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

SNAP4CITY

Powered by KM4CITY

Smart City and BIM

https://www.Snap4City.org

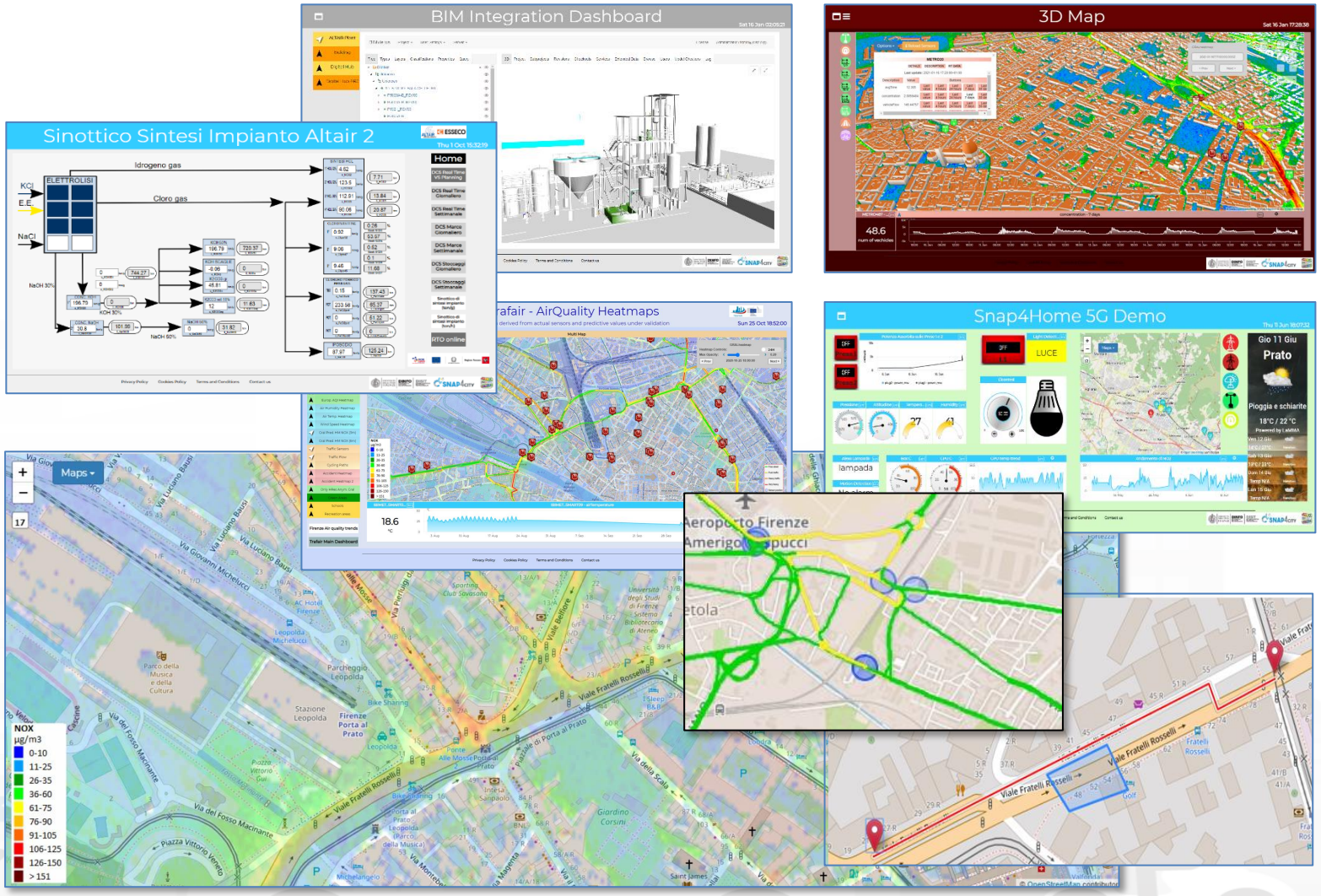
Paolo Nesi, paolo.nesi@unifi.it
https://www.Km4City.org
https://www.disit.org

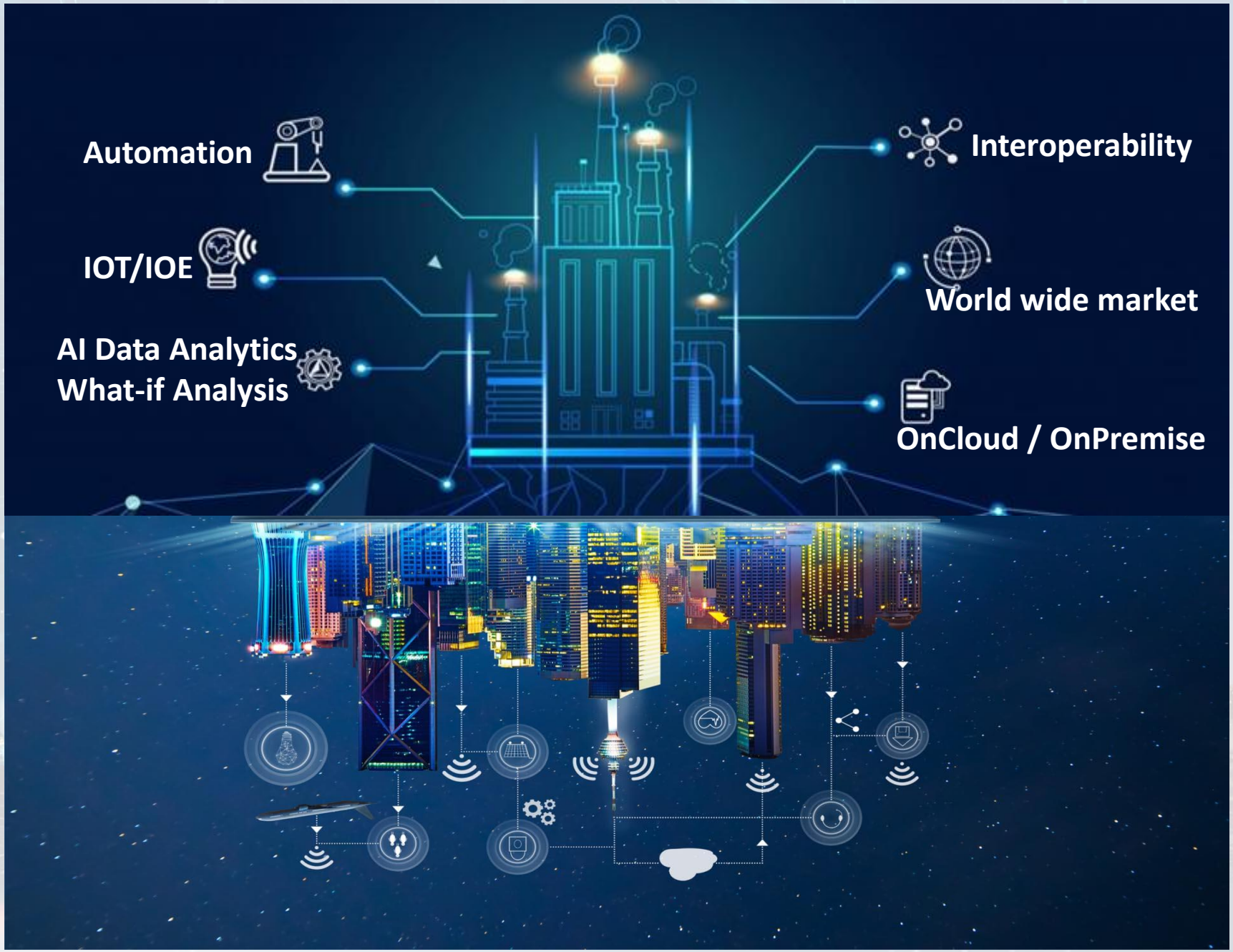
Information in Smart City is not so simple

- Data Coverage:
  - POI, IOT, shapes,..
  - maps, orthomaps, GTFS, GIS WFS/WMS,
  - calibrated heatmaps,
  - traffic flow, typical trends,
  - trajectories, events,
  - 3D, BIM, Workflow,
  - Dynamic icons/pins,
  - OD Matrices, scenarios,
  - prediction models, ….
  - decision support, ….
  - Synoptics, animations,
  - social media, Routing, etc.

Need a huge amount of standards

←back and forward→





Fast Tailored Deploy of Smart Applications & Decision Supports

exploiting our tools to cope with

- any data, format
- any channel, protocol
- any AI/ML
- any place
- online development
- multi-tenant
- secure
- GDPR, privacy
- → ***low costs***
- → ***easy to evolve***

Requirements and Objectives

- Serve as a **City Dashboard**, **App User Interface**, etc.
  - Real time and historical data, any device, sensors and actuators
  - Sensors, KPI, maps, data trends, real time data, charts, etc.
  - Multi domain, smart city + industry 4.0 scenarious
- Referral / **historical data, and Open Data**:
  - shadow, access (API, storage, any protocol), production of OD, export
- **Data Driven Real Time communication &** processing:
  - IOT Applications, IOT edge, multiple operating systems, embedded systems, **MicroServices**
  - in/out data driven from/to the field into: applications, notifications, etc.
- **Data Analytics**: Machine Learning, statistics, reasoning, …
- **Serve as Living Lab**: open innovation, co-working; collaborative work; sharing: data, processes, dashboard, experiences, solutions, ….
- Experimented on **large scale cases**

Non functional requirements

- **Open Source** based 100%
  - any **Standard**
- **Multi tenant:** to cope with multiple organization with a single installation
- **Scalable, Robust, Distributed** and Decoupled, modular, Service Oriented, open to external services and data sets, big data
- **Heterogeneous**: any device, private and public, custom and..
- **Security** by Design: HTTPS, TLS, … compliant with EC
- **User Centric** Design: privacy by Design (and **GDPR**), personalized, personal data management, ...

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SNAP4CITY
www.snap4city.org

KM4CITY

Powered by FIWARE

SNAP4 Appliances and Dockers Installations

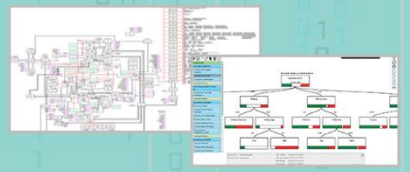
FREE TRIAL

PEN Test Passed

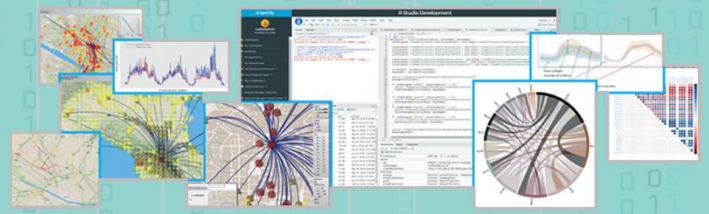
EU GDPR COMPLIANT

100% OPEN SOURCE

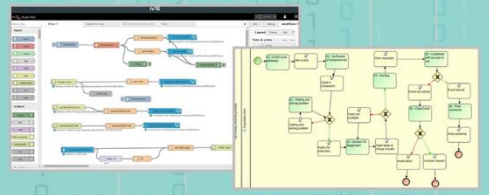
DASHBOARDS AND APPS - CONTROL ROOMS - DECISION SUPPORT SYSTEMS - WHAT-IF ANALYSIS



EXPERT SYSTEM
KNOWLEDGE BASE
STORAGE

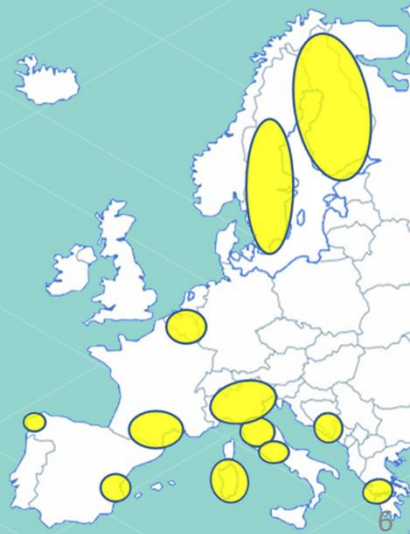


BIG DATA ANALYTICS
ARTIFICIAL INTELLIGENCE
BUSINESS INTELLIGENCE
MACHINE LEARNING



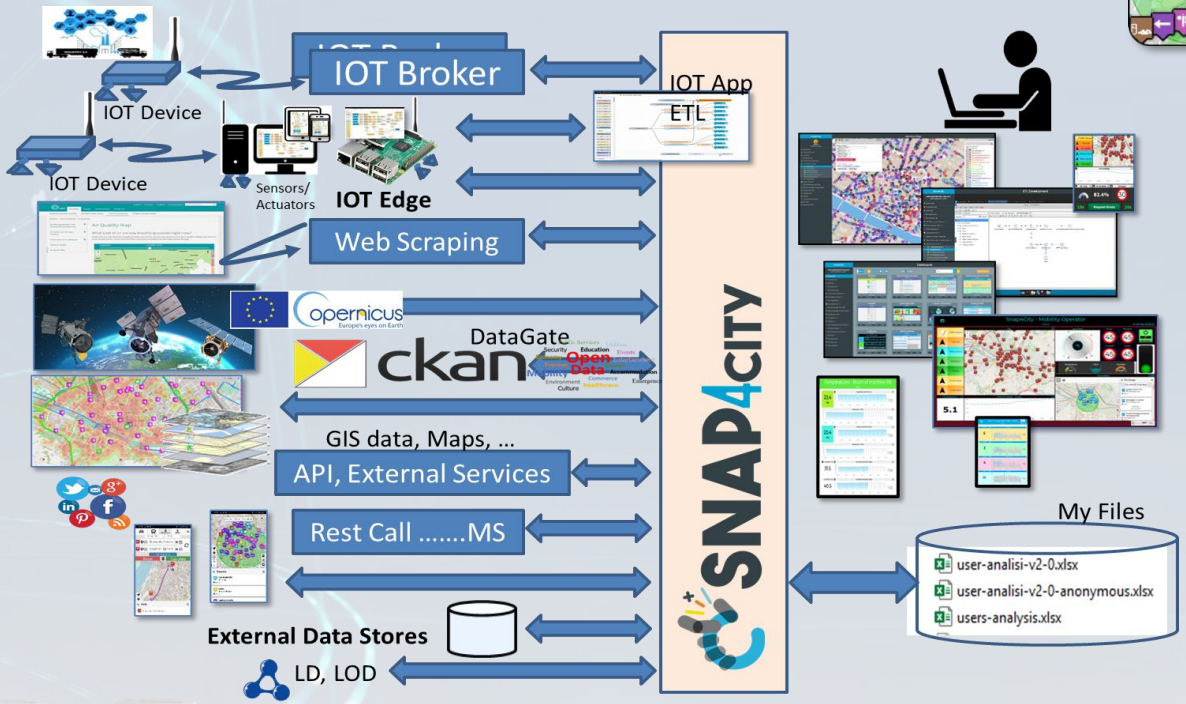
DATA FLOWS, WORKFLOWS
MICROSERVICES
MANAGEMENT

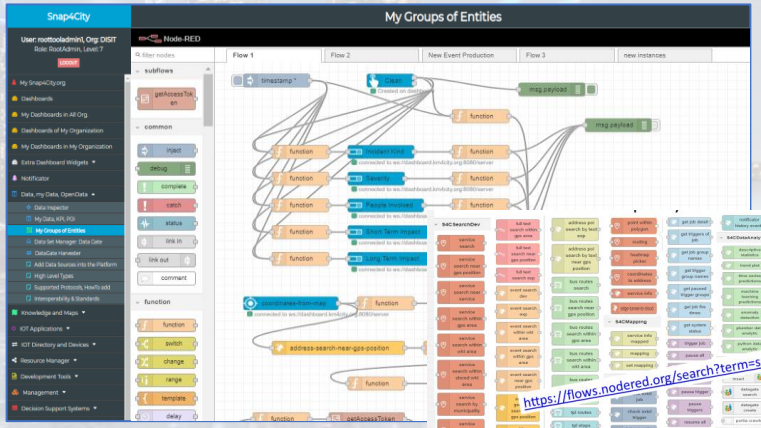
METHODOLOGIES
COURSES AND COMMUNITY
LIVING LABS
DEVELOPMENT TOOLS

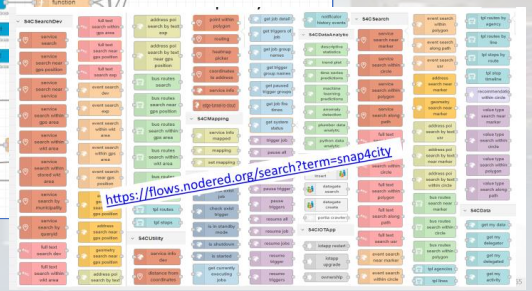


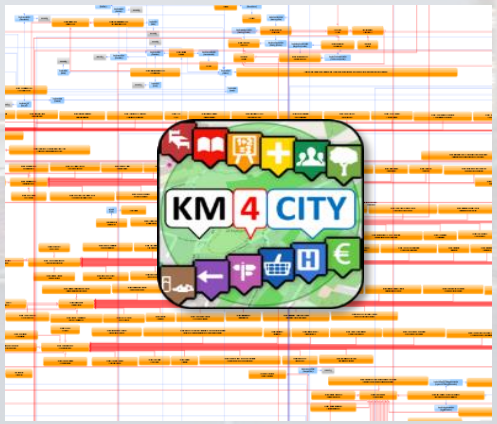
Ingestion, aggregation → exploitation

- **Snap4City efficient tools for**
  - Bidirectional data channels
  - Any format, any channel, any data, any broker, any protocol, …
  - **Km4City** Knowledge base Ontology reasoning on geo, space, time, relationships
- **Expert System semantic queries accessible via**:
  - **Smart City API** for Apps and third party
  - **MicroServices** data driven develop via visual language Node-RED





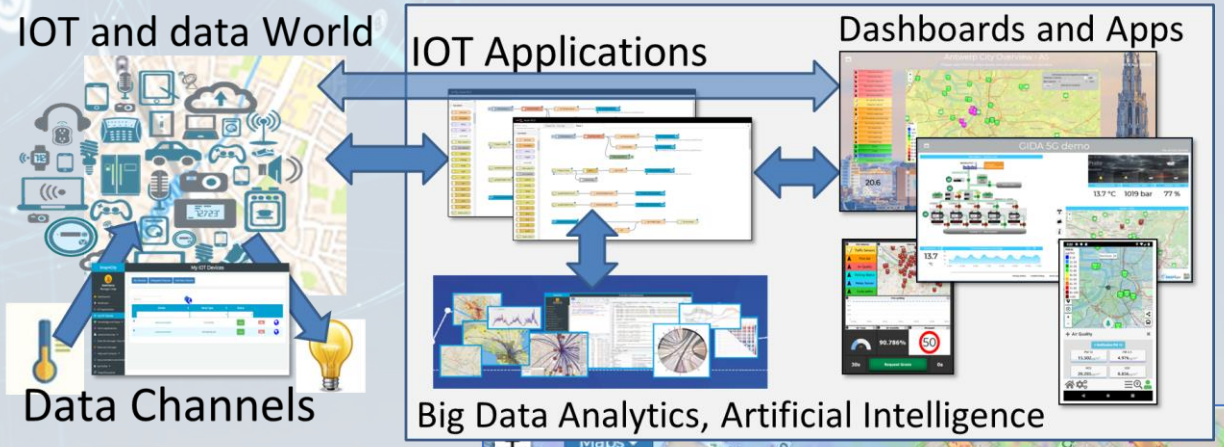


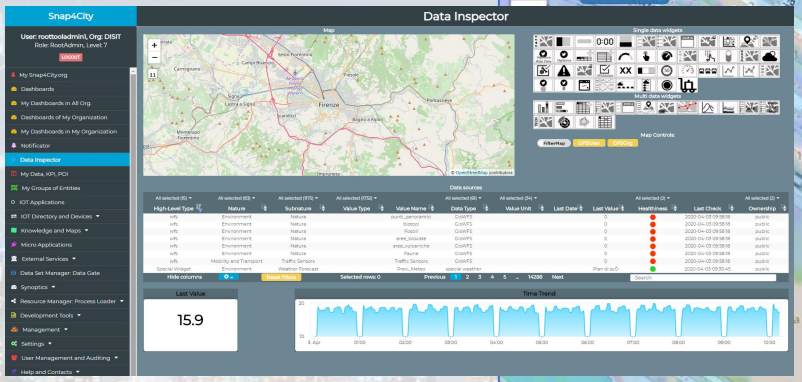


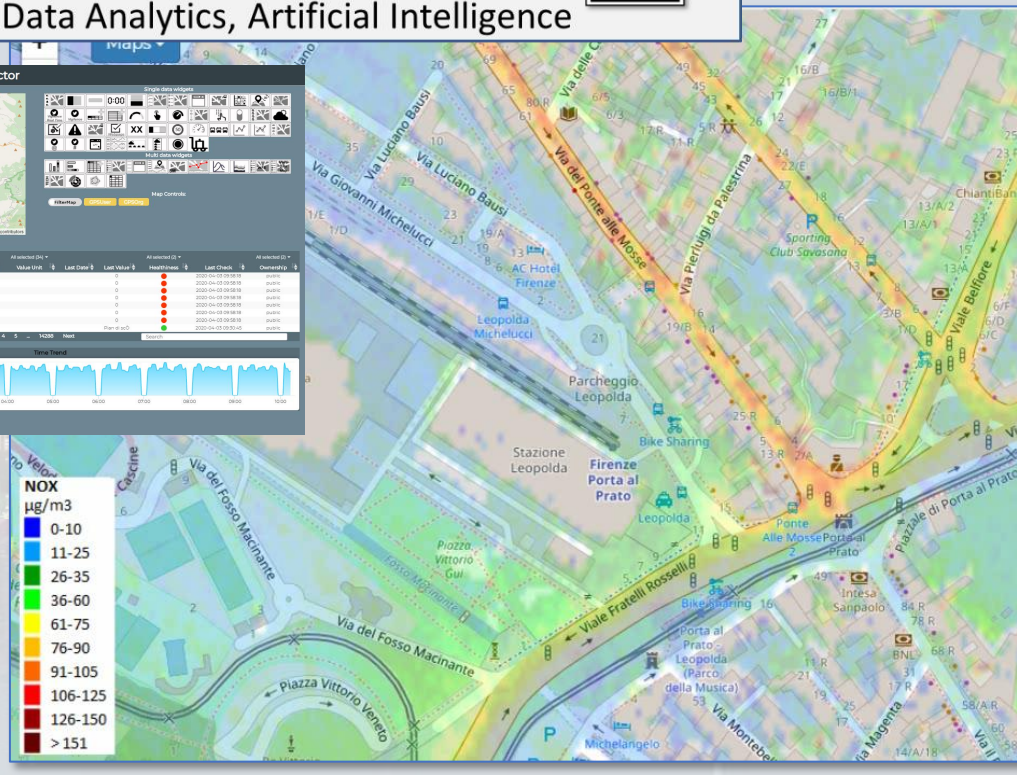
Solutions: reliable, secure and fast to realize

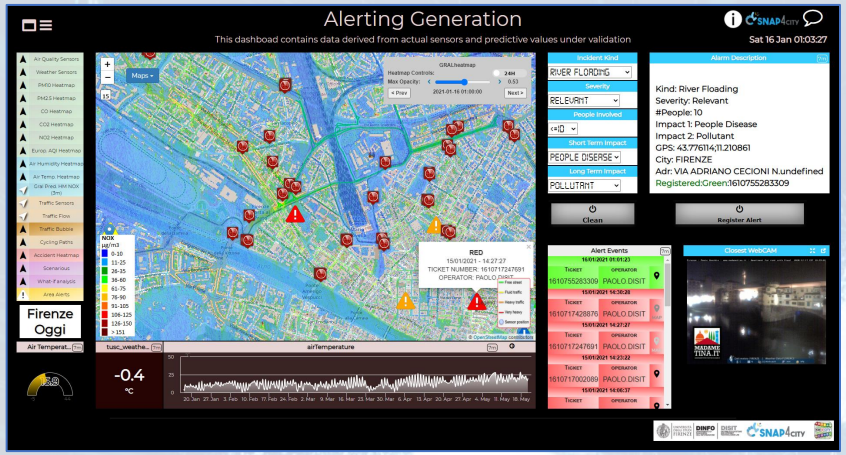
- **Via Snap4City tools**
  - **Dashboard Wizard**
  - **Dashboard Builder**
  - **Data/Visual Analytic**

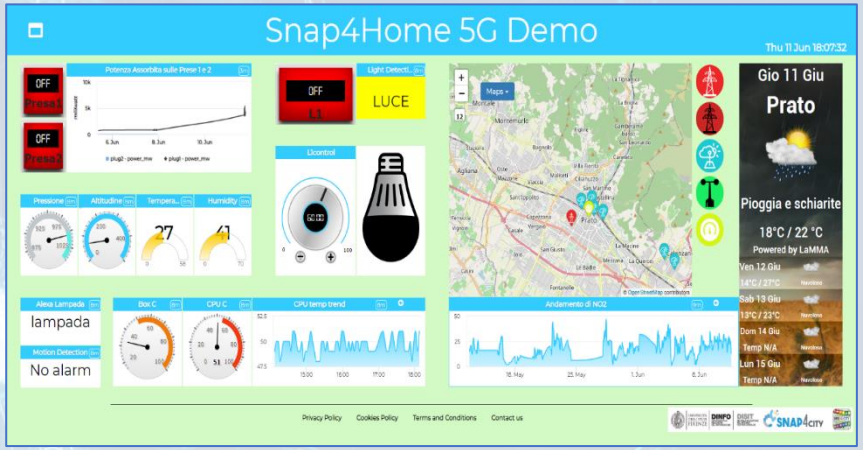
- **Smart Solutions results to be**
  - **Real time data drive**
  - **Secure end-to-end**
  - **GDPR compliant**
  - **Reliable, interoperable**
  - **Auditable, marketable**

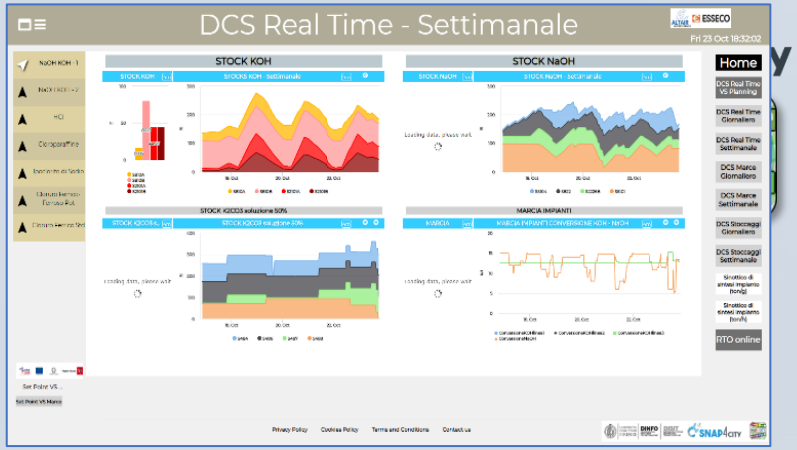


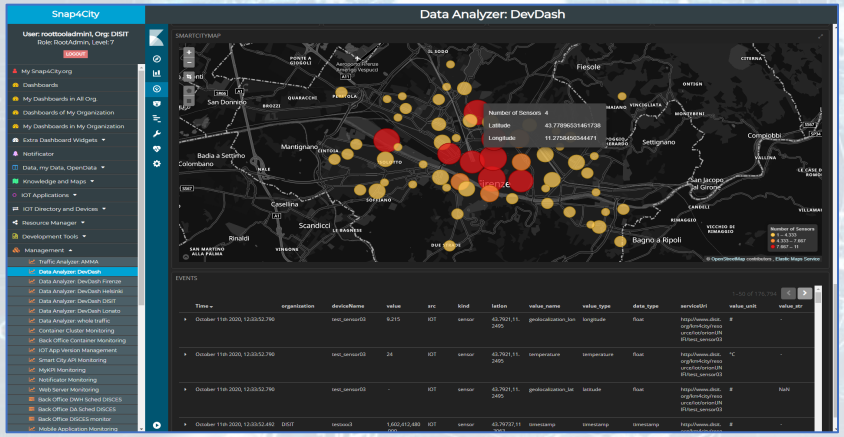


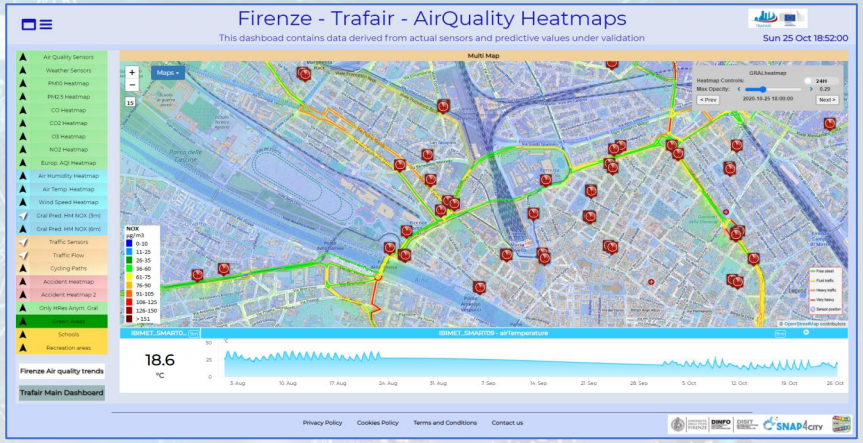


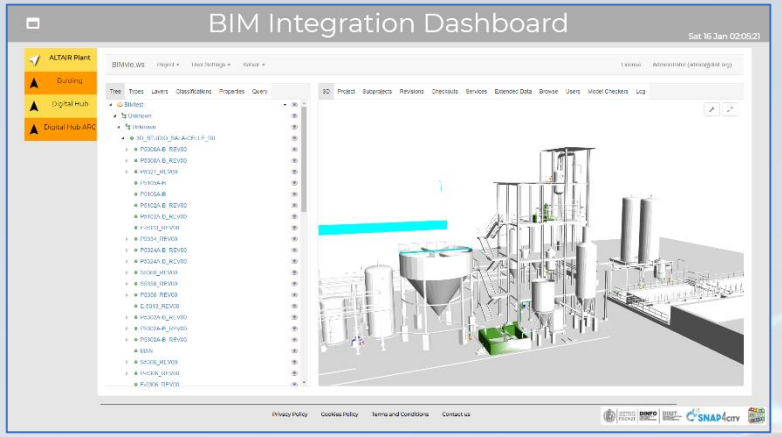

Alerting Generation
This dashboad contains data derived from actual sensors and predictive values under validation
Sat 16 Jan 01:03:27
Firenze Oggi
-0.4

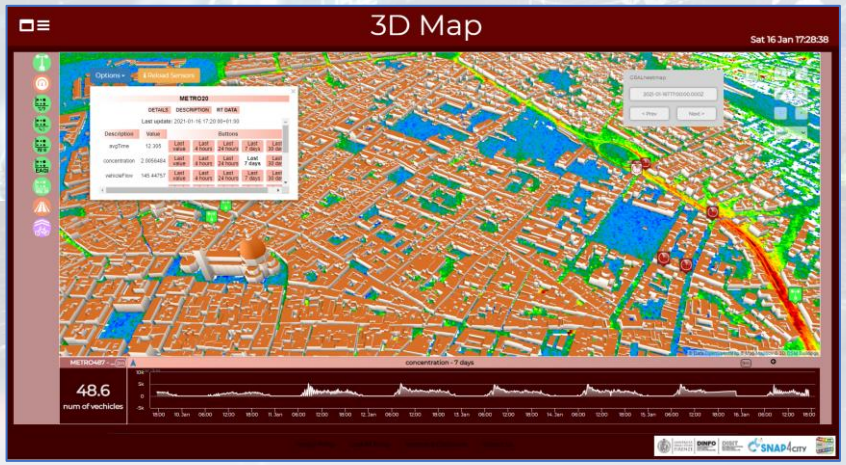

Snap4Home 5G Demo
Thu 11 Jun 18:07:32
LUCE
lampada
No alarm
Gio 11 Giu
Prato
Pioggia e schiarite
18°C / 22 °C

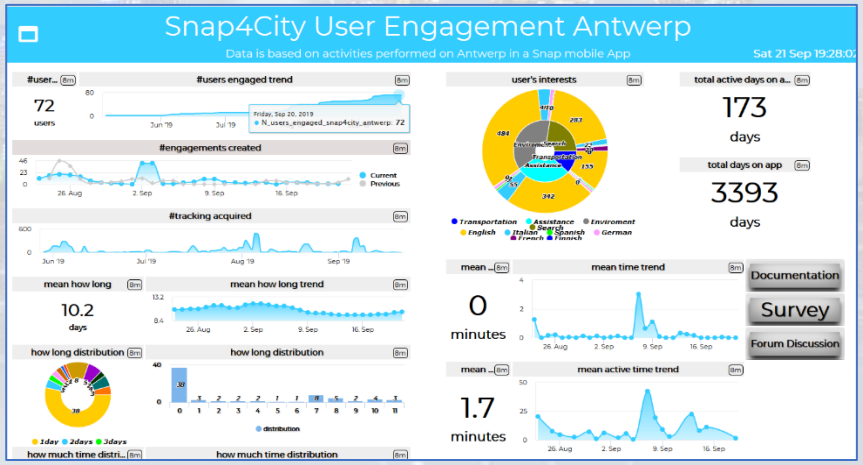

DCS Real Time - Settimanale
Fri 23 Oct 18:32:02
STOCK KOH
STOCK NaOH

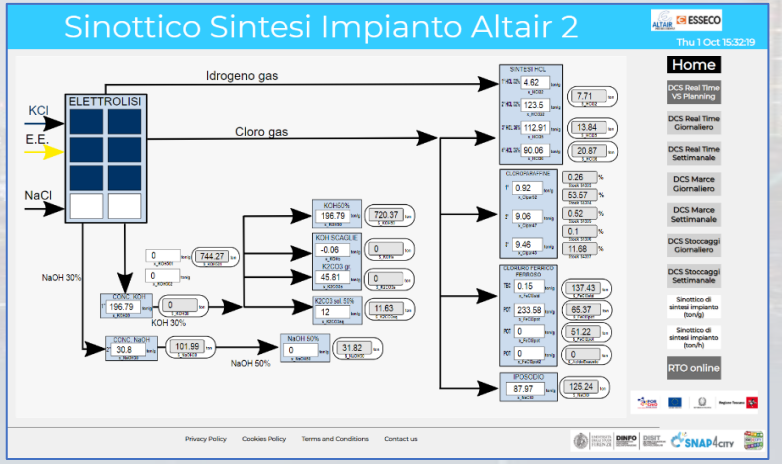

Snap4City
Data Analyzer: DevDash


Firenze - Trafair - AirQuality Heatmaps
This dashboad contains data derived from actual sensors and predictive values under validation
Sun 25 Oct 18:52:00
18.6


BIM Integration Dashboard
Sat 16 Jan 02:05:21


3D Map
Sat 16 Jan 17:28:38
48.6
num of vechicles


Snap4City User Engagement Antwerp
Data is based on activities performed on Antwerp in a Snap mobile App
Sat 21 Sep 19:28:07
72
users
173
days
3393
days
0
minutes
1.7
minutes
10.2
days
Documentation
Survey
Forum Discussion

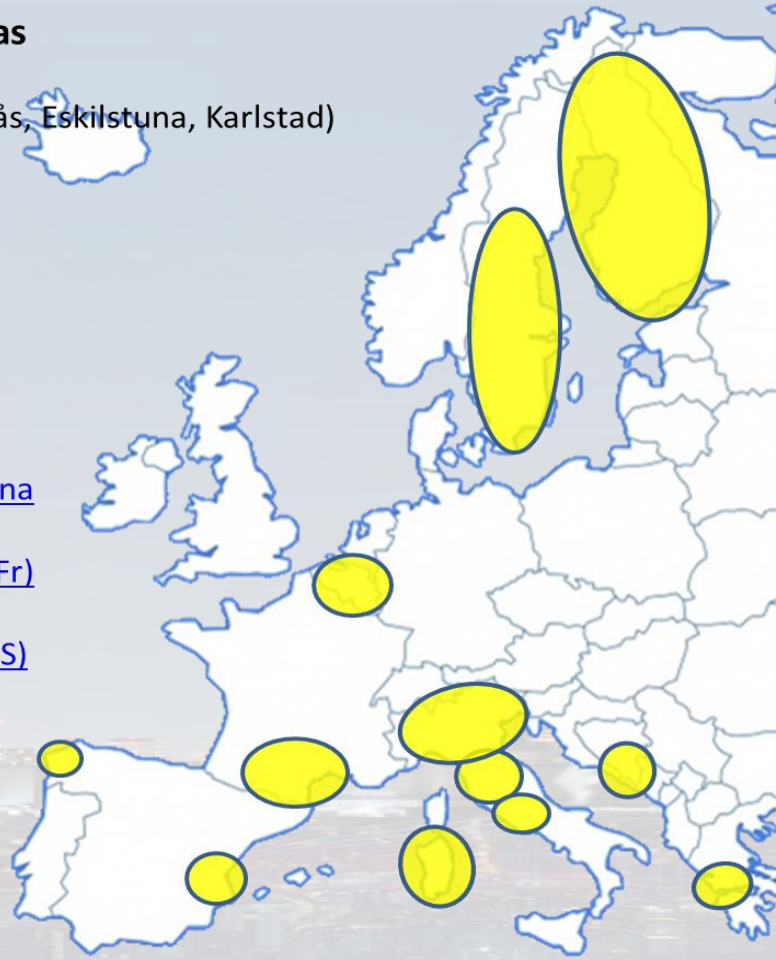

Sinottico Sintesi Impianto Altair 2
Thu 1 Oct 15:32:19
Idrogeno gas
Cloro gas
ELETTROLISI
KCl
E.E.
NaCl
NaOH 30%
KOH 30%
NaOH 50%

2021: Snap4City/Industry Numbers

- ***Domains**: mobility, energy, people flow, environment, Industry 4.0, vehicle tracking, Tourism,*
  - *smart park, smart waste, smart bed, smart ambulance, smart light, etc…*
  - *Predictions, simulations, anomaly detection, ..*
- 5 running installations, 13 projects, 12 pilots, 9 Countries
- > 100 Protocols
- **Scalable from vertical to large deploy**
- **On the largest deploy** https://www.Snap4City.org
  - 17 Organizations / tenant
  - > 80 applications on: cities, areas, scenarios
  - > 4800 users
  - > 1200 Dashboards
  - > 15 mobile Apps
  - > 2 Million of structured data per day in the larger deploy
  - > 500 IoT Applications/node-RED /Docker
  - > 680 web pages with training
  - > 40 videos, training videos

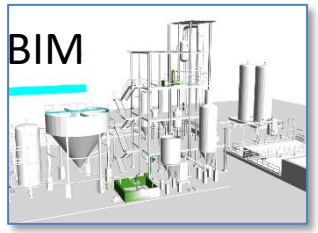
Main Organizations/areas

- Antwerp area (Be)
- Capelon (Sweden: Västerås, Eskilstuna, Karlstad)
- DISIT demo (multiple)
- Dubrovnik, Croatia
- Firenze area (I)
- Garda Lake area (I)
- Helsinki area (Fin)
- Livorno area (I)
- Lonato del Garda (I)
- Modena (I)
- Mostar, Bosnia-Herzegovina
- Pisa area (I)
- Pont du Gard, Occitanie (Fr)
- Roma (I)
- Santiago de Compostela (S)
- Sardegna Region (I)
- SmartBed (multiple)
- Toscana Region (I), SM
- Valencia (S)
- Venezia area (I)
- WestGreece area (Gr)



Concept

BIM

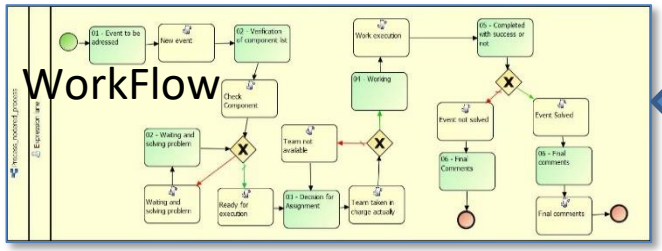


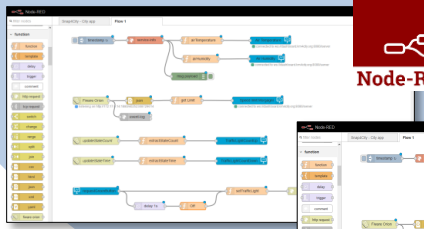
KPI, POI, MyKPI, …

API, External Services

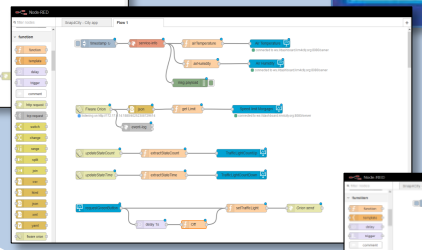
Web Scraping

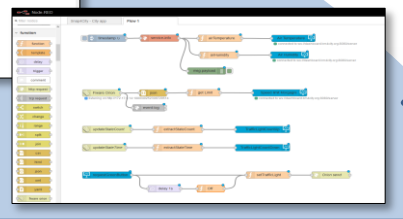
WorkFlow



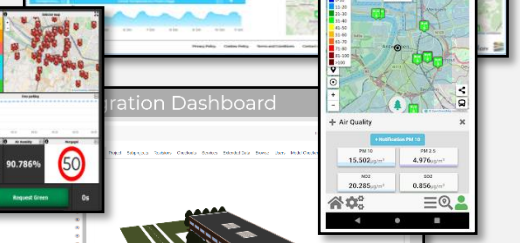


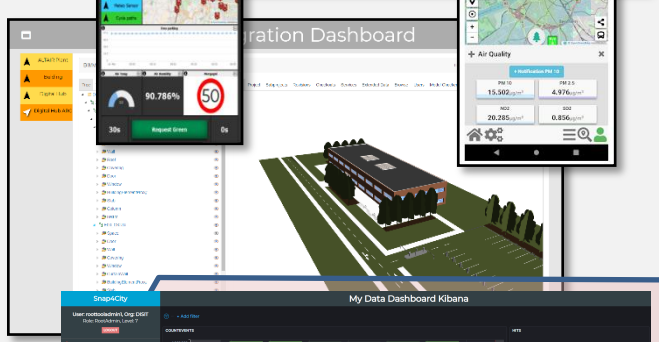
Node-RED

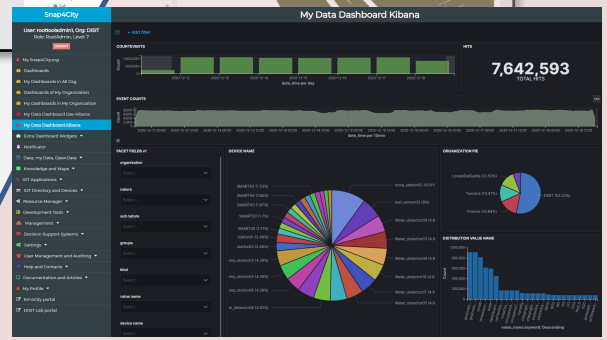




Data Analytics,
Artificial Intelligence







IOT Brokers

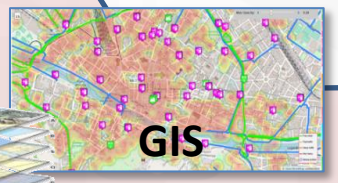
IOT Broker

IOT Broker

IOT Apps

FIWARE

ckan



GIS

Big Data

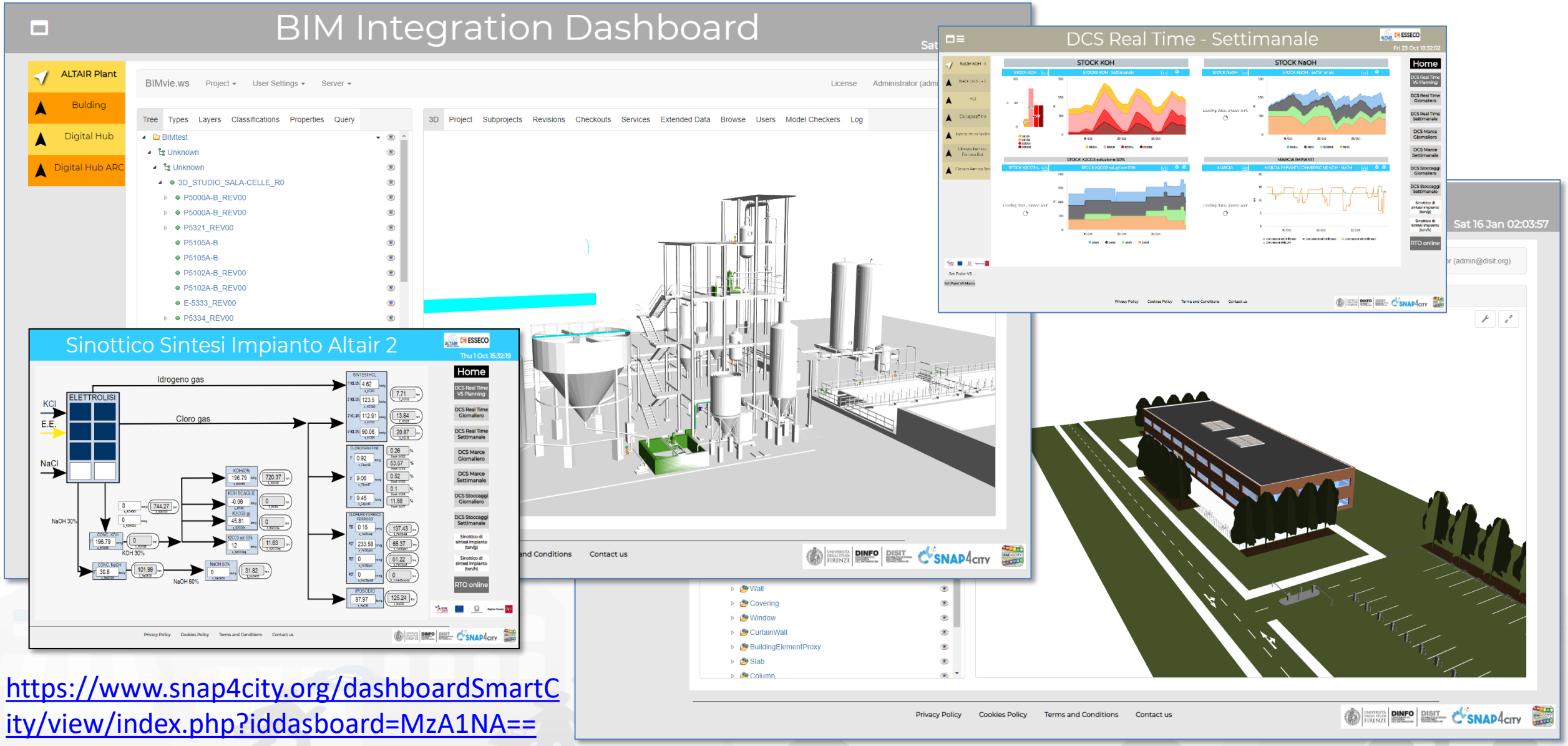
KB

LD, LOD

Dashboards and Apps

FI-WARE

BIM Server

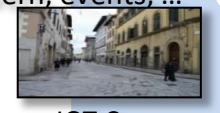


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA1NA==

Smart City Functional Architecture

Transport systems
Mobility, parking

Public Services,
Govern, events, …



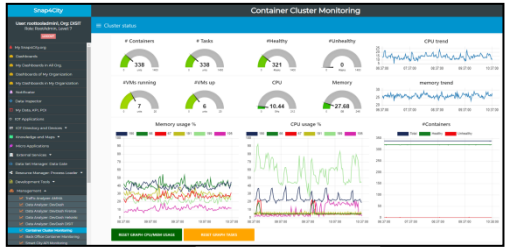
Sensors, IOT Cameras,
Wi-Fi

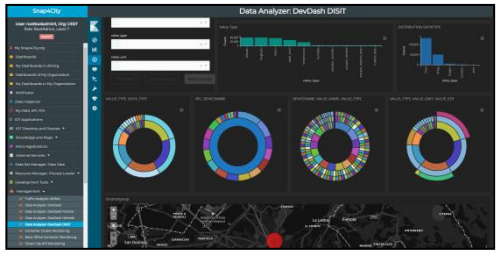
Environment, Water,
energy

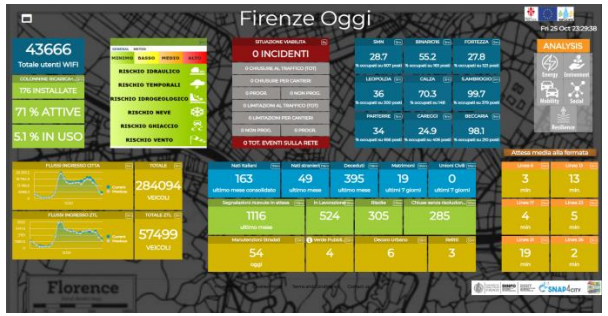
Shops, services,
operators

Social Media

Social Media Crawler and Manager







Back-End ⟵ ⟶ Front-End

Data Sources, External Services *PULL Data*

Data Sources, Brokers, External Services *Data Driven, Real Time*

Data Ingestion, aggregation, regularization, reconcile: IOT Directory, NIFI, special tools

Knowledge base
Semantic Reasoners

Indexing and aggregating
Elastic Search

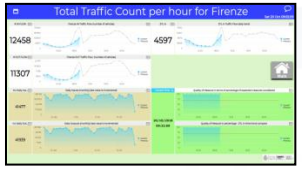
Federation

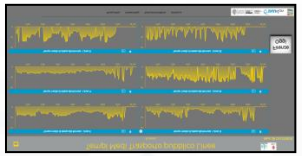
Search and Query, Smart City API, Web Socket Server, GIS, Facet, semantic

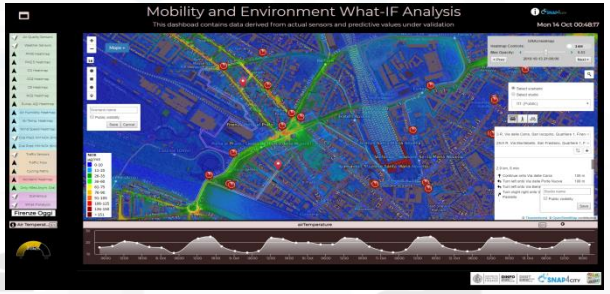
Data Analytics, Simulations, Special Tools
R Studio, Tensor Flow, Python, ….

IOT Applications, Business Logic
Node-RED + Snap4City MicroServices

Rendering Acting, Widgets, Synoptics, MicroApps
User interface, Drill down, maps, heatmaps





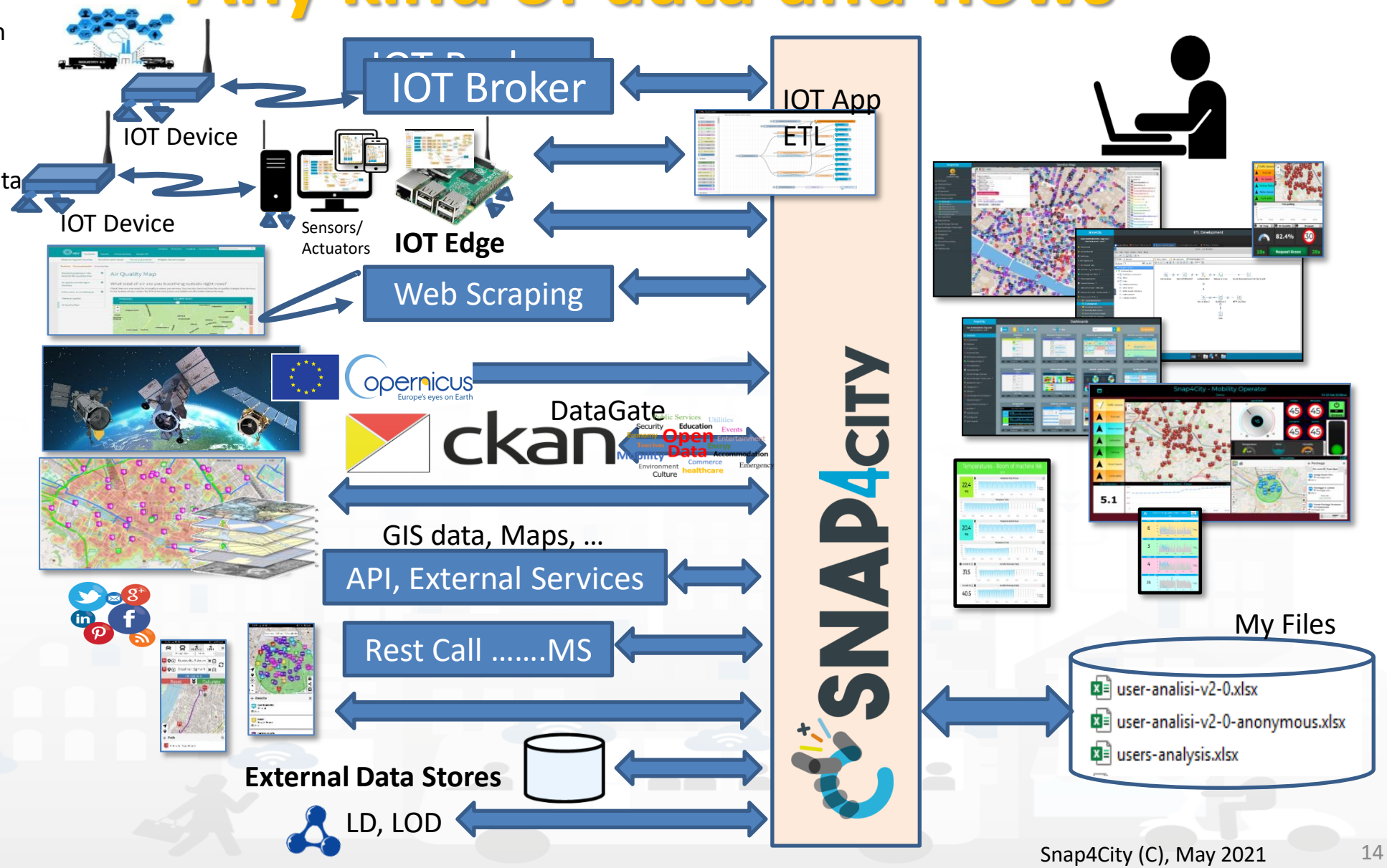


Inform, announce, Act!, warning, alarms, What-IF, ..

Authentication, Authorization, Platform & Processes Management, Data Inspector, Digital Twin, …

Any kind of data and flows

- **Open Data:**
  - Data gate, federation of Open Data Portals
  - IOT App, ETL proc(PULL)
- **IOT Networks:**
  - IOT Application processes, data driven or PULL
  - IOT Brokers (Push) → IOT Shadow
- **Web Pages:**
  - Web scraping, crawling processes
- **Satellite data**
- **Social media: Twitter, Facebook,..**
  - Twitter Vigilance, IOT App
- **Mobile Apps**
  - Smart City API
- **Files upload: CSV, Excel, etc.**
  - IOT Applications, ETL
- **REST API, WS, FTP, LD, LOD, etc.**
  - IOT Applications, ETL
- **Data base accesses**
  - GIS: WFS, WMS
  - ETL, IOT Application



Standards and Interoperability

Compliant with: AMQP, COAP, MQTT, OneM2M, HTTP, HTTPS, TLS, Rest Call, SMTP, TCP, UDP, NGSI, LoRa, LoRaWan, TheThingsNetwork, SigFOX, DATEX II, SOAP, WSDL, Twitter, FaceBook, Telegram, SMS, OLAP, MySQL, Mongo, HBASE, SOLR, SPARQL, EMAIL, FTP, FTPS, WebSocket, WebSocket Secure, ModBUS, OPC, GML, RS485, RS232, WFS, WMS, ODBC, JDBC, Elastic Search, Phoenix, XML, JSON, CSV, db, GeoJSON, Enfuser FMI, Android, Raspberry Pi, Local File System, ESP32, Libelium, IBIMET/IBE, OBD2, SVG, XLS, XLSX, TXT, HTML, CSS, KNX, Enocean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, BACnet, TALQ, Copernicus, Protocol Buffer, IFC, XPDL, etc.

Node-RED | JS Foundation | FI-WARE | E015 digital ecosystem | bee smart city

sigfox partner network | ckan | GJL | LABGEO | esri Italia | EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE

KB, ServiceMap

TOP

Some complete Use Cases

100% OPEN SOURCE

SNAP4 Appliances and Dockers **Installations**

Florence

Smart City Control Room
Florence Metropolitan City

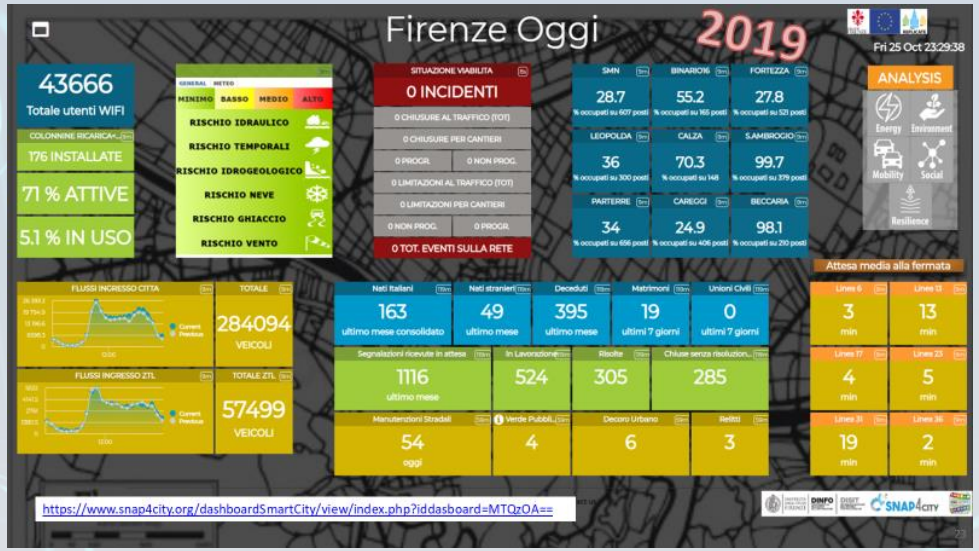
COMUNE DI FIRENZE

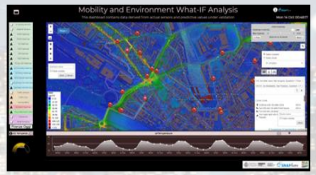
reference

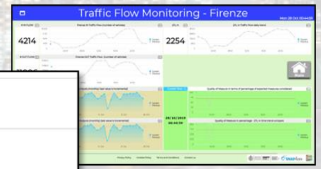
SNAP4CITY

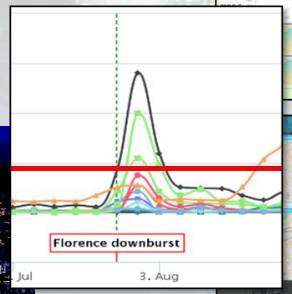
KM 4 CITY

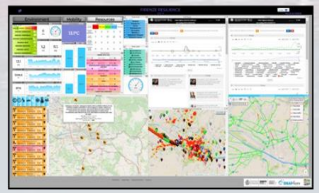
- **Multiple Domain Data**
  - ***Context***: Thousands OD, POI, IOT, etc.
  - ***mobility and transport***: accidents, public transport, parking, traffic flow, Traffic Reconstruction, KPI, …
  - ***AND***: civil protection, gov KPI, covid-19, social & social media, people flow, tourism, energy, …
- **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**

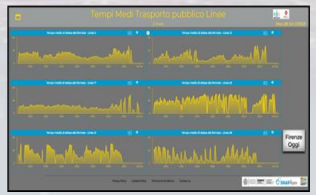




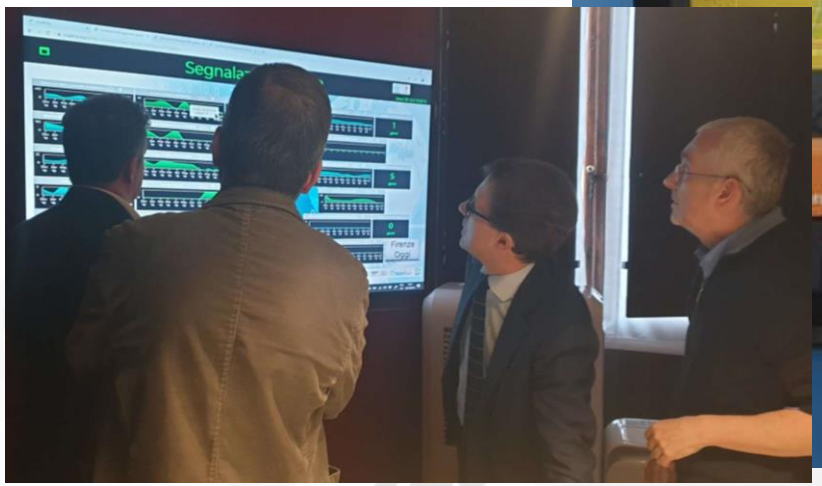








Major of Florence City



http://www.darionardella.it/il-sindaco-dario-nardella-in-missione-a-madrid-e-barcellona/

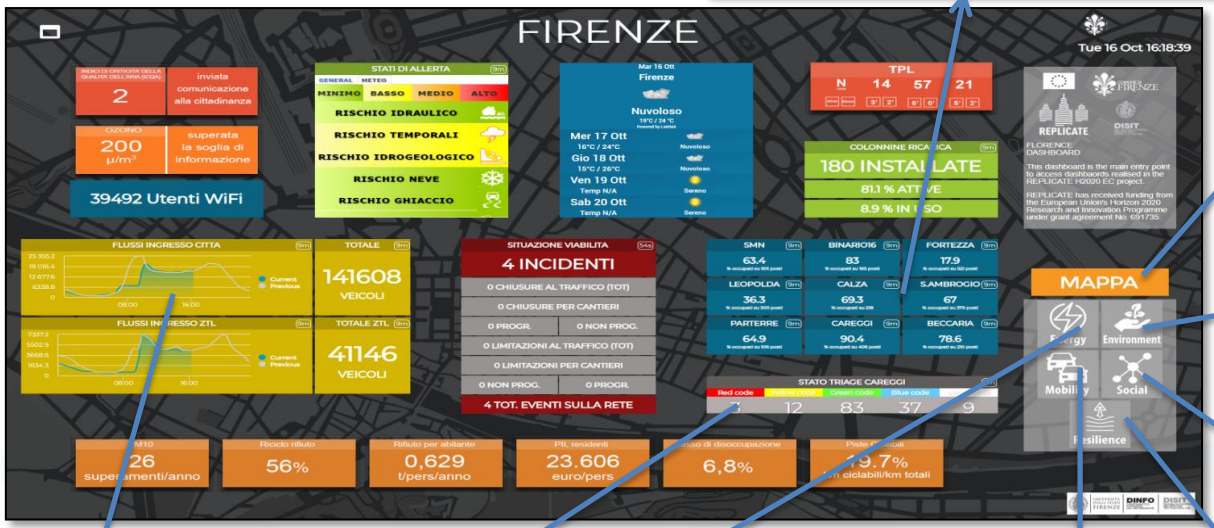
UNIVERSITÀ DEGLI STUDI FIRENZE

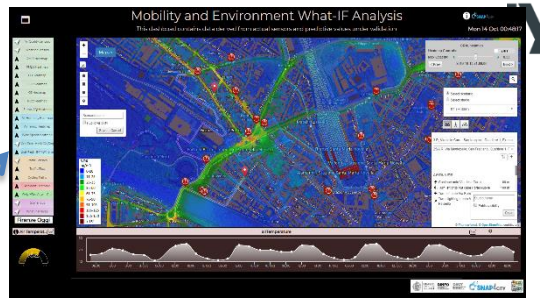
DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

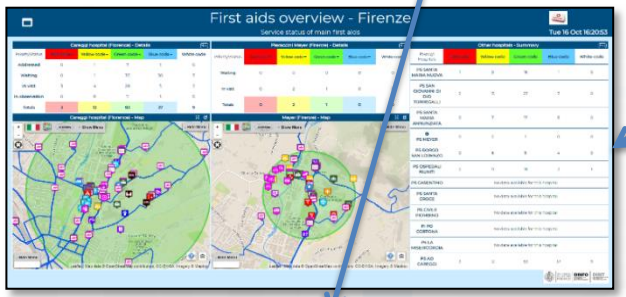
DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

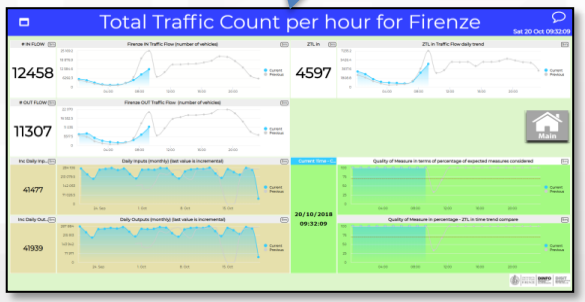
REPLICATE

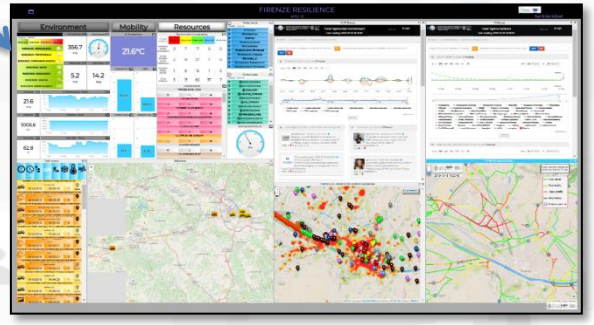
KM4CITY





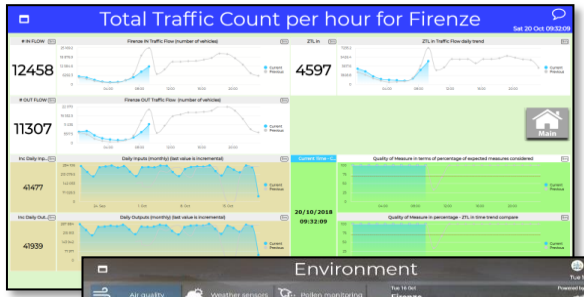






Florence Case

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

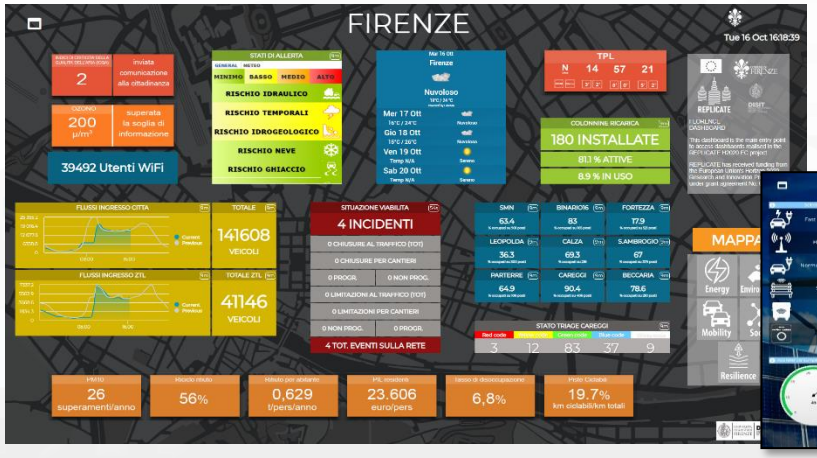


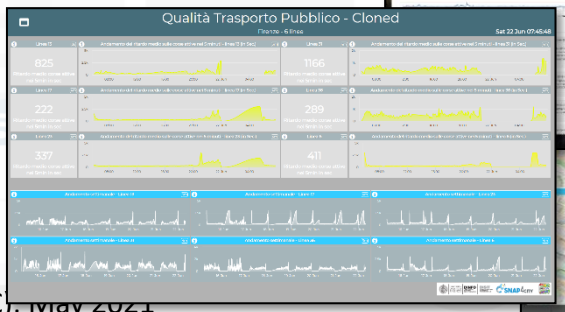
- **Mobility**:
  - quality of public transportation service (mean delay on bus-stops)
  - public transport operators schedule and paths, routing, multimodal routing
  - traffic flow reconstruction
  - Smart parking: predictions
  - Accidents and events, Log, heatmaps
- **Environment**:
  - smart irrigators
  - smart waste
  - Sensors: PM10. PM2.5,…..
  - Heatmaps: PM10, PM2.5, ….
  - NOX predictions
- **Energy**:
  - recharging stations (fast and reg.)
  - consumption meters (smart info)
  - smart light, street lights
- **Weather**
  - Forecast and actual

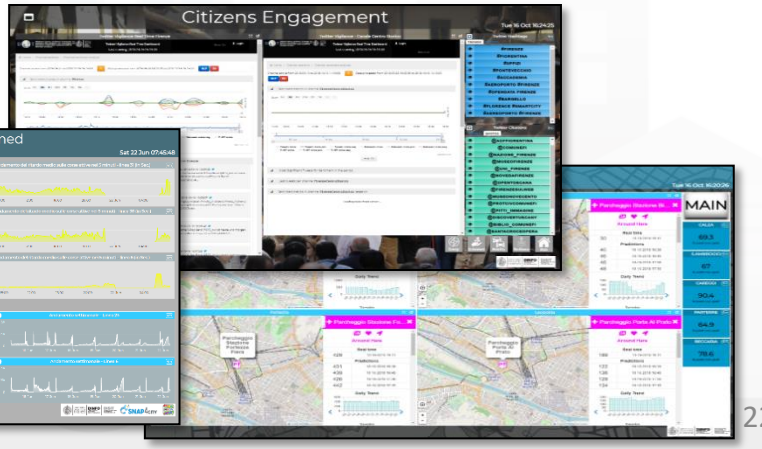
- **Social**:
  - smart benches
  - Twitter monitoring, Sentiment analysis, NLP text
  - TV camera streams
- **People Flows**:
  - Wi-Fi, people flow
  - Origin destination matrices
- **Governmental and Communications**:
  - KPI of the City
  - Digital Signage
  - Civil protection, Resilience (Resolute)
- **Tourism and Culture:**
  - POI, etc.

Analysis:

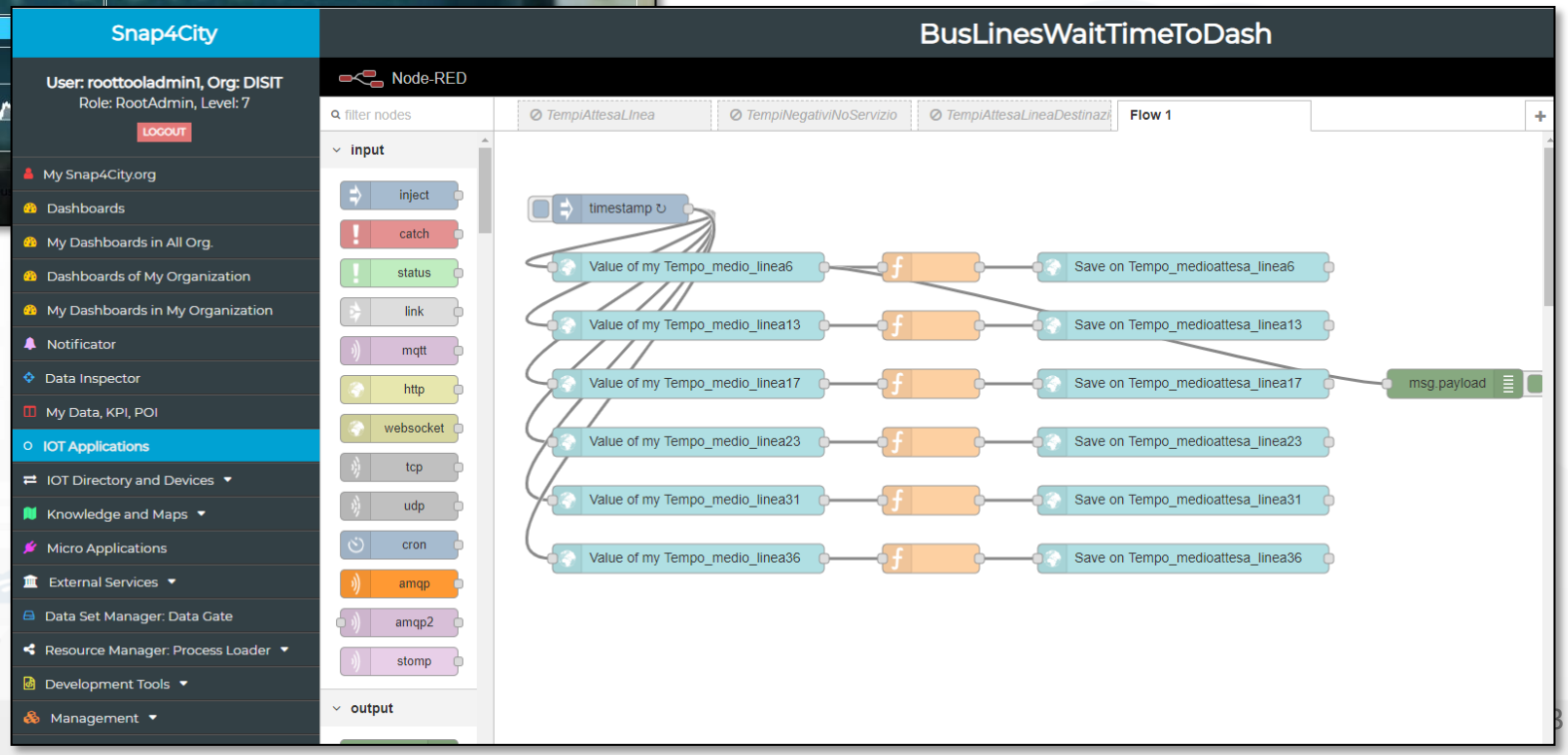
- **what-if routing, scenarios,**
- **traffic flow, environmental predictions**



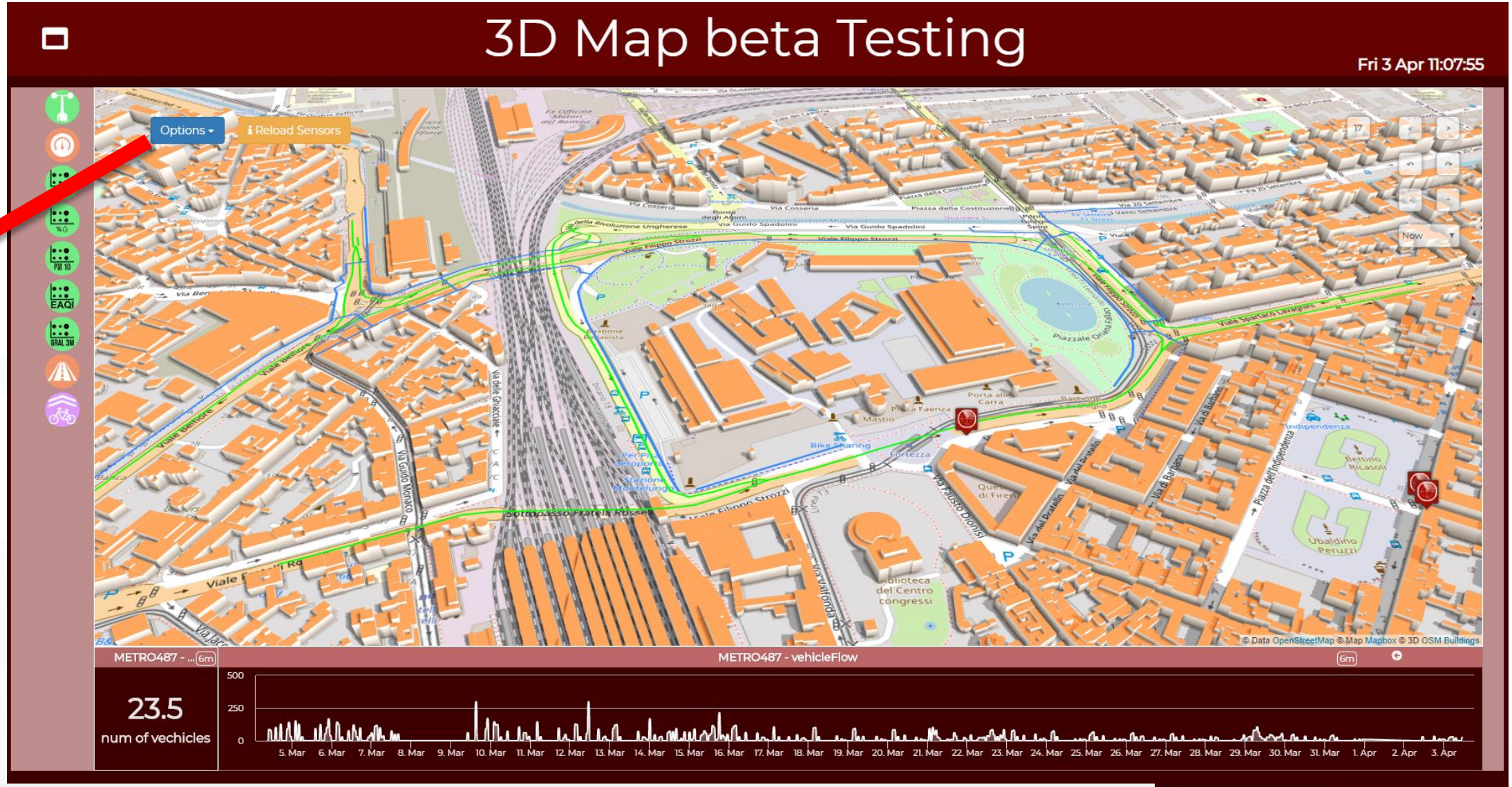




Estimation of the mean waiting time at bus stops



3D views



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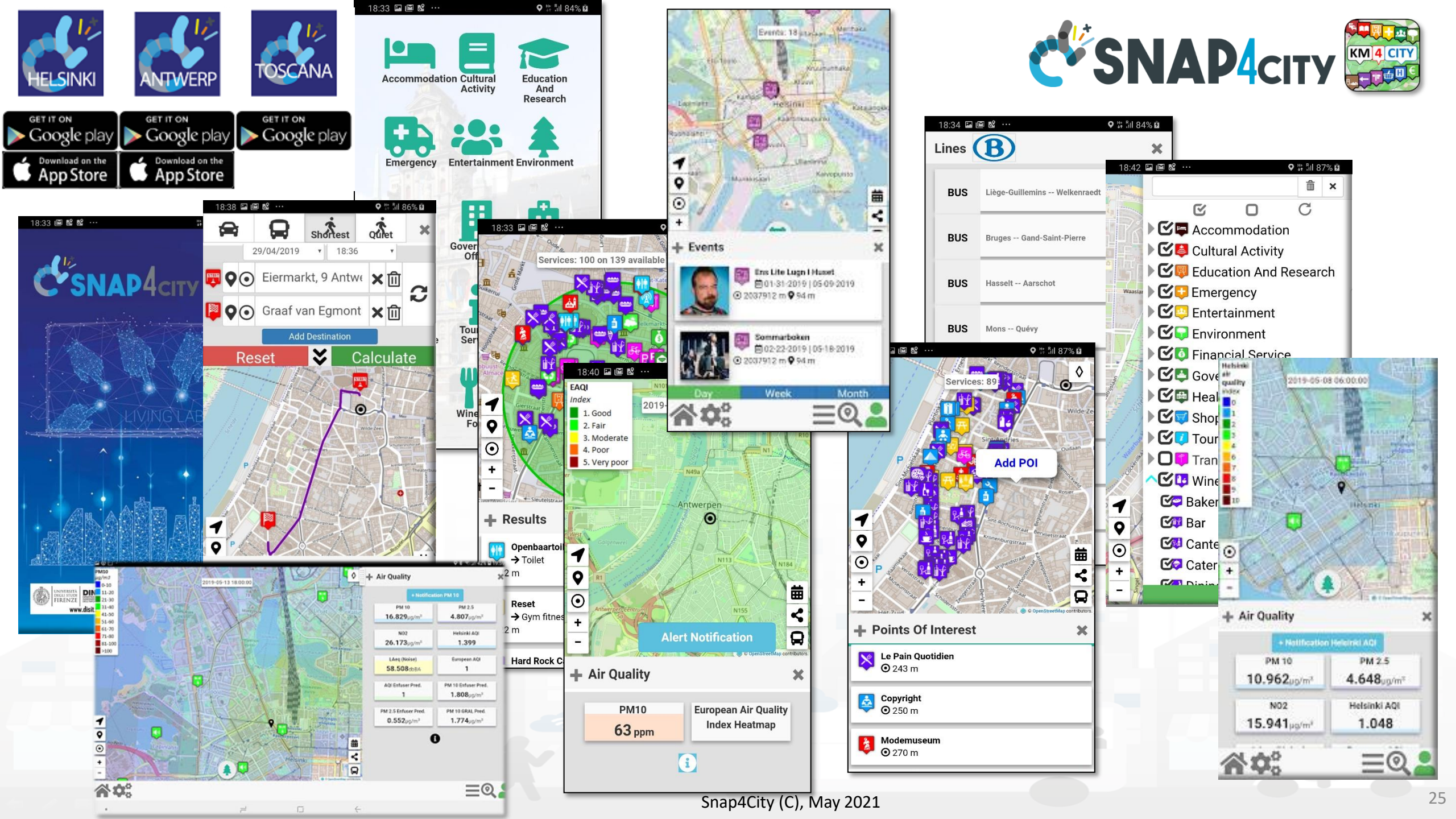
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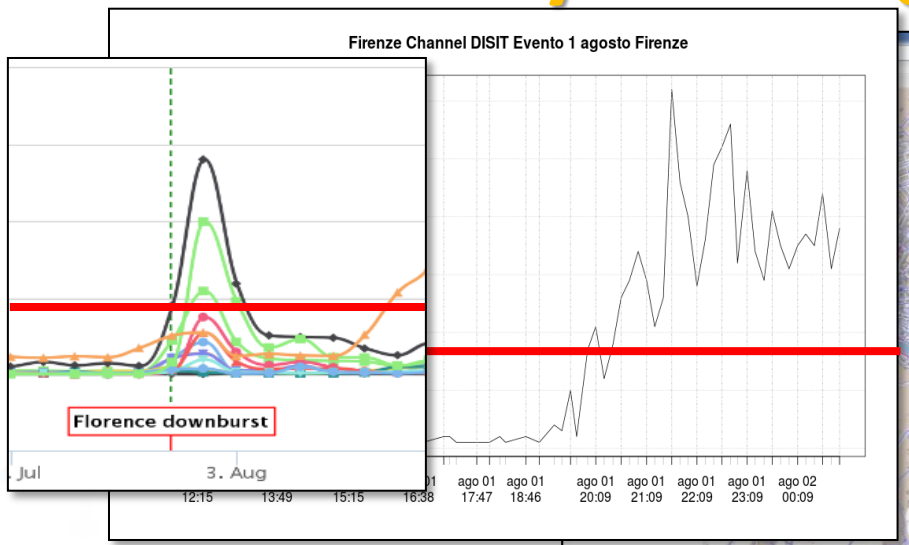
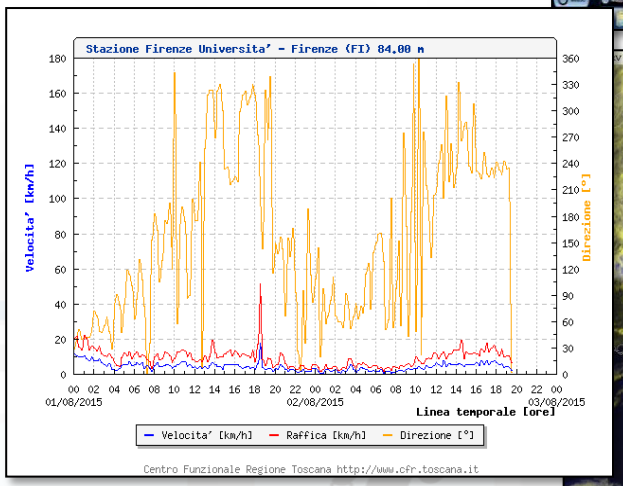
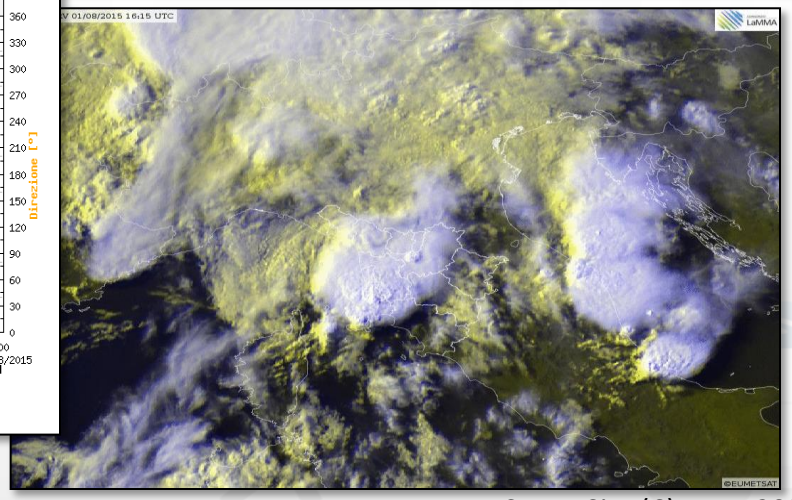
KM 4 CITY
Accommodation
Cultural Activity
Education And Research
Emergency
Entertainment
Environment
Shortest
Quiet
Add Destination
Reset
Calculate
Events
Day
Week
Month
Services: 100 on 139 available
EAQI Index
1. Good
2. Fair
3. Moderate
4. Poor
5. Very poor
Results
Antwerpen
Alert Notification
Air Quality
PM10
63 ppm
European Air Quality Index Heatmap
Lines
BUS
Liège-Guillemins -- Welkenraedt
Bruges -- Gand-Saint-Pierre
Hasselt -- Aarschot
Mons -- Quévy
Add POI
Points Of Interest
Le Pain Quotidien
243 m
Copyright
250 m
Modemuseum
270 m
Air Quality
PM 10
10.962
PM 2.5
4.648
NO2
15.941
Helsinki AQI
1.048

Twitter Vigilance

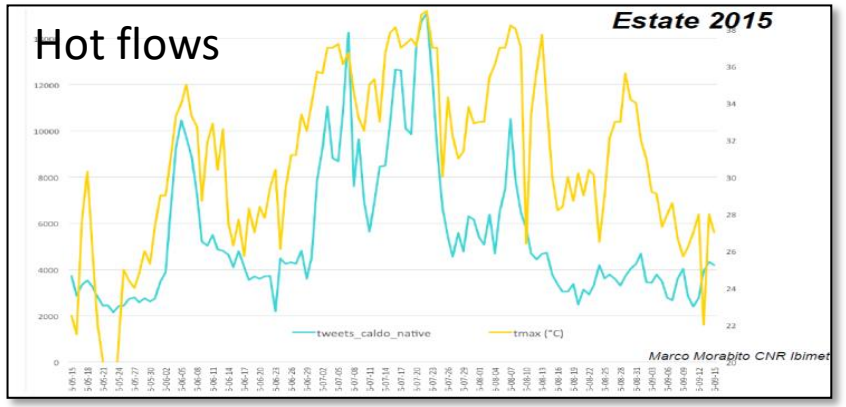
Early Warning







Predictive models



Attendance at long lasting events: EXPO2015

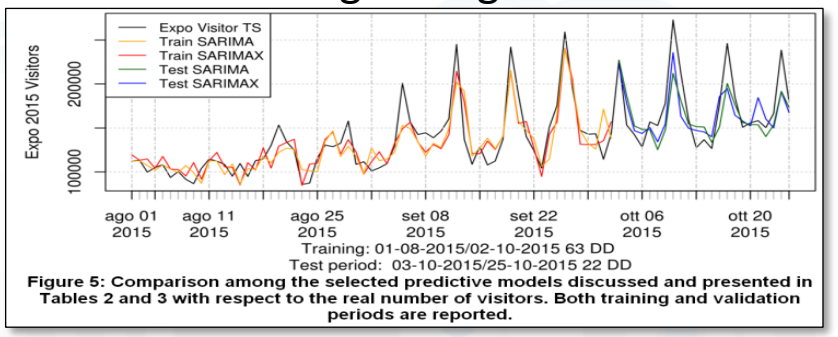
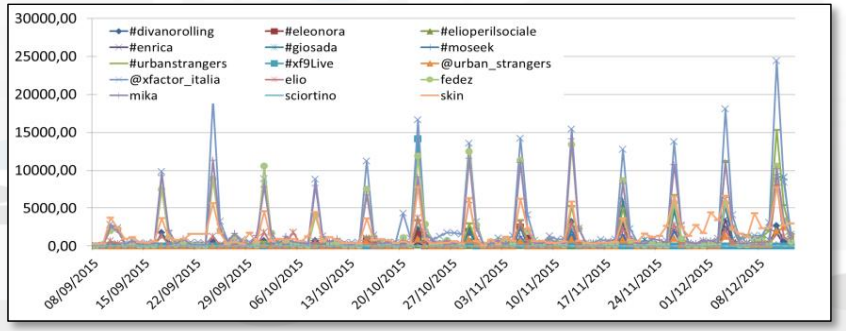


Figure 5: Comparison among the selected predictive models discussed and presented in Tables 2 and 3 with respect to the real number of visitors. Both training and validation periods are reported.

Attendance at recurrent events: TV, footbal



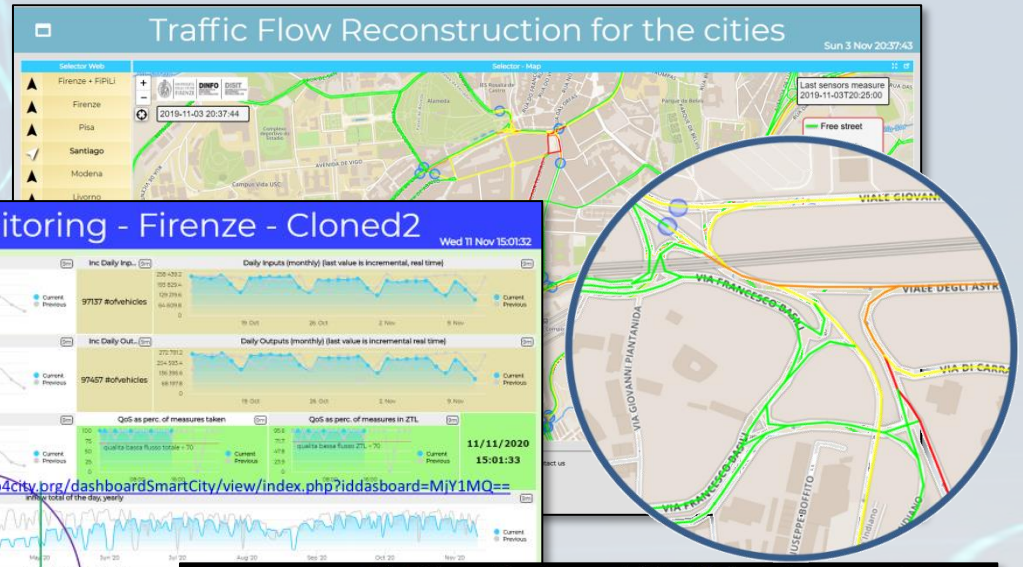
Tuscany Region
Firenze, Pisa, Livorno, Prato, etc.

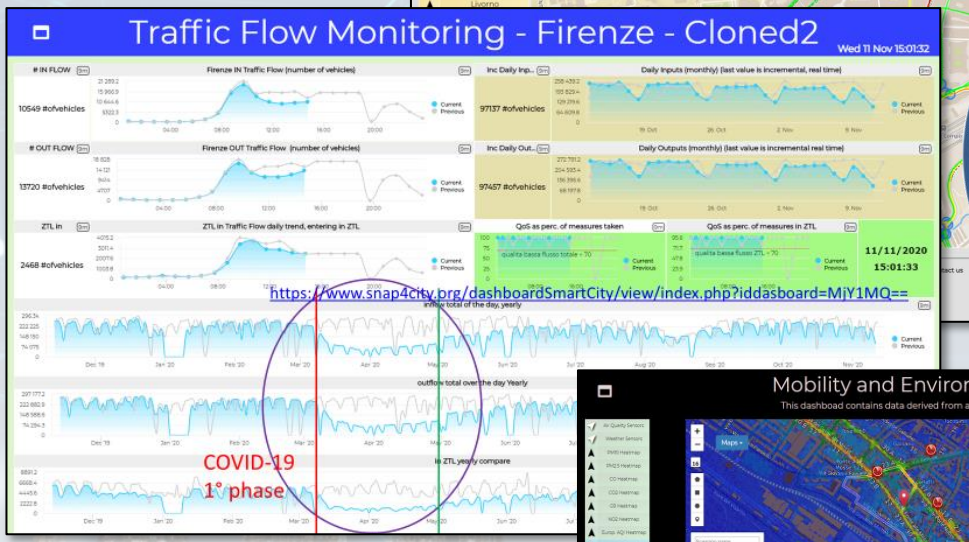
Mobility and Transport Traffic Flow Analysis

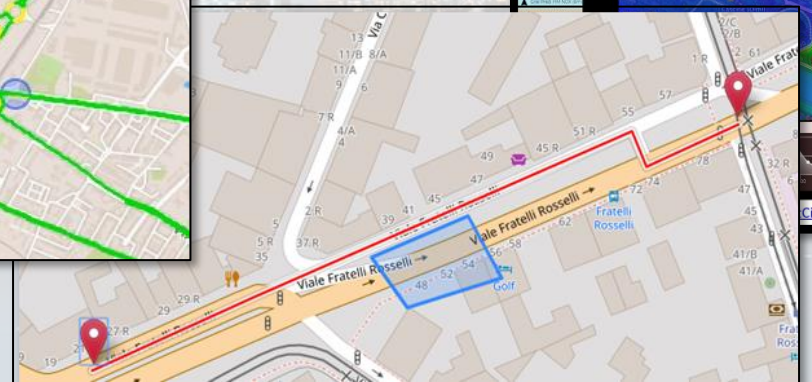
Cities: Firenze, Pisa, Livorno, Modena, Santiago di Compostela

reference

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

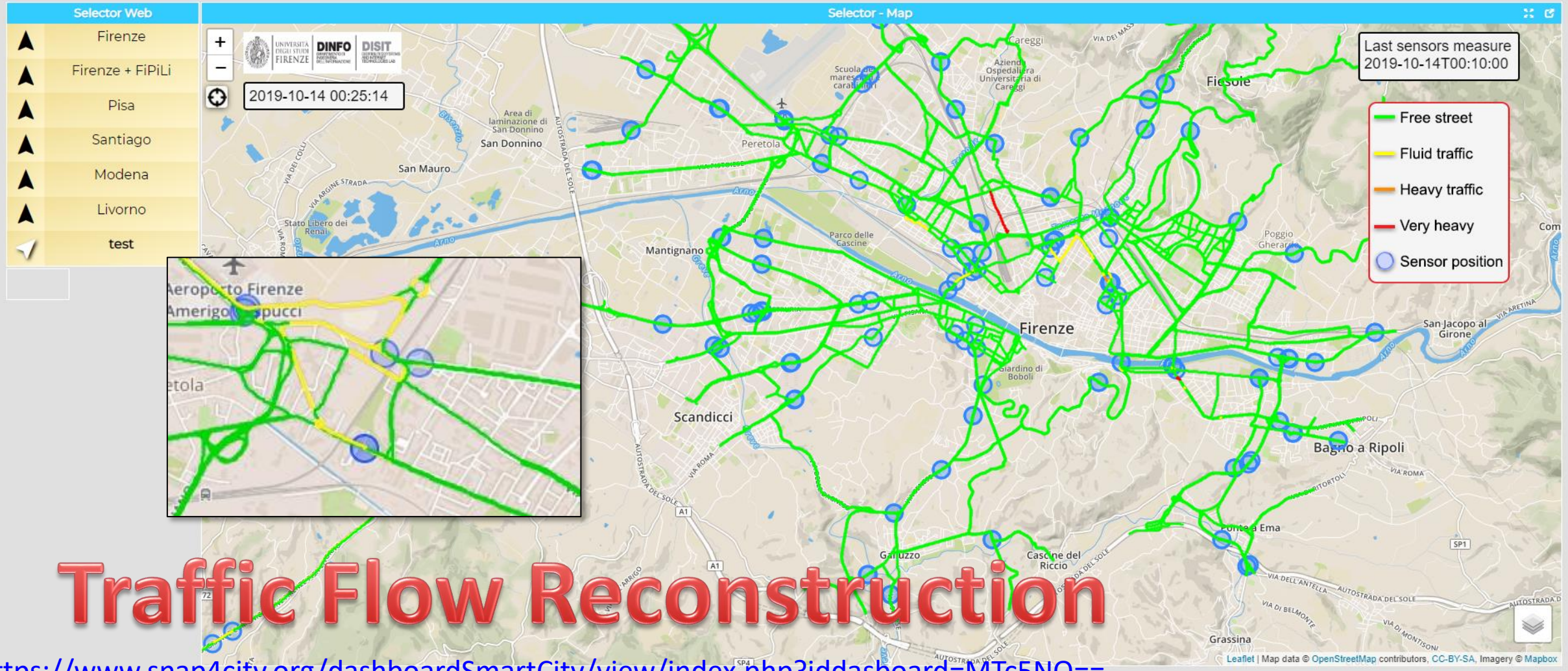






Traffic Flow Reconstruction for the cities

Mon 14 Oct 00:25:15



Traffic Flow Reconstruction

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

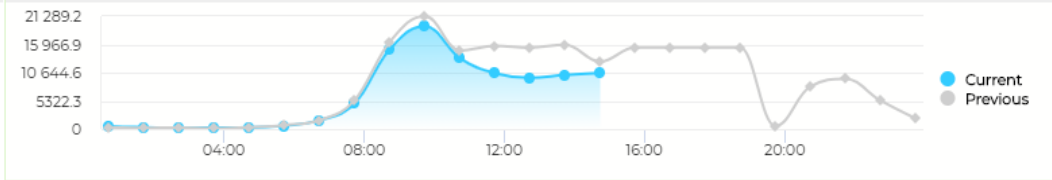
Traffic Flow Monitoring - Firenze - Cloned2

Wed 11 Nov 15:01:32

 # IN FLOW 9m

10549 #ofvehicles

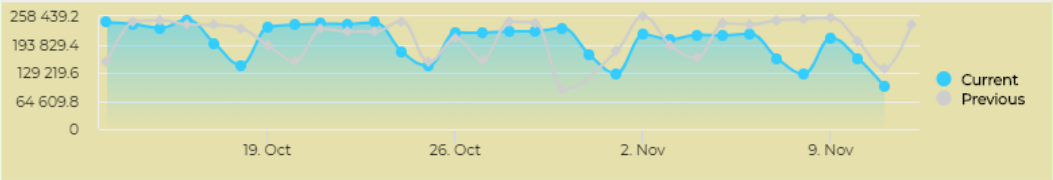
Firenze IN Traffic Flow (number of vehicles) 9m



Inc Daily Inp... 9m

97137 #ofvehicles

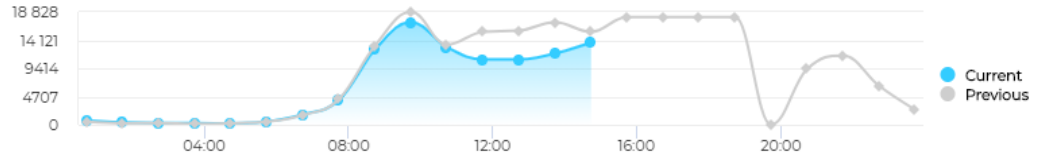
Daily Inputs (monthly) (last value is incremental, real time) 9m



 # OUT FLOW 9m

13720 #ofvehicles

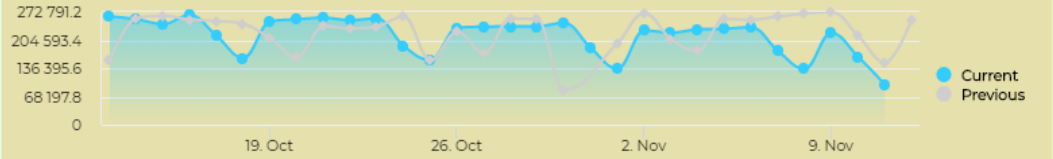
Firenze OUT Traffic Flow (number of vehicles) 9m



Inc Daily Out... 9m

97457 #ofvehicles

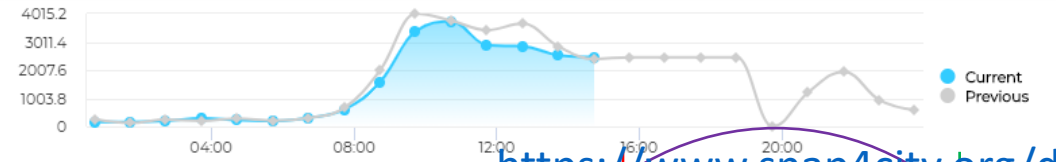
Daily Outputs (monthly) (last value is incremental real time) 9m



ZTL in 9m

2468 #ofvehicles

ZTL in Traffic Flow daily trend, entering in ZTL 9m



QoS as perc. of measures taken 9m

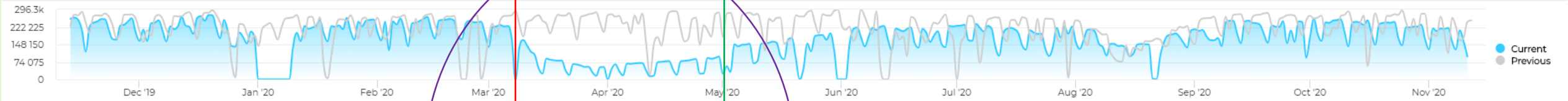
QoS as perc. of measures in ZTL 9m

11/11/2020

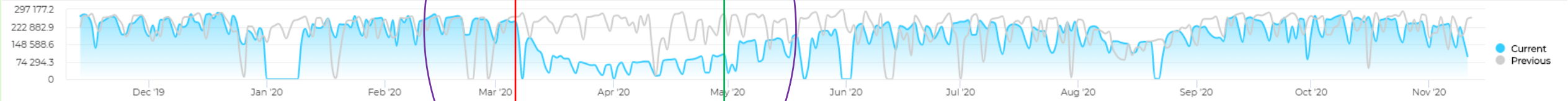
15:01:33

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjY1MQ==

inflow total of the day, yearly 9m



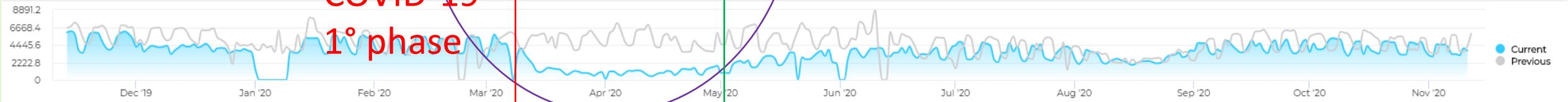
outflow total over the day Yearly 9m



COVID-19

1° phase

in ZTL yearly compare 9m



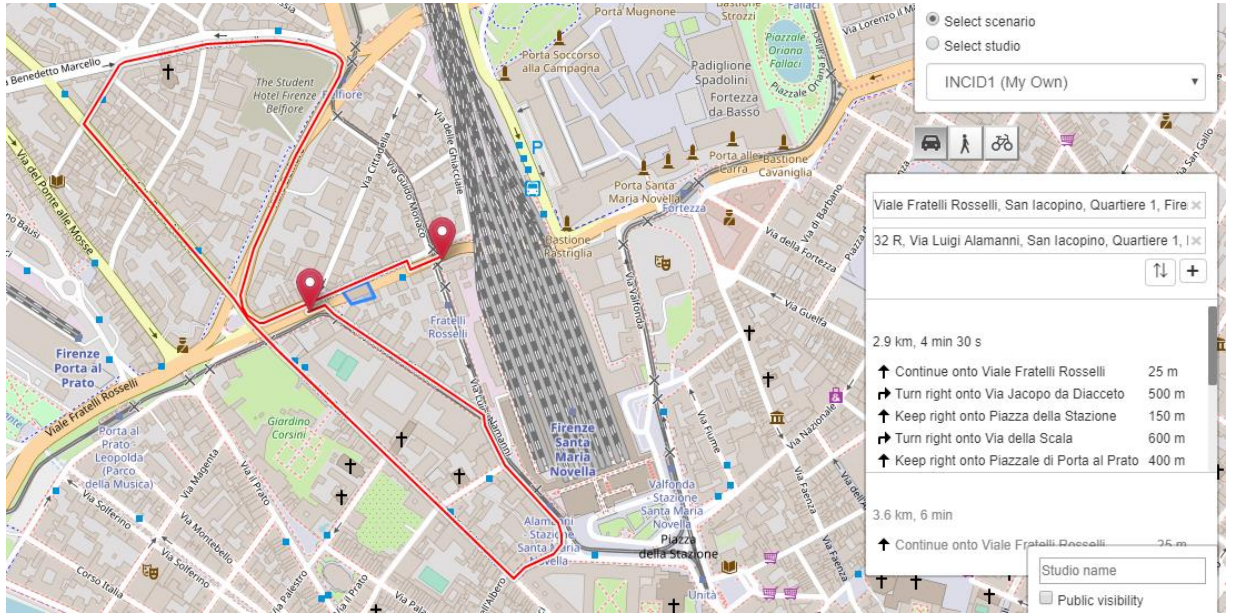
What-If Analysis

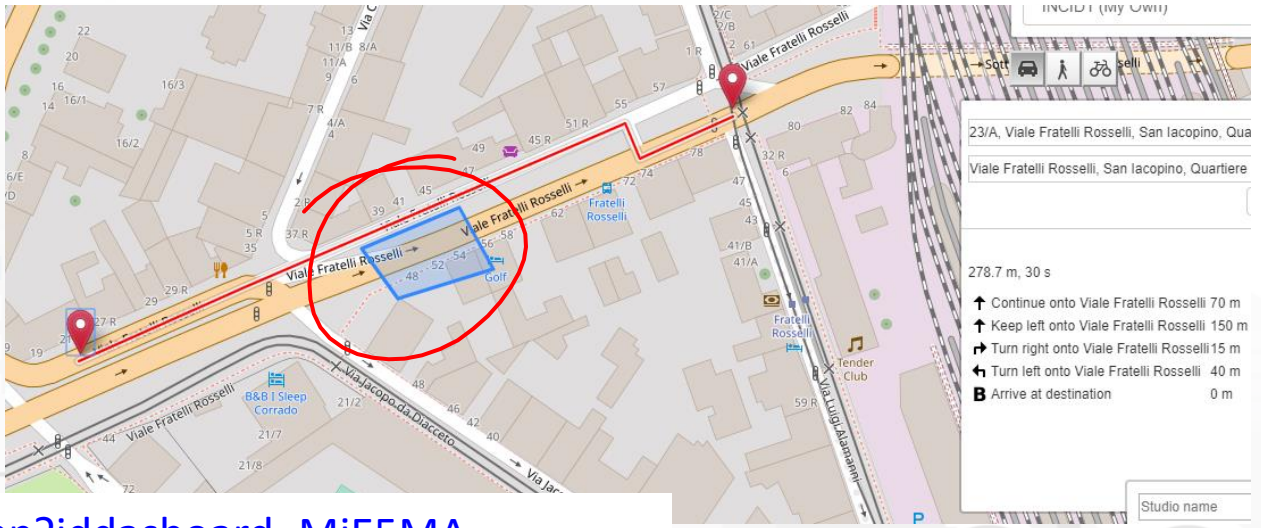
Accidents and elements blocking Points and Shapes taken into account for:

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

Assessment on the basis of changes:

- Mobility demand assessment
- Mobility Offer assessment



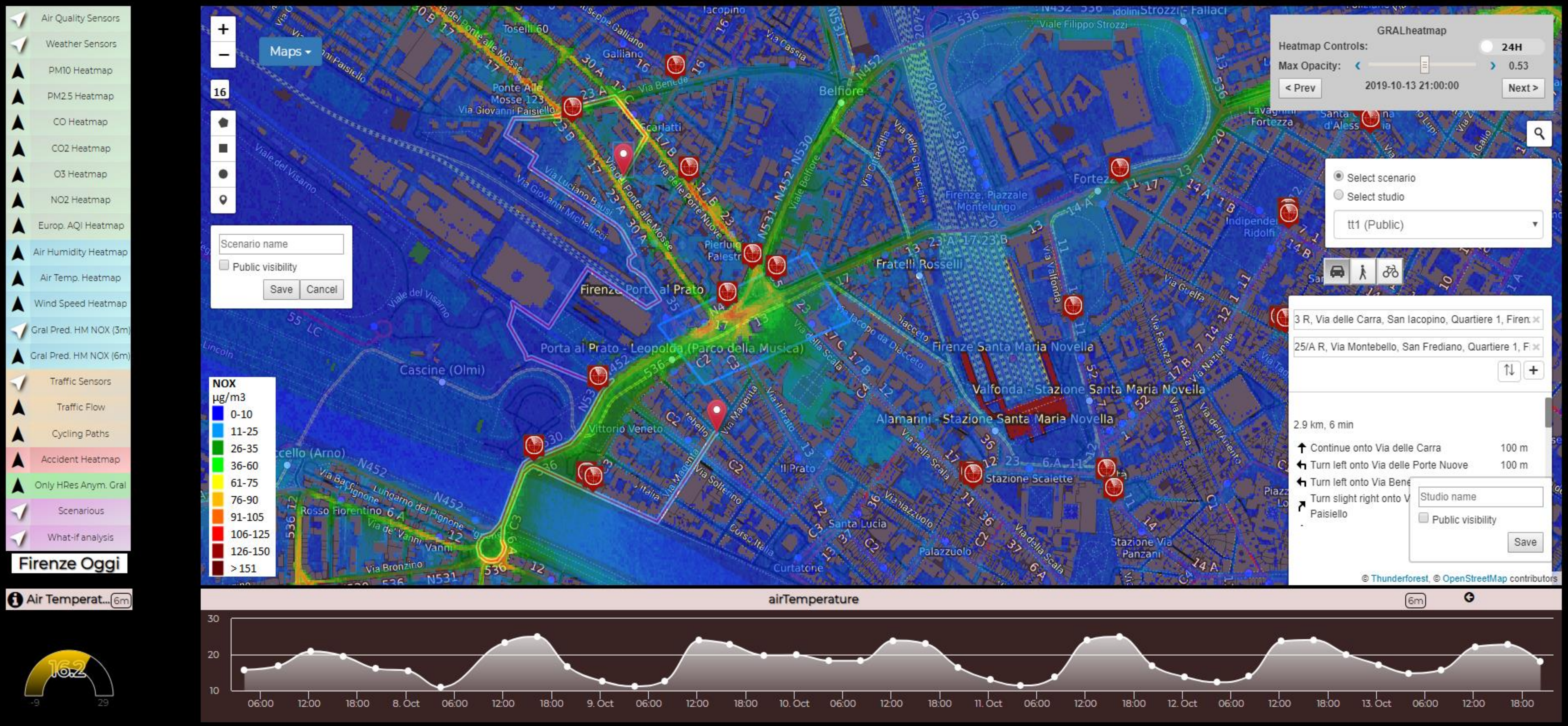


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjE5MA==

Mobility and Environment What-IF Analysis

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

Mon 14 Oct 00:48:17



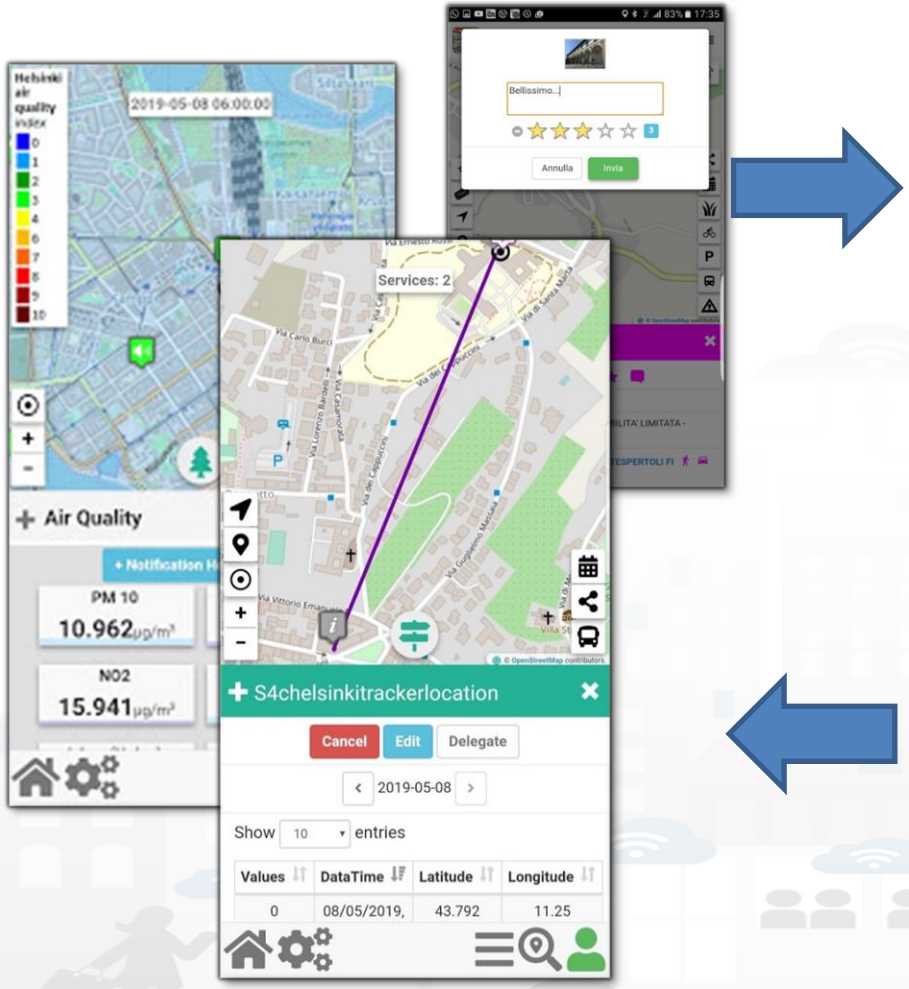
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjE5MA==

The App is a Bidirectional Device

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

Produced information

- Accepted ?
- Performed ?
- …



Derived information

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

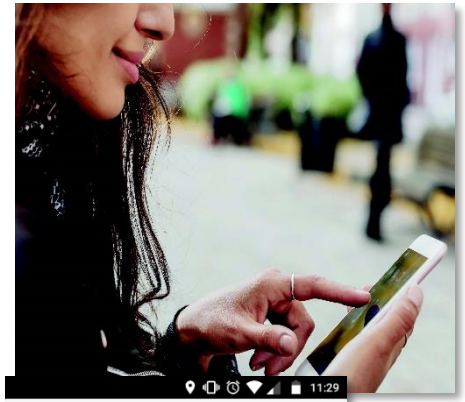
Produced information

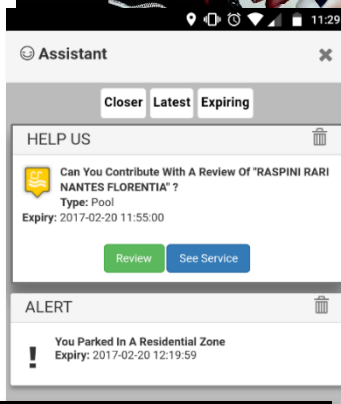
- Suggestions
- Engagements
- Notifications
- …

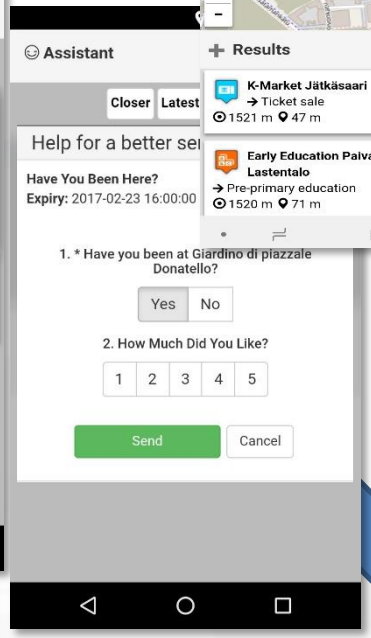
Users

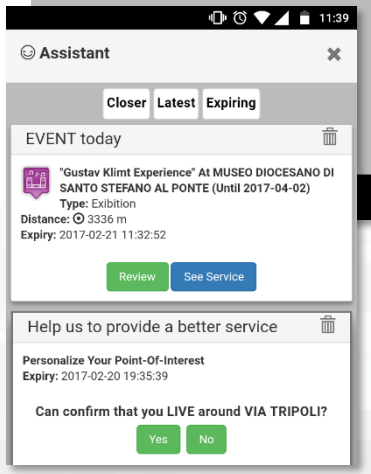
System

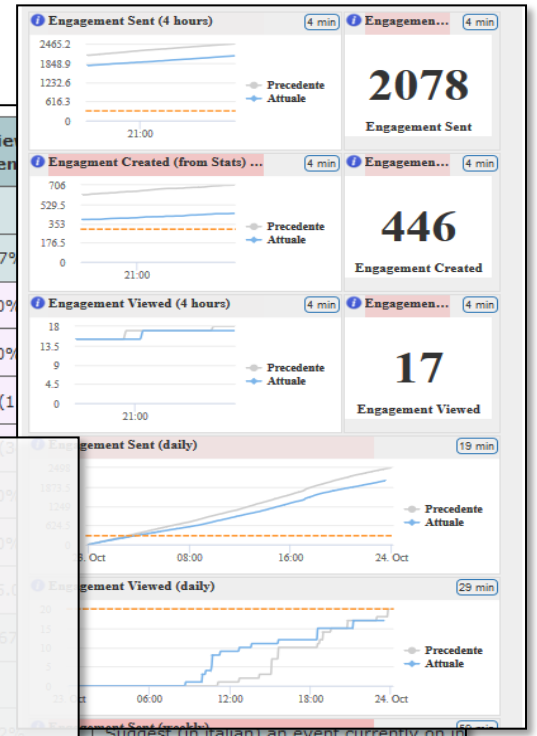
Users' Engagement











Rule name	Type	#sent	#viewed	#vie #sen
daily_event_de	ENGAGEMENT	1 (0%)	0 (0%)	0%
daily_event_en	ENGAGEMENT	1720 (2.12%)	70 (7.1%)	4.07%
	- commuter	5 (0.29%)	0 (0%)	0 (0%
	- student	14 (0.81%)	0 (0%)	0 (0%
	- tourist	1462 (85%)	25 (35.71%)	25 (1

Inform

Air Quality forecast is not very nice
You have parked out of your residential parking zone
The Road cleaning is this night
The waste in S.Andreas Road is full

Engage

Provide a comment, a score, etc.

Stimulate / recommend

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

Provide Bonus, rewards if needed

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

Suggest (in italian) an event currently on in
Alert (in english) if the user parked in a res
Alert (in spanish) if the user parked in a res
Alert (in italian) if the user parked in a resid
Ask (in german) a contribution for a nearby

Rules

User context

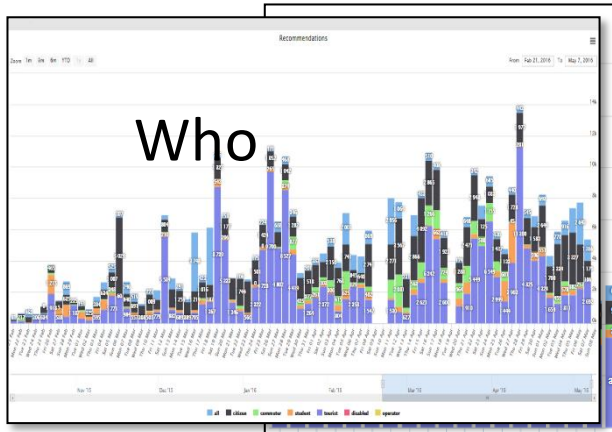
City context

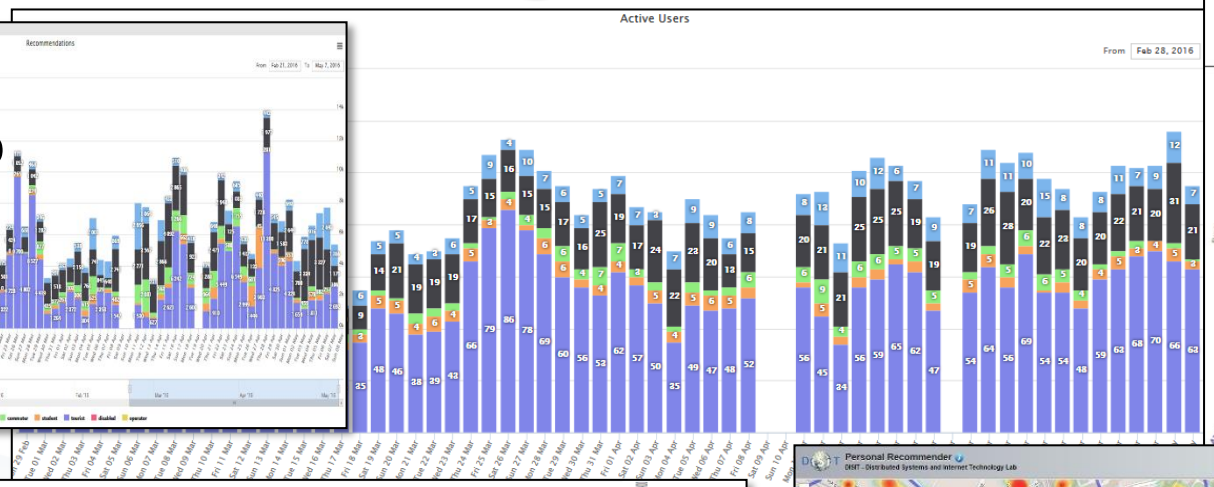
Campaing on Sustainable Mobility

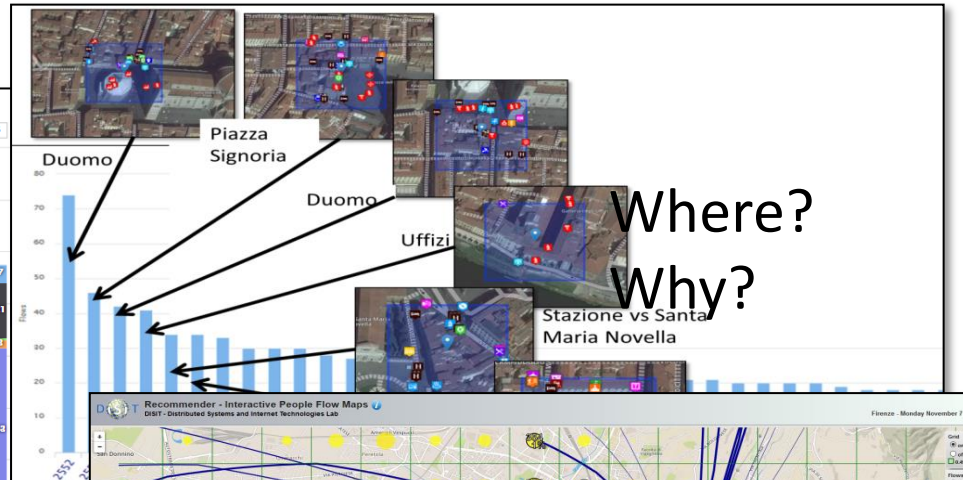
Sii smart.
Sii-Mobility!
Scarica, viaggia, vinci!

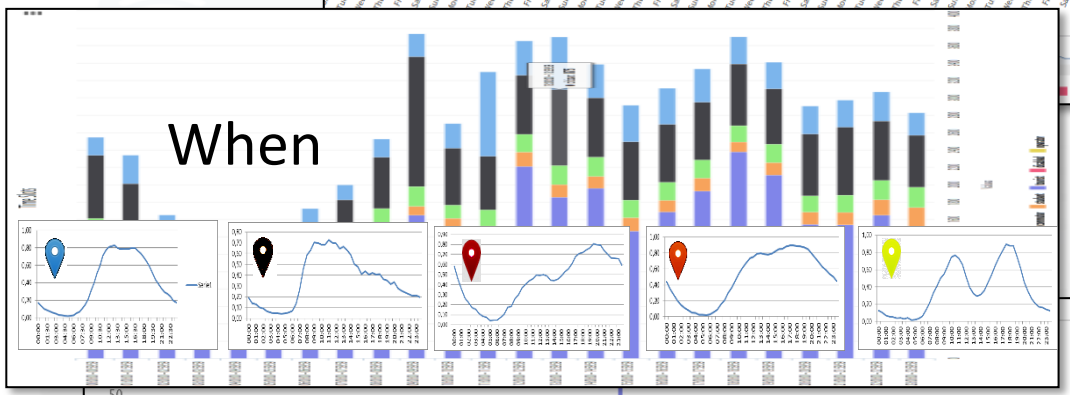
Dal 15 aprile al 15 luglio scegliere il trasporto pubblico ti premia!
Scarica l'app "Toscana dove, cosa", guadagna punti viaggiando in autobus e vinci tanti fantastici premi.
Per maggiori informazioni visita il sito info.sii-mobility.org
TOSCANA
ataf
BUSITALIA
GRUPPO FERROVIE DELLO STATO ITALIANE
MIUR
UNIVERSITÀ DEGLI STUDI FIRENZE
DINFO
DISIT

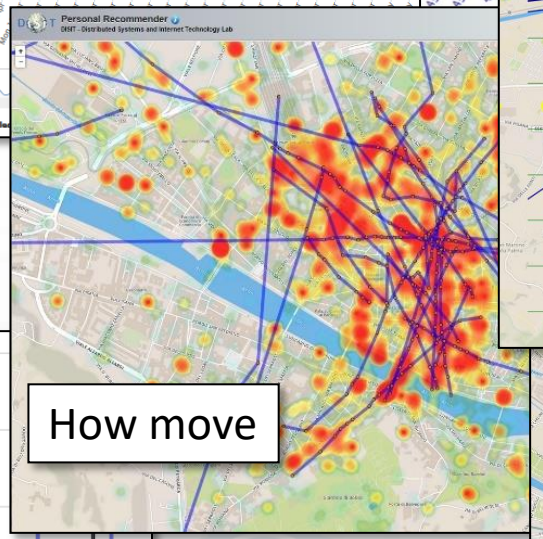
User Behavior Analyser for Collective Profiling

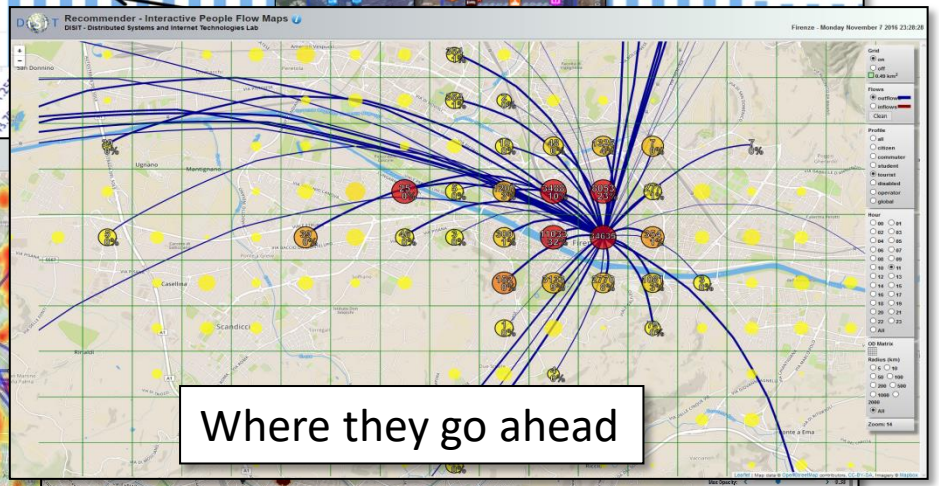


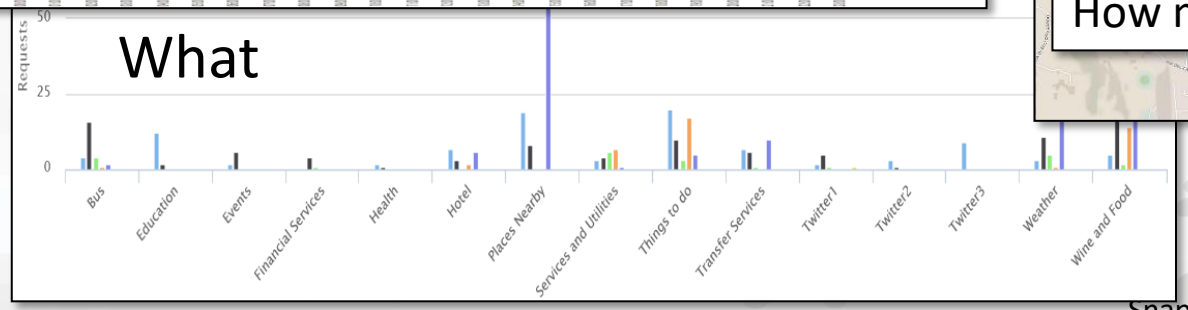


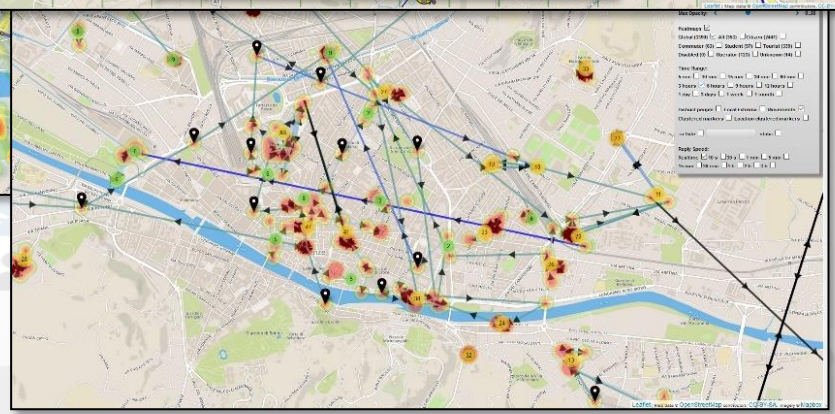




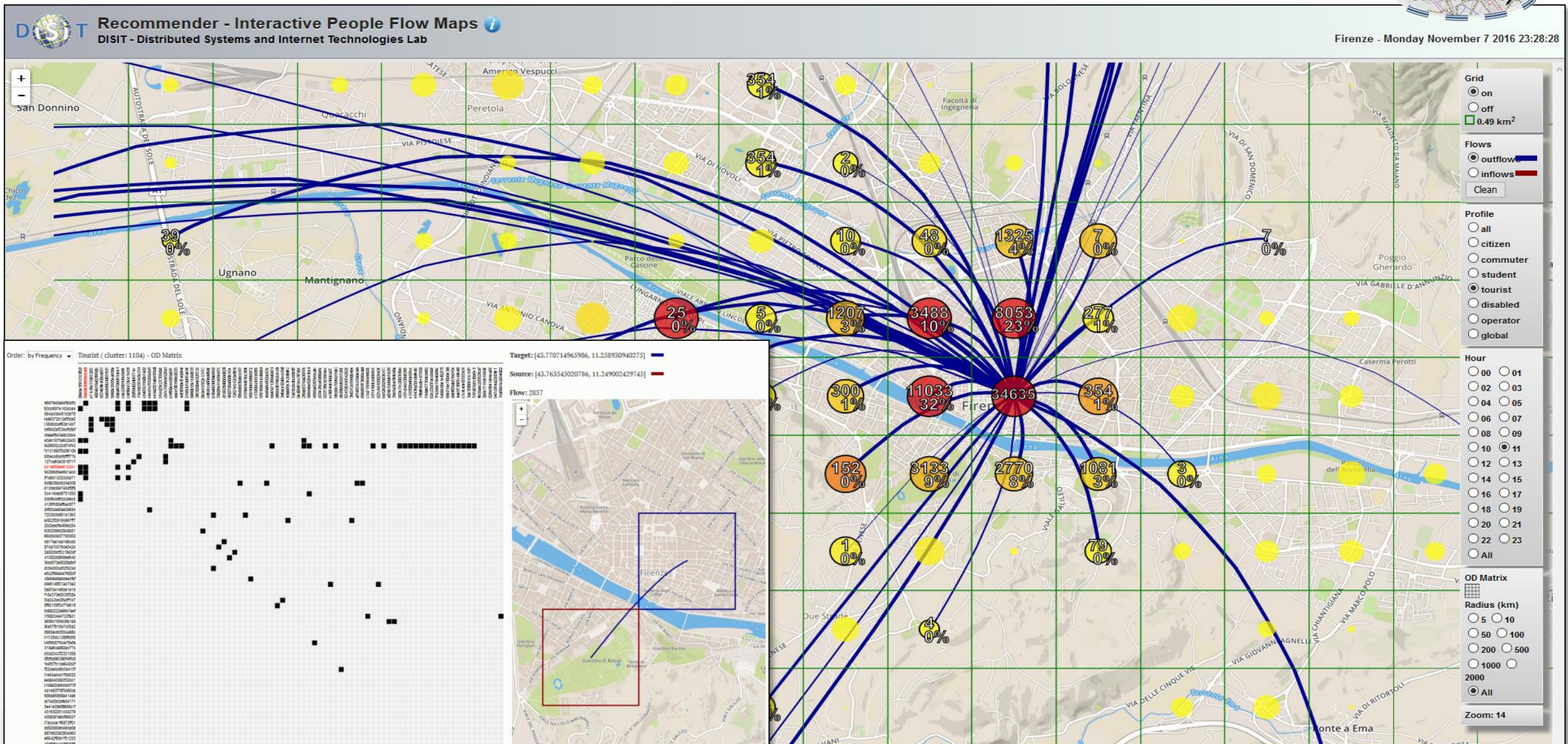








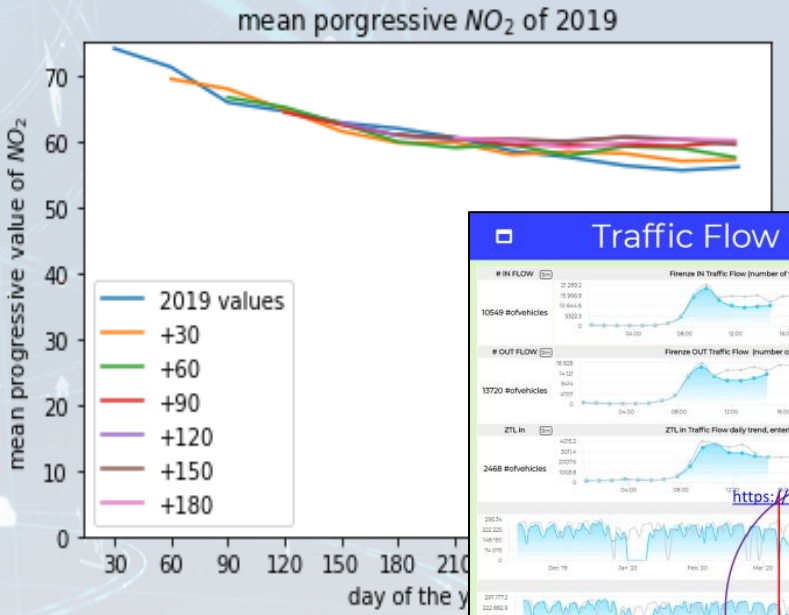
Scalable OD Matrix

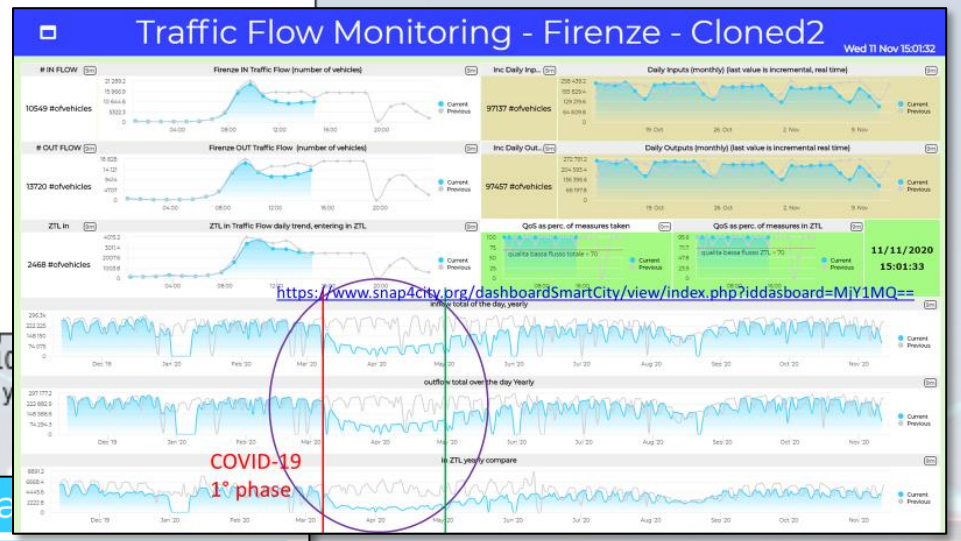


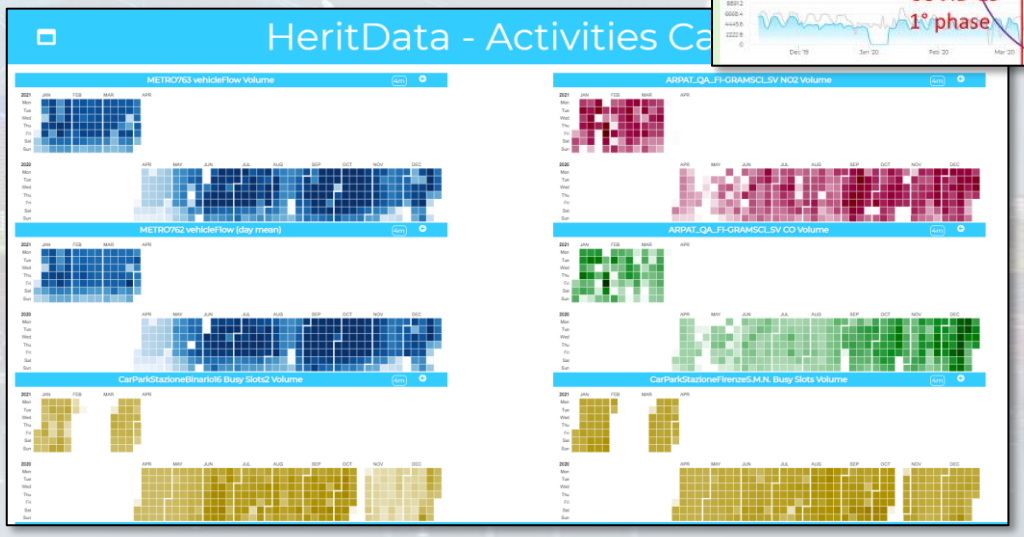
Impact of COVID-19

Cities: Firenze, Pisa, Livorno, Toscana

- **Multiple Domains Data**
  - Traffic, environment, People, parking, stock options, Twitter, tc.
- **Decision Makers Multiple Locations**
  - NO2 long term predictions
  - Twitter analysis
- **Historical and Real Time data**
- **Services Exploited on:**
  - Dashboards
  - Social media,
  - Sentiment Analysis
- **Since 2019, 2020**







metric	model30	model60	model90	model120	model150	model180
MAE	1.21	1.31	1.52	2.04	2.31	2.37
RMSE	2.16	2.61	4.18	6.77	7.83	7.93
MAPE	1.99	2.20	2.65	3.57	4.07	4.18
R2	0.91	0.83	0.80	0.54	0.45	0.14

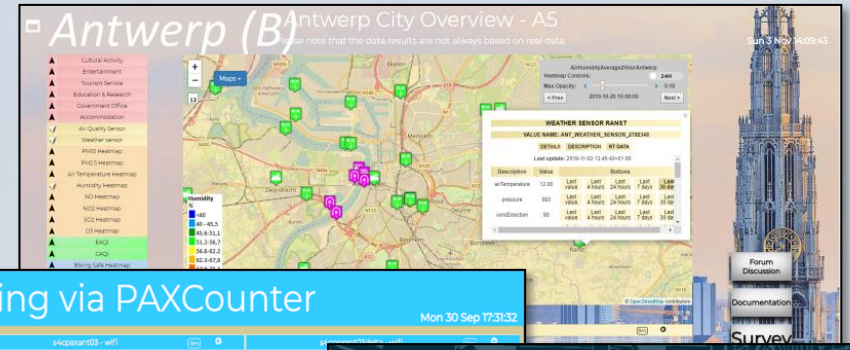
Table 4. Assessment of the predictive models with respect to the actual values of the 2019.

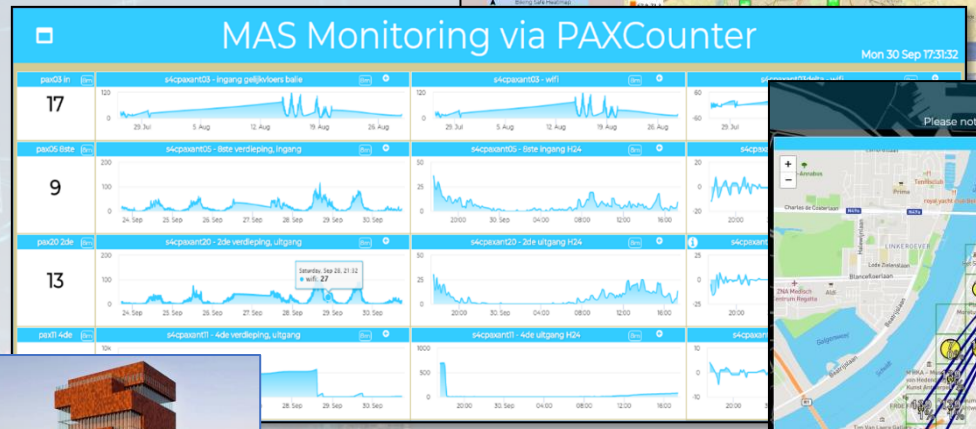
Antwerp

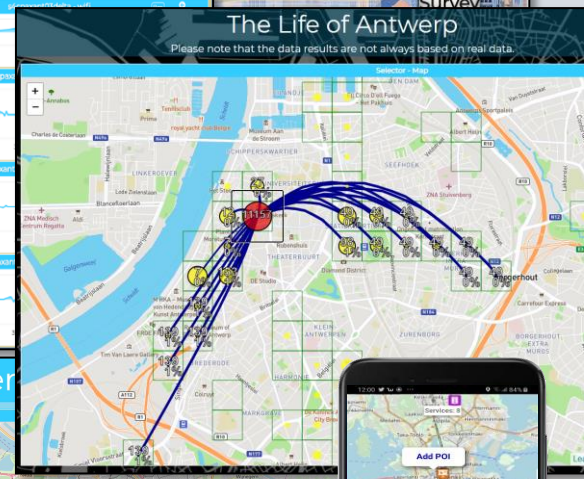
People Monitoring on Pub Services
DIGIPOLIS Antwerp

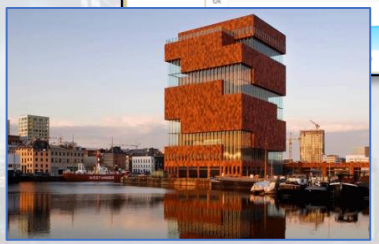
reference

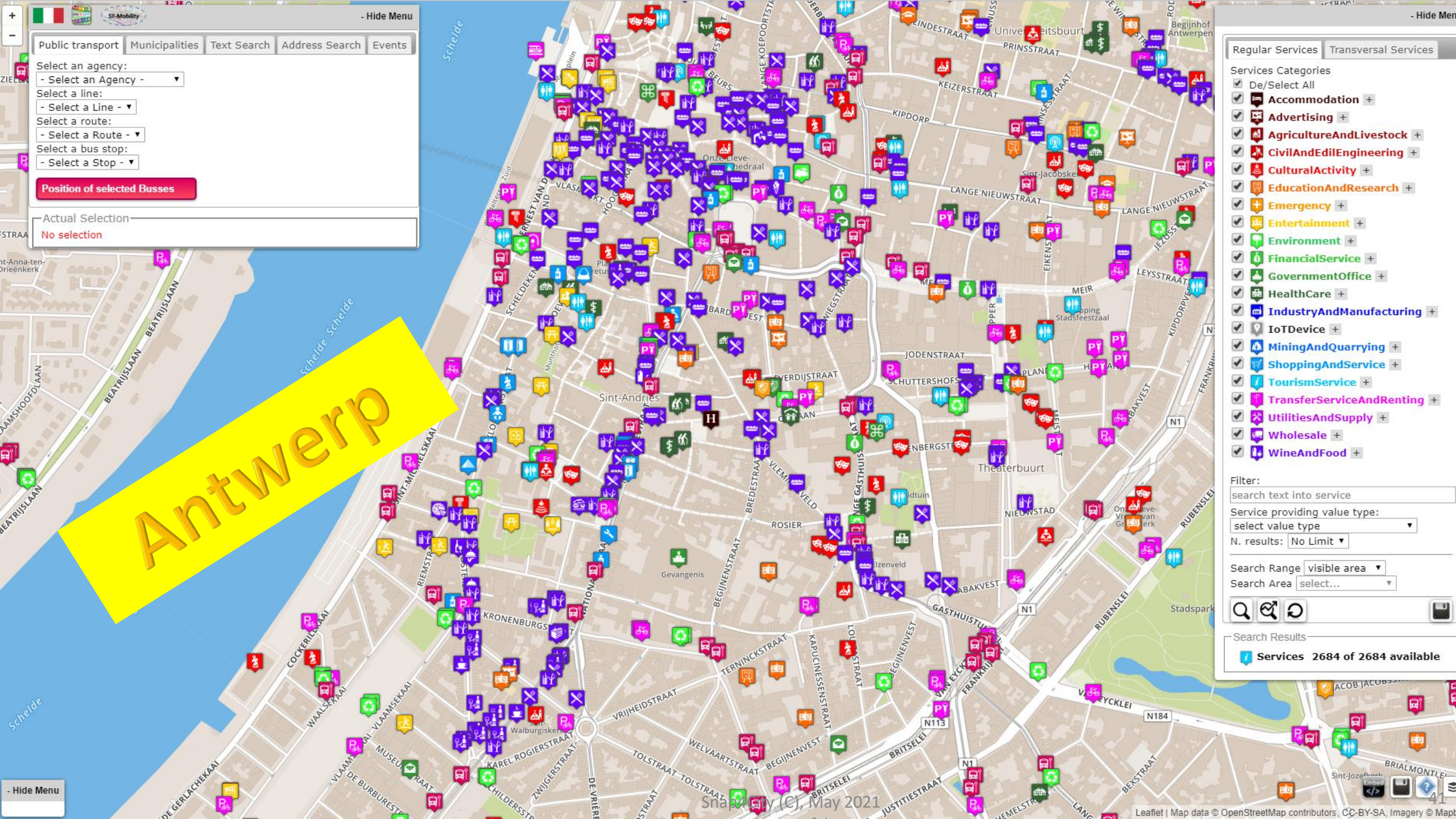
- **Multiple Domain Data**
  - PAX Counters: museum, pub services, COVID-19
- **Multiple Levels & Decision Makers**
  - Business Intelligence Dashboards
  - People flow, OD flows
  - Detection of critical conditions
- **Historical and Real Time data**
  - 20 fixed PaxCounters
  - 2 Mobile PaxCounters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



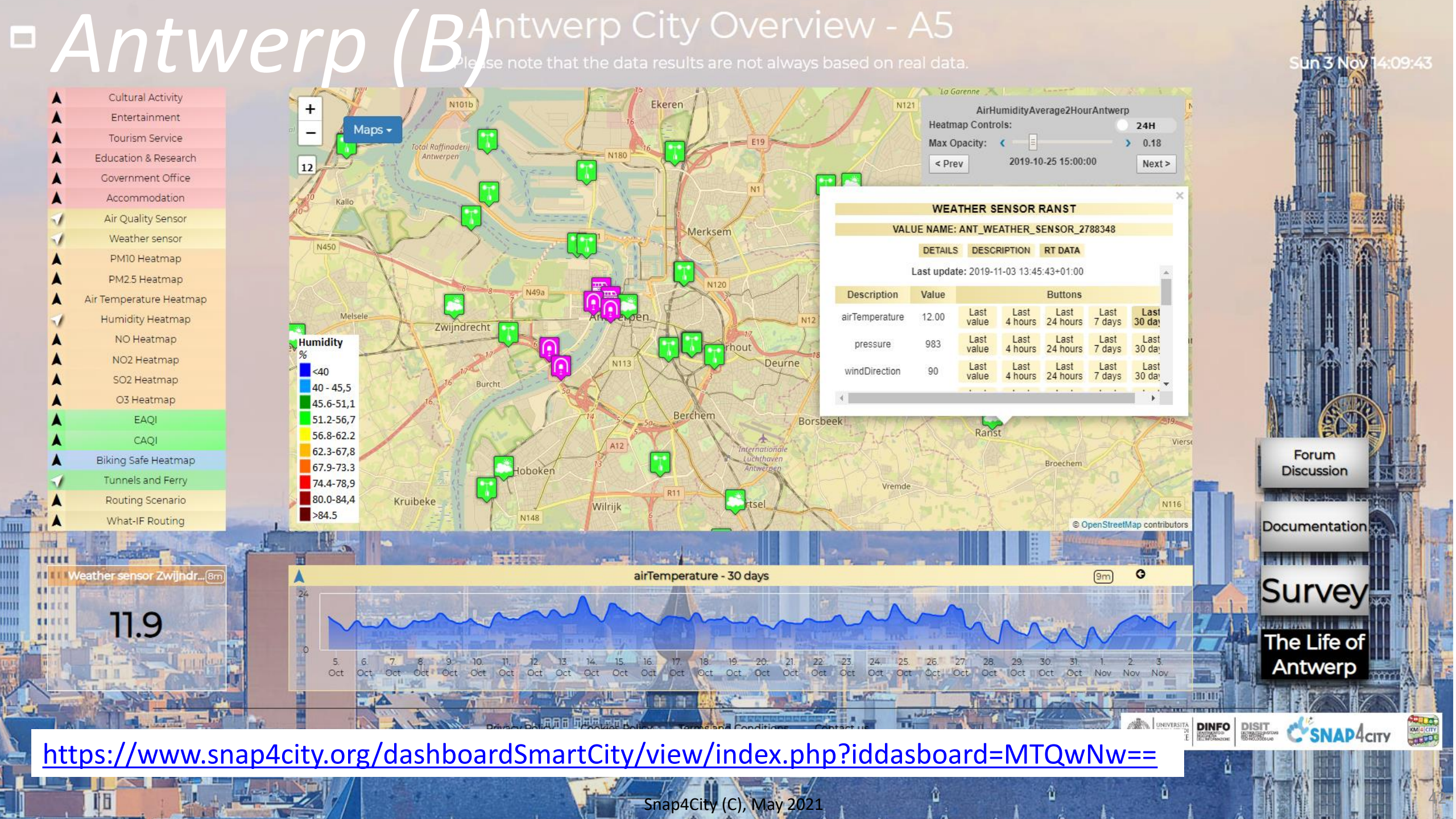







- Hide Menu
Public transport
Municipalities
Text Search
Address Search
Events
Select an agency:
- Select an Agency -
Select a line:
- Select a Line -
Select a route:
- Select a Route -
Select a bus stop:
- Select a Stop -
Position of selected Busses
Actual Selection
No selection
Antwerp
- Hide Menu
Regular Services
Transversal Services
Services Categories
De/Select All
Accommodation
Advertising
AgricultureAndLivestock
CivilAndEdilEngineering
CulturalActivity
EducationAndResearch
Emergency
Entertainment
Environment
FinancialService
GovernmentOffice
HealthCare
IndustryAndManufacturing
IoTDevice
MiningAndQuarrying
ShoppingAndService
TourismService
TransferServiceAndRenting
UtilitiesAndSupply
Wholesale
WineAndFood
Filter:
search text into service
Service providing value type:
select value type
N. results:
No Limit
Search Range
visible area
Search Area
select...
Search Results
Services 2684 of 2684 available
- Hide Menu
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapb

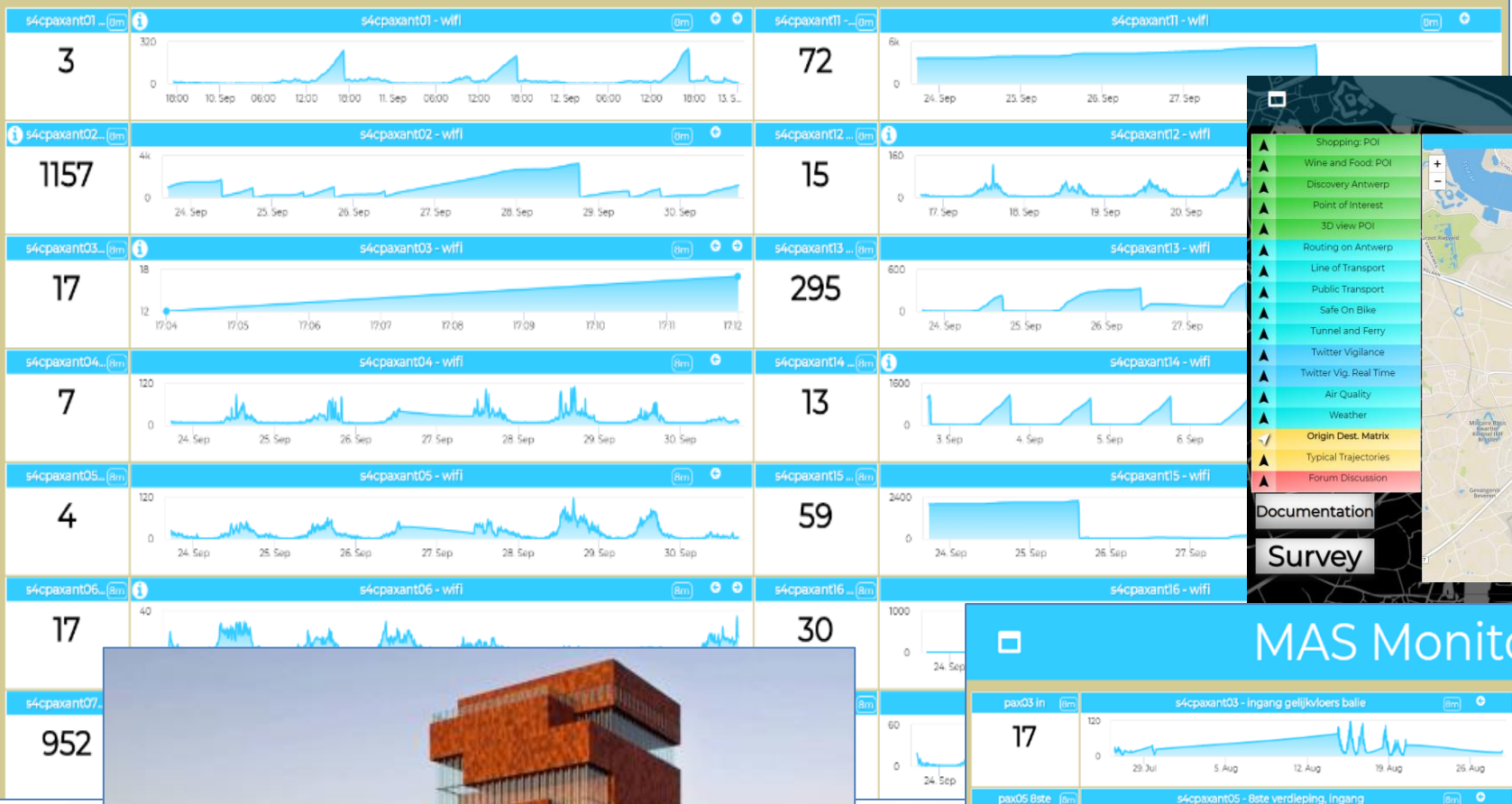
Antwerp (B)



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

PAXCounter real time and trend

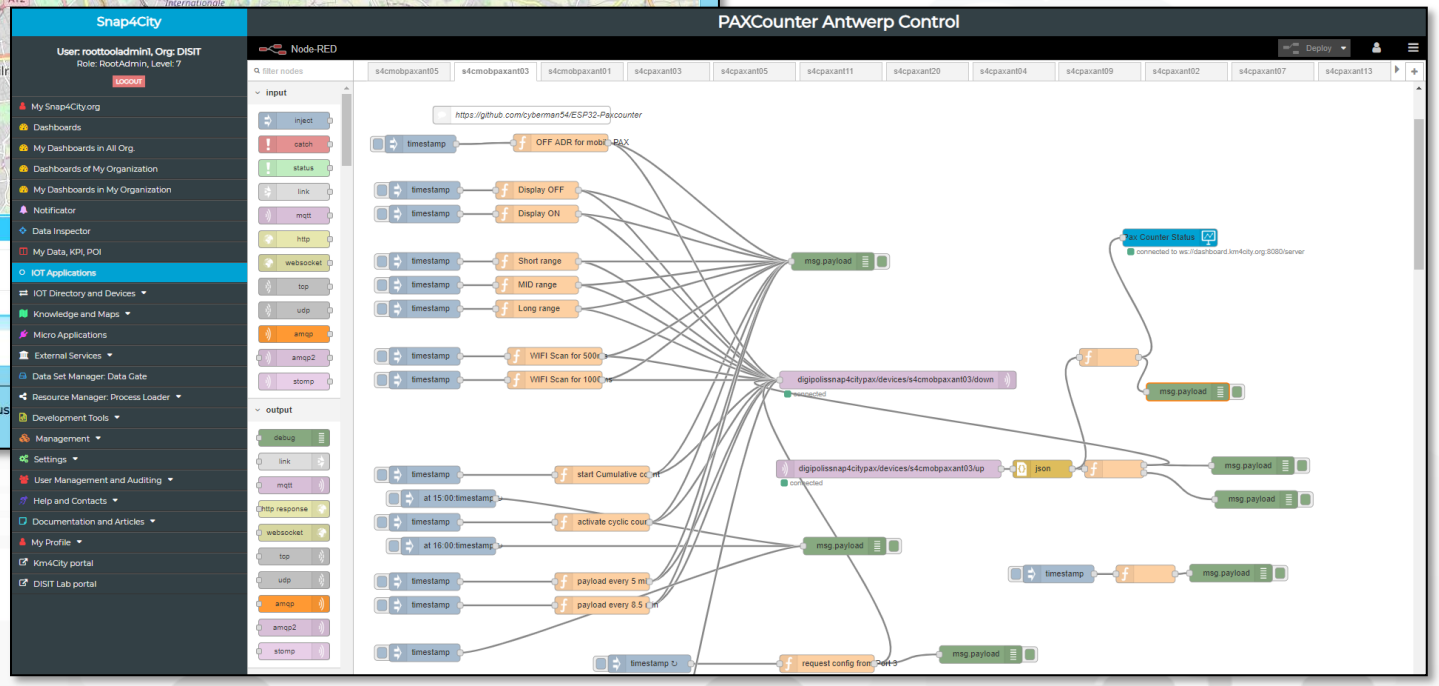
Mon 30 Sep 17:18:48



MAS Monitoring via PAXCounter

Mon 30 Sep 17:31:32

Programmable PAX counting



Antwerp

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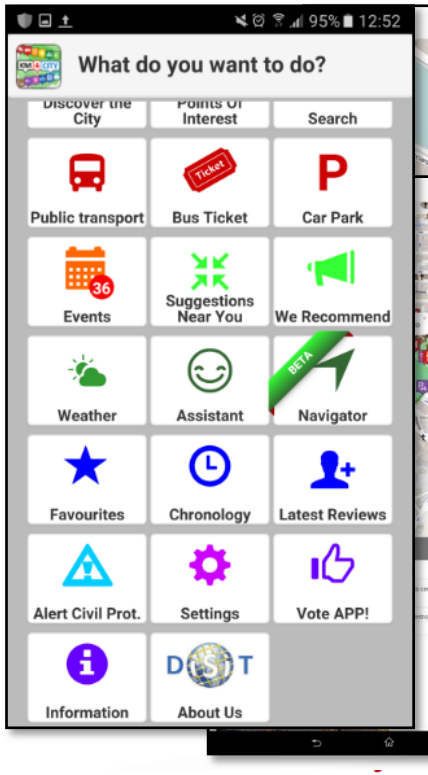
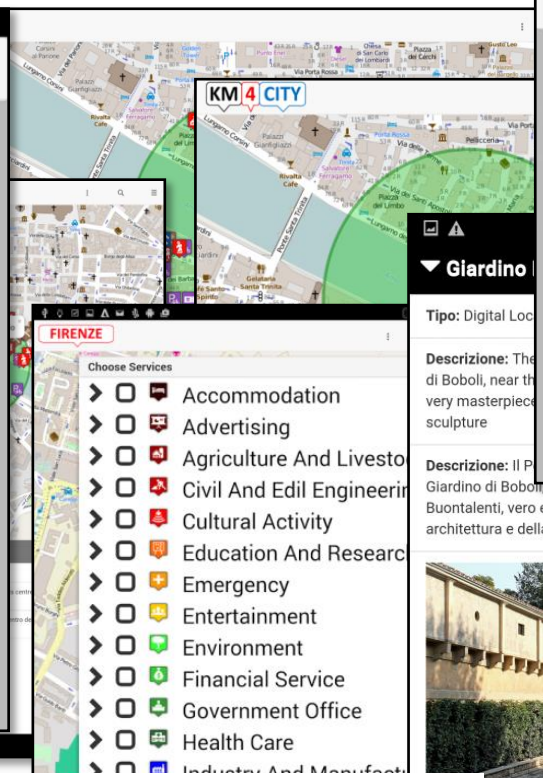
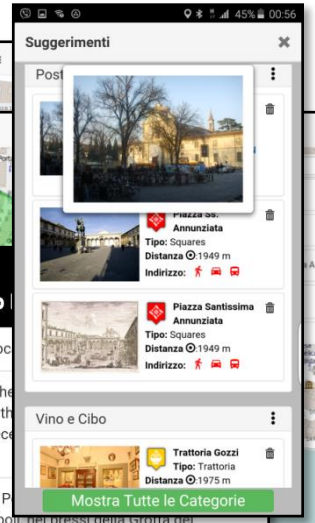
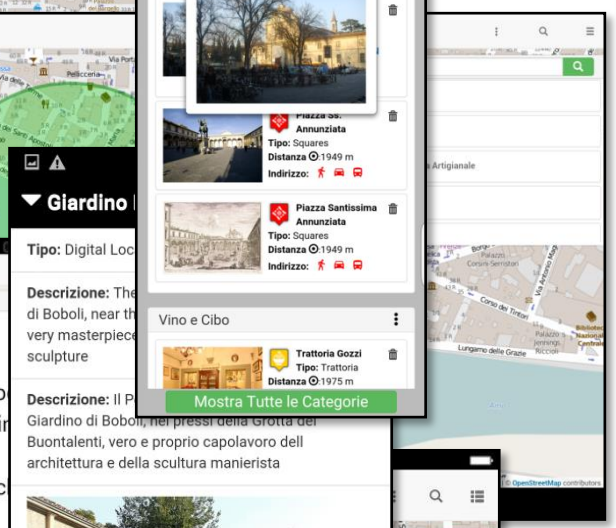
Mobile Apps

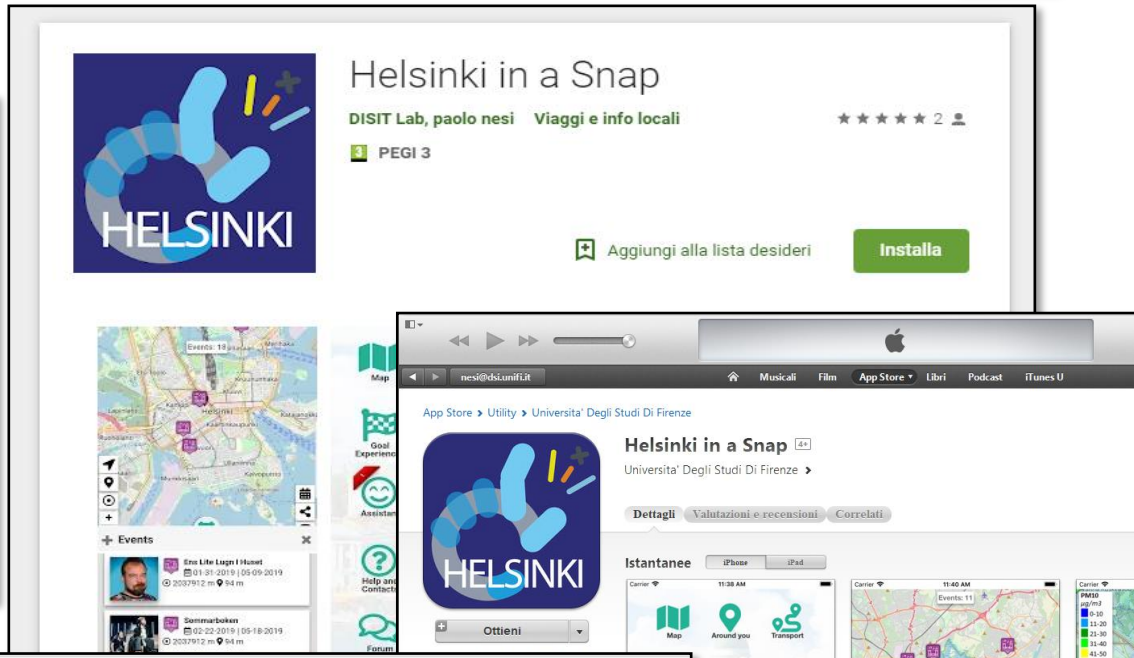
SNAP4CITY KM 4 CITY











DISPONIBILE SU Google play

Scarica da App Store

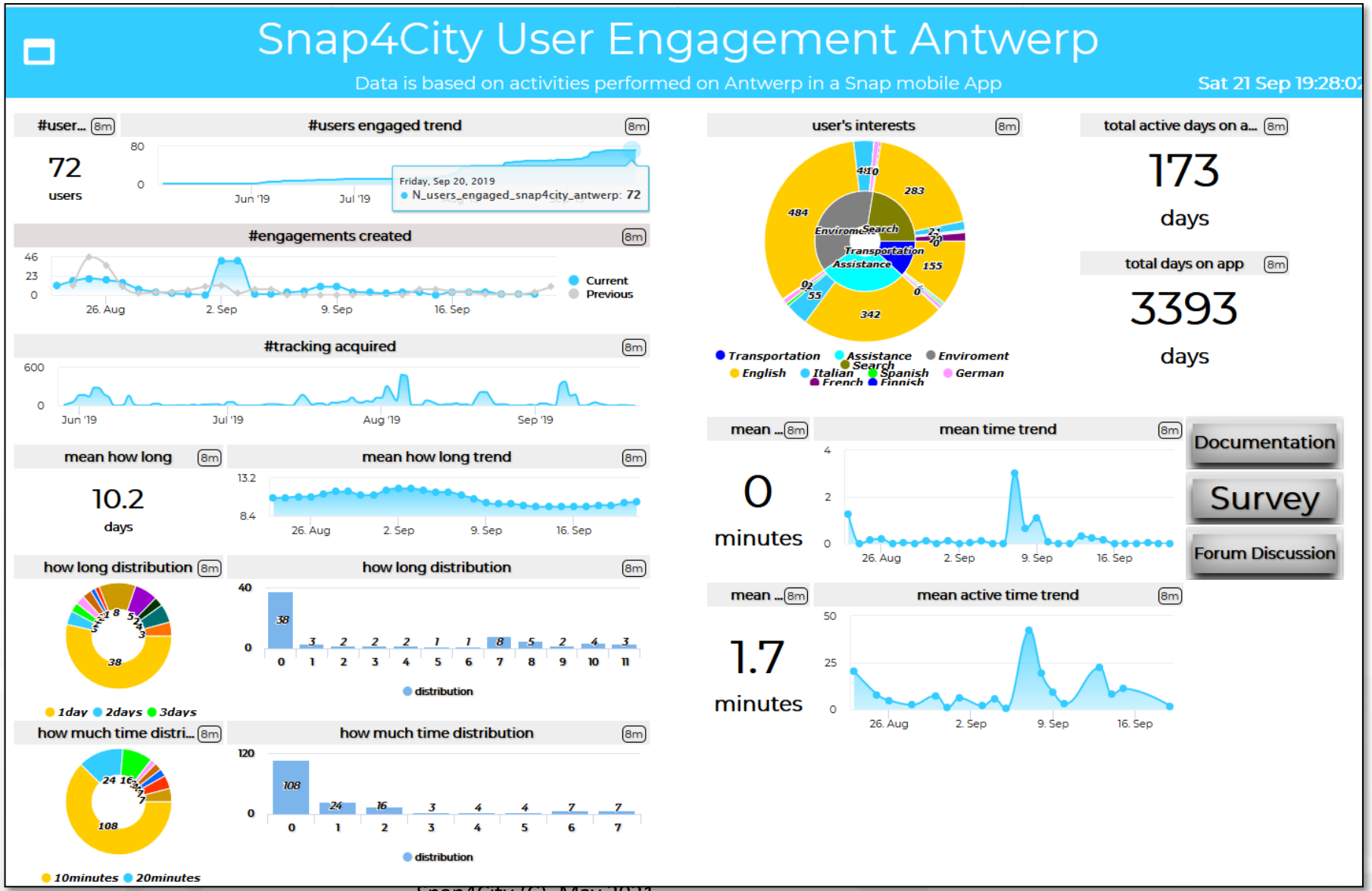
Scarica da Windows Store

SNAP4CITY

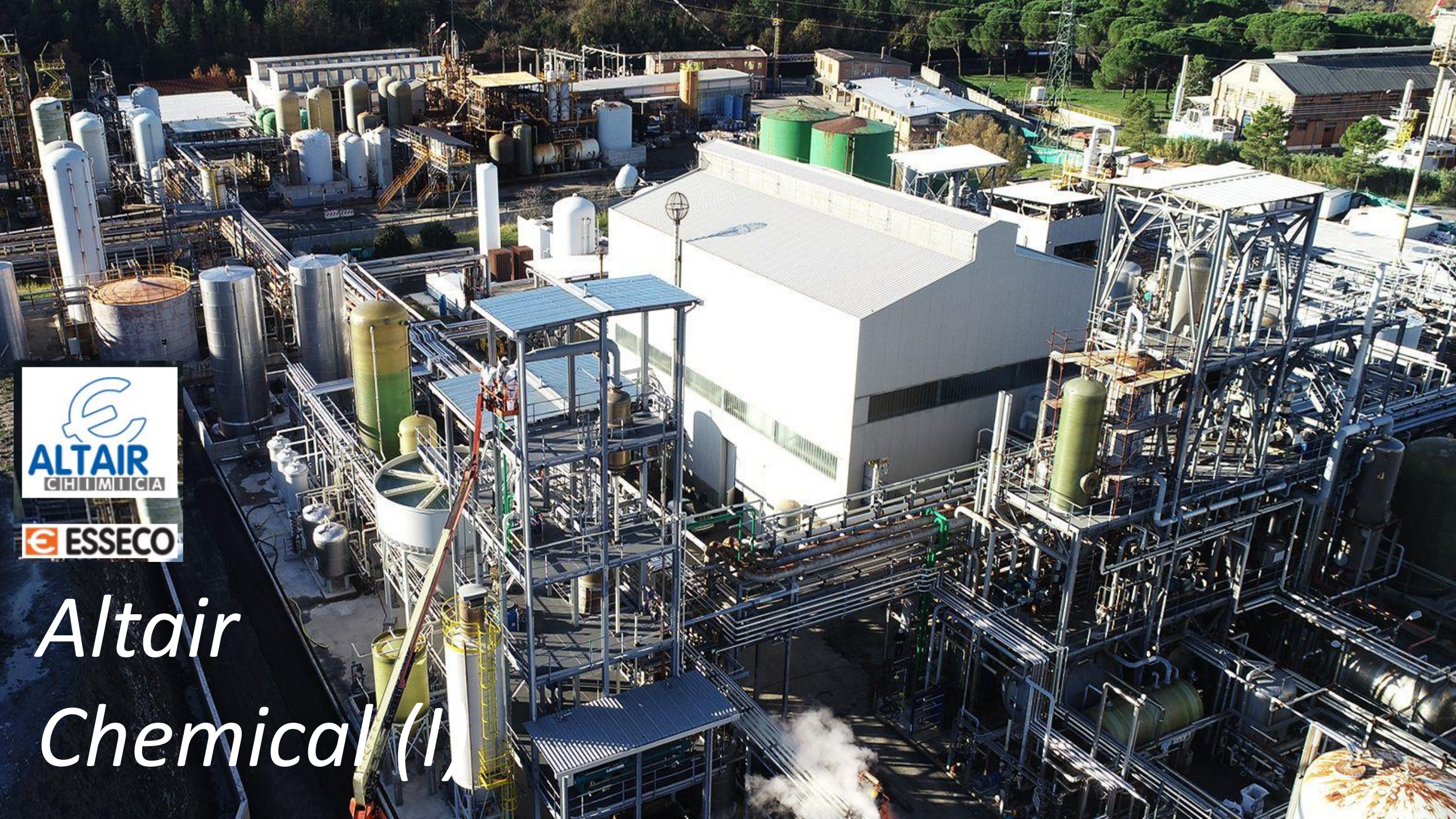
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc1OQ==

Dashboard monitoring the Mobile App:

- Collecting the clicks
- Describing the community of users in terms of the profile aspects
- Measuring the time spend, and topics of interest of the users, etc.



Antwerp

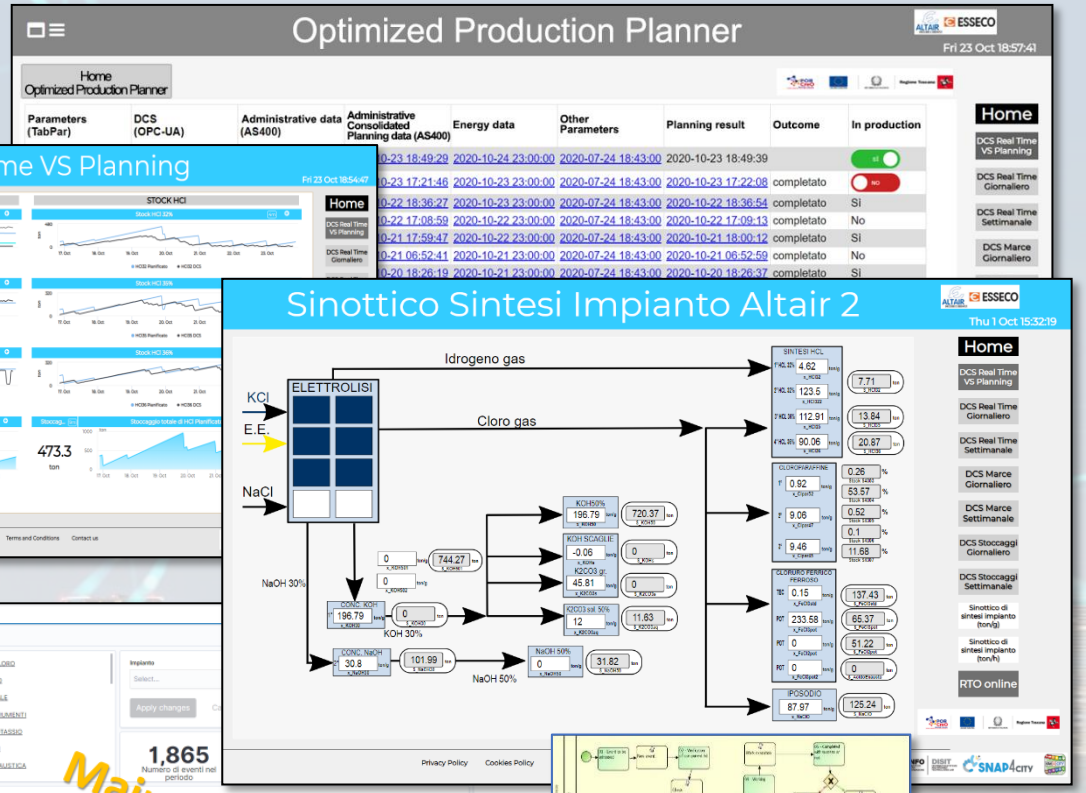


Altair Chemical (I)

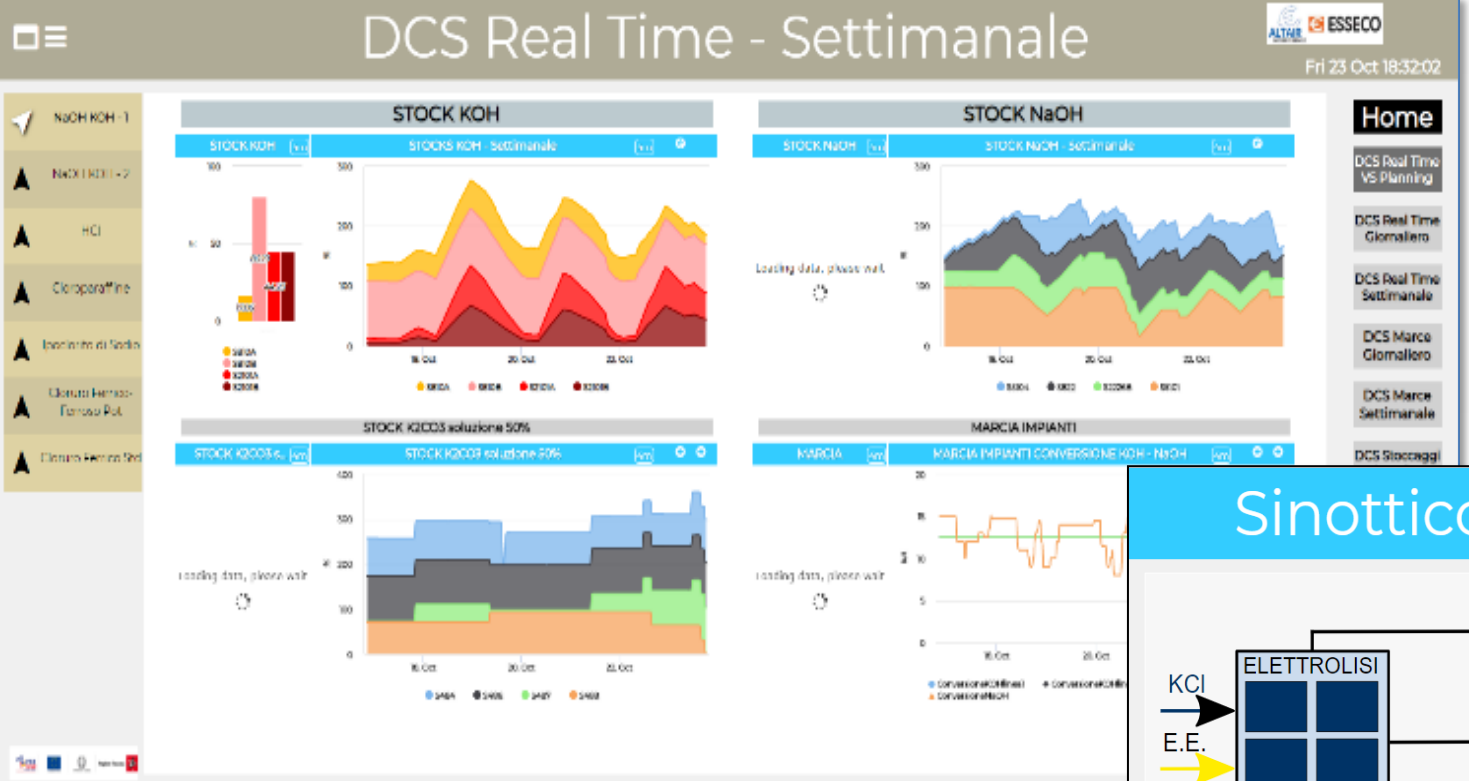
Snap4Altair Decision Support supervision and control, Industry 4.0

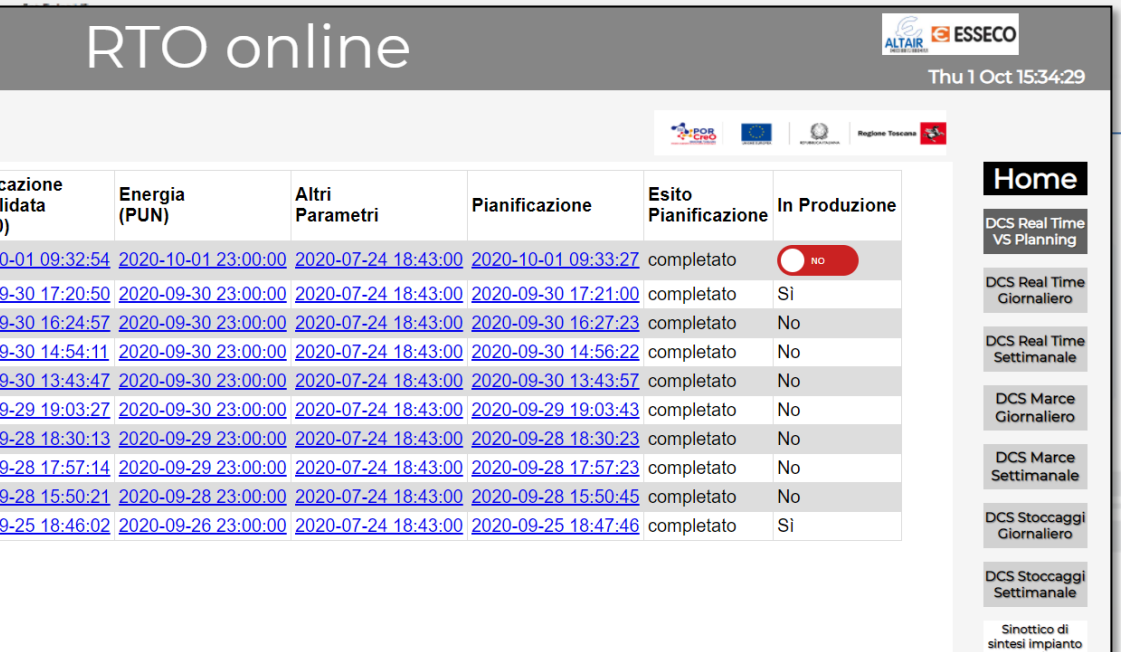
reference

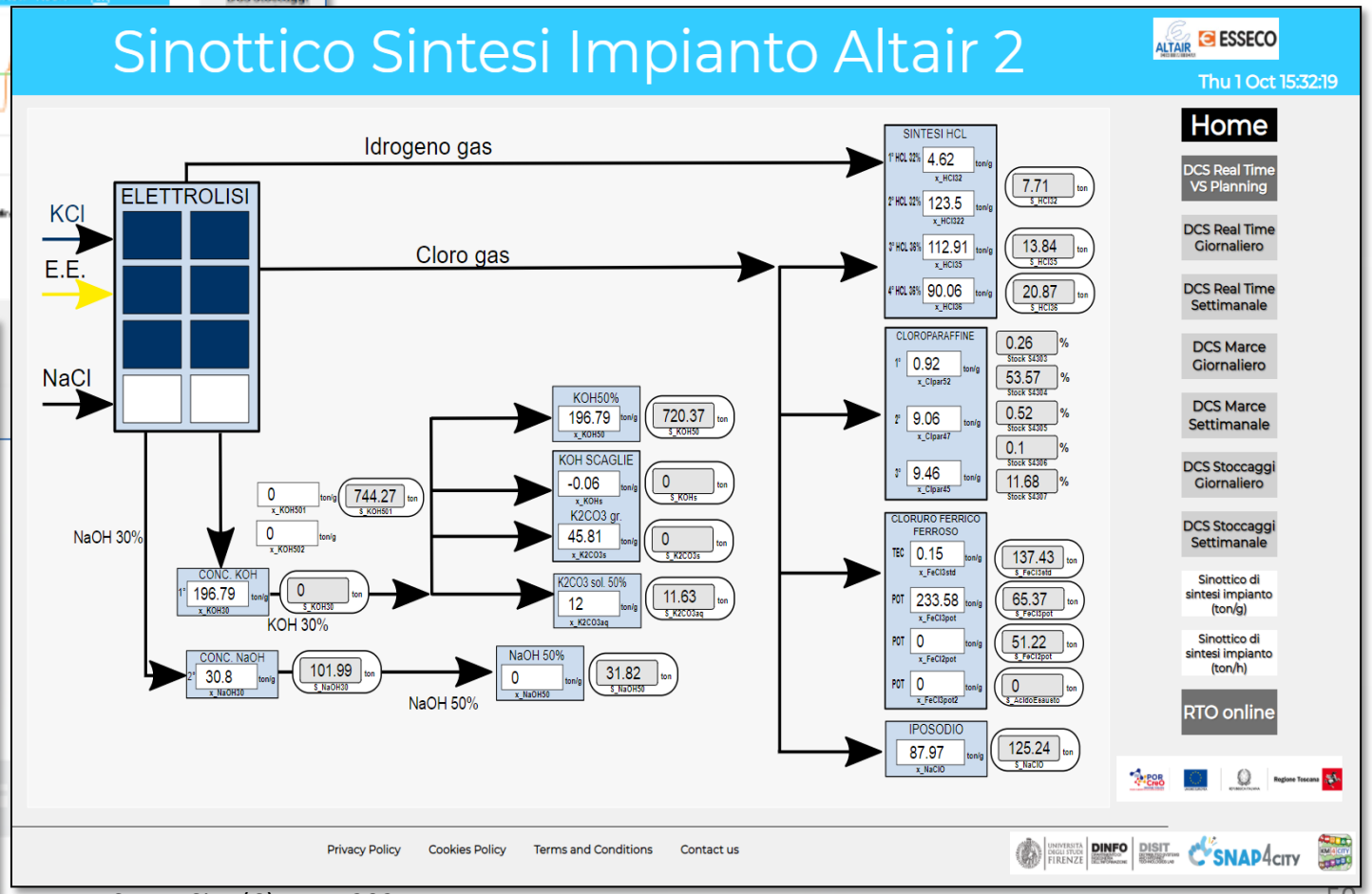
- **Multiple Domain Data**
  - Distributed Control System: energy, flows, storage, chemical data, settings, ..
  - Cost of energy, Orders,
  - Production Parameters
  - Maintenance data
- **Multiple Levels & Decision Makers**
  - Optimized planning on chemical model
  - Business Intelligence on Maintenance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



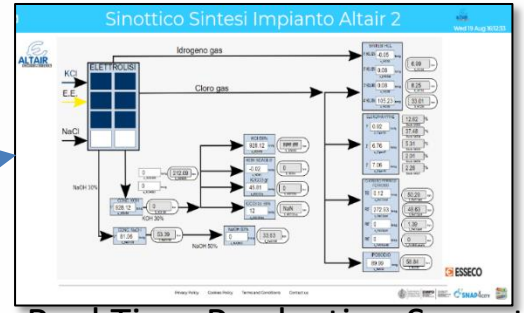
Altair Control room


DCS Real Time - Settimanale
ESSECO
Fri 23 Oct 18:32:02
STOCK KOH
STOCK NaOH
STOCK K2CO3 soluzione 50%
MARCIA IMPIANTI
Home
DCS Real Time VS Planning
DCS Real Time Giornaliero
DCS Real Time Settimanale
DCS Marce Giornaliero
DCS Marce Settimanale
DCS Stoccaggi


RTO online
ESSECO
Thu 1 Oct 15:34:29
Energia (PUN)
Altri Parametri
Pianificazione
Esito Pianificazione
In Produzione
2020-10-01 09:32:54 2020-10-01 23:00:00 2020-07-24 18:43:00 2020-10-01 09:33:27 completato NO
2020-09-30 17:20:50 2020-09-30 23:00:00 2020-07-24 18:43:00 2020-09-30 17:21:00 completato Sì
2020-09-30 16:24:57 2020-09-30 23:00:00 2020-07-24 18:43:00 2020-09-30 16:27:23 completato No
2020-09-30 14:54:11 2020-09-30 23:00:00 2020-07-24 18:43:00 2020-09-30 14:56:22 completato No
2020-09-30 13:43:47 2020-09-30 23:00:00 2020-07-24 18:43:00 2020-09-30 13:43:57 completato No
2020-09-29 19:03:27 2020-09-30 23:00:00 2020-07-24 18:43:00 2020-09-29 19:03:43 completato No
2020-09-28 18:30:13 2020-09-29 23:00:00 2020-07-24 18:43:00 2020-09-28 18:30:23 completato No
2020-09-28 17:57:14 2020-09-29 23:00:00 2020-07-24 18:43:00 2020-09-28 17:57:23 completato No
2020-09-28 15:50:21 2020-09-28 23:00:00 2020-07-24 18:43:00 2020-09-28 15:50:45 completato No
2020-09-25 18:46:02 2020-09-26 23:00:00 2020-07-24 18:43:00 2020-09-25 18:47:46 completato Sì
Home
DCS Real Time VS Planning
DCS Real Time Giornaliero
DCS Real Time Settimanale
DCS Marce Giornaliero
DCS Marce Settimanale
DCS Stoccaggi Giornaliero
DCS Stoccaggi Settimanale


Sinottico Sintesi Impianto Altair 2
ESSECO
Thu 1 Oct 15:32:19
Idrogeno gas
KCl
E.E.
NaCl
ELETTROLISI
Cloro gas
NaOH 30%
KOH 30%
NaOH 50%
SINTESI HCL
CLOROPARAFFINE
CLORURO FERRICO FERROSO
IPOSODIO
Home
DCS Real Time VS Planning
DCS Real Time Giornaliero
DCS Real Time Settimanale
DCS Marce Giornaliero
DCS Marce Settimanale
DCS Stoccaggi Giornaliero
DCS Stoccaggi Settimanale
Sinottico di sintesi impianto (ton/g)
Sinottico di sintesi impianto (ton/h)
RTO online
Privacy Policy
Cookies Policy
Terms and Conditions
Contact us

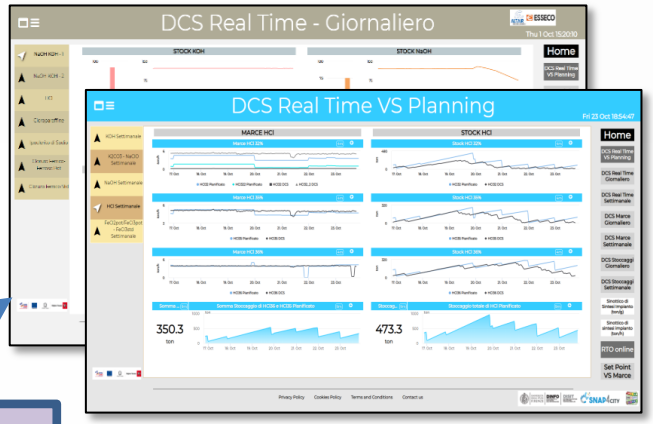
Plant Status



Real Time Production Synoptic

Production Plan

Production vs Planning



Data Storage

Data Ingestion

Decision Support

AS400

Orders

Energy Service

Transportation

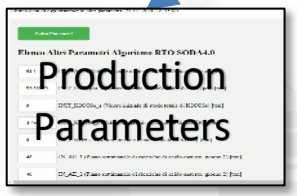
Other Costs

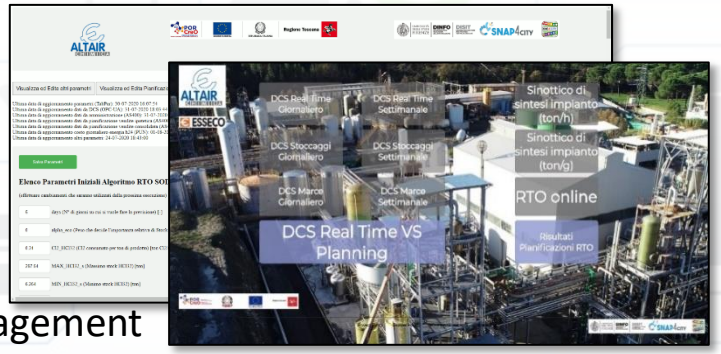
Production Plant Management

Optimized Production Planner

Possible Plan

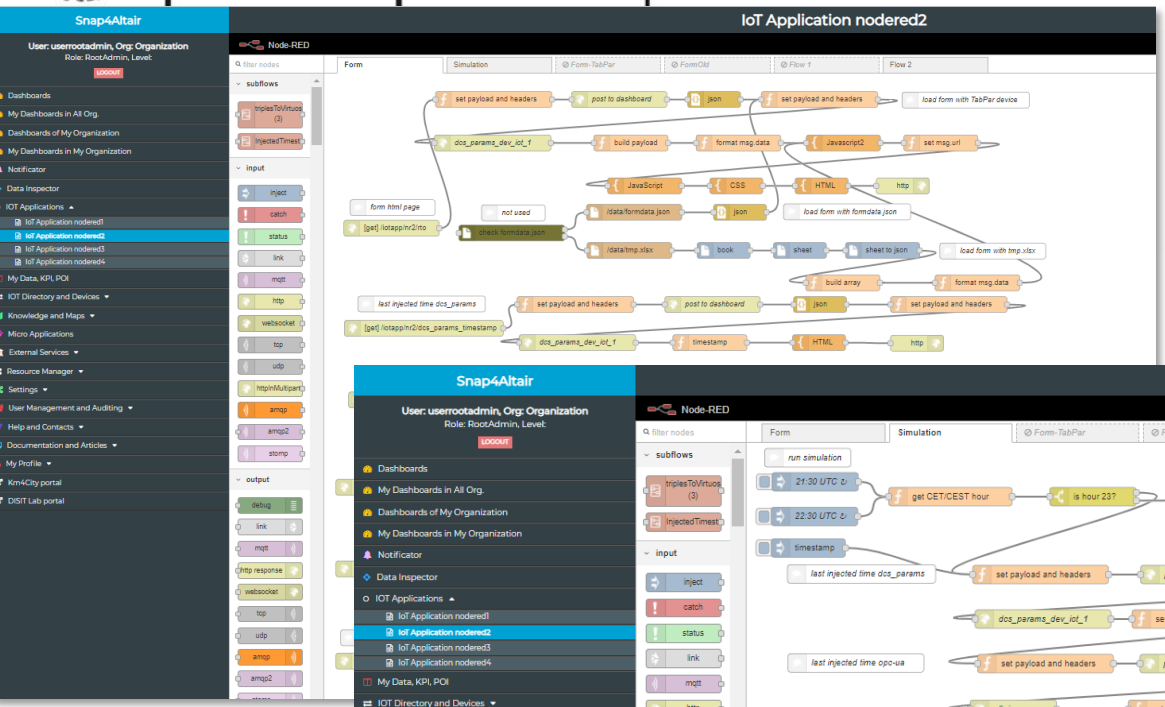
Possible Plans

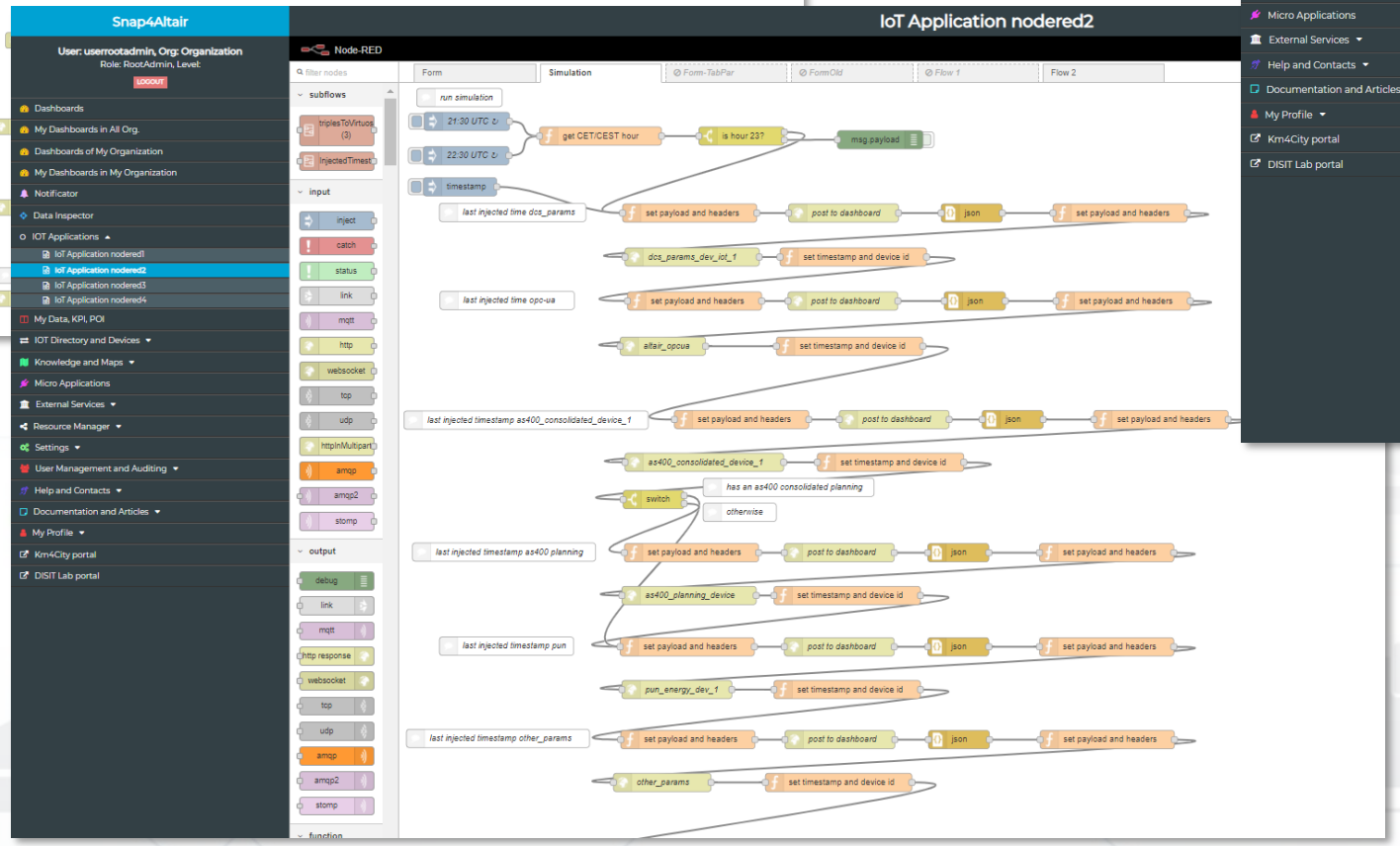


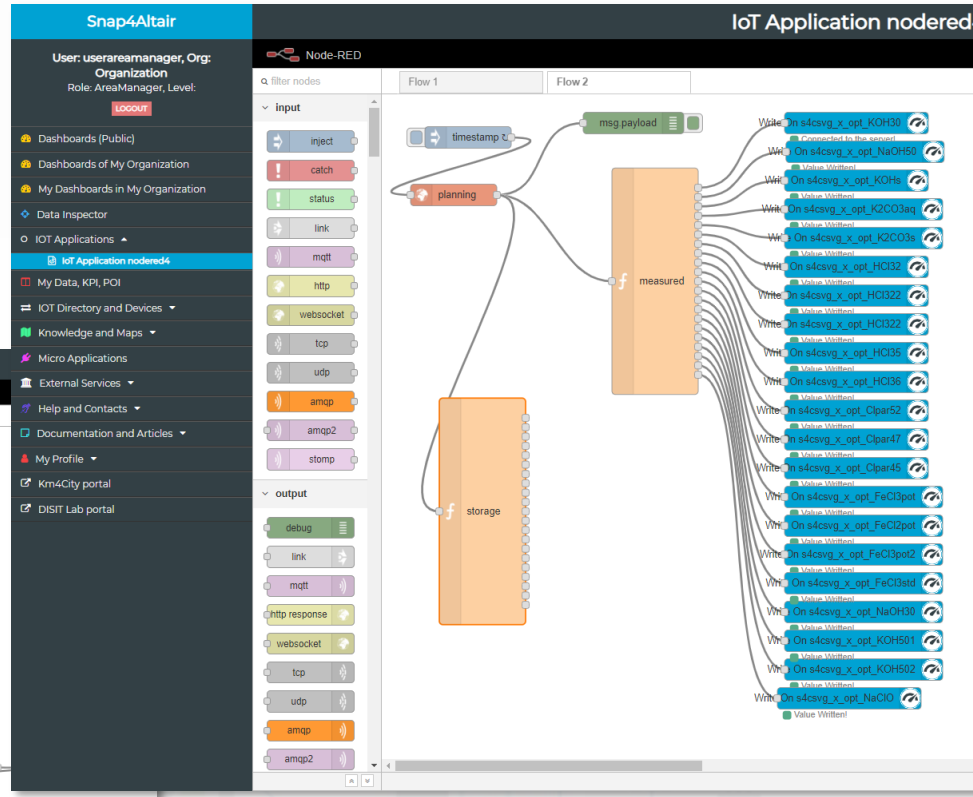


Plant Management

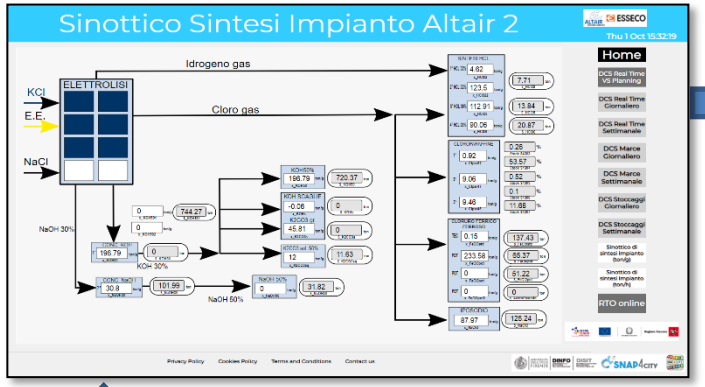
Some Altair Flows



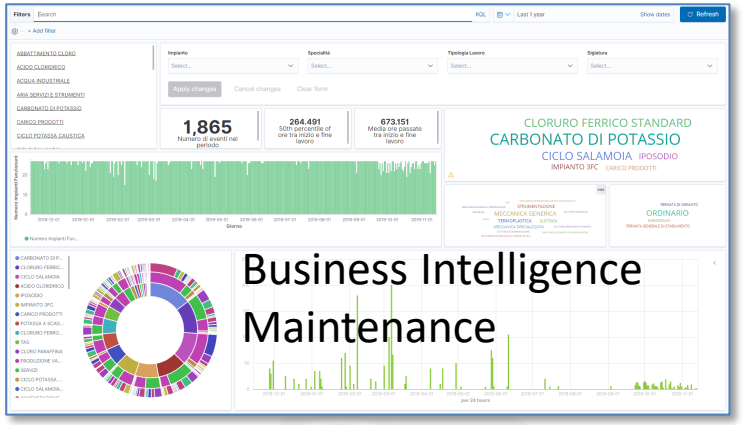




Workflow for Ticket management

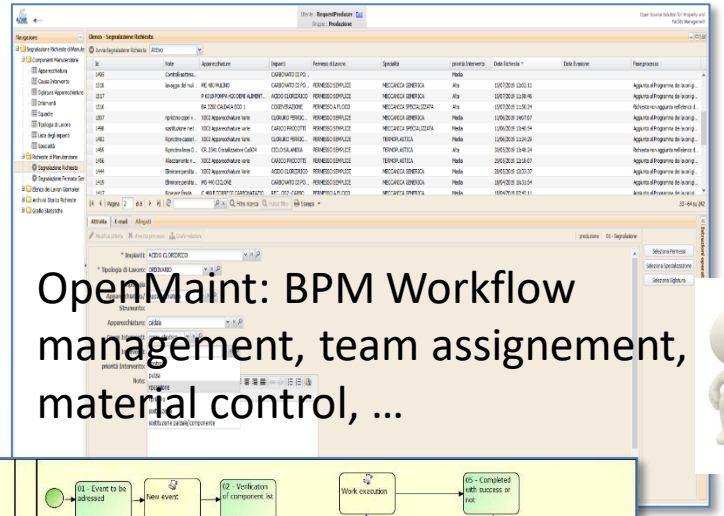


Consumptions/productions

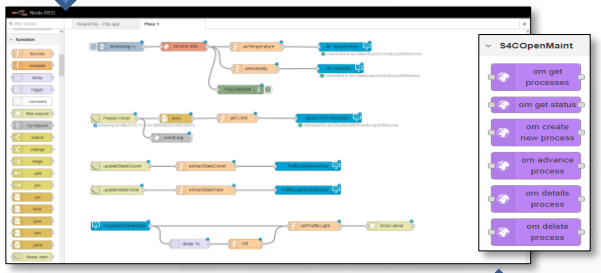


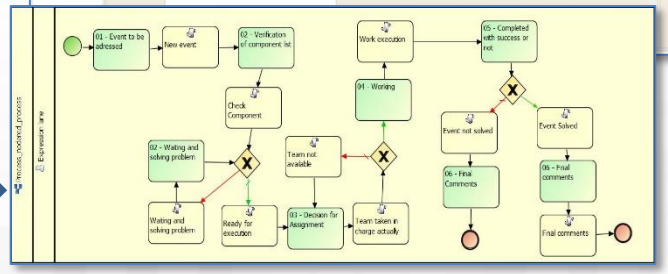
Dashboards and actions

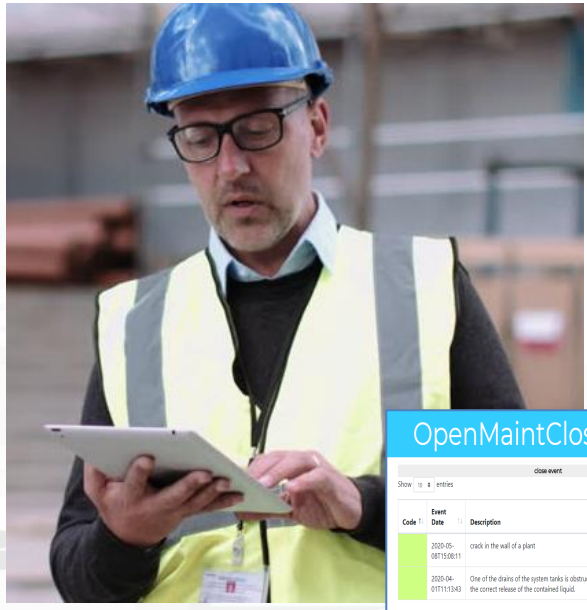
Events/actions

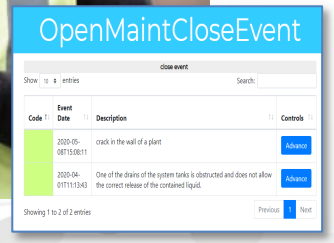


OpenMaint: BPM Workflow management, team assignement, material control, …









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

Filters | Search | KQL | Last 1 year | Show dates | Refresh

+ Add filter

- ABBATTIMENTO CLORO
- ACIDO CLORIDRICO
- ACQUA INDUSTRIALE
- ARIA SERVIZI E STRUMENTI
- CARBONATO DI POTASSIO
- CARICO PRODOTTI
- CICLO POTASSA CAUSTICA

Impianto: Select...

Specialità: Select...

Tipologia Lavoro: Select...

Siglatura: Select...

Apply changes | Cancel changes | Clear form

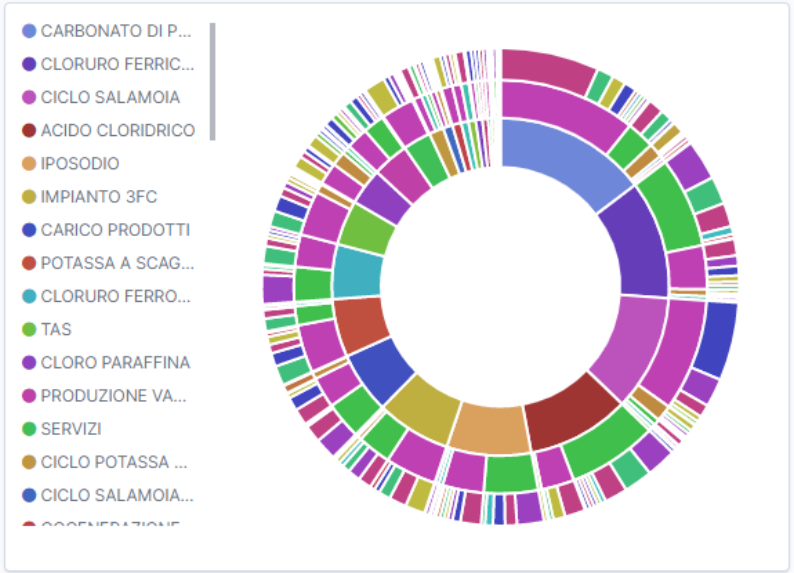
1,865
Numero di eventi nel periodo

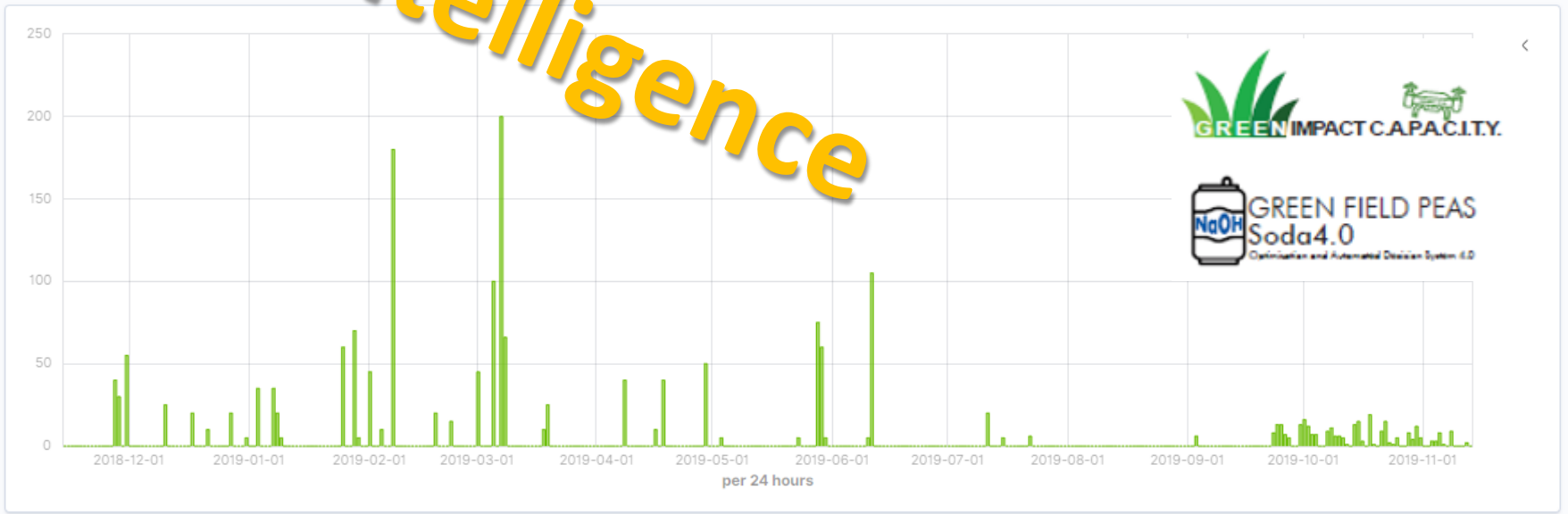
264.491
50th percentile of ore tra inizio e fine lavoro

673.151
Media ore passate tra inizio e fine lavoro

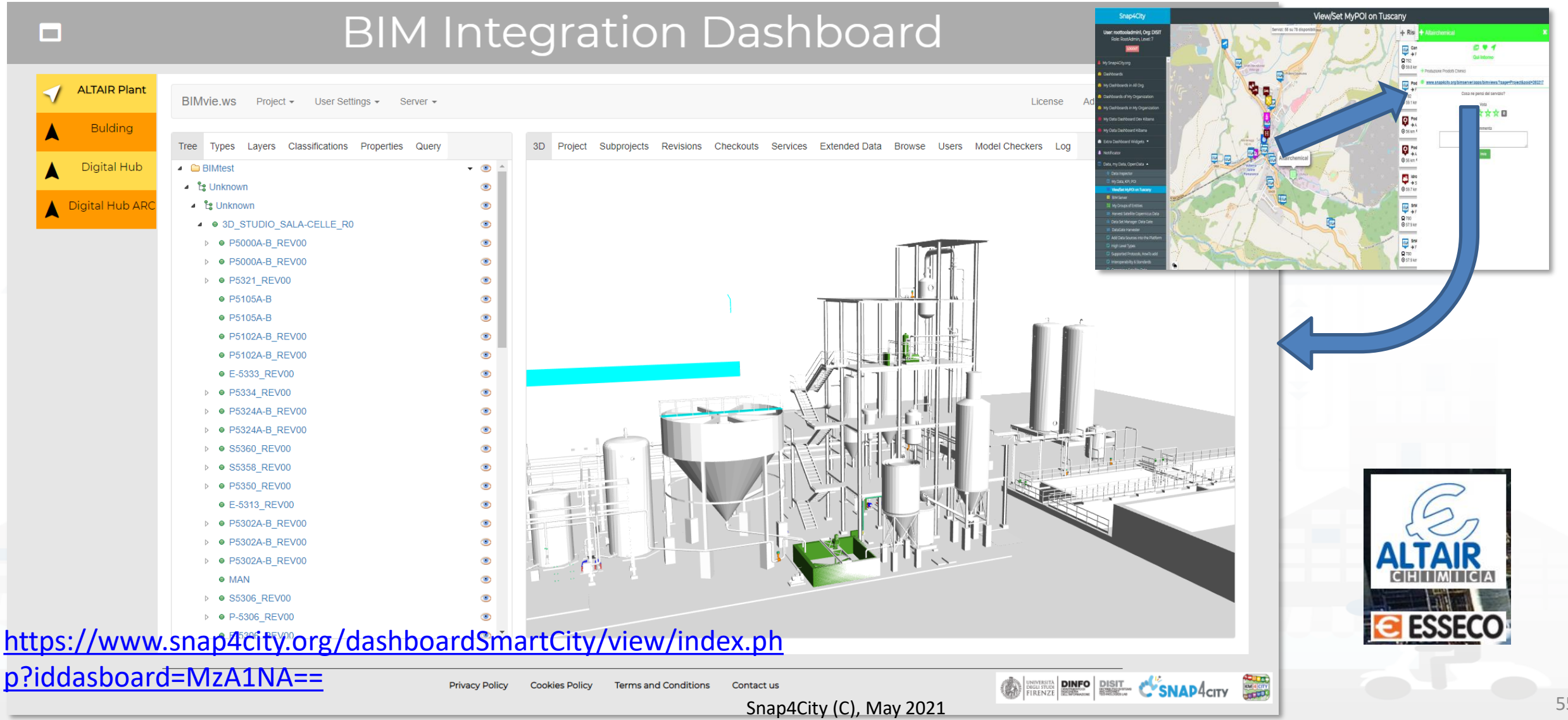
CLORURO FERRICO STANDARD
CARBONATO DI POTASSIO
CICLO SALAMOIA
IPOSODIO
IMPIANTO 3FC
CARICO PRODOTTI

Maintenance Intelligence



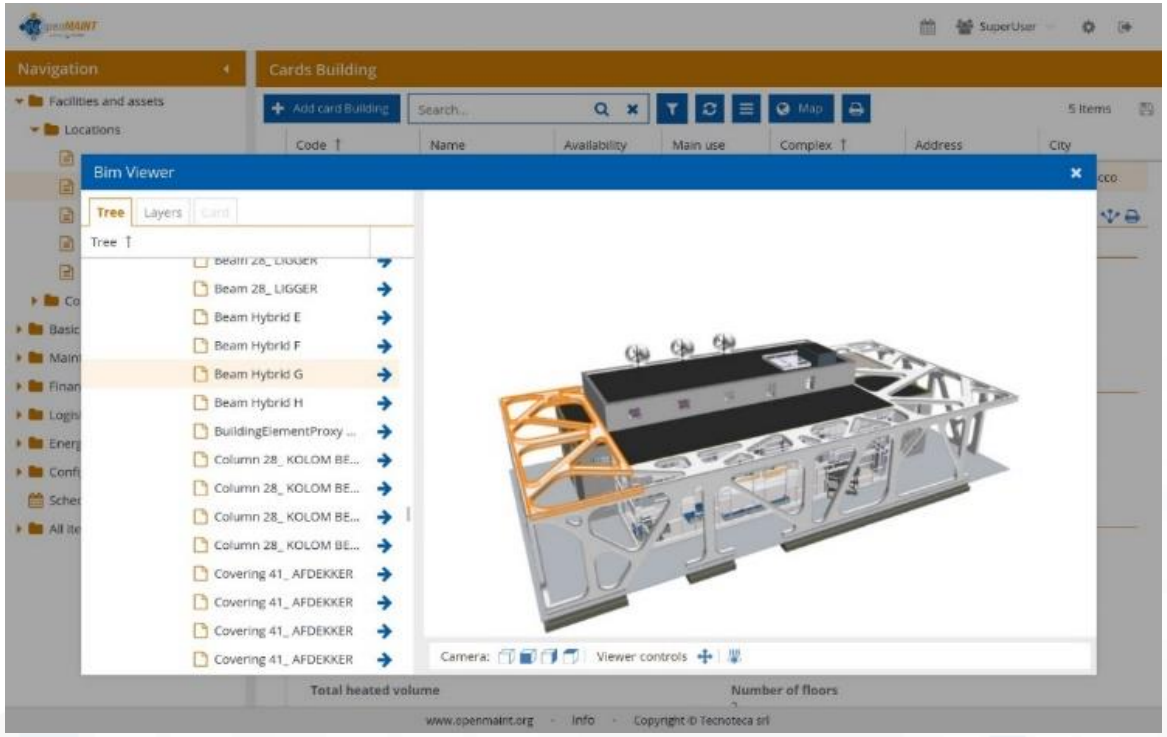


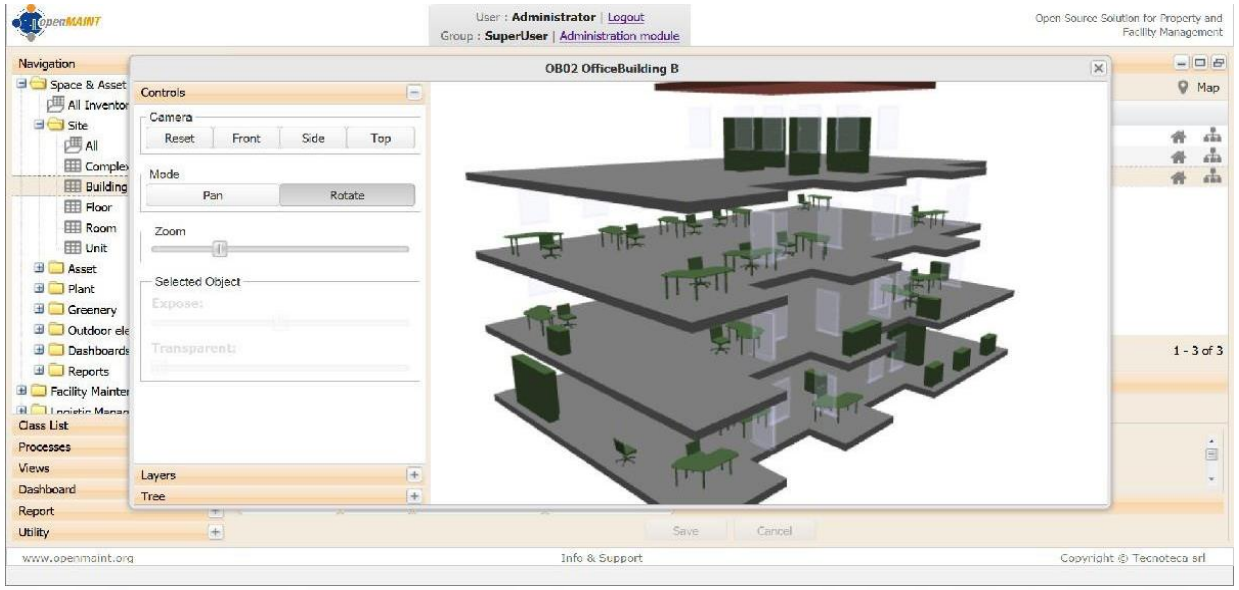
BIM view of the Altair Chemical Plant

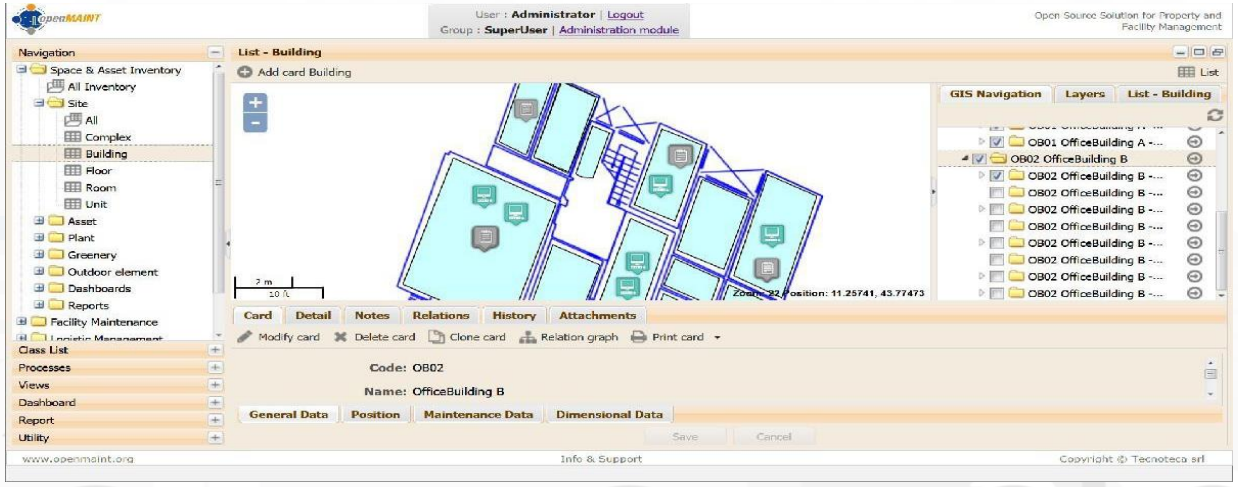


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA1NA==

OpenMaint BPM, BIMServer







Tuscany Region
Firenze, Pisa, Livorno, Prato, etc.

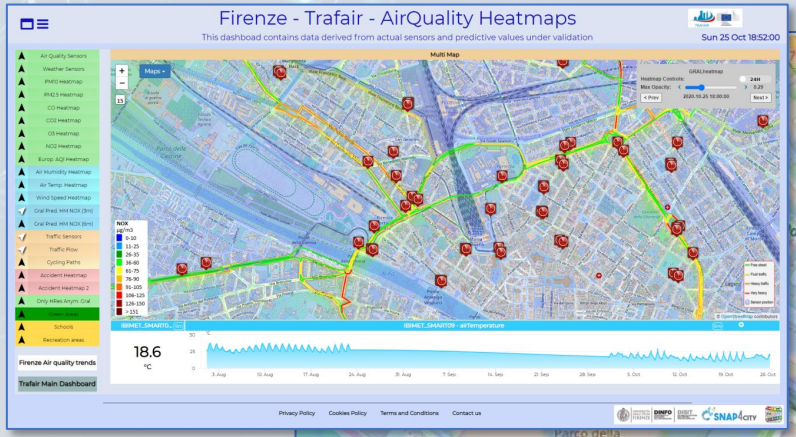


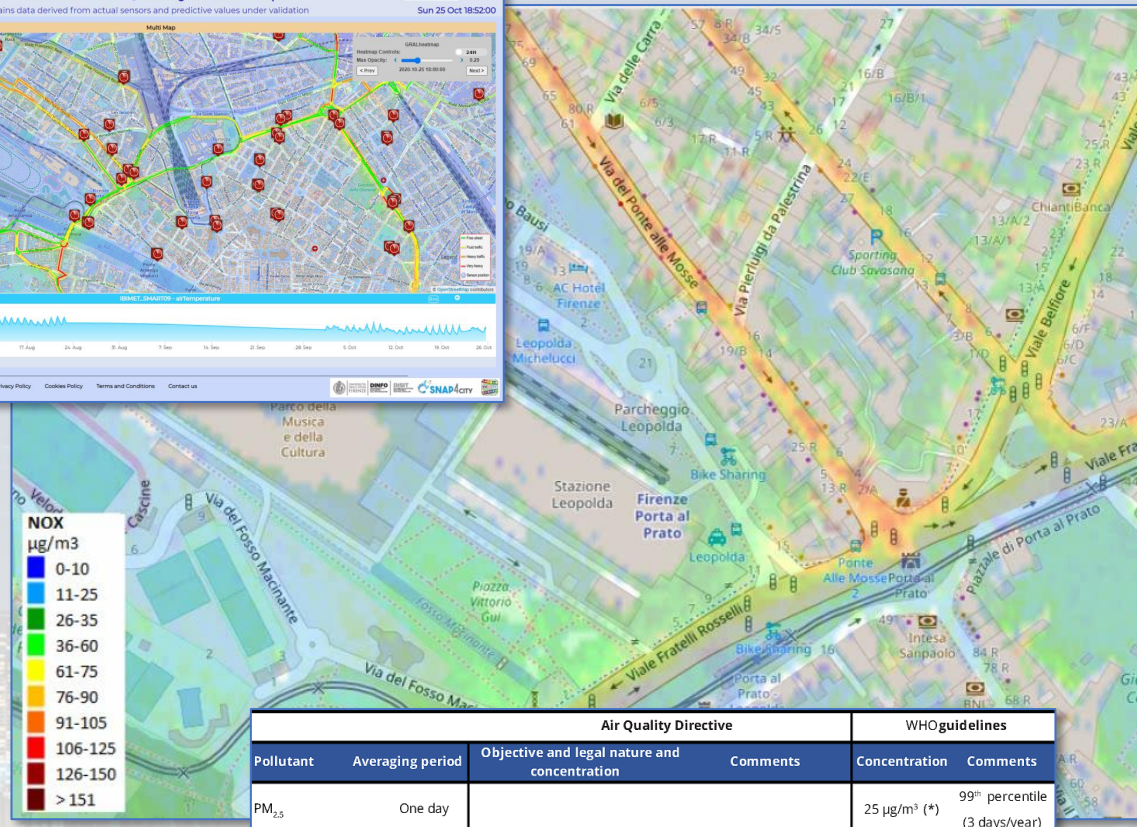
Environment and Quality of Life
Air Quality Predictions

Cities of: Firenze, Pisa, Livorno

reference

- **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**

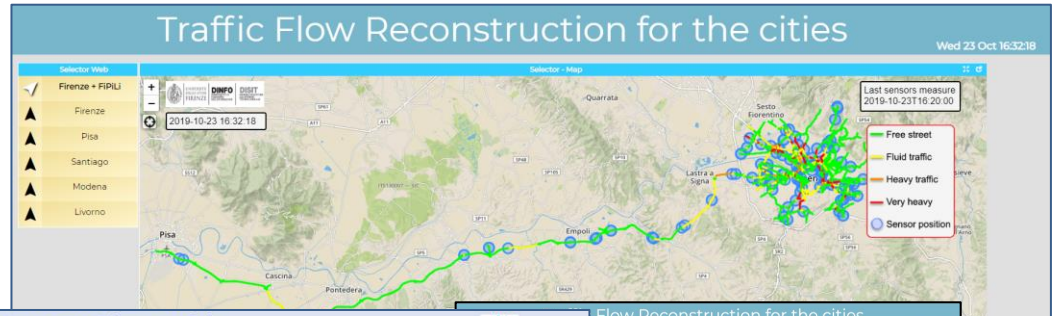


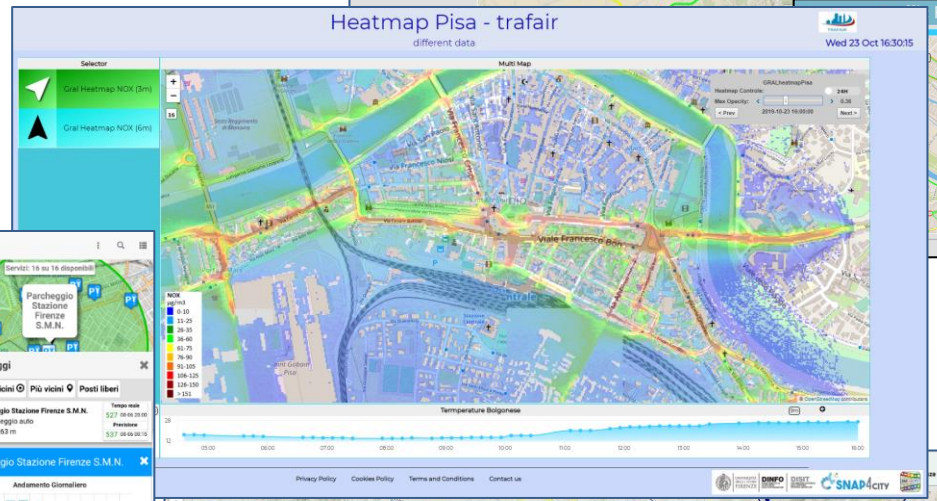


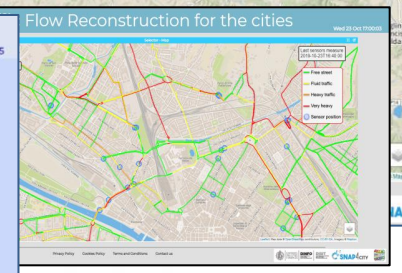
		Air Quality Directive		WHO guidelines	
Pollutant	Averaging period	Objective and legal nature and concentration	Comments	Concentration	Comments
$PM_{2.5}$	One day			25 µg/m³ (*)	99th percentile (3 days/year)
$PM_{2.5}$	Calendar year	Target value, 25 µg/m³	The target value has become a limit value since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

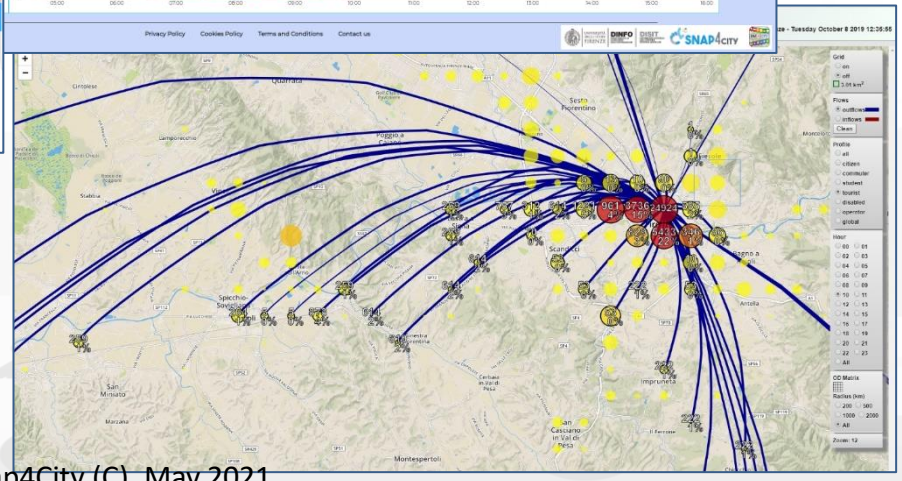
Tuscany Region

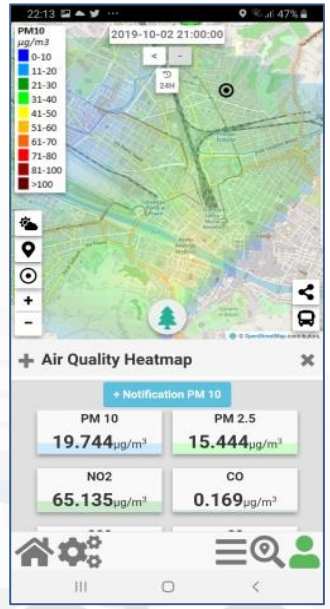
- **Dashboards & Services**:
  - **Mobility**: public transport operators schedule and paths, traffic Fi-Pi-Li main road, parking status and predictions, traffic sensors, Origin Destination matrix, routing, multimodal routing, etc.
  - **Social**: Hospitals and triage, etc.
  - **Environment**: sensors,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



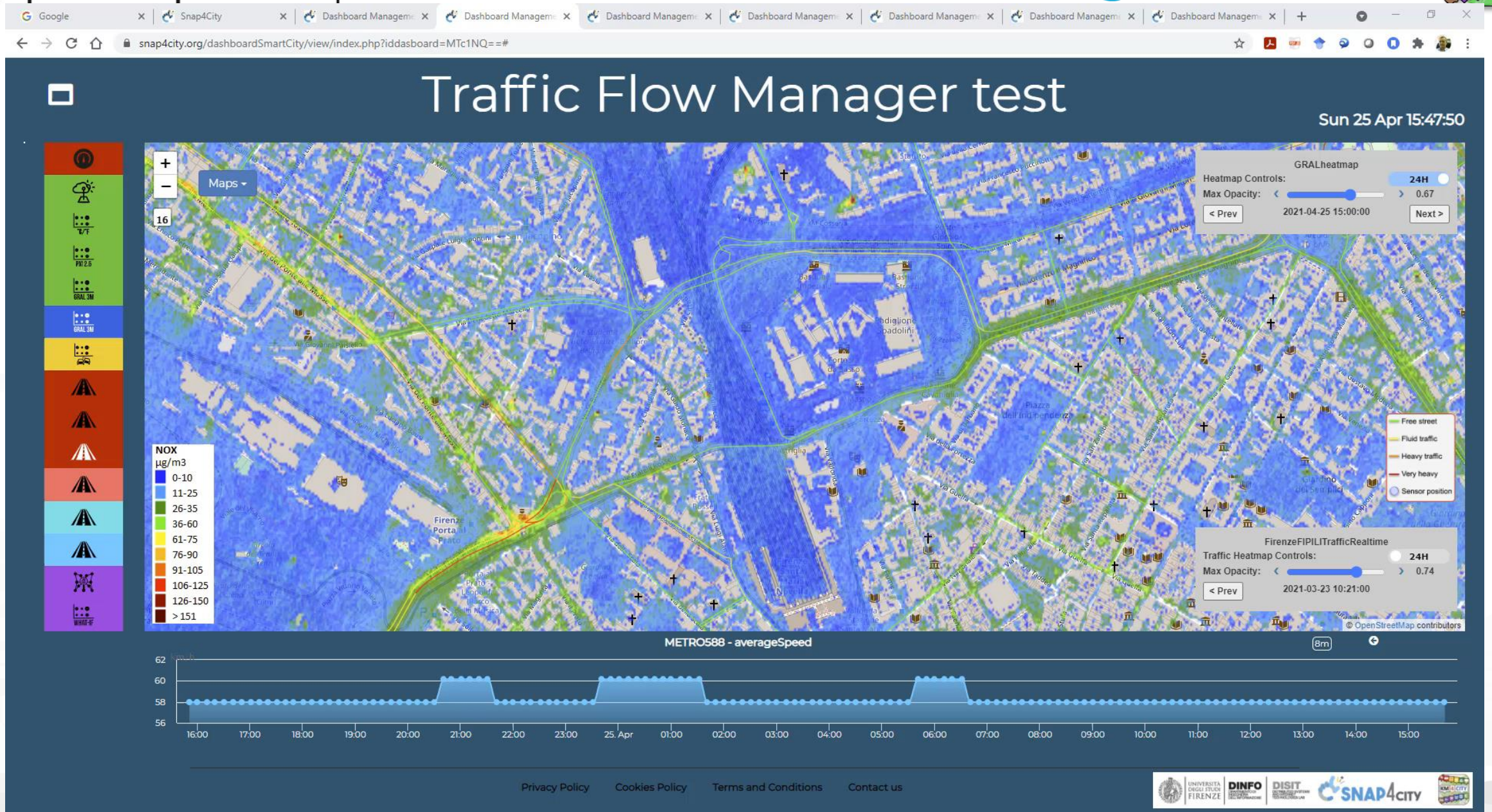




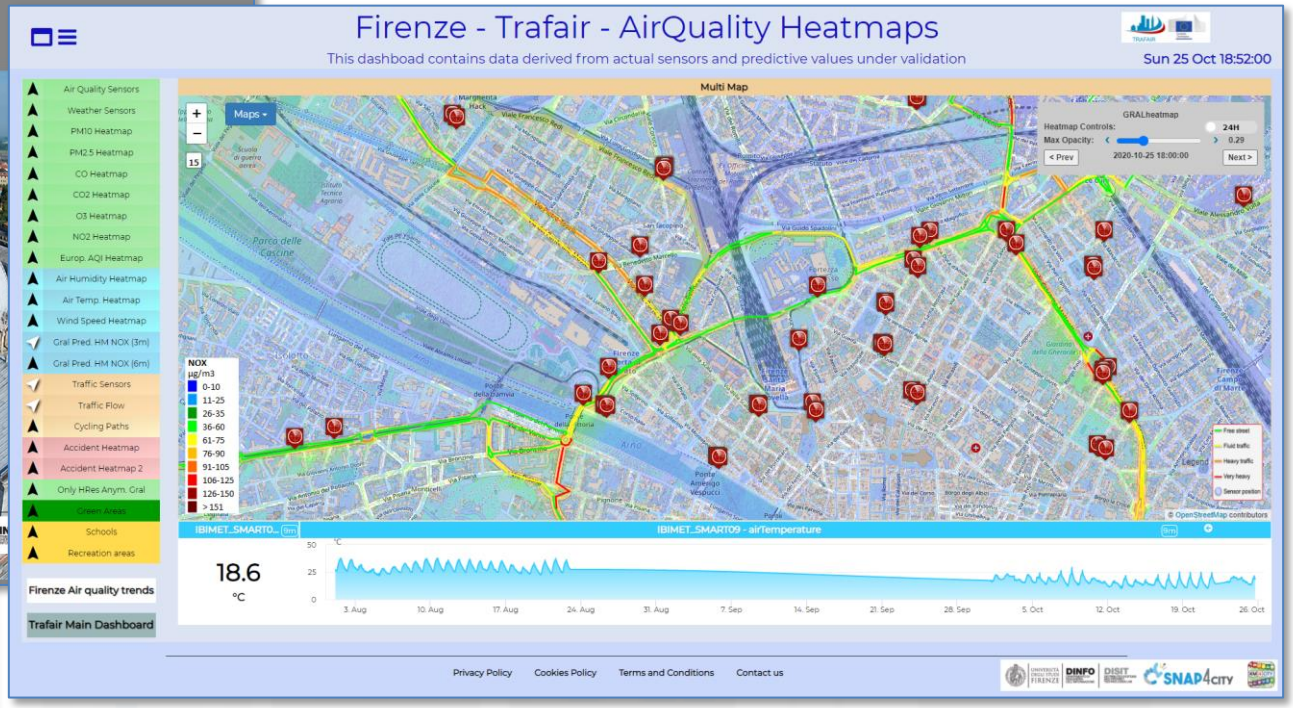




Traffic vs NOX



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjY4MQ==



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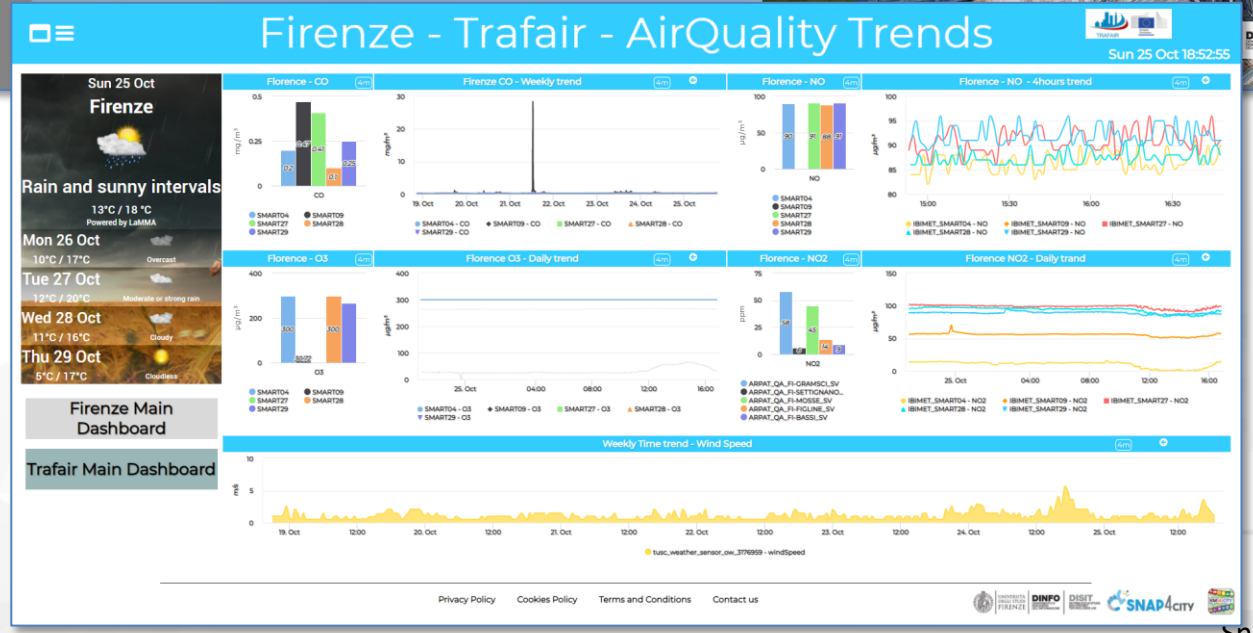


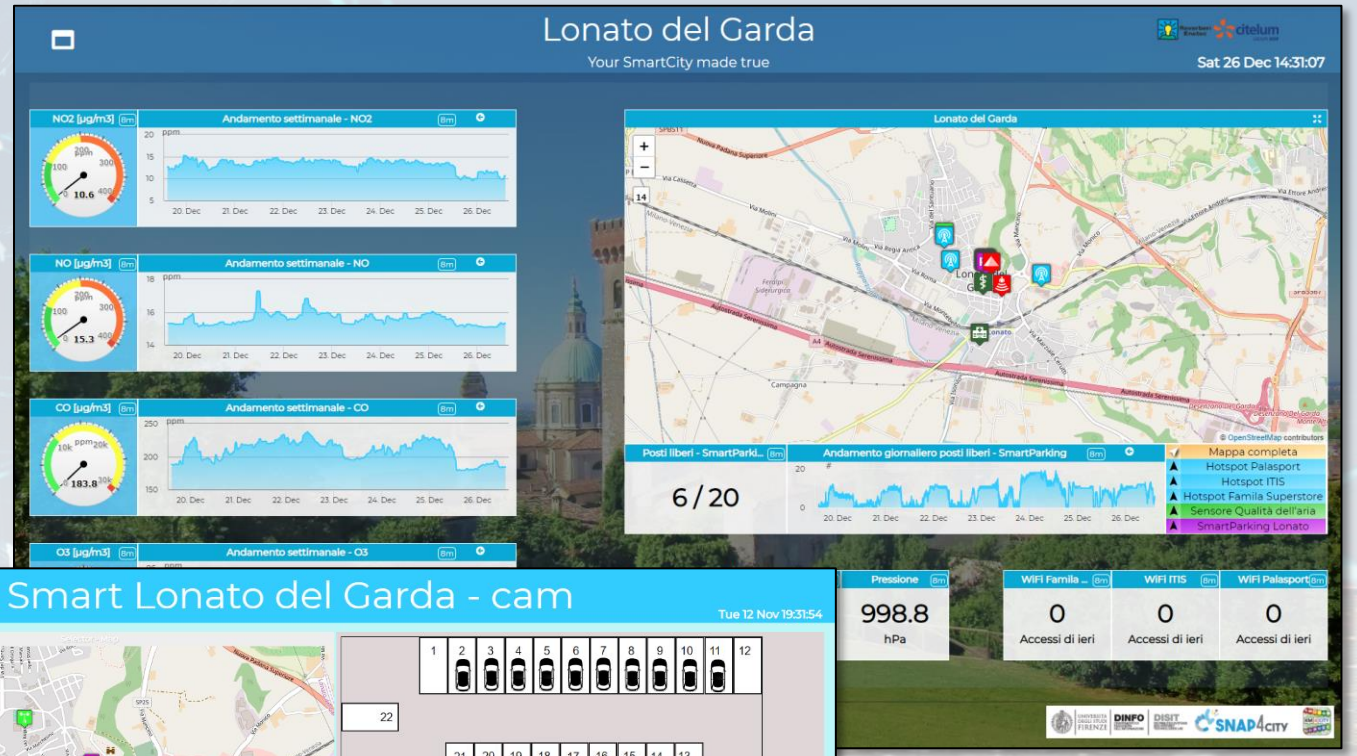
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjU0Mg==

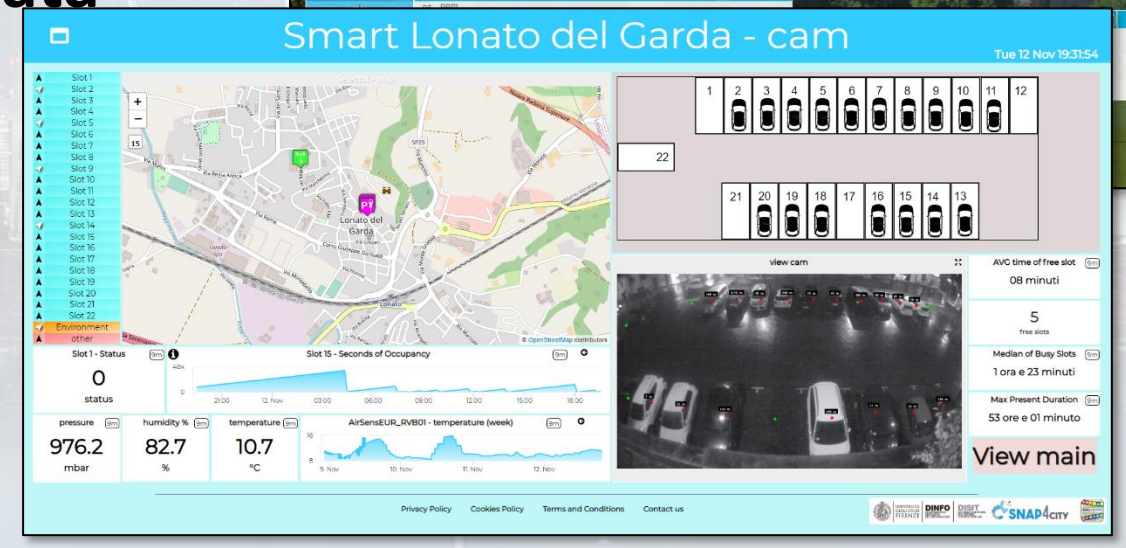

Lonato del Garda

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

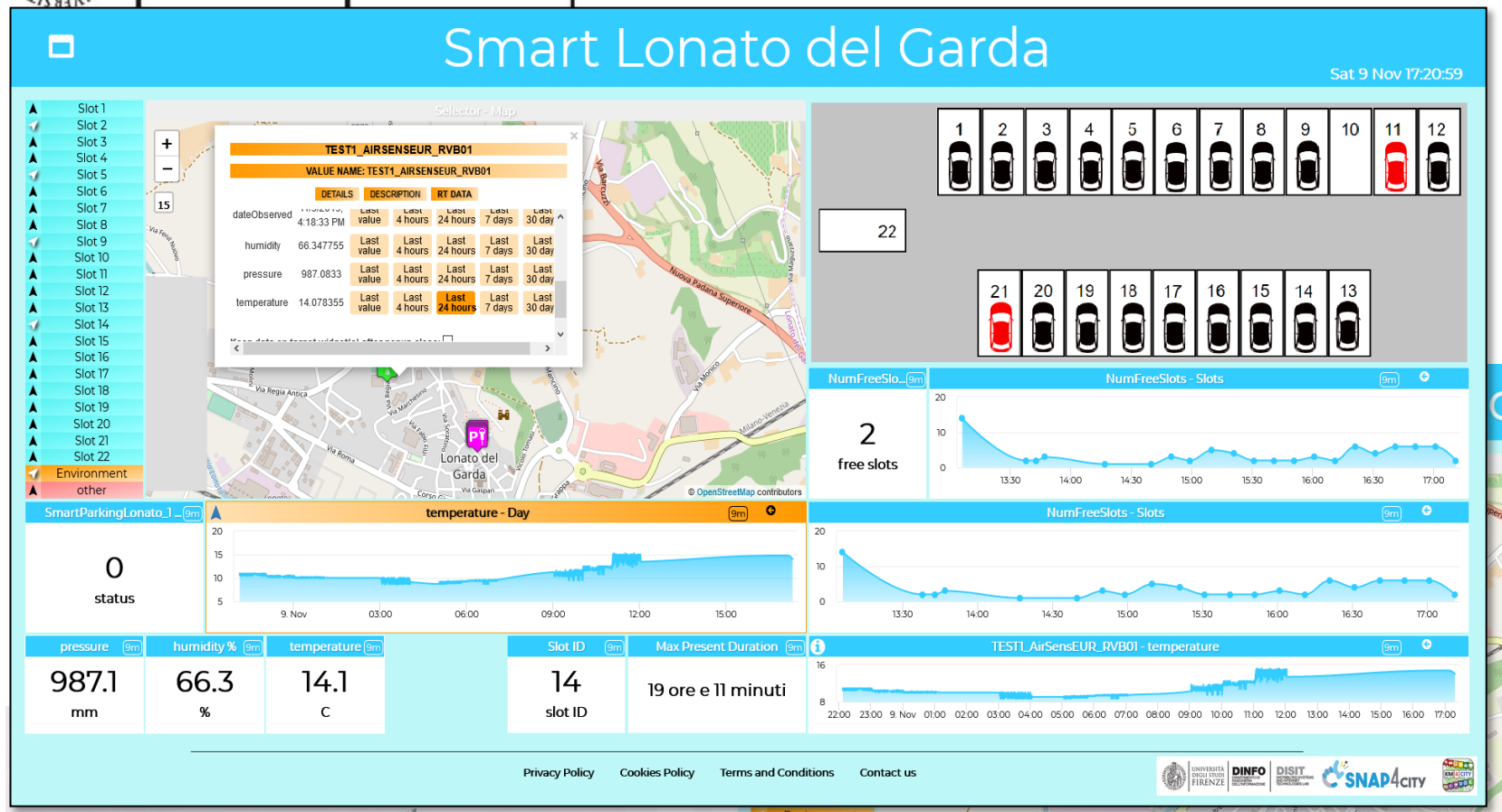
reference

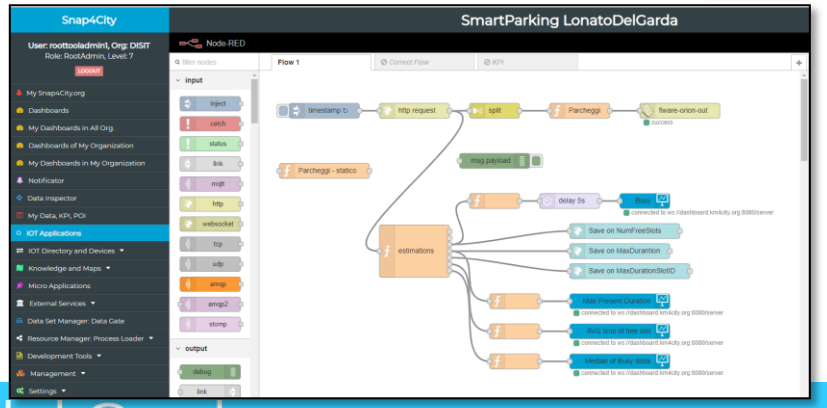
- **Multiple Domain Data**
  - Smart Parking, Environment, Wi-Fi
- **Multiple Decision Makers**
  - City Officer, operators
  - Data monitoring, alerting
  - analytics
- **Historical and Real Time data**
  - Dashboards
- **Services Exploited on:**
  - Dashboards, API
- **Since 2019**

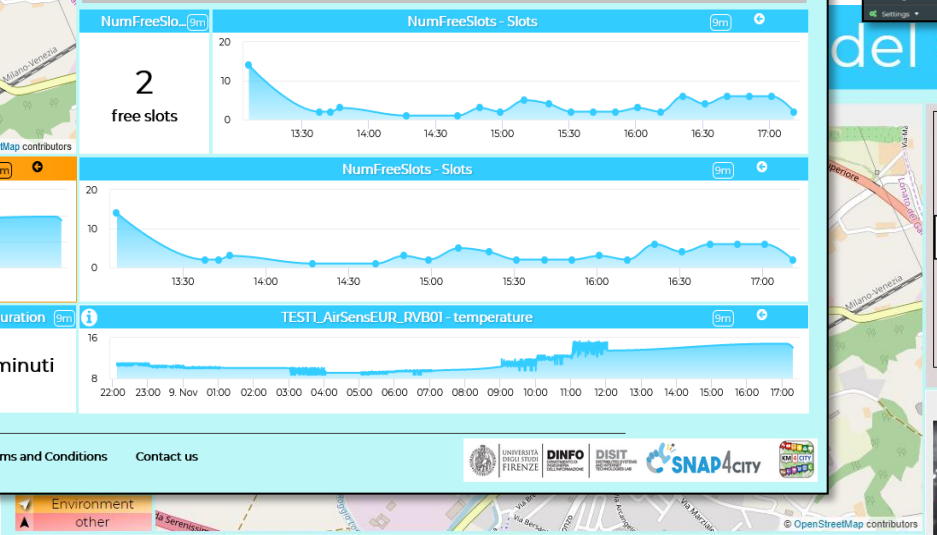




Smart Parking Monitoring





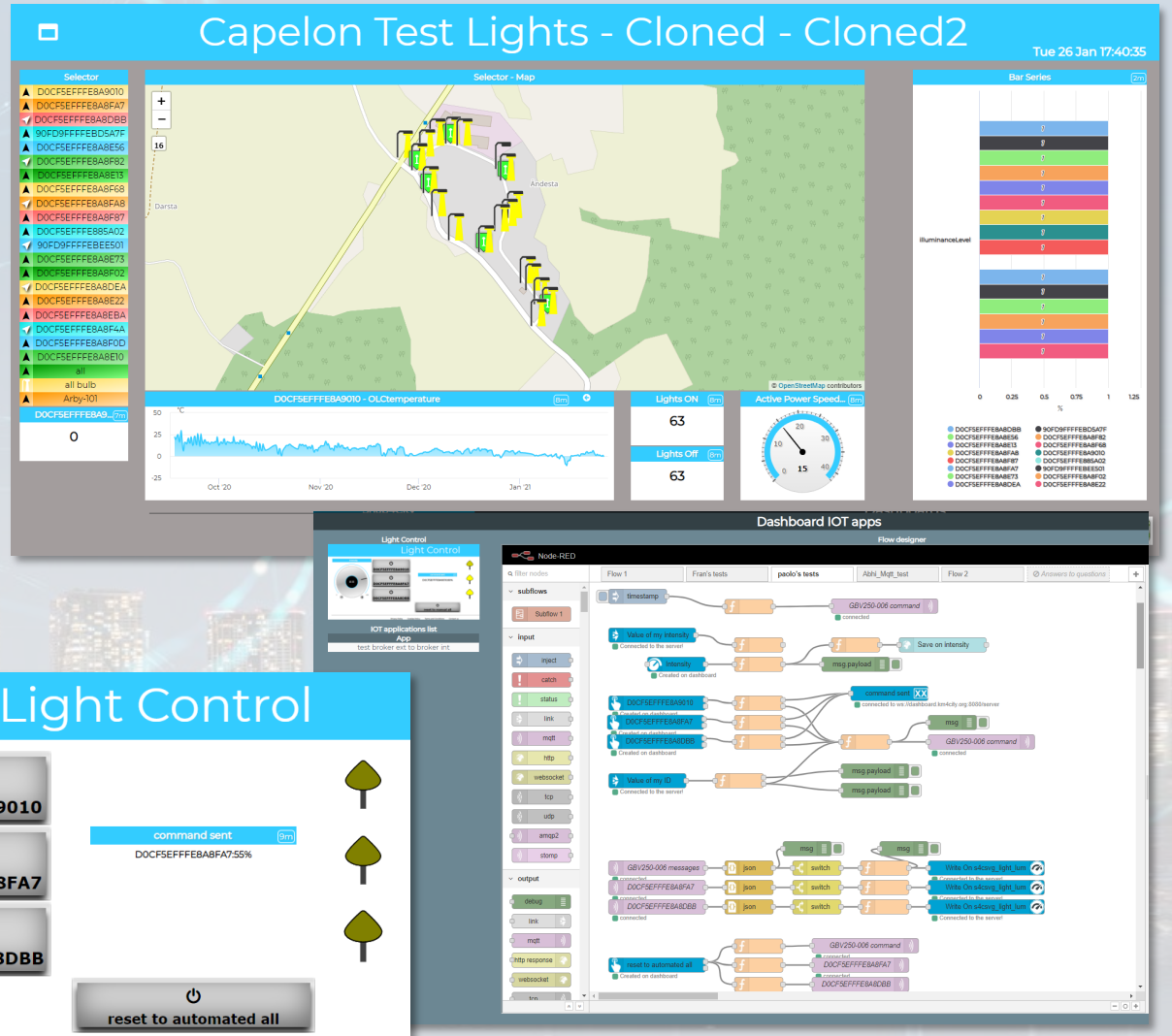


Västerås

Smart Light Control of CAPELON

reference

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

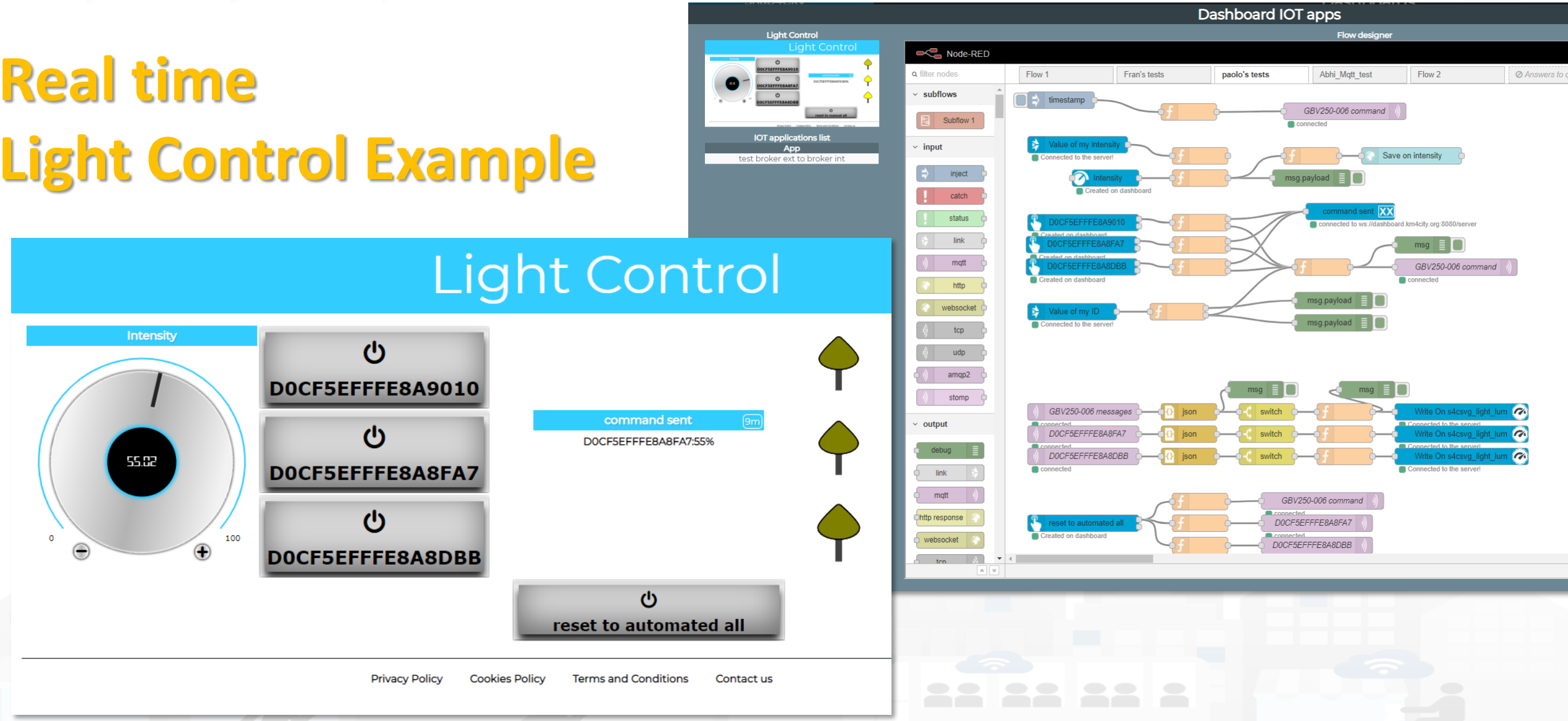


Capelon Case

Capelon Test Lights - Cloned - Cloned2

Tue 26 Jan 17:40:35

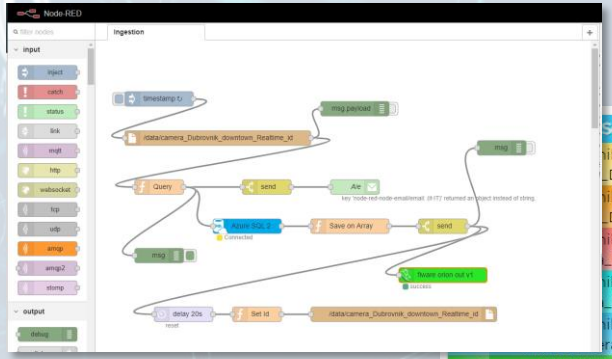
Real time
Light Control Example

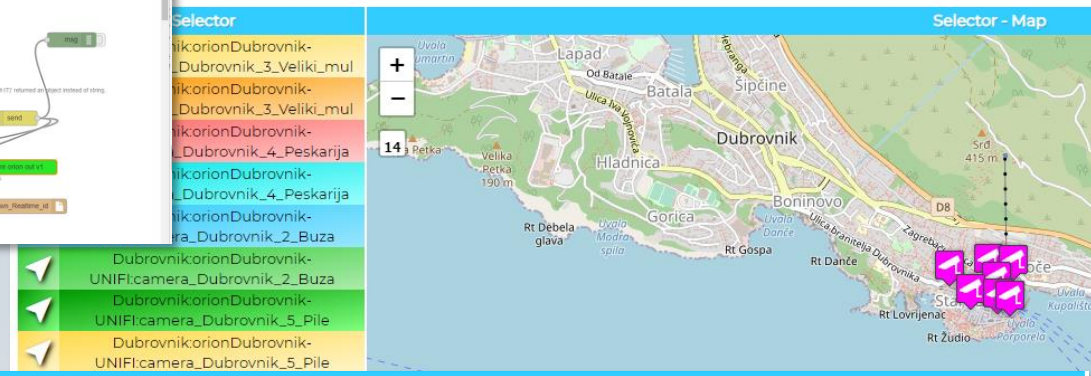


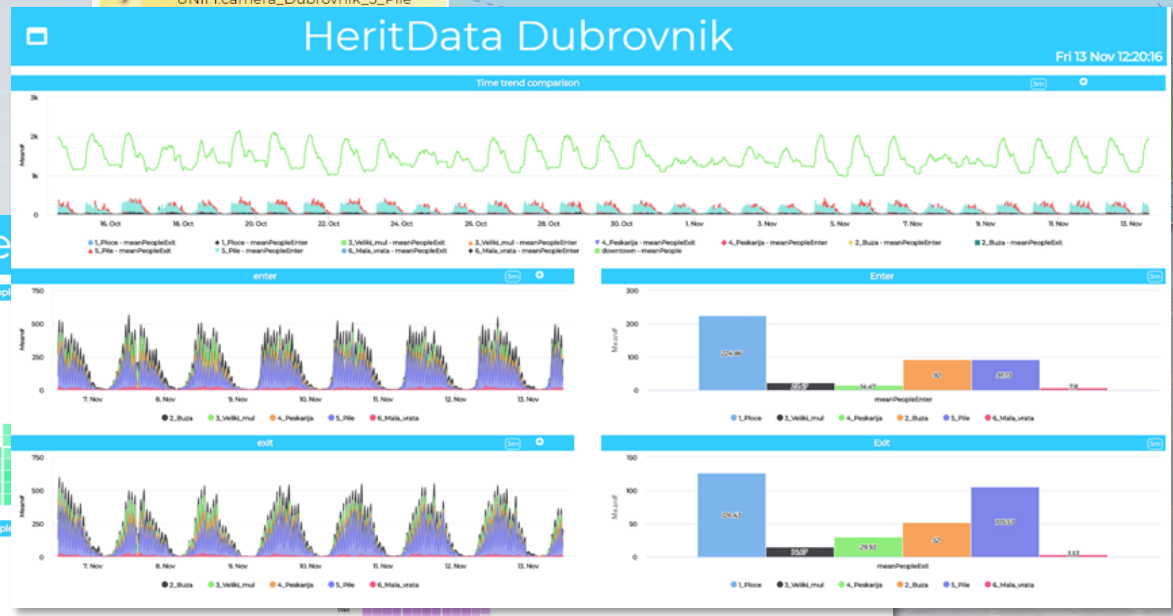
Dubrovnik, Croatia

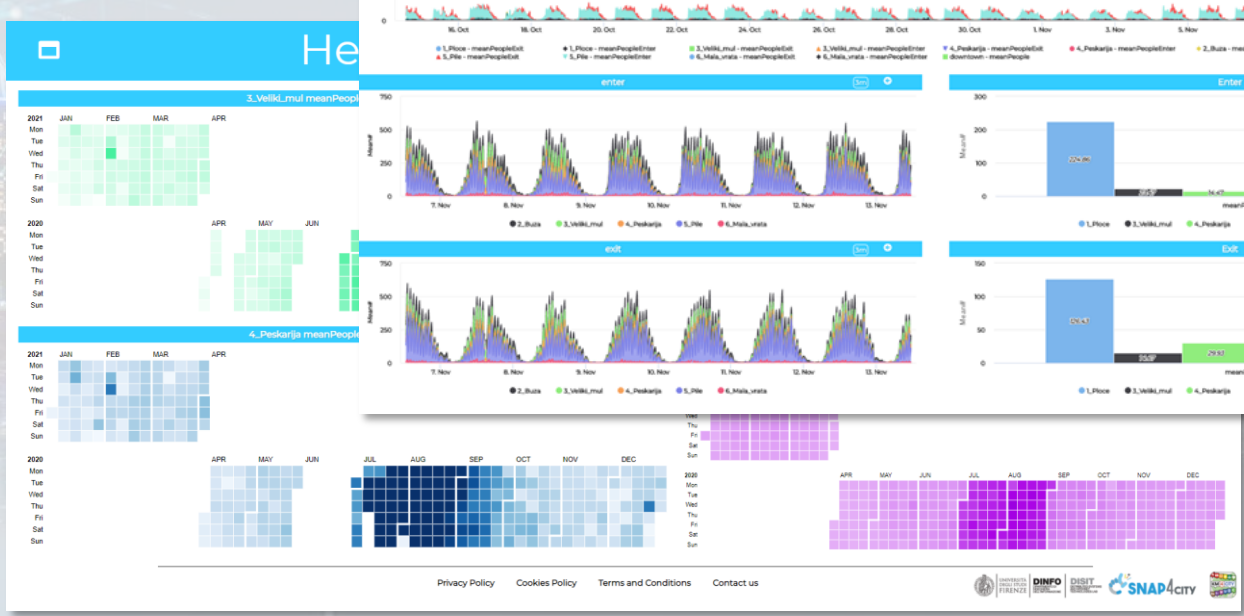
Dubrovnik

- **Tourism Domain**
  - Counting People
  - TV Cameras and WiFi
  - Social Media
- **Dashboards**
  - Monitoring and real time control
  - People flow
  - Twitter Vigilance
- **Historical and Real Time data**
- **Services Exploited on:**
  - Dashboard
- **Since 2020**





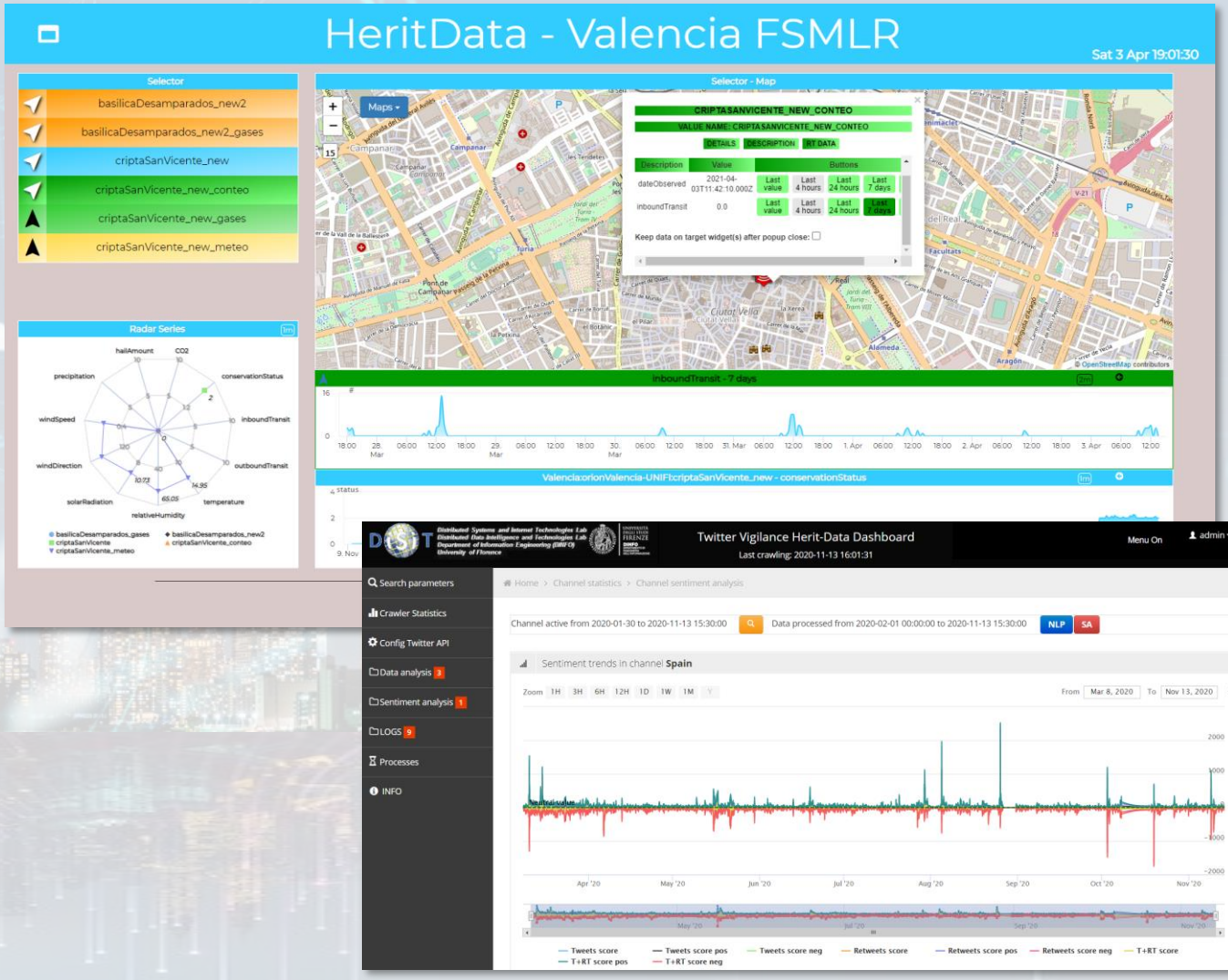





Interreg
Mediterranean
HERIT-DATA
Valencia, Spain

Valencia, FSMLR

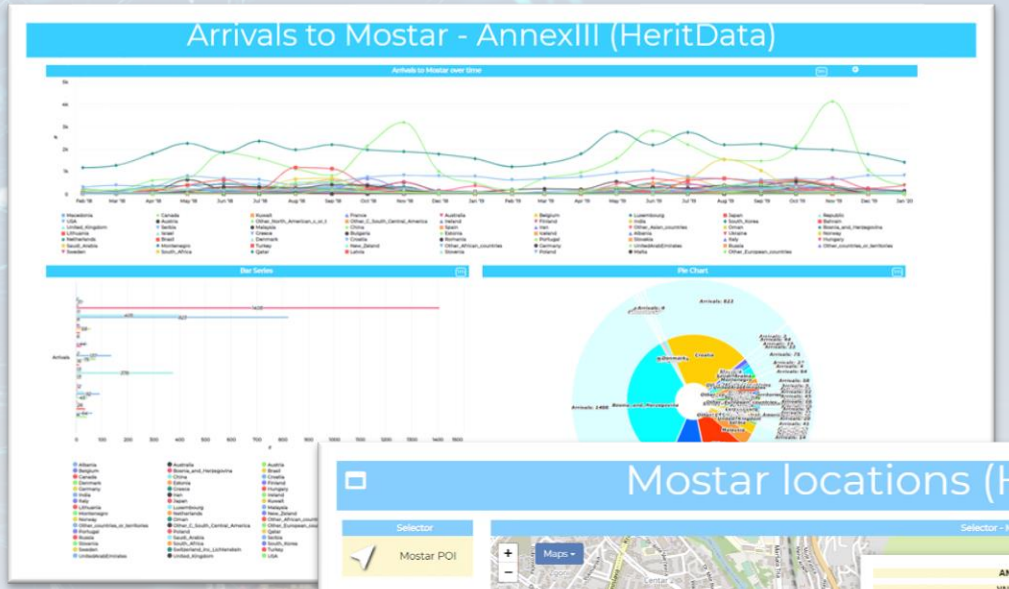
- **Tourism Domain**
  - Counting People
  - Environmental data
  - Social Media
- **Dashboards**
  - Monitoring and real time control
  - People flow
  - Twitter Vigilance
- **Historical and Real Time data**
- **Services Exploited on:**
  - Dashboard
- **Since 2020**

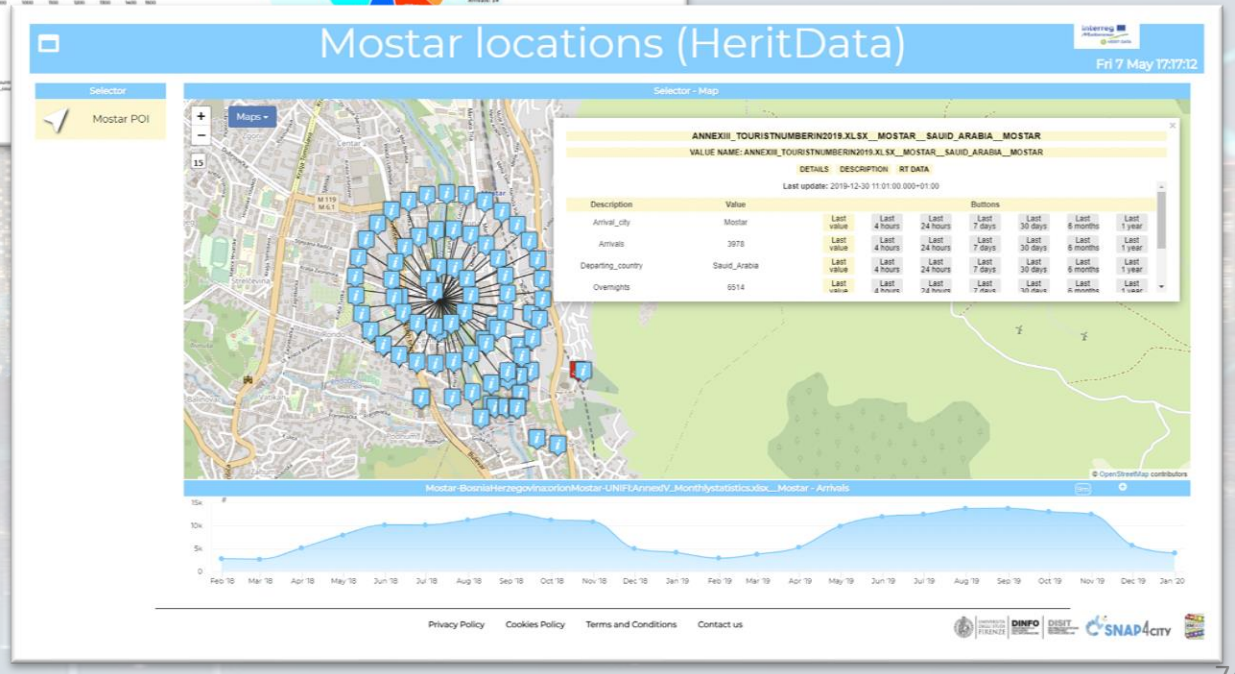


Mostar, Bosnia-Herzegovina

Mostar

- **Tourism Domain**
  - KPIs
  - People flows
  - POI
- **Dashboards**
  - Monitoring KPI
  - POI, flows
- **Historical and updated data**
- **Services Exploited on:**
  - Dashboard
- **Since 2020**

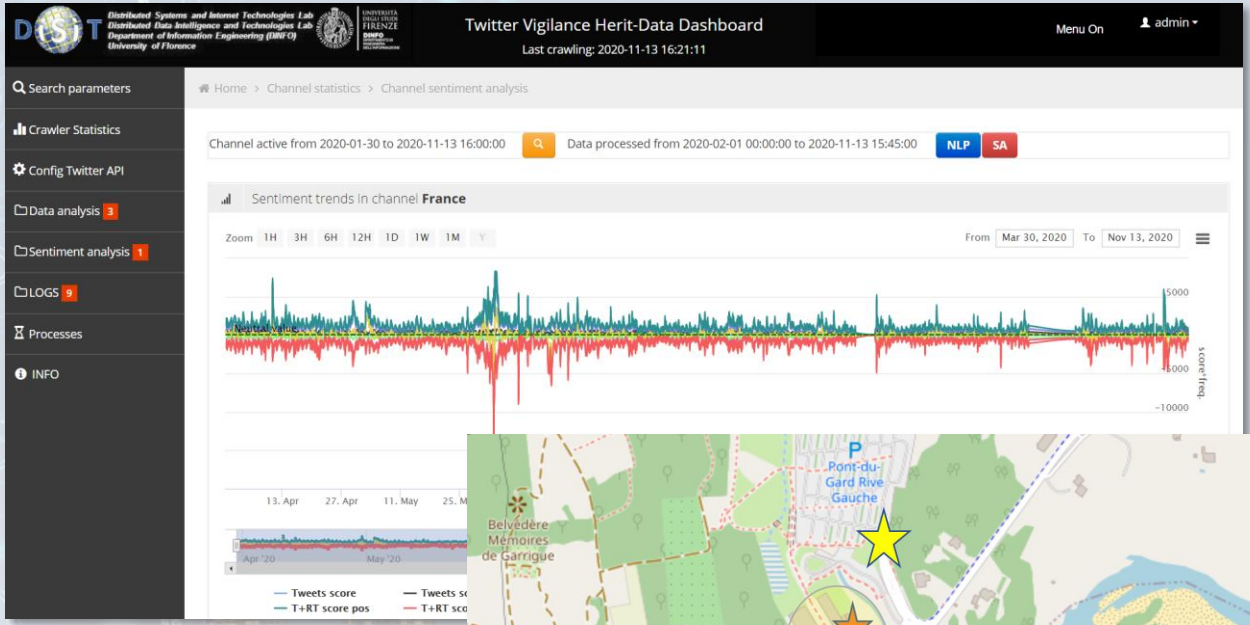


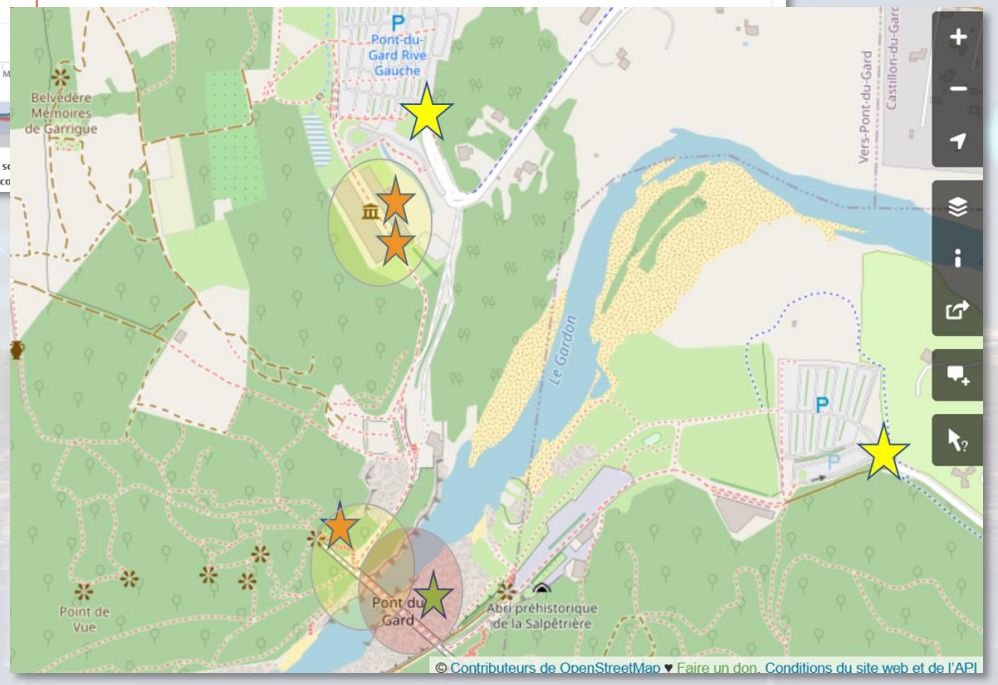



Interreg
Mediterranean
HERIT-DATA
Pont du Gard, Fr

Pont du Gard

- **Tourism Domain**
  - KPIs
  - Social Media
- **Dashboards**
  - Monitoring KPI
  - Twitter Vigilance
- **Historical and updated data**
- **Services Exploited on:**
  - Dashboard
- **Since 2020**

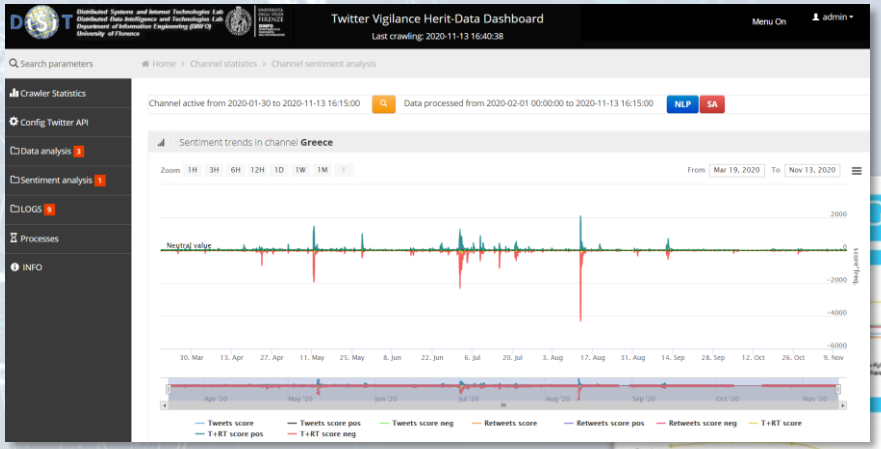


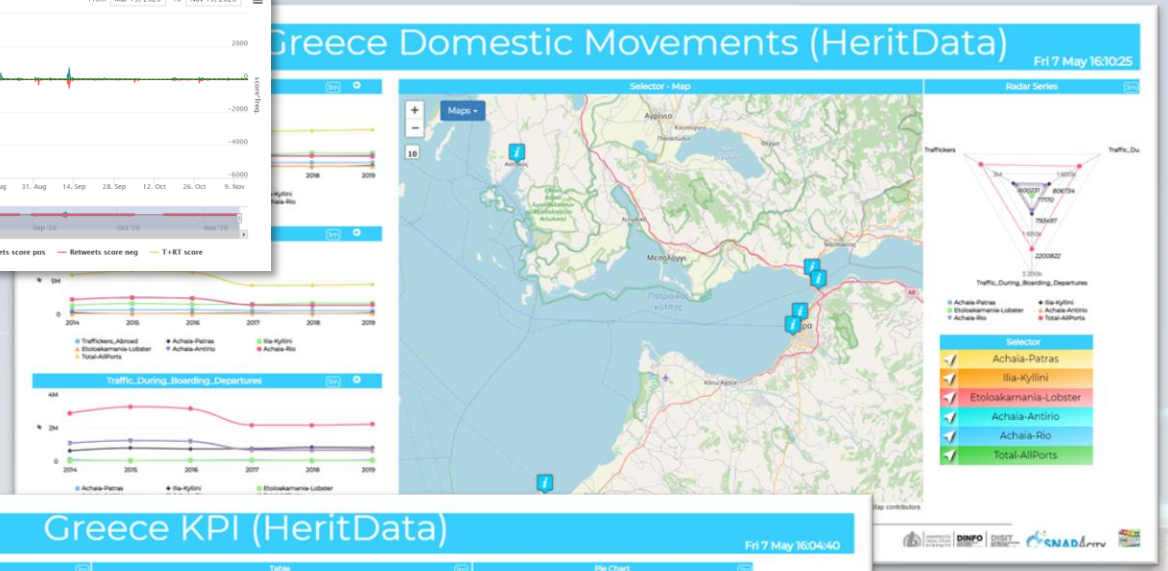


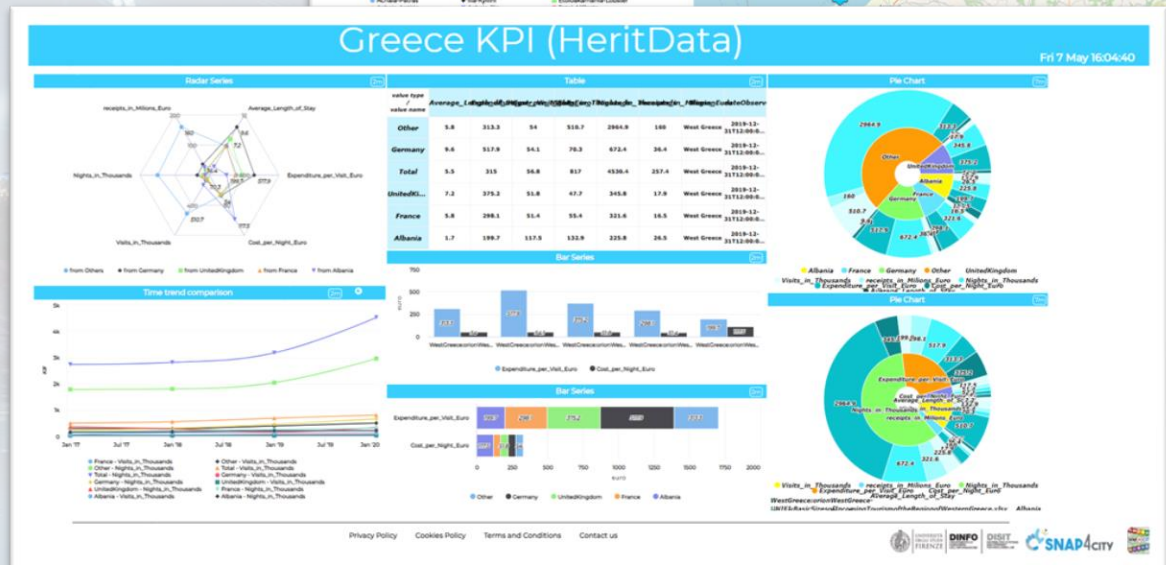

Interreg
Mediterranean
HERIT-DATA
West Greece

West Greece

- **Tourism Domain**
  - KPIs
  - Social Media
  - People Flows
  - Social Media
- **Dashboards**
  - Monitoring KPI
  - People flows
  - Twitter Vigilance
- **Historical and updated data**
- **Services Exploited on:**
  - Dashboard
- **Since 2020**







Santiago di Compostela

Traffic Flow Reconstruction for the cities

Sun 3 Nov 20:37:43

Santiago di Compostela

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

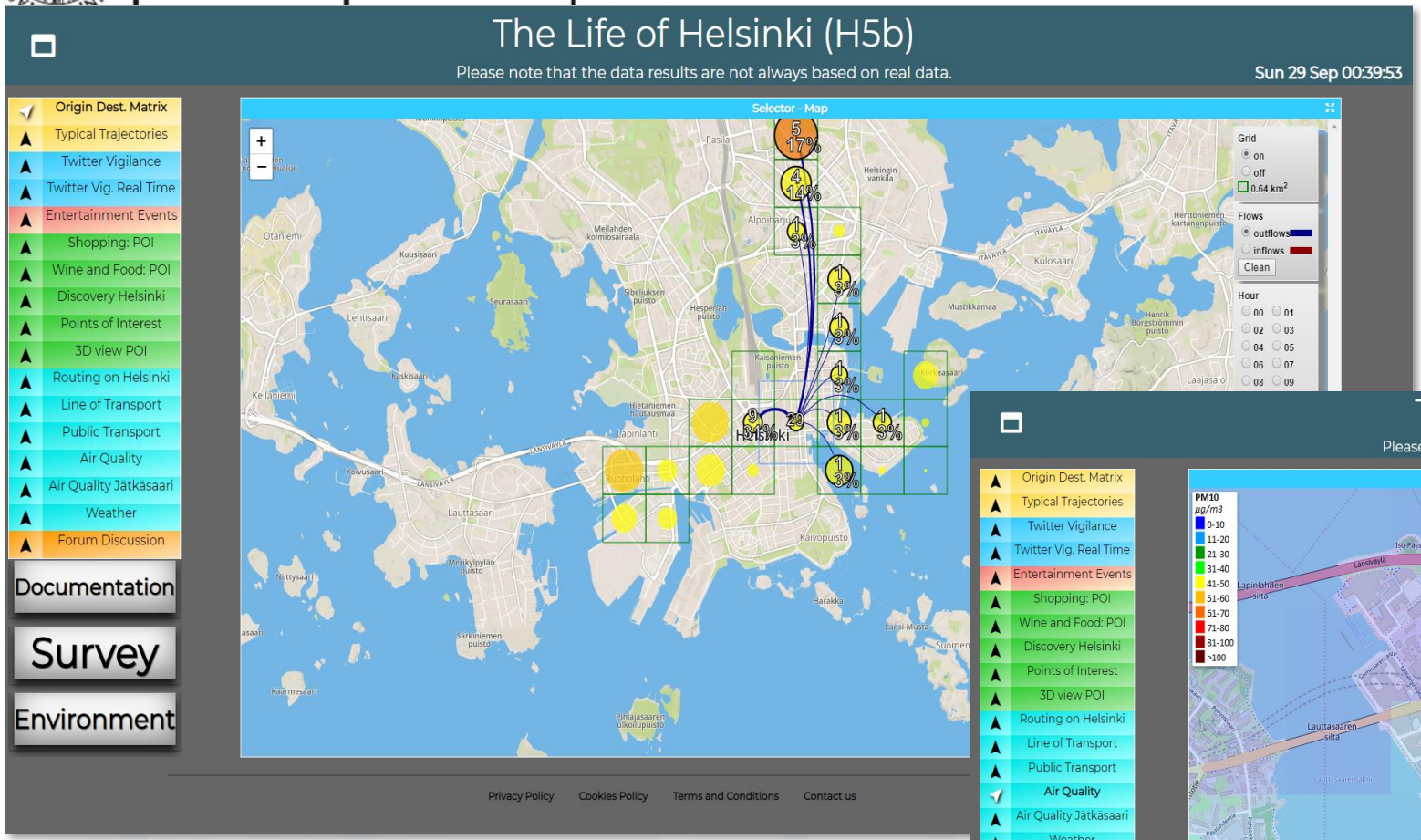
Helsinki

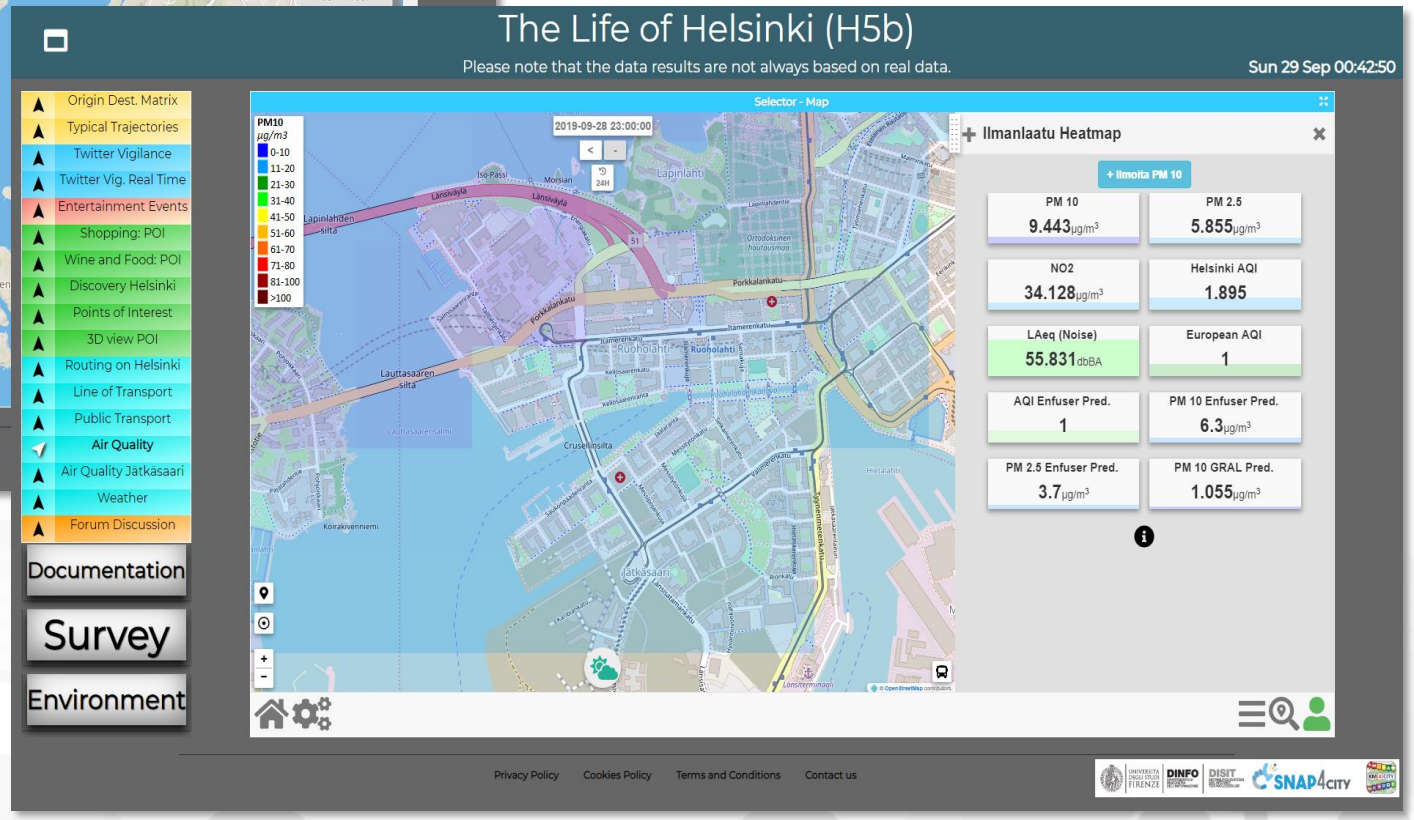
Helsinki Case

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

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

Helsinki





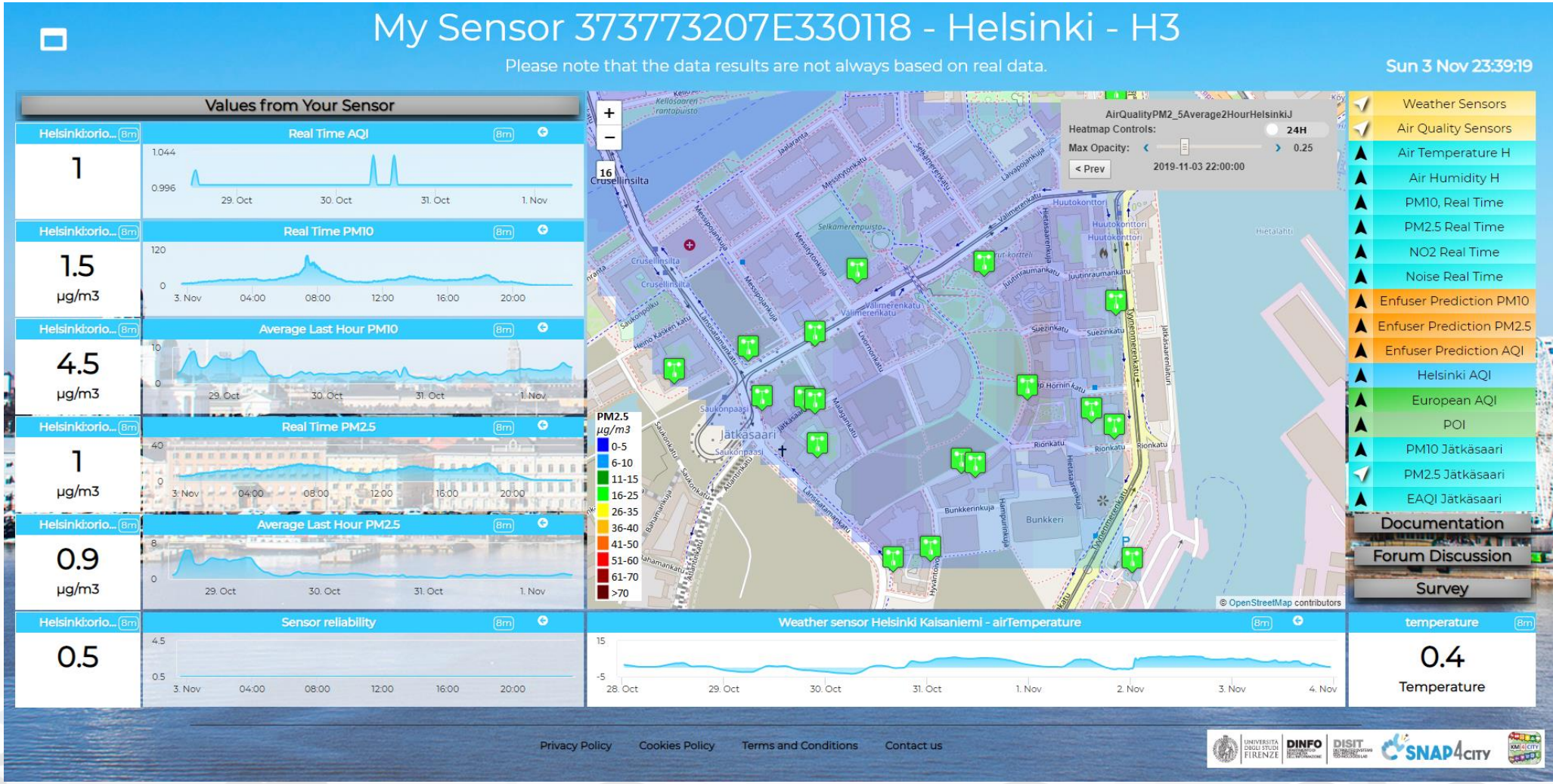
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc1Mg==

Environmental Data Predictions: GRAL

- **GRAL predictions: PM10, NOX, ….**
  - **Comparison wrt real time values in actual value of Sensors**
  - Graz Lagrangian Model.
- GRAL model takes into account:
  - pollution sources (for example the vehicles, their distribution on the streets, the about of pollution they produce according to their distribution over time and space, etc.),
  - structure of the city (streets and shape 3D of the buildings),
  - weather forecast (wind intensity and direction), etc.
- GRAL can be applied on NOX, PM10, PM2.5, … or any other particles

TRAFAIR

Environmental Devices hosted by Citizens

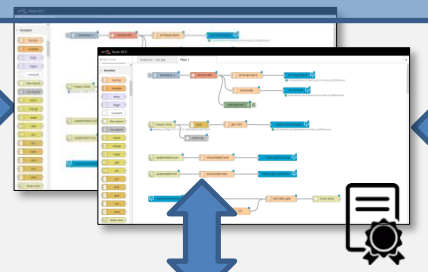


Prato
Smart City vs Industry 4.0

GIDA set up

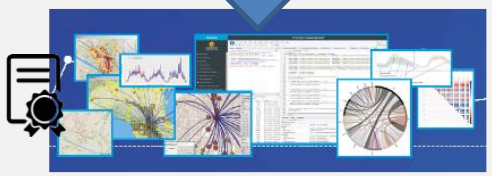
Smart City data from many sources

IOT Applications

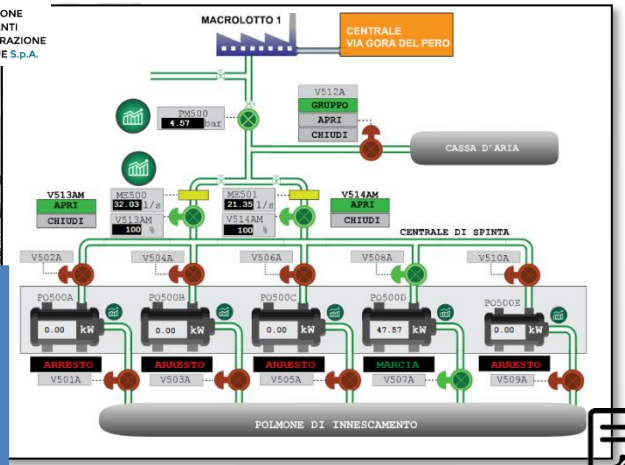


Dashboards and Apps

IOT Data Shadow Snap4City



Big Data Analytics, Artificial Intelligence



Modbus

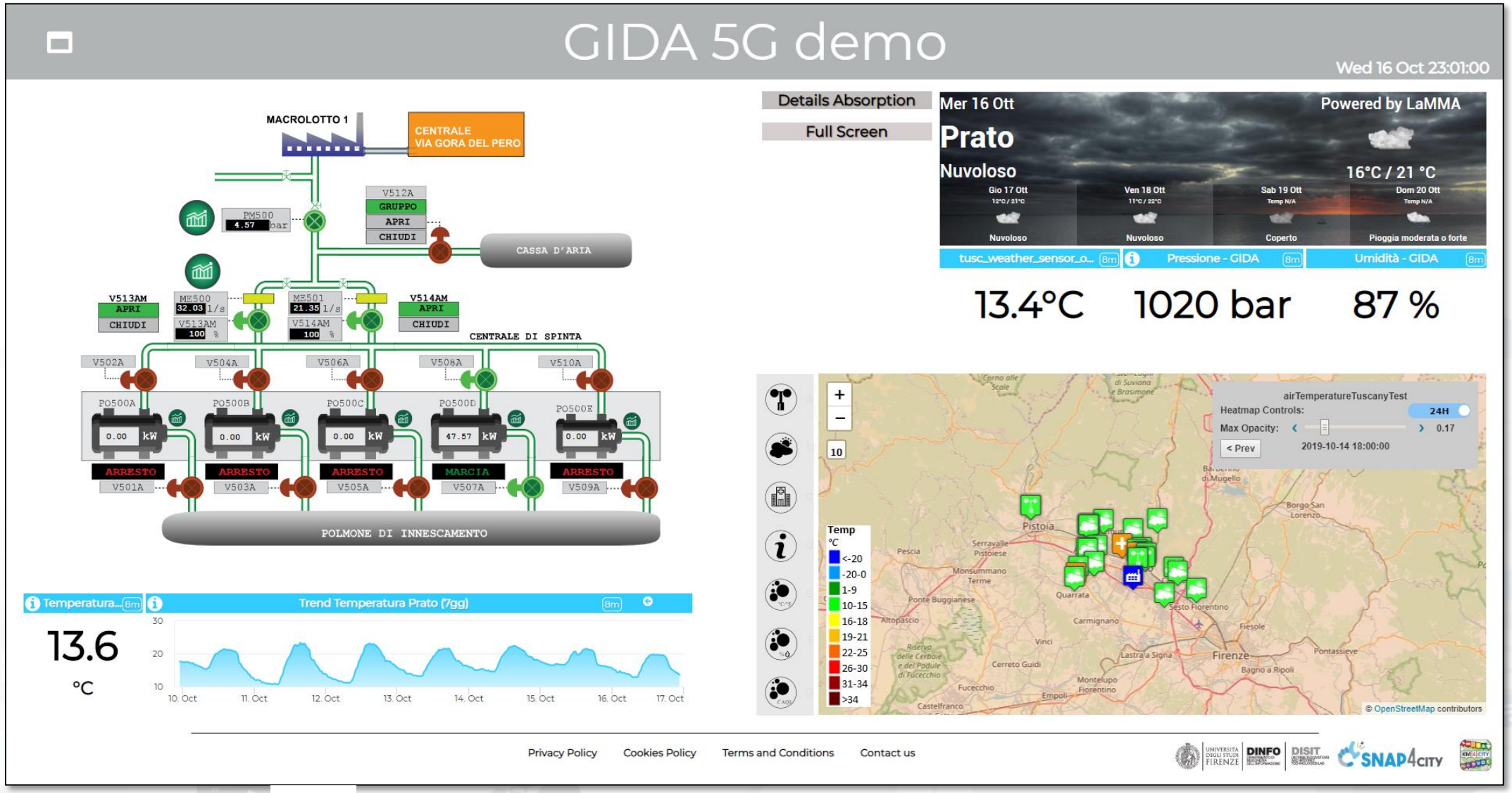
ModBus to Snap4City Gateway Edge

5G network devices

ZTE

Telemonitoring Telecontrol

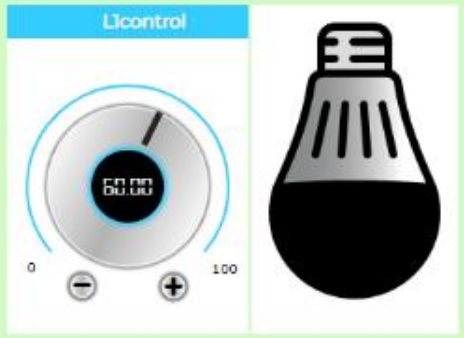
Dashboards & Services:

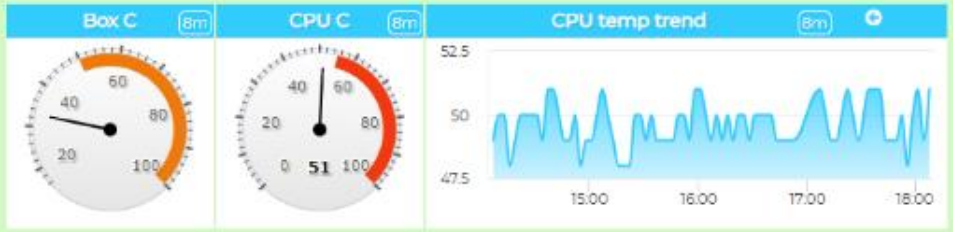


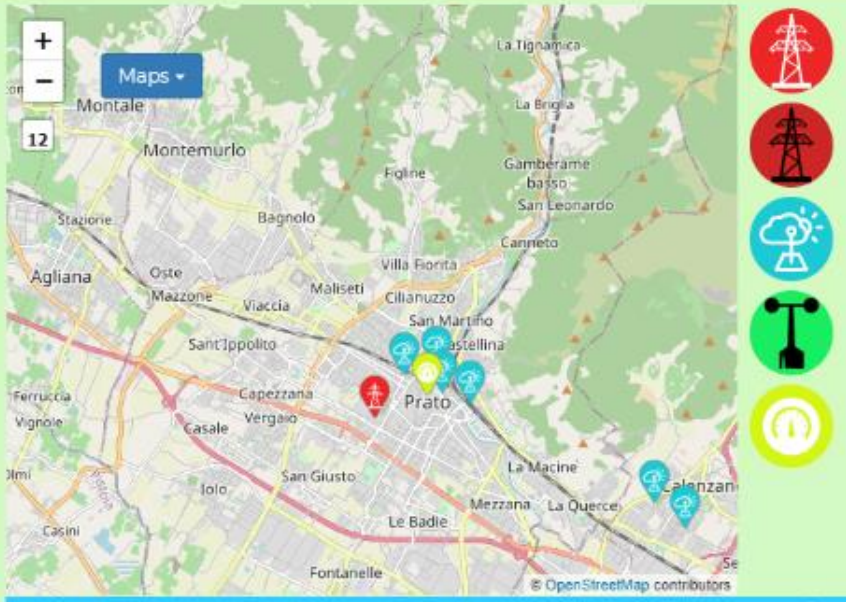
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjIyNg==

Snap4Home 5G Demo

Thu 11 Jun 18:07:32

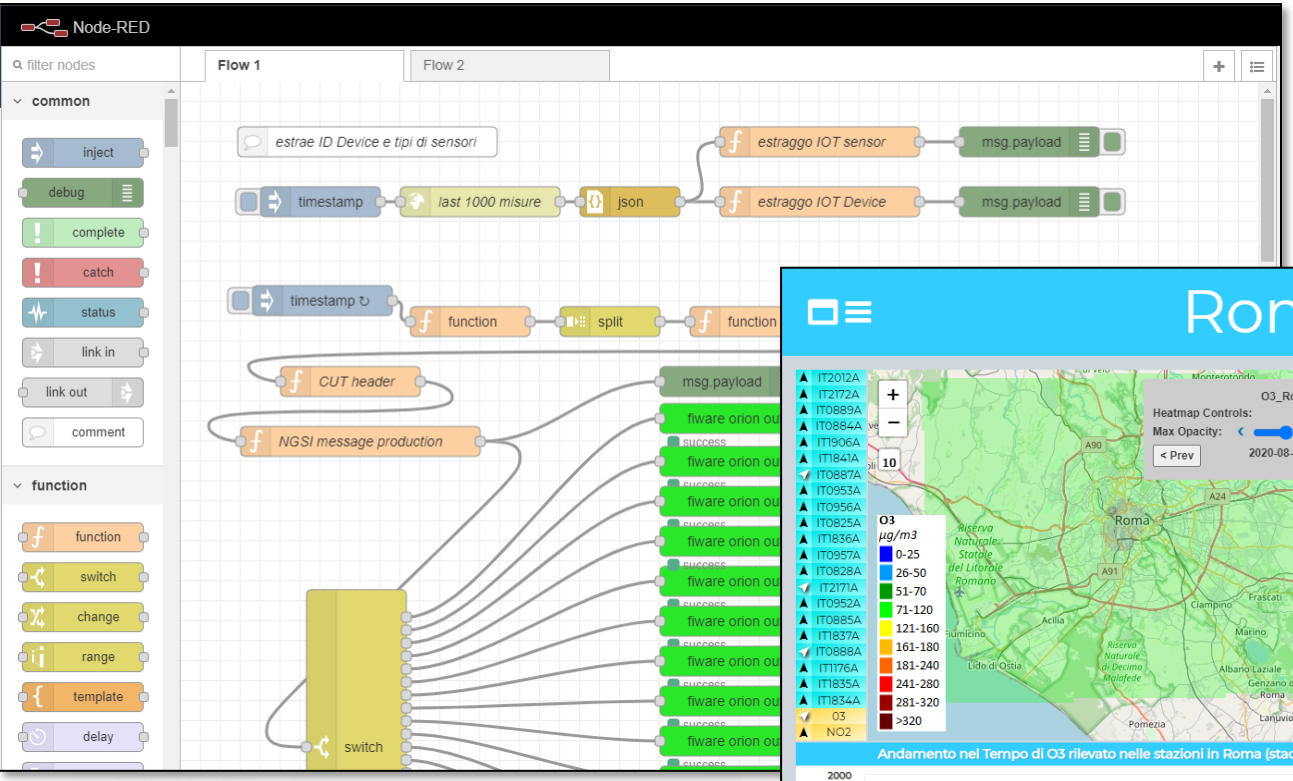


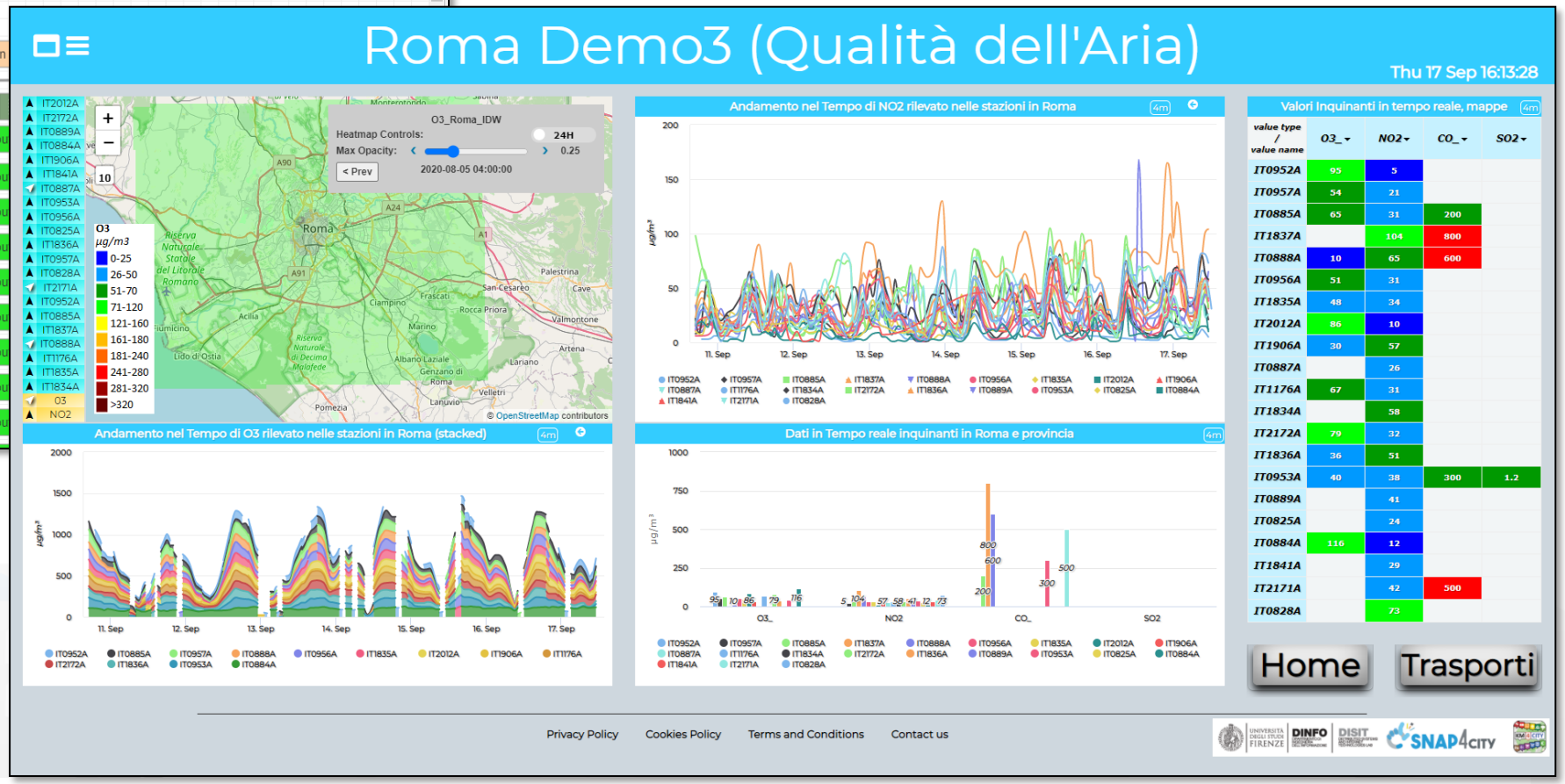




open fiber WIND 3 ZTE estra

Roma (I)

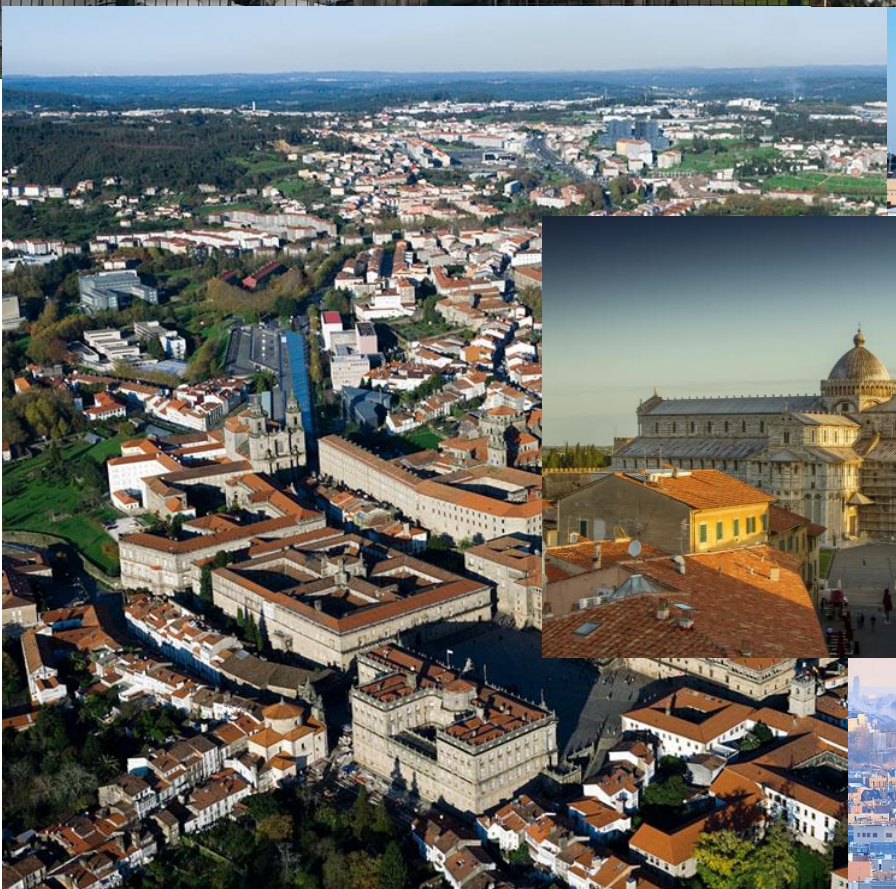




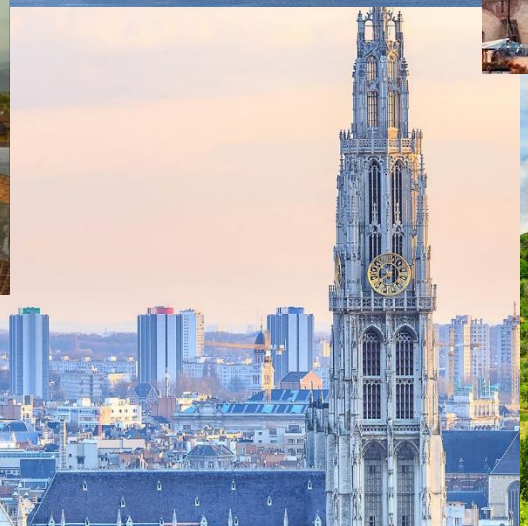
Roma (I)

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







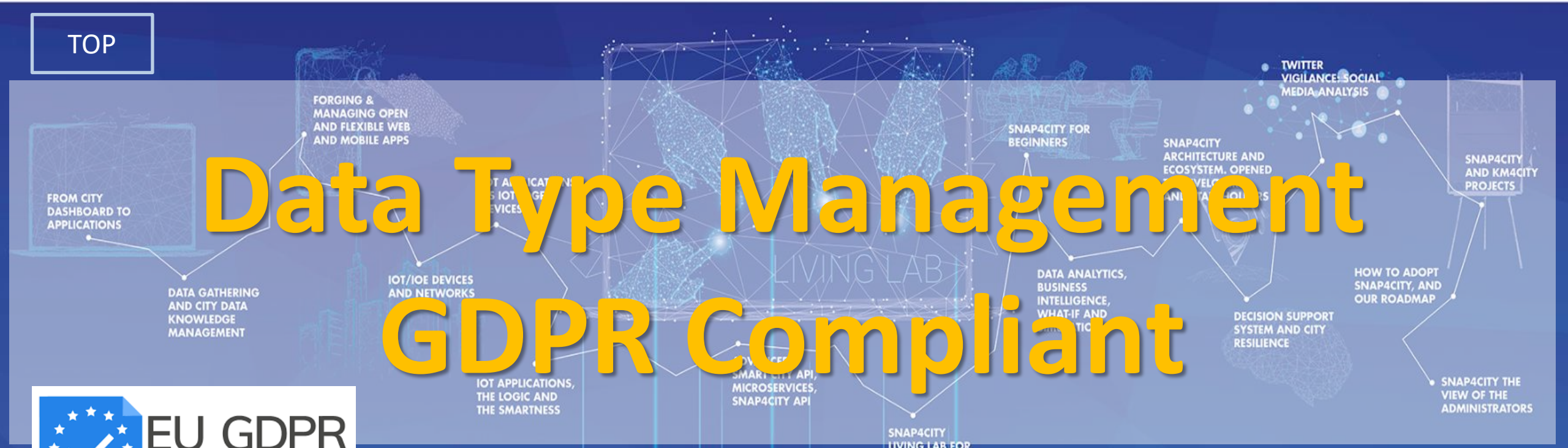
https://www.snap4city.org/4

- 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

- 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

TOP

Data Type Management GDPR Compliant



EU GDPR COMPLIANT

GDPR: General Data Protection Regulation

Users may decide to:

- provide access to who, for do what, until when consented
- accept terms of use by **signed** consent **for** data management **service**

- Correctness
- Transparency
- Security
- Integrity
- Privacy
- Auditing
- …

From each service, the user is capable to:

- **See** what we collect in terms of Data Type: traces, logs, paths, profiles, accesses, IOT devices, sensors, maps, etc.
- **Download**, **delete**, **inspect** Data
- **Auditing** and **Revoke access** or **grant** access right to each **single Data**
- **Delete all Data in single shot** or singularly (**forget all about me**)

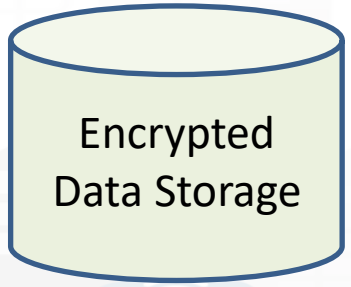
GDPR: General Data Protection Regulation

If personal data are **published by the owner:**

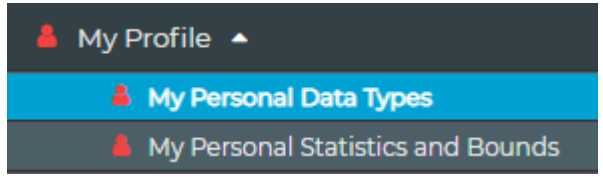
- the data are **released anonymously**,
  → also in this case they can be **revoked at any time**:

Snap4City is also compliant to GDPR **Technical Constraints** as it:

- **Performs Secure connections** in any private data exchange
- **Encrypts** data store for all private data
- **Decouples** data and personal IDs
- **Audits** private data usage



GDPR Compliant



My Personal Data Types

View | Edit | Track | Access control | Convert

This page allows you to access at your Data Types, which are your personal data that we c
most cases, a specific tool and view is provided to manage them.

- My profile data and Blogs
  - to manage your user profile data (name, email,): view, edit, delete
- My Personal Statistics and Bounds: daily or Monthly
  - to access at your statistics about the data access and volume of resources use
    that may depend on the Organization at which one belong and on the role in
- My Personal Data, My KPI and My POI
  - to manage your personal MyKPI, MyPOI and trajectories, if any: view, edit, dele
- My Personal Engagement
  - to manage your personal engagements recevied on the Mobile Apps, auditing
- My IOT Devices
  - to manage your IOT Devices in which it is possible to: edit, delete, make public
- My IOT Applications
  - to manage your IOT Applications in which it is possible to: delete, restart, char
- My Dashboards
  - to manage your Dashboards in which it is possible to: edit, delete, change owr
- My IOT sensor data service URI (for programmers)
  - to manage the Delegations to access at the ServiceURI of the knowledge base
- My IOT sensor data service GraphID (for programmers)
  - to manage the Delegations to access at the a Graph (data set) of the knowled
- My personal data by IOT App (partially deprecated)
  - to manage your MyPersonal Data, if any: view, edit, delete, delegation in acces
- My Annotation data
  - to manage the Delegation to access at the Annotations: delegation in access,
- Auditing Access to My Data
  - to audit the accesses to MyData

Manage Profile and MyPersonalData

For each Data Type:

- Start as private → making them public (anonymous) and revoke
- The Owner is the only one that can: (1) modify values; (2) change the ownership
- Define/revoke Delegation to Access
- Delete/forget per Data Type and “me all”!
- Auditing

GDPR vs Snap4City

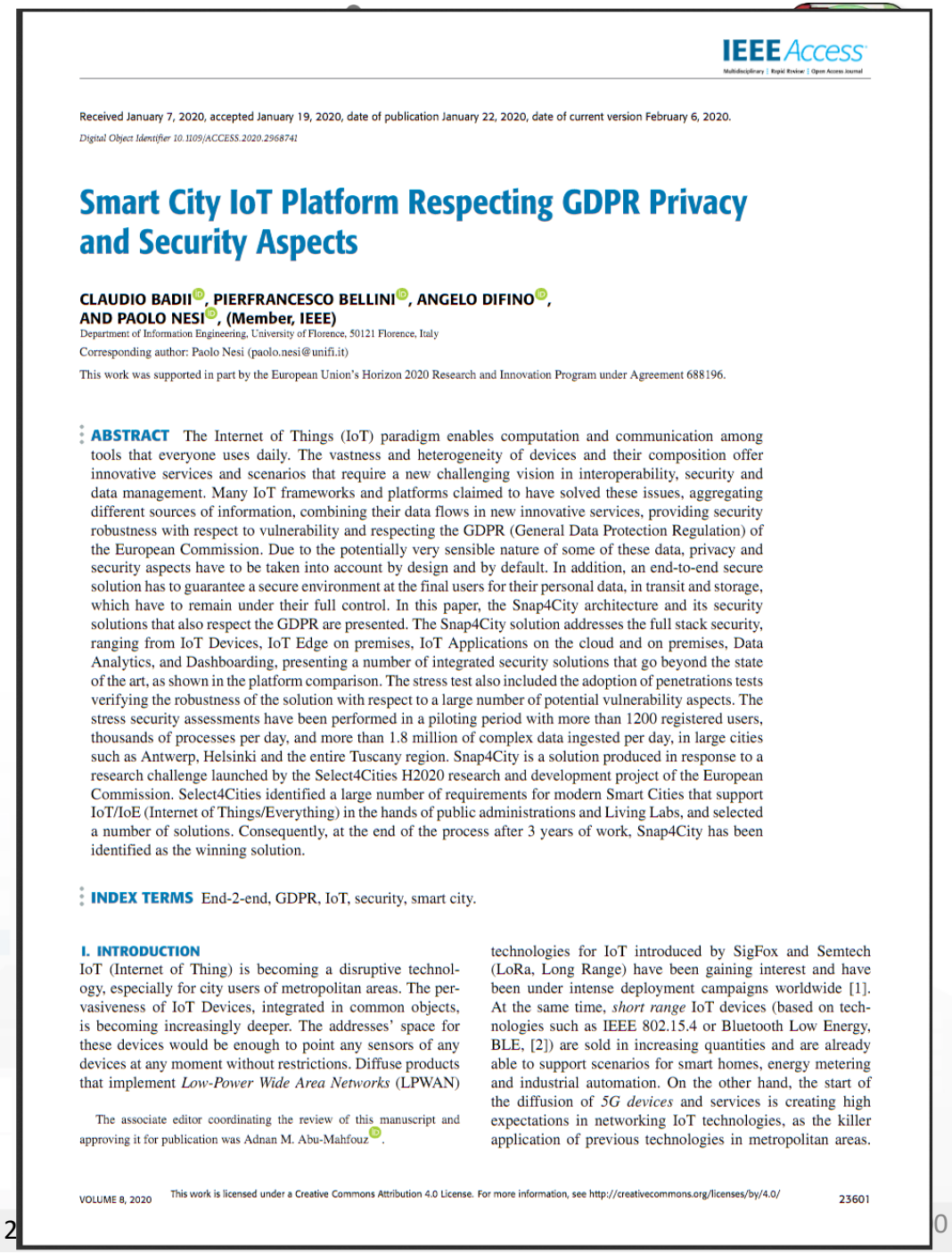
GDPR Compliance Verification Features	Verif.	Reqs.
Signed consent	UI	R8
User profile management and control	UI	R13
Data Type private as default	UI	R8
Rights to access per element	UI	R9
Rights to transfer per element	UI	R10
Rights to erase per element and total	UI	R13
Rights to revoke/change per Data Type	UI	R10
An interface for Right management for Data Type	UI	R9
Clear Terms of Use and Privacy Policy	UI	--
Auditing Tools for Data Type	UI	R14
Publish as Anonymous	UI	R9
Encrypt personal users' data	Code	R12
Secure Authentication and Authorization	Code	R3
Data protection by Design	Code	R17
Secure connection	Code	R6
Security Control, data breach control, anonymization, etc.	PEN Test	R15, R16, R18

Details on the paper cited in the following slide

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

IEEE Access

- C. Badii, P. Bellini, A. Difino, P. Nesi, "Smart City IoT Platform Respecting GDPR Privacy and Security Aspects", accepted for publication on IEEE Access, 2020. 10.1109/ACCESS.2020.2968741 https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8966344



IEEE Access
Multidisciplinary | Rapid Review | Open Access Journal

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Digital Object Identifier 10.1109/ACCESS.2020.2968741

Smart City IoT Platform Respecting GDPR Privacy and Security Aspects

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Department of Information Engineering, University of Florence, 50121 Florence, Italy
Corresponding author: Paolo Nesi (paolo.nesi@unifi.it)

This work was supported in part by the European Union's Horizon 2020 Research and Innovation Program under Agreement 688196.

ABSTRACT The Internet of Things (IoT) paradigm enables computation and communication among tools that everyone uses daily. The vastness and heterogeneity of devices and their composition offer innovative services and scenarios that require a new challenging vision in interoperability, security and data management. Many IoT frameworks and platforms claimed to have solved these issues, aggregating different sources of information, combining their data flows in new innovative services, providing security robustness with respect to vulnerability and respecting the GDPR (General Data Protection Regulation) of the European Commission. Due to the potentially very sensible nature of some of these data, privacy and security aspects have to be taken into account by design and by default. In addition, an end-to-end secure solution has to guarantee a secure environment at the final users for their personal data, in transit and storage, which have to remain under their full control. In this paper, the Snap4City architecture and its security solutions that also respect the GDPR are presented. The Snap4City solution addresses the full stack security, ranging from IoT Devices, IoT Edge on premises, IoT Applications on the cloud and on premises, Data Analytics, and Dashboarding, presenting a number of integrated security solutions that go beyond the state of the art, as shown in the platform comparison. The stress test also included the adoption of penetrations tests verifying the robustness of the solution with respect to a large number of potential vulnerability aspects. The stress security assessments have been performed in a piloting period with more than 1200 registered users, thousands of processes per day, and more than 1.8 million of complex data ingested per day, in large cities such as Antwerp, Helsinki and the entire Tuscany region. Snap4City is a solution produced in response to a research challenge launched by the Select4Cities H2020 research and development project of the European Commission. Select4Cities identified a large number of requirements for modern Smart Cities that support IoT/IoE (Internet of Things/Everything) in the hands of public administrations and Living Labs, and selected a number of solutions. Consequently, at the end of the process after 3 years of work, Snap4City has been identified as the winning solution.

INDEX TERMS End-2-end, GDPR, IoT, security, smart city.

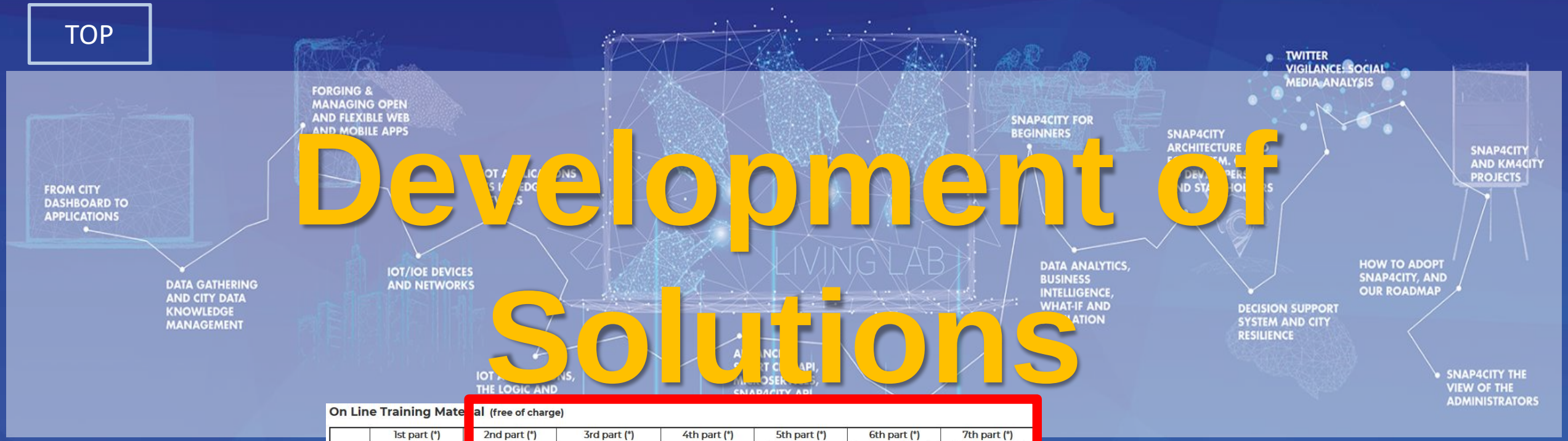
I. INTRODUCTION

IoT (Internet of Thing) is becoming a disruptive technology, especially for city users of metropolitan areas. The pervasiveness of IoT Devices, integrated in common objects, is becoming increasingly deeper. The addresses' space for these devices would be enough to point any sensors of any devices at any moment without restrictions. Diffuse products that implement *Low-Power Wide Area Networks* (LPWAN) technologies for IoT introduced by SigFox and Semtech (LoRa, Long Range) have been gaining interest and have been under intense deployment campaigns worldwide [1]. At the same time, *short range* IoT devices (based on technologies such as IEEE 802.15.4 or Bluetooth Low Energy, BLE, [2]) are sold in increasing quantities and are already able to support scenarios for smart homes, energy metering and industrial automation. On the other hand, the start of the diffusion of *5G devices* and services is creating high expectations in networking IoT technologies, as the killer application of previous technologies in metropolitan areas.

The associate editor coordinating the review of this manuscript and approving it for publication was Adnan M. Abu-Mahfouz.

TOP

Development of Solutions



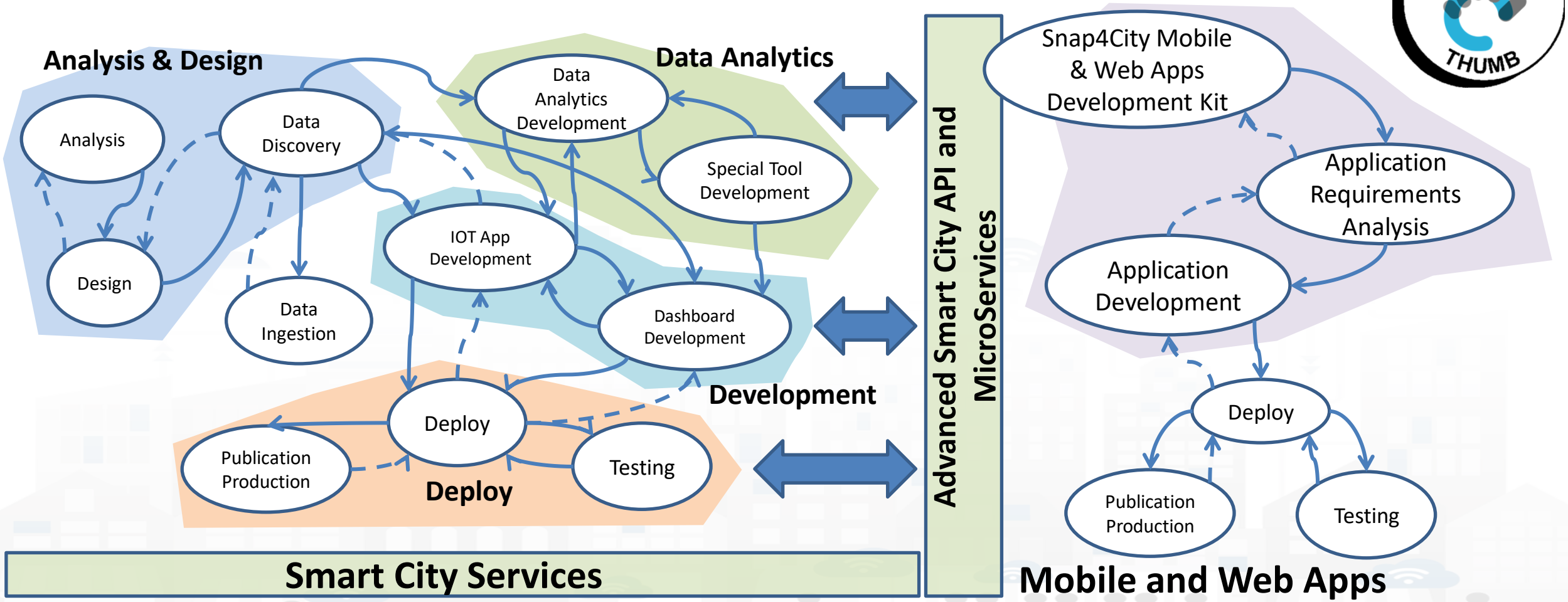
On Line Training Material (free of charge)

	1st part (*)	2nd part (*)	3rd part (*)	4th part (*)	5th part (*)	6th part (*)	7th part (*)
what	General	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App
PDF							
Inter active							
Video1							
Video2							
Video3							
Video4				none		none	none
duration	2:55	3:16	3:41	2:00	2:48	2:35	1:47

100% OPEN SOURCE

SNAP4 Appliances and Dockers **Installations**

Develop Mobile & Web Applications Exploiting Snap4City Smart City Services



https://www.snap4city.org/577

On Line Training Material (free of charge)

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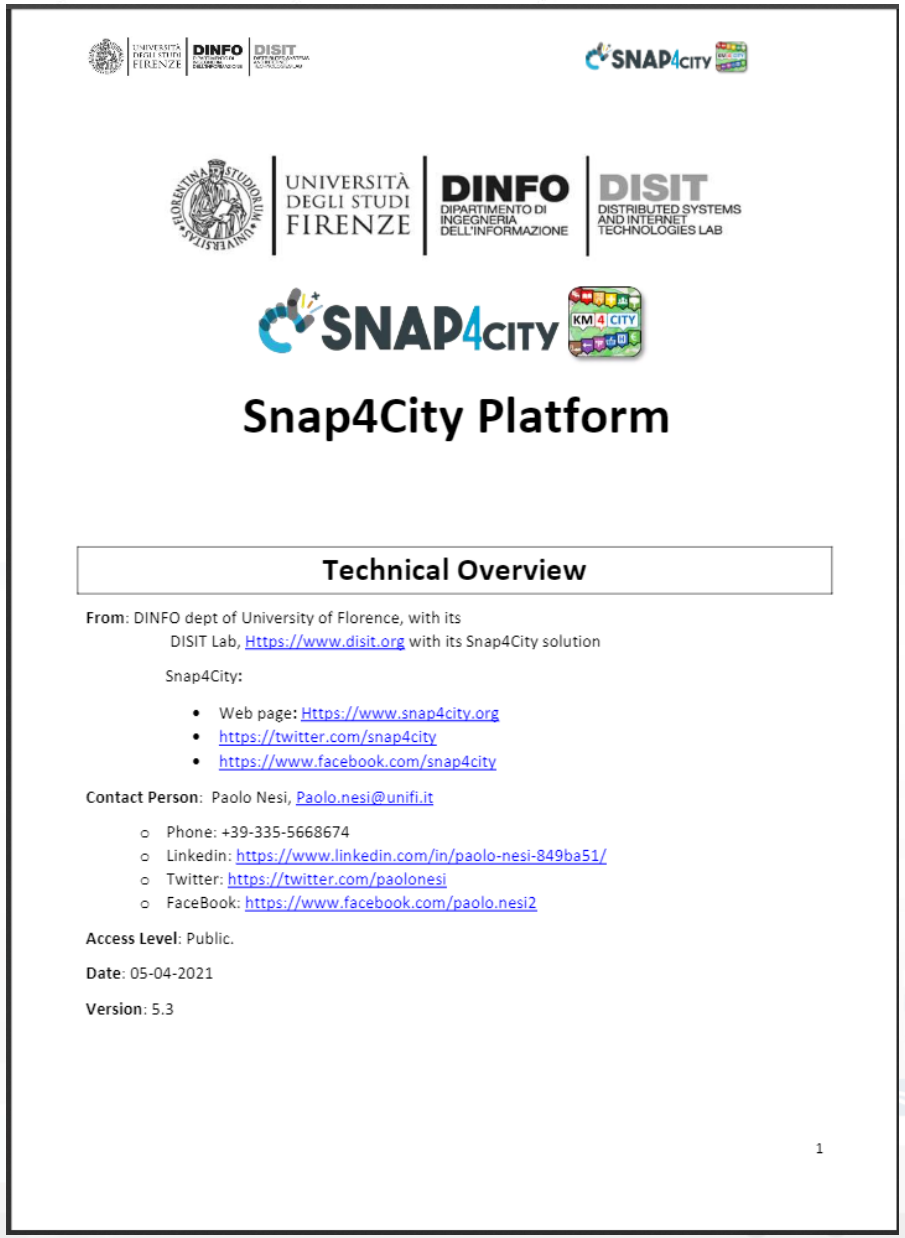
what	General	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App
PDF							
Inter active							
Video1							
Video2							
Video3							
Video4				none		none	none
duration	2:55	3:16	3:41	2:00	2:48	2:35	1:47

Overview



Snap4City Platform

Technical Overview

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

Snap4City:

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

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

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

Access Level: Public.

Date: 05-04-2021

Version: 5.3

1

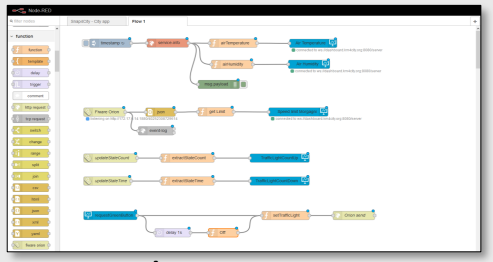
- April 2021
- https://www.snap4city.org/drupal/sites/default/files/files/Snap4City-PlatformOverview-April-2021-V5-3.pdf

Dashboard and tools Development

On Line Training Material (free of charge)

	1st part (*)	2nd part (*)	3rd part (*)	4th part (*)	5th part (*)	6th part (*)	7th part (*)
what	General	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App
PDF							
Interactive							
Video1							
Video2							
Video3							
Video4				none		none	none
duration	2:55	3:16	3:41	2:00	2:48	2:35	1:47

Dashboard Development



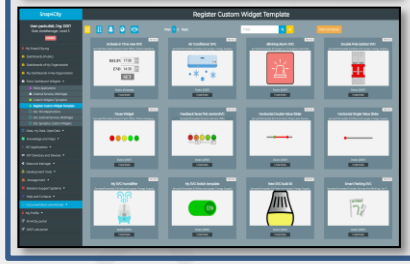
IOT Applications

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

Widget Collection

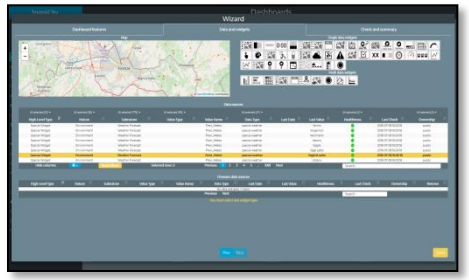
Micro Applications

External Services

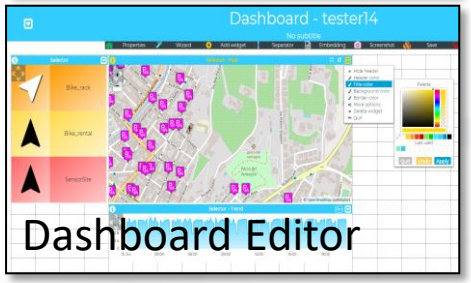


Custom Widgets/ Synoptics

Dashboard Wizard

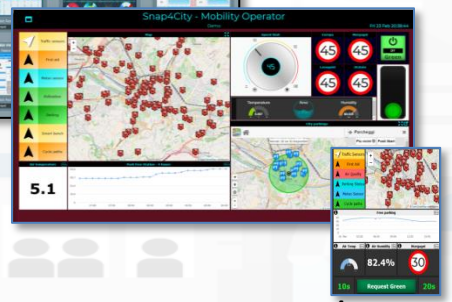


Create, save, load, delegate, grant access



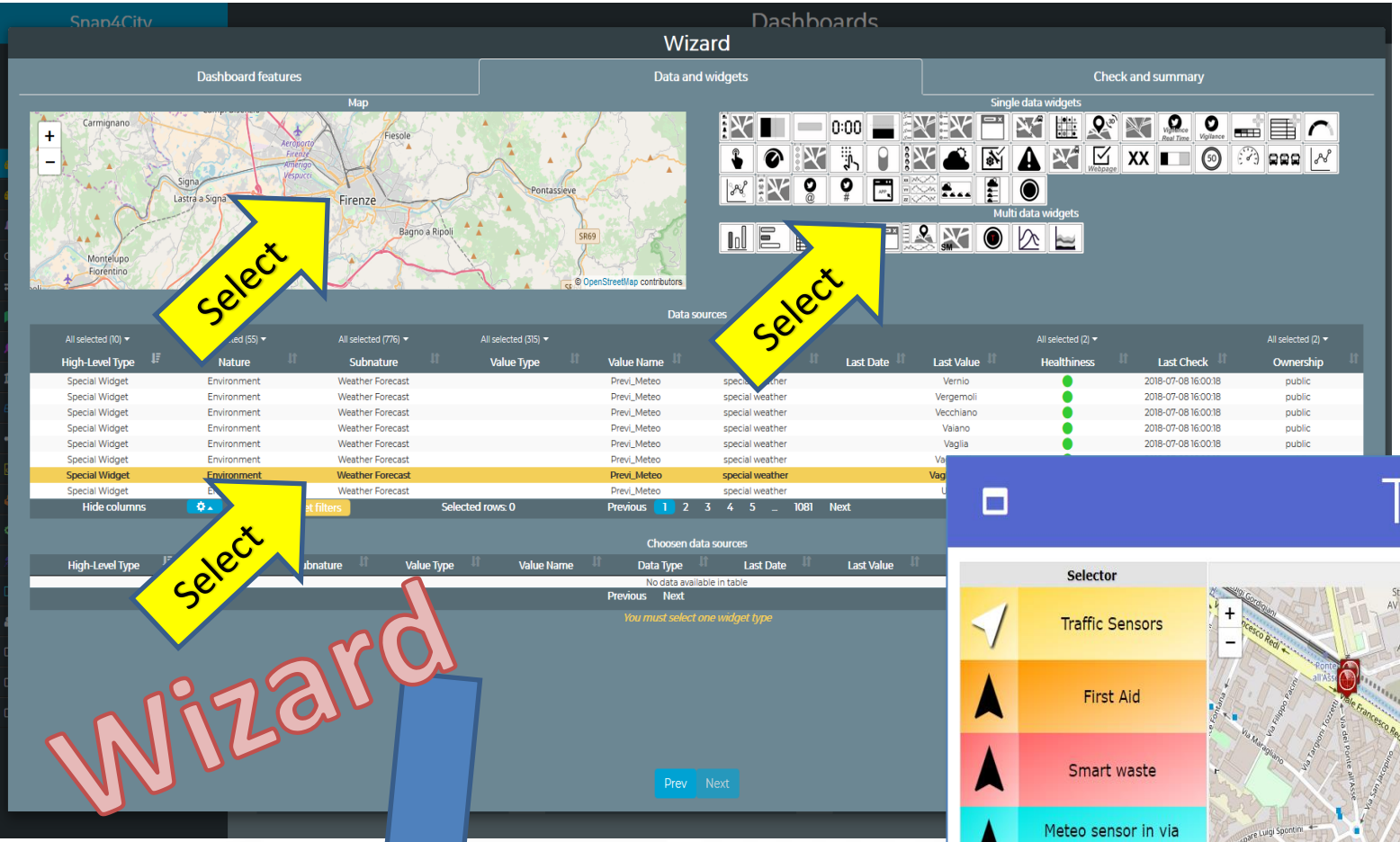
Dashboard Editor

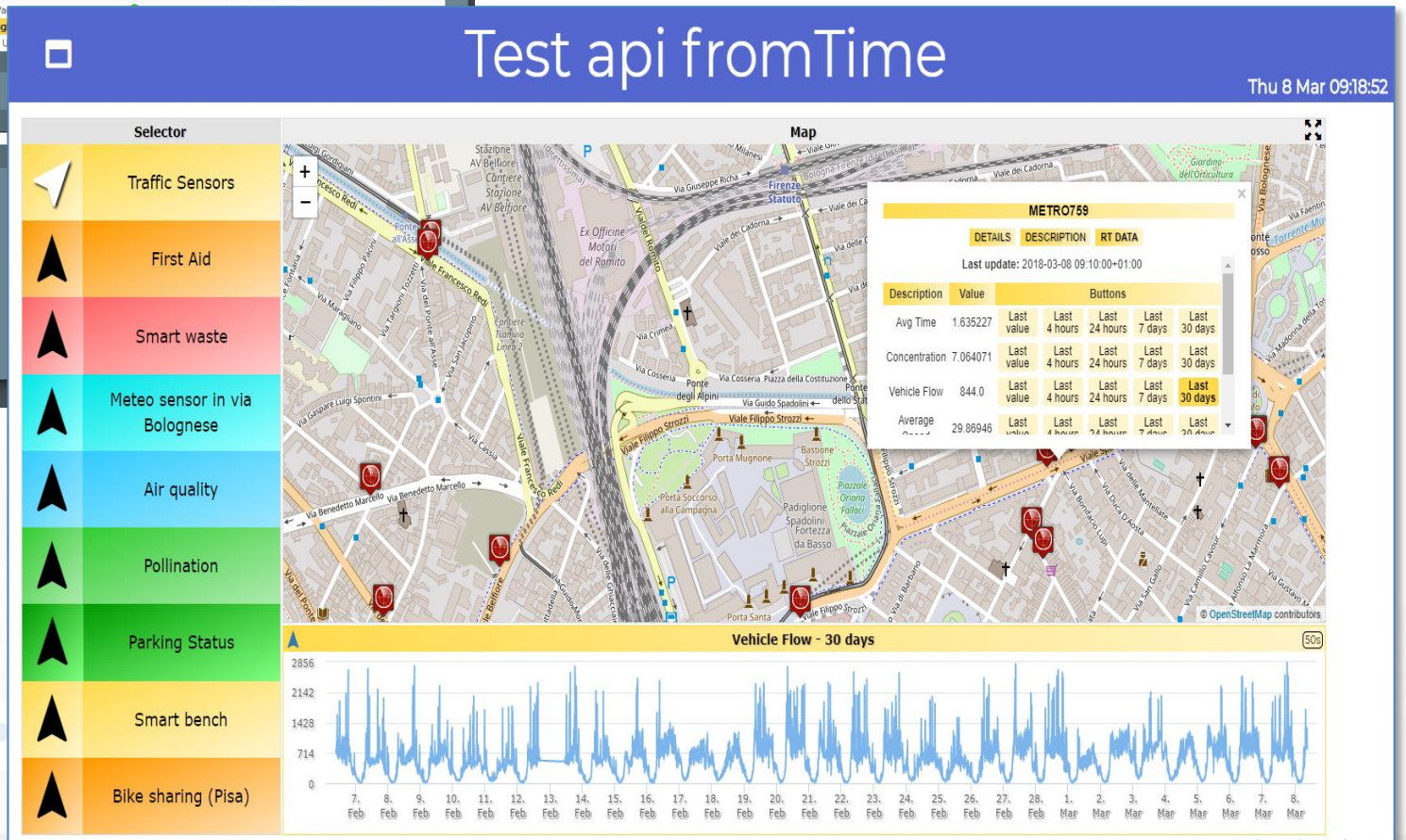
Public Dashboard Collection



My Own Dash/App

Dashboard Wizard





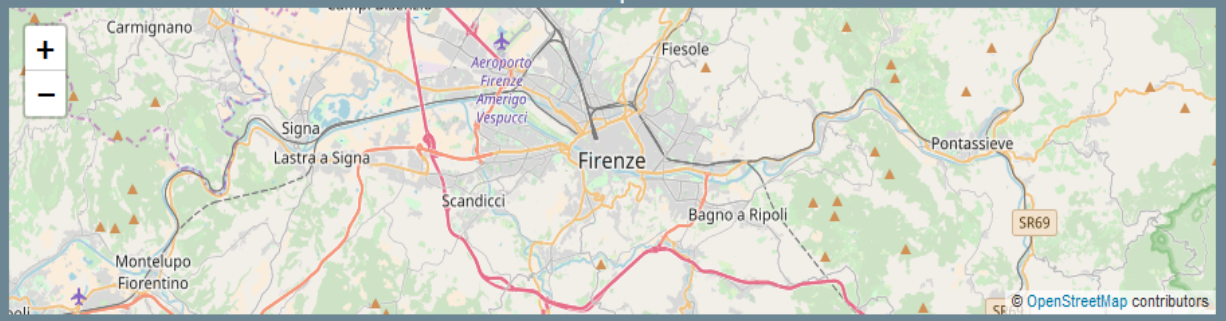
The Wizard help you in selecting only possible combination of data vs graphic representation

Snap4City Dashboards

Wizard

Dashboard features | Data and widgets | Check and summary

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
All selected (10)	All selected (55)	All selected (776)	All selected (315)		All selected (47)					All selected (2)
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather		Vaglia		2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather		Vagli sotto		2018-07-08 16:00:18	public
Special Widget	**Environment**	**Weather Forecast**		**Previ_Meteo**	**special weather**		**Vagli di sotto**		**2018-07-08 16:00:18**	**public**
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather		Uzzano		2018-07-08 16:00:18	public

Hide columns | Selected rows: 0 | Previous 1 2 3 4 5 ... 1081 Next | Search

Choosen data sources

High-Level Type	Nature	Subnature	Value Type	Value Name	Data Type	Last Date	Last Value	Healthiness	Last Check	Ownership	Remove

Previous Next | Search

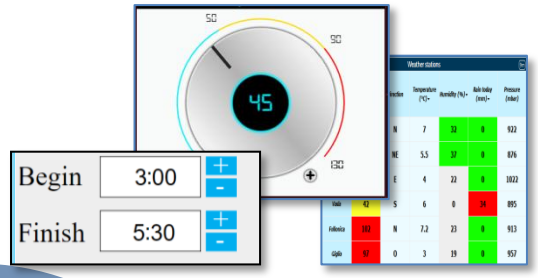
Close

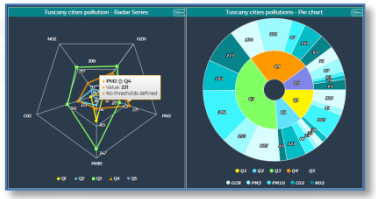
SNAP4CITY

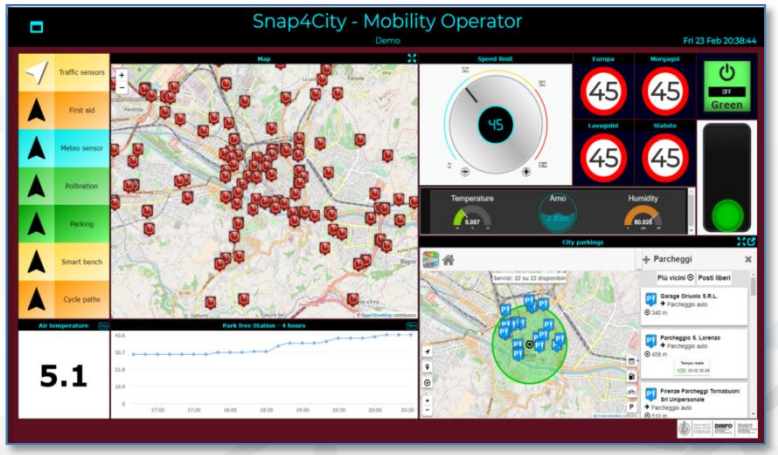
Wizard

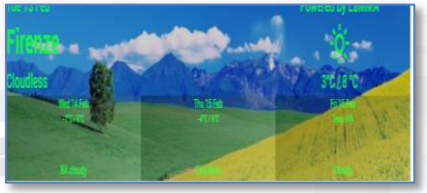
- Select the area of your interest: panning and zooming
- Select the
  - graphic aspect of your interest, or
  - High Level Type of your interest, or
  - Make a search if you a have a precise idea or
  - Act on filters: nature, subnature, type, name, value, date, health, owner, …
  - Combine them as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

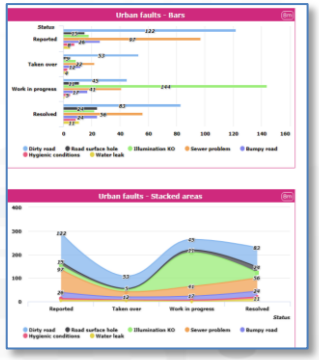
Dashboard List and Editor





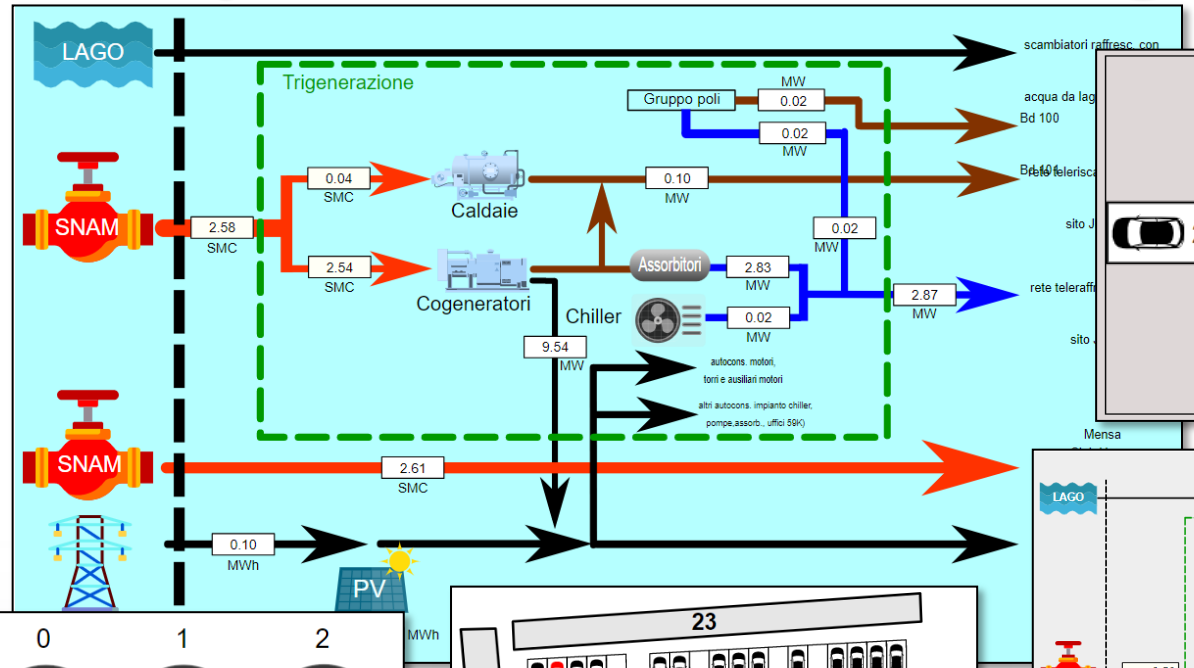


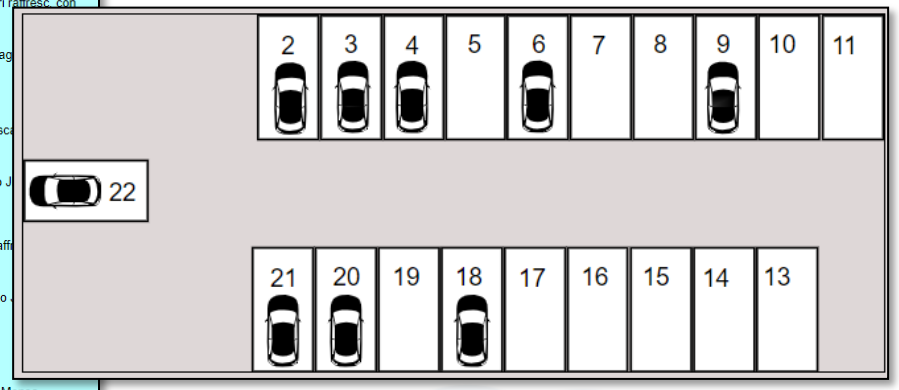


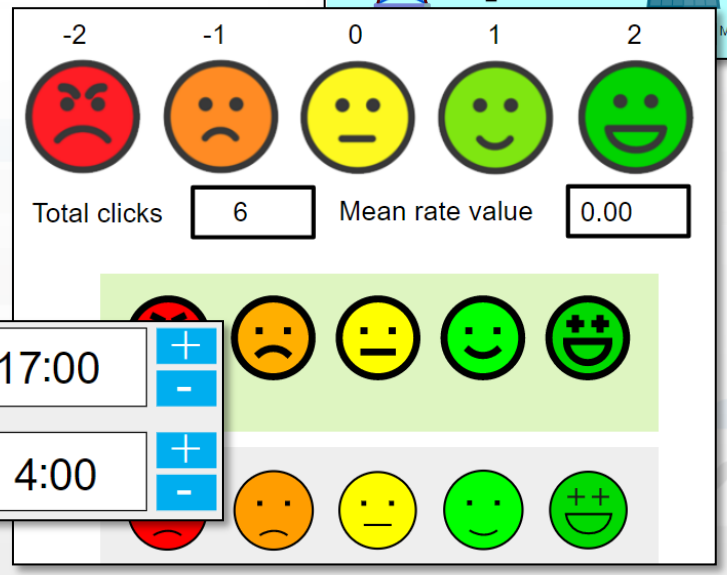


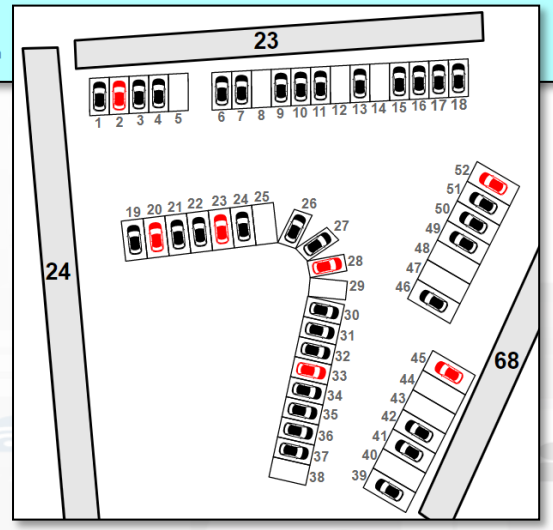
Special Custom Widgets

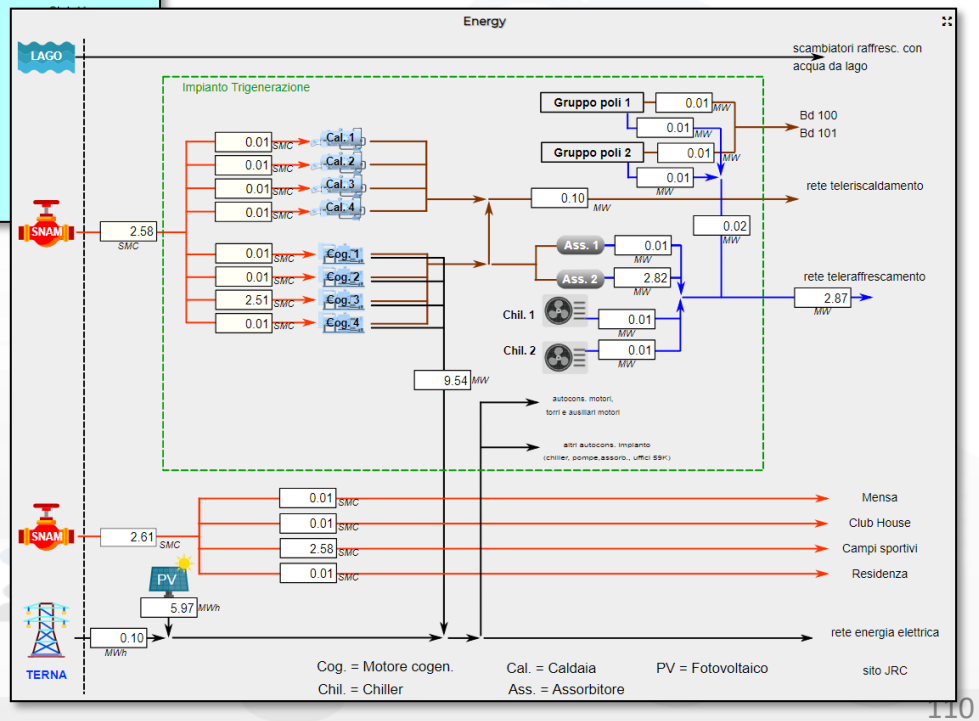
- Smart parking
- Smart Energy
- Smart Light
- Smart ….
- Energy View
- Custom Controls



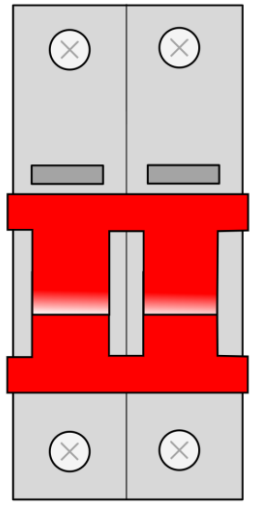




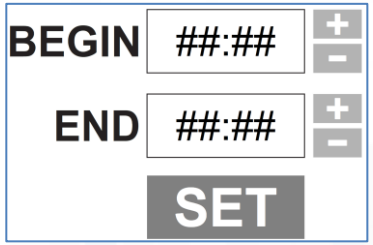


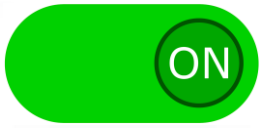


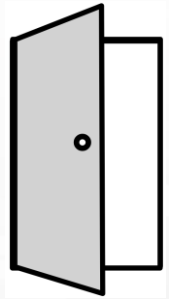
Other examples



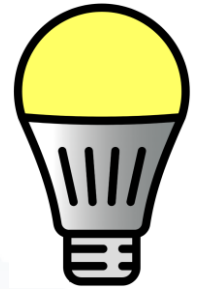
- **Virtual Actuators (sensor-actuator)**
  - From: Dashboard
  - To: IOT App, MyKPI, other Synoptics

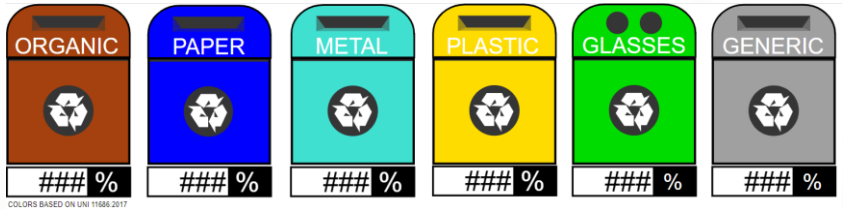


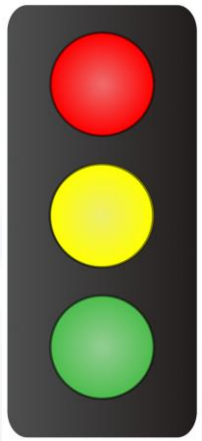


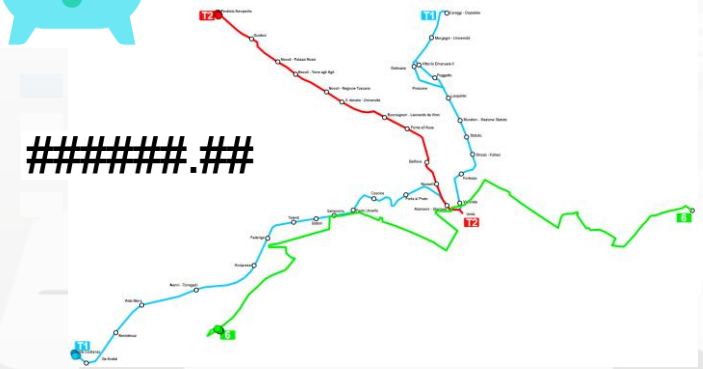


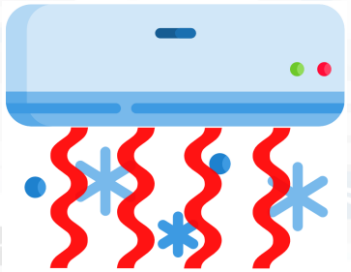
- **Virtual Sensors**
  - From: MyKPI, Sensors, IOT App, other Synoptics
  - To: Dashboards







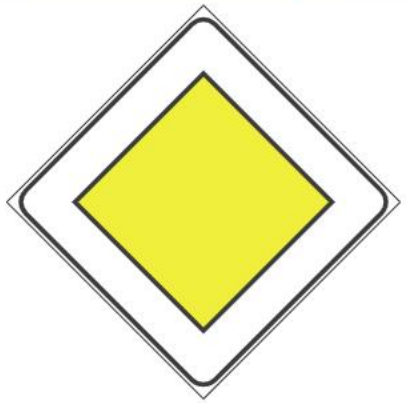




SVG Custom Widgets Examples

Sat 16 Jan 01:07:39

Precedence Italians Road signals

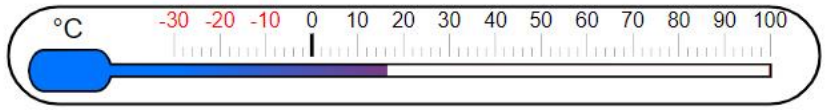


Select a code from 0 to 11 to change the road sign

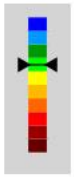
New		Last confirmed: None
7	8	9
4	5	6
1	2	3
0	.	Canc
Confirm		

s... Smart Light Luminosity

Air Temperature in Florence



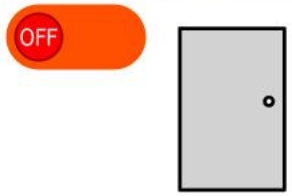
PM10 level - Bologna



fan Fan velocity

Symbols Legenda

open/... M...



Dynamic Prohibition...

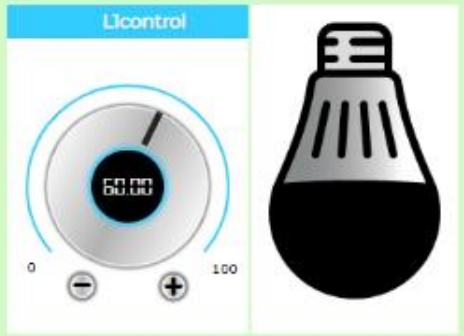
Prohibition Traffic Signs Co...

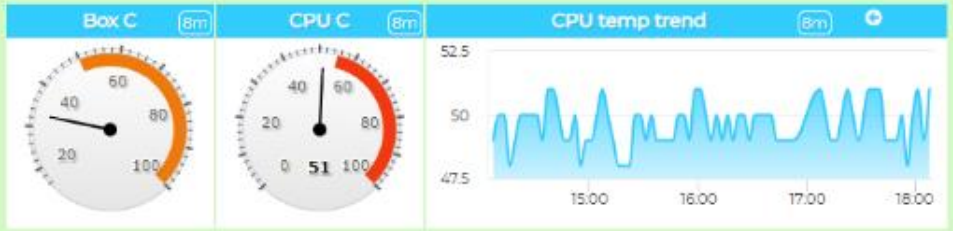
New		Last confirmed: None
7	8	9
4	5	6
1	2	3
0	.	Canc
Confirm		

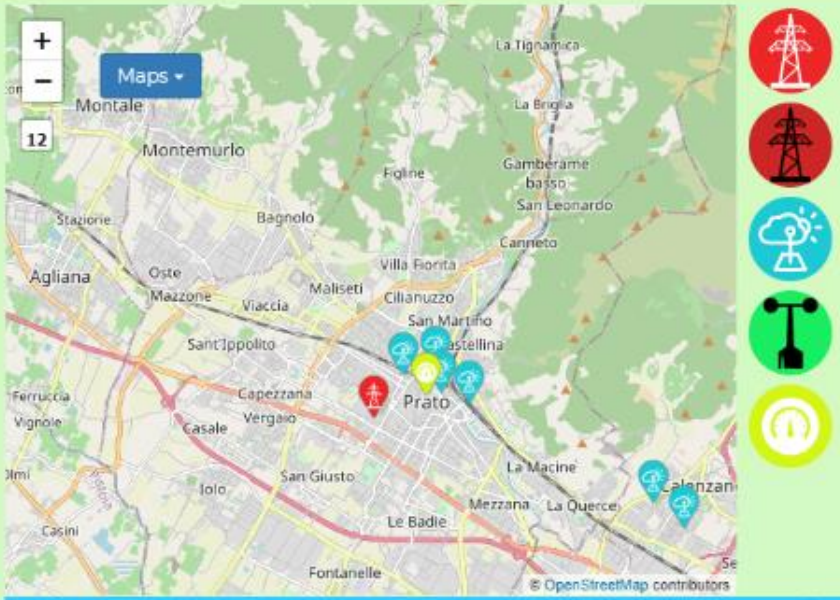
Prohibition Traffic Signs Legenda

Snap4Home 5G Demo

Thu 11 Jun 18:07:32







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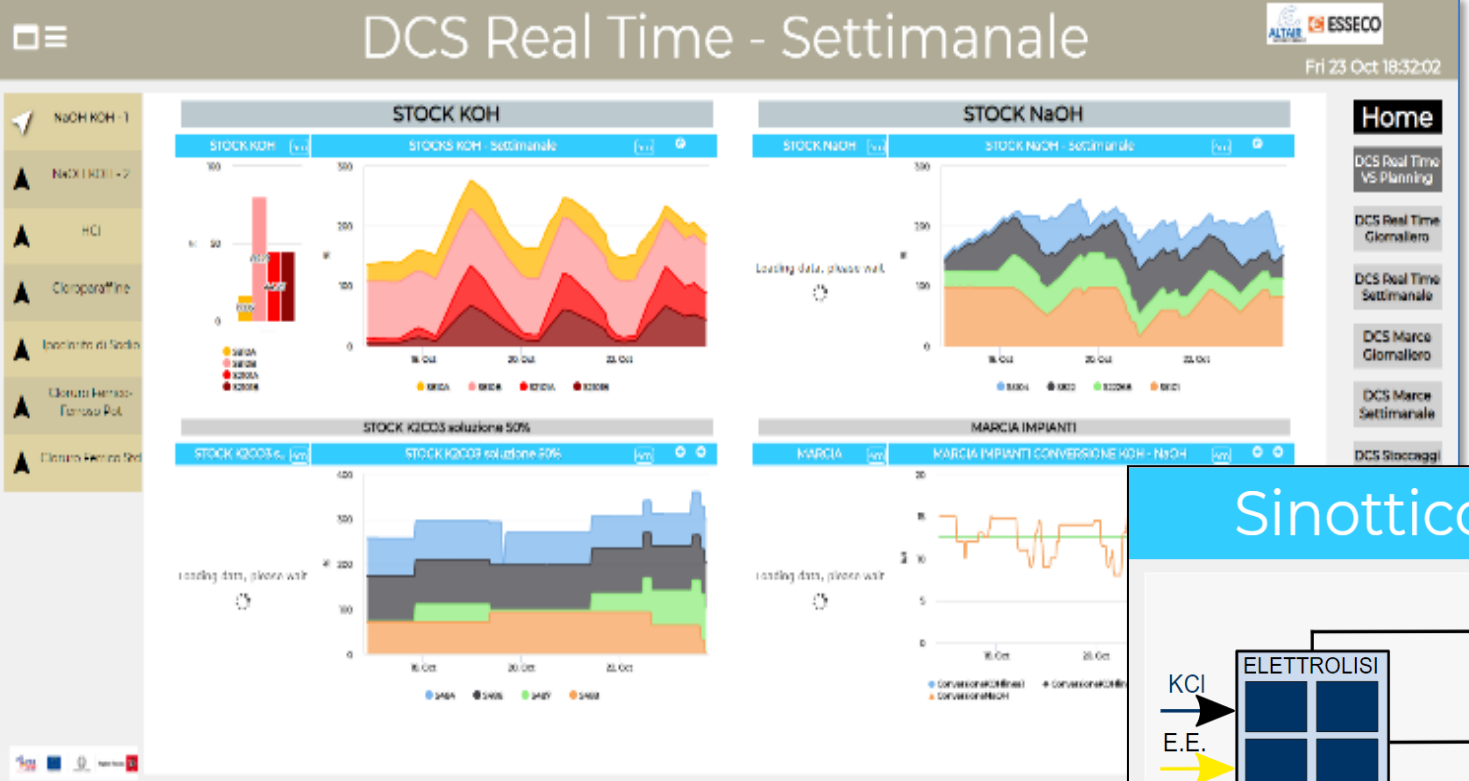
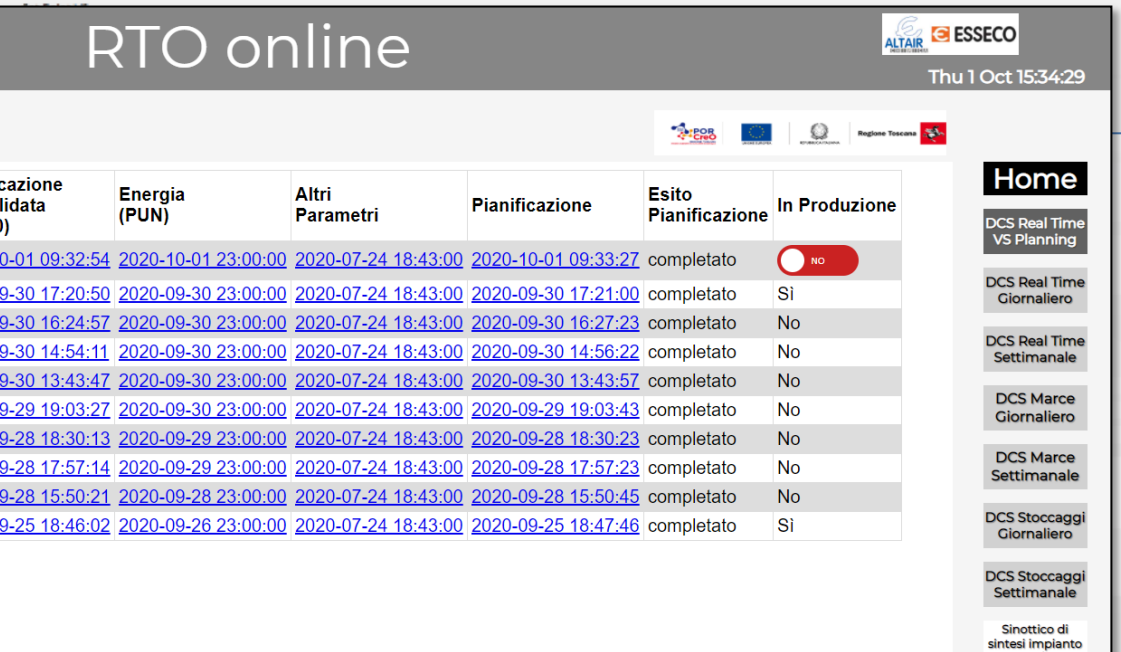
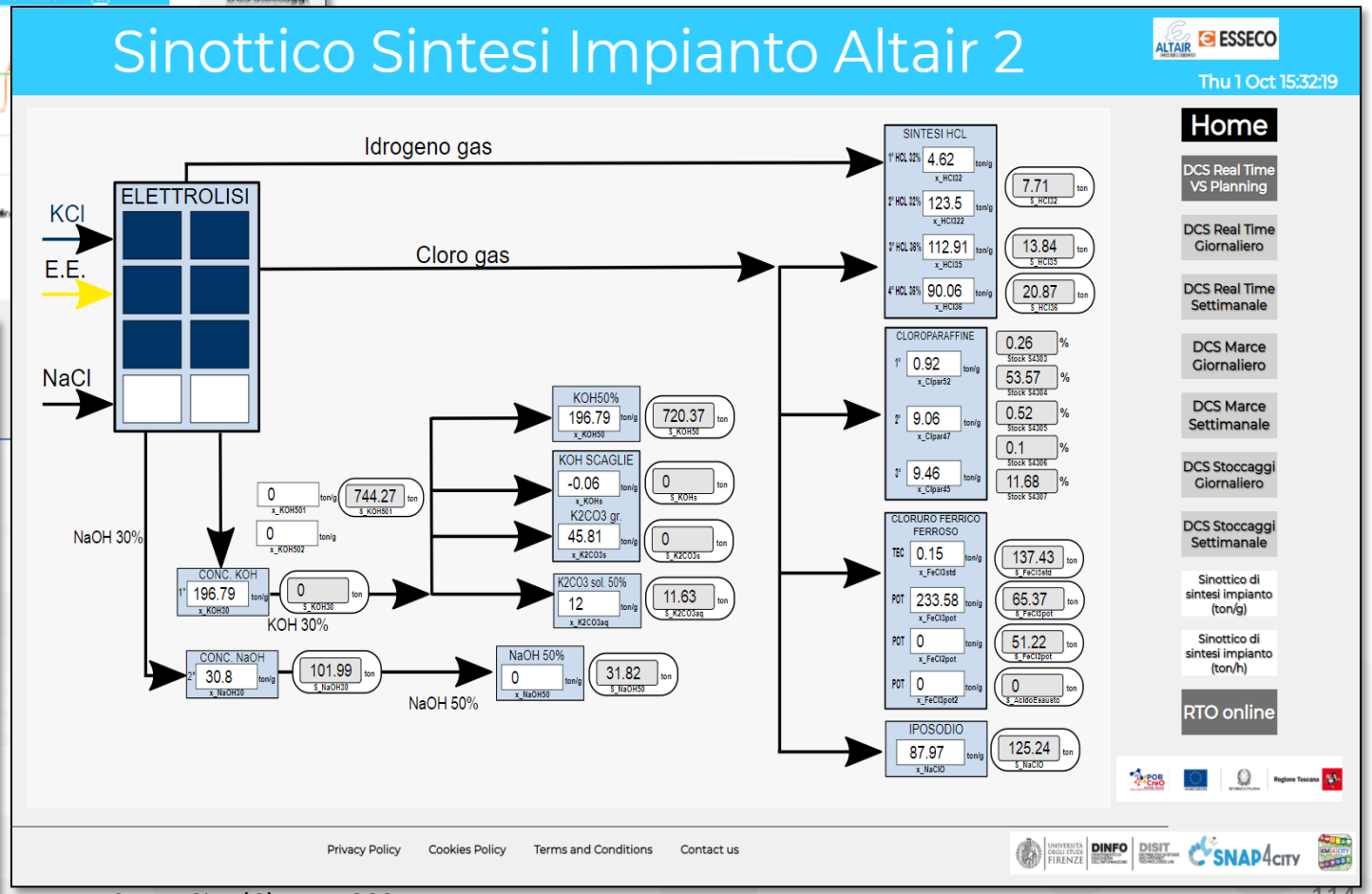
open fiber WIND 3 ZTE estra

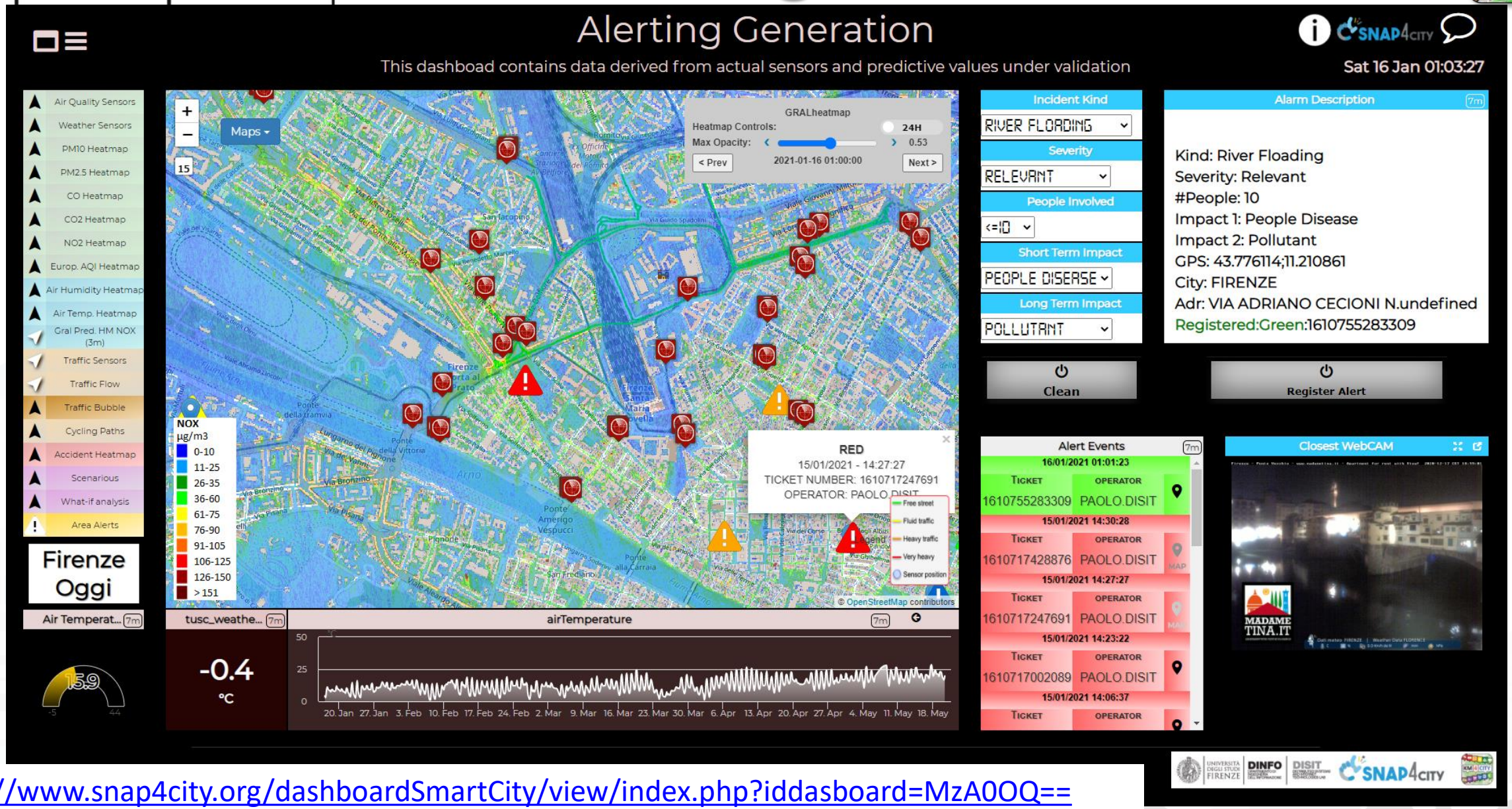




cazione lidata)	Energia (PUN)	Altri Parametri	Pianificazione	Esito Pianificazione	In Produzione
0-01 09:32:54	2020-10-01 23:00:00	2020-07-24 18:43:00	2020-10-01 09:33:27	completato	NO
9-30 17:20:50	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-30 17:21:00	completato	Sì
9-30 16:24:57	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-30 16:27:23	completato	No
9-30 14:54:11	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-30 14:56:22	completato	No
9-30 13:43:47	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-30 13:43:57	completato	No
9-29 19:03:27	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-29 19:03:43	completato	No
9-28 18:30:13	2020-09-29 23:00:00	2020-07-24 18:43:00	2020-09-28 18:30:23	completato	No
9-28 17:57:14	2020-09-29 23:00:00	2020-07-24 18:43:00	2020-09-28 17:57:23	completato	No
9-28 15:50:21	2020-09-28 23:00:00	2020-07-24 18:43:00	2020-09-28 15:50:45	completato	No
9-25 18:46:02	2020-09-26 23:00:00	2020-07-24 18:43:00	2020-09-25 18:47:46	completato	Sì

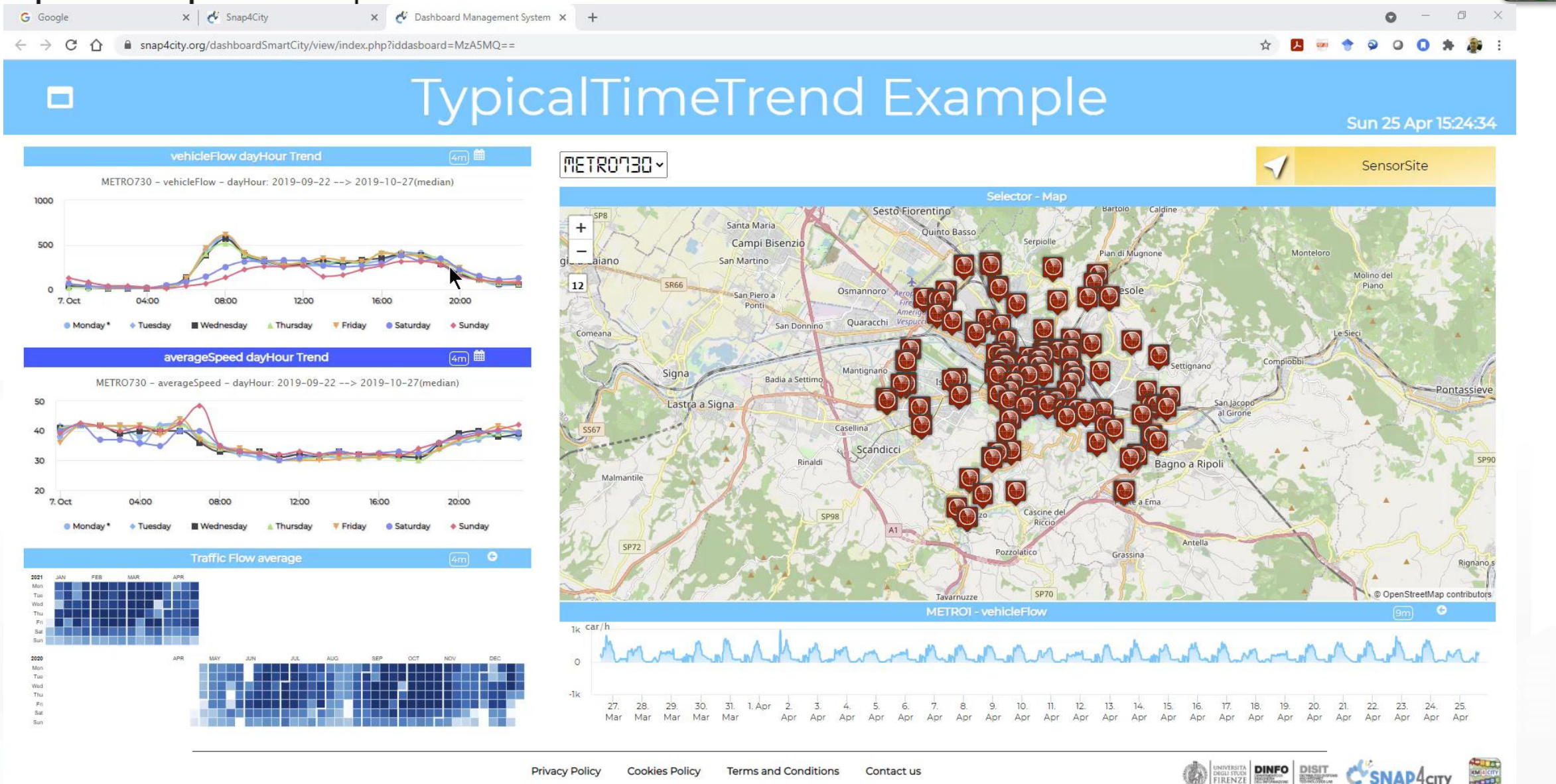


Alert Registration



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA0OQ==

Typical Time Trends



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA5MQ==

How the Dashboards exchange data

Snap4City BigData Storage and KB

IOT Broker Orion Quantum Leap

ServiceMap Super ServiceMap

- Req. ServiceURI

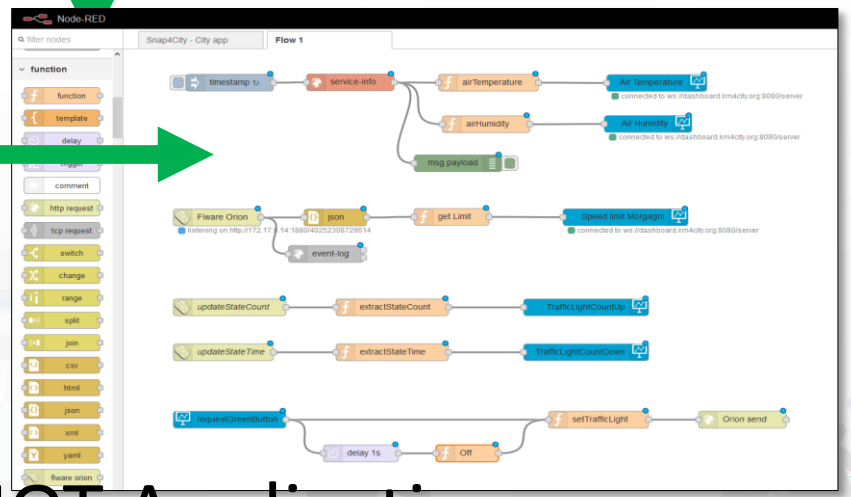
Metric, KPI

MyKPI, MyPOI, …

- Req. KPI, Metric ID
- Req. MyKPI ID

API, External Services, MicroApp

- Traffic Flow, MAPS, Heatmaps
- GIS, HTTPs URLs

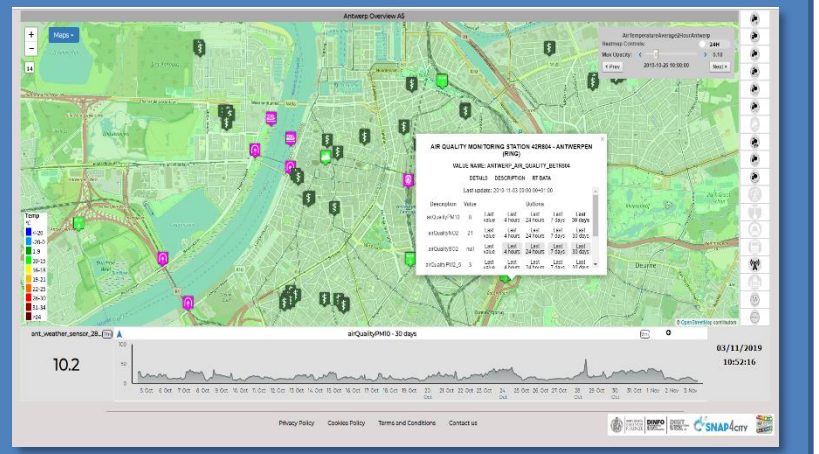


IOT Application

- ServiceURI (ID)
- MyKPI, Metric (ID)
- Dynamic Data, computed into IOT Application

- Rx. Dynamic Data
- Event Driven Synoptics
- Actions, Show

Dashboards

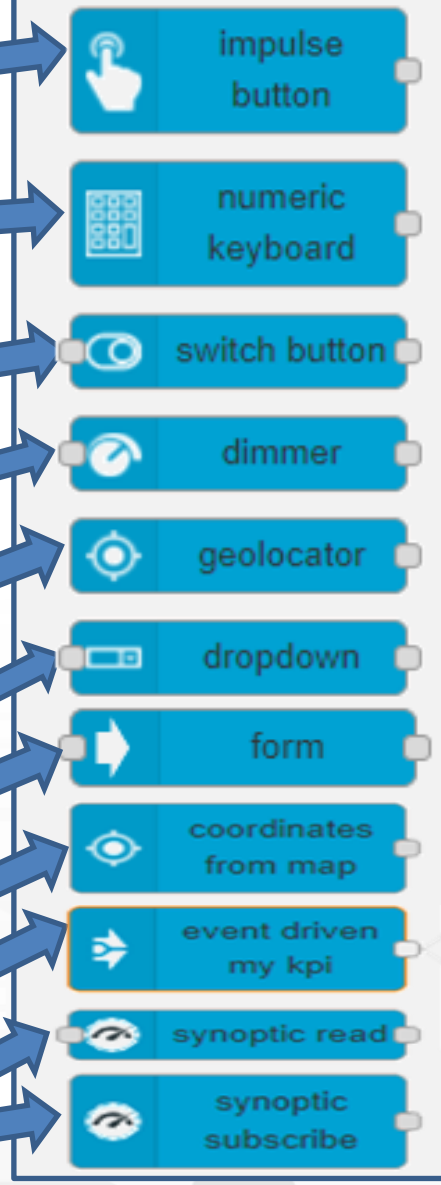


Dashboard-IOT App

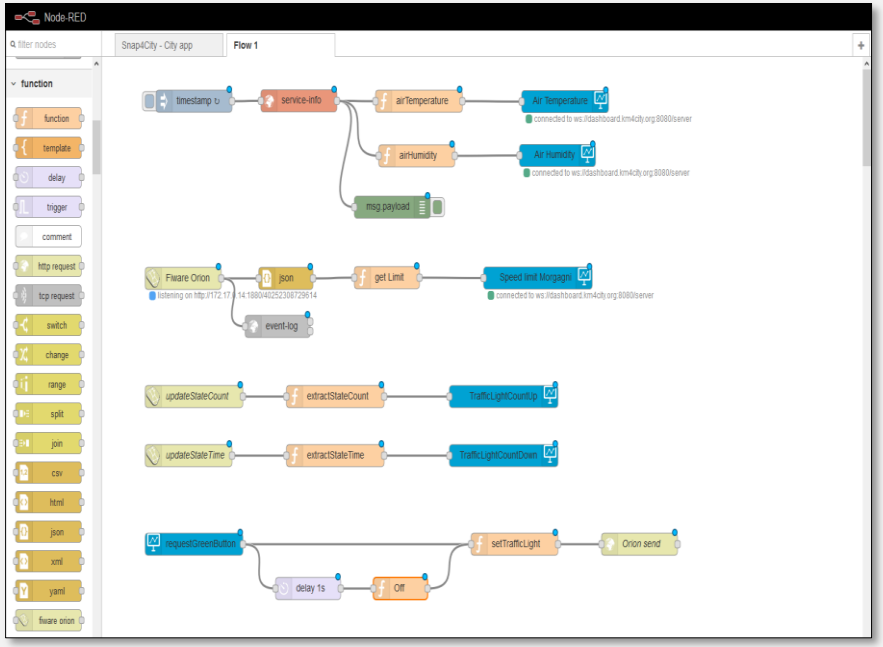
MapClick

MyKPI variable onchange

Synoptics



From Dashboard to IOT App

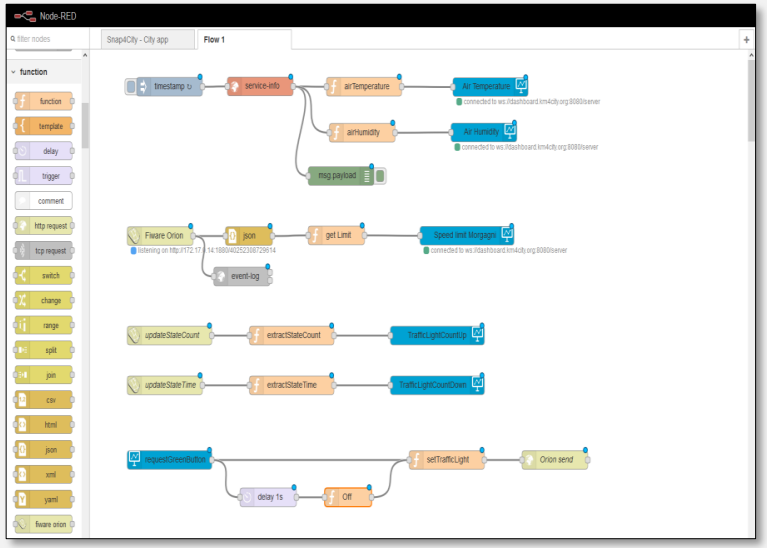


IOT Application

Nature

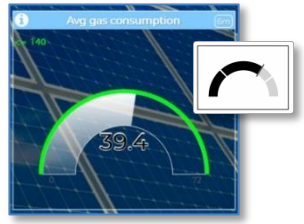
Dashboard-IOT App

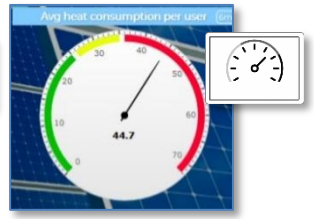
From IOT App to Dashboard

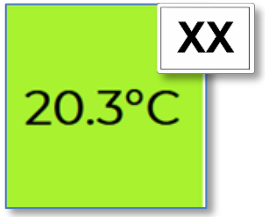


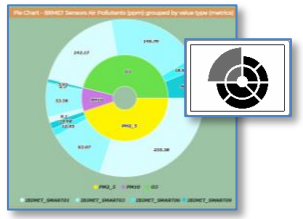
IOT Application

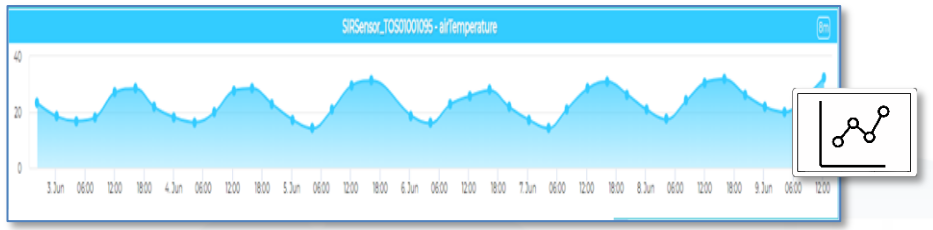
- gauge chart
- single content
- speedometer
- horizontal single bar
- vertical single bar
- web content
- time trend
- bar series
- radar series
- pie chart
- curved line series
- table content
- synoptic write
- calendar

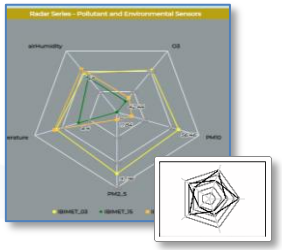


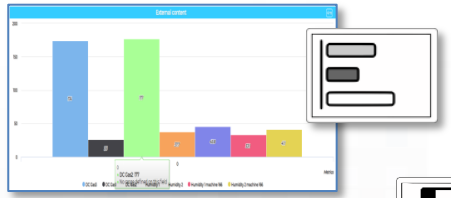


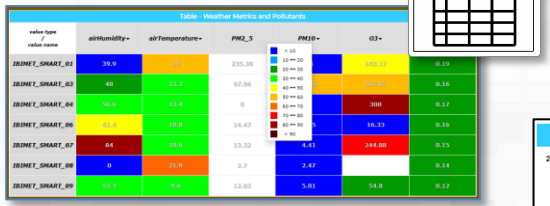


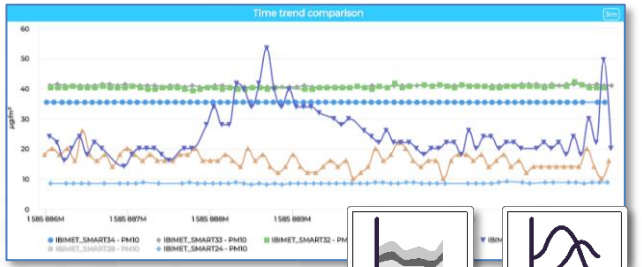


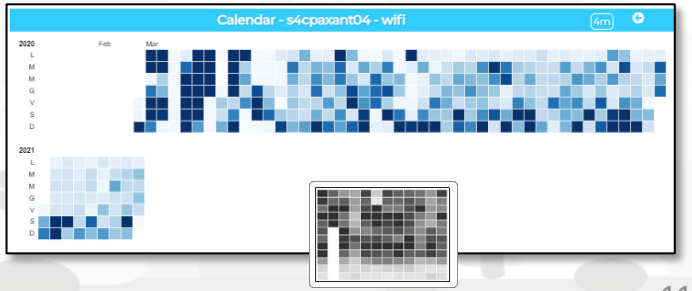


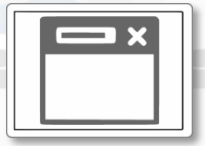












IOT Devices

Sensors/
Actuators

IOT Edge Devices

LoraWAN +
Arduino +
I2C, NGSI

Arduino,
Wi-Fi, NGSI

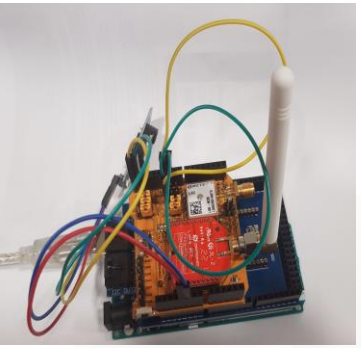
Snap4All
IOT Button
ESP, NGSI,
Wi-FI, BT

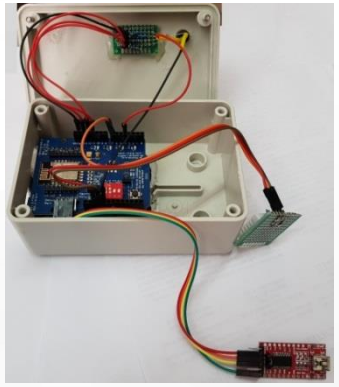
Snap4All PAX
Counter
LoraWAN
WIFI, NGSI,
GPS

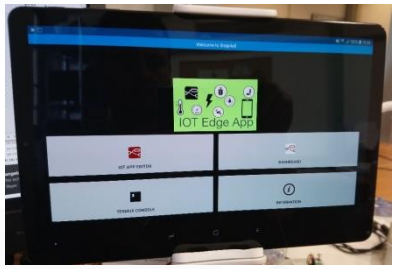
IOT Edge
NodeRED:
Raspberry Pi,
NGSI, WiFi,
RJ45,..

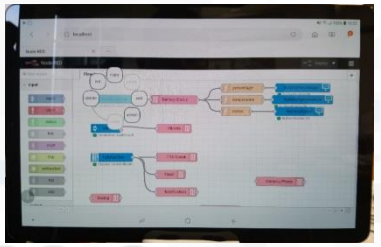
IOT Edge
NodeRED:
Android, LINUX,
Windows, …

LoraWan
Gateway:
IOT Edge, NGSI,
WIFI, RJ45, GPS







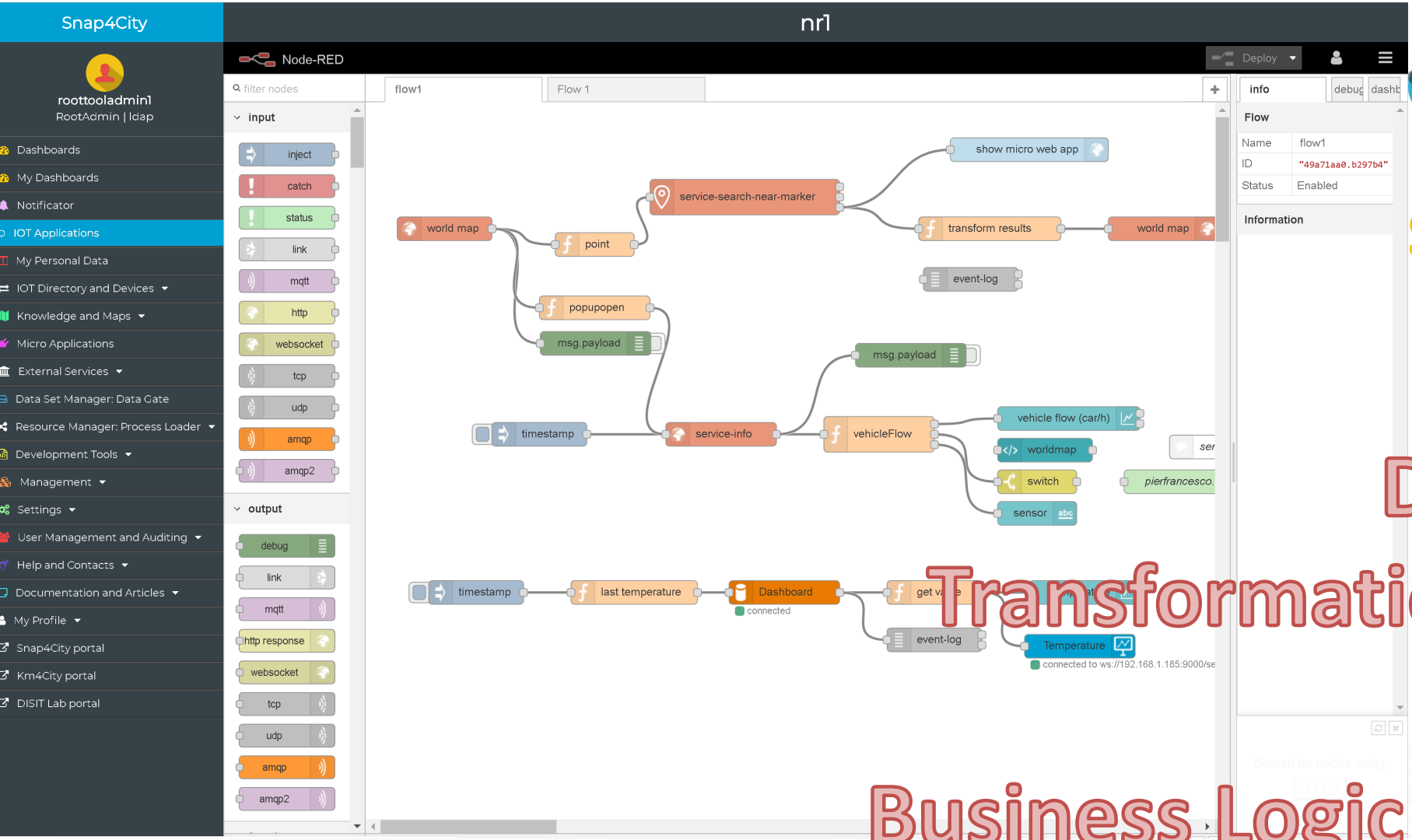


Any Sensor / Actuator
Open to other protocols

IoT Application Development smartening the solutions

On Line Training Material (free of charg

	1st part (*)	2nd part (*)	3rd part (*)	4th part (*)	5th part (*)	6th part (*)	7th part (*)
what	General	Dashboards	OT App, IOT Networ	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App
PDF							
Inter active							
Video1							
Video2							
Video3							
Video4				none		none	none
duration	2:55	3:16	3:41	2:00	2:48	2:35	1:47



Data Adapation
Transformation, Conversion
Integration
Business Logic vs Dashboards
Data Analytics control
Everywhere: Cloud, on IoT Edge Devices

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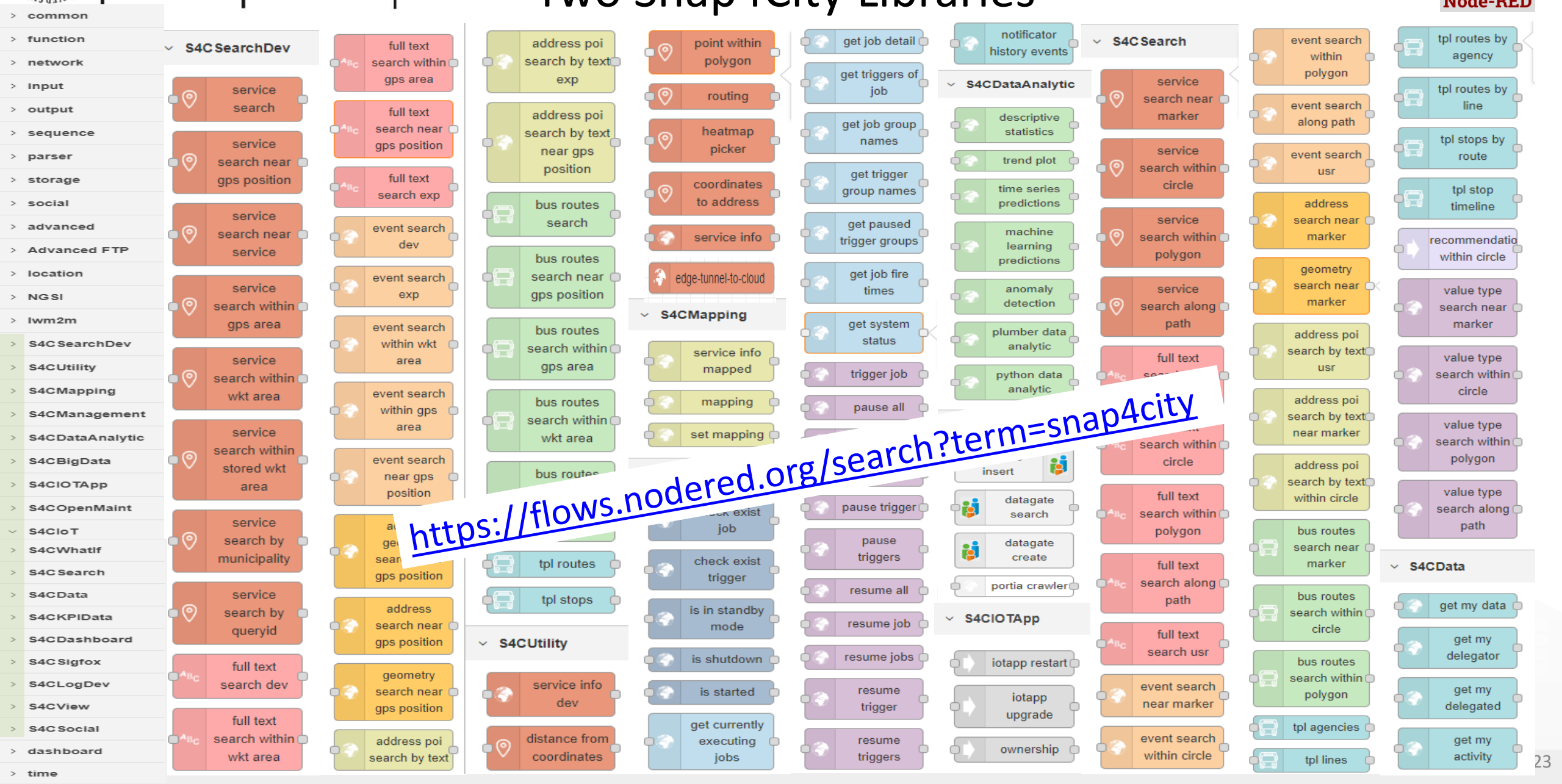
April 2021 collection

Two Snap4City Libraries

SNAP4CITY | Node-RED



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

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April 2021 collection

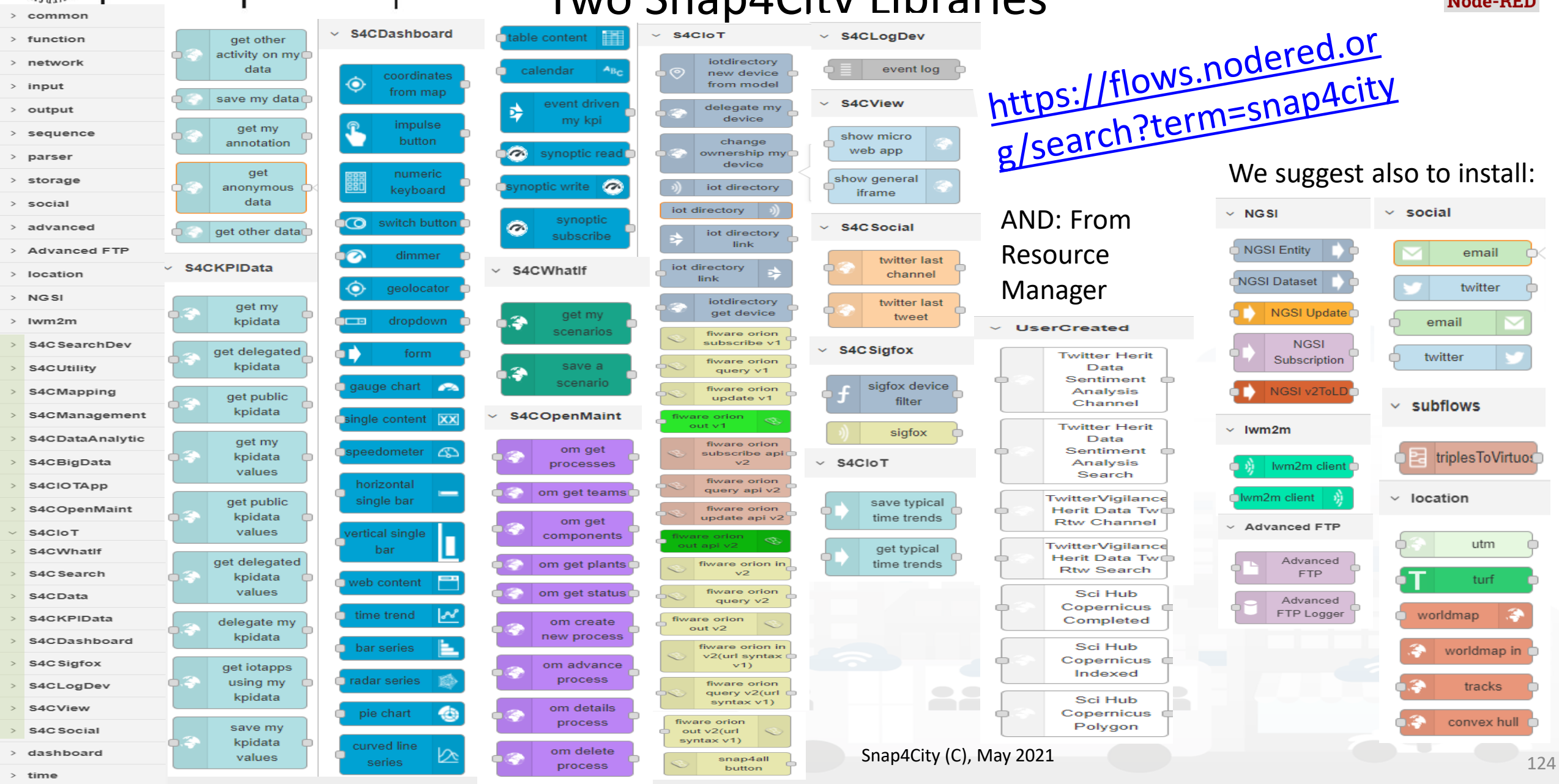
Two Snap4City Libraries

SNAP4CITY | Node-RED

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

We suggest also to install:

AND: From Resource Manager



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Nov. 2020 collection
Two Snap4City Libraries

SNAP4CITY Node-RED

-Search and management of Services, POI, Parking, Public Transport, etc.

-Event management, ticket management

-Routing, Data Analytic, Open Data processing

-IoT device registration, Virtual Devices full control

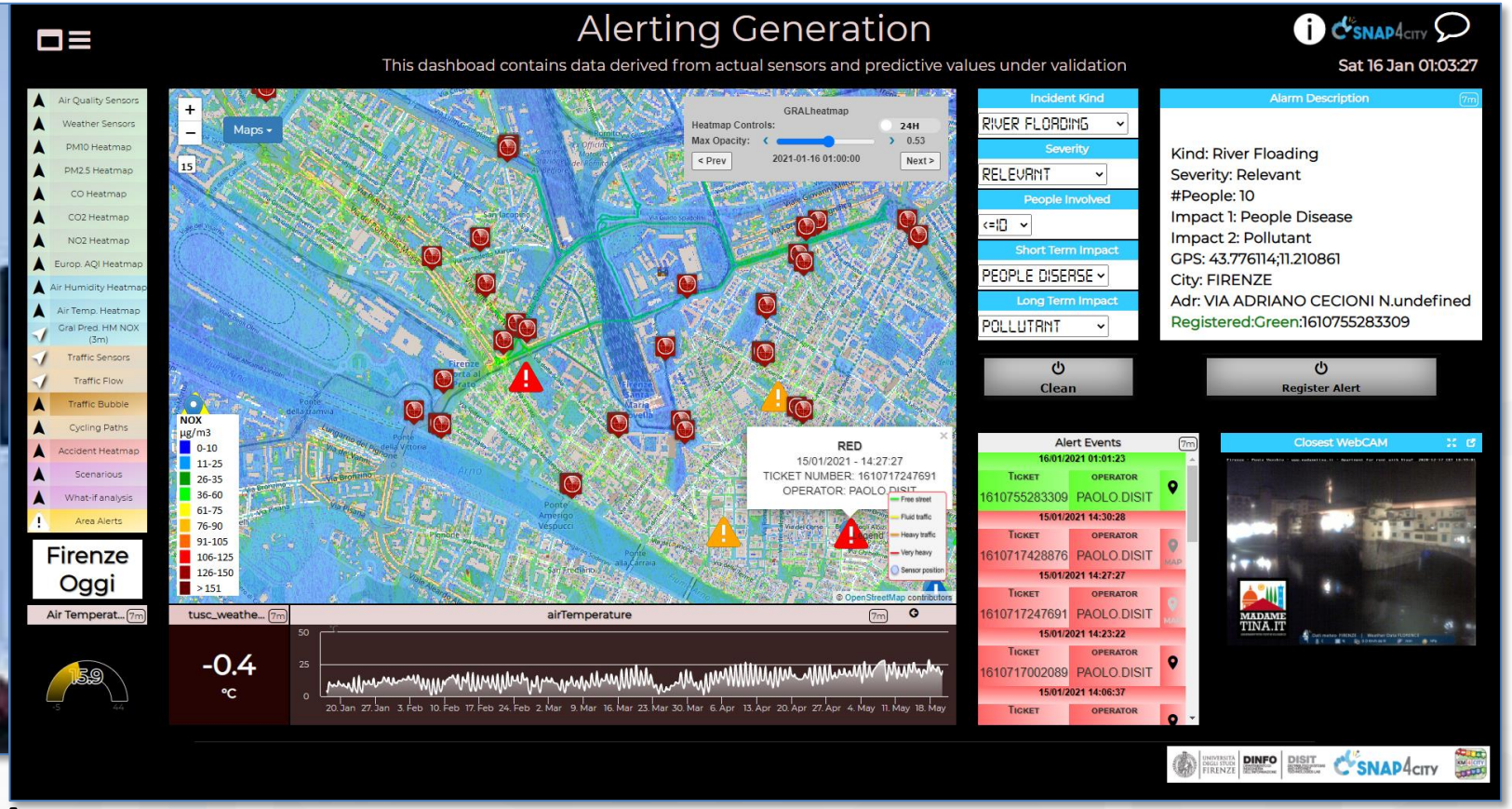
-IOT adaptation, network management

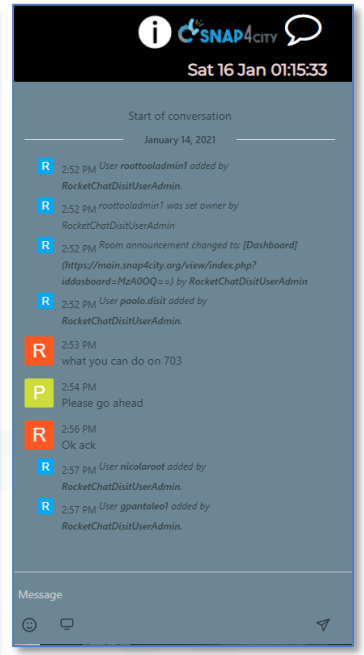
-Dashboard management

-Personal data management, KPI, etc.

.....

Registering Alerting events



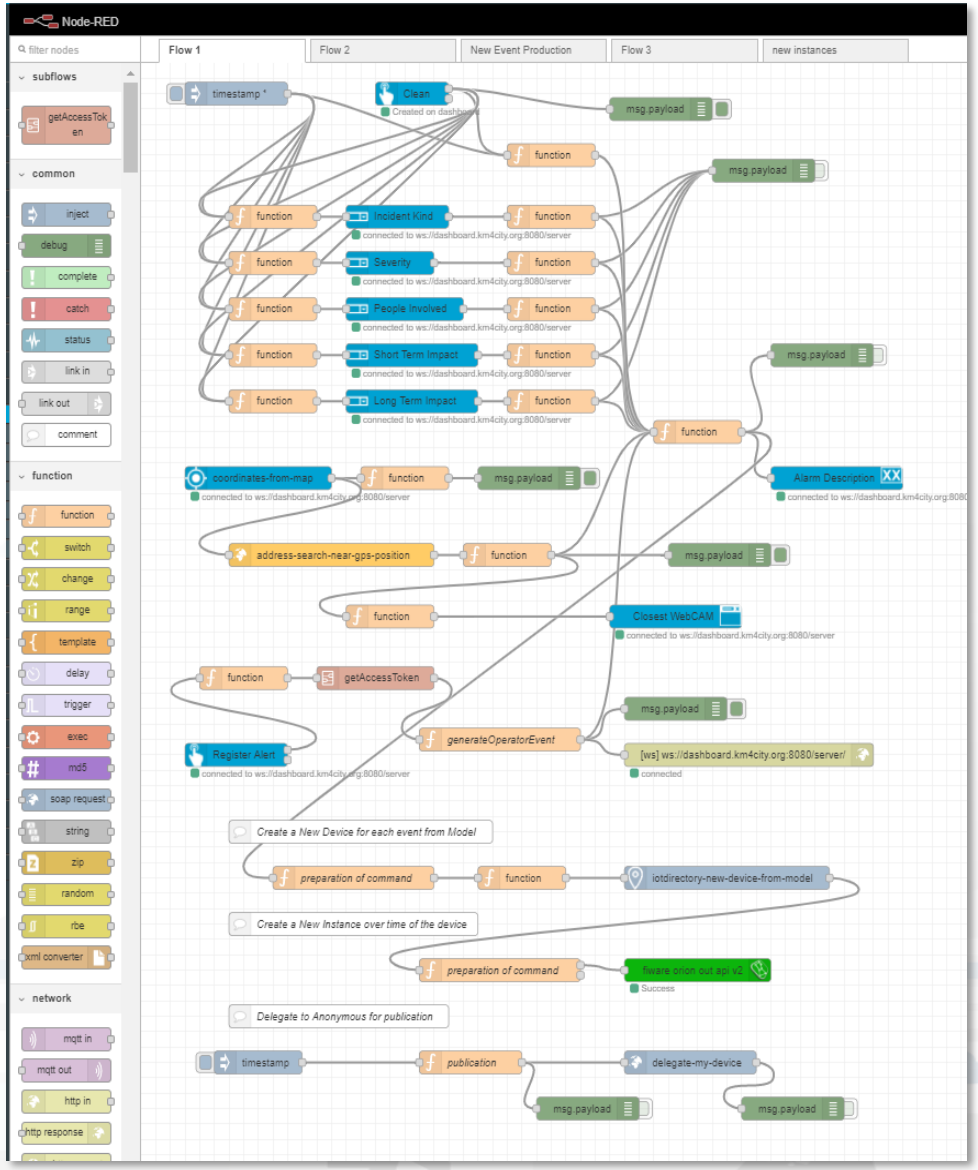


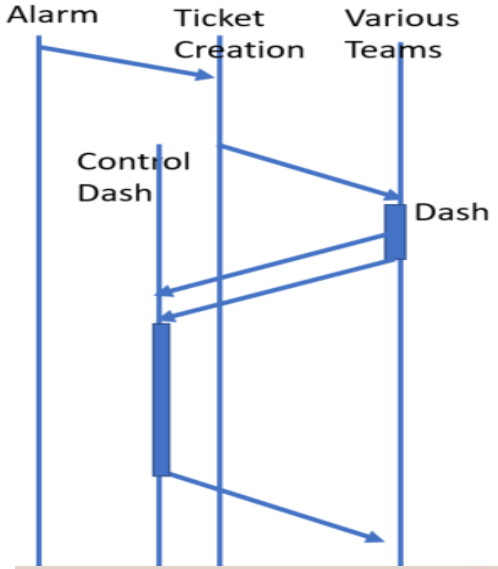
Control Room Operator

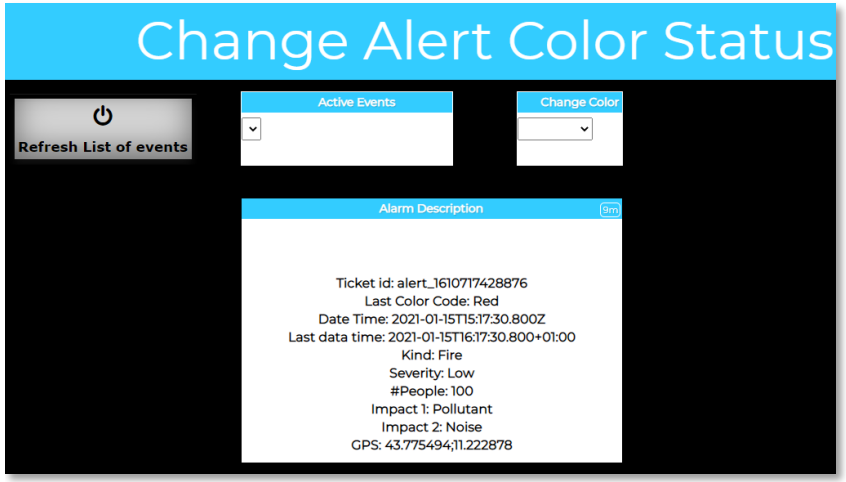
- **Monitor** traffic flow, Environment, Car parking, Cycling, First aid, temp., …
- **Registering Events: classification**
- **Changing status**
- **Acting**

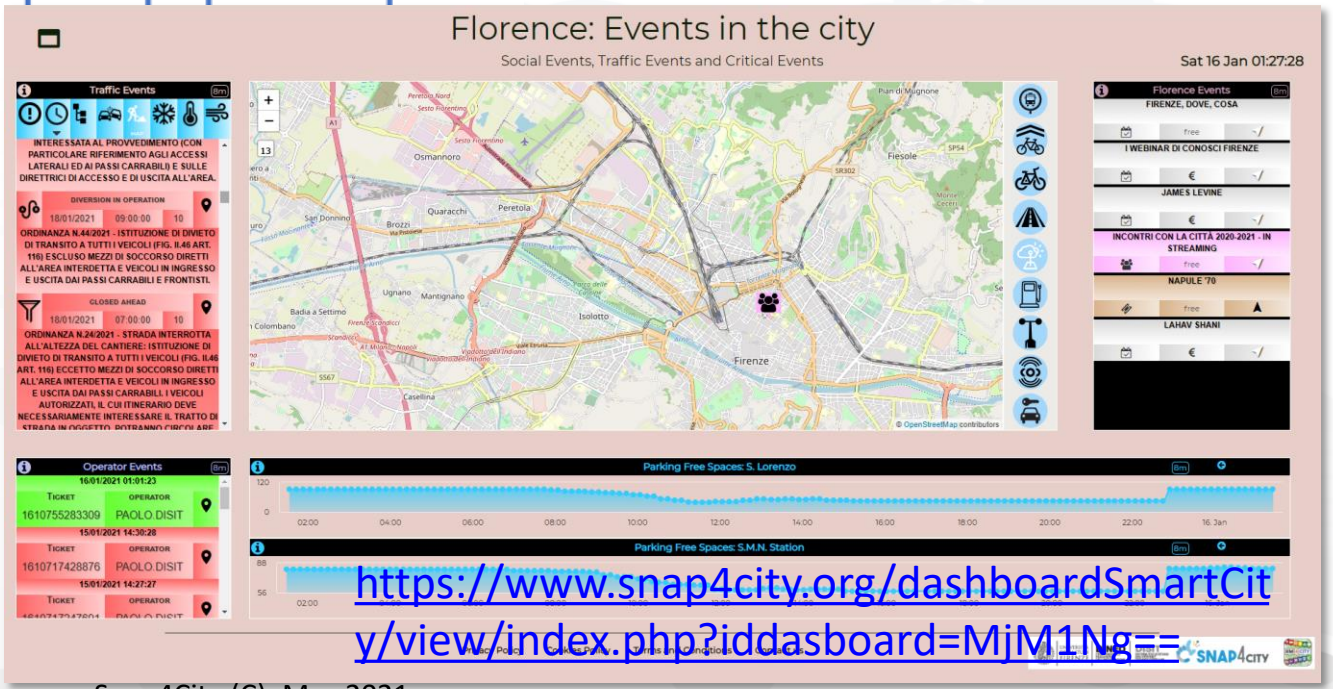
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA0OQ==

Flow Mng





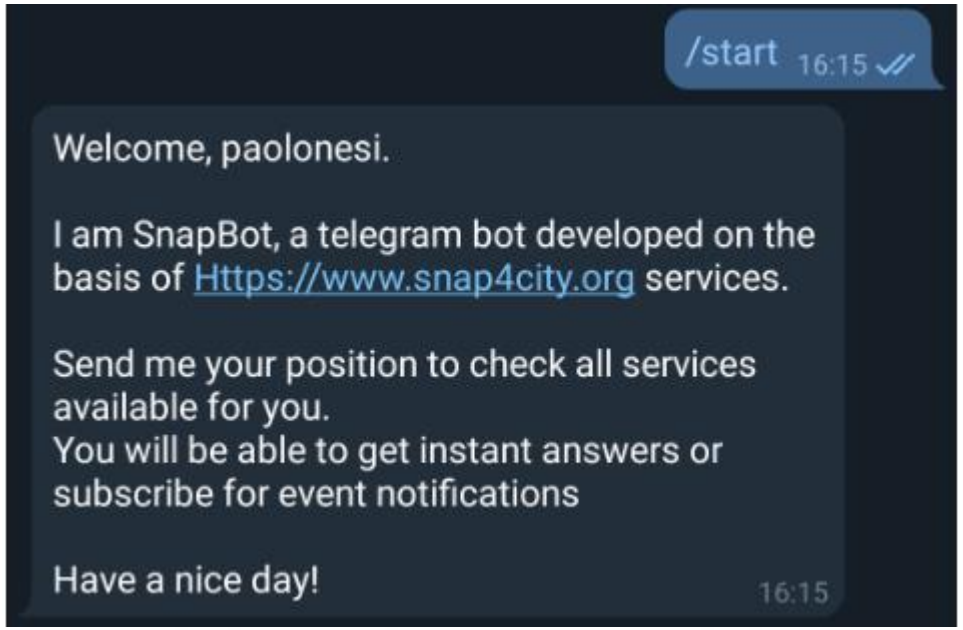


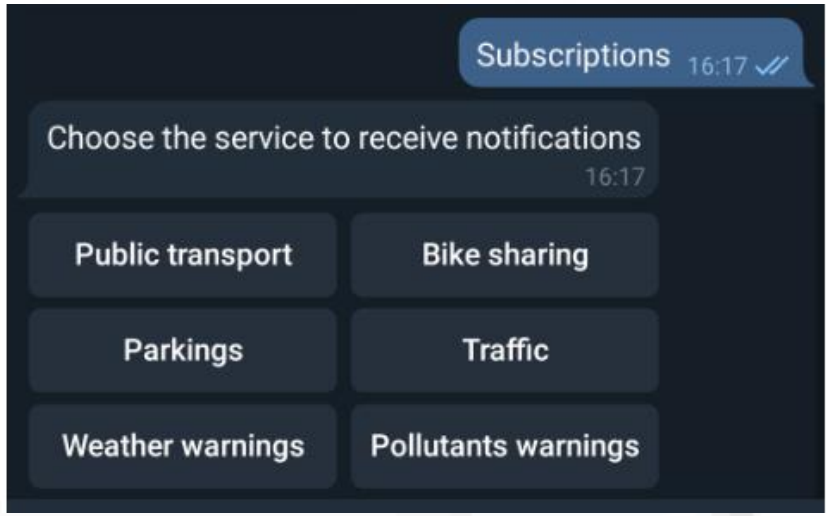


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjM1Ng==

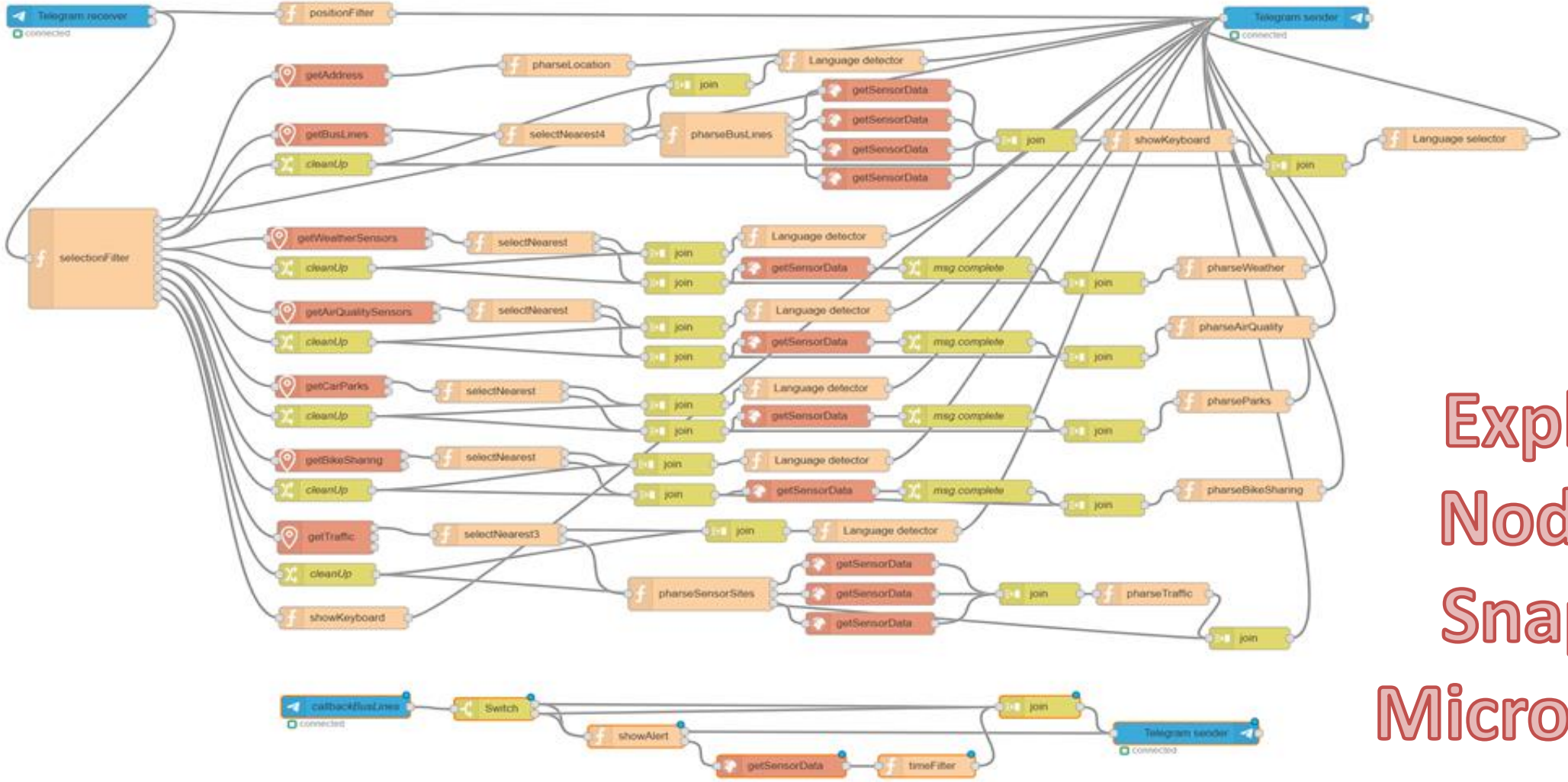
SnapBot

- provides real time smart city services to Telegram users, geolocalized, when you like, what you like
- active on Tuscany in all provinces and cities according to the data accessible on Https://www.snap4city.org
- Services on
  - Public Transport (more than 10 different operators),
  - bike sharing, parking lots,
  - traffic flow, weather warnings,
  - Air quality, pollutant,
  - find your location, etc.





IOT App of SnapBot: OneShot Services



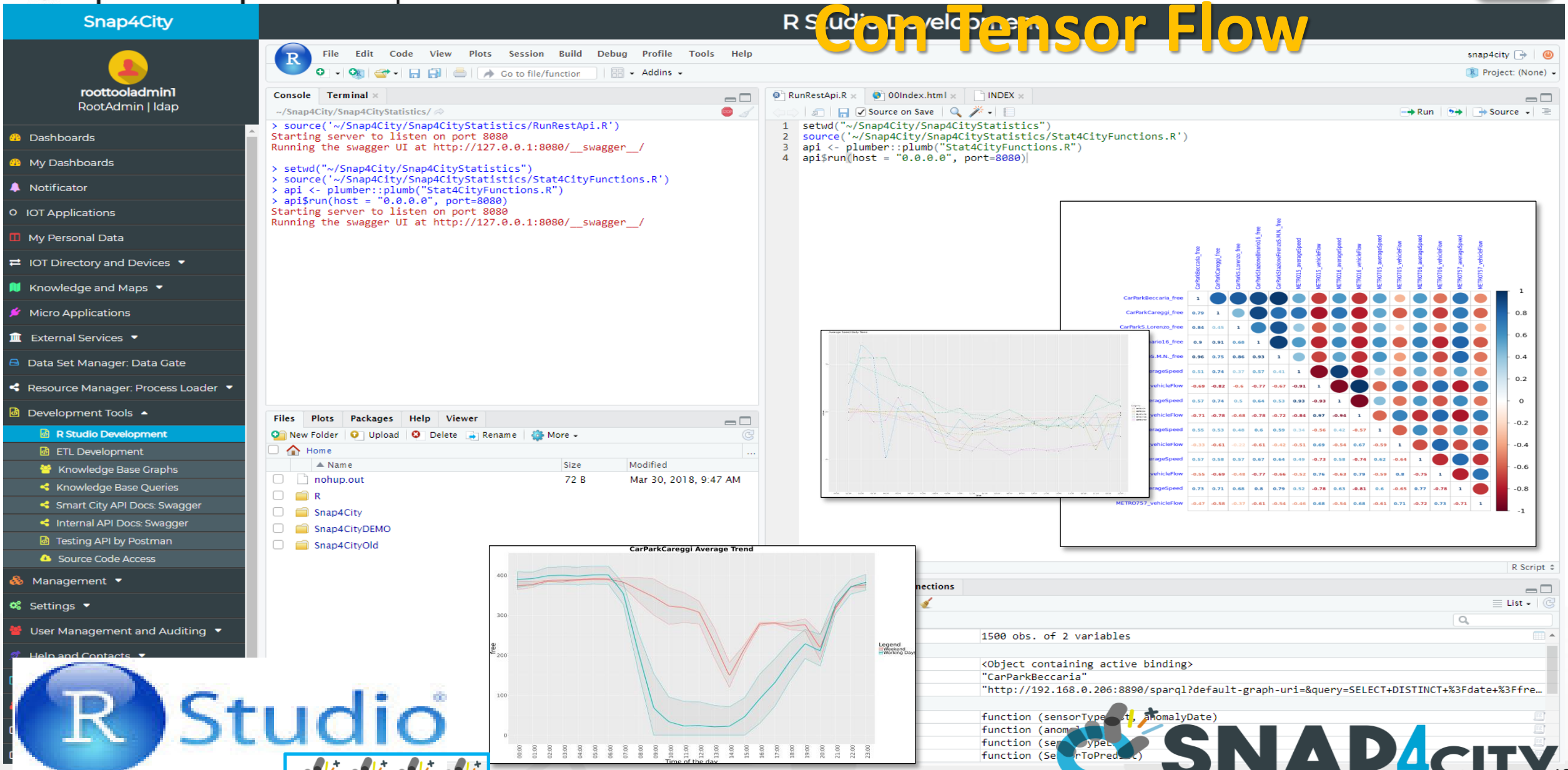
Exploiting Node-RED Snap4City MicroServices

Development of Data Analytics

On Line Training Material (free of charge)

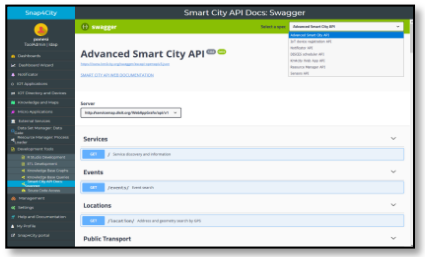
	1st part (*)	2nd part (*)	3rd part (*)	4th part (*)	5th part (*)	6th part (*)	7th part (*)
what	General	Dashboards	IOT App, IOT Networ	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App
PDF							
Inter active							
Video1							
Video2							
Video3							
Video4				none		none	none
duration	2:55	3:16	3:41	2:00	2:48	2:35	1:47

Data Analytics in R Studio Con Tensor Flow

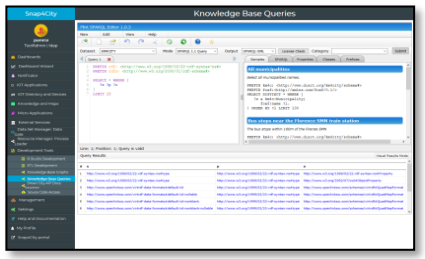


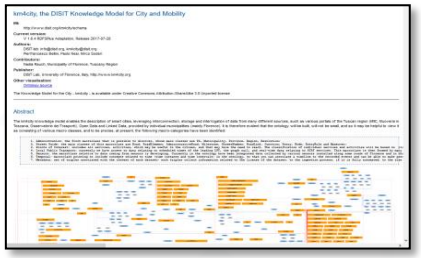
Data Analytics Dev. in R Studio and/or Tensor Flow

Swagger



SPARQL, FLINT





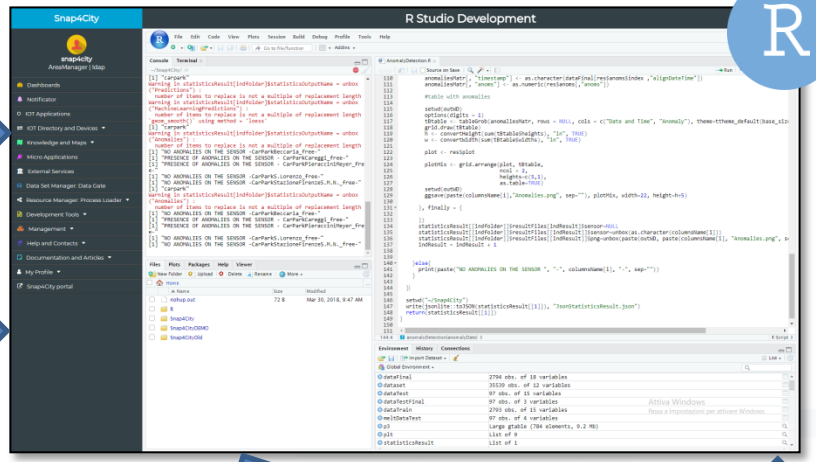
Ontology Schema

LOG.disit.org

Knowledge Base, Km4City

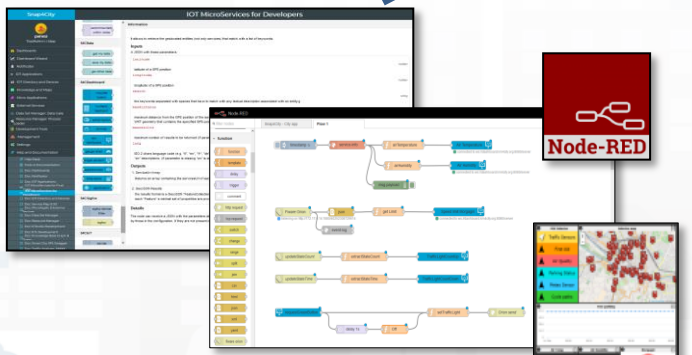
Big Data Store Facility

Smart City API from Knowledge Base and other tools



R Studio

Creating Micro Services



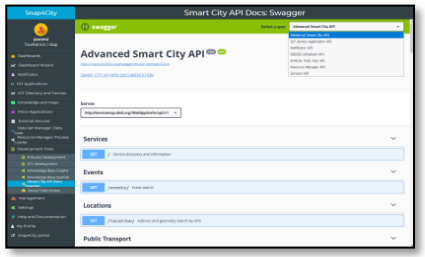
Using them into IOT Applications

Saving
Sharing
Reusing

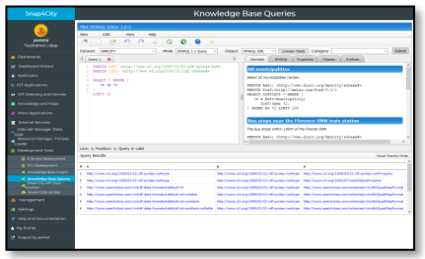
Resource Manager

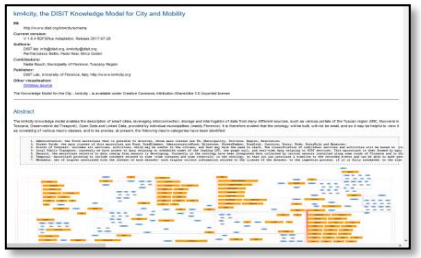
Data Analytics Development in Python,

Swagger



SPARQL, FLINT





Ontology Schema

LOG.disit.org

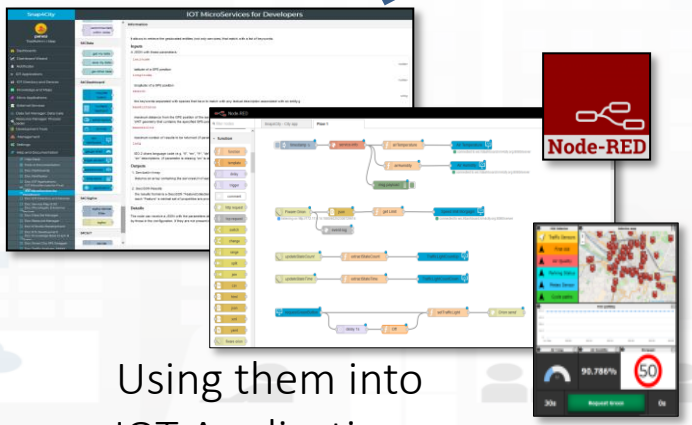
Knowledge Base, Km4City

Big Data Store Facility

Smart City API from Knowledge Base and other tools

Coding
Testing

Creating
Micro Services

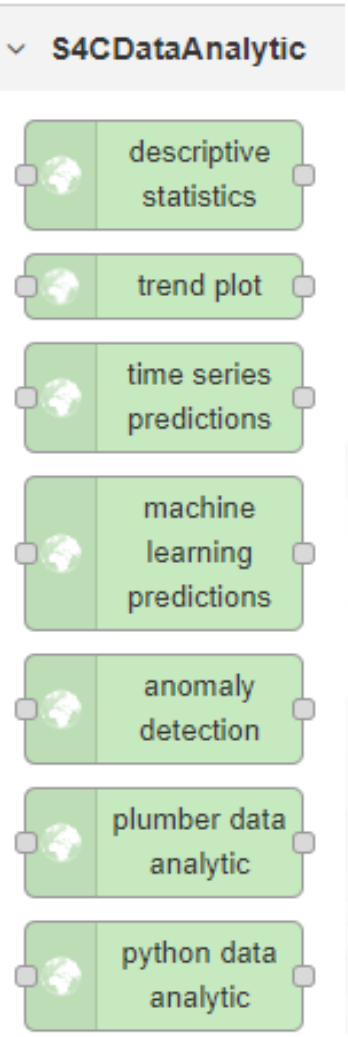


Using them into
IOT Applications

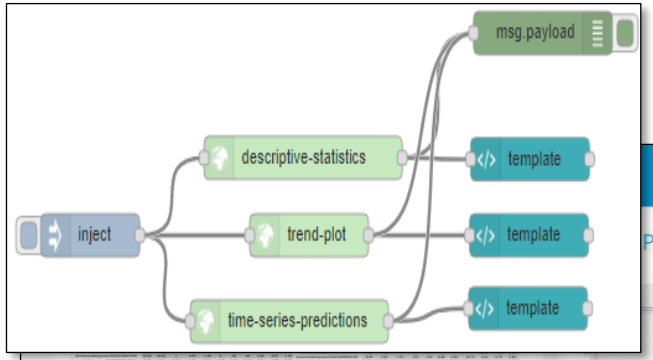
Saving
Sharing
Reusing

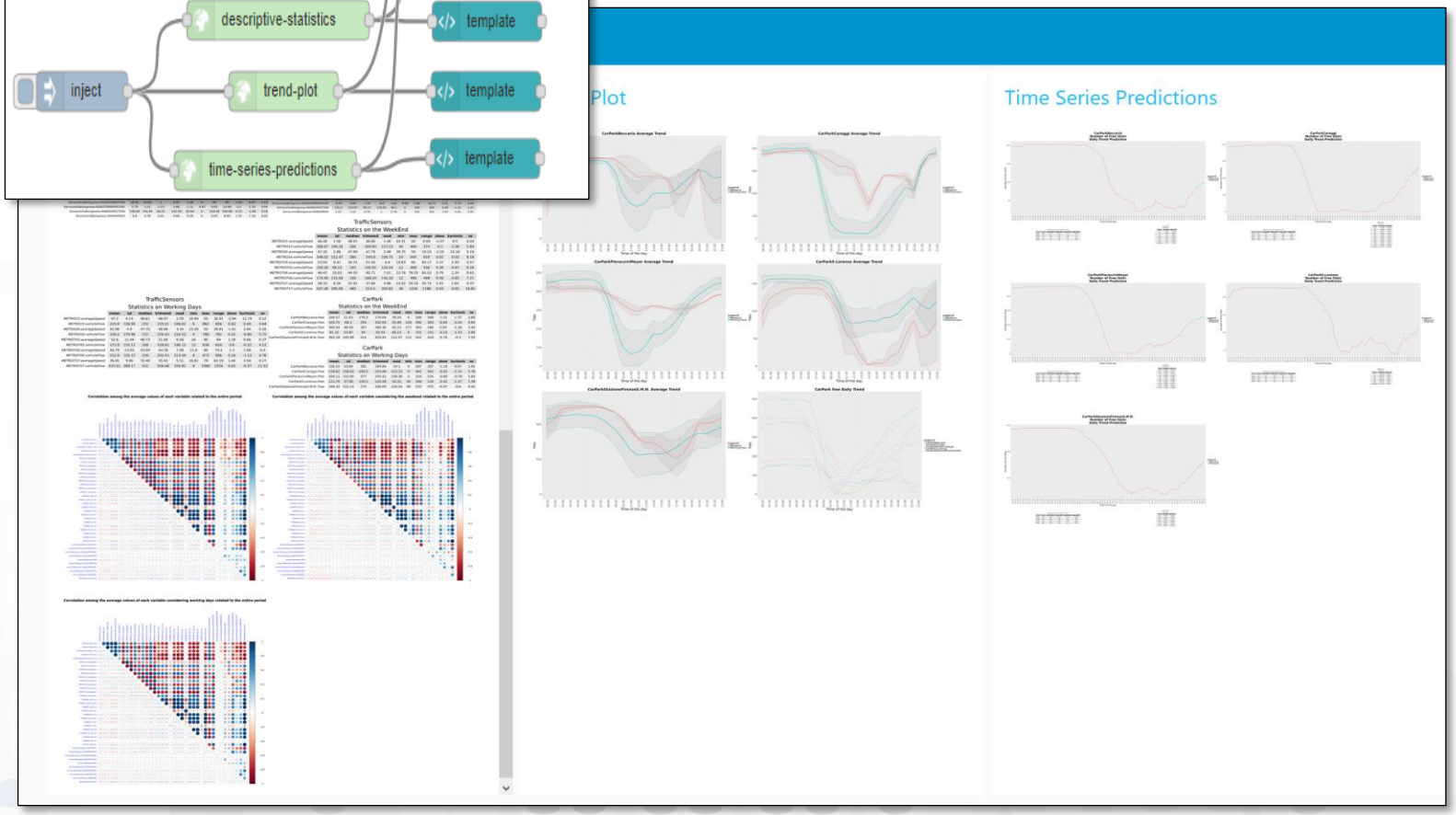
Resource Manager

Data Analytics to MicroServices



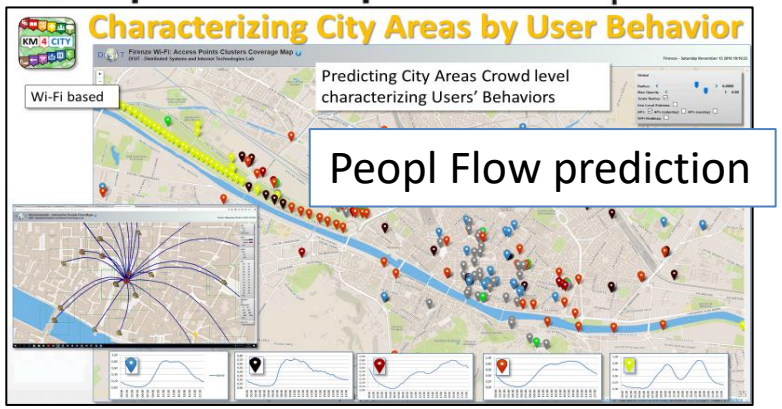
R Studio and Python algorithms are **automatically** transformed into **MicroServices** for your IOT Applications





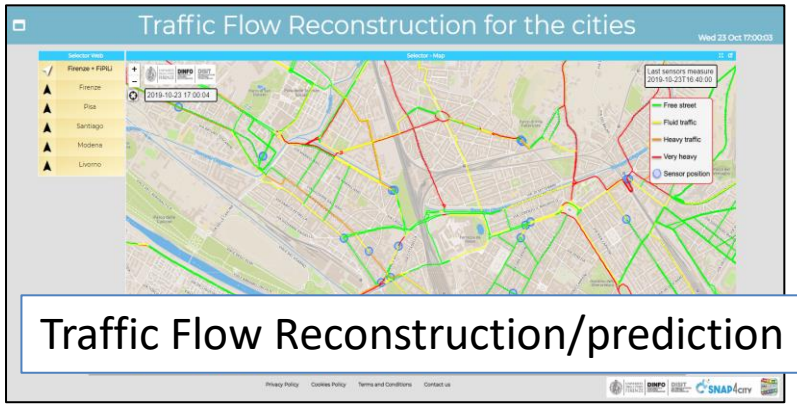
Data Analytics

Characterizing City Areas by User Behavior

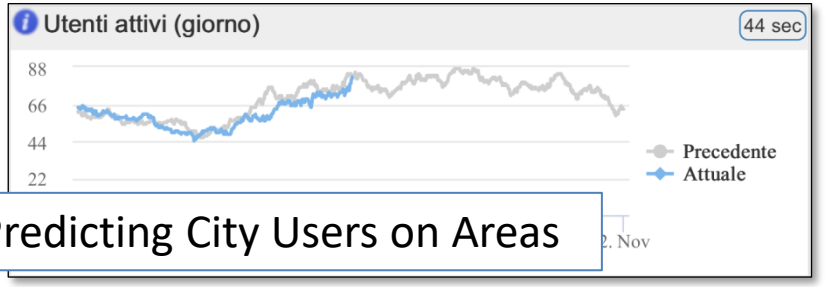


Peopl Flow prediction

Traffic Flow Reconstruction for the cities



Traffic Flow Reconstruction/prediction



Predicting City Users on Areas

Free Parking Predictions

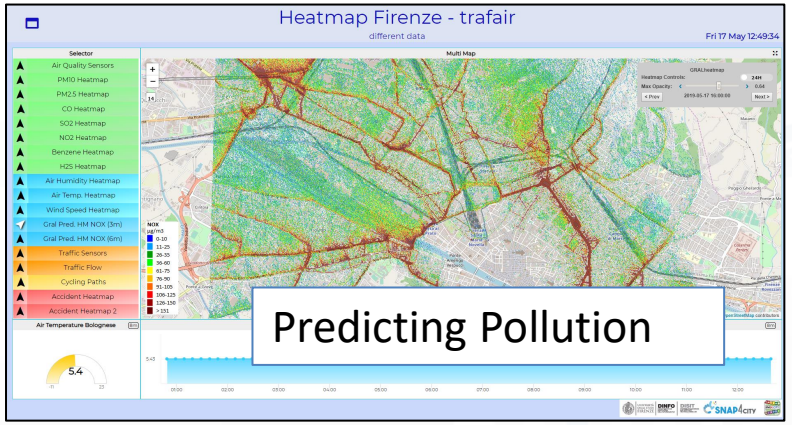
Careggi car park			
Model features	BRNN model results		
	R-squared	RMSE	MASE
Baseline	0.974	24	1.87
Baseline + Weather	0.975	24	1.75
Baseline + Traffic sensors	0.975	24	2.04
Baseline + Weather + Traffic sensors	0.975	24	1.87

Active on Mobile Apps as:

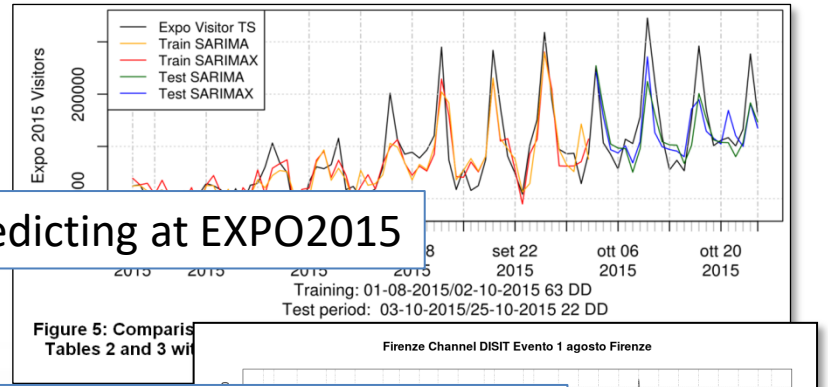
– «Firenze dove cosa»

– «Toscana dove cosa»

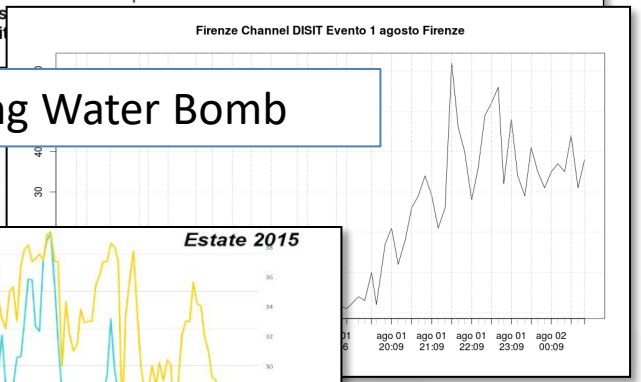
Precision: 97,5%



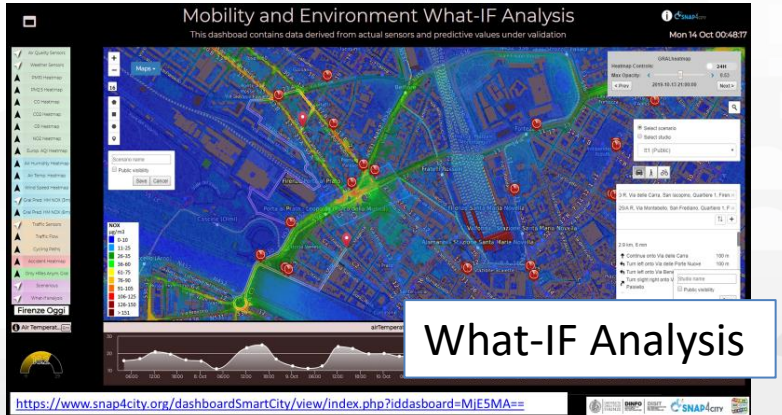
Predicting Pollution



Predicting at EXPO2015



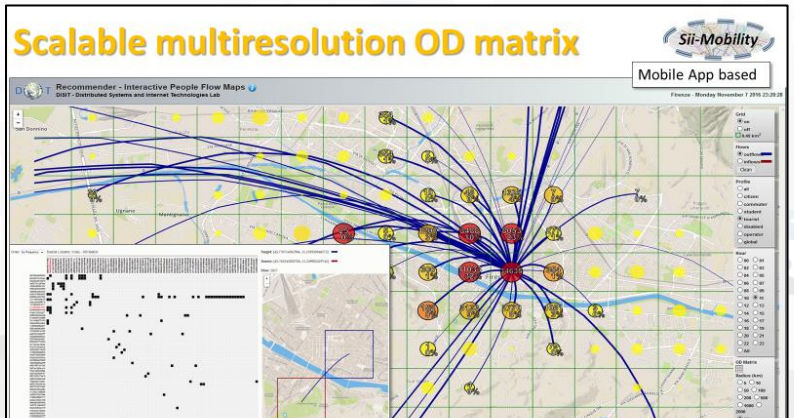
Early Warning Water Bomb

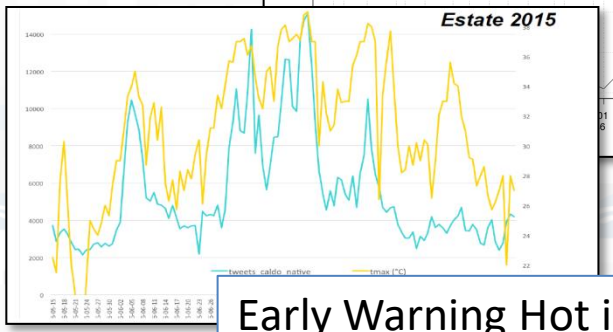


What-IF Analysis

Scalable multiresolution OD matrix

Mobile App based





Early Warning Hot in Tuscany

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Disappearing Data Analytics

SNAP4CITY | KM 4 CITY

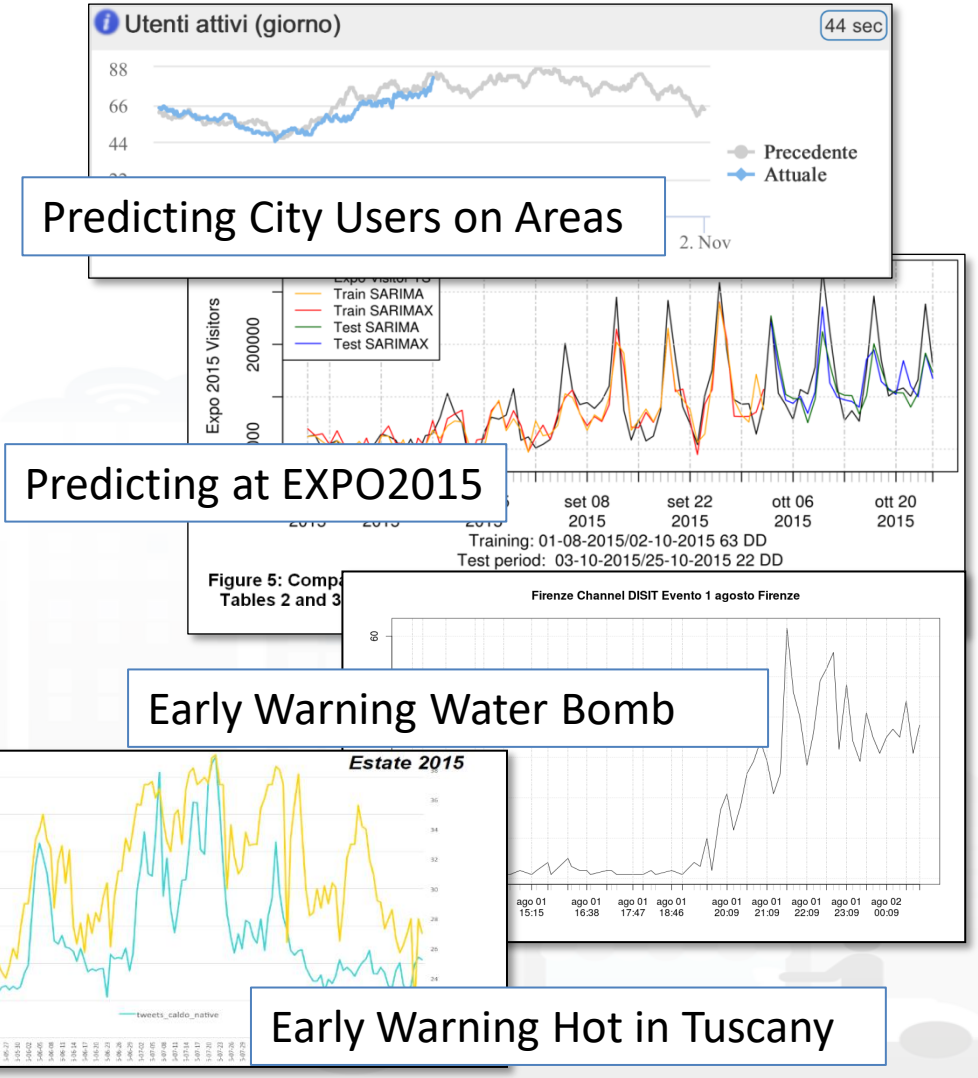
	Antwerp					Helsinki								Where				
SNAP4CITY	City official	ICT official	Developer	Citizen, tourist, visitor	Business owner	City officials	City officials Domain experts	City officials City developers	Third party developers	Citizen	Citizens with respiratory problems	Tourists	Business owners	Mobile	MIcroApplication	Tool, via Portal (ICT Developers)	Dashboards	RULE OF THUMB Main Data Sources
Discovery near to me	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			POI, OSM
Discovery along a path	X	X	X	X		X		X	X	X	X	X		X	X			POI, OSM
Discovery in an area, shape	X	X	X	X	x	X	X	X	X	X	X	X	x	X		X		POI, OSM
browsing Public Transport	X	X	X	X	x	X	X	X	X	X	X	X	x	X	X			OSM, GTFS
Full Text search	X	X	X	X	X	X		X	X	X	X	X	X	X		X		POI, OSM
Routing: pedestrian				X	x			X	X	X	X	X	x	X	X			OSM
Routing: pedestrian quite				X	x			X	X	X	X	X	x	X	X			OSM
Routing: private vehicles	X		X	X		X		X	X	X	X	X		X	X			OSM
Routing: Multimodal Public Transport				X					X	X	X	X		X	X	X		OSM, GTFS
heatmaps: weather (Temp, Humidity)	X	X		X	X	X	X		X	X	X	X	X	X			X	Sensors data, OSM
heatmaps: environmental variables, PM10, PM2.5, NO2, EAQI	X	X		X	X	X	X		X	X	X	X	X	X			X	Sensors data, OSM
heatmaps: environmental variables, Noise						X	X		X	X	X	X	X	X			X	Sensors data, OSM
heatmaps: safe on bike (Antwerp)	X	X		X	X									X			X	Spec. Portal
heatmaps: Enfuser prediction, PM10, PM2.5, AQI						X	X		X	X	X	X	X	X			X	Enfuser data
heatmaps piking values any place	X	X			X	X	X	X	X				X				X	Computed Heatmps
heatmaps: GRAL prediction, PM10						X	X		X	X	X	X	X	X			X	OSM, Traffic, Weather
Comparsison: Enfuser, Gral, Real Time						X	X										X	Enfuser, Sensors, GRAL
Sensors Data Time Trends, & drill down	X	X	X		X	X	X	X					X			X	X	Sensors data, OSM
Weather Forecast	X	X		X	X	X	X		X	X	X	X	X	X			X	Forecast Service
Origin Destination Matrices	X	X	X		X	X	X	X	X				X				X	Snap4City Mobile App
Typical trajectories	X	X	X	X	X	X	X	X	X				X			X	X	Snap4City Mobile App
Hot Area in the city	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	Snap4City Mobile App
Hot Places in Smart Zone	X	X	X	X	X									X		X	X	Snap4City PAXcounters
Services Suggestions on mobiles				X						X	X	X		X	X			Snap4City Mobile App
Alerts on critical cases: several variables	X			X	X	X	X			X	X		X	X				Sensors data, OSM
The most used services		X		X	X		X			X	X	X	X				X	Snap4City Mobile App
Twitter Trends Daily	X	X	X		X	X	X	X	X				X			X	X	Twitter Vigilance
The auditing of user and living lab		X				X		X								X		Snap4City Portal
Self assessment	X	X	X	X	X	X	X	X	X	X	X	X	X			X		Snap4City Portal
Trajectories reg from mobile PAX Counters	X	X	X			X	X	X							X		X	PAX Counters

DATA ANALYTICS

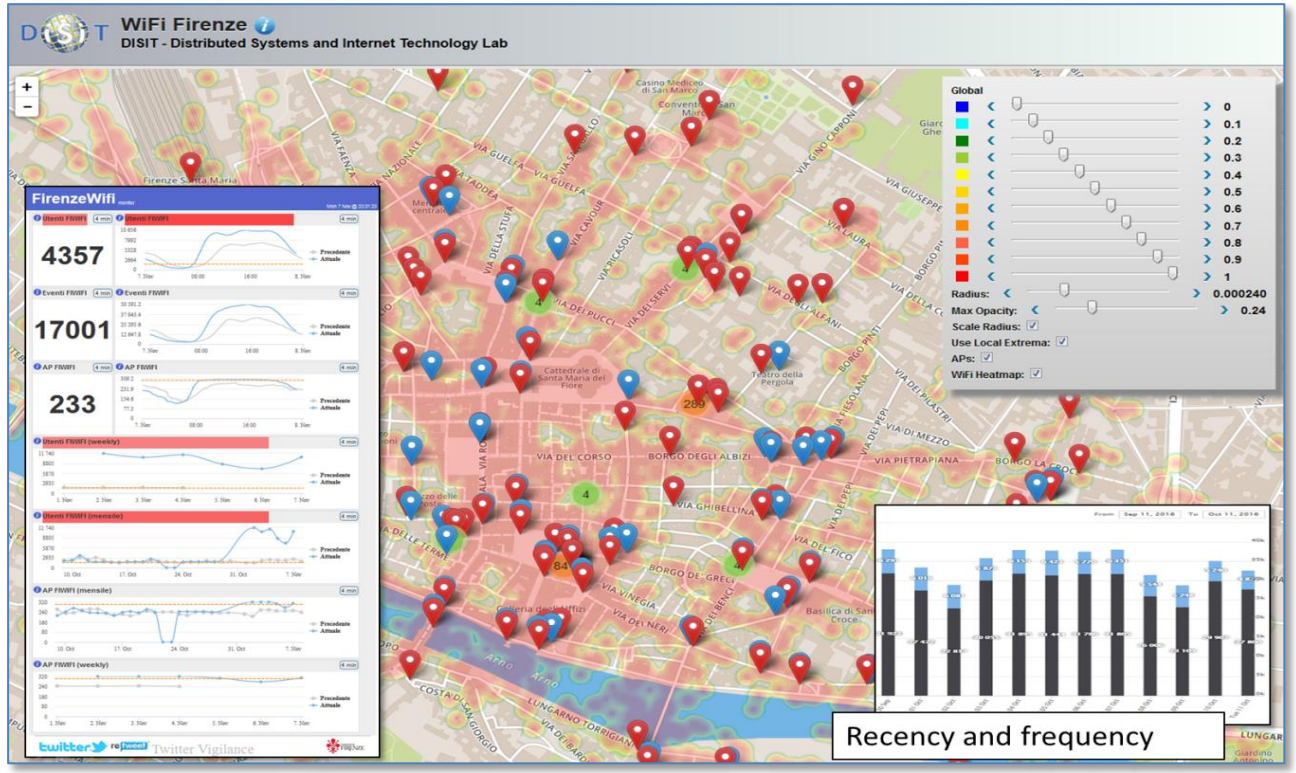
- Resilience
  - Resilience and risk analysis
  - Early warning computation
  - What-if analysis, dynamic routing, origin destination matrices production from a large range of sources
- Mobility and transport
  - Traffic flow reconstruction from sensors and other sources
  - Predictions for: traffic flow, smart parking, smart bike sharing, etc.
  - Analysis of the demand vs offer of mobility according to public transportation and multiple data sources
  - Accidents heatmaps
  - Tracking fleets, people, via devices: OBU, OBD2, mobile apps, etc.
  - Routing and multimodal routing
- Environment and weather
  - NOX, PM10 pollution prediction on the basis of traffic flow, 48 hours
  - Long term prediction of European Commission KPIs on NOX, PM10, etc.
  - Heatmaps production, dense data interpolation
- User and Social
  - People flows prediction and reconstruction, via Wi-Fi, mobile apps, etc.
  - User engagement for sustainable mobility
  - User's behaviour analysis, origin destination matrices, hot places, time schedule, Recency and frequency, permanence, etc.
  - People flow analysis from PAX Counters
  - Social media analysis on specific channel, specific keywords: see Twitter Vigilance, for NLP and Sentiment Analysis, SA
  - Tweet proneness, retweet-ability of tweets, impact guessing
  - Audience prediction to TV channels and physical events
- Generic
  - Data quality assessment, prediction, anomaly detection
  - Maintenance prediction and costs predictions
  - Estimation of KPI and local indexes for: quality of life, 15 minutes, etc.

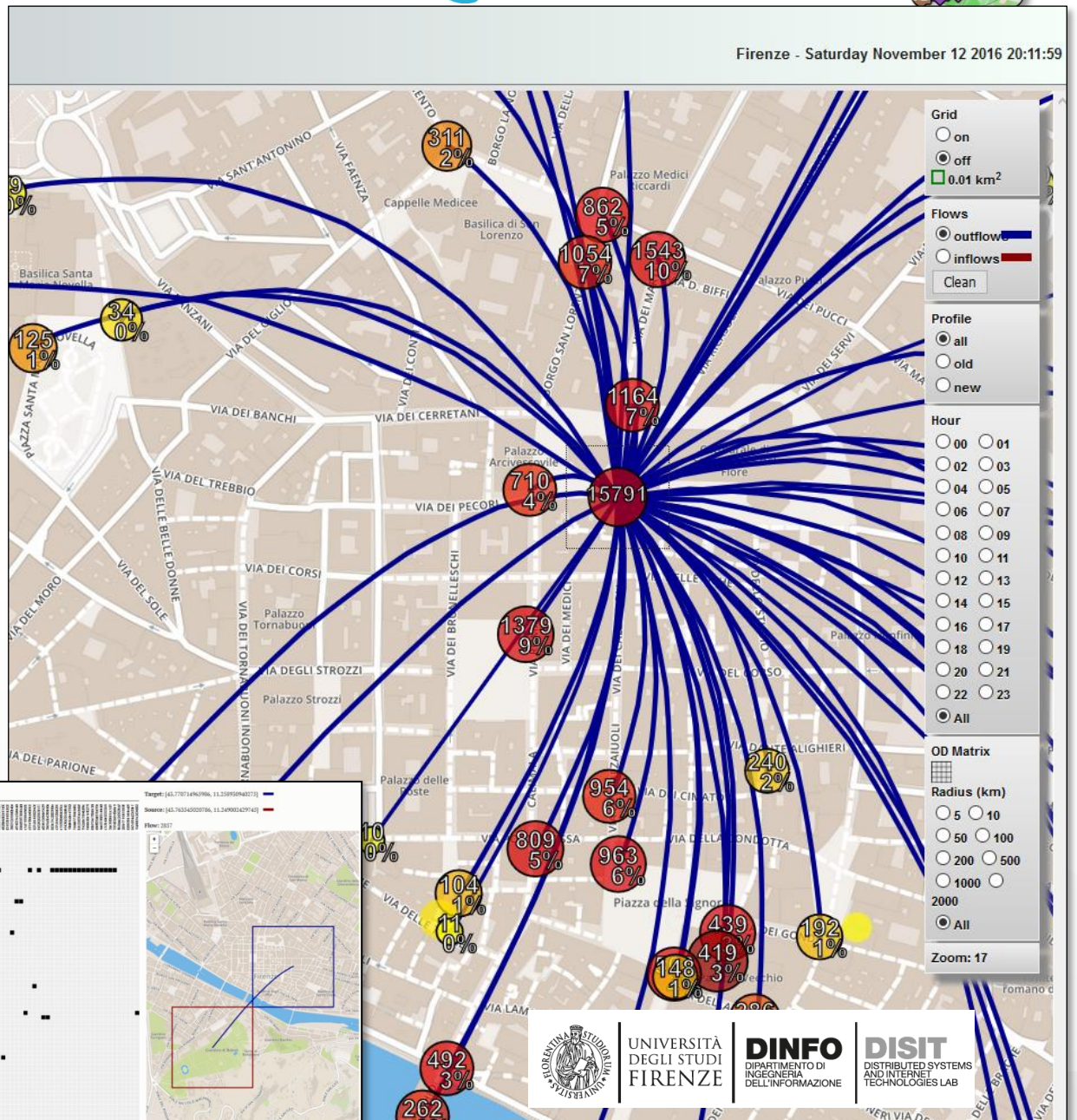
Predicting Models for Administrators & City Users

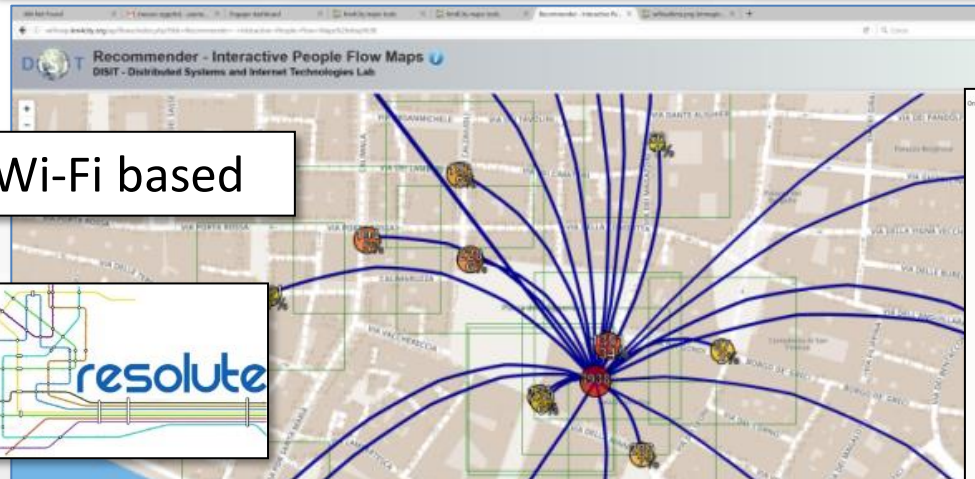
- **Aiming at improving**
  - quality of service, distributing workload
  - early warning
- **Predictions**: **Short** (15 min, 30 Min) and mid Term (1 week)
- **Data Analytics**: ML, NLP/SA, Clust., …
  - Traffic Flows → multi-flow reconstruction
  - Parking Status → free slots
  - Environmental Alarms
  - Air Quality parameters and indexes
  - People Flows (Wi-Fi, Twitter)
    → crowd , #number of people



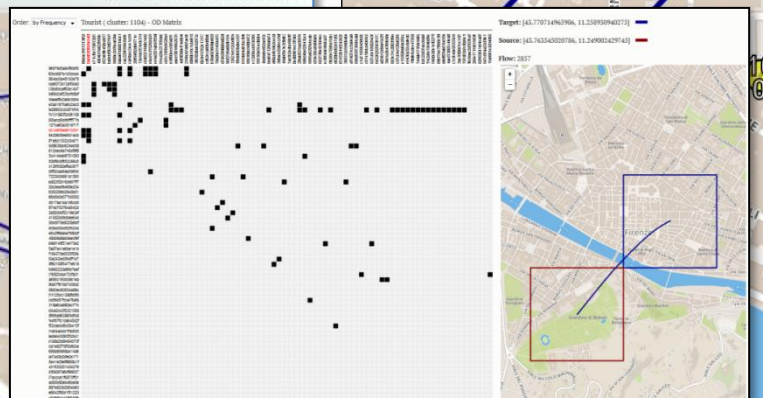
Origin Destination Matrix Estimation







Wi-Fi based

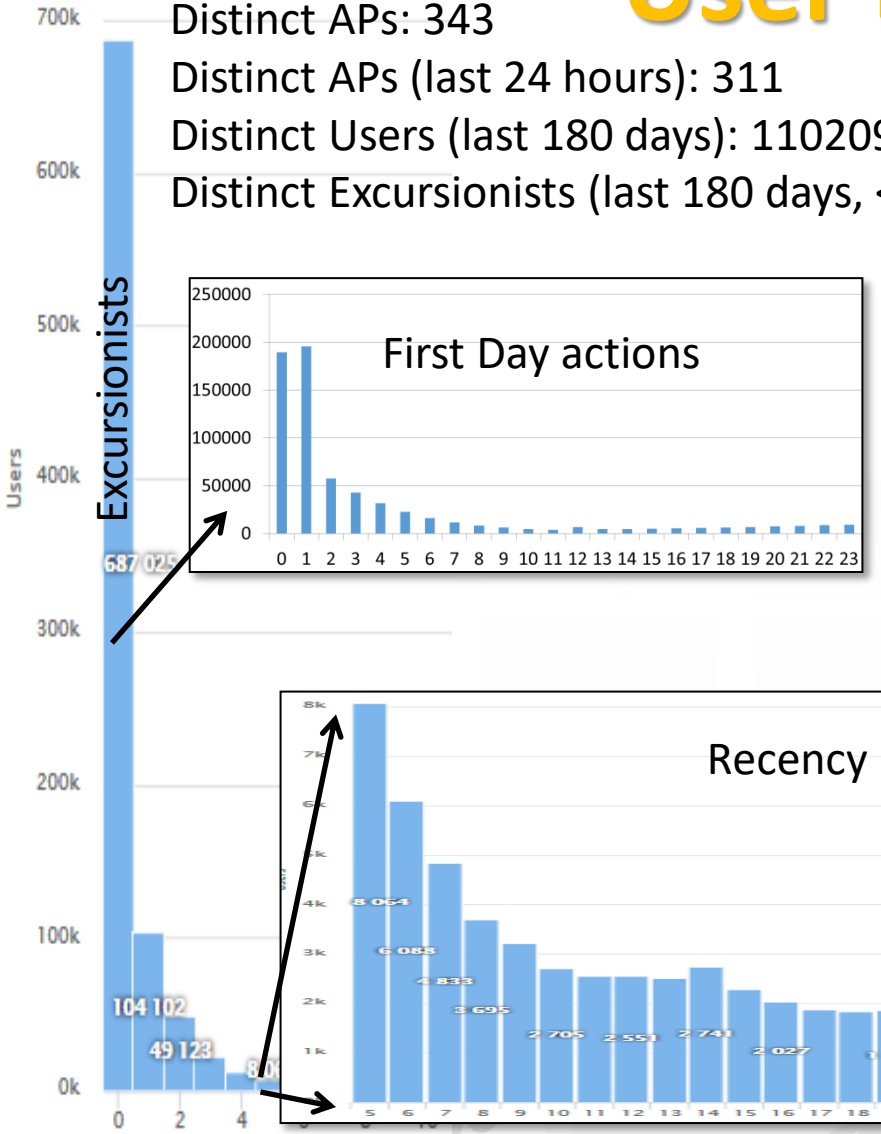


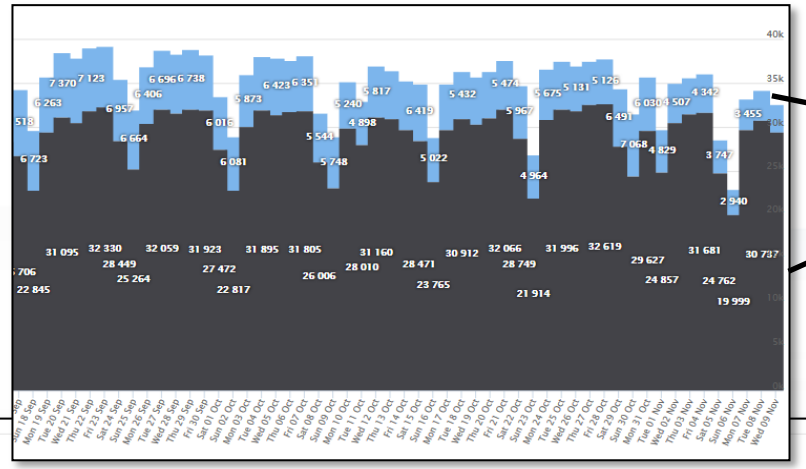
resolute

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

User Behaviour Analysis

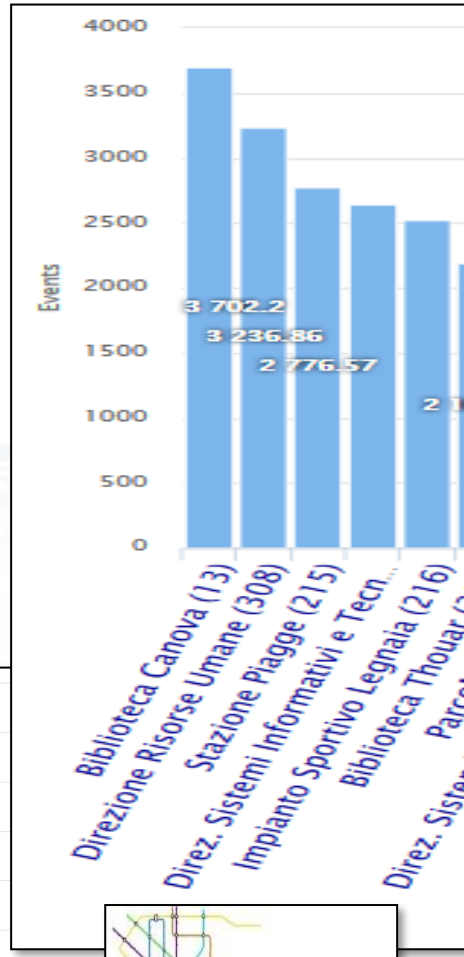
Distinct APs: 343
Distinct APs (last 24 hours): 311
Distinct Users (last 180 days): 1102098
Distinct Excursionists (last 180 days, < 24 h): 687025





New City Users
VS
Returning

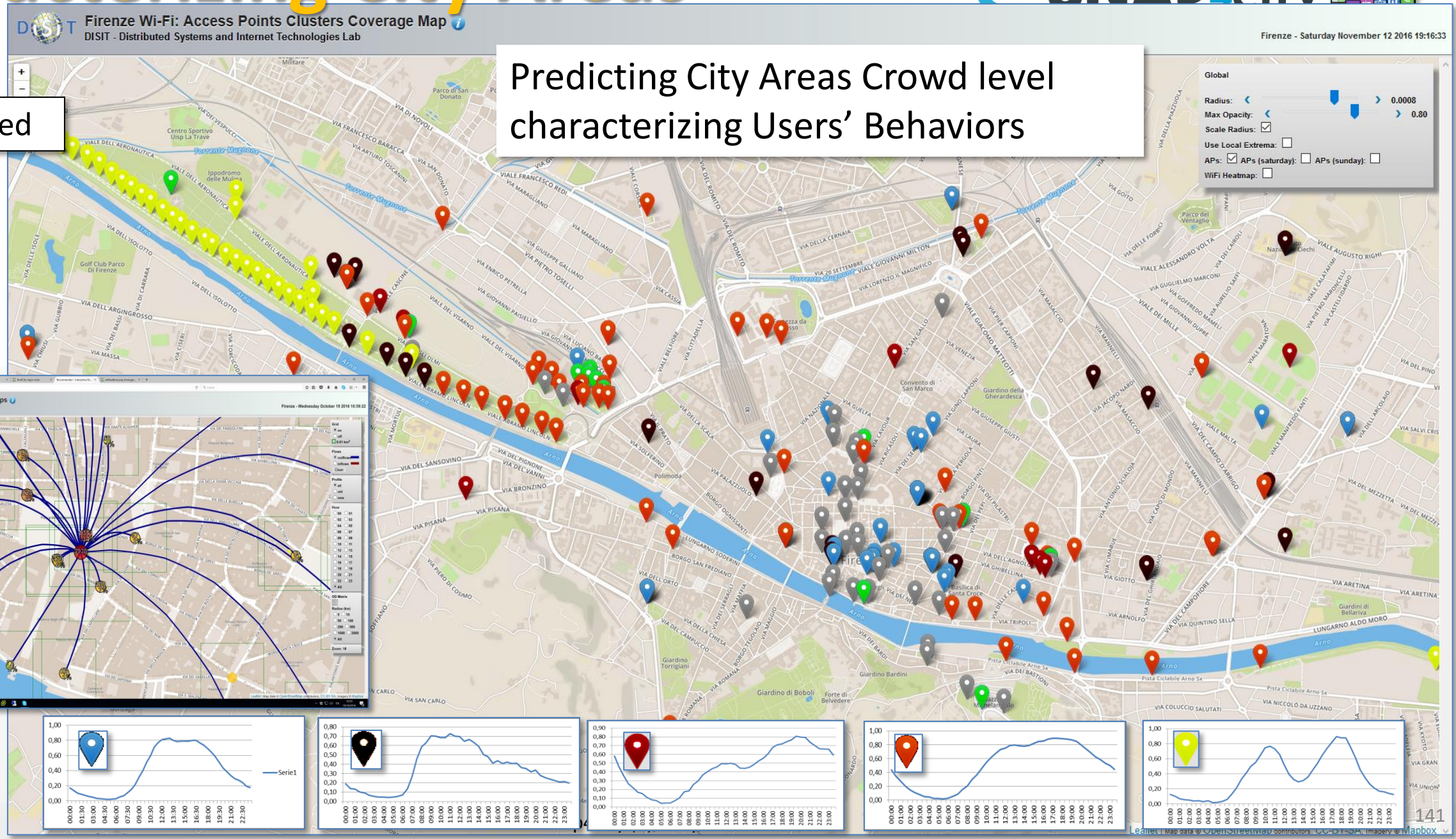
Where



Characterizing City Areas

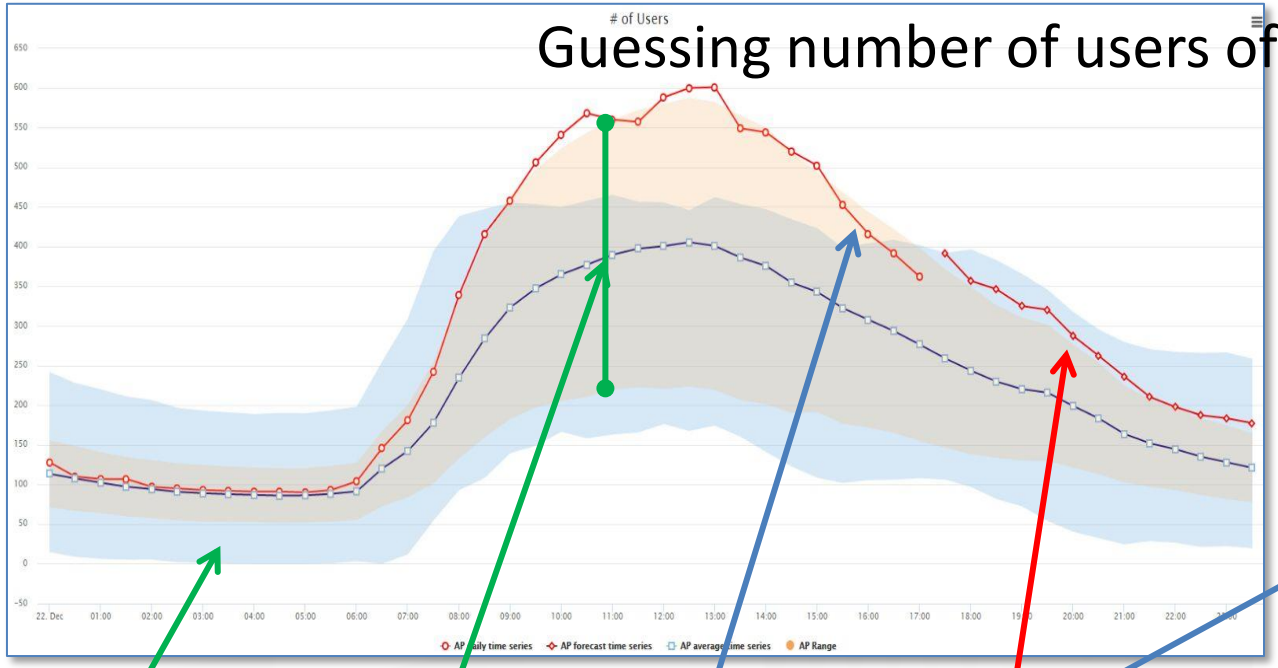
Wi-Fi based

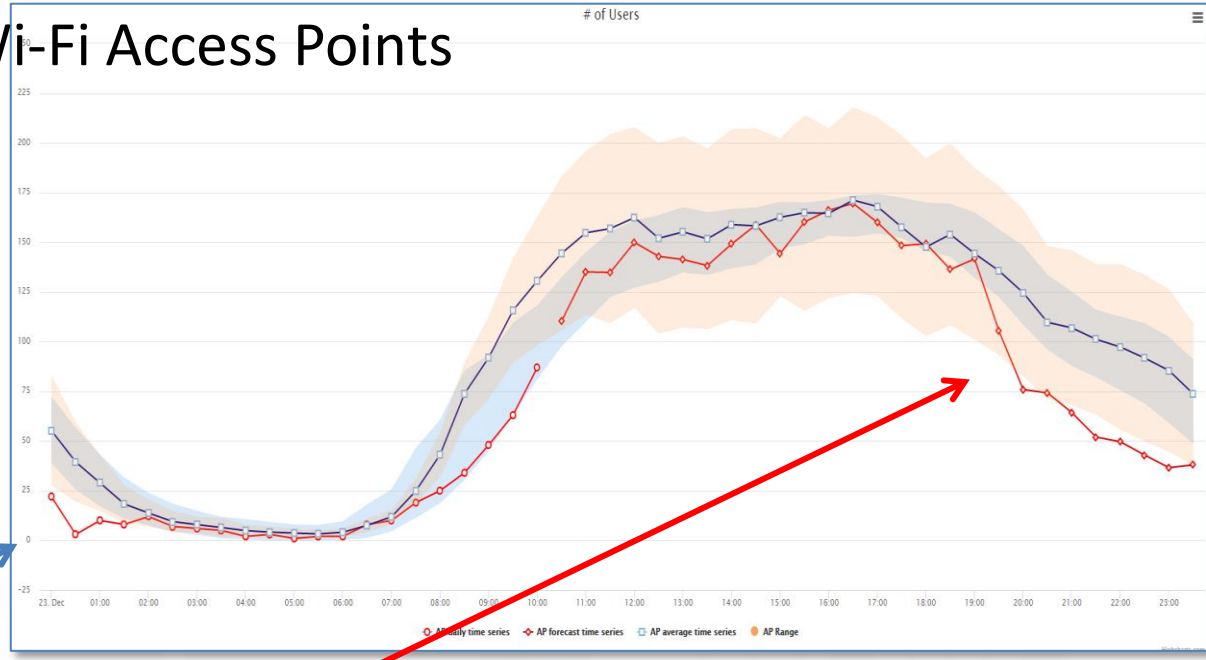
Predicting City Areas Crowd level characterizing Users' Behaviors



Prediction and Identification of Anomalies

Guessing number of users of Wi-Fi Access Points





Cluster confidence

AP average and confidence

Actual AP trend for today

AP prediction for the next time slot in the day on the basis of past weeks

Predictive precision of the 95%

Free Parking Predictions

Careggi car park			
Model features	BRNN model results		
	R-squared	RMSE	MASE
Baseline	0.974	24	1.87
Baseline + Weather	0.975	24	1.75
Baseline + Traffic sensors	0.975	24	2.04
Baseline + Weather + Traffic sensors	0.975	24	1.87

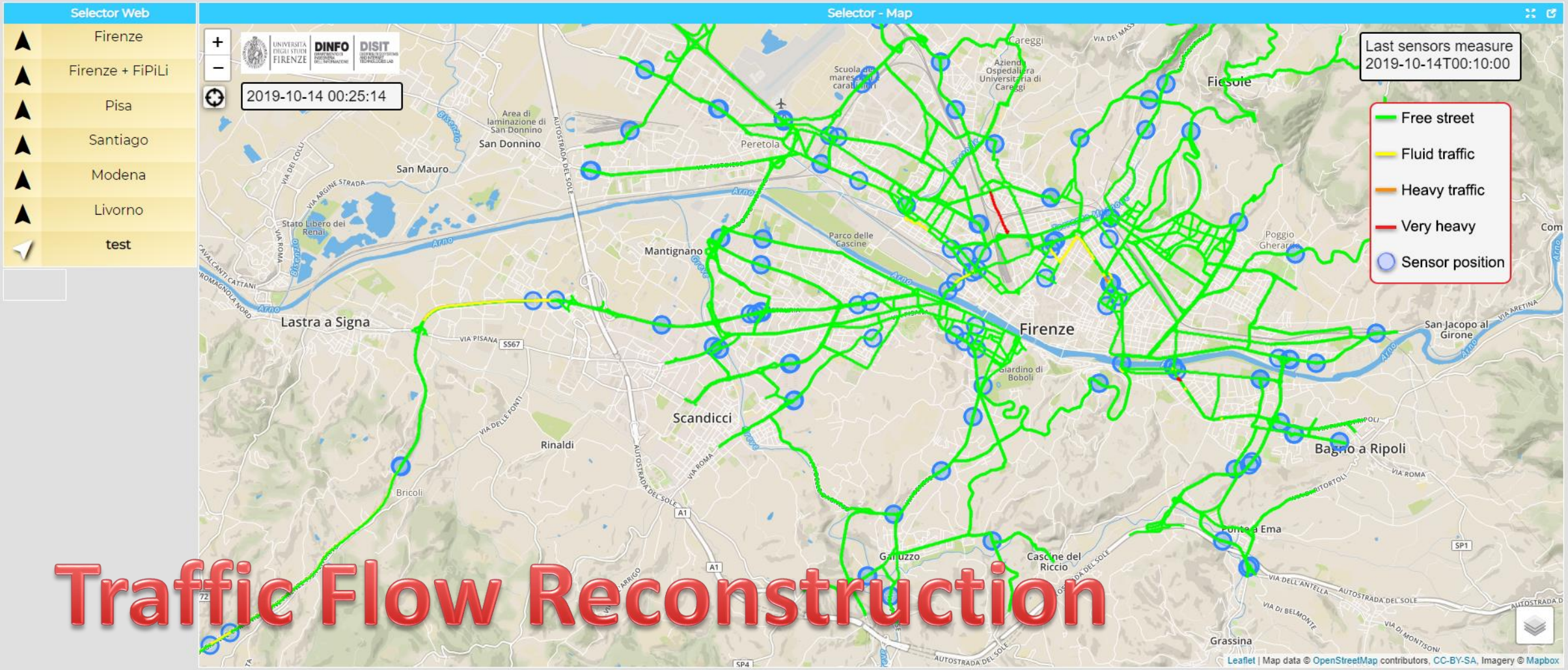
Active on Mobile Apps as:

- «Firenze dove cosa»
- «Toscana dove cosa»

Precision: 97,5%

Traffic Flow Reconstruction for the cities

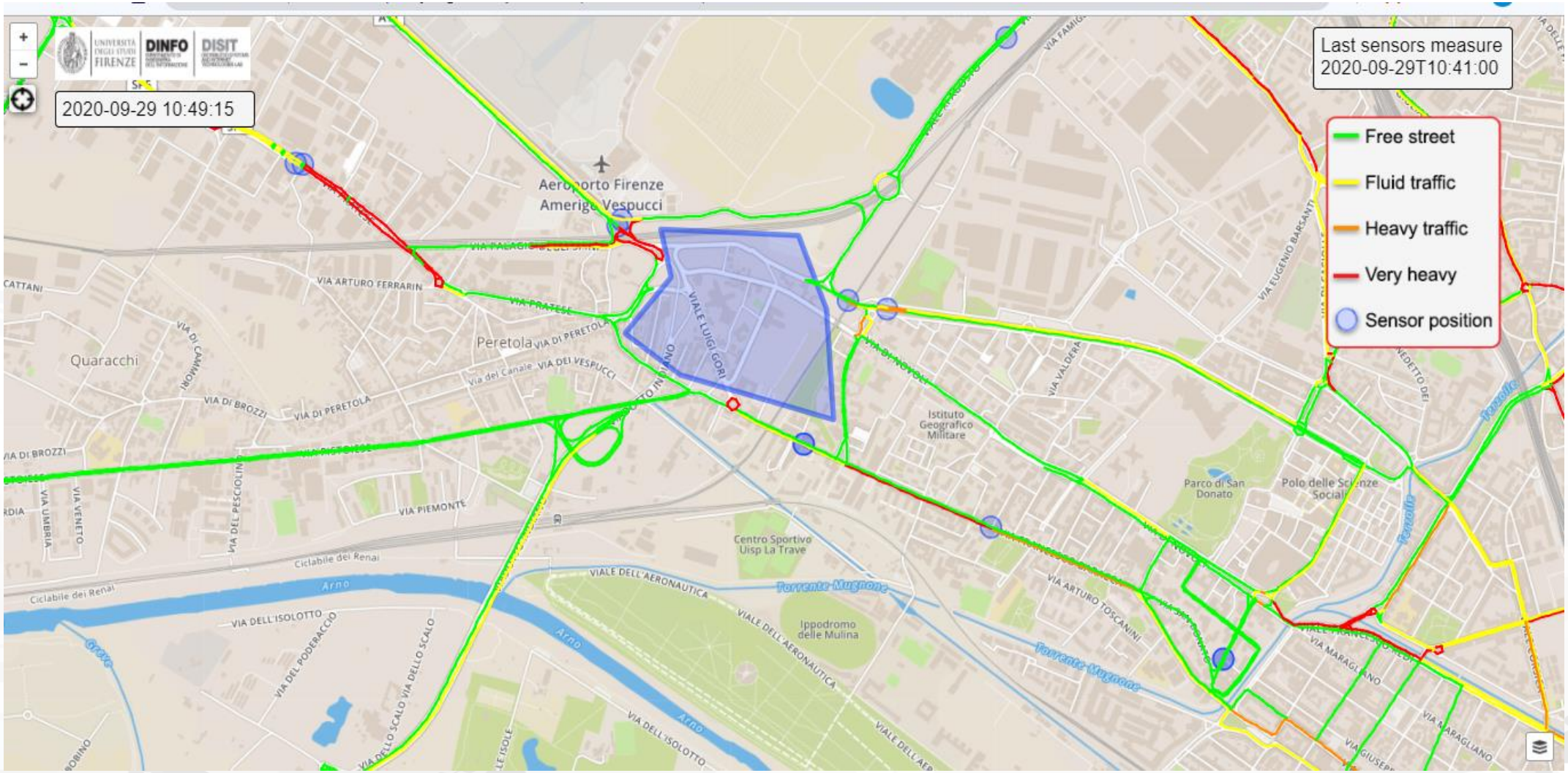
Mon 14 Oct 00:25:15



Traffic Flow Reconstruction

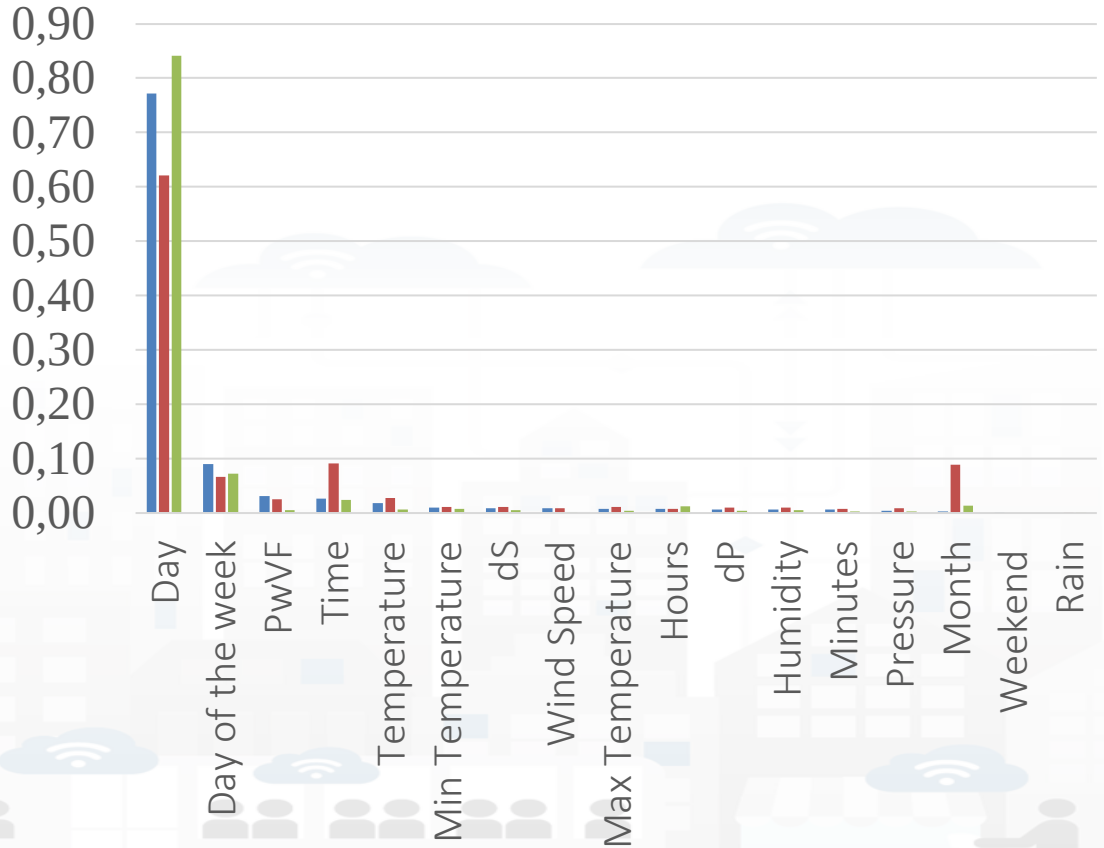
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc5NQ==

Computation of Traffic Flow Evolution



Traffic Flow predictions

XGBoost Model Results	R^2	RMSE	MASE
Sensors of Group 1	0.95	215	0.89
Sensors of Group 2	0.91	178	0.82
Sensors of Group 3	0.86	127	0.92



Heatmap Firenze - trafair

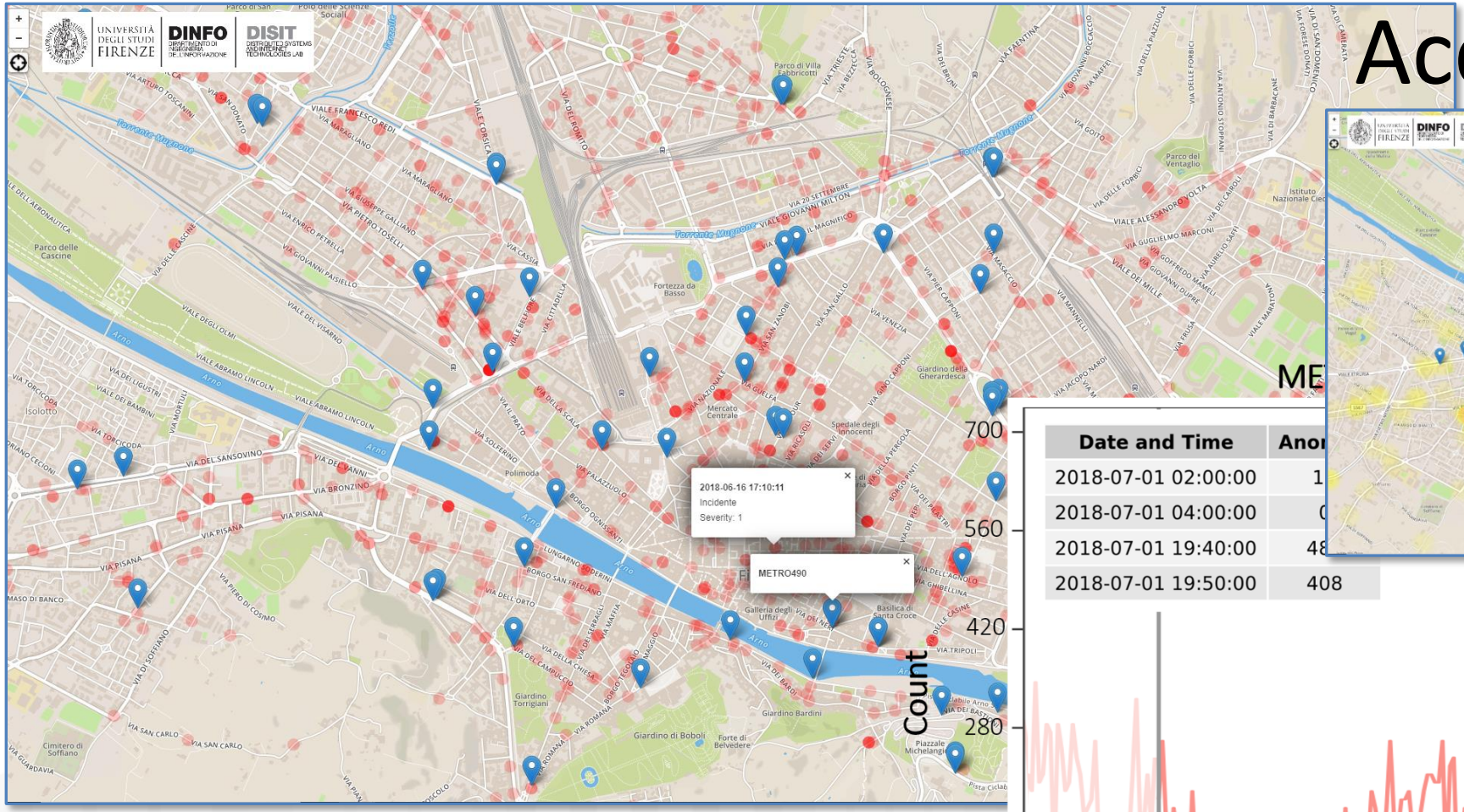
different data

Fri 17 May 12:49:34

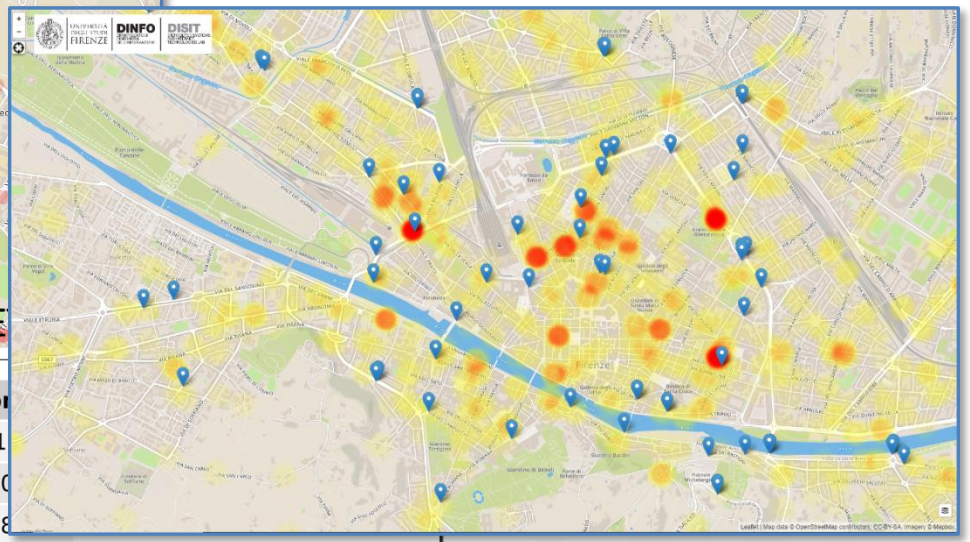
Florence, Pisa, Livorno

https://main.snap4city.org/view/index.php?iddasboard=MTUzMg==

Anomaly Detection

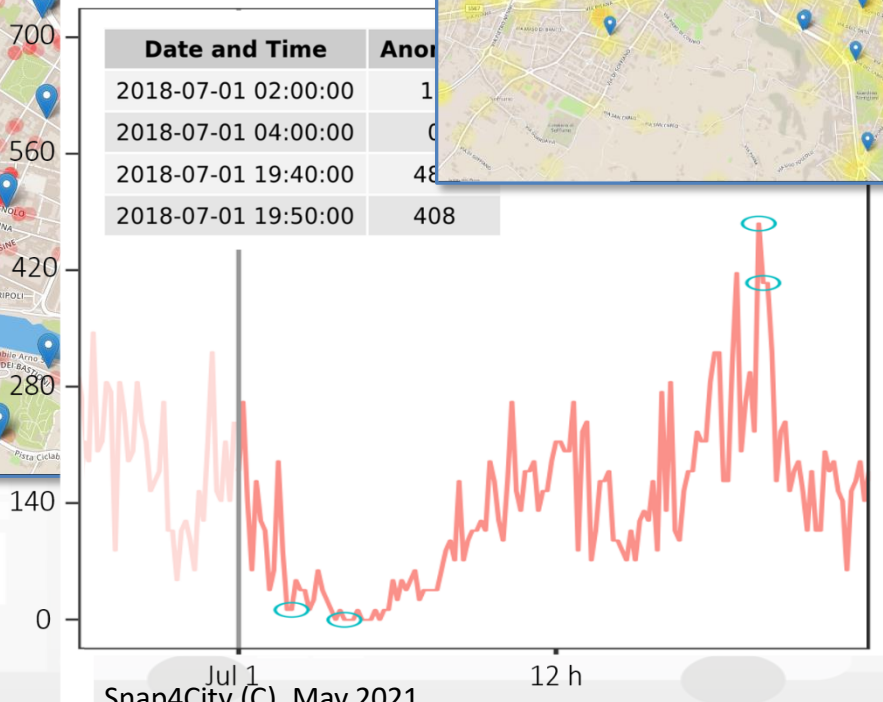


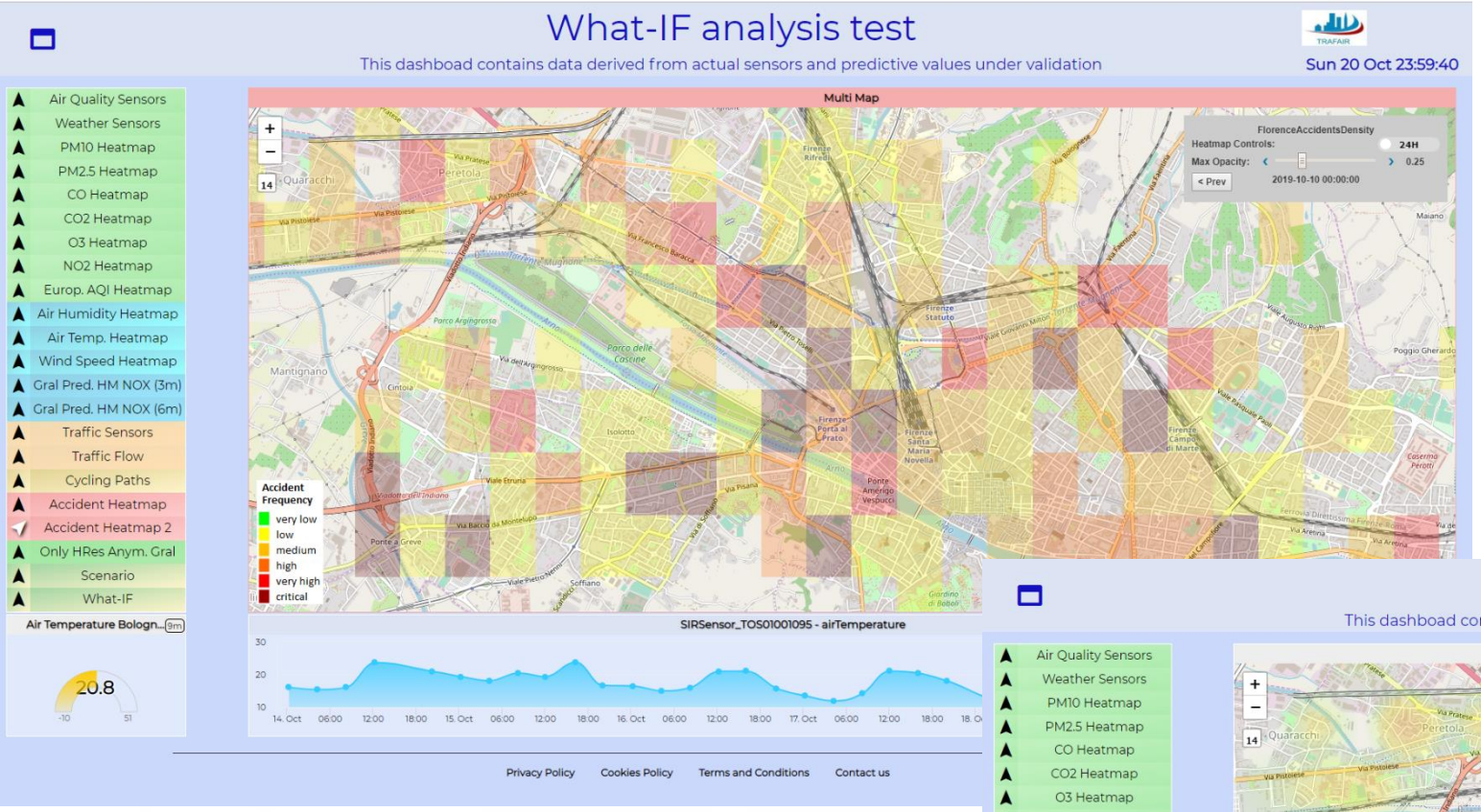
Accidents Density



Accidents vs Traffic

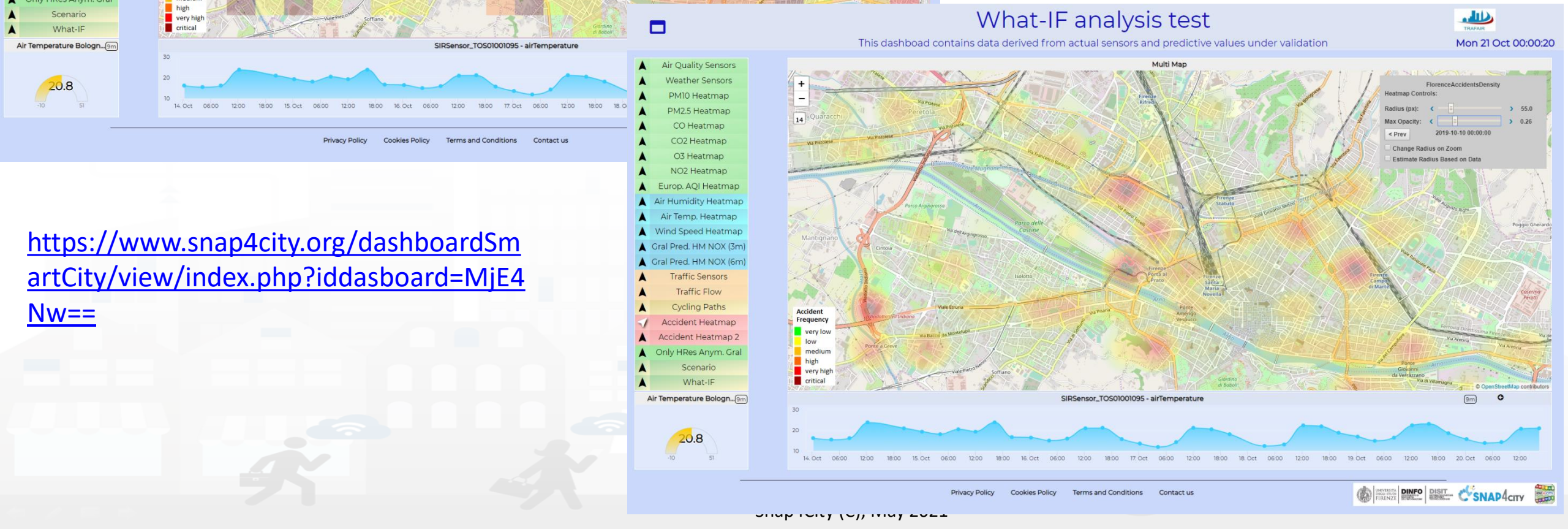
Date and Time	Ano
2018-07-01 02:00:00	1
2018-07-01 04:00:00	0
2018-07-01 19:40:00	48
2018-07-01 19:50:00	408





Florence

Accidents Density

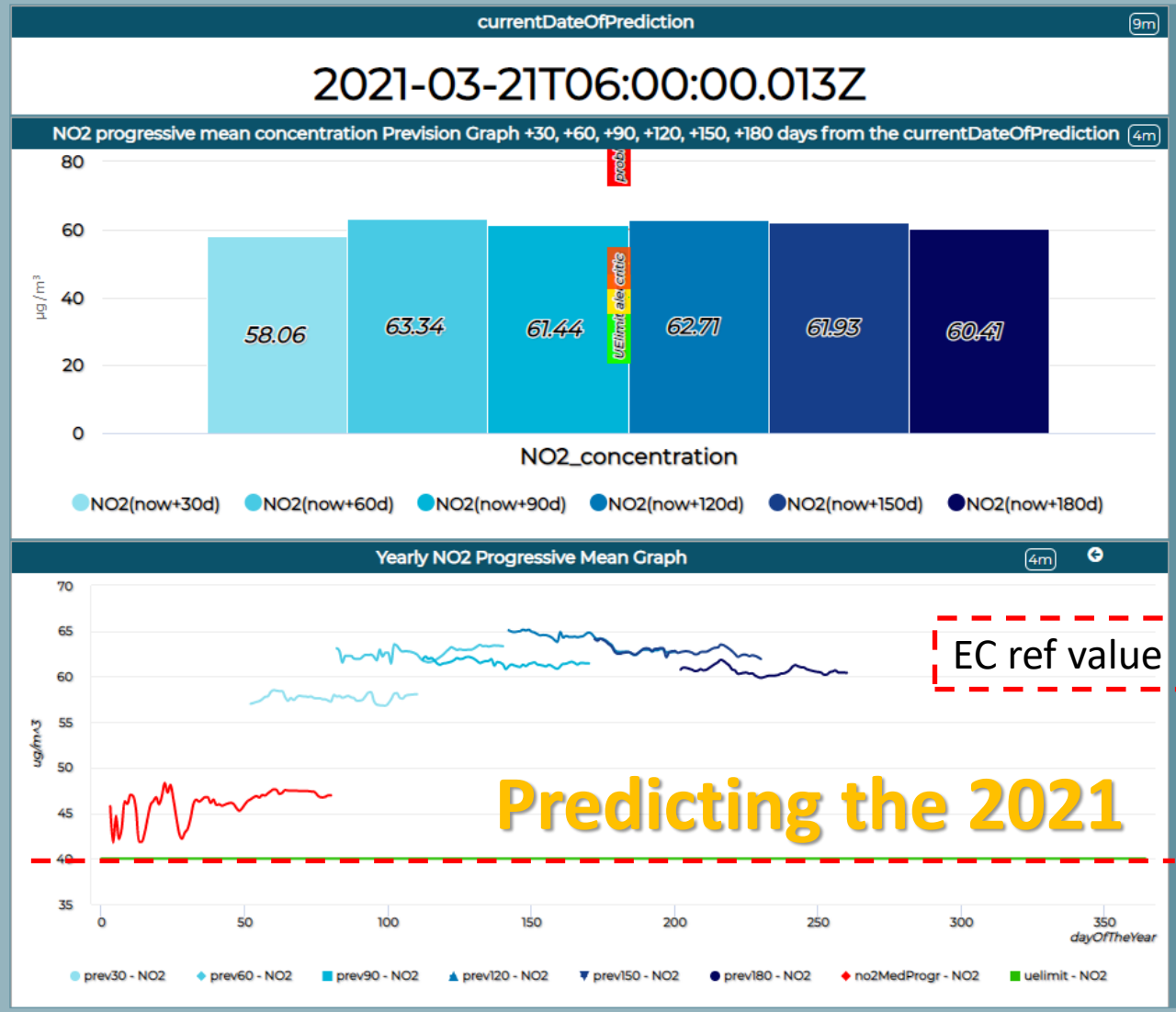


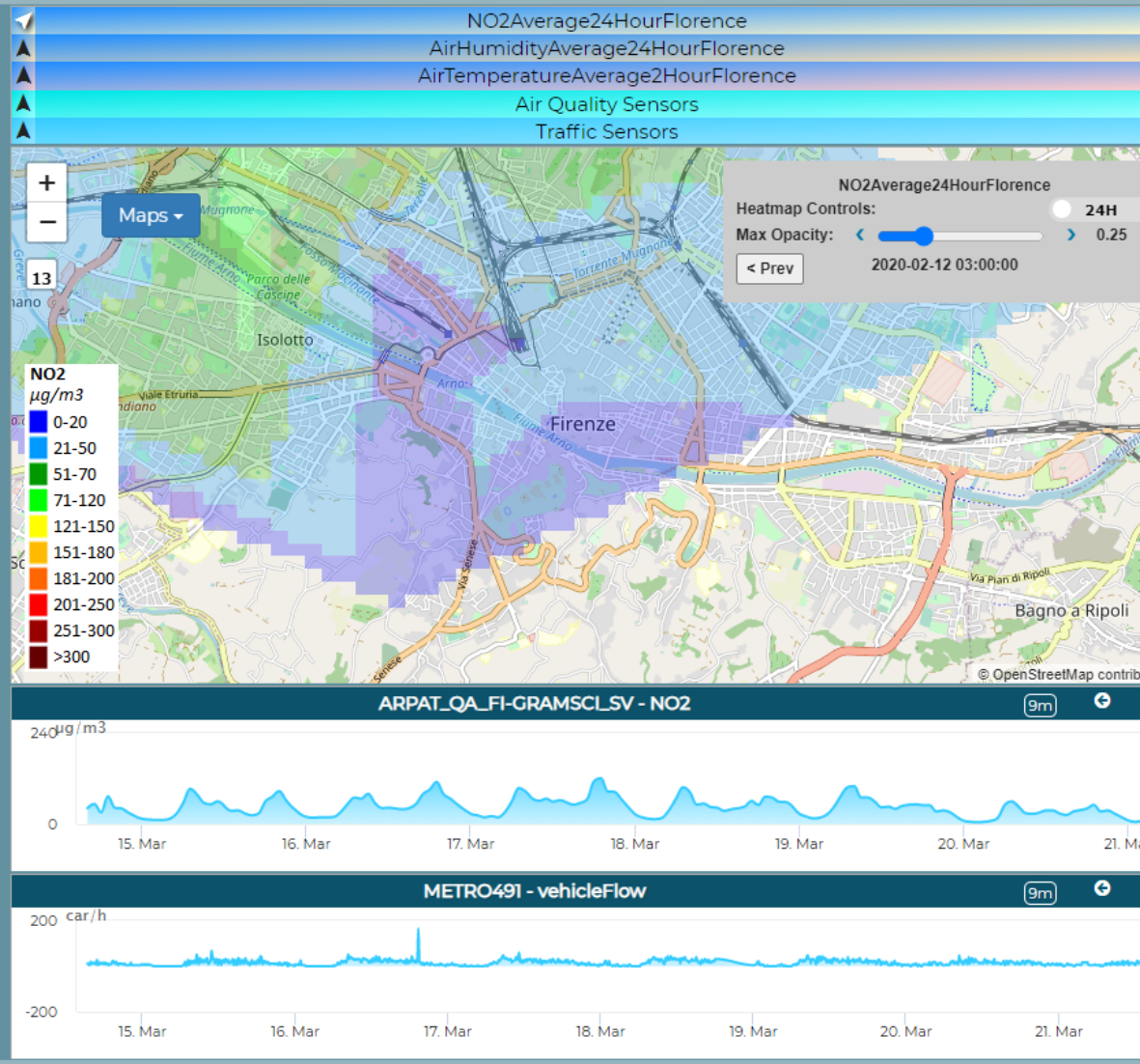
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjE4Nw==

Yearly NO2 Florence Monitoring Dashboard

This dashboard shows the predicted NO2 concentrations from the current date of prediction of 30, 60, 90, 120, 150 and 180 days ahead. The European Union has set the limit on the mean yearly value of NO2 concentration to 40 ug/m3.

Sun 21 Mar 15:18

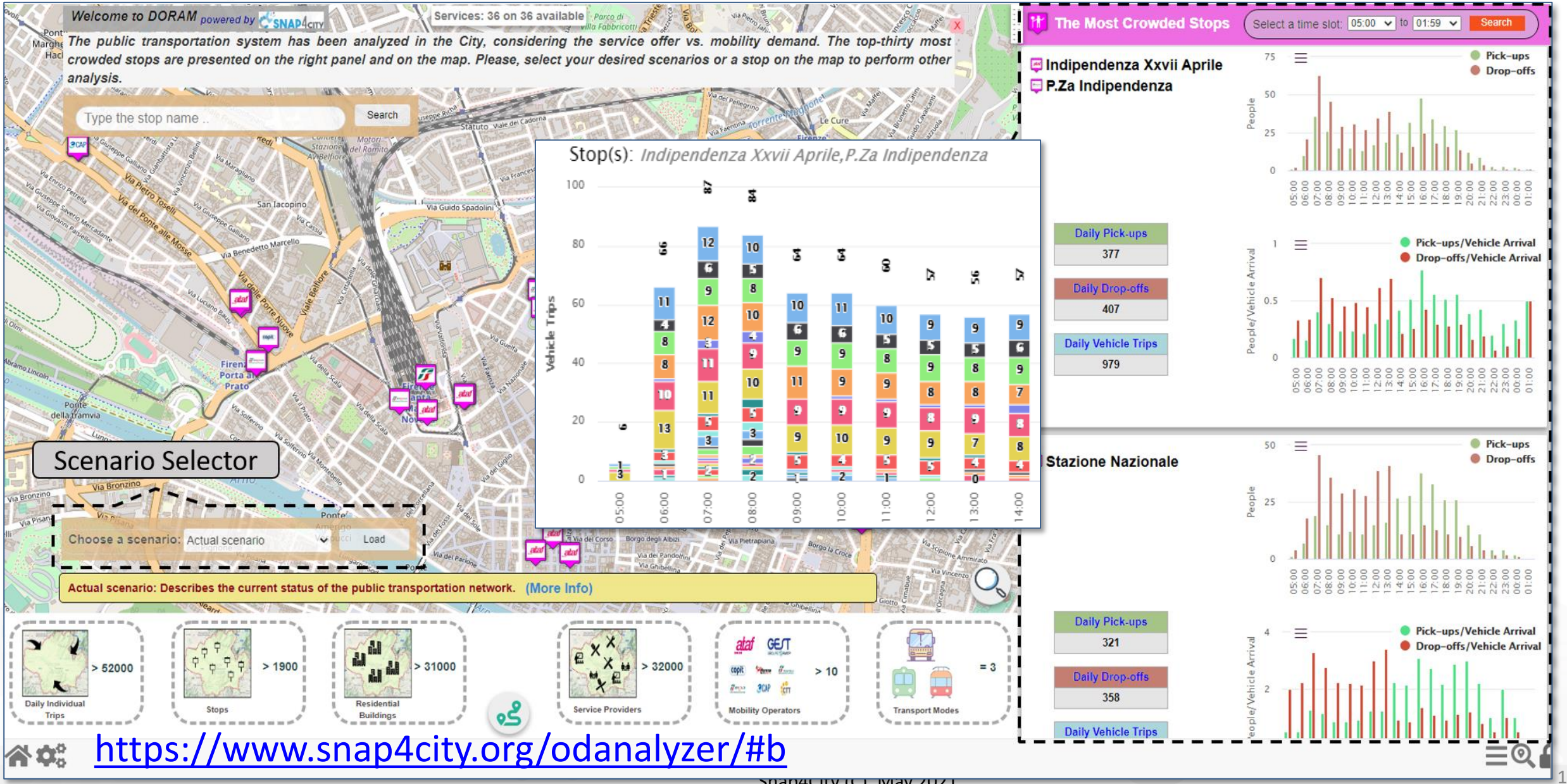




Privacy Policy Cookies Policy Terms and Conditions Contact us

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA2OQ==

DORAM

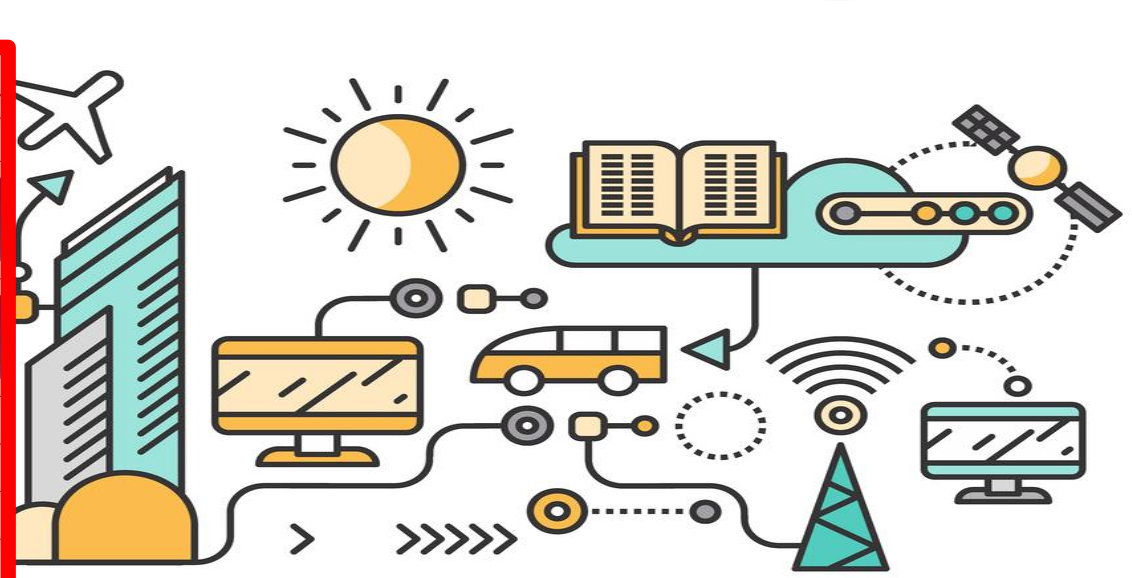


https://www.snap4city.org/odanalyzer/#b

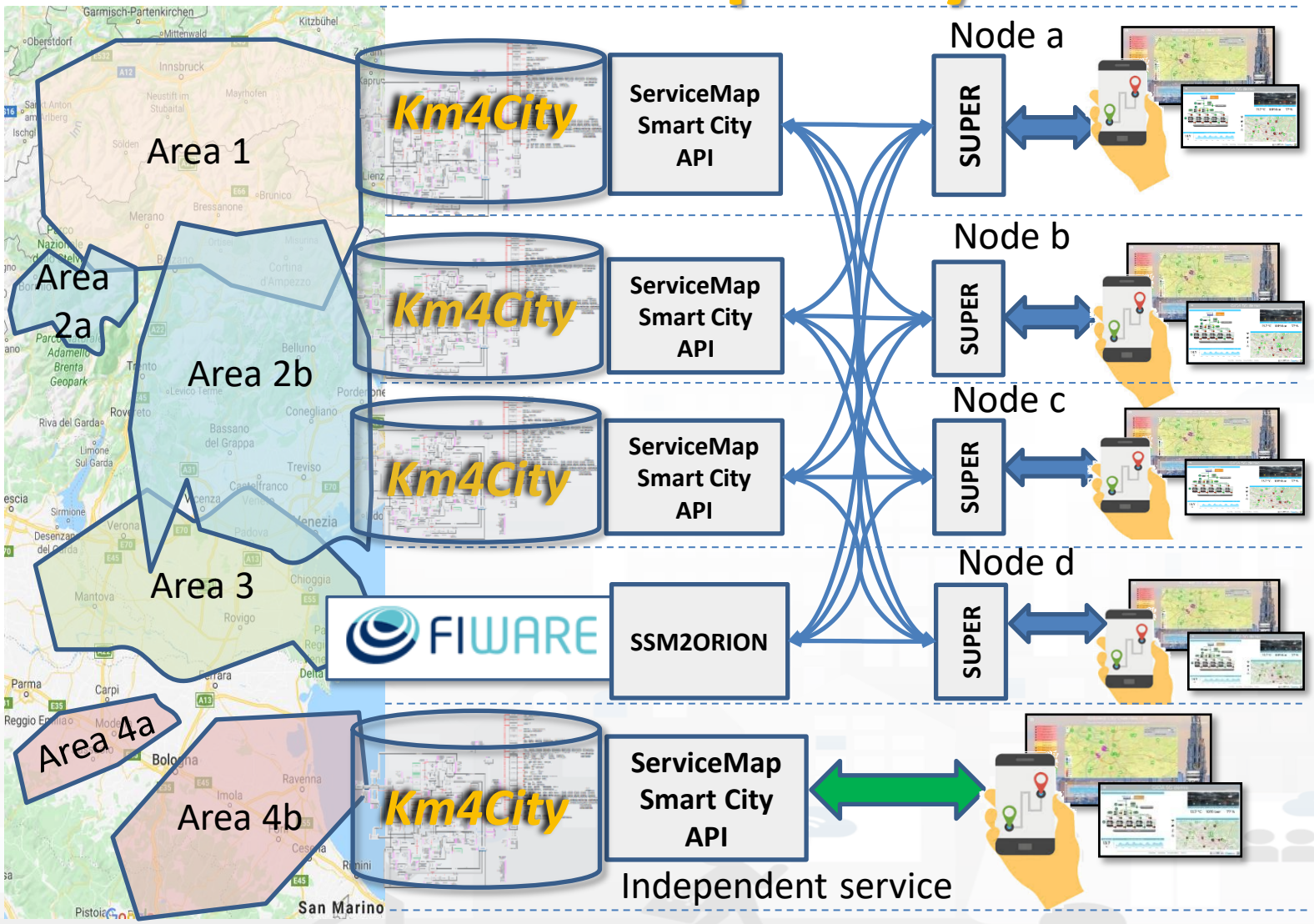
Mobile App Development
Smart City API and Federation

On Line Training Material (free of charge)

	1st part (*)	2nd part (*)	3rd part (*)	4th part (*)	5th part (*)	6th part (*)	7th part (*)
what	General	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	System and Depl Install	Smart City API: Web & Mob. App
PDF							
Inter active							
Video1							
Video2							
Video3							
Video4				none		none	none
duration	2:55	3:16	3:41	2:00	2:48	2:35	1:47

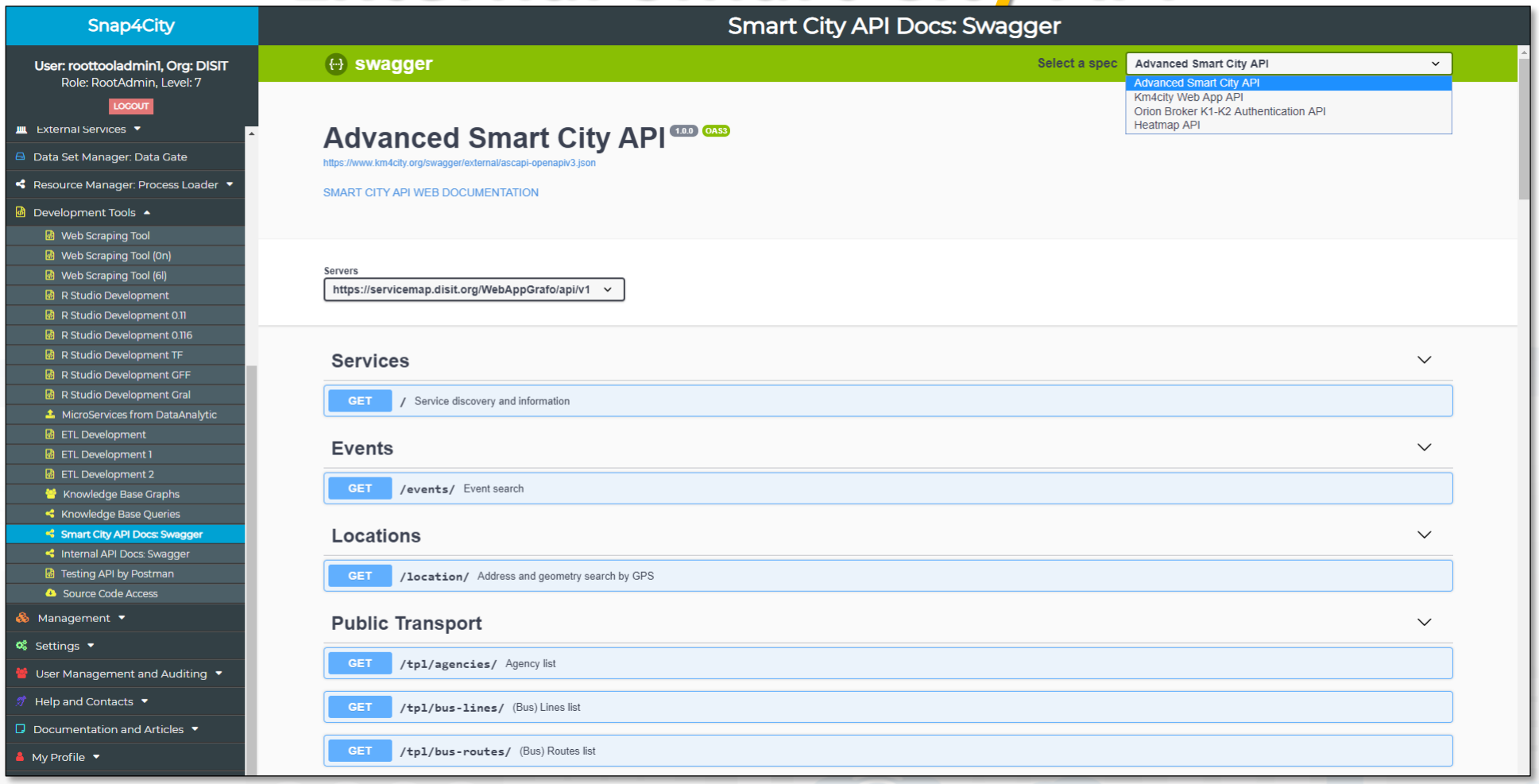


Federation of Snap4City Services



- A Mobile App may refer to one Smart City API Server (for Area 1) via SUPER and receive data from the Federated SUPERS (Area 2) if navigation, queries, etc. are leading to discover out of the addressed KB.
  - SUPER can be used for creating redundant and/or balanced distributed solutions for Federated KB. See Area 2, the two KB in the front.
  - Federated SUPER can have overlapped KB even totally.
  - A Mobile App can be developed to support multiple Smart City API servers, for balancing and
- The usage of Super is not mandatory so that separate services can be produced as well
- Super and Nodes present the same Smart City APIs.

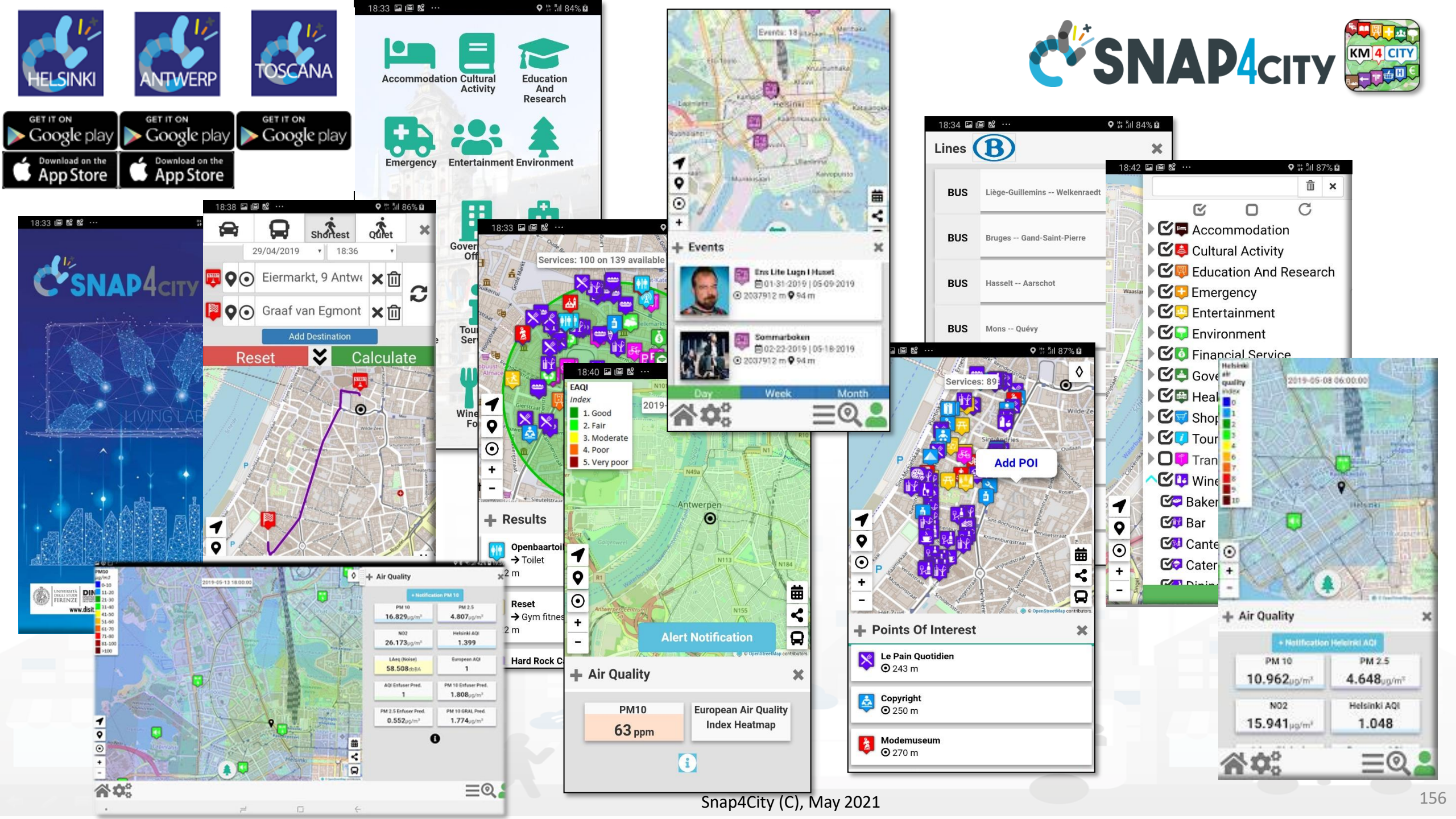
External Smart City API



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

External Smart City API

- **Advanced Smart City API**
  - To access the Service Map resources and query
- **Km4city Web App API**
  - To exploit MicroApplications created as tools for Dashboards, totem, web Apps, etc.
- **Orion Broker K1-K2 Authentication**
  - To communicate with IOT Orion Brokers exploiting the Secure Filter of Snap4City.
- **Heatmap**
  - To save and access to HeatMaps of the Heatmap server

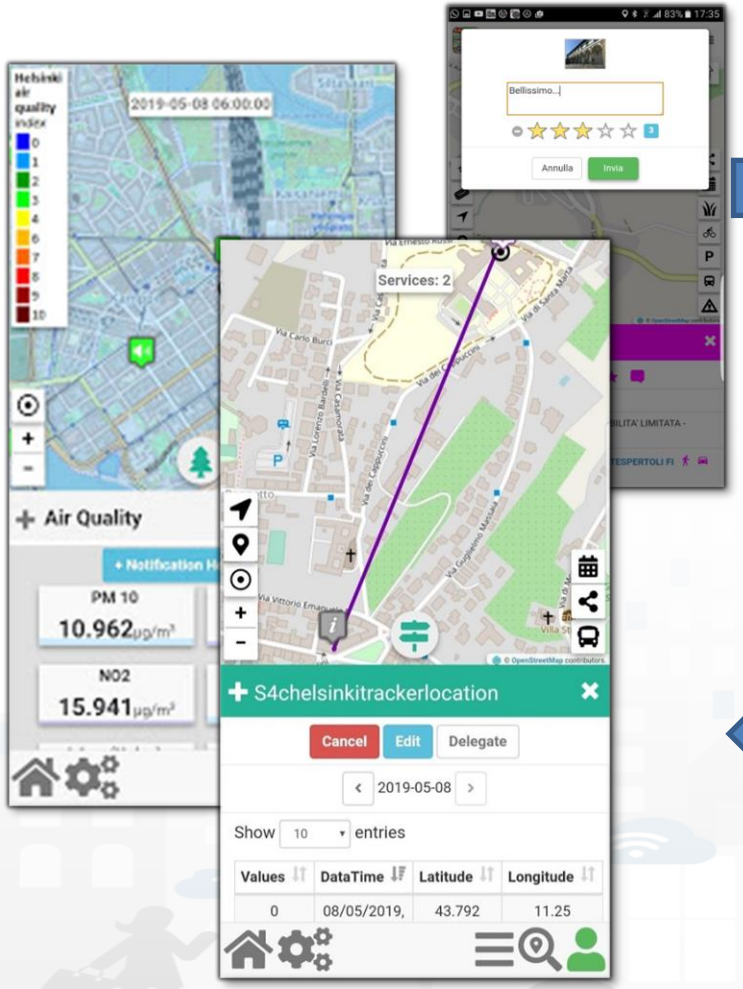

HELSINKI
ANTWERP
TOSCANA
GET IT ON Google play
Download on the App Store
SNAP4CITY
KM 4 CITY
Accommodation
Cultural Activity
Education And Research
Emergency
Entertainment
Environment
Shortest
Quiet
Add Destination
Reset
Calculate
Events
Day
Week
Month
Services: 100 on 139 available
EAQI
Index
1. Good
2. Fair
3. Moderate
4. Poor
5. Very poor
Results
Antwerpen
Alert Notification
Air Quality
PM10
63 ppm
European Air Quality Index Heatmap
Lines
BUS
Liège-Guillemins -- Welkenraedt
Bruges -- Gand-Saint-Pierre
Hasselt -- Aarschot
Mons -- Quévy
Add POI
Points Of Interest
Le Pain Quotidien
243 m
Copyright
250 m
Modemuseum
270 m
Financial Service
Bar
PM 10
10.962
PM 2.5
4.648
NO2
15.941
Helsinki AQI
1.048

The App is a Bidirectional Device

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

Produced information

- Accepted ?
- Performed ?
- …



Derived information

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

Produced information

- Suggestions
- Engagements
- Notifications
- …

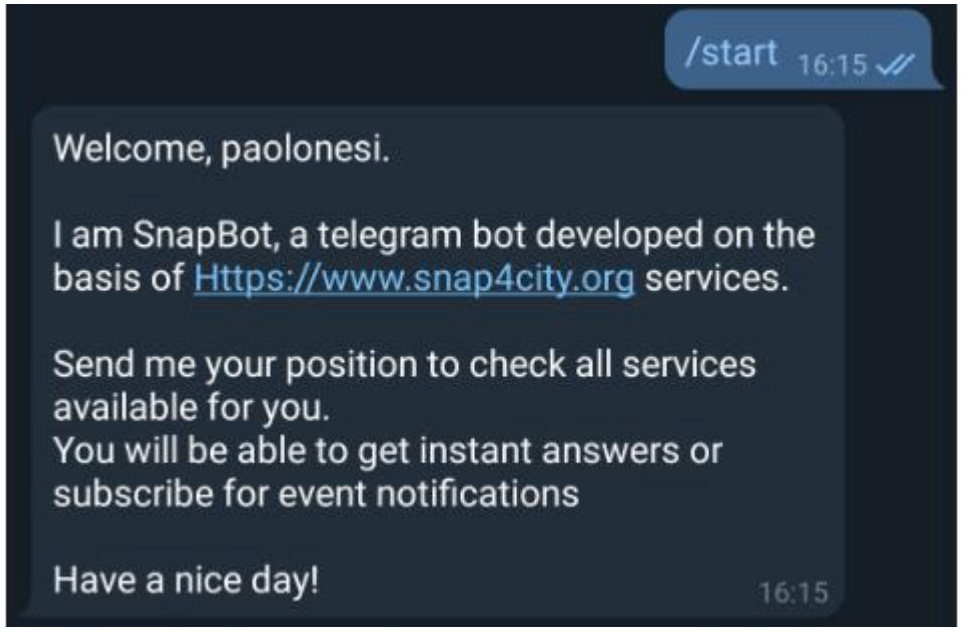
Users

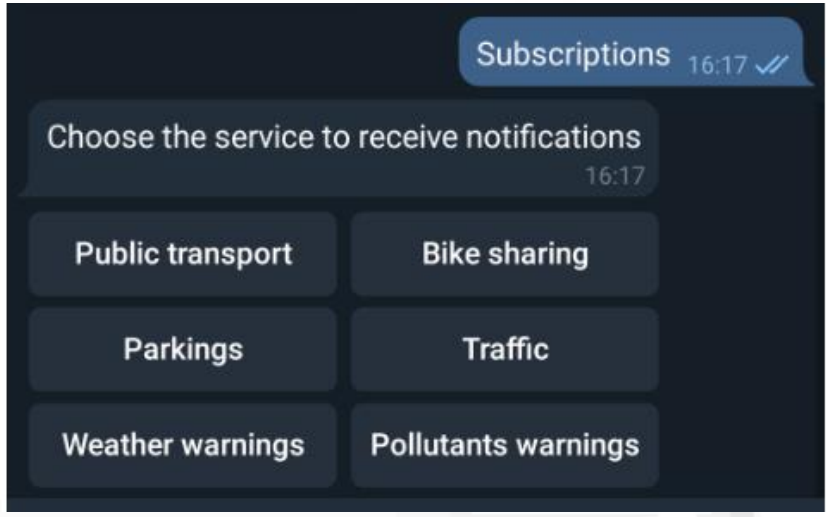
System

Integration with Telegram: SnapBot solution

SnapBot

- provides real time smart city services to **Telegram** users, geolocalized, when you like, what you like
- active on Tuscany in all provinces and cities according to the data accessible on Https://www.snap4city.org
- Services on
  - Public Transport (more than 10 different operators),
  - bike sharing, parking lots,
  - traffic flow, weather warnings,
  - Air quality, pollutant,
  - find your location, etc.





TOP

Data Model, Ingestion and Management

On Line Training Material (free of charge)

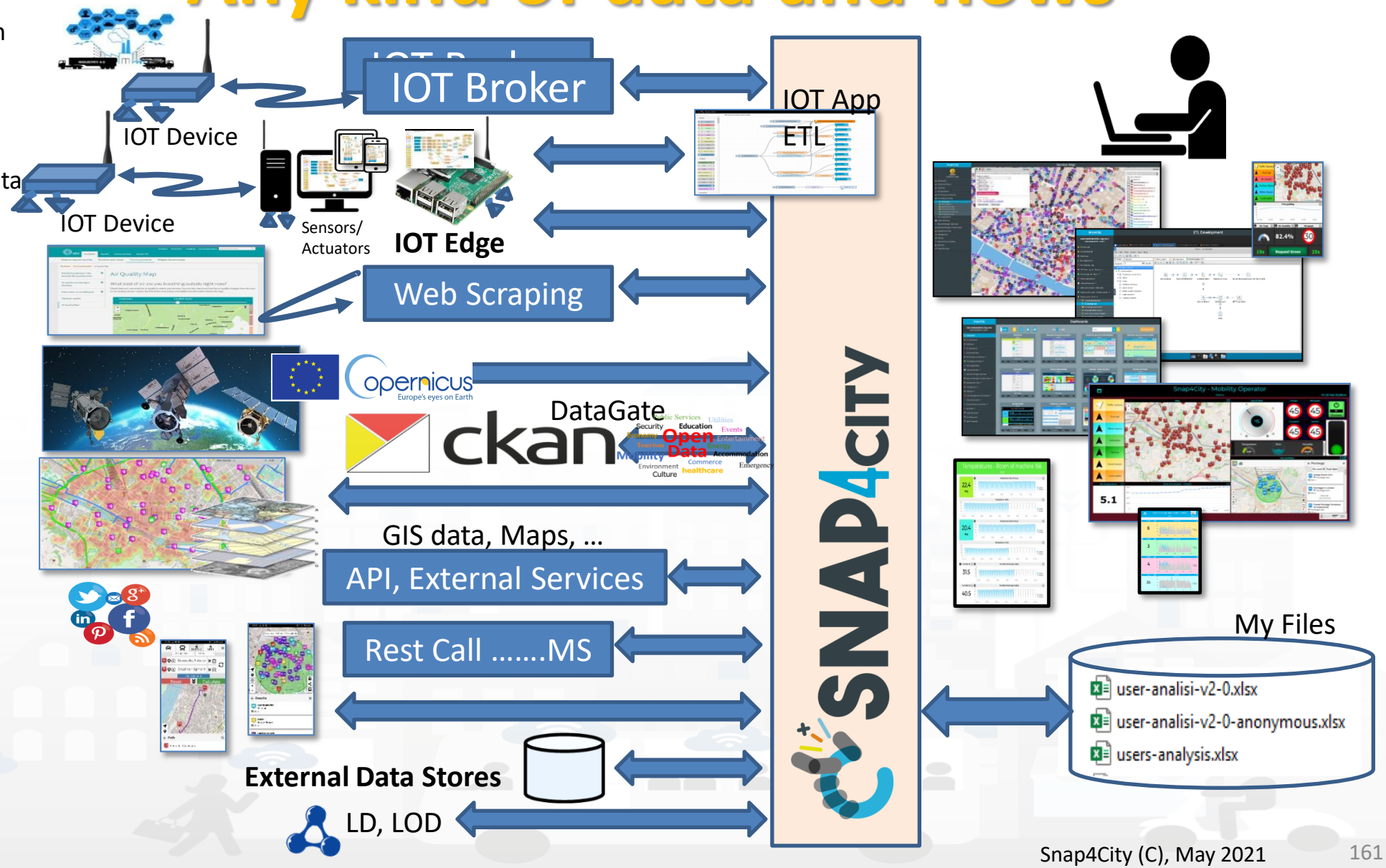
	1st part (*)	2nd part (*)	3rd part (*)	4th part (*)	5th part (*)	6th part (*)	7th part (*)
what	General	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	ystem and Deploy Install	Smart City API: Web & Mob. App
PDF							
Inter active							
Video1							
Video2							
Video3							
Video4				none		none	none
duration	2:55	3:16	3:41	2:00	2:48	2:35	1:47

100% OPEN SOURCE

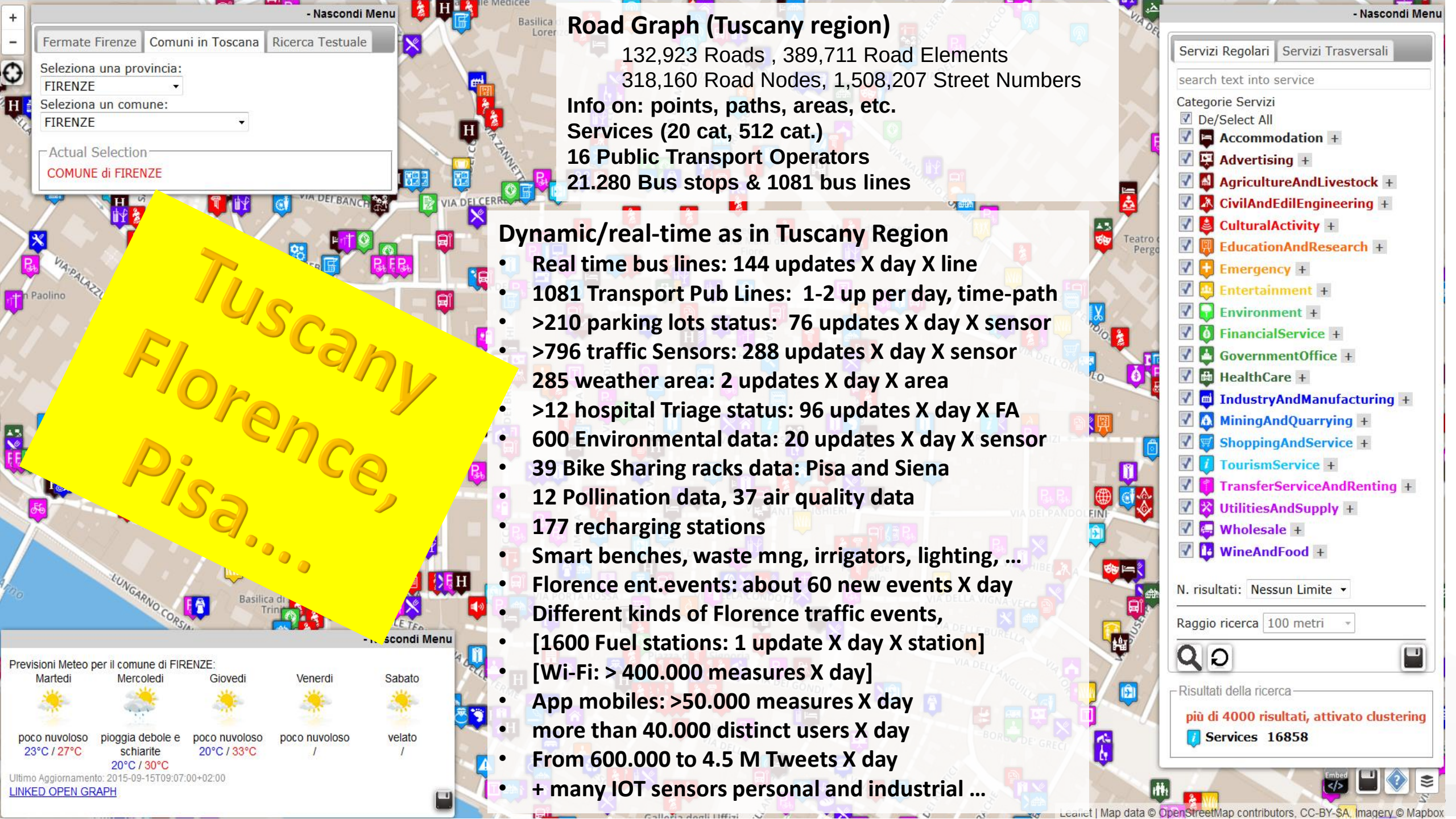
SNAP4 Appliances and Dockers **Installations**

Any kind of data and flows

- **Open Data:**
  - Data gate, federation of Open Data Portals
  - IOT App, ETL proc(PULL)
- **IOT Networks:**
  - IOT Application processes, data driven or PULL
  - IOT Brokers (Push) → IOT Shadow
- **Web Pages:**
  - Web scraping, crawling processes
- **Satellite data**
- **Social media: Twitter, Facebook,..**
  - Twitter Vigilance, IOT App
- **Mobile Apps**
  - Smart City API
- **Files upload: CSV, Excel, etc.**
  - IOT Applications, ETL
- **REST API, WS, FTP, LD, LOD, etc.**
  - IOT Applications, ETL
- **Data base accesses**
  - GIS: WFS, WMS
  - ETL, IOT Application



Data Modeling


- Nascondi Menu
Fermate Firenze
Comuni in Toscana
Ricerca Testuale
Seleziona una provincia:
FIRENZE
Seleziona un comune:
FIRENZE
Actual Selection
COMUNE di FIRENZE
Tuscany
Florence,
Pisa....
Road Graph (Tuscany region)
132,923 Roads , 389,711 Road Elements
318,160 Road Nodes, 1,508,207 Street Numbers
Info on: points, paths, areas, etc.
Services (20 cat, 512 cat.)
16 Public Transport Operators
21.280 Bus stops & 1081 bus lines
Dynamic/real-time as in Tuscany Region
• Real time bus lines: 144 updates X day X line
• 1081 Transport Pub Lines: 1-2 up per day, time-path
• >210 parking lots status: 76 updates X day X sensor
• >796 traffic Sensors: 288 updates X day X sensor
285 weather area: 2 updates X day X area
• >12 hospital Triage status: 96 updates X day X FA
• 600 Environmental data: 20 updates X day X sensor
• 39 Bike Sharing racks data: Pisa and Siena
• 12 Pollination data, 37 air quality data
• 177 recharging stations
• Smart benches, waste mng, irrigators, lighting, …
• Florence ent.events: about 60 new events X day
• Different kinds of Florence traffic events,
• [1600 Fuel stations: 1 update X day X station]
• [Wi-Fi: > 400.000 measures X day]
• App mobiles: >50.000 measures X day
• more than 40.000 distinct users X day
• From 600.000 to 4.5 M Tweets X day
• + many IOT sensors personal and industrial …
- Nascondi Menu
Previsioni Meteo per il comune di FIRENZE:
Martedi
poco nuvoloso
23°C / 27°C
Mercoledi
pioggia debole e schiarite
20°C / 30°C
Giovedi
poco nuvoloso
20°C / 33°C
Venerdi
poco nuvoloso
/
Sabato
velato
/
Ultimo Aggiornamento: 2015-09-15T09:07:00+02:00
LINKED OPEN GRAPH
- Nascondi Menu
Servizi Regolari
Servizi Trasversali
search text into service
Categorie Servizi
De/Select All
Accommodation
Advertising
AgricultureAndLivestock
CivilAndEdilEngineering
CulturalActivity
EducationAndResearch
Emergency
Entertainment
Environment
FinancialService
GovernmentOffice
HealthCare
IndustryAndManufacturing
MiningAndQuarrying
ShoppingAndService
TourismService
TransferServiceAndRenting
UtilitiesAndSupply
Wholesale
WineAndFood
N. risultati: Nessun Limite
Raggio ricerca 100 metri
Risultati della ricerca
più di 4000 risultati, attivato clustering
Services 16858
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

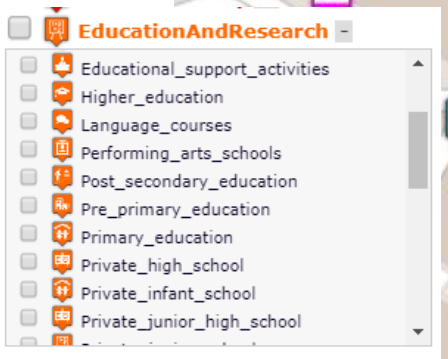
POI: Point of Interest vs Classification

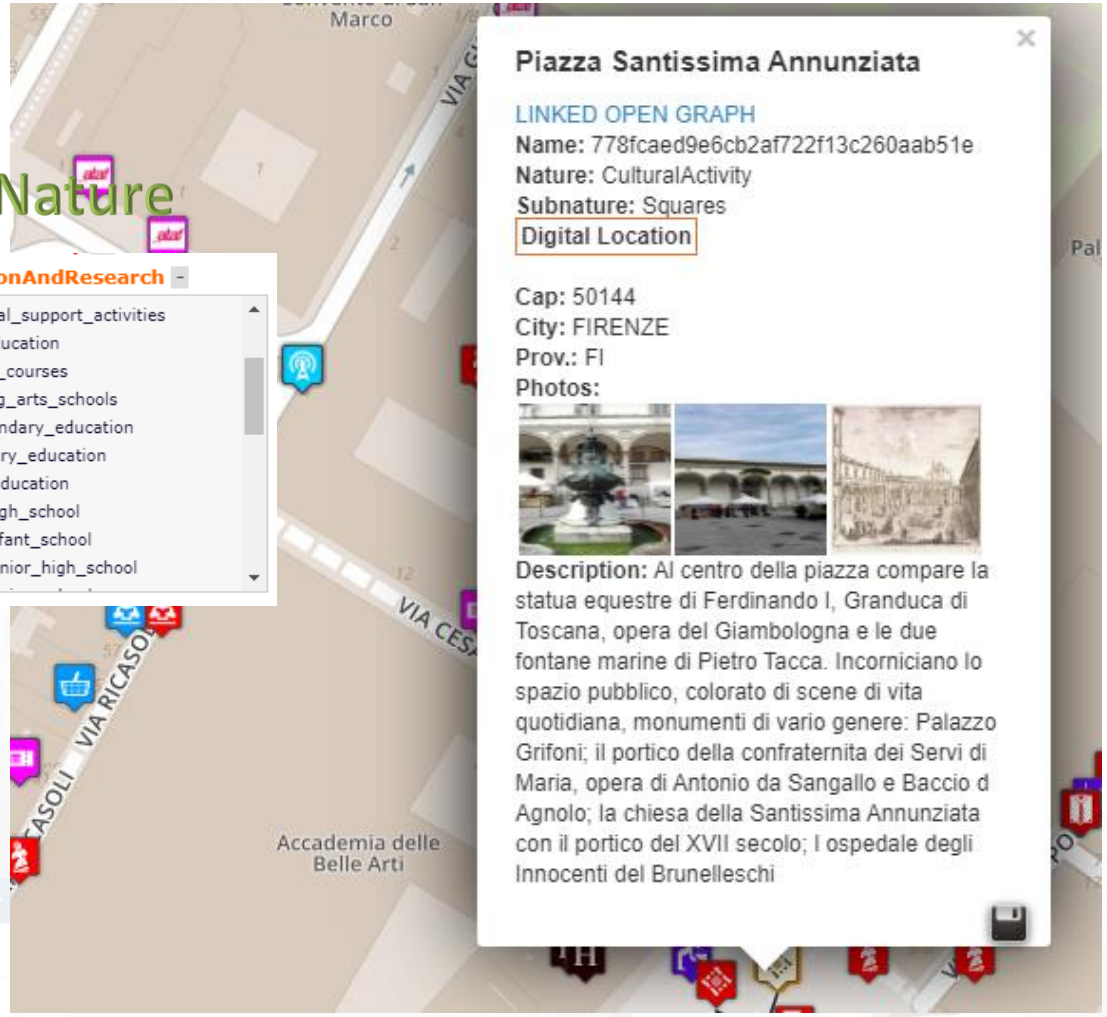
- A POI is defined as an **element of a set (collection)** and with general info:
  - **Nature**: ……..
  - **Subnature**: ….
- Specific infor for each POI
  - **Location**: lat, lon
  - A set of **Attributes**
    - www, email, opening time, phone, cap, address, city, etc.
  - Eventually a link to data

Nature

- Accommodation
- Advertising
- AgricultureAndLivestock
- CivilAndEdilEngineering
- CulturalActivity
- EducationAndResearch
- Emergency
- Entertainment
- Environment
- FinancialService
- GovernmentOffice
- HealthCare
- IndustryAndManufacturing
- IoTDevice
- MiningAndQuarrying
- ShoppingAndService
- TourismService
- TransferServiceAndRenting
- UtilitiesAndSupply
- Wholesale
- WineAndFood

SubNature





How to Ingest

All of them can be shown on Dashboards, what about manipulate them!!!!

HLT, High Level Types++	GPS	Static	Dynamic	Single	Time Series	Trajectory	HTTP	How to ingest/change/manage/see
POI (Point of Interest)	Yes	Yes		Yes				DataGate, ETL, IOT App, API
MyPOI data	Yes	Yes		Yes				Dashboard, IOT App, UserInterface, API
Sensor data	Yes	Yes	Yes	Yes	Yes			Dashboard, IOT Directory, IOT App, UserInterface, API
Sensor Actuator data	Yes	Yes	Yes	Yes	Yes			Dashboard, IOT App, UserInterface, API
MyKPI data	Yes	Yes	Yes	Yes	Yes	Yes		Dashboard, IOT App, UserInterface, API
Dashboard-IOT App (msg)		Yes	Yes	Yes	Yes			Dashboard, IOT App, API
Dashboard-IOT App real time			Yes	Yes	WS			Dashboard, IOT App, API WS
Synoptics data		Yes	Yes	Yes	Yes			Dashboard, IOT App, UserInterface
My Personal Data		Yes	Yes	Yes	Yes			Dashboard, IOT App, UserInterface, API
KPI (metrics) data		Yes	Yes	Yes	Yes			Dashboard, IOT App, API, SQL calls x Metrics
Special Widget (complex)		Yes	Yes	Yes	Yes		Yes	Dashboard, ETL, special, IOT App, API
Complex Event (msg)	Yes	Yes	Yes	Yes	Yes			Dashboard, ETL, special, IOT App, API
WFS/WMS (GIS data)	Yes	[yes]	[yes]				Yes	Dashboard, GIS tools, or GeoServer, IOT App
GTFS	Yes	Yes	Yes	Yes	Yes			ETL, special [IOT App], MicroApplications
OD Matrices	Yes	Yes	Yes	Yes	Yes			Special tools, MicroApplications

How to Ingest

All of them can be shown on Dashboards, what about manipulate them!!!!

HLT, High Level Types++	GPS	Static	Dynamic	Single	Time Series	Trajectory	HTTP	How to ingest/change/manage
API (Ext. Srv., any prot.)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	ETL, Special, IOT App, …
External Service (web pag)		Yes	--				Yes	ETL, Special, IOT App, Web Scraper, …
MicroApplication (webapp)		Yes	--				Yes	Dashboard, IOT App, API, FTP, …
Heatmap matrix	Yes	Yes	Yes	Yes	Yes			Maps, IOT App, MicroService, UserInterface, API
Synoptics (group)		Yes	Yes	(Yes)	(Yes)		Yes	Dashboard, Special Tools, IOT App, API, …
Special Tools (functional)	(Yes)		(Yes)	(Yes)		(Yes)	Yes	As MyPersonalData, …
Typical Trends (not yet)	(yes)	Yes	(Yes)		Yes		Yes	MicroApp, Special tools, (API) , …
Traffic Flows (are coming)	(yes)	Yes	Yes		Yes	Yes	Yes	Maps, Special tools, API, …
Color Maps		Yes		Yes				Maps, Tables, Special tool, User Interface, API
GTFS (see Sensors, POI)	Yes	Yes	Yes		Yes	Yes		Maps, Special tools, API, …
Typical Trajectory (MyKPI)	Yes	Yes	Yes		Yes	Yes		Maps, Special tools, API, …

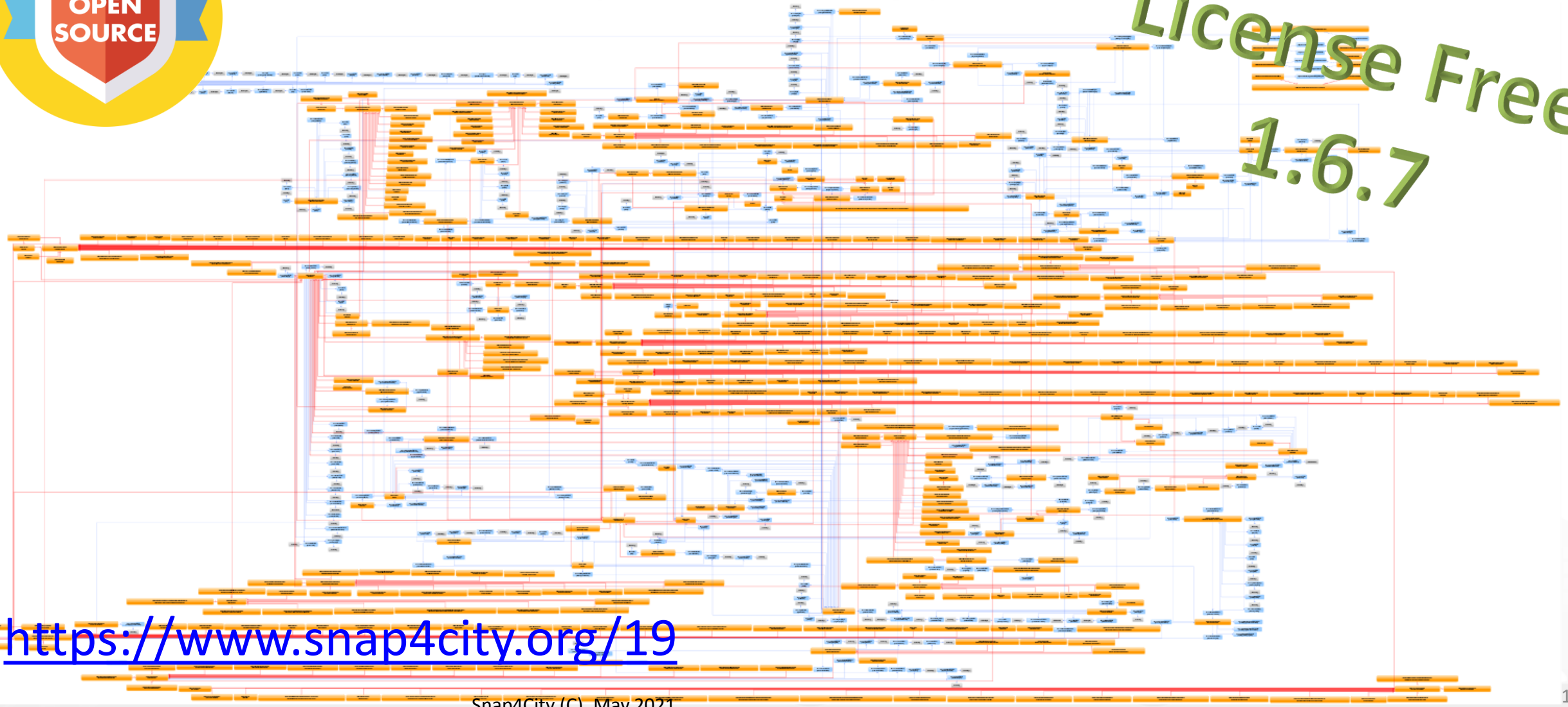
- Now, it is more clear about what we intend as:
  - ***High Level Types***

100% OPEN SOURCE

Smart-city Ontology km4city

License Free

1.6.7



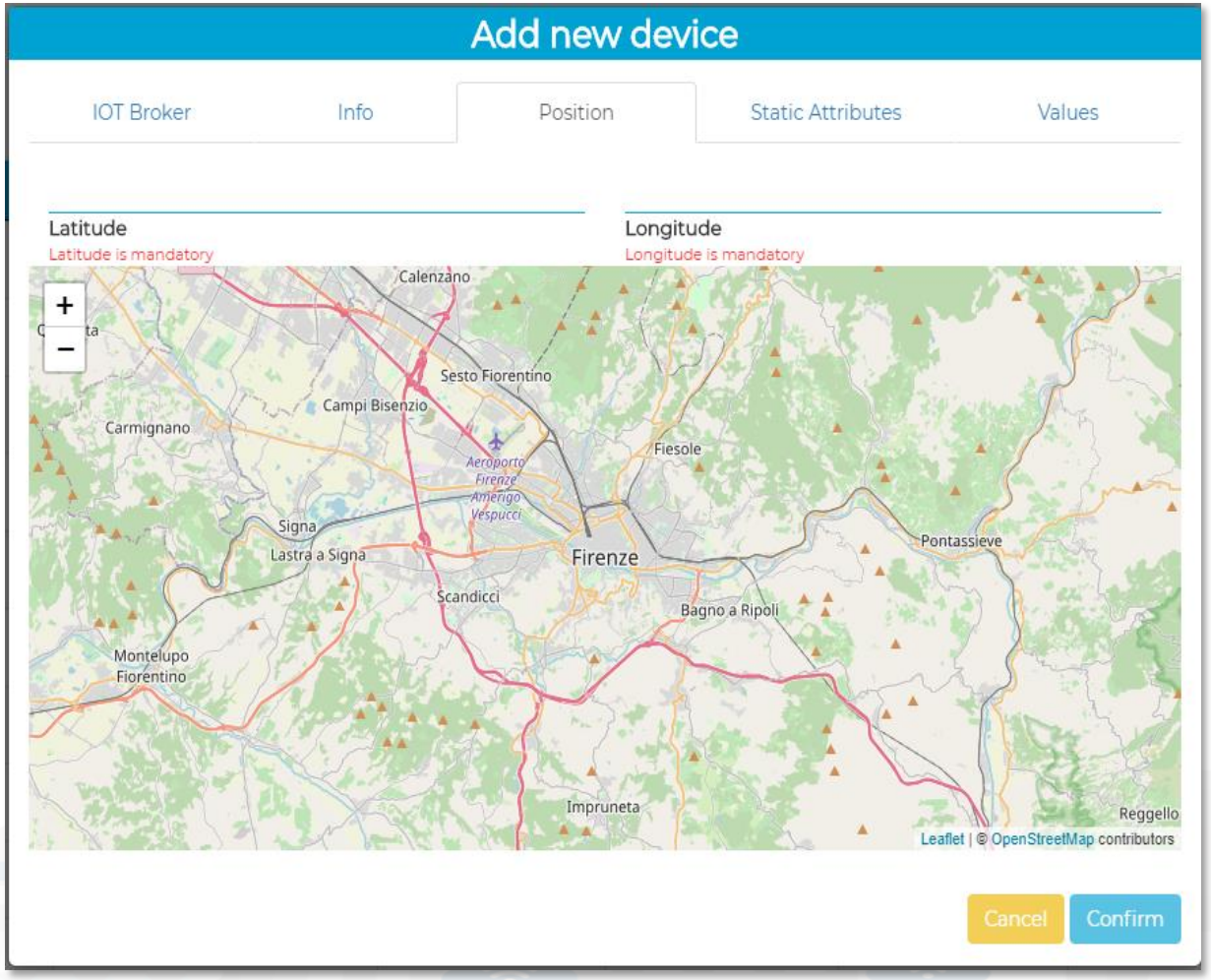
https://www.snap4city.org/19

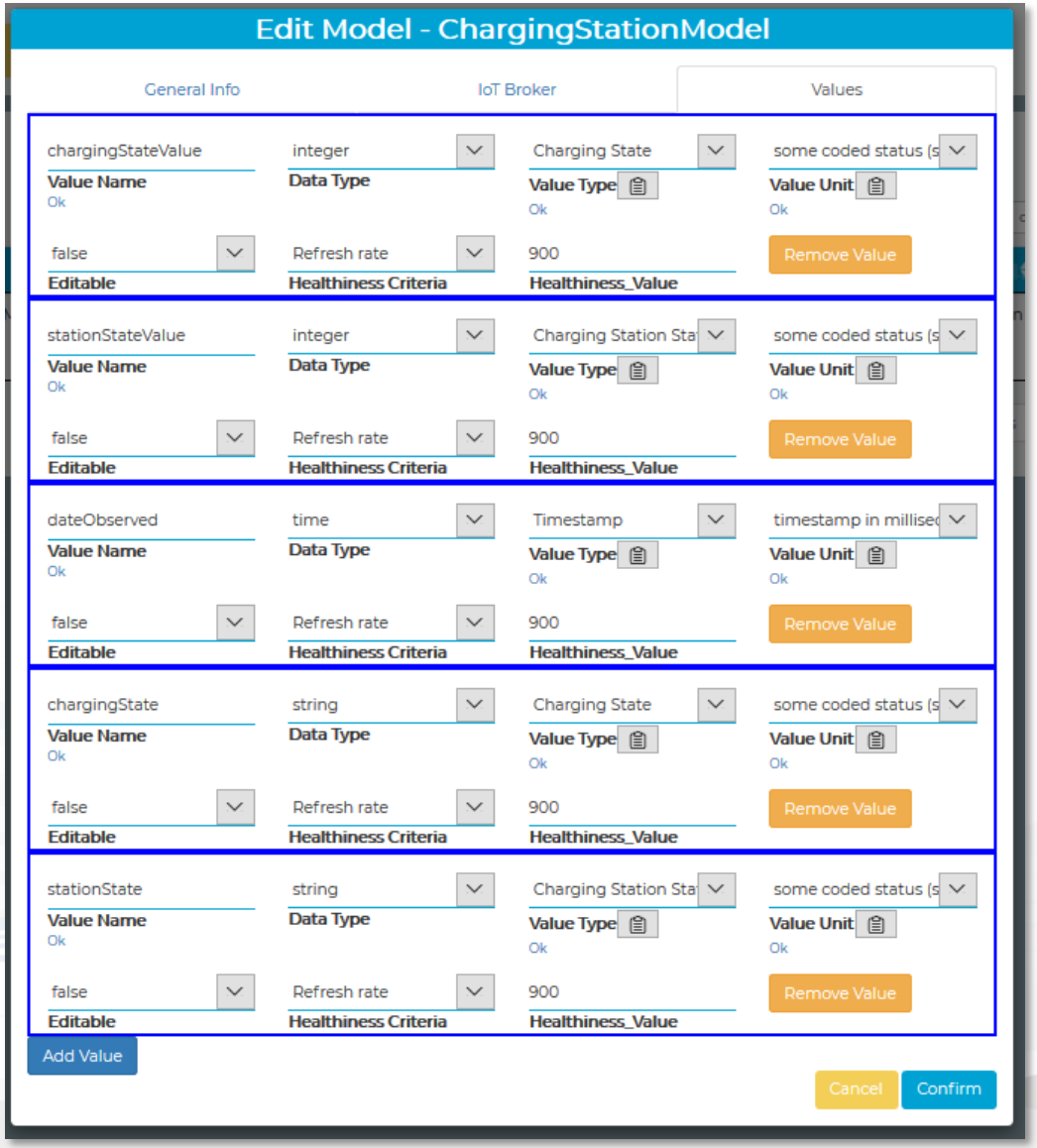
IOT Device Model

IOT Device Data Model (3): Attributes

Where	IOT Device Model	IOT Device	A Temporal Instance
IOT Broker	**Broker: OrionUNIFI**		
IOT Broker	**Protocol: NGSI**		
Info	**ID: string**	ID: "park45"	**park45**
Position	**GPS: lat, long**	GSP Position: 43.12, 11.34	GSP Position: 44.12, 11.12
Static attribute	**Description: string**	Description: "parking massaia"	
Static attribute	**Location: string**	Location: "Via Massaia"	
Static attribute	**Civic Number: string**	Civic Number: 3	
Static attribute	**MaxCapacity: number, cars**	MaxCapacity: 456	
Values	**dateObserved: Timestamp**		23-12-2019T20:13:12…
Values	**FreeSlots: Integer, #**		345
Values	**Humidity: float, %**		25,5
Values	**Temperature: float, celsius**		34

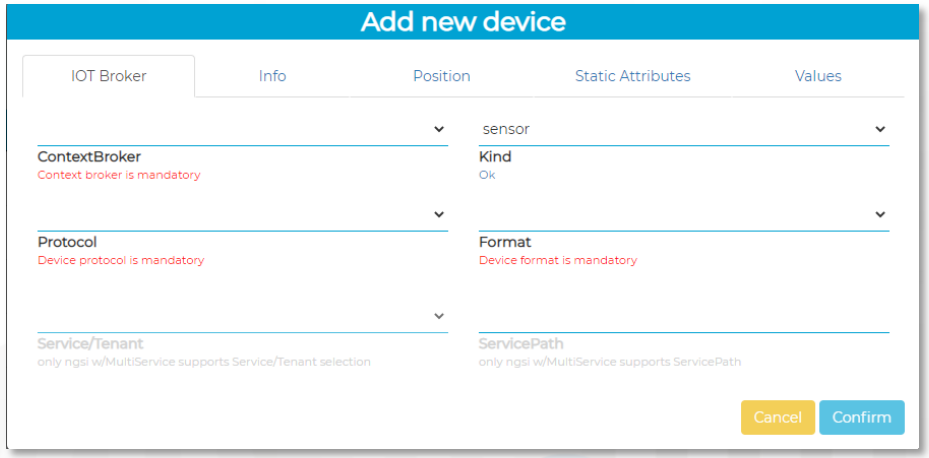
IOT Device Data Model (2)



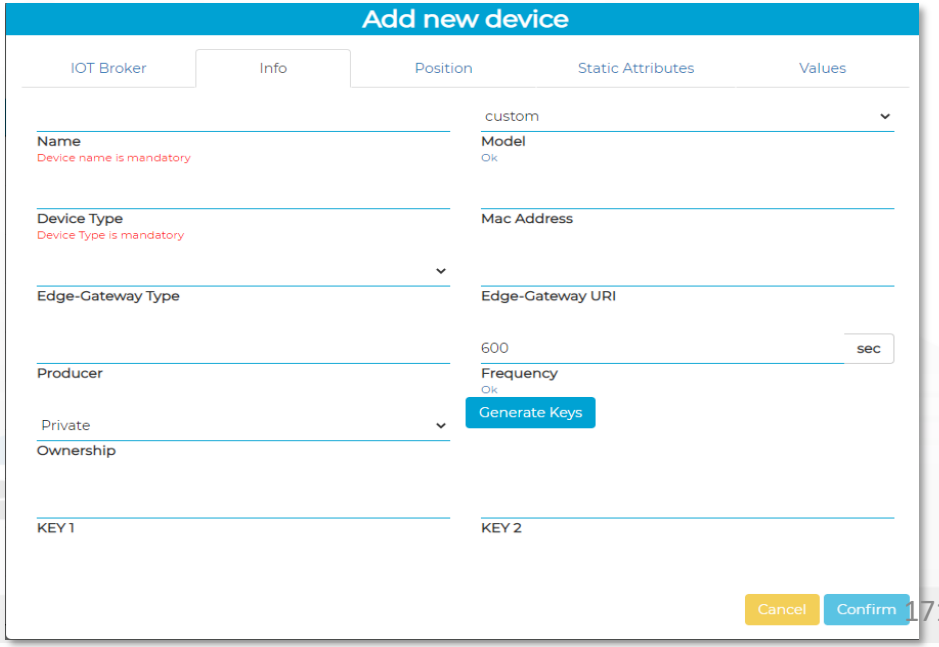


IOT Device Data Model (1)

- IOT Broker
  - Name of the Brokers: among those registered
  - Protocol: NGSI, AMQP, MQTT, etc..
  - Format: CSV, JSON, XML.
  - Service/Tenant:…….
  - ServicePath:……



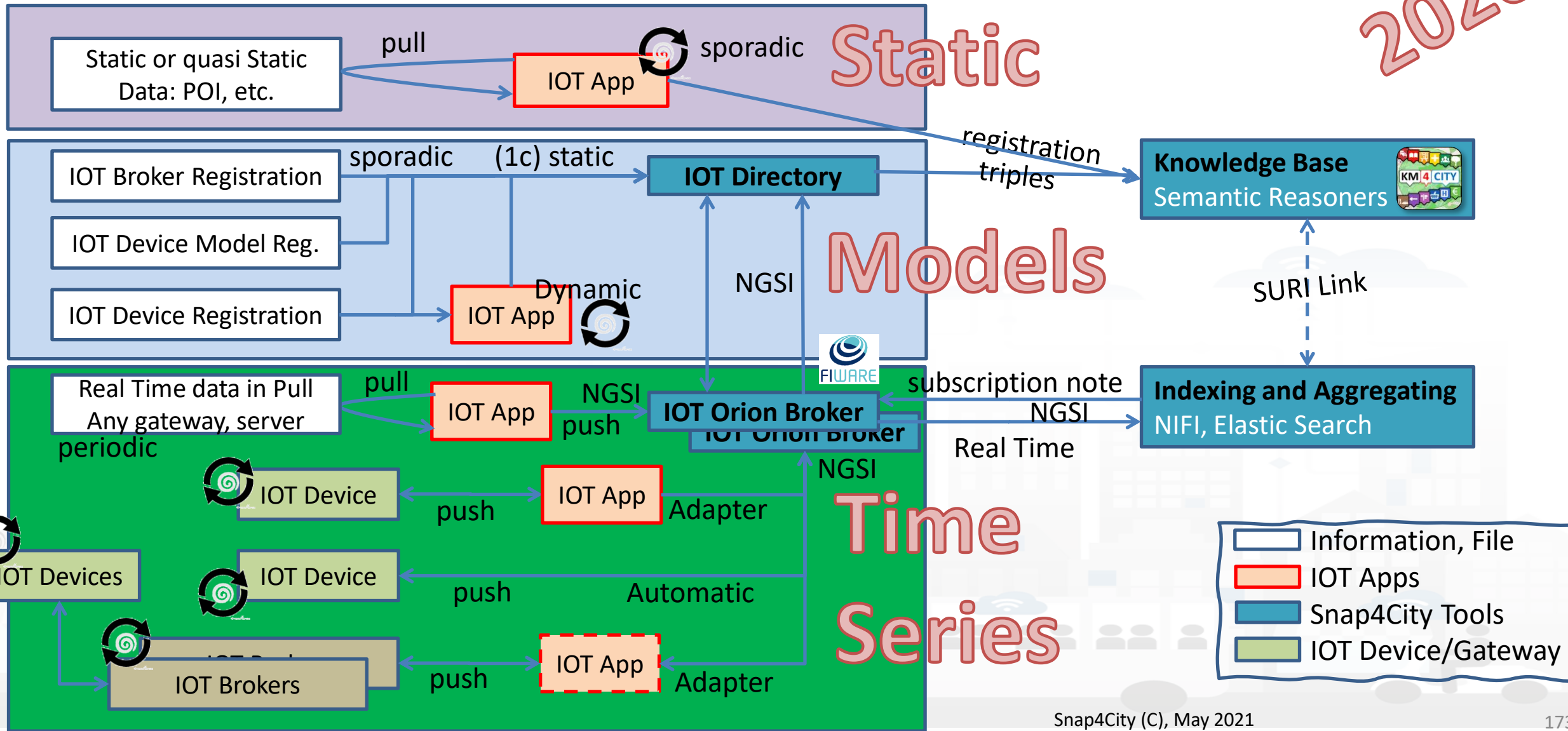
- Info
  - Name (Identifier)
  - Model: Custom or Model ID
  - DeviceType: ..a string..
  - MAC address: …optional…
  - Edge-GW: Raspberry, Android, …
  - Edge-GW: URI
  - Producer
  - Owner
  - Freq: ….. Sec
  - Keys: K1, K2



Data Ingestion and Management

Snap4city Data Ingestion Flow Diagram

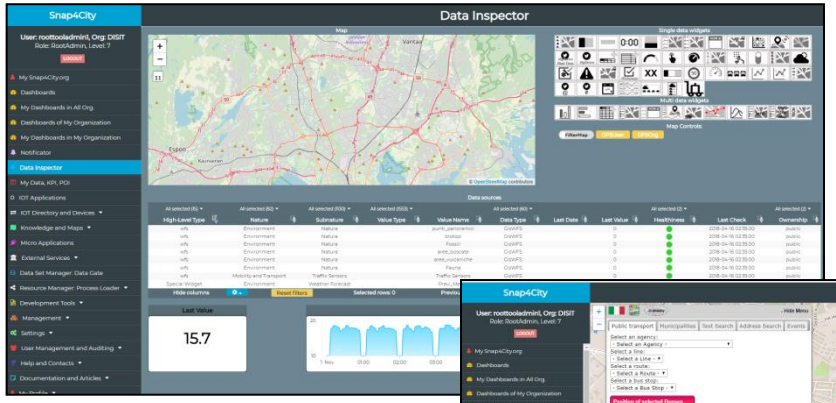
2020



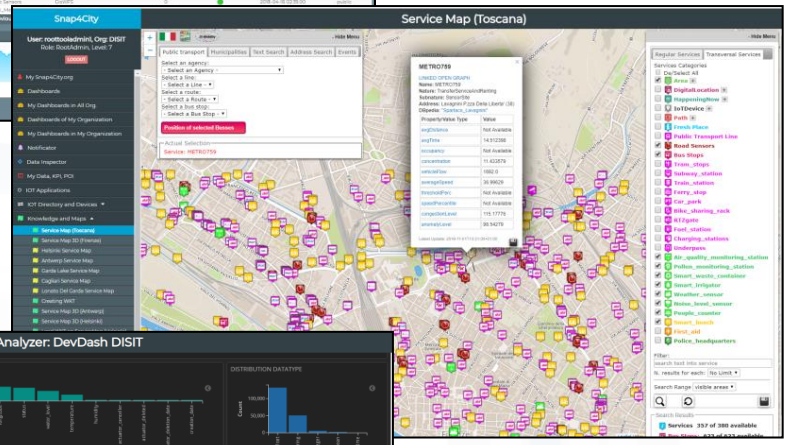
Checking data ingestion results

Knowledge base
Semantic reasoners

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



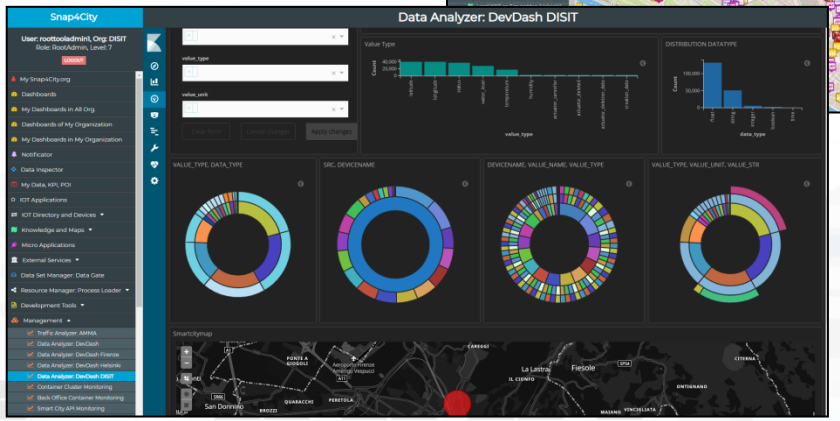
Data Inspector
Digital Twin view



ServiceMap

Indexing and aggregating
Elastic search

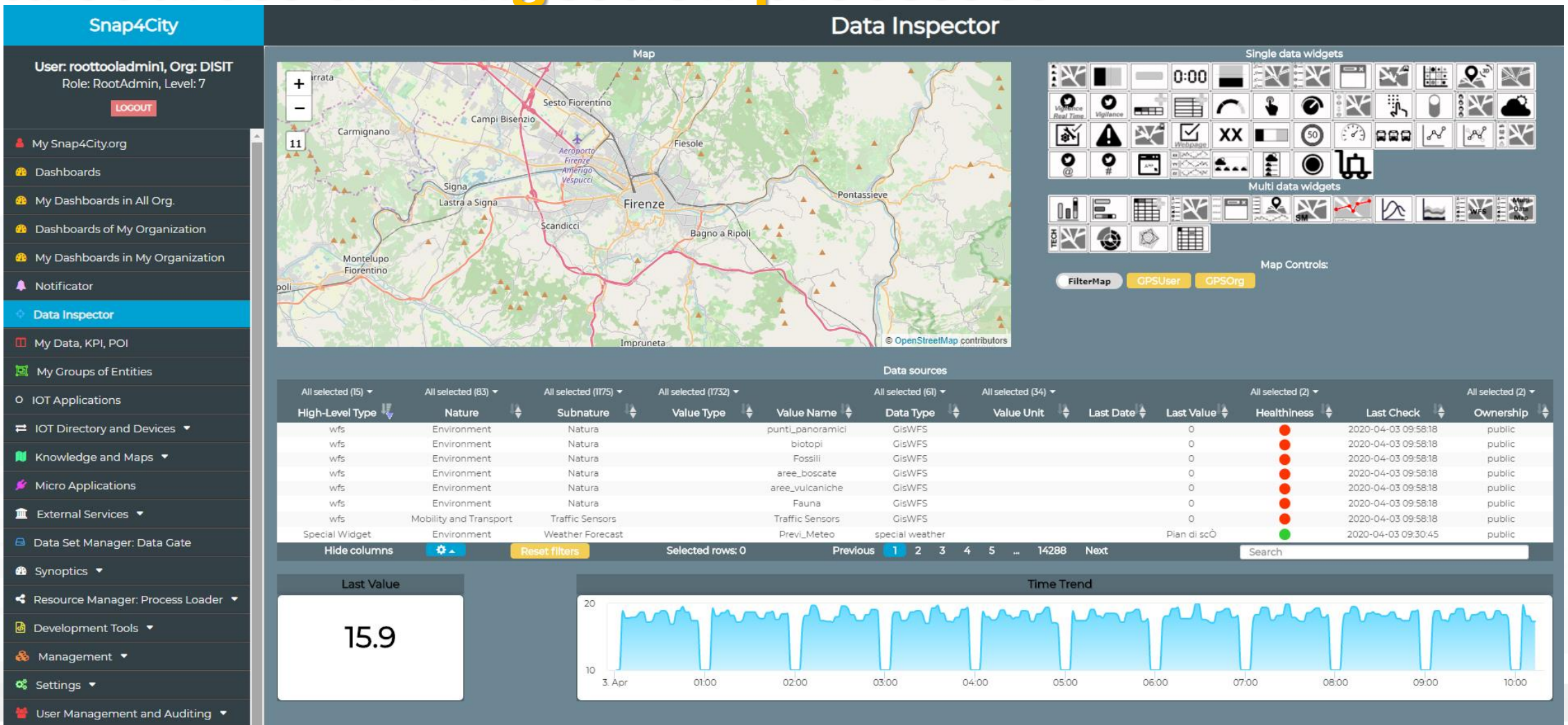
- **Data Inspector**
- **ServiceMap**, SCAPI
- **My Data Dashboard** (Kibana), DevDash
- Elastic Search



My Data Dashboard
DevDash

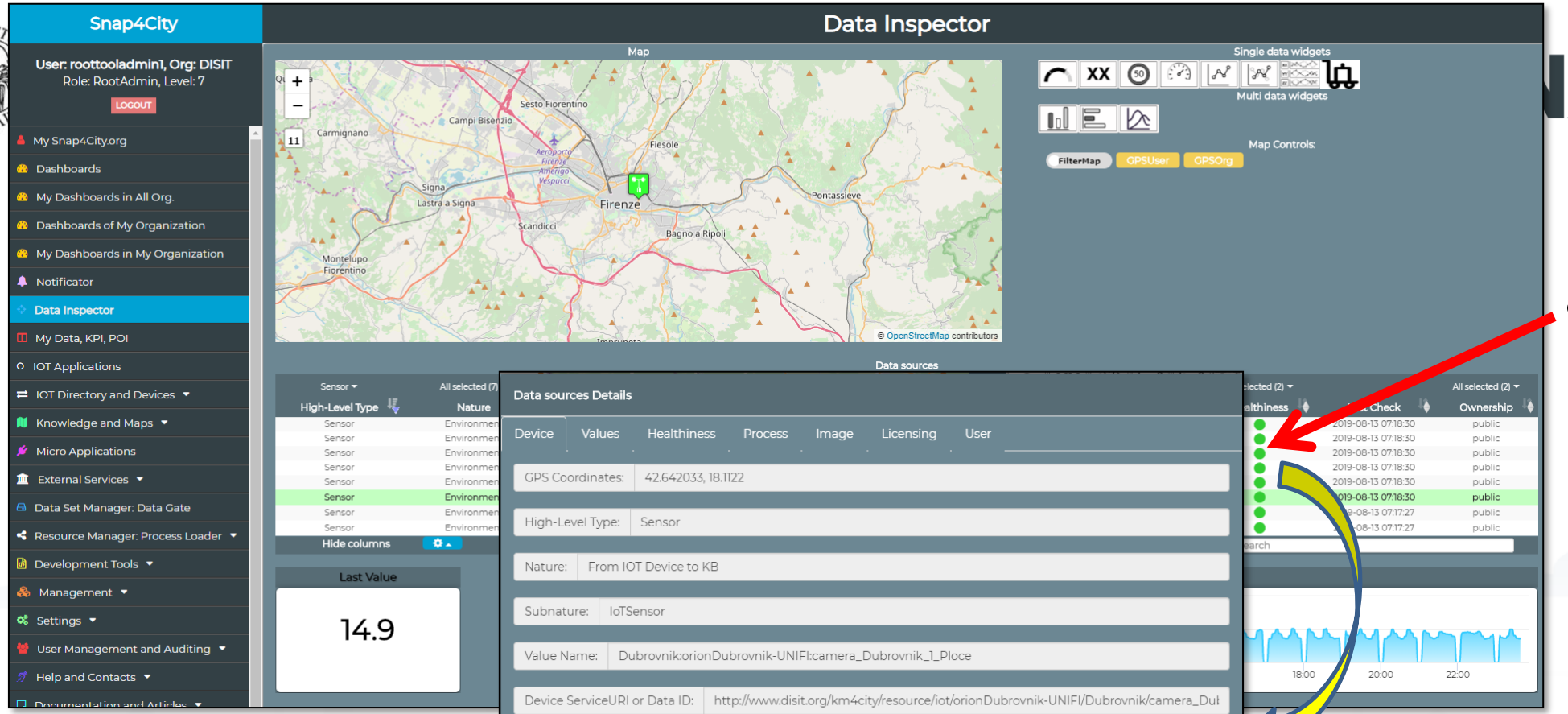
Some functionalities are limited to certain roles

Data Inspector: all you need to know about data, data sources and ingestion processes



Data Inspector (Digital Twin info) Major Submodels

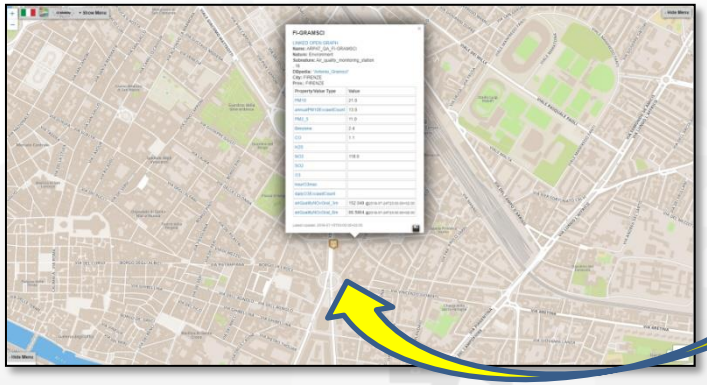
- **Digital Twin**
  - Device and sensors data
  - Values
  - Healthiness criteria and values
    - Machine learning tools
  - Images and physical world
  - Licensing
  - Users
- **Users**
  - Defined the Data and Devices
  - Defined the processes
  - Create dashboards
  - Etc.
- **Process Views**
  - Device Management tool
  - Data ingestion processes
    - ETL, IOT Apps
  - Data storage access views
    - Index views
    - Relationships view
  - Data Analytics and Transformation
    - IOT App, R Studio, Python
  - Data Rendering Dashboards
    - Synoptics
  - Processes' Developers

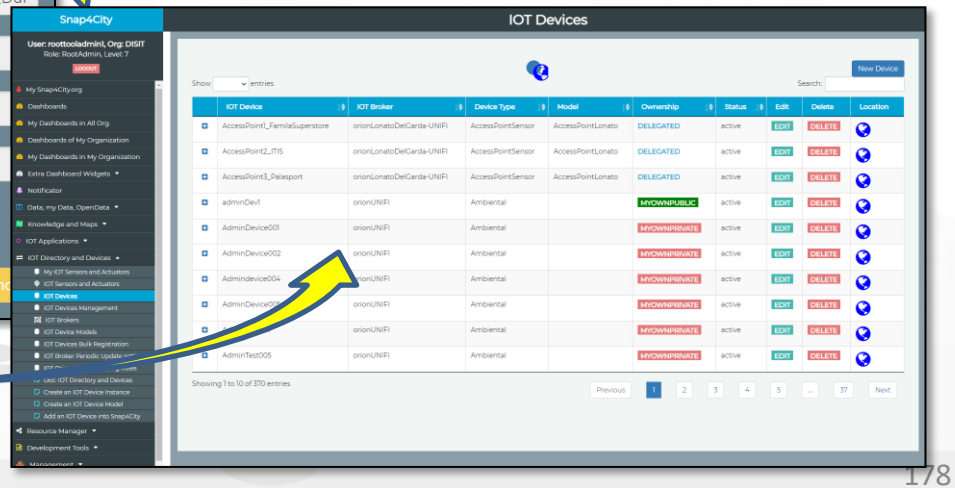


Knowledge Base view

- Click with the mouse on it

HLT: Sensor





Some functionalities are limited to certain roles

HLT: Sensor

Data sources Details

Device | Values | Healthiness | Process | Image | Licensing | User

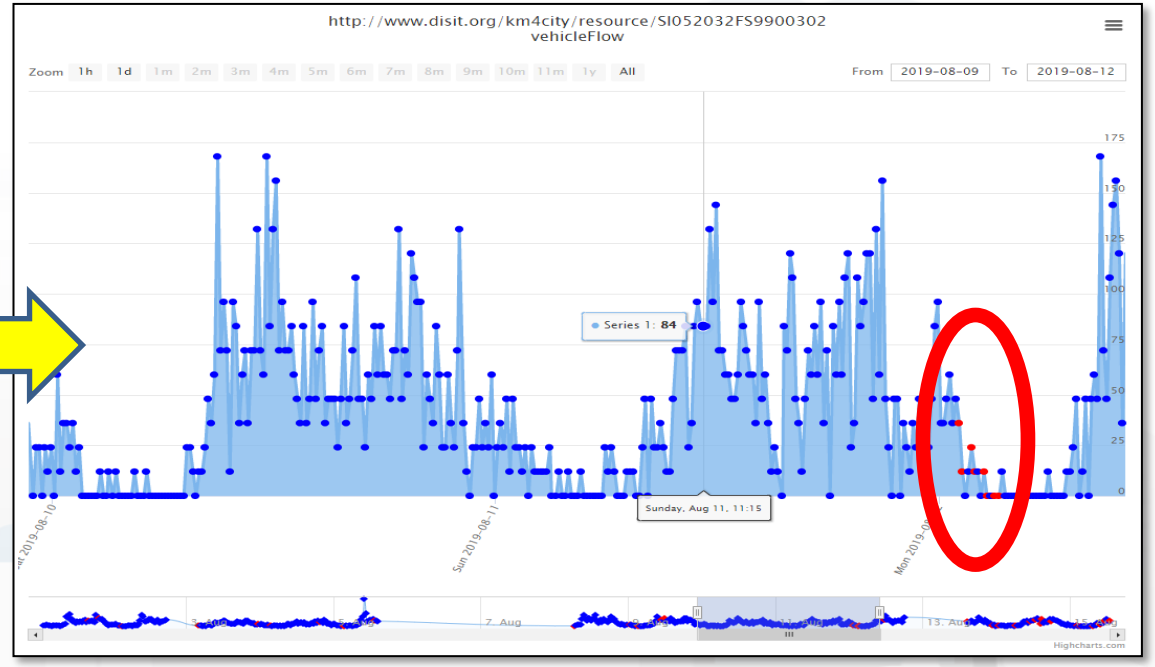
Last Date: 2020-07-21 19:00:00

Last Value:

Value Type	Healthy	Delay (s)	Reason	Healthiness Criteria	Refresh Rate (s)	Data type	Unit	Value	Time Trend
dateObserved	●	61890	undefined	undefined	300	time	timestamp	2020-07-21T17:00:00.000Z	VIEW
deceduti	●	61890	undefined	undefined	300	integer	#	16797	VIEW
dimessi_guariti	●	61890	undefined	undefined	300	integer	#	71775	VIEW
isolamento_domiciliare	●	61890	undefined	undefined	300	integer	#	6838	VIEW
nuovi_attualmente_positivi	●	61890	undefined	undefined	300	integer	#	-131	VIEW
ricoverati_con_sintomi	●	61890	undefined	undefined	300	integer	#	151	VIEW
stato	●	61890	undefined	undefined	300	string	#	ITA	VIEW
tamponi	●	61890	undefined	undefined	300	integer	#	1212468	VIEW
terapia_intensiva	●	61890	undefined	undefined	300	integer	#	21	VIEW
totale_attualmente_positivi	●	61890	undefined	undefined	300	integer	#	7010	VIEW
totale_casi	●	61890	undefined	undefined	300	integer	#	95582	VIEW
totale_ospedalizzati	●	61890	undefined	undefined	300	integer	#	172	VIEW
codice_regione	●	61890	missing value	undefined	300	integer	status		VIEW
denominazione_regione	●	61890	missing value	undefined	300	string	status		VIEW

Cancel

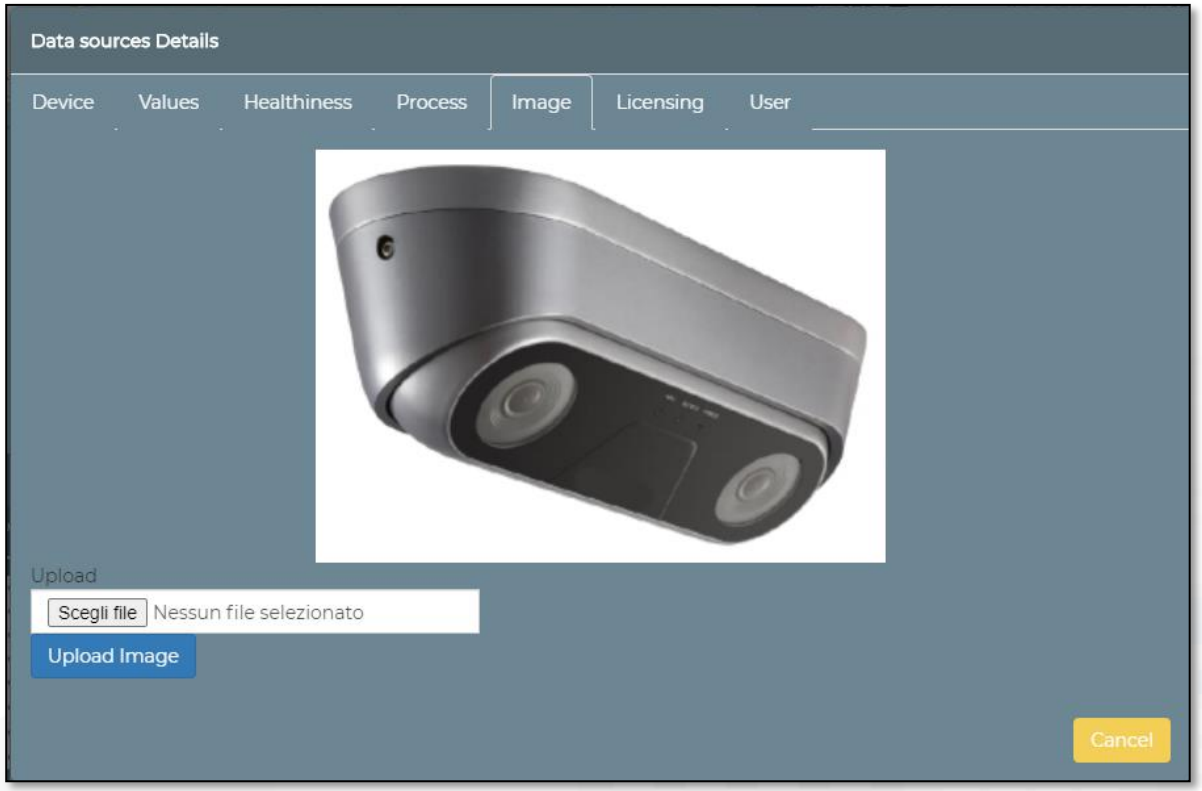
- Specific values of selected
- Information of the values of the other sensors on the same device
- View Trends, marking problems, healthiness by point according to a Fuzzy model
- Marking problems for future machine learning processes (separate tool)

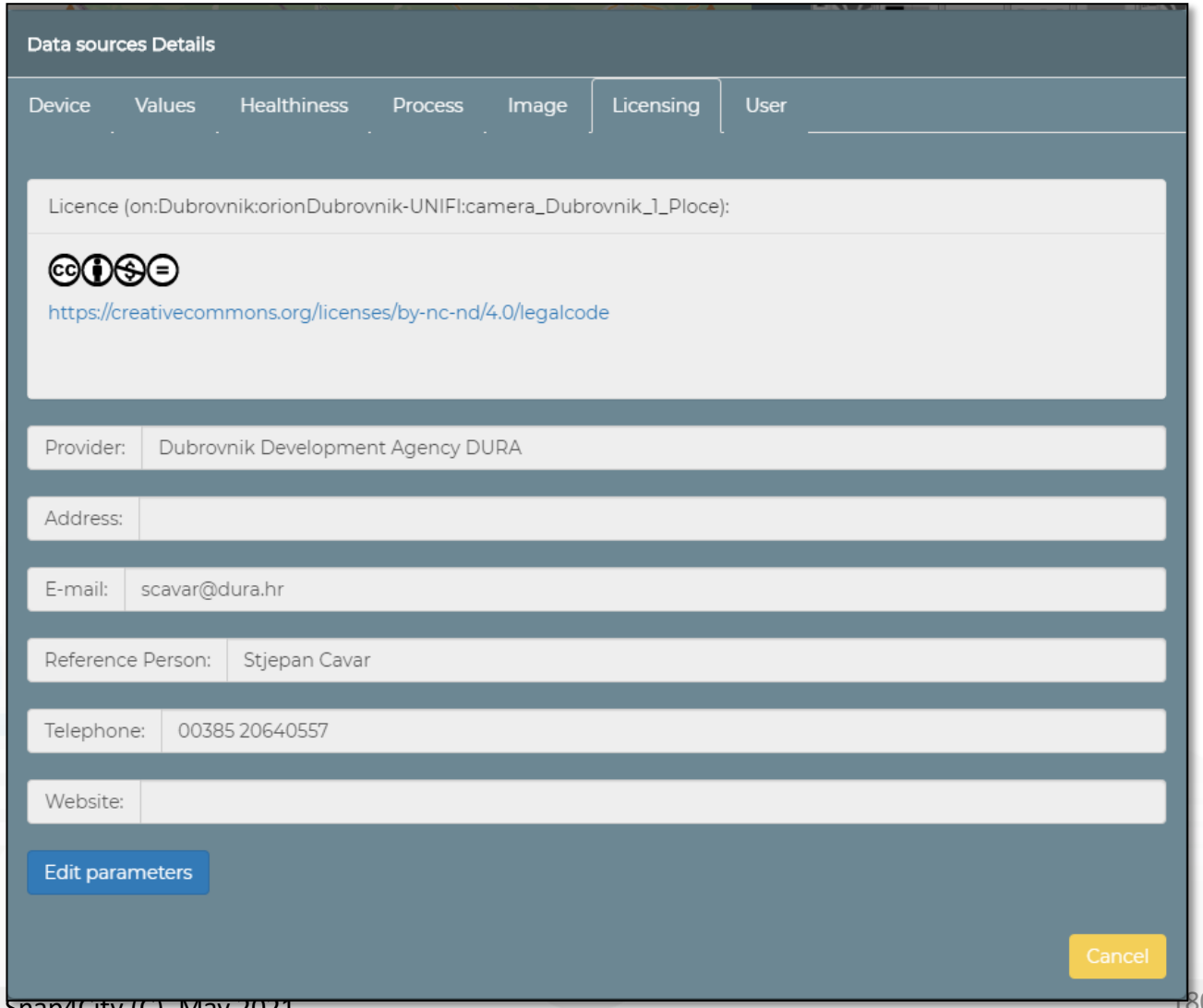


Some functionalities are limited to certain roles

HLT: Sensor

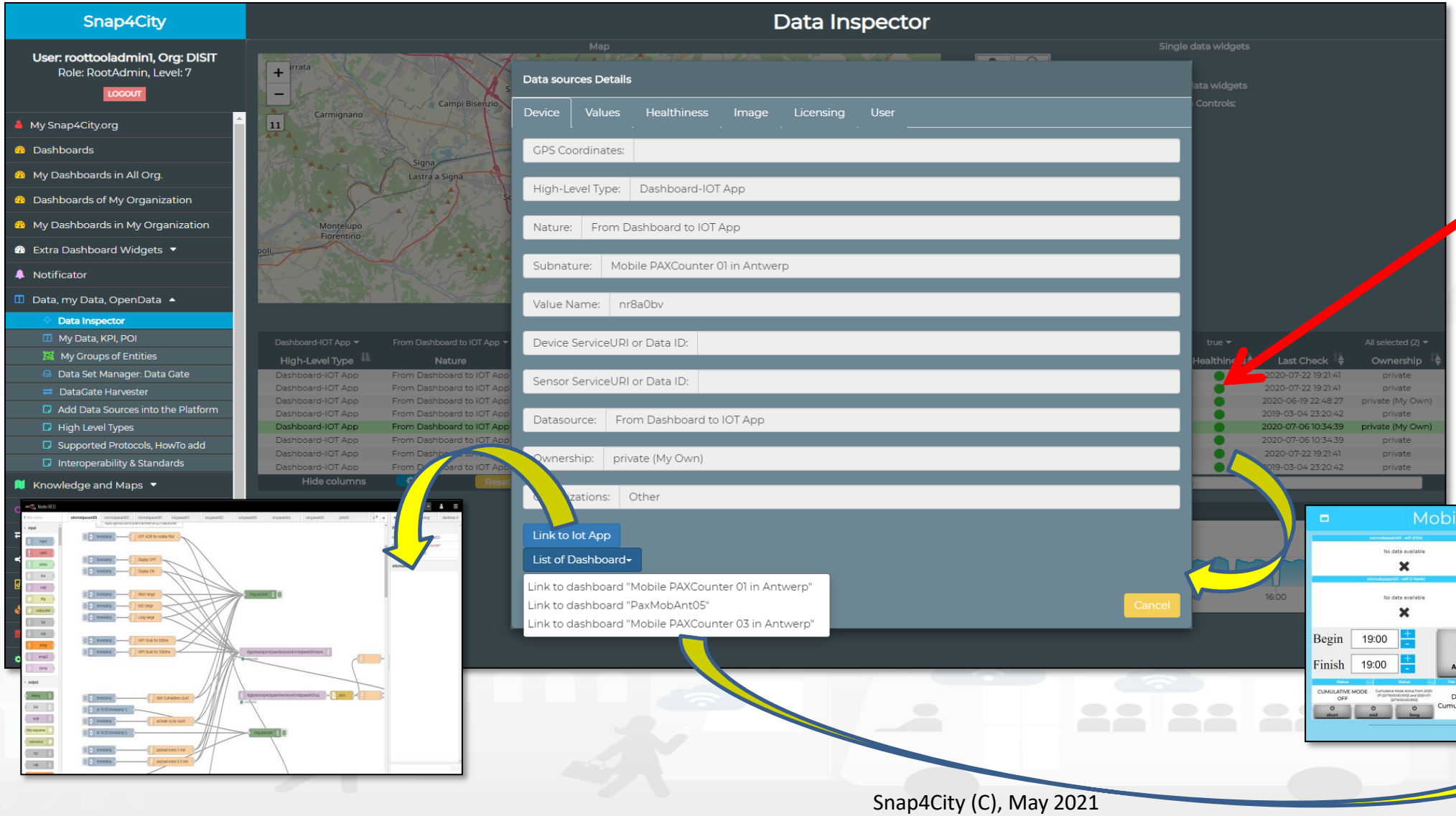
Image of the Devices and Licensing





Some functionalities are limited to certain roles

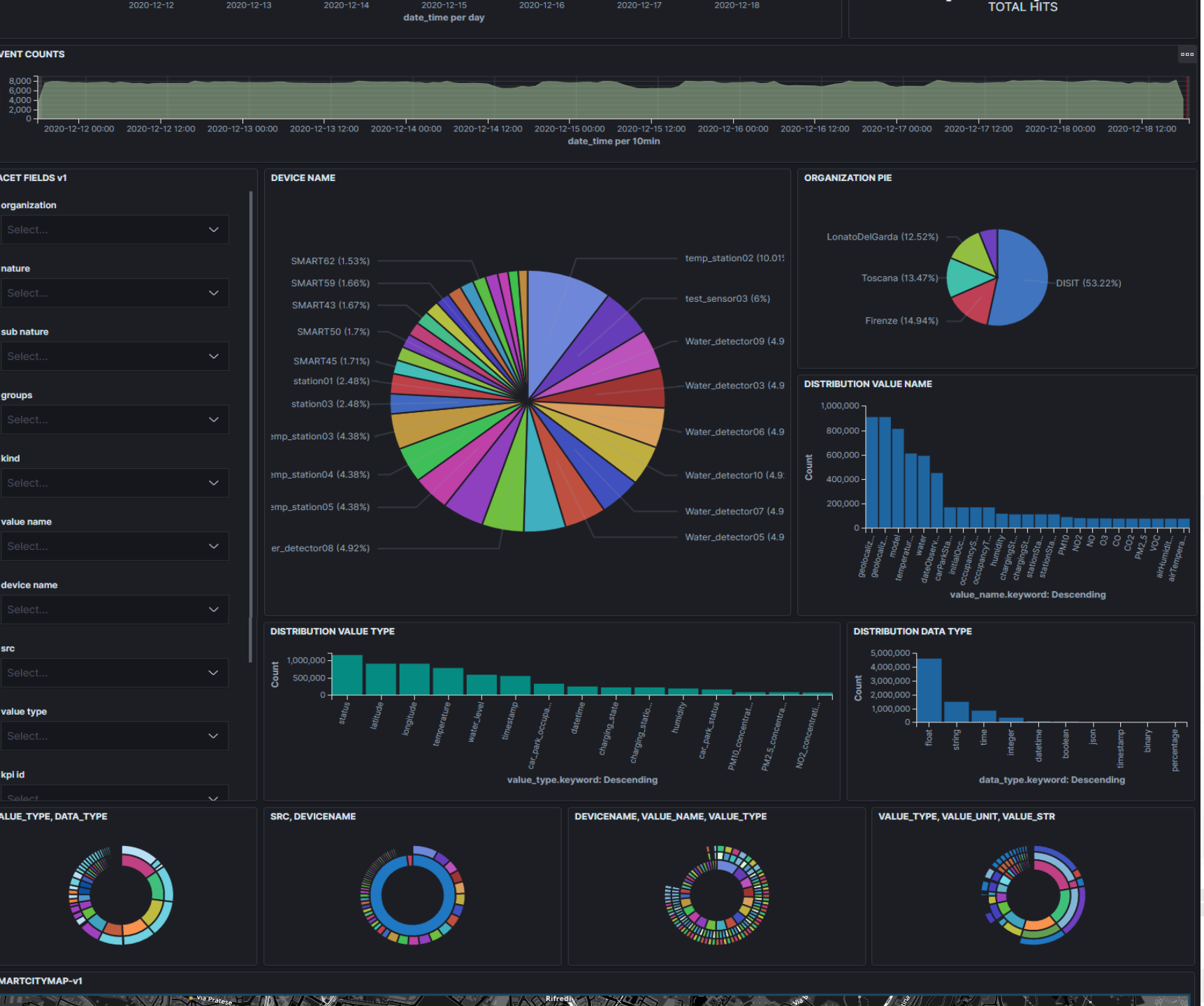
HLT: From Dashboard to IOT APP



- Click with the mouse on it

Business Analysis Dashboards For all kind of users: DevDash

- Dynamic Filtering, Adaptable, …
- Full data details, drill down,…
- Synergic with **Data Inspector** which addresses data relationships, processing and information
- **Only Your Data for**
  - Manager and Area Managers
- **All Accessible Data for**
  - ToolAdmin and RootAdmin

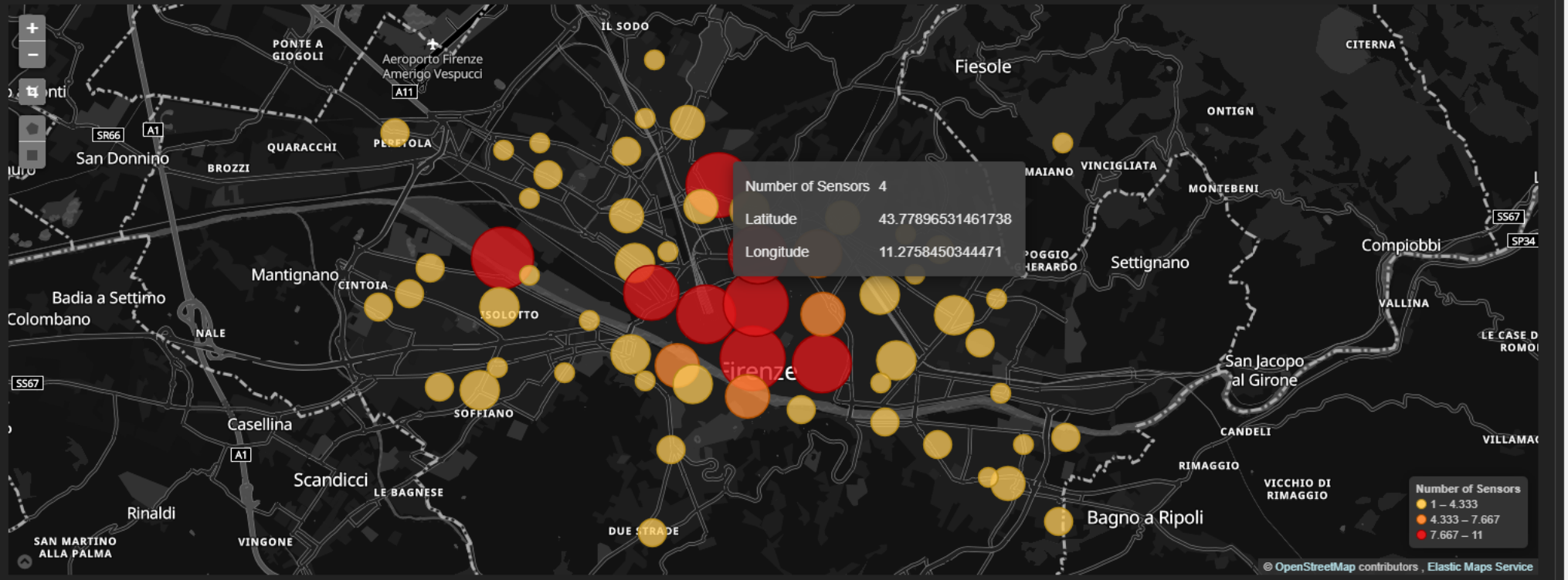


- Multi faceted Search by
  - Devices
  - Organization
  - Drill on Time
  - Drill on Map
  - Value Types
  - Data Type
  - Value name
  - Data table
  - Etc.
- Respect Privacy and GDPR

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

LOGOUT

SMARTCITYMAP



EVENTS

1–50 of 176,794

Time	organization	deviceName	value	src	kind	latlon	value_name	value_type	data_type	serviceUri	value_unit	value_str
October 11th 2020, 12:33:52.790		test_sensor03	9.215	IOT	sensor	43.7921,11.2495	geolocalization_lon	longitude	float	http://www.disit.org/km4city/resource/iot/orionUNIFI/test_sensor03	#	-
October 11th 2020, 12:33:52.790		test_sensor03	24	IOT	sensor	43.7921,11.2495	temperature	temperature	float	http://www.disit.org/km4city/resource/iot/orionUNIFI/test_sensor03	°C	-
October 11th 2020, 12:33:52.790		test_sensor03	-	IOT	sensor	43.7921,11.2495	geolocalization_lat	latitude	float	http://www.disit.org/km4city/resource/iot/orionUNIFI/test_sensor03	#	NaN
October 11th 2020, 12:33:52.492	DISIT	testxxx3	1,602,412,480,000	IOT	sensor	43.79737,11.3063	timestamp	timestamp	timestamp	http://www.disit.org/km4city/reso	#	-

TOP

Platform Integration Capabilities

URBAN PLATFORM: SMART CITY IOT AS A SERVICE AND ON PREMISE

100% OPEN SOURCE

APPLIANCES CONTAINERS

- LOCAL GOVERN
- STAKEHOLDERS
- CITY USERS
- IN-HOUSE
- ENERGY OPERATORS
- MOBILITY OPERATORS
- COMMERCIAL OPERATORS
- SECURITY OPERATORS
- INDUSTRIES
- RESEARCHERS
- START-UPS
- ASSOCIATIONS

- GDPR
- SECURITY
- PRIVACY
- ASSESSMENT
- AUDITING
- PENTESTED

- OPEN IOT DEVICES
- IOT EDGE
- IOT GATEWAY
- PAX COUNTERS
- IOT BUTTONS

- TEST CASES, SCENARIOUS, VIDEOS, HACKATHONS
- OPEN SOURCES, COMMUNITY OF CITIES
- TRAINING TUTORIALS, COMMUNITY MANAGEMENT

IOT APPLICATIONS - INSTANT APPS

DATA DRIVEN APPLICATIONS • REAL TIME PROCESSING • BATCH PROCESSING • ANY PROTOCOL & FORMAT

DASHBOARDS & APPLICATIONS

CONTROL ROOM • SITUATION ROOM • OPERATOR DASHBORDS • BUSINESS INTELLIGENCE • WHAT-IF ANALYSIS • DECISION SUPPORT • SIMULATIONS • RISK ANALYSIS • RESILIENCE ANALYSIS

MOBILE & WEB APPLICATIONS

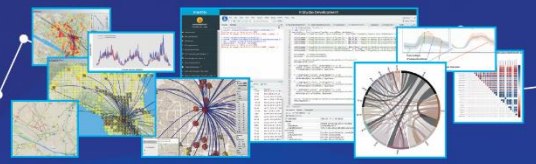
DEVELOPMENT KIT • SUGGESTIONS • MOBILE APPS • MONITORING PANELS • PLATFORM UTILITIES • READY TO USE SMART APPLICATIONS

MICROSERVICES & ADVANCED SMART CITY API

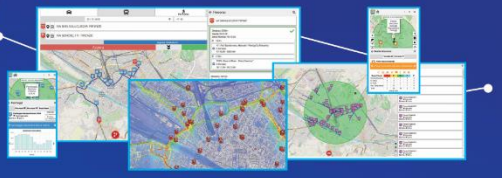
LIVING LAB - DEV TOOLS - COWORKING

IOT DIRECTORY • SERVICE MAP • RESOURCE MANAGER • DATA GATE • R STUDIO • ETL

BIG DATA - DATA ANALYTICS



DATA ANALYTICS TOOLS - MICRO-APPLICATIONS



PREDICTIONS • ANOMALY DETECTION • WHAT-IF ANALYSIS • TRAFFIC FLOW RECONSTRUCTION • ORIGIN-DESTINATION MATRICES • SOCIAL MEDIA ANALYSIS • OFFER VS DEMAND ANALYSIS • ENVIRONMENTAL DATA ANALYSIS AND PREDICTIONS • REAL TIME HEATMAPS • ROUTING • ALERTING • EARLY WARNING • PERSONAL AND VIRTUAL ASSISSTANTS • SMART SOLUTIONS • SMART SHARING • PARTECIPATORY

KM4CITY DATA AGGREGAT KNOWLEDGE BASE - EXPERT SYSTEM OF THE CITY – BIG DATA STORE

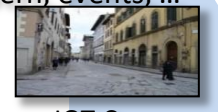
IOT MNG - DATA MNG - DATA INSPECTOR – PROCESS MNG – USER ENGAGEMENT – GDPR MNG ...

GIS	CITY UTILITIES	OPEN DATA	LEGACY & EXTERNAL SERVICES	PERSONAL DATA	IOT / IOE	BROKERS	KPI	INDUSTRY 4.0	SOCIAL MEDIA

Smart City Functional Architecture

Transport systems Mobility, parking

Public Services, Govern, events, …



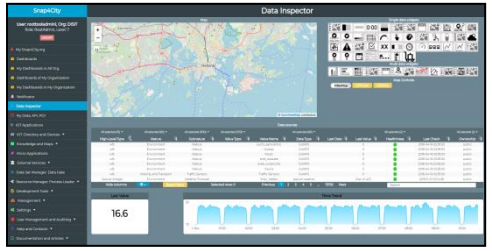
Sensors, IOT Cameras, Wi-Fi

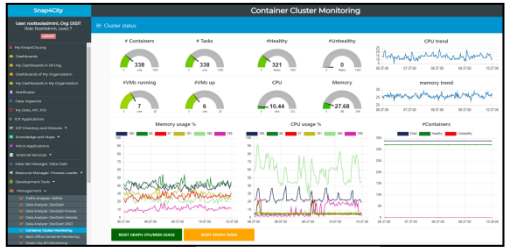
Environment, Water, energy

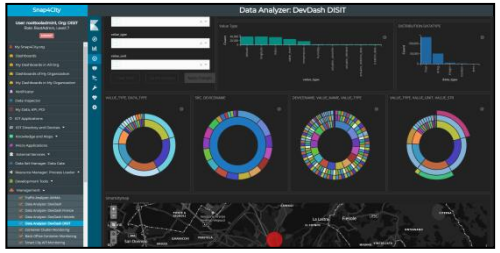
Shops, services, operators

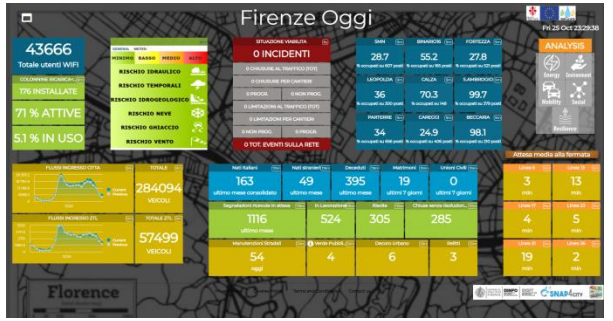
Social Media

Social Media Crawler and Manager









Back-End ← → Front-End

Data Sources, External Services *PULL Data*

Data Sources, Brokers, External Services *Data Driven, Real Time*

Data Ingestion, aggregation, regularization, reconcile: IOT Directory, NIFI, special tools

Knowledge base Semantic Reasoners

Indexing and aggregating Elastic Search

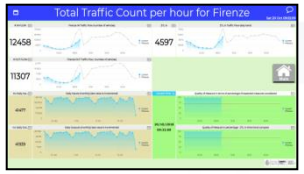
Federation

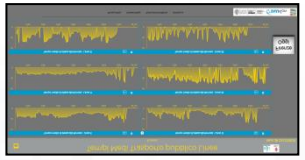
Search and Query, Smart City API, Web Socket Server, GIS, Facet, semantic

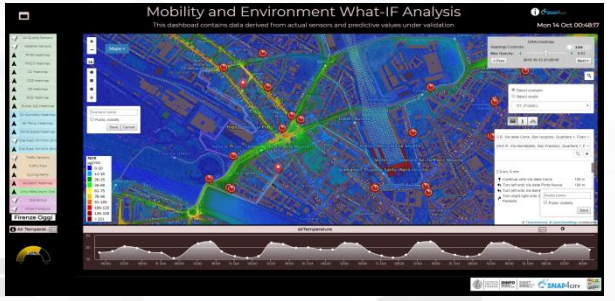
Data Analytics, Simulations, Special Tools R Studio, Tensor Flow, Python, ….

IOT Applications, Business Logic Node-RED + Snap4City MicroServices

Rendering Acting, Widgets, Synoptics, MicroApps User interface, Drill down, maps, heatmaps



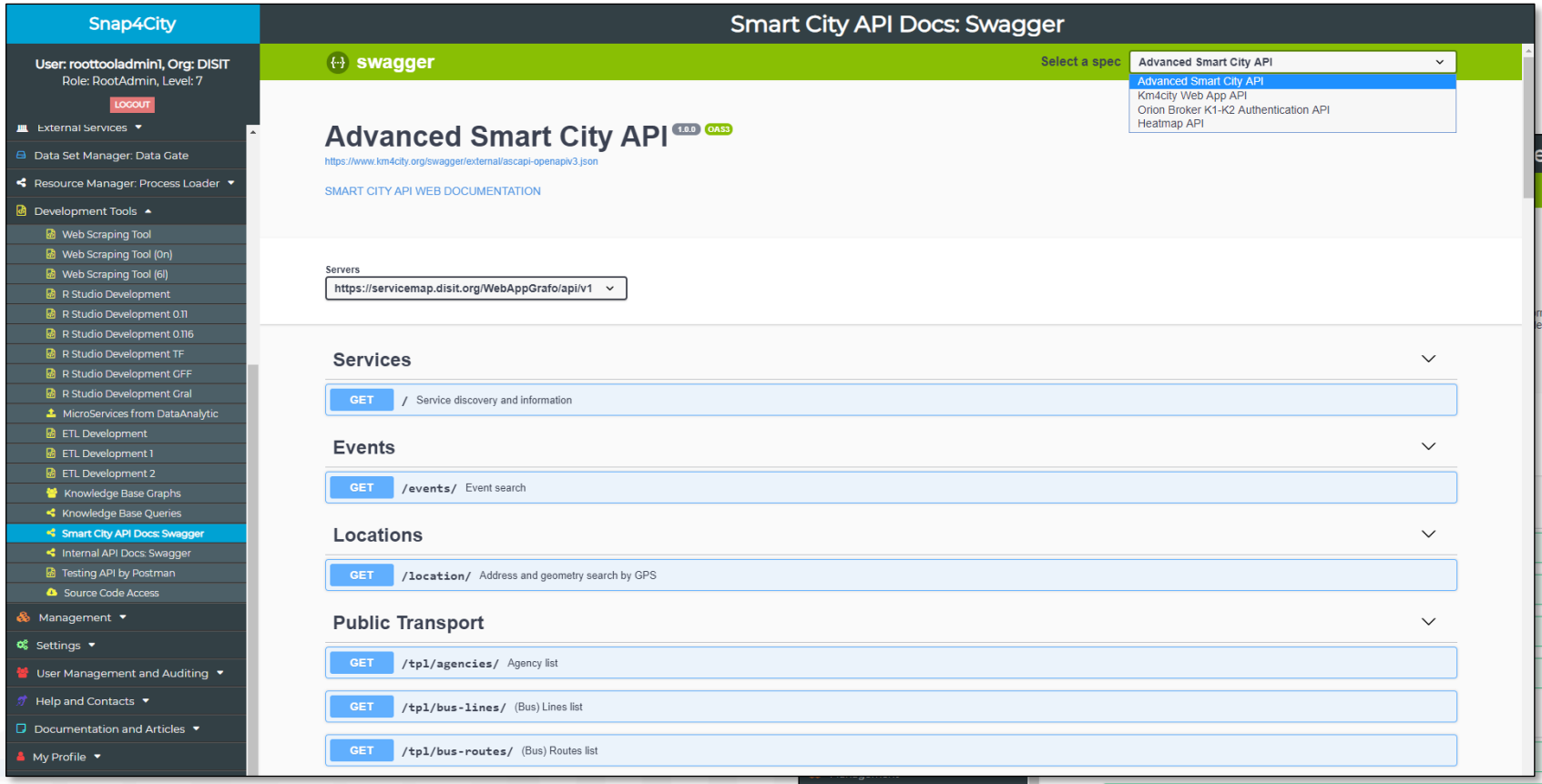


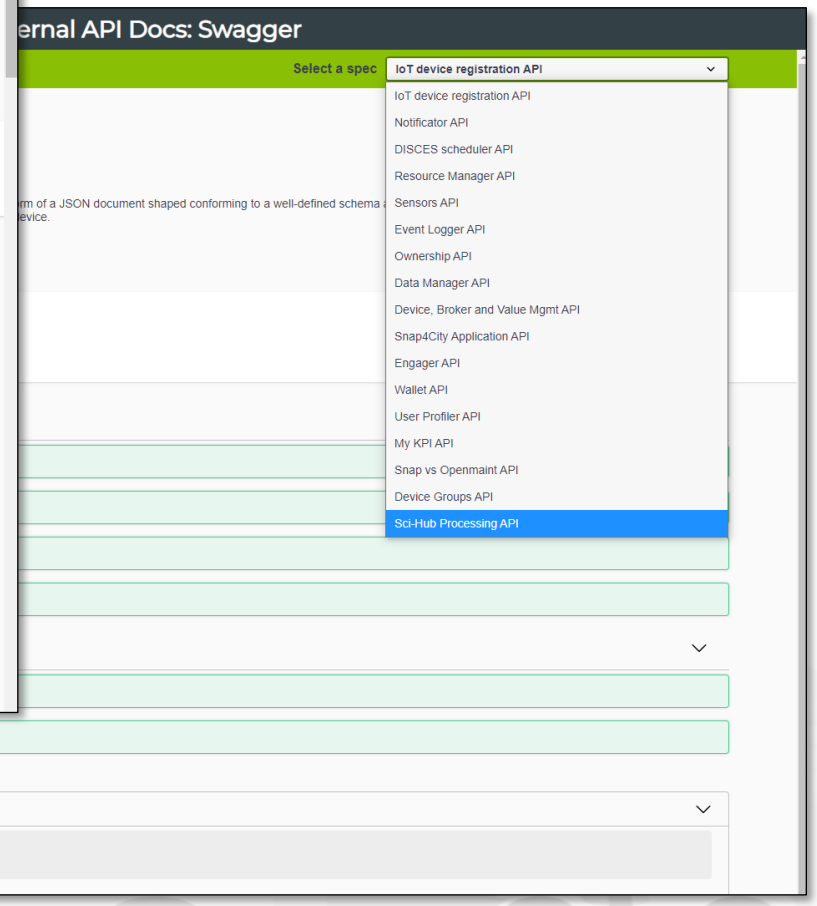


Inform, announce, Act!, warning, alarms, What-IF, ..

Authentication, Authorization, Platform & Processes Management, Data Inspector, Digital Twin, …

Internal and External Smart City API



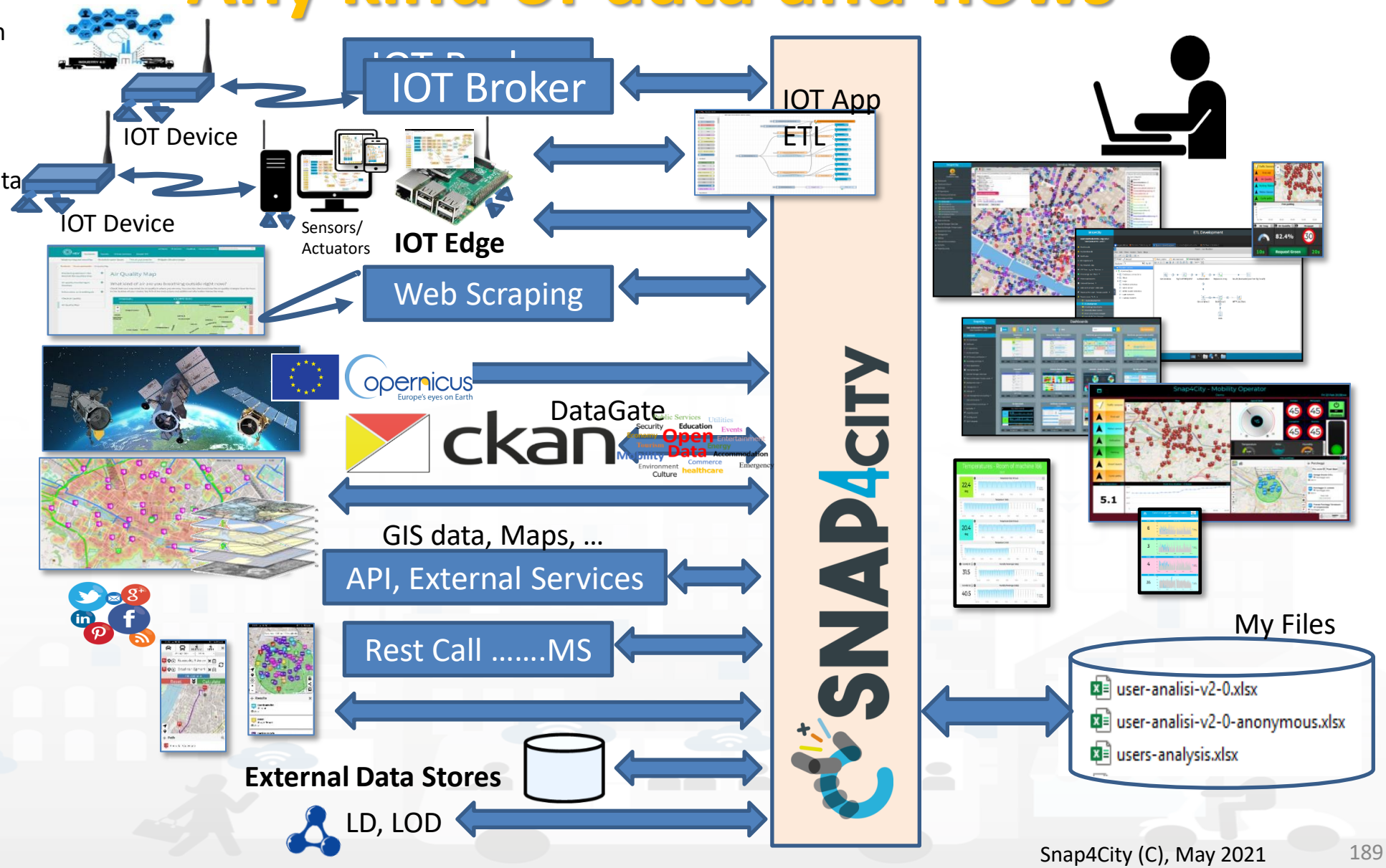


https://www.km4city.org/swagger/external/index.html

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

Any kind of data and flows

- **Open Data:**
  - Data gate, federation of Open Data Portals
  - IOT App, ETL proc(PULL)
- **IOT Networks:**
  - IOT Application processes, data driven or PULL
  - IOT Brokers (Push) → IOT Shadow
- **Web Pages:**
  - Web scraping, crawling processes
- **Satellite data**
- **Social media: Twitter, Facebook,..**
  - Twitter Vigilance, IOT App
- **Mobile Apps**
  - Smart City API
- **Files upload: CSV, Excel, etc.**
  - IOT Applications, ETL
- **REST API, WS, FTP, LD, LOD, etc.**
  - IOT Applications, ETL
- **Data base accesses**
  - GIS: WFS, WMS
  - ETL, IOT Application

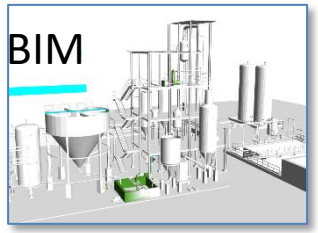


Standards and Interoperability

Compliant with: AMQP, COAP, MQTT, OneM2M, HTTP, HTTPS, TLS, Rest Call, SMTP, TCP, UDP, NGSI, LoRa, LoRaWan, TheThingsNetwork, SigFOX, DATEX II, SOAP, WSDL, Twitter, FaceBook, Telegram, SMS, OLAP, MySQL, Mongo, HBASE, SOLR, SPARQL, EMAIL, FTP, FTPS, WebSocket, WebSocket Secure, ModBUS, OPC, GML, RS485, RS232, WFS, WMS, ODBC, JDBC, Elastic Search, Phoenix, XML, JSON, CSV, db, GeoJSON, Enfuser FMI, Android, Raspberry Pi, Local File System, ESP32, Libelium, IBIMET/IBE, OBD2, SVG, XLS, XLSX, TXT, HTML, CSS, KNX, Enocean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, BACnet, TALQ, Copernicus, Protocol Buffer, IFC, XPDL, etc.

Concept

BIM

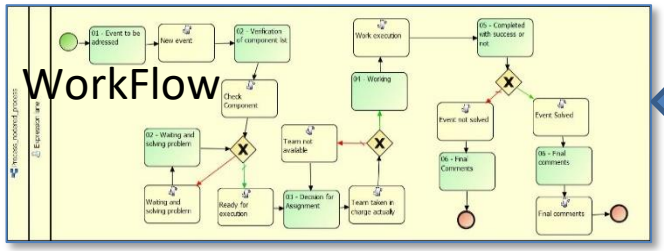


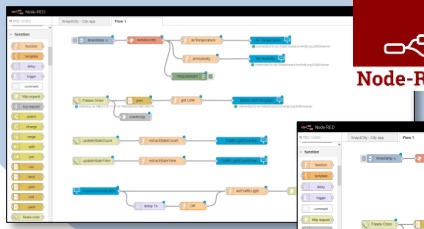
KPI, POI, MyKPI, …

API, External Services

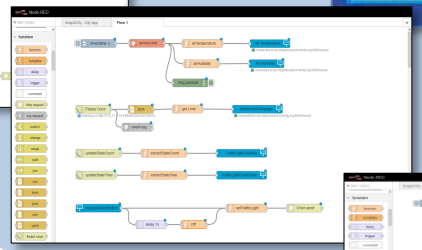
Web Scraping

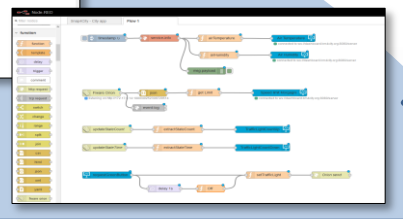
WorkFlow



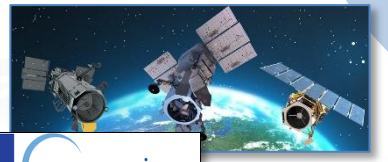


Node-RED





Data Analytics,
Artificial Intelligence



opernicus
Europe's eyes on Earth

IOT Brokers

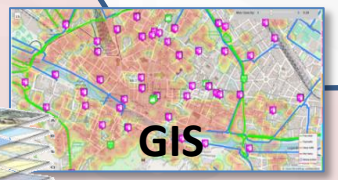
IOT Broker

IOT Broker

IOT Apps

FIWARE

ckan

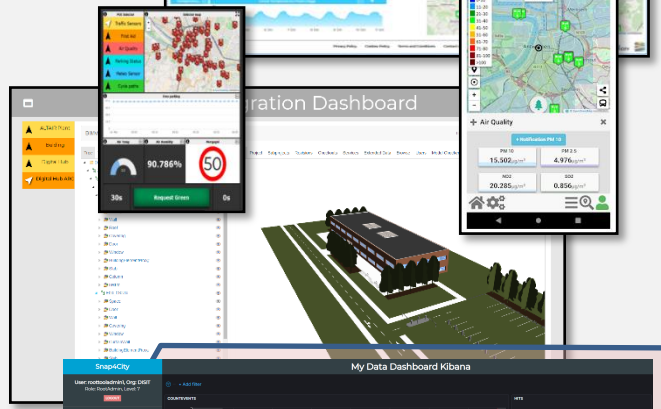


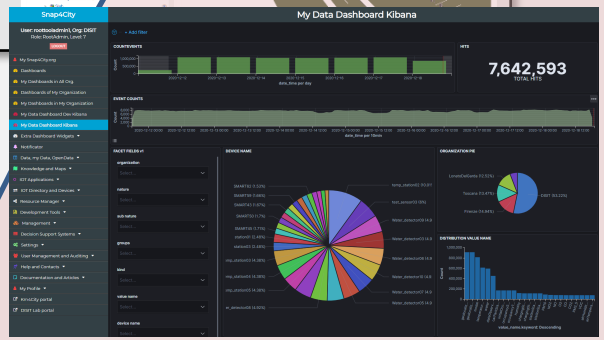
GIS

Big Data

KB

LD, LOD





Dashboards and Apps

FI-WARE

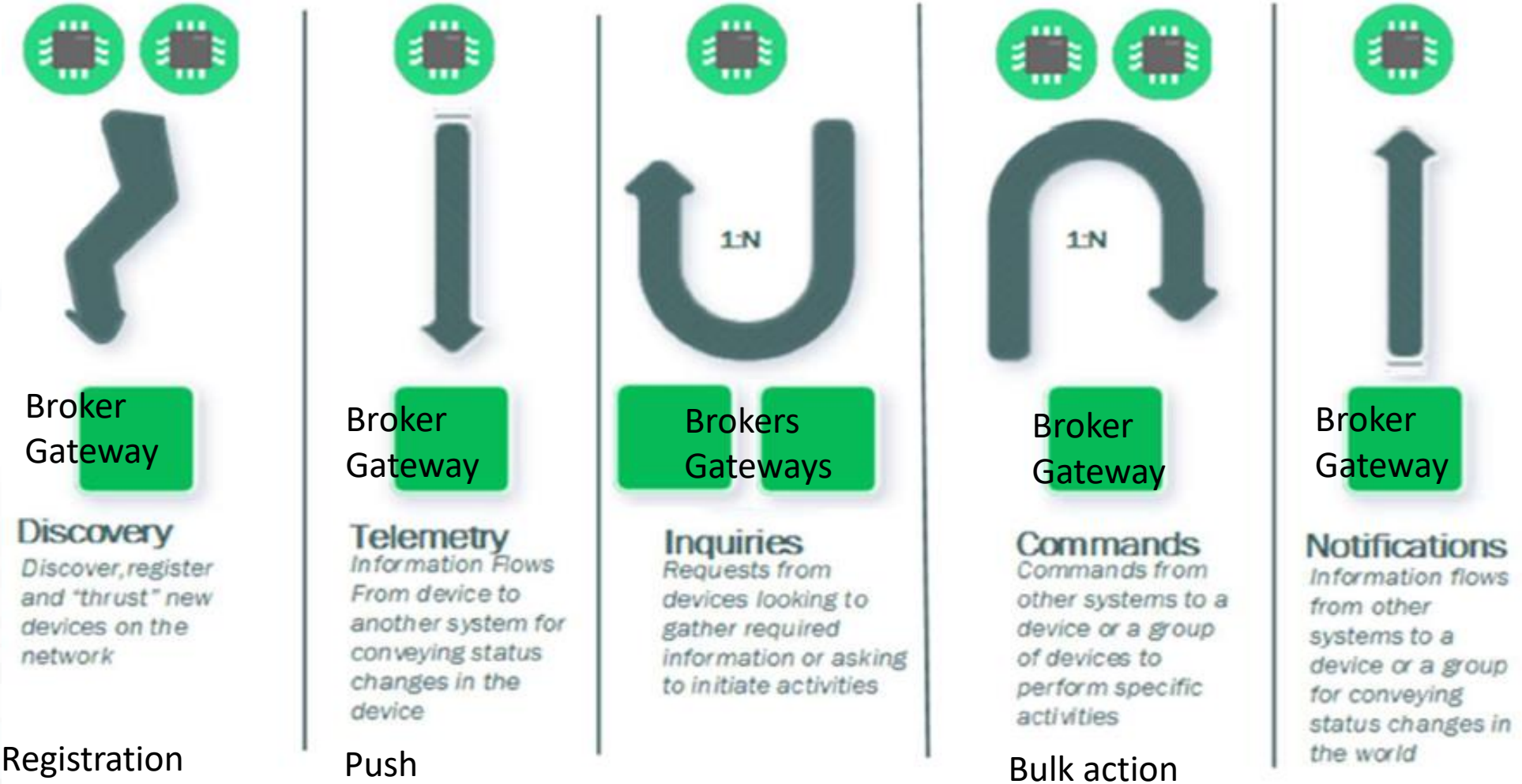
IOT Network Interoperability

IOT Interoperability

Compliant with: AMQP, COAP, MQTT, OneM2M, HTTP, HTTPS, TLS, Rest Call, SMTP, TCP, UDP, NGSI, LoRa, LoRaWan, TheThingsNetwork, SigFOX, DATEX II, Telegram, SMS, WebSocket, WebSocket Secure, ModBUS, OPC, GML, RS485, RS232, XML, JSON, CSV, GeoJSON, ESP32, Libelium, IBIMET/IBE, OBD2, XLS, XLSX, KNX, Enocean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, BACnet, TALQ, Protocol Buffer, etc.

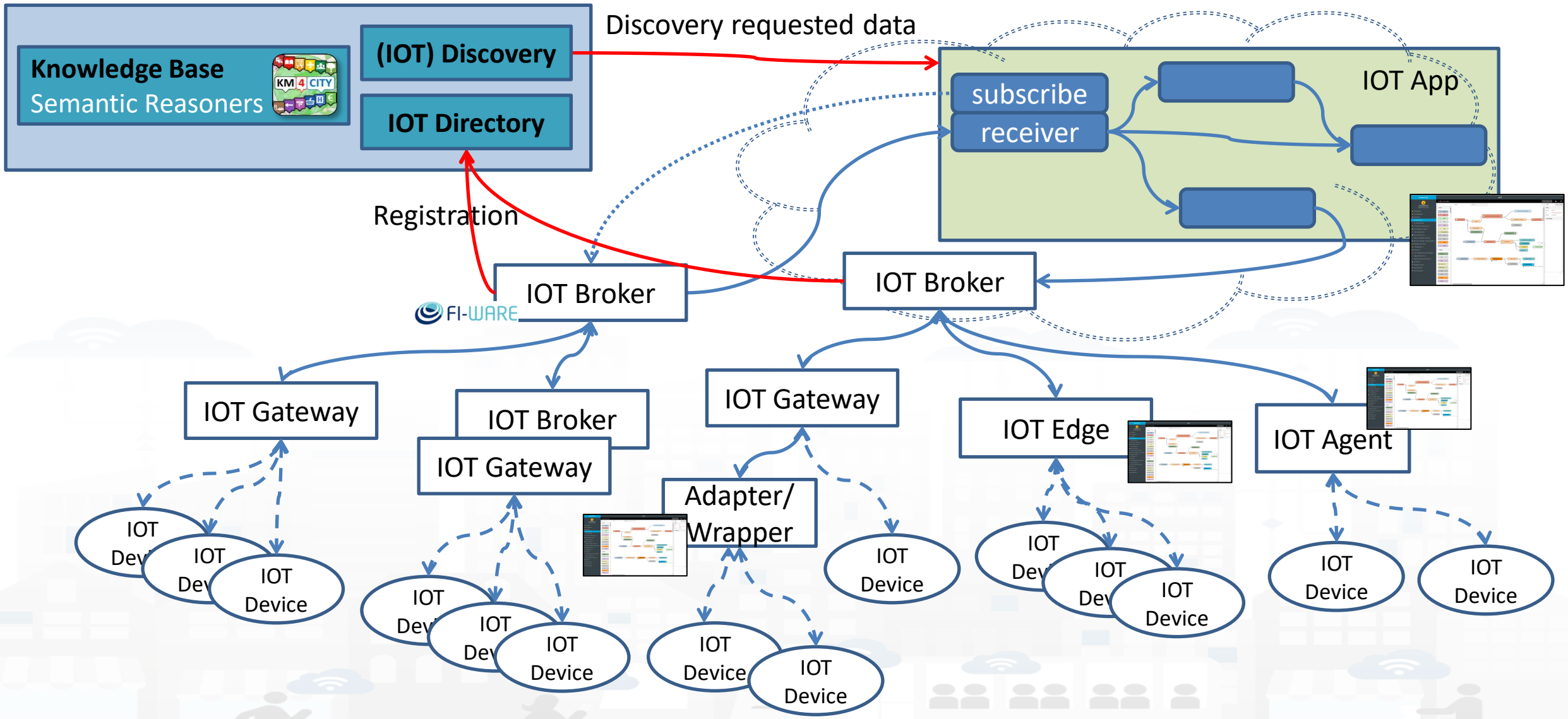
IOT/IOE Protocols

Communication Patterns



- MQTT
- HTTP(s)
- AMQP
- COAP
- NGSI
- OneM2M
- WebSockets
- ……..
- Etc.

IoT Network


Knowledge Base
Semantic Reasoners
(IOT) Discovery
IOT Directory
Discovery requested data
Registration
subscribe
receiver
IOT App
FI-WARE
IOT Broker
IOT Broker
IOT Gateway
IOT Broker
IOT Gateway
IOT Gateway
Adapter/
Wrapper
IOT Edge
IOT Agent
IOT Device

IOT Network Manager vs Final User

Network of IOT Brokers

IOT Broker

External

Internal

IOT Directory

IOT Network Manager

My IOT Device

Register

Registering

Discovering

Knowledge Base, Km4City

Knowledge and Storage Data from the Field and City

Browsing

ServiceMap Knowledge Base

Discovering

IOT Application

Final user Manager

Prepare

Deep Manage

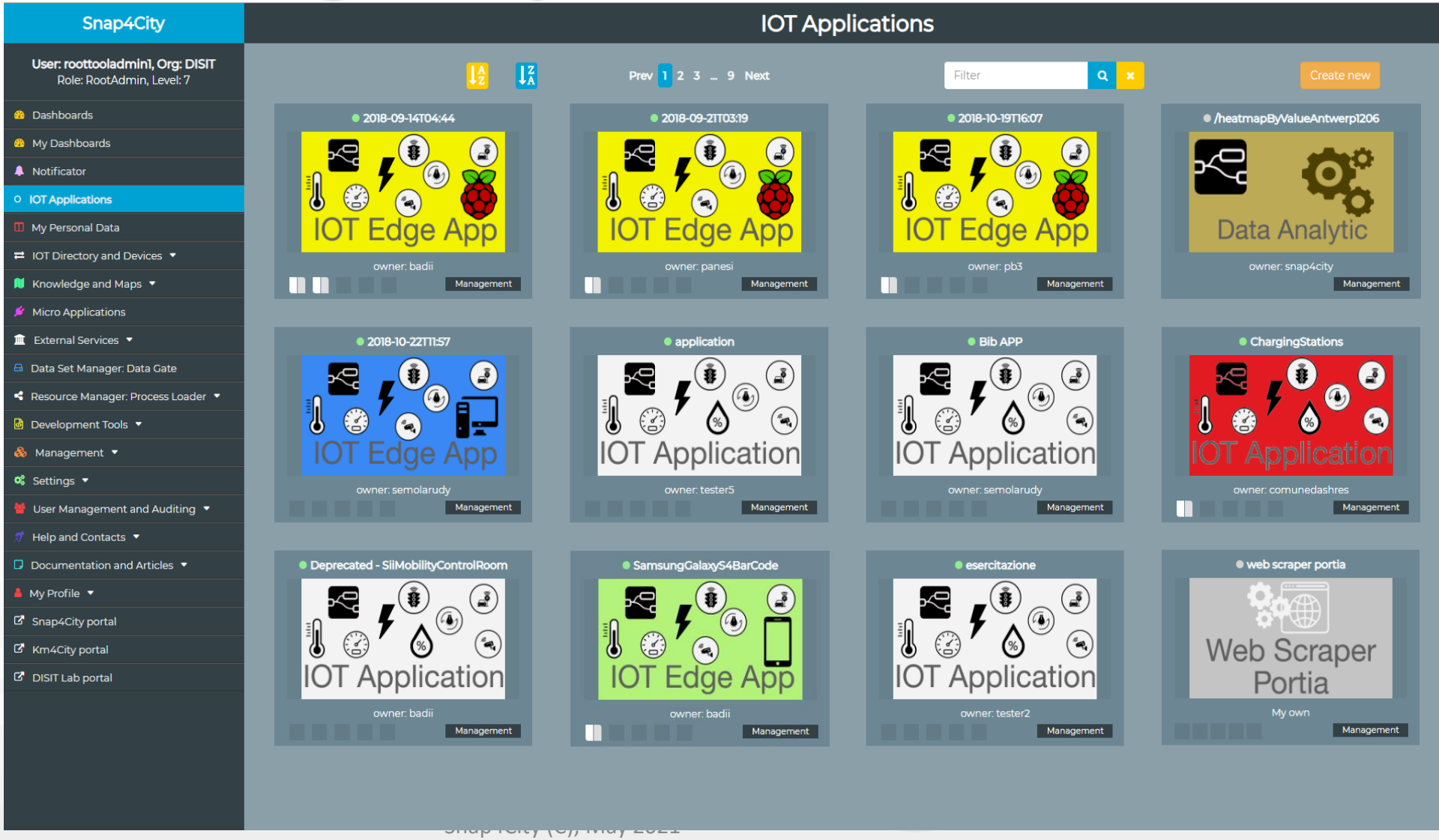
Exploit

Dashboard Wizard

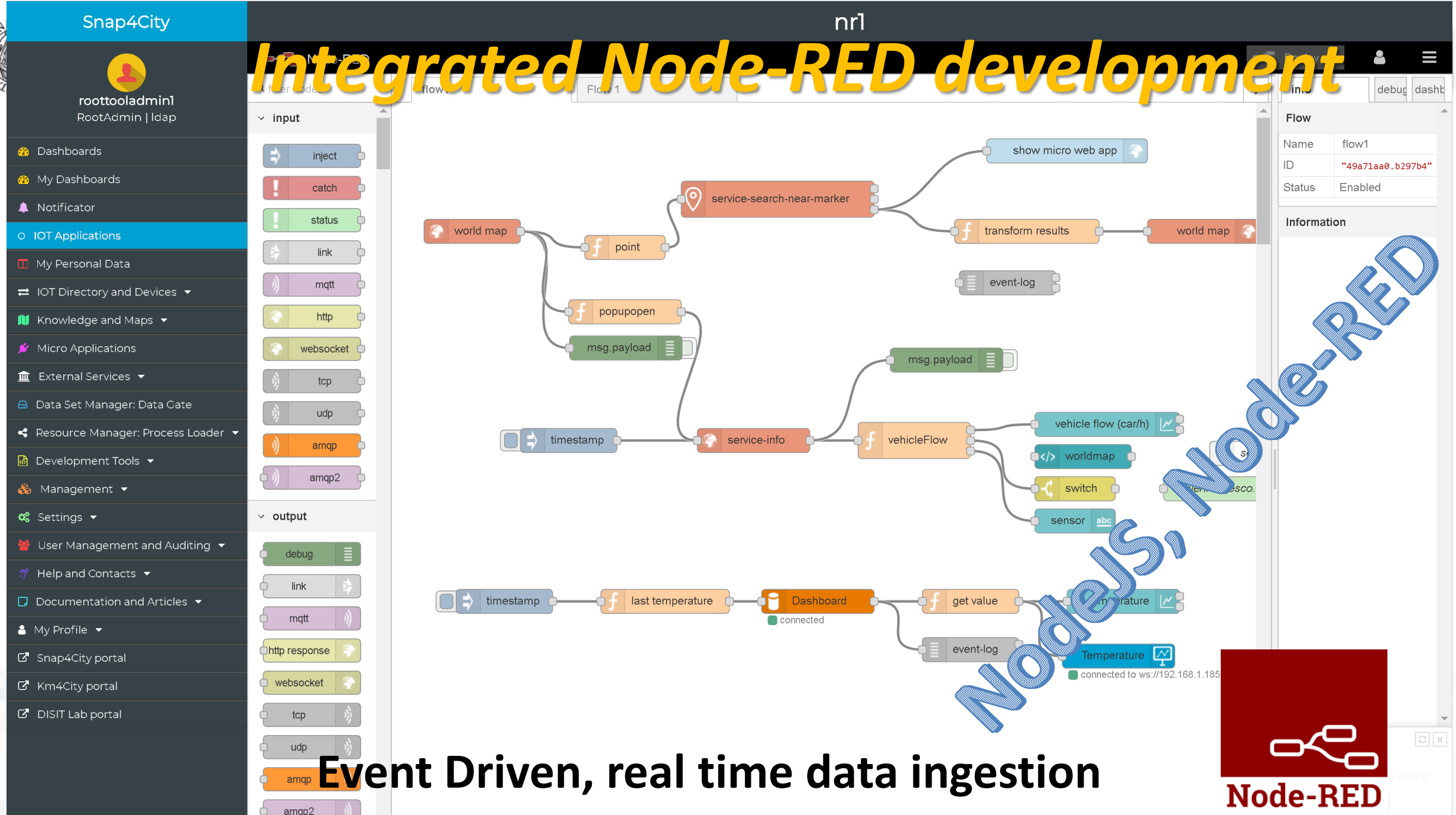
Integration via IoT Apps and processes

IOT Application Listing, they can be

- Basic (white)
- Advanced (red)
- IOT Edge
  - Raspberry Pi
  - Android
  - Win/Linux
- Data Analytic (Plumber)
- Web Scraper (Portia)

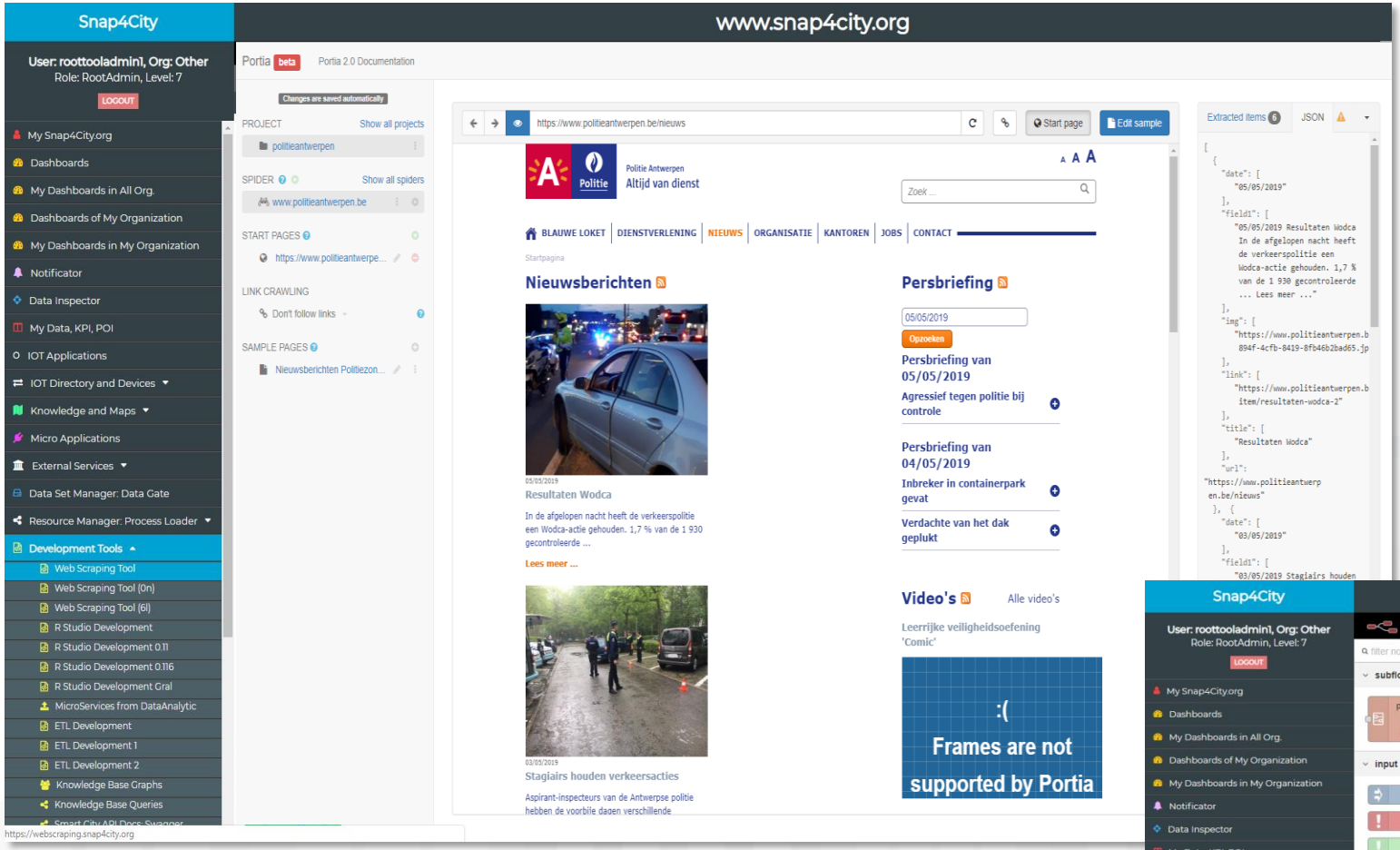


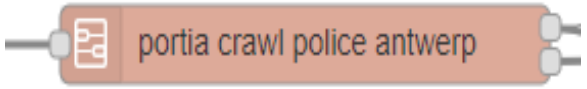
Integrated Node-RED development

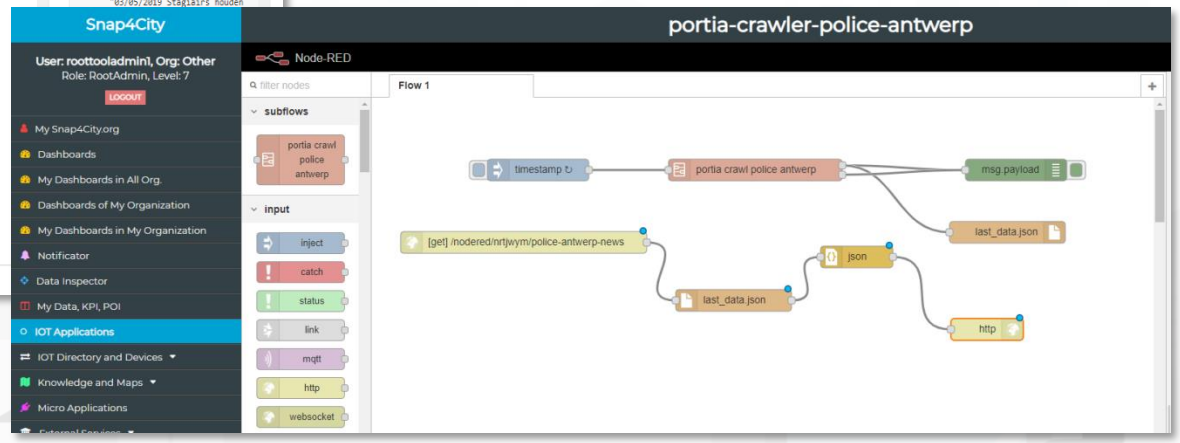


Event Driven, real time data ingestion

Web Scraping



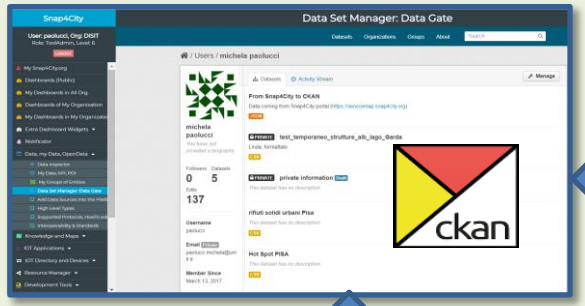




Snap4City vs CKAN

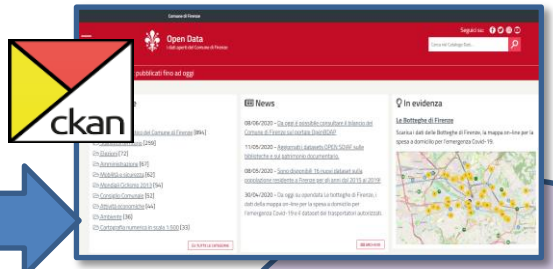
Snap4City Portal and Integrated tools

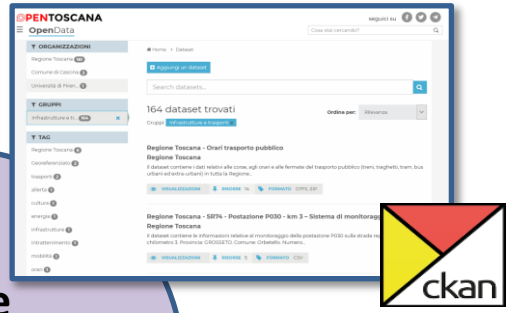
Datagate



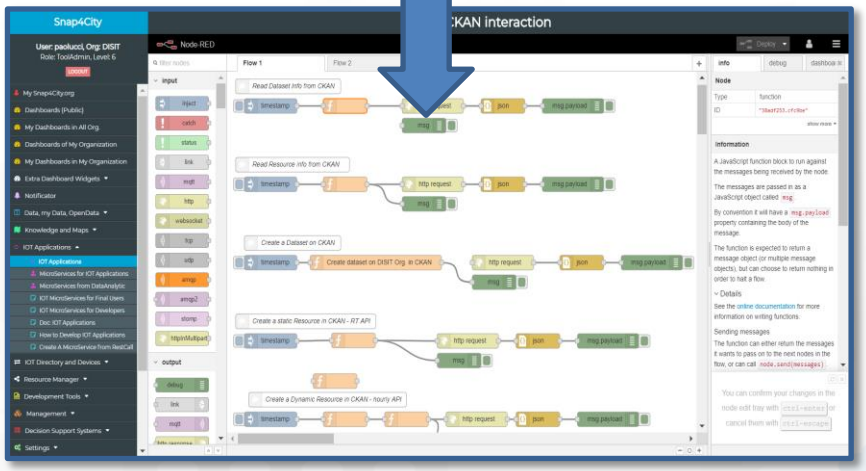
Advanced Snap4City APIs and Micro Services

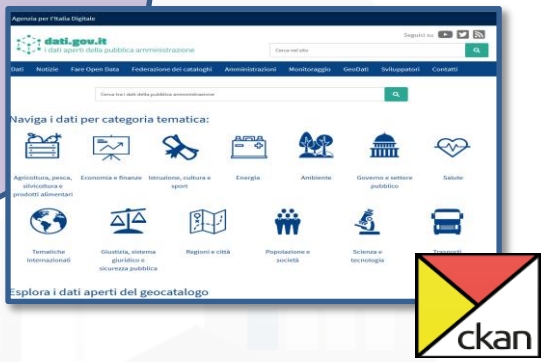
Harvesting and Publishing





Open or Private External CKAN Data Portals

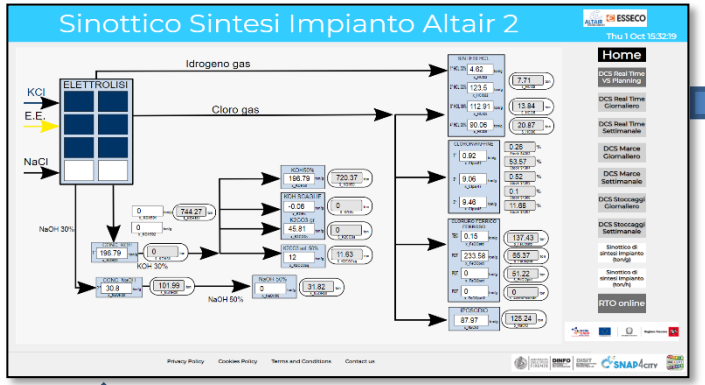




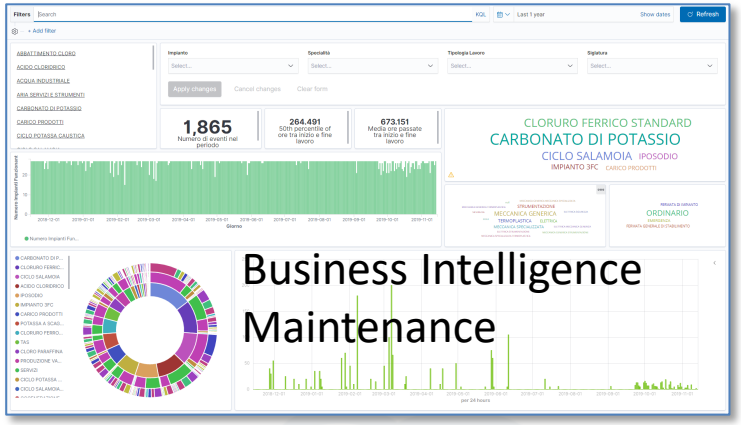
Automatize:

- Import data from CKAN to Snap4City
- Upload Public Data from Snap4City to CKAN
- Data Harvesting
- Dashboards and Mobile/Web Apps creation

Example of Integrated workflow

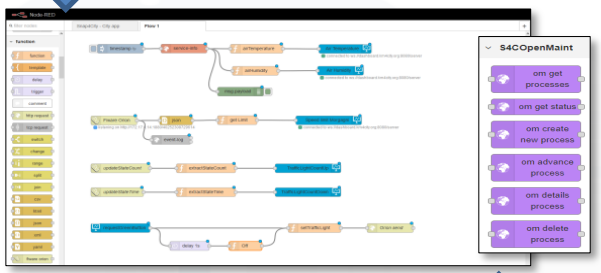


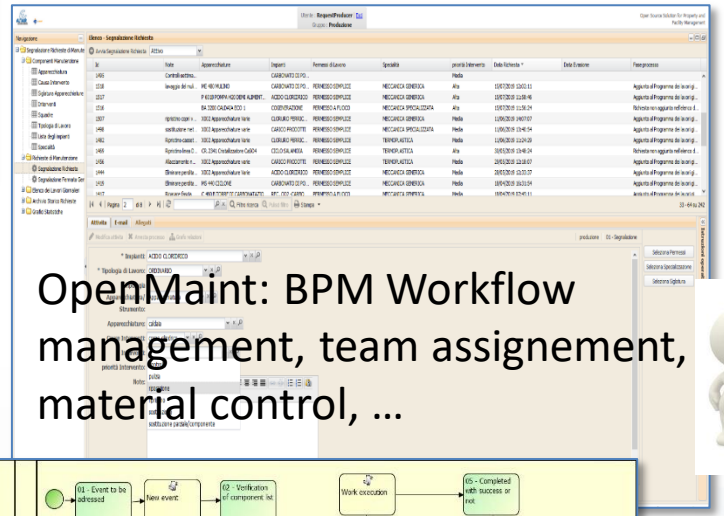
Consumptions/productions



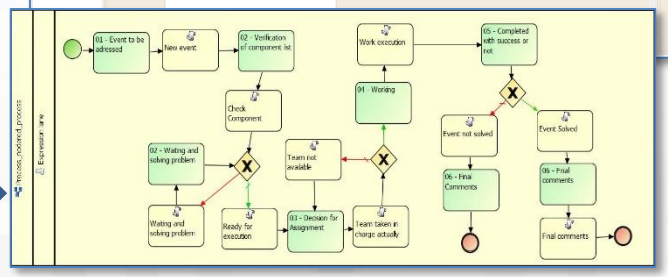
Events/actions

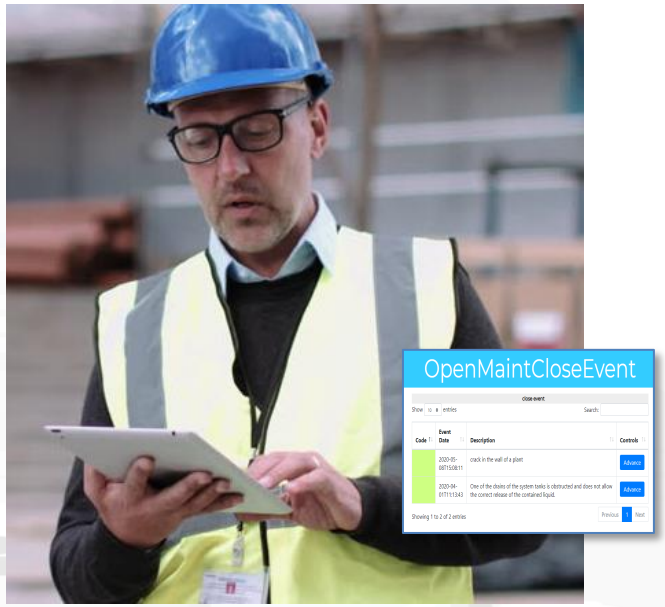
Dashboards and actions





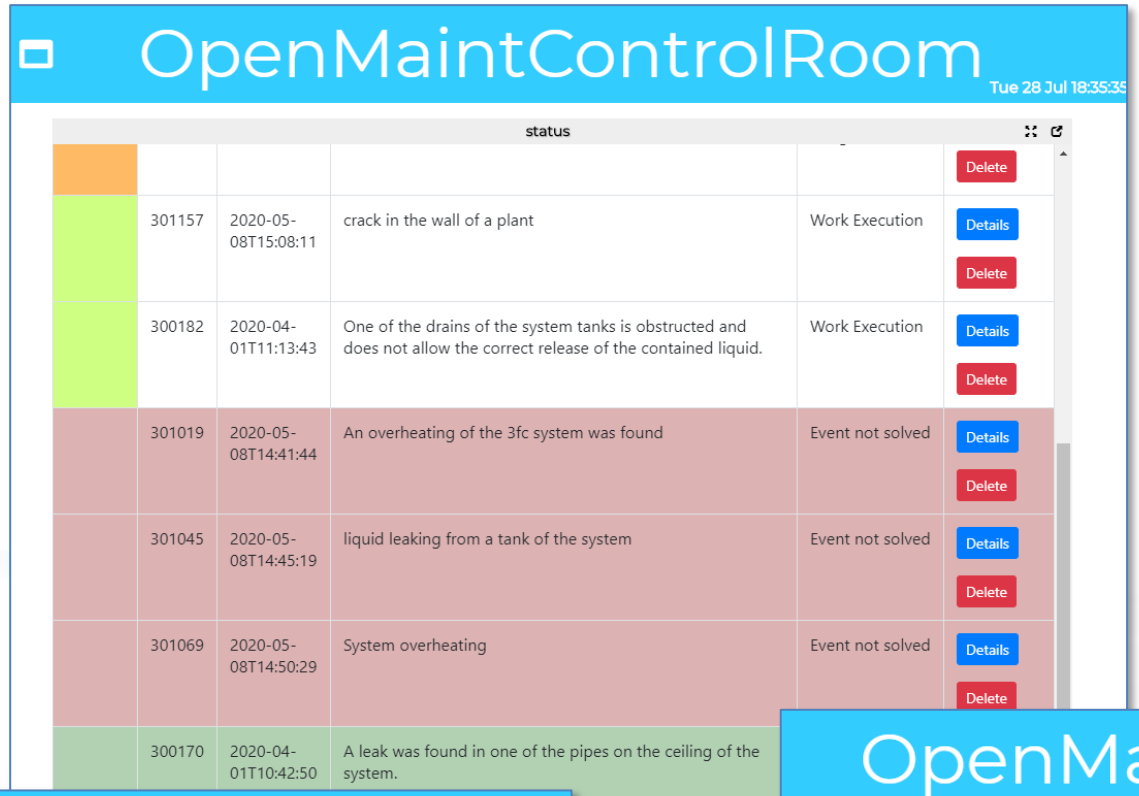
OpenMaint: BPM Workflow management, team assignement, material control, …

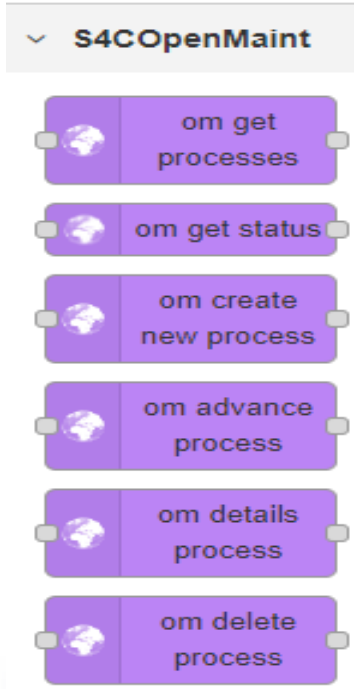


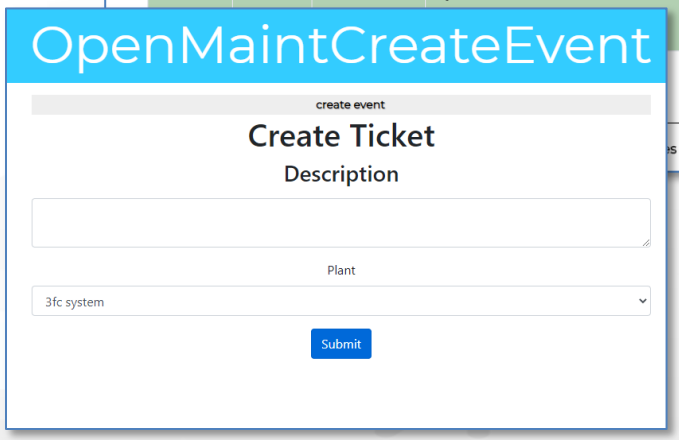


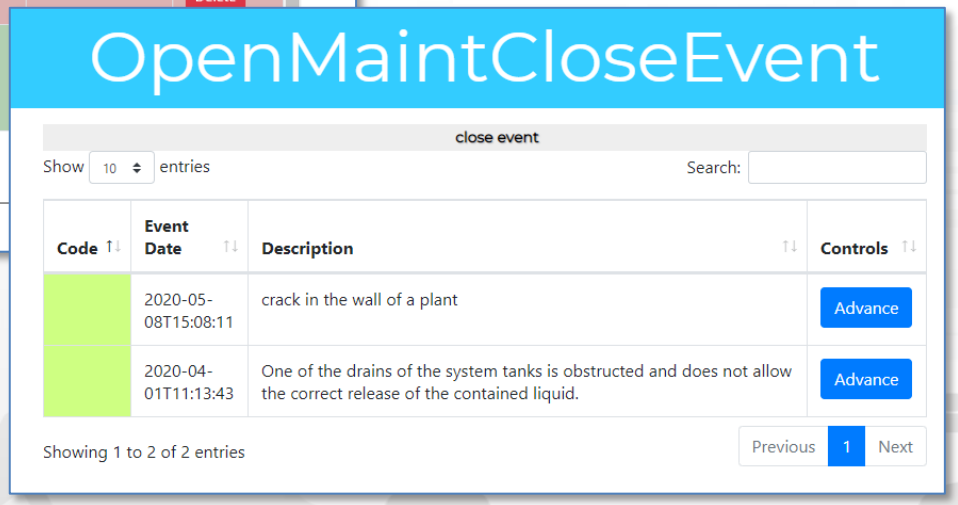
IOT App, Data event firing, event detection and firing Critical event management

Dashboards



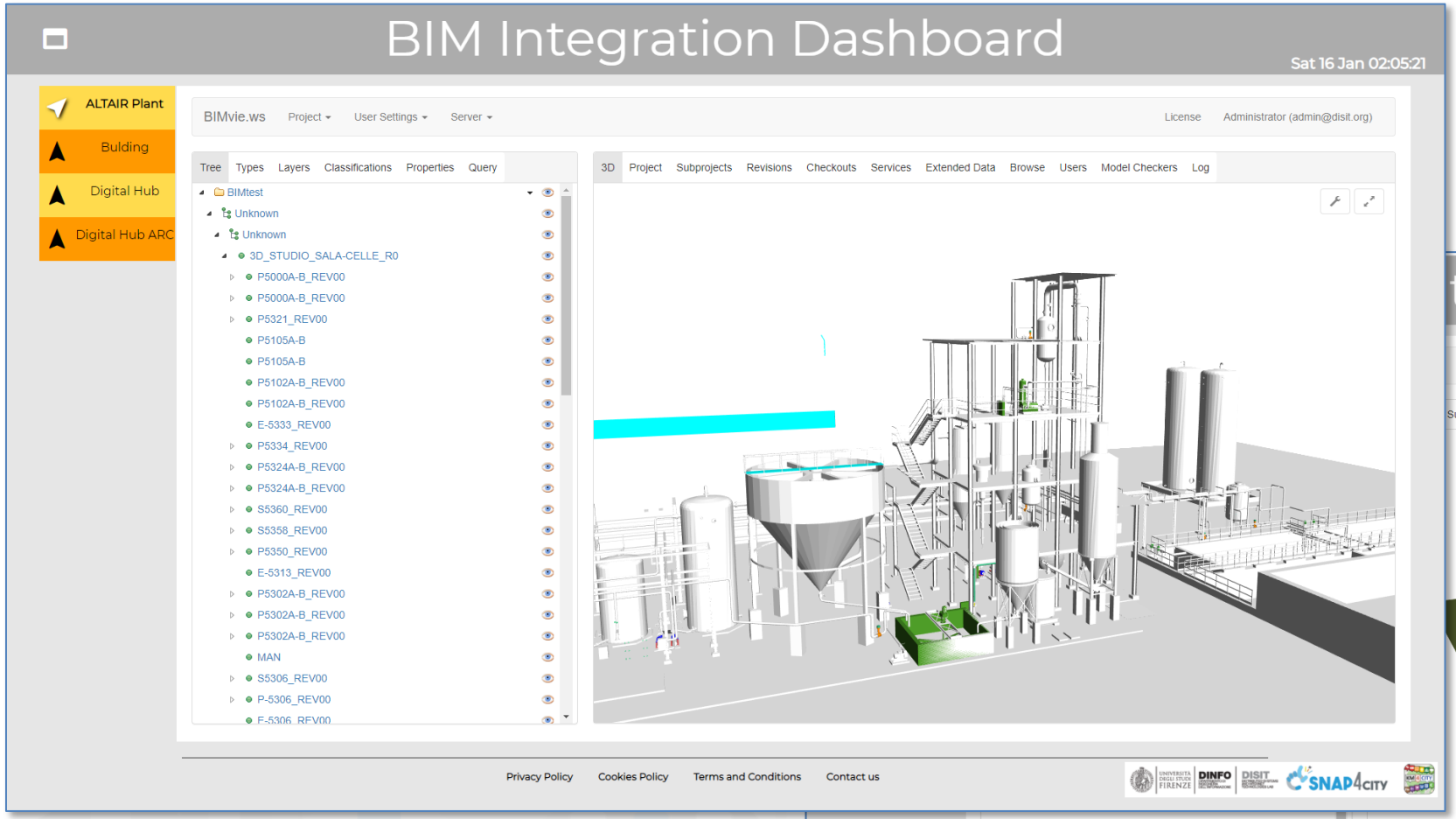


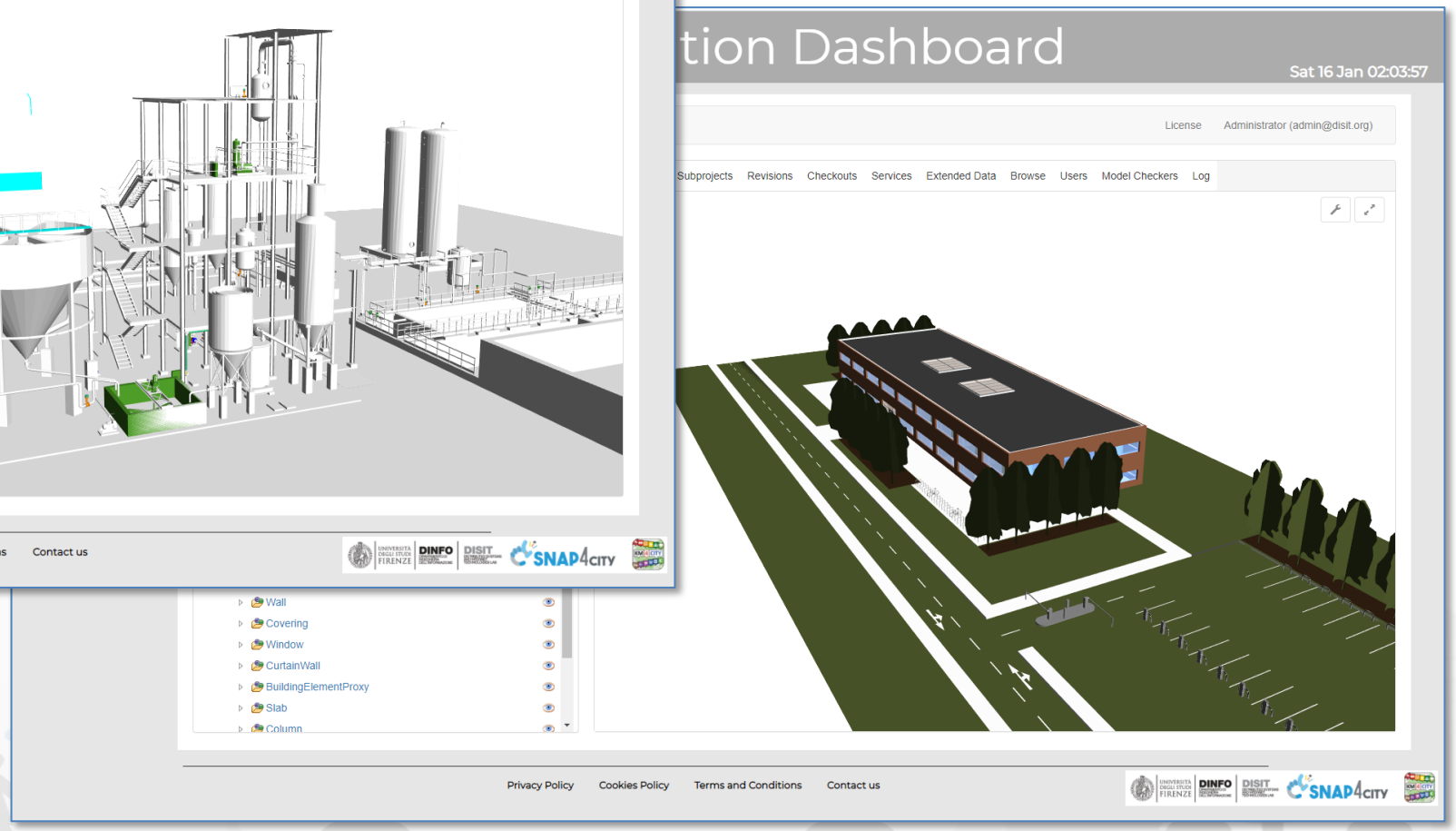




- **Snap4City can**
  - Create new tickets
  - Manage steps, workflow
  - Collecting feedbacks and results from teams
  - Manage all phases of the workflow on the fields via IOT Apps and logics
  - The integration if via API and MicroServices into IOT App.

BIM Server

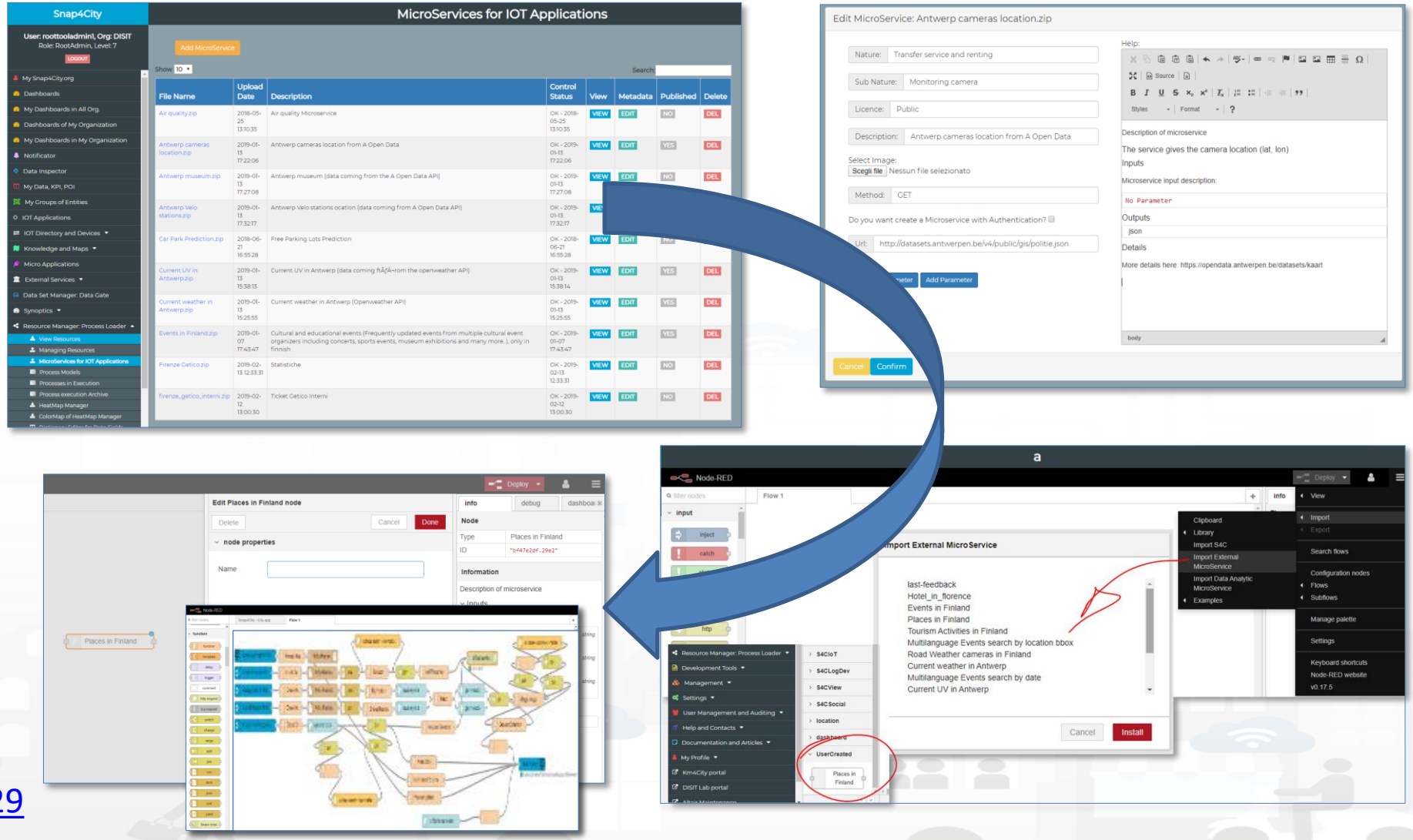




https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA1NA==

External REST Call API vs MicroServices

- Each Rest Call API can be automaticaly transformed into e MicroService for the IOT Applications



https://www.snap4city.org/129

Integration via IoT Apps on IoT Edge

https://www.snap4city.org/369

Measuring any kind of sensors values

Controlling Energy Power

Measuring
Energy Consumption

Any kind of notification channel

IOT Edge:
Node-RED
+
Snap4City

Local Control

Modbus

SCADA

OPC UA

DCS

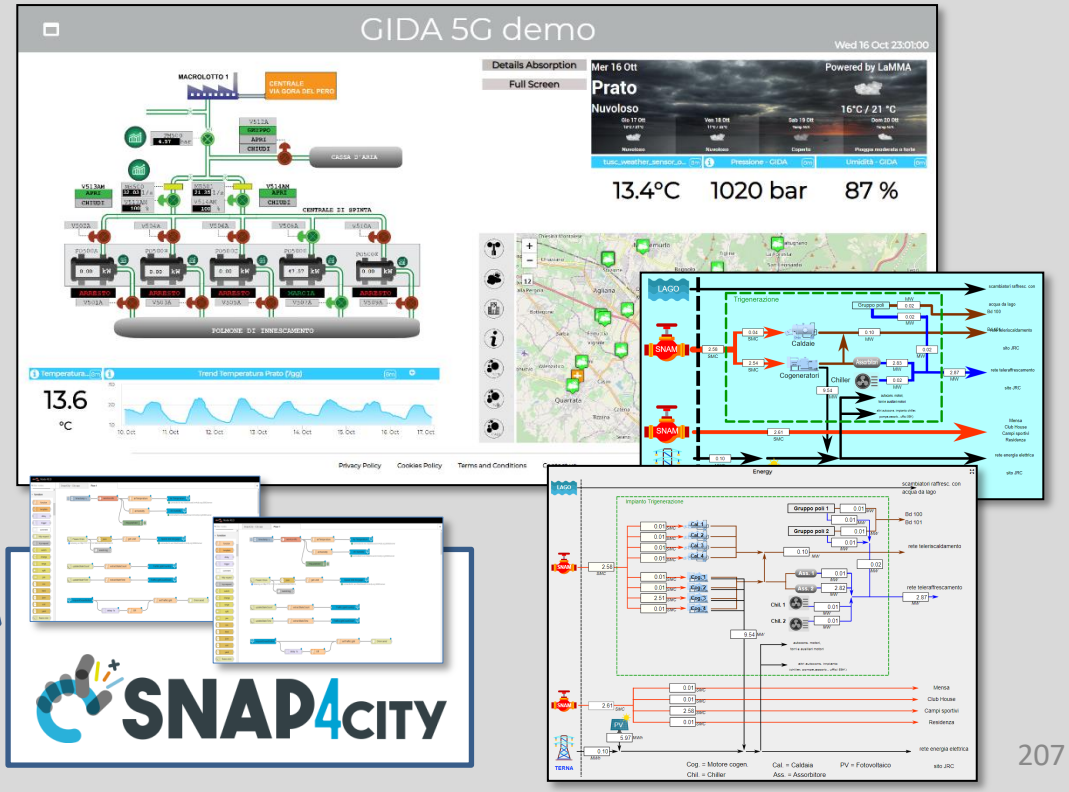
PLC

ODBC

Administrative Servers

Alexa: Voice Commands

Contextual (smart city/home) data, Data Analytics
Historical Data, Remote Control, Mobile App



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Snap4Home

SNAP4CITY | KM 4 CITY

Sonoff: Controlling Energy Power

Philips Hue: Controlling Lights

Hue: Motion Control / Alarm

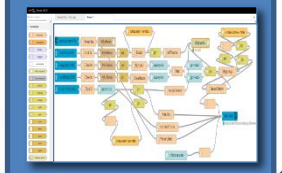
Measuring Energy Consumption

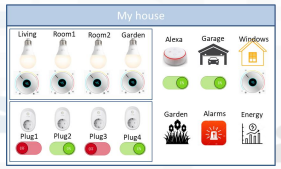
TP Link: Controlling / Measuring Energy Plugs

Alexa: Voice Control

IOT Edge:

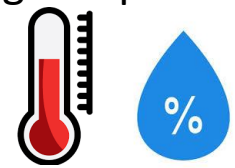
Raspberry pi: Node-RED + Snap4City





Local Control

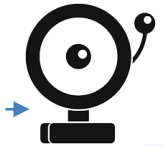
Measuring Temperature and Humidity



Garage Door

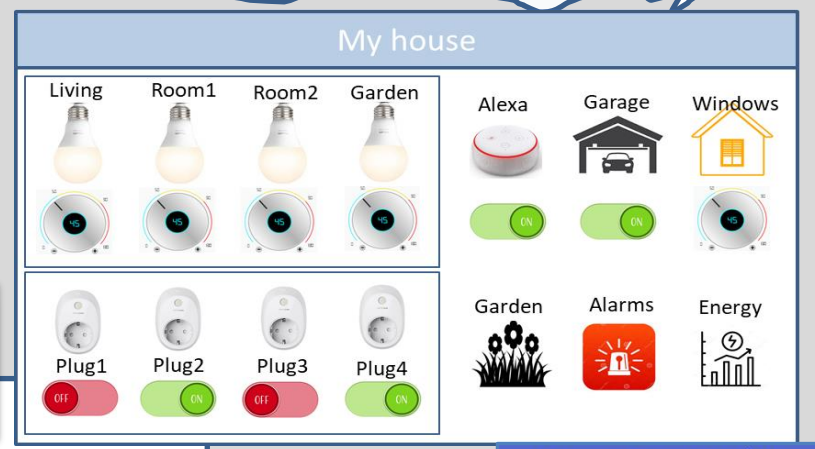
Window Roller Shutters

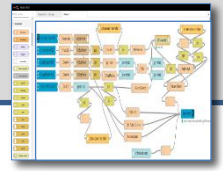
Controlling Motors



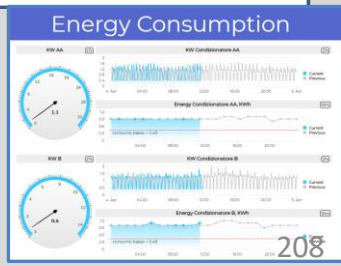
Alarm sound and light

Controlling Irrigators





SNAP4CITY



Environmental Contextual data from the city
Historical Data, Remote Control, Mobile App

https://www.snap4city.org/620

IOT Edge Device

Other Local Connections

IOT Brokers

IOT Brokers

HTTPS

HTTPS

WiFi

Modbus

OPC UA

IOT Edge:
Node-RED + Snap4City

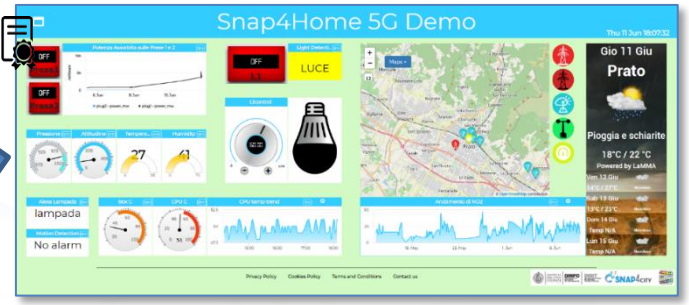
edge-tunnel-to-cloud

Search and Query, Smart City API
Facet, semantic search

Knowledge base
Semantic reasoners

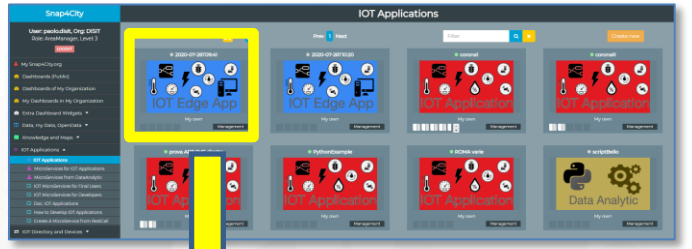
Indexing and aggregating
Elastic search

SNAP4CITY



WSs

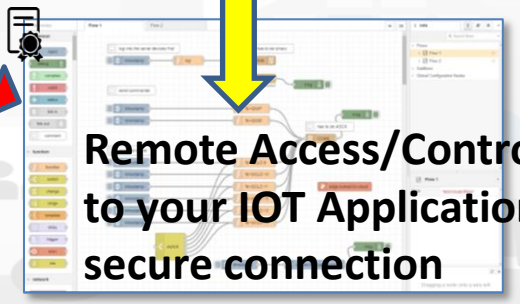
Firewall
Gateway
Towards internet



HTTPS

IOT Devices

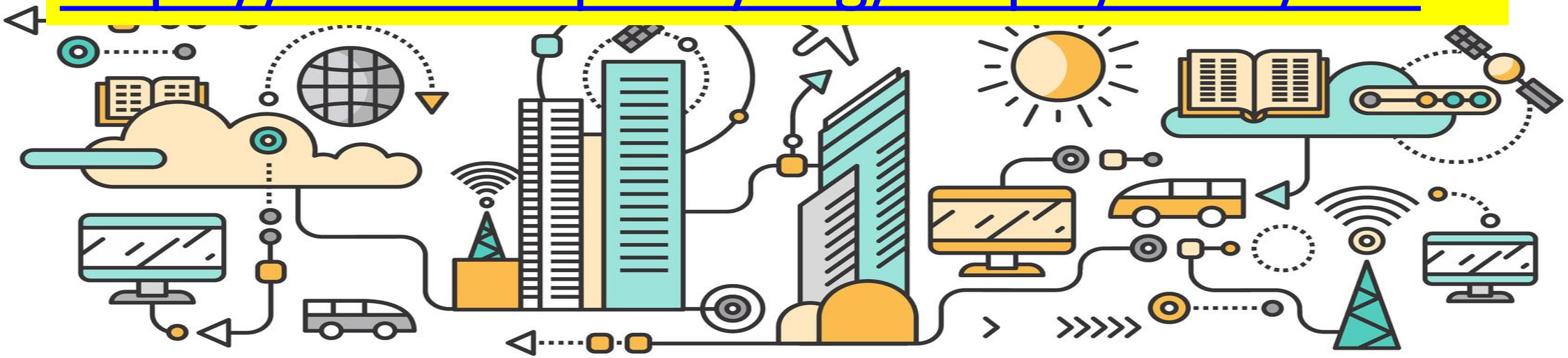
Access to IoT Edge Maintenance



Remote Access/Control/program to your IOT Applications via secure connection

Integration with GIS and ArcGIS

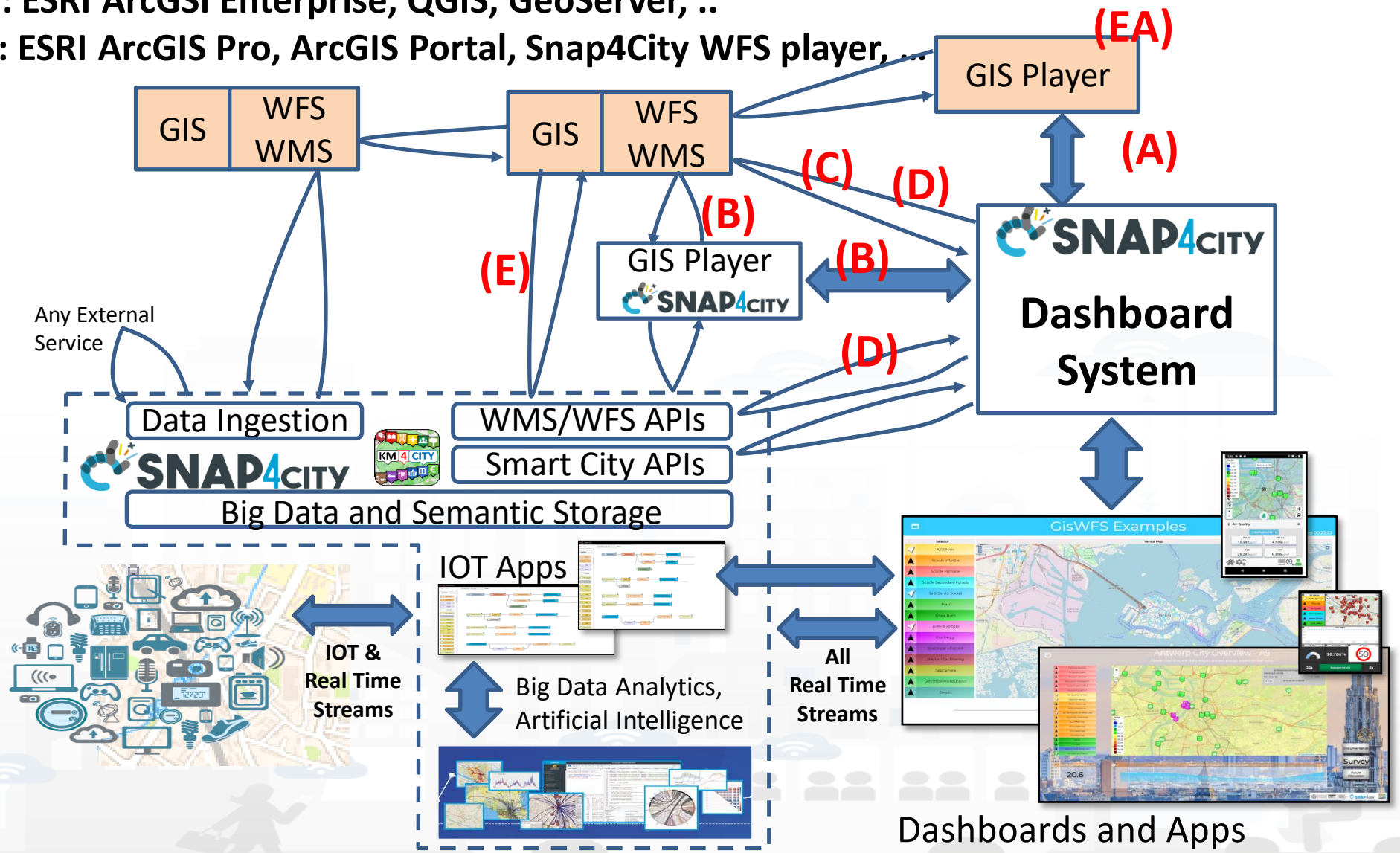
https://www.snap4city.org/drupal/node/368



GIS vs Sna4City

GIS Server can be: ESRI ArcGSI Enterprise, QGIS, GeoServer, ..

GIS Player can be: ESRI ArcGIS Pro, ArcGIS Portal, Snap4City WFS player, ...



- **GIS:**
  - Geographic Information System
- **WMS:**
  - Web Map Service
- **WFS:**
  - Web Feature Services

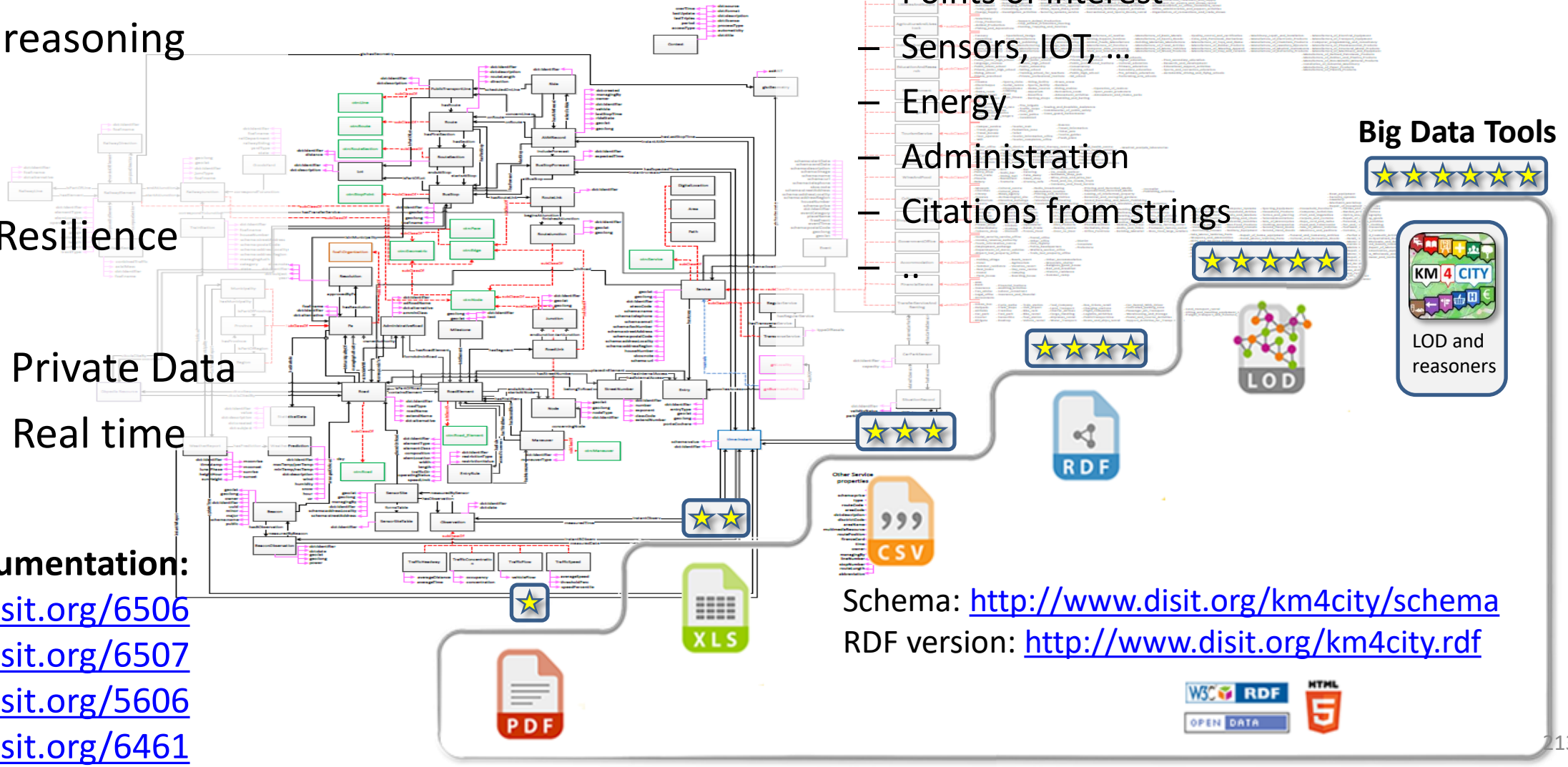
Linked Open Data

Km4City: Knowledge Base

- **Multiple DOMAINS**
- Geospatial reasoning
- Temporal reasoning
- Metadata
- Statistics
- Risk and Resilience
- Licensing
- Open and Private Data
- Static and Real time
- IOT/IOE

Ontology Documentation:
http://www.disit.org/6506
http://www.disit.org/6507
http://www.disit.org/5606
http://www.disit.org/6461

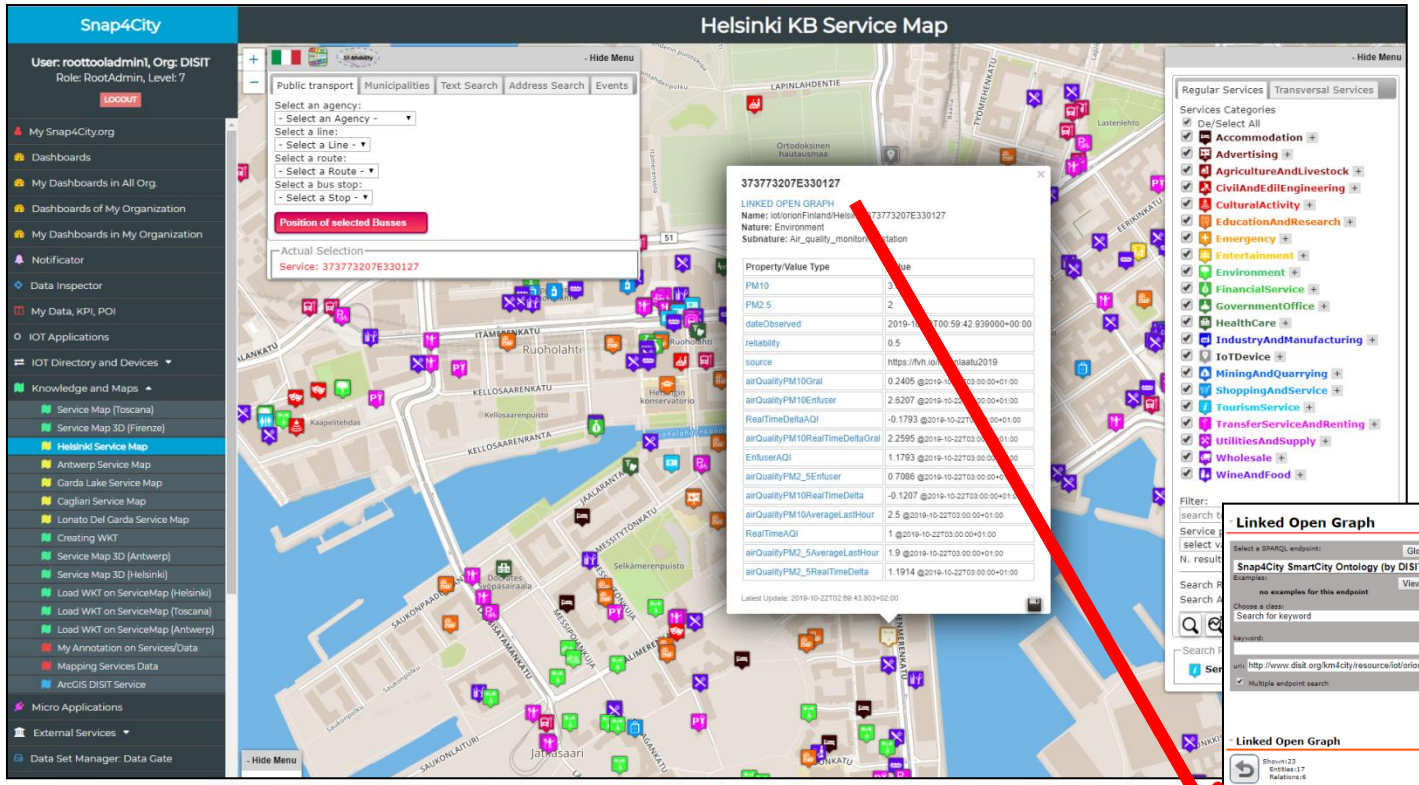
- Street-Guide
- Mobility and transport
- Points of interest
- Sensors, IOT, …
- Energy
- Administration
- Citations from strings
- ..

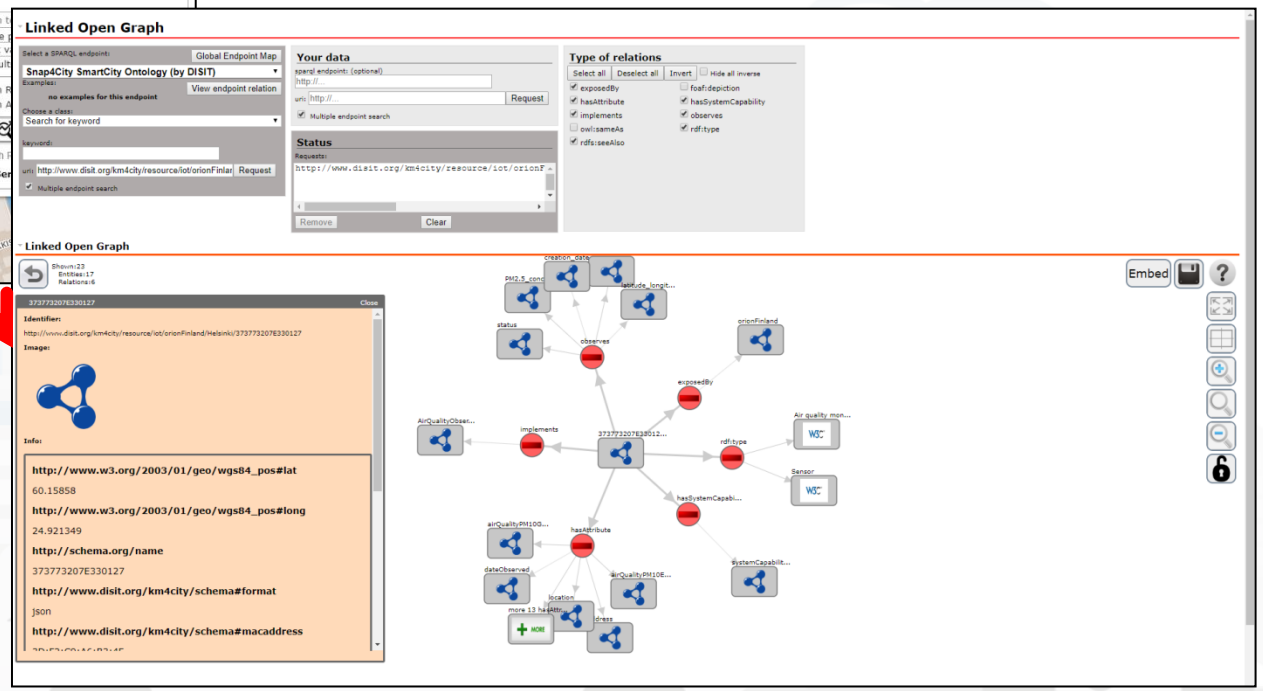


Schema: http://www.disit.org/km4city/schema
RDF version: http://www.disit.org/km4city.rdf

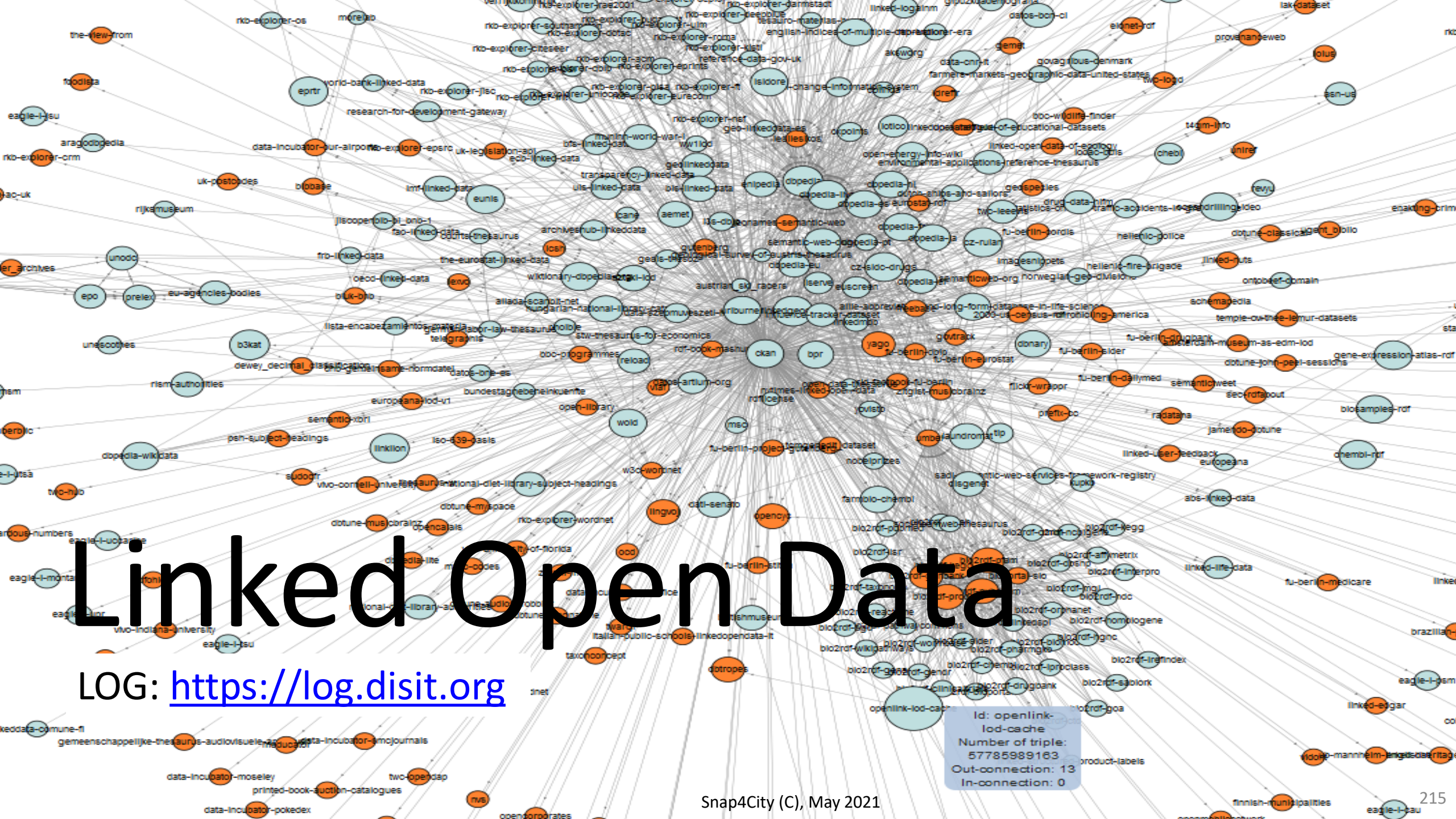
Views of the Knowledge Base

Knowledge Base
Semantic Reasoners





- How pass from ServiceMap to Linked Open Graph, Linket Data view tool


Linked Open Data
LOG: https://log.disit.org
Id: openlink-lod-cache
Number of triple: 57785989163
Out-connection: 13
In-connection: 0

TOP

Integrated command and control center

100% OPEN SOURCE

SNAP4 Appliances and Dockers **Installations**

Command and Control

- **Multiple dashboards**, different features and tools for different users and contexts:
  - decision makers, operators, tablet for operators, mobile phones,…
  - **situation room** with touch screen,
  - **Chat room** for each dashboard, network of dashboards, etc.
  - **Interactive and animated widgets**: custom widgets, dynamic pins,
- **Unique Visual Prog. IoT App**: Business Logic, Integration, Connectors, Data Transform, ….
- **Large range of data, beyond GIS and IoT, also derived data**
  - historical and real time even driven
  - rendering data and acting on the field, actuators, agents, final users, operators..
- **Easy to Reshape, adapt, evolve:** according to the City's Needs
- **Easy to Add Features:** data analytics, custom modules, integration, interoperable, ….
- **Controlling Control Room, video walls**:
  - automated reconfiguration on the basis of the events
  - passing from operators to wall, etc..
  - Multiple operators stations with multiple monitors

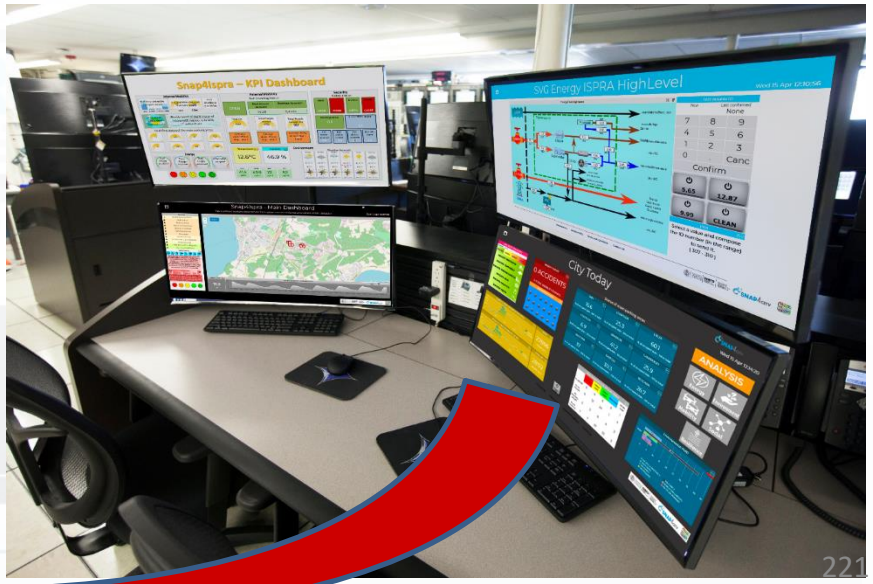

MAPPA FIRENZE
Fri 19 Oct 17:24:39
Colonnine Ricarica
Colonnine ricarica Fast
Pannelli a Messaggio Variabile
Parcheggi
Piste Ciclabili
Sensori del Traffico
Stazioni ambientali
Stazioni meteo
Traffico Real Time
Varchi ZTL
Wi-Fi
Eventi Traffico a Firenze
Concentration - 7 days
Main

Chemical Plant Dashboard Green Impact Capacity (GIC)

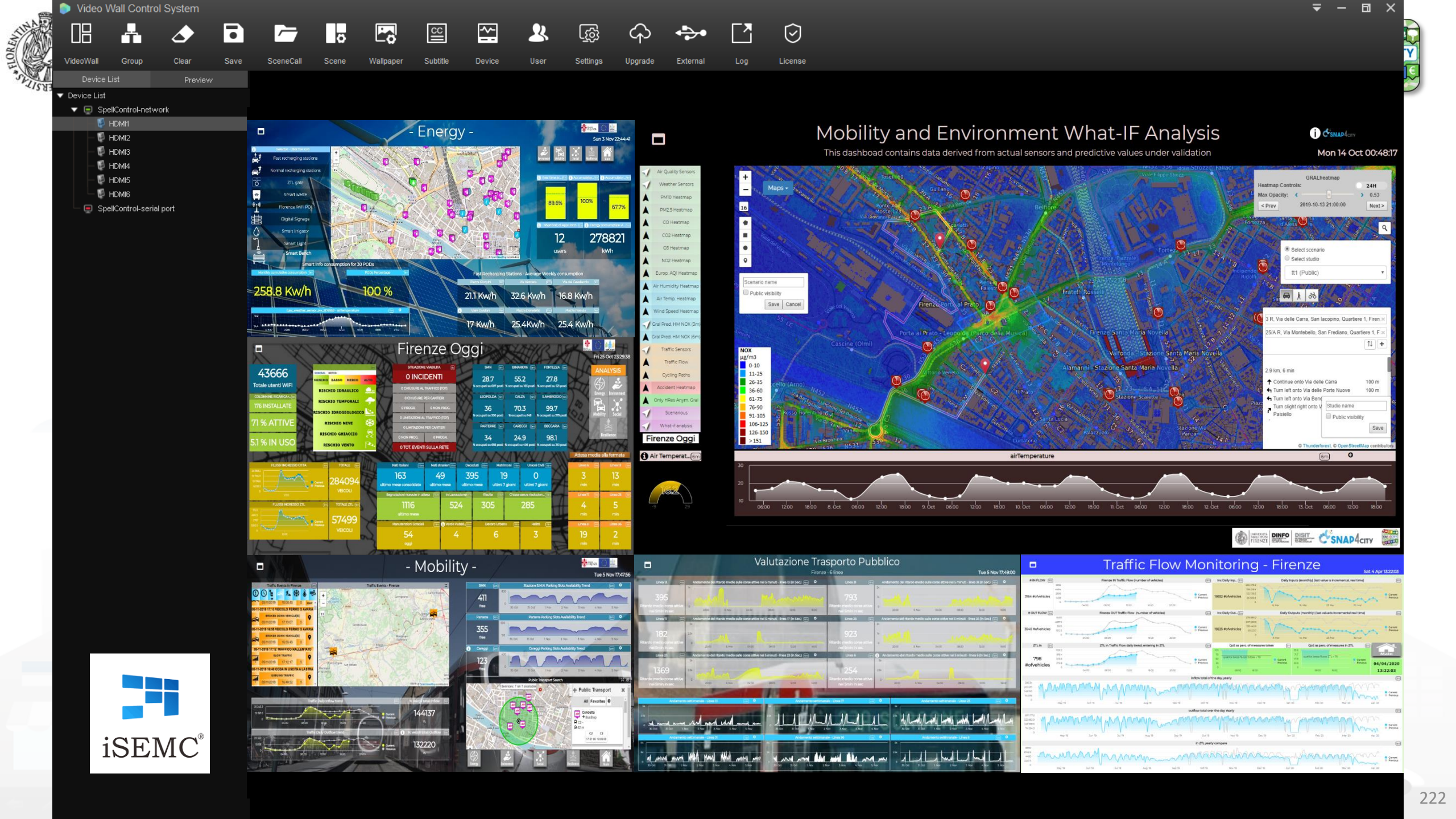
Altair Control room

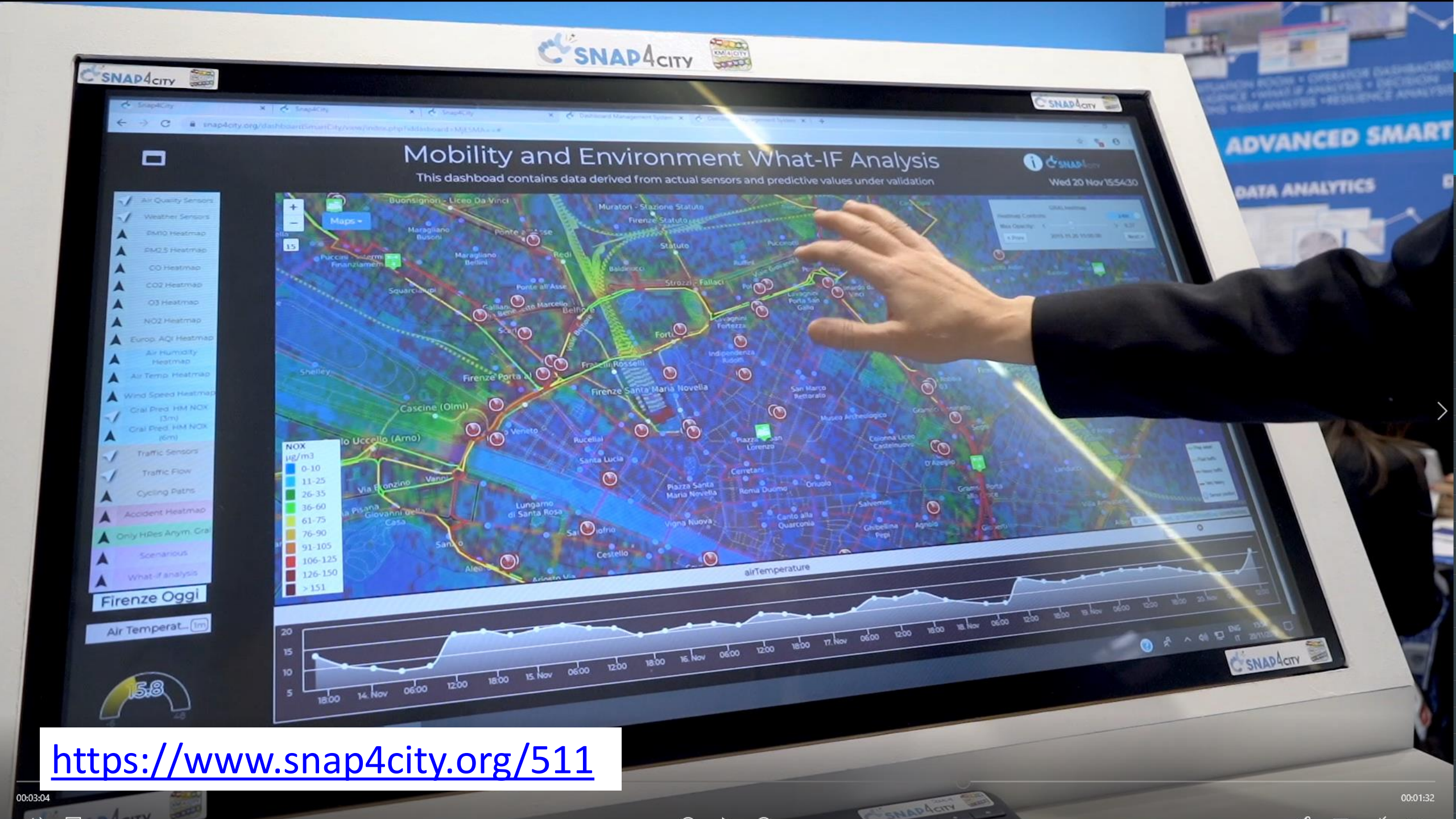
Control Room

Video Wall



From Consolle Operator to the Video Wall


Video Wall Control System
VideoWall
Group
Clear
Save
SceneCall
Scene
Wallpaper
Subtitle
Device
User
Settings
Upgrade
External
Log
License
Device List
Preview
Device List
SpellControl-network
HDMI1
HDMI2
HDMI3
HDMI4
HDMI5
HDMI6
SpellControl-serial port
- Energy -
Sun 3 Nov 22:44:41
89.6%
100%
67.7%
12
users
278821
kWh
Smart Info consumption for 30 PODs
258.8 Kw/h
100 %
Fast Recharging Stations - Average Weekly consumption
21.1 Kw/h
32.6 Kw/h
16.8 Kw/h
17 Kw/h
25.4Kw/h
25.4 Kw/h
Firenze Oggi
Fri 25 Oct 23:29:38
43666
Totale utenti WIFI
176 INSTALLATE
71 % ATTIVE
5.1 % IN USO
0 INCIDENTI
ANALYSIS
284094
VEICOLI
57499
VEICOLI
Mobility and Environment What-IF Analysis
This dashboad contains data derived from actual sensors and predictive values under validation
Mon 14 Oct 00:48:17
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
Traffic Sensors
Traffic Flow
Cycling Paths
Accident Heatmap
Only HRes Anym. Grid
Scenarious
What-if analysis
Firenze Oggi
Maps
NOX µg/m3
0-10
11-25
26-35
36-60
61-75
76-90
91-105
106-125
126-150
> 151
airTemperature
- Mobility -
Tue 5 Nov 17:47:56
144137
132220
Valutazione Trasporto Pubblico
Tue 5 Nov 17:49:00
Traffic Flow Monitoring - Firenze
Sat 4 Apr 13:22:03
iSEMC®



https://www.snap4city.org/511

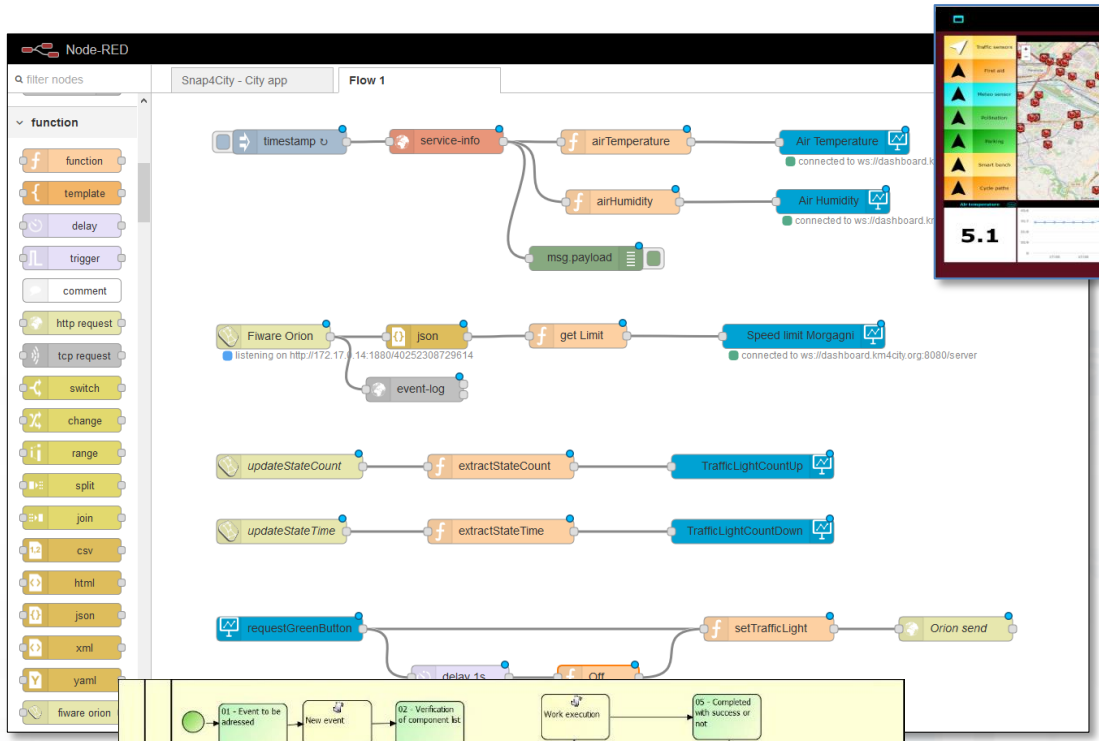
00:03:04

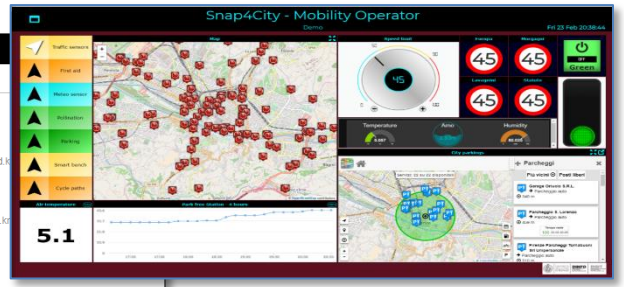
00:01:32

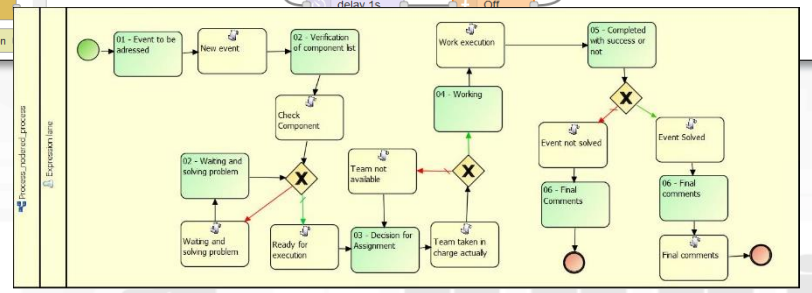
Smart City Monitoring: notifications, alerting

Notification with IOT App may

- Fire on any kind of condition exploiting on IOT App logic
- produce messages/events on
  - **Facebook, Telegram,**
  - **SMS, MMS, IOT Devices, ..**
  - **email, LOGS, FTP, ..**
  - **dashboards**, mobiles, …
  - **Workflow/incident** management system for **ticketing**
  - **video wall** management,
  - etc. etc.

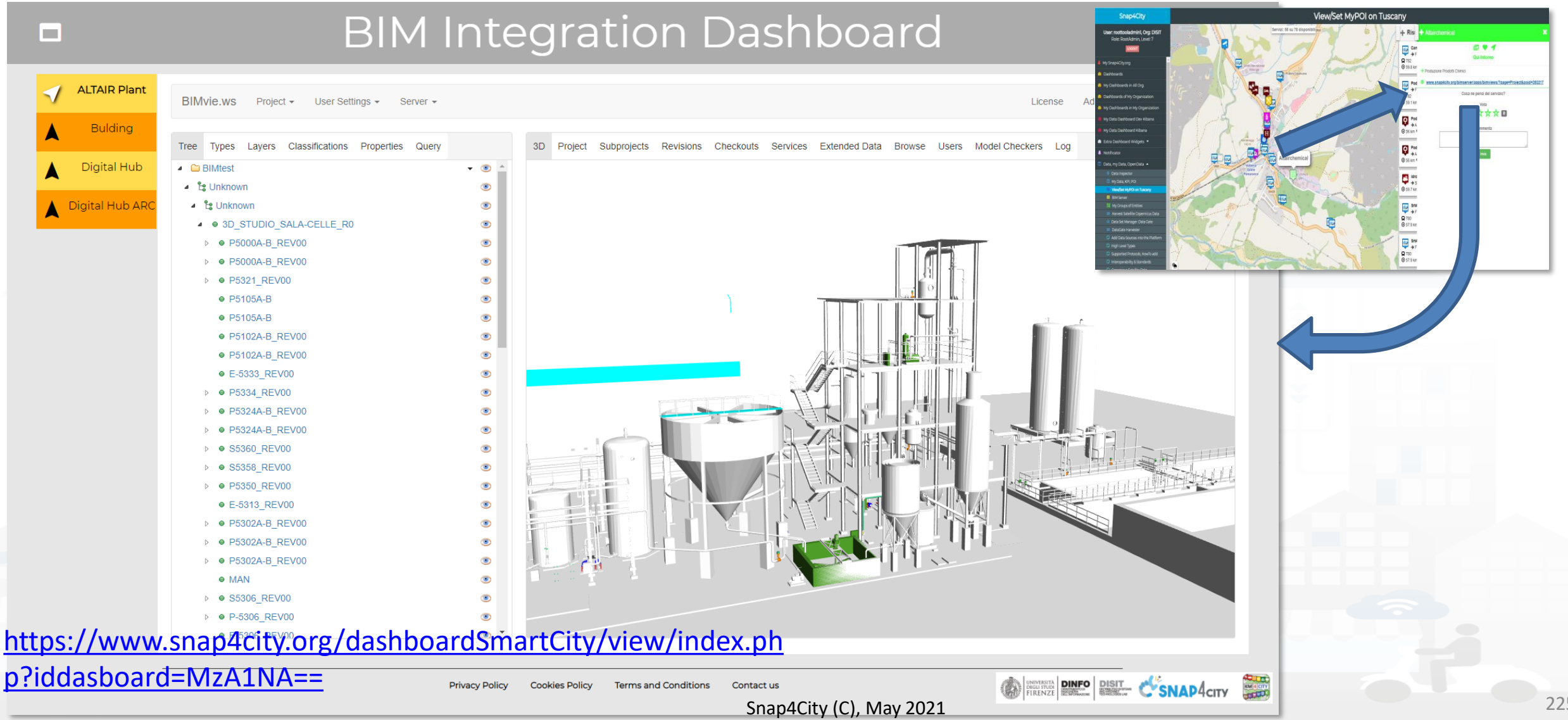






facebook

BIM view of the Altair Chemical Plant



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

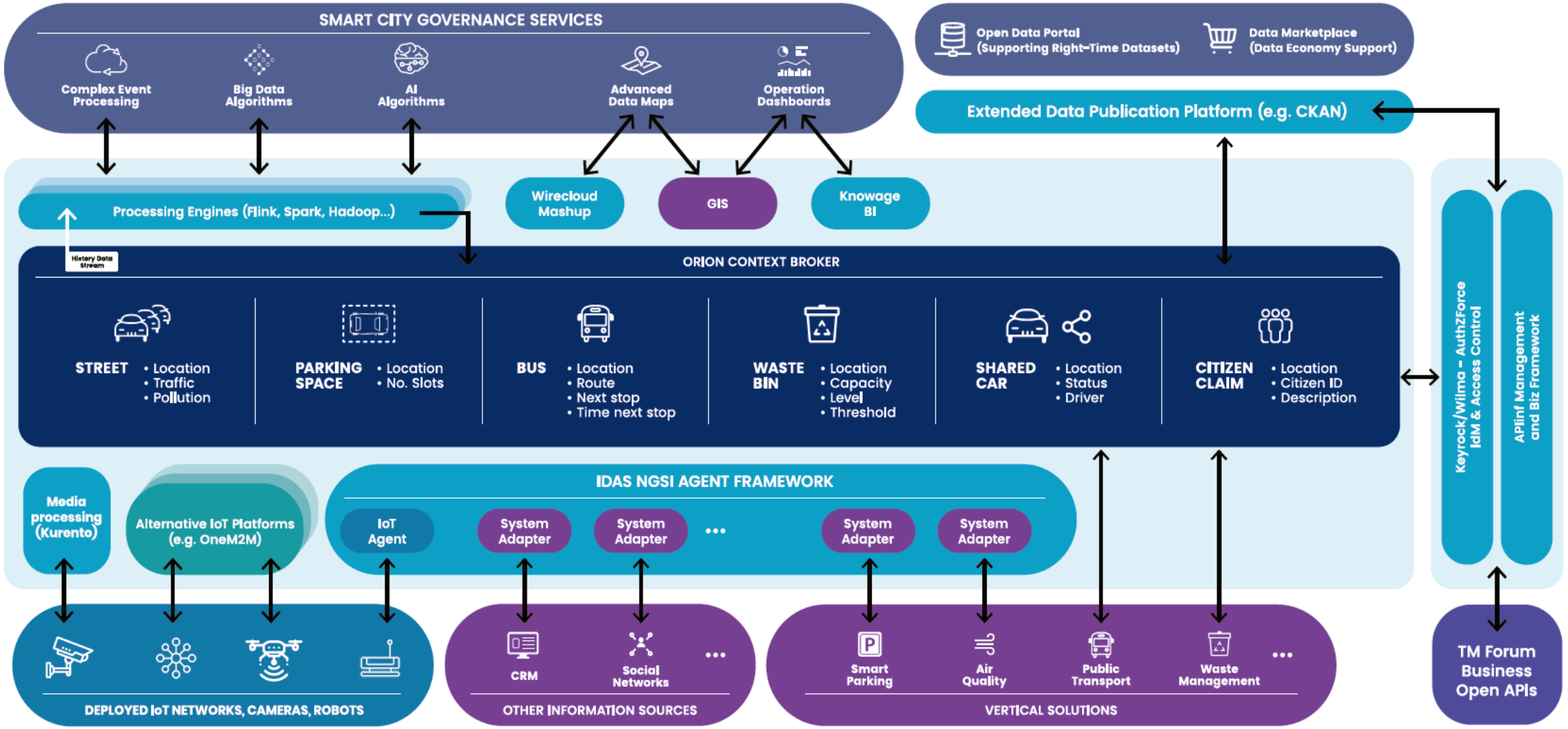
TOP

FIWARE & Snap4City

Powered by FIWARE

THE FIWARE SMART CITIES REFERENCE ARCHITECTURE

FI-WARE



- Snap4City - Powered by FIWARE Solution:
  - https://marketplace.fiware.org/pages/solutions/b8905e91973b420189cce972
  - NGSI V1, V2 The IOT Orion Broker
  - IOT Orion Broker can connect JSON, MQTT, Lightweight M2M, LoraWAN, OPC, SigFOX, etc. see FiWare Https://www.fiware.org
- Snap4City - FIWARE Training Services:
  - https://marketplace.fiware.org/pages/solutions/03bccd83a0e1b0398ba7a0bf
- Snap4City - FIWARE Consultancy Services:
  - https://marketplace.fiware.org/pages/solutions/907f5ecc63927f643dd8421b
- **Snap4City is compatible** with all the above protocols
  - via IOT Orion Broker,
  - via IOT Applications.
  - via direct connection on ETL processes on their corresponding IOT brokers, and/or
- **Snap4City is also compatible** with many other protocols, see the table reported in page: https://www.snap4city.org/65

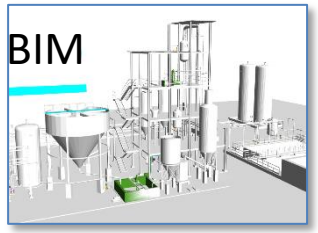
Powered by FIWARE

Overview

- 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

Concept

BIM

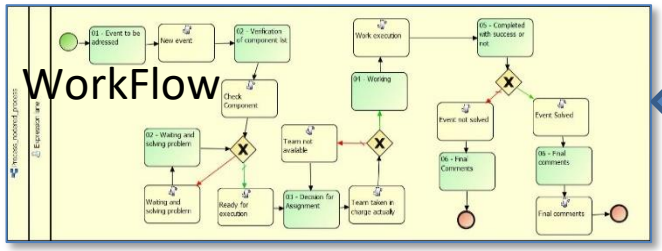


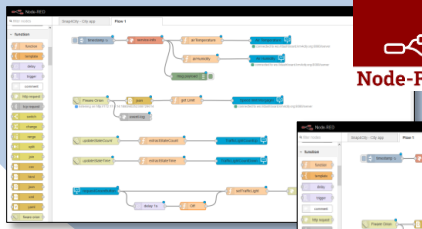
KPI, POI, MyKPI, …

API, External Services

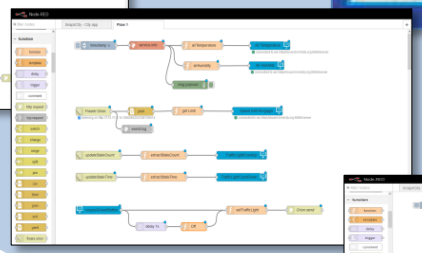
Web Scraping

WorkFlow

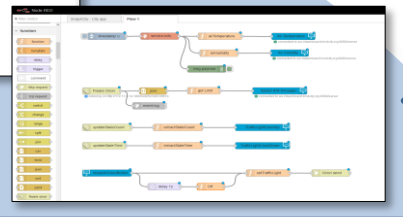




Node-RED



Data Analytics,
Artificial Intelligence



IOT Apps

IOT Brokers

IOT Broker

IOT Broker

FIWARE

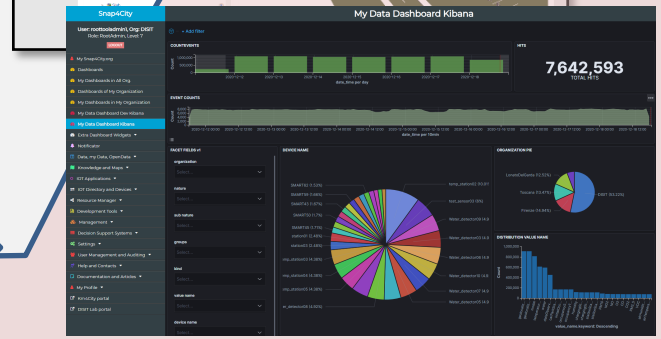
ckan

GIS

Big Data

KB

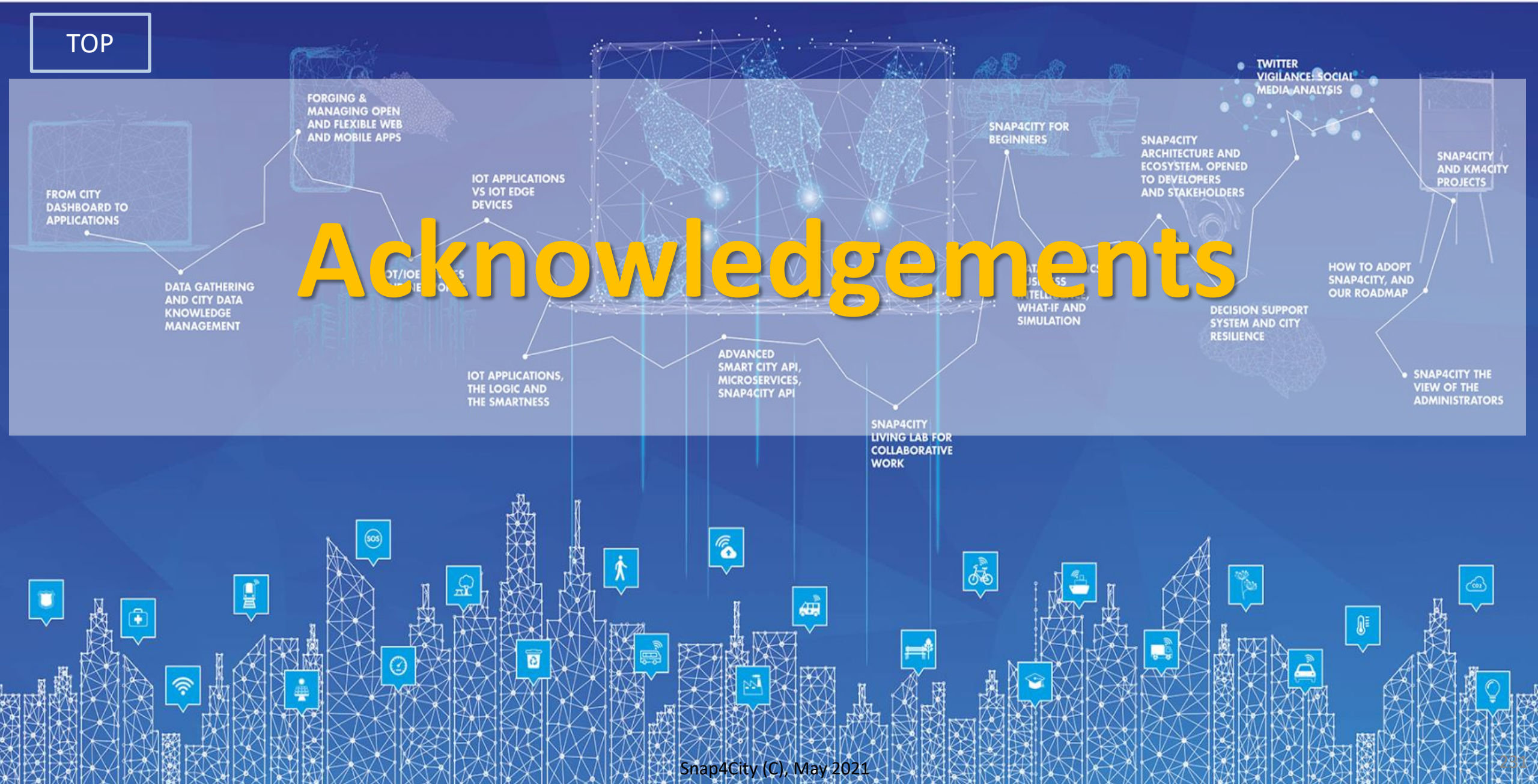
LD, LOD



Dashboards and Apps

FI-WARE

TOP



Acknowledgements

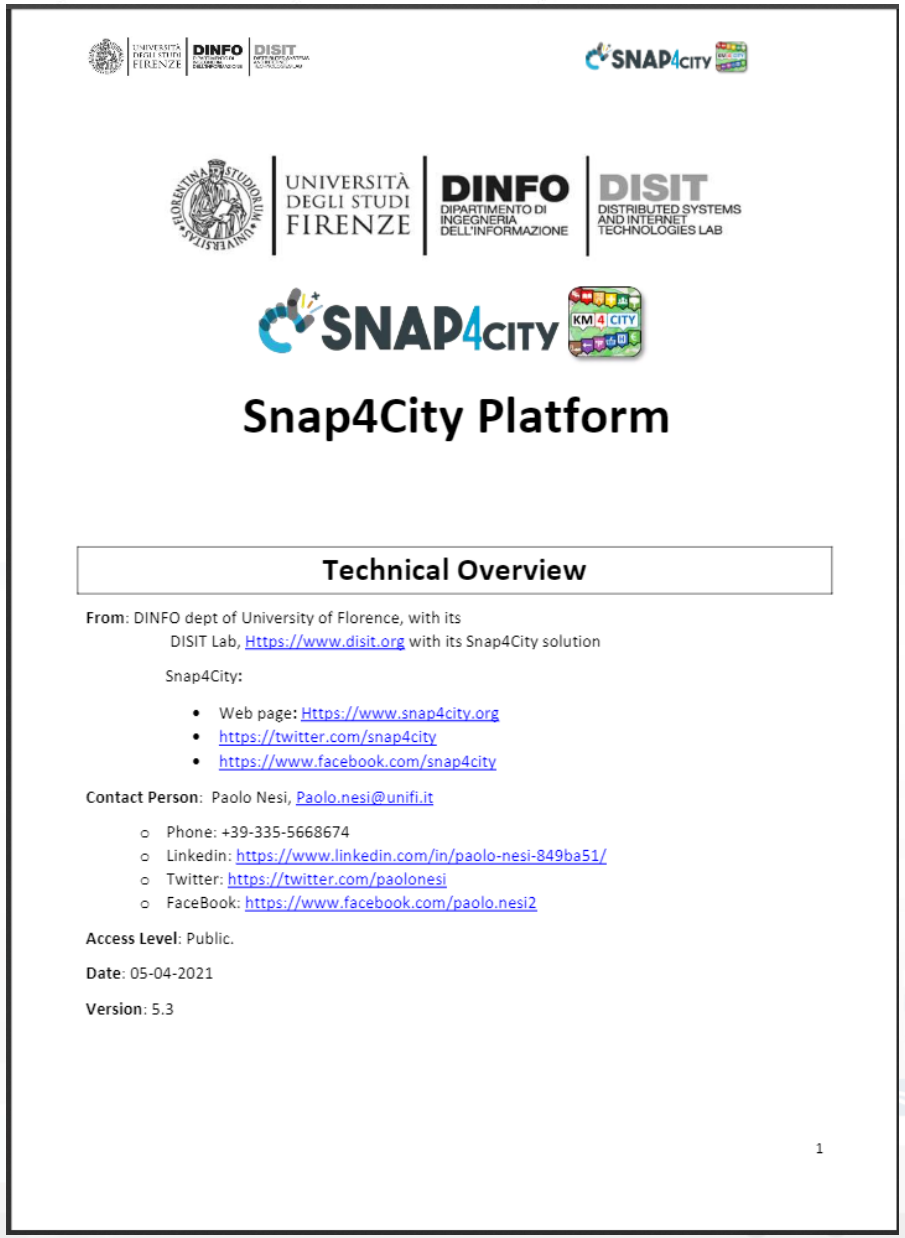
Main running instances

- Sii-Mobility → mobility and transport, sustainability
- REPLICATE → ICT, smart City Control room, Energy, IOT
- RESOLUTE → Resilience, ICT, Big Data
- GHOST → Strategies, smart city
- TRAFAIR → Environment & transport
- MOSAIC → mobility and transport
- WEEE Life → Smart waste, environment
- Smart Garda Lake → Castelnuovo del Garda, SMARTEA
- 5G → Industry 4.0 vs SmartCity
- Green Impact → Industry 4.0, Chemical Plant
- SmartBed (Laid) → smart health
- Green Field Peas (Soda) → Industry 4.0, Chemical plant
- MobiMart and PISA Agreement → data aggregation, mobility and transport, Living Lab
- Lonato del Garda → smart parking, environment
- Herit Data → tourism, culture and management
- ISPRA JRC → site management and services
- Capelon (Sweden) → smart light solutions

Acknowledgements

- Thanks to the European Commission for founding. All slides reporting logo of **Snap4City** https://www.snap4city.org **of Select4Cities H2020** are representing tools and research founded by European Commission for the **Select4Cities** project. **Select4Cities** has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation Programme (grant agreement n° 688196)
- **TRAFAIR is a CEF** project. All slides reporting logo of TRAFAIR project are representing tools and research founded by the EC on CEF programme http://trafair.eu/
- Thanks to the European Commission for founding. All slides reporting logo of **REPLICATE H2020** are representing tools and research founded by European Commission for the REPLICATE project. **REPLICATE** has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation Programme (grant agreement n° 691735).
- Thanks to the European Commission for founding. All slides reporting logo of **RESOLUTE H2020** are representing tools and research founded by European Commission for the RESOLUTE project. **RESOLUTE** has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation Programme (grant agreement n° 653460).
- Thanks to the MIUR for co-founding and to the University of Florence and companies involved. All slides reporting logo of **Sii-Mobility** are representing tools and research founded by MIUR for the Sii-Mobility SCN MIUR project.
- **Km4City** *is an open technology and research line of DISIT Lab exploited by a number of projects. Some of the innovative solutions and research issues developed into projects are also compliant and contributing to the Km4City approach and thus are released as open sources and are interoperable, scalable, modular, standard compliant, etc.*

Overview



Snap4City Platform

Technical Overview

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

Snap4City:

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

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

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

Access Level: Public.

Date: 05-04-2021

Version: 5.3

1

- April 2021
- https://www.snap4city.org/drupal/sites/default/files/files/Snap4City-PlatformOverview-April-2021-V5-3.pdf

TOP

SNAP4CITY

KM 4 CITY

Be smart in a SNAP!

SNAP4
Appliances and Dockers
Installations

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Università degli Studi di Firenze - School of Engineering

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