SNAP4CITY

KM4CITY

Be smart in a SNAP!

Appliances and Dockers
SNAP4 Installations

100% OPEN SOURCE

EU GDPR COMPLIANT

PEN Test Passed

Powered by FIWARE

SNAP4CITY on EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE

Node-RED

LIVING LAB

13 April 2021

SMARTCOMMUNITIES CONFERENCE 2021

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

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

scalable Smart aNalytic APplication builder for sentient Cities: for Living Lab and co-working with Stakeholders

https://www.Snap4City.org

Powered by

13 April 2021

SMARTCOMMUNITIES CONFERENCE 2021

100% OPEN SOURCE

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
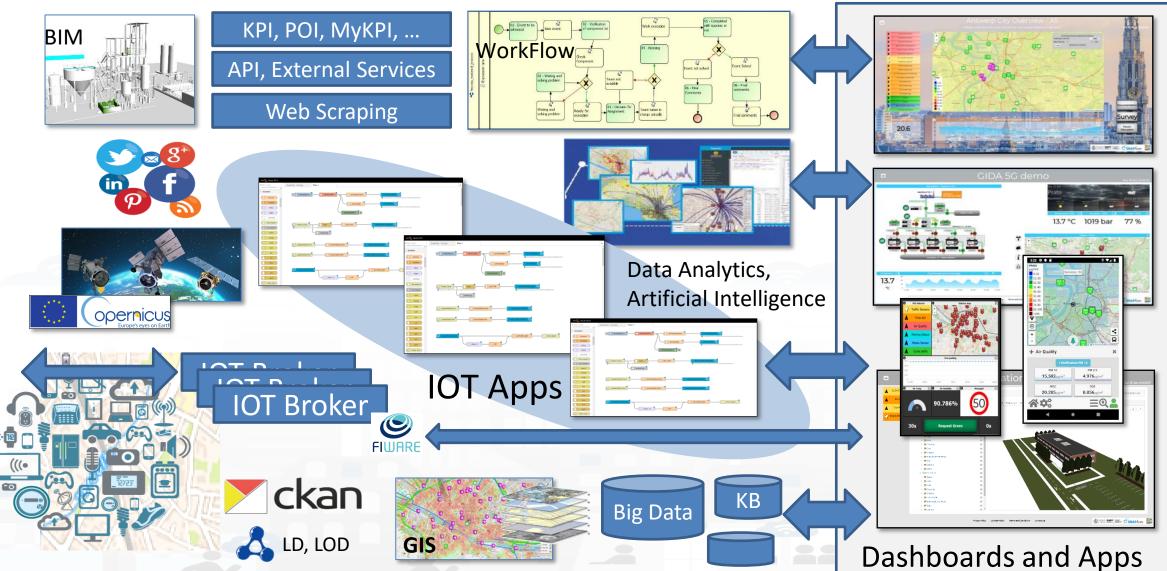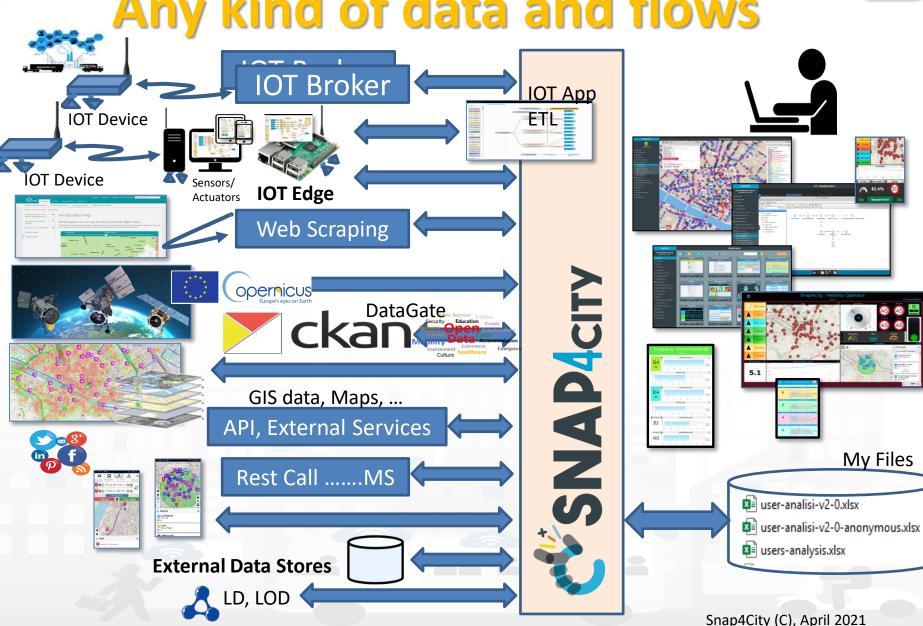COURSES AND COMMUNITY
LIVING LABS
DEVELOPMENT TOOLS

Powered by FIWARE

SNAP4 Appliances and Dockers Installations

FREE TRIAL

PEN Test Passed

EU GDPR COMPLIANT

100% OPEN SOURCE

www.snap4city.org

INDUSTRY4.0
CO_2
ENVIRONMENT
HEALTH
AGRICOLTURE
ENERGY
MOBILITY
WASTE
TRANSPORT
BUILDING
SECURITY
PARKING
CONTROL ROOM

Concept

BIM

KPI, POI, MyKPI, …

API, External Services

Web Scraping

WorkFlow

Data Analytics,
Artificial Intelligence

IOT Apps

IOT Broker

FIWARE

ckan

LD, LOD

GIS

Big Data

KB

Dashboards and Apps

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**
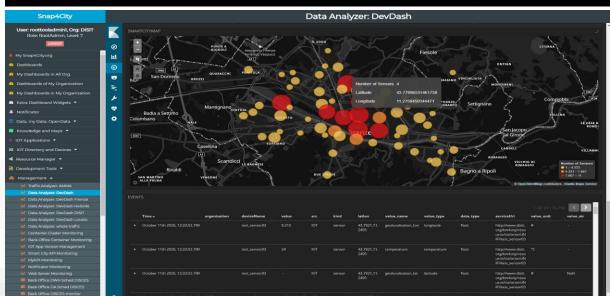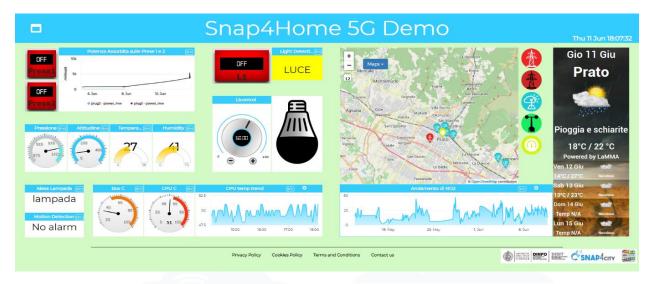 - GIS: WFS, WMS
  - ETL, IOT Application

Dashboards

BIM Server

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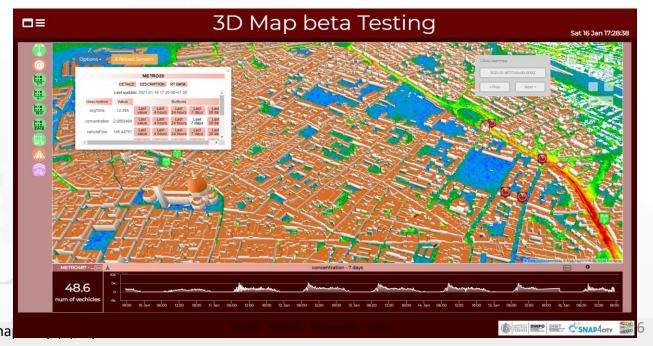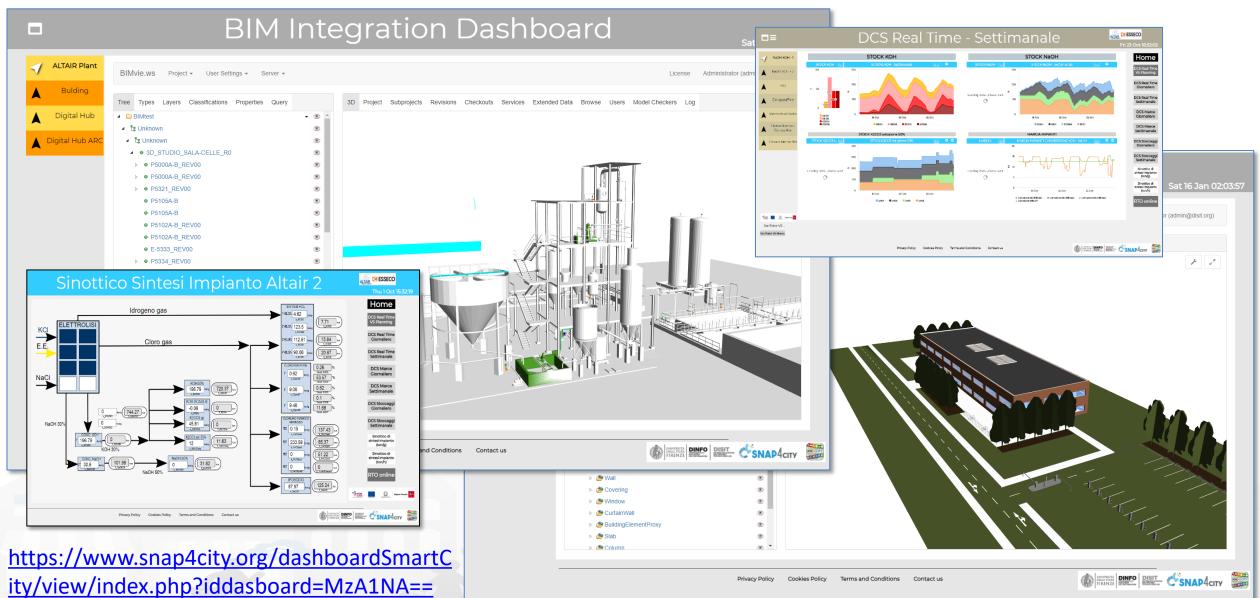
Florence

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:**
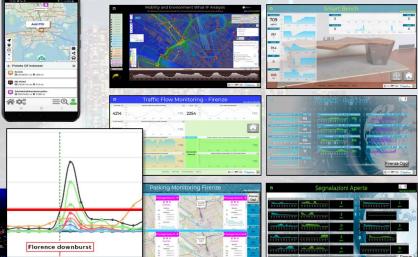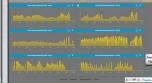 - Multiple Levels, Mobile Apps, API

- **Since 2017**
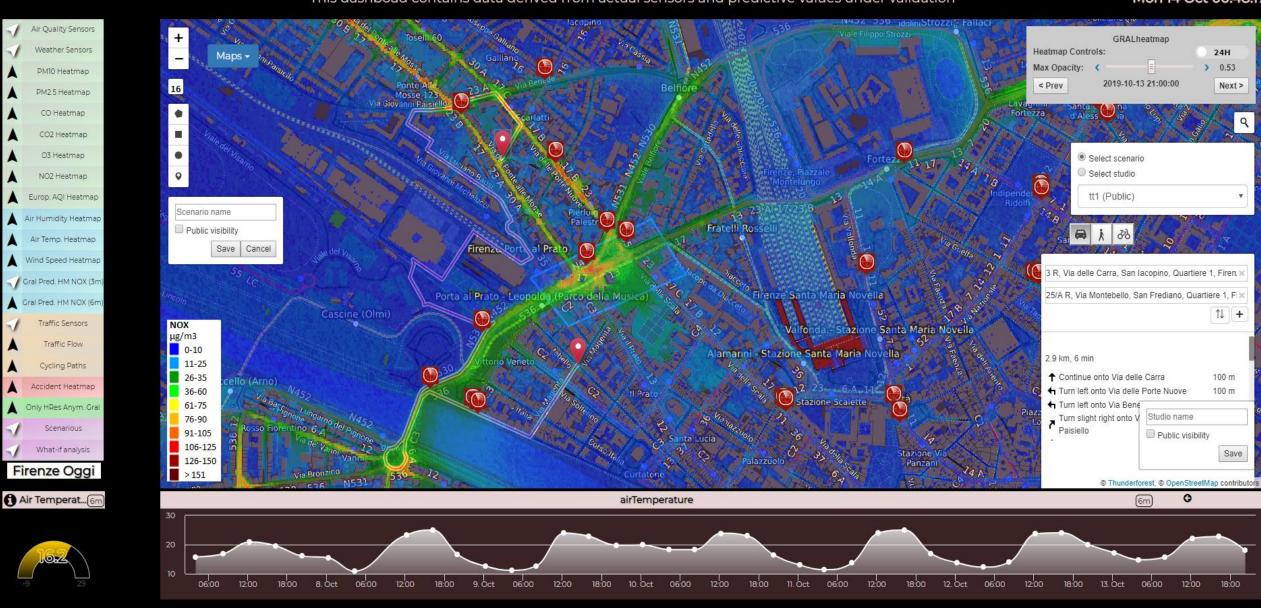
Mobility and Environment What-IF Analysis

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
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

GRALheatmap

Heatmap Controls: 24H
Max Opacity: <   > 0.53
< Prev   2019-10-13 21:00:00   Next >

○ Select scenario
○ Select studio

tt1 (Public)

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

Scenario name
☐ Public visibility
Save   Cancel

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

airTemperature   6m

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

Estimation of the mean waiting time at bus stops

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

Mobility and Transport Traffic Flow Analysis

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**
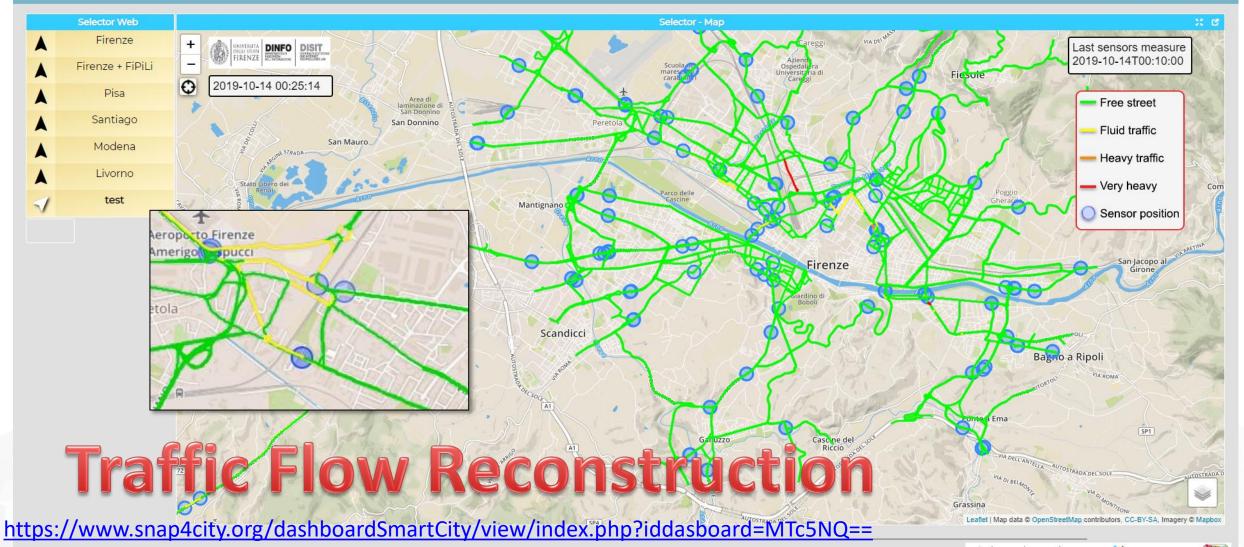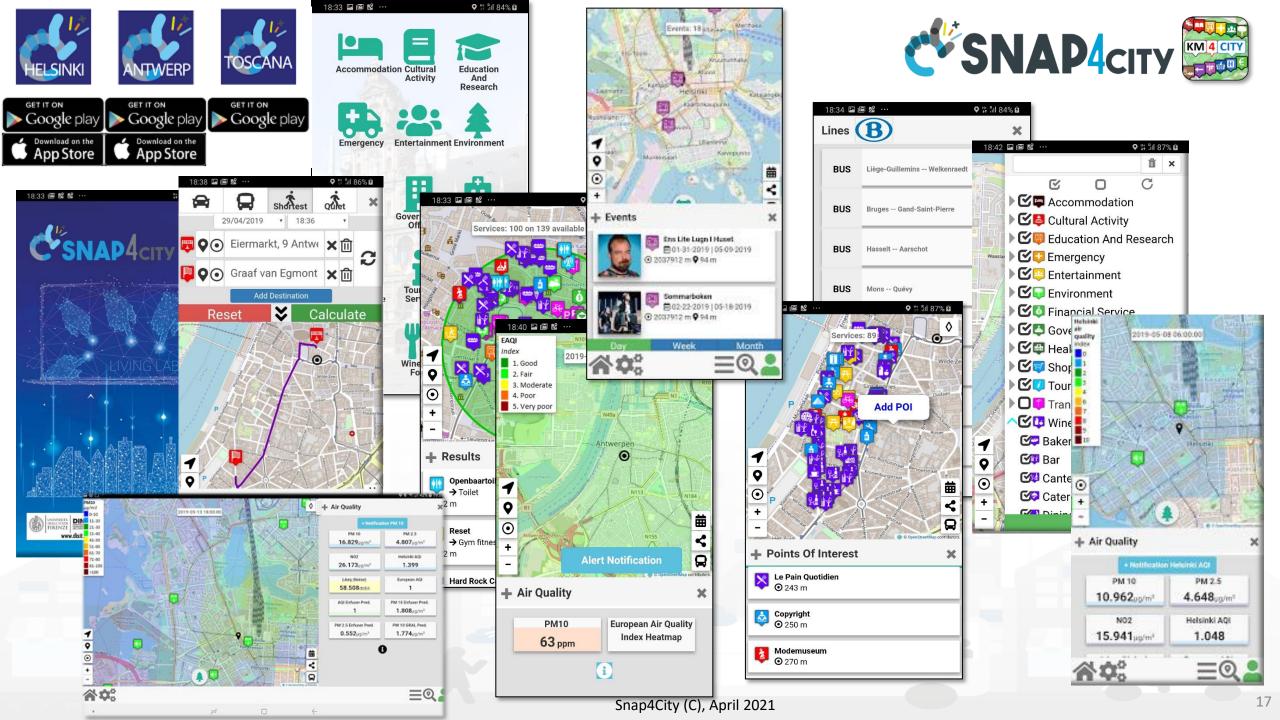
Traffic Flow Reconstruction for the cities

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc5NQ==
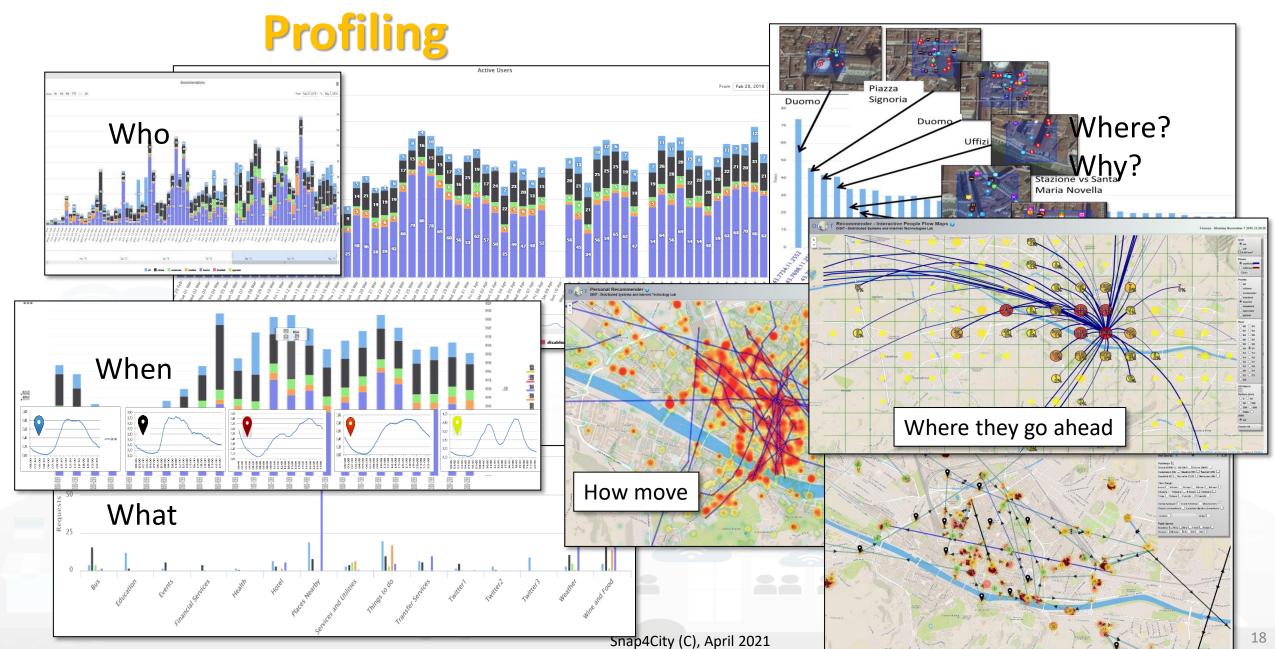
User Behavior Analyser for Collective Profiling

Who

Where?
Why?

When

What

How move

Where they go ahead

Campaing on Sustainable Mobility

Snap4City (C), April

Environment and Quality of Life
Air Quality Predictions

SNAP4CITY

KM4CITY

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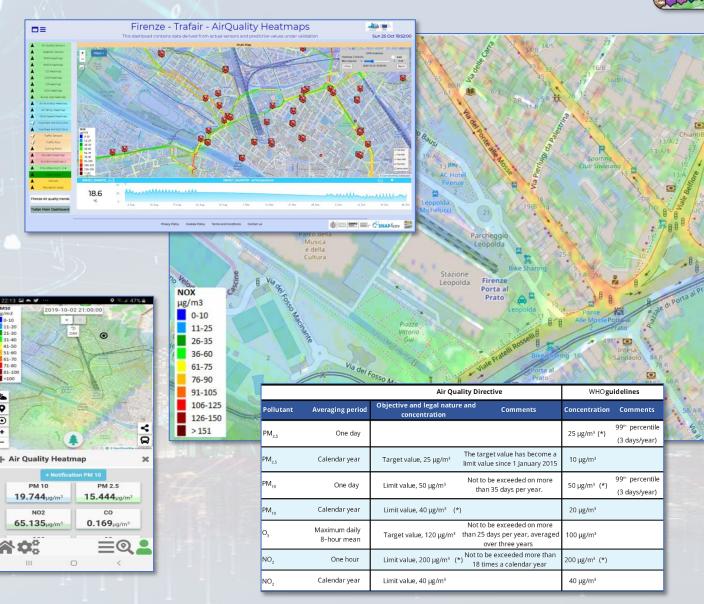
- **Services Exploited on:**
  - Dashboards, Mobile App

- **Since 2020**

		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	

Impact of COVID-19

- **Multiple Domain Data**
  - Traffic, environment, People, parking, stock options, Twitter, tc.
- **Decision Makers Multiple Locations**
  - NO2 predictions
  - Twitter analysis
- **Historical and Real Time data**
- **Services Exploited on:**
  - Dashboards
  - Social media,
  - Sentiment Analysis
- **Since 2019, 2020**
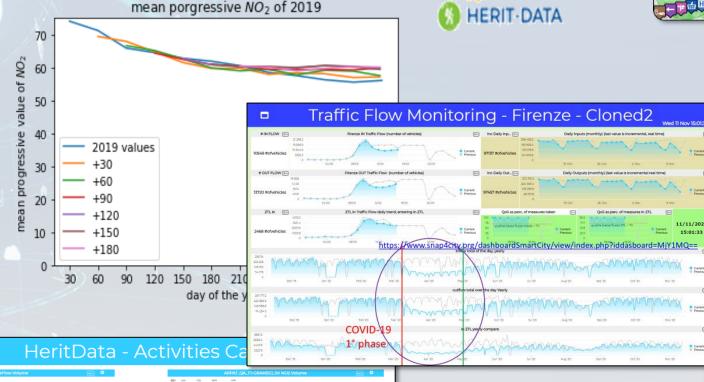
mean porgressive NO_2 of 2019

Legend: 2019 values, +30, +60, +90, +120, +150, +180

Traffic Flow Monitoring - Firenze - Cloned2

COVID-19 1° phase

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

HeritData - Activities Ca...

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
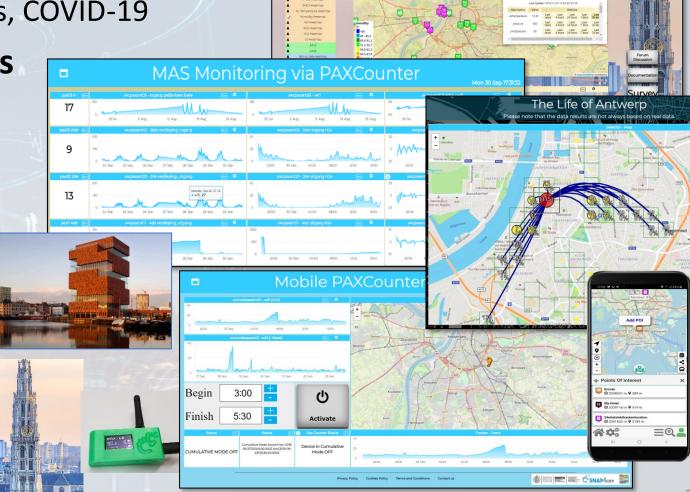
People Monitoring on Pub Services DIGIPOLIS Antwerp

- **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**

ALTAIR CHIMICA

ESSECO

Altair Chemical (I)

Snap4Altair Decision Support supervision and control, Industry 4.0

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

- **Multiple Levels & Decision Makers**

- **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**

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

- **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**

Dubrovnik
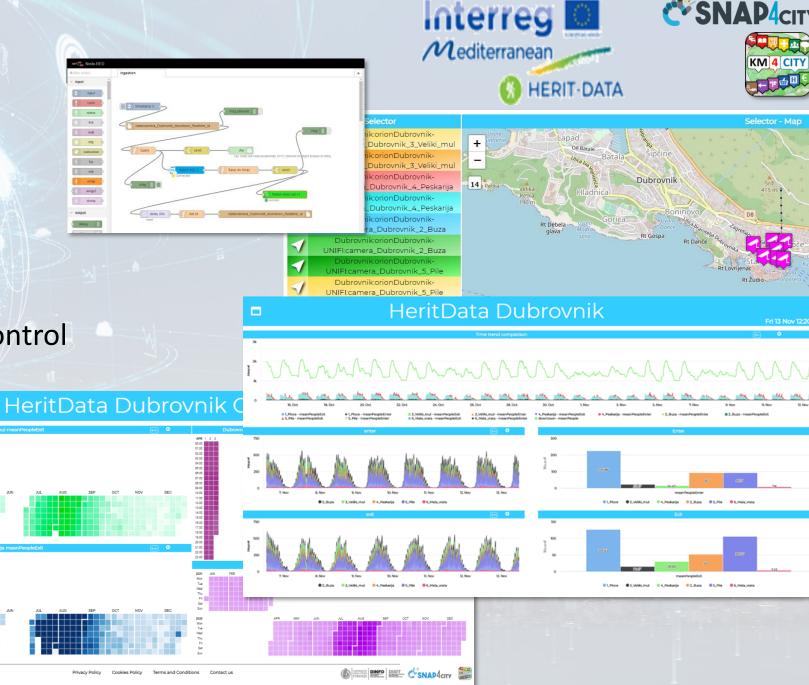
Dubrovnik

- **Tourism Domain**
  - Counting People

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

- **Tech:**
  - Snap4City
  - Twitter Vigilance
  - Historical and Real Time data

- **Since 2020**

Interreg Mediterranean
HERIT-DATA

Valencia

Valencia, FSMLR

- **Tourism Domain**
  - Counting People
  - Environmental data

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

- **Tech:**
  - Snap4City
  - Twitter Vigilance
  - Historical and Real Time data

- **Since 2020**

Santiago di Compostela
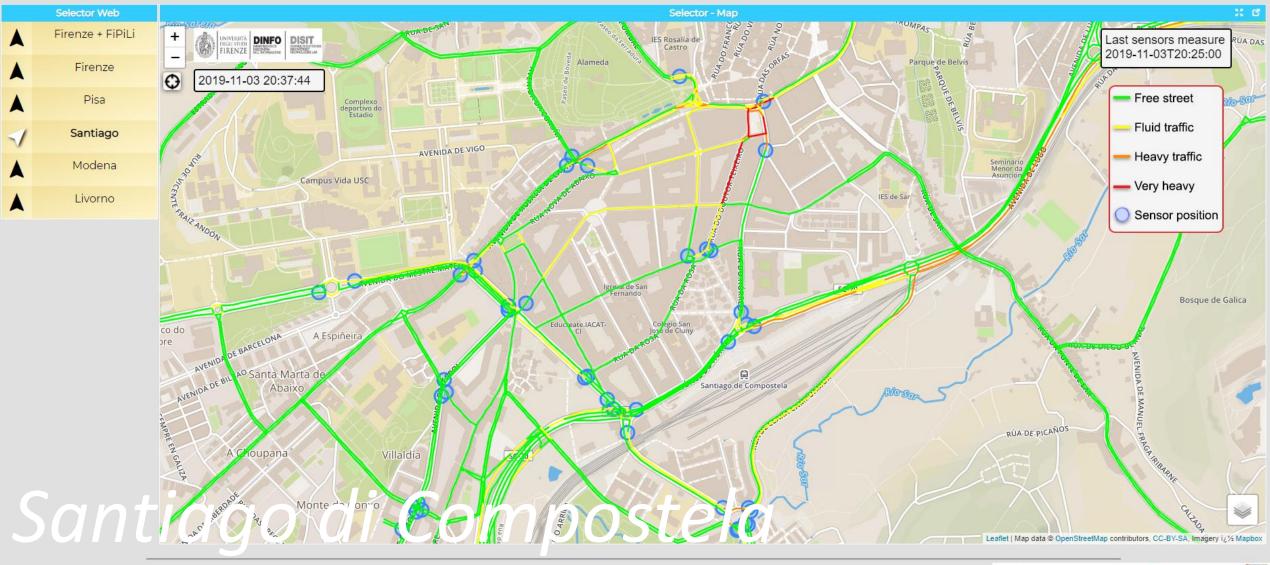
Traffic Flow Reconstruction for the cities

Sun 3 Nov 20:37:43

Santiago di Compostela

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==
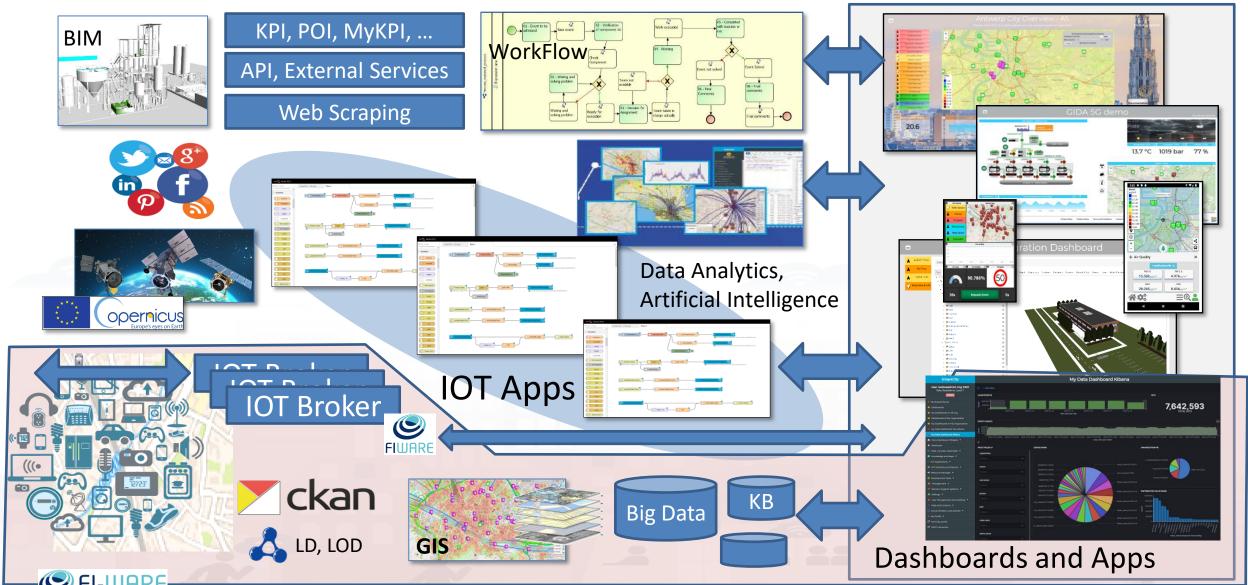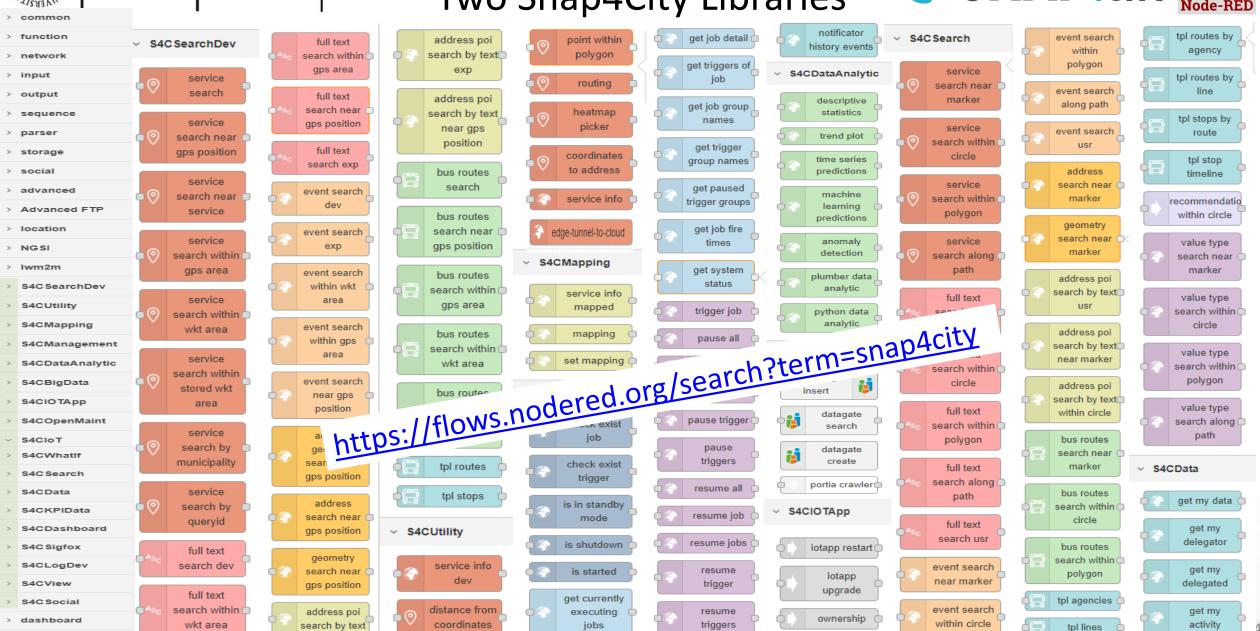
https://www.snap4city.org/4

Concept

WorkFlow

Data Analytics,
Artificial Intelligence

IOT Apps

IOT Broker

Dashboards and Apps

BIM

KPI, POI, MyKPI, …

API, External Services

Web Scraping

LD, LOD

GIS

Big Data

KB

April 2021 collection
Two Snap4City Libraries

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

April 2021 collection
Two Snap4City Libraries

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

We suggest also to install:

AND: From Resource Manager

Snap4City (C), April 2021

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, …

One Snap4City Platform may serve Multiple Cities

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

Collaborative Platform

Community Building

City Operators
agreements
collaborations
networking
Resource Operators
Inhouse companies
tutorials
subscription to applications
documentation
Tech providers
City Users
personal services
workshops
Category Associations
experiments
Advertisers
hackathons
Help desk
Corporations
events
Large Industries
Licensing, Gold services
partnerships
Case Studies
Research groups
Early Adopters
Start-ups

	Antwerp					Helsinki								Where				
	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	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	X			OSM
Routing: pedestrian quite			X	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	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	Snap4City Mobile App
Hot Places in Smart Zone	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					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		PAX Counters

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

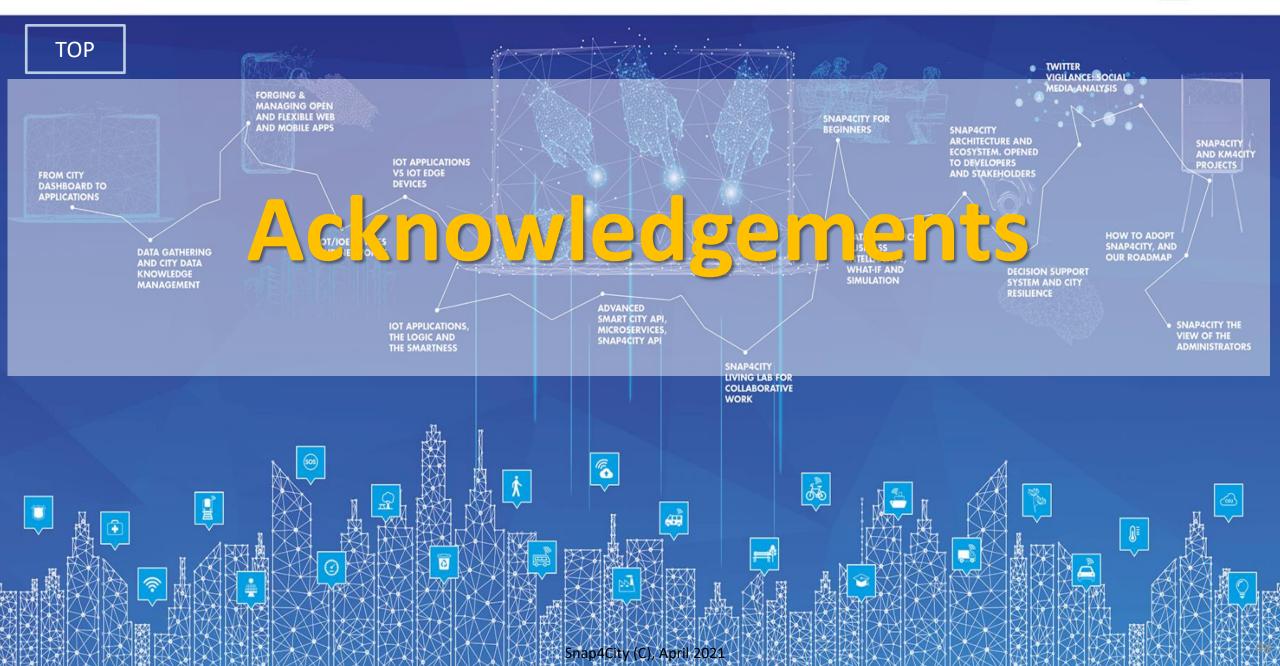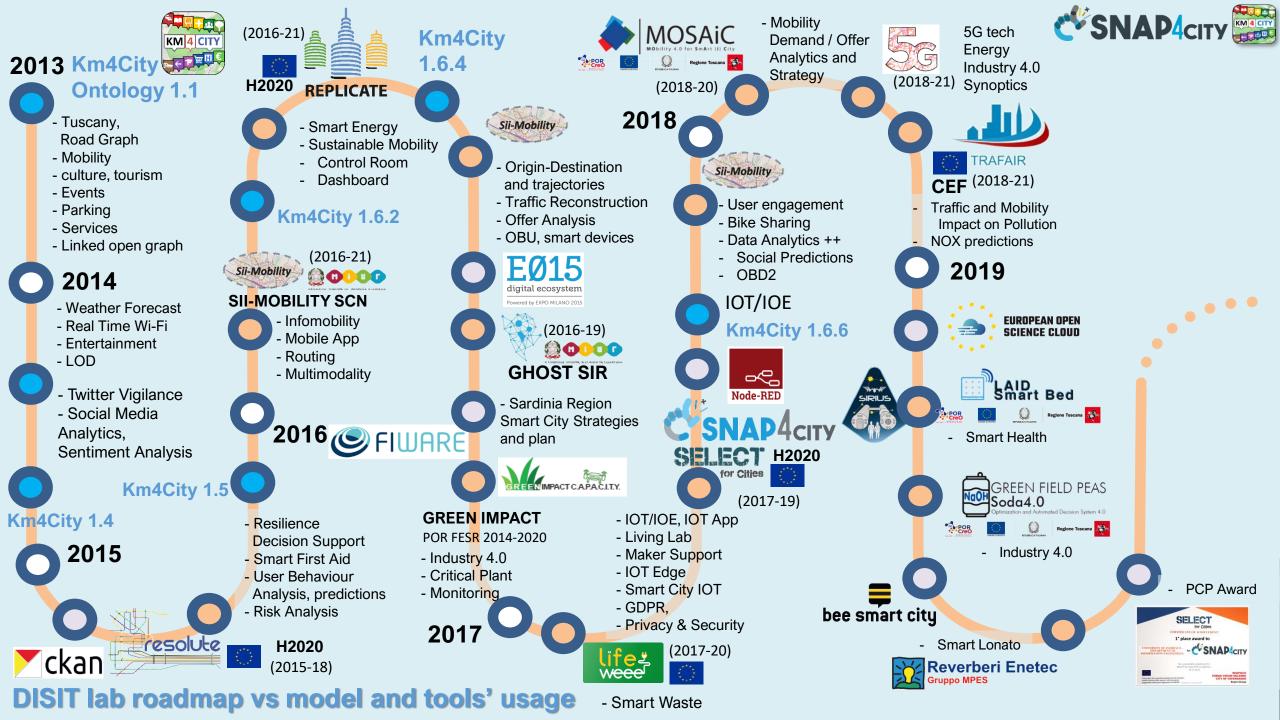- Snap4City - Powered by [FIWARE](#) Solution:
  - [https://marketplace.fiware.org/pages/solutions/b8905e91973b420189cce972](#)
    - NGSI V1, V2 The IOT Orion Broker
    - IOT Orion Broker can connect JSON, MQTT, Lightweight M2M, LoraWAN, OPC, SigFOX, etc. see FiWare [Https://www.fiware.org](#)
- Snap4City - [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](#)
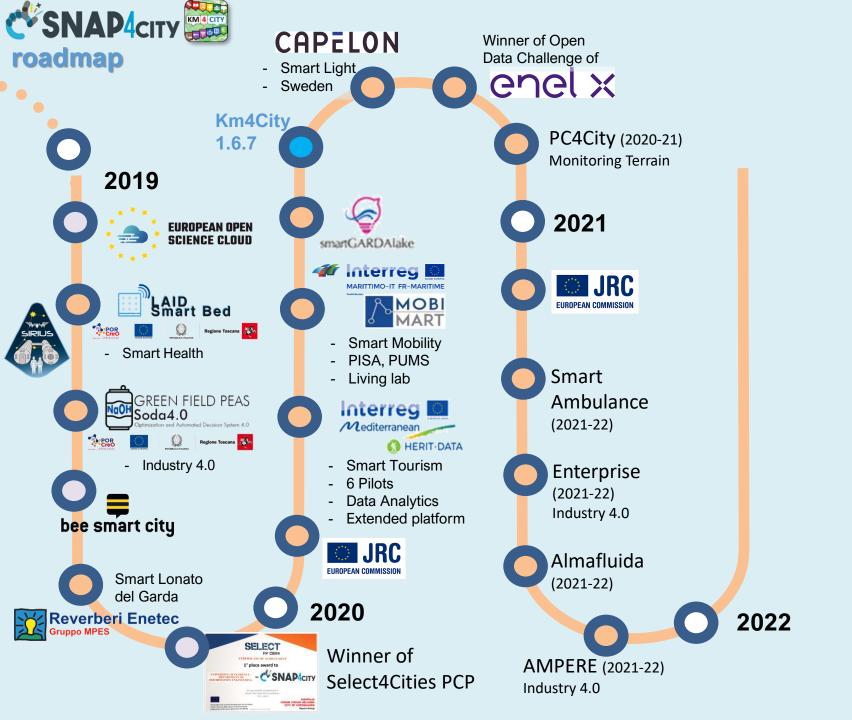
SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

TOP

Acknowledgements

2013 Km4City Ontology 1.1

KM4CITY

- 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 1.5

Km4City 1.4

2015

ckan   resolute   **H2020** (2015-18)

(2016-21)
H2020 REPLICATE

Km4City 1.6.4

- Smart Energy
- Sustainable Mobility
- Control Room
- Dashboard

Km4City 1.6.2

Sii-Mobility (2016-21)

SII-MOBILITY SCN
- Infomobility
- Mobile App
- Routing
- Multimodality

2016 FIWARE

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

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   UNIONE EUROPEA   REPUBBLICA ITALIANA   Regione Toscana
(2018-20)

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 tech Energy Industry 4.0 Synoptics
(2018-21)

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

2019

EUROPEAN OPEN SCIENCE CLOUD

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

SIRIUS

bee smart city
- Smart Lonato

Reverberi Enetec Gruppo MPES

SELECT for Cities
1° place award to SNAP4CITY

- PCP Award

SNAP4CITY KM4CITY

DISIT lab roadmap vs model and tools' usage

SNAP4CITY roadmap

CAPELON
- Smart Light
- Sweden

Winner of Open Data Challenge of
enel X

Km4City 1.6.7

PC4City (2020-21)
Monitoring Terrain

2019

EUROPEAN OPEN SCIENCE CLOUD

2021

JRC EUROPEAN COMMISSION

SIRIUS

LAID Smart Bed
- Smart Health

smartGARDAlake

Interreg MARITTIMO-IT FR-MARITIME
MOBIMART
- Smart Mobility
- PISA, PUMS
- Living lab

Smart Ambulance
(2021-22)

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

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

Enterprise
(2021-22)
Industry 4.0

bee smart city

JRC EUROPEAN COMMISSION

Almafluida
(2021-22)

Smart Lonato del Garda

Reverberi Enetec
Gruppo MPES

2020

SELECT for Cities
CERTIFICATE OF ACHIEVEMENT
1° place award to
SNAP4CITY

Winner of Select4Cities PCP

AMPERE (2021-22)
Industry 4.0

2022

Acknowledgements

TOP

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Be smart in a SNAP!

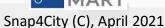100% OPEN SOURCE

SNAP4 Appliances and Dockers **Installations**

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