" type="checkbox"/> motorway | <input checked="" type="checkbox"/> motorway_link | <input checked="" type="checkbox"/> no | <input checked="" type="checkbox"/> path | <input checked="" type="checkbox"/> platform |
| <input checked="" type="checkbox"/> primary | <input checked="" type="checkbox"/> primary_link | <input checked="" type="checkbox"/> private | <input checked="" type="checkbox"/> raceway | <input checked="" type="checkbox"/> razed |
| <input checked="" type="checkbox"/> residential | <input checked="" type="checkbox"/> rest_area | <input checked="" type="checkbox"/> road | <input checked="" type="checkbox"/> secondary_link | <input checked="" type="checkbox"/> service |
| <input checked="" type="checkbox"/> services | <input checked="" type="checkbox"/> steps | <input checked="" type="checkbox"/> tertiary | <input checked="" type="checkbox"/> tertiary_link | <input checked="" type="checkbox"/> track |
| <input checked="" type="checkbox"/> traffic_island | <input checked="" type="checkbox"/> tram | <input checked="" type="checkbox"/> trunk_link | <input checked="" type="checkbox"/> unclassified | <input checked="" type="checkbox"/> via_ferrata |
| <input checked="" type="checkbox"/> secondary | <input checked="" type="checkbox"/> yes | <input checked="" type="checkbox"/> pedestrian | <input checked="" type="checkbox"/> bus_guideway | <input checked="" type="checkbox"/> ohm:military:Trench |

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

New Scenario

Editing
Drag & drop
Split & Join
Delete
Do and Undo

ODM, Traffic Flow

ODM Origin Destination Matrices

Select or new

- Admin Areas
- Areas or grids
- Traffic Sensors
- Traffic Flow
- Traffic Flow Manager New

Map

Flow

0-2%
2-3%
3-4%
4-5%
5-6%
6-7%
7-8%
8-9%
9-10%
10-100%

Origin-Destination Map Controls:

- Show all polygons: ON
- Time period: week
- Precision: municipality
- Flow: outflow
- Max Opacity: 0.6
- 2022-07-07 00:00:00
- week

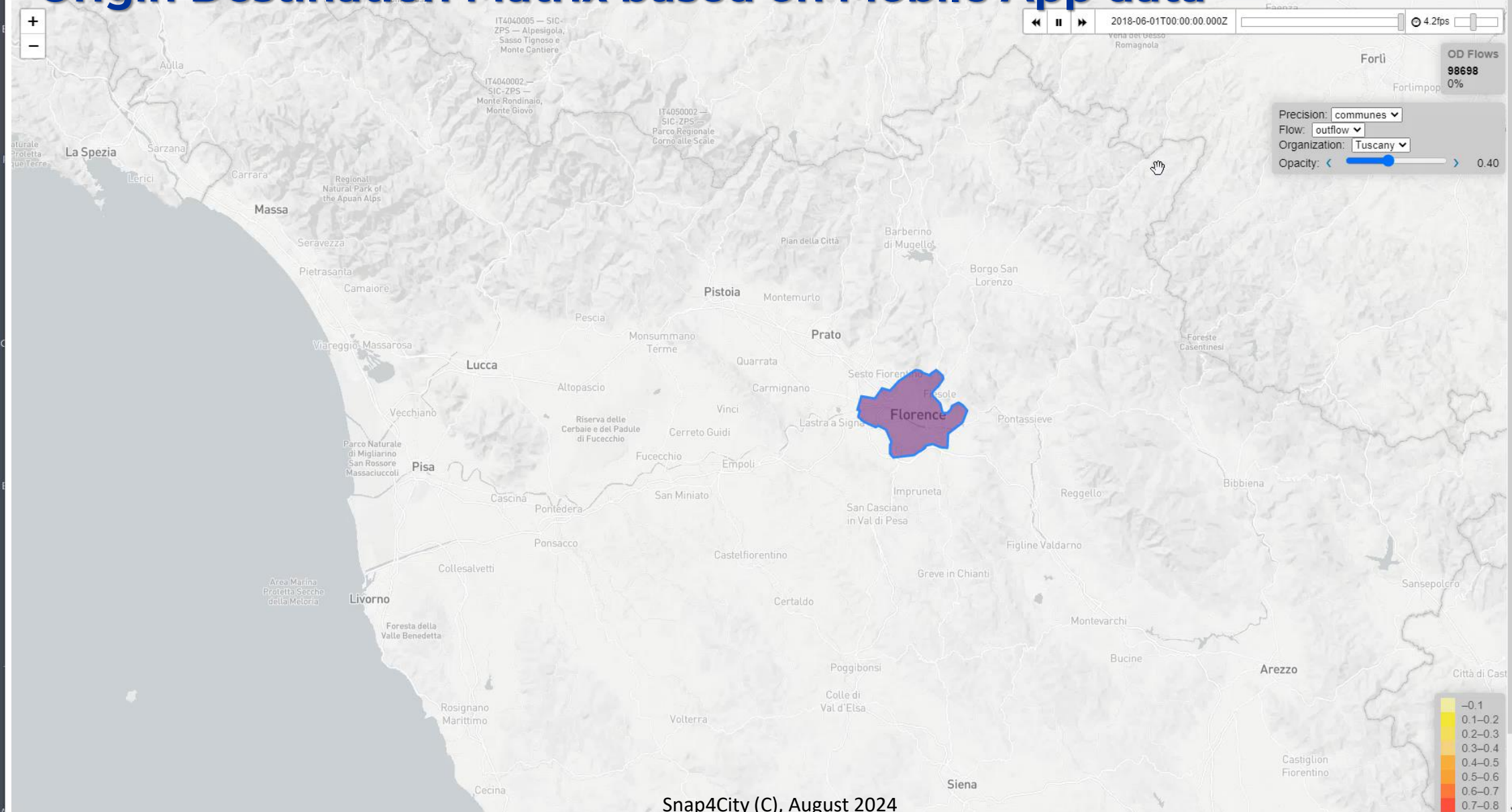
FirenzeFIPITrafficRealtime

Traffic Heatmap Controls:

- 24H
- Max Opacity: 1
- 2023-11-01 03:00:00

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

Origin Destination Matrix based on Mobile App data



Mobility and Transport Domain (2024/8)

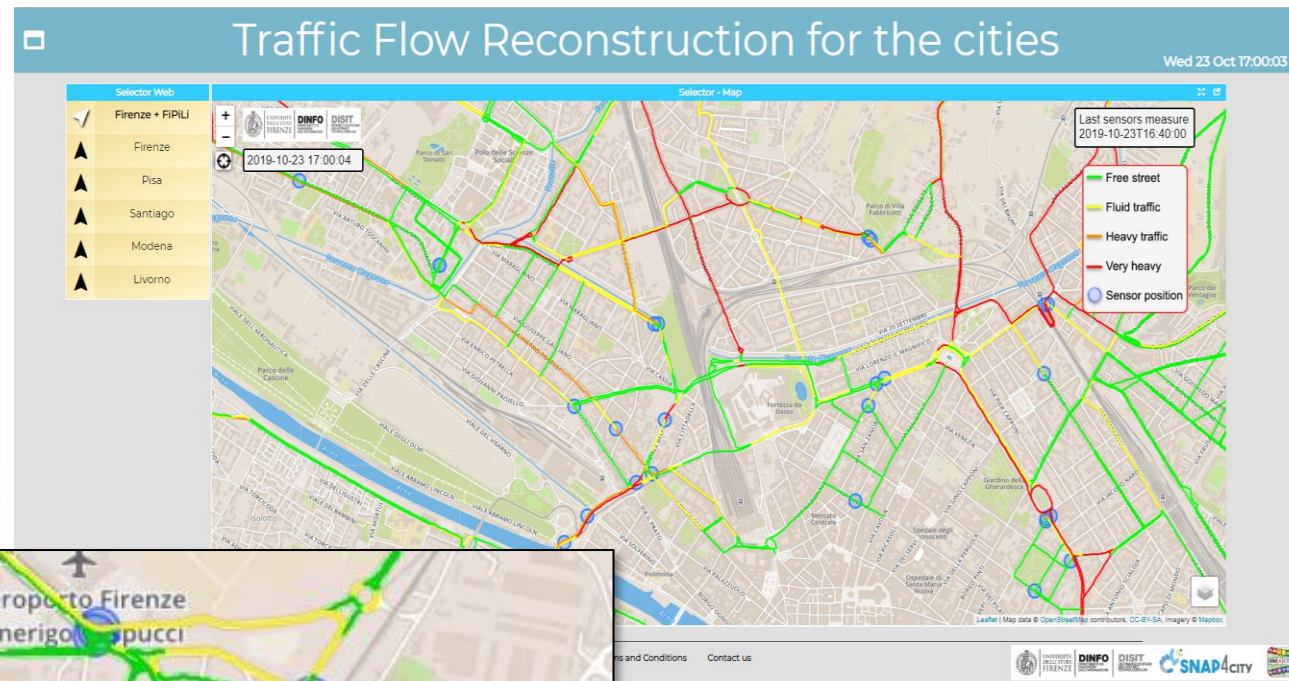
- **Goals:**
 - Decongestion
 - Decarbonization
 - Accessibility to services
 - Security/Safety of city users
- **Solutions for Operation (monitoring, managing, mobile apps, digital signages, control rooms)**
 - Monitoring traffic, parking, people flow, services, boats, ports, beaches, etc.
 - Early detection/warning of critical conditions: traffic, congestion, security/safety
 - Managing Smart Parking, transportation services, fines, etc.
 - Managing fleets: personal, sharing, waste collection, maintenance, etc.
 - Managing E-sharing, pooling services, MaaS, etc.
 - Managing entrances in city areas: restricted areas, touristic busses, etc.
 - Production of suggestions, recommendations, nudging
 - Computing predictions of any kind
- **Solutions for Planning (optimization and what-if analysis)**
 - Reduction of traffic congestion, via optimization: traffic light plans, viability, routing
 - Reduction of Pollutant Emissions, via optimization: traffic light plans, viability
 - Optimization of transportation offers wrt multimodal mobility demand
- **Algorithms and computational solutions, see next slide**

Tools for Mobility and Transport (2024/8)

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

Why 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



<https://www.snap4city.org/dashboardSmartCity/view/index.php?iddashboard=MTc5NQ==>

Decision Support Systems, What-if

○ Event planning, via what-if analysis

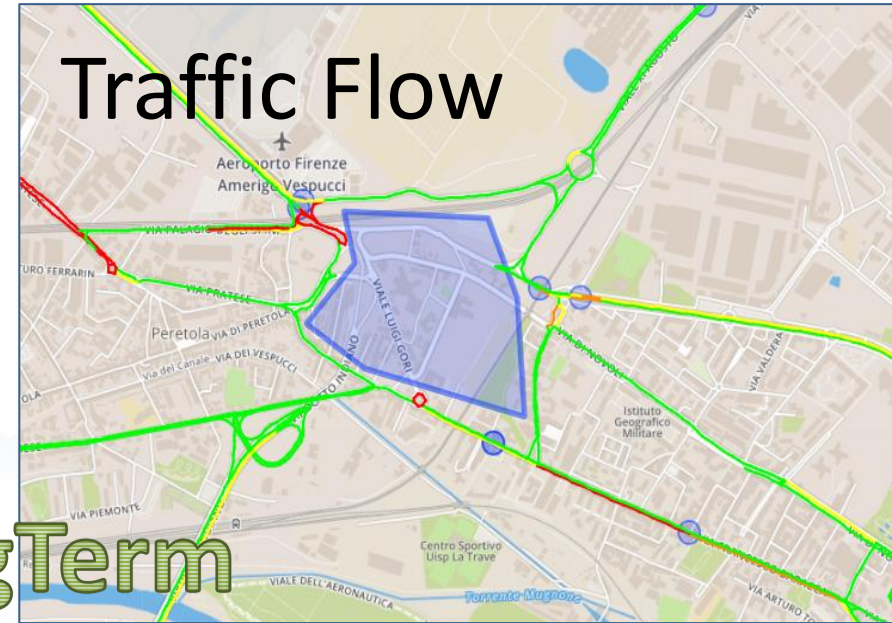
- Change in the graph structure of the city
- Impact on the flow of people and vehicles
- Adaptation: public transport, traffic, pedestrian management, etc.

○ Immediate reaction to natural events or not

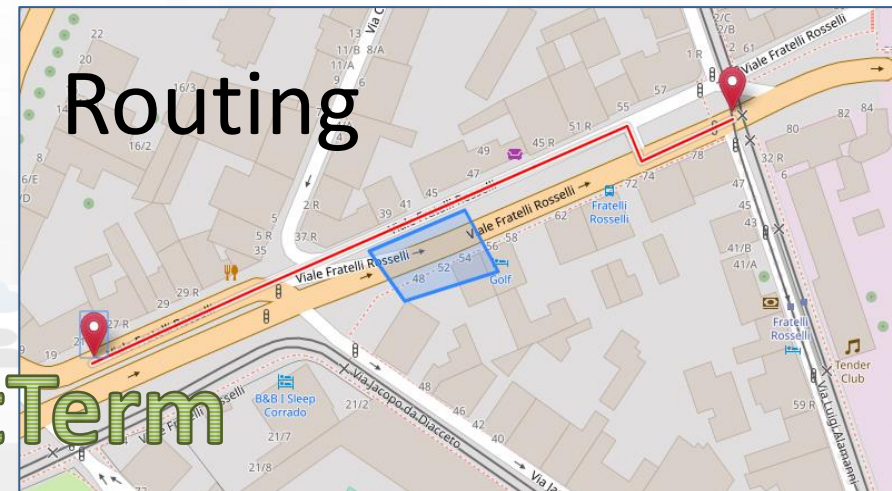
- Everything is ready and updated in real time
- Each view is contextualized in terms of data: descriptive and prescriptive

○ Digital Twin

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



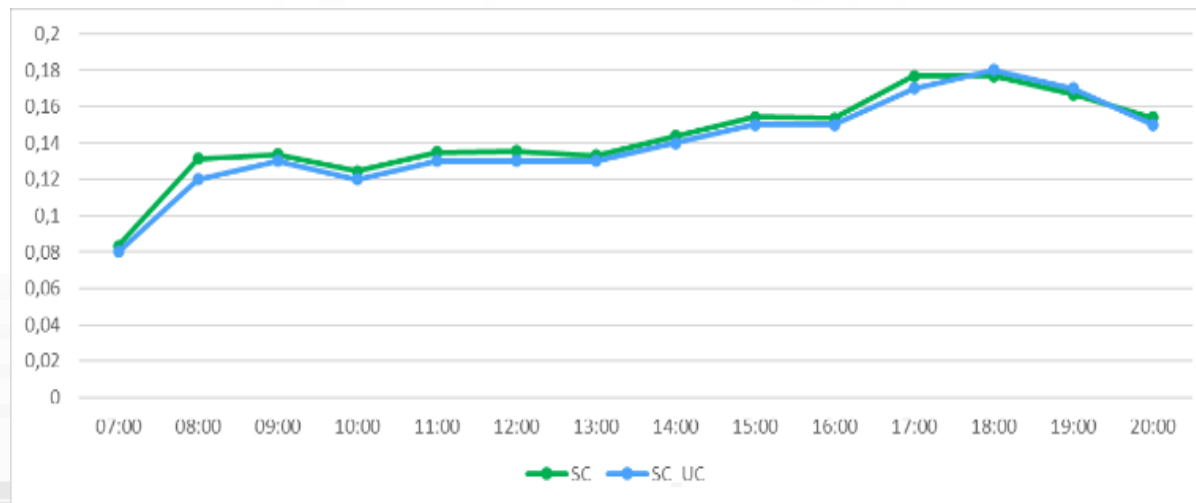
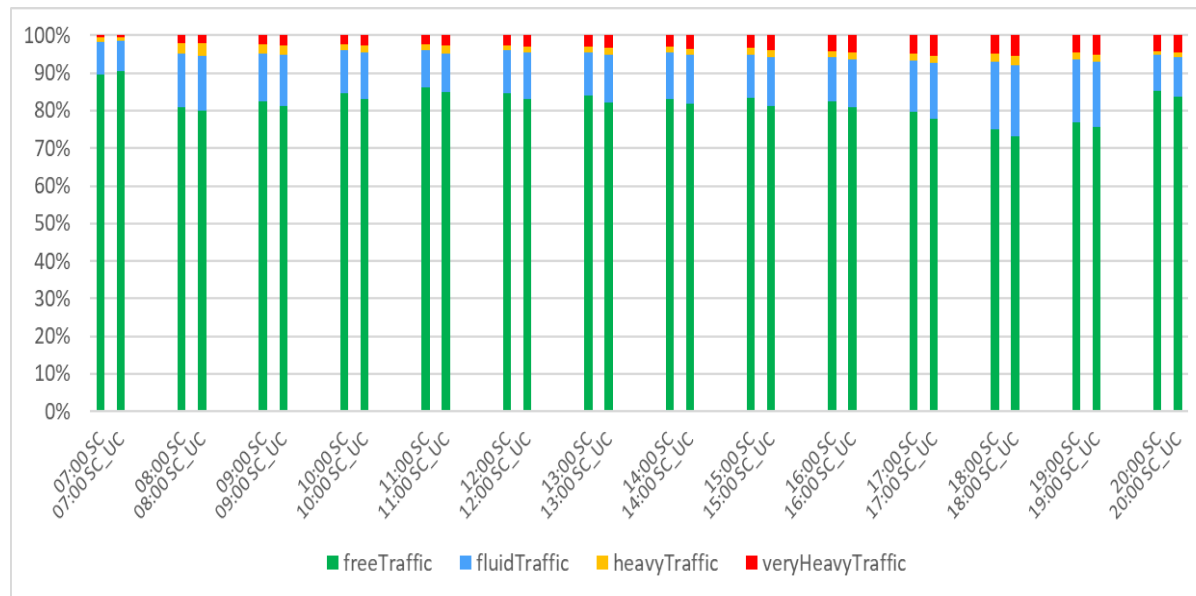
LongTerm



ShortTerm

What-if

	analysis results of $SC_{i,T}$	Actual Traffic Flow results of R_{T1}
09:00		
15:00		

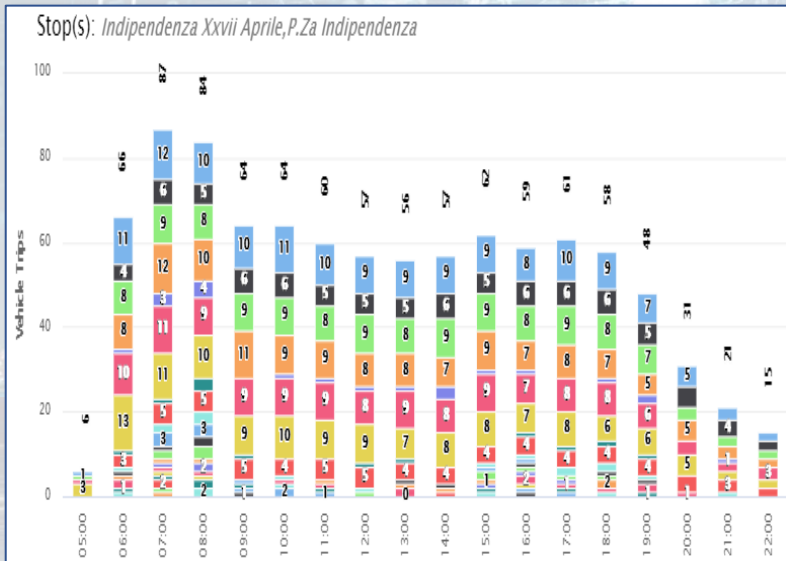


What-if Analysis on Pub Transport



- Simulation / analysis of Demand and Offer of transportation
- Definition of scenarious impact on
 - Traffic, Pollutant, parking, public transport, private flows, etc.
 - KPI analysis

Public Services



Welcome to DORAM powered by SNAP4CITY. Services: 36 on 36 available. The public transportation system has been analyzed in the City, considering the service offer vs. mobility demand. The top-thirty most crowded stops are presented on the right panel and on the map. Please, select your desired scenarios or a stop on the map to perform other analysis.

Type the stop name... Search

Stop panel

Scenario Selector

Choose a scenario: Actual scenario Load

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

Daily Individual Trips > 52000

Stops > 1900

Residential Buildings > 31000

Service Providers > 32000

Mobility Operators > 10

Transport Modes = 3

The Most Crowded Stops Select a time slot: 05:00 to 01:59 Search

Indipendenza XXVII Aprile
P.Za Indipendenza

Daily Pick-ups: 377
Daily Drop-offs: 407
Daily Vehicle Trips: 979

Stazione Nazionale

Daily Pick-ups: 321
Daily Drop-offs: 358
Daily Vehicle Trips: [unlabeled]

Welcome to DORAM powered by SNAP4CITY

Services: 36 on 36 available

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

Stop(s): Indipendenza Xxvii Aprile, P.Za Indipendenza

The Most Crowded Stops Select a time slot: 05:00 to 01:59 Search

Indipendenza Xxvii Aprile

P.Za Indipendenza

Daily Pick-ups
377

Daily Drop-offs
407

Scenario Selector

Choose a scenario: Actual scenario Load

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

- Daily Individual Trips > 52000
- Stops > 1900
- Residential Buildings > 31000
- Service Providers > 32000

<https://www.snap4city.org/odanalyzer/#b>

Traffic Light Plan Optimization

FROM CITY
DASHBOARD TO
APPLICATIONS



11 SUSTAINABLE CITIES
AND COMMUNITIES



MOST
CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

<https://www.snap4city.org/1015>

Traffic Light Plan Optimisation, Digital Twin

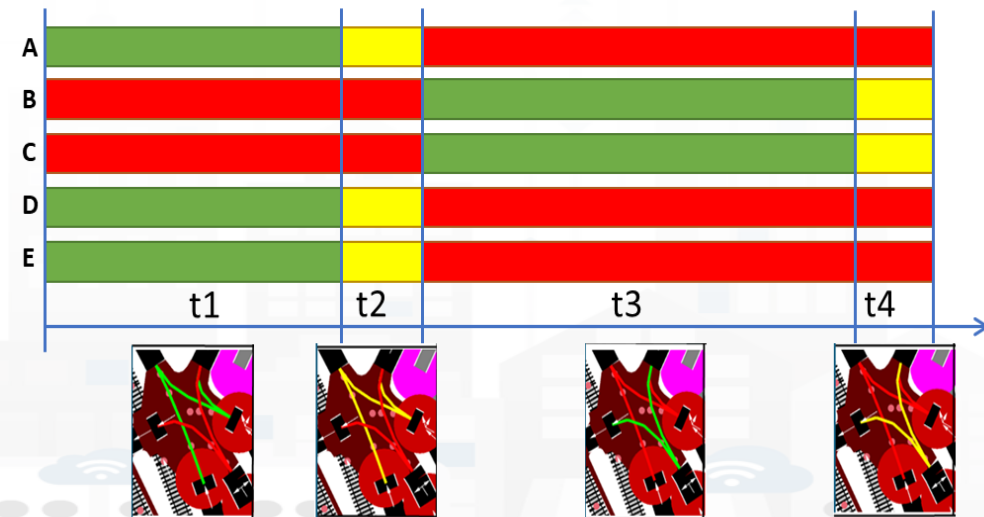
- **Match Multiple Objectives and Synchronization:**

- public and private traffic, tramway priority
- Micro and Macro Scales
- **AI: Genetic Algorithms, Reinforced Learning**
 - Fixed and Actuated Cycles
 - Adjusted on Demand

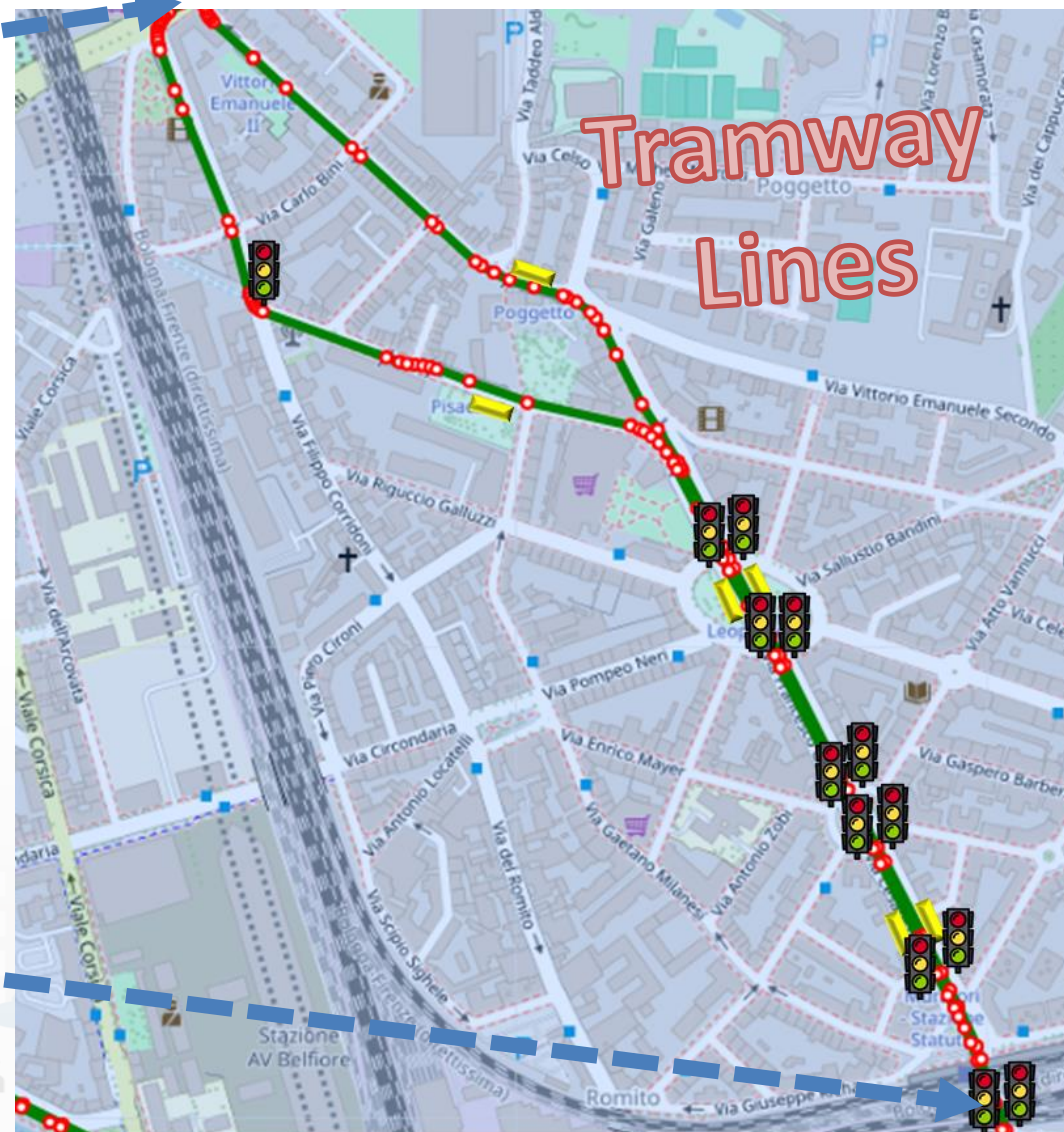
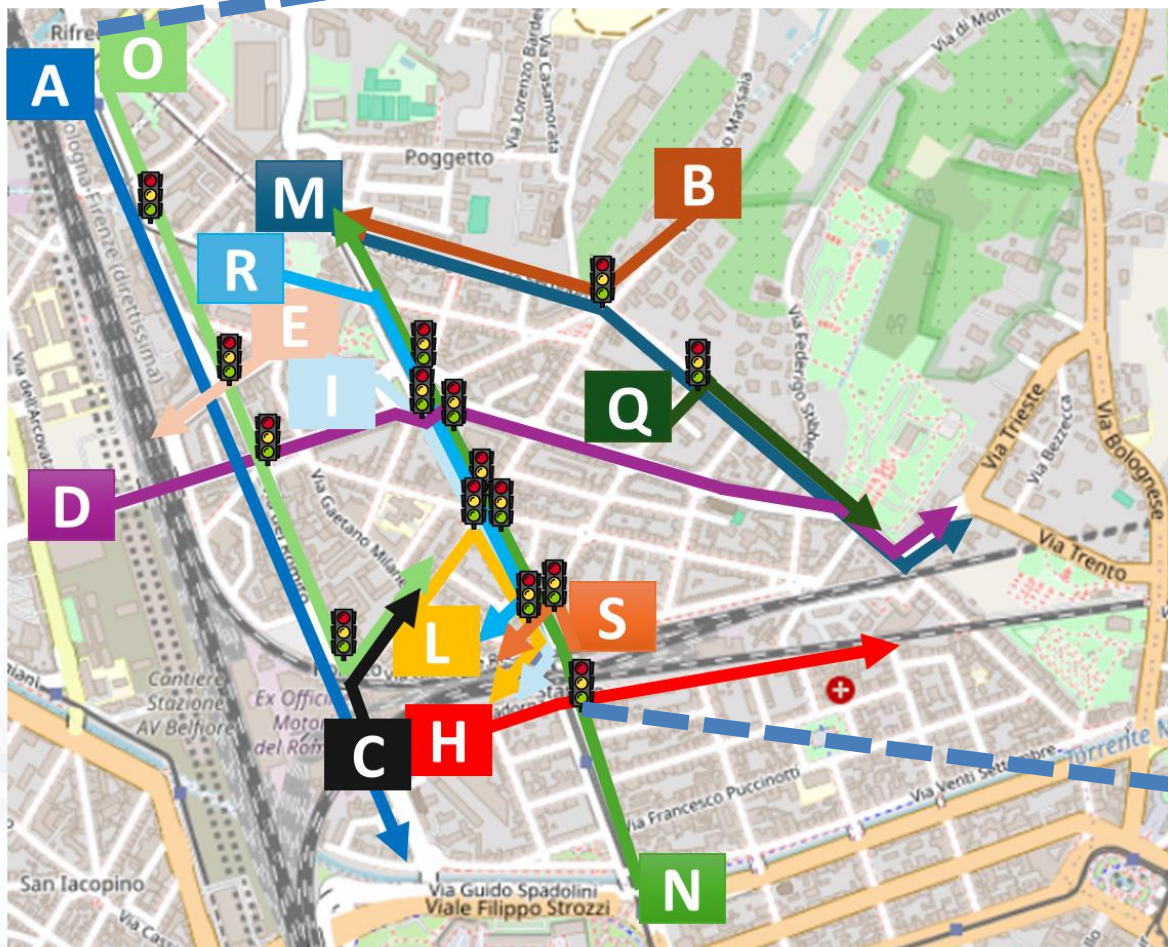
- **Validation/integ.** with *SUMO* simulation

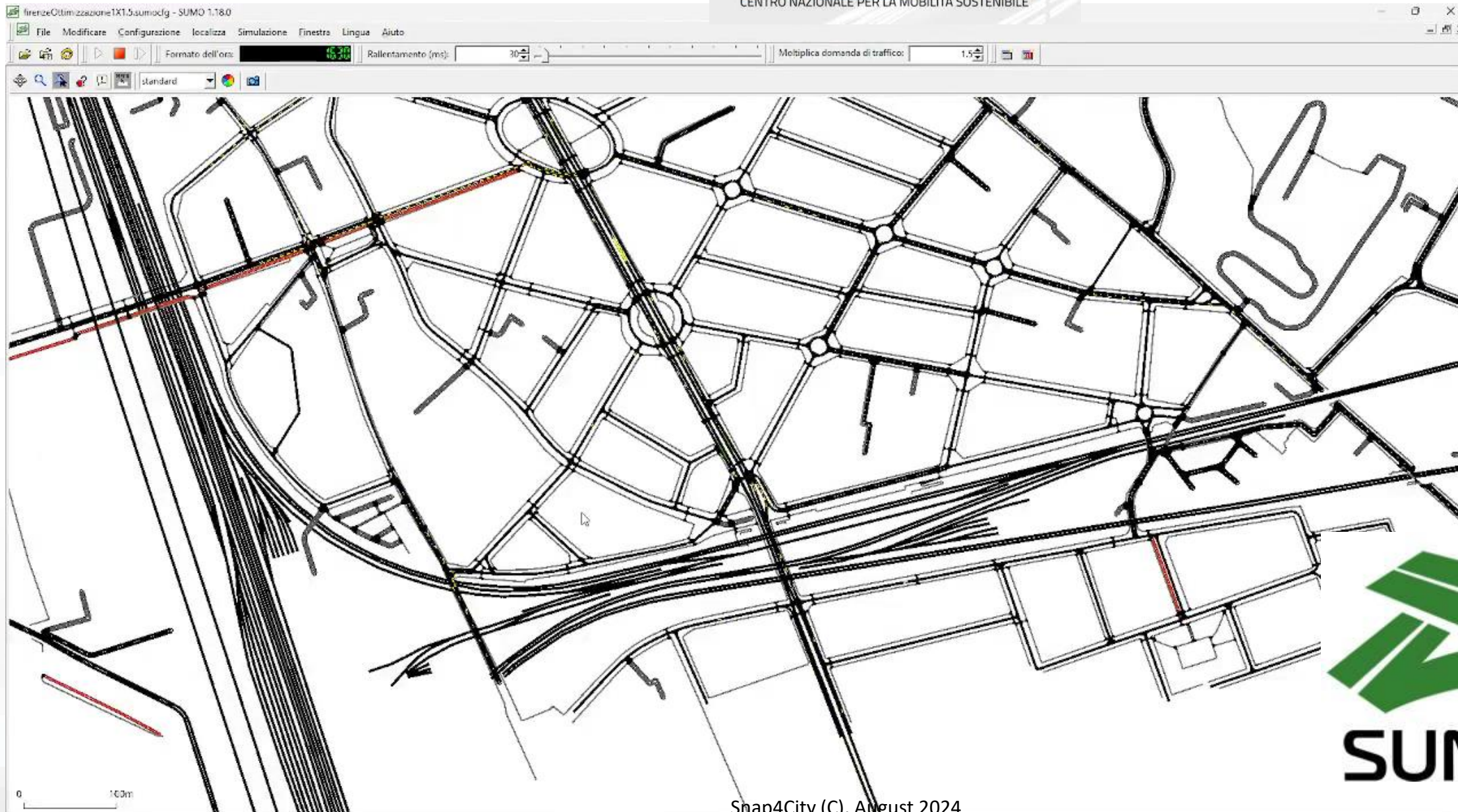
- Travel Time, waiting time, waiting count, specific travel time on directions, CO2 emissions, etc.

- **Reductions from 5% to 15%**



Example, main paths





Traffic Infrastructure Optimization

FROM CITY
DASHBOARD TO
APPLICATIONS

DATA G...
AND CIT...
KNOWL...
MANAG...

11 SUSTAINABLE CITIES
AND COMMUNITIES



MOST

CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

TO ADOPT
CITY, AND
ROADMAP

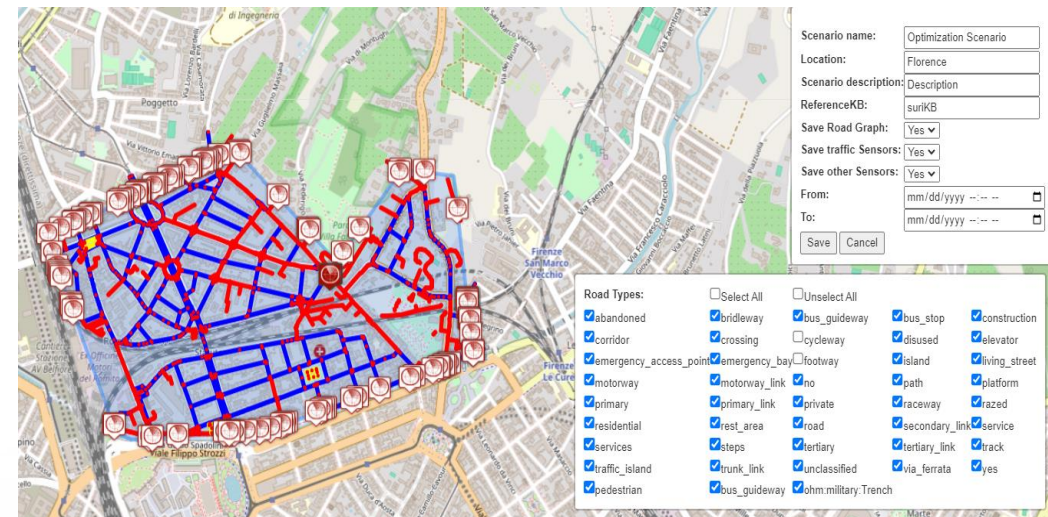
SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS

<https://www.snap4city.org/1014>

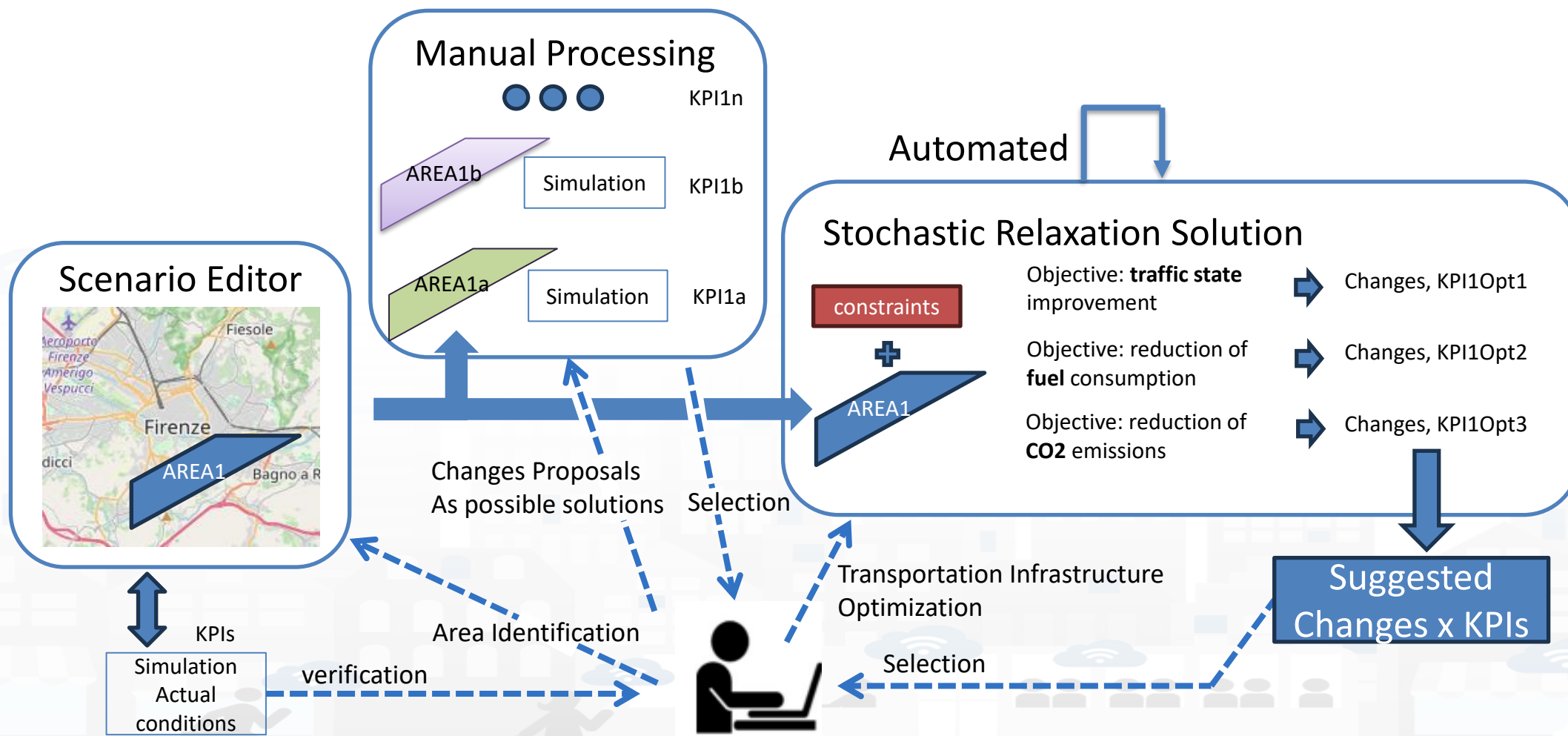


Traffic Infrastructure Optimisation, Digital Twin

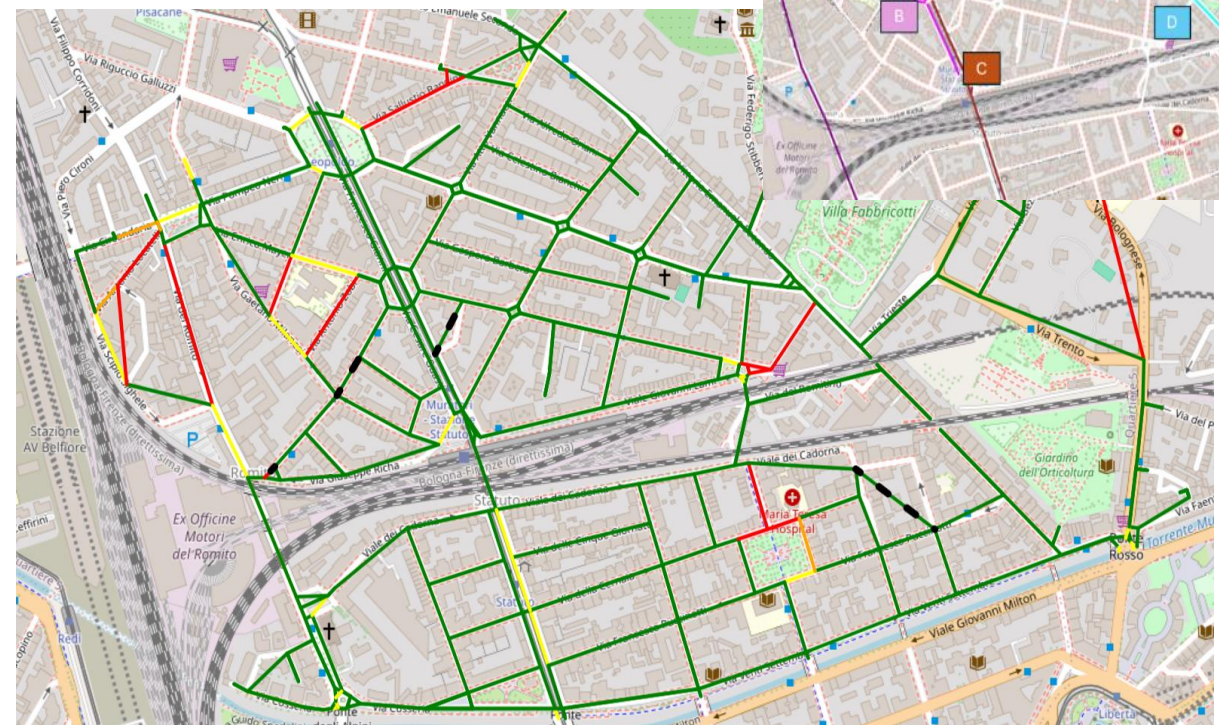
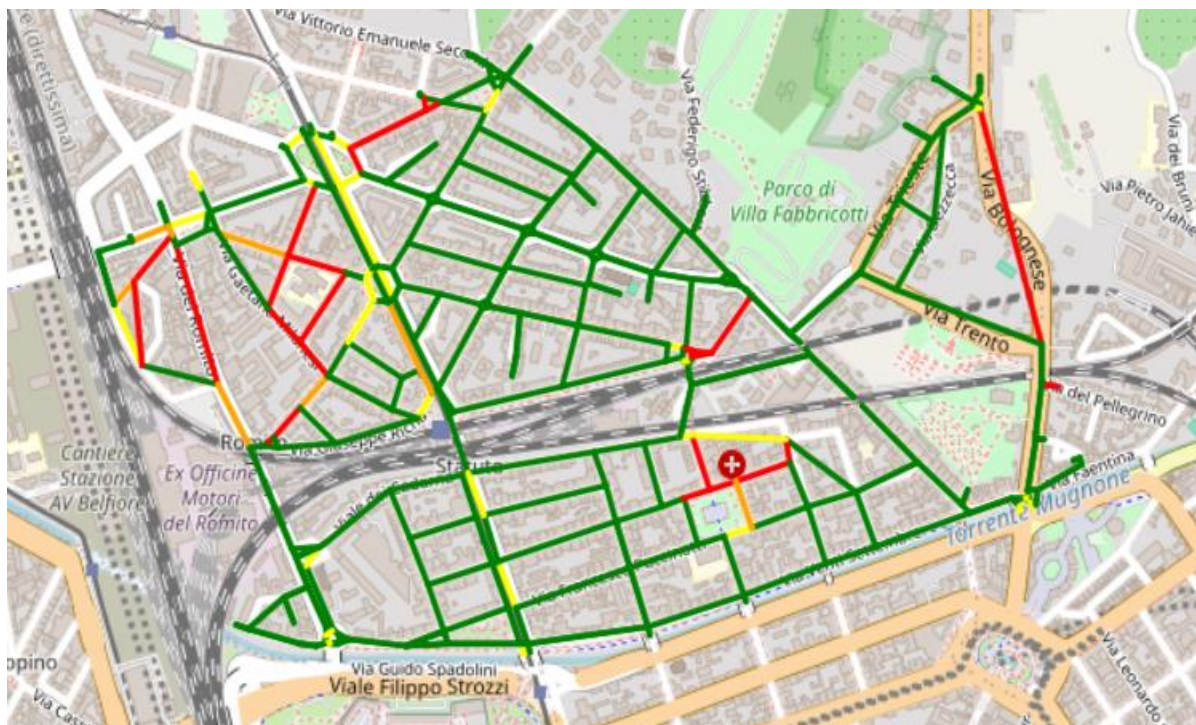
- **Identification of Scenario**
(Scenario Editor), any changes
 - Definition of traffic loads by flows
- **What-if or Automated Optimisation**
- **Automated Optimisation:**
 - Stochastic Relaxation, Simulated Annealing, Traffic Flow Reconstruction
 - Multiple objectives targeting
 - Travel time, emissions, fuel consumption, traffic status
 - Limiting the number of changes



Traffic Infrastructure Optimisation



Optimization Results



<i>Case max 4 changes</i>	<i>KPI estimation on the best solution</i>		
	<i>Traffic State</i>	<i>Fuel</i>	<i>CO2</i>
<i>Optim 4 Traffic State</i>	91.341	17.964	128536
<i>Optim 5 Fuel</i>	91.514	16.633	128227
<i>Optim 6 CO2</i>	92.859	19.192	127876
<i>Original</i>	115.475	25.680	165822

<i>Travel Time [s]</i>	<i>Path A</i>	<i>Path B</i>	<i>Path C</i>	<i>Path D</i>	<i>Total Time</i>
<i>Original Scenario</i>	183.2	59.6	80.9	132.5	456.4
<i>Optim 4 Traffic State</i>	93.2	60.0	63.7	96.0	313.1
<i>Optim 5 Fuel</i>	89.6	51.2	59.7	96.4	296.9
<i>Optim 6 CO2</i>	89.5	53.2	58.4	100.1	301.3

Environment, waste, land, etc., domain (2024/8)

- **Goals:**
 - Reduction of emissions and EC taxations
 - Cost reduction for waste collection, reduction of waste collection impact on mobility
- **Solutions for Operation (monitoring, managing, mobile apps, digital signages, control rooms)**
 - Monitoring emissions, weather, waste, water, etc.: sensors, traffic, flows,
 - Early detection/warning of critical conditions on *emissions, weather, waste, water, fire, animals, ...*
 - Early detection/warning of critical conditions for *landslides, water flooding, beach*
 - **Smart Waste Management:** bins/lockers, waste collection daily plan, pay as you throw, PAYT, etc.
 - Short terms prediction of emissions: CO₂, NO₂, etc.
 - Production of suggestions, nudging
 - Computing and predicting of long terms KPI indicators of the European Commission
- **Solutions for Planning (optimization and what-if analysis)**
 - Identification of main CO₂/NO₂ emissions locations in the city, total production from traffic
 - Reduction of Pollutant Emissions, via optimization: semaphore cycles, viability
- **Algorithms and computational solutions, see next slide**

Tools: Environment, waste, land, (2024/8)

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

Environment and Quality of Life

Air Quality Predictions

Cities of:
Firenze, Pisa, Livorno



- **Multiple Domain Data**

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

- **Multiple Decision Makers**

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

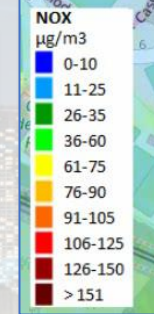
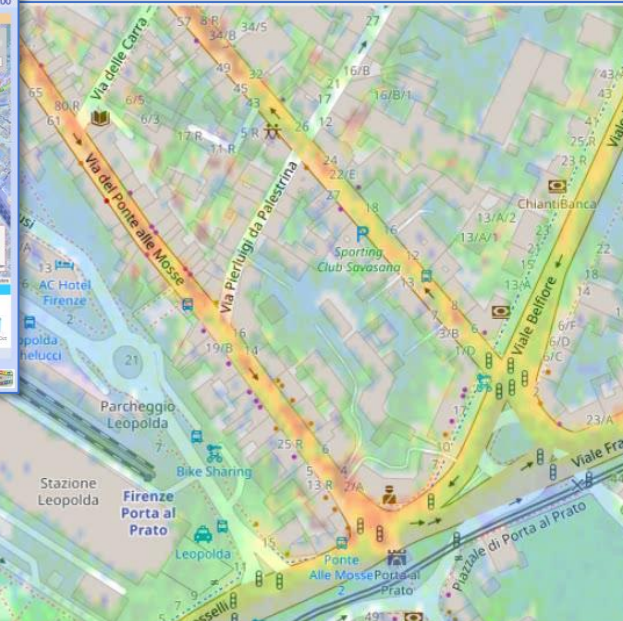
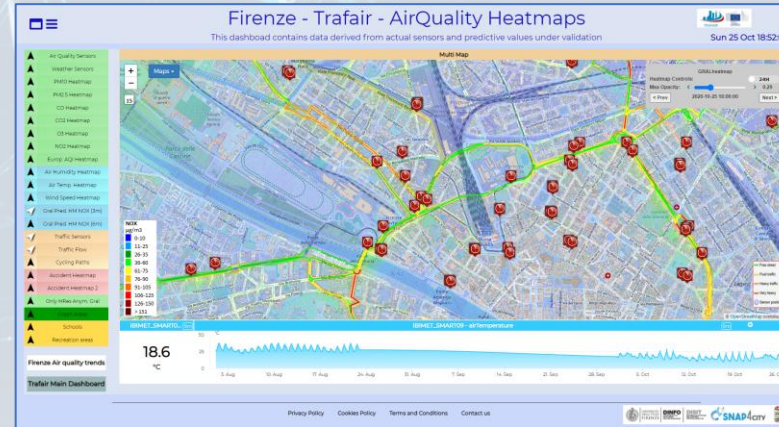
- **Historical and Real Time data**

- Billions of Data

- **Services Exploited on:**

- Dashboards, Mobile App

- **Since 2020**



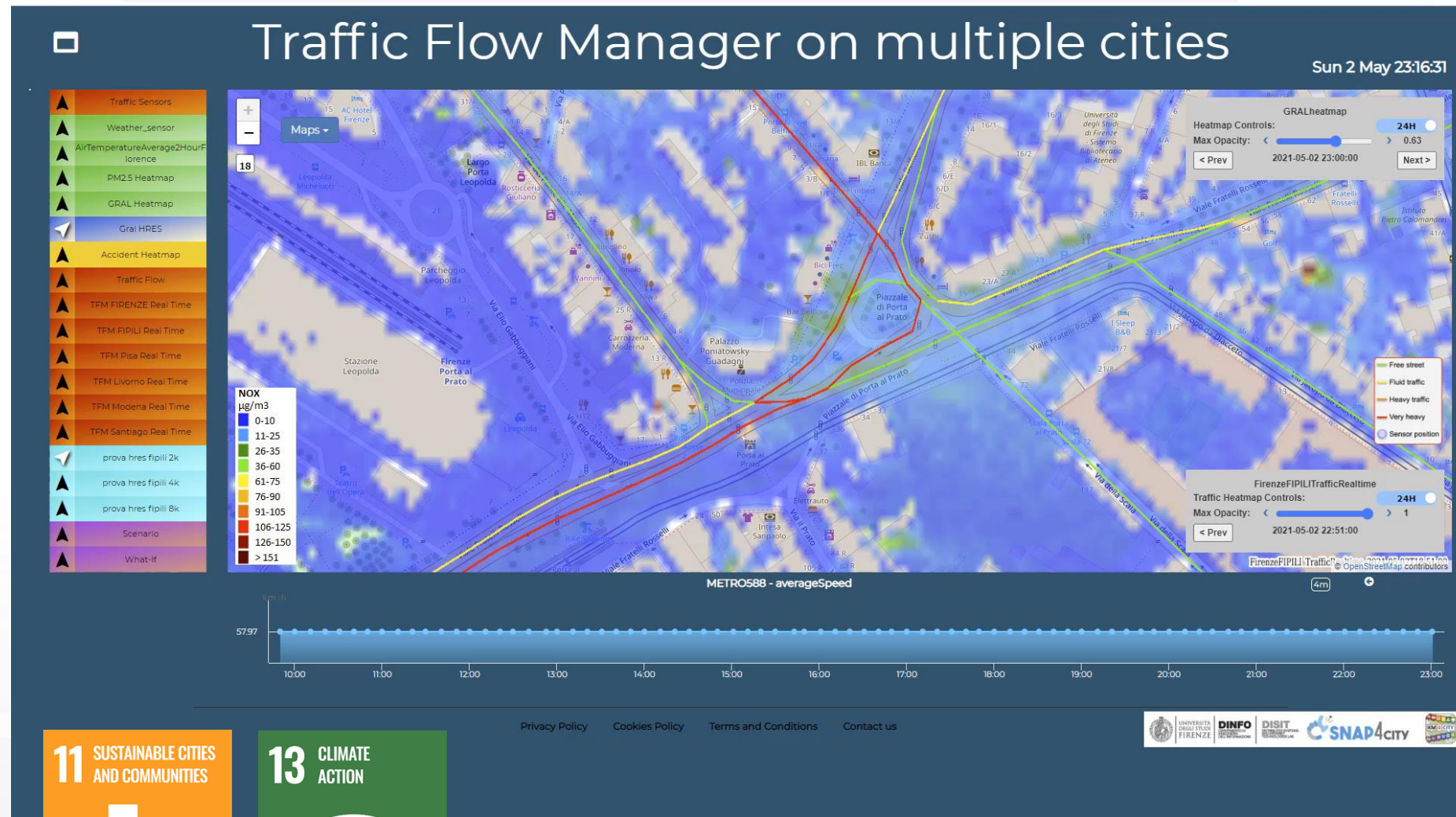
Pollutant	Averaging period	Air Quality Directive		WHO guidelines	
		Objective and legal nature and concentration	Comments	Concentration	Comments
PM _{2.5}	One day			25 µg/m ³ (*)	99 th percentile (3 days/year)
PM _{2.5}	Calendar year	Target value, 25 µg/m ³	The target value should become a limit value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

• **Prediction**

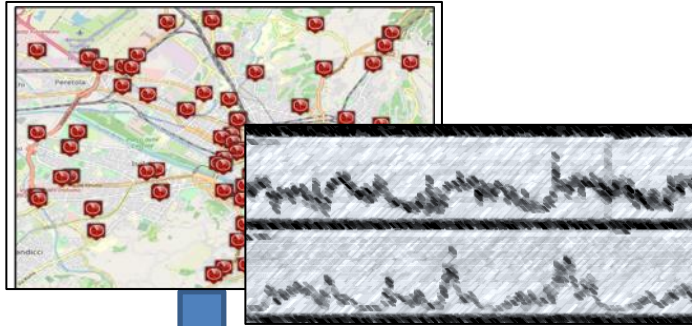
- **NOX Pollutant** diffusion on the basis of Traffic Flow (prediction), weather and 3D structure
- **NO2 progressive average** (Long term)

• **Project:**

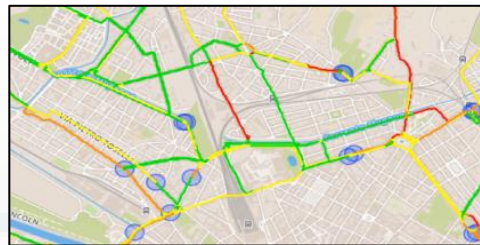
- **Trafair CEF EC**
- Mixed solutions of Fluidinamics modeling and AI



Estimating City Local CO2 from Traffic Flow Data



Computing Traffic Flow
into CO2 sensor area



Traffic Flow data

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



Computing CO2 on the basis of
traffic flow data



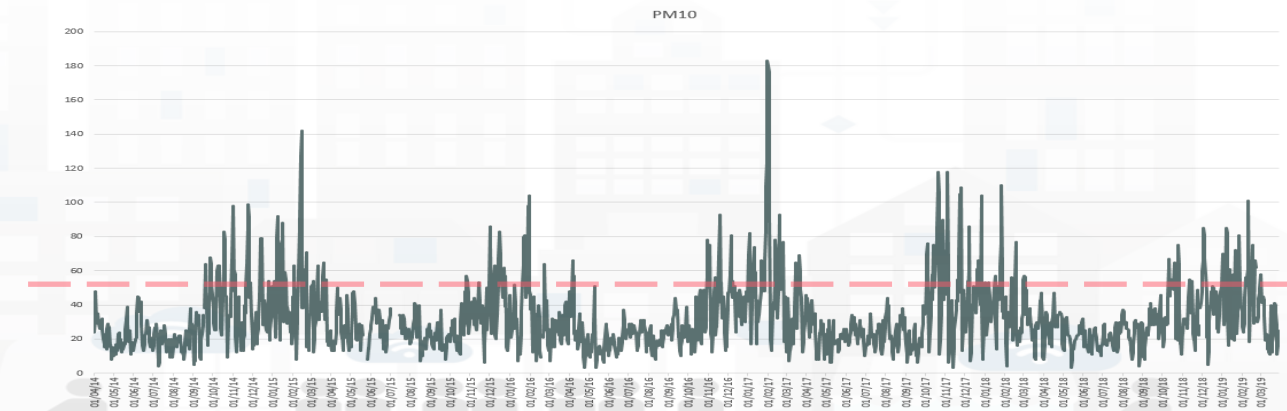
CO2 estimation

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

Predicting Air Quality

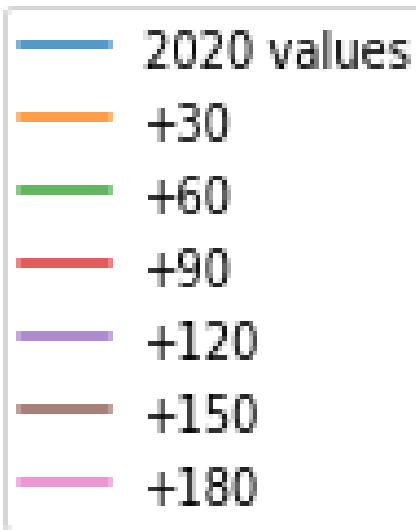
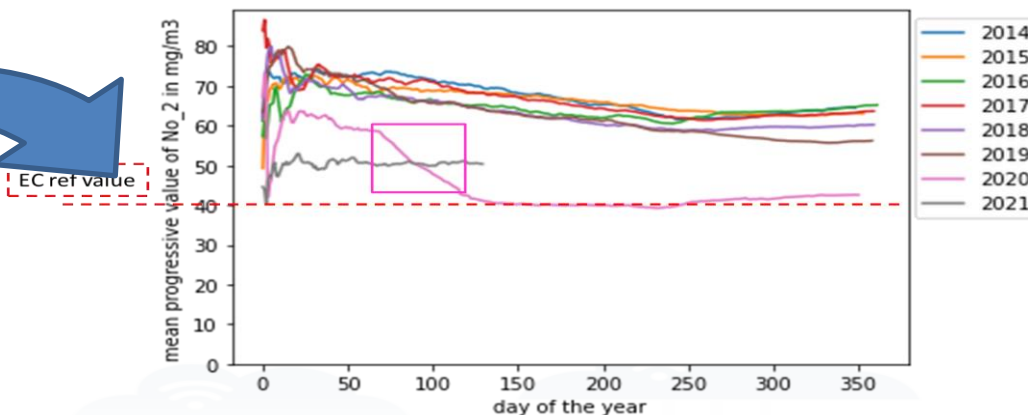
- European Air Quality Directive
- Predicting critical days
 - PM10 with an accuracy of more than 90% and precision of 85%;
 - PM2.5 with an accuracy of 90% and precision greater than the 95%.
- Simulating Long terms values
 - For long terms predictions

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



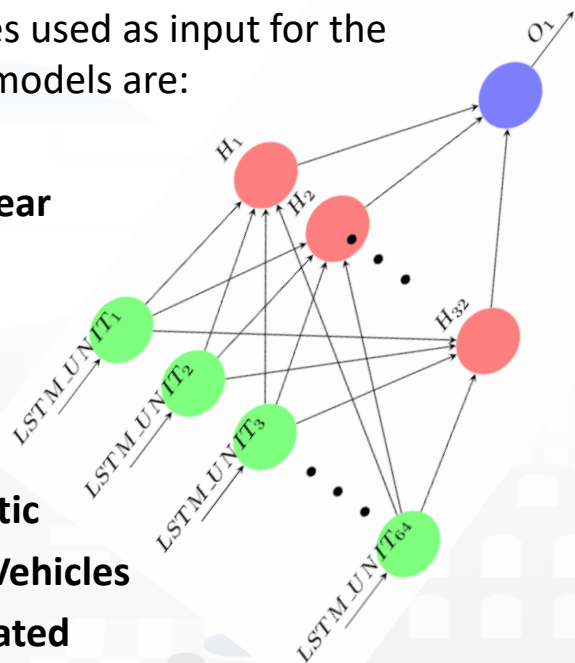
Predicting EC's KPI on NO2 months in advance

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



The features used as input for the predictive models are:

- **Month**
- **dayOfTheYear**
- **NO2**
- **Tmean**
- **Humidity**
- **windMean**
- **NoxDomestic**
- **numberOfVehicles**
- **NO2cumulated**
- **NO2progesseveMean**
- **numberOfVehiclesCumulated**



Pollutant	Averaging period	Air Quality Directive		WHOguidelines	
		Objective and legal nature and concentration	Comments	Concentration	Comments
PM _{2.5}	One day			25 µg/m ³ (*)	99 th percentile (3 days/year)
PM _{2.5}	Calendar year	Target value, 25 µg/m ³	The target value has become a limit value since 1 January 2015	10 µg/m ³	
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	

Waste Manager:

- **Collects and monitors data** from bins (status, temperature, and a number of alarms, etc.) and trucks (weights collected, when possible) according to differentiated waste collection;
 - Interoperable with different waste bin sensors and lockers.
 - Monitor waste bin status including alarms of critical conditions notified from the citizens, and/or detected by sensors such as: fire, up-side-down, hurts, too filled, run out of battery, errors, etc. (some of these events can be enabled on the basis of the sensors positioned to the bin)
- **supports of policies** as Pay As You Throw, PAYT, provided that the bins are controlled with fobs, NFC, rfid, etc.
- **promoting citizen engagement/participation**, to help cities optimize their waste management practices and move towards a more sustainable future. The engagement is especially addressed to the city commercial operators which have special need in providing a large amount of waste (such as restaurants, fast food, bars, and shopping centers). <https://www.snap4city.org/1018>
- **Reduce costs:** optimize waste collection and management in urban environments
 - identify the bins that risk to become full in advance (using predictive technologies based on AI, Deep Learning).
 - Computer the optimal path for waste collection provided to map on mobiles, reduction of costs for waste collection.
 - dashboards provides statistics and forecast.
- **Custom user interface** and theme can be defined for each municipality as usual on Snap4City.

Smart Waste – Map view



Smart Waste Management
Thu 5 May 11:14:28

Select the bins Kind, Fullness and Status from the dropdown below and press SUBMIT to see the results on the map.

Kind: Status:

Fullness:

Address:

Group ID:

DESCRIPTION	VALUE	Buttons						
dateObserved	2022-02-28T12:46:12.899Z	Last value	Last 4 hours	Last 24 hour	Last 7 days	Last 30 days	Last 6 month	Last 1 year
generic	[SURI id]	Last value	Last 4 hours	Last 24 hour	Last 7 days	Last 30 days	Last 6 month	Last 1 year
glass	[SURI id]	Last value	Last 4 hours	Last 24 hour	Last 7 days	Last 30 days	Last 6 month	Last 1 year
metal	[SURI id]	Last value	Last 4 hours	Last 24 hour	Last 7 days	Last 30 days	Last 6 month	Last 1 year
organic	[SURI id]	Last value	Last 4 hours	Last 24 hour	Last 7 days	Last 30 days	Last 6 month	Last 1 year
paper	[SURI id]	Last value	Last 4 hours	Last 24 hour	Last 7 days	Last 30 days	Last 6 month	Last 1 year
plastic	[SURI id]	Last value	Last 4 hours	Last 24 hour	Last 7 days	Last 30 days	Last 6 month	Last 1 year

Smart waste bins status

ORGANIC	PAPER	METAL	PLASTIC	GLASS	GENERIC
89 %	100 %	100 %	62 %	83 %	65 %

Via_Del_Medici: ORGANIC fullness

Search bins on map by filtering per:

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

- Reduction of costs for waste collection
 - Optimization of waste collection for the next day, forecast
 - Production of rides and paths for the drivers on waste collection
- Operator:
 - Refine a search by using the filters on the left side
 - Click on a waste bin pin on the map:
 - A popup with real time data is shown
 - The fullness status of the selected group of bins is shown in the synoptic below the map
 - Specific fullness weekly trends are shown below the map
 - Click on the «Table view» button to access the other dashboard





Trajectorywaste2 Fri 17 May 18:34:15

Selector - Map

DISIT:orionUNIFI:113043.960_485172.926-Rest

Please select a date: 02/09/2020

Please select a ride among: 3

DISIT-OrionUNIFI:114985.283_488088.814-Rest - Weight 8m

Trajectorywaste2 Fri 17 May 18:34:37

Selector - Map

DISIT:orionUNIFI:113043.960_485172.926-Rest

Please select a date: 02/09/2020

Please select a ride among: 3

DISIT-OrionUNIFI:114985.283_488088.814-Rest - Weight 7m

Logo: DIMP0, DISIT, SNAP4city, OpenStreetMap

Trajectorywaste2 Fri 17 May 18:30:58

Selector - Map

DISIT:orionUNIFI:113043.960_485172.926-Rest

Please select a date: 05/mm/yyyy

Please select a ride among: 3

116977.080_488279.962-REST

VALUE NAME: 116977.080_488279.962-REST

DETAILS DESCRIPTION RT DATA

Last update: 2021-12-04 10:10:34.000+01:00

Description	Value	Buttons
dateObserved	2021-12-04T09:10:34.000Z	Last 4h 24h 7d 30d 6m 1y 2y 10y
weight	215	Last 4h 24h 7d 30d 6m 1y 2y 10y

Keep data on target widget(s) after popup close:

Weight - 10 Year 9m



Snap4Building Domain (2024/8)

- **Goals:**
 - increase efficiency, cost reduction, sustainability
 - Accessibility to services
 - Security/Safety
- **Solutions for Operation (monitoring, managing, mobile apps, digital signages, control rooms)**
 - Monitoring: usage, energy, environmental conditions, people flows, services, etc.
 - Early detection/warning, alarm, of critical conditions, notifications, decision support
 - Production of suggestions/prescriptions, nudging
 - Managing smart services: cabinets, dispenser, lockers, etc.
 - Global and local 3D/2D representations of area and buildings
 - Integration with Video Management Systems
 - Computing predictions of any kind
- **Solutions for Planning (optimization and what-if analysis)**
 - Reduction of energy costs via optimization
- **Algorithms and computational solutions, see next slide**

Smart Buildings, Snap4Building (2024/8)

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

Ciao roottooladmin!

Tue 3 May 14:37:14

DIDA DATA 2 - NEWGUI

7 AFFORDABLE AND
CLEAN ENERGY



11 SUSTAINABLE CITIES
AND COMMUNITIES



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

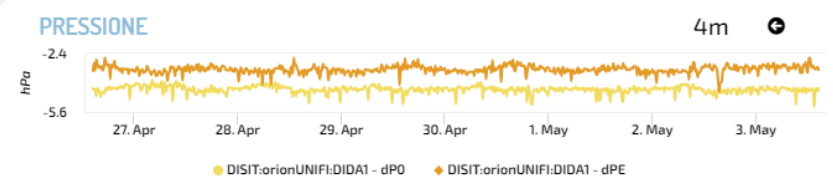
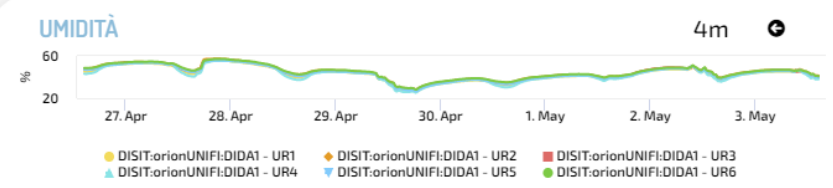
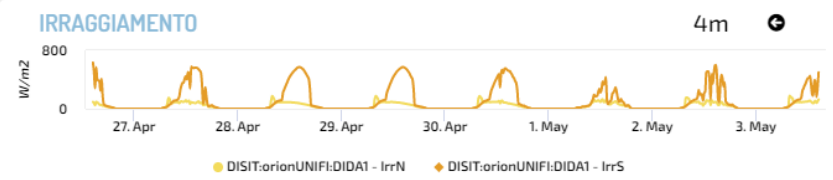
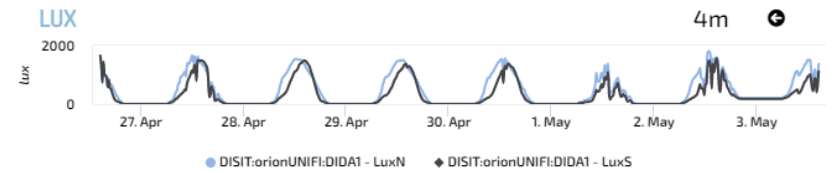
BIM SANTA VERDIANA



Last Value

Time Trend Chart: Glob - Day

No data



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

Building / Floor / Parking:

Building

All / Single Building:

All

Variable:

occupancy

Popup on Shape Click

Add To Map



ISPRA Site



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

Ispra - Occupancy 8m

883

Ispra - Occupancy



person My Profile

ISPRA JRC Site

Ispra Floor, Zone And Room Details

Fri 6 Oct 18:41:54

Allocation Number

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

Floor PT of Building 58A

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

[See Trends](#)

Select a Zone metric: Allocation

Building 58A PT Trends

Mon 9 Oct 13:51:30

Actual 4m

Capacity - Allocation - Occupancy 4m

Temp. 9m

21.7 °C

Organization: Orion-1:Floor2_58A_PT - Occupancy 9m

Percentage Per Zones - Monthly Time Trend Comparison 4m

Occupancy Per Zones - Monthly Time Trend Comparison Stacked 4m

Room 017

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

[See Trends](#)

Snap4City (C), August 2024

177

Energy Domain (2024/8)

- **Goals:**
 - Energy consumption reduction, increment of efficiency, sustainability
 - accessibility to services
- **Solutions for Operation (monitoring, managing, mobile apps, digital signages, control rooms)**
 - Monitoring energy consumption (heating, cooling, prod.,...), conditions, charging stations, etc.
 - **Managing Smart Light** for city: dimering, programming, traffic control, controllers, legacy, etc.
 - Early detection/warning, alarm, of critical conditions
 - Managing smart services: cabinets, lockers, etc.
 - Production of suggestions, nudging
 - Global and local 3D/2D representations of area and buildings
 - Managing Communities of Energy, certification via Blockchain
 - Computing predictions of any kind
- **Solutions for Planning (optimization and what-if analysis)**
 - Reduction of energy costs, via optimization
 - Identification of roofs with better orientation
 - Optimization of battery storage size for PV plants
 - Community of Energy planning and viability
- **Algorithms and computational solutions, see next slide**

Tools: Energy Domain (2024/8)

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



Capelon Cabinet (iot-search)

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

12

Radars Series 4m

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

Selector - Map

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

Time Trend 4m

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

My Profile

Privacy Policy Cookies Policy Terms and Conditions Contact us

Tin Maps Google Gmail YouTube Nuova scheda

ASM Merano Stadtwerke Merano

Elenco lampade Visualizzazione dati Log eventi Grafici Impostazioni

N. Punto Luce	11307
DevEui	70B3D58F100085D7
Via	RomStraÙe
Regolazione	
Ore di servizio	
Conta energia	
Potenza attuale	
Stato	Inattivo
Nome errore	null
RSSI	
SNR	
Data	01/11/2023 12:01:18
Regolazione	Invia

Stato Linea

Non Attivo Stato Linea verso Sinigo

Non Attivo Stato Linea verso Merano Centro

ON
OFF
ERR_DALL_POWER_LIM
ERR_DALL_POWER_FAIL
INF_POWER_FAIL
INF_BUS_POWERED_BY_FREE
INF_DALL_BANK_ERR

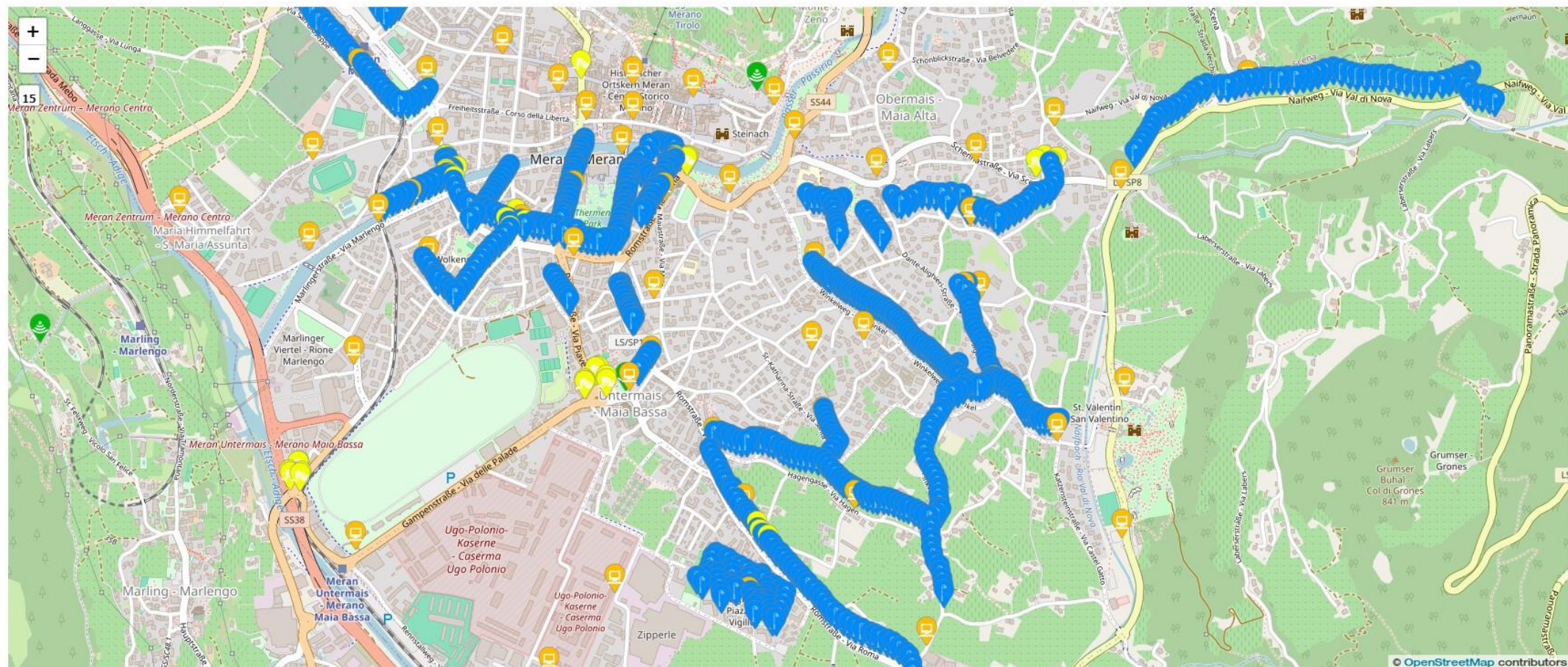
Smart Light Management

Smart Light in Merano

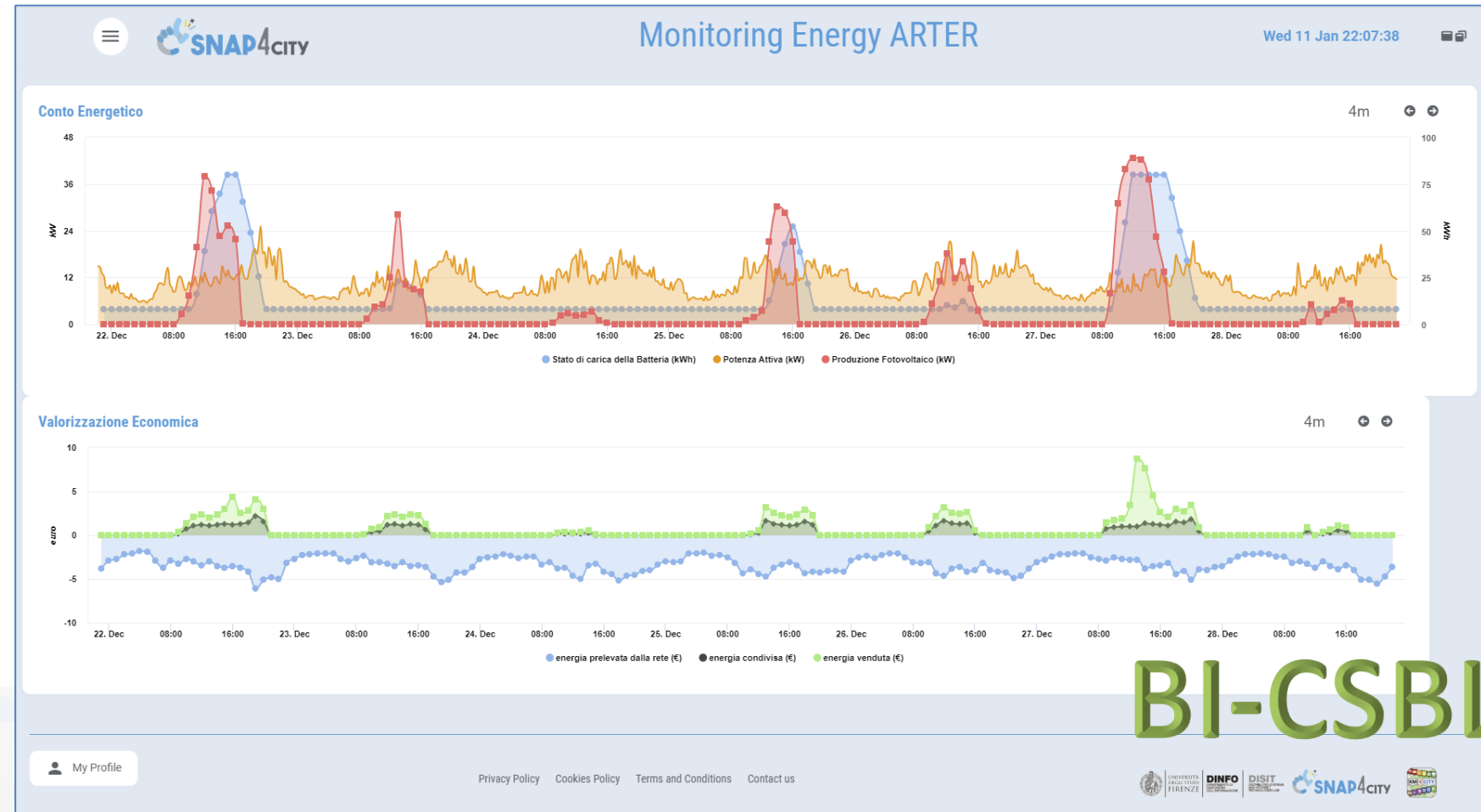


Merano - tutti i servizi

Wed 13 Dec 15:34:57



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



BI-CSBL

<https://www.selfuser.it>

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

Ciao roottooladmin!

Sat 11 Nov 17:26:28

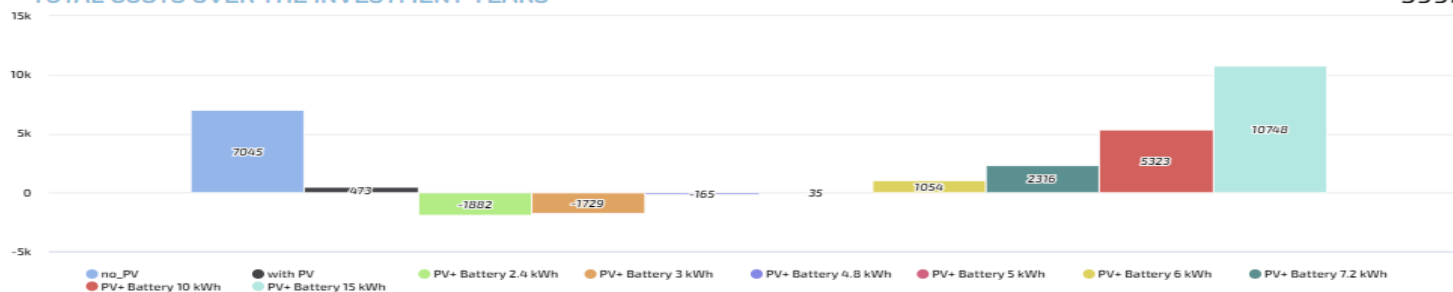
ONLINE PHOTOVOLTAIC SYSTEM SIMULATOR

User Manual

Italian Version

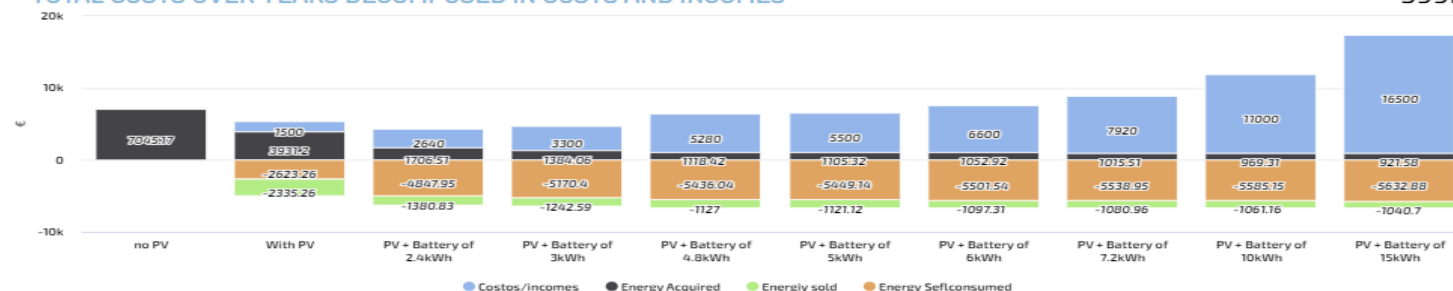
TOTAL COSTS OVER THE INVESTMENT YEARS

599m



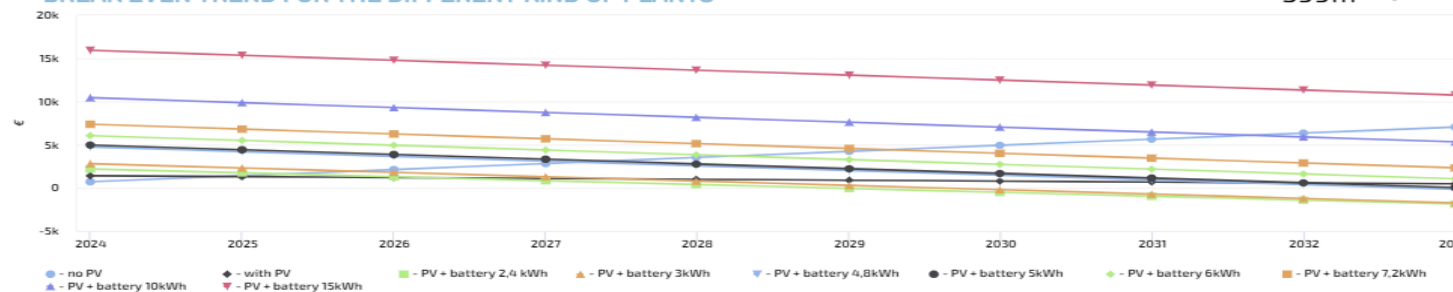
TOTAL COSTS OVER YEARS DECOMPOSED IN COSTS AND INCOMES

599m



BREAK EVEN TREND FOR THE DIFFERENT KIND OF PLANTS

599m



PARAMETERS OF YOUR PV PLANT

We suggest you PV plus battery of 2.4 kWh

Annual Consumption

Price of energy sold (€/kWh)

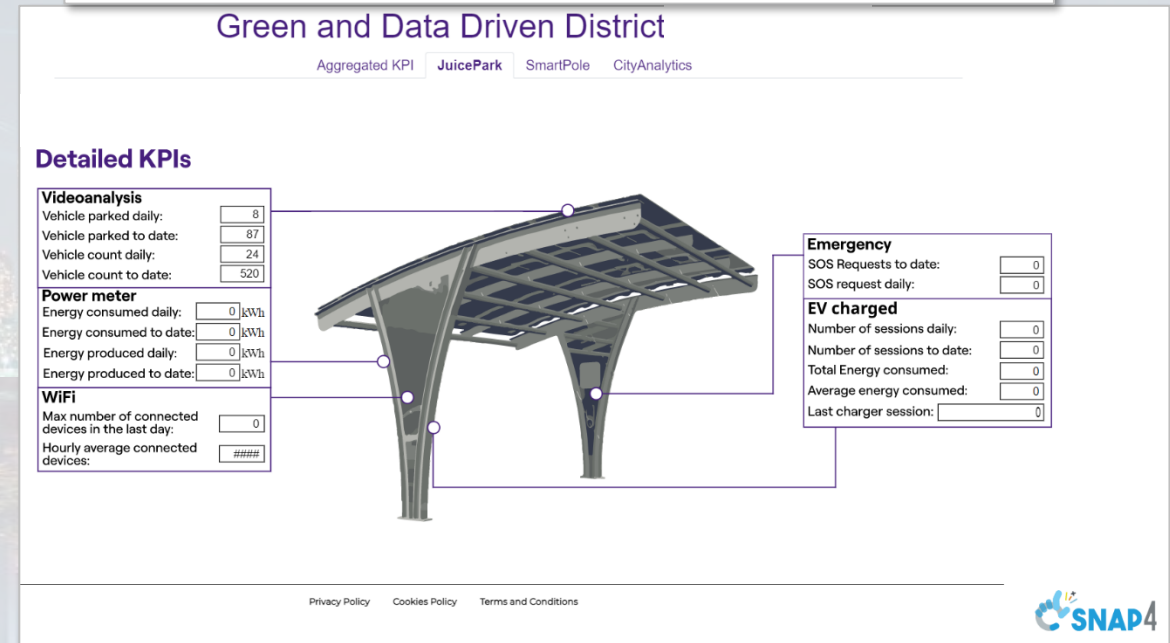
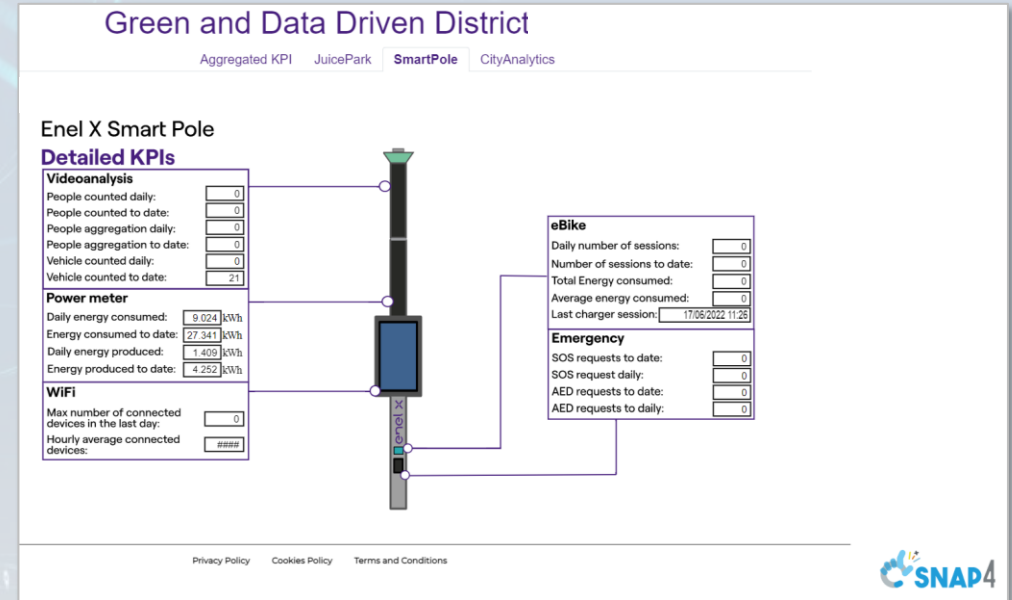
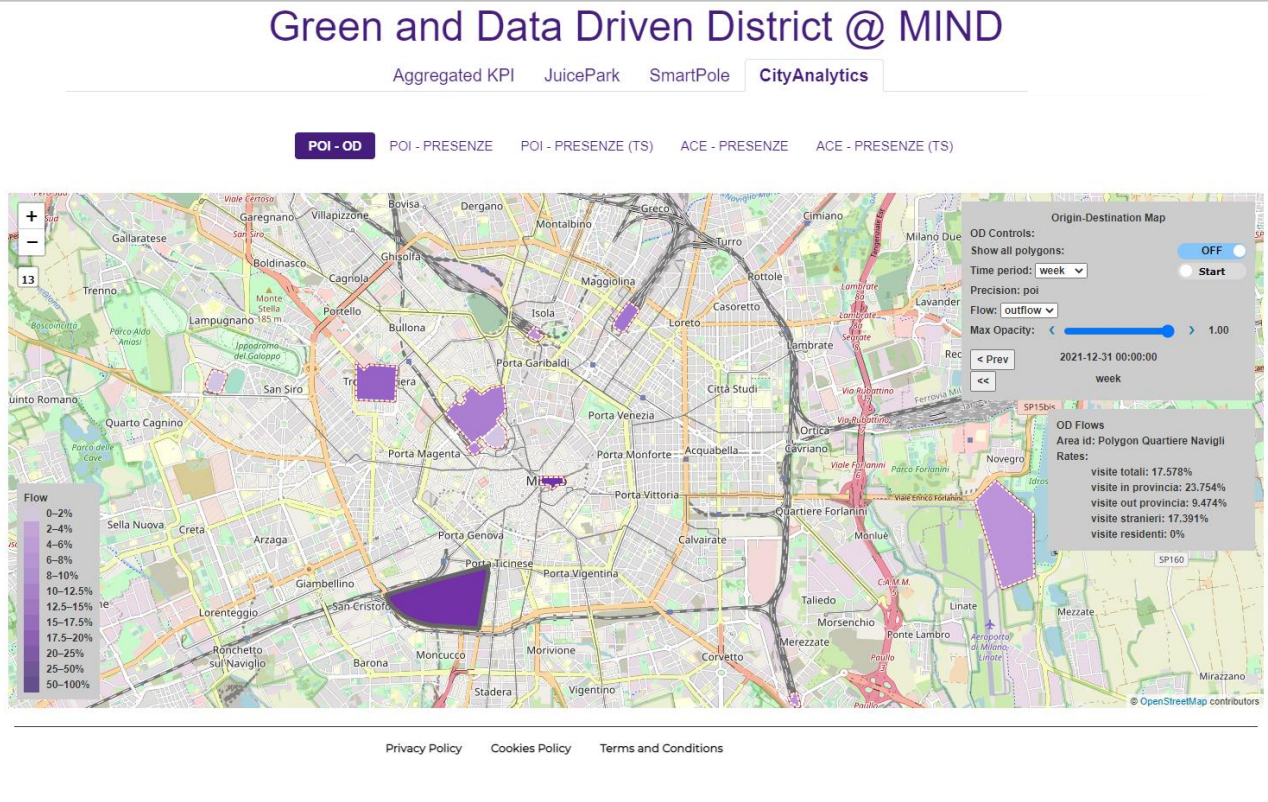
Price of Energy Acquired (€/kWh)

Years of Investment

Months for typical trends

Compute





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**



Monitoraggio Generale

Fri 2 Feb 17:08:24

- CameraModelP1448-LE
- UpsModelRiello
- UpsModelSeltec
- SwitchModelMicrosense
- SwitchModelNetonix

SWITCH027
VALUE NAME: 1721615236

DETAILS DESCRIPTION RT DATA

Last update: 2024-02-02 14:05:50 176Z

Description	Value	Buttons
dateObserved	02/02/24, 03:05:50 PM	Last 4h 24h 7d 30d 6m 1y 2y 10y
fanSpeed	6165	Last 4h 24h 7d 30d 6m 1y 2y 10y
generalStatus	0	Last 4h 24h 7d 30d 6m 1y 2y 10y
poeValue1	48	Last 4h 24h 7d 30d 6m 1y 2y 10y
poeValue2	48	Last 4h 24h 7d 30d 6m 1y 2y 10y
poeValue3	0	Last 4h 24h 7d 30d 6m 1y 2y 10y
poeValue4	0	Last 4h 24h 7d 30d 6m 1y 2y 10y
poeValue5	0	Last 4h 24h 7d 30d 6m 1y 2y 10y
poeValue6	0	Last 4h 24h 7d 30d 6m 1y 2y 10y

Legenda

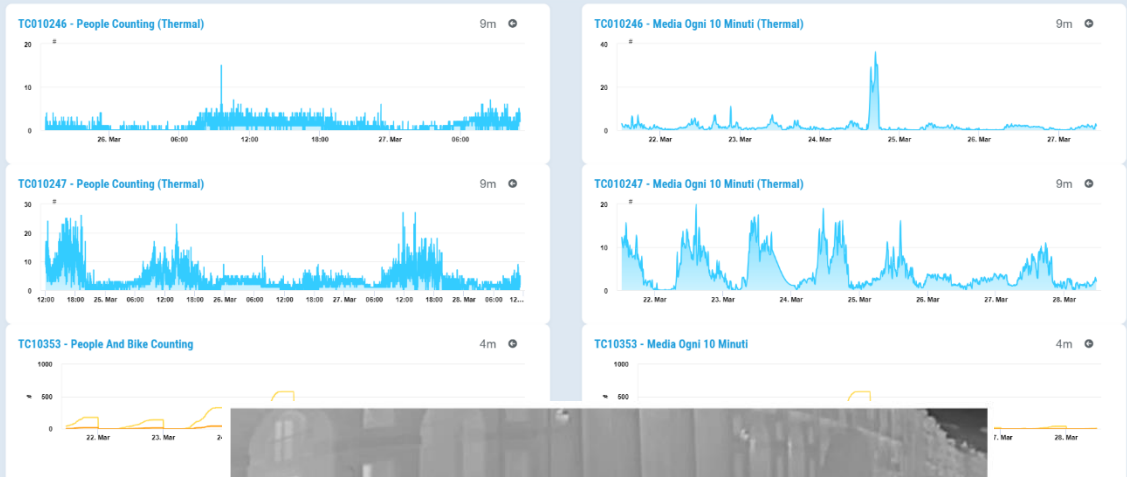
Valore	Significato	Simbolo
0	Buono stato	●
1	Non raggiungibile	●
2	Raggiungibile, dati non disponibili	●
3	Identificata anomalia	●

Stato Attuale 9m

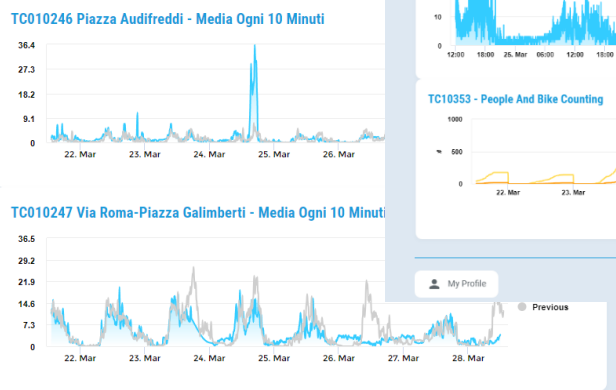
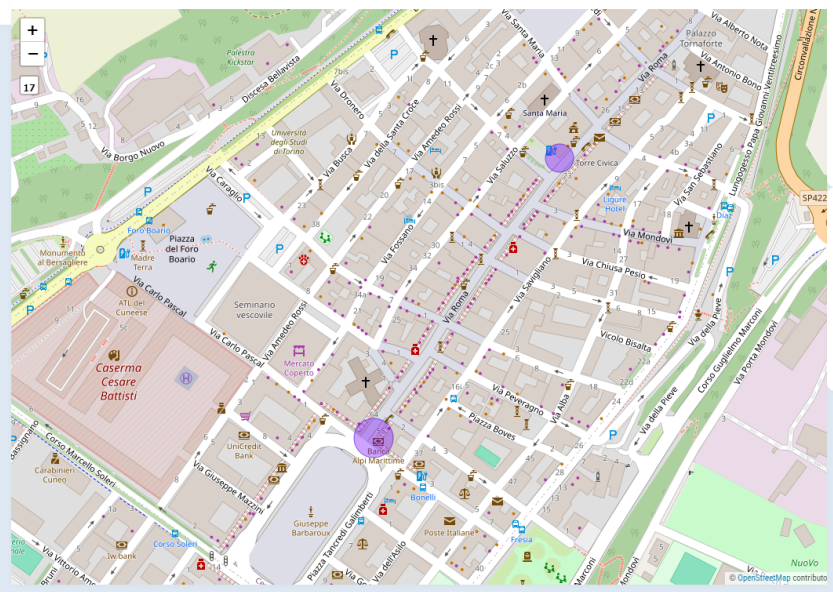
1721612145 - GeneralStatus - Andamento Settimanale

Telecamere Cuneo

Thu 28 Mar 11:18:02



Conteggi Telecamere



Powered by SNAP4Tech

Legenda

- 181
- 9
- 22
- 0

Selector - Map

TC01010

VALUE NAME: 172

Last update: 2024-02-02 14:05:50 101Z

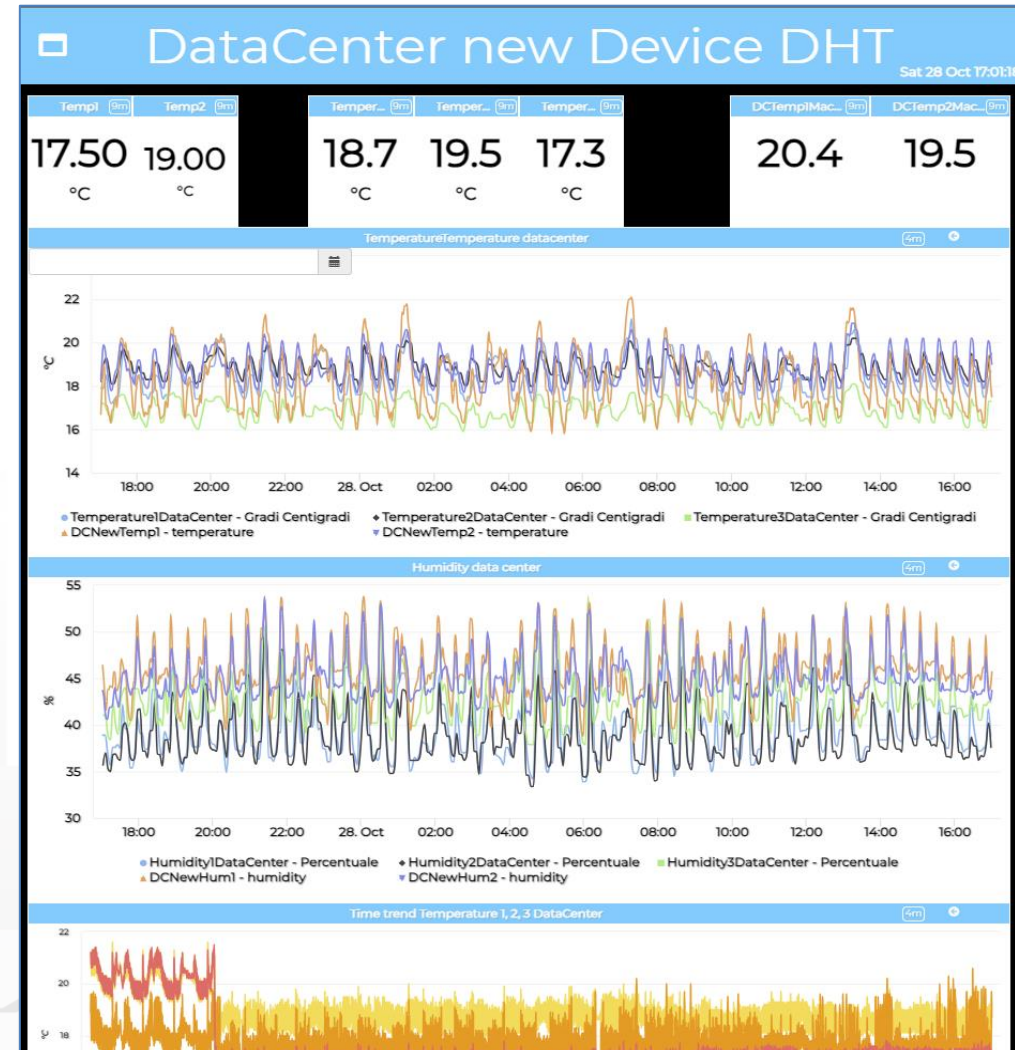
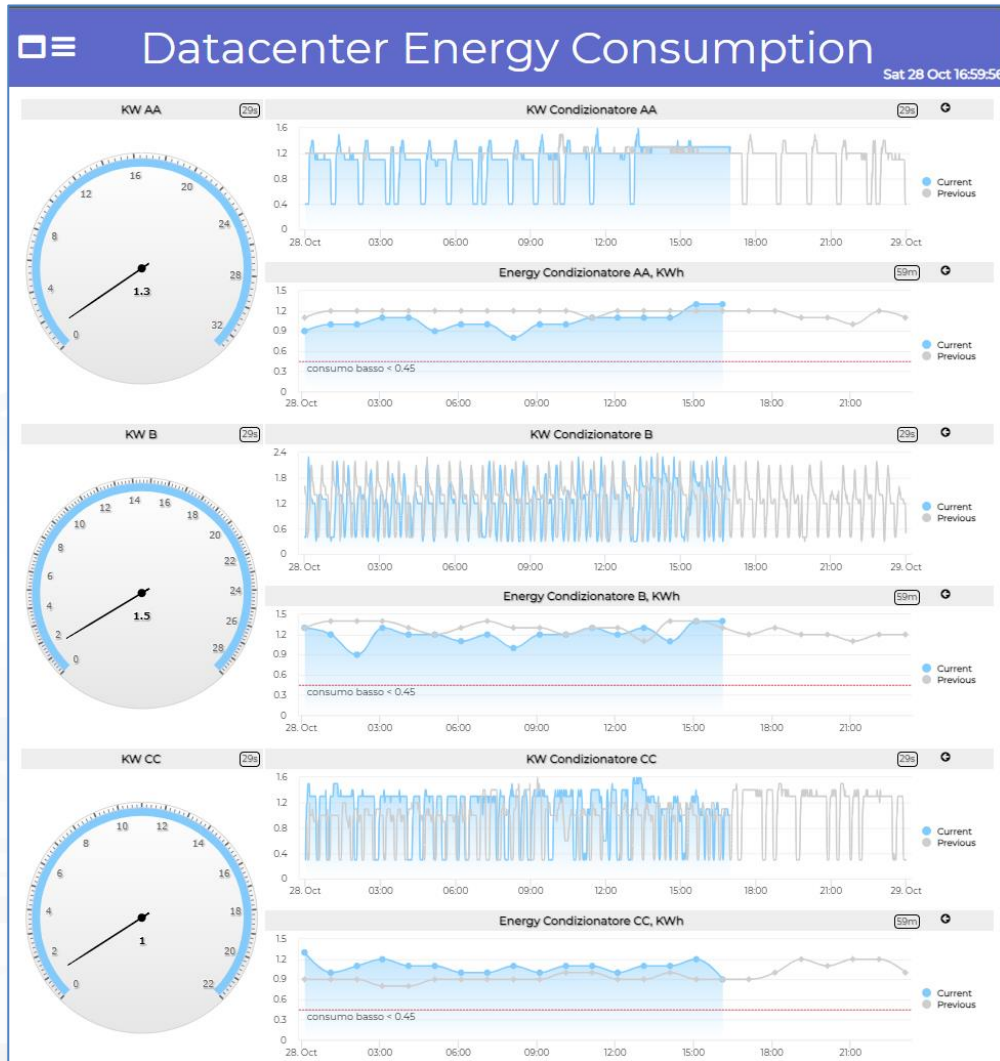
Description	Value
dateObserved	02/02/24, 03:05:50 PM
generalStatus	2

My Profile

My Profile

Previous

Data Center monitoring

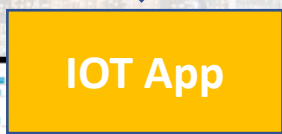
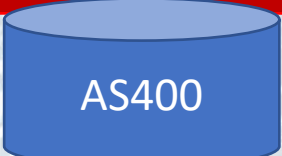


GeNotiLab Architecture for ALTAIR



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

Sample ID	Parameter	Value	Unit	Status
ALTAIR-001	Moisture	12.5	%	OK
ALTAIR-002	Moisture	15.2	%	Warning
ALTAIR-003	Moisture	18.7	%	Alert
ALTAIR-004	Moisture	20.1	%	Alert
ALTAIR-005	Moisture	22.3	%	Alert
ALTAIR-006	Moisture	25.8	%	Alert
ALTAIR-007	Moisture	28.4	%	Alert
ALTAIR-008	Moisture	30.1	%	Alert
ALTAIR-009	Moisture	32.5	%	Alert
ALTAIR-010	Moisture	35.2	%	Alert



Users
Analysis
Notifications



IOT App Analytics

Dashboards



IOT App Management

- Tools:
- List of Chemical Analyses
 - List of Notifications
 - Define notifications
 - Program, send notifications
 - see notification status



IOT App Vs Telegram



Telegram Bot



TOP

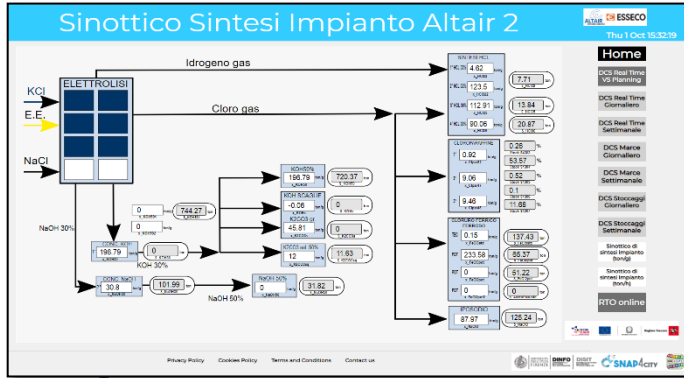
Industry Domain predictive maintenance



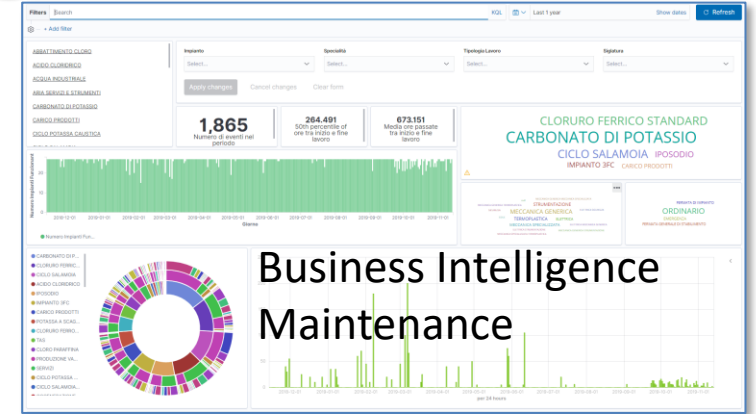
Industry production Domain (2024/8)

- **Goals:**
 - Cost reduction, increase control on production
 - Production optimisation
 - Quality Level
- **Solutions for Operation (monitoring, managing, mobile apps, digital signages, control rooms)**
 - Monitoring KPI: administration, production, commercial, faults, etc.
 - Early detection/warning, alarm, of critical conditions
 - **Multichannel** Event reporting: email, Telegram, mobile apps, SMS, etc.
 - Managing maintenance operation
 - Computing predictions on KPI
 - Computing predictive maintenance
- **Solutions for Planning (optimization and what-if analysis)**
 - Generative AI and predictive AI for production plan optimisation
 - Reduction maintenance costs, reduction of critical SLA conditions, improving quality level
- **Algorithms and computational solutions, see next slide**

Workflow for Ticket management



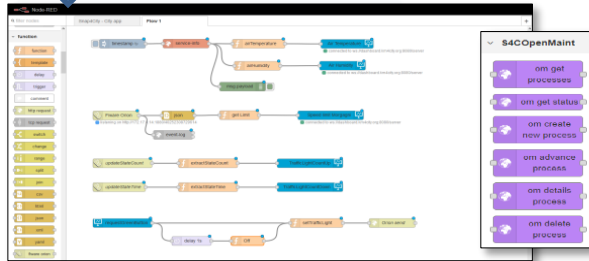
Consumptions/productions



Events/actions

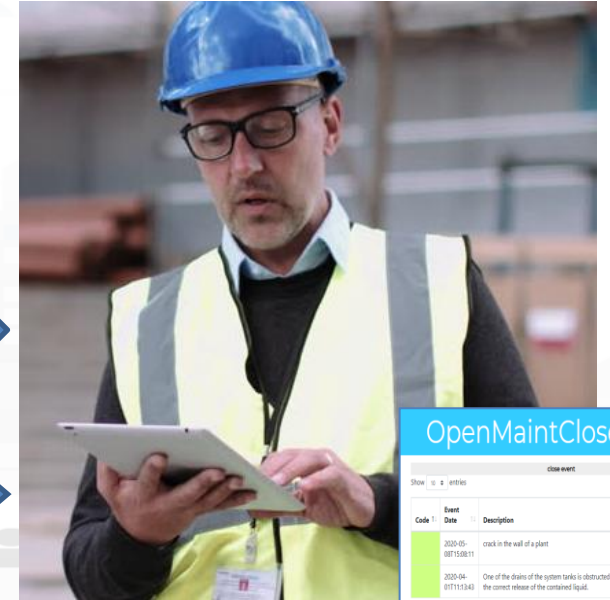
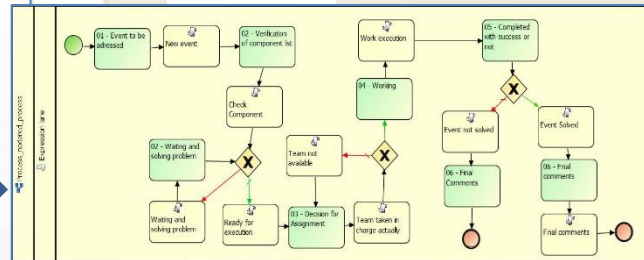
Business Intelligence
Maintenance

Dashboards and actions



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

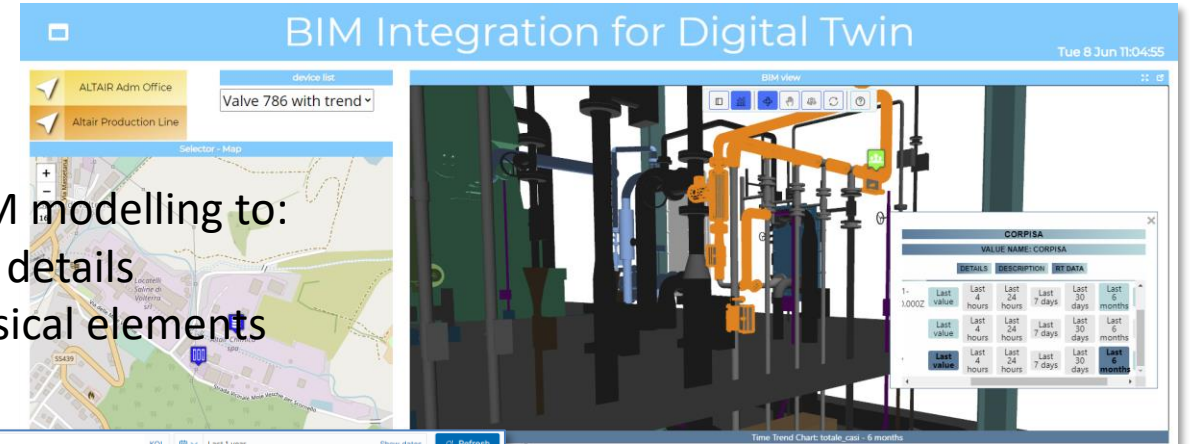
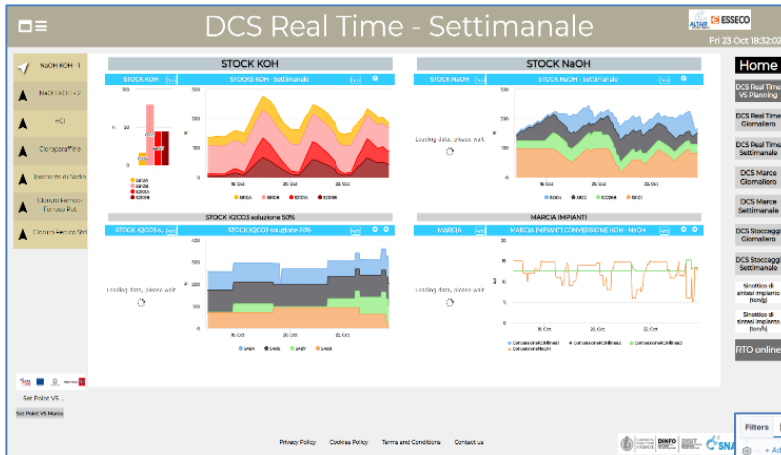
OpenMaint: BPM Workflow management, team assignment, material control, ...



OpenMaintCloseEvent

Event Code	Date	Description	Controls
2020-05-0815:08:11		crack in the wall of a plant	Adesso
2020-04-0711:13:43		One of the drains of the system tanks is obstructed and does not allow the correct release of the contained liquid.	Adesso

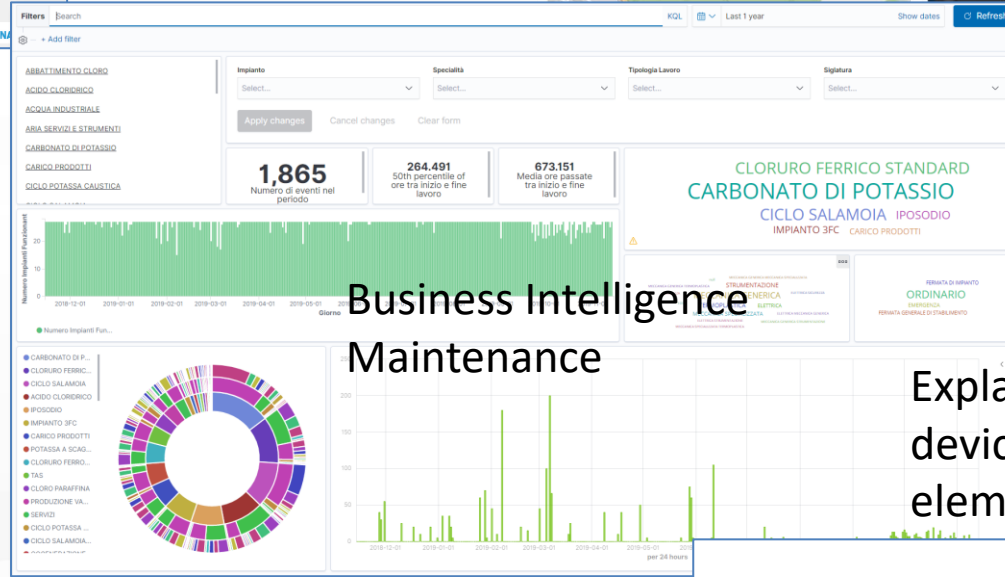
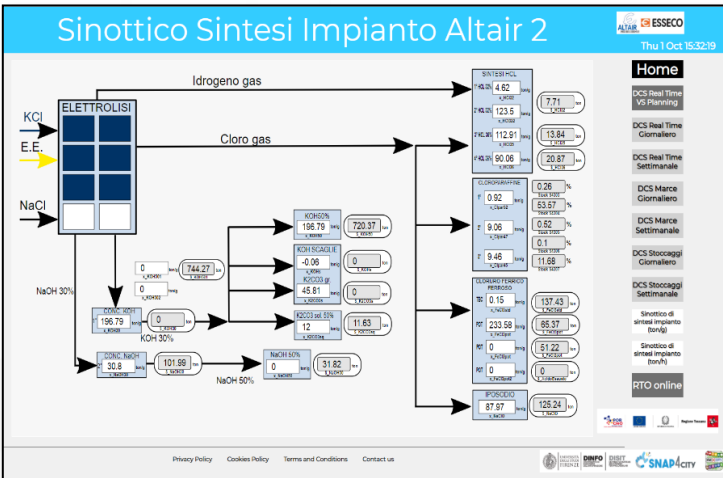
Closing the loop



Map and 3D BIM modelling to:
-- represent the details
-- associate physical elements with data

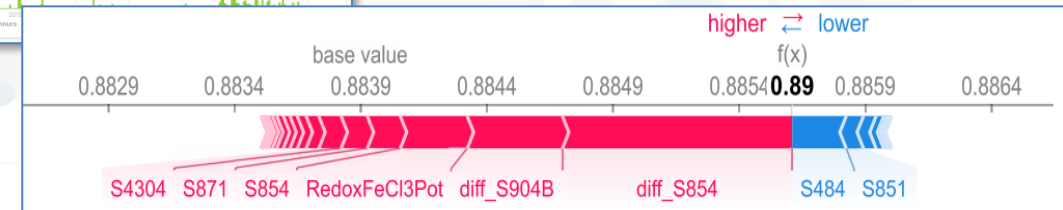
Historical and Real Time Data

Synoptics for real time monitoring



Business Intelligence
Maintenance

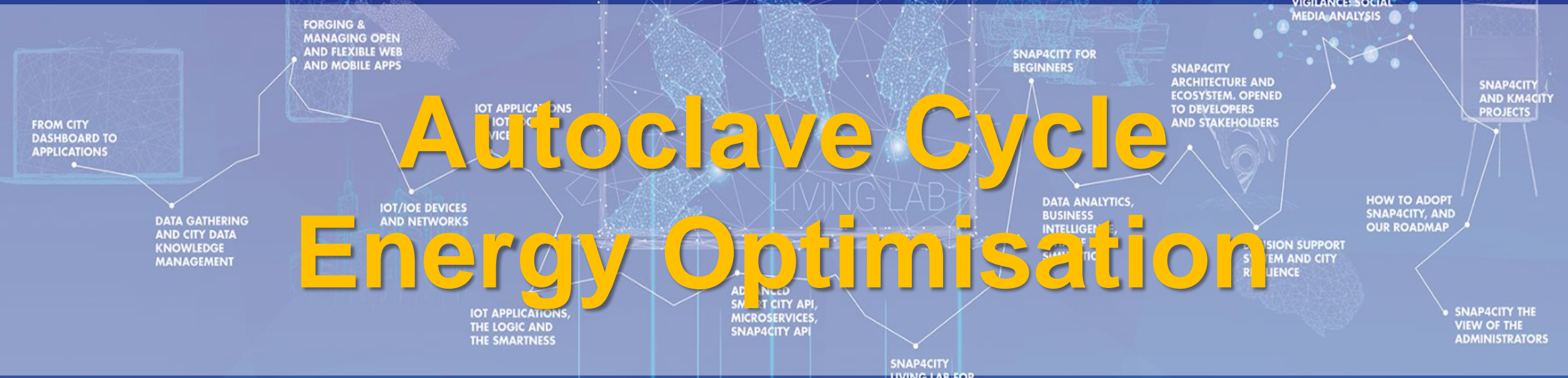
Explainable AI to map critical values of devices and detection to physical elements in the plant



<https://www.snap4city.org/dashboardSmartCity/view/index.php?iddashboard=MzA1NA==>

TOP

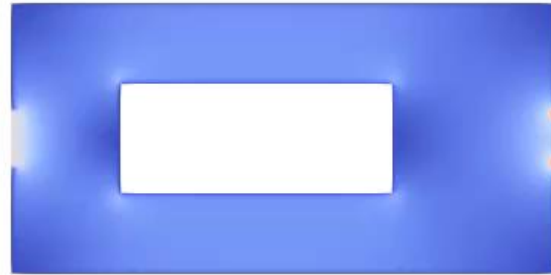
Autoclave Cycle Energy Optimisation



PINN: Physically Informed Neural Networks Models

- **Solving Navier-Stokes PDE** (partial differential equations) equation, **via PINN** approach
 - Reduction of computing costs for simulating load effect into the autoclaves curing process
 - Validation wrt Open Foam
 - Precision on steady and transitory cases
 - Definition of Transfer Learning techniques
- Videos on <https://www.snap4city.org/1010>

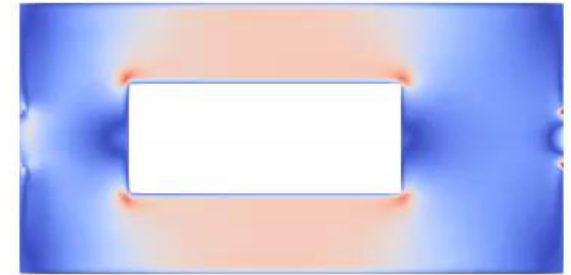
Comparison of PINN vs OpenFoam and error



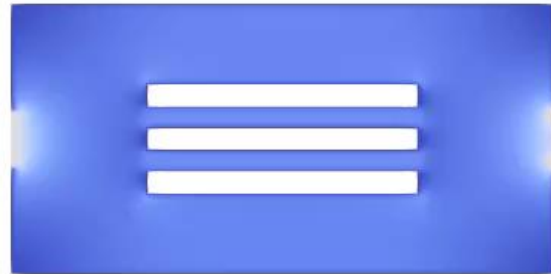
OpenFoam
0.000 2.000



MFN-PINN (512)
0.000 2.000



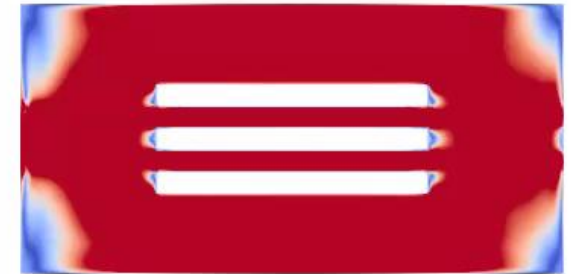
Absolute Error
0.000 0.250 0.500



OpenFoam
0.000 2.000



MFN-PINN
0.000 2.000



Absolute Error
0.000 0.050 0.100

Sinottico Impianto Presse - Autoclave

Stato Presse

Select Pressa

PRESSA 6

Press to update the list

Status

NO STATUS

Tempo Vulcanizzazione Pressa

Tempo Preriscaldamento Pressa

Temperatura Settore Pressa

Pressione Pressa

Temperatura Piani Pressa

Stato autoclave

USCITA_PRESSIONE: 100 %

INGRESSO_VAPORE: 0 %

Internal pressure: 0.027999997 BAR

Air Temp.: 28.666666 °C

Hitc Temp.: 27 °C

Lotc Temp.: 27 °C

SP Air Temp.: 0 °C

Motor: 0 A, 0 rpm, 0 kW

TEMP_MOTORE_VENT: 27.1 °C

TEMP_RAFFREDDAMENTO: 27.7 °C

NOME RICETTA: Cilindri ebanite aria calda

- Main Dashboard
- Autoclave db - Weekly
- Autoclave KPI - Weekly
- Impianto Presse - Weekly
- OpcUaValues - Weekly
- OpcUaValues and Historization

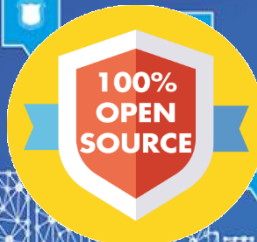


<http://dashboard/dashboardSmartCity/view/index.php?iddashboard=MTk=>

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

Developing on Snap4City

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



FROM CITY DASHBOARD TO APPLICATIONS

DATA AND KNOWLEDGE MANAGEMENT

FORGING & SHAPING THE FUTURE OF SMART CITIES AND IOT APPS

IOT APPLICATIONS VS IOT EDGE DEVICES

TWITTER VIGILANCE: SOCIAL MEDIA ANALYSIS

SMART CITY ARCHITECTURE AND ECOSYSTEM, OPENED TO DEVELOPERS AND STAKEHOLDERS

SNAP4CITY AND KM4CITY PROJECTS

OPT AND API

SNAP4CITY THE VIEW OF THE ADMINISTRATORS

Snap4City Developers ? Who they are?

- **Operators of the City** on: mobility and transport, environment, energy, tourism, safety, etc. Typically they work on
 - **Operation**: load data, monitor conditions via dashboards, receive multimodal early warning, act on ticketing systems, etc.
 - **Planning**: solving their problems via optimization tools provided
- **Integrators and Researchers**. Typically they:
 - **exploit tools and AI/XAI of Snap4City** for implementing advanced solutions, which remain of their Property Right
 - **develop new**: AI/XAI solutions, applications and tools which remain of their Property Right
- **Living Lab support and Development Support**

<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

Snap4City Training vs Targets/goals

- **Estimate Indicators: P1, P2, P3, P4, P5**
 - IoT App/Proc.Logic JavaScript, Data Analytics, Dashboards to see data and results
- **Load additional data: P1, P2, P3, P5**
 - IoT App/Proc.Logic JavaScript, IoT Directory, ServiceMap, advanced interoperability, Dashboards to see them
- **Performing AI/XAI on accessible data: P1, P2, P3, P4, P5 (P8)**
 - IoT App/Proc.Logic JavaScript, ServiceMap, ASCAPI, Python, Dashboards to see data/results
- **Developing Business intelligence: P1, P2, P3, P7, P8**
 - IoT App/Proc.Logic JavaScript, Dashboards to see them, ASCAPI, CSBL for making them intelligent, JavaScript
- **Developing Web and Mobile Apps: P1, P2, P3, P7, P8**
 - ServiceMap, ASCAPI, Dashboards
- **Deploy, install, test and management: P1, P2, P3, P6**
 - IoT App/Proc.Logic JavaScript, ServiceMap, Dashboards to see them

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>

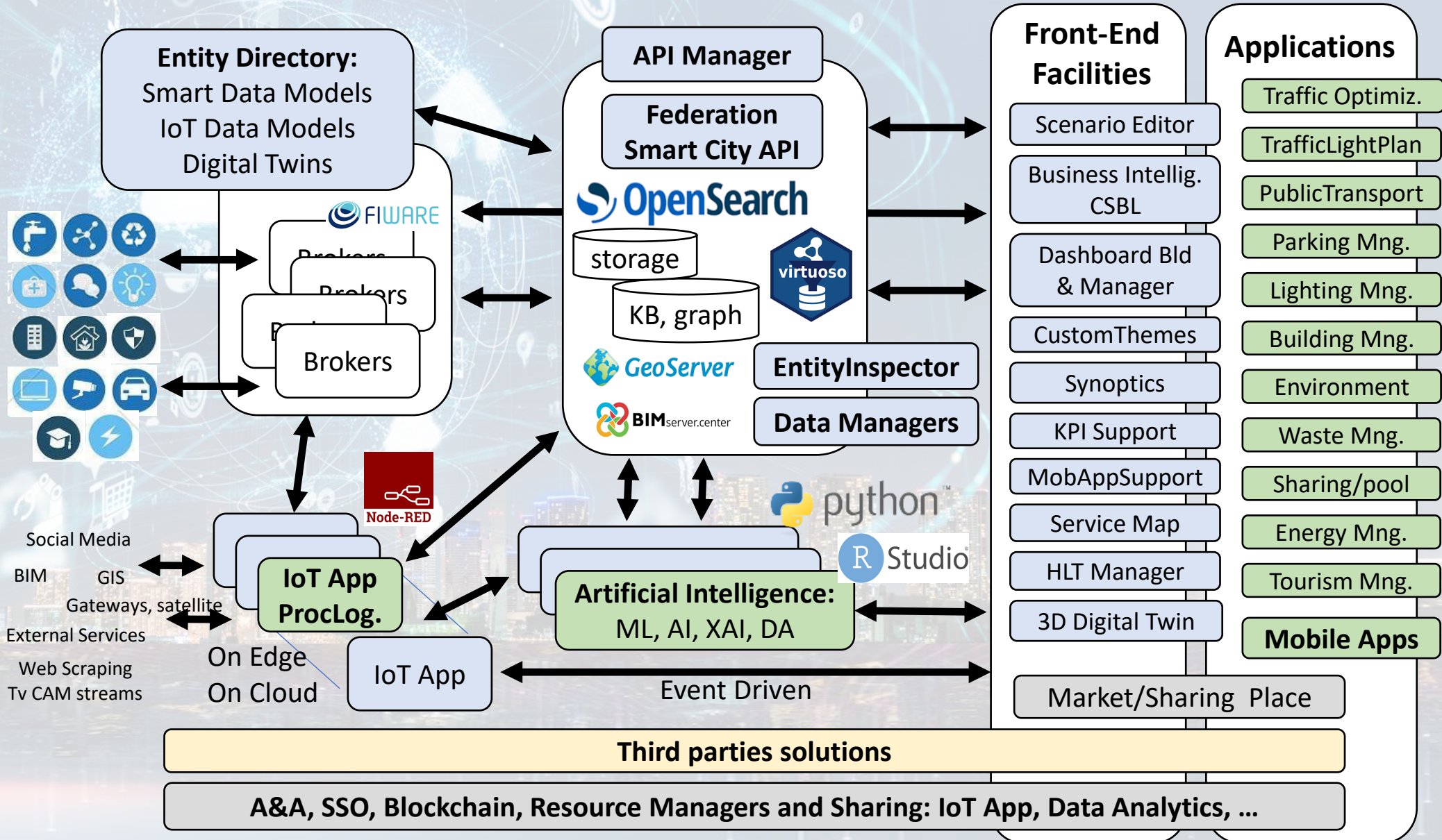
From Snap4City:

- 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-u4vandq>

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

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

Technical Architecture



Visual Development Tools



My IOT Sensors and Actuators

Add My New Device

Entities/Devices Management

ID	Device Name	Device Type	Model	Category	Color	Status	IP	Serial	Location
AN-QualityObservedMMA42802	Antwerp	AirQualityObserved	custom	INDOOR	Antwerp	INDOORfactoryAntwerp	active	192.168.1.1	192.168.1.1
AN-QualityObservedMMA42802	Antwerp	AirQualityObserved	custom	INDOOR	Antwerp	INDOORfactoryAntwerp	active	192.168.1.1	192.168.1.1
AN-QualityObservedMMA42802	Antwerp	AirQualityObserved	custom	INDOOR	Antwerp	INDOORfactoryAntwerp	active	192.168.1.1	192.168.1.1
AN-QualityObservedMMA42802	Antwerp	AirQualityObserved	custom	INDOOR	Antwerp	INDOORfactoryAntwerp	active	192.168.1.1	192.168.1.1
AN-QualityObservedMMA42802	Antwerp	AirQualityObserved	custom	INDOOR	Antwerp	INDOORfactoryAntwerp	active	192.168.1.1	192.168.1.1

Service Map (Toscana)

Data Inspector

My Dashboards in My Organization

My Data Dashboard Dev Kibana

29,146,065

3D MAP GLOBAL DIGITAL TWIN - NEWGUI

Client-Side Business Logic - Test

Proc.Logic / IoT App

Jupyter2-(7)5 Hub - Python

FIRENZE - TRAFFAIR - AIRQUALITY HEATMAPS - NEWGUI

ISMinindex

Custom Widgets / Synoptics

Mainten
Inspector
Managers

Service M

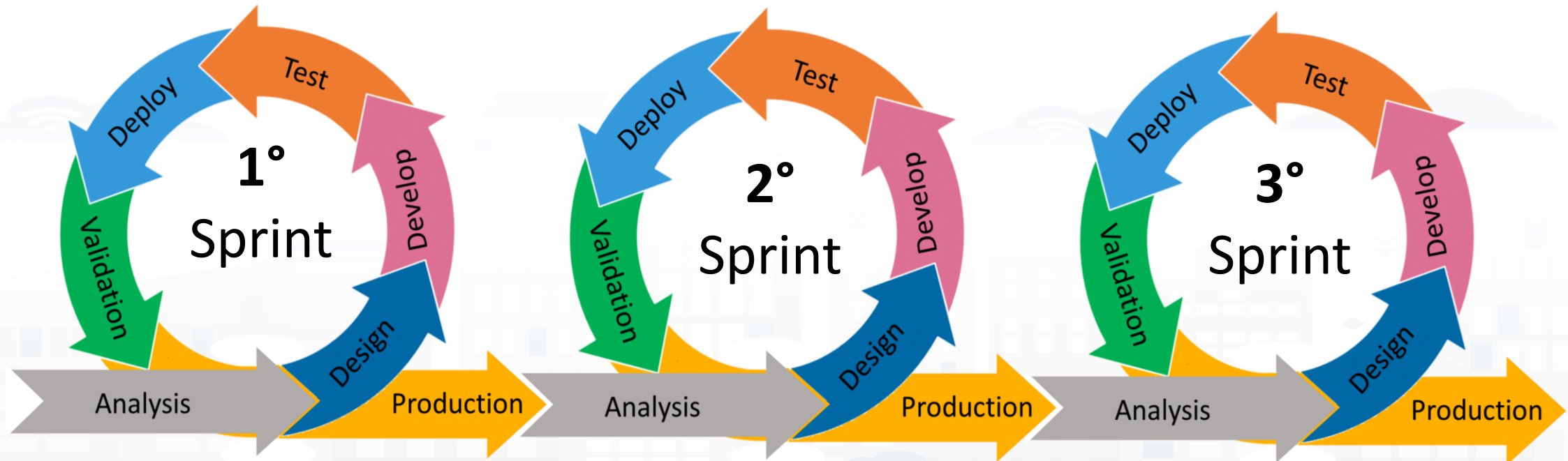
Third parties solutions

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

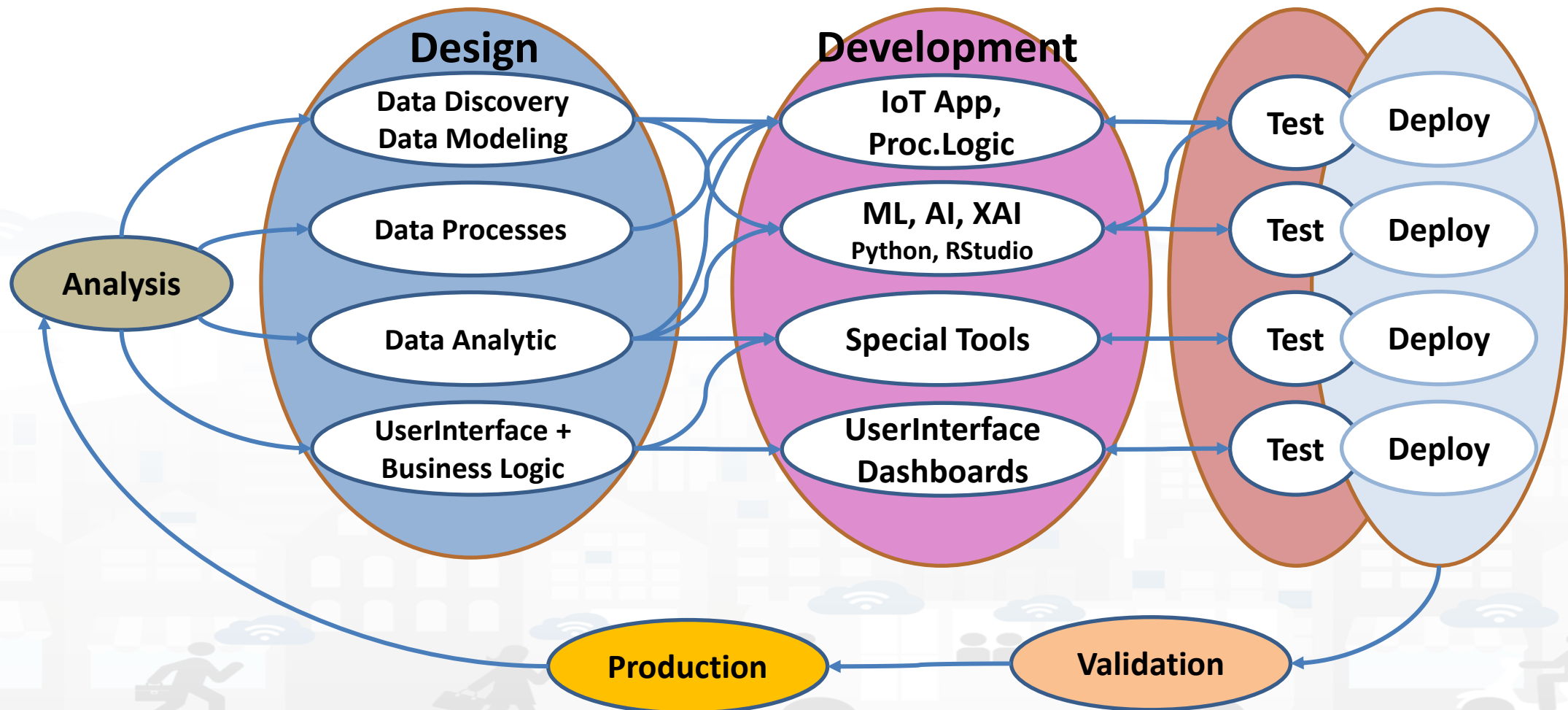


Agile Development Life Cycle by sprint

Smart Solutions



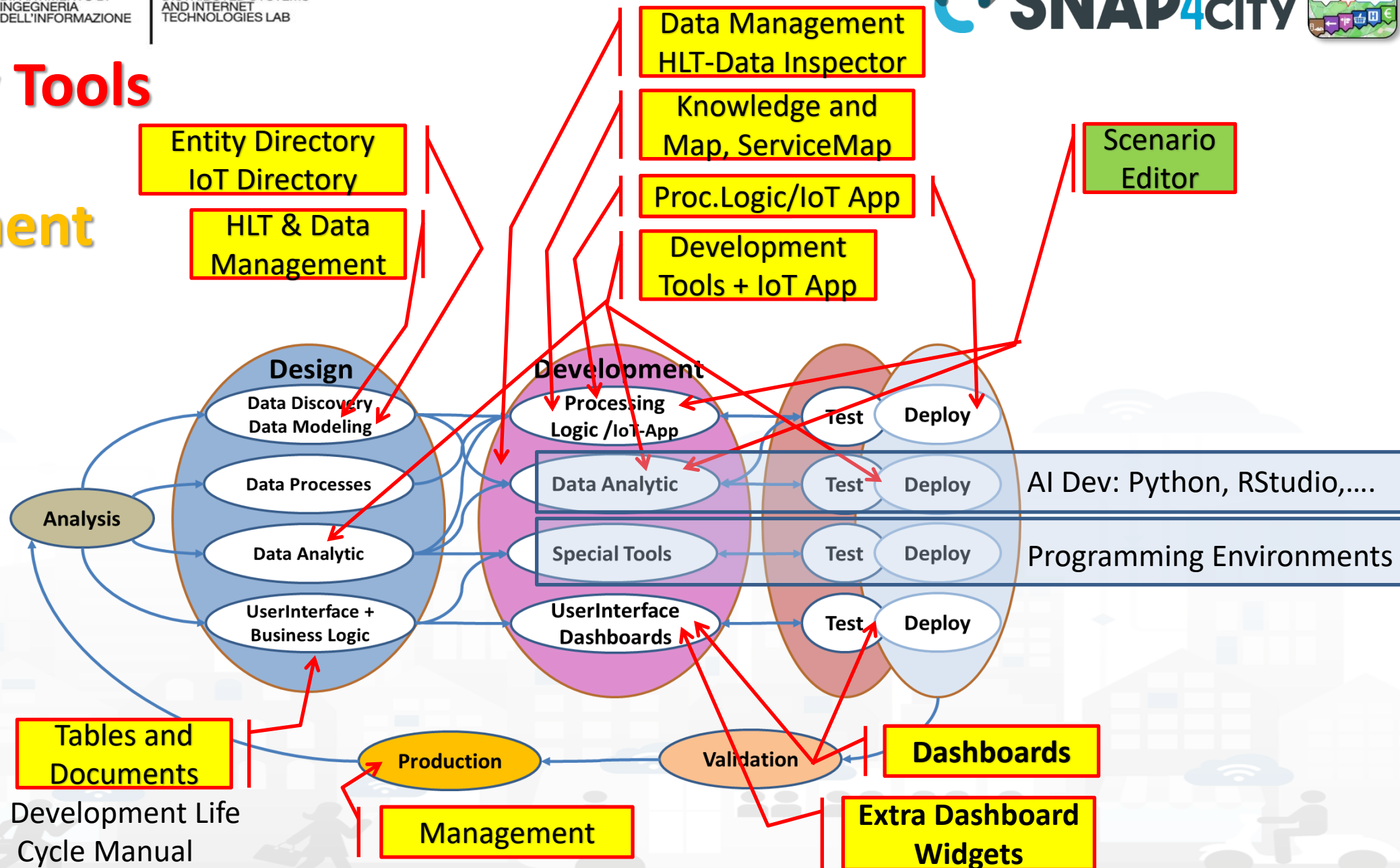
Development Life Cycle Smart Solutions



Snap4City Tools

vs

Development Life Cycle



Ciao roottooladmin!

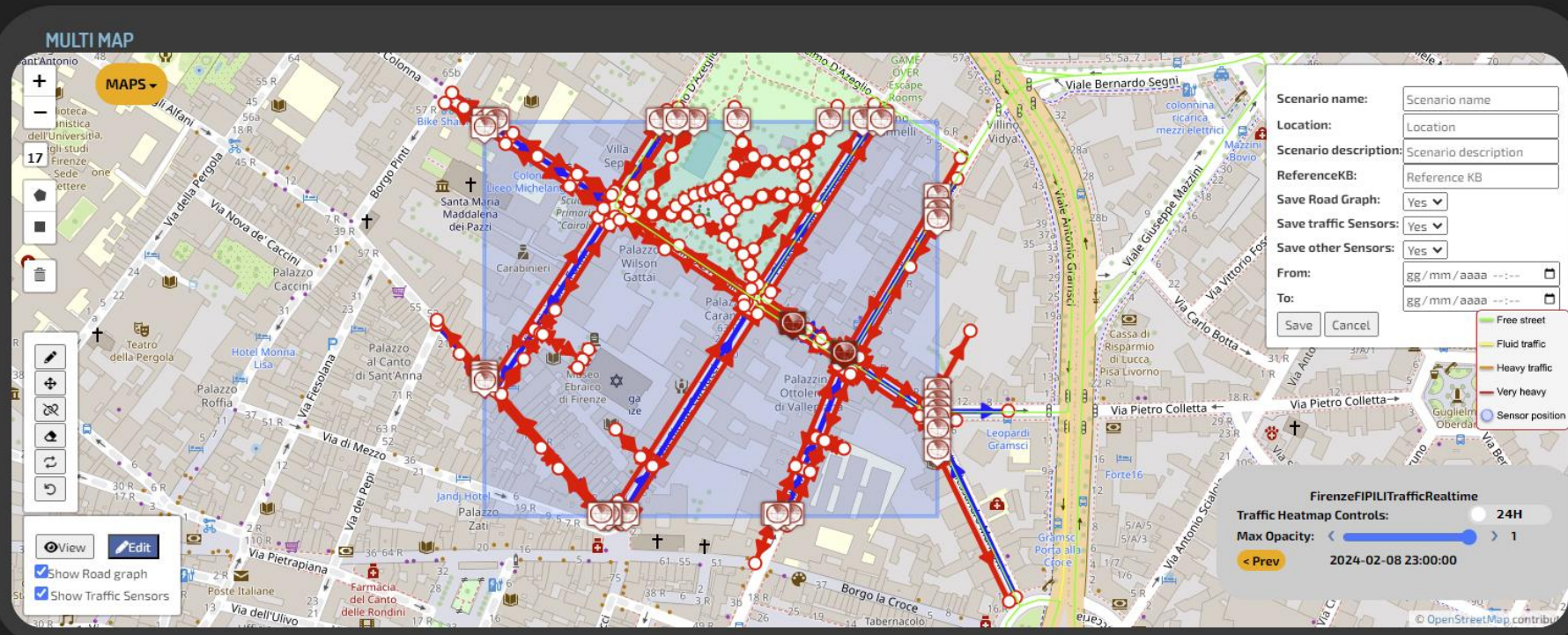
Wed 14 Feb 22:40:02

FIRENZE - TRAFAIR - AIRQUALITY HEATMAPS - NEWGUI

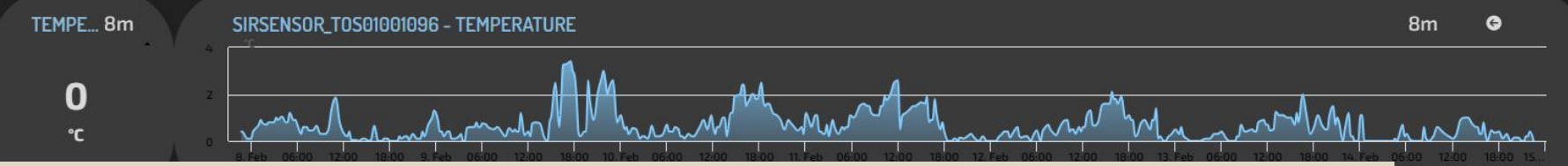
This dashboard contains data derived from actual sensors and predictive values under validation



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



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



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

Select map

Zoom

The interface shows a map with various road segments. A settings panel on the right allows editing a road segment with the following fields:

- Scenario name: Scenario name
- Location: Location
- Scenario description: Scenario description
- ReferenceKB: Reference KB
- Save Road Graph: Yes
- Save traffic Sensors: Yes
- Save other Sensors: Yes
- From: gg/mm/aaaa --:--
- To: gg/mm/aaaa --:--
- Buttons: Save, Show Summary, Cancel

A 'Category Street' panel shows:

- Category Street: primary
- Nr.Lanes: 3
- Speed Limit (km/h):
- Direction: Positive direction
- Restrictions: Select or create restriction
- Button: Update

A 'Road Types' panel lists various road categories with checkboxes for selection:

- Select All
- Unselect All
- abandoned
- corridor
- emergency_access_point
- motorway
- primary
- residential
- services
- traffic_island
- secondary
- brideway
- crossing
- emergency_bay
- motorway_link
- primary_link
- rest_area
- steps
- tram
- yes
- bus_guideway
- bus_stop
- disused
- island
- path
- raceway
- secondary_link
- service
- track
- via_ferrata
- bus_guideway
- ohm.military:Trench

At the bottom right, a list of 'Properties of Road Elements' is shown:

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

Edit Road Segment

New Scenario

Editing

Drag & drop

Split & Join

Delete

Do and Undo

ScenarioBuilder

Tue 12 Mar 15:53:34

Call the Scenario Editor

Some Points of Interest

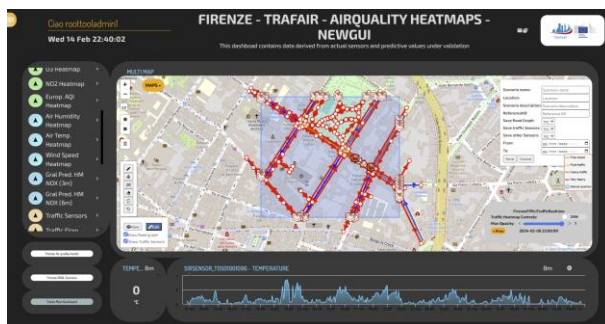
Load Scenario: Init Acc TDM

Scenarios waiting to be processed: FDSA Load Scenario

- Show Road graph
- Show Traffic Sensors
- Filter by road types

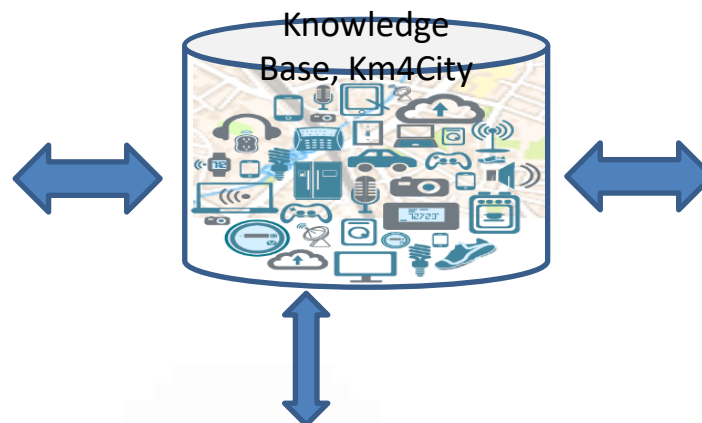
© OpenStreetMap contributors

The actual Scenario Exploitation



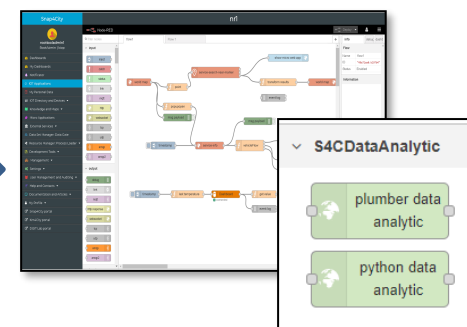
Defining Context via Editing Scenario:

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



A Scenario includes:

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



Computing in the Scenario Context as:

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

ReLoading Scenario in JavaScript

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



Part 2: Dashboard production and management

Part 2: Dashboards
production and
management

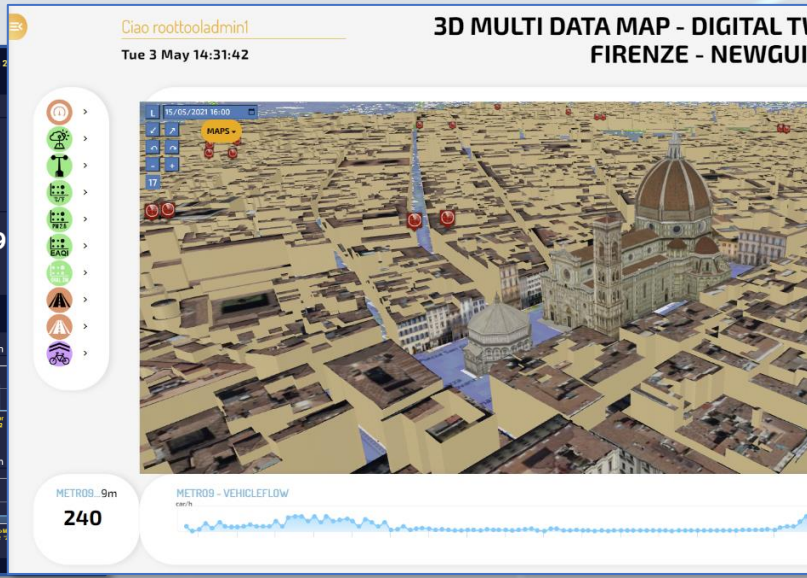
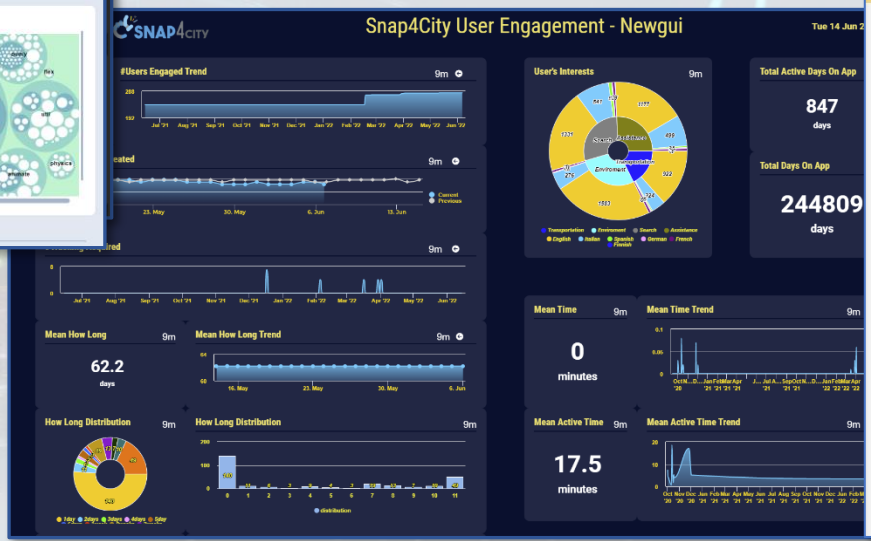
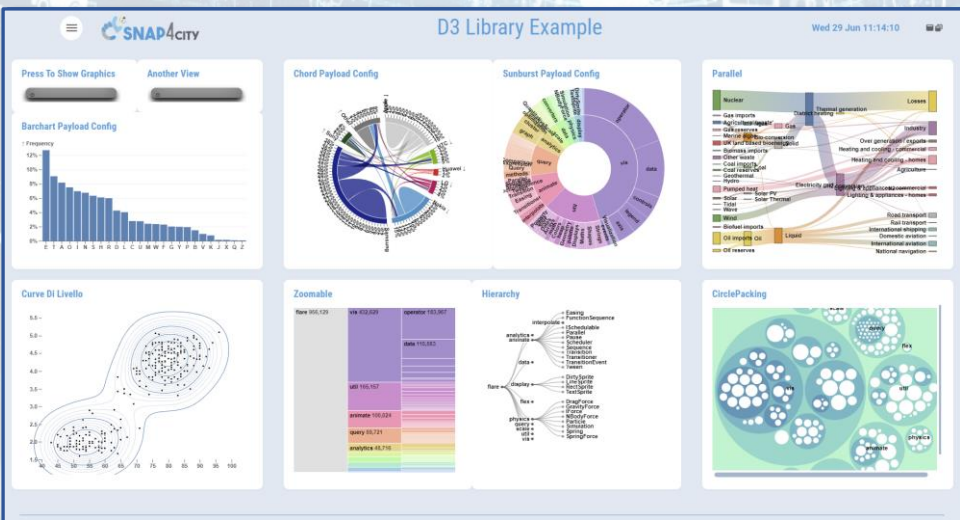
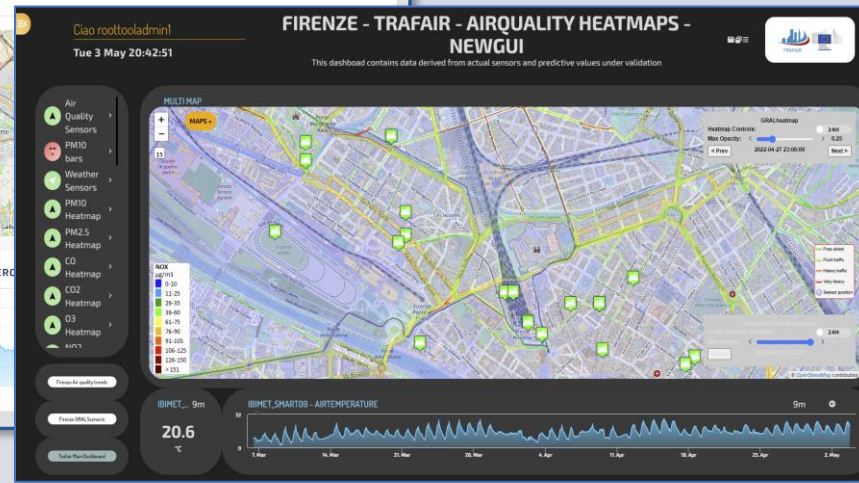
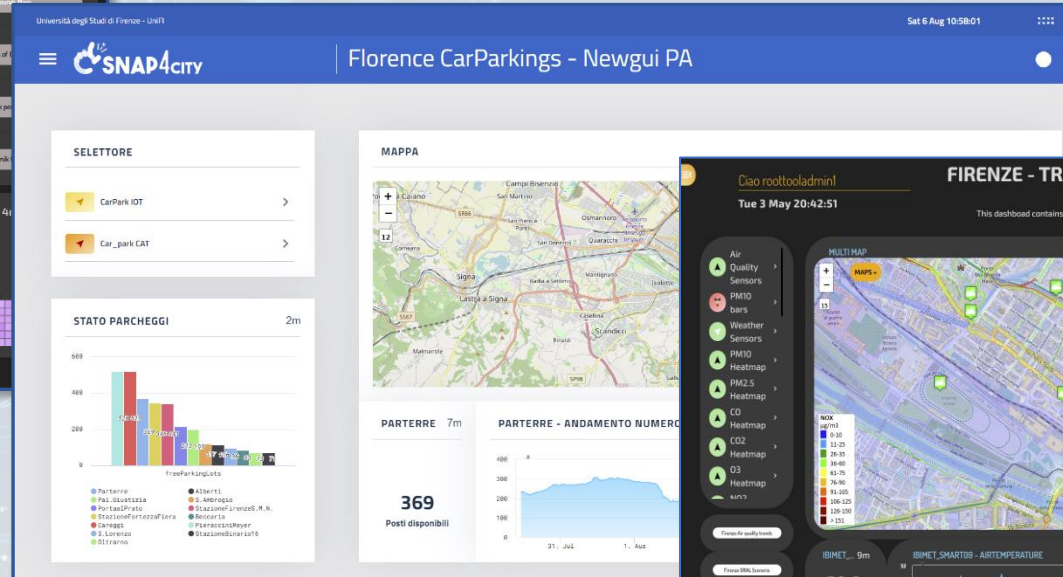
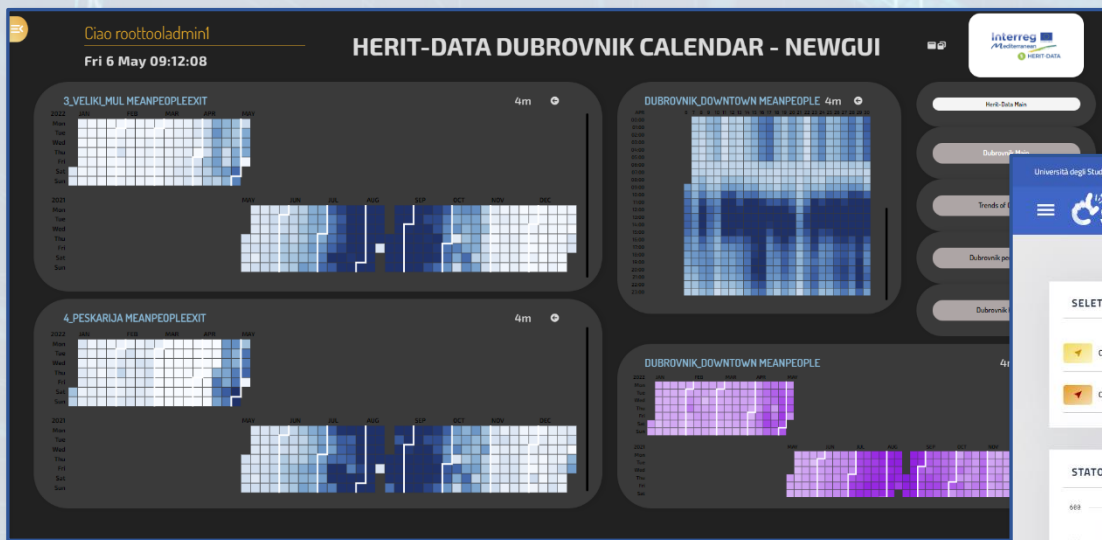
[SLIDES](#)

[Interactive Slides](#)



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

Different Themes



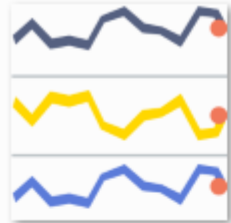
New styles/themes can be developed by specializing a few files from open source

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

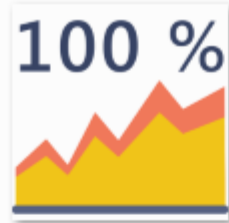
Visual Representations



Slider with multiple steps for KPI



sparklines



kpi



histogram



heatmap



flow-maps



geo-maps



donut-chart



Data-grid



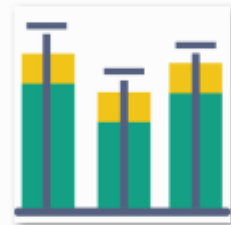
chord



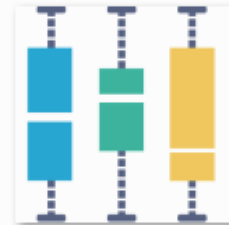
Cone



Bubble-matrix chart



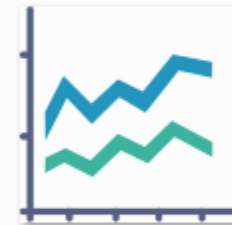
Bullet



Box-plot



staked-area



Stacked-line chart



Stacked-combination Chart



spider-maps



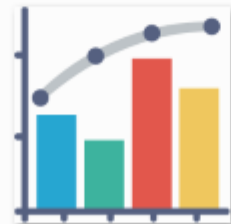
Sequence-Sunburst



Pivot



pie-chart-1



Pareto-chart



radar



Bubble-maps



waterfall



Sunburst



Sankey

Dashboard Builder: Development

Data Transformation
Business Logic

IOT Applications

Knowledge Base,
Km4City

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

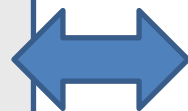


Widget Collection

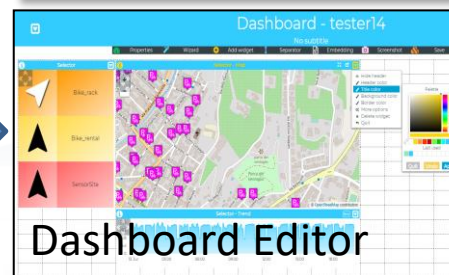
Micro Applications

External Services

Custom Widgets/
Synoptics

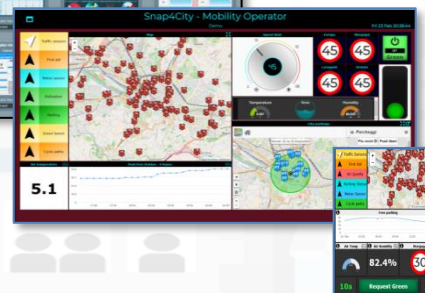


Dashboard Wizard



Public
Dashboard
Collection

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



My Own Dash/App



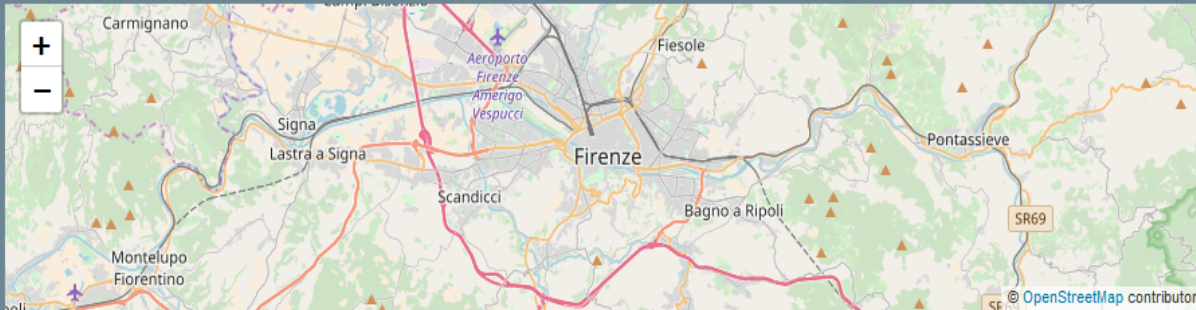
Wizard



Dashboard features

Data and widgets

Map



Single data widgets



Multi data widgets



Data sources

High-Level Type	Nature	Subnature	Value Type	Value Name	Data Type	Last Date	Last Value	Healthiness	Last Check	Ownership
Special Widget	Environment	Weather Forecast	Previ_Meteo	Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast	Previ_Meteo	Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast	Previ_Meteo	Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast	Previ_Meteo	Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast	Previ_Meteo	Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast	Previ_Meteo	Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast	Previ_Meteo	Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast	Previ_Meteo	Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast	Previ_Meteo	Previ_Meteo	special weather				2018-07-08 16:00:18	public

• Select the area of your interest: panning and zooming

• Select the

• graphic aspect of your interest, or

• High Level Type of your interest, or

• Make a search if you have a precise idea or

• Act on filters: nature, subnature, type, name, value, date, health, owner, ...

• Combine them as you like

• Select the lines of your interest

• Then click on Next and get the Dashboard by wizard



Close

New Data Inspector/Wizard

New Wizard

Data Inspector BETA OS

The interface includes a map of Florence, a 'Single data widgets' panel with various visualization options, a 'Multi data widgets' panel, and a 'Data sources' table. The table has columns for Level, Type, Nature, Subnature, Device, Model, Broker, Value Name, Value Type, Data Type, Value Unit, Last Date, Last Value, Healthiness, Last Check, and Ownership. A line graph below the table shows data trends over time.

- 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

Widget selection

Single data widgets

Multi data widgets

FilterMap GPSUser GPSOrg

All selected (1626) All selected (73) All selected (95) selected (3)

Map Co

Widget showing a multi-data list of point of interests, IOT devices, heatmaps and geometries (e.g.: traffic flows, cycle paths), with a map showing the position of the POIs, a set of sources have to be provided

New Data Inspector/Wizard

New Wizard

Data Inspector BETA OS

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

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

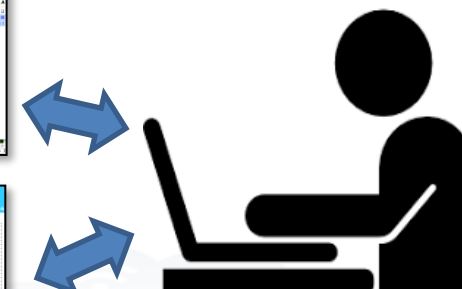
- Filtering/Searching for individual fields (even for some fields not displayed as geographic coordinates)
- Geographic Filtering
- Text Search on all fields
- Menu for choosing the fields to display in the table
- View on Map(via PREVIEW)
- Data and Trend visualization
- Opening Digital Twin
- Pass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

Custom Widget / Synoptic / PIN Development

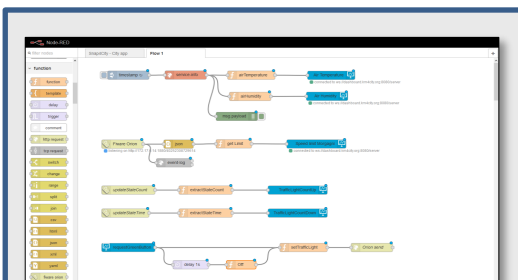
Inkscape editor on your computer



Create, save a Custom Widget in SVG



Create, save, load, delegate, grant access

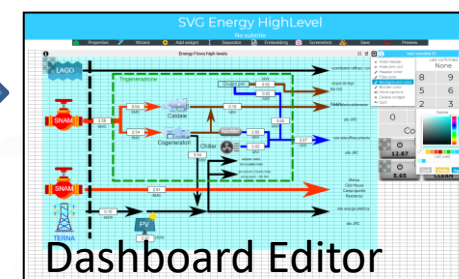
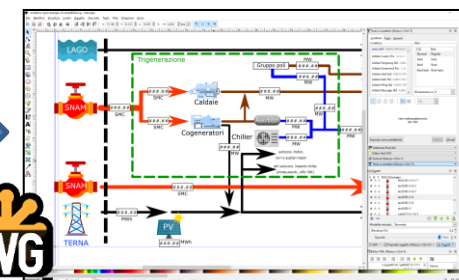


IOT Applications

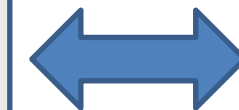


Knowledge and Storage Data from the Field and City

SVG Symbols Collection



Dashboard Editor



Public

Dashboard
Collection

My Own Dash/App

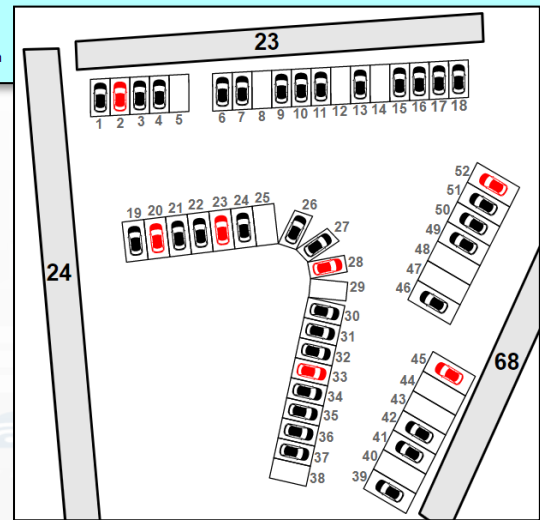
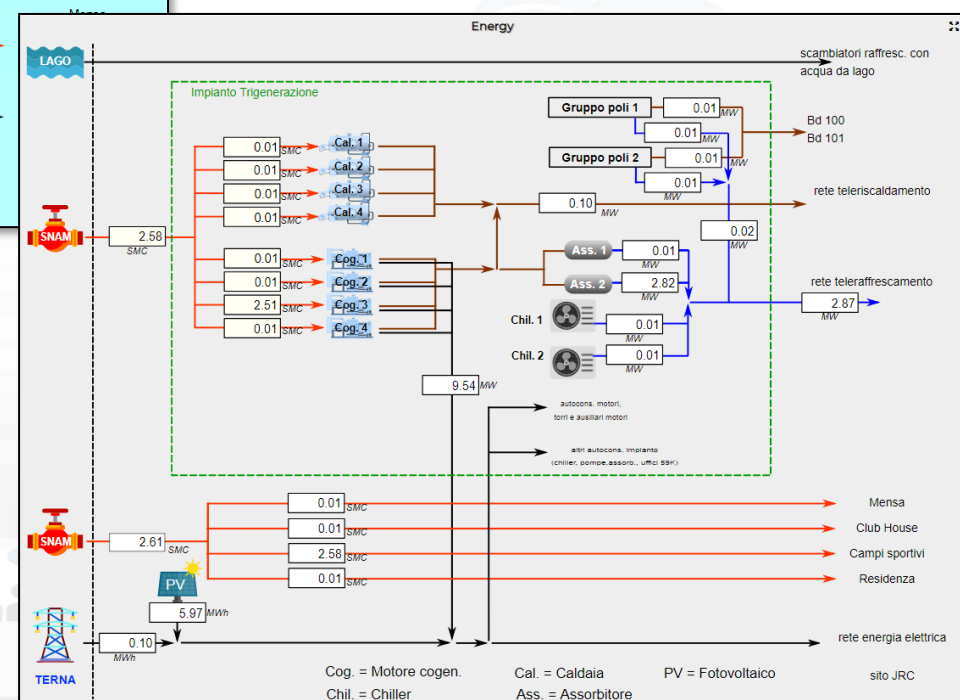
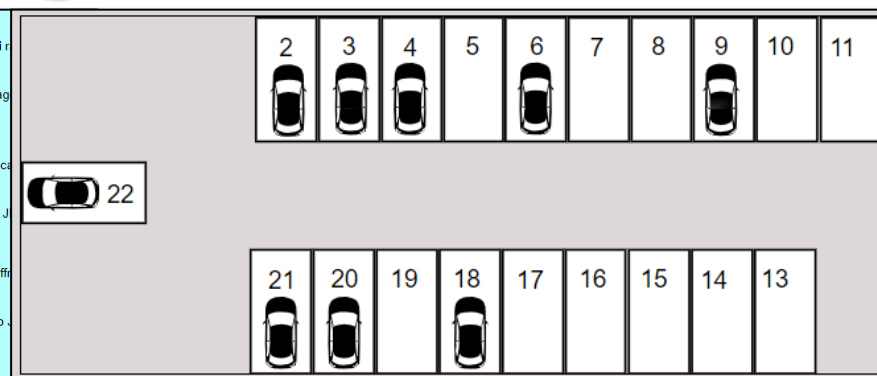
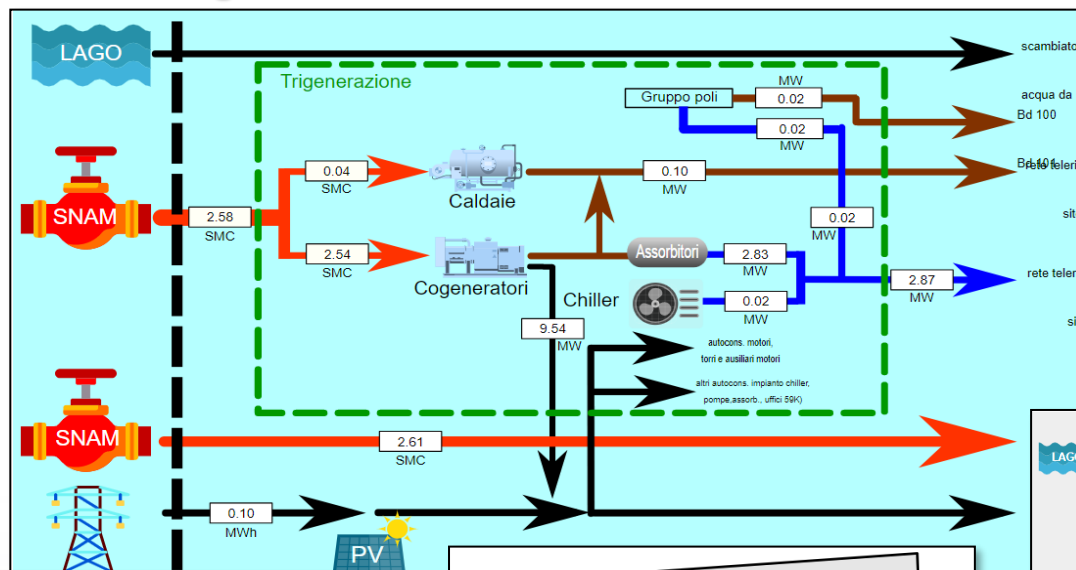


1. Create and Load a Custom SVG
2. Select/Reuse an SVG
3. Make and Instance of Synoptic by Associate Variables with MyKPI
4. Create on Dashboard a Widget based on Synoptic HLT such as Ext. Srv.:

- <https://www.snap4city.org/synoptic/v2/synoptic.html?id=xxxx>

Special Custom Widgets

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



Custom control widget showing a row of five smiley faces (from -2 to 2) and a display for "Total clicks" (6) and "Mean rate value" (0.00).

Custom control widget showing "Begin" (17:00) and "Finish" (4:00) time slots, a row of five smiley faces, and a display for "Total clicks" (6) and "Mean rate value" (0.00).

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

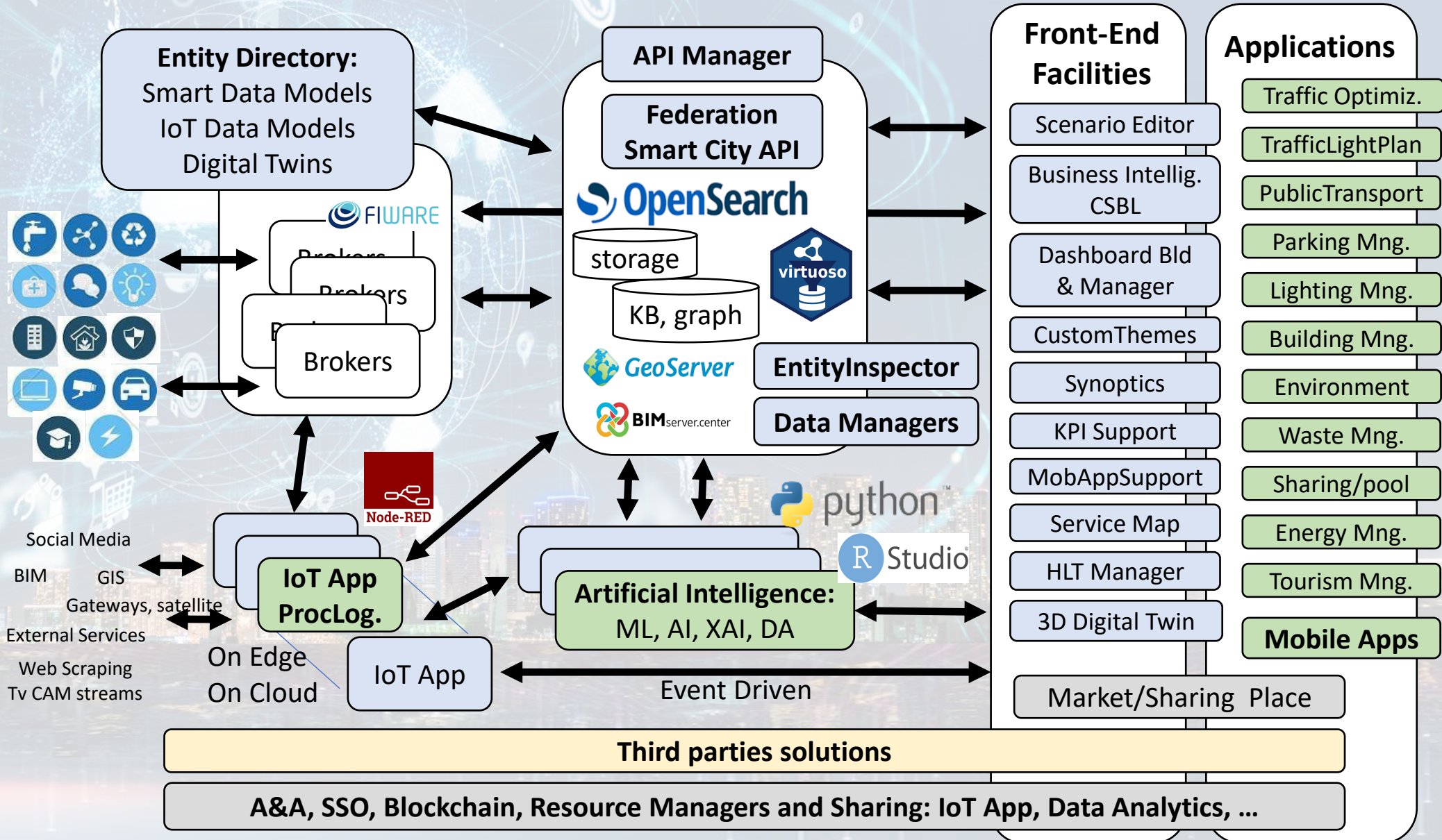
Part 3: IOT App, Process Logic, Server Side Business Logic

[SLIDES](#)

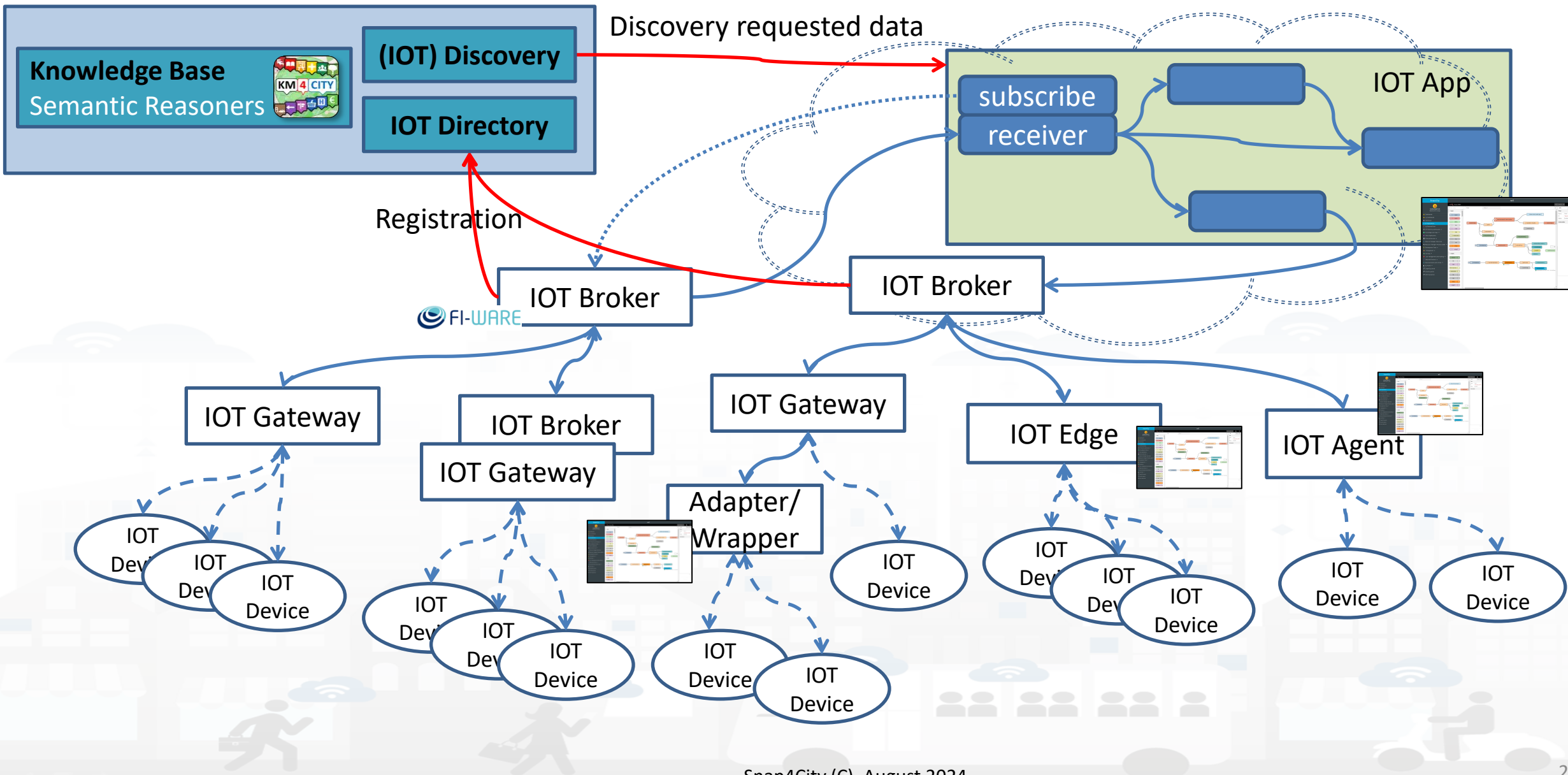
[Interactive Slides](#)



Technical Architecture



IoT Network



The image shows a Node-RED interface within the Snap4City environment. The main workspace displays a flow named 'flow1' with several nodes: 'world map', 'point', 'service-search-near-marker', 'transform results', 'show micro web app', 'event-log', 'popuopen', 'msg.payload', 'timestamp', 'service-info', 'vehicle flow', 'vehicle flow (car/h)', 'worldmap', 'switch', 'sensor', 'last temperature', and 'Temperature'. The left sidebar contains a 'filter nodes' search bar and lists various input and output nodes. The top right corner features the Snap4City logo and a 'Deploy' button. The bottom right corner shows a 'Node-RED' logo and a gear icon.

Data Adaption

Data Transformation, Conversion

Data Integration, Interoperability

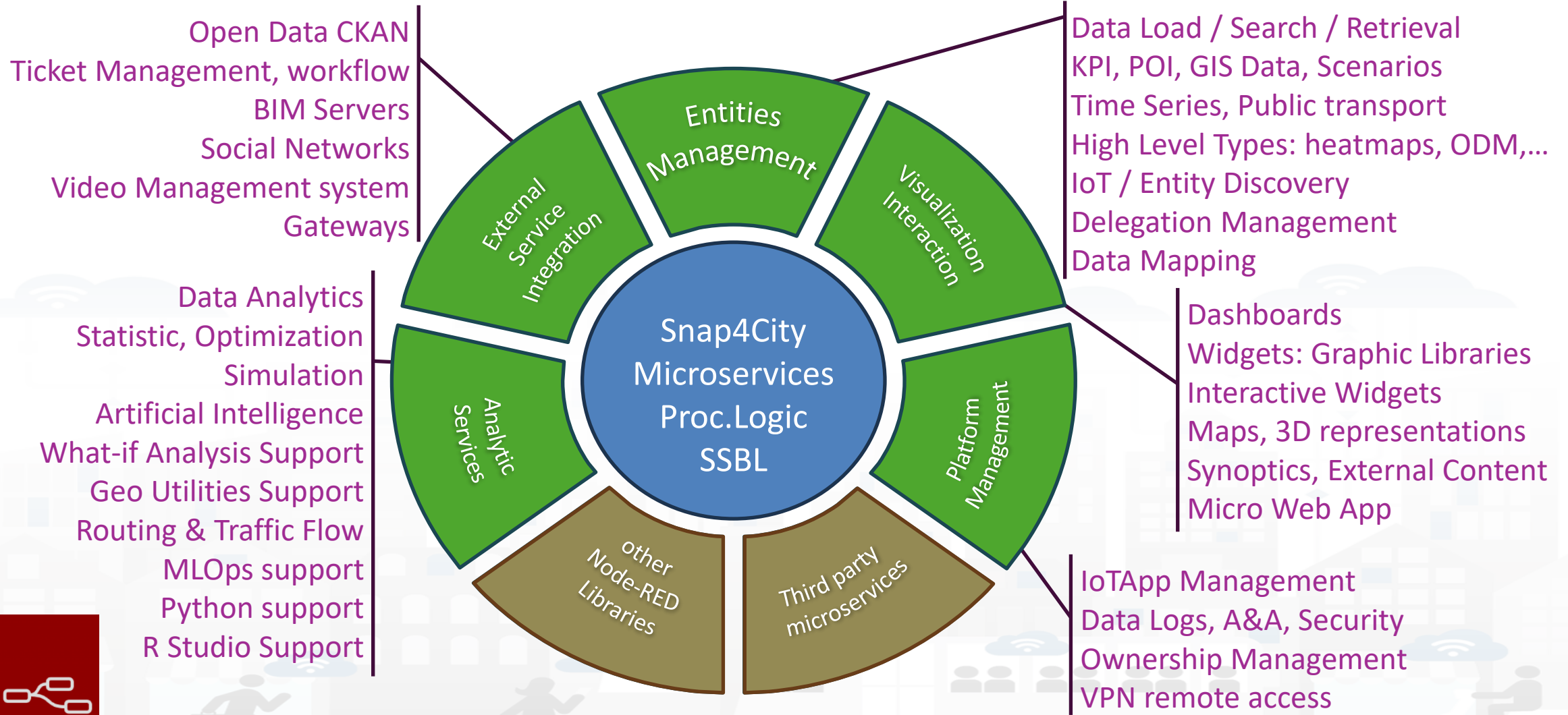
Business Logic vs Dashboards

Editing IOT Applications

Data Analytics control

Everywhere: Cloud, on IoT Edge Devices

Areas





Sept 2024 collection

Two Snap4City Libraries



Navigation menu on the left:

- > common
- > function
- > network
- > input
- > output
- > sequence
- > parser
- > storage
- > social
- > advanced
- > Advanced FTP
- > location
- > NGSi
- > Iwm2m
- > S4C SearchDev
- > S4C Utility
- > S4C Mapping
- > S4C Management
- > S4C Data Analytic
- > S4C Big Data
- > S4C IoT App
- > S4C Open Maint
- > S4C IoT
- > S4C Whatif
- > S4C Search
- > S4C Data
- > S4C KPI Data
- > S4C Dashboard
- > S4C Sigfox
- > S4C LogDev
- > S4C View
- > S4C Social
- > dashboard
- > time

Library categories and their contents:

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

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

▼ S4CUtility

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

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

- service info dev
- service info dev
- service info

Loggia San Paolo

LINKED OPEN GRAPH

Tipology: CulturalActivity - Monument_location

Digital Location

Address: VIA DELLA SCALA, 3

Cap: 50123

City: FIRENZE

Prov.: FI

Photos:

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

TPL STOP : Piazza Stazione (Fr. Cc)

Vaubus

LINKED OPEN GRAPH

Lines:

FI-LU FI-VG

No available routes

Display 50 Bus per page

Search:

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

Showing page 1 of 1

Real-time data currently not available

AURORA

LINKED OPEN GRAPH

Tipology: Accommodation - Hotel

Email: info@hotelaurora.info

Website: www.hotelaurora.info

Phone: 055210283

Address: VIA L. ALAMANNI, 5

Cap: 50100

City: FIRENZE

Prov.: FI

Giardino di piazza dell'Indipendenza

LINKED OPEN GRAPH

Tipology: Entertainment - Green_areas

Digital Location

Address: PIAZZA DELLA INDIPENDENZA, 15

Cap: 50129

City: FIRENZE

Prov.: FI

Note: areeeverdi238

Remove from map

ZCS_1_D

LINKED OPEN GRAPH

Tipology: TransferServiceAndRenting - Controlled_parking_zone

Digital Location

Address: VIA GUSCIANA

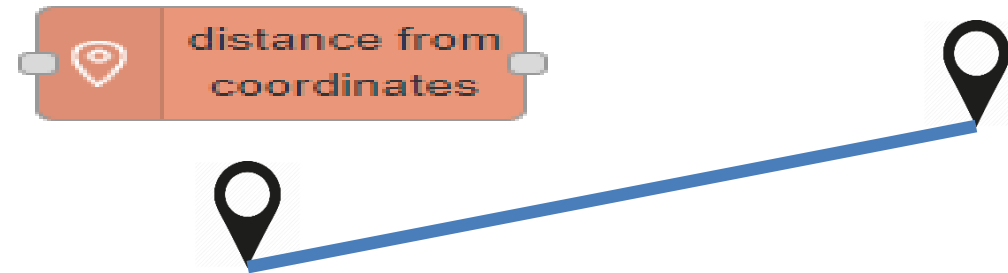
Cap: 50124

City: FIRENZE

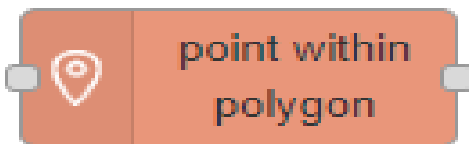
Prov.: FI

Remove from map

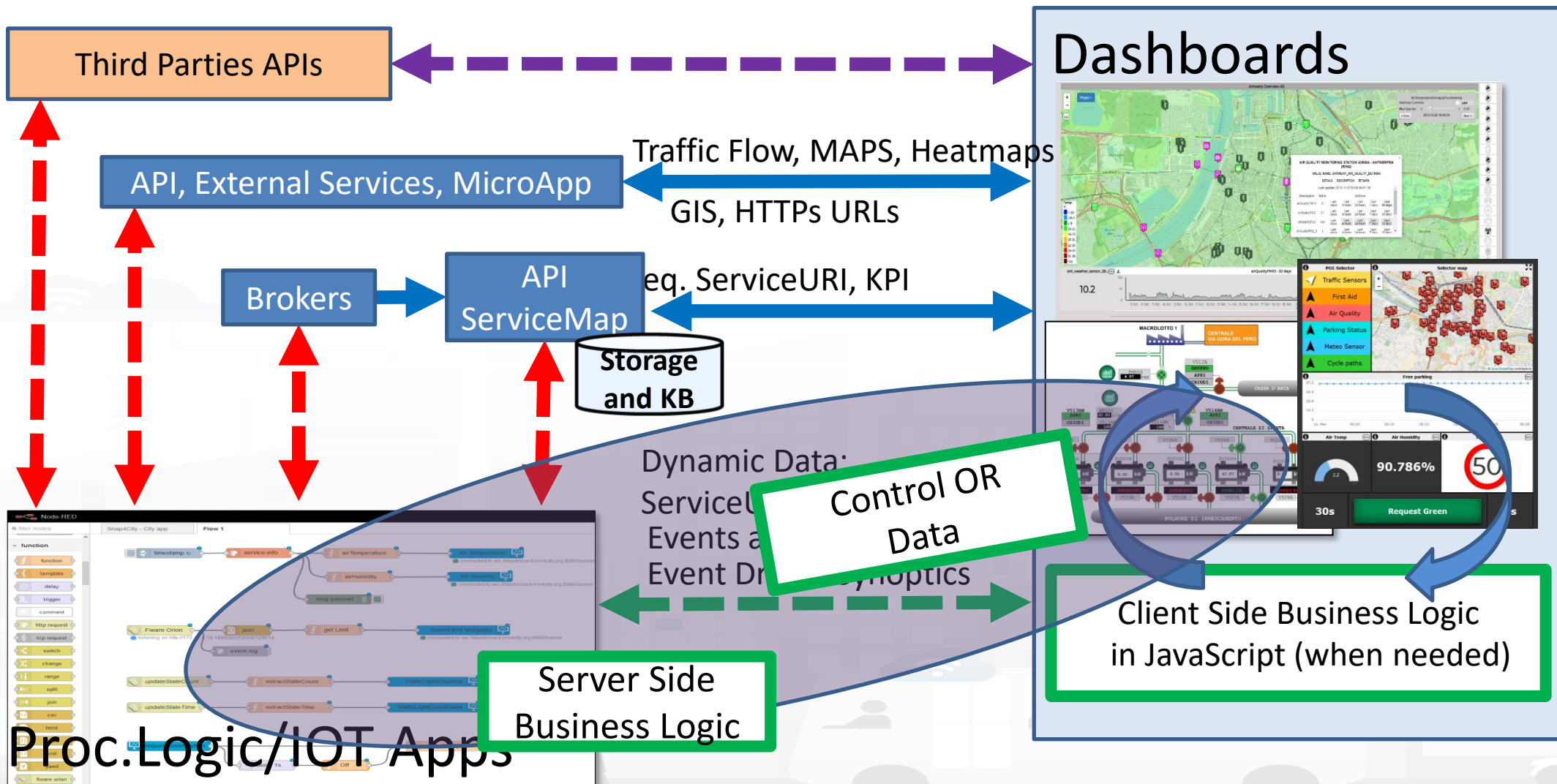
- **Distance from GPS point**



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



How the Dashboards exchange data

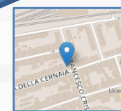
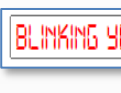
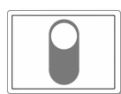


Dashboard-IoT App



PeopleNumber		
time	Last confirmed	
	None	
7	8	9
4	5	6
1	2	3
0	.	Cancel

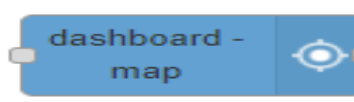
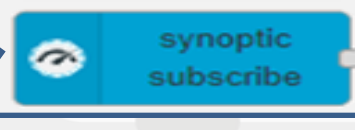
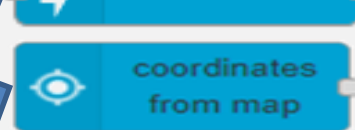
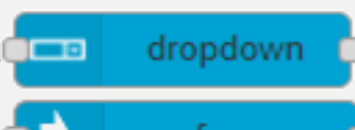
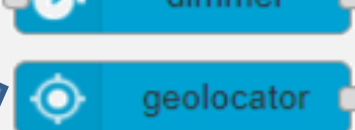
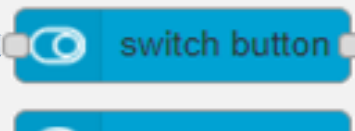
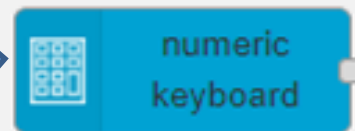
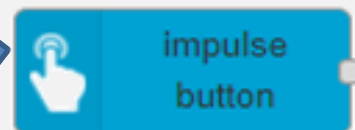
Confirm



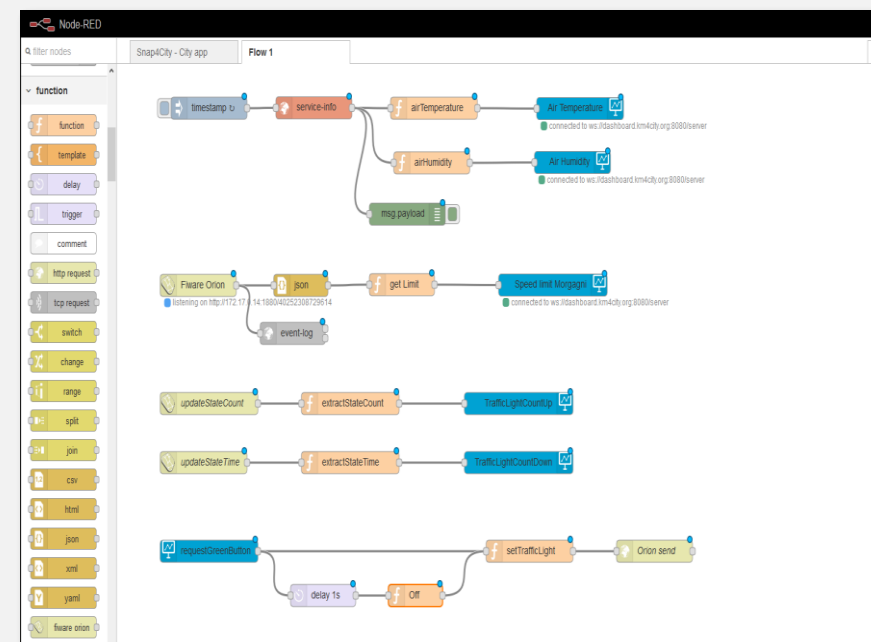
MapClick

MyKPI variable onchange

Synoptics



From Dashboard to IOT App



IOT Application

Dashboard-IOT App

From IoT App to Dashboard

IOT Application

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

Dashboard Widgets:

- Avg gas consumption (Gauge: 39.4)
- Avg heat consumption per user (Gauge: 44.7)
- Temperature (20.3°C)
- Pie Chart (Air Quality)
- Line Chart (Air Temperature over time)
- Bar Chart (Sensor Data)
- Table (Weather Metrics and Pollutants)
- Time trend comparison (Line Chart)
- Calendar (Wifi activity)
- Radar Series (Pollutants and Environmental Sensory)

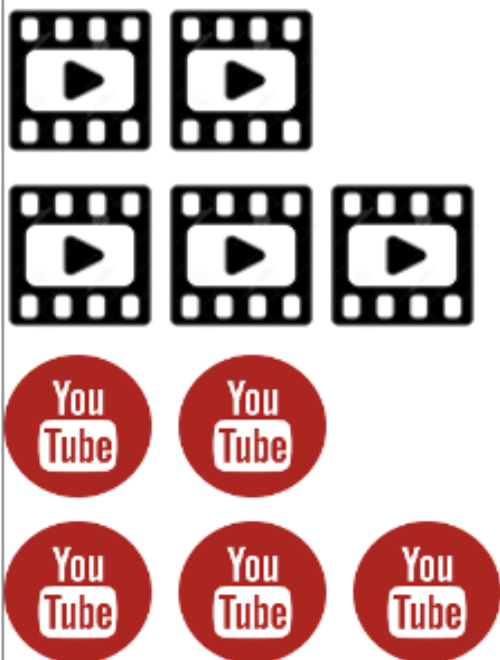
value name	airHumidity	airTemperature	PM2_5	O3
IBMET_SMART3 - RH0	55.8	17.0	225.26	0.14
IBMET_SMART3 - RH0	48	13.3	97.96	0.16
IBMET_SMART3 - RH0	56.2	13.4	0	0.17
IBMET_SMART3 - RH0	57.5	16.3	16.47	0.16
IBMET_SMART3 - RH0	64	16.2	13.33	0.15
IBMET_SMART3 - RH0	6	21.9	3.7	0.14
IBMET_SMART3 - RH0	51.3	9.5	13.03	0.12

Part 5: Data Ingestion and Interoperability

Part 5: Data Ingestion
and Interoperability

[SLIDES](#)

[Interactive Slides](#)

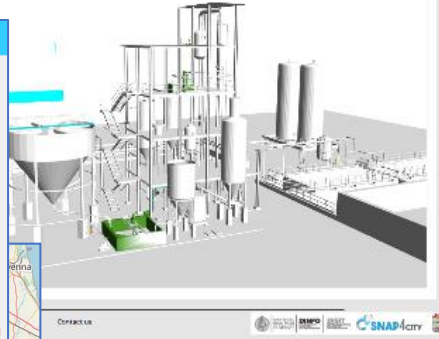
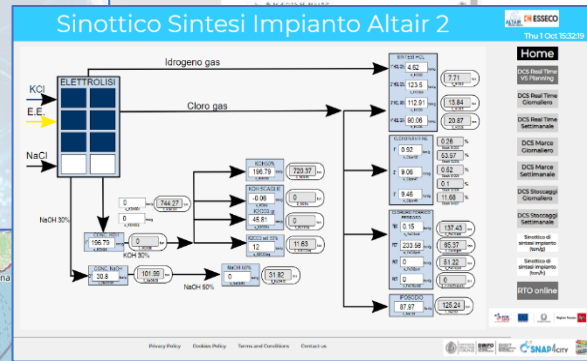
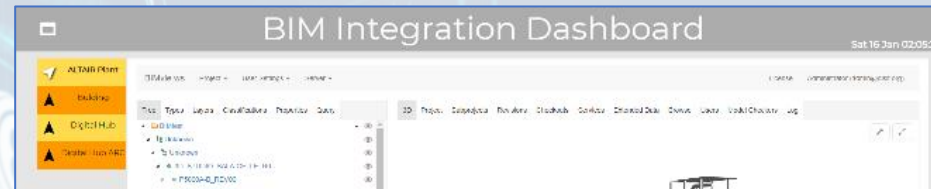


- When Solutions and tools for Data Ingestion and Interoperability are needed
- Overview of Snap4City Data Storage and Stack
- Knowledge Base: Modelling and Setting Up
- High Level Types vs Ingestion Process
- Data Ingestion Strategy and Orientation
- Ingestion of Points of Interest with POI Loader
- 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

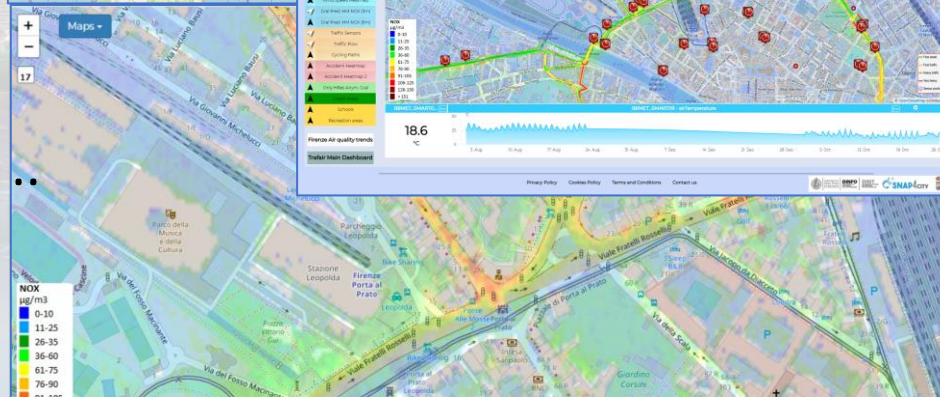
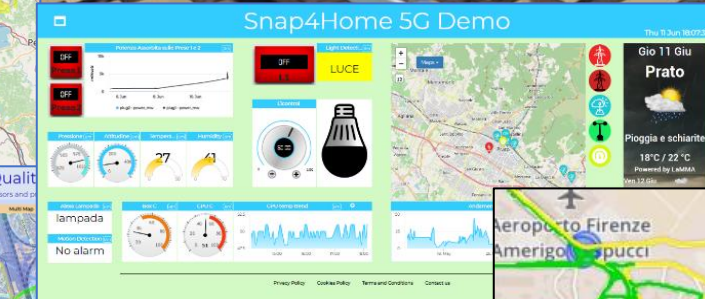
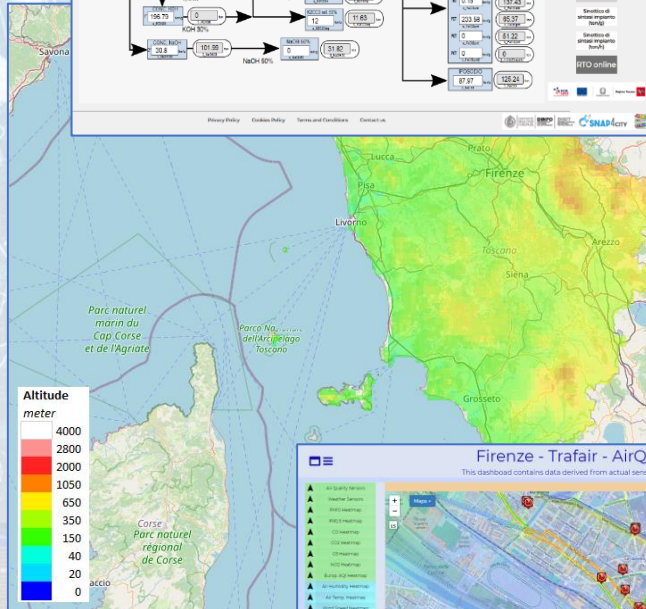
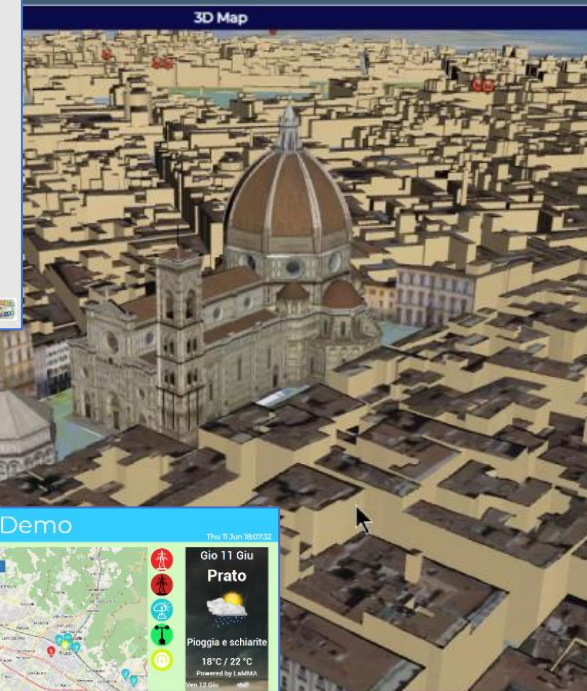
High Level Types

Snap4City (C), August 2024

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



SNAP4CITY
- Digital Twin Global - Fire
demonstrator



UNIVERSITÀ
DEGLI STUDI
FIRENZE

DINFO
DIPARTIMENTO DI
INGEGNERIA
DELL'INFORMAZIONE

DISIT
DISTRIBUTED SYSTEMS
AND INTERNET
TECHNOLOGIES LAB

Snap4City

Switch To New Layout (Beta)

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

LOGOUT

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

Entity Instances, IoT Devices

Show entries

Search:

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

Search Device Location on Map

Leaflet | © OpenStreetMap contributors

Cancel

Checking data/Entity ingestion results

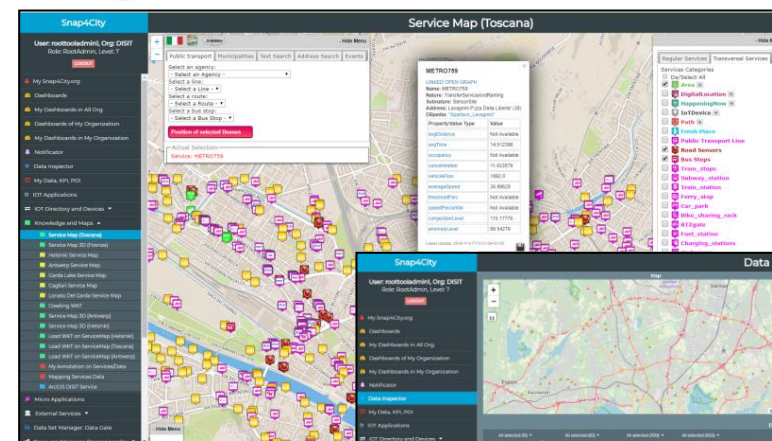
Knowledge base Semantic reasoners



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

ServiceMap, SCAPI, SuperSM

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



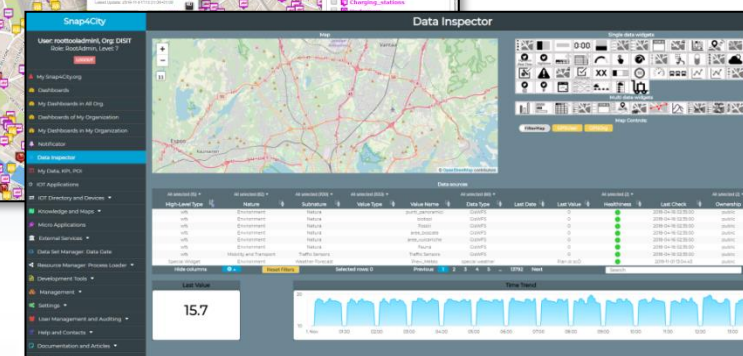
ServiceMap or
Super ServiceMap

Data Inspector (last data)

IoT/Entity Directory

- IoT Brokers

Data Inspector
Digital Twin view



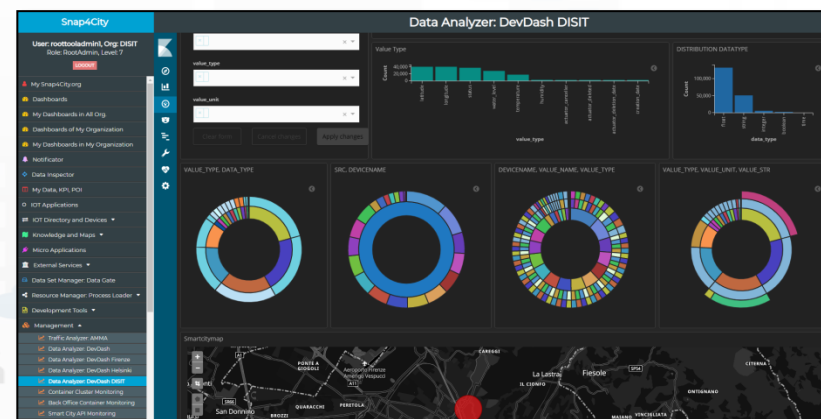
Indexing and aggregating NIFI, OpenSearch

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

ServiceMap, SCAPI (last data), SuperSM

My Data Dashboard, OpenSearchDash

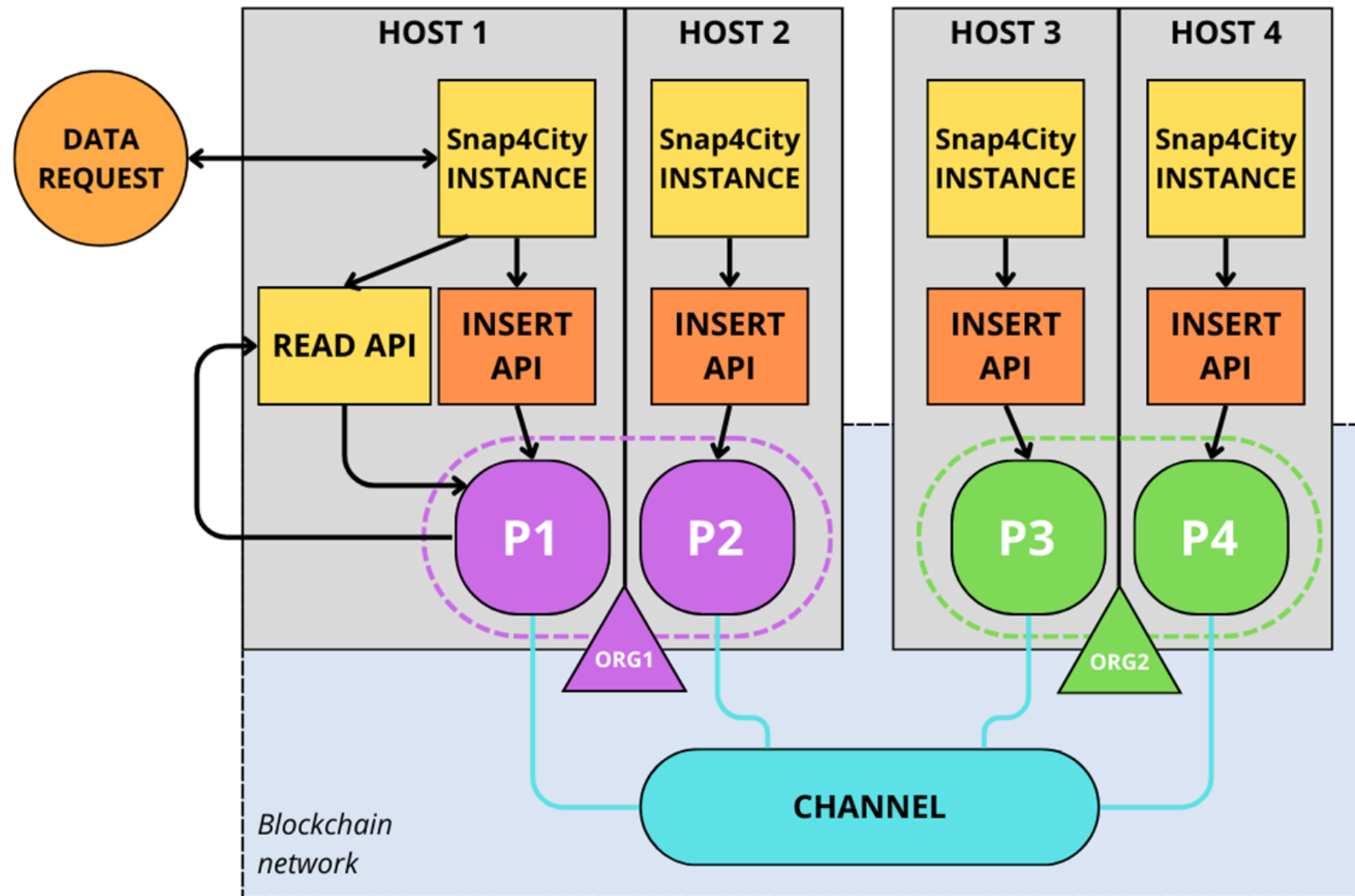
Data Inspector (last data)



My Data Dashboard

DevDash

Snap4City with Blockchain



Part 4: Data Analytics

Part 4: Data Analytics
and Artificial
Intelligence

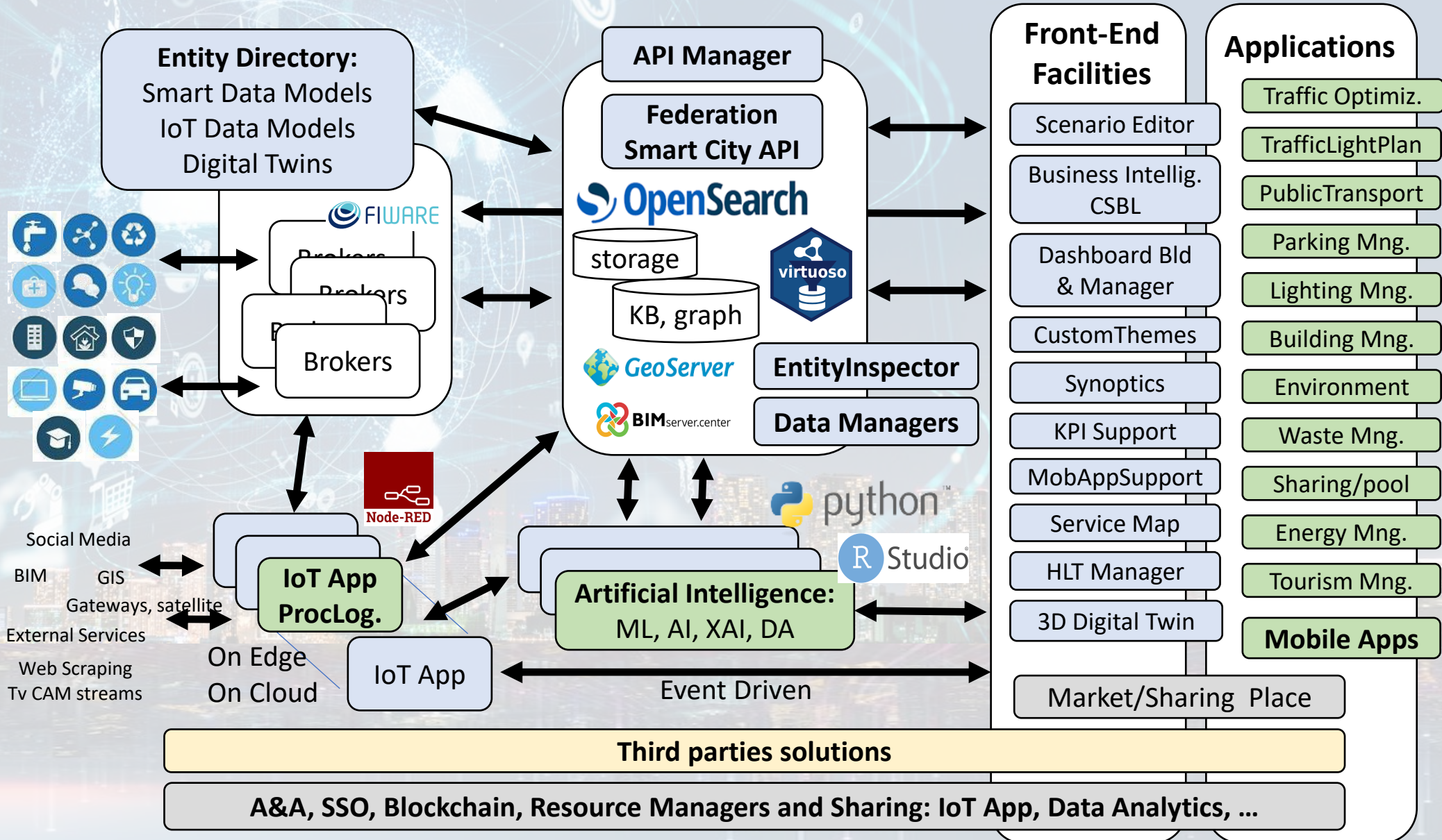
[SLIDES](#)

[Interactive Slides](#)

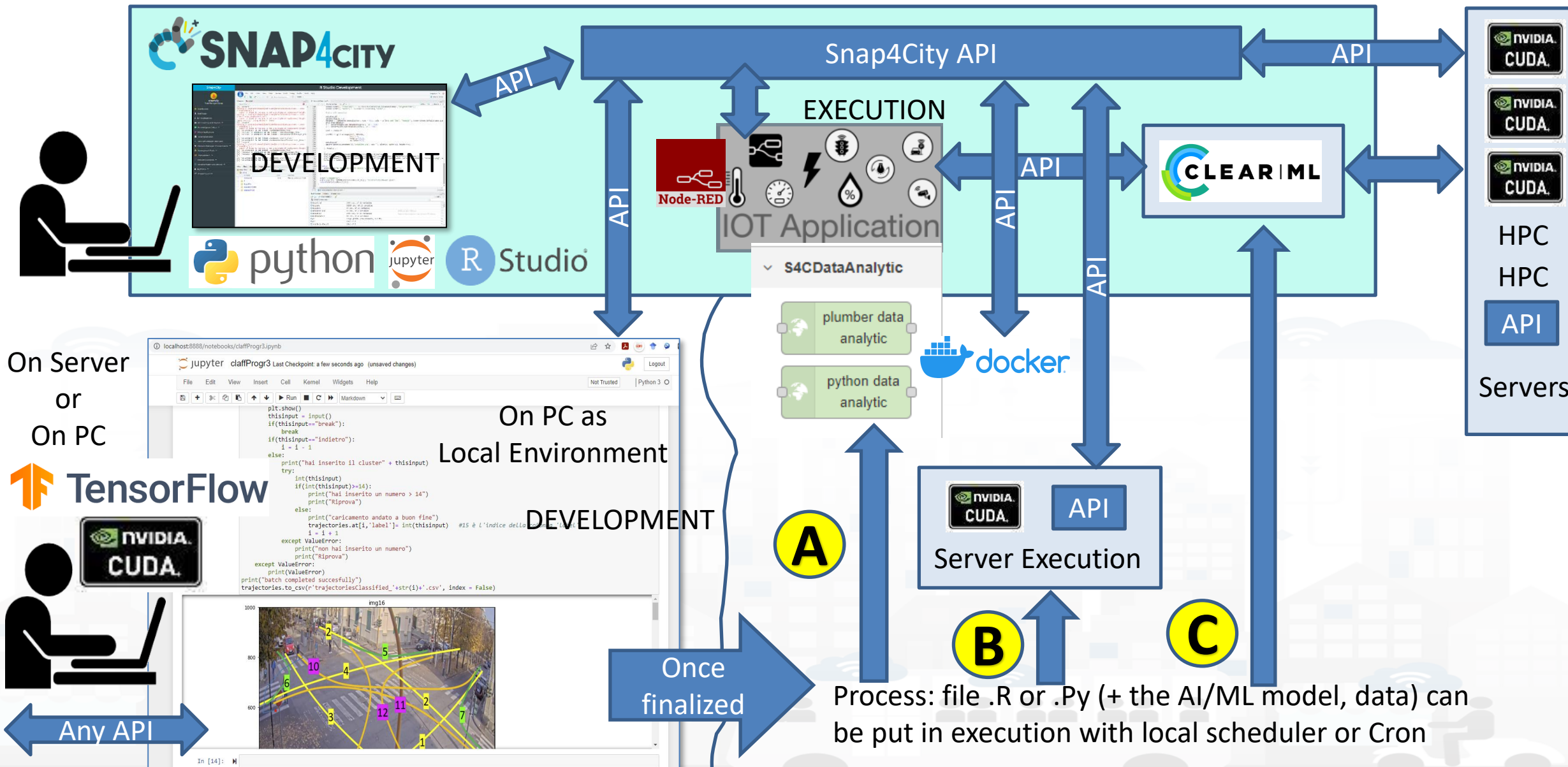


- Why and Where use DA, AI and XAI --> General Life Cycle
- Data Processing
- What is Data Analytics, DA and Artificial Intelligence, AI
- List of the most relevant available DA and AI Solutions
- Predictions and Anomaly detections
- Computing: Higher Level Types Data and their representations
- How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

Technical Architecture

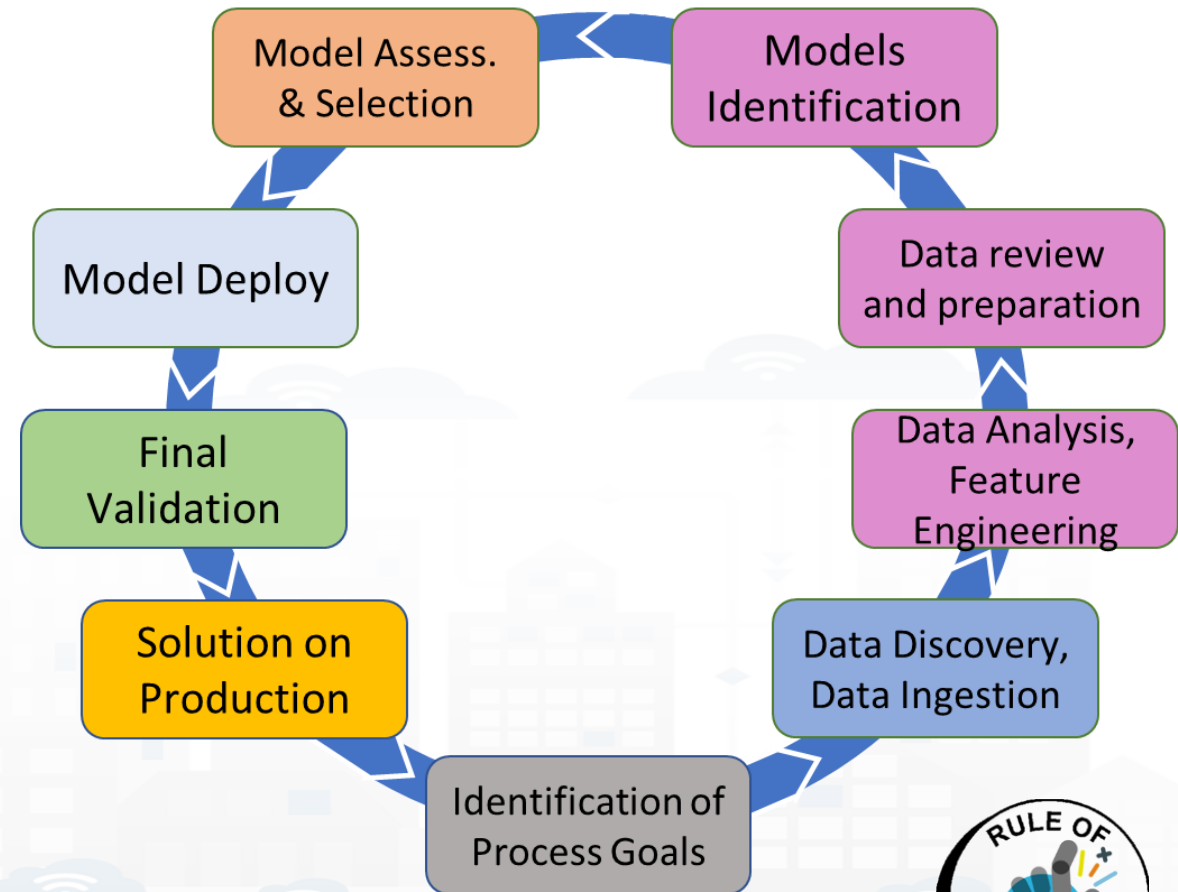


Development

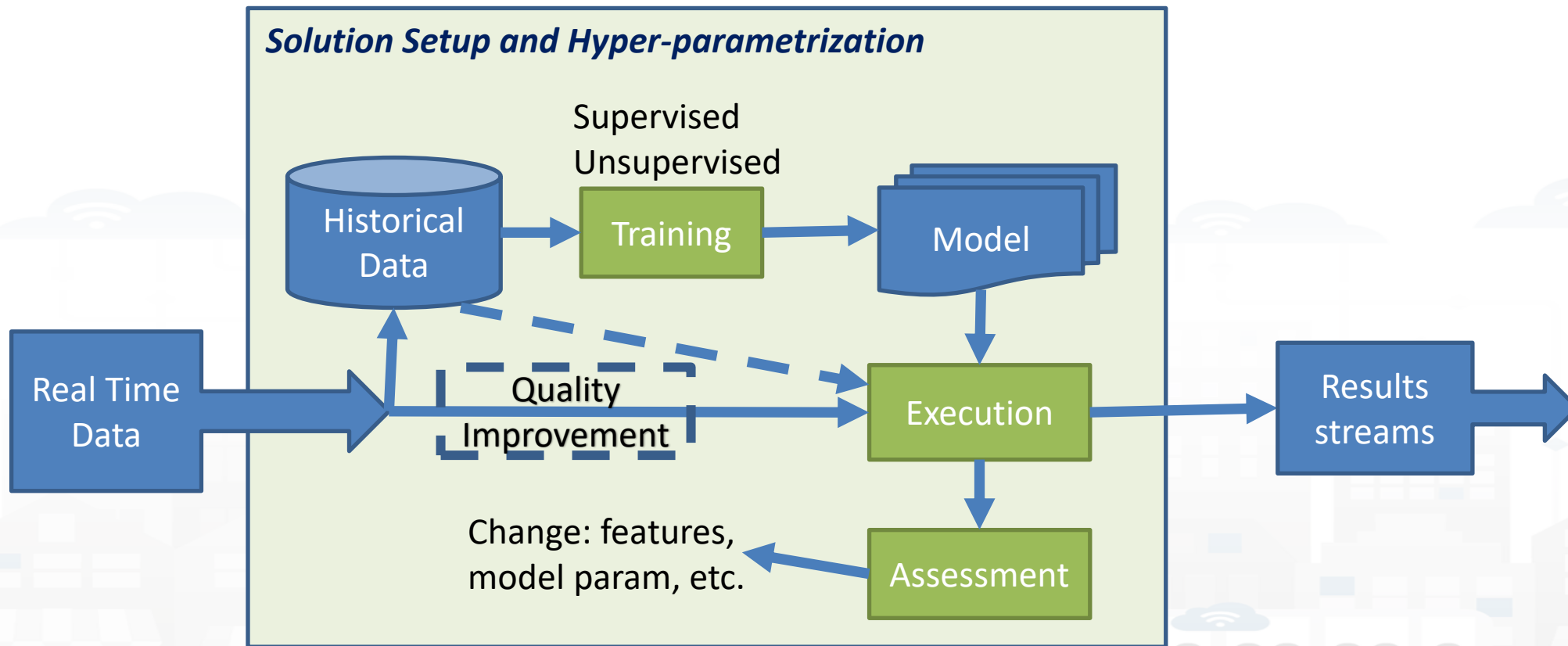


Model/Technique Development/testing

- **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**



Simplified Training and Deploy process

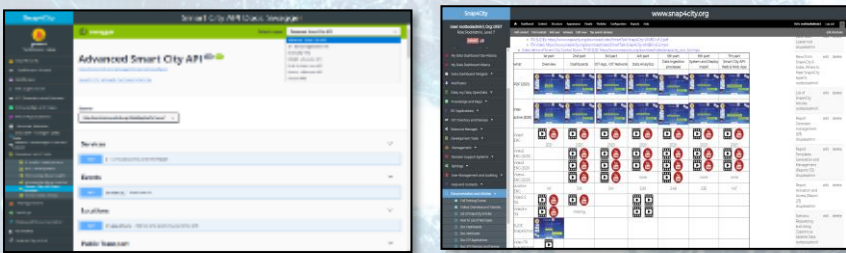


Prediction
Prescriptions
Anomalies
Classification
Detection
Etc.

Data Analytics on Snap4City platform



Swagger



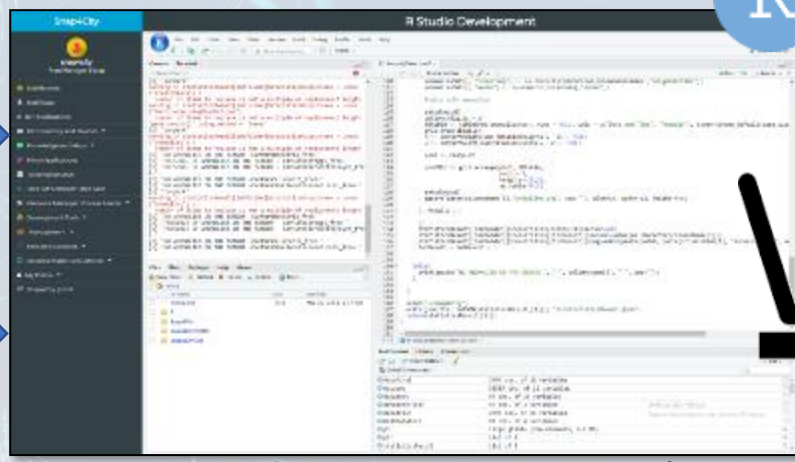
Ontology Schema



LOG.disit.org



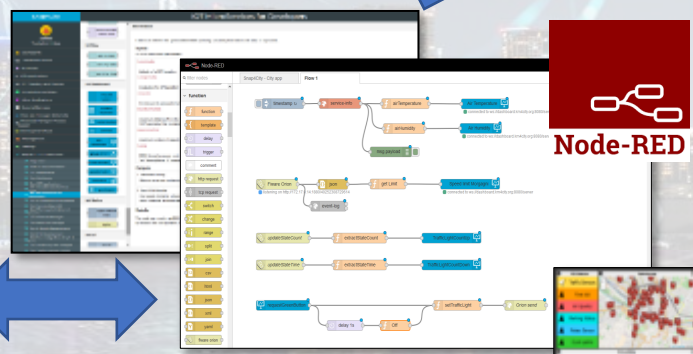
Smart City API from Knowledge Base and other tools



Creating MicroServices

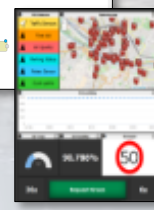


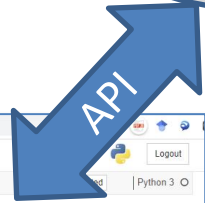
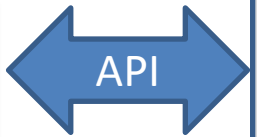
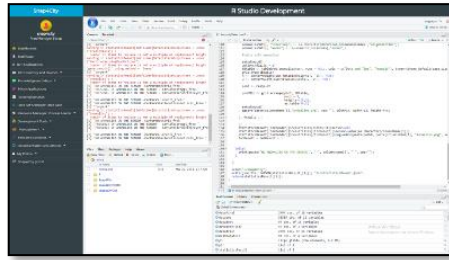
Saving / Sharing reusing



Resource Manager

Using them into IOT Applications





On Server
Or
On PC

On PC as Anaconda

```

jupyter claffProgr3 Last Checkpoint: a few seconds ago (unsaved changes)
File Edit View Insert Cell Kernel Widgets Help
Run | Markdown
plt.show()
thisinput = input()
if(thisinput=="break"):
    break
if(thisinput=="indietro"):
    if(thisinput=="indietro"):
        i = i - 1
    else:
        print("hai inserito il cluster" + thisinput)
        try:
            int(thisinput)
            if(int(thisinput)>=14):
                print("hai inserito un numero > 14")
                print("Riprova")
            else:
                print("caricamento andato a buon fine")
                trajectories.at[i,'label'] = int(thisinput) #15 è l'indice della colonna 'label'
                i = i + 1
        except ValueError:
            print("non hai inserito un numero")
            print("Riprova")
        except ValueError:
            print(ValueError)
print("batch completed successfully")
trajectories.to_csv("trajectoriesClassified_"+str(i)+".csv", index = False)

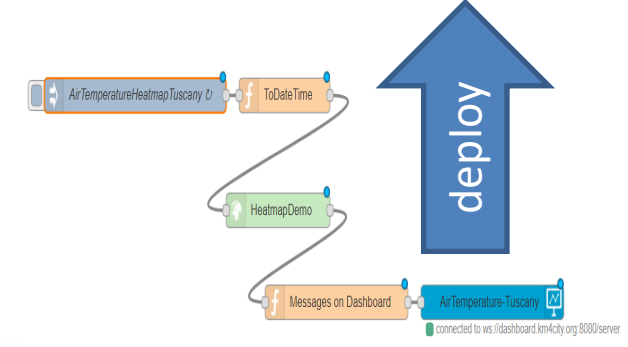
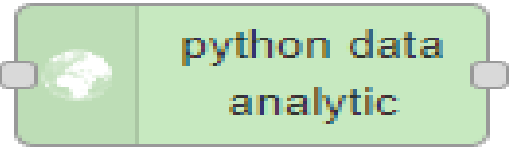
```



File.py
AI Model
Mapping
Data..



Load
File.py
or .zip



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

1

Developer in R Studio + Tensor Flow

R Studio Development

```

110 anomaliesMatr[, "timestamp"] <- as.character(dataFinal$res$anoms$index, "alignDateTime")
111 anomaliesMatr[, "anoms"] <- as.numeric(res$anoms[, "anoms"])
112
113 #table with anomalies
114
115 setwd(outD)
116 options(digits = 1)
117 tTable <- tableRob(anomaliesMatr, rows = NULL, cols = c("Date and Time", "Anomaly"), theme=ttheme_default(base_size=12))
118 grid.draw(tTable)
119 h <- convertHeight(sum(tTable$heights), "in", TRUE)
120 w <- convertWidth(sum(tTable$widths), "in", TRUE)
121
122 plot <- res$plot
123
124 plotMtx <- grid.arrange(plot, tTable,
125                       ncol = 2,
126                       heights=c(5,1),
127                       as.table=TRUE)
128
129 setwd(outD)
130 ggsave(paste(columnsName[i], "Anomalies.png"), plotMtx, width=22, height=h+5)
131
132 }, finally = {
133 }
134
135 statisticsResult[[indFolder]]$resultFiles[indResult]$sensor=NULL
136 statisticsResult[[indFolder]]$resultFiles[indResult]$sensor=unbox(as.character(columnsName[i]))
137 statisticsResult[[indFolder]]$resultFiles[indResult]$png=unbox(paste(outD, paste(columnsName[i], "Anomalies.png"), sep=""), indResult = indResult + 1)
138
139 }else{
140   print(paste("NO ANOMALIES ON THE SENSOR ", "-", columnsName[i], "-", sep=""))
141 }
142
143 }
144
145 setwd("~/Snap4City")
146 write(jsonlite::toJSON(statisticsResult[[1]]), "JsonStatisticsResult.json")
147 return(statisticsResult[[1]])
148 }
149 }
150 }
151 }
  
```

Environment

dataFinal	2794 obs. of 18 variables
dataset	35539 obs. of 12 variables
dataTest	97 obs. of 15 variables
dataTestFinal	97 obs. of 3 variables
dataTrain	2793 obs. of 15 variables
meltDataTest	97 obs. of 4 variables
p3	Large gtable (784 elements, 9.2 Mb)
plt	List of 9
statisticsResult	List of 1

Click on each .png file to visualize the statistics: a new tab will be opened

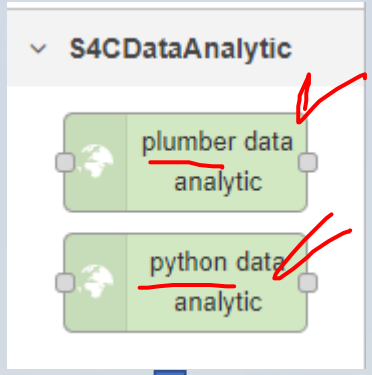
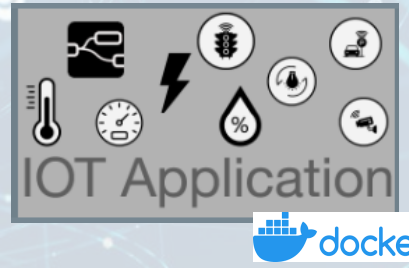
- AverageSpeedDailyTrend.png
- CarParksDailyTrend.png
- CorrelationMatrix.png
- PredictedFreeParking.png
- SensorsMeanPerDayMoment.png
- StatisticsBySensors.png
- StatisticsBySensorsAndDayMoment.png
- VehicleFlowDailyTrend.png



Data Analytic Container



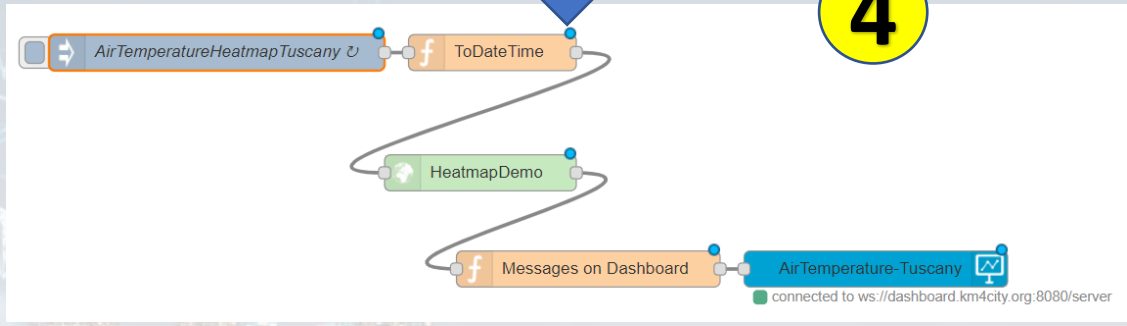
2 Open an Advanced IoT App / Node-RED



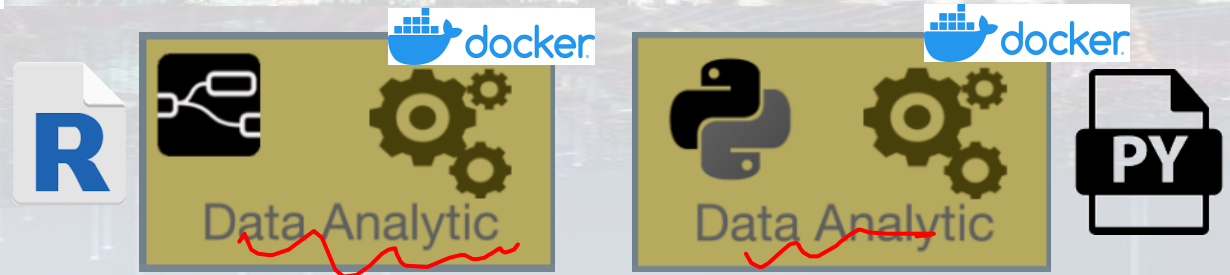
3 Use Snap4City Data Analytic Node, and load in the code you developed.

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

The code has to respect the guidelines provided for creating API. The API are called as a MicroService For example see: <https://www.snap4city.org/641> <https://www.snap4city.org/645>



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





IoT edge on
TV Camera

1

Send data to Broker

2

Device: CrossVenaria2
with trajectories

IOT Broker

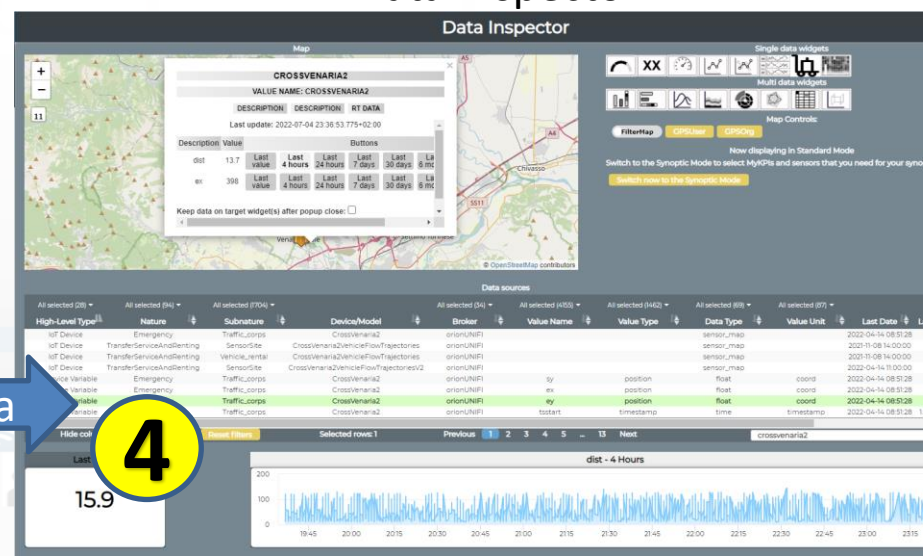
3

Save data

Big Data
Store
Facility

show data

4





IoT edge on
TV Camera



Send Trajectories

Send data to Broker

IOT Broker

Devices:

- CrossVenaria2VehicleFlowTrajectoriesV2
- VenariaConteggio



e

Send data to Broker

f

Save data

Save Counting per Cluster

Big Data Store Facility

c

Get data

Device:
CrossVenaria2
with
trajectories

Periodically

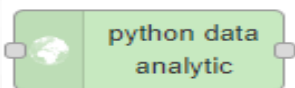
b

Activate



d

From Trajectories
to clusters.
Counting in/out
and flows

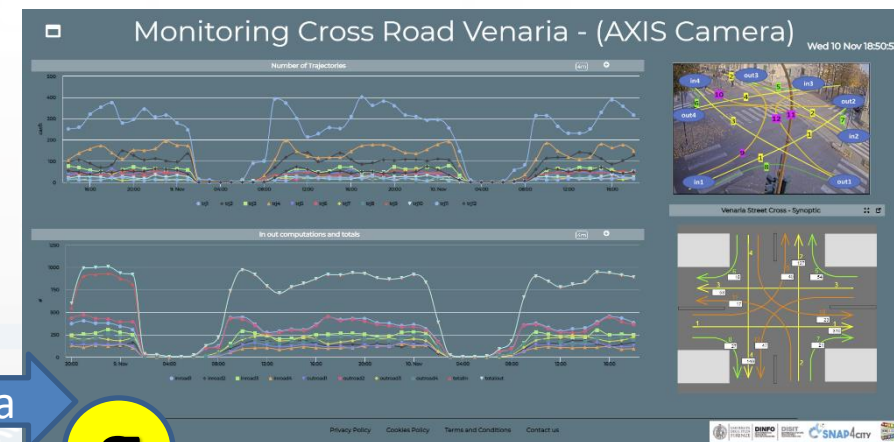


a

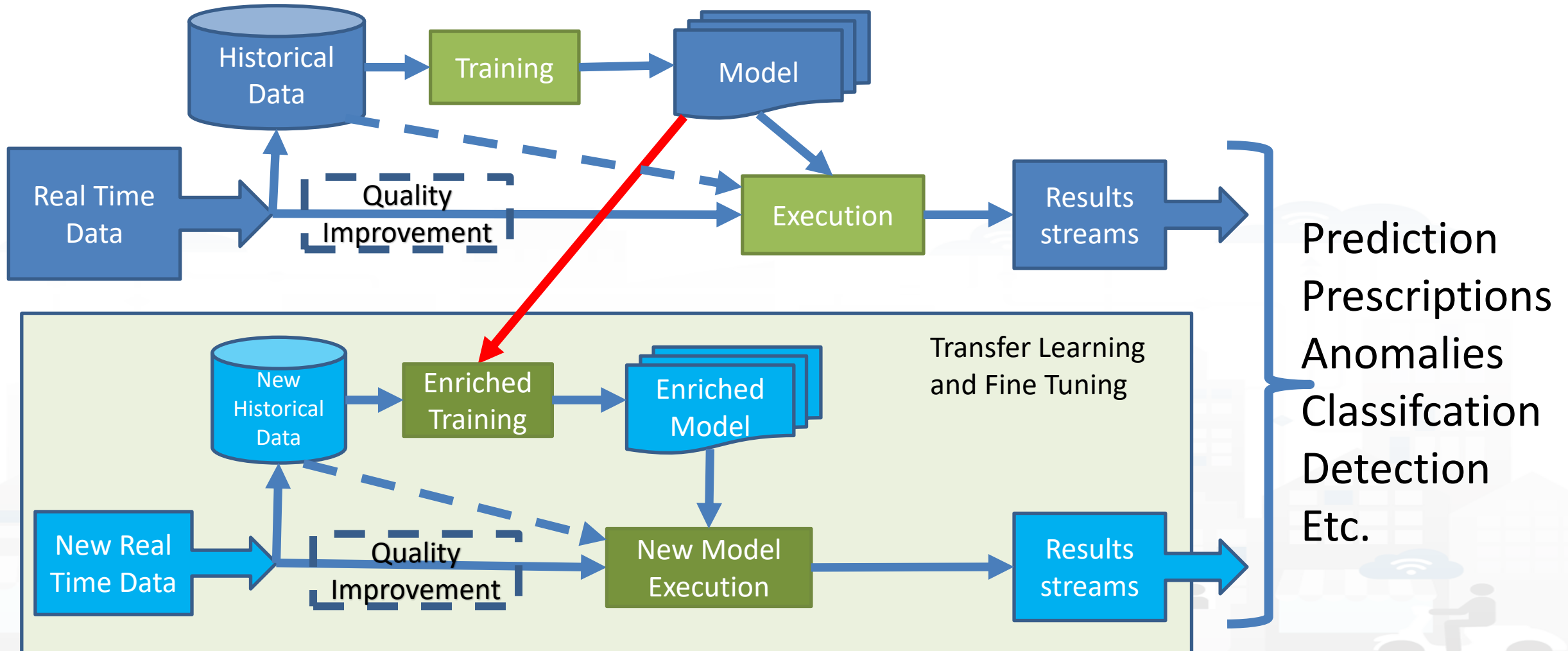
show data

g

Create and use a Dashboard



Simplified Deploy of Transfer Learning Model



Parts 7 & 8: API, Mobil, Business Intelligence

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

[SLIDES](#)

[Interactive Slides](#)



Part 8: Developing
Smart Applications &
Business Intelligence
Solutions

[SLIDES](#)

[Interactive Slides](#)



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

Development

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



Development Life-Cycle

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

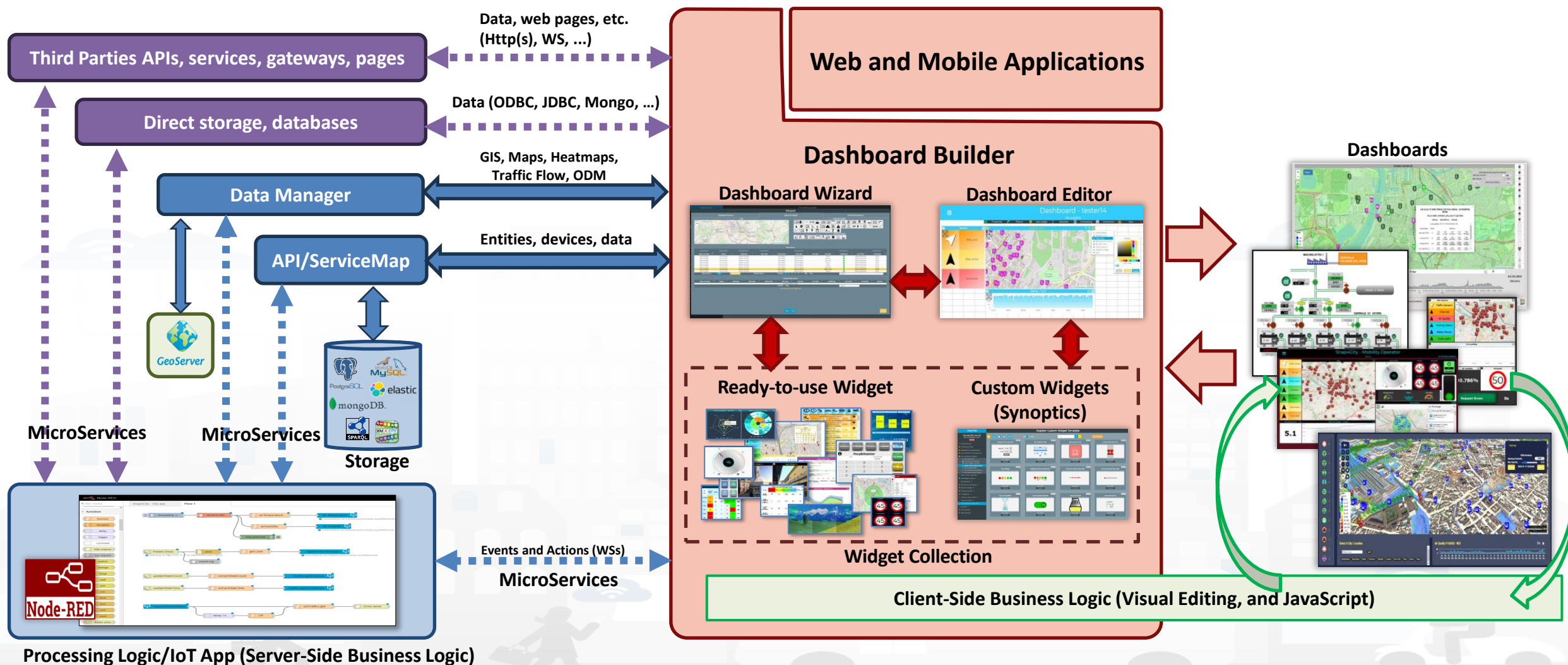
From Snap4City:

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

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

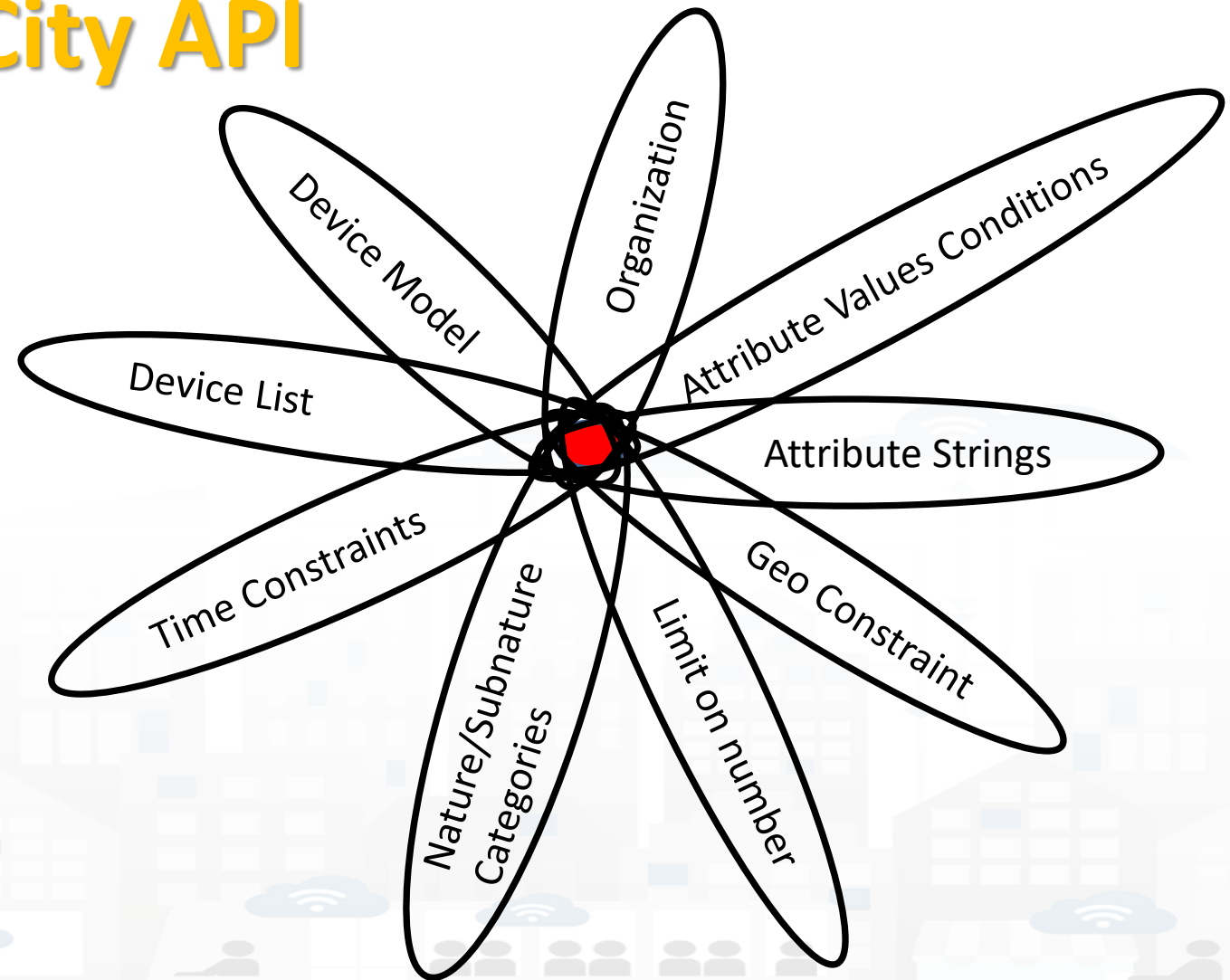
DISIT Lab, <https://www.disit.org>
DINFO dept of University of Florence,
Via S. Marta 3, 50139, Firenze, Italy
Phone: +39-335-5668674

How the Dashboards / Apps exchange data



Selection on Smart City API

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



Internal and External Smart City API

Smart City API Docs: Swagger

User: rootooladmin1, Org: DISIT
Role: RootAdmin, Level: 7

Logout

External Services

- Data Set Manager: Data Gate
- Resource Manager: Process Loader
- Development Tools
 - Web Scraping Tool
 - Web Scraping Tool (0n)
 - Web Scraping Tool (6i)
 - R Studio Development
 - R Studio Development 0.11
 - R Studio Development 0.116
 - R Studio Development.TF
 - R Studio Development.GFF
 - R Studio Development.Gral
 - MicroServices from DataAnalytic
 - ETL Development
 - ETL Development 1
 - ETL Development 2
 - Knowledge Base Graphs
 - Knowledge Base Queries
 - Smart City API Docs: Swagger**
 - Internal API Docs: Swagger
 - Testing API by Postman
 - Source Code Access
- Management
- Settings
- User Management and Auditing
- Help and Contacts
- Documentation and Articles
- My Profile

Advanced Smart City API ^{4.0.0} ^{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
- Notificator 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>

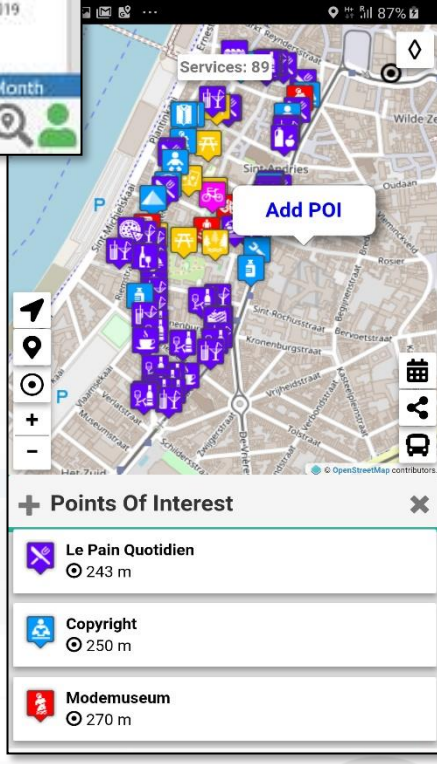
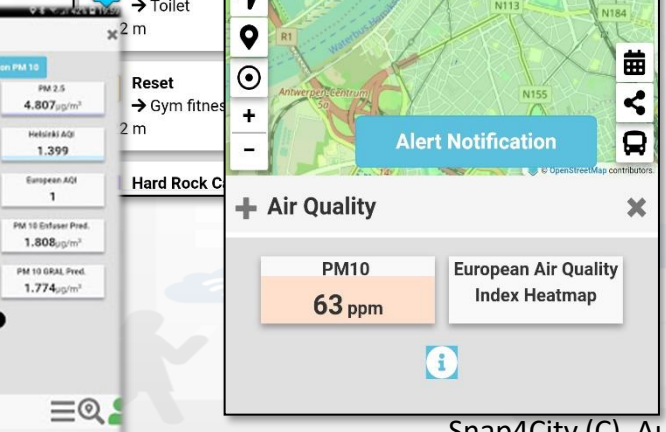
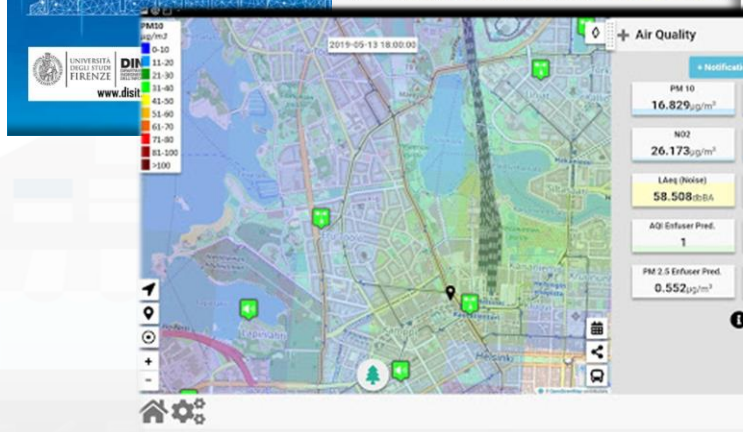
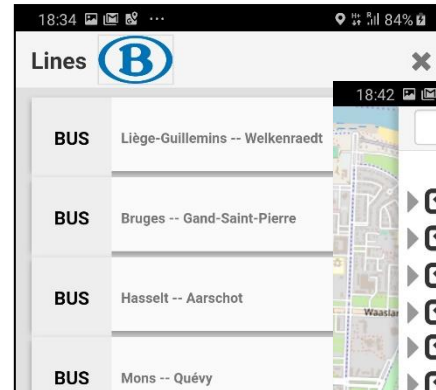
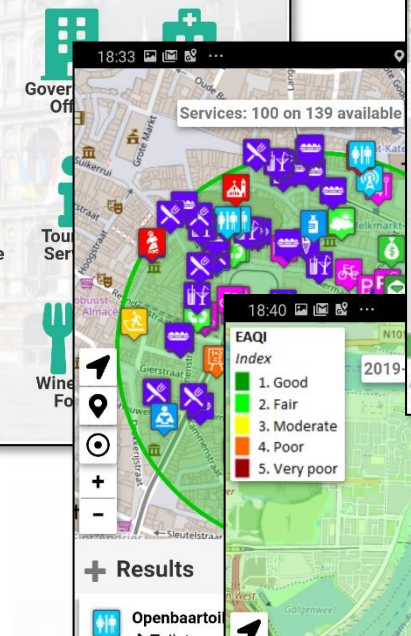
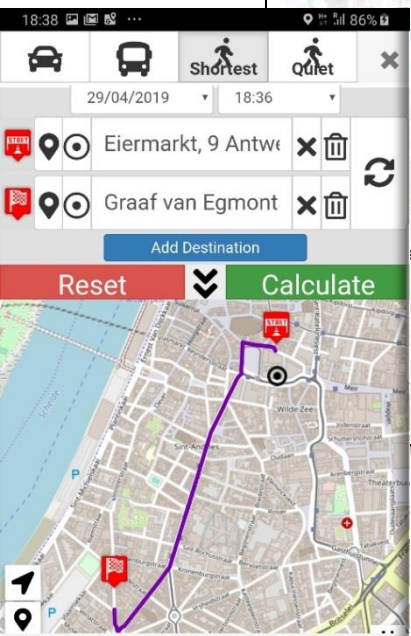
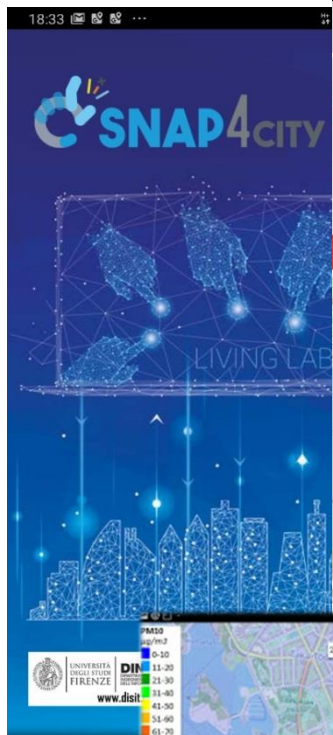
<https://www.km4city.org/swagger/internal/index.html>

How to Get the «Query» used in More Options (2a)

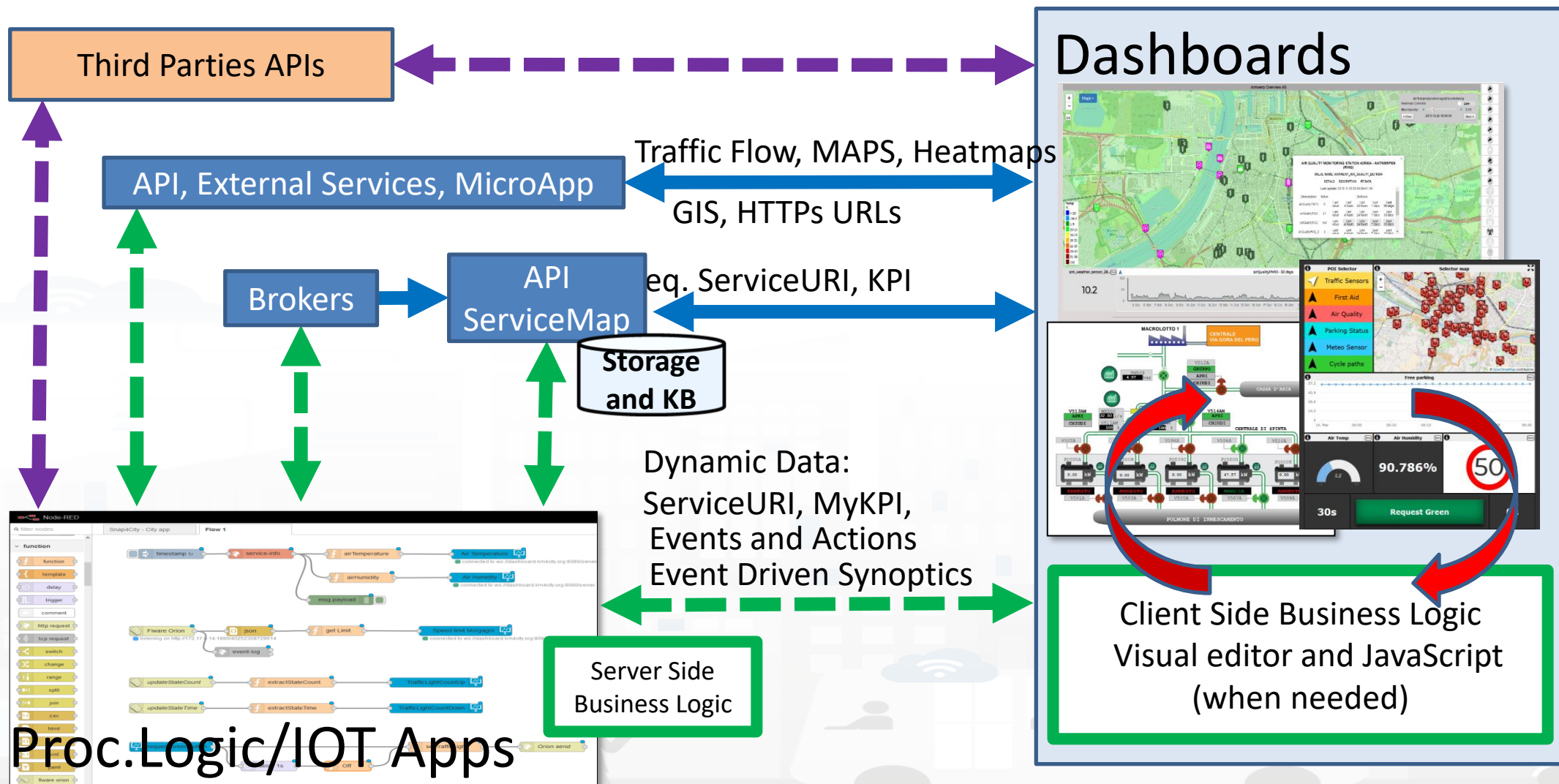
- **REST CALL by category → JSON (Options in RED), they are REST ASCAPI calls**
 - **Requesting a category, so that to see all Services of the same category (subNature)**
 - http://svealand.snap4city.org/ServiceMap/api/v1/?selection=59.581458578537955;16.71183586120606;59.62875017053684;16.875171661376957&categories=Street_light&maxResults=100&format=json
 - Please note that in the MoreOption dashboard the GPS area is neglected
 - https://servicemap.disit.org/WebAppGrafo/api/v1/?selection=43.64471;11.005751;43.89471;11.505751&categories=Green_areas&maxResults=200&format=json
 - Please note that in the MoreOption dashboard the GPS area is neglected
 - Custom PINS note: “selection” coordinates are used for collecting attributes in custom PINS. Other options such as “maxDists” cannot be used in custom PIN. All parameters can be used in other cases.
 - Different KB links are identified by their ASCAPI links: svealand.snap4city.org, servicemap.disit.org,
 - **Requests to SuperServiceMap for the network of Federated KBs by using /api/.....**

Without prefixed KB to obtain merged results from more KBs. For example as:

 - /api/v1/?categories=Air_quality_monitoring_station&format=json
 - Please note that the direct links to the superservicemap can be of the form:
 - <https://www.disit.org/superservicemap/api/v1/?>



How the Dashboards & Apps exchange data



Client Side Business Logic

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

Client-Side Business Logic Widget Manual

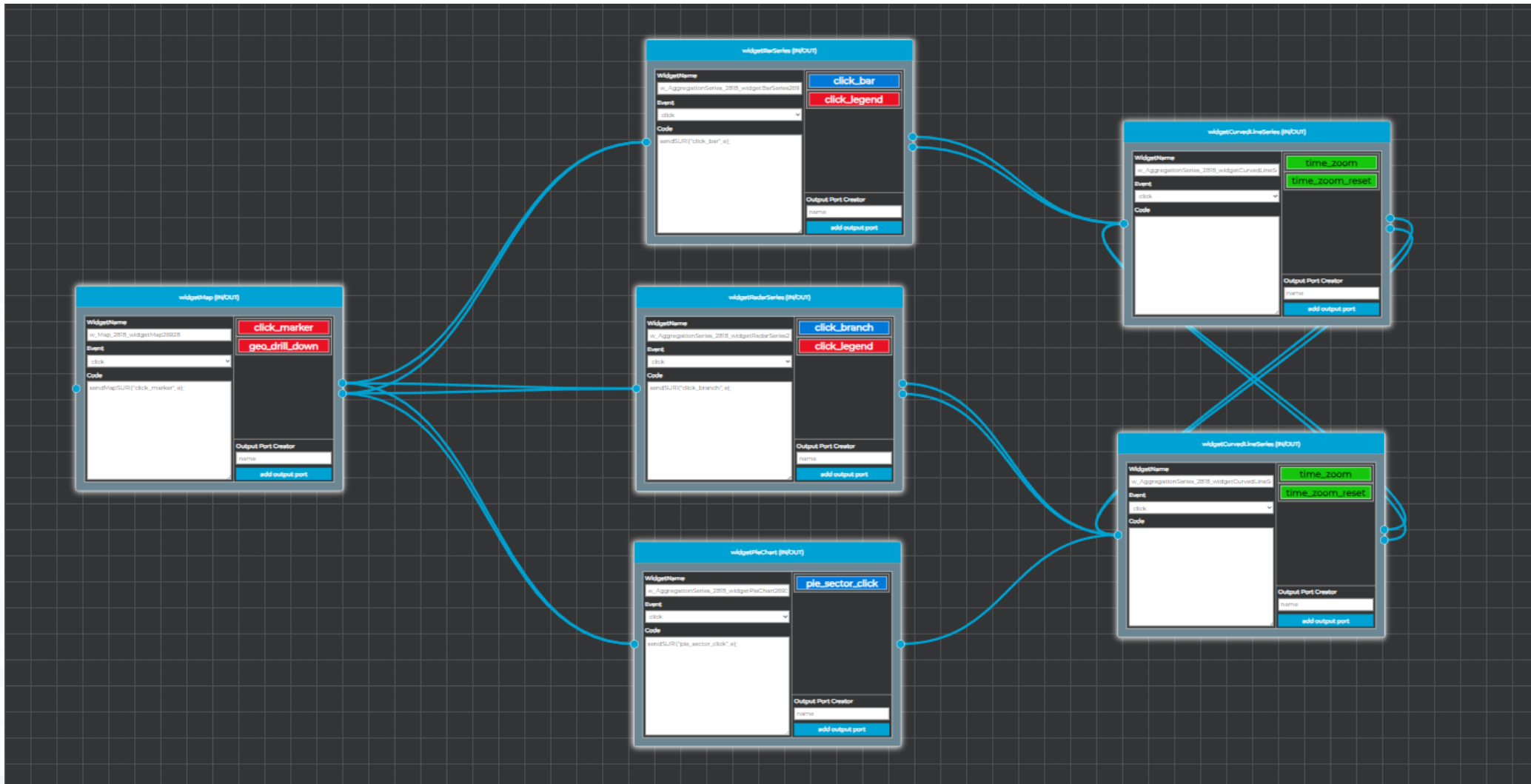
From Snap4City:

- We suggest you read <https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf>
- We suggest you read the TECHNICAL OVERVIEW:
 - <https://www.snap4city.org/download/video/Snap4City-PlatformOverview.pdf>
- slides go to <https://www.snap4city.org/577>
- <https://www.snap4city.org>
- <https://www.snap4solutions.org>
- <https://www.snap4industry.org>
- <https://twitter.com/snap4city>
- <https://www.facebook.com/snap4city>
- <https://www.youtube.com/channel/UC3TAO09EbNba8f2-u4vanda>

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



Visual programming for CSBL, accessible in beta



TOP

Training Suggestions DISIT publications



Note on Training Material

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

Snap4City Training vs Targets

• Estimate Indicators: P1, P2, P3, P4, P5

- IoT App/Proc.Logic JavaScript, Data Analytics, Dashboards to see data and results

• Load additional data: P1, P2, P3, P5

- IoT App/Proc.Logic JavaScript, IoT Directory, ServiceMap, advanced interoperability, Dashboards to see them

• Performing AI/XAI on accessible data: P1, P2, P3, P4, P5 (P8)

- IoT App/Proc.Logic JavaScript, ServiceMap, ASCAPI, Python, Dashboards to see data/results

• Developing Business intelligence: P1, P2, P3, P7, P8

- IoT App/Proc.Logic JavaScript, Dashboards to see them, ASCAPI, CSBL for making them intelligent, JavaScript

• Developing Web and Mobile Apps: P1, P2, P3, P7, P8

- ServiceMap, ASCAPI, Dashboards

• Deploy, install, test and management: P1, P2, P3, P6

- IoT App/Proc.Logic JavaScript, ServiceMap, Dashboards to see them



DISIT lab Publications: <https://www.disit.org/5487>

Home /

DISIT Publications

The publications that can be downloaded on this web site are provided for timely dissemination of scholarly and technical information. The permission to reprint/republish this material for advertising or for promotional purposes or for creating new collections of this work in other works have to be obtained from the right owners. Deliverables of projects are accessible from the web sites of the projects and partially on this portal, but not all, and not necessarily in full.

<https://www.snap4city.org/426>

www.snap4city.org

Dashboard Content Structure Appearance People Modules Configuration Reports Help

Hello roottooladmin1 Log out

Home / References, Citations and references of Snap4City and Km4City, last versions

References, Citations and references of Snap4City and Km4City, last versions

View Edit Track Access control Convert

- [HighPrecisionTrafficFlow2023] S. Bilotta, S. Bonsignori, P. Nesi, "High Precision Traffic Flow Reconstruction via Hybrid Method", IEEE Transactions on Intelligent Transportation Systems, 2023. <https://doi.org/10.1109/TITS.2023.3329544>
- [reputation2023] E. Collini, P. Nesi, G. Pantaleo, "Reputation Assessment and Visitor Arrival Forecasts for Data Driven Tourism Attractions Assessment", Online Social Networks and Media, OSNEM, Elsevier, 2023. <https://www.sciencedirect.com/journal/online-social-networks-and-media> <https://doi.org/10.1016/j.osnem.2023.100274>
- [ParkingPredDEEP] S. Bilotta, L.A. Ipsaro Plaesi, P. Nesi, "Predicting free parking slots via deep learning in short-mid terms explaining temporal impact of features", IEEE Access, 2023. <https://ieeexplore.ieee.org/abstract/document/10247516>, 10.1109/ACCESS.2023.3314660
- [DigitalTwinMTAP] L. Adreani, P. Bellini, C. Colombo, M. Fanfani, P. Nesi, G. Pantaleo, R. Pisanu, "Implementing Integrated Digital Twin Modelling and Representation into the Snap4City Platform for Smart City Solutions", Multimedia Tools and Applications, Springer, 2023 DOI: 10.1007/s11042-023-16838-0, <https://rdcu.be/dnQH3> <https://link.springer.com/content/pdf/10.1007/s11042-023-16838-0.pdf>.
- P. Bellini, S. Bilotta, E. Collini, M. Fanfani, P. Nesi, "Mobility and Transport Data for City Digital Twin Modeling and Exploitation", 2023 IEEE International Smart Cities Conference (ISC2), 24-27 September 2023, Bucharest.
- F. Alberti, A. Alessandrini, D. Bubboloni, C. Catalano, M. Fanfani, M. Loda, A. Marino, A. Masiero, M. Meocci, P. Nesi, A. Paliotto, "MOBILE MAPPING TO SUPPORT AN INTEGRATED TRANSPORT-TERRITORY MODELLING APPROACH", The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLVIII-1/W1-2023 12th International Symposium on Mobile Mapping Technology (MMT 2023), 24-26 May 2023, Padua, Italy
- M. Fanfani, M. Marulli, P. Nesi, Addressing domain shift in pedestrian detection from thermal cameras without fine-tuning or transfer learning, IEEE SmartComp, International Conference on Smart Computing, June 26-29, Nashville, Tennessee, 2023.
- P. Bellini, D. Bologna, M. Fanfani, L.A. Ipsaro Plaesi, P. Nesi, G. Pantaleo, "Rapid Prototyping & Development Life Cycle for Smart Applications of Internet of Entities", IEEE ICECCS 2023, 2023.

Search

Username: roottooladmin1

Powered by **www.km4city.org**

FIWARE

Sii-Mobility

Who's online

There are currently 2 users online.

TOP

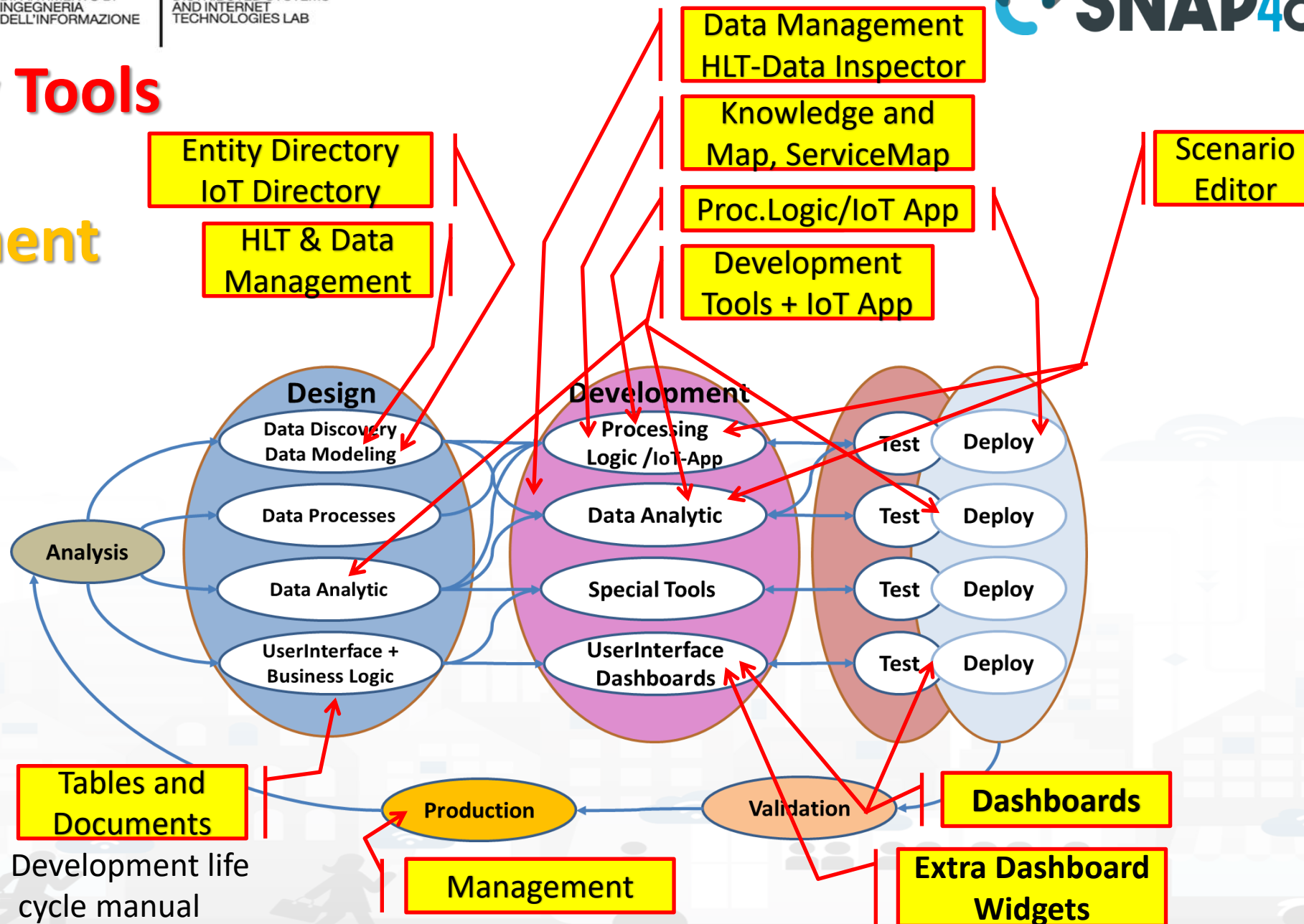
Development Costs



Snap4City Tools

vs

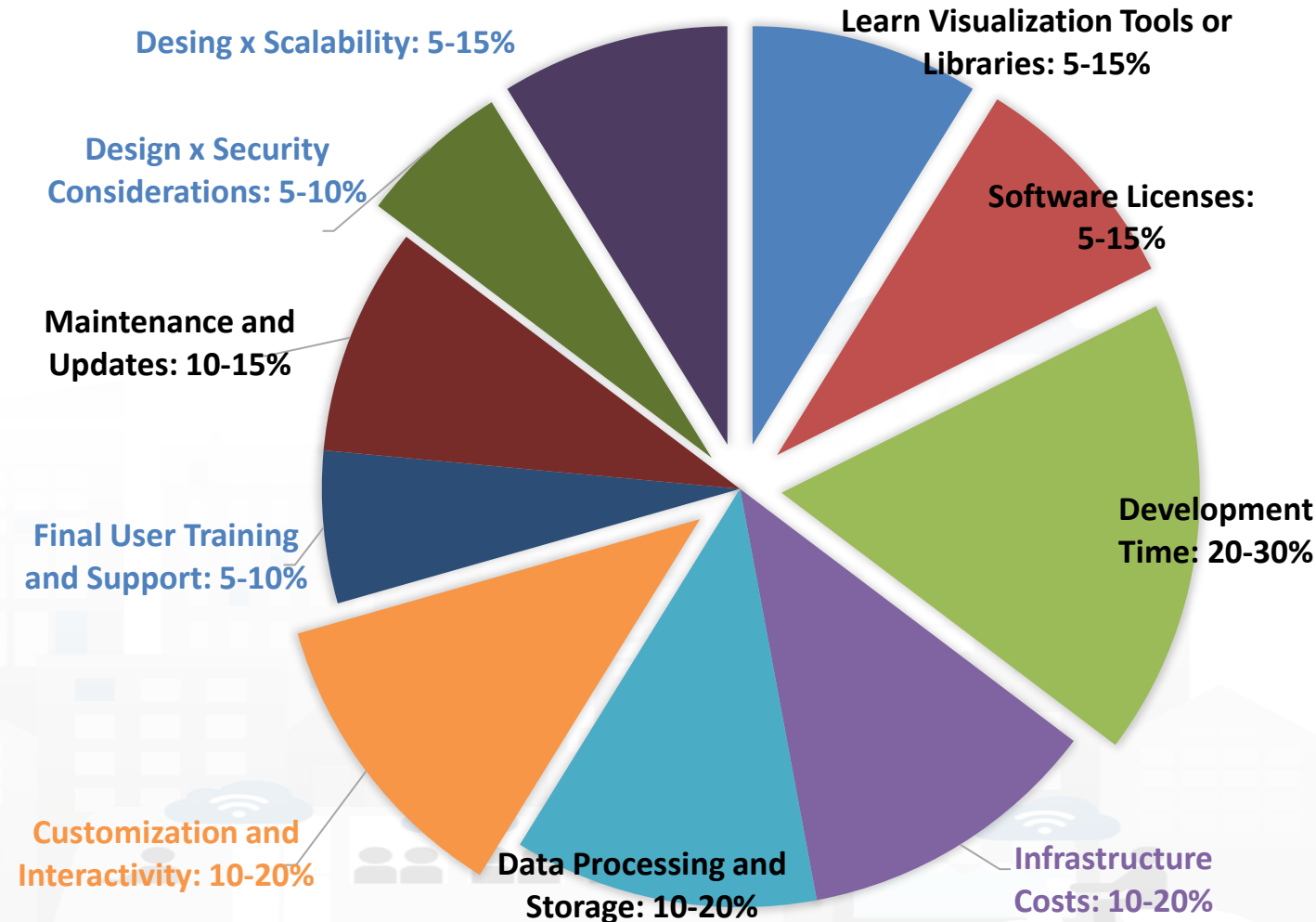
Development Life Cycle



Typical costs to setup operative conditions

- Learn Visualization Tools or Libraries: 5-15%
- Software Licenses: 5-15%
- Development Time: 20-30%
- **Infrastructure Costs: 10-20%**
- **Data Processing and Storage: 10-20%**
- Customization and Interactivity: 10-20%
- **Final Users Training and Support: 5-10%**
- **Maintenance and Updates: 10-15%**
- Design for Security/privacy: 5-10%
- Design for Scalability: 5-15%

• *In **yellow**, what is not impacted*

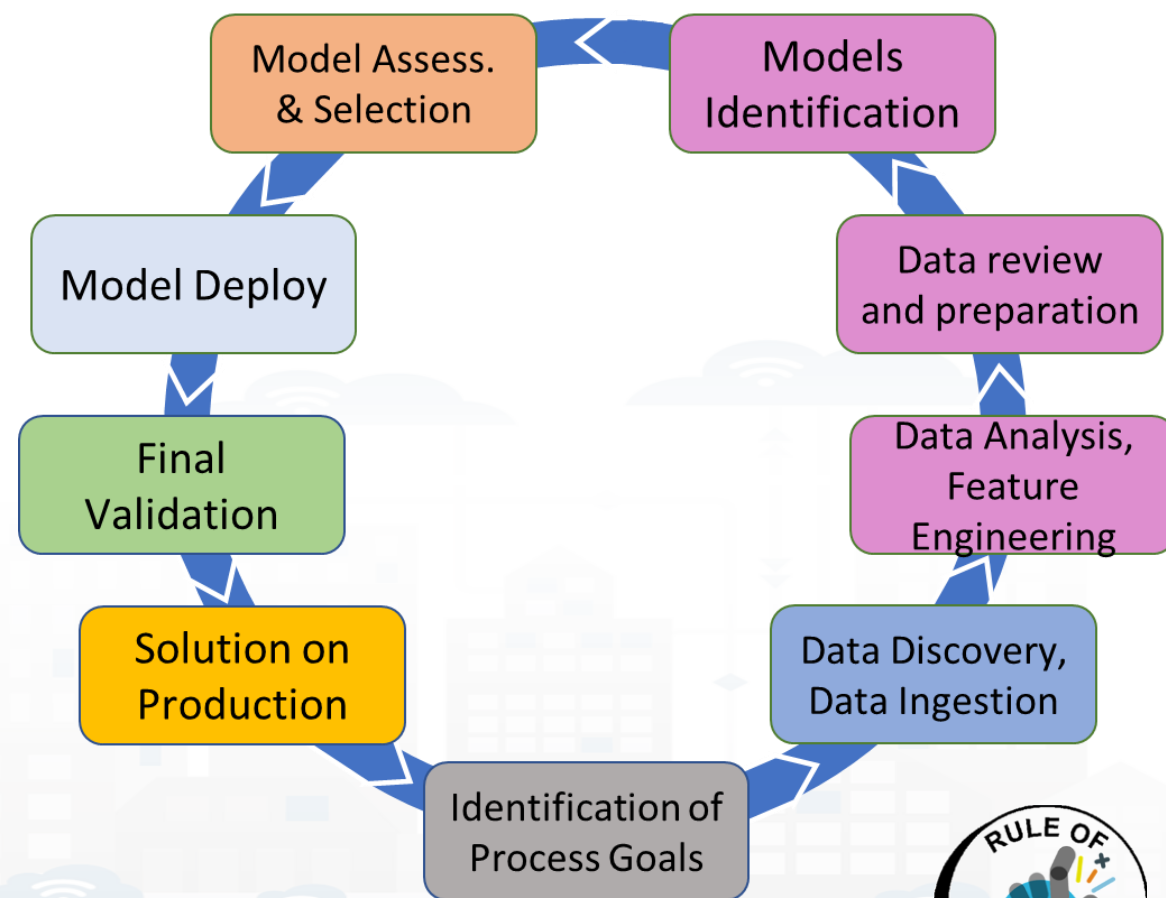


Snap4City strongly reduces the effort/costs for

- **Learn Visualization Tools or Libraries:** 5-15% → 10%
 - Visual tools, visual programming, training course, dev. Manuals, etc.
- **Software Licenses:** 5-15% → 0%
 - Development environment fully open source
- **Development Time:** 20-30% → 5%
 - Dashboard builder, synoptics, widget exchange, dashboard exchange, clone, delegations, etc.
 - Reused cloned and shared solutions, artefacts
- **Customization and Interactivity:** 10-20% → 10%
 - Dashboards with Business Logic: CSBL, Node-red SSBL
 - Direct development of Business Intelligence without coding all details
- **Design for Security/privacy:** 5-10% → **only respect the guidelines**
 - Snap4City is end-to-end secure and GDPR compliant, all is already in place
- **Design for Scalability:** 5-15% → **only respect the guidelines**
 - Snap4City is scalable from Back-End to Front-End, all is already in place
- **Reduction of: 45% for development effort of smart city solutions**

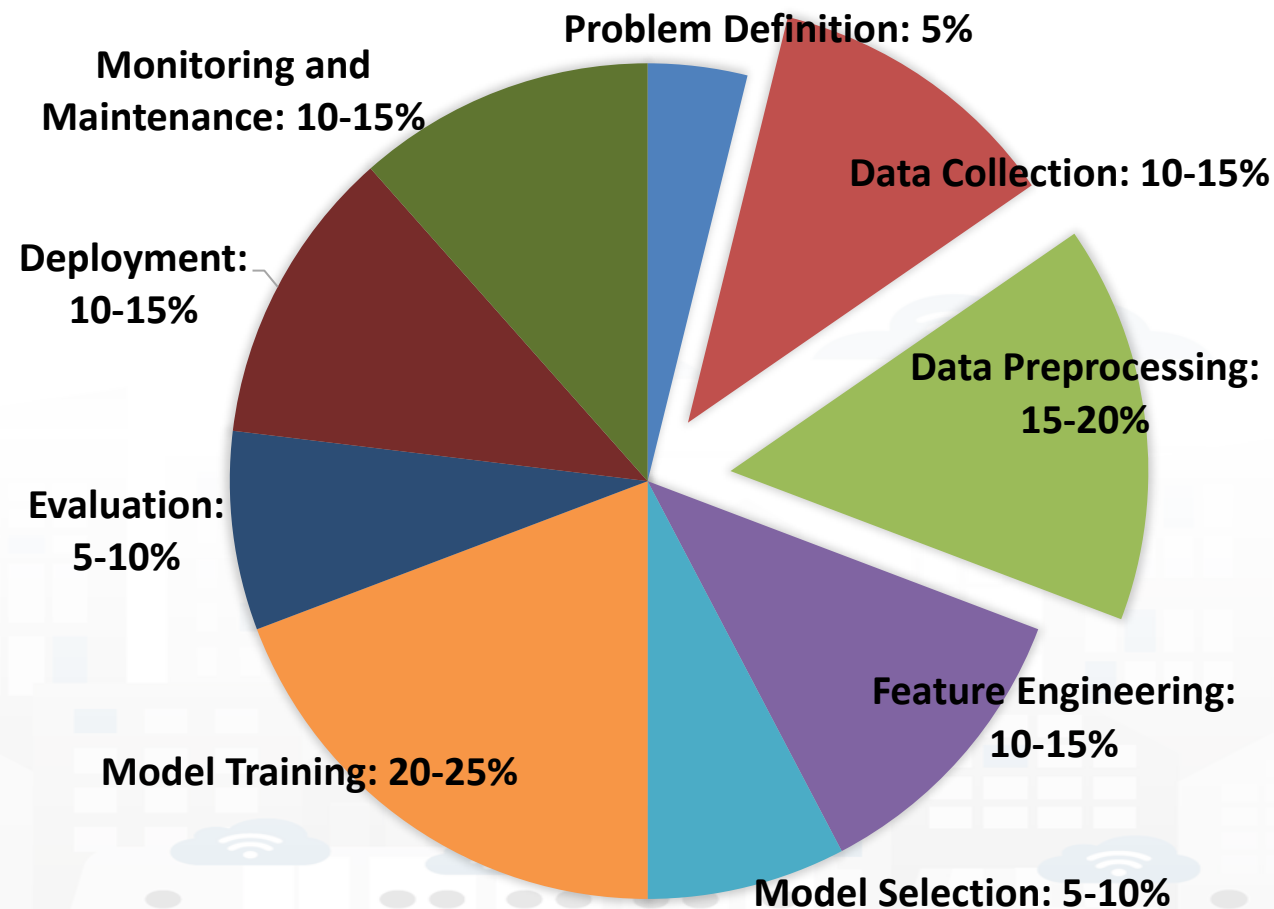
Model/Technique Development/testing

- **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**



Typical Effort of Phases without Snap4City

- Please note the *effort for Data Preprocessing and Data Collection*
 - 25-35%
- Please note that the pie has not taken into account the effort for creating
 - an actual applications or
 - simple web results rendering on dashboard



Snap4City on *Data Collection and PreProcess*

- **Effort reduction from 25-35% to 10-15%, >55% reduction of effort for**
 - **Data Collection** via
 - Direct collection access with Brokers, harvesting of external brokers and data models
 - Usage of library of data models, more than 1700 models: saving analysis
 - Custom data models, massive automated construction of entities
 - Automated enrichment of Km4City Ontology and knowledge base: saving time analysis
 - IoT App / Node-red development of data collection processes: fast development
 - **Data PreProcess** via
 - Node-red visual programming (node.js) for preprocessing, transcoding, thousands of microservices and libraries, reuse of blocks and data flows, etc.
 - Semantic recovering of data relationships via semantic graph DB with Km4City models
 - Eventually usage of Python or R-studio or others when needed
 - *Reuse and share of Node-RED solutions, large number of cases*

TOP

Accelerating on Smart City



Part 6: Platform Architecture, interop and Deploy

Part 6: Snap4City
Platform Architecture,
Interoperability,
Management and
Deploy

[SLIDES](#)

[Interactive Slides](#)



- Snap4City Architecture
- Interoperability of Snap4City Platform
- Interoperability with respect to Hardware staff
- Adding Features and Modules to Snap4City
- FIWARE and Snap4City
- Snap4City vs State of the Art Solutions
- Smart City planning with Snap4City Team Support
- The Role of the Living Lab Support
- Snap4City Platform: Administration Overview
- Snap4Tech: Smart Solutions as a Service
- Deploy Snap4Tech solutions: Docker Based

Tech Overview

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



Technical Overview

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

Snap4City:

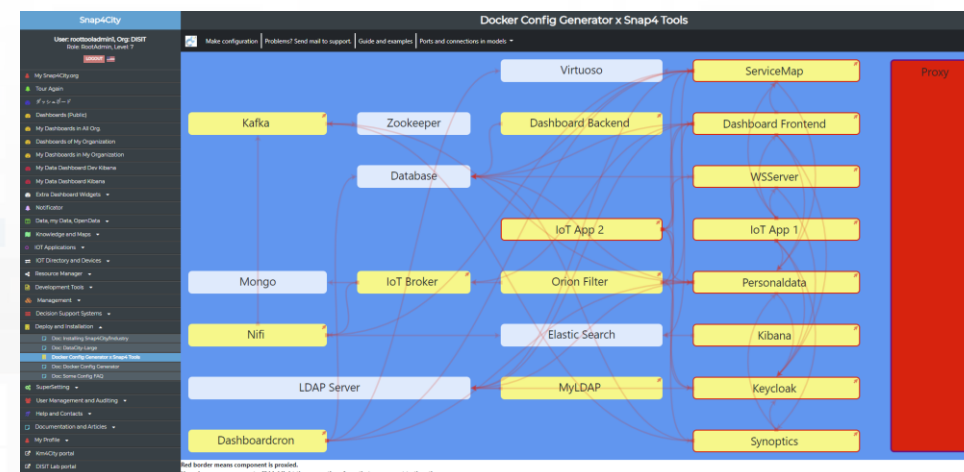
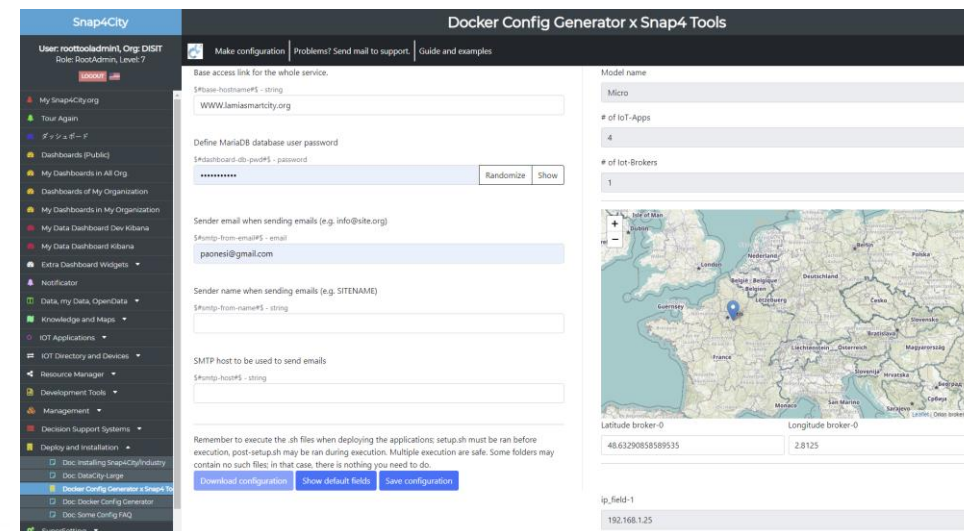
- Web page: <https://www.snap4city.org>
- <https://twitter.com/snap4city>
- <https://www.facebook.com/snap4city>

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>

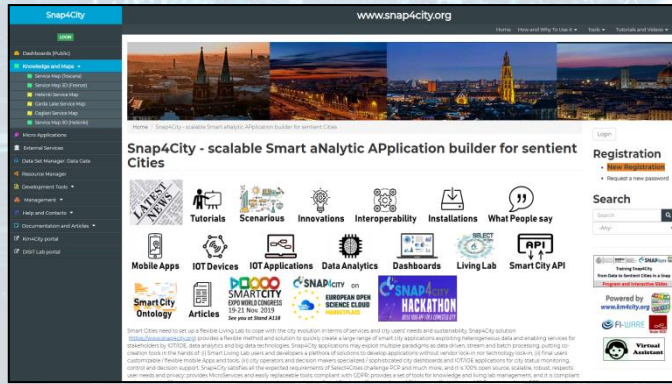
Installations, different models a TOOL to get them

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



https://www.snap4city.org/docker-generator/selecting_model

How to adopt Snap4City



On your premise



Smart City as a Service

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

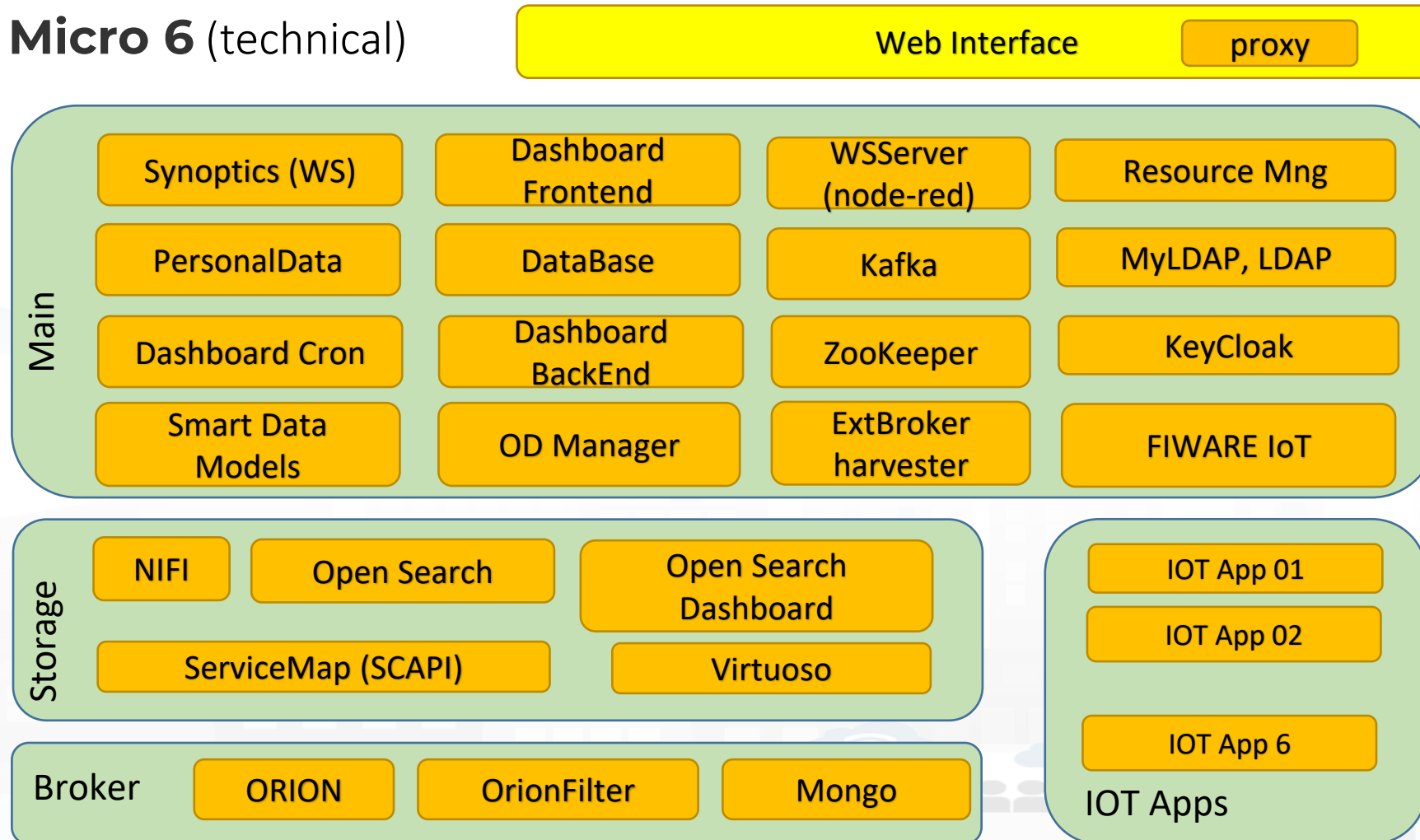


Installation on your premise

- Virtual Machines or Dockers
 - 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

Micro 6 model

Micro 6 (technical)



1Hour
installation
and
ready to use

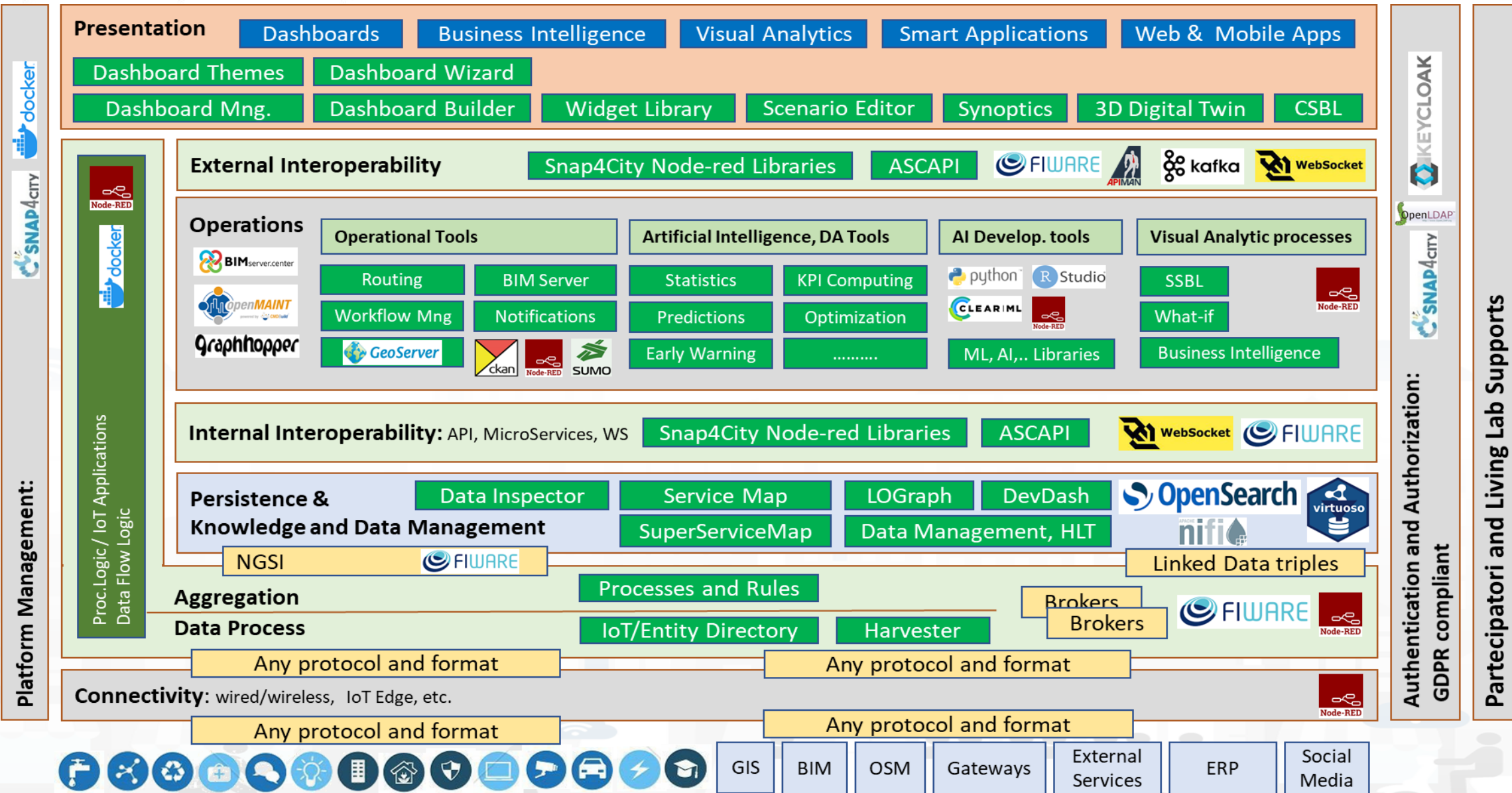
- **SLA:**
 - Including: Direct Contact, POC; Help Desk
 - may be an Organization on our cloud to test new tools, and work with the community, this is typically 5-12Keuro first 2years and 1-2keuro for each successive year depending on the feature and number of users you are placing.
 - Similar to: <https://www.snap4city.org/497> with some adaptation on the basis of your deploy and critical conditions, if any
 - Updates, help desk, etc.
- **Our support can be valued on:**
 - The basis of the complexity of your solution: 10% of the cost
 - Or
 - Block of: 16 hours, for 3000 euro / 50 hours, for 6000 euro
 - larger packages can be negotiated
- **Support can be provided by:** Snap4, DISIT Lab, and other companies
- **Customizations can be assessed separately**

Using from Cloud or Installing on Premise

- **Cloud «as a service»:** a number of installations are in place
 - The largest <https://www.snap4city.org>
 - 20 tenants/organizations, Billions of data
 - 1 hour deploy new organization, devices, data, dashboards
- **Installations on public or private cloud, or on private servers**
 - A number of ready to use configurations from 1VM to multiple scalable solutions: <https://www.snap4city.org/471>
 - VM: Appliances ready to use
 - Docker compose, Tool for generating and downloading the docker compose files
 - Micro X version can be installed and tested in 4 hours. <https://www.snap4city.org/738>



https://www.snap4city.org/docker-generator/selecting_model



TOP

Platform Administration



	1st part	2nd part	3rd part	4th part	5th part	6th part	7th part	8th
what	Overview	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App	Design and Develop Smart Solutions
PDF 2022								
Interactive (2022) with video and animations								

SNAP4
Services and Docker
Installations

Roles in Snap4City/Industry solutions

- **RootAdmin**
 - The gods of the specific installation, access to all tools for all Organizations
- **ToolAdmin**
 - The administrators of an Organization with some capabilities on single tools
- **AreaManager (developers)**
 - access to development tools, access to a wider number of resources, IOT with both basic and advanced, IOT Models, etc.
- **Manager (final users)**
 - limited access to development, IOT App development with Basic library.
- **Users of any Role** have full control on their own resources: data, devices, dashboards, IOT App, etc., which may control according to GDPR rules,
 - providing access, revoking, etc.
- **All users start as Manager roles**
 - All users have also a Level (numeric). A score about what they have exploited in the platform. Higher scores correspond to wider exploitation of capabilities.
- **RootAdmin users may**
 - pass Users to higher roles. Ask to snap4city@disit.org to become an AreaManager for testing
 - Provide/grant specific authorizations to data access on Tool usage
- In the Installation onPremise, you become the RootAdmin of it, you decide ALL.

Platform Management and control



Management	
Traffic Analyzer: AMMA	
Container Cluster Monitoring	
Container Cluster Intelligence	
Back Office Container Monitoring	
IOT App Version Management	
Smart City API Monitoring	
MyKPI Monitoring	
Notifier Monitor	User Management and Auditing
Web Server Monitor	User Management
Back Office DWH Scheduler	User Limits Management
Back Office Data Scheduler	User Engagement
Back Office DISCES	User Engagement Dash
Mobile Application M	User Role Management via LDAP
Mng Anonym. Photo	Manage Resource Ownership
Mng Photos Comme	User Chats Management
Mng Online Helps	Auditing Data Access Try-out
Config ResDash	Auditing Elements vs Ownership
Mesos view	Auditing Personal Data
DISCES-EM	Auditing Accesses Authentication
DISCES-EM tail	Auditing User Activities
IOT App for Conf Clu	Auditing Activities on Queries
	Auditing Activities on Articles
	Auditing IOT Directory Data
	Dashboard Builder Local Users
	Organizations vs Groups
	Users vs Organizations

Platform Management tools

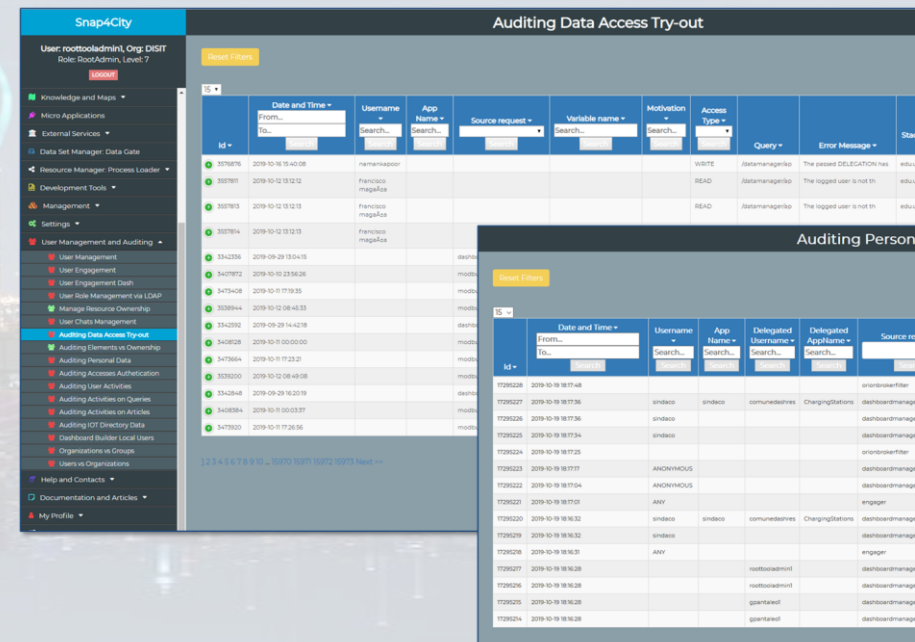
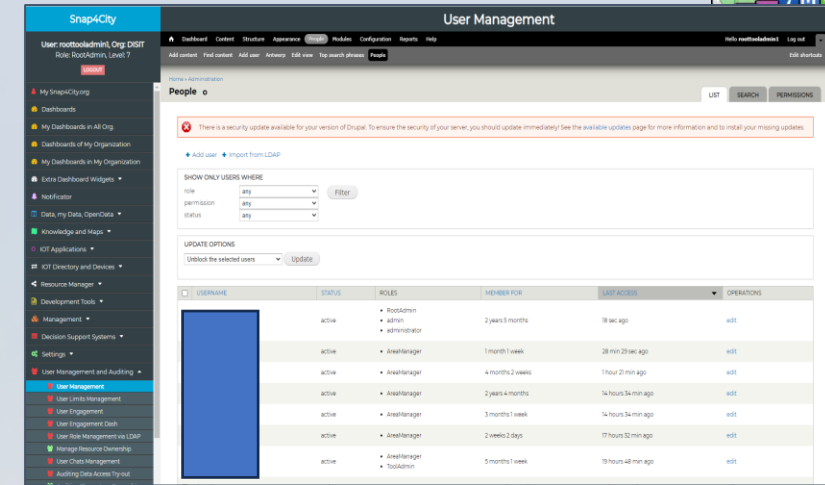
- Installation procedures
- monitoring and control tools
- Quality control
- Help desk and SLA

User management tools

- User profiling, limiting
- Auditing tools according to GDPR
- Menu profiling
- CRM

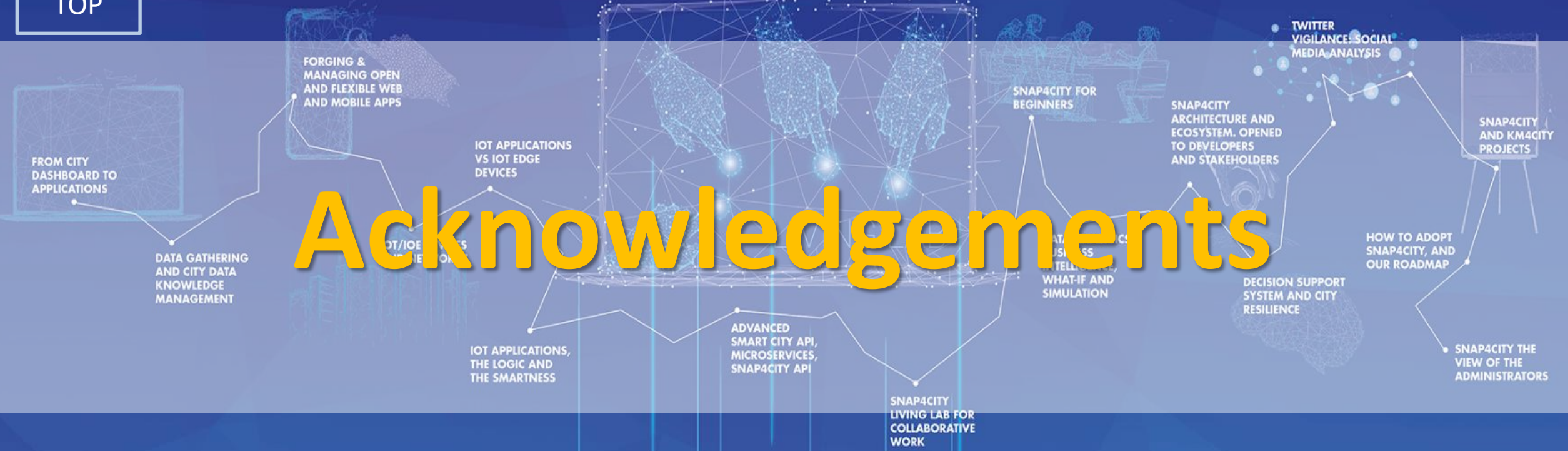
Training and tutoring tools

- Develop. Life Cycle
- Develop. tools
- Manual, courses, etc.
- Community
- etc.



TOP

Acknowledgements





SMART CITIES AND SMART INDUSTRY

Snap4City:
FIWARE powered smart app
builder for sentient cities

With the contribution of



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

2023 booklets



- Smart City



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

- Industry



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

- Artificial Intelligence



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

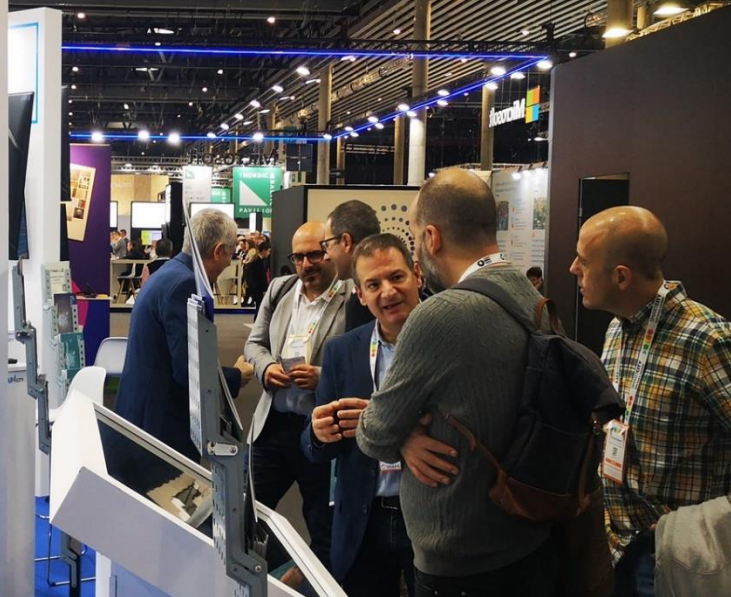
<https://www.snap4city.org/4>

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



Scenariious

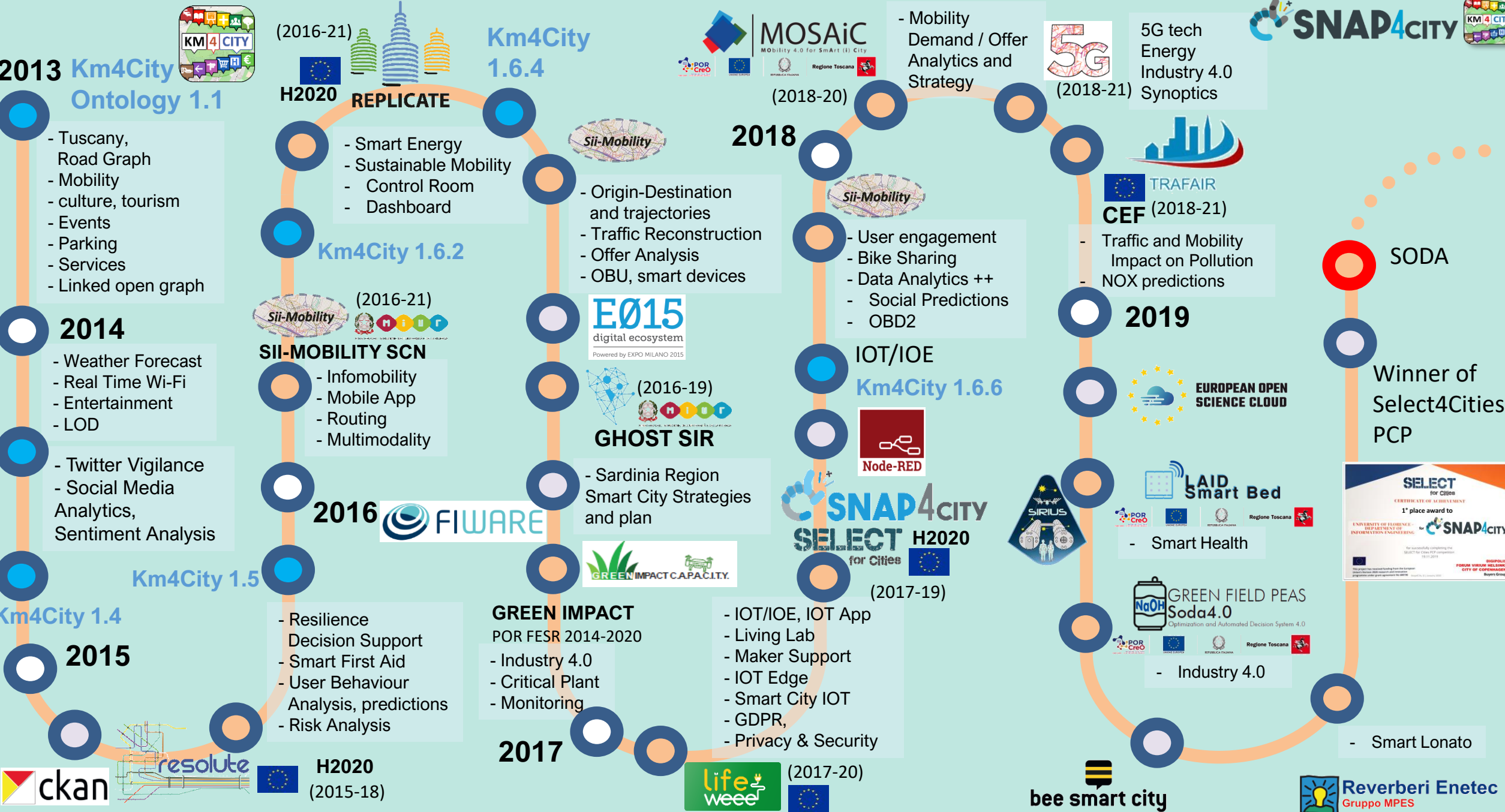
- [Data Analytic: Origin Destination Matrices, Algorithms and tools](#)
- [Data Analytic: Traffic Flow Reconstruction](#)
- [Data Analytic: in general, and the cases of Antwerp and Helsinki](#)
- [Data Analytic: Predicting Air Quality](#)
- [Data Analytic: Analyzing Public Transportation Offer wrt Mobility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



SMARTCITY
 EXPO WORLD CONGRESS
 7 - 9 NOVEMBER 2023



PAVILLON 1 - STAND D 100



2013 Km4City Ontology 1.1

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

2014

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

- Twitter Vigilance
- Social Media Analytics, Sentiment Analysis

Km4City 1.4

2015

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



(2016-21) H2020 REPLICATE

- Smart Energy
- Sustainable Mobility
- Control Room
- Dashboard

Km4City 1.6.2

(2016-21) SII-MOBILITY SCN

- Infomobility
- Mobile App
- Routing
- Multimodality

2016 FIWARE

Km4City 1.5

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

Km4City 1.6.4

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

E015 digital ecosystem

Powered by EXPO MILANO 2015

(2016-19) GHOST SIR

- Sardinia Region Smart City Strategies and plan

GREEN IMPACT CAPACITY

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

2017

life weee (2017-20)

- Smart Waste

MOSAIC Mobility 4.0 for Smart (II) City (2018-20)

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

IOT/IOE Km4City 1.6.6

Node-RED

SNAP4CITY SELECT for Cities H2020 (2017-19)

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

bee smart city

5G tech Energy Industry 4.0 Synoptics (2018-21)

- Traffic and Mobility Impact on Pollution
- NOX predictions

2019

EUROPEAN OPEN SCIENCE CLOUD

LAI Smart Bed

- Smart Health

GREEN FIELD PEAS Soda4.0

- Industry 4.0

bee smart city

SNAP4CITY

- SODA

Winner of Select4Cities PCP

SELECT for Cities

CERTIFICATE OF ACHIEVEMENT

1st place award to

UNIVERSITY OF FERUGINA - DEPARTMENT OF INFORMATION ENGINEERING

for **SNAP4CITY**

Smart Lonato

Reverberi Enetec Gruppo MPES

DISIT lab roadmap vs model and tools' usage



2020



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



- Smart Mobility
- PISA, PUMS
- Living lab



Km4City 1.6.7

Smart Ambulance (2021-22)

Enterprise (2021-22)
Industry 4.0



2021

PC4City (2020-21)
Monitoring Terrain



CAPĒLON

- Smart Light
- Sweden

Almafluida Industry 4.0 (2021-22)

AMPERE (2021-22)
Industry 4.0

SYN-RG-AI
SmartCity



uni.systems

SmartCity, 2021-23



AXIS collab
SmartCity

2022



Asymmetrica
Smart City, 2022-23

Contract, 2022-23



Contract, 2022-23



2022-2023



Contract, 15min



Security and Risk



Italferr, Smart City

2023

MOST
CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE
CN MOST, 2022-26



EI THE, 2022-26



G. Agile, 2021-23



2023-26 Finanziato dall'Unione europea NextGenerationEU

Merano, smart light

OceanRace, Genova, AWS

Cuneo, smart city

2024

TOURISMO



Co-funded by the European Union

ELLIE IA 2025-2027



Contract, 2024-25

CAI4DSA



OPTIFaaS
MOST
CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE



SASUAM
MOST
CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE



Rhodes, smart city

eShare
UNIFI TUSS

AMMIRARE



TOP



Be smart in a SNAP!



CONTACT

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Università degli Studi di Firenze - School of Engineering

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<https://www.disit.org>

www.snap4city.org

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Installations

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UNIVERSITÀ
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FIRENZE

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INGEGNERIA
DELL'INFORMAZIONE

DISIT
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AND INTERNET
TECHNOLOGIES LAB