LIVING LAB

General Overview

October 2020, Course
https://www.snap4city.org/577

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

Be smart in a SNAP!
scalable Smart aNalytic APPlication builder for sentient Cities: for Living Lab and co-working with Stakeholders

https://www.Snap4City.org

General Overview

October 2020, Course
https://www.snap4city.org/577

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

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

- Register on [WWW.snap4city.org](http://www.snap4city.org)
  - Subscribe on DISIT Organization
- You can:
  - Access on basic Tools
  - Access to a large volume of Data
  - Create Dashboards
  - Create IOT Applications
  - Connect your IOT Devices
  - Exploit Tutorials and Demonstrations

IF you need to go more in deep you can ask us to pass at the next Role becoming full AreaManager with full rights of development, also for Data Analytics, machine learning, etc.
## On Line Training Material (free of charge)

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<td>PDF</td>
<td>General</td>
<td>Dashboards</td>
<td>IOT App, IOT Network</td>
<td>Data Analytics</td>
<td>Data Ingestion processes</td>
<td>System and Deploy Install</td>
<td>Smart City API: Web &amp; Mob. App</td>
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https://www.snap4city.org/577
General Overview of the full Course

- **1st part**: General Overview
- **2nd part**: Dashboards Creation and Management
- **3rd part**: IOT Applications development, IOT Devices, IOT Networks
- **4th part**: Data Analytics, in R Studio, in Python, how to Exploit and Manage Data Analytics in IOT Applications
- **5th part**: Data Ingestion, Data Warehouse, Data Gate, IOT Device Data ingestion, IOT App for Data Ingestion, etc.
- **6th part**: Snap4City Architecture, How To Install Snap4City
- **7th part**: Smart city API (internal and external) Web and Mobile App development tool kit

A number of the training sections include exercitations

Updated versions on: [https://www.snap4city.org/577](https://www.snap4city.org/577)

See also courses in ITALIANO: [https://www.snap4city.org/485](https://www.snap4city.org/485)
this part Agenda

- **Overview**
  - Examples of: Firenze, Helsinki, Pisa, Livorno, Antwerp, Santiago, Lonato, etc.
- **Urban Platform (main concepts vs Living Lab)**
- **Snap4City Architecture**
- **Dashboards: from City Dashboards to Applications (overview)**
  - Demo Control Room for Decision Makers and for Operators
  - Real time tracking
  - Dashboard Intelligence
  - Smart City Control Rooms
- **Data Gathering and City Data Knowledge Management (overview)**
  - interoperability
- **IOT Applications, Devices and Dashboards (Overview)**
- **Forging & Managing Flexible Mobile Apps, Web App, MicroApplications (Overview)**
- **Data Analytic, Big Data Science (Overview)**
- **Snap4City Living Lab for Collaborative Work (overview)**
  - Development environment, tools, GDPR
- **Snap4City and Km4City Projects**
- **Acknowledgment**
Overview

Scalable Sentient Cities Builder
Snap4City: Builder of Sentient Cities Solutions

Dashboards with data driven IOT Applications enforcing intelligence

IOT and data World

My IOT Devices

IOT Applications

Dashboards and Apps

Big Data Analytics, Artificial Intelligence
URBAN PLATFORM: SMART CITY IOT AS A SERVICE AND ON PREMISE

IOT APPLICATIONS - INSTANT APPS
- Data-driven applications
- Real-time processing
- Batch processing
- Any protocol & format

DASHBOARDS & APPLICATIONS
- Control room
- Situation room
- Operator dashboards
- 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
- IOT directory
- Service map
- Resource manager
- Data gate
- R studio
- ETL

LIVING LAB - DEV TOOLS - COWORKING
- Test cases, scenarios, videos, hackathons
- Open sources, community of cities
- Training tutorials, community management

BIG DATA - DATA ANALYTICS
- 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 assistants
- Smart solutions
- Smart sharing
- Participatory

DATA ANALYTICS TOOLS - MICRO-APPLICATIONS

KM4CITY DATA AGGREGATE 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
Any kind of data and flows

Open Data:
- Data gate, federation of Open Data Portals
- ETL processes (PULL)
- IOT Application processes

IOT Networks:
- IOT Application processes, data driven or PULL
- IOT Brokers (Push) → IOT Shadow

Web Pages:
- Web scraping, crawling processes

Social media: Twitter, Facebook, ...
- Twitter Vigilance, IOT App

Mobile Apps
- Smart City API

Files upload: CSV, Excel, etc.
- IOT Applications, ETL

REST API, WS, FTP, LD, LOD, etc.
- IOT Applications, ETL

Data base accesses
- GIS: WFS, WMS
- ETL, IOT Application

API, External Services
Rest Call ……..MS

External Data Stores
LD, LOD

GIS data, Maps, ...

Web Scraping

DataGate

ETL

IOT Broker

IOT Device

IOT Edge

IOT Broker

IOT App

SNAP4City (C), October 2020
Standards and Interoperability


https://www.snap4city.org/65
19-21 November 2019 - Barcelona
See you at Snap4City Stand A118
Traffic Flow Reconstruction for the cities

Selector Web
- Firenze
- Firenze + FIPiLi
- Pisa
- Santiago
- Modena
- Livorno
- test

Selector - Map

Last sensors measure 2019-10-14 00:25:14

Traffic Flow Reconstruction

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

Snap4City (C), October 2020
Mobility and Environment What-IF Analysis
This dashboard contains data derived from actual sensors and predictive values under validation

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

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

Assessment on the basis of changes:

– Mobility demand assessment
– Mobility Offer assessment

Mobility and Environment What-IF Analysis

This dashboard contains data derived from actual sensors and predictive values under validation.
Smart City Control Room (Data View)

- **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
Early Warning

Predictive models

Hot flows

Attendance at long lasting events: EXPO2015

Attendance at recurrent events: TV, football

Figure 6. 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.
ERMG: European Resilience Management Guide

ANTICIPATING
- European Resilience Management Guidelines
- Game Based Training

RESPONDING
- Smart Decision Support Systems (DSS)
- Evacuation Decision Support
- Smart Intelligent Transport Systems
- Emergency Support Smart App
- Resilience DSS

LEARNING
- Human Behavior Analysis
- Predictive Analytics
- Urban Transport System Dynamic Analysis
- Resilience Quantification
- Network Analysis

MONITORING
- Big Data Platform
- IoT/IoE/Open Data
- Real Time Dashboard
- Resilience Control Room
- Data Analytics
- Early Warnings
- Urban Traffic Manager Data Exchange
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**: 1.5 M complex events per day
Traffic Flow Reconstruction for the cities

Pisa
Helsinki
Helsinki Case

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

- **Mobile App and MicroApplications:**
  - Helsinki in a Snap (all stores)

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTQwNg==
Helsinki City Overview (H5a)

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

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTQwNg==
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
The Life of Helsinki (H5b)

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

Sun 29 Sep 00:39:53

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddashboard=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
Environmental Devices hosted by Citizens

My Sensor 373773207E33011B - Helsinki - H3

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

Helsinki
Mobile Apps
Dashboard created to monitor in real time the answers to the survey provided on the Mobile App directly by the Engagement tool.

Dashboard monitoring the Mobile App:

- Collecting the clicks
- Describing the community of users in terms of the profile aspects
- Measuring the time spend, and topics of interest of the users, etc.
Antwerp City Overview - A5

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

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

Unique Dashboard builder Multiple Styles

Antwerp

Unique Dashboard builder Multiple Styles


Snap4City (c), October 2020
Antwerp

Technical Selector: TECH MultiDataMap

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

Snap4City (C), October 2020
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

https://www.snap4city.org/drupal/node/456
Programmable PAX counting

Mobile PAXCounter 01 in Antwerp

Begin 3:00
Finish 5:30

Antwerp

Snap4City (C), October 2020
PAXCounter real time and trend

Antwerp
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.

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**Snap4City User Engagement Antwerp**

Data is based on activities performed on Antwerp in a Snap mobile App

**User's Interests**

- 173 days
- Total active days on app: 3393 days

**Mean time trend**

- 0 minutes
- Mean active time trend: 1.7 minutes

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**Document**

- Documentation
- Survey
- Forum Discussion

---

**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

Telemonitoring

Telecontrol

Modbus to Snap4City Gateway Edge

5G network devices
Dashboards & Services:

GIDA 5G demo

Wed 16 Oct 23:01:00

13.4°C  1020 bar  87%
Santiago di Compostela
Traffic Flow Reconstruction for the cities

Santiago di Compostela

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc5NQ==
Roma Demo3 (Qualità dell’Aria)

Andamento nel Tempo di NO₂ rilevato nelle stazioni in Roma

Dati in Tempo reale inquinanti in Roma e provincia

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddashboard=MjcyNg==
• Scenario: MOBIMART Interreg: MOBilità Intelligente MARe Terra
• Scenario: City of Roma case, mobility and environmental data
• Scenario: Herit-Data video and aims
• Scenario: Control Room vs Video Wall
• Scenario: Snap4Home the case of: Alexa, Philips, Sonoff, TP-link, etc. (Italiano)
• Scenario: how to manage maintenance and accidents workflows
• Scenario: Snap4Home, how to exploit Snap4City solution on home automation
• Scenario: Energy Monitoring
• Scenario: Multipurpose User Engagement Tools
• Scenario: 5G Enabled Water Cleaning Control (smart city, industry 4.0)
• Scenario: High Level Control of Industrial Plant (industry 4.0)
• Scenario: Vehicle Monitoring via OBD2
• Scenario: Events and Museums Monitoring in Antwerp
• Scenario: High Resolution Prediction of Environmental Data
• Scenario: Mobility and Transport Analyses in multiple cities
• Scenario: People Flow Analysis via Wi-Fi
• Scenario: Antwerp Pilot on Environmental Data
• Scenario: Helsinki Pilot on Environmental Data
• Scenario: Firenze Smart City Control Room
• Scenario: Mobile & Web App: Toscana Where What ... Km4City, Toscana in a Snap
• Scenario: Helsinki Pilot on User Behaviour
• Scenario: Antwerp Pilot on User Behaviour

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

Snap4City (C), October 2020
URBAN PLATFORM: SMART CITY IOT AS A SERVICE AND ON PREMISE

IOT APPLICATIONS - INSTANT APPS
- DATA DRIVEN APPLICATIONS
- REAL TIME PROCESSING
- BATCH PROCESSING
- ANY PROTOCOL & FORMAT
- CONTROL ROOM
- SITUATION ROOM
- OPERATOR
- DASHBOARDS
- BUSINESS INTELLIGENCE
- WHAT-IF ANALYSIS
- DECISION SUPPORT
- SIMULATIONS
- RISK ANALYSIS
- RESILIENCE ANALYSIS
- DEVELOPMENT KIT
- SUGGESTIONS
- MOBILE APPS
- MONITORING PANELS
- PLATFORM UTILITIES
- READY TO USE SMART APPLICATIONS

MOBILE & WEB APPLICATIONS

MICROSERVICES & ADVANCED SMART CITY API

LIVING LAB - DEV TOOLS - COWORKING
- IOT DIRECTORY
- SERVICE MAP
- RESOURCE MANAGER
- DATA GATEWAY
- ETL
- PREDICTIONS
- ANOMALY DETECTION
- WHAT-IF ANALYSIS
- TRAFFIC FLOW RECONSTRUCTION
- ORIGIN-DESTINATION MATRICES
- SOCIAL MEDIA ANALYSIS
- OFFER VS DEMAND ANALYSIS
- ENVIRONMENTAL DATA ANALYSIS
- PREDICTIONS
- REAL TIME HEATMAPS
- ROUTING
- ALERTING
- EARLY WARNING
- PERSONAL AND VIRTUAL ASSISTANTS
- SMART SOLUTIONS
- SMART SHARING
- PARTICIPATORY

DATA ANALYTICS TOOLS - MICRO-APPLICATIONS

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

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

0HS  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

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

Search and Query, Smart City API
Facet, semantic search

Data Analytics
R, TensorFlow, Python, MapReduce, ...

Visual Analytics

IOT Applications
Node-RED + Snap4City MicroServices

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

Snap4City (C), October 2020
Snap4City: Builder of Sentient Cities Solutions

Dashboards with data driven IOT Applications enforcing intelligence

IOT and data World

My IOT Devices

IOT Applications

Dashboards and Apps

Big Data Analytics, Artificial Intelligence
Aug 2020 collection
Two Snap4City Libraries

https://flows.nodered.org/search?term=snap4city
Two Snap4City Libraries

We suggest also to install:

https://flows.nodered.org/search?term=snap4city
The Back-Office Data Flows (selection) Exploiting the Snap4City Node-RED MicroServices
IOT Devices

- LoraWAN + Arduino + I2C, NGSI
- Arduino, Wi-Fi, NGSI
- Snap4All IOT Button
- ESP, NGSI, Wi-Fi, BT
- Snap4All PAX Counter
- LoraWAN
- WIFI, NGSI
- GPS

Any Sensor / Actuator
Open to other protocols

IOT Edge Devices

- IOT Edge NodeRED: Raspberry Pi, NGSI, WiFi, RJ45,..
- IOT Edge NodeRED: Android, LINUX, Windows, ...
- LoraWan Gateway: IOT Edge, NGSI, WIFI, RJ45, GPS
Predicting City Areas on Areas

Traffic Flow Reconstruction/prediction

Predicting Pollution

Early Warning Water Bomb

Early Warning Hot in Tuscany

What-IF Analysis

Scalable multiresolution OD matrix

Free Parking Predictions

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<th>MAE</th>
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<td>Baseline + Weather sensors</td>
<td>1.64</td>
<td>1.83</td>
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<tr>
<td>Baseline + Weather + Traffic sensors</td>
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Active on Mobile Apps as:
- "Firenze dove cosa"
- "Toscana dove cosa"

Snap4City (C), October 2020
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<tr>
<th>City official</th>
<th>ICT official</th>
<th>Developer</th>
<th>Citizen, tourist, visitor</th>
<th>Business owner</th>
<th>City officials</th>
<th>City officials</th>
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<th>City officials</th>
<th>City officials</th>
<th>Third party developers</th>
<th>Citizens with respiratory problems</th>
<th>Tourists</th>
<th>Business owners</th>
<th>Mobile</th>
<th>Microapplication</th>
<th>Tool via Portal (ICT Developers)</th>
<th>Dashboards</th>
<th>Main Data Sources</th>
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<td>POI, OSM</td>
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Snap4City - scalable Smart aNalytic APPlication builder for sentient Cities

Smart Cities need to set up a flexible Living Lab to cope with the city evolution in terms of services and city users’ needs and sustainability. Snap4City solution (https://www.snap4city.org) provides a flexible method and solution to quickly create a large range of smart city applications exploiting heterogeneous data and enabling services for stakeholders by IOT/IDS, data analytics and big data technologies. Snap4City applications may exploit multiple paradigms as data driven, stream and batch processing, putting co-creation tools in the hands of: (i) Smart Living Lab users and developers a plethora of solutions to develop applications without vendor lock-in nor technology lock-in, (ii) final users customizable / flexible mobile Apps and tools, (iii) city operators and decision makers specialized / sophisticated city dashboards and IOT/IDS applications for city status monitoring, control and decision support. Snap4City satisfies all the expected requirements of Select4Cities challenge PCC and much more, and it is 100% open source, scalable, robust, respects user needs and privacy; provides MicroServices and easily replaceable tools, compliant with GDPR; provides a set of tools for knowledge and living lab management, and it is compliant with the FGF-OPEN-10 and FGF-OPEN-11 (FDG) living labs standards. Getting a living lab for your city (https://www.snap4city.org) is then a simple task!
## On Line Training Material (free of charge)

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Develop Mobile & Web Applications Exploiting Snap4City Smart City Services
How to adopt Snap4City

On your premise

Smart City as a Service
- Supporting Org
- 100% Open Source Platform: Github
- Further developments
- Publishing Appliances and Dockers
- Training courses, docs
- Consulting
- Forums
- Etc.

Installation on your premise
- Virtual Machines or Dockers
- Different configurations
  - From small to scalable
  - Exploiting your legacy tools
  - Interoperable with any tool
- No vendor lock-in, No tech lock-in

Mixed solutions! For example:
- Start on Cloud as Smart City as a Service
- Migrate on premise on the fly
- Start on Cloud into a sand box
- Pass to install on premise what you need

Download and deploy

Smart City as a Service
- Supporting Org
- 100% Open Source Platform: Github
- Further developments
- Publishing Appliances and Dockers
- Training courses, docs
- Consulting
- Forums
- Etc.
DISIT Lab roadmap vs model and tools’ usage

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

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

2015
Km4City 1.4
- Resilience Decision Support
- Smart First Aid
- User Behaviour Analysis, predictions
- Risk Analysis

2016
Km4City 1.5
- Infomobility
- Mobile App
- Routing
- Multimodality

2017
Km4City 1.6.2
- Origin-Destination and trajectories
- Traffic Reconstruction
- Offer Analysis
- OBU, smart devices

2018
Km4City 1.6.4
- Mobility Demand / Offer Analytics and Strategy
- Sardinia Region Smart City Strategies and plan

2019
IOT/IOE
- User engagement
- Bike Sharing
- Data Analytics ++
- Social Predictions
- OBD2

2020
H2020
- Mobility
- Critical Plant
- Monitoring
- IoT/IOE, IOT App
- Living Lab
- Maker Support
- IoT Edge
- Smart City IOT
- GDPR,
- Privacy & Security
- smartARD MADE
- Interreg
- MOBI
- MENT

2021
- CAPELON
- Sweden
- Smart Mobility
- PISA, PUMS
- Living lab

2022
- Smart Tourism
- 6 Pilots
- Data Analytics
- Extended platform
Urban Platform
Motivations of the Smart City

• Migration towards cities: in the 2050 more than the 75% of population will live in the cities.
  – More opportunities, higher salaries, etc.

• Cities have to cope with the increment of citizens providing higher quality of services & efficiency:
  – To this end, they have to conquer a high level of
    • control on: expenses, quality of services,....
    • quality of services, new services, etc.
    • sustainability of services ...
Smart City Process

• Many aspects should be taken into account for a successful Smart City transformation

• \textit{The influence of each of them depends on context, attitude of the institutions, internal structure, etc.}
  – Parallel actions can conflict, compete …
  – Spreading of efforts may distance the goals
  – ……

• \textit{The process may become sustainable, harmonized and faster with a Living Lab Strategy and Support}

Chourabi et al. 2012
Smart City Domains

• Health
• Education
• Economy & commercial
• Energy
• Environment
• Mobility & Transport
• People & Living
• Governmental
  – Risk management, Resilience
• ...
Sustainability of the Growth

• To be **planned and managed** with respect to increment of population and their needs
  – Increment of quality of life, more services or more efficient services
  – provisioning of new services in place of older services
  – Decision support for strategic aspects:
    • Corrections, prediction, new services, etc.

• **Towards citizens**
  – Informing citizens on the new adaptations, making them aware about that
  – Forming citizens to adopt virtuous behaviour in the usage of services and resources
  – Collecting their feedback continuously via a multichannel
Challenges: Requests and Deductions

- Public Admin.: detection of critical conditions, improving services
- Tuning the service, reselling data and services, prediction

Smart City Engine

- API for SME
- Services & Suggestions
  - Transport, Mobility, Commercial (retail), Tourism, Cultural
- User profiling
  - Collective profiles
  - User segmentation
- 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, …
Snap4City has been Created to satisfy requirements of:

- **ENOLL**: [https://www.openlivinglabs.eu/](https://www.openlivinglabs.eu/)
  - European Network of Living Labs

- **EIP-SCC**: European Innovation Partnership on Smart Cities and Communities
  - [https://eu-smartcities.eu/](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/](https://www.select4cities.eu/)
Requirements and Objectives

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

- **Open Source** and based on Open Source Tools and OS
- **Open Standard** for communication and API for In/Out
- **Scalable, Robust, Distributed** and Decoupled, modular, Service Oriented, open to external services and data sets
- **Data driven**, for reading and data analytic
- **Heterogeneous**: any device, private and public, custom and..
- **Interoperability**: protocols, internal API, Smart City API, capable to integrate with legacy conditions in place, modular, reusable,...
- Communication with things: any protocol, any format, ...
- **Security** by Design: HTTPS, TLS, ...
- **User Centric** Design: privacy by Design (and GDPR), personalized, personal data management, ...

Snap4City (C), October 2020
Security/Privacy Requirements

• **Managing** private data together with public data

• **Private data management** according to GDPR
  – Browsing, downloading, controlling rights, delegating access, revoking accesses, etc.
  – Keep them safe

• Secure enough to delegate management of data regarding public security:
  – Data that could be used against us by some terrorist, or anyway by someone with some bad intention, for example to access in our home when we are far away, etc.
1° place award to

UNIVERSITY OF FLORENCE - DEPARTMENT OF INFORMATION ENGINEERING

for SNAP4CITY

https://www.snap4city.org/558

DIGIPOLIS
FORUM VIRIUM HELSINKI
CITY OF COPENHAGEN
Buyers Group
Data Driven Decision Support

- Decision Support system
- Assessment / Strategies
- Data Rendering, visual analytics
- Data Processing
- Data aggregation, Storage, indexing
- Data Ingestion
Data Collection, ingestion (processes)

- **Data**
  - Open and private: Open Data: CKAN
    - licensing, private, GDPR
  - Static vs Real time
  - Any protocol, any standard: Push and Pull
  - Any format

- **From observations and milestones:**
  - sensors, database, KPI, etc.

- **From legacy services** of in-place operators
  - External Services: call of any kind
  - MicroServices, MicroApplications
  - Local databases

- **From citizens, city users, tourists, operators, ...:**
  - participated processes, feedback, Apps, etc.
  - Crawling web pages, etc.
Real time private

- Personal movements
- GPS traces
- Relationships among people

User Behaviour
- social media
- Contributions of energy, gas, banking

Real time public (open data)

- TV cameras
- Personal traffic
- Position of cars
- Position of taxi
- Position of CarSharing ...

Static Public (open data)

- Fiscal Code, SSN
- Non shared pictures
- Level aspects
- Patient health record

Position of commercial activities, POI
- # Accesses to RTZ ZTL
- Data from Public GOV
- Museums
- City services data, almost Active services

Static
- Public (open data)
- Non shared pictures
- Level aspects
- Patient health record

...
5V of Big Data

When data are BIG data?
The excel file size?

Other Vs have been also proposed...
Integrated Urban Platform

• Produce value from data supporting Living lab
  – Stimulate virtuous behavior, influence City Users!
  – Put in action CITY Strategies

• Data Exploitation performing
  – predictions, reasoning, business intelligence, ..
  – users behavior analysis, decision support system, ..
  – Control Room, Real Time Monitoring tools, ....

• Aggregate & integrate data
  – Multiple protocols from urban operators, ....
  – open data, IOT, sensors, internet of everything, cloud, mobile devices, Wi-Fi, social media, ...
Data Indexing & Semantic Data Indexing

• **Textual**, multilingual, NLP (Natural Language Processing)
  – For social media data, but also for metadata, descriptions

• **Spatial, geographical**, georeversing $\rightarrow$ Knowledge Base, Km4City
  – Around a point, along a line/path, near a path, into a polyline, etc.

• **Temporal** $\rightarrow$ Historical data

• **Semantic:** relationships among city entities.

• **Data Value** different data type (Data Lake/normalization), data unit, etc. $\rightarrow$ the so called IOT shadowing of Azure, AWS
  – Relating to Knowledge Base reciprocally

• **Traffic / volume of Data (KBps)** $\rightarrow$ Network Analysis, monitoring
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 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

Governance: goals, directives, high level decisions, plans

Other Stakeholders

Operators

Smart City Engine

Data: Public and Private, Static and Real Time

Competitive environment
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
Living Lab Accelerating

GO!

Community Building

- Upload context
- Open Data
- Connect IOT/IOE
- Connect external Services
- Data Ingestion and Analytic algorithms
- Advanced Smart City API, MicroServices
- Produce Apps and Dashboards for City Users
- Produce City IOT Applications & Dashboards
- Monitor City Platform
- Promote Applications & Dashboards
- Manage Apps & Dashboards, User Engagement
- agreements
- networking
- tutorials
- documentation
- Inhouse companies
- Tech providers
- experiments
- workshops
- Category Associations
- Corporations
- Advertisers
- Collaborative Platform
- City Operators
- Resource Operators
- Help desk
- Case Studies
- Research groups
- partnerships
- Start-ups
- Early Adopters
- Licensing, Gold services
- events
- hackathons
- personal services
- subscription to applications
- collaborations
- City Users
- Advertisers
- Large Industries
- Snap4City (C), October 2020
Welcome: how to start using Snap4City for beginners

Snap4City developers suggest you reading:

You have already created a Dashboard. Now you may decide to make it public (visible and accessible) to all on Web, or to provide access in view to other specific users that you know by nickname. In addition, you can pass the ownership of a Dashboard to some other user of the system, and you can clone the Dashboard as well, so that you can create Dashboard for other users as well.

We suggest to test these functionalities on you can:
- access to Data Set Manager to load/download share data sets as files in CSV: https://datafile.snap4city.org/servlet/login_handler;
- upload data for the knowledge base and databases via Data Set Manager;
- access to help and contacts, FAQ, documentation and articles;
- manage personal data profile: Sensors, Annotations, Personal Data, Dashboards: https://www.snap4city.org/django/mypersonaldata;
- Auditing Access to My Data according to GDPR;
- Delete/clone a Dashboard to access and manage ownership and/or cloning.

See this below possible solutions:
- TC310 - Dashboard delegation to access and manage ownership and/or cloning.

If you are not registered please apply for a free registration from https://www.snap4city.org and then pass to ACCESS AT THE TOOLS and full Snap4City environment.

Snap4City puts in the hands of Cities Users a single environment to quickly create a large range of smart city applications/views exploiting heterogeneous data and services of stakeholders by IoT and Big Data technologies.

For City4City Users can be citizens, students, operators, researchers, decision makers, developers, etc. see User Roles on Snap4City.

Manager is a final user, has the capability of accessing and creating Dashboards with a large set of data (high level types: AIO, sensors, KPI, micro applications, access to alerts and notifications; registering IoT Devices; creating IoT Applications exploiting Microservices: loading and sharing data sets; managing personal data and annotations: access full to document, help desk, FAQ, covering; managing personal profile and data according to GDPR.

Note: accessible features are mainly simple and small to use, and provide a limited number of parameters on each dialog and for each action.

Default values of created elements can be added editing elements.

An Admin: in a developer/researcher: students, city operators, with additional capabilities with respect to the Manager to: register IoT Brokers; creating advanced IoT Applications: create massive data transformation processes; create data analytics for large, complex data sets, using advanced statistical methods, efficient data analysis; sharing results, load shapes; analyzing performance of the back office. NOTE: technical views and details are fully accessible.

Suggested activities to be performed: how to use Snap4City: 

This page would guide you along few steps and how the solution allows you to incrementally pass from Level 0 to 5, from a Manager to an Area Manager:

- Level 0 user: access at data/services view of the city by using public Dashboards (Public User).
- Level 3 user: create personal/professional view of dashboards on data (Manager).
- Level 5 user: create personal view of dashboards on data (Area Manager).

Snap4City (C), October 2020
How to adopt Snap4City

On your premise

Download and deploy

Smart City as a Service
• Supporting Org
• 100% Open Source Platform: Github
• Further developments
• Publishing Appliances and Dockers
• Training courses, docs
• Consulting
• Forums
• Etc.

Installation on your premise
• Virtual Machines or Dockers
• Different configurations
  • From small to scalable
  • Exploiting your legacy tools
  • Interoperable with any tool
• No vendor lock-in, No tech lock-in

Mixed solutions! For example:
• Start on Cloud as Smart City as a Service
• Migrate on premise on the fly
• Start on Cloud into a sand box
• Pass to install on premise what you need
Develop Mobile & Web Applications Exploiting Snap4City Smart City Services

Analysis & Design
- Analysis
- Design

Data Analytics
- Data Discovery Development
- IOT App Development
- Dashboard Development
- Special Tool Development
- Data Analytics Development

Advanced Smart City API and MicroServices
- Snap4City Mobile & Web Apps Development Kit
- Application Requirements Analysis
- Application Development

Development
- Deployment
- Testing
- Publication Production

Smart City Services
- Mobile and Web Apps

Snap4City (C), October 2020
• We suggest you to start:
  – HOW TO: create a Dashboard in Snap4City
  – HOW TO: add a device to the Snap4City Platform
  – HOW TO: add data sources to the Snap4City Platform
  – HOW TO: define privacy rules for personal data, produced by the end-users own device

• Plus, more than
  – 150 Test Cases for training, with training sources for IOT Applications, ETL, Data Analytics on the Resource Manager
  – 40 Video of training
  – 30 articles

• Please follow the personalized suggestions Snap4City proposes you!
• A course in Italiano: https://www.snap4city.org/drupal/node/485
Snap4City Architecture
Unique of Snap4City Platform (1)

- Data ingestion and model
  - **Unified data model** (exploited in the Wizard and Knowledge base)
  - **Semantic Reasoner** modelling city entities, supporting semantic search, expert system, digital Twin, etc.
  - **IOT Directory** abstracting complexity of IOT Devices, Edge, Brokers, protocols and data formats

- Data Analytics and Data Processes
  - **Flexible and extensible IOT Applications**
  - **Data Analytic**: multiple programming languages,

- Visual Analytics, dashboarding, Apps
  - **Wizard**: expert system for immediate dashboard production matching data vs graphics representation
  - **Dashboards specialized** multidomain for Smart Cities
  - **Custom Widgets and Synoptics**
  - **Ready to use Mobile App, instant App, MicroApplication**
  - **Strategies** formalization supports
**Unique of Snap4City Platform (2)**

- **Openness to any developers**
  - Living Lab support for coworking, sharing, and delegating
  - Advanced Smart City APIs and MicroServices
  - 100% Open Source, Open hardware

- **Security and Privacy**
  - End-2-end encrypted communication, on devices, platform, ... dashboards
  - GDPR compliant privacy/security

- **Non functional**
  - on cloud and on premise, your private installation
  - Ready to use Appliance Virtual Machines and/or Containers for a modules and tools.
  - Flexible, Modular, Elastic, scalable and robust
Smart City Functional Architecture

Data Sources, External Services
PULL Data

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

Big Data Cluster
HDFS, Hbase, Phoenix

Knowledge base
Semantic reasoners

Indexing and aggregating
Elastic search

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

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

Search and Query, Smart City API
Facet, semantic search

IOT Applications
Node-RED + Snap4City MicroServices

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

Public Services, Govern, events, ...

Sensors, IOT Cameras, Wi-Fi

Environment, Water, energy

Shops, services, operators

Social Media

Social Media Crawler and Manager
Snap4City - scalable Smart aNalytic APplication builder for sentient Cities

Smart Cities need to set up a flexible Living Lab to cope with the city evolution in terms of services and city users' needs and sustainability. Snap4City solution (https://www.snap4city.org) provides a flexible method and solution to quickly create a large range of smart city applications exploiting heterogeneous data and enabling services for stakeholders by IoT/IIoE, data analytics and big data technologies. Snap4City applications may exploit multiple paradigms as data driven, stream and batch processing, putting co-creation tools in the hands of: (i) Smart Living Lab users and developers of solutions to develop applications without vendor lock-in nor technology lock-in, (ii) final users customizable / flexible mobile Apps and tools, (iii) city operators and decision makers specialized / sophisticated city dashboards and IOT/IIoE applications for city status monitoring, control and decision support. Snap4City satisfies all the expected requirements of Select4Cities challenge PCP and much more, and it is 100% open source, scalable, robust, respects user needs and privacy; provides MicroServices and easily replaceable tools compliant with GDPR; provides a set of tools for knowledge and living lab management; and it is compliant with the NDS and DSI framework.
DASHBOARDS: FROM CITY DASHBOARD TO APPLICATIONS
Public Dashboards for your perusal

https://www.snap4City.org
Smart City Control Room
a set of dashboards and tools
Smart City Control Room

a set of dashboards and tools
Mobility and Environment What-IF Analysis

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

Traffic Flow Monitoring - Firenze - Cloned2

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjY1MQ==
NOX reduction for COVID

Monitoraggio Area Gramsci: NO2 vs Traffico

https://www.snap4city.org/dashboardSmartCity/view/index.php?idDashboard=Mjl4OQ==
Andamenti Nazionali e Regionali infezione COVID-19
Sulla base dei dati della protezione civile, elaborazioni DISITLab

per evidenziare gli andamenti di vostro interesse: eliminare le curve che non interessano selezionandole in legenda.
Alcuni dati in passato non sono pervenuti alla protezione civile

Main IT Provinces vs Tuscany Provinces: COVID-19

Andamento Regione Toscana e Province, COVID-19

Sulla base dei dati della protezione civile, elaborazioni DISITLab

per evidenziare gli andamenti di vostro interesse: eliminare le curve che non interessano selezionandole in legenda.

Alcuni dati in passato non sono pervenuti alla protezione civile

DEMO

Section 1
Firenze - Trafair - AirQuality Heatmaps

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

Snap4City (C), October 2020
Valutazione Trasporto Pubblico

Firenze - 6 linee

Linea 13
Ritardo medio corse attive nei 5 min in sec
395

Andamento del ritardo medio sulle corse attive nei 5 minuti – linea 13 (in Sec)

Linea 17
Ritardo medio corse attive nei 5 min in sec
182

Linea 31
Ritardo medio corse attive nei 5 min in sec
793

Andamento del ritardo medio sulle corse attive nei 5 minuti – linea 31 (in Sec)

Linea 23
Ritardo medio corse attive nei 5 min in sec
1369

Andamento settimanale - Linea 13

Linea 36
Ritardo medio corse attive nei 5 min in sec
923

Andamento settimanale - Linea 36

Linea 6
Ritardo medio corse attive nei 5 min in sec
254

Andamento settimanale - Linea 6

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Snap4City (C), October 2020
Replicate Project @ReplicateEU · Oct 30
Last stop allowed to see the #smartcity #controlcenter an exciting experience and impressive
Helsinki City Overview (H5a)

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

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTQwNg==
Disit Lab, Distributed Data Intelligence and Technologies
Distributed Systems and Internet Technologies
Department of Information Engineering (DINFO)

Antwerp City Overview - A5
Please note that the data results are not always based on real data.

Snap4City (C), October 2020

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTQwNw==
Unique Dashboard builder Multiple Styles
Life in Toscana: Dashboard

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc3NA==

Snap4City (C), October 2020
Helsinki vs Florence comparison

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

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc0MQ==
Infomobility Dashboard

MicroApplications


3D Map beta Testing

MicroApplications for Dashboards
Operator Dashboards at different levels
Chemical Plant Dashboard
Green Impact Capacity (GIC)
Altair Control room
Technical Selector: TECH MultiDataMap

Antwerp Selector Tech
Multi-Widget Map

First aids overview - Tuscany

Service status of main first aids

Custom Dashboards and Widgets (interactive, Animations, etc.)
-- SVG for graphic design
-- MyKPI for collecting data
Demo UC5 GIDA

GIDA 5G demo

13.4°C  1020 bar  87%

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjIyNg==
Smart Lonato del Garda

0 status

987.1 mm
66.3 %
14.1 °C

TEST1_AIRSENSEUR_RVB01
VALUE NAME: TEST1_AIRSENSEUR_RVB01

Date/Time: 4:18:33 PM

Humidity: 66.34775
Pressure: 987.0833
Temperature: 14.07835

2 free slots

Snap4City (C), October 2020
External Services

- Twitter Vigilance:
  - Daily and real time
  - Volume and sentiment analysis
- Services on Maps, GIS, ArcGIS
- Real time sensors on 3D
- Web HTML5 Applications
- Origin Destination Matrix
- Real Time fleets
- Routing, Multimodal tools
- IPCAM connector
- Synoptics
- Third party tools!
- Other tools also internal
  - Traffic Flow Reconstruction
  - User behaviour monitoring
  - Tracking tools
  - Heatmaps tools
  - Trajectories tools
Operator Business Analysis
Dashboards: DevDash, AMMA

- Dynamic Filtering, Adaptable, ...
- Full data details, drill down,...
- Synergic with Data Inspector which addresses data relationships, processing and information
DevDash by Elastic Search + Kibana
AMMA by Elastic Search + Kibana
Knowledge Base view: ServiceMAP

- Click with the mouse

HLT: Sensor
### HLT: Sensor

- Specific values of selected
- Information of the values of the other sensors on the same device
- Trends and marking of problems, for machine learning

#### Data sources Details

<table>
<thead>
<tr>
<th>Device</th>
<th>Values</th>
<th>Process</th>
<th>Image</th>
<th>Ownership</th>
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<td></td>
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<tr>
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<td>Last Value:</td>
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<td></td>
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### Table:

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<th>Reason</th>
<th>Healthiness Criteria</th>
<th>Refresh Rate (s)</th>
<th>Data Type</th>
<th>Unit</th>
<th>Value</th>
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</tbody>
</table>
Trajectories and Real Time Tracking
**MyKPI: Tracking of Devices and Mobiles**

- Real Time Trajectories for
  - Mobile Phone
  - Moving IOT Devices
  - OBU, Vehicular Kits
  - Multiple tracks
  - Day by day

- Micro Application

![TrackerFordOBD2](image)

- Apps
- Mobile
- PAX Counter
- OBD2
- Mobile sensors

![Map](image)
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.
Dashboards’ Intelligence on Web and Mobile Devices
Snap4City: Builder of Sentient Cities Solutions

Dashboards with data driven IOT Applications enforcing intelligence

IOT and data World

My IOT Devices

IOT Applications

Dashboards and Apps

Big Data Analytics, Artificial Intelligence
Control Room Operator
Would like to:
- Monitor traffic flow, Environment, Car parking, Cycling, First aid, temp., ...
- Act and monitor Dynamic Plates
- Act and monitor red lights

Driver, Policeman
Would like to:
- Monitor traffic, Parking, env., speed limit, ...
- Act and monitor red lights
IOT Application with City Dashboard
Simple development

- Virtual Sensors and Virtual Actuators
- From Dashboard to IOT App and viceversa
- From Dashboard to IOT Brokers/Devices and viceversa
Dynamic Dashboards: changing from IOT App

- Dynamic Creation of Widget Content: BarSeries, trends, maps, single content, etc.
- Temporary data pushed on Dashboards
IOT Applications vs Dashboards

• IOT Applications, realized by using Snap4City Node-RED and integrated with Snap4City Nodes/MicroServices block, can be behind dashboards to get data from them with Virtual Sensors and Actuators.
  – Dashboards may be connected to multiple IOT Applications and IOT devices
  – IOT Applications may be connected with multiple Dashboards and IOT devices

• A network of Dashboards, IOT Apps and IOT Devices and data is easily realized exchanging data via secure connections.

• Training Cases:
  – US2. Using and Creating Snap4City Applications with Dashboards
  – US9. Creating Snap4City IOT Applications, different formats, protocols, brokers, communications
Dashboard Menu - Chatroom - Notifications
(support for Virtual Control Rooms)
Dashboard Menu a Short Cut for other.....

- Each Organization on Snap4City may define its own Menu on Dashboards
  - The Menu can be activated or not in each single Dashboard of the ORG
- Definition includes a list of Items and Subitems, each of which with
  - colors & icons
  - Links to web pages/dashboards to be activated and modality
  - User Roles at which it has to be proposed
  - Etc.

TC 1.23 - Dashboard Menu management per Organization

ChatRoom Per Dashboard

Chat Management
Smart City Monitoring: Notificator

- Notifications may arrive via Facebook, Telegram, SMS, email, etc., by exploiting IOT App behind the dashboard
- Integration with workflow management system for ticketing
Smart City Control Room
Smart City Control Room

*a set of dashboards and tools*
The Back-Office Data Flows (selection) Exploiting the Snap4City Node-RED MicroServices
Citizens Engagement

#Firenze

https://www.snap4city.org/511
Chemical Plant Dashboard
Green Impact Capacity (GIC)
Altair Control room
Operator Business Analysis Dashboards: DevDash, AMMA

- Dynamic Filtering, Adaptable, ...
- Full data details, drill down,...
- Synergic with Data Inspector which addresses data relationships, processing and information
Reports and Dashboards

Anomaly detection
Early Warning
Critical Events: ticket management

Personalised Workflows
Maintenance Intelligence
Example of Integrated workflow

Event detection and firing
Critical event management

Workflow management, team assignment, material control

Consumptions/productions

Events/actions

Business Intelligence
Predictive Maintenance

Snap4City (C), October 2020
Control Room vs Video Wall
Control Room
Video Wall

From Consolle Operator to the Video Wall

Snap4City (C), October 2020

e.g. 3x3 (HD)
A number of Scenarios

For example
Automated Control of Video Walls

• Large number of Sources into a video Wall
  – Any size 1x2, 2x2, 3x3, 3x4, 3x3, .......5x4..... any

• Scenarios
  – Change of Scenarios over 32. With: PIP, squeeze, stretch
  – Manual selection of scenarios
  – Automated activation of scenarios by Snap4City solution from:
    • Contextual information, firing conditions, from IOT Applications
    • Dashboard buttons
    • Workflow and maintenance
    • data analytics
    • arrival of external signals and/or messages in push from IOT Devices
    • etc. etc.
Dashboards Production
Snap4City: Builder of Sentient Cities Solutions

Dashboards with data driven IOT Applications enforcing intelligence

IOT and data World

IOT Applications

Dashboards and Apps

My IOT Devices

Big Data Analytics, Artificial Intelligence
Dashboard Development

IOT Applications

Knowledge Base, Km4City

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

Widget Collection

Dashboard Wizard
Create, save, load, delegate, grant access

Dashboard Editor

Public Dashboard Collection

My Own Dash/App

Micro Applications

External Services

Custom Widgets/Synoptics
From Templates to Wizard and Dashboards

- to create a new Dashboard
- to add widgets and/or groups of them on any Dashboard
The Wizard help you in selecting only possible combination of data vs graphic representation.
Select the area of your interest: panning and zooming

- Select the graphic aspect of your interest, or
- High Level Type of your interest, or
- Make a search if you have a precise idea or
- Act on filters: nature, subnature, type, name, value, date, health, owner, ...
- Combine them as you like
- Select the lines of your interest
- Then click on Next and get the Dashboard by wizard
Dashboard List and Editor
DATA GATHERING AND CITY DATA KNOWLEDGE MANAGEMENT
Any kind of data and flows

- **Open Data:**
  - Data gate, federation of Open Data Portals
  - ETL processes (PULL)
  - IOT Application processes

- **IOT Networks:**
  - IOT Application processes, data driven or PULL
  - IOT Brokers (Push) ➔ IOT Shadow

- **Web Pages:**
  - Web scraping, crawling processes

- **Social media: Twitter, Facebook...**
  - Twitter Vigilance, IOT App

- **Mobile Apps**
  - Smart City API

- **Files upload: CSV, Excel, etc.**
  - IOT Applications, ETL

- **REST API, WS, FTP, LD, LOD, etc.**
  - IOT Applications, ETL

- **Data base accesses**
  - GIS: WFS, WMS
  - ETL, IOT Application

---

**SemiOT Architecture**

- **IOT Device**
- **IOT Edge**
- **IOT Broker**
- **IOT App**
- **Web Scraping**
- **DataGate**
- **Web**
- **Scraping**
- **GIS data, Maps,...**
- **API, External Services**
- **Rest Call .......MS**
- **External Data Stores**

---

**SNAP4City**

- **GIS data, Maps,...**
- **API, External Services**
- **Rest Call .......MS**
- **External Data Stores**

---

**My Files**

- user-analysis-v2-0.xlsx
- user-analysis-v2-0-anonymous.xlsx
- users-analysis.xlsx

---

Snap4City (C), October 2020
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, ETL, DISCES, IOT Apps

**Big Data Cluster**
- HDFS, Hbase, Phoenix

**Knowledge base**
- Semantic reasoners

**Indexing and aggregating Elastic search**

**Data Analytics**
- R, TensorFlow, Python, MapReduce...

---

**Search and Query, Smart City API**
- Facet, semantic search

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

---

**IOT Applications**
- Node-RED + Snap4City MicroServices

---

**Inform, announce, Act!, warning, alarms, What-IF, ..**
Standards and Interoperability

IOT/IOE Protocols

Communication Patterns

- MQTT
- HTTP(s)
- AMQP
- COAP
- NGSI
- OneM2M
- WebSockets
- Etc.
Integrated Node-RED development

Event Driven, real time data ingestion
Web Scraping

Snap4City (C), October 2020
Integrated DataGate/CKAN
Static open data ingestion

Data Set:
- Search
- Loading
- Download
- Share
- Publish
- Also automated

Automated data regularization

Federated Crawling
Federated Distribution
Integrated ETL development

Batch Processing for dynamic data ingestion
Snap4City is interoperable with:
- ESRI ArcGIS Enterprise, Portal, Pro/MAP, ...
- other GIS tools supporting WFS, WMS, GeoJSON, GML

Snap4City is interoperable since:
- Provides info/data in WFS, WMS
- Exploits data/info from WFS, WMS
- Import data/info from WFS/WMS

The Snap4City platform can be installed on premise using Snap4City Appliance
https://www.snap4city.org/drupal/node/471
- StartSNAP4CITYVM includes the Dashboard Builder that is capable to work with WFS WMS protocols for the integration with GIS platforms as ESRI ArcGIS, QGIS, directly or using Snap4City GIS player.
- KBSSMVM includes the Smart City API and WFS API which can be used to data harvest from any GIS servers and GIS desktop tool.
IOT Applications, Devices and Dashboards
Snap4City: Builder of Sentient Cities Solutions

Dashboards with data driven IOT Applications enforcing intelligence

IOT and data World

IOT Applications

Dashboards and Apps

My IOT Devices

Big Data Analytics, Artificial Intelligence
## IOT Applications

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<th>Description</th>
<th>Owner</th>
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</table>
IOT Applications

– Basic / Advanced
– On IOT Edge Raspberry Pi
– On IOT Edge Android
– On IOT Edge Win/Linux
Editing IOT Applications

Snap4City (C), October 2020
### Basic Node.js Blocks on NodeRed on our Advanced IOT Apps

#### Input
- inject
- catch
- status
- http
- websocket
- tcp
- udp
- amqp
- amqp2
- stomp

#### Output
- debug
- link
- status
- mqtt
- http response
- websocket
- tcp
- udp
- amqp
- amqp2
- stomp

#### Function
- function
- template
- delay
- trigger
- comment
- http request
- top request
- switch
- change
- range
- split
- join
- csv
- html
- json
- xml
- yaml
- soap request
- base64
- msgpack
- random
- rbe

#### Social
- email
- twitter
- dropdown
- switch
- slider
- IRC
- text input
- date picker
- colour picker
- form

#### Storage
- tail
- file
- file
- mysql
- file

#### Location
- turf
- worldmap
- xml
- yml
- soap request
- base64
- msgpack
- random
- rbe

#### Advanced
- watch
- feedparser
- sunrise
- UI control
- exec

#### Dashboard
- button
- dropdown
- switch
- slider

#### Network
- ping

---

**+ on IOT Edge Raspberry**

- Raspberry Pi
- rpi gpio
- rpi gpol
- rpi mouse
- rpi keyboard
- camerapi takephoto
- rpi dh22
- imagecapture
- ledborg
- Sense HAT
- Sense HAT
Aug 2020 collection
Two Snap4City Libraries

https://flows.nodered.org/search?term=snap4city
Two Snap4City Libraries

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

We suggest also to install:
Estimation of the mean waiting time at bus stops
Programmable PAX counting

Mobile PAXCounter 01 in Antwerp

Snap4City (C), October 2020
**IOT Devices**

- LoraWAN + Arduino + I2C, NGSI
- Arduino, Wi-Fi, NGSI
- Snap4All IOT Button ESP, NGSI, Wi-Fi, BT
- Snap4All PAX Counter WiFi, NGSI, GPS

**IOT Edge Devices**

- IOT Edge NodeRED: Raspberry Pi, WiFi, RJ45,..
- IOT Edge NodeRED: Android, LINUX, Windows, ...
- LoraWan Gateway: IOT Edge, NGSI, WIFI, RJ45, GPS

Any Sensor / Actuator Open to other protocols
Humidity, Temperature, CO, CO2, O3, NO2, VOC, PM2.5, PM10) in urban environment
FORGING & MANAGING FLEXIBLE MOBILE APPS, Web Apps and MicroApplications
Snap4City (C), October 2020
The App is a Bidirectional Device

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

**System**

**Produced information**
- Accepted ?
- Performed ?
- ...

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

**Produced information**
- Suggestions
- Engagements
- Notifications
- …
User Behavior Analyser for Collective Profiling

Who

When

What

Where?

Why?

Where they go ahead

How move
Scalable OD Matrix
User Behaviour Analyser

Hot places, trajectories, heatmap
Engaging City Users Towards Virtuous Behaviours (real time)
Users’ Engagement

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

Rules

User context

City context
Campaing on Sustainable Mobility

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

Dal 15 aprile al 15 luglio scegliere il trasporto pubblico ti premia!
Scarica l’app “Toscana dove, cosa”, guadagna punti viaggiando in autobus e vinci tanti fantastici premi!
Per maggiori informazioni visita il sito info.sii-mobility.org

Sii smart. Sii-Mobility!
In palio per te
Carnet multicrosa Cpt e voucher per:

http://www.disit.dinfo.unifi.it
http://www.disit.org

Snap4City (C), Octob
DATA ANALYTICS, Big Data Science
WHAT IS DATA SCIENCE

- Big Data
- Semantic Computing
- Machine Learning
- Geo Spatial Reasoning
- Sentiment Analysis
- What If Analysis
- Text Analysis
- Simulations
- Visual Analytics
- MicroServices
- Scalability
- Engagement Analysis
- ...

Sentient and active processes
• Resilience
  • Resilience and risk analysis
  • Early warning computation
  • What-if analysis, dynamic routing, origin destination matrices production from a large range of sources

• Mobility and transport
  • Traffic flow reconstruction from sensors and other sources: parking predictions: wi-fi people flow prediction and reconstruction
  • Analysis of the demand vs offer of mobility according to public transportation and multiple data sources
  • Accidents heatmaps
  • Traffic flow predictions
  • Tracking fleets, people, devicesOBD2 support

• Environment and weather
  • NOX pollution prediction on the basis of traffic flow, 48 hours see
  • Pollution prediction at 48 hours, every hour

• User and Social
  • User’s engagement for sustainable mobility
  • User’s behaviour analysis, data reconstruction and calibration
  • People flow analysis from PAX Counters
  • Social media analysis on specific channel, specific keywords: see Twitter Vigilance, for NLP and Sentiment Analysis, SA
  • ReTweet proneness, retweet-ability of tweets
  • Audience prediction to TV channels and physical events

• Generic
  • Data quality assessment, prediction, anomaly detection
  • Maintenance prediction and costs predictions
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<th>ICT official</th>
<th>Developer</th>
<th>Citizen, tourist, visitor</th>
<th>Business owner</th>
<th>City officials</th>
<th>City officials, City developers</th>
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<td>Twitter Vigilance</td>
<td></td>
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<td>Snap4City Portal</td>
<td></td>
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</tr>
<tr>
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<td>X</td>
<td>Snap4City Portal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Main Data Sources**
- POI, OSM
- OSM, GTFS
- Sensors data, OSM
- Enfuser data
- Forecast Service
- Snap4City Mobile App
- Snap4City Mobile App
- Snap4City Mobile App
- Snap4City Mobile App
- Snap4City Mobile App
- Twitter Vigilance
- Snap4City Portal
- Snap4City Portal

**Snap4City**
- Antwerp
- Helsinki
- Where

**Discovery near to me**
- X

**Discovery along a path**
- X

**Discovery in an area, shape**
- X

**Full Text search**
- X

**Routing: pedestrian**
- X

**Routing: pedestrian quite**
- X

**Routing: private vehicles**
- X

**Routing: Multimodal Public Transport**
- X

**heatmaps: weather (Temp, Humidity)**
- X

**heatmaps: environmental variables, PM10, PM2.5, NO2, EAQI**
- X

**heatmaps: environmental variables, Noise**
- X

**heatmaps: safe on bike (Antwerp)**
- X

**heatmaps: Enfuser prediction, PM10, PM2.5, AQI**
- X

**heatmaps piking values any place**
- X

**heatmaps: GRAL prediction, PM10**
- X

**heatmaps: safe on bike (Antwerp)**
- X

**heatmaps: GRAL, Real Time**
- X

**heatsmaps: GRAL prediction, PM10**
- X

**Heatmaps Data Time Trends, & drill down**
- X

**Weather Forecast**
- X

**Origin Destination Matrices**
- X

**Typical trajectories**
- X

**Hot Area in the city**
- X

**Hot Places in Smart Zone**
- X

**Services Suggestions on mobiles**
- X

**Alerts on critical cases: several variables**
- X

**The most used services**
- X

**Twitter Trends Daily**
- X

**The auditing of user and living lab**
- X

**Self assessment**
- X

**Trajectories: rest from mobile PAX Counters**
- X
Data Analytics: Predictions
Predicting Models for Administrators & City Users

- **Aiming at improving**
  - quality of service, distributing workload
  - early warning

- **Predictions**: Short (15 min, 30 Min) and mid Term (1 week)

- **Data Analytics**: ML, NLP/SA, Clust., ...
  - Traffic Flows \(\rightarrow\) multi-flow reconstruction
  - Parking Status \(\rightarrow\) free slots
  - Environmental Alarms
  - Air Quality parameters and indexes
  - People Flows (Wi-Fi, Twitter) \(\rightarrow\) crowd, number of people

Predicting City Users on Areas

Predicting at EXPO2015

Early Warning Water Bomb

Early Warning Hot in Tuscany
Free Parking Predictions

<table>
<thead>
<tr>
<th>Model features</th>
<th>BRNN model results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R-squared</td>
</tr>
<tr>
<td>Baseline</td>
<td>0.974</td>
</tr>
<tr>
<td>Baseline + Weather</td>
<td>0.975</td>
</tr>
<tr>
<td>Baseline + Traffic sensors</td>
<td>0.975</td>
</tr>
<tr>
<td>Baseline + Weather + Traffic sensors</td>
<td>0.975</td>
</tr>
</tbody>
</table>

Active on Mobile Apps as:

– «Firenze dove cosa»
– «Toscana dove cosa»

Precision: 97,5%
Origin Destination Matrix Estimation

Wi-Fi based
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

Where

Recency

First Day actions

New City Users VS Returning
Characterizing City Areas

Predicting City Areas Crowd level characterizing Users’ Behaviors

Wi-Fi based
Prediction and Identification of Anomalies

Guessing number of users of Wi-Fi Access Points

- Cluster confidence
- AP average and confidence
- Actual AP trend for today
- AP prediction for the next time slot in the day on the basis of past weeks

Predictive precision of the 95%
## Traffic Flow Reconstruction for the cities

**Selector Web**

<table>
<thead>
<tr>
<th>Firenze</th>
<th>Firenze + FIPiL</th>
<th>Pisa</th>
<th>Santiago</th>
<th>Modena</th>
<th>Livorno</th>
<th>test</th>
</tr>
</thead>
</table>

**Selector - Map**

Last sensors measure 2019-10-14T00:10:00

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

---

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mtc5NQ==
Life in Toscana: Dashboard

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddashboard=MTc3NA==

Snap4City (C), October 2020
Bus Stop Analysis: identification of criticalities
Routing and Multimodal Routing

Modes:
- Pedonual, Vehicles
- Public Multimodal
- Multi Point for Delivering
- Constrained: quite, blocked, etc.

Test it on our:
- Mobile Apps
- MicroApplication
- Dashboard
- ServiceMap service on Tuscany in Snap4City

Snap4City (C), October 2020
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
Heatmap Firenze - trafair

different data

Florence, Pisa, Livorno

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

Accidents vs Traffic

Accidents Density

<table>
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<th>Anom. Count</th>
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<tr>
<td>2018-07-01 04:00:00</td>
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<td>2018-07-01 19:40:00</td>
<td>46</td>
</tr>
<tr>
<td>2018-07-01 19:50:00</td>
<td>408</td>
</tr>
</tbody>
</table>

Snap4City (C), October 2020
Florence Accidents Density

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

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

Assessment on the basis of changes:

- Mobility demand assessment
- Mobility Offer assessment

Mobility and Environment What-IF Analysis

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

Prediction/Assessment

- Football game results as related to the volume of Tweets
- Number of votes on political elections, via sentiment analysis, SA
- Size and inception of contagious diseases
- Marketability of consumer goods
- Public health seasonal flu
- Box-office revenues for movies
- Places to be visited, most visited
- Number of people in locations like airports
- Audience of TV programmes, political TV shows
- Weather forecast information
- Appreciation of services
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

Snap4City (C), October 2020
Twitter Vigilance
Early Warning

Attendance at long lasting events: EXPO2015

Attendance at recurrent events: TV, football

Predictive models

Hot flows

Snap4City (C), October 2020
SNAP4CITY LIVING LAB
FOR COLLABORATIVE WORK
Snap4City

Welcome: how to start using Snap4City for beginners

Snap4City developers suggest you reading:

You have already created a dashboard. Now you may decide to make it public (visible and accessible) to all on WEB, or to provide access in view to other specific users that you know by nickname.

In addition, you can pass the ownership of a dashboard to another user of the system, and you can clone the dashboard as well. So that you can create dashboard for other users as well.

We suggest you to test those functionalities too:

- access to Data Set Manager to load/download share datasets as files in CSV: https://dataset.snap4city.org/filefilter_handler
- upload data for the knowledge base and dashboards via Data Set Manager.
- access to help and contacts, FAQ documentation and articles.
- manage personal data profile, users, Annotations, Personal Data, Dashboards: https://www.snap4city.org/dropin/myprofiledata
- Auditing Access to My Data according to GDPR.

See this dashboard for more possibilities:
- TCO: Dashboard delegation to access and manage ownership and/or cloning
- If you are not registered please apply for a free registration from https://www.snap4city.org and then pass to ACCESS AT THE TOOLS and full Snap4City environment.

Snap4City puts the hands of City Users a single environment to quickly create a large range of smart city applications/views exploiting heterogeneous data and services of stakeholders by IOT and big data technologies.

For Snap4City City Users can be citizens, students, operators, researchers, decision makers, developers, etc. use useful tools and features:

- Manager: is a final user, has the capability of:
  - accessing and creating Dashboards with a large set of data (high level types such as PIS, POS, KPI, micro applications, external services, etc.).
  - registering IOT Devices; creating IOT Applications exploiting Microservices loading and sharing data sets;
  - managing personal and anonymous full access to documentation, help desk, FAQ, converting managing personal profile and data according to GDPR.

- AdminManager: in a developer/researcher, students, city operator, with additional capabilities with respect to the Manager to register IOT Brokers; creating advanced IOT Applications; create massive data transformation processes; create data analytics in modeling, testing and analysis, create mesoservices; add external services; sharing results, load sharing; analyzing performance of the back office.

NOTE: accessible features are mainly simple and useful to test and to use, and provide a limited number of parameters on each dashboard and for each action.

For detailed values of created elements can be edited by clicking elements.

Suggested activities to be performed are the next:
- HOW TO use Snap4City:

You are guided by a few steps that may help you to incrementally pass from Level 0 to 5, from a Manager to an Area Manager:

- Level 0 user: access at data/services view of the city by using public Dashboards; (Public User)
- Level 1 user: create personal/professional view of dashboards on data; (Manager)
- Level 2 user: create personal/professional view of dashboards on data; (Manager)
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
### Self Assessment

#### Snap4City (C), October 2020

#### My Personal Statistics and Bounds

**Username:** snap4city  
**Role:** AreaManager  
**Level:** 4  
**Date:** 2016-11-09

**User’s Limits:**  
- Dashboards: 100, IoT Apps: 100, IoT Devices: 10000

<table>
<thead>
<tr>
<th>Public</th>
<th>Private</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td><strong># Dashboards</strong></td>
<td><strong># Dashboards Accesses</strong></td>
<td><strong># Dashboards Minutes</strong></td>
</tr>
<tr>
<td>30 (23)</td>
<td>77</td>
<td>1050</td>
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</table>

<table>
<thead>
<tr>
<th>Public</th>
<th>Private</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong># IoT devices</strong></td>
<td><strong>IoT H (tx/rx)</strong></td>
<td><strong>IoT L (tx/rx)</strong></td>
</tr>
<tr>
<td>3216 (76326)</td>
<td>9873.79</td>
<td>0.0</td>
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</table>

<table>
<thead>
<tr>
<th>Names</th>
<th>Count</th>
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</thead>
<tbody>
<tr>
<td>email</td>
<td>13</td>
</tr>
</tbody>
</table>

---

**IoT App (s)**

- db_storage_rx
- db_request_rx
- dashboard
- device
- device_map
- device_map2
- device_map3
- envisage
- nsgov
- nsgov2
- nsgov3
- snap4city
- snap4city_portal
- ISIT Lab portal

---

**IoT messages (kB)**

- **Average:** 86562
- **Average:** 435614
SNAP4CITY HACKATHON
BUILD YOUR APP FOR A CONNECTED CITY

Open from
Jan 21 - Mar 15

CLICK HERE TO SEE THE HACKATHON WINNERS

see interim winner Fast Rabbit
Data-driven design platform for offline advertising

Built on big data to determine the most popular location for a customer group
Automatically select billboards with the highest traction. The platform is capable of predicting the reach of every location on a city based on big data analytics.

Skyrocket the traction of offline campaigns
Citizens will run into more relevant advertisements resulting in higher conversion rates and more successful campaigns.
Development Life Cycle
Develop Mobile & Web Applications
Exploiting Snap4City Smart City Services

Smart City Services

Analysis & Design
- Analysis
- Design
- Data Discovery
- Data Ingestion

Data Analytics
- Data Analytics Development
- Special Tool Development
- Dashboard Development

IOT App Development

Deploy
- Publication Production
- Testing

Advanced Smart City API and MicroServices
- Snap4City Mobile & Web Apps Development Kit
- Application Requirements Analysis
- Application Development
- Deploy
- Publication Production
- Testing

Mobile and Web Apps

Analysis & Design
- Analysis
- Design
- Data Discovery
- Data Ingestion

Data Analytics
- Data Analytics Development
- Special Tool Development
- Dashboard Development

IOT App Development

Deploy
- Publication Production
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Advanced Smart City API and MicroServices
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- Application Requirements Analysis
- Application Development
- Deploy
- Publication Production
- Testing

Mobile and Web Apps
Development Tools
IOT Applications Development

- MicroServices collections
- My IOT Applications
- IOT App. Editor
- Resource Manager
- Sharing/saving reusing IOT App
- Generating IOT App With Dashboard

IOI Discovering

ServiceMap Discovery

Dashboard Collection, Editor and Wizard

Knowledge Base, Km4City

Snap4City (C), October 2020
Data Analytics Dev. in R Studio and/or Tensor Flow

- Knowledge Base, Km4City
- Ontology Schema
- LOG.disit.org
- Big Data Store Facility
- Smart City API from Knowledge Base and other tools
- Creating MicroServices
- Using them into IOT Applications
- Saving / Sharing reusing
- Resource Manager

- Swagger
- SPARQL, FLINT
Data Analytics Development in Python,

- Swagger
- SPARQL, FLINT
- Ontology Schema
- LOG.disit.org
- Knowledge Base, Km4City
- Big Data Store Facility
- Smart City API from Knowledge Base and other tools
- Creating Micro Services
- Using them into IOT Applications
- Coding Testing
- Saving Sharing Reusing
- Resource Manager

Snap4City (C), October 2020
Data Analytics Dev. in Java

Knowledge Base, Km4City

Big Data Store Facility

Smart City API from Knowledge Base and other tools

DISCES scheduler

Distributed Back Office

Data sources

Process

Process

Process

Monitoring

Resource Manager

Saving / Sharing resusing

Coding Testing

Ontology Schema

LOG.disit.org

Swagger

SPARQL, FLINT

Snap4City (C), October 2020

398
Dashboard List and Editor
Special Custom Widgets

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

Snap4City (C), October 2020
Other examples

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

• Virtual Sensors
  – From: MyKPI, Sensors, IOT App, other Synoptics
  – To: Dashboards
Dashboard Development

Dashboard Wizard
Create, save, load, delegate, grant access

Widget Collection
Micro Applications
External Services
Custom Widgets/Synoptics

Public Dashboard Collection
My Own Dash/App

IOT Applications
Knowledge Base, Km4City
Knowledge and Storage
Data from the Field and City + MyKPI ++
Developing Web and Mobile Apps, MicroApps,...

Mobile Apps

Web App HTML5, MicroApplications

Embed into Web pages

City User

Advanced Smart City API

Mobile Application

Monitoring Administrator

Knowledge Base, Km4City

Swagger

Snap/Km4City Open Source development tool kit

ServiceMap

DataInspector

Snap4City (C), October 2020
Data Protection, Personal Data vs GDPR
GDPR: General Data Protection Regulation

Users may decide to:

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

From each service, the user is capable to:

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

If personal data are published by the owner:

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

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

- **Secure connection** in any private data exchange
- **Encrypted** data store for all private data
- **Decoupling** data and personal IDs
- Allow the **Auditing** of private data usage
# GDPR vs Snap4City

## GDPR Compliance Verification Feature

<table>
<thead>
<tr>
<th>Feature</th>
<th>Verif.</th>
<th>Reqs.</th>
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<tbody>
<tr>
<td>Signed consent</td>
<td>UI</td>
<td>R8</td>
</tr>
<tr>
<td>User profile management and control</td>
<td>UI</td>
<td>R13</td>
</tr>
<tr>
<td>Data Type private as default</td>
<td>UI</td>
<td>R8</td>
</tr>
<tr>
<td>Rights to access per element</td>
<td>UI</td>
<td>R9</td>
</tr>
<tr>
<td>Rights to transfer per element</td>
<td>UI</td>
<td>R10</td>
</tr>
<tr>
<td>Rights to erase per element and total</td>
<td>UI</td>
<td>R13</td>
</tr>
<tr>
<td>Rights to revoke/change per Data Type</td>
<td>UI</td>
<td>R10</td>
</tr>
<tr>
<td>An interface for Right management for Data Type</td>
<td>UI</td>
<td>R9</td>
</tr>
<tr>
<td>Clear Terms of Use and Privacy Policy</td>
<td>UI</td>
<td>--</td>
</tr>
<tr>
<td>Auditing Tools for Data Type</td>
<td>UI</td>
<td>R14</td>
</tr>
<tr>
<td>Publish as Anonymous</td>
<td>UI</td>
<td>R9</td>
</tr>
<tr>
<td>Encrypt personal users’ data</td>
<td>Code</td>
<td>R12</td>
</tr>
<tr>
<td>Secure Authentication and Authorization</td>
<td>Code</td>
<td>R3</td>
</tr>
<tr>
<td>Data protection by Design</td>
<td>Code</td>
<td>R17</td>
</tr>
<tr>
<td>Secure connection</td>
<td>Code</td>
<td>R6</td>
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<tr>
<td>Security Control, data breach control, anonymization, etc.</td>
<td>PEN Test</td>
<td>R15, R16, R18</td>
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</tbody>
</table>
SNAP4CITY AND KM4CITY PROJECTS
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
- MobiMart and PISA Agreement → data aggregation, Living Lab
- Lonato del Garda → smart parking, environment
- Herit Data → tourism, culture and management
- ISPRA JRC → site management and services

Snap4City (C), October 2020
Experimentations and validation in Tuscany
Integration with present central station and subsystems
DISIT lab, Università di Firenze, is the tech-scientific coordinator
Sii-Mobility

Sensori su trasporto Privato
Sensori Parcheggi
Monitoraggio traffico, autostrade
Rete Ferroviaria
Parametri ambientali
Servizi ed enti
Ordinanze: eventi, lavori pubblici, ...
Emergenze, polizia, 118
UTC
Infomobility
Varchi Telematici, ZTL

Sensori, sistema monitoraggio

Merci

AVM trasporto Pubblico

http://www.Sii-Mobility.org
General Objectives

http://www.Sii-Mobility.org

• Reduce the social costs of mobility
  – minor inconvenience,
  – greater efficiency,
  – greater sensitivity to the needs of the citizen,
  – lower emissions,
  – better environmental conditions;
  – info-training programs to help city user in getting virtuous habits;
  – reduce transportation costs and travel times for users, for operators and administrations,
  – optimization solutions.

• Testing on municipalities and provinces of Tuscany

• Contribute to the improvement of national and international standards

• simplify the use of mobility systems
  – innovative sensors for AVM and private transport on the territory
  – integrated systems for payment and identification
  – driving / offline routing solutions
  – connect the drive, smart drive or walk
  – Integration of data from operators and different type sources
  – advanced management of resources measurement of flows realization of sensors, actuators

Snap4City (C), October 2020
http://replicate-project.eu/

- Demonstrate Smart City technologies in energy, transport and ICT in districts in:
  - San Sebastian, Florence and Bristol,
  - follower cities of Essen, Nilufer and Lausanne
- Cities are the customer: considering local specificities
- Solutions must be replicable, interoperable and scalable:
  - Integrated Infrastructure: deployment of ICT architecture, from internet of things to applications
  - Low energy districts
  - Urban mobility: sustainable and smart urban services
• Develop European Resilience Management Guidelines (ERMG)
  – Develop a conceptual framework for creating/maintaining Urban Transport Systems
• Enhance resilience through improved support of human decision making processes, particularly by training professionals and civil users on the ERMG and the RESOLUTE system
• Operationalize and validate the ERMG by implementing the RESOLUTE Collaborative Resilience Assessment and Management Support Systems (CRAMSS) for Urban Transport Systems addressing Road and Urban Rail Infrastructures
  – Pilots in Florence and Athens
• Adoption of the ERMG at EU and Associated Countries level

University of Florence:
DISIT lab DINFO (Proj coordinator), DISIA and DST

<table>
<thead>
<tr>
<th>University</th>
<th>Country</th>
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</tr>
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<tbody>
<tr>
<td>THALES</td>
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<td>ATTIKOMetro</td>
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<td>Comune di Firenze</td>
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<td>Centre for Research and Technology Hellas</td>
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<td>DE</td>
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<td>FR</td>
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<td>SWARCO Mizar</td>
<td>IT</td>
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<tr>
<td>Associação para o Desenvolvimento da Investigação no Instituto Superior de Gestão</td>
<td>PT</td>
<td></td>
</tr>
<tr>
<td>Consorzio Milano Ricerche</td>
<td>IT</td>
<td></td>
</tr>
</tbody>
</table>
General Objectives

• Offer a **comprehensive framework** for measuring and reassessing urban smart development and related rankings

• **Critical assessment** of Smart City ranking index existence

• Definition of an **enabling technology** supporting the action plans for strengthening multi-level place-based governance, applied in the tourism context

• Definition of **strategies for good smart governance**, with the purpose of providing recommendations to start or implement an institutional and development process leading towards smart city governance.

**Partners:**
- University of Cagliari (Coordinator) DICAAR and DMI
- University of Florence SAGAS and DISIT
- University of Turin ESOMAS
- University of Sassari DADU

Under the patronage of the Municipality of Cagliari

Duration: 23/09/2015 - 23/09/2018

[http://sites.unica.it/ghost](http://sites.unica.it/ghost)
Understanding Traffic Flows to Improve Air Quality

**Objective:**

- to develop a service that **combines traffic data on air quality**, weather conditions, and traffic flows in order to allow citizens and municipalities to estimate the level of pollution resulting from varying traffic flow conditions.

**Where:**

- Zaragoza, Florence, Modena, Livorno, Santiago de Compostela, and Pisa

- Università degli studi di Modena e Reggio Emilia (UNIMORE) -- Italy
- **Università degli Studi di Firenze – DISIT DINFO -- Italy**
- Universidade de Santiago de Compostela (USC) - Spain
- Comune di Modena (CMO) - Italy
- Regione Toscana (TR) - Italy
- Concello de Santiago de Compostela (CSC) - Spain
- Fundación Pública Gallega Centro Tecnológico de Supercomputación de Galicia (Fundacion CESGA) - Spain
- Universidad de Zaragoza (UNIZAR) - Spain
- Lepida S.p.A. (LP) - Italy
MObility 4.0 for SmArt (i) City

Tools for Mobility operators

- Demand Analysis
- Prediction on Parking
- Connected Drive
- Offer Analysis
- Simulation of Mobility
- Etc.

Where: in Tuscany
WEEE: Waste from Electrical and Electronic Equipment

• maximize the collection of WEEE in Tuscany through a new governance model based on the involvement of SMEs and awareness raising activities towards citizens and its replication in Andalucía.

• Actions:
  – Improve the regional governance
  – Support municipalities in capacity building of public officials and improving services to citizens.
  – Develop a system of services and incentives for SMEs
  – Develop IT tools for companies and citizens: a software and guidelines for the simplification of administrative and bureaucratic activities and an App to easily locate collection sites.
  – Develop an awareness raising information campaign to increase public attention on the topic.
  – Test the replicability and transferability of project results through the implementation of actions in the Region of Andalucía.

http://www.regione.toscana.it/-/life-weee
Example of Mobile App on Stores
smartGARDAlake

www.smartgardalake.it

INTELLIGENT PUBLIC LIGHTING

SMART NETWORK

SENSORS

OPEN DATA, IoT, SOCIAL

INFRASTRUCTURE

CONTROL ROOM FOR SMART GOVERNANCE

APP E SERVIZI ON DEMAND
SMART CITY & SMART TOURISM

Snap4City (C), October 2020
Experimenting 5G

Fields:
- Internet of Things: Industry IOT, Smart City
- Mobility and transport
- Safety & Security: video analysis
- Culture and Tourism, Education, Health

Where in Italy:
- Prato and L’Aquila

Partners:
Piattaforma IoT/IIoT abilitata dal 5G per applicazioni di:

- Smart City management (in ottica Smart City)
- monitoraggio utenze in modo smart
- industrial automation (in ottica Industria 4.0)
GIDA set up

Smart City data from many sources

ModBus to Snap4City Gateway Edge

5G network devices

IOT Data Shadow Snap4City

IOT Applications

Big Data Analytics, Artificial Intelligence

Telemonitoring Telecontrol

Dashboards and Apps
Green Impact Capacity (GIC)

- Improve productivity of chemical plant
- Keep GREEN the environmental impact
- Exploiting innovative technologies
- Diversify the production
- Monitoring environmental conditions
Chemical Plant Dashboard
Green Impact Capacity (GIC)
Altair Control room
Maintenance: ticket management

Personalised Workflows
Sustainable Heritage Management towards Mass Tourism Impact thanks to a holistic use of Big and Open Data

**BUDGET:** 4.195.515,20 €

https://herit-data.interreg-med.eu/

- City of Dubrovnik development agency (Croatia)
- Turisme Comunitat Valenciana (Spain)
- AVITEM (France)
- Center for Spatial Research (Bosnia and Herzegovina)
- Conference of peripheral maritime regions of Europe (France)
- Santa Maria Real Foundation for Historical Heritage (Spain)
- Valenciaport Foundation (Spain)
- Foundation for Research and Innovation (Italy)
- Region of Western Greece (Greece)
- Occitanie Region (France)
- Faculty of Sciences and Technology (Portugal)

**Evaluation of impact**

**Cultural heritage**
Special Interest on UNESCO World Heritage Sites

**Big & Open data**
At service of Planners, visitors, local stakeholders and dwellers

**Sustainable and responsible Tourism Management**
Key aspect: Carrying Capacity
consider European Tourism Indicators ETIS
Respectful of the ICZM recommendations

Snap4City (C), October 2020
Dalla Sardegna alla Costa Azzurra, passando per Corsica, Toscana e Liguria: un unico strumento di
infomobilità per consentire a cittadini, turisti e pendolari di viaggiare tra le 5 regioni, pianificare gli spostamenti
ed essere informati in tempo reale.

Questo l'obiettivo di MOBIMART - MOBilità Intelligente MARe Terra, proposto da una partnership di 11 Enti
pubblici. Focus del progetto è l'integrazione dei servizi di trasporto che gli utenti utilizzano durante il viaggio,
considerato come un unico tragitto dalla partenza all'arrivo, indipendentemente dal mezzo: nave, bus, treno,
aereo - e a precludere dalle barriere amministrative e morfologiche dei territori attraversati.

Cuore delle attività, la realizzazione di una piattaforma integrata per fare comunicare tra loro in modo
intelligente i servizi di trasporto, facilitando gli spostamenti intermodali e rendendo più semplice l'accesso alle
informazioni.

Il progetto intende intervenire su:
1) L'innovazione dello scambio informativo tra sistemi al momento non dialoganti, con l'obiettivo di
sviluppare servizi anche oltre il termine del progetto, per consolidare le relazioni tra territori trasfrontalieri.
2) La molteplicità e la digitalizzazione dei prodotti realizzati: siti web, travel planner - strumenti per la
pianificazione dei viaggi da punto a punto - app per device mobili, canali social.

Per giungere a questi obiettivi il progetto sarà strutturato in un percorso triennale suddiviso in due step
principalì:
1) La standardizzazione delle informazioni sulla mobilità provenienti dai sistemi dei partner, in modo che siano
tutte utilizzabili in un'unica piattaforma.
2) La creazione di servizi di infomobilità specifici relativi ai porti, ai territori di Province e Comuni, alle Regioni.

Il progetto MOBIMART è finanziato nell'ambito del Programma Interreg Italia-Francia
Marittimo 2014-2020 per un totale complessivo di 6.098.030,52 euro, di
cui 5.183.325,94 euro provenienti dal Fondo Europeo di Sviluppo Regionale (FESR).
Comparison With other platforms
State of the Art Solutions vs Snap4City

<table>
<thead>
<tr>
<th>Provider</th>
<th>OT Discovery Abstraction</th>
<th>Device Management</th>
<th>Int. Community Management</th>
<th>Data Types: IoT Devices, IoT App, Dashboard, Data</th>
<th>Data Type: Publish/Share, Delegation, Consent and Change</th>
<th>Data Type: Download and Delete</th>
<th>Auditing on Data Type Access</th>
<th>Scalability IOT</th>
<th>Usual Programming end-to-end Applications</th>
<th>Advanced Smart City API, MicroServices</th>
<th>Multi Domain Semantic Platform</th>
<th>Standard based Modules and OT, Open Devices</th>
<th>Resource Sharing</th>
<th>Data Analytics Integrated</th>
<th>Dashboard 24/7, protected connection</th>
<th>Multi-protocol on IOT</th>
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<tr>
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</table>
## GDPR vs Snap4City

### GDPR Compliance Verification Feature

<table>
<thead>
<tr>
<th>Feature</th>
<th>Verif.</th>
<th>Reqs.</th>
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<tbody>
<tr>
<td>Signed consent</td>
<td>UI</td>
<td>R8</td>
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<tr>
<td>User profile management and control</td>
<td>UI</td>
<td>R13</td>
</tr>
<tr>
<td>Data Type private as default</td>
<td>UI</td>
<td>R8</td>
</tr>
<tr>
<td>Rights to access per element</td>
<td>UI</td>
<td>R9</td>
</tr>
<tr>
<td>Rights to transfer per element</td>
<td>UI</td>
<td>R10</td>
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<tr>
<td>Rights to erase per element and total</td>
<td>UI</td>
<td>R13</td>
</tr>
<tr>
<td>Rights to revoke/change per Data Type</td>
<td>UI</td>
<td>R10</td>
</tr>
<tr>
<td>An interface for Right management for Data Type</td>
<td>UI</td>
<td>R9</td>
</tr>
<tr>
<td>Clear Terms of Use and Privacy Policy</td>
<td>UI</td>
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<td>Auditing Tools for Data Type</td>
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<td>R14</td>
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<tr>
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<td>UI</td>
<td>R9</td>
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<tr>
<td>Encrypt personal users’ data</td>
<td>Code</td>
<td>R12</td>
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<tr>
<td>Secure Authentication and Authorization</td>
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<td>R3</td>
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<tr>
<td>Data protection by Design</td>
<td>Code</td>
<td>R17</td>
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<tr>
<td>Secure connection</td>
<td>Code</td>
<td>R6</td>
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<tr>
<td>Security Control, data breach control, anonymization, etc.</td>
<td>PEN Test</td>
<td>R15, R16, R18</td>
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</table>
Self Training articles


- See also courses in ITALIANO: https://www.snap4city.org/485

Smart City IoT Platform Respecting GDPR Privacy and Security Aspects

CLAUDIO BADII, PIERFRANCESCO BELLINI, ANGELO DIFINO, AND PAOLO NESI, (Member, IEEE)
Department of Information Engineering, University of Florence, Via S. Tommaso 7, 50139 Florence, Italy

Corresponding author: Paolo Nesi (paolo.nesi@unifi.it)

This work was supported in part by the European Union’s Horizon 2020 Research and Innovation Program under Agreement 959896.

ABSTRACT The Internet of Things (IoT) paradigm enables computation and communication among tools that everyone uses daily. The vastness and heterogeneity of devices and their composition offer innovative services and scenarios that require a new challenging vision in interoperability, security and data management. Many IoT frameworks and platforms claimed to have solved these issues, aggregating different sources of information, combining their data flows in new innovative services, providing security robustness with respect to vulnerability and respecting the GDPR (General Data Protection Regulation) of the European Commission. Due to the potentially very sensible nature of some of these data, privacy and security aspects have to be taken into account by design and by default. In addition, an end-to-end secure solution has to guarantee a secure environment at the final users for their personal data, in transit and storage, which have to remain under their full control. In this paper, the Snap4City architecture and its security solutions that also respect the GDPR are presented. The Snap4City solution addresses the full stack security, ranging from IoT Devices, IoT Edge on premises, IoT Applications on the cloud and on premises, Data Analytics, and Dashboards, presenting a number of integrated security solutions that go beyond the state of the art, as shown in the platforms comparison. The stress test also included the adoption of penetrations tests verifying the robustness of the solution with respect to a large number of potential vulnerability aspects. The stress security assessments have been performed in a piloting period with more than 1200 registered users, thousands of processes per day, and more than 1.8 trillion of complex data ingested per day, in large cities such as Antwerp, Helsinki and the entire Tuscany region. Snap4City is a solution produced in response to a research challenge launched by the Select4Cities H2020 research and development project of the European Commission. Select4Cities identified a large number of requirements for modern Smart Cities that support IoT/5G (Internet of Things/Everything) in the hands of public administrations and Living Labs, and selected a number of solutions. Consequently, at the end of the process after 3 years of work, Snap4City has been identified as the winning solution.

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

I. INTRODUCTION

IoT (Internet of Thing) is becoming a disruptive technology, especially for city users of metropolitan areas. The pervasiveness of IoT Devices, integrated in common objects, is becoming increasingly deeper. The addresses’ space for these devices would be enough to point any amounts of any devices at any moment without restrictions. Diffuse products that implement Low-Power Wide Area Networks (LPWAN).

The associate editor coordinating the review of this manuscript and approving it for publication was Armin M. Ahn-Mollenhauer.

technologies for IoT introduced by SigFox and Semtech (LoRa, Long Range) have been gaining interest and have been under intense deployment campaigns worldwide [1]. At the same time, short-range IoT devices (based on technologies such as IEEE 802.15.4 or Bluetooth Low Energy, BLE, [2]) are sold in increasing quantities and are already able to support scenarios for smart homes, energy metering and Industrial automation. On the other hand, the start of the diffusion of 5G devices and services is creating high expectations in networking IoT technologies, as the killer application of previous technologies in metropolitan areas.
Snap4City managed to provide a maximum of information, flows, in depth analysis with the data provided.

There is no other platform that collects all city actors together.

The City officials and ICT officials were impressed with the performance of the Platform when loading the heavy, “resource-demanding applications and dashboard.

The data handling throughout the Platform is considered as one of the strong points in the Platform and of an extremely sophisticated level.

The technical level of the Platform and its strong points such as the way real-time data is used, the algorithms, data clean-up possibilities of the Platform, presented data and information is state-of-the-art and impressive.

What People say about us
**DISIT Lab Roadmap vs Model and Tools' Usage**

**2013**
- Km4City Ontology 1.1
  - Tuscany, Road Graph
  - Mobility
  - Culture, Tourism
  - Events
  - Parking
  - Services
  - Linked Open Graph

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

**2015**
- Resilience Decision Support
  - Smart First Aid
  - User Behaviour Analysis, Predictions
  - Risk Analysis

**2016**
- Smrt Mobility
  - Infomobility
  - Mobile App
  - Routing
  - Multimodality

**2017**
- Smrt Mobility
  - Origin-Destination and trajectories
  - Traffic Reconstruction
  - Offer Analysis
  - OBU, smart devices

**2018**
- User engagement
  - Bike Sharing
  - Data Analytics ++
  - Social Predictions
  - OBD2

**2019**
- Smart Waste
  - Mobility Demand / Offer Analytics and Strategy
  - 5G Tech Energy Industry 4.0

**Roadmap**

- Social Predictions
- Bike Sharing
- Data Analytics ++
- OBD2
- Smart Waste
- Mobility Demand / Offer Analytics and Strategy
- 5G Tech Energy Industry 4.0

**Tools and Platforms**

- Twitter Vigilance
- Social Media Analytics
- LOD
- Weather Forecast
- Real Time Wi-Fi

**Projects and Initiatives**

- H2020
  - Smart Energy
  - Sustainable Mobility
  - Control Room
  - Dashboard

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

- GHOST SIR
  - Sardinia Region Smart City Strategies and plan

- IOT/IOE
  - User engagement
  - Bike Sharing
  - Data Analytics ++
  - Social Predictions
  - OBD2

- SNAP4city
  - Smart Mobility and Culture
  - Tourism
  - Events
  - Parking
  - Services
  - Linked Open Graph

- CEF
  - Smart Health

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

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

- H2020
  - IOT/IOE, IOT App
  - Living Lab
  - Maker Support
  - IOT Edge
  - Smart City IOT
  - GDPR,
  - Privacy & Security

- bee smart city
  - Smart Lonato
  - PCP Award

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

- Interreg Europe
  - smartGARD
  - Sweden
  - CAPELON
  - Sweden

- CEF
  - Smart Mobility
  - PISA, PUMS
  - Living Lab

- Interreg Europe
  - CAPELON
  - Sweden

- Interreg Europe
  - MobiMART
  - Smart Mobility
  - PISA, PUMS
  - Living Lab

- Interreg Europe
  - CAPELON
  - Sweden

- Interreg Europe
  - MobiMART
  - Smart Mobility
  - PISA, PUMS
  - Living Lab

- Interreg Europe
  - MobiMART
  - Smart Mobility
  - PISA, PUMS
  - Living 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
• MobiMart and PISA Agreement → data aggregation, mobility and transport, Living Lab
• Lonato del Garda → smart parking, environment
• Herit Data → tourism, culture and management
• ISPRA JRC → site management and services

Snap4City (C), October 2020
Acknowledgements

• Thanks to the European Commission for founding. All slides reporting logo of Snap4City [https://www.snap4city.org](https://www.snap4city.org) of Select4Cities H2020 are representing tools and research founded by European Commission for the Select4Cities project. Select4Cities has received funding from the European Research Council (ERC) under the European Union’s Horizon 2020 research and innovation Programme (grant agreement n° 688196).

• TRAFAIR is a CEF project. All slides reporting logo of TRAFAIR project are representing tools and research founded by the EC on CEF programme [http://trafair.eu/](http://trafair.eu/).

• Thanks to the European Commission for founding. All slides reporting logo of REPLICATE H2020 are representing tools and research founded by European Commission for the REPLICATE project. REPLICATE has received funding from the European Research Council (ERC) under the European Union’s Horizon 2020 research and innovation Programme (grant agreement n° 691735).

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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.
DISIT thanks to

Herit Data: Tourism and Mng.  
https://herit-data.interreg-med.eu/

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

Trafair: CEF project with several Cities  
http://trafair.eu/

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: retail and GDO Big Data analytics

5G with 3G-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

Snap4City (C), October 2020
Further readings

- HOW TO: create a Dashboard in Snap4City
- HOW TO: add a device to the Snap4City Platform
- HOW TO: add data sources to the Snap4City Platform
- HOW TO: define privacy rules for personal data, produced by the end-users own device
- HOW TO: Develop Smart Applications, Snap4City development Life Cycle
- HOW TO: HLT vs Ingestion, and HLT vs Widgets
- HOW TO: Develop an IOT Application for Data Ingestion
- HOW TO: Upload data into Knowledge Base, ServiceMap (triple upload)
- HOW TO: Create as set of Devices with BulkProcessing
- HOW TO: Create an IOT Device Model
- HOW TO: Create an IOT Device Instance from IOT Directory tool