scalable Smart aNalytic APplication builder for sentient Cities: for Living Lab and co-working with Stakeholders
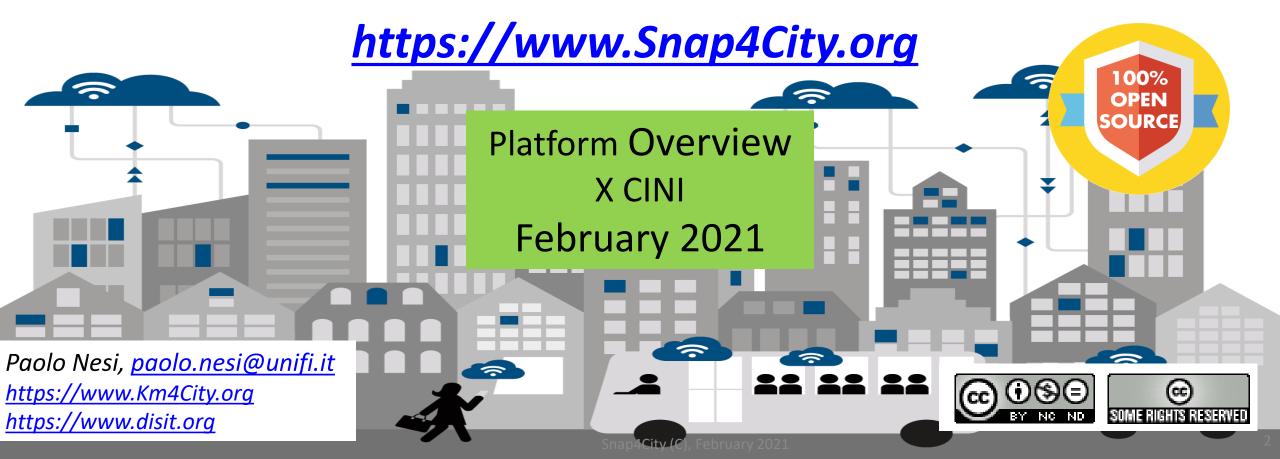
https://www.Snap4City.org

Platform Overview
X CINI
February 2021

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

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
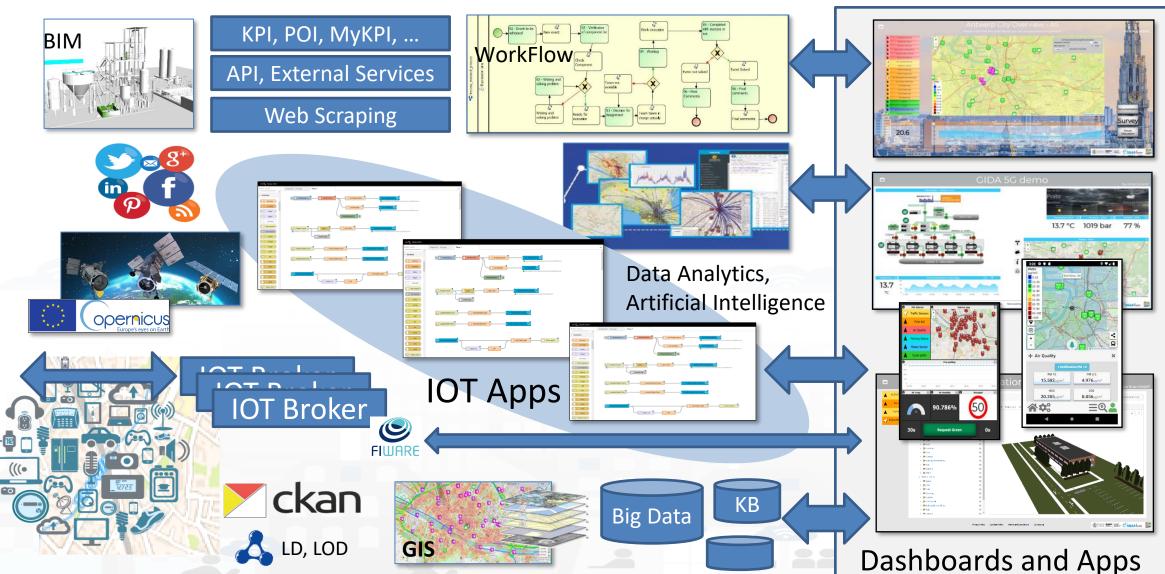COURSES AND COMMUNITY
LIVING LABS
DEVELOPMENT TOOLS

Powered by FIWARE

SNAP4 Appliances and Dockers Installations

FREE TRIAL

PEN Test Passed

EU GDPR COMPLIANT

100% OPEN SOURCE

UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB | SNAP4CITY | KM4CITY

www.snap4city.org

INDUSTRY4.0

CO2

ENVIRONMENT

HEALTH

BUILDING

SECURITY

AGRICOLTURE

ENERGY

MOBILITY

WASTE

TRANSPORT

PARKING

CONTROL ROOM

Concept

BIM

KPI, POI, MyKPI, …

API, External Services

Web Scraping

WorkFlow

Data Analytics, Artificial Intelligence

IOT Broker
IOT Broker
IOT Broker

IOT Apps

FIWARE

ckan

LD, LOD

GIS

Big Data

KB

Dashboards and Apps

Smart City Functional Architecture

Back-End ← → **Front-End**

Transport systems
Mobility, parking

Public Services,
Govern, events, …

Sensors, IOT Cameras,
Wi-Fi

Environment, Water,
energy

Shops, services,
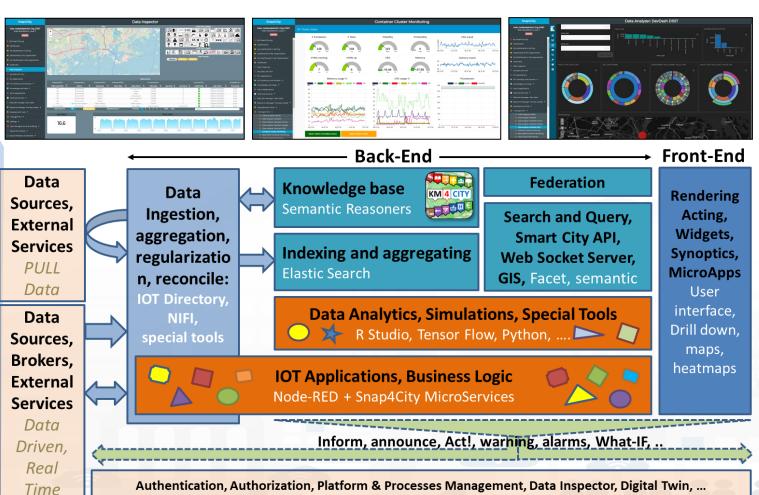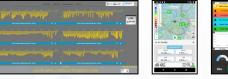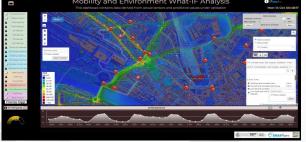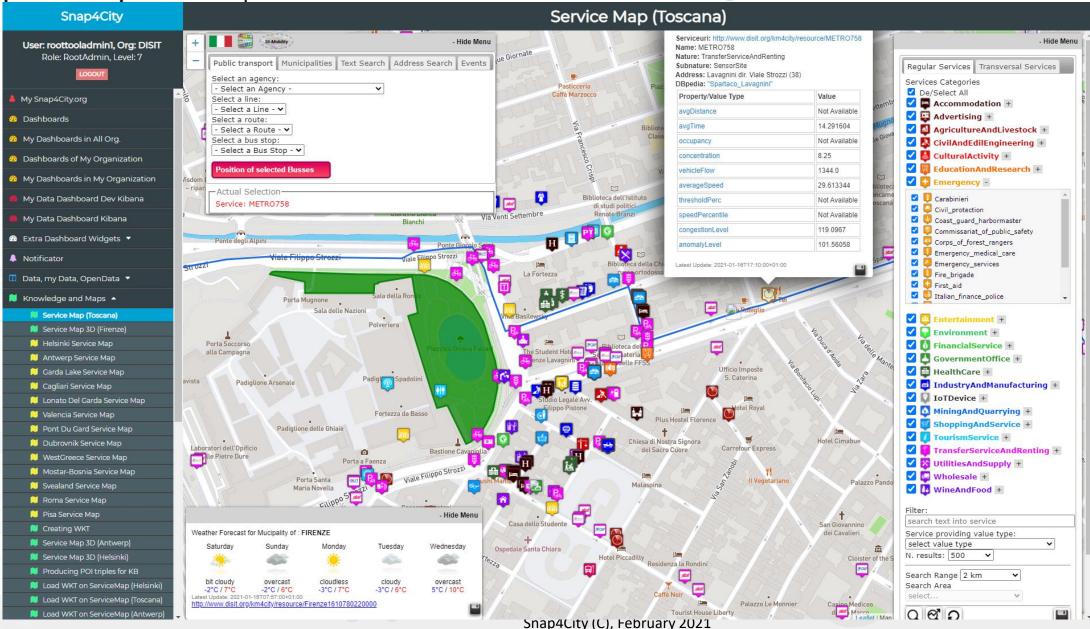operators

Social Media

Social Media Crawler and Manager

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

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

IOT Applications, Business Logic Node-RED + Snap4City MicroServices

Federation

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

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, …

KB, ServiceMap

One Snap4City Platform may serve Multiple Cities

Community Building

- collaborations
- agreements
- networking
- tutorials
- documentation
- subscription to applications
- personal services
- workshops
- experiments

City Operators
Resource Operators
Inhouse companies
Tech providers
Category Associations

City Users
Advertisers
hackathons
events
Large Industries
Early Adopters

Licensing, Gold services
partnerships
Start-ups

Help desk
Corporations
Case Studies
Research groups

Collaborative Platform

- Connect IOT/IOE
- Connect external Services
- Data Ingestion and Analytic algorithms
- Advanced Smart City API, MicroServices
- Produce City IOT Applications & Dashboards
- Produce Apps and Dashboards for City Users
- Monitor City Platform
- Promote Applications & Dashboards
- Manage Apps & Dashboards, User Engagement
- Upload context Open Data

Snap4 Appliances and Dockers Installations

Snap4City (C), February 2021

7

Dashboards

BIM Server

• DEMO

- Dashboards
  - Firenze: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTQzOA==
  - Firenze traffic: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=OTg5
  - Firenze air quality: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjU0Mg==
  - 3D: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjM2MA==#
  - Metro: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjg3MA==
  - What-IF: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjE5MA==
  - Alert: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA0OQ==
  - Capelon: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA2Mg==
  - Lonato: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjM0Nw==
  - Svg: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjk4Ng==
  - Svg: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjk0NQ==
  - Roma: https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjcyNg==

Florence

Smart City Control Room Florence Metropolitan City

- **Multiple Domain Data**
  - mobility and transport, accidents, public transport, parking, traffic flow, Traffic Reconstruction, …
  - civil protection, gov data, covid-19, social & social media, people flow, tourism, energy, …

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

- **Historical and Real Time data**
  - Billions of Data
  - Predictions, what-if analysis

- **Services Exploited on:**
  - Multiple Levels, Mobile Apps, API

- **Since 2017**
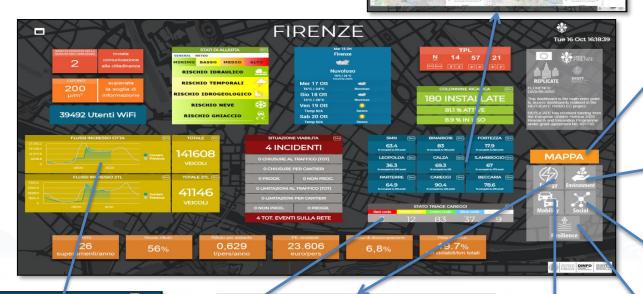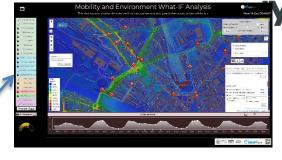
Florence Case

- **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.
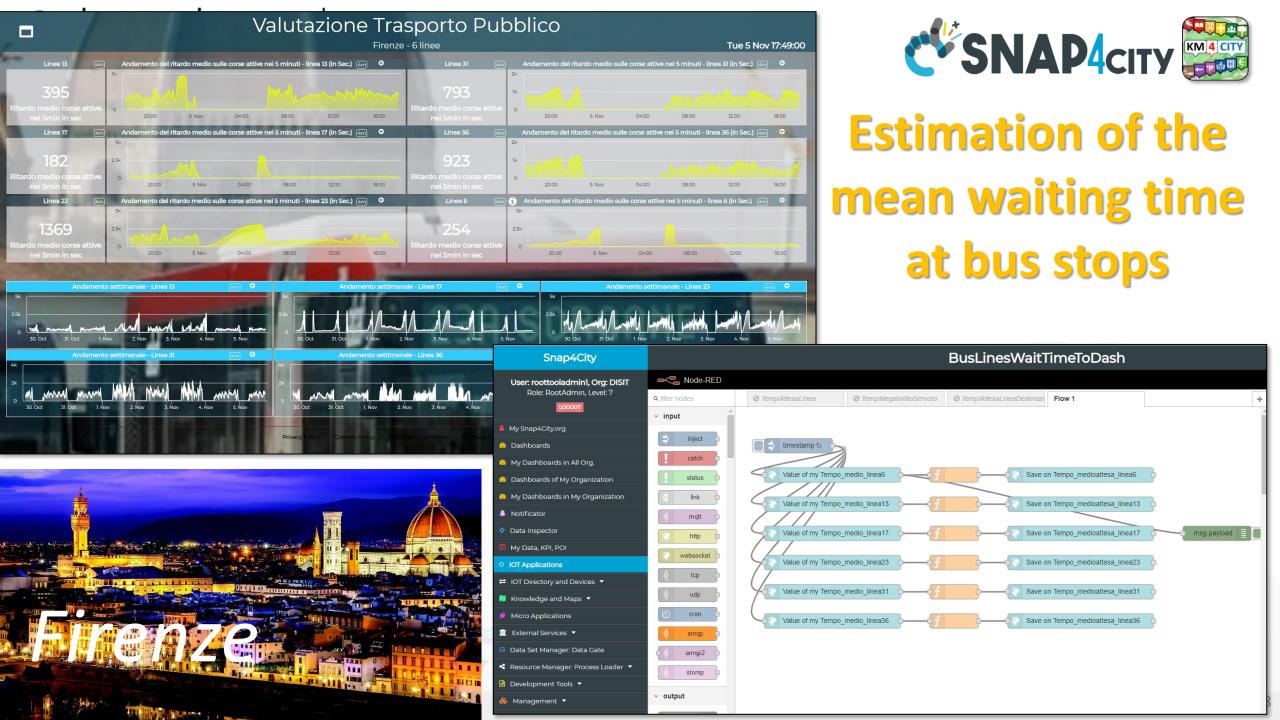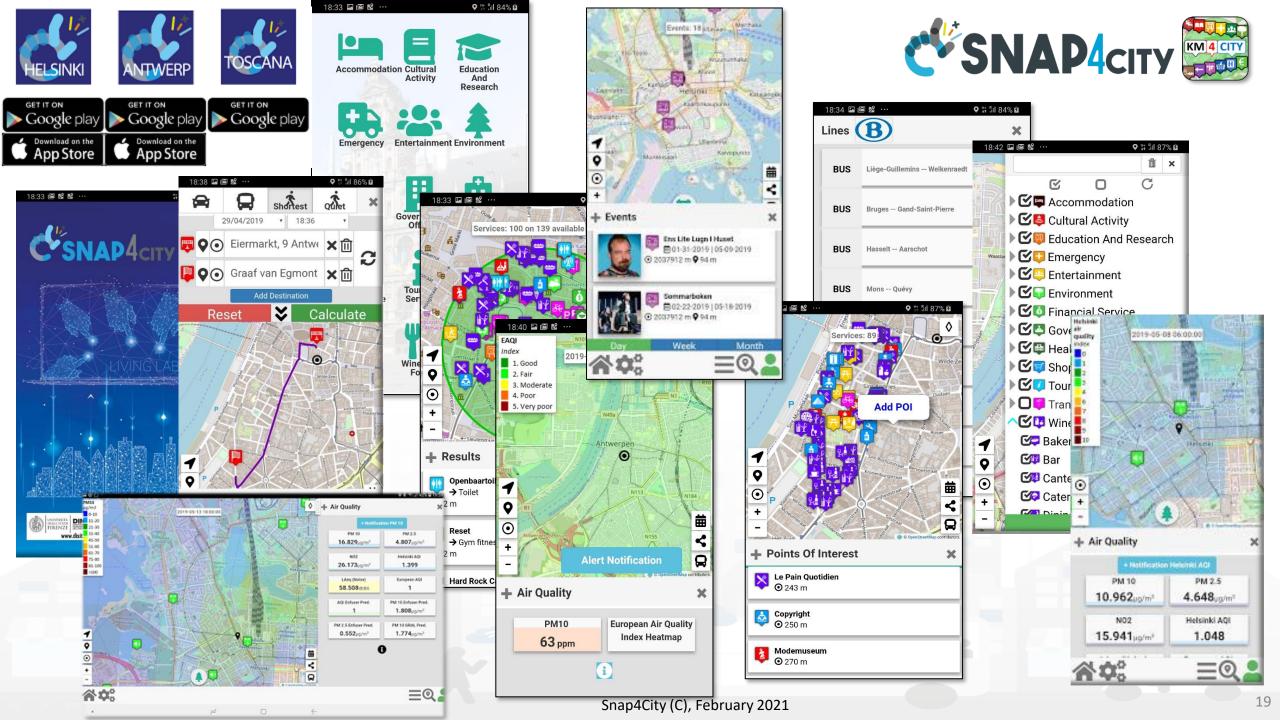
Analysis:

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

Estimation of the mean waiting time at bus stops

Tuscany Region
Firenze, Pisa, Livorno, Prato, etc.
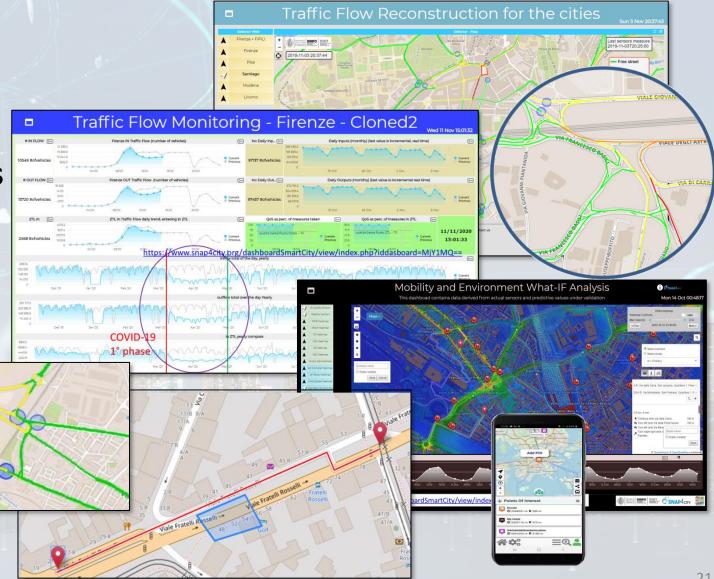
Mobility and Transport Traffic Flow Analysis

reference

SNAP4CITY

KM4CITY

- **Multiple Domain Data**
  - Traffic Flow sensors, city structure, weather

- **Decision Makers Multiple Locations**

- **Historical and Real Time data**
  - Dashboards, What-IF analysis
  - Traffic Flow Predictions,
  - Reconstructions, routing
  - Mobile App, people flows

- **Services Exploited on:**
  - Dashboards, Mobile App

- **Since 2017, 2019**

Traffic Flow Reconstruction for the cities

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc5NQ==
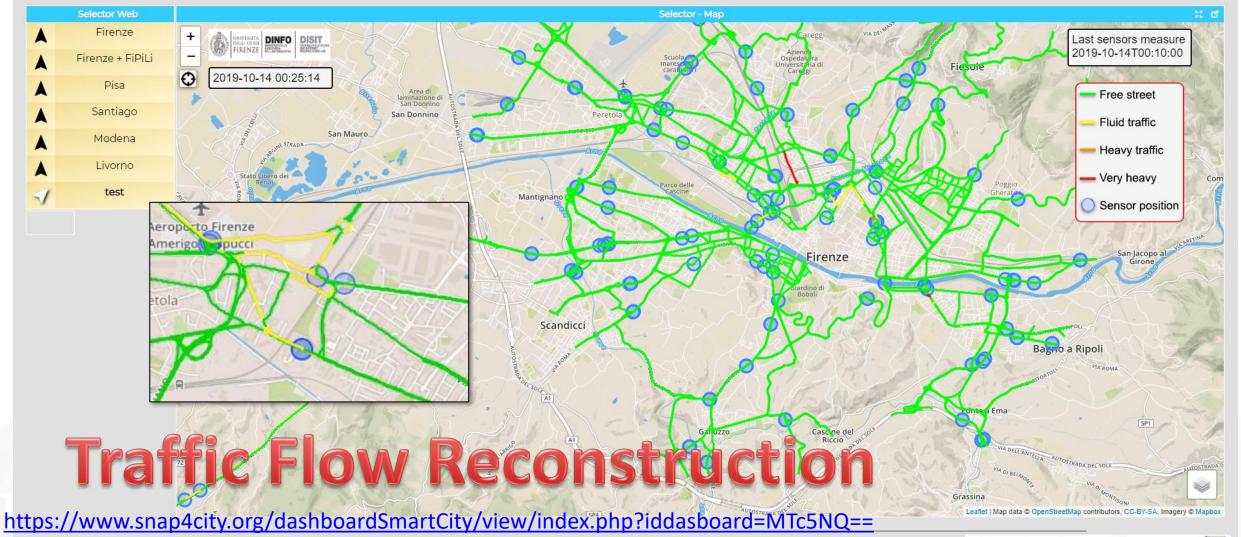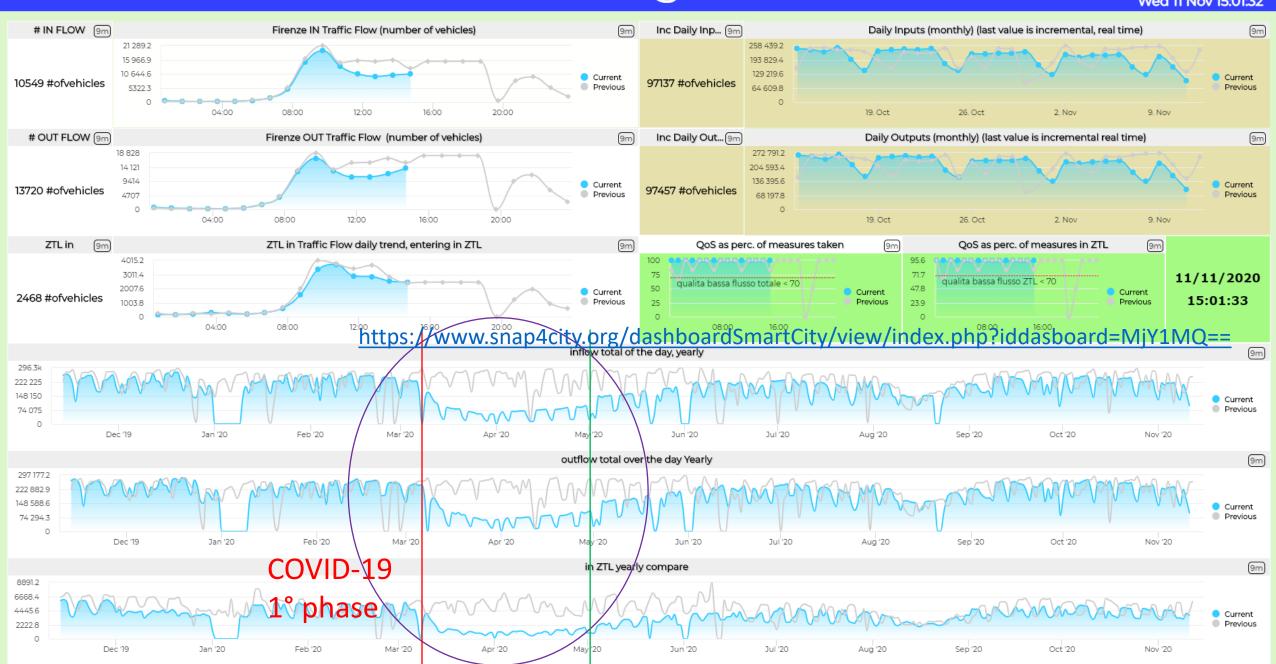
Traffic Flow Monitoring - Firenze - Cloned2

Wed 11 Nov 15:01:32

 # IN FLOW `9m` — Firenze IN Traffic Flow (number of vehicles) `9m`

10549 #ofvehicles

Inc Daily Inp... `9m` — Daily Inputs (monthly) (last value is incremental, real time) `9m`

97137 #ofvehicles

 # OUT FLOW `9m` — Firenze OUT Traffic Flow (number of vehicles) `9m`

13720 #ofvehicles

Inc Daily Out... `9m` — Daily Outputs (monthly) (last value is incremental real time) `9m`

97457 #ofvehicles

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

2468 #ofvehicles

QoS as perc. of measures taken `9m`

qualita bassa flusso totale < 70

QoS as perc. of measures in ZTL `9m`

qualita bassa flusso ZTL < 70

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`

in ZTL yearly compare `9m`

COVID-19
1° phase

Current
Previous

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==

Snap4City (C), February 2021

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

SNAP4CITY

Left sidebar legend
- Air Quality Sensors
- Weather Sensors
- PM10 Heatmap
- PM2.5 Heatmap
- CO Heatmap
- CO2 Heatmap
- O3 Heatmap
- NO2 Heatmap
- Europ. AQI Heatmap
- Air Humidity Heatmap
- Air Temp. Heatmap
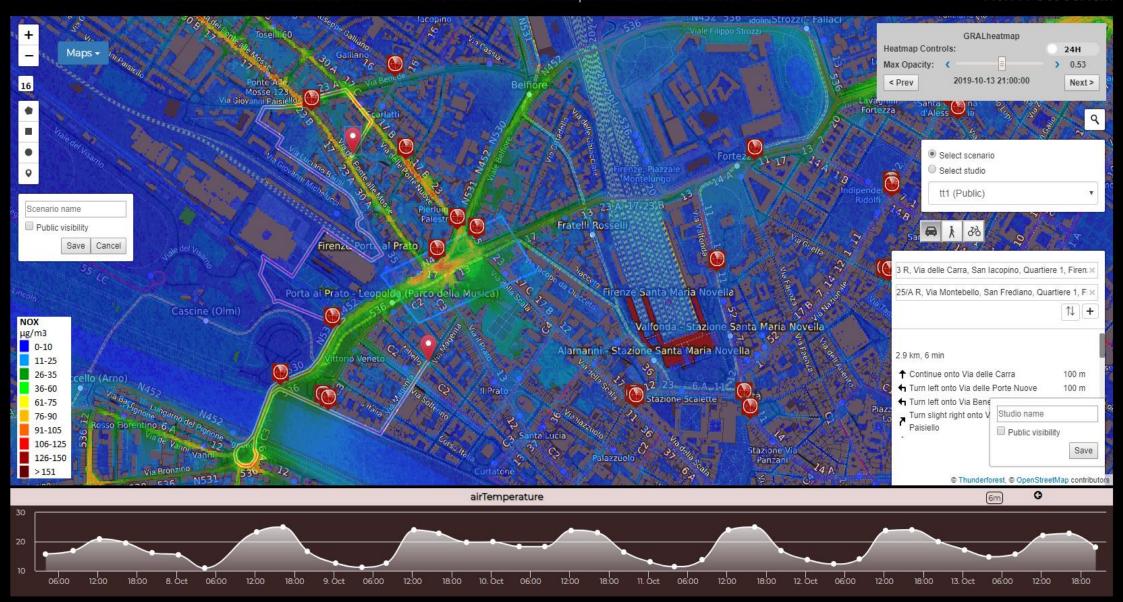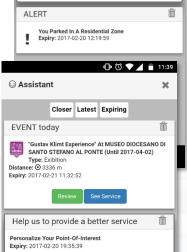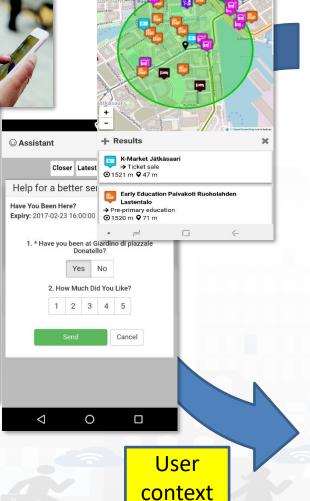- Wind Speed Heatmap
- Gral Pred. HM NOX (3m)
- Gral Pred. HM NOX (6m)
- Traffic Sensors
- Traffic Flow
- Cycling Paths
- Accident Heatmap
- Only HRes Anym. Gral
- Scenarious
- What-if analysis

Firenze Oggi

Air Temperat... 6m

16.2
-9   29

Map controls
+ / −
Maps ▾
16

GRALheatmap
Heatmap Controls: 24H
Max Opacity: ‹ ——|—— › 0.53
< Prev   2019-10-13 21:00:00   Next >

○ Select scenario
○ Select studio
tt1 (Public) ▾

Scenario name
☐ Public visibility
Save   Cancel

3 R, Via delle Carra, San Iacopino, Quartiere 1, Firen ✕
25/A R, Via Montebello, San Frediano, Quartiere 1, F ✕
⇅ +

2.9 km, 6 min
↑ Continue onto Via delle Carra   100 m
↰ Turn left onto Via delle Porte Nuove   100 m
↰ Turn left onto Via Bene
↗ Turn slight right onto V
   Paisiello

Studio name
☐ Public visibility
Save

© Thunderforest, © OpenStreetMap contributors

NOX legend
NOX
µg/m3
- 0-10
- 11-25
- 26-35
- 36-60
- 61-75
- 76-90
- 91-105
- 106-125
- 126-150
- >151

airTemperature
6m

30
20
10
06:00 12:00 18:00 8. Oct 06:00 12:00 18:00 9. Oct 06:00 12:00 18:00 10. Oct 06:00 12:00 18:00 11. Oct 06:00 12:00 18:00 12. Oct 06:00 12:00 18:00 13. Oct 06:00 12:00 18:00

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

UNIVERSITÀ DEGLI STUDI FIRENZE   DINFO   DISIT   SNAP4CITY   KM4CITY

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

Engagement Sent (4 hours) — **2078** Engagement Sent

Engagement Created (from Stats) — **446** Engagement Created

Engagement Viewed (4 hours) — **17** Engagement Viewed

Assistant

Closer | Latest | Expiring

HELP US
Can You Contribute With A Review Of "RASPINI RARI NANTES FLORENTIA" ?
Type: Pool
Expiry: 2017-02-20 11:55:00
Review | See Service

ALERT
You Parked In A Residential Zone
Expiry: 2017-02-20 12:19:59

Assistant

Closer | Latest

Help for a better ser...
Have You Been Here?
Expiry: 2017-02-23 16:00:00
1. * Have you been at Giardino di piazzale Donatello?
Yes | No
2. How Much Did You Like?
1 | 2 | 3 | 4 | 5
Send | Cancel

Results
K-Market Jätkäsaari → Ticket sale 1521 m 47 m
Early Education Paivakoti Ruoholahden Lastentalo → Pre-primary education 1520 m 71 m

Services: 62 on 62 available

Assistant

Closer | Latest | Expiring

EVENT today
"Gustav Klimt Experience" At MUSEO DIOCESANO DI SANTO STEFANO AL PONTE (Until 2017-04-02)
Type: Exibition
Distance: 3336 m
Expiry: 2017-02-21 11:32:52
Review | See Service

Help us to provide a better service
Personalize Your Point-Of-Interest
Expiry: 2017-02-20 19:35:39
Can confirm that you LIVE around VIA TRIPOLI?
Yes | No

User context

Rules

City context

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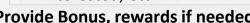The waste in S.Andreas Road is full

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...

User Behavior Analyser for Collective Profiling

Who

When

What

Where?
Why?

Where they go ahead

How move
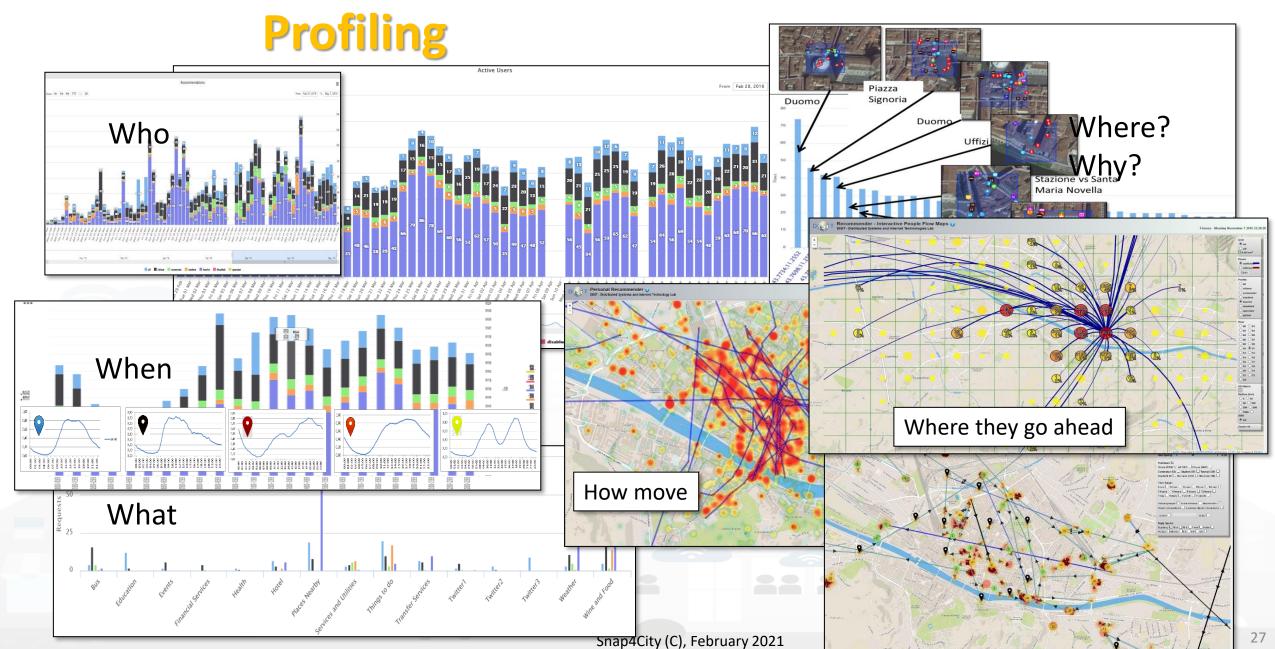
Antwerp

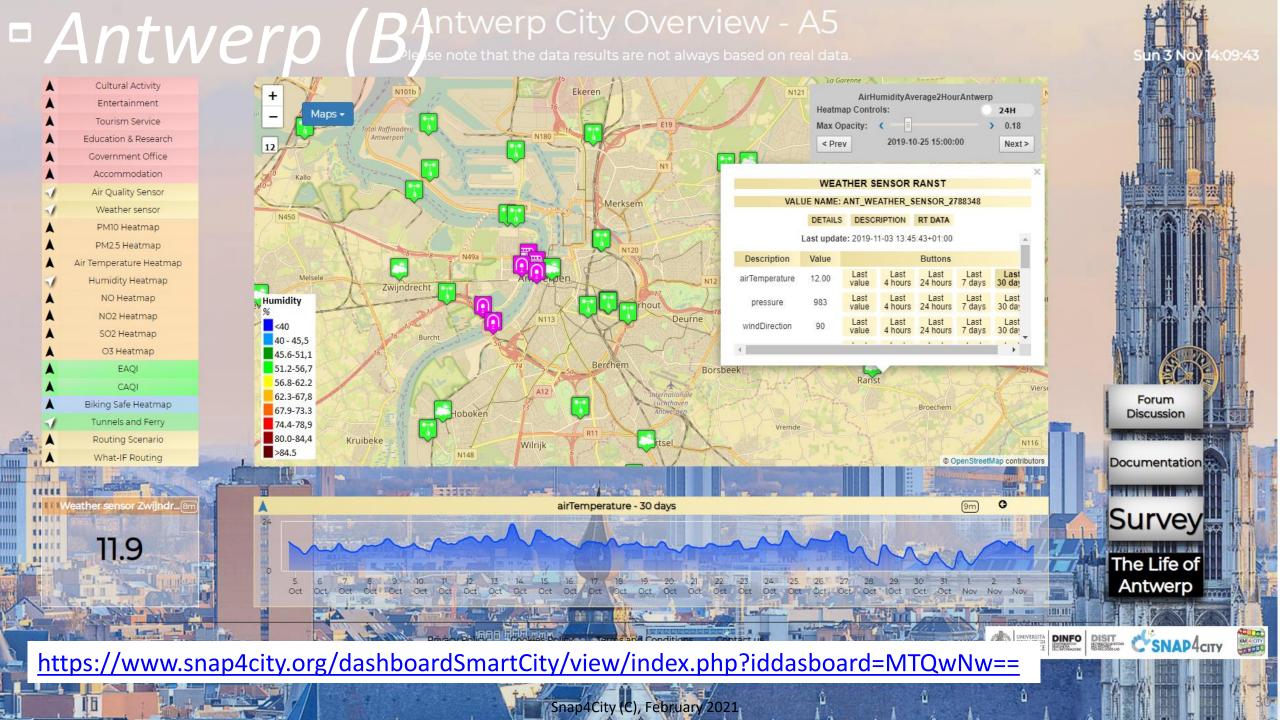# *People Control on Pub Services DIGIPOLIS Antwerp*

- **Multiple Domain Data**
  - PAX Counters: museum, pub services, COVID-19

- **Multiple Levels & Decision Makers**

- **Historical and Real Time data**
  - 20 fixed PaxCounters
  - 2 Mobile PaxCounters
  - Business Intelligence Dashboards

- **Services Exploited on:**
  - Dashboards, Mobile Apps, API
  - Fully Controlled Devices by Digipolis

- **Since 2019**

Antwerp (B)

PAXCounter real time and trend

Mon 30 Sep 17:18:48

The Life of Antwerp
Please note that the data results are not always based on real data.

Sun 29 Sep 00:26:08

MAS Monitoring via PAXCounter

Mon 30 Sep 17:31:32

Antwerp
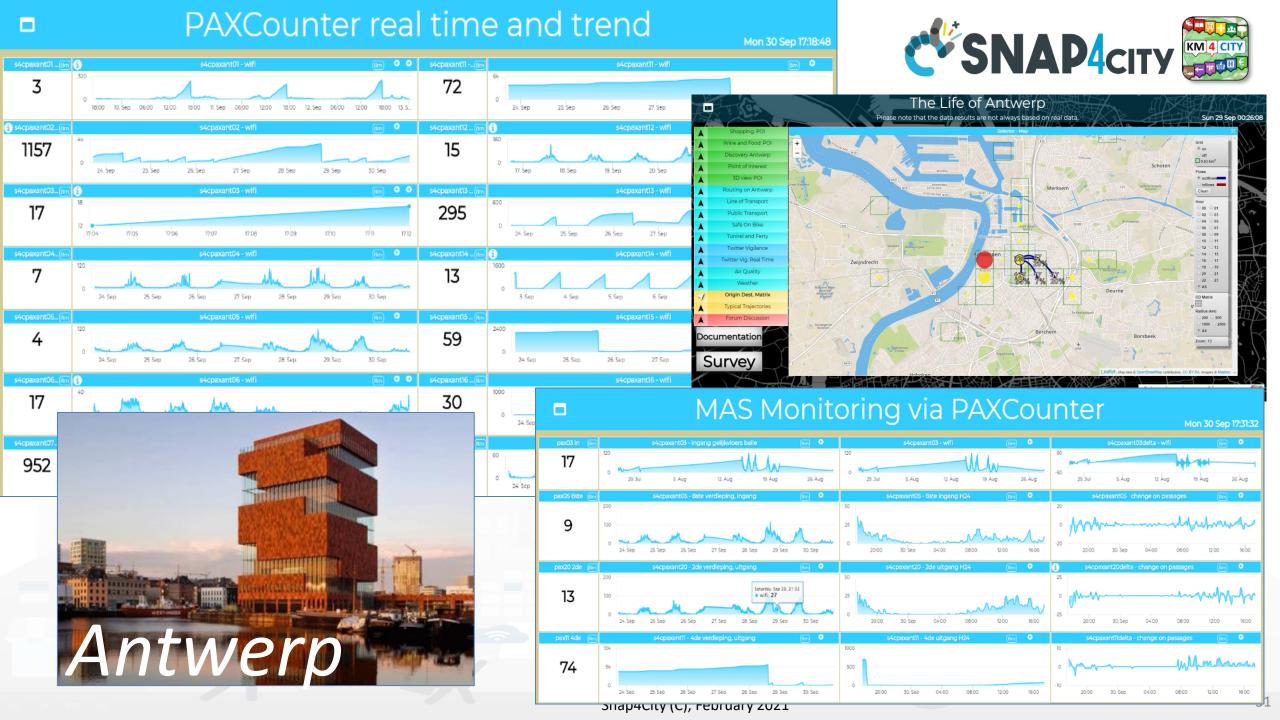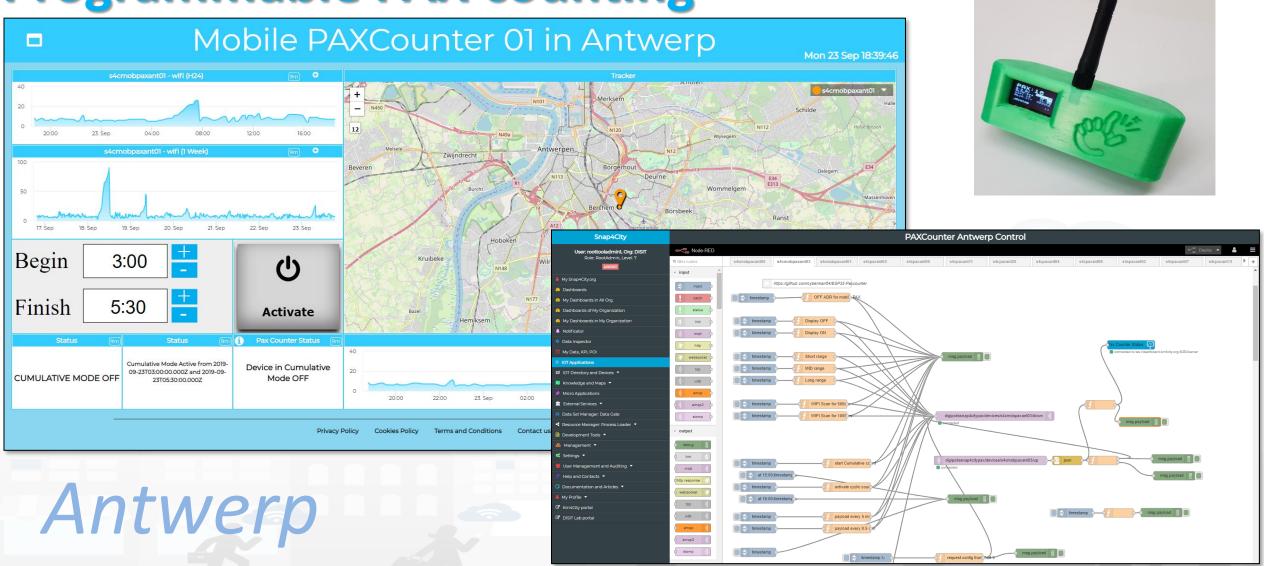
Programmable PAX counting
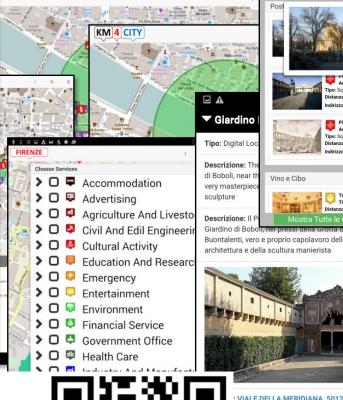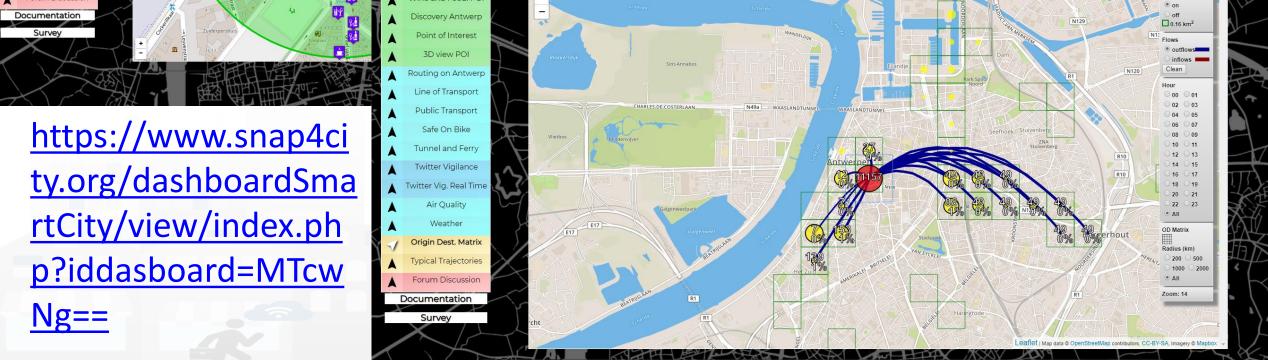

Antwerp

Mobile Apps
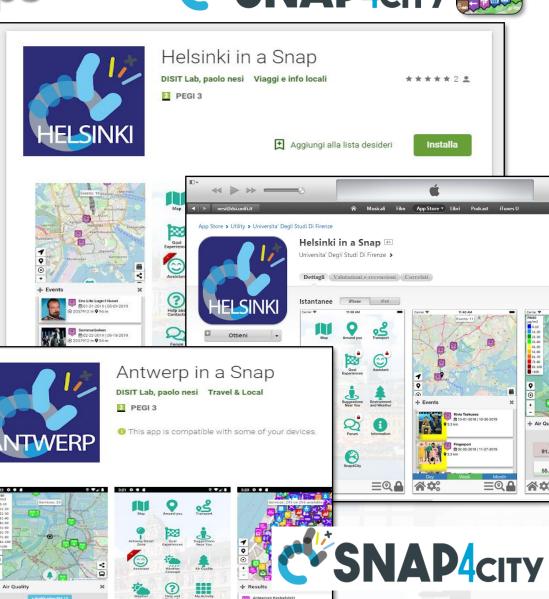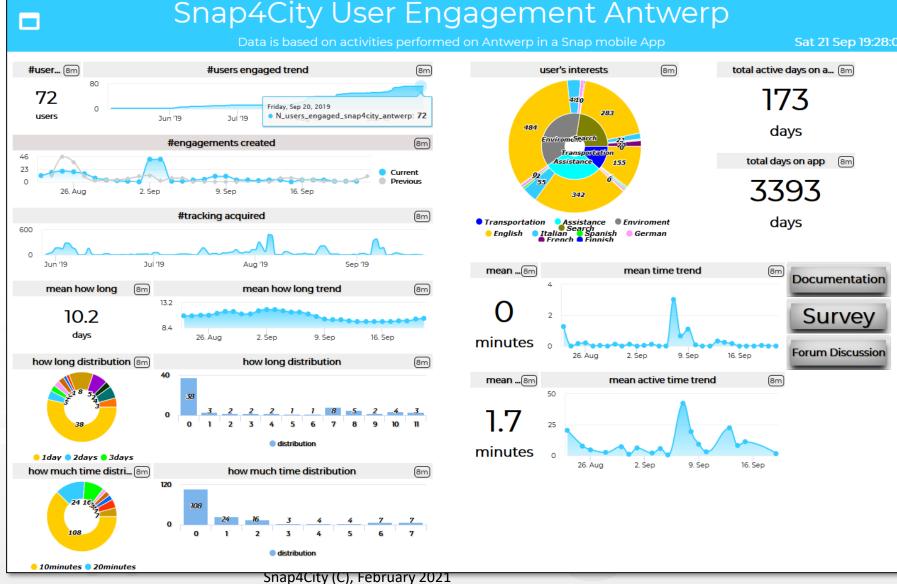
Dashboard monitoring the Mobile App:

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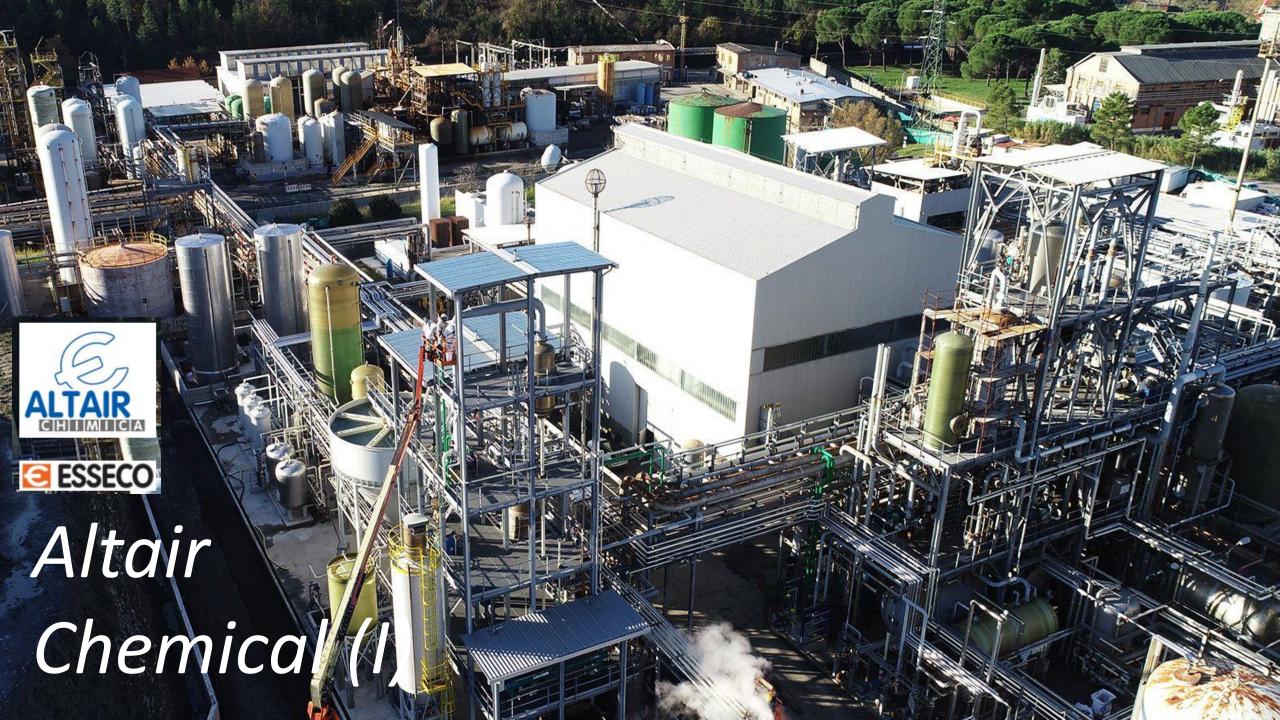- Measuring the time spend, and topics of interest of the users, etc.

Antwerp

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

ALTAIR CHIMICA

ESSECO

Altair Chemical (I)

Snap4Altair Decision Support supervision and control, Industry 4.0
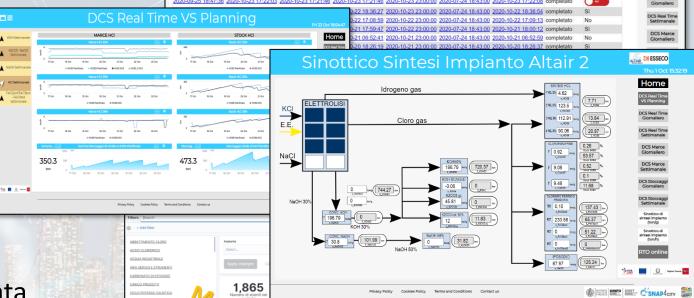
reference

- **Multiple Domain Data**
  - Distributed Control System: energy, flows, storage, chemical data, settings, ..
  - Cost of energy
  - Orders
  - Production Parameters
  - Maintenance data

- **Multiple Levels & Decision Makers**

- **Historical and Real Time data**
  - Billions of Data
  - Optimized planning on chemical model
  - Business Intelligence on Maintenance data

- **Services Exploited on:**
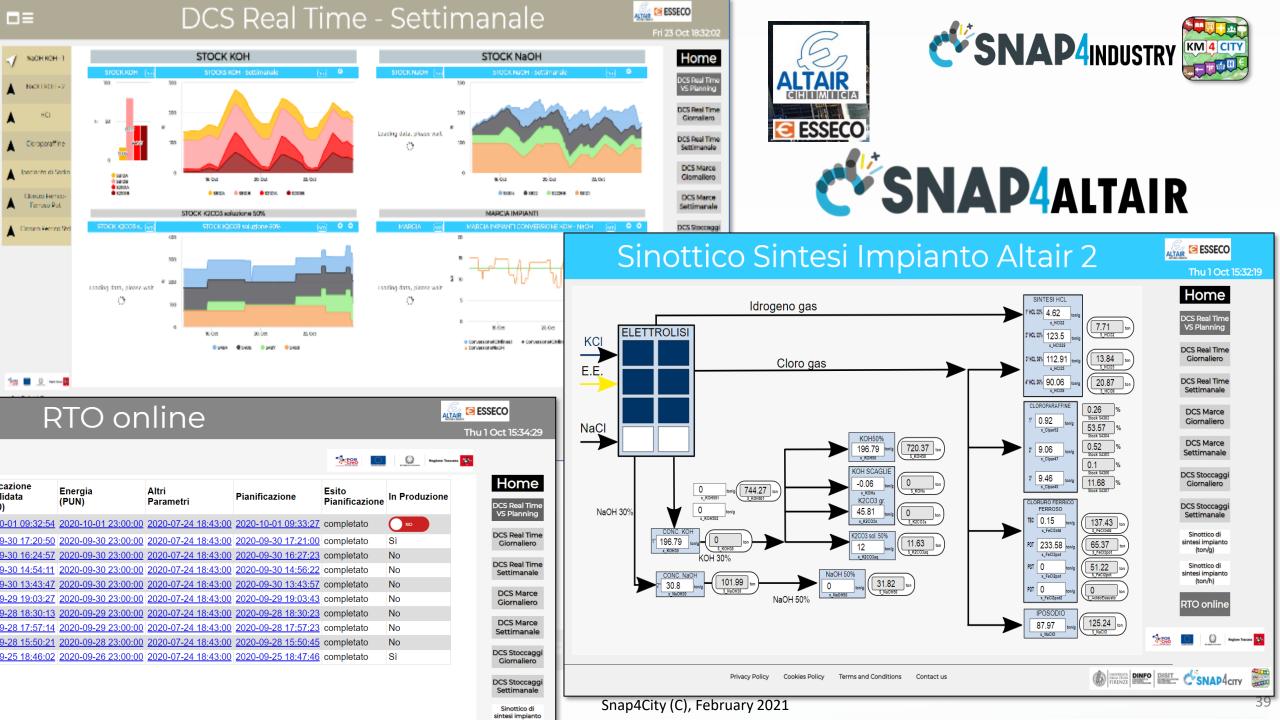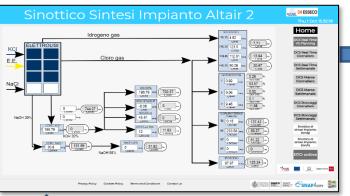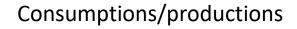 - Multiple Levels, Mobile Apps, API

- **Since 2020**

Maintenance Intelligence

Altair Control room

Workflow for Ticket management

Consumptions/productions

Events/actions

Business Intelligence Maintenance

Dashboards and actions

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

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

OpenMaintCloseEvent

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

Environment and Quality of Life Air Quality Predictions

- **Multiple Domain Data**
  - Traffic Flow data, Pollutant, 3D City structure, weather, ...
- **Multiple Decision Makers**
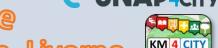 - City officers, energy industries
- **Historical and Real Time data**
  - Dashboards, What-IF analysis
  - Pollutant Predictions,
  - Traffic Flow Reconstruction
- **Services Exploited on:**
  - Dashboards, Mobile App
- **Since 2020**
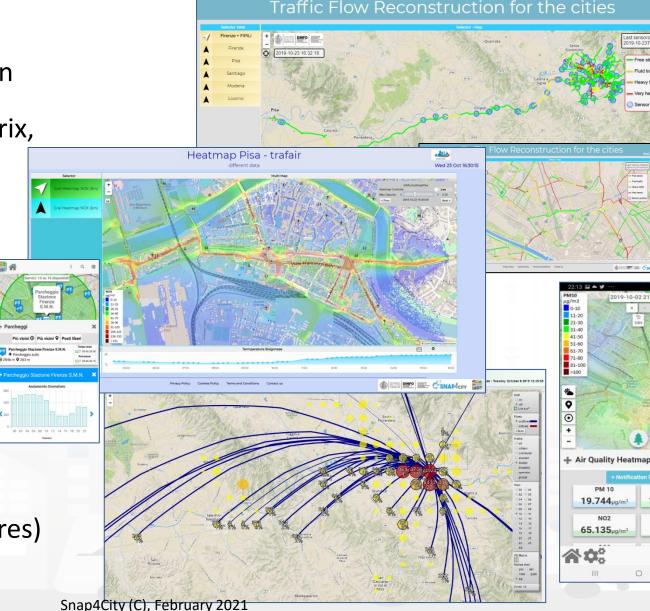
Tuscany Region

- **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

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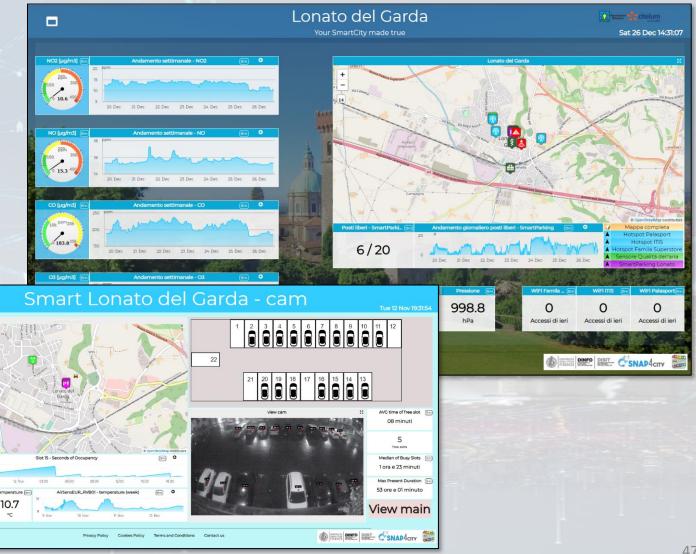
Smart City / Smart Parking + Environment Reverberi, Lonato del Garda

reference

- **Multiple Domain Data**
  - Smart Parking, Environment, Wi-Fi

- **Multiple Decision Makers**
  - City Officer, operators

- **Historical and Real Time data**
  - Dashboards

- **Services Exploited on:**
  - Dashboards, API

- **Since 2019**

Västerås

Smart Light Control of CAPELON

reference

- **Energy Domain**
  - Smart Light
  - FiWare Orion Broker

- **Dashboards**
  - Map coverage on Sweden
  - Monitoring and real time control

- **Historical and Real Time data**
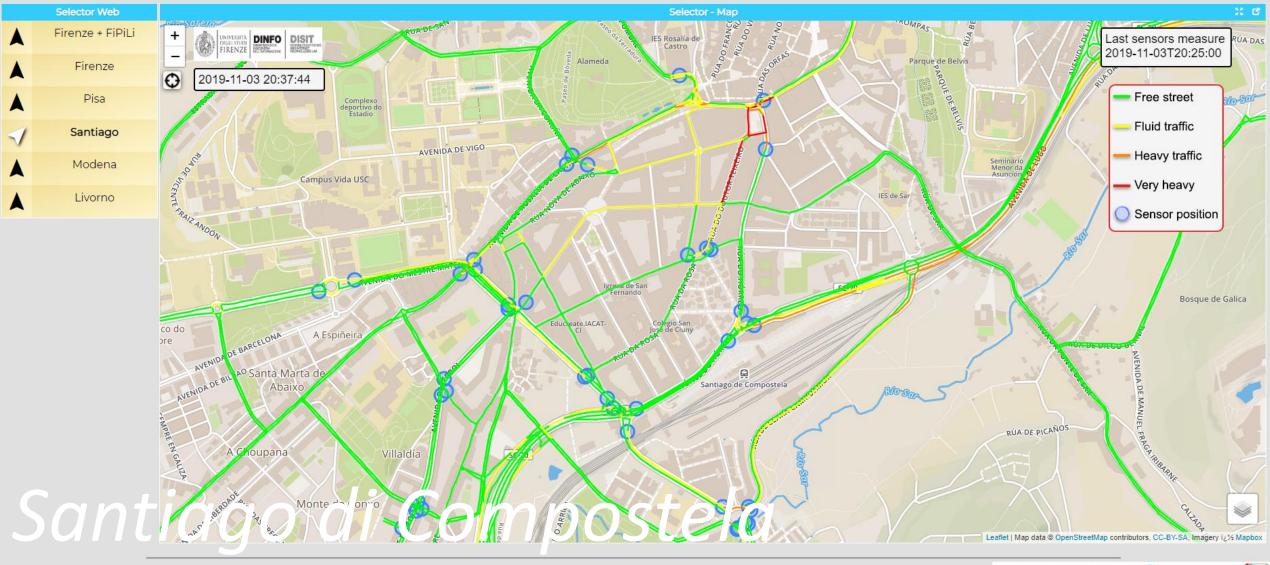
- **Services Exploited on:**
  - Multiple Levels, API

- **Since 2020**

Santiago di Compostela

Traffic Flow Reconstruction for the cities

Selector Web

- Firenze + FiPiLi
- Firenze
- Pisa
- Santiago
- Modena
- Livorno

Selector - Map

2019-11-03 20:37:44

UNIVERSITÀ DEGLI STUDI FIRENZE · DINFO · DISIT

Last sensors measure
2019-11-03T20:25:00

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

Santiago di Compostela

Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery ï¿½ Mapbox

Privacy Policy   Cookies Policy   Terms and Conditions   Contact us

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

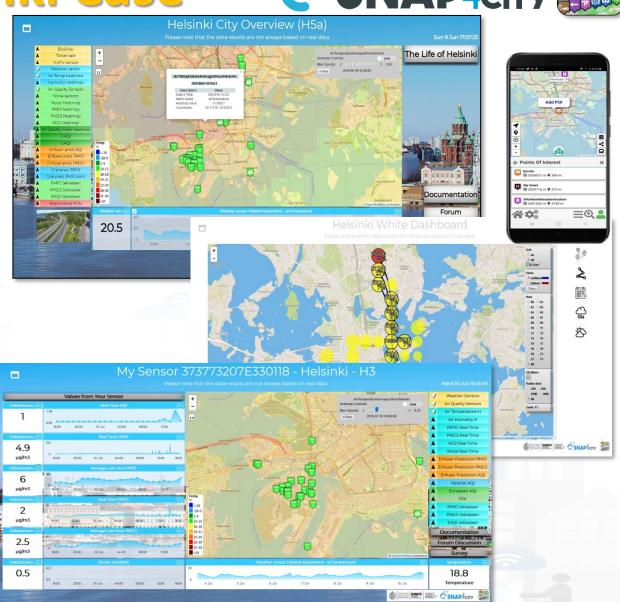# Helsinki

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)

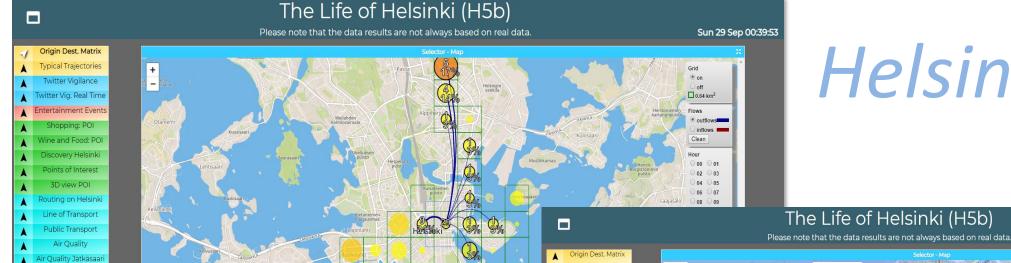https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTQwNg==

Helsinki

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.
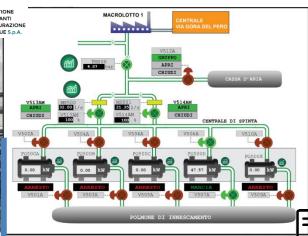- GRAL can be applied on NOX, PM10, PM2.5, … or any other particles
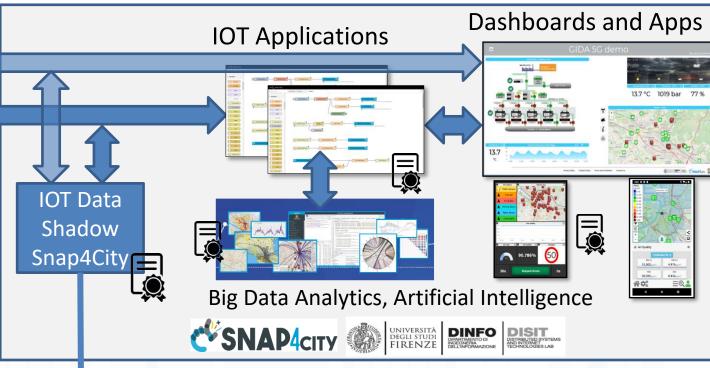
Prato
Smart City vs Industry 4.0

GIDA set up

Dubrovnik

People Flows

Dubrovnik

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

Scenarious

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

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
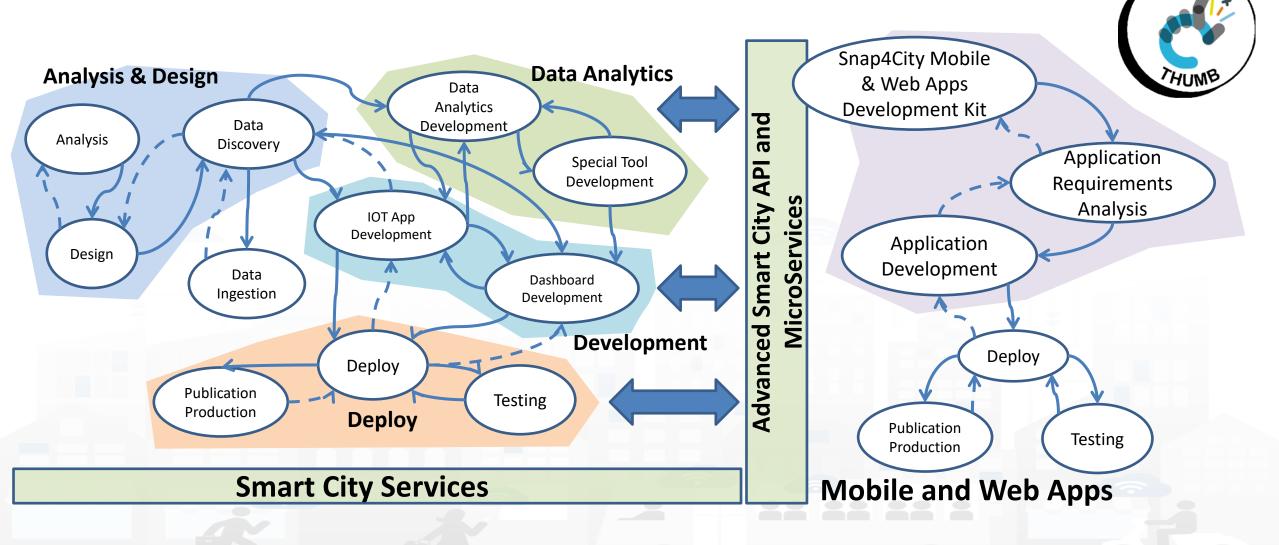
SNAP4 Appliances and Dockers **Installations**

Develop Mobile & Web Applications Exploiting Snap4City Smart City Services

On Line Training Material (free of charge)

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

Concept

BIM

KPI, POI, MyKPI, …

API, External Services

Web Scraping

WorkFlow

Data Analytics, Artificial Intelligence

IOT Broker

IOT Broker

IOT Broker

IOT Apps

FIWARE

ckan

LD, LOD

GIS

Big Data

KB

Dashboards and Apps
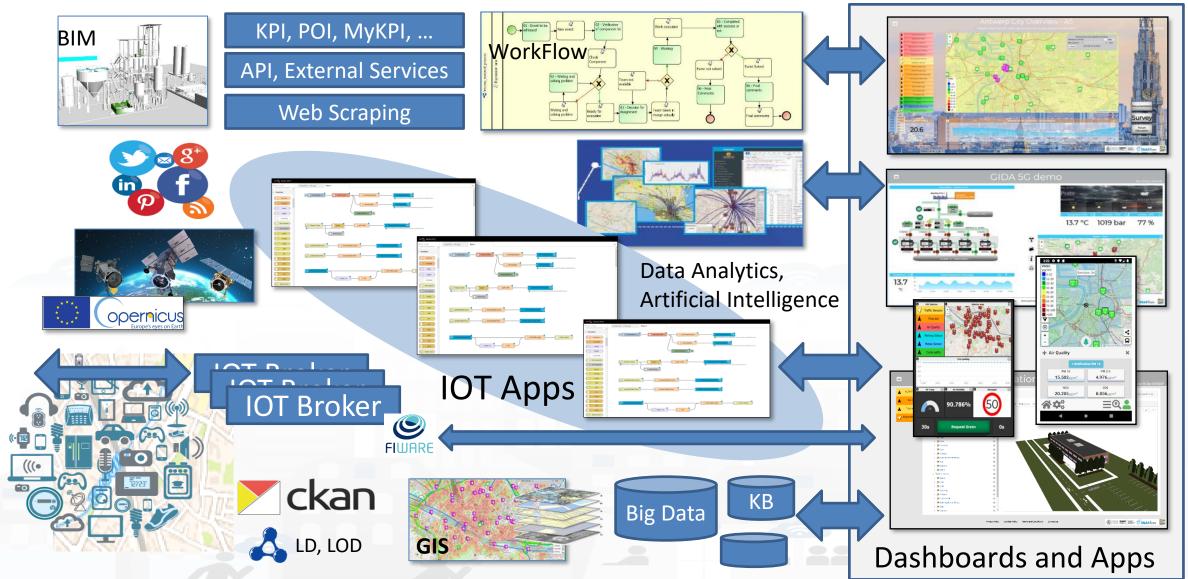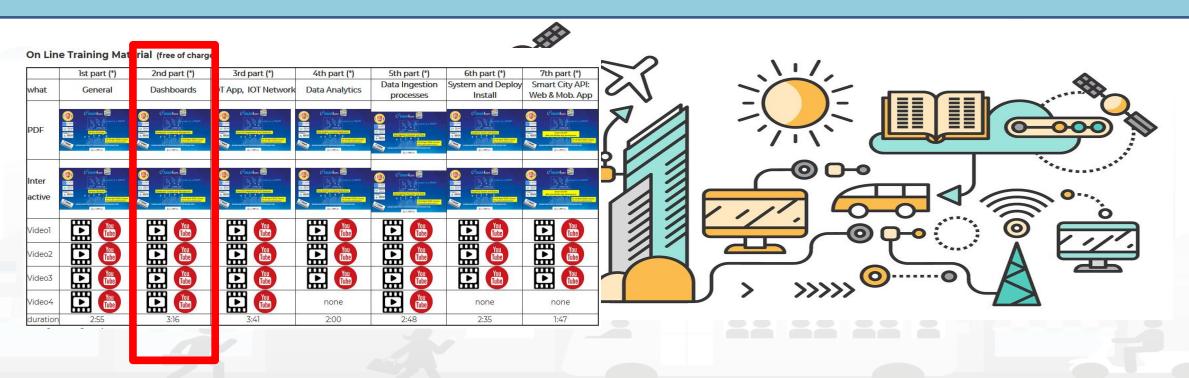
Dashboard and tools Development

Dashboard Development

IOT Applications

Knowledge Base, Km4City
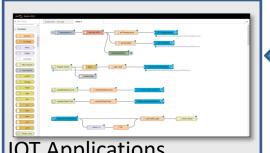
Knowledge and Storage Data from the Field and City + MyKPI ++

Widget Collection

Micro Applications

External Services

Custom Widgets/ Synoptics

Dashboard Wizard

Dashboard Editor

Public Dashboard Collection
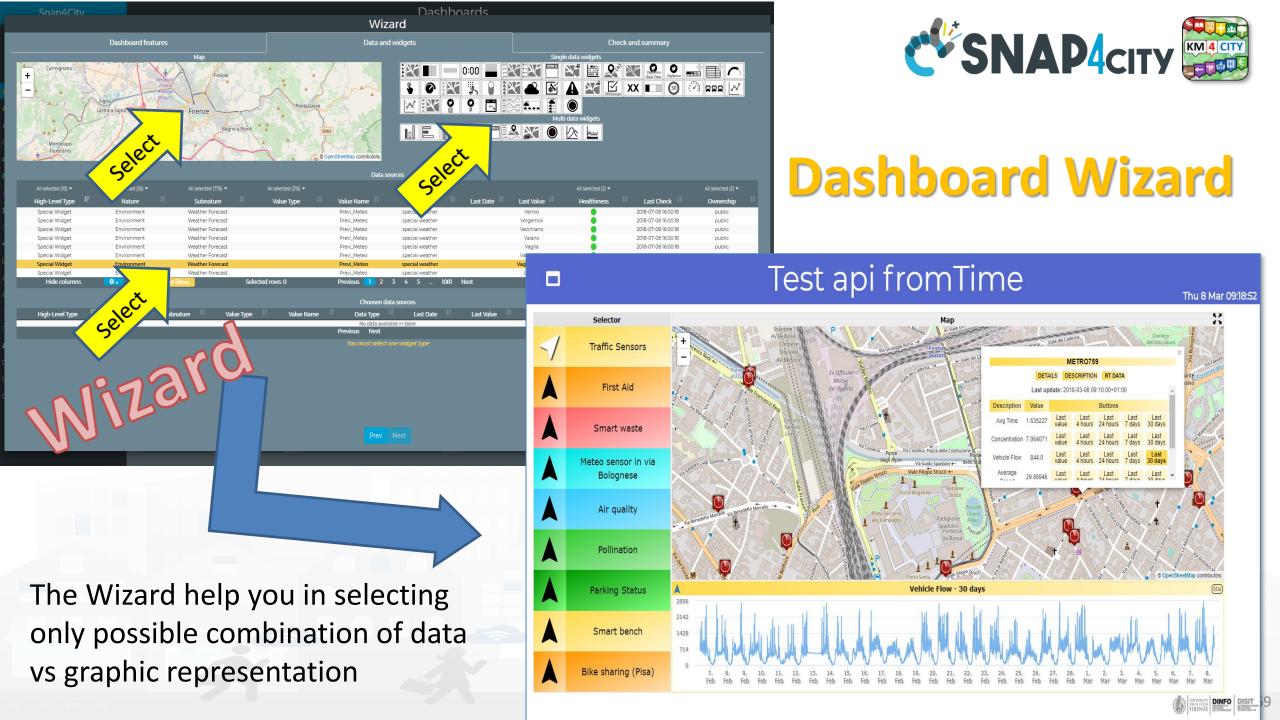
Create, save, load, delegate, grant access

My Own Dash/App

Dashboard Wizard

Test api fromTime

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

Dashboard List and Editor

Special Custom Widgets

- Smart parking
- Smart Energy
- Smart Light
- Smart ….
- Energy View
- Custom Controls
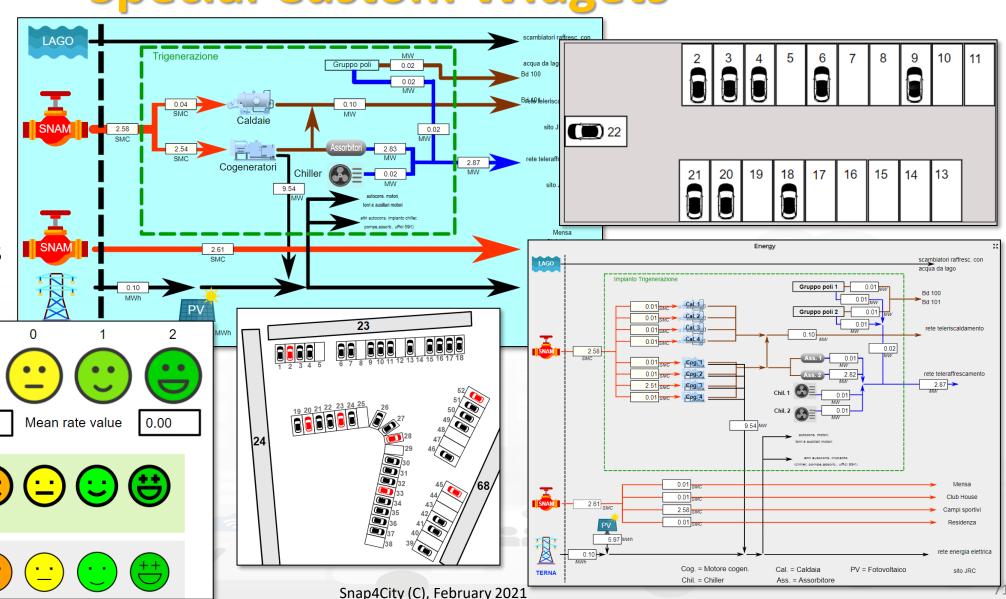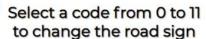
SVG Custom Widgets Examples
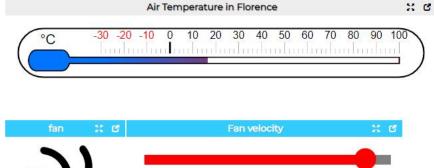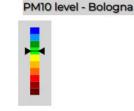
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjk0NQ==
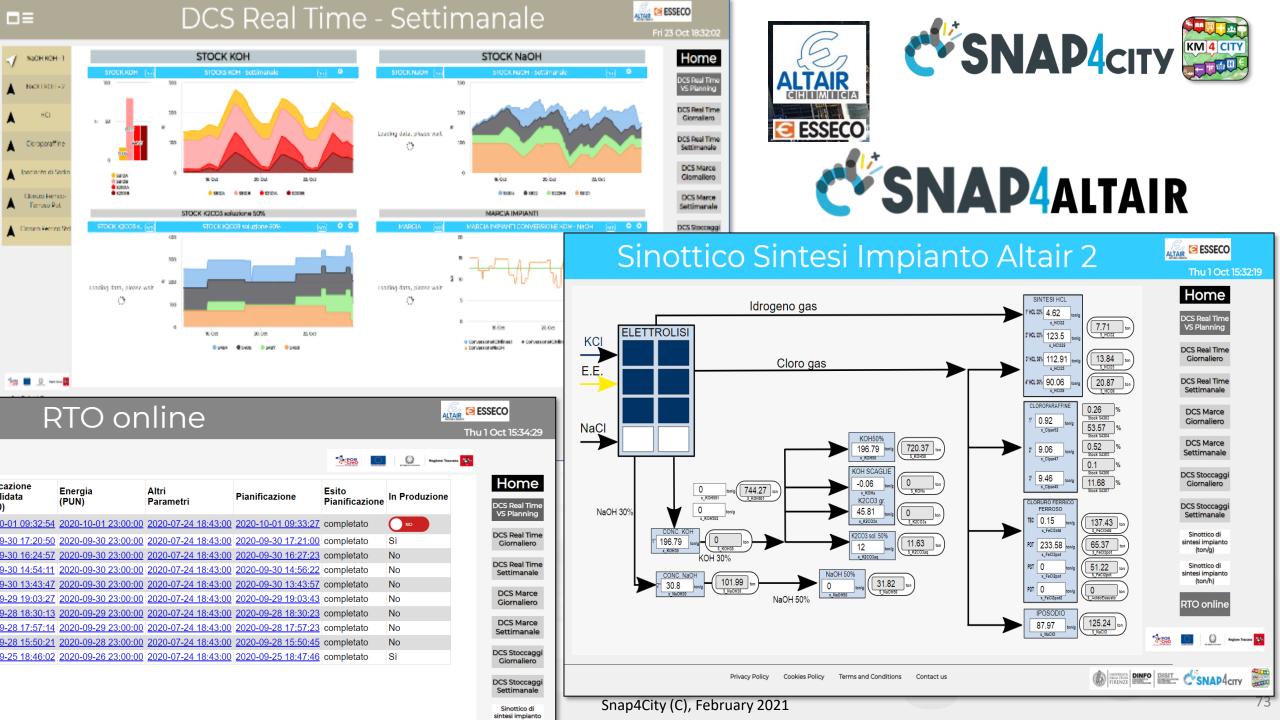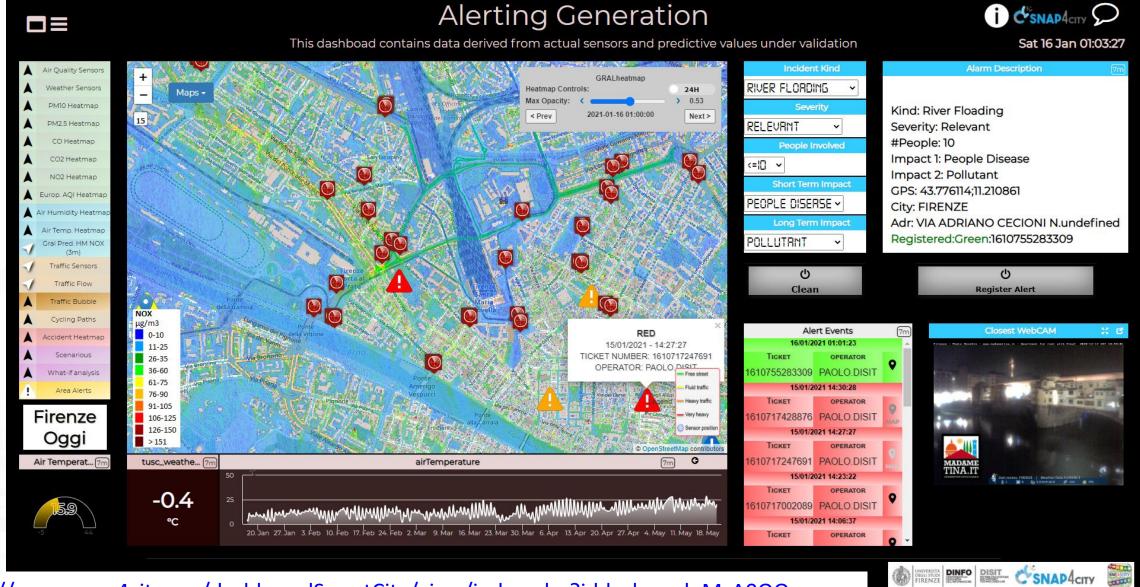
Alert Registration

How the Dashboards exchange data

- Req. ServiceURI
- Req. KPI, Metric ID
- Req. MyKPI ID
- Traffic Flow, MAPS, Heatmaps
- GIS, HTTPs URLs
- ServiceURI (ID)
- MyKPI, Metric (ID)
- Dynamic Data, computed into IOT Application
- Rx. Dynamic Data
- Event Driven Synoptics
- Actions, Show
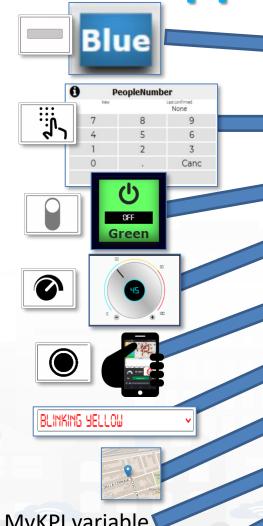
Snap4City BigData Storage and KB

IOT Broker Orion Quantum Leap

ServiceMap Super ServiceMap

Metric, KPI

MyKPI, MyPOI, ...

API, External Services, MicroApp

Dashboards

IOT Application

Dashboard-IOT App

Nature
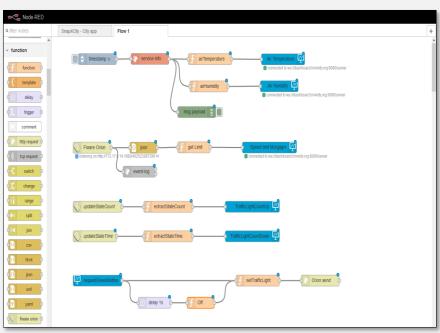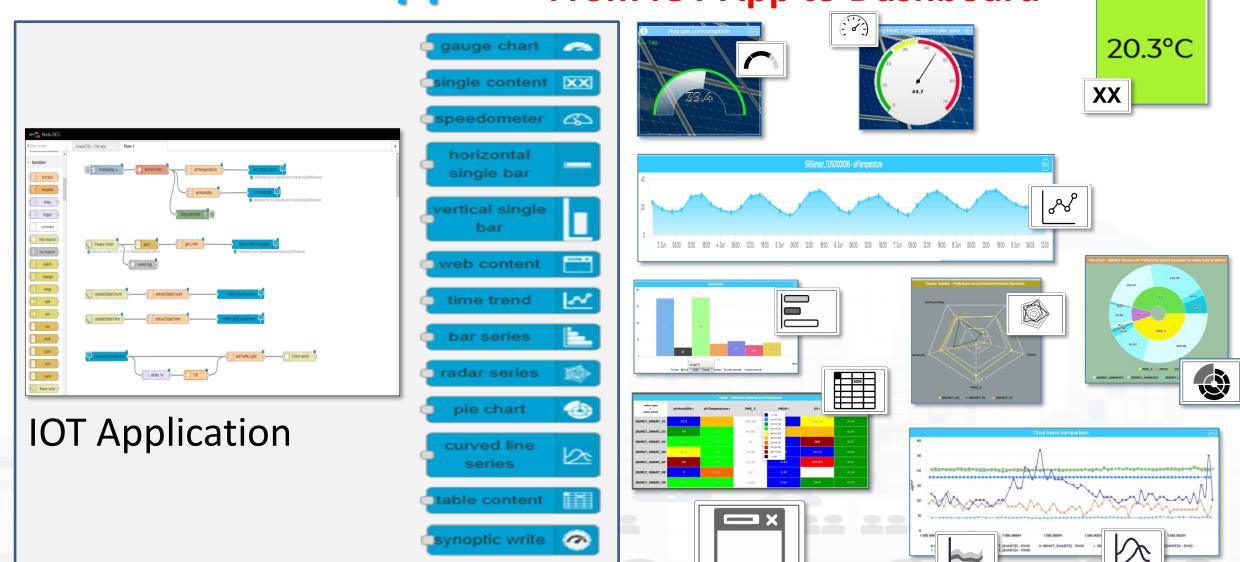
From IOT App to Dashboard

20.3°C

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

IOT Devices

Sensors/ Actuators

IOT Edge Devices

LoraWAN + Arduino + I2C, NGSI

Arduino, Wi-Fi, NGSI

Snap4All IOT Button ESP, NGSI, Wi-FI, BT
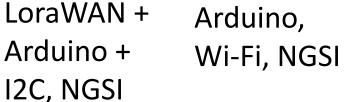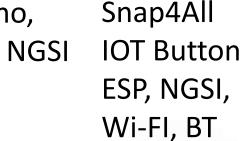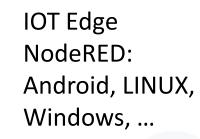
Snap4All PAX Counter LoraWAN WIFI, NGSI, GPS
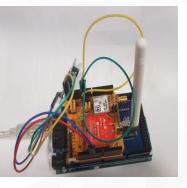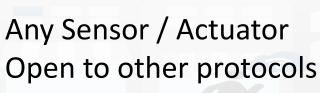
IOT Edge NodeRED: Raspberry Pi, NGSI, WiFi, RJ45,..

IOT Edge NodeRED: Android, LINUX, Windows, …
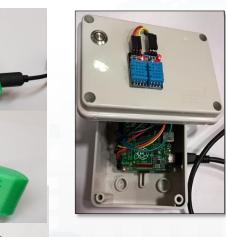
LoraWan Gateway: IOT Edge, NGSI, WIFI, RJ45, GPS

Any Sensor / Actuator
Open to other protocols
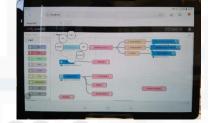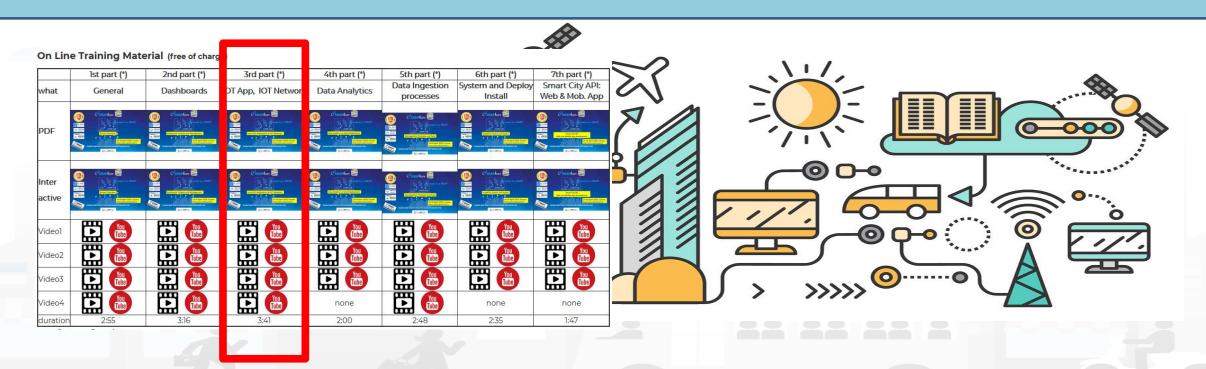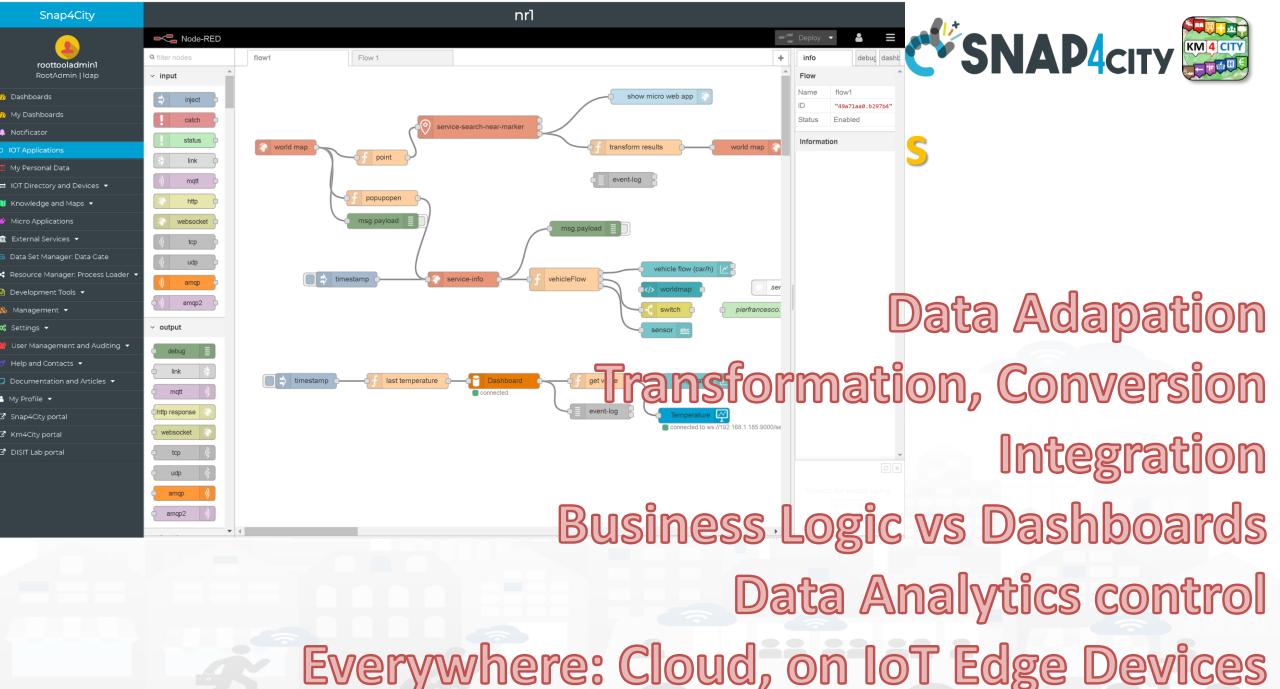
IoT Application Development smartening the solutions
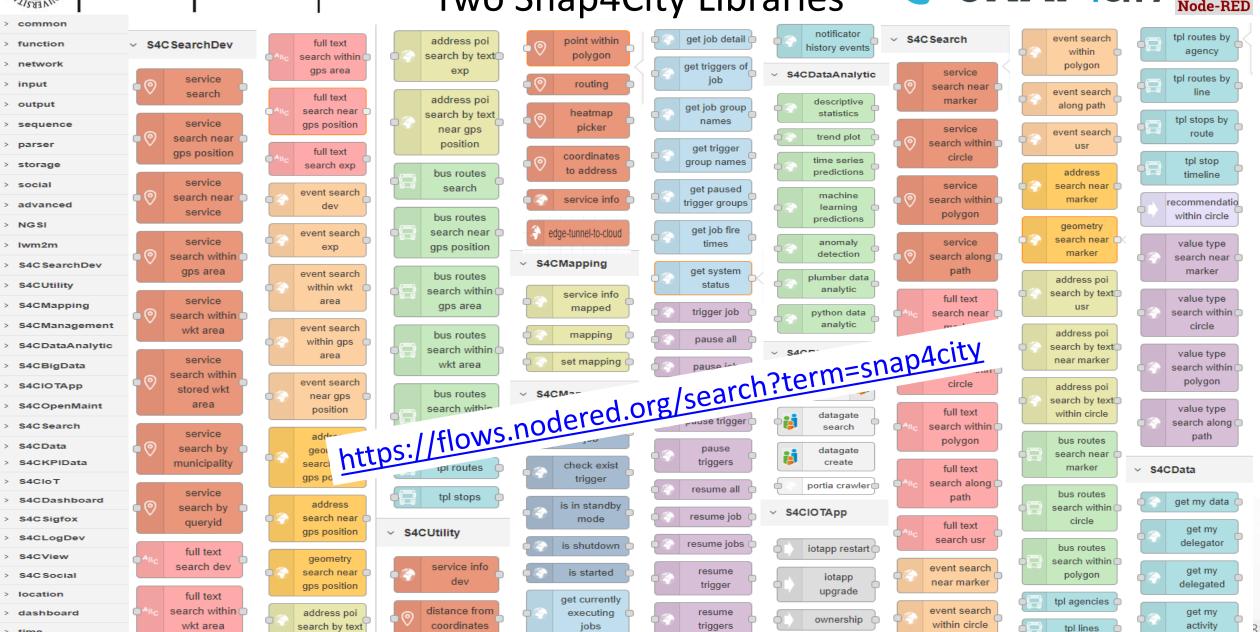
On Line Training Material (free of charge)

what	1st part (*) General	2nd part (*) Dashboards	3rd part (*) IOT App, IOT Network	4th part (*) Data Analytics	5th part (*) Data Ingestion processes	6th part (*) System and Deploy Install	7th part (*) 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

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

Nov. 2020 collection
Two Snap4City Libraries
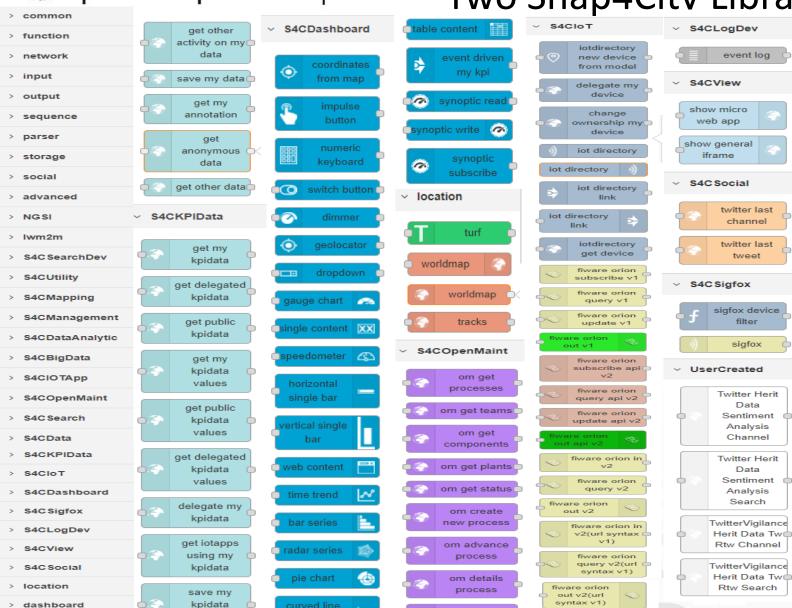
https://flows.nodered.org/search?term=snap4city
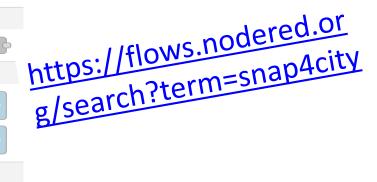
We suggest also to install:
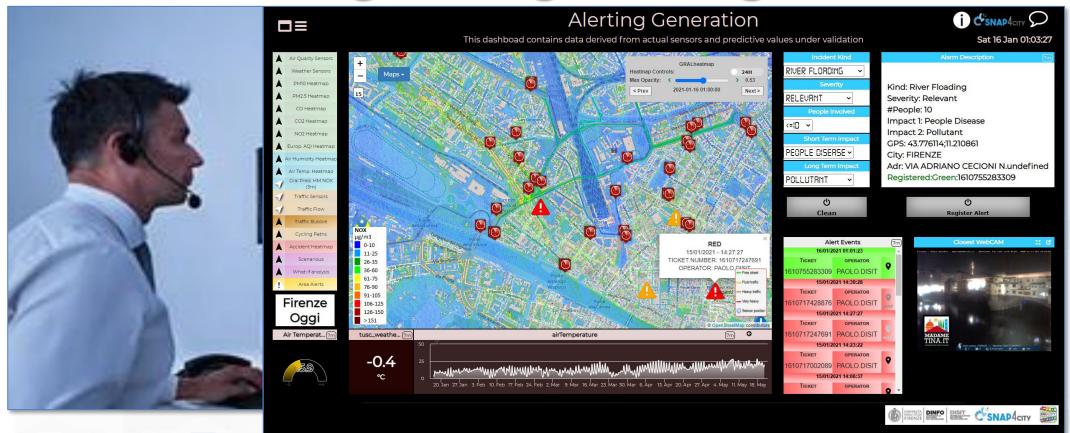
Registering Alerting events

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==

Development of Data Analytics
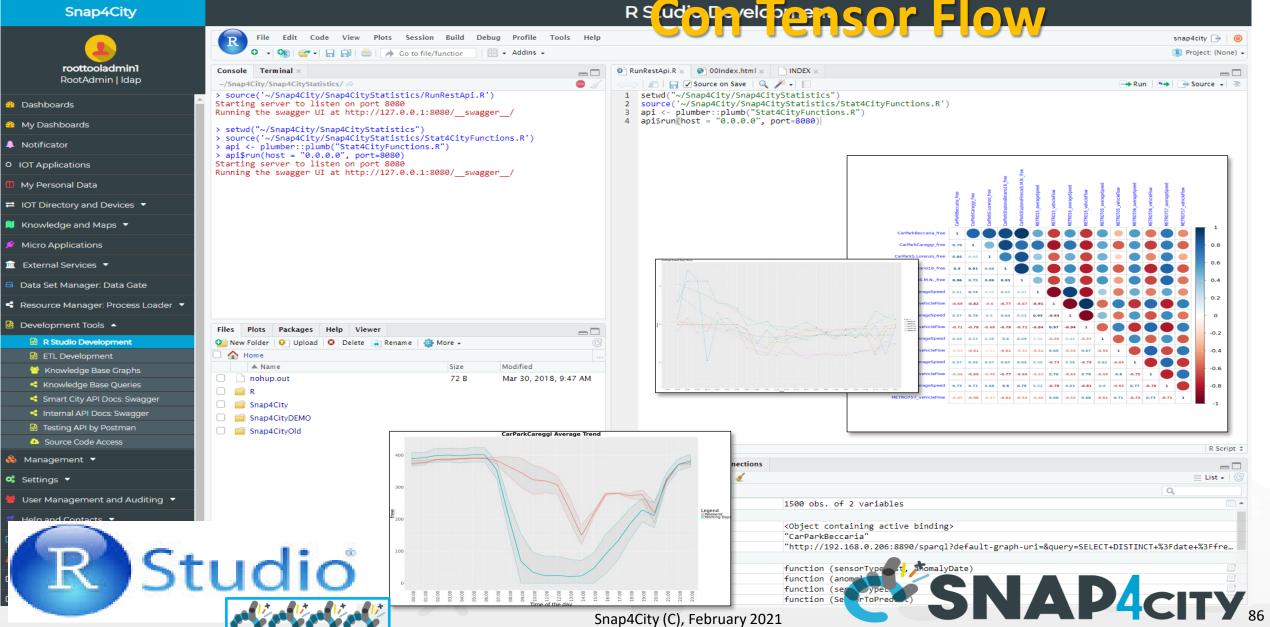
On Line Training Material (free of charge)

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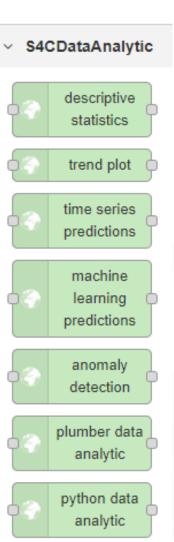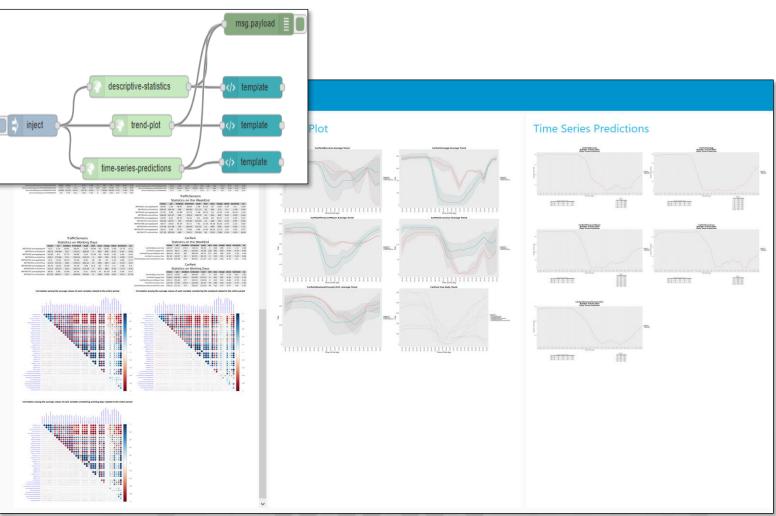
Data Analytics to MicroServices

S4CDataAnalytic

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

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
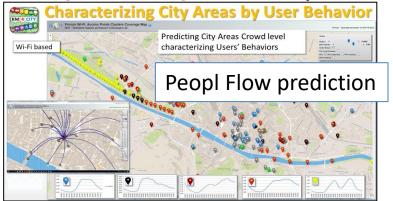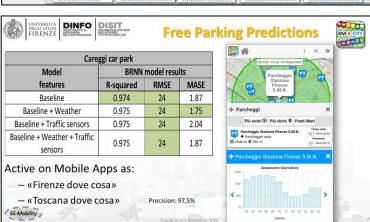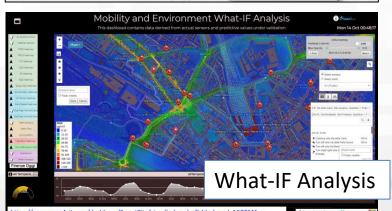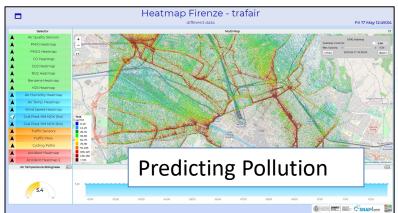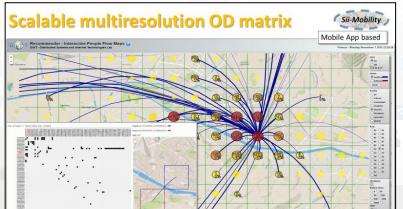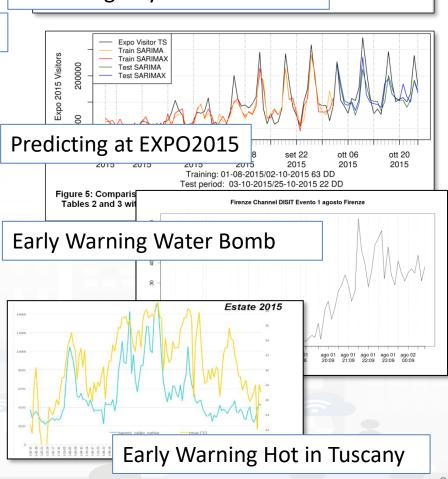
Traffic Flow Reconstruction/prediction

Predicting City Users on Areas

Free Parking Predictions

Predicting at EXPO2015

Predicting Pollution

Early Warning Water Bomb

What-IF Analysis

Scalable multiresolution OD matrix

Mobile App based

Early Warning Hot in Tuscany

88

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.

89
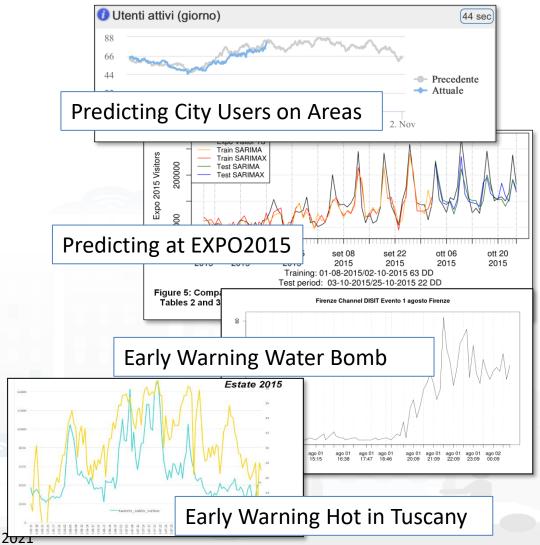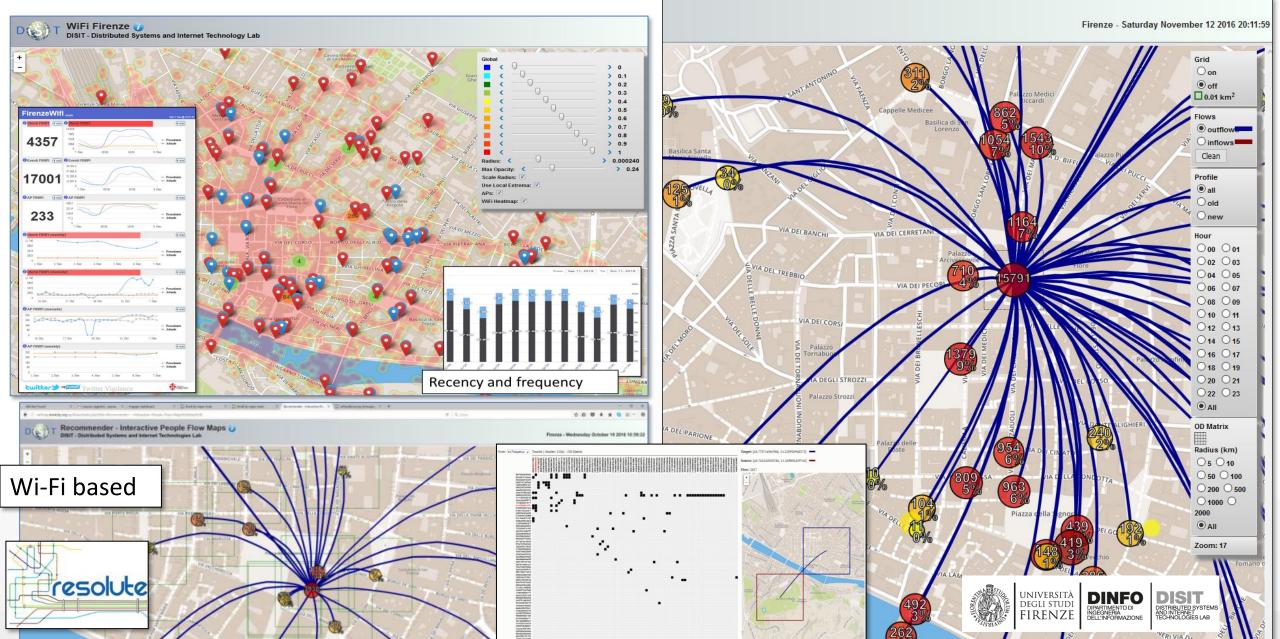
Predicting Models for Administrators & City Users

- **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

Predicting City Users on Areas

Predicting at EXPO2015

Early Warning Water Bomb

Early Warning Hot in Tuscany

Origin Destination Matrix Estimation

Recency and frequency

Wi-Fi based

Characterizing City Areas

Wi-Fi based

Predicting City Areas Crowd level characterizing Users' Behaviors

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

Traffic Flow Reconstruction
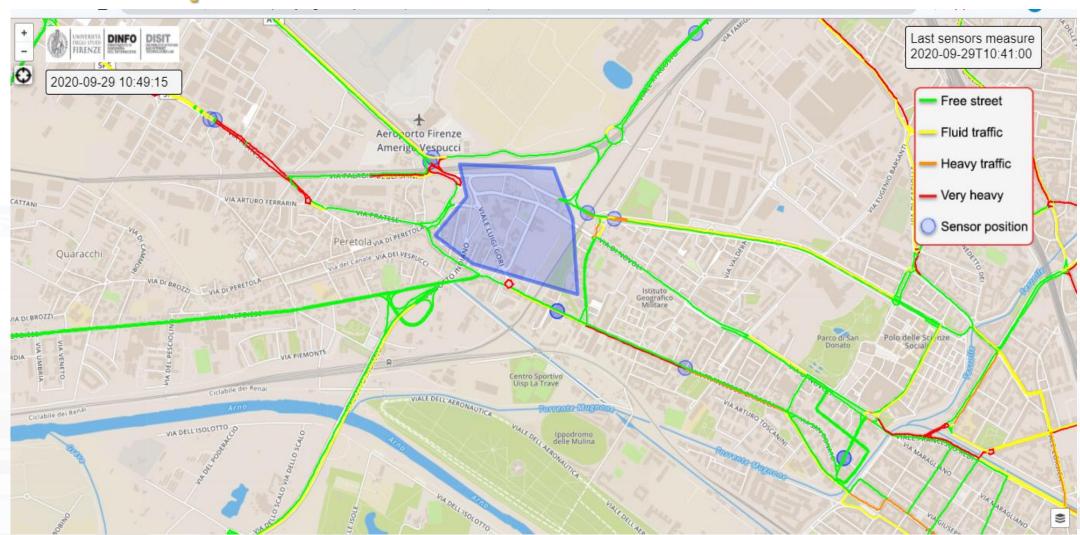
Computation of Traffic Flow Evolution

Florence
Accidents Density

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

DORAM

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

98
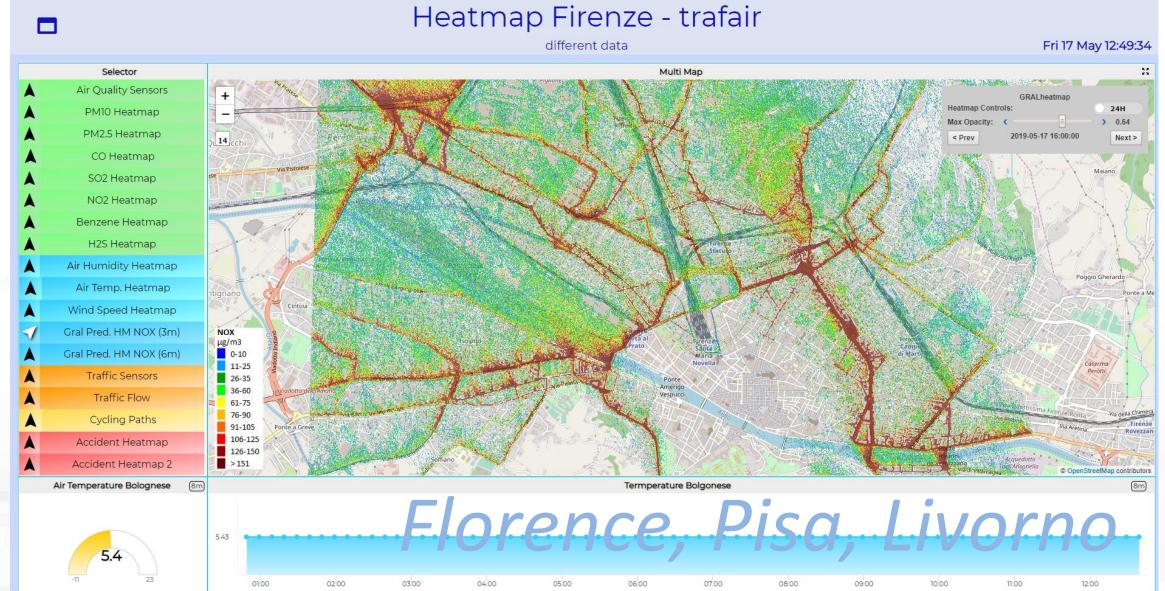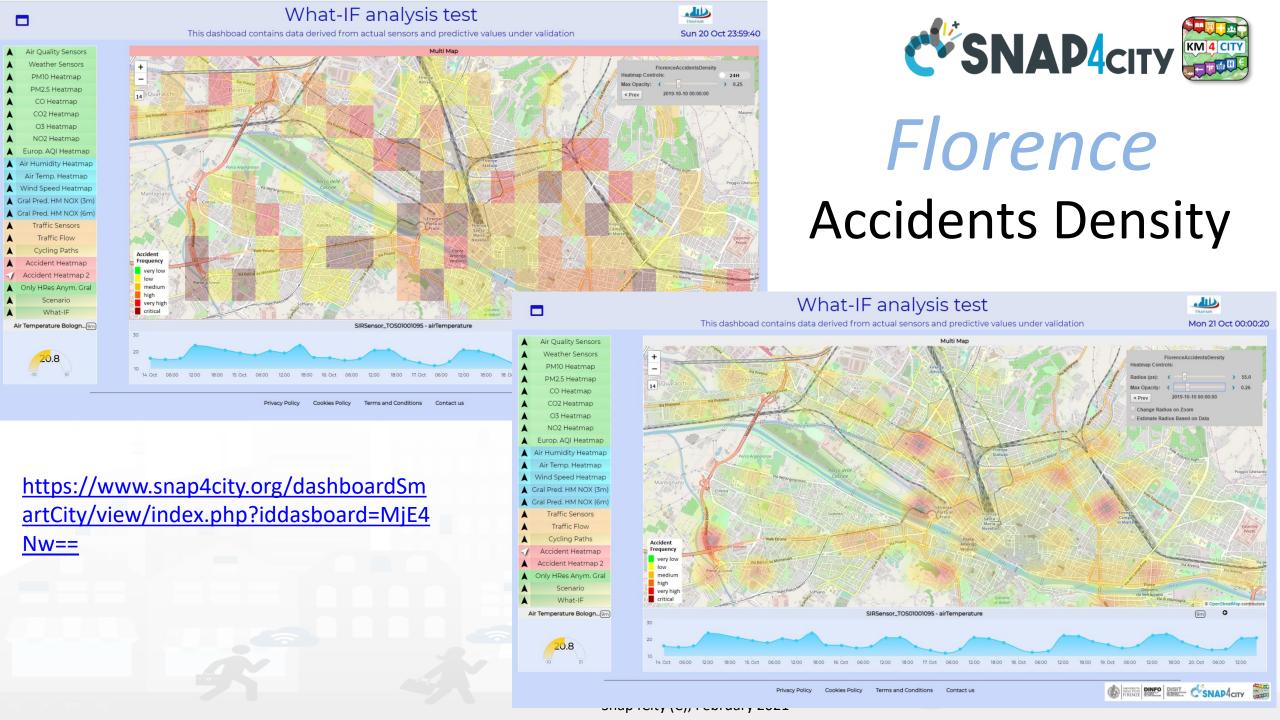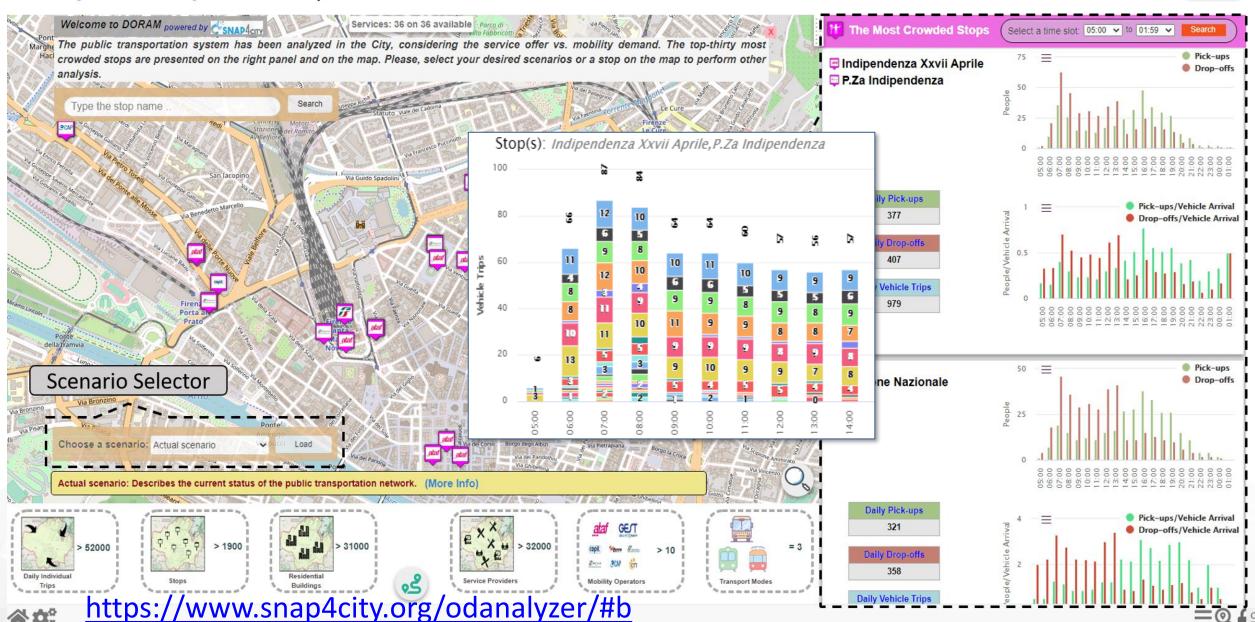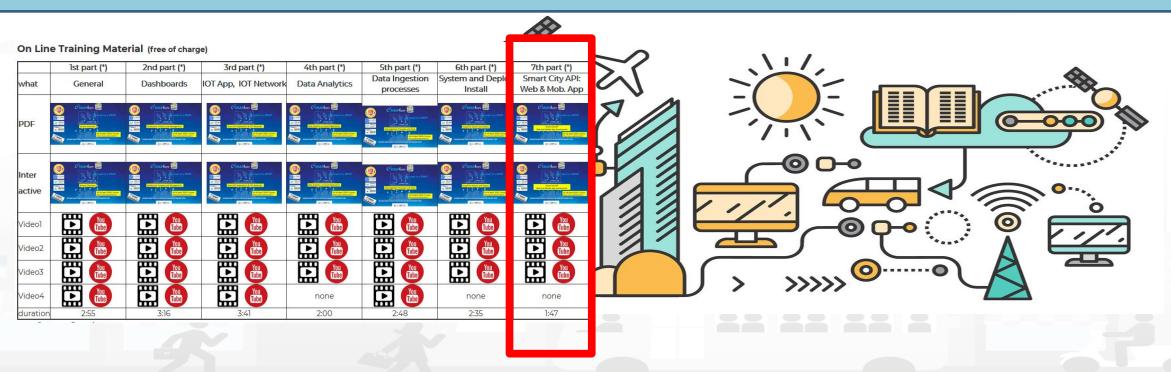
Mobile App Development Smart City API and Federation
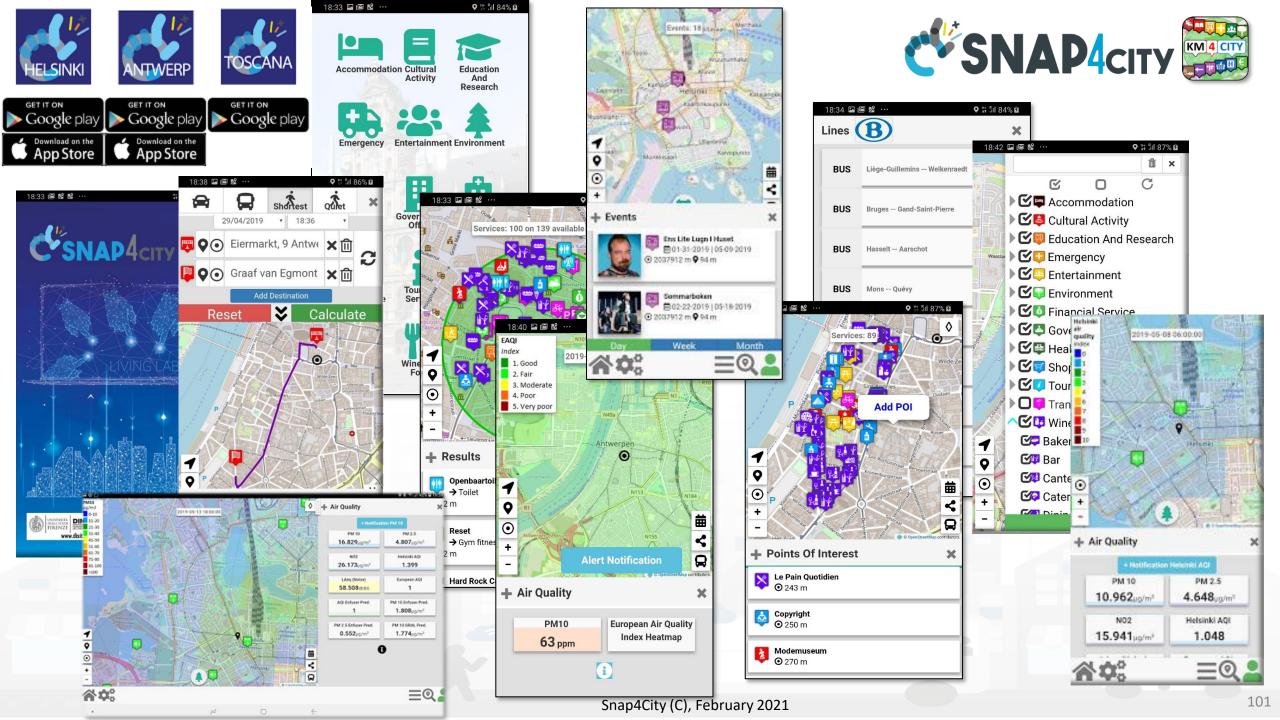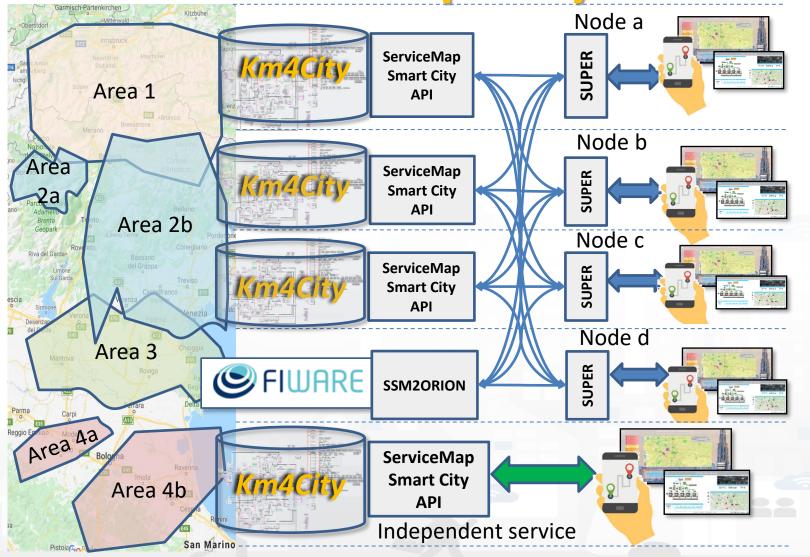
On Line Training Material (free of charge)

what	1st part (*) General	2nd part (*) Dashboards	3rd part (*) IOT App, IOT Network	4th part (*) Data Analytics	5th part (*) Data Ingestion processes	6th part (*) System and Deploy Install	7th part (*) 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

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.

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
- .....
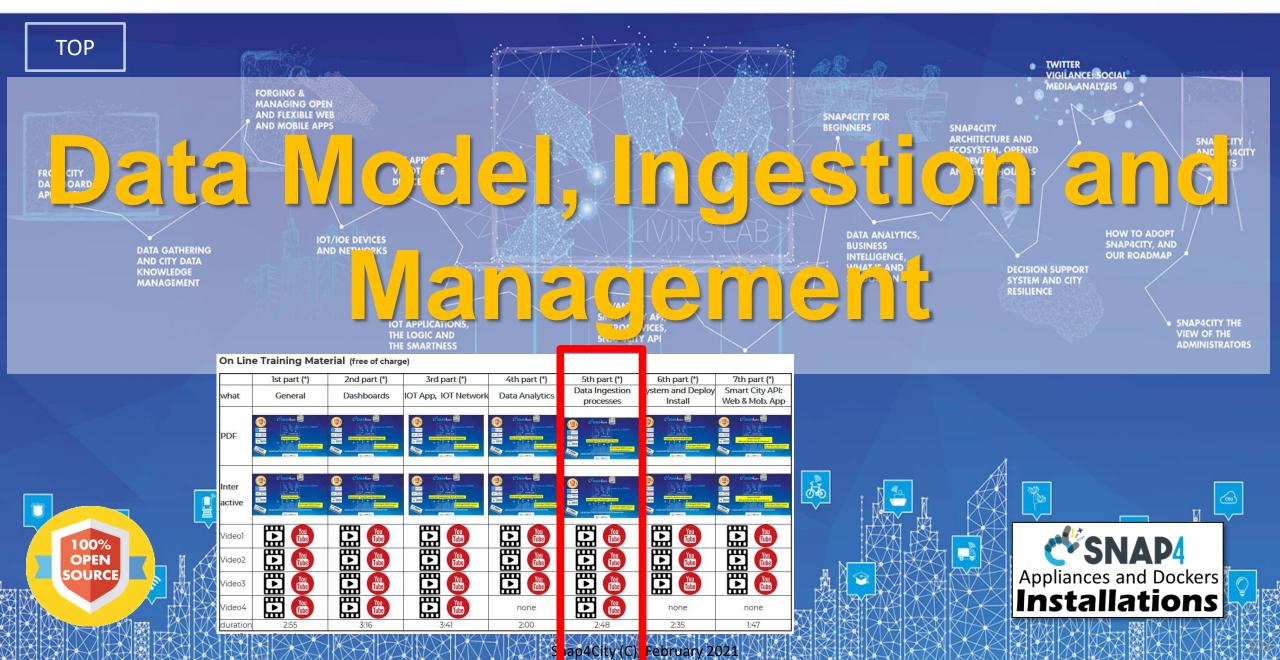
Produced information
- Suggestions
- Engagements
- Notifications
- ...

Users

System

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

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 ...**

Tuscany Florence, Pisa....

- Nascondi Menu

Fermate Firenze | Comuni in Toscana | Ricerca Testuale

Seleziona una provincia:
FIRENZE

Seleziona un comune:
FIRENZE

Actual Selection
COMUNE di FIRENZE

- 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
ℹ Services 16858

Previsioni Meteo per il comune di FIRENZE:
Martedi | Mercoledi | Giovedi | Venerdi | Sabato

poco nuvoloso 23°C / 27°C | pioggia debole e schiarite 20°C / 30°C | poco nuvoloso 20°C / 33°C | poco nuvoloso / | velato /

Ultimo Aggiornamento: 2015-09-15T09:07:00+02:00
LINKED OPEN GRAPH

Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

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__*

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
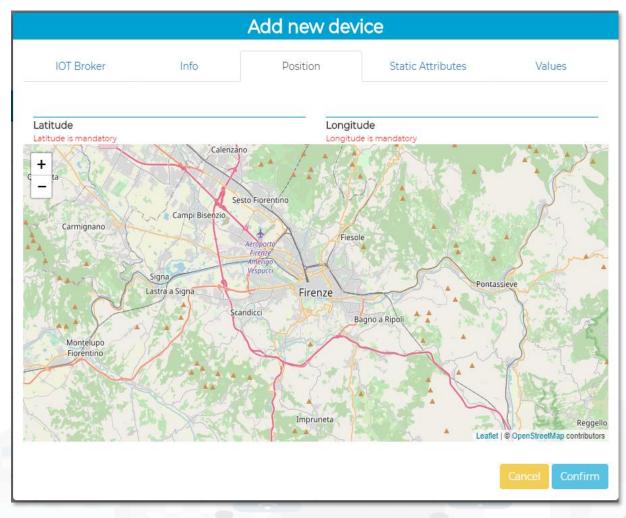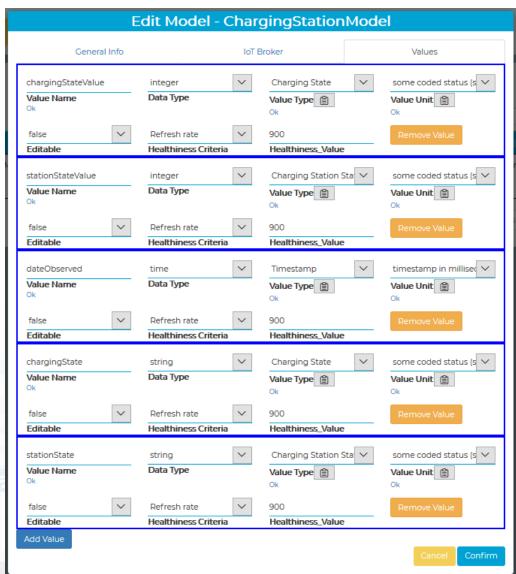
IOT Device Data Model (2)

Data Ingestion and Management
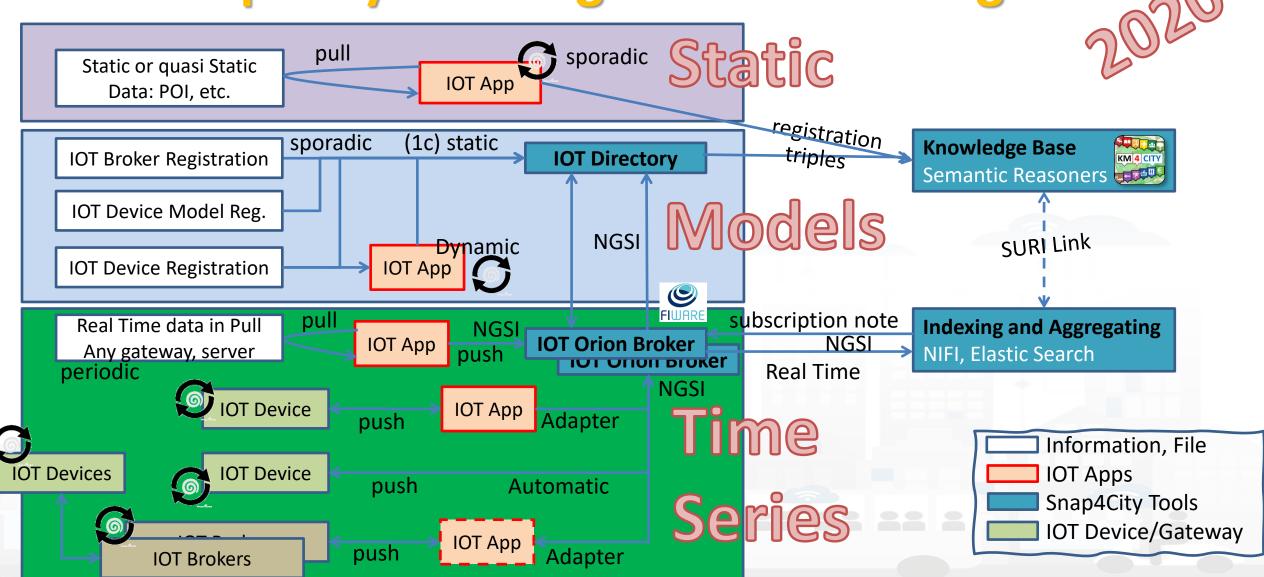
Snap4city Data Ingestion Flow Diagram
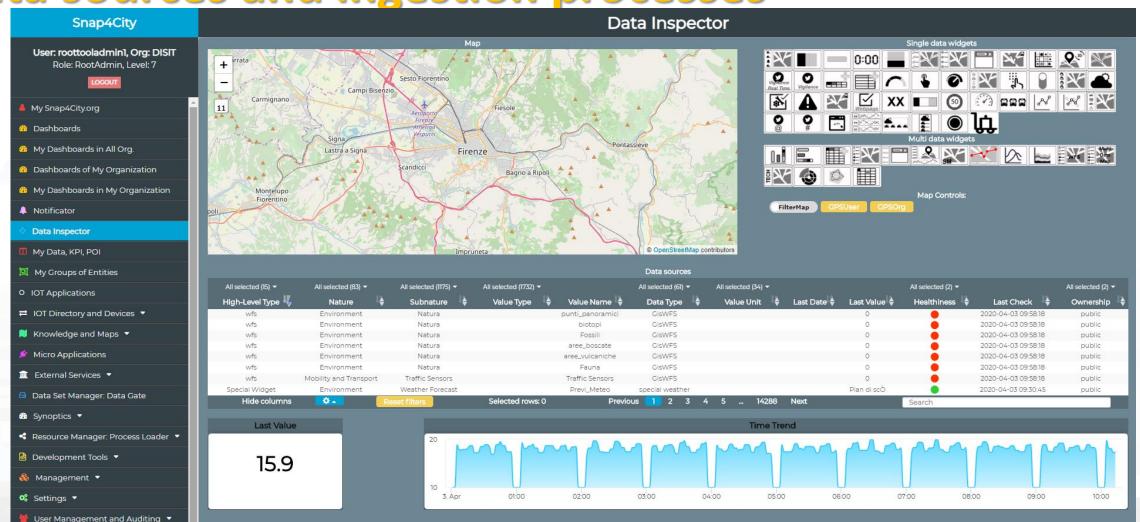
Data Inspector: all you need to know about data, data sources and ingestion processes

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
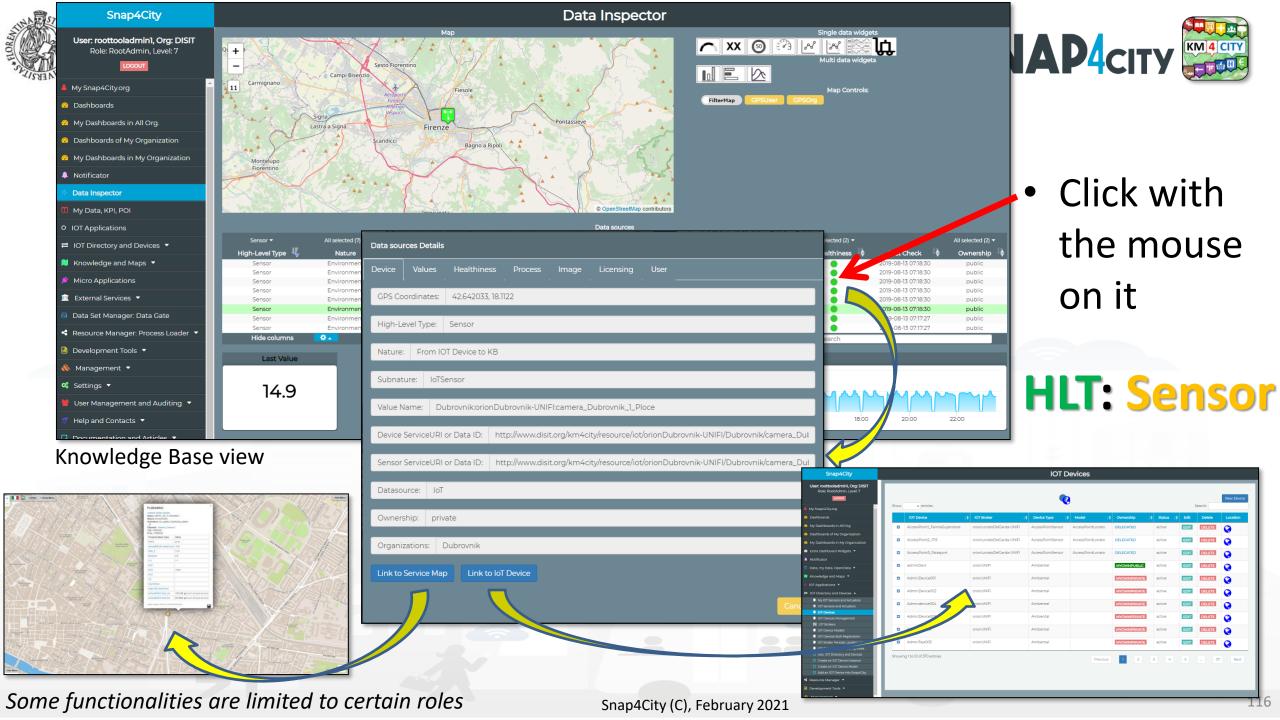
- **Users**
  - Defined the Data and Devices
  - Defined the processes
  - Create dashboards
  - Etc.

- **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

Data Inspector

Knowledge Base view

• Click with the mouse on it

HLT: **Sensor**

Some functionalities are limited to certain roles

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

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

LOGOUT
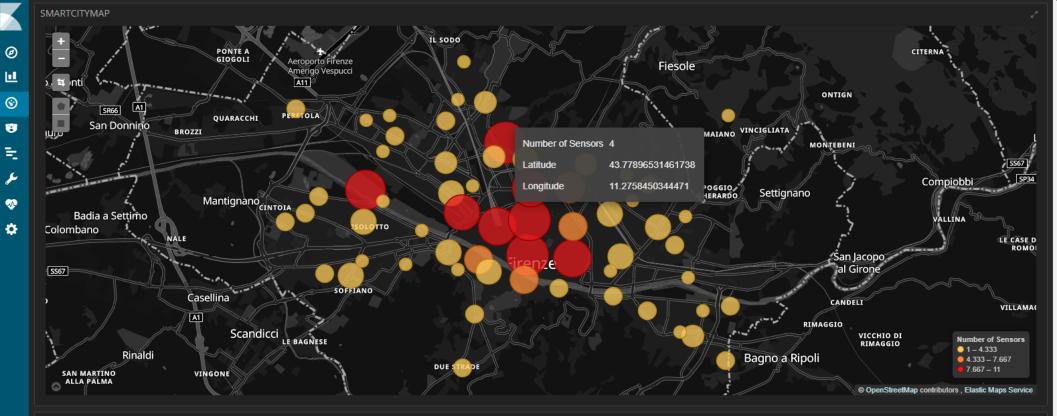
- My Snap4City.org
- Dashboards
- My Dashboards in All Org.
- Dashboards of My Organization
- My Dashboards in My Organization
- Extra Dashboard Widgets ▾
- Notificator
- Data, my Data, OpenData ▾
- Knowledge and Maps ▾
- IOT Applications ▾
- IOT Directory and Devices ▾
- Resource Manager ▾
- Development Tools ▾
- Management ▴
  - Traffic Analyzer: AMMA
  - **Data Analyzer: DevDash**
  - Data Analyzer: DevDash Firenze
  - Data Analyzer: DevDash Helsinki
  - Data Analyzer: DevDash DISIT
  - Data Analyzer: DevDash Lonato
  - Data Analyzer: whole traffic
  - Container Cluster Monitoring
  - Back Office Container Monitoring
  - IOT App Version Management
  - Smart City API Monitoring
  - MyKPI Monitoring
  - Notificator Monitoring
  - Web Server Monitoring
  - Back Office DWH Sched DISCES
  - Back Office DA Sched DISCES
  - Back Office DISCES monitor
  - Mobile Application Monitoring

SMARTCITYMAP

Number of Sensors 4
Latitude 43.77896531461738
Longitude 11.2758450344471

Number of Sensors
  1 – 4.333
  4.333 – 7.667
  7.667 – 11

© OpenStreetMap contributors , Elastic Maps Service

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	#	-

Platform Integration Capabilities

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

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

IOT Applications, Business Logic Node-RED + Snap4City MicroServices

Federation

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

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

IOT Broker

IOT Device

IOT Device

Sensors/Actuators

IOT Edge

Web Scraping

DataGate

IOT App

ETL

GIS data, Maps, …

API, External Services

Rest Call …….MS

External Data Stores

LD, LOD

My Files

Concept

WorkFlow

KPI, POI, MyKPI, …

API, External Services

Web Scraping

BIM

Data Analytics, Artificial Intelligence

IOT Broker
IOT Broker
IOT Broker

IOT Apps

FIWARE

ckan

LD, LOD

GIS

Big Data

KB

Dashboards and Apps

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.
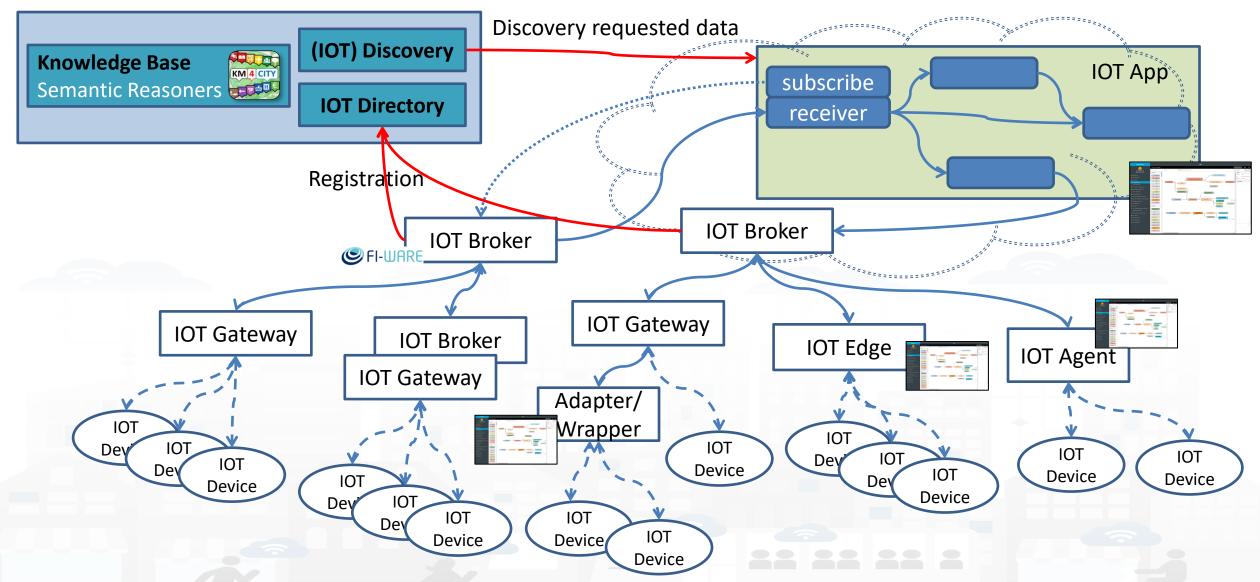
IoT Network

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==

Integration via IoT Apps on IoT Edge

Snap4Home

Sonoff: Controlling Energy Power

Philips Hue: Controlling Lights

Hue Hub

Hue: Motion Control / Alarm

Measuring Energy Consumption

TP Link: Controlling / Measuring Energy Plugs

Alexa: Voice Control

https://www.snap4city.org/620

Snap4City (C), February 2021

WiFi

Measuring Temperature and Humidity

IOT Edge:

Raspberry pi: Node-RED + Snap4City

Controlling Motors

Controlling Irrigators

Garage Door

Window Roller Shutters

Alarm sound and light

My house

Local Control

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

130

IOT Edge Device

Other Local Connections

IOT Brokers

IOT Brokers

WiFi™

Modbus

OPC UA

IOT Edge:
Node-RED + Snap4City

edge-tunnel-to-cloud

HTTPS

HTTPS

Search and Query, Smart City API
Facet, semantic search

Knowledge base
Semantic reasoners

Indexing and aggregating
Elastic search

SNAP4CITY

Snap4Home 5G Demo

WSs

Firewall Gateway Towards internet

IOT Applications

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
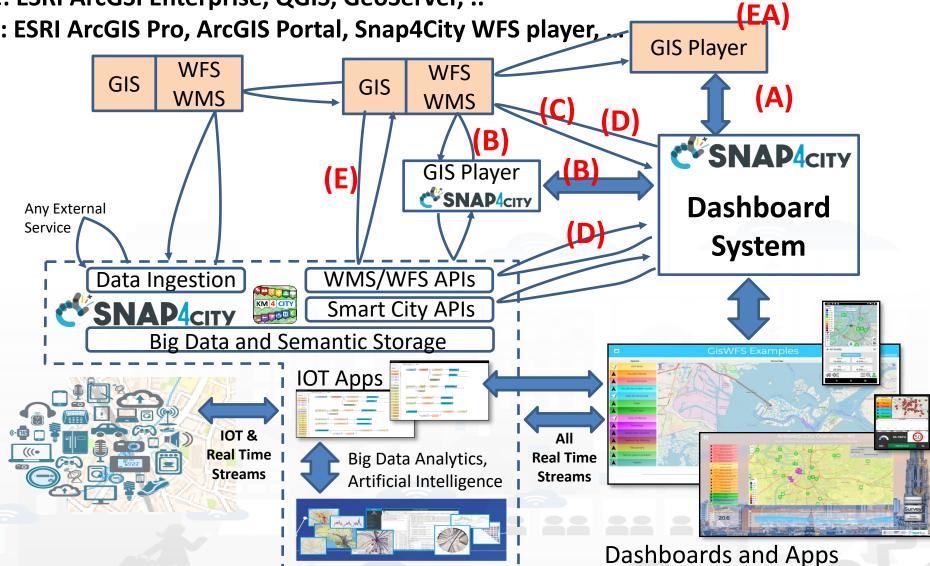
GIS vs Sna4City

GIS Server can be: ESRI ArcGSI Enterprise, QGIS, GeoServer, ..
GIS Player can be: ESRI ArcGIS Pro, ArcGIS Portal, Snap4City WFS player, ..

(EA)

GIS Player

GIS | WFS WMS

GIS | WFS WMS

(C) **(D)**

(A)

(B)

(E)

GIS Player
SNAP4CITY

(B)

SNAP4CITY
Dashboard System

Any External Service

(D)

Data Ingestion
SNAP4CITY

WMS/WFS APIs

Smart City APIs

Big Data and Semantic Storage

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

IOT Apps

IOT & Real Time Streams

Big Data Analytics, Artificial Intelligence

All Real Time Streams

Dashboards and Apps

API, and Federation of Smart Cities via API

Federation of Snap4City Services
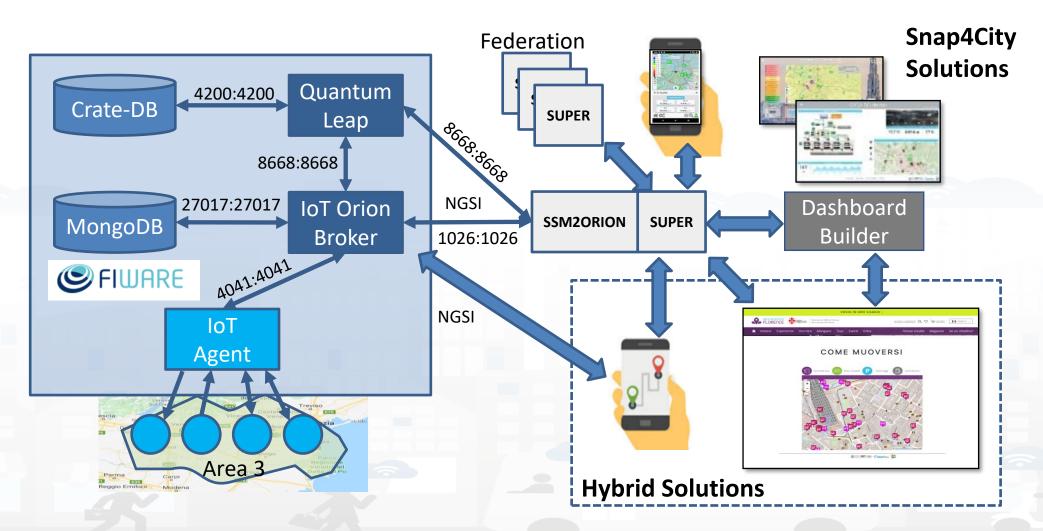
- A Mobile App may refer to one Smart City API Server (for Area 1) via SUPER and receive data from the Federated SUPERS (Area 2) if navigation, queries, etc. are leading to discover out of the addressed KB.

  – 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 presents the same Smart City APIs.

Federation of Snap4City vs IOT ORION Broker

Federation

Snap4City Solutions

SUPER

Crate-DB ←4200:4200→ Quantum Leap

8668:8668

MongoDB ←27017:27017→ IoT Orion Broker

8668:8668

NGSI

1026:1026

FIWARE

4041:4041

IoT Agent

Area 3

SSM2ORION   SUPER

NGSI

Dashboard Builder

COME MUOVERSI

Hybrid Solutions

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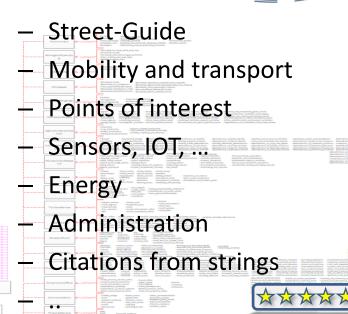
Ontology Documentation:
http://www.disit.org/6506
http://www.disit.org/6507
http://www.disit.org/5606
http://www.disit.org/6461

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

Big Data Tools

LOD and reasoners

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

Smart-city Ontology km4city

Knowledge Base
Semantic Reasoners

License Free 1.6.7

100% OPEN SOURCE

https://www.snap4city.org/19
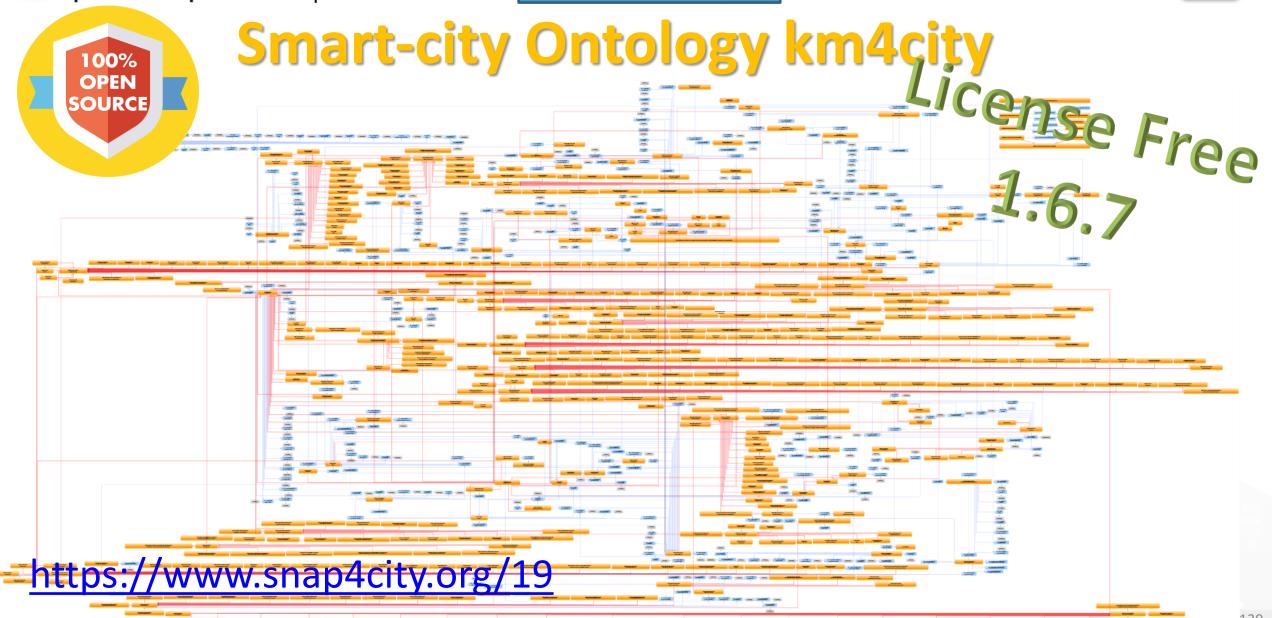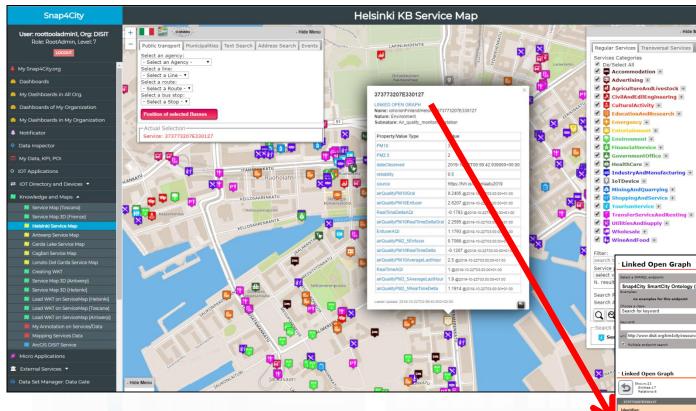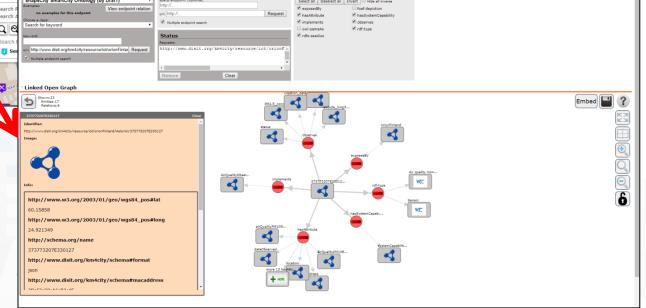
Views of the Knowledge Base

Knowledge Base
Semantic Reasoners

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

Linked Open Data
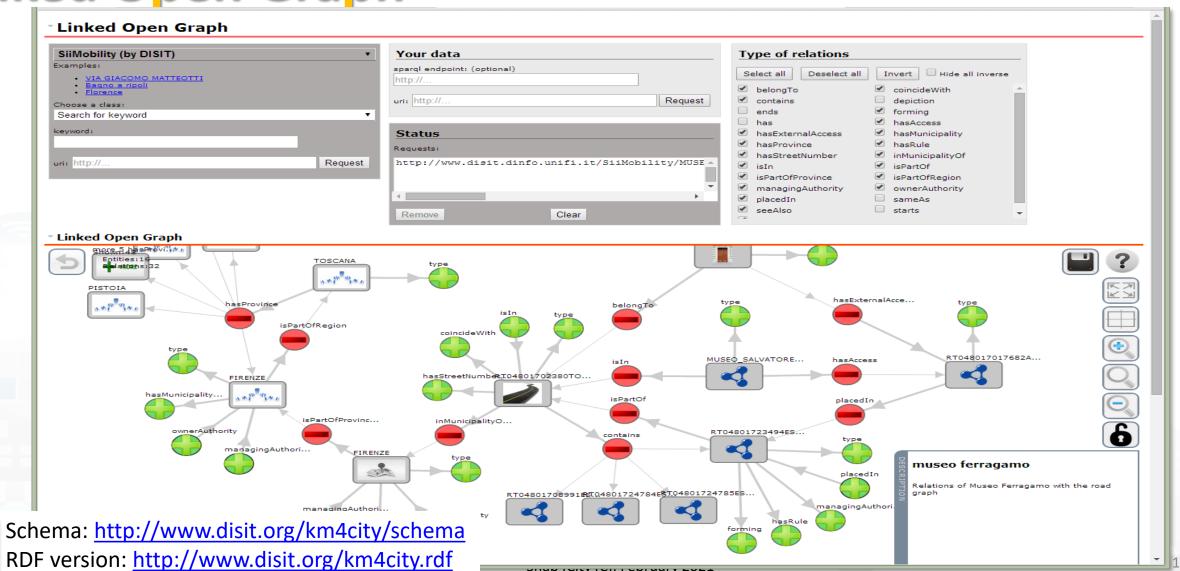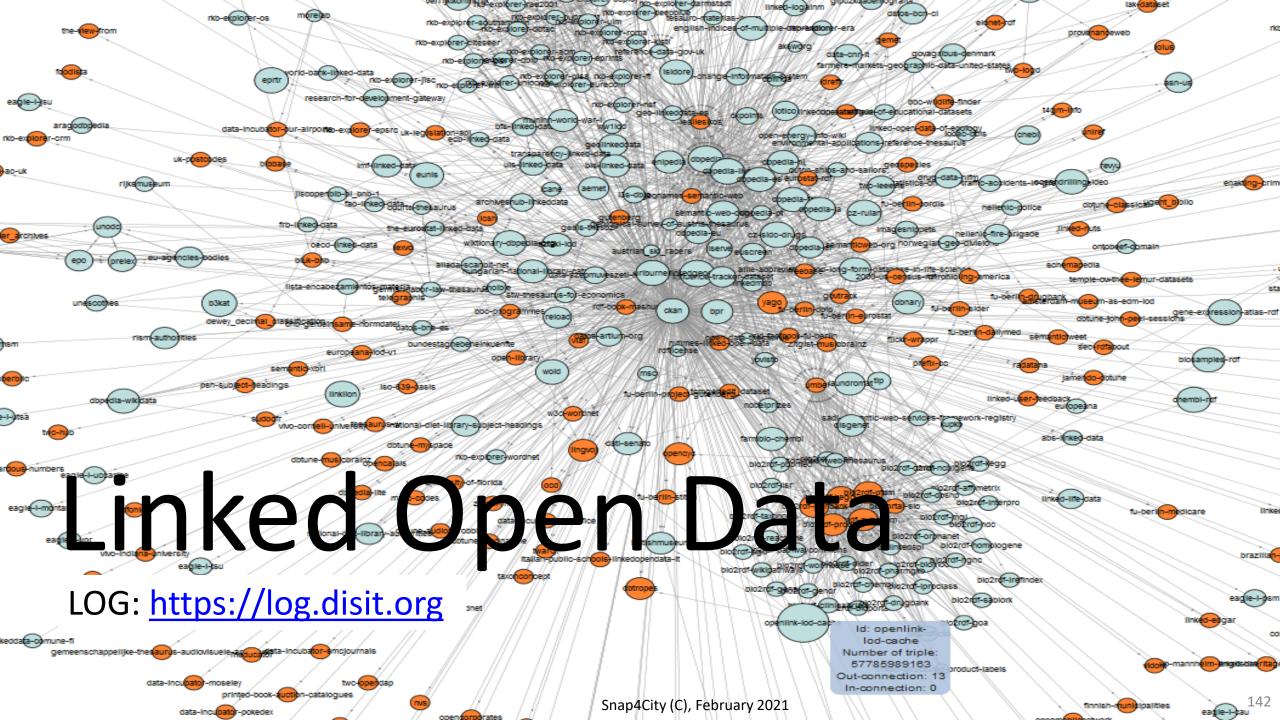
Linked Open Graph

LOG: https://log.disit.org

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

Linked Open Data

LOG: https://log.disit.org

TOP

How to Add on Features on Platform: capability and constraints

Adding new Features

- **Dashboard Features** --> Custom Widgets, Widgets
- **Connectors, adapters, IoT protocols, data transformations,** etc. --> by creating new MicroServices, new flows or new IoT Apps ...
- **Applications, Modules** --> for management, for verticals, in the core by using
- **IoT Devices** --> for collecting new data kind or acting on the field
- **Processes** --> Data Analytic of any kind, also exploiting machine learning, gpu, etc.
- **Web and Mobile Apps** --> new end-users services
- **Dashboards**
- **IoT Applications**
- **Data ingestion process**, integration, etc.
- **External Services** to be exploited on Dashboards
- etc. etc.

Adding new Features

- **Dashboard Features** --> Custom Widgets, Widgets
  - they can be created by using the Custom Widget SVG approach
    - TC1.22a: Create and configure a Snap4City SVG Custom Widget for real-time interaction
    - TC1.22b: Create and configure a Snap4City SVG Custom Widget for real-time interaction
    - Custom Widgets: Table explanation, as SVG
    - TC1.26: Use customised SVG pins in a map
    - TC9.19: Custom Widgets / Synoptics controlled by IOT Applications
  - they can be created by developing new elements programming in PHP, JavaScript, Angular, D3, etc..
    - Custom Synoptics and Widgets for Dashboards
- **connectors, adapters, IoT protocols, data transformations,** etc. --> by creating new MicroServices, new flows or new IoT Apps ...
  - https://www.snap4city.org/download/video/course2020/di/
  - HOW TO: Develop an IOT Application for Data Ingestion
  - they have to be in Node.JS, JavaScript according to Node-RED
    - Snap4City Supported Protocols, adding new protocols
    - how to create a flow and nodes in Node-red: https://nodered.org/docs/creating-nodes/first-node
  - They can be automatically created from API rest call
    - TC2.25. Registering external MicroService calling RestCall services, using it on IOT applications
  - business logic behind a dashboard
    - TC9.19: Custom Widgets / Synoptics controlled by IOT Applications

Adding new Features

- **Applications, Modules** --> for management, for verticals, in the core by using
  - any language you prefer, preferably exposing API for integration with other modules
    - https://www.km4city.org/swagger/external/index.html
    - https://www.km4city.org/swagger/internal/index.html
  - See Tutorial on how to transform any REST API in a MicroService
    - TC2.25. Registering external MicroService calling RestCall services, using it on IOT applications

- **IoT Devices** --> for collecting new data kind or acting on the field
  - HOW TO: add a device to the Platform
  - HOW TO: Manage IOT Network Components on Snap4City
  - you can add to the platform any kind of IoT Device, with any kind of IoT Protocol
  - You can exploit the open source for Android and raspberry for creating your safely connected IoT device with Snap4City using NGSI V1, V2 and exploiting our secure communication approach

https://www.snap4city.org/692

Adding new Features

- **Processes --> Data Analytic** of any kind, also exploiting machine learning, gpu, etc.
  - see tutorial on Data Analytics
  - https://www.snap4city.org/download/video/course2020/da/
- **Web and Mobile Apps** --> new end-users services
  - https://www.snap4city.org/download/video/course2020/app/
- **Dashboards: Dashboard Builder and Kibana**
  - https://www.snap4city.org/download/video/course2020/das/
- **IoT Applications in Node-RED**
  - https://www.snap4city.org/download/video/course2020/iot/
- **data ingestion process, integration, etc.**
  - https://www.snap4city.org/download/video/course2020/di/
- **External Services to be exploited on Dashboard**s
  - by simply registering their URLs on the portal
  - https://www.snap4city.org/55
- **Workflows**: via OpenMaint
  - TC 1.24 – Integrated Ticketing and Facility Management system
- **BIM models** via Bim Editor for IFC production → Bim Server
  - HOW To: Manage BMP and BIM: main features of openMAINT, BMP, BIM
- etc. etc.

Constraints

- **new version modules**
  - **to be integrated in the main version,** have to be tested and validated by DISIT Lab. They have to:
    - be in Affero GPL
    - do not affect the functionalities of other modules in negative manner
    - provide the needed quality, in terms of test cases, documentation, etc.
  - **If they are not part of the core**,
    - can be based on proprietary model, and exploit the Snap4City tools via APIs
      - **no constraints**
    - **but forked, they need to te** published version on Internet and linked to main according to **Affero GPL.**

- **Snap4City modules are mainly in Affero GPL**
  - **platform rebranding is not allowed**

Integrated command and control center
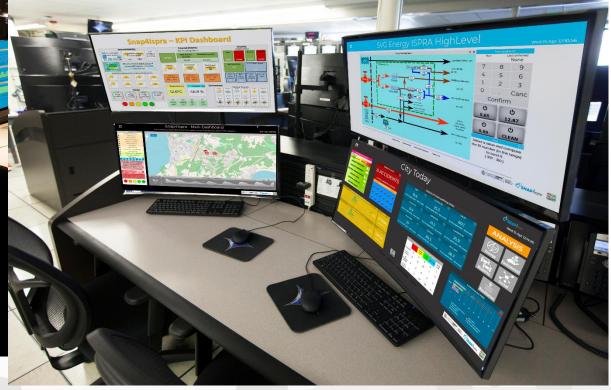
Chemical Plant Dashboard
Green Impact Capacity (GIC)
Altair Control room

Control Room

Video Wall

e.g. 3X3 (HD)
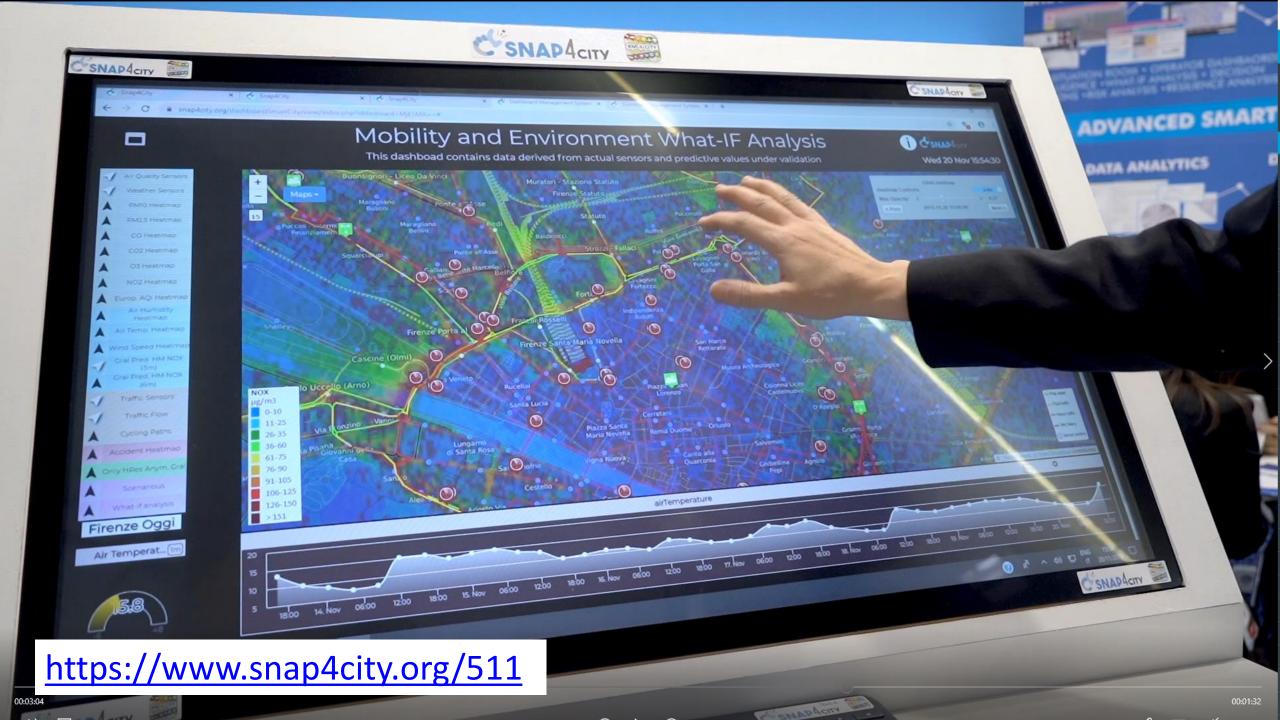
From Consolle Operator to the Video Wall

https://www.snap4city.org/511

SNAP4CITY | KM4CITY

TOP

DASHBOARDS in Snap4City
Kibana vs Snap4City DashBoard Builder

Two Main Lines for Dashboarding are present

- **Dashboard Builder of Snap4City**
  - For accessing and browsing data on: Elastic Search, Mongo, MySQL, Smart City API, Super and thus from federated Smart City API, etc.
  - Supports sensors/actuators: data driven data, maps in extended manner, data driven widgets, large collection of widgets, direct IoT Connections, custom widgets, animated PIN on maps, a large set of panel/widgets, etc.
  - Very simple to be used for control room, decision makers, situation rooms, operators, etc.
  - Very well integrated with IoT App, Custom widgets, animation, external services.
  - Very simple to be customized for non programmers since all the tools are visual.
  - Support for GDPR and deep control of access.
  - Can integrate Kibana/Grafana Views into a Widget
- **Kibana** (so called **DevDash**, **AMMA** and recently **My Dashboard (Dev) Kibana**), also accessible as Grafana
  - For accessing and browsing data on Elastic Search storage and other sources supported
  - No Support for real time event driven widgets/panels, actuators and synoptics, no sophisticated maps, etc.
  - Not simple for control room, decision makers, etc.
  - Not integrated with IoT App, Custom widgets, animation, external services.
  - Oriented to developers, complex production of custom views, etc.
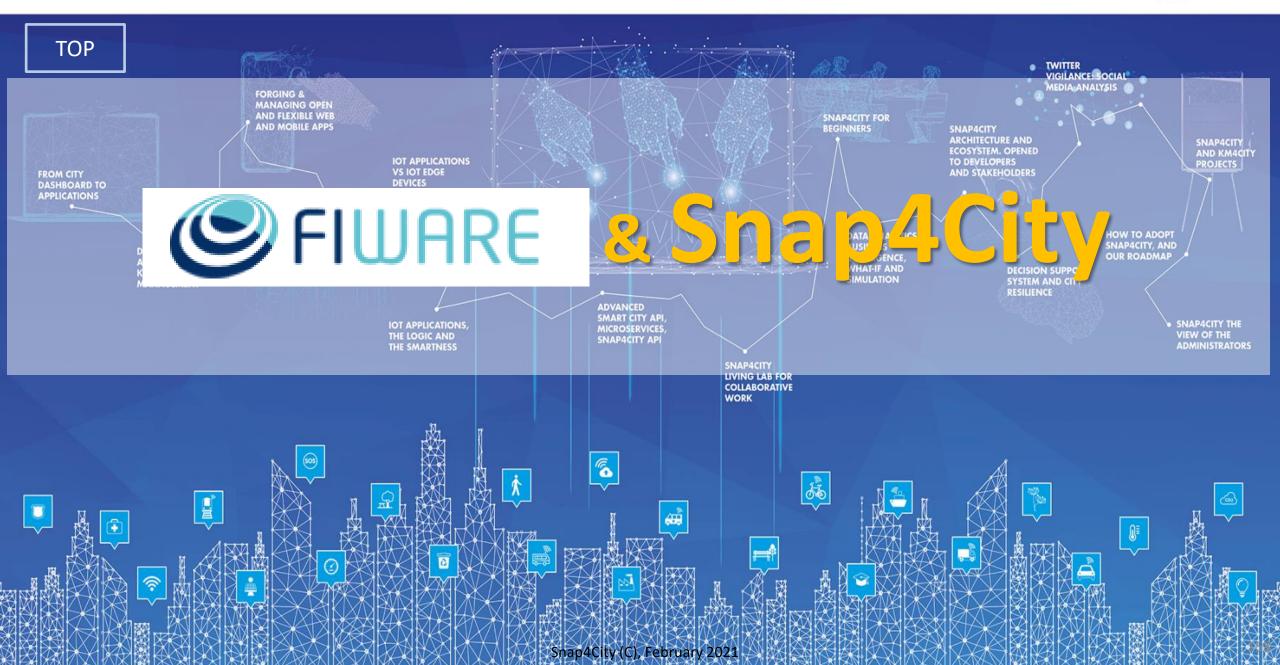 - Partial support of GDPR and deep control of access.

Snap4City Dashboard Builder vs Kibana

| Features	Snap4City Dashboard Builder	Kibana, Grafana
Large Collection of Widgets	YES	Nothing
Custom Widgets SVG of any kind	YES	Nothing
Real time event driven widgets and data	YES	Nothing
Business Logic for data transformation with visual programming	YES	Some coding
Maps with custom PIN, bubbles, animated and moving, etc.	YES	Nothing
Maps with paths, shapes, traffic flow, scenarios, routing, heatmaps, …	YES	Nothing
Maps with orthomaps from WFS, GIS connection, etc.	YES	Nothing
TV camera intergation and selection	YES	Nothing
Widgets for business logic integration on real time: buttons, selector, switch, etc.	YES	Nothing
Kiviat, Spider net	YES	Nothing
Typical Time Trends: day, week, …..	YES	Nothing
Time Trend Compare	YES	Nothing
Selectors/Menus: text, icons, etc.	YES	Nothing
Full control of graphic layout, font, colors, refresh per widget, etc.	YES	Nothing
Iframe integration of third party widgets and web pages, nesting dashboards	YES	Nothing
Connection among multiple Dashboards and Widgets	YES	Nothing
Synchronnization with Video Wall, and Operators Views	YES	Nothing
Multiseries, barlines, charts, pie, dunot, simple selectors, trends, multitrends, etc.	YES	Limited
Single content, string, html, any data, etc.	YES	Limited
Special widgets: Weather forecast, civil protection, road plates, Twitter, etc...	YES	Nothing
Faceted search	possible with selectors	YES

157
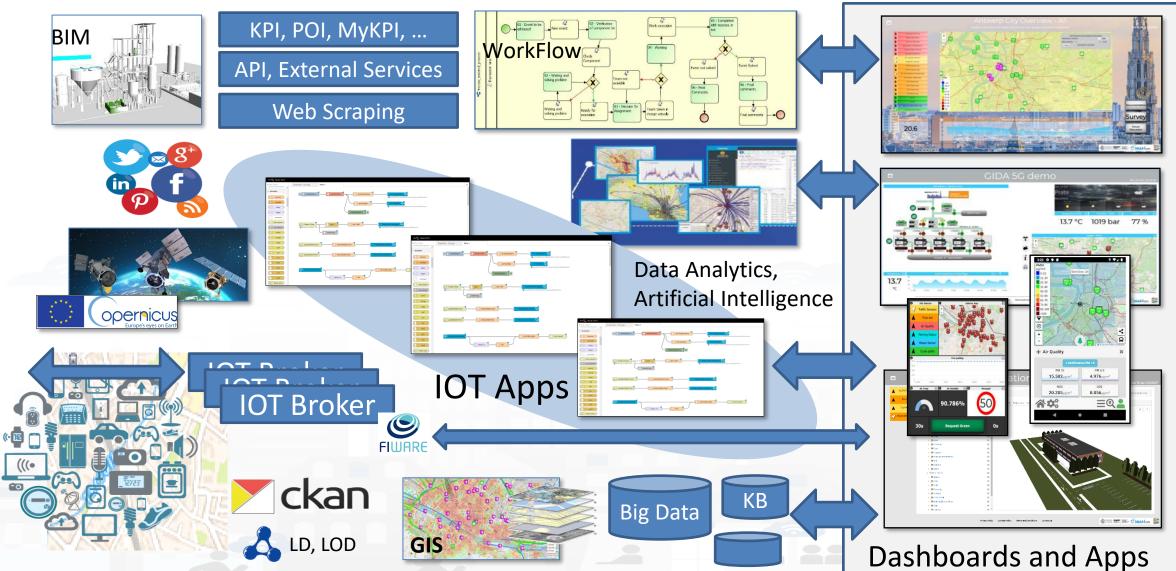
Concept
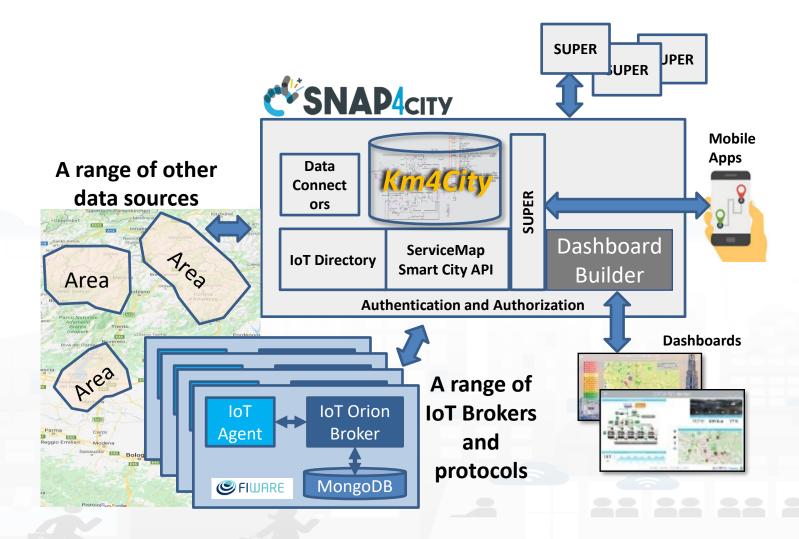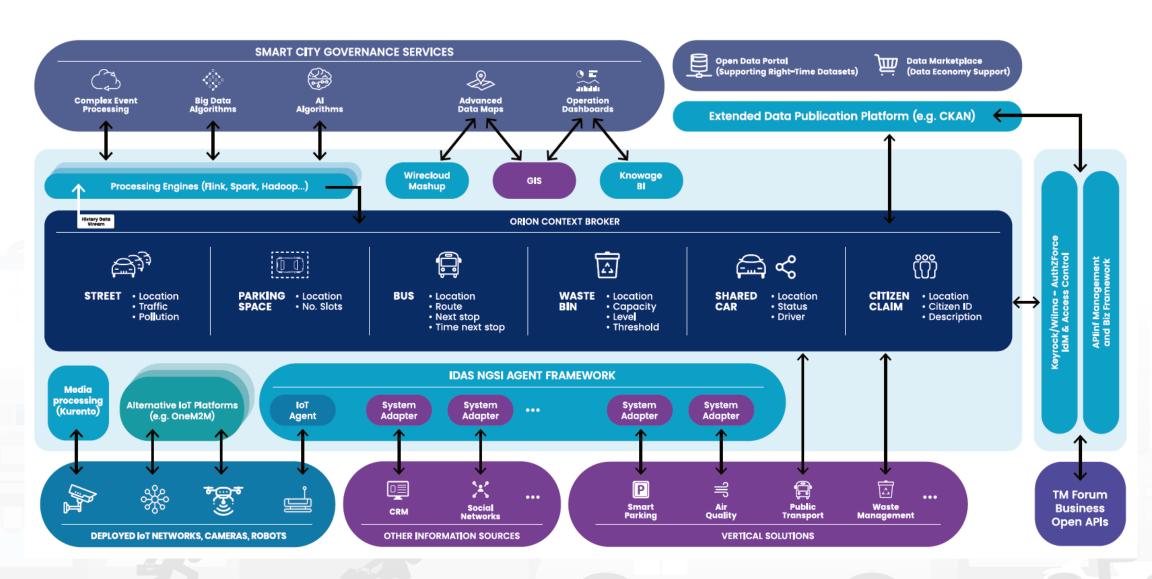
Snap4City IoT Registration and Access

Snap4City (C), February 2021

Federation of Snap4City vs IOT ORION Broker

The FIWARE Smart Cities Reference Architecture

FI-WARE

VS

SNAP4CITY

SMART CITIES REFERENCE ARCHITECTURE

- Is open to the Development of Applications leaving large space to developers
- Is centered on the Orion Broker that results central in the architecture: any Broker or data source is sending data to the Orion
- Data shadow for historical data with external data base as CrateDB on which you can attach Kibana
- **Security level** is based on TLS. User management partially demanded to developers
- Visual Flexible IOT processing is not clearly provided
- **Limited API** for smart city, API IOT data access mainly
- Limited data modelling for smart city, powerful on IoT
- **Knowage BI** presents several limitations in showing Smart City Data
- **Market place** on Open Data
- Support of Developers via Fi-Ware
- Deployed as VM and Dockers
- open source, not the applicative parts
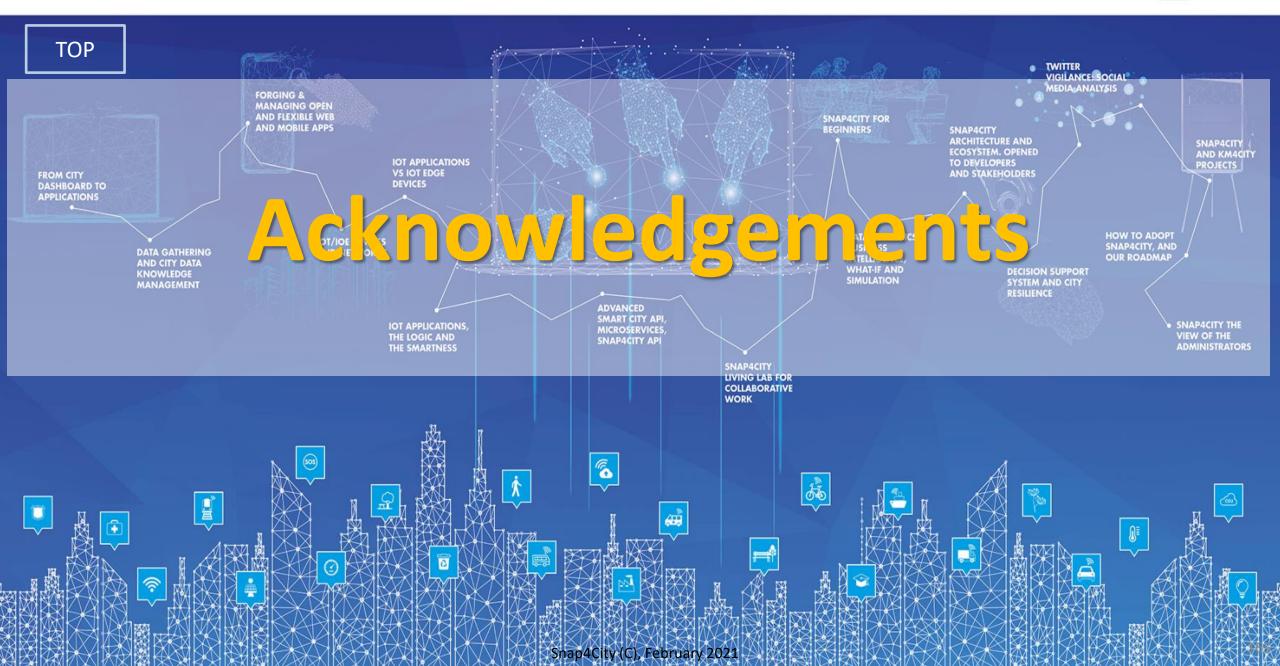
- Is open to the Development of Applications leaving large space and providing a **large set of ready to use applicative tools** and solutions to build their solutions on top or aside.
- Is fully distributed, **any kind of data source** can be ingested, automatically to form the Data Shadow.
- **Orion Broker is only one of the Brokers** that can be used. It can be also protected by Snap4City tech, with Mutual Authentication
- **Visual Flexible IOT processing is provided** as IOT App that is Node-RED plus Snap4City MicroServices suites
- **Advanced Smart City API** are provided on top of Knowledge Base
- **Dashboard Builder** has been designed for Smart City Data and automated dashboards' production
- **Storage** based on Elastic Search + Kibana or HBase/Phoenix
- **Market Place** for promoting, publishing and sharing Open Data, tools, processes, experiences
- Passed PEN test, GDPR compliant, **published security** on IEEE Access
- **Interoperable** with huge number of protocols and formats
- Full Support for **Living Lab** of the city, coworking, tutorials
- Fully support for **Multi-tenancy**
- Fully support **federation of smart cities, smart factories**
- Deployed as VM and Dockers, on cloud and on premise
- 100% open Source, including the management and applicative aspects
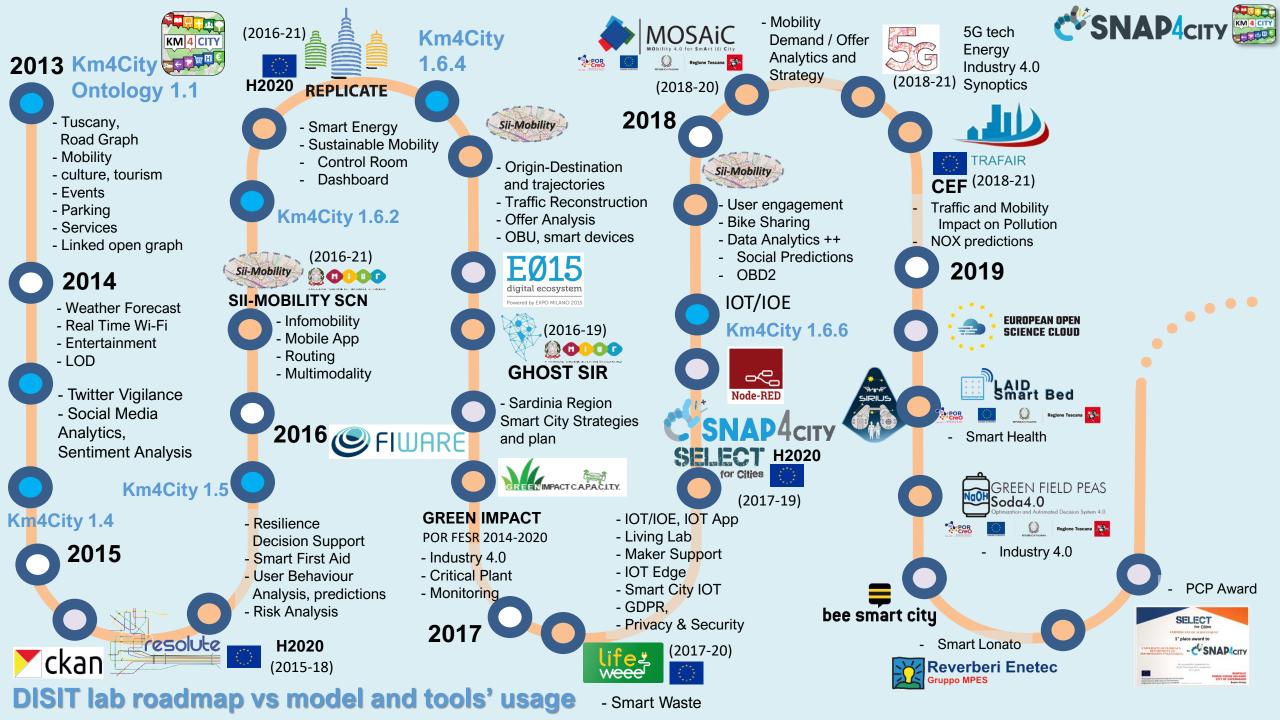
Installing Snap4City

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

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

TOP

Acknowledgements

DISIT lab roadmap vs model and tools' usage

2013 Km4City Ontology 1.1
- Tuscany, Road Graph
- Mobility
- culture, tourism
- Events
- Parking
- Services
- Linked open graph

2014
- Weather Forecast
- Real Time Wi-Fi
- Entertainment
- LOD
- Twitter Vigilance
- Social Media Analytics, Sentiment Analysis

Km4City 1.4
Km4City 1.5
2015

(2016-21)
H2020 REPLICATE
- Smart Energy
- Sustainable Mobility
- Control Room
- Dashboard

Km4City 1.6.2

(2016-21)
SII-MOBILITY SCN
- Infomobility
- Mobile App
- Routing
- Multimodality

2016 FIWARE

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

ckan resolute
H2020 (2015-18)

Km4City 1.6.4

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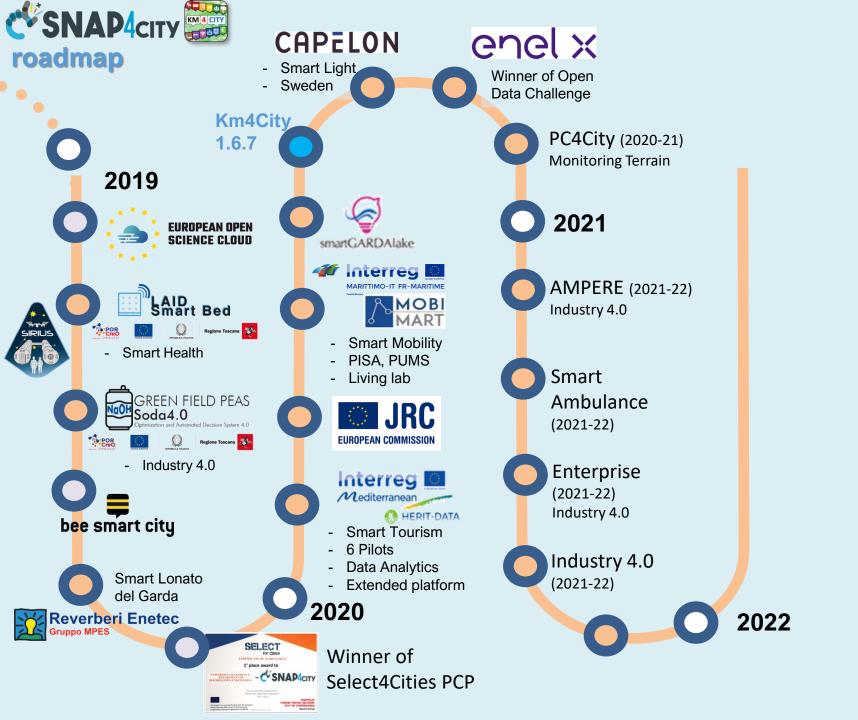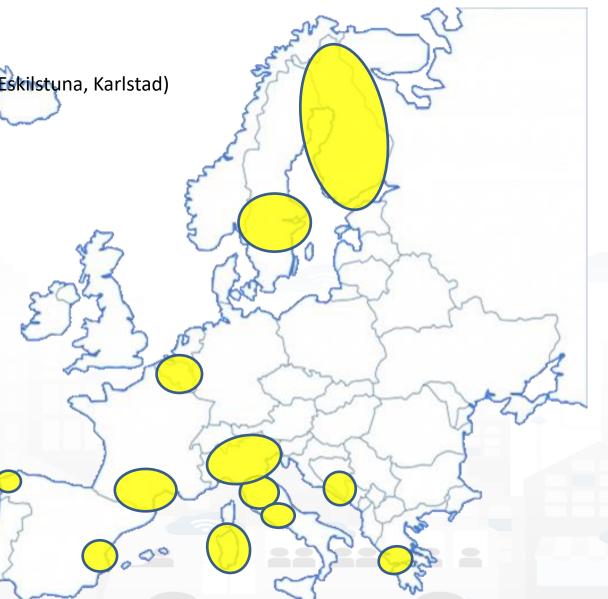- Offer Analysis
- OBU, smart devices

E015 digital ecosystem
Powered by EXPO MILANO 2015

(2016-19)
GHOST SIR
- Sardinia Region Smart City Strategies and plan

GREEN IMPACT C.A.P.A.C.I.T.Y.
GREEN IMPACT
POR FESR 2014-2020
- Industry 4.0
- Critical Plant
- Monitoring

2017
life weee (2017-20)
- Smart Waste

MOSAiC
MObility 4.0 for SmArt (i) City
POR CreO

2018

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

IOT/IOE
Km4City 1.6.6
Node-RED

SNAP4CITY
SELECT for Cities
H2020 (2017-19)

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

- Mobility Demand / Offer Analytics and Strategy

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

TRAFAIR CEF (2018-21)
- Traffic and Mobility Impact on Pollution
- NOX predictions

2019

EUROPEAN OPEN SCIENCE CLOUD

LAID Smart Bed
POR CreO
- Smart Health

SIRIUS

GREEN FIELD PEAS Soda4.0
NaOH Optimization and Automated Decision System 4.0
POR CreO
- Industry 4.0

bee smart city
- Smart Lonato
Reverberi Enetec Gruppo MPES

SELECT for Cities
1° place award to SNAP4CITY
- PCP Award

SNAP4CITY

SNAP4CITY roadmap

CAPELON
- Smart Light
- Sweden

enel x
Winner of Open Data Challenge

Km4City 1.6.7

2019

EUROPEAN OPEN SCIENCE CLOUD

SIRIUS

LAID Smart Bed
POR CreO · UNIONE EUROPEA · REPUBBLICA ITALIANA · Regione Toscana
- Smart Health

GREEN FIELD PEAS Soda4.0
Optimization and Automated Decision System 4.0
POR CreO · UNIONE EUROPEA · REPUBBLICA ITALIANA · Regione Toscana
- Industry 4.0

bee smart city

Smart Lonato del Garda

Reverberi Enetec
Gruppo MPES

smartGARDAlake

Interreg
MARITTIMO-IT FR-MARITIME
Fondo Europeo

MOBI MART
- Smart Mobility
- PISA, PUMS
- Living lab

JRC
EUROPEAN COMMISSION

Interreg Mediterranean
HERIT-DATA
- Smart Tourism
- 6 Pilots
- Data Analytics
- Extended platform

2020

SELECT for Cities
CERTIFICATE OF ACHIEVEMENT
1° place award to
SNAP4CITY
UNIVERSITY OF FLORENCE - DEPARTMENT OF INFORMATION ENGINEERING

Winner of Select4Cities PCP

PC4City (2020-21)
Monitoring Terrain

2021

AMPERE (2021-22)
Industry 4.0

Smart Ambulance (2021-22)

Enterprise (2021-22)
Industry 4.0

Industry 4.0 (2021-22)

2022

Coverage 2020

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)

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
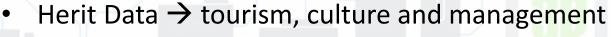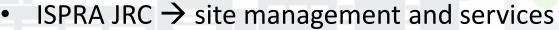
Acknowledgements

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Be smart in a SNAP!

SNAP4CITY KM4CITY

100% OPEN SOURCE

SNAP4 Appliances and Dockers **Installations**

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