Big Data Platform for Smart Cities

www.Snap4City.org
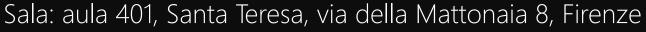
100% OPEN SOURCE

Paolo Nesi, Paola Zamperlin

paolo.nesi@unifi.it
www.Km4City.org
www.disit.org

Architecture of/with Data Urban Twin Models, Artificial Intelligence and innovation of design process
Data: 7 Febbraio 2020, 10:30 – 18:30
Sala: aula 401, Santa Teresa, via della Mattonaia 8, Firenze

Florence

Firenze Oggi

2019

Fri 25 Oct 23:29:38

43666
Totale utenti WIFI

COLONNINE RICARICA<... [9m]
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 [8s]
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 [9m]	BINARIO16 [9m]	FORTEZZA [9m]
28.7	55.2	27.8
% occupati su 607 posti	% occupati su 165 posti	% occupati su 521 posti
LEOPOLDA [9m]	CALZA [9m]	S.AMBROGIO [9m]
36	70.3	99.7
% occupati su 300 posti	% occupati su 148 posti	% occupati su 379 posti
PARTERRE [9m]	CAREGGI [9m]	BECCARIA [9m]
34	24.9	98.1
% occupati su 656 posti	% occupati su 406 posti	% occupati su 210 posti

ANALYSIS
Energy   Environment

Mobility   Social

Resilience

FLUSSI INGRESSO CITTA [9m]
26 393.2
19 794.9
13 196.6
6598.3
0
12:00
- Current
- Previous

TOTALE [9m]
284094
VEICOLI

FLUSSI INGRESSO ZTL [9m]
5522
4141.5
2761
1380.5
0
12:00
- Current
- Previous

TOTALE ZTL [9m]
57499
VEICOLI

Nati Italiani [119m]	Nati stranieri [119m]	Deceduti [119m]	Matrimoni [119m]	Unioni Civili [119m]
163	49	395	19	0
ultimo mese consolidato	ultimo mese	ultimo mese	ultimi 7 giorni	ultimi 7 giorni

Segnalazioni ricevute in attesa [119m]	In Lavorazione [119m]	Risolte [119m]	Chiuse senza risoluzion... [119m]
1116	524	305	285
ultimo mese			

Manutenzioni Stradali [59m]	ⓘ Verde Pubbli... [59m]	Decoro Urbano [59m]	Relitti [59m]
54	4	6	3
oggi			

Attesa media alla fermata

Linea 6 [9m]	Linea 13 [9m]
3 min	13 min
Linea 17 [9m]	Linea 23 [9m]
4 min	5 min
Linea 31 [9m]	Linea 36 [9m]
19 min	2 min

Florer
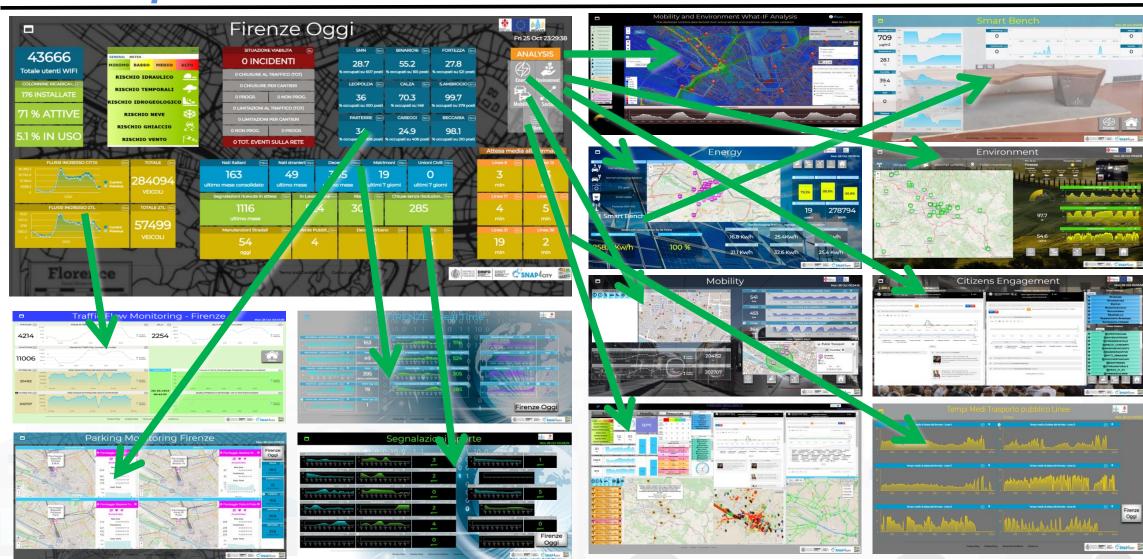
Smart City Control Room
a set of dashboards and tools
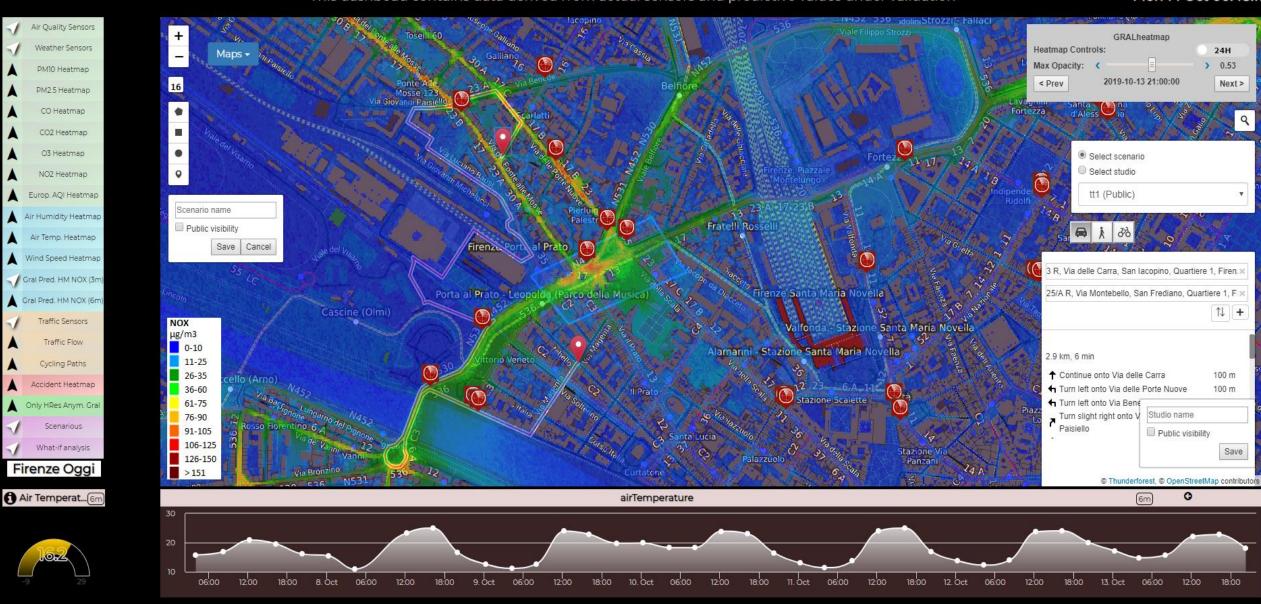
Mobility and Environment What-IF Analysis

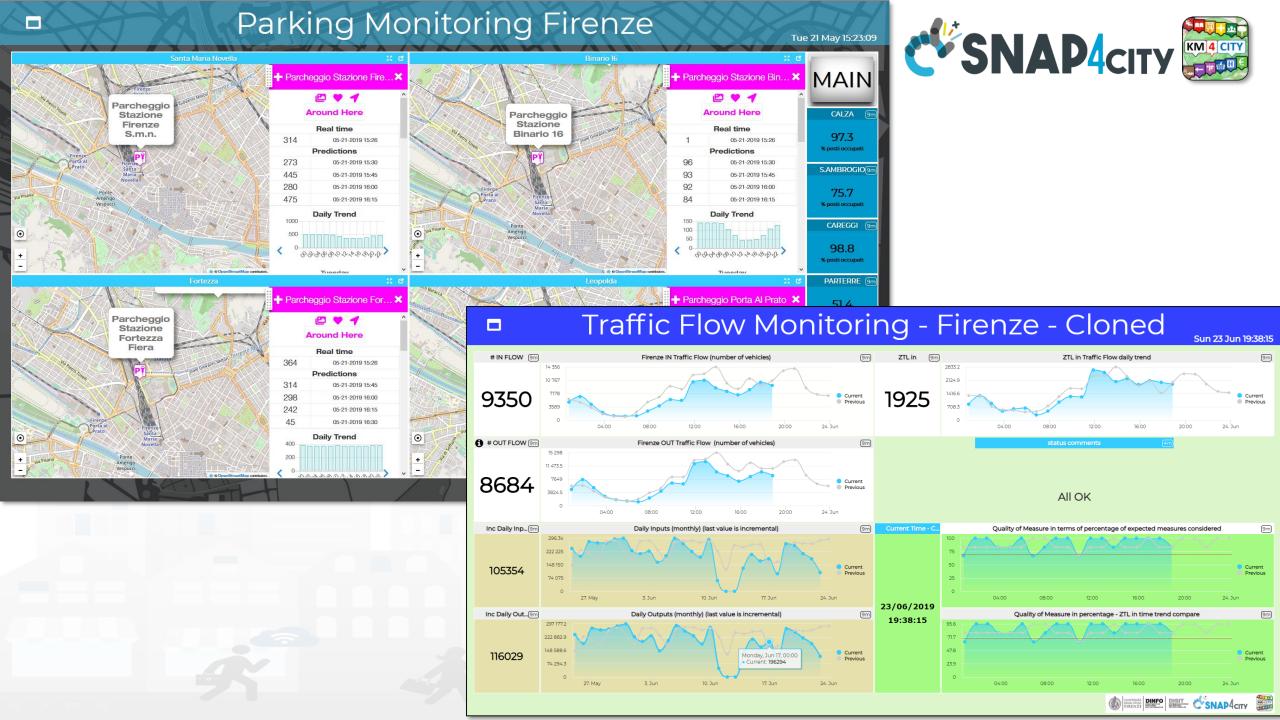This dashboad contains data derived from actual sensors and predictive values under validation

Mon 14 Oct 00:48:17

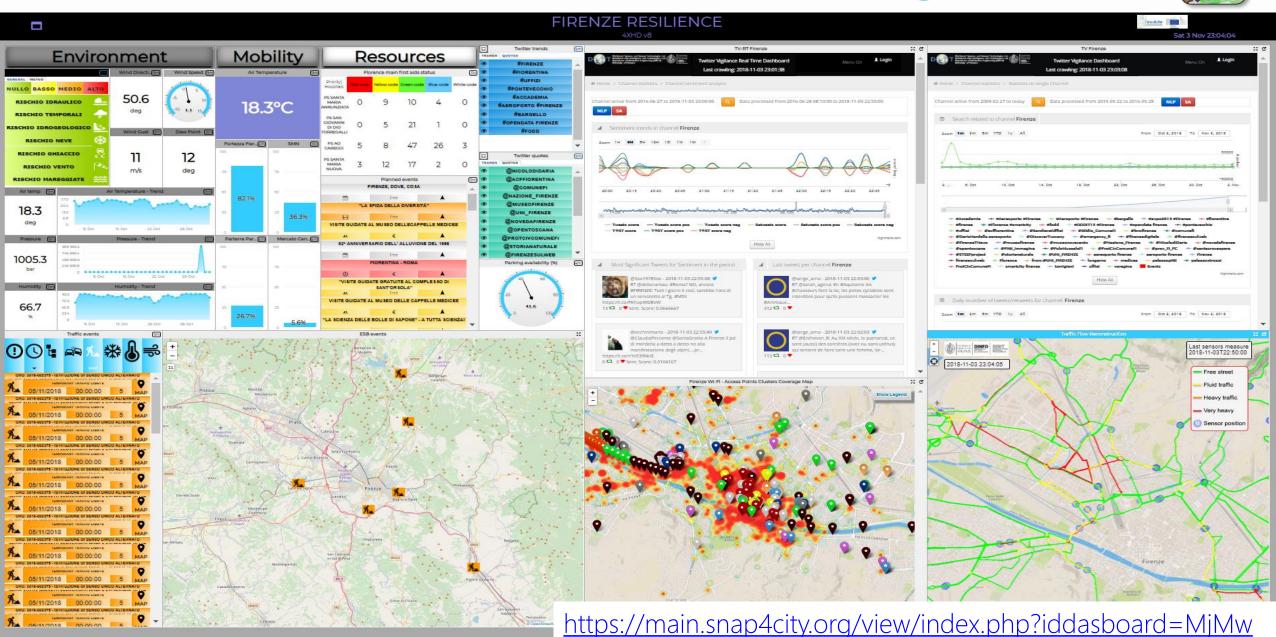Air Quality Sensors
Weather Sensors
PM10 Heatmap
PM2.5 Heatmap
CO Heatmap
CO2 Heatmap
O3 Heatmap
NO2 Heatmap
Europ. AQI Heatmap
Air Humidity Heatmap
Air Temp. Heatmap
Wind Speed Heatmap
Gral Pred. HM NOX (3m)
Gral Pred. HM NOX (6m)
Traffic Sensors
Traffic Flow
Cycling Paths
Accident Heatmap
Only HRes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

Firenze Oggi

Air Temperat... 6m

16.2

-9   29

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

GRALheatmap

Heatmap Controls: 24H

Max Opacity: < | >   0.53

< Prev   2019-10-13 21:00:00   Next >

Scenario name

☐ Public visibility

Save   Cancel

○ 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

airTemperature   6m

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

Parking Monitoring Firenze

Tue 21 May 15:23:09

Santa Maria Novella

Parcheggio Stazione Fire...

+ Parcheggio Stazione Fire... ✕

Around Here

Real time	
314	05-21-2019 15:26

Predictions	
273	05-21-2019 15:30
445	05-21-2019 15:45
280	05-21-2019 16:00
475	05-21-2019 16:15

Daily Trend

Tuesday

Binario 16

+ Parcheggio Stazione Bin... ✕

Around Here

Real time	
1	05-21-2019 15:26

Predictions	
96	05-21-2019 15:30
93	05-21-2019 15:45
92	05-21-2019 16:00
84	05-21-2019 16:15

Daily Trend

Tuesday

Fortezza

+ Parcheggio Stazione For... ✕

Around Here

Real time	
364	05-21-2019 15:26

Predictions	
314	05-21-2019 15:45
298	05-21-2019 16:00
242	05-21-2019 16:15
45	05-21-2019 16:30

Daily Trend

Leopolda

+ Parcheggio Porta Al Prato ✕

MAIN

CALZA	9m
97.3	
% posti occupati	

S.AMBROGIO	9m
75.7	
% posti occupati	

CAREGGI	9m
98.8	
% posti occupati	

PARTERRE	9m
51.4	

Traffic Flow Monitoring - Firenze - Cloned

Sun 23 Jun 19:38:15

 # IN FLOW 9m

9350

Firenze IN Traffic Flow (number of vehicles) 9m

14 356 / 10 767 / 7178 / 3589 / 0

04:00 08:00 12:00 16:00 20:00 24 Jun

● Current
● Previous

ZTL in 9m

1925

ZTL in Traffic Flow daily trend 9m

2833.2 / 2124.9 / 1416.6 / 708.3

04:00 08:00 12:00 16:00 20:00 24 Jun

● Current
● Previous

ℹ # OUT FLOW 9m

8684

Firenze OUT Traffic Flow (number of vehicles) 9m

15 298 / 11 473.5 / 7649 / 3824.5 / 0

04:00 08:00 12:00 16:00 20:00 24 Jun

● Current
● Previous

status comments 4m

All OK

Inc Daily Inp... 9m

105354

Daily Inputs (monthly) (last value is incremental) 9m

296.3k / 222 225 / 148 150 / 74 075 / 0

27. May 3. Jun 10. Jun 17. Jun 24. Jun

● Current
● Previous

Current Time - C...

23/06/2019

19:38:15

Quality of Measure in terms of percentage of expected measures considered 9m

100 / 75 / 50 / 25

04:00 08:00 12:00 16:00 20:00 24 Jun

● Current
● Previous

Inc Daily Out... 9m

116029

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

297 177.2 / 222 882.9 / 148 588.6 / 74 294.3

27. May 3. Jun 10. Jun 17. Jun 24. Jun

Monday, Jun 17, 00:00
● Current: 196294

● Current
● Previous

Quality of Measure in percentage - ZTL in time trend compare 9m

95.6 / 71.7 / 47.8 / 23.9

04:00 08:00 12:00 16:00 20:00 24 Jun

● Current
● Previous

SNAP4CITY   KM4CITY

Resilience Dashboard

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

Smart City Control Room (selected data)

REPLICATE

FIRENZE CITTÀ FARO

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

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

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

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
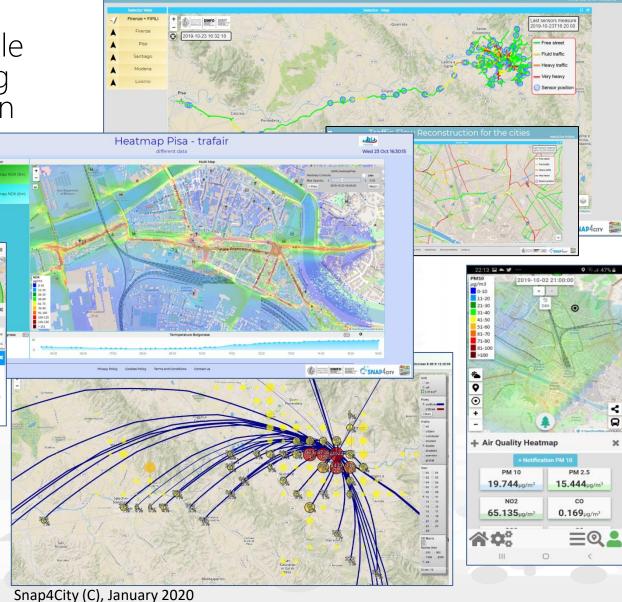
Etc.
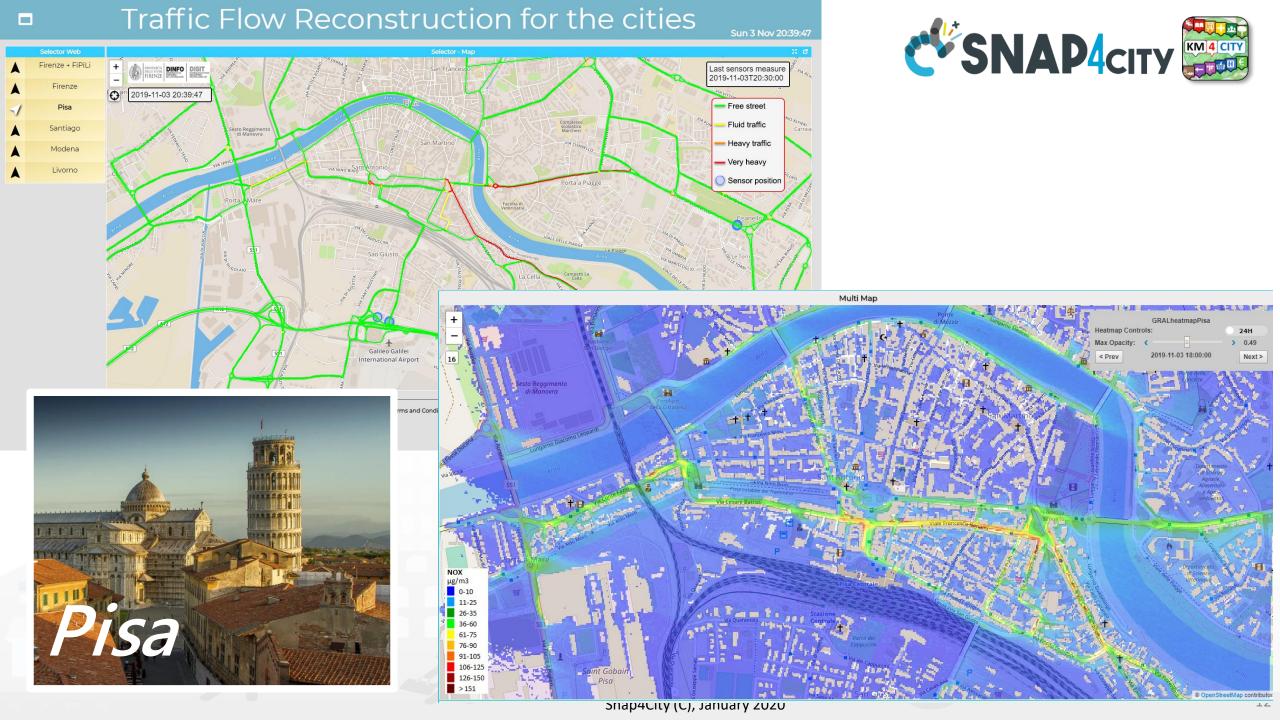
Mobile App and MicroApplications:
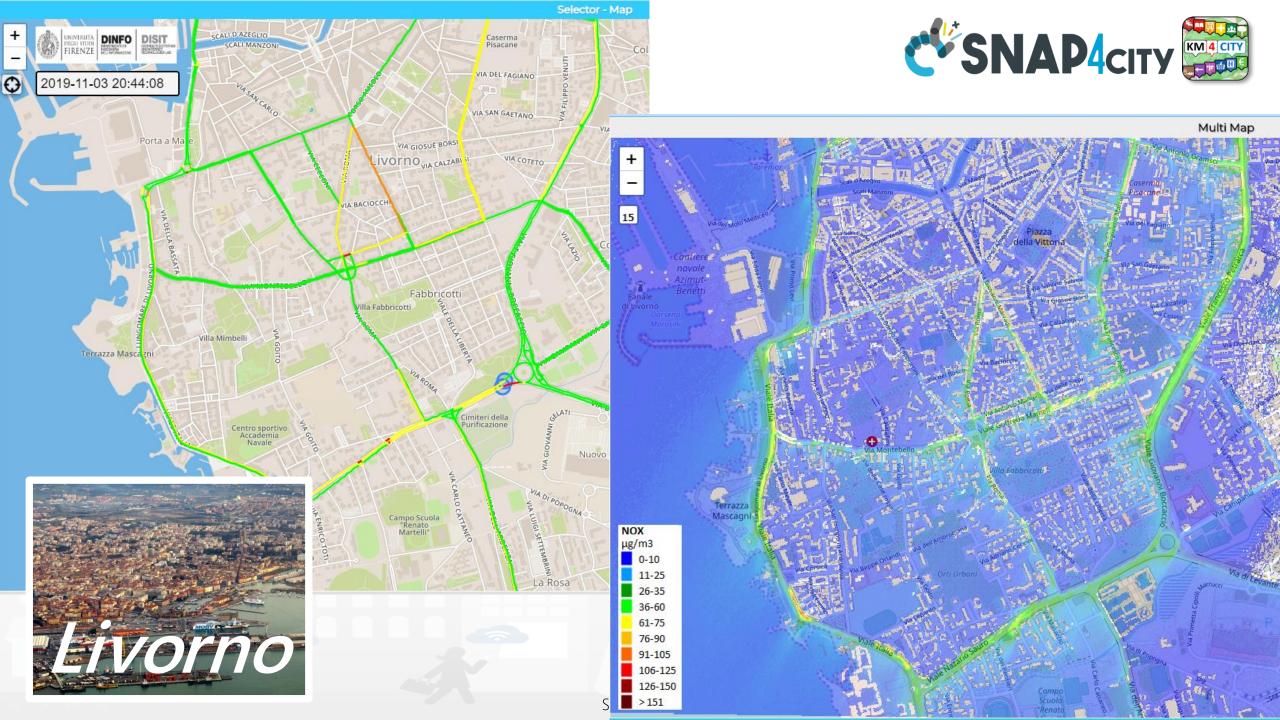
Tuscany in a Snap (all stores)

Tuscany where what... km4city (all stores)
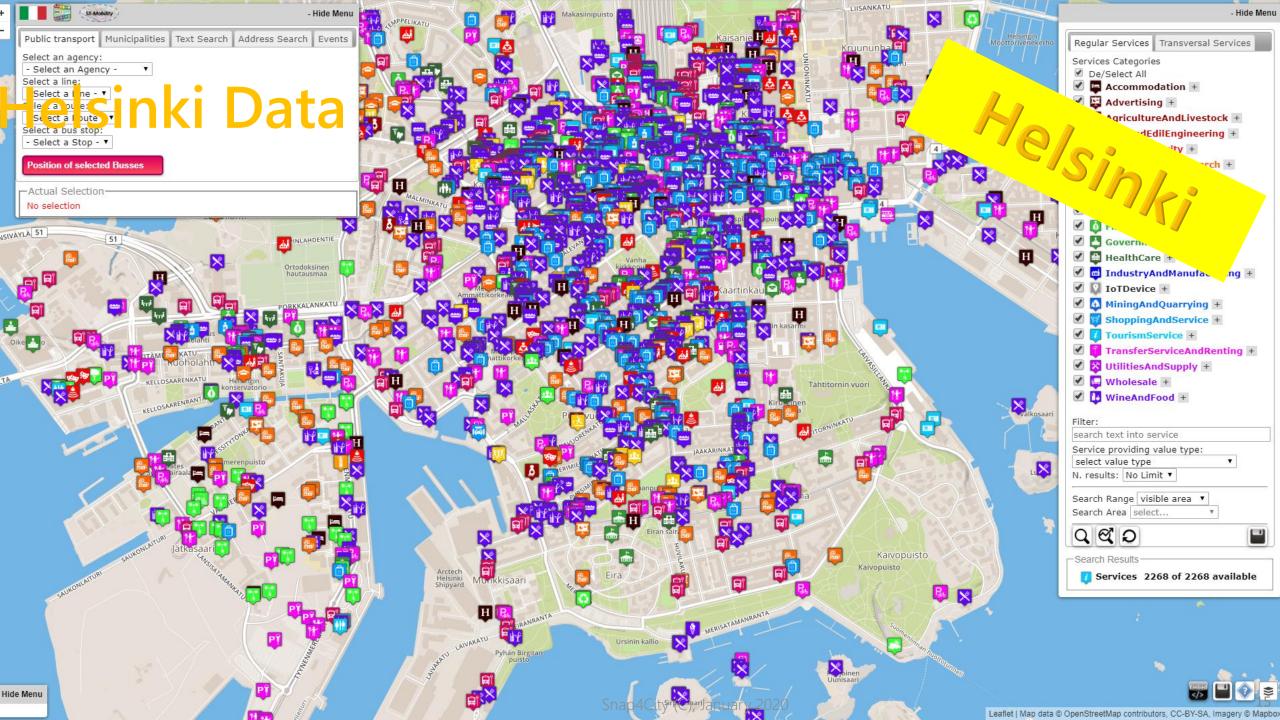
Numbers: 1.5M complex events per day

Snap4City (C), January 2020

11

Traffic Flow Reconstruction for the cities

Sun 3 Nov 20:39:47

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

Selector - Map

2019-11-03 20:39:47

Last sensors measure
2019-11-03T20:30:00

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

Multi Map

GRALheatmapPisa

Heatmap Controls:
Max Opacity: 0.49
24H
2019-11-03 18:00:00
< Prev   Next >

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

Pisa

Snap4City (C), January 2020

2019-11-03 20:44:08

Livorno

SNAP4CITY
KM4CITY

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

Helsinki

Helsinki Data

Helsinki

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

Regular Services | Transversal Services

Services Categories
☑ De/Select All
☑ Accommodation +
☑ Advertising +
☑ AgricultureAndLivestock +
☑ AndEdilEngineering +
☑ ity +
☑ rch +

☑ Fi
☑ Governm
☑ 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
ℹ️ **Services   2268 of 2268 available**

Hide Menu

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, what-if
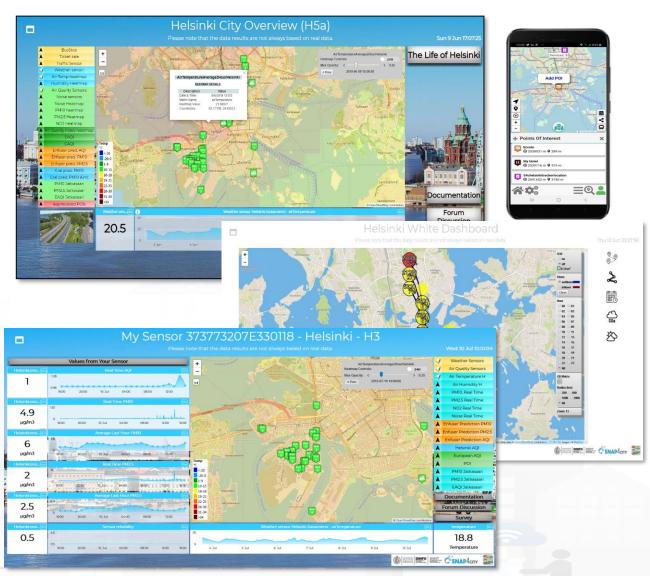
Social: Twitter Vigilance, early warning
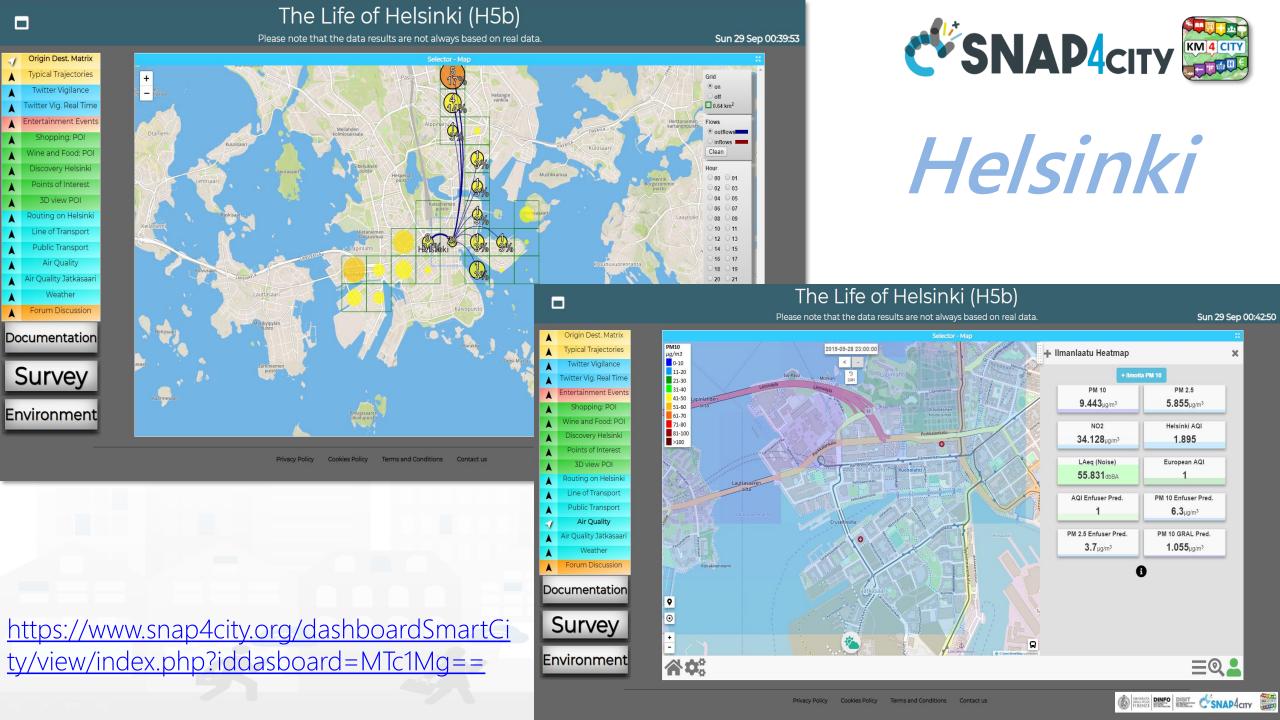
Life in Helsinki: OD matrix people flow, Twitter Vigilance SA, hot places, etc.

Tourism and Culture
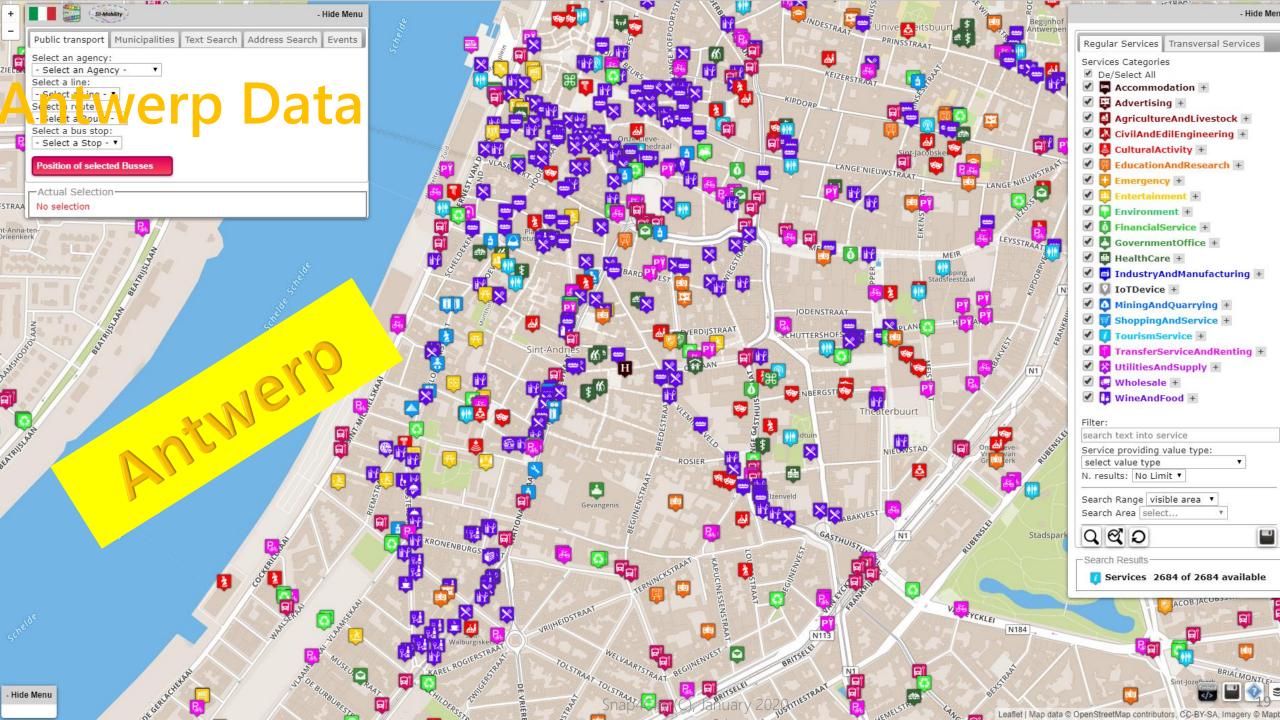
Mobile App and MicroApplications:

Helsinki in a Snap (all stores)

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

Antwerp

Antwerp Data

Antwerp

Snap4City (C), January 2020

19

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 real time and trend

People flows

The Life of Antwerp

MAS Monitoring via PAXCounter

Antwerp

Santiago di Compostela

Traffic Flow Reconstruction for the cities

Sun 3 Nov 20:37:43

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

Selector - Map

2019-11-03 20:37:44

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

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

Santiago di Compostela

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

Toscana Traffico

Traffic Events (9m)

TEMPORARY TRAFFIC LIGHTS
05/11/2018   00:00:00   5

ORD. 2018-002375 - ISTITUZIONE DI SENSO UNICO ALTERNATO REGOLATO DA IMPIANTO SEMAFORICO MOBILE E/O MOVIERI, OLTRE ALLA LOCALIZZATA LIMITAZIONE DI VELOCITA' A 30 KM/H IN PROSSIMITA' DEL CANTIERE, PER IL RESTRINGIMENTO DELLA CARREGGIATA, SULLA S.P. N.56 'DEL BROLLO E POGGIO ALLA CROCE' AL KM 16+600 CIRCA, IN LOCALITA' CAPANNUCCIA E SULLA S.P. N.34 'DI ROSANO' , PER INTERVENTI PUNTUALI, DAL KM 3+440 AL KM 5+500 CIRCA, IN LOCALITA' VALLINA, NEL COMUNE DI BAGNO A RIPOLI (FI), DAL GIORNO 05/11/2018 AL GIORNO 16/11/2018 CON ORARIO 08:00/17:00.

TEMPORARY TRAFFIC LIGHTS
05/11/2018   00:00:00   5

ORD. 2018-002375 - ISTITUZIONE DI UNICO ALTERNATO REGOLATO DA SEMAFORICO MOBILE E/O MOVIE ALLA LOCALIZZATA LIMITAZIONE D 30 KM/H IN PROSSIMITA' DEL CAN RESTRINGIMENTO DELLA CARREG S.P. N.56 'DEL BROLLO E POGGIO CAPANNUCCIA E SULLA S.P. N.34 ' PER INTERVENTI PUNTUALI, DAL K KM 5+500 CIRCA, IN LOCALITA' VALL COMUNE DI BAGNO A RIPOLI (FI), DAL 05/11/2018 AL GIORNO 16/11/2018 CON O 08:00/17:00.

TEMPORARY TRAFFIC LIGHTS
05/11/2018   00:00:00   5

ORD. 2018-002375 - ISTITUZIONE DI SENSO UNICO ALTERNATO REGOLATO DA IMPIANTO SEMAFORICO MOBILE E/O MOVIERI, OLTRE ALLA LOCALIZZATA LIMITAZIONE DI VELOCITA' A 30 KM/H IN PROSSIMITA' DEL CANTIERE, PER IL RESTRINGIMENTO DELLA CARREGGIATA, SULLA S.P. N.56 'DEL BROLLO E POGGIO ALLA CROCE'

Multi Map

METRO740
DETAILS   DESCRIPTION   RT DATA

Last update: 2018-11-01 14:11:00+01:00

Description	Value	Buttons				
Avg Time	59.28916	Last value	Last 4 hours	Last 24 hours	Last 7 days	Last 30 days
Concentration	10.46809	Last value	Last 4 hours	Last 24 hours	Last 7 days	Last 30 days
Vehicle Flow	984.0	Last value	Last 4 hours	Last 24 hours	**Last 7 days**	Last 30 days
Average Speed	47.0	Last value	Last 4 hours	Last 24 hours	Last 7 days	Last 30 days

Free street
Fluid traffic
Heavy traffic
Very heavy
Sensor position

© OpenStreetMap contributors

Average Speed - 30 days (9m)

1692
1128
564
0

18:00 26. Oct 06:00 12:00 18:00 27. Oct 06:00 12:00 18:00 28. Oct 06:00 12:00 18:00 29. Oct 06:00 12:00 18:00 30. Oct 06:00 12:00 18:00 31. Oct 06:00 12:00 18:00 1. Nov 06:00 12:00

Selector

- Air Quality
- Bus Stops
- Cycle Paths Geometry
- Cycle Paths Pins
- Hot places heatmap
- Meteo Stations
- Parkings
- Recharching Stations - Normal
- Recharging Stations - Fast
- Traffc Sensors
- Traffic Flow Density

Florence Events (9m)

CAMBIO DELLA GUARDIA A PALAZZO VECCHIO
free

PER GRANDI E PUCCINI
free

QUANTUOR EBENE, ALEXANDER LONQUICH
€

"GLI STRUMENTI DI GALILEO" - A TUTTA SCIENZA!
€

UNIVERSITA DEGLI STUDI FIRENZE   DINFO   DISIT

https://main.snap4city.org/view/index.php?iddasboard=MTE5MQ==

Lonato del Garda

www.snap4city.org/drupal/node/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

SNAP4CITY KM4CITY

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

100% OPEN SOURCE

APPLIANCES CONTAINERS

SMART CITY LIVING LAB

- 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 |

architettura

Any kind of data and flows

	Antwerp					Helsinki								Where				Main Data Sources
	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	
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			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				M X				X	Computed Heatmps
heatmaps: GRAL prediction, PM10						X	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	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	Snap4City Mobile App
Typical trajectories	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

Real Time Tracking

From mobile app:

Resolving GPS location: GPS, cells, wifi-network, ... mixt

Noisy, different kind of devices, ...

Smart algorithm on devices for location acquisition

Anonymized data, terms of use on mobile

Filtering:

GPS Accuracy, kind of measure (GPS, mixt)
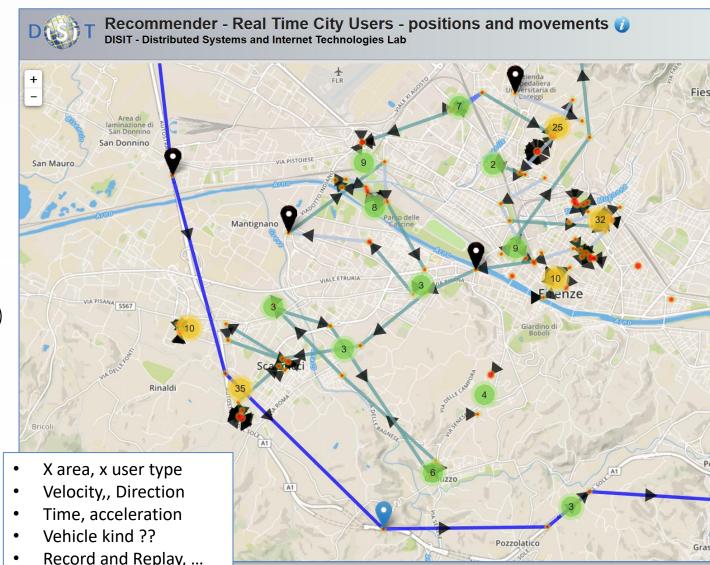
Jump in time, space, velocity

General noise (diff. devices)

Knowledge of precision map
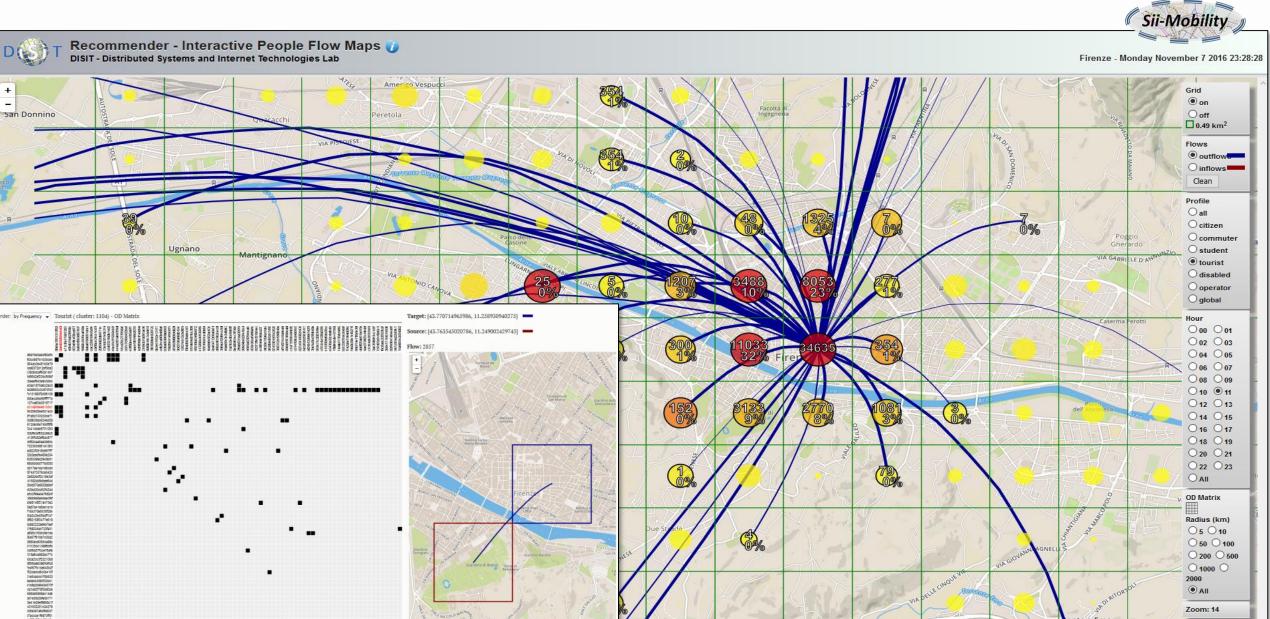
Clustering:

time, space, user kind, etc.

Recommender - Real Time City Users - positions and movements
DISIT - Distributed Systems and Internet Technologies Lab

- X area, x user type
- Velocity,, Direction
- Time, acceleration
- Vehicle kind ??
- Record and Replay, ...

Scalable OD matrix

User Behaviour Analyser

Hot places, trajectories, heatmap

Duomo

Piazza Signoria

Duomo

Uffizi

Stazione vs Santa Maria Novella

Piazza della repubblica

Snap4City (C), January 2020

32
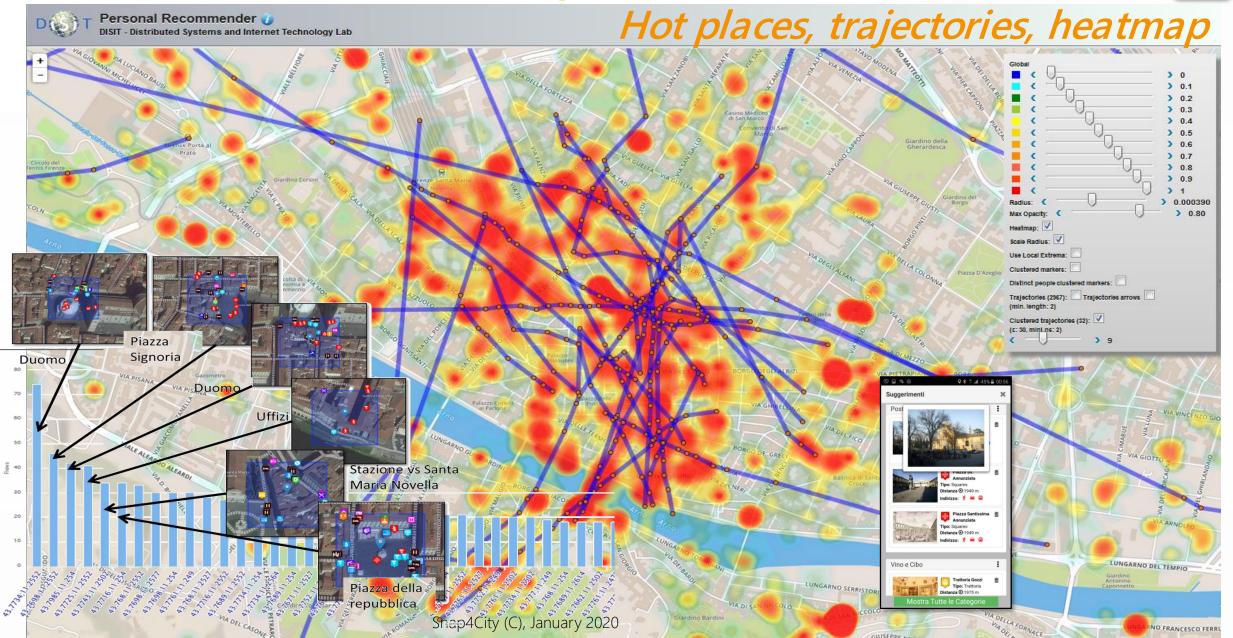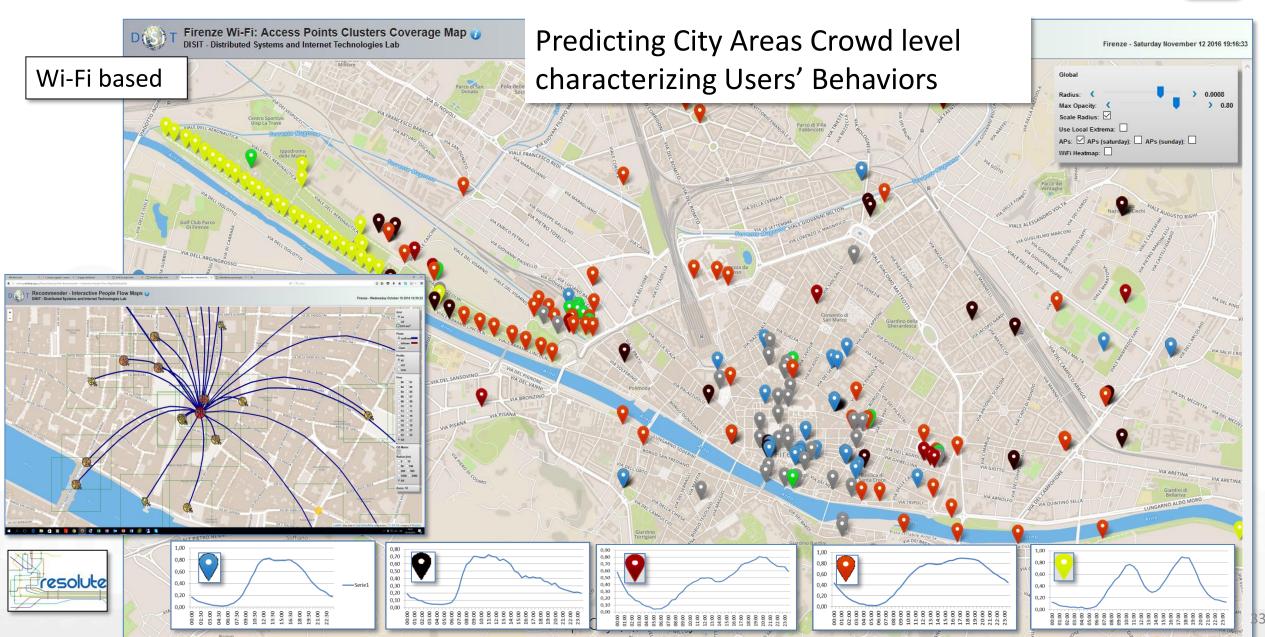
Characterizing City Areas

SNAP4CITY KM4CITY

Wi-Fi based

Predicting City Areas Crowd level characterizing Users' Behaviors

Twitter Vigilance

http://www.disit.org/tv

http://www.disit.org/rttv

Citizens as sensors to

Assess sentiment on services, events, …

Response of consumers wrt, …

Early detection of critical conditions
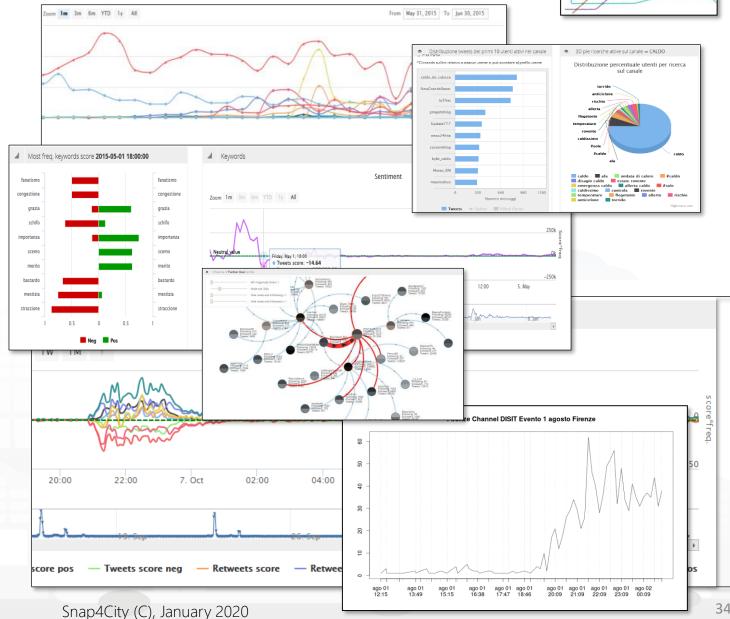
Information channel

Opinion leaders

Communities

Formation

Predicting volume of visitors for tuning the services
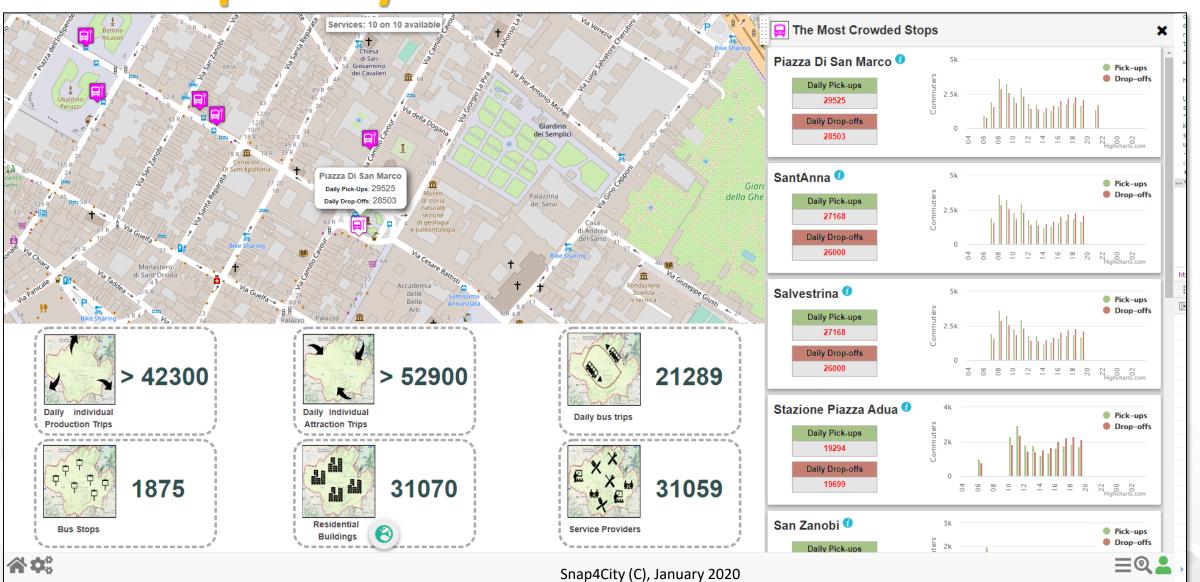
Bus Stop Analysis: identification of criticalities

Mobile Apps
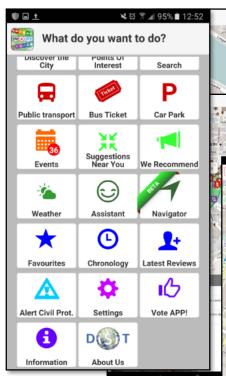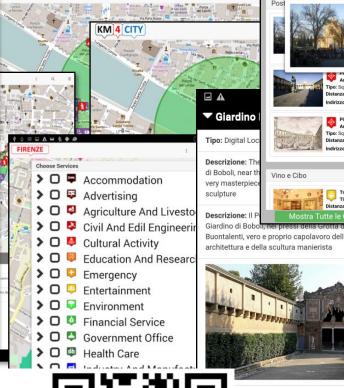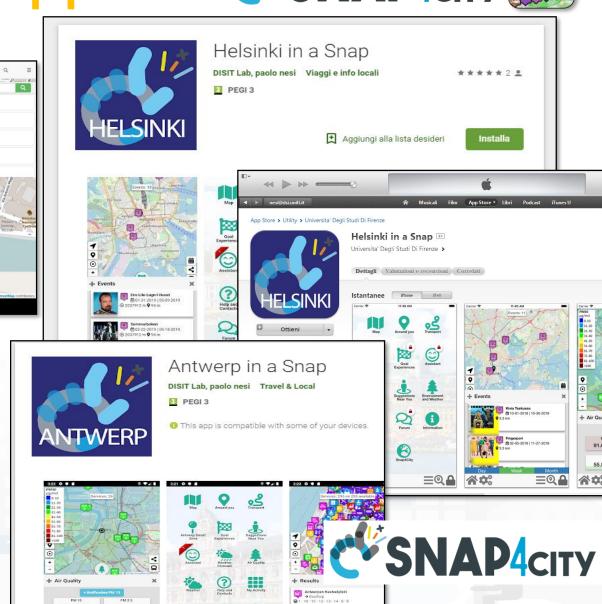
User Behavior Analyser for Collective Profiling

Who

When

What

Where?
Why?

Where they go ahead

How move

Snap4City (C), January 2020

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
- Twitter Vigilance
- Social Media Analytics, Sentiment Analysis

2015
- Sardinia Region Smart City Strategies and plan

Km4City 1.4

(2016-19) Sii-Mobility MIUR
SII-MOBILITY SCN

2016
- Infomobility
- Mobile App
- Routing
- Multimodality

Km4City 1.5

resolute (2015-18) H2020
- Resilience Decision Support
- Smart First Aid
- User Behaviour Analysis, predictions
- Risk Analysis

E015 digital ecosystem
Powered by EXPO MILANO 2015

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) MIUR
GHOST SIR

Km4City 1.6.6 IOT/IOE

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

lifeweee (2017-20)
- Smart Waste

2017

TRAFAIR CEF (2018-21)

GREEN IMPACT
POR FESR 2014-2020
- Industry 4.0
- Critical Plant
- Monitoring

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

...2022

2020

SELECT for Cities 1° place award to SNAP4CITY

2018
MOSAiC Mobility 4.0 for SmArt (i) City (2018-20)
- Mobility Demand / Offer Analytics and Strategy

POR CreO

Reverberi Enetec Gruppo MPES

bee smart city

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

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

POR CreO

2019
- Traffic and Mobility Impact on Pollution
- NOX predictions

SIRIUS

LAID Smart Bed

POR CreO

EUROPEAN OPEN SCIENCE CLOUD

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

Snap4City: IOT/IOE smart city www.snap4city.org

Trafair: CEF project con varie Città

Mosaic: Mobility and transport model

Km4City: http://www.km4city.org

REPLICATE H2020, SCC1, EC flagship

   http://replicate-project.eu/

Sii-Mobility SCN MIUR: http://www.sii-mobility.org

Feedback: reail and GDO Big Data analytics

5G with 3-Wind Open Fiber Estra

Coll@bora Social Innovation, MIUR:

   http://www.disit.org/5479

RESOLUTE H2020, EC:

   http://www.resolute-eu.org

TRACE-IT, RAISSS, TESYSRAIL, …

Mobile Emergency:

   http://www.disit.org/5404

Trace-IT

RAISSS

Acknowledgements