100% OPEN SOURCE

EU GDPR COMPLIANT

PEN Test Passed

SNAP4CITY on EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE

SNAP4 Appliances and Dockers Installations

SNAP4CITY

LIVING LAB

KM4CITY

Be smart in a SNAP!

CdLM in Advanced Design
Classe di corso: LM 12
a.a. 2019-20
Dipartimento di Architettura
Università di Bologna

Smart cities Lighthouse Projects + focus su REPLICATE

21 Aprile 2020

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO | DISIT

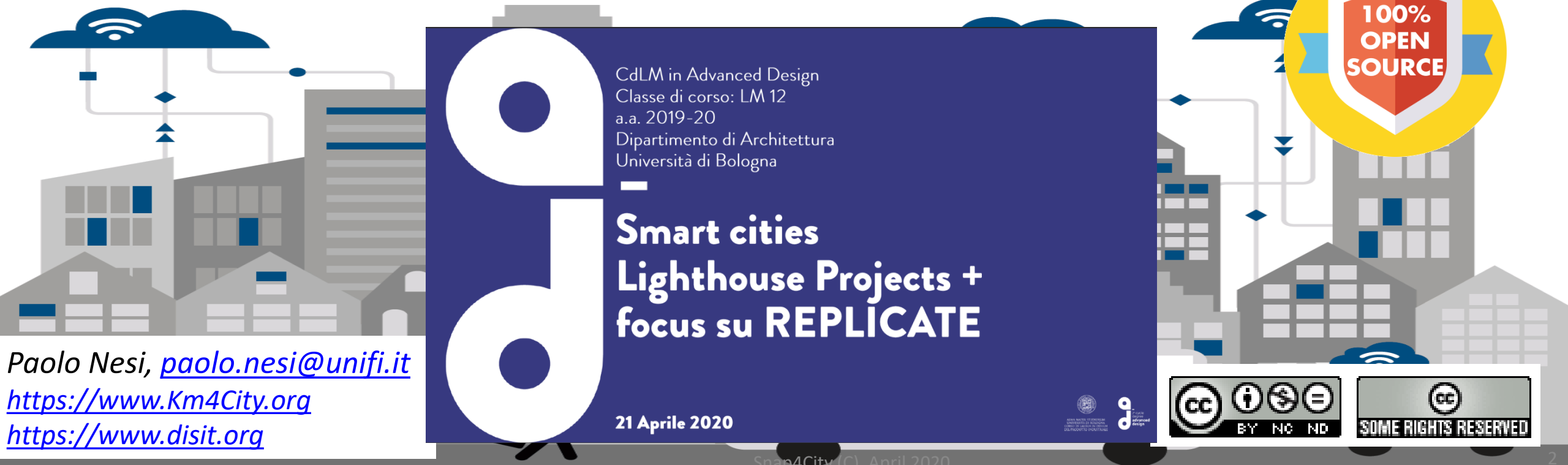
UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

SNAP4CITY

Powered by KM4CITY

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

https://www.Snap4City.org



100% OPEN SOURCE

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

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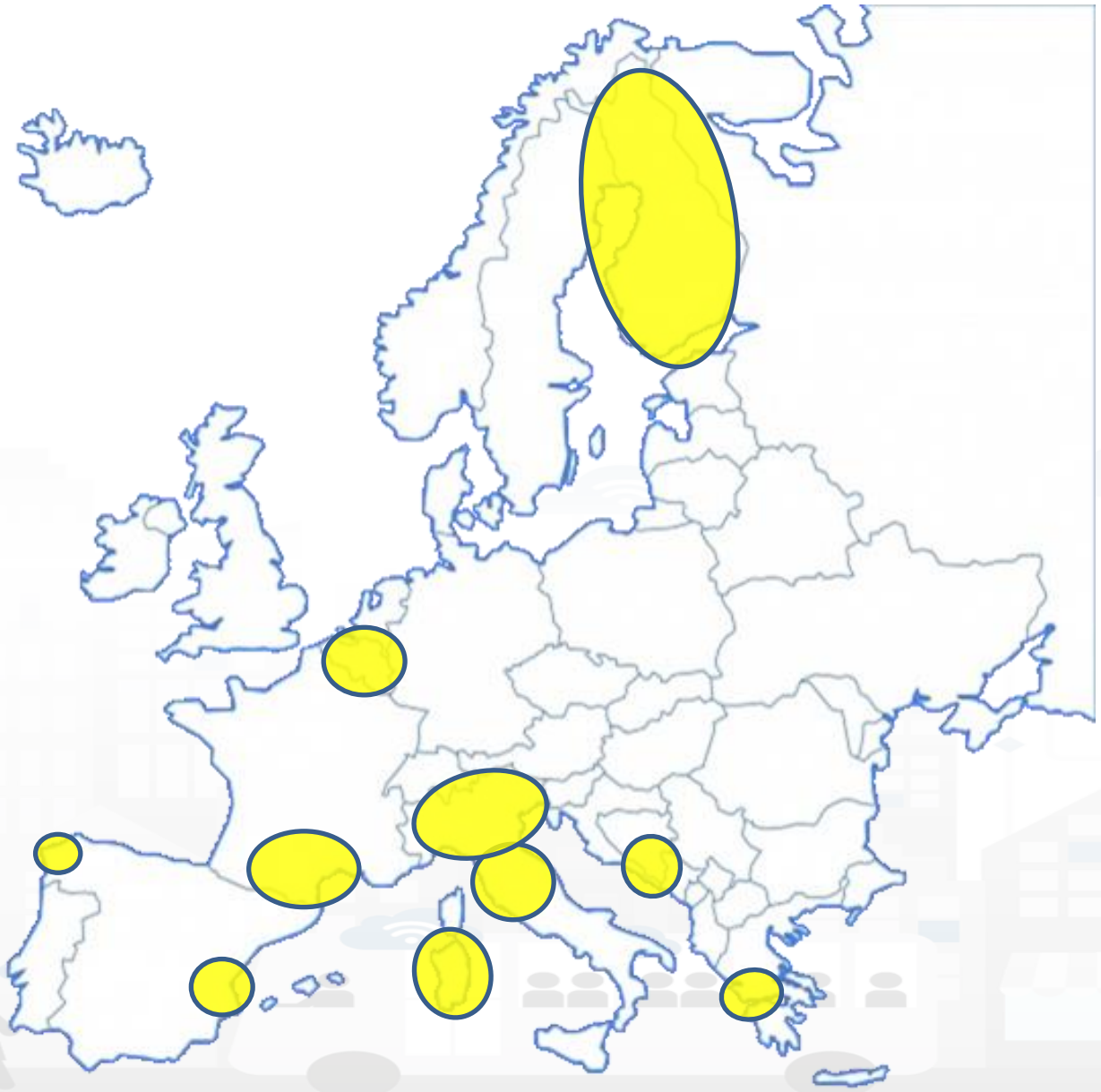
Coverage 2020

Organizations/areas

- Antwerp area (Be)
- DISIT demo (multiple)
- Dubrovnik, Croatia
- Firenze area (I)
- Garda Lake area (I)
- Helsinki area (Fin)
- Lonato del Garda (I)
- Mostar, Bosnia-Herzegovina
- Pisa area (I)
- Pont du Nord, Occitanie (Fr)
- Santiago de Compostela (S)
- Sardegna Region (I)
- SmartBed (multiple)
- Toscana region (I)
- Valencia (S)
- WestGreece area (Gr)



https://www.snap4city.org/577

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

City Today
0 ACCIDENTS
KPI Dashboard

Snap4Ispra – KPI Dashboard
SVG Energy ISPRA HighLevel
City Today
0 ACCIDENTS
ANALYSIS

TOP

Overview

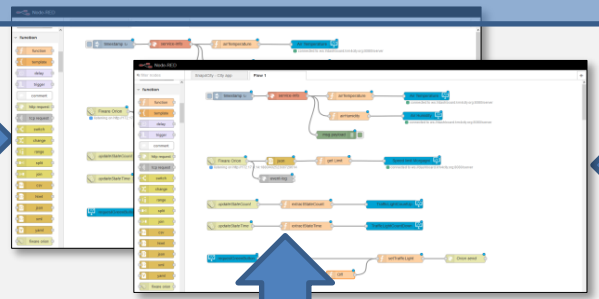
Scalable Sentient Cities Builder

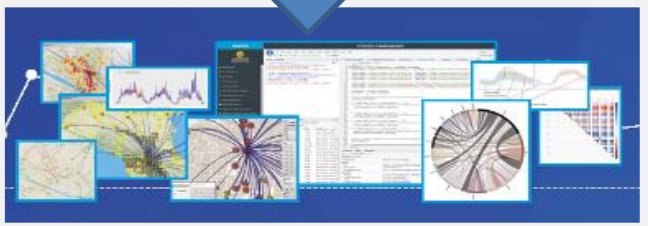
Snap4City: Builder of Sentient Cities Solutions

Dashboards with data driven IOT Applications enforcing intelligence

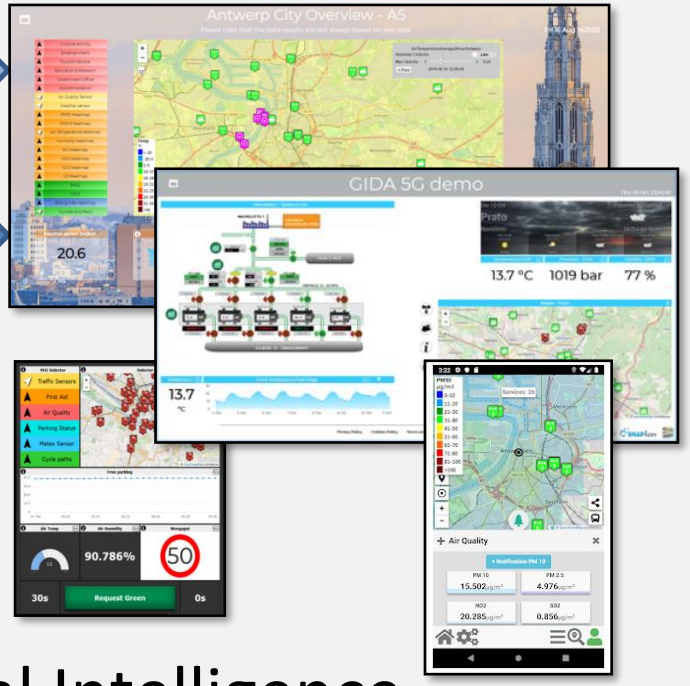
IOT and data World

IOT Applications





Dashboards and Apps



Big Data Analytics, Artificial Intelligence

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

100% OPEN SOURCE

APPLIANCES CONTAINERS

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

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

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

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

IOT APPLICATIONS - INSTANT APPS

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

DASHBOARDS & APPLICATIONS

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

MOBILE & WEB APPLICATIONS

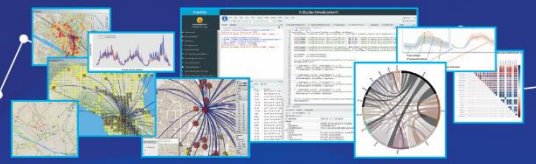
DEVELOPMENT KIT • SUGGESTIONS • MOBILE APPS • MONITORING PANELS • PLATFORM UTILITIES • READY TO USE SMART APPLICATIONS

MICROSERVICES & ADVANCED SMART CITY API

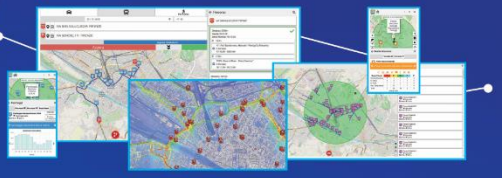
LIVING LAB - DEV TOOLS - COWORKING

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

BIG DATA - DATA ANALYTICS



DATA ANALYTICS TOOLS - MICRO-APPLICATIONS



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

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

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

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

Florence

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

Firenze Oggi 2019

Fri 25 Oct 23:29:38

43666
Totale utenti WIFI

COLONNINE RICARICA
176 INSTALLATE
71 % ATTIVE
5.1 % IN USO

GENERAL | METEO

MINIMO	BASSO	MEDIO	ALTO

RISCHIO IDRAULICO
RISCHIO TEMPORALI
RISCHIO IDROGEOLOGICO
RISCHIO NEVE
RISCHIO GHIACCIO
RISCHIO VENTO

SITUAZIONE VIABILITA
0 INCIDENTI
0 CHIUSURE AL TRAFFICO (TOT)
0 CHIUSURE PER CANTIERI
0 PROGR. | 0 NON PROG.
0 LIMITAZIONI AL TRAFFICO (TOT)
0 LIMITAZIONI PER CANTIERI
0 NON PROG. | 0 PROGR.
0 TOT. EVENTI SULLA RETE

SMN	BINARIO16	FORTEZZA
28.7 % occupati su 607 posti	55.2 % occupati su 165 posti	27.8 % occupati su 521 posti
LEOPOLDA	**CALZA**	**S.AMBROGIO**
36 % occupati su 300 posti	70.3 % occupati su 148	99.7 % occupati su 379 posti
PARTERRE	**CAREGGI**	**BECCARIA**
34 % occupati su 656 posti	24.9 % occupati su 406 posti	98.1 % occupati su 210 posti

ANALYSIS
Energy | Environment | Mobility | Social | Resilience

FLUSSI INGRESSO CITTA
26 393.2 / 19 794.9 / 13 196.6 / 6598.3 / 0
12:00
Current / Previous

TOTALE
284094
VEICOLI

FLUSSI INGRESSO ZTL
5522 / 4141.5 / 2761 / 1380.5 / 0
12:00
Current / Previous

TOTALE ZTL
57499
VEICOLI

Nati Italiani	Nati stranieri	Deceduti	Matrimoni	Unioni Civili
163 ultimo mese consolidato	49 ultimo mese	395 ultimo mese	19 ultimi 7 giorni	0 ultimi 7 giorni

Segnalazioni ricevute in attesa	In Lavorazione	Risolte	Chiuse senza risoluzion...
1116 ultimo mese	524	305	285

Manutenzioni Stradali	Verde Pubbli...	Decoro Urbano	Relitti
54 oggi	4	6	3

Attesa media alla fermata

Linea 6	Linea 13
3 min	13 min
Linea 17	**Linea 23**
4 min	5 min
Linea 31	**Linea 36**
19 min	2 min

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

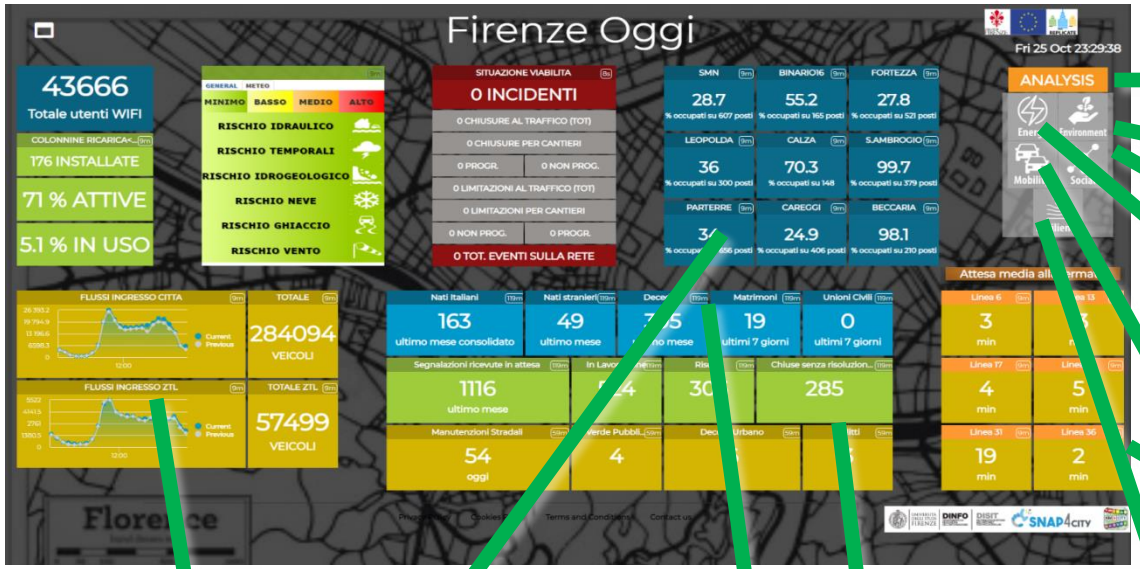
Smart City Control Room

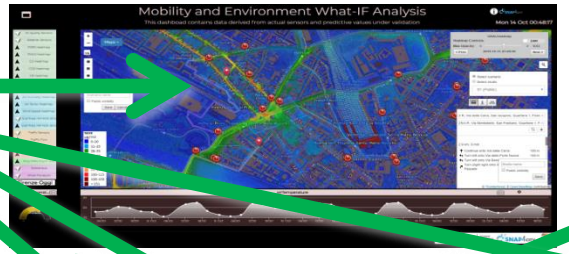
a set of dashboards and tools

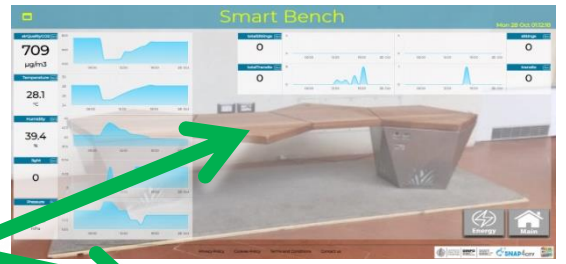
This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement Nº 691735

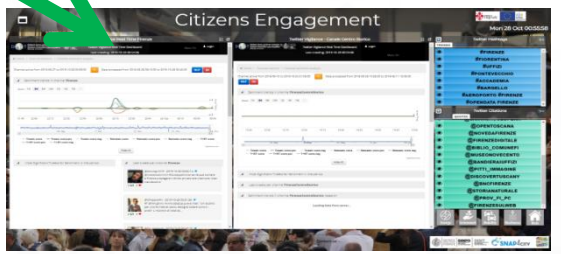
REPLICATE

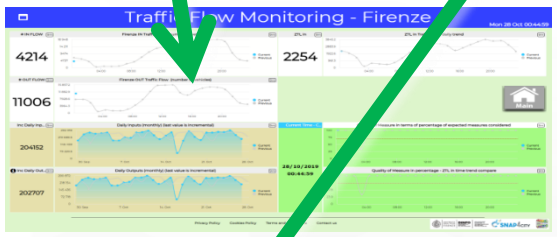
FIRENZE CITTÀ FARO

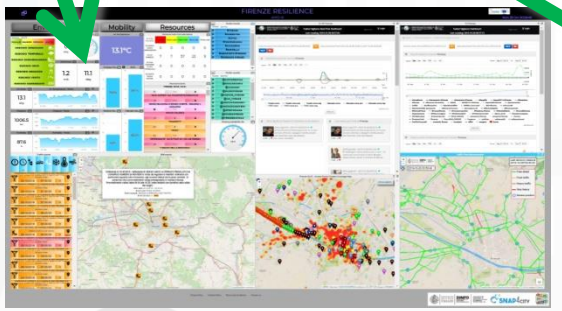


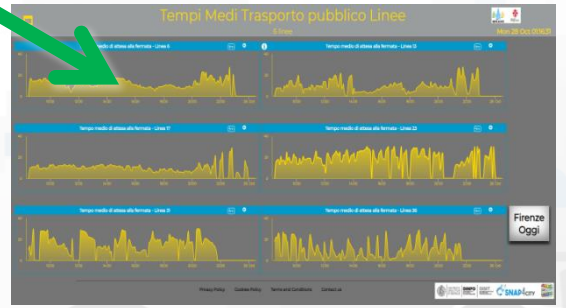












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SNAP4CITY

KM 4 CITY

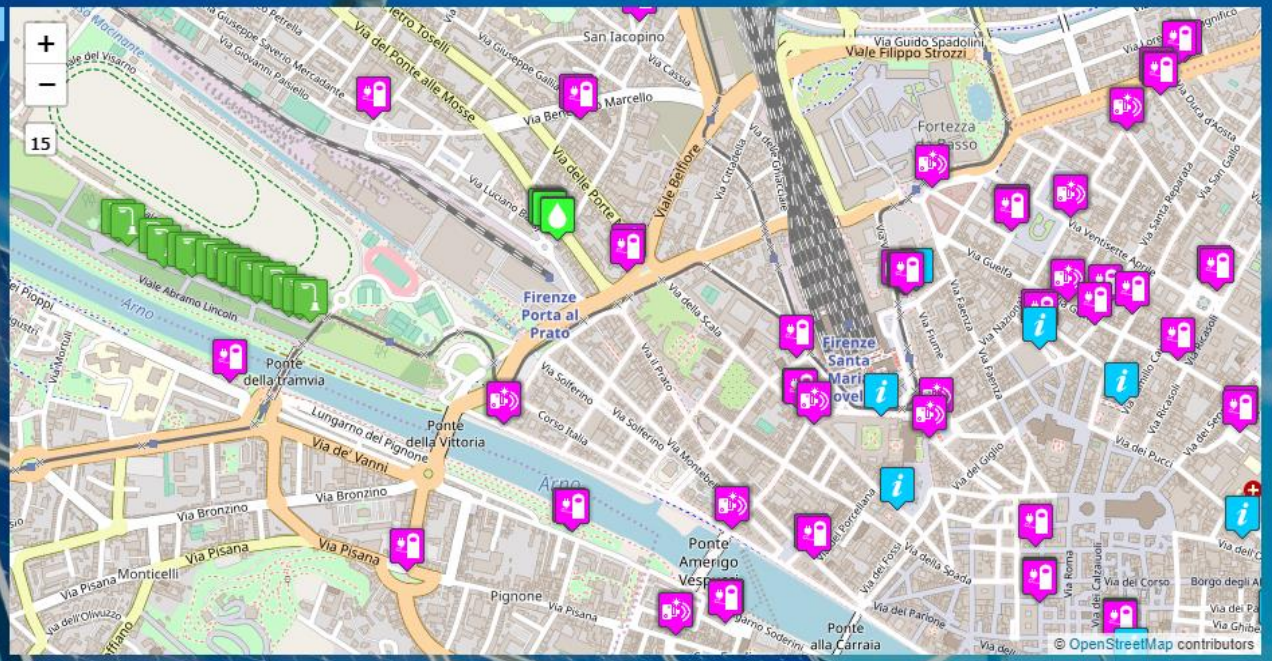
- Energy -

Sun 3 Nov 22:44:41

Environment | Mobility | Social | Resilience | Main

Selector - Click the icon

- Fast recharging stations
- Normal recharging stations
- ZTL gate
- Smart waste
- Florence WiFi POI
- Digital Signage
- Smart Irrigator
- Smart Light
- Smart Bench



Real time ac... 9m — 89.6%

Accumulator... 9m — 100%

Accumulator... 9m — 67.7%

N. of App Users 9m

12 users

Energy consumption vi... 9m

278821 kWh

Smart Info consumption for 30 PODs

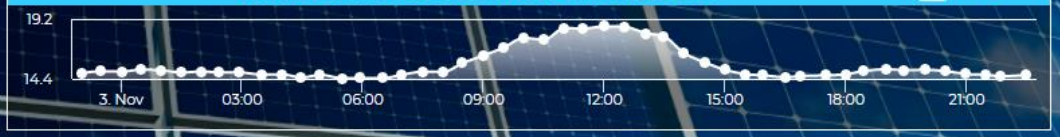
Monthly cumulative consumption 9m

258.8 Kw/h

PODs Percentage 9m

100 %

tusc_weather_sensor_ow_3176959 - airTemperature 9m



Fast Recharging Stations - Average Weekly consumption

Piazza Giorgini 9m	Via Venosta 9m	Via del Cavallaccio 9m
21.1 Kw/h	32.6 Kw/h	16.8 Kw/h
Viale Guidoni 9m	**Piazza Donatello 9m**	**Piazza Francia 9m**
17 Kw/h	25.4Kw/h	25.4 Kw/h

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SNAP4CITY | KM4CITY

- Mobility -

Tue 5 Nov 17:47:56

Traffic Events in Firenze

05/11/2019	16:00:45	5	MAP

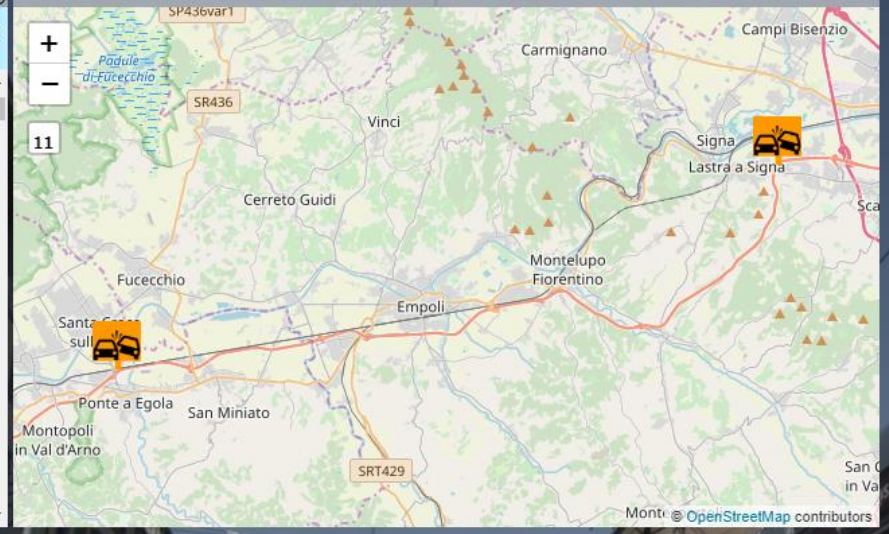
05-11-2019 17:13 VEICOLO FERMO O AVARIA
BROKEN DOWN VEHICLE(S) | 05/11/2019 | 17:13:07 | 5

05-11-2019 16:55 VEICOLO FERMO O AVARIA
BROKEN DOWN VEHICLE(S) | 05/11/2019 | 16:55:45 | 5

05-11-2019 17:12 TRAFFICO RALLENTATO
SLOW TRAFFIC | 05/11/2019 | 17:12:17 | 5

05-11-2019 16:40 CODA IN USCITA A LASTRA
QUEUING TRAFFIC | 05/11/2019 | 16:40:32 | 5

Traffic Events - Firenze



Traffic Daily Inflow trend

N. veicoli totali Inflow

144137 n.

Traffic Daily Outflow trend

N. veicoli totali Outflow

132220 n.

SMN

411 free

Stazione S.M.N. Parking Slots Availability Trend

Parterre

355 free

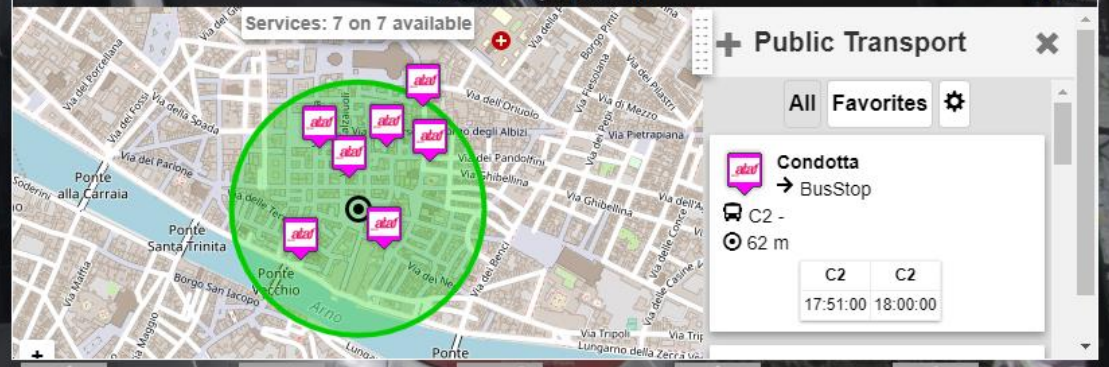
Parterre Parking Slots Availability Trend

Careggi

123 free

Careggi Parking Slots Availability Trend

Public Transport Search



Energy | Environment | Social | Resilience | Main

Valutazione Trasporto Pubblico

Firenze - 6 linee

Tue 5 Nov 17:49:00

Linea 13

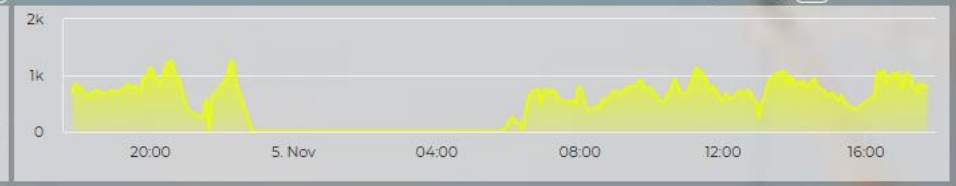
395

Ritardo medio corse attive nei 5min in sec

Linea 31

793

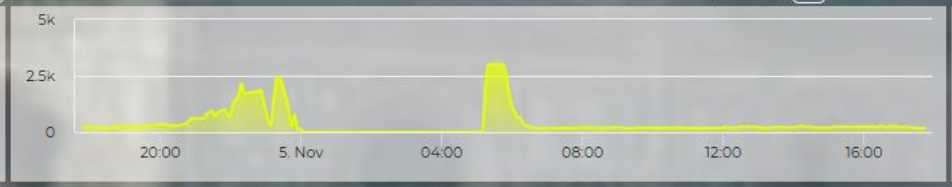
Ritardo medio corse attive nei 5min in sec



Linea 17

182

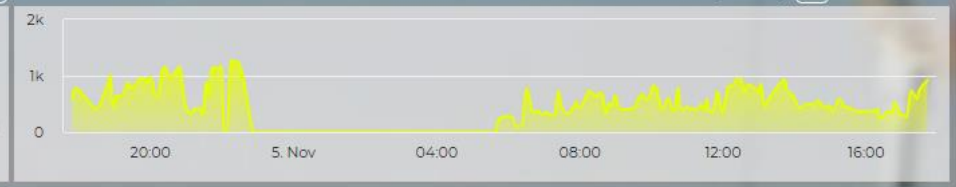
Ritardo medio corse attive nei 5min in sec



Linea 36

923

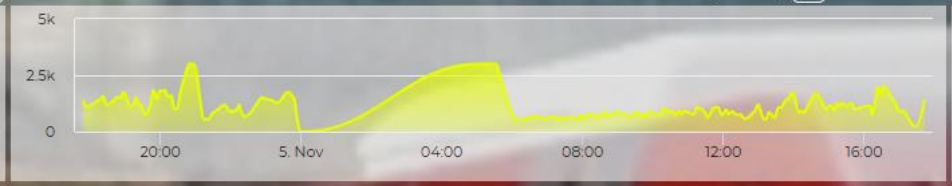
Ritardo medio corse attive nei 5min in sec



Linea 23

1369

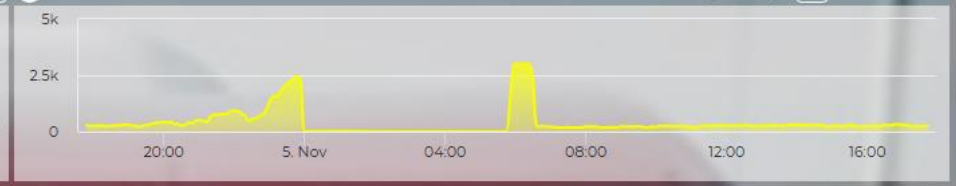
Ritardo medio corse attive nei 5min in sec



Linea 6

254

Ritardo medio corse attive nei 5min in sec



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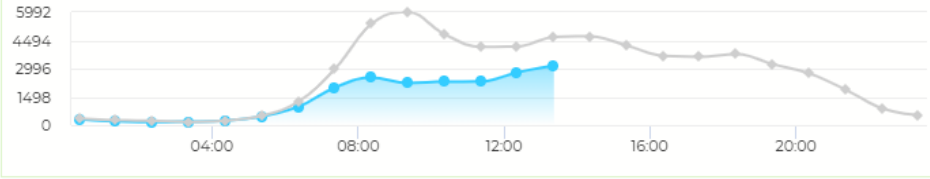
Traffic Flow Monitoring - Firenze

Sat 4 Apr 13:22:03

 # IN FLOW 9m

3164 #ofvehicles

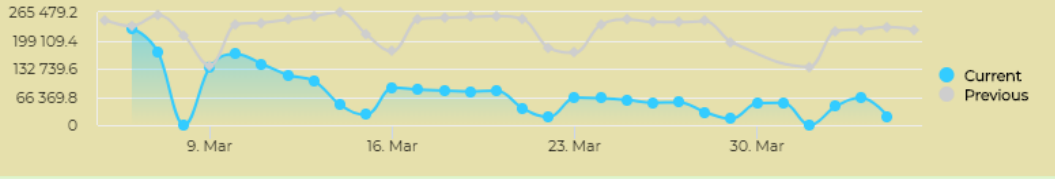
Firenze IN Traffic Flow (number of vehicles) 9m



Inc Daily Inp... 9m

19552 #ofvehicles

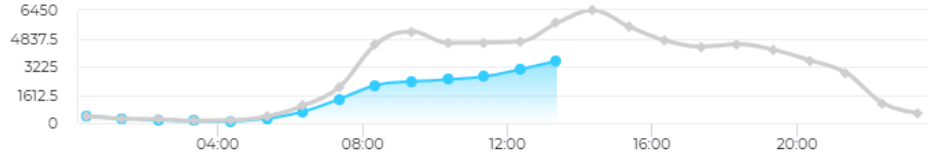
Daily Inputs (monthly) (last value is incremental, real time) 9m



 # OUT FLOW 9m

3540 #ofvehicles

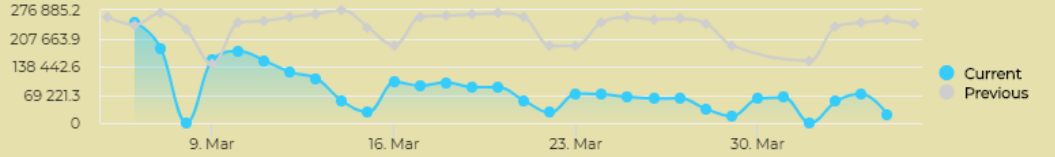
Firenze OUT Traffic Flow (number of vehicles) 9m



Inc Daily Out... 9m

19225 #ofvehicles

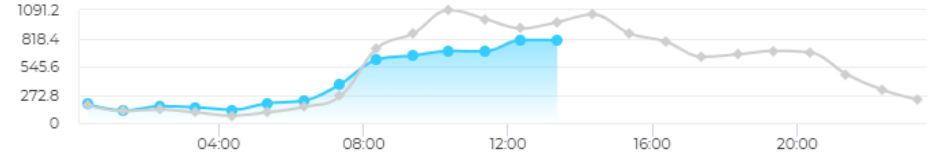
Daily Outputs (monthly) (last value is incremental real time) 9m



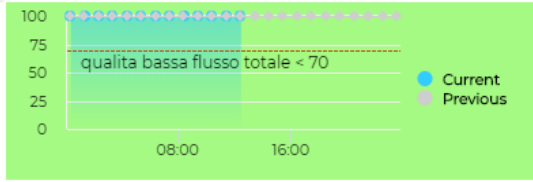
ZTL in 9m

798 #ofvehicles

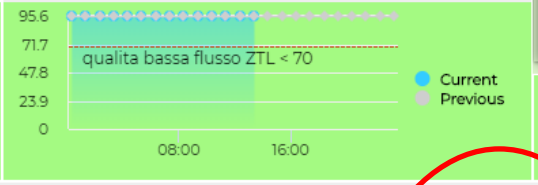
ZTL in Traffic Flow daily trend, entering in ZTL 9m



QoS as perc. of measures taken 9m



QoS as perc. of measures in ZTL 9m



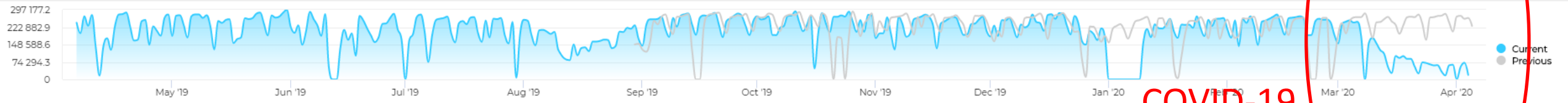
Main

04/04/2020

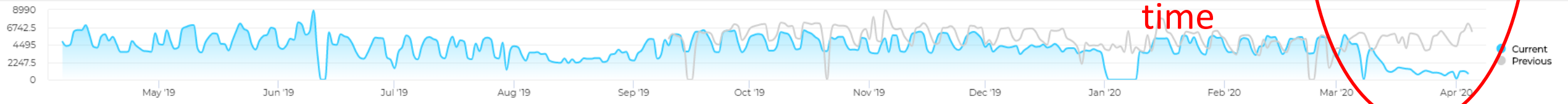
13:22:03

inflow total of the day, yearly 9m

outflow total over the day Yearly 9m



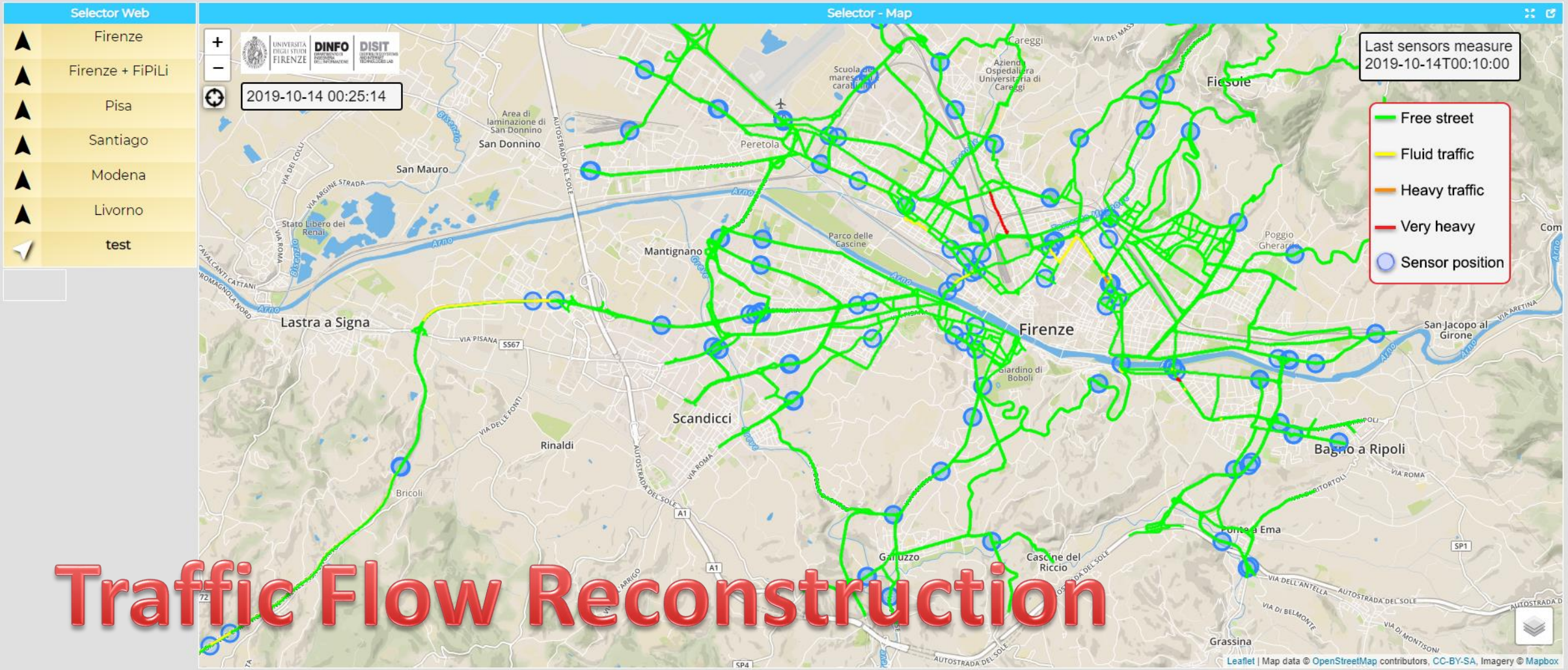
in ZTL yearly compare 9m



COVID-19 time

Traffic Flow Reconstruction for the cities

Mon 14 Oct 00:25:15



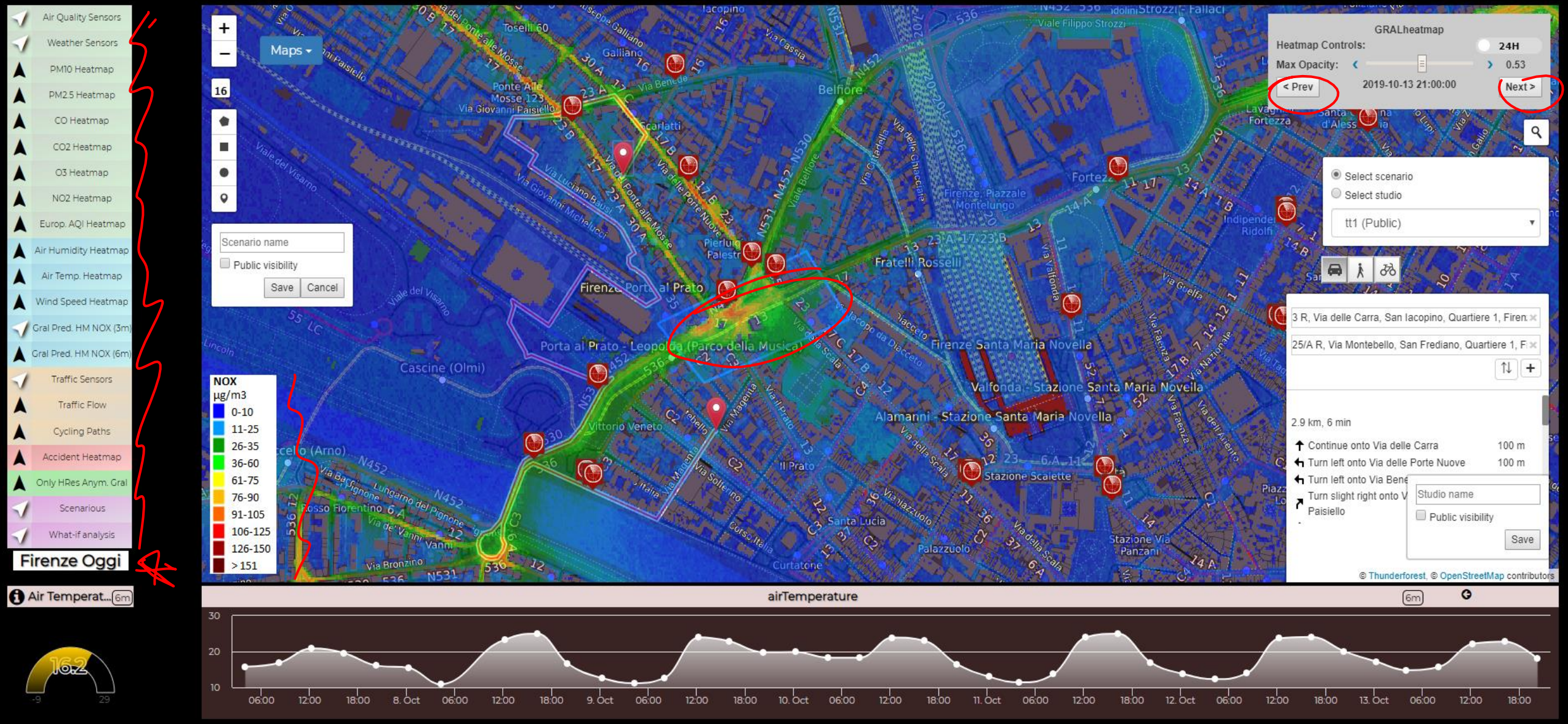
Traffic Flow Reconstruction

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

Mobility and Environment What-IF Analysis

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

Mon 14 Oct 00:48:17



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

Smart City Control Room (Data View)

REPLICATE
This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement Nº 691735

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

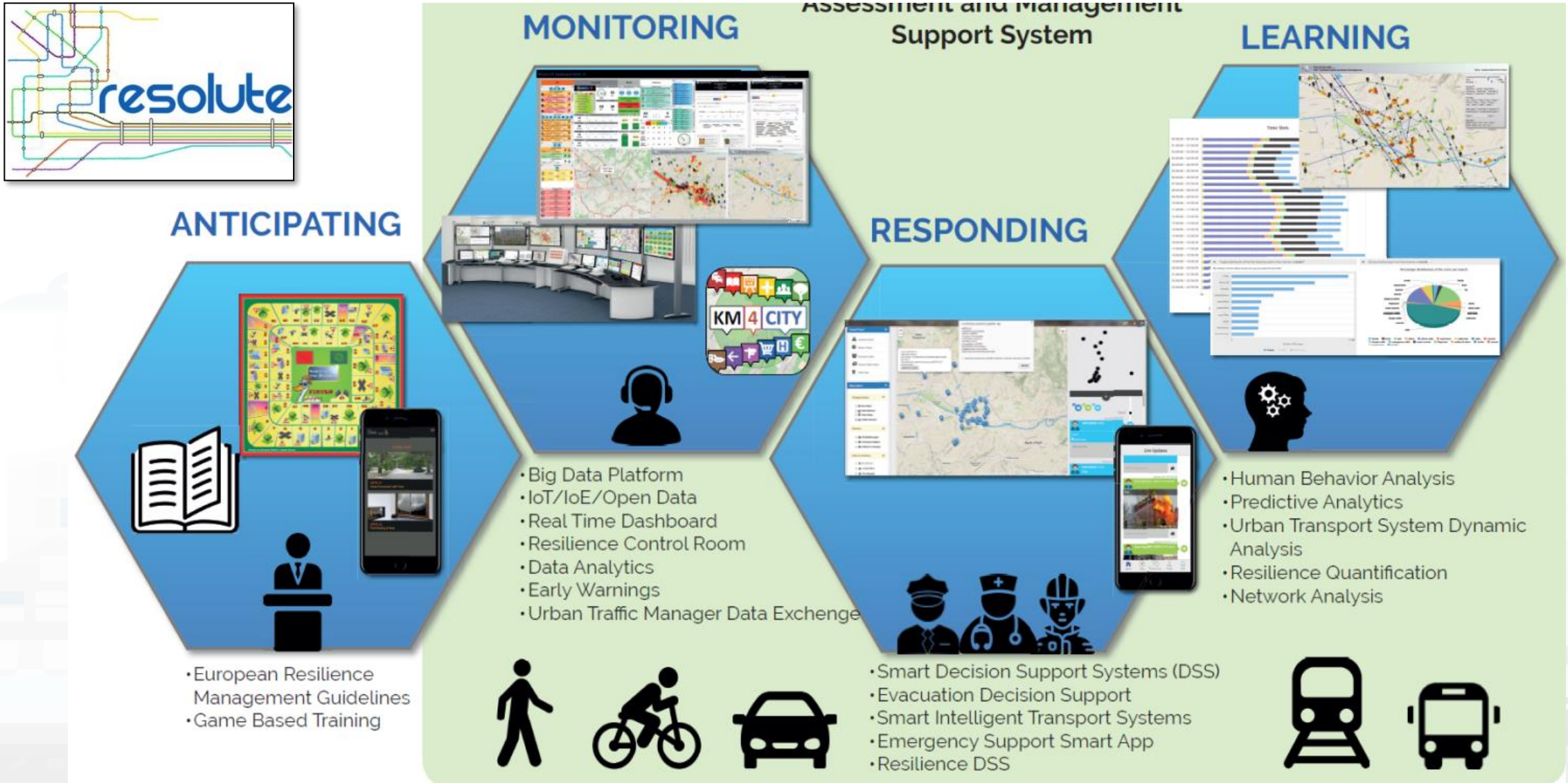
- **Weather**
  - Forecast and actual
- **Social**:
  - **smart benches**
  - Entertainment events
  - Twitter monitoring, Sentiment analysis, NLP text
  - TV camera streams
  - Triage status of some Hospital
- **People Flows**:
  - **Wi-Fi status**
  - Origin destination matrices, people flow (RESOLUTE)
- **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

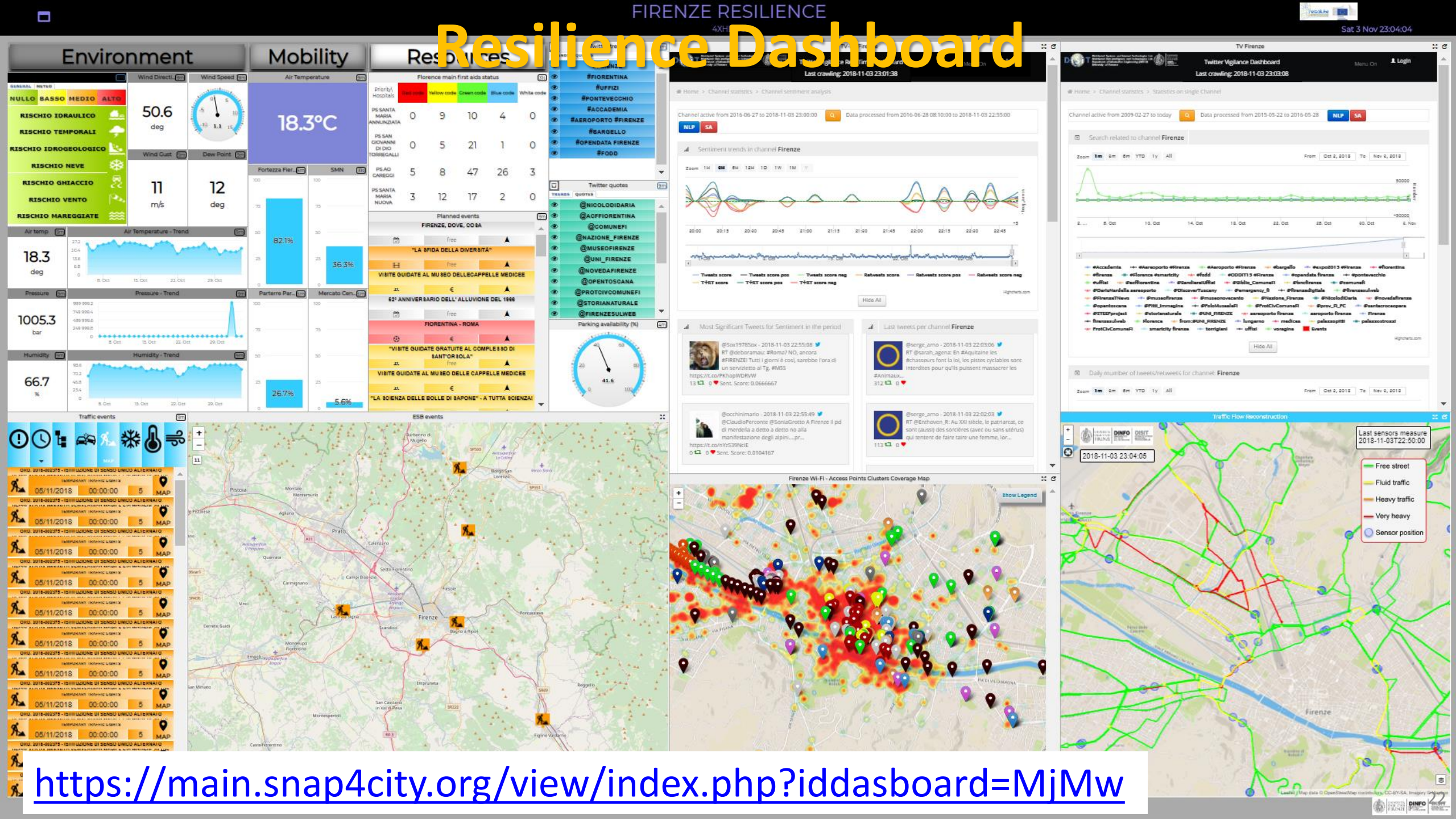
FIRENZE CITTÀ FARO

ERMG: European Resilience Management Guide



SIGNORVINO

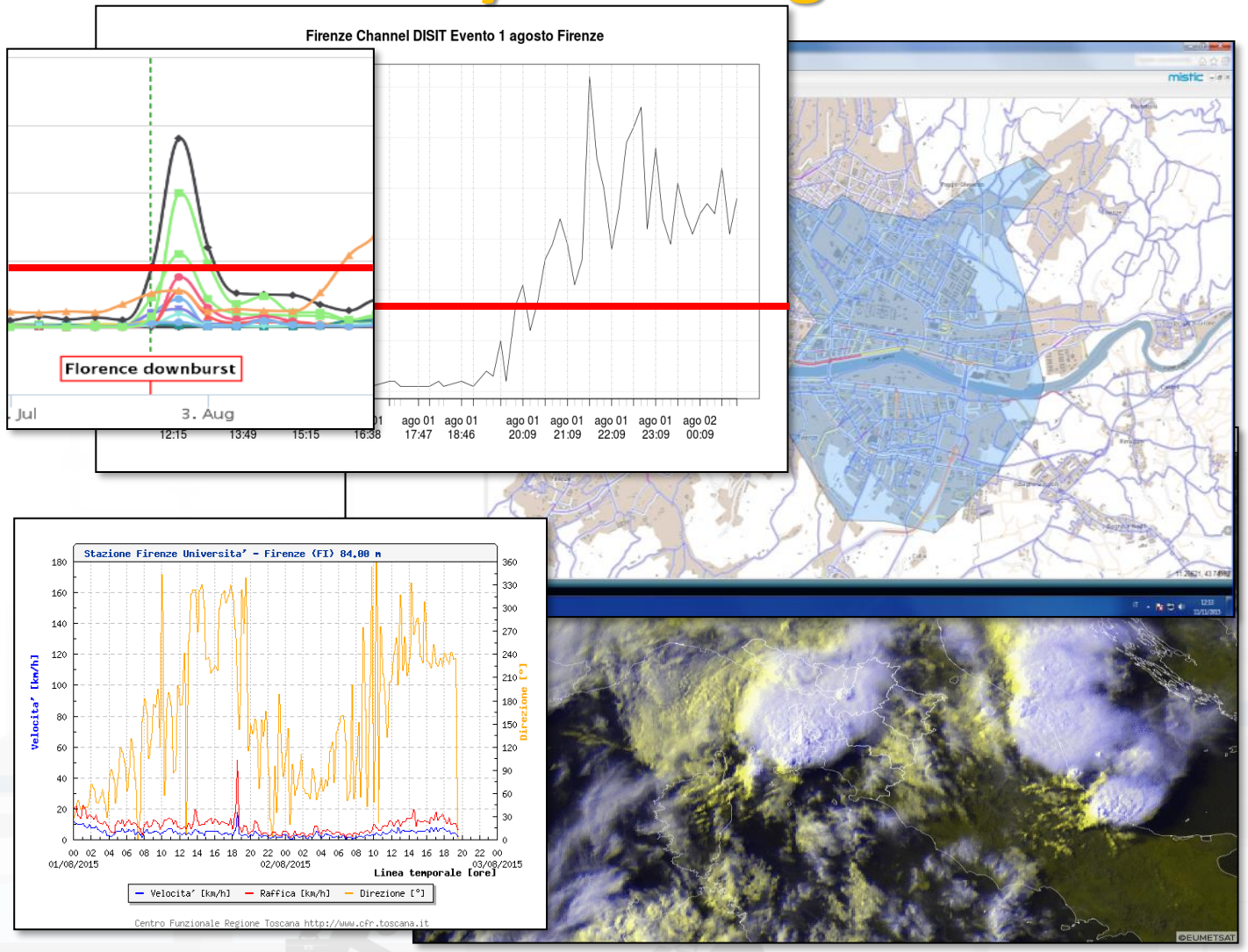
Resilience Dashboard



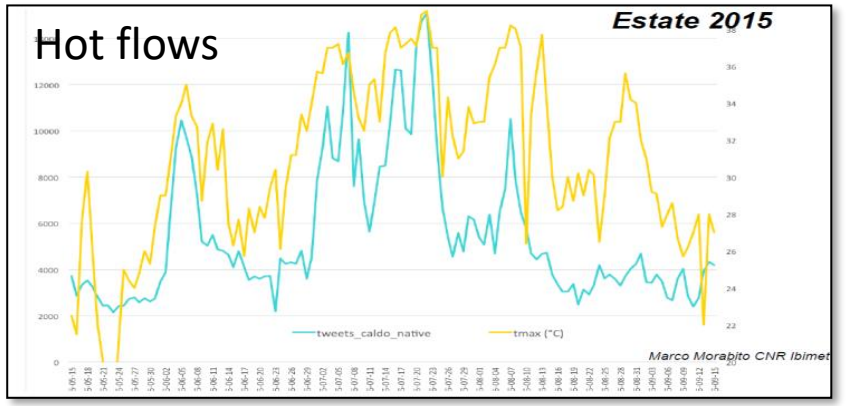
https://main.snap4city.org/view/index.php?iddasboard=MjMw

Twitter Vigilance

Early Warning



Predictive models



Attendance at long lasting events: EXPO2015

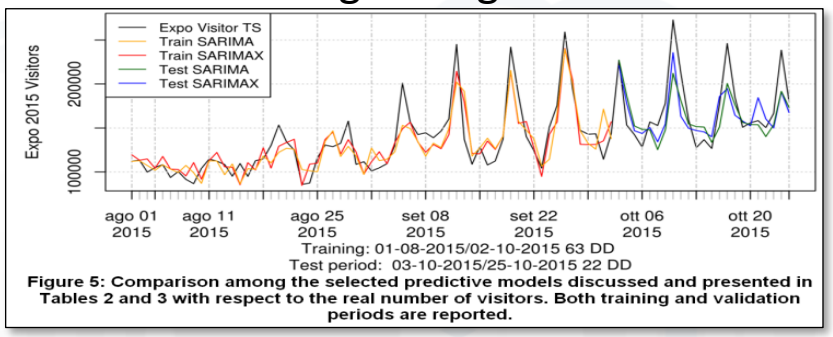
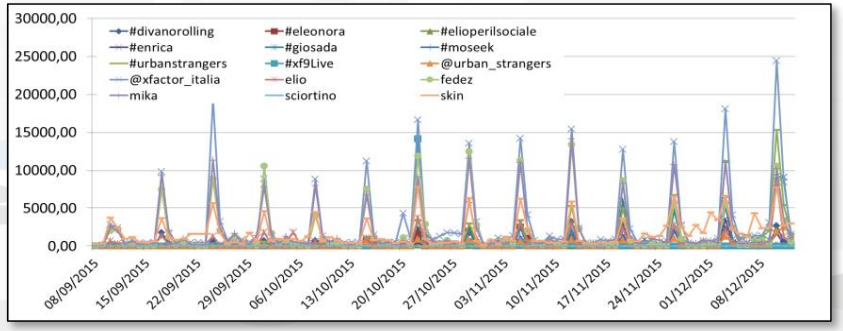


Figure 5: Comparison among the selected predictive models discussed and presented in Tables 2 and 3 with respect to the real number of visitors. Both training and validation periods are reported.

Attendance at recurrent events: TV, footbal

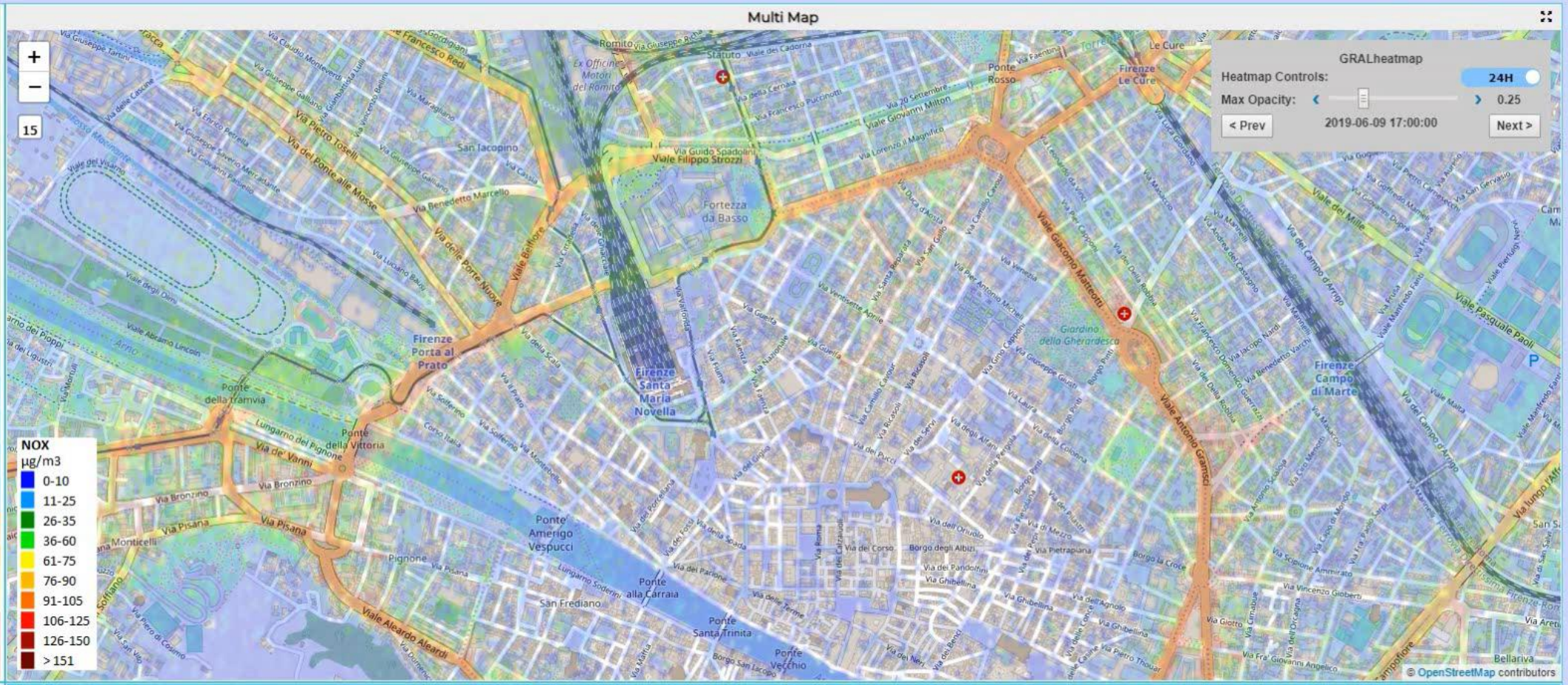


Firenze - Trafair - AirQuality Heatmaps

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

Sun 9 Jun 17:41:58

- Air Quality Sensors
- PM10 Heatmap
- PM2.5 Heatmap
- CO Heatmap
- CO2 Heatmap
- SO2 Heatmap
- O3 Heatmap
- NO2 Heatmap
- Benzene Heatmap
- H2S Heatmap
- Air Humidity Heatmap
- Air Temp. Heatmap
- Wind Speed Heatmap
- Gral Pred. HM NOX (3m)
- Gral Pred. HM NOX (6m)
- Traffic Sensors
- Traffic Flow
- Cycling Paths
- Accident Heatmap
- Accident Heatmap 2



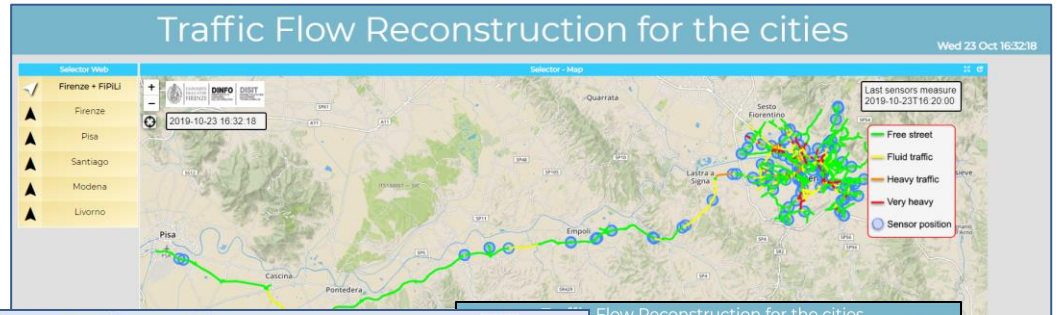
Air Temperature Bolognese 7m

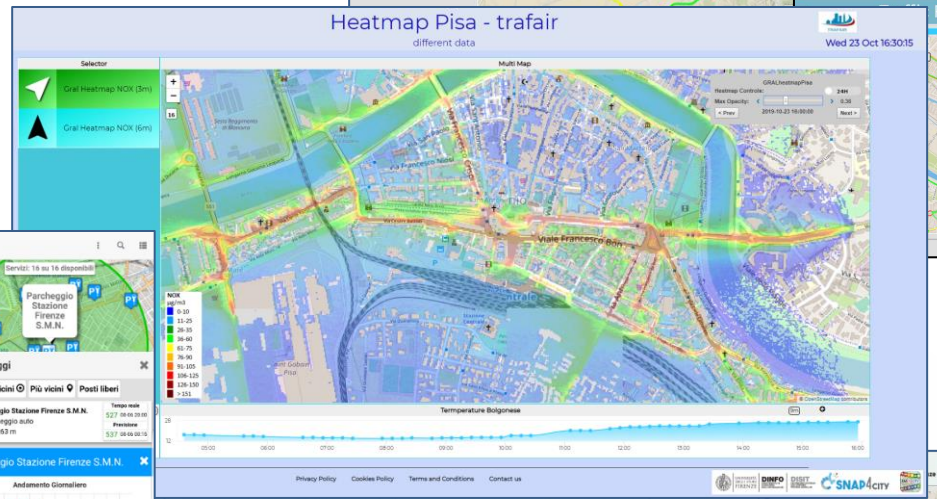
SIRSensor_TOS01001095 - airTemperature 7m

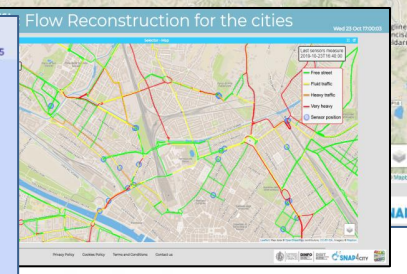
Tuscany Region
Firenze, Pisa, Livorno, Prato, etc.

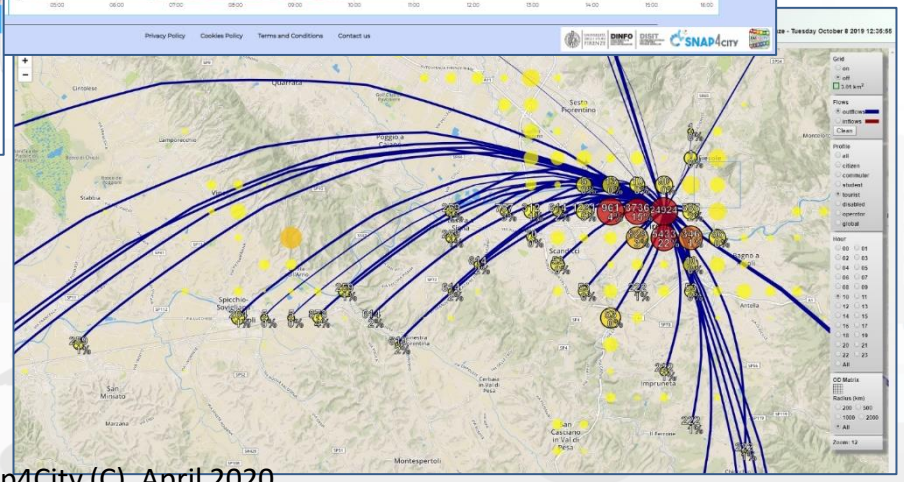
Tuscany Region

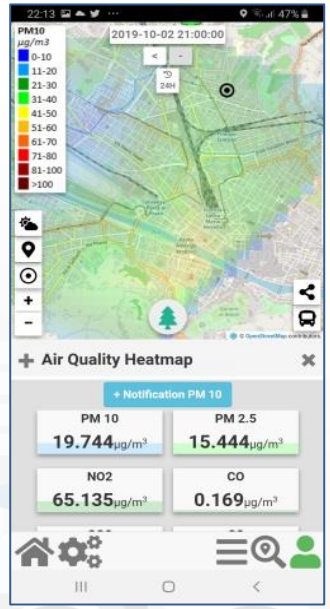
- **Dashboards & Services**:
  - **Mobility**: public transport operators schedule and paths, traffic Fi-Pi-Li main road, parking status and predictions, traffic sensors, Origin Destination matrix, routing, multimodal routing, etc.
  - **Social**: Hospitals and triage, etc.
  - **Environment**: sensors,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





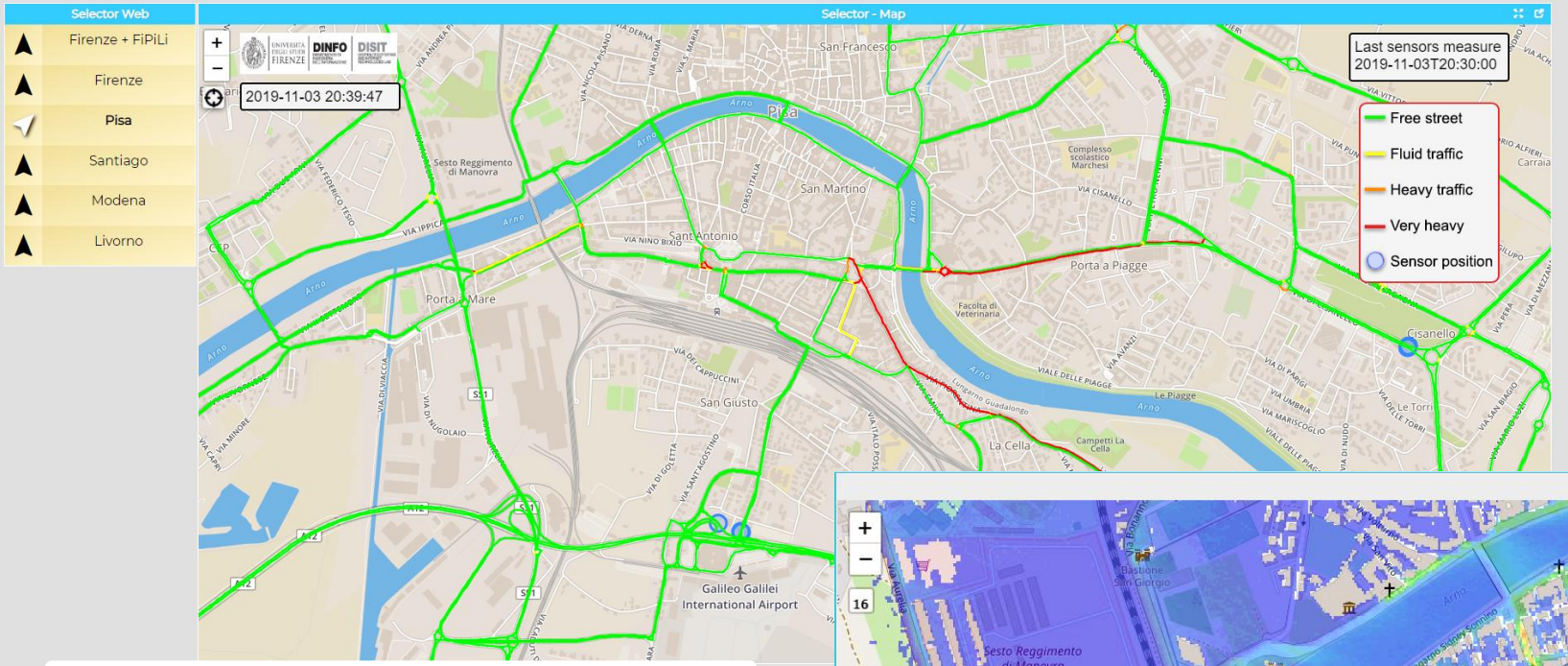


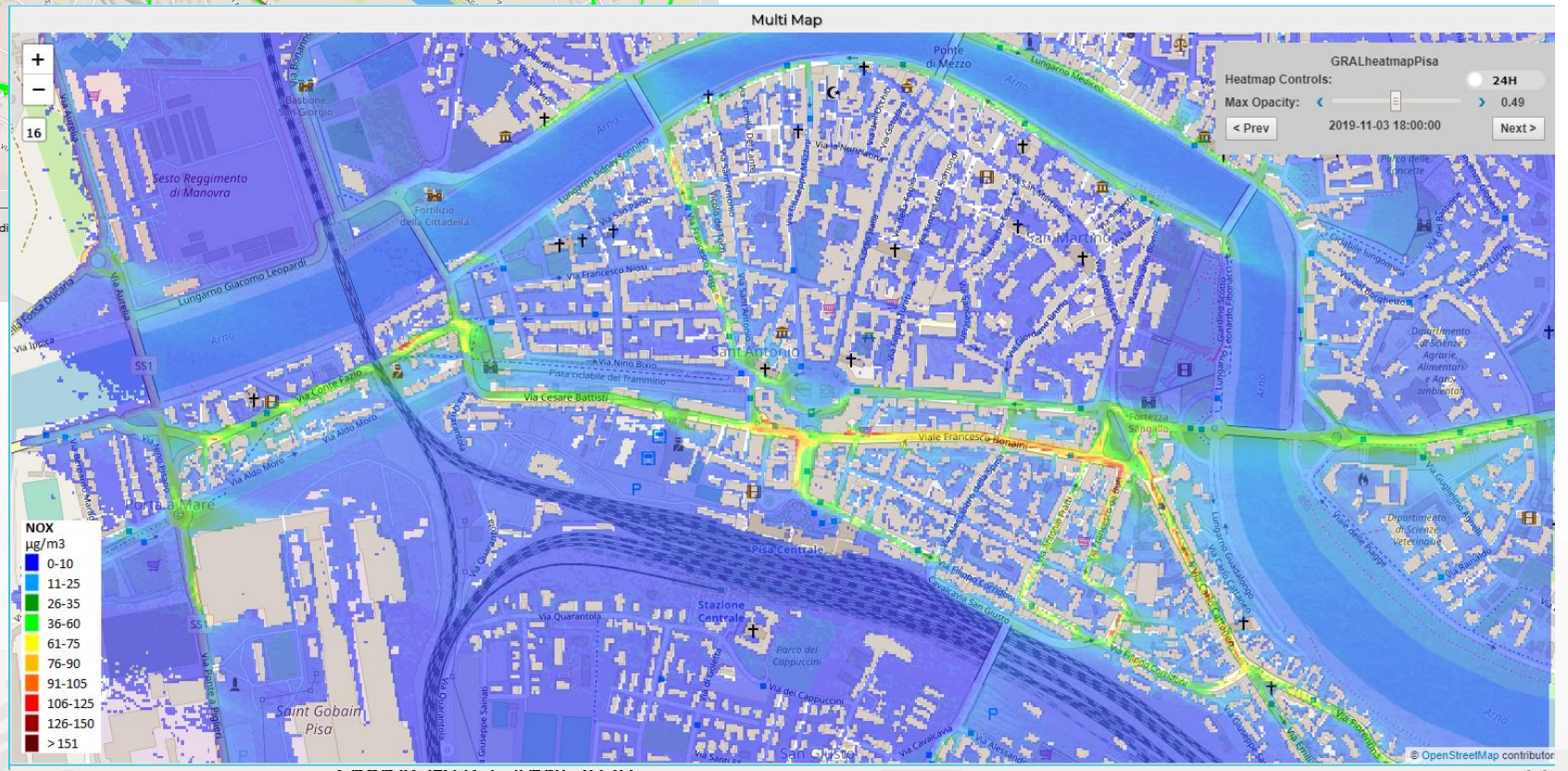




Traffic Flow Reconstruction for the cities

Sun 3 Nov 20:39:47





Selector - Map

2019-11-03 20:44:08

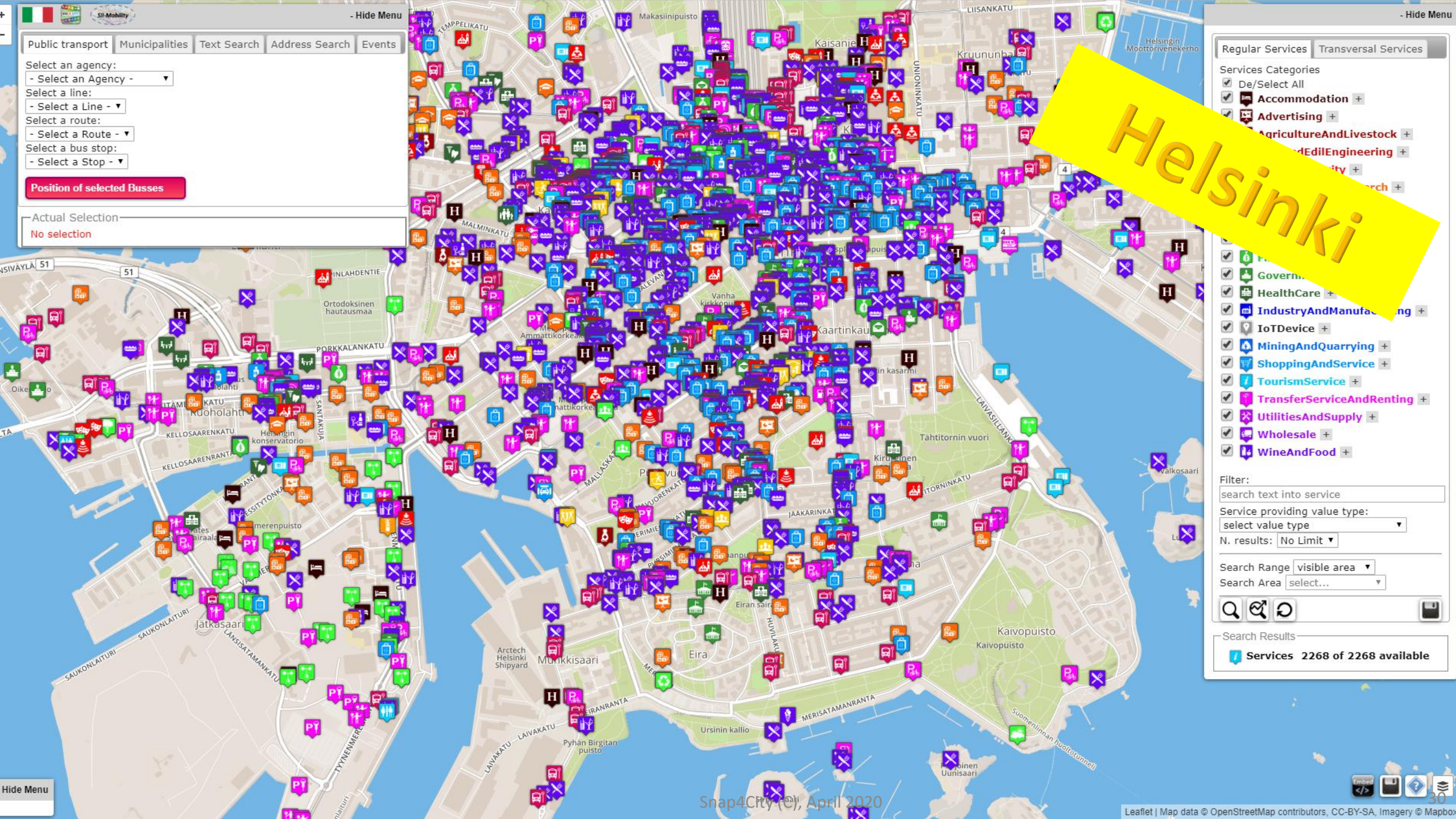
Multi Map

15

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

Livorno

Helsinki


- Hide Menu
Public transport
Municipalities
Text Search
Address Search
Events
Select an agency:
- Select an Agency -
Select a line:
- Select a Line -
Select a route:
- Select a Route -
Select a bus stop:
- Select a Stop -
Position of selected Busses
Actual Selection
No selection
Helsinki
- Hide Menu
Regular Services
Transversal Services
Services Categories
De/Select All
Accommodation
Advertising
HealthCare
IoTDevice
MiningAndQuarrying
ShoppingAndService
TourismService
TransferServiceAndRenting
UtilitiesAndSupply
Wholesale
WineAndFood
Filter:
search text into service
Service providing value type:
select value type
N. results:
No Limit
Search Range
visible area
Search Area
select...
Search Results
Services 2268 of 2268 available
Hide Menu
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

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)

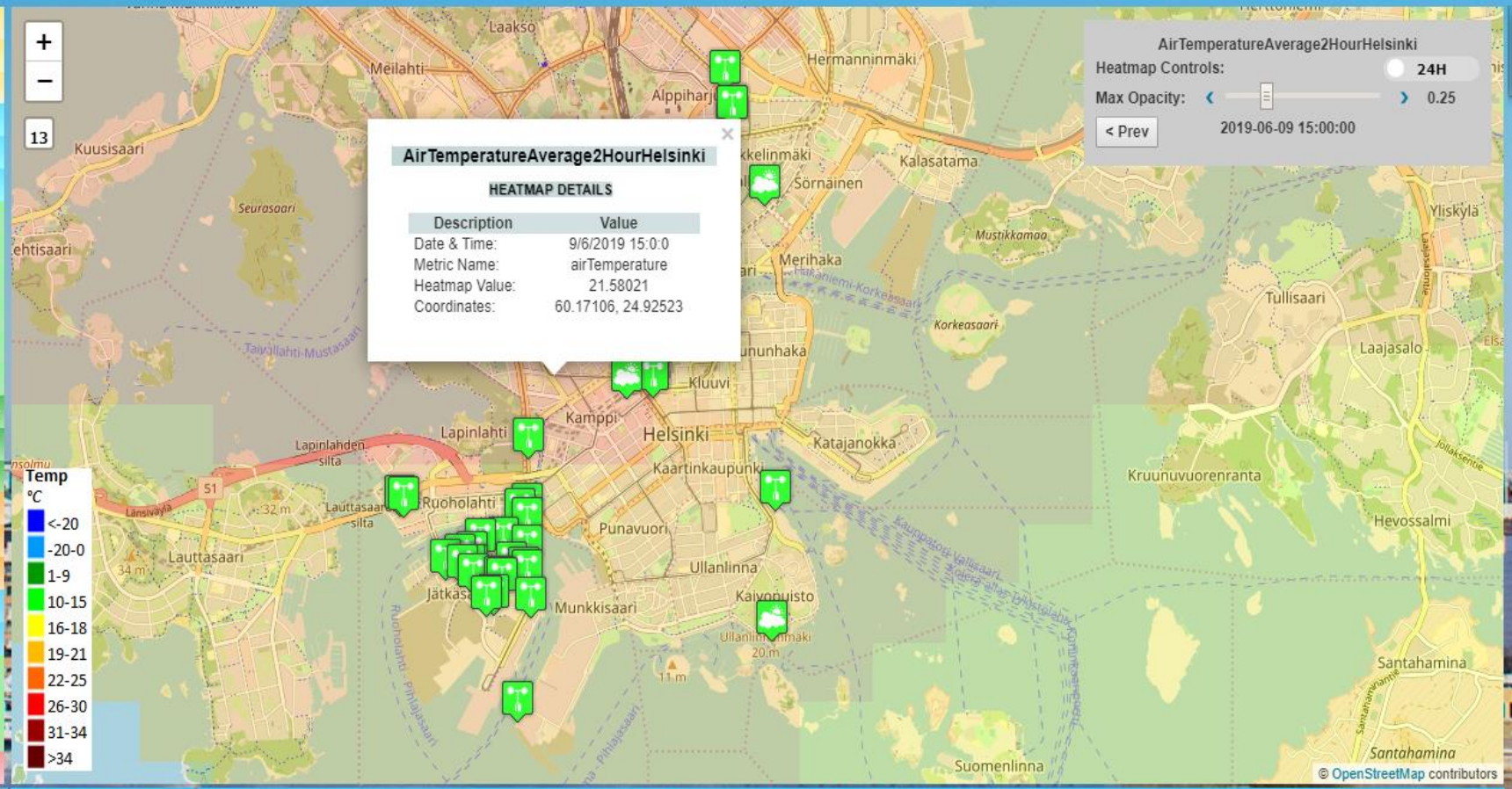
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTQwNg==

Helsinki City Overview (H5a)

Please note that the data results are not always based on real data.

Sun 9 Jun 17:07:25

- BusStop
- Ticket sale
- Traffic Sensor
- Weather sensor
- Air Temp heatmap
- Humidity Heatmap
- Air Quality Sensors
- Noise sensors
- Noise Heatmap
- PM10 heatmap
- PM2.5 Heatmap
- NO2 heatmap
- Air Quality Index heatmap
- EAQI
- CAQI
- Enfuser pred. AQI
- Enfuser pred. PM10
- Enfuser pred. PM2.5
- Gral pred. PM10
- Gral pred. PM10 (6m)
- PM10 Jatkasaari
- PM2.5 Jatkasaari
- EAQI Jatkasaari
- Appreciated POIs



Weather sen... 9m

20.5

Weather sensor Helsinki Kaisaniemi - airTemperature 9m

The Life of Helsinki

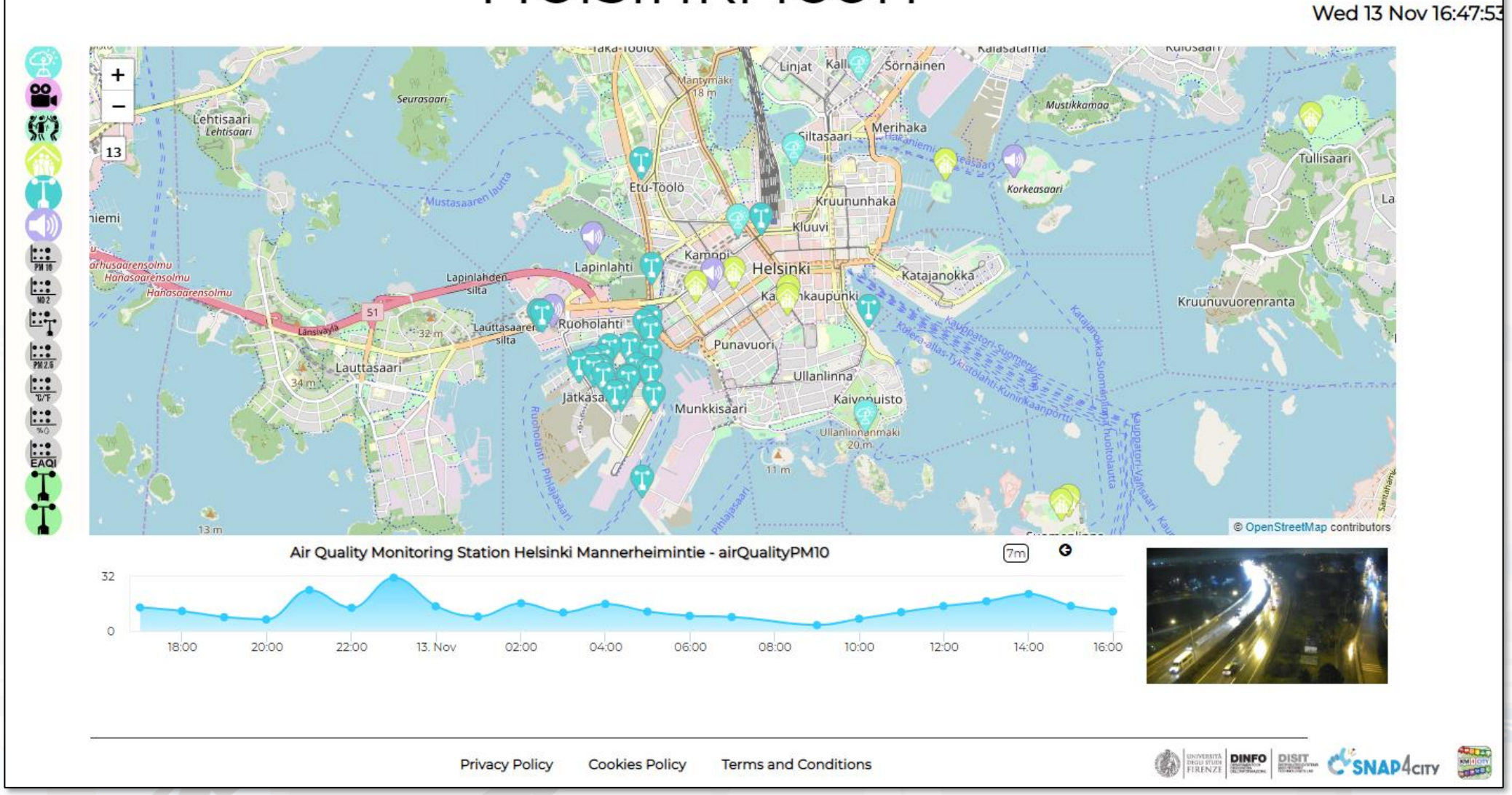
Documentation

Forum Discussion

Survey

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

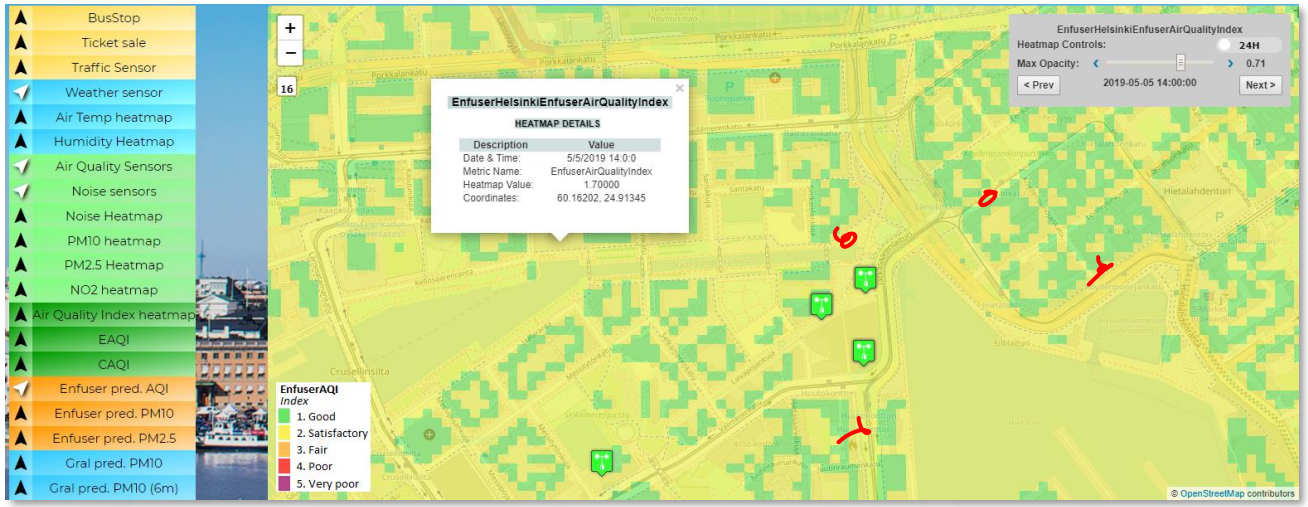
Helsinki icon

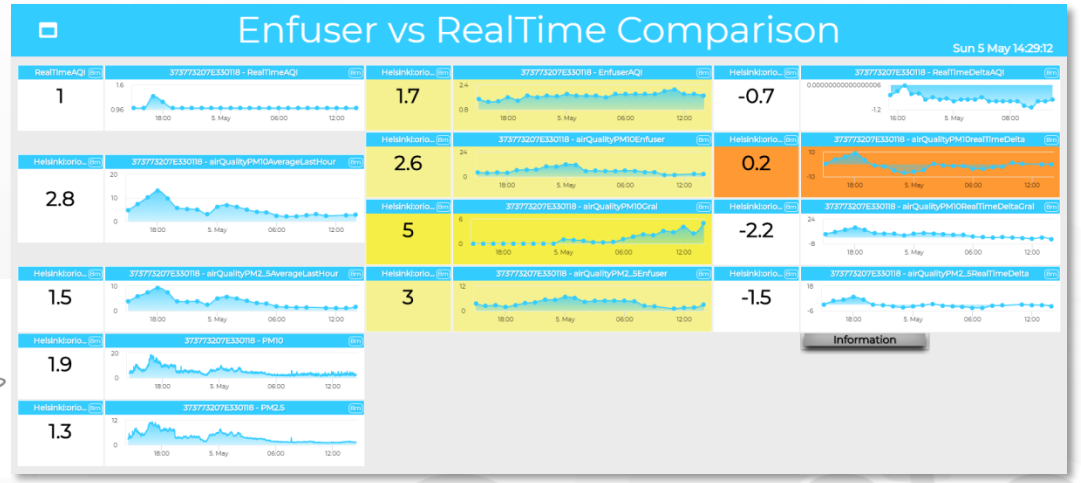


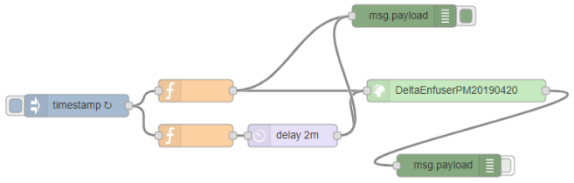
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjM1NQ==

Data Analytics: Enfuser predictions

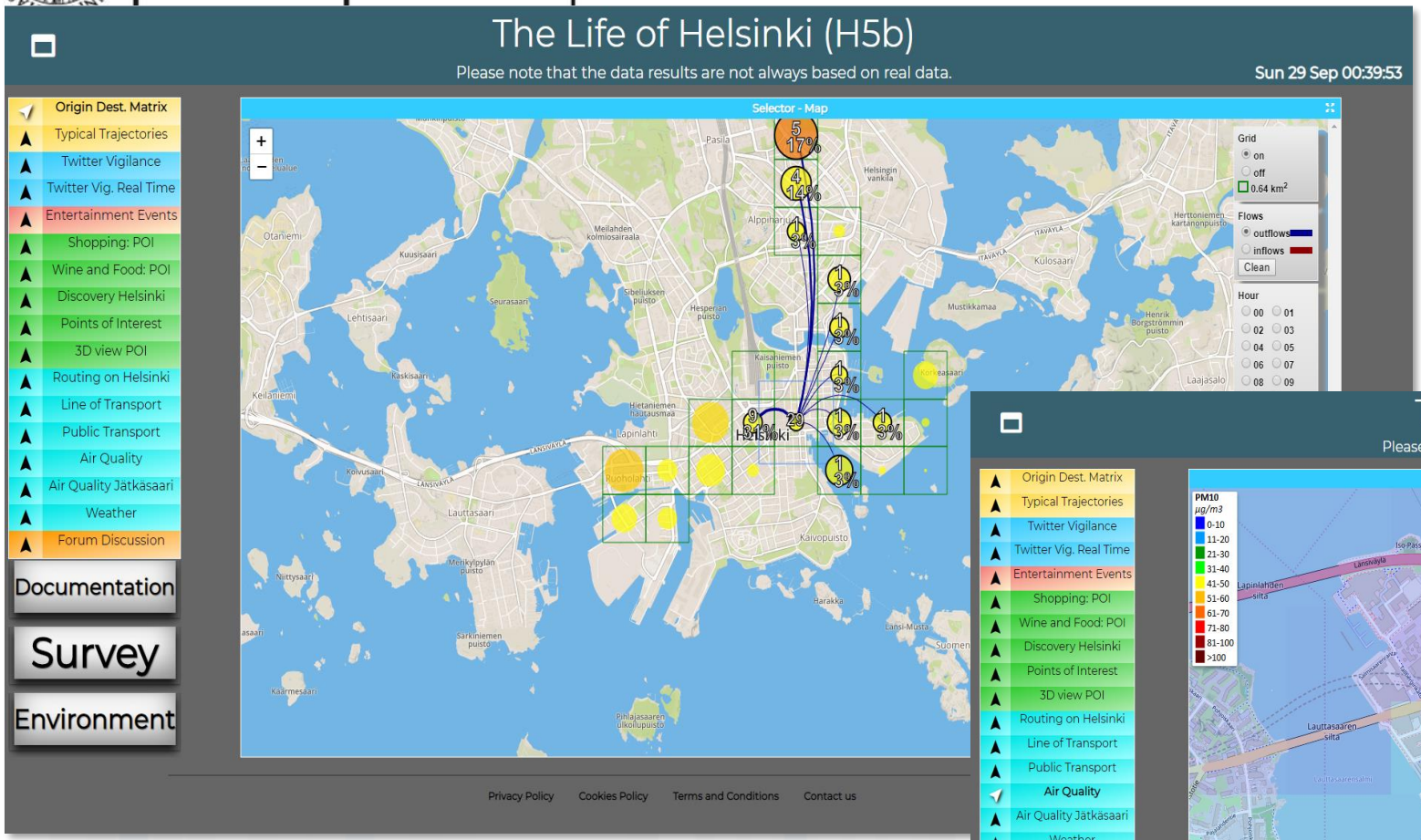
- **Enfuser predictions: AQI, PM10, PM2.5**
  - Data gathering, data processing for Piking
  - Delta Estimation Predictions vs Actual: on 12 points/sensors via R-Studio and IOT App
  - API for accessing data of Heatmaps in real time

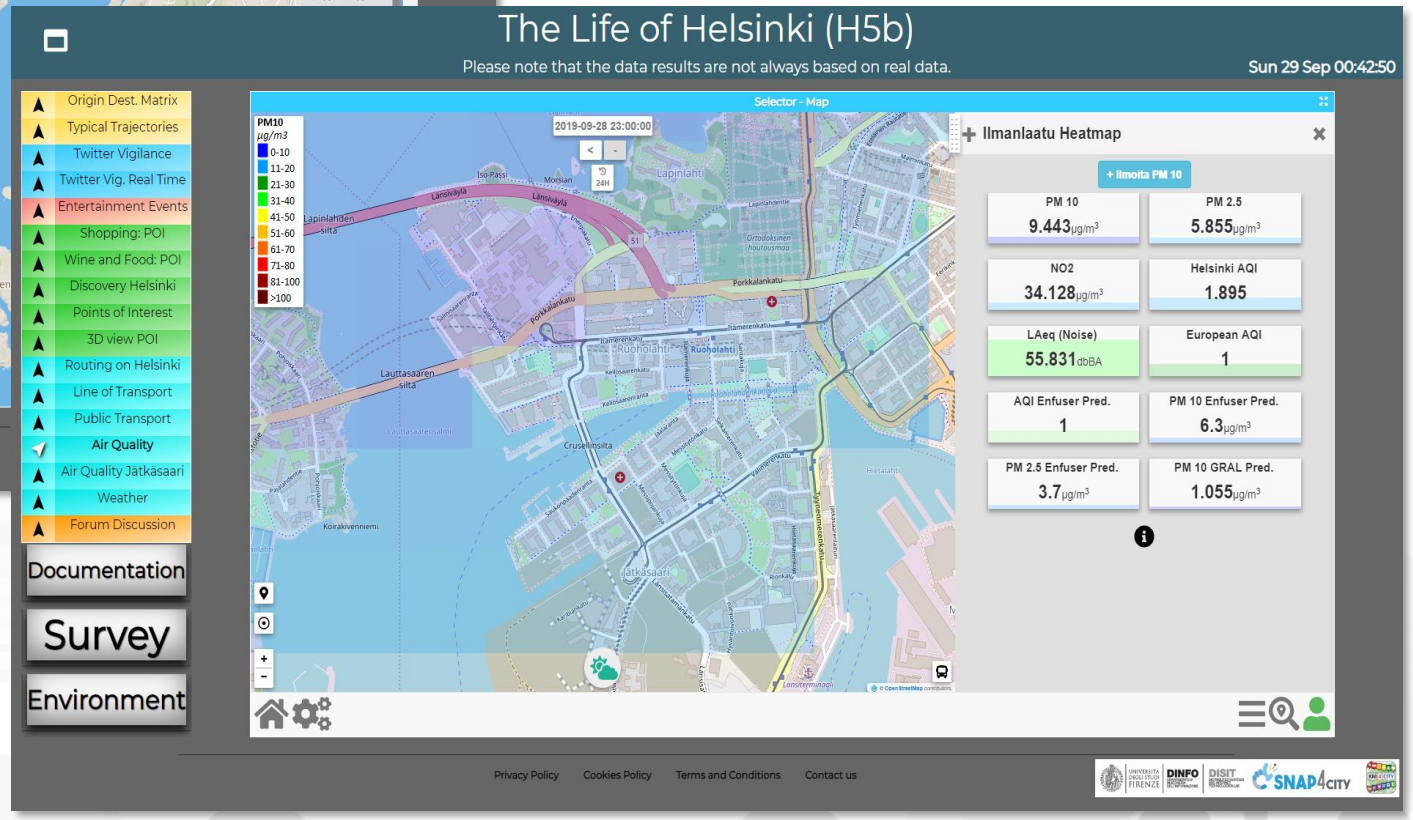






Helsinki





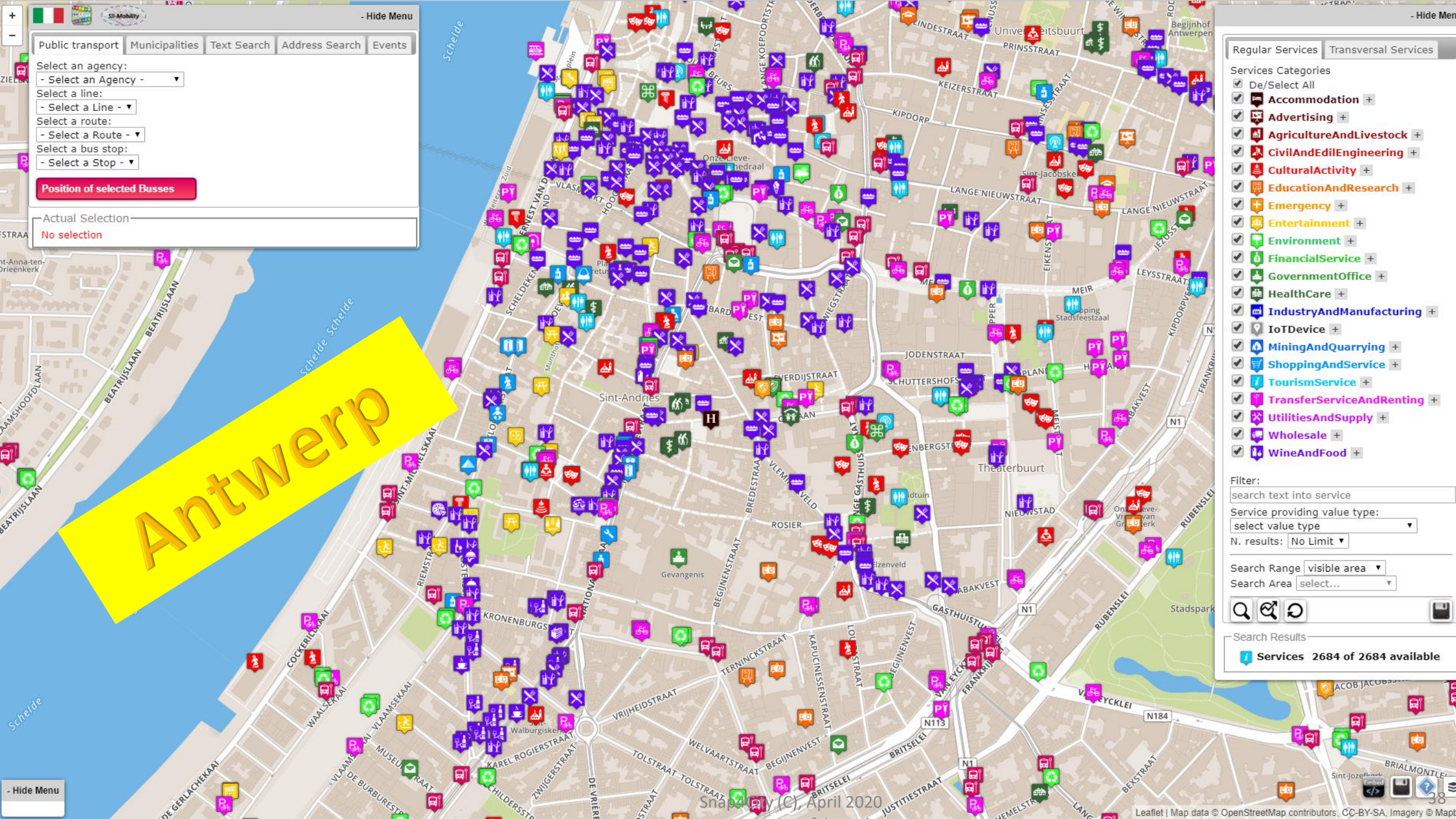
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc1Mg==

Environmental Data Predictions: GRAL

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

TRAFAIR

Antwerp


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

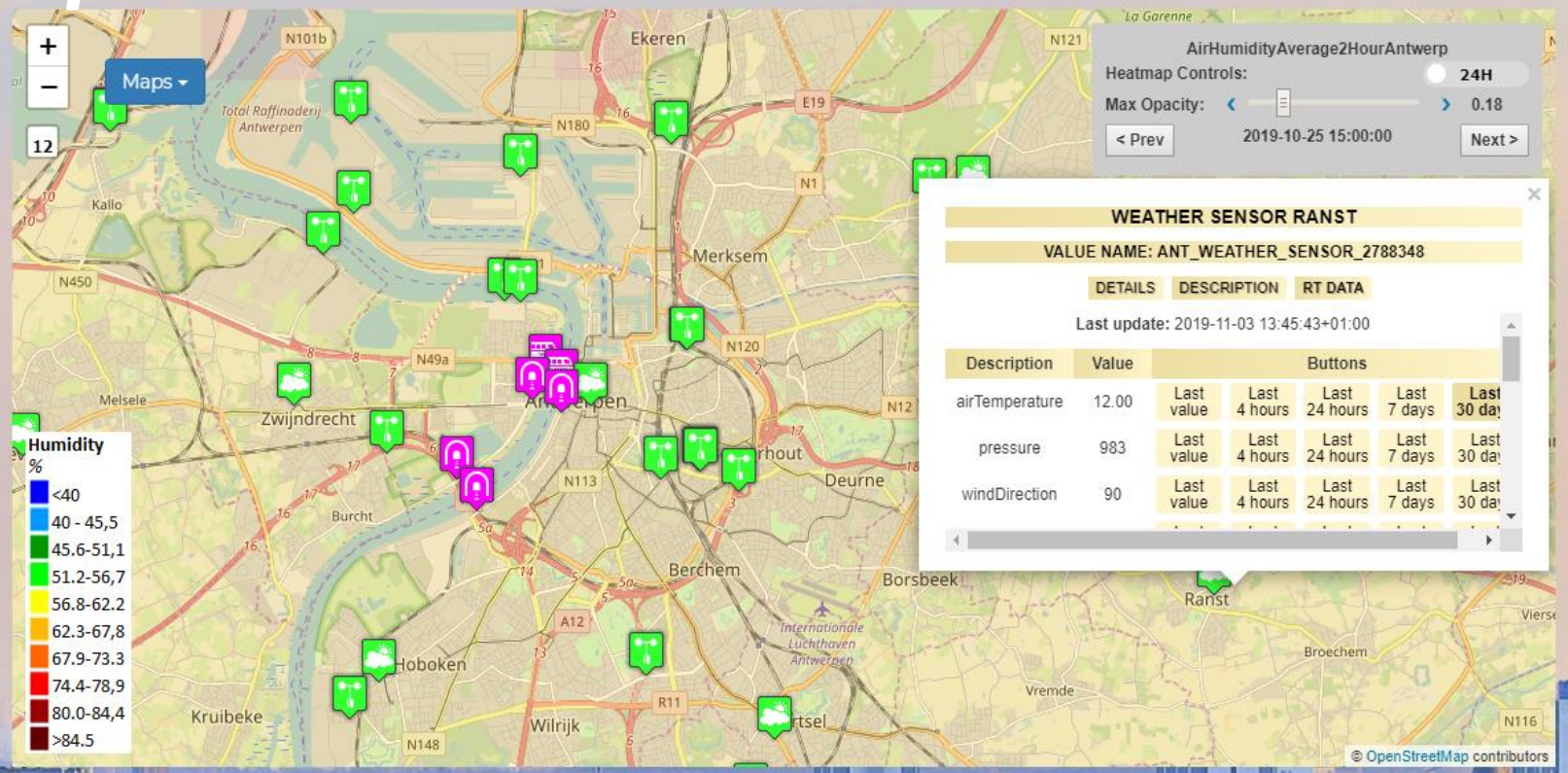
Antwerp

Antwerp City Overview - A5

Please note that the data results are not always based on real data.

Sun 3 Nov 14:09:43

- Cultural Activity
- Entertainment
- Tourism Service
- Education & Research
- Government Office
- Accommodation
- Air Quality Sensor
- Weather sensor
- PM10 Heatmap
- PM2.5 Heatmap
- Air Temperature Heatmap
- Humidity Heatmap
- NO Heatmap
- NO2 Heatmap
- SO2 Heatmap
- O3 Heatmap
- EAQI
- CAQI
- Biking Safe Heatmap
- Tunnels and Ferry
- Routing Scenario
- What-IF Routing



Weather sensor Zwijndr... 8m

11.9

Forum Discussion

Documentation

Survey

The Life of Antwerp

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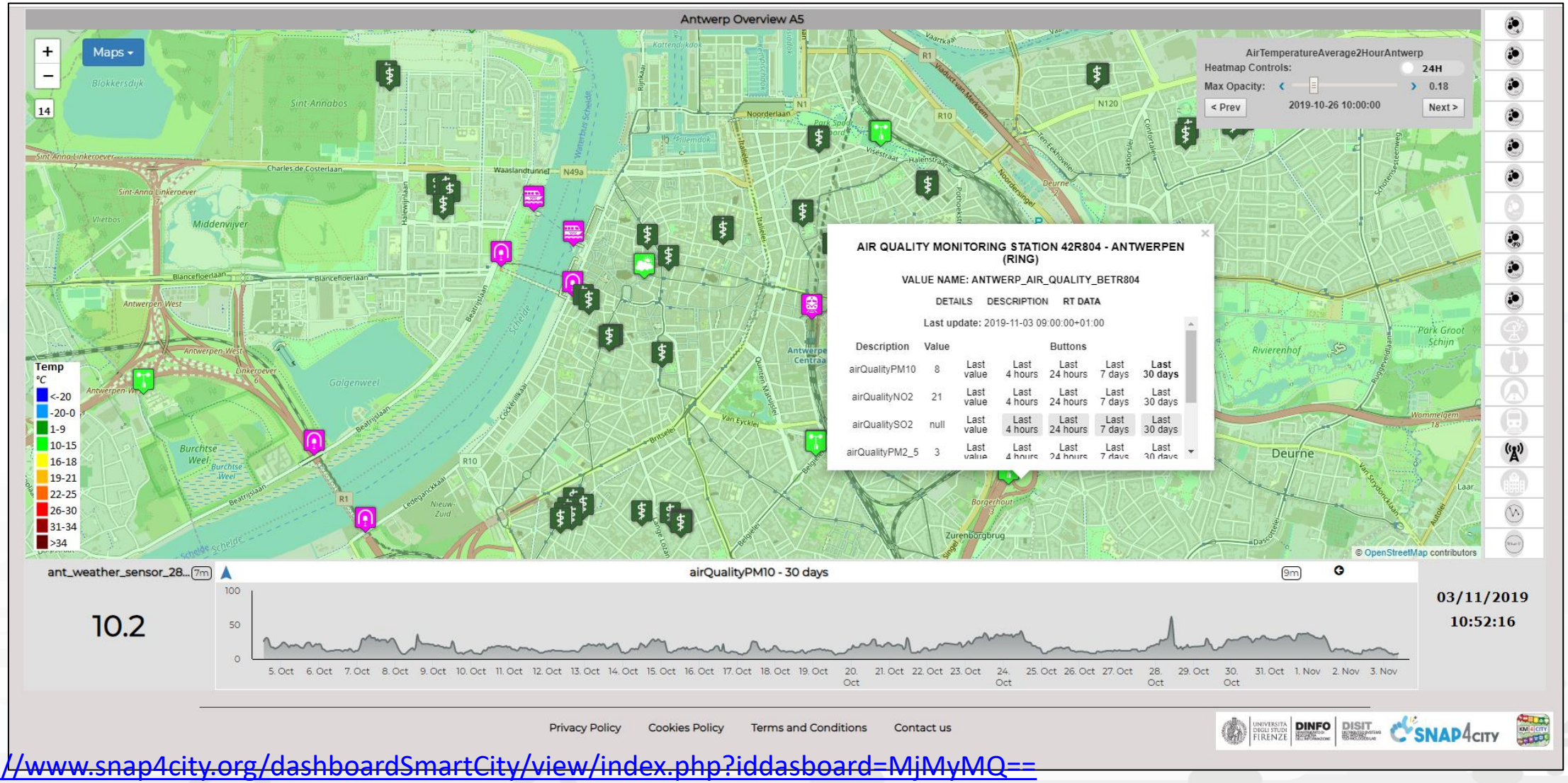
DINFO DISIT SNAP4CITY

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

Antwerp

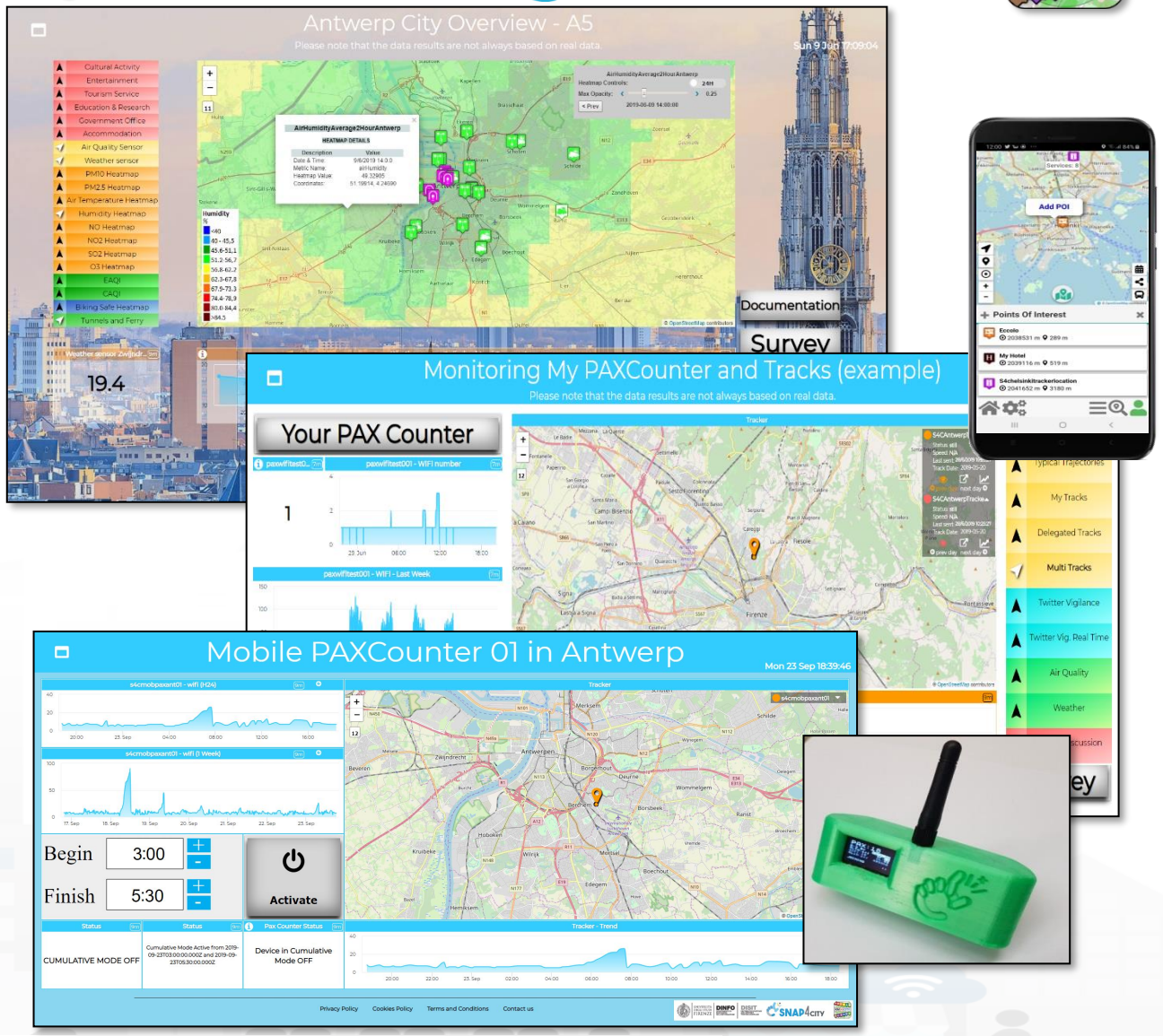
Unique Dashboard builder Multiple Styles



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

Antwerp Case

- **Dashboards & Services**:
  - **Environment** & **Weather**: PM10, PM2.5,NO, SO2, CO, etc.
    - Heatmap & **Alerts** on critical
  - **Mobility**: public transport Operators schedule and path, monitoring of river crossing, routing, what-if
  - **PAX Counters:** museum and public services, mobile PAX Counter for events
  - **Social**: Twitter Vigilance, early warning
  - **Life in Antwerp**: OD matrix people flow, Twitter Vigilance SA, hot places, ...
  - **Tourism and Culture**
- **Mobile App and MicroApplications:**
  - Antwerp in a Snap (all stores)



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

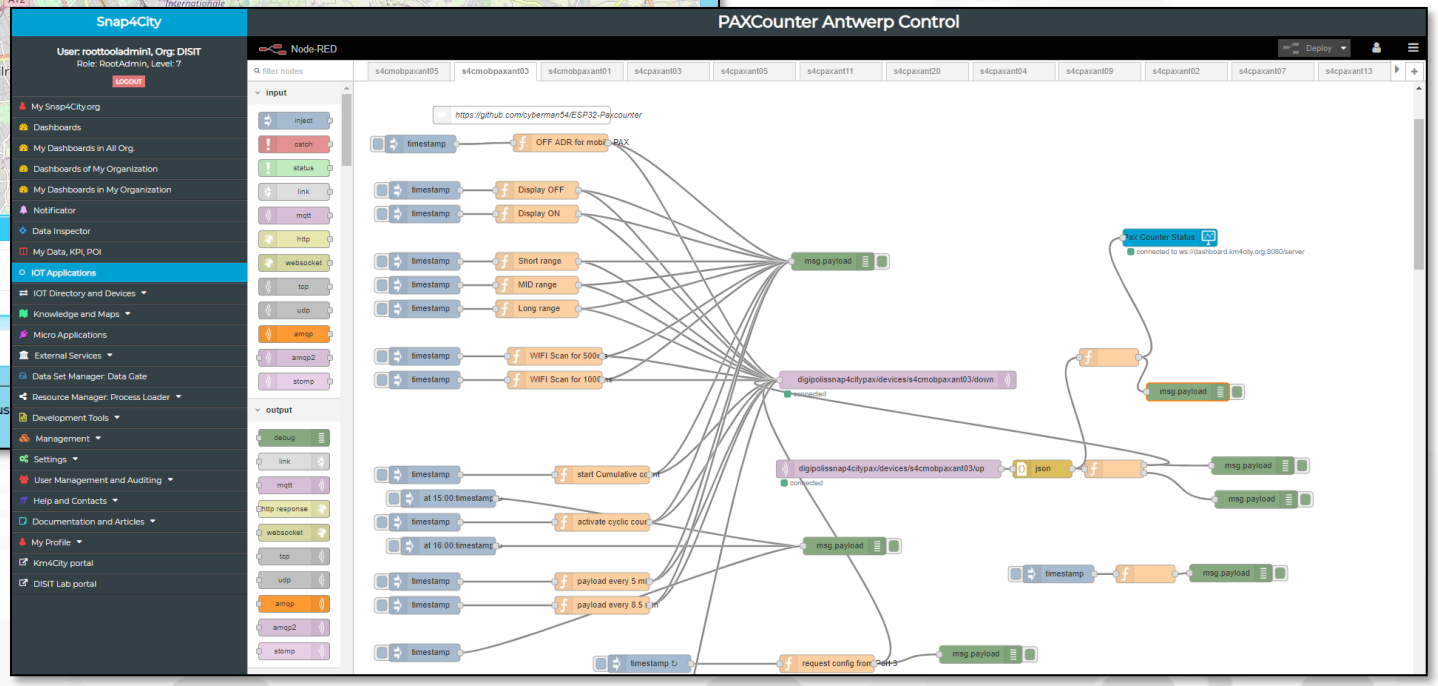
PaxCounter devices

- Fixed PaxCounter LoraWan
  - Based on Wi-Fi- Bluetooth
- Mobile PaxCounter LoraWan
  - Based on Wi-Fi- Bluetooth
- Fixed PaxCounter(LoraWan+Wifi out)
  - Based on Wi-Fi- Bluetooth

LoRa® Wi Fi Bluetooth™

https://www.snap4city.org/drupal/node/456

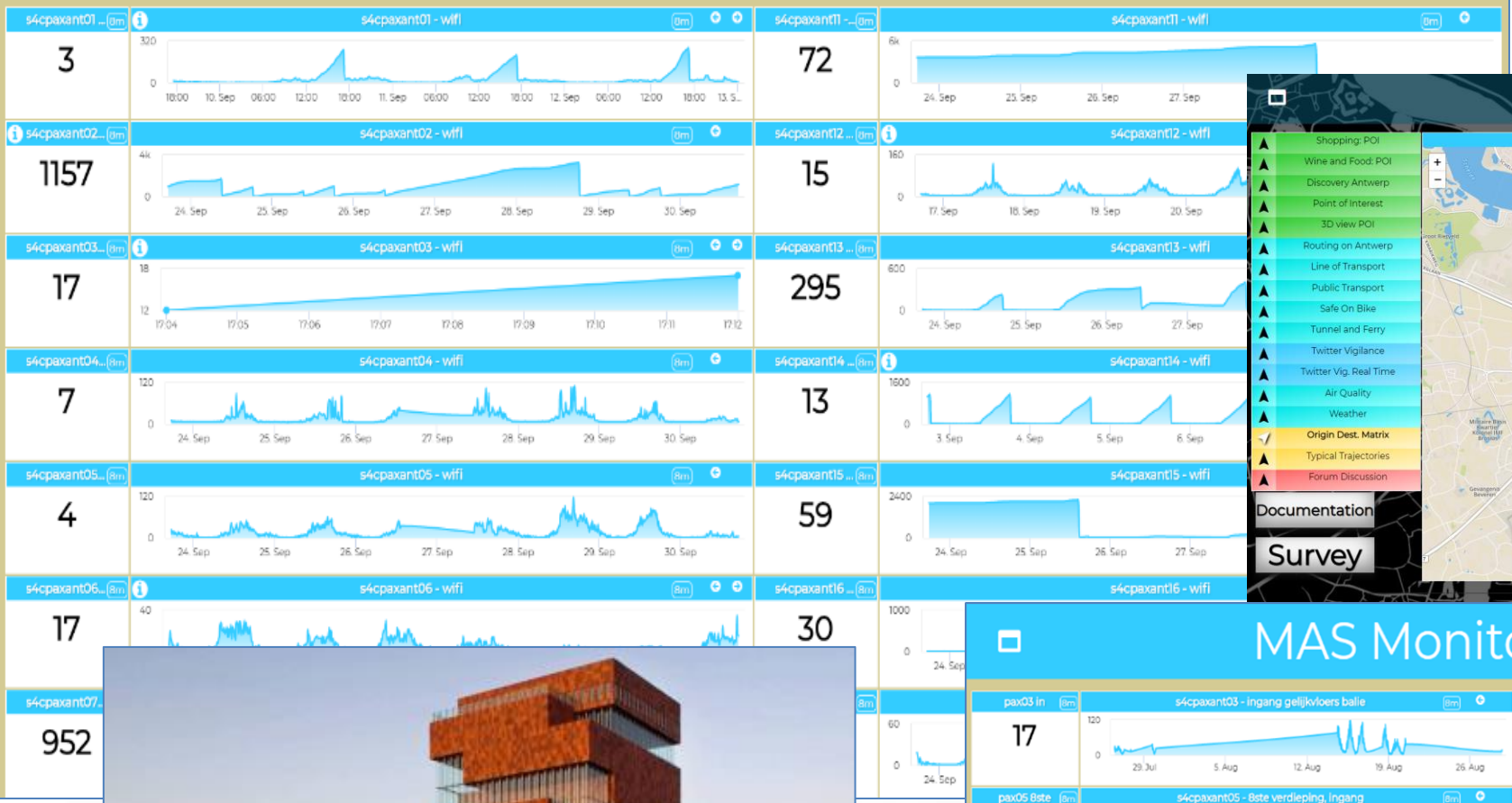
Programmable PAX counting



Antwerp

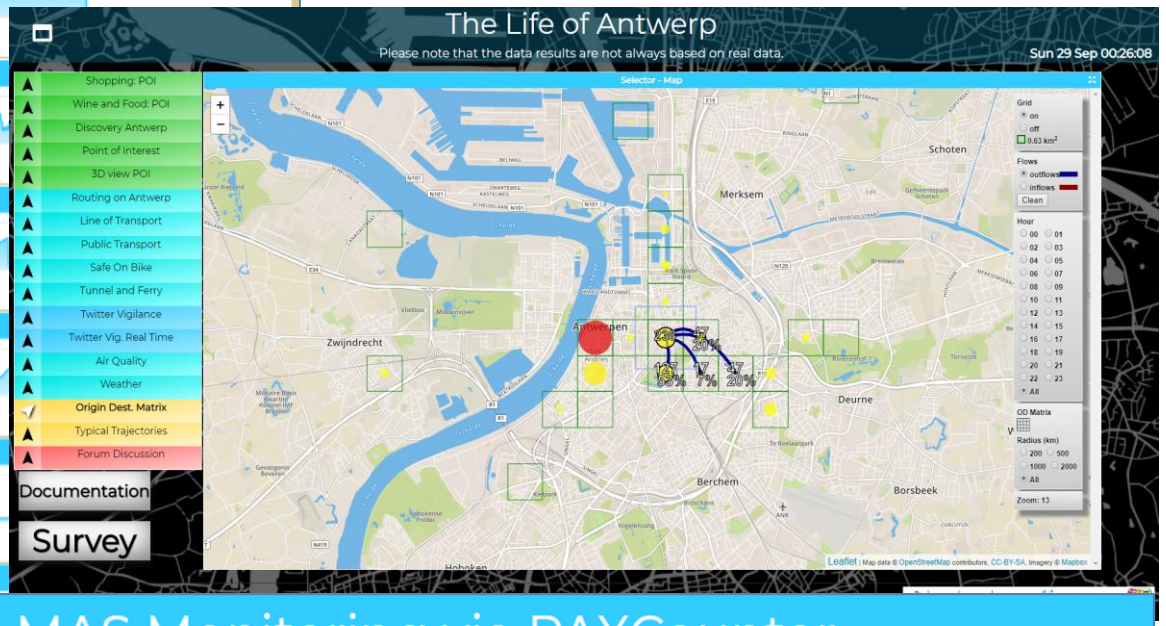
PAXCounter real time and trend

Mon 30 Sep 17:18:48



SNAP4CITY

KM4CITY



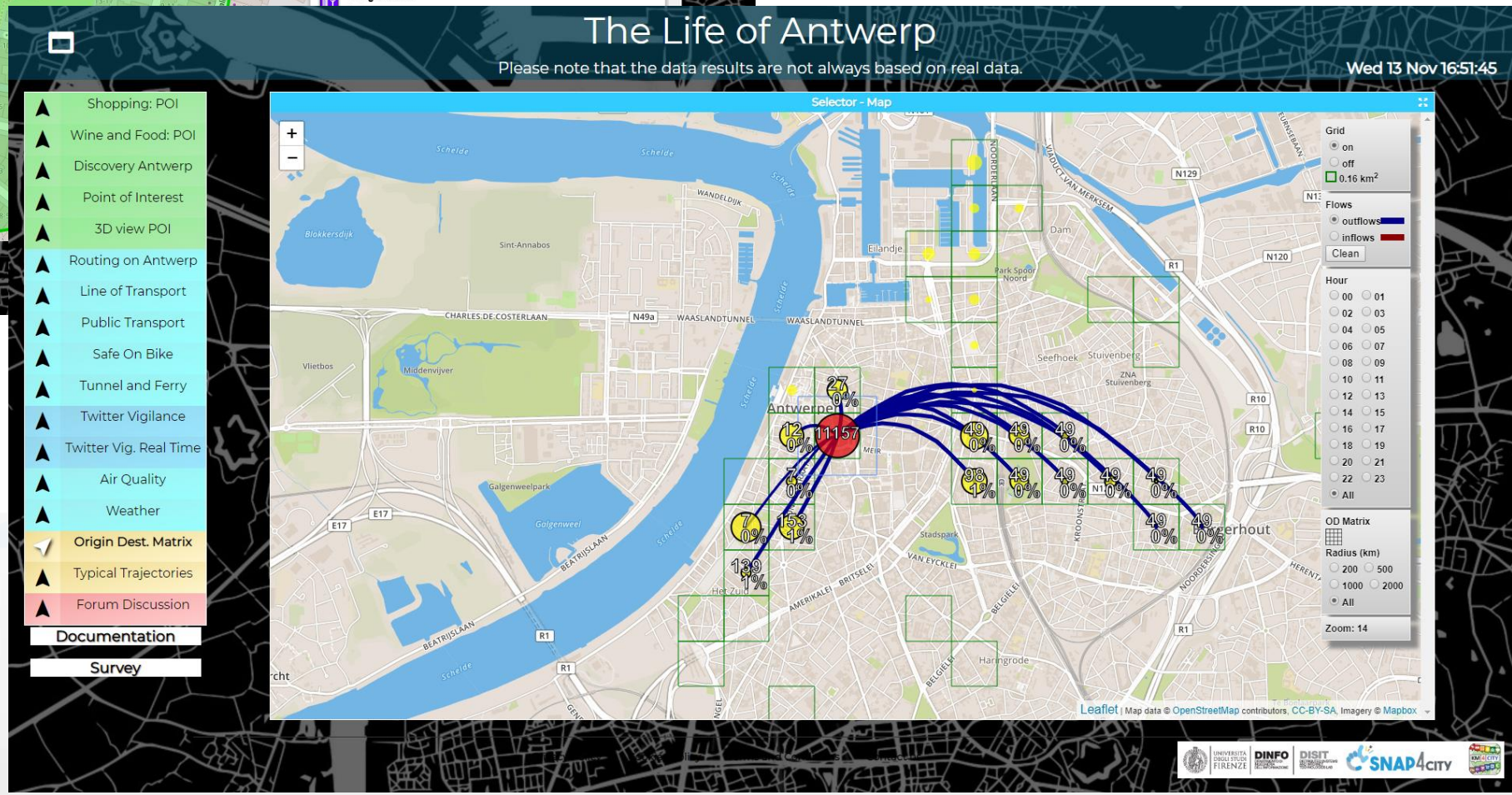
MAS Monitoring via PAXCounter

Mon 30 Sep 17:31:32

SNAP4CITY

KM4CITY

Antwerp



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

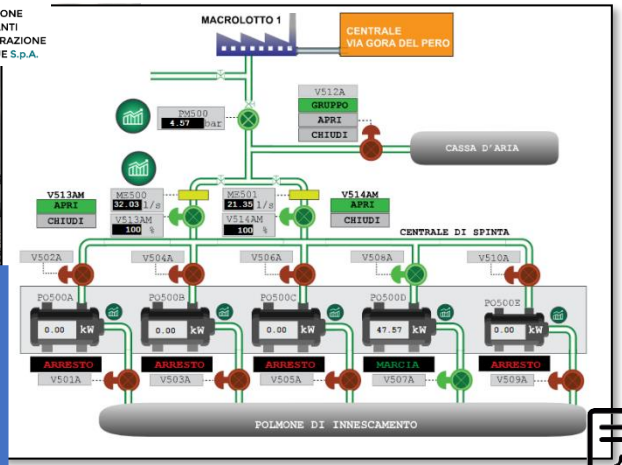
Prato
Smart City vs Industry 4.0

GIDA set up

Smart City data from many sources

IOT Applications

Dashboards and Apps



IOT Data Shadow Snap4City

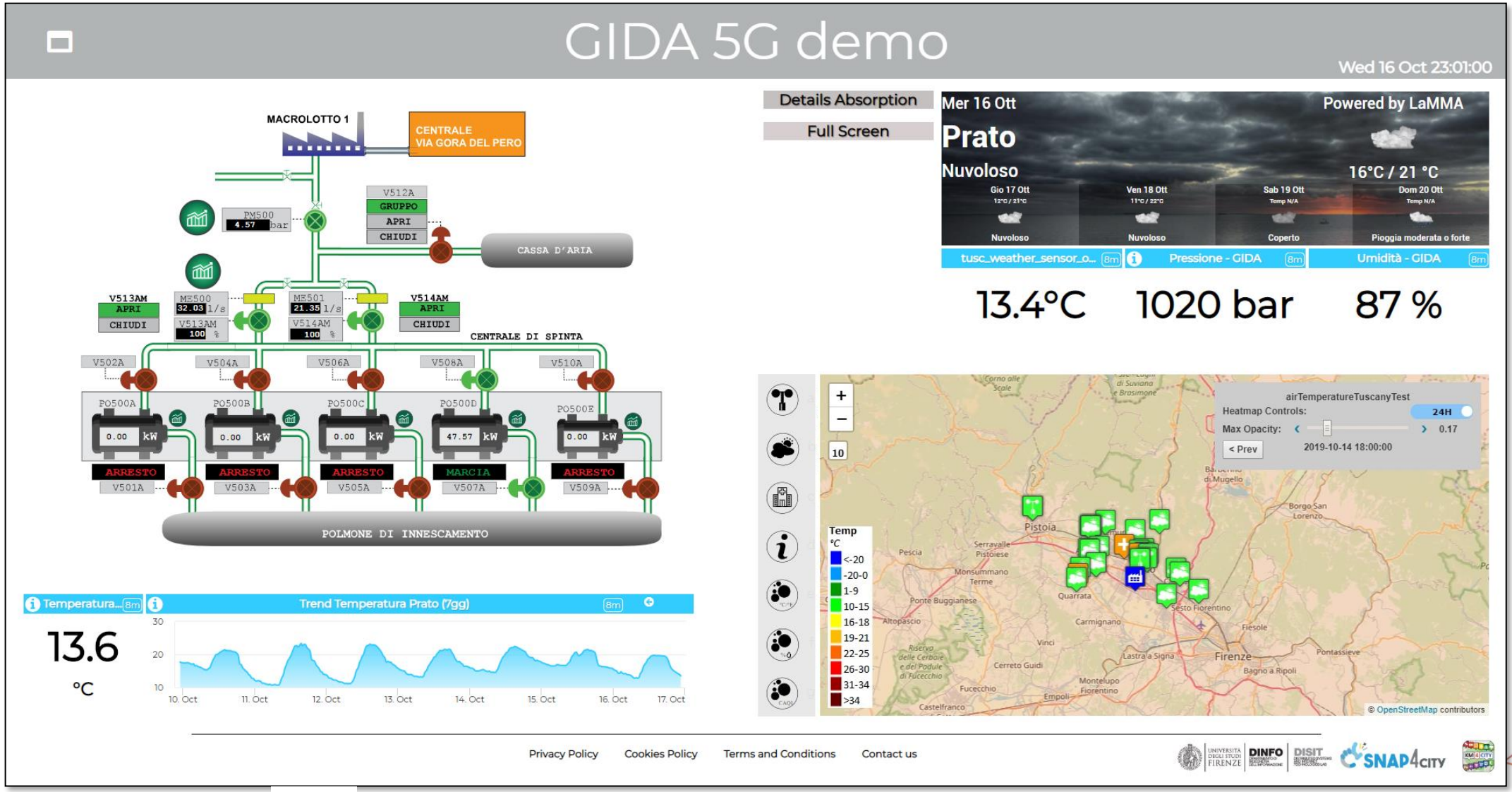
Big Data Analytics, Artificial Intelligence

ModBus to Snap4City Gateway Edge

5G network devices

Telemonitoring
Telecontrol

Dashboards & Services:

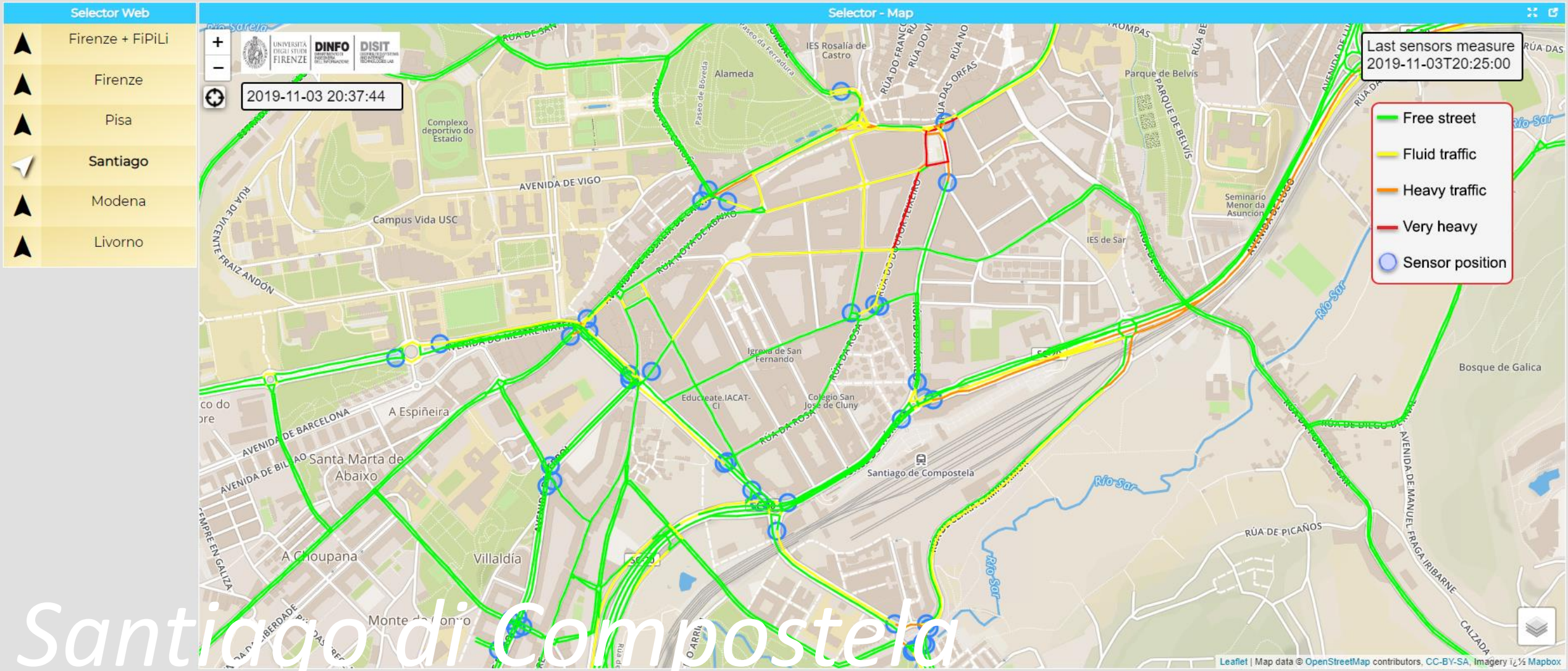


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjIyNg==

Santiago di Compostela

Traffic Flow Reconstruction for the cities

Sun 3 Nov 20:37:43



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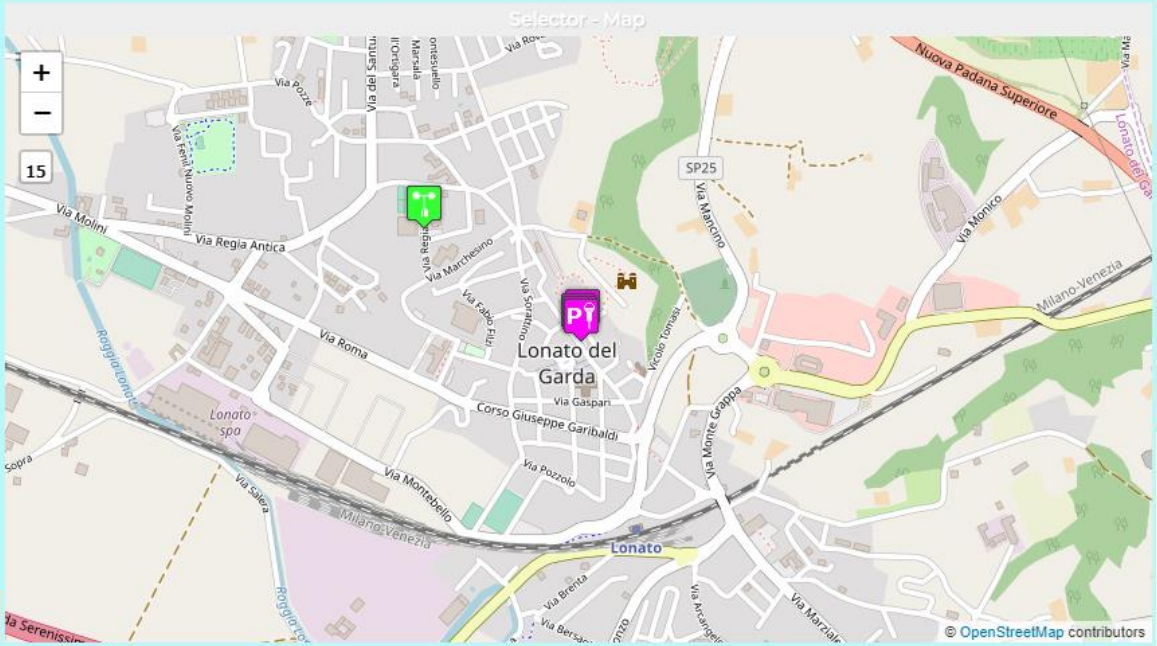
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc5NQ==

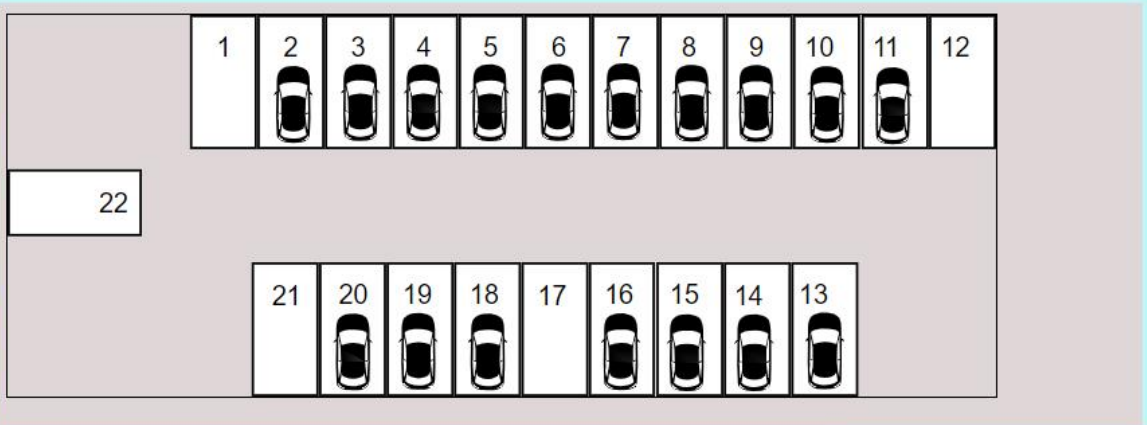
Lonato del Garda

Smart Lonato del Garda - cam

Tue 12 Nov 19:31:54

- Slot 1
- Slot 2
- Slot 3
- Slot 4
- Slot 5
- Slot 6
- Slot 7
- Slot 8
- Slot 9
- Slot 10
- Slot 11
- Slot 12
- Slot 13
- Slot 14
- Slot 15
- Slot 16
- Slot 17
- Slot 18
- Slot 19
- Slot 20
- Slot 21
- Slot 22
- Environment
- other





view cam

AVG time of free slot 9m
08 minuti

5
free slots

Median of Busy Slots 9m
1 ora e 23 minuti

Max Present Duration 9m
53 ore e 01 minuto

View main

Slot 1 - Status 9m
0
status

Slot 15 - Seconds of Occupancy 9m

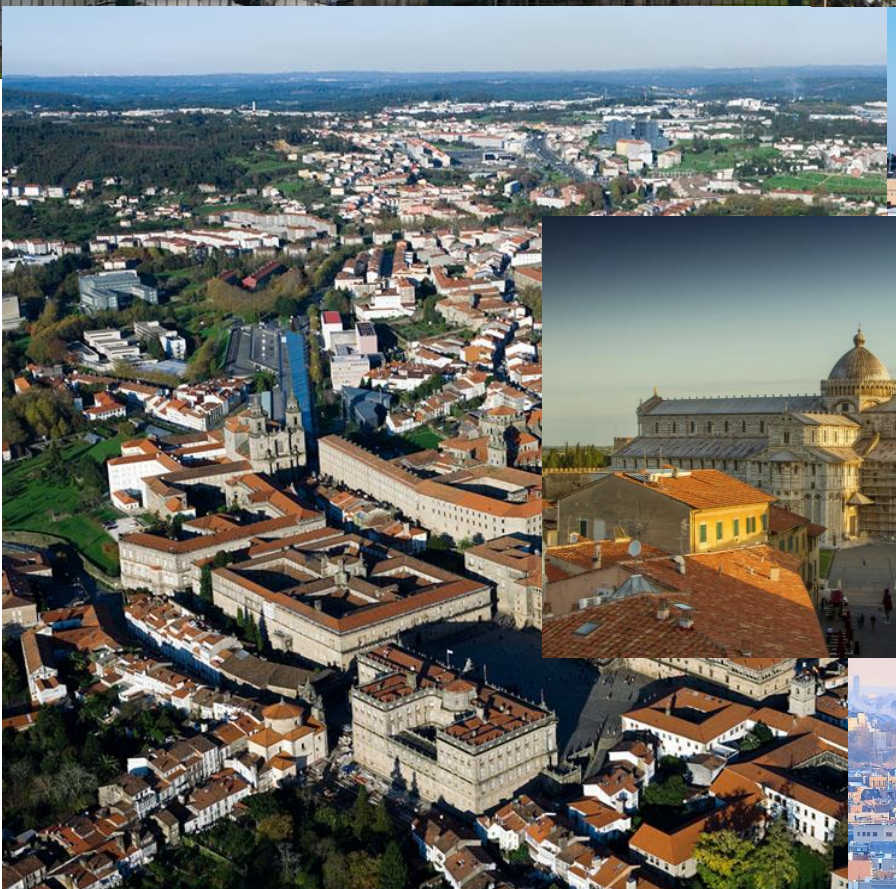
pressure 9m
976.2
mbar

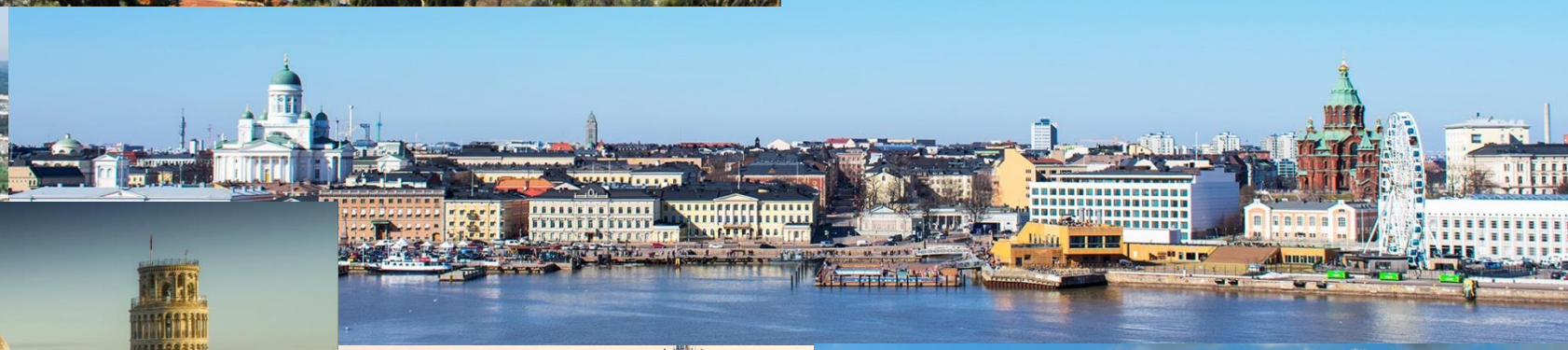
humidity % 9m
82.7
%

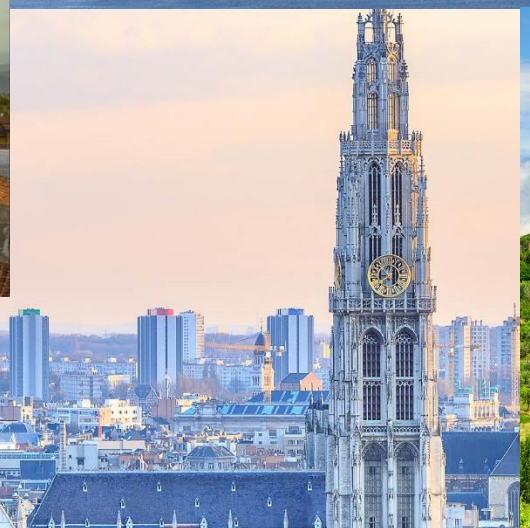
temperature 9m
10.7
°C

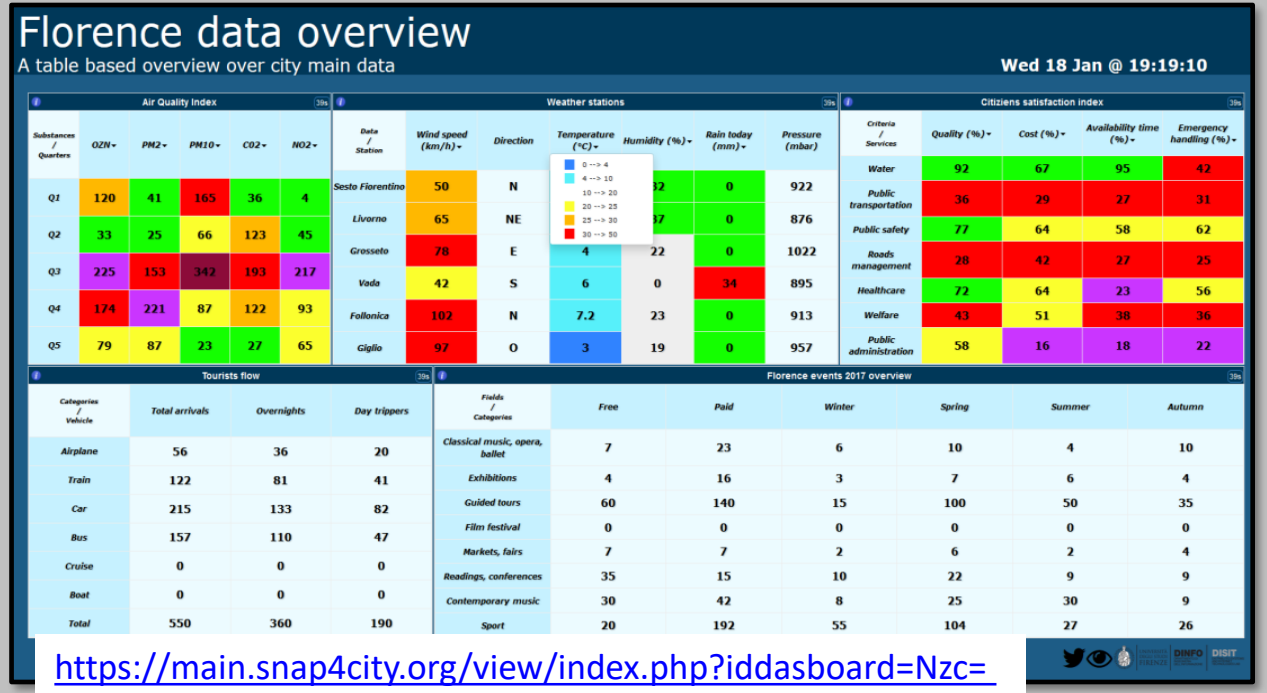
AirSensEUR_RVB01 - temperature (week) 9m

MOBY









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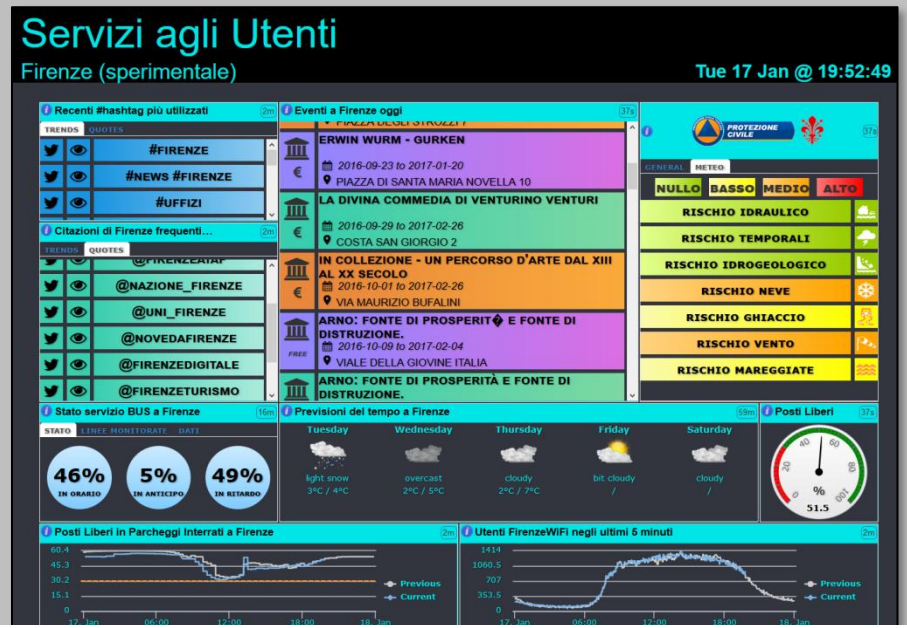

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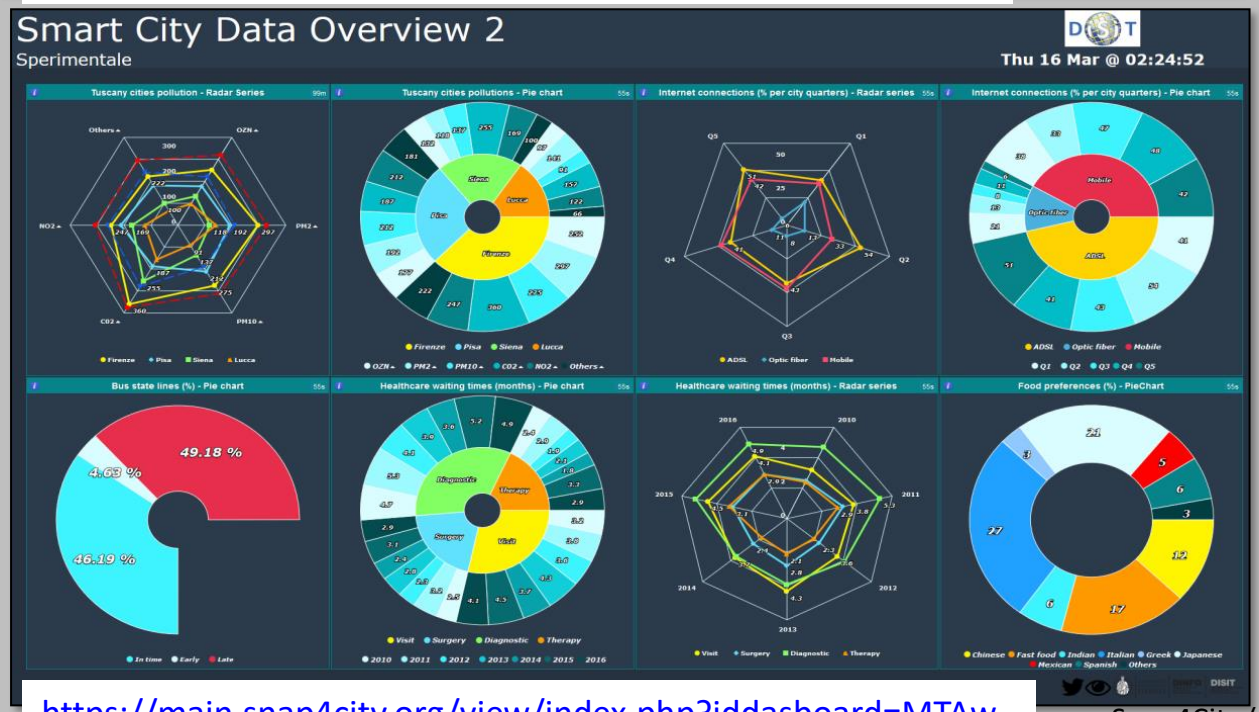

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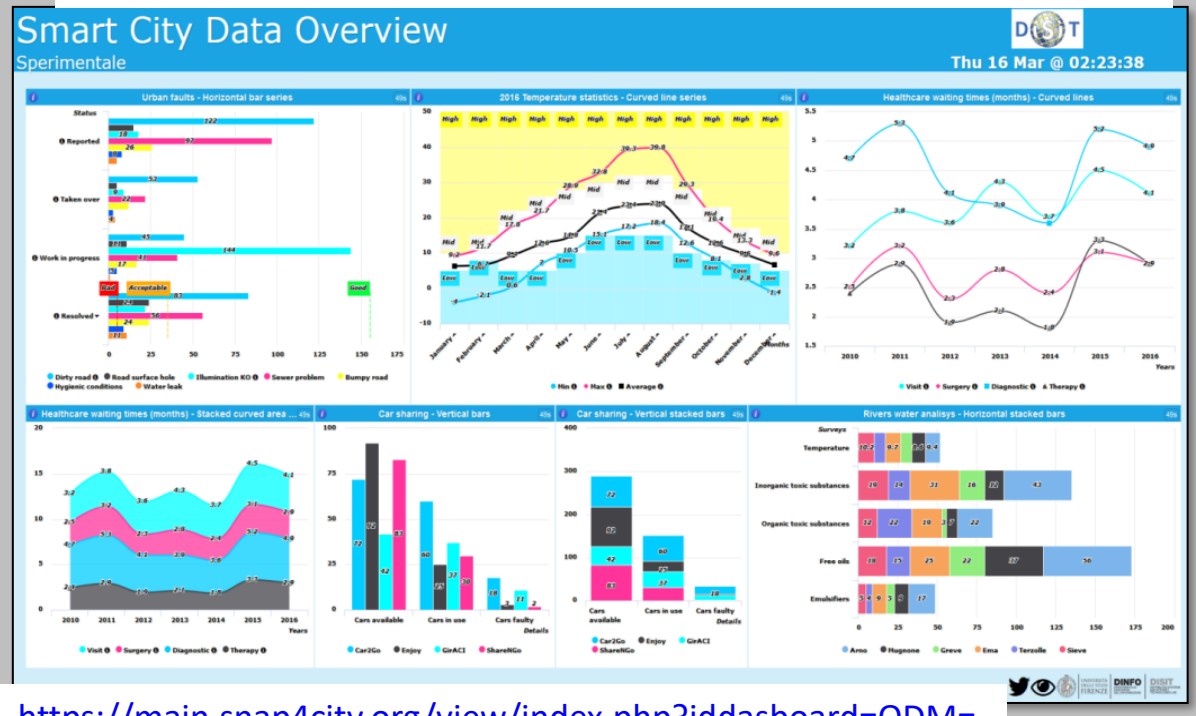


https://main.snap4city.org/view/index.php?iddasboard=ODM=

3D Map beta Testing

https://www.snap4city.org/4

- Scenario: Energy Monitoring
- Scenario: Multipurpose User Engagement Tools
- Scenario: 5G Enabled Water Cleaning Control (smart city, industry 4.0)
- Scenario: High Level Control of Industrial Plant (industry 4.0)
- Scenario: Vehicle Monitoring via OBD2
- Scenario: Events and Museums Monitoring in Antwerp
- Scenario: High Resolution Prediction of Environmental Data
- Scenario: Mobility and Transport Analyses in multiple cities
- Scenario: People Flow Analysis via Wi-Fi
- Scenario: Antwerp Pilot on Environmental Data
- Scenario: Helsinki Pilot on Environmental Data
- Scenario: Firenze Smart City Control Room
- Scenario: Mobile & Web App: Toscana Where What … Km4City, Toscana in a Snap
- Scenario: Helsinki Pilot on User Behaviour
- Scenario: Antwerp Pilot on User Behaviour

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

MORE data in other locations that we manage

- **Mobility**:
  - Underpasses (real time)
  - Ferry and railways (real time)
  - tracking of busses (real time)
  - Delay at bus-stops (real time)
  - ODB2 monitoring vehicles data and trajectories (real time)
  - Mobile trajectories (real time)
  - Bike sharing (real time)
  - Connected Driving (real time)
  - Fuel station prices (real time)
- **Environment**:
  - Sensors: Noise, distance, water flow, gas, …
  - Heatmaps: Noise, ….
  - Mobile sensors: PAX, environment
  - FMI predictions: PM10, PM2.5, EAQI
  - Quality index: AQI, EAQI, CAQI, ..
- **Energy**:
  - **…..**
- **Weather**
  - Forecast and actual, several sources
- **Social**:
  - PAX Counters, Mobile PAX Counters
  - Engagement data collected from mobile Apps
  - Clicks on Mobile Applications
  - Ranking, comments and images, from Apps (web and mob)
  - Entertainment events: different kinds
- **People and People Flows**:
  - Mobile Applications
  - Origin destination matrices, people flow
- **Governmental and Communications**:
  - Emergency, risk analysis and resilience
  - Notification of events, CAP, ..
- **Tourism and Culture:**
  - POI, many many kinds

Many data analytics, for example:

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

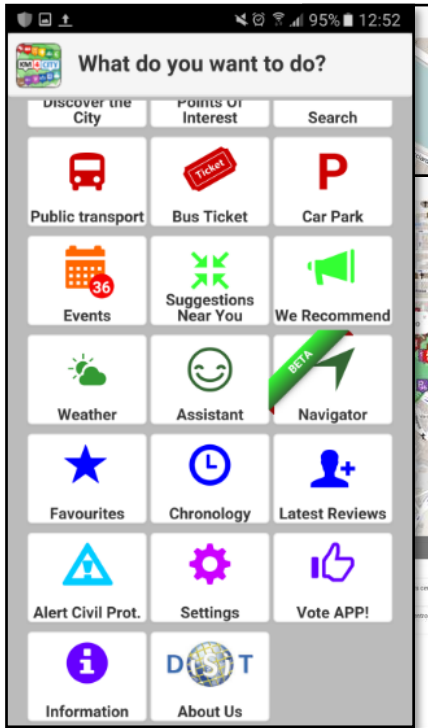
TOP

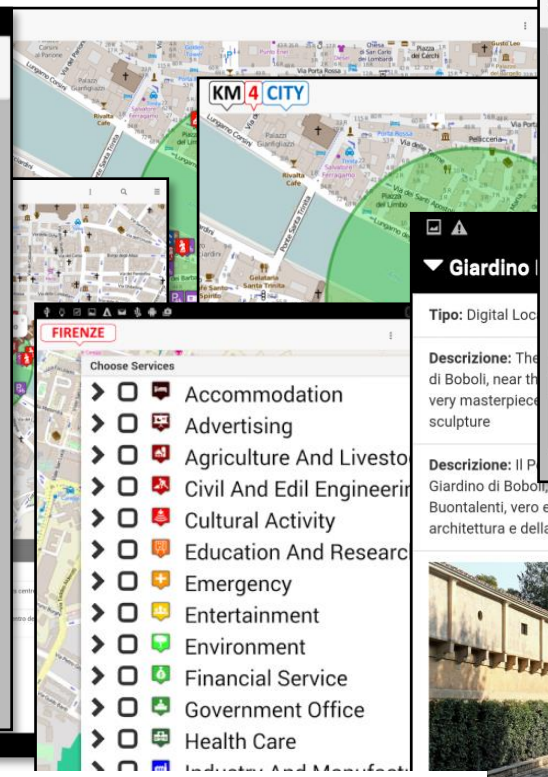
The Mobile and web Apps

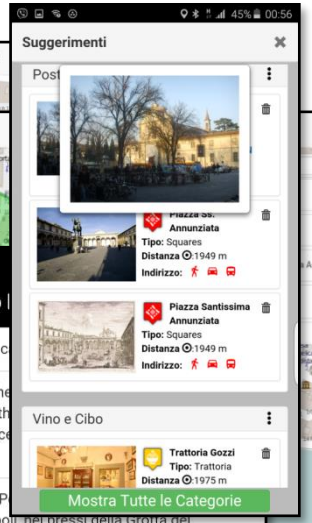
UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

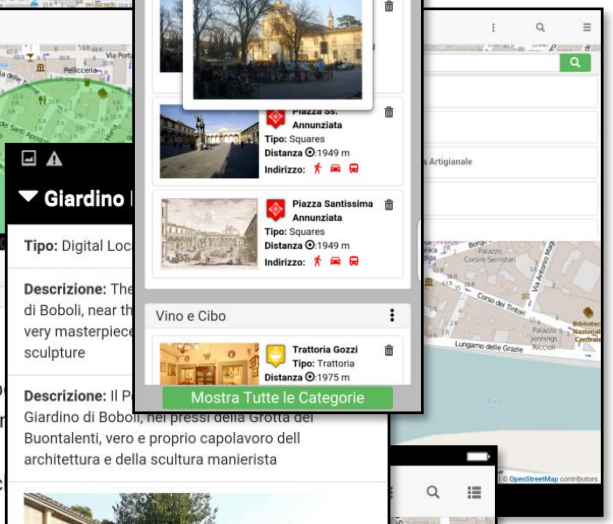
Mobile Apps

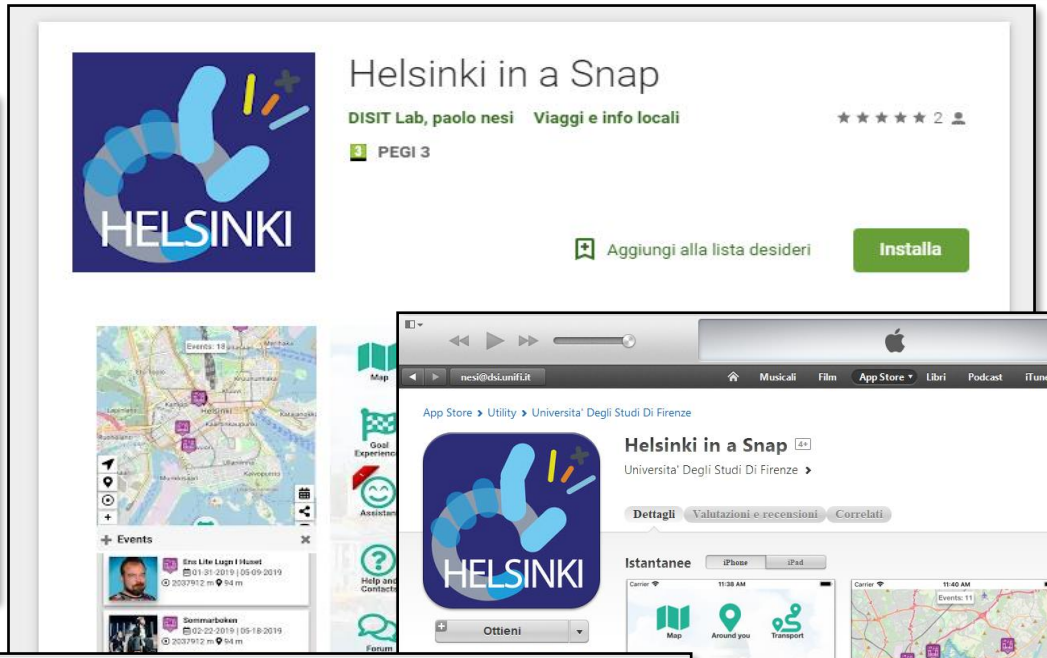
SNAP4CITY KM 4 CITY











DISPONIBILE SU Google play

Scarica da App Store

Scarica da Windows Store

SNAP4CITY

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 ?
- …

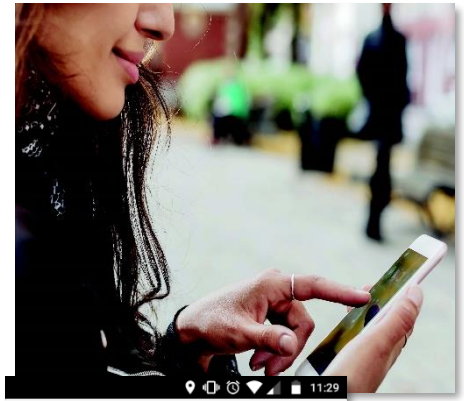
Derived information

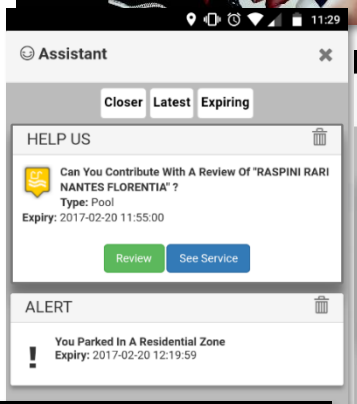
- Trajectories
- Hot Places by click and by move
- Origin destination matrices
- Most interested topics
- Most interested POI
- Delegation and relationships
- Accesses to Dashboards
- Requested information
- Routing performed
- …..

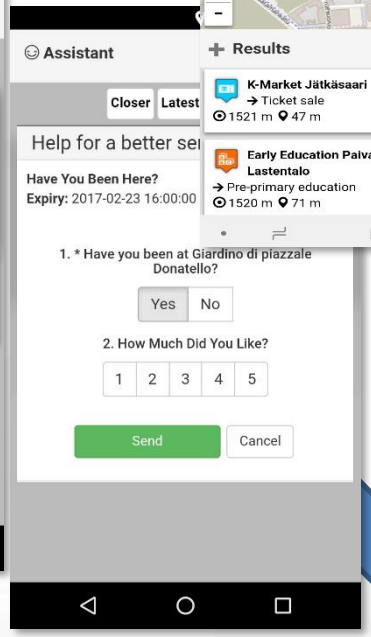
Produced information

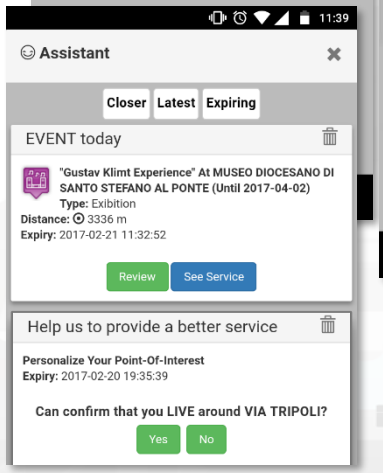
- Suggestions
- Engagements
- Notifications
- …

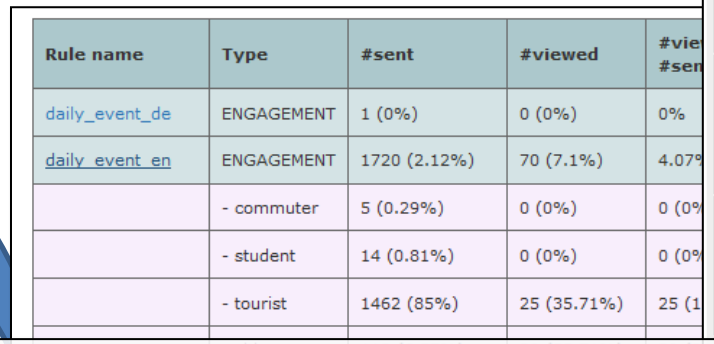
Users' Engagement



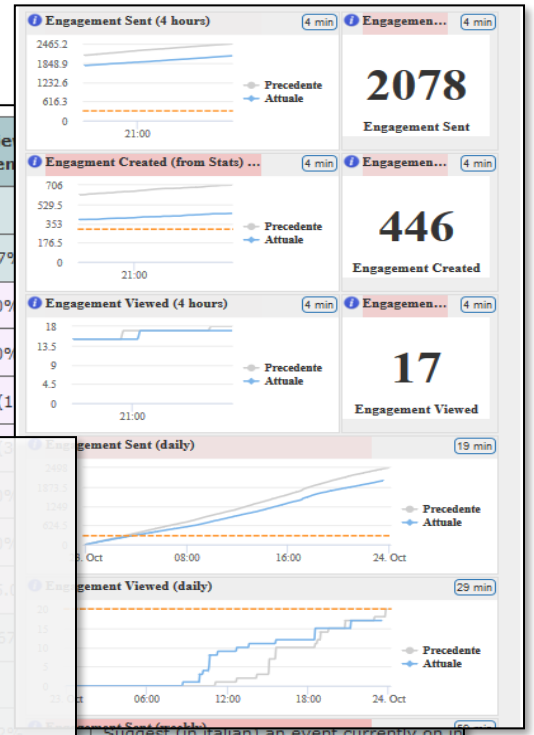


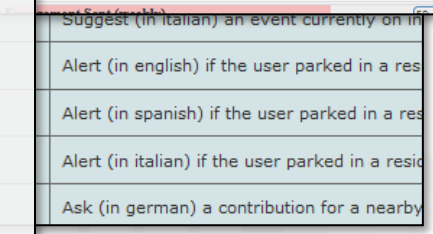






Rule name	Type	#sent	#viewed	#vie #sen
daily_event_de	ENGAGEMENT	1 (0%)	0 (0%)	0%
daily_event_en	ENGAGEMENT	1720 (2.12%)	70 (7.1%)	4.07%
	- commuter	5 (0.29%)	0 (0%)	0 (0%
	- student	14 (0.81%)	0 (0%)	0 (0%
	- tourist	1462 (85%)	25 (35.71%)	25 (1





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

Engage
- Provide a comment, a score, etc.

Stimulate / recommend
- Events in the city, services you may be interested, etc..

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

User context

Rules

City context

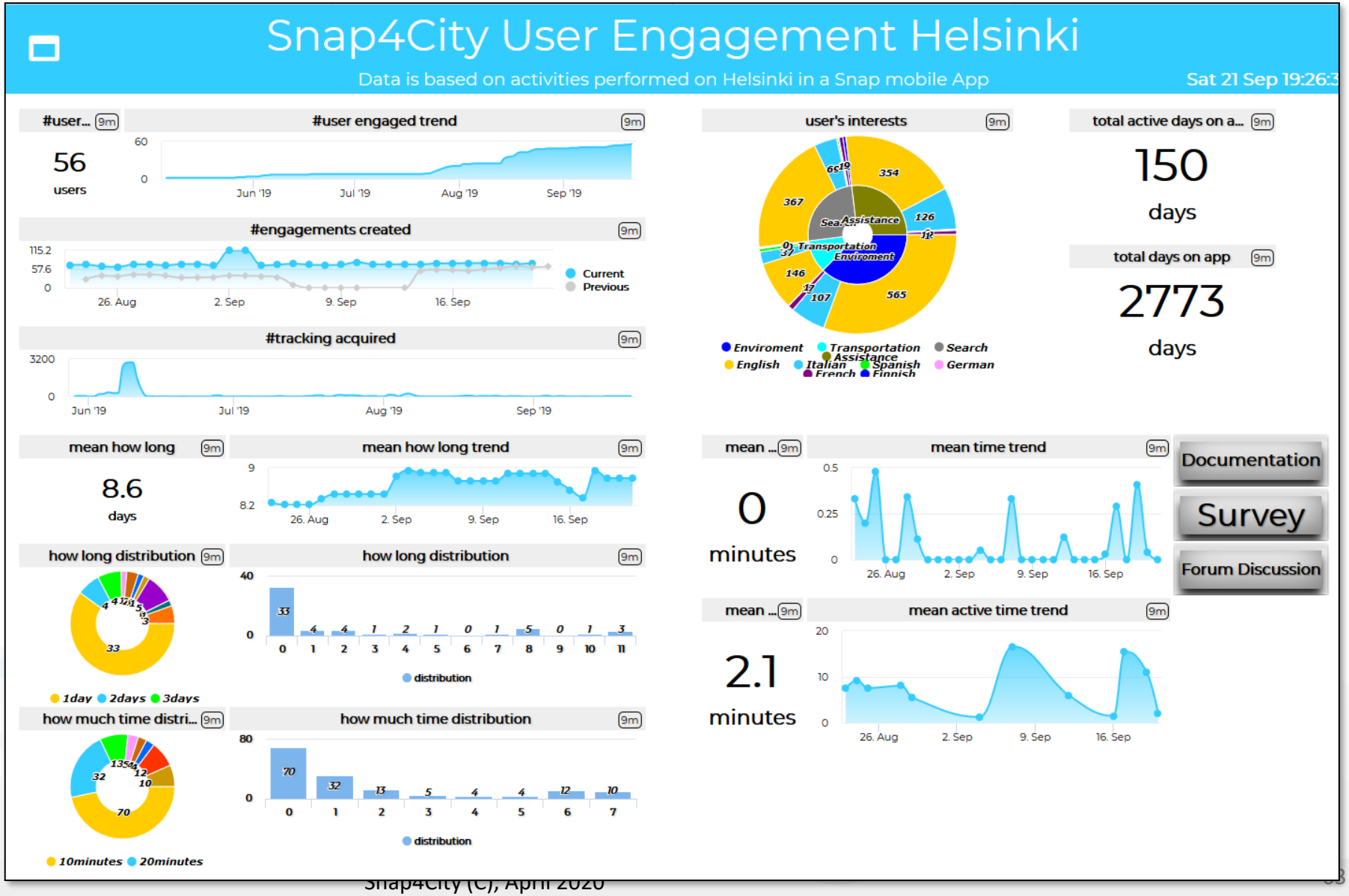
Campaing on Sustainable Mobility

Helsinki

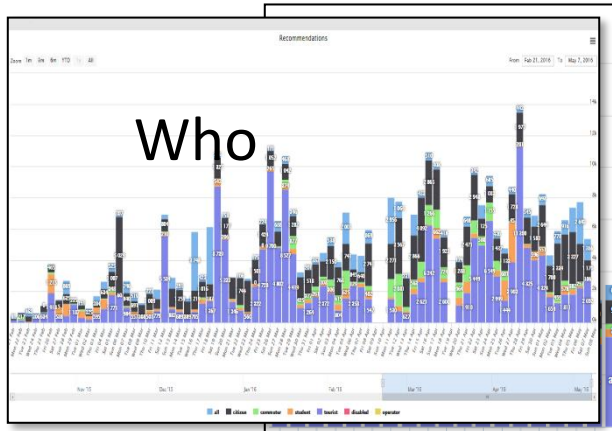
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc1OA==

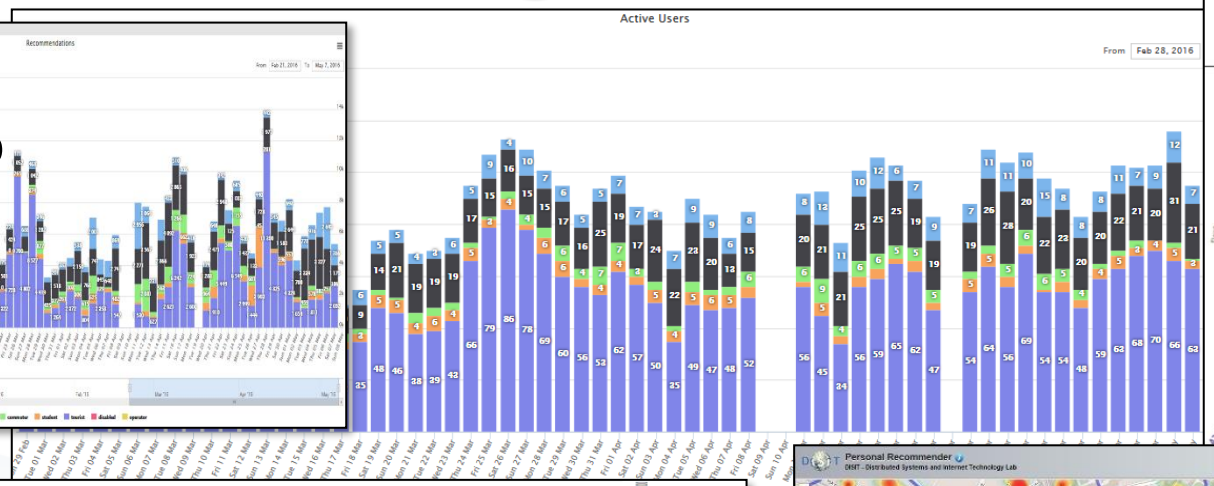
Dashboard monitoring the Mobile App:

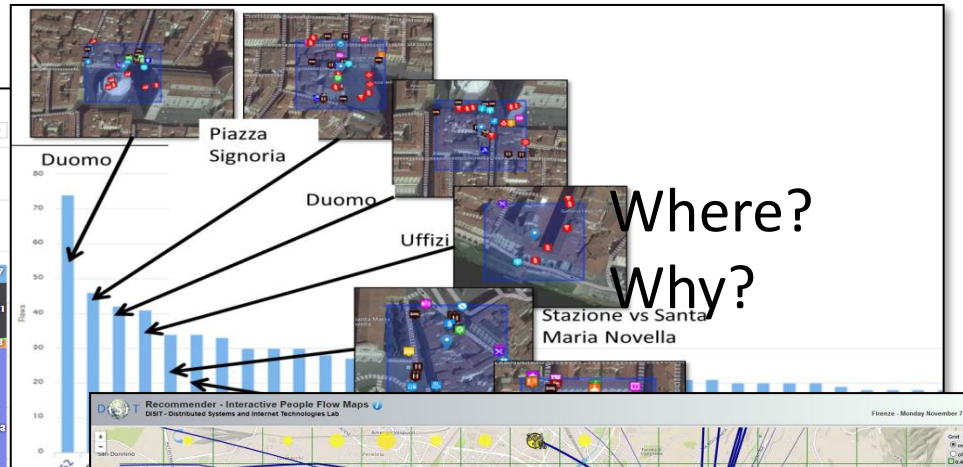
- Collecting the clicks
- Describing the community of users in terms of the profile aspects
- Measuring the time spend, and topics of interest of the users, etc.

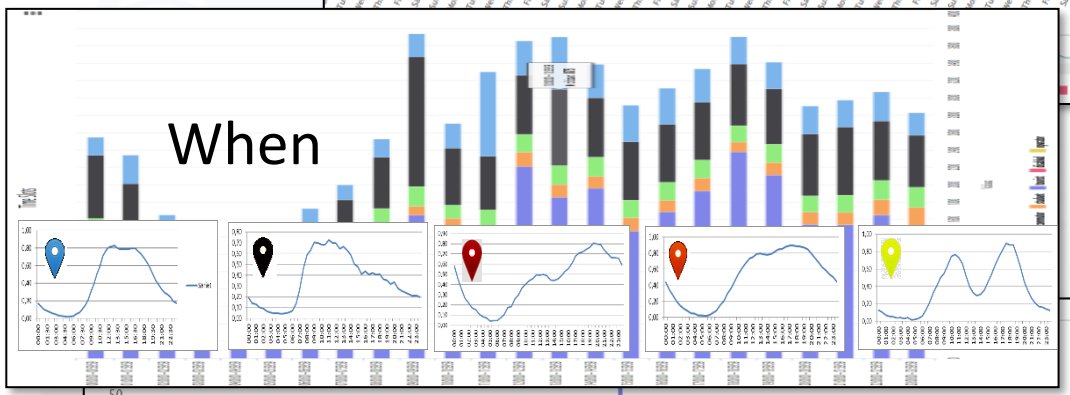


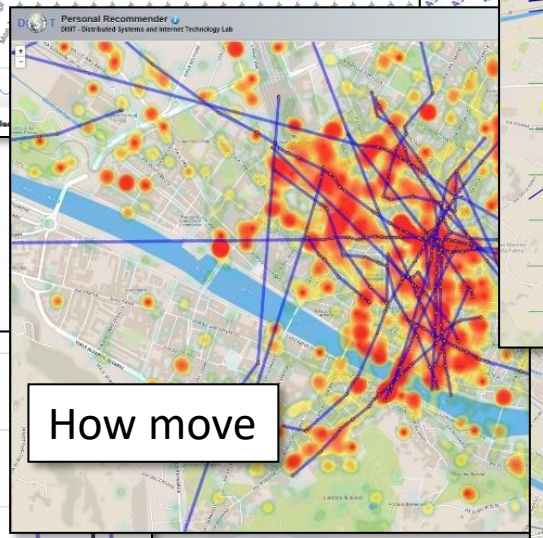
User Behavior Analyser for Collective Profiling

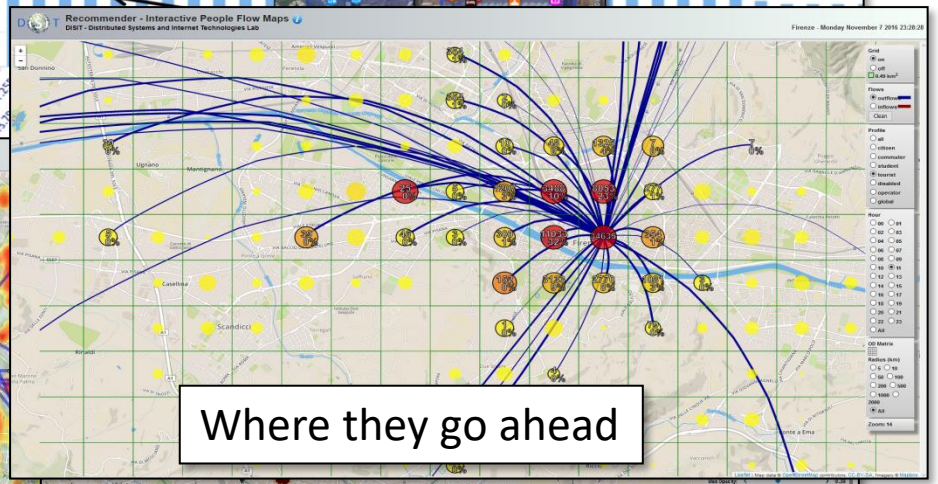


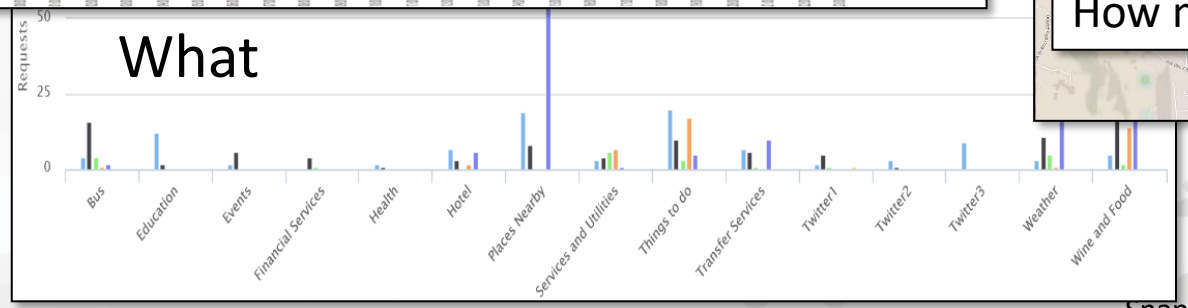


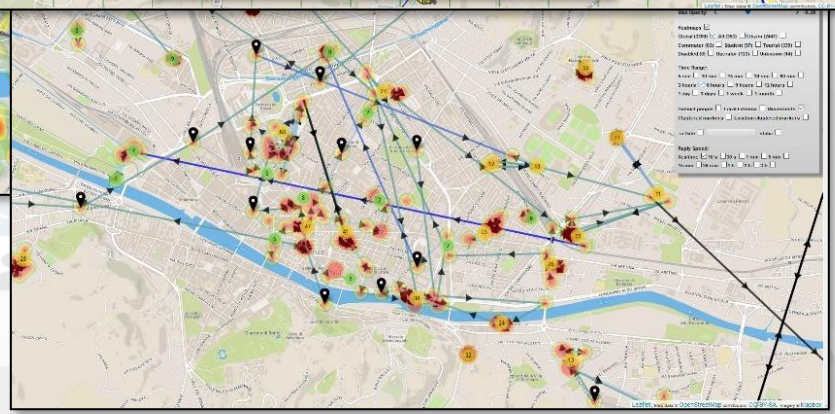






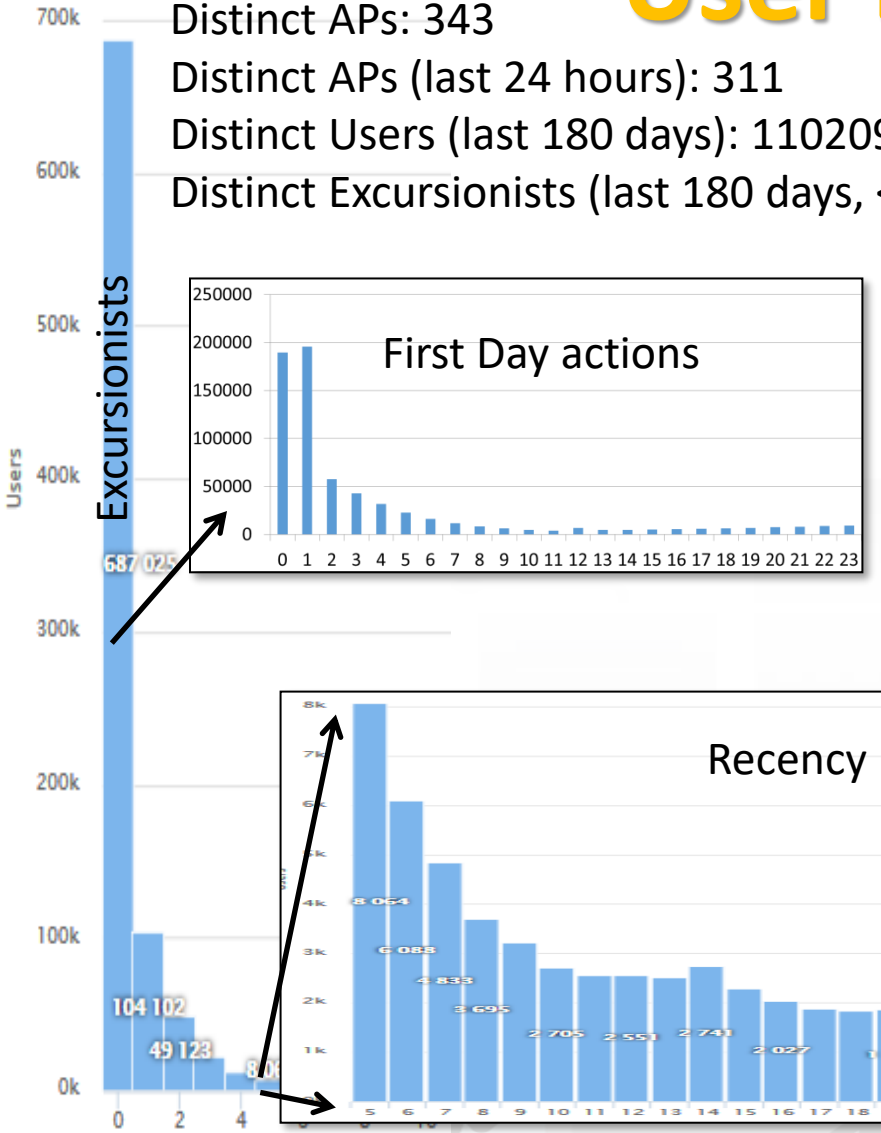


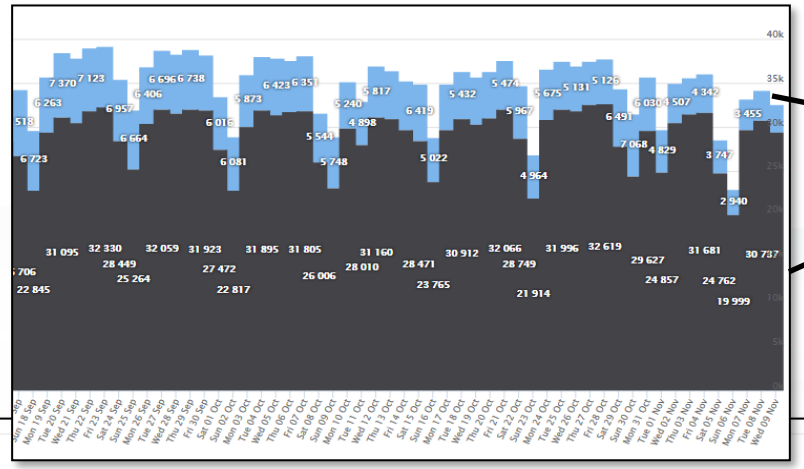




User Behaviour Analysis

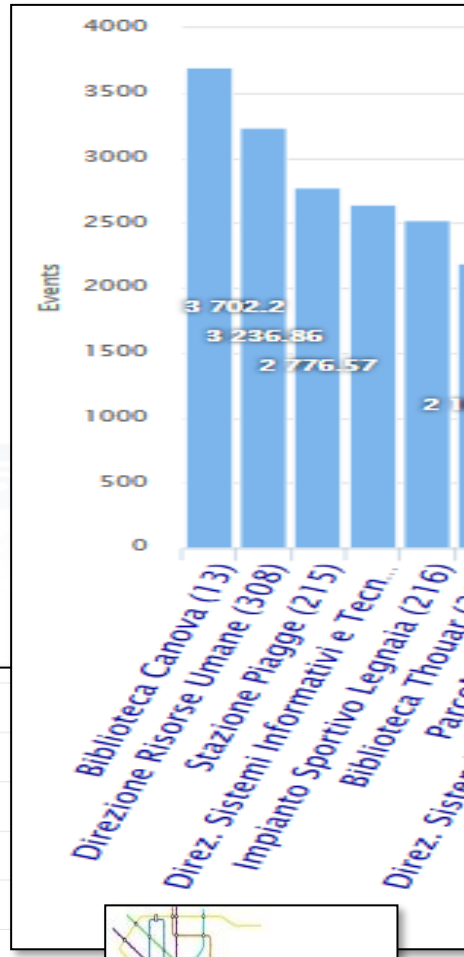
Distinct APs: 343
Distinct APs (last 24 hours): 311
Distinct Users (last 180 days): 1102098
Distinct Excursionists (last 180 days, < 24 h): 687025





New City Users
VS
Returning

Where



Scalable multiresolution OD matrix

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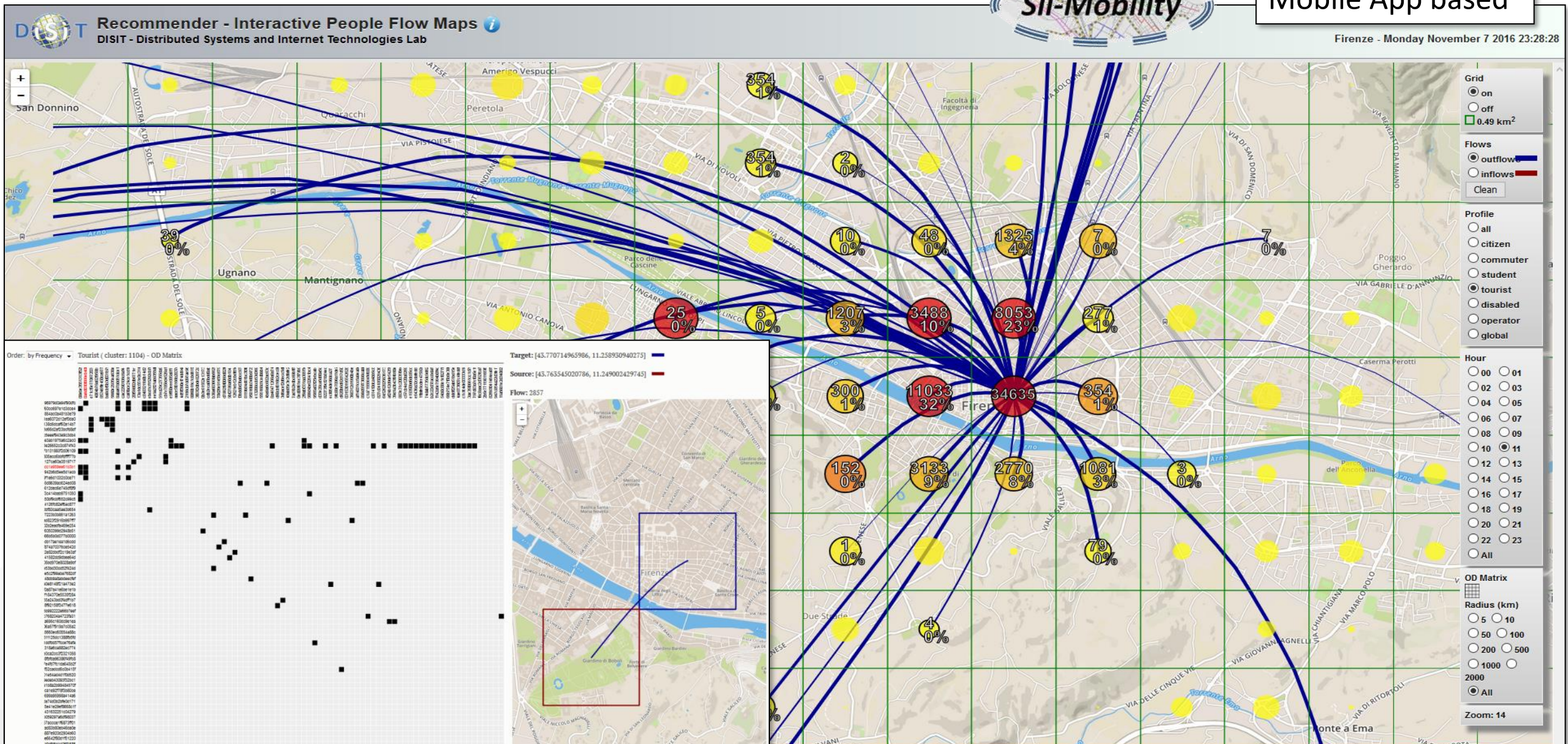
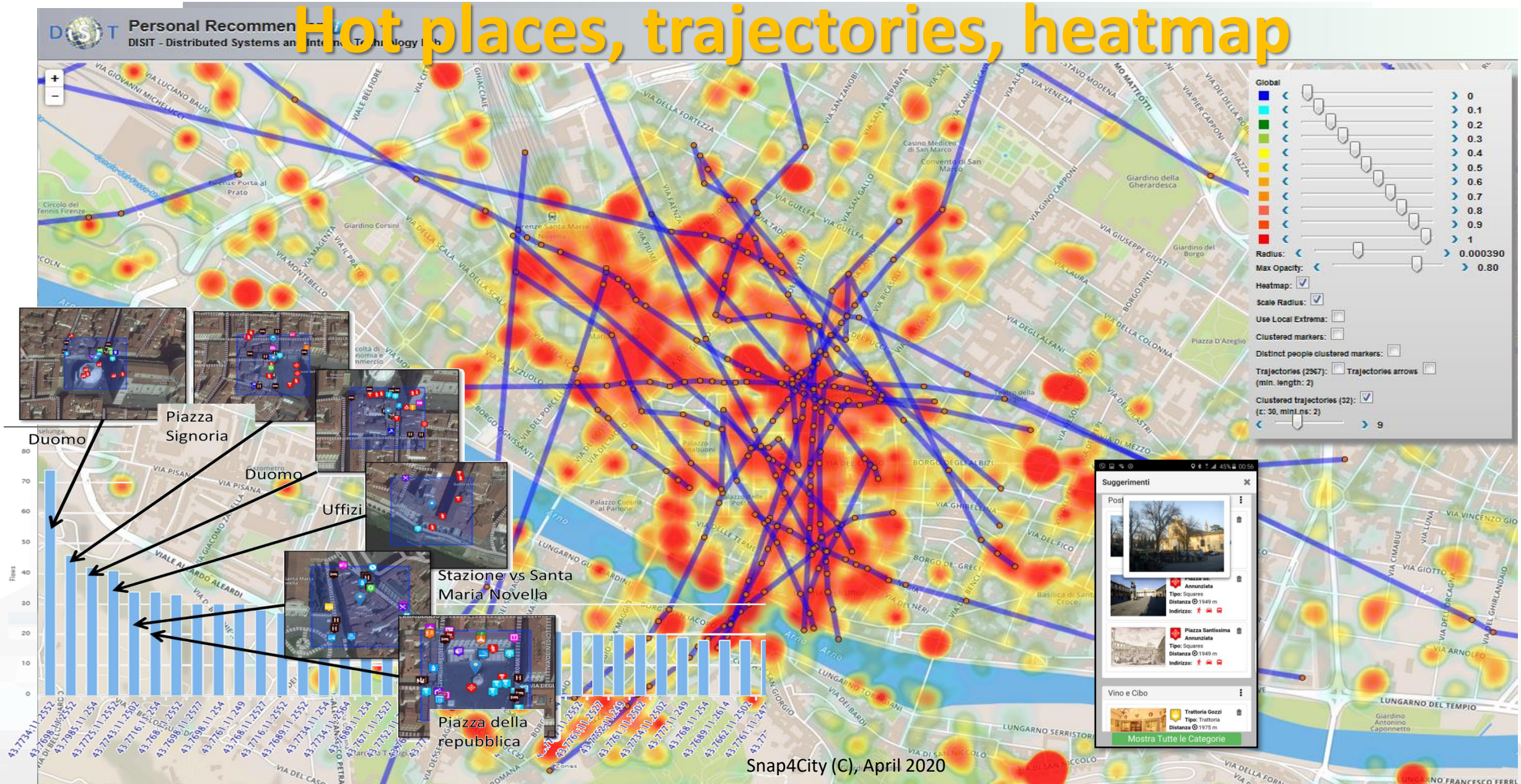
Sii-Mobility

Mobile App based



User Behaviour Analyser

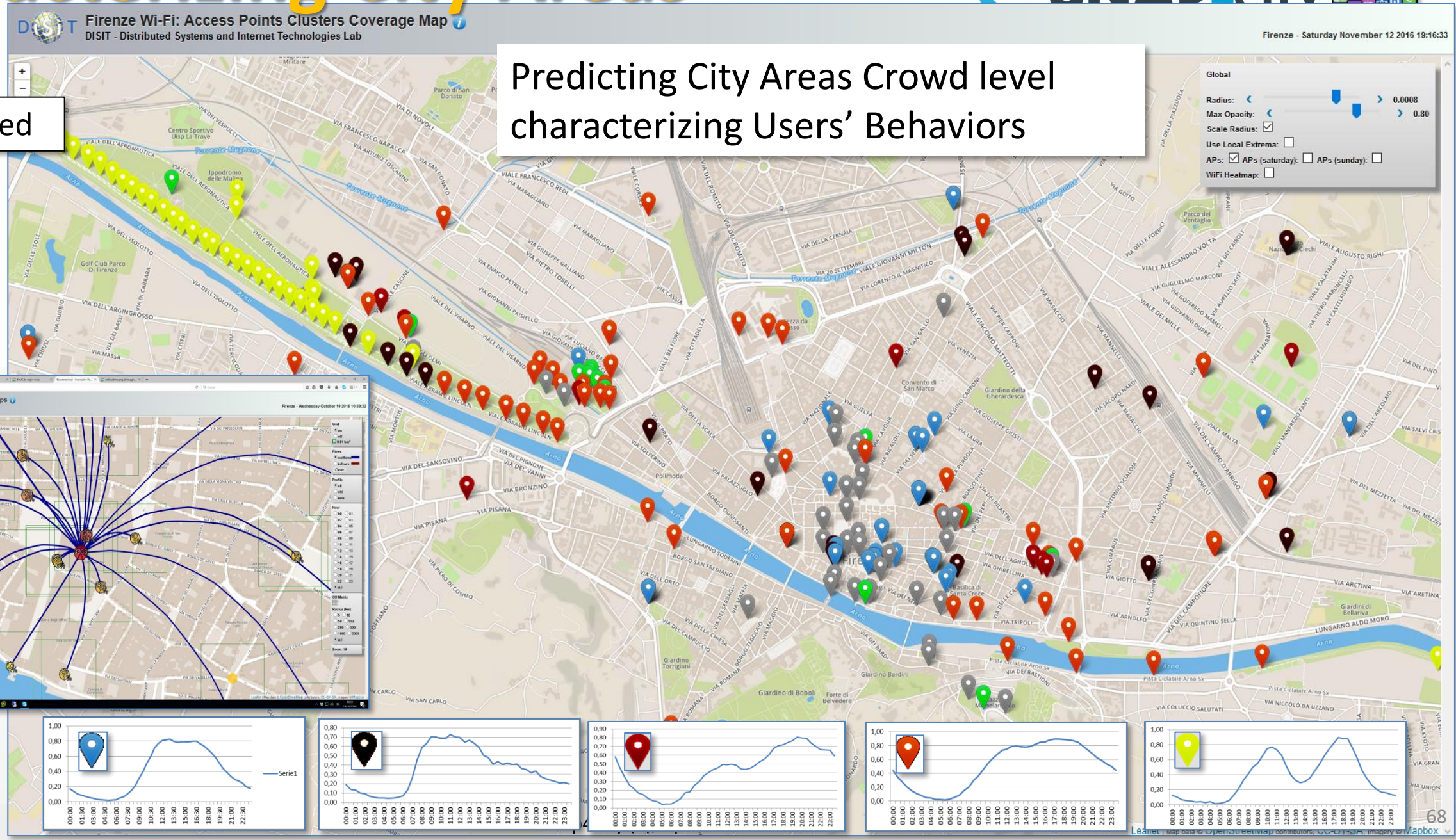
Hot places, trajectories, heatmap



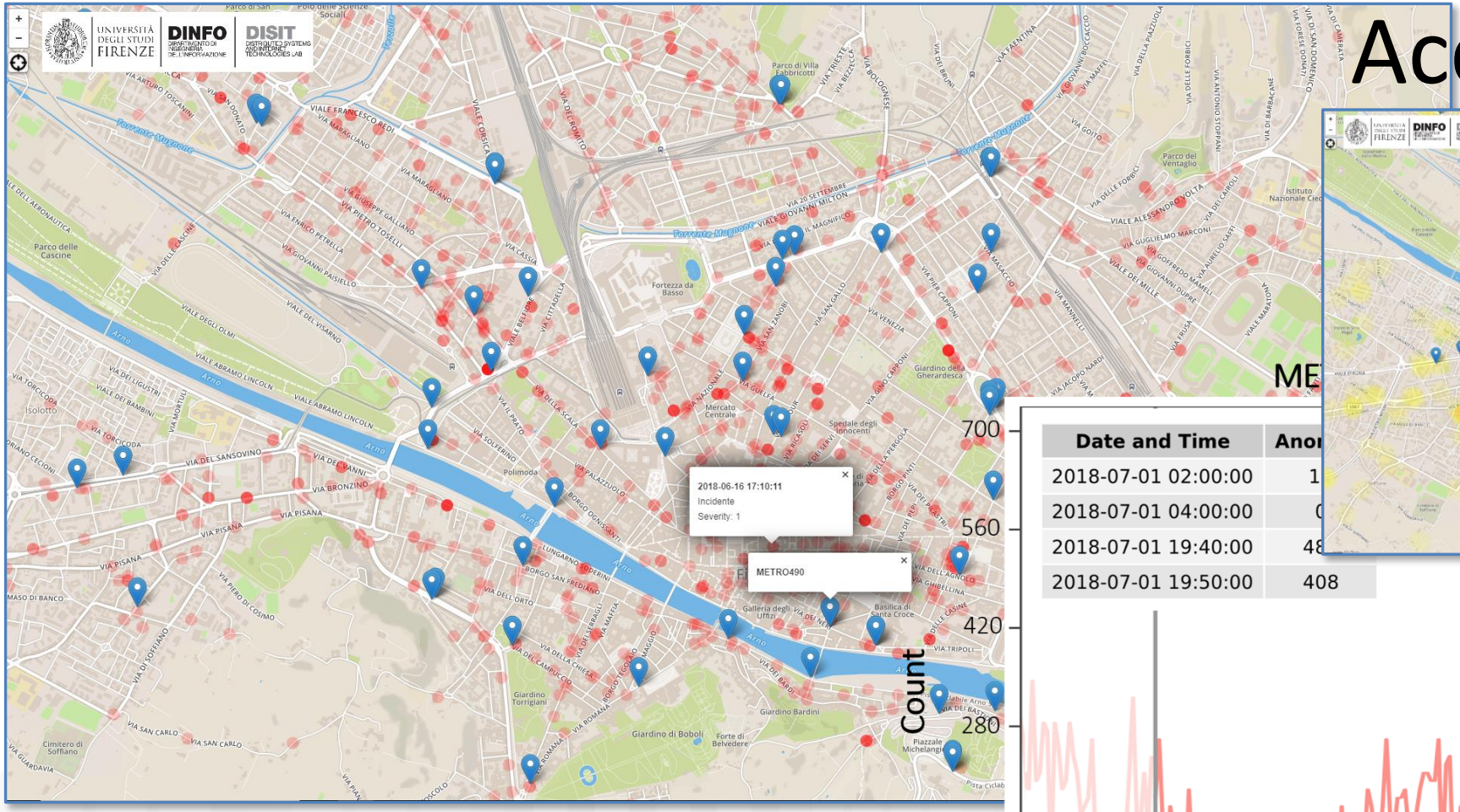
Characterizing City Areas

Wi-Fi based

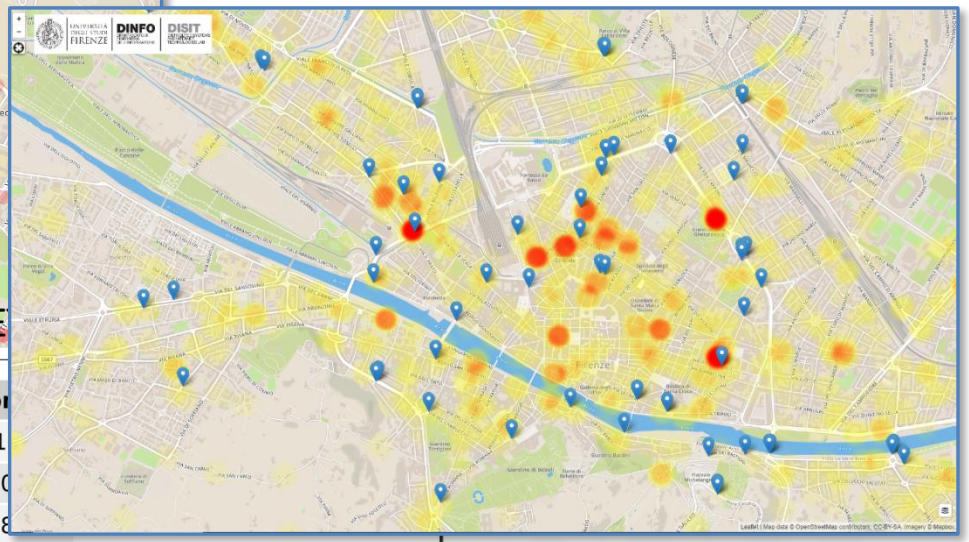
Predicting City Areas Crowd level characterizing Users' Behaviors



Anomaly Detection

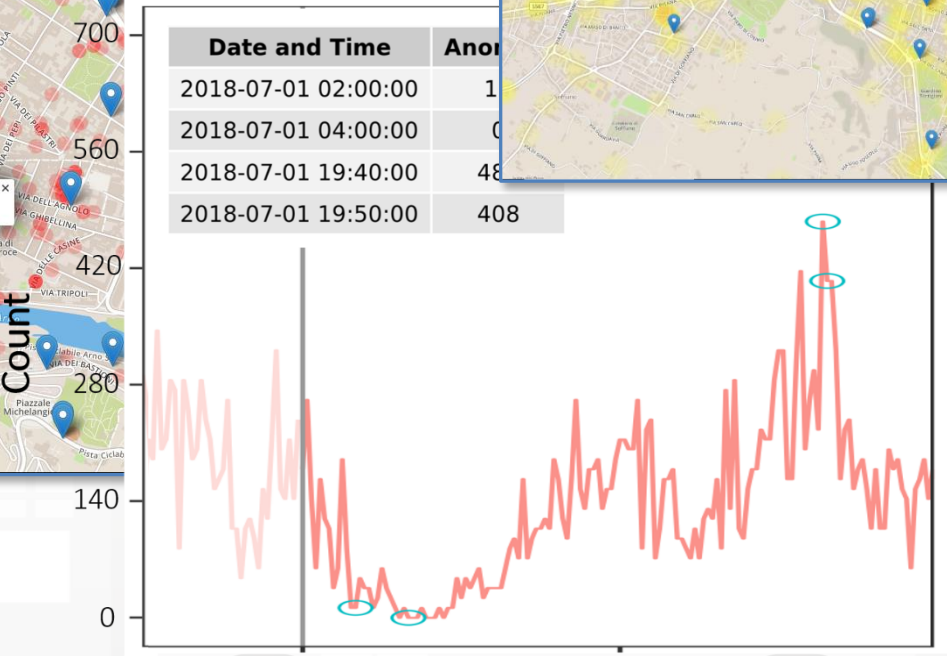


Accidents Density

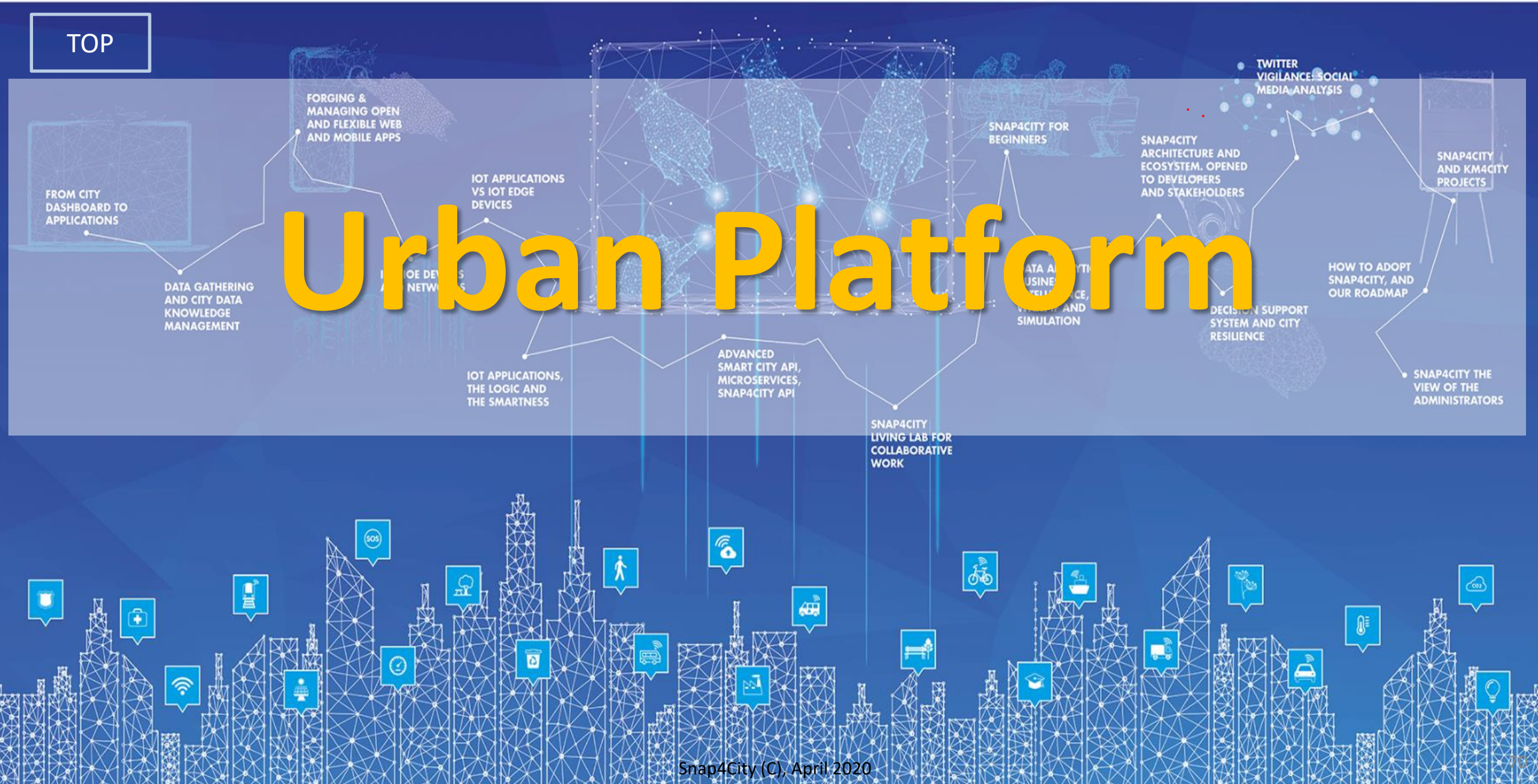


Accidents vs Traffic

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



TOP



Urban Platform

Challenges: Requests and Deductions

Public Admin.

Pub. Admin: detection of critical conditions, improving services

Mobility Operators

Tune the service, reselling data and services , prediction

Commercial: customers prediction and profiles, promotions via ads

Tourism Museums

Tune the service, prediction

API for SME

Smart City Engine

User profiling
Collective profiles
User segmentation

Services & Suggestions
Transport, Mobility, Commercial (retail), Tourism, Cultural

Personal Time Assistant
dynamic ticketing, whispers to save time and money, geoloc information, offers, etc.

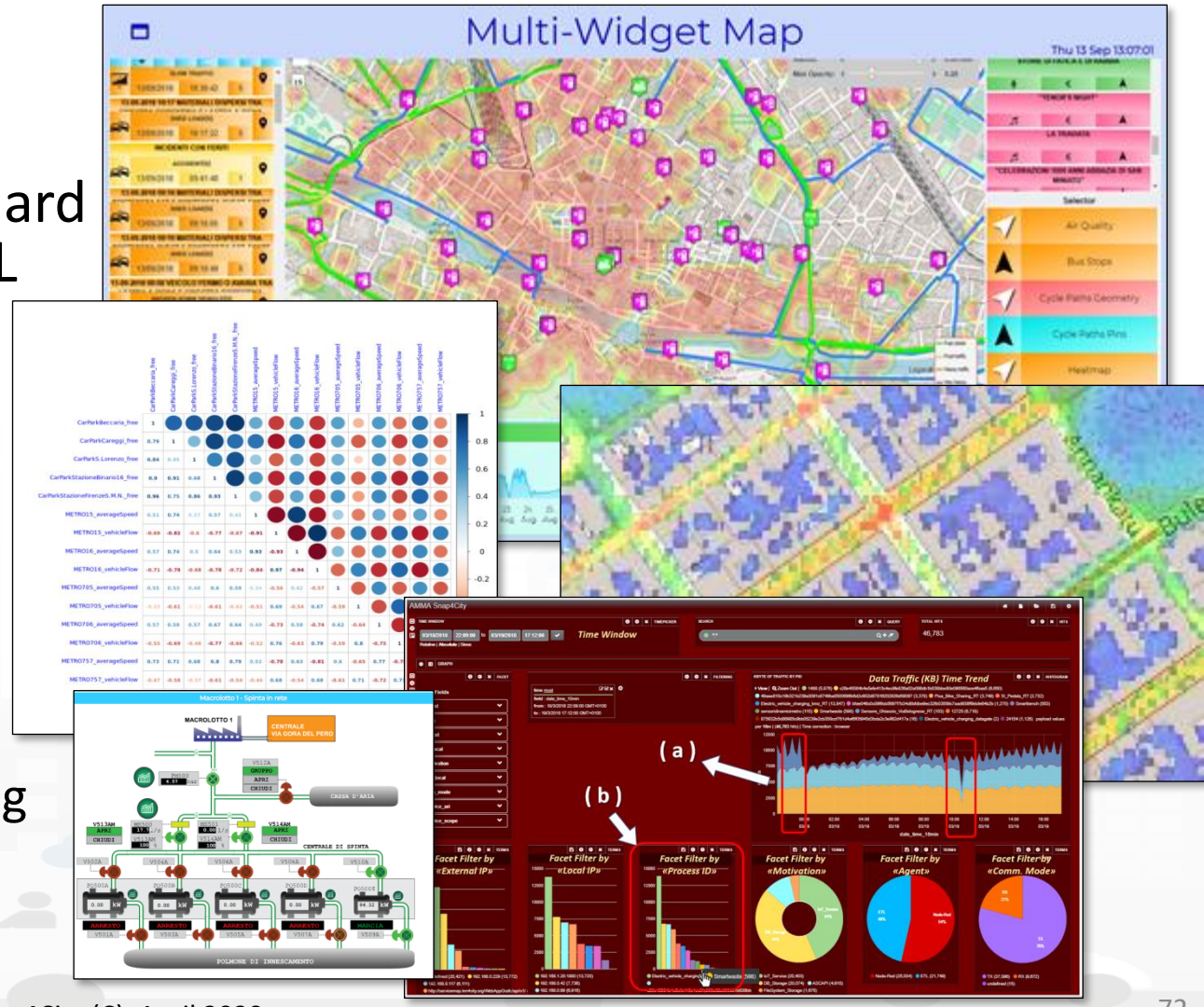
User Behavior
Crowd Sources

Data: Public and Private, Static and Real Time

Private: user movements, social media, crowd sources, commercial (retail)
Public: infomobility, traffic flow, TV cameras, flows, ambient, weather, statistic, accesses to LTZ, services, museums, point of interests, …

Data Rendering vs Control Room Dashboards

- **GIS** rendering by layers
- **Business intelligence** mainly focused on making statistics from tabular: no layer, hard relationships, ... Exploit Data Analytic, ETL
- **Visual Analytics**, data understanding
  - Rendering and drill down
  - Faceting/grouping (Elastic Search/SOLR)
  - Cross filtering (Kibana, Grafana, Banana)
  - Interactive, Cross Widgeting
- **Control Room Dashboards:**
  - Need: Visual Analytics, Data Analytic, geospatial reasoning, data driven processing
  - H24, alerting, Flexible rendering, custom widgets, interactive dashboards

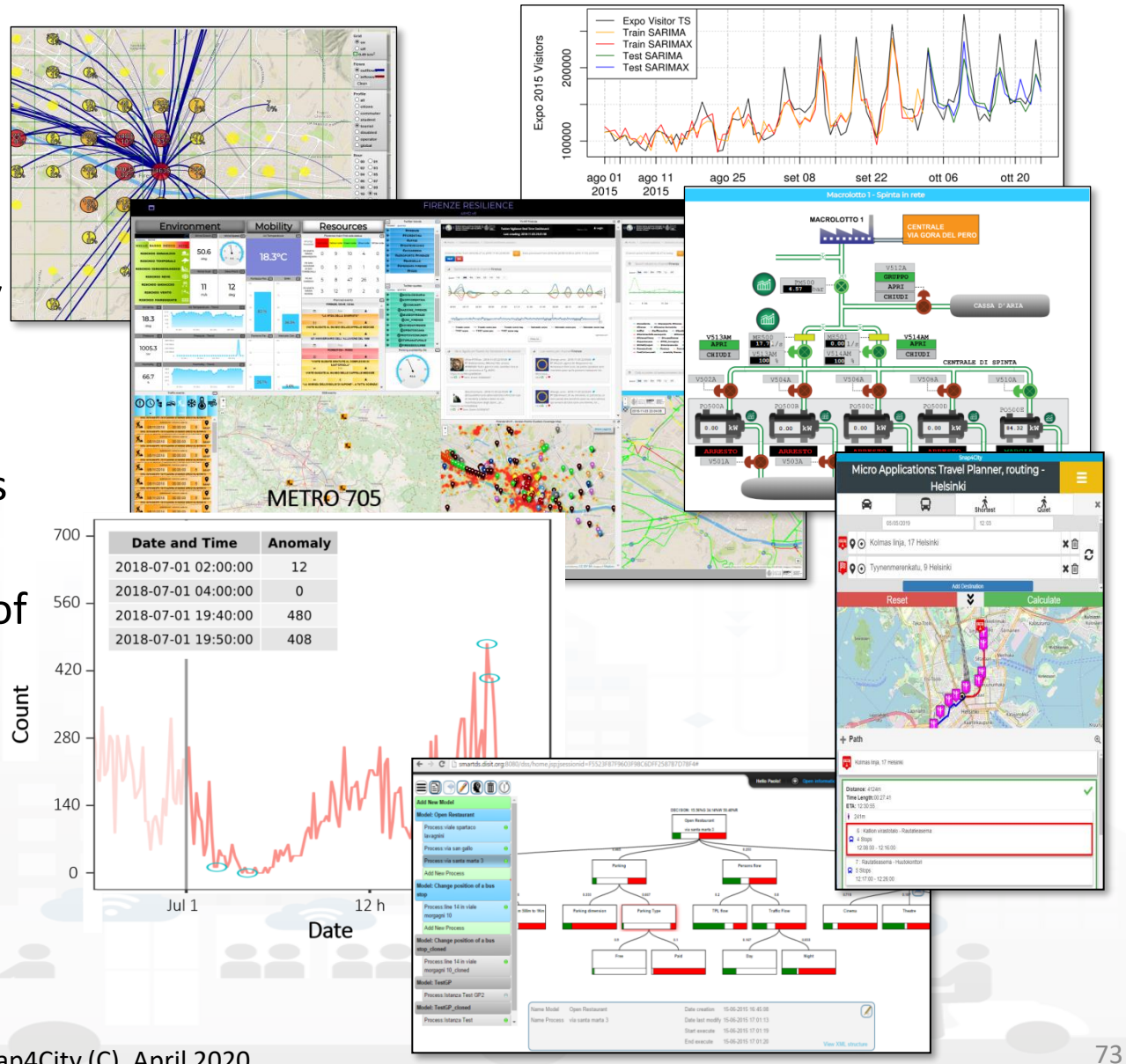


Decision Support, Act!

Smart City Control Room, SCCR, SCR

- Not only a collection of verticals

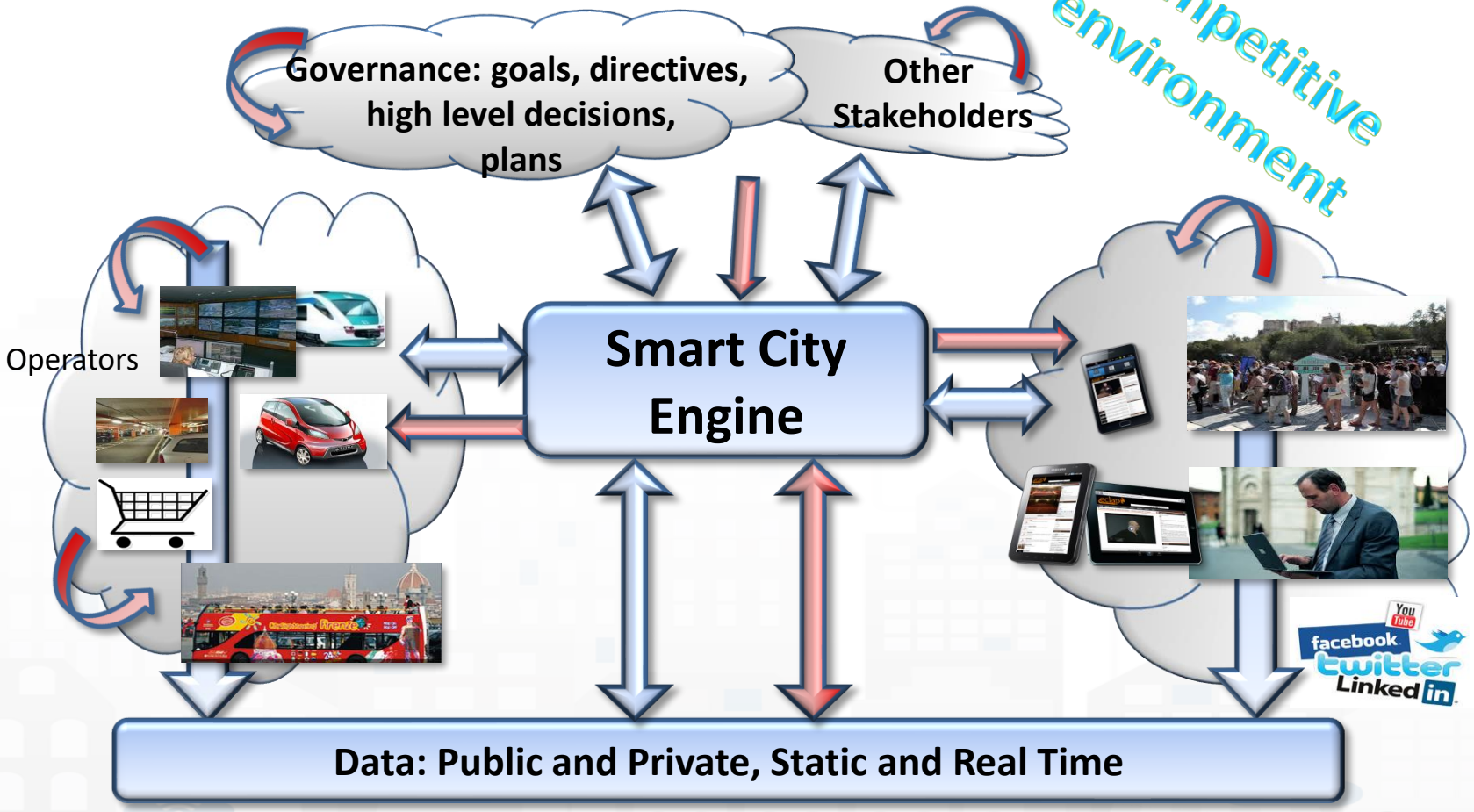
- **Exploiting analytics**: prediction, simulations, anomaly detection. ..
  - Big data approach to Data Analytics
- **Connecting Heterogeneous data** to defined strategies and alerting
- **Connected interactive dashboards** for different kind of decision makers: operators and majors
- **What-if Analysis taking into account multiple data sources**



From strategies to Actions

From Strategies to (re-)Actions

- Informing
- Suggesting
- Engaging
- Alerting, Early Warning
- Making Decision active
- New Plan



Snap4City has been Created to satisfy requirements of:

- **ENOLL**: https://www.openlivinglabs.eu/
  - European Network of Living Labs
- **EIP-SCC**: European Innovation Partnership on Smart Cities and Communities
  - https://eu-smartcities.eu/
- **Select4Cities**: Pre-Commercial Procurement Project to develop a data-driven, Internet-of-Everything (IoE) platform for large-scale urban co-creation
  - https://www.select4cities.eu/

Living Lab Flexibility

Snap4City Satisfies all Requirements of ENOLL Select4Cities and EIP-SCC

- **Multiple modalities to perform the same activities**
- **Tuned for Beginners and Skilled people**
- **Visual interface and programming tools**
- **Resources and artefacts sharing for learn acceleration and co-working**
- **Open Living and co-working Portal**: https://www.Snap4City.org

SELECT

for Cities

CERTIFICATE OF ACHIEVEMENT

1° place award to

UNIVERSITY OF FLORENCE - DEPARTMENT OF INFORMATION ENGINEERING

for SNAP4CITY

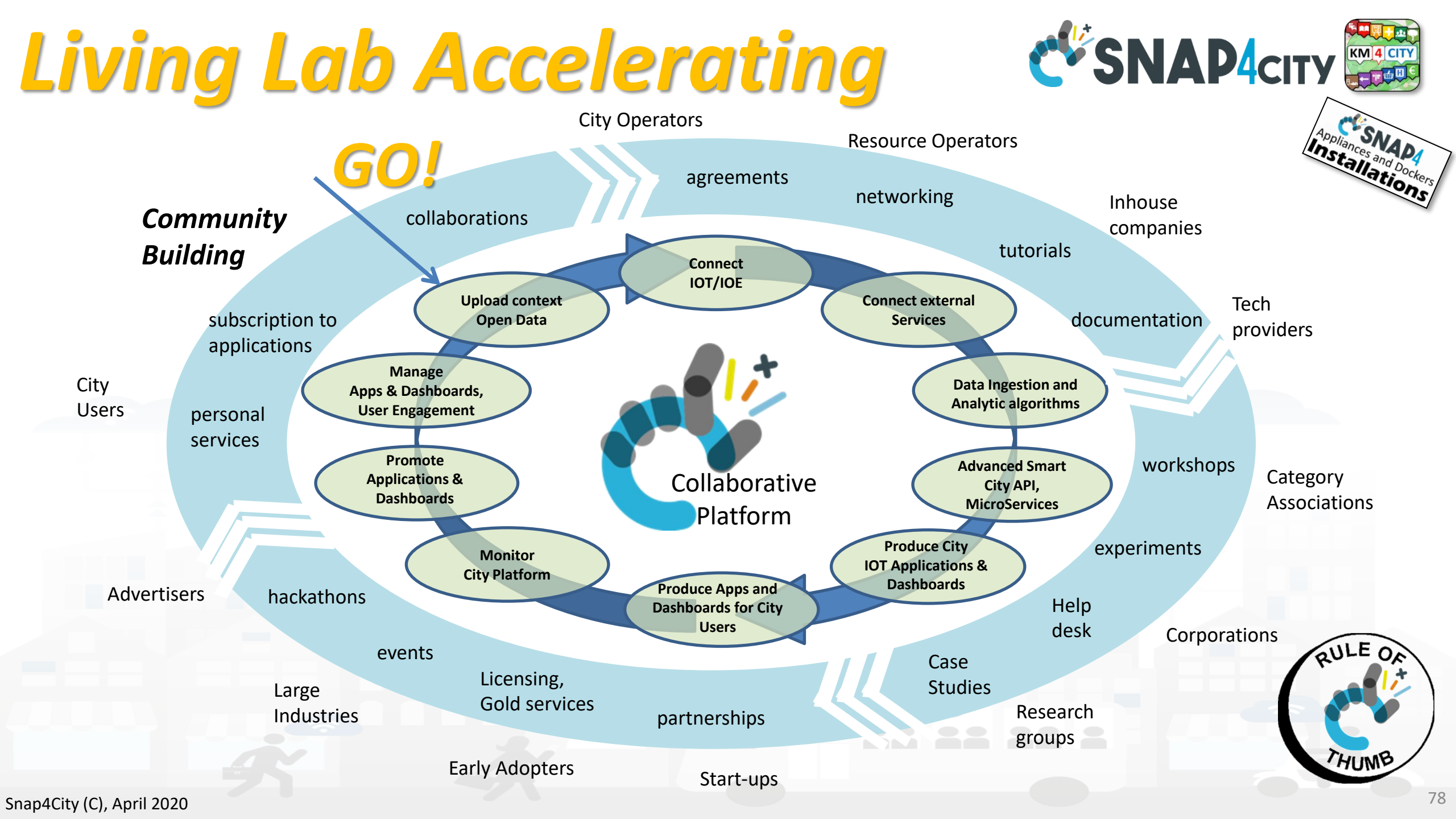
https://www.snap4city.org/558

for successfully completing the
SELECT for Cities PCP competition
19.11.2019

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 688196

DIGIPOLIS
FORUM VIRIUM HELSINKI
CITY OF COPENHAGEN
Buyers Group

Living Lab Accelerating



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

100% OPEN SOURCE

APPLIANCES CONTAINERS

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

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

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

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

IOT APPLICATIONS - INSTANT APPS

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

DASHBOARDS & APPLICATIONS

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

MOBILE & WEB APPLICATIONS

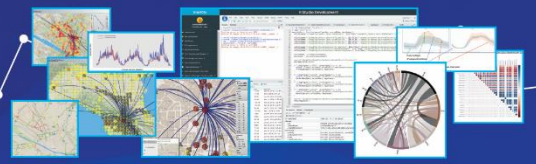
DEVELOPMENT KIT • SUGGESTIONS • MOBILE APPS • MONITORING PANELS • PLATFORM UTILITIES • READY TO USE SMART APPLICATIONS

MICROSERVICES & ADVANCED SMART CITY API

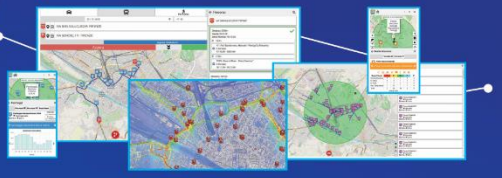
LIVING LAB - DEV TOOLS - COWORKING

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

BIG DATA - DATA ANALYTICS



DATA ANALYTICS TOOLS - MICRO-APPLICATIONS



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

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

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

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

Smart City Functional Architecture

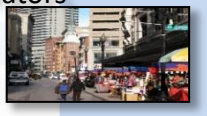
Transport systems
Mobility, parking

Public Services,
Govern, events, …

Sensors, IOT Cameras,
Wi-Fi

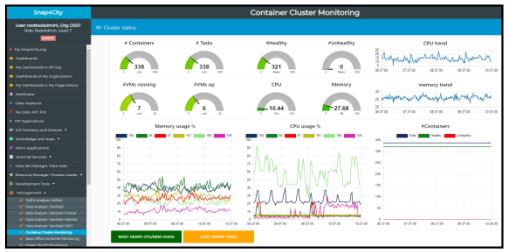
Environment, Water,
energy

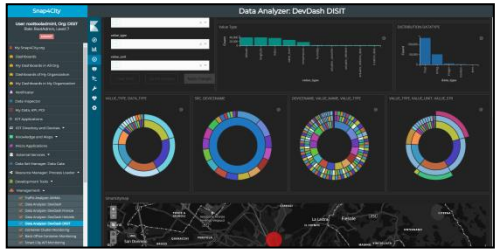
Shops, services,
operators



Social Media

Social Media Crawler and Manager





Data Sources, External Services
PULL Data

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

Data Ingestion, aggregation, regularization, reconcile
- NIFI
- Tools, [ETL], DISCES,
- IOT Apps

Big Data Cluster
HDFS, Hbase, Phoenix

Knowledge base
Semantic reasoners

Indexing and aggregating
Elastic search

Data Analytics
R, Tensor Flow, Python, MapReduce, …

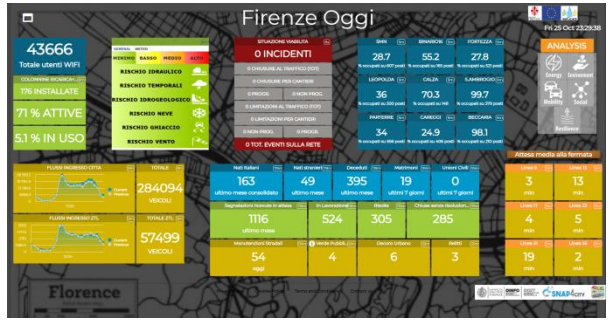
Visual Analytics

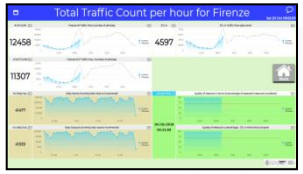
IOT Applications
Node-RED + Snap4City MicroServices

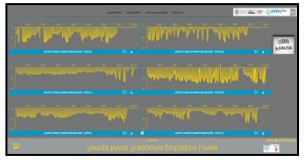
Search and Query, Smart City API
Facet, semantic search

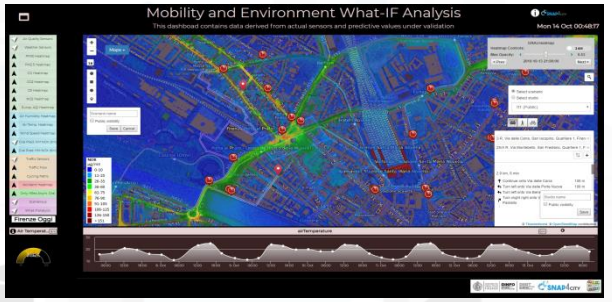
Rendering Acting, Widgets, MicroApps
User interface, Interactive Dashboard, Drill down, maps, heatmaps

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

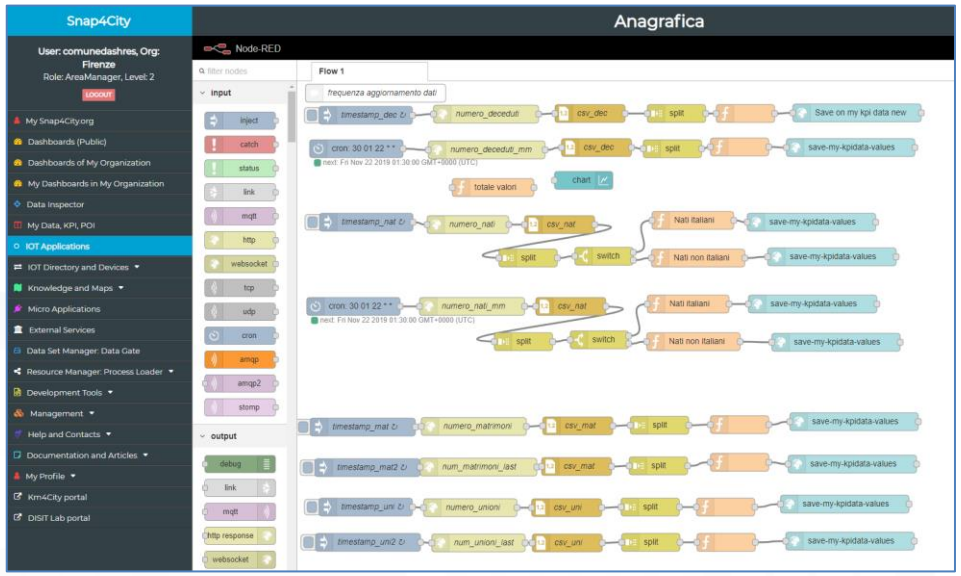


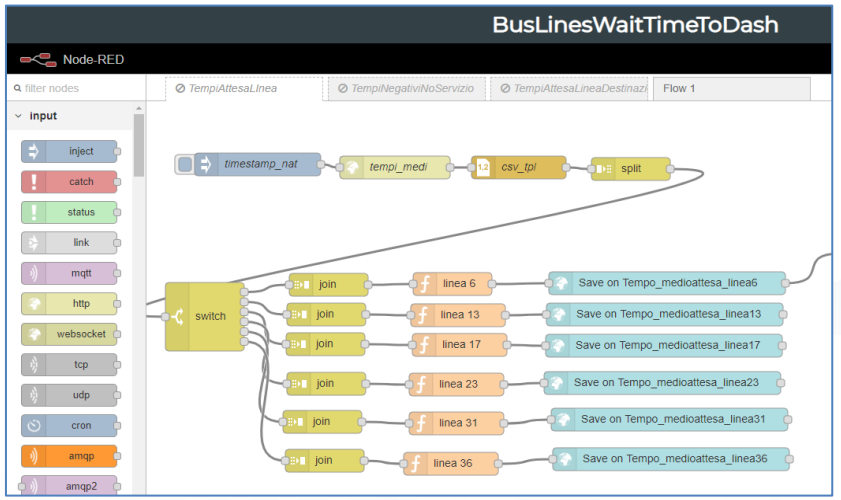


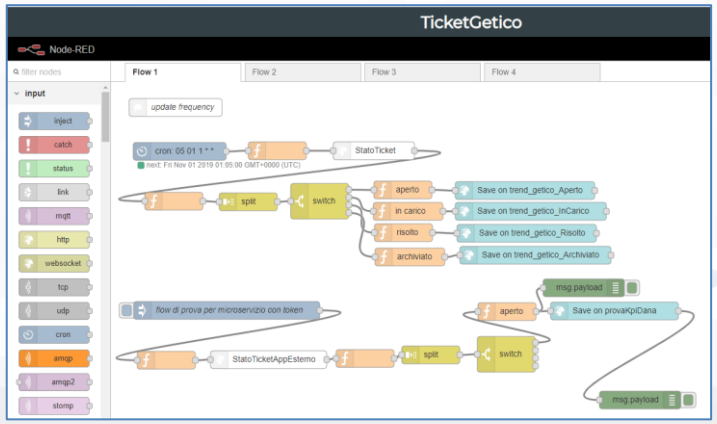


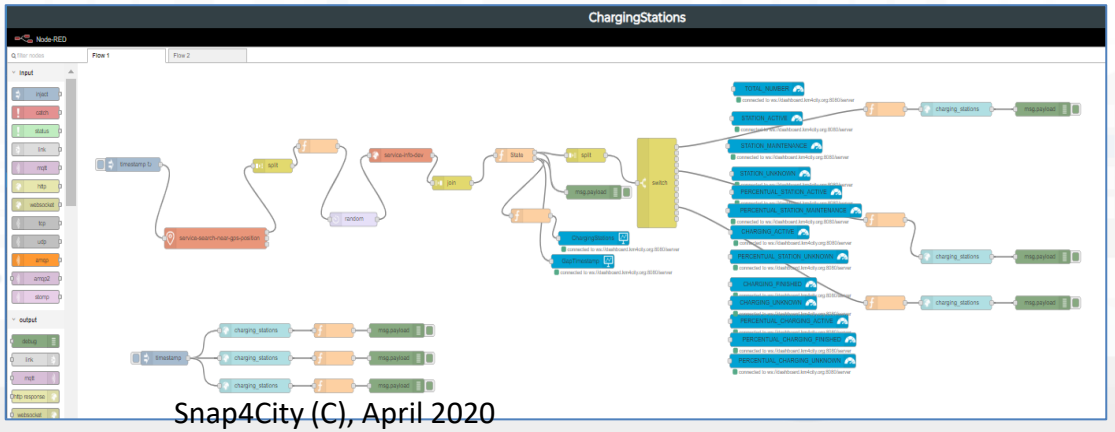


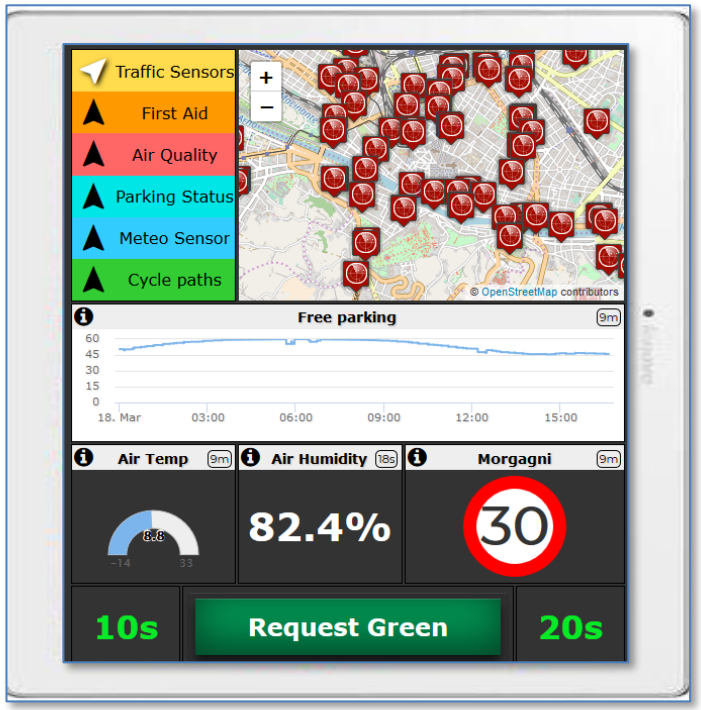
The Back-Office Data Flows (selection) Exploiting *the Snap4City Node-RED MicroServices*

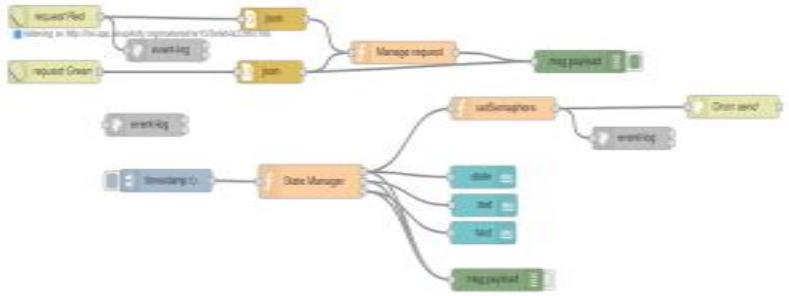


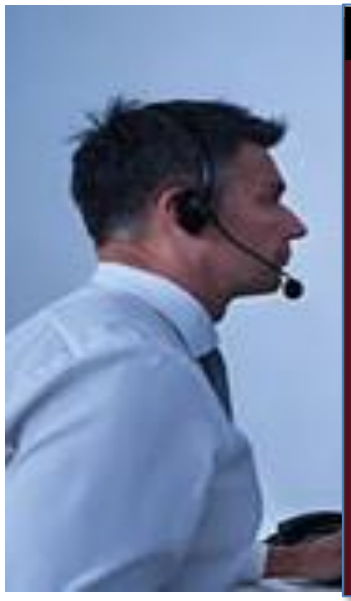


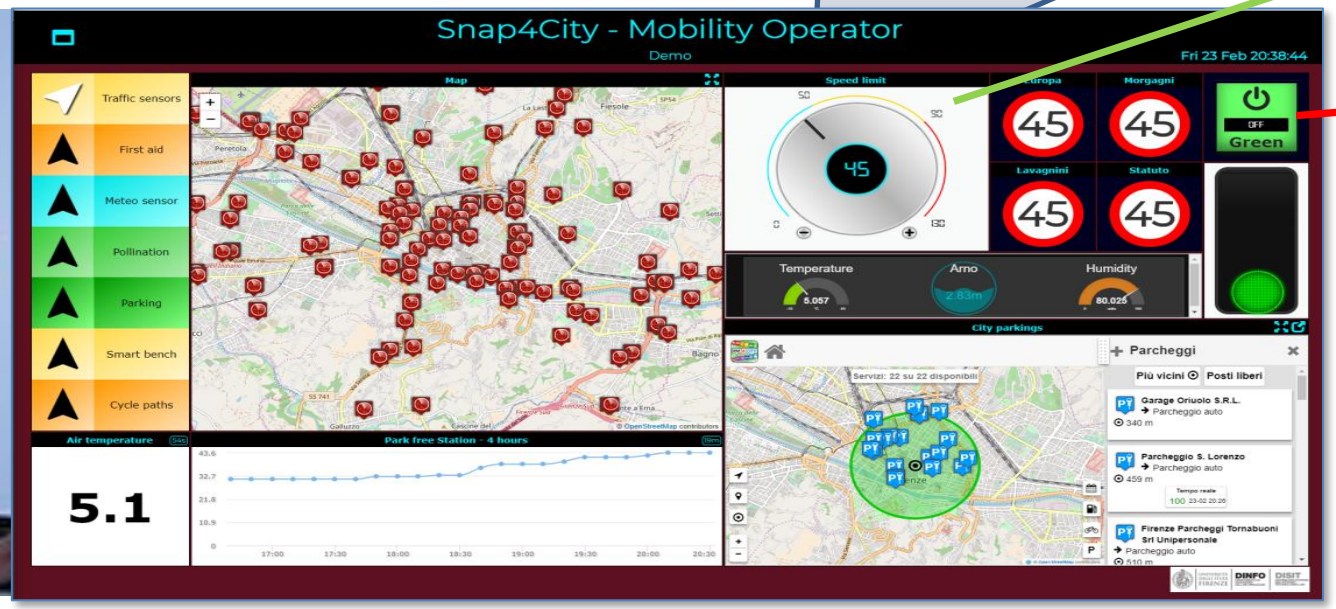


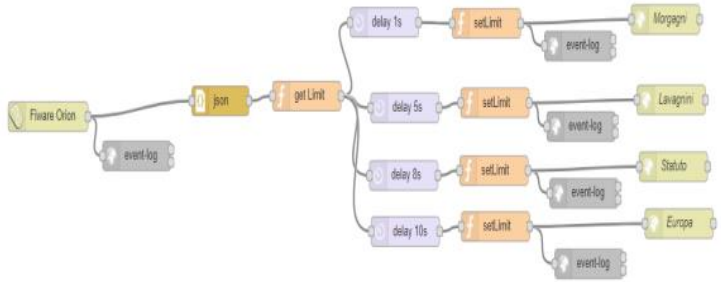



Traffic Sensors
First Aid
Air Quality
Parking Status
Meteo Sensor
Cycle paths
© OpenStreetMap contributors
Free parking
9m
60
45
30
15
0
18. Mar
03:00
06:00
09:00
12:00
15:00
Air Temp
9m
Air Humidity
18s
Morgagni
9m
82.4%
30
10s
Request Green
20s



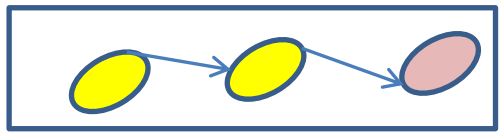


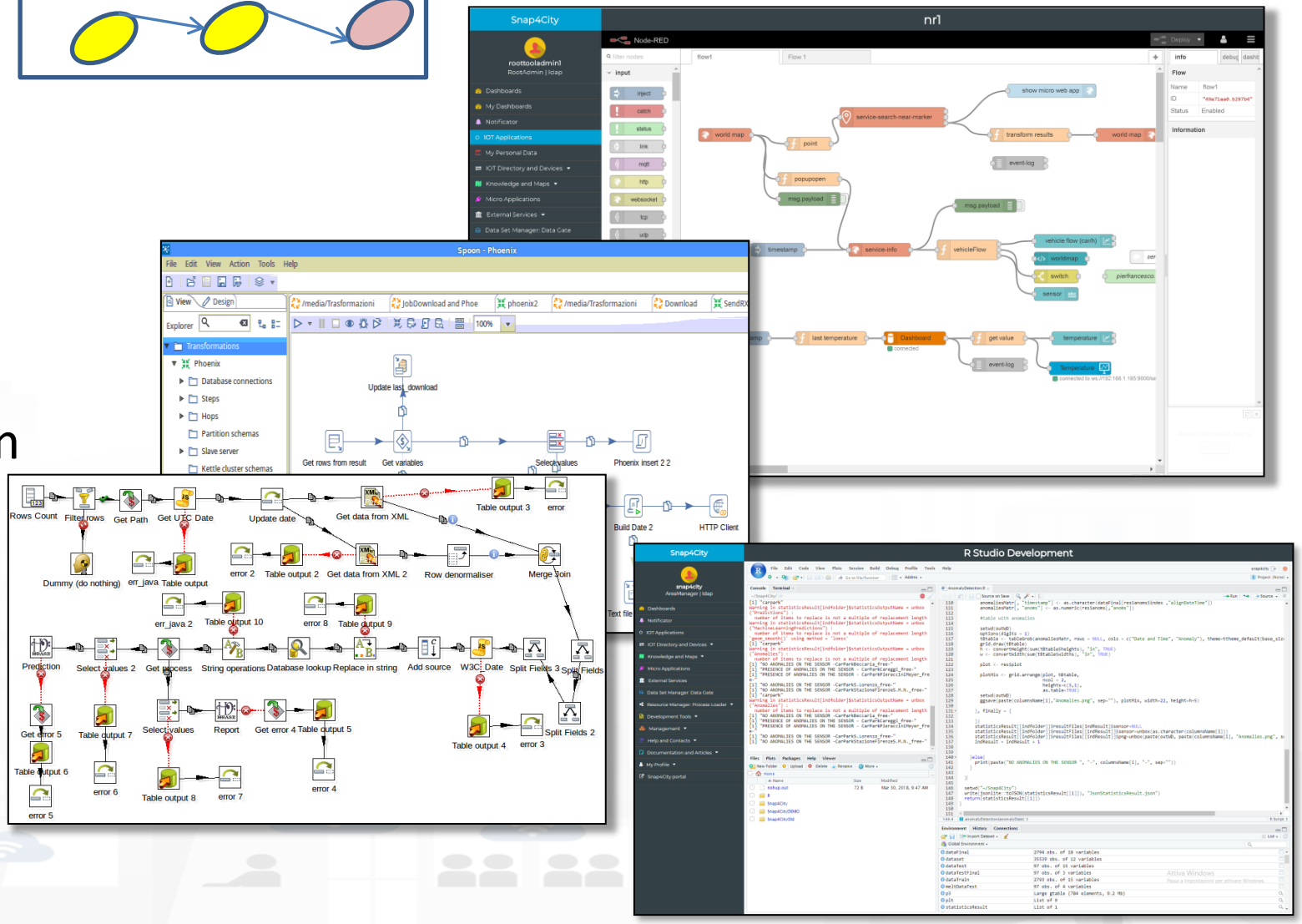

Snap4City - Mobility Operator
Demo
Fri 23 Feb 20:38:44
Traffic sensors
First aid
Meteo sensor
Pollination
Parking
Smart bench
Cycle paths
Map
Speed limit
Europa
Morgagni
Lavagnini
Statuto
45
OFF
Green
Temperature
Arno
Humidity
City parkings
Parcheggi
Air temperature
Park free Station - 4 hours
5.1


Fiware Orion
event-log
json
get Limit
delay 1s
delay 5s
delay 8s
delay 10s
setLimit
event-log
Morgagni
Lavagnini
Statuto
Europa

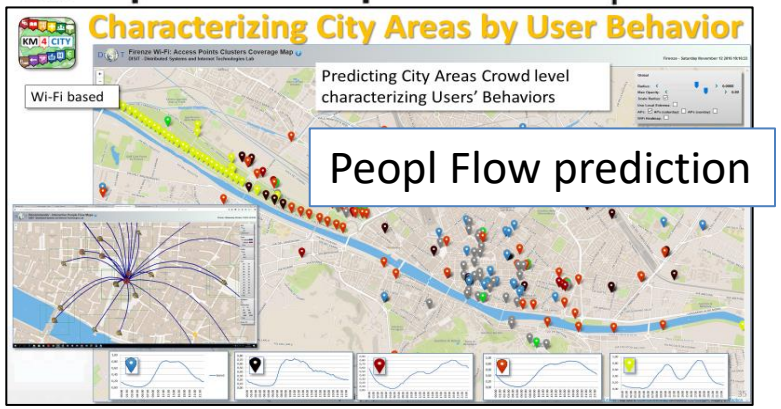
Data processing

- **Data analytics**
  - Periodic or event driven
    - On demand
  - Data transformation
    - ETL: extract transform load
  - Control Flow, data transform
    - Node-RED: Node.JS
- **For example**:
  - Assessment/monitoring
  - Predictions
  - Anomaly detection
  - Simulations
  - Etc.

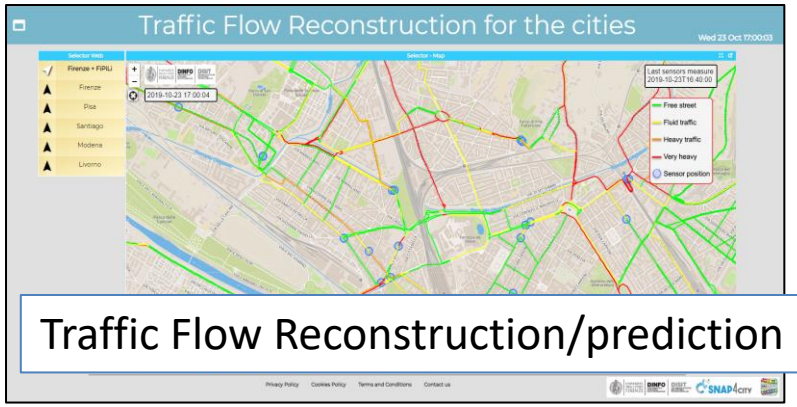




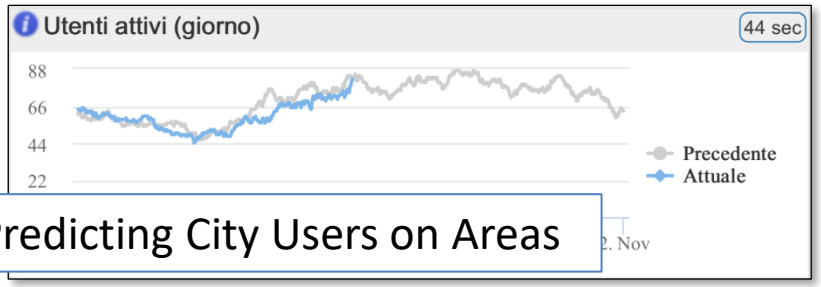
Data Analytics



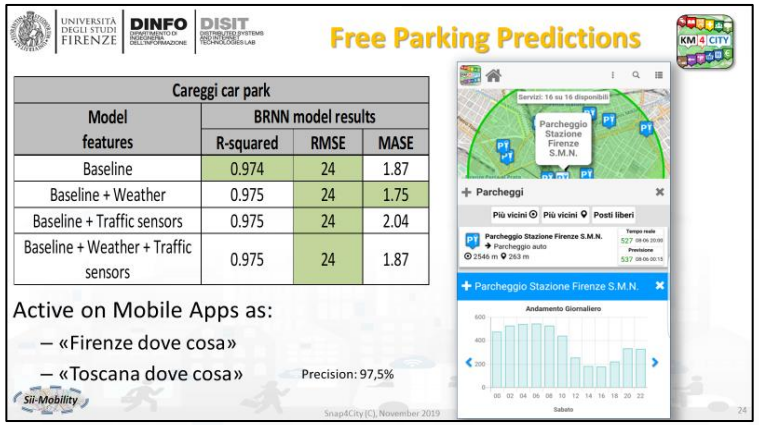
Peopl Flow prediction

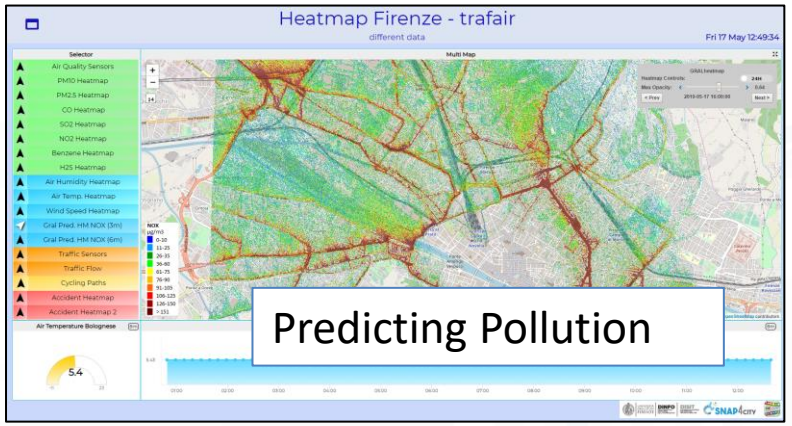


Traffic Flow Reconstruction/prediction

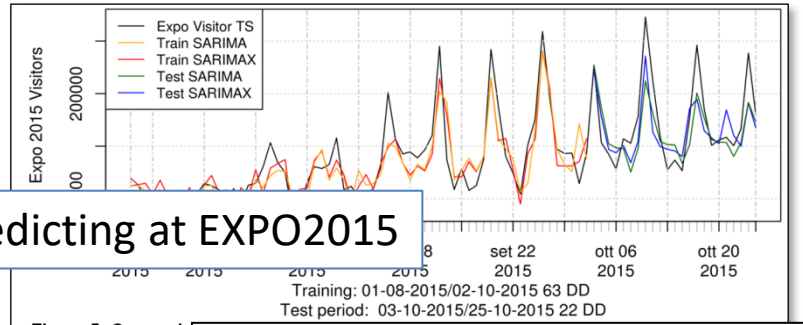


Predicting City Users on Areas

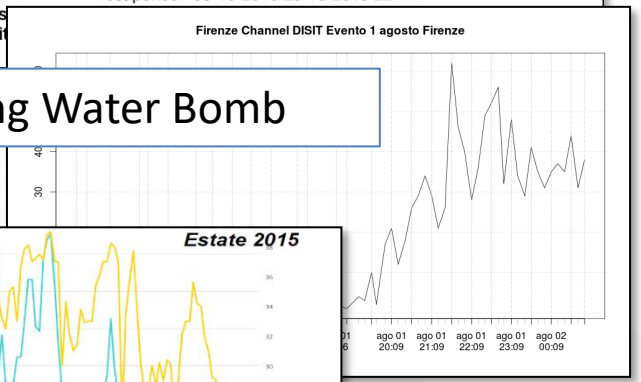




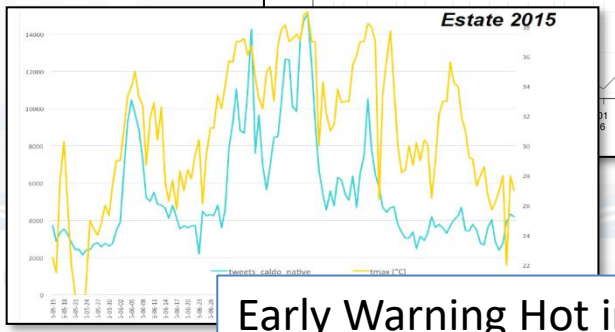
Predicting Pollution



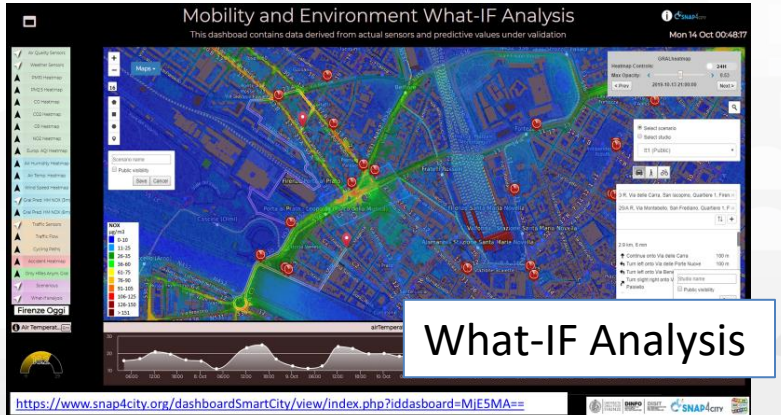
Predicting at EXPO2015



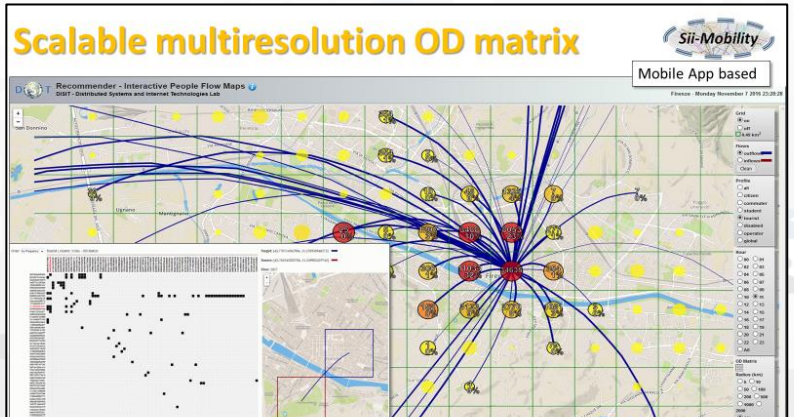
Early Warning Water Bomb



Early Warning Hot in Tuscany



What-IF Analysis



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

Disappearing Data Analytics

SNAP4CITY | KM 4 CITY

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

Free Parking Predictions

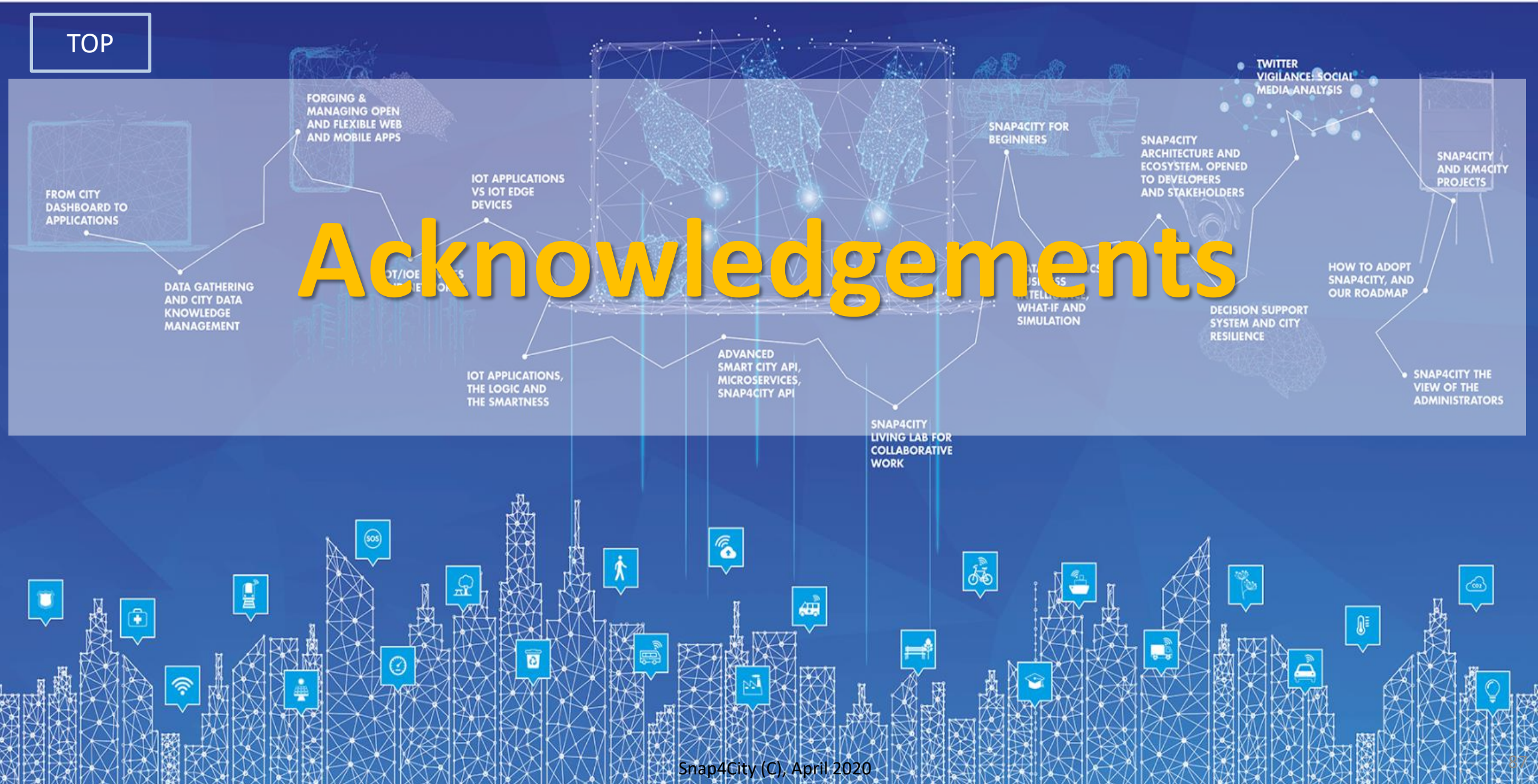
Careggi car park			
Model features	BRNN model results		
	R-squared	RMSE	MASE
Baseline	0.974	24	1.87
Baseline + Weather	0.975	24	1.75
Baseline + Traffic sensors	0.975	24	2.04
Baseline + Weather + Traffic sensors	0.975	24	1.87

Active on Mobile Apps as:

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

Precision: 97,5%

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
- Events
- LOD

ckan

- Twitter Vigilance
- Social Media Analytics, Sentiment Analysis

Km4City 1.4

2015

- Sardinia Region Smart City Strategies and plan

FIWARE

SII-MOBILITY SCN (2016-19)

2016

- Infomobility
- Mobile App
- Routing
- Multimodality

Km4City 1.5

(2015-18) resolute H2020

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

E015 digital ecosystem

Km4City 1.6.2

- Smart Energy
- Sustainable Mobility
- Control Room Dashboard

(2016-21) H2020 REPLICATE

Km4City 1.6.4

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

(2016-19) GHOST SIR

GREEN IMPACT C.A.P.A.C.I.T.Y.

Km4City 1.6.6 IOT/IOE

Node-RED

SNAP4CITY

SELECT for Cities H2020 (2017-19)

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

life weee (2017-20)

- Smart Waste

2017

TRAFAIR CEF (2018-21)

GREEN IMPACT
POR FESR 2014-2020

- Industry 4.0
- Critical Plant
- Monitoring

2018

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

MOSAiC MObility 4.0 for SmArt (i) City (2018-20)

- Mobility Demand / Offer Analytics and Strategy

(2018-21) 5G

5G tech
Energy
Industry 4.0
Synoptics

- Traffic and Mobility Impact on Pollution
- NOX predictions

2019

EUROPEAN OPEN SCIENCE CLOUD

…2022

Interreg Mediterranean HERIT-DATA

2020

SELECT for Cities 1° place award to SNAP4CITY

Reverberi Enetec Gruppo MPES

bee smart city

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

SIRIUS

LAID Smart Bed

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

Main running projects

- 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
- 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
- PISA MobiMart and Agreement → data aggregation, Living Lab
- Lonato del Garda → smart parking, environment
- Herit Data → tourism, culture and management
- ISPRA JRC → site management and services

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- **TRAFAIR is a CEF** project. All slides reporting logo of TRAFAIR project are representing tools and research founded by the EC on CEF programme http://trafair.eu/
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- **Km4City** *is an open technology and research line of DISIT Lab exploited by a number of projects. Some of the innovative solutions and research issues developed into projects are also compliant and contributing to the Km4City approach and thus are released as open sources and are interoperable, scalable, modular, standard compliant, etc.*

TOP

SNAP4CITY

KM 4 CITY

Be smart in a SNAP!

SNAP4
Appliances and Dockers
Installations

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