

**SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES**

**2019 EDITION**



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## INTRO

Cities are facing main challenges on reducing costs for city management, and at the same time providing more efficient services to the city users. One path for the sustainability can be to exploit multidomain services and infrastructures such as mobility and transport, energy, government, welfare, tourism, culture, environment, weather, education, security, etc. **Snap4City** enables the creation of citizen centric smart city services in the respect of general security and safety by offering a sustainable solutions exploiting the concept of **Living Lab** for coworking. The approach satisfies a large range of requirements of city officers, ICT officer, citizens, and tourists, contributing to strengthening of city capacities for attraction of industries and stakeholders. Snap4City supports the city in the process of sustainable innovation on services and infrastructures, through the usage of mechanism of co-design, collaborative work, exploiting solutions for control and supervision, business intelligence, predictions, anomaly detection, early warning, risk assessment, what-if analysis, and also setting up strategies for increasing city resilience with respect to unexpected unknowns. Indeed, Snap4City is actually able to keep the city evolution under control, by using advanced data analytics and machine learning for computing and controlling key performance indicators, detecting unexpected evolutions, performing predictions, taking actions from strategies and alarms, thus supporting the whole at the support of decision processes.

Thanks to its Knowledge Base and expert system, Snap4City provides flexible solutions to get immediate insights and deductions on the city's status and evolution, for optimizing resources, understanding social contexts and deriving facts from data, effects and causes, predictions and anomalies, by exploiting ultimate artificial intelligence, data analytics, IOT and big data technologies, activating sentient solutions, collecting and exploiting heterogeneous data of any kind, from any source (open and private, static, real time, event driven, IOT, streaming, certified and personal data). This capability is obtained by enforcing the innovative data analytics capabilities of Snap4City tools on cloud and on your premise.

**Snap4City is 100% open source (and it is grounded on 100% open source tools)**, secure, encrypted, scalable, modular and flexible; can be used to set up Living Lab and smart city solutions satisfying a widest range of requirements of city officers, ICT Officers, citizens, and tourists; and at the same time. Snap4City has been designed in response to the Select4Cities PCP call issued by Helsinki, Antwerp and Copenhagen, and satisfies all the requirements requested by an urban



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platform for IOT/IOE smart city living labs, as those identified by Select4Cities and by ENOLL. Snap4City is a winner of the Select4Cities PCP challenge. It has been designed for developers, companies and researchers that may continuously improve the city smartness and services, collaborating each and among different cities at international level. Snap4City can be easily integrated with any in place legacy solution. Snap4City is capable to produce from data, insights, causes effect analysis, predictions, anomaly detection, optimizing resources and understanding social contexts and meanings of facts from data.

Snap4City exploits Km4City knowledge base, expert system and Smart City API (<https://www.km4city.org>) for developing smart cities big data aggregators and data analytics. The combination has been adopted by REPLICATE H2020, RESOLUTE H2020, Sii-Mobility SCN, LIFE WEEE, TRAFAIR CEF, MOSAIC, SODA, etc., and in many other challenges. Snap4City has added to Km4City the necessary flexibility to set up Living Labs and co-working environments for IOT/IOE (internet of things/everything) in smart cities and Industry 4.0 domains; as well as use a large range of IOT devices, IOT Edge, IOT Buttons, Gateways, mobiles, OBU (on board unit, vehicular kit), social media and satellite data; as well as be open to all standards and custom models. Snap4City is compliant with more than 100 protocols, formats, standards, and it is: a Gold Member of Fi-Ware, an official Fi-Ware platform, an official library of Node-RED JS Foundation with MicroServices suite, partner of SixFOX, compliant with CKAN with DataGate integration tool, a platform of EOSC (European Open Science Cloud) Marketplace, a platform on BeeSmartCity Marketplace, and registered APIs an E015 API, etc.

Snap4City is therefore a proactive partner and technology provider for cities and regions, offering a solution on your own premise as well as on cloud or mixt; providing a collaborative environment in which experts and stakeholders (researchers, industries, students, commercial operators, tourists, etc.) can share their data and experiences, respecting privacy, find solutions, carry out data analytics, and develop Data Analytics, IOT Applications based on MicroServices, Dashboards, and all the management is GDPR compliant.

In conclusion, Snap4City is a sustainable data/service ecosystem in which cities and stakeholders can exploit resources to set up valuable services, free from the vendor lock-in and technology lock-in problems. When the cities are ready, the Living Lab or co-working environment can be gradually introduced to startup a collaborative context in the city and among several cities and international experts, where cities' users and stakeholders are involved in order to profitably exploit, produce and share data and services.

## SNAP4CITY ARCHITECTURE AND ECOSYSTEM. OPENED TO DEVELOPERS AND STAKEHOLDERS.

Snap4City consists of a set of modular tools accessible according to the user profile, as:

- **Data source registration, ingestion and publication.** They are accessible on **Data Inspector** for controlling them and verifying the process and healthiness. Data can come from any kind of:
  - **data source, protocol and format from/to:** open data, real-time data, GIS and Maps, personal data, IOT data, data stream, data driven, social media, Industry 4.0, etc.;
  - **IOT Devices and networks, IOT Edges, gateways, IOT Brokers,** via different protocols and formats, uniformly managed on IOT Directory via Knowledge Base for discovery;
  - **Web scraping** process that may be used for grabbing data from Public web pages according to the exposed terms of use;
  - **Dashboards widgets** presenting user interface capable to collect action from the user and transform those action in data into the platform: a button, a dimer, a time selector;
  - **Mobile Applications** registered on Smart City API of the platform;
  - **Data Analytics results and Data Transformation algorithms** of the platform including personal data produced by users;
- **Storing and indexing of data sources** is performed via the uniform classification model of Km4City smart city ontology and knowledge base on graphDB; big data store for data shadow based on Elastic Search and/or Hbase noSQL database. The spatial, temporal and semantic indexes are performed for fast and smart data retrieval with capabilities of inference, reasoning, faceted search, drill down, extracting insight from the data;
- **Advanced Smart City API and MicroServices** for accessing services and data. All the data collected and indexed can be accessed via APIs and/or MicroServices for: IOT Applications, Mobile and Web App developers and Dashboards. The data access is governed in Snap4City according to the GDPR, on the basis of users' role, level, delegation and organization;
- **Data Analytics and data transformations processes and tools** can be created and shared in a reliable and scalable cloud infrastructure (or on your premise) to provide advanced smart services, making prediction, signalling early warning, detecting anomalies, creating analysis, heatmaps,

supporting decision makers with insights and reports, etc. Analytics and data processing, exploit Smart City API, and can be developed in ETL, R, Python, Java, IOT App Node-RED, etc., and can be executed on demand/on events, periodically and in real-time. Resulting data are also saved and indexed into the platform;

- **Dashboards** can be created for different kind of users such as: decision makers, city operators, ICT operators, private for the users, etc., suitable for Smart City Control Rooms with video wall, Operators on Desktop of multiple monitors, mobile operators, and Situation Rooms with touch panels. Dashboards can exploit all kind of data and data analytic available, legacy services, and special tools as traffic flow reconstruction, decision support systems, etc.;
- **IOT Applications** are data driven and/or periodic data flow processes exploiting the suite of Snap4City MicroServices (more than 150 nodes), are based on Node-RED and may provide Snap4City Dashboards as user interface for rendering data by using a large range of Widgets, capable to act into the platform with physical and virtual IOT Devices; It is possible to have multiple IOT Apps using the same Dashboard, as well as multiple Dashboards referring and contributing to the same IOT App. MicroServices may also call the Data Analytics processes developed by the users as well as those performed for Web Scraping;
- **Web and Mobile Applications** can be created by developers exploiting Advanced Smart City APIs and may be controlled by Snap4City tools. For example, to send on the Mobile Apps: engagements, soudages, stimulus, and thus for monitoring user behaviour, creating origin destination matrices, getting reaction from the city users, informing user at the inception of critical conditions, etc.;
- **Living Lab support,** for creating a collaborative sustainable environment for smart city grown in which the city stakeholders can contribute according to their skill and commitment in creating and improving smart city services. Snap4City provides an environment in which they can exchange information, work on collaborative tools for data transformation and valorisation.

The whole platform is GDPR compliant and enforces privacy and security for data, dashboards, IOT devices, IOT applications, personal data, data analytics and processes, etc., which can be private of the user; and the user may delegate the access to them or pass the full control to other users. Snap4City also provide tools for the administrators to monitor and control the platform status via: auditing, assessment, management, GDPR, network flow monitoring, revoking, request to delete, etc. In Feb-April 2019, Sna4City has organized a successful Hackathon for coworking; in June-July 2019 a set of training courses. Snap4City has passed in August 2019 two Penetration Tests from major expert companies. In September 2019, Snap4City has completed iteration 3 of Select4Cities PCP.



## APPLIANCES CONTAINERS

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



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

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

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

### IOT APPLICATIONS - INSTANT APPS



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

### DASHBOARDS & APPLICATIONS



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

### MOBILE & WEB APPLICATIONS



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

## MICROSERVICES & ADVANCED SMART CITY API

### LIVING LAB - DEV TOOLS - COWORKING



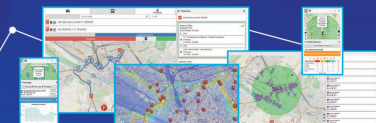
IOT DIRECTORY • SERVICE MAP • RESOURCE MANAGER • DATA GATE • R STUDIO • ETL

### BIG DATA - DATA ANALYTICS



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

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

GIS

CITY UTILITIES

OPEN DATA

LEGACY &  
EXTERNAL  
SERVICES

PERSONAL  
DATA

IOT / IOE

BROKERS

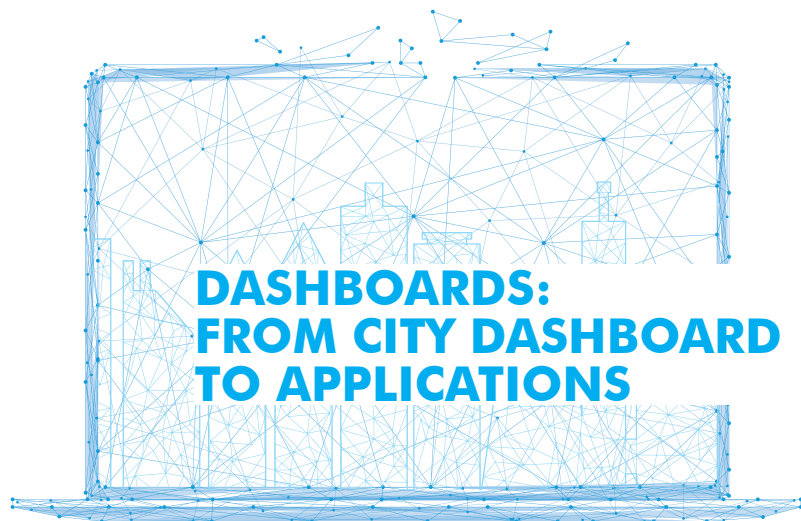
KPI

INDUSTRY 4.0

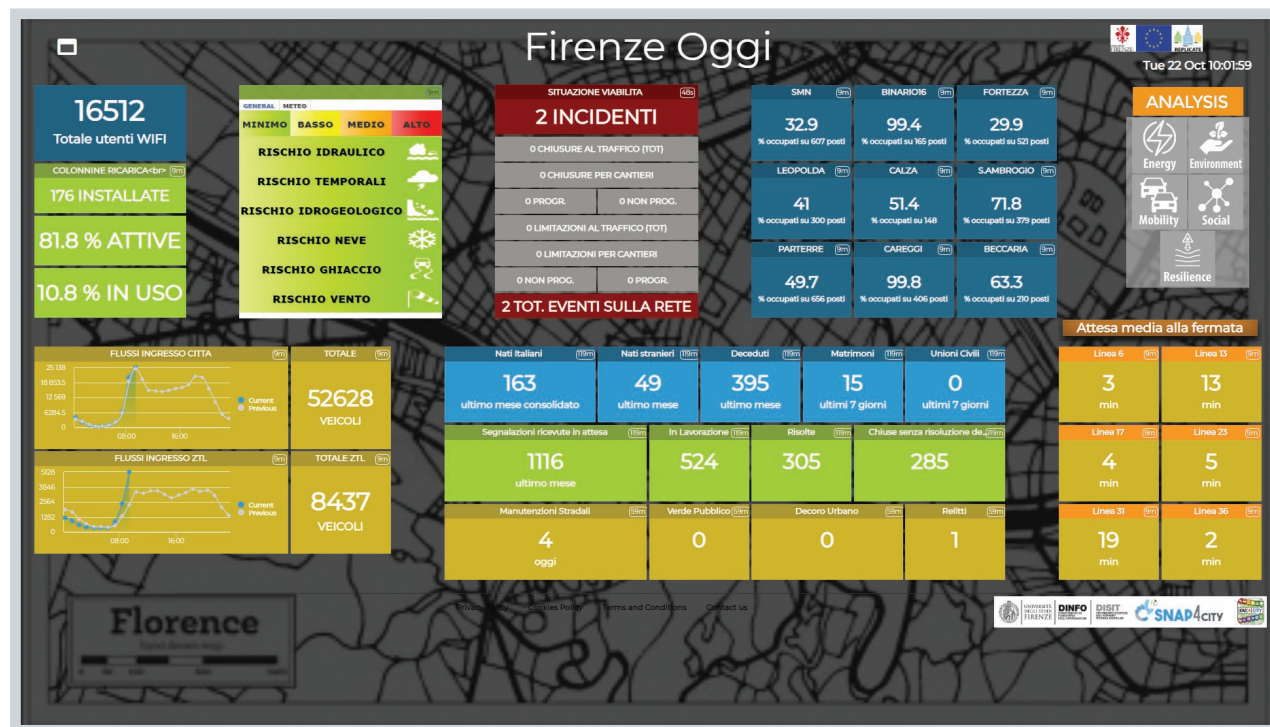
SOCIAL MEDIA







## DASHBOARDS: FROM CITY DASHBOARD TO APPLICATIONS



For privacy reasons, numbers shown in this dashboard are not those of Florence

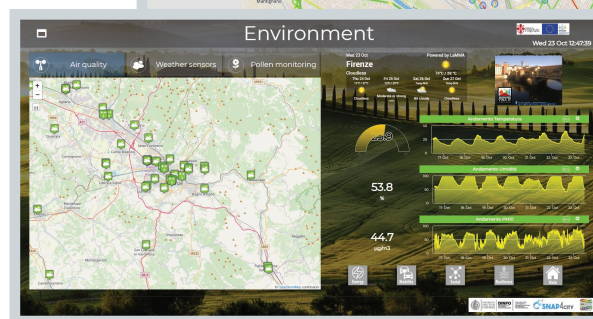
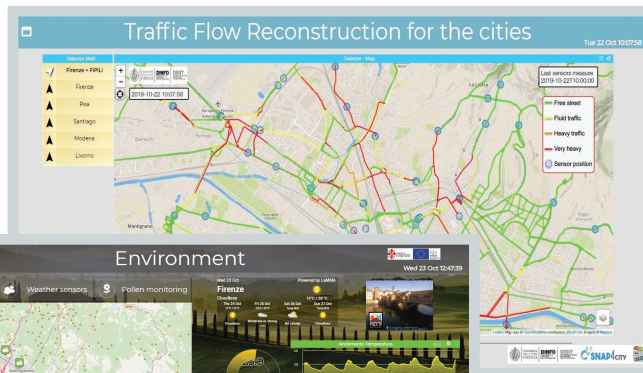
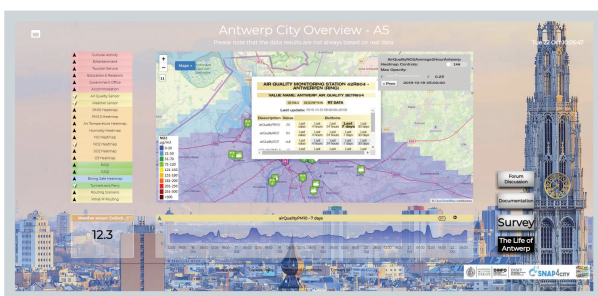
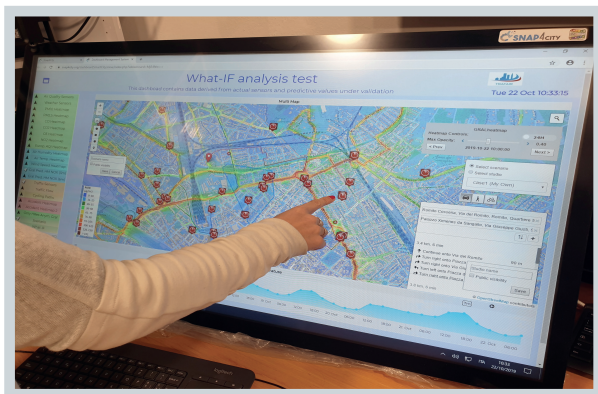
Snap4City allows creating city **Dashboards** which are interactive data & graphics applications including maps, trends, series, tables, gauge, pie, button, dimers, semaphores, time ranges, and a large set of special and custom graphic **Widgets** for representing city elements and acting on the city processes: weather forecast, social media and sentiment analysis, traffic flow, event reporting, event selectors, real time vehicle tracking, decision support suggestion, actuators, KPI (key performance indicator), POI (point of interest), IOT/IOE (internet of thing/everything), trajectories, heatmaps, TV cameras, dynamic routing, etc.

The **Snap4City Dashboards** can be profitably

- used for creating both professional city views and personal applications by compounding Widgets; dashboards are accessible from web for video walls,

touch screens and mobile devices, and the users do not need to install tools for their usage;

- created by using the **Dashboard Wizard** tool that helps exploiting semantic match from the multidomain multitype data of any kind (public, private, static, real time, KPI, POI, sensors, ...) and graphics Widgets representing/interacting on screen, on wide screen, mobile Apps, Totems, touch screens; A simpler version of the Dashboard Wizard, only focussed on Data Healthiness and data process aspect is provided as **Data Inspector**;
- used for creating professional views as decision support systems for Smart City Control Rooms, SCCR, reporting on H24/7 on a wall (with concise representation), touch screens for situations rooms, or monitor for operators (with tiny details, drill



Dashboards are available for many cities in Tuscany and other Italian regions. A few of the Florence Control Room dashboard are reported in the figures, together with some dashboard adopted by city operators.



down, WHAT-IF tools). The City Dashboards are typically used and shared with a number of city operators such as fire brigade, 118, civil protection, police, operators, leaders, decision makers, etc., according to a controlled and secure connection on HTTPS, secure WebSocket and GDPR compliant environment. They allow representing and managing critical events, receiving notifications, drill down on data, opening live chats for problem solving, acting in correspondence of alarms by an intelligent monitoring, defining workflows, performing simulation and What-IF analysis;

- used to create personal/private applications (for smart city, industry 4.0, home automation, energy management, etc.), for monitoring private data and those of the city, including actuators for controlling private devices, and with the possibility of sharing data with friends/colleagues according to GDPR. The

private Dashboards can mix and correlate personal data and city data, in real time and/or using historical data;

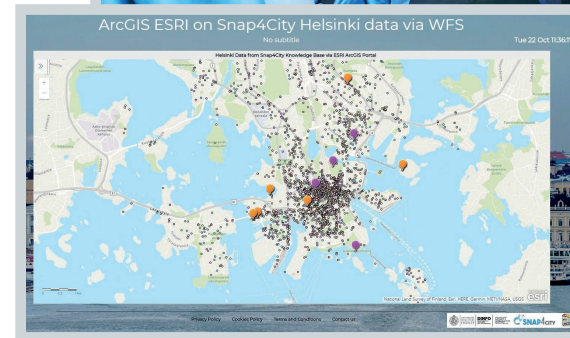
- highly interactive, for example allowing to: drill down on historical data timeline, on data relationships, and on spatial aspects; mix real time and historical data with data driven sensors and actuators; combine graphics widgets, custom widgets, dashboards and IOT Applications for creating complex functionalities and control flows; make them suitable for creating connections among dashboards and widgets each other, building complete applications;
- used to integrate legacy web applications, External Services and Micro Applications in Widgets, also exploiting authentication and authorization standards such as OAuth, SSO, LDAP, OpenIDConnect, monitoring access and auditing all the activities according to GDPR.



## DATA GATHERING AND CITY DATA KNOWLEDGE MANAGEMENT

Smart Cities have to cope with a large variety of data, such as: open and private, static and real time/events, data in pull and push, streams. Data may arrive and/or may need to be acquired from multiple sources, by using several different protocols, and formats, which may be standard as well as proprietary. Snap4City is capable to acquire/receive data from any kind of source (data base, WS, API, files, etc.), by means of any protocol and format, standard/proprietary and may be easily extended to cope with any new format, protocol and data source. Snap4city provides a distributed, efficient, scalable solution for data ingestion and aggregation grounded on the multi domain Km4City ontology and knowledge base, and providing an expert system (<https://www.km4city.org>). Km4City ontology is based on a number of standard vocabularies such as: WGS84, FOAF, DCT, OTN, SKOS, GEO, GR, etc.

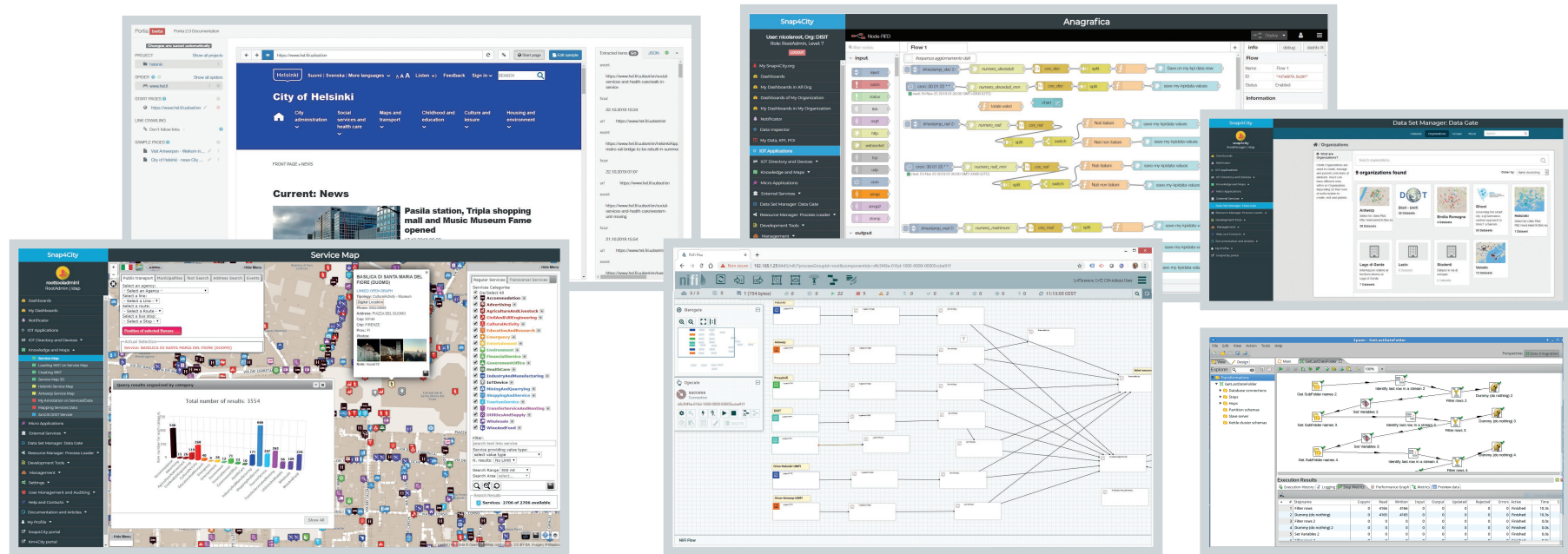
The structural information for feeding city knowledge base can be obtained from OSM (Open Street Map), from GIS (Geographical Information System), as well as integrating multiple sources. Static data sets with POI can be easily ingested via DataGate of Snap4City (a module of CKAN), which is capable to perform reconciliation with the unified knowledge base semantic model Km4City. All the



new data defining new relationships are indexed into the knowledge base; and real time data are collected for creating a data shadow for data analytics and the exploitation in applications and dashboards. Massive ingestion processes can be easily created as ETL processes (extract, transform, load language) (for example in Pentaho Kettle, open source), as well as NIFI and/or in Node-RED, or in other visual/programming languages. Snap4City provides a Smart City suite of nodes for Node-RED for shortening the production of IOT Applications and flows.

Snap4City users may contribute to the city, by providing: data via personal IOT Devices; data sets on DataGate; procedures, data analytics and IOT applications; contributions from mobile App connected to smart city API; and directly on the Snap4City Portal and city Living Lab providing suggestions and comments on services and dashboards.





In Snap4City, the model and data contribute to the city Knowledge Base which is an expert system of the city in which information is made interoperable according to the open ontology. In detail, thanks to the Knowledge Base, Snap4City manages city entities and data uniformly, enabling semantic interoperability, spatial & temporal reasoning. For example, among city entities/data: IOT Device and values of registration/classification, IOT Device and sensor/actuators discovery, data selection/filtering for Dashboard production via **Dashboard Wizard**, data analytics, data drill down, IOT Edges, etc. Thanks to Km4City ontology, Snap4City also provides a powerful classification/discovery service, with more than 20 macroclasses (including: commercial, cultural, accommodation, energy, security, IOT, mobility, traffic, weather, environment, etc., which can be easily extended), and more than 500 subclasses, other can be easily added when needed.

The Snap4City Knowledge Base can be exploited by means of:

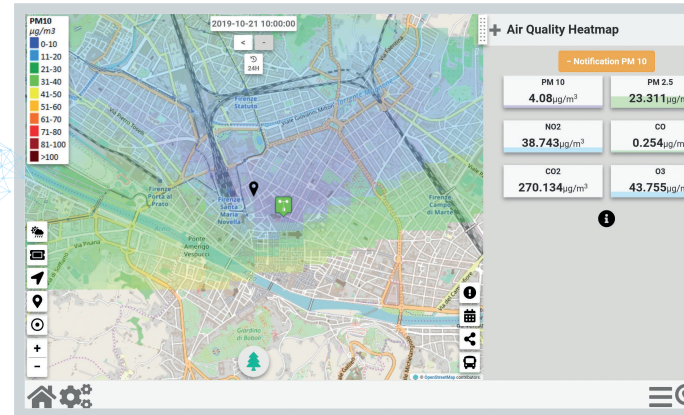
- semantic queries on city entities relationships (Linked Open Data and SPARQL according to W3C, 5 stars data of Tim Berners-Lee), and on spatial-temporal queries (along paths, inside an area, closed polylines/shapes, close to some point);

- full text queries on several kinds of information, performing natural language processing and sentiment analysis on social media data;
- Advanced Smart City APIs for developing web and mobile application and services;
- MicroServices to compose IOT Application exploiting smart city data in short time.

Snap4City provides open tools for knowledge management such as: ServiceMap for navigating on the knowledge base graphically and generating Advanced Smart City API and Federated Smart City API; LOG.DISIT.ORG for inspecting all details of the knowledge base model; to pose semantic queries; etc., and for discovering Linked Data repositories in the world. Each instance of Snap4City Knowledge Base can be federated with others instances obtaining enriched information, and a wider knowledge for all the cities connected

Relevant knowledge bases are those of Tuscany region (more than 340 million of elements), several cities; and those of Sardegna region, north of Italy on Garda Lake area, Reggio Emilia, Helsinki, Antwerp, Santiago de Compostela, Lebanon, etc.

## FORGING & MANAGING OPEN AND FLEXIBLE WEB AND MOBILE APPS



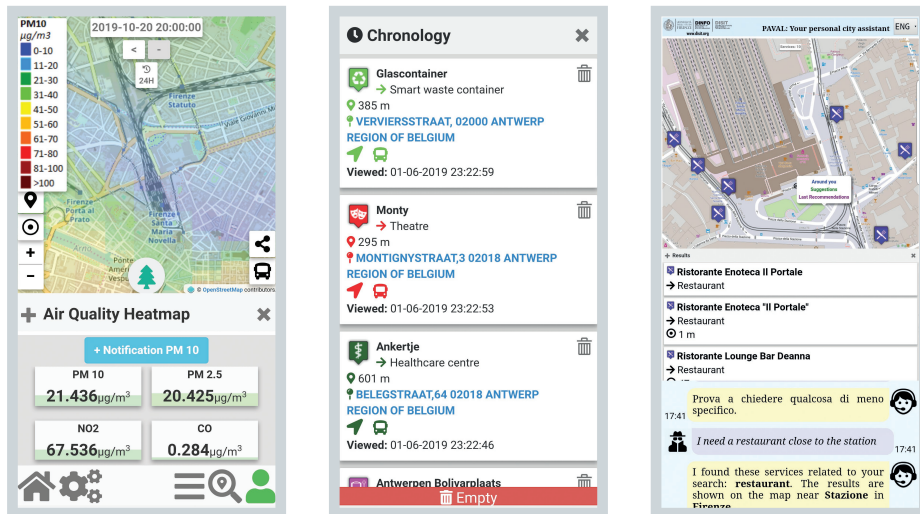
Web and Mobile Apps are commodities for city users for: car sharing, bike sharing, public transport, parking, environmental monitor, events, health, general information, weather, accommodation, pollination, etc.

A large number of mobile apps is offered to city users by commercial operators. On the contrary, relevant data for safety, security and dialoguing from the city with city users are not covered by commercial applications (e.g., civil protection information, official infomobility hints, real time information). Sadly, it is unrealistic to suppose that the right App to inform the city users in the context in which they are, and on time for actuating early warning strategies would be installed when critical conditions occur. The critical conditions, and panic will totally change the capabilities of the city user involved.

Thus, to create a participatory connection and communication from the city and the city users, the creation of an official Apps, with high quality and updated information and services is almost mandatory to be offered at the city users by the city. Thus, it will be on their mobile for communicating with city users when needed. On the other hand, it has been demonstrated that 10% of users escaping from a public area can move the rest of people in the area. These kind of Apps are a means to keep city users informed about critical events on timely basis and to collect daily information about the city usage and preferences. Apps may have

high costs of maintenance for: (i) data update in back office servers, and for the creation of new services; (ii) the development of the server side tools for monitoring App, collecting data, and sending information and stimulus to the city users, thus keeping the city users engaged and informed continuously.

- Snap4City provides a **flexible development kit** and source code for producing customizable web and mobile Apps capable to exploit smart city data, engaging city users, providing offers and collecting data from city usage, and managing the interactions, in short time and at low cost. With Snap4City, the costs to set up, maintenance and update of mobile apps are strongly reduced since: (i) data in the Knowledge Base become directly available for the Smart City API, Apps and Dashboards; and (ii) a powerful back office for App management and data monitoring is provided open source and it is modular. With Snap4City, you can create customized, modular, multi-language and multipurpose Apps providing information about multi-domain integrated data and point of interests (mobility and transport, culture, entertainment events, parking, tourisms, health, safety, restaurants, museums, POI, etc.), searching them by text, GPS, region, navigation, near to me, and a number of features for sharing opinions, accessing to dashboards, getting heatmaps, etc.
- **suggestions** for instilling virtuous behaviour according to the user's profile and



city purpose, with the personal assistant and connected drive features, and bonus delivering;

- **smart services** in real time: infomobility, smart parking, smart bike sharing, environmental data (pollution and pollination), first aid triage; entertainment events, news, navigation, public transportation tickets and time schedule, suggestions, recommendations, traffic conditions, heatmaps, chat and forum, personal trajectories, sharing trajectories and position with friends, etc.;
- hints about **city and alarms** at which the user may subscribe, from: civil protection, environment pollution aspects, weather forecasts, hot events, city communications, cycle paths, social media, changes in the viability, RSS feeds, etc.;
- support for navigation in the city, modal and multimodal routing, point of interest routing, pedestrian, public, and private routing, what if analysis with dynamic routing;
- solution for collecting information and ranking on services, posing questionnaires, etc.;
- features that can be personalized for and by the user at level of: menus, language, preferences, messages, notifications, views;
- continuous assistance to users about the city services via natural interaction requesting information by text.

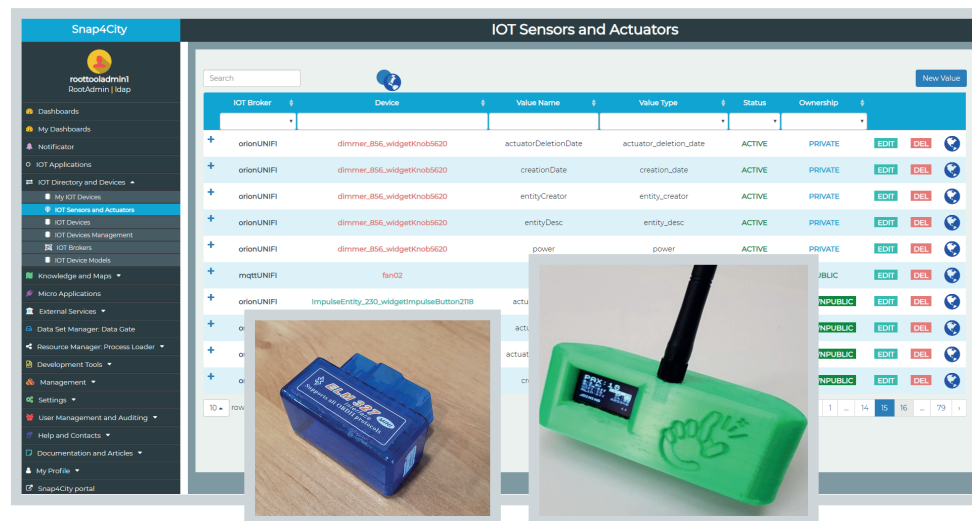
Snap4City and Km4City Mobile Applications in Tuscany, Antwerp, and Helsinki monitor city usage collecting information anonymously or in authenticated manner according to GDPR. Collected data are also analysed automatically to provide insight and information that may be used to implement strategies improving services, assisting users. The solution allows, to understand city users':

- needs from feedbacks about services, humours, ranking and images, answers to soundages;
- needs from the most requested features, queries, menus, etc.;
- needs from questions about what they expect from city and services;
- needs in using the city, by tracking their behaviour, producing origin destination matrixes, also observing the next visiting places of your tourists;
- acceptance from sent stimulus, and information to city users, stimulating them to have more
- sustainable behaviours or avoid specific actions (e.g., using public transportation, using different paths to reach their destination);
- reminding where parking is forbidden (only in Florence);
- acceptance of stimulus/proposals to change and services, also providing bonus and incentives to change attitudes, stimulating virtuous behaviours;
- The solution also may allow to collect technical information about city services, for example by measuring service efficiency, monitoring city Wi-Fi and Bluetooth iBeacon fields from the mobile devices.

A large campaign of user engagement for stimulating users to sustainable mobility has been organized in Tuscany by using Km4City App and public transport operators: ATAF, BUSITALIA and CTTNORD.



## IOT/IOE DEVICES AND NETWORKS



Snap4City can exploit/integrate new and legacy IOT networks and/or devices in a uniform and transparent manner for users/administrators, thanks to IOT Directory and Km4City Knowledge Base support.

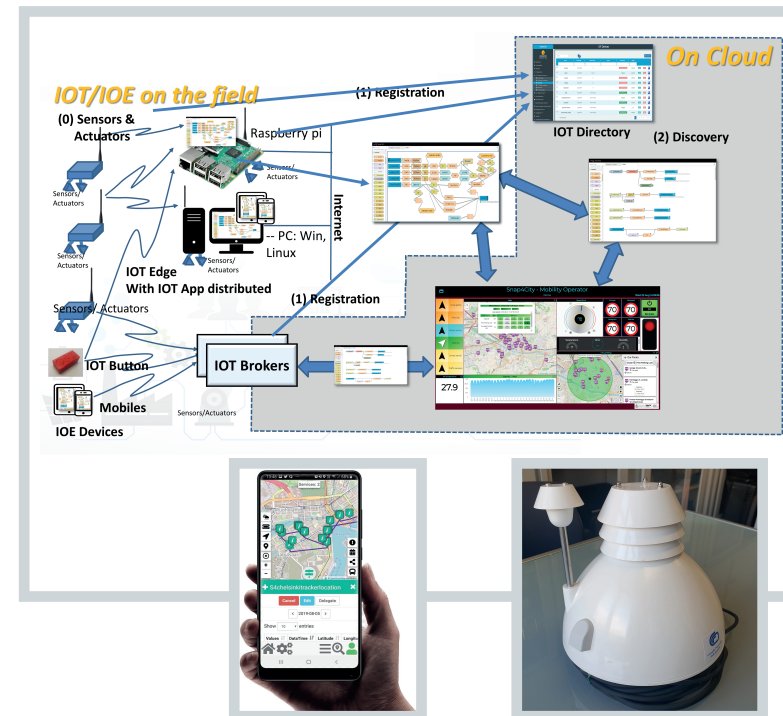
### Snap4City IOT/IOE approach supports:

- **multiple IOT and non IOT protocols**, such as: MQTT, COAP, AMQP, NGSi, OneM2M, ETSI M2M, SigFOX, LoraWan/Lora, HTTPS/HTTP, TLS, WS/sWS, WebSocket/WSs, HTTP/HTTPS, ModBUS, OPC, SMTP, WFS, WMS, Datex II, OBD2, FTP, ODBC, JDBC, XML, JSON, GeoJSON, GTFS, etc., and any kind of format via multiple and diverse IOT Brokers; it is also compliant with proprietary IOT protocols; and new brokers, protocols and formats can be easily added. <https://www.snap4city.org/drupal/node/283> ;
- **multiple IOT Brokers**: IOT Orion Broker Fi-Ware, Mosquitto, RabbitMQ, OneM2M, SigFOX, LoraWAN, etc.; Snap4City is an official platform of Fi-Ware and gold Member, and SigFOX;
- **end-to-end encrypted secure communications** with a range of IOT/IOE devices, supporting multiple approaches using HTTPS/TLS based on: certificates and private key; or by using K1 and K2, etc.; This means that also Machine to Machine communications are protected according to GDPR and security criteria;
- **public and private IOT Devices and sensors values**, so that personal

devices are managed according to GDPR, by which the owners may decide in any moment to make them public, and/or to control/provide access to its own private data, and performing auditing;

- **IOT Edge devices** include the possibility of executing IOT Application, which are Node-RED flows with Snap4City MicroServices on cloud and on premise as: Raspberry Pi, Windows, Linux, and Android, Docker, Artik, Simatic IOT, GE predix, Intelliedge A700, etc.;
- **IOT Devices Data Shadows** for registered IOT Devices sensors/actuators is provided by default;
- **IOT Device Models** and registration of IOT Devices in bulk for shortening their registration in the system, exploiting rules for IOT data mapping;
- **direct connections** from/to IOT Devices, IOT Applications and Dashboards for both sensors and actuators, using different protocols and Secure WebSockets. The actuators on Dashboard are the so-called Virtual IOT Devices, sensors/actuators;
- **special IOT Devices**: (i) Buttons that can be used as Keys, alarms, action button, (ii) PAX Counters, mobile PAX Counters, etc.;
- **Open IOT Devices**: Open Sources for creating personalized IOT Devices communicating with mutual authentication based on Arduino, Raspberry Pi, Android, Linux, Windows, ESP32, etc.

## IOT APPLICATIONS VS IOT EDGE DEVICES



Snap4City supports IOT Edge Devices which host IOT Applications implementing some local smart algorithms. They can be installed on the field to perform part of the computational work on the sensors data, acting on actuators and directly taking into account about context. For example, managing gardens and factories, autonomous robots, houses, and system healthiness, data filtering, data flow machine learning. IOT Edge devices can be realized on Raspberry Pi, Android, Windows, Linux, etc., as well as all platforms supporting Node-RED. On registered IOT Edge devices, Snap4City Libraries of MicroServices/nodes that can be installed from the official Node-RED library palette allow to exploit local services and those provided on cloud, such as: Dashboard, Data Analytics, Storage, Smart City API, MyKPI, Geo Utilities, Public Transportation, routing, heatmaps, etc.

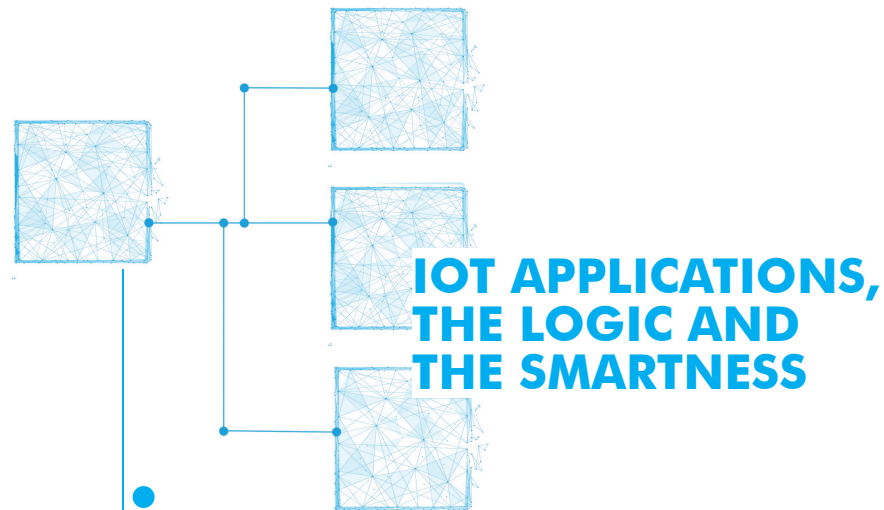
### Snap4City IOT Edge is available on:

- **Android** can be obtained installing Snap4All mobile application, and may exploit data from mobile sensors: GPS, but also TV camera, accelerometer, gyros, etc.;

- **Windows and Linux** solutions can be obtained as Docker images, as well as installing Node-RED and Snap4City Libraries of nodes, and may exploit the IOT devices/sensors in your intranet and sensors of you PC;

- **Raspberry Pi** examples are accessible on Snap4City portal as SD images to be directly placed on the device memory as integrated app and operating system. Node-RED is already installed in the official Raspberry Pi distribution. So that, you only need to install the Snap4City Libraries of Nodes from Node-RED Library. The IOT Edge has direct access to the nodes associated with GPIO, serial communication, etc., and thus, you may exploit the IOT devices/sensors in your intranet and sensors of your PC.

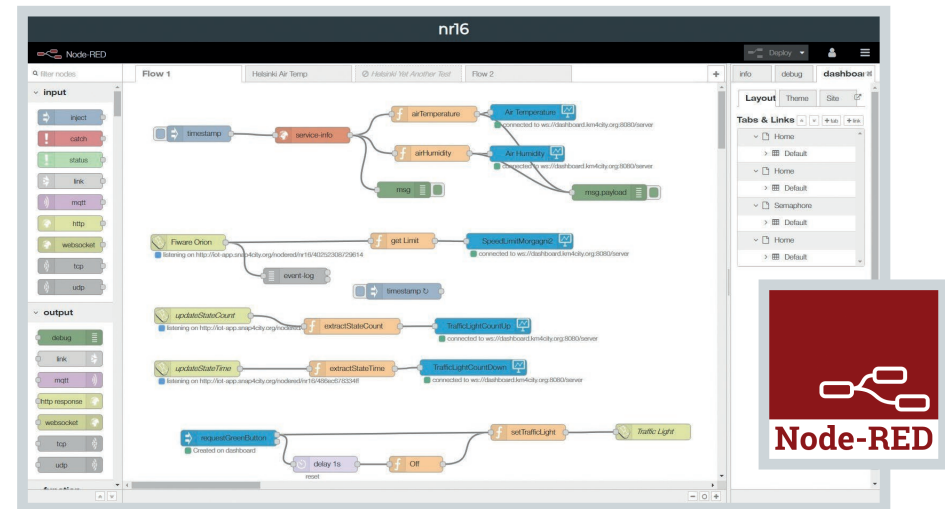
All data collected on the IOT Edge can be sent on Snap4City infrastructure for storage via a mutually authenticated connections, for further data analytics, exploitation in applications, and dashboarding, and thus Snap4City performs for you the Data Shadow.



Snap4City natively supports the visual creation of IOT Applications/flows by using Node-RED editor and a library of Snap4City MicroServices/nodes. Node-RED is 100% open source of JS Foundation, and it is widely diffused and powerful visual editor to compose IOT data flow applications based on Node.JS. Snap4City IOT Applications are used to implement data processing and logic, with or without Dashboards, and have the capability to react on data driven events coming from IOT Devices, IOT Brokers, notifications, Dashboards, humans, etc.; even driven or periodically processes. Dashboards may have multiple IOT Applications connected, which in turn may be connected each other by means of direct communications with IOT Devices, Dashboards, and Virtual IOT Devices, Sensors/Actuators.

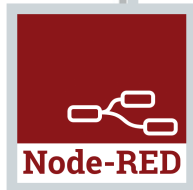
Snap4City has contributed to Node-RED community with Snap4City libraries of MicroServices/nodes that can be directly downloaded/installed in your Node-RED from official palette Library. They enable the creation of Snap4City IOT Applications exploiting **Snap4City MicroServices for:**

- **IOT Device Discovery**, connection, registration to IOT Directory independently on their protocols, brokers and formats, in connection with the Knowledge Base managing the whole city knowledge; thus, providing support for easily integrating IOT Edge, brokers, devices, gateways, buttons, actuators;
- **Exploiting Smart City API** to (i) provide answers to semantic queries on Knowledge Base: search by text, search for services close to a GPS coordinates,

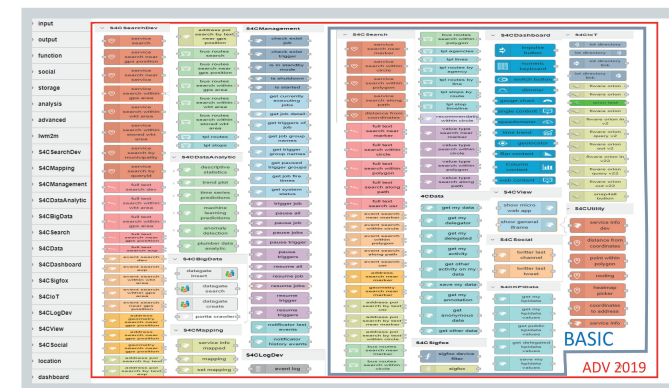
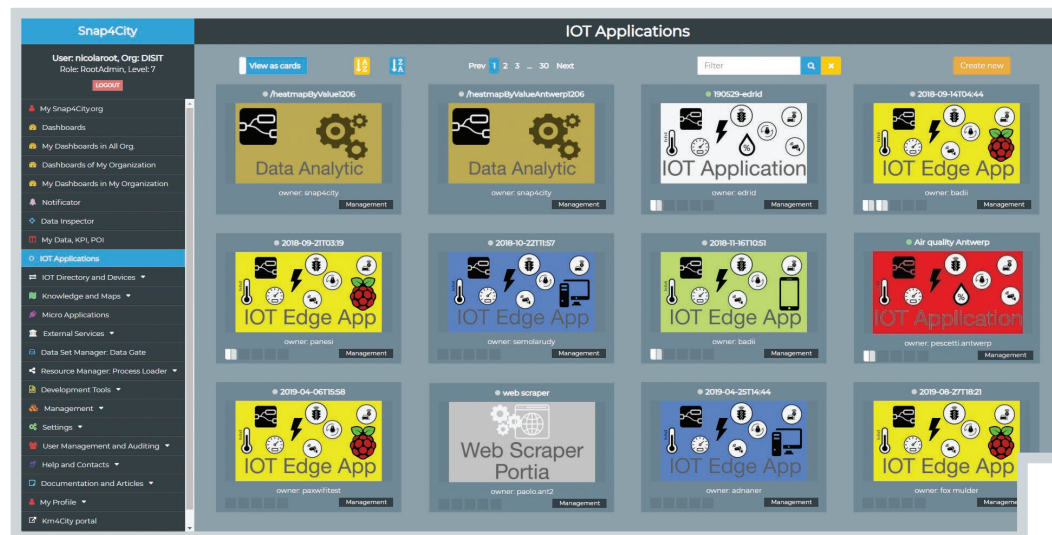


along path, in areas, and by relationships among city entities and time; (ii) provide suggestions and recommendations; (iii) perform routing, multimodal routing, constrained routing; (iv) inspecting data from public transportation; (v) exploiting smart services of the city (smart parking, weather forecast, bike sharing, pollution, pollination, etc.), etc., as described for the Advanced Smart City API;

- **Big data storage** save and retrieval: Big Data storage, time series and historical data storage;
- **Personal data:** MyKPI, personal key performance indicator (Trajectories, tracks of vehicles from OBD2, and mobiles Apps, etc.), My Personal Data storage for personal data and private KPI; all according to GDPR;
- **Data Analytics exploitation/activation** such as computing: prediction, anomaly detection, correlations, optimization of resources, social context analysis and meaning of the city data, regression, clustering, trajectories, machine learning, early warning, routing, etc.; Data Analytics processes can be implemented in R Studio as well as in other languages such as Python, Java,...;
- **Dashboard** connections and exploitation with a large range of graphic representations and functionalities as described above. They include Widget for showing data flow coming from the IOT Applications, as well as graphic Widget as Button, KeyPad, Switches, etc., to send data into the IOT Applications, via event driven messages;

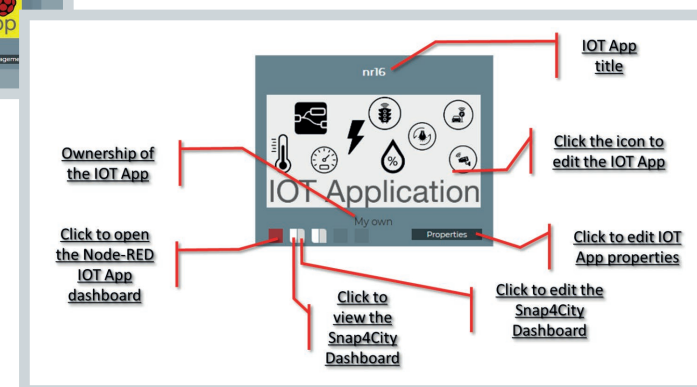






<https://flows.nodered.org/search?term=snap4city>

- **Events from the city:** collecting events of mobility, entertainment events, CAP events, events from operators with mobile Apps, etc.;
- **Notificator** of the Dashboard to implement sophisticated actions and flows on the basis of critical events detected on KPI and dashboards;
- **MicroApplications** are HTML5 functionalities ready to be used for Web and Mobile Apps of Snap4City and Km4City which can be exploited in Dashboard, in IOT Applications, as Macros;
- **MicroServices from Rest Call API**, to invoke and exploit external services of city stakeholders calling rest API, Web Services and other protocols;
- **Creating and Publishing data sets** on DataGate\CKAN portal. This approach allows the possibility of performing automated open data exchange with multiple cities and repositories, using different protocols;
- **Sending notifications** via: Telegram, SMS, email, Facebook, etc.;
- **GeoUtilities:** checking if GPS point are included into areas, computing distance between GPS points, geo-reversing passing from points to city elements and vice-versa, getting values from heatmaps.
- **And many other MicroServices such as:** Social Media interaction, several IOT protocols for devices, WFS connection, etc. The list of MicroServices for Node-RED is every day increased by the large community of contributors.



In Snap4City, IOT Applications can be easily created and are allocated on cloud as well as on your IOT Edge device (Raspberry, PC, Android, etc.). Each user may create several flows/Applications for each IOT Application/Node-RED. Developers have access to a wide library of MicroServices also including services for controlling jobs in the back office, managing event logs, managing notifications of the Dashboards to implement sophisticated actions and flows on the basis of critical events detected on KPI, personal data, sensors, and dashboards.

## ADVANCED SMART CITY API, MICROSERVICES, SNAP4CITY API

Snap4City framework provides a rich set of Advanced Smart City APIs, which can be used to develop Web and Mobile Apps and provides support to:

- **search data:** by text, near, along line, POI, resolving text to GPS and formal city nodes model, resolving from GPS to street civic number, etc.;
- **get information of services** in the territory such as: mobility and transport, cultural and tourism, e-health, public transportation, environment, weather, commercial, etc.;
- **get info on mobility** such as: pedestrian and car routing, multimodal routing, navigation in critical conditions, bike cycling paths, parking status, bike rack status, bike/car sharing, public transportation operator services: paths and timelines, ..;
- **obtain predictions**, for example on parking status, first aid status, traffic flow, people flow, social events, weather, temperature, environment data, etc.;
- **provide information to the city:** ranking, comments, images, feedback to direct questions (open and closed);
- **receiving notifications and alerts**, for example: alerts of civil protection, events of traffic, connected guide V2V and V2I, OBD2 errors, etc. The users on the move can subscribe on the notifications to receive alerts about a large range of events or when some data overcome the official warning level;
- **getting heatmaps**, for example on environmental parameters, weather, hot places, environmental predictions, traffic accidents, etc.;
- **getting suggestions**, assistance, incentives to a more virtuous behaviour.

Snap4City also provides via API a number of **MicroApplications** and corresponding API derived from the Advanced Smart City API which can be directly



embedded into Dashboards of any kind, and activated from IOT Applications Dashboards.

Snap4City provides via API: (i) a number of **MicroApplications** and corresponding APIs derived from the Advanced Smart City API which can be directly embedded into Dashboards of any kind, and activated from IOT Applications Dashboards, (ii) data via WFS and WMS protocols of GIS kind of applications.

Snap4City also includes **internal APIs** to interoperate with legacy solutions and among its modules, those for: GIS with WFS/WMS data exchange, heatmap loading, IOT Device Registration, process management and scheduling, notification and alert management, resource management, inter module communications, data analytics, etc. The whole set of APIs is documented in Swagger and it is public accessible.

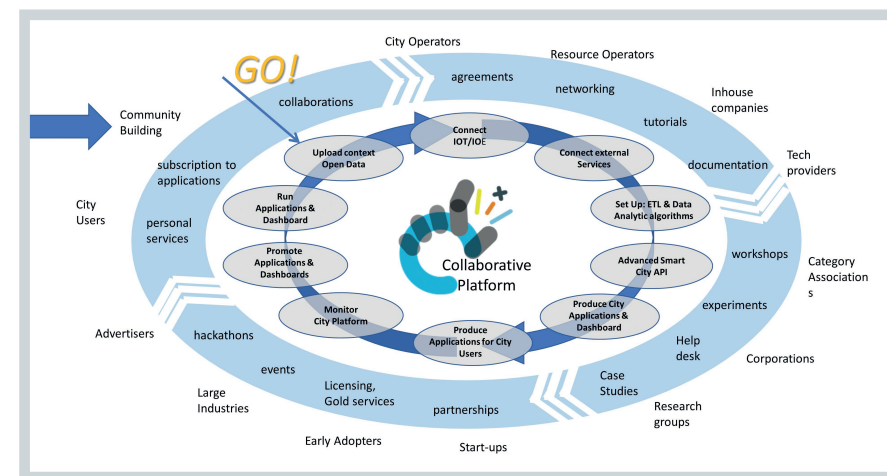


## SNAP4CITY LIVING LAB FOR COLLABORATIVE WORK

Snap4City has been developed with the aim of creating a tool for **Living Lab**, which should offer a citizen centric environment for collaborative development of smart solutions for the city. To this end, Snap4City provides a set of tools and methods which can be used by the Living Lab users to create a wide range of applications exploiting heterogeneous data and stakeholder services enabled by IOT/IOE technologies and Big Data analytic with limited effort. To this end, Snap4City has followed requirements and needs of several kinds of Organizations (ENOLL, Snap4Cities, EIP, Universities, SME and Large Industries, Public Administrations, also in the context of Select4Cities PCP of Helsinki, Copenhagen and Antwerp), end-users (City Operators, ICT Operators, Inhouse companies, Tech providers, Category Associations, Corporations, Research groups, Start-ups, Early Adopters, Large Industries, Advertisers, City users, Community builders, etc.), thus reflecting concepts of the Quadruple Helix, to facilitate the proactive and collaborative work in a Smart City community.

Thus, Snap4City has been designed to stimulate and follow the city evolution in terms of services, city users' needs and capabilities, and to support the setup and management of **Living Labs** by means of a set of tools and models for:

- **co-creation** of solutions, applications, and dashboards;
- **providing multiple methods** for data collection, IOT device registration, data analytics, creation of applications, creation of dashboards, data exchange, interoperability with legacy solutions, etc;
- **enabling users** covering different roles accessing to different kind of tools and data according to their role and specific delegations;
- **supporting the users** in the development process, engaging them in the



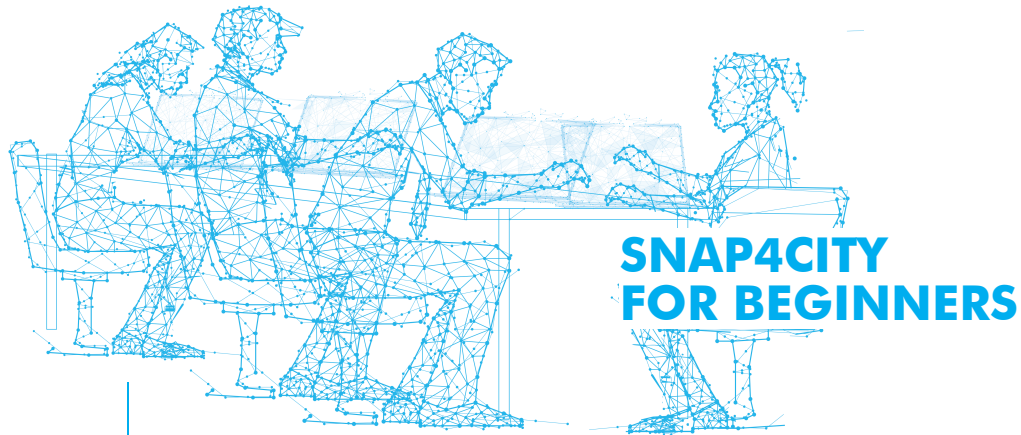
process, providing self-assessment and tutorials, supporting collaborative work on several tools;

- **training users** in conquering progresses towards the platform awareness and production of complex solutions, providing help desk and presenting effective SLA.
- The innovative aspects of the Snap4City, as open platform, and as Smart City IOT as a Service platform, are related to facility by which users can co-create each other smart Applications, Dashboards, IOT Devices, IOT Applications, and may share artefacts and experiences, concentrating their effort on the value of the results rather than on the technical aspects. During training courses of summer 2019, the speed up with respect to state-of-the-art solutions has been estimated of 7 times for Dashboards and 5 times for IOT Applications. So that different kinds of city users, from final users to students, from industries to researchers may find in Snap4City tools the needed easiness, innovations, flexibility, capabilities and facility of usage since all of them are profiled and the solution is tuned to satisfy the different kinds of users.

Snap4City has been designed in response to the Select4Cities PCP call issued by Helsinki, Antwerp and Copenhagen, and satisfies all the requirements requested by an urban platform for IOT/IOE smart city living labs, as those identified by Select4Cities and by ENOLL. Snap4City is a winner of the Select4Cities PCP challenge.

**SELECT**  
for Cities





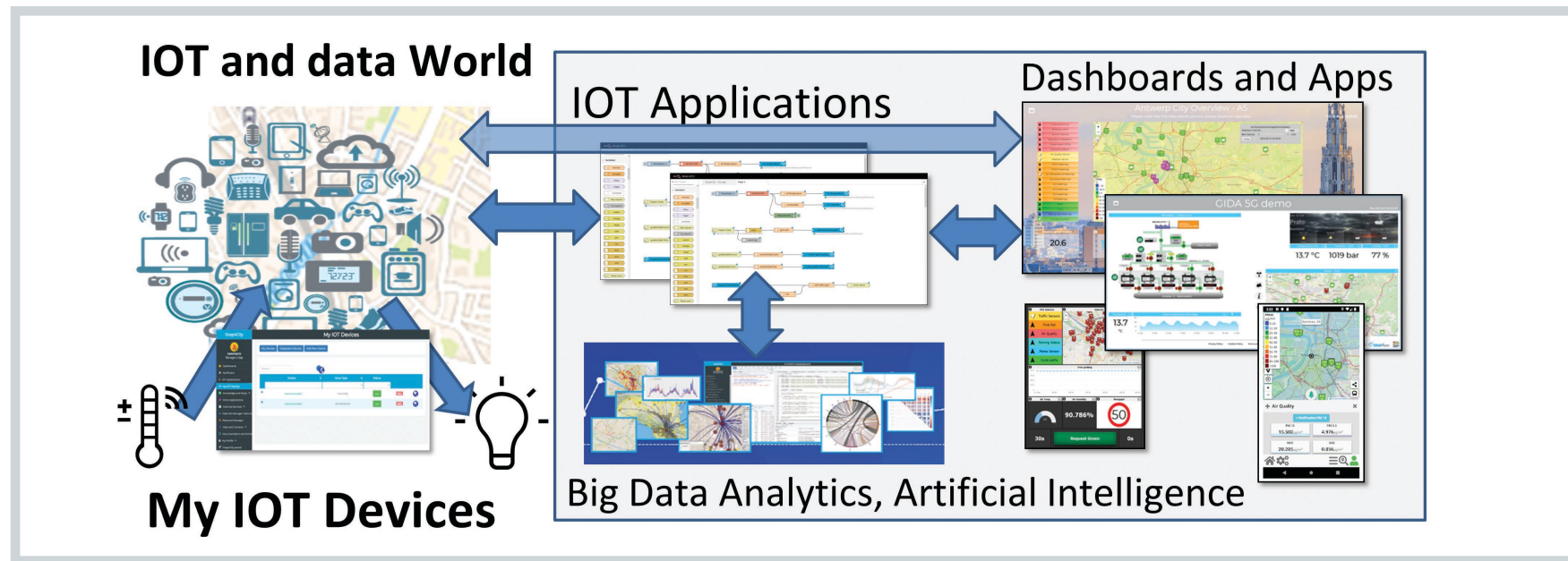
Snap4City empowers and engages city users and developers in contributing to the evolution and improvement of city services. Developers can come from research institutions, and city stakeholders. The platform is accessible on the web for users, developers, operators, city leaders, researchers, and stakeholders; where they can access and share data, design of IOT devices, example of experiences, resources, and can contribute at discussions, accessing to help desk, workshops and meetings, data analytic, processes, IOT Applications, etc. All accessible into the Resource Manager of Snap4City.

Snap4City users can create and share Applications with Dashboards (user interface) exploiting city data and IOT network/devices, and also adding their own devices (to follow the dog, to open the doors, to get alarm from grandma, to monitor the temperature of the garage, etc.). Then, they can manage and share their private data and IOT Devices, to create IOT Applications and dashboards for personal use and shared with their friends only. So that, they can start creating data applications

with graphics, exploiting accessible data, for passing to create sophisticated IOT Applications capable to react to events in real time, to manage their life and/or small business, exploiting a large range of MicroServices. For this purpose, Snap4City users have access to an integrated environment with visual editors for all the activities, on line help, tutorials, and videos for training. According to this approach, the Snap4City users can develop their IOT Applications and may public and share them with other users. Snap4City tools provide facilities for collaborative work and for sharing data, dashboard, IOT Applications, MicroServices, etc., via the Resource Manager, that is a market place for smart city resources.

See for training: <https://www.snap4city.org/drupal/node/108>

All the mechanisms have been validated during Snap4City Hackathon 2019 in which a large number of teams in Europe have created applications for Antwerp and Helsinki: mobile apps, IO Applications, Dashboards, etc. The results are available on the portal.



Snap4City users are stimulated to pass at the next levels to arrive at the end at developing sophisticated solutions for private/public usage, including:

- **creating dashboards** exploiting data of the city and personal data also collectable from their mobile devices, and personal IOT devices;
- **using IOT Applications**, enforcing intelligence, data transformation and logic of dashboards, by exploiting MicroServices and external or legacy rest API call;
- **registering IOT Devices** with simple or complex set of data values to be transmitted to the platform;
- **providing data** by creating processes of ingestion/transformation via visual editors and tools;

- **creating automated processes**, data driven applications, that on the basis of data, data analysis, commands from the dashboard, can react and provide services to users and customers.
- **developing Data Analytics processes** for producing predictions, anomaly detection, optimization, decision support, correlations, etc., in R Studio, Java, Python, etc., and also using Tensor Flow. The Data Analytics processes can become MicroServices for IOT Applications, and additional features of the Advanced Smart City API;
- **developing Web and Mobile Apps** using Advanced Smart City API, starting from the development tool kit available in source code.

## DATA ANALYTICS, BUSINESS INTELLIGENCE, WHAT-IF AND SIMULATION



- Snap4City has been designed to help the city in setting up a Smart City in a sustainable manner by stimulating the contributions of developers from stakeholders: researchers, SME, developers, operators, and makers, which can collaborate each other in a participatory community to create new idea and solutions, and not only demands. In Snap4City, different kinds of developers may cohabit and found suitable tools for developing, distributing and publishing, sharing and improving:
- data transformations processes, real-time streams;
- IOT Device registration and data collection;
- IOT applications to transform data in value and services;
- data analytics processes for creating smart solutions and making them accessible for the community, by using the Snap4City development environment and

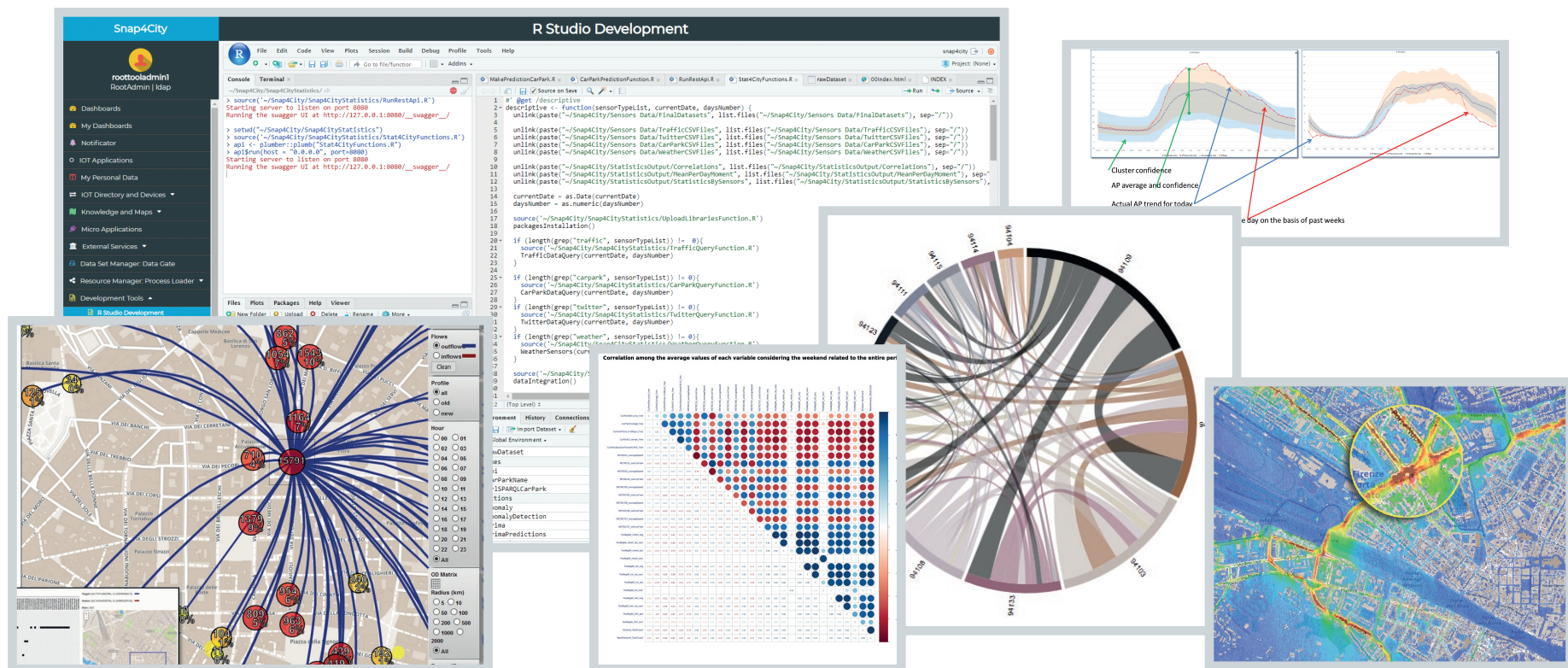
languages such as: R Studio, Java, ETL, Node-RED, Python, etc.;

- services from legacy services or that can be created by Data Analytics processes for example for: predictions, anomaly detection, early warning, identification of correlations, etc.

Among the several data analytics and business intelligence processes those for computing:

- IOT data analysis for quality assessment and problem detection,
- predictions and anomaly detection, events and critical events,
- origin destination matrices from Mobile data, WiFi Data, traffic data, ..
- user behavior trajectories, heatmap, user presences in the city and hot places,
- traffic flow reconstruction, traffic flow predictions,





- parking prediction for smart parking,
- bike sharing predictions and optimization,
- environmental particles predictions and diffusion in the city,
- offer of transportation vs mobility demand analysis,
- public and private transportation, offer and demand analyses,
- risk and resilience analyses,
- heatmap production for environment, accidents, hot places, bike safe, ..
- Air Quality Indexes estimations and heatmaps, EAQI, CAQI, AQI, ..
- social media analyses, sentiment analysis, event audience predictions,
- WHAT-IF analysis and simulations,
- user behavior analysis, user engagement for sustainable mobility,

- Early warning and alerting,
- Fleet management with OBD2 data, eco-guide,
- People flow analysis from People flow Counters,
- maintenance prediction and costs predictions,
- routing, multimodal routing, constrained routing, dynamic routing,
- Etc.

Snap4City developers are typically specialized, for example on: data ingestion, mobiles app, IOT applications, IOT networks/devices, data analytics, and/or integrated dashboards.

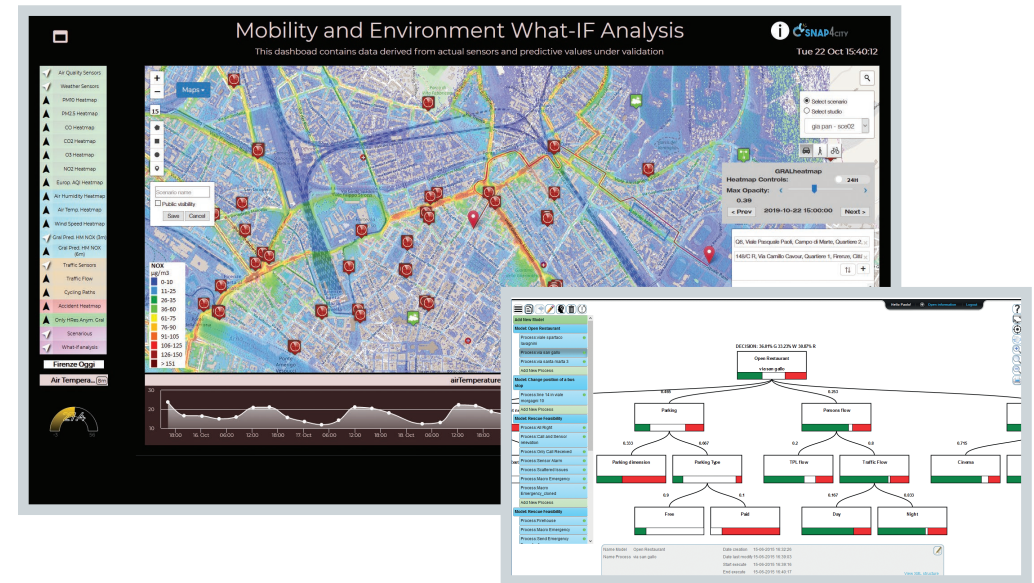
## DECISION SUPPORT SYSTEM, WHAT-IF ANALYSIS AND CITY RESILIENCE

Cities are engaged in keeping under control the quality of services, managing risks and planning events/strategies with: adapted transportation plans and intelligent transport systems, scheduling the usage of resource for security, waste collection, restricted traffic zone management, etc.

The City Dashboards may be used for the detection/evidence of critical cases since their inception, including the monitoring of any planned scenarios. City Dashboards can be regarded as **Decision Support Systems**, DSS, during preparation, event detection and phase for recovering from a critical event. For this reason, it is very important to properly design the Dashboards for the normal operating conditions which can be the basis for the early detection of the inception of critical conditions/cases, for example with anomaly detection algorithms.

Instrumented Smart Cities are quite efficient in collecting data on multiple domains: mobility, transport, health, people flow and city user behaviour, environment, weather, etc., and are less effective in putting in place:

- data analytics solutions transforming data in value and actions such as those of

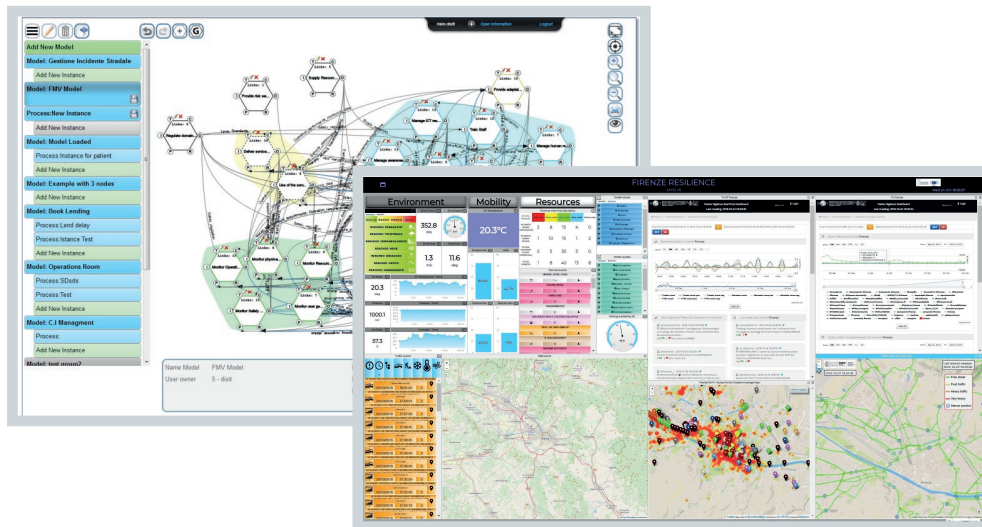


early warning, anomaly detection, predictions, and what-if analysis;

- strategies for reducing the impact of disasters independently on the planned risks, fast recovering, including: people evacuation, public transportation re-scheduling, simulation of the cascade effects of possible decisions, simulation of the effect of the planned changed in transportation and viability.

In fact, decision makers are frequently queried to decide at the last minute about unexpected unknown on: mobility and transportation changes, city shape and routing, dates for public works, changing strategies for lighting streets, opening commercial activities in a given area, performing welfare actions and services, interventions in the city, etc. Most of these decisions need to be grounded on data assessment, expert consultation, and should be more data driven.

**SmartDS** is a Smart DSS, based on the evolution of the Analytical Hierarchical Process model (which support System Thinking model), which has been integrated with the Italian Flag 3-values logic representation also into Dashboards to have updated in real time. It is substance a sophisticated Bayesian network model from



RESOLUTE H2020 of the European Commission, coordinated by DISIT lab, and based on Km4City and big data analytics, developed European Guidelines for the Resilience of critical infrastructures in the cities with a special care to the transport systems since it is the most relevant city infrastructure. Since it is used by rescue teams, but also is used to propagate problems (a broken bridge or closed street may create cascade effects in other parts of the city). In this context, in Florence, an infrastructure and resilience monitoring by dashboard have been realized and it is at disposal of Decision Makers, Major, Critical Infrastructure managers, Civil Protection, etc.

cause and effect which can help decision maker to assess probability of success. The adoption of shared DSS allows minimizing the discretionarily of the decision, making the model shared with other decision makers, and making the decision also grounded on updated data coming, thus reducing the disputes since the assessment model has been collaboratively built.

The shift to paradigm of **Resilience** suggests cities to become prepared to react to the so-called unexpected unknowns that may be due to natural and non-natural disaster. Cities present a number of interconnected critical infrastructures such as: transportation network, communication network, energy network, water network, hospitals, etc. In most cases, the failure of one of them in a part of a city may provoke failure of other connected infrastructure. For example, the lack of energy may create problems in communication and rescue teams.

**Resilient** cities have to be capable to continuously adapt the operational capabilities to persecute system intention/purpose, the quality of life for their city users. A city may present a number of interdependent sub-systems. Effects of unexpected critical

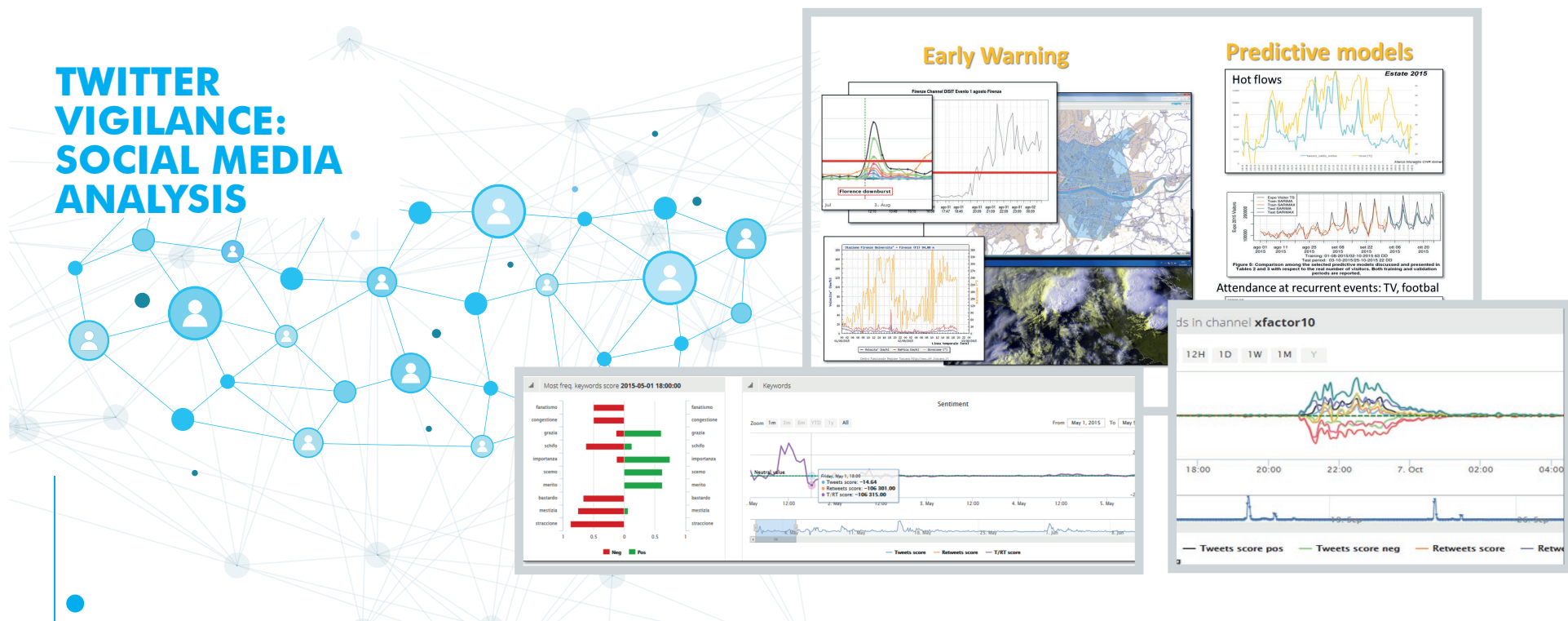
events triggered by climate changes or manmade behaviour can be propagated in the city with unpredictable dynamics and damages. Resilience analysis and assessment aims to tackle the challenges of the uncertainty and interdependency expanding and integrating the current Risk Management approach, usually based on known threats.

The aim of a Resilience Decision Support, **ResilienceDS**, is to support decisions at strategic, tactic and operational levels to assess and develop sustained adaptability capacity: to be effective during the preparation, plan, absorption, recovering and adapting phases. The main core of the ResilienceDS tool is based and extend the Functional Resonance Analysis Method (FRAM).

**ResilienceDS** is a visual tool for system resilience modelling and risk focuses on modeling and analysing system interdependencies, their dynamics, relationships and complexity; taking into account of the effective available resources in real time.



## TWITTER VIGILANCE: SOCIAL MEDIA ANALYSIS



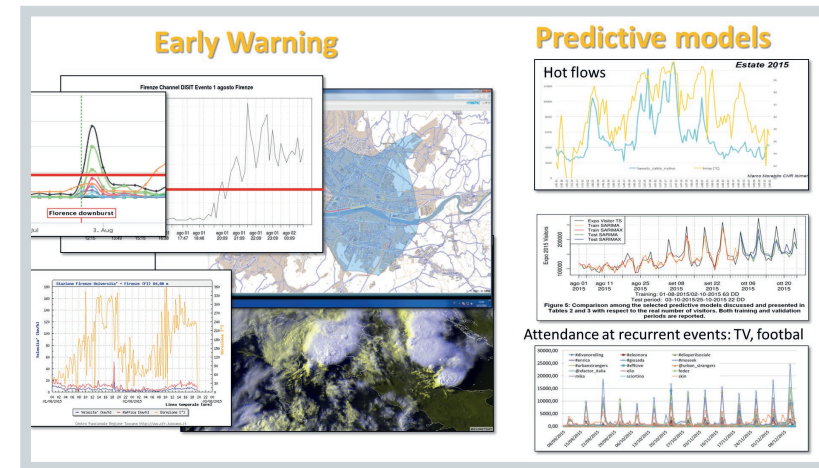
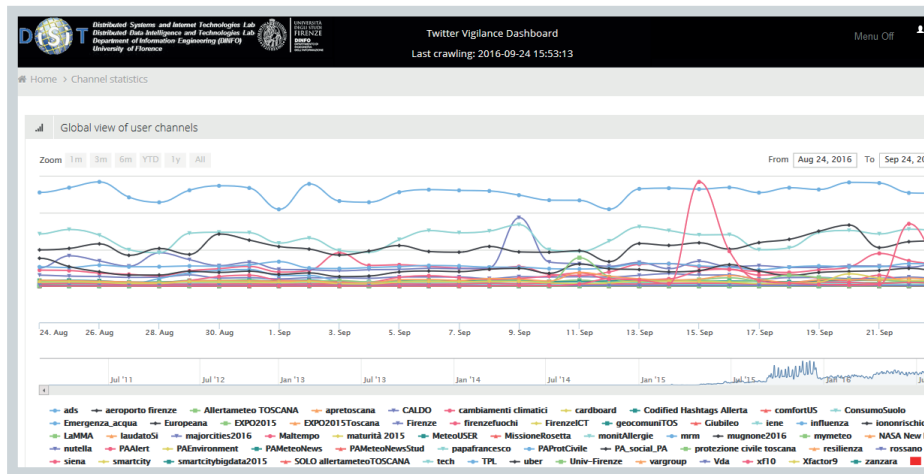
Social Media channels are sources of information for: assessing moods of city users on services and environment, identifying critical events at their inception, predicting audience at large events, communicating with the city users, creating early warning, etc. Among the several social media platforms, Twitter is probably one of the most reactive in terms of velocity and has been successfully used for the early detection of critical events in the cities.

**Twitter Vigilance, TV** (<http://www.disit.org/tv>) is a multi-user tool for Twitter analysis in real time and offline. Twitter Vigilance is capable to monitor and analyse slow and explosive events with high precision.

Twitter Vigilance ensures the collection of 98% of tweets/retweets referred to events by providing the yield and precision. Twitter Vigilance provides adaptive algorithms to allow effectively cope with slow events that become explosive without losses,

acquiring all tweets and retweets. **Twitter Vigilance Real Time** (<http://www.disit.org/rthv>) is used for monitoring events in real time and provide Twitter flow data also computing sentiment orientation in real time, permitting the setup of alerts on specific detector, also suggested.

Twitter Vigilance analysis is provided in terms of a large number of metrics. For example, regarding volume of tweets, retweets, ratio, natural languages processing, sentiment analysis, etc., and their compositions for tags, citations, channels. Twitter Vigilance solutions has been demonstrated to be effective in predicting audience to recurrent events with 97% of precision, virality with more than the 90% of precision, and the motivation of positive/negative sentiment regarding services and events with more than the 85% of precision.



In Florence and Tuscany, Twitter Vigilance is adopted by Florence Municipality, by LAM-MA agency for monitoring weather aspects (weather alerts, hot waves, early warning); by Sii- Mobility for assessing mobility and transport services of several agencies. In RESOLUTE, it has been used at the basis of the resilience dashboard of Florence city.

**Twitter Vigilance daily and Real Time** tools with its NLP and SA metrics can be used to:

- participatory analysis and stimulus;
- discover and evaluate new trends;
- discover and stimulate influencer;
- early detection of events;
- predictive audience assessment;
- assessments of service acceptance;
- marketing and communication;
- penetration of city information;
- assessing appreciation of decisions;
- assessing security perception.

Twitter Vigilance assessments and evaluations are relevant metrics in the estimation of early warning and in the detection of anomalies; and put results at disposal of decision makers in real time; and are exploited in SmartDS, monitored on City Dashboards, accessible from Data Analytics and as MicroServices.



## SNAP4CITY AND KM4CITY PROJECTS



European  
Commission

Horizon 2020  
European Union funding  
for Research & Innovation

### Snap4City - (<https://www.snap4city.org>)

### Select4Cities - (<http://www.select4cities.eu>)

Snap4City is an open, standardized, data-driven, service-oriented, user-centric platform enabling large-scale co-creation IOT/IOE applications. Snap4City is a fully open source, robust, scalable, easy to use solution, provides tools for co-creation of mixt data driven, stream and batch processing, extending the powerful semantic reasoner of Km4City <https://www.km4city.org>, with IOT/IOE, GDPR, and city dashboards.

Snap4City has been developed in response to Select4Cities PCP on top of former technologies and tools of DISIT Lab, University of Milano and Snap4 srl.



### Sii-Mobility - (<http://www.sii-mobility.org>)

- advanced mobility and transport services
- connected drive and participatory actions
- experimentation and validation in Tuscany
- integration with present central station and subsystems

DISIT Lab, University of Florence, is the technical-scientific coordinator



European  
Commission

Horizon 2020  
European Union funding  
for Research & Innovation

### Replicate - (<https://replicate-project.eu/>)

- To 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.

Comune di Firenze is managing the activity in the area of Florence.





Co-financed by the Connecting Europe  
Facility of the European Union

## TRAFAIR - (<http://trafair.eu/>)

- for the analysis of traffic impact on environment, with Univ. of Modena, Univ. of Florence, several cities and regions in Europe, founded by EC. University of Modena (Project coordinator)



## MOSAiC - (<http://mobility4smartcity.eu/>)

- for the computing of mobility strategies and tools by using big data techniques, Funded by Regione Toscana, ALSTOM, research centers, and industries. ALSTOM (Project coordinator)



Ministero dello  
sviluppo economico

## 5G

- to equip Italy with the 5th-generation mobile technologies, piloting innovative services in many fields, from health to energy, from automotive to industry 4.0 and security. Wind/3 - Open Fiber (Project coordinator)



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



[www.lifeweee.eu](http://www.lifeweee.eu)



**LAI Smart Bed**



Other Projects contributing and/or exploiting Km4City and/or Snap4City

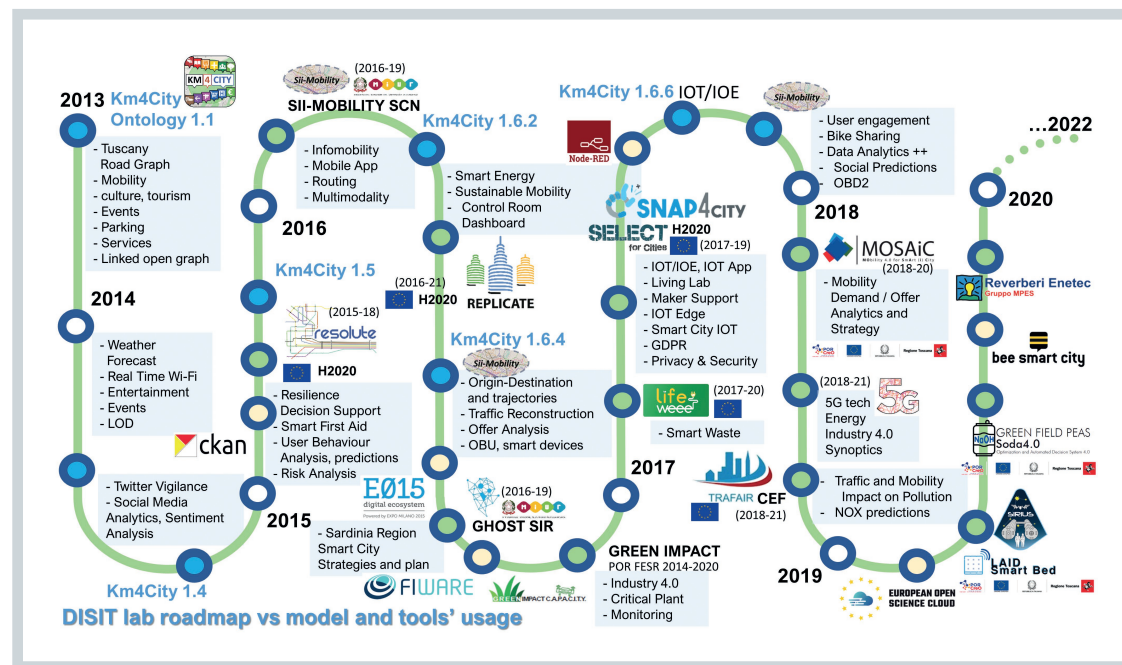
- **Metropolitan city of Florence** in its strategic plan;
- **FEEDBACK**: innovation of CRM-retail, to evolve towards a new generation of advanced user profiling products for adaptive and personalized user engagement.
- **LAI Smart Bed**: advanced integrated platform for evaluating the quality of sleep in the general population and extreme environments.
- **Green Field Peas - SODA4.0**: development of a Real Time Optimization system for optimization and assisted automatic production control in a chemical plant.
- **Ghost** (<http://sites.unica.it/ghost>): to offer a comprehensive framework for measuring and reassessing urban smart development and related ranking.
- **Smart Garda Lake**: as main technical smartening engine, supported by a large number of Municipalities in the Garda Lake area.
- **RESOLUTE** (<http://www.resolute-eu.org>): Develop European Resilience Management Guidelines (ERMG) and enhance resilience
- **LIFE WEEE European Commission**: strategies and tools for sustainable waste collection, supported by EC; Regione Toscana, Chamber of Commerce, etc.
- **Destination Florence** (City of Florence and chamber of Commerce): exploiting Km4City Dashboards.
- **First Lab**, CoWorking lab, Founded by Univ. Firenze, ECR Firenze, HP, VAR, etc.

## HOW TO ADOPT SNAP4CITY, AND OUR ROADMAP

Snap4City platform can be used from its portal, and a number of services can be provided as Smart City IOT as a Service, SCLaaS, platform, see also EOSC marketplace. Therefore, if you are interested in testing Snap4City you do not need to perform any installation on your computer.

On the other hand, Snap4City can be installed on premise and for this we provide examples with a number of configurations. Snap4City is 100% open source, license free solution, and the Appliances that you can download from Snap4City portal are license free. You can download and install Snap4City tools on premise or on cloud as you like, by starting from the Appliances and/or from the GITHUB/DISIT sources (Source Code and licenses). In <https://www.snap4city.org/drupal/node/471> you can find the configurations and the recipes for the implementation of Virtual Machine or Containers, on the other hand, mixed solutions may be viable as well.

For shortening time of your deploy and/or installation activities, Snap4City has created a number of Virtual Machines, VM/Container, Appliances. For example, in order to install on your premise Snap4City minimal tools, you need to download, and configure only a single VM, which includes: dashboard builder and engine, IOT Directory, registration of users, MyKPY, custom widget and dashboards, ownership manager, IOT Application, data inspector, notifiator, Resource Manager, micro applications, etc. Once downloaded and decompressed it can be put in execution on your premise in 5 minutes by following the instructions. The first page of Snap4City <https://www.snap4city.org> includes a guided tour on Snap4City for beginners and the access to test cases, examples, blogs, video,



tutorial, a large range of examples, etc. Snap4City team is at your disposal if you need help for the setup, installation, customization, further development, and training; as well as for providing you accesses to the Snap4City, Smart City IOT as a Service on cloud, SCLaaS. You may start using Snap4City in cloud and then request to migrate your data on your premise or on some public cloud under your control.

Snap4City is a continuously developing solution with many partners, groups and contributing projects. This means that if you have the needs to access to a new feature please ask to the coordinator <https://www.snap4city.org/drupal/contact> or post a question on <https://www.snap4city.org/drupal/node/5> to know if the activities of your interest have been already started. We will put you in contact with eventual groups working on the topics of your interest. Some of them are also contributing on the blogs of the portal.

Snap4City roadmap sees our team involved in a number of activities for the next years. The roadmap reported in the figure, also depicts how we reached the present level of Snap4City by starting with Km4City aggregator.

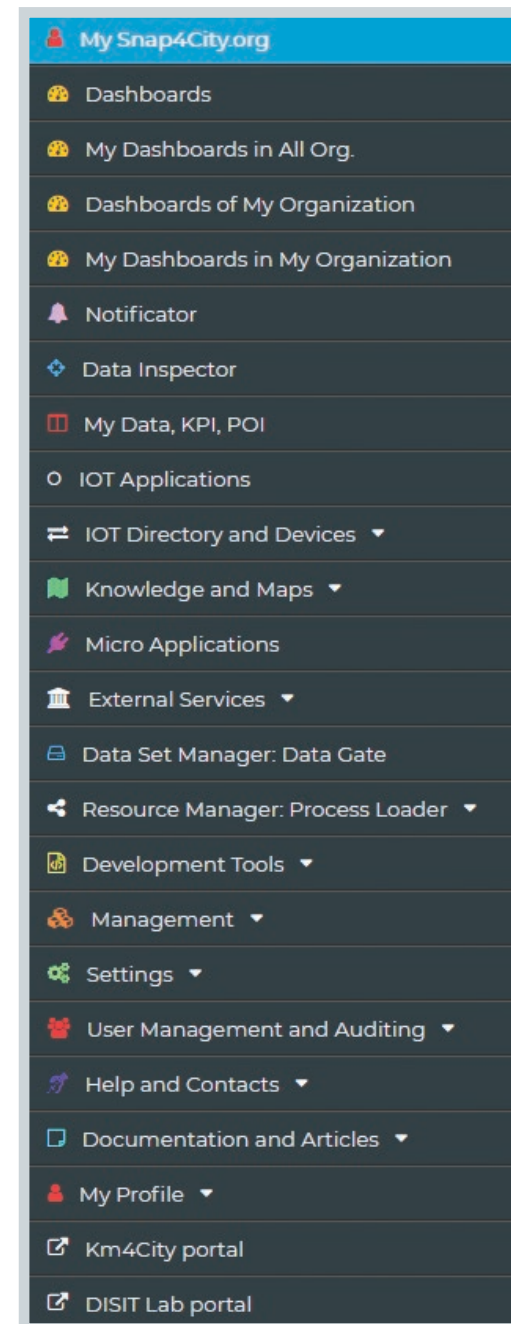
## SNAP4CITY THE VIEW OF THE ADMINISTRATORS

The full power of Snap4City ecosystem is in the hands of General Administrator that may control the all the tiny details regarding the infrastructure:

- Dashboards and system dashboards, notifications;
- Data Inspector for data management and data healthiness;
- IOT Applications on cloud and on IOT Edges;
- IOT Directory, IOT Devices, Edge, Gateways and Brokers;
- Knowledge and Maps, annotations, mappings, Micro Applications from Smart City API;
- External Services provided by legacy and third parties web servers;
- Data Sets Management (CKAN connected, for data ingestion and data share);
- Resource Management and sharing of: data, IOT Applications, libraries, ETL Processes, Data Analytics processes, data results, processes scheduler, heatmaps, etc.;
- Development Tools for developing and managing: ETL processes, R Studio, API documentation, source code access, smart city APIs, testing in Postman;
- Management: IOT traffic analyser, container management, cloud management, web server monitoring, Notificator monitoring, mobile applications management, Smart Decision Support, Resilience Decision Support, management of contributions from App, monitoring user engagement from App, monitoring on App questionnaires, etc.;
- Setting of details regarding dashboards and IOT directory;
- User Management and Auditing including GDPR aspects, change of ownerships, user engagement rules and reporting;
- Helps and Contacts including help desk and FAQ;
- Documentation and Articles including test cases, exercises, experiences, etc.;
- Snap4City Portal with all the documentation and co-working support, blogs, full search in the whole documentation, etc.

From the General Administrator and the Area Manager a number of intermediate roles can be configured according to your needs and to have even full control to specific tools as Tool Administrator.

If you are interested in setting up a full version of the Snap4City solution the first step is to ask for a demonstration at the Administrative level.





## ● Co-founding institutions on projects



Regione Toscana



## ● Qualified Partners



Comune di Modena



REGIONE AUTONOMA DE SARDIGNA  
REGIONE AUTONOMA DELLA SARDEGNA



Reverberi Enetec  
Gruppo MPES



Universidad  
Zaragoza



National Research Council of Italy

## ● Technical Partnerships

Powered by  FIWARE



With the support of

## ● Marketplaces



EUROPEAN OPEN  
SCIENCE CLOUD



Powered by EXPO MILANO 2015



## ● SCENARIOS

- Multipurpose User Engagement Tools  
<https://www.snap4city.org/548>
- 5G Enabled Water Cleaning Control  
<https://www.snap4city.org/547>
- High Level Control of Industrial Plant  
<https://www.snap4city.org/546>
- Antwerp Pilot on Environmental Data  
<https://www.snap4city.org/526>
- Events and Museums Monitoring  
<https://www.snap4city.org/532>
- Antwerp Pilot on User Behaviour  
<https://www.snap4city.org/527>
- People Flow Analysis  
<https://www.snap4city.org/540>
- Firenze Smart City Control Room  
<https://www.snap4city.org/531>

- Helsinki Pilot on Environmental Data  
<https://www.snap4city.org/528>
- Helsinki Pilot on User Behaviour  
<https://www.snap4city.org/529>
- Vehicle Monitoring via OBD2  
<https://www.snap4city.org/545>
- Origin Destination Matrices  
<https://www.snap4city.org/544>
- Mobile & Web App: Toscana Where What ... Km4City, Toscana in a Snap  
<https://www.snap4city.org/541>
- Mobility and Transport Analyses  
<https://www.snap4city.org/533>
- High Resolution Prediction of Environmental Data  
<https://www.snap4city.org/530>
- Multipurpose User Engagement Tools  
<https://www.snap4city.org/548>

## ● DATA ANALYTICS

- Origin Destination Matrices, Algorithms and tools  
<https://www.snap4city.org/544>
- Traffic Flow Reconstruction  
<https://www.snap4city.org/543>
- Data Analytic in general, and the cases of Antwerp and Helsinki  
<https://www.snap4city.org/524>

- Predicting Air Quality  
<https://www.snap4city.org/553>
- Analyzing Public Transportation Offer wrt Mobility Demand  
<https://www.snap4city.org/554>

## ● SOLUTIONS

- Using PAX Counters, monitoring museum and events  
<https://www.snap4city.org/518>

- Selecting the less pollute routing  
<https://www.snap4city.org/517>

- Smart City Control Room Dashboards: Big Data Infrastructure, from data to decision support  
<https://www.snap4city.org/525>
- Data Analytics on Antwerp and Helsinki  
<https://www.snap4city.org/524>
- Decision Support Engines and Models: SmartDS, ResilienceDS  
<https://www.snap4city.org/520>
- IPCAM on Dashboard Widget, Video Cameras  
<https://www.snap4city.org/519>
- Data Flow Management and Visual Analytic for Big Data Smart City/IOT  
<https://www.snap4city.org/512>

- Dashboards Touch Screen Support for Situation Rooms and What-if analysis Operators  
<https://www.snap4city.org/511>
- Snap4City on Social Media  
<https://www.snap4city.org/529>
- AIRQino: Compact low-cost air quality monitoring station, by CNR IBIE  
<https://www.snap4city.org/508>
- Security, Privacy and GDPR Aspects of Snap4City  
<https://www.snap4city.org/549>
- How to: Develop Smart Applications, Snap4City development Life Cycle  
<https://www.snap4city.org/542>

[www.snap4city.org](https://www.snap4city.org)



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**DISIT**  
DISTRIBUTED SYSTEMS  
AND INTERNET  
TECHNOLOGIES LAB



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